Abstract: This report explains the Texas Eastern Products Pipeline Company pipe rupture, subsequent release of propane, and resultant explosion and fire at North Blenheim, New York, on March 13, 1990. The safety issues discussed in the report are pipeline employee qualification and training requirements; procedures to safely move pressurized pipe, especially those manufactured from steel with a high ductile-to-brittle transition temperature; pipeline monitoring requirements for detecting the existence and location of failed pipeline segments; valve requirements for rapidly shutting down failed pipeline segments; and public education and emergency preparedness liaison requirements. The National Transportation Safety Board made safety recommendations addressing these issues to the Research and Special Programs Administration of the U.S. Department of Transportation, the Texas Eastern Products Pipeline Company, the American Petroleum Institute, the Interstate Natural Gas Association of America, and the American Gas Association.
EXECUTIVE SUMMARY

On March 13, 1990, the Texas Eastern Products Pipeline Company line P-41, an 8-inch-diameter liquid propane pipeline, ruptured within a pipeline casing beneath County Road 43 near the Village of North Blenheim, New York. Liquid propane gas escaped from the ends of the casing, vaporized, and formed a white, heavier-than-air gas cloud. The gas cloud flowed downhill along County Road 43 until it entered North Blenheim and ignited. The fire quickly consumed the propane vapor and flashed back to the pipeline rupture. Two people were killed, seven persons injured, and more than $4 million in property damage and other costs resulted.

The National Transportation Safety Board determines that the probable cause of the Texas Eastern Products Pipeline Company pipe rupture, subsequent release of propane, and resultant explosion and fire at North Blenheim, New York, was the failure of the pipeline company to provide adequate procedures, equipment, training, and management oversight to ensure that maintenance on its pipelines was accomplished using methods and equipment that protected its employees and the public.

The following safety issues are discussed in this report:

- pipeline employee qualification and training requirements;
- procedures to safely move pressurized pipe, especially those manufactured from steel with a high ductile-to-brittle transition temperature;
- pipeline monitoring requirements for detecting the existence and location of failed pipeline segments;
- valve requirements for rapidly shutting down failed pipeline segments; and
- public education and emergency preparedness liaison requirements.

As a result of its investigation, the Safety Board issued safety recommendations to the Research and Special Programs Administration of the U.S. Department of Transportation, the Texas Eastern Products Pipeline Company, the American Petroleum Institute, the Interstate Natural Gas Association of America, and the American Gas Association. It also reiterated previously issued safety recommendations to the Research and Special Programs Administration.
Although the crew, selected to perform the work at CR 43 in February 1990, did not possess the knowledge and experience to safely perform the work assigned, opportunities were available to correct this error. The maintenance supervisor should have acknowledged at the time the work was assigned that he was not experienced in moving pressurized pipes, that he had never been instructed on the use of the link seal, and that he had not received training for this work. Had he advised his supervisor of these facts, his supervisor might have delayed the work until a qualified person could perform the work or, at least, supervise it.

Although the maintenance supervisor may not have known at the time of the work assignment that the pipe required lifting to install the new casing seal, he should have recognized this when he inspected the casing and saw the broken insulator. At that time, he should have alerted his superintendent that he was not qualified to perform the work. Instead, he elected to use his "good judgment."

Although the Safety Board believes that the maintenance supervisor should have advised his superintendent that he needed assistance, it is not reasonable for management to rely on such notice to fulfill its supervisory responsibility. Rather, it is incumbent on the TEPPCO's management to assign work projects only to employees who possess the training and experience essential to the safe performance of the work, to determine that its employees are knowledgeable of the procedures applicable to the work assigned, and to periodically check that work has been completed correctly.

TEPPCO Employee Training and Supervision

The TEPPCO does not have a program to identify individual employee needs for initial or recurrent training. The TEPPCO's management failed to recognize the need to provide progressive technical training to supplement its employees' operational experience. In this accident, the TEPPCO misplaced its reliance on experience because the maintenance supervisor, with more than 20 years experience, had never performed the type of work required and had never seen the TEPPCO's written procedures for clearing casings, even if the usefulness of the procedures was limited.

The CPO's actions were also insufficient, which brings the adequacy of the TEPPCO's training for CPOs into question. The maintenance supervisor notified the CPO on duty of the work to be performed at CR 43, including the moving of the pipe. Had the CPO been trained on the TEPPCO procedure No. 70, he likely would have questioned the maintenance supervisor about performing such work without first isolating the pipe section and requesting a reduction in pressure. In addition, on the day of the accident when the resident's call alerted the CPO then on duty about the possibility of a rupture, that CPO did not effectively use available operating data within the SCADA system to determine if the pressure was dropping.

The TEPPCO's management believed that the maintenance supervisor's training was adequate because he had attended 54 training sessions in the previous 4 years. However, he had no experience in the work he performed on February 20-21, 1990; he had minimal training on applicable Federal
regulations; and he had no training on TEPPCO's procedures for clearing casing shorts. Likewise, management believed that the CPO's training was adequate. However, this training did not include either information on Federal regulations or on the TEPPCO procedures that required pipeline segments to be isolated and pressure reduced before work begins. Also, it did not adequately prepare the CPO to use the SCADA system computer capabilities to identify abnormal operating conditions.

The Safety Board has previously identified deficient pipeline operator training and employee selection practices in its February 18, 1987, report on accidents at Beaumont and Lancaster, Kentucky. In that report, the Safety Board found that no requirement existed for operators of pipelines to develop and conduct training and testing programs to annually qualify their employees to perform assigned responsibilities, even though the incorrect performance of such work could adversely affect public safety. Additionally, Federal regulations do not provide criteria for assessing the adequacy of the experience and training of persons performing or directing actions required for corrosion control. Thus, the Safety Board recommended that the RSPA:

P-87-2

Amend 49 CFR Parts 192 and 195 to require that operators of pipelines develop and conduct selection, training, and testing programs to annually qualify employees for correctly carrying out each assigned responsibility which is necessary for complying with 49 CFR Parts 192 or 195 as appropriate.

On March 23, 1987, in response to this recommendation, the RSPA issued an Advance Notice of Proposed Rulemaking (ANPRM), "Pipeline Operator Qualifications," Docket No. PS-94, to obtain information on the need to establish employee qualification and training requirements. The Safety Board responded to the ANPRM on May 14, 1987, advising the RSPA that among other improvements needed, operators should be required to develop and, under the direction of a responsible person, implement an employee qualification and training program that includes the following activities:

(a) Identification of each employee whose successful accomplishment of assigned responsibilities or tasks is a necessary part of an operator's actions for complying with Federal pipeline safety regulations.

(b) Analyses sufficient to identify for each employee the individual jobs, tasks, and responsibilities necessary to be performed as a part of the operator's program for complying with Federal requirements. These

analyses should be documented and should include routine job performance, in-plant emergency duties, and emergency responsibilities for events that occur along the pipeline right-of-way. Furthermore, these analyses should be used for establishing measurable performance standards.

(c) Identification and implementation of the specific training methods to be employed to provide adequate knowledge to each employee for effectively carrying out applicable jobs, tasks, and responsibilities identified in the analyses.

(d) Identification of the method(s) to be used in evaluating the effectiveness of the training including the identification of standard(s) for acceptance.

(e) Documentation for each employee of the training provided and the training evaluations.

Because the OPS informed the Safety Board that it intended to publish a Notice of Proposed Rulemaking (NPRM) in fall 1988, the Safety Board classified Safety Recommendation P-87-2 as "Open--Acceptable Action." However, the NPRM has not yet been published. Because of the time elapsed, the Safety Board now classifies this recommendation as "Open--Unacceptable Action" and urges the RSPA to expedite this rulemaking.

Pipeline Monitoring

The nearest monitoring location, Gibertsville, was about 47 miles from the rupture at CR 43, and its pressure differential alarm monitor was set to alert the CPO if pressure differentials were 80 psig pressure or more per minute. Because the average pressure drop per minute as the result of the rupture of CR 43 was only 23 psig, the monitor did not provide an alert to the CPO, and he was unaware of the rupture.

After the accident, the TEPPCO lowered the alarm point, to 20 psig pressure drop per minute on the pressure differential monitor at Gilbertsville. After Safety Board staff questioned the sensitivity of this monitor to detect similar or smaller releases along the 83 miles of pipeline between Gilbertsville and Selkirk, the TEPPCO installed RTUs to monitor the pressure at its pump stations and receiving terminals.

Although the operation of line P-41 is now better monitored, the Safety Board remains concerned about the adequacy of the monitoring system for protection of the public near this pipeline and other pipelines. Federal regulations require that, for facilities that are not designed to fail safely, pipeline operators must provide for the detection of abnormal operating conditions by monitoring appropriate operational data and transmitting it to an attended location. The regulations do not include any criteria on detection sensitivity or timeliness of detection. Consequently, the monitoring system installed by the TEPPCO before this accident complied with the requirement because eventually it would have detected an abnormal
pressure drop at Gilbertsville. However, the TEPCO's monitoring system was not adequate to detect the March 13, 1990, release from line P-41 in a timely manner and to promptly alert the CPO. Moreover, because no performance criteria for monitoring systems have been established by the RSPA, the adequacy of the improved system is uncertain. Therefore, the Safety Board believes that the OPS should develop performance criteria for monitoring systems installed by pipeline operators to detect abnormal operating conditions and incorporate these criteria into its regulations.

Pipeline Shutdown

This accident released more than 100,000 gallons of propane before the pipeline could be shut down and the ruptured section isolated. When liquid propane and other HVLS are released, they vaporize rapidly, expand 200 to 300 times the liquid quantity, and form heavier-than-air vapors. These vapors can remain close to the ground for long periods. Gravity or wind can move the vapors from the area of release to areas of lower elevation and far from the pipeline. Although HVLS pipelines are involved in only about 10 percent of liquid pipeline accidents, they have caused about 60 percent of the deaths and 40 percent of the injuries attributable to liquid pipeline operations. Contributing to the severity of HVLS pipeline accidents is the lack of effective means to safely contain, dissipate, or otherwise reduce the threat when HVLS are released near populated areas.

In this accident, the volume of liquid propane in a 1-mile length of this pipeline would have provided sufficient quantity of propane vapor to engulf the nearby village. Because ignition of the propane occurred within 10 minutes after the leak was detected, the delayed shutdown did not cause additional casualties or loss of property. However, prompt detection and isolation of a rupture would provide more time to evacuate residents if its location was farther from populated areas.

After the CPO was alerted about the release of propane, it required more than an hour to shut down the pumps and to close the mainline valves nearest the rupture. Although the CPO and the TEPCO employees dispatched to close the valves did all they could to shut down the system, their actions were limited because of the distance of the valve from the rupture. The only remote-operated valve affecting this accident was at Gilbertsville. Consequently, in the mountainous terrain, propane flowed by gravity to the rupture for more than 21 hours.

The release of propane from TEPCO's pipeline could have been substantially limited if remote or automatic-operated valves were installed. After the CPO remotely closed the valve at Gilbertsville, a check valve located just east of the rupture could have prevented the release of propane from flowing to the rupture from pipe located at higher elevations. In recognition of this, the TEPCO installed a check valve near the mainline block valve on the east side of the Schoharie Creek; a manual mainline valve on the west side of CR 43; remote-operated valves at Marathon, Jefferson, and Oneonta; and RTUs at Marathon, Jefferson, Oneonta, and Selkirk. Additionally, at all pump stations, the TEPCO set the pressure differential monitor units to detect pressure loss rates of 20 psig per
minute instead of 80 psig per minute. Although these actions have improved the TEPPCO's overall monitoring and control capabilities, they have not improved its ability to remotely isolate a pipeline leak near the village. Because the valve at CR 43 must be manually operated, it would take more than an hour for an employee from the closest attended facility to arrive at this location to close it. The TEPPCO needs to modify the mainline valves near populated areas and remote- or automatic-operated valves should be installed to enable the rapid isolation of any failure in those sections.

The pipeline industry's 1979 standard, "ASME B31.4, Code for Liquid Petroleum Transportation Piping Systems," paragraph 434.15.2, "Mainline Valves," included a recommendation that on HVL pipelines in industrial, commercial, or residential areas, the mainline block valves be spaced at intervals no greater than 7.5 miles and that these valves be equipped for remote closure from an operated control location. Although the current edition of this code no longer contains these recommendations, the Safety Board believes they are needed. The code does address the use of check valves on HVL pipelines. It recommends that check valves, where applicable, be installed with each mainline block valve to provide the automatic block of a reverse flow in the piping system.

The Safety Board first addressed the issue of rapid shutdown of failed pipelines more than 20 years ago. In its 1970 report, the Safety Board recommended that the OPS:

P-71-01

Conduct a study to develop standards for the rapid shutdown of failed natural gas pipelines and work in conjunction with the Federal Railroad Administration to develop similar standards for liquid pipelines.

In a 1972 report, the Safety Board found that the delay in shutting down the failed pipeline to reduce the quantity of propane released was due in part to the lack of any remote- or automatic-operated mainline valves to rapidly close off and isolate the failed section. The Safety Board recommended that the Federal Railroad Administration (the agency then responsible for regulating liquid pipelines):

P-72-10

Conduct a study, in cooperation with sources of qualified pipeline expertise, concerning minimum valve-spacing standards and the use of remotely operated


valves, and check valves on all liquefied petroleum gas pipelines.

The recommended studies were conducted, and the Safety Board classified both recommendations as "Closed--Acceptable Action." However, no regulations were issued to require the use of remote-operated valves or other means to rapidly isolate failed segments of pipelines.

In the Safety Board report on a propane pipeline accident at West Odessa, Texas,\textsuperscript{12} the Safety Board addressed the deficiencies in the liquid pipeline regulations compared with the natural gas pipeline regulations. On March 15, 1983, the Safety Board recommended that the RSPA:

\textbf{P-84-26}

Amend Federal Regulations governing pipelines that transport highly volatile liquids to require a level of safety for the public comparable to that now required for natural gas pipelines.

The Safety Board reiterated this recommendation on July 20, 1987, in its report on a products pipeline accident at Mounds View, Minnesota, on July 8, 1986.\textsuperscript{13} Also in the report, the Safety Board recommended that the RSPA:

\textbf{P-87-22}

Require the installation of remote-operated valves on pipelines that transport hazardous liquids, and base the spacing of the remote-operated valves on the population at risk.

The RSPA responded to these recommendations in its June 8, 1990, "Proposals for Pipeline Safety; Disposition for Safety Proposals, Notice 2 of Docket PS-93." The RSPA contended that Part 195 now contains many safety standards that vary in stringency according to population characteristics even though a class location scheme is not used and that a study was underway to determine if further rulemaking on this issue was required. The Safety Board addressed the RSPA's comment on Safety Recommendations P-84-26 and P-87-22 in a 1990 accident report on a pipeline rupture in San Bernardino,

\textsuperscript{12}Pipeline Accident Report—"Mid American Pipeline System Liquified Petroleum Gas Pipeline Rupture, West Odessa, Texas, March 15, 1983" (NTSB/PAR-84-01).

\textsuperscript{13}Pipeline Accident Report—"Williams Pipe Line Company, Liquid Pipeline Rupture and Fire, Mounds View, Minnesota, July 8, 1986" (NTSB/PAR-87/01).
California. 14 The Safety Board stated that the RSPA's comments on Safety Recommendation P-84-26 were directed more at supporting existing regulations than at objectively assessing the need to improve the existing regulations. The Safety Board reclassified this recommendation as "Open-Unacceptable Action."

On the issue of more rapid shutdown of failed pipelines in populated areas, the RSPA proposal advised that a study, as required by the Congress, was being conducted to determine whether remote- or automatic-operated valves are needed to enhance safety. It stated that should this study provide a basis for improving pipeline safety, new rulemaking would be initiated.

Also in the San Bernardino accident report, the Safety Board addressed the usefulness of check valves in HL pipelines to limit the quantity of product released in the event of a rupture. From its review of Federal regulations and based on testimony from an OPS representative, the Safety Board determined that Federal regulations do not include specific requirements on the location, accessibility, and maintenance of valves and, in particular, do not address the need for check valves. In that report, the Safety Board once again cited the need for Federal regulations to include requirements for the prompt detection and shutdown of failed liquid pipelines and urged the RSPA to objectively assess the increased operating, maintenance, and emergency response requirements essential to public safety when populated areas are exposed to the risks of unintended releases of HLs from pipelines.

Because of the RSPA's reluctance to consider the Safety Board's recommendation until required to do so by the Congress and because of the time elapsed before the RSPA initiated action, the Safety Board affirmed the status of Safety Recommendation P-87-22 as "Open-Unacceptable Action."

Releases of HVLS from pipelines cause more than 60 percent of the fatalities attributable to HL pipeline operations; nevertheless, the OPS has not adequately addressed the additional hazards present from the operation of these pipelines. Federal regulations governing liquid pipeline operations do not include specific valve spacing requirements, as do the regulations governing natural gas pipelines; the need for check valves in pipelines that traverse areas with large variations in elevations; and the need for remote- or automatic-operated mainline valves to minimize the quantity of hazardous liquids released.

Consequently, the Safety Board believes that the RSPA should act promptly to establish performance standards for required monitoring to provide for the effective, timely detection of product releases and for the identification of the leak area. Further, the Safety Board urges the RSPA to

require pipeline operators to install remote- and automatic-operated valves (including check valves) sufficient to allow the rapid isolation of failed pipe, especially for pipelines located near populated areas.

Public Education and Release Detection

The TEPPCO information to educate the public about how to recognize and report leaks and the protective actions to take was provided to residents living within 1/8 mile of the pipeline. This action exceeded Federal requirements. The information appeared to be effective as it was used by the resident who first alerted the CPO of the leak. However, the residents injured in this accident lived beyond the 1/8-mile limit and had not received the information. Additionally, since the propane did not naturally have a distinctive odor, nor was the TEPPCO required to add one, the vapor cloud could be perceived as fog, a condition normal for that time of year and day, unless residents had knowledge of the characteristic of HVLs to form vapor clouds.

As a result of its investigation of the propane pipeline accident at Ruff Creek, Pennsylvania, the Safety Board issued to the Materials Transportation Bureau (MTB) (a former DOT organization that had included the OPS):

P-78-10

Include in proposed regulations a section similar to the emergency plan section of the natural gas code (49 CFR 192.615) that will require operators to provide information to persons who live or work within 220 yards of a propane pipeline, and up to 1 mile if located downhill of a liquefied petroleum gas pipeline, about the particular hazards of liquefied petroleum gas and how to contact emergency response personnel.

On August 3, 1978, the MTB issued an NPRM (Docket PS-51) that addressed the issue in Safety Recommendation P-78-10. On October 5, 1978, the Safety Board responded in support of the NPRM. On July 6, 1979, the MTB issued its final rule on Docket PS-51 but did not include this requirement. In its final rule, the MTB advised that eight commenters had recommended the deletion of the provision because they believed it would be impossible to accomplish. While the MTB eliminated the specific requirement to educate persons residing near HVL pipelines, it did require pipeline operators to conduct a program directed at the public, appropriate government organizations, and persons engaged in excavation-related activities to recognize an emergency and to report it to the pipeline operator and fire, police, and other appropriate officials.

On June 3, 1980, the Safety Board advised the RSPA that Safety Recommendation P-78-10 had been classified as "Closed--Acceptable Action" because the RSPA had included it in the proposed rulemaking as recommended. The Safety Board noted that educating persons residing near an HVL pipeline about the hazards associated with such a pipeline was not a closed issue and
that it would be addressed further when found in future accident investigations.

As noted in the 1987 API research study, 24 percent of the fatalities and 7 percent of the injuries caused by releases from liquid pipelines occurred between 1/8 and 1 mile of the pipeline. This accident again demonstrates the need to provide essential hazard recognition information to persons most likely to be harmed by a release of HVL from pipelines. The Safety Board urges the TEPPCO to extend its public education program to persons who reside at elevations lower than and within 1 mile of its pipelines, and the RSPA to require that all operators of HVL pipelines similarly extend their public education programs.

Emergency Response

Because of previous training, the NBVFD assistant chief correctly recognized the vapor cloud as hazardous, and his actions to immediately alert and evacuate others reduced the number of casualties. Similarly, the resident of Burnt Hill Road promptly recognized the noises he heard and the vapor cloud he observed as symptoms of a hazardous situation, and he promptly notified the TEPPCO’s CPO. However, the short time between their observations and the ignition of the propane vapor cloud precluded the warning or evacuating of other residents.

Immediately after the explosion and fire, many residents telephoned the SCSD communications center. Its personnel promptly dispatched emergency response fire and rescue units and implemented the county’s disaster response plan. The early arrival on scene of emergency response and rescue personnel, their prompt implementation of rescue and fire suppression operations, and the rescue actions taken by residents resulted in the effective evacuation and treatment of injured persons and held additional fire damage to a minimum. State, county, and local responders worked cooperatively and efficiently to implement the county disaster plan. The radio communication difficulties experienced during the emergency did not contribute to loss of life, but did impair coordination of activities and likely caused additional fire damage.

Representatives of each response agency participated in an after-action critique of the emergency operation response. The critique addressed the issue of deficient communications during the emergency, and a task group was formed to improve and standardize public safety communications within the county. The task group recommended the installation of an additional radio tower to provide better broadcast coverage in the mountainous terrain and the upgrading of older radio equipment.

As a result of the difficulties the TEPPCO experienced in communicating by radio with its response personnel, the TEPPCO recognized the need to improve its communication system between Watkins Glen and Schoharie County. It plans to install an additional radio tower to increase radio coverage in the mountainous terrain. To further improve the emergency response capabilities, the TEPPCO donated $400,000 to the area emergency response