The Use of Subsea Gas-Lift in Deepwater Applications

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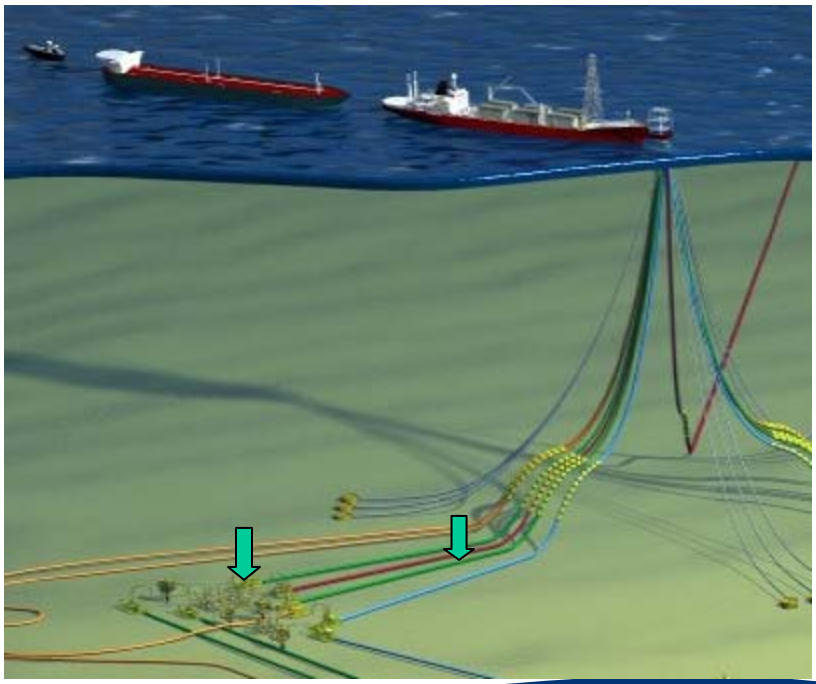
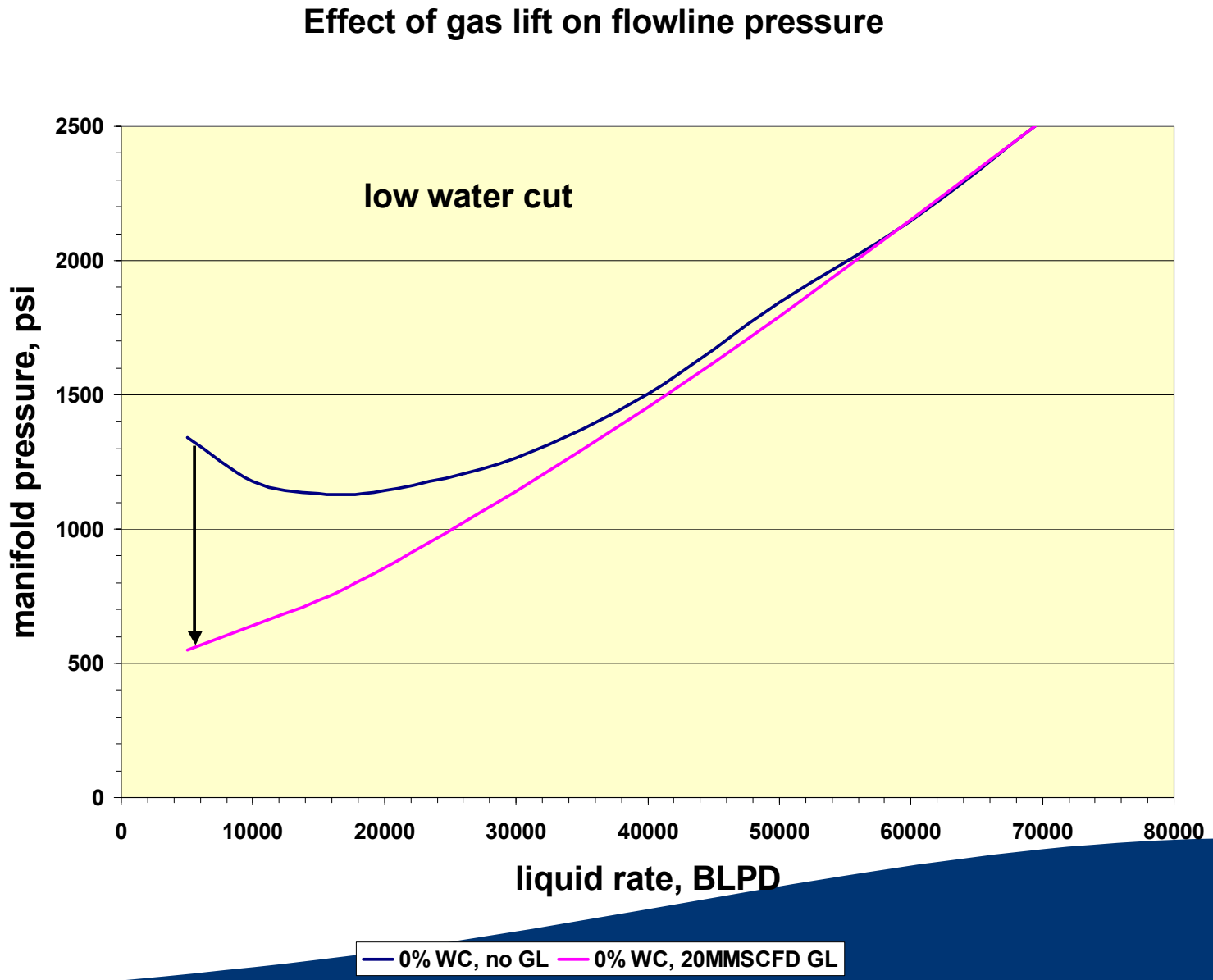


Why Gas-Lift is Needed - Production enhancement



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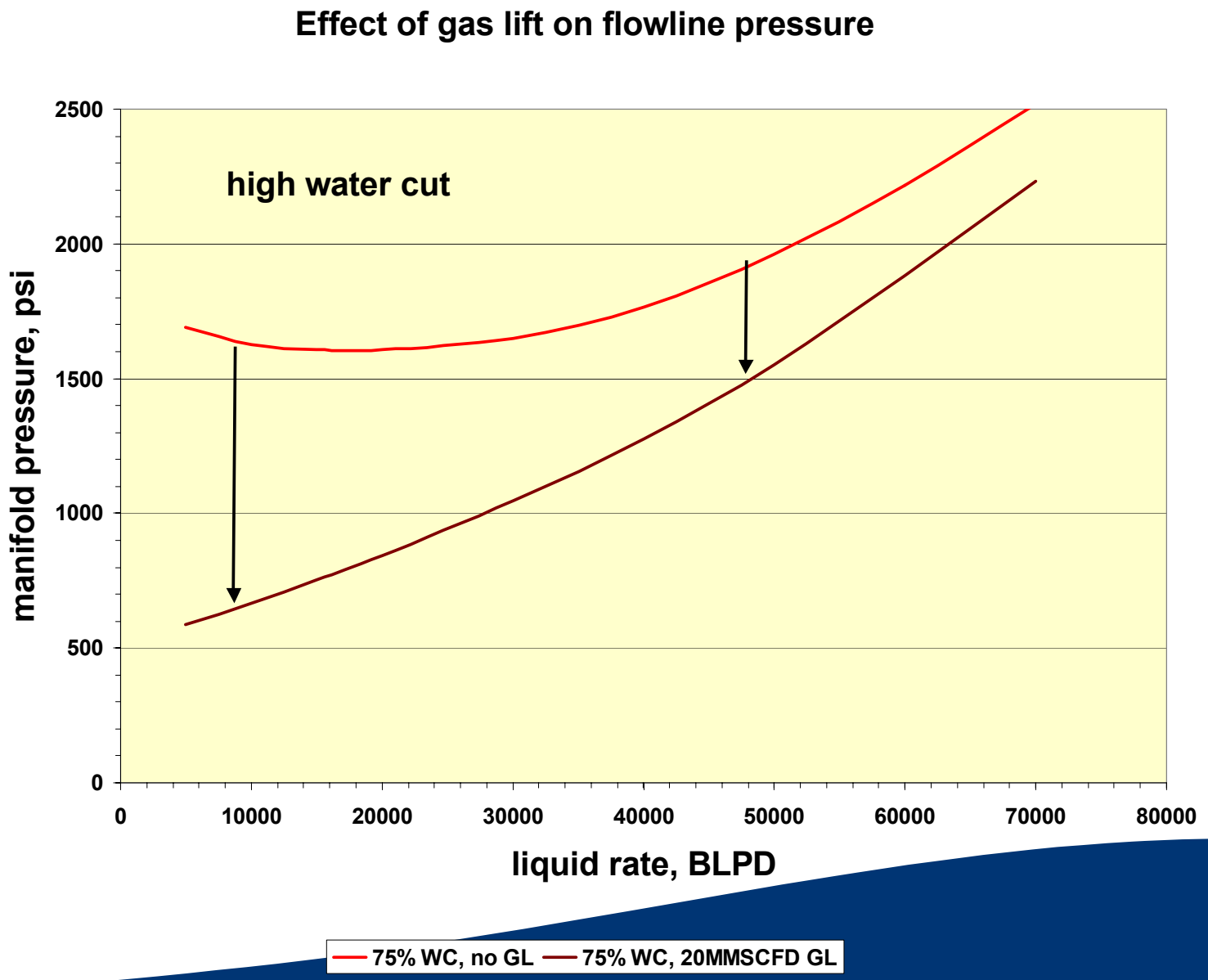

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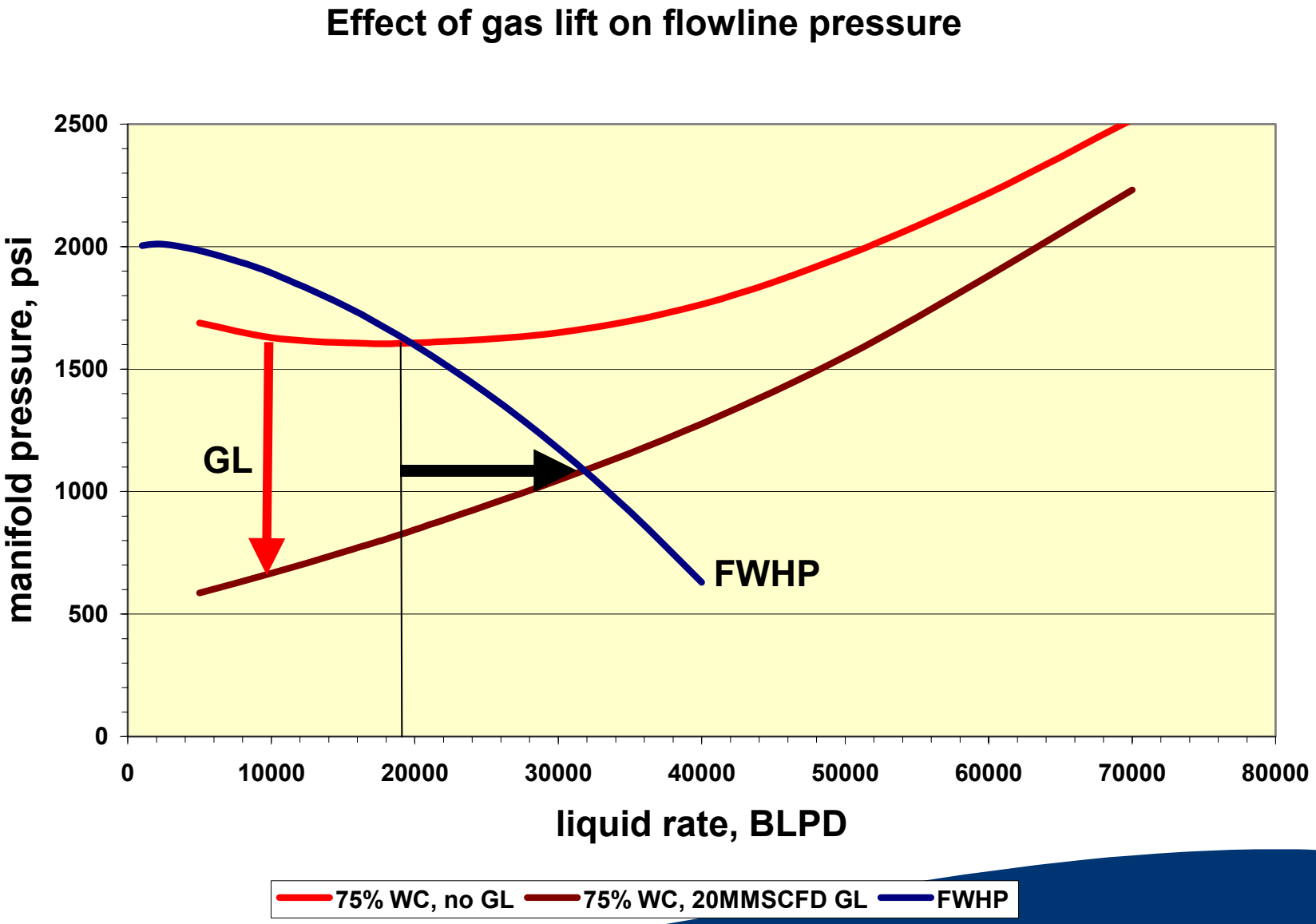
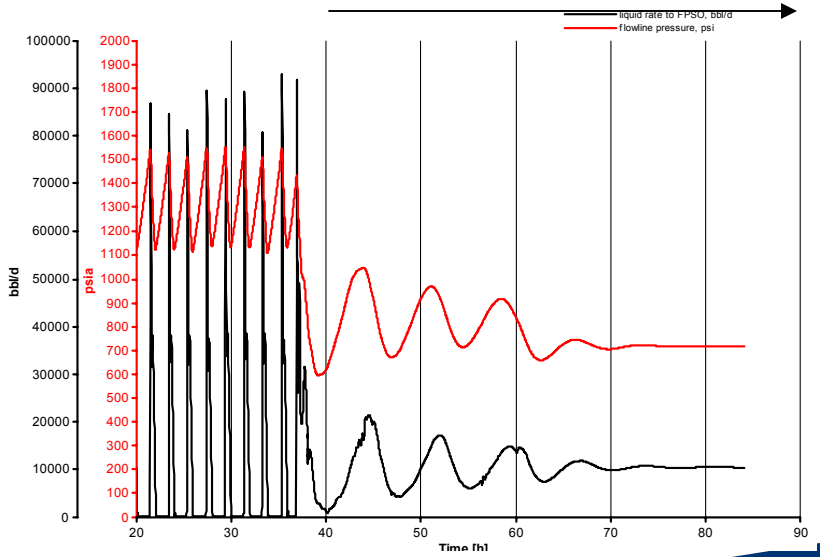


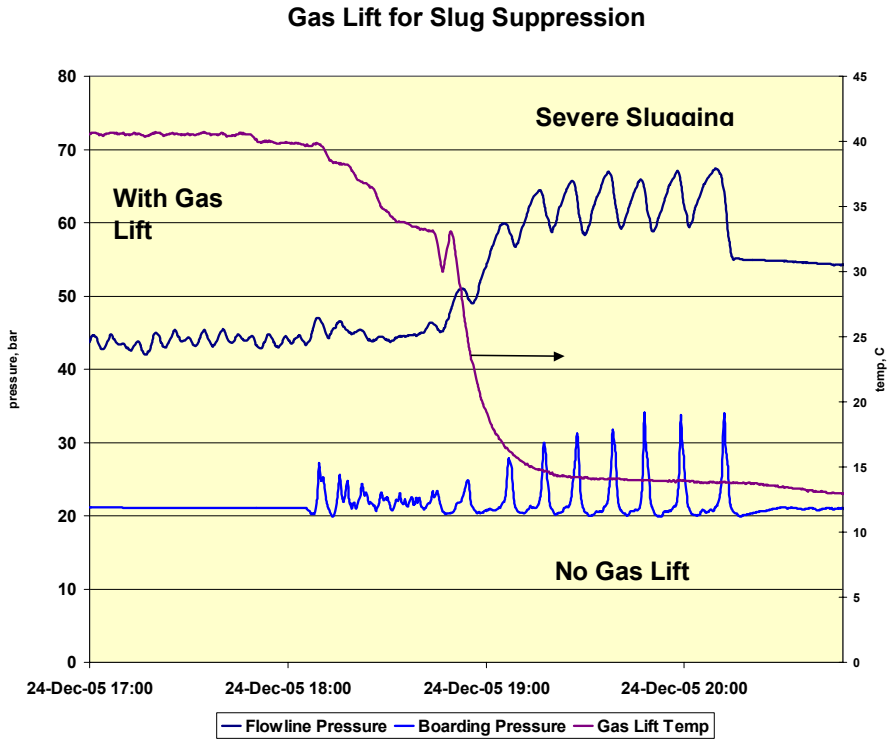
Why Gas-Lift is Needed - Flow stabilization

OLGA results

Flow rate to host & flowline pressure

No GL ← **With GL** →



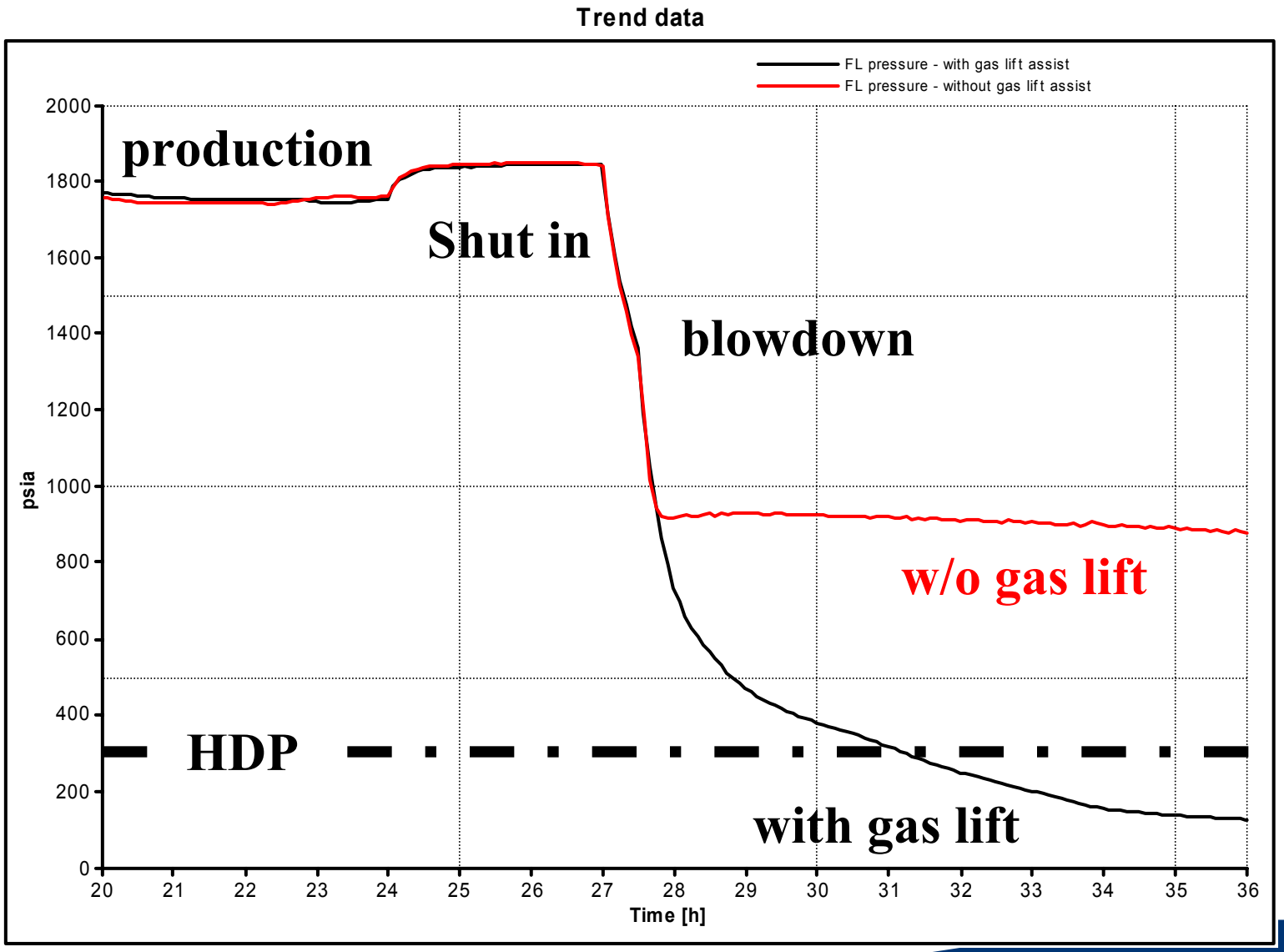


Field Data

pressures

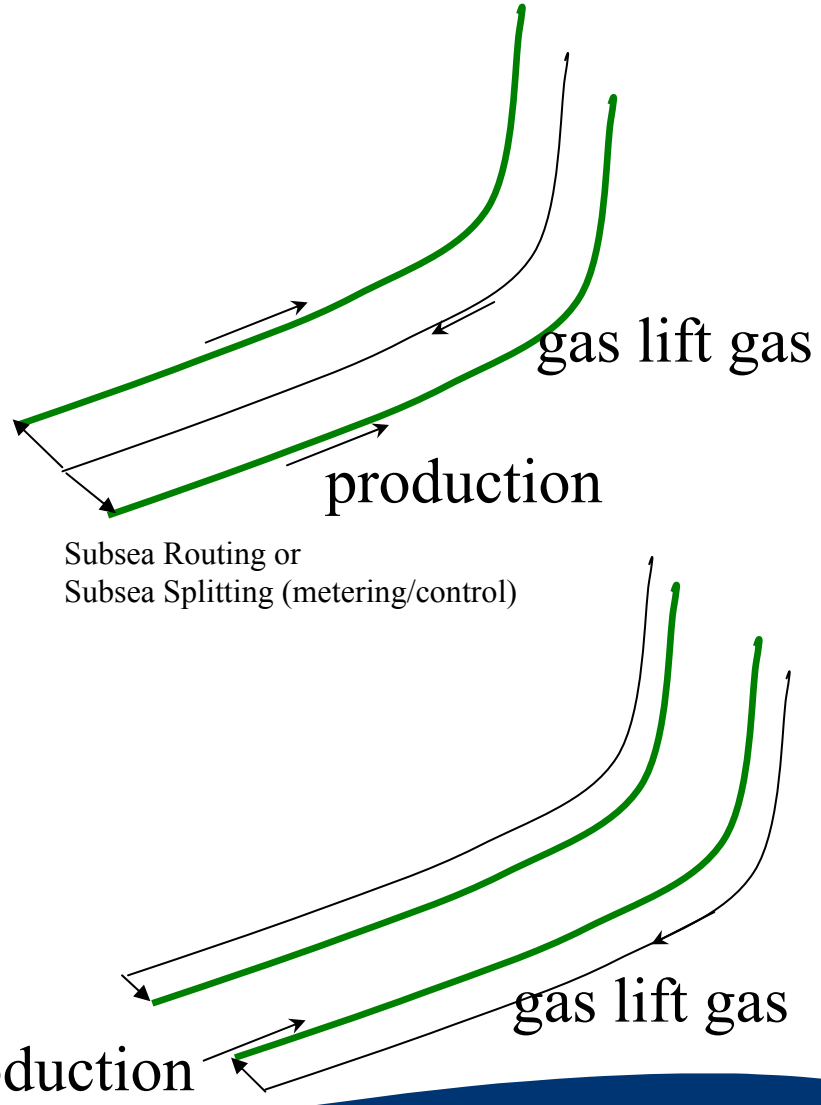
w/ & w/o gas lift

Why Gas-Lift is Needed - Flowline depressurization



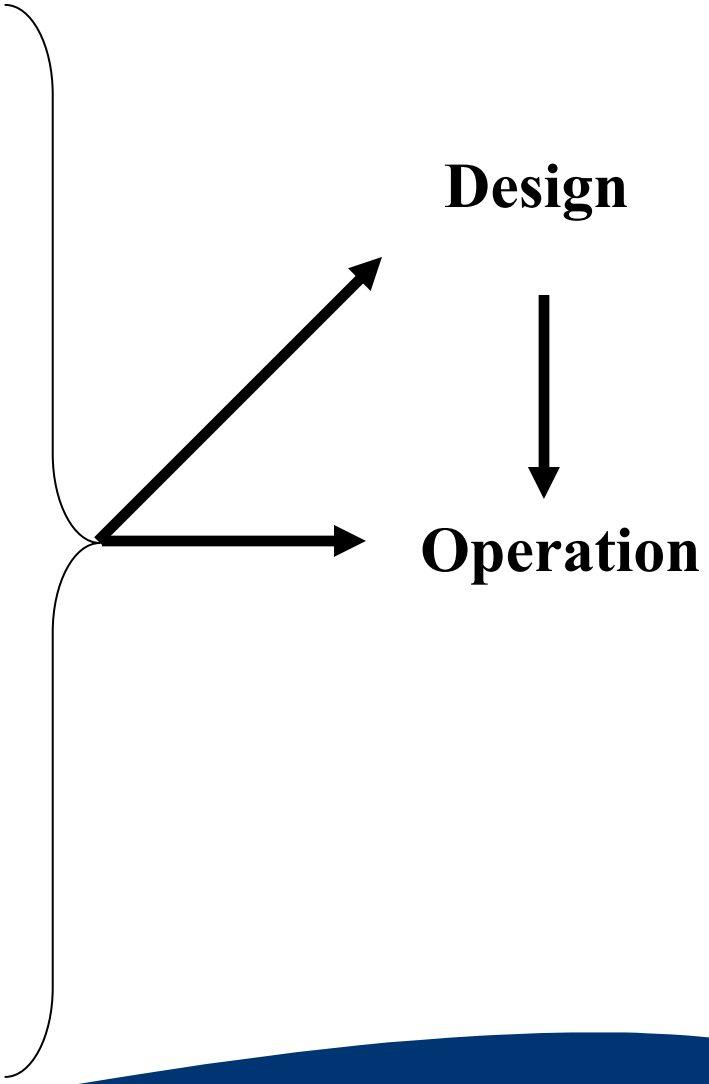
Gas Lift Delivery System Design

- Shared Gas Lift Risers
  - Uses of gas lift
  - Flowline operating conditions
  - Host limitations
- Gas Lift Injection Location
  - Geometry (FL, well location)
  - Uncertainty of reservoir performance
  - Blowdown
- Insulation
  - Cooldown time
- Cost Considerations



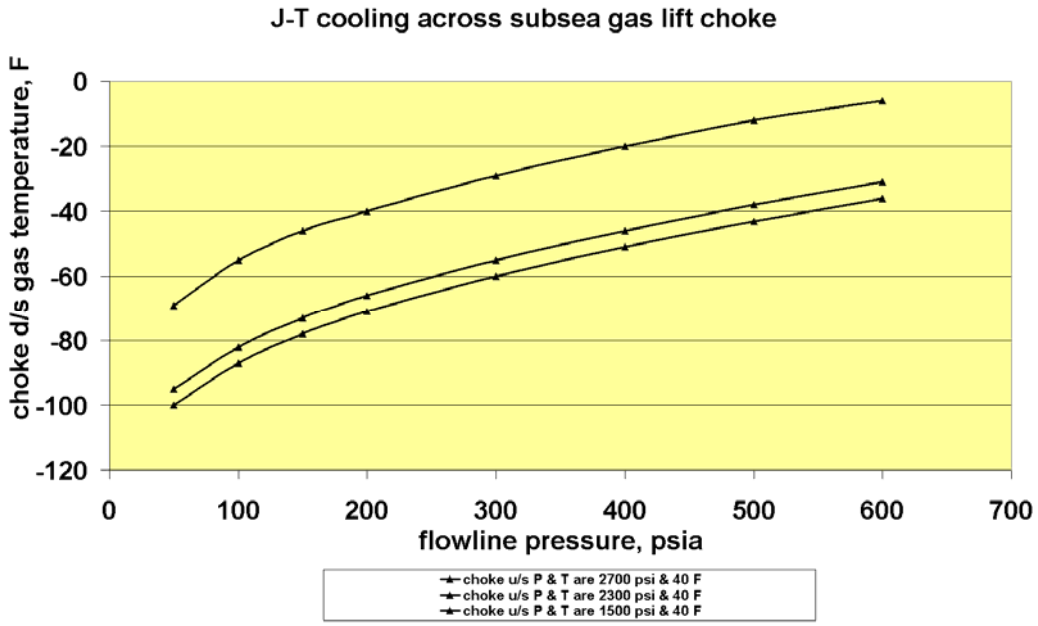
Operating Envelope

- GL Rate Needed (how much and when)
  - Production enhancement
  - Flow stabilization
  - Depressurization
- Source of lift gas
- Available pressure and temperature
  - Heating & compression
- Flowline Pressure
  - With and without gas lift
  - Dead oil filled
- Cooldown time considerations
- Consider all credible scenarios



Flow Assurance Concerns

- Hydrates in GL system
  - Prevention
  - Remediation
- Asphaltene Destabilization
- Thermal Considerations
  - Arrival Temperature
  - Cooldown time
- Slugging
- Erosion in flowline
- Available Gas - quality
- Low Temperature Concerns – J-T cooling
  - Engineering and procedural solutions



Case Studies

case	status	WD ft	FL Geometry	water inj	Gas-Reinj
1a	producing	6000	uphill	no	no
1b	producing	6000	downhill	no	no
2	producing	3000	uphill (with dip)	yes	no
3	design	3000	uphill	yes	no
4	design	3000	mixed	yes	no
5	producing	3500	uphill	yes	no
6	design	4500	downhill	yes	yes

Selected Solutions

case	FL Geometry	water inj	Gas-Reinj	location	shared	insulated	when
1a	uphill	no	no	RB	yes *	?	when needed
1b	downhill	no	no	RB/sled	no	yes/no	first oil
2	uphill (with dip)	yes	no	RB	no	yes	first oil
3	uphill	yes	no	manifold	yes	yes	first oil
4	mixed	yes	no	RB	no ?	yes	first oil
5	uphill	yes	no	manifold	?	yes	when needed
6	downhill	yes	yes	manifold	?	yes	when needed

- Location
  - Well & host locations, flowline size and uncertainties about production rates
- Shared vs. dedicated
  - Host limitations, flowline geometry
- Insulation
  - Arrival temperature and cooldown time, reservoir temperatures
- Timing
  - Uncertainty about gas-to-liquid ratio, uses of gas lift

Systems Suitable for Gas-lift

- Oil systems
- High water cut and/or low GOR → GLR < 500 scf/STB
- High water depth → 3000 to 6000+ ft
  - Watch for J-T cooling
- Downhill flowlines
- Some Uphill flowlines
- Low to moderate viscosities

Conclusions

- There is no *one size fits all* design of gas lift system.
- Need for integrated subsurface – flowline modeling over the field life
  - Accurate modeling of multiphase flow in large diameter, deepwater risers
  - Understand the uncertainties about the reservoir performance
- Defining the operating envelope of gas lift system – include all credible scenarios.
- Shared gas lift risers are possible, but not always.