Important PRS considerations when operating close to an asset that is not rigidly fixed to the seabed

1 Overview

It has come to the attention of the IMCA DP Committee that, in recent years, there have been several collisions between vessels undertaking DP operations near to a mobile asset, such as a drilling vessel, FPSO, or heavy lift vessel. The causes of these collisions could also impact offshore floating wind assets in the future.

From the DP Station Keeping Event reports received by IMCA, it is clear that the set up and mixing of position reference systems (PRSs) have contributed to these events. The IMCA DP Committee wants to promote understanding to reduce incidents of this nature. Therefore, instead of identifying a PRS as either absolute or relative, this bulletin defines absolute and relative DP positioning and provides examples of how the different PRSs can be used in both circumstances.

IMCA DP Station Keeping Event reports, in recent years, confirm that the following issues were contributory factors:

- set up and mixing of relative & absolute position reference sensors
- lack of special functionality within the DP Control Systems (DPCSs) to cope with the demands of relative position-keeping of moving targets
- lack of focused training on the perils of mixing absolute and relative PRSs without special DP functionality installed or in use
- lack of training in use of such special functionality
- improper PRS management along with operator error.

2 Absolute Position Referencing

Absolute position referencing for station keeping is when the vessel maintains its position over a fixed point on the ground.

DGNSS has become by far the most used system for absolute referencing. Tautwire is a subsurface system using its clump weight as the fixed reference point on the seabed. Similarly, hydroacoustic, when the transponder is fixed to the seabed or a fixed subsurface structure, provides absolute position referencing.

Microwave and laser systems traditionally known as relative position references may also provide absolute positioning, providing their reference points are on fixed structures.

3 Relative Position Referencing

Relative position referencing for station keeping is when the vessel maintains its position relative to an asset that may or may not be moving.

Typically, microwave and laser systems are used when a vessel is required to maintain position relative to another vessel or a structure that is not fixed to the seabed. This may include drilling vessels, FPSOs, heavy lift vessels and offshore floating wind assets. Relative DGNSS and accommodation support vessel gangways (with 3-axis measuring sensors) are also used for relative positioning. Hydroacoustic systems can be used for relative positioning to track subsea vehicles such as ROVs and trenchers in follow-sub mode or using the appropriate functionality of the DPCS.

Example:

As an absolute reference, a microwave system measures the bearing and distance from a transponder on a fixed asset. The vessel position is maintained over the ground, which is useful for tasks such as positioning a vessel alongside a fixed asset. As a relative position reference, the same system measures the bearing and distance from a transponder on a moving asset such as another vessel or other floating structure.

The hydroacoustic reference system is used as an absolute reference when referencing a transponder on the seabed. Alternatively, the same system can be used for relative positioning when the transponder is located on a moving asset such as an ROV or trencher.

4 Weighting

Weighting is the process of assigning different levels of importance to different PRSs. This is carried out to ensure that the DP system is using the most accurate and reliable data to control the vessel's position.

Several factors should be considered when weighting a PRS, including:

- accuracy of the PRS
- update rate of the PRS
- stability of the PRS
- availability of the PRS.

In general, a PRS with higher accuracy, faster update rates, and greater stability will be given more weight than a PRS with lower accuracy, slower update rates, and less stability.

The weighting of PRSs is typically assigned automatically by the DPCS's software. The software will calculate a variance for each PRS, and the PRS with the lowest variance will be given the most weight. The variance is a measure of how much noise is present in the PRS data. Some older DP systems permit manual weighting adjustment.

PRS weighting is complex, but it is an important function in dynamic positioning. By understanding how weightings are assigned, DPOs can help to ensure that their vessels are operating safely and efficiently.

IMCA recommends that specific original equipment manufacturer (OEM) operational documentation is referred to for further details.

5 What are the Concerns when Operating Next to a Non-Fixed Structure?

The concerns become apparent when a combination of absolute and relative PRSs are used. There is no conflict in the position measurements when a vessel is holding position adjacent to a fixed asset as all PRS are capable of absolute positioning and the DP system maintains the vessels position over the ground. However, when a vessel attempts to maintain position near to a moving asset, there is cause for concern as measurements between absolute and relative position reference systems will differ when the asset moves.

The DPCS estimates position based on motion in the "XY" plane of a measured reference. If the DPCS measures a PRS as moving and it is in use by the system (has weight) the system will compensate for the motion according to its auto-control model (position, heading, track, target, etc.). When the DPCS observes motion on a relative target which is considered "fixed", and it has a reference measuring the position of the vessel relative to earth "absolute", it will perceive the relative target motion as vessel drift. When both an absolute and relative target (in fixed mode) are compared, one is measuring motion of the controlled vessel and the other is measuring the position of the controlled vessel relative to the mobile asset. This can cause

the DPCS to drive off station when it is compensating for motion of the reference asset rather than the vessel it has control over. The mitigating methods for these phenomena are explained in the following sections.

6 Mitigation

Mitigations to be considered:

Refer to Figure 1 below.

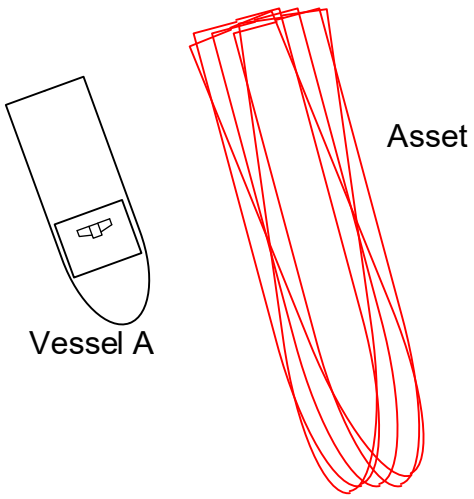

Figure 1 Representation of Vessels

6.1 Minimum Position Reference Systems online for Vessel A

Before executing DP Operations from a non-fixed asset, the operator (DPO) must examine the DPCS and its capacity to accomplish the task safely. The DPO must be aware of the capabilities of the DPCS in order to choose which alternatives are most appropriate for the operation.

Option 2 below is not a recommended practice, but it is known that the industry is utilising this method of vessel positioning. If Option 2 is to be used, then the operator needs to know the risks of such an operation, the OEMs must always be consulted.

MSC.1/Circ.1580 3.4.8 *Position reference systems* – states:

.3 For equipment classes 2 and 3, at least three independent position reference systems should be installed and simultaneously available to the DP control system during operation.

.4 When two or more position reference systems are required, they should not all be of the same type, but based on different principles and suitable for the operating conditions.

- **Option 1 – Using Follow Target / Ship Follow Functionality**
  - One absolute PRS (typically DGNSS)
  - Two relative PRSs with two targets (reflectors / responders on the asset) based on different principles, set as mobile targets and the DP control mode selected to Follow Target (Follow Position or Follow Position & Heading).

    Note: *Using Absolute PRS in conjunction with Relative PRS must only be considered if Vessel A is equipped with the appropriate follow target / ship follow functionality suitable for the Industrial Mission – i.e., capable of dealing with the expected movement velocities of the asset they are working with.*

Note: *Standard follow target functionality may not meet the performance criteria for the industrial mission. The OEM must be consulted.*

Note: *Redundancy of both absolute and relative reference systems must be considered.*

Note: *Vessels intending to follow position and heading of a target vessel will need multiple targets with horizontal spatial separation. OEM minimum recommended spatial separations is essential.*

Note: *The use of this functionality may necessitate the need for the operator to set up a 'Reaction Radius/Area' when set to mobile follow target mode (position and heading) and select specific features (for example: quick response, auto position fallback).*

- Operator defined area within which the target can move without causing the vessel to follow.
- When the target is at the edge of reaction radius/area, the position setpoint is updated automatically to restore the vessel position relative to the target.
- Reaction radius/area is redrawn around the new position of the vessel.

♦ **Option 2 – Using Auto-position**

- One absolute PRS – set to monitoring
- Three relative PRSs based on different principles such as Laser and Microwave – selected into DP Control without follow target mode (i.e. auto position mode).

  Note: *Practical experience has shown that employing relative targets with moving assets and not using follow target functionality allows the DP system to maintain a relative distance satisfactorily. This method avoids the additional risks involved in mixing absolute and relative PRSs when maintaining a relative position off a moving asset, for DP Vessels without a bespoke Follow Target Functionality required for the Industrial Mission.*
- The above approach can only work when the movement in surge sway and yaw of the target vessel is not excessive in velocity or distance.
- DP Operators must be diligent and competent to recognise degraded station keeping and take action to suspend ongoing operations and exit to safe zone. (E.g., excessive alarms and or movement of relative PRS's, thruster oscillation, thrusters ramping up too quickly, etc.)
- OEMs are consistent that the Autopos mode with Kalman filter is not designed for this, even when only using relative systems. PRSs may be rejected if the movement velocity of the target asset is excessive.

Lack of understanding of the functionality, improper/ineffective use of relative PRS and rapid / excessive movements of the target vessel may introduce unacceptable risk and consequences of a loss of position and or heading.

6.2 Activity Specific Operating Guidelines

The vessel's Activity Specific Operating Guidelines (ASOGs) need to address the correct setup and calibration protocols. When an issue emerges, the operator must be provided with clear instructions to assist them in the execution of clear and concise action.

Development of the ASOGs needs to explicitly consider and address:

1) Verification of target locations (targets on DPCS display matching physical locations on target vessel)

a) Proper target management (for example: reinstatement in safe area, prediction errors at the DPCS or PRS receiver, instability in reference systems observed on DPCS, eroded confidence in reference system management by DPCS) instruction on absolute PRS to be in monitoring mode and controls to ensure that absolute PRS is not enabled if only relative PRSs are used for station keeping when in close proximity to target vessel (close proximity to be defined (based on Industrial Mission)).

2) If "Follow-Target" mode functionality is installed:

a) Instructions specific to the version of the functionality installed and its use in the Industrial Mission being undertaken, including any specific features (e.g. auto position fallback functionality) – applies to Option 1 only.

3) Actions to be taken upon loss of redundancy:

a) Specific Operator interventions are required (note that variability exists in different versions of DPCSs). ASOGs must contain instructions relevant to the control system version that is installed.

b) For any option, it is imperative that OEM documentation is referred to and, if necessary, that OEMs are consulted regarding the best solution for the mission.

6.3 PRS Calibration – Disabling and Re-enabling the PRS

Calibration is used by the DPCS to centre a PRS with the vessel model. This action should stay a stationary 'correction' after completion. If a PRS is then 're-calibrated,' this might introduce unanticipated flaws in the model location, resulting in unexpected station-keeping difficulties.

Note: *Frequent recalibration when close to an asset is not to be undertaken. If a need arises for recalibration when close to an asset, activities must be suspended and the vessel moved out to a safe position, recalibration carried out, stability of reference systems to be verified and steps used for initial set-up to be repeated to position vessel to resume Industrial Mission.*

It is important that calibration of each unit is current to ensure all offsets and bearings are correct, in order to confirm the fore and aft lines as per OEM instructions. Prior to beginning operations, the PRSs used must be confirmed and recorded to match the physical position on the host asset.

The DPO needs to understand what is happening when the PRS diverges and how to respond. The typical DPO reaction is to reset the PRS (disabling and re-enabling the PRS) to bring it back to the central point. Such actions have the potential to induce position inaccuracies in the DP model and vessel excursions with unacceptable outcomes when close to assets.

Note: *All actions taken for the management of PRSs within the DPCS must align with the validated OEM design functionality of PRS management (for example, some DPCSs are designed with a built-in function for aligning the error of PRSs, while others are not).*

Changes to the PRS/DPCS (PRS-related) set-up must not be attempted when close to assets.

7 DP Vessel to another DP Vessel Interaction

When two DP vessels are engaged in interacting with each other and/or close quarter DP operations, one of the two shall be designated as the 'stationary' or 'master' vessel. When possible, this vessel will operate absolute positioning and maintain its position over the ground.

The vessel designated as the stationary or master/reference vessel must be using the appropriate absolute PRSs such as DGNSSs, HPR, tautwire, etc., and meet the requirement for a minimum of three PRSs using two different principles.

Any Relative PRS used in conjunction with an absolute PRS to reference the DPCS from moving structures (drillship, turret FPSO, pipelay vessels, etc.) must be inputted into the DP operator station as a mobile follow-target reference, provided the DPCS has the appropriate industrial mission-specific follow target functionality (consult OEM's instruction).

If only relative PRSs are being used for relative positioning off a target vessel, the relative PRSs must be inputted into the DP desk as fixed target references.

For more information, please contact imca@imca-int.com.

Related Guidance

The following IMCA Guidance would be relevant to this case study:

IMCA M117 – *The Training and experience of key DP personnel*

IMCA M220 – *Guidance on operational planning*

IMCA M252 – *Guidance on position reference sensors and sensors for DP operations*