Learning after platform supply vessel collision with Statfjord A

Managing Maritime operations through Human Factors, October 2019

Overview

- Brief introduction to DP
- The incident
- Alarms and such
- Recommendations for learning

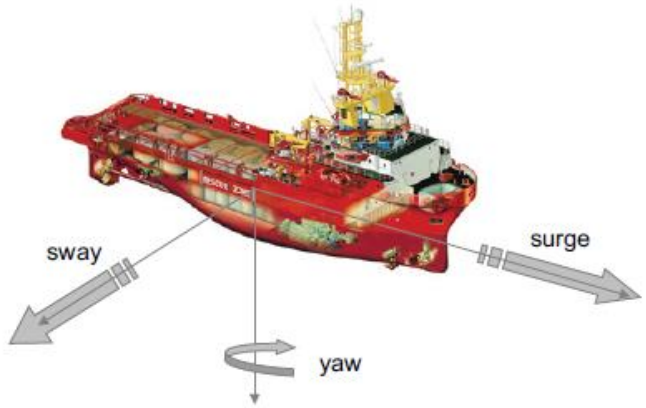
Some important definitions

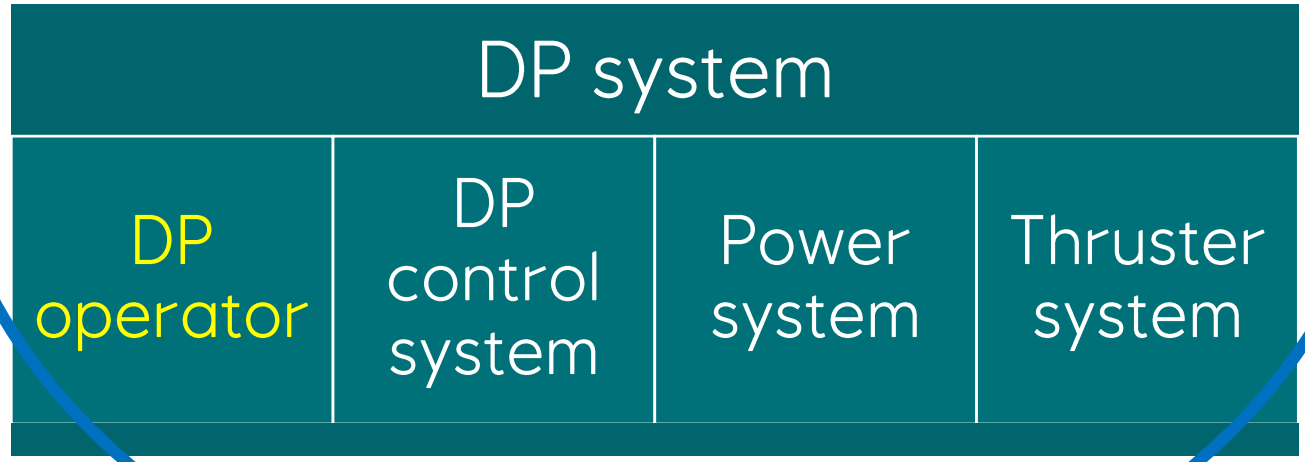
- *Dynamically positioned vessel (DP vessel)* means a unit or a vessel which automatically maintains its position and/or heading (fixed location, relative location or predetermined track) by means of thruster force
- *Dynamic Positioning operation (DP operation)* means using the DP system to control at least two degrees of freedom in the horizontal plane automatically
- *Dynamic Positioning system (DP system)* means the complete installation necessary for dynamically positioning a vessel comprising, but not limited to, the following sub-systems:

  .1 power system;

  .2 thruster system; and

  .3 DP control system



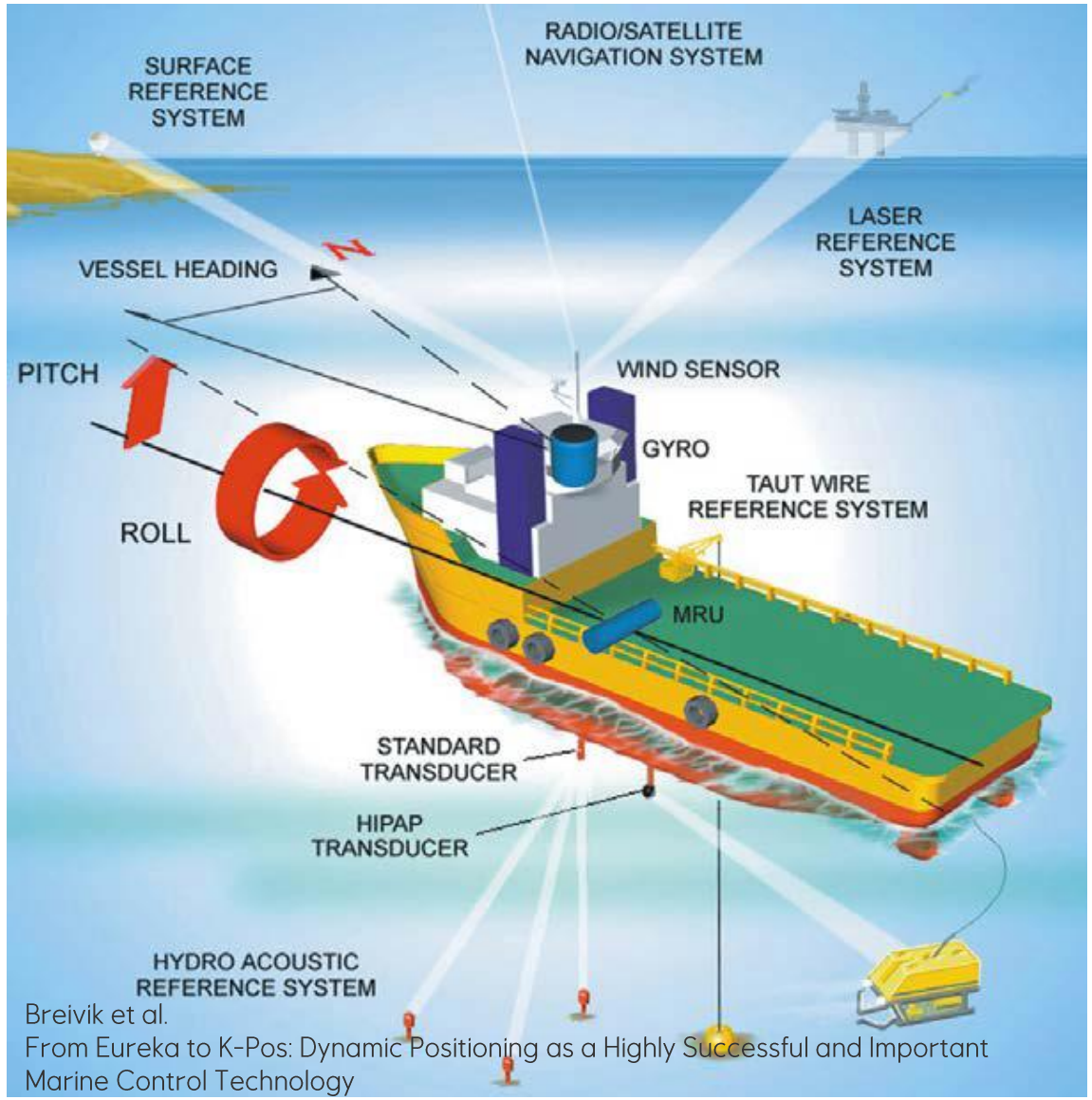


IMO Maritime Safety Committee (MSC) Circular 1580
Guidelines for Vessels and Units with Dynamic Positioning (DP) Systems

The DP control system

The objective is to keep the vessel at a specified position and heading, while keeping the position and heading excursions within the set limits for the operation, by proper action of the thruster system:

1. Read sensor information
2. Transform information into actions (force output)
3. Execute actions by thruster orders
4. Repeat the sequence



Breivik et al.
From Eureka to K-Pos: Dynamic Positioning as a Highly Successful and Important Marine Control Technology

Thruster system example

By courtesy of Hyundai Heavy Industries, Co., Ltd.
DP SHUTTLE TANKER MODEL TESTS
Models Tests of a Shuttle Tanker Equipped with Dynamic Positioning System
MARIN Report No. : 31518-1-OB, August 2019

Sjoborg´s thruster system

Single fault tolerance

- PSV Sjoborg's DP system is a redundant IMO DP equipment class 2

- *Loss of position and/or heading* means that the vessel's position and/or heading is outside the limits set for carrying out the DP activity in progress
- *For equipment class 2*, a loss of position and/or heading will not occur in the event of a single fault in any active component or system
- *For equipment classes 2 and 3*, a single inadvertent act should be considered as a single fault if such an act is reasonably probable

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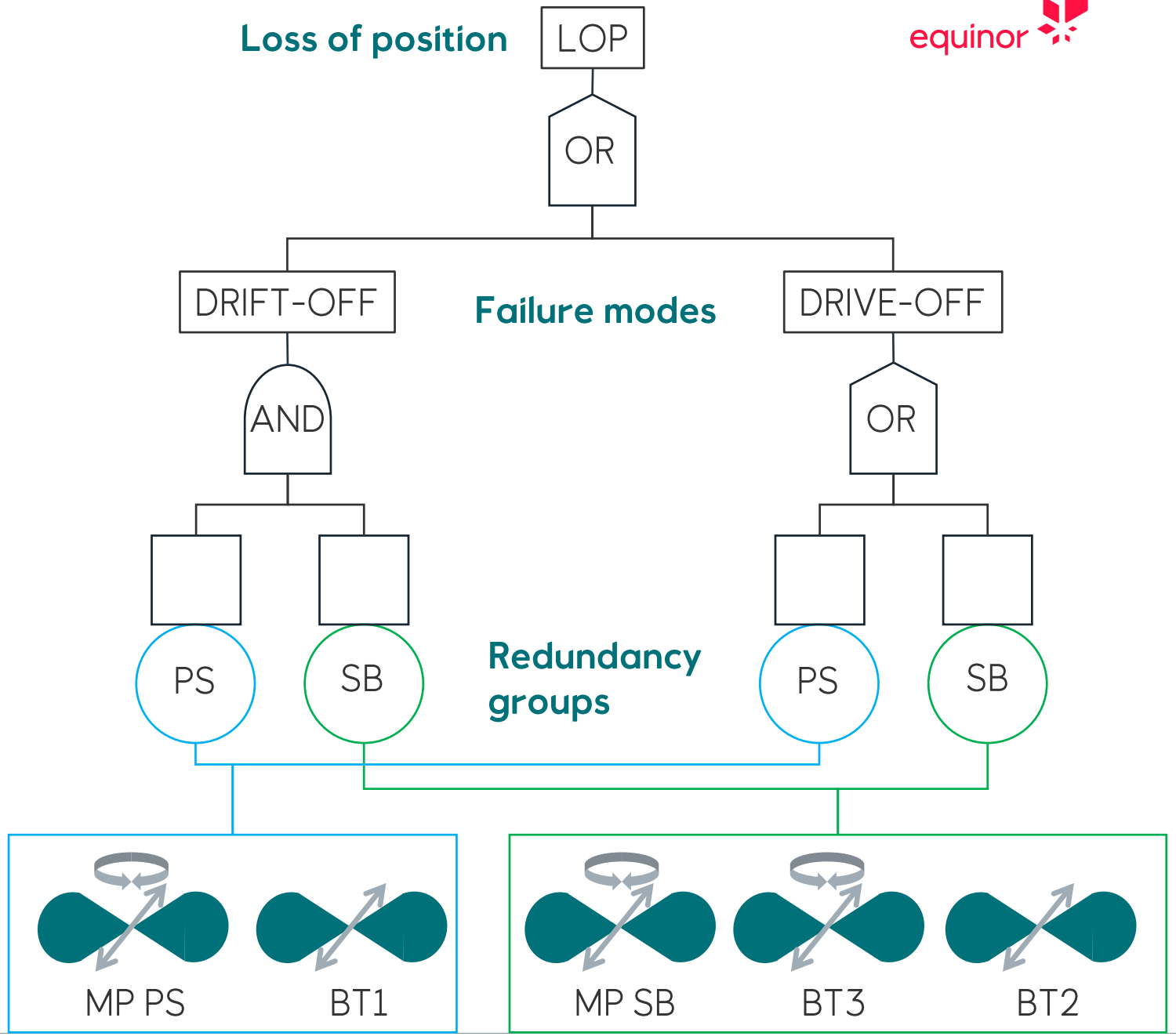


Bridge layout (aft bridge)

The incident 7 June 2019

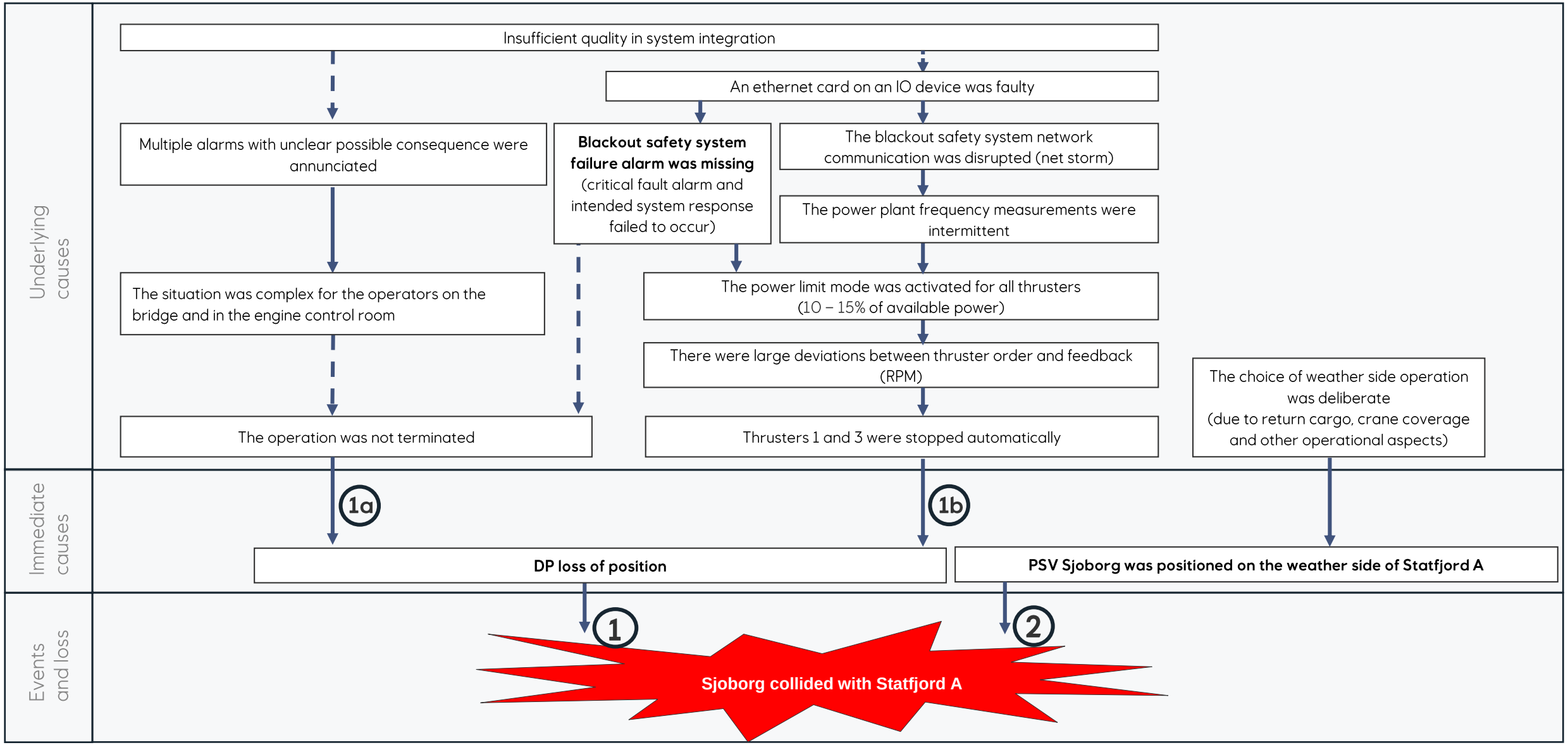
- The weather condition was Beaufort 4-5 from South West
- 01:50 AM the platform supply vessel Sjoborg lost DP-position in connection with a bulk operation at Statfjord A
- PSV Sjoborg subsequently collided SFA's lifeboat structure and drill shaft south
- SFA was in a planned shutdown and had 276 people on board
- PSV Sjoborg had 12 people on board
- Damage to the lifeboat station resulted in evacuation of 218 people by helicopter to surrounding installations in the area
- No persons were injured in connection with the incident, but an able-bodied seaman on PSV Sjoborg was hit by a bulk hose when it went overboard
- An investigation was conducted with the objective to learn such that recurrence can be prevented and to achieve an improvement of the safety level

The illustration is not in scale

Consequences

- The incident was classified by highest degree of severity to Red 1 according to Equinor´s classification matrix
  - The incident resulted in delayed start of SFA after the planned shutdown
  - If another part of the bulk hose had hit the able-bodied seaman the incident could have been fatal
- The structural integrity of SFA was not impaired by the collision

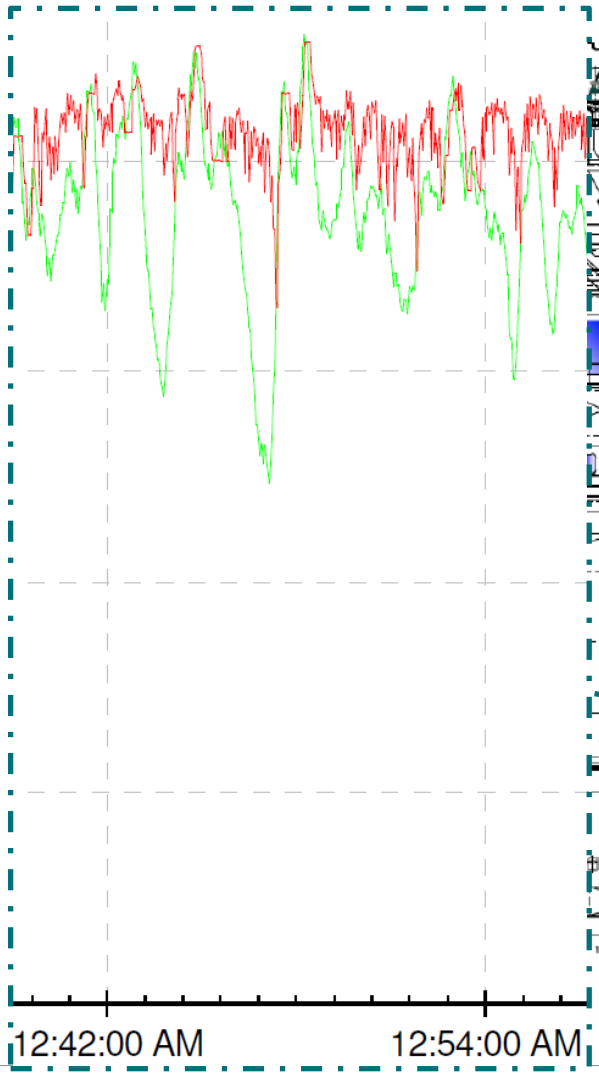
Cause map - Collision between PSV Sjoborg and Statfjord A

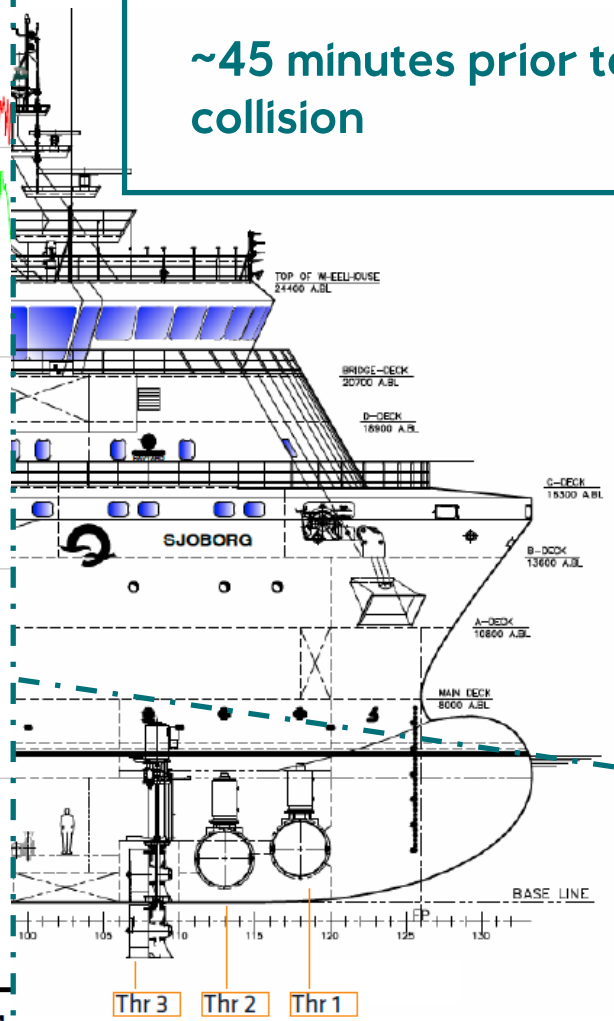


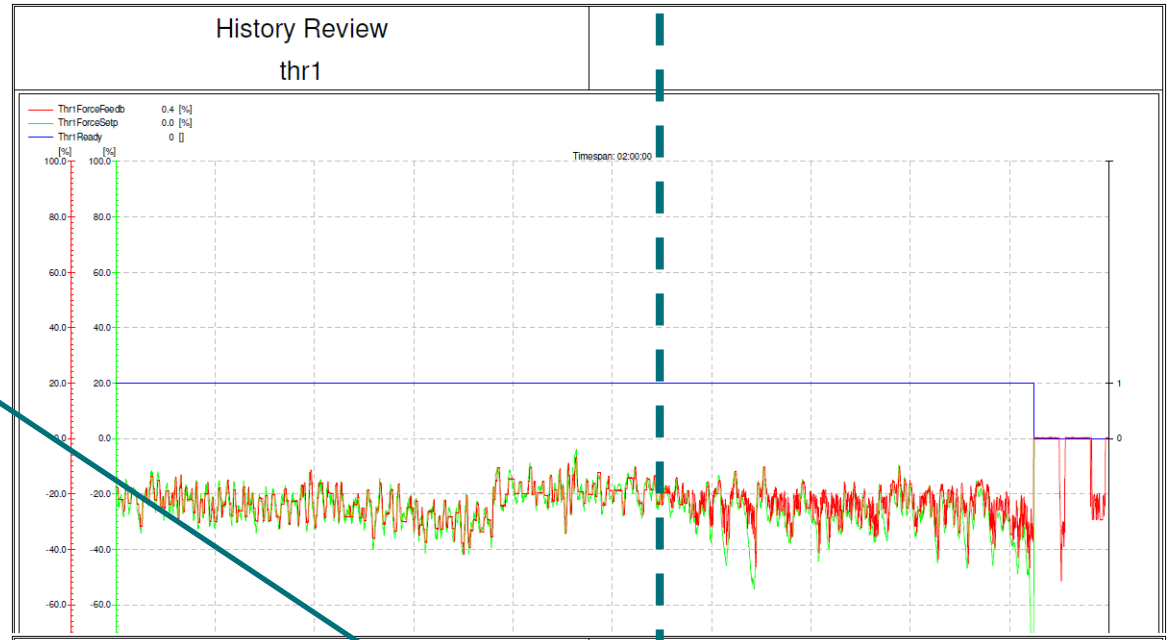
Dashed connectors are used for uncertain causality

Thrusters' order and feedback

~45 minutes prior to the collision

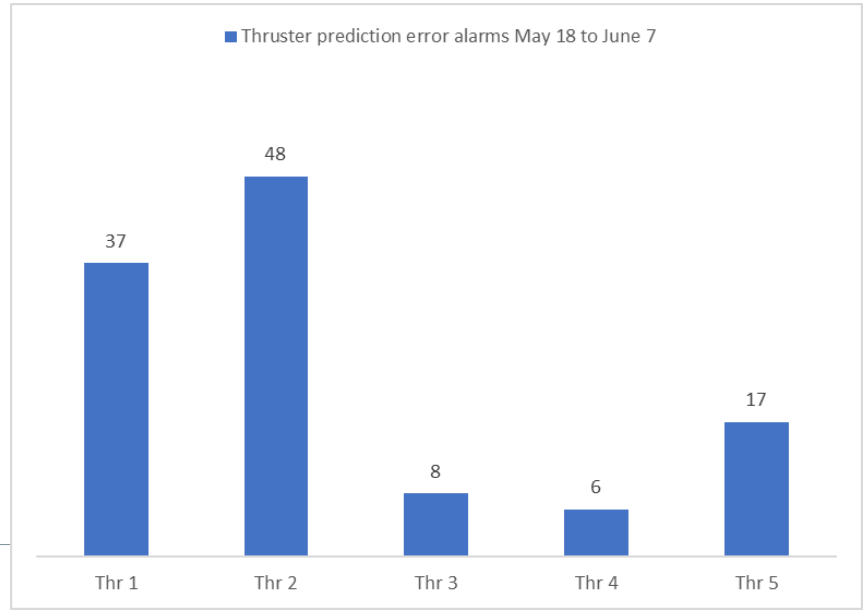






Multiple alarms with unclear possible consequence – the background

- The change of character of the thrusters' order and feedback concurred in time with the following general alarms annunciated by the blackout safety system:
  - FAULT IN B.O.S.S SYSTEM PS
  - FAULT IN B.O.S.S SYSTEM SB
- Presumably the blackout safety system activated power limit mode for all thrusters around the same time
- The FAULT IN B.O.S.S SYSTEM alarms had been periodically annunciated the last year
- According to the equipment maker the reason for the alarms could be attributed to total harmonic distortion and that this condition was assessed as not critical for the Dynamic Positioning of the PSV Sjoborg
- THRUSTER/RUDDER [#] PREDICTION ERROR alarms are reported if the order and feedback of a thruster do not agree (alarm points specified by the equipment maker)
- In the period from May 18 to June 7 there were in total 116 prediction error alarms annunciated by the DP-system on PSV Sjoborg
- As these alarms had no apparent detriment to the Dynamic Positioning of the PSV Sjoborg they were assessed as not critical



Multiple alarms with unclear possible consequence

- The change of character of the thrusters' order and feedback had a detrimental effect on the Dynamic Positioning of the PSV Sjoborg particularly for heading

- HEADING OUT OF LIMITS warnings or alarms are reported if the deviation between wanted and actual heading exceeds the operator specified alarm point
- Some important DP alarms and warnings were (the time stamps are approximate to Norwegian local time):

Time	Message	Additional info.
01:14:00	Heading out of limits	3.0 3.0
01:16:50	Tunnel bow 2 prediction error force	-23.0 -50.5
01:45:58	Azimuth aft STBD prediction error RPM	57.1 85.9
01:50:06	Azimuth aft STBD prediction error RPM	57.0 84.9
01:50:18	Azimuth aft STBD prediction error RPM	57.0 84.9
01:50:34	Tunnel bow 2 prediction error force	-21.1 -49.1
01:50:36	Azimuth bow 3 prediction error force	30.1 70.0
01:50:44	Heading out of limits	3.3 3.0
01:50:44	Azimuth aft PORT prediction error RPM	59.5 100.0
01:50:53	Tunnel bow 1 high force	80
01:50:53	Tunnel bow 2 high force	80
01:50:53	Azimuth bow 3 high force	80
01:50:54	Tunnel bow 1 not ready	
01:50:57	Azimuth aft STBD prediction error RPM	57.0 84.9
01:50:57	Heading out of limits	5.5 5.0
01:50:58	Azimuth bow 3 not ready	
01:51:09	Tunnel bow 1 prediction error force	-25.4 -71.2
01:52:07	Heading out of limits	3.3 3.0

Basis for decision making

- The purpose of alarm annunciation is to alert the operator when deviations from normal operating conditions occur
- The objective is to prevent loss of position and dangerous situations through operator intervention in response to the condition that was alarmed

- Excerpts from the DP maker's instructions regarding possible consequences of alarms and corrective actions related thereto:

Message	Possible consequences	Corrective actions
HEADING OUT OF LIMITS	Depends on the vessel's operation mode	Enable more propellers for DP or use the system selected heading if the system is in Auto mode to reduce power consumption
THRUSTER/RUDDER [#] PREDICTION ERROR	If the feedback loop is faulty the performance will be nearly unaffected. If the control loop is faulty unexpected movements may be the result.	If control seems to be degraded the thruster should be switched off

Industry guidance on DP alarm systems

IMO Maritime Safety Committee (MSC) Circular 1580
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.5 Alarms and warnings for failures in all systems interfaced to and/or controlled by the DP control system should be audible and visual. A record of their occurrence and of status changes should be provided together with any necessary explanations.

Marine Technology Society
DP Vessel Design Philosophy Document

19 ALARM MANAGEMENT

19.1 THE NEED FOR ALARM MANAGEMENT

19.1.1 An effective Alarm Management System should be incorporated into the design. Alarm management enables two fundamental functions:

1. Intervention.
2. Post incident analysis.

19.1.2 Poorly designed alarm management systems do not facilitate effective operator intervention. An effective design should facilitate:

1. Instant awareness of criticality and consequence.
2. Interpretation leading to effective response.
3. Focus and avoidance of alarm 'fatigue'.

Some perceived characteristics of typical alarm systems:

- Alarm management is at basic level
- Alarms are in abundance
- Priority of alarms is static
- Relationships between individual alarms are not considered
- Alarms do not respond to changes in the operating conditions
- Alarm points may not be properly customized
- Alarm texts are very technical
- Terminology is inconsistent across subsystems
- Instructions are unclear including possible consequences and corrective actions
- Alarms flood
- Alarm systems appear to be developed without consideration of human interaction
- → The industry needs help

Recommendations for learning (emphasis on alarm related factors)

- The investigation group recommends three learning packages related to the incident:
  - Learning package 1 (industry experience sharing) - Increased focus on the DP-system integration role
    - Strengthen the DP system integrator role during commissioning and operation including the responsibility of the equipment makers
    - Enhance the quality of FMEA documents and the equipment makers' involvement
    - Raise awareness of the importance of properly set alarm points, clear alarm messages and clear instructions
    - Increase competence on human factors in relation to alarms and alarm management
    - Improve familiarization onboard DP vessels to establish a common understanding of important alarms
  - Learning package 2 (PSV Sjoborg) - Improved quality in DP-system integration
    - Review and correct all technical findings after the incident
    - Assess the need for revising FMEA documents
    - Review the alarm points, alarm messages and instructions for some important alarms
  - Learning package 3 (SFA/Equinor) - Experience transfer from evacuation and personnel transfer

Learning after platform supply vessel collision with Statfjord A

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