DNV RULES FOR CLASSIFICATION OF DP SYSTEMS

Development, present focus areas and future directions
MTS DP 2013 Luncheon presentation

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Agenda

- Background
- DNV Rule development process
- DNV Rules and Standards related to DP
- Development within DP rules
- Present challenges influencing DP rule development
- Possible future rule development
- Present focus areas, incl. power systems operating with closed bus-ties
- Summary
Rule development

- Safeguarding life property and the environment (MTS: Incident free operations)

- Support the industry:
  - Technically (to support safe operations)

- Cooperation
  - Industry
  - Authorities
  - Universities and other research institutions

- Manageable pace:
  - Not to fast
  - Not to slow

- Incidents and accidents

- Politics

- IMO and other regulators

- Consistency and transparency is very important
DNV Rule development process

1. Need for rule change
2. Get Funding
3. Write proposal
4. Internal hearing
5. Internal comments concluded
6. Update proposal
7. External hearing
8. External comments concluded
9. Update proposal
10. Approval of rule proposal
11. Rules published
12. Rules in force (0.5 year after publ.)

Typically 15 to 24 months
Typical characteristics for such class 2 systems from the early days:

- No single fault shall cause a catastrophic failure
- Never exceed vessel’s capabilities
- Capable personnel
- FMEA
- Withstand the loss of one thruster
- Withstand the loss of one diesel generator
- Withstand the loss of one switchboard
- No failure to full thrust allowed for any propeller (note, almost all where CCP, and would typically have such a failure mode anyway)
- Three position references: 2 on line + one standby
- Redundant DP control system, or non-redundant + Joystick
If one should make an attempt to update the same list of characteristics based on today’s high end class 2 and 3 standards it might look something like this:

- No single fault shall cause a loss of position or heading (to avoid catastrophic events)
- Never exceed vessel’s sub failure capabilities, which is to be continuously monitored by the automatic DP control system
- Consequence Analysis
- Capable certified personnel and higher focus on operational aspects
- Designated workstations for DP operations
- FMEA, generally to a higher standard and often based on more than one “technical system operational mode” with inherent different integrity towards loss of position
- Withstand the worst case relevant failure mode
- Systems split in more than two redundancy groups
- More complex power systems
- Desire to operate with closed bus-ties
- No failure to full thrust allowed for any propeller (RPM control is the state of the art and the failure mode is easier mitigated on these thrusters as compared to CPP)
- (At least) Three position references: All on line
- Redundant DP control system + Joystick + Manual levers
- Back-up non-redundant DP control system for DP class 3
Todays DNV DP rules and other DP related standards
DP Industry and market, some present challenges…

- **Constant development (at a high pace):**
  - More suppliers of DP equipment and DP vessels
  - New operations being performed on DP, often in new and challenging environments (e.g. Arctic)
  - New designs and new technology (e.g. to be environmental friendly)
  - New ways to apply existing technology
  - More integration and automation
  - Closed bus-ties
  - New verification tools and methods
  - Complex and flexible systems, verification and testability is a challenge
  - Fight between being safe and environmental friendly
  - New rules and standards
  - …

- **Growth**
  - Both in high-end and low-end
  - High-end set very strong requirements on class
  - Other parts of the market are more focused on “getting the certificate”

- **Clear and up-to-date rules, being consistently applied**
Future? Some predictions/guesses…

- “All” vessels have automatic capabilities (can provide safer and more environmental friendly operations)
- This will probably also include DP capabilities
- Some functions will be standardized, others will be even more specialized
- Existing propuls./thruster/steering control vendors may implement such standard automatic functions
- More specialized DP control system vendors?
- DP 0 and 1 Notations disappears?, since the standard functions will always be delivered?, => part of main class?
- Capacity assessment will become more important and requested -> new standards
- More involvement from Flag states (IMO)
- Even more use and further focus on development of redundant system designs and notations
Possible future rule development focus/trends

- Introduction of new verification tools and methods
- Continue focus and development on systems designed for close bus-tie(s), operation with generators belonging to different redundancy groups running in parallel
- New standards for DP Capacity verification (also during failure conditions including WCF conditions)
- Higher focus on FMEA verification and testing
- Higher focus on Online Consequence Analysis, must reflect flexibility and limitations
- More vessel/vessel type specific requirements
- Rules for new technologies (e.g. use of batteries…)
- High focus on integration of control systems and software dependent systems
- Class scope for annual trials; better correlation with industry/IMO guidelines
- Very often such new initiatives will be introduced to the market in form of recommended practices or other guideline documents.

Voluntary additional class notations
Main class
New verification tools and methods, ESV

Background:
DNV sees the need for basic research and further development on verification methodologies and services.

- Why this need?
  - Completely different conditions
    (this is well known...)

- But equally important...
  - Completely different toolbox
What provides valuable verification benefit?, «test smarter»

- CMMI - RP
- ISO 17894
- IEC 61508
- FMEA
- HIL
- FSA - Risk
- Risk based ver
- ISDS
- SQALE
- MBE
- SCM
- Complex system

Process → Product → Performance
DP Power system trends
DP Power system trends
DP Power system trends
Example traditional DP-3 notation

\[ F_{\text{weather}} = F_{\text{wind}} + F_{\text{waves}} + F_{\text{current}} \]

\[ F_{\text{Thrusters}} = F_A + F_B + F_C + F_D = F_{\text{weather}} \]
Example DYNPOS-ER system

\[ F_{\text{weather}} = F_{\text{wind}} + F_{\text{waves}} + F_{\text{current}} \]

\[ F_{\text{Thrusters}} = F_A + F_B + F_C + F_D = F_{\text{weather}} \]
Closed bus power system integrity

This gap must be so small that the IMO 645 intention of equivalent integrity is achieved.

DP-2 Variable closed bus integrity

Expected and wanted development for DP-2 power system integrity

DP-2 closed bus specification 2013

DP-3 open bus-ties

DP-3 closed bus 2013

(Illustrations are not scaled)
<table>
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<tr>
<th>Failure Modes:</th>
<th>Minimum analysis and test requirement DP-2 (DP-3 has extensive additional requirements):</th>
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<tr>
<td>Short circuits, earth failures:</td>
<td>Selectivity between generator breakers and bus-tie on short circuit, in form of a discrimination analysis.</td>
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<td>Over load:</td>
<td>Overload required to be handled by functionality in control systems (PMS, DP, Switchboard logic), control system documentation, FMEA and functional testing at DP/PMS/FMEA trials. (Can I/O failure between DP/PMS/SWB be a hidden failure?)</td>
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<td>Governor failures:</td>
<td>Analyse and test all these.</td>
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<tr>
<td>Overvoltage and AVR, failure scenario:</td>
<td>Over excitation/expiation break-down/under excitation, to be analysed in the FMEA analysis. FMEA test requirement: loss of excitation (power or no output), loss of sense or over excitation (disconnect CT feedback or increase excitation).</td>
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<td>Failures related to PMS and active load sharing:</td>
<td>Analysis, functional testing. FMEA test: Power failure, network failure (disconnect), PMS I/O failure testing required as found necessary in FMEA analysis, load sharing line failure (disconnect).</td>
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| Transient under voltage (short circuit ride through): | The FMEA must analyse the effect of transient voltage dips in the system and identify measures necessary to avoid problems with:  
• unintended tripping of frequency converters  
• unintended deselection of thrusters from DP control (e.g. loss of ready signal from drives to DP control system)  
• unintended tripping of motors and other important components, like auxiliary system pumps (tripping of motor starters and/or contactors)  
• unintended activation of under voltage protection systems  
• DC control power systems, e.g. dual feeding through diodes or automatic change-over  
In relation with the above items, functionality must be checked in order to verify the potential effect of this failure mode.  
The requirement is that the equipment not belonging to the redundancy group directly affected by the failure shall ride through the transient period and be immediately available, without operator intervention, when the system voltage is re-established. Measures must be implemented as found necessary through analysis. No “short circuit test” requirement. (Additionally, or as an alternative, verification of the above mentioned items may also be based on testing. Such testing should be based upon non-destructive methods for simulating the transient low voltage period in the system.) |
| DP-3: Generator Protection (GP) systems | A system to detect failures not addressed by traditional generator and switchboard protection systems and to take appropriate action to prevent black-outs must be installed. |
| DP-3: Live short circuits must be introduced at the main switchboard level. Short circuit tests may be required for all power systems (AC, DC, UPS) if these are crossing the redundancy groups: |  
• Short circuit 3-phase  
• Short circuit 1-phase  
• Earth faults  

More additional DP-3 failure modes:

Examples of failure modes to consider can be found in DNV FMEA RP-D102.
Summary

- Keep up with the development in the industry:
  - Technically
  - Operationally
  - Political

- Push and pull in the direction of improved minimum requirements

- Be active and cooperate with the industry in setting new standards

- Consistency and transparency
Safeguarding life, property and the environment

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