TECHNICAL AND OPERATIONAL GUIDANCE (TECHOP)

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

OCTOBER 2019 (DRAFT)

(ADDENDUM)

DISCLAIMER AND LIMITATION OF LIABILITY

SUMMARY

This MTS TECHOP identifies competency elements that are desirable in DP professionals functioning in roles as DP SMEs in organizations as well as FMEA Practitioners. The TECHOP leverages the guidance documents published by the MTS DP Committee and utilizes the format of the Professional Development of DP Personnel Tool - PDDP2 (Formerly known as the MDAT) to provide a structured approach to obtaining and demonstrating the identified competencies.

Competency Elements for DP SMEs were developed. The approach and format used for the DP SMEs competence scheme has been adapted to identify competencies for FMEA practitioner by a Consultancy Organization engaged in the business of developing FMEAs for DP systems. This adaptation has been included within the TECHOP.

The Competency Elements for DP SMEs and FMEA Practitioners have been encompassed in two separate documents contained as appendices in this TECHOP. There is overlap between the competence elements. However, it was determined that the DP community would be best served by having separate standalone documents, one serving the DP SMEs and the other FMEA Practitioners.

The TECHOP restricts itself to identifying the competencies and points to the MTS Guidance documents where information on relevant topics can be obtained.

The TECHOP is not written with the objective of providing a prescriptive list of competencies for either of the roles. The TECHOP does not address minimum requirements for personnel in such roles nor does it prescribe a particular assessment methodology although an example of an assessment scheme is given.

It is acknowledged that end users may develop their own ‘fit for purpose’ competency requirements. It is envisaged that this TECHOP could be used as guidance by companies to develop their own company specific minimum requirements for personnel and competence assessment methodology. The MTS DP Committee has published this TECHOP with the objective of facilitating a level of standardization on the identification of minimum competencies.

The TECHOP acknowledges that the DP system is a complex system requiring ‘Systems Thinking’ and ‘Systems Engineering’ skills across a multitude of diverse disciplines. This is embedded in the recognition that there could be varying levels of competencies within the identified competencies ranging through Aware (FMEA Practitioners), Knowledgeable, Skilled and Mastery. It is further acknowledged that effective delivery of accountabilities of DP SMEs and FMEA Practitioners could be achieved by supplementing capabilities with access to competent resources where necessary.

CONTENTS

FIGURES

ABBREVIATIONS

MDAT	Mapping Delivery Ability Tool (now known as PDDP2)
OCIMF	Oil Companies International Marine Forum
PDDP2	Professional Development of DP Personnel (formally MDAT)
SMEs	Subject Matter Experts
TECHOP	Technical and Operational Guidance

1 ADDENDUM TO DP SME COMPETENCE TECHOP

1.1 PREAMBLE

In the Section for DP SME Competence - Interim Competence Techop, Themes, Key themes / subject matter have been listed with the reference column containing the text, ‘coaching and mentoring’. The practice of ‘coaching and mentoring’ is a recognized method of competence development.

The intent of this addendum is to provide a structured approach for the coaching and mentoring process.

It is expected that such a structured approach could be useful in achieving the objectives strived for in “training the trainer”. The structured approach is expected to provide:

- Consistency
- A comprehensive road map to developing the required competencies
- Upskilling and self-paced professional development

Elements of the Iconography developed by the MTS DP Sub Committee on guidance and standards are leveraged to promulgate a common understanding based on established vocabulary.

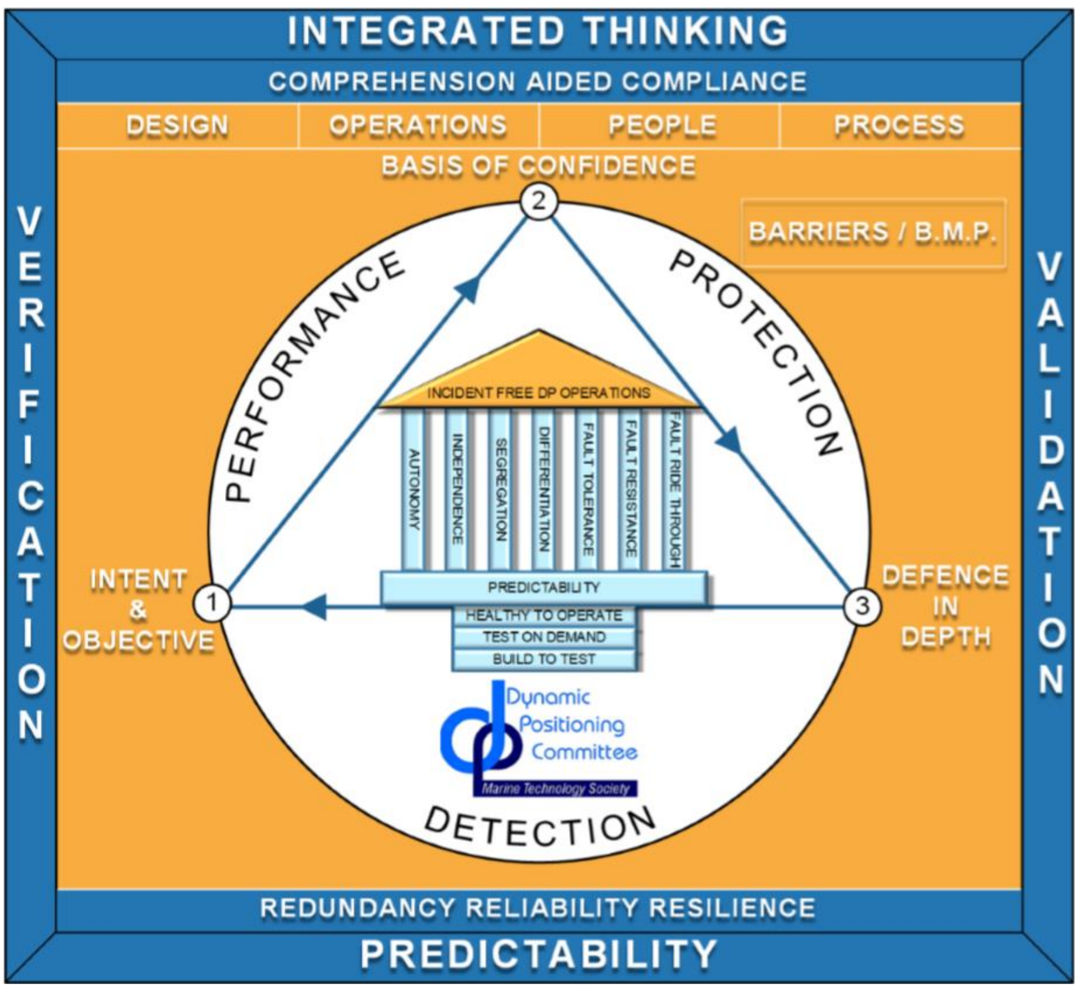

Figure 1 MTS Iconography

The terms used in Figure 1 above are described later in this document.

Foundational elements of DP SME Competency are:

- INTEGRATED THINKING:

  Intent / objective focused processes using verification and validation to increase the basis of confidence and create a defence in depth to maintain the confidence. The various aspects of integrated thinking are explained below in greater detail.

- COMPREHENSION AIDED COMPLIANCE:

  Comprehension aided compliance as opposed to blind compliance is deemed as an approach to understand why a rule or standard exists and thereafter satisfy its purpose instead of just blindly following its words. The various aspects of comprehension aided compliance are explained below in greater detail.

Personnel functioning in the roles of a DP SME are expected to have an in-depth knowledge of DP Operations and be able to understand the impacts of decisions on the industrial mission, usually made by a diverse range of stakeholders.

Legacy approaches to attaining skills and experience in managing marine and DP Operations have tended to be regarded as an “art” with a lack of engineering basis and subjectivity in the processes. A conscious and deliberate effort is being made to incorporate the foundational elements of ‘Integrated Thinking’ and ‘Comprehension Aided Compliance’ into the competence development of DP Personnel. This has succeeded in transitioning the acquisition and application of the above skills from an ‘art’ to a ‘science’ with its roots in objectivity with a clear engineering-based approach.

It is envisaged that treating such skills as a scientific process will enable the required upskilling of personnel and also enable the ability to scale personnel development to the demands of the Industry.

Effective Verification and Validation, and development of objective oriented Decision Support Tools are enablers to this transition.

This addendum to the Techop on DP SME Competency focuses on:

1. DESIGN, OPERATIONS, PEOPLE AND PROCESS.
2. CAUSAL AND CONTRIBUTORY FACTORS OF DP INCIDENTS.
3. PRAGMATIC AND EFFECTIVE RISK MANAGEMENT.
4. AWARENESS-OF AND CAUTION-AGAINST:
   a. Risk Normalization,
   b. Confirmation Bias
   c. Incrementalism

Note: These terms are elaborated in Section 1.4

5. INTEGRATED THINKING (3 PEGS THINKING) TO ACHIEVE PREDICTABLE OUTCOMES
6. COMPREHENSION AIDED COMPLIANCE DEVELOPED BY ADDRESSING 1, 2, 3, 4 AND 5.

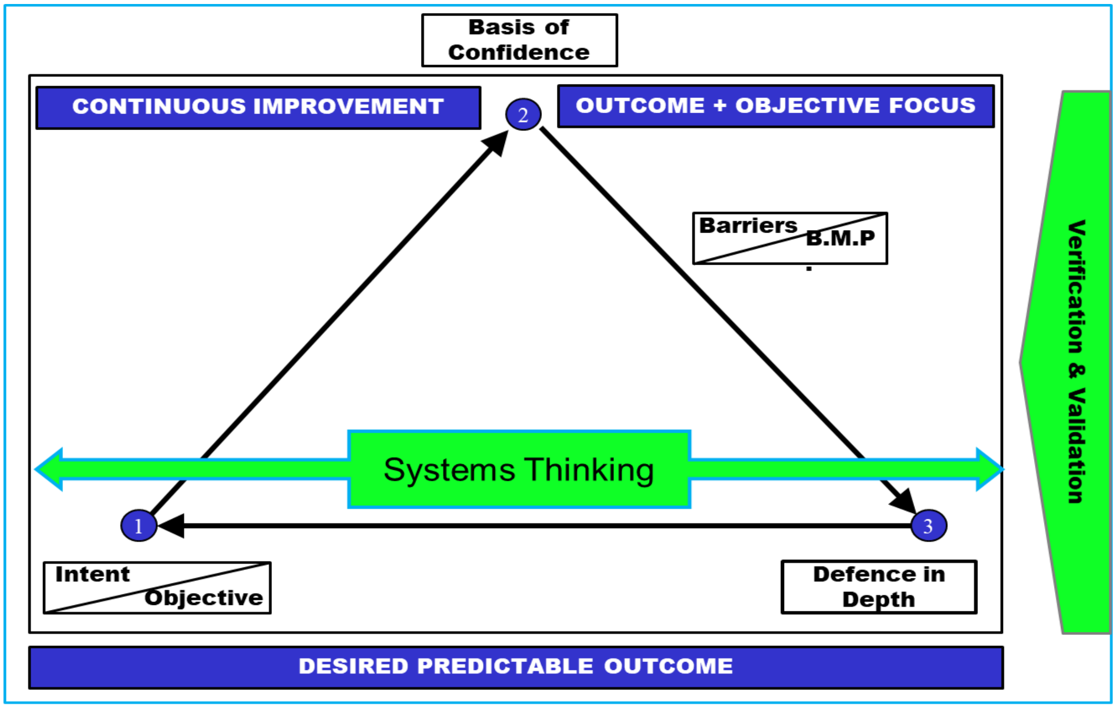

Figure 2 3 Pegs Thinking

1.2 EXPECTATIONS OF A DP SME

Reference is made to the definition of a DP SME in the DP ASSURANCE FRAMEWORK document published by OCIMF. Section 2 of the above document addresses the experience, qualification and competence of DP Personnel and Section 2,1 focuses on shore-based DP Personnel and DP assurance Practitioners.

The document identifies DP as a complex discipline that requires experts across a broad range of technical, operational and industrial mission specific areas. This usually takes the form of a multi-disciplinary team.

It is expected that personnel discharging the role of a DP SME will be supported, either by multidisciplinary teams, or have access to suitable skilled resources (internal or external to the organization)[1]

Amongst the diverse skills required, a DP SME is expected to have is the ability to:

- Interpret requirements accurately and measure them against a performance standard.
- Objectively evaluate proposals or offer alternate solutions and risk mitigations to resolve DP-related issues[2].
- Assist in resolving dilemmas.

Note[1,2]: This is also addressed in Appendix 1 Part 2 of the TECHOP ODP 16 (P) (Section 1.4).

Note: *This addendum TECHOP is not a comprehensive tome on the topics addressed. It provides a high-level overview of the issues that have been experienced in these areas and is intended to draw the DP SME's attention to the potential outcomes. It is expected that* *the DP SME will consult with relevant subject matter experts / skilled resources and leverage them as appropriate to aid delivery of predictable incident free DP operations.*

Integrated thinking[3] and Comprehension Aided Compliance have been identified as foundation elements of DP SME Competency.

The DP SME should recognize the above and be aware that the risk owner, who has overarching accountability for delivery of the Industrial mission, has to manage a multitude of risks of which station keeping risk is only one.

The DP SME should unambiguously identify who the ultimate overarching risk owner is.

It is expected that the DP SME would be able to ask the right questions of the range of relevant stakeholders in their respective areas of accountability / expertise, on matters pertinent to the delivery of predictable incident free DP Operations (incorporating a holistic approach addressing Design, Operations, People and Process)

DP SMEs can demonstrate competence in Integrated Thinking and Comprehension Aided Compliance by:

- Supplementing compliance with an outcome and objective focus (delivery of predictable incident free DP Operations). The limitations of compliance to achieve the desired outcome and the additional verification and validation to mitigate the gaps in compliance focused processes should be understood.
- Risk Awareness, hierarchy of risk control measures based on effectiveness.
- Pragmatic and effective Risk Management (Barrier Philosophy, Basis of confidence, Defense in Depth and importance of effective verification and validation)
- Development of compensating provisions (risk mitigations)

Note³: The term Integrated Thinking which includes elements of systems engineering was adapted in this TECHOP to differentiate it from the practise of engineering management in complex systems to which it is also applied.

1.3 INTEGRATED THINKING AND COMPREHENSION AIDED COMPLIANCE

The terms 'Integrated Thinking' and 'Comprehension Aided Compliance' have been embedded in the vocabulary developed by the MTS DP TECHNICAL COMMITTEE.

Integrated thinking is reflected in the iconography and vocabulary developed to effectively communicate focus on the essential elements that contribute to the delivery of predictable incident free DP operations. Vocabulary embedded in the iconography includes:

- Predictability
- Three Pegs thinking (Intent and Objective: Basis of Confidence: Defense in Depth)
- Effective Verification and Validation
- Barriers and Barrier Management Philosophy
- Design, Operations, People and Process

The term 'Integrated Thinking' is intended to emphasize the need to develop an objective and outcome focused approach which requires a holistic view of all elements contributing to achieving predictable outcomes.

Integrated thinking addresses:

- Systems and subsystems (all relevant parts that make up the whole)
- Interfaces, Influences and Dependencies ('Physical & Logical', 'Visible' and 'Not Readily Visible' or 'Apparent')

- Comprehensive Risk Picture (Process Safety Risk, Personnel Safety, Asset Damage, Technical Risks, Non-technical Risks (Commercial Exposure-Non-Productive Time (NPT)
- Stakeholder management as relevant to DP operations,
- Comprehension Aided Compliance,
- Basis of compromise and essential compensating provisions (mitigations)

Definition / explanation of the vocabulary used can be referenced in the MTS DP Design Philosophy document (2019) and in some cases within this document.

Integrated thinking and comprehension-based compliance is key competence for DP SMEs and are enablers to developing skills essential to resolve dilemmas.

This addendum document includes examples and scenarios from experience to promulgate Integrated Thinking skills and Comprehension Aided Compliance.

1.4 DILEMMAS AND THEIR RESOLUTION

The skills of a DP SME are evaluated in the 'field' and often measured by their ability to assist in resolution of dilemmas.

The commonly observed root cause for most dilemmas is the tension between productivity objectives (business objectives e.g. cost, schedule, quality) and achieving predictable safe operations (attempts to achieve this objective are usually through enforcement of compliance with codes / standards / practices and end user charterer requirements).

The DP SME should be aware that it is usually the business (the entity that is executing the industrial mission or on whose behalf an industrial mission is being executed) that owns the risk. That should not be construed as a license for the DP SME to abdicate responsibility to assist the business in the pragmatic management of risks. It is incumbent upon the DP SME to assist the business with developing compensating provisions[4] / mitigations This addendum document includes examples and scenarios from experiences to promulgate Integrated Thinking Skills and comprehension aided compliance.

Note[4]: Compensating Provisions / mitigations are discussed in IEC 60812 and DNV GL RP D-102 and in the MTS DP DESIGN PHILOSOPHY document.

Pragmatic and effective risk management relies on the efficacy of the compensating provisions which in turn rely on a good understanding of:

- Consequences of a loss of position.
- Impacts and Influences on the Industrial Mission.
- Objective Categorization of Risks.
- Risk Trade-Offs.
- Risk Normalization[5], Confirmation Bias, Incrementalism.
- Barriers and Barriers Management philosophy.

Note[5]: The meaning of the terms Risk Normalization, Confirmation Bias and Incrementalism (in the context used in this document) are as follows:

- **RISK NORMALIZATION**: The gradual process through which risky / dangerous practice or conditions become acceptable over time. e.g. one-time exemptions given because of special circumstances should not become the norm when those special circumstances do not exist.
- **CONFIRMATION BIAS:** Give more credence to information that supports what we already believe or validates prior decisions. Skip over info that calls into question what we have determined to be true vs. considering contrarian

views. For e.g. Undue trust on control system data to the exclusion of real world indicators.

- **INCREMENTALISM:** Organizational and operational adaptation around goal conflicts / dilemmas producing small, stepwise normalization. Every step seems only a small rationalization / deviation from previously accepted norm. e.g. Slow dilution of standards over a long period of time such that the overall increase in the risk profile of the activity is not immediately apparent.

(Term introduced by Sidney Dekker)

Hazards and Effects Management Process (HEMP) is at the heart of HSE Management Systems. HEMP is a risk management process which strives to ensure that hazards / risks to workforce / equipment / assets and environment are properly controlled.

HEMP has four elements:

1. Hazard Identification – What Hazards are present?
2. Risk Assessment – Can the hazards be eliminated or minimized
3. Risk Control – How are the hazards and their risks managed? What are the controls and barriers and how effectove are they?
4. Recovery – When a hazardous even does occur, what are the recovery measures in place? How can the consequences by mitigated or minimized?

Note: HEMP is not to be confused with Risk Assessments. HEMP is a process in which risk assessment is one tool amongst other tools such as HAZID, HAZOP, JSA (Job Safety Analysis) etc.

CAUTIONARY NOTES:

1. Risk assessments should be realistic and credible vulnerabilities should be addressed - not dismissed.
2. Effort should be expended in verifying and validating systems are safe and not solely focused on elaborate dissertations on why they are considered to be safe.
3. The dangers of Risk Normalization, Confirmation Bias and Incrementalism should be understood and guarded against.
4. Outcomes of incidents are often classified as high consequence but low probability. without an implicit demonstration of understanding that such incidents are low probability only if the systems have been designed well and operated within their design parameters. Low frequency should not be equated with low probability. It is not reasonable to assume that so called low frequency events are also of low probablity. TO confirm this, it is necessary to check that the circumstances and barriers which ensure the event is unlikely to occur are present in the case under consideration.

- There are different strategies involved in developing compensating provisions. They can all be tied to the 3 R's as applied to DP - Redundancy, Reliability and Resilience.
- Control measures and their hierarchy based on effectiveness (Removing the hazard, Replacing the hazard, Isolate exposure from the hazard, Procedural Controls (Train People and Explain Procedures e.g. project specific simulator training), Protect the worker (PPE).
- Minimizing duration of exposure (Time to Initiate, Point of No Return)
- Ability to respond to prevent escalation (example -e.g. Positioning Standby)

- Enhanced Verification and Validation to establish a basis of confidence.

1.5 CONSEQUENCES OF A LOSS OF POSITION

The codes / standards, practices and requirements applicable to DP strive to prevent the potential for a loss of position. Dilemmas present themselves when productivity drivers' conflict with enforcement of compliance with these requirements. They may also occur when compliance introduces more risks than it resolves or when the intent of the requirements not applicable for the type of operation and / or vessel

Deviations from the compliance requirements should not be attempted for the following:

- STATUTORY REQUIREMENTS
- REQUIREMENTS INTENDED TO MITIGATE AGAINST:

  a. Process safety exposure

  b. Compromising personnel safety

  c. Asset damage

Alternate compliance methods may be considered provided they:

- DELIVER THE INTENT OF THE ORIGINAL REQUIREMENT (VALIDATION TO BE DEMONSTRATED AND DOCUMENTED)
- APPROVAL ON SUITABILITY AND ACCEPTABILITY FROM THE APPROPRIATE ACCOUNTABLE AUTHORITIES.

Deviations may be considered from compliance requirements provided they are:

- NOT PROSCRIBED BY ITEMS LISTED ABOVE IN 1.5.2
- CONSEQUENCE OF LOSS OF POSITION HAS BEEN DEEMED ACCEPTABLE BY THE RISK OWNER BASED ON AN UNAMBIGUOUS APPRECIATION OF THE CONSEQUENCES, POTENTIAL FOR THE TRIGGERING EVENT AND EXPECTED OUTCOMES SHOULD THE TRIGGERING EVENT MANIFEST ITSELF (VALIDATION ACTIVITIES TO BE DOCUMENTED TO PROVIDE A BASIS FOR THE DECISIONS).
- TYPICALLY, EXAMPLES OF ACCEPTABLE CONSEQUENCES ARE:
  - NON-PRODUCTIVE TIME
  - ACCEPTABLE[6] EQUIPMENT DAMAGE AND CREDIBLE RESPONSE AND RECOVERY MEASURES ARE IN PLACE.

Note[6] *Similar consequences can be experienced for events unrelated to Station Keeping.*

1.6 COMPENSATING PROVISIONS

DP incident investigations have revealed the following to be causal and contributory factors of incidents.

- Design
- Operations
- People
- Process

The analysis of DP incidents over a 10-year period (IMCA Study conducted for DeepStar) concluded that the causes of DP incidents had the following distribution:

• Vessels operating outside of post failure DP capability	9%
• Incidents attributed to power and propulsion related issues	32%
• Incidents attributed to position references and sensors*	38%
• Incidents attribute to operator error	21%

Note*: *(and handling of same by control systems (DPCS, PMS & VMS))*

The above information has been used to develop compensating provisions.

Focus areas in decisions support tools such as Activity Specific Operating Guidelines (ASOG) have also been derived from the above information.

1.7 EXAMPLES OF ADDRESSING DILEMMAS THROUGH COMPREHENSION AIDED COMPLIANCE AND COMPENSATING PROVISIONS

1.7.1 EXAMPLE - DESIGN:

The ability to influence or address vulnerabilities by design changes is limited especially when a vessel in service is being deployed to undertake an industrial mission. It is not unusual for a class approval certificate to be presented as evidence of compliance and therefore reason to ignore or diminish the significance of the identified vulnerabilities. (example - fault propagation paths created by unprotected cross connections spanning redundant DP equipment groups).

There has been an enhanced focus on cross connections across DP redundant groups and their potential to serve as fault propagation pathways leading to failure effects that exceed the worst-case failure design intent. DP system FMEAs may not be comprehensive and vulnerabilities due to cross connections go undetected until a failure manifests itself (DP incident reports reveal that this occurs within the industry)

Such cross connections are usually introduced into control power systems as a means of providing a secondary power source with the well-intentioned but misguided notion of providing continuity of power supply. This is often accompanied by a lack of recognition that this secondary power source could be derived from within the same redundancy group and avoid the potential for fault propagation.

1.7.2 RESOLUTION:

The seven pillars concept and three pegs thinking are used to identify and communicate the issue. Pertinent Techops should be sent to the vessel Technical Operator and the ensuing dialog should raise the awareness of the consequences and the need to put in place mitigating measures. Such mitigating measures could be:

- Isolate[7] in line with the redundancy concept
- Prove fault ride-through capability by credible validation testing
- If analysis reveals that the cross connections are essential, then additional effort may need to be expended to identify consequences and implement effective mitigation measures to minimise the potential for a loss of position.

Note[7]: *Strategies that involve isolation should validate that the isolation does not result in unacceptable outcomes such as loss of functionality of protection and safety* systems or effects exceeding the worst-case failure design intent.

1.7.3 EXAMPLE - EXTERNAL INTERFACES WITH NON-DP RELATED EQUIPMENT

DP incidents have been recorded where interfaces with non-DP-related equipment have been identified as the triggering or causal factors. Examples include; automatic speed and latitude into gyros, automatic draught sensor inputs, doppler speed inputs into thruster controls.

1.7.4 RESOLUTION:

Automatic inputs which are not necessary for DP or interfaces which are not essential for DP should not be permitted. LFIs and technical notes should be shared with the vessel technical operator to enhance awareness. Where the objective cannot be achieved satisfactorily without an automated input / interface, they should be well designed, redundant, and have a predictable outcome after failure.

1.7.5 EXAMPLE - OPERATIONS:

Existing codes, standards and practices that have been invoked contractually may not address the specific nuances of the industrial mission that the vessel is undertaking. The vessel may not be equipped with the modes and features required to be able to achieve predictable incident free DP operations. In such cases, compensating provisions may take the form of procedural barriers – codified and embedded in the decision support tool. It is recognised that procedural barriers rely heavily on human factors and the ability to adhere to the defined procedures, due cognisance should be developed of the above and effective processes established to enhance 'defense in depth' of such barriers.

A thematic approach has been used to summarise operational focused mitigations. the following themes have been developed:

Uncompensated forces

Uncompensated forces will destabilise the DP model resulting in unpredictable behaviour with significant consequences. Examples of such consequences are:

- Dropped risers due to failure of transfer rigging when subjected to side loads.
- Loss of position combined with ineffective towline catenary management resulting in towline snagging subsea architecture ultimately breaking the gas export line.
- Loss of position resulting in collision with floating production facility

1.7.6 RESOLUTION

1. Functionality[8] has been developed within DP control systems to cope with the effects of such uncompensated forces. One of the terms that is used to develop such functionality is 'external force compensation'.

Implementation of such functionality will require engagement with the technical personnel of the OEM of the DP control system and vessel technical operator. It will be essential to ensure that visibility is provided into the industrial mission application in order to enable development of the appropriate functionality.

It should be recognised that deployment of such functionality will have to be accompanied by appropriate verification and validation activities including testing. Operator manuals will need to be amended to reflect the new functionality. The burden of providing effective training and familiarisation to the vessel operational teams should not be underestimated. Timely recognition of the need for this functionality (and acting on it) is essential.

Note[8]: It should be recognised that there is wide variability in experience levels of OEMs of DP control systems in the ability to develop and implement such functionality. This may impact the lead times required to develop implement, verify and validate such functionality.

2. An alternate mitigation will need to be implemented in situations where it is not feasible to develop and implement functionality to effectively address uncompensated forces. The alternate mitigations are:

- Constraints in position and or heading changes.
- Constraints on the manner in which changes are executed.

It should be recognised that these are procedural barriers. Strict adherence to procedures is essential for such procedural mitigations to be successful. No deviations are to be permitted without subjecting them to an effective MOC process. The temptation to rationalise decisions to deviate and retain control of such decisions at the field execution level is to be avoided. Productivity pressures should be recognised, and risk is not to be normalised to acquiesce to such pressures.

3. Heading and position changes should be avoided if feasible. Unavoidable heading and position changes should be carried out in small increments and with adequate waiting time to enable the model to stabilise between increments. The magnitude of the increments, and the waiting time, are driven by the magnitude of the uncompensated forces. Experience has shown that heading and position changes should not exceed increments of 2 to 4 degrees or 2 to 4 metres respectively. The waiting time between increments, to allow the model to stabilise, should be no less than 10 to 15 minutes. Response characteristics of the vessel (example - deviation from setpoint footprint) should be closely monitored. Wide variations should trigger an immediate cessation of the heading change to allow the model to stabilise.

A similar strategy is to be implemented for position changes with position change increments not to exceed 2 to 4 metres and waiting times of 10 to 15 minutes between increments.

4. Functionality that is developed for external force compensation, by the OEM, typically has more than one means of inputting compensating forces. It is not uncommon for such functionality to have the provision for sensor-based inputs. If automated interfaces are needed, they should be well designed, not compromise the redundancy concept and fail safe predictably. It is imperative that any such functionality should also have the means to allow manual inputs even though they might create an opportunity for operator intervention risk. Automatic inputs[9] into the DP control systems from sensors should not be permitted. Input values should be derived from analytical work (example - lay-tables). Sensor data should only be used as a monitoring function.

Note[9]: Default Position - Automatic inputs from such sensors should not be permitted as erroneous data output from sensors into DP control systems has resulted in loss of position incidents with significant consequences. Such systems are rarely subjected to a well-documented system engineering approach (e.g. comprehensive FMEAs and validation testing, including verification and validation testing for both benign and aggressive failure modes).

5. Potential for unpredictable station keeping performance due to uncompensated forces while undertaking operations should be recognized documented and mitigated against. If installation methodology involves heading changes, additional analytical studies may be warranted, and this may require specialist support (engineering and OEM of DP Control systems including physics-based simulation capability). Controlling criteria and parameters established from such studies should be strictly adhered to (rate of turn, small step changes with stops between changes to stabilize model etc.)
6. Any heading and or position changes while undertaking operations susceptible to uncompensated forces on a DP vessel could result in unpredictable station keeping performance. Additional precautions are essential, and this may impact productivity objectives due to waiting times between heading / position changes if warranted. This should be recognized and supported by all stakeholders involved in the activity,

7. Examples of Industrial missions where such external forces may be experienced are as follows:
   - Riser/Umbilical[10] pull-ins
   - Mooring line operations (Anchor Handling Operation)
   - Positioning of Floating Production Facilities during Installation
   - Lifting Operations where “Heavy Lift Mode[11] Phenomenon” may be experienced

Note[10:] The horizontal component of forces during umbilical pull-ins are typically much lower than that of risers. Incident free umbilical pull-ins have been accomplished on DP vessels without external force compensation functionality but with strict adherence to criteria imposed on rate of turn of heading changes, increment steps of heading changes and time between heading changes.

Note[11:] Heavy Lift Mode Phenomenon is discussed in the section on Novel Operations.

1.7.7 RISER / UMBILICAL INSTALLATION: -

Riser / umbilical installation operations with DP vessels result in operations with close proximity to surface assets. Such operations have the potential to result in horizontal forces that could potentially destabilize the DP model and result in unpredictable station keeping performance (if not compensated for effectively). Such unpredictable behaviour is more likely to manifest itself when heading and or position changes are undertaken.

Such installation operations can be undertaken either by ‘laying in’ or ‘laying away’. The choice of method is influenced by a number of factors including performance characteristics / limitation of industrial mission equipment (such as tensioner / winch capacity) as well as vessel propulsion characteristics (e.g. Bollard-pull etc).

It was not uncommon for ‘laying in’ to be the preferred method on the basis of a belief that should a station keeping event be experienced, the ‘tension’ of the product being installed would pull the vessel ‘away’ from the surface facility. This usually resulted in the requirement for vessels with higher capacity equipment (industrial mission and station-keeping, especially in deeper water).

Loss of position events have been experienced in industry during such laying-in’ operations and some of them have been with consequences. Such loss of position events have occurred, usually during rapid heading changes (rate of turn and large increments of heading), and mostly on vessels without the external force compensation functionality[12].

‘Lay Away’ operations are not precluded or proscribed. Similar precautions must be taken irrespective of whether a ‘lay in’ or ‘lay away’ methodology is used.

Note[12:] This is not meant to imply that vessels with this functionality are immune to unpredictable DP station keeping performance. Loss of position events have been experienced when the established criteria for rate-of-turn or stops between turns have not been adhered. In some instances, instability was compounded by unverified / unvalidated external force inputs.

1.7.8 MOORING LINE INSTALLATION / ANCHOR HANDLING OPERATIONS

Similar uncompensated forces as described above during riser installations can be experienced during installation of mooring lines or operations involving anchor handling. Unpredictable station keeping performance can be an outcome of such uncompensated forces.

Such operations should not be undertaken in Auto DP[13] (Three-axes auto DP- surge, sway and yaw). Two axes or single axis (usually yaw) is permissible.

Note[13:] Some DP Control System OEMs have developed functionality for anchor handling operations on DP. Such functionality should be subjected to failure modes and effects proving trials for both benign and more aggressive failure modes. Vessel specific training on functionality should be provided and documented. Training should include normal operations as well as response to abnormal conditions.

Positioning of Floating Production Facilities during Installation

It is not uncommon to see DP capability on vessels providing support functions in the offshore industry including towing vessels. Such towing vessels are typically used to tow floating production facilities from construction / readiness sites to locations on the fields they are expected to produce from. Occasionally these vessels are used to provide station keeping for the floating production facility while they are being moored up with the permanent mooring system. (anchors and moorings or tendons as examples)

Such station keeping can be accomplished by conventional vessels without DP capability. It is not unusual for projects to have a desire to leverage DP capability on these vessels if it is installed. Three axes auto DP should not be used on vessels providing such station keeping functionality unless all modes and features required to address uncompensated forces have been installed and validated through testing including FMEA verification and validation testing. Proposed station keeping configurations for the support vessels should be on the basis of a comprehensive engineering analysis and the results of the analysis should be operationalized effectively and alignment achieved by all stakeholders / vessels involved in the activity.

Working within anchor patterns and areas with crowded subsea architecture

Safety Zone Management (500m safety zone) around surface facilities and additional precautions for entry into such safety zones is a well-established practice. Similar caution is to be exercised when working within anchor patterns and in areas where there is critical subsea architecture or where the elevation of subsea architecture can create snag hazards. This is especially true when vessel moves are being contemplated with down lines in the water. (e.g. crane wires, ROV's (deployment lines tethers / umbilicals etc.), catenary of tow lines to assist heading control etc.)

The potential for dropped objects appears to get a strong focus and mitigating measures are adhered-to / enforced by ensuring that over boarding and retrieval is done at some offset distance. Vessel moves are managed diligently especially during installation operations. However, incidents experienced in industry reveals that the same diligence is not exercised when moves (position or heading) are made within anchor patterns with down lines especially after installation operations. Damage to assets in the water column have been experienced as a result.

It is essential that the risks of making vessel moves with downlines are well understood and communicated to all parties (Construction personnel, DPOs ROV teams and surveyors). Moves with downlines in water column where obstacles can be experienced should be avoided whenever possible. If unavoidable, compensating provisions should be in place and adhered to. Prior to making moves with down lines positive confirmation is to be documented that the intended pathway:

- Is clear of obstacles in the water column.
- A small step move is made to confirm that vessel is moving along the intended pathway which is free of obstacles.
- Controls embedded in the ASOG / Decision Support Tool (DST) are to be adhered to.

Vessel engaged in heading control operations with towlines and vessels engaged in towing activities should exercise robust Catenary Management when working within areas as described above.

HEMP practices, JSAs, Toolbox talks / DST etc. should specifically address and document these risks along with compensating provisions.

1.8 NOVEL OPERATIONS

The term 'Novel' as used in this document refers to operations that have specific nuances which require to be addressed from a DP station keeping perspective. There are subtleties, which, if not acknowledged effectively, would result in unpredictable outcomes including loss of control / loss of position.

1.8.1 ENHANCED FOLLOW TARGET MODE

Relative positioning of floating structures and moving objects by DP vessels have been undertaken for many years. Functionality such as Follow Target Mode and ROV follow have been developed and implemented on Industrial Missions.

FPSOs (Including FLNGs) are increasingly being used as the choice for field development. Some of these floating facilities are designed to weathervane, often with a mooring system forward of midships or at the bow, and in some cases, extending beyond the bow (example - external turrets). These floating structures are often ship-shaped and the length-over-all can be several hundred metres.

Relative positioning (DP) off such structures can be challenging. A small heading deviation in yaw can translate into several metres offset at the stern of the such structures where another vessel is trying to maintain a relative position. (Crane operations, bunkering operations, gangway connected operations etc.) Special functionality has been developed by different OEMs of DP Control Systems. Industrial missions requiring relative positioning in such conditions should take into account that vessels of opportunity may not be outfitted with the necessary sensors and functionality. In some instances, field specific conditions and analytical / modelling work (example - multi body motions) may be required to aid development of functionality specific to the Industrial Mission Requirements. The following are some of the factors to be considered:

- Adequate time for upfront planning.
- Early identification and engagement with speciality vendors / OEM (example - modelling facilities).
- Interface management between project teams, VTO and OEM.
- Potential for additional sensors to be fitted on the floating structure.
- Development of project specific procedures and updates of manuals.
- Additional verification and validation testing.
- Bespoke Training Requirements for Crew (Project Specific Simulator Training)
- Additional Decision Support Tools.

1.8.2 HEAVY LIFT MODE

Heavy Lift Mode phenomenon is the term used to describe the instability experienced when the cranes from the DP Vessel are used to set-down lifts (example - top sides on production facilities, modules etc). Usually, installation tolerances for such lifts are tight and setting guides are used to control / guide the lift. Instability has been experienced when the load being lifted makes contact with the setting guides and movement is restrained. When such restraint is experienced, the load acts as an anchor and the DP vessel experiences uncompensated forces leading to instability in station keeping.

Heavy Lift Phenomenon is often mistakenly construed as a phenomenon that only manifests itself when the loads being lifted are high. It should be recognized that the instability is caused by the 'stiffness' imparted on the vessel due to the restraining effect of the guides and this stiffness is expressed a tonnes / metre. Empirical observations have concluded that the typical stiffness in the DPCS gains (surge and sway) are in the range of 3.5 to 4 tonnes / metre. The potentially for such instability should be anticipated if the stiffness of the load (when constrained) is likely to be around these values or exceed them. An empirical method to estimate the stiffness is to consider the load as a pendulum with the length of the pendulum being measured from the crane tip to the point where the load first makes contact with the setting guides. The weight of the load divided by the length of the pendulum provides an estimate of the potential stiffness. If the result approaches or exceeds 3.5~4 tonnes / metre the potential for the manifestation of the heavy lift phenomenon should be acknowledged and addressed. It can be seen from the above that this phenomenon can manifest itself even if the loads are not heavy, but the length of the pendulum is small, and the resultant exceeds the inherent stiffness of the DPCS.

This phenomenon manifests itself as a position excursion. When the DPCS tries to correct for such excursions, instability develops causing ever-increasing position excursions. Lifting equipment has been subjected to side loading due to such excursion which has exceeded the design parameters. Lifting / Equipment/ Rigging has failed with significant damage as a consequence.

Industry has recognized this phenomenon and papers have been published which are available in the public domain, including the MTS DP Committee web site. Some OEMs have developed special functionality with the DPCS to address this phenomenon. (example - Heavy Lift Mode)

It is emphasized that implementation and use of such functionality should be supplemented by the appropriate level of analytical work, verification and validation, updates in manuals and procedures and bespoke training. Early identification and engagement with specialist resources / vendors is key.

1.8.3 WELL INTERVENTION OPERATION

DP vessels are often used as a foundation or platform to carry out well intervention operations. There is a wide range in the types of vessels that are used to undertake these operations. The range of vessels spans the spectrum of vessels including:

- Vessels purpose built and designed to undertake such operations.
- Packages installed on the back deck of a supply boat.
- Multipurpose support vessels (in the middle of the mix).

The risk profile of such intervention varies based on whether the intervention results in potential exposure to damage above the interface with the wellhead or with activities that are undertaken below the mudline. Dual barrier philosophy should be adhered to.

Well intervention operations include both diver and diverless operations. Diving operations are covered separately in this document. Diverless operations usually involves ROVs and cranes designed to undertake subsea operations along with bespoke equipment designed to interface with subsea architecture.

Areas that need attention are:

- Position reference sensors, Acoustics PRS limitations[14], Impacts of downlines and objects in the water column.
- Weak link in rigging, locking procedures, connected operations (Crane, ROV), potential for loss of position during connected operations and consequences.

- Red watch-circles, Disconnect Criteria (example - time to effect emergency disconnect, sequences of activities, notification protocols upon change in status).
- Decision support tools (ASOG / WSOG)
- Training and Familiarization of Vessel Management Team (especially when vessels-of-opportunity are being used).
- Interface Management, Roles and Responsibilities of Industrial Mission Personnel and Vessel Management Team.
- Masters Accountability and Authority.

Note[14:] Questions around acoustics position reference sensors usually come up in such operations. Some such questions are:

- Water depth impacts and requirements for LBL when water depth is > 700 m
  - It is recognized that imposing the requirements for LBL may have commercial consequences. The risk profile and exposure should determine whether or not it would be prudent to refrain from imposing this requirement
  - The potential to use Inertially Aided Acoustics should be considered.
- Number of transponders to be deployed on the seabed etc.
  - The default recommendation is for two seabed transponders to be deployed.
    - Diving operations should resist the temptation to deviate from this requirement.
    - Two seabed deployed transponders should be the minimum for well intervention operations below the mudline:
      - Rationale for deviations if any should be documented.
      - The transponder on the ROV and ability to set the ROV on the seabed and use the transponder for positions has been used in lieu of the second seabed transponder for operation above the mud line.
      - In all cases, performance of acoustics in the intended water depth and area of operations should be validated.

1.8.4 GANGWAY OPERATIONS

DP Vessels equipped with Gangways are increasingly being used in offshore activities for a multitude of reasons. These vessels are interfacing with a wide range of offshore assets. (examples - Fixed, Floating, Spread-moored, Turret-moored, Ship-shaped, Column-stabilized, Spars, Circular bodies). Coupled body motions are widely variable and influenced by the:

- Shape and motion characteristics of the supported facility,
- Metocean conditions,
- Positioning and orientation of the DP vessel with the gangway when interfacing with the facility being supported,
- Position and orientation of the gangway on the DP vessel.
- Motion compensating characteristics of the gangway (passive, three-axes, six-axes etc.)

The vessel with the gangway may be connected to the facility for long periods of time or may only enter the 500m zone to provide gangway access during shift change. The above factors combined with the inherent capacities of the DP Vessel (intact and post failure) have significant influence on the uptime and gangway connected availability.

Planning for gangway operations needs to consider all the above factors. A systems thinking / integrated thinking approach is essential to achieve the desired outcomes. Assurance processes should take into account the diverse stakeholders who can influence the outcomes, it is essential that a common understanding and alignment of the objectives is fostered by relevant stakeholders. The need to bridge multiple safety management systems and the effort required should not be underestimated. Contracting strategies could potentially play a significant role in the number of interfaces to be addressed / managed.

1.8.5 DIVING

Diving is a high-risk activity which warrants additional scrutiny. It should be recognized that there is wide variability in the way diving operations are managed. Requirements / Diving Standards (including statutory requirements) vary by region as well as by Lease Holders / Operators. Notwithstanding the above, the commonly referenced standards are IOGP, IMCA and ADCI. The referenced standards primarily address requirements for conducting and managing diving activities but do contain references to diving from DP vessels. DP SMEs should be aware of this referencing as it may introduce ambiguity / misalignment in the comprehension of requirements as it pertains to diving from DP vessels.

Learnings from incidents, safety flashes, incident reports etc abound in the public domain on DP station keeping related issues[15].

Note[15]: It is not intended to incorporate all the material available on this topic in the public domain into this addendum TECHOP. This TECHOP will address some of the more significant issues that have manifested themselves in recent years.

The examples described herein are from incidents that have occurred and have been used for illustration. It is emphasized that risk assessments should not be limited to only these examples. Risk assessments and compensating provision must be comprehensive.

Propulsion Configuration on DP vessels used as Dive Support Vessels

There are some DP 2 vessels configured with two tunnel thrusters in the bow and one tunnel thruster in the stern and two mechanically (shaft) driven main propellers (CPP's) and rudders.

The use of a vessel with a single stern thruster is often justified on the basis of:

- The stern thruster being switchable (from one redundant equipment group to the other).
- The ability to deliver transverse thrust using the propeller and rudder. on Categorisation based on propulsion (unwanted thrust).

There are significant weaknesses in the justifications offered above including:

- The ability to derive transverse thrust with the use of rudders and propellers is contingent upon the vessel heading into the environment (not always the case).
- Parasitic thrust in the surge direction will need to be addressed.
- Dynamic Capability analyses[16] have been carried out with vessels having such configurations. The analyses have revealed that vessels with such configurations are likely to lose position. The position excursions experienced exceed the thresholds set in place for blue and yellow triggers.

Note[16:] Papers have been published on such dynamic analysis and are available on the MTS DP Committee website.

Significant loss-of-position incidents have been experienced on DP vessels with the following configuration:

- Two bow tunnel thrusters.
- Two stern tunnel thrusters.
- Two mechanically driven (shaft) CPP main propellers.
- Shaft generators on the Main Propellers
- Thrust in the surge axis is developed only by the main propellers.
- Such propeller designs are usually optimized to maximize thrust in the ahead direction.
    - Full pitch in the stern direction thus tends to deliver reduced thrust when compared to the ahead direction.
    - Failure to full pitch ahead on one propeller with the other going to full astern is thus unlikely to prevent a loss of position.
    - Effects of such failure modes have resulted in significant position excursions in relatively short time (71 metres in 74 seconds)
- Reliance on timely operator intervention is not a credible mitigation.
- Vessels with such configurations have been categorized in a pertinent LFI as a ‘Type 1’ vessel.
- Learnings from such incidents have caused some operators to preclude such ‘Type 1’ vessels from undertaking confined space diving activities if they are not fitted with an independent protective function to address loss of position due to failure to full thrust.

Connection to subsea structures with cranes and divers working in proximity or underneath them (example - pipelines)

Cranes are used to aid diving operations. Dropped-object risks are identified, and steps are in place to mitigate against such risks.

There have been instances where divers have been required to work under subsea architecture (example - pipelines). Operations procedures had been developed where there was an intent to lift the pipelines using the crane on the DP DSV. The potential for a loss of position on a DP vessel and the consequences of having a crane connected to the pipeline with divers working underneath was not taken into account. Significant incidents and near misses have occurred, including fatalities. Lift bags (independent of the vessel) should be used to lift pipelines if it becomes necessary for such operations.

Umbilical and Tag Line Management

Umbilical management is crucial to diver safety when diving from a DP vessel. Poor umbilical management has resulted in diver fatality. There are documented events of divers being drawn into thrusters as well as umbilicals being severed when they were drawn into thrusters.

Processes should be in place, and assured by the accountable parties, that the umbilical management plan for both the primary and rescue diver has been verified to be accurate. The requirement for the rescue diver to have additional umbilical length should not result in compromising the safety barriers for the thrusters.

Tag line management should be an area of focus. The potential for tag lines to drawn into thrusters when they are being lowered or brought to the surface should be considered. It may become necessary to turn off the thruster in proximity to such lines. This could have the potential to compromise post failure capability. When tag lines are being lowered, or being brought up, the potential for them to be drawn into thrusters should be evaluated.

Drift on and Drift Off Operations

There is a perception that Diving Operations can only be carried out with the DP vessel operating in a drift-off condition. There is nothing to preclude carrying out DP diving operations in a drift-on condition if necessary, unless, there is an identified vulnerability in the DP System which could lead to a failure that exceeds the worst-case failure design intent and this failure cannot be mitigated. Even in such cases, all attempts must be made to ensure that the vulnerability is addressed with the appropriate effective compensating provisions prior to conducting diving operations.

Compensating provision should be developed, implemented and validated including training drills and exercises if it becomes necessary to dive with a vulnerability that cannot be mitigated. Restricting diving to a drift-off position alone may not be adequate. In all cases the risks should be documented and made visible to the risk owner and sign-off must be obtained from the accountable party. Risk normalization should be guarded against.

It is good practice to position the vessel in a drift-off position whenever possible, as an additional barrier. Usually a barrier against the unknown-unknowns.

1.8.5.1 SUPPLEMENTING CODES STANDARDS AND PRACTICES (IOGP / IMCA / ADCI)

The DP community has developed tools (Gap Analysis Tools (DP FMEA, Proving Trials, Annual Trials, Decision Support Tools (ASOG / WSOG)) and guidance. (Guidance documents on Design, Operations, People, TechOps (including this TechOp))

Efforts must be undertaken to familiarize the Diving Community with the above tools and guidance which is needed to supplement the Codes and Standards used by the Diving Community to aid delivery of predictable, incident free, DP Diving Operations.

1.8.6 WELL OPERATIONS

There are a number of interfaces between DP Operations and Well Operations which requires a DPSME to develop an awareness of Well Operations and have access to Deep Technical and Operational Expertise resources in Riser Analysis, Metocean, Geotech, Well Control, Drilling and Completions.

The Decision Support Tool for managing DP station keeping in well operations is called the Well Specific Operating Guidelines (WSOG). Key interfaces with well operations are codified within the WSOG. Care should be taken to ensure that only the relevant information is embedded, acknowledging that detailed information will be resident in other documents. The WSOG should only contain pertinent information relevant to the interfaces which trigger notifications-actions between the personnel accountable for DP operations and Well operations.

There are a number of disciplines involved in the planning and execution of Well Operations. It is essential to have input and reviews from the appropriate technical experts in the respective fields.

The potential for Non Productive Time (NPT) to be influenced by Red Watch Circles (RWC) should be acknowledged and made visible to the diverse stakeholders. It should be recognized that decisions will be driven by weather forecasts and the nature of the operations being contemplated. Quality of the weather forecasts and confidence in them will play a significant role in the management of NPT.

It is not unusual to have discussion about the required response to a Yellow on a DP MODU. It is essential that, at a minimum, the driller spaces out (clears non-shearables away from the shear ram) and hangs off and prepare to execute an EDS. There is discussion on whether it is necessary to displace the riser at this time. This is a discussion that is required to have alignment between the Vessel Management Team (VMT) and the Lease Operator.

- Release of mud from the riser, due to an EDS, is usually a reportable event.
- It should be recognized that the fluid in the riser serves as one of the two barriers.
- The nature and / or expected duration of an event that triggers a yellow, may create a requirement for additional barriers in the well (e.g. packers etc)
- Circumstances permitting, the dual barrier philosophy is usually adhered to.

1.8.6.1 Riser Analysis and Watch Circles

A key input into the WSOG is the Red Watch Circle (RWC). The RWC is a circle that is drawn around the wellhead and depicts the maximum acceptable position excursion before the Emergency Disconnect Sequence (EDS) is initiated. The intent of establishing the red watch circle is to ensure that integrity of the well foundation is not compromised due to a position excursion of the MODU that is connected to the wellhead. The riser analysis is used to establish the RWC.

It is not intended for this document to cover riser analysis[17] in detail. Discussion of riser analysis is focused on its role in establishing red watch circles.

Note[17]:

1. Companies may have specific philosophies/ strategies to develop and establish red watch circles.
2. The description that follows is a philosophy that has been adopted by several Drilling Contractors and Operators.

The riser analysis delivers information on a multitude of topics including the weak point analysis (also called “What Breaks First”). The weak point analysis is important as it is the governing factor that establishes the Point of Disconnect (POD). It is essential that the Lower Marine Riser Package (LMRP) is disconnected from the BOP before the POD is reached to avoid imparting loads on the wellhead foundation that could compromise its integrity. Strategies and tactics are developed to ensure that the LMRP is disconnected from the Blow Out Preventor (BOP) before the POD is reached in the event of a position excursion of the DP MODU.

Disconnection of the LMRP from the BOP requires a sequence of activities resulting the shearing of the tubular in the BOP and sealing of the well. The tubular is usually drill pipe or sometimes casing if the shear rams have been designed to shear it. Typically, this sequence is initiated through an automated function at the BOP control panel at the Drillers Shack on the drill floor. This functionality is called the Emergency Disconnect Sequence (EDS). Backup up control of the BOP is available in other locations on the vessel (e.g. The Navigation /DP Bridge)

The time to execute the EDS is variable and depends on the functions that need to be executed and the tubular that needs to be sheared. They are usually numbered and reflect:

- Sealing around an open hole and effecting a disconnect
- Shearing drill pipe and effecting a disconnect
- Shearing casing and effecting a disconnect.

Red Watch Circles are influenced by:

- The water depth
- Riser string make up
- Geotech characteristics

- Foundation design
- Metocean conditions
- Moon pool design
- EDS times

1.8.6.2 Metocean Conditions

RWCs are a product of time (to prepare and operate EDS) and vessel velocity. They are typically measured in metres. They are established for ‘drift off’ or ‘force off’ conditions but not ‘drive off’. Drift off and force off conditions result in position excursions and are influenced by the prevailing metocean conditions. The velocity of a drive off may be much greater and is to be addressed by converting a ‘drive off’ to a ‘drift off’ (drive off to drift of strategy). The default condition used for the analysis is One-Year return conditions (wind, wave height and current). A level of conservatism is consciously introduced by applying these forces in colinear condition.

Sometimes, the factors influencing the RWC result in position excursion limits that are considered to be unduly restrictive or ‘tight’. In such cases, it will become necessary to establish what would be considered as a credible RWC. Companies may have developed their own limiting RWC which they would consider as credible. In such instances it may become necessary to go through an iterative process by varying the metocean conditions in order to achieve credible watch circles.

This iterative process usually follows the sequence:

- One-year return conditions
- Seasonal Max (max values from hindcast data during which the mission is to be executed)
- Non-Exceedance factors (e.g. 98% NX, 95% NX, 90% NX etc.)
- Varying EDS Sequences (e.g. casing, drill pipe etc.)

1.8.6.3 Credible Red Watch Circles

Companies may establish what their minimum red watch circles are. It has been observed that circles with radii in the range 15 m to 21 m are typical of what has been accepted as a credible watch-circle by Drilling Contractors and Operators. It is acknowledged that these limits are derived empirically. Caution should be exercised before contemplating reducing watch circles below 15 m. The point of disconnect is calculated using the water depth and using the geometry of the riser amongst other things.

Some companies have developed watch-circle calculators (e.g. dynamic watch circle calculators) to help the operational teams with decision making. Such tools usually apply actual or forecasted conditions to establish red watch circles (collinearity is not assumed). It is believed that such an approach may reduce the inherent conservatism and could potentially increase operability. It should be recognized that if there is an intent to use such tools they should be verified and validated. The gains in operability envelope should not come at a cost of additional risk of compromising the integrity of the well foundation.

1.8.6.4 Yellow Watch Circles

Typically, yellow watch circles triggered by position excursions on DP vessels are set to 5 m or lower (subject to the industrial mission).

Operators of DP MODU’s have variability in how yellow watch circles are established. Some examples are as follows;

- Yellow watch circles are established as 50 % of RWC
- Yellow watch circles are established on the basis of 60 seconds decision time[18] and backed off from the RWC
- Arbitrarily established as 15 m

Note[18]:

1. When such decision time is used in the dynamic watch circle calculators, it is not unusual to find that the results show a zero yellow watch circle. Companies provide guidance on being able to reduce that number to 30 seconds or so following the appropriate risk assessments processes.
2. Typically, these times are imposed in order to clear personnel from their work areas (e.g. aloft/ moonpool). The objective of keeping personnel clear can be accomplished by the control of work processes triggered by increasing weather conditions if appropriate.
3. Some Operators (Oil Companies) adhere to the default 5 m yellow excursion limit. Response to a yellow on a DP MODU is to hang off and prepare to disconnect.

1.8.6.5 Heavy Weather Operations

Additional analysis will be required for DP MODUs undertaking operations in areas where heavy weather is encountered. Heave and impacts on the limits of the telescopic joint impose additional governing factors. Riser dynamics and vessel motions have the potential to put the riser string in compression. Industry has experienced failures of riser systems in such conditions both during connected operations as well as when the LMRP has been disconnected from the BOP.

Riser Analysis should specifically provide guidance on operations in such conditions and pertinent information should be disseminated as part of the project specific familiarization processes. Relevant information should be embedded in the WSOG.

1.8.6.6 Open Water Non-Connected (BOP) Operations

Open water operations when the BOP is not connected is usually taken for granted as a low risk activity. This may be true from the perspective of not being in the hydrocarbon zone. However, it should be recognized that when casing and cementing operations are being undertaken in these “top hole” sections there is no means to disconnect the drill string. Caution must be exercised, and administrative controls should be in place to manage the exposure (e.g. Positioning-Standby etc.)

1.8.6.7 Well Head Coordinates and Offsetting surface position from directly over the Well Head: -

Establishing the well head coordinates

Wellhead Target coordinates and installation tolerances are usually provided by the Lease Operator. It is essential that the datum for the coordinates provided is verified (Usually DP systems are set up with WGS84- Conversion may be essential if coordinates are provided with other datum) and this should align with the appointed Surveyor and or drilling datum used for well location in the RIG MOVE PLAN and sub surface planning documents.

The surface position of the MODU may need to be adjusted in order to ensure that the wellhead is established at the desired coordinates. Once the well head is established, the surface position of the well head must be ascertained (usually accomplished by positioning off a transponder mounted on the ROV and positioning the ROV at the well head) These coordinates then become the coordinates input into the DP system and used for station keeping.

Offsetting surface position and potential for reduction of distance to red watch circle.

Circumstances may manifest themselves where it becomes necessary to offset[19] the surface position of the MODU. Examples of such circumstances are: -

- Difficulty in getting tools through the BOP (effects of current on riser creating a bow)
- Desire to reduce the lower flex joint angle
- Well head at an inclination and desire to reduce the differential angle (to avoid “key seating”)

Note[19]: -

1. Offsetting the vessel deliberately to address examples as mentioned above should not be confused with position excursions.
2. Position excursion alarms limits are established around the set points while the red watch circles are referenced from the well head.
3. Offsetting the vessel may result in a reduction in the distance to the red watch circle and may compromise the criteria for credible red watch circles. Decision to offset must take this into account.
4. Vessel technical operator/ Lease operators may impose restrictions on maximum offsets permitted. Breaching of such limits may trigger a change in status in the WSOG.
5. Risk assessments conducted to evaluate /justify such offset operations should take above into consideration.

1.8.7 POSITION REFERENCE SENSORS (PRS)

DP Equipment Class notations drive minimum equipment requirements including Position Reference Systems (PRSs). What is not well known, or advertised, is that class rules are minimum compliance and do not consider operational or Industrial Mission (IM) requirements or even specify the type of PRS a DP vessel should have. Unless such operational or IM requirements are embedded through other mechanisms (example - invoking specific guidance or standards contractually) it is possible that selected vessels will not be equipped with the required equipment, modes or features.

Examples of common gaps in IM specific PRS requirements include:

- Redundancy in principle (three PRS principles for diving, two PRS principles for relative position keeping within 150 m of a surface facility)*.
- Acoustics suitable for the water depth (example, LBL for > 700m water depth or Inertially aided USBL acoustics).

- Redundancy in seabed deployed transponders for connected operations (2 for USBL, min 4 for LBL (Recommended 5)).

Note: Please refer to TECHOP_ODP_14_(D)_PRS & DPCS HANDLING OF PRS_Ver3-09201714*

When these gaps are not addressed, either due to a shortage of time, or unwillingness by the stakeholder(s), the DP SME will usually be called upon to either reinforce requirements or support deviations. A good understanding of the consequences of the loss of position and the compensating provisions that need to be in place is essential for a robust decision.

Understanding the consequence of the loss of position is important. Equally important is to understand if the same consequence could result from a non-station-keeping event. If they can, they may already have been accepted as a potential outcome. If this is the case, there is little to be gained from enforcing requirements. Any compensating provisions and recovery measures should be understood.

It would not be reasonable to enforce a requirement from a station keeping perspective to mitigate a consequence which has already been accepted and alternate compensating provisions or recovery measures are in place.

The following examples are used to illustrate the above statement.

- PSV with a single relative PRS involved in logistics function
  - Drift off condition imposed
  - Positioning Standby may be imposed
  - Snatch lifts may be permitted
  - Hose connected hydrocarbon transfer operations could be avoided. If essential to undertake such operations provision of breakaway coupling may be an acceptable compensating provision
- It should be acknowledged that some of the barriers are procedural barriers and they may not be as effective as barriers by design:
- Risk Normalization and the slide into Incrementalism should be avoided. The gap must be closed at first opportunity by the provision of the second relative PRS.
- USBL Acoustics in Deep Water Non-Connected Operations (outside 500 m zone and no obstructions in water column)
  - Consequence of LOP low.
  - Consider ROV transponder in lieu of seabed transponder
- USBL Acoustics in Deep Water Connected Operations (inside 500 m zone)
- Consider consequence of loss of position
- Supplement with usable relative PRS
- Consider transponder in bucket on an appurtenance (artificially ‘raise’ the seabed to address water depth limitation.
- USBL Acoustics in Deep Water Connected Operations (outside 500 m zone).
- Consider consequence of loss of position.
- Consider seabed transponders.
- Is the same outcome likely from a non-station-keeping related event and has the consequence been accepted? Is there a credible recovery plan if such a consequence can manifest itself?

1.9 PEOPLE

There is a perception in the Industry that the only personnel requiring DP awareness/ DP training are DPOs with credentials from certain accreditation bodies, as they are the ones that are responsible for DP Operations. This perception is invalid and needs to be addressed. There is a multitude of personnel from diverse disciplines and backgrounds that can influence the outcome of predictable DP operations other than the DPOs. Processes should be developed and put in place to ensure that there is this common understanding and alignment amongst the diverse stakeholders.

DPOs that have been through the Industry recognized accreditation process need to supplement their training competence and skills with industrial mission specific familiarization and / or training as required.

It should be acknowledged that the accreditation process for DPOs, as delivered today, by some of the accredited training institutions does not provide the level of detail on development and use of ASOGs. This gap should be closed by alternate means.

The MTS DP Committee TECHOP on Professional Development of DP Personnel (PDDP2) provides guidance on developing skills for all personnel involved in delivery of DP operations. In addition, personnel tasked with delivering operations where DP is used as a means of Station Keeping will benefit by participating in:

- ASOG / WSOG development engagement sessions
- ASOG / WSOG Roll Out Sessions
- Project Specific Simulator Training [19]Training[20] (When appropriate)

Note[20]:

Projects involving multiple DP vessels requiring to work in concert as well as DP Vessels undertaking complex operations and / or novel operations have leveraged Project Specific Simulator Training (PSST) to enhance delivery potential of their personnel. These PSSTs have been used to encourage and involve participation of the Industrial Mission personnel. These efforts have resulted in enhancing comprehension of all personnel and aided delivery of predictable outcomes.

Participation in ASOG/WSOG development and roll out engagement sessions have contributed to enhanced comprehension and driving alignment amongst all personnel.

1.10 PROCESS

The term ‘Process’ as utilized in this document is wide ranging and covers tangible (e.g. readily visible work processes) and intangible topics (e.g. soft skills). A DP SME’s effectiveness is enhanced by developing an understanding of these processes and skills in both areas.

1.10.1 STAKEHOLDER MANAGEMENT

A DP SME will be engaging with a multitude of internal and external stakeholders, with diverse expectations and varying authority and often competing priorities and interests. Effective Stakeholder Management is achievable by aligning all stakeholders around the common goal of predictable incident free DP operations by:

- A demonstrated strong focus on the objective- i.e. the Industrial Mission

- Fostering the understanding that DP Station Keeping is Safety Critical
- Demonstration of management of DP station keeping as Safety Critical is achieved by:
  - A focus on the Industrial Mission
  - Identification of critical spares and sparing philosophy with a focus on DP station keeping
  - Attention to Inspection Repair Maintenance (IRM) procedures
  - Level of detail in procedures
  - Effective Decision Support tools
  - Training, familiarization, drills and exercises by on board vessel personnel and vessel management
  - Adherence to codes standards and practices

Early engagement and a clear unambiguous alignment amongst all stakeholders is essential and this should be pervasive across the diverse groups including independent 3rd party assurance providers. Company Standards, including intent must be well understood.

1.10.2 INTERFACE MANAGEMENT

There are a multitude of interfaces that need to be managed in the course of discharging responsibilities as a DP SME. These interfaces will be with diverse Technical Disciplines, Operations (Vessel Operations and Project Operations) and Assurance Organizations. It is inevitable that commercial factors will come into play and the accompanying tension should be managed.

In general, technical and operational issues must be addressed on those grounds by personnel well versed in these matters. It is incumbent upon the DP SME to ensure that the right advice is solicited from relevant technical and operational personnel untainted by commercial considerations. Commercial aspects and discussions should be had as a follow up activity with the appropriate personnel including the risk owner. It is inevitable that there will be risk trade-offs, but these must be done on the basis of a sound understanding of the issues and potential outcomes. Lack of comprehension of the big picture (outcome /objective) and potential for inbuilt biases to skew decisions should be guarded against. and not on biases.

1.10.3 RISK, HEIRARCHY OF CONTROLS, BARRIERS AND BARRIERS MANAGEMENT

1.10.3.1 RISK

It should be recognized that there are two main categories of risk, Process Safety and Personal Safety (Occupational Risk).

It is not the intent of this document to provide a discourse on the differences or similarities.

In summary, management of Process Safety requires a blend of engineering and management skills focused on preventing catastrophic accidents and near misses, particularly structural collapse, explosions, fires and toxic releases associated with loss of containment of energy or dangerous substances such as chemicals and petroleum products. Process Safety[21] tends to focus on mitigating risks through the inherent design of the system.

Note[21]: -

Process Safety events are usually low frequency, high consequence events and when they do manifest themselves, impact reputation and sometimes the enterprise itself. These can be low frequency events provided attention is devoted to compensating provisions based on design, in addition to focus on elements of operations, people and process.

Personal Safety or occupational safety refers to classic health and safety normally associated with the prevention of slips trips and falls. Personal safety typically focuses on enforcing behavioral changes in workers or teams in order to prevent incidents.

1.10.3.2 HEIRARCHY OF CONTROLS

In the context of this document, executing work using DP as a means of station keeping in the offshore sector relies on managing risk as opposed to eliminating risk. Risk is typically managed by a variety of controls. There is a hierarchy of such controls based on effectiveness starting from 1 most effective to 5 least effective

1. Design it out - Address the Risk by designing it out
2. Substitution - Address the Risk by substituting it with a lower risk that can be managed
3. Engineering Controls - Address the Risk by keeping people away from the exposure
4. Administrative Controls - Address the Risk by Signage, Procedures, Training as examples.
5. Personnel Protective Equipment.

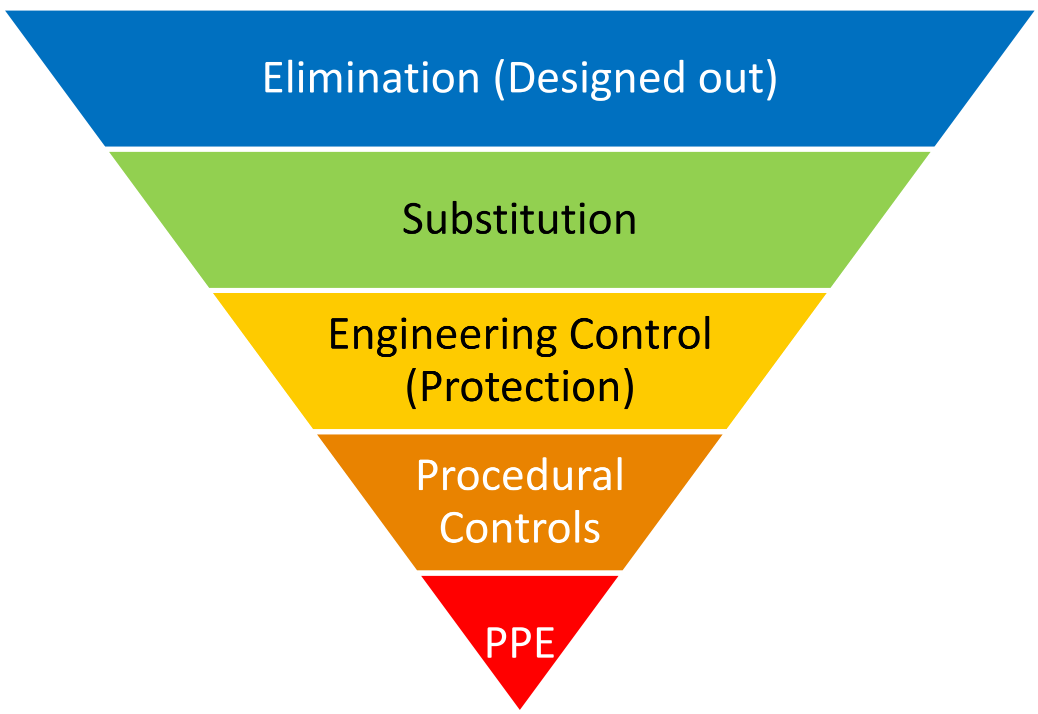

Figure 3 Hierarchy of Controls

1.10.3.3 BARRIERS AND BARRIER MANAGEMENT PHILOSOPHY

Barriers[22] are used to manage these risks. Several models are used to depict such barriers. Common models to depict barriers are the 'Swiss Cheese Model', 'Bow Tie Model'

The 'Swiss Cheese' model depicts barriers as a series of slices of 'swiss cheese' where the holes don't line up. It is believed that the threat line will not penetrate the barriers as long as the holes in the slices do not line up.

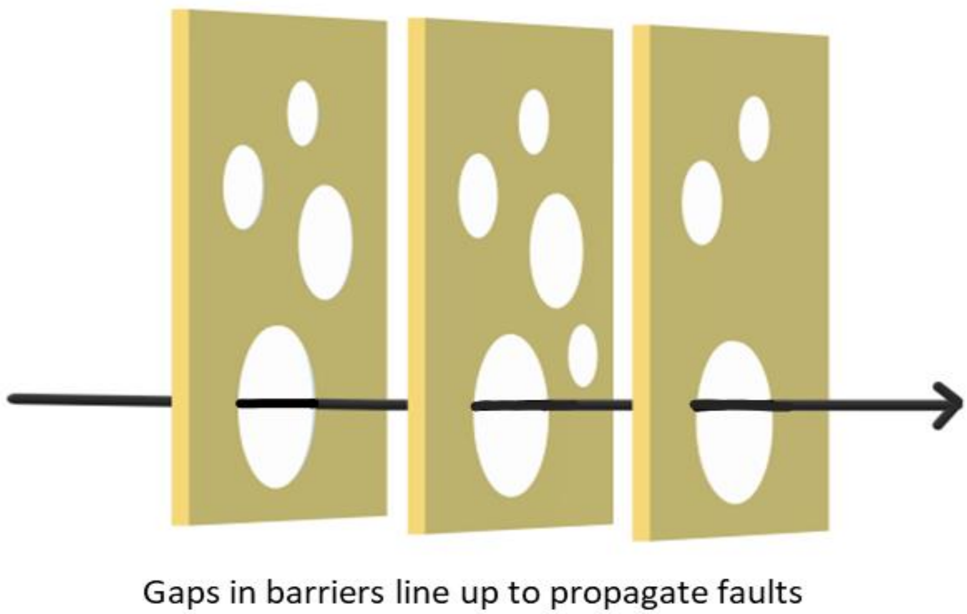

Figure 4 Swiss Cheese Model (Part 1)

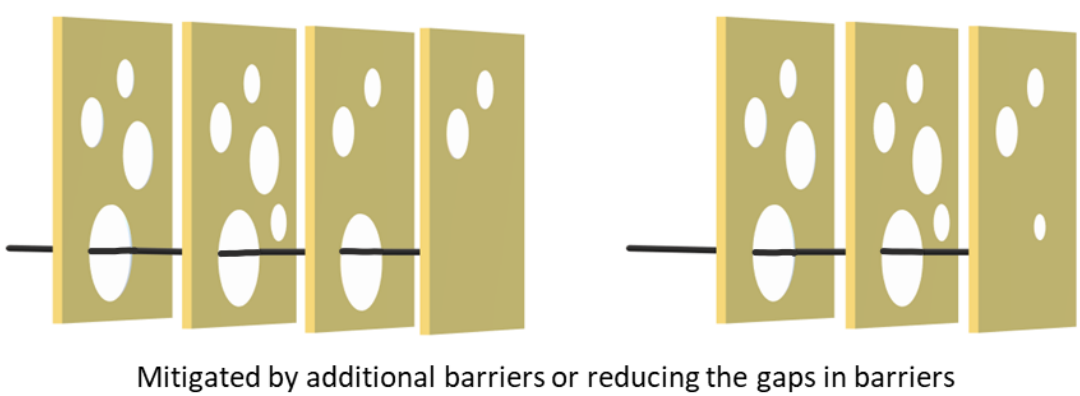

Figure 5 Swiss Cheese Model (Part 2)

The 'Bow- tie Model' identifies a top event as the knot in the middle of the bow tie. To the left of the knot are barriers to prevent the top event from happening. The right side of the bow tie (right of the knot) are the barriers in place to prevent escalation of the consequences should barriers on the left side fail leading to the occurrence of the top event.

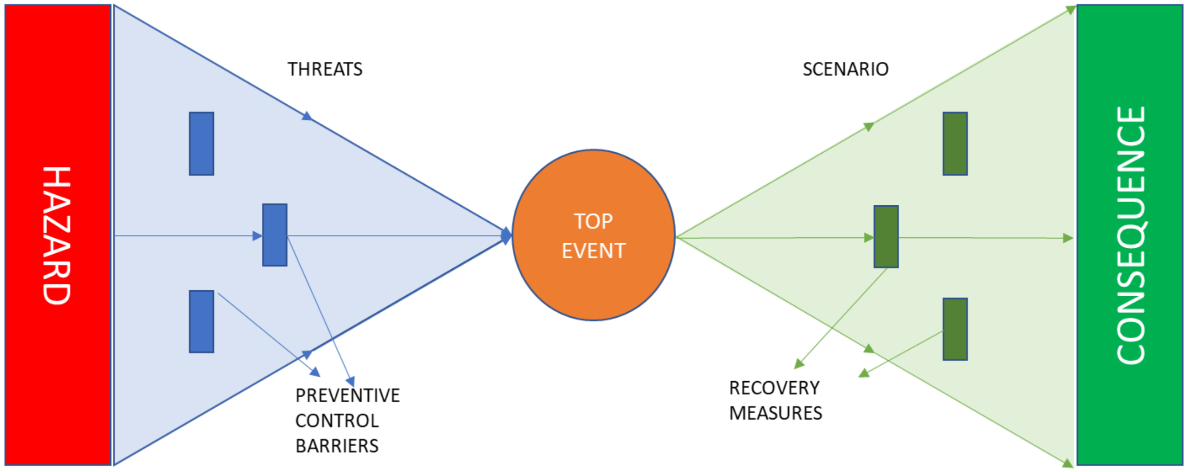

Figure 6 Bow Tie Model

Note[22]: -

1. It should be recognized that barriers will need to be defended (defense-in-depth)
2. In the Swiss Cheese Model, the effect of an additional 'slice' of cheese as a barrier can also be accomplished by making the holes smaller.
3. The barriers should be independent of one another. In other words, the failure of one barrier should not result in the failure of multiple barriers.
4. In the bow tie model it should be recognized that robust barriers on the left side of the bow tie (prevention) are likely warranted for those risks that have process safety implications (including reputational and enterprise risk exposure) while risks that do not have process safety implications (e.g. outcomes leading to non-productive time etc.) may be addressed by barriers on the right side of the bow tie
    a. It should be recognized that once the top event has occurred the effectiveness of the barriers on the right side of the bow tie are dependent upon manifestation of the conditions within the limitation that those barriers were designed for.
    b. The efficacy of the barriers on the right side of the bow tie upon the onset of the top event are less predictable.

1.10.4 POSITIONING STANDBY

Positioning Standby is a process that is implemented where equipment, personnel and processes are brought to a heightened state of readiness and personnel are positioning strategically where they can intervene and prevent escalation of an incident should it occur.

This is usually done during the conduct of critical activities such as:

- Critical activities (e.g. Riser transfer, passing through non shearables, mooring line hook up, lay in/ lay away operations in 500 m zone of critical surface and sub surface assets, personnel transfer operations)
- Deteriorating weather conditions
- Unforeseen activities triggered by exigencies (demands, necessities etc.)
- Eroded confidence in reliability of equipment and continued operations required to bring vessel and ongoing activity to safe condition.

Effects of imposing positioning standby could be reflected in a multitude of areas.

Some of the examples are:

- Change in configuration from TAM to CAM
- Bringing additional equipment online (active redundancy in lieu of standby redundancy
- Up-manning of personnel in critical control areas (Bridge/ Engine control room, switchboard rooms, Master on the bridge)
- Cessation of non-critical / routine Inspection Repair Maintenance for the defined period
- Proactive bringing forward routine maintenance of equipment

Positioning Standby is expected to bring people equipment and processes to a heightened state of awareness. It should be recognized that maintaining this heightened state of awareness is not sustainable for long periods of time. Experience has shown that efficacy diminishes if this period exceeds 24 hrs. Activities requiring positioning standby that extend over such periods need additional scrutiny and development of further granularity in procedures to further delineate critical activities (more number of smaller tasks with lesser durations with emphasis on risk profile - e.g. a completion operation that spanned days was broken up into 16 discrete steps where positioning standby was managed in a range of durations of 6 to 12 hours) .

1.10.5 RETURN TO WORK AUTHORIZATION

Companies (VTO and Operators) will usually have their own return to work authorization protocols developed in response to a change in ASOG/WSOG status from green. Typically, a change in status to yellow or red would require support from the DP SME to facilitate the assets return to work. In some cases, the DP SME is asked for his or her perspective based on the DP system and there may be others with the responsibility to incorporate this perspective and develop an overarching position on the return to work.

The changes in the traffic light status of the ASOG / WSOG is usually an outcome of a failure of equipment or anomalous behavior of equipment manifesting itself in unpredicted outcomes. Sometimes, the faults or intermittent and it cannot be proven conclusively that the cause has been ascertained or fixed. The decision to permit a DP vessel to return to work following a change in status in the ASOG could thus be challenging.

Evidence gathering in the form of alarms/ printouts, trends is critical along with reports from VMT and the OEM if mobilized. Remediations should be verified and validated. There usually are time pressures driving the need to expedite the process.

It should be recognized that the verification and validation process following a failure may require a “stress” test. (Testing carried out in boundary conditions as against a “soak test” (testing conducted in nominal conditions for a period of time)

In general, if the failure effect is within the expected effects of the worst-case failure the vessel, from a DP perspective, is supported to return to work fully acknowledging that the evidence may not be unambiguously conclusive. A repeat failure will usually trigger a more cautious approach and may require the OEM to be mobilized.

A failure effect that exceeds the worst-case failure should be investigated thoroughly, and causal / contributory factors established unambiguously prior to the vessel being permitted to return to work.

Failed equipment may need to be sent to the OEM for forensics. Processes should be in place in to follow through with the VTO for feedback and potential impact on other equipment on the vessel and in the fleet.

The DP SME should have access to resources with the requisite technical depth, skills, system knowledge and awareness of operational impacts and operations in general. It should be recognized that DP required multi-disciplinary skills and it may not be resident in one individual.

1.10.6 ENHANCED VERIFICATION AND VALIDATION

A wide range of triggers may be activated that makes it necessary to carry out enhanced verification and validation activities. Some of these triggers are:

- Poor Quality Documentation including FMEAs, Proving Trials, Annual Trials, DP Operations Manuals
    - Cross connections and dependencies causing failure effects exceeding worst case failure design intent (WCFDI)
    - Post Failure Capability reduction
- Specific Industrial Mission Requirements (E.g. Requirements for modes and features such as External Force Compensation, Heavy Lift Mode, Enhanced Follow Target Mode)
- Hull forms (semi-submersible hull forms with pontoons not widely separated, thruster to thruster and thruster to hull interactions losses in thrust capability, Capability Plots not reflective of actual capability)
    - A subjective test has been developed to address issues experienced in Industry.
    - This test is called the sideways speed test and is designed to estimate a vessels capability to work in environments with current.
    - It is used as an indicator of the vessel’s ability to work in high current environment.
- Lack of comprehensive Engineering Analysis (e.g. DP FMEAs, Riser Analysis, Installation Analysis including operability, effects of motions on conduct of industrial missions or limitations in station keeping etc.)

- Shallow water operations where the thruster force can be reduced due to limited under keel clearance.

Enhanced Verification and Validation may take the form of additional validation testing.

- Such testing usually requires assistance from specialist resources including the OEM.
- It is essential that the objectives of the verification and validation are clearly articulated and defined to avoid nonvalue added testing.
- In some instances, limitations (hardware and software) may preclude validation testing. In such cases a conservative approach may be necessary which may in turn reflect negatively on operability aspirations.
- In certain instances additional test protocols may need to be devised (e.g inability to carry out network storm testing may lead to additional testing to prove that IJS and manual controls are truly independent of the networks, level of detail in procedures, training drills and exercises may need to be enhanced)

1.10.7 DECISION SUPPORT TOOLS:

The ASOG/WSOG has proved to be an effective decision support tool to aid delivery of incident free DP Operations. The MTS DP Operations Guidance documents, Design Philosophy Documents and Techops all provide good guidance which if followed can lead to the development of a quality ASOG. IMCA M 220 also provides some guidance on operational activity planning and ASOG development.

IMO MSC 1580 (Section 4 Operational Planning) draws attention to ASOG's.

Notwithstanding the above there is a wide variability in the quality of the ASOG's. A DP SME will be called upon to be the arbiter of what constitutes a quality ASOG. The DP SME should have access to competent resources with the requisite technical depth and diversity in technical, operational and industrial mission specific disciplines. It is imperative that the DP SME leverage these resources to ensure that a quality ASOG/WSOG is in place.

It would behoove the DP SME to have an above average understanding of the process for the development of such decision support tools.

Additionally, a key tenet of the 'Comprehension Aided Compliance' is the understanding of the consequences of loss of position and or heading. It is expected that such comprehension should be the basis for imposing requirements and undertake assurance activities to verify and validate adherence to the same.

It is emphasized that statutory requirements are always to be complied with.

The following documents are essential for developing ASOG's /WSOG's[23]

- DP FMEA, FMEA Proving trials and Annual Trials
- DP Operations Manual (including pertinent details of CAM/TAM and Inspection repair maintenance strategies and control of work processes)
- Project Specific Procedures if relevant to Station Keeping (Riser Analysis for DP MODU's containing Drift off Riser Analysis) Including power requirements of non DP equipment, heading/position change requirements, restrictions for the use of PRS (DGNSS antenna obstructions, sea bottom infrastructure for taut wires etc)
- Pertinent OEM Service Records on DP Equipment

Note[23]: - The effort and skill required to develop a quality ASOG/WSOG is influenced heavily by the quality and comprehensiveness of the documents listed.

1.10.7.1 PROCESS FOR DEVELOPMENT OF THE ASOG (A SUMMARY)

It is not intended to provide a detailed account of developing ASOG's/WSOG's in this document. This section provides a summary of commonly used process[24].

Note[24]: - The process outlined in this document is not prescriptive. It is recognized that VTO's and Operators may have developed their own processes and methodology for developing, assuring and implementing ASOG/WSOG

The process outlined herein is a summation of practices that has evolved over a period of time and shared across industry by practitioners, DP SME's and developers of ASOG/WSOG.

1.10.7.2 THE QUESTION TRACKING SHEET (QTS) PROCESS

It is not unusual for discrepancies to be identified in the submitted documentation during the ASOG/WSOG development process. Resolution pathways to address discrepancies are an iterative process and usually documented through what has come to be known as a QTS process. The QTS process is used to maintain a documented record of the iterations that culminate in the closure of open items/gaps that are identified in the process of developing an ASOG/WSOG.

The QTS document lends itself to be leveraged by the accountable DP SME to aid the assurance process.

1.10.7.3 THE VESSEL OVERVIEW DOCUMENT

The ASOG/WSOG is a decision support tool to manage DP Station Keeping Risk and is a repository for pertinent information gleaned from a number of documents which could be. voluminous.

Information pertinent to managing station keeping risk (e.g. Configuration of power plant and control power supplies in accordance with the redundancy concept, identifying cross connections across redundancy groups, auxiliary systems, thruster and generator capacity, position reference sensors and sensors, single line electrical drawings, etc) are sometimes summarized in a document called the vessel overview document. Such vessel overview documents could be standalone documents or embedded within the ASOG/WSOG (worksheets/documents)

Ease of access to such pertinent information lends itself to the assurance process during intake of DP vessels and support requests when vessels are in service.

1.10.7.4 STRUCTURE OF THE ASOG/WSOG

The structure of the ASOG/WSOG has evolved over the years. Examples of ASOG/WSOG are provided within the referenced guidance documents in section 1,10,7. ASOG/WSOG typically follow the below mentioned structure. It is emphasized that this is not a prescriptive structure and it is not unusual for VTO's to have developed or adapted structures that meet their requirements.

Irrespective of the structure adopted, a quality ASOG/WSOG should clearly and unambiguously identify and contain the following

- Validated by testing in accordance with the redundancy concept, CAM and TAM Configurations of the DP System (generators, thruster, distributions systems, auxiliary systems, controller, position ref sensors, sensors etc)
- Post Failure Capability
- Effects of Inspection repair Maintenance on Post Failure Capability and Thruster and Generator Operating Strategy (TAGOS) if relevant
- Rationalization of triggers for yellow
- Control of work processes and executable contingency plans
- Notification Protocols for change in status in ASOG/WSOG (Who needs to be notified?)
- High Level Actions to be taken upon change in ASOG/WSOG traffic light status.

ASOG's typically have four sections

1. TITLE BLOCK
2. CONFIGURATION SECTION
3. CRITERIA SECTION
4. SIMOPS

1. TITLE BLOCK

There is value to be realized by keeping the ASOG ever green. One way to achieve this is to ensure that the ASOG development process incorporates lessons learned into the ASOG. Such lessons are usually contained within a section of the ASOG called the 'TITLE BLOCK'. It is not unusual for topics addressed by verbiage in the title block to contain additional detail in the Configuration section and in the Criteria Section. Title block to include date, revision number, project and project number.

2. CONFIGURATION SECTION

The configuration section identifies the configuration[25] of the DP system for CAM and TAM (if applicable). The objective of the configuration section is to identify the configuration that provides the optimum, validated through testing, fault tolerant configuration which aligns with redundancy concept. It contains pertinent details of all elements comprising the DP system. Though they may share many of the characteristics, existing DP checklists, may not be activity or well specific. Due diligence to be done to ensure the configuration for activity or well specific operations are defined in a detailed manner.

Configuration section typically contains two traffic lights (Green and Yellow).

Note[25]: -

Misconceptions persist around CAM and TAM Configurations. One of the most prevalent misconception is that the only difference between the two is the bus tie configuration (open bus or closed bus). Examples of other common misconceptions are: -

- Common Points are created only at the top level of the power distribution system. Opening the bus ties at this level is sufficient to segregate the plant in line with the redundancy concept.

- CAM configuration is only defined configuration and there is no requirement to define TAM configurations
- Post failure capability criteria for CAM and TAM configurations is the same.

Some examples of differences in CAM and TAM other than bus ties

- Automatic tension inputs may be permitted during TAM operations for open water pipe lay
- Redundant Position reference sensors on single principle (e.g. redundant DGNSS's may be acceptable for open water pipelay (TAM operations))
- Power plant configuration for both CAM and TAM may be the same, but the post failure capability criteria may be different (Worst Case Failure vs single generator/thruster criteria)
- Acceptance of ROV mounted transponder in lieu of seabed deployed transponders.
- Acceptance of USBL acoustics in water depths > 700 m in lieu of acoustics based on LBL

3. CRITERIA SECTION

The criteria section lists elements of the DP system that are monitored for triggers that would potentially cause a change in status of the traffic light system and the associated parameters of these triggers for the traffic light in question, (i.e. Green, Blue, Yellow and Red)

The criteria for a change in status to yellow is unambiguous. A change in status to yellow is triggered when the next failure[26] could potentially cause loss in position or heading.

In addition to the DP system parameters, some ASOG's/WSOG trigger a change in status to yellow for events related to fire, flooding and threat of collision. A confirmed fire, or flood event typically triggers a change in status to yellow. The rationale for this is driven by the recognition that the vessel management team will be engrossed in response to such events and could prove to be a distraction to the attention required for managing DP Station keeping risk.

Verbiage that introduces ambiguity should not feature in the criteria section, especially for yellow and red triggers. An example of such verbiage is the words "situation specific".

Note[26]: -

- Post failure capability for operations in CAM is based on the Worse Case Failure.
- Post failure capability for operations conducted in TAM is usually based on the more likely failures (e.g. single generator/single thruster failure)

4. SIMOPS

The SIMOPS section of the ASOG/WSOG addresses marine vessel interactions when multiple vessels[27] are working within a limited area. This section primarily addresses notification of change of status to all vessels working within a defined area and responses on own vessel to such change of ASOG/WSOG status on other vessel . It is emphasized that this section does not replace SIMOPS planning during execution of industrial mission.

A foundational principle is that a change in ASOG/WSOG status of any vessel triggers a change in status to Blue of all the vessels working in the defined area. It is expected that Masters of all vessels will assess the impact of the change in status of the “triggering vessel” to their own operations. The nature of the operations being undertaken may result in the Masters of the non triggering vessels to escalating a change in status to yellow, safely suspend their operation and move out of the area as a precautionary measure.

In some instances the nature of the Industrial mission may dictate that the “triggering vessel” is given the priority to complete its current operation and the risk management strategy may result in the non triggering vessels directed to suspend their operations and move out of the area. Usually such decisions are made in consultation with various stakeholders and on the basis of specialist advice. The DP SME may be called upon to participate in such discussions.

Note[27]:-

- SIMOPS section may cover non DP vessels as well if relevant (E.g. Heading control tugs and pull back tugs)
- Changes in status of such vessels may trigger a change in status of other vessels and elicit a response (Including cessation of ongoing operations.)

1.10.7.5 IMPLEMENTATION OF THE ASOG/WSOG

Due diligence and care in the implementation of Quality ASOG/WSOG’s have aided delivery of predictable incident free DP operations. Critical success factors are: -

- An understanding that this is a DP station keeping decision support tool containing information pertinent to design, operations, people and process.
- Ownership of ASOG/WSOG must reside with the Vessel Management Team/Vessel Operations Team/Vessel technical Operator[27] (Marine personnel (bridge and engine room) and Industrial Mission/Project personnel). It should not be seen as something that is imposed on the vessel by the end user charterer.
- The basis of confidence in delivering incident free DP operations should be based on effective verification and validation of attributes of performance, protection and detection and the defense in depth of the barriers in place to manage risk.
- Comprehension of the ASOG/WSOG by the end user/charterers personnel (onshore and offshore) and their support in adherence to the ASOG/WSOG
- ASOG/WSOG to be treated akin to a permit to work. Adherence is expected.
- The AS in the ASOG and WS in the WSOG is activity specific and well specific respectively. Changes in the activity or changes in the procedure to undertake the activity may result in changes to the ASOG. This should be recognized and managed effectively through change management processes.
- The ASOG/WSOG must be treated as evergreen. Lessons learned from industry must be incorporated as part of this ‘evergreening’ process.

Note[27]: - Specialist technical and operations resources may have been leveraged to develop the ASOG/WSOG. It is incumbent that ownership of the ASOG/WSOG is with the Vessel Management team, notwithstanding the foregoing and irrespective of where these specialist resources have been drawn from. (i.e. VTO provided resources/charterer end user provided resources),

1.10.7.6 ASOG REFRESHES

There is often debate on the term for the validity of the ASOG. Arguments are put forward that the industrial mission has not changed or that no changes have been made to the vessel which should cause the ASOG to be refreshed.

Prudent operators have acknowledged the value of refreshing ASOG at some defined period. Examples of such periods range from once every three months to once every six months. The reasons to undertake such refreshes are many. Some such reasons have been enumerated below

- To incorporate lessons learned (Vessel/Company/Industry)
- To cover crew changes (scheduled/unscheduled)
- To roll in observations from annual trials/ FMEA renewal trials/tests carried out as soak tests/stress tests post events
- Weakness in implementation/adherence to ASOG's observed during audits or post event analysis

In general, due consideration should be given to limiting the validity of the ASOG to a period not exceeding six months. The vessel's Master should be responsible to verify and validate (positive verification) that the ASOG in place covers the activities that are being undertaken and incorporate the nuances of the relevant procedures that may impact station keeping even if it is presumed that the industrial mission of the vessel has not changed.

1.10.7.7 IN SERVICE SUPPORT

ASOG's/WSOG's contain notification protocols which invoke requests for in service and ongoing support on DP related matters. It is expected that the DP SME has access to the appropriate skilled resources to respond to such requests. Return to work authorization following failures is covered in Section 1.10.5

Dilemmas present themselves during operations and in-service support is solicited from DP SME's Examples of such dilemmas are

- PROACTIVE YELLOWS
- LEGACY BLUES

1.10.7.8 PROACTIVE YELLOWS: -

There may be occasions where a change in status to blue is triggered due to failure or non-availability of equipment. The consequence of a loss of position for the current and ongoing operations may not be severe but may not be acceptable for the upcoming operations. In such instances the on-board vessel management team may elect to proactively trigger a change in status to yellow, suspend operations, address the concern that caused the activation of the trigger for a change in status to Blue and then resume operations.

Usually proactive yellows may be triggered by weather forecasts which predict increasing weather which may cause the post failure capability limits to be breached. In some instances, in may be triggered by frequent intermittent alarms, unexpected or inexplicable alarms, failure of equipment, anomalous or unpredicted behaviour of equipment with or without stimulus etc.

Typically, proactive yellows do not trigger the return to work authorization protocols. However, the DP SME plays a significant role in ensuring that the right level of support is available to the execution teams. Such support is essential not only for resolution but also to risk assess the situation and provide advice on compensating provisions when necessary.

1.10.7.9 "LEGACY" BLUES: -

"Legacy blues" is a term that is used to indicate those triggers that are of a nature where the resolution is going to take time. (e.g. unavailability of equipment for long durations due to long lead times, extensive or intrusive maintenance etc). It is acknowledged that sometimes such "blues" may have the tendency to mask other triggers for a change in status to blue and result in not getting the attention or resolution it deserves.

In order to avoid such potential, "legacy blues" can be acknowledged and documented as such and not leave the ASOG in a perpetual "blue status" This would allow fresh events to draw the attention by a change in status so that they can be addressed in a timely manner.

It is incumbent that processes are in place to ensure that "legacy blues" are monitored and resolution provided, and open actions closed out.