TOUGH TERRAIN MEETS TOUGHER PIPELAYING

Complex river crossings, mountainous terrain, protected flora and fauna. Surender Sharma, Punj Lloyd, India, details the construction of the Dabhol-Bangalore Pipeline Project.

Marking a significant project for India, GAIL (India) Ltd's Dabhol-Bangalore pipeline project aims to fulfil the gas and power requirements for the states of Maharashtra and Karnataka in the southwest of the country.

The 1000 km long pipeline will be part of an integrated national gas grid for the country, enabling gas distribution projects in smaller cities and towns. The complete construction work of the pipeline from Dabhol to Bangalore and two additional spurlines to Bangalore and Goa has been divided into 10 spreads. The pipeline will carry up to 16 million m^3/d of re-gasified LNG from the gas terminal of Ratnagiri Gas and Power Pvt. Ltd and supply to the industrial clusters of Maharashtra and Karnataka. The pipeline passes through the Ratnagiri and Kolhapur districts before entering Karnataka where it will travel across the districts of Belgaum, Dharwad, Haveri, Davengere, Chitradurga, Tumkur and Bangalore.

It was a prestigious moment when GAIL awarded Punj Lloyd a contract for the project in October 2010. The contract included the construction of seven out of the 10 spreads, comprising 825 km of the pipeline. The trunkline consisted of 250 km of 36 in. pipe,

Figure 1. Pipe lowering in progress.

Figure 2. Line pipe fit-up for mainline welding.

and 497 km of 30 in. pipe, with two spurlines: a 71 km, 18 in. spurline to Bangalore, and a 175 km, 24 in. spurline to Goa.

Punj Lloyd has executed many projects for GAIL in the past including the Thal-Usar-Thal pipeline, Jamnagar-Loni pipeline, Dahej Vijaipur pipeline and the Panvel-Dabhol pipeline, among others.

The detailed scope of work for the project includes supply of materials, installation, testing, pre-commissioning of the pipeline, preservation, drying and commissioning. The work also includes installation of the pipeline and related piping work at intermediate pigging stations, sectionalising valve stations, tap-offs and all associated mechanical, civil, structural, architectural, electrical, telecom and instrumentation work among others.

Before starting the project, Punj Lloyd undertook geotechnical and hydrological surveys of water body crossings, as well as road crossings. This enabled the company to mobilise equipment such as sidebooms, pipelayers, cranes, motor graders, excavators, dozers, rock breakers, automatic welding equipment and over 6000 workers from its dedicated workforce.

Pipe shifting was carried out by dozers and excavators with sledges on steep slopes. True to its 'never-say-die' spirit, the company also undertook construction and maintenance of approach roads, bridges, culverts and logging roads along the pipeline route. Punj Lloyd's fleet of equipment ensured quick mobilisation of 14 semi-automatic and eight automatic mainline welding crews, along with 45 tie-in crews. The company used specific welding technology including surface tension transfer process (STTP), normally used for higher grade welding on X80 pipe, for this project. Punj Lloyd is one of the first few companies in India to use this technology.

For easy facilitation of logistics, offices were set up at each spread along the entire route of the pipeline, which is connected to national highways (NH) and state highways. In addition to this, central co-ordination offices were built in Kolhapur, Maharashtra (for spreads A, B and C) and in Bangalore, Karnataka (for spreads E, F, G and H).

Punj Lloyd's unique execution plan can be summarised in the following points:

- Configuration of work in seven independent spreads.
- Establishment of seven camps with one camp in each spread.
- Establishment of two co-ordination offices – one each in Maharashtra and Karnataka.
- Close monitoring of work progress through video conferencing.
- Increased number of mini crews in tough and undulating terrain.
- Pipe shifting by bulldozers and excavators pulling sledges up steep slopes.
- Construction and maintenance of approach roads, bridges, culverts and logging roads.
- Huge mobilisation of resources to meet the target completion date.
- Mobilisation of 14 semi-automatic and eight automatic mainline welding crews along with 45 tie-in crews for completion of the project.

Smooth execution in rough terrain

The Dabhol-Bangalore pipeline traverses the tough terrain of Western Ghats, which consists of mountainous, rocky, swampy stretches and dense forest with slopes ranging from 35° to 60°. Western Ghats is a mountain range along the western coast of India and covers a 160 000 km^2 area, including a complex network of river systems that drain almost 40% of India. It is also a rich biodiversity area with hundreds of threatened species of flora and fauna.

Almost 200 km of the entire pipeline route passes through this difficult terrain. To save time, Punj Lloyd adopted innovative techniques to transport heavy earthmovers, trailers and welding equipment in the mountainous terrain. To transport the pipes and bends, special sledges and heavy towing equipment such as excavators, sidebooms, high capacity dozers and tractors were used for hauling and stringing in the hilly Ghat areas.

Besides terrain, one of the other major hurdles faced by the team was the incessant monsoon rain. As the site is situated in the mountainous Ghat region, the rains were a constant phenomena.

Crossing Ghats, creating milestones

The 825 km long pipeline route also included 27 river crossings, of which eight were horizontal directional drilling (HDD) crossings with the longest HDD of 1600 m in the Ghatprabha River drilled through hard rock. This is Asia's longest HDD crossing in hard rock. Achieving this task was no mean feat. Punj Lloyd's specialised and seasoned team of HDD engineers drilled 1600 m of hard rock using a single rig. Four HDD crews, 21 auger boring crews and 10 river crossing crews were mobilised for crossings completion on the project alone. The route also includes 57 railway/national highways

SCC and Cathodic Shielding

It started in 1988 when the Pipeline Research Council identified CP shielding as a prime cause of both corrosion and SCC (stress corrosion cracking). This study was also the first to indicate that shielding coatings might defeat defect survey systems.

lines. According to PRD sponsored research, SCC has proven in many cases to be associated with damaged or disbonded coatings. PRC research indicates that SCC is enhanced by cathodic protection shielding at the disbonded areas and by mill scale on the

to improper appli[illegible]

5. The survey indicated that disbondment in coatings is not easily detectable.

Pipeline Research Committee, 1988 "A Review of Gas Industry Pipeline Coating Practices", Pipeline Research Council International©, p.3 and 4
Published by Technical Toolboxes, Inc., 3801 Kirby Drive, Houston, TX 77098
http://www.techstreet.com/cgi-bin/detail?doc_no=prci%7C151586e;product_id=1702976

review of procedures for conducting SCC failure investigations was also performed. In regard to preventing the initiation of SCC, the single most important recommendation is the emphasis on coatings that remain bonded to the pipeline, but allow the passage of cathodic protection (CP) current in the event of disbondment. Emphasis should also be placed on the quality assurance/quality control (QA/QC) of the surface preparation and field application. These considerations would apply to both new pipeline installations as well as t[illegible] replacement

Since then a number of studies have come to the same conclusion. Here is a 2005 example.

Michael Baker Jr., Inc., "Integrity Management Program - Delivery Order DTRS56-02-D-70036 Stress Corrosion Cracking Study –Final Report", February 2005
http://primis.phmsa.dot.gov/iim/docstr/SCC_Report-Final_Report_with_Database.pdf

The requirement that pipeline corrosion coatings be non-shielding is now spreading. In 2009, U.S. DOT regulators began to explicitly require non-shielding coatings when companies want to increase pipeline pressure from 72% to 80% of MAOP. (CFR 192.112: http://www.gpo.gov/fdsys/pkg/CFR-2009-title49-vol3/pdf/CFR-2009-title49-vol3-sec192-112.pdf).

Two coatings are proven to be non-shielding and have decades of successful in-ground experience. One is FBE, and the other is Polyguard RD-6®.

It is particularly important to use non-shielding coatings for girth welds on new pipelines. Conditions and complicated coating processes during field application can lead to disbondment and other failures in adhesion of girth weld coatings.

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Figure 3. Automatic welding in progress.

crossings, 237 major road crossings and 276 other water body crossings.

The pipeline route in Maharashtra is made up of hilly dense forest terrain where approach roads are nonexistent. Punj Lloyd, true to its corporate social responsibility values, set out to construct the approach roads at over 25 locations along the inaccessible pipeline route. These approach roads have been of enormous help to the local villagers in the neighbourhood providing them with connectivity and infrastructure.

The Amba Ghat crossing

The 5.5 km section of the pipeline that crosses the hilly terrain of Amba Ghat is the most critical and the toughest part of the entire pipeline project. Amba Ghat is located along the Western Ghat crestline in Shahuwadi Taluk (16° 56' 22.4" N, 73° 47' 47.4" E) at an elevation of around 709 m above sea level. The region is covered by tall evergreen forest and receives rainfall of over 5000 mm over a four month period.

Due to its tough terrain, the Amba Ghat crossing was treated as a separate spread and executed independently. In order to counter the severe weather conditions and diverse topography, Punj Lloyd formed six mini crews to tackle the tough and undulating terrain to achieve the required objective. To test the strength of the pipe, the team conducted hydrotesting after noting the elevation of the terrain at several locations so that they could determine the impact of elevation pressure on the pipe. The hilly portion criss-crossed by several small roads, tracks and streams at short intervals increased the number of crossings and tie-in joints in the pipe. The undulating terrain called for a large number of bends, amounting to almost 60% of the total number of pipes in spreads A and B.

Conclusion

During the construction, Punj Lloyd lowered 39 km of pipeline in a single day, which also included a 12.63 km portion in the undulating terrain of Western Ghats. With this feat the company has again reaffirmed itself as an all-terrain specialist in the pipeline industry.

So far, Punj Lloyd has achieved 7.4 million man hours without any lost time injury. Adopting best practices in health, safety and environment at all its global sites, the company has identified associated risks and managed to erase errors through preventive measures. Apart from conventional hazard identification techniques and comprehensive risk assessment, daily site risks were assessed on the spot by the site in-charge as a part of STARRT – safety task analysis and risk reduction talk. This was communicated to the entire crew during daily toolbox talks. Three paramedical and medical doctors were available 24/7 onsite for emergencies.

Punj Lloyd in its history has laid more than 11 000 km of onshore and offshore pipelines for the world's prestigious oil and gas majors. A project of this magnitude and difficulty is being executed with great ease and efficiency only through a combination of skilled and motivated manpower along with unmatched expertise in pipelaying under challenging conditions. WP