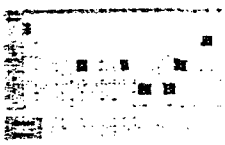

Corrosion of Natural Gas Pipeline

Rupture and Fire Near Carlsbad New Mexico August 19, 2000

Accident Synopsis

At 5:26 a.m., mountain daylight time, on Saturday, August 19, 2000, a 30-inch diameter natural gas transmission pipeline operated by El Paso Natural Gas Company (EPNG) ruptured adjacent to the Pecos River near Carlsbad, New Mexico. The released gas ignited and burned for 55 minutes. Twelve persons who were camping under a concrete-decked steel bridge that supported the pipeline across the river were killed and their three vehicles destroyed. Two nearby steel suspension bridges for gas pipelines crossing the river were extensively damaged. According to EPNGS property and other damages or losses totaled $998,296. (reference)

Accident Narrative

The EPNG pipeline system transported gas west from Texas and New Mexico to Arizona and California. A portion of the pipeline system crossed the Pecos River about 4 1/2 miles north of the Texas-New Mexico State line and 30 miles south of Carlsbad, New Mexico. About I mile west of the river crossing was the Pecos River compressor station, which received gas from four natural gas transmission pipelines 26-inch-diameter line 1100, 30-inch-diameter line 1103, 30-inch-diameter line 1110, and 16-inch-diameter line 3191. Three of these lines (1100, 1103, and 1110) ran parallel to Whitethorn Road (also known as Pipeline Road) from the Pecos River to the Pecos River compressor station. Lines 1103 and 1110 were supported at the river crossing a one-lane concrete-decked steel service bridge that was not open to the public.

This bridge, which had been built by EPNG in 1950, also supported a water pipeline and a gas gathering pipeline. EPNG which was at the time of the accident a subsidiary of El Paso Energy, owned and operated the water pipeline but not the gas gathering pipeline. Line 1100 was supported across the river on a pipeline suspension bridge approximately 70 feet northeast of the service bridge. Another EPNG pipeline, 16inch-diameter line 1000, was supported by a separate suspension bridge in this area, but this line had been removed from service and was filled with nitrogen at the time of the accident. The fourth pipeline, line 3191, ran from EPNG's South Carlsbad compressor station to the Pecos River compressor station.

Post-accident On-Site Inspection

NMOCD CASE NO. 13589
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The force of the rupture and the violent ignition of the escaping gas created a 51-foot-wide crater about 113 feet along the pipe. A 49-foot section of the pipe was ejected from the crater in three pieces measuring approximately 3 feet, 20 feet, and 26 feet in length. (See figure 6.) The largest piece was found about 287 feet northwest of the crater in the direction of the suspension bridges. Investigators visually examined the pipeline that remained in the crater as well as the three ejected pieces. All three ejected pieces showed evidence of internal corrosion damage, but one of the pieces showed significantly more corrosion damage than the other two. Pits were visible on the inside surface of this piece, and at various locations, the pipe wall evidenced significant thinning. At one location, a through-wall perforation was visible. No significant corrosion damage was visible on the outside surfaces of the three pieces or on the two ends of the pipeline remaining in the crater. Pieces were cut from the ruptured pipeline segments and shipped to the Safety Board's Materials Laboratory in Washington, D.C., for further evaluation.

The drip" between block valve No. 6 and the rupture site was removed from the pipeline and visually examined. The drip was found to contain a blackish oily powdery grainy material. At the area of its heaviest concentration, about 13 feet from the drip opening, this material filled approximately 70 percent of the cross-sectional area of the drip. No significant material was observed in the area just underneath and several inches away from the siphon drain at the closed end of the drip. No significant internal corrosion was observed in the drip.

Injuries

All 12 persons who were camping on the east bank of the Pecos River were fatally injured in the accident. The causes of death were extensive thermal burns, carbon monoxide poisoning, and smoke inhalation.

Damages

Approximately 49 feet of the underground portion of line 1103 were ejected in three pieces from the crater created by the rupture. Two of the pieces of pipe were thrown 234 and 287 feet, respectively, from the northwest end of the crater toward the river. One of these pieces hit the cables that supported the pipeline suspension bridges across the river. The concrete anchor blocks for the cables, the cables themselves, and the two suspension bridge steel structures on the east side of the river were burned, as were the aboveground portions of the pipelines. The two pipelines that were being supported on the bridges (EPNG's 26-inch line 1100 and the out-of-service 16-inch line 1000) fell and came to rest on the ground on each side of the river, but neither leaked. The three vehicles and camping equipment on the east side of the river were destroyed, and vegetation along both riverbanks was burned. Based on photographs taken of the fire as it engulfed the suspension bridges, the height of the flame was calculated to be about 496 feet. EPNG, in its incident report to the Research and Special Programs Administration (RSPA), stated the cost of the accident was $998,296.

Internal Corrosion in Line 1103

Interconnecting pits were observed on the inside of the pipe in the ruptured area of line 1103. Typically, these pits showed the striations and undercutting features that are often associated with microbial corrosion. A pit profile showed that chloride concentration in the

pits increased steadily from top to bottom. Increased chloride concentration can result from certain types of microbial activity. All four types of microbes (sulfate reducing, acid-producing, general aerobic, and anaerobic) were observed in samples collected from two pit areas in the piece of line 1103 where internal corrosion was discovered after the accident about 2,080 feet downstream of the rupture site. Though the individual contribution of various microbes in the corrosion process could not be estimated, the damage morphology and the corrosion product analyses data suggest that microbiological activity contributed to the corrosion process.

Dissolved O_2 in an electrolyte could cause pitting by creating concentration cells. CO_2 is soluble in water and will form carbonic acid, which is corrosive to carbon steel.

When dissolved in water, H2S forms a weak acid that could corrode carbon steel. In combination with dissolved 02, it could cause pitting. Though generally present in low concentrations, these potentially corrosive constituents were present in the gas that was being transported in line 1103. Also, upset conditions occasionally increased the concentrations of these constituents in the transported gas.

Chlorides were observed in all corrosion product/deposit samples. Anions, such as chloride, cause pitting and, typically, chloride concentration in a pit may be much higher than the chloride concentration outside the pit (bulk concentration).

Chemical analyses showed that the pH (6.7-6.8) of the liquid collected at the Pecos River compressor station plant inlet separator scrubber was more acidic than the pH (8.2) of the liquid collected at Keystone compressor station inlet scrubber. Also, the material collected at line 1100 and 1103 pig receivers (pH 6.2-6.3) and the inside material collected from a low spot on line 1103 west of the rupture (pH - 6.4) were more acidic than the material collected near the siphon drain area of the line 1103 drip (pH 8.9). The observed low pH in the samples could be a result of dissolved CO_2, and/or H_2S in the water, and/or intrusion of low-pH ground water into the gas supply. Typically, acidic (pH<7) water is more corrosive to carbon steel than basic water (pH>7).

Thus, water and contaminants such as chlorides, O_2, CO_2, and H_2S all likely contributed to the observed corrosion damage. The Safety Board therefore concludes that the corrosion that was found in line 1103 at the rupture site was likely caused by a combination within the pipeline of microbes and such contaminants as moisture, chlorides, O_2, CO_2, and H_2S.