Error tolerance in dynamic positioning systems

Executive Summary

Since 2016, the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) has been raising concerns with the offshore petroleum industry about the susceptibility of dynamic positioning (DP) system controls to human error. This concern originated from an incident in Commonwealth waters where a vessel unintentionally drifted off location when the DP system was inadvertently deactivated. Although no one was injured, the lives of divers working on the seabed nearby were put at risk.

Communications with DP manufacturers and industry bodies indicated that measures to improve the error tolerance of DP systems are available but may not be widely known or implemented. While inadvertent deactivation of DP controls across the marine industry are reportedly becoming less frequent, a report of station-keeping events published by the International Marine Contractors Association (IMCA) has noted two loss of position events due to inadvertent deactivation of DP controls in the first half of 2018. This suggests that the implementation of additional control measures is necessary to reduce risk to a level that is as low as reasonably practicable.

Consequently, NOPSEMA has undertaken a work program to identify the steps operators in Australia have taken to improve the error tolerance of their DP systems. Information received from 28 DP facilities indicates that 96% rely on double-press functionality as a means of protecting against unintentional deactivation of three-axis control. The majority of facilities had taken additional steps to protect against unintentional deactivation.

The information NOPSEMA has received from DP facility operators suggests that the majority of DP facilities operating in the Australian offshore petroleum industry are taking appropriate steps to ensure their DP systems are error tolerant, and that the risk of inadvertent mode deactivation is reduced to as low as reasonably practicable (ALARP). Where there is evidence of a gap between risk reduction methods that are available and those that are implemented, NOPSEMA will conduct inspections to ensure that all reasonably practicable measures are implemented to reduce the risk of inadvertent mode deactivation to ALARP.

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1. Background

During 2016, a vessel facility in Australian Commonwealth waters unintentionally drifted off-location while diving activities were being conducted adjacent to a hydrocarbon facility. The 'surge' button on the DP console was unintentionally deselected via a double-press action, deactivating the 'Auto Position' mode. The deselection was thought to have occurred by the placement of a notepad on the side of the console. The vessel drifted over 40 metres, putting at risk the lives of divers working on the seabed.

Following an investigation, NOPSEMA published a safety alert (Alert 62) describing the incident and highlighting the importance of error tolerance in safety critical control systems. The alert noted, "Double press activation for switches with safety critical functions may not be an adequate barrier to prevent an inadvertent action. More robust methods need to be considered."

The US Coast Guard (US CG) contacted NOPSEMA regarding the safety alert, advising they had issued a similar alert earlier in the year following an incident on a drillship where an inadvertent double-press of a 'manual' button on the DP console resulted in a loss of position.

The UK Health and Safety Executive (UK HSE) also contacted NOPSEMA having had a similar incident in their jurisdiction, in which an inadvertent double press of button to transfer control from DP to Manual resulted in a loss of position of a drillship. The UK HSE subsequently issued a safety bulletin focused on inadequate protection against accidental change of DP Status – Mode of Control, and inadequate indication of Status or Mode of Control.

2. Database review

Following liaison with the UK HSE and US CG, NOPSEMA undertook a preliminary analysis of a database of station keeping incident data from 2000-2016, sourced from IMCA. Incident description text was reviewed to identify loss of position incidents involving unintentional activation or deactivation of a switch or button. This analysis identified an additional fourteen incidents associated with inadvertent changes to the DP mode. This suggests that the frequency of unintended deactivation of DP systems is significantly greater when viewed from an international perspective rather than a single jurisdiction, as is the risk of loss of life. Notably, five incidents were caused by a clipboard / notebook placed on the DP console resulting in the de-selection of Auto DP mode.

The operator of the vessel facility involved in the 2016 incident had classified the probability of this type of event as "Unlikely", where "a rare combination of factors would be required for an incident to result". Analysis of the global dataset contradicts this classification. The frequency of unintended deactivation of DP systems indicates a larger probability, requiring the application of further control measures to mitigate the risk.

3. Industry communications

3.1. Global DP industry

NOPSEMA's CEO delivered a keynote address to the DP Asia conference in Singapore titled "Improving performance: A Global Approach", including an example based on the background material above. Subsequent discussions with conference participants identified an awareness of the vulnerabilities of double-press buttons. One oil company representative advised that their specification for the selection and operation of DP vessels includes requirements that "Vessels shall be equipped with positive and effective means to prevent inadvertent mode changes or loss of 3-axes control while on DP" and that "Such changes whether intentional or inadvertent shall be alarmed." NOPSEMA's GM Safety & Integrity delivered a similar keynote address at the Marine Technology Society (MTS) DP Conference in Houston.

NOPSEMA's CEO presented the DP Story at the International Regulators Forum (IRF) AGM in Denmark for discussion. During discussions, several regulators indicated they had been notified of similar incidents in their jurisdictions. An article was subsequently published on the IRF website.

3.2. DP manufacturers

NOPSEMA wrote to global DP manufacturers seeking information on the steps they have taken regarding the tolerance of their systems to human error. This communication included the message from the IRF meeting and an updated timeline of events and regulatory actions on the issue. From the four manufacturers that responded there was a general recognition that double-press buttons are susceptible to human error and, when used for mode changes on DP control panels, could result in a loss of three-axis control.

The manufacturers also noted that depending on factors such as the age, make and model of the DP control system, additional software controls may be available to reduce the risk of inadvertent mode changes, such as:

- audible alarms
- visual alarms
- audible voice messages confirming mode changes
- confirmation dialogue boxes
- touch-screen systems with confirmation dialogue box at a different location on the screen.

Manufacturers noted that where software changes are not an option, or as an interim measure pending software changes, clear covers over mode-change buttons can reduce their vulnerability to inadvertent double-presses.

3.3. Industry bodies

NOPSEMA similarly wrote to the International Maritime Organisation (IMO), International Association of Drilling Contractors (IADC), IMCA, International Association of Oil and Gas Producers (IOGP), Energy Institute, and MTS, seeking any input they may have on the issue. Following that correspondence, IMCA and MTS have published documents on their websites drawing attention to the inadvertent activation of

buttons that influence DP control, and have made suggestions on ways to reduce the likelihood and improve recovery/recognition time of such an action.

While inadvertent deactivation of DP controls across the marine industry are reportedly becoming less frequent, a report of station-keeping events published by the International Marine Contractors Association has noted two loss of position events due to inadvertent deactivation of DP controls in the first half of 2018. This suggests that the implementation of additional control measures is necessary to reduce risk to a level that is as low as reasonably practicable.

4. Survey of DP facilities operating in Australia

NOPSEMA has undertaken a work program to identify the steps operators in Australia have taken to improve the error tolerance of their DP systems. A survey was sent to 14 operators of 29 mobile facilities to determine the extent to which their dynamic positioning (DP) systems are tolerant to human error. Responses were received from 14 operators covering 28 facilities (vessels and MODUs), representing 96% of mobile facilities with safety cases accepted by NOPSEMA.

4.1. Survey questions

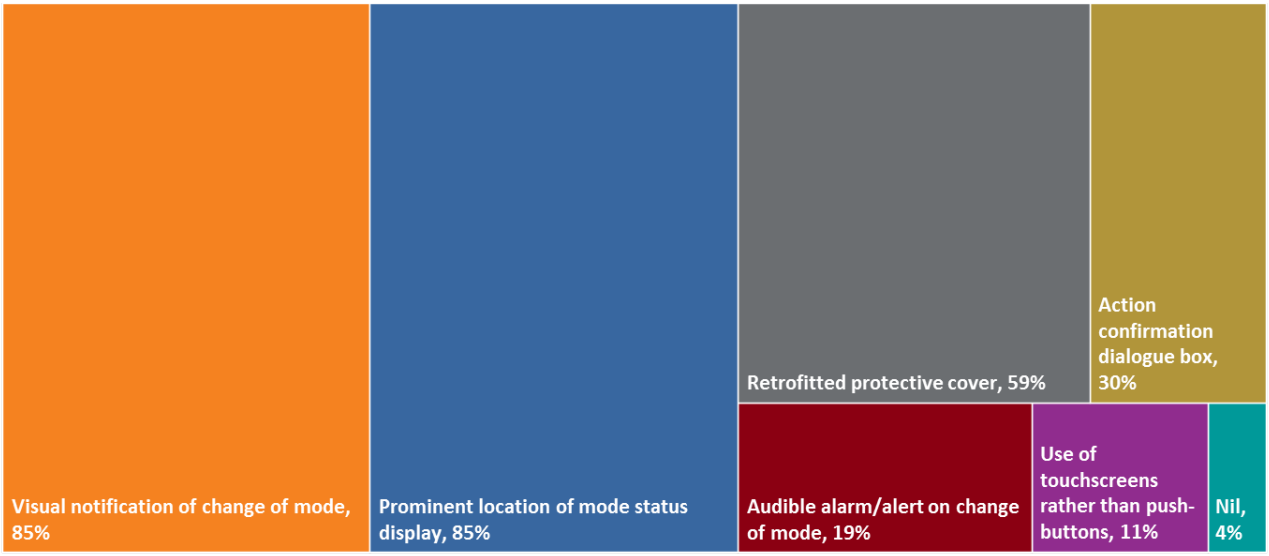
The following questions were sent in survey form to each facility operator.

1. Please detail the manufacturer and model number of the dynamic positioning (DP) control system for the facility.
2. Do the mode control buttons on your DP system use double-press functionality as a means of protecting against unintentional deactivation of three-axis control?
3. Does your DP system utilise any of the following additional means of protecting against unintentional deactivation of three-axis control?
    a. Use of touchscreens rather than push-buttons
    b. Action confirmation dialogue box
    c. Audible alarm/alert on change of mode
    d. Visual notification of change of mode
    e. Prominent location of mode status display
    f. Retrofitted protective cover (e.g. Perspex cover over mode buttons)
4. Does your DP system utilise any further means of protecting against unintentional deactivation of three-axis control? If yes, please describe.
5. A number of bulletins and alerts have been published recently addressing the potential for inadvertent mode changes during DP system operation. Please indicate which, if any, of the following publications you are aware:
    a. Kongsberg. 'Information Letter DP01-2018', March 218
    b. International Marine Contractors Association, *'DP Station Keeping Event Bulletin'*, Feb 2018
    c. Marine Technology Society, *'Classic DP Incident'*, April 2018
    d. NOPSEMA, 'Safety Alert 62 – Vessel loss of position while diving in close proximity to a hydrocarbon facility', June 2016.
6. Please describe what actions you have taken in response to the information contained in the publications identified in question 5.
7. Please describe what actions you plan to take in response to the information contained in the publications identified in question 5.
8. If you have neither taken nor plan to take any action in response to the information contained in the publications identified in question 5, please explain why.
9. Information provided by [Name] [Position].

4.2. Survey responses

Information received from 28 DP facilities[1] indicates that 96% rely on double-press functionality as a means of protecting against unintentional deactivation of three-axis control. The majority of facilities had taken additional steps to protect against unintentional deactivation. These are summarised in Figure 1.

Figure 1 - Means of protecting against unintentional deactivation of three-axis control



Free-text responses described additional control measures as follows:

- DP officers chair fitted with a table to avoid objects being placed on DP console.
- Altered keyboard layout has positioned the control-axis buttons in a location that reduces opportunities for inadvertent deactivation.
- Use of trace lines during DP operations to identify inadvertent vessel drift.
- Incorporation of alerts into training and drills.
- Clean desk policies.
- Procedural controls including standing orders and case study discussions.

It was noted that the visual notification of change of mode is not readily apparent and would easily be missed by a less experienced operator.

NOPSEMA asked DP facility operators if they were aware of a number of bulletins and alerts published addressing the potential for inadvertent mode changes during DP system operation. According to the responses, the publications from IMCA and NOPSEMA were the most widely circulated. Responses to this question are summarised in Table 1.

[1] A de-identified summary of responses from each facility is provided in Appendix 1.

Table 1 - Operator awareness of industry publications

Publication	Awareness
Kongsberg, *Information Letter DP01-2018*, March 2018	50%
International Marine Contractors Association, *DP Station Keeping Event Bulletin*, February 2018	100%
Marine Technology Society, *Classic DP Incident*, April 2018	61%
NOPSEMA, *Safety Alert 62 – Vessel loss of position while diving in close proximity to a hydrocarbon facility*, June 2016	96%

4.3. Summary

The information NOPSEMA has received from DP facility operators suggests that the majority of DP facilities operating in the Australian offshore petroleum industry are taking appropriate steps to ensure their DP systems are error tolerant, and that the risk of inadvertent mode deactivation is reduced to ALARP. Where there is evidence of a gap between risk reduction methods that are available and those that are implemented, NOPSEMA will conduct inspections to ensure that all reasonably practicable measures are implemented to reduce the risk of inadvertent mode deactivation to ALARP.

Appendix 1 – Summary of facility responses

		Protection measures								Publications				Action	
Operator	Facility	Double press	Touchscreens	Confirm action box	Audible alarm	Visual notification	Prominent mode status location	Retrofitted cover	Other means	Kongsberg	IMCA	MTS	NOPSEMA	Have taken action	Plan to take action
A	Vessel	X		X	X	X	X	X			X		X	X	X
B	MODU	X						X	X		X	X	X	X	X
C	Vessel	X				X	X		X	X	X	X	X	X	
	Vessel	X				X	X			X	X	X	X	X	
	Vessel	X				X				X	X	X	X	X	
	Vessel	X	X	X	X	X	X			X	X	X	X	X	
	Vessel	X					X			X	X	X	X		
D	MODU	X									X				X
E	Vessel	X				X		X			X		X	X	X
	Vessel	X		X	X	X	X		X	X	X	X	X		
	Vessel	X				X	X			X	X	X	X	X	X
	Vessel	X				X	X	X	X	X	X	X	X	X	X
F	Vessel	X		X		X	X				X	X	X	X	X
	Vessel	X		X		X	X			X	X	X	X	X	X
G	MODU	X				X	X	X			X		X	X	
H	Vessel	X						X		X		X	X	X	
	Vessel														
I	Vessel	X				X	X	X	X	X	X	X	X	X	
J	Vessel	X				X	X	X		X	X		X	X	X
	Vessel	X					X	X	X	X	X	X	X	X	X
	Vessel	X				X	X	X	X		X	X	X	X	X
	Vessel	X				X	X		X		X		X	X	X
K	Vessel	X			X	X	X	X			X	X	X	X	X
L	Vessel	X		X		X	X	X	X		X		X	X	X
	Vessel	X		X		X	X	X			X		X	X	X
M	Vessel	X	X	X	X	X	X	X	X		X	X	X	X	
	Vessel	X				X	X	X		X	X	X	X	X	X
	Vessel	X				X	X	X	X		X		X	X	X
N	Vessel		X			X	X	X	X		X		X	X	X