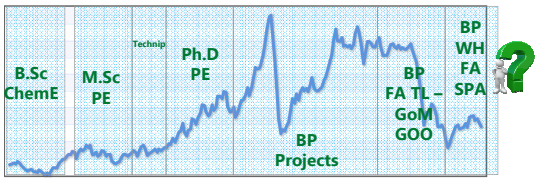
Upstream **Engineering**

Chronicles of a FA engineer in GoM Operations

Oris C. Hernandez
09/13/2017

About Me



What I have learned from that Journey:

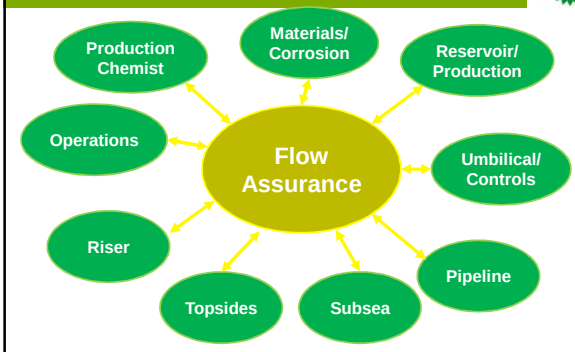
- Adapt to the environment, lots of things outside of your control, be creative!
  - Moving to US, pursuing M.Sc and Ph.D
- Ask, because you never know when you are going to get it
  - Financial aid for graduate school
  - FA TL role
- Don't be afraid of challenges, that's when you really grow
- Be nice to everyone, don't burn bridges!
  - After 13 years from leaving Technip, I report to the same person now at BP
- Work hard!!!!!!!

What is the role of Flow Assurance (FA) in Operations?

- **Interfacing** with asset teams and Contractors to assess the impact of **changing conditions**, new wells, workovers, interventions, and subsea tiebacks on existing systems.
- Providing technical support for and **monitoring** and evaluating of flow data, to confirm the risers and flow-lines are being operated and are performing within **design limits** or to **identify any anomalies**.
- Supporting BP's **engineering** application of tools and design methods for multiphase flow, in the context of FA, through delivering and directly managing modeling of **relevant flow scenarios**, and reviewing such scenarios on behalf of the GoM region when completed by contractors.
- **Engaging key stakeholders** as appropriate to convey understanding of multiphase flow and its relevance to their context (e.g. background to operating procedures, integrity management, control of systems, plant operating support tools) → **understand FA risks**
- Reviewing, updating and applying **FA strategies** of each system to **prevent line blockages and minimize operating downtime** as conditions change through field life.
- Providing FA operating philosophy to be executed by others i.e. chemical or operational requirements for FA both for steady state and transient conditions (start-up and shut-down)

BP Internal

Who do we interface with?



BP Internal

Where to start? Or how do you eat an elephant?

- Understand biggest risk / deferrals
  - Focused on hydrates in the beginning
- Understand your organization
  - Key interfaces / stakeholders
  - Threat ownership

Hydrates Decide Right

	STRATEGY				EXECUTION			
	Chemical Barrier	Mech. / Other Barrier	Plant / Facilities Barrier	Res. / Wells Barrier	Chemical Barrier	Mech. / Other Barrier	Plant / Facilities Barrier	Res. / Wells Barrier
THREAT								
Hydrate	PC	FA (OTO)	ES / SS[2]	N/A	Area	Area	Area	N/A

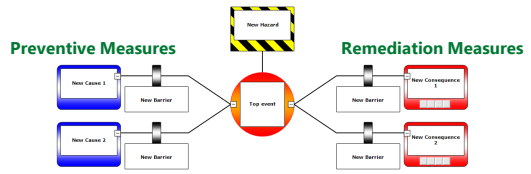
OTO = OVERALL THREAT OWNER responsible for strategy integration

[2] ES = topsides equipment / vessels, hardware, SS = SS equipment, hardware

BP Internal

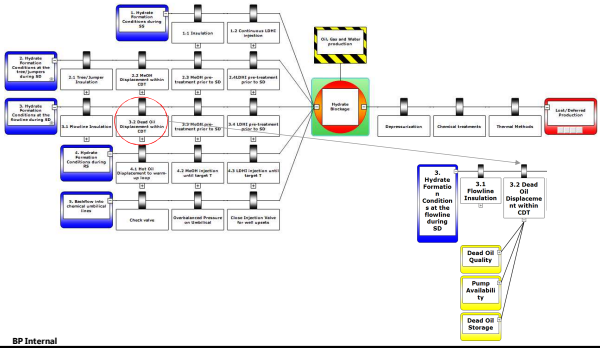
Expect what you Inspect – what to monitor?

- Bowties as a communication tool
- Methodology used for risk assessment to communicate risk in one easy picture
- Barriers are physical risk reduction measures intended to prevent the incident from occurring, control its impact or frequency and/or mitigate its effect on people, the environment or our business
- Each barrier should be **independent and fully functional** → by itself should be able to completely stop a risk scenario from developing



Bowtie Model applied to Hydrate Risk

- Bowties as a communication tool



Expect what you Inspect – what to monitor?

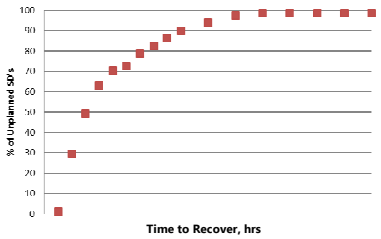
Cause	Barrier	KPI	Target	Dec	Jan	Feb	Mar	Apr	May
General		Hydrate Strategy Document	G: Doc. Valid (2 yr review) R: Doc. Out of review						
2. SD for Trees/Jumpers	2.1 Tree/Jumper Insulation	Tree CDT	G: Predicted CDT > Current CDT R: Predicted CDT < Current CDT						
	2.2 MeOH Displacement	MeOH injected within CDT	G: within Actual CDT R: beyond Actual CDT						
		MeOH Pumps / Umbilicals Availability	G: no known issues						
	2.3 MeOH pre-treatment	MeOH availability	G: 0.95 < actual rate/target rate < 1.05+ R: < 0.95	N/A	N/A	N/A	N/A	N/A	N/A
		MeOH Hydraulics	G: All wells can be pre-treated R: 1 or more wells cannot be pre-treated						
	2.4 LDHI pre-treatment	LDHI availability	G: 0.95 < actual rate/target rate < 1.05+ R: < 0.95	N/A	N/A	N/A	N/A	N/A	N/A
		LDHI effectiveness	G: No wells above LDHI limit in 6 months forecast Y: 1 or more wells potential to exceed it within 6 months R: 1 or more wells above LDHI limit						
		LDHI Hydraulics	G: All wells can be pre-treated R: 1 or more wells cannot be pre-treated						
		LDHI Pumps / Umbilicals Availability	G: no known issues						
3. SD for Flowlines	3.2 Dead Oil Displacement	DOD within CDT	G: within CDT R: beyond CDT	N/A	N/A	N/A	N/A		
		Dead Oil QA/QC	G: Water content > limit R: Water content < limit						
		DOD Pumps / Umbilical Availability	G: No known issues						
		Storage	G: Volume above target R: Volume below target						
		Dead Oil Rate	G: Q > 25 mbpd R: Q < 25 mbpd	N/A	N/A	N/A	N/A	N/A	N/A
	3.3 MeOH pre-treatment	MeOH availability	G: 0.95 < actual rate/target rate < 1.05+ R: < 0.95	N/A	N/A	N/A	N/A	N/A	N/A
		MeOH Hydraulics	G: All wells can be pre-treated R: 1 or more wells cannot be pre-treated						
	3.4 LDHI pre-treatment	LDHI availability	G: 0.95 < actual rate/target rate < 1.05+ R: < 0.95	N/A	N/A	N/A	N/A	N/A	N/A
		LDHI effectiveness	G: No wells above LDHI limit in 6 months forecast Y: 1 or more wells potential to exceed it within 6 months R: 1 or more wells above LDHI limit						
		LDHI Hydraulics	G: All wells can be pre-treated R: 1 or more wells cannot be pre-treated						
		LDHI Pumps / Umbilicals Availability	G: no known issues						

Where to start (cont…)

- Understand your models
  - Control models!
- Understand your procedures
  - Are Operators following the procedures?
  - Do procedures make sense?
  - Key Performance Indicator (KPIs)!!!!!
- Develop and maintain FA strategies → and then update procedures
- Procedures, Strategies, KPI's are evergreen, need to be updated depending on how things change
- Communicate, communicate & then communicate some more
  - Once strategies & procedures are up-to-date, make sure EVERYONE that needs to know, REALLY KNOWS … particularly when risk events are low frequency
- Statistics don't always help in FA:
  - Your KPI may have been green 99% of the time, what happens if it fails once?

BP Internal

Speaking of statistics…

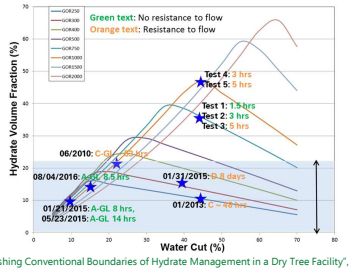


- For a large proportion of unplanned shutdowns, our platforms can recover (restart production or perform dead oil displacement) within a short time frame
- We still need to be prepared and design for that small proportion of instances where we can exceed cooldown time
  - Low probability / High Consequence Scenario

BP Internal

Some lessons: Reaching CDT doesn't always mean trouble

- **Dry tree facility where we have been moving from a hydrate avoidance to hydrate management**
- **Very short cooldown times**
- **Historical instances (planned and unplanned) → full hydrate blockages do not form when fluids have WC and GOR with predicted hydrate volume fraction below 20%.**



Ref: Kurup et al, "Pushing Conventional Boundaries of Hydrate Management in a Dry Tree Facility", OTC-27780, 2017

BP Internal

Some lessons: valves leak!

- Hydrate incidents in non-producing jumpers
- Dead oil displacement or MeOH used to safe out the jumper for setting the dead leg
- A few months later, when attempting to re-instate production through that jumper, a hydrate blockage has been found
- Typically remediated "easily" with MeOH injection

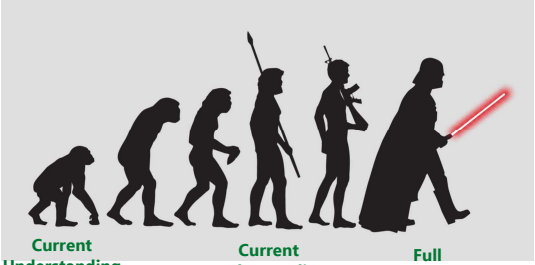
Check valves:

- Have had issues of blockages in umbilicals due to backflow of production fluids, even hydrated MeOH lines

Some lessons: hydrates **can** form under SD conditions

- Hydrates in dead leg jumpers
- System treated with LDHI (AA) but beyond maximum water cut qualification limit (tight emulsion?)
  - When attempting to restart after a month, hydrate was already there
- System treated with dead oil, but not enough dead oil volume
  - 2 days after we thought the system was hydrate-safe, again hydrate was there
- Emulsion properties of the system play a big part in hydrate blockage formation

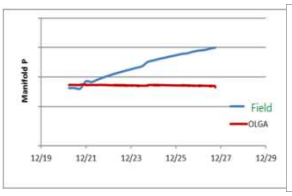
Understanding of blockages

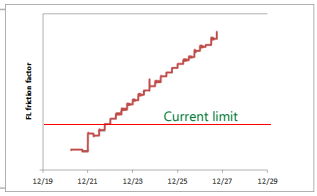


Picture Source: https://worldviewofjesus.files.wordpress.com/2015/02/evolution.jpg

Monitoring for solids deposition

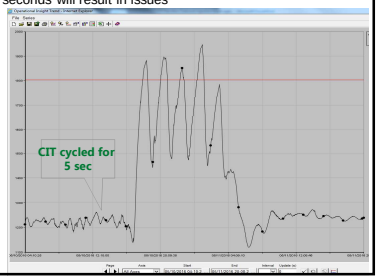
- DP in the line increased over 1000 psi in less than a week
- Since then we monitor FF = DP friction (field)/DP friction (model)
- Based on this incident, we have set limits
- We use this limit to determine when to pig the line or perform xylene soaks in the well
  - Constant challenge with balancing the risk of stuck pig and deferrals associated with pigging & well being down for xylene soak





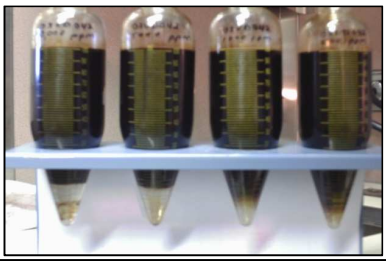
Some tricky problems: CI impact on water separation

- Mature field, with wells that experience difficulty to unload post shutdown
- Riser/flowline would be flowing steadily, and when attempting to restart corrosion inhibitor injection (CI), the riser will load up and result in flow instability and ultimately shut-in of the well
- Cycling the valve for as short as 5 seconds will result in issues
  - Inability to handle slugging sometimes leads to shut-in of the riser, dead oil circulation, difficult to restart the wells
    → production deferrals
  - loss of corrosion inhibitor injection could potentially affect the pipeline integrity (corrosion engineers not happy..)

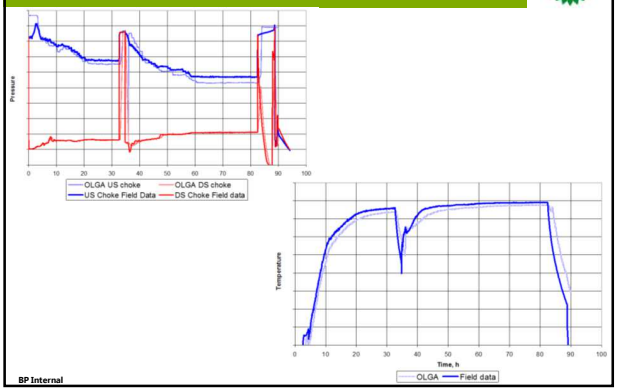


Some tricky problems: CI impact on water separation

- Because of sub-ambient pressures, umbilical is overbalanced, opening the valve even for a few seconds results in a surge of chemical into the flowline → very high concentrations of CI, much higher than normal operation
- High concentrations of CI result in water drop out in the riser, because of relatively low flow rates water struggles to flow up the riser → loading

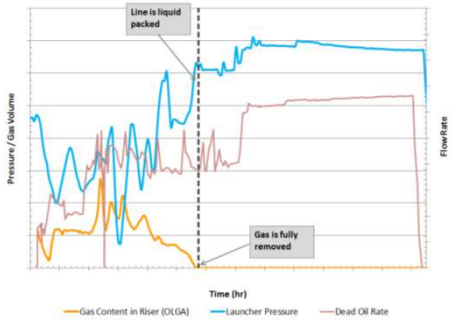


When OLGA is good, it is good! – P, T benchmark



BP Internal

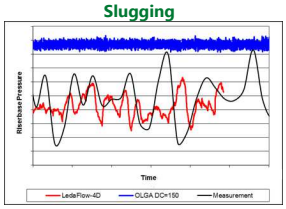
When OLGA is good, it is good! – Degassing time



BP Internal

But when OLGA fails ……

Slugging



- Water sweep is overestimated
- MeOH displacement, OLGA predicts piston like displacement, no mixing with the water phase
- JT heating across perforations → OLGA does not consider heat loss to the soil

OLGA is a tool, not the end all be all …

BP Internal

Typical day of a FA engineer in Ops

- Monitor KPI's
- Work with cross discipline teams on potential upcoming activities → things are always changing (new wells added, wells offline, equipment unavailable, re-routing)
- Participate in risk assessments for upcoming operations
- Improve monitoring tools
- Update FA strategies
- Share lessons with others in FA Community

What do you need to be successful?

- Be quick on your feet
- Communicate effectively with others
- Be proactive
- Be restless
- Be creative and challenge the "we've always done it this way", when needed
- Be outspoken

Concluding Remarks

- FA designs are typically conservative, for good reason!
  - In operations we will push the design much further than what was originally envisioned
  - Design conservatism has allowed us to "get away" with some potentially sticky situations
- Valves leak
- Bowties are very effective communication tools
- Document, Document, Document
- Learn from every incident
  - What you don't learn now will come back to haunt you later
- It takes a village, flow assurance strategies require interfaces with a lot of people
- Be nice to EVERYONE!!!