Dynamic Positioning Committee

Marine Technology Society

RISK, FMEA AND RELIABILITY

Machinery System for DP Vessels with Increased Efficiency and Reliability

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Wärtsilä Ship Power

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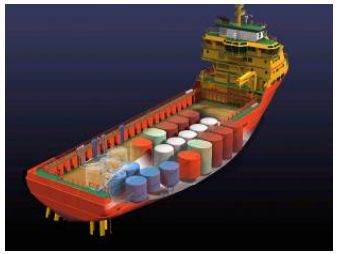
Diesel Electric Propulsion – Our development focus

Energy Efficiency

Redundancy and Reliability

Safety

Low Loss Concept



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Low Loss Concept

- **Improved redundancy and reliability due to less single failure consequences**
- **Improved fuel efficiency due to reduced electric losses**
- **Space saving**

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Diesel Electric System Characteristics

+ Increased operational flexibility

- Electric losses

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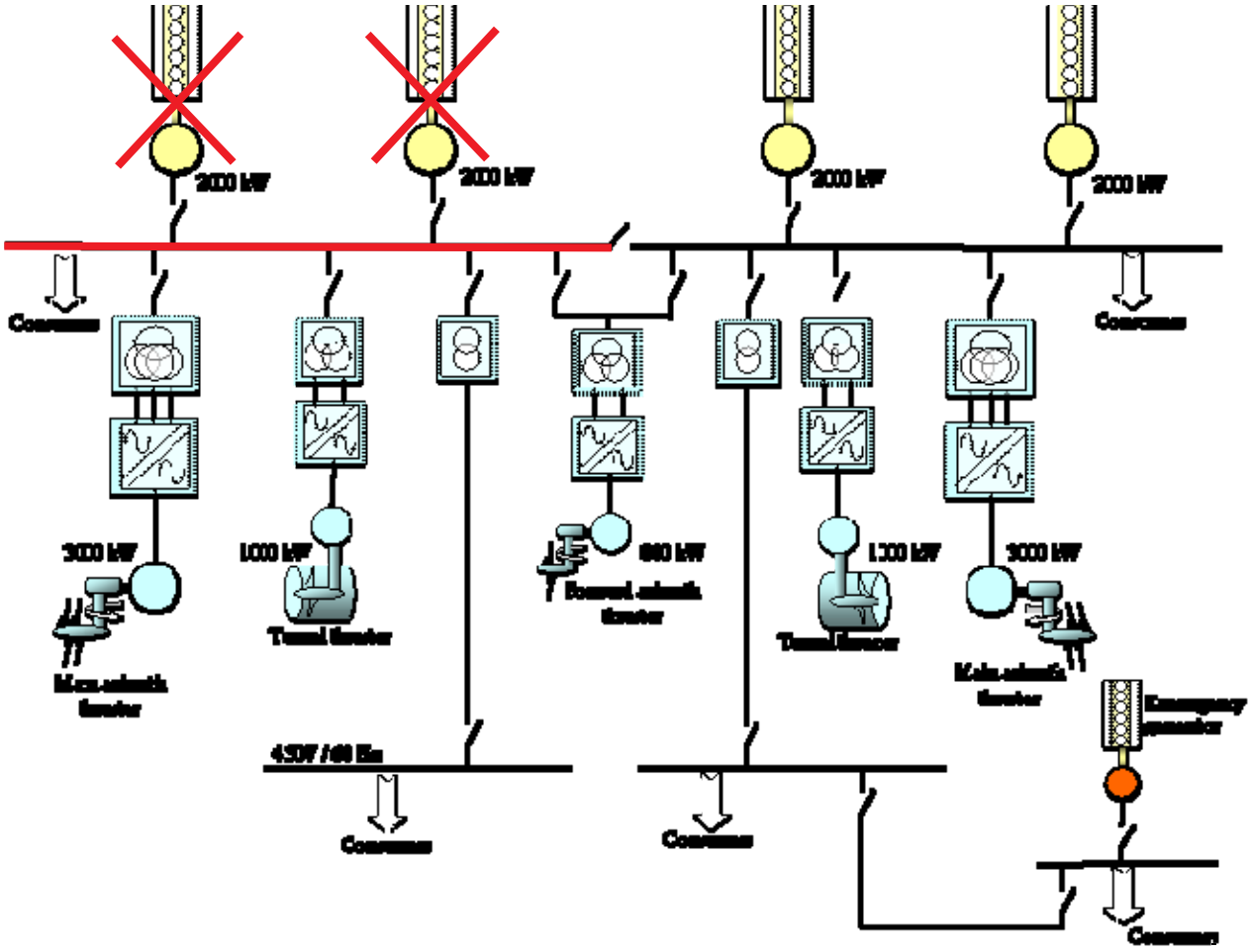
Typical Conventional DE system for OSV



Loss of one switchboard section → 50% of propulsion power lost

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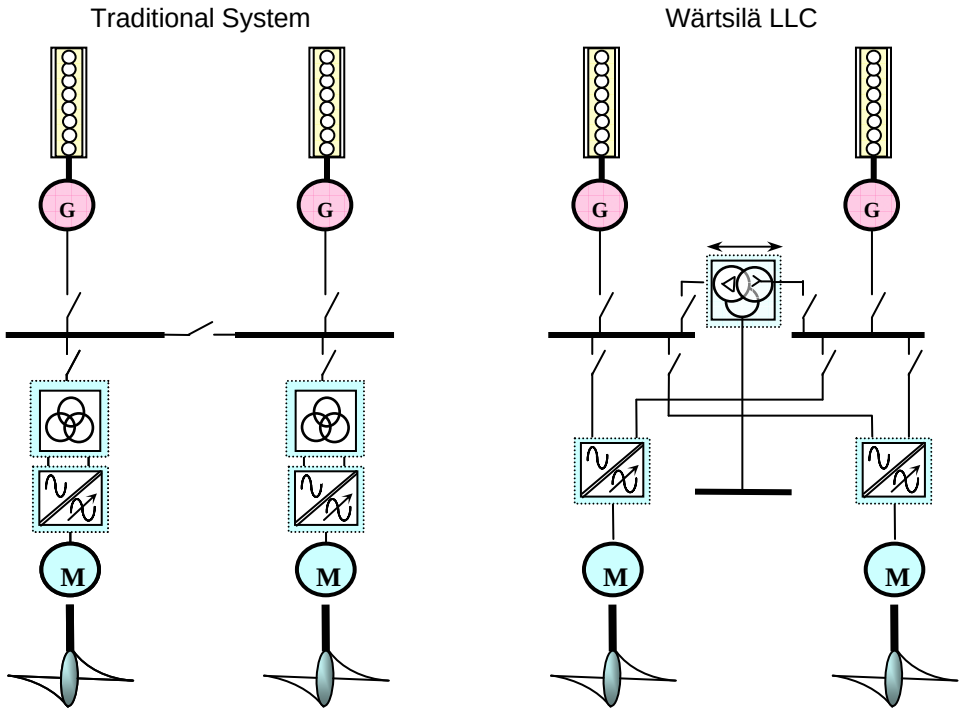
Basic principle of Low Loss Concept

LLC features

- Propulsion transformers eliminated
- 12 pulse solution
- THD-level < 5%
- Reduced Short circuit level
- Possible 690/450V transformation



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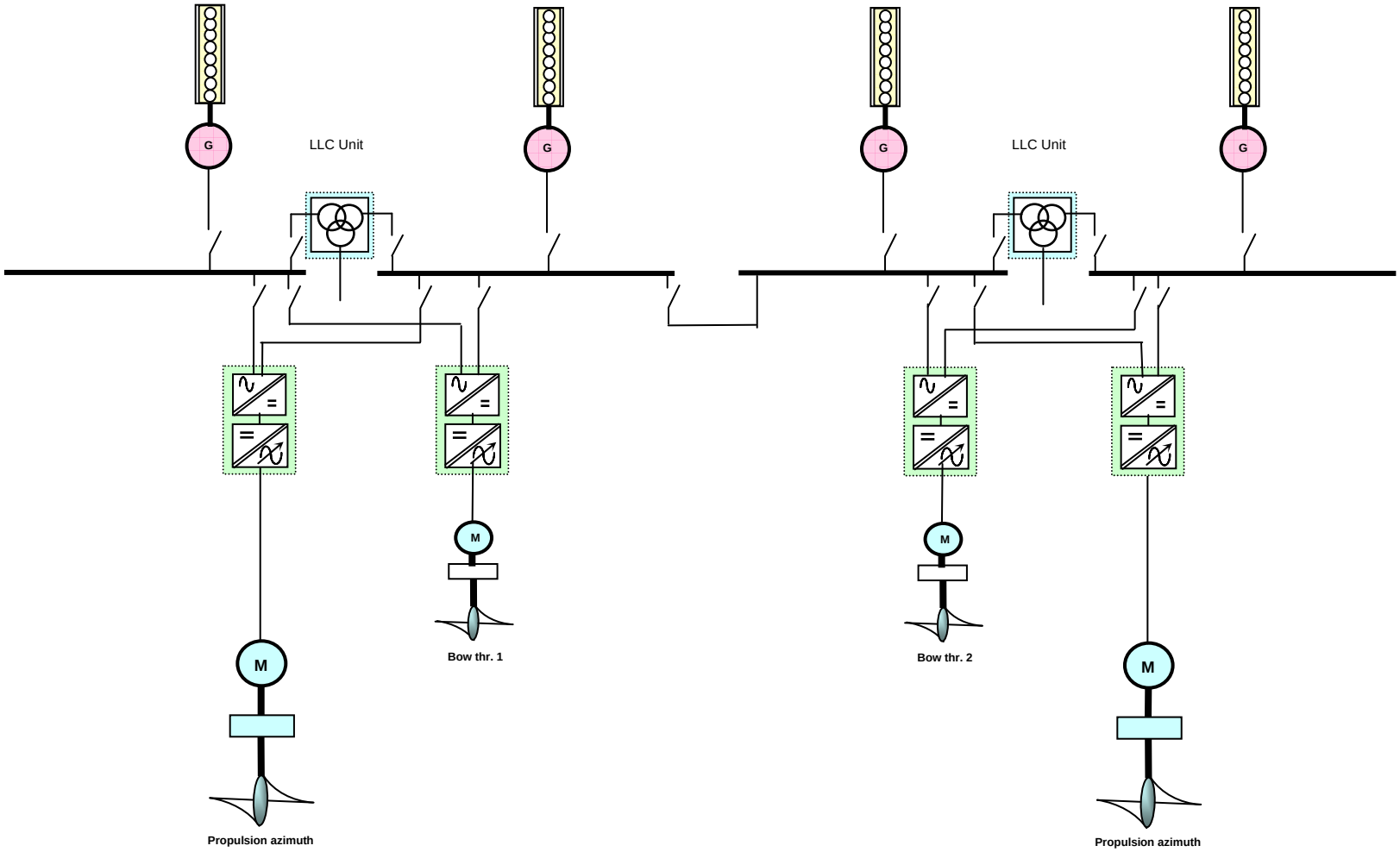
Low Loss Concept with four switchboard sections



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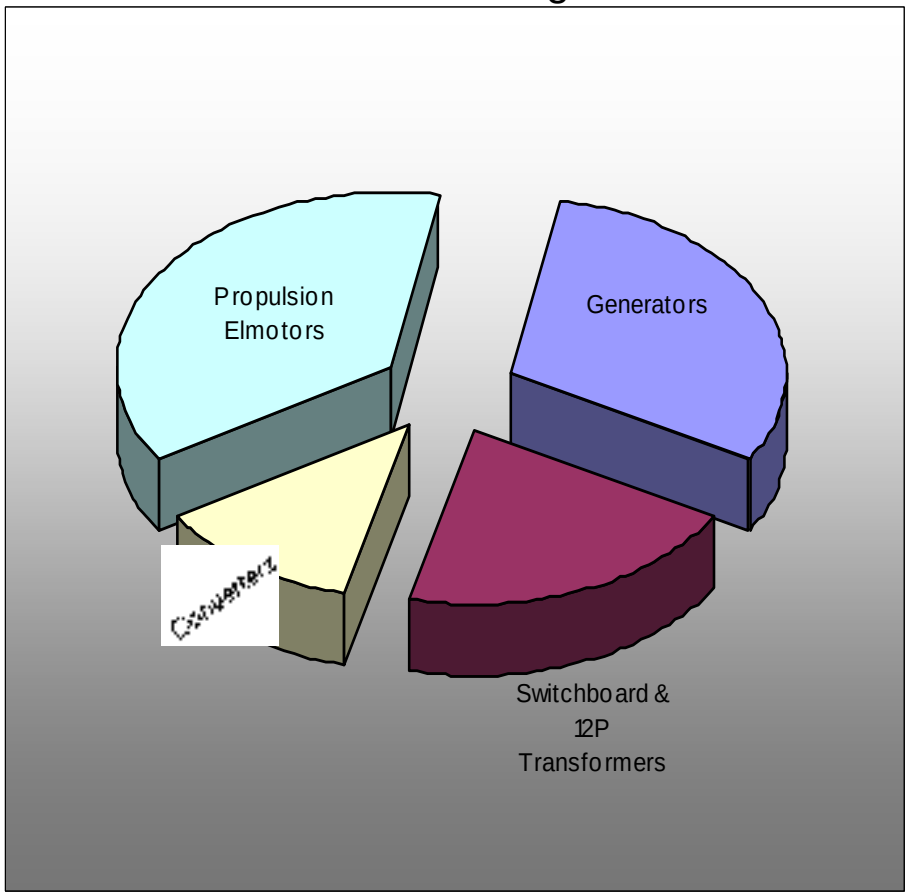
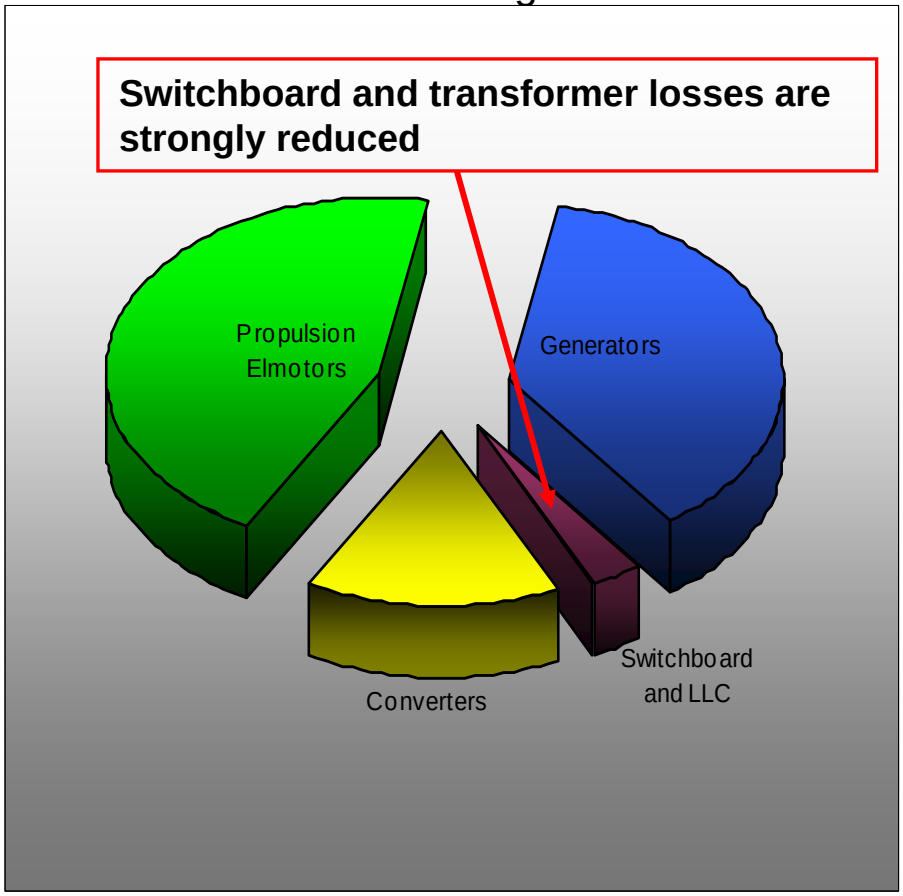
Electric Losses: Traditional versus Low Loss Concept

Traditional:
Losses in the range of **10%**



LLC:
Losses in the range of **7%**



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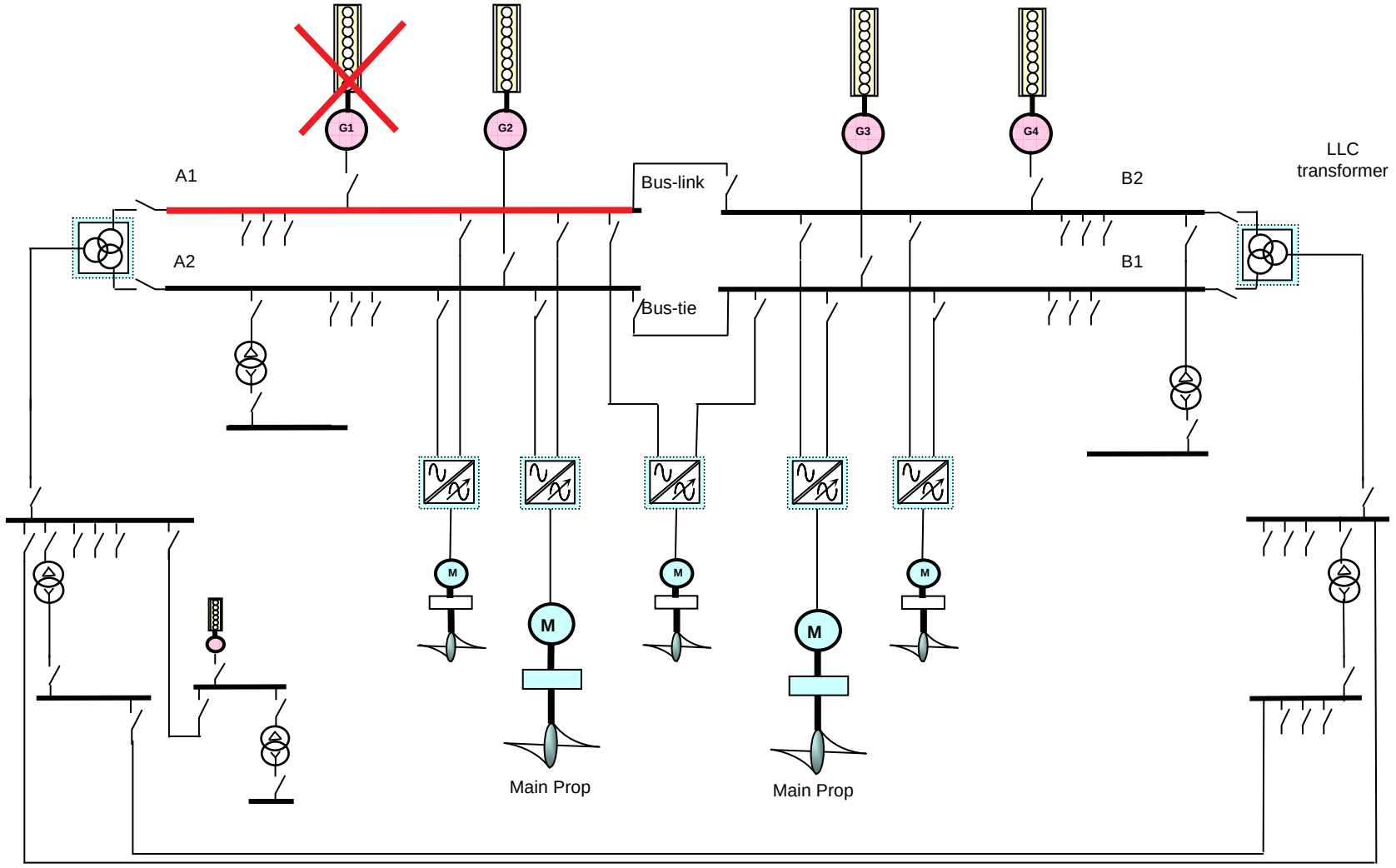
Typical DE system for OSV based on Low Loss Concept



Loss of one switchboard section → 25% of propulsion power lost
- All propellers running

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Advantages with Low Loss Concept

- Increased robustness for DP vessels
- Increased operational flexibility and availability
- Reduced electric losses giving lower fuel consumption and emissions
- Reduction in weight and space requirements for electric components
- Increased personnel safety due to reduced short circuit levels
- THD level below 5%

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PSV Viking Queen with Low Loss Concept

Main machinery and propulsion particulars

Vessel Design……: VS 493 Avant LNG
Vessel Dimension (LxBxD)……..: 92.2 x 21.00 x 9.60 m
Main diesel-generators……..: 4 x Wartsila 6L32DF (4 x 1950 kW)
Main propulsion……....: Pulling type thrusters – 2 x 2300 kW
Tunnel thrusters forw……....: 2 x 1200 kW
Azimuth thruster forw……....: 880 kW
Integrated Automation and PMS….: Wartsila
DP System……..: Kongsberg DPC-2
DNV DP Class……....: AUTR (IMO DP Class 2)

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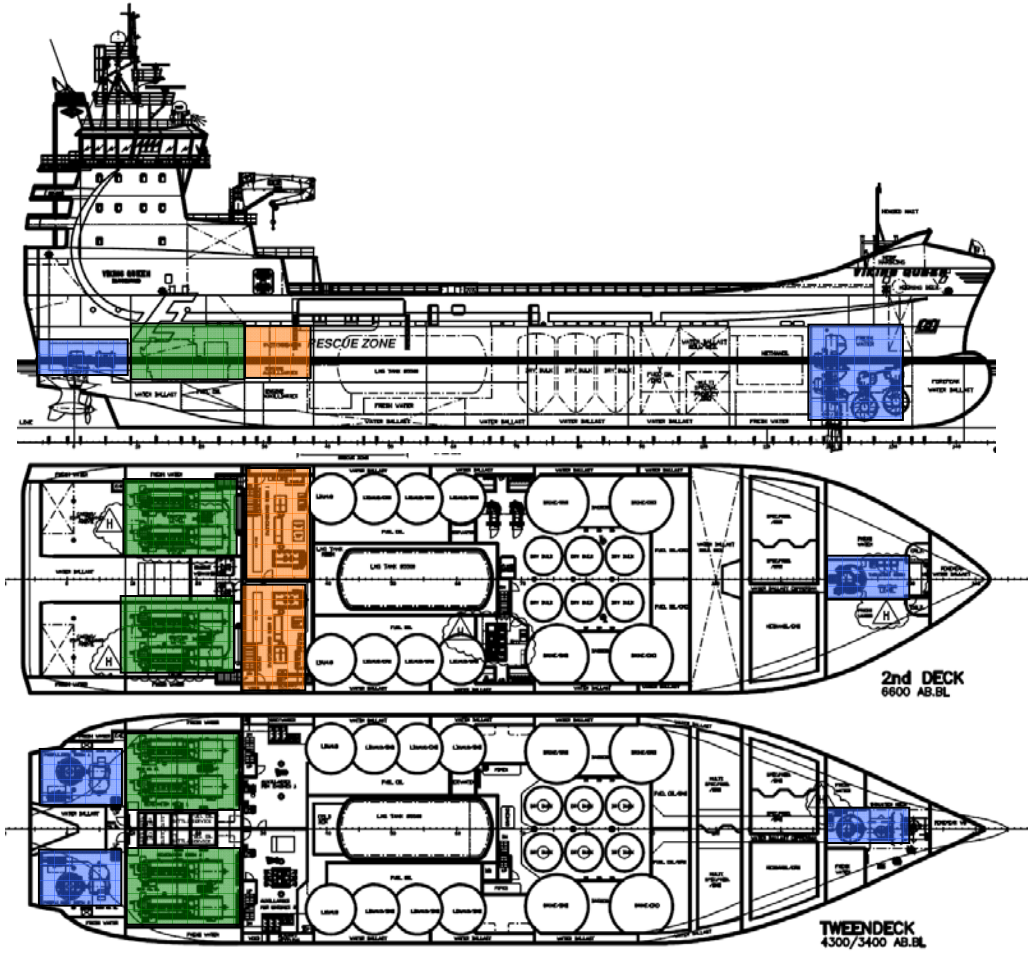
Viking Queen – Machinery & Propulsion Arrangement



Engines/generators

SWB room

Propulsion/thrusters

No transformers and/or converters in propulsion rooms

→ Space saved

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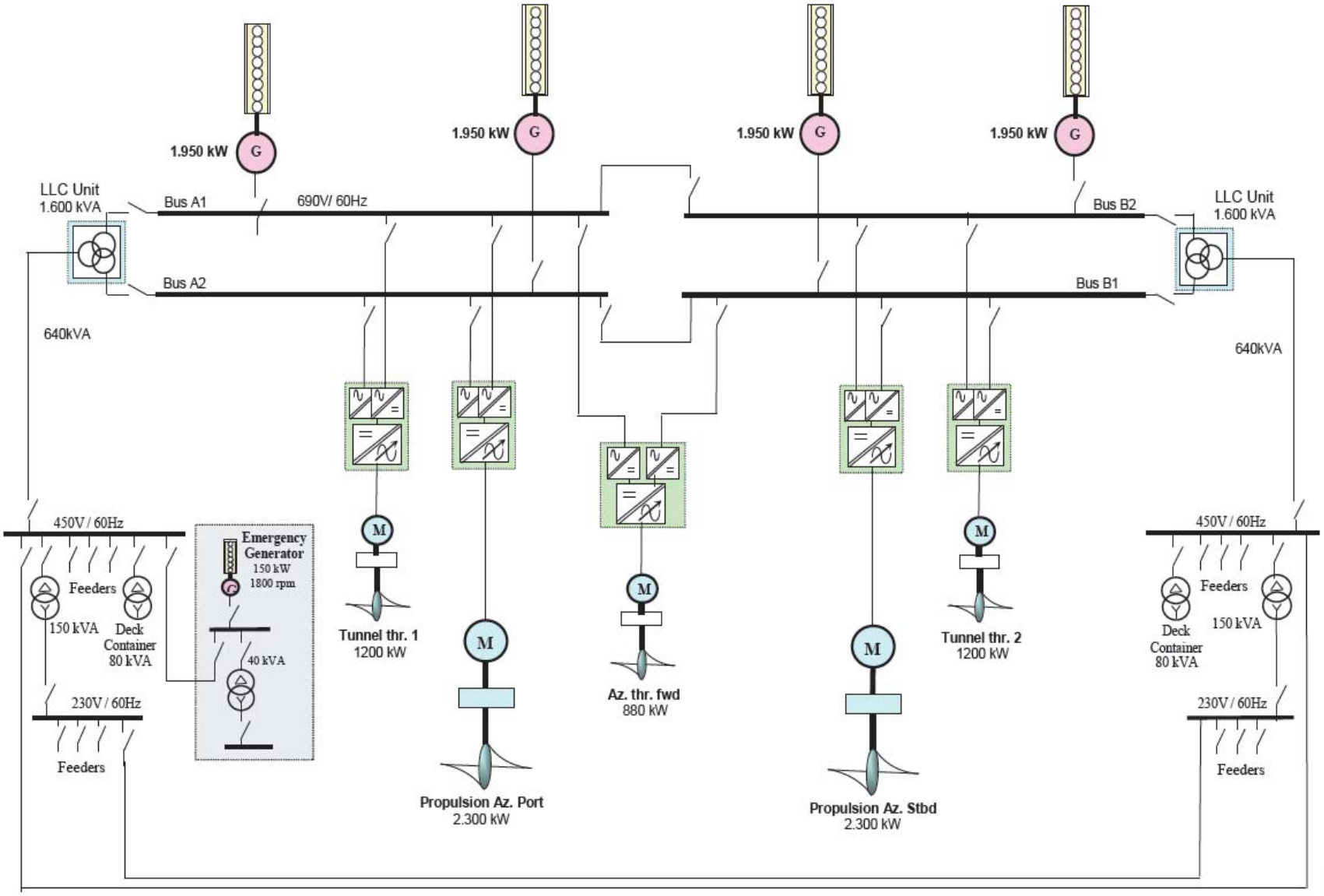
Viking Queen Propulsion Arrangement



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Viking Queen – FMEA analysis

Quote from FMEA report:

…“From the design documentation, we can not find any single fault that will stop or disconnect more than 1-one generator set simultaneously. If short circuit in 1-one of the 4-four 690V busbars, or in the LLC transformer occurs, then, the bus-tie breaker will open and prevent generators on other parts of the main switchboard from tripping.”

Consequence analysis

Loss of Busbar	Remaining thruster capacity (%)					Remaining prop. power (kW / %)
	Main PS	Main SB	TT 1	TT 2	Fwd Azim	
A1	50	100	50	100	50	**5690 / 73**
A2	50	100	50	100	100	**6130 / 79**
B1	100	50	100	50	50	**5690 / 73**
B2	100	50	100	50	100	**6130 / 79**

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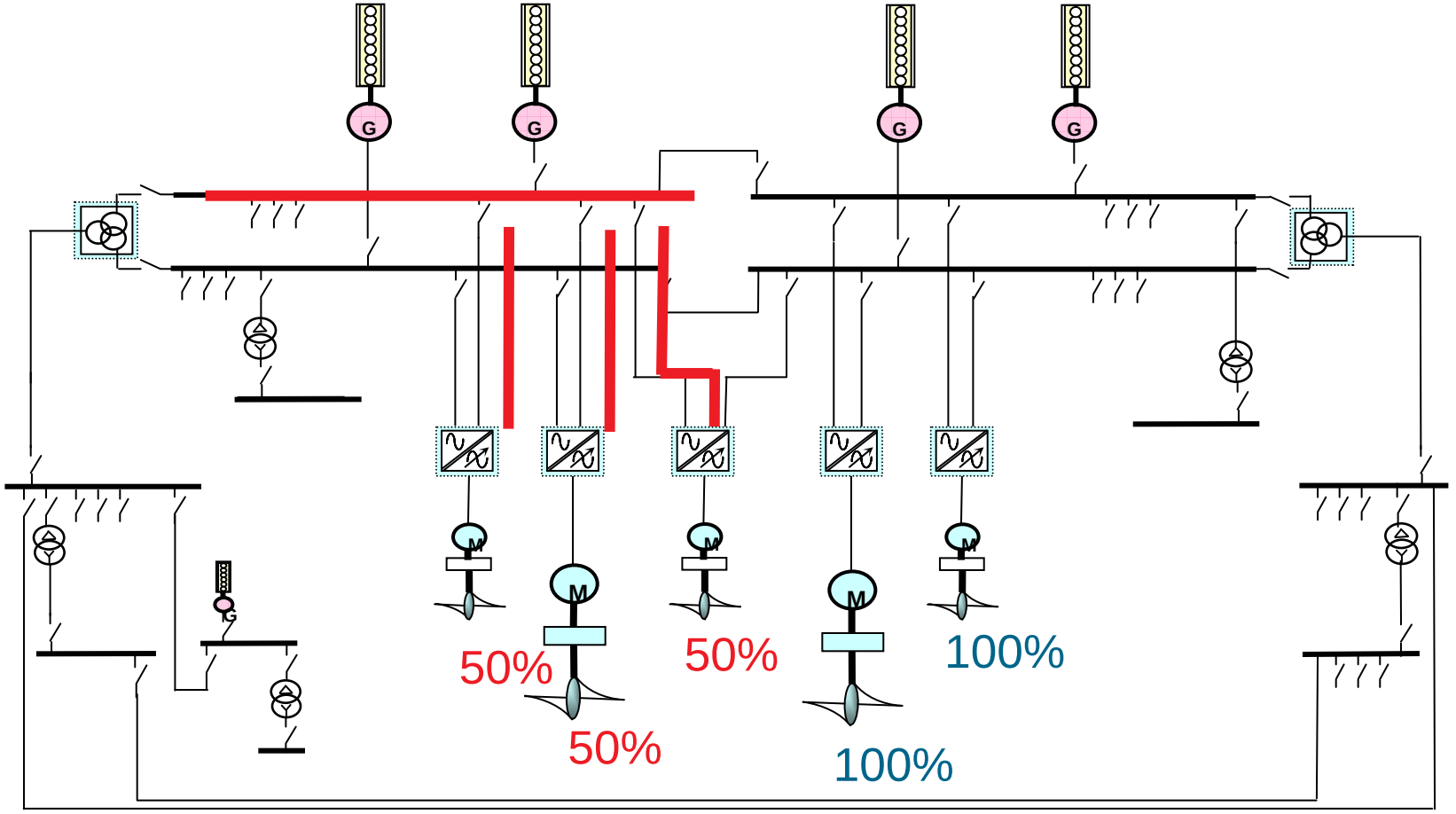
Viking Queen Failure Modes – Loss of busbar A1



Remaining propulsion power 5690 kW (73 %)

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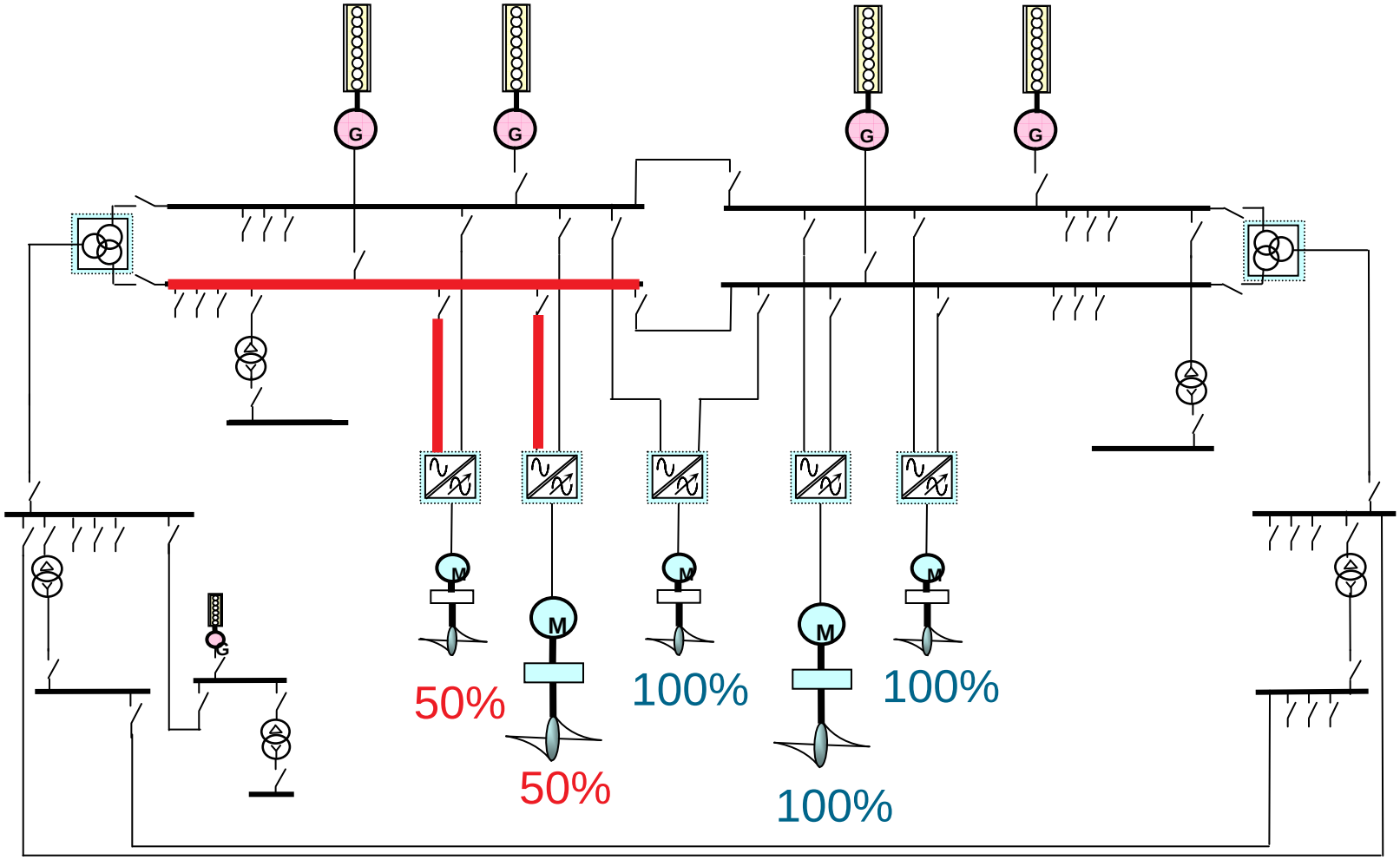
Viking Queen Failure Modes – Loss of busbar A2



Remaining propulsion power 6130 kW (79 %)

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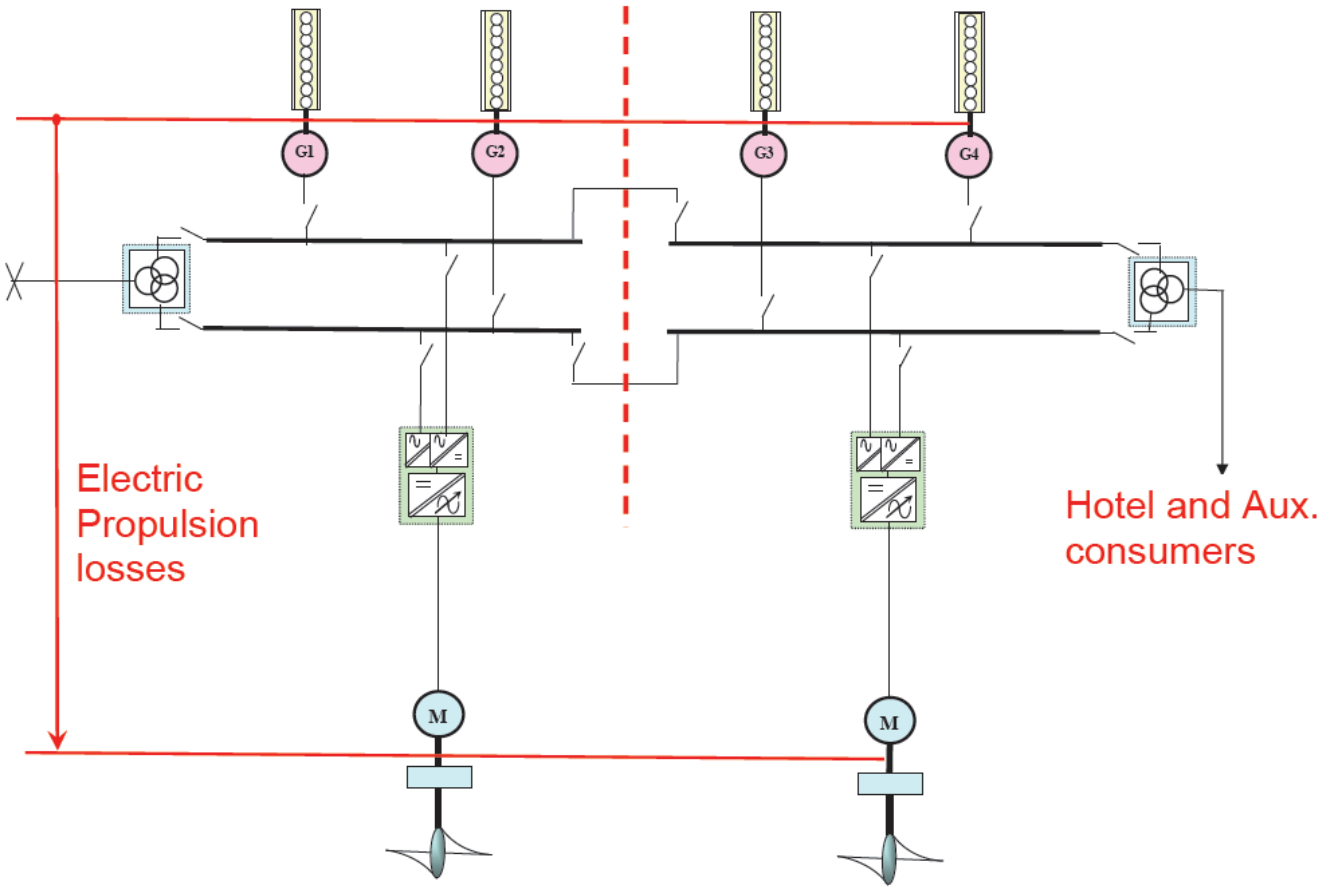
Viking Queen - LLC electric propulsion losses



4 – 7 % losses measured in full scale !

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Viking Queen - LLC electric losses measurement

	Test 1		Test 2		Test 3		Test 4		Test 5	
	Port	Stb.	Port	Stb.	Port	Stb.	Port	Stb.	Port	Stb.
Generators running	**G1**	**G3**	**G1 G2**	**G3**	**G1**	**G3 G4**	**G1 G2**	**G3 G4**	**G1 G2**	**G3 G4**
Diesel Power (kW)	1261	1526	1253	1531	1692	2021	1676	2078	2253	2588
Propulsion Power (kW)	1176	1139	1198	1155	1578	1555	1603	1592	2129	2121
Electric losses (%)	**6.74**		**4.39**		**6.74**		**4.36**		**5.50**	

Lowest losses when generators are running in parallel

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Low Loss Concept - Conclusion

- **Improved redundancy and reliability due to less single failure consequences**
- **Improved fuel efficiency due to reduced electric losses**
- **Space saving**

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Thank you for your attention !

DP Conference 2008