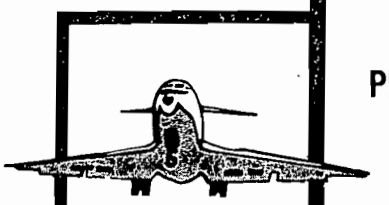

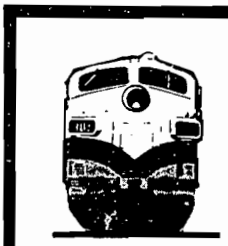

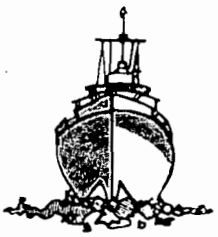

PB83-916503

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

PIPELINE ACCIDENT REPORT

MISSISSIPPI RIVER TRANSMISSION CORPORATION
NATURAL GAS FLASH FIRE
PINE BLUFF, ARKANSAS
OCTOBER 1, 1982

NTSB/PAR-83/03

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

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15. Supplementary Notes

16. Abstract At 12:15 p.m., c.d.t., on October 1, 1982, a 1/4-inch-thick steel plate, which had been welded by a work crew to cap temporarily the open end of a section of a 22-inch-diameter gas transmission pipeline which had been isolated by closing a gate valve and then gas freed, blew off under an initial pressure of possibly 260 psig. Rapidly escaping natural gas from the pipeline which had accumulated due to a leak in the gate valve, ignited almost immediately and the entire work area and a portion of U.S. Route 65 were momentarily engulfed in flames. Seven persons who were working to replace a section of the pipeline under the road about 2 miles south of Pine Bluff, Arkansas, were burned and hospitalized. Resultant property damage was minimal.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the gas company superintendent to monitor an isolated section of 22-inch-diameter pipeline, which allowed an internal pressure rise to occur without being detected, resulting in the failure of a welded temporary end cap and the release and ignition of natural gas. Contributing to the accident were the Mississippi River Transmission Corporation procedures which did not require specifically that pipelines isolated from gas under pressure solely by a closed valve be monitored continuously for the presence of natural gas.

17. Key Words	18. Distribution Statement		
Work area safety check; monitoring work area; checklist; overpressure; blowdown valve; air mover; air mover valve; gate valve leakage; escape ramp; supervisory presence; road crossing replacement; slick bore; hot cutting; cold cutting; hot welding; temporary end cap; isolated pipeline section; company procedures	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161		
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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

PIPELINE ACCIDENT REPORT

Adopted: July 26, 1983

MISSISSIPPI RIVER TRANSMISSION CORPORATION
NATURAL GAS FLASH FIRE
PINE BLUFF, ARKANSAS
OCTOBER 1, 1982

SYNOPSIS

At 12:15 p.m., c.d.t., on October 1, 1982, a 1/4-inch-thick steel plate, which had been welded by a work crew to cap temporarily the open end of a section of a 22-inch-diameter gas transmission pipeline which had been isolated by closing a gate valve and then gas freed, blew off under an initial pressure of possibly 260 psig. Rapidly escaping natural gas from the pipeline which had accumulated due to a leak in the gate valve, ignited almost immediately and the entire work area and a portion of U.S. Route 65 were momentarily engulfed in flames. Seven persons who were working to replace a section of the pipeline under the road about 2 miles south of Pine Bluff, Arkansas, were burned and hospitalized. Resultant property damage was minimal.

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INVESTIGATION

Events Preceding the Accident

The Mississippi River Transmission Corporation (gas company) owns and operates a 22-inch-diameter gas transmission pipeline constructed in 1929, one of its three parallel pipelines extending from Louisiana to Illinois. The pipeline had been cased 1/ in a pipe in many locations where it crossed under roads and railroads. Over the years, the casing pipe was found to be touching the pipeline at some crossings, resulting in possible corrosion. The gas company had begun a program to replace sections of the pipeline under

1/ Casing: a piece of pipe usually two sizes larger than the carrier pipe installed by boring, tunneling, or cutting through a road. After the casing has been put in position, the carrier pipe is pulled through the casing and centered within the casing with insulators designed to keep the carrier pipe from touching the casing. The ends of the casing are then sealed to keep dirt and water out, and vents are installed at each end of the casing to ventilate the annulus between carrier pipe and casing, and to mark the crossing site.

road crossings on a selected basis to correct these conditions. At U.S. Highway Route 65 about 2 miles south of Pine Bluff, Arkansas, the replacement program involved the installation of a new section of uncased, coated and wrapped, heavy wall pipe in a new passage bored under the road. The old, cased pipe at the road crossing was to be cut away, purged with an inert material, sealed at the ends, and abandoned in place. The newly installed pipe then was to be connected to the main pipeline by welding. The gas company previously had replaced the pipeline under several other road crossings in a similar manner without incident.

On September 13, 1982, materials and equipment were moved to the job site and new 22-inch-diameter, heavy wall pipe lengths were welded together for installation under the crossing. The Division Superintendent, four other gas company personnel, and four persons from an independent pipeline contractor with whom the gas company had contracted were assigned to the project. During the next several days the original pipeline was excavated and totally exposed for a distance on each side of the road. The excavated ditch on the north side of the road (the accident site) was approximately 8 feet deep, 10 feet wide at the bottom, 13 feet wide at the top, and 93 feet long (see figure 1), but it was dug shallower as the distance from the road increased. The north side of the ditch, where the newly installed alignment pipe section was to be welded to the pipeline, was approximately 4 feet deep; the south, east, and west sides of the ditch were almost vertical. One escape route, a sloping ramp out of the ditch, had been provided approximately halfway along the east side of the ditch; no ladders or other means of rapid escape were available. A similar excavation had been dug on the south side of the road. After the excavations were made, road boring equipment was set up, the passage under the road was "slick bored," 2/ and the new pipe was installed.

On September 28, 1982, a 10-mile section of the pipeline which included the section being replaced, was taken out of service by closing a 22-inch-diameter gate valve at milepost 94 (9.8 miles south of the road) and another 22-inch gate valve at milepost 104 (approximately 600 feet north of the road). Gas was transferred from the isolated section to adjacent looped lines 3/ using a portable compressor which reduced the pressure from 260 psig to 14 psig. The remaining 14 psig was vented to the atmosphere, leaving the isolated section of pipeline still full of gas at atmospheric pressure.

On September 30, 1982, air movers were installed on the 6-inch-diameter blowdown valves located on the bypass lines around the gate valves at mileposts 94 and 104 (see figures 1 and 2), and gas under 260-psig pressure from the high-pressure sides of the gate valves was directed through high-pressure hoses into the bottoms of the air movers and out through their open tops. This gas flow created a vacuum at the base of the air movers that educted and evacuated the gas remaining in the isolated pipeline section (see figures 3 and 4). An opening about the size and shape of a football then was cut in the top of the isolated pipe section on the south side of the road using an oxyacetylene torch. Similar "hot cuts" 4/ had been performed many times before by this crew. Air was forced into the pipeline through this opening by the operation of the air movers. The pipe was cut circumferentially near the opening and a second cut was made 20 feet to the north; thereafter the 20-foot section of pipe was removed.

2/ Slick bore is a means of installing pipe under roads and railroads without the use of casing pipe.

3/ Looped line is an industry term describing the construction of an additional line or lines generally parallel and close to the original lines to provide an increase in system capacity.

4/ A "hot cut" refers to the use of an oxyacetylene torch to cut a pipe that has gas inside.

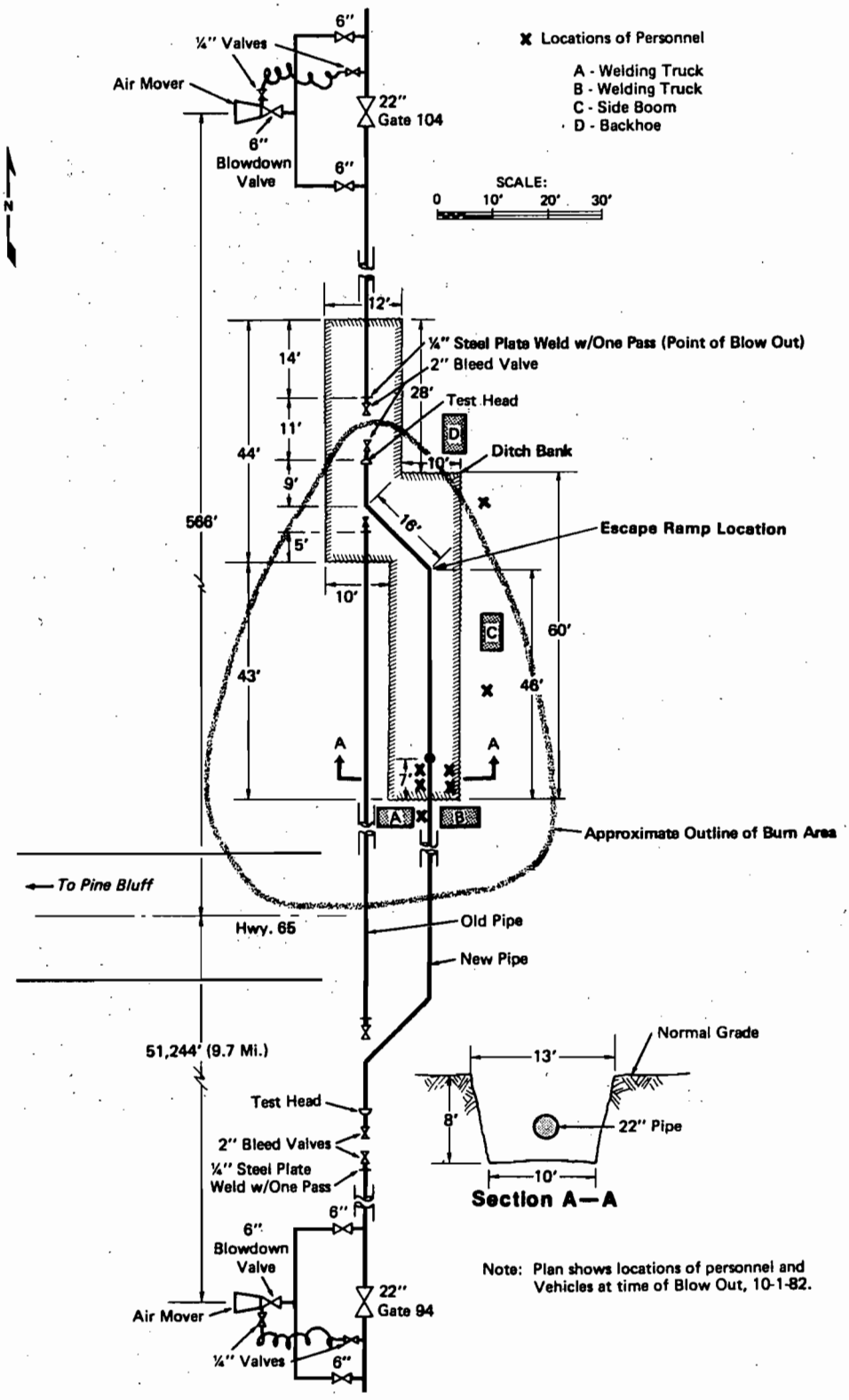

Figure 1.--Plan of the accident site.

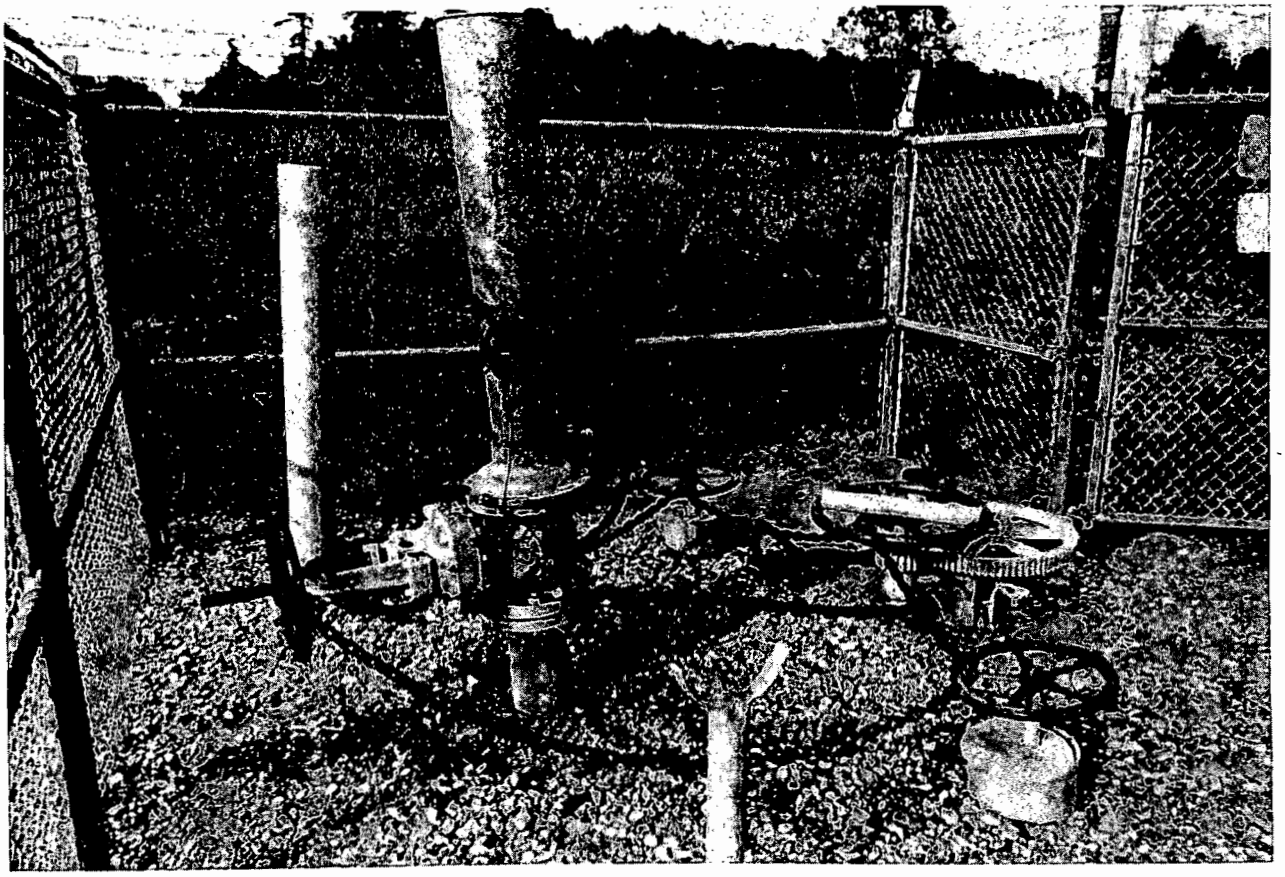

Figure 2.--Air mover and 22-inch-diameter gate valve at fenced valve site.

The workers installed a temporary cap on the open end of the remaining pipeline using a round, 1/4-inch-thick steel plate welded with one pass because the cap was intended only to keep water and debris out of the pipeline; it was not intended to hold pressure. The blowdown valve at milepost 94 was left open to prevent pressure from building in the section of the pipeline that was then isolated between the gate valve and the end cap at the excavation site. All valves within the valve site were chained and locked (see figure 2). Nevertheless, pressure would build up in the isolated section if gas leaked through the closed gate valve.

The work crew then moved to the north side of the road where it cut out and removed another 20-foot section from the pipeline; this was not a "hot cut" since the gas had been evacuated when the first 20-foot section had been removed from the pipeline on the south side of the road. The remaining pipeline and the stub abandoned under the road were capped with a round, 1/4-inch-thick steel plate and welded in the same manner as the cap on the south side. A hole was cut in the center of the two end plates on the

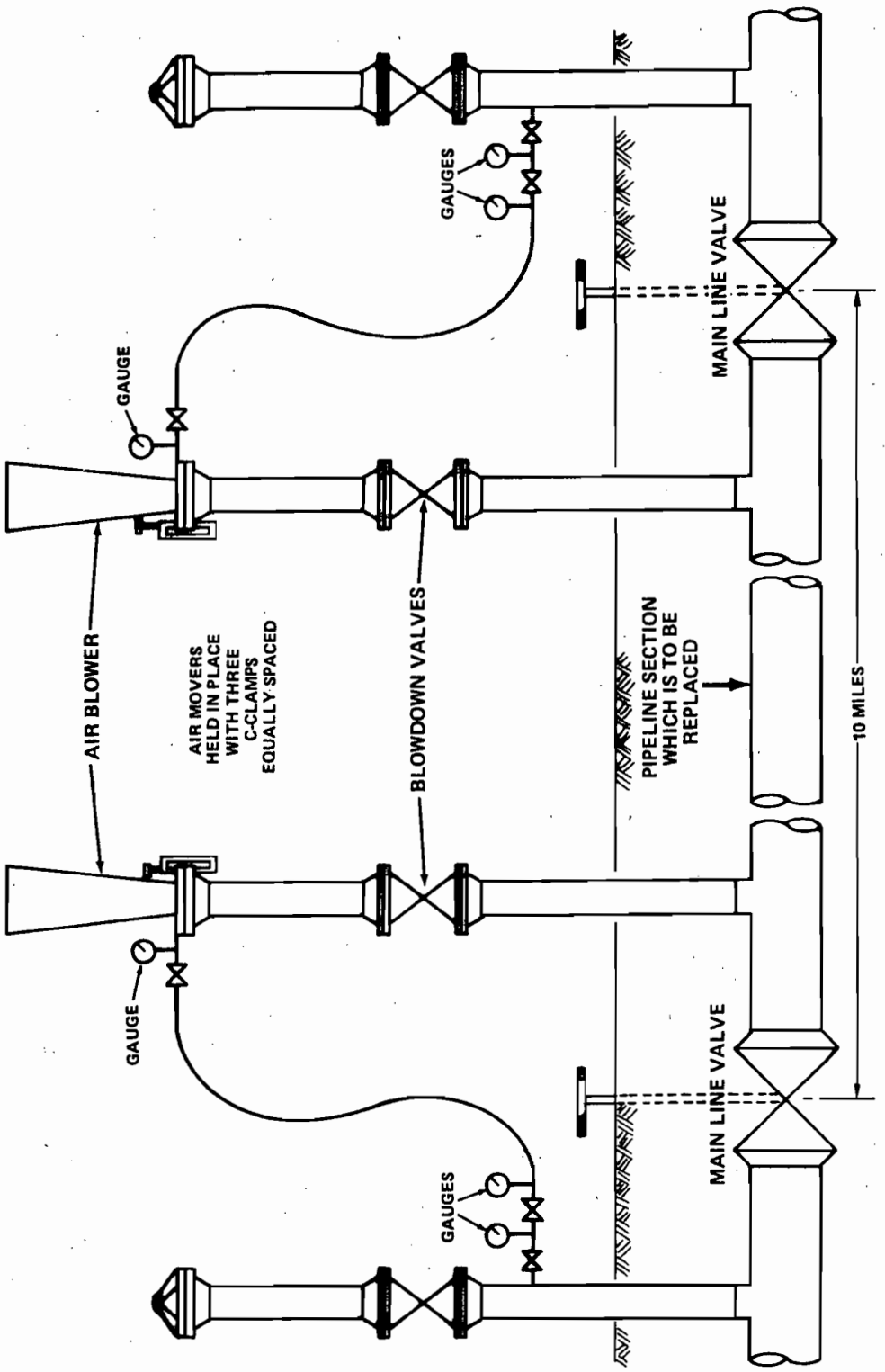

Figure 3.--Typical air mover installation.

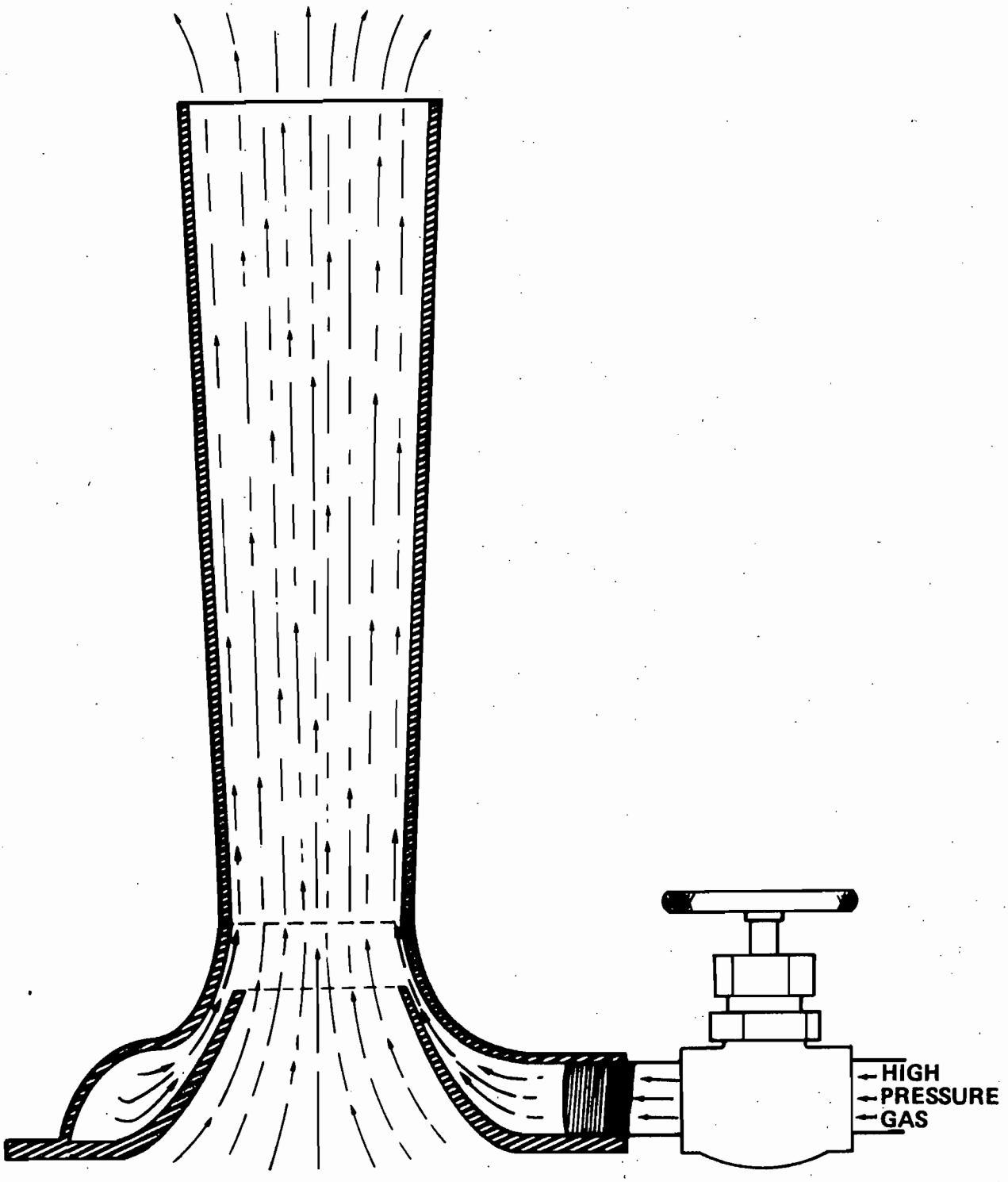

Figure 4.--Operation of an air mover.

remaining pipelines, and 2-inch valves were installed (see figure 5); the valves were intended to be used to check for pressure and to relieve pressure if necessary and to gas free the line when it was to be connected; however, no pressure gauge or other means to monitor pressure was installed. The blowdown valve at milepost 104 was left open to prevent pressure from building up in the approximately 500-foot section of the pipeline that was then isolated between the gate valve and the end cap at the excavation site north of the road.

By that afternoon, the new pipe had been installed under the road crossing, and a pipeline alignment section composed of two 45-degree bends for connecting the new pipe under the road crossing with the existing pipeline north of the road was being welded together (see figure 6). At the end of the workday (approximately 5 p.m.), the gas company division superintendent sent a gas company maintenance man to the gate valve site at milepost 104. The superintendent said he told the maintenance man "to close his air mover down" and "to leave the gas venting out of the 6-inch blowdown." The maintenance man walked to the gate valve site and closed the air mover valve; he also closed the blowdown valve. The maintenance man said that he closed the blowdown valve, even though he had been instructed not to do so, because he did not want rainwater to get into the pipeline. He further stated that he informed the superintendent later that evening that he had closed both the air mover valve and the blowdown valve.

The Accident

On the morning of October 1, 1982, when the crew resumed work, the air mover valve and the blowdown valve at milepost 104 were still closed. The end plate valve was also closed, and no pressure gauge had been connected to it. This shut-in condition had been in effect since about 5 p.m. the evening before. The valves were not checked for their correct open or closed positions, nor was the capped, isolated section of pipeline between the gate valve at milepost 104 and the excavation site checked for pressure buildup. The crew resumed welding on the new alignment section of pipe at the north side of the road.

Shortly before noon, the final weld was being made on the alignment section; two welders and two welder helpers were making the weld within the ditch and were about 70 feet from the capped end of the isolated section of pipeline leading from the gate valve at milepost 104. Two persons were standing at ground level at the east edge of the ditch, and one person was standing at ground level at the south edge of the ditch (see figure 1). The welders, who had almost completed the weld, decided to continue welding through the lunch hour; the gas company superintendent and a maintenance man left the area to eat lunch.

About 12:15 p.m., the end plate was blown off the end of the isolated section of the pipeline by gas under pressure that had leaked into the isolated section. (The exact pressure of the gas could not be determined, but the mainline pressure at the gate valve was 260 psig as indicated by a pressure gauge at the compressor station.) Rocks, dirt, and debris blown by the escaping gas pelted the welders in the ditch, and the escaping gas ignited almost immediately. Fire briefly filled the ditch and flashed across the road. The two welders and the two welder helpers in the ditch and the three workmen at the sides of the ditch were engulfed in the flames, and grass fires were started in the immediate area (see figure 7).

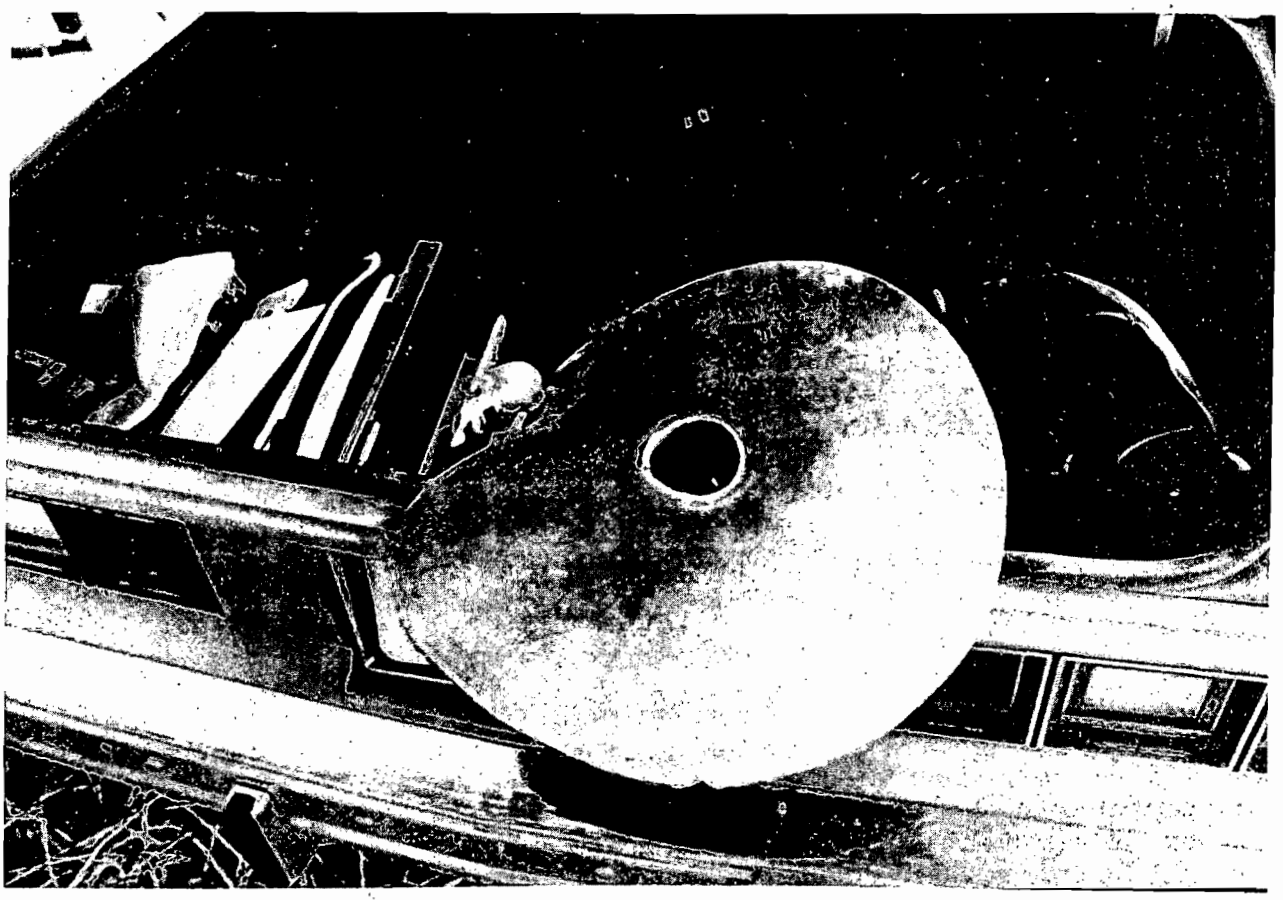

Figure 5.--Bent 1/4-inch-thick steel end plate showing 2-inch-diameter hole in center where 2-inch-diameter valve had been.

Injuries to Persons

Injuries	Company Personnel	Contractor Personnel	Others	Total
Fatal	0	0	0	0
Nonfatal	3	4	0	7
Total	3	4	0	7

Damage

There was only minor damage to the pipeline and equipment at the accident site.

Personnel Information

The division superintendent had been employed by the gas company for 28 years. He had attended the following training courses:

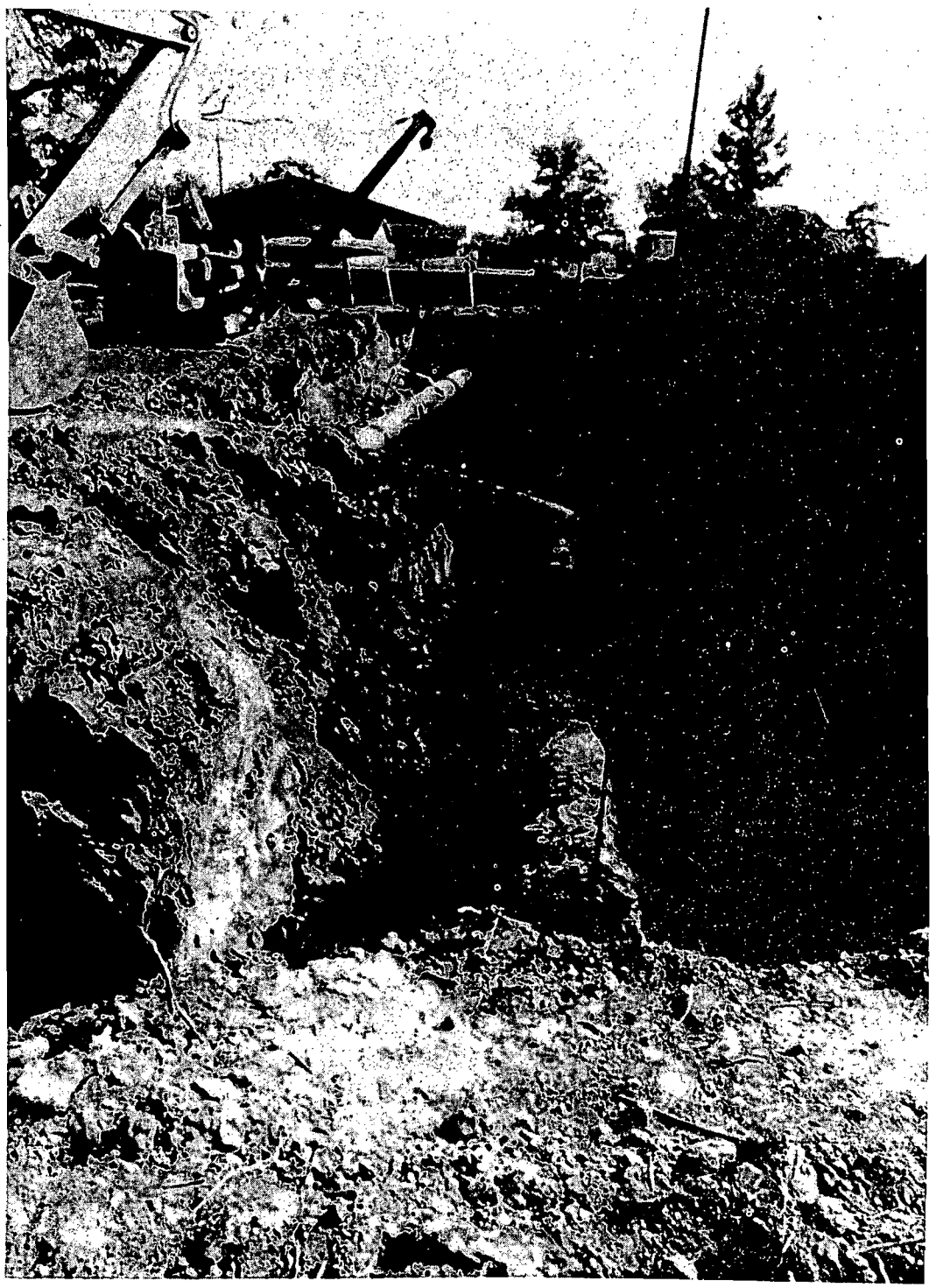

Figure 6.--Alignment section of 22-inch-diameter pipeline.

Figure 7.--Burned area on the north side of
U.S. Highway Route 65.

1962 - Rankin School of Mechanical Trades, St. Louis, Missouri
1971 - Fundamentals of Supervision, Norman, Oklahoma
1976 - Fisher Gas Control Conference
1977 - Associated Industries of Arkansas, Inc.
1979 - Motivation and Discipline
1980 - Southern Gas Association Inspection Training School

The last two courses covered, among other items, job discipline and performance, inspection responsibility, on-the-job safety, pipeline installation, and pipeline replacement with emphasis on safety (work area protection) purging and tie-ins.

Pipeline System

The Mississippi River Transmission Corporation owns and operates 1,969 miles of gas transmission pipelines varying in diameter from 2 to 30 inches. In addition, the gas company owns 244 miles of gathering and branch lines varying in diameter from 2 to 14 inches. The primary system consists of three parallel pipelines (22, 24, and 26 inches in diameter, respectively) extending northward from Perryville, Louisiana, a gas gathering

area, through the States of Arkansas, Missouri, and Illinois, to the St. Louis area. Three gas storage fields, one in Illinois and two in northern Louisiana, have a total storage capacity of 86 billion cubic feet of gas. The total pipeline system capacity is 950 million cubic feet per day.

Installation and Repair Procedures

The "hot cut" procedure was specifically described in the gas company's approved procedures 5/ (see appendix B) and required the following actions:

SAFETY PRECAUTIONS

The work shall be thoroughly planned and each operation scheduled by the Superintendents and Welders involved. All reasonable and necessary safety precautions shall be observed, including the following:

* * * * *

3. Pre-Job Briefing

No work shall be actually started until the Foreman in charge, the Welder or Welding Foreman and the Superintendent have studied the work to be performed in detail through a piping layout, diagram or drawing, if required by the complexity of the system to be worked on, and have learned without doubt the location of all control valves, points of inter-connection and the effect when a line or lines are cut or joined, valves removed or inserted, closed or opened, locked, tagged, etc.

* * * * *

5. Bell-Holes and Other Excavations

All bell-holes and excavations for leak repairs, pipe or fitting replacement and other work hereunder, shall be of sufficient size for that purpose. If they are of such depth and/or the soil is of such type as to require cribbing, shoring, bracing or reinforcement in any manner, this shall be done as necessary for safety as the excavation work proceeds. All holes shall be of such size and configuration as to afford maximum protection from flash burn and allow ready egress therefrom when necessary.

* * * * *

5/ "Approved Procedures for Welding - General Hot Cutting, Hot Welding, Welding on Loaded Lines, and Similar or Related Work," Mississippi River Transmission Corporation.

7. Testing for Gas

Prior to any cutting, welding or striking of arcs or sparks, all bell-holes, excavations and piping in confined areas where the facilities contain or have contained flammable gas or liquids, the area shall be tested with a company approved calibrated instrument to determine the concentration of flammable gas or liquid present. The test is to be conducted by experienced personnel familiar with the test instrument. If the instrument indicates no concentration of flammable gas or liquids, then all personnel shall be removed to a safe distance from the tested area and the Superintendent in charge shall designate one person to drop a lighted torch, rag, paper, etc. as may be appropriate, into the hole or area in such a manner that doubt is removed as to the absence of gas or liquid in flammable quantities within the work area. Both of the above tests shall be conducted in sequence as listed.

8. Venting and Purging for Hot Cutting and Hot Welding

[This section includes specific detailed instructions for "blowing down," "hot cutting," "hot welding," "air purging," and "gas filling" of pipelines.]

The gas company superintendent at the job site had a procedures manual. However, he did not refer to it daily. The manual did not contain a checklist that could be used by the superintendent to insure safe work conditions.

Operating and Maintenance Procedures

The gas company's Safe Operating and Maintenance Manual states:

Section 121.11

All bell holes shall be of adequate size to assure freedom of movement of men and materials and have ready exits on each side, exits being steps, a gentle slope or a ladder. All bell holes that are of appreciable length and may be defined as an excavation, such as uncovering several hundred feet of line to provide slack on a tie-in-job, additional exits other than the ones at each end shall be provided. [sic] On work of this type ready exits are to be provided on each side of the line adjacent to the work area in addition to the ones at each end.

* * * * *

Section 121.15

An adequate means of exit such as a ladder, steps or slope shall be provided and located so as to require no more than 25 feet of lateral travel.

The Gas Engineers Handbook states:

[Gate valves] . . . are suitable for the majority of applications that require full open or closed positioning - with infrequent operation. 'Bubbletight' service, however, cannot be achieved, since sealing depends

upon deformation of mating surfaces. Temperature changes and external pipe stresses interfere with such sealing. [Further, since pipeline gate valves are almost always in the open position, dirt and debris tend to settle in the valve seal recesses over the years further preventing a "bubbletight" seal.]

The gas company was aware of the fact, and the superintendent with 28 years pipeline experience should have been aware of this fact.

Meteorological Information

The weather in Pine Bluff had been hot and dry during September. The average daily high temperature was 84.6° F, while the average nightly low temperature was 59.4° F. Two inches of rain had fallen in Pine Bluff during the first 13 days of September; no rain had fallen for 17 days before the accident.

Fire

The Pine Bluff Fire Department and the Southeast Volunteer Fire Department responded to the emergency after being notified by the Sheriff's Department. A small fire fed by some residual gas at the open end of the pipeline was allowed to burn out. Firefighters concentrated their efforts on the grass fires around the excavation and on minor fires in the excavation; the major gas-fed fire that had engulfed the job site and flashed south across the road burned out within seconds after the end plate blowout. Neither the firefighters nor the police sustained injuries.

Medical and Pathological Information

All seven persons at the accident site were engulfed in the flash fire. The two welder helpers, who were wearing goggles but not welding helmets, and the two company employees standing atop the ditch at the east and south end were placed in intensive care at a local hospital. Another worker atop the ditch was admitted to the hospital in serious but stable condition. The two welders, who were under the pipe when the fire erupted and were more sheltered from the fire, were treated and released from the hospital. All of the injured persons are recovering.

Survival Aspects

The blowout of the end cap and the release and ignition of gas occurred so suddenly and violently that the workers received no warning. Assisting each other, the welders and their helpers ran north within the ditch toward the sloped escape ramp, the only rapid escape route. By the time they reached the ramp which was almost in line with the then open-ended pipeline, most of of the gas had burned. One of the injured used a nearby company truck radio to inform the superintendent about the accident and to request help. The seven injured workers then waited a few hundred feet east of the site until the ambulances arrived. All were taken to the Jefferson Regional Medical Center.

Other Information

The Code of Federal Regulations (49 CFR 192.751, Prevention of accidental ignition) states:

Each operator shall take steps to minimize the danger of accidental ignition of gas in any structure or area where the presence of gas constitutes a hazard of fire or explosion, including the following:

* * * * *

(a) When a hazardous amount of gas is being vented into open air, each potential source of ignition must be removed from the area and a fire extinguisher must be provided.

(b) Gas or electric welding or cutting may not be performed on pipe or on pipe components that contain a combustible mixture of gas and air in the area of work.

(c) Post warning signs, where appropriate.

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor investigated this accident and cited the gas company under 29 CFR 1926.652, Specific trenching requirements which states:

(h) When employees are required to be in trenches 4 feet deep or more, an adequate means of exit, such as a ladder or steps, shall be provided and located so as to require no more than 25 feet of lateral travel.

The OSHA citation read:

Employee(s) were required to be in the trench(es) which were more than 4 feet deep, and an adequate means of exit, such as a ladder or steps, was not provided, or located so as to require no more than 25 feet of lateral travel in the excavation, on the north sides of U.S. Highway 65. This violation occurred on or about 10/1/82.

No monetary penalty was invoked; the condition was corrected.

ANALYSIS

The Accident

Even though the gate valve at milepost 104 had been closed about 2 days before the accident and the isolated 500-foot section of pipe was made gas free at that time, gas must have been leaking through the valve continuously, but it would not have begun to accumulate in the isolated section until sometime after the pipe was capped. Even then, any gas leaking through the valve would have vented safely through the open blowdown valve until the blowdown valve was closed at 5 p.m. on September 30, 1982. Beginning at that time, the gas leaking through the valve and entering the isolated section of pipeline would have begun to build up pressure. The leakage of gas through the valve continued unnoticed because no means for monitoring the internal atmosphere of the isolated section had been provided and because no inspections or periodic checks were made to ensure that the isolated section remained gas free. As gas continued to leak through the valve, pressure within the 500-foot section increased for 19 hours until the single-weld bead on the end cap was abruptly ruptured, the end cap blew into the excavated work area, and the accumulated gas was rapidly released.

The amount of gas under pressure which accumulated in the 500-foot isolated section before the accident is not known. However, had the pressure in the isolated section been equal to the 260-psig pressure within the 22-inch pipeline, the section would have contained approximately 23,300 cubic feet of a gas-air mixture (1,250 cubic feet of air and 22,050 cubic feet of gas) and would have imposed a force of approximately 93,600 pounds upon the end cap.

The rapidly released gas was ignited almost immediately, possibly by a spark created when the end cap struck the alignment pipe which was directly in line with the original pipe, and the extremely hot, but short-lived, flash fire momentarily engulfed the work area and the road.

Monitoring of Isolated Pipeline Segments

The superintendent recognized the potential for gas leakage through the closed valves, but he neither installed pressure gauges for monitoring the pressure within the isolated sections nor checked to ensure that any gas leaking through the gate valve was being vented safely. The 2-inch valves installed on each end cap had been closed to prevent any water that might accumulate in the excavation from entering the pipe. If a pressure gauge had been installed on the valves in the end caps, pressure buildup could have been detected visually by anyone in the work area. Even if pressure gauges had not been installed, the 2-inch valves could have been opened periodically throughout the day, and any gas under pressure would have been released making an audible sound; such a gas release would have initiated a search for the leak source, would have revealed the closed blowdown valve, and would have prompted its opening.

The superintendent with 28 years of pipeline experience apparently was aware of the possibility of gate valve leakage, since he said he told the maintenance man to leave the blowdown valve open. He also had the valves chained and locked so that the valve position could not be changed inadvertently or be operated by vandals. However, valve sites can be entered easily, chains can be cut, and the position (open or closed) of the valves can be changed readily; it is not enough to assume that valves that are in their proper position at the end of one workday will still be in the correct position at the start of another workday. The valves and the pressure in this isolated section should have been checked before work began on the day of the accident.

The need for monitoring pipeline sections that have been isolated from gas under pressure solely by closed valves was discussed extensively in the Safety Board's investigation of an accident on November 30, 1981, in Flatwoods, West Virginia. 6/ In that accident, a section of gas transmission pipeline owned by the Columbia Gas Transmission Corporation (Columbia) was to be tested hydrostatically. The section of pipeline to be tested had been physically separated from the gas under pressure except at the point where it was interconnected to another parallel pipeline, and at this location it was isolated only by two closed valves. A contractor employed by Columbia began welding end caps on the open ends of the isolated pipeline segment to be tested. As the welding was begun, an explosion occurred within the pipe and the end cap blew off and killed a welder's helper. Natural gas had leaked through both closed valves and into the segment of pipe that was to be tested. Neither a means for monitoring nor a means for alerting workmen about the presence of gas within the isolated section of pipeline had been provided.

6/ Safety Recommendations P-82-12 through -16 issued May 13, 1982.

Company Procedures and Federal Regulations

The gas company procedures were specific about what to do when cutting and welding on gas-filled pipelines. However, the work crew was not welding on a gas-filled or a gas-freed pipeline at the time of the accident; it was welding a new section of pipe that had never had gas in it. Therefore, the welders and the superintendent apparently assumed that there could not be an explosion or fire because no gas was involved in the pipe; it was a "cold work" situation. The gas company procedures do not specifically cover this situation nor do the procedures adequately discuss the importance of checking and monitoring the work area daily to detect hazardous conditions. In this case, when the "hot cut" work had been carried out several days before the accident, all of the company safety procedures had been complied with and the "hot cut" had been completed safely. It was after the "hot cut" work had been completed and welding was undertaken on the alignment pipe, which had never been in gas service, that the problem arose.

Federal requirements relate generally to the work being performed in that they require operators of pipelines to take necessary steps to minimize the chance that gas will be ignited in structures or areas where its presence may constitute a hazard of fire or explosion. However, these general requirements do not address circumstances such as the one involved in this accident. No other portion of the Federal regulations pertaining to natural gas pipelines appears to relate to the unsafe conditions created when pipelines are isolated from gas under pressure solely by closed valves.

Not only did the superintendent fail to recognize an unsafe condition that is not covered by either gas company procedures or Federal regulations, but he also failed to follow specific company procedures and Federal regulations in that he did not make the work area safe. Company training in overall safety requirements and in recognizing potentially unsafe work conditions should have helped in this case. In addition, supplementary assistance could have been provided by the company to the superintendent in the form of a checklist of essential actions to be taken before work began. Such aids are helpful when performing nonroutine work such as this road relocation project. While checklists are not a foolproof means for eliminating unsafe conditions, they are in common use in many activities. A properly designed checklist for this project would have pointed out the need for adequate monitoring and other safety measures to ensure that gas did not reenter the isolated section of pipe undetected and the need for more and closer escape routes. 7/ Nevertheless, when a person has worked for 28 years around gas pipelines and has been promoted into a position of management, that person should be expected, based upon his background experience, to be able to conduct safely projects of this type even if they are not routine and are not performed on a daily basis.

Improved Supervision

At the work site, the supervisor or other person in charge is the gas company's official representative and is responsible for ensuring that company procedures for safe, effective operations are performed correctly. This person should be well-trained and possess the knowledge and experience necessary for conducting the required work efficiently and safely. An effective supervisor exercises disciplined thinking about the job in progress, about the next operation to be performed, and about the conditions or changes in conditions that might jeopardize job safety.

7/ The Safety Board concludes however, that the absence of a closer escape route was not a factor in the severity of this accident because the gas-fed fire was of very short duration.

Many accidents investigated by the Safety Board wherein pipeline personnel have been killed or injured could have been prevented through effective supervision. As examples:

> In Jacksonville, Maryland, on September 3, 1970, five workers were burned seriously while working in a gasoline-saturated area while looking for a leak in Colonial Pipeline Company's system. The men were not required to practice job-site safety and were working without the aid of safety devices in an area that was downhill and downwind of gasoline which had pooled on the ground. Gas vapors were ignited by equipment being used by the workmen. 8/
>
> In Pittsburgh, Pennsylvania, on November 17, 1971, two employees of the Equitable Gas Company were working in a regulator vault without breathing equipment and were overcome by natural gas. Four other gas company personnel also were overcome by natural gas while attempting to rescue the first two employees. The first two victims had not checked the work area and had not used the breathing equipment as required, nor was such equipment readily available. The next four victims also failed to check the work area and did not use the required breathing apparatus. 9/
>
> In Abilene, Texas, on December 1, 1974, six persons died while attempting to clamp a spraying sour crude oil leak on the 26-inch-diameter pipeline owned by West Texas Gulf Pipeline Company. The area had not been checked to determine if work could be safely performed, and breathing equipment, safety ropes, or gas detectors had not been used. All six persons were overcome by toxic fumes containing hydrogen sulphide and died. 10/
>
> Near Fairbanks, Alaska, on July 8, 1977, an explosion and fire destroyed an Alyeska Pipeline Service Company pump station and killed one person. A maintenance crew, without informing supervisory personnel, and against company procedures, had entered the pump room and opened a strainer. The pump station operator, not knowing of the presence of the maintenance crew and the work they were performing, started a pump which resulted in crude oil entering the open strainer and then spraying into the room where it vaporized and exploded. 11/
>
> In Kansas City, Missouri, on June 12, 1978, two employees of the Gas Service Company were burned seriously while they attempted to clamp a punctured gas main. These persons did not monitor the atmosphere for the presence of combustible mixtures of gas-in-air and used steel files and wire brushes to clean the pipe in the hazardous atmosphere. 12/

8/ Pipeline Accident Report--"Colonial Pipeline Company Petroleum Products Pipeline, Jacksonville, Maryland, September 3, 1970" (NTSB-PAR-71-2).
9/ Pipeline Accident Report--"Equitable Gas Company Natural Gas Distribution System, Pittsburgh, Pennsylvania, November 17, 1971" (NTSB-PAR-72-2).
10/ Pipeline Accident Report--"West Texas Gulf Pipeline Company, Abilene, Texas, December 1, 1974" (NTSB-PAR-76-4).
11/ Pipeline Accident Report--"Alyeska Pipeline Service Company, Explosion and Fire, Pump Station 8, Near Fairbanks, Alaska, July 8, 1977" (NTSB-PAR-78-2).
12/ Pipeline Accident Report--"The Gas Service Company, Natural Gas Pipeline Rupture and Fire, Kansas City, Missouri, June 12, 1978" (NTSB-PAR-78-5).

The foregoing pipeline accident summaries are based on major accident investigations conducted by the Safety Board. Several other accidents investigated by the Safety Board also have shown the need for improved supervision of hazardous operations within the pipeline industry. (It should be recognized that the Safety Board investigates accidents that result in fatalities or injuries and major damage and that accidents with lesser consequence or wherein persons were not injured often are not investigated or even reported to Federal authorities.) It is clear from the Safety Board's investigations that the safety of maintenance and operating procedures is dependent on their conscientious application by the company supervisor, who should know not only the letter of the procedures but also their basis, so that he can apply them to situations not covered expressly by the written material.

CONCLUSIONS

Findings

1. Gas under pressure leaked undetected through a 22-inch-diameter gate valve that had been closed to isolate a 500-foot section of pipeline.

2. The presence of gas in the isolated section of pipeline was not detected because no means had been provided to monitor the internal atmosphere of the section nor had periodic checks been performed to determine that the section remained free of gas.

3. Gas pressure continued to increase within the isolated section of pipeline until the weld on the temporary end cap was ruptured and gas was released in a brief burst and was ignited by an undetermined source.

4. Because the resulting fire was of very short duration and the workers were at some distance from its source, burns were not fatal. Had the fire been of longer duration, the workers probably could not have escaped from the excavation because the only exit was toward the pipe where the flames emanated.

5. The Mississippi River Transmission Corporation procedures, training, and other supervisory support were inadequate for identifying or assisting in the identification of the potential threat presented by the unmonitored section of isolated pipeline.

6. Federal regulations pertaining to gas pipeline safety do not address the potential threat to safety presented by unmonitored sections of pipelines that have been isolated from gas under pressure solely by closed valves.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the gas company superintendent to monitor an isolated section of 22-inch-diameter pipeline, which allowed an internal pressure rise to occur without being detected, resulting in the failure of a welded temporary end cap and the release and ignition of natural gas. Contributing to the accident were the Mississippi River Transmission Corporation procedures which did not require specifically that pipelines isolated from gas under pressure solely by a closed valve be monitored continuously for the presence of natural gas.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board made the following recommendations:

--to the Mississippi River Transmission Corporation:

Require continuous monitoring for the presence of gas when work is to be done in the vicinity of pipeline sections that have been isolated from gas under high pressure solely by closed valves and by the installation of temporary end caps. (Class II, Priority Action) (P-83-22)

Provide checklists to supervisory personnel for major work projects to identify the essential actions to be performed before starting work, and while work is in progress, to ensure employee and public safety. (Class II, Priority Action) (P-83-23)

Require that supervisory personnel check all work sites daily before work is begun to ensure that the work can be done safely. (Class II, Priority Action) (P-83-24)

Include in its training program courses designed explicitly for supervisory personnel to aid them in understanding the principles underlying established safety requirements and to assist them in assessing the need for additional safety precautions when performing work not specifically detailed within the written work procedures. (Class II, Priority Action) (P-83-25)

--to the American Gas Association and the Interstate Natural Gas Association of America:

Notify its member companies of the circumstances of the accident in Pine Bluff, Arkansas, on October 1, 1982, and urge them to monitor continuously for the presence of gas when work is to be performed in the vicinity of pipeline sections that have been isolated from gas under high pressure solely by a closed valve and by temporary end caps. (Class II, Priority Action) (P-83-26)

Urge its member companies to provide checklists to supervisory personnel for major work projects to identify the essential actions to be performed, before starting work and while work is in progress, to ensure employee and public safety. (Class II, Priority Action) (P-83-27)

—to the American Society of Mechanical Engineers, Gas Piping Standards Committee:

Develop guidelines for monitoring gas pipeline segments that have been isolated from gas under high pressure solely through the use of valves. Establish the conditions under which the monitoring should include an automatic means for alerting employees to the presence of gas within the isolated section and the timing and frequency of inspections that should be made to determine the presence of gas when an automatic alerting means is not incorporated within the monitoring equipment. (Class II, Priority Action) (P-83-28)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ G.H. PATRICK BURSLEY
Member

/s/ DONALD D. ENGEN
Member

July 26, 1983

APPENDIX

INVESTIGATION

The National Transportation Safety Board was notified of this accident at 9:30 p.m., e.d.t., on October 1, 1982, by the Materials Transportation Bureau of the U.S. Department of Transportation. Early on October 2, 1982, the Safety Board dispatched an investigator to the accident site.

A public hearing was not held and depositions were not taken.

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