



RISK, FMEA AND RELIABILITY

Crossing the Salt Barrier by Using a Reliable DP Vessel

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Petrobras

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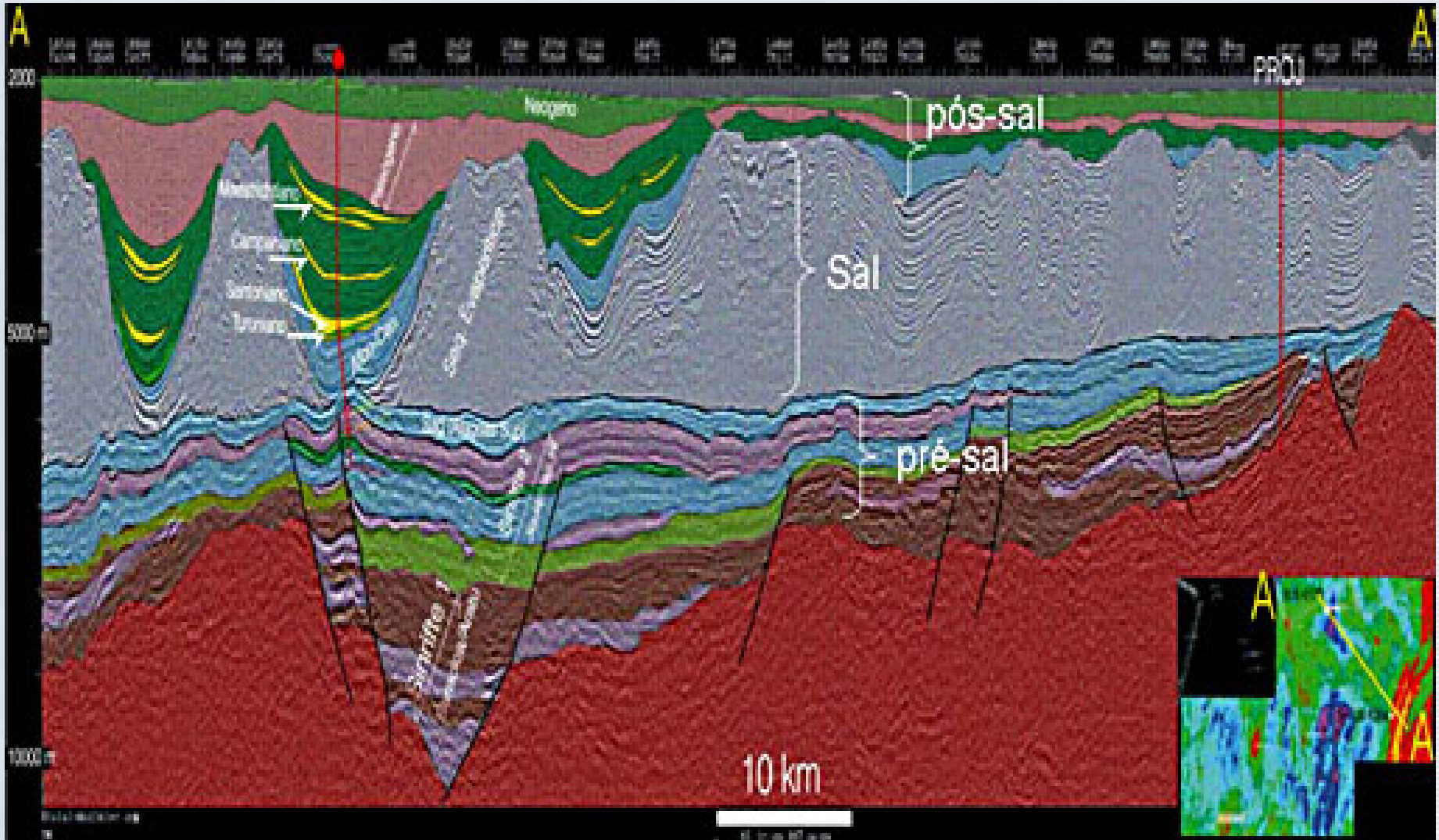


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Crossing the Salt Barrier by Using a Reliable DP Vessel



1. Pre-Salt Layer – the new challenge



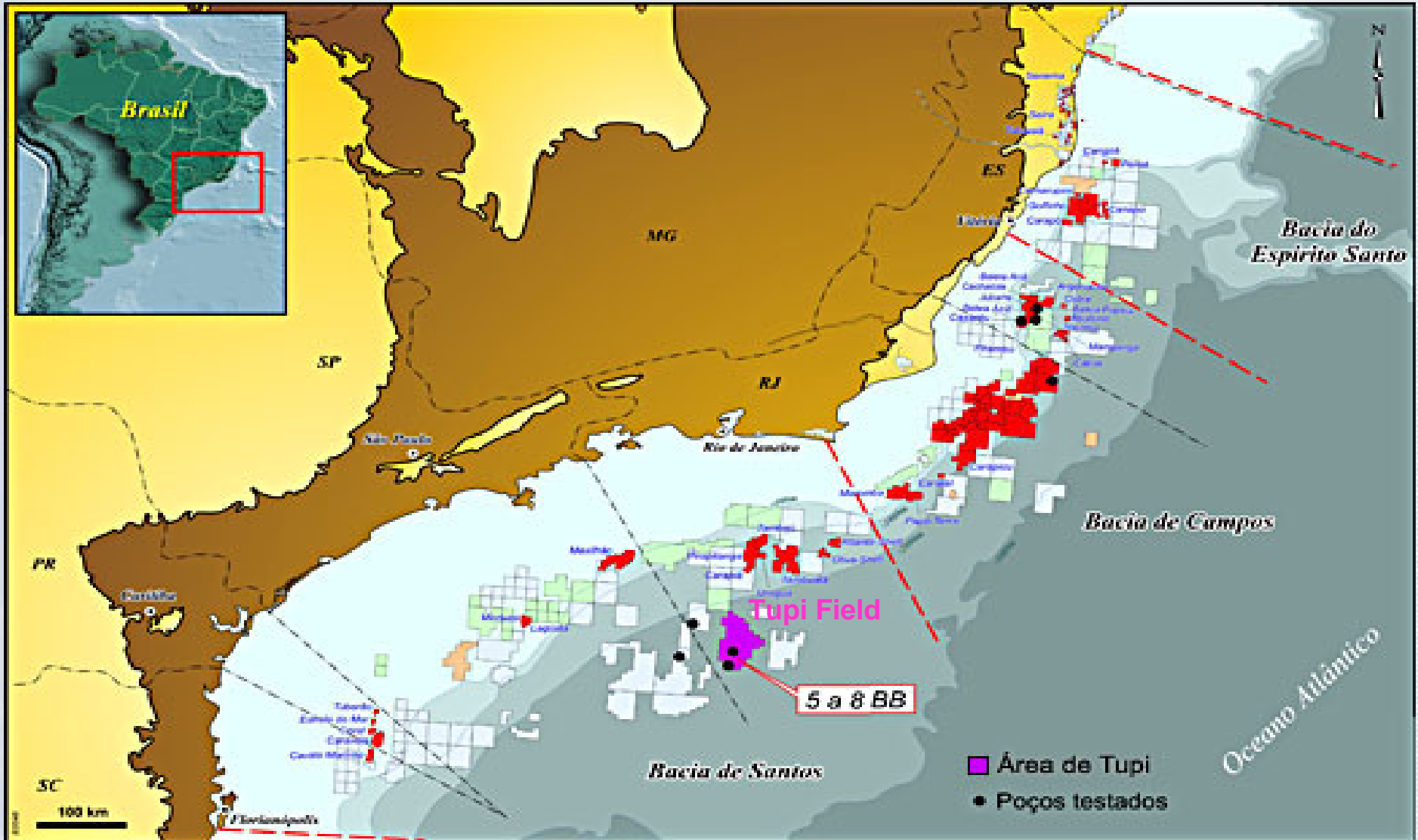


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1. Pre-Salt Layer – the new challenge





2. A 'reliable' DP vessel: definition

At first, a “reliable vessel” is the one that:

- Acceptance / annual trials were carried out;
- Medium and high risk nonconformances (including those of FMEA) were addressed and solved;
- A “degraded status” was defined and applied.



3. How to make a DP vessel reliable?

3.1 International Guidelines

3.1.1 IMO MSC-645 Standards, establish for class 2&3:

- Complete DP-system initial survey to ensure it fully complies with all the applicable items of the guidelines, including the ability to keep position after single failures.
- Annual survey to ensure that the DP-system is maintaining its ability to keep position after a single failure.
- Complete tests, similar to the initial survey at intervals not exceeding five years.
- Tests shall be made, either after accident which affects the safety of the DP-vessel or significant repairs / alterations, to demonstrate full operational condition capacity.
- ✓ The IMO MSC-645 is a broad standard, as a consequence, more detailed specifications are adopted by governments or operators.



3. How to make a DP vessel reliable?

3.1.2 IMCA Guidelines & Issues

- Guidance documents ensuring safe and efficient operations. A key document related to DP is the “Guidelines for the design and operation of dynamically positioned vessels” (IMCA M 103)
- Audits & Trials program for DP vessels in order to ensure every relevant aspect is being addressed to further enhancing efficiency.
- Technical reports aimed at helping vessel operators to review, specify, maintain and use the DP system



3. How to make a DP vessel reliable?

3.1.3 MTS Guidelines & Issues

- The main focus, especially at the DP conference, is to present a state-of-the-art technology pertaining to all aspects of DP.
- Panel discussions led by recognized experts in DP are focused on key issues, such as safety, *reliability*, training, design, configuration and experience.
- MTS, with its sections and subsections, works as a “best practices community” with focus on developing, validating and disseminating lessons learned and best practices to improve *reliability* on DP vessels.



3. How to make a DP vessel reliable?

3.1.4 Classification Societies Rules

- Establish and apply technical standards, issued as rules.
- ✓ A Class Notation certificate does not imply, and **should not be construed as an express warranty of safety**. It is just an attestation that the vessel is in compliance with the standards.
- ✓ DP system is extremely complex, and its specialists are not always available in every location where Classification Societies maintain representatives.



3. How to make a DP vessel reliable?

3.1.5 FMEA (Failure Modes and Effect Analysis)

- Not part of IMO standards, just recently on Classification Societies rules;
- *To guarantee reliability / redundancy on DP system, a FMEA should have;*
 - Operational description dig deep enough to provide in-depth information;
 - Test worksheet that reflects the operational description level;
 - Failure mode risk level classified according to a severity matrix ;
 - Recommendations list, confirmed by testing, and classified according to the risk level;



3. How to make a DP vessel reliable?

3.1.5 FMEA (Failure Modes and Effect Analysis)

- To be effective, the FMEA should;
 - Consider human error;
 - Use adequate qualified multi-disciplinary team;
 - Have a deep involvement with the DP team to search continuously for hidden *failures*;
 - Value the professional experience of the vessel operational / maintenance team especially on vessel specifics;
 - Consider different operational system modes like open /close bus bar;
 - Work as a living document being permanently updated;
- ✓ FMEA shall be adopted as a day-by-day tool. Due to its unique description of the entire DP system, including all its main redundancies, it is also considered as a training resource;



3. How to make a DP vessel reliable?

3.2.1 Petrobras / DPPS: the history

- 1978 First DP vessel in Brazil (under risk contracts) ;
- 1984 First DP vessel contracted by Petrobras;
- 1985 Giant Marlin field discovered by a DP vessel;
- 1992 DPPS is created to deal with a high number of incidents;
- 1995 DP incidents data bank is created; 2003 – updated: statistics friendly use; Restriction Diagram” (1G - empiric);1997 (2G -statistics); 2008 (3G- software model);
- 1996 Another very large field discovered (Roncador);
Acceptance and Annual trials is adopted to meet IMO-MSC-645 guidelines;
FMEA is provided to vessel with high number of incidents;
“First DPPS Seminar” to study “Emergency Disconnections”; 1998 – 3rd Seminar to discuss DP procedures; 2005 - 4th Seminar to analyze DP human error;
- 1998 “Nonconformances data-bank” is provided to deal with high number of DP vessels;
2000 -improved: friendly use; 2004 - last update, to interface with corporative software;
- 2006 “DP professional qualifications data bank” is implemented;
- 2008 “Acceptance and annual trials data bank” is implemented;



3. *How to make a DP vessel reliable?*

3.2.2 Tools Used to Increase Reliability

3.2.2.1 Technical Specifications

Petrobras' DP vessels specifications reflect years of experience and lessons learned taking into account:

- the nonconformances and/or incidents reported;
- Increasing on ultra deep water exploration;
- Improvement on monitoring the local environment weather data;
- difficulties to design an oil field project due to the application of restriction diagrams;
- state-of-the-art technology;

DP rig vessel attend IMO class 2 and detailed specification up to component level to eliminate the lack of redundancy that could cause loss of position.

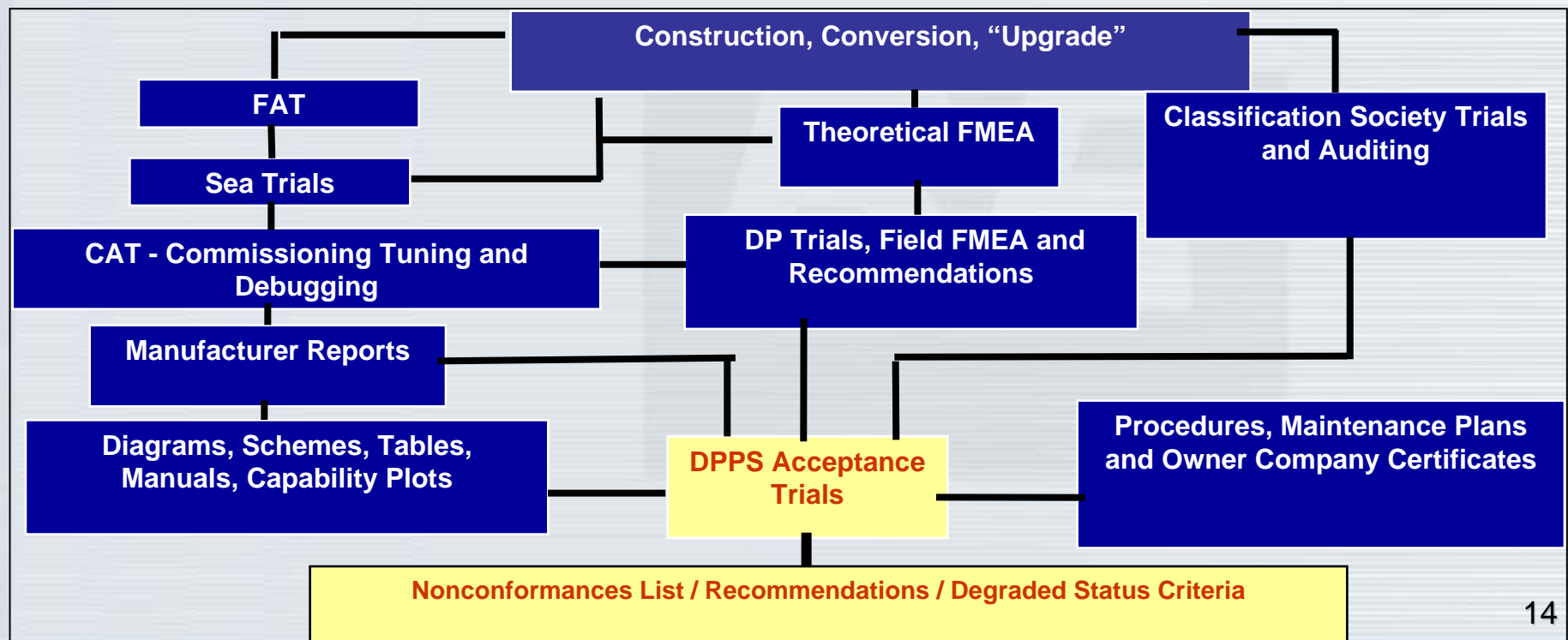


3. How to make a DP vessel reliable?

3.2.2.2 Acceptance Trials

An initial trial is carried out to ensure that:

- The DP system complies with all technical specifications stipulated in the contract;
- The DP system's professionals comply with required international qualifications;
- All the contractual nonconformances are in a data bank for treatment purposes;
- Contractors follow IMO, IMCA and equipment manufacturers' recommendation.





3. How to make a DP vessel reliable?

3.2.2.3 Annual Trials

As we consider annual trials the most important tool to ensure DP system's reliability, it should follow:

- IMO recommendations;
- Our equipment verifications and tests procedures;
- Our DP and PMS data loggers check procedures;
- Blackout recovery test procedures;
- Emergency towing and drift off test procedures;



3. *How to make a DP vessel reliable?*

3.2.2.4 Major Incident Investigations

All major incidents are investigated by a qualified Petrobras DPPS surveyor. Actions are performed in the following sequence:

- First, all vessel operations are stopped until the root cause of the incident is identified.
- Then, corrective / preventive measures are implemented to guarantee that the incident will not be repeated.
- Finally, incidents and nonconformances are registered on respective data bank for reference to help solving / preventing similar problems on other vessels.



3. *How to make a DP vessel reliable?*

3.2.2.5 DP Professional Qualification Databank

As known by the DP community worldwide as well as proved by our DP incident data bank, the human error, normally caused by lack of professional experience and qualification, is being considered as the main root cause of incidents. To prevent that, a data bank was created to:

- Identify those employees who do not meet a minimum international standard qualification;
- Identify those employees who require additional training;
- Implement actions to assure the necessary qualifications:



3. How to make a DP vessel reliable?

3.2.2.6 DP Incidents Databank

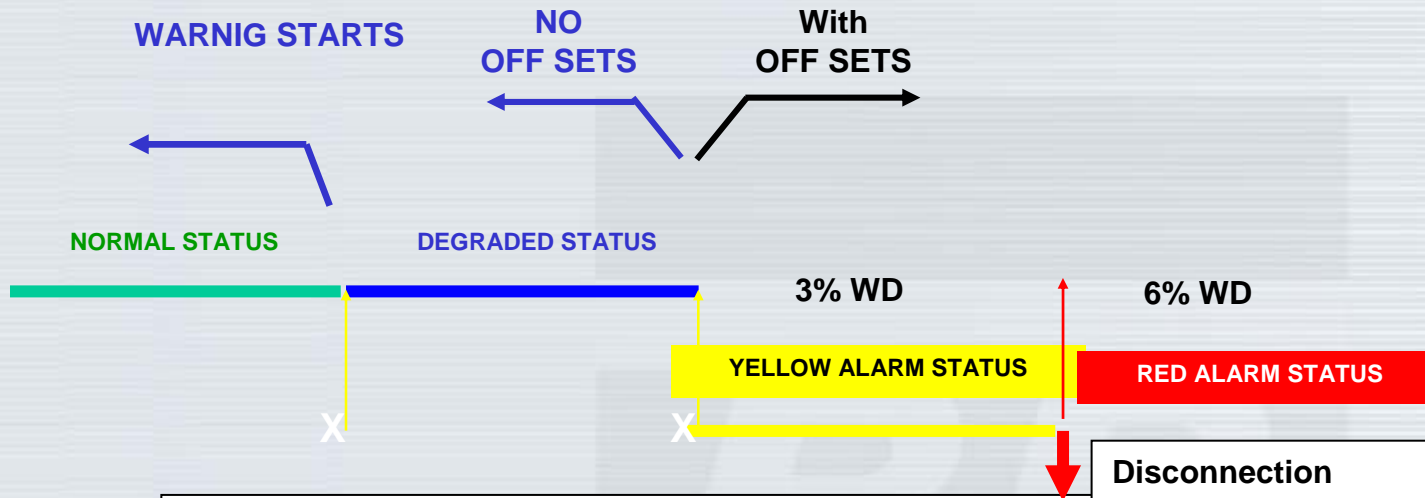
Developed in 1995, this databank (more than 750 incidents) is an excellent tool to prevent similar incidents to occur.

Incidents are events that potentially can lead to an emergency disconnection:

- Degraded Operational Status – when DP system redundancy is lost, i.e., the safe operational capacity of station keeping.
- Yellow Alarm Status – when the vessel's station keeping capacity is compromised, resulting in a vessel offset and/or an abnormal LFJ deflection.
- Red Alarm Status – when the vessel's station keeping capacity is irreversibly lost, resulting in a high offset and LFJ deflection. DPO must proceed with an emergency disconnection.
- Straight Red Alarm Status – when the vessel's station keeping capacity is suddenly lost, even though no offset or LFJ deflection is detected. DPO must immediately carry out the emergency disconnection.



3. How to make a DP vessel reliable?



CAUSE	EFFECT	CONSEQUENCE
Loss of Redundancy	Degraded	Without loss of position - Possible cease of operations (Critical Operation)
Progressive loss of station keeping capability	Yellow Alarm / Red Alarm	Loss of position with control – preparing for disconnection => disconnection
Sudden loss of station keeping capability (ex: black-out)	Straight Red Alarm	Loss of position without control => Immediate disconnection



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3. How to make a DP vessel reliable?

Microsoft Internet Explorer window showing a web application interface for monitoring vessel performance.

Endereço: <http://www.ep-serv.petrobras.com.br/aplicativo/e6iu-ridp/aplic/default.asp>

Registro de Incidentes

- Menu
 - Cadastros
 - Estadísticas
 - Ocorrências Por Sonda
 - Performance Por Sonda
 - Performance Geral/Classe
 - Consulta RIDP
 - RIDP
 - Help

PERFORMANCE GERAL/CLASSE

Tipo Sonda: Período: a

INFORMAÇÃO:	QTDE.
Degradação Operacional	39
Estado de Alarme Amarelo	96
Estado de Alarme Vermelho	97
Estado de Operação Degradado	440
Estado de Alarme Vermelho Direto	58
Desconexões de Emergência:	138
Blackouts:	63
Total de Dias de Operação:	93504
Quantidade Dias Média entre Desconexões:	678
Quantidade Dias Média entre Blackouts:	1484

Operação Degradado:

Alarme Amarelo:

Alarme Vermelho:

Alarme Vermelho Direto:

Degradação Operacional:

Desconexões Emergências:

Blackouts:

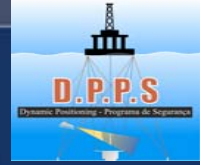
Local intranet

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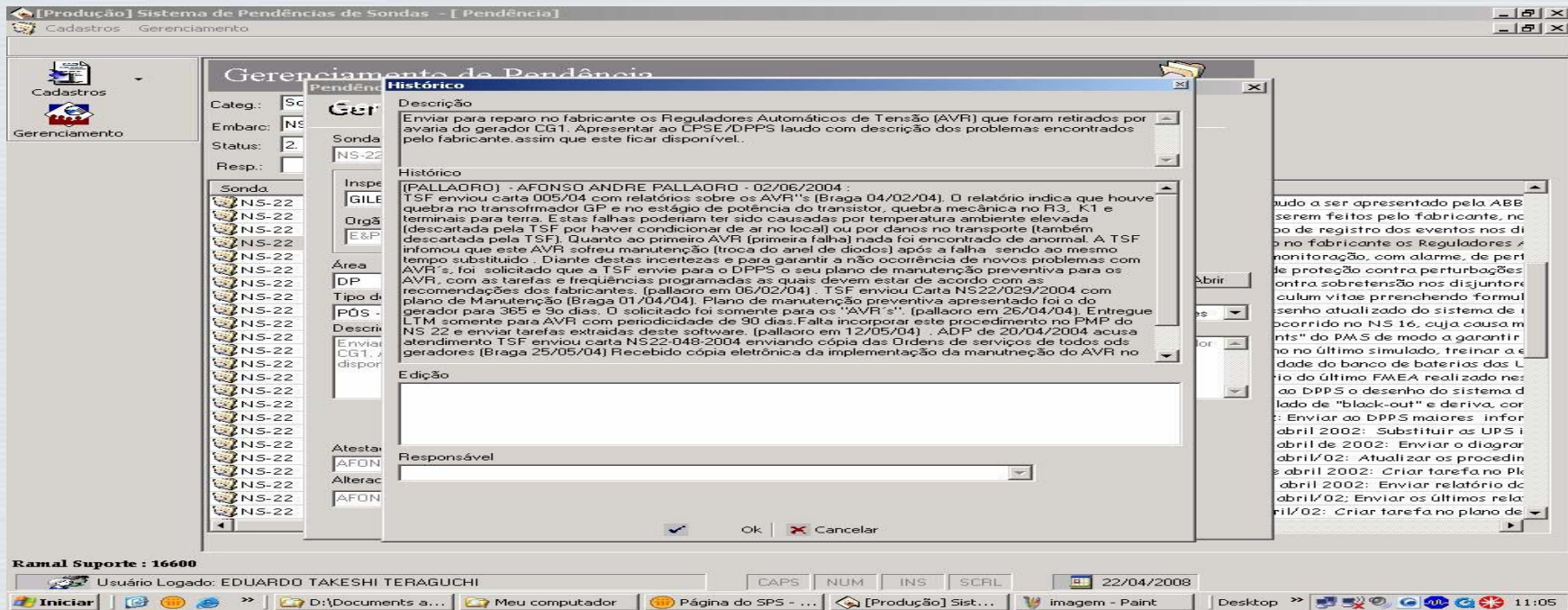


3. How to make a DP vessel reliable?

3.2.2.7 Nonconformances Control Databank

Nonconformances makes the DP system less reliable. The software's filter facilities and deadline alerts help Petrobras and Contractors to manage / solve them.

The following image shows one of its screens.





3. How to make a DP vessel reliable?

3.2.2.8 Computerized System for Acceptance and Annual Trials (a recently developed tool)

Trials!!!

- In the beginning , nobody likes them
- in the end , they are considered as necessary

Ideal trials !!!!

- No efforts for anybody
- Deeper to cover all DP aspects

The computerized system was developed to:

- Standardize the procedures providing predictable answers and accurate results;
- Reduce the spent time to obtain technical information and fill forms.
- Focus expert efforts on results, so increasing the probability of finding hidden failures



3. *How to make a DP vessel reliable?*

A catastrophe has its origin in a sequence of small incidents. Then, the following advantages of the Computerized Trials System are essential:

- Trials history per item of component/ equipment;
- *Failure* statistical analysis;
- Automatic software alert for negative test results;
- Automatic nonconformances being created for negative results;
- Better diagnostic for failure identified;
- Failure solutions to be provided with more consistence;
- Easy identification for systematical failures.

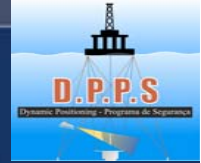
Characteristics / Facilities of this new system:

- Designed for tablet (digital pen computer) using;
- Tests and reports are done simultaneously;
- Off line operations, on line transmission;
- Interfaced with other computer databank.



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3. How to make a DP vessel reliable?

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Cadastro Característica de Equipamentos Cadastro do Checklist Inspeções Sincronismo Relatórios Sair

Limpar Incluir Alterar Salvar Consultar Excluir Imprimir Fechar

Home Padrão Geral Montar Item Inspeção Quick Planilha Inspeção

Cadastro

3.1.1 - Teste de carga grupo Motogerador

Item Planilha: Teste de carga grupo Motogerador

Geral Estrutura Célula Proc. Execução

Nome: Teste de carga grupo Motogerador

Linhas: 55 Comentário:

Colunas: 44 Criar

+ Linha - Linha + Coluna - Coluna

Item	Motogerador 1		Motogerador		Motogerador 3		Motogerador 4		Motogers
	50%	100%	50%	100%	50%	100%	50%	100%	50%
Temperatura ambiente na sala de									
G E R A L I T E M S	T E M P E R A T U R A	Rolamento LA							
		Rolamento LOA							
	P E S T R O L A M E N T O	B O B I N A D O E S T A T O R	Fase R ou U						
			Fase S ou V						
			Fase T ou W						
	T R O C A D O R D E C A L O R	d e c a l o r	Entrada						
			Saída						
	T R O C A D O R D E C A L O R	d e c a l o r	Entrada						
			Saída						
	M O T O G E R A D O R	P R E	Subsistema de lubrificação		Antes do filtro				
			Depois do filtro						
O S		Subsistema de refrigeração de		Circuito Alta					
				Circuito Baixa					

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4. Conclusion

- Petrobras /DPPS has shown very good results since its creation in 1992. We are confident that we are on the right track.
 - The most important result has been the reduction in the number of disconnections caused by *equipment failure*.
 - A fall in the rate of DP incidents attests the quality of the tools used to increase reliability.
- However, to guarantee continuous success, the problem of *insufficient qualified personnel*, which will continue for the foreseeable future, can only be solved through improved user-friendly technology, especially predictive maintenance and on-line equipment monitoring.
- We, at Petrobras, believe that *reliability* on DP vessels is the future, so we will continue to successfully pioneer new DPPS technology as needed, e.g., for the pre-salt exploration, ultra deep-water drilling, etc.





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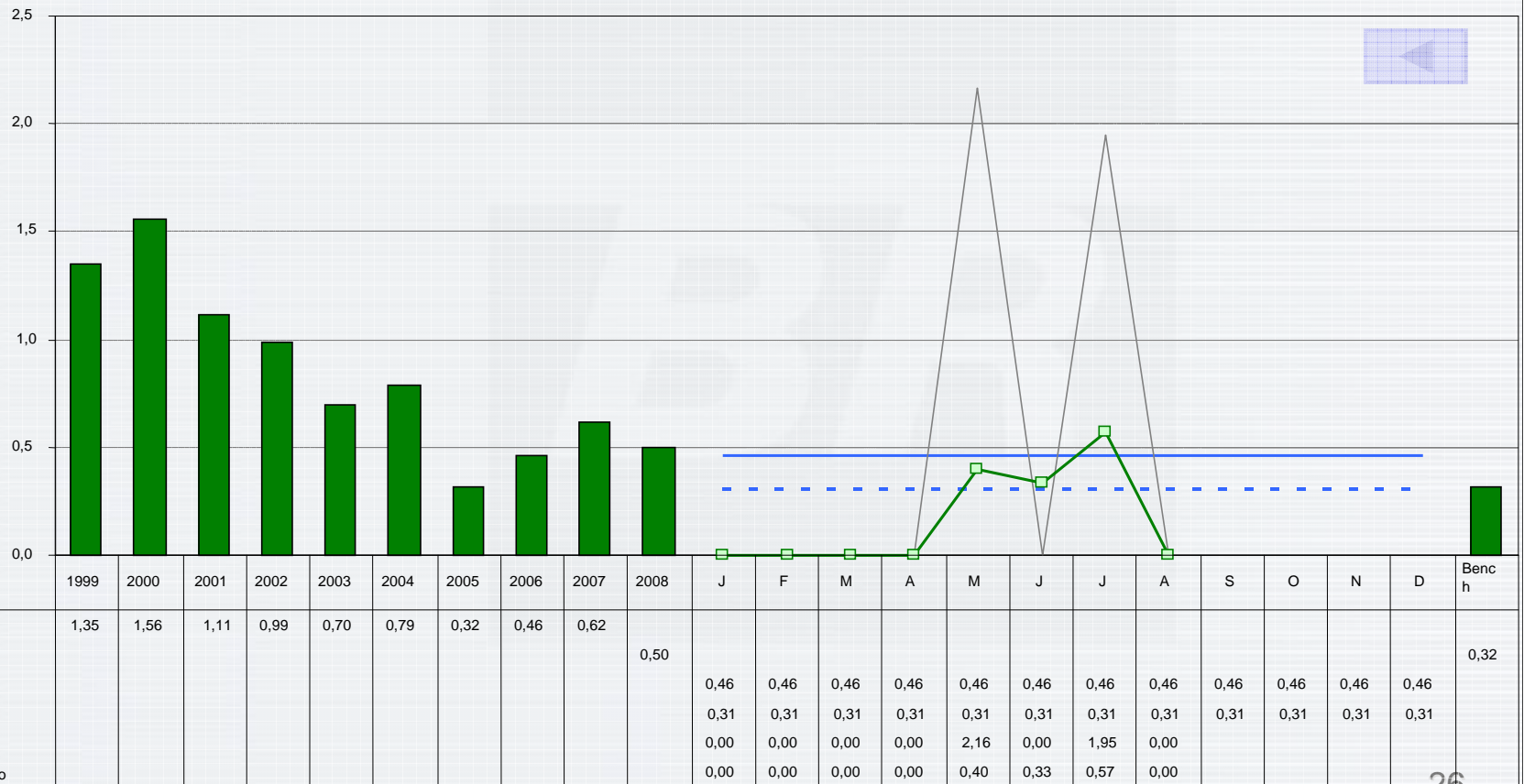


4. Conclusion



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DP VESSEL SAFETY UNCONTROLLED DRIFT PER 1000 OPERATIONAL DAYS





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Thank You