PETROBRAS Deepwater Gas Lift Projec

(an overview)

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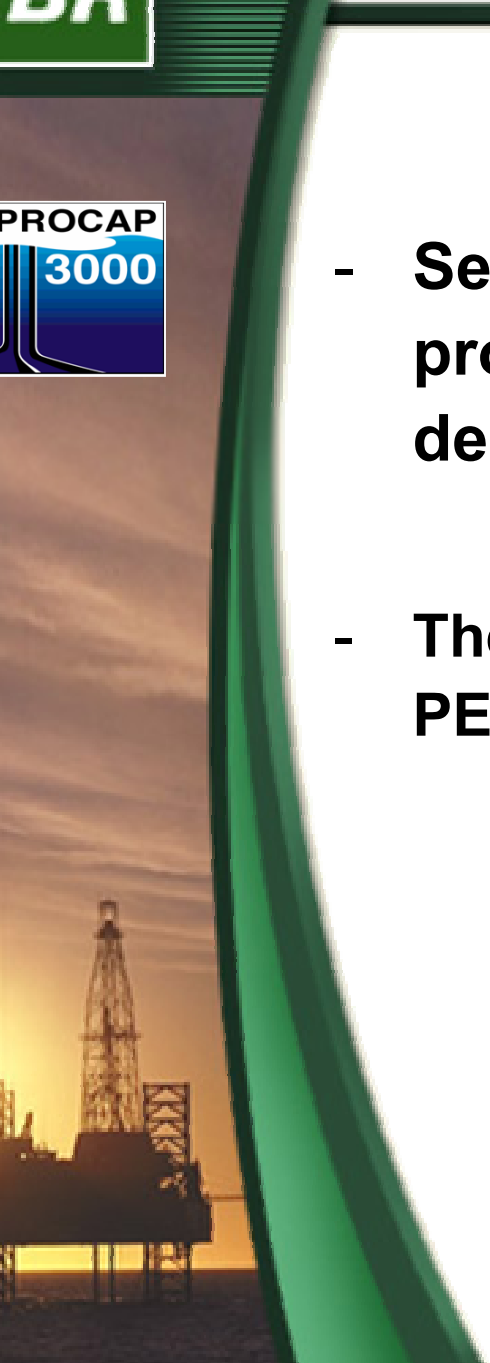
Rio de Janeiro, February 200



- Search for products that will optimize gas lift process in high pressure and high flow rate deepwater subsea wells

- The Deepwater Gas Lift Project is part of a major PETROBRAS Technological Program

  - PROCAP 3000 -

Deepwater Gas Lift Project Schedule:

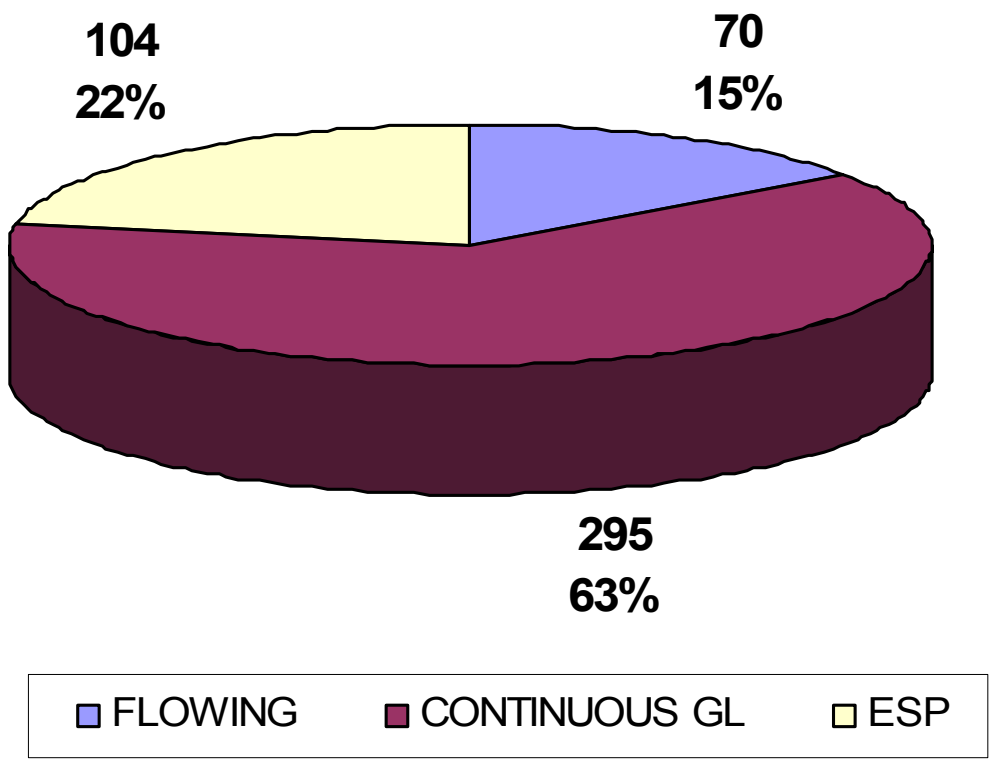
Phase I : Feb, 1999 to Feb, 2005

Phase II : Mar, 2005 to Jul, 2006

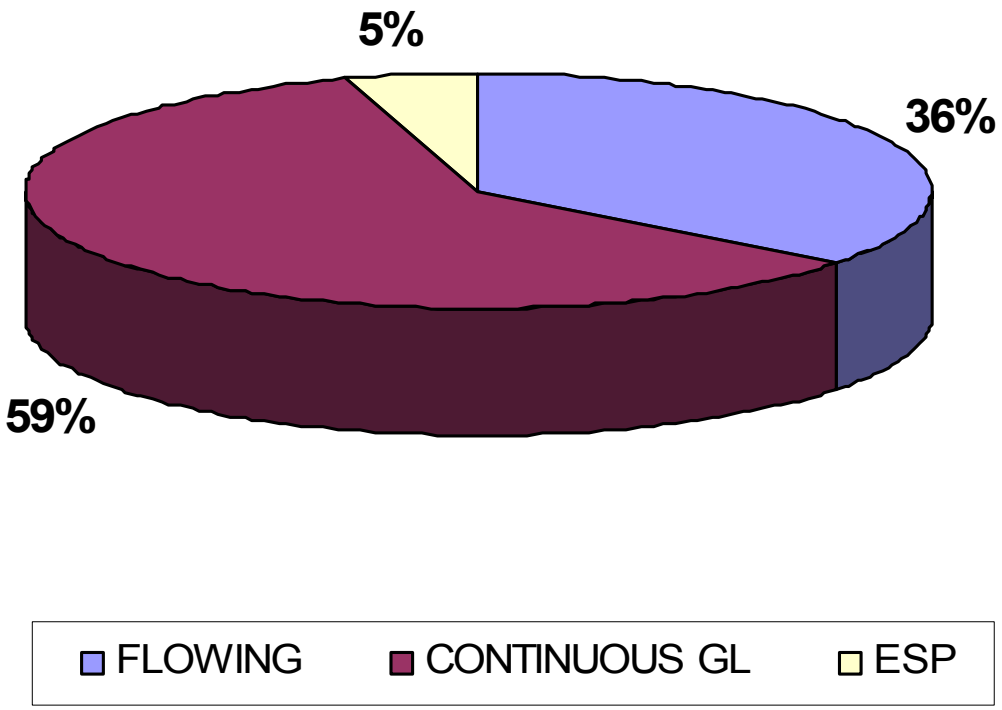
- 1 – Scenario Studies
- 2 – Gas Lift Equipment Development
- 3 – Gas Lift Software Development
- 4 – Gas Lift Automation

Scenario Studies

Number of Wells



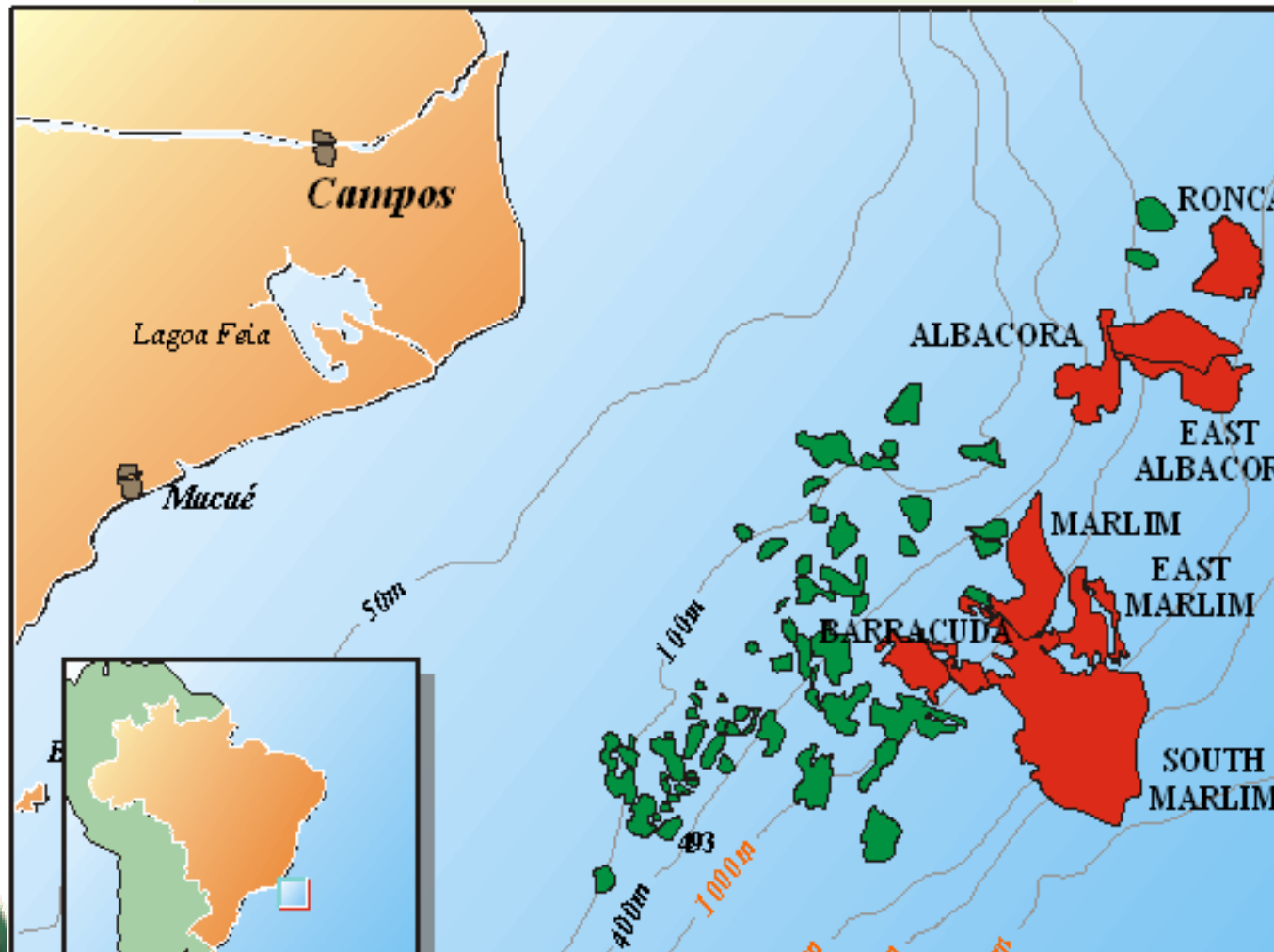
Flow Rate

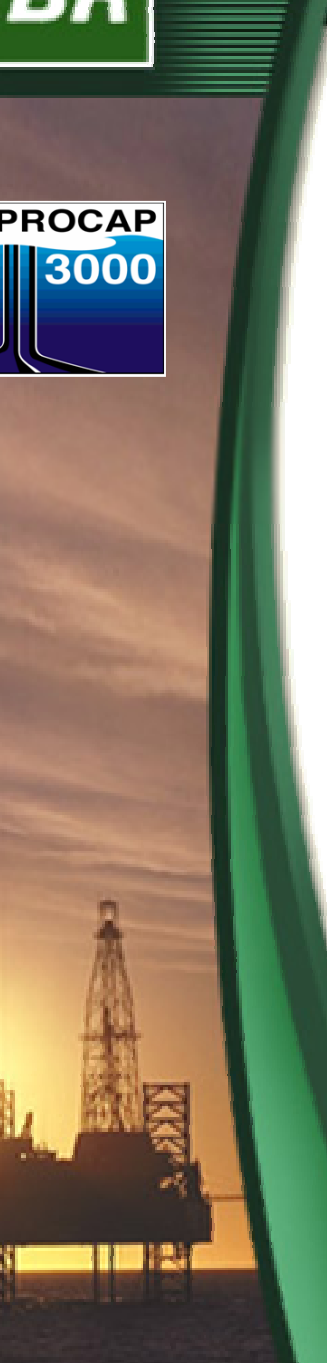


Focus in Campos Basin Fields:

1 – Roncador

2 – South Marlim





Main Oilfield Data:

Datum: - 2500 to - 3200 m

Water Depth: 1000 to 3000 m

Well to Platform distance: 1.5 to 12 km
(1 to 7.5 mi)

Oil Specific Gravity: 12 to 30 ^{o}API

Bottom Hole Pressure: 250 to 290 bar
(3600 to 4200 psi)

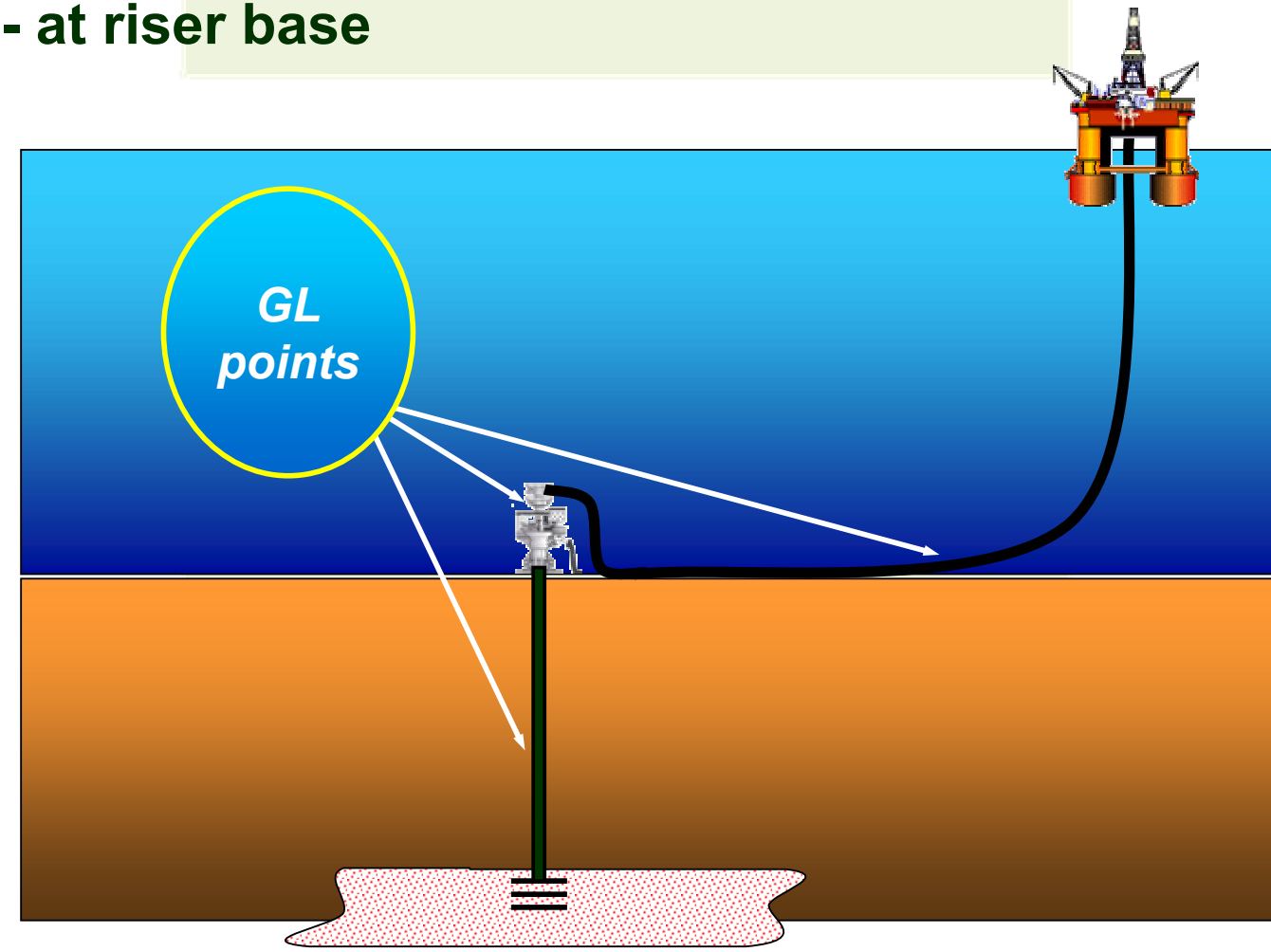
Productivity Index: 10 to 100 $m^3/d/bar$
(4.5 to 45 bpd/psi)

Formation GOR: 50 to 75 m^3/m^3

1 - downhole

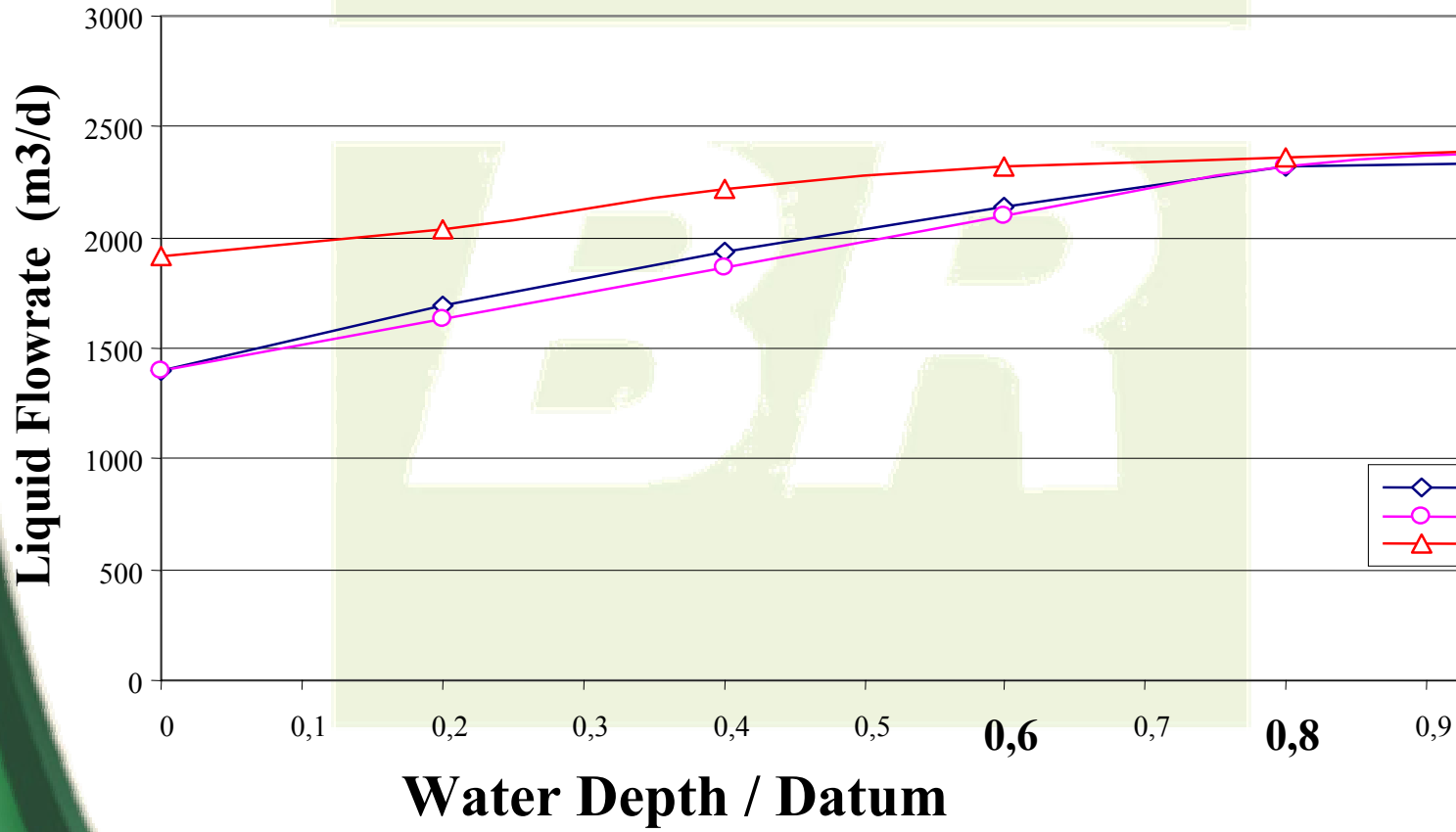
2 - at the Subsea Well Head

3 - at riser base



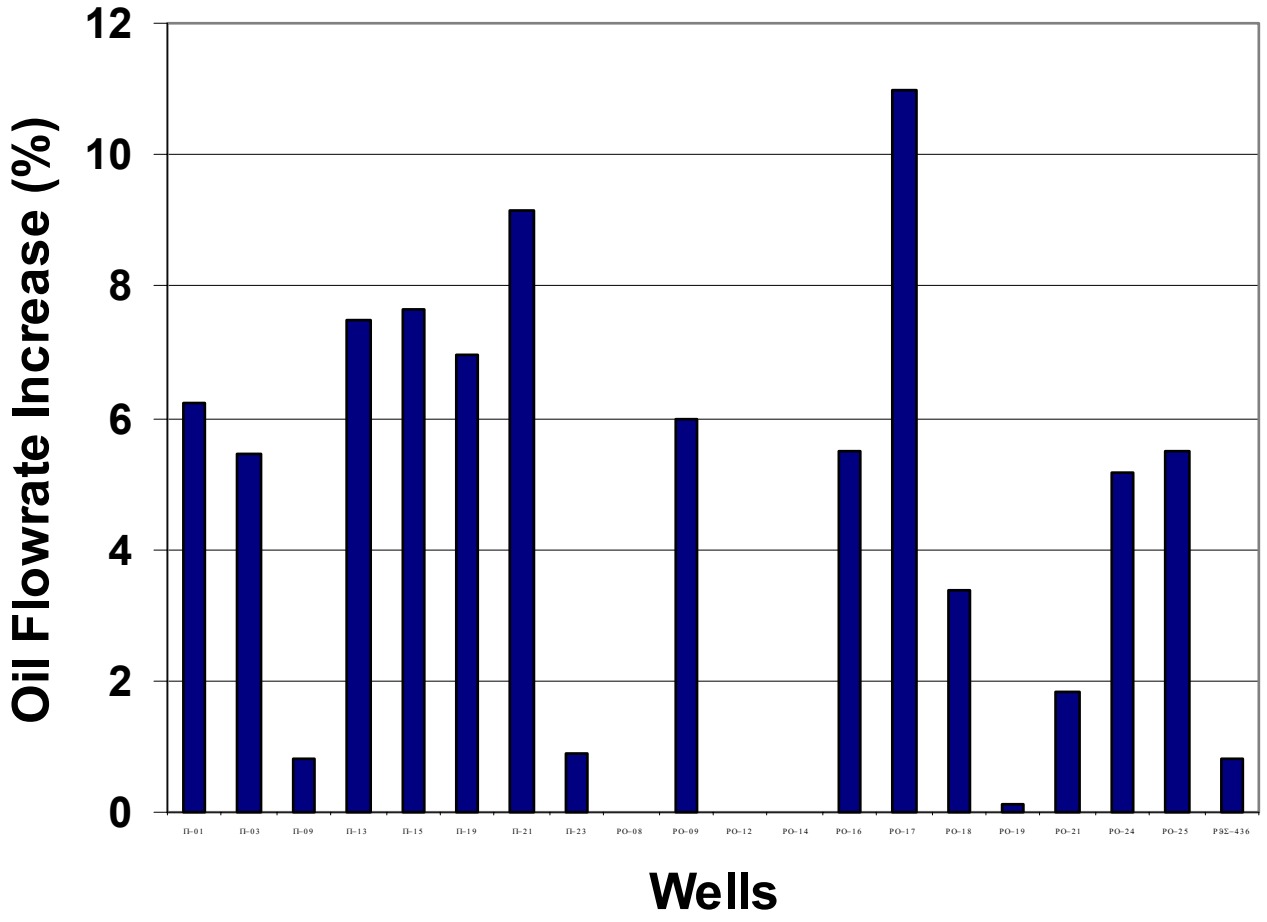
Depends on BHP, Flow Line Lenght, PI, ...

-EXAMPLE-

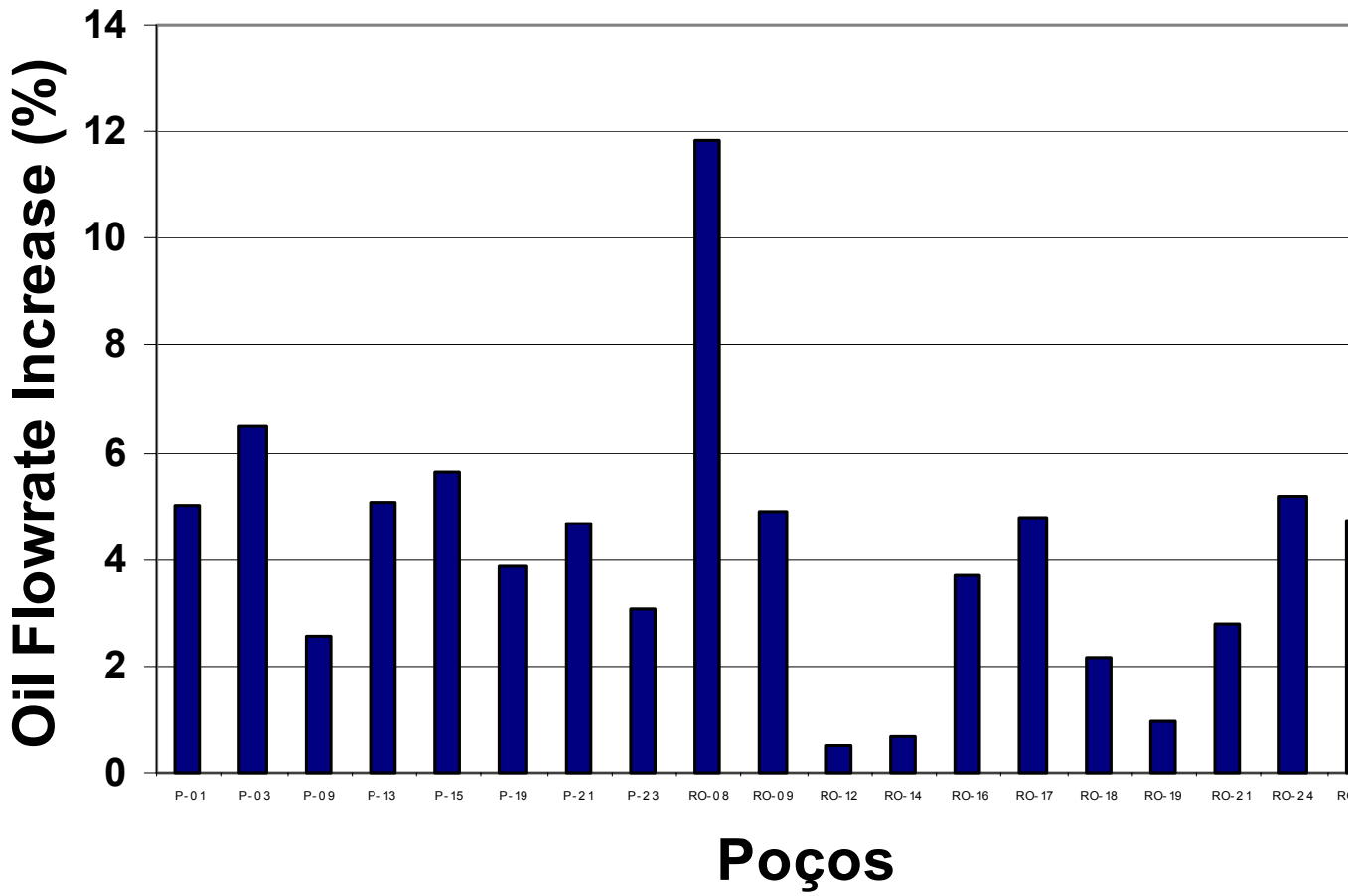


WD = 1500 m WD = 2000

Venturi X Orifice Gas Lift Valves



High Pressure X Conventional IPO Valve



- **Operational flexibility:**
  - **Reduce the number of GL valves**
  - **Prevent instabilities and severe slug**
  - **Easy way to start up the well**
- **Single point injection in ultradeep well**

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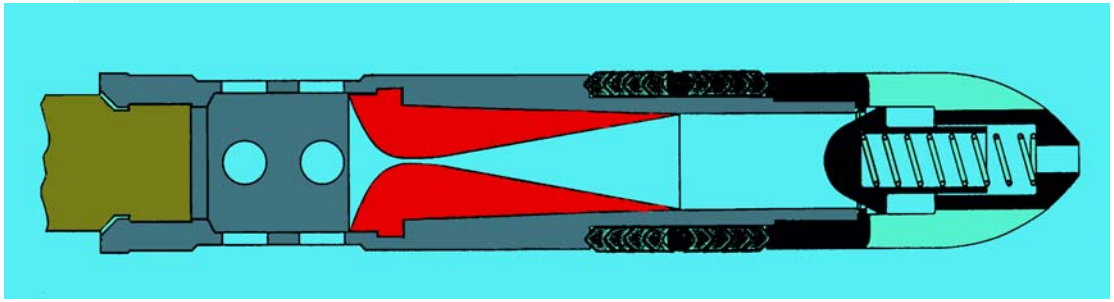
Equipment Development

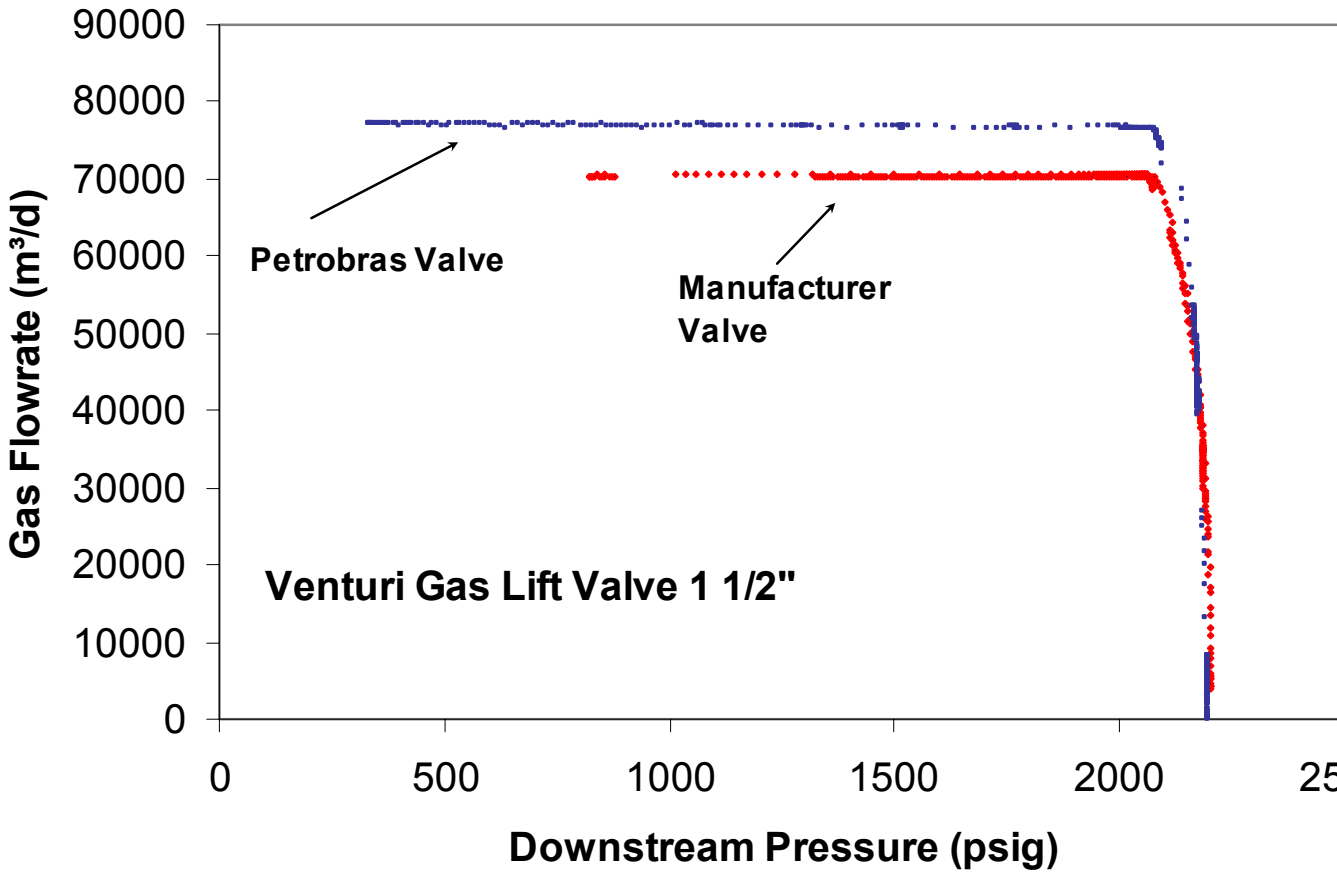
- New GL valves
  - Venturi
  - High pressure IPO
  - Normally Open Valve
  - Electric GL valve
- PETROBRAS Gas Lift Valve Test Site (Aracaju-SE)

  Dynamic Performance and Endurance Tests

– Venturi type valves

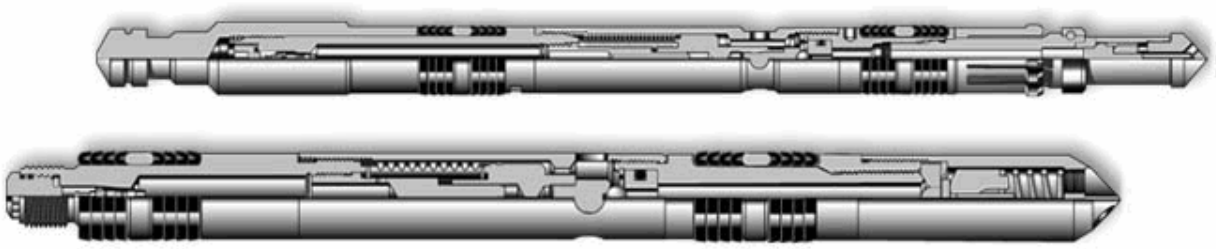
- Intensively bench and field tested by Petrobras
- Standard valve in Petrobras deepwater wells
- Petrobras patented valve is being manufactured in Brasil

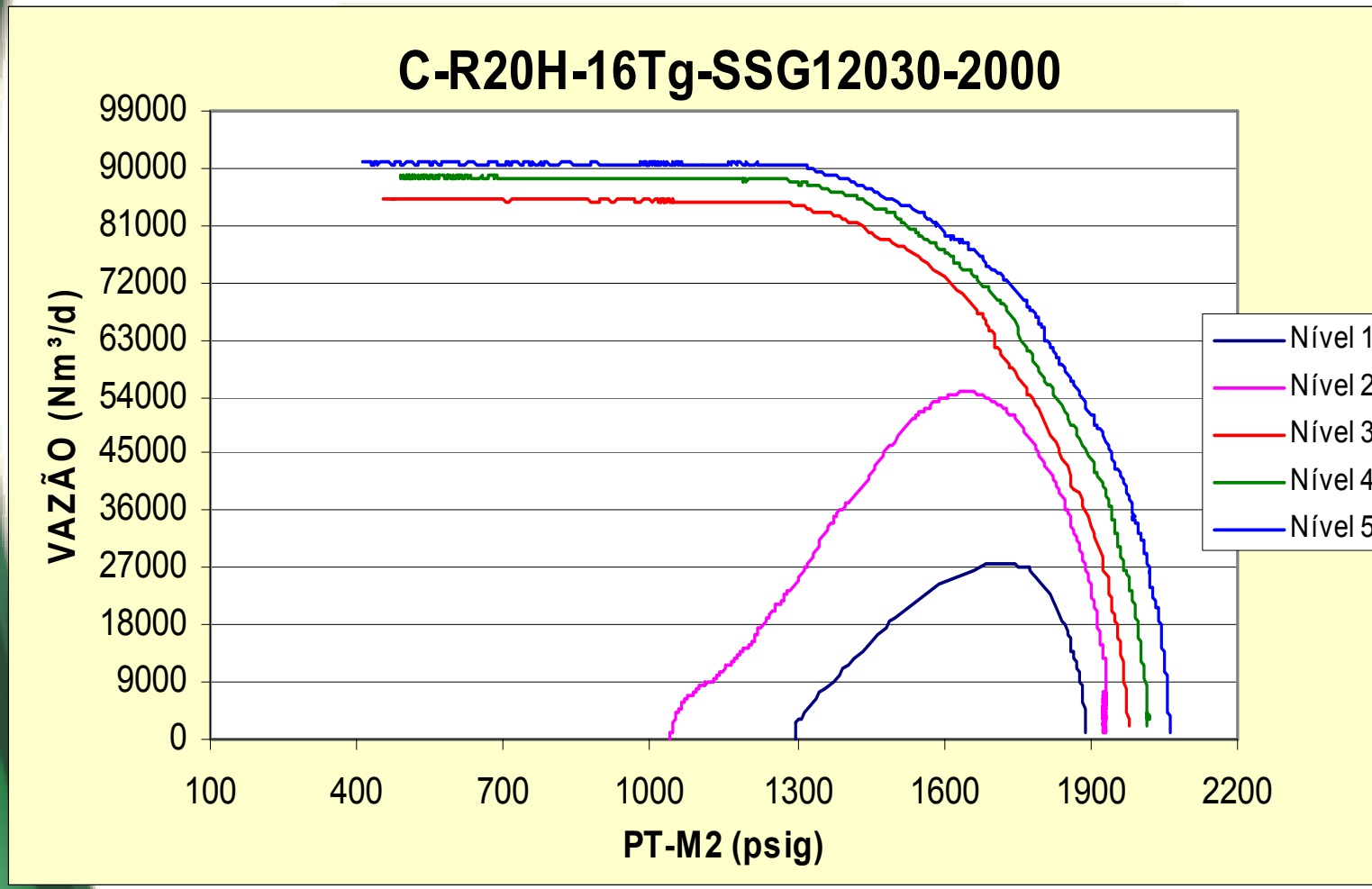



90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Gas Flowrate (m³/d)
0
500
1000
1500
2000
Downstream Pressure (psig)
Petrobras Valve
Manufacturer Valve
Venturi Gas Lift Valve 1 1/2"

– **3000 psi Gas Lift Valve**

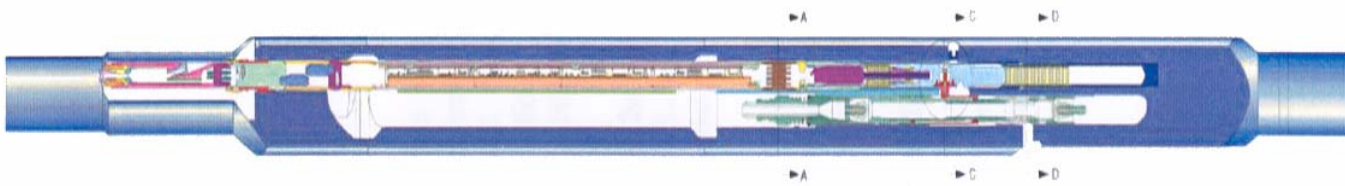
- **Developed under a Cooperation Agreement**
- **Allows deeper operation injection point**
- **Bench tested**
- **Field test: one valve is operating in Albacora field since July, 2003**




C-R20H-16Tg-SSG12030-2000
VAZÃO (Nm³/d)
99000
90000
81000
72000
63000
54000
45000
36000
27000
18000
9000
0
100
400
700
1000
1300
1600
1900
2200
PT-M2 (psig)
Nível 1
Nível 2
Nível 3
Nível 4
Nível 5

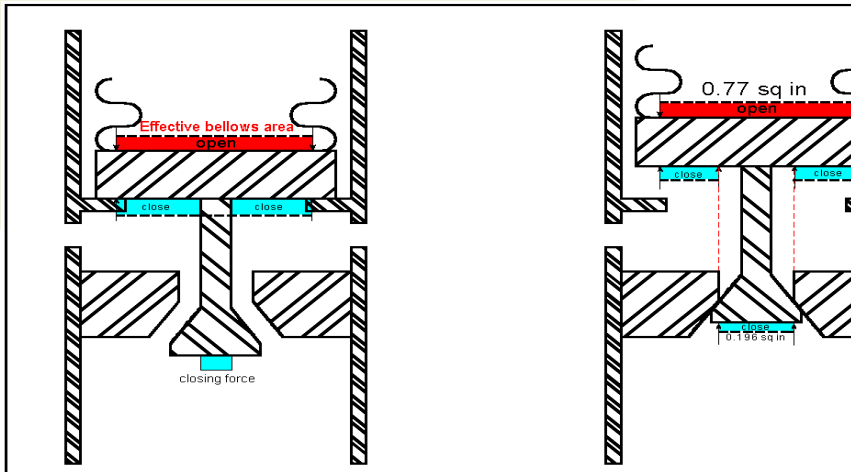
– **Electric Gas Lift Valve**

- **Petrobras was a member of a JIP with other operators and one manufacturer**
- **Field tested in the USA (Simpson Field, India in 2001**
- **High cost => not attractive for standard applications**



- Normally Open Gas Lift Valve

- opens with low injection casing pressure
- closes with high injection casing pressure
- failed in field test in Campos Basin in 2001 (Cherne fiel
- endurance tests in Atalaia Test Site in 2004 showed a n for further improvement
- Application scenario:
  - as an operating valve (dual compression sites)
  - as a kickoff valve



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Normally
Open Gas
Lift Valve

Problems
detected

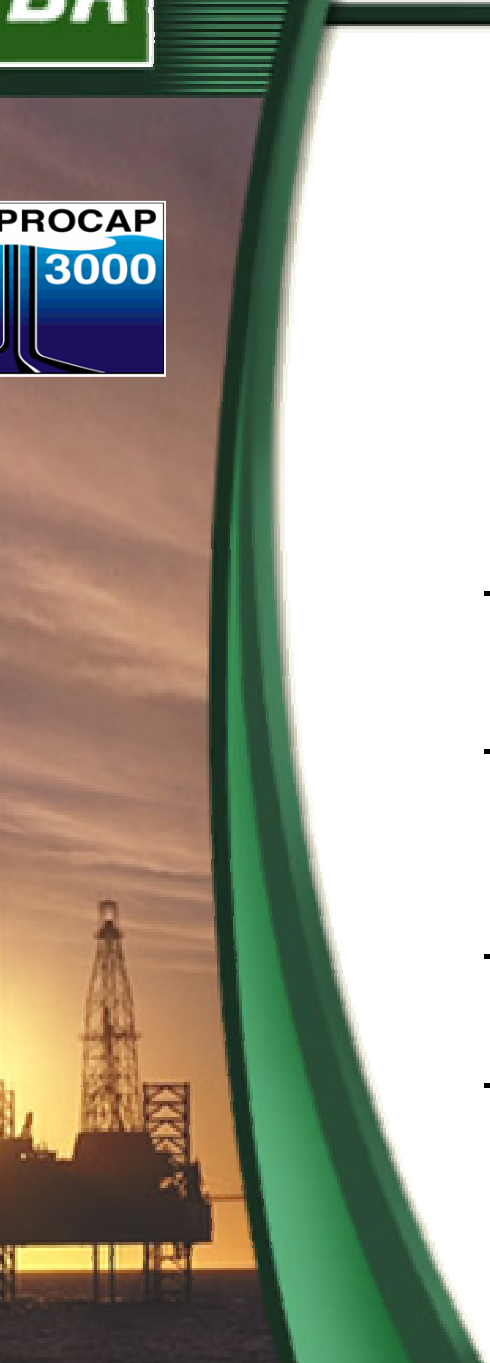
PROCAP
3000

PERFORMANCE TESTS

PROCAP 3000

ENDURANCE TESTS

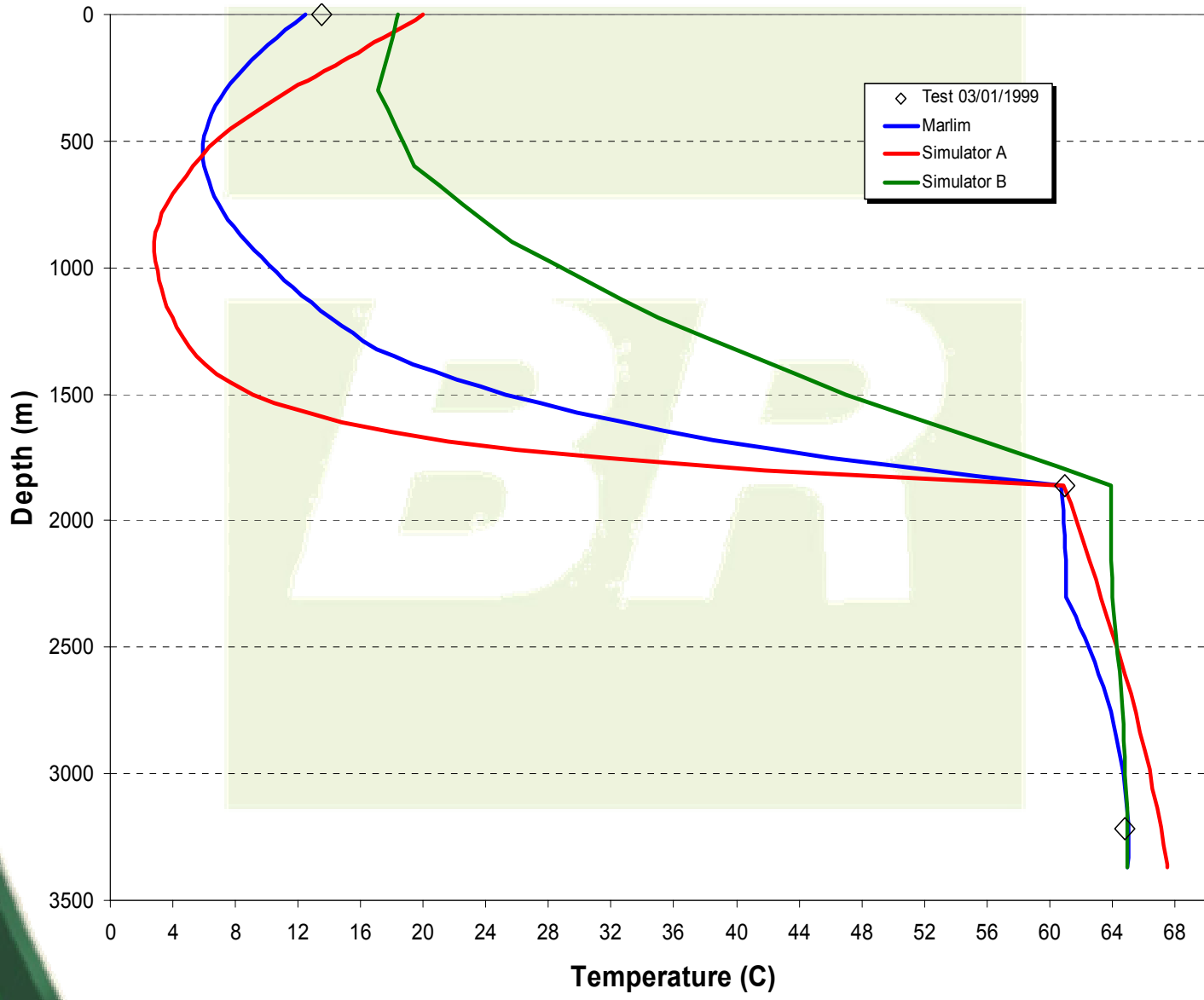
Software Development



MARLIM

(*Multiphase and Artificial Lift Modelling*)

- In-house and continuous development
- Accurate Pressure and Temperature profiles prediction in multiphase flow
- Used to design and troubleshooting analysis
- Includes dynamic performance of GL valves


Test 03/01/1999
Marlim
Simulator A
Simulator B
Depth (m)
0
500
1000
1500
2000
2500
3000
3500
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
68
Temperature (C)

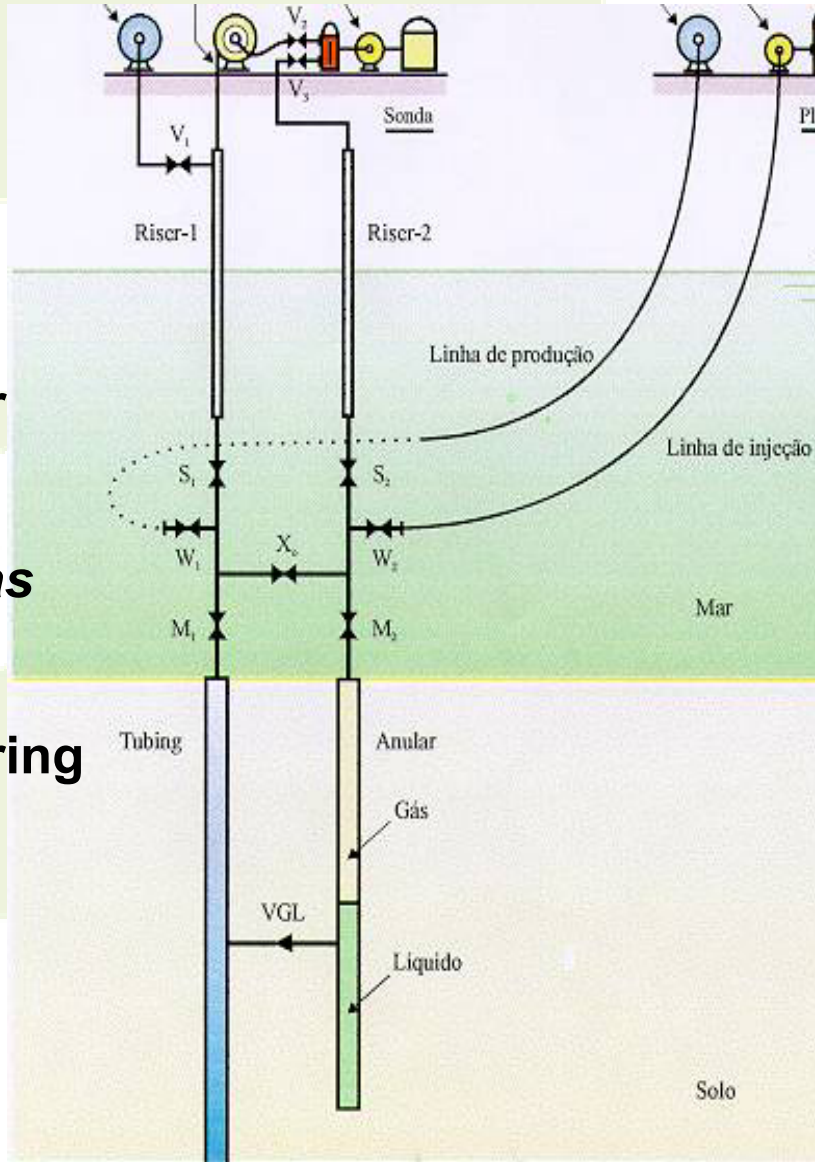
- Calculate transient temperature and pressure profiles (production and annular systems) in multiphase
- Useful for kickoff and design analysis with natural gas or nitrogen injection and including coiltubing if necessary
- Dynamic Performance of GL valves and chokes are inclu

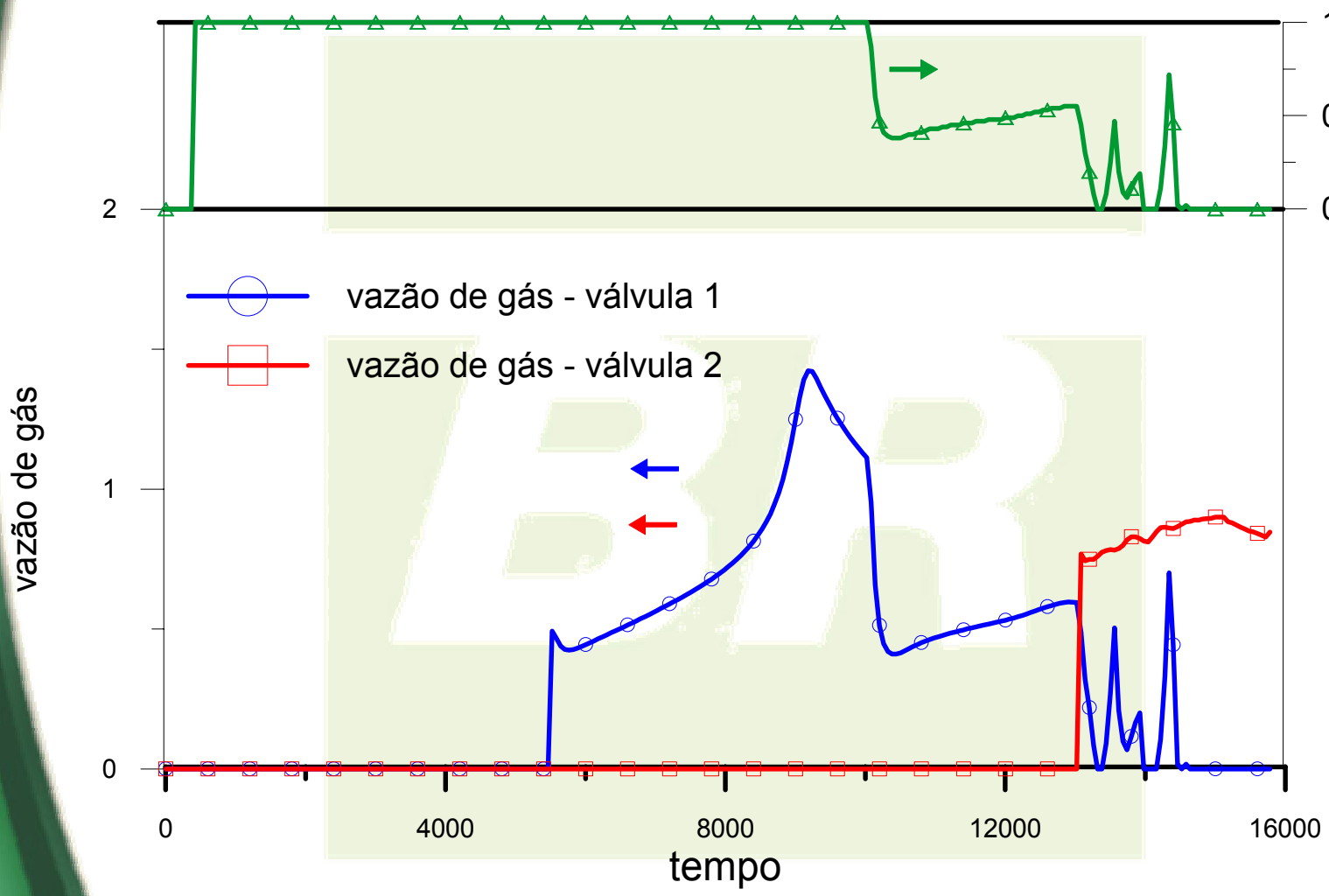
Two softwares are being developed by Petrobras:

- FLOWLIFT – with external consultant
- TRACELIFT – specific presentation will be made at GL workshop

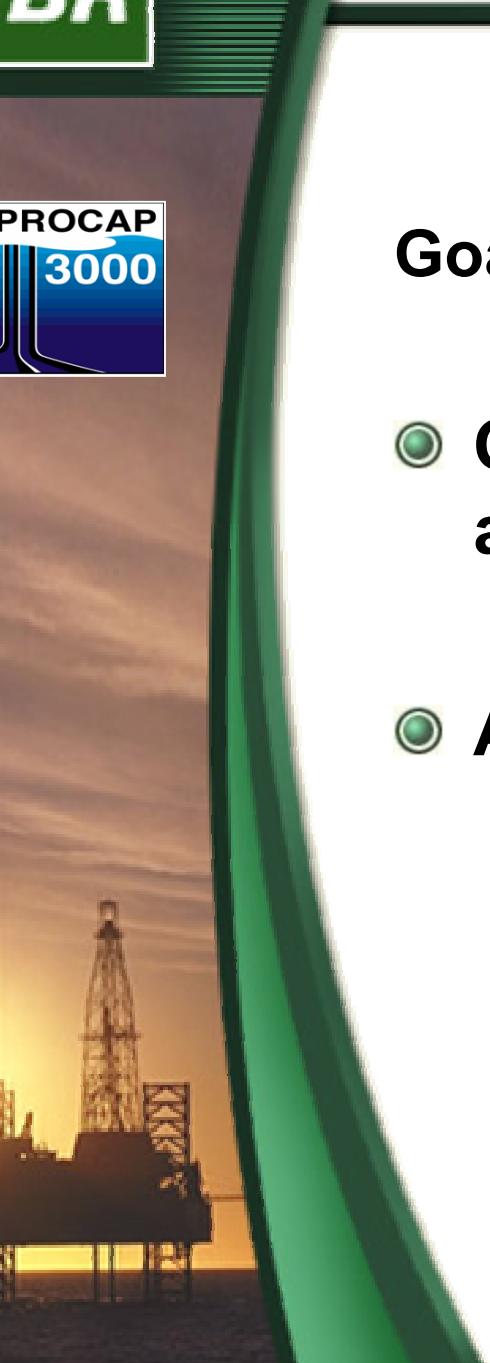
- **System geometry**

- **Fluids:**
  - **oil + formation water**
  - **Formation gas**
  - **Natural gas as *lift gas***
  - **Nitrogen as *lift gas***
  - **Completion fluid during kickoff**



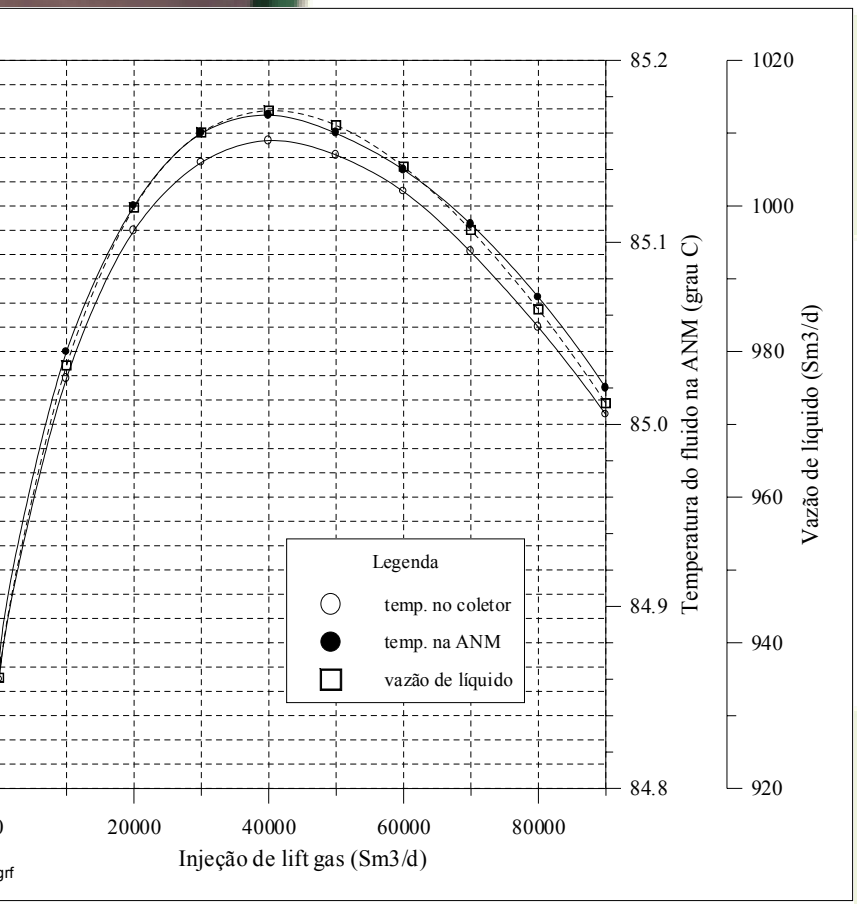

2
1
0
vazão de gás - válvula 1
vazão de gás - válvula 2
vazão de gás
0
4000
8000
12000
16000
tempo

Automation and Phase II of the Project



Goals:

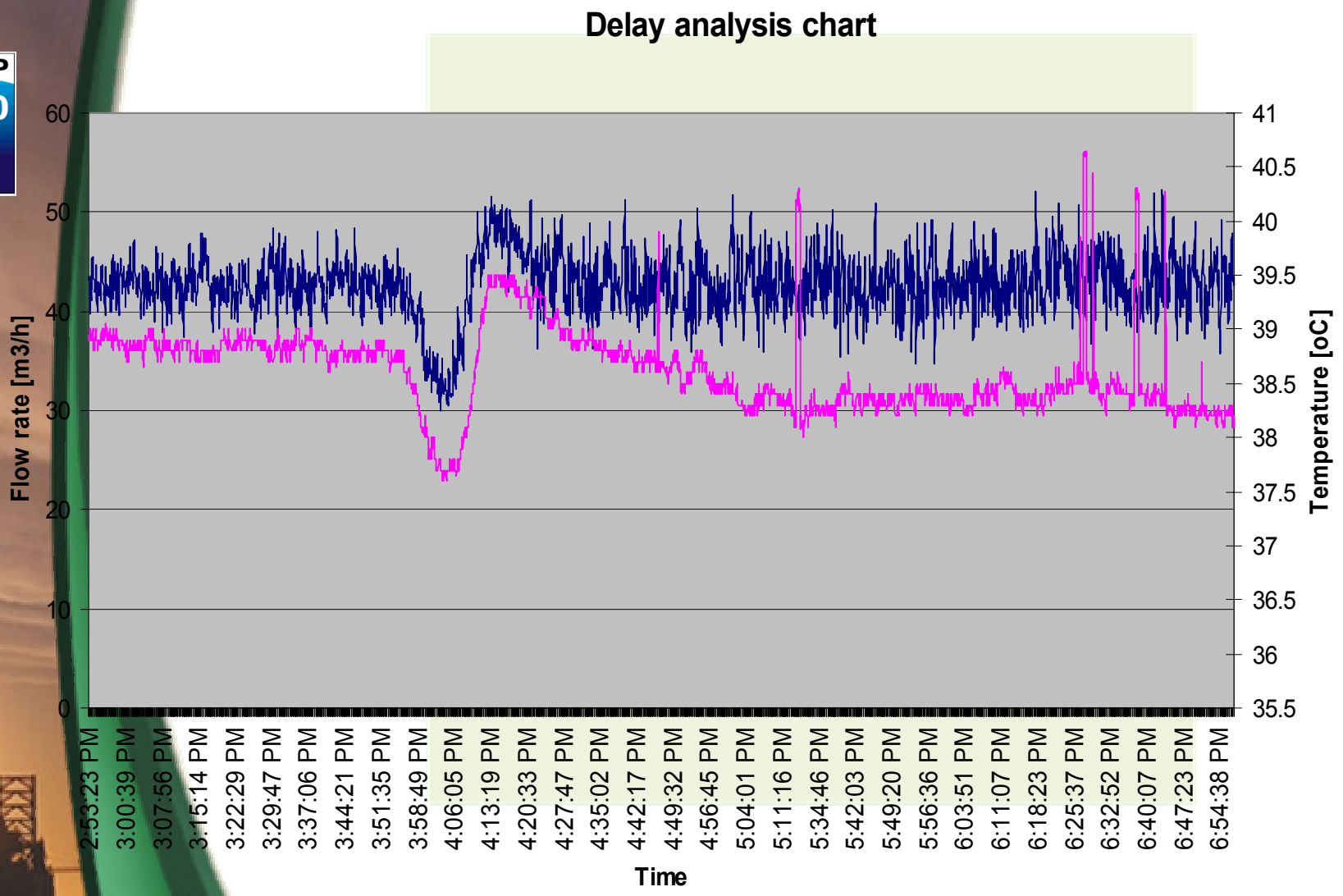
- Optimization and automation of gas allocation per well
- Automatic instabilities control
  - ➢ Specific presentation on the subject in this Workshop

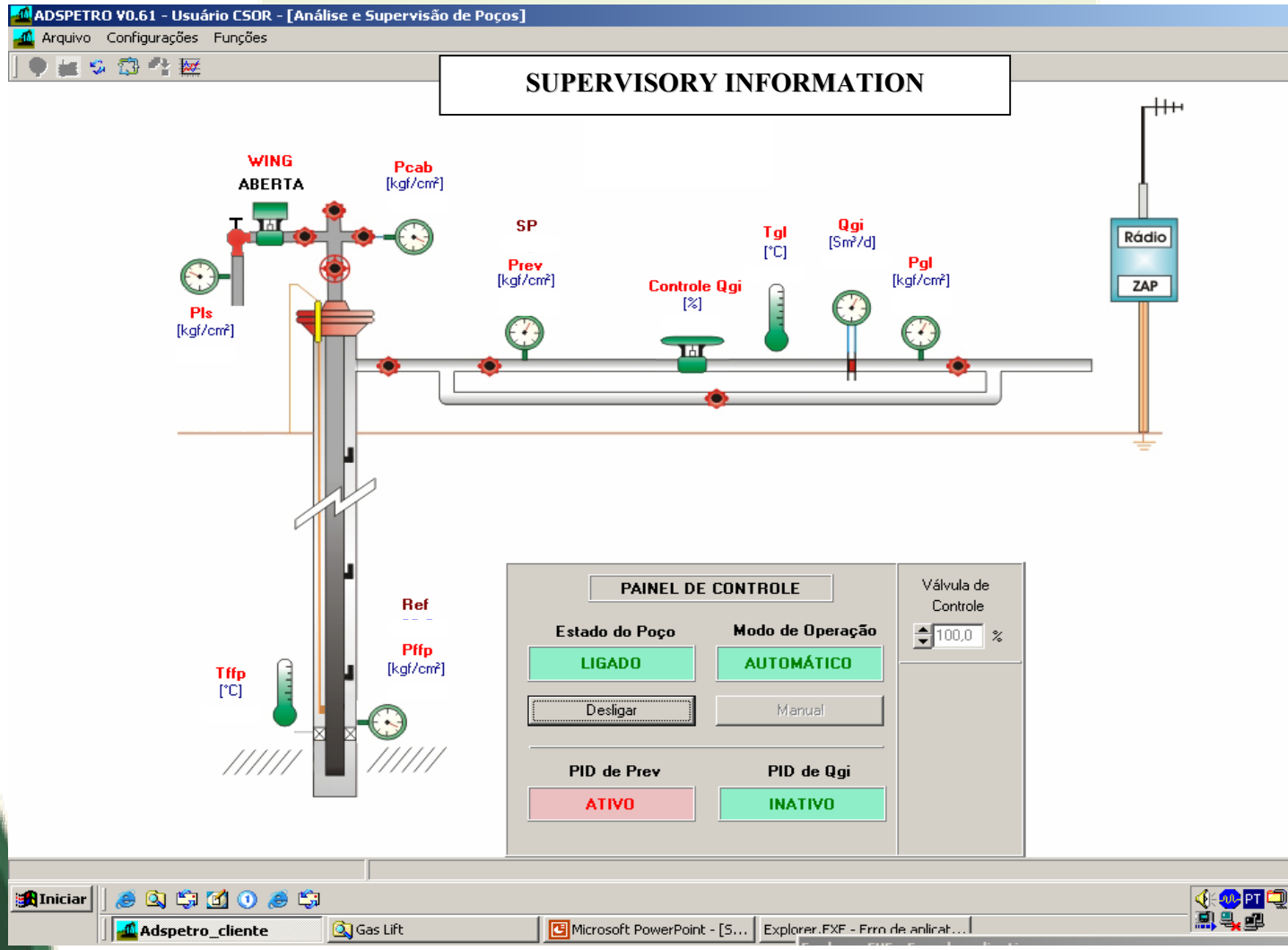


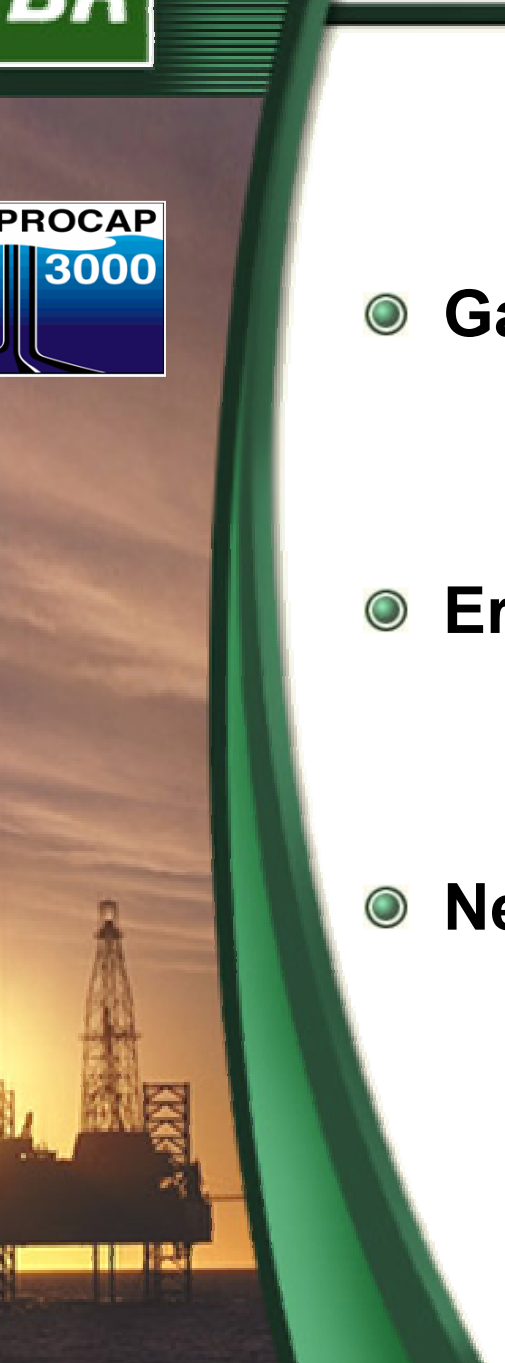
- **A low cost alternative for automation without depending on well intervention**
- **The optimum injection point m be inferred from the surface temperature**
- **Temperature is proportional to the flow rate (simulation result**
- **Keep GL optimized all the time**

rface temperature
ree temperature
uid flow rate

PROCAP 3000


Delay analysis chart
Flow rate [m3/h]
Temperature [oC]
Time
60
50
40
30
20
10
0
41
40.5
40
39.5
39
38.5
38
37.5
37
36.5
36
35.5
2:53:23 PM
3:00:39 PM
3:07:56 PM
3:15:14 PM
3:22:29 PM
3:29:47 PM
3:37:06 PM
3:44:21 PM
3:51:35 PM
3:58:49 PM
4:06:05 PM
4:13:19 PM
4:20:33 PM
4:27:47 PM
4:35:02 PM
4:42:17 PM
4:49:32 PM
4:56:45 PM
5:04:01 PM
5:11:16 PM
5:34:46 PM
5:42:03 PM
5:49:20 PM
5:56:36 PM
6:03:51 PM
6:11:07 PM
6:18:23 PM
6:25:37 PM
6:32:52 PM
6:40:07 PM
6:47:23 PM
6:54:38 PM


ADSPETRO V0.61 - Usuário CSOR - [Análise e Supervisão de Poços]
Arquivo
Configurações
Funções
SUPERVISORY INFORMATION
WING
ABERTA
Pcab
[kgf/cm²]
SP
Prev
[kgf/cm²]
Tgl
[°C]
Qgi
[Sm³/d]
Pgl
[kgf/cm²]
Controle Qgi
[%]
Pls
[kgf/cm²]
Rádio
ZAP
Ref
Tffp
[°C]
Pffp
[kgf/cm²]
PAINEL DE CONTROLE
Estado do Poço
LIGADO
Desligar
Modo de Operação
AUTOMÁTICO
Manual
PID de Prev
ATIVO
PID de Qgi
INATIVO
Válvula de Controle
100,0
%
Iniciar
Adspetro_cliente
Gas Lift
Microsoft PowerPoint - [S...
Explorer.EXE - Erro de aplicat...
PT



- Gas Lift Riser Base Injection
- Erosional Velocity – Bench Tests in Atalaia
- New Venturi Developments