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New Petrobras Concepts for WSOG (Well Specific Operating Guidelines)

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Abstract

Petrobras, the largest DP drilling units player, introduced in the early 1990's, the concepts of DP alert status in the Company, which contained "Normal", "Degraded", "Yellow" and "Red Status". The tool "Degraded Status Criteria" has been developed to evaluate the minimum allowable redundancy to safely operate DP drilling vessels. On the other hand, IMCA (International Marine Contractors Association) introduced the DP alert status system concepts, which differs from Petrobras DP alert status, by using "Normal", "Advisory", "Yellow" and "Red Status". As a consequence of this difference, Petrobras has been facing misunderstandings and many technical discussions on board the units and even during the planning phases of the wells to be drilled or to suffer workovers, caused by different points of view in dealing with the WSOG's prepared by several drilling contractors that follow IMCA concepts.
In order to minimize this issue and aiming to perform safest well operations, Petrobras internally agreed to get closer to what is applied by IMCA procedures by adding the "Advisory Status", thus avoiding a "culture clash" with Contractors. However, the main difference between them remains the same: IMCA defines "Degraded Status" as the same as "Yellow Status". For Petrobras, these two operational statuses should not be categorized as one single status as they require different actions on drilling units.
This paper aims to share the new Petrobras format for WSOG and show the company's DP alert status concepts.

Introduction

DP rigs have been used in Oil&Gas industry for a long period of time. Over the years, DP units have become a very important and necessary tool to explore oil fields in deep and ultra-deep waters despite the intrinsic risk of losing position. In 1994, IMO (International Maritime Organization) introduced the Guidelines for Vessels with Dynamic Positioning Systems (MSC / Circ 645) to regulate the market, which was strictly followed by Classification Societies and other organizations. IMCA (International Marine Contractors Association), created in 1995 by a merge of AODC and DPVOA, introduced the DP alert status system concepts.

In Brazilian waters, Petrobras had the first contact with DP rigs in 1978, initially operating by risk contracts. In the 1980's, the usage of this type of rig by the company increased rapidly, culminating in the discover of giant Marlim field, in Campos Basin, at 853 m wd. Due to lack of rules, Petrobras' well construction staff independently developed many concepts and procedures, establishing an integrated "operational philosophy" for DP MODUs. In 1992, motivated by a great number of incidents, Petrobras has created the DPPS (Dynamic Positioning Safety Program), grounded in the proactive policy, to avoid and minimize the consequences of such events.

A comparison between Petrobras and IMCA guidelines revels mostly points in common. However, a significant divergence is evidenced and hereby will be discussed. Such differences become relevant for Petrobras when discussing WSOG with international Drilling Contractors, which normally follow IMCA guidelines. As the WSOG require both approval (contractor + client), many technical discussion are needed to get into consensus.

This paper intends to start a discussion with the international DP community to analyse the concepts adopted by IMCA for WSOG by comparing them with Petrobras' point of view. This paper does not aim to discuss every specific condition/limit of WSOG, but the concepts themselves.

1. IMCA Procedures

1.1. DP Alert Status System

Considering the purpose of this paper, IMCA, MTS and Classification Societies have equivalent definitions about DP Alerts. IMCA M 103 ('The Design and Operation of Dynamically Positioned Vessels') item 3 presents the guidelines for Drilling Vessels. Item 3.4 defines the DP Alerts Status as below:

Green

- Normal operational status (green light). The vessel can be defined as connecting or connected to the sea bed in normal operational status when the following conditions apply:
- Vessel under DP control and DP system operating normally with appropriate back up system available;
- Thruster power and total power consumption is less than the maximum thrust and power that would be needed after the worst case single failure to avoid exceeding yellow alert limits;
- Vessel's indicated position and heading are within predetermined limits;
- Negligible risk of collision exists from other vessels.

Advisory

For DP drilling it has become normal practice for there to be an intermediate alert between green and yellow. This is called 'advisory' and is designed to provide an early warning that some condition exists that needs to be considered by the key DP personnel and all personnel involved with the permit to work system. This alert is to be covered by the WSOG. It is communicated internally by phone or e-mail and is an agenda item at all management meetings. The advisory events do not rate a yellow alert because there is still adequate DP system redundancy in the current weather conditions. It, for example, would warn of high thrust and power consumption and/or increasing environmental conditions and/or the need to change position to reduce the riser angle.

Yellow

Degraded status (yellow alert). The vessel can be defined as being in a degraded status when any of the following conditions applies:

- A failure in a sub-system has occurred leaving the DP system in an operational state (possibly after reconfiguration) but with no suitable backup available, so that an additional fault would cause a loss of position;
- Vessel's position keeping performance is deteriorating and/or unstable.
- The flex joint angle has reached 2°;
- Vessel's indicated position deviates beyond limits determined during risk analysis or HAZOP without simple explanation;
- Risk of collision exists from another vessel;
- Weather conditions are judged to be becoming unsuitable for DP drilling.

Note: A loss of position, other than a large excursion, should not be taking place. This means that the DPO is certain that the position will be restored. A large excursion is one that is outside the DP footprint for the existing circumstances.

Red

Emergency status (red alert). A vessel can be defined as in 'emergency status' if any of the following conditions apply:

- System failure results in an inability to maintain position or heading control;
- Any external condition exists, including imminent collision, preventing the vessel maintaining position;
- There is no time available for position recovery;
- The critical offset is expected to be reached;
- Maximum permissible riser angle is exceeded.

Note: The measurement of the critical offset depends on the position references and the position being sought by the DP control system. If these are wrong the offset is wrong.

1.2. WSOG Example

IMCA M 220 ('Guidance on Operational Activity Planning') presents the concepts of CAMO/TAM and ASOG. This document remits to MTS (Marine Technology Society) DP Operations Guidance for detailed guidance. MTS DP Operations Guidance Part 2 Appendix 1 deals the subject within the context of Mobile Offshore Drilling Unit (MODUs) and an example of WSOG is written below.

WELL SPECIFIC OPERATING GUIDELINES - OUTLINE				
	GREEN	BLUE	YELLOW	RED
Definition	*Normal operations – all systems fully functional and operating within acceptable performance limits.*	*Advisory status – approaching performance limits or reportable alarm status. Operations may continue whilst risks are being assessed. A failure has occurred that does not affect DP redundancy.*	*Actionable status -* *Pre-defined performance limits reached, component or system failure resulting in loss of redundancy.* *The vessel / rig maintains position although the vessel has lost its redundancy.*	*Emergency status – pre-defined operational or performance limits exceeded, component or system failure resulting in loss of control or position.*

EXAMPLE OF A WSOG – XXX WELL/LOCATION NAME				
Well Specific Operating Guidelines - Name of DP Drilling Rig				
Condition	GREEN	ADVISORY	YELLOW	RED
Notify Driller, Master, Chief Engineer, Rig Superintendent, Toolpusher and Client	NO	YES	YES	YES
Action	CONTINUE NORMAL OPERATIONS	INFORMATIVE/ CONSULTATIVE STATUS (RISK ASSESS)	HALT OPERATIONS AND INITIATE CONTINGENCY PROCEDURES (Prepare for disconnect)	INITIATE EDS (disconnect sequence)
Water Depth XXXX m				
Emergency Disconnect Time XXs	The Emergency Disconnect time is to be established from field trials. If the time is measured by a surface test, 10 seconds is to be added for conservatism. (Note There may be more than one EDS time. Appropriate one to be used for activity)			
The Red watch circle below is to be established from calculated drift off curves at 1 year environment, defined Point of Disconnect (POD) and the measured EDS (disconnect sequence) time. If environmental conditions are in excess of the 1 year environment and a blackout occurs, a Red status is to be issued immediately.				
From FMEA proving trials, blackout restart time was established at around 1minute 30 seconds from blackout to recovery of all thrusters				
1 Year Winter storm is 41 knots of wind, Hs 16 feet, Surface current is 0.7 knots	POD 4.1%, Time to POD 142 s			
10 Year Winter storm is 50.5 knots of wind Hs21.7 ft, Surface current is 0.86 knots				
10 year Loop current is 19 knots of wind, Hs 6 ft; current is 2.2 knots	POD 10%, Time to reach POD 352 s			
For Total EDS(disconnect sequence) and unlatch time XX s	Red watch circle at 39m	Based on mud weight aa ppg; top tension cccc kips		

Maximum Watch Circles Radius (From Well Head position) <1 year condition (<=Wind 41 knots, current 0.7 knots, Hs 16ft)				39m
Maximum Watch Circles Radius (From Well Head position)- > 41 knots, current 0.7 knots Hs 16 ft and collinear				Immediately if blackout occurs (Dictated by riser analysis)
Colinearity (1 year winter storm)	If wind < 30 knots and current is less than 0.5 knots and colinearity > than 15 deg	If Wind is >30 knots and current is >0.5 knots and colinearity within 15 deg	If wind approaching 41 knots and current is approaching 0.7 knots and colinear	
Colinearity (loop current)	If wind < 15knots and current is less than 1.5 knots and colinearity > than 15 deg	If Wind is >15 knots and current is >1.5 knots and colinearity within 15 deg	If wind approaching 19 knots and current is approaching 2 knots and colinear	
Weather Forecast	Within Post WCF Operating limits	Approaching Post WCF operating limits	Exceeding Post WCF operational limits	
DRIVE OFF or	All systems operating correctly	Discrepancy in PRS. Inexplicable ramp up of thrusters	Immediately when recognized by DPO	Unable to control Drive Off
DRIFT OFF				
Drilling offset from well head position	Position directly over wellhead	Any offset from ZAP	=/>12.m	
Heading excursion	No Heading Alarms or warning	If heading warning limit reached (>3 degrees)	If heading Alarm limit reached (>5 degrees) or Heading instability with frequent alarms	
Vessel Footprint/Weather related excursion (From Set point)	No position alarms or warning	If warning position limits reach (>3m)	If Alarm position reached (>5m) or Position instability with frequent alarms	
Drape Hose Heading Limitation	> -200 ° < +200 °	+/-200 to 240°	> -240 ° < +240 °	To be established at Field Trials

Long Turn		Being considered	Under execution	
Riser Limitation (UFJ)	0 - 2°	>2 °	>4 °	
Riser Limitation (LFJ)	0 - 2°	>2 °	>4 °	
'Power Trains'/Thrusters in use	At least two diagonally opposite pairs of thrusters running and selected to DP (1 thruster in each corner)	Any selected thruster in alarm	Less than two diagonally opposite thruster pairs running and selected to DP	
Thruster loading (thrust)	all <values given in generator configurations and limits document	any approaching values given in generator configurations and limits document	All > values given in generator configurations and limits document	
Any change in thrusters/propulsion in or out of use		Advisory		
Diesel Generator Loads	All generators available with at least one generator on line on each bus, generators usually symmetric configuration. Generator configuration as per TAGOS if available	Power consumption >= power demand required to maintain position following WCF (usually loss of one Switchboard/ loss of one E/R) Or values in TAGOS document	Power demand > 65% for duration of one minute with maximum number of generators on line Or values as described in TAGOS document	
Any change in generators in or out of use		Advisory		
Thruster phase back, drilling phase back or DP control system power limiting	No Alarm	Approaching operating limits	Alarms and or phasing back or limiting	-
DP UPS's and 24 VDC Systems	Main and back up supply available no UPS in by pass. No UPS alarms	Any UPS in bypass or in alarm	Main supply cannot be reinstated or total UPS failure	
DP Control System	Power mimic information correct	Any wrong information	Critical information wrong or DP is in power limit	

SIMOPS - Well Specific Operating Guidelines - Name of DP Drilling Rig				
Condition	GREEN	ADVISORY	YELLOW	RED
Notify Other vessels in the field, Driller, Master, Chief Engineer, Rig Manager, Toolpusher and Client	NO	YES	YES	YES
Action	CONTINUE NORMAL OPERATIONS	INFORMATIVE/CONSULTATIVE STATUS (RISK ASSESS)	HALT OPERATIONS AND INITIATE CONTINGENCY PROCEDURES	INITIATE EDS(disconnect sequence)
Change from Green DP Status of any other vessel in the field	Green	Advisory	Advisory	Advisory
Comms/interaction with other vessels	Vessels operating normally with no known problems	Comms problem or escape route compromised	No comms or escape route compromised	

Notes:
1. This document shall be followed as closely as possible during DP Operations.
2. Escape Route to be established.

Signed:

On behalf of Owner/Operator _____

Printed name _____

On behalf of Client _____

Printed name _____

2. Petrobras Procedures

2.1. DP Operational Status

Petrobras, since the beginning of DPPS, considered only “Normal Status”, “Degraded Status”, “Yellow Status” and “Red Status”. Its procedures did not take into account the “Advisory Status”, as the vessel still has adequate DP system redundancy. However, after a recent review induced by many discussions on board DP rigs, this status came to be considered.

Normal Status

State in which the DP Unit operates with all systems and equipment fully operational, online or in standby, with negligible risk of collision. The unit should work within its metocean envelope conditions (i.e. without exceeding power or thrust demand) and without reaching any positioning reference parameter (offset, riser angle, etc).

In short, there is no risk or evidence of loss of position and all operations scope of contract should be performed without problems regarding positioning.

Advisory Status

Defines a particular operating state of DP units as the simple failure of a given equipment or system that, despite the nature of such failure, there is still adequate DP system redundancy in the current weather conditions.

Alerts to abnormal condition and demands personnel actions. Must be reported internally, by phone or e-mail, and discussed to solve the problem.

It is important to emphasize that this must not interrupt operations. The Advisory Status is one step before the Degraded Status, non-critical, and therefore, less important when compared.

Degraded Status

Occurs when Rig loses redundancy in some equipment or system related to its dynamic positioning capabilities (generation, propulsion, controllers, sensors, position reference systems, etc.). All personnel in charge (Captain, OIM, Company Man, etc.) shall immediately be informed in order to analyse the situation and take the appropriate course of action.

The degraded status marks the beginning of concerns about a possible emergency disconnection, since an additional failure can lead to loss of position. It is referred to as the ideal time for decision making regarding operational safety. On board crew should decide for the continuity of operations, depending on the criticality of ongoing operations, risk to the well, the staff, the vessel and the environment.

Yellow Status

States that the main positioning parameters (offset, riser angle, etc.) reached the operating limit determined in the WSOG. There is actual loss of position keeping capability. From this moment on, well operations must be suspended and preventive measures must be immediately taken, preparing for a possible emergency disconnection.

Yellow Alarm must be triggered by DPO's or Captain of the unit. This alarm shall be audible and visual. The Yellow Alarm is to be taken as a "prepare to disconnect" order, following procedures previously established and well understood by the crew, once there is no more time for discussions, though eventually there may be still some possibility of recovery.

The Yellow Alarm should be immediately triggered in the event of a complete loss of propulsive power (caused by a blackout or loss of thrusters).

Red Status

States that the main positioning parameters (offset, riser angle etc.) reached "red" limit established in WSOG, signalling that station keeping capability is definitely lost. There's no more time for any mitigating action and, from this moment on immediate emergency disconnection from the well must take place. Failure or delay in proceeding may result in severe damage to the well, equipment, the environment or people.

Red Alarm must be triggered by the unit's DPO's or Captain. The alarm shall be audible and visual. Red Alarm is understood as a situation in which the vessel must disconnect immediately, following procedures previously established and well understood by the crew.

Operating limits with connected BOP are generally defined by each Contractor, for each well operation, by a Riser Analysis that must be early presented during the project phases of the well (internally named as GEP – Well Enterprise Group). A copy of the WSOG and the Riser Analysis must be kept on board and available for the Company Men, Rig Superintendent, Tool Pushers, Captains and DPO's.

Operational limits for wet X-Mas Tree operations ("light workover") are normally defined by Petrobras Subsea Engineering Group, which should attend the GEP meeting and determine the specific limits for their equipment.

Should all position monitoring systems (drift and angle) become unavailable for the DP operator, Red Alarm shall be triggered immediately. In exceptional cases when reaction times for position loss is extremely low, the WSOG can determine such a small distance from Yellow to Red alarms that, in practice, it may be necessary to trigger Red alarm immediately, depending on the restrictions imposed by shallow waters or an stress-limited well head.

2.2. WSOG Layout

The conventional WSOG table used by IMCA and most part of the Drilling Contractors consists in several lines, each one related to a specific positioning parameter (metocean condition, rig equipment, power demand, vessel condition, etc.). All of them classified in four different columns (green, advisory, yellow and red). Such layout normally causes confusion on board, especially because mixes "causes" with "consequences". Metocean condition strictly linked to emergency alarms is an example of this.

The format of the document now proposed by Petrobras was divided into different tables in order to separate different type of information and to make it easier to understand by the offshore staff, not only for DPOs and Captain, but also for driller, toolpusher, OIM, company man and other people involved with operations as well.

The model below was fulfilled for a generic rig, making a particular operation, on specific location. Values here presented are for illustrative purpose only and should be used only as a guide. The WSOG must be customized according to the specific job and risk involved.

Attached to this document, there is a table with weather condition and vessels movement limits for specific operations that is not exposed on this paper.

The tool “Degraded Status Criteria” (internationally shared in 1996 during the OTC - Offshore Technology Conference), specific for the Unit, should be one of the inputs for making the WSOG. The “Degraded Status Criteria” describes the minimum redundancy on equipment and systems to safely operate DP units, considering its various aspects (number, load demand, configuration and failure mode). The “degraded status criteria” is applicable to all DP rigs working for Petrobras.

GENERAL DATA			
Rig Name: SS-XX			**Date:** 12 Out 2012
Block: Marlin	**Well:** X-XXX-XXX-RJS	**Objective:** Drilling	
Geographic Coordinates (SIRGAS-2000)	**Lat.** 22 23 33.306 S	**Long.** 40 3 57.660 W	
Surface Obstacle: (distance/azimuth): P19: 0,63 Nm / 090 deg Falcon 100: 1,60 Nm / 347 deg	**Subsurface Obstacle: (distance /azimuth):** Buoy: 0,6 Nm / 344 deg Buoy: 0,9 Nm / 340 deg	**Escape Route:** 170 - 215 deg.	
EDS Time (BOP and/or Xmas Tree): EDS1: 45 seconds	**Water Depth:** 742 m	**Additional Information:**	

WEATHER CONDITION FOR STATION KEEPING			
Contractual Collinear Weather Condition for Station Keeping	Wind: 32 kts	Wave: 4 m	Current: 2,2 kts
Reference information only. Decisions regarding operational continuity must consider all other WSOG tables and parameters.			

DP OPERATIONAL STATUS – DEFINITIONS AND REQUIRED ACTIONS					
	GREEN	**ADVISORY**	**DEGRADED**	**YELLOW**	**RED**
Definitions	Normal Operation.	Simple failure of redundant equipment.	Loss of minimum redundancy.	High-risk event or pre-defined performance limits reached. Recovery still possible.	High-risk event or pre-defined performance limits reached. Recovery is no longer a possibility.
Action Required	N/A	Report parties involved and identify risks.	Petrobras and Contractor meeting to decide about operational continuity.	Activate alert and follow procedures. Prepare to disconnect.	Activate alert and follow procedures. Disconnect.
DP PARAMETERS					
PARAMETERS or EVENTS	**GREEN**	**ADVISORY**	**DEGRADED**	**YELLOW**	**RED**
Offset (Riser Analysis; Well Head Forces)	0 – 10 m	> 10 m	N/A	> 22 m	> 37 m
Differential Riser Angle (WH/PAB/BOP/LMRP x LFJ)	0° – 1°	> 1°	N/A	> 3°	> 5°
Heading Offset from Setpoint ("Station Keeping" x Capability)	0° – 3°	> 3°	N/A	As per Riser Twist	As per Riser Twist
Positioning Reference System (PRS)	All (3 DGPS + 2 HRP)	Any PRS failure/loss	One PRS type only	N/A	Loss of all PRS
DP Control System	All (03 main + 1 backup)	Any system failure/Loss	Only 01 main system	Loss of all systems	As per Red circle offset
DP Network	All (dual networks)	Alarms on 01 network	Loss of 01 network	Loss of all networks	As per Red circle offset
Gyro	All (03 operational)	02	01	Loss of all gyros	As per Red circle offset
Drive Off	N/A	N/A	N/A	Immediately when recognized	Immediately if the drive cannot be converted to a drift off
Collision (unintentional approach)	Dist. > 500 m	If collision possible	N/A	If collision probable	If collision imminent
Total Black Out	N/A	N/A	N/A	Immediately	As per Red circle offset
...					

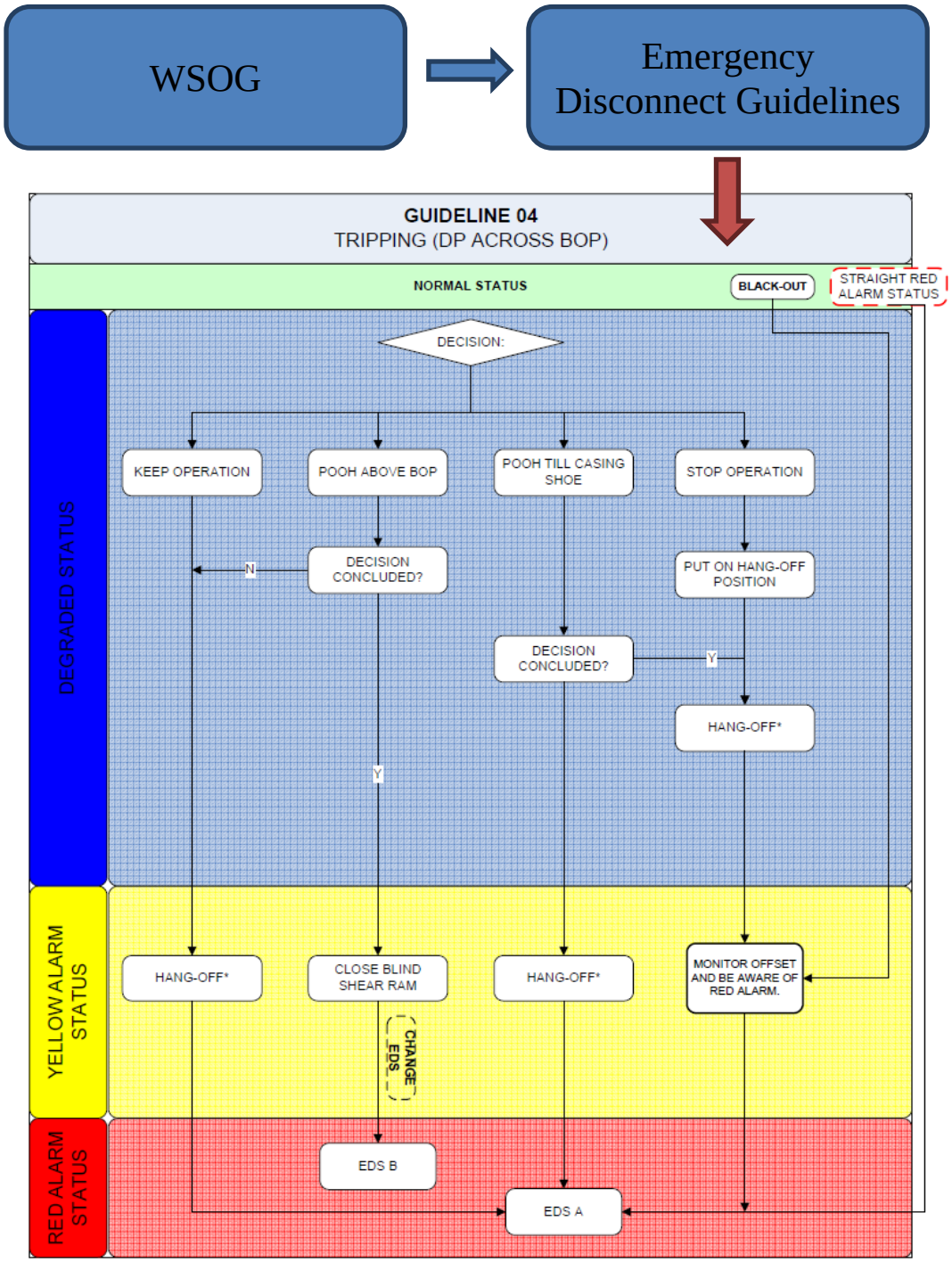
OPERATIONAL PARAMETERS					
PARAMETERS or EVENTS	**GREEN**	**ADVISORY**	**DEGRADED**	**YELLOW**	**RED**
Riser Twist (Heading Change Limits) – Difference of Ship Heading and BOP Heading	Less than +/- 180° from latched heading	More than +/- 180° from latched heading	N/A	More than +/- 180° from latched heading and no heading control	More than +/- 220° from latched heading and no heading control
Slip Joint Stroke / Riser Tensioner Cylinder	less than 50% of stroke	More than 50% of stroke	N/A	More than 80% of stroke	More than 90% of stroke
...					

DEGRADATION CRITERIA (Loss of Redundancy)		
DP	**Available on Unit**	**Normal State Minimum Configuration**
DP Operator Stations	03 main + 01 Back up	02 main
Acoustic System	02	01 (with at least 2 operational DGPS's)
DGNSS System	02	01(with at least 2 operational HPR's)
Wind Sensors (WS)	03	02 (WS loss doesn't cause a significant position change, except in case of blast)
MRU	03	02
DP UPS's	03	02
ERA / ARA	03 (2 ERAs e 1 ARA)	01
Power Generation	**Available on Unit**	**Normal State Minimum Configuration**
Number of Diesel Generators (DG)	06	05 (available)
Power demand on online DG's	---	
PMS Network	02	02
Switchboard UPS's	03	01 for each bus
Speed Drives UPS's	03	02
PMS UPS's	02	02
PMS Operator Stations	03	02
Thrusters	**Available on Unit**	**Normal State Minimum Configuration**
Number of bow Thrusters:	03	02
Bow Thruster Power Demand:	---	
Number of Stern Thrusters:	03	02
Stern Thruster Power Demand:	---	
Number of Propellers:	-	-
Propellers Power Demand:	---	
Degradation criteria of other equipments and systems is described in the "Degraded Status Criteria" of the unit. Power generation and thrusters information above regards typical DP configuration. Degradation criteria for other configurations is described in the "Degraded Status Criteria" of the unit.		

WSOG Signatures	
OIM:	Master:
Chief Engineer:	Rig Manager:
Company man:	DPPS Department:

2.3. WSOG and "Emergency Disconnect Guidelines" – An operational guidance to safely operate DP drilling units

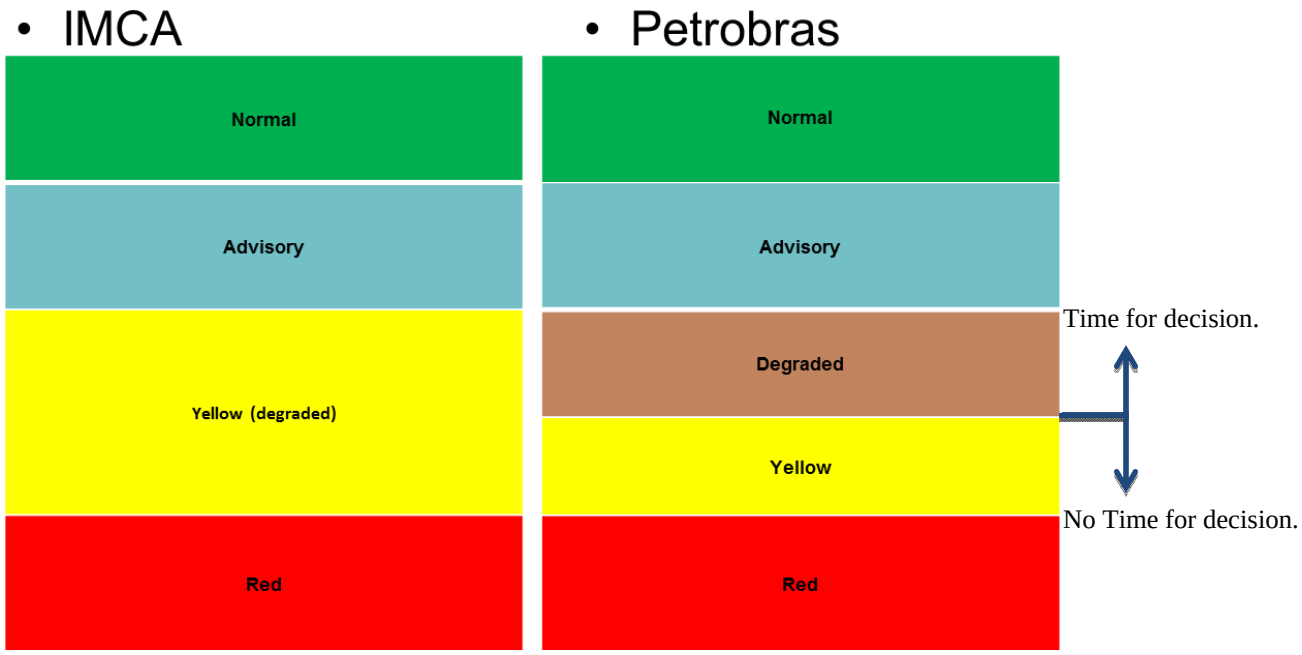
WSOG and "Emergency Disconnect Guidelines" are together a key set of drivers for improvement of operational safety on DP rigs, according to Petrobras procedures. Basically, the WSOG presents the requests for triggering the DP Alerts and the "Emergency Disconnect Guidelines" help people in charge to make decisions once each DP status is reached.



The "Emergency Disconnect Guidelines" has been designed for each operation individually. On the example above, is presented the guideline for a "tripping operation". This Guideline also defines operations like "critical" and "non-critical" (based on well), guiding the decision making process depending on the risk involved.

3. Comparison IMCA x Petrobras DP Alerts Concepts

By the definitions listed in this document, a comparison between IMCA and Petrobras can be summarized in the schematic below.



IMCA WSOG uses "Normal Status", "Advisory Status", "Degraded Status (Yellow)" and "Red Status" while Petrobras WSOG presents "Normal Status", "Advisory Status", "Degraded Status", "Yellow Status" and "Red Status".

We can notice that the difference between these concepts regards the triggering of the Yellow Alert. IMCA "Degraded Status (yellow alert)" incorporates what Petrobras defines as "Degraded Status" plus "Yellow Status". IMCA sound the Yellow Alert, immediately stopping the vessel operation due to any redundancy loss at DP system ("Degraded status"), even if the vessel is still able to maintain the station keeping capability.

Petrobras, for its turn, clearly considers the vessel DP system in two different situations: the "Degraded Status" condition, defined by loss of redundancy in any equipment or component of the DP system – but not necessarily related to abnormal offset, riser angle or positioning loss –, and the "Yellow Status", meaning that the rig has already lost its safe station keeping capability since abnormal offset or riser angle has already overstepped pre-defined parameters, although, eventually, it may be still possible to recover safe positioning. For Petrobras, "vessel in position with no redundancy" and "vessel drifting" are two different conditions (Status), which should be reflected in the WSOG [Pallaoro, 2013].

IMCA's procedure prioritizes an early preparation for a possible emergency disconnection, giving more time to driller put the well in a safe condition. However, an immediate Yellow Alert, in case of redundancy loss only ('degraded'), would end up the possibility of driller making other operation to put the well in a safer condition, since there is time to do so. Unnecessary 'prepare for disconnections' in some operations can be treated as a disadvantage when comparing with Petrobras procedures, endangering well situation and leading to possible human errors.

For Petrobras, the "Degraded Status" permits time for decisions. In some cases, the "Degraded Status" permits the driller to do operations to put the well in safer conditions than the immediate Yellow Alert procedure requires. Although, this can bring a delay on the "prepare for disconnect" when the situation evolves to it.

Petrobras procedures bring an easy understanding concept for the "Yellow Status", based only on very critical situation for the station keeping (by parameters such as offset, riser angle, etc). This means that once the Yellow Alert is sounded, the EDS has great chances to take place. At this stage, there is no time for discussions. Rig floor personnel cannot hesitate on doing pertinent procedures since they have limited time for a potential disconnection.

4. Petrobras Reasons for not merging "Yellow" and "Degraded Status"

Petrobras concepts are grounded on more than thirty years' experience of exploring Oil&Gas fields with DP MODUs. Statistic work, collected from BDIP (Petrobras' DP incidents Databank – events since 1978), supports the actual concepts adopted by the Company.

Some reasons for not merging these DP Operational Statuses are listed below:

1 - Excessively conservative choices can drive against safety. More adequate pre-treatment = less damaging consequences.

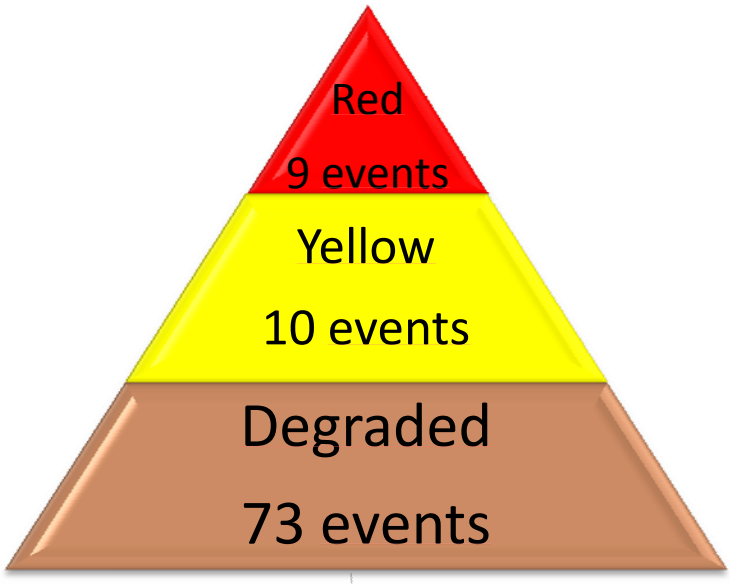
There are several rig operations in which 'immediately stop' worsens the level of safety. In these cases, keeping operation may be safer than stopping right away. Adequate pre-treatment considering operations such as 'tripping', 'drilling', 'logging', 'coiled tubing', 'well testing' (among many others) would result in improved safety and economic benefits, especially in open well operations without riser margin – most part of the well being drilled and completed in the giant pre-salt fields in water depths over 2200 m.

For a real comparison, let's imagine loss of DP redundancy while tripping drill pipe across BOP, a very simple operation. By IMCA procedure, the Yellow Alert should be triggered and driller should put the string on a hang off position. According to Petrobras, this critical situation should be faced as "Degraded Status". Despite the criticality of failure, there is no actual loss of position and there may still be time to pull the string above BOP or, at least, till casing shoe, leaving the well in a better condition.

Observe in this example that if the situation worsens to "Yellow Status" (i.e., positioning loss), bridge personnel would activate the Yellow Alert and staff would face it without stress, since decisions would have already been made during the "Degraded Status" period. If a disconnection becomes necessary, shearing drill pipe could be avoided. Or, in case of pulling till the casing shoe, it would minimize the risk of pipe sticking in open well and its consequences.

Note: In the "Degraded Status", it can be decided to perform the same action of "Yellow Status". The difference between them is the reaction time available to deal with the situation.

2 – Statistic shows that most of "Degraded Status" does not evolve to "Yellow Status".



Source: BDIP 2013/2014.

As seen above, during the last two years there were 73 events of "Degraded Status", 10 events of "Yellow Status" and 9 events of "Red Status". Note: The event is only registered once as the most severe status. In other words, if a "Yellow Status" progress to a "Red Status", this event would be registered only as "Red".

3 – DP MUDUs have some peculiarities when compared to other DP Units.

For Petrobras, only the "Yellow Alert (degraded status)" from IMCA is not enough for DP MODUs. On drilling vessels, immediately halting operation (a straightaway hang off, for instance) may not be the safest decision. Yellow Alert can possibly create unsafe conditions and should be triggered only if really necessary.

Petrobras "Degraded Status" allows all personnel in charge to analyse the situation and take the appropriate course of action, based on how "critical" the situation is in terms of risk to the well, the staff, the vessel and the environment.

4 – Yellow Alert meaning depreciation.

Separate "Degraded" and "Yellow" make it easy for staff comprehension. By Petrobras procedures, the Yellow Alert means critical situation which needs to be rapidly handled as the full station keeping capability has already been lost. Rig personnel clearly know that, once sounded the Alert, they have limited time for a potential disconnection and the "prepare for disconnect" procedure needs to be done immediately.

Signs of Yellow Alert meaning depreciation is evidenced on two events happened on Brazilian waters with contractors that follow IMCA procedures. In the first one, a loss of DP redundancy occurred and bridge personnel did not activate the Alert button, not following their own procedures.

In the second case, the Yellow Alert was activated and driller, instead of making the 'prepare for disconnect' straightaway, called bridge first to confirm the real situation. This action reduces available time for making the 'prepare for disconnect' procedure.

Conclusion

WSOG has become one of the most effective tools available for conducting DP operations safely. Its use has been widely adopted by Oil&Gas offshore drilling industry. However, the awareness and training of the staff is essential for the adequate use of the tool, as it require prompt actions. It's crucial that the document is well understood by all personnel involved. On this context, conceptual divergences are considered an issue, as they interfere on good understanding and course of actions.

Petrobras hereby call the DP community for a discussion on the concepts behind the WSOG. These concepts should ponder the rig efficiency and, specially, the rig's safety levels. This paper shows that unnecessary interruptions of well operations can possibly bring additional risks or even lack of well control and therefore, shall be avoided whenever possible, justifying Petrobras outlook over these concepts.

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