New initiatives related to classification of DP systems

MTS DP 2010 Quality assurance session

Aleks Karlsen
October 13th 2010

Return to Session Directory

MANAGING RISK

Content

- Background and DP class development 1975-2010
- Standards facilitating diversified market needs
  - New DPS notations
  - New DYNPOS-ER notation
- Enhanced System Verification (ESV) notation
- Guideline for FMEA of redundant systems
- Summary

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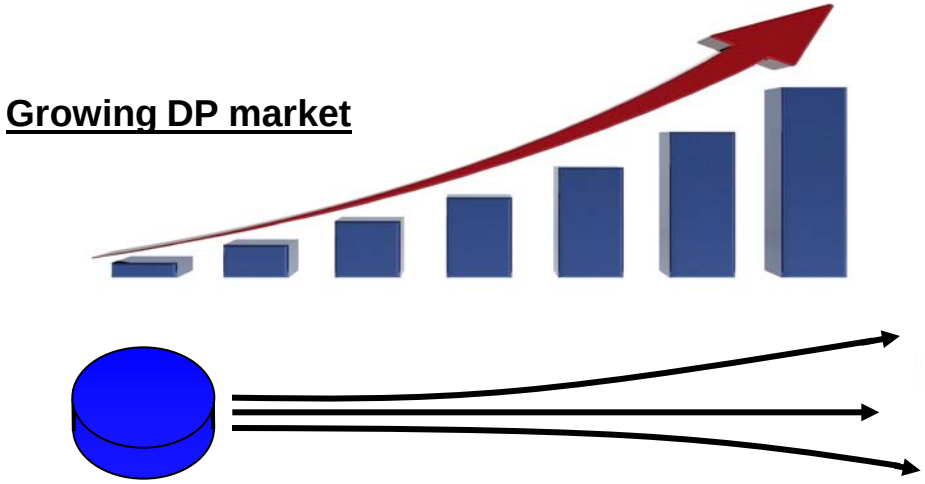
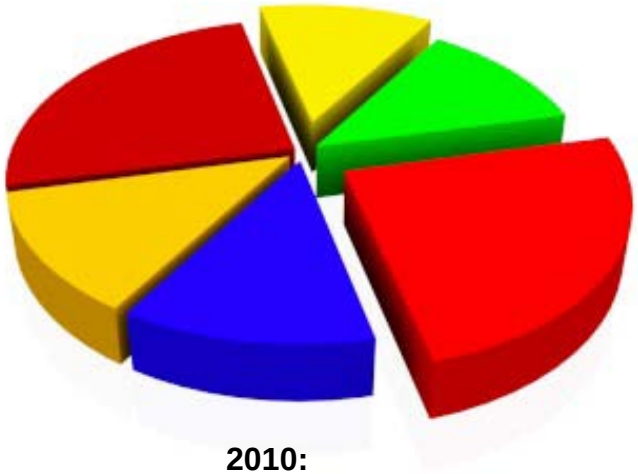
Market development from 1970's - 2010

Growing DP market



Diversified needs in the DP market

- **Vessel type**
- **Technology**
- **Operation / risk / verification needs**
- **IMO MSC/Circ 645 interpretations**
- **Harsh / benign waters**
- **…**



1977

4 DYNPOS Notations

1994

IMO MSC/Circ 645

2010:

4 DYNPOS Notations

4 DPS Notations

} **IMO MSC/Circ 645**

1 DYNPOS-ER Notation

ESV-DP[HIL]

FMEA Guideline

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New DPS notations

Pt.6 Ch.7 Dynamic Positioning Systems

IMO equipment class	*DNV class notations*
Not applicable	**DPS 0**
	DYNPOS-AUTS
IMO equipment class 1 (No redundancy)	**DPS 1**
	DYNPOS-AUT
IMO equipment class 2 (Redundancy in technical design)	**DPS 2**
	DYNPOS-AUTR
IMO equipment class 3 (Redundancy in technical design and physical separation of systems)	**DPS 3**
	DYNPOS-AUTRO

For the DYNPOS series additional requirements to achieve higher ***availability and robustness*** as compared to DPS will apply.

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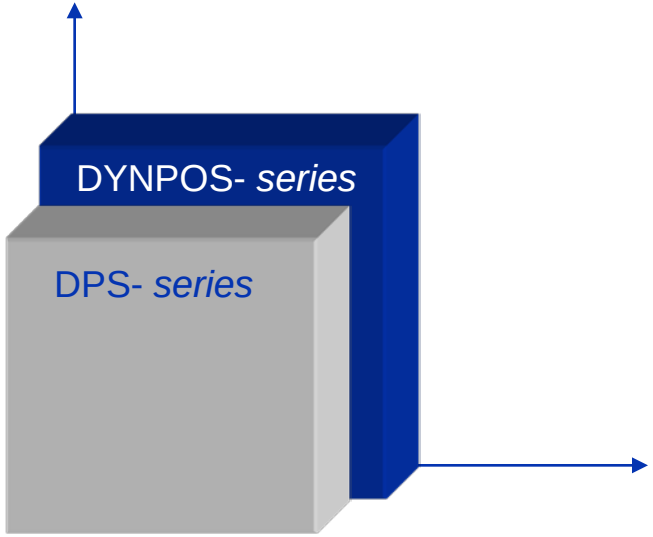
New DPS notations

- Parallel to the existing DYNPOS notations
- Less stringent – more flexibility
- Technically acceptable in some markets
- Correspond to the IMO MSC/Circ. 645 DP equipment classes
- DYNPOS notations are unchanged



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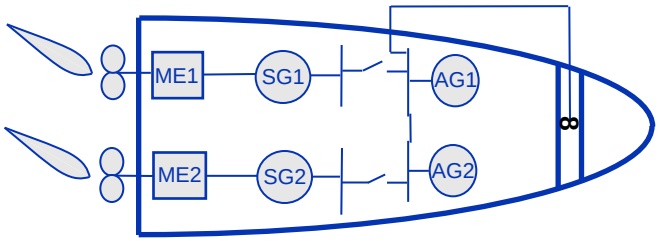
Main differences between DPS- and DYNPOS-series

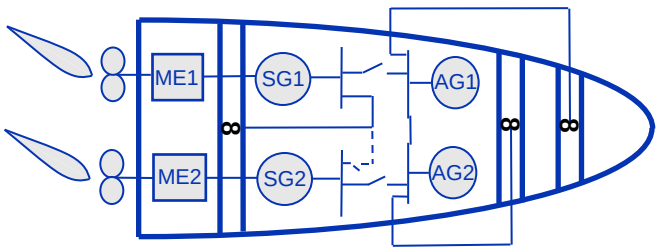
- **Minimum thruster configuration:**

  (Accepted by DPS / Not accepted by DYNPOS)

DPS 0/1



DPS 2



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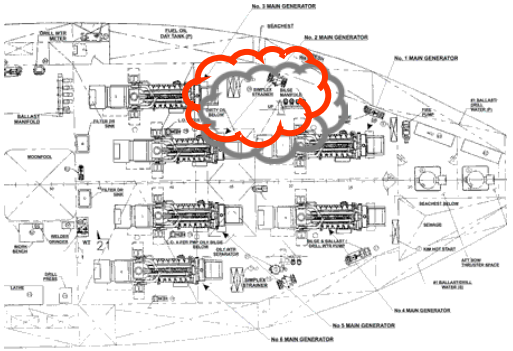
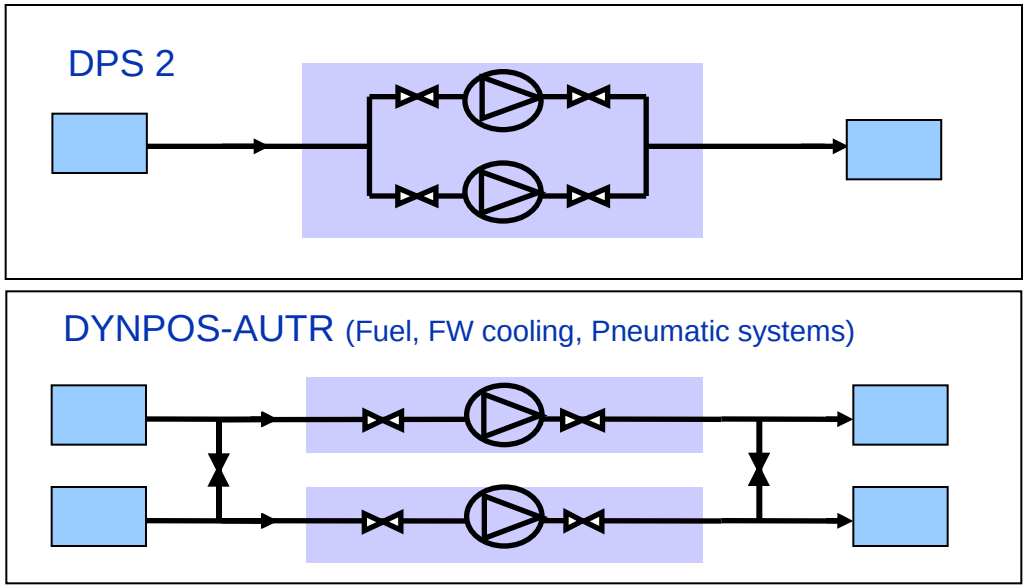
Main differences between DPS- and DYNPOS-series

- ***Auxiliary systems DPS 2:***

  Reference is made to IMO MSC/Circ.645:

  - *"Part 2.2.2 "… **Normally static components will not be considered to fail where adequate protection from damage is demonstrated**,…*
  - *static component (cables, pipes, manual valves, etc.)…"*





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Main differences between DPS- and DYNPOS-series

Table C2 Comparison table for the main differences between the DPS-series and the DYNPOS-series of notations.
(For complete overview of the differences the whole rule chapter must be considered.)

Technical item:	*Rule reference*	*Class notations*							
		DPS 0	DYNPOS-AUTS	DPS 1	DYNPOS-AUT	DPS 2	DYNPOS-AUTR	DPS 3	DYNPOS-AUTRO
Thruster configuration without stern thrusters, i.e. side thrust based on combination of rudders and propellers.	Sec.4 A201 & A301	Yes	No	Yes	No	No	No	No	No
Redundancy can be based upon change over of a single stern thruster.	Sec.2 B202 & 204	NA	NA	NA	NA	Yes	No	No	No
Additional monitoring requirements for steering gear.	Sec.4 A104	No	Yes	No	Yes	No	Yes	No	Yes
Power Management System required.	Sec.5 C101	No	No	No	No	No	Yes	No	Yes
Common static components may be accepted in redundant fuel oil, fresh water cooling and pneumatic systems.	Sec.6 B101 & Sec. 2 B401	NA	NA	NA	NA	Yes	No	No	No
Number of VRSs required.	Sec.2 C101 & Table C1	1	1	1	1	2*	3	3	3
Loop monitoring of emergency stop loops.	Sec.4 A405	No	No	No	No	No	Yes	No	Yes
HMI for position reference systems required outside DP-control system operator station(s).	Sec.3 E200	No	Yes	No	Yes	No	Yes	No	Yes
Main DP-control system shall include a joystick mode.	Sec. 3 C107	No	No	No	Yes	No	Yes	No	Yes
ERN required.	Sec.1 A701 & Sec.7	No	Yes	No	Yes	No	Yes	No	Yes
Class entry from other class societies will be based on corresponding valid notation from loosing class society.	Sec.1 A600	Yes	No	Yes	No	Yes	No	Yes	No
Class entry from other class societies requires documentation approval and testing (functional and FMEA) at entry.	Sec.1 A500	No	Yes	No	Yes	No	Yes	No	Yes

NA = Not Applicable

* Where necessary for the correct functioning of position reference systems, at least three vertical reference sensors are to be provided for notation **DPS 2**. If the DP-control system can position the ship within the operating limits without VRS corrections, only 2 VRSs are required.

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Rules for Dynamic Position Systems

RULES FOR
CLASSIFICATION OF

SHIPS

PART 6 SPECIAL EQUIPMENT AND SYSTEMS — ADDITIONAL CLASS

Chapter 1 Miscellaneous Notations . . . July 2010
Chapter 2 Redundant Propulsion . . . January 2003
Chapter 3 Periodically Unattended Machinery Space . . . July 2010
Chapter 4 Additional Fire Protection (**F-AMC**) . . . July 2006
Chapter 6 Centralised Cargo Control for Liquid Cargoes . . . January 2003
Chapter 7 Dynamic Positioning Systems . . . July 2010
Chapter 8 Nautical Safety . . . July 2010
Chapter 9 Loading Computer Systems (LCS) for Stability and Longitudinal Strength . . . January 2005
Chapter 10 Vapour Control Systems . . . January 2003
Chapter 11 Hull Monitoring Systems . . . January 2005
Chapter 12 Environmental Class . . . July 2008
Chapter 13 Gas Fuelled Engine Installations . . . January 2010
Chapter 14 Fuel Treatment and Conditioning Systems . . . July 2006
Chapter 15 Vibration Class . . . July 2004
Chapter 16 **NAV-O** Class Notation . . . January 2007
Chapter 17 Safety of Navigation for Naval Vessels . . . January 2005
Chapter 18 Ballast Water Management . . . July 2010
Chapter 19 Alternative Propulsion . . . July 2010
Chapter 20 Nautical Safety - Offshore Service Vessels . . . July 2006
Chapter 22 Enhanced System Verification . . . July 2009
Chapter 23 Fuel Cell Installations . . . July 2008
Chapter 24 **SILENT** Class Notation . . . January 2010
Chapter 25 Systems and Arrangement for Meeting Regulations in Emission Control Areas (ECA) . . . January 2010
Chapter 26 Dynamic Positioning System - Enhanced Reliability **DYNPOS-ER** . . . July 2010
Chapter 27 Recycling . . . July 2010

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New DYNPOS-ER notation (Enhanced Reliability)

Background

- More diversified market needs
- Technology development
- Standby/change-over/closed bus-ties

Industry drivers

- Flexibility
- Reliability
- Fuel economy
- Environment

Approach

- New principles and philosophies
- Target specific failure modes
- Advanced protection systems
- More autonomous thrusters and generator sets
- Separation of systems

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Highlights DYNPOS-ER

High integrity towards loss of position and heading

- meeting intentions comparable to or exceeding IMO equipment class 2 and 3

No direct relation to IMO MSC/Circ.645

- is not classified in terms of IMO equipment classes

Additional option

- may be used in combination with the other DP notations

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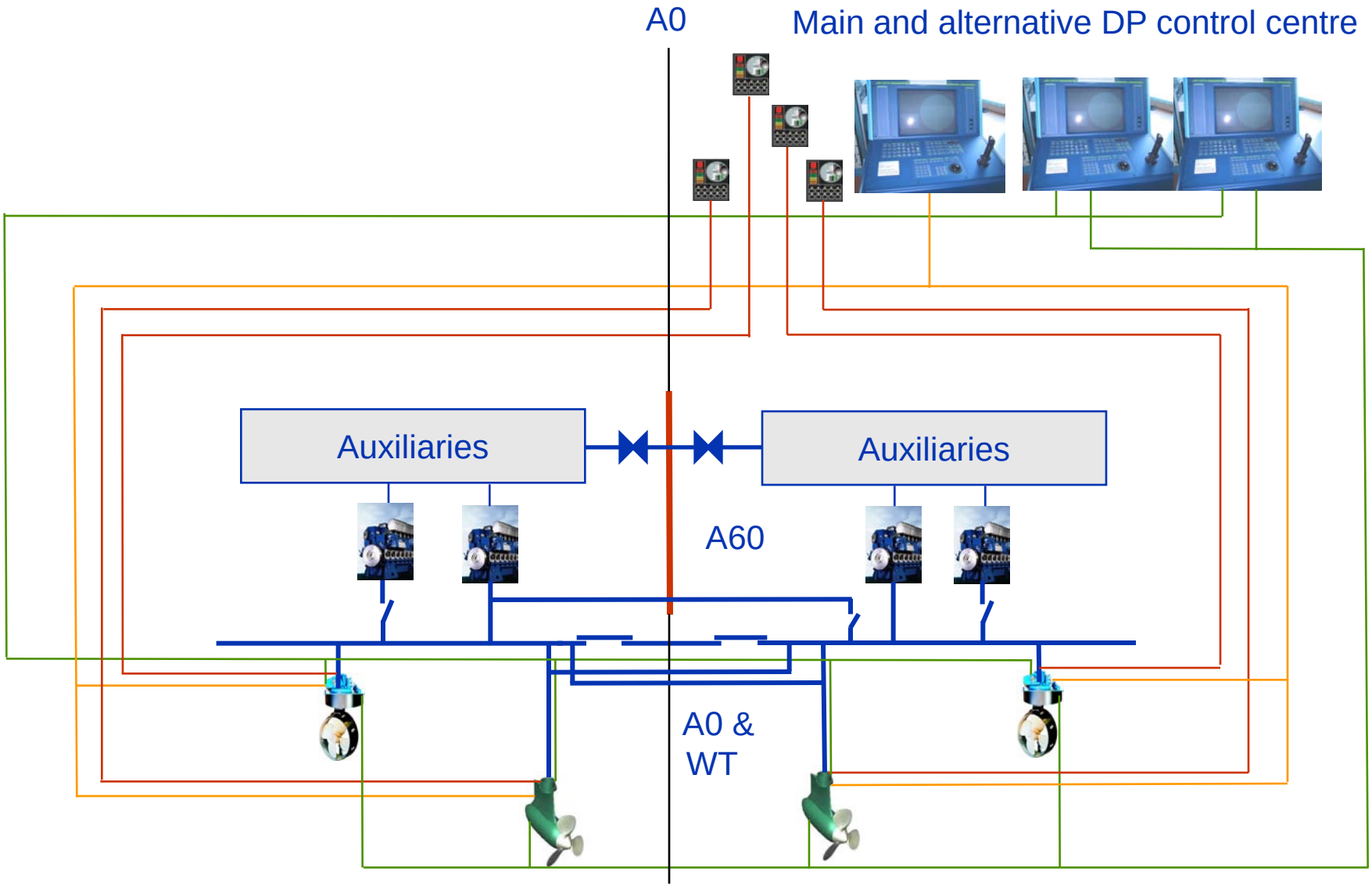
DYNPOS-ER basics



Challenges

- Documentation and verification
  - (e.g. FMEA)
- To maintain and ensure the integrity throughout the vessel lifetime
- Testability
  - (use of ESV-DP[HIL] will increase the verification level)

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Technology development

Mechanical ship ➔ computer-based ship

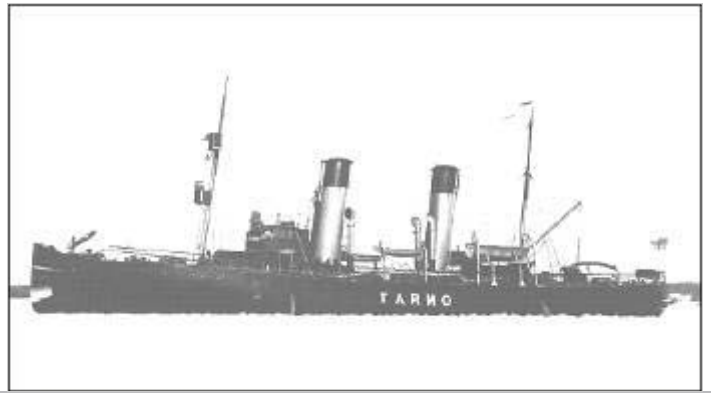
- large number of computer control systems

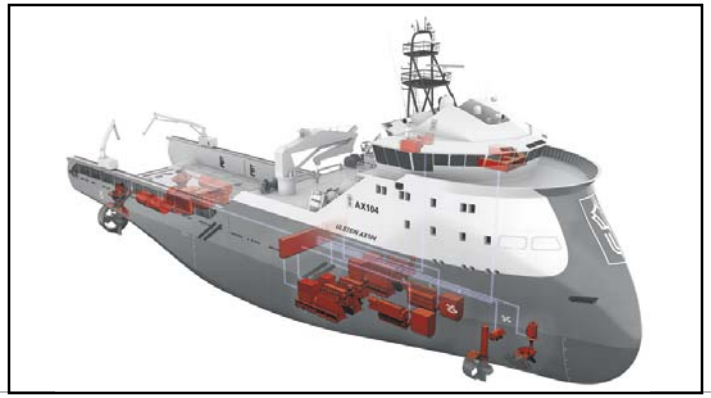
Increased system complexity

- more integrated sub-systems
- components delivered by different suppliers
- complex in operation

Challenges

- make it safe and predictable
- testing and verification





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Enhanced System Verification - ESV Notation

What it's all about

- framework for *earlier, deeper, and broader* testing and verification
- various verification methods
- verification *beyond and additional* to the minimum requirements

Consequences

- more comprehensive follow up of the systems
- reliability and safety will increase

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Class perspective – available verification tools

ESV toolbox:

- 2009/10 Rules for :
  - ESV-DP[HIL]
  - ESV-TAM[HIL]

- Future:
  - More systems
  - More methods
  - …

Quality assurance

Working methods

Process

Analysis

e.g. FMEA/FMD

Control and monitoring system

Plan approval

Testing / survey

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Guideline for FMEA of redundant systems

Intentions

- DP, RP, AP class notations requires FMEA
- establish and clarify a minimum set of requirements, terminology
  - *also for less experienced customers*
- a more structured documentation approach
  - *improved basis for the analysts when identifying complex failure modes and propagation paths*
- challenge the FMEA analysts
  - *e.g. closed bus-ties and complex control systems like PMS*
- supporting verification of new notations DYNPOS-ER
- possible future extension of ESV rules

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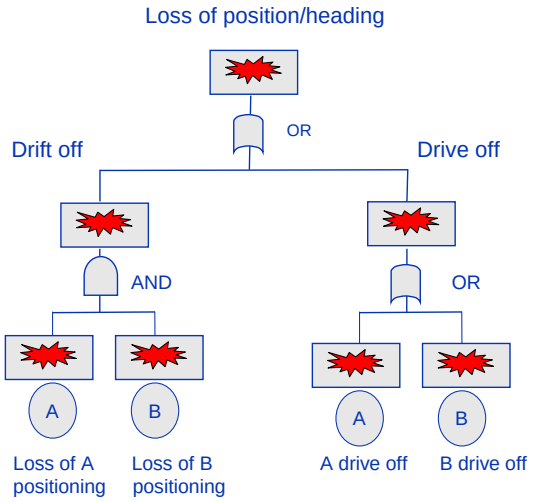
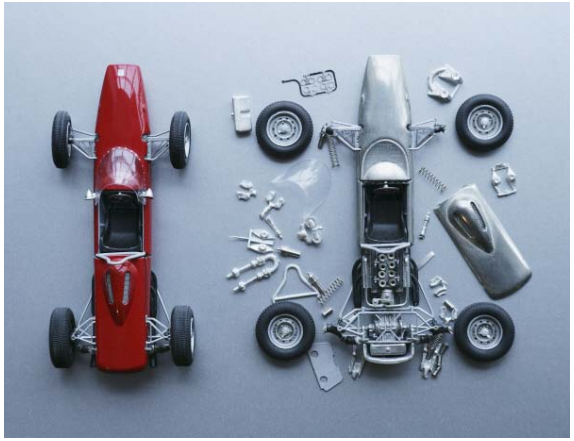
Guideline for FMEA of redundant systems

Main content

- general vessel information
- acceptance criteria
- redundancy design intent and operational modes
- the overall system boundary
- redundant components and single component groups
- systems interfaces and dependencies of external systems
- single failure analysis at unit and subsystem levels
- if applicable, installation in fire and flooding separated zones
- reference to a test program to support the conclusions
- compliance statement referring to acceptance criteria





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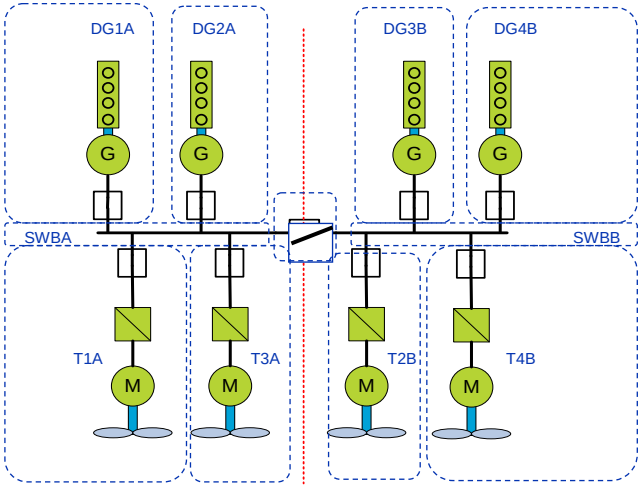
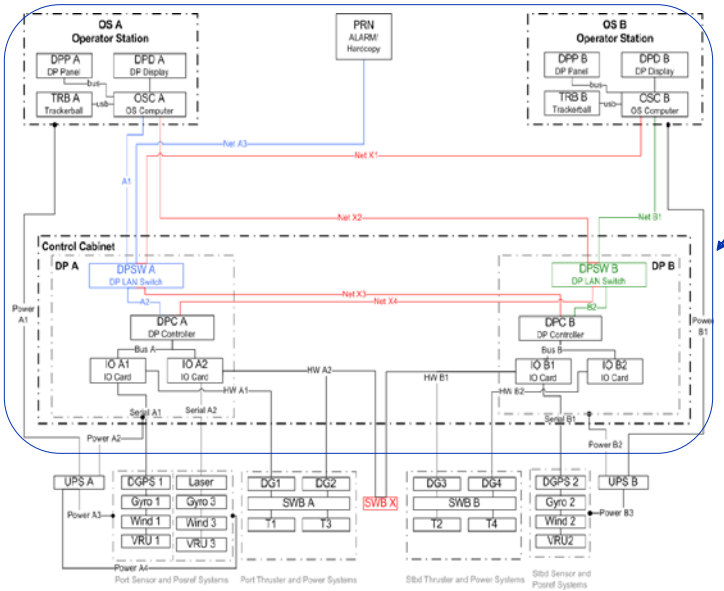
Design intent and system boundary description





Control system boundary

Redundancy design intention overview by redundant and common component groups		
Redundant A groups	**Common groups X groups**	**Redundant B groups**
Thrusters A T1A AND T3A		Thrusters B T2B AND T4B
Thrusters A dependent on:		**Thrusters B dependent on:**
Diesel generators A DG1A OR DG2A		Diesel generators B DG3B OR DG4B
Main switchboard A SWBA	Main bus tie switchboard SWBX	Main switchboard B SWBB

Redundancy design intention overview by redundant and common component groups		
Redundant A groups	**Common/connecting groups X groups**	**Redundant B groups**
Thruster System A T1, T3		Thruster System B T2, T4
Dependent on		**Dependent on**
Power System A Diesel gens A; DG1, DG2 Main swbs A; SWB A	SWB X	Power System B Diesel gens B; DG3, DG4 Main swbs B; SWB B
Operator Station A: DPP A, DPD A, TRB A, SC A		Operator Station B: DPP B, DPD B, TRB B, OSC B
DP LAN A: DPSW A, Net A1, A2 and A3	Net X1, X2, X3 and X4	DP LAN B: DPSW B, Net B1, B2
DP Controller A: DPC A, Bus A		DP Controller B: DPC B, Bus B

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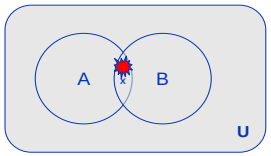
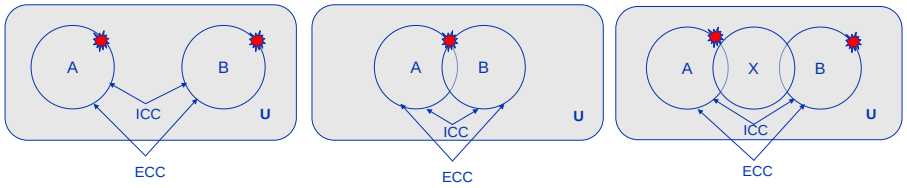
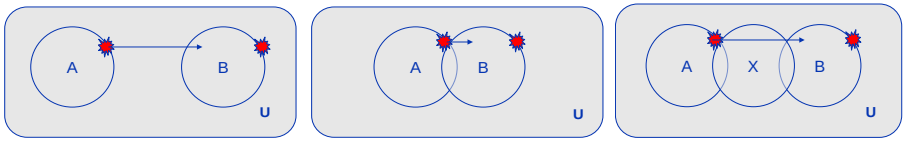
Failure propagation paths



- Common component X causing failures in A and B



- Common cause failure, from a single event related to U, External (ECC) or an (ICC) Internal Common Cause



- Primary and secondary failure

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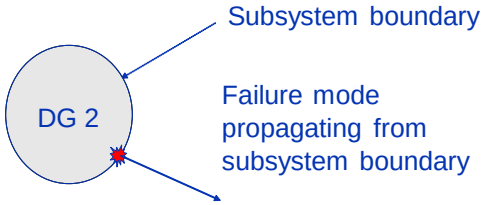
Single failure propagation analysis



Redundancy design intention overview by redundant and common component groups		
Redundant A groups	Common/connecting groups X groups	Redundant B groups
Thruster System A **T1, T3**		**Thruster System B** **T2, T4**
Dependent on		**Dependent on**
Power System A Diesel generators A; DG1, DG2 Main switchboard A; SWB A	SWB X	Power System B Diesel generators B; DG3, DG4 Main switchboard B; SWB B
Operator Station A: DPP A, DPD A, TRB A, OSC A		Operator Station B: DPP B, DPD B, TRB B, OSC B 3
DP LAN A: DPSW A, Net A1, A2 and A3	Net X1, X2, X3 and X4	DP LAN B: DPSW B, Net B1, B2
DP Controller A: DPC A, Bus A		DP Controller B: DPC B, Bus B
IO System A; IO A1, IO A2 Serial A1, A2 HW A1, A2		IO System B: IO B1, IO B2, Serial B1 HW B1, B2
Sensor System A: Gyro 1 , Gyro 3, VRU 1, VRU 3, Wind 1, Wind 3		Sensor System B: Gyro 2, VRU 2, Wind 2
Posref System A: DGPS 1 , Laser		Posref System B: DGPS 2
Power Distr A: UPS A, Power A1, A2, A3, A4		Power Distr B: UPS B, Power B1, B2, B3

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Summary

- DP market is growing – and more diversified
- New DPS notation series,
  - Correlates to IMO MSC/Circ. 645 equipment classes
- DYNPOS notations are maintained and unchanged
- New DNV DYNPOS-ER (Enhanced Reliability)
  - new principles and philosophy
  - high availability of power and thrust
  - no direct relation to the IMO MSC/Circ.645 equipment classes
- Enhanced System Verification
  - framework for additional requirements to earlier, deeper, and broader verification
  - ESV-DP[HIL], ESV-TAM[HIL]
- Developing guideline for FMEA of redundant systems
  - improve overall quality of FMEAs

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