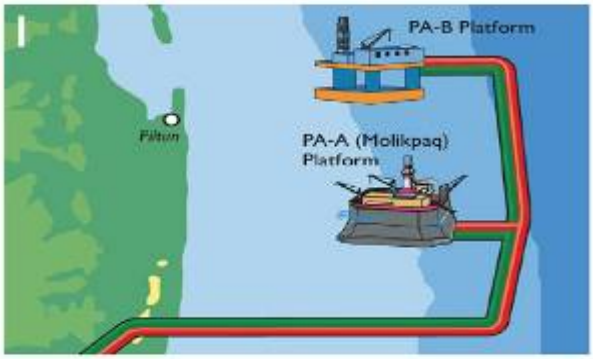
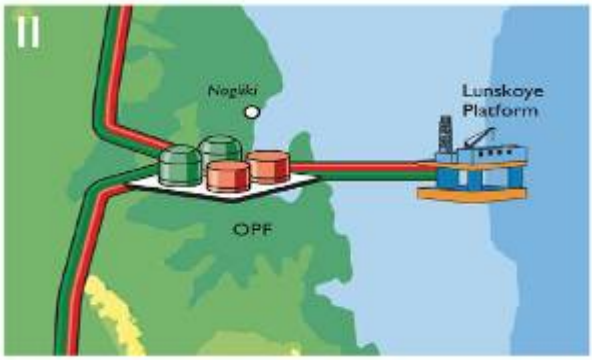
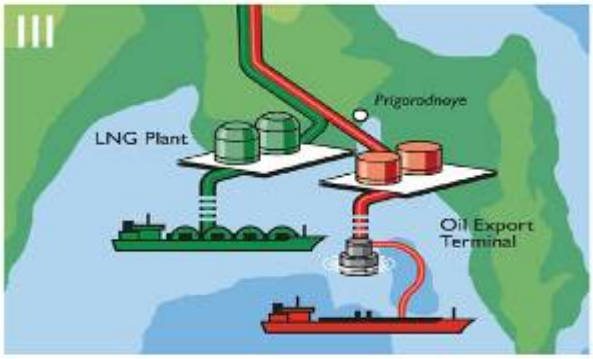
Weatherford®

Case Study: Sakhalin II phase 2 onshore pipelines, precommissioning and commissioning services for 1,000 miles (1,600km) of 4.5 inch to 48 inch pipelines in harsh remote locations







Delivering Product Under Pressure

Pipeline & Specialty Services

Precommissioning | Commissioning | Inspection | Shutdowns | Decommissioning

Introduction:

Weatherford P&SS have successfully completed the full precommissioning and start-up suite of activities on over 1,000 miles (1600km) of pipelines for Starstoi on the Sakhalin II phase 2 pipeline project (Fig. 1). This was followed with full nitrogen commissioning works to bring oil and gas onto the environmentally sensitive Sakhalin Island. Utilising strong environmental procedures and controls to avoid any disruption to the key salmon spawning areas, the rare Steller Sea Eagle nesting areas and general bear population, all facets of the project were completed successfully whilst also overcoming the key engineering difficulties in this remote and rugged region.

The project management team was mobilized in August 2006 with the first equipment arriving later that same year, the project was completed during January 2009.

The project is located on Sakhalin Island, which is on the far-eastern side of Russia. Together with the Kuril Islands, it forms an administrative region of Russia. Sakhalin Island is 589 miles (948km) long from north to south and about 100 miles (160km) wide, covering 29,500 square miles (76,400 square km). There is a lowland plain in the north, where swamps can deny access until the winter freeze in the north, but most of the land is mountainous, reaching an elevation of 5,279 feet (1,609m) at Mount Lopatin. It is a remote area with a notoriously poor transportation system, an overall rugged topography, and has temperatures ranging from -45°c to +30°c. Vegetation ranges from tundra and stunted forests of birch and willow in the north to dense deciduous forest in the south. Fishing, mainly of crab, herring, cod, and salmon, is the principal economic activity around the coast. Petroleum and natural gas extraction in the north, coal mining, and lumbering, including paper production, are the basis of the rest of the economy. The main agricultural activity is livestock raising. Most of the population is Russian and there has been considerable emigration since the 1960s.

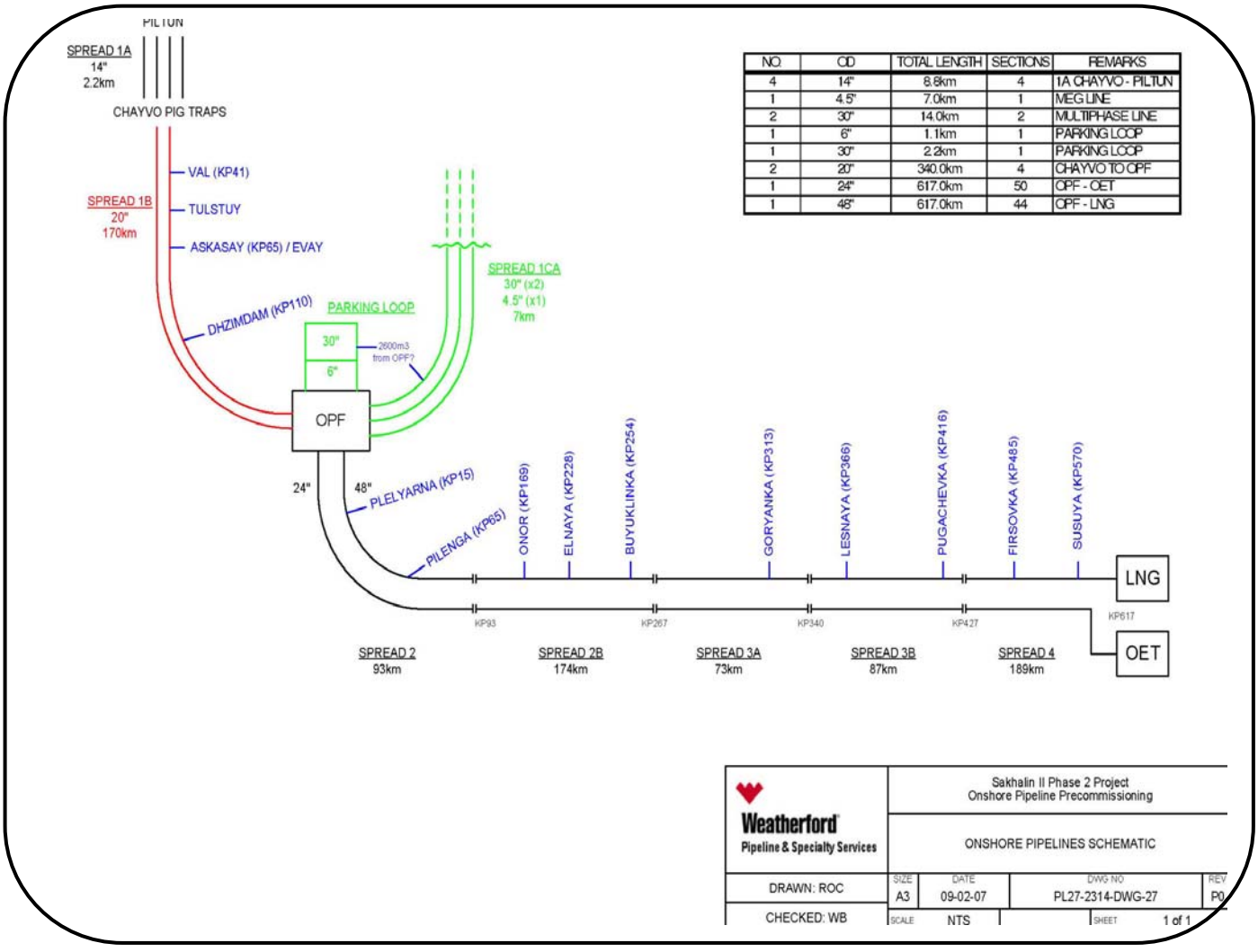


Figure 1: Onshore pipeline details

Project Details:

Figure 2: Piltun-Astokhskoye-B (PA-B)

Figure 3: Lunskoye Platform (LUN-A)

Figure 4: Offshore Pipeline

Figure 5: LNG Plant

Figure 6: Oil Export Terminal (OET)

Full-field development of the Sakhalin II Project involves extensive upgrading of the infrastructure as well as a multitude of pipelines and process facilities, a brief overview of which are as follows:

Two new offshore platforms:

- The Piltun-Astokhskoye-B (PA-B) (Fig. 2) is a drilling, processing and production platform that will extract oil and associated gas from the Piltun reservoir. It is located 12km off the northeastern coast of Sakhalin Island, in a water depth of around 30m. Its production capacity is; Oil approximately 70,00b/d (11,13m^3/d) Associated gas 100minscf/d (2.8min m^3/d).

- The LUN-A is a drilling and production platform (Fig. 3) with minimum processing facilities. Oil/condensate and gas separation including gas treatment for transport to the LNG plant will be done onshore at the onshore processing facility. This platform will produce the majority of the gas for the LNG plant. Its production capacity is approximately 1,80minscf/d (52mln m^3/d) and condensate about 50,000b/d (8,000m^3/d)

- The offshore pipelines systems (Fig. 4) includes oil and gas pipelines designed to transport production from PA-A and PA-B to the shore, multiphase pipelines from the LUN-A platform to the shore, a MEG (monoethyleneglycol) feed line from the onshore processing facility (OPF) to the Lunskoye Field platform, and an oil export pipeline in the south of the Island.

- A liquefied natural gas (LNG) (Fig. 5) plant on a 490 hectare site at Prigorodnoye on Aniva Bay 13km east of Korsakov far in the south of the Island. The LNG processing plant will have an annual production capacity of 9.6mln tonnes. The LNG plant has two process trains to purify, process and liquefy natural gas. Each of the two trains will have an annual capacity of 4.8mln tones.

- Oil Export Terminal (OET) (Fig. 6) for offloading crude oil and LNG. Located on the same site as the LNG Plant at Prigorodnoye. When operating the facility will provide oil storage in two tanks with conventional double deck floating roof. The total storage capacity will be 1.2mln barrels (190,000m^3). This is equivalent to about six days of throughput from the onshore oil pipeline.

Project Details:

Figure 7: Onshore processing facility (OPF)

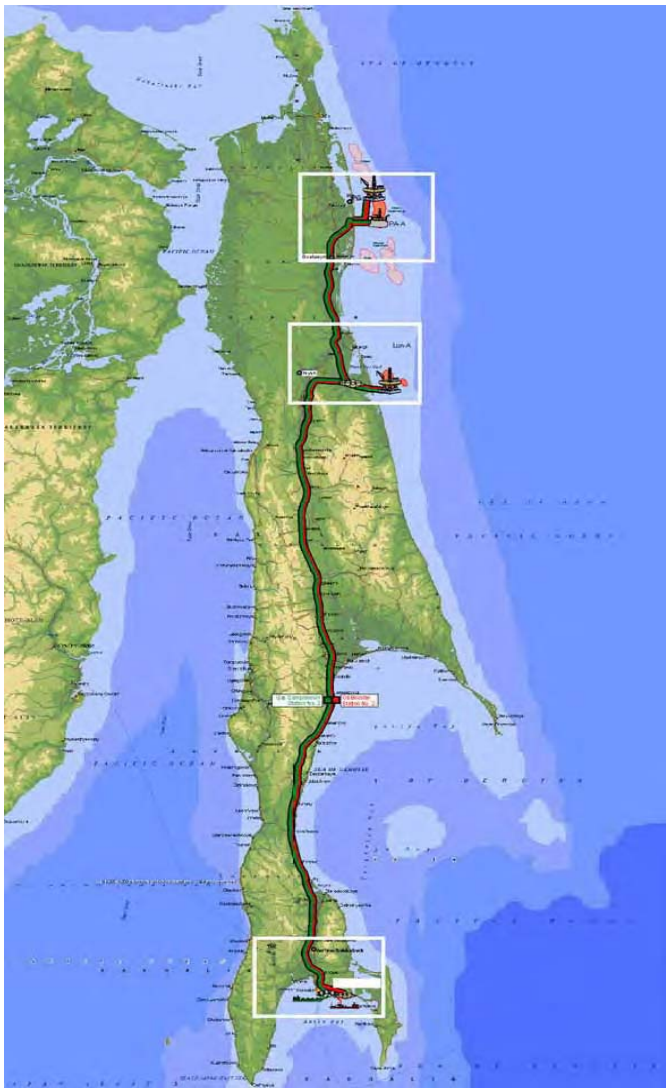


Figure 8: Pipeline Route

- An onshore processing facility (OPF) (Fig. 7) located off the north eastern shore of Sakhalin Island. At full capacity the plant will be capable of processing 1,800mln scf/d of gas (51mln m^3/day) and about 60,000 b/d of condensate/oil (9,500m^3/day), The condensate will be integrated with oil production from the PA field, and transported by pipeline via the OPF. The combined condensate and oil will then be sent through the main onshore oil line to the OET using booster pumps at the OPF with a capacity to pump up to 195,000bpd

- The onshore oil and gas pipelines (Fig. 8) run from Piltun in the north of Sakhalin Island via the onshore processing facility (OPF), near Lunskoye, to Prigorodnoye, in the south. The two pipeline systems each cover a distance of over 800km. From the Piltun landfall to the OPF are two 172km 20 inch pipelines, one oil and one gas. The distance from the OPF to the Liquefied Natural Gas (LNG) plant and Oil Export Terminal (OET) plant is 617km, 24 inch oil line and 48 inch coated gas line. Two short multiphase pipelines (30 inch diameter, onshore length 7km) and a 4 inch Mono-Ethylene Glycol – MEG – pipeline in the same right of way connect the landfall at Lunskoye to the OPF.

Project Details:

A large project required extensive resources:

To tackle such a huge project Weatherford installed a project management/ support team consisting of 7 personnel in the existing Weatherford facility in Yuzhno-Sakhalinsk. At times of peak activity we employed 142 personnel and mobilized nineteen equipment packages which were designed to cope with the different terrains we would encounter.

Figure 9: Weatherford prides itself on creating the right project team

- 5 x 1.3 million gallon/hr (1,000m³/hr) flooding spreads up to 700psig (49barg) working pressure for flooding, transfers and filtration. Each spread had its own test cabins, break tanks, fuel tanks and flooding low pressure instruments.
- 5 x 2,175psig (150barg) high volume hydrotesting spreads with all pumps, break tanks, test cabins and HP instrument packages required for a variety of test scenarios.
- 3 x 8,000scfm/min (226m³/min) drying spreads to 350psig (24barg) including, compression, dryers, fuel tanks required to dry different sections and drive drying pigs trains (Fig. 10).
- 4 x 247,000scf/hr (7,000m³/hr) Sirocco^{SM} air drying units with 500kVA generator compressor sets to -40°F (-40°C) dew point. This smaller footprint drying technology proved invaluable when tackling the tough logistics on the island. Pneumatic testing/high head booster package including Weatherford built combination compressor/ boosters 1,050scfm/min (30m³/min) 350psig (24barg) sullair compressor end feeding Ariel 1,050scfm/min (30m³/min) 1,800psig (130barg) booster HP coalescent filtration and scrubber tanks. This equipment was specified in case pneumatic testing was the only remaining option to be used during periods of extreme cold weather or where water was simply no longer available.
- Start-up and commissioning package capable of delivering dry air up to 30,000scfm/min (850m³/min) or membrane nitrogen MN_2^{SM} site generated nitrogen up to 4,500scfm/min (127m³/min). Air or nitrogen could also be boosted up to 1,800psig (130barg) at up to 4,500scfm.

Figure 10: Large compression spread

Challenges/Solutions:

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This unique project posed many challenges to traditional methods of filling, testing, dewatering and drying pipelines due to the geographical remoteness, extreme weather, tough landscape and sensitive environmental issues.

The seasons combined with regions created unique challenges; each season presented itself with it's own challenges and each region of the island also required it's own unique solutions:

- The north of the island is relatively flat and has the most snowfall over a longer season giving less time to win water from the rivers as well as difficult access in the winter. The main environmental concern in this region is due to the rare Steller Sea Eagle nesting grounds (Fig. 11). Snow clearance programs, strict journey management and varying working schedules were devised to ensure clear roads, personnel returned safely to camp (since telecommunications have limited coverage) and eliminate disturbance to Sea Eagles. One innovative solution enabled Weatherford to continue Hydrotesting the Chayvo landfall and pig trap stations throughout the winter season. This was achieved by converting fuel tanks to glycol storage farms, the glycol can be used as an effective test medium even in the extreme low temperatures due to its low freezing point. By ensuring all the glycol was transferred and reused from section to section we were able to return the clients schedule back on track, the client awarded the Chayvo team an early completion bonus as a result of this innovative approach.

- The Nish and Makharov regions are extremely mountainous with steep, undulating terrain (Fig. 12), these regions Weatherford developed smaller, more transportable hydrotesting packages utilizing small diesel driven test pumps, small test cabins and 10m^3 break tanks that could be easily transported up the steep, winding roads. Access to water again proved a major challenge however due to the relatively short sections of line (due to the steep terrain and consequent high hydraulic head) it was possible to continuously transfer from one tested section to the next. The small mobile equipment packages proved invaluable on these sections. Where required extra water could be pumped up through the pipeline from the valleys until over the mountain and back into the next valley, or flat long section, where the larger hydrotest pumps and spreads would take over again.

Figure 11: The rare Steller Sea Eagle nesting

Figure 12: Difficult terrain

Challenges/Solutions:

- The central Onor and Tymovsk regions are relatively flat, however on this central plateau, 400m above sea level and shielded from the sea by a wall of hills, is the coldest region on the island (-45°C, -65°C with wind chill). Weatherford utilized “winterisation” skills developed over several winters experience to continue where all others stopped. It was found that hydrotesting, dewatering and drying could be carried out by building tough habitats (Fig. 13 & 14) able to withstand heavy snow loads (Fig. 15) over all the equipment and exposed sections of pipeline. Several larger items of equipment were containerised with remote operation panels affording excellent protection from the elements. When containers were not practical to use, heat tracing and thermal insulation jackets covered all pumps, filters, hoses and instrumentation. Straw and snow berms were built up around exposed pipelines so that hydrotesting could be completed even with ambient temperatures at -20°C. As soon as hydrotesting was completed the dewatering operations were immediate to move the water to another test section to prevent freezing. Drying operations were able to continue in snow storms and -45°C temperatures by building habitats around all the compression and drying equipment. As the engines heated the space inside the habitats the compressors drew in only warm air and discharged it into the pipeline. Should temperatures fall inside the habitat the compressed air could be circulated inside the habitat to build temperature before drying once again resumed. Implementing these varied measures and always planning where the water had to go enabled Weatherford to continue working over Christmas and New Year at the coldest times when all other works had to be cancelled.
- In the relatively warmer south the winters are shorter with less snowfall but this leads to an extended thaw season, consequently the only federal road can be washed out by flash floods and the access to site is continuously treacherous and difficult to access. Weatherford created several “skidded trailers” to mount equipment onto. These acted like giant sledges (Fig. 16) to allow tracked vehicles to drag the equipment into location through the mud. Special Kamaz and Gaz crew buses were utilised to transport men to location through the swamplands to maintain schedules in this very challenging location.

Figure 13: Above ground pipeline section protected by habitat

Figure 14: Habitats covering equipment

Figure 15: Typical winter conditions

Figure 16: Tracked vehicle pulling equipment “sled” to site through the mud

Challenges/Solutions:

Combined with the unique seasonal and regional issues we faced the following situations in all locations:

Irrespective of the location on the island the salmon and crab industry is of huge importance to the population, contamination or disturbance of the natural water systems was simply not an option. Weatherford utilised robust bunding on all equipment (Fig. 17 & 18) within the water protection zones as standard. Extremely strict Sanitary Protection Zones (upstream of towns and villages) were identified and diesel driven equipment was strictly limited near water extraction points. In order to collect the water necessary Weatherford utilised electric submersible pumps inside 2mm mesh baskets to protect the salmon fry (baby salmon!) and thus gained permission to continue extracting water longer than other contractors, before inevitably heavy spawning halted all extraction. Weatherford created an extraction process that was literally "water tight" to ensure water made it to the inside of the pipeline whilst isolated from the water sources of the local flora and fauna.

Figure 17: Bunding for any diesel driven equipment was extensive

Figure 18: Part of environmental measures, bunding used to isolate water supply for hydrotesting

Figure 19: Sirocco^{SM} drying technology

Beginning with the end in mind enabled Weatherford to guide the client construction schedules sometimes whole seasons ahead. This advanced planning was done so that certain pipe sections could be completed in order to act as storage reservoirs for fluid transfer to other sections when all extraction licenses were revoked. Intermediate filtration and transfer pumping in the mountainous areas enabled water to be used and reused up to six times whilst retaining the cleanliness specifications.

Weatherford completed full engineering and risk assessments to carry out pneumatic testing in case of complete lack of water licenses. Pneumatic testing is never to be taken lightly and the attention to detail, planning and justification were meticulous. The work undertaken set a new standard in pneumatic testing which has been transferred to other locations in Russia experiencing similar climatic and environmental conditions. A full equipment spread was mobilized and ready to perform pneumatic testing in the event that no water was available. The pneumatic testing package was also used to clear sections that had become air-locked during the initial construction cleaning which was done with 350psig (24barg) compression only, the boosters could produce up to 1,800psig (130barg) if required to assist the local construction companies.

Weatherford proposed the use of Sirocco^{SM} drying technology (Fig. 19) in many area's of Sakhalin island. This technology provides the most efficient delivery of dry air available anywhere in the industry since *Sirocco* equipment is designed specifically for drying pipelines and no other task. From a very small footprint of only 2 x 20 foot containers 7000m^3 low pressure dry air can be fed into a pipeline. Such a small containerized package was easy to move around the difficult locations, an equivalent 350psig (24barg) spread would have had five times the footprint and five times the fuel consumption. Using *Sirocco* drying technology enabled the fleet of 350psig (24barg) machines to be used where operations required a little more pressure to drive pigs, such as for geometry inspection.

Challenges/Solutions:

Ensuring local personnel (Fig. 20) are recruited and well trained is not only sound business practice it is also local and federal law in Russia. Weatherford ensured 70% of their work force and 3rd party services were of Russian origin. From project inception HR and resource planning enabled us to build up and train a local workforce, proficient at the core P&SS skills as well as the local unique environmental conditions. Throughout the project local personnel were given training and encouragement and some have attained a sufficient level of expertise to supervise our operations, this is excellent news for the local market as operations continue into the future on Sakhalin Island.

Figure 20: Weatherford has developed a core team in Sakhalin for future phases of the islands energy development

Results/Benefits and Summary:

Results/Benefits:

Simply executing such a large onshore project would have been a challenge however the four key area's we see the major benefits gained by the project from using Weatherford P&SS:

- Sakhalin Island's remoteness, local legislation and the fact it is relatively new to this type of development made the requirement to deploy such huge resources a logistical challenge we are delighted to have achieved.
- Overcoming significant environmental hurdles with Weatherford being proactive and taking the lead in providing solutions to, not only Weatherford's scope of work, but also that of the client and contractors.
- Careful planning, innovation and engineering solutions ensured that the difficult topography, sensitive environment and extreme weather conditions did not impact adversely the progress of the project over several difficult regions and seasons.
- Being a responsible corporate citizen and creating a culture where the local environment, labour force and economy have all benefited from our presence on this project.

Summary:

Weatherford P&SS is proud of its association with Sakhalin II phase 2 onshore pipelines, over a two and a half year period we have moved huge resources on and off the island and executed precommissioning operations flawlessly, in the most extreme conditions. To achieve this with such care for the environment, whilst developing the local resources that can serve the emerging energy marketplace for the future is a testament to the hard work and dedication of all the personnel involved.

Weatherford provides a range of services used throughout the life cycle of pipeline and process facilities, onshore and offshore. Our global network of locations puts highly trained and experienced people, equipped with the latest technology, right at your doorstep. Pipeline & Specialty Services: **Delivering Quality Under Pressure℠.**

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