

his determination to warn his neighbors, prevented an accident of even more serious proportions.

- 12. The volunteer fire companies, the local Sheriff's officers, and the Missouri State Police combined effectively to extinguish the fire, aid and assist the displaced people, and restore and maintain order.

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the accident was the rupture of an insufficiently bonded longitudinal weld, which had been further weakened by internal corrosion. Contributing to the rupture was a pump station which shut down and produced a higher pressure on the failed pipeline section than it had been subjected to during recent operations.

The explosion and fire were caused by the ignition of the released propane which had been confined in a concrete block building. The explosion inside the building initiated a shock wave which caused the detonation of the entire unconfined propane-air cloud.

Contributing to the intensity of the explosion and fire were the weather inversion present at the time, which acted as a lid on the detonation and helped to deflect the resultant forces earthward, the delay in shutting down the pumping stations, and the amount of time taken to close the manually operated valves on either side of the split.

VI RECOMMENDATIONS

The National Transportation Safety Board recommends that:

- 1. The Federal Railroad Administration of the Department of Transportation:

(a) Review the proposals made by the Hazardous Materials Regulation Board in Docket No. HM-6A on April 18, 1969. Rulemaking should be undertaken to provide for more complete controls for the transportation by pipeline of liquefied petroleum gas. These regulations should include minimum standards for the design, construction, testing, operation, and maintenance of both new and existing pipelines.

(b) Initiate an amendment to the Code of Federal Regulations, Title 49, Section 195.218 *Welding: Seam offset*, to require longitudinal welds to be placed in the upper half of the pipe during construction. Similarly, that in repairs to a pipeline involving pipe replacement, a requirement be issued that the longitudinal welds of replacement pipe be positioned in the upper half.

(c) Conduct a study, in cooperation with sources of qualified pipeline expertise, concerning minimum valve-spacing standards and the use of remotely operated valves, automatically operated valves, and check valves on all liquefied petroleum pipelines. As an adjunct to this, the Safety Board invites attention to a recommendation made in its special study of "Effects of Delay in Shutting Down Failed Pipeline Systems and Methods of Providing Rapid Shut-down."⁸

(d) Undertake a study, in cooperation with sources of qualified pipeline expertise, of the various current practices in the handling, containing, and disposing of liquefied petroleum products resulting from pipeline failures. This study should include such external factors as weather conditions, leak site topography and population density in the vicinity of the leak. Based upon the

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results of this study, there should be formulated and added as an amendment to 49 CFR 195, minimum regulations regarding the handling of liquefied petroleum gas as a result of pipeline leaks.

2. The Phillips Pipe Line Company:

12 (a) Maintain as a maximum, the reduced pumping pressures recommended by the National Transportation Safety Board's Safety Recommendation P-71-6 issued April 27, 1971, which limits to 900 p.s.i.g. the maximum discharge pressures at each of the pump stations between Borger and East St. Louis, as well as Phillip's own pressure limitation of 900 p.s.i.g. on the four pump stations in the affected area; Syracuse, Jefferson City, Rosebud, and Villa Ridge. A 24-hour hydrostatic pressure test equal to 125 percent of the maximum anticipated pressure as specified in the CFR Title 49 Part 195 would be required before this line pressure could be again increased.

13 (b) Revise their pipeline operating procedures and initiate any equipment changes necessary to reduce substantially the time required to shut down the pump stations. Included in this review and revision should be explicit instructions to the dispatcher for the immediate emergency shutdown of all pump stations together with some means of practicing these procedures.

14 (c) Institute main line valve changes or modifications needed to reduce substantially the amount of time required to completely block off and isolate a failed pipeline section. Consideration should be given to the use of automatically operated valves, remotely operated valves, or check valves installed at strategic locations on this pipeline. Special consideration should be given to the concentration of population-at-

risk along and adjacent to the pipeline right-of-way. The Safety Board invites Phillips attention to the section on the Public-at-Risk in the Safety Board's special study of "Effects of Delay in Shutting Down Failed Pipeline Systems and Methods of Providing Rapid Shutdown."

15 (d) Provide maps of their pipeline system in sufficient detail to establish clearly the system location with regard to the various affected civil agencies along the right-of-way. These maps should be kept current by the notations of pipeline additions or route changes as required. Specifically recommended to receive this information are the fire departments, both civil and volunteer, the state, county and local police departments, and other agencies concerned with hazardous materials.

16 (e) Establish a line of communication with the affected civil agencies and all residents along the pipeline right-of-way, by supplying a card or sticker with the names, addresses, and telephone numbers of pipeline personnel to be contacted during an emergency.

17 (f) Hold periodic meetings to include the local fire departments and other interested agencies, to inform further and educate the attending personnel as to basic pipeline operations, and materials pumped, hazards encountered, and procedures to follow during LPG leaks.

18 (g) Continue with the experimental work in cooperation with other qualified pipeline groups in testing and developing a tool to detect longitudinal weld defects and thin wall pipe caused by corrosion. Based on the findings, the methods of operation should be incorporated in the pipeline industry standards, as an additional tool for the detection of in-place line pipe flaws, but not as a substitute for hydrostatic testing.