

DEP SPECIFICATION

**SELECTION AND OPERATION OF
DYNAMICALLY POSITIONED (DP) VESSELS**

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DESIGN AND ENGINEERING PRACTICE

DEM1



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PREFACE

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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the selection and operation of vessels to conduct DP operations safely on board dynamically positioned (DP) vessels, including the following:

- Physical aspects (e.g., position reference sensors, FMEA's, DPCS modes and features).
- Operational aspects (e.g., Activity Specific Operating Guidelines (ASOG), Well Specific Operating Guidelines (WSOG)).
- Demonstrating minimum performance levels of equipment.

This DEP is based on the following MTS DP Committee Guidance Documents, IMCA and Industry Guidance Documents.

MTS DP Committee Guidance Documents:

- DP Vessel Design Philosophy Guidelines (Part 1 and Part 2) (Published as DNV RP E306)
- DP Operations Guidance (Part 1 and Part 2 (Appendix 1, 2 and 3)) (Note DNV RP E307 is based on this guidance)
- Guidance for Professional Development of Personnel engaged in DP Operations using the Mapping Delivery Ability Tool (MDAT)
- Technical and Operational Guidance (TECHOPS) published on the MTS DP Committee website).

TECHOPS:

- FMEA (ODP_04 (D) _ - FMEA Gap Analysis)
- FMEA Proving Trials (ODP_01 (D) _ - FMEA Testing)
- Annual DP Trials (ODP_08 (O) _ - Annual DP Trials Gap Analysis)
- DP Operations Manual (ODP_05 (O) _ - DP Operations Manual)
- External Interfaces (ODP_10_(D))
- Cross Connections (ODP_11_(D))
- Control Power Supplies and Auto Changeovers (ODP_13_D)
- Position Reference Systems (PRS) and DP Control Systems (DPCS) handling of PRS (ODP_14_D)
- Proving the fault ride through capability of DP vessels (ODP_09_(D))
- Blackout Recovery (ODP_02_(D))
- Defining Critical Activities Selection of Critical Activity Mode (ODD_12_(O))
- DGNSS Position Reference Sensors (ODP_06_(D))
- Conducting Effective and Comprehensive DP Incident Investigations (GEN_03)

IMO, IMCA and Industry Guidance Documents:

- IMO MSC 645 – Guidelines for Vessels with Dynamic Positioning Systems
- IMCA M190 – Developing and Conducting Annual DP Trials programmes for DP vessels¹
- IMCA M191 - Guidelines for Annual DP Trials for Mobile Offshore Drilling Units²

- IMCA M117 – The Training and Experience of Key DP Personnel
- IMCA M178 - FMEA Management Guide
- IMCA M219 - Example Specification for a DP FMEA for a New DP Vessel
- IMCA M225 - Example Redundancy Concept and Annual DP Trials for a DP Class 3 Construction Vessel
- IMCA M119 Rev 1 – Fires in Machinery Spaces on DP Vessels
- DNV GL Recommended Practice for FMEA of Redundant Systems RP D102
- Offshore Technical Guidance DNV GL-OTG-10 Edition April 2015 DP Classed Vessels with Closed Bus³
- OCIMF-Dynamic Positioning Assurance Framework (First Edition 2016)
 - o Note¹ Additional requirements as specified in this DEP
 - o Note² Additional requirements for MODU's as specified in this DEP
 - o Note³ Additional requirements in specified in this DEP in (Appendix G).

Relevant IMCA Guidance documents are referenced within the MTS DP Committee Guidance Documents.

The requirements in this DEP are applicable to all vessels using Dynamic Positioning Systems to maintain station and to vessels using thrusters to assist moorings. Additional requirements for such applications where thrusters are used to assist moorings are contained within (4.7.3) and (Appendix K).

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual (DEM) 1 - Application of Technical Standards.

This is a revision of the DEP of the same number dated February 2011, amended 2012; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorisation to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases, the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.

1.3.2 Specific definitions

Term	Definition
Activity/Well Specific Operating Guidelines	ASOG/WSOG is a document used as a decision support tool, generally presented in a tabulated format containing a traffic light system, setting out the configurations of the DP system (CAM and TAM), operational, environmental and equipment performance limits and high level operator actions considered necessary for safe DP operations while carrying out a specific activity or industrial mission. ASOGs on a DP MODU are called WSOG (Well Specific Operating Guidelines).
Closed Bus	With reference to power systems of diesel electric vessels, the power plant is operated as a single connected power system.
Critical Activity Mode (CAM)	CAM is a tabulated presentation of how to configure the vessel's DP system including power generation and distribution, propulsion and position reference systems so that the DP system as a whole is fault-tolerant and provides the highest level of station keeping integrity, addressing the potential for hidden failures. CAM Configuration strives to minimise the potential for failures leading to a loss of position.
Diesel electric Vessel	For the purpose of this DEP Diesel electric vessels are those where propulsion for station keeping is provided by electric motor driven thrusters supplied from a power generation system using diesel generators. In the case of vessels where propulsion is provided by other means, but where station keeping depends on the supply of electric power for auxiliary services or other DP related systems, the power systems of such vessels will be configured as two or more isolated power distribution systems.
Dynamic Positioned Vessel	A unit or vessel which automatically maintains its position and or heading (fixed or predetermined track) by means of thruster force.

Term	Definition
Failure Modes and Effects Analysis (FMEA)	A procedure by which the effects of potential failure modes are analysed to determine the end effect. In the context of this DEP, the end effect addresses any impact on the ability to maintain position and heading.
Hidden Failures	A failure that is not immediately evident to Operations or Maintenance Personnel. In the context of this DEP it is the potential for failure of equipment to perform an on demand function such as protective functions in power plants and switchboards, standby equipment, lack of capacity / performance.
Industrial Mission	Is the primary operational role of the vessel, typically applicable to MODUs and Construction vessels (e.g., Pipe-lay/Heavy-lift, Subsea IRM vessel, ROV support vessels)
LIFE DP redundancy concept	The objective is to limit the failure effects, by design, to a loss of one thruster or engine or one position reference sensor for all failures except those caused by fire and flood events and failure of a bus.
Loss of Position	Loss of position and / or heading means an excursion in position or heading which impacts the conduct of the industrial mission being undertaken by the vessel or a breach of acceptable excursion criteria set for position and heading. Note: The nature of the operations being undertaken and the consequences of a loss of position usually determines acceptable excursion limits.
Open Bus	With reference to power systems of diesel electric vessels, the power plant is operated as two or more independent power systems.
Soak Test	This is an endurance test at normal operational load for a specified duration (as agreed with the Principal).
Statement of Verification (SoV)	The statement issued by the Principal verifying that the requirements of the implementation of this DEP have been met.
Stress Test	This is a test of the equipment's performance at the limit of its rated capacity for a specified duration (as agreed with the Principal).
Task Appropriate Mode (TAM)	The defined configuration(s) that the vessel's DP system may be set up and operated-in, recognising that in this configuration(s) the DP System as a whole is not as fault tolerant as in CAM, and failures could result in the potential for a loss of position. The consequences of a loss of position when operating in TAM are identified, acknowledged, accepted and mitigated against.
Worst Case Failure (WCF)	Is the failure effect with the greatest severity in respect of loss of thrust capacity revealed by analysis and proving trials. (Note: Usually this would be the loss of one redundancy group. in a well-designed vessel). The WCF defines the vessel's theoretical post worst case failure DP capability when all DP related equipment is capable of its nominal capacity.

Term	Definition
Worst Case Failure Design Intent (WCFDI)	This describes the minimum amount of propulsion and control equipment remaining operational following the worst case failure. The worst case failure design intent is used as the basis of design. Single fault tolerance is to be achieved by the provision of redundant systems. Failure criteria are as defined for the appropriate DP equipment class.

1.3.3 Abbreviations

Term	Definition
ABS	American Bureau of Shipping
AFC	Approved For Construction
AFI	Agreed For Implementation
AI	Asset Integrity
ASOG	Activity Specific Operating Guidelines
AVR	Automatic Voltage Regulator
BV	Bureau Veritas
CAM	Critical Activity Mode
DEM	Design Engineering Manual
DEP	Design Engineering Practice
DGNSS	Differential Global Navigation Satellite Systems
DGPS	Differential Global Positioning System
DNVGL	Det Norske Veritas Germanischer Lloyd
DP	Dynamic Positioning
DPCS	Dynamic Positioning Control System
DPO	DP Operator
DP	Daily Progress Report
ECR	Engine Control Room
ESD	Emergency Shutdown
EX	Explosion Proof
FMEA	Failure Mode and Effects Analysis
GLONASS	Global Navigation Satellite System (GLObalnaya NAVigatsionnaya Sputnikovaya Sistema)

Term	Definition
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
GSI	Global Solutions International, Inc.
IJS	Independent Joystick System
IMCA	International Marine Contractors Association
IMO	International Maritime Organisation
INS	Inertial Navigation System
IRM	Inspection Repair and Maintenance
LBL	Long Baseline
Lloyds	Lloyds Register of Shipping
MODU	Mobile Offshore Drilling Unit
MRU	Motion Reference Unit
MSC 645	IMO MSC Circular 645
MTS	Marine Technology Society
OEM	Original Equipment Manufacturer
OIM	Offshore Installation Manager
OSV	Offshore Support Vessel
PMS	Power Management System
PRS	Position Reference Sensor
PS	Process Safety
PTW	Permit To Work
ROV	Remotely Operated Vehicle
SIMOPS	Simultaneous Operations
SOV	Statement of Verification
STCW	Standards of Training, Certification and Watchkeeping
TAGOS	Thruster and Generator Operating Strategy
TAM	Task Appropriate Mode

Term	Definition
VRU	Vertical Reference Unit
WCF	Worst Case Failure
WCFDI	Worst Case Failure Design Intent
WSOG	Well Specific Operating Guidelines

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (10).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated February 2011. The following are the main, non-editorial changes.

Section/Clause	Change
Entire DEP.	Endorsement of the Industry Standard Guideline (MSC 645).
	Endorsement of the MTS DP Committee guidance documents and TECHOP guidance notes.
	Endorsement of specific IMCA Guidance documents.
	Endorsement of OCIMF-Dynamic Positioning Assurance Framework (First Edition 2016)
	Extending the applicability of the DEP to all vessels using Dynamic Positioning for position keeping and to vessels which use thrusters to aid moorings in automatic thruster assist mode.
	Removal of the reference to IMCA Standard 161 which is no longer in use.
	Addition of the definition of dynamic positioning as defined in MSC 645.
	Addition of definition of Worst Case Failure, Loss of Position
	Endorsement of and requiring DNV GL Recommended Practice for FMEA of Redundant Systems RP D102 as the minimum standard for DP FMEA
	Addition of a requirement for DP MODUs to develop a continuous trial program based on IMCA M191 with additional requirements as specified in this DEP.
	Emphasizing the requirement for DP vessels to develop an annual trials program based on IMCA M190 with additional requirements as specified in this DEP
	Endorsement of Offshore Technical Guidance DNV GL-OTG-10 Edition April 2015 DP Classed Vessels with Closed Bus
	Addition of Verification Process for Power Systems Operating in CAM with closed Bus Ties (permissible for DP MODU's only)

Section/Clause	Change
	Introduction of Section 2.3 (Big Rules) incorporating lessons learned from DP incidents and events. Identifying specific deliverables from the Contractor to aid verification of implementation and adherence to industry guidance and requirements of this DEP.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://www.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

1.9 DOCUMENT HIERARCHY

In the event of conflicts between contract documents, AFC drawings, specifications and other referenced standards, the following document hierarchy shall apply:

- a. Contract (including any approved exceptions. Note this DEP shall be included or referenced in the Contract);
- b. AFC drawings;
- c. Principal's specifications (including project specific data sheets);

2. GENERAL

2.1 GENERAL REQUIREMENTS

1. This DEP shall be used for the initial selection and subsequent operation of any DP vessel intending to operate in DP mode as well as vessels that use thrusters to assist moorings.
 - a. All vessels shall be positively vetted and cleared before use within the Group Requirements for the Quality Assurance of Maritime Vessels as published on 19 December 2014.
 - b. Implementation of this DEP and a statement of verification issued per process shall be a required step of the positive vetting and clearance activity.
2. An ASOG or WSOG SHALL [PS] be established for each project, well or logistics activity as appropriate and implemented during the execution of the work.

Execution of the work will be in accordance with the ASOG/WSOG agreed for implementation.

ASOG/WSOG is activity specific or well specific. It is valid for the duration of the specific activity (ies) or well.

ASOGs for certain industrial missions can be generic (e.g., DP vessels engaged in logistics support mission). The validity of such ASOGs is at the Principal's discretion and might need to be refreshed and reissued along with SoV.
3. The applicable Principal's requirements shall be documented in the ASOG/WSOG.

The Principal's specific requirements for a particular operation or task could be more stringent than the IMCA, IMO or coastal state guidelines.
4. The following documents SHALL [PS] be developed as evidence of implementation of the requirements in this DEP and submitted for the Principal's approval:
 - a. ASOG or WSOG
 - b. Addendum to the vessel's DP setup and field arrival checklist formalising the mode of configuration (Critical Activity Mode (CAM) and Task Appropriate Mode (TAM)).
 - c. Gap Analysis of the following documents against the MTS DP Committee Guidance documents using the MTS DP Committee Guidance Gap Analysis Template and Gap (if any) Closure Path.
 - i. DP System FMEA.
 - ii. DP System FMEA Proving Trials.
 - iii. Annual DP Trials.
 - iv. DP Operations Manual.
5. The Contractor shall assist the Principal and the Principal's delegates through the verification process resulting in the delivery of the statement of verification.
6. The appropriate "DP Equipment Class", in accordance with the IMO MSC Circular 645, for the proposed operations shall be identified as part of the output of project or activity risk analysis, taking into account the consequences of a loss of position.

In certain areas of operation, the local government or Coastal State might dictate the minimum "DP Equipment Class" required.
7. The minimum equipment class should not be over-specified.
8. In order to ensure consistency of approach and to ensure vessels with the correct capabilities are employed, both the vessel's ability to withstand faults or machinery breakdown and the post worst case failure DP capability of the vessel in any operating

mode shall be clearly understood and documented in the Activity Specific Operating Guideline (ASOG / Well Specific Operating Guideline) as appropriate.

9. If a DP Equipment Class 1 vessel is being considered, such use shall be validated against the HSE case (if applicable).
 - a. The justification for use shall be documented with the supporting structured risk assessment for the proposed industrial mission.
 - b. This risk assessment shall be subject to approval by the Principal.
10. DP Diving Vessels, Construction vessels and DP Drilling MODUs shall be DP Equipment Class 2 or higher.
 - a. Use of non-redundant or DP 1 Equipment Class vessels within the 500 m safety zone of offshore installation or critical subsea infrastructure should be documented with a formal risk assessment and signed-off from appropriate accountable person with the authority.

Generally, the minimum DP Equipment Class required is DP 2.

2.2 PHILOSOPHY

There is wide variability in the scope and depth of industry guidance available on Dynamic Positioning (DP).

1. The following shall be identified and documented to support the philosophy for managing operations of the DP vessel:
 - a. Identification of the Worst Case Failure (WCF) of the vessel's DP system and operating the vessel within the post failure capability criteria established by the WCF.
 - b. Default Post Failure Capability, established using the following criteria:
 - i. CAM Operations, criteria based on validated Worst Case Failure.
 - ii. TAM Operations criteria usually based on loss of a single thruster/single generator.
 - c. Identification of the following:
 - i. DP system configuration for the operations (CAM/TAM).
 - ii. Nature of operation and configuration that the vessel needs to be set up in (CAM/TAM).
 - d. Technical capability including post failure capability and any limitations of the station keeping capability of the vessel to undertake the industrial mission.
 - e. Post worst case failure capability for operating configurations (Including impacts of non-availability of equipment due to IRM).
 - f. Clear understanding of any limitations and impacts on the industrial mission equipment and capabilities imposed by operating the DP vessel in CAM/TAM configurations.
 - g. Contingency plans and recovery measures.
 - h. Validation of crew competence, experience and familiarization with the use of the ASOG/WSOG.
2. The chosen criteria for TAM Operations used to define default post failure capability shall be subject to the agreement of the Principal.
3. The limitations and impacts on the industrial mission equipment and capabilities imposed by the DP vessel in CAM/TAM configuration shall be incorporated in the DP operations manuals and other relevant manuals/standard operating procedures.

2.3 THE BIG RULES

1. A DEP Statement of Compliance of the big rules shall be issued by the Contractor.
2. Station-keeping utilising Dynamic Positioning shall be identified as Safety Critical and managed accordingly at all levels of the organization.
3. Vessels with DP notation equivalent to DP Equipment Class 2 or higher, both in the intact condition and following worst case failure, shall be able to keep position and heading without relying on the combined use of propellers and rudders to develop transverse thrust.
 - a. Vessels relying on combined use of rudders and propellers to develop transverse thrust following worst case failure shall not be used for diving operations.
 - b. Use of vessels relying on the combined use of rudders and propellers to develop transverse thrust following worst case failure for industrial missions other than diving operations, are subject to the Principal's approval.
4. DP FMEAs shall meet the requirements of DNV RP D102.
5. DP FMEAs for a vessel shall cover the following:
 - a. open bus;
 - b. all other configurations vessel is proposed to be operated in.
6. FMEA proving trials shall be conducted and documented for all configurations the vessel is intended to be operated in.
7. DP diving support vessels and DP MODUs shall be equipped with an independent joystick system and a means to monitor position independent of the DP control system.
 - a. The position monitoring system used to achieve this should have a charting function capable of marking and providing a range and bearing to the desired position.
8. The independence of the Independent Joystick System SHALL [PS] be verified during FMEA proving trials.
9. Practice in the transferring to and use of IJS by the DPOs shall be documented as part of field arrival checks or within a period of six months from the field arrival.
10. Position reference sensors shall be suitable to accomplish the industrial mission.
 - a. Refer to (Appendix E) for requirements on position reference sensors.
11. Acoustic position reference sensors shall meet both of the following:
 - a. Be suitable for the water depth they are operating in.
 - b. Be accepted into the position reference solution when used in conjunction with position reference sensors based on other principles.
12. Where acoustic position reference systems are essential for position keeping in water depths greater than 700 m, long baseline (LBL) arrays of at least five transponders shall be deployed.
 - a. Fewer transponders may be used when the acoustic position reference system is aided with an inertial navigation system, providing proven performance is demonstrated and documented.
 - b. DP MODUs shall be equipped with dual independent acoustic systems.
13. When DGNSSs are used in conjunction with a position reference system based on another principle, no more than 2 DGNSSs shall be used in the position reference solution.

14. Vessels using underwater acoustic systems shall abide by the field acoustics management plan, if applicable.
15. All DP Vessels shall be equipped with redundant relative position reference systems.
DP MODUs might be exempt.
16. Redundancy for relative position reference sensors shall be achieved by systems operating on difference principles.
Relative position reference sensors for the purpose of this rule are systems operating on laser based and micro wave radio frequency.
 - a. Laser based systems shall use prisms as reflectors.
 - b. Transponders for MW radio frequency based systems shall be of EX type.
 - c. DP MODUs and construction vessels (when applicable) shall be equipped with prisms and relative position reference transponders on either side to facilitate relative positioning of other DP vessels.
 - d. DP Shuttle tankers shall be equipped with redundant absolute and relative position reference sensors suitable to undertake their industrial mission.(e.g., DARPS, Artemis, Laser based systems, MW radio frequency systems).
17. DP control systems of DP vessels shall have the required modes and features for the industrial mission being undertaken.
For example, external force compensation, heavy lift mode, follow target mode, and barge alongside module.
For example, DP Shuttle tanker operations (approach mode, weather vaning mode).
 - a. Exceptions to these requirements shall have the written agreement of the Principal.
 - b. See (Appendix E) for modes and features for industrial missions.
18. Design and operation of ESD and Fire and Gas Safety shutdown systems shall meet all of the following:
 - a. be in line with the DP redundancy concept of the vessel;
 - b. subjected to a systems engineering approach;
 - c. subject to documented proving trials.
19. Low level ESD, Fire and Gas Safety Shut down alarms and non-explosive gas influx related triggers, shall not result in an automatic shutdown or loss of thrusters.
20. Default operation of ESD and Fire and Gas Safety Shutdown Systems shall be in advisory mode (initiating alarms).
 - a. Operating in supervisory mode with the potential of shutting down of DP critical equipment due to non-explosive gas influx related triggers shall be subject to written agreement from the Principal.
The Principal's agreement, if appropriate, will be based on verification of the systems engineering approach and proving trials to demonstrate that the system is resilient to shutdowns triggered due to spurious events (e.g., sensor failures, input output card failures (benign and aggressive failures)).

21. External interfaces (e.g. pipe tension, draft sensor, velocity inputs and riser tensioner stroke) with inputs into the DP control systems shall be subject to documented proving trials.

The proving trials objective is to demonstrate that failures of sensor used for such interfaces (both aggressive and benign failures) will not result in a loss of position.

- a. Manual inputs shall be used as default mode of operation.
 - i. Draft sensor inputs on DP Shuttle tankers may be input automatically, subject to verification of a documented systems engineering approach and proving trials.
- b. Use of automatic inputs is by exception and shall have written agreement of the Principal.

The Principal's agreement (if appropriate) will be based on verification of the systems engineering approach and proving trials.

- c. Non-essential (for DP operations) interfaces with DP station keeping equipment shall be avoided.
- d. Where such interfaces are provided for non-DP operations, they shall be clearly identified and means provided to isolate them (including processes in place to ensure isolation) during DP operations.

(e.g., GPS inputs into gyros, speed/latitude corrections, GPS inputs to thrusters).

22. DP MODUs annual trials shall be in accordance with IMCA M 191 (continuous trials program) with the additional provisions of this DEP.

A continuous trial program is only applicable to DP MODUs.

- a. All other vessels shall conduct annual trials witnessed by an independent 3rd party in accordance with IMCA M 190 and additional provisions of this DEP.
 - i. The competence of the independent 3rd party shall be verified by the Contractor and subject to agreement of the Principal.

23. Default configuration for DP operations identified as CAM operations on diesel electric vessels shall be with an open bus configuration.

- a. Segregation shall be maintained at all levels of the power plant including control power supplies.
- b. Closed bus configurations of power systems for vessels other than DP MODUs, which rely on protective functions for fault tolerance, shall not be permitted in CAM.
 - i. Closed bus operations for DP MODU's may be considered for vessels meeting the requirements of (Appendix G), subject to approval by the Principal.
- c. DP MODUs that have incorporated and achieved the MTS DP Design Philosophy Guidance of Autonomy, Independence, Segregation, Differentiation, Fault Tolerance, Fault Resistance and Fault Ride Through and can demonstrate meeting the requirements in (Appendix G), may apply to the Principal to conduct operations in CAM with closed bus ties.

24. Automatic changeover function of power systems during CAM operations shall not be permitted.

25. DP vessels shall prove all elements of performance, protection and detection on which the redundancy concept depends at the annual DP trials.

- a. DP MODUs shall comply with the requirements in this DEP for trials based on a continuous trials program.

26. The following shall be tested on DP MODUs and other vessels (if applicable) as part of the batch trials conducted on an annual basis with the vessel:
 - a. Networks testing (to prove protection against data storms).
 - b. Networks throughput testing.
 - c. Automatic blackout recovery (if applicable).
 - d. All-vessel shutdown test and recovery from an all-vessel shut down (ESD functionality including recovery).
 - e. Step load tests to prove generator load acceptance, load rejection and stability.
27. ASOG/WSOG stipulated change of status to Yellow or Red shall be communicated to the Principal.
 - a. A return to work post equipment failure shall require additional testing (i.e., 'SOAK' test to prove integrity of DP systems following failure is not acceptable).
 - b. A stress test shall be conducted to prove integrity of DP systems following failure.
 - c. Original Equipment Manufacturer (OEM) support shall be made available if deemed necessary by the Principal to carry out stress tests.
28. Vessels shall be equipped with positive and effective means to prevent inadvertent mode changes or loss of 3-axes control while on DP.
 - a. Such changes whether intentional or inadvertent shall be alarmed.
29. Azimuthing thrusters shall be tuned to achieve satisfactory station keeping performance in bias as well as free mode.
30. Three axis automatic DP control shall not be used by assist vessels when used for station keeping or heading control of floating production facilities (during installation and operation) or during anchor handling/mooring operations.
31. DP vessels engaged in industrial missions requiring relative positioning in both heading and position shall be equipped with the appropriate DPCS modes and features, position reference sensors.

For example, heading inputs from target vessels, a minimum number of required targets per OEM specifications (if applicable) on target vessel (e.g., minimum number of prisms and transponders).

 - a. Dynamic analysis results to validate ability to undertake industrial missions shall be provided by Contractor upon the Principal's request.
 - b. The scope of the analysis shall address site specific parameters and requirements.

2.4 APPLICABLE INDUSTRY GUIDELINES

1. The following industry guidelines may be used as applicable:
 - a. IMCA M103 – 'Guidelines for the Design and Operation of Dynamically Positioned Vessels'.
 - b. IMCA M140 – Specification for DP capability plots.
 - c. IMCA M182 – International Guidelines for the Safe Operation of Dynamically Positioned Offshore Supply Vessels.
 - d. IMCA M206 – A Guide to DP Electrical Power and Control Systems.
 - e. IMCA M212 – Example of an Annual DP Trials Report.
 - f. IMCA M220 - Guidance on Operational Activity Planning.

- g. IMCA 04/04. – IMCA Study into “Methods for Establishing the Safety and Reliability of DP Systems”.
- h. IEC 60812 Analysis Techniques for System Reliability – Procedures for Failure Modes and Effects Analysis.
- i. API RP 2SK where applicable.
- j. DNV GL ST-0111 Assessment of station keeping capability of dynamic positioned vessels

2.5 TECHNICAL AND OPERATIONS MANAGEMENT CAPABILITY

- 1. Contractors shall provide documentation as necessary for assessment of the technical capability and suitability of the DP vessel being proposed.
- 2. Contractors shall provide necessary supporting documentation and evidence to assess the competence of the Contractor's staff responsible for DP operational management.
- 3. Contractor shall establish minimum criteria and have an assurance process in place to validate competence of all personnel engaged in the delivery of DP operations, either internal (vessel based, shore based) or external (Third Party).
- 4. (2.5, Item 2) and (2.5, Item 3) shall be verified as part of the Contractor Maritime HSSE Capability Assessment, if applicable.

3. VERIFICATION PROCESS

3.1 GENERAL

- 1. The Contractor shall provide the documentation listed in Table 3.1 pre-contract award for the purpose of assessing the following:
 - a. The technical suitability of the vessel for the activity.
 - b. The vessel's station keeping capabilities following the worst case failure.
 - c. The general level of compliance with (2.3).
- 2. The verification assessment shall be made by the Principal.

Table 3.1 Documentation Required Pre Contract Award

Type / No.		Document	Applicable Reference Standard/Guidance	Remarks
Design	General	DEP Compliance Statement	This DEP	(2.3, Item 1)
	1	Vessel's Class Notation and Copy of Certificate	Class Rules applicable to the vessels class notations	To include a copy of the latest class status printout.
	2	DP System FMEA	DEP Section (4.3). MO MSC 645 1994, Guidelines For Vessels With Dynamic Positioning Systems. IMCA M 219 Example Specification For A DP FMEA For a New DP Vessel DNV Recommended Practice for FMEA of Redundant Systems RP D102 is the minimum acceptable standard	FMEA to cover all intended configurations for modes of operation
	3	DP FMEA Proving Trials.	MTS Techop_ODP_01_(D)_(FMEA Testing) DNV Recommended Practice for FMEA of Redundant Systems RP D102 is the minimum acceptable standard	
	4	Annual DP Trials	DEP Section (4.3). IMCA M191 Guidelines for Annual DP Trials for DP MODUs IMCA M190 Guidance for Developing and Conducting Annual DP Trials Programmes for DP Vessels	
	5	DP Operations manual	MTS Techop_ODP_05_(O) (DP Operations Manual) MTS DP Operation Guidance	
	6	Gap Analysis for DP System FMEA	MTS Techop_ODP_04_(D)_(FMEA Gap Analysis)	Gap analysis to be performed by a competent FMEA practitioner
	7	Gap analysis for DP FMEA proving trials	MTS Techop_ODP_01_(D)_(FMEA Testing)	Gap analysis to be performed by a competent FMEA practitioner

Type / No.		Document	Applicable Reference Standard/Guidance	Remarks
	8	Gap analysis for Annual DP trials program	MTS Techop_ODP_08_(O) (Annual DP Trials And Gap Analysis)	Gap analysis to be performed by a competent FMEA practitioner
Design	9	Gap analysis for DP Ops Manual	MTS Techop_ODP_05_(O) (DP Operations Manual)	Gap analysis performed by competent personnel familiar with DP operations and the industrial mission.
	10	Closure path for identified gaps	MTS Techop_ODP_01_(D)_(FMEA Testing)-Appendix - Flow Chart	
	11	Vulnerabilities to DP Equipment caused by Industrial Mission equipment contravening Independence and Segregation Principles across Redundant Groups	MTS DP Design Philosophy Document	(Appendix C of) DEP.
	12	Details of Fail Safe Condition of Thrusters	MTS DP Design Philosophy Document	(Appendix D) of DEP.
Operations	1	CAM and TAM operations identified	MTS Techop_ODP_12_(O) (Defining Critical Activities Requiring Selection of Critical Activity Mode)	
	2	ASOG/WSOG	DEP & MTS DP Vessel Operations Guidance. DNV RP E307. IMCA M220 Guidance on Operational Activity Planning	Single line drawing of power system to be provided (may be embedded within the ASOG/WSOG or provided as a separate sheet)
	3	DP Incident reports (last three years) including close-out reports		Incidents reports to cover triggers to yellow alert and red alert levels
	4	Service and breakdown reports concerning the DP equipment (last three years)		Trend analysis and causal and contributory factors assessments by contractor