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ACCIDENT REPORT

SERIOUS MARINE CASUALTY | REPORT NO 13/2011 | AUGUST 2011

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SBS TYPHOON

Contact in Aberdeen Harbour, 26 February 2011

SUMMARY

At 1524 (UTC) on 26 February 2011, the platform supply vessel (PSV) *SBS Typhoon* was undertaking functional trials of a newly installed dynamic positioning (DP) system while alongside in Aberdeen Harbour. Full ahead pitch was inadvertently applied to the port and starboard controllable pitch propellers (CPP), causing the ship to move along the quay. Contact was made with the standby safety vessel *Vos Scout* and the PSV *Ocean Searcher,* causing structural and deck equipment damage.

Ahead pitch was applied to the CPPs because an incorrect pitch command signal was generated by the DP system signal modules. The error was not identified during factory tests or during the pre-trial checks although the system documentation specified the correct signal values. Actions taken on board to limit damage were hampered by a defective engine emergency stop and because a mode selector switch on the DP system was not moved to the correct position.

In view of the actions already taken to prevent a recurrence, no recommendations have been made.

Figure 1

SBS Typhoon

FACTUAL INFORMATION

Background

In January 2011, SBS Marine Limited (SBS Marine) contracted Norwegian-based Kongsberg Maritime AS to upgrade the DP system fitted to *SBS Typhoon* **(Figure 1)** because the existing Kongsberg SDP11 DP1 System was susceptible to single-point failures. The replacement Kongsberg K-Pos DP-21 System offered improved redundancy, primarily through system duplication.

On 20 January 2011, the replacement DP system underwent a Factory Acceptance Test (FAT) in accordance with the manufacturer's "FAT Procedure" checklists. A representative from Det Norske Veritas (DNV) classification society witnessed the tests, following which a Certificate of Conformity was signed.

Narrative – events leading up to the application of propeller pitch

On 21 February 2011, an experienced Kongsberg technician, working for the project engineer, started the DP equipment installation work as detailed in the quality approved "Installation Procedure" documentation.

During the morning of 26 February, the technician rectified some minor cabling faults and then prepared the system for Harbour Acceptance Trial (HAT) commissioning. This involved connecting the DP system to the ship's tunnel thrusters, CPPs and rudders. The commissioning steps were laid out in a series of checklists contained within the Kongsberg HAT Procedure, Document Number 1162557.

Figure 2

Manual/DP/Joystick selector switch

At 1345, the technician informed the chief officer, who was on watch on the bridge with the second officer, that he needed to check the DP system's control of the tunnel thruster and CPP propeller pitches. This was to be done by selecting the DP mode **(Figure 2)** and manually inputting a small (2-3°, maximum 5°) pitch command signal using the engineer's maintenance screen at the forward most DP operator station on the bridge. The chief officer advised the chief engineer of the requirement. Preparations were then made to start both main engines, which were required to operate the shaft generators that provided electrical power to the four tunnel thruster main motors.

At about 1430, SBS Marine's technical superintendent arrived on board. By 1500, the tunnel thruster checks had been completed and had been witnessed by the technical superintendent, who then left the vessel for personal reasons.

Narrative – inadvertent application of CPP pitch

The technician checked the command signals for both CPPs on the engineer's maintenance screen which showed "4-20mA, current loop". He did not compare the value indicated against the Project Input Output (IO) Specification as required by HAT documentation Checklists 5.28 and 5.30. The specification showed that the command signal should have been "+/- 10 volts".

At about 1515, the technician tried to control the CPP pitches using the motor-driven CPP pump while the shaft clutches were still disengaged. This was unsuccessful and he concluded that the CPP controllers manufactured by Scana required a main shaft clutch-engaged "ready" signal to achieve control.

After the technician had discussed this requirement with the ship's officers, the chief engineer engaged the main shaft clutches and passed CPP control to the bridge. The chief officer confirmed he had pitch control of both propellers from the forward and after control positions **(Figure 3)**, the latter of which was sited adjacent to the DP operator's position. At 1524, the chief officer moved the "manual"/"DP"/"joystick" mode selector switch to the "DP" position **(Figure 2)**. As he did so, full ahead pitch was applied to both CPPs and the vessel started to move along the quayside. The mooring lines, which were only secured using turns on one half of the mooring bitts (ie not in figures of 8) or on winch drums, had not been doubled up and were payed out under load. One line parted.

Figure 3

Bridge aft CPP control position

Narrative – crew's actions

The second officer shouted to the chief officer that the vessel was moving. A few seconds later the chief officer reportedly moved the mode selector switch back to the "manual" position and set about 50-60% astern pitch on both after CPP control levers. However, the vessel continued to move ahead. At 1524.12 seconds, *SBS Typhoon* made contact with *Vos Scout,* whose master informed Aberdeen Harbour's Vessel Traffic Services (VTS) of the incident. Three seconds later the chief officer pressed the port and starboard main engine 'emergency stop' buttons, but only the starboard 'stop' functioned[1]. The starboard shaft stopped quickly, but video evidence confirmed that the port shaft was still driving ahead as the vessel forced *Vos Scout* off her berth. At about 1524.52 seconds, the chief officer pressed the 'port shaft emergency clutch disengage' button and, 5 seconds later, the port wake stopped as the clutch disengaged. As the master arrived on the bridge, the momentum of *SBS Typhoon* drove her into the starboard bow of *Ocean Searcher,* and then she stopped. The chief officer then sent the second officer to supervise attempts to send mooring lines ashore.

The master immediately contacted the chief engineer and asked for use of the tunnel thrusters. He was advised that only number 1 forward and number 1 aft could be used, as only the port engine shaft generator was running to provide the necessary electrical power. The master started the thrusters but was unable to control the pitch, which remained at zero. The chief engineer checked each thruster motor and servo unit and confirmed they were running correctly.

As *Vos Scout*'s engines were started to manoeuvre her back alongside her berth, a pilot launch arrived on the scene. *SBS Typhoon*'s master opted not to use the tunnel thrusters in favour of warping the vessel to the berth with the assistance of the pilot launch. At 1600, *SBS Typhoon* was secured alongside and, at 1605, the port main engine was stopped.

All three vessels sustained varying degrees of shell plate and frame damage. Additionally, the fast rescue craft and davit on board *Vos Scout* suffered extensive damage and *Ocean Searcher*'s forward winch drive shaft was fractured. At the time of the investigation the master of *Vos Scout* reported that one of his crew had suffered minor bruising. There were no other reported injuries and there was no pollution.

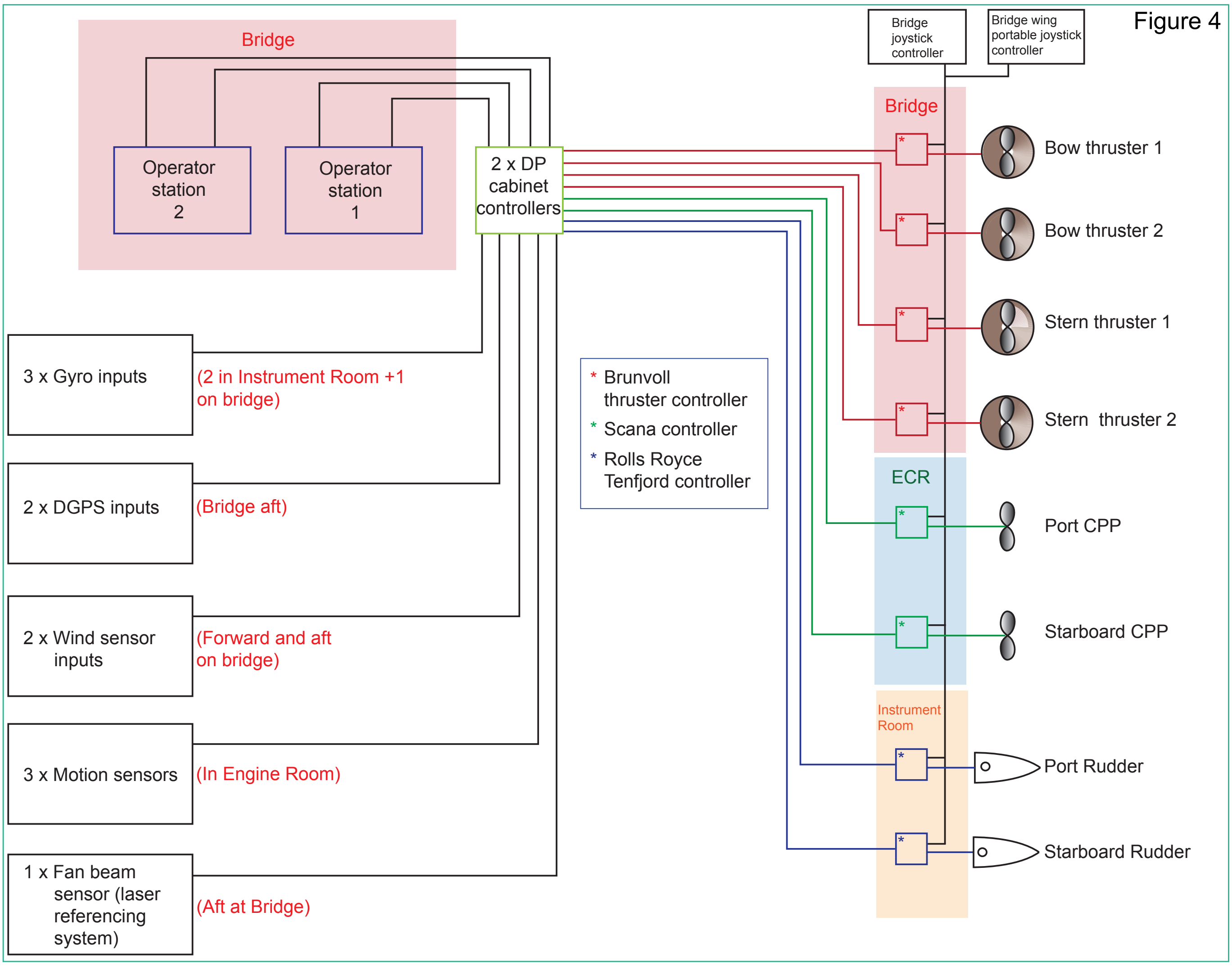
Dynamic positioning system – general description

A schematic of the Kongsberg K-Pos DP-21 System is at **Figure 4**.

Two operator stations, located at the aft end of the bridge, controlled the vessel when in the "DP" mode. Individual tunnel thrusters, CPPs and rudders could be selected for DP control when the mode selector switch **(Figure 2)** was in the "DP" position. The vessel's desired position was compared against gyro, differential global positional and laser referencing system, and wind and motion sensor information. The resultant command signals for pitch or rudder movement were generated by separate IO modules within the DP controller cabinet. The command and feedback signal type (ie voltage or milliamps (mA)) was determined by the configuration of the specific thruster, CPP or rudder controller.

When the mode selector switch was set to the "joystick" position, all available propulsion and steering machinery was controlled manually from the joystick positions at the after end of the bridge or at the bridge wings. The joystick system software determined the optimum use of the machinery to maintain the vessel's desired position.

[1] Subsequently, the port engine emergency stop was found to have a defective operating relay.



Schematic of Kongsberg K-Pos DP-21 System

Moving the mode selector switch from the "DP" position to either the "manual" or "joystick" positions would set the thruster and CPP pitch to zero and rudders to midships until the new control station took command and an alteration was made. When the mode selector switch was set to the "DP" position it was not possible to manually control CPPs, thrusters or rudders.

The system was also fitted with two uninterruptible power supplies to guard against electrical power failures.

Post-accident trials and reconstruction

Rigorous trials were carried out to check the correct operation of the CPP and thruster pitches from each of the control positions. No defects were found. Although there was misalignment of the "manual"/"DP"/"joystick" mode selector switch positions when compared to the illuminated etched positional legends on the mounting panel, the switch functioned correctly.

The functionality of the CPP Scana controller was checked by the manufacturer's technician. No defects were found.

In order to recreate the inadvertent application of pitch without the main shafts turning, the clutch solenoids were "linked out" to simulate the main clutch engaged signal. When the mode selector switch was set to the "DP" position, the pitch on both CPPs went immediately to the full ahead position without any additional adjustment at the DP operator's console. The engineer's maintenance screen showed the CPP command signal range as "4-20mA current loop" with the actual command value set at 12mA.

Safety management systems (SMS) and risk assessments

SBS Typhoon's SMS did not provide any guidance on the control of, or working with, contractors. Neither were there any risk assessments associated with the installation of new equipment or its testing and trials.

Section 2.3 of Aberdeen Harbour Board's SMS (Issue 3 – March 2009) covered the "Principal Hazards of the Port". The section identified the "Causes, Risks and Controls in Place" associated with the "Hazard" of impact with moored vessels through mechanical failure. However, neither the SMS nor its associated risk assessments covered the risks relating to machinery propulsion trials, or identified a need for a vessel's master to inform VTS when trials on unproven equipment were planned.

Previous relevant accidents

On 10 November 2008, the container ship *Maersk Newport* was undertaking hull repairs when a serious fire developed. The investigation found that poor communications were a major factor. While the technical superintendent, who was managing the repair, was aware of the repair plan, the crew were not; they were reluctant to become involved and risks were not adequately assessed.

On 19 February 2010, a shore worker fell to his death on board the oil/chemical tanker *Bro Arthur*. The MAIB investigation identified inadequate risk assessments and a lack of guidance in the SMS relating to the management of contractors to be significant factors.

Following the above accidents, a recommendation was made to the Maritime and Coastguard Agency (MCA). As a result, the MCA plans to review the Code of Safe Working Practices for Merchant Seamen and Marine Guidance Note 20 (M+F) - Merchant Shipping and Fishing Vessels, (Health and Safety at Work) Regulations 1997, to include guidance on the management of contractors.

On 26 March 2010, the chief officer of the ro-ro passenger ferry *Ben-My-Chree* was carrying out pre-departure control tests of the port and starboard CPPs. Pitch was normally applied while the engines were stopped, however, the chief officer failed to notice the starboard engine was running. The vessel moved along the quayside trapping eight passengers in the gangway compartment of the shore structure.

The accident was caused by poor machinery testing co-ordination. In addition to the company's action to prevent a recurrence, the port's managers were recommended to: review the risks of vessels running main engines while embarking and disembarking passengers and vehicles.

ANALYSIS

Cause of the inadvertent application of propeller pitch

Post-accident checks by Kongsberg Marine AS re-confirmed that an incorrect IO configuration of a command signal range of 4-20mA and an actual value of 12mA had been set for the pitch order instead of the "+/-10 volts" specified. With the 12mA value set in this configuration, it was found that there were +13.5 volts at the output from the IO modules, and this was also observed at the CPP Scana controllers. The Scana controllers operated in the range of +/- 10 volts. When the "manual"/"DP"/ "joystick" mode selector switch was set to the "DP" position, +13.5 volts was received by the Scana controller. A voltage of this size and polarity equated to greater than full pitch ahead, and this led to the vessel's unexpected and uncontrolled movement along the quay.

Subsequent checks, following re-setting of the command signal to "+/-10 volts", confirmed that the DP system controlled the CPPs in the designed manner.

Configuration checks

The K-Pos DP-21 system configuration should have been checked during the FAT in accordance with the checklist at Section 5.3.10 – "Thruster Interfaces" of the "FAT Procedure" documentation. However, the technician carrying out the checks did not set up the system with a voltage command instead of an mA command, which appears to have been the default setting. Neither the quality assurance procedures nor those personnel witnessing the FAT identified the error, so it was not corrected.

When the technician carried out his HAT checks of the pitch control modules, he also failed to identify the error because he did not refer to the IO specification for the correct configuration. He made an incorrect assumption that, as the system had passed its FAT and a Certificate of Conformity had been issued, it was correctly configured. The technician was not concerned that an mA signal was being displayed on the engineer's DPS screen because the majority of modern control systems use mA commands instead of voltage commands as it makes cable break identification easier.

"HAT Procedure" Checklists 5.28 and 5.30, covering the CPPs, stated in the "Requirements" column – of the "Command/Feedback Signals (Alongside)" Section – "According to IO spec +/- 10VDC or 4-20mA ….." While this may appear ambiguous as to whether it requires direct reference to the IO specification, the technician should have been referring to the IO specification anyway as part of the quality control procedure.

Risk perception and communication

The risks associated with connecting an unproven control system to rotating propulsion machinery were not recognised. Neither SBS Marine, Kongsberg Marine AS nor the vessel's staff conducted an appropriate risk assessment, so adequate control measures were not identified or implemented.

There were other, safer options for checking the command signals by "linking out" systems to simulate the conditions required for the Scana controller. There was still a need to turn propulsion machinery under power to check full functionality, but the risks would have been significantly reduced if simulation procedures had been conducted as a prerequisite before the propulsion machinery was engaged.

The conduct and control of the HAT was poorly managed. There was no one person clearly in charge of the operation and able to brief the master about the intended procedures. Although the technical superintendent was aware of the need to turn machinery, he had left the vessel before the critical period of CPP testing, and it was left to the technician to manage the HAT. The crew were vaguely aware that machinery would be turned at some point during the DP system installation. While they took little proactive action themselves, neither SBS Marine nor Kongsberg engaged them sufficiently in the installation planning process and no "toolbox talk" or other advisory action was taken. However, it was reasonable to have expected that the rudimentary precautions of testing the "emergency stop" systems, doubling up the mooring lines and removing the gangway would have been done when the chief officer became aware that the propulsion plant was to be turned under power. It is unlikely that additional mooring lines would have held the vessel, particularly as the existing lines were poorly secured to the bitts and winch drums, but doubling up the lines would have provided some additional time for corrective actions to be taken.

The Port Marine Safety Code requires that operations within the port are managed in a safe and efficient manner[2]. The current Aberdeen Harbour Board's SMS and risk assessments do not cater for potential accidents related to propulsion machinery trials. The responsibility for operating a vessel's equipment clearly rests with the crew. However, this accident, and that relating to *Ben-My-Chree,* demonstrates that propulsion system testing can impact on the safe operation of a port. Had divers been carrying out a hull survey on *Vos Scout* at the time of the contact, the potential for loss of life is clear. Diving and other critical operations require the approval of VTS and, where appropriate, the issue of Permits to Work. If similar approval is required for the conduct of HATs, then the harbourmaster would be able to assess the risks to the port and its users more effectively.

Loss of CPP and tunnel thruster control

The chief officer responded quickly and instinctively to the high pressure, fast-changing circumstances in which he found himself. His attempt to recover the situation, by putting the CPP control levers to the astern position, was correct. When this failed, his action in pushing the engine 'emergency stop' buttons and later using the 'port emergency clutch disengagement' button was appropriate. In analysing the failure to achieve astern pitch and the master's inability to control the tunnel thrusters, exhaustive tests of the controls and changeover switches were carried out. No defects were found. The only common link between the CPP levers and the thruster control was the "manual"/"DP"/"joystick" mode selector switch. As its functionality was also proven, it can only be concluded that the loss of pitch and thruster control was due to the switch not being moved from the "DP" to the "manual" position by the chief officer. This would have had the effect of maintaining full ahead pitch and preventing control of the thrusters.

CONCLUSIONS

1. The FAT was not conducted in accordance with the approved trial checklists. The K-Pos DP-21 system was delivered to *SBS Typhoon* with the incorrect CPP pitch IO configuration, which the onboard commissioning process during the HAT failed to identify.

[2] http://www.dft.gov.uk/mca/pmsc_oct_2009.pdf

2. Checks using simulation procedures would have reduced risks and could have been adopted to prove the control system before connecting it to running equipment.

3. No consideration was given by any of the involved parties to the risks of connecting an unproven control system to rotating propulsion plant. No trial prerequisites were considered, so no effective control measures were imposed.

4. No one person was identified as being in charge of the HAT. This placed the Kongsberg technician and the ship's crew in a vulnerable position. Weak communications left the crew isolated from the planning process and adversely affected preparedness for the HAT.

5. Actions taken by the chief officer to limit damage were hampered by the defective port main engine emergency stop and the mode selector switch not being moved from the "DP" to the "manual" position.

6. Aberdeen Harbour Board's SMS and associated risk assessments did not cover the risk to port operations from vessels inadvertently moving along the berth during propulsion trials.

7. The mooring lines were only secured using turns around one half of the mooring bitts or winch drums, which limited their effectiveness.

ACTIONS TAKEN

SBS Marine Limited is:

- Documenting procedures and risk assessments for testing machinery in port and during sea trials.
- Improving project work administration by including formalised meetings, risk assessments and toolbox talks, prior to, during and following major project work.
- Taking measures to ensure contractors involved in major project work submit detailed risk assessments before work starts.
- Developing procedures for increased frequency and more rigorous testing of 'emergency stop' systems.
- Improving processes and instructions on mooring techniques.

Kongsberg Maritime AS has:

- Revised the FAT procedures to include specific checks for the verification of IO configuration software.
- Amended the HAT documentation to include:
  - Guidance on liaison with customers, compliance with permit to work procedures and the conduct of risk assessments for the entire project.
  - Instructions to technicians that the master retains responsibility for safety, that equipment must not be operated until all 'emergency stop' systems have been tested, and that a responsible person oversees equipment operation and takes control if necessary.
  - A requirement to prove all IO signals are correct with the thruster, CPP and rudder manufacturer before switching to "DP" or "joystick" control.

Aberdeen Harbour Board has:

- Included the circumstances of the accident in the:
  - Periodic meeting held on 30 March 2011 with the Aberdeen Harbour marine stakeholders.
  - Review of the Board's safety management system and associated risk assessments.

RECOMMENDATIONS

In view of the actions already taken by stakeholders to prevent a recurrence of this accident, no recommendations have been made.

SHIP PARTICULARS

Vessel's name	*SBS Typhoon*
Flag	United Kingdom
Classification society	Det Norske Veritas
IMO number	9355965
Type	Platform Supply Vessel
Registered owner	SBS Typhoon KS
Manager(s)	SBS Marine Limited
Construction	Steel
Length overall	73.4 metres
Registered length	65.89 metres
Gross tonnage	2465
Minimum safe manning	10
Authorised cargo	None on board at the time of the accident.

VOYAGE PARTICULARS

Port of departure	Not applicable
Port of arrival	Not applicable
Type of voyage	Not applicable
Cargo information	Not applicable
Manning	Not applicable

MARINE CASUALTY INFORMATION

Date and time	26 February 2011 at 1524 (UTC)
Type of marine casualty or incident	Serious Marine Casualty
Location of incident	Regent's Quay, Aberdeen Harbour
Place on board	Not applicable
Injuries/fatalities	One reported case of minor bruising on board the contact vessel *Vos Scout.*
Damage/environmental impact	Shell plate penetration, frame buckling, scuffing. No pollution.
Ship operation	Undertaking harbour functional trials of a newly installed dynamic positioning system.
Voyage segment	Not applicable
External & internal environment	Visibility good. Wind southerly Force 4. Sheltered waters. Neap tide (75%) with LW at 1357 and HW at 2034.
Persons on board	13