ABB Seminar
Enhanced Operational Benefits for DP Drilling Vessels
Outline

- Introduction
- Key Facts _ ABB as a reliable supplier and problem solver
  - Long experience
- Safety through simplicity - New Products and Features
  - Diesel Generator & Monitoring System (DGMS)
  - Fast Restart After Blackout for DP operations (FRAB)
  - DriveMonitoring® and Remote Diagnostic System (RDS)
  - ABB thruster Azipod® for Drilling vessels
- Environment Friendlier Solutions /Reduced impact on environment
- Summary/Concluding Remarks
Introduction

Electric Power & Propulsion Systems for advanced oil & gas vessels

Availabilty is the game........
........simplicity and reliability is the name
Electric Power System
For Semisubmersibles and Drillships
Typical scope of supply for
-Semi Submersible type DP3

- 8 x Generators
  AMG 710@3600-4800kWe @900-720rpm

- Power Distribution system,
  - 4 x 11kV/60Hz Switchboards,
  - 690-440V Main Switchboards & MCC
  - 50- 3500kVA Transformers.

- 8 x Thruster drive system ACS800
  3300-4500kW@720rpm

- 8 x ABB Thrusters type CZ 3300-3800kW

- Drilling Drive System ACS800
  2-4 x 4000-7500kVA

- Calculation, Analysis
- Interface engineering
- Commissioning
Typical scope of supply for Drillship type DP3

- 6 - 8 x Generator AMG AMG900@ 5000-7400kW@720rpm

Power Distribution system,
- 2-3-4 x 11kV/60Hz Switchboards,
- 690-440V Main Switchboards & MCC
- 400 - 4000kVA Transformers.

6 -8 x Thruster drives system
ACS6000/800 4000 - 5500kW@720rpm

6 x ABB Thruster type CZ 3300-4500kW

Drilling Drive System ACS800wc
2-4 x 4000-7500kVA

- Calculation, Analysis
- Interface engineering
- Commissioning
In total 70 references for DP Drilling vessels from 1994

Stena Drillmax from SHI

Deepwater Champion & Deepsea Metro from HHI

West Sirius & West Taurus from Jurong Shipyards
Safety through Simplicity
Availability and Reliability
Statistics
Root Cause for Blackout (by Petrobras)

- Relative increase in human/operator errors
- Relative reduction in technical failures

Pallaroro, A.A.:
DPPS – A Petrobras DP Safety Program; Keynote Speech DPC 2005
Improvements in Technical Solutions
Potentials to Enhance Safe Operation

- **Fast load reduction**
  - Direct Torque Control, DTC, with fast response time
  - Independent frequency monitoring
  - Event based load reduction

- **Diesel Engine and Generator Monitoring System (DGMS)**
  - Advanced monitoring and protection system
  - First installation in operation since 2005

- **Fast Recovery after Blackout**
  - Critical review of start-up sequences and time delays
  - Battery backup to reduce start-up times
  - Keep low complexity to reduce chance for failures in start-up sequence
Important Technical Advances 1990 - 2010
From 4th to 6th Generation Drilling Rigs

- **Protection System**
  - From analog to digital protection relays
  - Multifunction and programmable logic
  - PLC based monitoring and protection

- **System Design**
  - Focus on functional integration, established industrial standard practices for interfacing
  - Simplicity in integration, reduced complexity

- **Thruster Drives**
  - From constant speed electric motors to VFD
  - Voltage source inverters with lower harmonics
  - Fast load control with PWM and DTC
  - Lower kVA loading of the generators
  - Higher reliability and MTBF

- **Power Management System**
  - Faster controllers
  - Better functional integration with the electric power system
Enhanced Blackout Prevention: DGMS - Diesel Engine and Generator Monitoring System

- PLC based system
- With supplementary protection system to those required by class:
  - Voting
  - Correlation
- System is in operation

Voting algorithm

Trig limit and time delay settings

Demagnetize
Disconnect
Excitation Alarm
Excitation Fault
DGMS - Principles of Functionality

- Voting
  - Three or more gen-sets in parallel
  - Abnormal behavior (deviation from average) is detected by voting
  - Voting in common PLC

- Correlation
  - Relations between:
    Voltage – Reactive Power Output
    Frequency – Active Power Output
  are analyzed by correlation algorithm
  - Abnormal behavior (deviation from normal regulation) is detected
  - Independent monitoring
- Hot standby feature during main and auxiliary supply interruption, e.g. blackout
- Standby time up to 10min without auxiliary supply feeding the water cooling unit
- During standby converter remains energized and enables restart of drive with minimum delay after main and auxiliary supply is restored in the power network.
- Available as in-build feature for new deliveries or as upgrade kit for already delivered and operating converters.
- Autonomous thruster system restart control functionality within drive control unit (optional).
Critical Review of Restoration Sequence

- Reduce Restoration Time

Integrated Automation & Thruster Control

Power OK

Drive

Running

Ride-through & Under-voltage function active

Power & Distribution Network

Running

Alarm

Fault

Loss Main/aux. Supply

MCB opens on under-voltage

Blackout

3s

Blackout Sequence

Rdy To Start

Backup charging active

Start

max. 1,0s

Motor Magnetizing, Flying Start

min. 6,0s

Motor Torque Release

Running

Auxiliaries & Steering Pump running

Running

Main & Aux. Power OK
Summary

- Since 4th generation rigs, power plant reliability is improved
  - Variable speed thruster drives
  - Fast power reduction
  - More sophisticated and robust protection relays
- Yet room for improvements
  - Blackout prevention
    - Build in functionality in DP, PMS, and thruster drives
    - Essential to coordinate and functionally integrate
    - Diesel Engine and Generator Monitoring Systems
  - Blackout restart time
    - Can be reduced by additional components
    - Must be evaluated case by case, as increased complexity inevitable gives more failure modes
    - Must be robust to ensure reliable restoration
Diagnostics for Marine

RDS
Remote Connection
-Architecture in general

Virtual Support Engineer
(Local application)

Service Center

Internet

ABB’s Customer

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DriveMonitor™: Monitoring, Fault alarm & parameter tracking

DriveMonitor™

DDCS OPTIC

FAULT?

ALARM?

Fault alarm notification

Drive Monitor Application (ver. 1.0.2147.24231)

Events | Loggers | Signals | Parameters | Monitor
---|---|---|---|---
Event: MCB Trip/Resignal
Kind: Alarm/Fault
Severity: Fault
State: Active
0 | 2005/11/17 14:42:03

Type | Variable Name | Unit | Value | Color
---|---|---|---|---
02.03 | DC VOL | % | 53.999 | Yellow
02.10 | NPEMUL | V | 1.36.03 | Green
05.01 | MCB Ope... | | | 
05.02 | MCB Ope... | | | 
05.03 | MCB Ope... | | | 
05.10 | MCB Sta... | | | 
05.11 | MCB Sta... | | | 
05.12 | Modulat... | | | 
05.13 | Modulat... | | | 
05.14 | Modulat... | | | 
05.15 | Modulat... | | | 
05.16 | Modulat... | | | 
05.17 | INU-VLU | | | 
05.18 | FC2 Time | | | 
05.20 | Emergency... | | | 
05.21 | Event | | | 
05.22 | Change | | | 
05.23 | Track | | | 

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RDS single line diagram, -Drillship
ABB Thrusters type CZ for Drilling Vessels
Azipod® products and applications for Drilling vessels

- Introduction

- ABB Thruster type CZ
- Drilling vessel version with nozzle
- 3.0 – 3.8 MW for Semisubmersible
- 4.5 MW for Drillship
- 63-84t efficient thrust
- No gears between motor and propeller.
Azipod CZ1400L-R2300
- Main data and features

- Underwater mountable, focus on short installation time to vessel – steering gears and slip rings under the inner dome
- Propeller shaft tilted 7 degrees, minimum thruster-hull interaction
- Design draught 30m (shaft line), installation draught up to 50m. Propeller design for 10m ship draught (drill ships) and for 20m shaft line draught (rigs).
- Wet weight 43 tonnes / dry weight 70 tonnes
- Design is based on the 10 years experience of existing Azipod C modules
Azipod CZ1400L-R2300
-ABB thruster room layout

Azipod room design guidelines for drill ships:

- E.g. 3 x 46 tonnes strand jacks to be used for Azipod lifting, located above water level
- 3 x guide tubes equipped with drain valves
- No space needed for thruster motor
Motor module cooling

DIRECTLY COOLED TO SEA
ABB thruster

Lube oil supply
Lube oil return
Gravity tank line
Oil + air piping
Power cables
Bearings
High speed swivel unit

Gear
Definition of Tilt Angle

- Adjusting the angle of the propeller shaft line relative to horizontal
Coandă effect

- Coandă effect pulls the thrust stream towards the pontoon (hull).
- By looking down 7° we can avoid the thrust reduction
Azipod CZ1400L-R2300
- Performance –very low thrust losses –semi-sub example
ABB Thrusters provides also the following benefits:

- Lower power demand
- Less noise and vibrations onboard
- Less space needed inside the vessel
- Environmentally friendly due to minimun amount of lubrication oil, and high efficiency
- Thruster unit cooling directly to the sea, no extra capacity to vessels cooling system are needed
Units delivered or on order: 75 pcs
- Azipod® CO: 50 pcs
- Azipod® CZ: 25 pcs

Vessels, total number: 26 vessels
- Supply vessels: 4
- Ferries: 4
- Research vessels: 5
- Yachts: 7
- Tankers: 1
- Drilling rigs: 2
- Crane vessels and Heavy Lift vessels: 2
- Wind Turbine Installation vessels: 1
Global Santa Fe DD 1 and DD 2 rigs

“The Azipod CZ thrusters installed on Development Driller I and Development Driller II have today (April 16th, 2009) over 450,000 cumulative operation hours.

The Azipod CZ Thrusters have provided Transocean the reliability and efficiency necessary in DP operations”

(Transocean April, 2009)

- Azipod CZ1400 – R1800
- Propulsion power 3,2 MW
- Available static thrust 62 metric tons
- 8 x Azipod CZ + 1 spare pod (total 17 pcs)
- Delivery: 2003, 2004
Summary

- ABB thruster is structurally simple with few moving parts
- The main motor unit is directly cooled to surrounding water
- Easy to tilt the motor module
  - Tilting the motor module gives hydro dynamically 4 to >10 % advantage in thrust compared to thrusters with tilted nozzle
  - With 7º tilt angle it has been possible to eliminate thruster hull interaction effects
- Lack of gear wheels decreases power demand about 3 % per gear
- ABB thrusters require about 9-13 % less installed power compared to mechanical thrusters with tilted nozzle
Environment friendlier solutions
"Green Aspect"
### Legislation

**- More Stringent IMO MARPOL Convention**

<table>
<thead>
<tr>
<th>Air</th>
<th>Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MARPOL Annex VI</strong></td>
<td>- <strong>Control of emissions to air</strong></td>
</tr>
<tr>
<td><strong>Kyoto Protocol</strong></td>
<td>- <strong>Requires reduction of CO₂</strong></td>
</tr>
<tr>
<td><strong>Montreal Protocol</strong></td>
<td>- <strong>Ozone depletion, reduction of greenhouse gases</strong></td>
</tr>
<tr>
<td><strong>MARPOL Annex I</strong></td>
<td>- <strong>Oil pollution prevention</strong></td>
</tr>
<tr>
<td><strong>MARPOL Annex V</strong></td>
<td>- <strong>Handling of garbage</strong></td>
</tr>
<tr>
<td>'German Rule'</td>
<td>- <strong>Law in Germany, but wide international acceptance</strong></td>
</tr>
<tr>
<td></td>
<td>- Sludge generation equivalent of at least 1.5% of daily fuel consumption</td>
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<tr>
<td></td>
<td>- Vessels using HFO produce 2.0–2.3% of daily fuel consumption as sludge</td>
</tr>
<tr>
<td><strong>MARPOL Annex I</strong></td>
<td>- <strong>Oil pollution prevention</strong></td>
</tr>
<tr>
<td><strong>MARPOL Annex II</strong></td>
<td>- <strong>Control of harmful chemicals</strong></td>
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<tr>
<td><strong>MARPOL Annex IV</strong></td>
<td>- <strong>Treatment of sewage</strong></td>
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<tr>
<td><strong>IMO International convention of Ballast Water Management</strong></td>
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<tr>
<td><strong>US Clean Water Act</strong></td>
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Speed Controlled Electric Auxiliary
- Approximately 5% reduction

Electric Auxiliaries
- Sea water pumps
- Fresh water pumps
- Ventilation and HVAC fans
- Compressors

Process Loads
Cargo pumps
Winches
Cranes

<table>
<thead>
<tr>
<th></th>
<th>Fuel reduction</th>
<th>Reduced CO2 emissions</th>
<th>Reduced NOX emissions</th>
<th>Fuel cost reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>495 816 kg/year</td>
<td>1 586 611 kg/year</td>
<td>19 833 kg/year</td>
<td>297 490 USD/year</td>
</tr>
</tbody>
</table>

MDO cost: USD600/MT, ex taxes
NOx: IMO Tier II
Financing the Environmental Friendly Solutions by the -Reduced Fuel Costs

- Energy efficiency has traditionally not been a key focus in drilling vessel design and construction. But today the shipping industry in general is adapting to a new reality with stringent environmental regulations and high, uncertain fuel prices.

- The most effective way to reduce CO2 emissions is by cutting fuel consumption.

- Installing Variable Speed Drives on auxiliary motors gives significant savings in CO2, SOx, NOx and dollars.

- The fuel emissions and savings generated by Variable Speed Drives may surprise you. As shown on the next slide, a single seawater cooling pump can save USD 29,000 and 117 tons of CO2 per year. When applied vessel-wide these savings can be tremendous.
Financing the Environmental Friendly Solutions by the Reduced Fuel Costs

- **Today:** Over-dimensioned and under-utilized
  
  - 10% speed reduction = 27% fuel reduction
    
    - By equipping a pump/fan motor with a VSD, the pump/fan will always run at the correct speed to meet current flow and pressure requirements. This greatly reduces energy usage.

- **Variable Speed Drives vs. manual control**

![Diagram showing power consumption for different flow control methods. The grey area represents the energy savings generated by using a VSD instead of manual throttling.]
Summary
How can ABB support shipyard
How can ABB support shipyards making vessels with reduced impact on the environment.

- By using carefully selected products with high efficiency as main components in the power and propulsion plant.
- By using ABB Thrusters as the preferred thruster system.
- By using Variable Frequency Drives (VFD) also for smaller auxiliary motors (Pumps, Compressors, Fans, Steering motor etc.)
- By using DGMS and FRAB provides increased availability with minimized efforts and additional components.
- By using Remote Diagnostic that provides faster problem solving for operator and higher availability of the system.
- Design philosophy is that new elements must not create new failure modes and reduce reliability (avoid hidden failures).
What are the benefits from ABB Thrusters for the shipyard.

- Easier assembly and installation. (Shorter installation time)
  - Azipod means Simple layout in thruster room, fewer components.
  - Equipment excluded by use of ABB thruster (Drillship):
    1. 6 x 140kW HPU motor for steering gear
    2. 6 x 14kW HPU motor for maintenance pump
    3. 6 x 10KW lube oil pump
    4. 6 x 4 tanks:
       1. Oil tank for steering HPU (50ltr.)
       2. Gravity tank for sealings (30-40 ltr.)
       3. Expansion tank for lube oil (400-500ltr.)
       4. Expansion tank for steering gear lube oil (30-40 ltr.)
    5. 6 x Heat dissipation HPU (20kW) versus 3-10kW for ABB steering.
    6. Heat dissipation lube oil unit 120kW
Other benefits for the shipyard.

- Easier commissioning.
  - By using standardised and uniform equipment.
  - By utilizing Diagnostic tools (DriveMonitor™) during commissioning, as commissioning tool for easier access and more efficient start-up of VFD’s
- No shaft alignments between el. Motor / thruster shaft.
- No need for huge amount of oil
  - ABB Thruster  85 ltr. x 6 = 510 ltr.
  - Mechanical thruster approx. 5000 ltr. x 6 = 30.000 ltr
Other benefits for the shipyard.

- Marketing vessels with less fuel consumption and emissions supporting a "green" profile which will be attractive for the oil companies and thus the vessel owners/operators.

- Electrical power and propulsion plant already prepared for Remote Diagnostic and Maintenance which will be attractive for owners/operators.

- Marketing vessels with features supporting improved powerplant availability and safety through simplicity.