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DYNAMIC POSITIONING CONFERENCE
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QUALITY ASSURANCE SESSION

Template for FMEA Quality Improvement

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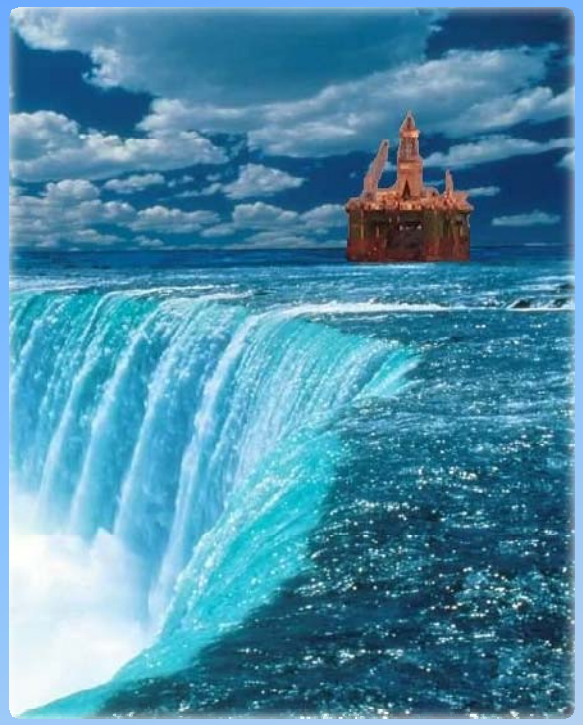
Introduction

- Why a template ?
- DP Classes and FMEAs as risk management.
- Limited Effectiveness of chosen solutions
- Improve the work process not the standards
- Does it better address the problems?
- Overview and Implementation

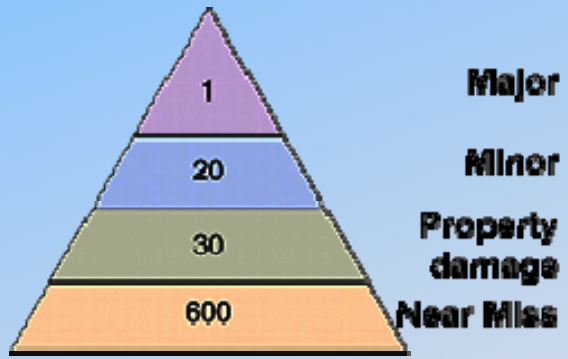
FMEAs And:



- Vessel Hiring
- FMEA Acquisition
- FMEA Writing
- FMEA Approval
- Flag Approval

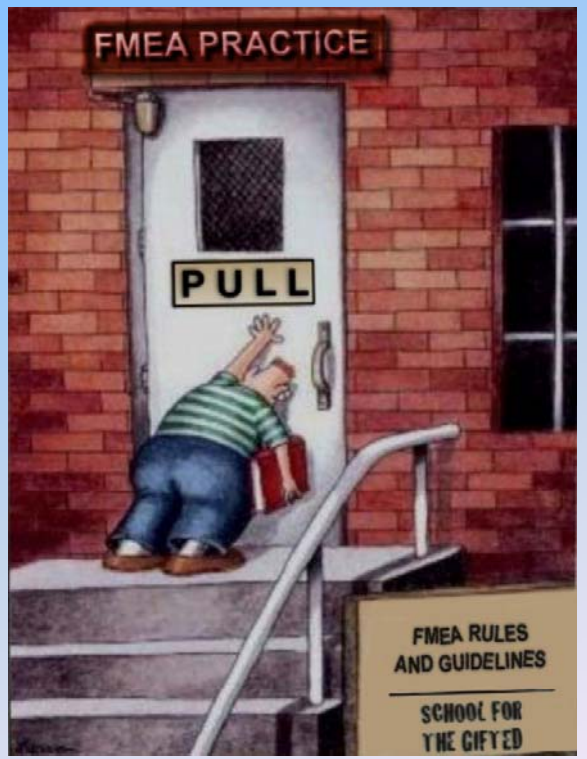
Discussion of Problems

- The Problems are real
- Overview of FMEA faults
- Economic structural incentives
- Complexity and the limits of human capacity.
- No one likes bad news.



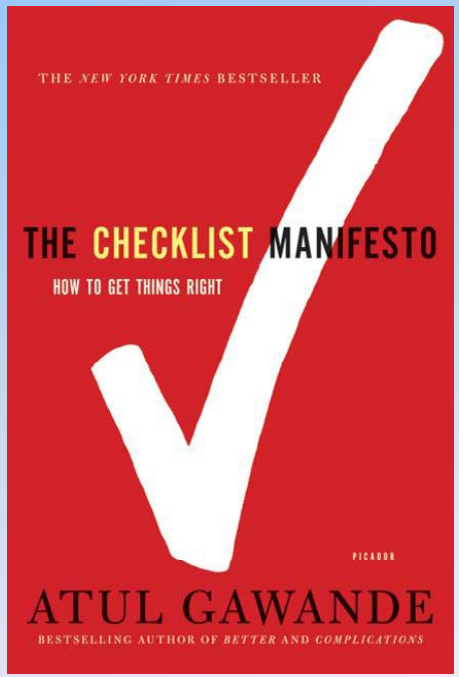
Attempted Solutions and their Limitations

- Limits of the possible
- Increased and more complex standards
- The effectiveness of standards
- Get the Memo
- Control of work process



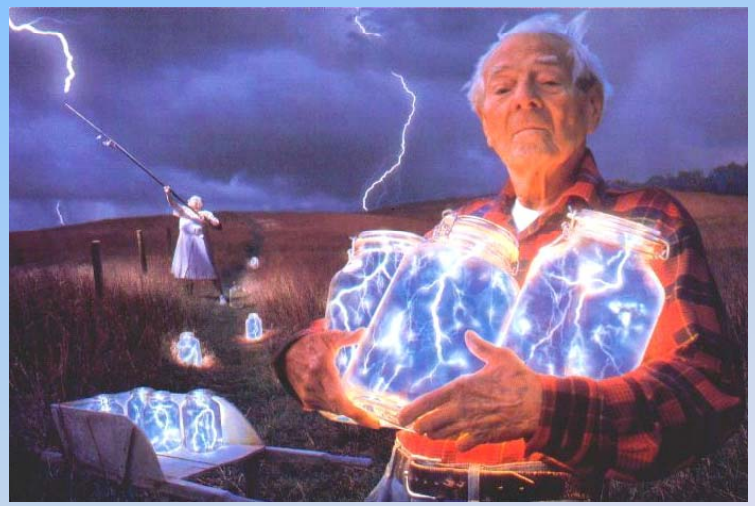
Applying a Solution to the Work Process

- Improve the standard of work rather than work standards
- Practices from other industries
- Create guidance where the work is done
- Break the work into manageable tasks
- Provide structure to ensure process integrity



Advantages of a Detailed Work Template

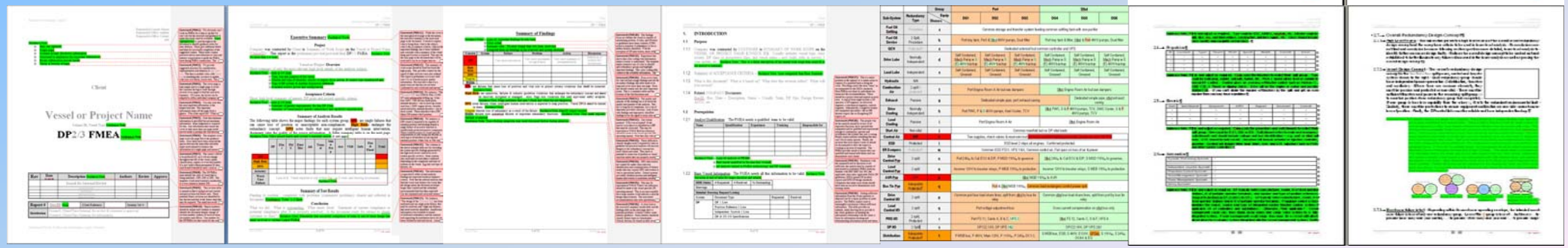
- Built in guidance directly supports and encourage best practice.
- Ensures thoroughness (Depth)
- Re-enforces good procedure
- Provides guidance at the point of action
- Limits and aids in the management of complexity



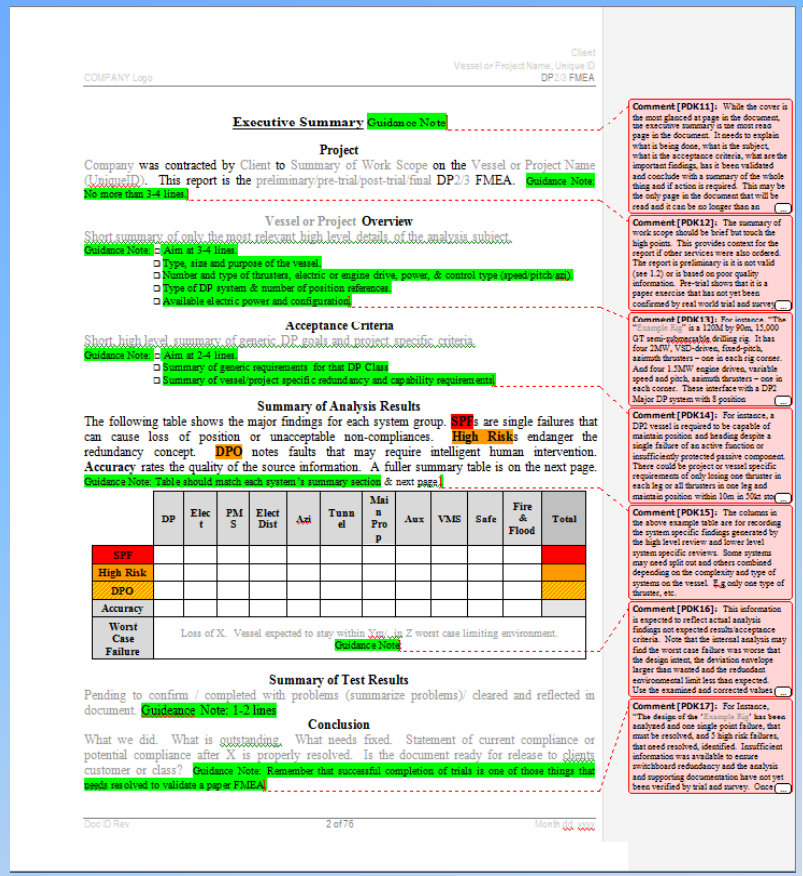
Engineers Capturing Best Work Practices

Overview of the DP FMEA Template

- Fully worked out template available
- Structure, Color, Tables & Drawings
- Choices & Limitations
- Who can use?
- Advantages of a common, master template



Overview of the DP FMEA Template



Client
Vessel or Project Name, Unique ID
COMPANY Logo DP2/3 FMEA

Executive Summary Guidance Note:

Project

Company was contracted by Client to Summary of Work Scope on the Vessel or Project Name (UniqueID). This report is the preliminary/pre-trial/post-trial/final DP2/3 FMEA. Guidance Note: No more than 3-4 lines.

Vessel or Project Overview

Short summary of only the most relevant high level details of the analysis subject.
Guidance Note: - Aim at 3-4 lines.
- Type, size and purpose of the vessel.
- Number and type of thrusters, electric or engine drive, power, & control type (speed/pitch/az).
- Type of DP system & number of position references.
- Available electric power and configuration.

Acceptance Criteria

Short high level summary of generic DP goals and project specific criteria.
Guidance Note: - Aim at 2-4 lines.
- Summary of generic requirements for that DP Class.
- Summary of vessel/project specific redundancy and capability requirements.

Summary of Analysis Results

The following table shows the major findings for each system group. SPFs are single failures that can cause loss of position or unacceptable non-compliances. High Risks endanger the redundancy concept. DPO notes faults that may require intelligent human intervention. Accuracy rates the quality of the source information. A fuller summary table is on the next page.
Guidance Note: Table should match each system's summary section & next page.

	DP	Elec t	PM S	Elect Dist	Azi	Tunn el	Mai n Pro p	Aux	VMS	Safe	Fire & Flood	Total
SPF												
High Risk												
DPO												
Accuracy												
Worst Case Failure	Loss of X. Vessel expected to stay within Xm, in Z worst case limiting environment. Guidance Note:											

Summary of Test Results

Pending to confirm / completed with problems (summarize problems)/ cleared and reflected in document. Guidance Note: 1-2 lines

Conclusion

What we did. What is outstanding. What needs fixed. Statement of current compliance or potential compliance after X is properly resolved. Is the document ready for release to clients customer or class? Guidance Note: Remember that successful completion of trials is one of those things that needs resolved to validate a paper FMEA.

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Comment [PDK11]: While the cover is the most glanced at page in the document, the executive summary is the most read page in the document. It needs to explain what is being done, what is the subject, what is the acceptance criteria, what are the important findings, has it been validated and conclude with a summary of the whole thing and if action is required. This may be the only page in the document that will be read and it can be no longer than an

Comment [PDK12]: The summary of work scope should be brief but touch the high points. This provides context for the report if other services were also ordered. The report is preliminary is it is not valid (see 1.2) or is based on poor quality information. Pre-trial shows that it is a paper exercise that has not yet been confirmed by real world trial and survey.

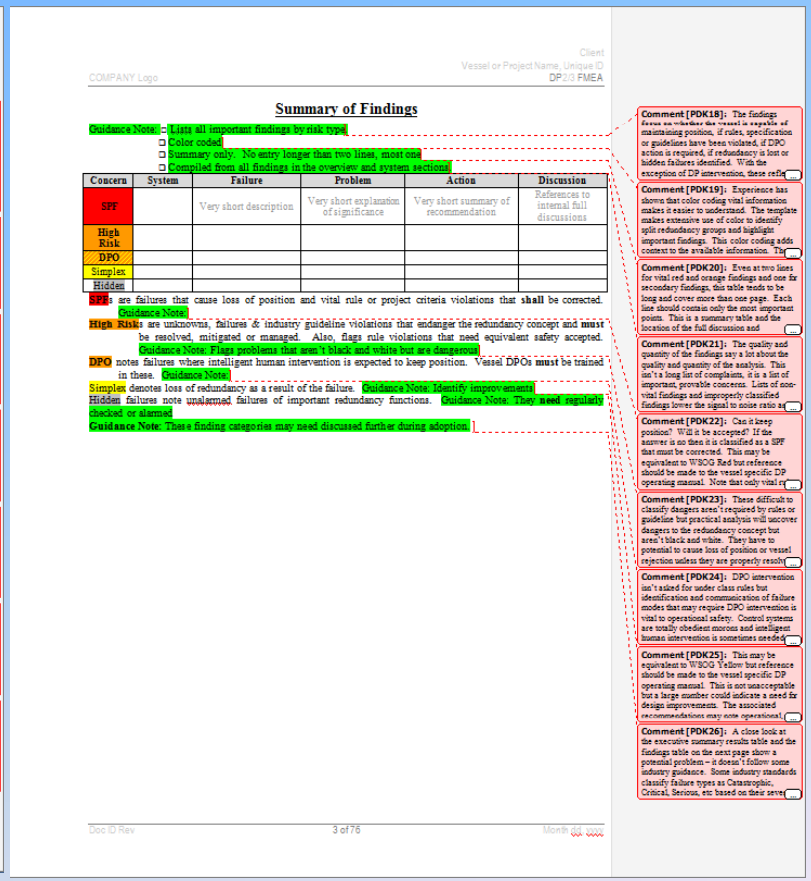
Comment [PDK13]: For instance, "The "Example Rig" is a 120M by 90m, 15,000 GT semi-submersible drilling rig. It has four 2MW, VSD-driven, fixed-pitch, azimuth thrusters – one in each rig corner. And four 1.5MW engine driven, variable speed and pitch, azimuth thrusters – one in each corner. These interface with a DP2 Major DP system with 3 position

Comment [PDK14]: For instance, a DP2 vessel is required to be capable of maintain position and heading despite a single failure of an active function or insufficiently protected passive component. There could be project or vessel specific requirements of only losing one thruster in each leg or all thrusters in one leg and maintain position within 10m in 50kt stor

Comment [PDK15]: The columns in the above example table are for recording the system specific findings generated by the high level review and lower level system specific reviews. Some systems may need split out and others combined depending on the complexity and type of systems on the vessel. E.g only one type of thruster, etc.

Comment [PDK16]: This information is expected to reflect actual analysis findings not expected results/acceptance criteria. Note that the internal analysis may find the worst case failure was worse that the design intent, the deviation envelope larger than wanted and the redundant environmental limit less than expected. Use the examined and corrected values.

Comment [PDK17]: For instance, "The design of the "Example Rig" has been analyzed and one single point failure, that must be resolved, and 7 high risk failures, that need resolved, identified. Insufficient information was available to ensure switchboard redundancy and the analysis and supporting documentation have not yet been verified by trial and survey. Once



Client
Vessel or Project Name, Unique ID
COMPANY Logo DP2/3 FMEA

Summary of Findings

Guidance Note: - Lists all important findings by risk type.
- Color coded.
- Summary only. No entry longer than two lines, most one.
- Compiled from all findings in the overview and system sections.

Concern	System	Failure	Problem	Action	Discussion
SPF		Very short description	Very short explanation of significance	Very short summary of recommendation	References to internal full discussions
High Risk					
DPO					
Simplex					
Hidden					

SPFs are failures that cause loss of position and vital rule or project criteria violations that **shall** be corrected.
Guidance Note:
High Risks are unknowns, failures & industry guideline violations that endanger the redundancy concept and **must** be resolved, mitigated or managed. Also, flags rule violations that need equivalent safety accepted.
Guidance Note: Flags problems that aren't black and white but are dangerous.
DPO notes failures where intelligent human intervention is expected to keep position. Vessel DPOs **must** be trained in these. Guidance Note:
Simplex denotes loss of redundancy as a result of the failure. Guidance Note: Identify improvements.
Hidden failures note unalarmed failures of important redundancy functions. Guidance Note: They need regularly checked, or alarmed.
Guidance Note: These finding categories may need discussed further during adoption.

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Comment [PDK18]: The findings focus on whether the vessel is capable of maintaining position, if rules, specification or guidelines have been violated, if DPO action is required, if redundancy is lost or hidden failures identified. With the exception of DP intervention, these refle

Comment [PDK19]: Experience has shown that color coding vital information makes it easier to understand. The template makes extensive use of color to identify split redundancy groups and highlight important findings. This color coding adds context to the available information. The

Comment [PDK20]: Even at two lines for vital red and orange findings and one for secondary findings, this table tends to be long and cover more than one page. Each line should contain only the most important points. This is a summary table and the location of the full discussion and

Comment [PDK21]: The quality and quantity of the findings say a lot about the quality and quantity of the analysis. This isn't a long list of complaints, it is a list of important, provable concerns. Lists of non-vital findings and improperly classified findings lower the signal to noise ratio a

Comment [PDK22]: Can it keep position? Will it be accepted? If the answer is no then it is classified as a SPF that must be corrected. This may be equivalent to WSOG Red but reference should be made to the vessel specific DP operating manual. Note that only vital r

Comment [PDK23]: These difficult to classify dangers aren't required by rules or guideline but practical analysis will uncover dangers to the redundancy concept but aren't black and white. They have to potential to cause loss of position or vessel rejection unless they are properly resolv

Comment [PDK24]: DPO intervention isn't asked for under class rules but identification and communication of failure modes that may require DPO intervention is vital to operational safety. Control systems are totally obedient morons and intelligent human intervention is sometimes needed

Comment [PDK25]: This may be equivalent to WSOG Yellow but reference should be made to the vessel specific DP operating manual. This is not unacceptable but a large number could indicate a need for design improvements. The associated recommendations may note operational

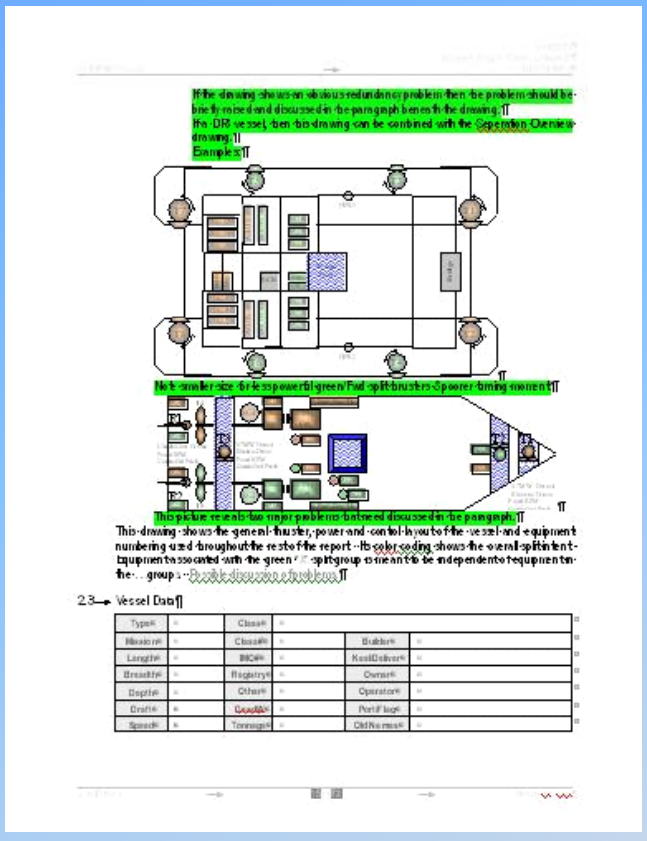
Comment [PDK26]: A close look at the executive summary results table and the findings table on the next page show a potential problem – it doesn't follow some industry guidance. Some industry standards classify failure types as Catastrophic, Critical, Serious, etc based on their seve

Summary

Technical Issues

Human Actions

Overview of the DP FMEA Template



If the drawing shows an obvious redundancy problem then the problem should be briefly raised and discussed in the paragraph beneath the drawing.
If a DP vessel, then this drawing can be combined with the Separation Overview drawing.
Example:

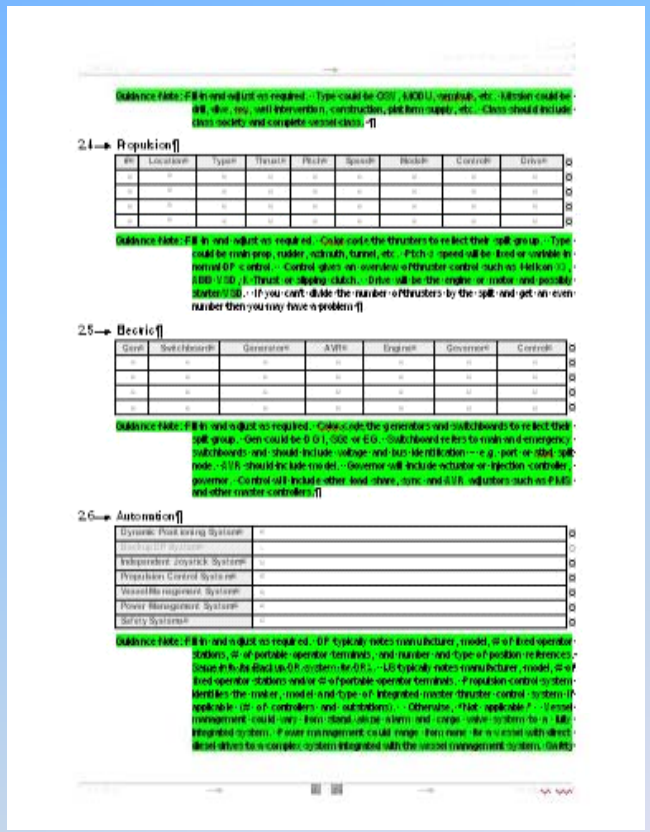
Note smaller size, brighter green/Red split thrusters (power/timing moment)

This picture reveals two major problems that need discussed in the paragraph.

This drawing shows the general thruster, power and control layout of the vessel and equipment numbering used throughout the rest of the report. Its color coding shows the overall split intent - equipment associated with the green "A" split group is meant to be independent to equipment in the "B" group. Provide discussion if unclear.

2.3 Vessel Data

Type		Class			
Mission		Class		Builder	
Length		IMO#		Keel Deliver	
Breadth		Registry		Owner	
Depth		Other		Operator	
Draft		Call Sign		Port Flags	
Speed		Tonnage		Old Name	



Guidance Note: Fill in and adjust as required. Type could be OSV, MODU, semisub, etc. Mission could be drill, dive, rov, well intervention, construction, platform supply, etc. Class should include class society and complete vessel class.

2.4 Propulsion

#	Location	Type	Thrust	Pitch	Speed	Model	Control	Drive

Guidance Note: Fill in and adjust as required. Color code the thrusters to reflect their split group. Type could be main prop, rudder, azimuth, tunnel, etc. Pitch / speed will be fixed or variable in normal DP control. Control gives an overview of thruster control such as Helicon VSD, SCR VSD, K-Thrust or slipping clutch. Drive will be the engine or motor and possibly starter/VSD. If you can't divide the number of thrusters by the split and get an even number then you may have a problem.

2.5 Electric

Gen#	Switchboard#	Generator#	AVR#	Engine#	Governor#	Control#

Guidance Note: Fill in and adjust as required. Color code the generators and switchboards to reflect their split group. Gen could be 9 G1, SG6 or E G. Switchboard refers to main and emergency switchboards and should include voltage and bus identification - e.g. port or stbd, split node. AVR should include model. Governor will include actuator or injection controller. Control will include other load share, sync and AVR adjusters such as PMS and other master controllers.

2.6 Automation

Dynamic Positioning System	
Backup DP System	
Independent Joystick System	
Propulsion Control System	
Vessel Management System	
Power Management System	
Safety System	

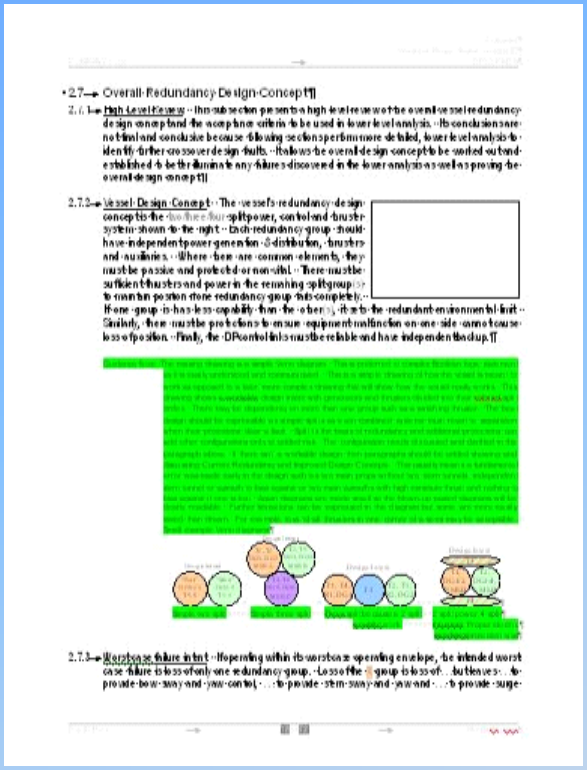
Guidance Note: Fill in and adjust as required. DP typically notes manufacturer, model, # of fixed operator stations, # of portable operator terminals, and number and type of position references. Same info for backup DP system for DP 2. HS typically notes manufacturer, model, # of fixed operator stations and/or # of portable operator terminals. Propulsion control system identifies the maker, model and type of integrated master thruster control system (if applicable, # of controllers and substations). Otherwise, "Not applicable". Vessel management could vary from stand alone alarm and cargo valve system to a fully integrated system. Power management could range from none for a vessel with direct diesel drives to a complex system integrated with the vessel management system. Safety

Equipment

Layout

Nomenclature

Overview of the DP FMEA Template



Sub-System	Redundancy Type	Group / Equip / Discuss	Port DG1	Port DG2	Port DG3	Stbd DG4	Stbd DG5	Stbd DG6
Fuel Oil Setling	Procedure	a	Common storage and transfer system feeding common settling tank with one purifier					
Fuel Oil Service	2 Split, Procedure	b	Port day tank, Port & Stbd 480V pumps, Dual filter			Port day tank & filter, Stbd & Port 480V pumps, Dual filter		
QCV	Protected?	c	Dedicated solenoid but common controller and UPS					
Drive Lube	Normally Independent	d	Self Contained, Mech Pump w S (E) 480V backup	Self Contained, Mech Pump w S (E) 480V backup	Self Contained, Mech Pump w S (E) 480V backup	Self Contained, Mech Pump w S (E) 480V backup	Self Contained, Mech Pump w S (E) 480V backup	Self Contained, Mech Pump w S (E) 480V backup
Load Lube	Independent	e	Self Contained, Greased	Self Contained, Greased	Self Contained, Greased	Self Contained, Greased	Self Contained, Greased	Self Contained, Greased
Hydraulic	N/A							
Combustion Air	2 split if protected	f	Port Engine Room A Air but see dampers			Stbd Engine Room Air but see dampers		
Exhaust	Passive	g	Dedicated simple pipe, port exhaust casing				Dedicated simple pipe, stbd exhaust casing	
Drive Cooling	Normally Independent	h	Port FWC, P & S 480V pumps, Keel Cooler, TCV			Stbd FWC, S & P 480V pumps, TCV, SWC Cooler, S & P 480V pumps, TCV		
Load Cooling	Passive	i	Port Engine Room A Air			Stbd Engine Room Air		
Start Air	Non-vital	j	Common manifold but no DP vital loads					
Control Air	SPF	k	Two supplies, check valves & reservoirs but common manifold feeding pneumatic governors and CPP TCV					
ESD	Protected	l	ESD level 2 stops all engines. Confirmed protected.					
ER Dampers	Protected?	m	Common ESD FS31, UPS Y&X, Common control air, Fail open on loss of air & power					
Drive Control Pwr	2 split	n	Port 24V_{dc} to Cat ECU & E/P, P MSD 110V_{ac} to governor			Stbd 24V_{dc} to Cat ECU & E/P, S MSD 110V_{ac} to governor.		
Load Control Pwr	2 split	o	Incomer 120V to breaker relays, P MSB 110V_{ac} to protection			Incomer 120V to breaker relays, S MSB 110V_{ac} to protection		
AVR Pwr	SPF	p	Stbd MSB 110V_{ac} to AVR					
Bus Tie Pwr	Adequately Protected?	q	Port & Stbd MSB 110V_{ac}, Common load endangers control power split					
Drive Control I/O	2 split	p	Common port bus load share lines, split from stbd by bus tie relay			Common stbd bus load share lines, split from port by bus tie relay		
Load Control I/O	2 split	q	Port voltage adjustment bus			Cross current compensation on stbd bus only		
PMS I/O	2 split, Protected	r	Port FS 11, Cards A, B & C, UPS 3			Stbd FS 12, Cards C, D & F, UPS 4		
DP I/O	2 Split	s	DPC22 U36, DP UPS 1&2			DPC22 U66, DP UPS 2&1		
Distribution	Adequately Protected?	t	P MSB bus, P 480V, Main 120V, P 110V_{ac}, P 24V_{dc} DC1-3,			S MSB bus, ESB, S 480V, E120V, UPSes, S 110V_{ac}, S 24V_{dc} DC4-6 & EG		

Redundancy Concept

Redundancy Cross-Reference

Does it really address the issues?

- Based on experience
- Inspired by lessons learned in other industries.
- HSE RP 195 study of FMEA weaknesses
  - ✓ Addresses 6 of 13 weakness
  - ✓ Improves the remaining 7
    - Trials and Operations issues must be addressed separately

Implementation

- Overall Meaningful improvement
- Limitations and the need for adaptation
- Adoption costs
- Who will use?
- The need for a Champion

Conclusion

- DP FMEA quality problems create industry risk
- A practical working template appears an effective solution
- Directly applies standards where work is performed
- Can make considerable improvement in company or industry FMEA quality
- Needs to be analyzed, adapted and adopted by industry to be fully effective