Plant life

Furmanite International is calling for 'joined up thinking' to build in long-term operational cost savings at an earlier stage in the plant or platform lifecycle, by recognising what are traditionally seen as remedial maintenance services in preventative measure terms.

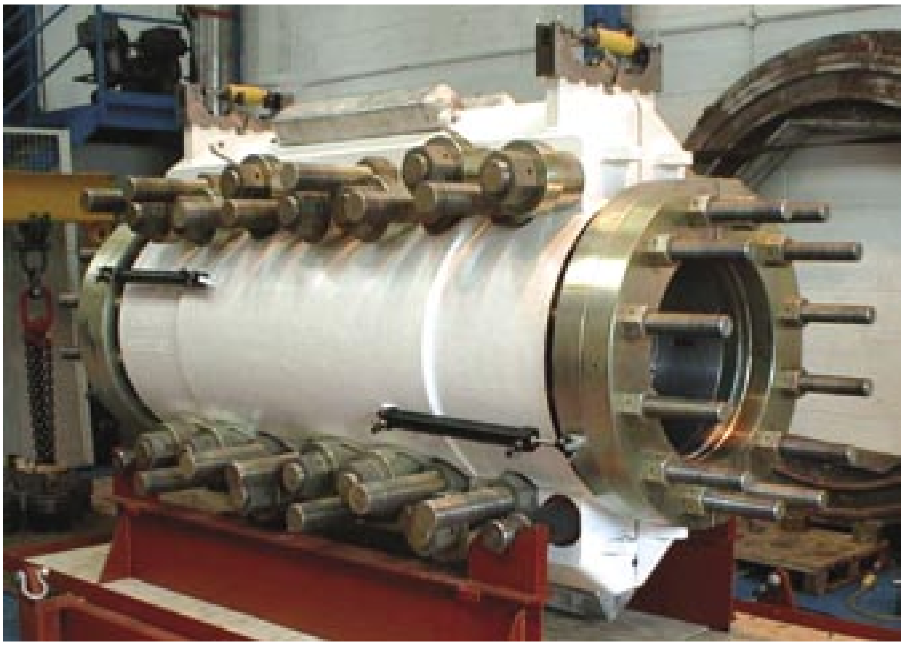
AT a time of expanding activity in the offshore oil and gas sector around the world, new build activity - be it platforms, pipelines, or processing facilities - is rife. But how high a priority are long term maintenance considerations at construction stage? The answer is not high enough, according to Mike Tucker, business development manager for Furmanite, worldwide experts in the field of on-site and on-line plant and pipeline maintenance.

"Asset maintenance and management costs can be significantly affected by decisions taken at design and construction stage, yet because plant construction or expansion is a capital expenditure, whereas on-going maintenance is an operating cost, there is insufficient joined-up thinking by many operators or asset managers to maximise on the considerable benefits and cost-savings available," Tucker claims.

Lifecycle

"A number of services that are traditionally viewed as maintenance measures (and are therefore not considered until the platform is operational) could be applied at a far earlier stage in the asset lifecycle - namely at front end engineering design (FEED) and/or construction stage - that would enable on-going operating costs to be reduced. Yet, because capital expenditure and operating cost budgets are handled as separate entities oil and gas operators could be losing out on these potential savings," he says. "Greater communication is needed between budget-holders, and greater recognition of the value that a number of on-site services can bring to both construction and operational requirements, to contain capital expenditure and build-in long-term operating cost savings from the beginning of the asset lifecycle."

When a pipeline needs work, whether repairs or modification, achieving this without shutdown or disruption to operation is often one of the primary considerations. To this end, the benefits of hot tapping and line stopping for live pipeline intervention have long been recognised, allowing pipelines and piping systems to remain on-stream during



Minimising downtime

A substantial joint integrity programme on nearly 1,000 critical joints has been successfully managed under the latest Pressurized Systems Integrity (PSI) Management service from Furmanite as part of the recently completed Brent Delta shutdown for Sigma 3.

Some 906 flanges, ranging in size from 0.5 to 36 inches and from 150 to 2500lb ratings, with stud sizes of 0.5 to 3 inches, have been worked on by Furmanite under the PSI Management programme, on the gas coolers, compressor (LPOP - low pressure option plus), manifold valves, gas export valve, test separation, high pressure (HP) separation, HP flare knock out drum, all main vessel isolations, and fuel gas tie-ins. The service covers every stage from joint inspection and engineering analysis, unbolting and machining as required, gasket installation and controlled bolting, to eliminate joint failure and ensure leak-free joints on start-up (which Furmanite guarantees).

Furmanite technicians undertook initial work in advance of the shutdown to identify the joints requiring work and marked these up on the process and instrument diagrams (P&IDs) at Shell's offices. Weekly meetings were also attended to help compile the plan for Furmanite's activities during the shutdown and gather information on the activities being added to the shutdown activity register (SDAR). This stage saves valuable time and minimises workscope pressures, avoiding delays during the shutdown.

Two visits were also made to the platform prior to the shutdown to tag the relevant joints using the PSI Management colour coded system. These are then updated as work proceeds, providing immediate status recognition.

The information relating to each joint, including all mechanical and work data, is also logged on the bespoke PSI Management system (held and managed by Furmanite and requiring no purchase by the client). A detailed history of each joint is thus built up to create a comprehensive, easily accessed record for full traceability and assistance in future maintenance planning.

The PSI Management system was introduced by Furmanite last year, and addresses all factors known to cause leaks (typically flange distortion, sealing surface damage, incorrect bolt loads and uncontrolled tightening methods) for an on-schedule, zero-leak start-up. Among the key benefits of the service are avoidance of costly delays, reduced equipment and testing costs and need for re-work, and earlier demobilisation of labour, all of which contribute to driving down cost and reducing risk.

In addition to the flanged joints, Furmanite also worked on the 58 inch and 79 inch diameter coolers. With the cooler cover and dome end removed the seal faces were surveyed for flatness, found to be within tolerance so no machining was required, and then closed and the 3 and 2.75 inch studs tensioned, to ensure a reliable seal.

Furmanite's technicians were also able to undertake additional services while mobilised to the platform. As well as general maintenance work, this included hot tapping and drilling a six inch hole into an 18 inch stainless steel line to tie in a new branch welded on to the line, as well as re-machining on-site two eight inch flanges that had been damaged in transportation.

"This project has highlighted both the benefits of our new PSI Management service for a leak-free, on-time start-up, and the ability of our Furmanite technicians to multi-task for optimum manning efficiency that's particularly valuable within tightly scheduled shutdowns offshore," Furmanite business manager Graham McKay commented. "This is representative of our approach to offer technologies and services to help minimise downtime."

Subsea service

Furmanite International has been awarded a second substantial contract by the Azerbaijan International Operating Company (AIOC) and BP Exploration (Shah Deniz) Ltd. both operated by BP, to supply subsea pipeline repair clamps for ACG and Shah Deniz subsea lines in the Azerbaijan sector of the Caspian Sea. This follows a similar contract won by Furmanite last year.

Under the contract, Furmanite will supply high pressure pipeline repair clamps, all meeting the stringent technical requirements for subsea application. The package will provide contingency measures for the new Shah Deniz and Azeri in-field lines, including oil, gas, condensate, and water injection lines in diameters from 4 to 26 inches, should repairs or modifications to the lines be required.

The high pressure repair clamps being provided are engineered to accommodate design pressures ranging from up to 520 bar for the 16 and 18 inch water injection lines and over 200 bar for the 4, 6 and 12 inch lines, to 70 bar for the 14 inch lines. They include Furmanite's specialist cross-asset clamp design, developed to accommodate variations in nominal outside diameters and out-of-roundness that could otherwise prove problematic, given the varying pipe schedules that exist in the field, making the clamps a viable and high value contingency measure should the need for repair arise.

Based on the FurmaSeal concept (specifically engineered for rapid and economical on-line pressure leak repair), the scaleable cross-asset clamps deploy a system of interchangeable inserts and seals, enabling a pipe outside diameter variation of more than 30mm to be accommodated. An exact fit on a high pressure line is crucial to maintain the seal and avoid extrusion.

Commenting on this second contract win, Furmanite business development manager Mike Tucker says: "We are delighted to be able to provide this subsea pipeline contingency package for AIOC, operated by BP, with whom we have a proven track record demonstrating our understanding of their requirements and our ability to respond quickly and effectively. This, coupled with our on-the-ground presence and commitment to Azerbaijan, plus our full design capability, has put us in an optimum position to provide this package for the Caspian region."

Furmanite has a strong presence in the Caspian, with an office in Baku complete with warehouse and fully equipped workshop facilities, giving it an enviable engineering resource in the region. With a workforce of ex-pat engineers based in Baku and supported by Azeri personnel trained in Furmanite technologies, the company provides its full breadth of engineering services in the region, where it has successfully undertaken numerous projects.

maintenance, retrofitting, alterations, and emergencies, or in system expansions. Such services are frequently undertaken offshore - but when required subsea, there are additional considerations to take into account.

Earlier this year, Furmanite acquired Flowserve's General Service Group (GSG), a leading provider of industrial flow management services. As part of the acquisition, Furmanite has gained the company Ipsco and so can now offer an extended capability and experience in hot tapping and line stopping at large diameters (to 72 inches), high pressure (over 100 bar), high temperatures (to 370°C) and on large scales requiring multiple simultaneous operations, on-shore, offshore, and subsea.

"Hot tapping and line plugging may be called upon to meet a range of maintenance and modification requirements," Furmanite business manager Martin Wilson explains. "A section of line or plant may need to be isolated to undertake repairs (emergency or planned) to the line or change out a malfunctioning valve or instrument, for example, or to tie in branch connections, install instrumentation, or re-route the line. In each case, hot tapping and line plugging can facilitate this with no disruption to operation, providing the benefits of avoiding downtime and the inherent cost-savings that brings."

Typically, hot tapping into hydrocarbons, natural gas, heavy oils, chemicals, water and steam, is widely used to provide additional branches or modifications, instrumentation monitoring points (flow meters, drain points, sampling points, pig indicators or internal visual surveillance equipment), or entry points for isolation. Line stopping techniques on the other hand temporarily stop the flow in an operating pipeline, providing a safe, cost-effective and efficient isolation while the line remains on-stream and pressurised, without the cost of fitting permanent valves. Typical applications here include a double stop and bypass for valve insertion or permanent relocation of the line.

Briefly, the hot tapping process involves a welded or mechanical fitting, compatible with the pipework specification, which is installed on the pipeline together with an appropriately-rated full-bore valve. A drilling machine is then used to remove a section of the existing pipe. The drilling process (using machines that are manually, pneumatically or hydraulically operated, depending on diameter size, and are suitable where intrinsically safe equipment is required) deploys a pilot drill to break through the pipe wall. The product content fills the void beneath the drill, and air is expelled through the drilling machine purge valve, which is then closed to retain the pressure. The drilling process continues to complete the cut, and the cutter and coupon (the disc produced by the process, which is retained by a positive retention device fitted to the cutter pilot drill) are withdrawn into the void above the valve.

"Factors such as pipeline product type, temperature, line pressure, line and branch nominal size, wall thickness and operating conditions are all taken into account," Wilson explains. "Material and size will affect the choice of cutters and pilots, machine and swarf clearance measures, for instance. Pressure and connection configuration will decide the adapter to be used, while temperature affects the machine's seals and whether cooling spools are needed, and product and chemical constituency will clearly impact in terms of corrosion, flammability, toxicity and so on and the measures that need to be taken accordingly."

Equipment

Similarly, line stopping uses a mechanical plugging head which is inserted into the line via a hot tap and temporary valve. The line stop equipment is installed on the temporary tapping valve, which is opened to allow the line stop head to be inserted into the pipeline, rotated and locked into position. The line stop head is fitted with a sealing element

Going offshore

The SmartShim cast-in-situ chocking system from Furmanite has undergone a new development which slashes installation time on offshore platforms, adds a high degree of control and flexibility, and makes the service even more efficient - with valuable benefits to operators. This has been demonstrated on one North Sea platform, where gaps as large as 750mm - the largest undertaken to date - were 'SmartShimmed' with significant time efficiencies.

The latest improvements to the SmartShim system are the result of a new pump skid developed by Furmanite, which fully automates mixing and pumping of the resin on-site - a key element in installing SmartShim - for maximum precision and control, and a speedier process.

SmartShim, an award-winning patented innovation, is designed to prevent costly damage to conductors or caissons created when the lateral force of wave movement causes them to impact against the conductor guides resulting in fatigue or even fracturing. The SmartShim slips are manufactured from a PVC-proofed nylon and are filled with a specialist Furmanite-developed polyurethane resin and cast-in-situ, thereby forming to fit the gap between conductor and guides precisely, whatever the dimensions. Importantly, SmartShim is engineered with sufficient elasticity to absorb the wave energy effects, while holding the riser or caisson firmly in place within the guides.

It is in filling and casting SmartShim on-site that the new pump skid is proving so valuable. For instance, removing the need to hand-mix the resin on-site before starting to fill the SmartShim slips saves significant time. It also means the process is more environmentally friendly. Precision and elimination of human error are further benefits of the new system.

"Mixing the resins correctly is critical to successful curing and therefore performance of the finished SmartShim," Furmanite's materials technology manager Dominic Dean explains, "so the ability to control the ratio and mixing process with absolute accuracy is invaluable, and with the new skid this is achieved using pneumatic pressure-monitoring devices. The whole process is monitored from a control panel by a trained Furmanite operator.

"Moreover, because (apart from one short length of hose) the pumps and hoses contain only un-mixed components, the process can be stopped and started again if necessary without concerns over the resin having begun to cure in the hoses and pump," Dean adds. "This provides maximum flexibility and minimum time demands, particularly valuable offshore where setting up and cleaning down time can be reduced from every day to once a trip."

The benefits of the new improvements were exemplified in the installation of SmartShims on some ten 20-inch nominal bore risers on one North Sea platform, situated at the +10 metre elevation guides. Damage was being caused at the guide location due to excessive movement at the wellheads and the existing centralisers not being designed to absorb any shock loading.

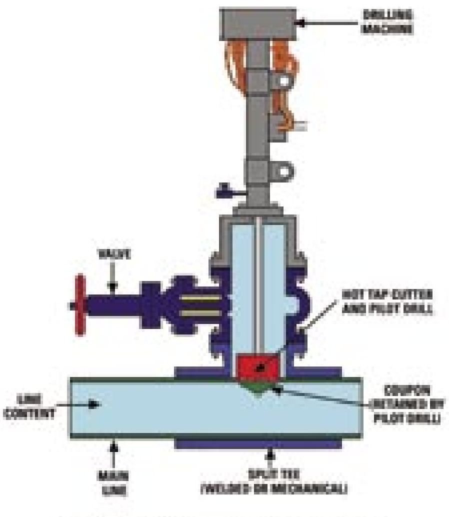
"The new pump skid enabled us to install the SmartShims quickly and efficiently," Furmanite business manager Graham McKay commented. "Despite the large gaps being chocked (750mm), installation time was reduced to just two days per conductor including curing time as a result of the new developments, as opposed to 4-5 days previously."

A full scale workshop trial was undertaken in advance of this project, including a mock-up of the conductor and guide built in the workshop to facilitate load tests and prove the system worked before going offshore.

which is activated in the line under pressure, achieving a temporary seal and stopping pipeline flow (or re-directing it through a by-pass). Once the repair, alteration or relocation is complete, the line stop head and equipment is removed, a completion plug installed and locked into position, and a blind flange is installed on the hot tap connection to complete the process. A feature of this system is that it allows the process to be reversed and the hot tap connection can be re-used to repeat the line stop process.

"The techniques are well proven, but a number of factors make subsea hot tapping and line plugging more complex," Wilson explains, highlighting practical issues such as visibility (highly visible colours are used on the equipment to aid the divers), and use of hydraulic actuators for ease of installation, to issues such as consideration of external water pressure and the need to keep the pressure balanced across the machine.

Work undertaken to date by Furmanite Ipsco includes both single line stops and double line stops with bypass, typically to 24 inch lines at pressures to over 150 bar on high pressure natural gas and crude lines, generally working with ANSI 600 and 900



Diagrammatic representation showing Hot Tapping process as drilling machine cutter breaks through into main line

RTJ flanged configurations.

"Numerous projects have been undertaken, particularly in the Gulf of Mexico and major tie-in hot taps in the UK and Norwegian sectors of the North Sea, among other regions," Wilson says. "Experience to date has included what is believed to be the world's largest subsea double hot tap on a 36 inch main sour gas line at 150 metres depth, through ANSI 900 ball valves. The project was completed in around eight hours from launch of equipment and fittings to hot tap completion, with no interruption of service. Similarly, the largest subsea line stop project undertaken by Furmanite Ipsco to date has been a double 20 inch line stop with 12 inch bypass on high pressure gas lines in over 200 metres of water."

Projects

Interestingly, one of the most unusual subsea hot tapping projects involved multiple hot taps to float a submerged fuel storage cell in 650 feet of water. The taps were made to float the unit, as well as balance the fuel cell on the way to the surface. As for future projects, these could include multiple line stops for a project in Egypt, and a large deepwater hot tap in the Gulf of Mexico, and research is ongoing to develop subsea hot tapping and line plugging further.

Where required, Wilson also points out that bespoke solutions can be engineered, citing one such example where Furmanite enabled a major operator in the Congo to avoid lost production when it installed six high pressure self-sealing hot tap tee-clamps on a main crude oil pipeline on the seabed, while the line remained in operation.

Production

"The line was 120 metres below sea level, and was suffering from flow restrictions caused by a natural build-up of deposits which was hindering production," Wilson explains. "Shutdown to carry out a repair would have been extremely costly with potentially days of lost production, but Furmanite was able to provide structural hot tap tees that could be fitted by divers while production continued uninterrupted. This enabled a connection to be made to allow a solvent to be injected into the line to dissolve and release the restriction."

The bespoke engineered subsea hot tap tee clamps were designed to be self-sealing, for simpler subsea installation, using a series of self-energising hydrocarbon- and chemical-resistant elastomer seals. Designed for pressures of 170 barg and tested to 255 barg, these were positioned to allow an interspace test to be used to confirm seal integrity once the clamp was bolted in place on the line. A valve was then installed and a drilling machine, adapted for subsea deployment, used to drill into the pipeline. The self-sealing tee assembly contained the system pressure and provided a branched outlet to allow injection of the solvent.

"This methodology was successfully repeated six times at intervals over the 115 metre length of affected pipeline," Wilson highlights.

Operation

As Wilson points out, with ever-expanding offshore and subsea activity where pipelines are modified or re-routed, or simply for routine instrument insertion or repair and maintenance, the ability to undertake the necessary work without interrupting operation will have high value to operators around the world.

"If the definitive goal is to attain operational excellence and maximum return on investment, this comes down to a number of key underlying requirements, including minimising capital asset investment, maximising productivity, and reducing operating cost," concludes Mike Tucker. "Greater co-ordination of capital expenditure and operating budgets could allow services to be applied to benefit both areas and help meet these objectives, reaping benefits all round for operators seeking to maximise asset performance and earning potential." E

Maintaining performance

A leaking sea-bed flanged connection has been successfully repaired using Furmanite leak sealing technology, installed by ROV, at 500 metres depth for BP in the Foinaven field, west of Shetland. The achievement has enabled oil production to continue at capacity, by allowing water injection pressure to continue.

The success was realised by Furmanite working with Subsea 7, whose ROV systems were used to install the bespoke Furmanite-designed clamp and to mix and inject the specially-formulated sealing compound - quite a challenge to achieve by remotely operated vehicle.

The 10-inch leaking flange joint was situated on the flowline termination assembly at the base of the Foinaven water injection riser, which feeds injected water to different parts of the reservoir. Seawater ingress at the joint had caused corrosion, which was threatening the output capacity of the field.

Furmanite's clamp solution was designed to cover the flange connection. "Space was limited and the clamp had to be operable by ROV, with no opportunity to use heavy lifting gear, so while designed to cover the flange connection the clamp was also kept to minimum dimensions (some 666mm wide, 680mm high and 140mm deep, weighing around 200kg). It was also engineered to be compatible with Subsea 7's bespoke ROV deployment system," the Furmanite project engineer explains.

Installation involved lowering the clamp over the pipe, with the lower half suspended by one clamp bolt; the clamp rotated until both halves were in-plane with each other, normal to the pipe axis; and (with both bolts now in place) the lower half drawn up on the bolts, bringing the clamp halves together. With the two halves some 100mm apart the clamp was moved along the pipe and positioned over the flanges, at which point the bolts were initially tightened to seat and compress the seals, and then fully tensioned to the necessary pre-load to ensure that internal pressure forces would not part the clamp halves.

Critical to the success was the sealing resin, which was injected once the clamp was in place to seal the gap and bolt clearances. The challenge was to get the resin mix absolutely right to match the leak profile - in other words sufficiently fluid to allow injection and ensure it reached the leak point, while sufficiently viscous to ensure it bridged the 60mm hole without extruding into the pipeline.

In keeping the clamp as small as possible (covering the flanged connection rather than fully enclosing it), the bolt clearances also had to be considered, as these in effect provided 32 potential leak points that, with full pressure restored, the water would seek to find once the original leak path was sealed. It was therefore crucial that the resin must reach and seal these too.

A further challenge was to ensure that the resin could be mixed and injected remotely. "Traditionally for subsea applications the sealing resin would be mixed on the surface, and divers used to install and inject the clamp," the project engineer explains.

"Clearly in this instance, with the depths involved, the whole process had to be undertaken by ROV. If the resin were sent down ready-mixed it would have cured before it could be injected, so a special remotely-operated injection and mixing system had to be developed. This involved injecting from separate storage cylinders through a mixer unit to ensure a good homogeneous mix, and then into the clamp."

He adds that extensive testing was undertaken to ensure that this crucial element in the repair design would work as required. Two clamps were manufactured so that one could be used for testing purposes, and two test spools were manufactured (at Furmanite's facility in Carlisle), with the appropriate type of 10-inch flanges and a representative defect in the gasket. The testing was undertaken at both Furmanite's and Subsea 7's premises. A test rig was built to the Subsea 7 skid injection unit specifications, and the two-part compound injected into the flange via the clamp, with the injection rig hoses, clamp and test spool flooded with water to simulate seabed conditions. The seal was then pressure-tested, following the cure period, by pressurising the test spool.

The clamp was successfully installed and injected, sealing the leaking joint, in just 24 hours (including injection and cure), ensuring that water injection pressure could be maintained. Commenting on the project, BP senior subsea engineer Sandy Meldrum says: "We were delighted with the solution design and implementation, and the co-operation between Furmanite and Subsea 7. The leak was presenting a problem to our production performance - a situation we had to resolve, preferably without having to shut down. We've long worked with Furmanite and know their capability to engineer bespoke solutions where required."