**ProAssure™ Wrap Extreme**

**Composite Pipeline Repair System**

**THE TECHNOLOGY**

*ProAssure™ Wrap Extreme* is a high-performing composite pipeline repair solution for onshore and offshore applications, developed by PETRONAS in collaboration with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) of Australia.

The wrap consists of E-glass fiber pre-impregnated with a proprietary epoxy resin formulation. *ProAssure™ Wrap Extreme* is curable in **dry and wet conditions**. It effectively protects pipes against corrosion and also provides structural reinforcement.

**Repair Types:**
- Type A Repair (Strengthening)
- Type B Repair (Leaks)
- Patching Work

**Applications:**
- Corrosion Prevention
- Strengthening
- Leak Repair
- Neoprene Repair
- Caisson Repair
- Subsea Caisson Repair
- Barrel/Launcher Repair
- Odd Geometry Repair i.e. Tee, Nozzle
- Welding Defect Repair
- Vessel Repair (Patchwork)

**FEATURES**

- Able to be applied under **dry, wet** or **subsea** conditions
- Pre-impregnated for quality consistency
- Effective corrosion protection properties
- Extends pipeline life
- Versatile and adaptable to various sizes of structures
- No hot-work required
- Can be **applied on live pipelines** without the need to shutdown
- Lightweight and **cost effective**
- Performs in accordance to ISO/TS 24817 and ASME PCC-2
Natural force damage from earth movement and heavy rains or floods accounts for only 8% of all pipeline failure incidents. However, these type of incidents account for a much higher percentage of overall property damage than any other cause. Natural force damage tends to result in rupture failure rather than leaks, hence greater spill volumes, longer downtime & increased property & environmental damage. This article discusses the low frequency but high consequence nature of natural force damage and explains why it requires careful mitigation. It goes on to outline how reliable and accurate data gathering and the use of inertial measurement unit (IMU) technology during in-line inspections (ILI) can help prevent failures of this kind.

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Hydraulic analysis, in some cases referred to as numerical analysis has become an essential prerequisite for any projects involving fluid transport facilities. Hydraulic models are built to illustrate their operational capabilities in order to evaluate the proposed design and its performance. Basing on the fundamental principles
of hydraulics, they help to predict pressure profiles and identify bottlenecks, if any, in inadequately designed facilities. This comes handy especially in transient analysis involving various upset conditions that may lead to pressure surge phenomenon in liquid systems. During the operation of a facility, hydraulic surges are potentially created due to sudden change in the flowing fluid velocity that becomes unsteady. This can either result in an upsurge from pressure build up or a downsurge caused by the occurrence of vacuum. Generally, the sudden change in fluid velocity may take only seconds to generate hydraulic surges in the system. Any such occurrence can culminate in accidents and fatalities and therefore, special care has to be warranted in their design, construction, and operation to assess the associated risks. Appropriate operational strategies and surge control devices should be integrated as methods of mitigation to potential inadequacy in the design of such systems.

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PROASSURE™ WRAP EXTREME (Formerly known as PIPEASSURE) – An ISO TS 24817 and ASME PCC-2 fully compliant composite overwrap repair system for rehabilitating damaged pipeline and piping due to leaks, corrosion and mechanical damage was successfully installed on a damaged neoprene section of a 6 inch gaslift riser at the splash zone area. A total of 3m meter length section of damaged neoprene was repaired with PROASSURE™ Wrap Extreme composite overwrap system to restore the pipeline integrity to pristine condition.

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We Will Not Be Moved....

There seems to be an unspoken undercurrent of malaise evident in the pipeline industry, as newbuild projects have been slow to be sanctioned and the burst of pipeline activity evident at the turn of the millennium is conspicuous through absence. However, I surely feel that the feeling is rather unjustified. There is only a finite number of pipelines that can be built currently and most of them already have been constructed; the current market is driven more through maintenance and operation issues.


Author, Matt Loffman, commented, “This represents a 14% increase on the previous five-year period. The substantial fall in oil prices has weakened the onshore market, causing project delays and a focus on reducing costs for pipeline owners. Despite this, the delays we have observed have a different complexion to other oilfield sectors and have been limited in large part to the North America region.”

“In general, the onshore pipeline construction market is fairly insulated from commodity price fluctuations when taking a global perspective. There are delays relating to a reduction in the rate of growth in major non-OECD economies in addition to falling US unconventional production figures. However these are offset to a large extent by major transmission lines and demand growth in the Middle East and Latin America.”

Research Team Leader, Hannah Lewendon, concluded, “The team has performed a full refresh of the market model with the latest DW data. The methodology has been revised and sense-checked through extensive consultation with industry in each global region. On a regional basis the Middle East continues to be a bright spot where solid growth is anticipated. As other developing regions increase their infrastructure footprint we expect pipeline construction to remain important.

“Other observable trends include a shifting towards large diameter lines over the past three years. This is expected to continue to 2016 but in 2017 and beyond, smaller diameter pipelines are expected to gain relative market share driven by maturing networks within population centres of non-OECD countries and a return of US onshore production growth. Investment in LNG infrastructure and a move towards gas as a power source is also a key factor in future pipeline construction. We anticipate 66% of installed lines between now and 2019 to transport natural gas.”

This report reinforces the belief of this editor that there is no major malaise affecting the pipeline industry, things are just a normal unlike the heavy metal concerto of the early 2000s. This is despite the emergence of FLNG, which no doubt places the question of relevance of natural gas pipelines in today’s environment. This is despite the plunge of oil prices. This despite the slowdown of new producing fields to be connected to receiving terminals. The focus has been shifted to maintenance, operations and cross-border pipelines such as the TAGP. Things may not be at a peak but they are certainly not in the doldrums.

Coming to a more invigorating topic, I’d like to take this chance to congratulate Petrovietnam on their 40th Anniversary. The gas-rich country has been slowly but surely been building its portfolio, both in the upstream and downstream. In conjunction, Petrovietnam will host the Petrovietnam Conference & Exhibition 2015 for the purpose and on the occasion of 40 year anniversary of Petrovietnam. The event will showcase Petrovietnam achievements over the last 40 years and its future growth plans for the next 10 years. It will an enriching experience revisiting down the memory lane and looking forward towards the future of what will be in store for the Vietnam oil and gas industry as whole. I look forward to all our readers supporting one of our regional leaders - Petrovietnam.

Group Editor
PetroMin PIPELINER

Congratulates PetroVietnam for 40 Years of Excellence!
Development in the Works

One of the most significant initiatives of ASCOPE, the Trans ASEAN Gas Pipeline (TAGP) Project is envisioned to “establish interconnecting arrangements of electricity and natural gas in ASEAN” to ensure greater security and sustainability of energy supply in the region.

A TAGP Masterplan has been prepared and this serves as the blueprint and/or plan of action in undertaking the gas pipeline project in the region.

To date, 13 bilateral connections have already been established with a total of 3,631 kilometers of pipeline connections making possible the transmission of gas molecules to and from ASCOPE Member Countries or Member States. ASCOPE has likewise started working on developing the necessary regulatory framework such as open access, gas transit principles and gas specification harmonization aimed at facilitating the implementation of the TAGP Project.

The completion of the pipeline from Block B17 in Malaysia-Thailand Joint Development Area to Kerteh, Terengganu in April 2015 represents the 13th bilateral interconnection of the TAGP, increasing the length of cross border gas pipelines to 3,631 km. Currently, the connections are bilateral in nature, with pipelines linking Singapore-Malaysia, Myanmar-Thailand, West Natuna-Singapore, West Natuna-Duyong, South Sumatra-Singapore, Malaysia-Thailand, and Singapore-Malaysia. The ultimate aim is to have multilateral pipeline projects.

Following an assessment of its strategic direction in 2012, the focus of TAGP Project now includes liquefied natural gas (LNG) as an option for gas supply in the region, especially for countries that
physical pipelines may not be economic, whereby LNG would be supplied to regional regasification terminals (RGTs) acting as virtual pipelines. Currently, the operationalisation of four (4) Regasification Terminals (RGTs), namely: (i) FSRU West Java in Indonesia; (ii) RGT Sungai Udang in Malaysia; (iii) Singapore LNG Terminal; and (iv) Map Ta Phut in Thailand. The current total capacity for regas terminal is 17.8 MTPA or equal to 2,492 mmscfd.

While there are several challenges at hand such as shortage of gas sources, huge investment requirements (for the infrastructure needed), among others, ASCOPE Member Countries have been closely working to address the same in the spirit of cooperation and synergy.

Unprecedented growth in global liquefied natural gas (LNG) supply is adding 150 billion cubic metres (bcm) of LNG capacity that is already under construction or set to start in the next four years. But prospects for further natural gas demand and, in particular, LNG growth in key regions, have never been so uncertain.

Since the 1990s, the economic development of nations in the Association of Southeast Asian Nations (ASEAN) has led to a thirst for energy. The IEA expects more than 80% growth in regional energy demand through 2035 compared with 2011, as the economy triples and population expands by almost one-quarter. Coal will supply much of the new energy, but gas will also play a role, with 100 bcm in new demand lifting consumption to 250 bcm.
Early on in planning for the demand surge, ASEAN expected to rely on pipeline supplies. New output for distribution was, and still is, expected from the East Natuna gas field in the sea between Indonesia, Malaysia and Singapore. So energy ministers announced the Trans-ASEAN Gas Pipeline (TAGP) system in 1999 to connect existing pipelines for a fully integrated network that would also deliver supply from East Natuna. The region has extensive pipelines that in many cases cross borders – but such links are only binational. Aimed at enhancing security of supply and greater economic co-operation within the region, the TAGP is to connect gas reserves in the Gulf of Thailand, Indonesia, Myanmar and the Philippines to the rest of the region.

But over the past four years, LNG developed quickly as countries in the region built terminals, while the TAGP project lost steam. However, these terminals suffer from the inefficiencies of the global LNG market and are sometimes too large for smaller domestic demand centres. A 400 megawatt gas-fired plant needs about 0.4 bcm per year to run 5,000 hours per year – about four LNG cargoes per year.

Within this context, a new IEA report, The Asian Quest for LNG in a Globalising Market, finds that the TAGP project could still be a valuable solution. The network could provide flexibility and diversity of supplies within the region, based on both LNG and the development of East Natuna with the TAGP as backbone. For example, the TAGP could facilitate swapping gas within the region for an optimal allocation, through time or cargo swaps of LNG or via additional LNG imports through terminals in neighbouring countries.

The TAGP, however, faces several significant challenges:
- overcoming technical issues such as different gas quality and obstacles to developing East Natuna
- reconciling differences in market structures and pricing among countries
- moving from the existing bilateral cross-border pipelines system to an integrated and harmonised system
- harmonising regulation such as third-party access rules and regulatory authorities.

All of these issues limit the access of buyers, sellers or both from non-neighbouring countries to the imagined single network. In other words, many fundamental issues limit third-party access and hence the move to an efficient integrated network.

The East Natuna field has been difficult to develop, despite its substantial 1,300 bcm of natural gas. Located in a basin in Indonesia’s most northern territory in the South China Sea, it is far from the consuming areas. Another difficulty is the very high carbon dioxide (CO2) content of the gas, which would compound technical issues in aligning gas quality across the TAGP. In Singapore, for example, imported natural gas must comply with Gas Network Code specifications before it can be injected into the transmission system. The minimum methane level in Singapore is set at 80% of the volume, with CO2 no higher than 5%. But in Thailand, natural gas from onshore fields in the north-eastern part on average contains 76% methane and 13% CO2, while that from offshore fields in Myanmar contains 72.4% methane, 6.2% CO2 and 16% nitrogen.

The quality issue also applies to LNG. TAGP-facilitated swaps of LNG between terminals or between LNG and pipeline gas offer an opportunity to harmonise qualities system-wide. Without becoming an obstacle to new LNG supplies, quality could be managed at the import terminals before the gas is injected into the TAGP.
PETRONAS has been entrusted to lead the task force for the development of the Trans-ASEAN Gas Pipeline (TAGP) project. This initiative under the auspices of the ASEAN Council on Petroleum (ASCOPE) will further enhance the region's energy security with the development of a cross border pipeline system between ASCOPE member countries.

Malaysia’s Peninsular Gas Utilisation (PGU) pipeline which is linked to the Trans Thailand-Malaysia (TTM) Gas Pipeline in the north of Peninsular Malaysia will serve as an important foundation for the realisation of the TAGP project. A joint project between PETRONAS and the Petroleum Authority of Thailand, the TTM pipeline transports gas from the offshore Malaysian-Thai Joint Development Area (MTJDA) - an overlapping economic area administered by the Malaysia-Thailand Joint Authority.

The TTM pipeline system comprises both onshore and offshore gas pipelines, including:
• A 277-km natural gas pipeline from the MTJDA to the TTM Gas Separation Plant (GSP) in Songkhla, Thailand,
• A 98-km sales gas pipeline from the TTM GSP to the state of Kedah, Malaysia where it is tied-in with PETRONAS’ PGU III pipeline system; and
• A 239-km LPG pipeline from the TTM GSP to PETRONAS Gas Berhad’s LPG receiving terminal at Prai Depot I in the state of Penang, Malaysia.

The Association of South East Asian Nations (ASEAN) is promoting the development of a Trans-ASEAN Gas Pipeline system (TAGP) aimed at linking ASEAN's major gas production and consumption centers by 2024. Because of Malaysia's extensive natural gas infrastructure and its location, the country is a natural candidate to serve as a hub in the ongoing TAGP project, which currently has 1,800 miles of pipelines in operation out of a proposed 4,500 miles. The first pipeline connected Malaysia with Singapore and was commissioned in 1991. Singapore currently has two contracts to import 84 Bcf/y of gas from Malaysia. Gas pipelines between West Natuna, Indonesia, and Duyong, Malaysia were installed in 2002, and Malaysia imported more than 40 Bcf of gas from Indonesia in 2013, according to the BP Statistical Review 2014. The Trans-Thailand-Malaysia Gas Pipeline was commissioned in 2005, which allows Malaysia to transport natural gas from the Malaysia-Thailand JDA to its domestic pipeline system.

A key component of expanding the TAGP is to transit natural gas from the massive East Natuna gas field, located in the South China Sea to Southeast Asia. The field is being developed by a joint venture consisting of Pertamina (Indonesia), ExxonMobil, Total, and PTT Exploration and Production (Thailand). Malaysia's PETRONAS exited the project in 2012, and the field's development has encountered several delays as a result of its remote location and high carbon dioxide levels. These challenges to East Natuna's development could also delay the TAGP, and several Southeast Asian countries are turning to LNG imports to deal with the region's gas shortages.
Perhaps the greatest challenge for the TAGP is the different market structures found among the ten ASEAN member countries. For example, besides national monopolies in several nations, Thailand and Indonesia have vertically integrated companies, while Singapore is on a firm course towards deregulation with the unbundling of transport and commercial activities. Most countries do not provide efficient and transparent third-party access, even if there is regulation supporting this principle. Fulfilling the TAGP aim of a single network would involve harmonisation of regulatory oversight.

Other limitations to development are national policies that favour domestic energy use before considering exports – policies that limit the most efficient allocation of gas within the region. The most common form of favouring domestic energy users is through subsidies, which many countries in the region use to protect gas consumers from higher international market prices, a trend likely to worsen as countries become increasingly reliant on imports.

Connecting these diverse markets through a single pipeline network would enable access to the various countries. But the distinctions among national market structures would limit that access, as the parties’ interests and risks vary. The absence of third-party access to the transmission grid in some countries would hinder the creation of an integrated network in which gas would flow to where the highest prices are paid, which would create additional challenges for the countries with artificially low prices.

Over the medium term, gas markets of non-OECD Asian countries will play a key role in attracting additional LNG supplies, according to the IEA Medium-Term Gas Market Report 2014. For Southeast Asia, LNG will always be necessary, as it brings flexibility and matches some countries’ island geography.

But ASEAN countries will be turning to a crowded market, as demand expands elsewhere, too. By 2019, total Asian LNG imports will near 150 bcm, more than Japan’s current world-leading deliveries. China will overtake Korea to rank as the second-largest overall gas importer behind Europe, relying on LNG as well as pipeline gas to maintain a diversified supply mix and feed its gas-hungry coastal region, which remains distant from pipeline or most domestic supplies. In India, LNG is the only likely source of imports over the medium term as pipeline projects remain a far-away dream.

As such, the requirements for ASEAN to develop import and transport infrastructure will be significant, and the competition for product high. As most Southeast Asian countries are interlinked bilaterally by pipeline, increasing these connections by reinvigorating the TAGP project can diversify delivery, buttressing the energy security crucial to the region’s economy.

Indonesia
Indonesia is reorienting energy production from serving primarily export markets to serve its growing domestic consumption. Indonesia’s energy industry has faced challenges in recent years from regulatory uncertainty and inadequate investment.

Oil
Indonesia has no international oil pipelines and few domestic pipelines, making maritime trade vital. Most petroleum trade is in the form of imports, chiefly motor gasoline and diesel for Indonesia's transport sector. The country exports some fuel oil for electricity fuel generation. The country both imports and exports crude oil and is a net crude oil importer as a result of the regional imbalances and growing demand for crude oil use in refineries and for power generation.

In 2013, Indonesia imported over 506,000 bbl/d of crude oil and lease condensate, according to the
Analysis of Petroleum Exports (APEX) tanker tracking service of Lloyd's List Intelligence. Roughly one-fourth of crude oil imports came from Saudi Arabia. Other significant suppliers included Nigeria (15%), Azerbaijan (15%), United Arab Emirates (5%), Qatar (4%), Malaysia (4%), and Angola (4%).

Indonesia's net oil product imports remain relatively high as a result of insufficient refining capacity to handle the growing demand for oil products. The country's oil product imports in 2012 were 435,000 bbl/d and are estimated to be 466,000 bbl/d in 2013, according to FGE. Oil product imports consisted primarily of gasoline (66%), gasoil for transport and power generation, LPG, and jet fuel. Pertamina is responsible for purchasing Indonesia's subsidized gasoline, RON 88 specification gasoline, which currently makes up the largest share of the country's gasoline demand.

Japanese demand for Indonesian fuel oil that increased after the Fukushima nuclear accident in 2011, is now subsiding as Japan increases natural gas and coal imports.

Indonesia continues to export crude oil and condensates even though the country has turned into a net importer of oil, partly because of a desire to maintain market access and oil revenues especially when international oil prices are high. In addition, regional imbalance in the archipelago between oil production and demand centers encourages both imports and exports. In 2013, APEX tanker data estimated Indonesian petroleum exports were roughly 455,000 bbl/d, primarily to regional buyers.

Gas

Indonesian natural gas production initially was exported, but the country's declining oil production led producers to shift increasing gas volumes toward domestic consumption. In 2012, Indonesia consumed 1,329 Bcf of natural gas, or slightly more than half of its total dry gas production. Although
the industrial sector accounts for the largest portion of domestic consumption, industry analysts expect the power sector to be the most significant driver of future consumption growth. Indonesia's Ministry of Energy and Mineral Resources stipulates that gas supply be allocated to the needs of enhanced oil recovery, the fertilizer industry, and the power sector before any other sectors.

State-owned Perusahaan Gas Negara (PGN) controls the midstream gas market and the transmission market, operating more than 3,600 miles of natural gas transmission and distribution pipelines. However, domestic distribution infrastructure is almost non-existent outside of Java and North Sumatra. PGN began operating the South Sumatra-West Java pipeline in 2008, providing an important link between the gas-producing region of South Sumatra and the densely populated market of West Java. The Grissik-Duri pipeline is another important domestic transmission pipeline, as it provides gas to Chevron's Duri oil field for its steam flooding and power generation activities.

Although the majority of Indonesia's gas exports are transported as LNG, Indonesia sends about a fourth of its gas exports to Singapore and Malaysia through two pipeline connections: one from its offshore fields in the West Natuna Sea and the other from the Grissik gas processing plant in South Sumatra. In 2012, Indonesia exported about 360 billion cubic feet per year (Bcf/y) via pipelines, with nearly 280 Bcf/y sent to Singapore, according to BP Statistical Review of World Energy 2013. These pipelines have a combined capacity of approximately 400 Bcf/y and deliver gas to Singapore under two long-term contracts, both set to expire around 2020. However, SKK Migas reported that Singapore plans to end gas purchases from Indonesia's pipeline exports once contracts expire. This reduction in exports should allow Indonesia to secure more domestic supply in the next few years.

Malaysia

Malaysia is the world's second-largest exporter of liquefied natural gas and the second-largest oil and natural gas producer in Southeast Asia, and
is strategically located amid important routes for seaborne energy trade.

**Oil**

Malaysia has a relatively limited oil pipeline network and relies on tankers and trucks to distribute products onshore. Malaysia's main oil pipelines connect oil fields offshore Peninsular Malaysia to onshore storage and terminal facilities. The 124-mile Tapis pipeline runs from the Tapis oil field and terminates at the Kerteh plant in Terengganu, as does the 145-mile Jerneh condensate pipeline. The oil pipeline network for Sabah connects offshore oil fields with the onshore Labuan oil terminal. This network is currently expanding following the launch of development projects including the Kebaban-gan cluster, the Malikai, Gumusut/Kakap, and Kikeh oil fields. For Sarawak, there are a few other oil pipelines connecting offshore fields with the onshore Bintulu oil terminal. The majority of pipelines are operated by PETRONAS, although ExxonMobil also operates a number of pipelines connected with its significant upstream holdings located offshore Peninsular Malaysia.

An international oil products pipeline runs from the Dumai oil refinery in Indonesia to the Melaka oil refinery in Melaka City, Malaysia. An interconnecting oil products pipeline runs from the Melaka refinery via Shell's Port Dickson refinery to the Klang Valley airport and to the Klang oil distribution center.

**Gas**

Malaysia has one of the most extensive natural gas pipeline networks in Asia, totaling about 1,530 miles. The Peninsular Gas Utilization (PGU) project, completed in 1998, expanded the natural gas transmission infrastructure on Peninsular Malaysia. The PGU system spans more than 880 miles and has the capacity to transport 2 billion cubic feet per day (Bcf/d) of natural gas. Other natural gas pipelines run from offshore gas fields to gas processing facilities at Kertih. Also, a number of pipelines link Sarawak's offshore gas fields to the Bintulu LNG facility. However, there is limited gas distribution coverage in much of the Sarawak and Sabah states.
Malaysia has an extensive gas pipeline network running through Peninsular Malaysia and pipelines that connect offshore fields in all three states to key infrastructure onshore.

The Sabah-Sarawak Integrated Oil and Gas Project, slated to be completed by 2015, includes the 325-mile Sabah-Sarawak Gas Pipeline (SSGP) that will transport 1 Bcf/d of gas from Sabah’s offshore fields to the PETRONAS LNG complex for liquification and export. Some natural gas from the terminal is also reserved for fueling downstream industrial projects and for power generation in Sabah. The SSGP is expected to be ready for operations in conjunction with the SOGT in 2014. Other pipelines link natural gas fields located in offshore Sabah to the Labuan Gas Terminal.

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Bottom Line Improvements: The Role of First Line Supervision

In times of slow growth, the pressure on managers to reduce costs and focus their efforts on productivity is particularly high. During periods of slow growth rate or of turbulent times - as we experience now with China trying to stabilize its currency and prevent the onset of an economic downturn - companies must take all possible steps to ensure that their processes and staff are operating at the highest level of productivity. In the context of capital intensive industries, the role of the First Line Supervisor in achieving Operational Excellence is of vital importance and yet is often overlooked and undermined by a lack of investment of the part of companies.

In this paper, the issues surrounding First Line Supervision will be discussed. Beginning with the expectations and perception of FLSs, the paper will highlight some common mistakes made by Managers and Supervisors alike, before outlining steps managers can take to ensure that FLSs contribute to real efficiency gains, translating into bottom line profit.

A Pivotal Role

The position of FLS within any organization is pivotal. Not only is he expected to translate management decisions into practical actions and then implement them, but also to organize work for his team, set objectives and then follow up to ensure plans are achieved. Operating at a level between management and the execution workforce, an FLS needs to be a team leader and motivator, technically skilled and competent, as well as a good communicator. It is one of the most demanding day to day positions at a plant, and yet frequently, FLSs are usually the most ill-equipped to assume their responsibilities.

There are multiple reasons for this. First, most FLSs are promoted up “from the ranks,” having shown technical expertise, or by length of service, sometimes by having showing leadership potential. As a result, in their new position, they are required to manage colleagues with whom they previously worked and ensure that the work they do is completed well and on time. Second, they are asked to do a huge volume of tasks and are often not sure which tasks form part of their remit. Third, they are rarely provided with the right tools or the training to do their jobs, so they simply do not know how to manage a team of people, how to ensure productivity levels are maintained or improved or how to use systems to follow up and ensure no lost time. Caused by a lack of investment on the part of managers to properly train and develop their FLSs, the perception of what the role entails varies widely from the point of view of the FLS himself and managers.

Varying Perception

In the context of Maintenance organization, during the initial assessment, our project team typically conducts a survey whose objective is to establish what the perception of the FLS and the Manager was concerning the percentage of time spent doing a number of key tasks, such as conducting feedback, follow up and confrontation. As you can see in Figure 1 - which represents a typical example - there is a marked difference between what Supervisors do, what they think they do and what they would like to do. If we look at
the Observed row for example, only 6% of an FLS’s time is spent on active supervision, interacting with his team in the field, but he perceived that time to be around 22%, while recognizing he would like it to be around 28%. If we consider administration, the perception of the FLS is closer to reality, and yet still not accurate, while time spent coaching would again ideally increase, but does not occur in practice.

This difference between what a FLS wants to do, what he thinks he should do and what he actually does stems from the lack of a clear definition and understanding of what his roles and responsibilities are. During the same survey, supervisory behavior was measured during a number of tasks, ranging from Making Assignments, Giving Directions and Follow Up to Providing Feedback and Reporting. The results showed that active behavior was not demonstrated at all when it came to providing feedback – regardless of whether that feedback was positive or negative. When questioned as to why that was, the FLSs understood that providing feedback was absolutely necessary, but they did not consider it to be part of their job, someone else had to do it.

The same survey then measured the tools available including Schedule Control, Variance Management, Review Meetings, Operating Reports and Perfect Day. Again, when it comes to having the right tools available, the survey showed that FLSs are rarely equipped to carry out their tasks. The ability to “Walk the Floor” for example, checking if tasks have been completed on time and if not, why not, was rarely demonstrated. Likewise the ability to handle and conduct meetings and operating reports was low. Without these tools, it will be extremely difficult for FLSs to demonstrate the right behavior.

**The Perfect Day**

The empowerment of the supervisor’s role during the execution of the work involved in supervising third parties is a big step forward in valuing the skills and knowledge of the supervisor. Management tools tailored to individual supervisory needs followed by training as well as skills development and shop floor coaching completed the set of solutions. In order to respond positively to a series of process and system enhancement opportunities, the concept of ‘active supervision’ needs to be introduced and successfully implemented.

By showing presence on the shop floor, active supervision is a means of making sure that work is being done at the right time, in the best way by applying strictly-set safety rules through planned actions and with an adequate short interval follow-up. Applied correctly, active supervision is the key to reacting quickly to avoid or rectify problems, to measure progress and to realise a set work plan within a given timeframe.

When it comes to exhibiting the right level of
interaction with their crew or with contractors’ crew, FLSs must understand what a “Perfect Day” should look like and how to go about getting the right performance from their team. Many only interact with their crews at the morning meeting where the day’s work is assigned and sometimes at the end of the day. They have no genuine perception of whether the work was accomplished or not, was executed at maximum efficiency or of any impediments the crew encountered.

As a result, training will need to be provided to help them understand the actions required of them. This will begin with first interaction with their respective crews after the day’s work has been assigned to ensure work has begun as planned and no major issue is foreseen. At least two other contacts or interactions in the field are also necessary before lunch time to ensure progress and re-assign the teams if needs be and by mid-afternoon, to provide feedback to the scheduler and to prepare for the next day schedule and the end of day review with Production.

Their interaction with the crew(s) during these rounds should be geared towards making certain the work has started as planned, permits are in-hand, parts / materials are onsite. It allows the FLS to clear barriers and obstacles. During these rounds the FLS also needs to check to see if the work is progressing according to the expectations of the daily schedule, i.e., a four hour job is not taking six or eight hours. If there is variance, he will understand the root cause and will be able to feed-back to the planner, so the methods or standards could be updated for the next time similar work is to be completed. If the crew is aware the FLS will be stopping at the job three or more times a day, they will tend to progress the job as planned, and contact / report the FLS immediately if they encounter any difficulties.

Performance Management
Once an FLS has been properly trained and is making progress with his daily responsibilities, further training should be provided to enhance his managerial skills. A combination of internal and external training could be provided according to in-house capabilities and be selected according to the role the individual will likely play in the company going forward.

Then, Managers should agree Key Performance Indicators with FLSs which define their goals and where work needs to be done. The FLS in turn should be shown how to agree KPIs with his team and to discuss barriers to success with workers on a regular basis. For example, if the lack of a work permit was prevented a scaffolder from erecting scaffolding on time, listening to the scaffolder and understanding the reasons for the work permit delay is fundamental to the smooth functioning of the team and to maintenance systems. Staff should be encouraged to communicate their knowledge as to the reasons for delays and issues so they can be addressed swiftly.

Operational Excellence
When it comes to the importance of an FLS on Operational Excellence (OE) initiatives, ensuring that FLSs have the right tools to do their jobs is critical. Roles and responsibilities need to be clarified, tools and processes made available and training and coaching conducted so that the FLS can ensure that all work is carried out on time and according to plan. This includes ensuring that robust Maintenance processes which cover Planning, Scheduling, Supervision and Reliability are in place, and that each step is clearly explained and a definition of RACI provided.

In our experience, companies that commit to investing in their FLSs reap valuable rewards. First, the increased capacity of the FLS to man-
age his team will contribute to the efficiency of the execution workforce – both internal and external – which results in increased productivity and reduced inefficiencies. As a typical example of what we observe in the chemical industry, the implementation of the above changes to FLS capability resulted in a reduction of non-value added time of 45 minutes at the start of the day, while also bringing the Average Start Time forward. Working together with his team, the particular FLS responsible had successfully removed barriers which were delaying work permits, slowing down the arrival of workers onsite and increased motivation due to transparent decision making.

If we look at how these changes can translate into bottom line gains, the average jobs completed per day increased from just about 3 to over 4. The direct effect of such changes on maintenance cost is visible: here the reduction of circa 20-25% of the day-to-day maintenance costs is noticeable after the first year of the implementation of the FLS in his new role, with adequate tools and training.

In conclusion, the importance of FLS capability to the success of site teams should not be underestimated. While committing to investing in training and managerial development may seem expensive at the start, the savings made as a result are worth more than the original outlay. Teams will remain motivated and repair durations will be reduced and quality of work will be improved, with less re-do. As a mindset, Productivity, Quality and Safety go together, improving the safety of employees and ultimately, all contributing to bottom line improvement.
When asked about the quality of their schedules, many turnaround managers complain that their schedules are not reliable enough, are incomplete and do not properly capture the ever-developing circumstances of the execution of a turnaround.

Alternatively, they state that the document is far too complicated, overly layered with activities and tasks and thus becomes somewhat redundant in terms of usage, as it is just too big to maintain with any confidence. Either way, the schedule fails in its role as the key driver to actively manage and control the full event.

This article lays out the reasons why most schedules fail and a number of steps Turnaround and Project Managers can take to build a successful schedule which in turn can deliver a smooth and punctual turnaround.

Static Scheduling Flaws

One of the key reasons that schedules are undervalued is that they are used only as a static schedule and so cannot reflect the developing and dynamic nature of a live turnaround. In simple terms, the schedule reflects the initial plan but not the actual delivery.

Consequently, the further into the execution you go, the more the schedule becomes redundant. It could be a question of the chicken and the egg - where either a restricted amount of detail or far too much detail mean that the document is badly constructed. Equally, it could be a self-fulfilling prophecy, where the TA manager has never used a schedule to actively manage the event and so continues not to, whatever the quality of the document.

If Turnaround (TA) Leaders are prepared to embrace a structured, controlled and comprehensive approach to building, utilising and managing a schedule, the dynamic methodology can make a significant difference to the success of their turnarounds.

Preconditions for Dynamic Scheduling

Schedule quality is paramount for dynamic scheduling to be successful. It is essential that scheduling principles, standards and quality need to be defined in a concept well in advance of actually creating the schedule.

The Schedule Concept is essentially an agreement between all stakeholders that defines the way in which the schedule will be developed, managed and utilized. Decisions about the schedule structure, levels of detail required, management of risk and schedule uncertainty, level of integration as well as roles and responsibilities of key stakeholders need to have been identified, defined and agreed by all major stakeholders. That could include TA Management, Operations/Process, Engineering, End-Users (Contractors), Lead Planners and Lead Schedulers. Note that the schedule is not typically geared to perform as a financial control document. It should be regarded as an activity/time/resource control tool.

Leadership must ensure that the organisation is capable and resourced to develop the “front-end”. Too often, resources are not released or engaged,
planning is left too late and subsequent schedule quality suffers massively. In addition, schedule structure and execution organization structure will need to be aligned to enable meaningful progress reporting and associated daily decision making. In simple terms, roles/responsibilities and reporting processes need to be assigned and agreed. Schedule creation and development should be in line with the principles laid out in the concept. Frequent reviews to ensure that the schedule will be developed on time and in line with pre-defined quality standards are crucial. Typical quality issues such as too many layers of detail of task per activity (planning breakdown simply copy/pasted into schedule); orphaned activities (i.e., activities with no predecessor or successor); actions with no allocated resources; and a high quantity of constraints such as fixed dates, lags, leads and lack of standardized milestones are likely to lead to a schedule that cannot be used for daily decision making during turnaround execution.

Additionally, ensuring that schedules are fully integrated by including all event activities such as all Operations tasks and all capital projects will dramatically improve the chances of it surviving execution. For example, by detailing the phased shutdown process, optimal utilization can be achieved by allocating resources as early as possible to each stage of the shutdown/start-up processes, and any delay implications can be recognized and taken account of immediately.

**Dynamic Execution and Optimization**

Optimizing the schedule is an iterative process that involves various aspects. The critical path, resources, network and simultaneous operations must all be taken into account if the schedule is to be fully optimized. Considering that risks are always present and that the risks may change as time moves on, it is crucial that they are also realistically and regularly evaluated to establish their most likely impact on the schedule completion date.

Sticking to a deterministic end date that has been dictated purely by the critical path and excludes a realistic understanding of risks involved can result in the schedule portraying an unrealistic and unachievable project end date.

Finally, the schedule owner and execution contractors must ensure there is a continuous update of reliable live progress information into the schedule during execution. Status reporting, reviewing and prioritizing updates accordingly and then communicating them to the execution team is vital so that the inevitable obstacles or changes can be accommodated and do not cause unnecessary delays or breaks. Minimising any surprises – whether big or small, knowing of them in good time and being able to take a decision earlier rather than later, is one of the keys to delivering the TA successfully.

**Disciplined Reporting**

This involves ensuring that a workable and very well disciplined daily routine is established in terms of reporting progress, updating the schedule, adjusting/agreeing priorities and communication through a series of planned daily turnaround meetings is in place. Without a rigorous daily time discipline for reporting and updating, agreeing and communicating, all the hard work in developing the schedule will have been a waste of effort.

As long as all stakeholders stick to the concept, from design and development of the schedule to a well thought through daily reporting and updating regime, the schedule should be more usable, reliable and a true reflection of what is actually happening out in the field. That means that it can be used with confidence to drive the execution activity and make decisions, rather than just as a secondary reporting tool.

**A Principled Approach**

Dynamic scheduling doesn't have to be difficult; it is simply the application of a principled approach to schedule development and management. Its
The foundation relies upon a deliberate mind-set within TA management that the schedule will be the daily key driver during execution. For that to happen, TA management has to have confidence in the design and implementation of the “Scheduling Concept”. If managers and schedulers are willing to challenge the status quo and commit to a scheduling methodology that is clearly defined from the outset and allows for improved schedule flexibility during execution, the chances of achieving a successful turnaround are infinitely higher.

Finally, the implementation of lessons learned involving the schedule utilisation will improve the chances of a well-planned, well laid-out, useable, reportable, flexible and therefore dynamic schedule for the next TA. Failure to learn from the last TA is the easiest way to ensure a repeat performance of all that was wrong next time round.

This publication thanks Mr. Dirk Traeger, CEO, T/ANGO Turnaround Management Group for providing this article, which was presented at the Downstream Business, Engineering & Technology Conference in Kuala Lumpur, Malaysia on 15th September, 2015.
Using Mapping to Add Longer-Term Value to In-Line Inspection

Natural force damage from earth movement and heavy rains or floods accounts for only 8% of all pipeline failure incidents. However, these types of incidents account for a much higher percentage of overall property damage than any other cause. Natural force damage tends to result in rupture failure rather than leaks, hence greater spill volumes, longer downtime & increased property & environmental damage. This article discusses the low frequency but high consequence nature of natural force damage and explains why it requires careful mitigation. It goes on to outline how reliable and accurate data gathering and the use of inertial measurement unit (IMU) technology during in-line inspections (ILI) can help prevent failures of this kind.

The remote nature of long-distance pipelines can expose them to a range of external loads. Earthquakes, landslides, sea bed movement, ship anchor drags, permafrost, flooding, 3rd party damage, construction and backfill all have the potential to locally deflect a pipeline from its as built position. While steel pipelines exhibit small amounts of inherent ductility, any deflection from the design centre-line will impart an increased level of strain into the material. Too much deflection can cause buckling, wrinkles, damage at weld or defect locations and ultimately, failure. While the incidence of natural force damage is comparatively low, the consequences are far greater. Natural force damage only equates to 8% of significant incidents but causes 34% of all property damage. This is because these incidents tend to result in pipeline rupture rather than leakage, hence greater spill volumes, longer downtime and increased property and environmental damage.

It is possible to identify ground conditions and locations where pipelines may be at risk of damage from bending deformation and where mapping should be considered as a matter of course. As well as any pipeline which has known or suspected pipeline movement or failure history, these include pipelines in areas of known or suspected soil settlement, washed out or flooding, known or suspected subsidence or landslide, known or suspected earthquake or seismic activity, known or suspected sand dune migration and areas experiencing large seasonal swings in ground conditions (dry to wet, frozen to thawed). Subsea pipelines in areas of known or suspected seafloor movement or areas of spanning, as well as subsea pipelines in areas of known marine activity where there is a chance of anchor drag or trawling should also be assessed routinely. There is also a major long term benefit of mapping newly laid pipelines in order.

Figure 1. Example of pipeline configuration susceptible to bending strain
to validate ‘as laid’ straightness and provide a baseline for future integrity surveys.

As it is not practical to directly measure the strain in the pipeline material along sections that might extend to hundreds of kilometers in length, the strain is calculated by considering the curvature of the pipeline. Curvature is a numerical measure of how ‘bent’ a pipeline is and it is defined as the angle a pipe turns through over distance. In order to assess the additional strain in a pipeline due to natural force damage or other external loading, the exact position is surveyed using an in-line inspection tool or ‘pig’ equipped with an inertial measurement unit (IMU) module. The IMU measures the pig’s movement in 3D, using three gyroscopes to measure rotation and three accelerometers measure acceleration plus gravity. The resulting data is used to determine pipeline coordinates in 3D so that pipeline curvature and resultant strain can be calculated.

Pipeline mapping can be carried out as part of a wider integrity monitoring program where defects and metal loss can also be identified in a single run using smart pigs. PII Pipeline Solutions’ (PII) MagneScan™ high-resolution metal-loss inspection for advanced length and width sizing of pitting and Narrow Axial External Corrosion (NAEC) or CalScan™ EP (Caliper) tools can locate and measure dents and other geometric deviations. Inclusion of the mapping function makes little change to the overall logistics of an inspection run. The main additional activity is the provision of surveyed reference points prior to inspection, approximately every 3 kilometres (2 mi) along the pipeline. These points can be features such as block valves or temporary above-ground markers. Applying multiple inspection techniques in a single run helps to make the best possible use of a time-limited inspection window.

The mapping data provided by the Inertial Mapping Unit (IMU) is used to provide a 3D model of the pipeline’s actual centerline co-ordinates so that any areas of significant curvature and the associated bending strain magnitude can be identified and investigated. When repairs are required for defects reported by an inspection, highly accurate IMU coordinates enable the pipeline operator to quickly and reliably locate them via a precise GPS location prior to excavation, significantly reducing digging costs and in-field time. With a GPS accuracy of ± 1.5 m the IMU mapping technology helps pipeline operators plan the most effective and efficient repair methodology by taking into account local geography and third-party constraints that may impede site access. If bending strain is found, remedial action can include exposing the pipe and replacing backfill or rock dumping. In extreme cases, extended environmental loading can lead to buckles, which need to be cut out and repaired.

Various existing industry codes consider the effect of excessive bending strain and offer guidance on limits. The presence of an axial bending stress can reduce the failure pressure of a circumferentially orientated defect including cracks and corrosion. Several fracture mechanics based methods can be used to estimate the axial failure stress for a circumferential flaw in a pipeline. The total stress due to internal pressure & axial bending load can then be compared to the estimated axial failure stress.

Reporting bending strain allows consistency of results between different pipe diameters as well as highlighting areas which may be a potential integrity threat. When a single run analysis is carried out without any historical data, the strain on the line is calculated from the measured curvature. Considering a pipeline subjected to a maximum radius bend of 400 x diameter (400D), over a 12m length the strain will be 0.125%. The 400D curvature threshold is roughly equivalent to the strain at yield for Grade B line-pipe. When historical data is available, the comparison with a previous inspection greatly improves confidence in
the identification of low-level deformations. Changes in strain as low as 0.02%, (equivalent to a 2500D bend, over a 12m length of pipeline), can be detected when new IMU data is compared with a benchmark dataset. During field testing the performance of PII’s IMU mapping system has been confirmed by blind tests in a client’s pipeline. In one particular test, the client exposed a 60m length of pipe and displaced the centre by 200mm. By running an IMU tool before and after the deformation, PII successfully located and sized the deformation feature in 29 kilometres of 30” pipeline. Other run-to-run comparisons have confirmed the repeatability of PII’s bending strain data, both onshore and offshore.

PII has first-hand experience of inspecting undersea pipelines that have been subjected to considerable external force. PII was engaged by a European customer who has a number of large diameter offshore lines in its infrastructure portfolio. A single IMU inspection run was undertaken as part of a strain screening investigation to produce a baseline assessment. When the data was analysed it identified areas of deflection from the design centreline by up to 90m. Further investigation indicated that previous repairs to the pipeline had been carried out in the area that had suffered the most severe deflection, potentially causing the movement. In other areas it appeared that the damage and pipeline movement was consistent with impact from an anchor and subsequent dragging.

As well as helping to assess bending strain, IMU mapping can help pipeline operators to satisfy regulatory demands. Increasingly, regulations demand that pipeline operators document the precise location of pipeline assets. In some cases, however, records are old and of unknown accuracy, or may not include details of centerline location. Pipeline mapping can also benefit operators by determining the precise location of each girthweld and pipe feature.

Another example of where mapping has been fundamental to an operator’s integrity monitoring programme came during PII’s inspection of a spirally welded crude oil pipeline. The pipeline had been built during the 1970s in a geologically unstable area with additional ground condition variations. A number of the spiral welds had suffered ruptures due to the combined loading from internal pressure, cyclic pressure loading and axial stress from ground movement. PII’s initial inspection established that the pipeline was subject to multiple threats including internal and external corrosion, spiral weld anomalies/ cracks, girth weld anomalies/ cracks, dents and ovalities. Triax Magnetic Flux Leakage (MFL), calliper and IMU ILI tools were deployed into the line to detect and quantify threats. Over 0.5 million defects were detected by the ILI tools together with over 1000 strain events. With such a wide range of combined threats, PII created an assessment matrix to govern assessment rules & criteria.

It was noted that crack defects that are identified as acceptable under pressure load may be unacceptable when bending strain taken into account.

Increasingly, strain-based designs are being considered for new pipelines. These designs can use modern pipe material such as x80, x100 or x120. With strain-based designs it is even more important to confirm that the strain capacity of the pipeline has not been fully utilized during pipe laying. An IMU Strain inspection can provide pipeline operators with this confirmation.

Strain measurement is an excellent indicator of where unknown or unexpected pipeline movement may have occurred. By identifying change of shape of a pipeline and any potential movement since the last inspection run it offers enhanced integrity monitoring and early warning of ground instability. Strain measurement also helps prevention of failures through identification of strain events and coincident features throughout the pipeline. Combined with PII’s IMU technology, it provides an invaluable integrity monitoring tool for oil and gas pipeline operators.

This periodical thanks Mr. Ian Murray of PII Pipeline Solutions for providing this article for publication.
The substantial fall in oil prices since July 2014 has weakened the onshore pipeline market, causing project delays and a focus on reducing costs for pipeline owners. Despite this, the delays we have observed to date have a different complexion to other oilfield sectors – deepwater capital projects or drilling programmes for example – and have been limited in large part to the North America region. In general, the onshore pipeline market itself is well-cushioned from short-term commodity price fluctuations with projects typically responsive to long-term demand and supply trends, both within and between regions. Other geopolitical factors tend to be of greater relative importance than for other sectors, which has played its part in limiting the impact of the downturn, so far.

Douglas-Westwood (DW) expects onshore pipeline capital expenditure to grow modestly, totaling $220bn over 2015-2019, an increase of 14% compared with $193bn over the preceding five-year period. The major expenditure categories of construction and line pipe procurement have steady growth throughout the forecast. In contrast, Capex relating to stations (pumping, compressor and pigging) is expected to plateau or decline slightly year-on-year, as gas lines gain market share over liquids and station efficiency gains are realised internationally.

Installation activity in most regions is expected to increase, supported by continued product demand growth in both new and existing population centres, new and increasing hydrocarbon supply, and a shift in energy demand preferences towards gas.

**Demand Shifting To Non-OECD Regions**

Population growth and overall energy demand continue to rise in non-OECD economies, particularly in the Asia Pacific region. This is driving additional infrastructure requirements of which transportation of fuel and products is an important element. In a number of Asia Pacific economies the level of development for product transportation infrastructure is still considered to be lagging behind existing demand, insulating the construction market further from near-term demand growth perceptions and commodity prices.
A continuation of robust growth in non-OECD markets is expected to see Asia overtake North America as the largest regional market by Capex in 2015, although the volume of pipeline installations will remain higher in North America throughout the forecast period.

North America will suffer the greatest impact as a result of the decline in commodity prices. Drilling activity in the unconventional plays has reduced significantly since mid-2014 and production is also declining, including in the Bakken where pipeline infrastructure remains under-developed. Driven in part by a higher crude price beyond 2015, pipe installation demand is set to increase steadily in this region from 2016 onwards. In contrast, Western Europe Capex is in decline, a trend expected to continue over the next five years.

A significant increase in expenditure in other regions, particularly those with fastest economic growth, is likely to provide opportunities for indigenous and international players alike as infrastructure develops towards an established network of pipelines carrying both raw hydrocarbons and finished products. This includes Africa, Latin America and the Middle East.

Pipeline activity in the Middle East is currently growing at a faster rate than in any other region, a trend expected to remain over the next five years. Driving the market expansion is rising energy demand both within and in neighbouring regions, especially Asia, alongside strong growth in domestic hydrocarbon production. Iraq, Saudi Arabia and the UAE in particular have followed a strategy of increasing production in recent months with a positive impact in the near-term on pipe installations. The lack of political stability and security in many areas, including Iraq, Syria and Yemen, is still a key threat to pipeline projects, however. As the level of uncertainty increases, there is potential for further project disruptions. The removal of US and EU sanctions on Iran is likewise anticipated to boost activity in that economy although the majority of lines included in the DW forecast are export lines to the north and east of the country.

**Key Trends Impacting the Nature of Pipeline Construction**

With an anticipated 35% increase in global energy demand between 2010 and 2040, natural gas is expected to significantly increase its share of the energy mix – growing by 65% over the same period. This trend, observable in our previous edition of this report, is progressing as expected, driven in large part by non-OECD demand growth and technology advancements, including in liquefied natural gas.

Investment in new infrastructure to support LNG and unconventional gas developments will be a major factor shaping future demand for pipelines. Outside the major oil province of the Middle East, gas pipelines accounted for 62% of km installed over the past five years with this figure expected to increase to 66% for the 2015-2019 period. The reduction in the oil price since mid-2014 has tempered the rise of gas demand to an extent, however, reducing investment in natural gas transport technologies. Less robust economic activity than expected in Asia has led to some delays in gas processing facility construction in that region, impacting our natural gas pipeline outlook. Despite this, gas installations are expected to increase by more than 20% in 2015. Furthermore, this constraining impact is anticipated to be short-term with industry fundamentals suggesting an increasing proportion of gas pipeline construction in the coming years.

While gas pipelines increase in volume, installation of liquid lines is expected to contract by 15% in 2015, primarily as a result of a reduction in US demand associated with additional unconventional liquid production. US crude production reached a peak of 9.6 mmbbl/d in April 2015 but has been in steady decline since according to the Energy Information Administration (EIA) Short-Term Energy Outlook (September 2015), a trend expected to continue into 2016. Eastern Europe & FSU and Latin America are both expected to continue to invest in liquid pipelines in 2015, despite the lower price environment. Approximately 105,000 km of liquid pipelines are expected to be installed between 2015 and 2019.
The specifications of the pipelines themselves have trended towards large diameter lines over the past three years. This trend is expected to continue to 2016, reflecting a high volume of major pipeline projects driven by historically high product demand growth in Asia and major additions to the pipeline networks in Eastern Europe & FSU and North America. In 2017 and beyond, smaller diameter pipelines are expected to gain relative market share driven in part by maturing networks within population centres of non-OECD countries and a return of US onshore production growth, requiring further development of smaller-scale midstream infrastructure within shale plays. This is likely to impact technology development for both construction and maintenance contractors.

We have seen lower steel prices and greater manufacturing capacity become available. Lower levels of near-term activity among tubular goods providers have released manufacturing capacity for line pipes. Lower than expected economic growth in Asia and reduced activity in North American unconventional production is expected to support this scenario in the short-term. There remains a low risk of delayed pipeline projects due to constrained capacity in the later years of the forecast which may reduce overall expenditure.

**Geopolitics and Environmental Concerns**

Geopolitics continues to challenge a wide range of projects around the world. Due to the lack of an overarching authority or jurisdiction for transnational pipelines, geopolitical complication is arguably the most difficult challenge to overcome, threatening the execution of ambitious inter-regional projects such as TAPI aiming to bring Turkmenistan gas to Pakistan and India via Afghanistan, and others. As a result, commercial interest must be the overriding driver for large transnational projects to be executed successfully as opposed to softer geopolitical interests.

The ongoing conflict between the Ukrainian Government and rebels with Russian sympathies in Eastern Ukraine has led to extensive sanctions on the Russian economy, imposed by North America and European governments. While this has limited some construction and maintenance activity in the immediate vicinity of the conflict, continued violence has led to increased political focus on alternative sources for European gas. This may provide upside to our forecast in the Middle East, North Africa and North America regions.

Environmental concerns remain a vital challenge for major pipeline projects with public opposition causing significant delays in the approval process. This trend is most often observed in highly regulated regions such as North America with the well publicised example of Keystone XL in the US.

**Relative Stability, Despite Project Delays**

While lower commodity prices threaten pipeline construction projects, particularly in the US and Canadian markets, global expenditure will continue to climb in 2015 and 2016 as sanctioned projects are delivered and international growth outweighs the contraction in North America. DW expects almost 309,000km of line pipe to be installed between 2015 and 2019, an increase of 11% compared to the previous five-year period. The relative consistency of annual expenditure in the global pipeline market (relative to other sectors of the upstream and midstream oil and gas industry) and high volume will facilitate opportunities for the supply chain around the world as the infrastructure network continues to grow.

This periodical thanks Matt Loffman, author of the World Onshore Pipelines Market Forecast, for providing this article for publication. Matt has led a range of commercial due diligence and market intelligence studies focusing on international drilling, pipeline services and downstream facility sectors. His previous experience includes posts as a consultant to the United Nations and to the Embassy of the Kingdom of Spain. In the past year, Matt has headed up global market studies relating to inline inspection services, cryogenic pumps, line pipe manufacturing and heat tracing equipment, amongst others. Matt is a graduate of the London School of Economics, a fluent Arabic speaker, and a member of the Society of Petroleum Engineers and of the Society for Underwater Technology.
Construction work started on 700-km pipeline from China to Pakistan

Minister of Petroleum and Natural Resources Shahid Khaqan Abbasi said Pakistan has started construction work on a seven hundred-kilometre pipeline to import liquefied natural gas (LNG) from China, said a report on Radio Pakistan.

Speaking to Voice of America (VoA), Abbasi said the project will be jointly funded by Pakistan and China.

He also said that Gwadar port will be used as the central hub for the China-Pakistan Economic Corridor (CPEC), allowing western China to gain access to warm waters from Pakistan.

Abbasi said funds from China, in relation to this project, will be beneficial to Pakistan for completion of the Iran-Pakistan gas pipeline project.

He said Pakistan has been trying to overcome its energy crisis by importing gas from Iran, adding that sanctions on Iran had resulted in difficulties in the way of inching closer to completing the Iran-Pakistan gas pipeline project.

The CPEC, with a planned portfolio of projects totalling around $46 billion, will link Gwadar, Khuzdar and other areas on way to Dera Ghazi Khan, Dera Ismail Khan and Peshawar along its central route.

The eastern route will connect Gwadar to Ratodero, Sukkur, and Karachi and upward to cities in Punjab, and from there to Khyber Pakhtunkhwa and the Khunjerab Pass.

There have been security concerns over much construction work on 700-km pipeline from China to Pakistan

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There have been security concerns over much...
of the plan, which relies on developing Gwadar — control of which was passed to a Chinese company in 2013.

Linking Gwadar to the rest of Pakistan and the western Chinese city of Kashgar, 3,000 kilometres away, will involve major infrastructure work in Balochistan.

**Australia, East Timor in Gas Pipeline Row**

Australia will vigorously defend legal action initiated by East Timor over Australia’s right to tax an oil and gas pipeline to Darwin from the Bayu Undan gas field, say senior ministers.

Foreign Minister Julie Bishop and Attorney-General George Brandis issued a statement on Friday saying the treaty covering the project states the jurisdiction depends on where the pipeline lands.

But East Timor says the countries are in dispute over the interpretation of a section of the treaty and its government disagrees with Australia’s assertion that it has absolute and exclusive jurisdictional rights over the entire length of the pipeline, including into the joint petroleum development area.

"Australia’s claim would deny Timor-Leste any jurisdictional rights relating to this pipeline or activities relating to this pipeline," a spokesman said.

"This is inconsistent with the text and purpose of the treaty and is not supported by any negotiating or other documents that have been brought to light."

The spokesman said efforts to discuss the matter had come to nothing.

"Timor-Leste remains willing to resolve the dispute directly with Australia," he said.

**Bechtel to Manage Construction of Pipelines in Thailand**

Bechtel announced on September 1st that its selection by Gulf MP Company Ltd of Thailand to manage construction of pipelines that will feed gas into a network of planned new power generation facilities. Bechtel will manage engineering, procurement and construction for 12 new gas pipelines with receiving stations.

The contract was awarded as part of Thailand’s Small Power Producer program in an effort to diversify the country’s energy mix and to support industrial energy needs. The 12 new combined-cycle plants will each provide 120-130 MW of electric power to industrial users and to the Electricity Generating Authority of Thailand. They will also provide steam to local industrial users. The pipelines will vary in size between eight and 16 inches and in length between one and 11 kilometres.

Bechtel has extensive global experience in pipeline construction, having delivered nearly 53,000 miles of pipeline—enough to circle the Earth twice—in the last 50 years. The company is currently building the Escondida Water Supply project in Chile and supporting facilities for the South Caucasus Pipeline extension.

**Technip Wins Flexible Pipe Contract**

Technip has been awarded an engineering, procurement, installation and commissioning contract by PETRONAS Carigali Sdn Bhd (PCSB) for D18 Project.

The project covers the procurement and installation of two 8” water injection flexible pipes totalling 9.5 kilometers. The flexible pipes will connect three fixed jacket platforms which form the existing D18 infrastructure offshore Sarawak, Malaysia, at a water depth of 36 meters.
This contract is part of the 5-year Framework Agreement signed with PETRONAS in late 2014 and is in line with Technip strategy to strengthen its partnerships with its clients to drive cost optimization.

Asiaflex Products, Technip’s flexible pipe manufacturing plant located in Johor, Malaysia, will execute the contract with support from Technip’s operating centre in Kuala Lumpur, Malaysia. The project is scheduled for completion in late 2015.

The flexible pipes will be manufactured at Asiaflex Products and the Deep Orient, one of Technip’s subsea construction vessel, will be mobilised for installation during the second semester of 2015.

**Wood Group Secures KPOC Pipeline Contract**

Wood Group Kenny (WGK) will support the Kebabangan Petroleum Operating Company (KPOC) in pipeline engineering and flow assurance engineering studies for the Kamansu East (KME) field offshore Sabah, Malaysia.

The scope of work will include concept select studies and definition engineering on subsea heating options, thus preventing hydrates, for...
the 30km gas pipeline which runs from the KME field in 750 meters of water to their new shelf edge Kebabangan platform.

The pipeline heating technology could be the first application for deepwater gas development in Malaysia.

The KME field and Kebabangan Northern Hub Project are part of the Kebabangan Cluster, which is owned by Petronas Carigali Sdn. Bhd. (40%), ConocoPhillips (Sabah Gas) Ltd (30%) and Shell Energy Asia Limited (30%). KPOC is a joint venture company which was established to act as the cluster operator. The first gas from the field is expected to be required in the early 2020’s.

PII Pipeline Solutions’ Next Generation MagneScan™ Hits 1,000 Successful Runs

PII Pipeline Solutions (PII) recently celebrated 1000 successful pipeline inspection runs of its Next Generation MagneScan™ inspection tool for assessing metal loss features, deformation and geometry plus advanced integrity assessments in oil and gas pipelines. Using high resolution Magnetic Flux Leakage technology (MFL), PII’s signature inspection system has distilled and enhanced the capability of all multiple legacy MFL, caliper and inertial measurement unit (IMU) mapping systems into a single system, reducing the number of runs required to meet a specification.

“1000 runs is a major milestone for a product that PII has developed from vison to reality and is now proven and continues to gain market share,” said Martin Bluck, Magnetics Product Manager at PII. “Every year we are serving more customers with more runs and delivering more reports. Next Generation MagneScan™ is a robust and accurate inspection tool that delivers a level of verification accuracy that sets new standards within the industry and ensures safety and peace of mind for our customers.”

Launched in 2009, Next Generation MagneScan™ has delivered over six years of year over year growth in numbers of runs. This super-high resolution, multi mission tool has provided increasingly high levels of first run success and reliability to customers on six continents across the globe, with proven performance, offering a higher specification of data than previously available from a single run. Next Generation MagneScan™ tools have completed 50,000+km of inspections in pipelines from 6” to 36” with a longest run of 560km since launch, and achieved 95% first run success in 2013, 2014 and to date in 2015 at time of publication.

A major part of Next Generation MagneScan’s™ success has come from the inherent system capability to deliver excellent performance on dig verification, coupled with PII’s focus on evolving the service in response to customer issues and tailoring new offerings to meet the customer’s needs. In order to make each inspection commercially flexible and cost-effective for the customer while maintaining excellent metrics, the Next Generation MagneScan™ tool is run in a standard configuration, with data processed, analysed and reported as required to comply with the customers’ specific requirements. This allows customers to choose combinations of data from MFL, caliper or IMU at a range of resolutions from High Resolution, to Super High Resolution Plus. Because data is recorded from each module at maximum resolution, the client has the option of revisiting the data up to Super High Resolution Plus without the need for an additional run. In 2013 and 2014, 70% of runs included mapping and 49% of reports were delivered at Super High Res specification or higher.

From Next Generation MagneScan’s™ first run, PII worked with its customers to gather dig verification data to validate and improve published specifications, and to develop new improved speci-
fications to address specific customer concerns. Feedback from blind test programs conducted by major customers around the world has been a key enabler to develop and validate these new applications, the results of which have been subsequently published in technical papers.

Next generation MagneScan™ was launched into the same market segment as PII’s existing MagneScan™ inspection tool offering new complementary services. Next Generation MagneScan has secured both new customers and additional runs with existing customers by offering 1) a higher resolution specification and 2) novel applications to deal with previously unaddressed threats including Pinholes and Spiral Weld Anomalies.

A leading provider of pipeline inspection and integrity management solutions for operators worldwide, PII Pipeline Solutions has provided integrity services to the global oil and gas industry for 35 years.

OptaSense Named Finalist in Global Pipeline Awards

OptaSense, a QinetiQ company and the global leader in Distributed Acoustic Sensing (DAS) has been recognised for its unique contribution to effective pipeline leak and intrusion detection by being shortlisted for a prestigious international award.

The company has been recognised in the ASME Pipeline Systems Division Global Pipeline Awards for the innovative use of its award-winning DAS system on Columbia’s Bicentennial oil pipeline.

The judging panel recognised OptaSense’s unique use of a single fibre system to provide both leak detection and intrusion detection on the country’s largest pipeline. The 235Km first phase of the pipeline was completed in 2012 and has a diameter of 36-42 inches with the capacity of 450,000 barrels per day (bpd) of crude.

The integrated DAS solution works across multiple functions via a single fibre-optic cable that effectively “listens” to the pipeline in order to provide detailed data about its current status. Any changes to the condition of the pipe are fed back through an interrogator unit in real time, allowing users to identify and address issues early and maintain the highest level of pipeline integrity and product throughput.

Leak and intrusion detection are vital to maintaining pipeline integrity and production maximisation in the oil and gas industry. The pipeline was closed last year due to third party attacks on it, costing the Columbian economy thousands of barrels per day in lost deliveries.

OptaSense executive director Magnus McEwen-King said: “This award not only recognises the innovative use of fibre but also the engineers of
Ecopetrol and OptaSense who have jointly worked to deliver real improvements to the integrity management process of the Bicentennial pipeline.

“This nomination is a further acknowledgment of our leading position in South America, and highlights our commitment to continued growth in the region. Our award-winning technology has a proven record of reducing the costs of asset ownership and providing life-long intelligence through highly effective monitoring, thereby reducing incidents and extending asset life.”

The annual awards ceremony aims to recognise pipeline technology innovation processes in phases such as: research laboratory, field applications, technology incubators, and development of markets for new products, and is open to all companies. The winners will be announced at the awards ceremony held on Thursday 24 September 2015. The four other finalists are: Rosen Group, GMC Inc., Subsea 7, and LABMETRO, CENPES Petrobas Research Center.

Wood Group Mustang Onshore Pipeline and Facilities Business Unit Created

Wood Group Mustang has consolidated the Pipeline, Onshore and Oil Sands business units into the Onshore Pipeline and Facilities (OPF) business unit, which provides oil and gas processing, transportation, and field services.

“By consolidating individual capabilities and streamlining client and project delivery overlaps, the new Onshore Pipeline and Facilities business combines industry-leading technology and expertise, and will enable us to provide our customers with more cost-efficient and effective project delivery capabilities,” says Edmund Lunde, executive vice president. “Our clients will experience strong work share skills and capabilities across our offices that will enable us to lower project costs while providing the same personal touch and fit-for-purpose project delivery.”

The OPF leadership team comprises senior leaders from the combined businesses.

Simon Wooler, previously president of the Onshore business unit, has been appointed president of OPF, managing a combined team of approximately 2,000 people.

Phil Schneider has been promoted to the role of vice president, US Operations, with responsibility for delivery of projects in the US and oversight of the pipeline engineering and pipeline integrity management teams.

Gil Weisberger has been promoted to the role of vice president, International Operations, with responsibility for international projects primarily executed from North American offices and oversight of the gas processing team.

Graeme McNeil has been promoted to the role of vice president, US Regional Operations, with responsibility for the Atlanta; Denver; Birmingham, Alabama; Canonsburg, Pennsylvania; Angleton, Texas; and Baton Rouge, Louisiana; offices.

Mark Nussbaum continues in his role as vice president, Construction & Field Services.

John Hearn, who was previously business manager of the Onshore business unit, has expanded his role to serve as business manager for the new Onshore Pipeline and Facilities business unit.

David Carpenter & Dany Jew are expanding their roles as senior vice presidents, North American Business Development, with responsibility for the pursuit of both pipeline and facility projects in North America.

James Woolley, senior vice president, International Business Development, is responsible for the pursuit of international projects to be executed primarily from the US, while also supporting business devel-
opment for our international offices. James retains responsibility for gas plant initiatives.

Mike Martinez continues to be responsible for business development in Latin America, and in a new role as vice president, Mexican Operations, will support the development of our capabilities and future operations in Mexico.

Kevin Allsopp continues in his role as general manager of Calgary operations, where the business primarily supports oil sands and related oil & gas facility and pipeline projects.

The OPF business unit has offices in the US, Canada, Colombia, Malaysia, United Kingdom and Saudi Arabia.

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Hydraulic Analysis Using Synergi Pipeline Simulator

Hydraulic analysis, in some cases referred to as numerical analysis has become an essential prerequisite for any projects involving fluid transport facilities. Hydraulic models are built to illustrate their operational capabilities in order to evaluate the proposed design and its performance. Basing on the fundamental principles of hydraulics, they help to predict pressure profiles and identify bottlenecks, if any, in inadequately designed facilities. This comes handy especially in transient analysis involving various upset conditions that may lead to pressure surge phenomenon in liquid systems. During the operation of a facility, hydraulic surges are potentially created due to sudden change in the flowing fluid velocity that becomes unsteady. This can either result in an upsurge from pressure build up or a downsurge caused by the occurrence of vacuum. Generally, the sudden change in fluid velocity may take only seconds to generate hydraulic surges in the system. Any such occurrence can culminate in accidents and fatalities and therefore, special care has to be warranted in their design, construction, and operation to assess the associated risks. Appropriate operational strategies and surge control devices should be integrated as methods of mitigation to potential inadequacy in the design of such systems.

Hydraulic surges are created when the velocity of a fluid suddenly changes and becomes unsteady or transient. Fluctuations in the fluid’s velocity are generated by restrictions like a pump starting / stopping, a valve opening / closing, or a reduction in line size. It only takes a matter of seconds to generate hydraulic surges anywhere in a system. As a result, the fluid velocity changes and the pressure wave can travel at very high rate of speed damaging equipment or causing piping / pipeline failures from over pressurising. The damage that can arise from such surge events can be categorised either as catastrophic failure of the pipeline system or equipment, or fatigue failure of the pipeline, supports, instrumentation, equipment, and component.

In the event a pipeline is isolated by closing its upstream valve, high pressure builds up and results in a shock wave at the upstream of the valve as the mass of the liquid in the line continues moving. This is due to the conversion of the kinetic energy to pressure as the fluid in motion is forced to stop. Similarly, other causes of such a phenomenon include, but are not limited to pump failure, and check valve slam. Pipeline surge can cause severe damages if the resulting pressure is high enough which could arise from relatively high operating pressure or operating flow. On the other hand, isolating the downstream section of a pipeline may create vacuum at the valve downstream and cause the pipe to collapse or implode as the fluid downstream of the valve attempts to continue flowing. Such an occurrence is referred to as a down surge phenomenon in addition to the high surge created at the valve upstream. This is especially anticipated and can potentially be acute if the pipe is on a downhill slope which sometimes, leads to column separation.
Column separation occurs when the pressure in a system drops below the vapour pressure of the fluid in the pipeline at pipeline temperature. Subsequently, a vapour cavity forms in a small fraction of the pipe while the liquid columns on either side of the pipe accelerate. As the pressure later increases beyond the vapour pressure of the liquid, it causes the bubbles to collapse leaving behind vacuum in the space formerly occupied by the vapour. Sudden collapse of these bubbles coupled up with the collision of the accelerating two liquid columns then causes an instantaneous spike in pressure. This occurrence is most likely to be observed at specific locations such as high points, closed ends, or where there is a change in pipe slope. It can cause damage to individual pipes and its supporting structures. In order to prevent this, installation of air and vacuum relief valves are normally recommended just downstream of the valve allowing the entering air to prevent this occurrence of vacuum.

Although the damage from hydraulic surges is usually limited to breakage of pipes or appendages, it can also cause accidents that can result in fatalities. Therefore, the risk of operating a pipeline system should always be assessed for potential causes of pipeline burst or any such occurrences. This is especially true for pipelines transporting hazardous liquids or gases as special care has to be warranted in their design, construction, and operation. Appropriate operational strategies and surge control devices should be integrated as methods of mitigation to potential inadequacy in the design of such systems. This includes prolonging valve closure times, initiating valve shutdown actions, tripping of pumps, installation of surge relief systems, or any combination of these and many more that help to suppress the high pressure surges and prevent it from traveling through the system.

In this paper, two industrial case studies are presented in which one demonstrates a transient analysis performed on a crude exporting facility in Eastern Java and the other in the Gulf Region. All case studies are implemented using Synergi Pipeline Simulator (SPS) 10.0 which is advanced transient hydraulic modelling software by DNV GL that simulates dynamic flow of fluid through almost any proposed pipeline configuration.

Software

The software used to perform the case studies presented in this paper is Synergi Pipeline Simulator (SPS) 10.0. The Synergi Pipeline Simulator (SPS) which was previously known as Stoner Pipeline Simulator has been developed by Stoner Associates Incorporation (formally known as DREM Incorporation), who have been producing such software since 1972. It is the proprietary simulation software of GL Industrial Services USA, Inc.

SPS is an advanced transient hydraulic modelling service that simulates dynamic flow of a single fluid, batched fluids, or mixed fluids of a single phase through a pipeline. SPS reads text files containing detailed data that represents the pipeline (including pipes, pumps, compressors, valves, controllers, etc.). Using these text files, SPS constructs a mathematically sophisticated model. SPS can model operating characteristics of almost any proposed pipeline configuration and predict the outcome of various control strategies for operating scenarios such as pipe rupture, equipment failure, or other upset conditions. SPS performs its simulations by calculating flow, pressure, density, temperature, and other variables at numerous locations along a pipeline model over time, and reports these values in the form of printed reports and graphs.

SPS simulates liquid (including column separation and slack line flow) or gas pipelines. It does not simulate two-phase flow systems. The simulation can be run either in batch mode (runs in the background) or in an interactive mode (responds to commands while the simulation runs). The
initial state of the simulation can be a zero-flow condition, a user-defined steady-state condition, or a state saved during a prior simulation.

**Modelling Basis and Assumptions**

With the use of the liquid module within SPS, frictional pressure loss with piping is estimated according to the following equation where $P$ is the pressure, $x$ is the length along the pipe in the direction of positive flow, $f$ is friction factor, $G$ is mass flow per unit area, $D$ is internal pipe diameter, and $\rho$ is fluid density:

$$\frac{dP}{dx} = -f\frac{|G|}{2D\rho}$$

The friction factor $f$ is determined by assuming fully turbulent flow for modelling purposes based on the piping configuration analysed from isometric drawings and piping plans supplied by client. Additional pressure losses due to bends and fittings are incorporated into the friction factor. The fundamental equations used in SPS 10.0 to model the piping fluid dynamics include the Continuity, Momentum, Energy, and Flow Area Equations which are solved by finite volume technique. The time step at each iteration varies dynamically depending on hydraulic conditions. Smaller time steps are used to model transients, but larger time steps are used when the model is relatively steady.

The subsequent sections of this paper present two industrial case studies that were performed with Synergi Pipeline Simulator (SPS) 10.0. The property package used in the case studies is the Slightly Compressible Liquid (SCL). This equation of state may be used for multi-fluid liquid simulations for which one or more fluids and their corresponding properties are defined. It also supports the built-in columns separation feature in the software. In general, the basis and assumptions for the case studies were adapted from the data and information supplied by contractors and licensors. These include, but are not limited to the detailed information on fluid properties, operating conditions, pumps, piping / pipelines, valves, metering stations, loading arms, storage tanks and instrument settings. In the event data is not available, assumptions were made based on engineering judgement and other sources of information.

**Case Study 1**

In this case study, the oil reserves facility located in Eastern Java is utilised for illustration. This development is expected to produce 185 KBPD of sour crude and associated gas from four well pads. The sour crude will be sweetened at the central processing facility and delivered to the offshore floating storage and offloading vessel (FSO) via the 73 kilometres, 20 in onshore pipeline and 23 kilometres, 20 in offshore pipeline. This facility consists of pipelines with ratings of 600 lb and 150 lb for which the design pressures are 93 bar and 18.54 bar, respectively. The allowable pressure limits known as the Maximum Allowable Surge Pressure (MASP) is considered to be 10% above the given design pressures. Pipeline roughness factor and modulus of elasticity for all the pipelines is assumed as 0.046 mm and 200 GPa, respectively, whereas that of the flexible hoses of mooring tower is assumed as 0.025 mm and 0.654 GPa, respectively based on the scope document. The system schematic is as shown in Figure 1.

A transient analysis was performed with the objective to analyse the surge pressure due to inadvertent closure of remotely operated shutdown valves and isolation valves in the pipeline. Any occurrences of surge pressure are then to be controlled within the maximum allowable limit by suitable modifications, if required. The adequacy of the existing surge control devices are also to be verified in the study. In line with this, a dynamic model was built using the SPS 10.0 which was run to an agreed steady state scenario of maximum crude oil loading at 185 KBPD. The steady state model which considered operation under the most conservative conditions was then used to analyse ten (10) different dynamic scenarios. Dynamic runs
1, 3, 5, 7, and 9 assume that surge control actions are initiated by activation of available pressure switch at the closed valve upstream. Meanwhile, dynamic runs 2, 4, 6, 8, and 10 assume that the pressure switch at the closed valve upstream fails and surge control actions are initiated by activation of the next closest pressure switch in the system. The transient surge analysis for this system concluded that by incorporating the proposed recommendations, the maximum surge pressure did not exceed the MASP at any point in the pipeline system for all the upset scenarios analysed. However, vacuum was observed in the onshore and offshore pipelines including the jumper hoses between Mooring Tower and FSO.

Table 1 summarises the upsurge and downsurge pressures observed in each of the analysed dynamic scenarios upon having the modifications in place.

<table>
<thead>
<tr>
<th>No.</th>
<th>Inadvertent Closure of:</th>
<th>Maximum Pressure</th>
<th>Maximum Pressure</th>
<th>Design Pressure</th>
<th>MASP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MOV_COT1/2</td>
<td>70.81 bar</td>
<td>No Vacuum</td>
<td>93.00 bar</td>
<td>102.30 bar</td>
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<td>2</td>
<td>MOV_COT1/2</td>
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<td>No Vacuum</td>
<td>93.00 bar</td>
<td>102.30 bar</td>
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<tr>
<td>3</td>
<td>MOV_644801-11</td>
<td>70.77 bar</td>
<td>-1</td>
<td>93.00 bar</td>
<td>102.30 bar</td>
</tr>
<tr>
<td>4</td>
<td>MOV_644801-11</td>
<td>45.42 bar</td>
<td>-1</td>
<td>93.00 bar</td>
<td>102.30 bar</td>
</tr>
<tr>
<td>5</td>
<td>SZV_544801-02</td>
<td>45.42 bar</td>
<td>-1</td>
<td>93.00 bar</td>
<td>102.30 bar</td>
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<tr>
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<td>102.30 bar</td>
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<td>7</td>
<td>MOV_644701-08</td>
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<td>8</td>
<td>MOV_644701-08</td>
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<td>9</td>
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<td>69.39 bar</td>
<td>-1</td>
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<td>69.48 bar</td>
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</tr>
</tbody>
</table>

Figure 1. System Schematic for Case Study 1
The modifications as part of the proposed recommendations include the provision of an 8 in surge relief valve at the downstream of Mooring Tower PV-64401-01 (as shown in Figure 1) with a valve flow coefficient, Cv of 1900 USGPM.psi0.5 and a set pressure to open at 17 bar. Based on the operator’s Sparing Philosophy, one additional surge relief valve of a similar specification as the aforementioned is also to be provided in a parallel arrangement. These surge relief valves outlets are then to be routed to a tank or collection vessel with a minimum capacity of 56.7 m³ each. It is to be noted that in the event the surge relief valves continuously discharge liquid to protect the hoses and pipeline, limiting the surge tanks to the aforementioned volume can fill the tanks within 3 minutes with the production rate of 185 KBPD. However, with the additional recommendations to initiate valve shutdown actions using pressure switches in order to mitigate high surge pressure will also help to minimize liquid relief from the surge relief valves which shall eventually go to a closed position. In the course of the study, the stroke time of some of the shutdown valves were also optimised in order to prevent the high surge pressure exceeding the MASP in the system.

Meanwhile, the occurrence of down surge is also a concern as it can cause vacuum below the saturation vapour pressure of export crude in the pipeline system which may lead to column separation. Further analysis with the Column Separation feature available in the SPS module was carried out in order to measure the spike in pressure for which the following simulation basis was adapted:

- The compressibility of the vapour bubbles is taken into account in calculating the wave speed. In the column separation regime, the wave speed is often quite low because it is related to the bulk modulus of the bubble-containing liquid which may only be a few hundred psi.
- An assumption is made that the fluid is free of entrained gases and that any vapour that forms will go back into solution. If there are entrained gases that dissolve slowly and/or incompletely, SPS calculates a larger surge due to collapse than is experienced in the field.
- The change in temperature from the collapse of the vapour cavity is not calculated.
- SPS default value of 9 bubbles per second was assumed for vapour cavity collapse rate.

The prediction by the software showed that the maximum pressure spike caused by these collapsing bubbles in the pipeline is well below the MASP. Besides, based on the pipeline design documents, it is assumed that the entire pipeline (including the hoses) can withstand full vacuum conditions. Therefore, additional vacuum protection is not required for this pipeline system.

**Case Study 2**

This case study summarises the hydraulic and transient analysis that was performed for a facility located in the Gulf Region. It involves the existing and new crude oil pipeline delivering 720 MBOD of Arabian Heavy (AH) crude from the crude oil terminal to the refinery with the remaining flow supplied for loading at the marine loading arms. It includes a 30 in crude export pipeline and 56 in marine loading line which consist of three pump stations in operation, i.e. booster pumps (old and new), marine loading pumps, and the new shipper pumps. The installation of these new shipper pumps with the other supporting facilities is to enhance the reliability of 720 MBOD of AH supplied to the refinery. This facility consists of piping / pipelines with a rating of 150 lb with design pressures of 10.34 bar, 17.24 bar, and 18.06 bar for different sections under which the scope is covered. The allowable pressure limits known as the Maximum Allowable Surge Pressure (MASP) is considered to be 10% above the given design pressures. Pipeline roughness factor and modulus of elasticity for all the pipelines is assumed as 0.046 mm and 200 GPa, respectively based on the scope document. The system schematic illustrating the arrangement of this facility is as shown in Figure 2.
The major objectives of this study is to establish system steady state pressure and temperature profiles under different modes of operation and to calculate the maximum surge pressure due to potential causes of transient pressure from upset scenarios. Any occurrences of surge pressure are then to be controlled within the maximum allowable limit by first applying operational strategies or applying suitable transient / surge control devices, if required. A dynamic model was built using the SPS 10.0 which was run to multiple agreed steady state scenarios involving crude oil loading to the refinery and the marine loading arms. The selection of steady states during the course of study was based on the different modes of operation considering the most conservative approach. The steady state models were then used to analyse a total of twenty four (24) transient scenarios which include a combination of inadvertent closure of valves, inadvertent trip of pumps, inadvertent start of standby pumps, and system start-up and shutdown.

The hydraulic analysis concluded that the required flowrate of 720 MBOD to the refinery via the shipper pumps could not be achieved with an impeller size of 553 mm for the aforementioned pumps due to insufficient pump head at design capacity. Also, the new booster pumps produce a high discharge pressure at design capacity causing the old booster pumps to underperform. Besides, the flow through the new booster pumps has a potential to exceed its design capacity which can cause occurrence of vacuum in the suction line. The transient surge analysis for this system, on the other hand, concluded that the surge pressure at some points in the pipeline exceeded...
the MASP in some of the analysed upset scenarios. Vacuum was also observed in piping / pipelines between downstream of MOV-1001 and upstream of NRV-10992 on the crude export pipeline as well as between downstream of booster pump discharge tie-in to the header and upstream of MOV-601 on marine loading line. Table 2 summarises the upsurge and downsurge pressures observed in each of the analysed transient scenarios.

In order to mitigate the inadequacies during steady state operations of the system, it is recommended to increase the shipper pumps’ impeller diameter from 553 mm to 565 mm and the rated power from 1827 kW to 1945.7 kW. A linearly operated new pressure control valve is also recommended to be installed at the downstream of the new booster pump common discharge MOV with a rated flow coefficient, Cv of 9261 USGPM, psi0.5 and a stroke time of 48s. This controller acting on the aforementioned valve’s actuator is to be configured with unique set points for the different steady state operations in order to load both the old and new booster pumps at their respective design capacities.

<table>
<thead>
<tr>
<th>No</th>
<th>Inadvertent</th>
<th>Case</th>
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<th>Min P</th>
<th>Design P</th>
<th>MASP</th>
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</thead>
<tbody>
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<td></td>
<td>Closure</td>
<td>Trip / Stop</td>
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<td>bar</td>
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<td>Marina Loading</td>
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<td>Standby Shipper</td>
<td>Recommended</td>
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<td>System Start-up</td>
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<td>System Shutdown</td>
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<td>17.86</td>
<td>-1</td>
<td>17.24</td>
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</tbody>
</table>

Table 2. Transient Results Summary for Case Study 2
Based on the transient run results as summarised in Table 2, multiple modifications were proposed to mitigate the occurrence of surge pressure exceeding the MASP. This includes the relocation of the pressure control valve PCV-2132 from the upstream of the 30 in pipeline to the immediate common discharge of the shipper pumps. Besides, the piping from the shipper pump suction line MOV to the upstream of the relocated PCV-2132 is recommended to be upgraded to 300 lb rating with a design pressure of 48.95 bar. In line with these modifications, a pressure transmitter is to be provided at the immediate downstream of the relocated PCV-2132 to initiate tripping of the shipper pumps at a HH trip set point of 16.41 bar. Similarly, the existing pressure transmitter at the immediate discharge of marine loading pump is to be configured with a HH trip set point of 15.86 bar to initiate tripping of the marine loading pump. A signal communication delay of 1 s is considered for tripping of the pumps.

In addition to the above, a 6 in surge relief valve (SRV-1) is also recommended to be provided at the upstream of XV-0014 (as shown in Figure 2) with a valve flow coefficient, Cv of 1200 USGPM. psi0.5 and a set pressure to open at 11.72 bar. The surge relief valve is to be routed to a tank with a minimum capacity of approximately 22 m3. The installation of a 30 in check valve at the upstream of MOV-1382, i.e. at the beginning of 30 in crude export pipeline is also recommended in order to avoid pressure spike due to the moving columns to the lower section of the pipeline which results in a significant impact from collapsing of the bubbles. Safe operating procedures is also proposed for the start-up and shut down operations of the system which includes the pump start and stop sequences that considers prevention of tank contaminations due to system elevation profile with their respective minimum continuous stable flow requirement. This procedure also takes into account of inadvertent start of standby pumps where it is recommended that all standby pumps are isolated and only started with a minimum circulation flow prior to being put in service. This recommendation shall also be applicable during a pump changeover scenario.

**Conclusion**

This paper describes the significance of hydraulic and transient analysis which has become an essential prerequisite for any projects involving fluid transport facilities. In line with this, two industrial case studies which include the crude export facilities in Eastern Java as well as in the Gulf Region were analysed using Synergi Pipeline Simulator (SPS) 10.0. The case studies were performed with the objective to establish system steady state pressure and temperature profiles under the most conservative conditions, and to calculate the maximum surge pressure from potential upset scenarios in order to provide suitable mitigation measures. Multiple recommendations were proposed such as the provision of additional surge control devices, upgrading of the pipeline specifications, initiation of shutdown sequences using pressure switches, and optimisation of valves closing time. The proposed recommendations took into account of the severity of the observed upsurge and downsurge cycles during the analysis of the different upset scenarios.

**References**


This publication thanks Harresh Kasivisvanathan, Senior Engineer, DNV GL for providing this article.
Splash Zone Riser Neoprene Sectional Composite Overwrap Repair

PROASSURE™ WRAP EXTREME (Formerly known as PIPEASSURE) – An ISO TS 24817 and ASME PCC-2 fully compliant composite overwrap repair system for rehabilitating damaged pipeline and piping due to leaks, corrosion and mechanical damage was successfully installed on a damaged neoprene section of a 6 inch gaslift riser at the splash zone area. A total of 3m meter length section of damaged neoprene was repaired with PROASSURE™ Wrap Extreme composite overwrap system to restore the pipeline integrity to pristine condition.

Offshore risers coated with neoprene at the splash zone areas are vulnerable to deterioration over time due to a range of structural and operational issues including mechanical damage and degradation caused by continuous exposure to the harsh offshore environment. The current best practice to repair damaged neoprene sections of risers at the splash zone is with the application of conventional coating systems. However, it could not last as expected due to the continuous exposure of the coating to severe conditions at the splash zone area; the coating can be easily stripped off, exposing the steel riser to corrosion attack.

Considerations in selecting an alternative solution in repairing damaged neoprene are:

• Durability of repair system – able to withstand harsh environment at splash zone
• Flexibility of repair system – ability to conduct live repair and to apply and cure in wet conditions
• Reliability of repair system – able to provide protection and reinforcement to the damaged area

Composite repair solutions are among the newer technologies that can be used in repairing damaged neoprene at the splash zone. PROASSURE™ WRAP EXTREME, a composite overwrap repair system, was considered due to its superior adhesion properties and its ability to be applied in wet conditions. PROASSURE™ WRAP EXTREME is able to protect the damaged neoprene section against corrosion and provide additional strengthening thus restoring its integrity.

Background of Repair

A section of the riser (see Figure 1) was damaged...
due to mechanical impact to the neoprene causing it to strip off from the pipeline. The damaged area will be exposed to a corrosive environment if not repaired immediately.

This is a gaslift pipeline with a design pressure of 98bar with a maximum allowable operating pressure of 80bar.

**Pipeline Info:**

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<thead>
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<th>Service</th>
<th>Gaslift</th>
</tr>
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<tr>
<td>Material</td>
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</tr>
<tr>
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<tr>
<td>Operating Temperature</td>
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<td>Design Pressure</td>
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<td>MAOP*</td>
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</table>

**PROASSURE™ WRAP EXTREME**

PROASSURE™ WRAP EXTREME is a pre-impregnated composite material that can be wrapped over pipelines and similar structures to protect and repair sections damaged by corrosion and other forms of degradation, even in wet environments and live conditions. The product is highly durable and resistant to moisture, capable of withstanding wet environments as well as submerged conditions.

Its properties include a high glass transition temperature and strong mechanical adhesion with the ability to be applied with minimal interruption, which allows it to be used for efficient pipeline repairs in a cost effective manner while avoiding lengthy pipeline shutdowns.

**PROASSURE™ WRAP EXTREME Specification:**

<table>
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<th>Property</th>
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**PROASSURE™ WRAP EXTREME Repair**

The PROASSURE™ WRAP EXTREME repair for the 6 inch carbon steel API 5L X42 riser coated externally with neoprene was performed on damaged section (see Figure 2) at the splash zone area without interrupting the pipeline operations.
The composite repair was based on ISO/TS 24817: Petroleum, petrochemical and natural gas industries – Composite repairs for pipework – Qualification and design, installation, testing and inspection and ASME PCC-2–2008: Repair of Pressure Equipment and Piping.

A total number of 3 wraps (spiral wrap) using PROASSURE™ WRAP EXTREME as corrosion protection layer was employed to replace the damaged neoprene section (see Figure 3). To protect the end termination point of the repair area, an overlap cigarette wrap technique was used over the neoprene and composite repair.

The procedure for the sectional neoprene repair involved the followings:
• Removal of damaged neoprene sections
• Surface preparation based on ISO 8501 SA 2.5
• Application of Primer on the substrate
• Application of PROASSURE™ WRAP EXTREME
• Tapering of neoprene
• Application of PROASSURE™ WRAP EXTREME to overlap the end termination point (see Figure 4).

Conclusion
The key challenges in performing sectional neoprene repair are:
• Accessibility: scaffolding requirements to give access to the team to conduct the repair
• Weather: tide and wave conditions that could damage the repair during curing stage
• Application: ensuring the repair termination point (weak point of repair) is protected from corrosive elements.

Surface preparation plays an important role in any repair job and this includes repairing damaged neoprene. The mechanical properties of the composite, its architecture and the method of installation can also greatly affect the integrity and life of the repair.

PROASSURE™ WRAP EXTREME has demonstrated its capability to perform sectional neoprene repair using a composite overwrap system meeting the oil and gas industry requirements.

KEY BENEFITS:
• Effective corrosion barrier and protection
• Effective offshore application splash zone repair
• Extend pipeline life
• Performs in accordance with ISO 24817, ASME PCC-2, and PTS 30.48.00.31-P
• Strengthens pipeline
• Potential reduction in maintenance cost
• No hot work required
• No shutdown required
• Designed to withstand intermittent submerged condition
• Cost effective

References

This periodical thanks Ir. Mohd Nazmi bin Mohd Ali Napiah, Custodian (Pipeline Integrity/Group Technical Authority), Ir. Rosman bin Hj Arifin (Principal Engineer (Pipeline)) (PETRONAS Group Technical Solutions), Ir. Mohd Iwan Jefry AM, Badrul HH, Qamaruzzaman S, Abd. Latiff, Kalai V (Innovative Oilfield Services Sdn. Bhd.) for providing this article for publication.
Superior Composite Technology Developed for Pipe Repair and Protection

Already with a 100% application success rate, Belzona’s high-tech pipe wrap repair system has undergone a major reformulation and enhancement.

Belzona Research and Development Manager, Jevon Pugh said, “Following the success and popularity of Belzona SuperWrap over the course of seven years, our R&D team has been busy developing and redesigning numerous aspects of the technology to create a superior composite repair and protection system, Belzona SuperWrap II.”

Belzona SuperWrap II has achieved compliance with industry standards; ISO 24817 (Composite Repairs for Pipework) and ASME PCC-2 Article 4.1 (Nonmetallic Composite repair systems: high risk applications). Specially developed for use on a variety of geometries including bends, straights and tees, it can also be applied as a patch repair to large diameter pipes (over 600mm) and tank walls. Due to its versatility and up to 20 year design life (in accordance with ISO 24817), Belzona SuperWrap has proven highly popular amongst pipework and pipeline maintenance engineers.

A Simple, Two-part Epoxy Resin System

Driven by SuperWrap’s success and popularity, the Belzona R&D Department conducted a rigorous series of independent and in-house tests to determine ways in which the system could be enhanced. These tests include Young’s modulus, Poisson’s Ratio, Shear Modulus, Thermal expansion, Glass Transition Temperature, Shore D Hardness and Lap Shear testing, 1000 hour survival tests for through wall and thin wall defects, physical testing to validate that the repair system strength meets the values generated by the independent laboratory testing. Following this careful and painstaking process, SuperWrap II was born.

The new wrap system comprises of two Belzona products; a cold curing fluid grade epoxy resin and a hybrid reinforcement sheet consisting of glass fibre and carbon fibres, which have been woven together to give an optimised balance of strength and flexibility.
In order to achieve a versatile product, SuperWrap II is now available with two different resin grades, Belzona 1981 and Belzona 1982. The main difference between these resin grades is the end service temperature and working life of the resin. Belzona 1981 has been developed for cool ambient temperatures above 5°C and has a maximum service temperature of up to 60°C, while Belzona 1982 has been designed for warm ambient temperatures above 20°C and has a maximum service temperature of up to 80°C.

Both grades use the same Belzona 9381 Reinforcement Sheet and Belzona 9382 Release Film. Belzona 9381 reinforcement sheet is a bespoke hybrid fabric combining glass fibre and carbon fibres. The glass fibre gives the sheet flexibility and acts as a wet out indicator, whereas the carbon fibre gives the applied composite the strength it needs to withstand high pressures and mechanical loading.

**Superior Composite Technology Four Times Stronger than Predecessor**

Three key areas of SuperWrap II have been enhanced, these include:

- Young’s Modulus (higher)
- Poisson’s Ratio (lower)
- Thermal Expansion Coefficient (to align with steel)

A common problem encountered by maintenance engineers when repairing pipework is pressure from the pipe acting on the defect area which can cause the repair material to bend. To address this, SuperWrap II exhibits a high Young’s modulus, approximately 38000 MPa, meaning the material will retain an extremely high level of stiffness and resist bending forces.

The new formulation also exhibits a low Poisson’s ratio, 0.26. This relates to the negative ratio of transverse to axial strain which occurs when a material is elongated in one direction, it usually tends to thin in the other two directions perpendicular to the direction of expansion. This means that with a low Poisson’s ratio, once the repair is put under stress, it will resist changes to its original profile.

The Thermal Expansion Coefficient of the system is a key value, this is the rate in which the repair will expand or contract with temperature change. If this coefficient is significantly different to that of the substrate material, changes in temperature will induce stresses, which can be detrimental to the repair. To combat this, SuperWrap II exhibits very similar thermal expansion coefficient to steel, approximately 0.00001 mm/mm°C, which means both the system and the substrate will expand and contract at a similar rate, thus minimising this problem.

The result of all these improved properties is a repair system that is four times stronger than its predecessor. This means a thinner repair can be engineered whilst still withstanding similar pressures, allowing for reduced downtime, material and labour costs, due to the shorter application time and lower volume of material required.

**Testing Performed- Wrap Outlasts Steel**

During the Annex C test (ISO 24817) and Appendix III (ASME PCC-2 Article 4.1), a test designed to rebuild the damaged section of pipe back to its original yield strength, the repair withheld the calculated yield pressure of the substrate, whilst the original steel profile showed signs of yielding.

The test involved machining a 125mm x 62.5mm rectangular defect into a 250mm diameter pipe (2000mm in length). The original wall thickness of the pipe was 10mm, and in the defect area this was reduced to 2mm. The yield pressure of the undamaged spool was calculated to be 39.2MPa, a repair was engineered to restore the pipe to this original pressure.

The repair was applied to specification and the pipe was then pressurised up to 39.2MPa, without failure, demonstrating that the Belzona SuperWrap II had performed as designed. Pressure was then increased to determine where a yielding would occur — in the
repair or in the original pipe. At around 42MPa, the pipe clearly yielded, outside of the repair area. This demonstrated that not only had the wrap returned the pipe to its original strength, it had also made the defect area stronger than the original pipe section.

Quick and Easy Application Procedure
The fluid grade product and simple wet out procedure enables quick application times along with wet on wet application procedure.

1) First apply the selected resin grade product, Belzona 1981 or Belzona 1982, to the blasted substrate.
2) On to this, the Belzona 9381 reinforcement sheet, wetted with the selected low density resin (Belzona 1981 or Belzona 1982), is spiral wound onto the repair area, adding strength.
3) When all wraps have been applied to specification, further resin grade product is then applied on top of the reinforcement layers if required.
4) The repair is then consolidated by tightly wrapping the Belzona 9382 Release Film over the repair area, ensuring a high quality laminate, with no air entrapment or voids.

Because this system uses higher density carbon and glass reinforcement than most, typically only three or four spirals or wraps are required, significantly cutting application time when compared to other systems.

The following shows application of Belzona Super-Wrap II:

<table>
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<tr>
<th>Resin Grade</th>
<th>Resin Colour</th>
<th>Cure Temperature</th>
<th>Minimum Cure Time [Return to Service]</th>
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<tbody>
<tr>
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</tr>
<tr>
<td>Belzona 1982</td>
<td>Green</td>
<td>&gt;20°C</td>
<td>24 Hours</td>
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</tbody>
</table>

Fully Compliant with Industry Standards
Where once maintenance engineers had doubts regarding composite technology, this repair system now sits at the forefront of pipework repair and maintenance.

Although composite technology was widely used and understood by sectors including automotive and aerospace, and was well established in the glass reinforced plastic (GRP) pipe industry, its use for the repair of steel pipes had been based upon experimentation rather than mathematical design. This, compounded by inconsistent application standards, led to composite repairs historically operating with varying degrees of success.

However, the publication of two international standards in 2007 has changed all of this and this technology sector is growing rapidly. These standards are:

- ISO/TS 24817- Composite repairs for pipework—qualification and design, installation, testing and inspection
- ASME PCC-2 Article 4.1- Non-metallic composite repair systems for pipelines and pipework: high risk applications

Now all aspects of composite pipe repairs are governed by these standards, from the prequalification of materials and repair systems, the design of a repair specific and ‘fit for purpose’ for the individual pipe defect, to the training and validation of applicators.

Application quality forms a major part of these standards because, as with welding, even the best
material in the world incorrectly applied will not perform as required.

The standards recognise that repairs must be applied to the required standard, stipulated in the design, i.e. the same manner as the compliance testing from which much of the performance data used in design is derived. They also require that all installers be validated through training and consequently pressure tests are carried out to confirm that an installer can produce work to the required standard.

Theoretical and Practical Training

In addition to improving the material's characteristics, Belzona has also perfected the theoretical and practical training courses to ensure Belzona SuperWrap II designers, installers and supervisors are fully trained and proficient in the use of the system.

These improvements include an online training module that covers the majority of the theoretical aspects which is required to be completed before attending the SuperWrap II practical training course.

This allows for more hands on time in an extended practical session, further improving the skills of the installer. The installer training course is a pass or fail course, so only the highest skilled installers are allowed to apply Belzona SuperWrap II, ensuring the product is applied in the way it was intended thus maintaining our high standards of application.

Belzona SuperWrap II can be used in a variety of application areas
2015

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Website: www.safan.com

Contact: Chris Wong
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PetroVietnam 40 Years Integration and Development
21-23 October 2015
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Ho Chi Minh City, Vietnam)

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Tel: +62 21 2525 320
Email: maysia@pamerindo.com
Website: www.pamerindo.com
or www.oilgasindonesia.com

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4 - 7 November 2015
(Jakarta International Expo Kemayoran, Indonesia)
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AXIS 2016
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(Kuala Lumpur, Malaysia)

March 2016

APM 2016
16 - 18 March 2016
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Email: apm@reedexpo.com.sg
Website: www.apmaritime.com

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April 2016
(Singapore)
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Email: zaman@safan.com
Website: www.safan.com

Applied Reliability Workshop
April 2016
(Kuala Lumpur, Malaysia)
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Website: www.safan.com

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### Conventions used within this magazine

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