Lessons Learned from a Pipeline Rupture

Controller's Failure to Accurately Evaluate Data and Initiate Timely Pipeline Shutdown Contributed to Accident's Severity, NTSB Report Says

The failure of a pipeline controller to accurately evaluate data and promptly respond to a pipeline emergency were major factors in a pipeline rupture that resulted in the release of 204,000 gallons of anhydrous ammonia in Kansas.

The National Transportation Safety Board (NTSB), which investigated the accident and issued its report in June, said the released material created a highly toxic vapor cloud. Although there were no injuries associated with the accident, the NTSB said chemicals from the pipeline entered a nearby stream in an environmentally sensitive area and killed more than 25,000 fish, including some threatened species. An 8 5/8-inch diameter steel pipeline operated by Enterprise Products Operating L.P. ruptured at about 11:15 a.m. on October 27, 2004, in an agricultural area 6 miles east of Kingman.

"We are very fortunate that such highly toxic chemicals of the amount and scope involved in this accident were not released in a populated area," said NTSB Chairman Mark V. Rosenker. "Had this same quantity of ammonia been released near a town or city, the results could have been catastrophic."

The Safety Board found that the probable cause of the rupture was a pipe gouge created by heavy equipment damage to the pipeline during construction in 1973 or subsequent excavation activity at an unknown time that initiated metal fatigue cracking.

Actions by the controller were a major focus of the investigation, prompting the NTSB to issue three recommendations to the Pipeline and Hazardous Materials Safety Administration (PHMSA).

The NTSB is urging PHMSA to require operators to revise pipeline risk assessment plans whenever they have failed to consider one or more risk factors that can affect pipeline integrity; require pipeline operators to have a procedure to calculate and provide a reasonable initial estimate of released product in the telephonic report to the National Response Center; and contact the center again if significant new information becomes available during the emergency response**.**

The NTSB also recommended that Enterprise Products provide initial and recurrent training for all controllers that includes simulator or noncomputerized simulations of abnormal operating conditions that indicate pipeline leaks.

The NTSB report said the controller told investigators after the rupture that he had been viewing the tabular screen and knew the alarms indicated a potential problem with the pipeline. To evaluate the alarms from the pipeline, he used the tabular data screen in the SCADA system. This screen listed the pipeline facilities and displayed current data for the entire pipeline system, including pump station suction and discharge pressures, pump status, tank levels, flow rates, valve status, and set points. Alarm information that was displayed on the alarm screen also flashed and changed color on the tabular screen.

The report said the controller's assessment was that he was delivering more ammonia from the pipeline than was being added to the pipeline and that this condition had decreased the pressure. This assessment led him to increase the flow rate at about 11:27. He later said that he thought that within 10 or 15 minutes, the pressure readings would increase. Therefore, he planned to wait for a few minutes, and, if the pressure readings for the pipeline did not increase, he would reevaluate and investigate the situation further.

The SCADA system can display a trend screen that shows pressure and flow trend data graphically, and the controller told investigators that looking at a trend screen would have been helpful in the analytical stage. However, the NTSB report said, he did not use trend screens in evaluating the incoming data. He told investigators that his training did not specify which screens to use to analyze and evaluate the SCADA data. He stated that from 11:15 a.m. to 11:48 a.m., an unusually high number of alarms and status events were displayed for the pipeline. During this 33-minute period, the SCADA system displayed 119 alarms and status events. The controller said that he felt that he had full authority to shut down the pipeline; he did not believe there would be consequences from Enterprise if he shut down a pipeline and it were subsequently determined that there was no leak.

The operations control supervisor stated in an NTSB interview that he expects pipeline controllers to use the tabular screen as the main screen, or "front page." He said that controllers are taught to access and display a trend screen, or "second page," to further investigate an alarm and the condition that caused it. The supervisor said that pressure and flow changes are the primary parameters used to detect leaks. He stated that at the time of the accident, rate-of-change alarms were displayed in blue and immediate response alarms were displayed in red. He indicated his belief that the controller had enough information between 11:20 a.m. and 11:25 a.m. to lead him to shut down the ammonia pipeline.

After the accident, the NTSB report said, Enterprise established a program to review the rate-of-change alarms systemwide because the company believed that the alarms were not as effective as they should be. The goal of the review was to make the alarms more meaningful by significantly reducing the number of alarms that could distract controllers from more critical alarms.

Enterprise supervisors reviewed the circumstances of the accident with the controller and identified deficiencies in his response. No disciplinary actions were taken against the controller. Enterprise conducted training sessions for its entire staff of anhydrous ammonia and natural gas liquid pipeline controllers. In the training sessions, Enterprise used a noncomputerized simulation to analyze the ammonia pipeline accident.

Enterprise developed a new telephonic reporting procedure for estimating the amount of product released and related damages based on pipeline physical characteristics and available operating data. The procedure also addresses a potential delay in telephonic reporting for releases that exceed the EPA reportable quantity. Enterprise revised its risk assessment model to incorporate a pipeline leak-history factor in its risk assessment calculation. It also revised its baseline assessment of pipeline segments using all risk factors to schedule baseline assessments.

The report is available on NTSB's Web site, http://www.ntsb.gov/publictn/2007/PAB0702.htm.