log # P 307C

NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C. 20594

Safety Recommendation

Date: December 15, 1993

In Reply Refer To: P-93-21 and -22

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President
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On April 7, 1992, an uncontrolled release of highly volatile liquids (HVLs) from a salt dome storage cavern in the Seminole Pipeline System near Brenham, Texas, formed a large, heavier-than-air gas cloud that exploded. Three people died from injuries sustained either from the blast or in the fire. An additional 21 people were treated for injuries at area hospitals. Damage from the accident exceeded $9 million.[1]

The Seminole Pipeline Company is a stock corporation in which MAPCO Natural Gas Liquids, Inc. (MAPCO) has controlling interest. When MAPCO constructed Brenham station, no industry or government standards existed that described the type or design of equipment needed to provide a specified level of safety control. MAPCO engineers designed the station, including the configuration of the station's cavern safety system and selected equipment, after reviewing the practices of other companies that were operating caverns at the time. Between the time that the Brenham station was originally constructed and the time of the accident, the company had never performed a comprehensive safety analysis of the Seminole system, including Brenham station, to identify potential points of failure and product release.

Following the accident, a MAPCO team looked at the Brenham station design and reconstructed a considerably more complex and extensive underground storage safety control system. However, the team redesigned the system without using safety analyses to identify and

[1]For more detailed information, read Pipeline Accident Report--*Highly Volatile Liquids Release From Underground Storage Cavern and Explosion, MAPCO Natural Gas Liquids, Inc., Brenham, Texas, April 7, 1992* (NTSB/PAR-93/01).

document potential failures, to assess the likelihood of their occurrence, and to assess whether modifications could be made to eliminate or minimize potential failures. The Safety Board believes that without such an analysis, the ability of the control system to protect public safety is unknown.

At a public discovery hearing held July 29-30, 1992, in Austin, Texas, the Safety Board asked representatives of the American Gas Association (AGA), the American Petroleum Institute (API), and the Office of Pipeline Safety (OPS) what assistance they provided to their members on underground storage. The API representative advised that since 1981, it has recognized the need to develop standards for solution-mined underground storage facilities. The API's transportation committee appointed a task force that began developing standards for solution-mined storage facilities, but the task force halted work after several years, apparently because of an industry economic downturn. In December 1989, the task force resumed working on standards for design and construction, and in July 1990, resumed working on standards for operations and maintenance. According to a spokesperson, a draft of the design and construction standards includes recommended practices on designer qualifications, cavern design parameters and criteria, wellhead safety equipment, cavern drilling and completion, cavern integrity testing, cavern product inventory measurement, cavern operation, and cavern abandonment. The API expects that both sets of standards will be issued by the end of 1993.

The AGA witness stated that the present standards applicable to underground natural gas storage were developed for the exploration and production of oil and gas. The API, the American National Standards Institute, and the International Association of Drilling Contractors have recommended practices on wellhead equipment, casing equipment, and drilling operations. The Gas Processors Suppliers Association also has some educational materials on underground storage.

The AGA representative stated that several agencies have some safety control over underground storage of natural gas. An organization proposing to build a system must first obtain a permit. For interstate operations, the Federal Energy Regulatory Commission (FERC) reviews both the environmental studies and the construction and design proposals for the facility. For intrastate operations, a State agency such as a utility regulatory commission performs reviews similar to those of FERC. The witness stated that all piping associated with underground storage facilities is regulated by the Research and Special Programs Administration because storage is defined in the Federal gas pipeline safety standards as a gas transmission function; but the OPS informed the Safety Board that it has not issued safety requirements on the underground storage of natural gas.

The spokesperson stated that although the AGA does not develop standards, the association has an underground storage committee that reviews and disseminates to its members technical information on the safe and efficient operation of both cavern and aquifer storage facilities. The committee works with standard-writing bodies by reviewing and recommending improvements; maintains technical papers; meets biannually to exchange technical information, to review research, and to review environmental regulatory requirements; and collects and publishes statistics on underground storage operations. Recently, the committee reviewed and proposed changes to the API's draft recommended practices on solution-mined caverns.

This accident and the lack of underground storage regulatory public safety oversight posed by the more than 1,400 liquid and more than 400 underground storage facilities in the country demonstrate that the AGA needs to continue working with the API to develop standards for underground storage facilities storing such dangerous materials as HVLs and natural gas.

From its investigation of this accident, the Safety Board determined that the dispatcher monitoring the Seminole pipeline system failed to recognize and consequently failed to respond timely to pressure changes in the product flow rate into the storage cavern. The Brenham accident demonstrates a problem that the Safety Board has noted in prior pipeline accidents: some display systems used by dispatchers do not display information in a format that facilitate ready identification of a problem.

The Supervisory Control and Data Acquisition (SCADA) system format that MAPCO used before the explosion displayed data in an alphanumeric format, updating the displayed pressure and flow rates every 15 to 20 seconds. When the monitor displayed a reading, the dispatcher had to mentally compare the pressure shown to an established operating norm. A subsequent display of data replaced the previous display. At no time did the system monitor display a "history" of previous pressure or flow readings; such histories would have helped the dispatcher recognize trends.

Research has shown that graphic displays have several advantages over text description or tabulation. First, graphic displays are easier to understand; thus, the user is more likely to detect trends. Second, it is easier to quickly scan and compare related sets of data; deviations are visually distinct. Third, it is easier to detect critical changes, and thus easier to monitor changing data. As compared with static, printed displays, a continuous dynamic display of changing data is more likely to direct the user's attention to abnormalities.

The Safety Board concludes that had the SCADA system monitor displayed pressure and flow information in a graphic format for an extended time interval, the dispatcher could have more easily recognized that it was abnormal for HVLs to continue to flow into the cavern after the pump had shut down. Consequently, he would have had time to close the valve between the lateral and cavern piping before the storage facility overfilled. Even if he had not recognized the abnormality until it was too late to stop the release of HVLs from the cavern, he would have been able to give local agencies and his management early warning.

Therefore, the National Transportation Safety Board makes the following safety recommendations to the Amreican Gas Association:

> Cooperate with the American Petroleum Institute in completing recommended safety practices for the design, construction, operation, and maintenance of solution-mined storage caverns and in developing recommended safety practices for other types of highly volatile liquid and natural gas underground storage facilities. (Class II, Priority Action) (P-93-21)

In cooperation with the American Petroleum Institute, develop standards and guidelines for the design and use of graphic information display systems used by dispatchers to control pipeline systems. (Class III, Longer Term Action) (P-93-22)

Also, the Safety Board issued Safety Recommendations P-93-09 to the Research and Special Programs Administration; P-93-10 through -14 to the MAPCO Natural Gas Liquids, Inc.; P-93-15 and -16 to Washington County; P-93-17 to the Texas Department of Public Safety; P-93-18 through -20 to the American Petroleum Institute; and P-93-23 to the International Association of Fire Chiefs. The Safety Board is also reiterating Safety Recommendation I-88-1 to the Department of Transportation. If you need additional information, you may call (202) 382-0672.

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 vitally 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 recommendations in this letter. Please refer to Safety Recommendations P-93-21 and -22 in your reply.

Chairman, VOGT, Vice Chairman, COUGHLIN, Members, LAUBER and HAMMERSCHMIDT concurred in these recommendations. Member HART did not participate.

By: Carl W. Vogt
Chairman