



Marginal and Mature Field Development and Operation

6 – 7 August 2024 | KUALA LUMPUR, MALAYSIA

New Water Injection Technology in An Integrated Asset Life Extension of BB Mature Field

Sriyanta Hadi, PhD

Setia Ak Dana



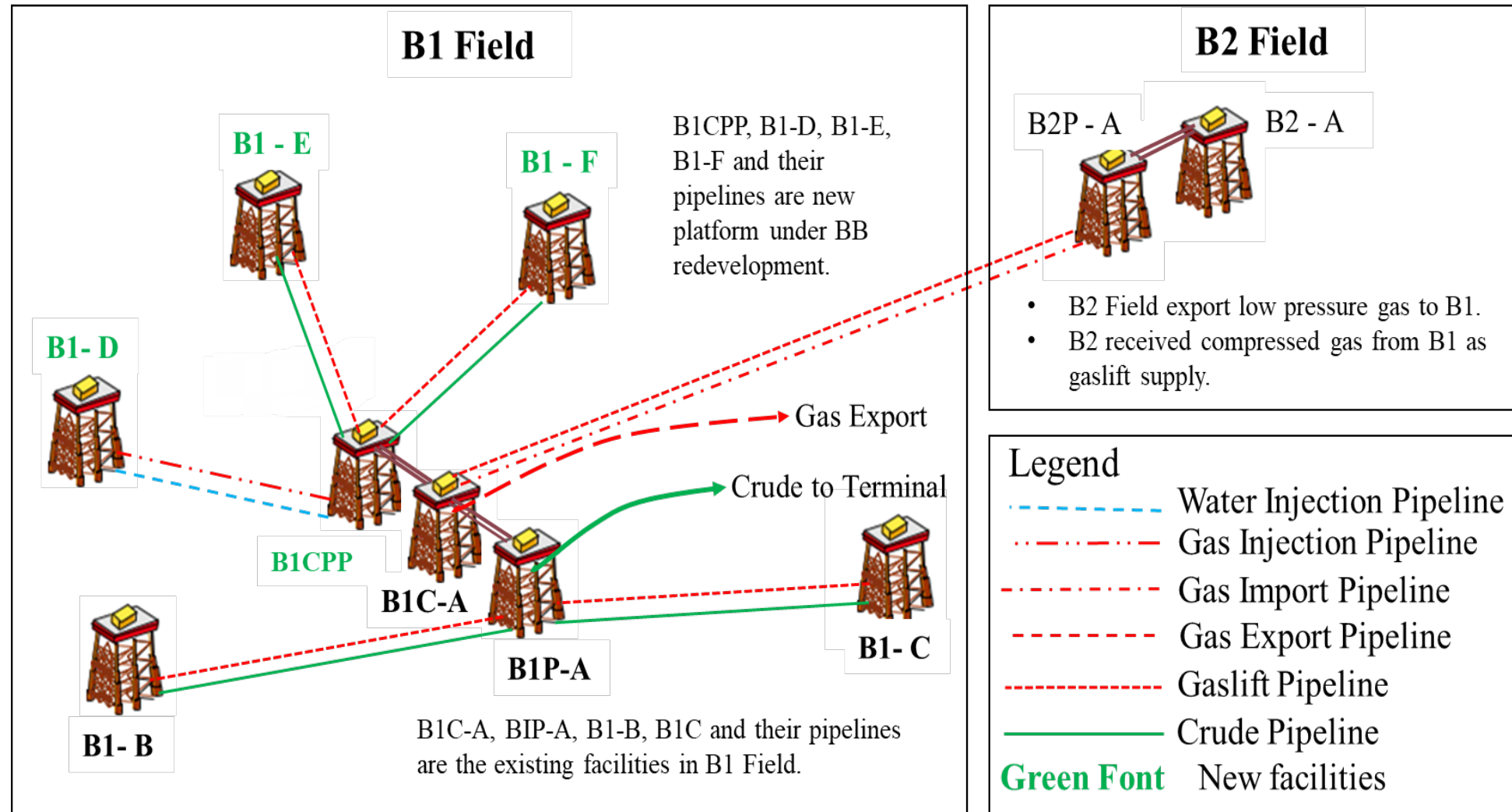
Introduction

BB Field is in Sarawak Water, managed under Sarawak Operations (SKO), PETRONAS Carigali Sdn Bhd (PCSB)



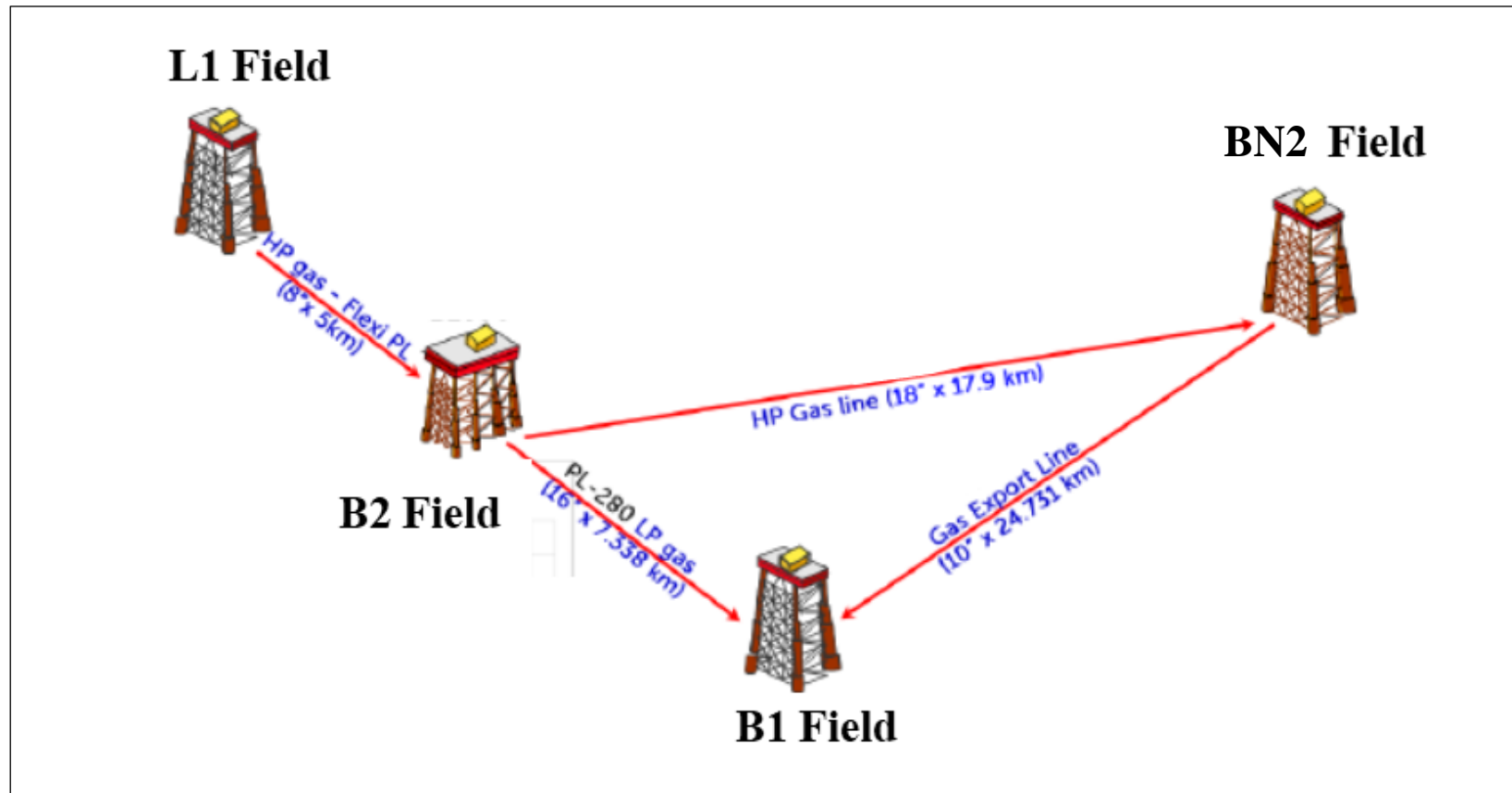
- BB field is field complex, under a Production Sharing Contract (PSC) block that operated by PETRONAS Carigali Sdn Bhd (PCSB).
- The field has been producing since 1980s.
- Immiscible Water Alternate Gas (IWAG) EOR is implemented for BB field.

BB Integrated Redevelopment



BB Integrated Redevelopment

Possible Gas Supply for B1 IWAG



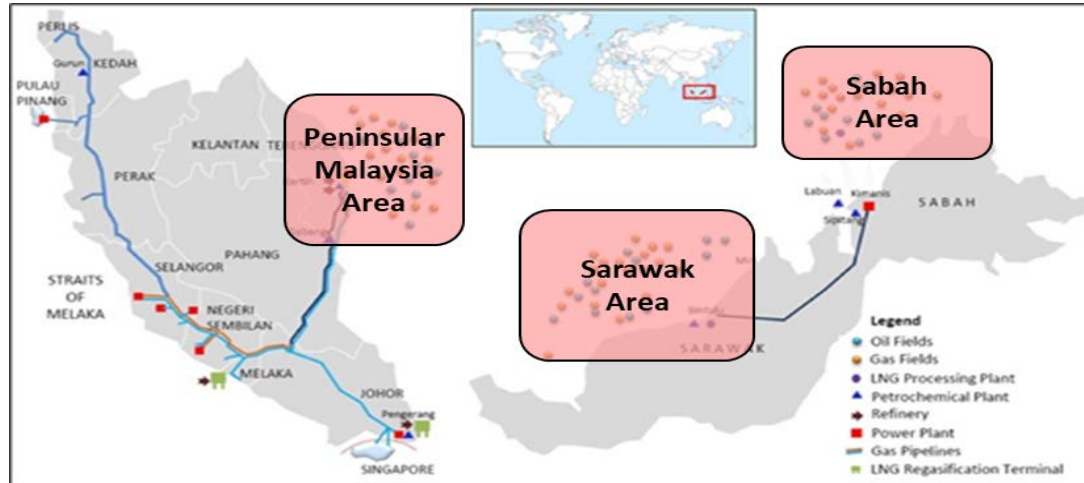
BB Integrated Redevelopment

No	Category	Descriptions
1	New Central Processing Plant (CPP)	<ol style="list-style-type: none"> 120 KBD - three phase separation process. 90 MMscfd - gas compression (60 mmscfd sales, 20 mmscfd gas injection, 10 mmscfd GL). Gas dehydration system. 80 kbpd - produced water treatment for disposal. 40 kbpd - crude export system. 60 kbpd - sea water treatment for water injection. Flare system
2	Production and Injection Platforms	<ol style="list-style-type: none"> 2 new production platforms for infill wells: B1-E and B1-F. 1 new injection platform: B1-D.
3	Infill Wells	<ol style="list-style-type: none"> Phase 1 drilling campaign : 10 oil producers. Phase 2 drilling campaign : 13 oil producers and 4 water injectors.
4	Pipelines	6 segment of new intra-field pipelines connecting new CPP and production and injection platform for flowing produced fluids, gaslift, gas injection and water injection.
5	Living quarters	Living quarters, 98 (ninety-eight) personnel on board (POB) capacity to cater Western Cluster Operation in SKO.

Water Injection

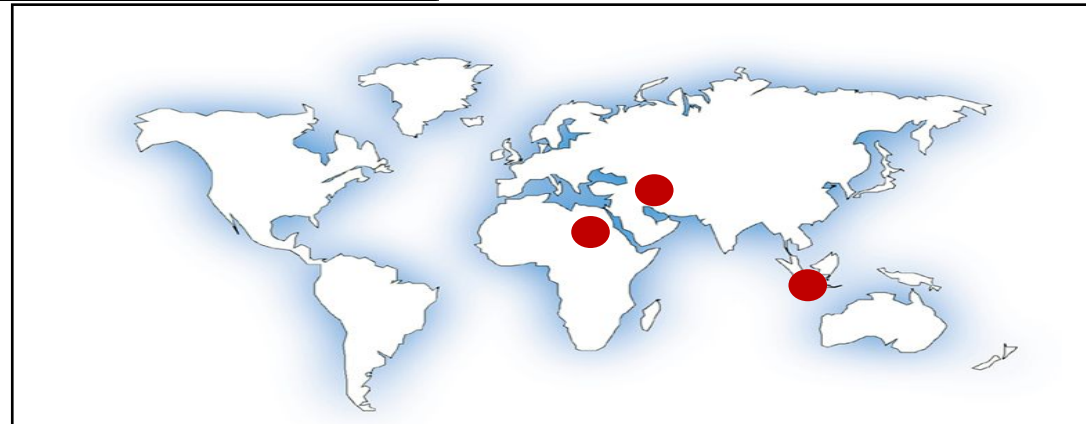
- Water injection is an effective method and widely applied to improve oil recovery through **maintaining reservoir pressure** and **improving oil sweeping and/or displacement** (Mandal et al., 2018; Hadi et al., 2019; Hadi et al., 2008; Hadi et al., 2013).
 - **30 oil fields** in PETRONAS (Malaysia Assets, International Assets & OBOs)
 - Onshore and offshore operations
 - Green and brown fields
 - Self operated WIMs
 - **3** Supplier operated WIMs (Portable and MOPU/PWIF)

Water Injection in PETRONAS

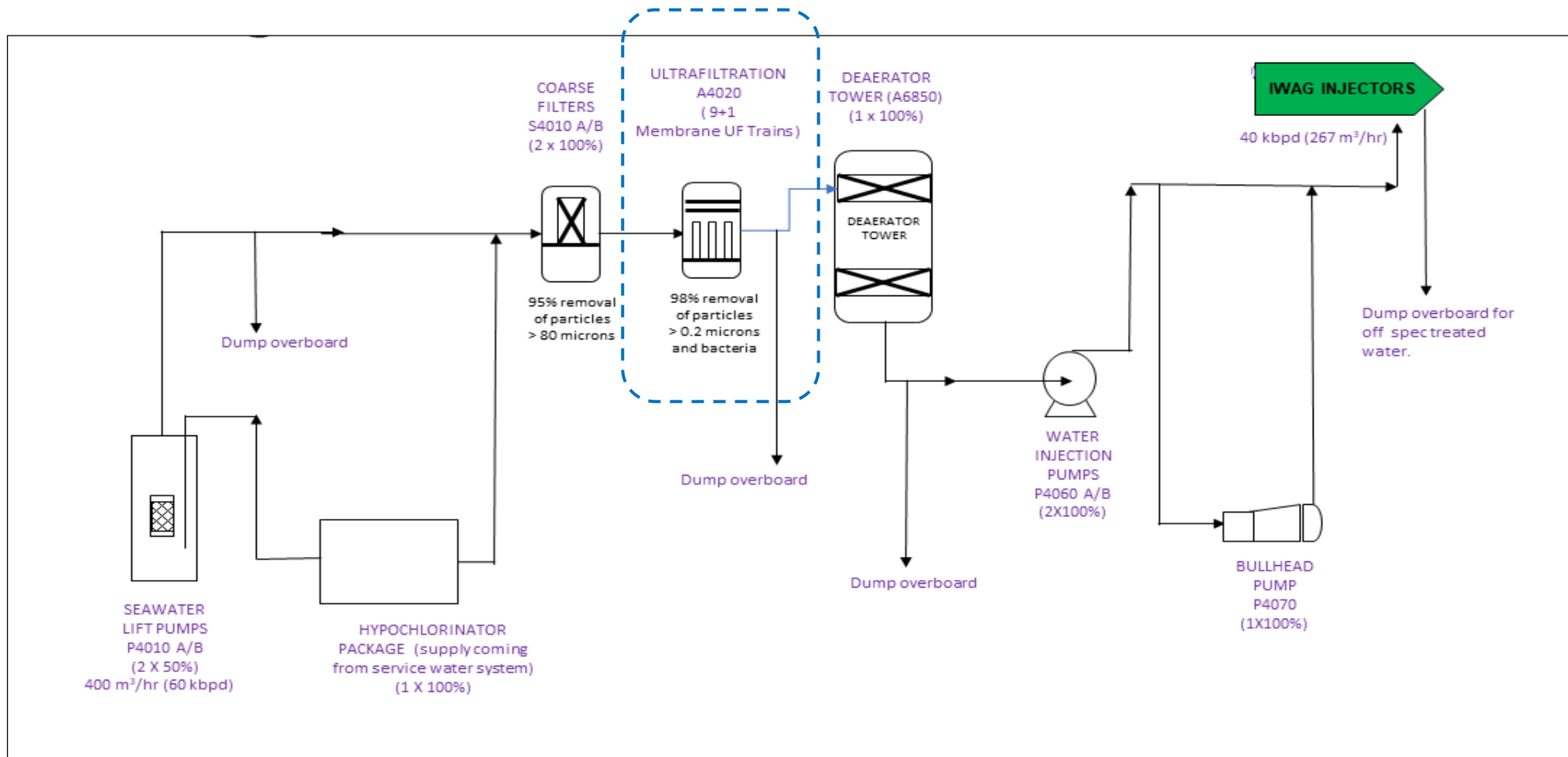


- Number of water injection operations increases from 3 to 30 (1990-2024)
- In total water injection rate increased up to 800 KBWD

Water injection operations in International Assets (IA)



Ultrafiltration for Water Injection



Water Injection Specification

No	Item	Raw Water	Injectable water specification	Actual	Analysis Method
1	Particle count* of < 2 μ particle size	400 – 30000/ml (seasonal)	< 300 per ml	< 100	Coulter Counter
2	Dissolved O ₂ (ppb)	7000-9000 ppb	< 10 ppb	< 5 ppb	Chemetric Method
3	Total iron (mg/l)	N/A	< 0.5	0.1 – 0.3	Hach Method 8008
4	pH	6.5 – 7.0	6.5 – 8.5	8.1	pH meter
5	SRB Count	> 10 ³	< 10 ³	10 ²	Culture Media
6	Residual Sulfate*(ppm)	N/A	< 5ppm	2-3 ppm	Chemetric method

* Slop Test is an alternative

- Surface water injection operations is to **provide quality water injection required** by subsurface.
- Water specification is determined by **Core Flood Test**.
- Water quality** determines whether the water are injectable or not.

Ultrafiltration: critical operations

UF membranes are typically made up of polyvinylidene fluoride (PVDF) or poly-sulfone with low nominal pore size, e.g. 0.02 micron.

No	Operation	Description
1	Filtration	Filtration using membrane made of polyvinylidene fluoride (PVDF) or poly-sulfone with nominal pore size is 0.02 micron
2	Backwash	Backwash is set every 1 hour automatically. It takes 20 seconds for once complete backwash.
3	Chemical Enhanced Backwash (CEB)	After 23 backwash cycles, CEB will be initiated automatically. It takes 45 minutes operation. Clean water and Caustic Soda and Sulfuric Acid are required.
4	Clean in Place (CIP)	When backwash and CEB are ineffective to recover the performance due to fouling on the membrane. Decrease of permeability and Trans Membrane Pressure (TMP) are the indicator for CIP. Citric Acid is used for CIP.

Challenges

No	Category	Challenges	Efforts/Mitigations
1	People	New Technology : New Knowledge and Skill.	<ol style="list-style-type: none"> 1. Upskilling as soon as possible to anticipate problems during commissioning and operations. 2. Get involvement of key and operation personnel from early stage. 3. In-house training for production operators.
2	Technology	New Technology in the region, even in the oil and gas industry.	<ol style="list-style-type: none"> 1. Identify critical operations and anticipate it with reliable control design. 2. Pre-assessment to anticipate the problems. 3. Supply chain of consumable material/stuff. 4. Manage technical support from technical principal.
3	Work Process	Guideline/Governance.	<ol style="list-style-type: none"> 1. Replicate best practices from available operations. 2. Establish procedures from early stage.
		Collaborative working environment (CWE)	<ol style="list-style-type: none"> 1. Understanding the collaborative working environment concept and practice it. 2. Campaign on CWE.

Learn from possible sources



Onshore operations of Ultrafiltration technology application for cooling water maker in a power plant and municipal desalination water treatment plant.



Keys Take Away

1. Integrated field redevelopment may involve many things such drilling, processing, water injection, gas injection, etc.
2. Implementation of a new technology may be chosen to have the best operations to achieve the common objective.
3. Challenges of new technology implementation need to be identified. Mitigation plan in three areas: people, work process and technology shall be developed accordingly.
4. Adapt and practice collaborative working environment (CWE) among involved parties.
5. Creativity in providing solutions for marginal and mature field is required to make the project feasible.

Acknowledgment

The author would like to thank PETRONAS, PETRONAS Carigali Sendirian Berhad (PCSB), and the Malaysia Petroleum Management (MPM) for permission to publish this paper. The author would like to appreciate the collaboration work that involves the Asset.



[\[Open\]](#)



Thank You

