National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: October 27, 2009

In reply refer to: P-09-1 through -3

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On November 1, 2007, at 10:35:02 a.m.[1] central daylight time,[2] a 12-inch-diameter pipeline segment operated by Dixie Pipeline Company (Dixie) was transporting liquid propane at about 1,405 pounds per square inch, gauge (psig), when it ruptured in a rural area near Carmichael, Mississippi. The resulting gas cloud expanded over nearby homes and ignited, creating a large fireball that was heard and seen from miles away. About 10,253 barrels (430,626 gallons) of propane were released. As a result of the ensuing fire, two people were killed and seven people sustained minor injuries. Four houses were destroyed, and several others were damaged. About 71.4 acres of grassland and woodland were burned. Dixie reported that property damage resulting from the accident, including the loss of product, was $3,377,247.[3]

The National Transportation Safety Board (NTSB) determined that the probable cause of the November 1, 2007, rupture of the liquid propane pipeline operated by Dixie Pipeline Company near Carmichael, Mississippi, was the failure of a weld that caused the pipe to fracture along the longitudinal seam weld, a portion of the upstream girth weld, and portions of the adjacent pipe joints.

Safety and Performance of Electric Resistance Welded Pipe

Identifying the causes and the initiation sites of pipeline fractures is important for understanding the factors that are involved in and contribute to pipe failures. Even more important is to be able to locate a critical flaw or condition before it leads to a catastrophic

[1] The times associated with events indicated in hours:minutes:seconds are from either the Supervisory Control and Data Acquisition system or the 911 system.

[2] All times are central daylight time except where otherwise noted.

[3] For additional information, see <http://www.ntsb.gov/publictn/2009/PAR0901.pdf>. *Rupture of Hazardous Liquid Pipeline With Release and Ignition of Propane, Carmichael, Mississippi, November 1, 2007*, Pipeline Accident Report NTSB/PAR-09/01 (Washington, DC: National Transportation Safety Board, 2009).

failure, such as occurred in Carmichael. Currently, most pipeline operators rely upon in-line inspections to identify, detect, and monitor the growth of potential defects in their pipeline systems. In-line inspections are conducted to detect and size the anomalies that may be present in the pipe wall. The data then can be analyzed to evaluate the severity of the anomalies (that is, the size [length and depth] and the rate of growth). The data can be used by a pipeline operator to establish a schedule to repair or remove the pipeline before an anomaly grows to a critical size and causes a pipe rupture.

Segments of the Carmichael pipeline had been inspected using in-line inspection tools multiple times in the 9 years before the November 2007 rupture. In 1998, Tuboscope Vetco Pipeline Services inspected the pipeline segment from Hattiesburg to Demopolis, using a first-generation metal-flux leakage tool to search for evidence of metal loss caused by internal corrosion. The test did not find any anomalies related to metal loss in the pipe joint that ruptured in this accident.

In 2005, Dixie conducted a special electric resistance welded (ERW) seam integrity assessment over the entire Hattiesburg-to-Demopolis segment, using the General Electric UltraScan crack detection tool that can detect defects in the pipe in the longitudinal direction. This tool is not designed to detect circumferentially oriented defects in the girth welds. This inspection identified 21 pipe joints with reportable indications, and Dixie removed all 21 pipe joints, including the girth welds on each end of each joint, as part of its pipeline integrity repair program. The inspection also identified two features in the pipe joint that ruptured at Carmichael, but the features did not meet the criteria for reportable indications and were not factors in the accident.

In 2006, Magpie Systems Inc. (Magpie) inspected the Hattiesburg-to-Demopolis pipeline segment, using a geometry tool followed by a high-resolution axial magnetic flux leakage tool to detect metal loss in the pipe. The latter tool is used to detect metal loss in or near the girth weld. Magpie reported no geometric anomalies and detected no metal-loss-related anomalies in the joint that ruptured in Carmichael.

The results of the three in-line inspections that were conducted in the 9 years before the accident found no defects or anomalies in the Carmichael pipe joint that could be correlated with the 2007 accident rupture. It is possible that detectable anomalies did not exist at the times of the three tests, or the inspection tools did not find detectable anomalies that may have existed, or anomalies existed below detection limits but grew at a very fast rate.

Dixie contracted with Stork Metallurgical Consultants (Stork) to conduct hydrostatic pressure burst tests on the pipe joints and girth welds that had been removed after the 2005 in-line inspection. All 21 pipe joints ruptured during the burst tests at pressures ranging from 2,055 psig to 3,250 psig and along the longitudinal seam weld. Over this pressure range, ruptures occurred above the specified minimum yield strength. Stork's conclusions after examination of the ruptures show the difficulty of identifying fracture origins in ERW pipe. For a majority of the 21 pipe joints, Stork identified a general region or area of the fracture surface as the origin of the fracture when an apparent fracture origin was not identifiable. The fracture surface of only one pipe joint had a hook crack with chevrons on each side pointing to the fracture initiation site.

Stork also correlated the location of the identified fracture origin for the pipe joints with indications reported from the 2005 in-line inspection. Stork found that for 12 of the 21 ruptures, an indication from the 2005 in-line inspection coincided with either an identified fracture origin or a point on the fracture surface. No reportable indications were found during the in-line inspection for 9 of the 21 ruptured pipe joints.

The accumulated data from the three in-line inspections of the Carmichael pipeline and from the examination of the pipe joints that were removed and subjected to hydrostatic testing illustrate the limitations of current in-line inspection technology for detecting significant flaws in low-frequency ERW pipe. The Pipeline and Hazardous Materials Safety Administration (PHMSA) believes that in-line inspection technology is improving and data analysis capabilities are increasing each year. Reliable and effective in-line inspection tools have become more critical in recent years as the focus of the pipeline safety program has shifted to risk-based integrity management plans that are developed and implemented by individual pipeline operators. The NTSB concludes that current inspection and testing programs are not sufficiently reliable to identify features associated with longitudinal seam failures of ERW pipe prior to catastrophic failure in operating pipelines. Accordingly, the NTSB recommends that PHMSA conduct a comprehensive study to identify actions that can be implemented by pipeline operators to eliminate catastrophic longitudinal seam failures in ERW pipe; at a minimum, the study should include assessments of the effectiveness and effects of in-line inspection tools, hydrostatic pressure tests, and spike pressure tests; pipe material strength characteristics and failure mechanisms; the effects of aging on ERW pipelines; operational factors; and data collection and predictive analysis. The NTSB further recommends that PHMSA, based on the results of the study requested in the previous safety recommendation, implement the actions needed.

Pipeline Operator Public Education Programs

Under the Pipeline Safety Improvement Act of 2002, each pipeline operator was required to develop and implement a written, continuing public education program (including both awareness for the general public and training for and outreach to emergency response agencies), and the U.S. Department of Transportation was to issue standards prescribing the elements of an effective public education program. In response to these mandates, PHMSA issued a final rule on May 19, 2005, that required each operator of a gas or hazardous liquid pipeline to develop and implement a written, continuing public education program that follows the guidance provided in American Petroleum Institute Recommended Practice 1162 (API RP 1162), *Public Awareness Programs for Pipeline Operators*, which was also incorporated by reference in Title 49 *Code of Federal Regulations* Parts 192 (gas transmission lines) and 195 (hazardous liquid pipelines). Operators in business on June 20, 2005, were to have completed their written programs not later than June 20, 2006. An operator's program documentation and evaluation results also had to be available for periodic review by appropriate regulatory agencies.

Following the publication of the new regulations, PHMSA established a process to review by the June 2006 deadline all public education plans and to identify those plans that did not meet the critical elements and that required revision. In response to the mandate for operators and PHMSA to evaluate the effectiveness of the public education programs, PHMSA stipulated that operators were to assess the effectiveness of their programs within 4 years, that is, by June 20, 2010.

Dixie's Public Education Program

The core element of Dixie's public education program was the distribution of safety literature to identified stakeholders that include residents, businesses, emergency response agencies, excavators, and public officials. Under the plan, Dixie mailed pipeline public awareness and safety literature each year to all emergency response officials and excavators in the county, every 2 years to the residents and businesses located within 1 mile on either side of the pipeline, and every 3 years to public officials within the county.

Dixie did not mail the literature itself; instead, it relied upon contractors to acquire the mailing data and mail the literature. Dixie did not exercise any oversight of its contractors to ensure that the mailings were accurate, nor did Dixie survey residents and businesses about the content of the mailings to determine their effectiveness.

In May 2007, Paradigm Alliance, Inc. (Paradigm), a contractor for Dixie, reported that it had mailed 258,284 copies of the brochure, *A Public Service Message—Pipeline Safety is Everyone's Responsibility,* to all stakeholders, including the residents and businesses within 1 mile of the pipeline in the Carmichael area. Paradigm used mailing data provided by a second company, Tele Atlas. On November 4, 2007, 3 days after the accident, Dixie's public awareness and damage prevention coordinator discovered that 10 addresses on County Road 621 were missing from the mailing data used by Paradigm in the May 2007 mailing. The 10 addresses included those of the houses and one business on County Road 621 that were destroyed and most heavily damaged in the Carmichael accident. Also, the houses on County Road 621 that were missed in the 2007 mailing included the homes of the two fatalities.

The timetable set forth in PHMSA's final rule published in May 2005 gave pipeline operators until June 2006 to develop public education programs and, in supplemental guidance following publication of the final rule, until June 2010 to evaluate the effectiveness of those programs. After Dixie acknowledged in January 2009 that it had failed to tell the NTSB and PHMSA about the missed addresses in May 2007, PHMSA began to consider possible actions to assess operators' self-evaluations of the effectiveness of their public awareness program plans. The actions under consideration include conducting targeted public awareness inspections, issuing an advisory bulletin urging pipeline operators to conduct their self-evaluations and modify their plans before the 2010 deadline, and initiating research about effectively reaching the public with the appropriate safety information. However, PHMSA has not completed action on these initiatives. The Carmichael accident has shown that although an operator's public awareness program plan may meet API RP 1162 requirements and federal pipeline standards, this is not a guarantee that implementation of the program is effective or that the operator is exercising sufficient oversight. Therefore, the NTSB recommends that PHMSA initiate a program to evaluate pipeline operators' public education programs, including pipeline operators' self-evaluations of the effectiveness of their public education programs, and provide the NTSB with a timeline for implementation and completion of this evaluation.

As a result of its investigation, the National Transportation Safety Board makes the following recommendations to the Pipeline and Hazardous Materials Safety Administration:

> Conduct a comprehensive study to identify actions that can be implemented by pipeline operators to eliminate catastrophic longitudinal seam failures in electric resistance welded pipe (ERW); at a minimum, the study should include assessments of the effectiveness and effects of in-line inspection tools, hydrostatic pressure tests, and spike pressure tests; pipe material strength characteristics and failure mechanisms; the effects of aging on ERW pipelines; operational factors; and data collection and predictive analysis. (P-09-1)
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> Based on the results of the study requested in Safety Recommendation P-09-1, implement the actions needed. (P-09-2)
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> Initiate a program to evaluate pipeline operators' public education programs, including pipeline operators' self-evaluations of the effectiveness of their public education programs. Provide the National Transportation Safety Board with a timeline for implementation and completion of this evaluation. (P-09-3)

The NTSB also issued safety recommendations to the Clarke County Board of Supervisors, the American Petroleum Institute, and Dixie Pipeline Company.

In response to the recommendations in this letter, please refer to Safety Recommendations P-09-1 through -3. If you would like to submit your response electronically rather than in hard copy, you may send it to the following e-mail address: correspondence@ntsb.gov. If your response includes attachments that exceed 5 megabytes, please e-mail us asking for instructions on how to use our secure mailbox. To avoid confusion, please use only one method of submission (that is, do not submit both an electronic copy and a hard copy of the same response letter).

Chairman HERSMAN, Vice Chairman HART, and Member SUMWALT concurred in these recommendations.

[Original Signed]

By: Deborah A.P. Hersman
Chairman