

SHAPING THE WELL DECOMMISSIONING IN BRAZIL

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NON-SEC COMPLIANT OIL AND GAS RESERVES:

CAUTIONARY STATEMENT FOR US INVESTORS

We present certain data in this presentation, such as oil and gas resources, that we are not permitted to present in documents filed with the United States Securities and Exchange Commission (SEC) under new Subpart 1200 to Regulation S-K because such terms do not qualify as proved, probable or possible reserves under Rule 4-10(a) of Regulation S-X.

VARIED OFFSHORE PORTOFLIO

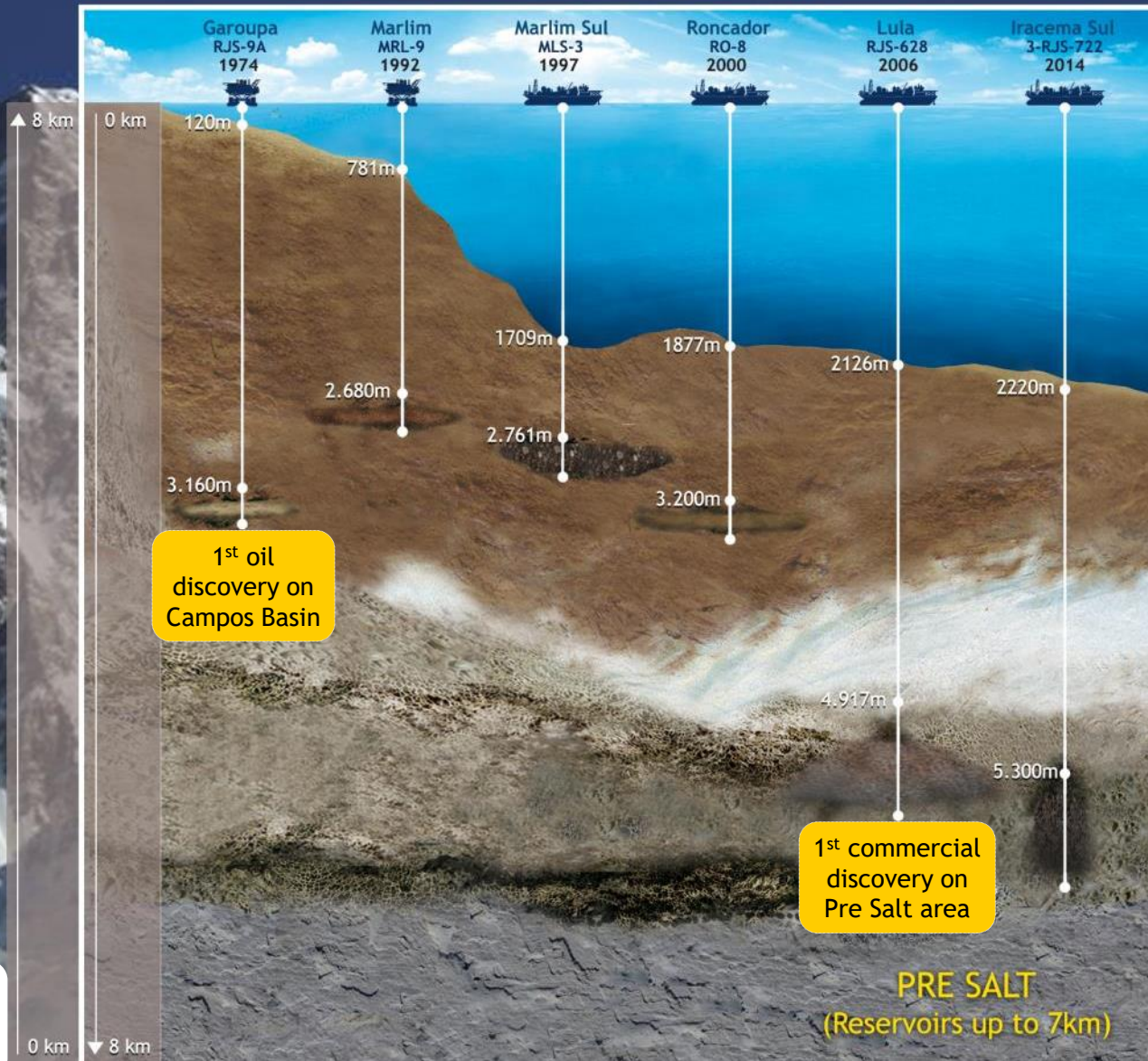
LATE LIFE MANAGEMENT COEXISTS WITH NEW ASSETS

2.8 million

boe/d (average 2018)

85%

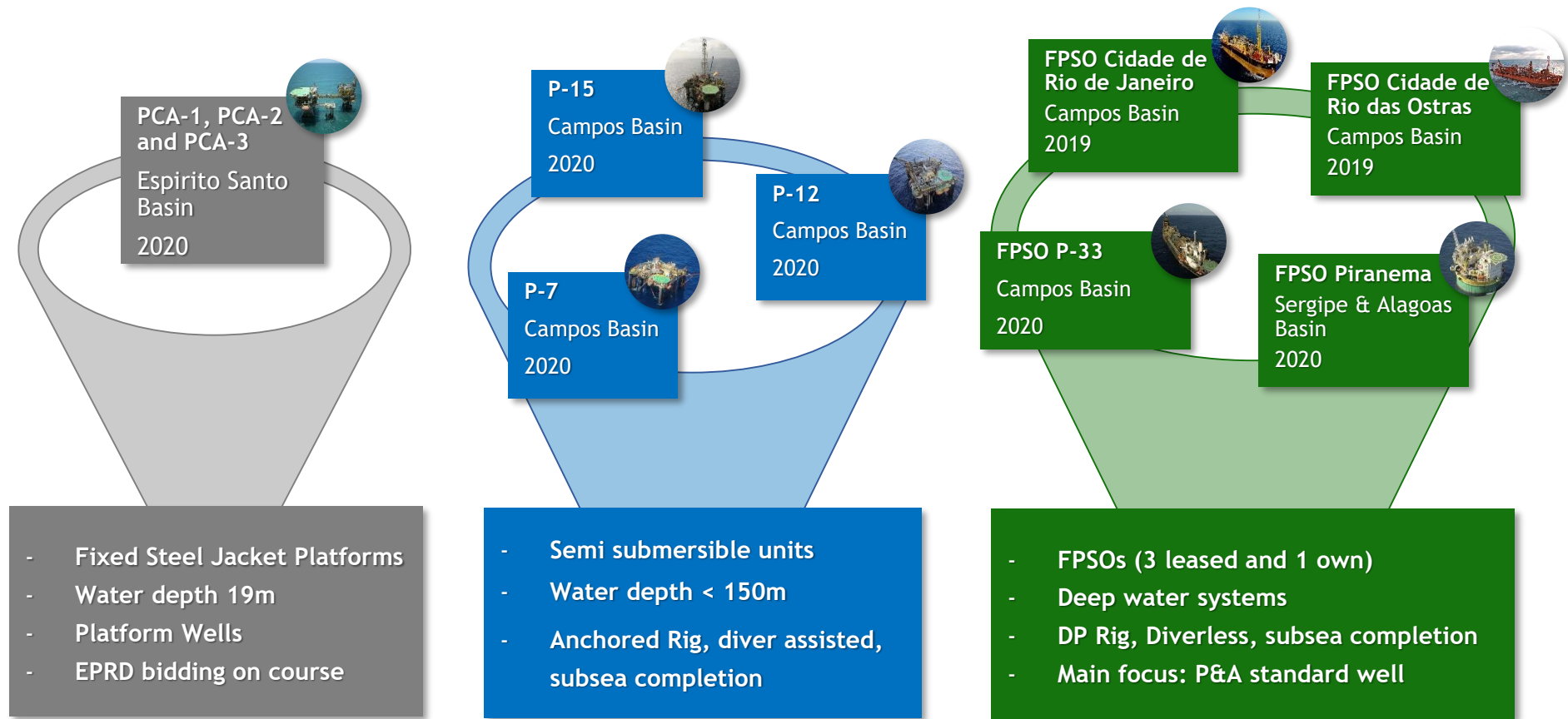
Of our production comes from offshore fields



K2 MOUNTAIN, HIMALAIA
(8.8KM)

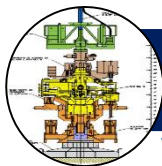
CURRENT PETROBRAS DECOMMISSIONING PROJECTS

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



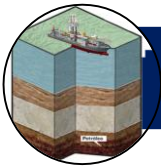
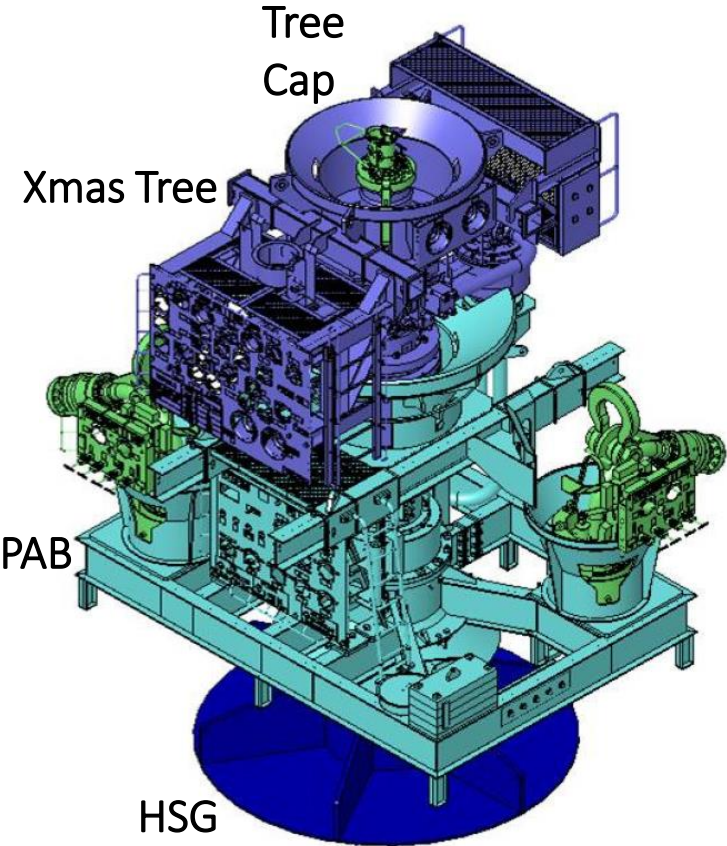
And more under evaluation...

STANDARD WELL TO BE CONSIDERED



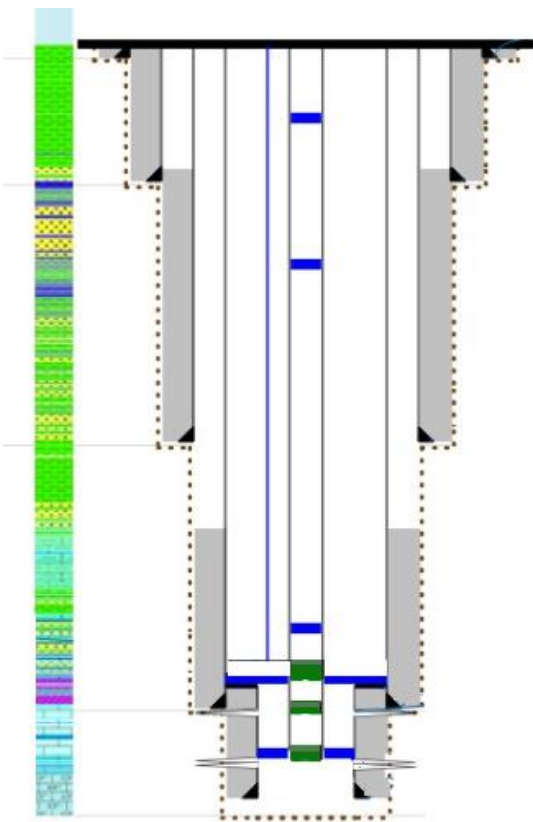
CHRISTMAS TREE

- Multiple standardized families
- Rarely horizontal
- PAB vertically connected to flowlines

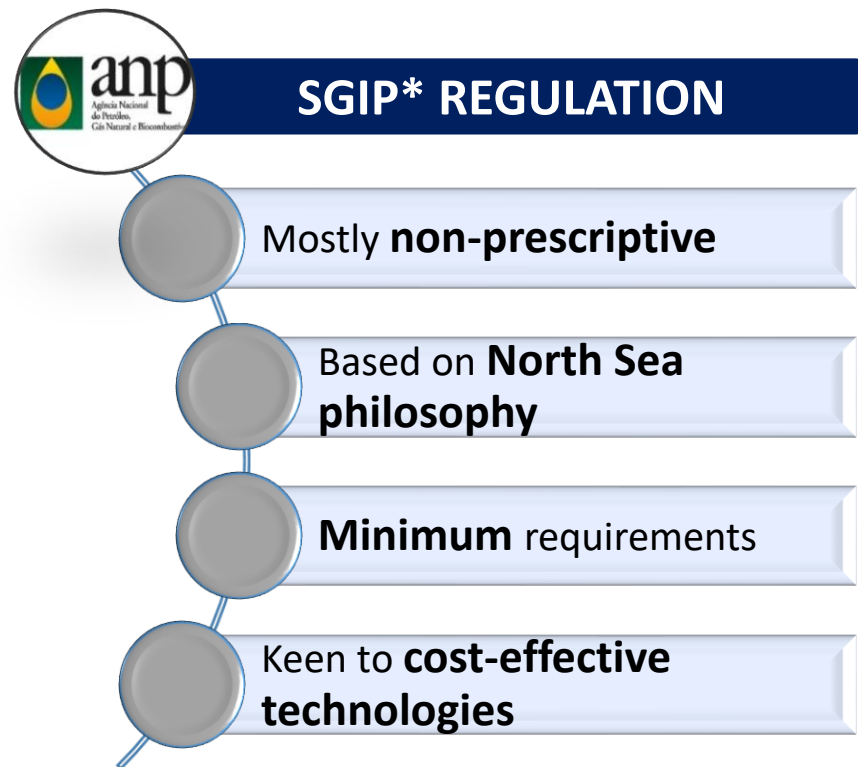


WELLBORE GEOMETRY AND ZONES

- 4 ½" or 5 ½" OD Tubing
- Gas lift valves
- 9 5/8" OD casing and 7" OD Liner eventually
- Maximum restriction of 3,68" or 3"
- Vertical or Deviated
- 1 or 2 Interval with Flow Potential
- Wellhead Removal Not Required if WD > 100 m



INDUSTRY ALIGNMENT AND BRAZILIAN REQUIREMENTS



*SGIP – Well Integrity Management System

PHILOSOPHY AND BEST PRACTICES



PHILOSOPHY EMPLOYED

- **Holistic** approach
- Ensure **well integrity**
- **Environmental** preservation
- Prioritize **operational safety**
- Global **risk reduction**



IDENTIFICATION OF INTERVALS WITH FLOW POTENTIAL



Does the formation have a **mappable** extension?



Is the formation **permeable**?



Does the formation **hold mobile hydrocarbons**?



Is the formation **overpressured**?



Industry Best Practices



NORSOK Standard
D-010
Rev. 4, June 2013

“**One well barrier** shall be in place” to prevent “**undesirable cross flow** between formation zones”

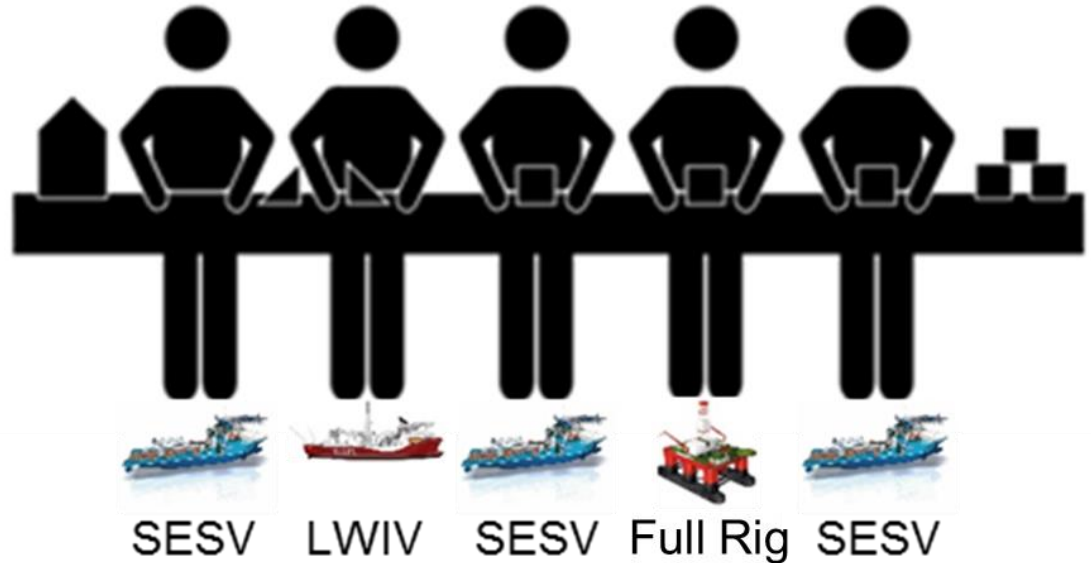
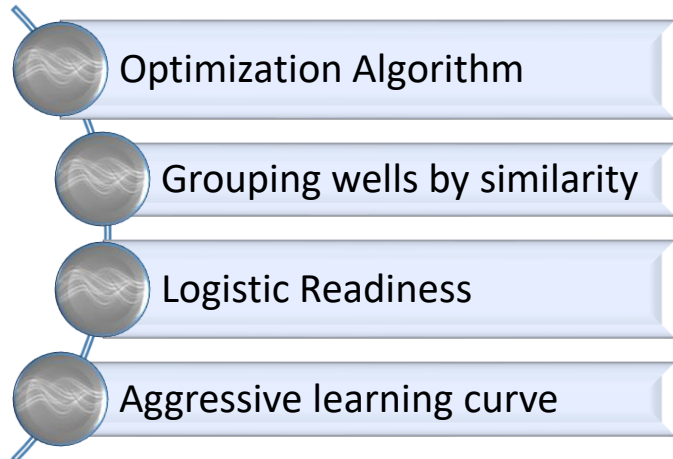
OIL&GAS^{UK}
Well Decommissioning Guidelines
Issue 6
June 2018

“Zones with flow potential may be grouped such that they **do not need to be isolated** from each other if the risk of cross-flow **is deemed to be acceptable**”
(...)
“This assessment may allow a shallower cap rock to be acceptable for isolation of the group, with a **consequent reduction in decommissioning complexity**”

CADERNO DE BOAS PRÁTICAS DE EGP
DIRETRIZES PARA
ABANDONO DE POÇOS

“Intervals with flow potential that were connected by the drilling of the well shall be isolated establishing **1 well barrier to prevent unacceptable cross-flow** between formations not naturally connected”

DESIGNING WELL ABANDONMENT AS AN ASSEMBLY LINE



Using this philosophy, Petrobras reduced the average duration for P&A operations of subsea wells by almost **28%**

P&A planning is on an advanced stage, so where do we look for improvements?

TECHNOLOGY

THE CHALLENGE AND THE TOOLS

The Future of Well Decommissioning

- Qualification and Homologation of existing technology
- Multiple R&D initiatives to increase through tubing permanent abandonment
- Reduce full rig dependency for permanent abandonment
- Disruptive technology
- Engineering and quantitative risk based decisions

What usually defines the necessity to remove the tubing?

Lack of verified cement on annulus to “restore the cap rock”

Presence of cables and control lines

What to do:

Does it have to be 200ft long? How long is enough?

Through Tubing Cement Verification

Remove/mill/destroy part of the tubing faster than usual

Homologate/verify creeping formations

Create discontinuities to the cables/lines

Mill/destroy tubing and cables/lines

SHORT TERM P&A



Adequate Scope: Isolate what you have to isolate
Group by Similarities: Gain in scale, lessons learned, maximize usage

Phase 0 →

SESV



Recover Tree Cap

Phase 1A →

LWIV
or
RIG




Set temporary barriers

Latch and test DP riser and EDP/LWRP/TRT
Bullhead tubing and annulus
Set lower barrier, test and perforate tubing
Set upper barrier and test
Unlatch DP riser and tree RT

Phase 1B →

SESV

Recover X-Tree

Phase 2 →

RIG



Set permanent barriers

Latch BOP
Run THRT with DP and test BOP
Pull upper completion
Run cement evaluation log
Set deep permanent cement barriers
Set shallow permanent barrier when applicable
Unlatch BOP

SHORT TERM P&A



Maximize Open Sea Tubing Removal

Adequate Scope: Isolate what you have to isolate
Group by Similarities: Gain in scale, lessons learned, maximize usage

Phase 0



SESV



Recover Tree Cap

Set temporary barriers

Phase 1A



LWIV

or

RIG



Latch and test DP riser and EDP/LWRP/TRT
Bullhead tubing and annulus
Set **2 deep barriers**

Unlatch DP riser and tree RT

Set permanent barriers

Phase 2



LWIV

or

RIG



Run THRT with DP and test BOP
Pull upper completion
Run cement evaluation log
Set deep permanent cement barriers
Set shallow permanent barrier when applicable

SHORT TERM P&A



**Position cement Through
Tubing when possible**



Adequate Scope: Isolate what you have to isolate
Group by Similarities: Gain in scale, lessons learned, maximize usage



Less operations that may go wrong (fishing, hydrates, etc.)

Fewer operational disconnections to the well

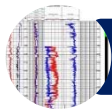
Less vessels involved

**SAFER, FASTER
COST EFFECTIVE**

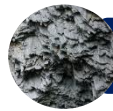
MID TERM AND LONG TERM P&A - R&D

Incremental Gains

Groundbreaking Technologies



THROUGH
TUBING LOGGING



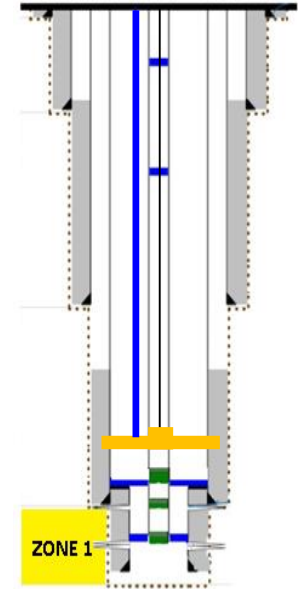
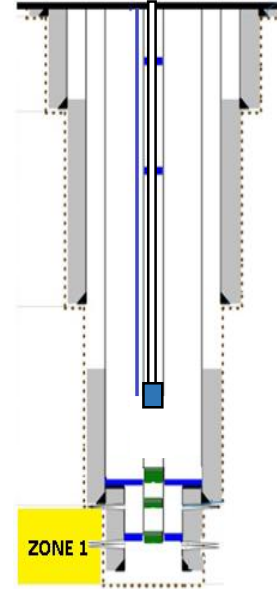
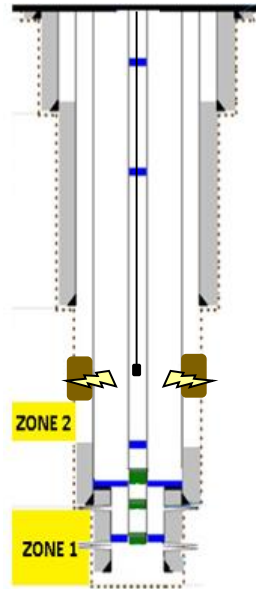
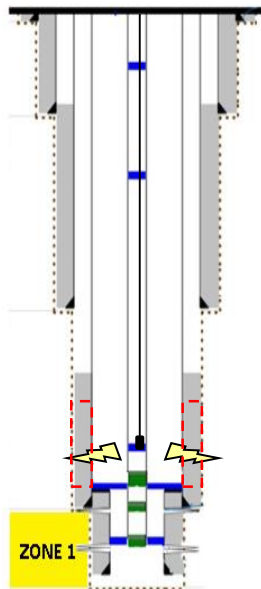
CREEPING
FORMATION



UNCONVENTIONAL
MILLING



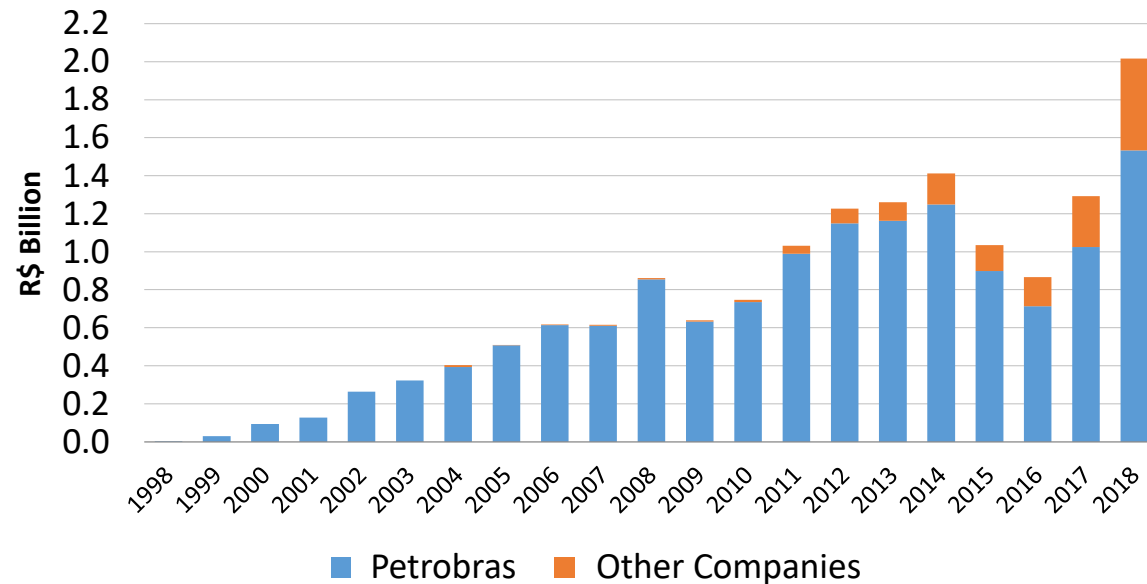
THERMITE
AND OTHERS



BARRIER QUALIFICATION

Higher Reliability and Smaller lengths compared to cement
Element Acceptance Criteria table adherent with the material
Industry Alignment towards regulators

R&D IN BRAZIL - LEVY AVAILABILITY



Operators established in Brazil have to carry out qualified expenditures of approx. **US\$500 MM every year (and soaring)** in the search for **disruptive technologies**



Access to the infrastructure developed in Universities, Institutes and Companies



- Only companies **established in Brazil** may use levy.
- Companies with P&A technologies **aligned with Petrobras' drivers** are welcome
- Petrobras is **eager to join JIPs in Brazil** with other majors that have to use levy

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**


THANK YOU

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