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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

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In Reply Refer To: P-96-24

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In mid-October 1994, serious flooding occurred in the San Jacinto River flood plain near Houston, Texas, forcing over 14,000 people to evacuate and resulting in 20 deaths. Due to the flooding, eight pipelines ruptured and many others were undermined. More than 35,000 barrels of petroleum and petroleum products were released into the river. Ignition of the released products resulted in 547 people receiving (mostly minor) burn and inhalation injuries. Spill response costs exceeded \$7 million, and estimated property damage losses were about \$16 million.

The National Transportation Safety Board undertook a special investigation¹ to assess: (1) the adequacy of Federal and industry standards on designing pipelines in flood plains, (2) the preparedness of pipeline operators to respond to threats to their pipelines from flooding and to minimize the potential for product releases, and (3) the preparedness of the Nation to minimize the consequences of petroleum releases. The investigation report also addressed the need for effective operational monitoring of pipelines and for the use of remote- or automatic-operated valves to allow for prompt detection of product releases and rapid shutdown of failed pipe segments. The Safety Board made nine safety recommendations — one to the Research and Special Programs Administration, five to the National Response Team, and one each to the American Petroleum Institute, the Association of Oil Pipe Lines, and the Interstate Natural Gas Association of America.

¹For further information, read Special Investigation Report—*Evaluation of Pipeline Failures During Flooding and of Spill Response Actions, San Jacinto River Near Houston, Texas, October 1994* (NTSB/SIR-96/04).

In its investigation of the Houston accident, the Safety Board found that the location of the pipelines within the flood plain and the design of the pipelines in this location were the most relevant factors affecting their survival. The pipelines that were ruptured or damaged most severely in the flood plain were those installed in areas where the river course meandered the most, where significant mining operations had been conducted, and where streambed scouring could be expected.²

Survey information provided by pipeline operators whose pipelines had been seriously affected by the flood indicated that most of the pipelines in such areas had been designed using only the Federal regulations and/or industry codes as the bases for their design and construction. Operators of only 7 of the 21 pipelines in these areas had performed some study of the river to supplement the design and installation practices for their construction. The design bases of most pipelines undermined or ruptured during the flood did not include study of the flood plain to identify potential threats; rather, operators used only general design criteria applicable at the time the pipelines were installed.

In fact, few design basis tools concerning river and flood plain areas were available to pipeline operators. Between 1934 and 1978, the *Gas Engineers Handbook*³ was available to designers of gas pipelines. The handbook advised them to develop a complete historical survey of areas where streams were to be crossed and to consider during the design process those future changes that might occur in navigation, river traffic, and flood control. Designers of liquid pipelines had the 1955 American Petroleum Institute (API) Bulletin 1105 available to them for a brief time. The bulletin provided comprehensive guidance on designing pipeline crossings of streams and flood plains. It included explicit cautions and advice on the types of studies, tests, and historical reviews that should be performed as integral parts of the designing of pipelines crossing flood plains. Nevertheless, no San Jacinto pipeline operator cited either of these guidance documents in response to the survey questions about the design bases of their pipelines.

API Bulletin 1105 was a tentative standard in effect for only 1 year. Had the API Bulletin 1105 been maintained as a permanent design support document, the information it contained would have raised strong reservations to designers against installing a pipeline across the San Jacinto flood plain in areas of significant stream meanders. Such information would have strongly recommended against installing a pipeline in such an area, especially since previous sand mining operations had made the route less stable. If no other cost-effective routes had been available, then extensive testing and research to define the potential safety threats and provide protection against such threats would certainly have been indicated. If unacceptable threats of failure remained for pipe segments in the flood plain after design modifications had been made, a plan should have been developed for shutting down and purging the pipeline of product any time projected environmental conditions were likely to exceed the design limitations of the pipeline.

²Particularly where the river width constricted.

³Sponsored by the American Gas Association and published by The Industrial Press, New York, New York.

The need to periodically reassess the forces that might be imposed on the pipeline by changes within the flood plain should also have been recognized through the use of API Bulletin 1105.

Federal regulations, industry codes, and present-day design and guidance manuals do not give adequate guidance to designers on the types of studies of flood plains that should be performed. Designers are not sufficiently warned of the specific hazards to pipelines, such as riverbed scour, that can occur during flooding where a channel is narrowed by obstructions like bridges. Current documents do not address the need for pipeline operators to monitor changes within flood plains that might increase the threat potential beyond that evaluated at the time the pipeline was designed and installed.

While multiple pipeline failures such as occurred in the San Jacinto flood plain are infrequent, individual flood-caused failures are not. No effective standards or guidance currently exist for designing pipelines that cross flood plains or river crossings. This deficiency is especially significant with respect to pipelines located near bridges and other locations where the potential for streambed scour is greatest. Consequently, such standards are needed to identify to designers the many threats posed to pipelines when crossing rivers and flood plains, and to define the types of research, study, and future design considerations that must be conducted preparatory to designing pipelines that cross flood plains.

The National Transportation Safety Board therefore issues the following recommendation to the Interstate Natural Gas Association of America:

Develop, in cooperation with the American Petroleum Institute and the Association of Oil Pipe Lines, design and construction standards adequate for pipelines to safely cross flood plains and streambeds, including the development of recommended practices for periodically reassessing crossing designs in light of changes that have occurred in the flood plain or streambed. (Class II, Priority Action) (P-96-24)

Similar recommendations have been issued to the American Petroleum Institute (P-96-22) and the Association of Oil Pipe Lines (P-96-23). The Safety Board also issued Safety Recommendations I-96-1 through -5 to the National Response Team and Safety Recommendation P-96-21 to the Research and Special Programs Administration.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendation P-96-24. If you require additional information, you may call (202) 382-0672.