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DYNAMIC POSITIONING CONFERENCE
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QUALITY ASSURANCE SESSION

The Meaning of LIFE

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What is the meaning of LIFE ?

Low
Impact
Failure
Effect

Where Has LIFE Come From?

- Low Impact Failure Effect (LIFE) is not a new concept, it is simply the application of good practice and lessons learned.
- It is a design concept with which most practitioners in the DP community will be familiar.
- The LIFE concept simply gives a name to this practice and formalises its application in a simple methodology.

Why Do We Need LIFE ?

- Essentially to improve the post failure capability of the vessel after a single failure.
- Maximise the vessel's availability for work and to provide a very high degree of reliability and fault tolerance.

Good Design

How do we use the LIFE Concept to achieve a robust Design?

- Designing a vessel to meet Class Rules does not necessarily produce a vessel that is fault tolerant enough to address the ability of the vessel to continue its Industrial Mission following a single failure.

Industrial Mission

- Defined as – Primarily the operational role of the vessel, typically applicable to MODUs and Project Construction Vessels.

Key Elements of a Fault Tolerant Design

- Performance
- Protection
- Detection

Performance: For a DP system to be fault, tolerant each redundant equipment group and all of the DP related machinery and systems within it must be capable of their defined performance – Performance means more than steady state capacity, it also includes dynamic performance, response time and accuracy.

Protection: Even the best separated DP systems inevitably have some common points between redundant equipment groups and these represent potential fault propagation paths. There must be effective protective functions or features to prevent faults in one system adversely affecting the operation of others.

Detection: It is important to know when full fault tolerance has been lost. Potential hidden failures can be detected by suitable alarms and periodic testing.

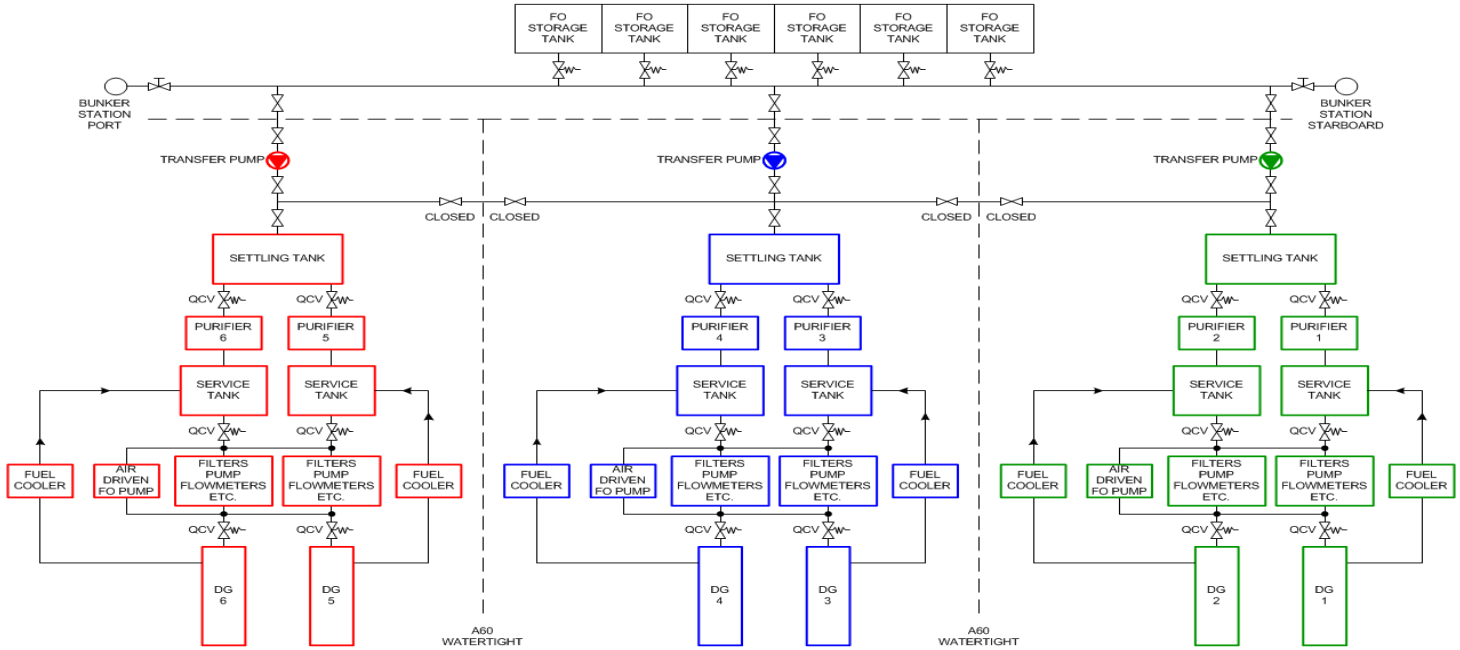
MTS DP Vessel Design Philosophy

The ‘7 Pillars of Wisdom’ for a Robust DP System:

1. Independence
2. Segregation
3. Autonomy
4. Fault tolerance
5. Fault resistance
6. Fault ride through capability
7. Differentiation

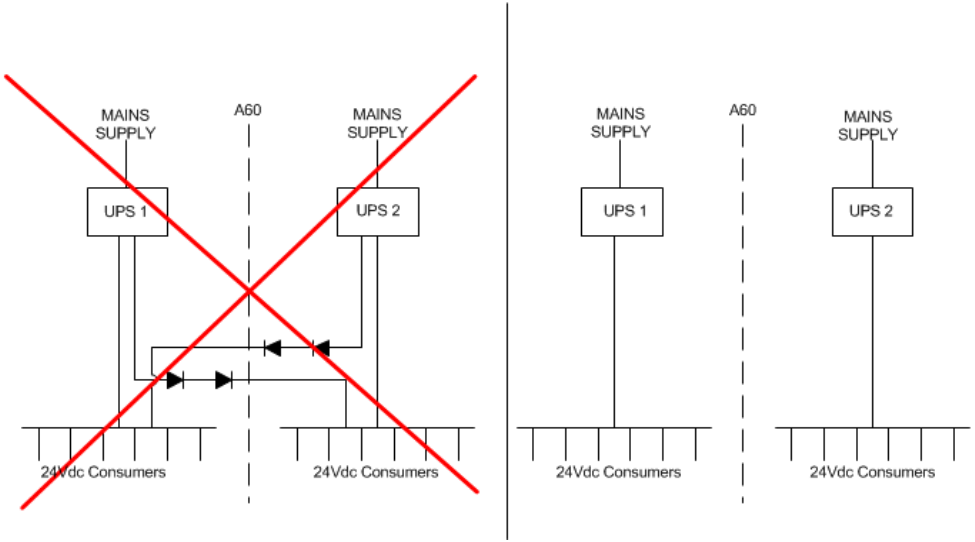
Independence

- Main machinery should be made as independent as possible.



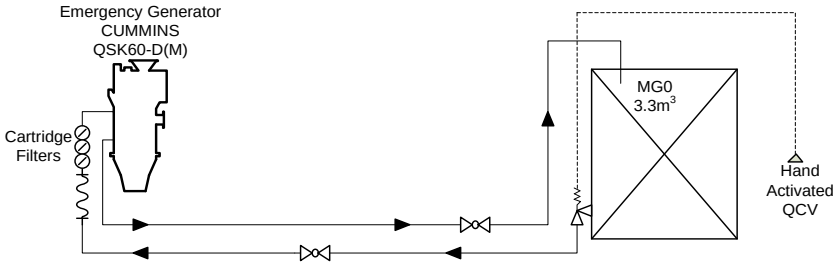
Segregation

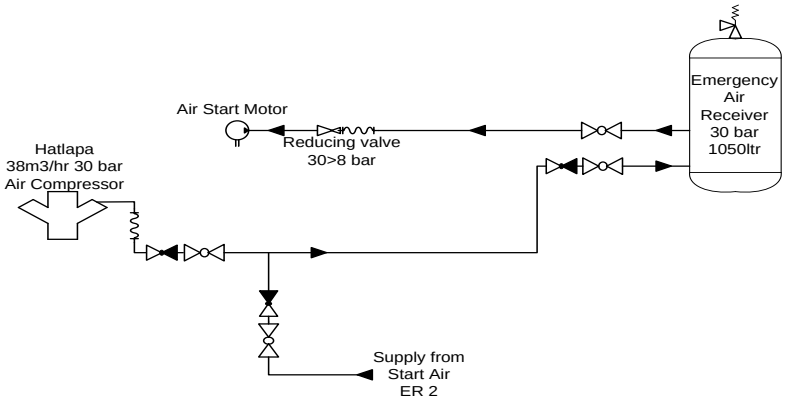
Systems intended to provide redundancy should have as few common points connecting them as possible.



Autonomy

Control and automation functions should be decentralized to the point that each item of main machinery (generators and thrusters) is capable of making itself ready for DP operations independently of any centralised or hierarchical control system.



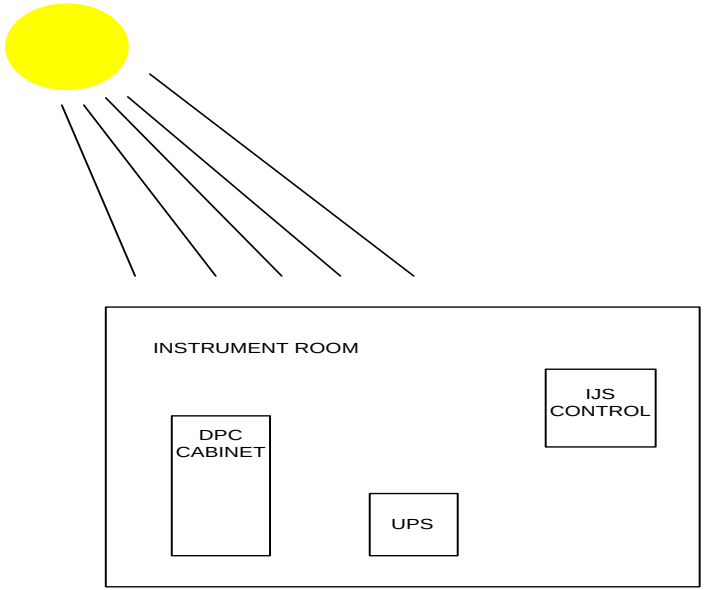


Fault Tolerance

DP systems of equipment classes 2 & 3 are required to be fault tolerant in respect of defined single failure criteria appropriate to each DP class notation. Remain in position until Time to Terminate (TTT).

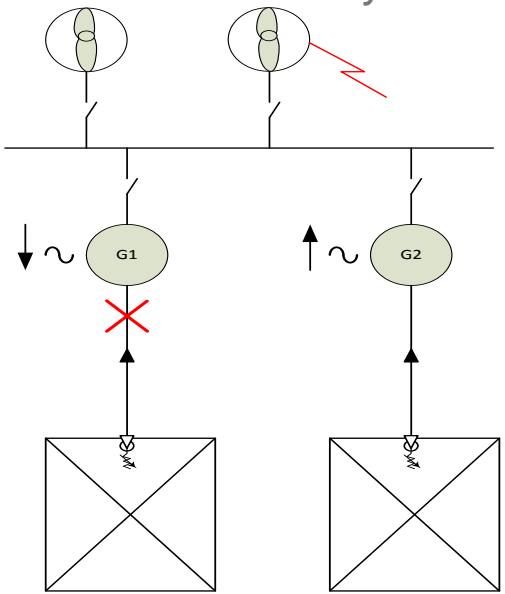
Fault Resistance

DP related equipment should be selected on the basis of high reliability and resistance to internal and external influences which may reduce reliability.



Fault Ride Through Capability

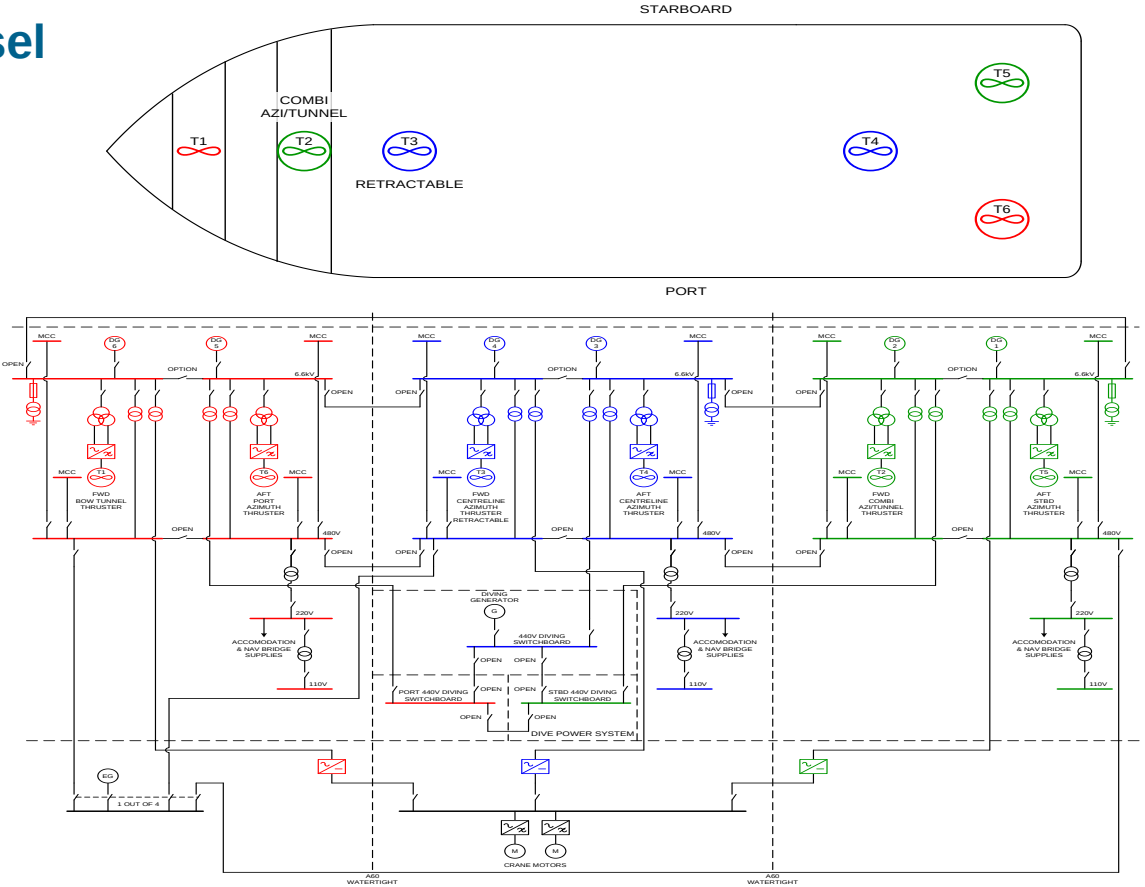
The ability of redundant systems to continue operating without malfunction when subjected to the effects of failures in other systems to which the surviving systems are connected.



Differentiation

The principles of differentiation, diversity and orthogonality in the design of redundant systems should be used to best advantages.

Example Vessel



Vessel WCFDI$_{class}$

PART I - WCFDI $_{CLASS}$ - *'No single failure as defined for class notation DP3 will have a greater effect on the vessel's ability to maintain position and heading than the loss of one of the three independent power and propulsion systems consisting of two generators and two thrusters (one fwd & one aft). This statement is considered to be valid when the power plant is operated with all the bustie circuit breakers between the three power systems open and at least one generator connected to each of the three main switchboards.'*

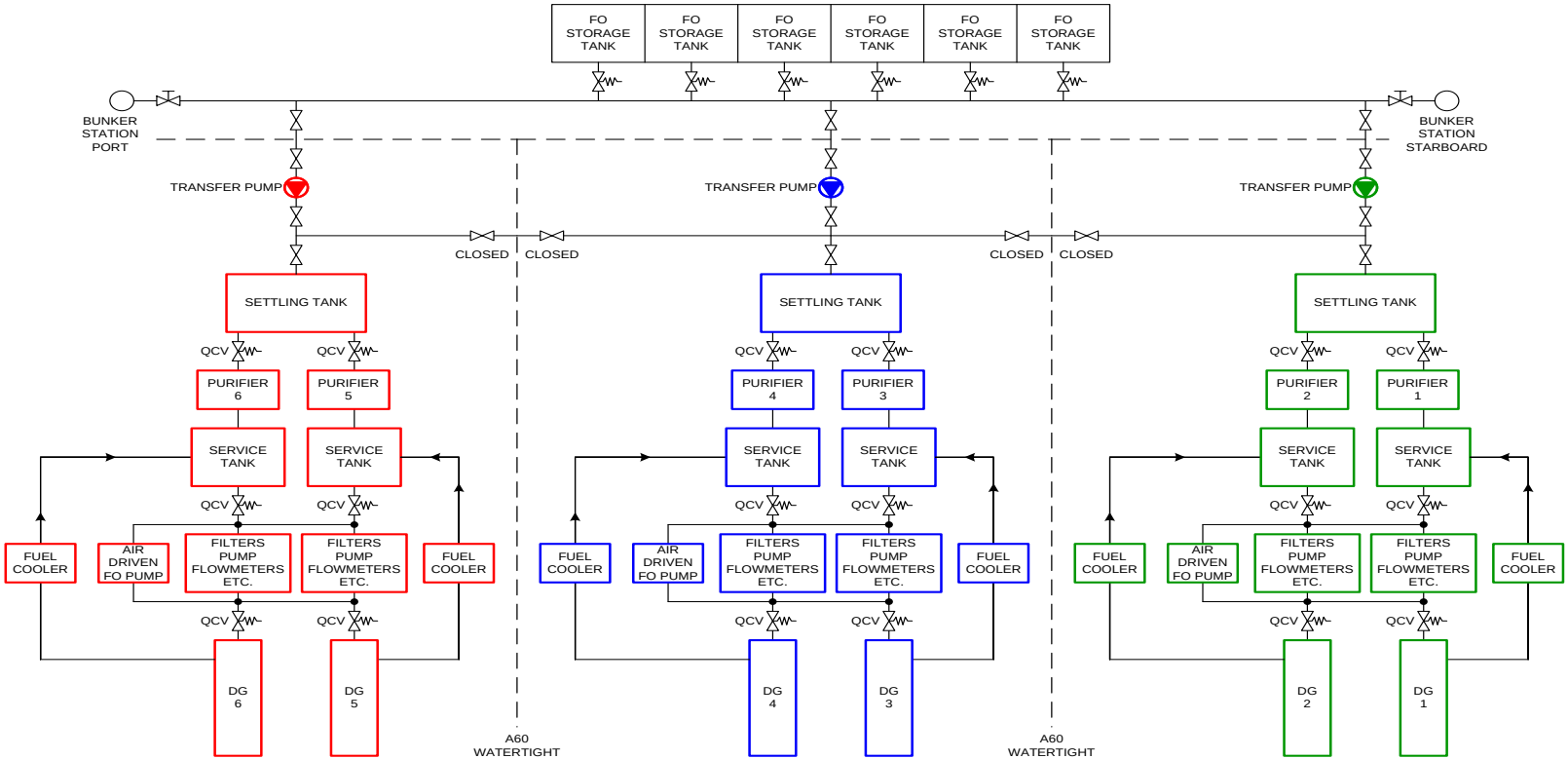
LIFE WCFDI$_{LIFE}$

PART II - WCFDI $_{LIFE}$ -*'No single failure with the exception of the effects of fire, flooding, Main bus bar fault and passive components (as defined in IMO MSC 645) will have a greater effect on the vessel's ability to maintain position than the loss of one thruster and/or one generator in the same independent power and propulsion group. This statement is considered to be valid when the power plant is operated with all the bustie circuit breakers between the three power systems open and two generators connected to each of the three Main switchboards (it is accepted that the whole independent power system may be temporarily lost if only one generator is connected). Note this requirement is not to be misunderstood as indicting any requirement for compliance with failure criteria other than that situated in this definition, for example Class DP3 or IMCA guidance. This definition simply guides the development of non-critical redundancy intended to improve reliability and vessel availability.'*

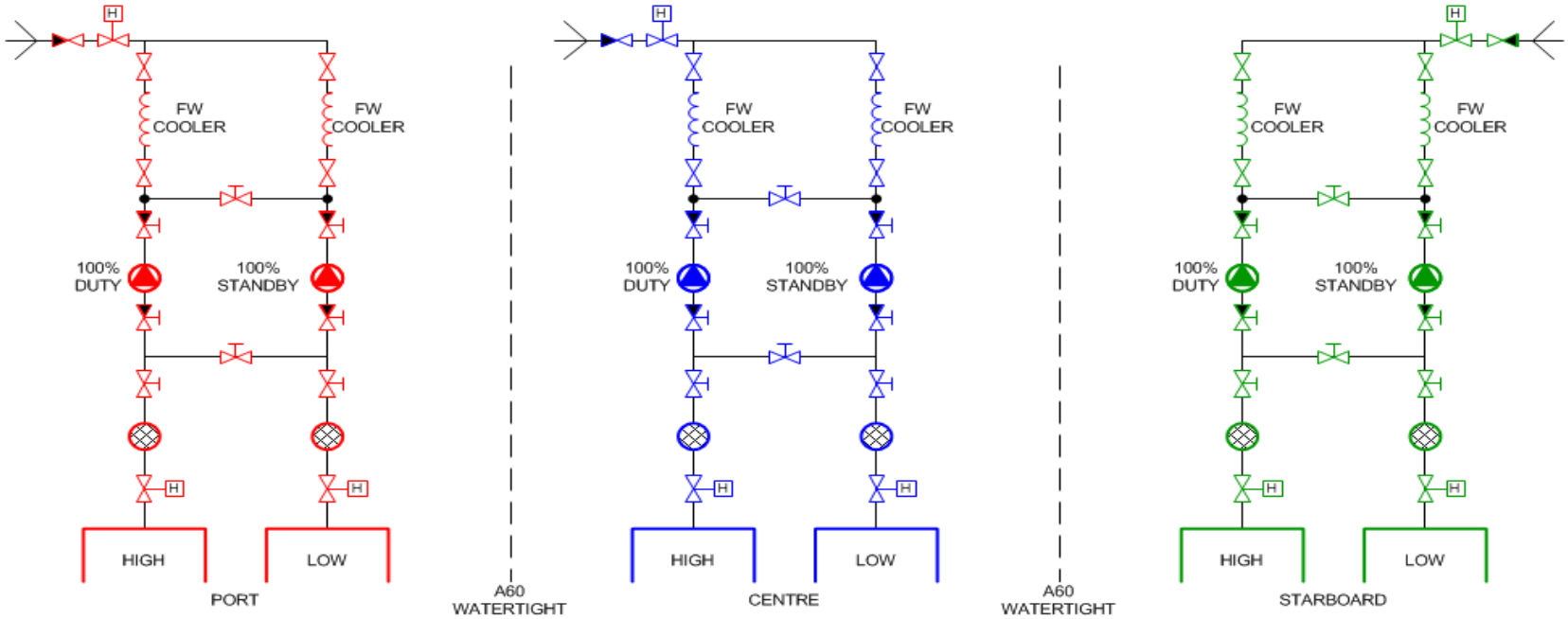
Summary of LIFE Redundancy Design Objectives on a System by System Basis

System	Fire & Flooding	Technical Faults (Excluding Bus Fault)
Generators	Two out of three groups survive any single failure	Independent (6 way split)
Thrusters	Two out of three groups survive any single failure	Independent (6 way split)
Marine Auxiliary	Two out of three groups survive any single failure	Single generator and/or single thruster affected
DP Control	Dual redundant (main & backup)	Triple redundant
Control Networks	Dual redundant	Dual redundant
VMS/PMS	Two out of three groups survive any single failure	Loss of associated machinery ≤ WCFDI Part II
Safety / ESD	Fail safe ≤ WCFDI Part I	Fail safe ≤ WCFDI Part I

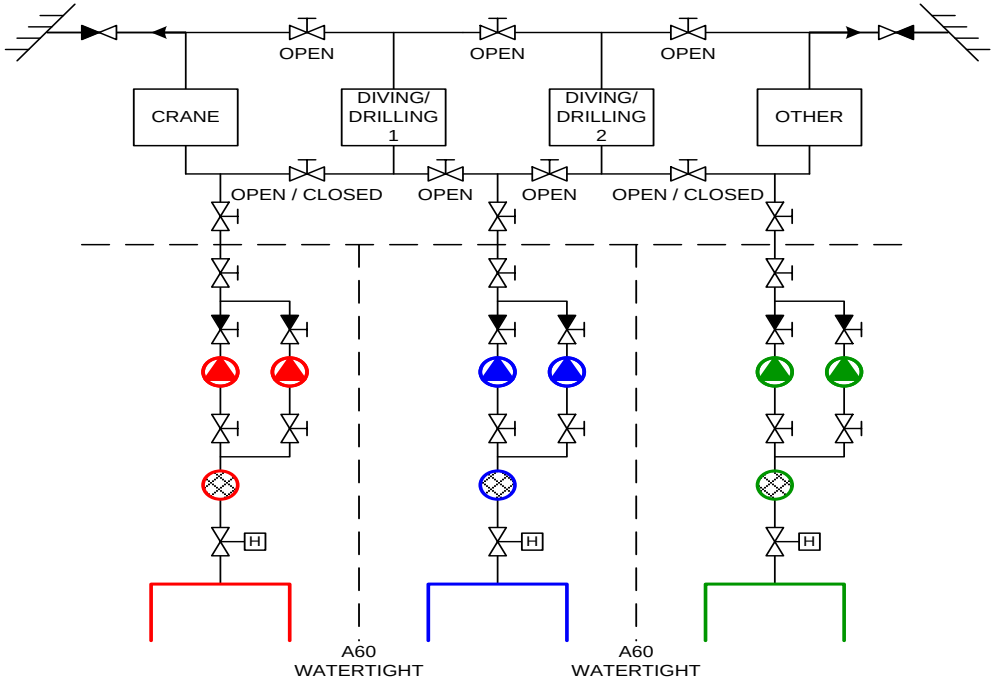
Fuel System for 3 Way Split - 6 Generators



Sea Water System for 3 Way Split



Sea Water System for Industrial Equipment



Networks

- Vessel automation system networks are generally only available in a dual redundant configuration.
- The expected level of vessel availability can be achieved by carrying sufficient on-board spare parts (and expertise to change them). The design should ensure there are adequate spare fibres within the main data backbones.
- All automation system failures should leave the DP system operating in a stable pre failure condition and available for manual control.

General

The sections outlined above give an example of how to apply the LIFE concept to a few of the vessel's marine auxiliary systems. This philosophy is followed through to the other systems, including but not limited to:

- Fresh water cooling
- Compressed air – start, control & service
- Engine room ventilation
- Combustion air
- Remote control valves
- Quick closing valves

Why Is LIFE Not More Widespread ?

Elements of the LIFE concept will be familiar to many in the DP community and already exist, in part, in many designs, sometimes by intent, occasionally by accident.

- COST
- IN HOUSE DESIGNS (Template)
- PERSONAL CAPITAL CONVINCING OTHERS
- 10% EXTRA ON TOP OF POWER PLANT
- ASOGs, CAMSs & TAMs EVER TIGHTENING RULES & GUIDELINES FOR INDUSTRY BEST PRACTICE.

Implementing the LIFE concept at the design stage would have a cost implication, but a forward thinking owner would have a highly marketable vessel for a wide range of industrial missions once they have demonstrated the robustness of the redundancy and the reliability of each of the redundancy groups.

Benefits of Adopting the LIFE Concept Over and Above The Basic Three Way Split

- Reduces the probability of experiencing the WCFDI.
- Reduces the risk of cascade failure when crane and thruster load is reallocated. This could be an issue with IMO Tier-3 engines which have poor load acceptance characteristics.
- Provides a safety margin that reduces the risk that a hidden ‘loss of capacity’ in engines or thrusters (not capable of rated output power or thrust output) will lead to a loss of position.
- The efficiency of power to thrust conversion increases with the number of thrusters online (particular for FPP thrusters). Therefore LIFE concept designs makes even more thrust available after a failure.

Benefits of Adopting the LIFE Concept Over and Above The Basic Three Way Split

- Because the system has been designed to satisfy the single generator, single thruster failure criteria (LIFE concept) most of the more likely faults that occur will not completely disable the entire power train and therefore the surviving machinery should be able to contribute to the new post failure DP capability after the first fault.
- The vessel's post failure DP capability becomes greater as only 50% of a single redundancy group is lost. That extra thrust and generating capability might be the difference between being able to finish the work 'ON HIRE' or not?

What Can LIFE Do For Us?

The LIFE concept adds common sense redundancy over and above that required by Class.

The LIFE concept is essentially the embodiment of the MTS DP Vessel Design Philosophy Guidelines tailored to take advantage of the trends in DP operations driven by the MTS DP Operations Guidance. It is not intended to be a matter of compliance but rather the application of good practice and common sense should allow a vessel owner to identify where design improvements could be made that would bring commercial benefits in the vessel's operational life cycle.

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So lets all look on the Bright Side of LIFE

References:

- MTS DP Vessel Design Philosophy Guidelines.
- MTS DP Operations Guidelines.
- DNV-RP-E307 Dynamic Positioning Vessel Design Philosophy Guidelines Sept. 2012.
- DNV-RP-D102 FMEA of Redundant Systems.
- IMCA M219 Example Specification for a DP FMEA for a new DP vessel.
- IMCA M220 Guidance on Operational Activity Planning.
- IMCA MSC645 Guidelines for Vessels with Dynamic Positioning Systems.

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