Tandem Loading Guidelines

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London Office:
6th Floor East, Portland House, Bressenden Place, London, SW1E 5BH
Tel: 020 7802 2400 Fax: 020 7802 2401

Aberdeen Office:
Exchange 2, 3rd Floor, 62 Market Street, Aberdeen, AB11 5PJ
Tel: 01224 577250 Fax: 01224 577251

Email: info@oilandgasuk.co.uk
Website: www.oilandgasuk.co.uk

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1. Introduction

1.1 Purpose & Application

The purpose of this document is to provide guidelines to operators of FPSOs and FSUs, and tanker owners, with regard to best practice to be adopted for tandem offtake by tanker. The document is aimed primarily at UK Continental Shelf operations but may be adopted by other regimes where this guidance does not contravene any local regulations.

This document outlines the best practice to be adopted in tandem offtake activities by bow loading tankers from turret moored floating production and storage vessels. For activities covered by this document:

- Tandem (see *Definitions*) is considered to be where both vessels are on a similar heading in line astern at all stages of the operation. Other offtake concepts may have similar issues to those given in this document, but may also have some differences which should be carefully considered. *Appendix H* gives some non-specific guidance on other aspects that may apply
- This document specifically concerns DP and taut hawser tanker operations, and is not intended to cover operations by unmodified conventional trading tankers.
- This document may also be a useful reference for tandem offtake activities in other parts of the world.

1.2 Background

The first edition of these Guidelines was published by the then United Kingdom Offshore Operators Association, (UKOOA) in March 2002.

The upgrade of these Guidelines is to keep pace with progress in the relevant technologies, and to assimilate lessons learned and experience gathered during the last decade.

The update involved reviewing current UK practices, the implications of UK legislation, existing industry guidance and international initiatives. It was undertaken with the active participation of operators, Duty Holders, the HSE, tanker operators and marine consultants. Oil & Gas UK has noted from an investigation of incidents during the last decade that the incident rate does not appear to depend on the technical sophistication of the shuttle tanker, be it:

- DP Class 2,
- DP Class 1,
- non-DP (but specially modified for bow loading),
- DP Classed tankers operating in taut hawser (non-DP) mode.

1.3 Objective

These Guidelines are intended to help reduce the incident rate and to reduce the inherent risk of a major accident to as low as reasonably practicable (ALARP) in accordance with UK goal setting legislation.

1.4 Summary of Principal Factors

These Guidelines consider that operators and Duty Holders should concentrate on the following principal factors to reduce the risks associated with tandem offtake operations:

- Undertaking an effective conceptual risk assessment of offtake alternatives as part of the concept selection process for all future UK field developments to ensure offtake risks are ALARP.
- Ensuring that the installed hardware and software, as far as reasonably practicable, reduces the ability of a single point failure to cause a significant loss of station-keeping, or a significant loss of containment, whilst the tanker is in close proximity.
- Ensuring that failure mode effects on the tanker and the FPSO/FSU are tested and understood by the crews, as well as being theoretically analysed. This should apply to modifications as well as the original system.
- Providing appropriate guidance on the equipment failure, operational, environmental and station keeping limits, beyond which the station-keeping mode should be changed or connection abandoned.
- Providing sufficient key personnel of appropriate competence on both the FPSO/FSU and the offtake tanker.
- Ensuring the management culture is such that the FPSO/FSU's OIM and marine operators plus the tanker Master and senior DPO's are all confident that any decision to disconnect on the grounds of safety or environmental risk is fully supported by onshore management.
- Encouraging the effective sharing of information on the causes of incidents, or potential incidents, between operators and tanker managers to speed up learning and reduce the risk of repeat events.

These guidelines deal mainly with the above areas, but only in so far as they affect the risks when the two vessels are operating in close proximity to each other during offtake. Where possible Oil & Gas UK have tried to adopt or reinforce appropriate International or Industry guidance rather than develop a new conflicting set of standards.

1.5 Standards

Generic standards are given in these guidelines for critical elements of the offtake activity. These are elements on the FPSO/FSU and offtake tanker with a potential impact on safety or pollution during preparatory or connected offtake activities. Some of these elements may also be safety critical elements (SCE), as defined in the Safety Case and supporting legislation, but only if they form part of the FPSO/FSU fixed installation, and are found to be SCEs by a field specific evaluation process. The standards largely adopt existing IMO, IMCA and OCIMF guidelines.

Under UK goal setting legislation the generic guidance and standards described in this document can be varied or replaced with standards more appropriate to a specific field by any Operator or Duty Holder provided they undertake field specific risk assessments to justify ALARP within their safety case. These Guidelines are intended to focus effort on critical areas and identify typical norms to help manage UK tandem offtake operations in an acceptable manner. They

are not intended as a substitute for performing field specific risk assessments, setting field specific standards, or managing on board tanker operations in a safe manner.

The overall Oil & Gas UK scheme to manage tandem offtake risks is summarised in *Figure 1.1*.

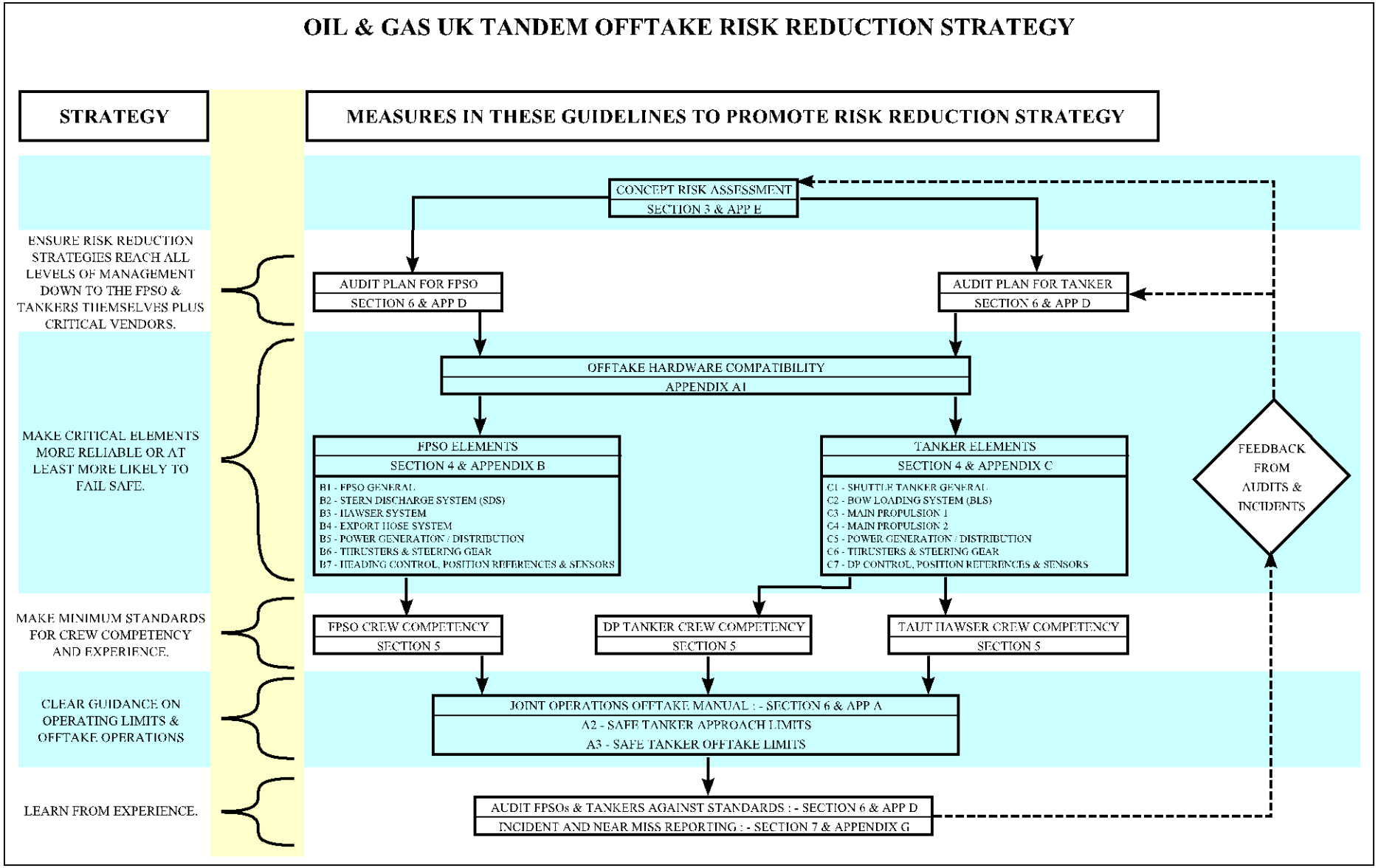

Figure 1.1: Oil & Gas UK Tandem Offtake Risk Reduction Strategy

2. Definitions and Abbreviations

2.1 Preamble

The following abbreviations and terminology are commonly used in the offshore industry and, in particular, the tanker loading and dynamic positioning fields. The objective of this section is to clarify the meaning of these terms as they are used in this document.

2.2 Definitions

Annual DP Trials

The Annual Trials is a set of system failure tests and operational tests of the DP and ancillary systems in accordance with IMCA M139. These tests should be carried out annually and witnessed by an independent 3rd party. The Classification Society is not normally defined as a 3rd party since they will have their own requirements for maintenance of DP Class.

ASD 1

Automatic Shut Down Class 1. Automatic shut down of the FPSO/FSU export pumps, and in some cases the export valve, followed by closing of the tanker coupler valve and the first loading line valve, on loss of the "Green Line". This may be expanded to be related to a position loss which reaches the yellow sector in the DP Operating Limits diagram. (See *ESD 1*)

ASD 2

Same as ASD 1 but will also include auto disconnection of the hose and hawser. (See *ESD 2*). Should an ASD system be fitted, vessels should make suitable provision for warning to be given locally, and crews to be trained to react appropriately.

BLS FMEA

Bow Loading System Failure Mode & Effect Analysis. The FMEA covers all loading related systems and should be focused on the consequences of a single point failure in this system.

DP System

All relevant shipboard equipment used for automatic positioning of the vessel including all propulsion units and their controls, both manual and automatic, power generation equipment, computer systems and all vessel heading, motion, wind and position reference systems.

DP Class 1

Describes a DP vessel where a single failure may cause loss of position, as per IMO MSC 645 guideline definition.

DP Class 1 Enhanced

Describes a DP 1 Class vessel with several improvements which minimise the risk from certain failures e.g. full pitch on a single main propeller. DP 1 Enhanced should have no more probability of Drive Off than DP Class 2, and uses the ALARP principle with respect to the practicability of conversion to address the more improbable causes of Drift Off. A Class 1 vessel which

complies with these guidelines can be considered to be Enhanced from a basic Class 1.

DP Class 2

Describes a DP vessel where a single failure of an active component of the total positioning system should not cause loss of position, as per IMO MSC 645 guideline definition.

DP FMEA

Dynamic Positioning Failure Mode & Effect Analysis. The FMEA is a document which describes the system in terms of the effects of failures of DP related components, and may also include operational limitations required to maintain station-keeping capability after such failures. The FMEA should clearly describe the theoretical worst case single failure. The FMEA is a Classification Society requirement for all DP Class 2 vessels. In this context the FMEA should also be made for any DP vessel.

ESD 1

Emergency Shut Down system – level 1. Manual activation of a single button which shuts down the pumps on the FPSO/FSU and in some cases the export valve, followed by closing of the tanker coupler valve and the first loading line valve.

ESD 2

In addition to the ESD 1 sequence, ESD 2 will also release the hose coupler claws, followed by the hawser chain stopper. This should only be possible from the tanker bridge (or other main control position) and at the cabinet in the BLS area.

Note: The ESD1 and 2 as described above may also be carried out automatically, as per the ASD descriptions. However, operators should be aware that the terminology “Auto ESD” will more commonly be used on a UK installation to describe this automatic function.

FSOG

Field Specific Operating Guidelines. Guidance on the level of status reporting between FPSO/FSU and offtake tanker, in table format as per Section 6.

Green Line

This term is used to describe the “permit to pump” telemetry system installed on virtually all North Sea offtake tankers. Sensors are fitted to various systems on the tanker, and it is only when all of these sensors are in the correct position that the permit to pump signal is given to the FPSO which allows the offloading pump to be started.

These sensors typically comprise:

Chain Stopper	Closed
Hose	In Position
Bow Coupler	Closed
Cargo system	Ready
Crude Oil pressure	Normal

Hawser Tension	Normal
Accumulator pressure (bow hydraulics)	Normal
Crude Oil line valve (1st inboard)	Open
Coupler valve	Open

Tandem Operation

This describes the normal method of loading from a ship-shaped FPSO or FSU, where the tanker keeps station astern of the FPSO/FSU on approximately the same heading relative to the weather. Either one or both vessels will have some means of propulsion, certainly the offtake tanker but potentially the FPSO/FSU too. There are similar types of offtake operation that are undertaken, such as from a spread moored ship shape or round FPSO/FSU, and while these have similar elements to tandem operation, the differences should also be understood. Some guidance is given in *Appendix H*.

2.3 Abbreviations

ALARP	As Low as Reasonably Practicable
AOGBO	Application Outside Great Britain Order
ATC	Automatic Thruster Control
BLS	Bow Loading System
CAPEX	Capital Expenditure
CCR	Central Control Room
CCTV	Close Circuit Television
CoA	Contract of Affreightment
COW	Crude Oil Washing
CPP	Controllable Pitch Propeller
DARPS	Differential Absolute & Relative Positioning System
DCR	Design & Construction Regulations - part of the body of Safety Case regulations
DGPS	Differential Global Positioning System
DISPORT	Discharge Port
DP	Dynamic Positioning
DP CAP	Dynamic Positioning Competence Assurance Practice
DPO	Dynamic Positioning Operator
DSV	Diving Support Vessel
ERS	Emergency Release System. System which allows for the operation of the ESD 2 sequence.
ERRV	Emergency Response & Rescue Vessel
ESD	Emergency Shut Down. Besides denoting the progressive emergency shutdown of the FPSO/FSU production plant the term ESD (or sometimes ESD 1) is also used to denote “stop pumping” between the FPSO/FSU and tanker.
FMEA	Failure Mode and Effects Analysis

FPSO/FSU	Floating Production, Storage & Offtake vessel / Floating Storage Unit
FSOG	Field Specific Operating Guidelines
HiPAP	High Precision Acoustic Positioning
HPR	Hydro-acoustic Position Reference
HSE	Health & Safety Executive
Hs	Significant Wave Height. Equivalent to the average height of the highest 1/3 of all waves in a sample
Hmax	Maximum wave height. The statistical height of the highest wave of all the waves in a sample, typically taken as 1.86 x Hs in the North Sea
HSWA	Health & Safety at Work Act (UK Legislation)
ICP/B	Independent Competent Person/Body
IG	Inert Gas
IMCA	International Marine Contractors Association
IMO	International Maritime Organisation
JOM	Joint Operations Manual
LV	Low Voltage
MAR	Management and Administration Regulations (UK HSE)
MARPOL	International Convention for the Prevention of Pollution from Ships (as amended). The principal body of rules, framed by IMO, to control pollution of the marine environment.
MBC	Marine Breakaway Coupling
MBL	Minimum Breaking Load
MODU	Mobile Offshore Drilling Unit
MSC	Maritime Safety Committee
MSS	Marine Services Superintendent
NDBS	New Dry Breaking Strength of a hawser. This is often listed as the rope's MBL in equipment catalogues.
NMD	Norwegian Maritime Directorate
NVQ	National Vocational Qualification
OCIMF	Oil Companies International Marine Forum
Oil & Gas UK	Oil & Gas UK – the association of offshore operators on the UK Continental Shelf
OIM	Offshore Installation Manager
OLS	Offshore Loading System
OPEX	Operating Expenditure
OPITO	Offshore Petroleum Industry Training Organisation – The UK National Training Organisation For Oil & Gas Extraction
PFEER	The Offshore Installations (Prevention of Fire & Explosion, and Emergency Response) Regulations 1995

PLC	Programmable Logic Controller
PMS	Planned Maintenance / Power Management / Position Monitoring System depending on context.
PPE	Personal Protective Equipment
PSD	Process Shut Down
QCDC	Quick Connect Disconnect Coupling
ROV	Remotely Operated Vehicle
SAL	Single Anchor Loading system
SCE	Safety Critical Element
SCR	Safety Case Regulations
SIMOPS	Simultaneous Operations
SIRE	OCIMF's Ship Inspection Report programme (tankers)
SMS	Safety Management System
SPM	Single Point Mooring system
ST	Shuttle Tanker
STCW 95	1995 amendments to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW).
STL	Submerged Turret Loading system
SVQ	Scottish Vocational Qualification
TAV	Towing Assist Vessel
TM	Transverse Mercator
UHF	Ultra High Frequency
UPS	Uninterruptable Power Supply
VHF	Very High Frequency
VOC	Volatile Organic Compound

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3. UK Legislation & Oil & Gas UK Risk Reduction Strategy

3.1 Legislation

Health & Safety at Work Act (HSWA)

The key piece of Safety Legislation governing the operation of UK sector offshore oil installations is the Health & Safety at Work etc. Act 1974 (HSWA). HSWA applies to Great Britain. HSWA is applied offshore via a further statutory instrument, The Health and Safety at Work etc. Act 1974 (Application Outside Great Britain) Order 2001, as amended. (AOGBO).

AOGBO applies HSWA to offshore installations by virtue of Article 4(1)(a). AOGBO also applies HSWA to activities in connection with the offshore installation by virtue of Article 4(1)(b). It is as follows:

"The prescribed provisions of the Act 1974 shall apply within the territorial sea or a designated area to and in relation to-

(b) any activity in connection with an offshore installation, or any activity which is

immediately preparatory thereto, whether carried on from the installation itself, in or from a vessel or in any other manner, other than –

(i) transporting, towing or navigating the installation; and

(ii) any activity in or from a vessel being used as a stand-by vessel;"

All activities in connection with the activity of tandem off take are covered by HSWA whether they be on the FPSO/FSU itself, on the tanker or on any attendant vessel. AOGBO applies HSWA to an activity in connection with the offtake, regardless of whether it is also a normal shipboard activity. HSWA places general duties on employers. Section 2 of the HSWA requires the provision and maintenance of plant and systems of work that are safe. It also requires the provision of information, instruction, training and supervision for those involved in the work activity. HSWA is also an enabling Act allowing regulations specific to offshore to be made under it.

Safety Case Regulations

Two of the principal offshore regulations made under HSWA, that bear on the major risks associated with tandem off take operations in the UK sector are the Offshore Installation (Safety Case) Regulations 2005 (SCR05) and the Offshore Installations and pipeline works (Management and Administrations) Regulations 1996 (MAR).

The safety case regulations are at the heart of the UK sector's offshore legislation, originally brought into force in 1992, they have been updated and SCR05 came into force in 2006. SCR05 brought in a number of changes, for example:

Regulation 5, Duties of licensee

The licensee has to appoint the operator and he has to ensure that the appointed operator is capable of carrying out his functions and discharges his duties under the relevant statutory provisions.

Regulation 6, Design and relocation notification for production installation

The operator has to submit a design notification for the installation to HSE. This notification shall be submitted at such time before the operator submits the field development plan to the Department of Energy & Climate Change (DECC), as will enable him to take account in the design of any matters relating to health and safety, which may be raised by HSE.

Regulation 12, Management of health and safety and control of major accident hazards.

The duty holder has to demonstrate in his safety case that his management system is adequate to ensure that:

All hazards with the potential to cause a major accident have been identified; and all major accident risks have been evaluated and controls put in place to ensure that the relevant statutory provisions will be complied with.

He should also ensure the satisfactory management arrangements with contractors, and has established adequate arrangements for audit and for the making of reports thereof.

Note: Guidance on risk assessment for offshore installations can be found at http://www.hse.gov.uk/offshore/sheet32006.pdf

Regulation 13, Review of safety case

This requires the duty holder to thoroughly review the safety case when directed by HSE or otherwise every five years. This review should confirm that the fundamentals of the safety case are sound. It should identify and implement any reasonably practicable improvements to enhance safety.

Further guidance can be found at http://www.hse.gov.uk/offshore/sheet42006.pdf

Regulation 19, Verification scheme

The duty holder shall ensure a record of the Safety-Critical Elements (SCE) and the specified plant is made. A verifications scheme shall be drawn up and put into place. An Independent Competent Person (ICP) shall comment on record of SCE and the verification scheme, a record of this comment should be kept at a notified address in Great Britain.

Regulation 20, Review and revision of verification scheme

The duty holder shall ensure the verification scheme is reviewed and revised in consultation with the ICP as often as may be appropriate. A note of any reservation by the ICP should be drawn up.

MAR regulation 8 places a duty of co-operation on everyone who can contribute to health and safety on the installation or activities connected with an installation. This includes everyone doing business in connection with the installation; - owners, operators, licensees, employers, managers, employees and people in charge of visiting vessels and aircraft. Masters of other vessels should also co-operate with the installation manager, so long as this does not conflict with their own statutory duties.

Taken together the legislation applying to offshore, requires duty holders to identify all potential accident hazards, evaluate the risks, and ensure that the risks have been reduced to ALARP.

The size, weight and close proximity of offtake tankers makes tandem offtake operations a source of major accident hazards requiring ALARP demonstration

and risk management. The historical frequency of minor collisions and potential incidents, published by IMCA, HSE and others, suggests that, while all operations have been reviewed, assessed and accepted as ALARP further efforts are required to ensure that the procedures on which these assessments are based are being carried out in practice. This will require the co-operation of all involved parties including Duty Holders and tanker managers. The following hierarchy of risk reducing techniques can be applied throughout the entire field life of any offshore project.

3.2 Concept and Design Phase

	Risk Reduction Technique	Oil & Gas UK Proposal
1)	Eliminate the hazard by selecting an inherently safe export concept if such a concept exists. If this is not practicable then minimise the hazard by selecting the most appropriate ALARP concept from all possible alternatives during concept selection	It is recommended that concession holders on all future UK developments should risk assess alternative offtake methods and make an ALARP concept selection.
2)	If it is not practicable to select an inherently safe concept, then continue to reduce the residual risk during the design phase by ongoing risk assessment, adding safeguards and introducing risk control measures until the risks are ALARP.	Duty holders on both new and future installations should ensure that appropriate safeguards and risk reduction strategies are both selected and implemented. This document provides guidance criteria for controlling risks on current tandem offtake systems.

3.3 Operating Phase

	Risk Reduction Technique	Oil & Gas UK Proposal
3)	Ensure that personnel are adequately trained and have adequate experience levels.	A method for Oil & Gas UK members to specify and audit both training and experience levels is proposed in Section 5.
4)	Ensure that equipment remains fit for purpose and risk reduction safeguards remain adequate.	The Standards in the Appendices include ongoing assurance as well as initial verification.
5)	Ensure that personnel are adequately briefed on operational limits, procedures and that there is adequate feedback.	The Standards in the Appendices include guidance on limits and procedures. Section 7

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4. Safe Operations

4.1 Use of the Guidelines

These guidelines use best practice targets in a performance standard type of format to supply guidance on how Duty Holders can verify that their tandem systems fulfil their intended duty. These are intended to focus effort on critical areas and identify typical norms to help manage UK tandem offtake operations in an acceptable manner. They are not intended as a substitute for performing field specific risk assessments, setting field specific standards, or managing on board operations in a safe manner.

Tandem offtake operations are by definition joint operations involving not only the installation Duty Holder but also the offtake tanker management company. These guidelines identify major elements of the joint operation, upon which the close proximity phase of the operation depends, and provide standards for these elements in order to avoid adverse impacts on safety and pollution. These elements fall naturally into three main groupings:

- Those which are entirely under the Duty Holder's control on the FPSO/FSU, but which should be controlled in such a manner that they cannot jeopardise the offtake tanker's safety, or cause a joint pollution incident.
- Those on board the offtake tanker which should be controlled by the tanker management company, to satisfy not only maritime legislation and their own standards, but also in a manner to assure the Duty Holder that the operation is satisfactory in terms of safety, and pollution risk.
- Those which are common to both the FPSO/FSU and the offtake tanker and there is a joint responsibility for compatibility.

4.2 Safety Critical Elements

As described in the Introduction, there are some elements of the offtake activity which could rightly be described as Safety Critical Elements as the term is used in the SCR and supporting regulations such as PFEER. The following list is intended as a guide to Duty Holders as to what elements may be considered in this regard. This list is not exhaustive, neither is it definitive in terms of any particular installation.

General	Weather Limitations Communications
Tanker Approach	SIMOPS Approach Speed Position Reference Systems Power Generation Propulsion / Thrusters
Tanker Connection	Messenger Transfer & Handling Hose Transfer Hose Connection
Tanker Offloading	Station Keeping Power Consumption / Limits Hose Offloading ESD Telemetry

The preparation of and compliance with SCE Performance Standards is entirely the responsibility of the FPSO/FSU Duty Holder. The main tools for providing assurance are based on maritime industry standards and offshore industry best practice such as:

- DP FMEA and FMEA proving trials. The DP FMEA should be a dynamic document which is evaluated after every change to the DP system, and in any event at a maximum interval of 5 years.
- FMEA of tanker BLS.
- FMEA of the FPSO/FSU export system as it interfaces with the offtake tanker.
- Annual DP trials as an ongoing confirmation of the FMEA and/or Operator's criteria.
- Normal design analysis, backed up by commissioning tests / periodic proving tests.
- Control and, where appropriate, tests, of modifications.
- Inspection and planned maintenance routines.
- Audits.
- Provision of suitable and comprehensive operating procedures.
- Personnel competence assurance.

All of the above, except where stated otherwise, apply to both the tanker and the FPSO/FSU.

4.3 Safe Operations

This section describes some of the most important points gained from a review of various Operators' SCEs and checklists. It is not exhaustive but provides information on the practical aspects of the FPSO/FSU and tanker hardware and operations.

Weather Limitations

The offtake tanker should normally only approach within 3nm provided the maximum wind speed, Hs, Hmax, visibility, and FPSO/FSU motions and yaw rate are within safe limits.

Typical values for DP and taut hawser tankers are described in *Appendix A*. It should be noted that these are typical maximums and it should not be construed that these values are targets which should be achieved on all occasions. Both the OIM and the tanker Master have authority to cease or suspend operations at any time on the basis of safety.

Communications

The expected level for close approach should be a minimum of two different systems providing clear and uninterrupted voice communications e.g. VHF and UHF. Any loss of communications should be seen as being potentially serious and operations should not take place where any systems required for this minimum level are not operating correctly. Further guidance is provided in the Appendix.

Crew Competence

This is discussed at length in Section 5.

Simultaneous Vessel Operations (SIMOPS)

The FPSO/FSU procedures should contain guidance as to any precautions necessary where one or more additional vessels are operating in the vicinity of the installation, but it is appreciated that, due to the multitude of potential scenarios, this may not be practicable other than for routine operations such as supply vessels and ERRVs. Other SIMOPS are usually addressed by specific HIRA taking account of the locations and workscopes of all vessels.

Approach Speed

The speed of approach of the tanker to the FPSO/FSU forms one aspect of the joint operations and should be specific to each installation. Typical values are as follows:

3 nautical miles from the FPSO//FSU -	< 5 knots
1 nautical mile from the FPSO/FSU -	< 2 knots
1000 metres from the FPSO/FSU -	< 0.5 knot

At a safe distance, and in any event before reaching 500 metres, the tanker should be stopped to engage DP approach mode, followed by a suitable settling time for the DP model.

Speed of approach from 500m to line shooting position should not exceed 0.5 knots.

Position Reference Systems

In order to be in line with all other critical DP operations, this guidance recommends the use of three independent position reference systems, operating on different principles. For tandem offtake use, these may include:

- Artemis
- Relative GPS
- Radius/RadaScan or similar radar based system
- Hydro acoustic systems (Not normally used for tandem operations but is necessary for other types of offtake facilities such as SAL)
- Laser based systems (where meteorological conditions are suitable)
- Absolute DGPS*

* The absolute DGPS is typically only used for the purpose of selecting the reaction box (FSU Position function – Kongsberg only)

In selecting the position references to be used the following should be considered:

- The total reference package should provide for the activation and use of the reaction box while maintaining a minimum of three independent systems on-line.
- Absolute and relative references should not be used simultaneously for tanker positioning except in the context of the reaction box setting.
- The use of an additional reference (total 4) is not necessarily adding to the safety of the system unless it operates on a different principle from the other three.

- Operators of first generation DARPS systems should be aware that they can be affected by interference from similar systems in use elsewhere.
- Some early radar based systems may be affected by, or affect, other high frequency radio systems.
- Laser based systems can, and have been known to, follow retro reflective targets e.g. tape on boiler suits, and can affect installation fire detection systems.
- Radar based systems are commonly used by PSVs, and their use for tanker offtake requires careful positioning, selection, and segregation.

Calibration and Recalibration of references (position drop out) requires careful consideration of the location relative to the FPSO, such that the enhanced accuracy which can be achieved close in, is balanced with the consequences of a potential drive-off.

Gyros

Gyros are important for position keeping. The heading sensor on the FPSO has a direct impact on the accuracy of the relative position reference systems. Any gyro fitted to a new FPSO should be a high accuracy gyro, defined as having an accuracy of 0.7deg/cos lat or better.

Power Generation

Both DP 2 and DP 1 Enhanced vessels should have redundancy in power generation such that a single generator failure will not rob the vessel of all electrical power. This principle should also be applied when assessing the use of a tanker which may have one generator out of action for maintenance.

Propulsion and Thrusters

Both DP 2 and DP 1 Enhanced vessels should have redundancy in transverse thrust capability at the bow and stern. A main propeller and high lift rudder is acceptable as one of the means of providing this capability. DP 1 Enhanced vessels are acceptable with one main propeller only because it is a requirement that a means of preventing full pitch reaction to a single failure of control and/or feedback systems is fitted and operational.

Messenger Transfer & Handling

The messenger should be assessed in detail in order to calculate the optimum length. This should include a consideration of the maximum distance off which will be used for line shooting. The assessment should also include a review of modern rope materials which may make a graded increase in cross section unnecessary, and generally improve the ease of handling and hence reduce the time. Consideration should also be given to the winch design on the tanker when selecting the rope type.

Consideration should also be given to the point in the operation at which the messenger is detached from the hawser chafe chain, in order to ensure that the capability for disconnection is available prior to the ESD system becoming available.

Cargo Transfer

The major safeguard against pollution incidents caused by high pressure hose failure is the “Green Line” system. It should be ascertained at the start of each loading that the FPSO/FSU export pump stop is operating correctly and in a suitable time which is compatible with the tanker’s inlet valve closure time.

Station Keeping

The shuttle tanker should maintain position within the limits defined by the operating limits diagram. However, in addition to “out of position” reports as required by this diagram, the tanker should inform the FPSO/FSU of any condition on board which may reduce the station keeping capability. This is further discussed under Field Specific Operating Guidelines in Section 6. In any event, the shuttle tanker Master or duty officer has a duty to stop the operation should he feel that the station keeping is deteriorating. This will also be the case where the overall power consumption and/or a single thruster power level have reached their defined limit, in terms of continuous average power usage.

There should also be an instruction on the FPSO/FSU to relate any degradation on the installation, that can affect the shuttle tanker, with reference to the FSOG.

Checklists

Properly designed and easy to operate check-lists can go a long way towards ensuring that the tanker and FPSO/FSU systems are correctly checked and mutually acceptable prior to the connection taking place.

Generally three systems of check-lists should be in place:

1. FPSO/FSU Internal Check-lists
2. Offtake Tanker Internal Check-lists
3. Common Check-list

The internal check-lists (1. and 2.) should be designed to ensure that all system parameters for the offtake are within limits; this will generally mean that these systems are all in working order and to expectations of performance. There will be times where this is not the case and it is important that the vessel understands the criticality of any outages and has suitable plans in place which clearly define whether operations can proceed or not.

The check-lists should reflect and reference the appropriate system manuals and procedures, and there should be no items in the check-list which cannot be verified and further information found elsewhere. Checklists should be completed in hard copy or electronic means which can be filed for future auditing if necessary.

The Common check-list (3.) should be designed to pass relevant information between the two vessels, and should ensure a phased review of readiness such that this checklist is completed for each step of the operation, and with clear hold points such that the operation can be aborted if the checklist parameters cannot be met.

Examples of suitable checklists are given in *Appendix F*. These are examples only and not necessarily suitable for all FPSOs/FSUs and Tankers. However, the layout of the columns may be considered as a template.

4.4 Background to Station Keeping Assurance

IMO Circ 645

The International Maritime Organisation (IMO) has issued extensive DP guidelines in the form of "Guidelines for Vessels with Dynamic Positioning Systems" - IMO MSC / Circ 645 1994

MSC Circ 645 sets good standards for equipping, checking and testing DP vessels. However UK Duty Holders should be aware that MSC / Circ 645 only applies to DP vessels having keels laid after 01/07/1994. Moreover Circ 645 does not have universal Flag State adoption and some Flag States which have adopted it, do not apply it to all types of DP ships even if their keels have been laid after 01/07/1994. IMCA have developed further DP guidance (M 103) for offtake tankers based on MSC 645 but the development and adoption of IMCA standards is also voluntary on a case by case basis. Similarly there is no obligation for an FPSO/FSU to be either Flagged or Classed and the application of equipment standards and assurance testing to heading control is not necessarily linked to any DP specific legislation or guidance.

Recommendation

It is recommended that IMO 645 is applied to any offtake tankers operating in the UK sector irrespective of the age of the vessel, and, where appropriate, to the heading control systems on FPSOs/FSUs.

4.5 IMO Equipment Class

DP Classification

MSC Circ 645 states; 1) that the equipment class of a vessel required for a particular operation should be agreed between the owner of the vessel and the customer based on a risk analysis of the consequence of a loss of position. 2) Alternatively, the administration or coastal state may decide the equipment class for the particular operation. For UK FPSOs, UK FSUs or tankers performing DP offtakes in UK fields and where there are no more rigorous administration or coastal state prescriptive definitions of equipment class for UK then:

- These guidelines consider that IMO MSC Circ 645 Equipment Class 2 standard should be adopted, as far as reasonably practicable, for FPSOs/FSUs intended for tandem offtake with active heading control, and for offtake tankers intended for DP offtake in the UK sector.
- These guidelines recognise that there are existing active heading controlled FPSOs, FSUs and also DP offtake tankers in service, which are exceptionally difficult to upgrade to fully comply with IMO Equipment Class 2 requirements. Oil & Gas UK consider that the bare minimum Class 1 requirements are insufficient for either FPSO/FSU active heading control or tankers performing DP offtake. However under the UK goal setting regime it is possible to risk assess such vessels and upgrade many of the less difficult, but more critical, systems to reduce collision risks to ALARP levels. Some such installations and tankers already have equipment levels nearer to Class 2 standards than Class 1 in many safety critical areas.
- These Guidelines recommend that such existing units should demonstrate their adequacy by:
    - A) risk assessment,
    - B) making enhancements where practicable towards Class 2 levels,

C) appropriate FMEA analysis with proving trials which use the ALARP principle as reference to identify any improvements. In the case of the enhanced Class 1 tankers, some residual short falls in best practice redundancy may be compensated by reverting to taut hawser operation in certain failure scenarios where this is compatible with FPSO/FSU systems. *Section 4.3* of this guidance, and the notes in *Appendix C*, indicate acceptance levels for "DP Class 1 Enhanced" systems.

Class 1 for Taut Hawser

Oil & Gas UK consider that basic DP Class 1 or non-DP tankers are suitable for use in manual taut hawser mode provided that they have adequate safeguards to prevent CPP drive off ahead following single point failure.

4.6 Historical Incident Data

The guidelines governing station-keeping hardware are based on the following premises which appear to be supported by the analysis of past incidents.

- Tanker failures which could cause drive off are the most critical, and hence should be mitigated by failsafe mechanisms or automatically implemented redundancy. However, the most common causes of drive off, i.e. position reference malfunction and/or mis-management, will by-pass the redundancy by the nature of the fault, and can only be mitigated by good DP operator practices and vigilance.
- FPSO/FSU failures which could cause FPSO/FSU major heading change, and hence the possibility of a DP drive off on the tanker, are the most critical, and hence should be mitigated by failsafe mechanisms or redundancy.

The recorded incidents for the past 10 years have been collated and assessed as part of the preparation of this revision. The results and recommendations from the major incidents are reflected in the guidance throughout this document.

4.7 DP FMEA and Annual DP Trials

These Guidelines consider that the standards of FMEA analysis and subsequent FMEA trials and periodic testing outlined in MSC Circ 645 and further detailed in IMCA M112 Part 2, M166, and M178, should be applied both to FPSO/FSU active heading control systems and to tanker DP systems to ensure ongoing assurance, e.g.

- In the absence of a Flag State Verification and Acceptance Document; a FMEA, including a complete FMEA proving trial, should be conducted by an independent company. The trial should cover all systems and components and assess the ability to maintain station after a single component failure. The minimum Oil & Gas UK acceptance standard for DP offtake or active heading control is DP Class 1 Enhanced, and there should be an ability to maintain station for as many single failure modes as is reasonably practicable. Hence the FMEA proving and other DP trials should be based on the Class 2 rather than the Class 1 philosophy to ensure that failure modes are identified.
- Conduct annual surveys and trials. The extent and level of survey and trials should be in accordance with IMCA M139 and may be embedded in the vessel maintenance programme to the satisfaction of an ICP. The

annual trials should be performed by, and may be documented by, ships staff but in any event should be witnessed by a competent 3rd Party. The trials should be performed as a single exercise.

- Resurvey against the FMEA, every 5th year, and in any event after either a DP system failure or modification. This should be timed to coincide with the Annual DP trials for that year.
- Whenever a fault is discovered and repaired or the system modified in even a minor way, full tests of the effect of the changes should be performed and logged. The changes and type of tests performed and results achieved should be recorded. A note of the tests and results should be made in the onboard FMEA report.

These guidelines consider the FMEA, including proving trials and the above tests and checks, to be the primary means of providing initial and ongoing assurance of station keeping hardware integrity.

5. Crewing Levels Training & Competency

5.1 Introduction

Crew competency in station keeping tasks is a key factor in reducing offtake risks to ALARP levels. Oil & Gas UK recommend the use of goal setting matrices for evaluating whether tanker crews have sufficient competence to undertake offloading operations in UK waters. The first is a training matrix; the second is an experience matrix. The standards set out in the matrices are in addition to the existing flag state competency requirements for tanker masters, deck and engineering officers and crews as required by IMO's STCW 95.

The training elements for DP shuttle tankers concentrate on issues related to dynamic positioning and offshore loading and are inclusive of training requirements for relevant auxiliary equipment and systems. The experience elements are concerned principally with tanker experience, experience at the specific type of loading facility and DP CAP (or equivalent) to hone ship-handling skills. Training and experience gained, including DP CAP (or equivalent) hours, should be logged in the officer's individual DP logbook.

The concepts of goal setting and competence requirements are well established in the UK offshore sector and should be used for FPSO/FSU marine personnel.

For those Oil Companies without internal Marine Assurance organisations to help assess suitability of Shuttle Tanker and Operator for service at their Installations, attention is drawn to the Industry standard information such as Ship Inspections (SIRE) and Tanker Management Self Assessment (TMSA) programmes administered by the Oil Companies International Marine Forum (OCIMF).

SIRE inspections are non-judgemental inspection reports (the Inspector and the Report are NOT commissioned by the Ship Operator) that allow recipients to review the general state of the ship and a sense of the management ethos and control using their own risk assessment parameters. TMSA is a tool that allows ship operators to assess their own management processes and continuous improvement needs in an industry standard format. Such information is used extensively by Oil Companies, Charterers, Terminal Operators and a number of National Administrations in their individual risk assessment programmes for vessels.

5.2 FPSO/FSU Competence

These Guidelines recognise that operators have competence programmes set to National Vocational Qualifications, or equivalent, for marine roles. OPITO have developed minimum training and competency standards for personnel serving on FPSOs/FSUs.

This should recognise that the following critical operations will inevitably need to be performed in quick succession or in some cases in parallel within the 20 to 30 hour period:

- The tanker has to be moored and the hose deployed.
- Regular FPSO/FSU communication should be maintained with the tanker master to ensure the tanker is still able to maintain position within safe limits and it is safe to continue cargo transfer operations. FPSO/FSU position references, sensors and telemetry systems have to be monitored.

- The cargo has to be completely discharged and the FPSO/FSU re-ballasted without exceeding the hull's structural shear force or bending moment limits.
- The FPSO/FSU should be cycled through her complete discharge envelope without exceeding stability or allowable centre of gravity limits at any step.
- The cargo tanks all have to be inerted to ensure the atmosphere is kept within safe non-explosive limits.
- Some tanks may have to be crude oil washed to limit wax and sediment build up.
- On FPSOs/FSUs with active heading control the FPSO/FSU heading should be maintained within agreed limits and adjusted in tandem with the tanker.
- The tanker should be un-moored and all running rigging and hoses inspected for wear or damage as they are recovered.
- The crude quality should be analysed and commercial documentation prepared and sent onshore.

In addition, the standards should include requirements for competency in the following:

- risk assessment of critical marine activities.
- evaluation of departures from standard procedures.
- recognition of, and response to, developing marine related emergency situations.

Individual Duty Holders should develop competency assurance schemes to ensure that all personnel performing tandem offtake functions are qualified and remain competent to fulfil their role.

The principles on which the competence assurance should be based are as follows:

1. The OIM should have an understanding of the risks involved in the joint operation. This can be based on prior knowledge and experience or a combination of formal training and experience.
2. The OIMs understanding of the joint operation should be such that he is capable of the decision making required to ensure that the operation is managed and carried out safely.
3. The Duty Holder should have a Competence Assurance management program in place which ensures that personnel engaged in the tandem loading operations have achieved a minimum standard of competency for those parts of the operation that they are directly involved in. This should include an appreciation of the FSOG table and the importance of advice given under the FSOG. Guidance with regard to minimum levels of competence can be found in the OPITO National Occupational Standards for FPSO/FSUs.
4. In addition, for active heading FPSOs/FSUs, a minimum level of competence in the operation of heading / position control systems and an appreciation of the importance of these to tandem loading operations, is required. Guidance with regard to this minimum level of competence can be found in IMCA M117.

5. Management arrangements should be in place to ensure that an adequate number of personnel having the above competencies are available throughout the tandem loading operation, with due consideration being given to simultaneous activities and provision of adequate cover for meal breaks, toilet breaks etc

In addition the FPSO/FSU should have competence in maintenance and fault finding of the position reference, telemetry and station keeping control systems.

Guidelines for designing effective assurance processes for FPSOs/FSUs are available from several sources, including HSE, OCIMF and Oil & Gas UK.

5.3 Matrices

Purpose

It is proposed that the Tanker Owner/Manager should complete the blank training and experience matrices for each tanker crew. The Duty Holder should maintain competence records for each FPSO/FSU crew. For each tanker and FPSO/FSU crew the responsible party should ensure that there is the best match of training and experience within each watch.

The matrices for tanker personnel are configured to cover all known types of offshore loading facility, so that the tanker managers only have to complete one pair of forms, rather than a different set of forms for each Duty Holder or field. Completed matrices should be updated and forwarded to the FPSPO/FSU prior to every offtake. Matrices should be supplied to the field Duty Holder before a new tanker is introduced. Additional updates may also be requested for audit, for spot check purposes, or during the nomination process of approving the vessel for next offtake. Alternatively, Tanker Managers who have their own system for tracking and controlling experience may transfer equivalent data from their system to the Duty Holder for comparison to the Oil & Gas UK standards.

The matrices and minimum acceptable experience levels are described in the following sections.

5.4 DP Tanker Training and Experience Matrices 1 & 2

All DP operators should maintain a DP logbook as per IMCA M117 and be certified in accordance with the Nautical Institute or NMD.

Matrix 1 contains the Oil & Gas UK training standard for DP tankers

The required training courses are listed in the left-hand column of the matrix. Key DP personnel are listed along the top row.

At least one person on board the tanker is recommended to have undergone appropriate training for equipment maintenance. Typically, this is likely to be the onboard electrician or engineer, however the other comments box in matrix 1 allows tanker operators flexibility in allocating the training to some other position on board. However, in the case of telemetry and DP maintenance the tanker operators are recommended to provide the electrician with the appropriate training.

Matrix 2 contains the Oil & Gas UK experience standard for DP tankers. The experience matrix has been developed on the same basis as the training matrix. The key DP personnel are listed along the top row with the experience elements listed in the left-hand column.

The experience matrix is broken down into two categories, i.e. professional (including DP offtake tanker) experience and facility type specific experience.

The first category, professional experience, is concerned with years in rank, also DP offtake tanker experience, regardless of the offtake facility type. Although years in rank are considered an important part of competency assessment, no guidance for number of years in rank has been given. Requirements for years in rank should be addressed directly between operator and client.

The second category is concerned with experience associated with specific types of facility. Three types of offloading have been considered. The first is tandem offloading in DP mode at heading controlled FPSOs/FSUs. The second is tandem offloading in DP mode at passive weathervaning FPSOs/FSUs. Third is offloading in DP mode at STL, FSL, OLS, SPM,SAL, FLP and spread moored FPSO's facilities.

Minimum navigating officer levels on a DP tanker performing a tandem offtake should be set at a Master plus four navigating officers/DPOs, with qualifications and experience as per Matrices 1 and 2, including the comments in the footnotes. At least two of these will be on the bridge at any one time and DP positioning and control changes should be repeated and verified by the 2nd person. For this reason the two on-duty DP watch keepers should not be involved in critical cargo loading operations. The DP watch keeper should be rotated from the console every hour to minimise the risk of concentration lapses. The DP experience should be apportioned as evenly as possible between the watches. (i.e. a senior and junior DPO on each watch).If the qualifications and experience as outlined in the matrices and flow chart are not met, risk assessment should be performed and appropriate cover provided by the Master in conjunction with the ship operator.

Minimum engineering manning levels on a DP tanker performing a tandem offtake should be set to permit 24 hour per day manning of the engine room during offtake, plus an electrician competent to trace and repair position reference, telemetry and control system faults. The chief engineer and/or the 1st engineer and the electrician should all be familiar with the vessel and its equipment. In addition to DP qualifications and experience, all the above officers should be qualified to the appropriate level under STCW 95 code.

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OGUK Matrix 1: - Training of personnel o/b DP shuttle Tanker

Tanker : M/T . . . . . Installation : .....

Voy.: ..... **Date : 14/10/2014**

Position during approach, loading and departure from offloading installation:			**Master : .....**	**Senior DPO 1: .....**	**Senior DPO 2: .....**	**DPO 1: .....**	**DPO 2: .....**	**Electrician/ Engineer: .....**	**Extra Master: .....**
DP Basic[1] (Induction)			Y	Y	Y	Y	Y	N/A	Y
DP Advanced (Simulator)[2]			Y	Y	Y	N	N	N/A	Y
Bridge Resource Management			Y	Y	Y	Y	Y	N/A	Y
Offshore Loading Phase 1 (Basic)[2]			Y	Y	Y	Y	N	N/A	Y
Offshore Loading Phase-2 (Advanced)[2]			Y	Y	Y	N	N	N/A	Y
DP Simulator or Offshore loading course (3Y +/- 4 mnth) (dd/mm/yy)			Insert Date	Insert Date	Insert Date	Insert Date	Insert Date	N/A	Insert Date
DP certificate [3]								N/A	
Position Reference Systems [4]	**Eq. operational on board**		**Operating courses [4]**					**courses [4]**	
	Artemis								
	DGPS/GPS rel (DARPS)								
	HPR/HiPAP								
	Parker/BLOM								
	RADIUS								
	CyScan								
	specify other								

Notes

1) DP Training courses should ideally be carried out on the type of DP system fitted used by the ship Operator. How ever, w here Ship Operator's have more than one type of system in their fleet, a suitable " Conversion" course should be set up for officers transferring from one system to another.

2) Ship Operators should specify w hich Offshore Loading Systems their vessels are designed for and ensure these are included in the train

3) DP certificate issued by Nautical Institute or equivalent Approved Body.

4) Position reference system operational cources are recommended for SDPO's, but in case at least one DPO on each w atch should be trained. PRS-Maintenanance cources are recommended for electrician and/or engineer for the equipment as installed on the actual vessel and recorded.

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OGUK Matrix 2: - Experience of personnel o/b DP Shuttle Tanker:

Tanker : M/T . . . . . . **Installation: .....**

Date : 14/10/2014

Voyage : .....

Master can carry out loading operations unsupervised (see Flow chart 1)	**Yes/No**	when superv. required

Position during approach, loading and departure from offloading installation:		**Master :**	**Senior DPO 1:**	**Senior DPO 2:**	**DPO 1:**	**DPO 2:**	**Extra Master:** . . . . .
General Professional Experience [1]							
Shuttle tanker (S)DPO experience Sea time, in position (years)							
Number of offloadings performed in **DP-mode at any offshore installation:**		Ref FC	18	18	0	0	
Facility Specific Experience							
Number of offloadings performed in **DP-mode** at, **each type of single point** offshore installations [4]	**Tandem, heading controlled FPSO's** [3]	FC	2	2	0	0	
	Tandem, passive FPSO's [3]	FC	2	2	0	0	
	STL	6	2	2	0	0	
	FSL	6	2	2	0	0	
	OLS	6	2	2	0	0	
	SPM	6	2	2	0	0	
	SAL	6	2	2	0	0	
	FLP	6	2	2	0	0	
	Spread moored FPSO's	6	2	2	0	0	
Number of **Tandem** offloadings performed in **Taut Hawser** mode without DP [4]		FC	2	2	0	0	
Hours of DP Play Time in last 12 months. [5]							

Comments Master:

Notes

General Marine Experiance: Further informationon on general marine experiance may be requested from Ship's Operator or obtained from SIRE.

1) Loading Terminals w ishing to access OCIMF SIRE Experiance matrix for officer's individual history w ill need to register w ith OCIMF as Receipient SIRE Member

2) This form notes experiance at all types of offshore installations. Compilers are requested to note all types of experiance held, and specify "none" in any row /column w here appropriate (use input option).
Where any individual may have less than the recommended experiance, ship's operator should ensure that arrangements are in place to compensate, such as ensuring remaining staff are very experianced; the master is temporarily integrated into the DP w atch schedule; and/or additional staff w ith appropriate specific skills are added

3) The prime mode of operation being assessed on this sheet is as a DP tanker. How ever there are circumstances at passive w eather vaning FPSO's w here DP tankers may operate in taut haw ser mode and hence experience in this area is appropriate. If the officers lack experiance of taut haw ser operation, the operation requires to be risk assessed and everyone to be comfortable to carry on in this mode prior to commencement.

4) For each facility type, 2 offloadings are recommended as a minimum for Master and SDPOs, how ever, if Master or SDPO 1/ 2 have minimum of 2 offloadings at a Heading Controled Tandem FPSO, then only one offloading at a Passive Tandem FPSO w ill be sufficient to meet these guidelines, and vice versa.

5) DP CAP (or equivalent) / DP-playing time shoud be gained w hen ever feasable.

6) Number included in the spreadsheet are examples only.

5.5 Master's Experience Flowchart (Refer to *Flowchart 1*)

There are specific experience requirements for the tanker Master, which are in addition to the above training and experience matrices, and competence requirements for the FPSO/FSU heading control operator. The experience requirements in Matrices 1 and 2 do not differentiate between offloading operations carried out in a particular rank, e.g. the required number of offloads may have been carried out at a lower rank. However, the Master's experience flow chart does address the issue of the Master's actual experience in command of shuttle tanker operations.

In order for a Master to be allowed to carry out an unsupervised offload operation at the facility in question, he should be able to comply with the requirements of the flowchart as well as the training and experience matrices. The exception is a newly promoted Master, who should comply with the provisions of Note 2.

The flowchart is self-explanatory. If the serving Master does not comply with the provisions of the flow chart then the vessel manager should transfer an appropriately qualified and experienced master to the FPSO/FSU or tanker. The additional Master will remain on board the tanker in an advisory capacity for the duration of the offloading operation. The additional Master will not take command of the vessel.

5.6 DP Training & Competence Assurance

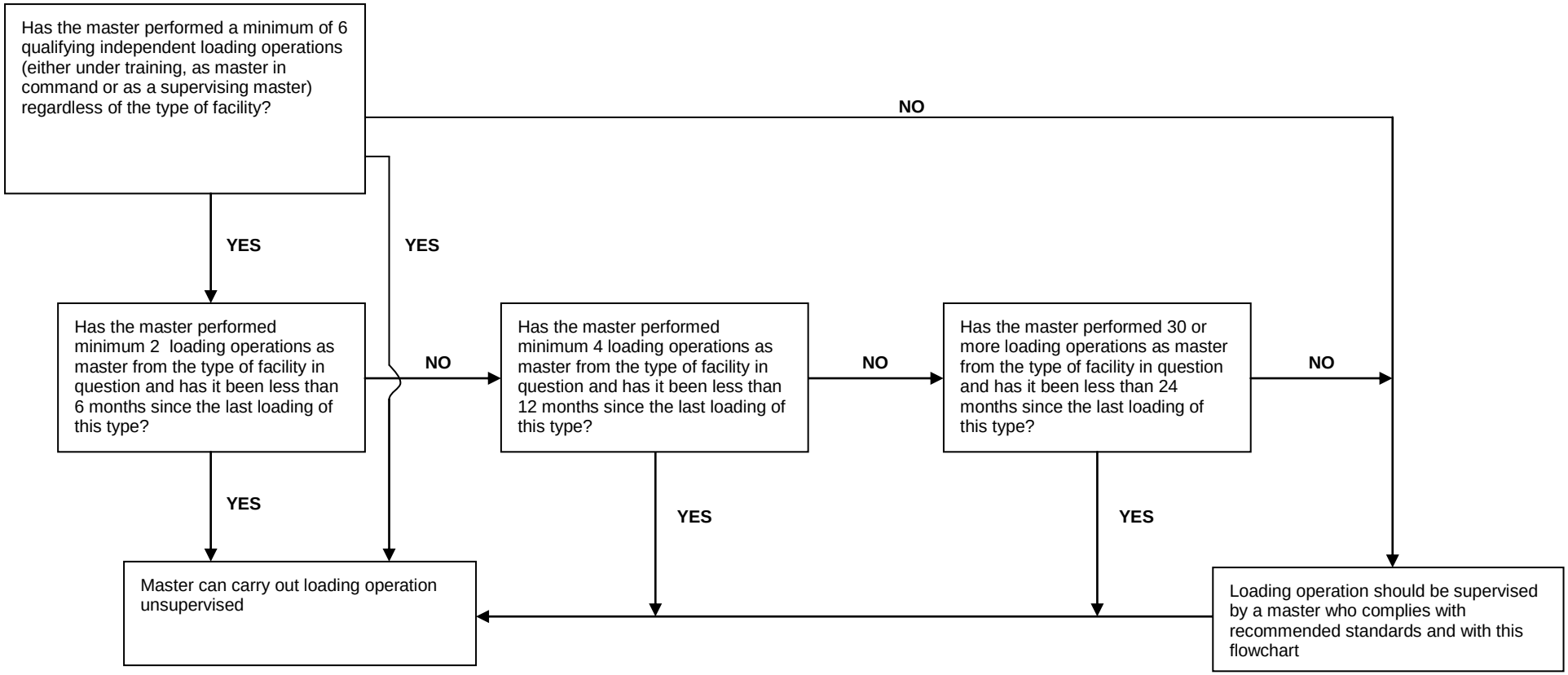
DPCAP

DP CAP is a training tool, developed by Navion (now TK) in close cooperation with Global Maritime and the Ship Manoeuvring Simulation Centre in Trondheim, which has been in service since 2003. A row is included in Matrix 2 to permit Duty Holders to monitor that DP CAP is actually being carried out. Oil & Gas UK members should actively encourage tanker Masters to use lay time for DP CAP whenever it can be accommodated without jeopardising other infield operations. Presently (2010) the programme is confined to vessels equipped with the Kongsberg DP control system.

Other Systems

Other systems may be available both for training and confirming the competence of personnel. These should be taken into consideration and assessed if new tools for this enter the market.

Flowchart 1: Master's Recent Experience Flowchart (of Tandem Loading Operations)



NOTE Box 2 and 3: Where change is from passive to active heading control, the type of facility can be considered to be unchanged for competence assessment.

6. Management System

6.1 Objective

The object of the Field Operator and Duty Holder's management systems should be to ensure that:

- All new offtake systems have been selected to reduce inherent risk to ALARP at the field concept selection stage.
- All critical elements on both the FPSO/FSU and all associated offtake tankers have been adequately designed, installed, assured and verified as per the standards in these Guidelines including the Appendices.
- Key personnel on both the FPSO/FSU and associated offtake tankers have been trained and have adequate experience in accordance with the requirements of Section 5.
- Duty Holders, offtake tanker managers and key personnel on the FPSO/FSU and associated offtake tankers all learn from previous experience by being open about problems experienced and sharing incident data as described in Section 7.
- Key personnel on both the FPSO/FSU and all associated tankers have clear guidance on the special features, Duty Holder requirements and operational limits for each field by issuing a Joint Operations Loading Manual.
- There are adequate management controls and audit checks all the way down the supply chains for both FPSO/FSU and offtake tanker services to ensure that risk reducing measures are applied effectively on both vessels participating in any tandem offtake (FPSO/FSU and Tanker).

6.2 Management Audits

Contractual Aspects for Provision of FPSO/FSU

The contractual arrangements in relation to FPSOs/FSUs and offtake tankers, and their supply chain, can become very complicated.

For example a field operator could have subcontracted the FPSO/FSU by leasing the unit from a third party company who may or may not be the installation Duty Holder. The Duty Holder could have subcontracted the specification, design procurement and installation of critical offtake equipment. Further sub-contracts may be in place for the maintenance of each system and provision of competent personnel on the FPSO/FSU.

Contractual Aspects for Provision of Offtake Tanker(s)

On the tanker supply side, the offtake tanker supply contractor could have a contract with any of the field operator partners rather than the Duty Holder. The tanker supply contractor could be supplying several tankers to the one FPSO from his supply pool but the tankers supplied are likely to come from several different partners, vessel management companies or owners.

Joint Responsibility

The FPSO operator (in co-operation with the Duty Holder if separate) shall maintain and act on a management audit plan covering the audit of all levels down the supply chain. This will include both direct audits of main contractor's organisations, review of each main contractor's own audit plan for relevant subcontractors or vessels, and sample observation / participation in the main contractor's audits of their sub contractors and vessels to ensure that the overall system is consistent and that risk reducing strategies are not diluted as they pass down the supply chain.

6.3 Vessel Acceptance and Auditing

Preamble

The FPSO/FSU and shuttle tankers should be audited against field specific performance standards and Oil & Gas UK training and experience requirements. Any findings should be actively closed out and documented closed. The tanker audit programme should cover both initial acceptance and ongoing maintenance in a condition acceptable for offtake. This is the management tool to ensure that equipment and personnel are initially checked as fit for purpose and continue to be maintained in that condition.

FPSO/FSU

The general safety condition of the FPSO/FSU to perform production and / or storage should be covered by the Duty Holder's existing SMS and ICP inspection under UK regulations. However, offtake systems and tandem offtake station keeping aids do not fall readily within the experience of many of the specialist companies or personnel who routinely deal with these issues on production platforms, and suitable expertise should be sourced for these systems.

Offtake Tanker

The general safety condition of a tanker to perform crude oil transport and discharge at inshore terminals is covered by Duty Holder and Operator vetting systems, generally using the OCIMF SIRE system. The SIRE system, however, does not cover bow loading systems or close proximity station keeping arrangements. The Duty Holder should ensure that suitable expertise for these aspects is sourced, and suitable audits are carried out.

6.4 Joint Operations Manual

The field specific joint operations manual is the main procedure controlling discharge operations on any field. It should contain the following information:

- Summary field position and field layout and FPSO/FSU information including plans of the stern offtake arrangements, and appropriate photographs.
- Contact numbers, call signs and communications channels for both Operational and Emergency use.
- Description of the offloading equipment on board the FPSO/FSU.
- Description of standard and occasional joint operations including cargo transfer rates, line flushing etc.
- Data sheets on all tankers nominated for regular offtake at that field.

- Tendering and accepting Notice of Readiness (NOR), and any special requirements for cargo quality, Bills of Lading and Cargo calculations.
- Speed reduction sequence and limits on approaching Facility.
- Operational limits and executive actions on exceeding limits.
- ESD systems and executive actions at each ESD level. (Both for the FPSO/FSU ESD system and the joint "Offtake ESD" system).
- Detailed check lists for the FPSO/FSU covering each stage of pre offtake checking, approach, offtake, disconnection and post offtake checking of hardware.
- Detailed check lists for each type of tanker covering field specific actions and requirements not covered by the tankers own detailed checklists.
- Duties and requirements for the towing assist vessel if required.
- Emergency responsibilities and procedures. Note this section of the joint operations manual should be prepared jointly between the Duty Holder's management team responsible for running the installation, and the tanker management company to ensure that there are no gaps or overlaps in cover. (Some Duty Holders prefer to cover this topic by a separate bridging document or emergency response manual for this reason).
- A short synopsis describing key requirements and where to find more detailed information on each topic within the manual. (i.e. an overview that the Tanker Master can quickly use to get the key facts without having to wade indiscriminately through the full manual).
- A station-keeping sector limits diagram giving key operational and station keeping limits and key communications channels (i.e. key information that can be posted on one sheet on the bridge for immediate use). An example of this diagram is included on the following page.
- A Field Specific Operations Guideline (FSOG) which lists the reporting requirements for that field in a format as per *Figure 6.2*.

Joint Operations Manual Layout

This guidance recommends that a standard layout for the joint operations manual, at least for the order of the main sections and sub sections, should be adopted by all UK FPSO/FSU operators. This is to simplify the task of the tanker personnel when offloading from different operators' installations, and in particular for familiarising a new vessel. It is not intended to standardise the content of these sections. The recommended sections list is as follows:

Introduction

- JOM Objective
- JOM Administration
- Definitions
- Abbreviations

Roles & Responsibilities

Personnel Competence

Offshore Terminal & Field Information

- Field Location and Description

- FPSO Overview (including including plans of the stern offtake arrangements, and appropriate photographs)
- ERRV
- FPSO Facilities
  - Communication facilities
    - Contact Details
  - Navigation Aids
  - Position Reference Systems
  - Mooring facilities
    - Hawser tension and angle criteria
  - Cargo transfer facilities
  - Emergency Shutdown Facilities

Nomination, Notification and Pre-arrival

- Nomination procedure
- Offtake tanker acceptance Criteria
  - Initial acceptance
  - Pre-lifting acceptance
- ETA notification
- Pre-arrival checks
- Notice of Readiness

Tanker Approach

- Environmental limitations
- Decision to Berth
- Direction of Approach
- Approach Speeds
- Simultaneous Operations
  - Helicopter operations
  - Supply Vessels
  - MODUs
  - Subsea Operations
  - Emergency Towing Trials

Mooring & Hose Connection

- Initial line connection
- Hawser and hose transfer and connection
- ESD telemetry test
- Station Keeping Sector Limits Diagram
- Field Specific Operating Guidelines (FSOG)

Cargo Transfer

- Start-up

- Routine checks
- Record keeping
- Completion of discharge
- Hose flushing

Disconnection & Departure

- Hose and hawser disconnection and transfer
- Departure
- Cargo documentation

Emergency Response

- Incident Response Procedures
- Emergency Notification Flowchart

Offtake Tanker Specifications

FPSO Checklists

Joint Operations Procedure Checklist

Documentation Templates (timesheets, sailing advice, cargo reports etc)

Field Specific Operating Guidelines (FSOG)

These Oil & Gas UK guidelines support the concept of a FSOG to assist the FPSO/FSU and Offtake Tanker interaction. The diagram in *Figure 6.2* provides a typical level of status reporting.

The principal point to note is that a column is introduced for reporting advisory messages of any status less than full Green on either side, in an effort to warn the FPSO/FSU or Tanker of a possible impending Yellow, to allow a discussion of the offtake between senior personnel, from which it will be decided to either adopt a Yellow alert status or revert to Green.

It is to be hoped that the advisory category will encourage communication between the vessels such that safety is enhanced without jeopardising the contractual obligations.

Figure 6.2 is an indication of principles to be included. The table should include concerns regarding both the offtake tanker and FPSO/FSU related issues.

The development of the FSOG should be undertaken jointly by the FPSO/FSU operator and the tanker operator. The ownership of the FSOG lies with the installation and demonstrates the requirements for offtake from that field. The FSOG should be included in the JOM. The offtake tanker should carry its own vessel specific operation standard, and, where this differs from a particular FSOG, the more stringent standard should be followed.

During the approach, the operational status should be confirmed to be as per the FSOG “green” level, and should be periodically confirmed at agreed intervals, throughout the offtake operation e.g. 1 hour.

Remote Position Monitoring System

For some FPSOs/FSUs, it may be beneficial to have the means for the marine operator to monitor various parameters of the tanker, such as position, heading, power usage etc. This may be as simple as a "Traffic Light" system showing Green, Yellow or Red status, or may include a full readout of the monitored parameters.

The benefit of such a system to the individual FPSO/FSU depends on the crew's ability and competence to assimilate, understand and act appropriately in response to a non-conformance. It also depends upon the increase in workload of the FPSO/FSU offtake personnel, and whether this detracts from their concentration on their core tasks.

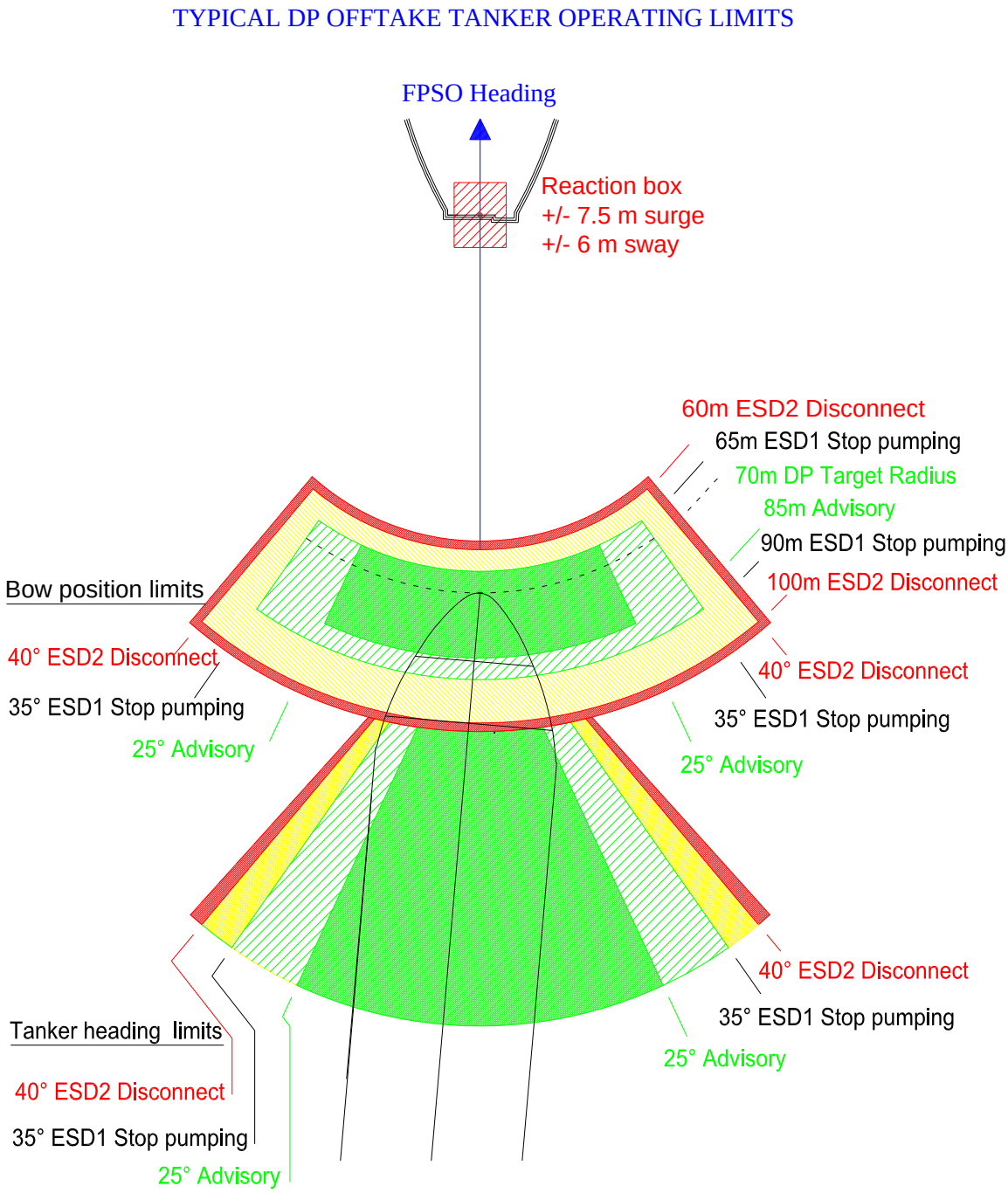


Figure 6.1: Typical Operating Limits

Vessel name/Installation name :

Date:

Condition			GREEN	ADVISORY	YELLOW	RED
Action Required			Normal Status	Advise Master / OIM, Others (TBA)	Inform Contact to FPSO/Installation. Activate alert, ESD I	Contact to FPSO/Installation. Activate alert, ESD II
Notify Master & OIM			No	Master/OIM and any other who can reflect the situation	Master/Client and any other who can reflect the situation	Master/Client and any other who can reflect the situation
DP INCIDENT	BLACKOUT	ALL BUS	Main bus closed/open	Move to red	Move to red	Assess whether it is safe to be connected or disconnect immediately by using ESD II
		ONE BUS		Move to yellow	Prepare for red	Move to safe location
	DRIVE OFF		0-3m	3m	Reaching yellow area specific operational limits	Reaching red area specific operational limits
	DRIFT OFF / FORCE OFF		0-3m			
INTACT DP SYSTEM	Vessel foot print offset from start point		0-3m			
	Heading Excursion		<= 3 degrees	3 degrees	>3 degrees	>5 degrees
Power generator-Power consumption			<45%	>45%	>50%	>60%
Thrusters (system) Individual thruster demand			<60% on each thruster. <50 % on thrusters	>60% on individual thruster, >50% on thrusters.	>60% on individual thruster, >50% on thrusters.	>70% on individual thruster, >60% on thrusters
Position reference available			3 independent ref. systems	Loss of 1 reference system	Assess whether it is safe to be connected or disconnect immediately by using ESD II	Loss of 2 reference system
DP control system			Kongsberg K-pos, A & B control	Loss of single system, A or B	Loss of single system, A or B	Loss of system A & B
Wind sensors			2 x Wind Sensors	Loss/or de-selection of single sensor	Loss/or de-selection of single sensor	Loss of both Wind sensors
Motion sensors (VRU)			2x MRU	Loss of M.R.U	Loss of M.R.U	Loss of both MRU
Heading sensors (Gyro)			3 x Gyrocompass	Loss of 1 Gyro	Loss of 1 gyro	Loss of two Gyro
Network			All network operational	Alarm/Fault indication on network	Alarm/Fault indication on network	Loss of network
Comms system Internal			VHF Radio, Clear comm and UHF radio	Loss of any	Loss of any	Loss of communication
Comms system Ship/FPSO			VHF Radio and UHF radio	Loss of any	Loss of any	Loss of communication
Environment parameters (Wind speed, Hs, Current), approach			Weather & Sea conditions as per operation/location	>30 knots	reaching agreed limits	Situation Specific
Environment parameters (Wind speed, Hs, Current), Offtake/Departure			Weather & Sea conditions as per operation/location	>40 knots	reaching agreed limits	Situation Specific
Hawser Tension			<30 tonnes	>30 < 50 tonnes	>50 tonnes	Situation Specific
Telemetry system			Both frequencies are working	One frequency is working	Communication is missing	Situation Specific
Heave, pitch and roll			Weather & Sea conditions as per operation/location	reaching agreed limits	reaching agreed limits	Situation Specific
FPSO RELATED EQUIPMENT						
Gyro			3 x Gyrocompass	Loss of 1 Gyro	Loss of 1 gyro	Loss of two Gyro
Artemis			Working as per designed	Any degradation to design	Loss of equipment/transmission	Situation Specific
DGPS/DARPS			Working as per designed	Any degradation to design	Loss of equipment/transmission	Situation Specific
RADIUS/RADARSCAN			Working as per designed	Any degradation to design	Loss of equipment/transmission	Situation Specific
Thrusters			<60% on each thruster. <50 % on thrusters	>60% on individual thruster, >50% on thrusters.	>60% on individual thruster, >50% on thrusters.	>70% on individual thruster, >60% on thrusters
Switchboards			<45%	>45%	>50%	>60%
Additional emergency scenarios for DP in event of fire, imminent collision etc. noted in Emergency Response Procedures, shall follow the Ship's marine Operation Instructions.			Actions advisory: Status: Refer to specific Ship's marine operations procedure	Move to yellow	Prepare for abandon	Actions Red alarm: Abandon operation & relocate
OFFTAKE TANKER OPERATOR				FPSO/FSU DUTY HOLDER		

Figure 6.2: Example of Field Specific Operating Guidelines

7. Incident Reporting

7.1 Objective

The objective of this guidance is to improve the safety and efficiency of tandem loading operations through the sharing of information on related incidents.

7.2 Background

UK legislation places a duty of co-operation on everyone doing business in connection with an installation, and who can contribute to health and safety on the installation or activities connected with it.

In compliance with this, the crews and managers of FPSOs / FSUs and offtake tankers have a duty to co-operate by supplying information, if such information can reduce the level of risk to which others may be exposed.

In this context Oil and Gas UK strongly encourage the reporting of any incident or potential incident, and sharing of this information with others, where this can increase awareness and reduce or remove the potential for recurrence.

Voluntary systems for reporting of incidents relating to offtake operations are available via the following bodies;

- Oil & Gas UK (all incidents)
- IMCA (Thruster Assist / DP station keeping incidents only)

Reporting of incidents via Oil & Gas UK and IMCA is in addition to the statutory reporting requirements applicable to the installation / vessel involved.

7.3 Incident Reporting via Oil & Gas UK

Any incident should be reported which occurs onboard an installation or tanker during an offtake operation (including activities prior to connection or following disconnection), and which involves one of the following events;

- Injury to personnel.
- Hydrocarbon loss from pipework and / or offtake hose.
- Loss of position and / or heading.
- Failure / instability of a position reference, input sensor or machinery, with the potential to result in a loss of position / heading control.
- Collision or potential collision between any vessels / installations.
- Failure of a hawser / hose or ancillary equipment.
- High hawser tension loads beyond operational limits.
- Damage to equipment.
- Major impact on operational availability and / or efficiency.
- Any other event with the possibility of escalation and potential for causing any of the above.

Reporting of incidents via Oil & Gas UK should be carried out using the following guidelines;

1. Confirm responsibility for preparing and submitting the report. Note – where an incident involves both the FPSO/FSU and offtake tanker, both parties should agree on the content of the report prior to submission.

2. Using the appended pro-forma (electronic copies of which are available on the Oil & Gas UK website), provide brief details of the incident, including advice on the availability of further information if requested.
3. Identify any additional documents which may be provided to assist in describing the incident, including;
    - Sketches
    - Photographs
    - Full incident report
    - IMCA Station Keeping Incident Form
4. Submit the Incident Reporting form together with any additional documents to the following email address:

offtakereporting@oilandgasuk.co.uk

Submitted reports (including any attachments) will be made available to members of the Oil & Gas UK FPSO Forum and may be discussed at regular Forum meetings.

7.4 IMCA Station Keeping Incident Reporting

In addition to the voluntary reporting via Oil & Gas UK, FPSO/FSU and offtake tanker operators are requested to report station keeping incidents involving Thruster Assist / DP vessels using the IMCA reporting form appended to this document.

This report should be completed and sent to IMCA on the following occasions:

- For any unexpected loss of position and/or heading
- For an unexpected loss of functionality or availability of equipment which results in a reduced level of redundancy leading to a degraded operational status
- When the DP system performance differs from the operator's expectations

7.5 Forms

Blank examples of both of the above reporting forms are given in *Appendix G*.

8. References

1)	Guidelines For Vessels With Dynamic Positioning Systems.	IMO -1994 MSC Circular 645 IMCA M113
2)	Training and Experience of Key DP Personnel.	IMO – 1996 MSC Circular 738 IMCA M117
3)	Guidelines For The Purchasing and Testing of SPM Hawsers.	OCIMF -2000
4)	Guide to Manufacturing and Purchasing Hoses for Offshore Moorings 5th Edition	OCIMF – 2009
5)	Guidelines for the Handling, Storage, Inspection and Testing of Hoses in the Field 2nd Edition	OCIMF - 1995
6)	Offshore Loading Safety Guidelines With Special Reference To Harsh Weather Zones.	OCIMF - 1999
7)	Information Paper – Marine Beakaway Couplings	OCIMF - 2008
8)	Guidelines For The Design And Operation Of Dynamically Positioned Vessels	IMCA – M103
9)	DP Training And The Experience Of Key Personnel	IMCA – M117
10)	Standard Report For DP Vessels Annual Trials	IMCA – M139
11)	Specification for DP Capability Plots	IMCA – M140
12)	Quantified Frequency Analysis of Shuttle Tanker Collision During Offtake Operations	IMCA - M150
13)	Guidelines for the Design and Operation of Dynamically Positioned Vessels – Two Vessels Operations – A Supplement to IMCA M103	IMCA – M161
14)	Risk Minimisation Guidelines for Shuttle Tanker Operations Worldwide at Offshore Locations	INTERTANKO
15)	FPSO/FSU Marine Occupational Standards – Various	OPITO

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Appendix A

Standards Common to both FPSO/FSU & Tanker

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Appendix A: Standards Common to Both FPSO/FSU & Tanker

The following generic standards have been derived for elements which are common to both the FPSO/FSU and the Offtake Tanker. These are defined as major elements of the offtake operation which are critical for safety or the avoidance of pollution during the close proximity phase of the offtake.

The standards consider two types of FPSO/ FSU, those which have active heading control, and those which passively weather vane around the turret. There are two ways of operating the shuttle tanker during offtake; either in DP with a slack hawser or slow astern in manual control with a taut hawser. The equipment requirements on the FPSO/FSU vary not only with whether they use active or passive heading control but also with which type of tanker is attached. Hence each description identifies which combinations of heading control and tanker control method they apply to using the following abbreviations.

FPSO/FSU with active heading control	= active
FPSO/FSU with no heading control	= passive
Tanker operating in manual mode on taut hawser	= tauthaw
Tanker operating on DP	= dptank
All FPSOs/FSUs and Tankers, irrespective of type	= all

Hence the term “Applies active, dptank” means the performance requirement indicated applies only if the FPSO/FSU uses active heading control or the offtake tanker is on DP.

The standards in *Appendix A* relate to areas where the Duty Holder and Tanker Manager have to ensure compatibility between their units, and work together to ensure the operation is performed within pre-agreed safe limits.

A range of typical values or guidance information is included in *{italic text}.* This typically applies to an offtake tanker in the Aframax to Suezmax size range and is intended as preliminary information to Duty Holders unfamiliar with the subject rather than as a substitute for correct design.

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
A1	**Hardware Compatibility** Applies to all		
	To ensure connection integrity with minimum offshore remedial action.	Duty Holder and Tanker Manager to agree all interfaces during the FPSO/FSU design and build / conversion phases for any new field. The following areas represent the principal interfaces between the two vessels.	1) to 6) **Initial Assurance:** Interface review and information exchange during design and procurement. Check of layouts on FPSO/FSU tanker. *{It is particularly important that all antennae transmitting to the tanker have the correct position, separation and height on the aft end of the FPSO/FSU to avoid interference but assure alignment with corresponding tanker antennae. Normally they should have clear line of sight astern +/- 70 degrees to cater for relative yaw between the FPSO/FSU and tanker.}* Factory acceptance tests or contractor acceptance test when fitted to FPSO/FSU / Tanker to ensure that frequencies, channel ids, address codes etc are as agreed. **Verification:** Trial of position references and telemetry by passing tanker's when FPSO/FSU first installed or tanker first proposed followed by trial connection for physical interfaces.
	1) Verbal Communications	1) Agree telephone, fax and / or e-mail details plus VHF channels for initial long range contact and exchanging notices and reports. Each FPSO/FSU should have 2 x Simplex UHF channels *{primary and backup in case of external interference}* dedicated for offtake operations. There should be UHF radios fitted for both agreed channels in the FPSO/FSU CCR, Tanker Bridge, ERRV bridge, TAV bridge and minimum 2 x hand-helds on each of the tanker foc'sle and FPSO/FSU aft deck. *{the deck hand-helds should have headsets to leave hands free and offset surrounding noise. Common send and receive frequency should be used so that hand-helds can monitor both sides of conversations between tanker bridge and FPSO/FSU CCR. The frequencies should be chosen to avoid clashing with other frequencies used on the FPSO/FSU or adjacent fields}*	
	2) Telemetry System	2) Agree telemetry frequencies, ID and, if necessary, time slots, with a view to minimising interference from surrounding fields.	
	3) Position references	3) Agree address code and frequency pair for each Artemis beacon. Agree telemetry channel for each DARPS system and notify other fields in UK and Norway which use the same channel. (Applicable only to 1st generation DARPS systems) Agree requirements for other systems e.g. RADIUS/RADASCAN, HPR beacons, Fanbeam etc	
	4) Hawser Interface	4) Agree size and length of hawser chafe chain to match tanker stoppers. Agree make-up, diameter, and lengths of hawser messengers to a)match tanker traction winch, b)fit on tanker storage drum, c)provide sufficient length for transfer to tanker at a safe distance & d) avoid excess length that may foul tanker bow thrusters or slow the operation. Agree hawser transfer mechanism *{Normally pneumatic rocket for DP tankers, but possibly longer messengers and end float run out by TAV for taut hawser tankers}*	

	5) Hose Interface	5) Agree the interface requirements to match the FPSO/FSU's dry break coupling flange to the tanker's bow loading system. *{Normally dry break flange thickness and diameter plus the length and diameter of the dry break coupler's body (behind the flange) have to be matched to the tanker's flange, tanker's latch settings and the space required to engage the tanker's latching dogs behind the dry break flange. The pitch between the two eyes on the dry break coupling's lifting ring need to be wide enough for the hose bridle to pass around the bow loading systems latching mechanism without fouling. Bridle and suspension line size, materials, and lengths have to be agreed.}*	
	6) Operating procedures, limits and disconnect criteria.	6) It is vital to agree a safe system of work and communication details before the first trial connection on the field.	

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
A2	**Safe tanker approach limits** Applies to all. Note differences in guidance limits for different types of vessel are noted in the text. To ensure tanker only comes within close proximity of the FPSO/FSU if it is a) safe to do so and b) can offtake oil.		
	1) Limiting Weather for approach & Connection	1) The offtake tanker should normally only approach within 3nm provided the wind speed, Hs, visibility, and FPSO/FSU motions and yaw rate are within safe limits, as per the FSOG. *{Typical values for DP tankers are measured 10 min mean wind < 40 knots, Hs < 4.5 m, Visibility > 500 m, FPSO/FSU heading stable +/- 5 degrees}. {Typical values for taut hawser tankers are measured 10 min mean wind < 35 knots, Hs < 3.5 m, Visibility > 1000 m, FPSO/FSU heading stable +/- 5 degrees}. {Note if the FPSO/FSU heading changes more than 15 degrees during approach then DP tankers may have to pause and realign whereas taut hawser tankers may have to abort and recommence approach on the new heading if they don't have transverse thruster capability. Where taut hawser tankers have a primary and secondary relative position reference system to the FPSO/FSU stern and know the FPSO/FSU heading then it can make an approach when visibility is >500m. If either FPSO/FSU or tanker roll or pitch excessively on the approach heading then the offtake may have to be postponed to avoid excessive hawser loads on connection}*	1) to 6) **Initial Assurance:** System design limits, appropriate FMEA / trial results, and previous experiences from the Duty Holder, tanker operators and incident lessons incorporated into useable check lists and understandable limits within the offtake terminal manual. **Verification:** Review of manual by offtake tankers, tanker managers and an independent competent person from within Duty Holder's organisation (or external). Checklists tested by use during trial connection. **Ongoing Assurance:** All checks and information exchanges performed during approach, at the correct approach distance, for each offtake. FPSO/FSU OIM / Marine Operator and tanker Master to discuss the actual conditions and equipment versus the advisory limits and take a joint decision on it being safe to proceed with mooring approach. Both parties should be fully aware that either has the right to abort or postpone the offtake if they are not fully happy that it is safe to approach.
	2) Communications, Position References & Telemetry systems (common to both FPSO/FSU and Tanker)	2) VHF communications should be established at or before 10 nm. All possible position references and telemetry systems should be tested and confirmed operational prior to the tanker approaching within 10 nm with the remaining short range relative position references tested and confirmed operational as soon as possible thereafter. UHF communications should be established and tested for interference at 3nm. The approach should be aborted if the minimum levels of communications, position references or telemetry are not available at each test.	

		3) FPSO/FSU equipment	3) FPSO/FSU Gyros should be checked against each other before the tanker approaches within 10nm to ensure that they all agree. FPSO/FSU cargo & ballast pumps, IG plant, load computer, valve controls, stern discharge system and necessary power supplies should all be tested and functioning. (For active heading controlled FPSOs/FSUs the DP controls, all thrusters and redundant power supplies should have been tested and be functioning adequately to ensure heading control. The thrusters and generators should be holding the FPSO/FSU on the required approach heading within agreed thrust / power limits *{<50% Capability}* and with any load shedding system giving thrusters priority. All FPSO/FSU on board plant adjustments, maintenance, equipment / fuel changeovers and other activities which may trip generators to an extent where the FPSO/FSU could lose heading control should have been completed or put on hold until the offtake tanker has finished and departed). The FPSO/FSU should complete all checks prior to the tanker approaching within 3nm.	
		4) Tanker Equipment	4) Tanker Bow Loading System (BLS), cargo lines & all equipment in machinery space required for close proximity operations should be tested and functioning, sufficient generators should be on line and available; all pitch controls including fail safes, all thrusters and steering motors, redundant power sources should be tested and confirmed functioning *{at 10nm range}*. Tanker gyros & repeaters should be checked against each other *{before the shuttle tanker approaches within 10nm}* to ensure that they agree *{check no gyro is drifting}.* The thrusters and generators should be tested for holding the tanker on the required approach heading within agreed thrust / power limits *{<50% Capability for approach to continue}.* The machinery space should be manned up *{at 10nm}* and all electrical and mechanical maintenance that could inadvertently lead to critical systems tripping should be brought to a close, until after the tanker has completed the offtake and departed. For DP tankers, the tanker's DP systems should be tested before approaching within 500m of the FPSO/FSU. The tanker should have both computers and three independent relative position references working and on line.	
		5) Tanker Approach Speed	5) The tanker should reduce speed to agreed limits as it approaches the FPSO/FSU and confirm having done so to the FPSO/FSU at each stage. *{Typical speed limits are, <5knts @ 3nm; <2knts@1nm; <0.5knts @ 1000m and < 0.5 knots within 500m.} NB - Tanker to be stopped before 500m to select DP control and stabilise the mathematical model.*	

		6) Helicopter & 3rd party ship Operations	6) <u>Helicopter Operations</u> Helicopter Operations to the tanker should be suspended whilst the tanker is approaching or departing, and helicopter operations to the FPSO/FSU should be suspended during tanker connection and disconnection. Helicopter operations to the FPSO/FSU during tanker approach should be advised to the tanker beforehand, in order that any potential impact on position reference signals may be foreseen and reacted to appropriately. Heliops may be permitted during actual offtake provided the tankers' IG vent plumes are prevented from interfering with the helicopter approach and departure tracks <u>Simultaneous Field Operations</u> Field operations involving other vessels / installations within 3nm of the FPSO/FPU should be advised by the FPSO/FPU to the tanker in advance of arrival. This advice should comprise a summary of the vessel/installation position, planned movements, workscope, restrictions on movement, and any foreseeable impact on the offtake operation. Exclusion and restricted zones/sectors may be pre-agreed and incorporated into the Field Joint Operations Manual to provide generic guidance on tanker movement restrictions, and to assist with specific risk assessment where appropriate. Planned operations involving other vessels/installations within 500m of the FPSO/FSU during tanker approach and whilst connected, should either be covered by generic procedural restrictions, including that the tanker should be downweather, (for routine operations such as supply vessel operations), or be subject to specific risk assessment (for non-routine operations). All planned simultaneous operations should be agreed between all vessels/installations prior to tanker approach. Where the risk of collision exists between a tanker and other vessel/installation operating within the field (e.g. within 3nm of the FPSO/FPU), the field operator may provide a Towing Assist Vessel (TAV) to further reduce the risk to the tanker and other installation/vessel. Assurance of equipment compatibility between the tanker and TAV, and capability of the TAV to provide effective assistance may be provided by emergency towing trials. A typical tanker operator standard for towing trials is as follows:	

		Regular trials to maintain the effectiveness of the Emergency Towing Procedures and Systems should be carried out between the TAV and the ST. The frequency of these trials should be based on the results achieved, but should in general be as follows; - DP Class I vessels: Emergency towing should be conducted minimum every 3 months; - DP Class II vessels: Emergency towing should be conducted minimum every 6 months.	

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
A3	**Safe Tanker Offtake Limits** Applies to all. Note differences in guidance limits for different types of vessel are noted in the text. To ensure tanker departs from close proximity to the FPSO/FSU prior to it becoming dangerous to remain. To ensure tanker only comes within close proximity of the FPSO/FSU if it is a) safe to do so and b) can offtake oil.		
	1) Limiting Weather for Approach & Connection	1) The tanker should normally only continue offtake provided the wind speed, Hs, visibility, and FPSO/FSU motions are within safe limits, as per the FSOG. *{Typical values for DP tankers are measured 10 min mean wind < 50 knots, Hs < 5.5 m, , Visibility > 100 m, FPSO/FSU. {Typical values for taut hawser tankers are measured 10 min mean wind < 45 knots, Hs < 4.0 m, , Visibility > 100 m FPSO/FSU / tanker roll and pitch not leading to snatch loads on hawser}.*	1) to 7) **Initial Assurance:** System design limits, appropriate FMEA / trial results, and previous experiences from the Duty Holder, tanker operators and incident lessons incorporated into useable check lists and understandable limits within the offtake terminal manual. **Verification:** Review of manual by offtake tankers, tanker managers and an independent competent person from within Duty Holder's organisation (or external). Checklists tested by use during trial connection.
	2) Limiting Hawser Tensions	2) The offtake should normally only continue offtake provided the hawser tension remains within acceptable limits. *{**The hawser in a DP offtake** is normally slack with tensions < 3%NDBS, so any significant hawser tension is indicative of a problem. {**The hawser in a taut hawser offtake** is obviously used in tension, so it is particularly important that all tension cycles are recorded and added to keep track of fatigue life remaining. Typical tension alarm values for DP tankers are as follows. Tanker Master and OIM consider disconnect if one pull > 19% of the hawser NDBS and particularly if two pulls exceed 19% in any 30 minute period. Immediate disconnect if any pull exceeds 27% of the hawser NDBS}.*	

		3) Position and Relative Heading Limits	3) The offtake should normally only continue if the tanker bow is within agreed separation limits from the FPSO/FSU stern and if the Tanker Heading aligns with the FPSO/FSU heading within agreed limits. These limits together with appropriate actions should be shown on a drawing within the manual. *{Typical values of separation depend on the hawser and hose length both for DP and taut hawser operations. A typical manual drawing is shown in section 6. The inner yellow (stop export) and red (disconnect) tanker limit are placed relatively close to the tanker's normal operating box, to ensure that remedial action is taken before the tanker builds up forward momentum. The outer yellow and red separations are intended to release hose and hawser before the equipment is damaged. The relative heading limit is a measure both of fishtailing and of one vessel being wind rode whilst the other is current rode. Red should normally take place by the time the relative misalignment exceeds 40 to 45 degrees.}*	**Ongoing Assurance:** All checks and information exchanges performed during approach, at the correct approach distance, for each offtake. FPSO/FSU OIM / Marine Operator and tanker Master to discuss the actual conditions and equipment versus the advisory limits and take a joint decision on it being safe to proceed with mooring approach. Both parties should be fully aware that either has the right to abort or postpone the offtake if they are not fully happy that it is safe to approach.
		4) Communications, Position References & Telemetry systems (common to both FPSO/FSU and Tanker)	4) In the event of failures resulting in fewer than 3 references being on line, DP tankers should suspend cargo transfer and risk assess the situation. The assessment should take into account the overall risk including the risks involved in disconnection and reconnection. or revert to manual taut hawser operation if all parties agree and are happy with this course of action. The offtake should only continue if there are adequate communication links between the tanker and the FPSO/FSU. In all cases the change of status will be discussed between FPSO/FSU and Tanker as soon as practicable but this will not inhibit the tanker crew taking safe action first.	
		5) FPSO/FSU equipment	5) FPSO/FSU should inform Tanker immediately if there is any reduced functionality or in any critical equipment e.g. gyros, FPSO/FSU cargo & ballast pumps, IG plant, load computer, valve controls, stern discharge system and necessary power supplies which may either cause the tanker to lose station *(e.g. gyro error)* or inhibit transfer. (For active heading controlled FPSOs/FSUs this would also include the DP controls, all thrusters and redundant power supplies required to ensure FPSO/FSU heading control. The FPSO/FSU marine operator and Tanker Master should agree a new heading if the thrusters and available power supply have difficulty holding the FPSO/FSU on the required heading within agreed thrust / power limits *{>50% Capability}.* Reference should be made to the FSOG as appropriate. The FPSO/FSU should inform the tanker master of any process instabilities which may affect their ability to continue discharge (FPSO/FSU plant and generation ESDs) and request him to disconnect immediately if the situation could jeopardise the FPSO/FSU's ability to maintain heading.	5, 6 & 7) **Initial Assurance:** System design limits, appropriate FMEA / trial results, and previous experiences from the Duty Holder, tanker operators and incident lessons incorporated into useable check lists and understandable limits within the offtake terminal manual. **Verification:** Review of manual by offtake tankers, tanker managers and an independent competent person from within Duty Holder's organisation (or external). Checklists tested by use during trial connection.

	6) Tanker Equipment	6) Tanker Master should inform FPSO/FSU immediately if there is any reduced functionality in any critical equipment e.g. BLS, all equipment in machinery space required for close proximity operations, generators, all pitch controls including fail safes, all thrusters and steering motors, redundant power sources, tanker gyros. Reference should be made to the FSOG as appropriate. The Tanker master and FPSO/FSU marine operator should agree a new heading if the thrusters and available power supply have difficulty holding the tanker on the required heading within agreed thrust / power limits *{>50% Capability}.*	**Ongoing Assurance:** All checks and information exchanges performed at the agreed frequency during each offtake. FPSO/FSU OIM / Marine Supervisor and tanker Master to discuss any change in actual conditions or equipment status / availability on either vessel compared to the advisory limits. They should take a joint decision on it being safe to continue but either may decide it is prudent to stop loading or disconnect. Both parties should be fully aware that either has the right to abort or postpone the offtake if they are not fully happy that it is safe to continue.
	7) Helicopter & 3rd party ship Operations	7) <u>Helicopter Operations</u> Helicopter operations to the Tanker or FPSO/FSU may be permitted during actual offtake provided the tankers' IG vent plumes are prevented from interfering with the helicopter approach and departure tracks. Any helicopter operations should be advised to the other vessel beforehand, in order that any potential impact on position reference signals may be foreseen and reacted to appropriately. <u>Simultaneous Field Operations</u> Field operations involving other vessels / installations within 3nm of the FPSO/FPU should be advised by the FPSO/FPU to the tanker in advance of arrival. This advice should comprise a summary of the vessel/installation position, planned movements, workscope, restrictions on movement, and any foreseeable impact on the offtake operation. Exclusion and restricted zones/sectors may be pre-agreed and incorporated into the Field Joint Operations Manual to provide generic guidance on tanker movement restrictions, and to assist with specific risk assessment where appropriate. Planned operations involving other vessels/installations within 500m of the FPSO/FSU during tanker approach and whilst connected, should either be covered by generic procedural restrictions (for routine operations such as supply vessel operations), or be subject to specific risk assessment (for non-routine operations). All planned simultaneous operations should be agreed between all vessels/installations prior to tanker approach. Where the risk of collision exists between a tanker and other vessel/installation operating within the field (e.g. within 3nm of the FPSO/FPU), the field operator may provide a Towing Assist Vessel to further reduce the risk to the tanker and other installation/vessel.	

		Assurance of equipment compatibility between the tanker and TAV, and capability of the TAV to provide effective assistance, may be provided by emergency towing trials. A typical tanker operator standard for towing trials is as follows: Regular trials to maintain the effectiveness of the Emergency Towing Procedures and Systems should be carried out between the TAV and the ST. The frequency of these trials should be based on the results achieved, but should in general be as follows; - DP Class I vessels: Emergency towing should be conducted minimum every 3 month; - DP Class II vessels: Emergency towing should be conducted minimum every 6 month."	

Appendix B

Standards for FPSO/FSU

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Appendix B: Standards for FPSO/FSU

The following generic standards have been derived for elements on the FPSO/FSU. These are defined as major elements of the offtake operation which are critical for safety or the avoidance of pollution during the close proximity phase of the offtake.

The standards consider two types of FPSO/FSU, those which have active heading control , and those which just passively weather vane around their turret. There are two ways of operating the shuttle tanker during offtake; either in DP with a slack hawser or slow astern in manual control with a taut hawser. The equipment requirements on the FPSO/FSU vary not only with whether they use active or passive heading control but also with which type of tanker is attached. Hence each description identifies which combinations of heading control and tanker control method they apply to using the following abbreviations.

FPSO/FSU with active heading control	= active
FPSO/FSU with no heading control	= passive
Tanker operating in manual mode on taut hawser	= tauthaw
Tanker operating on DP	= dptank

Hence the term “Applies active” means the performance requirement applies only if the FPSO/FSU uses active heading control.

A range of typical values or guidance information is included in *{italic text}.* This typically applies to a FPSO/FSU in the Aframax to Suezmax size range and is intended as preliminary information to Duty Holders who are unfamiliar with the subject rather than as a substitute for correct design.

The Standards distinguish between “new” and “existing” FPSOs/FSUs.

An “Existing FPSO/FSU” means any floating vessel already installed on a UK field before 1st July 2002 to export produced oil to an offtake tanker in a direct tandem offtake operation.

A “New FPSO/FSU” means any floating vessel which is installed on a UK field after 1st July 2002 to export produced oil to an offtake tanker in a direct tandem offtake operation. *{In this context “New” includes both newly built facilities and existing facilities being relocated to a new field}.*

Although the standards in this revision of the document differ from the original document, this document retains the above definitions since the majority of FPSOs/FSUs referred to are still operating.

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
B1	**FPSO/FSU General** Applies active & unless noted otherwise as applying to Passive.		
	1) To have accepted safety case for intended duty To limit pollution risk offshore To be equipped for stern discharge To safely maintain heading during offtake (if Active). Else to freely weather vane (if Passive) *FPSO/FSU's may need to be equipped for VOC recovery (where future National regulations or local company policy requires).*	1) FPSO/FSU to have fully functioning machinery, load computer, cargo system, inert gas & venting systems, ballast system, COW systems, position reference / sensors, radio equipment and safety systems. The FPSO/FSU should be suitably manned *{refer to section 5}*, and be able to demonstrate adequate inspection, maintenance and repair.	1) **Initial Assurance & Ongoing Assurance:** ICP review and inspection of FPSO/FSU build and operation. **Verification:** Auditing of FPSO/FSU and independent survey of all arrangements that could affect offtake.
	2) Stern Discharge System	2) Covered by separate standard	2) Refer to B2 for details
	3) Station Keeping Capability	3) **For North Sea & Irish Sea:** Passive freely weathervaning FPSOs/FSUs may be acceptable. **For Atlantic Frontier or other areas with very strong currents and difficult metocean conditions:** Active heading control should be employed to assist the tanker provided the FPSO/FSU can demonstrate adequate redundancy / integrity. New "Active" FPSOs should be built to IMO Class 2 equivalent redundancy standards.	3) Refer to B6 for details, including the need to document that the systems station keeping capabilities match the expected duty and operating limits at the field.
	4) FPSO/FSU Emergency Shut Down (ESD) System	4) FPSO/FSU's typically have multi-level ESD systems Certain offtake elements are also safety critical, *{as per Section 4) }*. These should only be shutdown on the higher level of ESD or when there is a direct safety threat from continued operation. (e.g. gas detected in vicinity of aerials / intakes). *{Hose and hawser reel power should also be available at higher ESD levels on FPSOs/FSUs where trailing equipment poses a risk subsea.}*	4) **Initial and Ongoing Assurance:** Hazop, review of FPSO/FSU shutdown logic versus tandem offtake requirements for safe approach both by those skilled in process control and those skilled in offtake tanker collision risks.

			Verification: Testing shutdown logic cause and effects on CEs.
	5) Plant layout versus collision zone.	5) New FPSOs/FSUs should be laid out to minimise the escalation potential from shuttle tanker collision *{e.g. Gas flaring and high risk process plant located away from the stern collision zones}*. Existing FPSOs/FSUs should evaluate the cost benefit of external structure and fendering to reduce the shuttle tanker collision risk to such process plant. Consideration should be given to ensuring that equipment which should be placed close to the stern e.g. for hose and hawser handling, can resist foreseeable impacts.	5) Concept Risk Assessment for New FPSOs/FSUs or cost / benefit ALARP analysis for existing FPSOs/FSUs.

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
B2	**Stern Discharge System** Applies to Active & Passive		
	1) To deploy FPSO/FSU hawser	1) Hawser winch to be able to deploy or recover the hawser in a timely manner *{10 minutes}.* Winch to be fitted with automatic spooling gear for the correct rope size. Hawser winch and hose winch to be controlled by a single man from the same point if hose deployed and recovered with hawser.	1) **Initial Assurance:** Design check winches & foundations versus guaranteed hawser weak link load. *{Load to be applied from all feasible directions due to potential FPSO/FSU & shuttle tanker position losses}.* Acceptance test on speed and spooling. **Ongoing Assurance:** Planned maintenance of winch and spooling mechanism. Refer to B1 for details of interface to FPSO/FSU ESD system.
	2) To deploy FPSO/FSU hose	2) The hose storage and recovery system should be appropriate for the field water-depth and FPSO/FSU deck space. A) Chute systems should be covered in Teflon or similar to reduce friction and prevent damage to the hose. There should be adequate recovery and deployment winches to overcome friction in the chute both ways. The mechanism for connecting the inboard hose end to the export pipe should require minimal manual intervention from aft deck crew. B) Powered reels should be capable of deploying and recovering the entire hose length *{within 10 minutes}* and storing the entire length on the drum. The reel should incorporate fluid swivels to allow export crude to be pumped from the export system into the hose without the need to connect the hose to the export pipe work following deployment. The reel should incorporate a spooling mechanism or hose guide on the drum surface. These should be suitably lined or coated to minimise damage to the hose. The hawser winch and hose winch should be controlled by a single man from the same point if hose deployed and recovered with hawser.	2) **Initial Assurance:** Design check reels or other offtake hose support systems including foundations to withstand a load well in excess of the dry break / marine breakaway coupling pull off load. *{Load to be applied from all feasible directions due to potential FPSO/FSU & tanker position losses}.* Acceptance test on speed and spooling. **Ongoing Assurance:** Planned maintenance of all recovery connection and spooling mechanisms. Refer to B1 for details of interface to FPSO/FSU ESD system.

		C) Where the hose is suspended from the stern there should be adequate water depth to prevent the lower end striking the seabed in storm conditions. A retrieval line should be permanently connected to the outboard end dry break coupling for recovery. *{The hose recovery system should be powerful enough to recover a 100% full hose without any need to drain the hose down. All systems should either have redundant power and recovery motors or an alternative means of recovering the hose to a safe configuration should the reel motor fail. All systems including hawser winch should be operated from a safe position, {i.e. a location clear of the hawser} with good vision of the hawser and hose going over the stern and preferably protected from the elements.All systems should have provisions onboard the FPSO/FSU to flush oil out of the export hose and back to slops tank}.*	
	3) Export Pipework	3) The export pipework should be fitted with a FPSO export shutdown valve inboard of the hose reel / or other hose coupling. *This valve should be located inboard away from potential collision damage zones}.* The valve should shut {tripping export pumps} on export shut down being initiated from either the FPSO/FSU or the Shuttle Tanker via a 2-way telemetry system between the two.	3) **Initial Assurance:** Test and record PSV leak integrity and closure time from issuing FPSO/FSU and tanker ESD signals. **Ongoing assurance:** Annual repeat of leak integrity and closure time tests. **Verification:** ICP reviews records. Refer to B1 for details of interface to FPSO/FSU ESD system.
	4) Telemetry, emergency export stop and disconnect.	4) The telemetry system should provide a “greenline” permit for the FPSO/FSU to start export pumps. Export should automatically cease if the Green Line permit to pump signal is lost during export. The export pump and export valve shut down times should be as short as possible commensurate with the surge pressure study of the FPSO/FSU pipework, and in any event shorter than the tanker bow loading valve closing time.	4) **Initial Assurance:** Commissioning tests, trial tanker connection on field. **Ongoing Assurance:** test telemetry based ESD systems functioning before start of each loading.
	5) To control the effects of oil ignition	5) The stern discharge area should be protected by either a deluge system at the PSD valve the hose coupler and any fluid swivels or by foam monitors which can be trained on these areas from a safe location.	5 & 6) **Initial Assurance:** Design review and acceptance tests. **Ongoing Assurance :** Periodic tests
	6) To monitor aft deck operations	6) The Stern Discharge Area should be monitored by CCTV with a display adjacent to the cargo control console during offtake. Lighting on the aft end of the FPSO/FSU shall be configured so as not to blind its own CCTV system or indeed the CCTV used to view the Hawser and Hose catenary from the shuttle tanker.	

	7) To limit risk to aft deck personnel	7) The deck in way of stern discharge equipment should be non-slip coated and fitted with save alls to prevent hydrocarbon overspill to main deck. All machinery should be guarded as far as practicable given the duty. Access platforms and guard-rails should be fitted to ensure messengers can be connected *{e.g. between the hose and hawser end}* without personnel having to hang overboard outside the guarded areas. All machinery and aft deck work should only be performed by FPSO/FSU crew having being briefed on the operation, hazards, and machinery and issued with adequate PPE. Control stations and personnel standby locations should be protected from the effects of breaking ropes by location or physical protection. *{All non- inducted personnel should be kept clear during connected operations. Occasional chaperoned access for inspection}.*	7) **Initial & Ongoing Assurance:** Design review plus onboard housekeeping and training routines.

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
B3	**Hawser system** Where applicable 1 & 2) To provide mooring link between FPSO/FSU and tanker To be suitable to connect to tanker BLS system To be easily deployable and recoverable with easy rigging connections and fast enough winches to minimise the time the tanker is in close proximity. To be equipped with sensors to alert operators when tension too high *{Typically comprises a chafe chain at each end, where it passes through fairleads or into stoppers, with a nylon "braidline" or "superline" in between}.* This is the main station keeping mechanism for taut hawser tankers. It also forms a backup station keeping mechanism for DP tankers in the event of any single failure occurring. Its slack catenary shape provides a visual back up position check for DP tankers which also can revert to taut hawser mode in the event of a single failure.	1) Long enough to maintain adequate tanker to FPSO/FSU clearance when connected. *{> 80m though short separation of 40m and occasionally bridle arrangements are used for some taut hawser offtakes, particularly where different FPSO/FSU and tanker size makes the arrangement prone to fishtailing on longer hawsers}* 2) NDBS & Load extension properties matched to permit tanker to sit back slow astern on hawser and still absorb relative vessel motions within low tension range. *{Typical range 80m x 650 tonne NDBS Nylon Superline for mixed DP / taut hawser operation to 40m double grommet made from 540 tonne NDBS Nylon Braidline for some taut hawser operations with no DP option.* 3) To have enough residual strength on retirement to safely survive the maximum 'disconnect' tensions permitted operationally before immediate disconnection. This should allow for fatigue damage and non-inspectable internal yarn degradation, e.g. under high tension or compressive cycling. *For operations requiring regular taut hawser connections as well as DP, higher loads are normal and a more sophisticated retirement criteria may be required.*	1, 2 & 3) **Initial Assurance:** Hawser sized by operator / tanker owner's previous successful practice and checked / **verified** by tandem mooring computations and / or model tests for operational metocean conditions. Hawser is specified, manufactured, spliced inspected and tested in accordance with OCIMF Guideline (Ref 3) Specify a retirement criteria based on OCIMF prototype test fatigue load data (wet service) and OCIMF load range vs load cycle relationship. *{Note that a safety factor of 10 on load range should be applied to ensure a factor of at least 2 on fatigue endurance and take account of the inability to inspect internal condition}.* Specify operating tensions where crew should disconnect immediately. {Typically 1 pull @ 19% NDBS for pure DP operation. Typically 1 pull @ 27% or 2 pulls > 19% NDBS in any ½ hour period for taut hawser operations.) Fit and calibrate a load cell to monitor tension loads.

			Ongoing Assurance: Crew inspect hawser for external damage as it is recovered. FPSO/FSU & tanker crew disconnect if tensions exceed specified limits. Crew log hawser history and significant tension peaks during each offtake. (Note if the hawser is ever used for taut hawser operations then the crew should calculate cumulative fatigue damage versus retirement criteria for all operations). Regular calibration of load cell in PM system. **Verify** by auditing operations and records. **Verification** of the specified retirement criteria can be by destructive testing of used hawsers (yarn realisation techniques may be used). All of the requirements should point to a decision which restricts taut hawser use of normally DP hawsers. Retirement of taut hawsers should be based on a tension monitoring and recording device which advises on a combined number and level of peak loads to provide a good indication of probable fatigue.
	4) *Consider incorporation of weak link.*	4) Weak link to break at a predictable load *{< 66% of hawser NDBS}* which is greater than the maximum hawser "disconnect" tension but less than the load which can damage the hawser winch mechanism, stoppers or foundations at either end. The weak link is to ensure that the hawser parts rather than cause structural damage The decision as to whether a weak link should be incorporated in a hawser system should take account of the inherent risks involved in activation / failure of the link. This should include consideration of the potential energy present in a stretched hawser and the destructive potential of components catapulted at high velocity following activation / failure of the link.	4) **Initial Assurance:** Design check winch & foundations versus weak link load. Weak link concept based on predictable reliable failure *{e.g. Notched well supported section in pure shear}.* **Verify:** Test break of new prototype. **Ongoing assurance:** Inspect weak link during hawser change out & **verify** by test breaking 1st retired weak link.

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
B4	**Export Hose System** Applies all		
	1) to 8) To provide flexible oil flow path between FPSO/FSU and Tanker. To be electrically discontinuous To maintain high standards of integrity under all design conditions, including emergency disconnect, to minimise the risk of pollution. To be easily deployed and recovered back to the FPSO/FSU. To be suitable for connection to ST BLS system. *{Typically comprises bolted sections of reinforced bonded construction offshore loading hose.}*	1) Long enough to provide enough slack for the hawser system to stretch to breaking point, but short enough to minimise the risk of the hose catenary chafing against the tanker's bulbous bow, and to also minimise the risk of interference with the bow thrusters. *{Typical lengths in use, range between 1.5 and 2.0 times hawser length}*. 2) When considering the hose diameter the following factors should be among those considered: - the duration of pumping. The larger the hose the less flowing friction and the shorter the offtake duration with a potential impact on the overall risk. However tankers have a maximum bulk loading rate that they are designed to accept, sometimes limited by their venting capability, and this should not be exceeded; - the faster the flow rate the higher the potential surge pressures in the event of a valve failure on the tanker. The surge pressures should be analysed as to whether they can be accepted not just by the hose (refer to paragraph 4) below), but by the FPSO piping systems; - the volume of oil that may enter the sea in the event of a hose failure or MBC activation; - the volume of oil that is stored in the hose when on the FPSO reel or other arrangement, and the safety risk that this inventory may represent; - the larger the hose diameter the larger the necessary reel to ensure the hose minimum bend radius is not exceeded and hence the loss of available deck space; - the mass of each hose section which may have to be handled from the reel during any hose section repairs or hose string replacement" 3) Hose sections to be designed and fitted with bend restrictors at the flanged connections as required to match the local bending and torsion loads to which they may be subjected during construction service and offshore replacement. *{Typical reinforcements may be to protect the flanges and hose whilst on a storage reel or chute and to withstand extra local bending or torsion at the outboard dry break coupling, the inboard FPSO/FSU coupling, or any intermediate breakaway coupling. The hose design*	1 & 2) **Initial Assurance / Verification:** Hose length and hawser length demonstrated by catenary calculations and plots taking into account hawser stretch characteristics and FPSO/FSU / tanker geometry. 3) **Initial Assurance:** Hose manufacturer design calculations checked as reflecting the correct FPSO/FSU storage and retrieval system plus end / ancillary fittings.

			should take account of the degrees of freedom in the attachment systems on both the FPSO/FSU and Tanker versus operational movement, and also of tension/bending on the FPSO/FSU storage and retrieval system.} 4) Hose system to resist maximum working pressure under all possible operating conditions throughout the life. This includes loads when full of oil or seawater and dynamic pressure surges possible under valve failure, emergency disconnect or pull off scenarios. Guidance on the capability of the hose to accept surge pressures can be found in Reference 4 Section 5.5 5) Dry break hose end valve should fail closed under all flow conditions if the hose is released from or pulled off the tanker bow fitting to minimise pollution. *{The hose end disk valve should typically close over a duration of 25 to 35 seconds. Manufacturers of 20"dry-break couplers include Pusnes, Hitec, Speedseal & MIB}* 6) Reference 4 provides general guidance on the standard for electrically discontinuous hoses, and on their use within its Section 5.3. This guidance is also given in the International Oil Tanker and Terminal Safety Guide Section 18.2.6.4, that only one discontinuous hose should be used in a string. For a reeled system the discontinuous section is typically placed at the tanker end of the string so that any accumulated static charge would be earthed back to the FPSO during operation, and avoid the risk of arcing during either disconnection at the tanker bow manifold or during reeling back to the FPSO. It is also worth mentioning that during the procedure for the recovery of export reeled hose, the hose should be depressurised and either emptied of fluid or the level reduced after flushing but before reeling. 7) Where offloading hoses are purged to remove fluids prior to disconnection, the following considerations should be taken into account: • The purging medium should comprise an inert gas. Use of compressed air for hose purging, with the resultant introduction of air to the hydrocarbon-rich ullage space in loaded cargo tanks, should be avoided.	4 & 5) **Initial Assurance:** System pressure surge calculations performed and checked in accordance with process design codes taking due account of actual valve closing sequence and times during all emergency disconnect and shut down scenarios. Such calculations should take into account: - valve type (disc valves may decrease flow linearly with displacement; butterfly valves constrict the flow very little in the first 85% of closure and then very rapidly in the last 15%); - closing sequence and times; valve closing times should be verified to be no less than used in the design assumptions; - the possibility of pressure surge waves reflected from diameter step changes or from severe bends, and the combining of these at the same time and location at an interval after the initial pressure surge. 3, 4 & 6) **Initial Assurance:** Hose system specified, manufactured and tested in accordance with OCIMF guidelines (ref 4) & ISGOTT.

		• During connection and disconnection a floating hose may form a bight in the vicinity of the tanker bow and thus require greater care in the co-ordination of the hose transfer in order to avoid contact between the hose end coupling and the tanker hull. • The effect of surface current on the floating section of the hose. If the hose is deployed and recovered using a reel, then this may cause the angle of the hose approach to the reel to be outwith that required for correct stowage on the drum. • Where an MBC is incorporated into the hose string, the introduction of bending loads on the MBC due to its weight in relation to the adjacent buoyant hose sections, together with the bending loads on the adjacent hose sections. Consideration may be given to reducing these loads by the installation of MBC flotation collars. • The wave induced loads and consequent bending moments imposed on a floating hose (and MBC where appropriate) in the most severe weather conditions in which connection and disconnection are carried out.	
	8) Marine Breakaway Coupling. (MBC) This typically comprises a link designed to fail at a known load. Spring loaded petals close the upstream hose end automatically on failure	8) MBC used if the bow fitting on any of the offtake tankers is not designed to automatically release the dry break coupling under loads before the hose ruptures or the FPSO/FSU hose / reel connection is damaged. *{If fitted the position should be near the outboard hose end, the design failure load should be > max working tension/bending & below the hose burst pressure.* *Refer to Ref. 7) OCIMF information paper*	8) **Initial Assurance:** Design calculations demonstrate break load in correct range. **Verified** Prototype component testing. **Ongoing Assurance** Inspection for bolt stretch / displacement on retrieval after every offtake. Dismantle, check times / components & remake annually. **Ongoing Assurance:** Inspect MBC for bolt stretch or carcass movement on every recovery. Dismantle , check closure times and remake every third year.

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
B5	**Power Generation / Distribution** Applies Active FPSO/FSU		
	1 & 2) To reliably power thrusters, control systems, references and all normal hull, production and stern discharge functions. To fail to safe condition as a far as can reasonably be achieved. To alert operators on system malfunction.	1) Existing active heading control FPSOs/FSUs should have their power generation and distribution systems enhanced as far as reasonably practicable to achieve the ability to maintain heading following a failure of any single active component including a main generator. *{It is important that where thruster and control system power comes from generators & boards also powering main production loads that the overall load shedding logic assigns a top priority to maintaining active heading control during tandem offtake operations. Thruster failure under active heading control could result in a sudden FPSO/FSU change in heading and a resulting over correction from the tanker's DP system as it tries to follow}* 2) FPSOs/FSUs which were built or substantially converted after 2000, where they require active heading control should have all power generation and distribution *{which is used to actively control heading}* to IMO DP Class 2 standards in all areas where power loss could affect its ability to maintain station in close proximity FPSO/FSU operations. *{Load shedding logic and priorities versus other production supplies should consider the adequacy of redundancy to resist single failures to IMO DP 2 standards}*	1) to 7) **Initial Assurance:** FMEA including proving trials of FPSO/FSU power, thrusters and controls in accordance with IMO and IMCA standards (Ref section 4.4). System capabilities should be calculated and documented both with everything working and with each significant single failure. *{This to illustrate the power balance between duplicate systems is understood, and that crew understand operating limits to cater for the effects of a single failure}.* **Ongoing Assurance:** Annual trials to confirm functioning of equipment and alarms plus retrial following repair or modification (ref. Section 4.4). *{All trials should be carried out by proper simulation of failures (e.g. by removing terminals, disconnecting 24V distribution circuits, tripping machinery etc) and investigating unexpected results and recording results}.* **Verification:** On board independent audit of FMEA, trials reports and annual tests. *{All such reports should be on-board, up to date, and understood by CCR DP / ATC operators and maintenance supervisors / technicians with respect to actions which need to be taken a) to maintain high levels of integrity and b) to diagnose and overcome failures}*
	3 & 4) Power generation and main switch board	3) Single HV switchboards are acceptable for existing FPSOs/FSUs where it is no longer reasonably practicable to provide redundant supplies to the thrusters. *{However all reasonably practicable enhancement and operational control steps should be taken to ensure integrity so that they don't fail or trip during close proximity operations. This may include limiting large production motor starts / changeovers during offtake and any maintenance activities which could induce load shedding / generator tripping or any other instability in the system. Retaining thrusters should be a top priority during offtake in any load shedding scheme on an active FPSO/FSU}*	

		4) Where thrusters are powered from a single switchboard, the cells should be separated so that a local fire or fault in one thruster cell will not immediately affect the other thrusters cell. GF	Refer to B1 for details of interface to FPSO/FSU ESD system.
	5) DP Heading Control	5) The DP heading control system should monitor the generator outputs versus thruster and additional load consumers and excessive power levels should alarm to alert the operators. Where thrusters are powered by the main bus an alarm should activate at {50%} power level. Good planning of standby and on-line generators should be arranged to ensure that sufficient power is always available, to include for a single generator failure.	
	6) Power Management	6) For vessels with power management systems, such systems are to be UPS powered. The UPS should have alarms for low voltage and charger failure. Loss of the power management system should result in the boards "failing as set". Generator control systems and charging units should be alarmed for low voltage and charger failure.	
	7) LV Power / Control system power	7) Special attention shall be given to the 220V & 24V distribution for DP, references, sensors, controls, & thrusters, such that failure of a single fuse will not disable any non redundant system. On vessels with a single 220 V main board, consumers where single fuse failure could lead to loss of a critical control function, resulting in potential loss of vessel position, should have backup supplies from either the 220 V emergency board or a 24 V system. Systems where single fuse failure could lead to loss of a critical control function, resulting in potential loss of vessel position, should have duplicate power from an independent source. All battery-backed systems should be fitted with status monitoring such that charger failure or low voltage alerts the operators.	

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
B6	**Thrusters & Steering Gear** Applies to Active FPSO/FSU		
	1 & 2) To provide adequate FPSO/FSU heading control to assist tanker connection, offtake & disconnection To fail to safe condition as a far as can reasonably be achieved. To alert operators on system malfunction	1) Existing active heading control FPSOs/FSUs should have minimum two operational thrusters at a significant lever arm from the turret. *{The minimum is 2 transverse stern thrusters if the turret is near the bow whereas more transverse bow thrusters may be required if the turret is nearer amidships. Number and size of thrusters to match required moment to maintain heading control after worst single failure}.* 2) FPSOs/FSUs which were built or substantially converted after 2000, where they require active heading control should have thrust arrangements to IMO DP class 2 requirements and thrusters should be sized with due regard to residual capability following worst case single failure matching the required metocean operating limits for offtake at the most severe operating location.	1) to 6) **Initial Assurance:** FMEA including proving trials of vessel power, thrusters and controls in accordance with IMO and IMCA standards (Ref section 4.4). System capabilities should be calculated and documented both with everything working and with each significant single failure. *{This to illustrate the power balance between duplicate systems is understood, and that crew understand operating limits to cater for the effects of a single failure}.* **Ongoing Assurance:** Annual trials to confirm functioning of equipment and alarms plus retrial following repair or modification (ref. Section 4.4). *{All trials should be carried out by proper simulation of failures (e.g. by removing terminals, disconnecting 24V distribution circuits, tripping machinery etc) and investigating unexpected results and recording results}.* **Verification:** On board independent audits of FMEA, trials reports and annual tests. *{All such reports should be on-board, up to date, and understood by CCR DP / ATC operators and maintenance supervisors / technicians with respect to actions which need to be taken a) to maintain high levels of integrity and b) to diagnose and overcome failures}* Refer to B1 for details of interface to FPSO/FSU ESD system.
	3) Thrusters & Steering gear	3) Thrusters should be arranged so that they do not fail to full pitch in either direction and that azimuthing gear (if fitted) fails to set. {Thrusters should sound an audible alarm, if there is a large discrepancy between desired and actual pitch or between desired and actual azimuth. DP / ATA operators should stop the relevant thruster immediately on alarm}. Thrusters should as far as reasonably practicable be powered from separate sources to reduce the risk that more than one thruster / rudder fails in the same event.	
	4, 5 & 6) Controls and Alarms	4) Thrusters should take control signals from both DP computers and from separate manual control consoles close to the DP console in the CCR and also from a backup location within the engine room. Even on DP class 1 heading control system 5) FPSO/FSU thruster controls should be powered from separate sources with the use of UPS so that no single power failure could result in the loss of sufficient thrusters to cause a loss of FPSO/FSU position or heading.	

		6) Independent thrust & azimuth indicators should be installed close to the DP console, fed from a separate circuit than the DP thruster pitch angle / azimuth signals. Any thruster power failures or thruster failures should sound alarm to alert operators.	

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
B7	**Heading Control System, Position References & Sensors** Applies to active and where noted also to passive FPSO/ FSU's accepting DP tankers. 1) to 4) To provide accurate heading control To provide accurate FPSO/FSU stern position and heading information to DP tanker. To fail to safe condition as a far as can reasonably be achieved. To have enhancements that provide adequate redundancy to prevent minor or common single point failures compromising station-keeping integrity. To alert operators on system malfunction.	1) The FPSO/FSU heading control system should always be a duplex system with 'bumpless' changeover from one to the other. The system should be UPS supplied and alarmed. 2) Existing Active FPSOs/FSUs having heading control systems equivalent to IMO DP Class 1, should be enhanced so that there are 2 computers configured so that common facilities, interfaces, data check or data transfer routines are incapable of crashing both. Controls should be designed and operated so that no single inadvertent act can cause loss of heading. DP Class 1 FPSOs/FSUs may alternatively revert to passive weather-vaning mode without thruster assist during tandem offtake operations if their turret type permits. *{Duty holders should be aware that, for FPSO/FSU heading control in close proximity operations the Simplex levels of equipment and redundancy specified in IMO guidelines for Class 1 DP are not adequate to provide ALARP if the FPSO/FSU could dramatically alter heading on failure. This is achievable by providing industry standard duplex DP heading control systems, whereby the second system monitors the performance of the on-line system and assumes control in the event of a malfunction of the on line system without affecting the vessel position. }* 3) Hawser tension monitoring systems should have an output to the heading control DP system which alarms when the tension is excessive. The DP heading control system should be equipped with an events printer which should be switched on during close proximity operations. 4) New Active heading control FPSOs/FSUs should have on line capability plots and warnings if capability being exceeded.	1) to 8) **Initial Assurance:** FMEA including proving trials of vessel power, thrusters and controls in accordance with IMO and IMCA standards (Ref section 4.4). **Ongoing Assurance:** Annual trials to confirm functioning of equipment and alarms plus retrial following repair or modification (ref. Section 4.4). *{All trials should be carried out by proper simulation of failures (e.g. by removing terminals, disconnecting 24V distribution circuits, tripping machinery etc) and investigating unexpected results and recording results}.* **Verification:** On board independent audit of FMEA, trials reports and annual tests. *{All such reports should be on-board, up to date, and understood by bridge officers and engineers with respect to actions which need to be taken a) to maintain high levels of integrity and b) to diagnose and overcome.* Refer to B1 for details of interface to FPSO/FSU ESD system.

	5) Position References & Sensors Applies to active and also to passive FPSO/FSU's accepting DP tankers. **Note:** if a Passive FPSO/FSU is only accepting taut hawser tankers which do not use DP even for approach or departure then it needs to provide no position references other than an approximate heading (+/- 5deg). This is only to enable the tanker to make its initial run to pick up the messengers. In this case the FPSO/FSU may only have a single gyro and the stated heading should be corroborated by ERRV, or tanker visual during approach.	5) All FPSOs/FSUs should provide three completely independent relative position references. All new position fixing antennae should be located as close to the offtake point (normally stern) as possible, without causing signal loss, to minimise the gyro error in position data.	
		6) All FPSOs/FSUs should consider the use of a remote Position Monitoring System showing data on the offtake tanker position and heading, and thrusters power consumption, by telemetry, for use by the Marine Operator / CCR in assessing reference quality and tanker station keeping versus ESD1 and ESD2 limits.	6) The assessment should include the ability of the FPSO/FSU crew to assimilate the data in a meaningful way, and the effect of the workload increase on the crew. It should also consider what actions would be appropriate. In assessing the necessity for this equipment, FPSO/FSU operators should take into account the enhanced reporting regime recommended in Section 7.
		7) All FPSOs/FSUs should be equipped with three gyros powered from separate UPS, actively monitored to alarm if one gyro differs. The tanker is to be informed immediately on alarm.	7) One potential exception is having 1 DGPS antenna far enough forward to derive heading checks.

		8) The position reference systems and sensors should be UPS supplied and alarmed to provide DP Class 2 level redundancy under IMO MSC 645 and alert the DP / ATA operator of any position reference or sensor dropping out.	

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Appendix C

Standards for Offtake Tankers (Offloading FPSO/FSUs)

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Appendix C: Standards for Offtake Tankers (Offloading FPSO / FSU)

The following generic standards have been derived for elements on offtake tankers performing tandem offtakes from a FPSO or FSU. These are defined as major elements of the offtake operation which are critical for safety or the avoidance of either pollution or production loss during the close proximity phase of the offtake.

The standards consider two types of FPSO / FSU, those which have active heading control, and those which just passively weather vane around their turret. There are two ways of operating the shuttle tanker during offtake; either in DP with a slack hawser or slow astern in manual control with a taut hawser. The equipment requirements on the FPSO/FSU vary not only with whether they use active or passive heading control but also with which type of tanker is attached. Hence each description identifies which combinations of heading control and tanker control method they apply to using the following abbreviations.

FPSO or FSU with active heading control	= active
FPSO or FSU with no heading control	= passive
Tanker operating in manual mode on taut hawser	= tauthaw
Tanker operating on DP	= dptank

Hence the term “Applies dptank” means the performance requirement applies only if the offtake tanker is on DP.

The Standards distinguish between “new” and “existing” tankers.

An “Existing Tanker” means any offtake tanker that either has had its keel laid before 1st July 2002 or has commenced upgrade to accommodate bow loading or close proximity station keeping capability before 1st July 2002, and which is seeking tandem offtake work on the UK sector.

A “New Tanker” means any offtake tanker that either has had its keel laid after 1st July 2002 or has commenced upgrade to accommodate bow loading or close proximity station keeping capability after 1st July 2002, and which is seeking tandem offtake work on the UK sector. *{In this context “New” includes both newly built tankers and existing tankers being newly converted to permit offshore offtake}.*

Although the standards in this revision of the document differ from the original document, this document retains the above definitions since some of the “existing tanker” as defined above, are still in operation.

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
C1	**Offtake Tanker General** Applies Tauthaw & dptank • To be certified as trading tanker for intended use • To limit pollution risk both offshore and on port entry • To be equipped for bow loading and manifold discharge • To be equipped to safely maintain station at the proposed offshore location • *Tankers may need to be equipped for VOC recovery (where National regulations or local company policy requires).*	1) The vessel should be fully certified, have no significant limitations of Class and be capable of unrestricted trading. DP tankers should have DP Class notation. The vessel should be suitably manned for offtake service, and be able to demonstrate adequate inspection, maintenance and repair. 2) Offtake tankers can suffer a higher rate of fatigue damage particularly when they are operating on the Atlantic Margin. The owner operator should be able to demonstrate negligible risk of pollution through fatigue or corrosion failure of the hull. *{Stress monitoring should be provided on new tankers if the ships are intended for Atlantic margin. It should be considered as a retrofit on older tankers performing these duties}*	1) **Initial Assurance & Ongoing Assurance:** Vetting under OCIMF SIRE scheme and against DISPORT specific requirements. **Verification:** Auditing of ships vetting records and frequency else independent survey if frequency by oil majors not adequate. 2) **Initial and Ongoing Assurance:** Vessel built to an IACS Class, surveyed and maintained in accordance with Class requirements. For vessels over 10 years old or operating on the Atlantic Margin the tanker Owner / operator should be able to demonstrate knowledge of and inspection of critical fatigue locations in excess of normal Class requirements. E.g. Through analysis of Stress monitoring and or increased inspection. **Verification:** Review of owner operator's inspection.
	3) Overfill avoidance systems	3) Cargo tanks should be equipped with a suitable remote level monitoring system with independent alarms *{High & High High Level}*. *{ }.*	3) **Initial & Ongoing Assurance:** Review of equipment layouts and description. Verification: Auditing of ships.
	4) The Bow Loading System	4) Covered by separate standard.	4) Refer to C2 for details

	5 & 6) Station keeping capability as follows:	5) **For North Sea & Irish Sea:** Enhanced DP Class 1 tankers may be acceptable for DP offtake after suitable risk assessment. Non DP or basic DP Class 1 Tankers working on taut hawser are acceptable. 6) **For environmentally sensitive areas and harsh weather conditions:** Class 2 DP tankers should be utilised where possible, though Enhanced DP 1 may be acceptable if demonstrated to have an equivalent risk level as DP2.	5 & 6) Refer to C6 for details including the need to document that the system's station keeping capabilities match the expected duty and operating limits at the worst anticipated operating location.
	7) Emergency towing capability	7) Tanker will be fitted with standard IMO/OCIMF pattern emergency towing gear for sea-going duty. If it is intended to use towing assist vessels to reduce the risk of collision by the tanker then Duty Holders should liaise with the tanker operator so that the correct equipment is provided. Testing of the towing procedure, to keep both the tanker and TAV personnel familiar with this operation, should take place at appropriate intervals. (See *Appendix A, Section A2 – 6*)	7) **Initial & Ongoing Assurance:** Review of equipment layouts, design check calculations and procedure.

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
C2	**Bow Loading System BLS** Applies to Tauthaw & dptank		
	To recover & latch FPSO/FSU hawser	1) BLS should be of standard offshore design with bow roller / fairlead, traction winch for the main hawser, remotely operated chain stopper for hawser chafe chain and powered storage reel for messengers.	1) to 8) **Initial and Ongoing Assurance:** The bow loading, telemetry and control systems are not covered by a standard OCIMF vetting nor fully covered by class requirement. Hence tanker owner / operators should be able to demonstrate that they have an adequate in house standard and procedure including BLS FMEA, functional requirements, operation inspection and testing. This should include testing of ESD functions, telemetry, pressure related trips, and hose connection integrity prior to pumping. The BLS FMEA should be to a level and depth which includes the effects of failure of any component including the effects of failure of each individual hydraulic hose. **Verification:** Auditing the existence of such a standard /procedure and completion records of testing against it. Verification of working practices.
	2, 3 & 4) To recover & latch FPSO/FSU hose	2) The hose recovery system should be of standard offshore design. 3) The hose latching mechanism should accommodate a standard 20"dry break coupling flange with remotely and locally controlled latching mechanism and downstream ball valve. 4) The hose & hawser should be capable of remote release from the offtake control station as well as local operation. {*There should be a remote CCTV system with views of the upper foc'sle, hawser winch, hose winch, coupler and hydraulic systems.*}	
	5) To permit emergency disconnection	5) There should be hydraulic accumulators in the system to allow the system to operate in the event of hydraulic failure. *{The accumulators should also allow emergency shut down and disconnection with no main system hydraulic pressure available. Coupler claws should have dedicated accumulator}*. The controls should have two sources of power supply.	
	6) To limit the effects of an oil leak from connection by dual channel telemetry and establishment of green line permit to pump	6) The BLS controls should be of the 'green line' principle based on 2 way telemetry with FPSO/FSU and with automatic closure of FPSO/FSU PSD valve (pump trip) and closure of BLS valves in the event of high crude oil pressure, low hydraulic pressure, coupler not open, end valve not open or inboard valve non open. *{Note either FPSO/FSU or Tanker should be able to initiate ESD 1 but normally only tanker should initiate disconnect}*	

	7) To control the effects of oil ignition	7) The BLS area should be protected by a deluge system covering the chain stopper, bow fairlead, traction winch, and cargo hose coupler area with an additional remotely operated foam monitor for the bow loading area. The deluge systems should be arranged to automatically operate on ERS or by manual initiation. Vessels should consider the means of evacuation from the BLS area.	
	8) To limit risk to foredeck personnel	8) The deck in way of BLS should be non-slip coated and fitted with save alls to prevent hydrocarbon overspill to main deck. All machinery should be guarded as far as practicable given the duty. All machinery and foredeck operations should only be performed by ship's crew having being briefed on the operation, hazards, and machinery and issued with adequate PPE. Control stations and personnel standby locations should be protected from the effects of breaking ropes by location or physical protection.	

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
C3	**Main Propulsion 1** Applies tauthaw with no DP used during approach, offtake or disconnection. • To provide adequate manoeuvrability for connection disconnection. • To provide finely controlled low power astern thrust for prolonged offtake periods. • To fail to safe conditions. • To alert operator on malfunctions.	1) A single main engine is acceptable provided measures have been taken to reduce the risk and consequences of engine failure to ALARP. 2) Main engine(s) should be suitable for prolonged lower power operations. *{ i.e. by using auxiliary scavenge air supply fan, trace heating on fuel lines, cooling water re-circulation and governor booster pumps as required. Isolating individual cylinders from fuel injection is acceptable.}*	1) to 6) **Initial Assurance:** FMEA including proving trials of vessel main engine, CPP and controls in accordance with IMO and IMCA standards (Ref section 4.4). System capabilities should be calculated and documented both with everything working and with each significant single failure. **Ongoing Assurance:** Annual trials to confirm functioning of equipment and alarms plus retrial following repair or modification (ref Section 4.4). *{All trials should be carried out by proper simulation of failures (e.g. by removing terminals, disconnecting 24V distribution circuits, tripping machinery etc) and investigating unexpected results and recording results}.* **Verification:** On board independent audit of FMEA, trials reports and annual tests. *{All such reports should be on-board, up to date, and understood by bridge officers and engineers with respect to actions which need to be taken a) to maintain high levels of integrity and b) to diagnose and overcome failures}*
	3) Propeller(s)	3) A single CPP main propeller is acceptable on existing tankers provided it fails safe and in particular cannot drift or fail ahead in taut hawser mode.	
	4) Main Engine / CPP Auxiliaries	4) Essential pumps (lube oil, camshaft oil, governor booster, gearbox oil, fuel, and especially CPP hydraulic pumps, should be duplicated and arranged for automatic change over (without engine trip) powered from separate cells of the switchboard. *{The changeover system should be such that failure of a fuse in the changeover relays should not trip all the pumps. An alarm should activate to alert watch-keepers on changeover}.*	
	5 & 6) Main Engine / CPP Controls	5) Main engine / CPP should take control signals from separate manual control consoles on bridge and within engine room. The control units should have a backup (non-follow up) control unit. 6) Main engine and CPP controls should have dual supplies, one of which is UPS or battery back up so that equipment continues to function after a single failure. An alarm should sound to alert operators of failure on either power supply or changeover. The back-up non-follow up controls should be powered from a separate third source.	

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
C4	**Main Propulsion 2** Applies dptank • To provide adequate manoeuvrability for DP connection, offtake & disconnection. • To provide finely controlled low power thrust for prolonged periods. • To fail to safe conditions. • To alarm on malfunctions. 5 & 6) Propeller(s) 7) Main Engine / CPP Auxiliaries 8 & 9) Main Engine / CPP Controls 10) Networks	1) A single main engine is acceptable on existing tankers provided measures have been taken to reduce the risk and consequences of engine failure to ALARP. 2) New tankers entering service should have redundant fore and aft propulsion. 3) Conventional large slow-speed main engine(s) should be suitable for prolonged lower power operations. *{ i.e. by using auxiliary scavenge air supply fan, trace heating on fuel lines, cooling water re-circulation and governor booster pumps as required.}* 5) A single CPP main propeller is acceptable on existing DP tankers provided it fails safe and in particular cannot drift or fail full ahead in DP mode. 6) New DP tankers entering service should have redundant fore and aft propulsion to IMO Class 2 standards. 7) Essential pumps e.g. lube oil, camshaft oil, governor booster, gearbox oil, fuel, and especially CPP hydraulic pumps should be duplicated and arranged for automatic change over (without engine trip) powered from separate cells of the switchboard. *{The changeover system should be such that failure of a fuse in the changeover relays should not trip all the pumps. An alarm should activate to alert watch-keepers on changeover}.* 8) Main engine / CPP should take control signals from both DP computers and from separate manual control consoles on bridge and within engine room. The control units should have a backup (non-follow up) control unit. 9) Main engine and especially CPP controls should have dual supplies, one of which is UPS or battery back up so that equipment continues to function after a single failure. An alarm should sound to alert operators of failure on either power supply or changeover. The back-up non-follow up controls should be powered from a separate third source. 10) Distributed control systems should have 2 networks, duplex control computers and separate UPS supply.	1) to 10) **Initial Assurance:** FMEA including proving trials of vessel main engine, CPP and controls in accordance with IMO and IMCA standards (Ref. section 4.4). **Ongoing Assurance:** Annual trials to confirm functioning of equipment and alarms plus retrial following repair or modification (ref Section 4.4). *{All trials should be carried out by proper simulation of failures (e.g. by removing terminals, disconnecting 24V distribution circuits, tripping machinery etc) and investigating unexpected results and recording results}.* **Verification:** On board independent audit of FMEA, trials reports and annual tests. *{All such reports should be on-board, up to date, and understood by bridge officers and engineers with respect to actions which need to be taken a) to maintain high levels of integrity and b) to diagnose and overcome failures}*

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability / *{Typical Values / Guidance @ April 01}*	Initial Assurance / Ongoing Assurance / Verification
C5	**Power Generation / Distribution** Applies dptank • To reliably power thrusters, engine / steering auxiliaries, control systems, references and all normal ships and BLS functions. • To fail to safe condition as a far as can reasonably be achieved. • To alert operators on system malfunction. 2) to 6) Power generation and main switch board	1) All DP tankers should have power generation and distribution systems to achieve the ability to maintain station following a failure of any single active component. Tankers being brought into shuttle tanker service should have power generation and distribution to IMO DP Class 2 standards in all areas where power loss could affect its ability to maintain station in close proximity FPSO/FSU operations. 2) For existing vessels single switchboards are acceptable but two or more generators should be on line during close proximity operations. 3) Where thrusters are powered from the main switchboard, the cells should be separated so that a local fire or fault in one thruster cell will not immediately affect the other thrusters cell. A bus tie breaker should be installed, and, where operated in the closed position, it should be designed to open before generator breakers for both directional and non-directional faults. 4) The DP control system should monitor the generator outputs versus thruster and additional load consumers and excessive power levels should alarm to alert the operators. 5) Shaft alternators should not be used to power thrusters on ships with a single main engine. Thrusters should in this case be supplied from main board with at least two auxiliary generators on-line. Shaft alternators can be used to power thrusters on twin engine ships provided both shaft generators are functioning and each shaft generator only supplies one thruster at each end of the vessel. If the main board is also supplied from the two shaft generators then the board should be split. Alternatively if the main board is being supplied by auxiliary generators then at least two shall be on line during close proximity operations.	1) to 6) **Initial Assurance:** FMEA including proving trials of vessel power, thrusters and controls in accordance with IMO and IMCA standards (Ref section 4.4). System capabilities should be calculated and documented both with everything working and with each significant single failure. *{This is to ensure the power balance between duplicate systems is understood, and that crew understand operating limits to cater for the effects of a single failure}.* **Ongoing Assurance:** Annual trials to confirm functioning of equipment and alarms plus retrial following repair or modification (ref Section 4.4). *{All trials should be carried out by proper simulation of failures (e.g. by removing terminals, disconnecting 24V distribution circuits, tripping machinery etc) and investigating unexpected results and recording results}.* **Verification:** On board independent audit of FMEA, trials reports and annual tests. *{All such reports should be on-board, up to date, and understood by DPO / bridge officers and engineers with respect to actions which need to be taken a) to maintain high levels of integrity and b) to diagnose and overcome failures}*

		6) For vessels with power management systems, such systems should be UPS powered. The UPS should have alarms for low voltage and charger failure. Loss of the power management system should result in the boards "failing as set".	
	7) LV Power / Control system power	7) Special attention shall be given to the 220V & 24V distribution for DP, references, sensors, controls thrusters, such that failure of a single fuse will not disable any non redundant system. On vessels with a single 220 V main board, consumers where single fuse failure could lead to loss of a critical control function, resulting in potential loss of vessel position, should have backup supplies from either the 220 V emergency board or a 24 V system. The 24V distribution should preferable by split into 2 sections Systems where single fuse failure could lead to loss of a critical control function, resulting in potential loss of vessel position, should have duplicate power from an independent source. All battery-backed systems should be fitted with status monitoring such that charger failure or low voltage alerts the DP operators.	See Previous Sheet for Assurance and Verification.

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
C6	**Thrusters & Steering Gear** Applies dptank & where noted to tauthaw • To provide adequate manoeuvrability for DP connection, offtake & disconnection • To fail to safe condition as a far as can reasonably be achieved. • To alert operators on system malfunction 5, 6 & 7) Thrusters & Steering gear 7 & 8) Controls and Alarms	1) Existing DP vessels should have minimum two bow thrusters with a combined transverse thrust capability as required for the design weather conditions. 2) Single screw DP tankers should have at least one stern thruster, which works in combination with a high lift rudder to give a total transverse thrust capability as required for the design weather conditions . 3) Where DP class 2 vessels have two main propellers then twin high lift rudders should be located to take advantage of the propeller wash unless stern transverse thrust is to be supplied solely by stern thrusters for close proximity station keeping. 4) DP offtake tankers should have thrust arrangements to IMO DP class 2 requirements. 5) Thrusters should be arranged so that they do not fail to full pitch in either direction and that azimuthing gear (if fitted fails to set). 6) Thrusters and individual steering gear motors should as far as reasonably practicable be powered from separate sources with the use of UPS so that no single power failure could result in the loss of sufficient thrusters or rudders to cause a loss of tanker position or heading. 7) Thrusters & Rudders should take control signals from both DP computers and from separate manual control consoles near the DP console on bridge and within engine room. Even on DP Class 1 vessels thruster controls should be powered from two sources, one of which is UPS or battery back up so that a single failure will not result in loss of more than one thrusters. 8) Independent rudder angle, thrust & azimuth indicators should be installed close to the DP console, fed from a separate circuit than the DP rudder / thruster pitch angle / azimuth signals. Any thrusters power failures or thruster failures should sound alarm to alert operators.	1) to 8) **Initial Assurance:** FMEA including proving trials of vessel power, thrusters and controls in accordance with IMO and IMCA standards (Ref section 4.4). System capabilities should be calculated and documented both with everything working and with each significant single failure. *{This is to ensure that the power balance between duplicate systems is understood, and that crew understand the operating limits to cater for the effects of a single failure}.* **Ongoing Assurance:** Annual trials to confirm functioning of equipment and alarms plus retrial following repair or modification (ref Section 4.4). *{All trials should be carried out by proper simulation of failures (e.g. by removing terminals, disconnecting 24V distribution circuits, tripping machinery etc) and investigating unexpected results and recording results}.* **Verification:** On board independent audit of FMEA, trials reports and annual tests. *{All such reports should be on-board, up to date, and understood by DPO / bridge officers and engineers with respect to actions which need to be taken a) to maintain high levels of integrity and b) to diagnose and overcome failures}*

Ref.	Function / *{Description}* / Applicability	Requirements / Survivability	Initial Assurance / Ongoing Assurance / Verification
C7	**DP Control System, Position References & Sensors** Applies dptank • To provide accurate station keeping for DP connection, offtake & disconnection. • To fail to safe condition as a far as can reasonably be achieved. • To have enhancements that provide adequate redundancy to prevent minor or common single point failures compromising station-keeping integrity. • To alert operators on system malfunction.	1) The DP controls system should always be a duplex system with 'bumpless' changeover from one to the other. The DP control system should be UPS supplied and alarmed. DP Class 1 Enhanced should be equivalent to DP Class 2 with regard to DP control systems and reference systems and sensors. 2) Loading terminal software should specify limits for ESD 1 and ESD 2 actions. Warning alarms should sound at ESD limits. DP software should have a "reaction box" facility to be used for tandem offtake. *{The FPSO/FSU DP reference point has to move outside the box before the tanker follows}.* 3) Hawser and hose tension monitoring systems should have an output to the DP control system which alarms when the tension reaches the agreed set limit. The DP control system should be equipped with an events printer which should be switched on during close proximity operations. 4) All DP tankers should be equipped with three independent relative position references, operating on different principles, which should be tested, operational and on-line at all times during offtake. In addition, there should be one absolute position reference system. The total reference package should provide for the activation and use of the reaction box while maintaining triple redundancy (ref "Operating Limits" diagram). 5) Displays on the tanker bridge relating to position keeping should be clearly marked to indicate the source of the information being provided. Display of raw PRS data should be clearly indicated as such to avoid confusion between raw data (e.g. between antennae) and corrected data (i.e. adjusted to provide data relating to reference points on FPSO/FPU stern and tanker bow).	1) to 6) **Initial Assurance:** FMEA including proving trials of vessel power, thrusters and controls in accordance with IMO and IMCA standards (Ref section 4.4). **Ongoing Assurance:** Annual trials to confirm functioning of equipment and alarms plus retrial following repair or modification (ref Section 4.4). *{All trials should be carried out by proper simulation of failures (e.g. by removing terminals, disconnecting 24V distribution circuits, tripping machinery etc) and investigating unexpected results and recording results}.* **Verification:** On board independent audit of FMEA, trials reports and annual tests. *{All such reports should be on-board, up to date, and understood by DPO / bridge officers and engineers with respect to actions which need to be taken a) to maintain high levels of integrity and b) to diagnose and overcome*

	6) Visual References	6) There should be CCTV screens adjacent to the DP operating station. As well as permitting the bridge crew to monitor and check all areas of the BLS by selection, there should be a CCTV monitor permanently showing the hawser and hose catenary during offtake. *{This is to give the DP operator a visual reference on separation from the FPSO/FSU stern}*	

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Appendix D

Oil & Gas UK Model FPSO/FSU & Tanker Acceptance System

1. Introduction

The following acceptance process is aimed at enabling Duty Holders to ensure that they can demonstrate taking adequate management actions to ensure that offtake risks are ALARP.

2. Acceptance of New Vessels Intended to be Regularly Used in the Field (Primary / Secondary Pool Tankers)

New FPSOs/FSUs or tankers should be assessed and accepted by the following process

- Review design, verification and operational documents as listed in *table D1* for FPSOs/FSUs and, if required, *table D2* for offtake tankers. Where a third party supplies the tanker or FPSO/FSU a vessel information folder should be prepared by the third party and submitted to the Duty Holder.
- Review the FMEA study, the FMEA trials report, the Annual DP Trials report, the FSOG, and follow up and close out of any recommendations.
- Send the field Joint Operations Manual to the new FPSO/FSU or tanker to give the crew time to familiarise themselves with the field particulars and procedures. This also gives the new vessel an opportunity to review and comment on any field procedures or equipment that could lead to complications with their vessels.
- Assess the new FPSO/FSU or tanker by an on-board audit to check that equipment, crew training and experience comply with the required performance standards / assessment matrices (either from this document or field specific requirements or Safety Case or Written Scheme). If any serious shortfalls are found they have to be rectified against an agreed schedule, e.g. by hardware rectification or by adding a supplementary mooring master or other supplementary crew whilst experience is built up.
- Check annual DP trials, close out and the recent audit / inspection record on board, together with the crew's understanding of their DP system and failure modes. The assessment of crew competence should be carried out in the field, offloading from a particular FPSO/FSU to a particular tanker, so that it is not purely paper based.
- Ensure that the ATC / DP control software and all telemetry and position reference frequencies are adapted to reflect the field requirements.
- Carry out a field test confirming that all communications, telemetry links and relative position references actual communicate, that all ATC / DP software functions correctly and that the FPSO/FSU and tanker(s) are compatible for offtake. Usually the field test is carried out at the start and during an offloading trial or at the start of the first offloading.

3. Ongoing Acceptance of Regularly used Vessels (Primary or Secondary Pool Tankers)

Once installed, the same FPSO / FSU will probably be used for the bulk of field life. The majority of the tankers visiting the field will probably be regularly used primary or secondary tankers that have been accepted as a new vessel as per item 1 above. These regularly used FPSOs/FSUs and Tankers shall be audited and reassessed occasionally by the Duty Holder. As a guidance an interval of two to three years between inspections to assess the tanker and crew as follows:

- Tanker & hardware assessed against the field specific performance standards for the areas indicated in these guidelines.
- Latest generic OCIMF SIRE inspection reports and close out of actions reviewed on board.
- Crew logged experience and training compared to the levels defined in the matrices included in these guidelines for the type of offloading facility concerned. There should be evidence of increasing experience levels and suitable refresher training.
- Latest FMEA and Annual trials documented onboard with evidence that the crew understand the findings and evidence of action close out.
- Confirmation that the FSOG is in use and evidence that the hierarchy of advisory, yellow and red alerts is understood and being used correctly. Evidence that, where an alert has taken place, the correct action was taken.

It is further proposed that the tanker operators should update the vessel dossiers described in table D2 for Duty Holders every second year to reflect updated information e.g. inspections, FMEA / annual trials and new equipment. The Duty Holder should also update the FPSO/FSU dossier described in table D1 on the same frequency.

The assessment of the crew's increased competence in offloading from the particular FPSO/FSU to the particular tanker should be carried out in the field by witnessing an offloading.

4. One off Acceptance of Previously Unapproved Alternative Tankers at Short Notice

Even when quite a large pool of primary or secondary tankers have been approved for a particular field, there may be odd occasions when operational circumstances dictate that none of them are available when the Duty Holder requires. In such circumstances the tanker owner and Duty Holder may wish to substitute another tanker which should normal be of equivalent equipment level and standard to those normally used on that field. In such circumstances it may be possible to accept a tanker for a one off operation on a quicker acceptance procedure than that described in item 1 above.

A shortened acceptance procedure would be as follows.

- Tanker operator / manager informs Duty Holder of the intended substitution as soon as possible to initiate the acceptance as quickly as possible.
- Tanker operator issues the following to Duty Holder in advance of acceptance.
  - justification for using an alternative tanker

  - capacities
  - propulsion spec.
  - thruster spec.
  - DP system
  - position reference systems
  - bow valve closing times
  - confirmation shuttle tanker was subject to FMEA & FMEA revisions, findings and recommendations
  - confirmation that vessel is free of outstanding Conditions of Class and OCIMF SIRE non-conformances.
  - Confirmation that Annual DP Trials were performed less than 1 year ago
  - crew training and experience matrices, particularly numbers of offloadings performed from the particular type of FPSOs/FSUs (active or passive)
  - remedial measures to increase experience on the day in order to meet the minimum training & experience requirements for the type of facility concerned (e.g. passive FPSO/FSU).

- Tanker operator places field specific offtake joint operations manual and other operational documentation on board the tanker.
- If tanker is to operate on DP then the DP software should be adapted for the specific field (e.g. install field specific files).
- If the tanker and crew is acceptable based on the above then proceed to field but Duty Holder should be given the opportunity of putting a representative onboard.
- Field test position references, telemetry and DP if fitted before final close approach and connection.
- Complete field test procedures.

Table D1: Offtake Information of FPSO/FSU

Item To Be Included In Information Dossier	FPSO/FSU	
Photograph of stern arrangement	🗐	
Stern Discharge arrangement drawings	🗐	
Stern discharge valve type and ESD shut-in time	🗐	
Pressure surge analysis of ESD & hose disconnection scenarios on pumps, hose and pipe work.	🗐	
FMEA + FMEA revisions, to include trials reports	Only equipment critical to tanker station keeping as per the standards	
Confirmation of close out statements on FMEA / trials findings	as above	
Annual trials & close outs	as above	
FPSO/FSU incident record affecting tandem ops	🗐	
FPSOs/FSUs offtake related audit / inspection record (last 3 years)	🗐	
Crew Experience Matrix (Each shift) or alternative Oil & Gas UK means of demonstrating competence	🗐	
Joint Operations Manual	🗐	

Table D2: Offtake Information of Offtake Tanker

Item To Be Included In Information Dossier	Offtake Tanker	
Photograph	🗐	
General arrangement plan	🗐	
Tank capacity plan	🗐	
Fire control and safety plan	🗐	
Bow loading arrangement drawing	🗐	
Bow valve type & shut-in time (ESD)	🗐	
FMEA + FMEA revisions, to include trials reports	Only equipment critical to station keeping as per the standards	
Confirmation of close out statements on FMEA / trials findings	as above	
Annual trials & close outs	as above	
DP Capability Plots (all systems running + worst case single failure)	🗐	
Vessel's offloading incident record	🗐	
Vessel's audit / inspection record	🗐	
Oil & Gas UK Crew Competence Matrix	🗐	
Oil & Gas UK Crew Experience Matrix	🗐	
Operating Procedures & Parameters	🗐	

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Appendix E

Offtake Concept Risk Evaluation

The use of shuttle tankers to export crude oil from the field provides an extremely valuable service and assists the exploitation of marginal or remote reserves. However it is important to reduce the inherent risks of tanker export at all stages of a development project. The maximum risk reduction impact can often be achieved for least expense by designing out hazards at the concept design or concept selection stage of a project. Concession holders and Duty Holders have often applied only limited resource in a very limited time-scale to this stage of a project. This can, and in some cases has, led to offtake risks being unexpectedly higher than envisaged, resulting in accidents and high financial consequences.

It is recommended that concession holders and Duty Holders perform an effective risk assessment of all practicable offtake options as part of their concept selection process for all future field developments. Concept selection should be based on the demonstration of ALARP risks for the development as a whole. Particular care should be applied at this stage before selecting untried offtake solutions or applying existing solutions in a new area having different metocean parameters to those experienced before.

Duty holders should consider all of the offtake options that may be practicable for the development and take life of field costs and risks into account in making the ALARP selection. The risks evaluated should include: -

- The hazards to each vessel arising from incidents occurring on the other vessel or due to close proximity operation.
- Environmental / pollution risks as well as safety.
- Risks to life of field production uptime.

Even where the installation is likely to be a FPSO or FSU, consideration should be given to pipeline export, remote loading buoys, submerged loading systems, as well as stern offtake.

The offtake concept risk assessment should consider the following factors: -

Tandem loading versus pipeline or remote surface / submerged buoy

Exporting oil back through the turret and out to a remote loading system or existing pipeline obviously removes the need to have a tanker in immediate proximity to the manned FPSO/FSU. This reduces the risk of low energy tanker collisions and may also reduce the major accident hazard potential of a high-energy tanker collision. However other factors need to be taken into account in the ALARP assessment such as: -

- Ullage availability, tariff structure, age and condition of any existing pipeline; plus the life cycle cost and risks associated with installing an export swivel, riser, pipeline spur, tapping into any existing pipeline and decommissioning at the end of field life.
- Tanker black out collision risks. When a tanker performs a tandem offtake operation it is located close to and down weather from the manned FPSO/FSU. Thus the inherent risk of a high consequence collision following tanker loss of propulsion, during off-take, may be lower than if

the tanker has to offload from a remote loading point in the immediate vicinity which will on occasions be upwind of the manned FPSO/FSU.

- The life cycle costs and risks associated with installing, inspecting, maintaining and decommissioning an export swivel, riser, seabed line and remote loading system. Note that the environmental risks of a remote system may be higher than from an FPSO/FSU even if the personnel consequences may be lower.
- The lost satellite development potential if swivel paths and riser space are used for oil export.

Passive weathervaning versus active heading control on the FPSO / FSU

There are a series of passive weathervaning FPSOs/FSUs in the central North Sea which currently have a good offtake safety record and have the merit of being simple with very little opportunity for FPSO/FSU equipment failure or operator error to cause a sudden loss of heading during offtake. FPSO/FSU heading misalignment problems can normally be controlled by the offtake tanker applying hawser tension in manual control should this become necessary. There is relatively little loss in the useable weather window by using taut hawser in the central North Sea.

Experience suggests, however, that the use of passive weathervaning FPSOs/FSUs may be less attractive in other parts of the UK sector where the wind, wave or current climate is significantly more severe. (E.g. the Atlantic frontier, or areas with very high currents). Offtake tankers by nature of their size, shape and thruster configuration have very limited ability to move sideways to follow the stern movements of a passive weathervaning FPSO/FSU without getting seriously out of alignment, in these more stringent metocean conditions. It becomes more attractive to use active heading control on the FPSO/FSU to help damp out fishtailing and permit the offtake tanker to adopt an optimum heading to the prevailing conditions. Active heading control also has side benefits in providing the ability to limit roll motions in certain sea conditions. Whenever active heading control is selected it is important that the system is designed with sufficient redundancy and fail safe features to prevent single point failures causing major change in heading. This involves installing thrusters having sufficient power and performance to cope with the expected metocean conditions as well as just providing redundancy. Active heading control does however come with a step increase in complexity, potential failure modes, redundancy requirements and operator training, so would need careful evaluation before implementing, at the concept stage or on existing vessels.

DP Offtake Tanker operation versus Taut Hawser operation

There is a long history of successful taut hawser tandem offtake operations in the central North Sea and indeed world-wide. Taut hawser has the merits of having few potential failure modes and relatively uncomplicated operator options should something unexpected occur, once the hawser has been attached and the propeller locked slow astern. There is relatively little loss in useable weather window by using taut hawser in the central North Sea. The loss in useable weather window increases in parts of the UK sector having more severe wind, wave or current conditions and the use of taut hawser mode becomes less attractive. DP tankers can connect and remain connected in slightly higher sea-states. In extremely harsh operating areas (e.g. Atlantic Frontier) the tanker should be equipped with thrusters having sufficient power and performance to cope with the expected metocean conditions as well as having adequate

equipment redundancy. IMO equipment class 2 becomes more important as falling back on the hawser, as a back up to DP equipment failure becomes less practicable in harsh sea areas.

FPSO/FSU Pumping Rate and Hose Size

The standard offtake tanker bow connector and piping systems are sized to accommodate loading rates of 8000 m^3/hr. Many existing FPSO/FSU offtake systems and low budget remote offloading systems are constrained to much lower transfer rates because the installation's pumps, transfer hose or pipeline have been sized to minimise CAPEX. The exposure to hose damage or collision risk is lower, the quicker the tanker can offtake a cargo. For Contract of Affreightment (CoA) users there is also an OPEX saving over the field life if offtakes are quicker. Consideration should be given to the offtake rate at the concept selection stage.

FPSO/FSU Layout, Subdivision and Damage Stability Criteria

Consideration of FPSO/FSU layout at the concept selection stage can eliminate or reduce some of the most significant major accident potentials by design.

- Placing the flare tower, gas compression, turbines, exhausts or other process plant at the very stern of the FPSO/FSU increases the risk of a minor offtake tanker collision escalating to a major accident scenario. The inherent major accident potential of tandem loading is greatly reduced if the likely stern collision zone is kept clear of process equipment. The probability of being able to easily remove injured personnel from the FPSO/FSU after a collision is greater if the helideck can be kept clear of the likely collision zone.
- Designing the FPSO/FSU to Marpol damage stability criteria, or otherwise designing it to survive raking damage over a significant length at the stern, dramatically reduces the inherent major accident potential from an offtake tanker contact when compared to the minimum damage stability standards which may be applied.
- Designing the FPSO/FSU to have double sides in way of the aft fuel bunker tanks reduces the inherent pollution potential of a tandem loading collision, when compared to normal pre-2000 tanker construction practices.
- Specifying offtake tankers to have double hull reduces the inherent pollution potential of tandem loading collision. If single hull tankers have to be accommodated then requiring them to avoid or at least delay loading oil into forward wing tanks also reduces the pollution potential of a tandem loading collision.
- The concept FPSO/FSU design should consider the positioning of telemetry and position reference antennae at the concept / contractual specification stage. The consequences of gyro error can be drastically reduced if position reference antennae can be fitted at the optimum heights and as near as possible to the stern offtake point. This is to ensure adequate communication line of sight to the tanker's operating sectors and sufficient panoramic field of view to pick up satellites.

FPSO/FSU Storage Capacity versus Offtake Parcel Size

Consideration should be given to the storage volume requirements at the concept design stage. The useable on-board storage volume should ideally be sufficient to cover the desired export parcel size plus a buffer margin to allow for weather down time or tanker arrival windows. If this ideal storage cannot be achieved at the concept design stage, then other means will have to be found later to manage the increased risk potentials. E.g. from taking the tanker in twice for each parcel or from personnel having subconscious pressure to hook up and discharge in excessive weather conditions. A holistic systems approach should be adopted to match FPSO/FSU storage volume, parcel size, weather down time and contractual limits to ensure that offshore personnel are not put under sub-conscious pressure to repeatedly accept tankers in unsuitable conditions for offtake.

If the development has less inherently safe design features then it is placing a greater stake on tanker and FPSO/FSU station keeping control and extra safeguards may be necessary to demonstrate ALARP.

Appendix F

Example Checklists

These are examples only and not necessarily suitable for all FPSOs/FSUs and Tankers. However, the layout of the columns should be considered as a template.

Cargo No: _____

Date: ___/___/_____

Vessel: _____

1. On nomination of tanker

Step	Dist	Request / Information / Action	Manual Reference	Comms method	From	To	Time /Check
1-1	n/a	[FPSO Name] to e-mail weather forecast at earliest practicable time.		e-mail	[FPSO Name]	Tanker	✓
1-2	n/a	Tanker to inform [FPSO Name] of any operational issue with tanker or Bow Loading Equipment which may require additional pre-planning requirements. Inform [FPSO Name] of any issue which takes the Tanker below its normal operating parameters, not just outwith Oil & Gas UK Tandem Loading Guidelines.		e-mail	Tanker	[FPSO Name]	✓
1-3	n/a	[FPSO Name] to carry out forward planning review to establish offtake schedule has no conflicts with supply boats, fuel or water, requirements elsewhere or other operational requirements.		n/a			✓
1-4	n/a	[FPSO Name] to advise Tanker of: • predicted berthing schedule; • any rig, DSV or similar operation on the field; • any operational limitations by other field ops; • any obstruction or other navigational hazard on the field.		e-mail	[FPSO Name]	Tanker	✓
1-5	n/a	Tanker to request towing trial if one is considered applicable.		e-mail	Tanker	[FPSO Name]	✓
1-6	n/a	Tanker to advise [FPSO Name] when its ESD2 was last tested. If more than 4 offloads previously, ESD2 test to be included at Step 8-7.		e-mail	Tanker	[FPSO Name]	✓
1-7	n/a	Update Tanker with latest MSDS – if required.		e-mail	[FPSO Name]	Tanker	✓
1-8	n/a	Confirm Tanker has the correct revision of this Offtake Manual xxx and DP software is the correct version.		email	Tanker	[FPSO Name]	✓

Tanker & [*FPSO Name*] confirm this section 1 is complete (each to sign own copy)	Signature	d/t

2. [FPSO Name] Pre Offtake Checks

Step	Dist	Request / Information / Action	Manual Reference	Comms method	From	To	Time /Check
2-1	n/a	[FPSO Name] to advise expected offtake time to: LMMT/Deck Foreman/CCR/Metering Tech/ Lab Tech.		n/a			✓
2-2	n/a	Cargo Tank water dips taken and logged		n/a			✓
2-3	n/a	Ensure pumproom/COP's and IG plant are all available and ready for offtake. Confirm pumproom fan(x 1) is running.		n/a			✓
2-4	n/a	Confirm all scupper plugs are in place.		n/a			✓
2-5	n/a	Offtake rigging checked for wear.		n/a			✓
2-6	n/a	Advised to be ready for offtake operations. Em Towing equipment to be rigged as in Task 4-4.		VHF	[FPSO Name]		✓
2-7	n/a	Offloading plan created and ready for use on [FPSO Name].		n/a			✓

[*FPSO Name*] to confirm this section 2 is complete	Signature	d/t

3. Previous port to 10 nm & NOR

Step	Dist	Request / Information / Action	Manual Reference	Comms method	From	To	Time /Check
3-1	Sail Prev Port	Tanker to email ETA at 10nm, crew list, OBQ and crew competency matrices. Tanker to identify if there are any deficiencies against required experience or training levels.		e-mail	Tanker	[FPSO Name]	✓
3-2	10 nm	Tanker to report at 10nm and tender NOR if a/ within laycan and b/ Tanker ready to carry out offloading operations. NB: Provided the time of tanker readiness has been clearly radioed to [FPSO Name] Control formal NOR can be given retroactively.		VHF/ e-mail	Tanker	[FPSO Name]	d/t
3-3	10 nm	[FPSO Name] to acknowledge receipt of NOR.		e-mail	[FPSO Name]	Tanker	d/t
3-4	10 nm	[FPSO Name] to confirm: • when offloading is expected to commence; • when Tanker should be at rocket line position; • quantity of cargo to be loaded; • whether COW will be used; • expected duration of offload; • name of .		e-mail	[FPSO Name]	Tanker	✓
3-5	10 nm	[FPSO Name] to confirm no supply boat operations expected during the offtake; of if supply boat operations are considered essential, then to carry out Nopras procedure fully involving the Tanker.					✓
3-6	10 nm	[FPSO Name] OIM to confirm with the Master of the Tanker that he/she is familiar with this Offtake Manual and the procedures within it.		VHF	[FPSO Name]	Tanker	✓
3-7	10 nm	Tanker to consider use of any waiting time for training with DP CAP (or equivalent) (Competence Assurance and Practice). Tanker to keep [FPSO Name] fully advised; permission to use [FPSO Name] Pos Refs shall not be unreasonably with-held.		VHF	Tanker	[FPSO Name]	✓

Tanker & [*FPSO Name*] confirm this section 3 is complete (each to sign own copy)	Signature	d/t

4. At or before readiness to commence approach

Step	Dist	Request / Information / Action	Manual Reference	Comms method	From	To	Time /Check
4-1	10 nm	Tanker and [FPSO Name] to agree daylight status and present weather, plus forecast, is suitable for Offtake Operations: • wind speed and direction; • significant wave height and period; • maximum wave height and period; • visibility; • current.		VHF	[FPSO Name]	Tanker	✓
4-2	10 nm	Confirm that oil export pipeline and hose are at ambient pressure (ie. not pressurised) and in readiness for connection.		VHF	[FPSO Name]	Tanker	✓
4-3	10 nm	[FPSO Name] to inform Tanker of any changes to offtake equipment e.g. bridle replaced, MBC overhauled, etc. Identify if any specific feedback is requested.		VHF	[FPSO Name]	Tanker	✓
4-4	10 nm	Confirm emergency towing equipment is prepared on board both the Tanker and TAV (if applicable).		VHF	Tanker	[FPSO Name]	✓
4-5	10 nm	Agree max loading rate and any restrictions at specific stages. Agree whether Tanker or [FPSO Name] will initiate end of loading.		VHF	Tanker	[FPSO Name]	✓
4-6	10 nm	[FPSO Name] to advise present heading.		VHF	[FPSO Name]	Tanker	✓
4-7	10 nm	[FPSO Name] to confirm to Tanker that there are no known deficiencies in any offtake equipment.		VHF	[FPSO Name]	Tanker	✓
4-8	10 nm	Tanker to confirm to [FPSO Name] that there are no known deficiencies in any navigational, positioning, DP, manoeuvring or any other system required for an offtake.		VHF	Tanker	[FPSO Name]	✓
4-9	10 nm	Both the Tanker and [FPSO Name] should mutually exchange that they are satisfied that all conditions for a successful offtake operation are in place, and agree to commence the operation.		VHF	Tanker/ [FPSO Name]	[FPSO Name]/ Tanker	✓
4-10	10 nm	Tanker to advise they are proceeding inwards.		VHF	Tanker	[FPSO Name]	d/t

Tanker & [*FPSO Name*] confirm this section 4 is complete (each to sign own copy)	Signature	d/t

NB: In the event that the approach is aborted during this phase, the new approach should resume Checklist at Step 4-1 (i.e. at a range of 10 nm).

5. From 10 nm to 3 nm

Step	Dist	Request / Information / Action	Manual Reference	Comms method	From	To	Time /Check
5-1	10 nm	to confirm 3cm radar is on Stand By for duration of offload.		UHF		[FPSO Name]/ Tanker	✓
5-2	3 nm	Back-up VHF channels (73 and 8) tested. Nominated and back-up UHF channels tested.		UHF	Tanker	[FPSO Name]	✓
5-3	3 nm	Tanker to reduce vessel speed to no more than 5 knots and notify [FPSO Name] when passing 3nm.		UHF	[FPSO Name]	Tanker	✓
5-4	3 nm	Request to position close to [FPSO Name] FPSO and to prepare for mooring and connection of Tanker.		UHF	[FPSO Name]		✓
5-5	3 nm	Tanker to prepare the following equipment and advise ready to [FPSO Name] : • Forerunner on the traction winch with 2m lashing line (to connect forerunner and pick-up line); • Forerunner with lashing line on the hose handling winch; • Air gun with plastic and grapnel projectiles (in case required); • Rope cutting equipment to be ready at forecastle deck.					✓
5-6	3 nm	Tanker to confirm activation of “Zero Pitch” function, or “Main Engine De-clutch” function, or “Emergency Stop Main Engine” function depending on the configuration of the vessel.		UHF	Tanker	[FPSO Name]	✓
5-7	3 nm	Tanker to advise [FPSO Name] it is passing 3nm and continuing inwards to 3000 metres.		UHF	[FPSO Name]	Tanker	d/t

Tanker & [*FPSO Name*] confirm this section 5 is complete (each to sign own copy)	Signature	d/t

NB: In the event that the approach is aborted during this phase, the new approach should resume Checklist at Step 4-1 but at a range of 3 nm.

6. From 3 nm to 500 m

Step	Dist	Request / Information / Action	Manual Reference	Comms method	From	To	Time /Check
6-1	3 nm	Tanker to carry out internal Telemetry Checks.		UHF	Tanker	[FPSO Name]	✓
6-2	3000 m	Tanker to notify [FPSO Name] when passing 3000 metre and reduce vessel speed to maximum 3 knots.		UHF	Tanker	[FPSO Name]	d/t
6-3	3000 m	Tanker to: • select '[FPSO Name] ' on the DP Control System; • select Artemis first so becomes primary Position Reference System; • when Artemis acquired, acquire 2 other independent ref sys; • confirm that the Tanker's own absolute DGPS is at "monitored" status; • activate "Zero Pitch" function, or "Main Engine De-clutch" function, or "Emergency Stop Main Engine" function depending on the configuration of the vessel. Confirm all to [FPSO Name] .		UHF	Tanker	[FPSO Name]	✓
6-4	3000 m	[FPSO Name] to initiate the Telemetry System.		UHF	[FPSO Name]	Tanker	✓
6-5	1500 m	Tanker to notify [FPSO Name] when passing the 1500 metre zone.		UHF	Tanker	[FPSO Name]	✓
6-6	1000 m	Tanker to activate the BLS operator panel.		UHF	Tanker	[FPSO Name]	✓
6-7	1000 m	Select "Approach mode" on the DP system.		UHF	Tanker	[FPSO Name]	✓
6-8	700 m	Tanker to notify [FPSO Name] when passing 700 m.		UHF	Tanker	[FPSO Name]	✓
6-9	600 m	Tanker to notify [FPSO Name] when passing 600 m. Tanker to reduce speed to maximum 2 knots and proceed to 500 m.		UHF	Tanker	[FPSO Name]	✓
6-10	500 m	Stop the vessel and confirm to [FPSO Name] . "Stop" means maximum speed in any direction to be less than 0.2 knots.		UHF	Tanker	[FPSO Name]	d/t

Tanker & [*FPSO Name*] confirm this section 6 is complete (each to sign own copy)	Signature	d/t

NB: In the event that the approach is aborted during this phase, the new approach should resume Checklist at Step 4-1 but at a range of 3 nm.

7. From 500 m to rocket line

Step	Dist	Request / Information / Action	Manual Reference	Comms method	From	To	Time /Check
7-1	500 m	Tanker to: • activate the BLS operator panel; • start the hydraulic pump units; • open bow door/bow gate; • make winch systems and Bow Loading Equipment ready for mooring and connection; • check the Tanker chain stopper load cell reading "zero tension"; • confirm FSOG green level status and confirm all to [FPSO Name] .		UHF	Tanker	[FPSO Name]	✓
7-2	500 m	Tanker to request [FPSO Name] for permission to enter the 500 metre safety zone.		UHF	Tanker	[FPSO Name]	✓
7-3	500 m	Tanker to proceed inwards to 300 metres. Reduce speed to maximum 0.6 knots (0.3 m/sec).		UHF	Tanker	[FPSO Name]	d/t
7-4	300 m	[Tanker to notify [FPSO Name] when passing 300 m. Reduce speed to maximum 0.4 knots (0.2 m/sec).		UHF	Tanker	[FPSO Name]	✓
7-5	200 m	Tanker to notify [FPSO Name] when passing 200 m.		UHF	Tanker	[FPSO Name]	✓
7-6	200 m	Tanker to monitor the alignment of Tanker and [FPSO Name] FPSO headings to be within maximum limitation of 15 degrees. If not, reposition the vessel or abort the approach attempt.		UHF	Tanker	[FPSO Name]	✓
7-7	150 m	Tanker to commence DP trials and station keeping verification trials according the DP guidelines including its additional checklists and the vessels own DP trial procedures. Tanker to carry out a "position drop out" on the DP system by deselecting all position reference systems.		UHF	Tanker	[FPSO Name]	✓
7-8	150 m	Tanker to select Artemis as the Primary Position Reference System. Tanker's own absolute DGPS should not be mixed with the relative system.		UHF	Tanker	[FPSO Name]	✓
7-9	100 m	[FPSO Name] to confirm permission to Tanker to proceed to firing position. Tanker deck crew to establish comms via UHF with "[FPSO Name] Deck". [FPSO Name] Deck operations are under the supervision of the Deck Foreman.		UHF	Tanker/ [FPSO Name] Deck	[FPSO Name] Deck / Tanker	✓
7-10	70 m	Tanker to arrive at firing position and stop; advise [FPSO Name] Deck that the Tanker is ready to receive the rocket line.		UHF	Tanker	[FPSO Name] Deck	d/t
7-11	70 m	Tanker to connect hawser/hose as per procedure.		UHF	Tanker/ [FPSO Name] Deck	[FPSO Name] Deck / Tanker	✓
7-12	70 m	Tanker to visually inspect messenger, hawser and hose equipment as it comes into view. Inform [FPSO Name] Deck of any damage or confirm if all equipment is in satisfactory order.		UHF	Tanker	[FPSO Name] Deck	✓
7-13	70 m	Tanker to confirm time Hawser connected.		UHF	Tanker	[FPSO Name]	d/t
7-14	70 m	Tanker to confirm time Hose connected.		UHF	Tanker	[FPSO Name]	d/t

Step	Dist	Request / Information / Action	Manual Reference	Comms method	From	To	Time /Check
7-15	70 m	Tanker to select “weathervane mode” on the DP.		UHF	Tanker	[FPSO Name]	✓

Tanker & [*FPSO Name*] confirm this section 7 is complete (each to sign own copy)	Signature	d/t

NB: In the event that the approach is aborted during this phase, the new approach should resume Checklist at Step 4-1 but at a range of not less than 2000 m.

8. Commence Offload

Step	Dist	Request / Information / Action	Manual Reference	Comms method	From	To	Time /Check
8-1	70 m	Tanker/[FPSO Name] agree again that weather conditions are suitable to continue Offtake.		UHF	Tanker/ [FPSO Name]	[FPSO Name]/ Tanker	✓
8-2	70 m	Tanker to confirm they are ready to load by initiating the telemetry "Permit to Load" signal.		UHF	Tanker	[FPSO Name]	✓
8-3	70 m	[FPSO Name] to inform the Tanker when ready to carry out the shutdown test.		UHF	[FPSO Name]	Tanker	✓
8-4	70 m	[FPSO Name] to start the first Main Oil Export pump on slow speed.		UHF	[FPSO Name]	Tanker	✓
8-5	70 m	Once running and green line is established [FPSO Name] will request the Tanker to initiate a stop of the pump. Both parties to confirm trip was successful.		UHF	[FPSO Name]	Tanker	d/t
8-6	70 m	[FPSO Name] to reset the trip on the Main Oil Export pump and prepare for restart. Repeat the shut down test with [FPSO Name] initiating the Export ESD1. Complete the Record boxes below. "Permit to Load" to be re-established.		UHF	[FPSO Name]	Tanker	d/t

	FPSO		Tanker	Remarks
	Cargo pump(s) tripped	Export ESDV closed	Bow coupler closed	
ESD1 initiated from Tanker	secs	secs	secs	
ESD1 initiated from FPSO	secs	secs	secs	
Max allowable	2 seconds	20 seconds	25 seconds	

8-7	70 m	If Tanker has not carried out an ESD2 test in the last four bow loading cargoes, ESD2 test to also be done with a cargo pump running, but without dropping of hose and hawser.		UHF	Tanker/ [FPSO Name]	[FPSO Name] / Tanker	✓
8-8	70 m	Tanker and [FPSO Name] to agree all tanker safety safeguards are in place, as per ISGOTT recommendations including: • hotwork restrictions; • firefighting equipment in place and ready; • radios grounded; • VHF radios on reduced power ([FPSO Name] sets in Admin, Radio Room and CCR); • all accommodation doors closed; • restricted access barriers in place ([FPSO Name] poop deck, Tanker focsle).		UHF	Tanker/ [FPSO Name]	[FPSO Name] / Tanker	✓
8-9	70 m	Tanker and [FPSO Name] to both confirm their hawser tension recorders working.		UHF	Tanker/ [FPSO Name]	[FPSO Name]/ Tanker	✓
8-10	70 m	[FPSO Name] to advise Tanker of any expected Helicopter operations during offtake.		UHF	[FPSO Name]	Tanker	✓

Step	Dist	Request / Information / Action	Manual Reference	Comms method	From	To	Time /Check
8-11	70 m	[FPSO Name] to inform the Tanker that oil loading is about to commence. Tanker to verbally confirm she is lined up for offtake.		UHF	[FPSO Name]	Tanker	✓
8-12	70 m	[FPSO Name] to start the first Main Oil Export pump. Deck watch to monitor Export Hose on poop deck. Metering Technician to be informed. Print off Stability Data.		UHF	[FPSO Name]	Tanker	d/t
8-13	70 m	Tanker to visually control/inspect the BLS Coupler and all visible parts of the hose/line system for possible leaks. If leaks, the Tanker to initiate "Stop" at once.		UHF	Tanker	[FPSO Name]	✓
8-14	70 m	Tanker to confirm cargo is being received and to request increase to full rate.		UHF	Tanker	[FPSO Name]	d/t
8-15	70 m	[FPSO Name] to ensure IG< 5% is being supplied to tanks.		UHF	[FPSO Name]	Tanker	✓

Tanker & [*FPSO Name*] confirm this section 8 is complete (each to sign own copy)	Signature	d/t

NB: In the event that the offtake operation is aborted during this phase, once the Tanker is in a safe location, [FPSO Name] and the Tanker are to fully review the reason and ensure this has been recorded before any reconnection operation is commenced. A new approach should resume at Checklist Step 4-1.

9. During Offload

Step	Dist	Request / Information / Action	Manual Reference	Comms method	From	To	Time /Check
9-1	70 m	If any deficiency of offtake related equipment on either Tanker or [FPSO Name] arises, whether affecting the present offtake or not, then Tanker/[FPSO Name] to immediately discuss with the other.		UHF	Tanker/ [FPSO Name]	[FPSO Name] / Tanker	✓
9-2	70 m	Every hour during the loading operation, Tanker and [FPSO Name] to exchange following information: • Tanker & [FPSO Name] headings; • wind speed and direction; • wave height and period; • hose (Tanker) and hawser ([FPSO Name] & Tanker) tension; • status as per FSOG • cargo quantity last hour; • total cargo discharged/received; • expected/requested total cargo size; • estimated time to completion. Data to be recorded on Form xx.		UHF	Tanker/ [FPSO Name]	[FPSO Name] / Tanker	✓
9-3	70 m	As a minimum Tanker/[FPSO Name] to give 1 hours notice regarding "Loading Completed".		UHF	Tanker/ [FPSO Name]	[FPSO Name] / Tanker	✓
9-4	70 m	[Tanker/[FPSO Name] 30 minutes notice regarding "Loading Completed". *[FPSO Name] to inform Metering Tech, Lab Tech, Plant Op, Deck Crew and Pumpman*.		UHF	Tanker/ [FPSO Name]	[FPSO Name] / Tanker	✓
9-5	70 m	Tanker is in charge of "Topping Off" at the end of the operation; Tanker may ask [FPSO Name] to reduce the flow rate at any time but should keep [FPSO Name] fully advised before cargo loading is stopped.		UHF	Tanker	[FPSO Name]	✓
9-6	70 m	Complete Offtake. [FPSO Name] to stop export pumps when parcel is complete or by mutual consent Tanker to activate "Loading Off" by telemetry when topping off tanks is complete. [FPSO Name] to confirm that the export pumps are stopped and the ESDV is closed. [FPSO Name] to print off Stability data		UHF	Tanker/ [FPSO Name]	[FPSO Name] / Tanker	d/t

Tanker & [*FPSO Name*] confirm this section 9 is complete (each to sign own copy)	Signature	d/t

NB: In the event that the offtake is aborted at any time during the loading, once the Tanker is in a safe position, [FPSO Name] and the Tanker are to fully review the reason and ensure this has been recorded before any reconnection operation is commenced. A new approach should resume at Checklist Step 4-1.

10. Disconnection/Departure

Step	Dist	Request / Information / Action	Manual Reference	Comms method	From	To	Time /Check
10-1	70 m	[FPSO Name] /Tanker: Agree that the Tanker is to disconnect. Tanker deck crew to establish comms (via UHF) with "[FPSO Name] Deck".		UHF	[FPSO Name] / Tanker	[FPSO Name] / Tanker	✓
10-2	70 m	Tanker to inform [FPSO Name] and any other vessels of the intended departure course.		UHF	Tanker	[FPSO Name]	✓
10-3	70 m	Tanker to switch to Approach mode in readiness for moving astern, max speed 0.6 knots.		UHF	Tanker	[FPSO Name]	✓
10-4	70 m	Tanker to disconnect hawser/hose. Note any damage to offload equipment and inform [FPSO Name] Deck.		UHF	Tanker/ [FPSO Name]	[FPSO Name] / Tanker	✓
10-5	70 m	Tanker to inform [FPSO Name] Deck when hose has been released.		UHF	Tanker	[FPSO Name] Deck	d/t
10-6	70 m	[FPSO Name] to complete hawser/hose recovery. Note any damage to Offload Equipment		UHF	[FPSO Name]	Tanker	✓
10-7	70 m	Tanker to inform [FPSO Name] Deck when hawser has been released.		UHF	Tanker	[FPSO Name] Deck	✓
10-8	100 m	Tanker to inform [FPSO Name] Deck when messenger line is clear.		UHF	Tanker	[FPSO Name] Deck	d/t
10-9	350 m	Tanker to change to manual mode and proceed clear of [FPSO Name] .		UHF	Tanker	[FPSO Name]	✓
10-10	500 m	Tanker to notify [FPSO Name] of the time when leaving the 500m safety zone and proceeding to 3 nm.		UHF	Tanker	[FPSO Name]	d/t
10-11	3 nm	Tanker to notify [FPSO Name] of the time when passing 3 nm and proceeding to 10 nm.		UHF	Tanker	[FPSO Name]	✓
10-12	3 nm	[FPSO Name] to forward Lab Report to Tanker.		e-mail	[FPSO Name	Tanker	✓
10-13	3 nm	[FPSO Name] to complete post offload checks: • IG/hawser recorders off & marked; • COP log completed; • Hawser Log completed; • Complete Offtake Observation Report – fwd to Tanker; • turn off Reference system; • send sailing advice message to shore; • stop both stern discharge hydraulic pumps; • prepare PLT for next use.		- - - - e-mail - - e-mail	[FPSO Name]		✓
10-14		Tanker to: • complete the remaining items on the Port Log including the ETA at the destination port; • send departure message; • de-rig emergency towing arrangement.		- - e-mail -	Tanker		✓
10-15	10 m	Notify [FPSO Name] when leaving the 10 NMZ.	VHF	VHF	Tanker	[FPSO Name]	d/t

Tanker & [*FPSO Name*] confirm this section 10 is complete (each to sign own copy)	Signature	d/t

Intentionally Blank

Appendix G
Incident Report Forms

- Oil & Gas UK - Tandem Loading Incident Reporting Form
- IMCA Station Keeping Incident Form

Oil & Gas UK - Tandem Loading Incident Reporting

Reporting of Incidents via Oil & Gas UK is intended to provide opportunities for lateral learning and increased awareness of potential risks relating to tandem offloading operations.

Reporting is voluntary, and submission of any incident report is subject to prior approval from installation and tanker operators involved.

Submitted reports (including any attachments) will be made available to members of the Oil & Gas UK FPSO Forum and may be discussed at regular Forum meetings.

Electronic Copies of this form are available on the Oil & Gas UK website: www.oilandgasuk.co.uk

Completed Incident Report forms should be submitted to the following email address: offtakereporting@oilandgasuk.co.uk

1. Incident Summary *(Single sentence description of what occurred)*	
2. Date / Time *(when the incident happened)*	
3. Location *(general location – e.g. Central North Sea, WoS etc)*	
4. Installation Name *(voluntary – leave blank if desired)*	
5. Offtake Tanker *(voluntary – leave blank if desired)*	
6. Weather Conditions *(wind, sea, visibility)*	
7. Description of Incident *(summary of what happened)*	
8. TLG Reference *(which section(s) of the guidelines does the incident relate to)* **e.g. Ch.4.3.11 or App. A3 4) 4)**	
9. Root causes identified	
10. Attachments *(list any submitted attachments which help describe the incident - e.g. sketches, photographs, full incident report, IMCA report etc)*	
11. Further Information Available *(advise whether further information will be made available if requested)*	Yes / No
12. Contact details for further information *(telephone / email contact for any specific questions or requests for further information)*	

IMCA
Station Keeping Incident Form
for
Thruster-Assisted Vessels/FPSOs/FSUs/DP Tankers/EWTs/Semis/Flotels, etc.

Reportable Station Keeping Incident

This report should be completed and sent to IMCA on the following occasions:

- For any unexpected loss of position and/or heading
- For an unexpected loss of functionality or availability of equipment which results in a reduced level of redundancy leading to a degraded operational status
- When the DP system performance differs from the operators expectations

DOCUMENT DETAILS AND ISSUE RECORD			
Vessel:		Date:	
Place:		Reported By:	
Client:		Position:	
This section is confidential			
Class Notation: (e.g. DYNPOS AUTR)			

Please return completed form to:

Jane Bugler, Technical Director
IMCA, Carlyle House, 235 Vauxhall Bridge Road, London SW1V 1EJ, United Kingdom
E-mail: imca@imca-int.com Tel: +44 (0) 20 7931 8171 Fax: +44 (0) 20 7931 8935

This form is to be populated by the Thruster Assisted Vessel or the Non-DP Vessel. The separate DP Vessels form should be returned by the DP Vessel involved.

1.) Description of work being carried out:

2.) Environment			
Wind Speed:	Wind Direction:	Wave Height:	Visibility:
Current Speed:	Current Direction:	DP Current or Real Current:	Water Depth:

3.) Thruster Assisted Vessel Equipment On-Line			
Control System:		Switchboard Status:	
		Open:	Closed:
Thrusters On-Line: (selected to DP)	Thrusters on Stand-By: (available for immediate start)	Generators On-Line: (selected to DP)	Generators on Stand-By: (available for immediate start)

Position References: (populate fields with numbers)

Status:	HPR	Artemis	Fan-Beam	Taut Wire	DGPS	DARPS	Other
Available							
Stand-By							
On-Line							
Preferred							

Sensors: (populate fields with numbers)

Status	GYRO	VRS	WIND	Other
Available				
Stand-By				
On-Line				
Preferred				

4.) Thruster Assisted Mooring Systems		
Is the vessel Catenary Moored with Thruster Assist? (Y / N)		
	Spread	Turret
What type of primary mooring system is in place?		
If a Turret Moored vessel, what type is the Turret?		
Was the tanker operating on DP or Manual Taut Hawser (if applicable)?		
Is the tanker Non DP classed, IMO Class I DP or IMO Class II DP?		

What is the percentage utilisation of the Thruster Assistance for the following operational modes? (100% for always enabled, 0% for never enabled)	Monitoring	
	Heading Control	
	Damping	
	Position Control	
	Other	

What percentage of the operating time is the Thruster Assist system	a) Manned?	
	b) Unmanned?	

If offtake operations were in progress what was the status?	Approaching	
	Connected	
	Departing	

Shuttle Tanker Equipment On-Line			
Control System:		Switchboard Status:	
		Open:	Closed:
Thrusters On-Line: (selected to DP)	Thrusters on Stand-By: (available for immediate start)	Generators On-Line: (selected to DP)	Generators on Stand-By: (available for immediate start)

Position References: (populate fields with numbers)

Status	Artemis	DGPS	DARPS	Other
Available				
Stand-By				
On-Line				
Preferred				

Sensors: (populate fields with numbers)

Status	GYRO	VRS	WIND	Other
Available				
Stand-By				
On-Line				
Preferred				

5.) Sketch (Vessel outline, heading, location of pos. ref., relative positions, hawser length, tracks of FPSO/FSU stern and Tanker, etc.)

(Screen grab from DP System if available)

6.) Sequence of Events: (attach DP, PMS/VMS alarm printouts, if available)

1.

2.

3.

4.

5.

6.

7.

8.

9.

7.) Narrative Description of Events: (if available attach internal incident reports)

8.) Incident Numerical Description:	
Distance travelled to peak of Excursion (m):	
Time to recover from Blackout i.e. DP back on-line (secs):	
Time to recover to Green Watch Circle (seconds):	

9.) Corrective Action Taken	
	Tick as Appropriate
Modify Procedures	
Modify Standing Instructions	
Report to Shore Management	
Repair	
Modify Maintenance Procedures	
Report to Supplier	
Additional Alarm Installed	
Operator / Technician Training	
Warning Label fitted	
Other (specify)	
Is there more work to do before close out is complete?	
Has the incident been closed out with a satisfactory conclusion?	

10.) Human Factors
Were too many tasks being performed, or were there too many people involved / discussions taking place at the time of the incident?
Were the factors leading to the incident adequately covered by the circumstances within the training and familiarisation sessions with the DP Operators?
Would another DP Operator react with a different set of actions?
Have changes been made to the training and familiarisation procedures?
Should changes be made to the Annual DP Trials in light of the incident?
Do you believe that the DP Operator, if faced with a similar situation now, would react in a different way?

11.) Comments
Please add any comments or suggestions that have not been fully covered in the report.

Have you attached any alarm printouts (DP/VMS/PMS), internal reports and correspondence that may assist in the analysis of the incident?

Both DP Vessel and Thruster Assist Vessel/Tanker should return separate forms.

Appendix H

Guidance in Respect of Non-Tandem Offtake Concepts

Preamble

This Appendix recognises that some of the specific guidance in the main document may not be applicable to non-tandem offtake operations, and just as importantly there may be other aspects that the tandem operations guidelines do not consider. This Appendix, based on the experience of non-tandem Operators, lists some of the additional factors that Operators may use as a Checklist if they intend to utilise a non-tandem DP offtake concept. This list should not be treated as necessarily complete since each system will have unique features and an in-depth review should be carried out to ensure all hazards have been captured.

Other offtake concepts already exist in the UK and elsewhere, that also use DP tankers, but not in a tandem methodology. Notable existing systems are SAL and round FPSOs/FSUs (such as the Sevan units), but other concepts may also be viable.

Crew Training

The following are considered to be the main points to achieve a successful start-up:

- involve Tanker Operator shore personnel in the offtake regime concept development;
- involve Tanker crew personnel as early as practicable;
- ensure Tanker onshore and offshore personnel are part of creating the Offtake Operations Manual, so it is truly “joint”;
- consider the less tangible features, such as if there is no FPSO there to sight;
- build a specific syllabus for crew training for offtake operations, making these joint if possible;
- control training of future personnel.

If the concept is new, then neither the FPSO nor the Tanker personnel will be familiar with it. It is likely, and normally considered beneficial, that the FPSO personnel will be involved with their unit during at least the commissioning phase; they may even be part of the design of the offtake methodology. However with a new concept, or a concept that is not in common use, the Tanker personnel, specifically the bridge staff but also the deck crew to handle equipment during the connection, would not have that automatic exposure to the offtake methodology. Experience has shown that presenting a Tanker with an Operations Manual, however clear and pretty the drawings and sketches may be, is insufficient preparation to remove as much risk as is practicable. Early involvement of the Tanker Operator is recommended, and to make at least the onshore management a part of the development of the offtake regime.

Joint training sessions at suitable briefing meetings, and ideally also at a simulator, i.e. FPSO and Tanker personnel together, can be a considerable advantage, especially with a new offtake concept. This activity;

a) allows all personnel to understand the issues as they are seen from the other vessel, so that they can tailor their own actions to make it easier for the other and to avoid misunderstandings; and

b) acts as a validation of the offtake regime, since typically simulator sessions are those that try to recreate incidents.

It is suggested that using training sessions in a simulator to develop all but the final details of the offtake regime could be counter-productive as it can lead to confusion with some participants as to the final regime and procedure.

Clearly the training requirements are reduced if only one or two Tankers are involved. Nevertheless some care is required to ensure that sufficient personnel, not just in each crew but on each watch/shift, have received the full intended training program. If this is not the case, leave rotation may make a future offtake operation less safe.

Some offtake concepts may not weathervane around the FPSO. A typical tandem loading system has one advantage in that typically the FPSO appears as a huge obstruction to the DPOs in the Tanker wheelhouse; it is an obvious visual reminder and ready check that the Tanker is generally in the correct position. However, if the point of rotation is just a nominal piece of seawater, especially if the FPSO is out of the normal arc of vision or is too far away for an unconscious worthwhile judgement of range, then the Tanker DPO is effectively relying on instruments. This intangible missing feature of some offtake regimes may make it prudent for additional simple instrumentation to clearly illustrate whether the Tanker is correctly positioned or not.

Development of a specific written syllabus for training each DPO and Master, and where necessary deck crew, that can be followed for all future new starts, is recommended. Use of DP CAP (or equivalent) and periodic simulator training should be included on a regular basis, to recognise that while Tanker personnel generally gain lots of experience with tandem offtakes, due to the small number of the new offtake concepts installed there is less opportunity to gain experience.

DP Program

When considering the DP program for a new concept the Operator should:

- ensure sufficient time is allocated to building a new DP program and having it tested;
- consider 3rd party testing of a new DP program, specifically a simulator;
- ensure there is a control method for future versions of the DP program.

It is usual for each offtake location to have a field specific DP program, and the Tanker switches to this program at the start of his approach for connection.

A new offtake concept at the very least is likely to require different ranges and bearings from the weathervaning centre than previous programs, and may require an entirely different DP application. In either case it should be borne in mind that the programmers, however experienced they may be, could inadvertently have missed a line or character of code, or not understood one of the implications of changing a line of code when adjusting a previous program.

While DP equipment and program suppliers will most probably undertake their own tests, it is strongly recommended from experience that a 3rd party independently review all new DP programs, against all normal and abnormal operational criteria and event sequences, in order to capture any anomalies. Use of a simulator can be a very useful tool for this activity – and it also provides

the simulator staff with the opportunity to become familiar with the offtake regime in preparation for training sessions.

This process can take a few months and should be started in sufficient time to ensure that a full review and test programme can be maintained, and that this stage is developed in sufficient time for crew training to commence.

The DP program for a new offtake concept, once it has seen some operational use, may also be tweaked to account for operational experience; it can then become important to check that each visiting Tanker does have the correct version of the program.

Orientation

The main point when considering orientation (of the Tanker) is to ensure that drift-off safeguard generally exists.

One of the principles of a standard tandem offtake system is that the Tanker is in a blow-off situation; if the Tanker blacks out, or the mooring connection (if any) and the hose fail then the Tanker will naturally pass clear astern of the FPSO, unless the Tanker personnel take contrary action. There are some exceptions, rapid change of tide direction, or a flat calm and the hawser/hose weight pull the two ships together; but generally tandem loading Tankers do not have to consider drift on scenarios with a FPSO.

However a different offtake concept may not necessarily achieve this natural drift-off capability. In considering drifting of Tankers it should be noted that Tankers do not typically stay on a heading into the weather, but may well start to change heading to be beam on, and thus have a wider drift path than their own beam. Determining a safe drift off clearance should be made based on available air drafts of both vessels taking into account all operating conditions including heel, trim and motions in waves of the Tanker, and consideration of clearances from risers and moorings in different FPSO draft, heel, trim and motion conditions. Consider also the underwater features – refer to subsection below.

Hose Angle

When considering the hose angle, the following main points should be considered:

- side loads from hose catenaries;
- ensure operating limits of thrusters for station-keeping and for bow loading systems are taken into account;
- contact with the Tanker hull, consider dynamic analyses;
- model emergency release scenarios;
- consider hose tension in black-out scenario.

Tandem loading systems have the hose leading ahead from the tanker bow, and due to a planned maximum heading difference, the hose does not often lead at a high angle from the tanker bow. Some offtake concepts, however, may require higher angles in order to obtain sufficient weathervaning arcs of operation, and this will likely require some additional considerations, and likely some compromise. These considerations may include:

- station-keeping capability, noting that some of the thruster power may be used to counter the sideways pull on the bow from the hose catenary. This pull can be lessened by having a high declination leaving the bow coupler, but this can lead to contact with a bulbous bow;

- at the extreme the limits of the bow loading system may be reached – for example 35º to port or starboard. It is recommended that banging against such stops is designed out of the offtake regime;
- contact during dynamic motions, such as bad weather. Time domain finite element simulation of hose systems, with each end being moved according to the motion characteristics (RAOs = Response Amplitude Operators) of each vessel, is quite feasible with a number of software packages. Such analyses should follow normal good practice as regards hose element length, hose axial and bending stiffness values (easily obtainable from hose suppliers, even if not on their normal specification sheets), damping, and wave profiles (period, height, steepness and type including a number of random wave trains not just regular waves);
- emergency hose release from the tanker bow coupler should also not be ignored, as a hose end valve contacting in free fall to a bulbous bow can conceivably puncture hull plating, and/or damage the hose integrity. Dynamic analysis programs can also typically model emergency release scenarios;
- it is well understood that the weight of the hose can bring a Tanker into contact with a FPSO, in calm weather and if the Tanker is blacked out. A longer hose string will increase the pull on the tanker, and precautions that may apply to a typical tandem arrangement may not be a sufficient safeguard for an initially larger FPSO/Tanker separation distance. For example if in a Tanker blackout situation a tandem operation allows the separation to close to 50 m (from say a normal operating range of 75 to 80 m) before a ESD2 should be initiated, this can be sufficient distance to stop the Tanker continuing forward to make contact with the FPSO; but if the Tanker started at 200 m, by the time it reaches 50 m its forward momentum would result in contact with the FPSO.

Underwater Features

The following points should be considered:

- consider dropped object protection from the hose end valve, both for integrity and hose recovery;
- ensure sufficient vertical clearance from all underwater architecture;
- review hose disconnection locations taking account of possible drive-off speeds.

A typical tandem offtake operation results in the tanker bow being at an expected fairly standard distance from the centre of rotation of the FPSO, and it is normal practice to ensure that subsea features, such as pipelines, riser bases, manifolds and well heads, have suitable protection from dropped objects. One specific case of a dropped object is the consequences of an ESD2, or, with less control on location, an ASD2.

If the offtake regime does not result in the Tanker also weathervaning around the same centre as the FPSO, then the Tanker bow may be covering a much greater area of potential hose end valve drop locations. This should be carefully reviewed, not just for protection of the subsea asset and potential safety and environmental consequences if their integrity is breached, but to ensure that there is a means of recovery of the hose, and that snagging risks are eliminated.

The normal tanker bow operating zone, or the probable zones where a hose disconnection may occur, taking account of possible drive off accelerations (up to

41m in the 40 seconds it takes to execute a disconnection during pumping), should be considered when determining normal operating arcs. For example if a hose disconnection takes place when the Tanker bow is beyond a riser or a mooring line, then the export hose string may be draped across this asset, damaging possibly the asset but also itself.

The potential drive off and drift off tracks of the Tanker should also be considered in view of all the subsea architecture, and that mooring line vertical clearances may determine the nearest safe distance that a drift or drive off path should be permitted.