TECHNICAL AND OPERATIONAL GUIDANCE (TECHOP)

TECHOP_ODP_16_(P)
COMPETENCY ELEMENTS FOR DP PROFESSIONALS - DP SMEs / DP FMEA PRACTITIONERS

APPENDIX 2

PART 3
(COMPETENCY REQUIREMENTS FOR DP FMEA PRACTITIONERS)

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(INTERIM)

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SUMMARY

This MTS TECHOP provides general guidance on subjects with which prospective DP FMEA Practitioners should become proficient in order to be effective in contributing to the delivery of incident free DP operations with predictable outcomes.

CONTENTS

ABBREVIATIONS

ASOG	Activity Specific Operating Guidelines
CAM	Critical Activity Mode
IJS	Independent Joy Stick
IRM	Inspection Repair and Maintenance
MDAT	Mapping Delivery Ability Tool (now known as PDDP2)
OCIMF	Oil Companies International Marine Forum
PDDP2	Professional Development of DP Personnel (formally MDAT)
PMOE	Principal Marine Operations Engineer
PRS	Position Reference Systems
SIMOPS	Simultaneous Operations
SMEs	Subject Matter Experts
TAGOS	Thruster and Generator Operating Strategy
TAM	Task Appropriate Mode
TECHOP	Technical and Operational Guidance
WSOG	Well Specific Operating Guidelines

1 DP FMEA PRACTITIONER COMPETENCE OVERVIEW

1.1 COMPETENCE

1.1.1 Competence can be described as the appropriate combination of skill, knowledge, experience and behaviors. This guide describes technical competence requirement for those undertaking the role of FMEA Practitioner for Dynamic Positioning (DP) systems. Several competences are shared with other DP service roles but requirements for skill levels vary from role to role and there are specific technical competencies for DP FMEA and proving trials practitioners.

1.2 PROFICIENCY SCALE

1.2.1 The purpose of the proficiency scale is to provide a consistent framework that enables those responsible for managing the competence scheme to, assess and provide feedback to those undertaking the role of DP FMEA Practitioner.

1.2.2 There are four levels of proficiency described as:

- Aware
- Knowledgeable
- Skilled
- Mastery

1.2.3 Aware: Have an awareness of a particular subject sufficient to allow further study to be carried out if required.

1.2.4 Knowledge: Allows questions to be asked of specialists. Work can be undertaken with assistance.

1.2.5 Skill: At this level, skill allows assigned tasks to be undertaken with a minimum of assistance.

1.2.6 Mastery: Permits diagnosis, troubleshooting and complex problem solving. Development and implementation of best practice, standards and guides. Ability to objectively evaluate alternate proposals with a strong emphasis on predictable outcomes.

1.2.7 A category of ‘not-aware’ may also be assigned but this is not considered to contribute to the competency required to by a DP FMEA Practitioner.

1.3 DISTRIBUTION OF PROFICIENCY LEVELS

1.3.1 DP FMEA Practitioners must have 9 core competencies at the following levels or higher:

- 4 Mastery
- 2 Skill
- 2 Knowledgeable
- 1 Aware

1.3.2 The four competencies required at the level of Mastery are:

- DP Concepts
- DP Guidance & Basis of Requirements
- FMEA, DP Verification and Validation
- Cross connections, External Interfaces and Influences.

1.4 DP FMEA PRACTITIONER – COMMON POWER SYSTEM (CLOSED BUSTIES)

1.4.1 There are additional requirements for FMEA Practitioners undertaking unsupervised work- See Sections 2.1 & 2.3 on Definitions and Assessment of Competence.

1.5 PROOF POINTS

1.5.1 Table 1 provides a more detailed guide to the expectations at each proficiency level.

Table 1 Detailed Proof Points

What can be expected from a DP FMEA Practitioner at each skill level:

Level	Proof Points
Aware	• Able to recognize the relative importance of an item or concept. • Be able to find further information in guidance and standards. • Be able to recognize when it is necessary to seek assistance.
Knowledge	• Able to interpret and evaluate information and advice from experts in an area of expertise. • Able to use the correct terminology (vocabulary) of the subject. • Able to hold an informed debate with subject matter experts. • Able to ask questions that test the viability of technical explanations and solutions. • Able to carry out some of the activities with help.
Skill	• Able to perform the majority of activities required for DP system FMEA in a consistent and satisfactory manner. • Able to translate guidelines and standards for DP system FMEAs into practical actions. • Able to solve imaginatively, common technical/operational problems in the area DP system redundancy and fault tolerance. • Able to guide and advise others in technical/operational aspects of DP System FMEA and related mission critical equipment.
Mastery	• Evaluate alternate and / or novel solutions objectively. • Be able to diagnose and resolve significant complex, non-routine problems in the area of DP system design and related mission critical equipment. • Able to creatively solve significant, complex, non-routine problems. • Able to adapt practices from other engineering disciplines for use in DP system verification. • Able to generate substantial improvements to local practices and procedures for DP system design and analysis. • Demonstrate experience in applying technical and operational expertise to the evaluation of DP system design and analysis. • The ability to objectively evaluate proposals (including alternate solutions) or offer alternative solutions and risk mitigations to resolve DP-related issues.

2 CORE DP COMPETENCIES

2.1 DEFINITIONS

2.1.1 The nine core DP competencies are.

1. Deliverables and decision support tools
2. Barrier philosophy & defense in depth
3. DP concepts and engineering
4. DP guidance & basis of requirements
5. Verification and validation
6. Power Plant configured as a Common Power System (Closed Busties)
7. Cross connections, External Interfaces and Influences
8. In execution support
9. Industrial Mission (Impacts and Management)

Note 1: Competencies in **RED** font must be attained at a Mastery level for a DP FMEA Practitioner.

Note 2: Of the remaining five competencies two should be attained at Level 'Skilled', two at level 'Knowledgeable' and one at level 'Aware'.

Note 3: DP FMEA practitioners need only demonstrate awareness of the issues in Competency 9 (Industrial Mission).

Note 4: Mastery level in Common Power systems is a requirement for those undertaking unsupervised work on vessels utilizing this power plant configuration.

Note 5: The competencies above are considered appropriate for those carrying out DP FMEAs and Proving Trials. A reduced set of competencies may be appropriate for Annual DP trials practitioners in terms of technical Mastery.

2.2 ELEMENTS OF COMPETENCE

2.2.1 Within each competence there are three elements which indicate the ability to:

- Assess / Evaluate
- Define / Specify
- Execute

2.2.2 Detailed definitions for the 9 core DP competencies are given below in Section 3.

2.2.3 Competence on scale level of Mastery includes the ability to objectively evaluate alternate proposals with a strong emphasis on predictable outcomes.

2.3 ASSESSMENT OF COMPETENCE

2.3.1 DP FMEA practitioners generally work in multi-disciplinary teams under the direction of a team leader. Part of this role is to supervise the work of those in development. Supervision in this context refers to close supervision of an individual's work by someone involved directly with the project and not the higher-level supervision associated with routine technical checks and report approval process. Meeting the requirements of this competency scheme is a prerequisite for:

- Carrying out unsupervised work on an assigned element of the DP system.
- Being an FMEA team leader for analysis or trials.

2.3.2 Competence will be assessed through a combination of:

- Interview – This document
- Attendance at formal training courses
- DP Introduction course – 1 day
- Advanced DP surveyors' course – 5 days
- Coaching and mentoring using the PDDP2 tool in Appendix B
- Observation during 'On the job training' – At DP FMEA proving trials in particular
- Formal review of work examples:
  - Preparation of three DP system FMEAs and proving trials of which the first two will be done under supervision and the third unsupervised.
  - For DP FMEA practitioners carrying out unsupervised work on vessels operating with closed busties a further two FMEAs of the electrical sections of DP systems operating with closed busties (total of 5 FMEAs and proving trials) of which the first closed bus FMEA will supervised and the second unsupervised.
  - MTS TECHOP_ODP_04_(D)_(FMEA GAP ANALYSIS) can be used to assess the competence of the work. A score of 70% or greater is anticipated.
- Formal written assessments:
  - Exercise on Review of DP Redundancy Concept (closed book) – A score of 60%.
  - Exercise on Common (closed Bus) Power Systems (open book) - A score of 80%.

2.3.3 It is the responsibility of the person charged with implementing the overall competence scheme to combine the experience, scores and grades awarded into an overall assessment of competence.

2.3.4 Details of the interview process are given in Appendix 1.

2.3.5 Note: This competence assessment is heavily weighted towards technical competence and not limited to behavioral competence. One of the two assessors is expected to have the necessary depth and breadth of technical and operational knowledge to undertake an effective assessment.

2.4 PREPARATION AND ORDER

2.4.1 Individuals developing their competence are expected to undertake training in the following order in so far as it is practical to do so:

- DP Introduction Course – Attendance
- FMEAs and trials under supervision of team leader - Supervision
- Advanced DP Surveyors' Course - Attendance
- Written assessment of Review of DP Redundancy Concept (FMEA Theory and Practice)
- Submission of FMEAs - Unsupervised but subject to assessment (open busties)
- Interview
- FMEA on closed bus power systems - Supervision
- Witten assessment on Common Power Systems
- Submission of FMEAs unsupervised but subject to formal assessment (closed busties)
- Interview only if Mastery Level not previously achieved for Competency 6 (Common Power Systems)

Note: All DP FMEA Practitioners are expected to have a knowledge of the failure modes and effects of power system operating with closed busties but mastery level is required to carry out unsupervised work or to be team leader on a project using this power system configuration. This is necessary because even power plant operating with open busties may have fault propagation paths similar to closed busties associated with industrial consumers and dual fed thrusters.

2.4.2 It is therefore anticipated that the interview process will be the last step in assigning competence for Open and Closed bus FMEAs and trials and the assessors will have reviewed the candidate's experience, achievements and PDDP2 up to this point as part of their overall assessment of competence. During the process the assessor will be mindful of the Definitions and Proof Points for each competence and skill level.

2.4.3 Candidates are expected to receive coaching and mentoring during their day to day work and undertake self-study using the 'Professional Development of DP Personnel' tool provided and relevant TECHOPs if applicable in Appendix B.

NOTE: Coaching and Mentoring will be facilitated through a TECHOP (to be generated and published through MTS G&S subcommittee)

2.5 CONTINUED PROFESSIONAL DEVELOPMENT

2.5.1 Expectations

2.5.1.1 It is expected that the DP FMEA practitioners will continuously improve their knowledge through the work they carry out and by review of industry publications and guidance such as Learnings From Incident (LFI) report published by the MTS DP committed and available on their website and DP incident reports published by IMCA.

2.5.2 Opportunities

2.5.2.1 Development opportunities will be provided to attend relevant industry events, conferences and to present papers. Participation in the development of industry guidance is encouraged.

3 DEFINITIONS

3.1 COMP 1 - DELIVERABLES AND DECISION SUPPORT TOOLS

3.1.1 Definition

3.1.1.1 DP Decision Support Tools are generated from knowledge of the DP redundancy concept and DP FMEA – Provide input to and guidance on the following decision support tools and elements of such tools:

- Activity Specific Operating guidelines (ASOG)
- Critical Activity Mode (CAM)
- Task Appropriate Mode (TAM)
- Criteria Section (Post failure capabilities, rationalization of yellows etc.)
- Configuration Section (Permissible configurations of DP system - Power generation, distribution, propulsion, position reference sensors, external interfaces, external influences etc.)
- Modes and features required for industrial mission.
- Thruster and Generator Operating Strategy (TAGOS)

3.1.2 Assess / Evaluate

3.1.2.1 Ability to review and identify issues associated with the scope and depth of ASOGs

3.1.3 Define / Specify

3.1.3.1 Identify the level of detail required to be embedded in decision support tools

3.1.4 Execute

3.1.4.1 Be able to create an ASOG for any type of DP vessel using a DP FMEA and Trials as the input materials.

3.1.4.2 Evaluate ASOGs for completeness and identify the remedial work required if necessary.

NOTE: For those involved in the management of DP FMEA practitioners, the ability to create an ASOG could be supplemented by access to competent personnel.

3.2 COMP 2 - BARRIER PHILOSOPHY – DEFENCE IN DEPTH

3.2.1 Definition

3.2.1.1 Knowledge and application of ‘Barrier Philosophies’ for risk management.

3.2.2 Assess/ Evaluate

3.2.2.1 Evaluate the suitability of barriers such as:

- Barriers proposed in mitigation of vulnerabilities in DP systems and deficiencies in fault tolerance.
- Technical barriers to fault propagation such as protection systems and essential attributes.
- Barriers to prevent loss of position
- CAM
- Operate within Post Worst Case Failure Capability
- Use of IJS
- Barriers to prevent IRM on DP equipment.
- Operational restrictions as a barrier.
- Provisions for positioning standby.

3.2.3 Define / Specify

3.2.3.1 Specify the type of barriers required for a particular activity.

3.2.3.2 Engage with relevant SMEs for input into project specific simulator training.

3.2.4 Execute

3.2.4.1 Support the development of technical barriers to:

- Drift off – independence compromised by fault propagation.
- Drive off – fail-safe compromised by design or inadequate protection.

3.3 COMP 3 - DP CONCEPTS

3.3.1 Definition

3.3.1.1 Knowledge and application of DP Concepts - Preform as a subject matter expert and knowledge resource on essential concepts associated with dynamic positioning:

- Dynamic Positioning theory and practice
- Basis of Confidence
- DP Systems redundancy and fault tolerance
- Power, control and safety systems
- Seven Pillars
- Post failure capability.

3.3.2 Assess/ Evaluate

3.3.2.1 Be able to articulate the concepts listed above and below and their importance to DP. Evaluate the extent to which these concepts are addressed in the design of DP systems and related mission critical equipment.

- Basic principles of dynamic positioning
- Drift off
- Drive off
- Force off
- Fault Tolerance
- Redundancy
- Reliability
- Resilience
- Predictability
- Fail safe
- Performance
- Protection
- Detection
- Cross connections
- External interfaces and influences
- Independent performance validation.

3.3.3 Define / Specify

3.3.3.1 Define and specify which of these concepts are required to be emphasized for specific industrial missions.

3.3.4 Execute

3.3.4.1 Be able to apply DP concepts in the design and analysis of DP systems and their external interfaces.

3.3.4.2 Be able to extract and utilize relevant DP related information from diverse sources (Example: MTS DP committee, IMCA, Marine Forums, Recommended Practices, OCIMF etc.)

3.4 COMP 4 - DP GUIDANCE

3.4.1 Definition

3.4.1.1 Knowledge of:

- Company and Client DP standards / requirements
- OCIMF DP Assurance Framework
- Industry guidance - IMO, MTS & IMCA Guidance
- IADC RP 2SK

3.4.2 Assess/ Evaluate

3.4.2.1 Be able to use industry guidance documents to assess levels of implementation, application or adherence to guidance and good practice contained therein. In particular, the DP FMEA Practitioner should be fully familiar with the concepts described in:

- Company and Client DP standards / requirements
- OCIMF DP Assurance Framework
- IMO MSC 645 & 1580
- DNVGL RP E307
- DNVGL RP E306
- Professional Development of DP Personnel (PDDP2) TOOL
- DNVGL RP D102
- IMCA M117
- IMCA M166
- IMCA M190
- IMCA M191 (Now incorporated into M190)
- IMCA M206
- IMCA M220
- IMCA M225
- IMCA M182
- All TECHOPs

Note: The written examinations cover relevant principles contained within the above documents.

3.4.3 Define / Specify

3.4.3.1 Be able to specify requirements from relevant guidance pertinent to the DP system design, industrial mission and consequences of a loss of position.

3.4.4 Execute

3.4.4.1 Be able to:

- Confirm compliance with relevant rules and guidelines.
- Understand and articulate the intention, limitations and interruption of relevant rules and guidelines.
- Identify and support the implementation of alternate compliance strategies.
- Evaluate the extent and efficacy of the implementation of the relevant guidance as stipulated in the requirements.

3.5 COMP 5 - FMEA VERIFICATION AND VALIDATION

3.5.1 Definition

3.5.1.1 Be proficient in the execution and evaluation of:

- DP system FMEAs and FMECAs.
- DP system FMEA gap analysis.
- Annual DP Trials.
- FMEA Proving Trials.
- Post Event Verification Trials.
- Technical content for DP Operations manuals.

3.5.1.2 Be proficient in managing the FMEA process including the use of tools to:

- Manage time efficiently.
- Handel technical queries.
- Log, track, communicate and close-out concerns and finding.
- Identify where the reducing concept relies on periodic testing and maintenance.

3.5.1.3 Understand:

- Purpose of FMEAs and FMEA proving trials.
- Purpose of annual DP trials.
- The need for supporting studies to complement the DP system FMEA.
- FMEA & Trials findings, categories and significance of same.
- The fail-safe condition of thrusters and position references systems and the protective functions upon which this attribute relies.

3.5.2 Assess / Evaluate

3.5.2.1 Be able to assess:

- The content of supporting studies.
- The degree of completeness with which a DP system FMEA, Annual DP trial, FMEA proving trials and post event trials have been performed. In particular, whether or not they achieved their objectives.

3.5.3 Define / Specify

3.5.3.1 The scope of a DP system FMEA and proving trials given basic design information.

3.5.3.2 The type of supporting studies required to complement the FMEA.

3.5.3.3 Requirements for effective review of DP FMEAs, DP FMEA proving trial.

3.5.3.4 Requirements for review and acceptance of effective gap closure proposals.

3.5.4 Execute

3.5.4.1 Preform DP systems FMEAs and FMEAs of related mission critical equipment.

3.5.4.2 Perform gap analysis of DP system FMEA, Proving trials, Annual Trials and DP Operations manuals.

3.5.4.3 Perform effective engagements with DP vessel crew, Shipyard representatives and vessel owner's organization.

3.5.4.4 Evaluate DP redundancy concepts for compliance with rules, guidelines and specification in scope of work.

3.5.4.5 Results of DP FMEA reviews, DP FMEA proving trials and post event / return to work authorization process.

3.5.4.6 Evaluate results of post event / return to work authorization process.

3.6 COMP 6 - POWER PLANT CONFIGURED AS A COMMON POWER SYSTEM

3.6.1 Definition

3.6.1.1 Be proficient in the electrical engineering required to analyses the design and fault tolerance of DP power plant operating as a common power systems (closed busties) with busties closed.

3.6.2 Assess / Evaluate

3.6.2.1 Evaluate DP power plant designs for vulnerabilities that compromise fault tolerance. In particular:

- Failure modes and their effects
- Fault propagation paths
- Fault ride through capability
- Efficacy of protective functions

3.6.3 Define / Specify

3.6.3.1 Specify the supporting studies required to demonstrate fault tolerance in addition to the DP systems FMEA including:

- Protection coordination study
- Load flow balance
- Harmonics - WCF
- Voltage dip ride-through at all distribution levels
- Crash synchronization & connection of stationary machine
- Power plant modelling

3.6.3.2 Specify the need for testing including:

- Fuel control failures.
- Excitation control failures.
- Short circuit and earth fault testing.
- Blackout recovery initiated by the above failures.
- Protection system testing to validated modelling.

3.6.4 Execute

3.6.4.1 DP System FMEA for power plant operating with closed busties

3.6.4.2 DP FMEA proving trials for power plant operating with closed busties

3.7 COMP 7 – CROSS-CONNECTIONS, EXT INTERFACES AND INFLUENCES

3.7.1 Definition

3.7.1.1 Be proficient in:

- The identification and analysis of fault propagation paths crated by common points in the DP redundancy concept and the effects of internal and external common cause failures.
- The identification and analysis of common points created by External Interfaces to the DP systems such as:
  - ESD, F&G systems
  - Power distribution for the industrial mission, cranes, drilling & pipelay
  - Industrial mission control interface
  - The indentation external influences on the DP systems
  - Contamination of combustion and ventilation air
  - Atmospheric and Hydrospheric effects
  - External forces & unwanted thrust

3.7.2 Assess / Evaluate

3.7.2.1 Identify vulnerability in the DP system and its interfaces that have the potential for effects exceeding the worst case failure design intent.

3.7.3 Define / Specify

3.7.3.1 Be able to identify the analysis and testing required to demonstrate the effects of cross connections are adequately mitigated

3.7.3.2 Specify equipment vendor FMEAs

3.7.3.3 Offer guidance on potential mitigations identified in learnings from incidents

3.7.4 Execute

3.7.4.1 Perform the analysis required to reveal vulnerabilities in the DP systems associated with cross connections and external influences

3.8 COMP 8 - IN EXECUTION SUPPORT

3.8.1 Definition

3.8.1.1 Deliver as a subject matter expert and knowledge resource in response to requests for assistance related to:

- The design features and failure modes of DP related systems and external interfaces.
- Incident investigations involving DP station keeping.

3.8.1.2 In particular:

- Support the response to yellows and reds as triggered by the ASOG/WSOG when requested to provide technical support.
- Provide technical information and analysis supporting return to work processes.
- Responding to and resolving dilemmas.
- Advise on testing, e.g. soak test or stress test.

3.8.2 Assess / Evaluate

3.8.2.1 Evaluate the relevance and applicability of the advice provided by other subject matter experts, crew and equipment vendor’s representatives.

3.8.3 Define / Specify

3.8.3.1 Define engagements with other subject matter experts. Develop questions that need to be asked and answered.

3.8.4 Execute

3.8.4.1 Provide in-execution support when requested. Engage with other relevant subject matter experts, vessel crew, project teams and owner's organization in order to resolve issues and progress the execution of marine operations and the industrial mission.

3.8.4.2 Perform incident investigations.

3.9 COMP 9 - INDUSTRIAL MISSION (IMPACTS AND MANAGEMENT)

3.9.1 Definition

3.9.1.1 Identify, understand and communicate the impacts of DP station keeping requirements on the execution of the industrial mission.

3.9.1.2 Delivery of incident free DP operations is dependent on effective interface management across a diverse group of stakeholders including non-DP domain stakeholders. Thus, interface management has been identified as a key competence as it effects two other competencies impacts of station keeping on industrial mission and impacts of industrial mission on station keeping.

3.9.1.3 Identify, understand and communicate those elements of the industrial mission being undertaken which impact upon DP station keeping.

3.9.2 Assess / Evaluate:

3.9.2.1 Assess whether the activity is suitable for execution using DP station keeping, consequences of loss of position, thruster wash, gangways, walk to work, shallow water operations, automatic thruster assisted moorings.

3.9.2.2 Identify other options for carrying out the activity that might be more suitable.

3.9.2.3 Identify interfaces that need to be managed.

3.9.2.4 Evaluate impacts to the delivery of DP operations

3.9.2.5 Evaluate, develop and implement engagement plan (plan to identify extent and time of engagement)

3.9.2.6 Evaluate the need to engage specialist resources and other subject matter experts

- Vendor engagement
- Requesting and managing specialist vendor support
- Identifying need for and requesting/managing other subject matter experts (Not only those with direct interfaces but also those that could influence outcomes).

3.9.2.7 Evaluate the suitability of the DP system functions and features for the specific activity to be undertaken.

- Determine whether aspects of the activity to be undertaken will impact the performance of the DP system.
- Heavy lifting operations.
- Riser pull-in.
- Hold back vessels.
- SIMOPS.
- Shadowing of PRS.

- Relative PRS and target vessel motions.
- Gangway connected operations.
- Impact of external forces on DP station keeping (Example: Moorings and Automatic Thruster assist, hydrodynamics of leg length, forces imparted through legs on touching bottom etc.)

3.9.2.8 Evaluate the need for particular types and combinations of position reference systems.

3.9.3 Define / Specify

- Specify, modes functions and features for the activity to be undertaken using DP station keeping, e.g. external force compensation, heavy lift mode, automatic thruster assisted moorings, additional barriers if applicable.
- Identify, define, specify impacts to or from station keeping from industrial mission in consultation with relevant non-DP domain SMEs (Example Logistics-Aviation, Offshore coordination team lead, OIM, Completions & Intervention Superintendents, Drilling superintendents, Construction superintendents, Project Engineers, Business Opportunity Managers, etc.)
- Define and specify industrial mission specific modes and features and any other requirements. Develop questions (pertinent to impacts of industrial mission on station keeping) that need to be asked and answered.
- Be able to specify remedial actions.

3.9.4 Execute

- Advise on the suitability of DP station keeping as a means of carrying out the specified activity.
- Advise on additional measures/ mitigations needed if DP station keeping is essential.
- Engage with and oversee the activities of specialist vendors and subject matter experts.
- Communicate pertinent information to relevant stakeholders
- Minimize escalation of unforeseen events
- Rationalize DP specific requirements against an integrated risk management strategy based on system's thinking - Professional Development of DP Personnel Tool
- Manage station keeping risk by balancing against overarching business / venture risk in consultation with diverse and pertinent stakeholders.
- Supervise activities requiring special DP station keeping modes functions and features and advise on the conduct of the operations with reference to the stability of the DP system and the security of the industrial mission.

4 MISCELLANEOUS

Stakeholders	Impacted	Remarks
MTS DP Committee	✓	To track and incorporate in next rev of MTS DP Guidance Documents
USCG	✓	MTS to communicate
ABS	✓	MTS to communicate
DNV GL	✓	MTS to communicate
Equipment vendor community	X	MTS to engage with suppliers.
Consultant community	✓	MTS members to cascade/ promulgate.
Training institutions	✓	MTS members to cascade/ promulgate.
Vessel Owners/Operators	✓	Establish effective means to disseminate information to Vessel Management and Vessel Operational Teams.
Vessel Management/Operational teams	✓	Establish effective means to disseminate information to Vessel Operational Teams.

APPENDICES

APPENDIX A EXAMPLE ASSESSMENT PROCESS

A.1 Example Assessment Interview

Note: This Appendix A contains an example assessment process. It is envisaged that companies will develop their own assessment processes that meet their needs and client's expectations.

- The DP FMEA Practitioner Competence Assessment is designed to assess whether the nominated candidate will be able to discharge the functions of a DP FMEA Practitioner effectively in support of the businesses objective of managing DP Station keeping risk. It is an assessment to be conducted before a nominated individual is placed in the role of a DP FMEA Practitioner. It is not meant to replace the due diligence performed in selecting an individual for nomination.
- After all scoring, has been completed; please indicate the final result here for data entry purposes:

  Overall Result (Tick One)

  Competence gaps identified ☐ Competent ☐

- This assessment template includes a comprehensive assessment over a broad range of identified DP competencies and each may include several possible questions. The assessment questionnaire is designed to be flexible and allows the assessor to use the questions judiciously to evaluate the skill level on the described scale. Assessors may also add questions to the template in order to explore the candidate's depth of understanding of the subject matter.
- It is emphasized that the assessment is not designed to test what the candidate does not know. On the contrary, it is designed to surface and build on what the candidate does know.
- The subject matter contained in the assessment provides a road map for developing required competencies for candidates aspiring to be DP SMEs
- The topics addressed in the assessment template include the nine identified competencies required of a DP FMEA Practitioner.

A.2 Example Assessment Overview

- Candidate are asked to prepare for this assessment in advance using the Professional Development of DP Personnel Tool in Appendix 2. The Candidate will be asked to come prepared to discuss their competence and skill set as it relates to managing DP Station Keeping risks, including the various Industry guidance documents and company requirements on the subject matter.
- Through appropriate answers to the structured questions, the Candidate MUST be able to demonstrate the necessary competence and skill per the described scale to demonstrate ability to function as a DP FMEA Practitioner to the business.
- The aim is to assess the individual in the nine identified areas and to ensure skill level can be consistently applied in the management of DP station keeping risk.

A.3 Suggested Assessor Instructions

- Two assessors will conduct the assessment. Assessors are required to complete Assessor Training prior to use of this assessment.

Before Interview	Preparation □ Familiarize yourself with the structure of the assessment process □ Review the questions and rating scales □ Determine whether additional assessors are needed □ Agree to assessor roles
During the Interview	Collect Relevant Evidence from Candidate □ Welcome the Candidate – develop rapport □ Introduce yourself and describe the assessment structure and process □ Ask clear, precise, and relevant questions, using follow-ups to get full responses □ Take notes – be an active assessor
After the Interview	Evaluate Candidate on Relevant Elements □ Review your notes – classify your evidence to the evaluation dimensions □ Rate the Candidate

A.4 Opening the Exercise

- Spend 5 minutes setting up the interview and ensuring the Candidate is clear on the process:
- Greet the Candidate, stating your name and role in the DP community
- Ask the Candidate to do the same (name and role)
- Give an overview of the exercise plan, duration and process
- State that you will be taking notes. Explain these notes will be used to ensure the ratings are accurate, and will not be retained for other purposes
- Ensure that the Candidate is clear on the process
- Ask if they have any initial questions.
- Remind the Candidate of the following points:
  - they will try to discuss previous specific experience that they have been in, trying wherever possible to keep to one situation per question;
  - you may ask situational questions to explore DP FMEA Practitioner competence: if the Candidate has not encountered such experiences, they should advise the assessor.
- ask if the Candidate has any final questions before beginning.

A.5 Asking Questions

- Ensure you dedicate sufficient time to obtain evidence on the technical and operational depth possessed by the candidate.
- Remember, you may need to ask follow-up questions to fully explore an issue. Some questions may have already been answered in the initial presentation from the Candidate, so be careful not to repeat them unnecessarily.
- Politely interrupt and re-direct the Candidate if the information they are providing is not relevant to the assessment.
- Remember, you need to ensure they provide the information relevant to the scoring.

- Spend as much time as is necessary to build confidence in the competence of the Candidate.
- At the end, thank the Candidate.

A.6 Closing the Exercise

- Allow 5-10 minutes to close the interview.
- Indicate that you've reached the end of your questions.
- Ask the Candidate to take a moment to consider whether they would like to add any further information.
- Advise the Candidate that you will advise them of the outcome of the interview within the next five working days. The interviewers will require time to review notes and ensure agreement is reached on the outcome.
- Please evaluate the interview as soon after completion as possible following the guidance on the following page.

A.7 After the Exercise

- After the exercise, review the evidence and complete the Evaluation Forms.

A.8 Evaluating Evidence

- Look through the scale as listed on the rating matrix and tick the appropriate position on the scale. Skill is rated in terms of five bands of performance.
- To determine the overall score for a dimension, look at the position of the majority of the ticks.

As a rough guide:

Not aware	Most of the ticked responses are in the 1st column
Aware	Most of the ticked responses are in the 2nd column
Knowledgeable	Most of the ticked responses are in the 3rd column
Skilled(>K,<M)	Most of the ticked responses are in the 4th column
Mastery	Most of the ticked responses are in the 5th column

Avoid errors associated with halo/horns effect, central tendency, recency and stereotyping. In addition, when evaluating evidence gained during an interview do not be influenced disproportionately by the Candidate's ability or inability to talk persuasively and articulately though the ability to communicate effectively is an essential skill for a DP FMEA Practitioner.

See also **Guide to Assigning Skill Levels on the Basis of Answers** in the following section.

A.9 Question, Response and Scoring

Guide to assigning skill levels on the basis of answers:

Always start by asking the main question which is generally broad in scope. No more than nine questions should be required in each competency to arrive at a conclusion regarding competence levels.

MASTERY - A candidate with mastery in the subject competency will speak fluently and be able articulate all the main concepts associated with a particular subject without prompting or recourse to asking follow-on questions. (that is to say they will mention many of the issues which are the subject of the follow-on questions). The candidate will demonstrate that they understand all or most of the issues at a conceptual, philosophical and practical level – Mastery may be awarded on the basis of such a performance alone but further confidence in the appropriateness of the categorization may be gained from the answers to follow on questions.

SKILLED - A candidate who is skilled in the subject competence is likely to demonstrate a sound understanding of the practical issues in the main question but may be less able to articulate the philosophical and conceptual issues in the main question and may need to be prompted to expand their answer to allow their understanding of the conceptual and theoretical issues to be assessed. The score awarded to such a candidate is likely to be influenced by their performance in the follow-on questions.

KNOWLEDGEABLE – A candidate who is knowledgeable in a particular competence may give a fairly limited response in reply to the main questions but will be able to demonstrate the scope of their knowledge by correctly answering most of the follow-on questions in a manner that gives confidence they understand the practical important of the issues raised by the questions.

AWARE – A candidate who is only aware of issues within the subject competence is likely to need significant prompting and use of follow-on questions to gain an understanding of their knowledge. Their answers may be at a superficial level. They may struggle to answer the main question. They may not be able to answer all the follow-on questions.

NOT AWARE – A candidate who is not aware will likely ask for the main question to be repeated in a different way or be expanded or may state they have no knowledge of a particular subject.

NOTE – FAILURE TO ACHIEVE MASTERY – When it becomes clear during the oral exam that a candidate is not going to achieve Mastery in the four competencies required to be a DP FMEA Practitioner, the examiners should use the follow-on question to help develop a study plan to assist the candidate in achieving the required competencies at the next opportunity.

SUMMARY – The nature of the answer provided to the Main Question is likely to influence the assignment of a particular skill level most strongly – The follow-on questions will typically reinforce that assessment or improve the score of a candidate who did poorly in the main question.

APPENDIX B DEVELOPMENT OF DP FMEA PRACTITIONERS

B.1 The Professional Development of DP Personnel

Information on the use of the professional development of DP personnel tool can be found in the publication of the DP committee of the Marine Technology Society titled, 'Guidance For Professional Development of Personnel Engaged In DP Operations using the Professional Development of DP Personnel Tool (PDDP2)' - (PDDP2 was formerly known as MDAT).

The sections that follow provide tables for each of the nine core competencies that enable self-study. Each table provides study guidelines in the form of lists of DP related subjects, associated industry guidance and important terms and concepts with which the prospective DP FMEA Practitioners should become familiar and proficient.

Each table contains the following columns:

Competence 1 - Deliverables and Decision Support Tools							
Themes	Description	Key Themes / Subject Matter	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / principles	Actions

Themes	Broad concept or subject.
Description	A brief overview of the concept or subject to be studied. The information is sufficient to allow the prospective DP FMEA Practitioner to seek out more information on the subject or start a conversation with colleagues.
Key Subject Matter	Important terms, concepts and vocabulary.
Reference	Where more information can be found. Typically, industry guidance or other publications.
Competence Scale	Prospective DP FMEA Practitioners are encouraged to assess their own competence levels. Two columns are provided. In the first column, the DP FMEA Practitioner may assign their own estimate. The second column may be used to record the estimate based on conversations with mentors or from feedback given in the assessment process.
Evidence	The evidence column is used to collect evidence of competence. This may be experiential, or a record of study undertaken to gain familiarity and competency in a particular subject.

Competence 1 - Deliverables and Decision Support Tools							
Themes	Description	Key Themes / Subject Matter	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
ASOG / WSOG	1. Activity Specific Operating Guidelines (ASOG) are a form of decision support tool designed to assist crew in safely managing the conduct of the DP operation. The same tool is titled Well Specific Operating Guidelines (WSOG) for use on MODUs. 2. Information is presented in a two or four column format where each column is associated with 'traffic light' colors indicating DP system status. 3. The four-column 'Criteria' section supports decision making in response to events, observation and environmental limits. The user is guided to advise stakeholders, continuing or suspend operations and implement contingency plans. 4. Green – Normal operations. 5. Blue – Abnormalities exist or limited are being approached 6. Yellow – Redundancy has been lost or is at defined operational limits. 7. Red – Position is being lost or contingency plan is in operation. 8. The two-column 'configuration' section is a go-no-go for being in Critical Activity Mode configuration 9. Green – Normal operations 10. Blue – Risk assess and inform 11. An ASOG requires the following five elements: - i. CAM and TAM configuration ii. Yellow status rationalization iii. Suitable modes and features iv. Position reference systems v. Manage the vessel's worst-case failure capability	ASOG / WSOG	MTS DP Ops Pt2 Appendix 1 Section 4.8				
		Watch circles	MTS DP Ops Pt2 Appendix 1 Section 4.8				
		Riser analysis	API RP16Q & Company Riser Analysis doc				
		What-breaks-first?	API RP16Q & Company Riser Analysis doc				
		SIMOPs	MTS DP Ops Pt2 Appendix 1 Section 4.8				
		Worst Case Failure Design Intent	MTS DP Design Pt2 Section 3.13				
		Worst Case Failure	MTS DP Design Pt2 Section 3.13				
		Post failure DP Capability (Key ASOG element)	MTS DP Design Pt2 Section 3.13				
		Capability plots	MTS DP Design Pt2 Section 4.2				
		Footprints	MTS DP Ops Section 1.2.12				
		ASOG Development Process	MTS DP Ops Guidance Document				
		Statement of Verification	As per company / client requirements				
		Process For ASOG Implementation	Coaching and mentoring (future ASOG development course)				
		Title Block – Background & Why	Coaching and mentoring				
		Triggers for Yellow and Red	MTS DP Ops Pt2 Appendix 1 Section 4.8				
		Position References Sensors (Key ASOG Element)	TECHOP_ODP_14_(D)_PRS & DPCS Handling of PRS				
		Modes And Features (Key ASOG element)	MTS DP Design Pt2 Section 14.7				
		Offset From Wellhead	MTS DP Ops Pt2 Appendix 1 Section 4.7				
		Drive off to drift off conversion	DP Training Course / Company requirements				
		Traffic Lights - Colors	Mts DP Ops Appendix C				
		Fault tolerance	MTS DP Design Pt2 Section 2				
		Station keeping integrity	MTS DP Design Pt2 Section 3.3				
		Loss of position & position excursion	MTS DP Design Pt2 Section 4.2				
		INDUSTRIAL MISSION	MTS DP Design Pt2 Section 4.0				
		Contingency plans and recovery measures	Coaching and mentoring				
		Positioning standby	MTS DP Ops Pt2 Appendix 1 Section 4.8				
		Proactive yellows	Coaching and Mentoring (Future Techop In Development)				
		Legacy blues					
		ASOG refresh					
		Question Tracking Sheet (QTS)					
		Vessel Overview Document					
		Back to work - Reinstatement					
		Escape Routes	MTS DP Ops Pt2 Appendix 1 Section 4.8				
		Manning	MTS DP Ops Pt2 Sec 4.14				
		Cross Connections	Techop_ODP_11_(D)_(Cross Connections)				
		External Interfaces and influences	MTS gudinace on External Interfaces to DP System				

Competence 1 - Deliverables and Decision Support Tools							
Themes	Description	Key Themes / Subject Matter	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
CAM	CAM - The configuration of the DP systems required to conduct operating in Critical Activity Mode. This is the configuration that provides the highest level of station keeping integrity.	CAM & CAMO (LEGACY SMO)	TECHOP_ODP_12_(O) (Defining Critical Activities Requiring Selection of Critical Activity Mode)				
		CAM is default for any operation					
		Activities requiring CAM					
		Post failure capability and criteria to establish same. (Example Based on WCF)					
		Default open busties					
		Requirements for Closed Bus CAM in MODUs					
TAM	TAM – Task Appropriate Mode is a risk-based DP system configuration that provides acceptable levels of station keeping integrity appropriate to the risk of a loss of position. TAM may offer other advantages such as higher post failure DP capability.	TAM	TECHOP_ODP_12_(O) (Defining Critical Activities Requiring Selection of Critical Activity Mode)				
		Post failure capability based on one generator and/or one thruster					
		Risk based mode – consequences of LOP					
		Risk Assessment – HEMP used to justify TAM					
Criteria	Trigger points for change of DP system status including thrust and power levels, the existence of abnormality or following loss of redundancy or equipment in defined DP related subsystems	TAM	MTS DP Ops Pt2 Appendix 1 Section 4.8				
		Post failure capability based on one generator and/or one thruster					
		Risk based mode – Consequences of LOP					
		Risk Assessment – Hemp Used To Justify TAM					
CONFIGURATION	The configuration of the DP system including marine auxiliary systems and power distribution. The setup of the DP control systems. The condition of PRS and vessel sensors and associated targets types etc.	Valves in marine auxiliary systems	MTS DP Ops Pt2 Appendix 1 Section 4.8				
		Circuit breakers & tie lines					
		Diodes and DC to DC convertors					
		Modes and Features					
		DP control system settings					
TAGOS	Thruster and Generator Operating Strategy – For vessel with complex or highly configurable power distributions systems – recommended combination of thrusters and generators to achieve redundancy	Transferable thrusters and generators	MTS DP Ops Pt2 Appendix 1 Section 4.8				
		Thrust allocation					
		Thrust against power curves					
		Thruster types					
		Rudders in DP					

Competence 2 - Barrier Philosophy – Defense in Depth							
Themes	Description	Keywords	Reference	Competence Scale		Competence Scale	
				Self-Assessment	Self-Assessment	Theory / Principles	Actions
Barrier Philosophy	'Barriers' is the term used to describe the means by which the risk of loss of position or another defined hazard occurring is reduced. Barriers may be physical or procedural.	Principles of CAM and TAM and operating within post failure capability.	TECHOP 12				
		Hard and soft barriers	Coaching and Mentoring (Future Techop In Development)				
		HEMP					
		Bow tie analysis					
		Swiss cheese model					
		Redundancy	MTS DP Design Pt2 Section 1.5				
		Predictability	MTS DP Design Pt2 Section 12.9.4				
		Seven pillars	MTS DP Design Pt2 Section 3				
		Performance, Protection and Detection	MTS DP Design Pt2 Section 3.16				
		Use of IJS and independent positioning display	Company Standards				
		Barriers to prevent IRM on DP equipment	Company Standards				
		Provisions for positioning standby	MTS DP Ops Pt2 Appendix 1 Section 4.8				
		Defense against errors in user configurable settings	TECHOP_ODP_D_14_PRS and DPCS handling of PRS				
		Well control – Barriers used in drilling	Coaching and Mentoring (Future Techop In Development)				
		Simulator training					
Defense in Depth	Defense in depth is an aspect of barrier philosophy related to the process of assuring the suitability and integrity of the barriers deployed to mitigate the risks in any DP operation	Principles of defense in depth					
		Defense in Depth - Demonstrating barrier integrity is being maintained					

Competence 3 - DP Concepts							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Basis of Confidence	The basis of confidence is all the activities that are undertaken to ensure predictable outcomes leading to delivery of incident free DP operations	By Design – Seven Pillars	MTS DP Design Pt2 Section 3				
		By Operations - Validation and verification efforts	MTS DP Design Pt2 Section 22				
		Operating within post failure DP capability	MTS DP Design Pt2 Section 4.5				
		Demonstrating attributes of performance, protection and detection	MTS DP Design Pt2 Section 3.16				
		Positioning Standby	Coaching and Mentoring (Future TECHOP In Development)				
		Effects of inspection repair and maintenance in determining post failure capability	MTS DP Design Pt2 Section 22				
		Training of crew in vessel specific equipment	PROFESSIONAL DEVELOPMENT OF DP PERSONNEL TOOL				
		Industrial mission	MTS DP Ops guidance				
		Contingency plans – Point of initiation & no-return	MTS DP Ops guidance & coaching and mentoring (Future TECHOP in Development)				
DP Redundancy	Redundancy is the ability of a system to remain in operation following a failure. DP redundancy is the ability of a DP system to maintain position and heading following the worst-case failure. Active redundancy uses the idle capacity is surviving equipment to continue positioning when the failure has occurred. Fault tolerance depends upon each redundant group having the required performance to maintain position on its own, the necessary protection system to reject erroneous data, make system fail safe and to isolate faults that might propagate between redundant groups causing more severe failure effects.	Fault tolerance	MTS Design Guidance & Seven pillars				
		Redundancy	MTS Design Guidance & Seven pillars				
		Reliability	MTS Design Guidance & Seven pillars				
		7 - Pillars - Resilience	MTS Design Guidance & Seven pillars				
		Predictability	MTS Design Guidance & Seven pillars				
		Fail Safe	MTS DP Design Pt2 Section 3.3				
		Performance	MTS DP Design Pt2 Section 3.16				
		Protection	MTS DP Design Pt2 Section 3.16				
		Detection	MTS DP Design Pt2 Section 3.16				
		Cross connections	TECHOP_ODP_11_(D) (Cross Connections)				
		External influences	TECHOP				
		External interface	TECHOP				
Seven Pillars	The seven pillars are desirable attributes in the design of a DP system – Together they contribute to predictable outcomes and deliver incident free DP operations. Predictability is:	Provided by:	Compromised by:	MTS DP Design Pt2 Section 3.3				
		Autonomy	Centralized control systems				
		Segregation	Cross connections between main machinery				
		Independence	Cross connections between redundant groups				
		Differentiation	Common equipment types and measurement principles				
		Fault tolerance	Single point failures				
		Fault resistance	Poor choice of components				
		Fault ride through	Poor design				

Competence 3 - DP Concepts							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Post failure Capability	Post failure DP capability defines a vessel's ability to maintain position and heading following the worst-case failure. Post failure capability may be documented by a series of capability plots showing the maximum wind envelope for a range of sea currents. The worst-case failure may be heading dependent. The worst-case failure may change depending on the failure criteria.	Capability plot	MTS DP Design Pt2 Section 4				
		Drift off, drive off, force off	Company Riser analysis document				
		Watch circles – Yellow and Red	MTS DP Ops Pt2 Appendix 1 Section 4.8				
Basic principles of Dynamic Positioning	Dynamic Positioning is a method for maintaining the position of a vessel with respect to a point on the sea bed by means of vectored thrust.	Six - degrees of freedom	DP Training course / Company requirements				
		Surge Sway & Yaw	MTS DP Ops Pt2 Appendix 1 Section 3.13				
		Position references	MTS DP Design Pt2 Section 15				
		Vessel sensors	MTS DP Design Pt2 Section 15				
		Power system	MTS DP Design Pt2 Section 9, 10				
		Thrust allocation & barred zones	MTS DP Design Pt2 Section 14.7				
		Thruster, azimuthing, tunnel, main propellers, rudders	MTS DP Design Pt2 Section 7				
		Power available for thrust & Spinning Reserve	Coaching and Mentoring (Future Techop In Development)				
		Mathematical model	MTS DP Design Pt2 Section 14				
		Sideways speed tests	Coaching and Mentoring (Future Techop In Development)				

Competence 4 – DP Guidance							
Themes	Description	Key Themes / Subject Matter	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Company Standards	Company standards which specify the types of equipment, decision support tools and minimum performance levels required to conduct DP operations safely on board a dynamically positioning vessel. These may be based on Industry guidance and standards from bodies like IMCA / MTS / OCIMF.	Design engineering manual	As per Company DP Standards / Client Requirements)				
		General requirements					
		Philosophy					
		Applicable Industry guidelines					
		Big rules					
		Technical and Operations Management					
		Verification process					
		Newbuild vessels					
		Manning					
		FMEAs and Trials					
		Fires in Machinery Spaces					
		ESD, F&G					
		PRS					
		Tools Simulations, analysis, special modes and features					
		Modes and Busties configurations					
		Data logging and alarms					
		DP Status					
		Documentation					
		Operational guidelines					
		DP SIMOPs					
		Pre-Field arrival checks					
		Reporting					
		Simulator Training					
		PRS					
OCIMF DP Assurance Framework	The oil companies' international marine forum published a 'risk-based' dynamic positioning assurance framework. This framework sets out sound DP assurance practices and minimum requirements for DP subject matter experts	DP Assurance Category Identification (ACID)	Sec 3.5				
		Qualifications, experience and competency	Sec 2				
		Shore-based DP personnel	Sec 2.1				
		DP vessel-based personnel	Sec 2.2				
		Vessel handling skills	Sec 2.3				
		DP assurance framework aims	Sec 3.5				
		Loss of position and consequences	Sec 3.2				
		Risk-based approach	Sec 3.3				
		DP assurance management and records	Sec 3.4				
		Use of manual mode to manage external forces	Sec 4.2				
		Modes on a DP vessel	Sec 4.1				
		DP Equipment Class	Section 2				

Competence 4 – DP Guidance							
Themes	Description	Key Themes / Subject Matter	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
IMO MSC 645 (113 IMO)	This is the high-level document which defines IMO guidance for vessels and units with dynamic positioning systems.	Failure criteria	Section 2.2				
		Physical separation A60 & WT	Section 2.2.3				
		Active components	Section 2.2.2.1				
		Passive components	Section 2.2.2.2				
		Power system configuration (Busties)	Section 3.2				
		Fail safe condition of thrusters	Section 3.3				
		Consequence analysis	Section 3.4.3.4				
		Ergonomics	Section 3.4.1				
		Inadvertent acts (maloperation)	Section 2.3				
		Backup DP control system	Section 3.4.2.6				
		PRS operational requirements	Section 3.4.3.1				
		Number and diversity in PRS	Section 3.4.3.3				
		Vessel sensors	Section 3.4.4				
		Cable and pipe routes	Section 3.5				
		Non-DP related systems	Section 3.6				
		Initial, annual & periodic surveys	Section 5.1				
		FSVAD DPVAD	Section 5.2				
DNVGL RP E307	This is the DNVGL version of the MTS DP Vessel Operations guidance	Activity operational planning	DNVGL RP E307, DP Operations Guidance' – All Parts				
		ASOG, WSOG					
		Competence & manning					
		Capability plots and foot prints					
		Logistics vessels					
		Project and construction vessels					
		MODUs					
		DP Incidents					
DNVGL RP E306	This is the DNVGL version of the MTS DP Design Philosophy guidelines	Time to terminate	DNVGL E306 'DP Vessel Design Philosophy Guidelines' – All Parts				
		Redundancy concept					
		Post WCF DP capability					
		Critical and non-critical redundancy					
		Low Loss Redundancy Concept – (LIFE)					
		Defending the redundancy concept					
		Key elements of redundancy concept					
		Autonomy and decentralization					
		Diversity and differentiation					

Competence 4 – DP Guidance							
Themes	Description	Key Themes / Subject Matter	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
DNVGL RP E306	This is the DNVGL version of the MTS DP Design Philosophy guidelines	Modelling					
		Management of change					
		Propulsion					
		Marine auxiliary systems					
		Power generation & Power station concept					
		Power distribution					
		Power and vessel management					
		Blackout recovery					
		Networks and serial lines					
		Uninterruptable power supplies					
		DP control systems					
		Sensors					
		External Interfaces					
		Safety systems					
		Ergonomics					
		Alarm management					
		Communications					
		Inspection repair and maintenance					
		Commissioning and testing					
PROFESSIONAL DEVELOPMENT OF DP PERSONNEL TOOL 1 & 2	Mapping Delivery Ability Tool – A self-assessment process develop for use by the DP community	FMEA specification					
		Design, Operations, Process and People	DYNAMIC POSITIONING CONFERENCE October 15-16, 2013, 'Leveraging MTS PROFESSIONAL DEVELOPMENT OF DP PERSONNEL TOOL for the Development of Marine Risk Staff Professionals' MTS 'Guidance for Professional Development of Personnel Engaged in DP Operations Using the Mapping Delivery Ability Tool (PROFESSIONAL DEVELOPMENT OF DP PERSONNEL TOOL)' – All parts				
		Enabling					
		Leveraging					
		Behaviors					
		Recognizing challenges					
		Critical success factors					
		Roll out and implementation methodology					
RP D102	DNVGL's Recommended Practice for FMEA of Redundant Systems – This is the minimum requirement for DP systems FMEAs.	FMEA of Systems with redundancy	DNV 'Recommended Practice for FMEA of Redundant systems', RP D102 – all Parts				
		Redundancy verification table					
		Redundancy design intent					
		Single failure propagation analysis					
		Unit and subsystem FMEA					
		FMEA table					
		Redundant systems with physical separation					
		Inspection and tests					
		FMEA report and compliance statement					
		Failure modes in systems with closed busties					

Competence 4 – DP Guidance							
Themes	Description	Key Themes / Subject Matter	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
IMCA M166	FMEAs methodology	FMEA	Guidance for FMEAs				
IMCA M117	Competence	Accreditation for DP Practitioners	The Training and Experience of Key DP personnel				
IMCA M190	Guidance for developing and conducting annual DP trials programs for DP vessels	Development of Annual DP trials programs	IMCA M190 ‘Guidance for developing and conducting annual DP trials programs for DP vessels’ – All Parts.				
		Difference between annual and proving trials					
		Competence of persons developing the trials programs					
		Lifetime management of trials					
		Conduct of trials					
		Independent witness					
		Findings					
IMCA M191 (Now incorporated into M190)	Guidelines for annual DP trials for DP mobile offshore drilling units	Continuous trials for MODUs	IMCA M191 – ‘Guidelines for annual DP trials for DP mobile offshore drilling units’ – all Parts (Now incorporated into M190)				
		Objectives					
		Annual verification					
IMCA M206	A guide to DP Electrical Power and Control Systems	Power Systems, Control Systems, Equipment function and failure	IMCA M206 – ‘A Guide to DP Electrical Power and Control System’				
IMCA M220	Guidance on operational activity planning	CAMO	IMCA M220 – ‘Guidance on Operational Activity Planning’ – All Parts				
		TAM					
		ASOG					
		Operational activity planning					
IMCA M225	Example redundancy concept and annual DP trials for a DP class 3 construction vessel	Linking redundancy concept to trials	IMCA M225 ‘Example Redundancy Concept and Annual DP Trials for a DP Class 3 Construction vessel’ – All Parts				
		Performance					
		Protection					
		Detection					
		Use of planned maintenance					
IMCA M182	International guidelines for the safe operation of dynamically positioned offshore supply vessels	Crew competence	IMCA M182 - International guidelines for the safe operation of dynamically positioned offshore supply vessels – All Parts				
		Supply vessel manning					
		Rolling trials for PSVs					
Incident Investigation	TECHOP_Gen_03 Conducting Effective and Comprehensive DP Incident Investigations)	Fish Bone Structure	TECHOP_Gen_03 Conducting Effective and Comprehensive DP Incident Investigations)				
		Short, Medium & Long-Term Actions					
		Causal and contributory factors					
		Data gathering					
		Learning from Incidents (LFIs)					

Competence 4 – DP Guidance							
Themes	Description	Key Themes / Subject Matter	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
TECHOPs	TECHOP_ODP_13_(D) (Control Power Supplies and Auto Changeovers)	Cross connections in control power supplies	TECHOP_ODP_13_(D) (Control Power Supplies and Auto Changeovers) – All Parts				
		Failure modes of diodes					
		DC to DC convertors					
		Grounding strategies					
		Cross connections created by ground faults					
		Dual supplies – Mitigating failure effects					
		Auto-changeovers					
	TECHOP_ODP_09_(D) (A Method For Proving The Fault Ride-Through Capability Of DP Vessels With HV Power Plant)	Case for action	TECHOP_ODP_09_(D) (A Method For Proving The Fault Ride-Through Capability Of DP Vessels With HV Power Plant) – All Parts				
		Requirements					
		Attributes to be verified					
		Expertise					
		Practical considerations					
		Model validation					
		Alternative forms of testing					
	TECHOP_ODP_08_(O) (Annual DP Trials and Gap Analysis)	Review of DP systems FMEA	TECHOP_ODP_08_(O) (Annual DP Trials and Gap Analysis)- All Parts				
		Proving the integrity of the redundancy concept					
		Fail safe condition of thrusters					
		Control mode tests					
		Performance tests					
		Testing protective functions					
		Testing switched or standby redundancy					
		Testing physical separation					
		Testing control modes					
		Group redundancy tests					
		Findings					
		Annual DP Trials Gap Analysis					
	TECHOP_ODP_02_(D)_ (Blackout Recovery)	Design objectives	TECHOP_ODP_02_(D)_ (Blackout Recovery) - All Parts				
		Desirable and undesirable features					
		Testing blackout recovery					
		Specification for blackout recovery systems					

Competence 4 – DP Guidance							
Themes	Description	Key Themes / Subject Matter	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
TECHOPs	TECHOP_Gen_02_ (White Paper On Continuous Trials For DP MODUs)	Maintaining MODU redundancy concept by continuous trials	TECHOP_Gen_02_ (White Paper on Continuous Trials for DP MODUs)				
		Developing continuous trials					
		Performance, Protection & Detection					
		Crew training opportunity					
		Planned maintenance					
		Tests of opportunity					
		Charterers batch trials					
	TECHOP_ODP_11_(D) (Cross Connections)	Cross connections for reliability and maintenance	TECHOP_ODP_11_(D) (Cross Connections)- All Parts.				
		Fault propagation paths					
		Closed busties					
		Auto-changeovers					
		Dual AC supplies					
		Load sharing lines					
		Switchboard control power and synchronizing lines					
		Marine auxiliary services					
		Networks					
		Influence of CAM in TAM					
		Identifying cross connections					
	TECHOP_ODP_12_(O) (Defining Critical Activities Requiring Selection of Critical Activity Mode)	Concepts of CAM & TAM	TECHOP_ODP_12_(O) (Defining Critical Activities Requiring Selection of Critical Activity Mode)- All parts				
		Drivers for operating in TAM					
		Default is CAM					
		Examples of critical and non-critical activities					
	TECHOP_ODP_06_(D) (DGNSS Position Reference Sensors)	Impacts of design, operations and people	TECHOP_ODP_06_(D) (DGNSS Position Reference Sensors)- All Parts.				
		Antenna location					
		Weatherization					
		Lightening protection					
		Interfacing					
		Principles					
		Corrections					
		Inertial navigation systems					
		Over reliance on DGNSS					

Competence 4 – DP Guidance							
Themes	Description	Key Themes / Subject Matter	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
TECHOPs	TECHOP_ODP_05_(O) (DP Operations Manual)	Expected content for DP operations manuals	TECHOP_ODP_05_(O) (DP Operations Manual)- All Parts				
		The importance of the redundancy concept					
		The configurations that are required to support the redundancy concept					
		The role of defined individuals in maintaining / defending the redundancy concept					
		A clear understanding of post failure capability					
		Content and use of ASOG / WSOG					
	TECHOP_ODP_03_(D) (Evaluation Of Protection Systems)	Classification of protective functions - what purpose do they serve	TECHOP_ODP_03_(D)_(Evaluation Of Protection Systems) - All Parts				
		Good practice in the design of control, monitoring and protective functions.					
		The disadvantage of combining protection and control					
TECHOPs	External Interfaces – ESD F&G safety shutdown systems, VMS interface such as draught sensors etc. and other IM interfaces	DP Incidents caused by external interfaces	Covered in main MTS design philosophy document				
		Identifying, analyzing and improving external interfaces					
		F&G and ESD systems					
		External force compensation					
		Draught sensors					
		Power control for industrial consumers					
		Power distribution for industrial and hotel loads					
		Firefighting systems					
		Communication and navigation equipment					
		Roll stabilization					
	TECHOP_ODP_04_(D) (FMEA Gap Analysis)	Why perform a DP FMEA gap analysis?	TECHOP_ODP_04_(D)_(FMEA Gap Analysis) - All Parts				
		Purpose of gap analysis					
		Meaning of color codes					
		First stage gap analysis					
		Second stage gap analysis					
	TECHOP_ODP_01_(D) (FMEA Testing)	The need for testing	TECHOP_ODP_01_(D)_(FMEA Testing) - All Parts				
		What, when, where and why to test					
		How to test					
		Acceptance criteria and scope					
		Unacceptable test results					
		Gap Analysis of DP FMEA proving trials					

Competence 4 – DP Guidance							
Themes	Description	Key Themes / Subject Matter	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
TECHOPs	Technical and Operational Guidance (TECHOP)	TECHOP ODP	Technical and Operational Guidance (TECHOP) – All Parts				
		TECHOP Gen					
	TECHOP_ODP_00_(O) (High Level Philosophy)	Identifying DP as a Safety Critical Element	TECHOP_ODP_00_(O)_(High Level Philosophy)				
		Additional information to be incorporated in Operations Manual					
		Establishing a Vessel Specific Drive off to Drift off strategy					
		Reinstatement of equipment post failure					
		Drive off to drift of strategy					
	TECHOP_Gen_01 (Power Plant Common Cause Failures)	Common cause failures	TECHOP_Gen_01_(Power Plant Common Cause Failures) – All Parts				
		Common control power supplies					
		Common backup supplies					
		Lack of excitation support					
		Severe voltage dips					
		Selectivity					
		Default to factory settings					
		Effects of regeneration					
		Load acceptance and rejection					
		Poor power factors					
		Environmental conditions					
		Contamination of fuel and combustion air					
		Fouling of cooling water systems					
		Common software errors					
		Common sensor principles					
		Inappropriate combinations of sensor principles					
		Harmonic distortion and inrush transients					
		Fuel and excitation control failures					
		Broken conductors and single phasing					
		Overload					
		Effects of fire and flooding					
	TECHOP	The need for software testing	TECHOP Software Testing				
		Hardware in the loop testing (HIL)					
		Software in the loop testing (SIL)					
		Endurance testing					
		Independent and dependent HIL					

Competence 4 – DP Guidance							
Themes	Description	Key Themes / Subject Matter	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
TECHOPs	TECHOP_ODP_14_(D) (PRS and DPCS Handling of PRS)	Golden rules for all PRS	TECHOP_ODP_14_(D)_(PRS and DPCS Handling of PRS) - All Parts				
		Functional objectives of PRS and DPCS handling of PRS					
		Choices of PRS and Modes to suit industrial mission					

Competence 5 – Verification & Validation							
Themes	Description	Keywords	Reference	Competence Assessment		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Classification society rules	Classification society rules represent the minimum standard to which DP vessels should be constructed. Vessel owners may specify a higher standard based on industry guidance.	International Association of Classification Societies	Coaching and mentoring (Future TECHOP in development)				
		Classification societies and recognized organizations					
		Class notations					
		Type approval					
		Inspection and sea trials					
		Plan approval					
Annual DP Trials	Annual survey of all important equipment associated with the DP system is performed within a three-month window either side of the anniversary date of the DP FMEA proving trials. The trials report should demonstrate that the DP system is in good order and it responds correctly to single failures.	Proving the system operates as intended	113 IMO				
		Proving the DP system is intact and well maintained	113 IMO				
		The effects of single failures	113 IMO				
		Rolling and continuous trials	IMCA M190 & M191 (Now incorporated into M190)				
		Role of Independent witness	IMCA 190				
		Findings - Categories	IMCA 190				
		Use of planned maintenance	IMCA M225				
FMEA Proving Trials	The DP FMEA proving trials are intended to confirm the findings of the DP system FMEA and are one of the document submissions which, together with the FMEA, contributes to the approval process for the appropriate DP notation.	Proving the conclusions of the DP system FMEA	DNV RP D102				
		Proving system complies with rules and guidelines	113 IMO				
		New knowledge and lessons learned	TECHOP_ODP_01_(D)_(FMEA Testing)				
		Opportunity for improvements	TECHOP_ODP_01_(D)_(FMEA Testing)				
		Exploratory testing	TECHOP_ODP_01_(D)_(FMEA Testing)				
		Categories for concerns or findings	TECHOP_ODP_01_(D)_(FMEA Testing) DNVGL RP E306				
Post event trials	These trials or related activities are performed in order to establish the basis of confidence that the DP vessel has the expected station keeping integrity following an incident	Back to work criteria	Company Standards or Client Requirements				
		Reinstatement of equipment					
		Stress test					
		Soak tests					
		Vendor support					
Project specific simulator requirements	Training carried out to allow crews to practice unusual operations. Particular useful with SIMOPs when crews of several vessels may practice together	Simulator Training	Company Standards or Client Requirements				
Effective onboard engagements	A primary function of DP SMEs to ensure communication of requirements	Engagements	Company Standards or Client Requirements				

Competence 6 – Power Plant Configured as a Common Power Systems – (Closed Busties)							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Electrical engineering – AC power theory	These are the basic terms used in electrical engineering to describe power systems quantities	Voltage	IMCA M206				
		Current					
		Frequency					
		Impedance - Triangle					
		Reactance					
		Resistance					
		Capacitance – Relationship to impedance and frequency					
		Inductance – Relationship to impedance and frequency					
		Power – triangle					
		Active Power (kW)					
		Reactive Power (kVAr)					
		Apparent power (VA)					
		Three phase systems					
		Phase displacement 120°					
		Phase quantities (V&I)					
		Line quantities (V&I)					
		Relationship between line and phase					
		Power factor (Cosϕ)					
		Magnetic flux density (T)					
		Magnetic field strength					
		Reluctance					
Power system earthing / grounding	There are several ways in which AC power systems can be referenced to the ship's hull.	Concept of ground reference ac system	IMCA M206				
		Neutral					
		Star-point					
		High resistance ground					
		Low resistance					
		Isolated ground					
		Neutral Earthing Transformer					
		Broken Delta					
		Zig-Zag					

Competence 6 – Power Plant Configured as a Common Power Systems – (Closed Busties)							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Generators	These are some of the components and attributes associated with synchronous generators	Synchronous	IMCA M206				
		Stator					
		Rotor – cylindrical and salient pole					
		Exciter					
		Pilot Exciter					
		Rotating diodes					
		Bearings – lubrication					
		Bearings insulated					
		Cooling systems					
		Capability plot – PQ diagram					
		Thermal limits – current limit					
		Power limits – engine overload					
		Stability limits					
		Reverse power					
		Pole slipping					
		Parallel operation of generators					
		Load acceptance capability					
		Load rejection capability					
		Phase to ground faults					
		Phase to phase faults					
		Inter turn faults					
		Current and voltage imbalance					
		Negative sequence faults					
		Zero sequence faults					
		Excitation faults					
		Fuel control faults					
		Over & under frequency					
		Over and under voltage					
Synchronizers	Equipment used to connect synchronous generators to a power system	Crash synchronization	IMCA M206				
		Synchronizing window					
		Speed control					
		Voltage control					
		Phase Rotation					
		Check sync relay					
		Dead bus detection					
		Bus impedance test					

Competence 6 – Power Plant Configured as a Common Power Systems – (Closed Busties)							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Automatic voltage regulators	Automatic Voltage Regulators control the excitation current in the generator exciter to maintain terminal voltage and reactive power sharing.	Buck-boost	IMCA M206				
		Compounding CTs					
		Droop CT					
		Voltage / Potential Transformer					
		Excitation support - PMGs					
		Quadrature current compensation					
		Voltage droop					
		Astatic loop					
		Thyristor Divert					
		Over excitation and limiters					
		Voltage sensing and wire break detection					
		V to F ratio					
		Data connections – Serial links					
Speed regulators / governors	The speed regulator or governor is responsible for maintaining engine speed and load sharing – it may be interfaced to a power management system or to other speed regulators	Speed / frequency control	IMCA M206				
		Raise / Lower					
		Load sharing					
		Load sharing lines – analogue and Digital					
		Transfer from Isoch to droop					
		Forward and reverse acting					
		Proportional, integral and derivative control					
		Isochronous					
		Speed droop					
		Stability					
		Damping					
		Magnetic speed pickups					
		kW transducers					
		Ball-head backup					
		Hydraulic / Electric actuators					
		Mechanical / electronic / Analogue / Digital					

Competence 6 – Power Plant Configured as a Common Power Systems – (Closed Busties)							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Switchboards and switchgear	Switchboards and switch gear are the means by which consumers and generators are connected and disconnected from a power system. They also provide facilities for control, monitoring and protection	Switchboards, Enclosures & Cubicles	IMCA M206				
		Bus bars supports - S/C withstand					
		Stabs and shutters					
		Vents					
		Cable Entry					
		Switchgear - Withdrawable					
		Switchgear – non-withdrawable					
		Vacuum circuit breakers					
		Gas filled circuit breakers					
		Air circuit breakers					
		Molded Case Circuit Breakers					
		Miniature circuit breakers					
		Spring winders					
		Fuses – High Rupture Current- slow blow					
		I^2t – Let through energy					
		Flashover and arc flash					
		Coordination, selectivity & discrimination – Definite time – inverse time – very inverse time					
		Load diversity					
		Contactors and latching contactors					
		Control and protection circuit					
		Interlocks and keys					
		VTs, CT and Core Balance CTs					
		CTs Measuring and Protection – Burden – Saturation off – Rogowski coils – hall effect transducers.					
Cables		Bus Link & No Load Switch	IMCA M206				
		Thermal rating					
		Cores					
		Cross section					
		Construction and insulation, armored, fire-resistant					
		Stress grading					
		Bend radius					
		Skin effect and proximity effect					
		Single core cables					
		Derating bundles					
		Intumescent coatings					
		Voltage drop					

Competence 6 – Power Plant Configured as a Common Power Systems – (Closed Busties)							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Protection devices and functions	Protection devices are located in switchboards and Motor control centers to isolate the effects of faults as close to the fault as possible by disconnecting the faulty circuit using the circuit breaker.	Protection relays					
		Overcurrent & short circuit					
		Differential over current					
		Zone protection					
		Directional over current (blocking schemes)					
		Reverse power					
		Field failure					
		Negative phase sequence protection					
		Over and under voltage					
		Over and under frequency					
		Ground fault protection					
		Neutral displacement					
Transformers and wound components	Transformers are used to convert between different voltage distribution levels – specialist transformers are used to convert large currents and voltages to signals levels suitable for measuring and protection devices.	Power and instrumentation types	IMCA M206				
		Turns ratio					
		Autotransformers					
		Cooling types – AN, AF, WF					
		Number of windings Primary and secondary					
		Phase shifting					
		Vector group & clock number					
		Harmonic cancelation					
		Neutral connection – circuiting currents					
		Over voltage protection					
		Pre-magnetization					
		Earthed screens					
		Line reactors					
		Split reactors					
Motors	Various type of motors are used in different applications	Synchronous	IMCA M206				
		Asynchronous / induction					
		Three phase - single phase – cap start cap run					
		DC – series – shunt – compound – PM - brushless					
		Series AC – shaded pole					
		Rotary condenser					
		Soft start					
		Star and delta connection					
		Star-delta starter					
		Korndorffer starter (auto transformer)					

Competence 6 – Power Plant Configured as a Common Power Systems – (Closed Busties)							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Variable speed drives	Variable speed drives are used for thruster drives and also for some auxiliary system such as pumps and fans	Voltage source PWM	IMCA M206				
		Multi-level drives					
		Line commutated inverters					
		DC drives					
		Cycloconverters					
		Effects of inflow – ‘fly catching’					
		Regeneration					
		Active front end					
		Rectifier front end					
		Braking resistors					
		Torque / speed control					
		Thyristor – SCR - IGBT					
		DC link over & under voltage					
		Pre-charging and pre-magnetization					
		Emergency stops					
		Drive protection					
Fault ride through testing		Short Circuit, Fault Ride Through, Testing, Voltage Dip	TECHOP_ODP_9_(D) A Method for Proving The Fault Ride-Through Capability of a HV Power Plant)				
Power management		Interface to DP control systems	TECHOP_ODP_2_(D) (Blackout Recovery)				
		Blackout detection					
		Blackout recovery					
		Blackout prevention – load shedding	IMCA M206				
		Thruster and IM process phase back	IMCA M206				

Competency 7 – Cross Connections, External Influences and Interfaces							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Concepts	These concepts are important in the understanding of how faults propagate between redundant groups in DP systems and some of the methods which are used in full or partial mitigation of those failure effects	Independence	MTS DP Vessel Design Philosophy Guidelines				
		Fail safe					
		Configuration					
		Commonality					
		Control, monitoring and protection – (independence of)					
		Fault tolerance					
		Fault propagation					
		Ride through capability					
		Galvanic isolation					
		EMI & EMC					
		filters					
		Voltage multiplication					
		Voltage and frequency excursions					
		Burn-out and punch-through					
		flashover					
		Clearance and creepage					
		Switching transients and harmonics					
		Thermal effects / coupling					
Redundant power supplies		Diodes and bridge rectifiers	MTS DP Vessel Design Philosophy Guidelines				
		DC to DC convertors					
		Synchronized inverters					
		Switched mode power supplies					
		Autochangers					
		Solid state switches					
		Interlocks					
		Inter trips					
		Tie lines					
		Fuses and circuit breakers					
		Selectivity and coordination					

Competency 7 – Cross Connections, External Influences and Interfaces							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Ground strategies		Common grounding point	LFI No – 01/2015 Blackout On A Dp 2 Class Vessel Operating With An Asog And A Segregated Power Plant				
		Mixed ground / return references					
		Floating / isolated returns					
		Ground loops					
		Multiple ground faults					
		Ground fault detection					
		High resistance grounding					
		Isolated power systems					
		Isolated neutral					
		Low resistance grounding					
Load sharing	Load sharing between generators opening in parallel and with electronic generators uses some form of load sharing which can introduce the potential for common cause failures.	Isochronous	IMCA M206				
		Compensated droop					
		Uncompensated droop					
		Isoch -Transfer to Droop					
		Master Slave					
		LON					
		CAN					
		Analogue					
		Load sharing line isolation at busties					
Marine auxiliary services	All these systems have the potential to introduce commonality between redundant DP groups	Fuel storage, purification and service systems • MGO / MDO • HFO & Transfer • Thermal oil & Steam	MTS DP Vessel Design Philosophy Guidelines				
		Seawater cooling • Sea chests and strainers • Blow downs • Fouling and aeration • Box coolers • Shell / Hull valves	MTS DP Vessel Design Philosophy Guidelines				
		Freshwater cooling (HT & LT) • Temperature control valves (failure modes and power supplies) • Wax valves • Pneumatic valves • Hydraulic valves • Header tanks	MTS DP Vessel Design Philosophy Guidelines				

Competency 7 – Cross Connections, External Influences and Interfaces							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Marine auxiliary services	All these systems have the potential to introduce commonality between redundant DP groups	Charge air • Turbochargers • Dump valves • Intercoolers • Jet assist • Rig savers	MTS DP Vessel Design Philosophy Guidelines				
		Duty / Standby controls	MTS DP Vessel Design Philosophy Guidelines				
		Lubrication for engines and thrusters	MTS DP Vessel Design Philosophy Guidelines				
		Remote valve control HPUs and pipework Solenoid valve cabinets • Fail as set • Fail closed • Fail open	MTS DP Vessel Design Philosophy Guidelines				
		Hydraulic systems	MTS DP Vessel Design Philosophy Guidelines				
		HVAC and ventilation – Chilled water	MTS DP Vessel Design Philosophy Guidelines				
		Compressed air • Service • Control • Starting • Thruster brakes • Fire dampers	MTS DP Vessel Design Philosophy Guidelines				
		Combustion air Internal • External • Jalousies • Temperature controlled • Icing – winterization	MTS DP Vessel Design Philosophy Guidelines				
		Exhaust systems • Routing • Fire hazard	MTS DP Vessel Design Philosophy Guidelines				
		Power distribution • Main power • Auxiliary power • Control system power • Hotel load • Emergency power	MTS DP Vessel Design Philosophy Guidelines				
		Watertight doors and dampers	MTS DP Vessel Design Philosophy Guidelines				

Competency 7 – Cross Connections, External Influences and Interfaces							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Communication networks	Communication networks frequently connect redundant elements for control. Monitoring and protection. They are vulnerable to interruption and can also expose controllers to faulty and excessively high levels of traffic	Ethernet	MTS DP Vessel Design Philosophy Guidelines				
		Modbus RS485					
		Profibus					
		CANBus					
		RBus					
		Serial links RS235, RS422 etc.					
ESD systems (Impact on FMEA)	Emergency shut down system are found on MODUs and some project and construction vessels – they can introduce significant commonality between DP redundancy groups and are a known cause of DP incidents	• ESD – Hardware and Software • Separation along the lines of redundancy concept – Physical and functional • Fail-safe condition of I/O • Commonality introduced by shutdown groups • Cascading from one level to another • External push buttons	MTS DP Vessel Design Philosophy Guidelines				
F&G systems	Fire and Gas detection systems re capable of initiating action through the ESD systems or directly in some cases	• Executive action • Triggered by • Voting • Fire zones	MTS DP Vessel Design Philosophy Guidelines				
Fixed Fire-fighting	Fixed fire-fighting system may introduce common points associated with their control systems and interface to ESD	• CO_2 • Water mist • Fire dampers	MTS DP Vessel Design Philosophy Guidelines				
Emergency stops	Emergency's stops often bring redundant groups to a common point or in close proximity introducing a risk of common cause failures. Group emergency stops may not be segregated along the lines of the DP redundancy concept. A risk of maloperation exists	Grouping	MTS DP Vessel Design Philosophy Guidelines				
		• Line monitoring • Thermal fused links • Power supply monitoring • Fail safe – Normally de-energized • Hidden failure • Effects of fire and flooding	MTS DP Vessel Design Philosophy Guidelines				
Industrial consumers	The power and control requirements of industrial consumers frequently introduce commonality between redundant DP equipment groups	Cranes	MTS DP Vessel Design Philosophy Guidelines				
		ROV					
		Diving					
		Drilling					
		Pipe-Lay					
		Power consumption and indication					
		Phase-back					

Competency 7 – Cross Connections, External Influences and Interfaces							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Switchboard control wiring	Control wiring between switchboards introduces a significant common point particularly in respect of control power and lines for protection devices such as CTs and VTs	• Interlocks • Status lines • CTs • VTs / PTs • Synchronizing • Load sharing	MTS DP Vessel Design Philosophy Guidelines				
External force compensation	Interfaces which provide the DP control system with information on external forces must be	I/O Interfaces Redundancy Fail safe User Inputs	MTS DP Vessel Design Philosophy Guidelines				
North speed correction	Gyro compass independence may be compromised by inputs from a single GPS subject to 'GPS Position Jump'	Manual inputs Isolation during DP DGPS jumps	LFI No. 01/2016 – External Interface With DP Station Keeping Equipment				
Pipelaying systems - tension	Information on pipe tension must not compromise station keeping integrity	Systems engineering approach required	MTS DP Vessel Design Philosophy Guidelines				
Power management systems	Power management systems typically form a significant common point even when power plant is operated with open busties	Ability to disconnect multiple generators Ability to phase back multiple consumers	MTS DP Vessel Design Philosophy Guidelines				
Vessel management systems	Vessel management systems and their field station may span the redundancy groups	Field stations for auxiliary systems Pump control	MTS DP Vessel Design Philosophy Guidelines				
Remote valve control	Remote valve control systems are often not split in line with the redundancy concept but have the ability to control cooling water valves as well as ballast valves	• Split in line with redundancy • Ability of control system to drive valves closed • Failure condition of valves on loss of power or control signal	MTS DP Vessel Design Philosophy Guidelines				
Energy storage	To be developed	To be developed	To be developed				

Competence 8 – In Execution Support							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Marine Operations	Provide in-execution support when requested. Engage with other subject matter experts, vessel crew, project teams and owner's organization in order to resolve issues and progress the execution of marine operations and the industrial mission.	Response to yellows and reds	Company Standards or Client Requirements				
		Specifying analytical / engineering work relevant to impacts on station keeping	Coaching and mentoring				
		Return to work authorization	Company Standards or Client Requirements				
		Responding to and resolving dilemmas	Coaching and mentoring (Future TECHOP in Development)				
		Follow the sun support	Coaching and mentoring – In service support - Company Standards or Client Requirements (Future TECHOP in Development)				
Incident investigations	Perform incident investigations.	TECHOP_GEN_03 Conducting Effective and Comprehensive DP Incident Investigations	TECHOP_GEN_03 Conducting Effective and Comprehensive DP Incident Investigations – all Parts				
		Organize specific vendor support, analysis and testing					
		Creating LFIs					

Competence 9 – Industrial Mission (Impacts and Management)							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Modes and features	DP control system require certain special modes and features to perform some type of industrial mission	Relative and absolute PRS	MTS DP Design Section 14.7				
		Heavy lift mode					
		External force compensation					
		Suspended loads					
		Three axis and two axis control					
		Pipelay mode					
		Follow target					
		Weather vane					
		Fire monitor compensation					
		Draught sensors					
Environmental forces at work location	The nature of the work to be carried out may require working in a less favorable location with respect to weather and the risk of contact with surface assets and other vessels in the case of blackout or insufficient thrust. Extreme environmental weather phenomena may also require consideration.	Drift off, Drift on scenarios	MTS DP Design Section 15.4, MTS DP Design Section 2.6.4				
		Solitons					
		Tropical storms					
		Lightning strikes					
Heavy lifting operations	Heavy lifting operations include the transfer of topsides to jackets. The lifting of modules on to production platforms. Takes account of the effects of the load transfer on the mass of the vessel and the additional lateral force, normally by reducing gain and relaxing the DP controller.	Side forces – Destabilization of DP	DP Design Pt 2 Section 3.25, 14.7, 2.4 MTS DYNAMIC POSITIONING CONFERENCE – Nils Albert Jensen October 7 - 8, 2008 Operations ‘On the Use of Safety Moorings in DP Operations’ Coaching and mentoring (TECHOP in Development)				
		Suspended loads					
		Deselecting DP at touch down					
		Wind profile and model					
Riser pull-in or handover	This is typical of operations in which a DP vessel will transfer a load to another DP vessel or surface assets	External Forces	Company Standards or Client Requirements (TECHOP in Development)				
Subsea obstructions		Working / diving within anchor patterns	Coaching and Mentoring (TECHOP in Development)				

Competence 9 – Industrial Mission (Impacts and Management)							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
External force compensation	Where the measured external force acting on the vessel, which is separate from the environment, is included in the DP calculation and treated as a force feed forward. This mode is used to account for pipe tensions in a pipe layer and hawser tension in a shuttle tanker.	Design of inputs to DP - Manual input	MTS DP Design Pt2 Sec 14.20, TECHOP				
		Need for systems engineering approach in design of interface. Fault tolerance in interface and redundancy					
Hold back vessels	The practice of using a tug or other DP vessel as a safety mooring to reduce the risk of a loss of position. This practice is potentially hazardous and may have unintended consequences.	Interaction leading to instability	MTS DP Conference, 2008. 'On the use of Safety Moorings in DP Operations'				
SIMOPS	Operations involving several vessels	SIMOPS tools	MTS DP Conference 2005 Operations II Case Study of DP Vessels Performing SIMOPS Xiaobing Shi Diego Martinez Doug Phillips				
PRS Hazards	Interference, shadowing, loss of line of sight and other hazards associated with the industrial mission. For example, the view of the sky from DGNSS antennas may be obscured by decks of surface assets or by project equipment.	View of the sky	TECHOP_ODP_14_(D) (PRS and DPCS Handling of PRS)				
		Thermoclines					
		Noise in the water column					
		Swinging loads through line of sight					
		Ex rated equipment					
Relative PRS and target vessel motions	Absolute PRS provide a position references with respect to a fixed point on the earth surface. Relative PRS provide a reference from a non-earth referenced object which may be moving object (typically range and bearing). If the object to which the reference moves too much it may not be possible to use that reference in Auto Position	Follow target modes	TECHOP_ODP_14_(D) (PRS and DPCS Handling of PRS)				
		Analysis of target vessel motions					
		Redundant relative PRS Competence 9					
Gangways	Gangways re used to allow transfer of personnel and equipment from one DP vessel to a surface asset such as a production platform or FPSO	Walk to work	Coaching and Mentoring, Company Standards or Client Requirements – (TECHOP in Development)				
		Instrumented gangways as PRS					
		Active – Heave compensated - gangways					
		Risk of loss of position to gangway vessel and to surface asset					

Competence 9 – Industrial Mission (Impacts and Management)							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Consequences of loss of position	Before commissioning a DP vessel to carry out a particular industrial mission it is necessary to evaluate the consequences. If the consequences of loss of position are unacceptably high. It may be necessary to create additional barriers or find an alternative way of performing the work	Barriers required	TECHOP_ODP_12_(O) (Defining Critical Activities Requiring Selection of Critical Activity Mode)				
		CAM & TAM	TECHOP_ODP_12_(O) (Defining Critical Activities Requiring Selection of Critical Activity Mode)				
Range and water depth restriction	Position reference systems have range restrictions including distance to target and water depth restrictions	Limitations	TECHOP_ODP_14_(D) (PRS and DPCS Handling of PRS)				
Diving	Single stern thruster design not to be used for diving	Poor transient response following WCF	Company Standards or Client Requirements				
Decision points	When certain go-no-go points are reached	Time to terminate	MTS DP Operations Guidance				
		Time for which positioning standby can be applied / is effective	MTS DP Operations Guidance				
Modes and Features	Requirements & need for 'systems Engineering Approach'	PRS	Company Standards or Client Requirements, TECHOP 14 PRS & DPCS handing of PRS				
		Industrial Mission					
DP Capability	DP vessels have a static and a dynamic positioning capability. Both may need to be considered for some types of industrial mission. DP vessel can be equipped with different types and combinations of propulsion including tunnel thrusters, azimuthing thrusters, main propellers and rudders. Not all arrangements are suitable for all types of industrial mission	Stat cap	MTS DP Design Section 4				
		Dyn cap					
		Foot prints and position excursion					
		Thruster wash					
		Barred Zones					
		Thruster arrangements					
DP SME role	DP SME role in managing business risks	Business / project objectives Stakeholder management Interface management	Coaching and Mentoring (Future TECHOP in Development)				
Balancing risks	Determining when to allow operations to continue in Yellow status. Deciding which side of bow-tie to address risk.	Enterprise risk Process safety risk Bow ties					
Developing and creating barriers and compensating measures	Barriers and compensating measures initiated when operations continue in yellow status	Barrier philosophy					

Competence 9 – Industrial Mission (Impacts and Management)							
Themes	Description	Keywords	Reference	Competence Scale		Evidence	
				Self-Assessment	From Competence Assessment	Theory / Principles	Actions
Strategies – Business risk V DP station keeping risk	Strategies and approaches to manage overarching business / venture risks in conjunction with managing station keeping risk	Business / venture risk Commercial risks Reputation risk	Coaching and Mentoring (Future TECHOP in Development)				
Interface management	There are many stakeholders who may be impacted or who may have an impact over DP operations. The DP SME may be required to establish dialog with these stakeholders.	Stakeholders					

4.1.1.1