Replacing 32 pipes on the Druzhba oil pipeline in under 88 hours

By Dr Ing. Petr Crha and Dipl. Ing. Ales Brynych CEPS a.s., Jesenice, Czech Republic

In September 2007, a unique event in terms of its scope and speed was carried out on the Czech section of the 20 inch diameter Russia to Germany Druzhba Oil Pipeline in South Moravia, where 32 pipe sections were replaced in a very short time.

An internal inspection had shown that wall thickness loss on sections of the Druzhba Oil Pipeline meant the pipe no longer met the operating pressure requirements. The pipes concerned were in two sections approximately 8 km downstream from a pumping station.

It was necessary for the pipe to be replaced during a planned shutdown that was scheduled to last for 96 hours; any extra time taken over this limit would result in prohibitively damaging cost penalties to the pipeline operator. Considerable planning was therefore required to have all the necessary skills and equipment onsite at the five locations involved, and to co-ordinate the activities of the large number of contractors required for the project. Because it was impractical to separately drain each of the sections containing the pipe that was to be replaced, it was decided to drain the whole 9.7 km long pipe section, and then decontaminate the inside of the pipe to allow flame-cutting and welding to be undertaken.

Following isolation of the relevant section, the normal procedure would have been for the contents of the pipeline to be drained into road (or rail) tankers from the nearest pumping station. In this case around 2,000 cubic metres of oil was involved, and due to the short time available for the whole operation, time was not available for the pumping option. An alternative solution that was considered was to pump the oil into neighbouring sections: this would require extra pumping capacity and pressurising the nearby sections to around 35 bar, equipment for which was neither available in the Czech Republic or even in Europe. It was therefore decided to drain the oil to a parallel 28 inch diameter pipeline, in which capacity could be made available by prior planning.

Exchange of 32 pipes within 96 hours represented a great deal of work that involved large numbers of personnel and equipment. Between 19 and 20 September 2007 up to 100 workers from 14 co-operating companies directly participated in the work.

The workflow for the pipe-replacement project was planned as follows:

- Preparatory works before pipe isolation:
  - » Draining the section of the 28 inch diameter pipeline to create storage capacity for transfer of the oil from the 20 inch diameter line.
  - » Preparation of the five work sites for the pipe replacements, including identification, excavation, and non-destructive testing (NDT) of the pipe to be replaced, earthworks, and transport of new pipe to the correct locations.

Timeline

The pipe-replacement project was completed in 87.5 hours of continuous work – nine less than the 96 hours allowed – and included the following major activities on the 20 inch diameter pipeline:

- Removal of oil from almost 11 km of pipeline;
- Decontamination of 9.66 km of pipeline; and,
- 32 cut-outs, replacement, and NDT.

17 September

- 06.00: start of pipeline shutdown and evacuation of the oil
- 09.00: final oil removed to downstream of the last cut-out
- 09.45: displacement of approximately 2,400 cubic metres of oil completed; compressed air discharge initiated
- 12.00: discharge of compressed air completed
- 12.00–19.00: cut-out of pipe no. 974 made and temporary cleaning-pig trap welded in place
- 19.00–23.00: pipe filled with Petrosol decontamination surfactant
- 23.00–10.30, 18 September: decontamination of 9.7 km of the 20 inch diameter pipeline

- After pipeline isolation:
  - » Draining the oil from an 11 km long section of 20 inch diameter pipeline.
  - » Preparing the 20 inch diameter pipeline for decontamination by cutting out the last downstream out-of-specification pipe (pipe no.974) and welding on a temporary cleaning-pig trap.
  - » Decontaminating the 9.6 km long section between the pumping station and pipe no.974.
  - » Replacing the 32 out-of-specification pipes by cutting them out and replacing them with new ones, together with NDT inspection of the new welds.
  - » Restarting pipeline operation.
  - » Reinstatement of the pipeline, reburial, and final completion of earthworks.

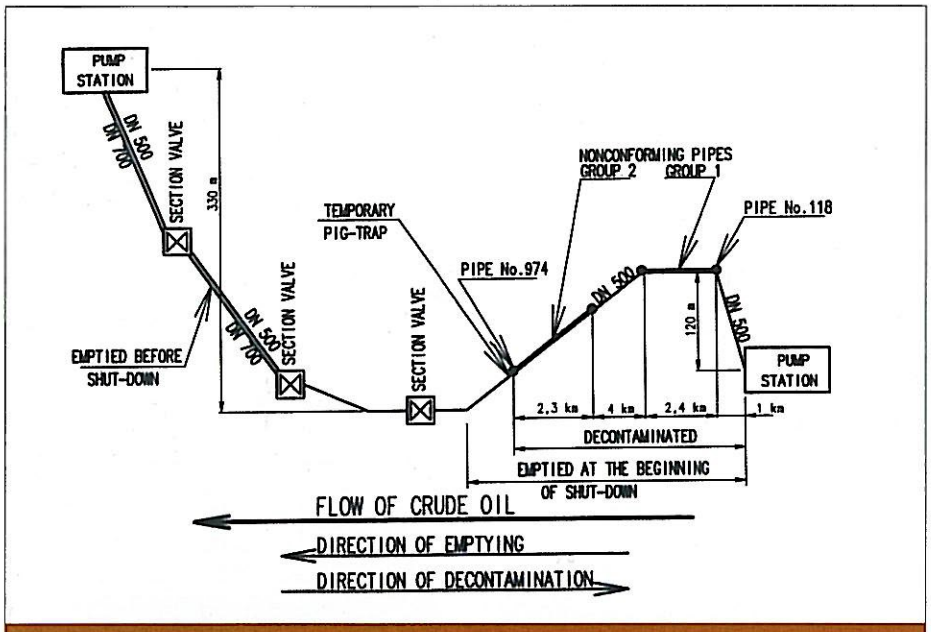

Diagram of the 20 inch diameter crude oil pipeline route.

Draining the 28 inch line to create temporary storage capacity

The 28 inch diameter pipeline was drained in advance so that it would be possible to immediately fill it with the oil from the section of the 20 inch diameter line that was to be repaired upon its shutdown. The line was emptied using a multi-disc bi-directional pig driven by compressed air from a nearby section valve to the end of the pipeline, where the oil was loaded into road tankers. The oil was transported to a neighbouring pump station where it was gradually pumped back into the 20 inch diameter pipeline via a balancing tank. Around 2,450 cubic metres was transported over a five-day period, using eight road tankers with capacities of 10 and 30 cubic metres each. Considerable efforts were made during this process to protect the environment, and any minor spills were rapidly cleaned up.

Displacement of oil from the 28 inch diameter pipeline into road tankers.

CONTINUED ON PAGE 26 »

18 September

- 10.30–17.45: Petrosol cleaning agent pumped from the pipeline into road tankers for ecological disposal
- 17.45–18.30: depressurising of decontaminated section of the 20 inch diameter pipeline
- 18.30: checking for environmental safety, first pipe cut out using oxyacetylene cutting
- 18.30–20.00: five pipes cut out

19 September

- 20.00: all 32 pipes cut out, 16 new pipes inserted

20 September

- 21.30: NDT of the last new pipe completed, and pipeline start-up initiated, after 87.5 hours of work.

« CONTINUED FROM PAGE 25

Preparation of the sites for pipe exchange

The out-of-specification pipe was identified from internal inspection reports, and was located onsite from pipe weld data. After excavation and coating removal, it was important to ensure that the pipe identified for the exchange was correct: the locations were carefully measured from adjacent weld-reference points, and the wall thicknesses of the pipes for exchange and those of the adjacent pipes were then measured using ultrasonic thickness gauges, with the measured values being compared with those from the internal inspection reports. The final check was to compare the positions and distances of spiral circumferential welds on the adjacent pipes to those seen in the inspection reports.

During excavation it was found that there was a parallel 8 inch pipeline that in some places was only 100 mm away. This meant that great care had to be taken to avoid damage.

The replacement pipes were asphalt-coated 21 inch diameter, 8 mm wall thickness, spiral-welded pipe from Mittal Steel (now MittalArcelor) in Ostrava. The unusual external diameter was required because the original pipeline was built in the mid-1960s when applicable Czechoslovakian standards stipulated that this size was standard. Asphalt coating of the new pipe was specified following analysis of the anti-corrosion performance of the existing coating, which was seen to have survived intact for almost 50 years.

Time flow

Exchange of 32 pipes within 96 hours represented a great deal of work that involved large numbers of personnel and equipment. Between 19 and 20 September 2007, up to 100 workers from 14 co-operating companies directly participated in the work.

The work was carried out by 16 teams from 14 separate contractors for the pipe cut-outs, and a further eight teams from a number of NDT contractors, including five mobile laboratories.

Access to a few of the sites, especially to most of the sites in Section 1, was difficult due to waterlogged ground; four sites in Section 2 were in a relatively steep ravine.

Having ensured that all pipe, with the exception of pipe no.974, had been totally decontaminated, it was possible to use oxyacetylene flame for the cutting, which significantly speeded up the work. During the cutting, it was found that the pipeline was very strongly magnetised, and this significantly complicated the subsequent welding, not only prolonging it, but causing several defects. To counteract this, a second magnetic field was applied by wrapping loops of welding wire around the pipeline.

Pipe cut-out using oxyacetylene flame.

The adjacent 8 inch diameter line, at the location of pipe no.118.

To replace pipe no.974 at the end of the repaired section, a special procedure was required. This pipe had not been decontaminated and it was not possible to ensure an explosion-proof environment as the end of the pipe was not a part of the decontaminated line. At the end of the adjacent pipe, no.975, a sealing pig had been placed at the start of the work, and the replacement pipe was inserted as one of the last. Using a degreasing agent, the free part of pipe no.975 (between the sealing pig and the pipe's end) was manually cleaned. Prior to welding the joint, the safety of the atmosphere was verified, and the position of the sealing pig was checked to ensure that it had not moved. A temporary clay plug was inserted in front of the sealing pig to ensure that the pipe was strictly fire and environmentally secured.

Replacement of pipe no.118 which was the nearest to the pumping station, was carried out in a similar way.

After the pipe exchange, the pipeline was gradually refilled with oil pumped from the pumping station at the beginning of the repaired section. The displaced air was allowed to escape through a 2 inch diameter nipple, after which normal operation of the pipeline resumed.

Since this replacement project, the process has been used several more times, both on crude oil pipelines and oil products, and the total length of decontaminated pipelines in the Czech and Slovak Republics now exceeds 400 km.

This is an abstract of the full article, which was presented at the Evaluation, Rehabilitation, and Repair of Pipelines Conference & Exhibition held in Berlin on October 2010, and organised by Tiratsoo Technical and Clarion Technical Conferences.