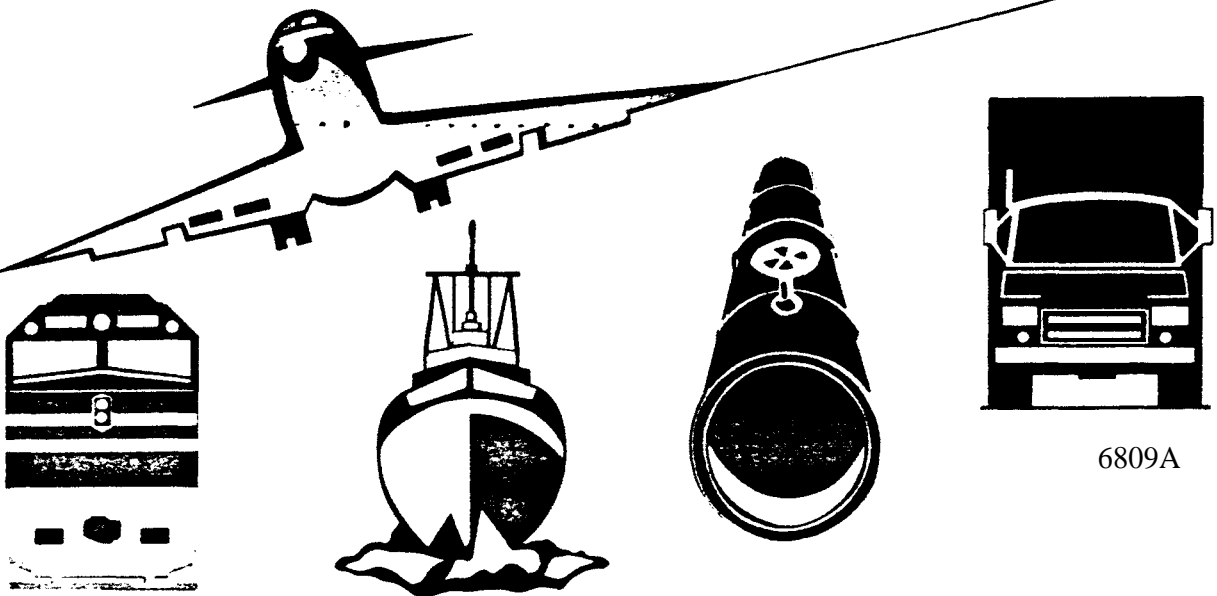


NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

PIPELINE ACCIDENT SUMMARY REPORT

NATURAL GAS PIPELINE RUPTURE AND FIRE
DURING DREDGING OF TIGER PASS, LOUISIANA
OCTOBER 23, 1996



6809A

Abstract: About 4:50 a.m. on October 23, 1996, in Tiger Pass, Louisiana, the crew of a Bean Horizon Corporation dredge dropped a stern spud into the bottom of the channel in preparation for dredging operations. The spud struck and ruptured a 12-inch-diameter submerged natural gas steel pipeline owned by Tennessee Gas Pipeline Company. The pressurized natural gas released from the pipeline enveloped the stern of the dredge and an accompanying tug, then ignited, destroying the dredge and the tug. No fatalities resulted from the accident.

The safety issues discussed in this report are the adequacy of Tennessee Gas Pipeline Company's practices and procedures for locating, marking, and maintaining markers for gas transmission pipelines through navigable waterways; the lack of Federal requirements for placing and maintaining permanent markers where gas and hazardous liquid pipelines cross navigable waterways; and the adequacy of Bean Horizon Corporation's vessel emergency and crew accounting procedures.

As a result of its investigation, the National Transportation Safety Board issued safety recommendations to the Research and Special Programs Administration, Tennessee Gas Pipeline Company, Bean Horizon Corporation, the Western Dredging Association, the Interstate Natural Gas Association of American, and the American Petroleum Institute.

The National Transportation Safety Board is an independent Federal agency dedicated to promoting aviation, railroad, highway, marine, pipeline, and hazardous materials safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The Safety Board makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

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Pipeline Accident Summary Report

**Natural Gas Pipeline Rupture and Fire During
Dredging of Tiger Pass, Louisiana
October 23, 1996**

**NTSB/PAR-98/01/SUM
PB98-916501
Notation 6809A
Adopted: September 28, 1998**



**National Transportation Safety Board
490 L'Enfant Plaza East, S.W.
Washington, D.C. 20594**

Factual Information

About 4:50 a.m. central daylight time on October 23, 1996, in Tiger Pass, Louisiana,¹ (figure 1) the crew of the Bean Horizon Corporation (Bean) dredge *Dave Blackburn* dropped a stern spud² into the bottom of the channel in preparation for continued dredging operations. The spud struck and ruptured a 12-inch-diameter submerged natural gas steel pipeline owned by Tennessee Gas Pipeline Company (Tennessee Gas).³ The pressurized (about 930 psig) natural gas released from the pipeline enveloped the stern of the dredge and an accompanying tug, the *G.C. Linsmier*. Within seconds of reaching the surface, the natural gas ignited.⁴ The resulting fire destroyed the dredge and the tug. All 28 crewmembers from the dredge and tug escaped into the water or onto nearby vessels. As a result of its investigation of this accident, the National Transportation Safety Board identified three major safety issues:

- Adequacy of Tennessee Gas's practices and procedures for locating, marking, and maintaining markers for gas transmission pipelines through navigable waterways;
- Lack of Federal requirements for placing and maintaining permanent markers where gas and hazardous liquid pipelines cross navigable waterways; and
- Adequacy of Bean Horizon Corporation's vessel emergency and crew accounting procedures.

The Accident

On September 20, 1996, Bean was awarded a U.S. Army Corps of Engineers contract to dredge portions of Tiger Pass, including areas where several underwater pipelines were located. The Corps of Engineers provided Bean with Corps of Engineers drawings showing the approximate locations of the pipelines. On these drawings, the Tennessee Gas pipeline was shown as crossing Tiger Pass at centerline station 614+20, or 61,420 feet from the point at which Tiger Pass joins the Mississippi River.⁵ A dredging contract

¹Tiger Pass is a channel through the Mississippi River delta near Venice, Louisiana, that connects the Mississippi River with the Gulf of Mexico. The channel extends partially into the Gulf of Mexico, where the sides of the pass are defined by rock jetties.

²A spud is a large steel shaft that is dropped into the river bottom to serve as an anchor and a pivot during dredging operations.

³At the time of the accident, Tennessee Gas was a division of Tenneco, Inc. Since the accident, it has become a subsidiary of El Paso Energy Corporation.

⁴The ignition source could not be determined but could have been any of a number of electromechanical devices located on the dredge in the area of the escaping gas.

⁵The junction of Tiger Pass and the Mississippi River was used as a zero reference point by the Corps of Engineers for measuring distances downstream along the center of Tiger Pass. Postaccident measurements determined that the pipeline actually crossed Tiger Pass at station 615+12, or about 92 feet downstream from the Corps of Engineers' approximate location.

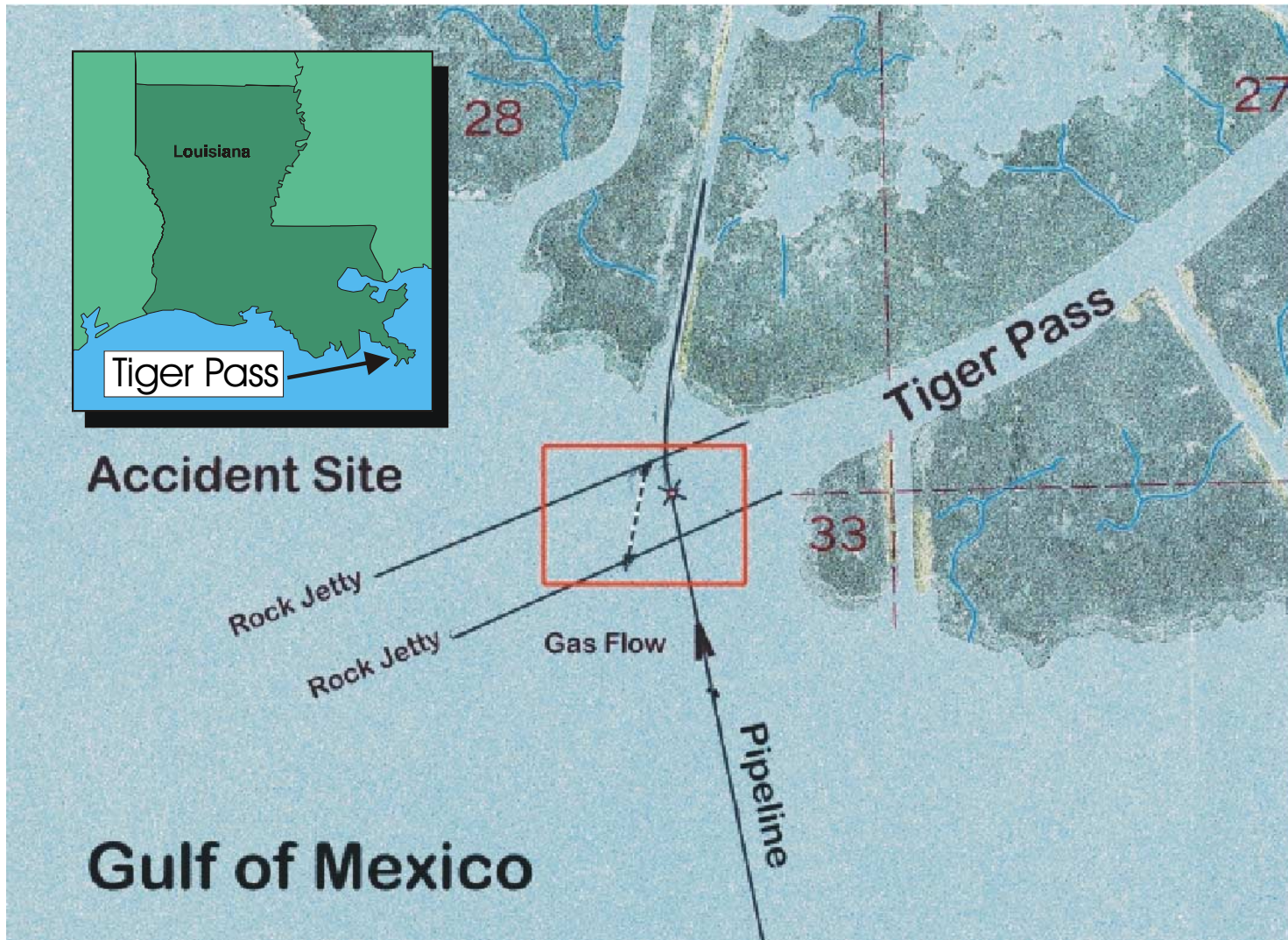


Figure 1. Overview of accident site. Dotted line marks location of pipeline as identified by pipeline operator. (Rectangular area shown in greater detail in figure 2.)

provision, with which Bean complied, required Bean to verify the pipeline locations and to notify pipeline owners by certified mail at least 7 days before dredging within 500 feet of their pipelines.

On September 22, Bean began dredging about 1,000 feet southwest of the location of the pipeline as shown on the Corps of Engineers drawing. The initial dredging operation was to move toward the Gulf of Mexico and away from the pipeline.

The unpowered, 180-foot-long *Dave Blackburn* was moved to the dredging site by a tug.⁶ Several other vessels, including tugs and barges, accompanied the dredge and assisted during dredging, which was done using a 7-foot-diameter cutting head that was mounted on a 77-foot-long structure referred to as “the ladder.” The ladder and cutting head were raised and lowered on a hinge mounted on the bow of the dredge. The crew moved the dredge and cutting head from side to side by hauling on swing anchors set in the river bottom off the port and starboard sides of the dredge. A spud was dropped into the river bottom from the stern of the vessel and used as a pivot point for rotating the dredge. The silt loosened during digging was removed by suction pumps and deposited outside the contour of the channel.

On October 17, while the *Dave Blackburn* was dredging toward the Gulf of Mexico, the crew received weather reports predicting rough weather. The supervisor of the dredging operation decided to move the operation to a more sheltered area to the northeast, near the point where the dredging had begun but still southwest of the pipeline. According to the supervisor, the plan was to begin dredging there and then move toward the northeast, toward the pipeline. Tennessee Gas was notified by phone that the dredge would soon be approaching the pipeline. Bean’s project engineer on the dredge said he questioned a Tennessee Gas supervisor several times about the pipeline’s exact location and was told that the location of the pipeline was marked by two pilings, one near either side of the pass.⁷

About 2 p.m., on October 19, a Tennessee Gas inspector boarded the dredge and, using information and a sketch provided by her supervisor, established a 100-foot safety zone in the area of the two pilings. (See figure 2.) In order to avoid damage to the pipeline, dredging in that area was to be done with the suction pumps only, without using the cutting head. Bean’s daily quality control reports showed that the pipeline location identified by Tennessee Gas personnel did not match the location shown on the Corps of Engineers drawings.

Dredging, using only the suction pumps, proceeded across the area of Tiger Pass where the pipeline was believed to be located. The dredge’s daily quality control report indicated that the ladder struck an object believed to be the pipeline about 15 feet south-

⁶Although the dredge had no propulsion power, the vessel was equipped with four diesel-electric units that powered the dredging machinery.

⁷These pilings were located at about station 618+10, about 300 feet downstream of the actual pipeline location.

west of the site identified by the Tennessee Gas inspector. Dredging then continued to the northeast to within about 130 feet of the actual pipeline location. Then, on October 20, because of improving weather, the dredging supervisor decided to return the operation to the Gulf of Mexico end of the channel where weather conditions had previously halted work. The Tennessee Gas inspector left before the dredge was moved, with an agreement that the gas company would be notified when the dredge returned to work in the area of the pipeline.

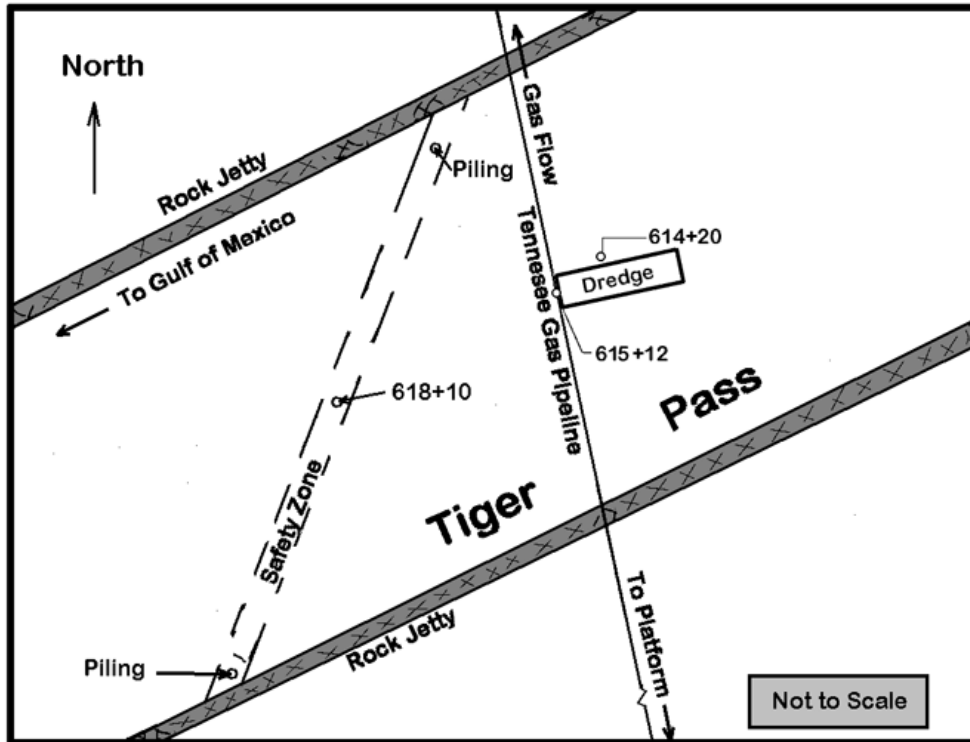


Figure 2. Detailed view of accident area. Corps of Engineers drawings showed location of pipeline at 614+20; pipeline owner identified location as 618+10; actual location was 615+12.

On October 22, after completing its work at the lower end of the pass, the dredge returned, at 9:40 a.m., to an area about 140 feet to the northeast of the area previously identified by Tennessee Gas as the pipeline's location. The crew began dredging to the northeast, believing that the operation was outside the safety zone and moving away from the pipeline. In reality, the dredge was moving *toward* the pipeline, which was about 100 feet away. By 9:30 p.m., the cutting head had crossed over the pipeline without incident.

On October 23, at 4:50 a.m., after stopping the dredging to clean the cutting head and reset the swing anchors, the crew dropped a stern spud into the river at about station 615+12 and directly into the Tennessee Gas pipeline, rupturing the pipeline and releasing pressurized natural gas. (See figure 3.)



Figure 3. Aerial view of the stern of dredge *Dave Blackburn* (large white vessel near the center) and the pilings (marked by arrows) that were believed to locate the pipeline. The rectangular framework on the stern of the dredge is directly over the ruptured pipeline.

Emergency Response

According to crew statements, as the water began to churn and a vapor cloud of natural gas enveloped the stern of the dredge *Dave Blackburn* and the tug *G. C. Linsmier*, crewmembers on the stern of the dredge ran to the forward part of the vessel, warning other crewmembers as they ran. The natural gas quickly ignited; however, all crewmembers from both the dredge and the tug escaped (with only one reported injury) onto other vessels (tugs *Capt. Shane II*, *Desire*, and *Glenn Bauer*) in the area or into the water and then onto the other vessels. Dredge personnel took a “head count” and determined that all the crewmembers had survived. When the accident occurred, most of the crewmembers were awake, either standing watch or preparing for the 7 a.m. scheduled crew change.⁸

⁸The dredge worked round the clock and the dredge crews worked 12-hour shifts. The crews worked tours on the vessel that ranged from 14 to 21 days before being relieved by crews rotating in from the shore. At the time of the accident, the crew was divided among those who were already on duty, those who were going off duty, those who were coming on duty, and those who were packing and preparing to go ashore when the relief crew arrived at 7 a.m.

When the pipeline ruptured, a check-valve in the pipeline about 2 miles downstream of the rupture closed automatically, as designed. Because pressure in the pipeline did not drop below the alarm set point on the supervisory control and data acquisition (SCADA) system used by Tennessee Gas to operate and monitor its pipelines,⁹ the system did not alarm and thus did not alert Tennessee Gas controllers that a rupture had occurred. The SCADA system, while designed to alarm at a preset minimum pipeline pressure, was not equipped to alarm at any given change in pressure over a period of time or upon closure of the check valve.

The deck captain of the *Dave Blackburn* called the U.S. Coast Guard and reported the pipeline rupture and fire. According to the Coast Guard incident log, about 5:16 a.m., the watchstander at Coast Guard Group New Orleans notified Marine Safety Office (MSO) New Orleans that the *Dave Blackburn* had ruptured a pipeline in Tiger Pass and that the dredge and the channel were on fire. The MSO issued an urgent marine information broadcast to warn vessels of the danger in the Tiger Pass area.

Some time between 5:18 a.m. and 5:35 a.m.,¹⁰ an employee of Chevron Pipe Line Company, which also had pipelines across Tiger Pass, called Tennessee Gas and reported that a Tennessee Gas pipeline had ruptured and caused a fire in Tiger Pass. According to Tennessee Gas event logs, employees began to examine the company's system to identify the accident pipeline.

About 5:25 a.m., the Coast Guard watchstander called Bean and left a message. The call was returned about 5:29 a.m. by the company vice president, who said he had no information about the accident but was on his way to his office. About 5:42 a.m., the watchstander called Chevron to determine whether the rupture belonged to that company. According to the incident log, the Chevron representative told the watchstander that the pipeline belonged to Tennessee Gas and provided him with a telephone number. About 5:45 a.m., the watchstander reached a Tennessee Gas representative and reported the pipeline rupture. The Tennessee Gas representative told the watchstander that a pipeline was losing pressure at an offshore platform in the Gulf of Mexico and that it might be the affected pipeline. He said the company was in the process of shutting down that line.

Tennessee Gas control personnel contacted personnel on the offshore platform (located about 9 miles upstream of the rupture), and about 6 a.m., those workers closed a valve to isolate the break. About 7:25 a.m., according to Tennessee Gas records, the company's personnel manually closed a valve adjacent to the closed check valve (about 2 miles downstream of the rupture) to ensure that the damaged section of pipe was completely closed off on each side of the rupture.

⁹SCADA systems in various configurations are used by pipeline operators to control and monitor the status of their pipeline systems.

¹⁰Safety Board investigators examined three Tennessee Gas event logs and the Coast Guard incident log to develop a time line of events in the accident sequence. Because the four logs showed variations in the recorded times for some of the same incidents, investigators were able to establish only a range of times for certain events.

Shortly after being notified of the accident, the commander of MSO New Orleans assumed the role of incident response commander and designated the officer in charge of Coast Guard Station Venice as the on-scene commander. The on-scene commander coordinated response activities on the scene and reported directly to the incident response commander, who, by about 7 a.m., had established a command center within the MSO. Coast Guard assets from Coast Guard Station Venice and a 41-foot utility boat were on scene by 5:45 a.m. By the end of the day, five tugs and five offshore supply vessels from Venice, Morgan City, and New Orleans were on scene, as well as a local firefighting vessel. In addition, during the day, at least two helicopter overflights were made by the Coast Guard and Bean. By 7 a.m., the flow of natural gas had stopped, and the gas-fueled fire went out. The vessel fires were not completely extinguished until about 1 p.m.

Tennessee Gas Pipeline Location Marking

The pipeline involved in this accident was installed in 1957, at which time, according to Tennessee Gas drawings, the company placed a 4.3-foot-by-6-foot sign on the south side of the channel near the pipeline. In 1977, the pipeline was buried deeper in the bottom to accommodate future dredging of the channel. The information provided by Tennessee Gas to the Corps of Engineers in obtaining a permit for the work did not refer to the centerline river channel measurements used by the Corps of Engineers; instead, the company identified the pipeline crossing location by plotting x and y coordinates, using the Louisiana coordinate system. The Corps of Engineers converted these coordinates to channel centerline measurements. These were the measurements that appeared on the drawings provided to Bean before dredging began and that were found to be more than 90 feet northwest of the actual location.

In 1995, Tennessee Gas established a company procedure requiring that:

The identity and route of the Company's pipelines . . . be made conspicuous by the use of markers. Pipeline markers serve to acquaint persons performing construction and excavation activities with the presence of Company pipelines in order to minimize the possibilities of damage to the line from outside forces (excavation, drilling, encroachment, etc.).

The procedure specified that:

Pipeline markers will be installed as nearly as practicable, directly over all pipeline crossings of public roads and highways, railroads, rivers, streams, navigable waterways, and shore landfalls.

The procedure required that signs marking crossings of navigable waterways include the words "Do Not Anchor or Dredge." The procedure gave the local supervisor responsibility for maintaining the pipeline markers and signs and stated that:

Markers and signs are to be replaced or repaired as needed to insure that the pipeline location and identity is clearly visible at all times, both from the air and the ground.

At the time of this accident, no signs or markers were in place at the Tiger Pass crossing, and Tennessee Gas officials were unable to explain why they believed the location of that pipeline was marked by the two pilings that were 300 feet southwest of the actual pipeline location. After the accident, the company erected signs in Tiger Pass to alert mariners to the location of the crossing.

Tennessee Gas's written procedures specified that:

Where a planned excavation affects a Company pipeline, the Area Manager or his designee is responsible for seeing that the pipeline is properly located and marked before the excavation activity begins.

The procedures did not specify the methods or documentation that were to be used to locate the pipeline, and none of Tennessee Gas's procedures specifically addressed excavations to be performed within navigable waterways.

Vessel Emergency and Crew Accounting Procedures

Bean had established a safety program for its vessels that included initial, crew-change-out, and monthly abandon-ship and man-overboard drills and weekly all-hands safety meetings. These drills and safety meetings were recorded in the vessels' log books, and written summaries were submitted to the company's loss control department. *Dave Blackburn* crewmembers stated that no crew list, crew team assignment, or other crew accounting procedure was in place on the vessel.

Initially, the Coast Guard on-scene commander believed that 33 crewmembers were on board the *Dave Blackburn* and the *G. C. Linsmier* at the time of the accident. The Coast Guard incident log indicates that 30 crewmembers were aboard the dredge. The required accident report (CG-2692) submitted by Bean indicated that 28 people were aboard the *Dave Blackburn* at the time of the accident, including 3 crewmembers from the tug *G.C. Linsmier*, who were having breakfast on board the dredge when the pipeline ruptured. No crewmember interviewed after the accident knew with certainty how many people had been on board the vessels at the time of the accident. Crewmembers stated that, after the accident, they used an informal survey and quick "head count" to determine that no crewmembers were missing.

A review of Bean's emergency response instructions and the *Dave Blackburn's* station bill revealed no provision for accurately accounting for the number of people on board the dredge vessels at any one time.

Safety Issues

Pipeline Locations and Marking

In the view of the Safety Board, responsibility for correctly identifying the location of the Tennessee Gas pipeline through Tiger Pass belonged to Tennessee Gas. The Safety Board is, therefore, concerned about the imprecise method used by Tennessee Gas to locate its pipeline, particularly in a case involving a dredging operation that would, of necessity, have to pass directly over the pipeline, placing the pipeline in jeopardy of being damaged or even ruptured. Tennessee Gas representatives relied on the location of two pilings to determine the location of the pipeline through Tiger Pass, even though company officials, after the accident, could not determine the purpose of the two pilings or explain why company representatives believed the pilings marked the pipeline location.

The actual dredging machinery passed over the pipeline without incident, and had the dredge not, by chance, dropped a spud into the pipeline, the erroneous identification of the pipeline's location might have gone unnoted. As the accident revealed, however, the efforts of Tennessee Gas to ensure the safety of its pipeline were inadequate. Those Tennessee Gas employees responsible for making the dredging company aware of the location of the company's pipeline did not employ precise means of locating the pipeline, such as surveying or probing, nor did company procedures require that they do so. The Safety Board concludes that Tennessee Gas took inadequate steps to precisely identify and mark the location of its pipeline through Tiger Pass before dredging operations were undertaken in the pipeline area. The Safety Board believes that Tennessee Gas should develop formal, written company procedures for identifying the precise locations of its pipelines that traverse navigable waterways before dredging or similar activities are commenced in the pipeline area.

Even had Tennessee Gas attempted to use a probe to determine the location of its Tiger Pass pipeline, the company may have encountered a delay in locating the pipeline because of the absence of any markings to indicate the pipeline's approximate location. The two pilings that were thought, erroneously, to be markers were about 300 feet from the pipeline. Permanent and correctly positioned markers indicating the presence and location of the pipeline would have allowed the correct safety zone to be established on either side of the pipeline. Permanent markers would have served the additional purpose of making commercial and recreational boaters aware of the presence and location of the pipeline, thus reducing the risk of damage to the pipeline caused by vessel anchoring or other activities in which communication with the pipeline operator would not be required or expected. The Safety Board notes that, after the accident, Tennessee Gas took steps to ensure that its pipelines crossing navigable waterways are clearly and permanently marked, but the Board is disappointed that these actions came only after an accident that, under only slightly different circumstances, could have resulted in multiple serious injuries or fatalities.

Over the years, many gas and hazardous liquid pipeline companies have voluntarily installed pipeline markers at navigable waterway pipeline crossings in order to reduce the possibility of pipeline damage from such activities as anchoring, dredging, pile driving, or spud mooring. In 1970, the U.S. Department of Transportation adopted 49 *Code of Federal Regulations* (CFR) 195.410, which required that hazardous liquid pipeline companies place and maintain line markers over each buried pipeline. The regulation specified the minimum information to be included on the marker and the size and presentation of the information. The regulation required that markers at navigable waterway crossings contain the additional wording “Do Not Anchor or Dredge.”

In 1975, provisions were added to 49 CFR 192.707 requiring the marking of gas pipelines (in addition to hazardous liquids pipelines) that cross navigable waterways. The regulation stated:

192.707(e) *Markers at navigable waterways.* Each line marker at a navigable waterway must have the following characteristics:

- (1) A sign, rectangular in shape, with a narrow strip along each edge colored international orange and the area between lettering on the sign and boundary strips colored white.
- (2) Written on the sign in block style, black letters—
 - (i) the word ‘Warning,’ ‘Caution,’ or ‘Danger,’ followed by the words ‘Do Not Anchor or Dredge’ and the words ‘Gas Pipeline Crossing’; and
 - (ii) The name of the operator and the telephone number (including the area code) where the operator can be reached at all times.
- (3) In overcast daylight, the sign is visible and the writing required by paragraph (e)(2)(1) of this section is legible from approaching or passing vessels that may damage or interfere with the pipeline.

In 1981, the Research and Special Programs Administration (RSPA) issued an advance notice of proposed rulemaking (ANPRM)¹¹ requesting comments on:

the problem of interference with underwater pipeline crossings of navigable waterways, the benefits of installing line markers at these crossings, and the size of markers at these crossings.

The preamble indicated that the rulemaking was part of a RSPA program, in accordance with Executive Order 12291, to review existing regulations and revoke or revise those that were not achieving their intended purpose. The preamble also noted two prob-

¹¹*Federal Register*, Vol. 46, No. 119, June 22, 1981, p. 32287.

lems with existing regulations. First, the term “navigable waterway” was not defined, leading to a concern that the Coast Guard’s interpretation of this term may be:

broader than reasonably necessary to assure safe pipeline crossings. As a result, the current rules may require markers where there is little or no susceptibility to damage from marine activities, for example, at minor stream crossings which have no vessel traffic and where dredging is unlikely to occur.

The second problem was that in order to be visible and legible from vessels passing through wide bodies of water, the signs marking a pipeline crossing must be “larger, until a point of impracticality or strong environmental objection is reached.”

In a response to the ANPRM, the Safety Board acknowledged some of the points made by RSPA but stated that:

as a minimum, the MTB^[12] should maintain a requirement for marking the location where pipelines enter or leave navigable waters and...such markers should be similar to those now required for marking the location where pipelines cross roads.

A July 9, 1981, letter from the Corps of Engineers South Atlantic Division in response to the ANPRM stated that division authorities believed that:

crossings [should] be marked on all waterways and streams which have (1) U.S. Coast Guard aids to navigation and (2) regularly scheduled commercial traffic or dredging operations.

The letter stated that some type of marker, as opposed to a legible sign, could be used, but that:

Assuming that dredgers, mariners, and other users of the waterway that have potential to damage the pipeline are forewarned by Corps of Engineers’ navigational charts and instructional letters to permittees of the presence of pipeline crossings, these same users will have a need to know the exact vicinity of the crossings.

In January 1983, RSPA issued a Notice of Proposed Rulemaking (NPRM)¹³ proposing the revocation of “the regulations that require pipeline operators to place and maintain line markers at locations where gas and hazardous liquids cross navigable

¹²The Materials Transportation Bureau was created in 1975 and subsumed into RSPA when that agency was established in 1977. The MTB was abolished in 1985, with RSPA retaining the MTB’s pipeline safety responsibilities.

¹³*Federal Register*, Vol. 48, No. 16, January 24, 1983, p. 2987.

waterways.” In the preamble to the notice, RSPA said that marine navigation charts show the locations of submarine cables and pipelines and that such charts are required to be kept on board all vessels “with sufficient capacity to damage pipelines.” The preamble further noted that the Corps of Engineers has the authority to regulate and grant permits for pipeline crossings of navigable waters and for dredging or other activities that might interfere with such crossings.

Thus, the Corps not only furnishes information about pipeline crossings that is used by mariners, but also conducts a case-by-case review of the safety of pipeline crossings of navigable waters, including the need for line markers.¹⁴ Furthermore, after a crossing is constructed, the Corps’ permitting program in regard to dredging and marine construction activities serves to protect the crossing against damage. It follows, therefore, that the present requirements...for marking navigable waterway crossings are to a large extent unnecessary in light of the Corps of Engineers’ practices.

RSPA also noted that Federal requirements were not needed because “most pipeline operators will voluntarily install and maintain line markers at crossings where they consider line markers to be helpful.”

The Coast Guard, in its response to the NPRM, stated:

The Coast Guard feels strongly that pipeline crossings under navigable waters should be marked in areas of regular commercial traffic, dredging and other waterside operations. Although charts are helpful for locating pipelines, signs at pipelines more effectively pinpoint the location of a crossing.... The Coast Guard recommends that the requirements for pipeline markings found in 49 CFR 192.707 and 195.410 not be changed.

The Safety Board also responded to the NPRM, stating that the lack of firm data on the effectiveness of markers in preventing damage to underwater pipelines “does not constitute a convincing case that the costs for signing underwater crossings outweigh the safety benefits.” The Safety Board stated that “there is substantial merit...in shoreside signing of underwater crossings which can be damaged by vessels anchoring or other causes.” In support of its position, the Safety Board referred to an accident in the Mississippi River delta in which four workers drowned attempting to escape a fire that resulted when a crane barge dropped a mooring spud into an unmarked high-pressure natural gas pipeline.¹⁵ The Safety Board response stated that “the premise that voluntary signing will take care of the most exposed pipelines is unrealistic” and cited the NPRM acknowledgement that a substantial portion of the pipeline industry would not object to a continuation of the Federal requirement if it were more “tempered.”

¹⁴In a written response to a Safety Board query, the Corps of Engineers stated that the agency does not require pipeline operators to install pipeline markers.

¹⁵For more information, see Marine Accident Report--*Crane Barge C.L. Dill 10 Fire, Garden Island Bay, Mississippi River Delta, June 5, 1979* (NTSB/MAR-80/9).

In 1983, despite arguments presented by the Safety Board, the Coast Guard, and the Corps of Engineers, RSPA revoked the marking requirements as unnecessary in light of the permit requirements of the Corps of Engineers and the voluntary practices of the pipeline industry.

As shown by other fatal accidents investigated by the Safety Board that involved damage to pipelines traversing navigable waterways,¹⁶ underwater pipelines represent a risk for both recreational and commercial vessels. In light of this accident, RSPA's 1983 revocation of Federal requirements for marking pipeline crossings of navigable waterways appears to have been ill advised. Even though Tennessee Gas clearly recognized the need for marking the company's underwater pipelines, it had not marked the Tiger Pass crossing, notwithstanding the fact that the company's own procedures required it to do so. While Tennessee Gas probably would have eventually marked the crossing in any case, the pipeline would likely have already been marked if Federal requirements for markings had not been eliminated by RSPA in 1983. The Safety Board therefore concludes that, had RSPA not revoked Federal requirements for installing and maintaining markings of pipeline crossings of navigable waterways, the pipeline involved in this accident may have been accurately marked, and this accident may not have occurred. The Safety Board therefore believes that RSPA should require pipeline system operators to precisely locate and place permanent markers at those sites where their gas and hazardous liquid pipelines cross navigable waterways.

In the meantime, the Safety Board believes that the Interstate Natural Gas Association of America and the American Petroleum Institute should inform their members of the circumstances of this accident and urge them to take the actions necessary to ensure that all their pipelines that cross navigable waterways are accurately located and marked.

Emergency Evacuation of Bean Company Vessels

The Safety Board is concerned that the emergency procedures for Bean's dredging vessels, because they do not require that an accurate and up-to-date count be maintained of all personnel aboard vessels, are inadequate to ensure the safety of the company's crews and other personnel during an emergency. Without a system to accurately account for all personnel—including crewmembers, contractor personnel, vendors, and visitors—aboard the dredging vessels, the risk is substantial that, in the event of a serious emergency, some individuals may be left behind, perhaps with life-threatening injuries, without anyone knowing of their plight until it is too late.

¹⁶In addition to the accident report mentioned above involving the *C.L. Dill 10*, see Pipeline Accident Report—*Fire on Board the F/V Northumberland and Rupture of a Natural Gas Pipeline in the Gulf of Mexico Near Sabine Pass, Texas, October 3, 1989* (NTSB/PAR-90/02).

The Safety Board has investigated several passenger and fishing vessel accidents in which accountability for the passengers and crew was an issue.¹⁷ The lack of an accurate personnel list or count has been identified in dredge accidents as well.¹⁸

In this accident, the speed and extent of the gas release and fire placed all crewmembers aboard the dredging vessels in grave danger. Fortunately, despite the early hour, most crewmembers were awake, alert, and able to respond quickly to the emergency. Given the rapid ignition of the natural gas and the extent of the damage to the vessels, had this accident occurred while most of the crew was sleeping, numerous serious injuries or fatalities may have occurred. The Safety Board concludes that in even a slightly more serious accident, Bean's emergency procedures, because they did not require that a precise count be kept of the number of personnel on board the company's vessels at all times, would have been inadequate to account for and facilitate the rescue of missing crewmembers, increasing their risk of serious injury or death.

The Safety Board therefore believes that Bean's emergency response procedures should be amended to require that an accurate count of all people aboard company vessels be maintained at all times by someone in authority on the vessel. An accurate personnel count should also be accessible to the vessel operating department on shore so that the number is readily available to emergency responders to ensure that all personnel are accounted for after an emergency.

Because the Safety Board's concern about emergency procedures for dredging vessels is not limited to this one operator, the Safety Board believes that the Western Dredging Association should inform its members of the circumstances of this accident and urge them to amend their emergency response procedures as necessary to require that an accurate count of all people aboard their vessels be available at all times. This count should be maintained by someone in authority on the vessel and be accessible to the vessel operating department on shore so that the number is readily available to emergency responders in the event of an on-board emergency.

¹⁷For more detailed information, read Marine Accident Reports--*Capsizing of the Charter Passenger Vessel San Mateo in Morro Bay, California, on February 16, 1983* (NTSB/MAR-83/09); *Sinking of the Charter Fishing Boat Joan La Rie III off Manasquan Inlet, New Jersey, on October 24, 1982* (NTSB/MAR-84/02); *Collision of the U.S. Passenger Vessel Yankee and the Liberian Freighter M/V Harbelle Tapper in Rhode Island Sound on July 2, 1983* (NTSB/MAR-84/05); *Sinking of the U.S. Fishing Vessel Amazing Grace 80 Nautical Miles East of Cape Henlopen, Delaware, on November 14, 1984* (NTSB/MAR-85/07); *Collision between the U.S. Passenger Vessel Mississippi Queen and the U.S. Towboat Crimson Glory in the Mississippi River, Near Donaldsonville, Louisiana, on December 12, 1985* (NTSB/MAR-86/09); *Near Capsizing of the Charter Passenger Vessel Merry Jane Near Bodega, California, on February 8, 1986* (NTSB/MAR-86/11); *Capsizing of the Charter Fishing Vessel Fish-N-Fool in the Pacific Ocean Near Roca Ben, Baja California Norte, Mexico, on February 5, 1987* (NTSB/MAR-87/11); and *Safety Study--Passenger Vessels Operating from U.S. Ports, 1989* (NTSB/SS-89/01).

¹⁸The following accidents, although not investigated by the Safety Board, highlight the confusion that can occur when rescue authorities cannot document the number of people on board a vessel: the United Kingdom Marine Accident Investigation Branch's June 5, 1990, report of the collision between the passenger launch *Marchioness* and the MV *Bowbelle*, with loss of life, on the Thames River on August 20, 1989; and the Hong Kong Marine Department's report of inquiry into the circumstances surrounding the capsizing of the Hong Kong registered training suction hopper dredger *Maas* in the approaches to Nan-sha Wan off the island of Dongao Dao on August 1993.

Delay in Responding to the Rupture

The Safety Board notes that about 30 minutes elapsed between the time of the rupture and the time Tennessee Gas became aware that one of its pipelines may have ruptured and that more than an hour passed before the pipeline was shut down. A check valve downstream of the rupture closed automatically after the break to limit the backflow of product to the rupture, but the SCADA system used by Tennessee Gas did not report the check valve's closing to pipeline controllers. Had it done so or had the company's SCADA system been equipped with an alarm that responded to a change in pressure over a period of time, the pipeline controllers may have been alerted to an anomaly within a certain segment of the pipeline, and the flow of gas feeding the fire in Tiger Pass may have been terminated more quickly than it was.

Insufficient evidence was available to indicate what effect, if any, the earlier shutoff of the gas flow would have had on this accident. Clearly, however, one of the first priorities in any accident involving the release of natural gas should be to curtail the escape of the product. The Safety Board concludes that the delay in recognition by Tennessee Gas that it had experienced a pipeline rupture at Tiger Pass was due to the piping system's dynamics during the rupture and to the design of the company's SCADA system. The Safety Board believes that Tennessee Gas should review its SCADA system and make any modifications necessary to increase the likelihood that any critical event involving the company's pipelines is quickly and accurately reported to pipeline controllers, allowing them to take timely action to correct or limit the effects of any failure in the pipeline system.

Conclusions

Findings

1. Tennessee Gas Pipeline Company took inadequate steps to precisely identify and mark the location of its pipeline through Tiger Pass before dredging operations were undertaken in the pipeline area.
2. Had the Research and Special Programs Administration not revoked Federal requirements for installing and maintaining markings of pipeline crossings of navigable waterways, the pipeline involved in this accident may have been accurately marked, and this accident may not have occurred.
3. The delay in recognition by Tennessee Gas that it had experienced a pipeline rupture at Tiger Pass was due to the piping system's dynamics during the rupture and to the design of the company's supervisory control and data acquisition system.
4. In even a slightly more serious accident, Bean Horizon Corporation's emergency procedures, because they did not require that a precise count be kept of the number of personnel on board the company's vessels at all times, would have been inadequate to account for and facilitate the rescue of missing crewmembers, increasing their risk of serious injury or death.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the failure of Tennessee Gas Pipeline Company to accurately locate the company's pipeline across Tiger Pass before that location was dredged. Contributing to the accident was the revocation by the Research and Special Programs Administration of Federal requirements for all pipeline operators to install and maintain markers to identify the locations at which their pipelines cross navigable waterways.

Recommendations

As a result of this accident, the National Transportation Safety Board makes the following safety recommendations:

to the Research and Special Programs Administration:

Require pipeline system operators to precisely locate and place permanent markers at sites where their gas and hazardous liquid pipelines cross navigable waterways. (P-98-25)

to Tennessee Gas Pipeline Company:

Develop formal, written company procedures for identifying the precise locations of your pipelines that traverse navigable waterways before dredging or similar activities are commenced in the pipeline area. (P-98-26)

Review your supervisory control and data acquisition system and make the modifications necessary to increase the likelihood that any critical event involving the company's pipelines is quickly and accurately reported to pipeline controllers, allowing them to take timely action to correct or limit the effects of any failure in the pipeline system. (P-98-27)

to Bean Horizon Corporation:

Amend your emergency response procedures to require that an accurate count of all people aboard your vessels be maintained at all times by someone in authority on the vessel and be accessible to the vessel operating department on shore so that the number is readily available to emergency responders in the event of an on-board emergency. (M-98-123)

to the Western Dredging Association:

Inform your members of the circumstances of the pipeline rupture and fire in Tiger Pass, Louisiana, and urge them to amend their emergency response procedures as necessary to require that an accurate count of all people aboard their vessels be available at all times. This count should be maintained by someone in authority on the vessel and be accessible to the vessel operating department on shore so that the number is readily available to emergency responders in the event of an on-board emergency. (M-98-124)

to the Interstate Natural Gas Association of America:

Inform your members of the circumstances of the pipeline rupture and fire in Tiger Pass, Louisiana, and urge them to take the actions necessary to ensure that all their pipelines that cross navigable waterways are accurately located and marked. (P-98-28)

to the American Petroleum Institute:

Inform your members of the circumstances of the pipeline rupture and fire in Tiger Pass, Louisiana, and urge them to take the actions necessary to ensure that all their pipelines that cross navigable waterways are accurately located and marked. (P-98-29)

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September 28, 1998