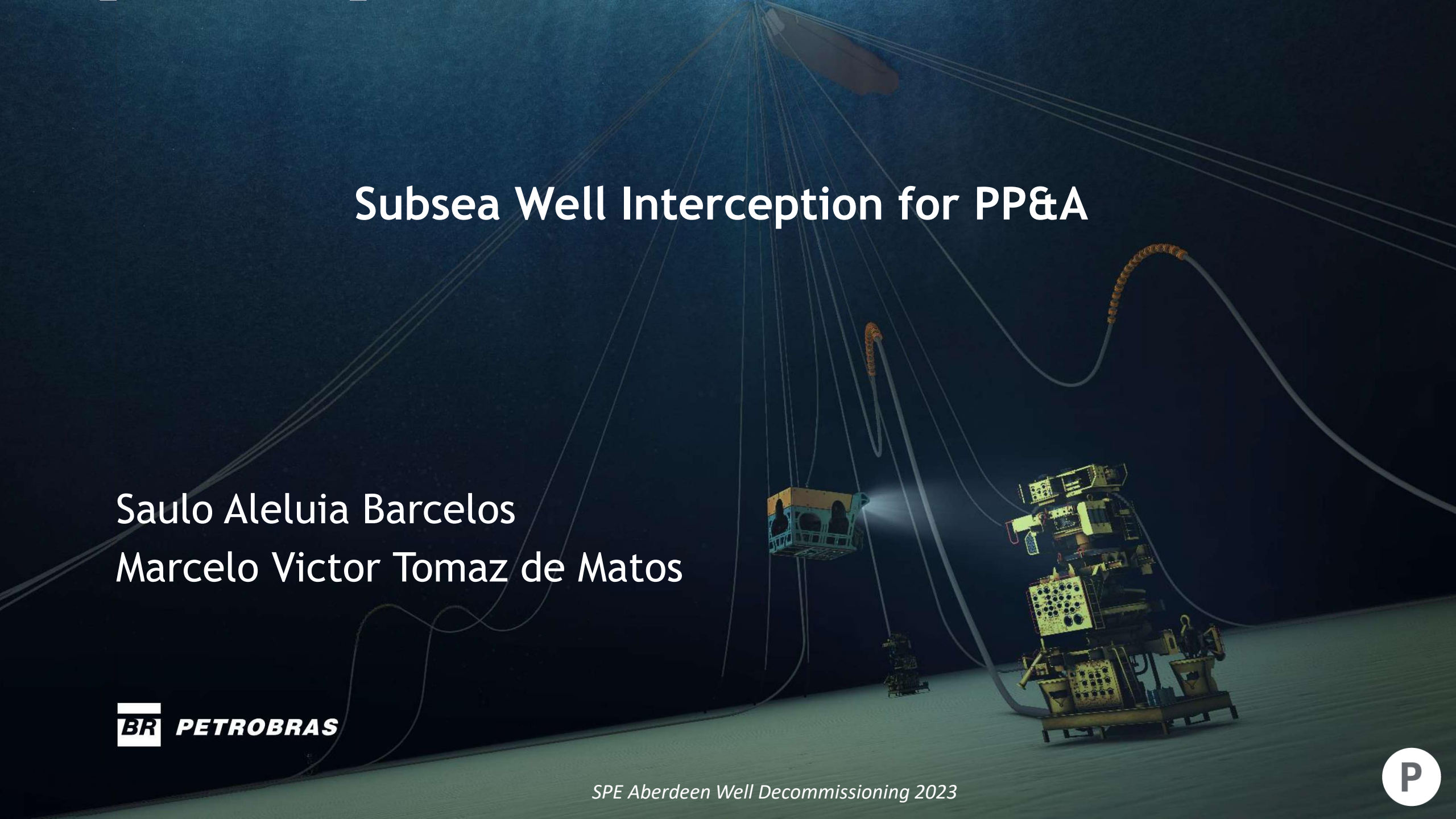
Subsea Well Interception for PP&A



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PETROBRAS

SPE Aberdeen Well Decommissioning 2023

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SUMMARY

1. Case Scenario Description;
2. P&A Strategy;
3. Interception Well Design - Challenges;
4. Plug and Abandonment Sequence;
5. Permanent Well Barrier Attribute;
6. Brazilian Regulator Authority (ANP) Interaction;

Case Scenario Description

- **Communication with external environment** identified when pressuring up the well from the intervention unit (2017).
- **No flow from reservoir** to external environment (insufficient reservoir pressure/DHSV and production tubing sealing capacity preserved?).

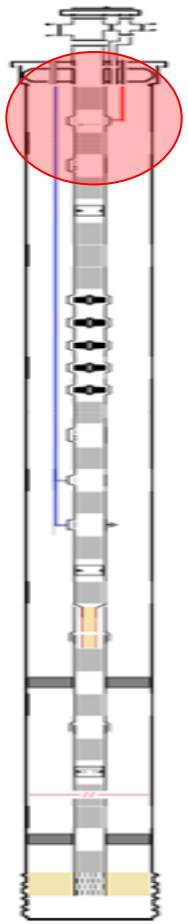
- **Well Construction**: 2007;
- **Production Casing**: 13 3/8” + 10 3/4“;
- **Completion**:
  - **Upper**: DHSV + 6 5/8” Tubing + ESP[1] + GL&CI[2] Side Pocket Mandrels + PDG[3];
  - **Intermediate***: 5 1/2” Tubing + VCH Packer + 5 1/2“ Slotted liner
  - **Lower***: TSR[4] + 6 5/8” Tubing + 6 5/8” Gravel Screen Assembly

*** There is a 2,3 m discontinuity between the intermediate and lower completions.**

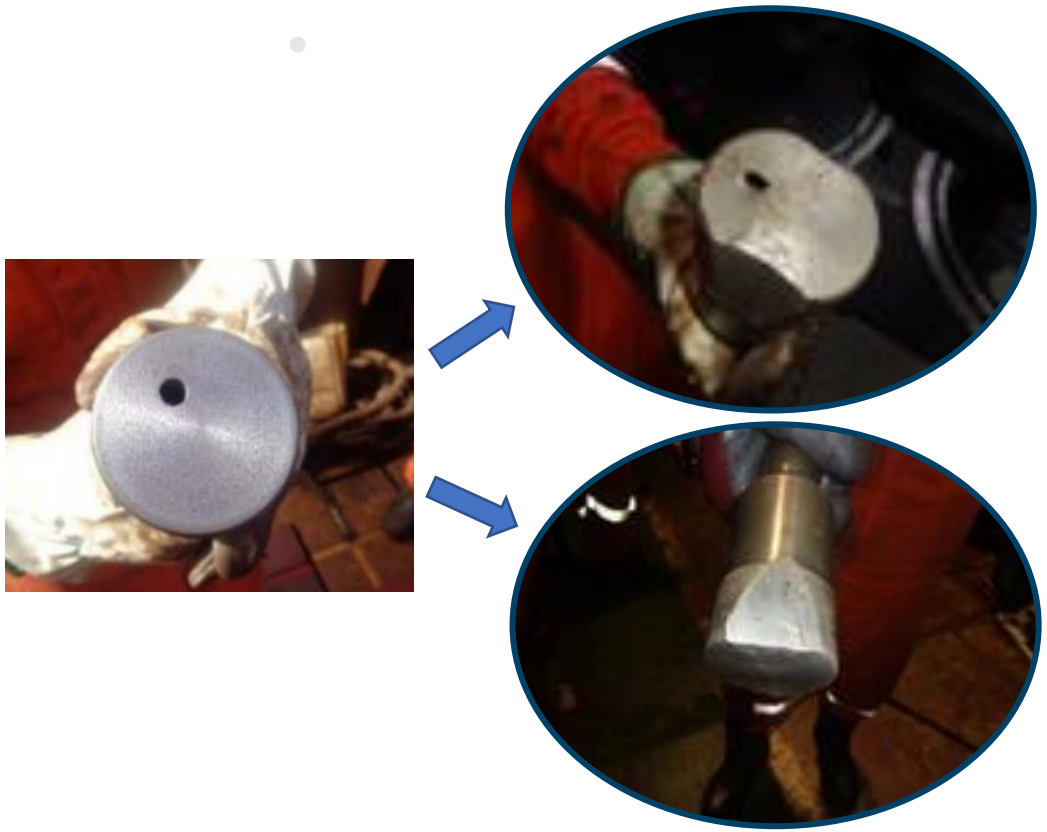
[1] Subsea Electric Submersible Pump
[2] Gas Lift and Chemical Injection
[3] Permanent Pressure and Temperature Gauge
[4] Tubing Seal Receptacle

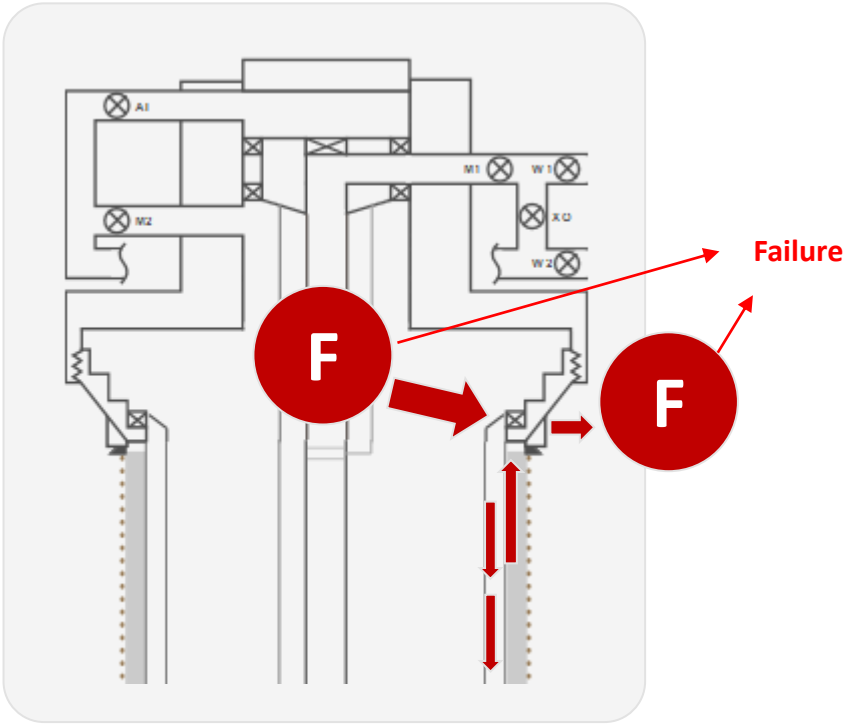
Source: authors (Petrobras)

Case Scenario Description



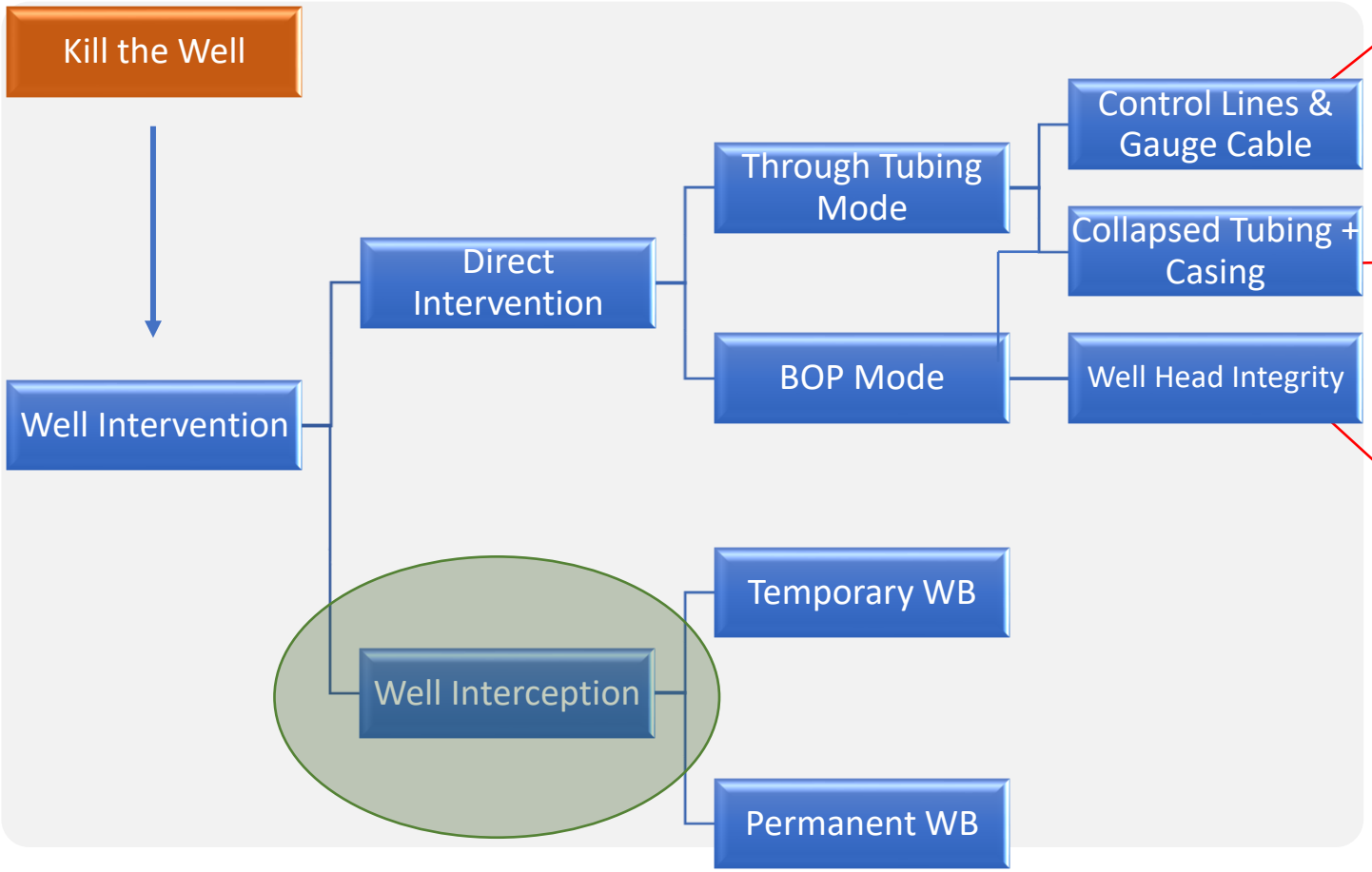
Lead impression blocks: 2 ½” and 1 ¾” (restriction 9 m below TH)





Down Hole Video (DHV) and Multifinger Caliper also confirmed the scenario

P&A Strategy



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

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

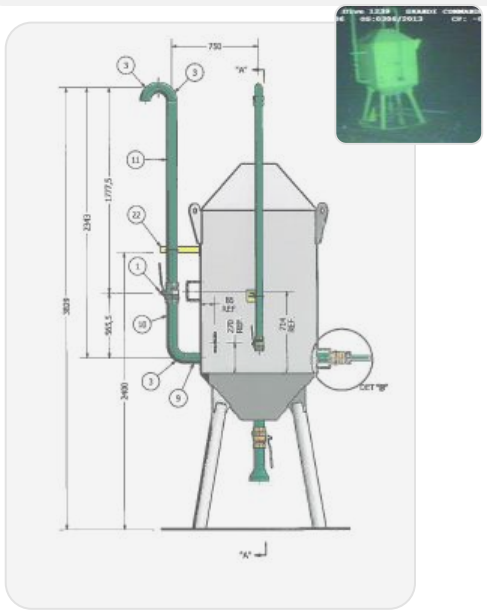
Lack of technology to overcome the colapse in both modes (Tubing decollapse / Casing decollapse)

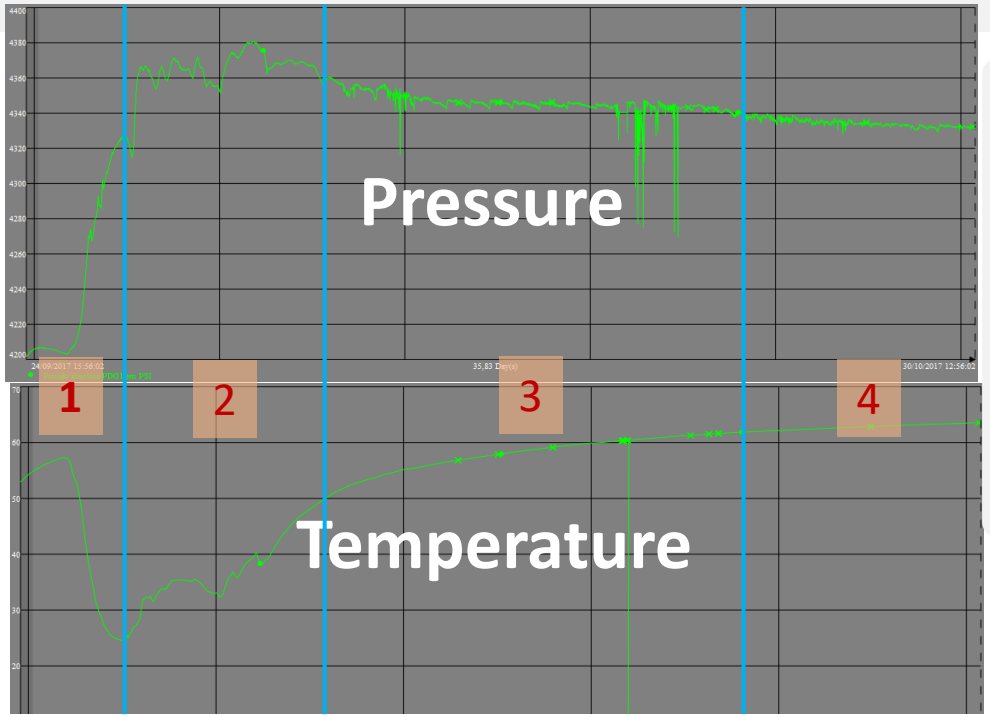
Uncertainty on damage extension (length and cascade effect)

What's the reliability of a riser analysis in this scenario?

P&A Strategy (To kill the well)

- Spill containment:
  - Subsea Shuttle tank + draining strategy;
- Tubing and A-Annulus cleaning;
  - Tubing HC was bullheaded to reservoir;
  - A-Annulus HC was segregated.





1: Bullheading production string fluid;

2: Brine + LCM pills displacement (bentonite);

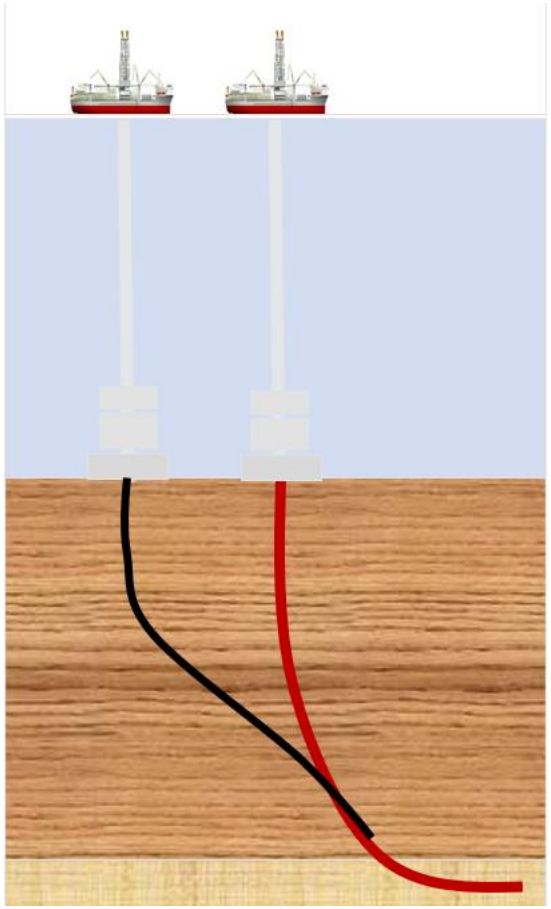
3: Flowcheck and well monitoring;

4: Success in well control strategy.

Interception Well Design - Challenges

➢ Drilling Rig Selection:

- DP-3 Type (proximity with TW);
- 16 ¾” BOP (Slender design);
- High riser collapse resistance capacity;
- High tanking capacity (fluid loss after interception);



Source: authors (Petrobras)

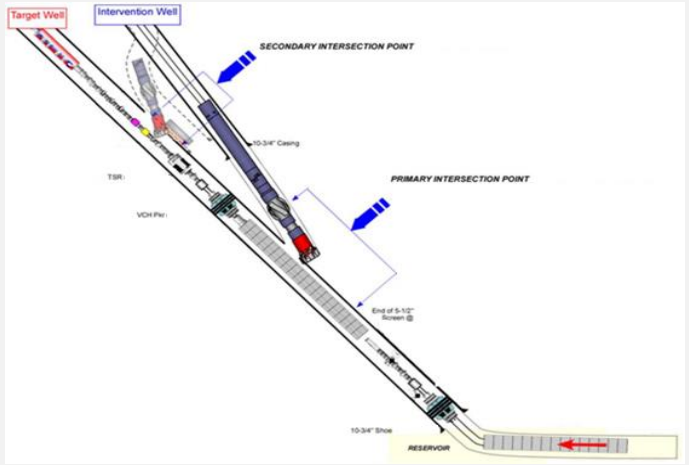
➢ Wellhead Positioning:

- Higher number of interception points;
- Shallow KOP;
- Avoid fault lines;
- Less risk in coexistence between vessels;

Interception Well Design - Challenges

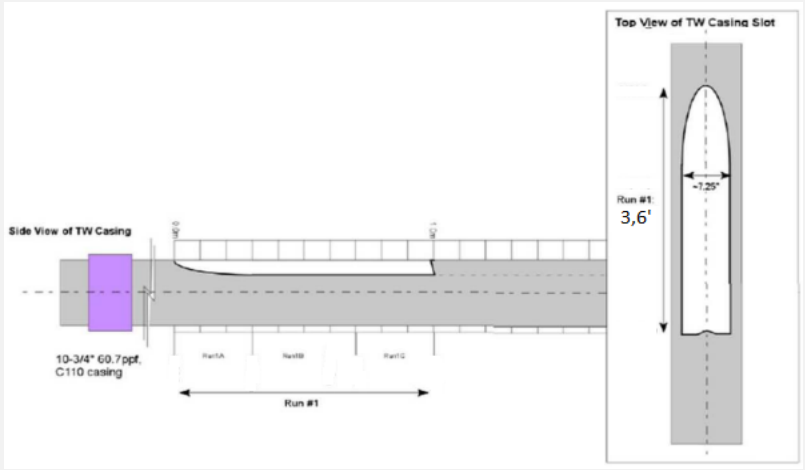
➢ Interception:

- **Possible target points**:
  - ↑ or ↓intermediate Packer;
    - ✓ **Below (2,3 m discontinuity).**



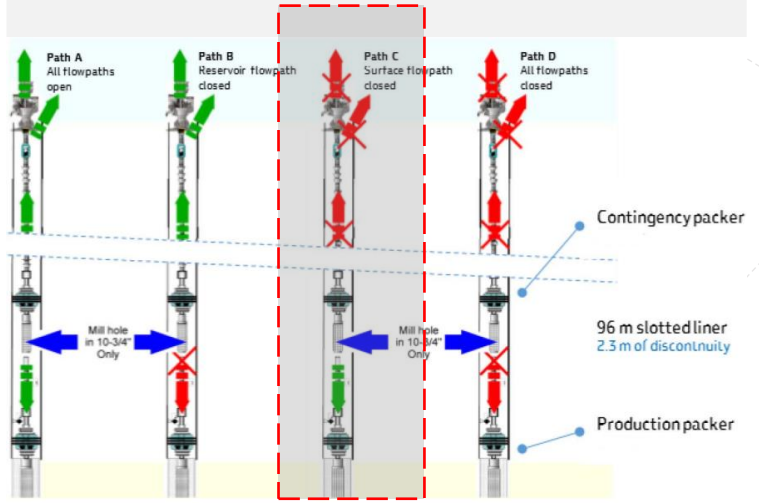
Source: authors (Petrobras)

- **Interception/Window opening**:
  - Above the casing with aid of gravity;
  - 3,6 feet extension x 7,25 inch wide.
    - ✓ **85% of 10 ¾" flow opening area.**



Source: authors (Petrobras)

- **Possible flow path during plugging operation**:



Source: authors (Petrobras)

Interception Well Design - Challenges

Restrictions and uncertainties:

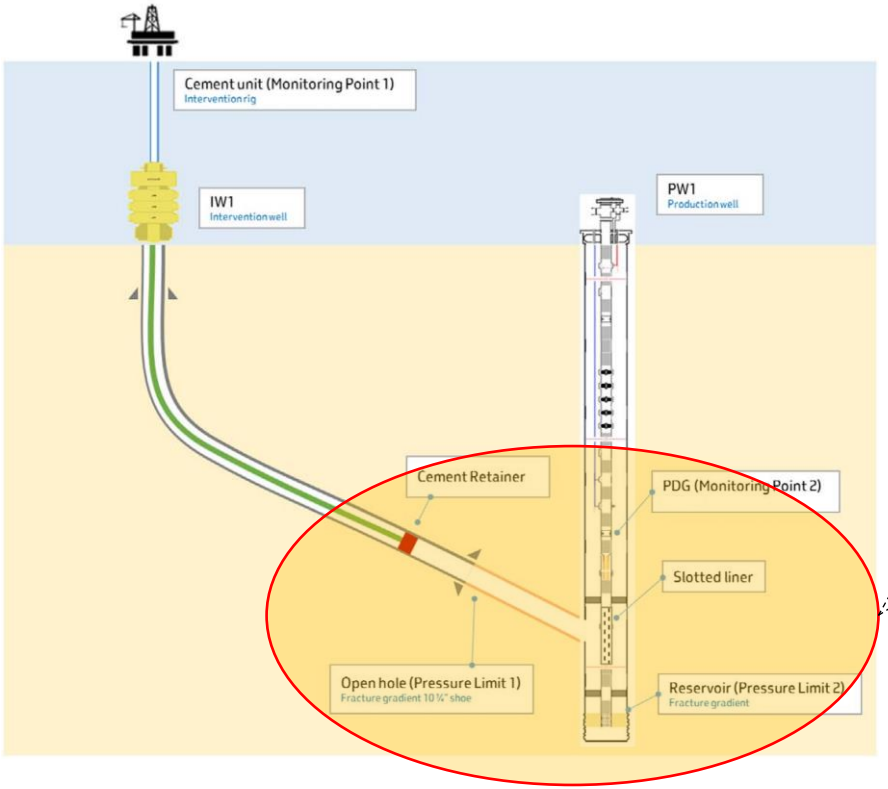
- **Fracture limit** of casing shoe at IW;
- Good **surface cleaning** for cement bond;
- **Cement slurry must be tolerant to possible contaminations** during displacement;
- Comply with **regulatory agency demands** for PWB;

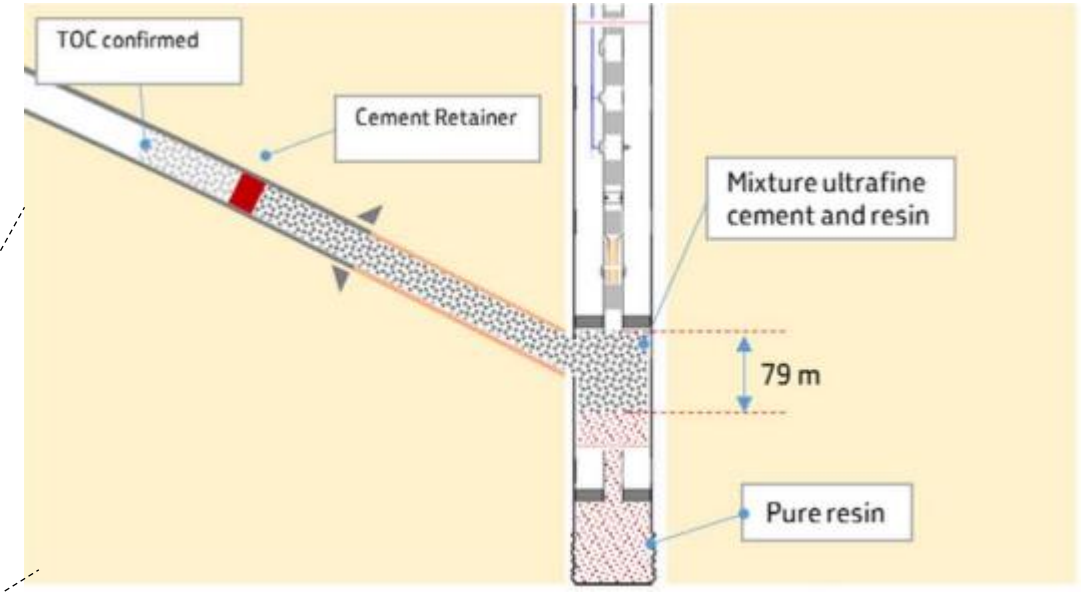
Definitions:

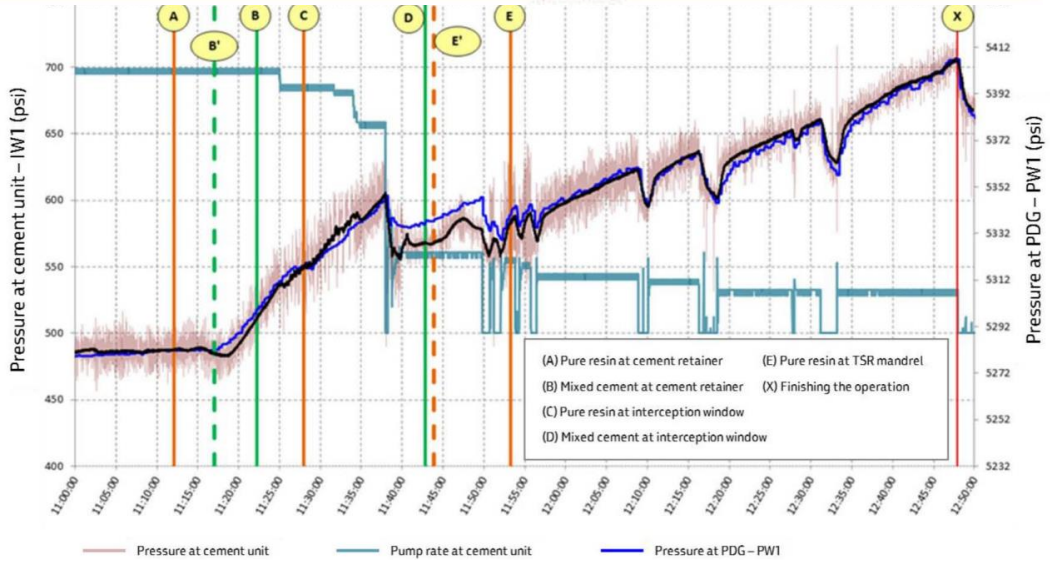
- Install a **Cement Retainer** (CR);
- **Termo-hydraulic simulations** for all 4 possible scenarios;
- **Real Time monitoring** (Cement unit + PDG);
- Pumping Schedule:
  1. Pure Resin;
  2. Ultrafine cement + resin;
  3. Brine (displacement).

Plug and Abandonment Sequence

➢ Interception and plugging schematic:

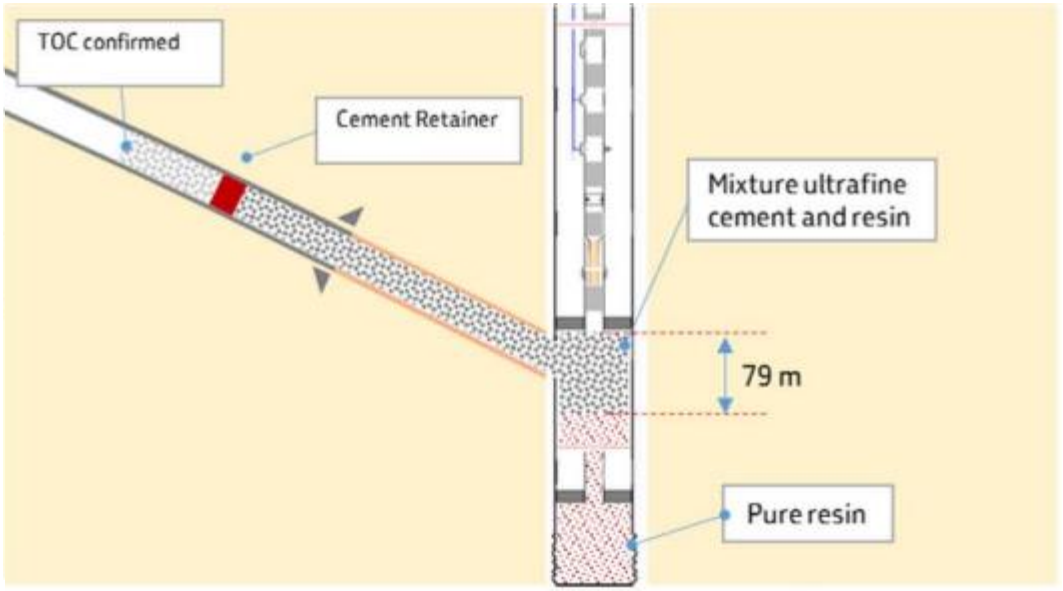






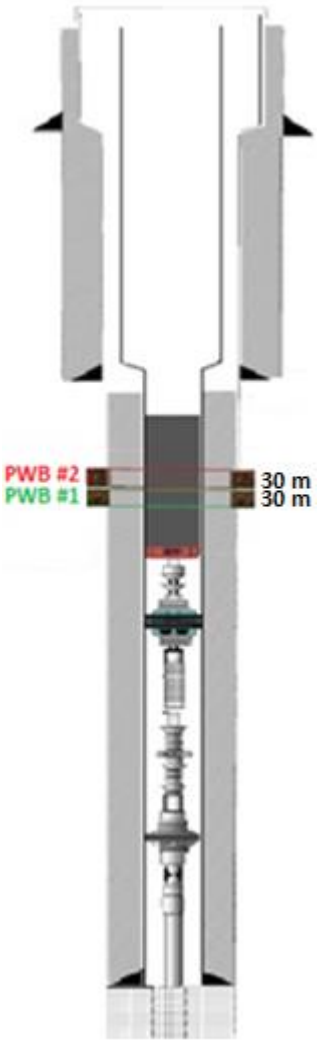
➢ WB confirmation (P&A achieved)

- Drilled up to 20 m below CR, attesting **high compressive strenght**;
- **Positive and negative (inflow) pressure tests** conducted;
- Operational **data collected versus numerical simulation** as expected;
- **PDG readings** mantained high-pressure value while waiting on cement.

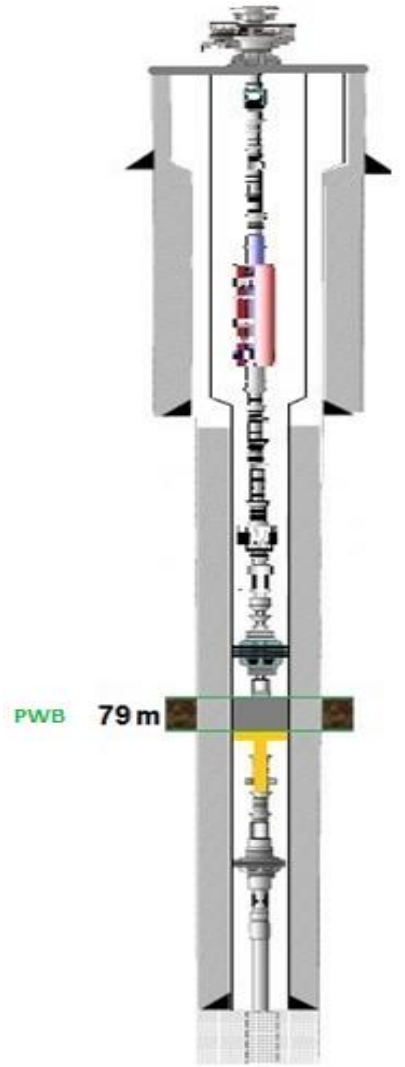


Brazilian Regulator Authority (ANP) Interaction

- **Regulator was involved** and had been updated since the leakage confirmation;
- A PWB was confirmed and an **inspection plan are on going** to evaluate if the ALARP were achieved.



PP&A Originally Planned



P&A Accomplished

Source: authors (Petrobras)

Summary

- Interception occurred after 70 days of spudding and intervention well (IW) successfully abandoned after 87 drilling days;
- Ultrafine cement and resin played a key role for IW plugging;
- Many time could have been saved with ranging while drilling (avoiding changes between wireline x drill BHA);
- The well ranging ocurred in a casing depth. What if it was necessary to be in a open hole depth? Are there any available technology for these scenarios (salt or shale formations)?
- A decollapsing tool might be a game changer for the direct intervention scenario.
- The PWB configuration was the best possible to set at that moment. What would be the risk-based difference between it and the originally planned?
- After the interception, there is a big challenge to overcome: Avoid sidetrack while opening the window. Are there any disruptive technologies that avoid these operations and their risks?

Source: Petrobras

THANK YOU

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