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Society of Petroleum Engineers

SPE workshop

Gas Field Development and Production – State of Play

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Revolutionising Gas Field Development with Standardized NUF LWS Design

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Presentation Outline

- Objective
  NUF Definition
- PETRONAS's Ambition 2030
  NUF Mission
- NUF Roadmap
- O&M Philosophy
  Design Principles
- Potential Value Creation

Objective

To drive Normally Unattended Facilities (NUF) as the new operating philosophy in PETRONAS, an initiative has been formed to evaluate the development of standardized design for normally unattended light weight wellhead structures (LWS) with extended planned visit. This is focused on marginal field development with planned crew intervention of once in every year (NUF1Y), and to achieve one-year autonomous operation without planned intervention.

PETRONAS's Upstream Ambition 2030

Supporting PETRONAS' Pathway to Net Zero Carbon Emissions by 2050

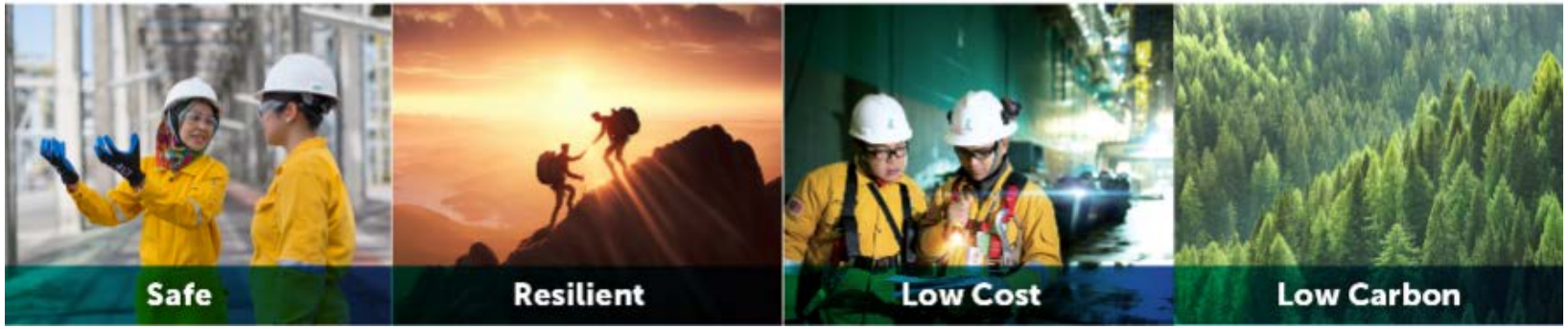
GHG Emissions

Mid term target:
25% reduction by 2030

NET ZERO 2050

Net zero carbon emissions by 2050

We aspire to be as "A Safe, Resilient, Low Cost, and Low Carbon EP Business"



NUF MISSION

To develop standardized design for NUF with targeted end state of one (1) year autonomous operation for marginal field development.

Executed in stages through an Agile approach (MVP), the project involved designing MVP1 with monthly visits to the platform, followed by MVP2 3 monthly, MVP3 6-monthly, and MVP4 yearly.

Outline key design specifications and operations and maintenance strategies that were applied to ensure safe operations and sustained production.

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NUF Roadmap

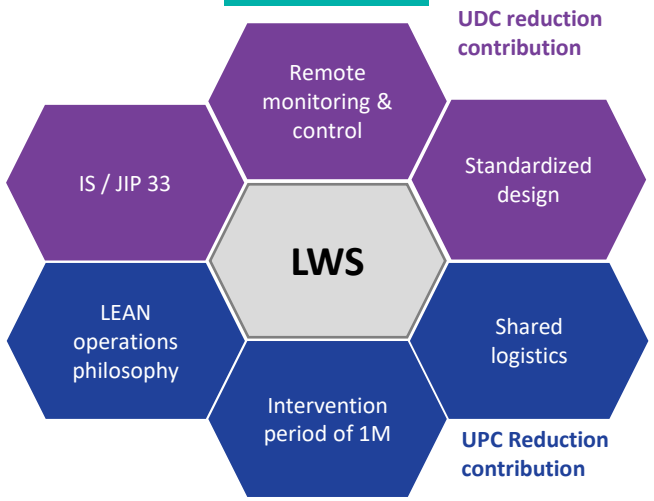
NUF Journey aimed at 1 Year Autonomous Operation for Light Weight Structure (LWS)

MVP1 (2020) — NUF 1M

MVP2 (2021) — NUF 3M

MVP3 (2022) — NUF 6M

MVP4 (2023) — End State: NUF 1Y



Quick Win Solution through 3 months (3M) and 6 months (6M) autonomous operation

- Leaner design for extending crew intervention from 1 month to 3 / 6 months.
- O&M philosophy simplification through lean manning & high reliability
- Reducing risk to personnel through ALARP demonstration

Deployment of 1 Year remote autonomous operation for marginal field development by 2024

Expanding the application to several other portfolios for CPP, FPSO, etc

NUF Definition

NUF is defined as “A facility/installation where all process control and operations (including startup and shutdown) are **either completely automatic or managed remotely,** such that human personnel are not normally present for **determined periods of time**”

The chosen time between human intervention deeply impacts the design and the operating philosophy of a given facility (e.g. NUF 1Y, NUF 6M, NUF 3M, NUF 1M)

Source: IOGP NUF Taskforce

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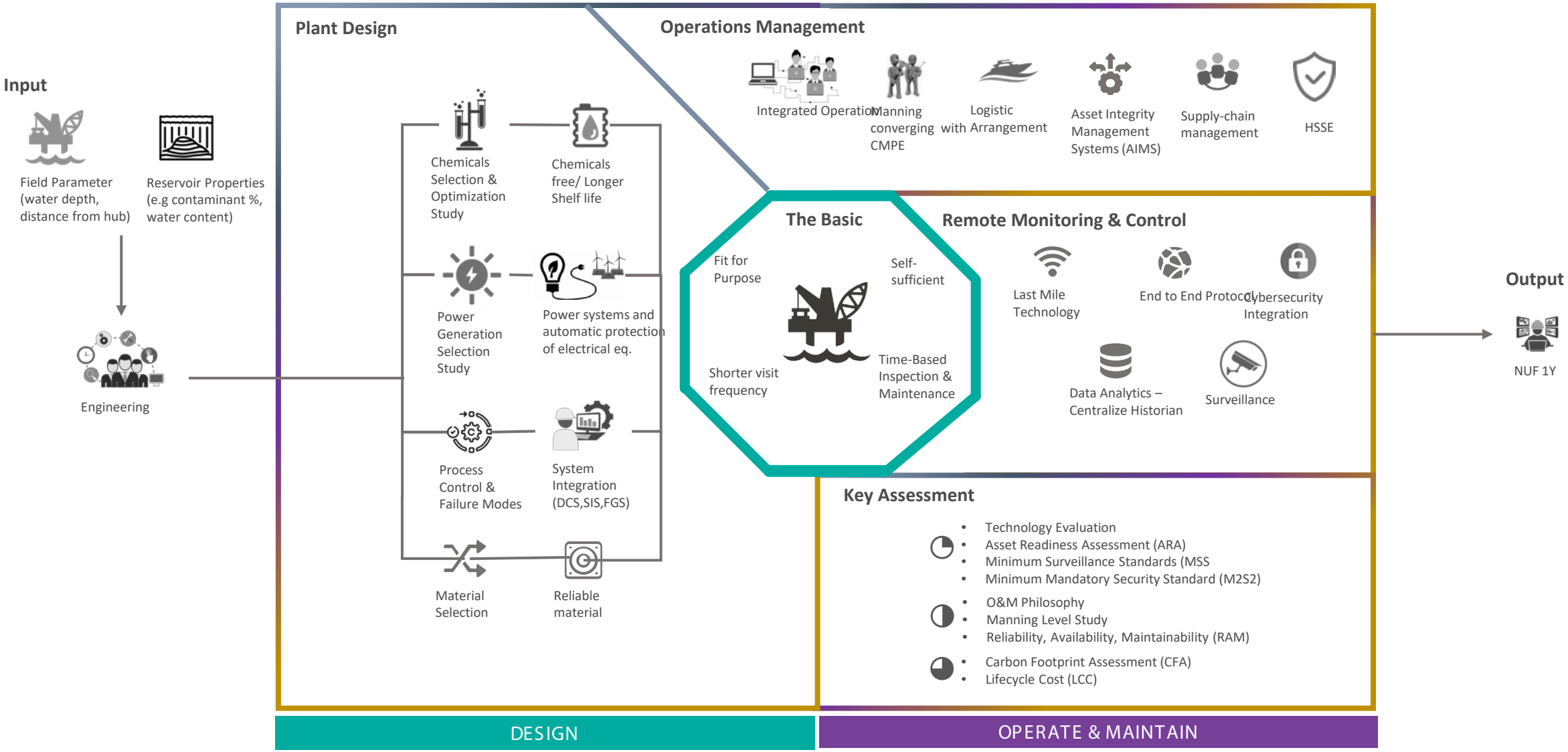
Navigating the NUF Evaluation



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Unlock the Technology – Be vibrant to enhance the solutions

Chemicals Selection & Optimization study

Corrosion Inhibitor (CI) *is additive developed for multiphase gas pipelines with high CO_2, will slow down and reducing corrosion rates. Technology with higher concentrated with lower dosage can help NUF facilities pipeline to extend life and optimizes chemical dosage and storage.*

- Effectively mitigates CO_2 (sweet) and H^2S (sour) corrosion.
- Excellent for continuous treat application in multiphase pipelines.
- Partitions to both water and hydrocarbon phases.
- Exceptional continuous and batch treat applications in gas pipelines.
- Excellent performance in treating high velocity gas systems

45% cost reduction
from the typical chemical storage

Power Generation Selection Study

Solar-Wind Turbine Hybrid System *designed to provide cost-effective, renewable energy with minimal maintenance requirements and continuous remote monitoring for health status assessment*

- Able to cater up to 3kW with retractable panel design.
- Minimum tools hours to perform inspection and maintenance at the solar panel, wind turbine, battery banks and battery chargers.

Green Energy
Highly reliable electricity supply

Process Control & Failure Modes

Process cycle efficiency *improvement for abnormalities via machine learning based on historical dataset.*

- Readjust the process parameter to ensure the system run at the optimum condition.
- Hierarchy of remote reset and start-up based on the first up alarm and critical function device.

Low (UPD) Downtime
Quicker intervention

Remote Monitoring & Control

PETRONAS Inhouse Develop Digital Twin to *enable early detection of potential failure and optimizing routine maintenance frequency.*

Dual function technology

- Highly repetitive operational tasks mandating manual intervention e.g., sampling, pigging etc.
- Physical verification for process upset (ESD scenario).
- PSB technology allow the mechanism of automated multiple pig launcher.
- Auto sampling systems for calibration and measurement

- Digital tools for analytic and diagnostic rotating equipment (RotaPRO) and well performance (smart well).
- Features with real time surveillance to reduce the dependency on the human intervention.

High (98%) Reliability
Live performance monitoring & autonomous operation

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Operations & Maintenance Philosophy

Integrated Operation (IO)

❑ Integration of Functionalities of Monitoring and Control Systems

Remote Monitoring & Control

Full operating and controlling capabilities from Remote Operation Centre (ROC) Platform

- Deploy scalable collaboration tools for real time data analysis and timely response avoiding Unplanned Deferment (UPD).
- Capable to remote reset and start-up procedures for USD, PSD and ESD (P).
- Provision space and infra for deployment robot (ANYmal).

Production Operations

Maximizing production efficiency through minimum surveillance standard and LEAN operations

- Online condition based monitoring and remote assistance (sampling, remote well test).
- Wells equipped with Smart Wells device to minimize the well intervention activities.

Asset Integrity Management Systems (AIMS)

Design Integrity

- Compliance to COMPANY / JIP codes and standards.

Technical Integrity

- Equipment selection shall be based on proven technology with high reliability and low maintenance.

Maintenance Integrity

- Develop Inspection & Maintenance plan and managing deviations in systems and integrity tasks.

Maintenance Philosophy

❑ Drive the operability, maintainability, integrity in cost-effective manner without compromising safety

Inspection & Maintenance Philosophy

- Reduces intervention hour requirement by adopting the Risk Based for strategic planning execution.
- Predictive Maintenance leverage from the data driven captured in digital tools.
- Strive to minimize and standardize the equipment to reduce the different type of spare part and allow interchangeability/ plug and play equipment.

Manning Philosophy

- Multiskill Roving Teams covering all disciplines to optimize resources and costs under Centralized Maintenance Planning & Execution (CMPE).
- Reduce and merge total number of PM WO content align with COMPANY Guideline.

Logistic Arrangement

- Campaign based maintenance will be carried out using work barge as Base and for unplanned activities via standby vessel or Fast Crew Boat (FCB) at Hub.
- Integrate vessel with others field (ULCT) aims to reduce the number of vessel on hire at site.

HSSE

❑ Safety performance by reducing exposure at site (IRPA) and through ALARP demonstration

Health (H)

- Eliminate the cause for loss of containment and leak preventing hydrocarbon or contaminant release

Safety (S)

- Minimizing site tool hours reduce exposure risk (IRPA) to personnel
- Safeguard the technical integrity of critical equipment warranting for longer MTBF

Security (S)

- Implementing physical security measures, including 24/7 CCTV monitoring, enables early detection in the event of an intruder approaching the platform.
- Cybersecurity strategy to protect digital assets and maintain overall safety and reliability of operations.

Environment (E)

- Implementing zero venting/flaring and minimizing emission

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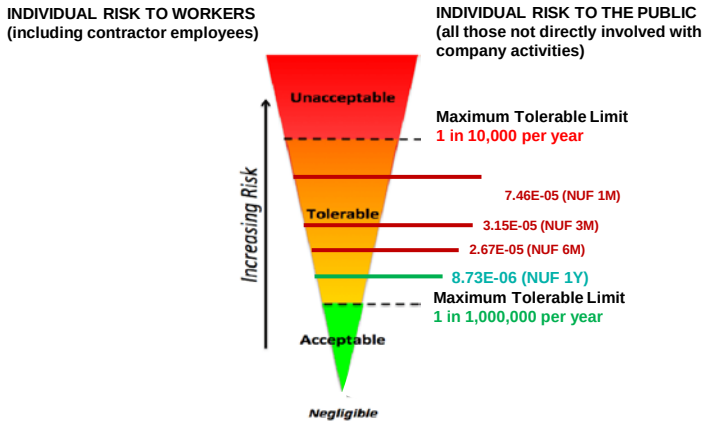
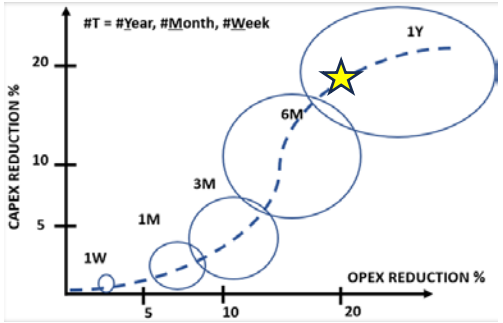
Potential Value Creation

Reduce or maintain IRPA at **ALARP** level



IRPA reduction for NUF showing reducing trend from NUF 1M until up to NUF 1Y. The risk profile is generally lower by minimizing the tools hours operation at the LWS as well reducing the average boat transfer frequency per year.

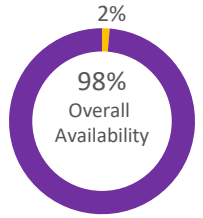
Potential **10%** reduction in **LCC**



Overall commercial savviness of the engineering contribute to the reduction of the LCC around 15 % compared to NUF 1M.

RAM performance **> 96%**

- Indicative Telecommunication System Availability is 99.9% in the overall system unavailability.
- Monsoon delay is the highest contributor 60.72% of the overall production unavailability. This is followed by planned maintenance which consisting of two (2) types of planned maintenance that contribute to 19.59% as follows:
  i. Major turnaround will be every 5 years for 7 days meanwhile
  ii. Minor turnaround will be done every 3 years for 2 days.



NET ZERO 2050

30% *reduction in portfolio carbon intensity*

GHG footprint improvement due to logistics arrangement, equipment selection and design reliability.

Emission Source	GHG Emissions (Tonnes of CO_2e)			
	NUF 1M	NUF 3M	NUF 6M	NUF 1Y
Gas Venting	16,546	4,964	4,964	2,200
Stationary Combustion	21,117	8,940	7,130	6,330
Total	37,663	13,940	12,094	8,330

Conclusion

Despite technical challenges, there are no “showstoppers” that prevent the pursuit of NUF in the near future. This study prove that standardize is possible for planned visit of NUF 1Y with significant value creation in term of HSSE and LCC.

Collaboration with industry value chain will enable this aspiration for higher complexity facilities.