Swagelining Renews Potable Water Transmission Lines

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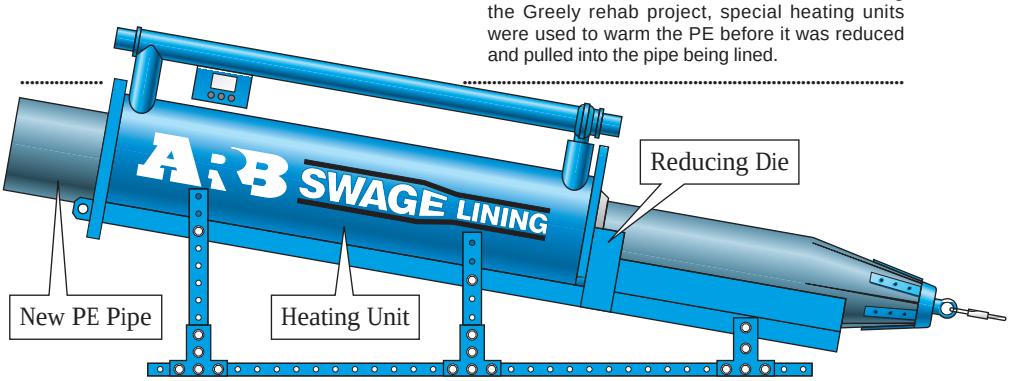


Because of the extreme cold during the Greely rehab project, special heating units were used to warm the PE before it was reduced and pulled into the pipe being lined.

The city of Greeley, CO, depends upon two parallel 27"steel transmission lines to supply it with potable water from a source 33 miles away. The pipelines are about 50 years old and a significant corrosion problem had developed in an 8,000' section of each pipe. To make matters worse, rapid development around and over these water mains severely limited access to them.

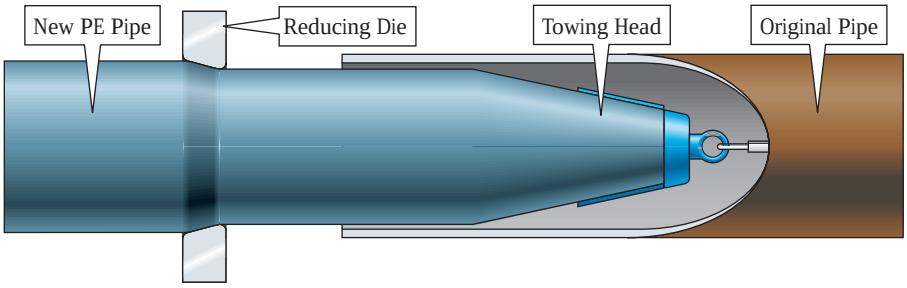
A sacrificial anode cathodic protection system was installed when the pipelines were new, but it had been neglected for the next 40 years. During that time, corrosion found its way through damaged and misapplied coatings and weakened the pipes. In 1988 a new cathodic protection system was installed to replace the old one and the incidence of new leaks dropped dramatically, but serious damage had already been done. Prior to installing the new cathodic protection system, as many as ten leaks per year developed in the most seriously damaged section. Since these leaks developed under normal working pressures, planned pressure increases would create even more leaks.

The Water and Sewer Department wanted to be proactive and replace the pipelines, but found the lines were now covered with residential and commercial development. Homes had been built within a few feet of the pipelines, and a trailer park, state highway, railroad, other utilities, and even a cemetery had been built over them. It would be extremely difficult, costly, and disruptive to dig the pipelines up and replace them.

The severity of the problem became apparent in the middle of July, 1995, one of the hottest days of the year. A leak was reported near a railroad track in the troublesome area. This was very serious because the pipe was not in a casing and the owner of the railroad would not allow an excavation through the tracks to find the leak.

Leaks are normally easy to find from the exterior of an exposed, pressurized pipe and can be repaired quickly, with the pipe in service, by inserting a gasketed tapping screw in the hole. However, without access to the exterior of the pipe, the line would have to be taken out of service, and an attempt made to find the leak from the inside without benefit of water pressure.

Opening the pipe would deprive the city of a much-needed 10 million gallons of water every day the line was out of service, and the odds of a quick repair were not very good. As it turned out, the leak was found to be accessible and was repaired without any major incident. However, the leak did motivate the city to find a long-term solution for this high-risk section of pipeline. It was decided that one pipe could be taken out of service and replaced or repaired during the winter months. The other pipe would remain in service to supply Greeley with potable water. That pipe could be replaced or repaired the following winter.



The PE pipe is reduced slightly during the installation process. This allows it to be pulled easily through an existing pipeline. Within a short time after installation, the PE attempts to return to its original size and presses tightly against the inside of the original pipeline.

Solution criteria

In order to find the best solution to the problem, a performance specification outlining the desired result was given to interested contractors. The criteria specified the solution should:

- be NSF approved for potable water;
- remain leakproof for at least 50 years;
- minimize excavations and couplings;
- maintain existing flow capacity as much as possible;
- be installed during the winter months when demand is lowest;
- withstand 200 pounds pressure while spanning a 2.5" hole;
- be economical and maintenance-free;
- and, install in compliance with OSHA's safe construction practices

Several proposals were made and each was evaluated on how well it met the specified criteria. The first proposal was for a an open-cut, total replacement. This proposal was attractive because the pipe could be up-sized, but the total cost, in terms of money, time, and social disruption, was considered to be too high. The estimated monetary cost was at least $200 per linear foot.

The second proposal was for sliplining a polyethylene (PE) pipe capable of withstanding 80 psi without any dependence upon the host pipe. In order to withstand that 80 psi, the wall of the liner would have to be 1.5" thick. The installation method required annular space between the host pipe and liner so the liner would not bind when it was pulled through the host pipe. It was decided that the combination of liner thickness and annular space would result in too great a reduction in flow capacity. This method would have cost about $75 per linear foot.

Two proposals were received for inserting a tight-fitting, high-density polyethylene (HDPE) liner into the old pipeline. Both methods would take advantage of the remaining structural strength of the host pipe. This would allow a relatively thin-walled SDR-40 liner to be used. The smoothness of the HDPE appeared to offset the small reduction in inside diameter, resulting in very little, if any, reduction in flow capacity. The decision was made to

➧ ➧ ➧ Roads, a railroad, trailor park, other utilities, and even a cemetery had been built over the water transmission line during the past 50 years.

award the rehabilitation contract to ARB Inc., Lake Forest, CA, a licensee of the Swagelining process, at approximately $85 per linear foot.

The Swagelining process was developed by BG plc, formerly British Gas plc, as a rehabilitation process for its own gas lines. However, because of Swagelining's uniqueness, the process has been used successfully to protect over 500 miles of pipe ranging from 3 to 36 inches in diameter. This protection includes water, forced sewer, gas, oil, and a wide range of industrial production lines all over the world.

The Swagelining process uses PE pipe which has an outside diameter slightly larger than the inside diameter of the pipe to be lined. During the installation process, the PE pipe is pulled through a die to temporarily reduce its outside diameter. This reduction allows the PE to be easily pulled through the outer pipe. When the pulling force has been disconnected, the PE pipe begins to return to its original diameter. However, just before the PE pipe relaxes completely it presses tightly against the inside of the host pipe, eliminating all annular space.

Planning the installation

Dave Arthurs, Manager, Pipe Rehabilitation Division, ARB, explained that it is not unusual to install PE liners in single pulls of up to 1,500' with the Swagelining process. However, the process does not handle bends well if they are over 15˚. Since there were several bends greater than 15˚ in the 8,000' Greeley rehabilitation project, the contractor decided to place an entry/exit pit at each bend. The locations of other entry/exit pits were based on balancing the length of the pulls with convenience of locations. This resulted in eight pulls which averaged 1,000' each.

The polyethylene pipe was delivered in 50' lengths and was joined together using the butt-fusion method. This process heats two touching ends of PE pipe until their molecules are homogenetically intertwined. The fusion actually creates a new pipe without a joint. Only a small bead is left where the fusing occurred, and it is removed from the exterior surface.

Since the wind chill factor at the job site often resulted in temperatures well below zero, plywood tents were made to house the fusing operation. A special heater was also used to warm the PE pipe to approximately room temperature before it was pulled through the reducing die. Since the heater was only 18 feet long and the outside temperature was so low, the insertion process was much slower than normal. Between 3 and 4 hours were required for a 1,000' pull.

A 20' to 25' spool section of the original steel pipe was removed from the line in each entry/exit pit. This would allow sufficient room for the liner to be pulled into the relatively straight sections of host pipe. When straight sections of pipe were removed, they were lined with the PE pipe above ground and reinserted to close the pipeline after the rest of the host pipe had been lined. When curved sections which could not be lined were removed, they were epoxy coated on the inside before they were used again.

After two adjacent pipeline sections and the spool pieces had been lined, the pieces were joined with special connectors designed and manufactured by ARB and Greeley's Water and Sewer Department. Epoxy-coated steel sleeves were inserted into the ends of the PE liners to reinforce them enough to withstand the exterior pressure of 4-piece shell clamps. Dresser couplings were also used to finish the connections.

After the pipe was completely connected, the line was pressure tested at 150 psi. When no leaks were found, the line was chlorinated and flushed before it was put back in service. The line was pigged a year later to be sure there were no leaks due to liner shrinkage or loose reinforcement rings.

The first 8,000' of one of the two parallel pipes was lined in the 1996-97 winter and the same section of the other pipe was lined in the winter of '97-'98. There have been no leaks on either of these two pipes since the PE liner was installed. The standard design life of the PE liner is 50 years, but it may last longer. As long as the outside pipe holds up, there is no known reason for the PE liner to fail. The remainder of the pipeline is in good enough shape that no rehabilitation is pending.

In order to find the best solution to the problem, a performance specification outlining the desired result was given to interested contractors.