# PROJECT DELIVERY & TECHNOLOGY

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# 1 PETRONAS TECHNOLOGIES

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iCWD™ is a circulation sub, placed as one of the bottom hole assembly (BHA) for drilling. Its design is based on a remotely controlled 3-way valve system, enabling the driller to command the tool in any of the special modes below:

- Normal Drilling Mode
- Bypass Mode
- Hole Cleaning Mode
- Isolation Mode

iCWD™ provides significant cost savings for drilling operations in challenging drilling environments.
**FEATURES**

- Lost Circulation Material (LCM) Placement.
- Cementing at losses zone - In severe losses cases, placement cement plug is possible through BHA without the need to pull out of the hole.
- Hole Cleaning.
- Isolation Mode - Downhole isolation mode to isolate the top pipe from BHA.

**BENEFITS**

- Quick and efficient LCM placement while protecting sensitive BHA tools against damage.
- Hole cleaning helps to remove cutting Beds, which is a source of stuck pipe, particularly while pulling out of hole.
SolidClenz™ is a unique and proven, custom-designed technology used to remove organic (wax, asphaltene, napthenate) and inorganic (CaCO₃ and BaSO₄ scales) solid deposits for wells, pipelines and heat exchangers to increase well flow and enhance production. This technology is a holistic solution that completely removes wax and scale depositions in production tubings, well bores, pipelines and heat exchangers. The custom designed chemical is compatible with formation rock, reservoir fluids, well completion accessories and refinery products. Jointly developed with a technology partner, the formulation of chemicals used in SolidClenz™ can be customised according to the characteristics of the deposit formed and the profile of each well.
Shortlisted as finalist for the Annual World Oil Awards 2014 and IChemE International Awards 2014.

SolidClenz™ has been applied in various wells and process units including one pipeline, creating more than USD100 million to the clients from increased oil production or cost savings to PETRONAS.

Its use at a crude oil terminal in Terengganu, the first application of SolidClenz™ for pipelines, has successfully solved a problem that had plagued the terminal for over a decade.

<table>
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<tr>
<td>➤ High temperature flexibility range of 80°C to 200°C.</td>
</tr>
<tr>
<td>➤ Modular technology and cost effective, yielding high Return On Investment.</td>
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<tr>
<td>➤ Restores rock wettability.</td>
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<tr>
<td>➤ Long-term productivity improvement.</td>
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<table>
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<th>BENEFITS</th>
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<td>➤ Online cleaning implementations contribute a huge amount of value creation in terms of saving the production loss and zero downtime savings for Downstream Plants.</td>
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SmartCen™ is an online real-time Smart Centralised Fiscal Metering Supervisory System that supports centralised data for remote monitoring, diagnostics and analysis, which clearly surpasses conventional metering systems. The system was developed in collaboration with a technology partner for use in all Custody Transfer and Fiscal Allocation metering operations.
## ACCOLADES

- Won the 2015 Special Meritorious Awards for Engineering Innovation (SMEA) under the Intelligent Systems and Components category from Hart Energy E&P editor USA at the OTC 2015 in Houston, Texas USA.

## FEATURES

- Mis-measurement management, the Virtual Flow Computer, integrated validation and online uncertainty calculation.
- Real-time verification of flow computer computation.

## BENEFITS

- Reduces human intervention during metering activities.
- Prevents late detection of abnormalities in flow measurement that occurs in conventional metering systems.
- Enables proper analysis, trending and diagnostic on field instrumentation and devices, including flow metres through centralised data.
- Standardises validation methods, reduces validation period, and improves system availability by facilitating metering system validations via integrated validation software which could standardise validation methods, reduce the validation period and improve system availability.
- Enables quick detection of abnormalities, with remote accessibility enabling quick response to metering issues.
- Ensuring mis-measurement caused by instrument failure/partial failure that leads to billing errors are acted upon.

## TESTIMONIAL

- Deployed at more than 28 metering sites including:
  - Onshore Gas Terminals
  - Onshore and Offshore Crude Oil Terminals
  - Pipeline Metering Installations
  - LNG Plants
  - Petrochemical Plants
  - Gas Processing Plants
  - Refinery and Offshore Platforms
- Contributed to a substantial amount of cost saving at the Terengganu Crude Oil Terminal (TCOT).
- New installations in more than 30 sites including on-going projects such as PETRONAS Refinery and Petrochemical Integrated Complex Projects (RAPID) as well as the Pengerang Deep Water Terminal.
Aqua MTM® is a non-intrusive tool, based on Magnetic Tomography Method (MTM) used for subsea pipeline inspections, jointly-developed with Transkor-K. It evaluates defects in metal and weld joints, monitoring any development of corrosion and assessing the state of corrosion based on the relative change in local stress levels in the pipeline. This has an advantage over subsea inspection of unpiggable pipelines done using a temporary launcher and auxiliary pumping to run an Inline Inspection (ILI) tool, which is often costly even for short distance pipelines.
To-date, a substantial amount of cost saving is derived from a total of 500km of subsea pipelines have been inspected using Aqua MTM® technology at PETRONAS facilities in Sabah and Sarawak as well as international clients in Indonesia and Abu Dhabi. Resulted in nearly 70% cost savings compared to Inline Inspection (ILI) methods.

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<td>▶ Inspection of subsea/underwater pipelines, particularly for non-piggable pipelines.</td>
<td>▶ Only one tool is required to inspect all pipeline sizes.</td>
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<tr>
<td>▶ Real-time pipeline inspection.</td>
<td>▶ Uninterrupted pipeline inspection due to non-intrusive nature.</td>
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PN-1™ membrane is a multi-fibre membrane design jointly developed by PETRONAS and Cameron Solutions Inc., utilising two or more different types of membrane fibres with different performance characteristics into a single membrane element.
PN-1™ was tested onshore in SACROC, Texas, United States of America operated by Kinder-Morgan from 2010 to 2013 for CO₂ concentration.

PN-1™ was also tested at Carigali PTT-EP Operating Company (CPOC) offshore at the Muda field from 2011 to 2012. It has achieved resounding success in the field where it managed to reduce CO₂ from 45% to 23%.

PN-1™ was entrusted to be the main acid gas removal system and was commercialised at Terengganu Gas Terminal (TGAST) in Kerteh, Terengganu in 2014.

- The first in-house PETRONAS membrane.
- PN-1™ is the largest membrane ever made, designed for 30” size to process high CO₂ gas content.
- The first multi-layer membrane arrangement henceforth able to process a wide range of CO₂ content ultimately reducing weight and footprint requirement of the whole membrane system.

- Improves separation performance and maximises overall gas processing capacity:
  - 10% increase in separation performance
  - 10%-15% hydrocarbon losses

- Estimated 60% potential reduction of membrane skids total deck footprint and 40% potential reduction of membrane skids total weight.

- Potential cost savings – up to 5% CAPEX reduction.

- 7% reduction of annual replacement cost.

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HycaPure™ Hg is an award winning technology that targets removal of most mercury species including elemental, inorganic and organic mercury. The chemistry enables the capture of mercury to form an insoluble and stable form of mercury complex which does not dissolve in the feed stream. Other variants of HycaPure™ Hg are also being developed and are at various technology readiness levels. They include mercury removal from wet gas, natural gas condensate, naphtha and produced water.
### ACCOLADES

- HycaPure™ Hg won three categories; Chemical Engineering Project of the Year, Sustainable Technology, and Outstanding Achievement in Chemical & Process Engineering from IChemE Global 2013.
- HycaPure™ Hg won the best overall entry, making PETRONAS the first company to receive such award from Global IChemE 2013.
- HycaPure™ Hg Won the award for Sustainable Technology from IChemE Niklin Medal in 2013, making PETRONAS the first in Asia to receive such a prestigious recognition.
- HycaPure™ Hg won the Sustainable Technology and Teamwork in Innovation Awards from the Royal Society of Chemistry UK in 2014. It is the first RSC award for PETRONAS.
- HycaPure™ Hg Condensate won the Oil & Gas Category for Mercury Removal from Natural Condensate from Global IChemE Awards 2016.

### FEATURES

- High mercury adsorption capacity.
- Outperformed best commercial system by more than 3 times.
- Capable of handling mercury concentration surges in the gas stream and maintain outlet specifications.

### BENEFITS

- Direct replacement for current commercial products without any plant modification or additional costs required.
- Contributed to a significant amount of cost savings since 2013, compared to other mercury removal products available on the market.

### TESTIMONIAL

- Voted by the British Science Museum as the ”Most Important British Innovation of the 21st Century”.
In Field Liner (IFL™) is flexible reinforced liner for the rehabilitation of hydrocarbon pipelines. This technology is applied to the lining of pipelines such as those that run from onshore to offshore installations or between offshore installations, including oil or gas production well heads to offshore gathering platforms or offshore gathering platforms to onshore storage or process facilities.
Successfully deployed pilot trial at PETRONAS Carigali Sdn Bhd (PCSB) in September 2013.

Successfully deployed commercial trial at a PCSB offshore platform in Miri, Sarawak in November 2014.

Generated a substantial amount of cost saving per kilometre (KM) of pipelines with IFL™, compared to carbon steel pipelines.

TESTIMONIAL

BENEFITS

FEATURES

Application: IFL™ can be utilised in very aggressive, hot, sour hydrocarbon service conditions of up to 110 degrees centigrade.

Diameter range: Ranging from 6” to 18”.

Liner length: Single liner lengths available in multiple kilometres.

More cost effective than offshore pipeline replacement.

Minimal pipeline repair time.

Quick and easy installation/deployment.

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Generated a substantial amount of cost saving per kilometre (KM) of pipelines with IFL™, compared to carbon steel pipelines.
ProAssure™ Wrap is an overwrap pipeline repair system that is based on high strength composite materials. The composite is developed to afford quick in-situ repairs to be undertaken cost effectively. It is highly flexible and hence can overcome the issue of tight access and complex shaped pipelines. Upon application the wrap can harden through curing in ambient conditions. The wrap can be used to repair and restore the functionality of corroded and leaking pipelines whilst providing protection against further corrosion attack.
FACTSHEET

Successfully deployed pilot trial at a PCSB offshore platform in Miri, Sarawak in June, 2014.

External application on caisson pipeline repair at an offshore field in Indonesia in January, 2016.

Between January 2016 to June 2017, more than 25 locations and 4,600 metres of materials installed.

Contributed to a substantial value creation to-date, through Cost Avoidance, compared to other overwrap pipeline repair systems available in the market.

<table>
<thead>
<tr>
<th>Property</th>
<th>Typical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impregnation System</td>
<td>On-site impregnation system</td>
</tr>
<tr>
<td>Tensile Strength (MPa)</td>
<td>413</td>
</tr>
<tr>
<td>Tensile Modulus (GPa)</td>
<td>25.9</td>
</tr>
<tr>
<td>Lap Shear Adhesion Strength (MPa)</td>
<td>7.4</td>
</tr>
<tr>
<td>Maximum Glass Transition Temperature $T_g$ (°C)</td>
<td>Up to 85</td>
</tr>
<tr>
<td>Pot life of primer at 30° (mins)</td>
<td>60</td>
</tr>
<tr>
<td>Cure Time at 30°C (days)</td>
<td>&lt; 1 day</td>
</tr>
<tr>
<td>Barcol Hardness</td>
<td>39.4</td>
</tr>
<tr>
<td>Unscribed Salt Spray Test</td>
<td>Passed 4,500 hours</td>
</tr>
</tbody>
</table>

TESTIMONIAL

Live, in-situ repairs are possible, thus avoiding costly shutdowns and interruption to operations.

Provides cost effective corrosion protection and assists in strengthening of pipelines.

BENEFITS

Cures at ambient temperature and does not require special handling during transportation.

Contributes to safer working conditions with no or minimal hot work required.

Qualified to ISO/TS 24817 and ASME PCC-2 by independent third party laboratory and signed off by DNV GL.
ProAssure™ Wrap Extreme is a composite overwrap repair system for corrosion prevention and strengthening of risers, pipelines and pipings, as well as other bonded repairs, both onshore and offshore. Consisting of ‘E-Glass fibre’ pre-impregnated with a proprietary underwater epoxy resin formulation, ProAssure™ Wrap Extreme is designed to be applied and to cure in wet and underwater environments, while maintaining superior adhesion and mechanical properties.
Proven track record, having been deployed at over 40 locations, predominantly at offshore sites and several onshore sites.

Applied at more than 700 repair points, utilising approximately 7,000 metres of materials, for repair and rehabilitation of offshore risers, topside/plant piping, refinery fire water lines, gas receiving lines, caissons and others.

Subsea repairs have been installed up a 70 metres depth.

Contributed to substantial value creation to-date, through Cost Avoidance, compared to other composite overwrap repair systems available on the market.

Affords safer working conditions with no hot work required.

No shutdown required.

Proven track record, having been deployed at over 40 locations, predominantly at offshore sites and several onshore sites.

Applied at more than 700 repair points, utilising approximately 7,000 metres of materials, for repair and rehabilitation of offshore risers, topside/plant piping, refinery fire water lines, gas receiving lines, caissons and others.

Subsea repairs have been installed up a 70 metres depth.

Contributed to substantial value creation to-date, through Cost Avoidance, compared to other composite overwrap repair systems available on the market.

Won the Innovation Award Asia 2012 by JEC Composites.

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<tr>
<td>Impregnation System</td>
<td>Pre-impregnated system</td>
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<tr>
<td>Tensile Strength (MPa)</td>
<td>235</td>
</tr>
<tr>
<td>Tensile Modulus (GPa)</td>
<td>17.5</td>
</tr>
<tr>
<td>Transverse Adhesion Strength (MPa)</td>
<td>18.5</td>
</tr>
<tr>
<td>Lap Shear Adhesion Strength (MPa)</td>
<td>14.4</td>
</tr>
<tr>
<td>Maximum Glass Transition Temperature $T_g$ (°C)</td>
<td>Up to 130</td>
</tr>
<tr>
<td>Pot life of primer at 30°C (mins)</td>
<td>60</td>
</tr>
<tr>
<td>Cure Time at 30°C (days)</td>
<td>4</td>
</tr>
<tr>
<td>Barcol Hardness</td>
<td>42</td>
</tr>
<tr>
<td>Unscribed Salt Spray Test</td>
<td>Passed 4,500 hours</td>
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</table>
ProAssure™ Clamp is a leak containment solution. It is applied in anticipation of a leak to contain it, or in the event of a leak, to arrest it. Unlike other repair clamps, ProAssure™ Clamp is constructed from advanced composite materials so that it is both lightweight and corrosion resistant. The methods used to fabricate these clamps also provide a clear cost advantage and quick delivery even for non-standard sizes. The clamp comprises two half shells with flanges, cylindrical in shape to conform to the pipe. During installation, the flanges are brought together and bolted in position to secure the repair. Pressure is contained by use of rubber seals.
**ACCOLADES**

- Won the JEC Europe 2014 Innovation Award for the Oil and Gas Category by JEC Composites.
- Won the Excellence in Innovation Award from the Cooperative Research Centres Association (CRCA), Australia in May 2014.

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**FEATURES**

- Corrosion resistant.
- Lightweight.
- High chemical and temperature resistance.

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**BENEFITS**

- Repairs can be deployed rapidly and cost-effectively.
- Contributes to safer working conditions with no hot work required.
- No shutdown required.

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**TESTIMONIAL**

- Successfully deployed pilot trial at a PETRONAS facility in Kerteh in August, 2015.
Vibration Clamp™ is a tool that was developed by PETRONAS to control pipe vibrations in onshore and offshore facilities that can be used for insulated and non-insulated piping systems.
**FEATURES**

- Designed for piping usage with temperature range of up to 300°C.

**BENEFITS**

- Can be used for both insulated and non-insulated piping systems.
- No pumps and power generation required.
- Able to hold vibration level up to 33Hz and more.
- Able to hold significant level of pipe loading.

**TESTIMONIAL**

- Successfully installed at one of PETRONAS’ facilities since August 2013 with piping vibration issues having been successfully resolved.
# Standard Engineering Solutions

## Asset Integrity
- P-ALSTM
- P-RBITM
- P-IPFTM
- P-ELSORTM
- P-EDMSTM
- FnGMapTM
- PERSTM
- P-ALARMTM
- P-PEMS
- P-ESS
- P-Met
- GUSATM
- PSFATM
- QPiRATM

## Operational Optimisation
- iCON®
- P-VIPTM
- PRSTM
PETRONAS Asset Life Study (P-ALS™)

It is a standardised application across all PETRONAS plants and facilities. It is an independent quantitative engineering study to establish the current ‘health’ and predict the remaining ‘useful life’ of assets. Based on design criteria, operation, inspection and maintenance history of an asset, P-ALS™ helps to determine its current operational status and viability to be able to further operate safely to a period determined by the asset owner. Typically, P-ALS™ would be conducted before end of asset’s design life to determine rejuvenation requirements to further operate the asset beyond its design life, as determined by the asset owner, in a safe and reliable manner.
<table>
<thead>
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<th>FEATURES</th>
<th>BENEFITS</th>
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<tr>
<td>✅ Identify premature operational and/or maintenance degradation of equipment. &lt;br&gt; ✅ Determine potential obsolescence of major equipment which are unlikely to achieve safe and reliable operational effectiveness in an asset’s typical design life of 20 years. &lt;br&gt; ✅ Core of asset life extension program e.g. rejuvenation, revamp.</td>
<td>✅ Provides clear strategy for phased asset capital expenditure plan to coincide with the turnaround plan to minimise overall expenditure and downtime. &lt;br&gt; ✅ Enhancement to equipment’s short-term maintenance and inspection plan.</td>
<td>✅ Implemented at 60 sites covering Upstream, Gas Operations, Refineries, Petrochemicals and Downstream Distributions including Fuel Depot and Aviation Fuel Terminals. &lt;br&gt; ✅ Assisted plants in realising the Asset Health and Remnant life with a cumulative indirect value creation of more than RM400 million for PETRONAS. &lt;br&gt; ✅ Realising value creation of over RM100 million and cost avoidance of RM66 million for two platforms in Sarawak in evaluating health status while extending operability and reliability of such assets for the next 30 years.</td>
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It is a standardised application fit to be used across all PETRONAS plants and facilities. It is a new generation web-based, API 580 code compliant Risk Based Inspection software for optimisation of plant inspection and maintenance activities. It can evaluate risk failure distribution for all types of pressurised process equipment. It also estimates remnant life based on the in-service damage mechanism and design codes. The software delivers an optimised inspection plan for each asset.
| FEATURES | Facilitates extension of plant run length and execution of Special Scheme of Inspection in line with DOSH requirements.  
| Determines the risk and material damage mechanism in relation to process parameters and predicts future risk with the potential process and environment changes. |
| BENEFITS | Optimises inspection and maintenance plan while enhancing asset integrity assurance.  
| Successful application at plants and platforms across the Group, enabling plant run length extension through Specialised Scheme of Inspection (SSI) up to 75 months.  
| Adopted for development of Offshore Self-Regulation (OSR) programme, which will eventually allow DOSH to provide surveillance of equipment at offshore facilities. |
| TESTIMONIAL | Excellent basis for Regulators to standardise requirements and audits.  
| Malaysian Department of Occupational Safety and Health (DOSH) has adopted P-RBI™ web-based application to deploy a SSI at PETRONAS facilities. |
P-IPF™ is a methodology which provides an automatic protective layer to prevent operation beyond safe operating limits for Downstream Operations. It is an engineering design methodology and study which provides design assurance for the implementation of Instrumented Protective Function that is in full compliance to PTS 30.80.10.10 and IEC 61508/61511.
### FEATURES

- **IPF consists of two parts:**
  - IPF Classification – a quantification of the risk level
  - IPF Verification – a study to confirm that the instrument safety design meets the required risk level
- IPF will ensure risks identified by IPF layer is correctly quantified. Thus, the IPF layer is designed to appropriately mitigate risks.

### BENEFITS

- Reduces over-engineering, thereby reducing project cost and increases plant reliability, reduces spurious tripping.
- Prevents under-engineering, thereby increasing plant safety integrity.
- Common platform: Standardised safety risk methodology which ensures standard consistency of IPF design is applied across all PETRONAS plants and facilities with a centralised data repository for life-cycle support.

### TESTIMONIAL

- Successful application at more than 200 P-IPF™ reviews.
- PETRONAS has credible instrument engineers who are certified by TUV Functional Safety.
PETRONAS Electrical Safety and Operability Review (P-ELSOR™)

It is a standard application across all PETRONAS plants and facilities. It is an independent structured engineering review of complex electrical generation, distribution and protection system to enhance safety and operability of plants and facilities. P-ELSOR™ is used to verify electrical system safety and operability during preliminary and detail design stages. It identifies potential safety and operability related issues due to design and human errors.
<table>
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<td>- P-ELSOR™ provides a systematic review methodology to address any discrepancy and/or inadequacy with regards to design parameters, philosophy as well as installation, operation and maintenance of electrical-related systems and equipment.</td>
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<table>
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<tr>
<td>- Improves electrical system safety and reliability by:</td>
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<td>- Addressing operational limitations upfront</td>
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<td>- Verifying system’s operability from susceptibility to upsets</td>
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<tr>
<td>- Avoiding nuisance tripping of existing plants during tie-in and commissioning</td>
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<tr>
<td>- Product complements safety requirements from International Standard (e.g. IEC 61850, NFPA 70)</td>
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<td>- Successful deployment at more than 60 PETRONAS’ facilities (greenfield and brownfield).</td>
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PETRONAS Engineering Data Management System (P-EDMS™)

It is a standard application across all PETRONAS plants and facilities. It is a web-based engineering design and data management system which leverages on a Smart Plant system to provide a single platform for integration and management of a range of engineering applications and solutions. The solution ensures effective engineering data sharing and avoids duplication of resources.
P-EDMS™ has been used in over 30 projects and operating units in 14 countries, by over 30 Contractors.

**TESTIMONIAL**
- Project teams located in different time zones benefit greatly from this system, as well as large projects where thousands of documents at different revision levels can be managed electronically and accurately.
  - Standardises EDMS on a single platform
  - Ensures data and design consistency across projects and operations
  - Includes standards and governance that cover Project Documentation, Numbering Conventions, Handover Technical Specifications and Document Control
  - Facilitates Integrated Turnaround Management Systems (iTAMS)
  - Functions as an Engineering Design Library
  - For asset owners, the solution offers a seamless handover of projects from engineering design through to procurement, construction, commissioning and finally operations

**FEATURES**
- P-EDMS™ enables documents to be retrieved electronically from any location with Internet access, saving time and costs, besides providing full traceability and enabling collaboration during the review process.

**BENEFITS**
- P-EDMS™ has been used in over 30 projects and operating units in 14 countries, by over 30 Contractors.
- Successful applications in PETRONAS’ Upstream and Downstream projects plant operation.
FnGMap™ is one of PETRONAS’ significant Standard of Engineering Solutions for groupwide implementation. It is a 3-Dimensional software incorporating a combination of risk-based assessment methodology and 3D visualisation. The method utilises risk data from Quantitative Risk Assessments in identifying fire risks and quantifying fire and gas detector’s coverage using software algorithm.
| FEATURES | this 3d fire and gas mapping visualisation software accurately quantifies detection coverage of a given process area; thus, optimising placements and number of detectors.  
| | With FnGMap™, 3D models of site equipment are digitally built. Thus, areas of detection coverage provided by detectors can be simulated and quantified.  
| | The software complies with International Guideline, ISA-TR84.00.07. |
| BENEFITS | fast and accurate when determining optimum placement of fire and gas detectors, thereby avoiding over/under engineering.  
| | Fit for purpose design balancing safety and economical. |
| TESTIMONIAL | successful deployment in over 40 PETRONAS’ Upstream and Downstream facilities. |
| ACCOLADES | Won the Most Commendable Award for Process Safety at the inaugural Institution of Chemical Engineers (IChemE) Malaysia Awards 2013. |
PETRONAS Equipment Reliability Strategy & Information System (PERSIS™)

It is a web-based engineering management system used to develop specific asset and equipment reliability strategies. It covers critical areas such as preventive maintenance, inspection and operations strategies through sharing of Equipment Degradation Mechanism (EDM), Risk Ranking, MPLAN and Equipment Basic Care (EBC).
Expedite development of Equipment Reliability Strategies.

Risk Based Approach to measure explicit and implicit associated risks.

Web-based application.

Successfully rolled out to PETRONAS’ Upstream and Downstream operating units.

FEATURES

- PERSIS™ tool and database assists in developing short-term and long-term equipment strategies through Standardisation application by providing Centralised Equipment Degradation and Preventive Maintenance Strategy e.g. Preventive Maintenance (PM), Equipment Basic Care (EBC) Information into web base with backups, easily accessible from multiple locations.

- It also assists in developing structured management of Asset Engineering Data and Information across OPUs and Projects.

- It facilitates smooth interfacing between other Management Systems and Engineering Solutions such as PETRONAS Maintenance Management System (PMMS), and related support services.

BENEFITS

- Expedite development of Equipment Reliability Strategies.

- Risk Based Approach to measure explicit and implicit associated risks.

- Web-based application.

TESTIMONIAL

- Successfully rolled out to PETRONAS’ Upstream and Downstream operating units.
It is an integral part of Process Safety Management. P-ALARM™ provides an independent layer of protection to prevent operations from exceeding safety limits. It consists of:

- **Alarm Philosophy** – guidelines on implementation and management of alarm systems.
- **Alarm Rationalisation** – studies to reconcile each alarm process with the principles and requirements of alarm philosophy and standards.
- **Alarm Suppression** – assessments to identify permissive elements and parameters for intelligent alarm management.
Implemented in PETRONAS’ Upstream and Downstream facilities as well as third party projects, significantly improving alarm performance.

**TESTIMONIAL**

Ensures consistency in standard and design of Alarm Management System.

Seamless integration with SOL and IPF.

Differentiated approach allows efficient execution of Alarm Management Study regardless of project size.

Comprehensive life-cycle analysis.

Endorsed for implementation across all PETRONAS facilities and projects.

**FEATUERS**

- Fully complies with PTS 14.12.08.
- Referenced to EEMUA Recommendations.
- Facilitates alarm rationalisation and priority analysis.
- Includes Automated Alarm Variable Table generation.
- Incorporates Process Safety Time Analysis.
- Provides automated guide-word and consistency checks.
- Includes dynamic and static alarm suppression analysis.

**BENEFITS**

- Ensures consistency in standard and design of Alarm Management System.
- Seamless integration with SOL and IPF.
- Differentiated approach allows efficient execution of Alarm Management Study regardless of project size.
- Comprehensive life-cycle analysis.
- Endorsed for implementation across all PETRONAS facilities and projects.

**TESTIMONIAL**

- Implemented in PETRONAS’ Upstream and Downstream facilities as well as third party projects, significantly improving alarm performance.
P-PEMS focuses on assisting PETRONAS OPU to monitor stack emission and complies with Clean Air Regulations (CAR) 2014 requirement. P-PEMS will predict stack emission from available process parameters. No additional hardware will need to be maintained, however, quarterly audit needs to be carried out to ensure prediction accuracy. P-PEMS has been approved fit to be utilised as a Continuous Emission Monitoring tool by the Malaysian Department of Environment (DOE).
Approved Implementation
- PETRONAS Chemicals MTBE (PCMTBE) Sdn Bhd: Boiler B-1001, B-1002 & B-1003
- PETRONAS Gas Berhad (PGB): GPK A Boiler F3-781

On-going Implementation
- PETRONAS Chemicals Fertiliser Kedah (PCFK) Sdn Bhd: Boiler B-53-01A, B-53-01B
- PETRONAS Gas Berhad (PGB): GPK A Boiler F2-781
- PETRONAS Chemicals Methanol (PCMSB) Sdn Bhd: Combined Stack S-101

TESTIMONIAL

An in-house application developed by GTS.

No spare parts required, therefore is cost efficient.

Technical & Technology know-how is in PETRONAS, therefore continuous support is available.

Prevent value leakage from PETRONAS.

Close working relationship with DOE is an added advantage during implementation.

FEATURES

- Predicts stack emission from available process parameters.
- No additional hardware to maintain.
- Fit to be utilised as a Continuous Emission Monitoring tool by Malaysian Department of Environment (DOE).

BENEFITS
P-ESS is a comprehensive electrical system study simulation using ETAP simulation software to assess behaviour of electrical system under various scenarios. Power system studies are essential to support the design of new electrical systems or to determine operational performance that can be expected from an existing system, especially if it is to be reconfigured.
More than 50 projects completed, comprising upstream, downstream, greenfield and brownfield using P-ESS as an analytical tool in understanding electrical network behaviour.

**FEATURES**
- It consists of:
  - Load Flow Analysis
  - Short Circuit Analysis
  - Motor Starting Analysis
  - Protection Coordination Study
  - Transient Stability Study
  - Arc Flash Assessment.

**BENEFITS**
- Vital component to ensure secure and safe electrical supply.
- Reduction of risk to projects and for on-going safety in the operating plant.
- Utilisation of ETAP software for simulation.
- Standardisation of standard application (PTS, IEC, IEEE).
- Ability to integrate with PEDMS system through SPEL Interface.

**TESTIMONIAL**
- More than 50 projects completed, comprising upstream, downstream, greenfield and brownfield using P-ESS as an analytical tool in understanding electrical network behaviour.
PETRONAS Metocean Solution (P-Met) is a holistic package of Metocean applications covering all phases of the project life cycle, from exploration to decommissioning stage.
### FEATURES

The solution consists of four main tools as follows:

- **Metocean Report & Study**
  - Metocean analysis for the development of extreme value analysis, operability statistics, modelling, joint probability and special studies

- **Real Time Metocean Observation System (RTMOS)**
  - Installation and maintenance of offshore Metocean stations for real time data measurements and recording

- **Weather Forecast**
  - Daily weather forecast subscription

- **Metocean Measurement**
  - Oceanographic marine deployment of Metocean sensors for underwater measurement

### BENEFITS

- Cost reduction due to in-house analysis and development.
- Enhanced capability with successful deployment of in-house Metocean processing software (SeaMOME).
- Display of real time Metocean data which is crucial for operations to ensure compliance to helideck safety requirement.
- Daily weather forecast reports with 24/7 weather monitoring support.
- No value leakage.
- Facilitates delivery of Metocean solutions.

### TESTIMONIAL

- Quality and standards of Metocean assessment verified according to ISO and PTS.
- Development of over 150 Metocean criteria reports worldwide through in-house reporting resulting in total value creation of RM15 million.
- Successful RTMOS installation in over 20 PETRONAS offshore facilities across the Malaysian region.
- Issuance of over 36,000 weather forecast reports.
- Successful deployment of Rig ADCP at Kerupang and Pahu in Sulu Sea, Kebaya and Songket in Malacca Strait, and NC3, as well as standalone current measurement at Limbayong in Deepwater Sabah for soliton monitoring.
GUSA™ is a standard application across all PETRONAS fixed offshore facility structures. It provides cutting edge solutions in structural integrity assessments of offshore structures through pre-emptive engineering recommendations, complete with specific mitigation.
### FEATURES
- Able to keep offshore structures in good working order.
- Assesses and monitors integrity of offshore structures, and provides prioritised structural assurance and facilitates mitigation works.
- Works through the design stage all the way to decommissioning phase.

### BENEFITS
- Avoidance of repair or strengthening of structure.
- Prolonged inspection intervals for cost avoidance.
- Compliant with ISO 19902 safety requirements.

### TESTIMONIAL
- Supports PETRONAS Structural Integrity Management System (SIMS) in ensuring technical integrity of existing fixed offshore structures by meeting code requirements.
- Continues to support PMO, SKO, SBO and PETRONAS’ international facilities with an estimated total cost optimisation of more than RM400 million.
PSFA™ is an advanced engineering solution that combines in-house tools (PRIA, SuperCorp) proprietary software (ABAQUS, HydroCor, CrackWise) and database to assess and demonstrate that a pipeline has adequate hoop, longitudinal and fatigue strength to continue to operate safely.
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| ▶ Solutions include:  
  - Assessment of dent/gouge for determining strain limits and fatigue life  
  - Assessment of free span for determining limit state and fatigue life  
  - Assessment of girth weld for determining strain limits, fatigue life and crack propagation  
  - Corrosion reliability analysis for determining hoop strength and pipeline reliability |

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<th>BENEFITS</th>
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| ▶ Assist in decision-making on whether to replace pipeline sections, delay replacement, fit to repair or other mitigations permitted by Regulatory authorities.  
  ▶ Generate significant cost saving and minimise production loss, prolong inspection intervals and safe operations. |

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| ▶ Pipeline integrity status/safety case accepted by Regulators i.e. DOSH since complies to Petroleum (Safety Measures) Act 1984 & Regulations 1985.  
  ▶ Successfully implemented at over 20 PETRONAS Upstream and Downstream facilities.  
  ▶ More than RM73 million cost avoidance for the past four years. |
QPiRA™ is an advanced engineering solution that combines in-house tools (PRIA), proprietary software (PHAST, MiniTab) and database to quantify risk of critical threats, determine ALARP level and establish Integrity Management Plan (IMP) and HSE Case to ensure safe and reliable operations of pipeline.
### Features
- Solutions include:
  - Assessment and quantification of probability of failure (PoF) for pipeline threats
  - Determination of consequence of failure (CoF) in terms of safety (fatality) and monetary value to assets, environment, people and reputation
  - Pipelines’ risks are ranked and prioritised; ALARP level is determined; and IMP established
  - Establishment of HSE Safety Case for regulatory and statutory compliance pipeline reliability

### Benefits
- Assist decision making whether to sectionally replace the pipeline, delay the replacement, adequate to repair or other mitigations that are allowed by Regulatory authorities.
- Generate significant cost saving and production lost, prolong inspection intervals and safe operations.

### Testimonial
- Pipeline integrity status/safety case accepted by Regulators i.e. DOSH since complies to Petroleum (Safety Measures) Act 1984 & Regulations 1985.
- Successfully implemented at over 20 PETRONAS’ Upstream and Downstream facilities.
- More than RM73 million cost avoidance for the past four years.
iCON® (Process Simulation Software)

iCON® is a steady state and dynamic process simulation software for the enhancement of plant performance, designs, operations and process optimisation.
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<th>FEATURES</th>
<th>BENEFITS</th>
<th>TESTIMONIAL</th>
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| ➤ Offers multiple engineering solutions via built-in Optimiser and Regression Tools.  
➤ Open architecture allows seamless integration with third party software and database such as OLGA, PVTsim, HTRI, IPR/VLP data and proprietary thermo property packages.  
➤ Highly reliable thermodynamic engine due to wide range of component database and specialised thermodynamic property packages.  
➤ With the new pipeline pigging modelling, pig location and velocity can be tracked throughout the gathering system for single or multiple pipes. It can be combined with the Event Scheduler to develop a pigging schedule for pipelines at regular intervals.  
➤ Fast and accurate in performing equipment sizing and rating for separators, tray columns, heat exchanges, relief valves, control valves and gas orifice.  
➤ Fast and easy way to monitor plant and equipment performance through online modelling with Plan Data Historian. | ➤ More than 300 licenses worldwide, with a growing market share.  
➤ Application in upstream optimisation has generated oil increment of 2% per field.  
➤ Start-up and shut down stability test for smooth Floating LNG operation (PFLNG1).  
➤ Reduced pigging frequency for upstream pipelines by 30% (PMA).  
➤ Standard application across all PETRONAS plants and facilities. |
P-VIP™ is a structured approach to assess and improve plant performance, focusing on yield, throughput, energy and hydrocarbon loss. It is a Process Optimisation methodology that blends engineering know-how and process simulation capability and is applicable in both Upstream and Downstream facilities.

P-VIP™ supports the aspirations of the PETRONAS Sustainability Council (CSC) on energy performance targets through additional value creation and efficient plant operations. It is based on a proven methodology which is repeatable, replicable and reproducible.
P-VIP™ has been used to streamline and align practices in PETRONAS Groupwide in an engineering structured approach to assess and improve plant performance. Reduction in hydrocarbon losses while ensuring environmental compliance supports the Corporate Sustainability agenda for energy efficiency and zero flaring targets.

**TESTIMONIAL**

- P-VIP™ enhances the following:
  - Yield Performance
  - Throughput Performance
  - Energy Performance
  - Hydrocarbon Loss Performance

**FEATURES**

- P-VIP™ is used to access, improve and monitor plant performance and track gap closure efforts. It is supported by a complete suite of tools including:
  - iCON® – Inflow Performance Relationship (iCON® – IPR)
  - Strategic Energy Review (SER)
  - Flare Reduction & Recovery (FRR)
  - Energy & Loss Management (ELM)
  - Steam System Modelling, such as iOU
  - Profit Tracker

**BENEFITS**

- P-VIP™ has been used to streamline and align practices in PETRONAS Groupwide in an engineering structured approach to assess and improve plant performance.
  - Reduction in hydrocarbon losses while ensuring environmental compliance supports the Corporate Sustainability agenda for energy efficiency and zero flaring targets.
PRSM™ is hosted in the web-based PiriGIS. It offers a quick screening tool to assess Jack Up (JU) and Platform suitability and has a one-stop-centre for geotechnical and geohazards information for Malaysian Waters. This system is built from a customised risk assessment framework to better identify and assess geotechnical and geohazards issues affecting the installation and operations of Jack Up (JU) and Platform.

Digitisation and integration of survey data into PRSM™ allows maximum utilisation of the money spent on the data as they will be used repeatedly throughout the field life cycle. A new comprehensive intelligent database consisting of JU and Platform characteristics, geohazards, geophysical, geotechnical and drilling records are available.
**FEATUES**

- Built from a customised risk assessment framework.

**BENEFITS**

- Enhance project delivery and performance.
- Quick decision making tool for higher management.
- Customised quantified risk assessment mapping for Jack Up and Platform foundation design.
- Strengthening engineering capability.
- Simplification, standardisation and fast guidance for Site Investigation work-scoping requirement at various project phases.

**TESTIMONIAL**

- PRSM™ has created value through:
  - Cost reduction via Optimisation of Site Investigation programs
  - Price of non-conformance (PONC) avoidance via better assessment of risks
  - Monetisation opportunities for high-hazard areas via geohazards assessment