

Petrobras P&A - updates and future plans

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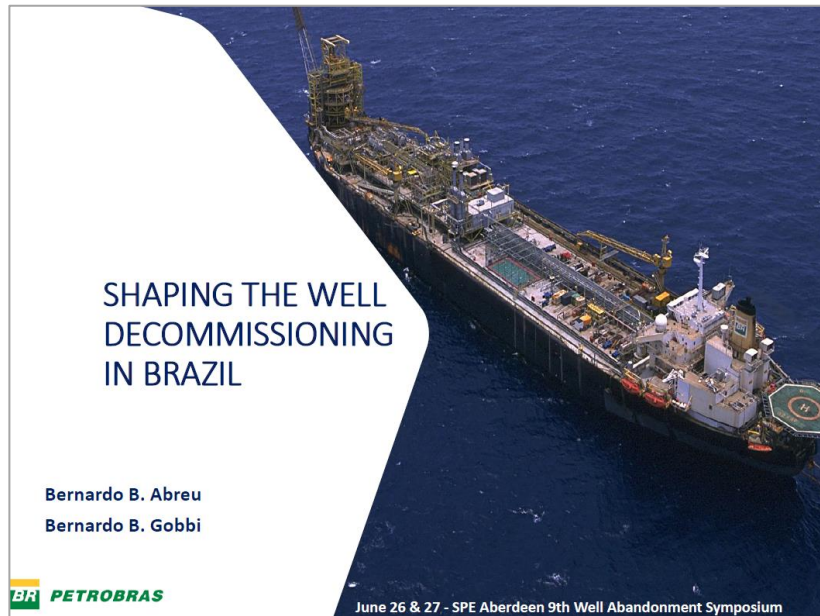
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Over 100 subsea wells are planned to be plugged & abandoned between 2019 and 2023

THE CHALLENGE SUMMARY

- Petrobras prioritizes Through Tubing and Open Sea operations (no need for Drilling BOP) for subsea well decommissioning
- For mid and long term maximize Through Tubing operations and new materials
- Any solution that maximizes through tubing and open sea operations will be gladly evaluated by Petrobras
- If there is a potential solution on low TRL, be advised that operators established in Brazil have to carry out qualified expenditures of approx. US\$500 MM every year (and soaring) searching for disruptive technologies

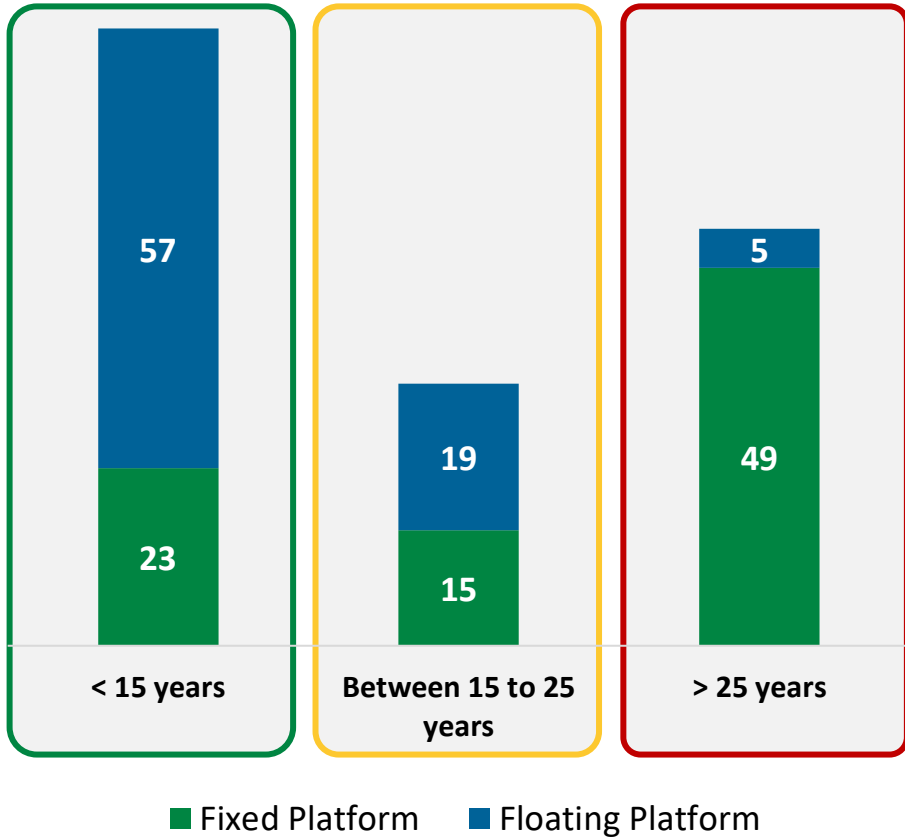


Source: Petrobras

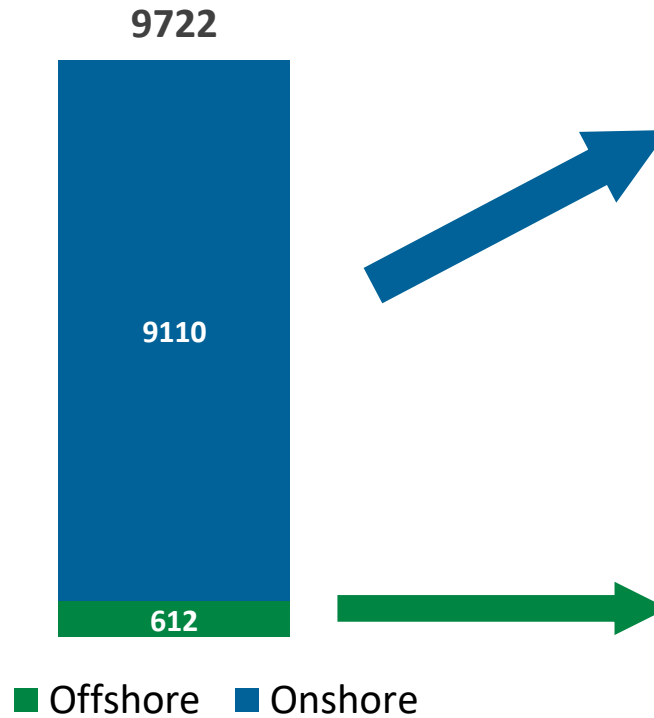
Source: Petrobras

Brazil - perspective and forecasts

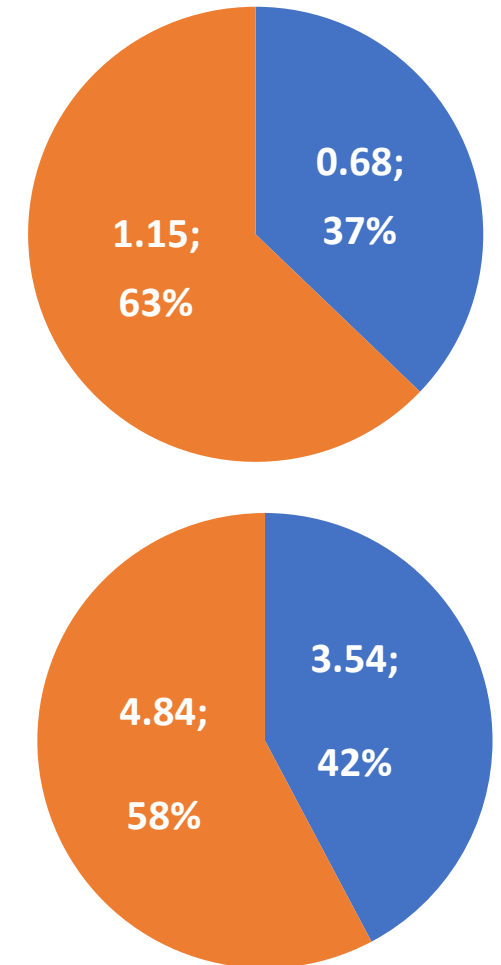
Brazil – Offshore Platforms age



Brazil – Wells to be decommissioned (2022 – 2026)



Brazil – Costs forecast¹ [USD billions]



Source: Adapted by the authors, data from ANP Decommissioning Panel

<https://app.powerbi.com/view?r=eyJrIjojY2UyMjUyMmMtM2Y5Y00yZU1LWjM2M2YzJkODJINGEYmZhiwidCI6IjQ0OTImNGZmLTl0YTtNGI0Mi1iN2VmLTEyNGFmY2FkYzIxMyJ9>

¹ Assuming exchange rate of 1 USD = 5 BRL

■ Other Decommissioning costs ■ P&A + Wellhead removal

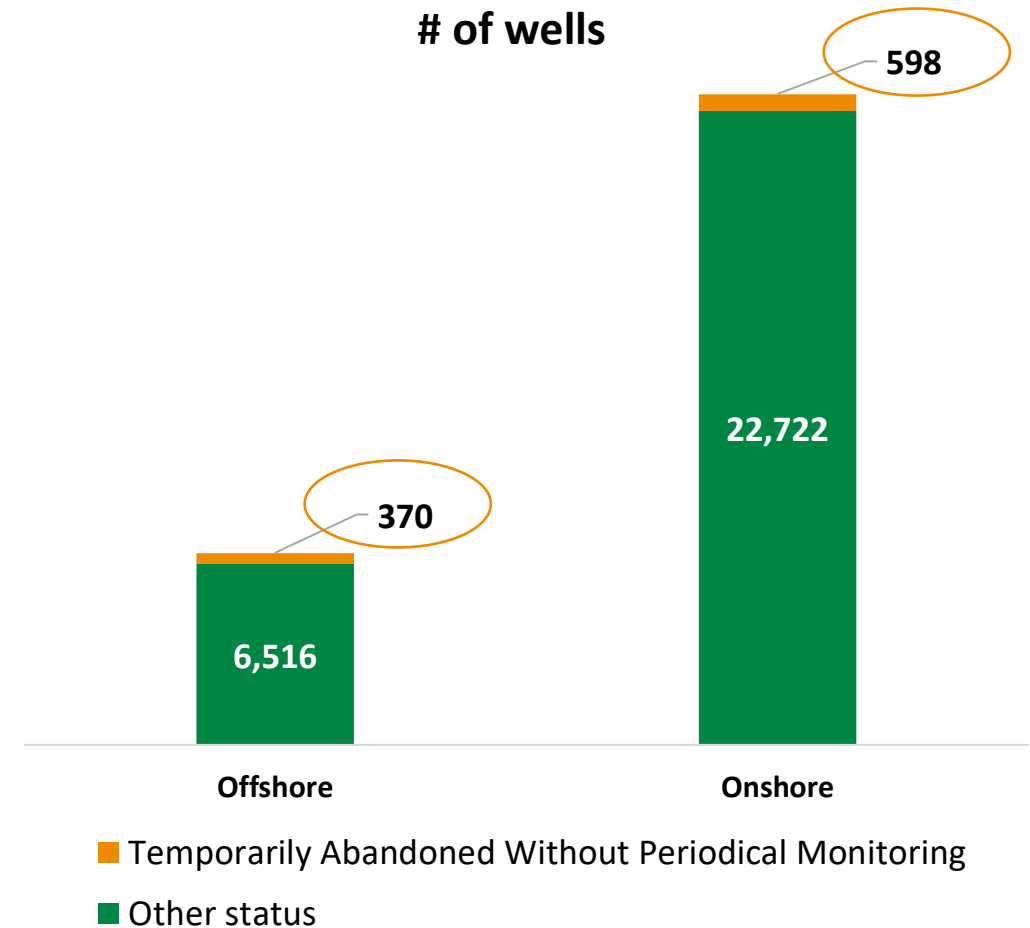
Brazil - P&A demand not only related to Unit decommissioning

- Brazil: approx. **30.200 wells**, **65% operated by Petrobras**;
- No monitoring requirement prior to May/2017;
- New regulation introduced in Nov/2016, requiring:

Temporary Abandonment period shall be limited to a 3 years maximum, non-extendable.

Source: Resolução ANP nº 46/2016 (free translation)

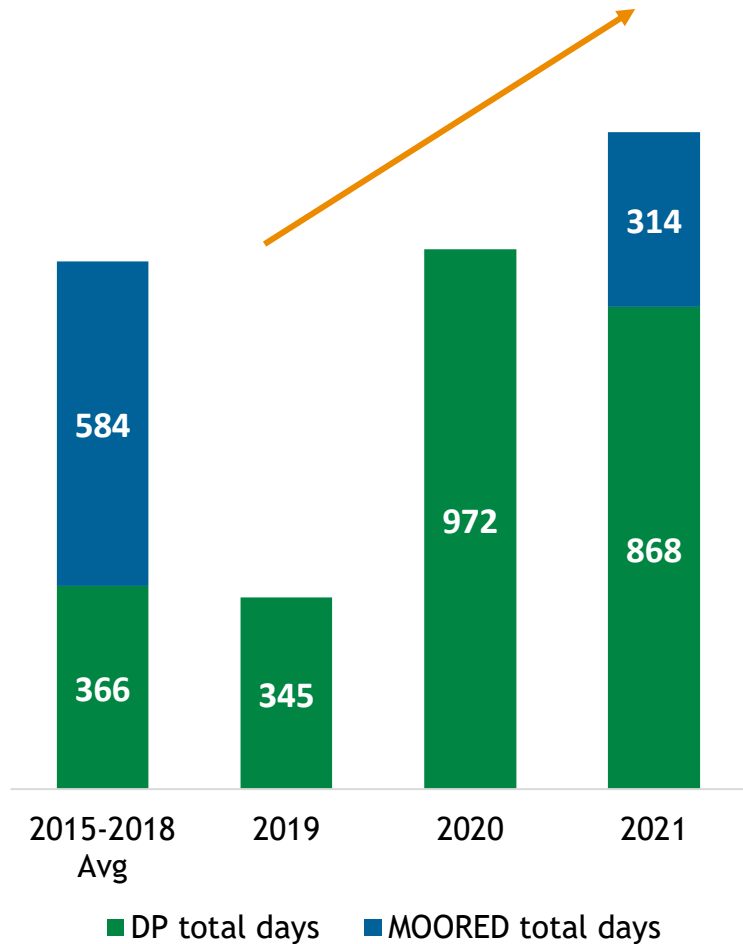
- **Significant part of these wells without Operators' interest to exploit**



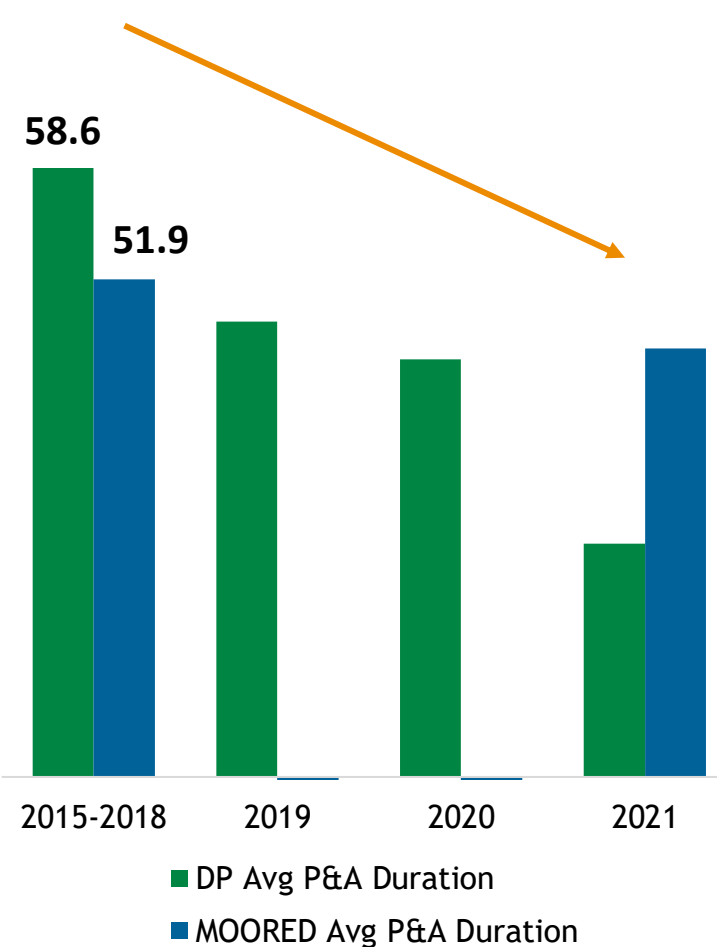
Source: Adapted by the authors, data from ANP website, updated 03/16/2022
<https://www.gov.br/anp/pt-br/assuntos/exploracao-e-producao-de-oleo-e-gas/dados-tecnicos/acervo-de-dados>

Petrobras - P&A activities & performance

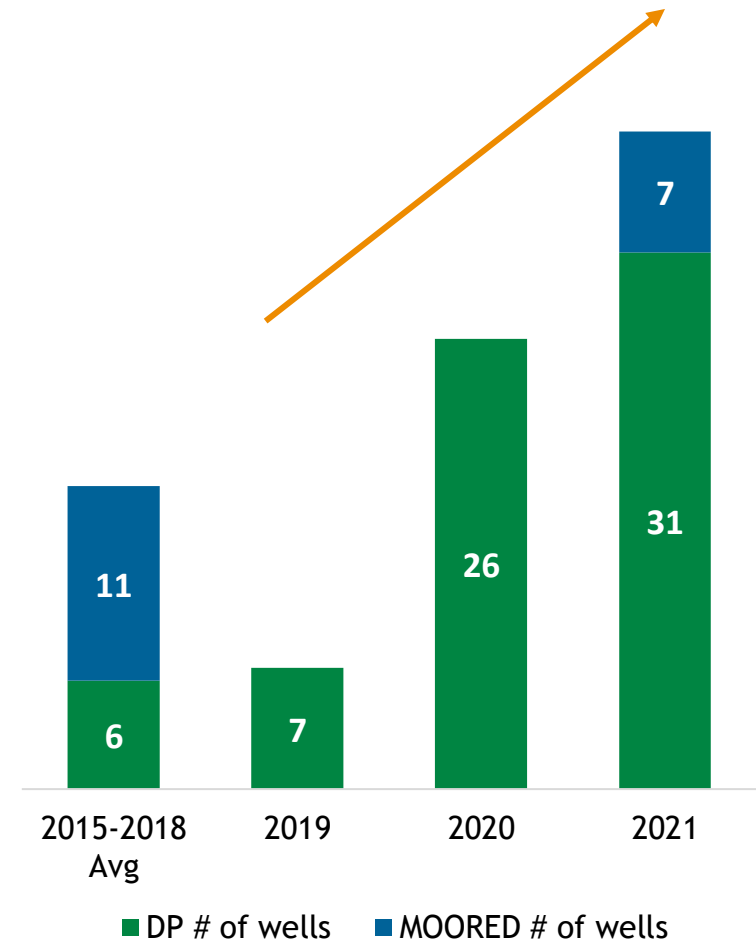
Total operating days (subsea wells)



Avg P&A Duration (subsea wells)



of wells [P&A + TA] (subsea wells)



Source: Authors (Petrobras)

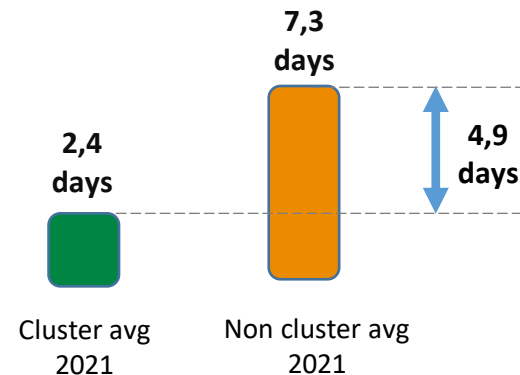
Avg P&A Duration is a normalized value comprising all workscopes executed, resulting in expected total PP&A duration per well

P&A clusters

- Clusters play a **key role on P&A duration reduction**;
- Clusters applicable to Phase 1 (TRT) **and** Phase 2 (BOP);
- Currently campaign stage: mostly Phase 1;
- Phase 2 execution expected to increase in the upcoming years;
- Phase 1 clusters restricted by TRT suppliers (**sealing stabs reliability**)



Source: authors (Petrobras)



Source: authors (Petrobras)



Source: authors (Petrobras)

Through tubing P&A in highly deviated wells and complex scenarios

- Through tubing P&A also plays a **key role on P&A duration reduction**;
- TT P&A Applied to aprox. **60% of Petrobras PP&A on 2021**;
- Successfully P&A'd in **highly deviated wells (up to 85°)**;
- Successfully P&A'd in **complex scenarios, such as in-between 2 packers**;

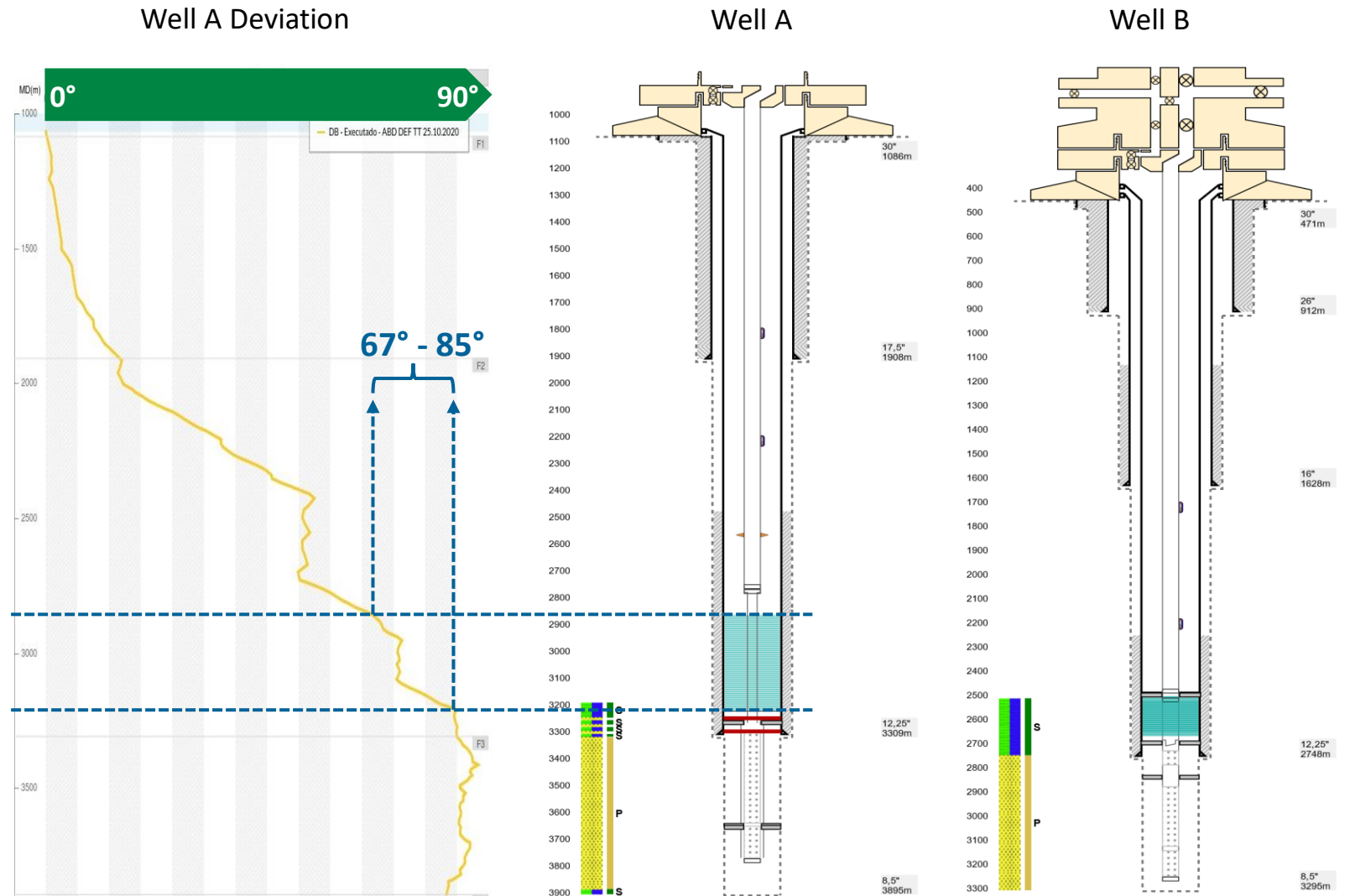
Well	Water depth	Unit type	P&A duration ¹
Well A	956 m	DP	9 days
Well B	961 m	DP	10 days
Well C	834 m	DP	14 days
Well D	1852	DP	19 days
Well E	397	Moored	14 days

Source: authors (Petrobras)

¹ P&A Duration including transit time and WoW.

Through tubing P&A in highly deviated wells and complex scenarios

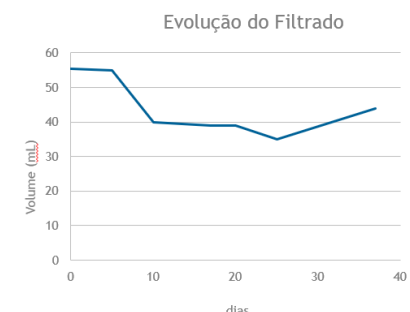
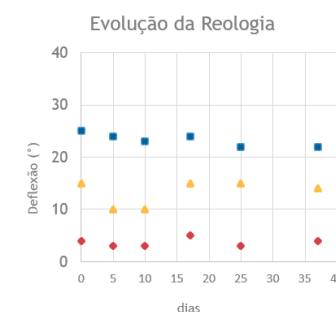
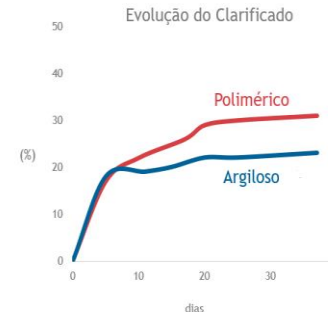
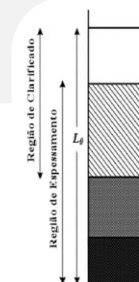
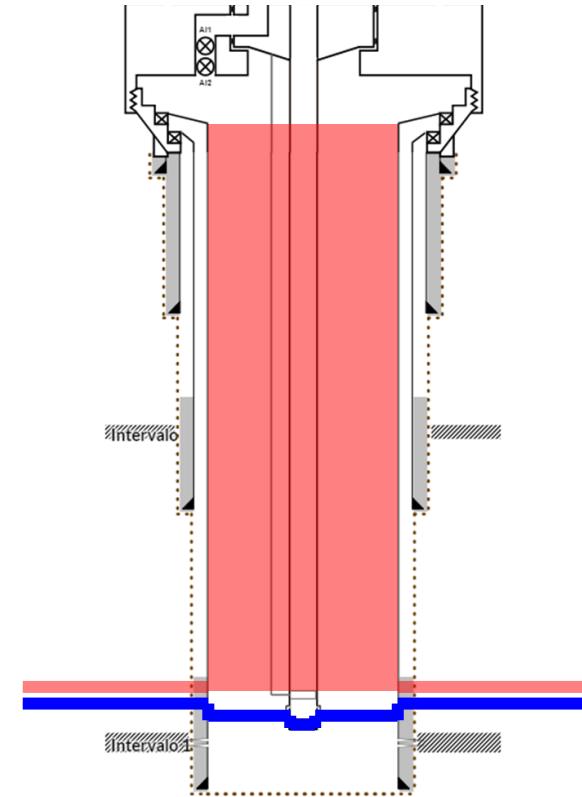
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Source: authors (Petrobras)

Fluid as WBE for non-monitored Temporary Abandonment

- **EAC Table developed for Non-monitored Fluid as WBE;**
- EAC to be published on **Brazilian Industry Best Practices Guidelines** (expected to Apr/2022);
- Fluid shall have the **ability to plug potential Sol and sustain sufficient overbalance** in case of primary barrier failure;
- Seawater **natural supply admitted** in case of depleted potential Sol for short term TA;
- **Ongoing Petrobras R&D** to evaluate and develop:
 - Long term filtration ability;
 - Long term settling;
- Currently **qualified for 9 months** application;
- **Aiming 36 months** application;

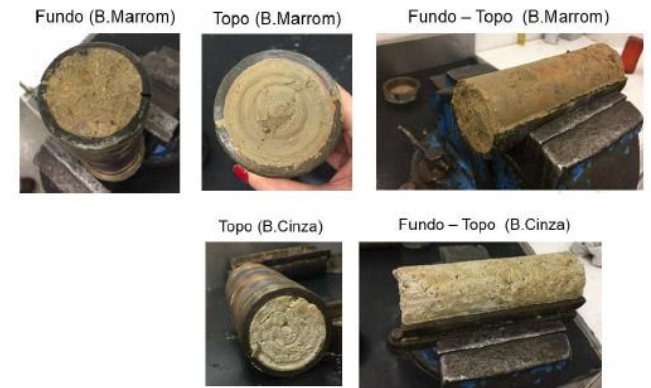


Non-cement pumpable WBE

- **Mechanical access restriction;**
- Enable **Temporary Abandonment through FPSO** with 2 independent WB (well ready to have the XT removed);
- **Ongoing R&D** to develop pumpable **Bentonite pellets for subsea wells** application;
- **Ongoing qualification/tests planning** for Chemically Induced Scale (**Xclude**);
- **Open to other pumpable solutions;**



Source: Aubing Group website



Source: authors (Petrobras)

Through Tubing cement bullheading

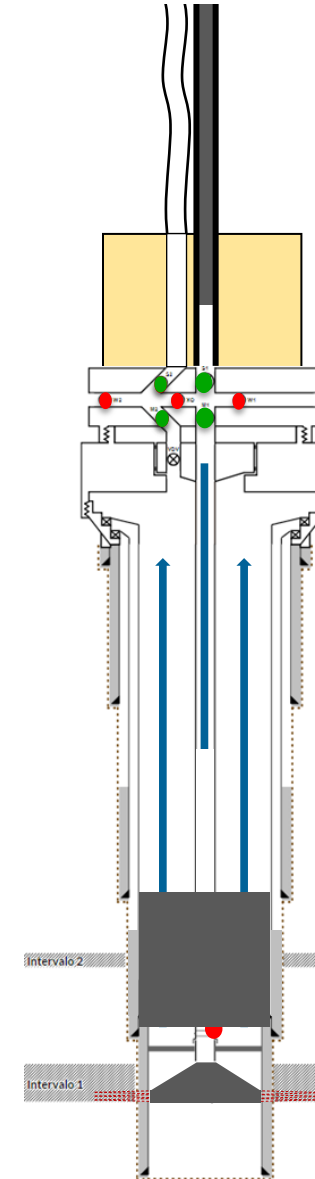
- Presented as a **challenge for subsea wells** on previous SPE Aberdeen Decommissioning Symposium;
- **Ongoing Petrobras R&D** to develop bullheading simulator;
- New specific **requirements for workover riser and TRT** suppliers;
- **Record-breaking duration result** to Petrobras PP&A with Moored Unit;

Unconventional P&A (Phase 1) by bullheading a combination of gasified and foamed fluids in a deepwater gas well

CONCLUSIONS

- Successful and useful modeling for **bullheading** with multiphase fluids and foamed cement and displacement;
- Successful isolation achieved verified by both negative and pressure tests and pumping parameters;
- Extremely valuable information provided by both XT sensors for the control of pumping parameters;
- Well in safe conditions for phase 2 P&A;
- There is opportunity to develop / improve simulation capabilities for challenging P&A operations.

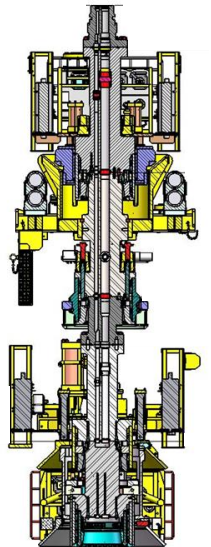
Source: Petrobras, 2021, SPE Aberdeen Well Decommissioning Symposium



Surface equipment



Subsea equipment



Source: authors (Petrobras)

- *Good engagement with the regulator necessary to avoid unnecessary costs*
- Regulation – **Permanent Well Barrier to isolate cross flow:**

Year	# of derogations required	Potentially Saved P&A days
2019	1	15
2020	4	41
2021	6*	84

Non naturally connected Formations with Flow Potential shall be isolated by, at least, 1 Permanent WB to avoid cross flow.

Source: Resolução ANP nº 46/2016 (free translation)

- Regulation – **Well Barrier length**

Year	# of derogations required	Potentially Saved P&A days
2021	1*	Not defined

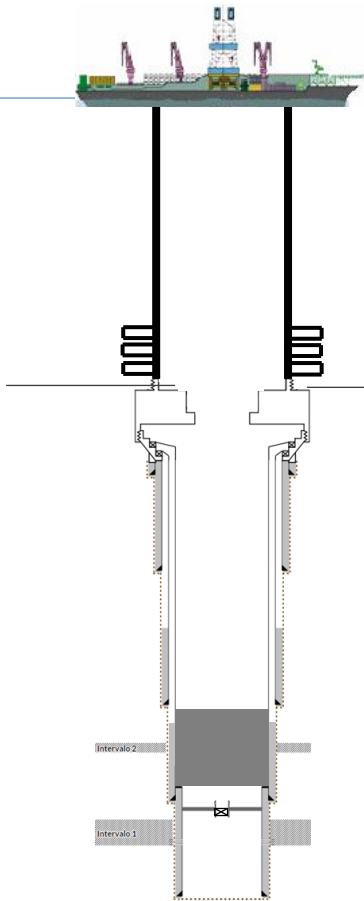
Ensure Permanent WBE length and placement are in compliance with industry best practices and relevant standards.

Source: Resolução ANP nº 46/2016 (free translation)

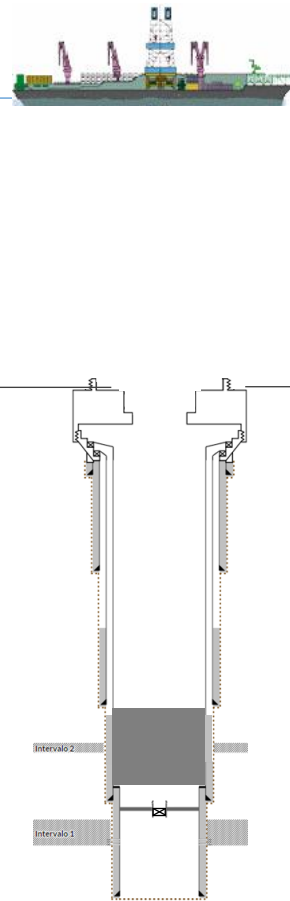
* Including wells where the non-derogation scenario was not an option. In that case, the *Potentially Saved P&A Days* wasn't estimated.

Open Water Tubing Retrieval

Tubing retrieval with BOPs



Open Water tubing retrieval



- ...
- ~~Run / test BOPs~~
- Run THRT
- Retrieve tubing
- Install/verify barriers
- ~~Pull out BOPs~~

THRT latched to TH in OWTR operation



Source: authors (Petrobras)

Unseated TH in OWTR operation



Source: authors (Petrobras)

Through Tubing PWC

- RFI issued on Feb/2022;
- R&D Project expected to 2022;
- Technology **delivery expected to 2024**;
- Petrobras Shaped Charges field test → **partially successful**;
- Important alternative to **enable TT P&A in Brazil across gauge cables** and control lines;
- Important alternative **enable TT P&A in case of Tubing x A-Annulus communication on undesired depth.**

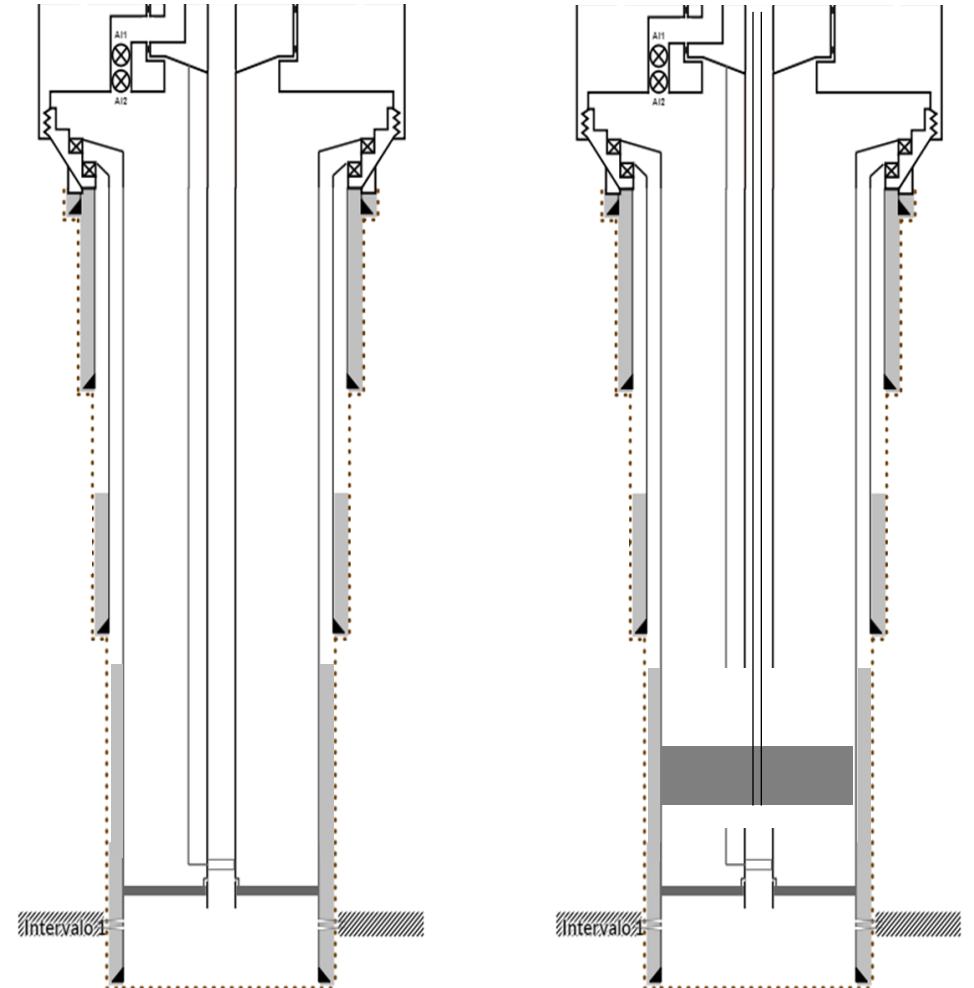


Control or injection lines and gauge cables shall be removed on the depths where Permanent WBE will be installed.

Thermite melting, P&A, Self abandonment

- **RFI** issued on **Jun/2021**;
- Market technical evaluation on Jan/2022
- **R&D Project** expected to **2022**;
- Enable TT P&A in Brazil across **gauge cables** and control lines;
- **Thermite milling** delivery expected to **2024 or sooner**;
 - **Cement PWB** still considered, but possibility to apply alternative materials
- **TT Thermite P&A** delivery expected to **2026 or sooner**;
 - **Alternative material** mandatory
- **Self abandonment technology** expected to **2030 or sooner**;
- **Significant potential to reduce average P&A duration and costs/provisions.**

P&A sequence with Thermite milling

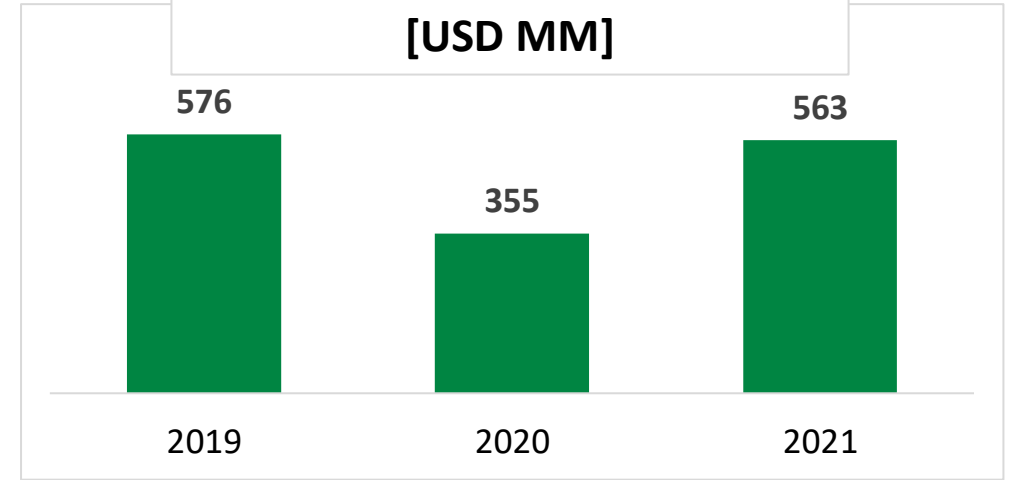


Source: authors (Petrobras)

R&D investments

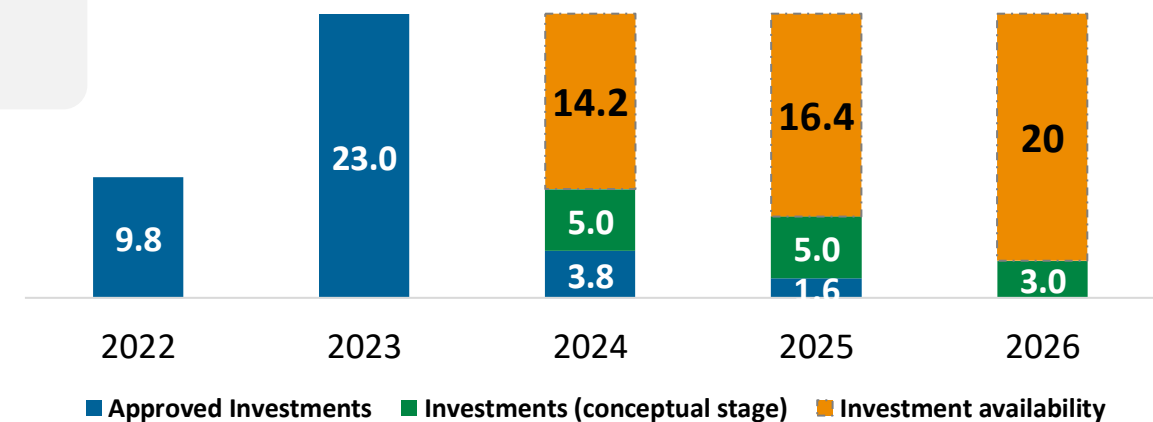
- Significant **R&D investment (1,5 bi USD last 3 years)**;
- Operators established in Brazil **have to** carry out qualified expenditures (**levy**);
- Any solution that **maximizes through tubing operations and/or** helps **surpassing mechanical restriction (i.e collapse)** will be gladly evaluated by Petrobras;
- New solutions are always interesting, but also consider **grouping already existing solutions** (single trip).

Petrobras total R&D investment [USD MM]



Source: Petrobras financial results

Petrobras P&A R&D investment forecast [USD MM¹]



Source: Petrobras

¹ Assuming exchange rate of 1 USD = 5 BRL

Summary

- **Increasing P&A activity** in Brazil, as predicted;
- Challenge to **surpass regulatory requirement on wells monitoring**;
- **Good costs and duration achieved** for subsea wells so far;
- **Through tubing P&A and Clusters campaign** playing key role on P&A duration reduction;
- Successful **TT P&A even in challenging scenarios**, but caution is needed;
- **Non monitored fluid as WBE**: disruptive, although extremely simple;
- **Non-cement pumpable WBE**: always interesting to have as an option;
- Derogation: motivation to ensure regulation and best practices are continuously improved;
- **R&D: great technologies (hopefully) on the way, but we still need more.**



Source: Petrobras

THANK YOU

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