DYNAMIC POSITIONING CONFERENCE
October 9-10, 2012

QUALITY ASSURANCE SESSION


Sue Wang, Bret Montaruli, Cornelia Wessel
ABS
Development of a Classification Guide for the Dynamic Positioning (DP) System

Sue Wang, Cornelia Wessel and Bret Montaruli
Offshore Technology Group

Houston, Texas
9-10 October 2012
Outline

- Background on the Guide Development
- DPS Enhanced System Notation
- DPS Stationkeeping Performance Notation
- Summary
Rapid Expansion of DP Demand

- Deep-water activity
- More complex field development
- Wider range of application
- Advancement of technology
- Industry expansion
Innovation & New Technology

- Robust redundancy concept
- Advanced computing technology
- Enhanced FMEA process
- Enhanced generator protection
- Advanced thruster control and protection
- Quick black-out recovery
- Comprehensive operation monitoring
Current ABS DPS Rules & Notations

- DPS notations
  - DPS-0
  - DPS-1
  - DPS-2
  - DPS-3
Other ABS Rules Related to DP Components

- **ABS Steel Vessels Rules**
  - Diesel Engines – Section 4-2-1
  - Gas Turbines – Section 4-2-3
  - Electric Motors and Motor Controllers – Section 4-8-3
  - Gears – Section 4-3-1
  - Shafting – Section 4-3-2
  - Propellers – Section 4-3-3
  - Piping System – Chapter 4-6
  - Thrusters and DP Systems 4-3-5
  - Control Equipment and Systems – Section 4-9-7

- **ABS MODU Rules**
  - Pumps and Piping Systems – Chapter 4-2
  - Electrical Installation – Chapter 4-3
  - Survey After Construction – Chapter 6-1

- **ABS Rules for Survey After Construction**
  - Machinery Surveys – Chapter 7-6
  - Shipboard Automatic and Remote Control Systems – Chapter 7-8
  - Survey Requirements for Additional Systems and Services – Chapter 7-9
Gaps between Industry & Class Rules

- Level of details
- Closed bus operation versus design requirement
- Recognition of enhanced safety features
  - Propulsion system
  - Position reference system and sensors
  - Risk level based on fire and flood tolerance design
- Criteria for stationkeeping performance
- Software quality management
- Software verification
- Compatibility on testing requirement within industry
Development of ABS DPS Guide

- General
- DP System Design
- Power System
- Thruster System
- Control System
- Marine Auxiliary System
- Initial Test of DP System
- Survey
- Enhanced DP System
- Stationkeeping Performance
- Specific Vessel Types
- Other Optional DP System Notations

Red: New Sections
New Notations for Enhanced System

- Notations
  - EHS-P for enhanced propulsion system
  - EHS-C for enhanced control system
  - EHS-F for fire and flood tolerance design

- Supplement information for DPS-series notations

- Provide three groups for flexibility and easy recognition

- Objective
  - Improve reliability, operability and maintainability
  - Recognize safety features that beyond minimum requirements
  - Encourage higher safe design standard
Enhanced Propulsion System EHS-P

- Applicable to DPS-2 and DPS-3 system
- Features on power plant protection and quick blackout recovery
- High safety measurement against closed bus operation
- Targeting reduced consequence of failure
EHS-P Requirement

• Enhanced generator protection
  ■ Failure detection and discrimination of failed components before a full or partial black-out situation occurs
  ■ Open the bus-tie if the faulty generator fails to trip
  ■ One protection system per generator

• Robust redundancy design
  ■ Autonomous generator sets
  ■ Autonomous thruster sets

• Fast automatic blackout recovery
Enhanced Control System EHS-C

- Applicable to DPS-2 and DPS-3 system
- Aiming for higher availability and reliability of input data to the control system
- Statistics point to the necessary of improvement
- Encourage for higher design standard

Incidents that led to loss of position 1994-2007

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP Computer</td>
<td>62</td>
</tr>
<tr>
<td>Environment</td>
<td>40</td>
</tr>
<tr>
<td>Power Generation</td>
<td>50</td>
</tr>
<tr>
<td>Operator Error</td>
<td>89</td>
</tr>
<tr>
<td>References</td>
<td>103</td>
</tr>
<tr>
<td>Thruster</td>
<td>76</td>
</tr>
<tr>
<td>Electrical</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>442</td>
</tr>
</tbody>
</table>
EHS-C Requirement

- Three position reference systems and sensors available at any given time
- A total of four position reference systems and four sensors with combination of different systems
- Redundancy of relative reference system for offshore support vessels
- A total of three DP control systems (one alternative)
- Equipment from different suppliers or using different principles of operation
- Utilization of Inertial Aided Navigation System
- DP Data Logger
Fire & Flood Tolerance Design EHS-F

- Applicable to DPS-2 system
- Provide another level of measurement for fire and flood tolerance design
- Focus on fire risk spaces
- Flexibility for diversified market needs
## Summary of Enhanced DP System

<table>
<thead>
<tr>
<th>EHS-P</th>
<th>EHS-C</th>
<th>EHS-F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autonomous Generator Set</td>
<td>2+1 backup DP control computers and controllers</td>
<td>Generators and Prime Movers</td>
</tr>
<tr>
<td>Bus Tie Breaker</td>
<td>Wind Sensors</td>
<td>Separate compartments, A60 for high fire risk area. Watertight below damage waterline</td>
</tr>
<tr>
<td>Redundantly configured between each bus segment</td>
<td>3 + 1 in back up control station</td>
<td></td>
</tr>
<tr>
<td>Enhanced Generator Protection</td>
<td>Gyros</td>
<td>Power Distribution System</td>
</tr>
<tr>
<td></td>
<td>3 + 1 in backup control station</td>
<td>A0 between redundant groups. Watertight below damage waterline</td>
</tr>
<tr>
<td>Enhanced Power Management</td>
<td>MRU</td>
<td>Thruster System</td>
</tr>
<tr>
<td></td>
<td>3 + 1 in backup control station</td>
<td>A0 between redundant groups. Watertight below damage waterline</td>
</tr>
<tr>
<td>Autonomous Thruster Set</td>
<td>Position reference systems</td>
<td>Controller Space</td>
</tr>
<tr>
<td></td>
<td>3 + 1 in backup control station</td>
<td>A0 between redundant groups</td>
</tr>
</tbody>
</table>
DPS Stationkeeping Performance Notation

- **Notations**
  - **SKP**: verification for given design environmental conditions through analysis
  - **SKP(a,b,c,d)**: determine limiting environments for a given environment site through analysis

- **Supplement information for DPS-series notations**

- **Objective**
  - Recognition of DP capability
  - Encourage robust design and consistent assessment
SKP Notation

- Owner specify limiting environment conditions
  - Design wind speed and directions
  - Design wave height, related period and directions
  - Design current speed and directions
- Station keeping performance assessment
  - Environment load calculation
  - Available thrust calculation including effect due to thruster interference with others
  - Proper thrust allocation algorithm
- Analysis results demonstrate the capability of stationkeeping for the specified environment conditions
  - Quasi-static approach 20% safety margin
  - Dynamic analysis approach 10% safety margin
Result Presentation for SKP

Total Thrust Utilization Plot for given Environment Condition
SKP(a,b,c,d) Notation

- **a**: the probability that the vessel can remain on station with all thrusters operating and for location **d** and current speed **c**
- **b**: the probability that the vessel can remain on station with the worst case failure condition and for location **d** and current speed **c**
- **c**: current speed in knot (owner specify or typical 1.5 kt)
- **d**: environment location (owner specify or typical North Sea)
- Same analysis procedures for load and thrust calculation
- May cover SKP if design environments are given and are within the limit
- Require for the relationship between wind speeds and wave heights
- Require probability of non-exceedance of wind speed
Result Presentation for SKP(a,b,c,d)

Typical DP Capability Plot
Summary

- DPS Guide to reduce the gaps between industry practices and class requirements
- New notations for enhanced system (EHS) and stationkeeping performance (SKP)
- Encourage robust design and higher safe design standard
- Provide more flexibility for owners and operators
- Need industry feedbacks for further improvement