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PIPELINE TRANSPORTATION SAFETY

VOLUME I - NTSB REPORTS, STUDIES, AND RECOMMENDATIONS

1970 - 1979

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
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Washington DC 20590

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bstract

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1. INTRODUCTION

This document is a compendium of all Pipeline Accident Reports (PAR) and Pipeline Special Studies (PSS) published by the National Transportation Safety Board (NTSB) from 1970 through 1979. Abstracts have been provided for each report with special emphasis on their research and development (R&D) aspects along with all NTSB recommendations. A summary table of all Pipeline Accident Reports showing accident cause, pipeline type, injuries , fatalities, and property damage is also included.

2. OBJECTIVE

The objective in preparing this compendium of the National Transportation Safety Board (NTSB) Pipeline Accident Reports (PAR) and Pipeline Safety Studies (PSS) published from 1970-1979 was to assist in the establishment of a data base of accidents investigated by NTSB and its associated recommendations.

3. PIPELINE ACCIDENT REPORTS AND SPECIAL STUDIES, CY-1970

The following is the only pipeline accident report published during CY-1970. No special study was issued .

SB-PAR-70-1	Pipeline Accident Report - Low Pressure Natural Gas Distribution System, Burlington, Iowa, November 6, 1979.

NTSB-PAR-70-1 PIPELINE ACCIDENT REPORT - LOW-PRESSURE NATURAL GAS DISTRIBUTION SYSTEM, BURLINGTON, IOWA, NOVEMBER 6, 1969

On November 6, 1969, during a highway construction project in Burlington, Iowa, a 70,000-pound bulldozer drove over and partially collapsed the steel covers of a gas regulator pit, damaging the primary regulator. Unregulated gas entered the distribution system,causing high gas pilots and fires. The fires caused major damage to 10 homes and minor damage to 42 other homes. Property damage was estimated at $80,000.

The NTSB determined that the probable cause of the fires was the continuous overpressure in the system to five times the normal pressure, which caused high gas flames to ignite nearby objects. The overpressure was caused by damage to the primary regulator which normally served to reduce gas pressure in the system. Contributing to the incident was the lack of knowledge by the construction crew of the location of the gas regulator, the failure of the State highway commision to notify the gas company of work in the area, and the failure of the gas company to stake out the regulator or take other steps to prevent damage to the regulator.

R & D CONSIDERATIONS

1) Study the regulator design, maintenance, and testing procedures to determine if proper protection against overpressurization is maintained in the event of malfunction of a primary regulator.
2) Conduct a study to determine the safe maximum operating pressure for low-pressure distribution systems.

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D. C. 20591
PIPELINE ACCIDENT REPORT

Adopted: October 14, 1970

LOW-PRESSURE NATURAL GAS DISTRIBUTION SYSTEM BURLINGTON, IOWA NOVEMBER 6, 1969

I. SYNOPSIS

At 1:30 p.m. on Thursday, November 6, 1969, during a highway construction project in Burlington, Iowa, a bulldozer weighing 70,000 pounds drove over and partially collapsed the steel covers of a gas regulator pit, damaging the regulator. The regulator served to reduce high-pressure gas from about 55 p.s.i.g. 1/ to low pressure for distribution to 7,500 customers of the Iowa Southern Utilities Company (ISU) in this east Iowa town of 33,000 people. While the pressure was partially controlled by a monitoring or safety regulator, gas, reportedly at four to five times the normal operating pressure, entered the distribution system. At 1:55 p.m., gas customers in the affected area started reporting high gas pilots and fires to ISU and the fire department. The high-pressure gas source was turned off about 2:20 p.m., but fires continued to be reported until 4:30 p.m.

The fires wrought major damage to the interiors of 10 houses and minor damage to kitchens and appliances in 42 others. Property damage was estimated at $80,000.

About 35 to 40 percent of all gas pipeline accidents throughout the country are caused by damage to underground gas facilities from earth-moving or other equipment. Such accidents occur with more than twice the frequency as a result of this cause than from any other cause. There are programs in use by some States and by the gas industry which, if adopted nationally, will greatly reduce the number of accidents resulting from damage by excavating and other earth-moving equipment.

The probable cause of the fires in the houses was the continued overpressure condition of the low-pressure distribution system for an extended period of time, which allowed pressure to build up until high gas flames ignited nearby objects. The initiation of the overpressure was caused by a bulldozer which damaged the largest primary working regulator which, with other regulators, controlled the gas pressure entering the low-pressure

1/ Pounds per square inch gauge.

system; and by inadequate performance of the monitoring regulator which failed to operate to limit the gas pressure to a safe level.

Contributing causes to the damage of the regulator were: (1) the lack of knowledge on the part of construction personnel at the work site of the location of the regulator station, (2) the failure of the Iowa State Highway Commission to provide Iowa Southern Utilities Company with a copy of the revised final plans showing that the regulator station was to be included in the area to be cleared and, (3) the failure of ISU to stake out the regulator, have inspectors at the scene, or take other steps to prevent damage to the regulator.

Contributing causes to the continued overpressure condition were: (1) the delay by the bulldozer operator and the Iowa State Highway Commission Inspectors in reporting the damage to ISU due to failure to recognize the significance of the damage, and (2) the lack of overpressure relief devices on the low-pressure system.

Contributing causes to the failure of the monitoring regulator to limit the gas pressure to a safe level were: (1) the absence of a specification of the safe level in United States of America Standard B31.8 and the interim minimum Federal Safety Standards based upon USAS B31.8, and (2) the probable use of a checking procedure by ISU which did not disclose the maximum pressure which could be produced.

CONCLUSIONS

(Listed after each conclusion are page numbers in this report which contain facts and analysis leading to the conclusions.)

The Board concludes that:

1. The severing of the primary regulator spring by the bulldozer resulted in the failure of the regulator valves in a wide-open position. The monitoring regulator reacted to the flow of high-pressure gas at about 55 p.s.i.g., but did not control the pressure as necessary and allowed gas at a reported four to five times normal operating pressure to enter the low-pressure distribution system. (Pages 6, 20.)

2. The absence of a pressure relief device at the damaged regulator station or elsewhere in the low-pressure distribution system allowed the pressure to build up beyond a pressure at which fires were initiated. No such relief devices were required by the USAS B31.8 Code, which provided for either a monitoring regulator or relief device, but not both. (Pages 21, 28.)

3. About 25 minutes were required for the pressure to build up in this large, integrated low-pressure distribution system after the regulator was damaged. (Page 26.)

4. Regulator station R-5 generally complied with the overpressure protection requirements of USAS B31.8 Code and ISU's standards insofar as its design was concerned; however, the adjustment and checking of this station did not comply with the code requirements, in that the pressure produced by the monitoring regulator was above a safe pressure. (Pages 21, 22, 30, 31.)

5. The maximum allowable operating pressure for low-pressure distribution systems was not adequately defined in the USAS B31.8 Code, the interim standard, or in the minimum Federal Safety Standards issued by Office of Pipeline Safety. There was no definition of the maximum pressure to which the monitoring regulator should have been set, and the code allowed the setting of an unsafe pressure. (Pages 20, 31.)

6. The monitoring regulator installed at station R-5 could not be adjusted to comply with ISU's standards. Furthermore, this standard was unrealistic and was probably ignored when the monitoring regulator was adjusted. (Pages 30, 31.)

7. It could not be determined whether the monitoring regulator was inspected and checked as frequently as required by ISU due to a lack of records. The relevant USAS B31.8 Code, which was the basis of the interim Federal Safety Standards, does not specify the keeping of maintenance records. (Pages 21, 22, 29, 30.)

8. The control line to the monitor, buried under only 1 foot of cover, was bent. Had it been broken, the monitor would not have operated, and the overpressure to 7,500 customers would have been of the order of 200 times

the normal operating pressure instead of the four to five times normal actually encountered. Thus this accident narrowly escaped becoming a catastrophe of very large proportions. (Pages 16, 21, 28, 29, 30.)

9. The damage to the monitoring (safety) regulator control line was contrary to the intent of the USAS B31.8 Code and the ISU Standard, but these standards are nonspecific as to the protection against mechanical injury required, and are unenforceable in this respect, as written. (Page 29.)

10. The overpressure condition of the system was prolonged after the pressure was shut off by the failure of ISU to vent the gas pressure in the low-pressure system by disconnecting system piping. (Page 28.)

11. The numerous meetings conducted by the State Highway Commission to discuss various aspects of the project and problems to be encountered failed to provide the necessary information to the proper parties to avoid the damaging of the regulator by the bulldozer. (Pages 4, 6, 26, 39, 40, 41.)

12. The Iowa State Highway Commission procedures for preventing accidents of this type were satisfactory. However, these procedures were not properly implemented. (Pages 4, 6, 26.)

13. Neither the B31.8 Code nor the minimum Federal Safety Standards issued August 12, 1970, have provisions which would have required ISU to have formal procedures for the prevention of damage of its underground facilities. (Page 23.)

14. Even though ISU thought the regulators would not be endangered by the proposed construction work, a short distance away, the distance and possibility of damage was such that it should have taken some type of positive action to prevent damage to such an important installation as the regulator which was subsequently damaged. (Pages 4, 6, 24, 25, 26.)

15. The contractors failed to heed the notes in the final construction plans, warning that the location of underground facilities shown in the plans were approximate and that it was the contractors' responsibility to determine the exact location and avoid any damage. (Pages 4, 10, 26.)

16. ISU's telephone facilities were inadequate to receive emergency calls from its consumers during the accident, and this resulted in a long delay in learning the source of the trouble. (Pages 11, 28.)

PROBABLE CAUSE

The probable cause of the fires in the houses was the continued overpressure condition of the low-pressure distribution system for an extended period of time, which allowed pressure to build up until high gas flames ignited nearby objects. The initiation of the overpressure was caused by a bulldozer which damaged the largest primary working regulator which, with other regulators, controlled the gas pressure entering the low-pressure system; and by inadequate performance of the monitoring regulator which failed to operate to limit the gas pressure to a safe level.

Contributing causes to the damage of the regulator were: (1) the lack of knowledge on the part of construction personnel at the work site of the location of the regulator station, (2) the failure of the Iowa State Highway Commission to provide Iowa Southern Utilities Company with a copy of the revised final plans showing that the regulator station was to be included in the area to be cleared and, (3) the failure of ISU to stake out the regulator, have inspectors at the scene, or take other steps to prevent damage to the regulator.

Contributing causes to the continued overpressure condition were: (1) the delay by the bulldozer operator and the Iowa State Highway Commission Inspectors in reporting the damage to ISU due to failure to recognize the significance of the damage, and (2) the lack of overpressure relief devices on the low-pressure system.

Contributing causes to the failure of the monitoring regulator to limit the gas pressure to a safe level were: (1) the absence of a specification of the safe level in United States of America Standard B31.8 and the interim minimum Federal Safety Standards based upon USAS B31.8, and (2) the probable use of a checking procedure by ISU which did not disclose the maximum pressure which could be produced.

RECOMMENDATIONS

(Listed after each recommendation are the numbers of the conclusions upon which such recommendations are based)

The Safety Board recommends that:

1. The Office of Pipeline Safety of the Department of Transportation take the following actions:

   (a) Require in the minimum Federal Safety Standards that each gas utility establish a program for the prevention of construction-originated damage to its underground facilities. This program should contain provisions: (1) for education and general liaison with contractors and their machine operators; (2) for obtaining notices of construction work in close proximity to underground gas facilities; (3) to insure that gas facilities are marked or otherwise protected during such construction work; and (4) to followup and investigate accidents which do occur, to determine where the program failed and how it can be strengthened. (Conclusion 13, Appendix IV.)

   (b) As a part of its enforcement activity, study the regulator design, maintenance, and testing procedures of the utilities under its direct jurisdiction, including municipal operations not regulated by States, to determine whether gas consumers will be properly protected against overpressurization in the event of a malfunction of a primary regulator. This would include sampling observations to determine whether regulators are adjusted properly, maintained, and tested on a regular basis so that they will function correctly, and whether the control line is protected from damage. (Conclusion 1, 4, and 8.)

   (c) Conduct a study to determine what constitutes a safe maximum operating pressure for low-pressure distribution systems. Further, use the results of such study in formulating minimum Federal Safety Standards, so that the desired pressure and the correct functioning of monitoring regulators and other overpressure protection devices will be defined. (Conclusion 5.)

(d) Review the ability of the gas utilities under its direct jurisdiction to receive and process telephone calls during emergencies. Determine whether a minimum Federal Safety Standard is necessary. (Conclusion 16.)

2. All States, the District of Columbia, and Puerto Rico take the following actions:

(a) Consider the enactment of legislation to require: (1) persons planning to excavate or blast to notify the gas utility operating in the area (Conclusion 13, Appendix III), and (2) local authorities and others who issue construction permits to cooperate with the gas utilities to facilitate the obtaining of notices of proposed excavation. (Appendix IV.)

(b) Encourage utilities having underground facilities in the same area such as gas, electric, and telephone, etc., to establish a coordinated notification facility, where practicable, so that a person planning to excavate or blast can inform all utilities by making one telephone call. (Appendix IV.)

(c) Review the regulator design, maintenance, and testing procedures of the gas utilities under State jurisdiction to determine whether all gas consumers will be properly protected against overpressurization in the event of a malfunction of a primary regulator, along the same lines recommended in 1(b), above. (Conclusion 4.)

(d) Review the ability of the gas utilities under their jurisdiction to receive and process telephone calls during emergencies. (Conclusion 16.)

3. Iowa Southern Utilities, Inc., take the following actions:

(a) Review its own regulator design, maintenance, and testing procedures to determine whether its gas consumers will be properly protected against overpressurization in the event of a malfunction of a primary regulator. (Conclusions 4, 6, 9.)

(b) Establish a written procedure for preventing damage to underground facilities. The program should contain the same methods recommended to the Office of Pipeline Safety, above. (Conclusion 13, Appendix IV.)

(c) Improve its ability to receive and process telephone calls during emergencies. (Conclusion 16.)

(d) Develop a written, comprehensive regulator maintenance and testing procedure to assure proper operation during normal use and in the event of emergencies, pending any government-originated requirements. Appropriate records of maintenance work performed should be made. (Conclusion 7.)

4. The Iowa State Highway Commission take the following actions:

(a) Revise its procedures so that its inspectors, who will be assigned to a construction job, are aware of the various aspects of the project and problems of interference with utilities. (Conclusions 11, 12.)

(b) Provide copies of the final construction plans and specifications to all parties involved in the project, such as gas and other utilities, and city officials. (Conclusion 12.)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

/s/ OSCAR M. LAUREL
Member

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

October 14, 1970.

TSB-PSS-71-1 SPECIAL STUDY OF EFFECTS OF DELAY IN SHUTTING DOWN FAILED IPELINE SYSTEMS AND METHODS OF PROVIDING RAPID SHUTDOWN

This study points out that by reducing the time between pipeline failure id shutdown, the accident effects can be minimized or eliminated. The use of vices such as excessive flow shutoff devices, automatic or remote controlled lves,etc.,could have prevented or minimized every accident discussed in this udy.

D CONSIDERATIONS

R&D requirement

DEPARTMENT OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20591

OFFICE OF
THE CHAIRMAN

February 2, 1971

Honorable John A. Volpe
Secretary of Transportation
400 Seventh Street, S. W.
Washington, D. C. 20590

Dear Mr. Secretary:

The National Transportation Safety Board has recently conducted a study entitled, "The Effects of Delay in Shutting Down Failed Pipeline Systems and Methods of Providing Rapid Shutdown."

In many recent pipeline accidents, a delay in promptly shutting down the failed pipeline system has magnified the effects of the accident. The study points out that by reducing the time between failure and shutdown, the accident effects can be minimized or eliminated. Equipment and procedures, which could have prevented the accidents discussed in the study if they had been employed, are currently available and in use by some pipeline operators on a limited basis. The study discusses in general terms some of the methods and types of equipment that are available to the industry at present to obtain rapid shutdown of failed facilities. The equipment is quite varied, ranging greatly in complexity and in cost.

Use of the rapid shutdown equipment and plans vary greatly within the gas and liquid pipeline industries, mainly because there are no industry guidelines or Federal requirements as to what constitutes a reasonable period of time between a failure and a shutdown.

The need for such Federal regulation is pointed out by the fact that the current regulations would not have prevented any of the tragic accidents referred to in the study.

The study also discusses the degree of security to be provided to the public.

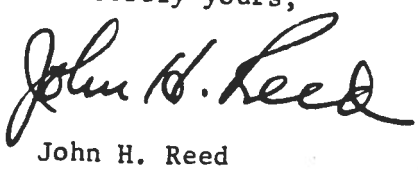
On the basis of the study, the National Transportation Safety Board recommends that:

> The Office of Pipeline Safety of the Department of Transportation conduct a study to develop standards for the rapid shutdown of failed natural gas pipelines and work in conjunction with the Federal Railroad Administration to develop similar standards for liquid pipelines.

The purpose of the rapid shutdown is to reduce the amount of hazardous materials released, and any method which will quickly reduce the amount released should be considered.

The degree of security provided by the standards should also consider the relative hazard of the commodity, the size of the population-at-risk at points along the pipelines, and the potential damaging effects on property and the environment. Two special factors concerning the population-at-risk should be taken into account; namely, (1) that in most situations the risk is concentrated in the relatively small proportion of the population near pipelines, whereas the remainder of the population benefits with lesser risk from the use of the commodities, and (2) that the population-at-risk is often unaware of the hazard and therefore unable to escape it or guard against it, and is dependent upon the protection of the regulations. The risk to those near pipelines should not be appreciably greater than the risk to the remainder of the population. A substantially greater effort to protect those near pipelines should be provided than would be justified by balancing the cost of safety measures against the lives to be saved.

Sincerely yours,



John H. Reed
Chairman

RECOMMENDATION

On the basis of this study, the National Transportation Safety Board recommends that:

> The Office of Pipeline Safety of the Department of Transportation conduct a study to develop standards for the rapid shutdown of failed natural gas pipelines and work in conjunction with the Federal Railroad Administration to develop similar standards for liquid pipelines.

The purpose of the rapid shutdown is to reduce the amount of hazardous materials released, and any method which will quickly reduce the amount released should be considered.

The degree of security provided by the standards should also consider the relative hazard of the commodity, the size of the population-at-risk at points along the pipelines, and the potential damaging effects on property and the environment. Two special factors concerning the population-at-risk should be taken into account; namely, (1) that the population is often unaware of the hazard, and therefore unable to escape it or guard against it, and (2) that in many situations the risk is concentrated in a relatively small proportion of the population near pipelines in order to achieve benefits for the remainder of the population. The risk to those near pipelines should not be appreciably higher than the risk to the remainder of the population. A substantially greater degree of security for those near pipelines should be provided than would be indicated by requiring that the cost of the safety measures be justified entirely by the lives to be saved.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

/s/ OSCAR M. LAUREL
Member

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

December 30, 1970.

71856

NTSB-PAR- 71-1 PIPELINE ACCIDENT REPORT - MOBIL OIL CORP., HIGH-PRESSURE NATURAL GAS PIPELINE ACCIDENT, HOUSTON, TEXAS, SEPTEMBER 8, 1969

On September 9, 1969, a 14-inch pipeline carrying natural gas at 780-psig pressure, ruptured in a newly-constructed residential subdivision near Houston, Texas. All residents were evacuated, and about 10 minutes later, the escaping gas exploded violently. Thirteen houses were destroyed by the blast. In all, 106 homes were damaged and property damage was estimated at $500,000. There were no deaths, but nine people were injured, two seriously.

The NTSB determined that the probable cause of the accident was the rupturing of the pipe along a weak zone in the electric resistance weld made when the pipe was manufactured in 1941, due to the subjecting of the pipeline to higher pressures than it ever before experienced. Also contributing to the high pressure was the setting of the pressure regulator at levels above the maximum allowed by the American Standards Association Code and the failure of Federal and State regulations to limit the maximim operating pressure.

R & D CONSIDERATIONS

1) Conduct a study to develop standards for the rapid shutdown of a failed pipeline.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-71-1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report Mobil Oil Corporation, High-Pressure Natural Gas Pipeline Accident, Houston, Texas, September 9, 1969		5. Report Date July 1, 1971 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address Bureau of Surface Transportation Safety National Transportation Safety Board Washington, D. C. 20591		10. Work Unit No. 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		13. Type of Report and Period Covered Pipeline Accident Report (accident on September 9, 1969) 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract At 3:40 p.m. on September 9, 1969, a 14-inch pipeline carrying natural gas at a pressure of more than 780 p.s.i.g. ruptured in a residential subdivision 3½ miles north of Houston, Texas. All residents were evacuated, and about 8 to 10 minutes later, the escaping gas exploded violently. Thirteen houses, ranging from 24 feet to 250 feet from the rupture, were destroyed by the blast. The leaking gas caught fire and burned for 1½ hours until valves on either side of the leak were closed by Mobil workmen. In all, 106 houses were damaged, and property damage was estimated at $500,000. Miraculously, there were no deaths, but 9 people were injured, 2 seriously.

The National Transportation Safety Board determines that the probable cause of the accident was the rupturing of a length of pipe along a weak zone in the electric resistance weld made when the pipe was manufactured in 1941, due to the subjecting of the pipeline to pressures higher than ever before experienced.

Contributing causes to the rupture were: (1) the setting of the regulators to control the gas pressure at levels higher than the maximum allowable operating pressure permitted by the American Standards Association Code for Pressure Piping, and higher than the pressure to which the pipeline was tested, (2) the lack of any written procedures for making the tie-in, (3) the failure of the Federal or State regulations to limit the maximum operating pressure.

Contributing to the extent of the damage was the delay in shutting down the pipeline after the rupture occurred.

17. Key Words Pipeline accident, natural gas pipeline, accident investigation, gas explosion, gas fires, houses destroyed, pipe seam failure, hydrostatic testing, high pressure regulators, pipeline standards, pipeline operating procedures, hoop stress, maximum allowable operating pressure, pipeline shutdown delays.		18. Distribution Statement Released to public Unlimited distribution	
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IV. CONCLUSIONS

The National Transportation Safety Board concludes that:

1. The operating pressure permitted on the pipeline at the point and time of failure was higher than the maximum allowable working pressure as determined by Mobil Oil Corporation (Mobil) by use of the American Standards Association Code for Pressure Piping, and was also higher than the pressure to which the line had been tested. This operating pressure, as controlled by the setting of the upstream regulator, was established to provide for an increased flow rate.
2. The blocking of the line downstream to make a tie-in, and the continued packing of gas into the pipeline, allowed the pressure in the segment of pipeline which ruptured to be higher than at any time in the past.
3. The pressure control regulators did not control the pressure in the line as intended; the valve on one controlled the pressure 20 p.s.i.g. below its setting; on the second, 11 p.s.i.g. above its setting, and the third did not function, allowing the pressure downstream to exceed the set pressure by 165 p.s.i.g.
4. Even if the regulators had performed as intended, the accident still could have occurred. The basic design of the system and regulator operation did not assure that the maximum allowable pressure would not be exceeded.
5. There were no written procedures for tying in the relocated section of pipe, and there was no consideration of the pressure levels that would be reached by the tie-in operation. Written procedures for each planned shutdown of a section of pipeline are not specifically required by the Federal regulations.
6. The Texas Railroad Commission regulations in effect at the time of the accident did not restrict the maximum operating pressure when that pressure was established prior to the effective date of the regulations.
7. Most of the destruction and injuries occurred when the gas leaking from the ruptured pipe exploded and burned 8 to 10 minutes after the failure.
8. Current Federal regulations would have restricted the allowable operating pressure to a point below the pressure at which the failure occurred.
9. Mobil was not operating the pipeline in compliance with the code provisions requiring protection against accidental overpressuring.
10. The monitoring system in use prior to the accident was inadequate to detect promptly failures of the pipeline. Even though pressures and flow rates at a number of points along the pipeline were telemetered to the dispatcher at the Beaumont refinery, he did not become aware of the rupture until he received a radio message 15 minutes after the failure.
11. After the accident, Mobil made changes in the operation of the line to improve its safety. Had these changes been made prior to the accident, it would have been prevented.
12. The use of joint factors in determining maximum allowable operating pressure for existing pipelines is not stated clearly in the B31.8 Code or the Federal regulations.
13. The maximum allowable operating pressures, determined after the accident and retesting program, were obtained by the incorrect use of a joint factor of 1.00 instead of 0.85 for ERW pipe, thereby permitting operation of the line at higher pressures.
14. The weak zone in the electric resistance weld (ERW) pipe, present since manufacture, would not have been a factor had the pressure in the line been controlled at a level reflecting its test-pressure and past-operating-pressure levels. The subsequent ERW seam failures, which occurred during hydrostatic test after the accident, point out that even though certain defects existed, they did not create problems as long as the operating pressure in the pipeline was controlled to a point well below test pressures.

V. GENERAL CONCLUSIONS

This accident involving an older pipeline, typifies the situation with many natural gas and liquid pipelines in the United States. This pipeline included an old flaw of a type not identified, probably not identifiable when the pipe was made, possibly not identifiable today. These lines rely upon pressure testing under conditions which will not be hazardous, should a break occur, to demonstrate their continued safety, and also upon adequate control of operations to prevent overpressure. Neither of these conditions was present here. The line had never been pressure-tested to a pressure that the system allowed to be present, and the control of operations was not sufficient to prevent overpressure. In addition, population growth had brought homes quite close to the pipeline. Because of this factor, many homes were destroyed and serious loss of life was averted only because ignition of the gas did not occur until evacuation was complete.

The Safety Board has dealt with the factor of delay in shutting down lines and the need to minimize the loss of gas in a special study, "Effects of Delay in Shutting Down Failed Pipeline Systems and Methods of Providing Rapid Shutdown."

It is important to note the key role of the so-called "grandfather clause" approach to regulating older lines in this accident.

The B31.8 Code, the rules of the Texas Railroad Commission, and the Federal regulations did not require pressure reductions on existing lines in most instances. This permitted pipelines to be operated at pressures above that for which they were tested.

Thus, grandfather clause effects, which tend to resist hazard-reducing changes in the operation of older lines (as distinguished for reconstruction), were found here in private standards, State regulations, and indirectly in the Federal regulations, since the predominant State regulations were required to be the basis of the initial Federal regulation. The allowing of safety exemptions under grandfather clauses is not such a new practice in safety regulation. Such clauses are seldom, if ever, written for a safety purpose. Most often, grandfather clauses are intended to reduce resistance to new laws or regulations on the part of those who would have to make costly changes to reach the new levels of safety. In this case, it is clear that the grandfather clause approach was an underlying cause of this accident.

It is to be noted that, after the first set of standards adopted by the Secretary of Transportation under the Natural Gas Pipeline Safety Act of 1968, additional regulations are subject to the grandfather clause approach to only an insignificant degree. Under Section 3(b) of the Act, the Secretary can require effective standards of inspection and testing during the later life of a pipeline which can insure its safe operation, and if the Secretary finds a hazardous condition, he can require any form of correction which will remove the hazard. It appears that, although the grandfather clause approach in earlier standards was an underlying cause of this accident, there is no need to urge the demise of its effects in private or State standards, for Congress has wisely insured that older inadequate practices will no longer be automatically protected.

VI. PROBABLE CAUSE

The National Transportation Safety Board determines that:

The probable cause of the accident was the rupturing of a length of pipe along a weak zone in the electric resistance weld, made when the pipe was manufactured in 1941, due to the subjecting of the pipeline to pressures higher than ever before experienced.

Contributing causes to the rupture were: (1) the setting of the regulators to control the gas pressure at levels higher than the maximum allowable operating pressure permitted by the American Standards Association Code for

Pressure Piping, and higher than the pressure to which the pipeline was tested, (2) the lack of any written procedures for making the tie-in, and, (3) the failure of Federal or State regulations to limit the maximum operating pressure.

Contributing to the extent of the damage was the delay in shutting down the pipeline after the rupture occurred.

VII. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Office of Pipeline Safety of the Department of Transportation take the following actions:
   (a) Review the methods used by pipeline operators to protect existing transmission lines against accidental overpressuring upon the failure of pressure control equipment. This review should be made in conjunction with the States. If problem areas are detected, adequate regulatory action, including rulemaking, should be undertaken to assure protection against overpressuring.
   (b) Clarify the Federal regulations pertaining to the determination of maximum allowable operating pressure for existing pipelines so that the joint factor in use when the pipe was manufactured is utilized for current computations.
2. The Mobil Oil Corporation take the following actions:
   (a) Recalculate the present maximum allowable operating pressure on this pipeline, utilizing a joint factor of 0.85 for the ERW sections of the line, and reduce the pressure at which the line is operated, where necessary, to comply with these new calculations.
   (b) Prepare written procedures for each planned shutdown of sections of its pipeline system. In addition to general requirements for all planned shutdowns, these specific procedures should include methods of handling specific problems which might be encountered during each shutdown.
3. American Society of Mechanical Engineers Gas Piping Standards Committee take the following action:
   (a) Develop guidelines for procedures to be prepared by operators of gas systems for each planned shutdown of a section of pipeline system. In addition to general requirements for all shutdowns, these procedures should include methods of handling specific problems which might be encountered during each shutdown. These guidelines should be included in the ASME "Guide for Gas Transmission and Distribution Piping Systems" and recommended for use in complying with the operating and maintenance plan requirements of paragraph 192.605 of the Federal regulations.

The Safety Board wishes to point out the following recommendation made in its special study of Effects of Delay in Shutting Down Failed Pipeline Systems and Methods of Providing Rapid Shutdown:"

> "The Office of Pipeline Safety of the Department of Transportation conduct a study to develop standards for the rapid shutdown of failed natural gas pipelines and work in conjunction with the Federal Railroad Administration to develop similar standards for liquid pipelines." This recommendation was made February 12, 1971, partially in response to the events of this accident which is cited."

NTSB-PAR-71-2 PIPELINE ACCIDENT REPORT - COLONIAL PIPELINE CO., PETROLEUM PRODUCTS PRIPELINE, JACKSONVILLE, MARYLAND, SEPTEMBER 3, 1970

On September 2, 1970, a pipeline leak occurred near Jacksonville, Maryland. Residents of the area detected gasoline odors and noticed gasoline in a small creek which flowed through the area. The pipeline company shut down the pumping stations and pressure was reduced. Contractors worked continuously for 20 hours to locate the leak in the 30-inch arc-welded pipeline. The next day, an explosion occurred followed by a fire. There were no fatalities,but five workmen were burned. Four days later, the leak was located. A flaw in the pipe had caused a weak spot which failed, allowing the gasoline to leak. Repairs to the pipe were made in place, and the system was placed back into operation.

The NTSB determined that the probable cause of the leak was a flaw in the pipe wall of undetermined origin, which failed after a period of constantly fluctuating pumping pressures. The probable cause of the explosion was the ingestion of gasoline-vapor-rich atmosphere by the diesel engine in a backhoe which resulted in the speeding up and back-firing of the engine, igniting the atmosphere. Contributing to the ignition of the vapor-laden atmosphere was the lack of planning and precaution in the operation and positioning of the backhoe without the use of a vapor-detecting device.

R &D CONSIDERATIONS

1) Study current recording meter practices in the liquid pipeline industry to determine the existing state-of-the-art in detecting small pithole-type leakage by meter variance, particularly regarding large diameter pipeline operating at high volumes.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-71-2	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report Colonial Pipeline Company Petroleum Products Pipeline Jacksonville, Maryland - September 3, 1970		5. Report Date December 8, 1971 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address Bureau of Surface Transportation Safety National Transportation Safety Board Washington, D. C. 20591		10. Work Unit No. 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		13. Type of Report and Period Covered Pipeline Accident Report September 3, 1970 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

On September 2, 1970, a pipeline leak occurred in the Colonial Pipeline System near Jacksonville, Maryland. Contractors worked continuously for 20 hours to find the leak, and on the next day at 5:50 p.m. an explosion occurred followed by a fire. There were no fatalities, but five workmen were burned.

The National Transportation Safety Board determines that the probable cause of the leak was a flaw of undetermined origin in the pipe wall, crater-like in appearance, wide at the surface and narrowing down to a thin metal membrane, which failed after a period of constantly fluctuating pumping pressures. The probable cause of the explosion and fires was the ingestion of the gasoline vapor-rich atmosphere by a diesel engine which resulted in the speeding up and backfiring of the engine, igniting the atmosphere. The engine of the backhoe was working downhill and downwind of a ditch partially filled with gasoline. Contributing to the accident were the lack of planning and precaution in the operation and positioning of the backhoe, in the training of the workmen in safe working procedures, and in the failure to use vapor detecting devices.

17. Key Words	18. Distribution Statement		
Pipeline Accident, Products Pipeline, Accident Investigation, Gasoline Explosion, Gasoline Fire, Pipe Flaw, Pipe-line Standards, Government Standards, Emergency Procedures, Pipe Manufacture, Hydrostatic Test, Operating Pressure, Pressure Gradient, Pipeline-Civil Agency Liaison, Injured Workmen, Gasoline Spill	Released to Public Unlimited Distribution		
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 42	22. Price $3.00

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and clothing required for this work, the kind of powered equipment permitted in a vapor filled area, the vapor-testing instruments to be utilized, or the vapor concentration levels at which men are allowed to work. Specific precautionary measures and procedures for this type of work are found in the Petroleum Safety Data Sheet PSD 2200 "Repairs To Crude Oil, Liquefied Petroleum Gas, and Products Pipelines" compiled by the American Petroleum Institute. The API data sheet is referenced in the USAS B31.4-1966, Liquid Petroleum Transportation Systems, which was in effect at the time of the leak and referred to by some sections of 49 CFR 195. However, section 195.422(a) does not make specific reference to B31.4 and thus even the voluntary guide lines are not referred to by the Federal regulations for pipeline repair.

IV. CONCLUSIONS

The National Transportation Safety Board concludes that:

1. The leak was due to the failure of a thin membrane of steel in a crater-like flaw in the pipe wall. Although the cause of the flaw was not determined, nor conclusively identified as to type, it should have been detected at some point after it developed and before the pipe was buried, either (a) at the steel mill, (b) prior to shipment to the coating plant, (c) at the coating plant after the cleaning process, or (d) during the final hydrostatic test. Adequate inspection was not made in at least one of these areas, hence the pipe flaw remained undetected for years.
2. Colonial officials did not (a) remove the defective section for metallurgical analysis, or (b) dispatch experts to the scene of the flaw to attempt to determine the cause, or (c) take adequate professional photographs for study by metallurgists at a later time.
3. The leak could not be detected by the metering system or the pressure gauges used by Colonial. This large diameter pipeline, pumping at high volumes, does not have either meters or pressure gauges sensitive enough to detect leaks or seepages of this magnitude.
4. Inadequate liaison and cooperation was affected by Colonial with the Jacksonville Volunteer Fire Company prior to the accident. If this fire company had been provided with pertinent information, it would have been able to ascertain the prevailing hazardous conditions. Additional fire equipment could have been called and the available fire equipment would have been ready.
5. Colonial, did not notify any other affected civil agencies, request their aid, or suggestions, or alert them to the potential hazard.
6. Colonial's activity during this period was focused on getting the pipeline back into operation as rapidly as possible.
7. Colonial did not hold an effective briefing session with the contractors to explain the conditions, to discuss the method of operations, and to outline work safety procedures.
8. The work area was not checked for safe working conditions prior to or during the leak search activities. A hazardous vapor detector was not on hand at the site; engine-driven equipment was allowed to work in a vapor-laden area; men and equipment were allowed to work downwind and downhill of the gasoline fumes.
9. No clear-cut emergency procedure was prepared, no explosion or fire was anticipated, and the location and telephone numbers of the nearest first aid, ambulance, and hospital facilities were not known.
10. Colonial did not follow the rules outlined

in their own "Emergency Directory" regarding notification of outside, affected agencies, prevention of personal injury and property damage; use of fire foam to prevent vaporization; clearance of the repair area of hazardous vapors; and location of equipment in relation to vapors and air movement.

11. Contractors' work crews had received no formal training or indoctrination in pipeline maintenance work. The instruction received was "on-the-job" type training, with "seasoned" men working alongside "green" men.
12. The Federal regulation on pipeline repairs, 49 CFR 195.422(a), is vague, nonobjective and does not provide for any specific action on the part of carriers.
13. Contractors' work crews were improperly dressed to work in and around a hazardous vapor area.
14. Unnecessary personnel were allowed to stand over the ditch, watching the activity after they had been relieved by other workers.
15. The diesel engine backhoe did not have any exhaust protective equipment which might have prevented the vapor ignition.

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the leak was a flaw of undetermined origin in the pipe wall, which failed after a period of constantly fluctuating pumping pressures.

The probable cause of the explosion and fires was the ingestion of the gasoline vapor-rich atmosphere by the diesel engine in a backhoe which resulted in the speeding up and backfiring of the engine, igniting the atmosphere. The backhoe was working downhill and downwind of a ditch partially filled with gasoline.

Contributing to the ignition of the vapor-laden atmosphere was the lack of planning and precaution in the operation and positioning of the backhoe without the use of any vapor-detecting device.

Contributing to the amount of accumulated gasoline was the long period of dry weather preceding the accident (which had dehydrated the soil in the area), the existing rock strata which underlaid the pipeline from the leak site down to the accident area, and the more than usual amount of backfill over the pipeline which kept the gasoline from surfacing. The large underground column of entrapped gasoline, which was released suddenly by digging operations, deluged the work area with gasoline fumes.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Federal Railroad Administration of the Department of Transportation initiate an amendment to the Code of Federal Regulations, Title 49, Section 195.206, Material inspection, requiring specific inspection criteria. This recommendation is not intended to delete or mitigate any visual, mechanical, or nondestructive inspection practices already in existence, but to prescribe a system of inspection at strategic points in the manufacture, transportation, and further processing of the pipe before it is buried in the ground.
2. The Federal Railroad Administration undertake a study of the current metering practices in the liquid pipeline industry, with the possible assistance of qualified pipeline groups, to determine the existing state of the art in detecting small pithole-type leakage by meter variance with particular regard to large diameter pipelines operating at high volumes. The study should

include those pipelines whose pumping operations are regulated by the use of recording meters which monitor the receipts and deliveries and are set to shut down or otherwise inform the pipeline dispatcher upon the occurrence of a specified amount of input/output variance. The study should include meter accuracies with the intent to establish certain minimum standards regarding receipt and delivery variances within which liquid pipelines shall operate. Based upon the results of this study, the number of barrels-per-hour variance allowable between the input and output of liquid petroleum pipelines should be included in 49 CFR 195.

3. The Federal Railroad Administration formulate and add to 49 CFR 195 the requirement that all pipeline companies formally notify appropriate State and local civil agencies of the route the pipelines follow in detail, the type of material they carry, and the lines of communication to be used in an emergency.
4. The Federal Railroad Administration incorporate by reference in 49 CFR 195.422, Pipeline Repairs, the American Petroleum Institute Petroleum Safety Data Sheet - Repairs to Crude Oil, Liquefied Petroleum Gas, and Products Pipelines, PSD 2200 - June, 1964.
5. The Colonial Pipeline Company provide maps of the pipeline route in sufficient detail to establish clearly the system location with regard to the various affected civil agencies and residents along the right-of-way. These maps should be kept current by the notation of pipeline additions or route changes as required. Specifically recommended to receive this information are fire departments, both civil and volunteer; State, county, and local police departments; departments of water resources; and any agency concerned with hazardous materials.
6. The Colonial Pipeline Company meet with appropriate State safety agencies to coordinate safe working rules and regulations and hold periodic pipeline safety meetings with fire departments and other interested agencies, to familarize their personnel with basic pipeline operations, materials pumped, hazards encountered, and the procedures to be followed when encountering pipeline leaks or other emergencies.
7. The Colonial Pipeline Company compose a formal, in-depth manual or procedure depicting the step-by-step method of handling petroleum spills, combating fires, notifying the various agencies, and the guidance of contractors' crews in safe working procedures. Incorporate in this manual the American Petroleum Institute Petroleum Safety Data Sheet, PSD 2200, June 1964, as a minimum so as to comply fully with the Federal regulation 49 CFR 195.422. A list of hospitals and first aid units, complete with addresses and telephone numbers, should be included.

5. PIPELINE ACCIDENT REPORTS AND SPECIAL STUDIES, CY-1972

The following are the six pipeline accident reports and special studies published during CY-1972.

-PSS-72-1	Special Study - A Systematic Approach to Pipeline Safety
-PAR-72-1	Pipeline Accident Report - Phillips Pipe Line Company, Propane Gas Explosion, Franklin County, Missouri, December 9, 1970
-PAR-72-2	Pipeline Accident Report - Equitable Gas Company, Natural Gas Distribution System, Pittsburgh, Penn., November 17, 1971
-PAR-72-3	Pipeline Accident Report - Lone Star Gas Co., North Richland Hills, Texas, October 4, 1971
-PAR-72-4	Pipeline Accident Report - Washington Gas Light Co., Natural Gas Explosion at Annandale, VA., March 24, 1972.
-PAR-72-5	Pipeline Accident Report - Lone Star Gas Co., Fort Worth, Texas, October 4, 1971

NTSB-PSS-72-1 SPECIAL STUDY - A SYSTEMATIC APPROACH TO PIPELINE SAFETY

This study discusses the need for and the benefits to be obtained by using system safety techniques in the pipeline industry. Pipeline systems have the greatest potential of any surface mode of transportation for benefiting from a systematic approach to safety techniques. This is because pipelines are definable as engineering systems and hazards may be identified and risks defined to a greater degree than other modes.

Past pipeline accidents are reviewed and it is pointed out that hazard analysis prior to the accidents would have identified problems which eventually resulted in accidents.

R & D CONSIDERATIONS

No R & D requirement.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PSS-72-1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Special Study A Systematic Approach to Pipeline Safety		5. Report Date May 25, 1972
		6. Performing Organization Code
7. Author(s) -		8. Performing Organization Report No.
9. Performing Organization Name and Address Bureau of Surface Transportation Safety National Transportation Safety Board Washington, D. C. 20591		10. Work Unit No. 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		13. Type of Report and Period Covered Special Study 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The study discusses the need for and the benefits to be obtained by using system safety techniques in the pipeline industry. Past pipeline accidents are reviewed, and it is pointed out that analysis of the hazards in the pipeline systems prior to the accidents would have identified problems which eventually resulted in the accidents. The approach, which was developed for use in the aerospace and aviation fields, has proved to be extremely effective and is now being adapted to many other areas. The surface modes of transportation have the greatest need for these techniques. The study also describes system safety, and how it can be implemented.

Recommendations are made to the pipeline industry and to the Department of Transportation concerning the use of system safety to prevent accidents.

17. Key Words	18. Distribution Statement
System Safety, Risk Management, Prevention of Pipeline Accident, Fault Tree Analysis, Pipeline Hazard Identification, Hazard Control or Elimination, Failure Mode and Effects Analysis, Hazard Analysis, Pipeline Accidents	Released to the Public Unlimited Distribution

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	17	

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VI. CONCLUSIONS

By utilizing the systematic approach to safety, pipeline accidents can be predicted and analyzed before they occur. They can then be prevented by taking the action necessary to eliminate or control the hazards which lead to accidents. Systems analysis methods will identify possible hazards. Risks will not be assumed unknowingly. Those risks which are assumed will be those that have been identified, and in which a management decision has been made to accept them. This approach avoids crises by foreseeing them.

The benefits to be derived from the above approach go far beyond the prevention of an accident. The resources allocated for system safety are well spent. In addition to the large sums needed to settle accident claims, make repairs to the system, and restore the environment, consideration must be given to the value of the operating company's reputation, image, and future business potential. One accident that could have been avoided can cost many times the price of an effective analysis effort.

A number of recent accidents investigated by the Safety Board reveal the existence of hazards that were activated into accidents. System safety analysis would have made these hazards known and given management a chance to correct them before the accident occurred.

The systematic approach can be carried through for the total operational life of a pipeline system since it can be used during the design stage and in the operation and maintenance of existing systems.

VII. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The American Society of Mechanical Engineers Gas Piping Standards Committee develop guidelines for the use of systems analysis by gas distribution and gas transmission pipeline operators. These guidelines should serve a similar function for gas pipeline systems as the Military Standard, *Requirements for System Safety Program for Systems and Associated Subsystems and Equipment* (MIL-STD-882), does for military systems. These guidelines should cover the full life cycle of a gas pipeline system and be applicable to the design of new pipelines as well as to the operation and maintenance of existing pipelines. This work should be undertaken with the cooperation of the American Gas Association.

2. Each gas pipeline operator review his operation with a view toward instituting a more systematic and authoritative approach to understanding and controlling hazards, not only for new projects, but for day-to-day operations and maintenance. The guidelines developed by the Gas Piping Standards Committee should be used to set up individual system safety programs.

3. The American Petroleum Institute develop guidelines for the use of system safety by liquid pipeline operators. These guidelines should serve a similar function for liquid pipeline systems as the Military Standard, *Requirements for System Safety Program for Systems and Associated Subsystems and Equipment* (MIL-STD-882), does for military systems. These guidelines should cover the full life cycle of liquid pipeline systems, and be applicable to the design of new pipelines as well as to the operation and maintenance of existing pipelines. This work should be undertaken with the cooperation of the American National Standards Institute Section Committee for Liquid Petroleum Transportation Piping Systems (ANSI-B31.4).

4. Each liquid pipeline operator review his individual operations with a view toward instituting a more systematic and authoritative approach to understanding and controlling hazards, not only for new projects, but for day-to-day operation and maintenance. The guidelines developed by the American Petroleum Institute should be used to set up individual system safety programs.

5. The Office of Pipeline Safety of the Department of Transportation encourage the use of the systematic approach to safety by gas pipeline operators, in general, especially in their compliance with Title 49, Paragraph 192.605, *Essentials of Operating and Maintenance Plan*, of the Minimum Federal Safety Standards - Transportation of Natural and Other Gas by Pipeline.

6. The Federal Railroad Administration encourage the use of the systematic approach to safety by liquid pipeline operators, in general, but especially in their complying with Paragraph 195.402 of the Title 49, Transportation of Liquids by Pipeline. This paragraph requires written procedures for ensuring safe operation and maintenance of pipeline systems during normal operations and during abnormal and emergency situations.

NTSB-PAR-72-1 PIPELINE ACCIDENT REPORT - PHILLIPS PIPE LINE CO., PROPANE GAS EXPLOSION, FRANKLIN COUNTY, MISSOURI, DECEMBER 9, 1970

On December 9, 1970, a rupture occurred in a 8-inch uncoated pipeline in a rural area of Franklin County, Missouri, which released 4,538 barrels of propane. The propane-air-mixture exploded with a force equivalent to 50 tons of TNT, destroying all buildings at the blast origin, extensively damaging 13 homes within a 2-mile radius, and snapping trees and telephone poles in the area.

The NTSB determined that the probable cause of the accident was the rupture of an insufficiently bonded longitudinal weld which had been further weakened by internal corrosion. Contributing to the rupture was a pump station which shut down and produced a higher pressure than the pipeline had been subjected to in the recent past.

R & D CONSIDERATIONS

1) Conduct a study concerning minimum valve spacing standards and the use of remotely operated valves and check valves on all liquified petroleum pipelines.

2) Conduct a study of of the various current practices in the handling, containing, and disposing of liquified petroleum products resulting from pipeline failures. This study should include external factors such as weather conditions, topography, and population density in the vicinity of the leak.

3) Continue experimental work in testing and developing a tool to detect longitudinal weld defects and thin wall pipe conditions caused by corrosion.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-72-1	2.Government Accession No.	3.Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report, Phillips Pipe Line Company, Propane Gas Explosion, Franklin County, Missouri December 9, 1970		5.Report Date March 1, 1972 6.Performing Organization Code
7. Author(s)		8.Performing Organization Report No.
9. Performing Organization Name and Address Bureau of Surface Transportation Safety National Transportation Safety Board Washington, D. C. 20591		10.Work Unit No. 11.Contract or Grant No. 13.Type of Report and Period Covered Pipeline Accident Report December 9, 1970
12.Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		14.Sponsoring Agency Code

15.Supplementary Notes

16.Abstract

On December 9, 1970, a rupture occurred in the Phillips Pipeline Company system in Franklin County, Missouri, which released 4,538 barrels of propane. An explosion, equivalent to 100,000 pounds of TNT, and a fire resulted in extensive property damage within a 2 mile radius. No fatalities occurred, but ten persons sutained injuries.

The probable cause of the accident was the rupture of an insufficiently bonded longitudinal weld, further weakened by internal corrosion. Contributing to the rupture was a pump station which shut down and produced a higher pressure on the failed pipeline section than it had been subjected to during recent operations. The explosion and fire were caused by the ignition of the released propane which had been confined in a concrete block building. The explosion inside the building initiated a shock wave which caused the detonation of the entire unconfined propane air cloud.

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

17.Key Words Pipeline Accident, Products Pipeline, Accident Investigation, Propane Explosion, Propane Fire, Pipe Longitudinal Weld Rupture, Cold Stitched Weld, Internal Longitudinal Weld Corrosion, Pipe Manufacture, Hydrostatic Tests, Pressure Gradient, Operating Pressure, Pump Station Shutdown, Crash Down, Government Standards, Industry Standards, LPG		18.Distribution Statement Released to Public Unlimited Distribution	
19.Security Classification (of this report) UNCLASSIFIED	20.Security Classification (of this page) UNCLASSIFIED	21.No. of Pages 49	22.Price

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IV CONCLUSIONS

The National Transportation Safety Board concludes that:

1. The Phillips Pipe Line Company's "A" line from Borger, Texas, to East St. Louis, Illinois, in its physical condition was not safe for the transport of liquefied petroleum gas under the operating pressure in effect at the time of the rupture.
2. The pressure on the failed section of pipe at the time of rupture was higher than that pipe had been subjected to in the recent past.
3. After this accident, Phillips reduced the maximum allowable discharge pressures on this system. The National Transportation Safety Board, in its Safety Recommendation P-71-6 issued on April 27, 1971, recommended a further reduction in pressure. If these pressure reductions had been effected prior to this accident, it would not have occurred at this location.
4. During construction, the longitudinal welds were positioned in the pipeline ditch in a random manner; some were located on the bottom, some on the sides, and some on the top half of the pipe. For about the first 17 years of operation, free water and product-absorbed water were pumped through this pipeline. Some of this water initiated a corrosion attack on the bottom of this pipe, and on those longitudinal welds lying on the bottom.
5. This 40-year old bare pipeline, which contains many imperfectly made longitudinal welds and has internal corrosion problems, has had numerous longitudinal weld failures at various pressures and at various locations along its length. In the 6-year period from 1965 to 1970 inclusive, 12 longitudinal weld failures have occurred, which released more than 39,000 barrels (1,638,000 gallons) of liquefied petroleum products.
6. There remain in this pipeline system an unknown number of faulty longitudinal welds at unknown locations, and in varying stages of deterioration. A newly developed tool has been used by Phillips in an attempt to detect these defective welds. This tool is still in the experimental stage.
7. The delay in shutting down the pipeline and reducing the amount of escaping propane was due to (a) the excessive amount of time taken to shut down the initial pump station on this system; (b) the fear of rupturing the line again at another location by a rapid shutdown of a pump station, creating a pressure surge; and (c) lack of any automatically or remotely operated main line valves to close off and isolate the failed section rapidly.
8. Liquefied petroleum gases are more hazardous than crude oils or other refined products normally transported by pipelines. Little can be done to contain, dispose of, or dissipate the resulting flammable mixture after it leaks from a pipeline. Statistics for the 3 years of 1968, 1969, and 1970 show that LPG leaks represented only 9 percent of the total accidents, but they caused 71 percent of the total deaths, 65 percent of the personal injuries, and 26 percent of the property damage during this same period.
9. The greater hazards inherent in the transportation of LPG by pipeline require a higher degree of safety controls than other petroleum products. Currently there is no major distinction in the regulations.
10. If this type of accident, which consumed over 4,538 barrels of propane and detonated with a force equivalent to 100,000 pounds of TNT, had occurred in a more densely populated area, there would have been numerous fatalities, more injuries, and greater damage.
11. The alertness of a local resident, who heard the roar of escaping propane, and

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

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

V. PROBABLE CAUSE

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

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

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

VI RECOMMENDATIONS

The National Transportation Safety Board recommends that:

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

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

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

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

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

[8]Report Number NTSB-PSS-71-1.

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

2. The Phillips Pipe Line Company:
(a) Maintain as a maximum, the reduced pumping pressures recommended by the National Transportation Safety Board's Safety Recommendation P-71-6 issued April 27, 1971, which limits to 900 p.s.i.g. the maximum discharge pressures at each of the pump stations between Borger and East St. Louis, as well as Phillip's own pressure limitation of 900 p.s.i.g. on the four pump stations in the affected area; Syracuse, Jefferson City, Rosebud, and Villa Ridge. A 24-hour hydrostatic pressure test equal to 125 percent of the maximum anticipated pressure as specified in the CFR Title 49 Part 195 would be required before this line pressure could be again increased.
(b) Revise their pipeline operating procedures and initiate any equipment changes necessary to reduce substantially the time required to shut down the pump stations. Included in this review and revision should be explicit instructions to the dispatcher for the immediate emergency shutdown of all pump stations together with some means of practicing these procedures.
(c) Institute main line valve changes or modifications needed to reduce substantially the amount of time required to completely block off and isolate a failed pipeline section. Consideration should be given to the use of automatically operated valves, remotely operated valves, or check valves installed at strategic locations on this pipeline. Special consideration should be given to the concentration of population-at-risk along and adjacent to the pipeline right-of-way. The Safety Board invites Phillips attention to the section on the Public-at-Risk in the Safety Board's special study of "Effects of Delay in Shutting Down Failed Pipeline Systems and Methods of Providing Rapid Shutdown."
(d) Provide maps of their pipeline system in sufficient detail to establish clearly the system location with regard to the various affected civil agencies along the right-of-way. These maps should be kept current by the notations of pipeline additions or route changes as required. Specifically recommended to receive this information are the fire departments, both civil and volunteer, the state, county and local police departments, and other agencies concerned with hazardous materials.
(e) Establish a line of communication with the affected civil agencies and all residents along the pipeline right-of-way, by supplying a card or sticker with the names, addresses, and telephone numbers of pipeline personnel to be contacted during an emergency.
(f) Hold periodic meetings to include the local fire departments and other interested agencies, to inform further and educate the attending personnel as to basic pipeline operations, and materials pumped, hazards encountered, and procedures to follow during LPG leaks.
(g) Continue with the experimental work in cooperation with other qualified pipeline groups in testing and developing a tool to detect longitudinal weld defects and thin wall pipe caused by corrosion. Based on the findings, the methods of operation should be incorporated in the pipeline industry standards, as an additional tool for the detection of in-place line pipe flaws, but not as a substitute for hydrostatic testing.

NTSB-PAR-72-2 PIPELINE ACCIDENT REPORT- EQUITABLE GAS CO., NATURAL GAS DISTRIBUTION SYSTEM, PITTSBURGH, PENNSYLVANIA, NOVEMBER 17, 1971

On November 17, 1971, while revamping a regulator station in Pittsburgh, Penn., gas company employees were replacing a valve on the low-pressure side of a regulator in an underground vault. The shutoff valve on the high-pressure side was turned off but there was no valve on the low-pressure side to stop the flow of gas. Rags were stuffed into the line in an effort to cut off the flow of gas. Two men were overcome by gas and four others were overcome attempting to rescue the first two. All six men died of asphyxiation and three others were injured.

The NTSB determined that the probable cause of death by asphyxiation was the failure to shut off completely the flow of gas. Contributing to the accident was the failure to use respirators, air blowers, or vapor detectors, and the lack of written procedures for revamping the regulator station.

R & D CONSIDERATIONS

No R & D requirement

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-72-2	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report Equitable Gas Company, Natural Gas Distribution System, Pittsburgh, Pennsylvania, November 17, 1971		5. Report Date May 25, 1972 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address Bureau of Surface Transportation Safety National Transportation Safety Board Washington, D. C. 20591		10. Work Unit No. 11. Contract or Grant No. 13. Type of Report and Period Covered Pipeline Accident Report November 17, 1971
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

On November 17, 1971, while in the process of revamping a regulator station, employees of the Equitable Gas Company were attempting to replace a valve on the low-pressure side of a regulator in a vault without first stopping the flow of gas. Two men working in the vault were overcome by gas leaking into the vault. Four others also were overcome attempting to rescue the first two. All six men died of asphyxiation. Three other men also were injured.

The National Transportation Safety Board determines that the probable cause of death by asphyxiation of the first two men was the inhalation of natural gas released into the vault in which they were working, when an attempt was made to change a valve in the vault without first stopping the flow of gas. Four other workmen also died of asphyxiation while they were attempting to rescue the first two. Contributing to the accident were the lack of: (1) use by any of the workmen of respirators, air blowers, or vapor detectors; (2) any written procedures for accomplishing the regulator station revamping; and (3) proper personnel training.

17. Key Words	18. Distribution Statement
Pipeline accident, natural gas, asphyxiation, distribution system, "on the fly," pipeline safety standards, employee training, safety equipment, respirators, working in vaults	Released to public Unlimited distribution

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	29	

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IV. CONCLUSIONS

1. In its proposed revamping of regulator station R.B.-26, Equitable was not in compliance with the intent of paragraph 192.199(g) of the Minimum Federal Safety Standards for the Transportation of Natural and Other Gas by Pipeline. This paragraph concerns the design and installation of pressure-relief and limiting devices so that the operation of both will not be affected by any single incident.
2. The Federal regulation on regulator design, 49 CFR 192.199(g) is vague and does not clearly convey the intent, which is to require separation, either by distance, barrier or separate housing, of the pressure-limiting device and the overpressure protection device.
3. Equitable's "Standard Safety Practices" were adequate to prevent the accident, but were not followed by its employees.
4. The equipment required to comply with Equitable's standards, such as masks and ventilators, was not available at the job site.
5. Equitable's training procedures were inadequate in that they did not provide the employees involved in this accident with the necessary knowledge of how to work safely in and around gas facilities.
6. The decision to replace the downstream valve in the vault without stopping the flow of gas was highly irregular, not condoned by Equitable, and was made in the interest of saving time.
7. There was no need to replace the downstream valve in the vault to accomplish the revamping of the regulator station to house both the regulator and the relief device. A field inspection of the regulator station as it existed prior to redesign would have shown that the dimensions on the sketch were incorrect, and that replacing the valve would have provided 2¼ extra inches of space instead of the planned 7¼ inches.
8. Equitable had no written procedures for the revamping of regulator station R.B.-26. Preparation of such procedures would have pointed out the problem of shutting off the downstream flow of gas and allowed for adequate planning to complete the job in a safe manner.
9. After the accident, Equitable made changes in its operating procedures to improve safety. If these changes had been made prior to the accident, it would have been prevented.
10. The practices of the American Telephone and Telegraph Company for working in vaults are effective in preventing accidents related to gas leakage in underground structures.

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of death by asphyxiation of the first two men was the inhalation of natural gas released into the vault in which they were working, when an attempt was made to change a valve in the vault without first stopping the flow of gas. Four other workmen also died of asphyxiation while they were attempting to rescue the first two. Contributing to the accident were the lack of: (1) use by any of the workmen of respirators, air blowers or vapor detectors; (2) any written procedures for accomplishing the regulator station revamping; and (3) proper personnel training.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Office of Pipeline Safety of the Department of Transportation clarify the language of 49 CFR 192.199(g) to state clearly that the intent of the regulation is to separate pressure-limiting devices and overpressure-protection devices by distance, barrier, or separate housing.

2. The American Society of Mechanical Engineers Gas Piping Standards Committee:
   (a) Include in its "Guide for Gas Transmission and Distribution Piping Systems" procedures for testing the atmosphere of underground structures prior to entering and while working in these structures. The practices of the American Telephone and Telegraph Company should be considered during the establishment of these guidelines.
   (b) Develop guidelines that pipeline operators can use in their training programs which will help employees understand the characteristics of natural gas, its effects on the human body, and how to act properly while in its presence.
3. The Equitable Gas Company:
   (a) Distribute its "Standard Safety Practices" manual to all employees affected by its contents.
   (b) Include programs in its training that will insure that all employees are familiar with the contents of its "Standard Safety Practices" manual.
   (c) Include in its training programs a course on understanding the characteristics of natural gas, its effects on the human body, and the correct procedures to be used in its presence.
   (d) Prepare written procedures for each planned shutdown of a portion of its pipeline system, or the installation or replacement of portions of the system which require stopping, or initiating the flow of gas.
   (e) Conduct a field inspection of existing facilities it plans to upgrade, replace, revamp, relocate, or change, prior to commencing the redesign.
   (f) Develop standards for the design of typical regulator station installations for various types of service.

NTSB-PAR-72-3 PIPELINE ACCIDENT REPORT - LONE STAR GAS CO., NORTH RICHLAND HILLS, TEXAS, OCTOBER 4, 1971

On October 4, 1971, a small explosion and intense fire completely destroyed a house in North Richland Hills, Texas. The accident caused the death of three members of the family and severe injuries to another. The fire department extinguished the fire and the gas company searched for a gas leak. While the search was still going on, another explosion and fire occurred in the attached garage of an adjacant residence which caused the death of one occupant and extensive damage to the garage. The neighborhood was then evacuated. The major leak was found at the junction of the 6-inch welded steel gas main and a 1-1/4-inch galvanized steel service line. The 13-year-old galvanized service connection had become brittle in the thread cut zone due to hydrogenation (caused by galvanic action). The dense clay soil had exerted stresses on this pipe through the years every time rain saturated the soil and caused it to swell.

The NTSB determined that the probable cause of the explosions and fires was the accumulation of natural gas which had leaked from a broken service-line connection with a 6-inch gas main (coated, wrapped, and cathodically protected), and had migrated up and under the concrete slabs of both homes. Contributing to the second explosion and fire was the length of time taken by the gas company to find the leak and their failure to shut off the gas main in order to isolate the affected area.

R & D CONSIDERATIONS

1) Conduct a study of the stress effects of various types of soils and backfull on service line-gas main connections.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-72-3	2. Government Accession No.	3. Recipient's Catalog No. PB 213 615
4. Title and Subtitle Pipeline Accident Report - Lone Star Gas Company, North Richland Hills, Texas, October 4, 1971.		5. Report Date November 8, 1972 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20591		10. Work Unit No. 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		13. Type of Report and Period Covered PIPELINE ACCIDENT REPORT October 4, 1971 14. Sponsoring Agency Code

15. Supplementary Notes

This report contains Pipeline Safety Recommendations P-72-34 thru P-72-39.

16. Abstract

At about 4:45 a.m., on October 4, 1971, a small explosion and intense fire completely destroyed a house at 8300 Jerrie Jo Drive in North Richland Hills, Texas. This accident caused the deaths of a father and his two sons and the severe burning of their mother. Almost 3 hours later, the neighboring house at 8304 Jerrie Jo experienced an explosion and fire in the garage which caused the death of the woman occupant and extensive damage to the garage.

The National Transportation Safety Board determines that the probable cause of the explosions and fires was the ignition of an accumulation of natural gas which had leaked from a broken service-line connection with a 6-inch gas main and had migrated up and under the concrete slabs of both houses.

The length of time taken by gas company personnel to find the leak and their failure to close the three valves on the gas main to isolate the affected area contributed to the second explosion and fire.

The delay in the decision to evacuate the houses until after the second explosion and fire was caused by lack of liaison and cooperation between the gas company and the fire department.

17. Key Words	18. Distribution Statement
Natural gas leak; Lone Star Gas Company; North Richland Hills (Fort Worth), Texas; service-line - gas main connection; migrating gas; concrete foundation slab; fire department liaison; electric switch ignition.	Released to public Distribution unlimited

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	22	

NTSB Form 1765.2 (11/70)

IV. CONCLUSIONS

The National Transportation Safety Board concludes that:

1. The zinc coating on the service line combined with air and moisture to cause a dissimilar metal condition and to set up a galvanic action which ultimately produced the hydrogenation brittle, faceted cleavage of the pipe.
2. The service line, weakened after repeated soil stresses over a period of years and embrittled by hydrogenation, finally failed due to the forces exerted on it by the swelling clay, which was saturated by recent heavy rains.
3. The explosion and fire in the house at 8300 Jerrie Jo Drive were due to natural gas leaking at 20 to 25 p.s.i.g. from a break at the junction of the gas main and service line.
4. The explosion and fire in the house at 8304 Jerrie Jo Drive, which occurred almost 3 hours later, were due to natural gas still leaking at 20 to 25 p.s.i.g. from the break at the junction of the gas main and service line and migrating in a well-defined path up under the concrete driveway and garage slab.
5. Lone Star Gas Company employees and fire department personnel did not establish proper liaison or communication. Thus, the firemen were unaware of the leaking gas.
6. This lack of communication resulted in the late evacuation (after the second explosion) of the area residents still unaffected.
7. The fact that gas company employees did not close the three valves on the gas main to isolate the affected section contributed to the amount of gas released, and to the severity of the second explosion.

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the explosions and fires was the ignition of an accumulation of natural gas which had leaked from a broken service-line connection with a 6-inch gas main and had migrated up and under the concrete slabs of both houses.

The length of time taken by gas company personnel to find the leak and their failure to close the three valves of the gas main to isolate the affected area contributed to the second explosion and fire.

The delay in the decision to evacuate the houses until after the second explosion and fire was caused by lack of liaison and cooperation between the gas company and the fire department.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Office of Pipeline Safety
   (a) Amend 49 CFR 192 to include a section based on a review of the suitability of threaded galvanized pipe, or pipe coated with other dissimilar metals, for the transportation of natural and other gas. (Recommendation No. P-72-34)
   (b) Amend 49 CFR 192.615 to include an explicit requirement that pipeline operators notify and coordinate their activities with local fire and police officials when gas leaks create hazardous conditions. (Recommendation No. P-72-35)

2. The American Society of Mechanical Engineers Gas Piping Standards Committee:

   Conduct, in conjunction with the American Gas Association, a study of the stress effects of various types of soils and backfill on service line-gas main connections. As a result of this study, guidelines should be issued for installing underground gas-piping systems. (Recommendation No. P-72-36)

3. The Lone Star Gas Company:

   (a) Undertake a program acceptable to the Railroad Commission of the State of Texas, to inspect, on a random-sample basis, the service line - gas main connections similar to those at the accident site, to determine their current condition and the existing stress on the piping. The results of this program will determine the action to be taken on other installations in the Lone Star system. Copies of these test results should be forwarded to the Railroad Commission of the State of Texas

and the Office of Pipeline Safety of the Department of Transportation. (Recommendation No. P-72-37)

(b) Establish a line of communications and hold periodic meetings with local fire departments and other interested agencies to inform them of gas company emergency procedures and maintenance operations. (Recommendation No. P-72-38)

(c) Notify and coordinate its activities with local fire and police officials when gas leaks create hazardous conditions. (Recommendation No. P-72-39)

NTSB-PAR-72-4 PIPELINE ACCIDENT REPORT- WASHINGTON GAS LIGHT CO., NATURAL GAS EXPLOSION AT ANNANDALE, VA., MARCH 24, 1972

On March 24, 1972, in Annandale, Va., a contractor's backhoe snagged a 2-inch wrapped-steel gas main, operating at 22 psig, and pulled it out of a compression coupling 22 feet away. Gas company personnel arrived on the scene 40 minutes later and started to search for the reported leak. The gas was not shut off and the nearby homes were not checked for the presence of gas. About 20 minutes later, three houses exploded, killing three persons and injuring one gas company workman.

Contributing to the accident was the delay of the gas company in shutting off the gas, the failure to check for gas in the houses, and the failure to notify police and fire officials. Also contributing were the failure of residents to quickly report the oder of gas, and the failure of the county to supply the contractor with accurate gas line location maps which had been provided by the gas company.

R&D CONSIDERATIONS

1) Research is needed to study the flow of natural gas through various house foundation wall materials and types of construction. The project whould also include effective methods of sealing the space around underground utility lines where they enter a building. The effects of aging, settlement, and exposure to water should also be considered.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-72-4	2.Government Accession No.	3.Recipient's Catalog No. PB-214 228
4. Title and Subtitle Pipeline Accident Report - WASHINGTON GAS LIGHT COMPANY, NATURAL GAS EXPLOSIONS AT ANNANDALE, VA., MARCH 24, 1972.		5.Report Date November 22, 1972 6.Performing Organization Code
7. Author(s)		8.Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20591		10.Work Unit No. 11.Contract or Grant No. 13.Type of Report and Period Covered PIPELINE ACCIDENT REPORT March 24, 1972
12.Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		14.Sponsoring Agency Code

15.Supplementary Notes

This report contains Pipeline Safety Recommendations P-72-40 thru P-72-62.

16.Abstract

On March 24, 1972, in the Annandale section of Fairfax County, Va., a contractor's backhoe snagged a 2-inch steel gas main, operating at 22 p.s.i.g., and pulled the main out of a compression coupling 22 feet away. Gas company personnel arrived on the scene about 40 minutes later and started to search for the break. The gas was not shut off and the nearby houses were not checked for the presence of gas. About 20 minutes after the gas company crew had arrived, a house, 240 feet away from the point at which the line was snagged, exploded. Within the next few minutes, two other houses exploded and burned. As a result of the accident, three persons died and one was injured; two houses were destroyed and a third was badly damaged; and $153,000 worth of property was damaged.

The National Transportation Safety Board determines that the cause of the explosions in the three houses was the ignition of gas that leaked from a main damaged by a contractor's backhoe.

Contributing to the accident were the delay by the gas company in shutting off the flow of leaking gas, the failure to check for gas in houses, and the failure to notify police and fire officials. Also contributing were the failure of the area residents to report the presence of leaking gas in their houses, and the failure of the county to supply the contractor with the accurate gas main location which had been provided by the gas company.

17.Key Words Pipeline accident, natural gas leakage, pulled main, pipeline safety standards, public awareness of gas emergencies, valve operation, gas migration through soils.		18.Distribution Statement Released to public; distribution unlimited.	
19.Security Classification (of this report) UNCLASSIFIED	20.Security Classification (of this page) UNCLASSIFIED	21.No. of Pages 40	22.Price $3.00 MF $0.95

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CONCLUSIONS

The National Transportation Safety Board concludes that:

1. Pipeline operators are required by Federal regulations to have emergency plans; however, the regulations do not control or specify problems or emergency measures to be covered in such plans.

2. The plans for the sewer project provided to the contractor by the county showed the 2-inch pipeline that was subsequently hit to be 5 feet west of its actual location. A correct location, including the depth of the line, was provided to the county by WGL prior to the letting of the contract.

3. The warning given to the county by WGL that the contractor would have to exercise extreme caution to prevent damage to the gas line was not passed along to the contractor.

4. The gas mains to be encountered during this project were not discussed at the county's preconstruction meeting with the contractor.

5. The contractor and his foreman at the job site were aware that the gas main was in the path of the sewer replacement being undertaken. They were not aware, however, whether the gas line passed above or below the 42-inch sewer being removed.

6. The backhoe operator was not being guided adequately at the time that he pulled the gas main with the backhoe. Neither the foreman nor other workmen were observing conditions in the excavation to advise the operator of the presence of other facilities.

7. The workload of the WGL dispatcher was such that he was unable adequately to direct and coordinate the activities of WGL's field forces to respond promptly to the report of the pulled main.

8. WGL's program to educate its customers and the general public to recognize gas emergencies was not effective, in that it did not reach the general public or adequately point out the possible hazards or consequences of not reporting gas odors.

9. Since gas was observed emanating from the crack between the blacktop and concrete at the catch basin, the WGL personnel on the scene prior to the explosions should have realized that all of the gas was not venting to the atmosphere but was traveling through the ground.

10. Even though the line was separated, the gas continued to flow through the separation and into the main that supplied the homes in Magdalene Court. The sources of ignition are unknown but could have been gas-stove flames or pilot lights.

11. Tests performed by the NBS indicate that the gas which leaked from the separated coupling flowed rapidly through rock-filled utility trenches to the front walls of 4909 and 4911, and the front and side walls of 4907 Magdalene Court. The gas entered the buildings through the mortar and asphalt-coated concrete blocks and/or through spaces where utility piping entered the buildings.

12. WGL's personnel did not follow their operating instruction, Investigation of Gas Leaks, which required them to determine whether gas is entering any structure before attempting to locate the source of leakage. Although this instruction concerns leak complaints and is not for large failures of this nature, no additional instructions were issued to its employees.

13. The practice by WGL of restricting the operation of valves to pressure division personnel increased the time taken to shut off the flow of gas.

14. The marking of valves in the field would allow them to be positively identified in emergency situations.

15. The methods used by WGL to classify the leak reported by telephone by the resident of 4909 Magdelene Court was inadequate and incomplete, in that the true hazard that existed was not determined.

16. Although 96 percent of the construction-caused damages that occur on WGL distribution system affect lines 2-inch in size or smaller, the equipment to squeeze off lines of this size was not readily available in the field.

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the cause of the explosions in

the three houses was the ignition of gas that leaked from a main damaged by a contractor's backhoe.

Contributing to the accident were the delay by the gas company in shutting off the flow of leaking gas, the failure to check for gas in houses, and the failure to notify police and fire officials. Also contributing were the failure of the area residents to report the odor of gas in their houses, and the failure of the county to supply the contractor with the accurate gas main location which had been provided by the gas company.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Office of Pipeline Safety
   (a) Amend 49 CFR 192 to require onsite identification of all valves on high-pressure distribution systems which may be necessary for the safe operation of the system. (Recommendation No. P-72-40)
   (b) Amend 49 CFR 192 to require that each pipeline operator prepare preplanned shutdown procedures so that any section of a high-pressure distribution system can be shut down in an emergency. (Recommendation No. P-72-41)
   (c) Amend 49 CFR 192 to require that each operator maintain a log which shows the receipt and handling of each leak or emergency report received. Information concerning the time that the report was first received, that a crew was first dispatched to the scene, that such a crew arrived, and that the condition was considered safe should be included. In addition, each pipeline operator should be required to analyze his performance in responding to gas-leak emergencies and reports. Both the logs and the analysis should be made available to State agencies and the Office of Pipeline Safety. (Recommendation No. P-72-42)
   (d) Amend 49 CFR 192 to require that each pipeline operator have on duty a sufficient number of dispatching personnel to effectively coordinate emergency situations. A study may be required to determine the relationship between various conditions and the number of dispatchers necessary. (Recommendation No. P-72-43)
   (e) Amend 49 CFR 192.615 to include an explicit requirement that each pipeline operator notify and coordinate his activities with local fire and police officials when gas leaks create hazardous conditions.[7] (Recommendation No. P-72-44)

2. The American Public Works Association develop guidelines for preconstruction meetings, which should include methods of preventing damage to underground utilities to be encountered during the proposed construction work. Such preconstruction meetings should be attended by all operators whose facilities are involved. (Recommendation No. P-72-45)

3. The American Society of Mechanical Engineers Gas Piping Standards Committee
   (a) Recommend methods of numbering or marking valves in the field so that they can be readily and positively identified. (Recommendation No. P-72-46)
   (b) Develop guidelines to be used by pipeline operators in establishing preplanned sectionalizing programs to shut down any section of main in an

[7] Same as Recommendation 1(b) in Board report, "Lone Star Gas Company, North Richland Hills, Texas, October 4, 1971."

emergency. (Recommendation No. P-72 47)

(c) Develop guidelines to assist pipeline operators in preparing their emergency plans. These plans should indicate the action to be taken by the first gas company employee arriving at the scene of an emergency. (Recommendation No. P-72-48)

(d) Develop guidelines to assist pipeline operators in educating customers and the general public in the proper action to take if gas leaks are detected. (Recommendation No. P-72-49)

(e) Develop guidelines in cooperation with the National Fire Protection Association to assist pipeline operators in determining the conditions under which local fire and police officials should be notified. (Recommendation No. P-72-50)

(f) Develop guidelines for classifying and responding to leaks reported by the public. (Recommendation No. P-72-51)

4. The National Science Foundation, the Office of Emergency Preparedness, and the National Bureau of Standards initiate a research project, under their cooperative program, "Building Practices for Disaster Mitigation," to study the flow of natural gas through various basement wall materials and types of construction. This project should also include effective methods of sealing the space around underground utility lines where they enter a building. The effects of aging, settlement, and exposure to water should be considered. (Recommendation No. P-72-52)

5. The American Gas Association study the flow of gas through various construction fill media and recommend methods and types of fill to be used in the installation of underground utility lines. (Recommendation No. P-72-53)

6. The Washington Gas Light Company

(a) Extend, in cooperation with other utility companies and governmental agencies, the Miss Utility program to receive reports of proposed excavation work in the entire Washington metropolitan area. (Recommendation No. P-72-54)

(b) Develop a sectionalizing program of its high-pressure distribution system so that preplanned procedures are available to isolate any section of its system in an emergency. (Recommendation No. P-72-55)

(c) Train and equip all appropriate radio-equipped field personnel to locate and operate main line valves under the direction of knowledgeable office personnel. (Recommendation No. P-72-56)

(d) Expand its customer education program so that its customers and the general public can be made aware of the proper action to take if gas leaks are detected. (Recommendation No P-72-57)

(e) Maintain a leak log which will give appropriate information relative to all aspects of receiving and responding to reported leaks. This information should be analyzed periodically to provide information which will readily point out problem areas in WGL's response. (Recommendation No. P-72-58)

(f) Indentify all valves in the field to permit positive identification. (Recommendation No. P-72-59).

(g) Realign its dispatching facilities so that one dispatcher can contact all field personnel capable of responding to an emergency when such a situation is encountered. (Recommendation No. P-72-60)

(h) Coordinate the activities of the transmission and distribution department dispatcher with the customer appliance dispatcher so that an appliance serviceman is dispatched to the scene of any reported leak in the distribution system. (Recommendation No. P-72-61)

(i) Provide all maintenance foremen with the equipment necessary to squeeze off 2-inch and smaller gas lines. (Recommendation No. P-72-62)

NTSB-PAR-72-5 PIPELINE ACCIDENT REPORT- LONE STAR GAS COMPANY, FORT WORTH,TEXAS, OCTOBER 4, 1971

On October 4, 1971, a violent explosion blew out the roof and four walls of a house in Fort Worth, Texas, when a gas stove was lit, destroying the house and severly injuring its occupant.

After the fire department extinguished the blaze, the gas company employees initiated a leak search, and discovered five ruptures in the plastic distribution system that served the area. Each of these ruptures had a 1/8-inch-wide crack which extended across the top half of the pipe circumference.

The NTSB determined that the probable cause of the explosion and fire was the ignition of an accumulation of natural gas which had migrated under a pressure of 20 p.s.i.g. from a failed plastic service saddle-tapping nipple connection into the house. Contributing to the failure was its improper installation, previously imposed load stresses which resulted from the repeated operation of heavy construction equipment over the connection, and heavy rainfall which caused the soil to exert pressure on the pipe.

The specifications called for reinforcing sleeves to be fitted over the heat-fused joint between the service saddle and the 3/4-inch tapping nipple. However, these sleeves were not immediately available. Shorter lengths, not specifically designed for this task, were cut from a coil of plastic pipe and were substituted for the required sleeves.(These short sleeves, however, did not provide the required reinforcement needed to protect the heat-fusion weld.)

R & D CONSIDERATIONS

1) Undertake further studies in the field of heat-fusion welding of plastics.
2) Develop guidelines for reinforcement. special backfill, and tamping of mains and service lines in areas subject to external forces or unstable soil conditions.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-72-5	2. Government Accession No.	3. Recipient's Catalog No. PB-214 777
4. Title and Subtitle Pipeline Accident Report - Lone Star Gas Company, Fort Worth, Texas, October 4, 1971.		5. Report Date December 13, 1972 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20591		10. Work Unit No. 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		13. Type of Report and Period Covered Pipeline Accident Report October 4, 1971 14. Sponsoring Agency Code

15. Supplementary Notes

This report contains Pipeline Safety Recommendations P-72-63 thru P-72-68.

16. Abstract

At approximately 4:30 a.m. on October 4, 1971, a woman who resided in a small, frame house at 2109 Amanda Street in Fort Worth, Texas, lit a gas stove in her kitchen. A violent explosion blew off the roof and blew out the four walls of the house. The roof fell back into the burning rubble and the house was completely destroyed. The woman suffered severe burns.

The Fort Worth Fire Department arrived on the scene at 4:38 a.m., and the fire was extinguished shortly thereafter. Two gas company employees arrived at 5:10, initiated a leak search, and discovered five ruptures in the plastic-pipe distribution system that served the area. Each of these ruptures had a 1/8-inch-wide crack which extended across the top half of the pipe circumference. The rupture which caused the accident was in the service line which supplied gas to the house across the street.

The National Transportation Safety Board determines that the probable cause of the explosion and fire was the ignition of an accumulation of natural gas which had migrated under a pressure of 20 p.s.i.g. from a failed plastic service saddle-tapping nipple connection into the house. Contributing to the failure of the connection were its improper installation, previously imposed load stresses which resulted from the repeated operation of heavy construction equipment over the connection, and heavy rainfall which caused the soil to exert pressure on the pipe.

17. Key Words	18. Distribution Statement		
Lone Star Gas Company; natural gas leak; plastic pipe; service line-gas main connection; installation and inspection of gas distribution systems; migration of gas.	Released to public; distribution unlimited.		
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 20	22. Price $3.00

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IV. CONCLUSIONS

The National Transportation Safety Board concludes that:

1. The Lone Star construction specifications for the installation of plastic pipe were not specific in detailing the type, size, and kind of reinforcing sleeve to be used in service saddle-tapping nipple fusion welds.

2. The plastic gas distribution system which suffered failures in this area was installed improperly and was not adequately inspected during construction.

3. The newly installed gas distribution system had been subjected to repeated loads and stresses by the heavy equipment which had operated directly over it while widening the road and laying curbs and sidewalks.

4. The plastic service connection was weakened additionally by improper fusion and by an incorrect reinforcing sleeve. The connection failed under the stress applied to it by the rain-soaked, heaving soil.

5. The leaking gas which migrated up and seeped into the house at 2109 Amanda Street came from a break in the plastic service line which served the house across the street.

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the explosion and fire was the ignition of an accumulation of natural gas which had migrated under a pressure of 20 p.s.i.g. from a failed plastic service saddle-tapping nipple connection into the house. Contributing to the failure of the connection were its improper installation, previously imposed load stresses which resulted from the repeated operation of heavy construction equipment over the connection, and heavy rainfall which caused the soil to exert pressure on the pipe.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Office of Pipeline Safety of the Department of Transportation:

Undertake a study in the field of heat fusion of plastics and, as a result of that study, issue regulations for the heat-fusion welding of plastic piping systems i.. 49 CFR Part 192, Fusion Welding, in as much detail as is contained in the existing welding specification for steel piping systems. (Recommendation No. P-72-63).

2. The American Society of Mechanical Engineers Gas Piping Standards Committee:

(a) Develop guidelines for the use of reinforcing sleeves at plastic service line-gas main connections and incorporate them in the "Guide for Gas Transmission and Distribution Piping Systems." (Recommendation No. P-72-64).

(b) Develop guidelines for the requirements concerning reinforcement, special b.. k-fill, and tamping of mains and service lines where their installation will be subjected to external forces due to anticipated road, curb, or sidewalk construction, as well as unstable soil conditions. (Recommendation No. P-72-65).

3. The Lone Star Gas Company:

(a) Revise its plastic pipe construction specifications to include the specific type and size reinforcing sleeve to be used with each type of service saddle-tapping nipple connection. (Recommendation No. P-72-66).

(b) Educate its construction inspectors as to the necessity for correct installation of plastic piping systems. (Recommendation No. P-72-67).

(c) Undertake a program acceptable to the Railroad Commission of the State of Texas, to inspect on a random sample basis the plastic service line-gas main connections, similar to those at the accident site to determine the present condition of and the existing stress on the piping. The results of this program will determine the action to be taken on the other installations in the Lone Star system. Copies of these test results should be forwarded to the Railroad Commission of the State of Texas and the Office of Pipeline Safety of the Department of Transportation (Recommendation No. P-72-68).

6. PIPELINE ACCIDENT REPORTS AND SPECIAL STUDIES, CY-1973

The following are the four pipeline accident reports and special studies published during CY-1973.

B-PSS-73-1	Special Study - Prevention of Damage to Pipelines
B-PAR-73-1	Pipeline Accident Report - Northern States Power Co., Lake City, Minn., October 30, 1972.
B-PAR-73-2	Pipeline Accident Report - Exxon Pipeline Co., Crude Oil Explosion at Hearne, Texas, May 14, 1972.
B-PAR-73-3	Pipeline Accident Report - Atlanta Gas Light Co., Atlanta, Georgia, August 31, 1972

The Associated General Contractors of America estimate that between now and the year 2000, new construction in the U.S. will equal the entire amount of previous construction. Since almost all construction involves the movement and excavation of earth, this will undoubtedly affect pipeline safety.

A Federal Power Commission survey of interstate gas transmission pipeline indicated that from 1950-1965, "carelessness in the operation of farming, roadbuilding, and excavation equipment caused the largest number of line failures (26%)".Since 1965, while other major causes of pipeline accidents have decreased in frequency, the number of accidents caused by excavation damage has increased to 42% in 1972.

More than 600,000 of the approximately 935,000 miles of gas pipeline in the U.S. are in distribution systems. In 1972, more than 71% of distribution system accidents involved outside force damage, with 42% of these related to excavation damage.

In 1971, the Office of Pipeline Safety reported that of the 693,000 leaks which were repaired on gas distribution systems, 325,000 were caused by corrosion, 90,000 by outside force damage, 60,000 by material failures, 29,000 by construction defects, and 189,000 by "other" factors.

Among the programs which are being used to prevent damage by outside forces are: a one-call system for quick notification of all operators of underground facilities prior to excavation, publicizing the telephone number and procedures to be taken in applying for excavation permits, procedures for locating and marking pipeline facilities, more accurate and complete records and maps of underground installations, and programs for following up an accident if it does occur.

R & D CONSIDERATIONS

Improved technology for detecting underground pipes made of plastic, cast iron, and ductile iron is needed. Some operators have buried steel wire along with plastic piping so it can be located more easily with currently available equipment. A downward looking radar system seems to be the most promising approach available to locate underground pipes of various materials.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PSS-73-1	2.Government Accession No.	3.Recipient's Catalog No.
4. Title and Subtitle Special Study - Prevention of Damage to Pipelines		5.Report Date June 7, 1973 6.Performing Organization Code
7. Author(s)		8.Performing Organization Report No.
9.-Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20591		10.Work Unit No. 1108 11.Contract or Grant No. 13.Type of Report and Period Covered Special Study
12.Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		14.Sponsoring Agency Code

15.Supplementary Notes

This Special Study contains Pipeline Safety Recommendations P-73-12 through P-73-28.

16.Abstract

This special study concerns damage to gas and liquid pipelines caused by excavation and construction activities, including blasting. Several recent damage-related pipeline accidents are described, and Federal, State, and industry statistics are provided in order to illustrate the scope of the problem. The study discusses the damage-prevention responsibilities of excavators, contractors, and pipeline operators. Programs, methods, and devices which have proven effective in preventing damage to pipelines are reviewed, as are laws and proposed laws in several States and local communities. A model statute issued by the Office of Pipeline Safety of the U. S. Department of Transportation is discussed. The study contains recommendations which are intended to help prevent future damage-related pipeline accidents.

17.Key Words Pipeline Accidents, Excavation Damage to Pipelines, Excavation Equipment, Utility Coordinating Committees, One-Call Notification Systems, OPS Model Statute.		18.Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Va., 22151	
19.Security Classification (of this report) UNCLASSIFIED	20.Security Classification (of this page) UNCLASSIFIED	21.No. of Pages 35	22.Price

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V. CONCLUSIONS

Pipeline accidents caused by excavation and construction activities, including blasting, can be prevented. Although new technological advancements and new concepts should be developed, the hardware and the knowledge currently available in many parts of the country can be used to reduce the number of excavation-damage accidents. The major effort must come on the local level.

The operators of all underground systems must work together with local government officials, contractor associations, individual contractors, State officials, planners, and developers. The first step in achieving cooperation is generally the formulation of a Utility Coordinating Committee in a local area. In many instances, these committees will need guidance and a background of local and State laws and regulations to assist them in preventing damage during excavation activities.

Guidance and assistance could come from statewide coordinating committees and even a national organization of Utility Coordinating Committees, which could help distribute information concerning the latest techniques and methods of preventing damage. Regulatory measures should require notification of excavation work and should be sufficiently flexible to permit the operators of underground systems to establish convenient methods of receiving notification. Penalties should be adequate to deter potential violators and to encourage cooperation by all parties concerned.

Regulatory measures alone will not prevent damage. The OSHA regulations, if complied with by the excavators, might be all that are needed. Statutes and regulations must be augmented by on-going damage-prevention programs of the pipeline operators. These programs must be given priority and must provide the rapid service that the excavator needs to avoid damaging an operator's facilities. The assistance of the excavator and his machine operator in determining methods of and cooperation in avoiding damage should be enthusiastically sought. They should be educated as to the damage and loss of life which they can cause and should be given as much assistance as necessary to help them avoid hitting a pipeline. On the other hand, both contractors and machine operators should be licensed and have their licenses revoked if they will not cooperate and if they continue to cause accidents. A concerted effort by all parties involved can drastically reduce the number of excavation accidents.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Office of Pipeline Safety of the Department of Transportation:
   (a) Amend 49 CFR 192 and 49 CFR 195 to require each pipeline operator to establish a program for the prevention of excavation-type damage to its underground facilities.[5] (Recommendation No. P-73-12)
   (b) Revise its methods of summarizing the reports of individual gas pipeline leaks and failures to show clearly those accidents resulting from excavation activities. (Recommendation No. P-73-13)

[5] This recommendation is similar to Recommendation 1(a) in the Burlington, Iowa, pipeline accident report. (See Reference 3.)

(c) Amend CFR 192 and 49 CFR 195 to require that consideration be given during the design of pipelines to prevention of damage to them in the future, especially in locations where later excavation might be expected. (Recommendation No. P-73-14)

2. The American Public Works Association:
   (a) Encourage its local chapters to establish Utility Coordinating Committees in all urban and suburban communities where effective committees are not currently in operation. (Recommendation No. P-73-15)
   (b) In regard to Recommendation 2(a), develop guidelines that will assist communities to develop systems, procedures, and organizational arrangements for coordinating and regulating the activities of all parties working near underground facilities. (Recommendation No. P-73-16)
   (c) Encourage its local chapters to adopt standards which show the desired locations for all facilities installed below ground. (Recommendation No. P-73-17)
   (d) Develop standard colors for identifying underground facilities to be used for temporary marking and staking by operators of such facilities, and urge local chapters to support adoption and use of these standard colors. (Recommendation No. P-73-18)
   (e) Coordinate, with support from the groups which participated in the Safety Board's April 18, 1972 symposium, the establishment of a national organization of Utility Coordinating Committees. (Recommendation No. P-73-19)

3. The National Association of Regulatory Utility Commissioners:
   (a) Urge its member commissions to encourage the establishment of local and statewide Utility Coordination Committees where non exist. (Recommendation No. P-73-20)
   (b) Urge its member commissions to propose and support legislation that will help prevent damage. (Recommendation No. P-73-21)
   (c) Urge its member commissions to propose and support legislation requiring persons planning to excavate, and operators of excavation equipment to be licensed. (Recommendation No. P-73-22)

4. The American Society of Mechanical Engineers Gas Piping Standards Committee:
   (a) Develop guidelines that can be followed by gas pipeline operators during design and installation of piping systems, with emphasis on prevention of future excavation damage. (Recommendation No. P-73-23)
   (b) Develop guidelines to assist gas pipeline operators in establishing excavation damage prevention programs. (Recommendation No. P-73-24)

5. The American National Standards Institute Section Committee for Liquid Petroleum Transportation Piping Systems (ANSI B31.4) include in its standards the requirement that consideration be given, during design and installation of liquid piping systems, to avoiding future excavation damage. (Recommendation No. P-73-25)

6. The American Petroleum Institute develop guidelines to assist liquid pipeline operators to establish excavation-oriented damage prevention programs. (Recommendation No. P-73-26)

7. The American General Contractors of America and the International Union of Operating Engineers develop guidelines to be used by contractors and machine operators prior to and during construction, with emphasis on prevention of damage to underground facilities. (Recommendation No. P-73-27)

8. The American Gas Association and the Independent Natural Gas Association of America design a standard gas pipeline marker that can be utilized by all gas pipeline operators to mark the location of their transmission pipelines. (Recommendation No. P-73-28)

NTSB-PAR-73-1 PIPELINE ACCIDENT REPORT - NORTHERN STATES POWER CO., LAKE CITY, MINN.,OCTOBER 30, 1972.

On October 30, 1972, a bulldozer struck and snapped a 3/4-inch steel gas service line in Lake City, Minn. Gas at 36-psig pressure migrated to a department store which blew up and later caught fire. Six persons died and 10 more were injured.

The power company later unearthed the entire gas line and discovered that in addition to being snapped by the bulldozer, the line had also been pulled out of compression coupling next to the main.

The NTSB determined that the probable cause of the accident was the ignition of an accumulation of natural gas leaking from the unmarked service line which had been struck by the bulldozer. Contributing to the accumulation of gas was the failure of the company representatives to realize that the 15-foot displacement of the pipe meant that another break had occurred elsewhere. Also contributing to the migration and permeation of gas from the leak into the department store was the wooden plug which was inserted into the broken pipe to stop the flow of gas, but which acted to seal off the escape route for the gas.

R&D CONSIDERATIONS

1) Undertake a study of fail-safe devices which will stop the flow of gas from ruptured gas lines.
2) Study methods of readily identifying conditions which could produce forces or loads on compression couplings which cannot be sustained.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-73-1	2. Government Accession No.	3. Recipient's Catalog No. PB-221 393
4. Title and Subtitle PIPELINE ACCIDENT REPORT - Northern States Power Company, Lake City, Minn., October 30, 1972		5. Report Date May 16, 1973 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20591		10. Work Unit No. 1074 11. Contract or Grant No. 13. Type of Report and Period Covered Pipeline Accident Report October 30, 1972
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		14. Sponsoring Agency Code

15. Supplementary Notes

The report contains Pipeline Safety Recommendations P-73-2 through P-73-11.

16. Abstract

The report details the pipeline accident

At 4:15 p.m., on October 30, 1972, a bulldozer struck and snapped a ~~3/4-inch~~ gas-service line ~~in Lake City, Minn.~~ ~~At 4:30 p.m.,~~ a department store located near the rupture, but not served by gas, blew up and later caught fire. Six persons died as a result of the explosion and 10 more were injured.

The Northern States Power Company (NSP) later unearthed the entire service line and discovered that in addition to being snapped by the bulldozer, the line had been pulled out of a compression coupling next to the main. Gas, at 36 p.s.i.g pressure, had permeated the soil, migrated into the department-store basement, accumulated, and exploded.

The National Transportation Safety Board determines that the probable cause of the explosion and fire in the department store basement was the ignition of an accumulation of natural gas leaking from the unmarked service line which had been struck by the bulldozer.

17. Key Words	18. Distribution Statement
Pipeline accident, natural-gas leakage, compression couplings, pipeline safety standards, public awareness of gas emergencies, valve operations, gas migration through soil, electric-switch ignition.	Document is available to the public through the National Technical Information Service, Springfield, Va., 22151.

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	23	$3.00

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IV. CONCLUSIONS

The National Transportation Safety Board concludes that:

1. The source of the explosion in the department store was natural gas which leaked from a pulled compression coupling, permeated the soil, migrated into the basement through fissures in the cellar walls, and accumulated in the basement.

2. The 15-foot displacement of the pipe by the bulldozer should have warned observers that some failure had occurred at some point other than the visible break.

3. The buildings adjacent to the leak were not checked for gas, in violation of the intent of the NSP Gas Operation and Maintenance Procedures Manual. The manual, however, placed more emphasis on testing and checking for gas than on the evacuation of inhabitants.

4. The wooden plug driven into the severed end of the service line shut off the avenue of escape for the leaking gas, increased the gas pressure within the soil, and caused the gas to permeate the surrounding soil and migrate into the department store more rapidly than would otherwise have occurred.

5. The flow of gas through the failed service line was not shut off expeditiously, because the necessary valve key was on a service truck miles from the scene. Two other local valves to stop the gas flow were inoperable for the same reason.

6. It is questionable whether the designation by NSP of only one emergency valve for the entire Lake City distribution system complies with the general intent of 49 CFR 192.181(a). That regulation, however, does not establish objective criteria for the number and location of such valves.

7. A preconstruction meeting was not held between the gas company and the contractor nor was one required to be held. Such a meeting, however, might have shown what gas lines were in the work area and might have averted this accident.

8. The Safety and Health ... contained in 29 CFR 1926.651(a) does not require that a definite determination be made whether any underground facilities exist in the immediate area of construction work. This part of the regulation appears unenforceable as presently written.

9. The compression coupling pulled out as a result of the line being hit and displaced by the bulldozer.

10. The Federal pipeline regulations (49 CFR 192) are vague insofar as establishing the conditions under which compression-type couplings may be used. The decision of whether to use such couplings, in effect, is left to the individual gas-company design engineer.

11. The Lake City Fire Department, Police Department, and Office of Civil Defense combined effectively to extinguish the fire, evacuate the dead and injured and maintain order in the affected area.

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the explosion and fire in the department store basement was the ignition of an accumulation of natural gas leaking from the unmarked service line which had been struck by the bulldozer.

Contributing to the accumulation of gas was the failure of the NSP representative to realize that the 15-foot displacement of the pipe meant that another break had occurred elsewhere.

Contributing to the migration and permeation of gas from the leak into the department store was the wooden plug which was inserted in the broken pipe end in an effort to stop the flow of gas, but which sealed off the escape route for the gas.

Contributing to the amount of gas released was the unavailability of the required valve key, which necessitated a time-consuming excavation and exposure of the buried valve before it could be shut off.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Office of Pipeline Safety of the Department of Transportation:

(a) Undertake a study of fail-safe devices which will stop the flow of gas from ruptured lines. Based on the results of this study, OPS should consider amending 49 CFR 192 to require the installation of such devices at appropriate locations in gas distribution systems. (Recommendation No. P-73-2)

(b) Undertake a review of 49 CFR 192.367(b) relative to the uncertainty as to the conditions which permit the use of compression couplings, and initiate a rulemaking which will definitely identify conditions which permit or prohibit the use of compression couplings. If necessary, the review should include a study of objective methods of readily identifying conditions which could produce forces or loads which cannot be sustained. (Recommendation No. P-73-3)

(c) Amend 49 CFR 192.181(a) to include requirements which express clearly the intent of OPS concerning the number and the location of emergency valves in high-pressure gas distribution systems and which treat the need for keys in the hands of local authorities. (Recommendation No. P-73-4)

2. The Department of Labor review its Occupational Safety and Health Regulation 29 CFR 1926.651(a) to require that a positive determination be made as to the location of underground facilities at the proposed excavation site. (Recommendation No. P-73-5)

3. The American Society of Mechanical Engineers Gas Piping Standards Committee develop guidelines to be used by distribution pipeline operators in designating the location of emergency valves to be used to assure a minimum time to shut down a section of main in an emergency. (Recommendation No. P-73-6)

4. The Northern States Power Company:

(a) Revise the Gas Operating and Maintenance Procedures Manual to emphasize more fully and clearly the importance of rapidly shutting down failed pipelines, evacuating persons from the affected area, checking buildings adjacent to the leak area, and notifying police and fire officials. Attention should be given to the importance of having the proper valve keys immediately available. (Recommendation No. P-73-7)

(b) Designate emergency valves in its distribution systems to permit rapid shutdown of failed sections without interrupting gas service to an entire community. (Recommendation No. P-73-8)

(c) Emphasize to the maintenance personnel the importance, need, and desirability of supplying pipeline location information and clearly marking existing lines. (Recommendation No. P-73-9)

(d) Undertake to inform the public more fully as to the nature, characteristics, and hazards of natural gas and the steps to be taken when it is encountered. (Recommendation No. P-73-10)

5. The Department of Public Works of Lake City, Minn., require coordination between the contractors and the affected owners and operators of underground facilities in the city as a prerequisite for obtaining a construction permit. (Recommendation No. P-73-11)

NTSB-PAR-73-2 PIPELINE ACCIDENT REPORT - EXXON PIPELINE CO., CRUDE OIL EXPLOSION AT HEARNE, TEXAS, MAY 14, 1972

This report describes and analyzes the explosion on May 14, 1972 of crude oil vapors which had sprayed from a 6-inch long rupture in a 8-inch liquid pipeline near a pumping station in Hearne, Texas. The explosion was followed by a fire which consumed over 300,000 gallons of crude oil. One person was killed, two injured, one house was destroyed,and several nearby communications lines were melted.

The pressure in the 48-year old pipeline at the point of the failure had increased over a 10-hour period from 400 psig to 530 psig. There were no pressure-relief devices installed on this system.

NTSB determined that the probable cause of the failure was excessive internal liquid pressure. Contributing to the failure of the pipe was its thin-wall condition, caused by corrosion of the unprotected bare steel walls.

R&D CONSIDERATIONS

No R&D requirement.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-73-2	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report - Exxon Pipe Line Company, Crude Oil Explosion at Bearne, Texas, May 14, 1972		5. Report Date August 1, 1973 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20591		10. Work Unit No. 1131 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		13. Type of Report and Period Covered Pipeline Accident Report May 14, 1972 14. Sponsoring Agency Code

15. Supplementary Notes

This report contains Pipeline Safety Recommendations P-73-29 through P-73-36.

16. Abstract

This report describes and analyzes the explosion, on May 14, 1972, of crude oil vapors which had sprayed from a ruptured 8-inch pipeline operated by the Exxon Pipe Line Company near Bearne, Texas. The explosion was followed by a fire, which killed one person, seriously burned two others, destroyed a house, and melted nearby railroad, telephone, and pipeline communications lines.

The National Transportation Safety Board determines that the probable cause of the explosion and fire was the ignition of an accumulation of crude oil vapors which had sprayed from a shutdown, closed-in pipeline which had ruptured by excessive internal pressure. Contributing to the failure of the pipe was its thin-wall condition, caused by corrosion of the unprotected bare steel walls.

The report contains recommendations to the Office of Pipeline Safety of the Department of Transportation and the Exxon Pipe Line Company. The recommendations to OPS concern hydrostatic testing of old lines and the clarification of 49 CFR 195.408, "Communications". The recommendations to Exxon concern steps which should be taken for safer operation of this and other Exxon pipelines.

17. Key Words Closed-in Pipeline, Crude Oil, Thermal Expansion (Crude Oil), Corrosion, Pipeline Pressure Relief, Cathodic Protection, Hydrostatic Testing, Continuous Reading Station Discharge Pressure Recorders, Alternate Pumping		18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151.	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 23	22. Price $3.00

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IV. CONCLUSIONS

The National Transportation Safety Board concludes that:

1. The Exxon Pipe Line Company's 8-inch pipeline from Conyo to Satsuma was not structurally adequate for the containment of crude oil under the static pressures in effect at the time of the rupture.

2. At the time of the accident, there were no pressure-relief devices installed and in operation on this system. If such devices had been in operation and had been set at a pressure which reflected accurately the true condition of the pipeline, the line failure would not have occurred.

3. The successful 1,100-p.s.i.g. hydrostatic test performed on this pipeline by Exxon in 1958 was nullified by the effects of continued corrosion. The line failed at 530-p.s.i.g. pressure.

4. It will be necessary to conduct a new hydrostatic test on at least this failed section of line in order to evaluate the current condition of the pipe and to determine accurate pressure data on which to base a safe pressure rating.

5. The lack of facilities to transmit the continously recorded line pressures from the unattended pump stations to the dispatching office resulted in the dispatchers' being unaware of trouble in the closed-in system.

6. At the time of the accident, Exxon was not in conformance with the intent of 49 CFR 195.408, Communications. This regulation, however, is vague and therefore unenforceable, and is not specific enough to guide pipeline companies to provide the correct kind and amount of communicable information for the safe operation of pipelines.

7. Unawareness on the part of the dispatchers of any line trouble from 12:30 a.m. until 6:20 a.m. resulted in the late notification of the maintenance personnel and the subsequent failure to shut off the leaking crude oil until after the explosion and fire.

8. The 4½-hour lapse between the line rupture and the explosion allowed enough crude oil to escape to fuel a fire which temporarily severed all pipeline, railroad, and telephone communications and blocked the main highway into Bearne from the south.

9. If an undetected leak of this nature had occurred in a more densely populated area, numerous fatalities, more injuries, and greater property damage would have occurred.

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the explosion and fire was the ignition of an accumulation of vapors from crude oil which had sprayed from a shutdown, closed-in pipeline that had been ruptured by excessive internal pressure.

Contributing to the excessive internal pressure were an increase in the temperature of the crude oil within the pipe, the resultant expansion of the crude oil, and the failure by the pipeline company to provide any pressure relief for the closed-in pipeline system.

Contributing to the failure of the pipe was its thin-wall condition, caused by the corrosion of the unprotected bare steel walls. The lack of any Federal regulations to require periodic, hydrostatic pressure testing was a factor in the pipeline rupture.

periodic hydrostatic retesting of these pipelines or progressive reduction in their operating pressures based upon the effects of continuing corrosion, or both. (Recommendation No. P-73-29.)

(b) Amend the 49 CFR 195.408, Communications, to describe more fully the type of information required for the safe operation of pipelines and the conditions under which this information should be transmitted remotely. (Recommendation No. P-73-30.)

2. The Exxon Pipe Line Company:

(a) Install pressure relief devices on this system and similar systems, if applicable, to prevent a repetition of the failure of a closed-in system due to overpressure. (Recommendation No. P-73-31.)

(b) Install facilities capable of remotely transmitting the continuous recording pressures from the Comyn and Hearne pump stations to the central dispatching office. (Recommendation No. P-73-32.)

(c) Instruct the dispatchers to monitor carefully those lines which are closed-in and inoperative to preclude the possibility of overpressure. (Recommendation No. P-73-33.)

(d) Initiate a thorough cathodic protection survey over this system, from Hearne to Satsuma as a minimum, and at random intervals uncover and physically inspect the pipe, with particular emphasis on the known "hot spot" corrosion areas. (Recommendation No. P-73-34.)

(e) Add additional cathodic protection equipment, based upon the results of this survey, to mitigate the continuing effects of corrosion on this system. (Recommendation No. P-73-35.)

(f) Not operate or close in the Comyn to Satsuma system from Hearne to Satsuma at a pressure greater than 400 p.s.i.g., until at least this section of line has been hydrostatically tested successfully and found to be safe for higher operating pressures. (Recommendation No. P-73-36.)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

August 1, 1973

NTSB-PAR-73-3 PIPELINE ACCIDENT REPORT - ATLANTA GAS LIGHT CO., ATLANTA, GEORGIA, AUGUST 31, 1972

This report describes and analyzes a gas explosion which occurred on August 31, 1972 in the one-story annex building of an Atlanta high school. Gas had leaked into the building from a cracked 6-inch cast-iron gas main. The building was evacuated and gas company employees arrived 30 minutes before the explosion. One person died and seven were injured.

The NTSB determined that the probable cause of the accident was the ignition of gas which migrated from the pipeline which had cracked as a result of uneven soil settlement which applied a bending force to the pipe in an area weakened by graphitization (corrosion). Contributing to the explosion was the failure of the gas company to check for gas in the building, to shut off the flow of leaking gas, and to notify police and fire officials.

R & D CONSIDERATIONS

1) A more extensive testing program to determine the effect of graphitization on the strength of cast iron pipe would be useful in establishing at what point a graphitized main should be considered for replacement.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-73-3	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report - Atlanta Gas Light Company, Atlanta, Georgia, August 31, 1972.		5. Report Date August 16, 1973
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20591		10. Work Unit No. 1138
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C 20591		13. Type of Report and Period Covered Pipeline Accident Report August 31, 1972
		14. Sponsoring Agency Code

15. Supplementary Notes
This report contains Pipeline Safety Recommendations P-73-37 through P-73-46.

16. Abstract

This report describes and analyzes a gas explosion which occurred shortly after 9 a.m. on August 31, 1972 in the annex building of an Atlanta, Ga., high school. Gas had leaked into the building from a cracked cast-iron main located beneath the street in front of the annex. Atlanta Gas Light Company (AGL) personnel arrived at the leak site approximately 1 hour after AGL was first notified of the leak and approximately 1/2 hour before the explosion. One person died and seven others were injured as a result of the accident.

The National Transportation Safety Board determines that the probable cause of the explosion was the ignition of gas that leaked from a cast-iron main cracked by uneven soil settlement which applied a bending force to the pipe in an area weakened by graphitization. Contributing to the explosion was the failure by the gas company to check for gas in the building, to shut off the flow of leaking gas, and to notify police and fire officials.

The report contains recommendations to the Office of Pipeline Safety of the Department of Transportation, the American Society of Mechanical Engineers Gas Piping Standards Committee, and the Atlanta Gas Light Company. The recommendations concern, among other items, OPS accident-reporting requirements, nationwide compliance with Federally required written emergency procedures, factors involved in cast-iron pipe failures, and the effect of graphitization on cast-iron mains.

17. Key Words	18. Distribution Statement
Natural Gas Explosion, Cast Iron, Fractured Cast-Iron Pipes, Pipeline Shutdown Delay, Natural Gas Leak, Migration of Gas, Fire Department Liaison, Graphitization, Pipeline Safety Standards, Corrosion	This document is available to the public through the National Technical Information Service, Springfield Va., 22151

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	30	3.00/1.45

NTSB Form 1765.2 (11/70)

CONCLUSIONS

1. The Atlanta Gas Light Company was not in compliance with 49 CFR 192.615, which requires written emergency procedures.

2. The actual hazard that existed at the annex building was not known by AGL when it received the leak report, nor was it determined by the emergency crew after they arrived at the scene.

3. An accurate history of the causes of breakage of cast-iron mains cannot be obtained from the accident reports filed with the Office of Pipeline Safety by the gas distribution operators.

4. Preventative measures are needed to reduce the hazard from fractures of cast-iron mains. These measures can be determined by a systematic review of conditions that cause such failures.

5. The role of graphitization in failures of cast-iron mains has been established by the National Bureau of Standards. Graphitization reduces wall thickness, which, in turn, reduces resistance to bending stress.

6. It is difficult to determine the extent of external corrosion in cast-iron pipe by the visual examination required by 49 CFR 192.459.

7. Since AGL records did not indicate the frequency and causes of failures of cast-iron mains, it was difficult for AGL to assess the problem accurately and plan remedial action.

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the explosion was the ignition of gas that leaked from a cast iron main cracked by uneven soil settlement which applied a bending force to the pipe in an area weakened by graphitization.

Contributing to the explosion was the failure by the gas company to check for gas in the building, to shut off the flow of leaking gas, and to notify police and fire officials.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Office of Pipeline Safety of the Department of Transportation:

   (a) Improve the accident-reporting requirements in order to obtain a better understanding of the causes of failures of cast-iron mains. (Recommendation No. P-73-37)

   (b) In cooperation with the various State regulatory agencies, determine the degree of nationwide compliance with 49 CFR 192.615, written emergency procedures, and take enforcement action accordingly. (Recommendation No. P-73-38)

(c) In cooperation with the various State regulatory agencies, encourage gas distribution operators to review the factors that cause failures in cast iron mains in their systems, and to take necessary action to reduce the hazard to the public. (Recommendation No. P-73-39)

(d) Give additional regulatory consideration to the effects of graphitization on the resistance of cast-iron mains to external loads. Localized and general graphitization should be defined. (Recommendation No. P-73-40)

2. The American Society of Mechanical Engineers Gas Piping Standards Committee:

(a) Develop criteria which can be used by gas distribution operators for reducing the potential hazards from breaks in cast-iron mains. The criteria should consider replacement or repair of mains, based on pipe size, graphitization, external loads, traffic, soil condition and stability, and gas pressure. (Recommendation No. P-73-41)

(b) Develop guidelines for determining the extent of graphitization of cast-iron pipe by means of visual examination, as required in 49 CFR 192.459, and the effects of such graphitization on possible future leaks or fractures. (Recommendation No. P-73-42)

3. The Atlanta Gas Light Company:

(a) Prepare written emergency procedures and acquaint appropriate operating and maintenance employees with the procedures. (Recommendation No P-73-43)

(b) Improve its record-keeping system so that the number and causes of cast-iron main breaks can be readily obtained. (Recommendation No. P-73-44)

(c) Take whatever remedial action is necessary to reduce the possibility of breakage of cast-iron mains. This action should include replacement of those sections of cast-iron main susceptible to failure. (Recommendation No. P-73-45)

(d) Develop a sectionalizing program of its high-pressure distribution system so that preplanned procedures are available to isolate any section of its system in an emergency. (Recommendation P-73-46)

7. PIPELINE ACCIDENT REPORTS AND SPECIAL STUDIES, CY-1974

The following are the six pipeline accident reports published during CY-1974.

NTSB-PAR-74-1	Pipeline Accident Report - UGl Corp., Coopersburg, Penn., February 21, 1973
NTSB-PAR-74-2	Pipeline Accident Report - Southern Union Gas Co., El Paso, Texas, April 22, 1973
NTSB-PAR-74-3	Pipeline Accident Report - Missouri Public Service Co., Clinton, Missouri, December 9, 1972
NTSB-PAR-74-4	Pipeline Accident Report - Columbus Gas of West Virginia, Inc., Charlestown, West Virginia, December 2, 1973
NTSB-PAR-74-5	Pipeline Accident Report - Washington Gas Light Co., Bowie, Maryland, June 23, 1973
NTSB-PAR-74-6	Pipeline Accident Report - Mid-America Pipeline System Anhydrous Ammonia Leak, Conway, Kansas, December 6, 1973

NTSB-PAR-74-1 PIPELINE ACCIDENT REPORT - UGI CORP., COOPERSBURG, PENN., FEBRUARY 21, 1973

This report describes and analyzes a natural gas explosion in Coopersburg, Penn., on February 21, 1973. A contractor was constructing a sewer line parallel to and near a 49-year old, 8-inch bare steel gas main. Dynamite charges were detonated and the contractor notified the gas company that gas was escaping and he thought the line had been broken. Gas company personnel arrived and attempted to evacuate a nearby apartment house. The building exploded and collapsed and the escaping gas caught fire. Five persons were killed, 16 were injured, and two buildings were destroyed.

The NTSB determined that the probable cause of the explosion and fire was the ignition of an accumulation of gas which leaked from an acetylene weld in the gas line after the weld had cracked by the detonation of excessively heavy and closely positioned dynamite charges. Contributing to the accident was the failure of the municipality and the gas company to act upon an earlier warning by the gas company inspector about excessive use of dynamite and the failure of the contractor to fully observe blasting regulations.

R & D CONSIDERATIONS

No R & D requirement

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-74-3	2. Government Accession No.	3. Recipient's Catalog No. PB 232 678
4. Title and Subtitle Pipeline Accident Report -- UGI Corporation, Coopersburg, Pennsylvania, February 21, 1973.		5. Report Date February 7, 1974 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20591		10. Work Unit No. 1242 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		13. Type of Report and Period Covered Pipeline Accident Report February 21, 1973 14. Sponsoring Agency Code

15. Supplementary Notes

This report contains Pipeline Safety Recommendations P-74-1 through P-74-9.

16. Abstract

This report describes and analyzes a natural gas explosion in Coopersburg, Pa., on February 21, 1973. A gas pipeline was ruptured by dynamite, and gas at 50 psig entered an apartment house and exploded. Five persons were killed, 16 persons were injured, and 2 buildings were destroyed.

The National Transportation Safety Board determines that the probable cause of the explosion and fire was the ignition, by an unknown source, of an accumulation of gas which leaked from an acetylene weld in an 8-inch pipeline after the weld had been cracked by the detonation of excessively heavy and closely positioned dynamite charges. Contributing to the pipeline failure was the failure of the Municipal Authority of the Borough of Coopersburg and the UGI Corporation to act upon an earlier warning by a UGI inspector about excessive use of dynamite near this gas main, despite a previous gas leak which had been caused by dynamiting on this same construction project.

The report contains recommendations to the National League of Cities, the National Association of Counties, the U. S. Conference of Mayors, the U. S. Office of Pipeline Safety, the American Society of Mechanical Engineers, and the UGI Corporation. These recommendations include proposals for more adequate inspection of pipelines during outside construction, more comprehensive and detailed preconstruction meetings, and preplanned emergency procedures.

17. Key Words Natural Gas Explosion, Dynamite, Construction, Acetylene Welds, Migration of Gas, Pipeline Safety Standards, Preplanned Emergency Procedures, Preconstruction Meeting, Liaison, Pipeline Marking.		18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Va., 22151.	
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IV. CONCLUSIONS

1. The failure of the acetylene weld was caused by a sudden, abrupt, external shock wave produced by an excessive weight of dynamite charges detonated next to the gas main.

2. A previous gas leak caused by dynamiting did not alert the contractor, UCI, or the Municipal Authority to the hazard of blasting near gas lines. The warning given by the UCI inspector to the contractor, UCI, and the Municipal Authority about the excessive weight of the dynamite charges and their proximity to the 8-inch gas main also went unheeded.

3. No preplanned emergency procedure had been prepared by UCI to cope immediately with the consequences of a serious gas leak.

4. Although the Municipal Services Conference had been held with the Municipal Authority, the contractor, UCI, and other affected parties, no one had carefully detailed the proposed dynamiting, nor had the size or proximity of charges been discussed.

5. The Municipal Authority, through the engineer whom it had assigned to the sewer project, failed to inspect closely enough to prevent the contractor from using unsafe blasting practices.

6. The weight of the charge and the detonation of one heavy charge below the line instead of three light charges at various depths were in excess of State blasting regulations.

7. The actions of the UCI and contractor's personnel as well as those of the Pennsylvania State Police and the Coopersburg fire and police departments in extinguishing the fire, evacuating the injured, and maintaining order were exemplary.

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the explosion and fire was the ignition, by an unknown source, of an accumulation of gas which leaked from an acetylene weld in an 8-inch pipeline after the weld had been cracked by the detonation of excessively heavy and closely positioned dynamite charges.

Contributing to the pipeline failure was the failure of the Municipal Authority of the Borough of Coopersburg and the UCI Corporation to act upon an earlier warning by a UCI inspector about excessive use of dynamite near this gas main, despite a previous gas leak which had been

caused by dynamiting on this same construction project. Contributing to the excessive weight of the dynamite charges was the failure by the sewer contractor to observe fully the State blasting regulations. Contributing to the explosion and fire was the lack of a specific preplanned emergency procedure for leaks. Contributing to the delay in extinguishing the fire was the failure to isolate rapidly the failed section of pipe.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Office of Pipeline Safety of the Department of Transportation issue regulations to require that pipeline operators have definite procedures to protect their facilities affected by blasting operations. These regulations should consider, at a minimum, the age of the pipeline, the operating pressure, the type of weld or mechanical joint, the general condition of the facility, the type of soil, and the area geography. (Recommendation No. P-74-1)

2. The American Society of Mechanical Engineers Gas Piping Standards Committee develop guidelines for use by pipeline operators to protect pipeline facilities affected by blasting operations. (Recommendation No. P-74-2)

3. The Municipal Authority of the Borough of Coopersburg, the National League of Cities, the National Association of Counties, and the U. S. Conference of Mayors:

   (a) Initiate more comprehensive and more controlling inspection procedures on construction projects to insure that all work is performed safely and correctly as detailed in construction plans and specifications, particularly where blasting is involved. (Recommendation No. P-74-3)

   (b) Conduct comprehensive and detailed preconstruction meetings for all projects to explain the full scope, timing, and critical or hazardous elements involved. At these meetings, the contractor and the affected utility companies should be instructed to work closely with each other and with any Government representatives on the jobsite. (Recommendation No. P-74-4)

   (c) Insure that any utility company affected by construction have a preplanned emergency procedure which is understood by all parties and which can be carried out expeditiously. (Recommendation No. P-74-5)

(d) Use a qualified inspector on each Government job, who will be at the jobsite at all times during construction. (Recommendation No. P-74-6)

4. The UGI Corporation:

(a) Initiate more controlling inspection procedures on construction projects in the vicinity of all gas facilities. Where these projects involve blasting, the UGI inspector should observe the shot hole loadings and obtain a copy of the blaster's "diary" for UGI records. (Recommendation P-74-7)

(b) Initiate specific preplanned emergency procedures for use when construction projects are in proximity to gas facilities. Such procedures should include the use of preselected and prelocated valves which can be closed immediately in the event of a gas lead. (Recommendation No. P-74-8)

(c) Develop liaison, before and during construction, with the contractor and other parties affected by construction. As part of this liaison, UGI should fully inform the contractor and the other parties of emergency procedures and should be fully informed of the daily progress of construction. (Recommendation No. P-74-9)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

February 7, 1974

John H. Reed, Chairman, and William R. Haley, Member, were absent, and did not participate in the adoption of this report.

NTSB-PAR-74-2 PIPELINE ACCIDENT REPORT- SOUTHERN UNION GAS CO., EL PASO, TEXAS, APRIL 22, 1973

A natural gas explosion occurred in El Paso, Texas, on April 22, 1973. The explosion destroyed seven of 15 units in an apartment complex, killed seven people, and injured eight.

The explosion was caused by the migration and ignition of an accumulation of natural gas which had leaked primarily from a broken thread in a cast-iron reducer and to a lesser extent from two nearby corrosion leaks in the 2-inch cast iron distribution main. The uncovering and disturbing of the earth around the pipe by the gas company 6 days earlier, in an unsuccessful search for a gas leak, contributed to the failure of the 6-inch to 2-inch reducer.

The fact that the reducer was cast-iron, a more brittle material than steel, contributed to the thread failure. The gas company also did not follow up the report of its maintenance crew that a reported leak could not be located.

R & D CONSIDERATIONS

No R & D requirement

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-74-2	2. Government Accession No.
3. Recipient's Catalog No. PB-229 968	
4. Title and Subtitle: Pipeline Accident Report - Southern Union Gas Company, El Paso, April 22, 1973	5. Report Date February 13, 1974
7. Author(s)	6. Performing Organization Code
	8. Performing Organization Report No.
9. Performing Organization Name and Address: National Transportation Safety Board, Bureau of Surface Transportation Safety, Washington, D. C. 20591	10. Work Unit No. 1244
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address: NATIONAL TRANSPORTATION SAFETY BOARD, Washington, D. C. 20591	13. Type of Report and Period Covered: Pipeline Accident Report, April 22, 1973
	14. Sponsoring Agency Code

15. Supplementary Notes

This report contains Pipeline Safety Recommendations P-74-10 through P-74-15.

16. Abstract

This report describes and analyzes a natural gas explosion which occurred in El Paso, Texas, on April 22, 1973. The explosion destroyed 7 of 15 units in an apartment complex; 7 persons were killed, and 8 were hospitalized.

The National Transportation Safety Board determines that the probable cause of the explosion was the ignition of an accumulation of natural gas which had leaked primarily from a broken cast-iron reducer and to a lesser extent from two corrosion leaks in the distribution main. The gas migrated beneath the concrete road surface, permeated the area, entered the apartment complex via the crawl space, and was ignited by an undetermined source. The uncovering and disturbing of the cast-iron pipe by the gas company in an unsuccessful search for a gas leak 6 days before the accident contributed to the failure of the reducer.

The report contains recommendations to the U. S. Office of Pipeline Safety concerning regulations requiring the replacement or adequate protection of cast-iron pipe or fittings uncovered during construction or maintenance work and regulations requiring that gas company educational material for customers and the public be written bilingually in communities where a language other than English is commonly used. Recommendations are also made to the American Society of Mechanical Engineers, the American Gas Association, and the Southern Union Gas Company

17. Key Words

Natural Gas Explosion; Cast-Iron Reducer; Corrosion Leaks; Gas Migration; Public Awareness of Gas Emergencies; Pipe Support; Leak Source; Leak Followup; Removal of Pipe and Fittings.

18. Distribution Statement: This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

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Gas Odorization and Public Education

Gas odors had been detected by some tenants at least a day before the explosion, but either through ignorance or indifference to the potential danger no one had alerted the fire department or the gas company. In the past, Southern Union had distributed gas educational material to their customers, but had not included a telephone number to call in the event of a leak. This omission could be the cause of a considerable delay on the part of someone who is trying to report a gas leak. In addition, the safety messages went only to customers and did not reach all persons who might be exposed to leaking gas.

The explosion occurred in an area where many Mexican-Americans resided. This should have alerted the gas company to print the gas educational material in Spanish as well as English. It is difficult to evaluate, however, whether this precaution would have helped in this particular case. Multilanguage advertising is conducted by other pipeline operators when significant segments of the community served speak and understand languages other than English. The problem of customer and public warnings was also discussed in the Board's report of the Annandale, Va., accident of March 24, 1972. 3/

IV. CONCLUSIONS

The National Transportation Safety Board concludes that:

1. The gas which accumulated under the apartment house floors had leaked primarily from a broken cast-iron reducer and to a lesser extent from two corrosion leaks in the gas main.

2. The cast-iron reducer failed in the threaded section because of lack of adequate support from below and repeated shock loads delivered by the heavy traffic above.

3. Southern Union did not properly follow up the report of its construction and maintenance crew that the reported leak could not be located.

4. Southern Union personnel failed to locate or to determine absolutely the absence of a leak in this area before they left the scene.

5. The tenants and the apartment superintendent who had smelled gas odors failed to report the condition to either the gas company or the fire department.

3/ Report No. NTSB-PAR-72-4.

6. The El Paso Fire Department and the Police Department combined effectively to evacuate the dead and injured, to reroute traffic in the area, and to maintain order.

7. 49 CFR 192.615(d) does not specifically require pipeline operators to use languages other than English in their customer education program.

8. Neither the Federal regulations nor industry standards provide guidance to pipeline operators concerning replacement or protection of disturbed cast-iron piping.

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the explosion was the ignition of an accumulation of natural gas which had leaked primarily from a broken cast-iron reducer and to a lesser extent from two corrosion leaks in the distribution main. The gas migrated beneath the concrete road surface, permeated the area, entered the apartment complex via the crawl space, and was ignited by an undetermined source.

The uncovering and disturbing of the cast-iron pipe by the gas company in an unsuccessful search for a gas leak 6 days before the accident contributed to the failure of the reducer.

Contributing to the loss of life and the property damage were the failure of the gas company to locate or to confirm positively the existence of a leak, and the failure of both the tenants and the apartment superintendent to notify either the gas company or the fire department of the gas odors which had been detected previously.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Office of Pipeline Safety of the Department of Transportation:

(a) Amend 49 CFR 192 to require that cast-iron piping or fittings uncovered during construction or maintenance work in such a way as to weaken their support from below be replaced or reinforced to protect against outside forces which could cause failure. (Recommendation No. P-74-10)

(b) Amend 49 CFR 192.615(d) to require that educational programs intended to enable customers and the general public to recognize and report gas emergencies be printed in English and in other languages which a significant portion of the community served speak and understand. (Recommendation No. P-74-11)

2. American Society of Mechanical Engineers Gas Piping Standards Committee develop guidelines for pinpointing the location of reported gas leaks. These guidelines should include procedures to determine the degree of hazard that exists as a result of the reported leak. (Recommendation No. P-74-12)

3. The Southern Union Gas Company:

(a) Instruct the maintenance crews concerning the hazards of inadequate support during the filling of recently excavated piping facilities. (Recommendation No. P-74-13)

(b) Improve followup procedures to assure that all reported leaks are located. (Recommendation No. P-74-14)

(c) Initiate a program of instruction for gas customers and the general public concerning the potential hazards of natural gas. This program should include mailing flyers to customers which include names and telephone numbers to be used in emergencies and placing educational material in the news media. This program should, where applicable, be bilingual to reach both the English and non-English speaking communities within the distribution systems. (Recommendation No. P-74-15)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ WILLIAM R. HALEY
Member

Isabel A. Burgess, Member, was absent and did not participate in the adoption of this report

February 13, 1974

NTSB-PAR-74-3 PIPELINE ACCIDENT REPORT - MISSOURI PUBLIC SERVICE CO., CLINTON, MISSOURI, DECEMBER 9,1972

This report describes and analyzes a gas explosion and fire in downtown Clinton, Mo., on December 9, 1972. GAs had leaked into a building from a cracked 4-inch high pressure cast-iron main. Gas company employees arrived at the site 50 minutes before the explosion. Eight persons were killed and seven were injured.

The NTSB determined that the crack in the 4-inch cast-iron pipeline was caused by a combination of soil stresses and vibrations from a nearby railroad,which applied a bending force to the pipe in an area weakened by graphitization (corrosion). Contributing to the explosion were the failure of the gas company to shut off the gas to the leak site and the inadequate efforts of gas company personnel to prevent the ignition of leaking gas detected in the building.

R&D CONSIDERATIONS

1) Develop guidelines for the use of telemetering on gas distribution systems so that system failure can be promptly detected.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-74-3	2. Government Accession No.	3. Recipient's Catalog No. PB-230 617
4. Title and Subtitle Pipeline Accident Report - Missouri Public Service Company, Clinton, Missouri, December 9, 1972		5. Report Date February 27, 1974
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20591		10. Work Unit No. 1252
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		13. Type of Report and Period Covered Pipeline Accident Report December 9, 1972
		14. Sponsoring Agency Code

15. Supplementary Notes

The report contains Pipeline Safety Recommendations P-74-16 through P-74-27.

16. Abstract

This report describes and analyzes a gas explosion and fire which occurred on December 9, 1972, in downtown Clinton, Mo. Gas had leaked into a building from a cracked cast-iron main located behind the building. Missouri Public Service Company personnel arrived at the site of the reported leak 50 minutes before the explosion. Eight persons died, and seven others were injured.

The National Transportation Safety Board determines that the probable cause of the explosion was the ignition of gas that had leaked from a cast-iron main cracked by a combination of soil stresses and railroad vibration, which applied a bending force to the pipe in an area weakened by graphitization.

Contributing to the explosion were the failure of the gas company to shut off the flow of gas to the leak site and the inadequate efforts of the gas-company personnel to prevent the ignition of the leaking gas detected in the building.

The report contains recommendations to the Office of Pipeline Safety of the Department of Transportation, the American Society of Mechanical Engineers Gas Piping Standards Committee, and the Missouri Public Service Company. They concern emergency response, shutoff valve operation, and prompt detection of system failures.

17. Key Words	18. Distribution Statement		
Natural Gas Explosion, Cast-Iron Main, Pipeline Shutdown Delay, Natural Gas Leak, Telemetering, Graphitization, Pipeline Safety Standards, Migration of Gas	This document is available to the public through the National Technical Information Service, Springfield, Virginia, 22151		
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CONCLUSIONS

1. The actions taken by MPS after MPS confirmed the presence of leaking gas in the basement did not prevent the explosion.

2. The gas which exploded in the office building at 208 Main Street leaked from a cracked high-pressure cast-iron gas main and entered the building through cracks in the east basement wall.

3. The MPS emergency procedure was incomplete, because it covered the interruption of gas service to entire communities only and did not cover hazardous emergencies of lesser scope.

4. Even though certain valves were designated for use in emergency situations, MPS did not attempt to operate them initially, but instead closed them only after other non-emergency valves closer to the break could not be located. This increased the delay in shutting off the flow of gas to the break and defeated the purpose of emergency valves.

5. The practice by MPS of not providing valve keys and valve location information to all field personnel increased the time required to shut off the flow of gas.

6. The Federal safety standard in 49 CFR 192.741 concerning telemetering of distribution-system pressures is vague and inconsistent. It does not require sufficient information to permit an operator to detect failures in his system promptly.

7. The Federal pipeline safety standards do not define an emergency and do not offer adequate guidance to operators concerning the areas which should be covered in emergency procedures.

8. Although the Federal safety standards in 49 CFR 192.181 and .747 require designation and maintenance of valves to shut down a section of main in an emergency, there is no requirement that these designated valves be operated first.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the explosion was the ignition of gas that had leaked from a cast-iron main cracked by a combination of soil stresses and railroad vibra-

tion, which applied a bending force to the pipe in an area weakened by graphitization.

Contributing to the explosion were the failure of the gas company to shut off the flow of gas to the leak site and the inadequate efforts of the gas-company personnel to prevent the ignition of the leaking gas detected in the building.

RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Office of Pipeline Safety of the Department of Transportation:

   (a) Revise 49 CFR 192.741 to require pipeline operators to telemeter gas pressure or flow data in such a way as to insure prompt warnings of significant system failures shown by pressure or flow changes. The type and location of the data points should be considered on an individual basis and should include single-fed systems serving substantial numbers of customers. (Recommendation No. P-74-16)

   (b) Define what constitutes an emergency and provide clarification of the requirements of emergency procedures under 49 CFR 192.615, Emergency plans. (Recommendation No. P-74-17)

   (c) Require that designated emergency valves be the valves closed initially when a section of main is required to be isolated in an emergency. (Recommendation No. P-74-18)

2. The American Society of Mechanical Engineers Gas Piping Standards Committee:

   (a) Develop guidelines for the use of telemetering on gas distribution systems so that system failures can be promptly detected. (Recommendation No. P-74-19)

   (b) Expand the guidelines on the prevention of accidental ignition, to provide for more comprehensive guidance to pipeline operators when gas is detected in buildings and structures. The guidelines should include such subjects as ventilation of structures, prohibition of electrical switch operation, and occupant evacuation. This work should be coordinated with the guidelines currently being developed

concerning the action to be taken by the first gas company employee arriving at the scene of an emergency. 1/ (Recommendation No. P-74-20)

3. The Missouri Public Service Company:

(a) Expand its emergency procedures to include the actions to be taken in all types of emergencies. (Recommendation No. P-74-21)

(b) Install telemetering equipment at the Clinton and other town border stations, so that system failures can be promptly detected. (Recommendation No. P-74-22)

(c) Expand its formal training program to provide employees who respond to reported leaks with the knowledge and techniques required to assist them in handling emergency situations. (Recommendation P-74-23)

(d) Take remedial action to reduce the possibility of breakage of cast-iron mains. This action should include replacement of those sections of cast-iron main susceptible to failure. (Recommendation P-74-24)

(e) Develop a sectionalizing program of its high-pressure distribution system so that preplanned procedures are available to isolate any section of its system in an emergency. (Recommendation No. P-74-25)

(f) Train and equip all appropriate radio-equipped field personnel (including electric servicemen) to locate and operate main line valves in emergencies. (Recommendation No. P-74-26)

(g) Provide valve location and other necessary information to dispatchers in radio contact with servicemen, supervisors, and repair crews, so that emergency efforts can be expeditiously coordinated. (Recommendation No. P-74-27)

1/ See NTSB Recommendation P-72-48 contained in NTSB-PAR-72-4.

NTSB-PAR-74-4 PIPELINE ACCIDENT REPORT - COLUMBUS GAS OF WEST VIRGINIA, INC., CHARLESTOWN, WEST VIRGINIA, DECEMBER 2, 1973

On December 2, 1973, an explosion followed by an intense fire,killed three persons, injured two others,and destroyed a house in Charlestown, West Virginia. After the accident, two pit-hole leaks were discovered and repaired in the 2-inch bare steel gas main, operated at 39-psig pressure.

The NTSB determined that the probable cause of the accident was the ignition of an accumulation of natural gas which had migrated from the two corrosion holes in the cathodically-unprotected pipe. Contributing to the intensity of the fire was the large amount of gas which had accumulated in the attic and in the walls of the house. Gas odors were noticed by the owners of the house, but were not reported to the gas company or the fire dept.

R & D CONSIDERATIONS

1) Develop guidelines to determine when to conduct leak surveys on various types of pipes and to determine areas of actual corrosion.

2) Investigate the availability and feasibility of gas vapor detectors currently manufactured and their installation in manholes, conduits, basements and other substructures for the automatic detection and reporting of gas vapors. If none are found acceptable, sponsor research to develop such detectors.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-74-4	2. Government Accession No. PB 236 479	
4. Title and Subtitle Pipeline Accident Report--Columbia Gas of West Virginia, Inc., Charleston, West Virginia, December 2, 1973		5. Report Date August 21, 1974 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20591		10. Work Unit No. 1349 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		13. Type of Report and Period Covered PIPELINE ACCIDENT REPORT December 2, 1973 14. Sponsoring Agency Code

15. Supplementary Notes

This report contains Pipeline Safety Recommendations P-74-29 through P-74-36.

16. Abstract

At 3:30 p.m., on December 2, 1973, an explosion followed by an intense fire killed three persons, injured two others, and destroyed a house on the outskirts of Charleston, W. Va. Fire, fueled by natural gas which had saturated the soil, later rekindled briefly in the ground around the house. After the accident, two pit-hole leaks were found in the 2-inch gas main, operated at 39 psig, which served the area; the leaks were 11 feet from the house and 1 foot from the concrete driveway which led to the house. Gas company personnel later repaired both leaks without shutting off the gas main or interrupting service to any other customers.

The National Transportation Safety Board determines that the probable cause of the explosion and fire was the ignition, by an unknown source, of an accumulation of natural gas which had leaked from two corrosion holes in a nearby 2-inch gas main. Contributing to the intensity of the ensuing fire was the large amount of natural gas which had accumulated in the attic and between the original exterior walls of the house and a newer exterior brick veneer. Contributing to the accident was the fact that none of the victims reported previously detected gas odors to the gas company or to the fire department.

The report contains recommendations to the Office of Pipeline Safety, the ASME Gas Piping Standards Committee, and Columbia Gas of West Virginia, Inc., intended to prevent a recurrence of an accident of this type.

17. Key Words	18. Distribution Statement		
Corrosion, Pit-hole Leak, Gas Migration, Permeation, Customer Education, Gas Leak Survey, Cathodic Protection, Old Pipelines, Gas-fueled Fire.	This document is available to the public through the National Technical Information Service, Springfield, Va. 22151		
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 36	22. Price $3.25

NTSB Form 1965.2 (11/70)

CONCLUSIONS

1. The source of the natural gas which had accumulated in the air space between the old and new walls of the house and in the soil near the house was two pit holes in the 2-inch gas main located 11 feet from the house.

2. The path of the leading gas into the building was underneath the concrete driveway and concrete floor carport.

3. The two leaks occurred because of corrosion of the bare, cathodically unprotected 2-inch gas main which served the neighborhood.

4. Corrosion type leaks of this variety will continue to be a problem until all of the older, bare pipelines have been cathodically protected and are checked for leakage frequently.

5. The owners of the house had detected gas odors on the day before the accident, but did not notify the gas company or the fire department.

6. Columbia's customer-education program was ineffective in alerting this customer to the hazards of natural gas, and did not meet the intent of 49 CFR 192.615(d) requiring the education of the public to recognize and report gas emergencies.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the explosion and fire was the ignition, by an unknown source, of an accumulation of natural gas which had leaked from two corrosion holes in a nearby 2-inch gas main.

Contributing to the intensity of the ensuing fire was the large amount of natural gas which had accumulated in the attic and between the original exterior walls of the house and a newer exterior brick veneer.

Contributing to the accident was the fact that none of the victims reported previously detected gas odors to the gas company or to the fire department. This was partially the result of the fact that the gas company's educational program submerged warnings and instructions within promotional material not needed by the customer and did not inform the customer of the possible consequences of failure to report a gas odor to the gas company or to leave the premises.

RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Office of Pipeline Safety of the Department of Transportation:

   (a) Amend 49 CFR Section 192.723 to require more frequent leak surveys on older, uncoated, and cathodically unprotected pipelines than required currently. (Recommendation No. P-74-29)

   (b) Amend 49 CFR Section 192.615(d) to better define the intent of a public education program to warn against the full range of hazards of natural gas, to require retainable and specific instructions and pictures of how to detect hazards, what to do, and why action is necessary. (Recommendation No. P-74-30)

2. The American Society of Mechanical Engineers Gas Piping Standards Committee:

(a) Develop guidelines to aid pipeline operators determine when to conduct leakage surveys on various types of pipe. These guidelines should take into account age of pipe, general condition of pipe, class location of pipe and metallurgy of pipe. (Recommendation No. P-74-31)

(b) Develop guidelines to aid pipeline operators in determining areas of active corrosion as required by 49 CFR 192.457(b). (Recommendation No. P-74-32)

3. The American Gas Association (AGA):

Investigate the availability, economic feasibility, and practicability of gas vapor detectors currently manufactured and explore the possibility of their installation in manholes, conduits, basements, and other substructures for the automatic detection and reporting of natural gas vapors. If none are found acceptable, sponsor research to develop such a detector. (Recommendation No. P-74-33)

4. Columbia Gas of West Virginia, Inc.:

(a) Conduct more frequent leak detection surveys on those areas where the gas pipelines are old, uncoated, and cathodically unprotected. (Recommendation No. P-74-34)

(b) Initiate a more intense general public and gas customer information program as to the nature, characteristics, and hazards of natural gas and the steps to be taken when it is encountered. (Recommendation No.P-74-35)

(c) Initiate a thorough survey to determine the areas of active corrosion on the entire length of this 2-inch gas main from its junction with the 3-inch gas main at Bakers Fork and similar pipes in its system. Make excavations for the physical examination of these pipes when indicated by the survey and replace or repair the pipe where indicated. When finished, place these pipes under adequate cathodic protection. (Recommendation No. P-74-36)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

LOUIS M. THAYER, Member, did not participate in the adoption of this report.

August 21, 1974

NTSB-PAR-74-5 PIPELINE ACCIDENT REPORT- WASHINGTON GAS LIGHT CO., BOWIE, MARYLAND, JUNE 23, 1973

This report describes and analyzes gas explosions and fire which occurred on June 23, 1973, in Bowie, Maryland. Gas had leaked from a crack in a high pressure plastic service line. Three occupants of a house were killed and a fourth was seriously injured. The house was badly damaged and houses in a five-block area were evacuated.

The gas had evidently been leaking for several months prior to the accident, building up into a reservoir of underground gas.

The NTSB determined that the probable cause of the accident was the ignition of gas that had leaked from a stress crack in the ½-inch plastic pipe. The pipe had cracked because an occluded particle, lodged in the pipe during manufacture, had created a stress point and weakened the pipe. Contributing to the accident was the lack of odor in the leaked gas when it reached the house and atmosphere.

R&D CONSIDERATIONS

1) Determine whether occluded particles during extrusion are a significant safety problem.
2) Study the flow of natural gas through various basement walls and floor materials and through various types of construction. The study should include effective methods of sealing the space around underground lines and ducts where they enter a building, and methods of permitting gas to escape in the open atmosphere when conducted to these entrance areas.
3) Develop an improved odorant with high priority given to the problem of soil adsorption of odorant compounds.
4) Study the natural gas permeation and migration phenomena in various types of soil and under paved surfaces. Based on the results of this study, recommend the use of certain types of soil for pipeline backfill material that improve the venting of gas to the atmosphere with a minimum of permeation or migration effect.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-74-5	2. Government Accession No.	PB 238 039
4. Title and Subtitle: Pipeline Accident Report - Washington Gas Light Company, Bowie, Maryland, June 23, 1973		5. Report Date: October 24, 1974
7. Author(s)		6. Performing Organization Code
9. Performing Organization Name and Address: National Transportation Safety Board, Bureau of Surface Transportation Safety, Washington, D. C. 20591		8. Performing Organization Report No.
		10. Work Unit No. 1398
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address: NATIONAL TRANSPORTATION SAFETY BOARD, Washington, D. C. 20591		13. Type of Report and Period Covered: Pipeline Accident Report, June 23, 1973
		14. Sponsoring Agency Code

15. Supplementary Notes

This report contains Pipeline Safety Recommendations P-74-37 through P-74-48

16. Abstract

This report describes and analyses a gas explosion and fire which occurred on June 23, 1973, in Bowie, Maryland. Gas had leaked from a crack in a plastic service line. Three persons died and a fourth was injured.

The National Transportation Safety Board determines that the probable cause of the accident was the ignition of gas that had leaked from a stress crack in a plastic service line. The pipe had cracked because an occluded particle had created a stress point and weakened the pipe.

Contributing to the accident was the lack of odor in the leaked gas when it reached the houses and the atmosphere.

The report contains recommendations to the Office of Pipeline Safety of the Department of Transportation, the Department of Housing and Urban Development, the American Society of Mechanical Engineers of the Gas Piping Standards Committee, the American Gas Association, and the National Fire Protection Association. They concern leaking gas migration through soils and into buildings, odorant adsorption by soils, use of new materials in piping systems, odorant testing, and plastic pipe.

NOTES SUBJECT TO CHANGE

17. Key Words	18. Distribution Statement
Natural Gas Pipeline Explosion, Plastic Pipe, Soil Adsorption of Gas Odorants, Gas Reservoir, Migration of Gas, Pipeline Safety Standards.	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

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UNCLASSIFIED	UNCLASSIFIED	43	3.25/2.25

NTSB Form 1765.2 (Rev. 9/74)

CONCLUSIONS

The National Transportation Safety Board concludes that:

1. The occluded particle found in the wall of the filed pipe became lodged in the wall during some stage of its fabrication.

2. The gas which leaked into 12321 Welling Lane and other houses in the area did not contain sufficient odorant to make the gas detectable.

3. The odorant compounds added to the gas by WGL were adsorbed by the surrounding soil when the gas leaked from the service line.

4. Whereas the data on the adsorption of the odorant compounds by certain types of soils have been known to the industry since 1961, no appreciable action has been taken to use this knowledge to assure proper odorant protection of the public in all parts of gas distribution systems.

5. There are not enough data available to determine whether occluded particles in plastic pipe pose a significant safety problem.

6. A vegetation survey, or some other type of leakage survey, during the months preceding the accident probably would have revealed a gas leak.

7. Under the current Federal regulations, any material could be used to transport natural or other gas by pipeline without the Office of Pipeline Safety's knowledge or approval.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the accident was the ignition of gas that had leaked from a stress crack in a plastic service line. The pipe cracked because an occluded particle had created a stress point and weakened the pipe.

Contributing to the accident was the lack of odor in the leaked gas when it reached the houses and the atmosphere.

RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Office of Pipeline Safety of the Department of Transportation:

   (a) Require pipeline operators who use materials not specifically covered in the Federal regulations to formally advise the Department of Transportation of its use. (Recommendation No. P-74-37)

   (b) In its study of plastic pipe, determine whether occluded particles during extrusion are a significant safety problem, and, if so found, take necessary regulatory action to control that problem. (Recommendation No. P-74-38)

2. The Department of Housing and Urban Development:

   (a) Study the flow of natural gas through various basement wall and floor materials and through various types of construction. The study should include effective methods of sealing the space around underground utility lines and ducts where they enter a building, and methods of permitting gas to escape in the open atmosphere when conducted to these entrance areas. (Recommendation No. 74-39)

3. The American Society of Mechanical Engineers Gas Piping Standards Committee:

   (a) Develop guidelines to assist pipeline operators to maintain adequate public protection in areas where odorant adsorption by soil could occur. (Recommendation No. P-74-40)

   (b) Develop guidelines for the sampling of combustible gases to assure proper concentrations of odorant as required by 49 CFR 192.625(f). (Recommendation No. P-74-41)

   (c) Develop guidelines to assist pipeline operators in training meter readers and others who work at customers' premises to detect vegetation areas that might be an indication of gas leakage. (Recommendation No. P-74-42)

4. The American Gas Association:

   (a) Give a high priority to the problem of soil adsorption of odorant compounds in its planned research to develop an improved odorant. (Recommendation No. P-74-43)

(b) Give consideration to measuring the odorant level of gas escaping from underground leaks in its planned research on odorant monitoring. (Recommendation No. P-74-44)

(c) Develop methods of testing soils to determine the potential effect on odorants. (Recommendation No. P-74-45)

(d) Study the natural gas permeating and migration phenomena in various types of soil and under paved surfaces. Based on the results of this study, recommend the use of certain types of soil for pipeline backfill material that will aid in allowing leaking gas to vent to the atmosphere at the leak location with a minimum permeation or migration effect. (Recommendation No. P-74-46)

5. The National Fire Protection Association:

(a) Advise firefighting personnel of the phenomenon of adsorption of gas odorant compounds by certain types of soils. They should be reminded of the need to use combustible gas indicators when attempts are being made to detect the presence of leaking gas. (Recommendation No. P-74-47)

6. The Washington Gas Light Company:

(a) Continue its efforts at the accident site to dissipate the residual gas remaining in the ground.

(b) Continue to monitor and test the affected homes in the area for the presence of gas until no further hazard from the residual gas is apparent. (Recommendation No. P-74-48)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

October 24, 1974

NTSB-PAR-74-6 PIPELINE ACCIDENT REPORT- MID AMERICA PIPELINE SYSTEM ANHYDROUS AMMONIA LEAK, CONWAY, KANSAS, DECEMBER 6, 1973

This report describes and analyzes a pipeline rupture in a rural area in Kansas and the release of 2,138 barrels of anhydrous ammonia, a volatile, toxic substance. Two persons who had driven through the ammonia vapors were hospitalized.

The pipeline dispatcher remotely started the anhydrous ammonia pump station and then remotely opened the line block valve. The valve failed to open, however,and the pressure increased on the entire system. A 12½-inch rupture occurred in the pipeline.

The NTSB determined that the probable cause of the rupture was the above-normal pressure in a section of pipeline which had been weakened by previous damage (20-inch gouge) by outside forces. Contributing to the above-normal pressure was the failure of the dispatcher to insure that the line-block valve was open after he started the pump,and the delay in shutting down the correct pipeline.

R&D CONSIDERATIONS

1) Develop a more specific inspection and repair program of the pipeline system pressure recording devices.
2) Institute a more systematic approach to understanding and controlling hazards including the full life cycle of the pipeline system, the design of new pipelines, and the operation and maintenance of existing pipelines.

TECHNICAL REPORT ADMINISTRATIVE DATA

1. Report No. NTSB-PAR-74-8	2. Government Accession No.	PB 238 158
4. Title and Subtitle: Pipeline Accident Report - Mid America Pipeline System Anhydrous Ammonia Leak, Conway, Kansas, December 6, 1973		5. Report Date: November 11, 1974
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address: National Transportation Safety Board, Bureau of Surface Transportation Safety, Washington, D. C. 20591		10. Work Unit No. 1338-A
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address: NATIONAL TRANSPORTATION SAFETY BOARD, Washington, D. C. 20591		13. Type of Report and Period Covered: Pipeline Accident Report, December 6, 1973
		14. Sponsoring Agency Code

15. Supplementary Notes

This report contains pipeline safety recommendations P-74-30 through P-74-38.

16. Abstract

This report describes and analyzes a pipeline rupture in a rural area in Kansas and the release of 2,138 barrels of anhydrous ammonia, NH3, a volatile, toxic material. Two persons who had driven through the ammonia vapors were hospitalized with burns to the eyes, nose, throat and lungs.

The National Transportation Safety Board determines that the probable cause of the pipeline rupture was the above-normal pressure on a section of pipe which had been damaged previously by outside forces. Contributing to the above-normal pressure was the failure of the dispatcher to insure that the line block valve at Conway was open after he started the pump at Borger.

The report contains recommendations to the Office of Pipeline Safety for more stringent regulations for NH3 pipelines; for studies on the handling of spilled NH3, for more pipeline liaison with appropriate public officials to inform them of the hazards of NH3, to have MAPCO improve its written operating procedures, check their pipeline instrumentation, reevaluate their inspection training program and institute a more systematic and authoritative control of hazards.

17. Key Words	18. Distribution Statement
Anhydrous Ammonia, Pipe Dent, Pipe Gouge, Over Pressure, Vapor Cloud, Dispatcher Error, Inadequate Instrumentation, Remote Valve Closure, Remote Station Startup, Line Rupture, Oxygen Breathing Equipment, Domino Collision Effect, Mucous Membrane Burns	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

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UNCLASSIFIED	UNCLASSIFIED	39	3.75

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PRICES SUBJECT TO CHANGE

CONCLUSIONS

1. The Mid America Pipe Line Company's anhydrous ammonia pipeline system was not adequately controlled or monitored at the time of the Conway accident nor at the time of the Hutchinson accident.

2. The pipeline at Conway ruptured in a previously damaged section of pipe when it was subjected to higher-than-normal pressures.

3. The failed pipe at Conway had been damaged during the construction of another pipeline, but the damage had not been reported to MAPCO because of ineffective inspection.

4. Since the Borger station pressure recorder was partially inoperative at the time of the Conway accident, it is impossible to determine the exact pressure at the point of rupture and to verify the length of time that Borger pumped against the closed valve at Conway.

5. Although in the Conway accident the block valve at Conway was reported to have been initiated to the open position and it failed to open, no reason for the failure to open could be found, and no repairs to the system were made.

6. The visible vapor cloud in the Conway accident into which the trucks were driven was not pure ammonia, because concentrations of 0.5 percent would have been lethal to both truckdrivers. The vapor cloud probably consisted mostly of water vapor produced by condensation from the air, chilled by expansion and vaporization of the high-pressure NH_3.

7. MAPCO did not act in conformance with Federal regulation 49 CFR 195 in that it did not report this accident by telephone and it did not have a communications system that insures the transmission of information required for the safe operation of its pipeline system.

8. The Federal regulation, 49 CFR 195.260, Valves: Location (c), is vague and difficult to enforce, because it permits each pipeline operator to be the judge of the adequacy of valve spacing.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the pipeline rupture at Conway was the above-normal pressure on a section of pipe which had been weakened by previous damage by outside forces.

Contributing to the above-normal pressure was the failure of the dispatcher to insure that the line block valve at Conway was open after he started the pump at Borger.

Contributing to the amount of anhydrous ammonia spilled were the delay in shutting down the correct pipeline, the distance between line block valves, the time taken to manually close the existing block valve, and the highly volatile characteristics of the escaping product.

Contributing to the delay in shutting down the correct pipeline was the lack of any pressure-sensing devices on the upstream side of the line block valve at Conway.

RECOMMENDATIONS

The National Transportation Safety Board recommends that the Office of Pipeline Safety of the Department of Transportation:

1. In its upcoming rulemaking action for the transportation of highly volatile, toxic, or corrosive liquids, include anhydrous ammonia pipeline systems. Particular emphasis should be placed on a reduction of the maximum allowable pressures for NH3 systems, more closely spaced valves, and more remotely or automatically operated valves. (Recommendation No. P-74-50) 6/

2. In its consideration to take regulatory action concerning the methods of handling, containing, and disposing of liquefied petroleum gases, include NH3. Necessary information should be obtained from the OPS study on highly volatile, toxic and/or corrosive liquids currently underway. Rulemaking should take into account such external factors as weather conditions, leak site topography, and population density. Attention should be given to the local temperature inversions caused by the rapid expansion of the escaping NH3 and the possible use of externally supplied heat and air blowers to force the NH3 vapors to rise and dissipate. (Recommendation No. P-74-51) 7/

3. Amend CFR 49 195.404(b), Maps and records, to provide for pressure recording instruments to be installed and properly maintained at each pump station and each pipeline terminal and that these recorded pressures be retained at a central location for at least 3 years. (Recommendation No. P-74-52)

4. Amend 49 CFR 195 to require liquid petroleum pipeline operators to establish liaison with appropriate public officials, including fire and police officials, to better inform them of the characteristics and hazards of liquid petroleum and related products. These regulations should include anhydrous ammonia and should be similar to those which appear in 49 CFR 192, "Transportation of Natural and Other Gas by Pipeline; Minimum Safety Standards." (Recommendation No. P-74-53)

5. Require the Mid America Pipe Line Company to:

   (a) Improve its current written procedures under 49 CFR Section 195.402, General requirements, to require that dispatchers perform detailed monitoring of all points on a pipeline system during startup until conditions have stabilized. (P-74-54)

   (b) Check the instrumentation at all stations, terminals and control points under 49 CFR Section 195.402 and make changes or additions as necessary to protect this pipeline system against overpressure. (P-74-55)

   (c) Reevaluate their training program for inspectors and their inspection procedures under 49 CFR 195.204, Inspection-

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6/ This recommendation is similar to recommendations 1(a) of NTSB-PAR-72-1 and 1(a) of NTSB-PAR-73-4.

7/ This recommendation is similar to recommendation 1(d) of NTSB-PAR-72-1 and 1(b) of NTSB-PAR-73-4.

general, to increase the probability that damage to their pipelines by outside parties is prevented or detected and reported. (P-74-56)

(d) Initiate a program for a more specific inspection and repair program of the pipeline system pressure recording devices under 49 CFR 195.402 so that they will operate as designed and intended in a more reliable fashion. (P-74-57)

(e) Review the operations of the pipeline system in the light of 49 CFR 195.402 to institute a more systematic and authoritative approach to understanding and controlling hazards. This review should cover the full life cycle of the pipeline system and be applicable to the design of new pipelines, as well as to the operation and maintenance of existing pipelines. (Recommendation No. P-74-58)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
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/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

November 11, 1974

8. PIPELINE ACCIDENT REPORTS AND SPECIAL STUDIES, CY-1975

The following are the three pipeline accident reports published during CY-1975.

NTSB-PAR-75-1	Pipeline Accident Report - Michigan - Wisconsin Pipeline Co., Gas Transmission Line Failure, South of Monroe, Louisiana, March 2, 1974
NTSB-PAR-75-2	Pipeline Accident Report - Transcontinental Gas Pipeline Corp., 30-inch Transmission Line Failure near Bealeton, VA, June 9, 1974
NTSB-PAR-75-3	Pipeline Accident Report - Southern Union Gas Co., Transmission Pipeline Failure, Near Farmington, New Mexico, March 15, 1974

NTSB-PAR-75-1 PIPELINE ACCIDENT REPORT - MICHIGAN-WISCONSIN PIPELINE CO., GAS TRANSMISSION LINE FAILURE, SOUTH OF MONROE, LOUISIANA, MARCH 2, 1974

This report describes and analyzes a natural gas pipeline accident near Monroe, La., on March 2, 1974. A 30-inch coated, wrapped, and cathodically protected pipeline failed at a girth weld inside a 34-inch casing pipe under a highway. The escaping gas ignited immediately resulting in a fire which consumed 10 acres of forest, but caused no deaths or in juries.

A pressure operated safety valve 1 mile upstream from the failure activated and closed immediately, blocking the flow of gas from the south. However, another safety valve 17.1 miles downstream from the failure did not close, and gas continued to flow into the failed section from the north at over 400 psig pressure. As a result of the rupture, over 53 million cubic feet of natural gas was lost.

The NTSB determined that the probable cause of the accident was the failure of a substandard girth weld due to repeated soil stress.

R&D CONSIDERATIONS

1) Conduct an industry-wide survey on the value of casing pipeline under roads and railroads.
2) Develop guidelines for the effective operation of automatic valves.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-75-1	2. Government Accession No.	PB 241 988
4. Title and Subtitle Pipeline Accident Report - Michigan-Wisconsin Pipe Line Company, Gas Transmission Line Failure, South of Monroe, Louisiana, March 2, 1974		5. Report Date April 2, 1975
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20594		10. Work Unit No. 1494
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Pipeline Accident Report March 2, 1974
		14. Sponsoring Agency Code

15. Supplementary Notes
This report contains pipeline safety recommendations P-75-1 through P-75-4

16. Abstract
This report describes and analyzes a natural gas pipeline accident near Monroe, La., on March 2, 1974. A 30-inch pipeline failed at a girth weld inside a casing under a highway. A resulting fire burned 10 acres of forest, but no deaths or injuries resulted.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of a substandard girth weld due to repeated soil stresses.

Contributing to the imposed stresses were the position of the pipe inside the casing and the heavy clay soil surrounding the pipe at each end of the casing.

Recommendations are made to determine the effectiveness of using casing for pipelines beneath highways and railroads and to develop guidelines for the effective operation of automatic valves.

PRICES SUBJECT TO CHANGE

17. Key Words Gas Transmission Pipeline, 30-inch Line, Casing Vents and Seals, Pipeline Casing, Carrier Pipe Automatic Valves, Pipe Rupture, Blow Down, Valve Crossovers, Looped Lines, Class Location, Girth Weld Failure, Weld Undercut		18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151	
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CONCLUSIONS

1. The pipeline failed because of a substandard girth weld which was undected during construction in 1956.

2. The automatic line block valve which failed to close, although in compliance with the Federal regulations for valve spacing, was too far from the failure site and too coarsely set to actuate on the pressure drop which occurred when the line failed.

3. If carrier pipe with heavier walls had been installed at this road crossing instead of casing pipe, this failure might not have occurred.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the accident was the failure of a substandard girth weld due to repeated soil stresses.

Contributing to the imposed stresses were the position of the pipe inside the casing and the heavy clay soil surrounding the pipe at each end of the casing.

RECOMMENDATIONS

The National Transportation Safety Board recommends that the Office of Pipeline Safety of the Department of Transportation:

1. Conduct an industrywide survey on the value of casing pipelines beneath roads and railroads. This survey should be undertaken in cooperation with the American Association of State Highway and Transportation Officials, The Federal Highway Administration, appropriate industry associations and engineering societies; and 49 CFR 192.323, Casing, should be amended, if necessary. (Recommendation P-75-1)

2. Require the Michigan-Wisconsin Pipe Line Company to:

   (a) Recalibrate the pressure-drop settings on their existing automatic valves to better insure their actuation on pressure drops caused by line failure. as required under 49 CFR 192.745, Valve Maintenance: Transmission lines. (Recommendation P-75-2)

   (b) Conduct tests along its pipeline system (including casing locations) in areas of severe soil swell potential and take appropriate corrective measures to prevent similar failures from occurring, as required under 49 CFR 192.705 Transportation lines: Patrolling. (Recommendation P-75-3)

The Safety Board further recommends that the ASME Gas Piping Standards Committee:

1. Develop guidelines for the use, setting, and maintenance of automatic valves on gas transmission pipeline systems. (Recommendation P-75-4)

NTSB-PAR-75-2 PIPELINE ACCIDENT REPORT- TRANSCONTINENTAL GAS PIPELINE CORP., 30-inch TRANSMISSION LINE FAILURE NEAR BEALETON, VA., JUNE 9, 1974

This report describes and analyzes a 30-inch natural gas transmission pipeline rupture and resulting fire in a rural area near Bealeton, Va. Gas escaped at 718-psig pressure and ignited within seconds, illuminating the countryside for miles. Flames were seen and reported by airline pilots over 100 miles away.

One automatic valve 10.6 miles downstream of the accident, failed to close when the pressure dropped. A second automatic valve 15.26 miles from the first, also failed to close. Although no one was killed or injured, the accident would have been more catastrophic if it had occurred in a more densely populated area.

The NTSB determined that the probable cause of the accident was the material failure of the 30-inch pipe because of a hydrogen stress crack at a hardspot in the pipe wall. The crack progogated along and around the pipe for 55 feet. The hardspot had probably been created during manufacture. At the time of construction, the pipe was coated with a hot tar enamel and wrapped in fiber glass reinforcement and asphalt-impregnated felt.

R&D CONSIDERATIONS

1) Initiate a study of the effects on automatic valve operation of open versus closed crossover valves on looped natural gas transmission systems.
2) Review the use, maintenance, and testing of failure alarm systems on gas transmission lines. If necessary, reevaluate and redesign these alarm systems

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-75-2	2. Government Accession No.	PB 244 547
4. Title and Subtitle Pipeline Accident Report- Transcontinental Gas Pipe Line Corporation, 30-inch Transmission Line Failure near Bealeton, Va., June 9, 1974		5. Report Date May 28, 1975
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20594		10. Work Unit No. 1560 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Pipeline Accident Report June 9, 1974 14. Sponsoring Agency Code

15. Supplementary Notes
This report contains Pipeline Safety Recommendations P-75-7 through P-75-11

16. Abstract This report describes and analyzes a pipeline failure and resulting fire in a rural area near Bealeton, Va. Although no one was killed or injured, the accident would have been castastrophic if it had occurred in a more densely populated area.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the 30-inch pipe because of a hydrogen stress crack propagation at a hardspot in the pipe wall. The hardspot probably had been created during pipe manufacture.

PRICES SUBJECT TO CHANGE

17. Key Words	18. Distribution Statement		
Natural Gas Transmission Pipeline, Automatic Line Valves, Crossover Lines, Crossover Valves, Sustained Pressure Drop, Pressure Drop Settings, Compressor Station Recording Gages, Pipeline Failure Alarm, Pipeline Rupture, Hardspots	This document is available through the National Technical Information Service, Springfield, Virginia, 22151		
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 35	22. Price 3.75/6.25

NTSB Form 1765.2 (11/70)

CONCLUSIONS

1. The pipeline failure was caused by a hydrogen stress crack at a hardspot which was produced in the steel at the time of manufacture.

2. Atomic hydrogen formed by electrolytic action reacted with the hardspot through a defect in the protective pipe coating and initiated a stress crack. The electrolytic action was provided by the moisture in the soil surrounding the pipe and the electric current which was part of the cathodic protective system.

3. The automatic line valves upstream and downstream of the rupture failed to operate because the pressure drop settir were too coarse and because the large diameter crossover lines were open at the time of failure, which tended to equalize the pressure across all three lines and mitigated the effect of the pressure drop.

4. The automatic valves on the TRANSCO system, which was operating under full loop with open crossovers, were less likely to close on a pressure drop caused by a line failure than similar automatic valves on full looped transmission systems operating with closed crossover valves.

5. Compressor station 180 personnel ordered the wrong valve to be closed because they erroneously analyzed the pressure drop indications and because the line failure alarm did not operate.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the 30-inch pipe because of a hydrogen stress crack propagation at a hardspot in the pipe wall. The hardspot probably had been created during the pipe manufacture.

RECOMMENDATIONS

The National Transportation Safety Board recommends that the Office of Pipeline Safety of the Department of Transportation:

1. Initiate a study, in cooperation with the American Gas Association (AG.) and other interested groups, of the effects on automatic line valve operation of open versus closed crossover valves on looped natural gas transmission systems, and amend 49 CFR 192.179, Transmission line valves, to incorporate the findings. (Recommendation P-75-7) (Class II)

2. Review the use, maintenance, and testing of failure alarms on gas transmission systems and amend 49 CFR 192 to provide for improved warning of pipeline failures. (Recommendations P-75-8) (Class I)

3. Require TRANSCO to:

(a) Review its emergency procedures for the entire pipeline system, using system safety analysis techniques, and correct any unreliable or inadequate shutdown processes. (Recommendation P-75-9) (Class II)

(b) If necessary, reevaluate, and redesign their compressor station failure alarms on the entire transmission system to prevent a recurrence of the equipment failure. (Recommendation P-75-10) (Class I)

(c) Examine the necessity of installing additional pipeline failure alarms on the station recording suction and discharge pressure gage, the station recording fuel pressure gage, the station fuel flow gage, or the other pressure-sensitive points. (Recommendation P-75-11) (Class I)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

May 28, 1975

NTSB-PAR-75-3 PIPELINE ACCIDENT REPORT - SOUTHERN UNION GAS CO., TRANSMISSION PIPELINE FAILURE, NEAR FARMINGTON, NEW MEXICO, MARCH 15, 1974

Om March 15, 1974, a 12-inch natural gas transmission pipeline ruptured in a desert near Farmington, New Mexico. Natural gas at nearly 500-psig pressure escaped, ignited, and burned several hundred feet high. An 8-foot section of the 12-inch pipeline blew out, digging a crater 40 feet long, 17 feet wide, and 10 feet deep. Three persons driving in a truck down a service road adjacent to the pipeline died.

The NTSB determine that the probable cause of the accident was the brittle fracture of a longitudinal flash weld that had been weakened by localized crevice corrosion. When the pipe was installed in 1948, it was not required to be cathodically protected but this would not have prevented crevice corrosion. The gas may have became ignited by the truck as it drove near the rupture site.

R & D CONSIDERATION

1) Determine if an internal inspection tool could be utilized to detect defective flash welds.
2) Determine if longitudinal weld failures constitute a recurrent safety problem.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-75-3	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report -- Southern Union Gas Company, Transmission Pipeline Failure, Near Farmington, New Mexico, March 15, 1974.		5. Report Date December 23, 1975 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20594		10. Work Unit No. 1722 11. Contract or Grant No. 13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		Accident Report March 15, 1974 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract About 3:45 a.m. on March 15, 1974, the Southern Union Gas Company's 12-inch natural gas transmission pipeline ruptured in a desert near Farmington, New Mexico. Natural gas at almost 500-psig pressure escaped, ignited, and burned several hundred feet high. An 8-foot section of the 12-inch pipeline blew out, digging a crater 40 feet long, 17 feet wide, and 10 feet deep. Three persons driving down a road adjacent to the pipeline died and the earth within a 300-foot diameter was charred. At 5 a.m., the valves on both sides of the break were closed, isolating the failed section within 8.9 miles.

The National Transportation Safety Board determines that the probable cause of the accident was the brittle fracture of a longitudinal flash weld that had been weakened by localized crevice corrosion.

As a result of its investigation of this accident, the National Transportation Safety Board made recommendations to the Department of Transportation and to the Southern Union Gas Company concerning the problem of corrosion-weakened, flash-welded pipe.

17. Key Words Natural gas pipeline accident; flash weld failure; crevice corrosion.		18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151.	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 28	22. Price $ 4.00

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CONCLUSIONS

1. The New Mexico State Corporation Commission and the Southern Union Gas Company considered the failed pipeline to have been operated in compliance with the Federal corrosion standards, but the Office of Pipeline Safety did not. The regulations concerned were vague, so two interpretations were possible.

2. The presence or absence of cathodic protection on the pipeline at the point of crevice corrosion probably would have had no effect on the failure. Crevice corrosion is not prevented by cathodic protection.

3. The crevice corrosion in the flash weld reduced the overall strength of the pipe by reducing the wall thickness; this caused higher-than-normal stresses in the weld line.

4. The failure originated where the crevice corrosion had extended across the pipe wall, weakening the weld over a sufficient length to initiate a fracture along the weld.

5. The pipe failed before the truck was in the area, but the gas was not ignited until after the truck was near the failure.

6. Although other sections of the line had been pressure-tested recently, the failed pipeline had not been pressure-tested since its manufacture in 1948. At the time of the accident, pressure in the line was only 35 percent of the mill test pressure used at the time of manufacture.

7. The "grandfather clause" in the Federal regulations, under which the maximum allowable operating pressure for old lines is established at the highest previous operating pressure, permitted this line to be operated with a zero safety factor for pressure.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the accident was the brittle fracture of a longitudinal flash weld that had been weakened by localized crevice corrosion.

RECOMMENDATIONS

The National Transportation Safety Board has made two recommendations based on its investigation of this accident, one to the Department of Transportation, and the other to the Southern Union Gas Company. (See Appendixes B and C.)

will only be operated to a maximum pressure of 565 psig, it appears that no other severely weakened flash welds existed at the time of the tests, but since crevice corrosion could continue, despite cathodic protection efforts, failures could result in the future.

Experimental work has been conducted by several firms to develop an internal inspection tool which could detect longitudinal weld defects. While this tool has been perfected for most longitudinal seam defects, the excess metal left in the weld area in A. O. Smith flash weld pipe is so great that it has a tendency to mask out any signal which would indicate a defect. Additional testing and refinements have now resulted in a tool which may be able to detect the type of defect which resulted in the flash weld failure.

Therefore, the National Transportation Safety Board recommends that the Southern Union Gas Company:

> Work with developmental manufacturing firms to determine if an internal inspection tool could be utilized to detect defective flash welds in its Farmington-Albuquerque pipeline system. If a tool is found effective, it should be used in areas where crevice corrosion could be expected. (Recommendation P-76-2) (Class II, Priority Followup)

REED, Acting Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendation.

By: John H. Reed
Acting Chairman

APPENDIX C

Therefore, the National Transportation Safety Board recommends that the Department of Transportation:

> Review all pertinent data such as leak and failure reports submitted by all pipeline operators to determine if longitudinal weld failures constitute a recurrent safety problem, and take appropriate regulatory action if they do. (Recommendation P-76-2) (Class II, Priority Followup)

REED, Acting Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendation.

By: John H. Reed
Acting Chairman

9. PIPELINE ACCIDENT REPORTS AND SPECIAL STUDIES, CY-1976

The following are the eight pipeline accident reports published during CY-1976. No special studies have been issued during this period.

ɜS-PAR-76-1	Pipeline Accident Report - Texas Oil and Gas Corp., 6-inch Natural Gas - Gathering Pipeline Failure, near Meridian, Mississippi, May 21, 1974
SB-PAR-76-2	Pipeline Accident Report - Consolidated Edison Co., Explosion at 305 East 45th Street, New York, New York, April 22, 1974
SB-PAR-76-3	Pipeline Accident Report - Mid-Valley Pipeline Co., Crude Oil Terminal Fire, near Lima, Ohio, January 17, 1975
ˈSB-PAR-76-4	Pipeline Accident Report - West Texas Gulf Pipeline Co., Abilene, Texas, December 11, 1974
ˈSB-PAR-76-5	Pipeline Accident Report - Dow Chemical U.S.A., Natural Gas Liquids Explosion and Fire near Derers, Texas, May 12, 1975
ˈSB-PAR-76-6	Pipeline Accident Report - Nebraska Natural Gas Co., Pathfinder Hotel Explosion and Fire, Fremont, Nebraska, January 10, 1976
TSB-PAR-76-7	Pipeline Accident Report - Sun Pipe Line Co., Rupture of 8-inch Pipeline, Romulus, Michigan, August 21, 1975
ˈTSB-PAR-76-8	Pipeline Accident Report - Standard Oil Company of California, Pipeline Rupture, Los Angeles, California, June 16, 1976

NTSB-PAR-76-1 PIPELINE ACCIDENT REPORT - TEXAS OIL & GAS CORP., -- 6-INCH NATURAL GAS-GATHERING PIPELINE FAILURE, NEAR MERIDIAN, MISSISSIPPI, MAY 21, 1974

At 9:45 p.m.,on May 21, 1974, a 6-inch pipeline that was gathering natural gas from several oil wells, ruptured about 12 feet from a paved road near Meridian, Miss. Hydrocarbon-rich gas, escaping at 300-psig pressure, blasted a 10-foot diameter, 6-foot deep crater near the road. Three persons living nearby heard the roar of escaping gas and drove to the leak site, where they saw a white, low-lying fog and smelled gas. They then returned to their house to evacuate the rest of the family. The family drove back to the paved road in two vehicles, both of which stalled as they approached the leak.A third vehicle, approaching from the opposite direction, also stalled close to the rupture site, its four occupants attempted to get out of the area on foot. The escaping gas then ignited and killed one person at the site. Of the five persons hospitalized, four died. The three vehicles were destroyed and about 40 acres of woodland was burned.

The NTSB determined that the probable cause of the accident was the rupture of the 6-inch pipe which had been weakened by internal corrosion and hydrogen embrittlement as a result of poor operating practices. The pipe was 4 years old and was coated externally and wrapped. No cathodic protection had been applied.

R & D CONSIDERATIONS
No R & D requirement

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-76-1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report - Texas Oil & Gas Corporation, 6-Inch Natural Gas-Gathering Pipeline Failure, Near Meridian, Mississippi, May 21, 1974		5. Report Date February 4, 1976 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20594		10. Work Unit No. 1738 11. Contract or Grant No. 13. Type of Report and Period Covered Pipeline Accident Report May 21, 1974
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

At 9:45 p.m. on May 21, 1974, a 6-inch pipeline that was gathering natural gas ruptured about 12 feet from a paved road near Meridian, Mississippi. Three persons living nearby heard the roar of escaping gas and drove to the leak site where they saw a white, low-lying fog and smelled gas. They then returned to their house to evacuate the rest of the family. The family drove back to the paved road in two vehicles, both of which stalled as they approached the leak. A third vehicle which had been driven into the area from the opposite direction stalled close to the pipeline rupture; its four occupants attempted to get out of the area on foot.

At 10:05 p.m., the escaping gas ignited and killed one person at the site. Of the five persons hospitalized, four died. The three vehicles were destroyed and about 40 acres of woodland were burned.

The National Transportation Safety Board determined that the probable cause of the accident was the rupture of the pipe which had been weakened by internal corrosion and hydrogen embrittlement as a result of poor operating practices.

As a result of its investigation, the Safety Board made recommendations to the Department of Transportation and to the Texas Oil and Gas Corporation.

17. Key Words	18. Distribution Statement		
Gas gathering pipeline; rural area; sour gas; hydrogen sulfide; carbon dioxide; internal corrosion; hydrogen embrittlement; oil separator; inhibitors; scrapers; test coupons; compressor station; gas processing plant.	This report is available to the public through the National Technical Information Service, Springfield, Virginia 22151.		
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 29	22. Price $4.00-2.25

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PRICES SUBJECT TO CHANGE

CONCLUSIONS

1. The 6-inch pipe failed because its wall had been thinned by severe internal corrosion and had been weakened further by hydrogen embrittlement.

2. The internal corrosion was caused by an accumulation of water in the bottom of the pipe which combined with the hydrogen sulfide and carbon dioxide in the natural gas and formed an acid.

3. The corrosive conditions remained inside the pipe because of the infrequent scraper operations and the inadequate inhibitor practices and the infrequent inspection of the corrosion coupons.

4. The location of the longitudinal seam weld at the bottom of the pipe, in contact with the corrosive elements and the hydrogen sulfide, further weakened the pipe.

5. The improper operation of this pipeline, both in detecting and in mitigating the corrosive conditions in a timely manner, allowed conditions to exist which ultimately caused the pipeline's failure.

6. The Secretary of Transportation has not issued Federal regulations for gas-gathering lines in rural areas to control the possibility of similar pipeline failures.

7. The source of ignition of the gas in this accident could not be determined.

PROBABLE CAUSE

The National Transportation Safety Board determined that the probable cause of the accident was the rupture of the pipe which had been weakened by internal corrosion and hydrogen embrittlement as a result of poor operating practices.

RECOMMENDATIONS

The National Transportation Safety Board has made five recommendations based on the investigation of this accident. One is addressed to the Office of Pipeline Safety Operations of the Department of Transportation and the others are to the Texas Oil and Gas Corporation. (See Appendixes C and D.)

Therefore, the National Transportation Safety Board recommends that the Department of Transportation:

Promulgate regulations under the Hazardous Materials Transportation Act for natural gas-gathering pipelines in rural areas, similar to the regulations promulgated for natural gas transmission and distribution pipelines in 49 CFR 192. (P-76-5) (Class II, Priority Followup.)

REED, Acting Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendation.

By: Webster B. Todd, Jr.
Chairman

APPENDIX D

Therefore, the National Transportation Safety Board recommends that the Texas Oil and Gas Corporation:

(1)(a) Establish a periodic scraper program and install appropriate hydrogen probes, test coupons, resistance probes, or other testing equipment at strategic locations to identify and locate internal corrosion problems, (b) examine the test equipment and analyze the scraper residues carefully at regular time intervals to monitor the internal condition of the lines, and (c) take necessary action to repair deficiencies found in the pipes and to improve operational procedures for the prevention of corrosion and hydrogen embrittlement. (P-76-6) (Class I, Urgent Followup)

(2) Determine the correct frequency, types, and amounts of inhibitor and the proper injection points so that further internal corrosion can be deterred. (P-76-7)(Class I, Urgent Followup)

(3) Instruct its employees on the importance of proper operation and maintenance of scrubbers and separators to prevent water from entering the pipelines. (P-76-8) (Class I, Urgent Followup)

(4) Install pipe used in the construction or repair of its gathering lines with the longitudinal seam on the top half of the pipe. (P-76-9)(Class III, Longer Term Followup)

REED, Acting Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendations.

By: Webster B. Todd, Jr.
Chairman

NTSB-PAR-76-2 PIPELINE ACCIDENT REPORT - CONSOLIDATED EDISON CO., EXPLOSION AT 305 EAST 45TH STREET, NEW YORK, NEW YORK, APRIL 22, 1974

At 6:57 a.m. on April 22, 1974, a massive, low-order explosion demolished the west wall of a 25-story commercial building in New York City. No one was killed, but over 70 were injured, mostly people in an adjacent apartment house.

The NTSB determined that the probable cause of the accident was the rupture of an overpressured hydro-pneumatic tank in the basement, which rocketed upward and tore a 6-inch overhead gas service line out of its threaded joint. The service line was connected by only two or three threads instead of the nine required by code. This allowed gas to flow unabated into the building above. Contributing to the spread of the explosive gas-air mixture were the elevators, which drew the explosive mixture up through the elevator shafts before ignition.

R & D CONSIDERATIONS

1) Determined the availability, practicability, and the state-of-the-art in the manufacture of excess flow valves for use on low-pressure gas distribution systems.
2) Investigate the practicability and the availability of gas vapor detection instruments for installation at strategic locations in buildings.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-76-2	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report -- Consolidated Edison Company, Explosion at 305 East 45th Street, New York, New York, April 22, 1974		5. Report Date February 19, 1976 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20594		10. Work Unit No. 1745 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Pipeline Accident Report April 22, 1974 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

At 6:57 a.m. on April 22, 1974, a massive, low-order explosion demolished the west wall of a 25-story commercial building at 305 East 45th Street in New York City, New York. The structure of the adjacent building was damaged and glass was broken in other buildings in the area. Glass fragments and slivers were blown onto 46th Street, where they lay 1 inch thick in places. No persons were killed, but more than 70 persons were injured.

The National Transportation Safety Board determines that the probable cause of the accident was the rupture of an overpressured hydropneumatic tank which rocketed upward and tore an overhead gas service line out of its threaded joint; this allowed gas to flow unabated into the building. Contributing to the spread of the explosive gas-air mixture were the elevators, which drew the explosive mixture up through the elevator shafts before ignition.

As a result of its investigation of the explosion, the Safety Board made recommendations to the Department of Transportation, the Department of Housing and Urban Development, the Building Officials and Code Administration International, Inc., the Southern Building Code Congress, and the International Association of Plumbers and Mechanics Officials.

17. Key Words	18. Distribution Statement		
Hydropneumatic pressure tanks; natural gas; excess flow valves; threaded connections; elevators; gas service line location; gas detection instruments; gas-air explosive mixture; glass fragments; fire departments; structural damage; pipeline accident; natural gas explosion.	This report is available to the public through the National Technical Information Service, Springfield, Virginia 22151		
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 28	22. Price $4.00-2.25

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PRICES SUBJECT TO CHANGE

CONCLUSIONS

1. The source of the ignition was unknown, but the origin of the accumulated natural gas was a separated 6-inch gas service line in the basement.

2. The service line was torn from its threaded joint when a pressure tank below the line burst and hit it.

3. The service line was connected inadequately by only two or three threads instead of the nine required by code.

4. The location of the pressure tanks directly beneath the service line created an avoidable hazard; however, no Federal, State, or city regulations existed concerning the installation of pressure tanks or other hazardous materials near gas service lines.

5. When the service line was installed, no excess flow equipment was available and practical to shut off any sudden, rapid flow of gas from a separated pipe. Research is underway to solve this problem.

6. No instruments to detect and warn of leaking gas had been installed in this building although such equipment is available. No regulations exist which require this installation although regulations do exist requiring instrumentation to detect and warn of smoke and fire.

7. The Federal regulation requiring pipeline operators to be responsible for the operation and maintenance of gas piping inside buildings over which they have no control is unrealistic and impractical.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the accident was the rupture of an overpressured hydropneumatic tank which rocketed upward and tore an overhead gas service line out of its threaded joint; this allowed gas to flow unabated into the building. Contributing to the spread of the explosive gas-air mixture through the building were the elevators, which drew the explosive mixture up through the elevator shafts before ignition.

RECOMMENDATIONS

The National Transportation Safety Board made five recommendations based on the investigation of this accident. Two are addressed to the Department of Transportation, one is addressed to the Department of Housing and Urban Development, and one is addressed to the Building Officials and Code Administration International, Inc., the Southern Building Code Congress, and the International Association of Plumbers and Mechanics Officials.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

APPENDIX A

The 6-inch gas service line in the basement was considered by the Office of Pipeline Safety to be a gas distribution main and therefore under the Federal regulation 49 CFR 192.3. The New York State Public Service Commission's regulation, 16 NYCRR 255.1855, maintains that the pipeline operator's jurisdiction ends at the first fitting inside the wall of a customer's structure. This is based on the impracticability of a pipeline operator's trying tc operate and maintain thousands of feet of gas piping inside the walls and ceilings of thousands of buildings within the state.

Therefore, the National Transportation Safety Board recommends that the Office of Pipeline Safety Operations of the Department of Transportation:

(1) Determine the availability, the practicability, and the state-of-the-art in the manufacture of excess flow valves for use on low-pressure gas distribution systems. Based upon the results of these findings, amend 49 CFR 192 to incorporate the use of these valves in commercial buildings. (Recommendation P-76-9)(Class II, Priority Followup)

(2) Amend 49 CFR 192 to define more realistically an operator's responsibility for gas piping inside buildings. (Recommendation P-76-10)(Class II, Priority Followup)

(3) Expedite its review of the study of "Rapid Shutdown of Failed Pipeline Systems and Limiting of Pressure to Prevent Pipeline Failure Due to Overpressure" and determine what regulatory action is necessary concerning the use of excess flow valves. (Recommendation P-76-11)(Class II, Priority Followup)

TODD, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendations.

By: Webster B. Todd, Jr.
Chairman

APPENDIX B

Many commercial buildings are required to have smoke or heat detection instruments located at strategic positions in their interior. These instruments are designed to activate sprinkler systems if the instruments are triggered by the smoke or heat of a fire. It seems logical that similar regulations could be adopted for the installation of gas detection instruments in buildings.

Therefore, the National Transportation Safety Board recommends that the Department of Housing and Urban Development:

> Investigate the practicability and the availability of gas vapor detection instruments for installation at strategic locations in buildings. Based on the results of this investigation, recommend guidelines to appropriate State and local government agencies for regulations for the installation of gas detection instruments in buildings. (Recommendation P-76-12) (Class II, Priority Followup)

TODD, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendations.

By: Webster B. Todd, Jr.
Chairman

APPENDIX C

The location of the hydropneumatic pressure tanks directly under the gas service line was a critical factor in this accident. Since the gas line was installed first around 1930, and the pressure tanks were installed at a later date, the tanks should have been located at some other point in the basement where potential danger to existing facilities would be at a minimum. No Federal, New York State, or New York City regulations exist for the placement of equipment in relation to other equipment in basements. The plumbing codes also do not specifically relate to the placement of equipment in relation to other equipment, but these codes form the basis for the city regulations.

Therefore, the National Transportation Safety Board recommends that the Building Officials and Code Administration International, Inc., the Southern Building Code Congress, and the Plumbing Code Committee of the International Association of Plumbers and Mechanics Officials:

> Review their codes to insure that adequate instructions are listed for the location of natural gas service lines in relation to other plumbing facilities such as pressure tanks and boilers in industrial, commercial, and residential buildings. (Recommendation P-76-13) (Class II, Priority Followup)

TODD, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendations.

By: Webster B. Todd, Jr.
Chairman

NTSB-PAR-76-3 PIPELINE ACCIDENT REPORT - MID-VALLEY PIPELINE CO., CRUDE OIL TERMINAL FIRE, NEAR LIMA, OHIO, JANUARY 17, 1975

On January 17, 1975, a pipe ruptured at a crude oil terminal in Lima, Ohio. A motor-operated valve within the terminal was closed inadvertantly and pressure built up. When the pressure exceeded the 720-psig working pressure rating of a substandard flange, a 14-inch long crack developed. Crude oil was sprayed from the crack, atomized, ignited and burned; flames shot up over 100 feet high.

Attempts to extinguish the fire and shut off input valves were hampered when overhead high-tension power lines burned, arched, and fell into the pipeline terminal yard. The fire destroyed the terminal building and killed the terminal deliveryman.

The NTSB determined that the probable cause of the accident was the inadvertant closing (either by malfunction or human error) of a 12-inch, motor-operated valve. The oil probably was ignited when a truck in the meter building was started. The pipe would not have ruptured if a properly sized pressure-relief valve had been installed

R & D CONSIDERATIONS

No R & D requirement.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-76-3	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report -- Mid-Valley Pipeline Company, Crude Oil Terminal Fire, Near Lima, Ohio, January 17, 1975		5. Report Date April 27, 1976
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20594		10. Work Unit No. 1534-A
		11. Contract or Grant No.
		13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

About 3:00 p.m. on January 17, 1975, a pipe ruptured at the Mid-Valley Pipeline Company's Lima, Ohio, crude oil terminal. A motor-operated valve within the terminal closed inadvertantly and pressure built up. When the pressure exceeded the 720 psig working pressure rating of a substandard flange, a 14-inch long crack developed. Crude oil was sprayed from the crack, atomized, ignited, and burned; flames resulted which were more than 100 feet high.

Attempts to extinguish the fire and to shut off valves to the terminal were hampered when overhead high-tension power lines burned, arced, and fell into the pipeline terminal yard. The fire destroyed the terminal buildings and killed the terminal deliveryman.

The National Transportation Safety Board determines that the probable cause of the accident was the inadvertent closing of a 12-inch, motor-operated valve against the crude oil stream; this caused the unrelieved pressure to build until a substandard flange in a low-pressure meter manifold ruptured. The oil probably was ignited when a truck in the meter building was started.

17. Key Words	18. Distribution Statement		
Crude oil pipeline fire; overpressure control device; motor-operated gate valve; overhead power lines.	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151		
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CONCLUSIONS

1. The pipeline was blocked when a 12-inch, motor operated, gate valve was closed inadvertantly. This caused pressure to build up in the Buckeye meter manifold; unrelieved pressure built up until a substandard flange in the low-pressure meter manifold ruptured.

2. The ten 1-inch pressure relief valves on the Lima meter facilities were designed for temperature relief and had a total capacity of only 3 percent of the oil stream.

3. Because there were no properly sized and positioned pressure-relief valves on the 20-inch pipeline between Fyrmont and Lima, portions of the line were overpressured.

4. The oil probably was ignited when a pickup truck in the meter building was started.

5. As a result of the fire, high-tension power lines overhead burned, arced, and fell into the pipeline terminal yard.

6. The fallen overhead electric power lines prevented the immediate closing of valves to the terminal, caused delays in firefighting, and created a hazardous condition for emergency personnel.

7. If the pickup truck had not been parked inside the meter building, or if it had not been started, the oil probably would not have been ignited.

8. If the pipeline system had been analyzed systematically, the area of inadequate pressure relief probably would have been detected and corrected before the accident.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the accident was the inadvertent closing of a 12-inch, motor-operated valve against the crude oil stream; this caused the unrelieved pressure to build until a substandard flange in a low-pressure meter manifold ruptured. The oil probably was ignited when a truck in the meter building was started.

RECOMMENDATIONS

As a result of its investigation of this accident, the Safety Board made the following recommendations.

On May 8, 1975, the Safety Board recommended that the Office of Pipeline Safety Operations of the Department of Transportation:

"Require the Mid-Valley Pipeline Company to review all their pump station and terminal facilities to determine whether conditions exist, similar to those at Lima, which could cause additional accidents on their system.

"Urge the Mid-Valley Pipeline Company to utilize a total systems approach to pipeline safety in the redesign and reconstruction of the destroyed facility at Lima so that single failures and frequent combinations of failures do not escalate to leaks or over pressure."

In addition, the Safety Board has recommended that the Department of Transportation:

"Study and incorporate in 49 CFR 192 and 195 the effects of overhead power lines on the safety of gas and liquid pipelines. The minimum safe distances of overhead power lines from compressors, pumps, and terminals should be established where necessary. The locations of power lines in relation to emergency shutoff valves and gas blowdown facilities also should be studied and minimum safe distances should be established where necessary."

The Safety Board has recommended that the Mid-Valley Pipeline Company:

"Install pressure-relief devices not only to protect the rebuilt terminal at Lima, but also to protect the 20-inch pipeline between Fyrmont and Lima.

"Enquire portions of its procedures manuals to prohibit the routine parking of vehicles in terminal or station buildings where hazardous products are handled."

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ WEBSTER B. TODD, JR.
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

/s/ PHILIP A. HOGUE
Member

April 27, 1976

NTSB-PAR-76-4 PIPELINE ACCIDENT REPORT - WEST TEXAS GULF PIPELINE CO., ABILENE, TEXAS, DECEMBER 1, 1974

On December 1, 1974, a seven-man repair crew working on a leak on a 26-inch pipeline near Abilene, Texas, began excavating the pipe while it was pumping sour crude oil. They attempted to clamp the leak while the oil was spraying into the air. They were down in the trench, not using oxygen masks, gas vapor detection instruments, or ropes attached to their belts. All but one man, who ran to the truck to radio for help, were overcome by fumes and died.

The NTSB determined that the probable cause of the accident was the attempted repair,in a manner which did not follow the company's written procedures, of a leak in a cracked fillet weld on a full-wrap repair sleeve. The fillet weld, made improperly during the repair of an earlier leak, failed.

R & D CONSIDERATIONS

No R & D requirement.

PB257166

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-76-4	2. Government Accession No.
3. Recipient's Catalog No.	
4. Title and Subtitle: Pipeline Accident Report -- West Texas Gulf Pipe Line Company, Abilene, Texas, December 1, 1974	5. Report Date: June 9, 1976
7. Author(s)	6. Performing Organization Code
9. Performing Organization Name and Address: National Transportation Safety Board, Bureau of Surface Transportation Safety, Washington, D. C. 20594	8. Performing Organization Report No.
	10. Work Unit No. 1841
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address: NATIONAL TRANSPORTATION SAFETY BOARD, Washington, D. C. 20594	13. Type of Report and Period Covered: Pipeline Accident Report, December 1, 1974
	14. Sponsoring Agency Code
15. Supplementary Notes	

16. Abstract

About 1:00 p.m., on December 1, 1974, a repair crew at work on a leak on the West Texas Gulf Pipe Line Company's 26-inch pipeline near Abilene, Texas, began to excavate the pipe while it was pumping sour crude oil. They attempted to clamp the leak while the sour crude oil was spraying into the air; they were not using oxygen breathing equipment, gas vapor detection instruments, or ropes attached to their belts. All but one man, who ran to the truck to radio for help, were overcome by fumes from the sour crude oil. Of the seven men in the repair crew, six died.

The National Transportation Safety Board determines that the probable cause of the accident was the attempted repair, in a manner which failed to follow the company's written procedures, of a leak in a cracked fillet weld on a full-wrap repair sleeve. The fillet weld, made improperly during the repair of an earlier leak, failed. The failure allowed toxic, sour crude oil to spray and permeate the leak site.

As a result of its investigation, the Safety Board made recommendations to the West Texas Gulf Pipe Line Company.

17. Key Words: Sour crude oil; hydrogen sulfide (H_2S); full-wrap repair sleeve; fillet weld; toxic fumes; oxygen breathing equipment; safety ropes; gas detection equipment; leak repair; pit hole corrosion; post mortem examination; autopsy.		18. Distribution Statement: This report is available to the public through the National Technical Information Service, Springfield, Virginia 22151.	
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There were at least two ways in which they could have repaired the pipeline successfully. First, they could have followed the company's safety procedures and completed the specially fitted clamp. Carefully done, the repair could have been accomplished without incident, although it would later have to be cut out and replaced because this was to have been only a temporary repair. Second, the supervisor could have examined the leak and, because of its location, ordered the pipeline shut down and drained and ordered the leaking section replaced. Had this been done, the only loss would have been 1 or 2 days of pumping.

CONCLUSIONS

1. Three months before the accident, six full-wrap sleeves were installed to repair a corroded, leaking, section of pipeline. Metallurgical tests showed that the repair sleeves contained substandard fillet welds. The crack in the weld that failed propagated until leakage occurred.

2. The repaired pipe was backfilled at that time but it was not adequately supported from beneath. The pipe settled in its excavation, which placed the fillet weld in tension and propagated the initial crack through the pipe wall until it leaked again.

3. While the men were repairing the leak, the pipeline was pumping sour crude oil; sour crude oil contains hydrogen sulfide, a highly toxic gas.

4. Because company safety procedures which specified the use of oxygen breathing equipment, vapor detection devices, and safety ropes were ignored, six men died.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the accident was the attempted repair, in a manner which failed to follow the company's written procedures, of a leak in a cracked fillet weld on a full-wrap repair sleeve. The fillet weld, made improperly during the repair of an earlier leak, failed. The failure allowed toxic, sour crude oil to spray and permeate the leak site.

RECOMMENDATIONS

The National Transportation Safety Board submitted the following recommendations to the West Texas Gulf Pipe Line Company:

"Instruct its personnel in the safety requirements contained in the Operations and Maintenance Manual and monitor employees' work to assure that procedures are followed. (P-76-30) (Class II, Priority Followup)

"Use qualified welders to instruct its personnel in the proper installation of fillet welding on repair sleeves. (P-76-31) (Class II, Priority Followup)

"Assure that any contractor engaged to do pipeline repairs is familiar with West Texas Gulf operation and maintenance procedures and insist that the contractor have available and use the required safety equipment. (P-76-32) (Class II, Priority Followup)

"Instruct its maintenance and operating personnel in the hazards of working around sour crude oil. (P-76-33) (Class II, Priority Followup)

"Equip its company vehicles or provide, at strategic locations, oxygen breathing equipment, safety ropes, and gas vapor detection instruments. Monitor employee actions to insure that equipment is used in accordance with written procedures. (P-76-34) (Class II, Priority Followup)

"Examine the repair records for its pipeline system to determine where other fillet weld repairs had been made and excavate the pipeline at these locations to inspect the fillet weld quality. (P-76-35) (Class II, Priority Followup)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ WEBSTER B. TODD, JR.
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

June 9, 1976

NTSB-PAR-76-5 PIPELINE ACCIDENT REPORT - DOW CHEMICAL U.S.A., NATURAL GAS LIQUIDS EXPLOSION AND FIRE, NEAR DEVERS, TEXAS, MAY 12, 1975

On May 12, 1975, an 8-inch pipeline, which was shut down and closed in under pressure 4 days earlier, ruptured near Devers, Texas. Natural gas liquids at 1,425-psig pressure erupted from a fracture near the top of the pipe. The liquids vaporized, mixed with air, and formed a cloud which drifted over a highway. An automobile drove into the vapor cloud and ignited the vapors. The resulting explosion and fire killed all four persons in the automobile, melted telephone and power lines, warped railroad tracks, burned adjacent woodlands, and interrupted rail and highway traffic.

The NTSB determined that the probable cause of this accident was the rupturing of the 8-inch pipe in a area of stress concentration caused by a gouge in the pipe. The pipe was gouged by a backhoe when valve assemblies were installed in the line. The failure was caused by a combination of reduction in wall thickness, residual bending and tensile stresses, and fatigue due to the cycle loading of the pipe.

R & D CONSIDERATIONS

No R & D requirement

PB-255 979

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-77-3	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle: Pipeline Accident Report — Dow Chemical U.S.A., Natural Gas Liquids Explosion and Fire, Near Devers, Texas, May 12, 1975		5. Report Date: June 30, 1976
7. Author(s)		6. Performing Organization Code
9. Performing Organization Name and Address: National Transportation Safety Board, Bureau of Surface Transportation Safety, Washington, D. C. 20594		8. Performing Organization Report No.
12. Sponsoring Agency Name and Address: NATIONAL TRANSPORTATION SAFETY BOARD, Washington, D. C. 20594		10. Work Unit No. 1850
		11. Contract or Grant No.
		13. Type of Report and Period Covered: Pipeline Accident Report, May 12, 1975
		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract: At 12:28 p.m. on May 12, 1975, an 8-inch pipeline, which was closed in under pressure and which was owned by Dow Chemical U.S.A. and operated as the Bronco Pipe Line Company, ruptured near Devers, Texas. Natural gas liquids at 1,425-psig pressure erupted from a fracture near the top of the pipe. The liquids vaporized, mixed with air, and formed a cloud which drifted to the southwest over U.S. Highway 90. An automobile entered the vapor cloud and ignited the ethane-propane vapors. The resulting explosion and fire killed the four persons in the automobile, melted telephone and electric power lines, warped railroad tracks, burned and scorched adjacent woodlands, and interrupted rail and highway traffic.

The National Transportation Safety Board determines that the probable cause of the accident was the rupturing of the 8-inch pipe in an area of stress concentration caused by a gouge in the pipe; the pipe was gouged by a backhoe when valve assemblies were installed in the line. The failure was caused by a combination of reduction in wall thickness, residual bending and tensile stresses, and fatigue due to the cyclic loading of the pipe. The escaping LPG vapors were ignited by an automobile which entered the vapor-rich zone.

As a result of its investigation of the explosion, the Safety Board made three recommendations to Dow Chemical U.S.A. and one recommendation to the American Petroleum Institute.

17. Key Words: Closed in pipeline; stress concentration; mechanical equipment; natural gas liquids; cyclic loading; total system concept; communications; continuous reading; hydrostatic testing; pressure recorders; remote operated valves; delayed reporting		18. Distribution Statement: This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151.	
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Total System Concept

Had DOW employed the total system concept in the design, construction, inspection, and testing of this pipeline, DOW could have recognized that the pipeline could be damaged during excavations without the damage being detected. Therefore, DOW could have constructed the pipeline to maximize the benefits of testing to a high stress level, increased inspections where excavations would be performed after strength tests were performed, or found other means to minimize the potential for damage from excavations.

Had DOW applied the total system concept to the proposed system operation, it could have identified the potential for a rupture occurring without prompt detection, and DOW could have corrected this situation before the pipeline began operation.

In a special study, 5/ the Safety Board recommended that the American Petroleum Institute, the American Society of Mechanical Engineers (ASME), and the American Gas Association (AGA) develop guidelines for the use of the total system concept, and recommended that the Department of Transportation (DOT) encourage the use of the total system concept by pipeline operators. The AGA has published a report 6/ and has recommended it to the industry, and the ASME and the American Petroleum Institute are progressing in their response to the Safety Board recommendation. DOT has also acted upon its recommendation.

CONCLUSIONS

1. The pipe was gouged when the valve assemblies were installed.

2. The pipe ruptured because of the gouge, which created an area of stress concentration.

3. The internal cyclic loading, which was experienced after testing, probably caused cracks to form in the area of stress concentration.

4. The escaping ethane-propane mixture vaporized, mixed with air, formed a low-lying cloud, and drifted over Highway 90, where it was ignited by an automobile.

5. DOW did not adequately inspect the construction of the pipeline, so it did not know that the pipeline was gouged.

6. The DOW dispatchers were not aware that the pipe had ruptured because they had no equipment to transmit pressure data to them; therefore, the pipeline was not shut down promptly.

5/ National Transportation Safety Board, "Special Study - A Systematic Approach to Pipeline Safety," PSS-72-1.

6/ American Gas Association, "Guide to System Safety Analysis in the Gas Industry."

7. The lack of equipment to transmit pressure data was not in conformance with 49 CFR 195.406, "Communication." However, this regulation is unenforceable because it is not sufficiently specific.

8. Liquefied petroleum gases are more hazardous than crude oil or other refined products which are transported by pipeline because they are difficult to contain and dispose of after they leak from a pipeline.

9. The greater hazards inherent in the transportation of LPG require more stringent safety controls than do other petroleum products.

10. The employment of the total systems concept could have reduced the likelihood of a damaged pipe surviving inspection and testing and could have alerted DOW to the deficiencies in the communications of data to the dispatchers.

11. If this rupture had occurred in one of the more densely populated areas which this pipeline traverses, greater damage could have resulted.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the accident was the rupturing of the 8-inch pipe in an area of stress concentration caused by a gouge in the pipe; the pipe was gouged by a backhoe when valve assemblies were installed in the line. The failure was caused by a combination of reduction in wall thickness, residual bending and tensile stresses, and fatigue due to the cyclic loading of the pipe. The escaping LPG vapors were ignited by an automobile which entered the vapor-rich zone.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board submitted the following recommendations to Dow Chemical U.S.A.:

"Initiate necessary equipment changes to provide data necessary for the safe operation of the pipeline continuously to the dispatch centers. (P-76-39) (Class II, Priority Followup)

"Review periodically with local fire departments and other interested agencies the pipeline location, basic pipeline operations, materials transported, hazards encountered, and procedures to follow during leaks. (P-76-40) (Class II, Priority Followup)

"Use the total system concept to review day-to-day operations, new projects, and maintenance operations in order to assist in recognizing and controlling potentially hazardous conditions. (P-76-41) (Class II, Priority Followup)"

The National Transportation Safety Board also recommended that the American Petroleum Institute:

"Implement the recommendation made in the Safety Board's Special Study on 'A Systematic Approach to Pipeline Safety.' (P-76-42) (Class II, Priority Followup)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

NTSB-PAR-76-6 PIPELINE ACCIDENT REPORT - NEBRASKA NATURAL GAS CO., PATHFINDER HOTEL EXPLOSION AND FIRE, FREMONT, NEBRASKA, JANUARY 10, 1976

On January 10, 1976, a gas leak was reported in the vacinity of the 6-story Pathfinder Hotel in Fremont, Nebraska. Several calls were made to the gas company, who responded but did not locate the leak. About 1½ hours after the first call and before the hotel could be evacuated, the hotel exploded and caught fire. Twenty people were killed, 29 were injured, and the hotel was destroyed. Three of the dead were gas company supervisory employees.

The gas had leaked from a 2-inch plastic pipe which had pulled out of its compression coupling and migrated into the hotel under frozen earth and a concrete road surface.

The NTSB determined that the probable cause of the accident was the 2-3/8 inch contraction (due to cold temperatures) of a 2-inch polyethylene plastic main within a 4-inch steel casing. The plastic pipe pulled out of the inadequately connected compression coupling. The plastic main was not anchored to the ends of the steel casing.

R & D CONSIDERATIONS

1)Study the plastic-to-steel transition problem and take appropriate regulatory action.

2) Determine if there are locations or circumstances where standard compression couplings are unsafe.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-76-6	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report - Nebraska Natural Gas Company, Pathfinder Hotel Explosion and Fire, Fremont, Nebraska, January 10, 1976		5. Report Date July 7, 1976
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20594		10. Work Unit No. 1741-A
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Pipeline Accident Report January 10, 1976
		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

At 9:32 a.m. on January 10, 1976, gas which was leaking into the Pathfinder Hotel in Fremont, Nebraska, ignited. The gas was leaking from a 2-inch plastic pipe which had pulled out of its compression coupling; the gas seeped into the hotel because it had been capped above by frozen earth and a concrete road surface. The hotel exploded and fire ensued; the explosion and fire destroyed the hotel, damaged nearby buildings, and broke windows within a one-block radius. Thirty-nine persons were injured and 20 persons were killed.

The National Transportation Safety Board determines that the probable cause of the accident was the contraction, due to cold temperatures, of a 2-inch polyethylene plastic main within a 4-inch casing. The contraction of the plastic main caused the pipe to pull out of the inadequately connected compression coupling.

As a result of its investigation of the accident, the National Transportation Safety Board made recommendations to the Nebraska Natural Gas Company, the Department of Transportation, and the City of Fremont.

17. Key Words Thermal contraction; polyethylene plastic pipe; compression couplings; main insertions; transition fittings; system design inadequacy; pullout; emergency plans.		18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151.	
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CONCLUSIONS

1. During two winters, thermal contraction caused the 2-inch polyethylene plastic main to contract 2 3/8 inches on one end and 5/8 inch on the other end.

2. The pipeline was not designed and installed so that the tie-in compression coupling would sustain the longitudinal pull or the thrust forces which were caused by the pipe's contraction within its 4-inch steel casing.

3. The pipe had not been anchored to the casing ends to prevent it from pulling out of the coupling.

4. The smooth steel stiffener which was used in the end of the plastic pipe, underneath the compression nut of the coupling, was not made by the same manufacturer that made the coupling, and the resulting combination produced a joint which was weaker than the plastic pipe that was being joined.

5. When the contracting pipe pulled out of the weaker compression coupling, leaking gas migrated into the hotel and was ignited by an unknown source.

6. The pipe was not installed in accordance with several important manufacturer's recommendations and the quality of workmanship at the tie-ins was marginal.

7. The gas company's emergency provisions were inadequate with regard to employee training, availability of emergency equipment, emergency communications, public education, and its liaison with fire and police officials.

8. The spacing of distribution valves in the downtown area was insufficient to shut off gas to the area quickly, and those valves which were present were not mapped to facilitate an emergency shutdown.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the accident was the contraction, due to cold temperatures, of a 2-inch polyethylene plastic main within a 4-inch casing. The contraction of the plastic main caused the pipe to pull out of the inadequately connected compression coupling.

RECOMMENDATIONS

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

On February 24, 1976, the Safety Board recommended that the Nebraska Natural Gas Company:

"Review its entire system to see if pipe had pulled out of its coupling elsewhere and to rectify any potentially hazardous conditions found. (P-76-3) (Class I, Urgent Followup)

"Conduct tests below the frost level during this review of the system to monitor all plastic pipe joints made with short compression couplings where pullout and resultant gas leaks could occur. (P-76-4) (Class I, Urgent Followup)"

In addition, the Safety Board has recommended that the Nebraska Natural Gas Company:

"Use manufacturer's proprietary transition fittings, installed in accordance with written procedures, or use pipe-to-casing anchors to limit contraction of plastic pipe, until a compression coupling is verified by tests to be as strong as the plastic pipe being joined. (P-76-49) (Class II, Priority Followup)

"Develop written procedures and an inspection program to insure that all plastic pipe joints meet the design and installation provisions of 49 CFR 192(F), 'Joining of materials by means other than welding.' (P-76-49) (Class II, Priority Followup)

"Revise the company's written procedures to include the maximum length of plastic pipe to be used with compression couplings, the number of foot-pounds of torque required for each size of compression coupling, a time interval during construction between retorquing of couplings, and the type of stiffener to be used with each brand of coupling. (P-76-50) (Class II, Priority Followup)

"Develop written procedures to handle gas leak emergencies and evacuation, and instruct operating and maintenance employees as to their roles in carrying out these procedures. (P-76-51) (Class II, Priority Followup)

"Develop a procedure to shut down the system during emergencies. As part of this procedure, develop distribution system maps showing valve locations, determine optimum spacing of high-pressure valves in each of the NNG distribution systems, and install additional valves, if necessary, to reduce the time required to shut down a section of main in an emergency. (P-76-52) (Class II, Priority Followup)

"Develop a method of receiving emergency telephone calls in order to assure immediate response to emergencies. The method should include logging of all emergency calls. (P-76-53) (Class II, Priority Followup)

"Improve the customer education program and liaison between the gas company, the police, and the fire departments. Include in written procedures the methods for notifying police and fire departments of gas emergencies and the planned responses to them. (P-76-54) (Class II, Priority Followup)

"Equip emergency vehicles with combustible gas leak detectors, distribution maps, and other necessary work tools. (P-76-55) (Class II, Priority Followup)"

The Safety Board has recommended that the Department of Transportation:

"Study the plastic-to-steel transition problem and take appropriate regulatory action to correct any unsafe practices. (P-76-43) (Class II, Priority Followup)

"Revise 49 CFR 192.281(e)(2), 'Mechanical Joints,' to require that stiffeners be designed to be compatible with compression couplings so that pipes cannot pull out of the couplings. (P-76-44) (Class II, Priority Followup)

"Determine if there are locations or circumstances where standard compression couplings are unsafe, and amend 49 CFR 192 accordingly to prohibit their use for such applications. (P-76-45) (Class II, Priority Followup)

"Analyze the methods which operators use to receive and respond to emergency calls and, based upon this analysis, amend 49 CFR 192, 'Operations,' to specify minimum acceptable standards. (P-76-46) (Class II, Priority Followup)

"Amend 49 CFR 192,'Operations,' to require that operators record the receipt of emergency calls, the response to the calls, and the time of each significant action taken by the operator. (P-76-47) (Class II, Priority Followup)"

The Safety Board has recommended that the City of Fremont:

"Reemphasize to city personnel who are assigned to the emergency desk the importance of helping people who call in to report gas leaks, and require the personnel to furnish emergency gas company numbers to the public. (P-76-56) (Class II, Priority Followup)

"Coordinate emergency activities with the gas company and determine what responses should be made to various types of gas emergencies. (P-76-57) (Class II, Priority Followup)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

NTSB-PAR-76-7 PIPELINE ACCIDENT REPORT - SUN PIPE LINE CO., RUPTURE OF 8-INCH PIPELINE, ROMULUS, MICHIGAN, AUGUST 21, 1975

On August 21, 1975, an 8-inch refined product pipeline ruptured in Romulus, Michigan. Propane escaped from the rupture, sprayed into the air, vaporized, and then ignited. Flames 500 feet high engulfed the area. The fire burned nine persons, destroyed four homes and damaged three others, burned 12 vehicles and consumed 2,389 barrels of propane.

The NTSB determined that the probable cause of the accident was the propagation of surface cracks in a section of 8-inch pipe, which had been dented and gouged previously. The cracks propagated when a valve which had been closed caused an abnormally high pressure to develop. Contributing to the accident was inadequate inspection during contruction of the pipeline.

R & D CONSIDERATION

1) Study the use of lockout equipment which shuts down a pipeline system unless all valves are positioned properly and full clearance to operate has been obtained.

PB257671

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. [illegible]	2. Government Accession No.
3. Recipient's Catalog No.	
4. Title and Subtitle: Pipeline Accident Report — Sun Pipe Line Company, Rupture of 8-inch Pipeline, Romulus, Michigan, August 2, 1975	5. Report Date: July 28, 1976
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
9. Performing Organization Name and Address: National Transportation Safety Board, Bureau of Surface Transportation Safety, Washington, D. C. 20594	10. Work Unit No. 1809
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address: NATIONAL TRANSPORTATION SAFETY BOARD, Washington, D. C. 20594	13. Type of Report and Period Covered: Pipeline Accident Report, August 2, 1975
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

At 1:51 a.m. on August 2, 1975, an 8-inch pipeline which was owned by the Sun Pipe Line Company ruptured in Romulus, Michigan. Propane escaped from the rupture, sprayed into the air, vaporized, and then ignited; flames 300 feet high engulfed a 600-foot-diameter area. The fire burned nine persons, destroyed four houses and damaged three others, burned 12 vehicles, and consumed 2,389 barrels of propane.

The National Transportation Safety Board determines that the probable cause of the accident was the propagation of surface cracks in a section of 8-inch pipe, which had been dented and gouged previously. The cracks propagated when a valve which had been closed against the pipeline stream caused an abnormally high pressure to develop at the leak site. Contributing to the accident was the inadequate inspection during construction.

PAGES SUBJECT TO CHANGE

17. Key Words	18. Distribution Statement
Propane; ignition; structural damage; dents and gouges; crack propagation; 8-inch pipe; construction inspection; pump station operation; terminal operation; propane storage caverns; closed valves.	This report is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	22	$3.50

NTSB Form 1765.2 (Rev. 9/74)

CONCLUSIONS

1. The pipe had been dented and gouged previously, which caused surface microcracks to develop.

2. The dent and gouge in the pipe had been undetected and unreported because Sun did not provide adequate inspection during construction.

3. A closed valve on a propane cavern caused the pressure to build up along the entire pipeline.

4. The pipe ruptured when the cracks propagated to a critical size because of the higher-than-normal pressure.

5. The Toledo pump station personnel failed to get clearance before they restarted a pump which had shut down automatically after the failure.

6. Undetected, unreported damage to pipelines which occurs during subsequent construction poses a serious hazard, because the lines may fail unpredictably later on.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the accident was the propagation of surface cracks in a section of 8-inch pipe, which had been dented and gouged previously. The cracks propagated when a valve which had been closed against the pipeline stream caused an abnormally high pressure to develop at the leak site. Contributing to the accident was the inadequate inspection during construction.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board has recommended that the Sun Pipe Line Company:

"Instruct its personnel more adequately in inspection techniques and procedures and emphasize the potential hazards of undetected, unreported, construction damage to an operating pipeline. (P-76-58) (Class II, Priority Followup)

"Reevaluate its propane cavern operating procedures and emphasize to its terminal personnel the potential hazards created by a line blockage. (P-76-59) (Class II, Priority Followup)

"Study the possible use, at its terminals and pump stations, of lockout equipment which shuts down a pipeline system unless all valves are positioned properly and full clearance to operate has been obtained. (P-76-60) (Class II, Priority Followup)"

The National Transportation Safety Board also recommended that the American Petroleum Institute:

"Advise its member companies that operate similar pipeline facilities to reassess their station and terminal operating procedures in light of this accident. (P-76-61) (Class II, Priority Followup)

"Reemphasize to appropriate personnel the importance of thorough and continuous inspection during construction to prevent or to report damage to pipeline facilities by outside parties. (P-76-62) (Class II, Priority Followup)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

NTSB-PAR-76-8 PIPELINE ACCIDENT REPORT- STANDARD OIL COMPANY OF CALIFORNIA, PIPELINE RUPTURE, LOS ANGELES, CALIFORNIA, JUNE 16, 1976

On June 16, 1976, an 8-inch pipeline was struck and ruptured by a front end loader excavating near an intersection in Los Angeles, Cal. Gasoline under a initial pressure of 550-psig, sprayed from the rupture and drenched nearby buildings and objects. Ninety seconds later, the gasoline ignited, causing flames to engulf the area, killing 9 persons, injuring 14 others, and causing extensive property damage.

The NTSB determined that the probable cause of the accident was the rupture of the pipeline by excavation equipment, whose operator was unaware of the pipeline's precise depth and location. Neither the pipeline operator, the contractor, nor the California DOT knew the exact location of the pipeline.

R & D CONSIDERATIONS

No R & D requirement

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-76-8	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report - Standard Oil Company of California, Pipeline Rupture, Los Angeles, California, June 16, 1976		5. Report Date December 9, 1976
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 1939
		11. Contract or Grant No.
		13. Type of Report and Period Covered Pipeline Accident Report June 16, 1976
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

At 10:32 a.m., on June 16, 1976, an 8-inch pipeline owned by the Standard Oil Company of California was struck and ruptured by excavation equipment, which was working on a road-widening project. Gasoline sprayed from the rupture and drenched nearby buildings. Ninety seconds later, the gasoline ignited; the ensuing fire killed 9 persons, injured 14 persons, and caused extensive property damage.

The National Transportation Safety Board determines that the probable cause of the accident was the rupture of the pipeline by the excavation equipment, whose operator was unaware of the pipeline's precise depth and location. Although the line was known to exist, its precise depth and location were not known by the pipeline operator, the construction contractor, the subcontractor, or the California Department of Transportation.

17. Key Words	18. Distribution Statement
Excavation damage; equipment rupturing pipelines; gasoline pipeline; one-call system; road-widening project; rapid ignition; gasoline spray; police command post; evacuation of residents.	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	22	

NTSB Form 1765.2 (Rev. 9/74)

CONCLUSIONS

1. The 8-inch, gasoline pipeline was hit and ruptured by the subcontractor's excavation equipment because the equipment operator, although aware of the pipeline's existence, believed it to be buried deeper.

2. SOCAL, when it supplied CALTRAN with information about the location of its pipeline in the median of Venice Boulevard, failed to provide the precise pipeline depth at the accident site and did not monitor the construction activities continuously.

3. No attempt was made to verify the pipeline depth at the accident site by the four parties, even though 700 feet of the pipeline near the accident site had been previously lowered because of insufficient depth; the two testholes dug by SOCAL 628 feet apart were spaced too far for an accurate depth determination of the pipe at the point of rupture.

4. No "one-call" system was in effect in the area at the time of the accident.

5. High-pressure pipelines require more and closer monitoring in congested areas than in rural areas to guard against excavation damage.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the accident was the rupture of the pipeline by the excavation equipment, whose operator was unaware of the pipeline's precise depth and location. Although the line was known to exist, its precise depth and location were not known by the pipeline operator, the construction contractor, the subcontractor, or the California Department of Transportation.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board made the following recommendations:
— to the Standard Oil Company of California:

"Submit precise, accurate data concerning the depth and location of its pipelines for all future construction projects. (Class II, Priority Followup) (P-76-87)

"Conduct inspections of operations along its pipelines to insure that construction does not risk the integrity of its pipelines. (Class II, Priority Followup) (P-76-88)

"Insure adequate communications with contractors and other parties through written, substantiated means during excavation work including testhole verification for the depth and location of its pipelines. (Class II, Priority Followup) (P-76-89)

"Join any "one-call" systems in areas where its pipelines operate and help to organize systems where they do not exist. (Class II, Priority Followup) (P-76-90)"

— to the State of California Department of Transportation:

"Develop guidelines for preconstruction meetings, which should include methods of preventing damage to underground utilities to be encountered during the proposed construction work. Such preconstruction meetings should be attended by all operators whose facilities are involved. (Class II, Priority Followup) (P-76-91)"
(The Safety Board made this same recommendation to the American Public Works Association on February 2, 1973.)

"Cooperate and coordinate with those groups attempting to establish a "one-call" notification system in southern California and other areas of the State where none exist, and work with systems already in existence. (Class II, Priority Followup) (P-76-92)

"Require, as a prerequisite of a contract award, that the contractor be in contact with the "one-call" notification system or the individual facilities operators to determine the precise depth and location of any underground facilities before beginning the project. (Class II, Priority Followup) (P-76-93)"

— to the American Petroleum Institute, the American Gas Association, and the Interstate Natural Gas Association of America:

"Advise member companies whose facilities are exposed to excavation construction projects to take immediate action to mark and locate their facilities accurately. (Class II, Priority Followup) (P-76-94)"

— to the Griffith Company and C. W. Poss, Inc.:

"Cooperate and coordinate with those groups attempting to establish a "one-call" system in areas in which they conduct excavation activities. (Class II, Priority Followup) (P-76-95)."

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ WEBSTER B. TODD, JR.
Chairman

/s/ KAY BAILEY
Vice Chairman

/s/ PHILIP A. HOGUE
Member

/s/ WILLIAM R. HALEY
Member

FRANCIS H. McADAMS, Member, did not participate in the adoption of this report.

December 9, 1976

NTSB-PAR-77-1 PIPELINE ACCIDENT REPORT - UNITED GAS PIPE LINE CO., 20-INCH PIPELINE RUPTURE AND FIRE, CARTWRIGHT, LOUISIANA, AUGUST 9, 1976

On August 9, 1976, a road grader ruptured a 20-inch gas transmission pipeline near Cartwright,La. Natural gas at 770-psig pressure escaped and ignited within seconds. The resulting flames engulfed the area, killing six persons, injuring one person, and causing extensive property damage. The operator of the road grader heard the gas escaping after he struck the pipeline. He jumped from the grader and ran from the site, leaving the grader out of gear, but with the engine still running.

The NTSB determined that the probable cause of the accident was the rupture of the pipeline by a road grader whose operator was unaware of the existence of the pipeline. Contributing to the accident was the previous construction of a rural road over the pipeline right-of-way which reduced the pipeline cover, and the failure of the construction agency to notify the pipeline operator of the road maintenance work over its right-of-way.

R & D CONSIDERATIONS

No R & D requirement

10. PIPELINE ACCIDENT REPORTS AND SPECIAL STUDIES, CY-1977

The following four pipeline accident reports were published during CY-1977. No pipeline safety studies were issued.

NTSB-PAR-77-1	Pipeline Accident Report - United Gas Pipe Line Co., 20-inch Pipeline Rupture and Fire, Cartwright, Louisiana, August 9, 1976
NTSB-PAR-77-2	Pipeline Accident Report - UGI Corp., Natural Gas Explosion and Fire, Allentown, Pennsylvania, August 8, 1976
NTSB-PAR-77-3	Pipeline Accident Report - Exxon Gas System, Inc., Natural Gas Explosion and Fire, Robstown, Texas, December 7, 1976
NTSB-PAR-77-4	Pipeline Accident Report - Pennsylvania Gas and Water Co., Natural Gas Explosion, Williamsport, Pennsylvania, January 25, 1977

NTSB-PAR-77-1 PIPELINE ACCIDENT REPORT - UNITED GAS PIPE LINE CO., 20-INCH PIPELINE RUPTURE AND FIRE, CARTWRIGHT, LOUISIANA, AUGUST 9, 1976

On August 9, 1976, a road grader ruptured a 20-inch gas transmission pipeline near Cartwright,La. Natural gas at 770-psig pressure escaped and ignited within seconds. The resulting flames engulfed the area, killing six persons, injuring one person, and causing extensive property damage. The operator of the road grader heard the gas escaping after he struck the pipeline. He jumped from the grader and ran from the site, leaving the grader out of gear, but with the engine still running.

The NTSB determined that the probable cause of the accident was the rupture of the pipeline by a road grader whose operator was unaware of the existence of the pipeline. Contributing to the accident was the previous construction of a rural road over the pipeline right-of-way which reduced the pipeline cover, and the failure of the construction agency to notify the pipeline operator of the road maintenance work over its right-of-way.

R & D CONSIDERATIONS

No R & D requirement

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-77-1	2. Government Accession No.
3. Recipient's Catalog No.	
4. Title and Subtitle: Pipeline Accident Report - United Gas Pipe Line Company, 20-Inch Pipeline Rupture and Fire, Cartwright, Louisiana, August 9, 1976	5. Report Date: April 26, 1977
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
9. Performing Organization Name and Address: National Transportation Safety Board, Bureau of Accident Investigation, Washington, D.C. 20594	10. Work Unit No. 1906A
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address: NATIONAL TRANSPORTATION SAFETY BOARD, Washington, D. C. 20594	13. Type of Report and Period Covered: Pipeline Accident Report, August 9, 1976
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

About 1:05 p.m., on August 9, 1976, a road grader ruptured a 20-inch United Gas Pipe Line Company transmission line near Cartwright, Louisiana, and natural gas at 770 psig escaped and ignited within seconds. The resulting flames engulfed the area and killed six persons, injured one person, and caused extensive property damage.

The National Transportation Safety Board determines that the probable cause of the accident was the ignition of natural gas that was escaping from a pipeline which had been ruptured by a road grader whose operator was unaware of the pipeline's existence. Contributing to the accident was the previous construction of a road over the pipeline right-of-way which reduced the pipeline's cover, and the failure of the Jackson Parish Police Jury to notify the pipeline's operator of the road maintenance work.

17. Key Words: Excavation damage; excavator; natural gas; one-call system; road grader; pipeline marker; incineration.		18. Distribution Statement: This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151	
19. Security Classification (of this report): UNCLASSIFIED	20. Security Classification (of this page): UNCLASSIFIED	21. No. of Pages: 17	22. Price: A02-A01

NTSB Form 1765.2 (Rev. 9/74)

CONCLUSIONS

Findings

1. The 20-inch natural gas pipeline was gouged and punctured by a road grader during road maintenance work.

2. Operator No. 2 was not aware of the existence of the pipeline because Operator No. 1, who was aware of the pipeline, failed to inform him.

3. United did not lower or encase its pipelines after the road had been constructed even though the cover over the pipelines had been decreased by 18 inches.

4. United's efforts to inform the Jury about the hazards of working near pipelines did not deter the Jury road grader from striking the pipeline.

5. The Jury did not notify United as requested before the Jury began grading in the vicinity of the pipeline.

6. At the time of the accident no "one-call" system was in effect to assist excavators in notifying pipeline operators of the time and location of proposed excavations.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the ignition of natural gas that was escaping from a pipeline which had been ruptured by a road grader whose operator was unaware of the pipeline's existence. Contributing to the accident was the previous construction of a road over the pipeline right-of-way which reduced the pipeline's cover, and the failure of the Jackson Parish Police Jury to notify the pipeline's operator of the road maintenance work.

RECOMMENDATIONS

As a result of this accident, the National Transportation Safety Board on October 27, 1976, made the following recommendations:

— to the Interstate Natural Gas Association of America, the American Petroleum Institute, and the American Gas Association:

> "Advise their member companies of the circumstances of this accident and urge them to determine if the original cover depths of their pipelines have been significantly reduced, and to take action to correct deficient areas. (Class I, Urgent Followup) (P-76-74)
>
> "Urge their member companies to participate in or establish damage prevention programs, including the "one-call" notification system. (Class I, Urgent Followup) (P-76-75)"

— to the Jackson Parish Police Jury:

> "Cease grading operations on Jury roads until a plan is developed and implemented to notify operators of buried facilities at least 2 working days before excavating near their facilities; this would allow time for identification of the facilities' location and depth. (Class I, Urgent Followup) (P-76-76)
>
> "Instruct operators of excavation equipment in safety precautions that should be taken when working near buried facilities, and provide these operators with information on how the location and probable depth of these facilities may be identified. (Class I, Urgent Followup) (P-76-77)"

— to the United Gas Pipe Line Company:

> "Protect the 20-inch and 24-inch pipelines from future damage before reopening Griffin Road. (Class I, Urgent Followup) (P-76-78)
>
> "Determine the depth of pipelines at all other road crossings where the cover over the pipe line may have been reduced by later road construction and take necessary action to prevent damage by ditch-cleaning or road-grading activities. (Class I, Urgent Followup) (P-76-79)

"Complete promptly development of an educational program for excavators and institute a program to advise excavators how to recognize pipeline rights-of-way, provide general information about precautions when excavating near pipelines, and encourage notification before excavating. (Class I, Urgent Followup)(P-76-80)"

-- to the Governor of the State of Louisiana:

"Encourage the implementation of the proposed Louisiana "one-call" notification system to provide statewide coverage. (Class I, Urgent Followup)(P-76-81)

"Advise all State and parish agencies about the circumstances of this accident and urge that they notify operators of pipeline and other underground facilities before excavating near these facilities. (Class I, Urgent Followup) (P-76-82)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ WEBSTER B. TODD, JR.
Chairman

/s/ KAY BAILEY
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

/s/ WILLIAM R. HALEY
Member

April 26, 1977

NTSB-PAR-77-2 PIPELINE ACCIDENT REPORT - UGI CORP., NATURAL GAS EXPLOSION AND FIRES, ALLENTOWN, PENNSYLVANIA. AUGUST 8, 1976

On August 8, 1976, a gas explosion destroyed a house in Allentown, Penn. The gas migrated from a break in a 4-inch cast-iron main into the building. The exterior walls were blown out and the rafters fell in, trapping a man. Firemen arrived and rescued the man and also began to fight small fires erupting from debris left by the explosion. Police and firemen began to evacuate the residents of the block.

Shortly thereafter, a house across the street from the first house exploded. The front brick wall collapsed into the street and trapped two firemen. The street then caved in directly in front of the trapped firemen. The firemen were killed, 14 persons were injured, four buildings were destroyed, and several buildings were damaged.

The NTSB determined that the probable cause of the break in the main was structural weakening by localized graphitization and was also undermined by a sink hole which was enlarged during heavy rainfall. The failure to check the second house for an explosive atmosphere and to shut off its gas supply,resulted in two fatalities and numerous injuries.

R & D CONSIDERATIONS

1) Encourage, coordinate, and monitor development of equipment which could be used to detect the location of sinkholes in the area of underground utility lines.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-77-2	2.Government Accession No.	3.Recipient's Catalog No.
4. Title and Subtitle - Pipeline Accident Report - UGI Corporation, Natural Gas Explosions and Fires, Allentown, Pennsylvania, August 8, 1976		5.Report Date May 18, 1977
		6.Performing Organization Code
7. Author(s)		8.Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Pipeline Accident Branch Washington, D.C. 20594		10.Work Unit No. 2048
		11.Contract or Grant No.
12.Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13.Type of Report and Period Covered Pipeline Accident Report August 8, 1976
		14.Sponsoring Agency Code

15.Supplementary Notes

16.Abstract

At 2 p.m., on August 8, 1976, a gas explosion destroyed a house at 1127 Oak Street, Allentown, Pennsylvania. The gas migrated from a break in a 4-inch cast-iron main under the street through loose soil under a concrete sidewalk and into the building through cracks and openings in its foundation.

At 2:26 p.m., another house exploded across the street from the site of the first explosion. The front brick wall collapsed into the street and trapped two firemen. The street then caved in directly in front of the trapped firemen. The cast-iron gas main within the sinkhole broke into several pieces; flames from the broken main were more than 10 feet high and hampered rescue of the trapped firemen. Two firemen were killed, 14 persons were injured, 4 buildings were destroyed, and several buildings were damaged.

The National Transportation Safety Board determines that the probable cause of the accident was the ignition, by unknown sources, of natural gas which had leaked from a broken cast-iron gas main under the street in front of the houses. The gas main had been weakened structurally by localized graphitization and was undermined by a sinkhole. The failure to check the second house for an explosive atmosphere and to shut off its gas supply resulted in two fatalities and numerous injuries.

17.Key Words Natural gas explosion; fractured cast-iron pipes; gas migration; fire department liaison; graphitization; corrosion; sinkholes, "downward-looking" radar.		18.Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151	
19.Security Classification (of this report) UNCLASSIFIED	20.Security Classification (of this page) UNCLASSIFIED	21.No. of Pages 28	22.Price PC A03 / MF A01

NTSB Form 1765.2 (Rev. 9/74)

CONCLUSIONS

Findings

1. An unusually heavy rainfall of 3 inches in 2 days caused a sinkhole under the gas main to enlarge.

2. The first break in the gas main occurred more than 45 minutes before the other four breaks, but all were caused by settlement of the gas main over the sinkhole.

3. The main first broke where it had been weakened by graphitization where a 3/4-inch, copper water service line to 1127 Oak Street contacted the main. The graphitization resulted from a galvanic action between the two dissimilar metals.

4. Breaks in the sewer and water lines were caused by the sinkhole.

5. Continued gas supplies to 1128 and 1130 Oak Streets left possible sources of ignition for the second explosion.

6. Neither the gas company personnel nor firemen used combustible gas indicators at the accident site and the atmosphere in the second house that exploded had not been checked for a possible explosive mixture. Specific training in and conscientious use of combustible gas indicators might have prevented the second explosion.

7. The trapped firemen and rescue personnel might have been injured less if the gas fire in the street had been extinguished with dry chemicals.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the ignition, by unknown sources, of natural gas which had leaked from a broken cast-iron gas main under the street in front of the houses. The gas main had been weakened structurally by localized graphitization and was undermined by a sinkhole. The failure to check the second house for an explosive atmosphere and to shut off its gas supply resulted in two fatalities and numerous injuries.

RECOMMENDATIONS

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

— to the UGI Corporation:

"Revise its 1968 Guide for Fire Fighters and training program by incorporating instructions on how to deal with events similar to this accident with particular emphasis on the proper use of combustible gas indicators. (Class III, Longer Term Followup) (P-77-1)

"Revise its emergency plans to incorporate the revisions that became effective October 1, 1976, to 49 Code of Federal Regulations 192.615, and to insure emergency response coordination with fire and other public officials. Particular emphasis should be placed on the availability and the proper use of combutible gas indicators. (Class III, Longer Term Followup) (P-77-2)

"Expedite, in conjunction with equipment manufacturers, the development of a survey unit that could be used to detect the location of sinkholes in the vicinity of cast-iron gas mains. "Downward-looking" radar equipment should be investigated as one possible means of surveying for sinkholes. (Class III, Longer Term Followup) (P-77-3)"

— to the Office of Pipeline Safety Operations of the Materials Transportation Bureau of the U.S. Department of Transportation:

"Encourage, coordinate, and monitor development of equipment which could be used to detect the location of sinkholes in the vicinity of underground utilities. (Class III, Longer Term Followup) (P-77-4)"

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

"Develop guidelines to assist operators during emergencies to promptly isolate leaking segments of pipe in a low-pressure system. (Class III, Longer Term Followup) (P-77-5)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ WEBSTER B. TODD, JR.
Chairman

/s/ KAY BAILEY
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

/s/ WILLIAM R. HALEY
Member

May 18, 1977

NTSB-PAR-77-3 PIPELINE ACCIDENT REPORT- EXXON GAS SYSTEM, INC., NATURAL GAS EXPLOSION AND FIRE, ROBSTOWN, TEXAS, DECEMBER 7, 1976

On December 7, 1976, a natural gas compressor operating at 1000-psig pressure failed and then exploded and burned during a routine maintenance inspection at an Exxon Gas Systems compressor station near Robstown, Texas. An emergency shutdown system was activated, but the four automatic fire gate valves on the pipelines that supplied the station did not close. Another emergency control system also failed to automatically close the shutoff valves leading to two of the five compressors in the station. Thirty minutes later, another explosion occurred in the station. Pipeline valves upstream and downstream of the station had to be closed manually. Gas burned for 3 hours until the pipeline pressure dropped to 250-psig and the fire gate could be approached and closed manually. The fire killed one person, injured two, and caused property damage and gas loss amounting to $5 million.

The NTSB determined that the probable cause of the accident was the failure of the studs securing the 10-inch valve cover. The studs failed from stress fatigue and tension because they were overtightened. Contributing to the large losses was the failure of a compressor due to overheating and a high internal gas pressure,and the failure of several automatic emergency shutdown valves to close.

R & D CONSIDERATIONS

No R & D requirement

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-77-3	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report - Exxon Gas System, Inc., Natural Gas Explosion and Fire, Robstown, Texas, December 7, 1976		5. Report Date October 13, 1977
7. Author(s)		6. Performing Organization Code
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		8. Performing Organization Report No.
		10. Work Unit No. 2198
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Pipeline Accident Report December 7, 1976
		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract At 11 a.m., c.s.t., on December 7, 1976, a natural gas compressor operating at 1,000 psig pressure failed and then exploded and burned at an Exxon Gas System, Inc., station near Robstown, Texas. An emergency shutdown system was activated by a worker at the station, but the four automated fire gate valves on the two pipelines that supplied the station did not close. Another emergency control system also failed to automatically close the shutoff valves leading to two of the five compressors in the station. At 11:30 a.m., a second explosion occurred within the burning building in one of the compressors that had not shut down automatically. Pipeline valves upstream and downstream of the station had to be closed manually. Gas burned for 3 hours until the pipeline pressure decreased to 250 psig and the fire gate valves could be approached and closed manually. The fire killed one person, injured two persons, and destroyed three engine-driven compressors and the compressor building. Property damage and gas loss was estimated to be $5 million.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the studs securing the 10-inch valve cover; the studs failed from stress fatigue and tension because they were overtightened. The natural gas that was released ignited, possibly by an electrical spark from a compressor engine. Contributing to the large losses was the failure of a cast-iron compressor cylinder due to overheating and a high internal gas pressure, and the failure of several automatic emergency shutdown valves to close.

17. Key Words Natural gas explosion; stress fatigue fractures of studs; cast-iron fractures in compressor cylinders; emergency unit shutdown; fire gate valves; over-torquing of studs; instrument air; solenoid valves; valves; system safety; compressor station design.		18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 51	22. Price A04 A01

NTSB Form 1765.2 (Rev. 9/74)

Fire Protection System

Adequate fire protection equipment is required by 49 CFR 192.171 for all compressor stations. Some of the other Exxon compressor stations have chemical fire extinguisher systems, but only small hand-held fire extinguishers were available at station No. 1. These would not be effective against such a large gas fire. The water and chemical sprays brought in by tanks were not used by the firemen because the fire at that time was too intense to be approached even with the use of asbestos firesuits. It is also doubtful if the water and chemical sprays could have put out such a large fire. The termination of the gas supply was the only effective way to extinguish such a large gas-fed fire.

CONCLUSIONS

Findings

1. Five of the eight studs that held a 10-inch cap on suction valve No. 3 of cylinder No. 2 of compressor unit No. 1 failed because of metal fatigue caused by excessive stresses from overtorquing. The other three studs failed in tension at near maximum allowable operating pressure.

2. The source of ignition of the gas was probably from the electrical system of the gas engine inside of the building.

3. One, and possibly two, of the men that had been working in compressor building No. 1 pushed an emergency shutdown (ESD) button, but the station did not shut down as designed.

4. The operational and emergency shutdown system for each compressor unit did not function in units No. 1 and No. 2 for a combination of reasons:

   (a) The 8-inch cylinder operators on the 10-inch bypass and 24-inch suction and discharge valves were too worn and too small;

(b) the valves were sequential, and it is possible that the electrical circuitry was destroyed by fire before all valves could complete the sequence of operation to fully open or close;

(c) one of the air lines in compressor building No. 1 was destroyed by fire, and the instrument air supply to operate the controllers of the suction and discharge valves at this building was lost.

5. A 1/8-inch vent on a 3-way solenoid valve was clogged and prevented the closing of the two fire gate valves on the 30-inch-diameter pipeline.

6. The linkage in a 4-way control valve became stuck and prevented power-loading gas from closing the two fire gate valves on the 36-inch-diameter pipeline because the valve had not been operated for more than 6 months.

7. A second explosion occurred one-half hour after the first when the cast-iron, No. 1 cylinder of compressor unit No. 2 failed as a result of heat damage and 800-psig pressure.

8. The radiated heat from the 1,00('oot-long flames made any rescue or firefighting attempts possible. The fire burned for more than 3 hours until pipeline block valves upstream and downstream from the station were closed.

9. The closing of a power gas-operated, 30-inch-diameter mainline valve was delayed over 1 hour because the workcrew from a distant compressor station was unfamiliar with the operation of a power gas valve that had been taken out of service and they had to close the valve manually.

10. The 1-year period between the inspection and the operation of the remotely and automatically controlled compressor station valves is too long to insure their dependable operation; in this accident the control systems for eight automatic power-operated station valves failed to function properly resulting in about $5 million in property damage and gas loss.

11. A manually operated control to remotely operate emergency blowdown valves from a safe location within the station should have been installed to blow down all of the station piping.

12. An effective total system analysis was not made before this accident of the various emergency shutdown control systems.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the studs securing the 10-inch valve cover; the studs failed from stress fatigue and tension because they were overtightened. The natural gas that was released ignited, possibly by an electrical spark from a compressor engine. Contributing to the large losses was the failure of a cast-iron compressor cylinder due to overheating and a high internal gas pressure, and the failure of several automatic emergency shutdown valves to close.

RECOMMENDATIONS

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

— to Exxon Gas Systems, Inc.:

"Take necessary steps to insure that studs on compressors and engine components are tightened to the number of foot-pounds of torque recommended by the equipment manufacturer. (Class II, Priority Followup) (P-77-27)

"Inspect emergency shutdown valves and their components at compressor stations at more frequent intervals than 1 year (monthly or quarterly) until equipment of proven reliability has been installed, tested, and shown to be responsive for longer periods of inactivity. (Class II, Priority Followup) (P-77-28)

"Make a total systems review of electric, air, and gas-operated emergency equipment, with particular emphasis on interconnected air systems and backup or duel-feed air systems in compressor stations. (Class II, Priority Followup) (P-77-29)

"Include, in emergency shutdown systems, a separate control to remotely operate valves that can independently blow down the station piping. (Class II, Priority Followup) (P-77-30)

"Investigate more dependable items of control equipment and replace existing solenoid and 4-way valves at fire gate valves with this equipment. (Class II, Priority Followup) (P-77-31)

"Designate critical valves on control lines (gas, air, and hydraulic) as to whether they should be normally open or closed, and place signs on these valves whenever the lines are shut down for maintenance or when the valves are not in their normal positions. Such changes should be authorized, logged, and reported to all personnel responsible for the operation of the system. (Class II, Priority Followup) (P-77-32)

"Train operating personnel from other stations and other nearby operating divisions of the company on the operation of emergency transmission line valves and emergency station fire control valves. Furnish each nearby company office that could be expected to help in an emergency with a contingency plan book and drawings of all of the facilities they might be expected to operate. (Class II, Priority Followup) (P-77-33)"

— to the Materials Transportation Bureau of the U.S. Department of Transportation:

"Review compressor station accidents to determine if there have been similar problems with remote-control shutdown devices. If there have been reliability problems, make a survey to determine the optimum time between inspections and amend 49 CFR 192.731(c) by decreasing the time interval between inspection and testing from the current minimum of 1 year to reflect these findings. (Class III, Longer Term Followup) (P-77-34)

"Add to 49 CFR 192 a requirement for pneumatic-operated compressor station equipment, similar to the requirement in 49 CFR 192.167(3) for electric-operated equipment, to isolate instrument air supply to automatic facilities, and to provide backup or separate emergency pneumatic facilities. (Class III, Longer Term Followup) (P-77-35)

"Add to 49 CFR 192.729 a section to require the proper torquing procedures for studs, as specified by the compressor manufacturer, when reassembling compressors after maintenance work. Include periodic testing of these studs, by ultrasonic or other means, to insure their integrity during operation. (Class III, Longer Term Followup) (P-77-36)"

NTSB-PAR-77-4 PIPELINE ACCIDENT REPORT - PENNSYLVANIA GAS AND WATER CO., NATURAL GAS EXPLOSION, WILLIAMSPORT, PENNSYLVANIA, JANUARY 25, 1977

On January 25, 1977, a low-order explosion and fire destroyed a house in a residential area near Williamsport, Penn. Volunteer firemen were extinguishing the flames, and gas company employees were trying to locate a natural gas leak, when a second explosion demolished a house 70 feet away. A resident of this house and a bystander were killed by the explosion and 23 persons were injured. Neither of the houses were served by gas.

The NTSB determined that the probable cause of the accident was the failure, due to thermal contraction (caused by the cold temperatures), of a substandard weld on a 4-inch high pressure gas main, which had been lowered and stressed by sewer construction. Contributing to the fatalities and the large number of injuries to firemen was the gas company's failure to detect the gas accumulation in the second house, to evacuate its occupants, and to warn the volunteer firemen of the dangers when a high pressure gas main is leaking and is capped by frozen earth.

R & D CONSIDERATIONS

No R & D requirement.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-77-6	2. Government Accession No.	3. Recipient's Catalog No. PB277052
4. Title and Subtitle Pipeline Accident Report - Pennsylvania Gas and Water Company, Natural Gas Explosions, Williamsport, Pennsylvania, January 25, 1977		5. Report Date November 23, 1977
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 2088A
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Pipeline Accident Report January 25, 1977
		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract At 1:36 a.m., e.s.t., on January 25, 1977, a low-order explosion and fire destroyed a house in a residential area near Williamsport, Pennsylvania. Firemen were extinguishing the fire, and employees from the Pennsylvania Gas and Water Company were attempting to locate a natural gas leak when a second explosion at 2:39 a.m. demolished a house 70 feet away. A resident of this house and a bystander were killed by the explosion; 23 persons, including 19 firemen, were injured. Automobiles, a fire truck, and houses within a one-block radius were damaged severely.

The National Transportation Safety Board determines that the probable cause of the accident was the failure due to thermal contraction of a substandard weld on a 4-inch, high-pressure gas main, which had been lowered and subsequently stressed by the open-cut sewer construction. The escaping gas migrated into two houses not served by gas and was ignited by unknown sources.

The gas company did not detect the substandard weld when it was made nor did they stipulate that the subsequent sewer construction adjacent to their gas main not impose additional stress on the main.

Contributing to the fatalities and the large number of injuries to firemen was the gas company's failure to detect the accumulation of gas in the second house that exploded, to evacuate its occupants before the explosion, and to warn the volunteer firemen of the potentially hazardous conditions that can be created when a high-pressure gas main is leaking and is capped by frozen earth.

17. Key Words	18. Distribution Statement		
Natural gas explosion; fracture of welds; nondestructive testing; inadequate penetration; gas migration; inadequate inspection practices; sewer construction damage; emergency shutoff valves; volunteer firemen; evacuation procedures.	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151		
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 24	22. Price PC-A03 MF-A01

NTSB Form 1765.2 (Rev. 9/74)

CONCLUSIONS

Findings

1. Because of the cold temperatures at the time of the accident, the 4-inch gas main was experiencing extreme thermal contraction stresses.

2. Severe stresses were created on the gas main when its grade was lowered by 1 1/2 feet during the 1972 sewer construction.

3. Uncompacted backfill placed over and under the gas main, and large cobblestones placed on the gas main during sewer construction also created stresses because of subsequent settlement.

4. The substandard weld which failed would not have passed welding codes in effect at the time it was made because of a lack of penetration into the walls of the pipe by the stringer bead. The second weld pass was also very porous and of poor quality.

5. The gas company did not have an adequate inspection program to detect and correct the faulty weld when the gas main was constructed.

6. The gas company emergency plans had not been updated to include the new requirement for liaison with fire departments contained in 49 CFR 192.615, which became effective on October 1, 1976. The gas company had not informed the firemen concerning their response to this type of gas emergency.

7. The gas company training program on its current emergency procedures was inadequate. The gas company dispatcher and serviceman did not follow the written company procedures.

8. The gas main showed a shutoff valve which did not exist within a block of the gas leak. This caused a long delay in shutting off the gas.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure due to thermal contraction of a substandard weld on a 4-inch, high-pressure gas main, which had been lowered and subsequently stressed by the open-cut sewer construction. The escaping gas migrated into two houses not served by gas and was ignited by unknown sources.

The gas company did not detect the substandard weld when it was made nor did they stipulate that the subsequent sewer construction adjacent to their gas main not impose additional stress on the main.

Contributing to the fatalities and the large number of injuries to firemen was the gas company's failure to detect the accumulation of gas in the second house that exploded, to evacuate its occupants before the explosion, and to warn the volunteer firemen of the potentially hazardous conditions that can be created when a high-pressure gas main is leaking and is capped by frozen earth.

RECOMMENDATIONS

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

— to Pennsylvania Gas and Water Company on June 6, 1977:

"Excavate, on a random sample basis acceptable to the Pennsylvania Public Service Commission, the welds in the failed 4-inch gas main and nondestructively test them according to the American Petroleum Institute 1104 Welding Code to determine if there are more faulty welds on the pipeline. Replace or repair all welds which do not pass reinspection. (P-77-6)

"Instruct its personnel in inspection techniques and procedures and emphasize the potential hazards of undetected faulty welds and construction damage to operating pipelines. (P-77-7)

"Reemphasize and instruct gas operations personnel on the importance of liaison with the fire department and establish with all fire departments, including volunteer fire departments, what the proper response should be to every type of gas emergency. (P-77-8)"

On December 1977, the National Transportation Safety Board issued these additional recommendations:

— to Pennsylvania Gas and Water Company:

"Initiate an effective general public and gas customer information program about the nature, characteristics, and hazards of natural gas and what to do when it is encountered. (Class II, Priority Action) (P-77-38)

"Test the effectiveness of the emergency procedure training of all operating personnel. If the training is found to be ineffective for any group of employees, provide additional instruction. (Class II, Priority Action) (P-77-39)

"Verify the location of all high-pressure shutoff valves shown on gas main atlases and change maps where necessary. (Class II, priority Action) (P-77-40)"

— to the Materials Transportation Bureau of the U.S. Department of Transportation:

"Extend its Emergency Services Training Course contract to include a section on the hazardous materials aspects of flammable pipeline materials such as natural gas and liquid hydrocarbons. Coordinate and cooperate with the American Gas Association, the American Petroleum Institute, and the Interstate Natural Gas Association of America to use their expertise in this area. (Class III, Longer Term Action) (P-77-41)

"Instruct all Office of Pipeline Safety Operations regional compliance offices and state agents to inspect gas companies under their jurisdiction for compliance to the amended 49 CFR 192.615 (emergency plans) effective October 1, 1976. Particular attention should be given to the provision that requires that the gas company train its appropriate operating personnel to assure that they are knowledgeable of the emergency procedures and how the company tests its employees to verify that the training is effective. (Class II, Priority Action) (P-77-42)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

11. PIPELINE ACCIDENT REPORTS AND SPECIAL STUDIES, CY-1978

The following are the six pipeline accident reports and special studies published during CY-1978.

-PSS-78-1	Special Study - Safe Service Life for Liquid Petroleum Pipeline
-PAR-78-1	Pipeline Accident Report - Consolidated Gas Supply Corp., Propane Pipeline Rupture and Fire, Ruff Creek, PA, July 20, 1977
-PAR-78-2	Pipeline Accident Report - Alyeska Pipeline Service Co., Explosion and Fire, Pump Station 8, Near Fairbanks, Alaska, July 8, 1977
-PAR-78-3	Pipeline Accident Report - Atlanta Gas Light Co., High-Pressure Gas Main Rupture, Atlanta, Georgia, December 1, 1977
-PAR-78-4	Pipeline Accident Report - Kansas Public Service Co., Inc., Explosion and Fire, Lawrence, Kansas, December 15, 1977
-PAR-78-5	Pipeline Accident Report - The Gas Service Company Natural Gas Pipeline, Rupture and Fire, Kansas City, Missouri, June 12, 1978

NTSB-PSS-78-1 SPECIAL STUDY - SAFE SERVICE LIFE FOR LIQUID PETROLEUM PIPELINE

The NTSB made a study of liquid petroleum pipeline accident data gathered from 1968-1976 by the Office of Pipeline Safety Operations (OPSO) — the pipeline safety regulatory office within the Materials Transportation Bureau.

The study originally was to develop a means of measuring safe service lives for liquid petroleum pipeline. However, the NTSB found that the existing OPSO data collection system was initiated in 1968 with no plan for its use in writing safety regulations or in providing its own analysis of the data.

NTSB's study of the data collected revealed that corrosion and pipeline ruptures by construction equipment caused over twice as many accidents as all other causes. Corrosion accidents declined steadily through the study period due to "continuing improvements in pipeline materials, technology and preventive maintenance programs." Construction damage accidents have remained relatively constant since 1970. Michigan's statewide "one-call" system was cited as an effective method of reducing such accidents and is recommended by the NTSB for other states with high accident rates. Under a one-call system, an excavator is able to report his proposed project to operators of all underground facilities in the excavation area with only one phone call.

The NTSB also made recommendations to seek improvement in the OPSO data collection system, including: computerization of liquid pipeline accident data to permit calculation of leak rates per mile and rates based on such factors as pipeline age, strength, depth, product carried, etc.

R & D CONSIDERATIONS

No R & D requirement.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PSS-78-1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Special Study - Safe Service Life for liquid Petroleum Pipelines		5. Report Date October 12, 1978
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D. C. 20594		10. Work Unit No. 2484
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Special Study
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

The report includes the results of an analysis of liquid pipeline accident data collected over a 9-year period (1968 to 1976) by the Department of Transportation. The purpose of the analysis was to determine if a model could be developed to help determine when a liquid pipeline has become so hazardous that its operation should be modified or terminated. Also, the analysis highlights significant trends from the causes of pipeline leaks and accidents. The analysis revealed that sufficient data has not been collected to support a model of this sort. The report presents summarized data that will aid in the evaluation of current damage prevention programs and the assessment of accident trends in such areas as the cause and frequency of leaks and the fatalities or injuries resulting from the leaks.

As a result of this study, recommendations were made to the U.S. Department of Transportation, American Petroleum Institute, and the Governors of the States of Texas and Oklahoma to improve DOT techniques for gathering and analyzing data, to strengthen Federal regulations concerning LPG pipelines, and to promote and encourage participation in statewide "one-call" systems.

17. Key Words	18. Distribution Statement
Pipeline; interstate; weld failures; leaks; accidents; liquefied petroleum gas; LPG; fires; explosions; fatalities; loss; safe service life data; operations; corrosion; rupture; excavation inspection; cathodic protection.	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	43	

NTSB Form 1765.2 (Rev. 9/74)

CONCLUSIONS

1. Corrosion was the leading cause of liquid pipeline accidents from 1968 through 1973. Continuing improvements in pipeline materials, technology, and preventive maintenance programs have greatly reduced the frequency of these accidents.

2. Equipment-caused pipeline ruptures were the second leading cause of accidents from 1968 through 1973. Because the number of these accidents remained relatively constant after 1970, equipment-caused pipeline rupture accidents exceeded the number of corrosion accidents during the years 1974 and 1976. This accident cause also was the leader in losses of transported pipeline products as well as total casualties from 1968 through 1976.

3. The damage prevention program in Michigan appears to have been effective in reducing the frequency of equipment-caused pipeline ruptures. The State's "one-call" system is a major factor in the reduction.

4. "One-call" systems in Oklahoma and Texas would reduce the number of equipment-caused ruptures.

5. Although LPG is involved in only 10 percent of the reported accidents leaks, it caused 62 percent of the fatalities, 51 percent of the injuries, and 24 percent of the property damage.

6. Instructions for filling out the Form 7000-1 are not adequate to insure consistency and thoroughness. Because the persons completing the forms have not interpreted the instructions in the same way, a variety of responses to similar accident leak situations have resulted. The OPSO also has not audited Form 7000-1 responses sufficiently to insure the completeness and accuracy of each report.

7. There is no way to predict safe service life of a liquid pipeline using the currently available data.

RECOMMENDATIONS

As a result of this study, the National Transportation Safety Board recommended that:

...the Office of Pipeline Safety Operations of the Materials Transportation Bureau of the U.S. Department of Transportation:

"Publish a plan that describes how the OPSO will use accident report data to formulate safety regulations and to develop a safe service life model for pipelines. (Class II, Priority Action) (P-78-58)

"Redesign the Liquid Pipeline Accident Reporting System to include data similar to that collected in the Natural Gas Accident Reporting System. (Class III, Longer Term Action) (P-78-59)

"Provide clear instructions and definitions to insure the accuracy and consistency of the data recorded on the liquid pipeline accident report forms. (Class III, Longer Term Action) (P-78-60)

"Computerize the redesigned Liquid Pipeline Accident Report System. Include the capability to:

a. compute the historical accident/leak rate-per-mile of pipe for each carrier as well as the nationwide rate;

b. make periodic comparisons of each carrier's accident/leak rate against the nationwide accident/leak rate;

c. compute and plot selective accident/leak rates based on pipeline parameters such as age, specified yield strength, depth of cover, product transported, etc;

d. selectively retrieve and summarize accident/leak data pertaining to any given accident or classification of accidents;

e. produce summarized reports reflecting the above-listed information. (Class III, Longer Term Action) (P-78-61)

"Conduct audits of the completed liquid pipeline accident reports to insure that mandatory data is provided. (Class III, Longer Term Action) (P-78-62)

"Expedite completion of the rulemaking to strengthen the Federal regulations concerning LPG pipelines. (Class II, Priority Action) (P-78-63)"

...the American Petroleum Institute:

"Urge its member companies to participate in and encourage improvement in any 'one-call' system in areas where their pipelines operate, and help organize systems where they do not exist. (Class II, Priority Action) (P-78-64)"

...the Governors of the States of Texas and Oklahoma:

"Take action to develop and implement statewide 'one call' excavation notification systems. (Class II, Priority Action) (P-78-65)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
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/s/ ELWOOD T. DRIVER
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Member

/s/ PHILIP A. HOGUE
Member

October 12, 1978

NTSB-PAR-78-1 PIPELINE ACCIDENT REPORT - CONSOLIDATED GAS SUPPLY CORP., PROPANE PIPELINE RUPTURE AND FIRE, RUFF CREEK, PA., JULY 20, 1977

On July 20, 1977, a 12-inch propane pipeline ruptured near Ruff Creek, Pa. The liquid under 450-psig pressure, vaporized and propane gas fumes settled like a fog over the bottom of a valley. One and one-half hours later, two men in a pickup truck entered the area, the truck stalled, and the propane gas ignited when they tried to restart the truck. The flash fire that followed killed the two men and caused property damage in an area 1 mile long and 100 yards wide.

The NTSB determined that the probable cause of the accident was the stress-corrosion cracking of a 12-inch propane pipeline which had been subjected to earth subsidence caused by previous coal mining operations beneath the pipeline. Contributing to the amount of propane burned and the time taken to isolate the failed pipeline section was the absence of leak detection equipment to quickly detect and isolate the failure.

R & D CONSIDERATIONS

1) Conduct research into stress-corrosion cracking, particularly on older steel gas pipelines that have been converted to liquid service.

2) Conduct field tests, using acoustic emission testing techniques developed by the gas industry, to determine if highly stressed portions of liquid pipelines can be located, and stress-corrosion cracking can be detected by this means before failure.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-78-1	2. Government Accession No.	3. Recipient's Catalog No. PB278192
4. Title and Subtitle Pipeline Accident Report - Consolidated Gas Supply Corporation, Propane Pipeline Rupture and Fire, Ruff Creek, Pennsylvania July 20, 1977		5. Report Date January 12, 1978
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 2260
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Pipeline Accident Report July 20, 1977
		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

At 4:30 a.m., e.d.t., on July 20, 1977, a 12-inch propane pipeline, owned by the Consolidated Gas Supply Corporation, ruptured near the town of Ruff Creek, Pennsylvania. The liquid, under 450-psig pressure, escaped from the pipeline, vaporized, and propane gas fumes settled like a fog over the bottom of a valley. About 6 a.m., two men in a pickup truck entered the propane cloud; the truck stalled and the propane gas ignited when an attempt was made to restart the truck. A flash fire, approximately 100 yards wide, followed a streambed located along the bottom of the valley and burned everything in its path for a distance of 1 mile.

As a result of this accident, the 2 persons in the truck were killed, the truck was destroyed, 57 head of cattle were killed, overhead power and telephone lines were destroyed, a hay storage shed containing 450 bales of hay was burned, 1,800 barrels of propane burned, and a meadow and wooded area 1 mile long by 100 yards wide was burned.

The National Transportation Safety Board determines that the probable cause of the accident was the failure by stress-corrosion cracking of a 12-inch propane pipeline which had been subjected to earth subsidence caused by previous coal mining operations underneath the pipeline.

The fatalities and property damage resulted from the escaping liquid which vaporized and settled in a valley where it was later ignited by an electrical spark from a truck.

17. Key Words Propane fire; liquefied petroleum gas (LPG); stress-corrosion cracking; stopples; coal mining; earth subsidence; LPG statistics; cathodic protection; magnetic-particle-inspection techniques.		18. Distribution Statement This report is available to the public through the National Technical Information Service, Springfield, Virginia 22151	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 43	22. Price PC A03-A01

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CONCLUSIONS

Findings

1. The leaking propane went undetected for 1 1/2 hours after the failure because no leak detection equipment had been installed and because the pump station personnel at Hastings thought they were having pump vapor lock problems.

2. Because there was no meter at the originating pump station on this propane pipeline, there was no way to detect a leak by comparing the propane volume entering the pipeline with the volume leaving the pipeline.

3. Consolidated did not have written procedures for the safe operation of the pipeline under normal operations or during emergency operations as required by 49 CFR 195.402.

4. Communications, as required by 49 CFR 195.408, is vague and therefore unenforceable. However, Consolidated's communications to safely operate this propane pipeline was not adequate.

5. The leaking propane vaporized and migrated downstream through a valley for 1 mile before it was ignited by an electrical spark from a truck.

6. In the past 9 years liquid petroleum gas (LPG) was involved in less than 10 percent of all reported liquid petroleum pipeline accidents, but it caused 66 percent of all the fatalities, 48 percent of all the injuries, and 31 percent of all the property damage.

7. The rupture in the 12-inch propane pipeline was caused by the propagation of stress-corrosion cracks to the point of failure.

8. Stress-corrosion cracking is affected by time and the crack propagation on this pipeline probably had been developing for a period of years.

9. Earth subsidence due to underground coal mining, which affected the pipeline in 1974, and the removal of coal pillars in the mine directly underneath the pipeline in 1974 and 1975 probably created additional stresses on the pipeline that abetted the stress-corrosion cracking.

10. Although documented for natural gas pipelines, this failure was possibly the first reported case, verified by laboratory analysis, of stress-corrosion cracking on a liquid pipeline.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure by stress-corrosion cracking of a 12-inch propane pipeline which had been subjected to earth subsidence caused by previous coal mining operations underneath the pipeline.

The fatalities and property damage resulted from the escaping liquid which vaporized and settled in a valley where it was later ignited by an electrical spark from a truck.

Contributing to the amount of propane burned and to the time taken to isolate the failed pipeline section was the absence of provisions to detect the failure in a timely manner and to isolate the failed section.

RECOMMENDATIONS

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

— to Consolidated Gas Supply Corporation:

"Inspect the field sagbend under the stream and adjacent to the overbend that failed and at any other known locations where the pipeline has undergone settlement of this type with the magnetic-particle-inspection or other suitable technique, for signs of stress-corrosion cracking. Replace the sagbend or other pipe if incipient cracking is present. (Class II, Priority Action)(P-78-1)

"Test pipe for stress-corrosion cracking using a nondestructive testing method such as the magnetic-particle-inspection method or other suitable technique every time the pipeline is exposed for maintenance purposes. (Class II, Priority Action)(P-78-2)

"Establish written procedures to insure the safe operation and maintenance of this pipeline system under normal and emergency conditions as required by Federal regulations. (Class II, Priority Action) (P-78-3)

"Install a meter at the Hastings Extraction Plant on the inlet to the propane pipeline to determine how much liquid is entering the pipeline. (Class II, Priority Action)(P-78-4)

"Investigate the feasibility of detecting pipeline leaks by the use of electronic In/Out flow monitors or other leak detection devices, and install one capable of detecting both small and large leaks. (Class III, Longer Term Action)(P-78-5)

"Establish a control center for the liquid propane pipeline and telemeter all pressure, flow, and other pertinent data necessary for the safe operation of this pipeline to this central location. (Class III, Longer Term Action)(P-78-6)

"Inspect on a random sample basis the segment of pipeline 10 miles downstream of the former Preston Compressor Station, including the area between Interstate Highways 70 and 79 where coal mines are prevalent, for other evidence of stress-corrosion cracking or increased-depth, general corrosion pitting. Increase cathodic protection or consider line replacement in areas where severe corrosion or stress-corrosion cracking is found. (Class II, Priority Action) (P-78-7)

"Train pump station personnel on pump maintenance procedures and how to tell the difference between line pressure losses caused by leaks and by pumps being vapor locked. (Class II, Priority Action) (P-78-8)"

— to the Materials Transportation Bureau of the U.S. Department of Transportation:

"Expedite the publishing of the Notice of Proposed Rulemaking on regulations for the safe transportation by pipelines of liquefied petroleum gases (LPG). Include a comprehensive section on the communications required for the safe operation of LPG pipelines. (Class II, Priority Action) (P-78-9)

"Include in proposed regulations a section similar to the emergency plan section of the natural gas code (49 CFR 192.615) that will require operators to provide information to persons who live or work within 220 yards of a propane pipeline, and up to 1 mile if located downhill of a LPG pipeline, about the particular hazards of LPG and how to contact emergency response personnel. (Class III, Longer Term Action) (P-78-10)

"Include in proposed 49 CFR 195 regulations, provisions for checking natural gas pipelines that are being converted to liquefied petroleum gas (LPG) service for stress-corrosion cracking. (Class III, Longer Term Action) (P-78-11)"

— to the American Petroleum Institute:

"Participate in and encourage research into stress-corrosion cracking, especially on older steel gas pipelines that have been converted to liquid service. (Class III, Longer Term Action) (P-78-12)

"Conduct field tests, using acoustic emission testing techniques developed by the gas industry, to determine if highly stressed portions of liquid pipelines can be located, and stress-corrosion cracking can be detected by this means before failure. (Class III, Longer Term Action) (P-78-13)

"Conduct research to develop some form of detector, either as an odorant or irritant, of the presence of liquefied petroleum gas. The detector should be one that will not contaminate the product or make it unsuitable for use with processing catalysts. (Class III, Longer Term Action) (P-78-14)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

NTSB-PAR-78-2 PIPELINE ACCIDENT REPORT - ALYESKA PIPELINE SERVICE CO., EXPLOSION AND FIRE, PUMP STATAION 8, NEAR FAIRBANKS, ALASKA, JULY 8, 1977

On July 8, 1977, during the initial startup of the Alaska pipeline, pump station 8 exploded and burned. As a result of the accident, one person was killed, five were injured, and the entire pipeline was shut down. Damage was estimated to be about $35 million.

The NTSB determined that the probable cause of the accident was the failure of the poorly coordinated and inadequately supervised personnel at pump station 8 to follow the written procedures for performing maintenance work and starting the pump. Contributing to the accident was the absence of a sole authority or station manager in complete control of all station activities during the critical startup period. Contributing to the amount of crude oil spilled and to the explosion and fire was the inability of control room personnel to see the activities going on in the pump room (located in another building) and the lack of safety and overriding controls in the pump room.

R & D CONSIDERATIONS

No R & D requirements.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-78-2	2. Government Accession No.	3. Recipient's Catalog No. PB 284651
4. Title and Subtitle Pipeline Accident Report - Alyeska Pipeline Service Company, Explosion and Fire Pump Station 8, Near Fairbanks, Alaska, July 8, 1977		5. Report Date March 9, 1978
7. Author(s)		6. Performing Organization Code
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		8. Performing Organization Report No. 10. Work Unit No. 2145E 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Pipeline Accident Report July 8, 1977 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract At 2:38 p.m., on July 8, 1977, the Alyeska Pipeline Service Company's pump station No. 8, located 17 miles southeast of Fairbanks, Alaska, exploded and then burned. As a result of this accident, one person was killed, five persons were injured slightly, pump station No. 8 was rendered inoperable, and the entire pipeline from Prudhoe Bay to Valdez was shut down. Damage was estimated to be $35 million.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the poorly coordinated and inadequately supervised personnel at pump station No. 8 to follow precisely the written procedures for performing maintenance work and starting the pumps.

Contributing to the accident was the absence of a sole authority or station manager in complete control of all activities within the pump station during this critical startup period.

Contributing to the amount of crude oil spilled, to the explosion, and to the fire were the inability of the control room personnel to see the activities going on in the pump room, and the lack of controls in the pump room to enable personnel in that location to close or override the valves and to shut down the pump.

17. Key Words Trans-Alaska pipeline; pump station; explosion and fire; crude oil pipeline; Valdez Control Center; training program; Halon fire system; special work permits; safe practices Nos. 4 and 14; pump No. 1 suction valve; pump No. 1 strainer; motor control's electrical lockout; pump station log book.		18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 45	22. Price A03-A01

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CONCLUSIONS

Findings

1. The Alyeska safety and operations manuals were complete but Alyeska personnel did not strictly adhere to these procedures.

2. There was no sole authority in charge of all phases of the operations at pump station No. 8 to insure strict compliance with the procedures or to coordinate the activities of the personnel to insure a safe startup.

3. The maintenance personnel who removed the strainer from pump No. 1 did not use the required procedures to notify the pump station control room personnel of their work. In turn, the pump station control room personnel did not notify the maintenance crew of their decision to restart pump No. 1.

4. The complete lack of visibility of the pump room from the control room and the lack of controls in the pump room to shut down the pump and to control or override the valves contributed to the accident.

5. The spraying and vaporizing of the crude oil from the partially opened strainer top rapidly filled the entire pump room with an explosive mixture which ignited.

6. The Halon fire extinguishing system, designed for enclosed areas only, could not function effectively because the explosion blew the roof off and the walls out of the pump room.

7. The fire foam system could not have successfully extinguished the ensuing, massive, pump room fire.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the poorly coordinated and inadequately supervised personnel at pump station No. 8 to follow precisely the written procedures for performing maintenance work and starting the pumps.

Contributing to the accident was the absence of a sole authority or station manager in complete control of all activities within the pump station during this critical startup period.

Contributing to the amount of crude oil spilled, to the explosion, and to the fire were the inability of the control room personnel to see the activities going on in the pump room, and the lack of controls in the pump room to enable personnel in that location to close or override the valves and to shut down the pump.

RECOMMENDATIONS

As a result of this accident investigation the National Transportation Safety Board made the following recommendations to the Alyeska Pipeline Service Company:

> "Designate a manager or management team at each pump station with the responsibility and authority to supervise and require all personnel involved in the operation of the pump station to comply completely and consistently with all written procedures during the startup period and the continuing operations of such stations. (Class I, Urgent Action) (P-77-16) (Issued July 15, 1977.)
>
> "Review all procedures and practices which apply to pipeline startup and the ensuing operation to insure that all critical actions will be done in a safe manner. Particular attention should be given to the interrelationships between those procedures which apply to startup and those which apply to the ensuing operations to insure complete coordination of functions. (Class I, Urgent Action) (P-77-17) (Issued July 15, 1977.)
>
> "Install a control in the pump room to shut down the pumps from that location. (Class I, Urgent Action) (P-77-21) (Issued September 9, 1977.)
>
> "Install a control in the pump room to operate the pump valves from that location at any time. (Class I, Urgent Action) (P-77-22) (Issued September 9, 1977.)
>
> "Install a closed circuit-type video camera in the pump room and turbine room to allow the pump station control center to monitor visually all activities at these locations. (Class I, Urgent Action) (P-77-23) (Issued September 9, 1977.)
>
> "Review its training program for adequacy, reinstruct its personnel in the procedures contained therein, and monitor the employees to assure their compliance with the required standards of safety for pipeline operation. (Class II, Priority Action) (P-77-37)" (Issued December 13, 1977.)

Additional information regarding these recommendations is contained in appendix C.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

NTSB-PAR-78-3 PIPELINE ACCIDENT REPORT - ATLANTA GAS LIGHT COMPANY, HIGH-PRESSURE GAS MAIN RUPTURE, ATLANTA, GEORGIA, DECEMBER 1, 1977

On December 1, 1977, a 12-inch, cast-iron, high pressure gas main owned by the Atlanta Gas Light Company was ruptured by an 8-inch steel I-beam pile, which was driven through the pipe at a construction site in downtown Atlanta. Within minutes, the natural gas at 10-psig pressure migrated through the ground, entered sewer lines and electric conduit systems, and spread through them into nearby buildings. The area was evacuated. Fortunately, the gas did not ignite.

Construction had been in progress almost 2 months at the site, but the gas main had not been marked by the gas company. The NTSB determined that the probable cause of the accident was the failure of the contractor to use information available to him on his blueprint. Although the contractor requested gas line locations via the one-call system, the gas company only located and marked some of its gas lines, not all of them in the area.

R & D CONSIDERATIONS

No R & D requirement.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-78-3	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report - Atlanta Gas Light Company, High-Pressure Gas Main Rupture, Atlanta, Georgia, December 1, 1977		5. Report Date May 18, 1978
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 2360
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Pipeline Accident Report December 1, 1977
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract At 1:00 p.m. e.s.t. on December 1, 1977, a 12-inch, cast-iron, high-pressure gas main owned by the Atlanta Gas Light Company was ruptured by an 8-inch, steel I-beam pile, which was driven through the pipe at a construction site in downtown Atlanta, Georgia.

Within minutes, natural gas at 10-psig pressure migrated through the ground, entered sewer lines and electric conduit systems, and spread into nearby buildings. The gas did not ignite, but thousands of people were evacuated from nearby office buildings. A valve was closed at 2:45 p.m. to shut off the flow of gas to the ruptured main, and the area was declared safe at 4:00 p.m.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the construction contractor to use information available to him on his blueprint which resulted in the rupture of the 12-inch, cast-iron, high-pressure gas main by the contractor's 8-inch, steel I-beam pile when it was driven through the pipe. Although the contractor requested gas line locations via the one-call notification system and although the gas company located and marked some of its lines, the gas company failed to mark all of the gas lines in the area.

Contributing to the accident was the failure of the gas company to meet on-site with the contractor to specify which gas lines were to be located.

17. Key Words Gas migration; emergency shutoff valves; one-call system; construction damage; evacuation; cast-iron; rupture.		18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 21	22. Price

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CONCLUSIONS

Findings

1. The rupture of the 12-inch cast-iron gas main was caused by the 8-inch, steel I-beam pile, which was driven through the pipe by the contractor.

2. At the time of the accident, the State of Georgia exempted contractors on municipal government projects from a requirement to notify gas companies before excavating.

3. Neither the construction company nor the gas company made it clear to each other which gas lines were involved in the construction project because both parties failed to meet with each other.

4. Although the gas lines were shown on the construction blueprints, the contractor apparently did not heed this information and did not make certain that the gas main was precisely located before any piles were driven in that location.

5. Federal regulations regarding the designation and location of emergency valves for high-pressure gas distribution systems are not adequate because they do not provide pipeline operators with requirements for the number and location of emergency valves.

6. The Atlanta Fire Department and the Atlanta Gas Light Company worked effectively together to evacuate buildings and eliminate ignition sources.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the construction contractor to use information available to him on his blueprint which resulted in the rupture of the 12-inch, cast-iron, high-pressure gas main by the contractor's 8-inch, steel I-beam pile when it was driven through the pipe. Although the contractor requested gas line locations via the one-call notification system and although the gas company located and marked some of its lines, the gas company failed to mark all of the gas lines in the area.

Contributing to the accident was the failure of the gas company to meet on-site with the contractor to specify which gas lines were to be located.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board recommended that:

-- the George Hyman Construction Company:

"Require its employees to follow completely the instructions given by one-call notification systems. (Class II, Priority Action) (P-78-18)

"Instruct its employees to ascertain by all possible means the locations of underground facilities before excavating at a construction site. (Class II, Priority Action) (P-78-19)"

-- the city of Atlanta, Georgia:

"Request that a representative of each operator of an underground facility attend all pre-construction meetings for excavation projects contracted by the city. (Class II, Priority Action) (P-78-20)"

-- the Atlanta Gas Light Company:

"Instruct its employees to respond precisely to notices of planned excavations provided by one-call notification systems. (Class II, Priority Action) (P-78-21)

"Develop a sectionalizing program of its high-pressure distribution system so that the location of designated valves will reduce the size of an affected area during an emergency. (Class II, Priority Action) (P-78-22)"

-- the American Society of Mechanical Engineers Gas Piping Standards Committee:

"Develop and issue guidelines to pipeline operators concerning the number and location of emergency valves in high-pressure gas distribution systems. (Class II, Priority Action) (P-78-23)"

-- the Materials Transportation Bureau (Office of Pipeline Safety Operations):

"Amend 49 CFR 192.181(a) to specifically define the requirement for location and number of emergency valves. (Class III, Longer Term Action) (P-78-24)"

NTSB-PAR-78-4 PIPELINE ACCIDENT REPORT - KANSAS PUBLIC SERVICE COMPANY, INC., EXPLOSION AND FIRE, LAWRENCE, KANSAS, DECEMBER 15, 1977

In 1975, the Kansas Public Service Company, Inc., (gas company) inserted 394 feet of 2-inch, polyethylene plastic pipe in an abandoned 3-inch distribution system with boltless, 2-inch, standard compression couplings. The plastic-to-metal joint was not made in compliance with regulations, anchored properly, installed properly, nor inspected. The gas company did not have any engineers or enough technically trained personnel to understand and apply the various Federal code provisions for this coupling installation. The plastic pipe pulled out of its 6-inch long compression coupling after the pipe had contracted 2½-inches in length due to temperature changes.

Subsequent tests have determined that the pullout resistance of plastic pipe in a standard compression coupling decreases with time. This indicates that more acciddnts of this type could occur involving the thousands of feet of polyethylene plastic pipe that have been connected with standard compression couplings. Other tests have indicated that a 2-inch, 400-foot long plastic pipe could be shortened by 4.32 inches by a 10°F temperature reduction and by 12.96 inches by a 30°F temperature reduction.

The NTSB believes that standard compression couplings with smooth stiffeners used on plastic main inserts more than 100-feet long are unsafe unless the pipeline is securely anchored. The NTSB is also considering the possible linkage between the size and resources of the company and the safety of the system. The personnel of smaller gas companies may have less technical capabilities if the number of technical personnel is proportional to the size of the company.

R and D Considerations

1) Improve the design of anchoring to prevent pullout of plastic pipe in compression couplings.
2) Conduct further tests to determine the effect of time on the pullout resistance of standard compression couplings and polyethlyene plastic pipe.
3) Conduct additional tests on the more common types of mechanical joints used in plastic pipe and internal stiffeners used to reinforce plastic pipe. Determine what style of compression coupling is compatible with each stiffener.
4) Determine the effect of polymer aging, outdoor exposure and stacking of coiled plastic pipe on its ultimate use.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-78-4	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle - Pipeline Accident Report - Kansas Public Service Company, Inc., Explosion and Fire, Lawrence, Kansas, December 15, 1977		5. Report Date July 5, 1978
7. Author(s)		6. Performing Organization Code
		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 2386
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Pipeline Accident Report December 15, 1977
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

At 12:50 a.m., c.s.t., on December 15, 1977, a 2-inch plastic gas main under an alley in downtown Lawrence, Kansas, pulled out of a compression coupling which joined it to a steel gas main. Natural gas escaped from the main and migrated through the stone foundation walls of two nearby buildings. At 1:20 a.m., the accumulations of gas in the two buildings ignited. The resulting explosion and fire destroyed one building, severely damaged the other building, and broke nearby windows. Two persons were killed and three persons were injured.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the gas company to properly design, install, test, inspect, and anchor the installation of a 394-foot-long polyethylene plastic gas main that had been inserted in a casing and connected to a steel gas main with a compression coupling. The 2 1/2-year-old unrestrained plastic gas main contracted 3 1/2 inches because of cold temperatures and pulled out of the compression coupling, the resistance of which had decreased with age.

17. Key Words	18. Distribution Statement		
Thermal contraction; polyethylene plastic pipe; compression couplings; pullout; main insertions; coiled plastic pipe; tensile tests; pullout resistance; destructive burst tests; late accident notification; written installation procedures; gas migration; fire; ignition.	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151		
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 57	22. Price

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CONCLUSIONS

Findings

1. Beginning shortly after its installation, and during the three winters, thermal contraction caused one end of the polyethylene plastic main to contract eight times and eventually its length was shortened by 3 1/2 inches.

2. The pipeline had not been designed or constructed so that the tie-in compression coupling could contain the longitudinal forces created by thermal contraction of the plastic pipe within its 3-inch steel casing as required by 49 CFR 192.273(a).

3. The plastic pipe had not been anchored to prevent it from pulling out of the coupling as required by 49 CFR 192.161(e).

4. The compression coupling and smooth steel stiffeners were manufactured by different companies and although they individually met code requirements, the resulting combination produced a joint that was weaker than the plastic pipe that was being joined and therefore the joint was in violation of 49 CFR 192.281(a).

5. The plastic pipe joint was not made in accordance with written procedures that had been proven by destructive burst tests to produce a joint that was as strong as the pipe being joined, as required by 49 CFR 192.281(a).

6. When the contracting pipe pulled out of the compression coupling, the leaking gas was sealed by a concrete alley and migrated into the building foundation 5 feet away.

7. The pipe was not installed in accordance with the manufacturer's recommendation to use special plastic pipe cutters. The end of the pipe cut squarely using the special pipe cutters did not pull out, whereas the end of the pipe cut on a bias using a hacksaw did pull out.

8. The gas company did not have an inspector to assure that the joint was properly made and complied with the code, as required by 49 CFR 192.273(c).

9. When the pipe and coupling were pressurized, the torque relaxed 46.7 percent. An inspector could have directed the retorquing of the coupling nut to 100 percent, 15 to 30 minutes after the makeup of the coupling.

10. Test results indicated that torque relaxation, internal pressure, temperature reduction, or pull rate were not the most significant factors in the pullout resistance of the pipe from the compression coupling. Pullout occurred in each of the above tests which proved that the joint was not as strong as the plastic pipe that was being joined.

11. Testing indicated a reduced pullout resistance by approximately two-thirds from 825 pounds to 300 pounds in the 2 1/2-year-old test specimens.

12. In all of the tensile tests there was an increase in axial loading of approximately 125 pounds in the last 3/8 inch of travel before pullout occurred. This "tail phenomenon" was first reported by the Safety Board in its Fremont, Nebraska, pipeline accident report. This 125-pound increase is due to the flared stiffener and is the reason the plastic pipe pulls almost all the way out of the coupling during extremely cold weather. After being allowed to relax over the next summer, the plastic will no longer require the 125-pound additional force for pullout and can pull out of the coupling the following winter when the soil temperature again drops below the installation temperature by 10° F or more.

13. There was an unnecessary 8-hour delay in reporting this accident which was partially caused by waiting for business offices to open before the call was made.

14. The gas company in Lawrence did not have any engineers or enough technically trained personnel to understand and apply the various Federal code provisions to this coupling installation.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the gas company to properly design, install, test, inspect, and anchor the installation of a 394-foot-long polyethylene plastic gas main that had been inserted in a casing and connected to a steel gas main with a compression coupling. The 2 1/2-year-old unrestrained plastic gas main contracted 3 1/2 inches because of cold temperatures and pulled out of the compression coupling, the resistance of which had decreased with age.

RECOMMENDATIONS

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

--to the Kansas Public Service Company, Inc:

"Complete the review of its plastic pipe systems before the 1978-79 winter season for other unanchored insertions more than 100 feet long, and rectify any potentially hazardous conditions found. (Class II, Priority Action)(P-78-25)

"Require an engineer or engineering consultant firm to review the design of its plastic pipeline system, including the design of anchors, so there are safeguards to prevent pullout at the mechanical joint for each pipe size and insertion length. (Class II, Priority Action)(P-78-26)

"Conduct destructive burst tests on each type of joint by which a plastic pipeline is connected to insure that the joint is as strong as the pipe being joined. (Class II, Priority Action)(P-78-27)

"Write installation procedures on how to make up each type of plastic pipe joint based on tests that have proven that the joint is as strong as the pipe being joined, and test employees on compliance and proficiency. (Class II, Priority Action)(P-78-28)

"Designate emergency shutoff valves on system maps and provide these maps to personnel on emergency call status. (Class II, Priority Action)(P-78-29)

"Issue an emergency plan that conforms to 49 CFR 192.615 and train emergency response personnel to insure that they are knowledgable of the emergency procedures, including the evacuation procedures and the emergency shutdown of the system. (Class II, Priority Action)(P-78-30)

"Train an installation inspector on the various code provisions and have him inspect each joint for code compliance. The time required for temperature stabilization of inserted plastic pipe and the torque requirements of compression couplings should especially be inspected. (Class III, Longer Term Action)(P-78-31)

"Include in its emergency plans the after-hours telephone numbers of the various agencies to which accidents must be reported, and instruct emergency response personnel to notify the appropriate officials at the earliest possible opportunity after hazards to life and property have been eliminated. (Class II, Priority Action)(P-78-32)"

--to the Materials Transportation Bureau of the U.S. Department of Transportation:

"Reconsider its responses to safety recommendations P-76-44 and P-76-45 in light of this and other accidents that have occurred with plastic pipe and 'standard' compression couplings since 1977. (Class I, Urgent Action) (P-78-33)"

--to the American Gas Association:

"Conduct tests to determine the effect of time on the pullout resistance of standard compression couplings and polyethylene plastic pipe. (Class III, Longer Term Action)(P-78-34)

"Conduct tests on the more common types of mechanical joints used on plastic pipe. Publish the results of these tests to member companies along with the recommendations of the manufacturers regarding whether the joint should be used for gastightness only or also for pullout resistance. (Class III, Longer Term Action) (P-78-35)

"Conduct tests on the more common internal stiffeners used to reinforce plastic pipe. Determine what style of compression coupling is compatible with each stiffener. (Class III, Longer Term Action)(P-78-36)

"Determine the effect of polymer aging, outdoor exposure, and stacking of coiled plastic pipe on its ultimate use. Specify to the natural gas industry what tests should be conducted on the pipe to prove its integrity if excessive storage is found to be detrimental. (Class III, Longer Term Action)(P-78-37)"

--to the Dresser Manufacturing Company:

"Enclose strongly worded warning literature in each box of Style 90 couplings shipped indicating that this standard compression coupling is NOT recommended for connecting long lengths of inserted plastic pipes or the anchoring of plastic pipe. (Class II, Priority Action)(P-78-38)

"Provide test data to the American Gas Association and make recommendations to them as to what the safe application should be for each fitting that Dresser manufactures to join plastic pipe. (Class III, Longer Term Action)(P-78-39)

"Investigate the possibility of setting up a testing laboratory where customers can send in samples of plastic pipe and inserts to be tested with couplings and then be provided certified results of the tests and application recommendations. (Class III, Longer Term Action)(P-78-40)"

--to the E.I. du Pont de Nemours & Company:

"Enclose warning literature and installation instructions in each carton of internal stiffeners indicating that the stiffeners do not provide any anchoring properties, and that it is the gas company's responsibility to properly design and install plastic pipelines in accordance with the applicable provisions of 49 CFR 192. (Class II, Priority Action)(P-78-41)

"Work with the American Gas Association and the Society of the Plastic Industry, Inc., to conduct tests to determine the effect of time on the pullout resistance of polyethylene plastic pipe and standard compression couplings. (Class III, Longer Term Action)(P-78-42)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

/s/ ELWOOD T. DRIVER
Member

July 5, 1978

NTSB-PAR-78-5 PIPELINE ACCIDENT REPORT - THE GAS SERVICE COMPANY NATURAL GAS PIPELINE, RUPTURE AND FIRE, KANSAS CITY, MISSOURI, JUNE 12, 1978

On June 12, 1978, a 10-inch pipeline owned by the Gas Service Company was struck and ruptured by excavation equipment operated by an unsupervised equipment operator during constructin of a sewer in Kansas City. Two hours after the rupture, the 48-year old pipeline was being repaired when leaking gas ignited and burned two members of the repair crew.

On June 6, 1978, the contractor called the gas company dispatcher and requested that the location of the gas pipeline be marked in an area where he was installing an 18-inch clay tile sewer. A gas company inspector located the 10-inch pipeline with an electronic pipe locator and placed two flags over it 75 feet apart, one on each side of the permanent sewer easement. The contractor did not ask,nor was he told about the depth of the pipeline (which was only 2 feet deep).

The NTSB investigation showed that the contractor was clearly in violation of the law requiring that underground facilities be located (horizontally and vertically) in advance of and during the excavation. This should have been done by digging test holes or requesting the gas company to determine the depth of the pipeline.

R & D CONSIDERATIONS

No R & D requirement

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-78-5	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report — The Gas Service Company, Natural Gas Pipeline Rupture and Fire, Kansas City, Missouri, June 12, 1978		5. Report Date December 7, 1978
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 2533
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Pipeline Accident Report June 12, 1978
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

At 1:30 p.m., c.d.t., on June 12, 1978, a 10-inch pipeline owned by the Gas Service Company was struck and ruptured by excavation equipment during construction of a sewer in Kansas City, Missouri. Natural gas, at more than 110-psig pressure, escaped from a 5-inch-long hole in the 2-foot-deep pipeline. At 3:15 p.m., the gas ignited while two gas company employees were cleaning the pipe with hand tools prior to installing a pipe repair clamp. Both men were burned seriously.

The National Transportation Safety Board determines that the probable cause of the accident was the rupture of the pipeline by heavy excavating equipment operated by an unsupervised equipment operator. The sewer contractor had failed to previously establish the exact horizontal and vertical locations of the pipeline either by digging test holes or by requesting the gas company to locate the pipeline more precisely. Sparks from hand tools used to clean the pipe prior to its repair ignited the escaping natural gas which seriously burned two gas company employees.

17. Key Words	18. Distribution Statement	
Excavation damage; equipment operator; pipeline rupture; working foreman; pipe-cleaning tools; emergency valve; repair clamp; protective clothing; emergency plan; pipeline cover; State excavation damage laws; electronic pipe locator.	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 24 / 22. Price

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In this accident, several aspects of employee safety were not covered by Federal regulations. Although the hard hats and safety goggles did provide some burn protection and possibly saved the vision of the injured men, a hood and flame-resistant coveralls and gloves, which are not currently required by Federal regulations, would have provided more protection. The MTB should either set clothing standards for gas company employee safety or assist OSHA in establishing these needed standards as soon as possible.

Polyester work clothing should be banned for all gas company employees working around blowing gas where ignition could occur and set their clothes on fire. In this accident, the worker wearing the short-sleeve polyester work uniform supplied by the company was burned more severely -- even though his flaming clothes were extinguished with the fire extinguisher -- than the worker who wore cotton clothing including a long-sleeve shirt.

CONCLUSIONS

Findings

1. The contractor violated Missouri law because he did not locate the pipeline in advance of the excavation work.

2. The contractor did not make a diligent effort to precisely establish the location and depth of the pipeline by digging tests holes, as called for in the construction specifications, before using excavation equipment in the vicinity of the pipeline.

3. No pipeline depth measurements were made by the gas company, contractor, or consulting engineer when the pipeline was exposed for maintenance in the spring of 1978.

4. The horizontal location of the buried pipeline was accurately flagged by a gas company inspector 1 week before the accident.

5. The contractor's first telephone inquiry about the depth of the pipeline, 2 hours before the accident, was not followed up by a second call for an inspector to establish the exact depth of the pipeline; the gas company also did not follow up on the telephone inquiry.

6. The contractor's superintendent did not give adequate instructions to the operator of the highloader concerning the gas pipeline's location and depth before the operator started the excavation.

7. The crossing of the pipeline at a 60-degree angle brought the west end of the pipeline 3 feet closer to the excavation equipment than it would have been at the centerline of the sewer, and its shallow 2-foot depth also made it more vaulnerable to excavation damage.

8. The gas company crew had received on-the-job training, but they did not have formal training about how repairs to higher pressure transmission pipelines might differ from repairs to distribution mains.

9. There was a communication problem between the gas company foreman and his supervisor concerning the installation of a repair clamp because of the roar of the blowing gas.

10. The hand tools used by the gas company workers to clean the pipeline were made of steel and generated the spark that ignited the blowing gas.

11. The dry chemical fire extinguisher and three water streams from the fire engine pumpers were not sufficient to extinguish the large gas fire when the pressure was about 80 psig.

12. The pipeline crossing location would have been more noticable to everyone in the contractor's crew if the 3-foot-high weeds had been cleared from the pipeline right-of-way and around the permanent markers.

13. The gas company had no procedures that stated what a "safe" repair pressure might be.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the rupture of the pipeline by heavy excavating equipment operated by an unsupervised equipment operator. The sewer contractor had failed to previously establish the exact horizontal and vertical locations of the pipeline either by digging test holes or by requesting the gas company to locate the pipeline more precisely. Sparks from hand tools used to clean the pipe prior to its repair ignited the escaping natural gas which seriously burned two gas company employees.

RECOMMENDATIONS

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

— to the Gas Service Company:

"Improve liaison with the municipalities and consulting engineers within its operating area and request that the gas company be notified of all preconstruction meetings to determine if gas facilities will be affected by the construction activities. (Class II, Priority Action) (P-78-68)

"Improve communications and cooperation between its engineering and field personnel to insure that responsible gas company employees are aware of a contractor's questions regarding gas facilities as the contractor's work progresses. (Class II, Priority Action) (P-78-69)

"Require its personnel to record all information requested on the Pipe Condition Report Form. Any pipeline depth of less than the minimum required in 49 CFR 192.327 should be carefully noted on pipeline maps and other records. (Class II, Priority Action) (P-78-70)

"Revise its emergency plan to show what segments of a pipeline can be taken out of service for repairs, and establish the maximum safe operating pressures for repairs to such pipelines. (Class II, Priority Action) (P-78-71)

"Revise its emergency plan to include all of the liaison and coordination requirements of 49 CFR 192.615, and provide training material to local fire departments about the hazards of extinguishing gas fires. (Class II, Priority Action) (P-78-72)

"Include in company maintenance procedures the requirement that vegetation on pipeline rights-of-way and around line marker signs be cleared before construction equipment is used near gas pipelines. (Class II, Priority Action) (P-78-73)

"Require the use of flame-retardant material in the uniforms of personnel required to work in gaseous atmospheres. (Class II, Priority Action) (P-78-74)

"Train its distribution repair crews to work safely on high-pressure transmission pipelines. (Class II, Priority Action) (P-78-75)"

-- to the Torson Construction Company:

"Protect pipelines to be crossed during construction by verifying the location, elevation, and dimensions of all known or suspected underground obstructions ahead of the work and by reviewing all requirements in the specifications with its field supervisor. (Class II, Priority Action) (P-78-76)

"Establish an early liaison with the gas company before commencement of construction projects and coordinate the field activities of the construction crews to afford maximum protection of pipeline facilities. (Class II, Priority Action) (P-78-77)

"Require its employees to precisely establish the horizontal and vertical locations of gas pipelines by means of hand-excavated test holes before allowing heavy excavation equipment in the area of a pipeline crossing. (Class II, Priority Action) (P-78-78)"

-- to the Occupational Safety and Health Administration of the U.S. Department of Labor:

"Establish standards for gas industry safety clothing to protect workers repairing leaking gas pipelines where ignition of the gas could cause serious burns. (Class III, Longer Term Action) (P-78-79)"

-- to the Governor, State of Missouri:

"Amend State law to specify the use of hand-excavated test holes, or other proven, accurate method, to establish a precise depth or location of the underground facility, and to establish a wide buffer zone beside a pipeline location, over which heavy equipment cannot operate, to allow for errors in establishing the approximate location of underground facilities. (Class III, Longer Term Action) (P-78-80)

"Require municipalities to incorporate the amended State 'Underground Facility Safety and Damage Prevention Act' in the specifications of construction projects which use large excavating equipment and during which gas pipeline facilities will be crossed, and require that the contractor have the specifications with the State law requirements at the job site for ready reference by the workers. (Class III, Longer Term Action) (P-78-81)"

12. PIPELINE ACCIDENT REPORTS AND SPECIAL STUDIES, CY-1979

The following three pipeline accident reports were published during CY-1979. No pipeline safety studies were issued.

NTSB-PAR-79-1	Pipeline Accident Report - Mid-America Pipeline System, Liquified Petroleum Gas Pipeline, Rupture and Fire, Donnellson, Iowa, August 4, 1978
NTSB-PAR-79-2	Pipeline Accident Report - Gas Service Co., Explosion and Fire, London, Kentucky, January 16, 1979
NTSB-PAR-79-3	Pipeline Accident Report - Natural Gas Pipeline Rupture Explosion and Fire, Philadelphia, Pennsylvania, May 11, 1979

NTSB-PAR-79-1 PIPELINE ACCIDENT REPORT - MID-AMERICA PIPELINE SYSTEM, LIQUIFIED PETROLEUM GAS PIPELINE, RUPTURE AND FIRE, DONNELLSON, IOWA, AUGUST 4, 1978.

On August 4, 1978, an 8-inch LPG pipeline under approximately 1200-psig pressure ruptured in a cornfield near Donnellson, Iowa. Propane leaked from a 33-inch long split and vaporized. The heavier-than-air gas rapidly spread out across a highway and eventually covered 75 acres of woods and fields and surrounded a farmhouse and its facilities. The propane vapors were then ignited by an unknown source.

Two volunteer fire departments arrived,but neither one knew the locations of any shutoff valves, nor did they know who could help them locate the valves.

The NTSB determined that the probable cause of the failure of the 8-inch pipeline was due to the combined stresses that were exerted on the pipeline when it was lowered 3 months before the accident in conjunction with highway excavation work, and, more importantly, to a dent and gouge which had weakened the pipe. The dent and gouge had been incurred before the pipeline had been completed in 1962.

Among the recommendations made by the NTSB to the pipeline company were increased training of emergency response personnel and updating of the list of key personnel to close specific valves.

R & D CONSIDERATIONS

1) Determine by analytical means the stresses produced on steel pipeline when it is lowered, and design a safety factor to insure that these stresses will not affect the integrity of the line.
2) Undertake research for more stringent specifications for pipeline manufactured for LPG service to minimize the effects of dents and gouges.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-79-1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report -- Mid-America Pipeline System Liquefied Petroleum Gas Pipeline Rupture and Fire, Donnellson, Iowa, August 4, 1978		5. Report Date May 3, 1979 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 2460B 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Pipeline Accident Report August 4, 1978 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

At 12:02 a.m., c.d.t., on August 4, 1978, propane that had vaporized and spread widely from a ruptured 8-inch liquefied petroleum gas (LPG) pipeline owned by the Mid-America Pipeline System (MAPCO) was ignited by an unknown source in a rural area near Donnellson, Iowa. The intense fire killed two persons and critically burned three others as they fled their homes; one of the critically burned persons later died. A farmhouse and six outbuildings were destroyed, and two adjacent homes were damaged. Before the fire burned out at 3:30 a.m., 3,750 barrels (157,500 gallons) burned and 75 acres of cornfields and woods were damaged.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of an 8-inch propane pipeline due to the combined stresses that were exerted on the pipeline when it was lowered 3 months before the accident and to a dent and gouge which had weakened the pipe. The dent and gouge had been incurred before the pipeline had been completed in 1962.

17. Key Words	18. Distribution Statement
Liquefied petroleum gas (LPG); propane fire; external mechanical damage; dent; gouge; emergency valves; education; liaison; LPG statistics; pipeline lowering; construction inspection.	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22152

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CONCLUSIONS

Findings

1. The rupture in the 8-inch propane pipeline was due to the combined stresses that were exerted on the pipeline when it was lowered 3 months before the accident.

2. The failure occurred at an area on the pipe that had been dented and gouged previously.

3. The dent and gouge in the pipe occurred sometime between manufacture of the pipe and the construction of the pipeline.

4. The leaking propane vaporized and migrated over a 75-acre area within minutes before it was ignited by an unknown source.

5. Due to operating procedures at that time, MAPCO's personnel did not realize there was a leak in the system until 25 minutes after the rupture occurred.

6. If the valve at Birmingham Junction had been closed at the time of the accident the pressure drop would have been larger and would have rapidly shown the trouble to be on the Farmington section of the pipeline.

7. Public emergency response personnel who responded to the accident had not received any instruction or education from MAPCO on the hazards of LPG and how to handle an LPG fire.

8. MAPCO's list of persons to contact to close specific valves for the Farmington lateral in case of an emergency was not kept current nor was it used by the dispatcher.

9. The OPSO has not differentiated between highly volatile liquid petroleum pipelines and other liquid petroleum pipelines in its regulations for liquid petroleum transportation.

10. The OPSO should expedite action on Safety Board recommendations concerning LPG regulations.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of an 8-inch propane pipeline due to the combined stresses that were exerted on the pipeline when it was lowered 3 months before the accident and to a dent and gouge which had weakened the pipe. The dent and gouge had been incurred before the pipeline had been completed in 1962.

RECOMMENDATIONS

During its investigation of this accident, the National Transportation Safety Board recommended that the Mid-America Pipeline System:

"Update the list of individuals who should be contacted to close specific valves in the event of an emergency and institute a procedure to assure that the list is updated at least annually. (Class I, Urgent Action)(P-78-66)

"Conduct periodic training for public emergency response agencies along the route of its pipelines. As a minimum, this training should be conducted annually and be sufficient to inform emergency response agencies of the properties of the various products transported, the expected behavior of each product when released to the atmosphere, the locations of shutdown valves, the residents designated to operate each valve, and other information necessary for emergency response personnel to take effective actions and minimize losses. (Class I, Urgent Action)(P-78-67)"

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

-- to the Mid-America Pipeline System:

"Determine by analytical means the stresses produced on the pipe steel when projects require the lowering of a section of pipeline, and design a safety factor to insure that these stresses will not affect the integrity of the line. (Class II, Priority Action)(P-79-2)

"Establish written procedures that require its personnel to ascertain that precautions are taken in the field to eliminate excessive or sudden changes in elevation when lowering a section of pipeline. (Class II, Priority Action) (P-79-3)

"Emphasize to its pipeline construction inspection personnel the importance of careful, thorough inspection to minimize the occurrence of dents and gouges which could result in similar accidents. (Class II, Priority Action)(P-79-4)

"Check all other segments of its pipeline for conditions similar to the open valve condition in the line section involved in this accident and make changes or additions as required. (Class II, Priority Action)(P-79-5)"

NTSB-PAR-79-2 PIPELINE ACCIDENT REPORT - GAS SERVICE CO., EXPLOSION AND FIRE, LONDON, KENTUCKY, JANUARY 16, 1979

On January 10, 1979, personnel exployed by the Gas Service Co., began installing regulators to increase the gas pressure in a downtown business section of London, Kentucky. The 7-inch bare steel gas main, installed in 1930 and 1931, was to be uprated from 4 ounces to 17 psig pressure. Personnel continued work through the weekend and repaired some leaks where detected.

On January 16,1979, natural gas, which had escaped from a large corrosion hole in the 7-inch main and had accumulated in several buildings nearby,exploded and then burned. Five buildings were destroyed, two more damaged extensively, windows within a five-block radius were shattered, and a truck damaged. Two persons were injured slightly.

The condition of the 7-inch steel pipe,which had never been cathodically protected against corrosion, indicated that corrosion had existed for a considerable period of time. A complete leakage survey would have indicated the condition before the system was uprated.

R & D CONSIDERATIONS

No R & D requirement.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-79-2	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report - Gas Service Company, Inc. Explosion and Fire, London, Kentucky, January 16, 1979		5. Report Date August 16, 1979
7. Author(s)		6. Performing Organization Code
		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 2660A
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Pipeline Accident Report January 16, 1979
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

At 9:30 p.m. e.s.t., on Tuesday, January 16, 1979, natural gas which had escaped from a large corrosion hole in a 7-inch steel gas main and had accumulated in several buildings in a downtown business section of London, Kentucky, exploded and then burned. Five buildings were destroyed, two adjacent buildings were damaged extensively, windows within a five-block radius were shattered, and one truck was damaged. Two persons were injured slightly.

The National Transportation Safety Board determines that the probable cause of the accident was the ignition of an accumulation of natural gas which had leaked from an existing corrosion hole in a 7-inch steel gas main when the pressure was increased suddenly from 4 ounces to 17 psig in one step. Contributirg to the accident was the failure of gas company personnel to conduct an adequate leak survey, using combustible gas indicators (CGI), and to check adjacent sewer manholes during the period the gas pressure was increased. A possible source of ignition was a spark from an electric motor in a beverage cooler.

17. Key Words	18. Distribution Statement
Pipe corrosion; uprating; written procedures; combustible gas indicator; sewer manhole gas check; personnel evacuation; 7-inch diameter bare steel gas main; area gas check; sudden pressure increase.	This document is available to the public through the National Technical Information Service, Springfield, Springfield, VA 22151

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CONCLUSIONS

Findings

1. The 7-inch-diameter bare steel gas main had not been cathodically protected against corrosion nor adequately surveyed to determine areas of active corrosion as required by 49 CFR 192.453, 49 CFR 192.457, and the gas company's standards.

2. Three corrosion holes were found in the bare steel gas main after the accident; one hole measured over 1 inch in diameter.

3. Before the uprating, while the gas main was operating at 4 ounces of pressure, there was probably no leakage or minimal leakage from these corrosion holes because of the well-compacted dirt around the pipe.

4. After the gas pressure was increased to 17 psig, the well compacted dirt around the pipe at the corrosion holes was insufficient to contain the gas within the pipe.

5. Gas company personnel should have increased the pressure in the gas main from 4 ounces to 17 psig in at least two stages: from 4 ounces to 8 psig and from 8 psig to 17 psig, as required by 49 CFR 192.557.

6. Between stages of uprating, at 8 psig and again at 17 psig, gas company personnel should have surveyed the gas main for leakage, using a combustible gas indicator and checked the sewer manholes, as required by 49 CFR 192.553(a)(1), 49 CFR 192.723(b)(1), and the gas company's standards. This would have revealed the presence of the leak.

7. The gas company's operation and maintenance plan had no conversion procedures for uprating to higher pressure as required by CFR 192.605(d).

8. The gas company failed to establish a written procedure for the proposed uprating as required in 49 CFR 192.553(c).

9. The gas company did not adequately review the facilities to be uprated as required by 49 CFR 192.557(b)(1).

10. The leak detection survey, which preceded the uprating by 5 months, did not include a sewer manhole survey, as required by 49 CFR 192.557(b)(2) and 49 CFR 192.723(b)(1).

11. The occurrence of the accident at night when the commercial buildings in the downtown area were closed and unoccupied, prevented numerous fatalities and injuries.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the ignition of an accumulation of natural gas which had leaked from an existing corrosion hole in a 7-inch steel gas main when the pressure was increased suddenly from 4 ounces to 17 psig in one step. Contributing to the accident was the failure of gas company personnel to conduct an adequate leak survey, using combustible gas indicators (CGI), and to check adjacent sewer manholes during the period the gas pressure was increased. A possible source of ignition was a spark from an electric motor in a beverage cooler.

RECOMMENDATIONS

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

-- to the Delta Natural Gas Company, Inc.:

"Determine the condition of other cathodically unprotected pipe which may be comparable to the failed pipe, and develop a schedule for system improvement based on the findings. (Class II, Priority Action) (P-79-9)

"Develop written uprating procedures sufficient to comply with requirements of 49 CFR 192 Subpart K and related American Society of Mechanical Engineers guide material. (Class II, Priority Action) (P-79-10)

"As a part of the uprating procedures, provide the project foreman with a written plan that will account for the specific elements and variables of each case before the commencement of any uprating project. (Class II, Priority Action) (P-79-11)

"Train all personnel involved with uprating procedures to insure knowledge of applicable regulations and written company uprating procedures. (Class II, Priority Action) (P-79-12)"

-- to the American Gas Association:

"Advise its member companies of the circumstances of this accident and urge them to review their actual operating practices for uprating pipelines to insure that they conform to established company procedure, related industry guidelines, and Federal regulations. (Class I, Urgent Action) (P-79-13)"

-- to the Materials Transportation Bureau of the U.S. Department of Transportation:

"Monitor, through its State agent, the Kentucky Public Service Commission, the activity of the Gas Service Company, Inc., to uprate its gas distribution system in London, Kentucky, in compliance with the Federal regulations. (Class II, Priority Action) (P-79-26)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ PATRICIA A. GOLDMAN
Member

/s/ G. H. PATRICK BURSLEY
Member

FRANCIS H. McADAMS, Member, did not participate.

August 16, 1979

NTSB-PAR-79-3 PIPELINE ACCIDENT REPORT - NATURAL GAS PIPELINE RUPTURE, EXPLOSION AND FIRE, PHILADELPHIA, PENNSYLVANIA, MAY 11,1979

On May 11, 1979, two almost simultaneous explosions and an ensuing fire occurred in Philadelphia, Pennsylvania. Seven persons, including a gas company ecmployee were killed, 19 persons were injured, three buildings were destroyed, and seven adjacent rowhouses were damaged. The explosion also caused a section of the street to cave in, exposing a large cavern under the paved surface.

The NTSB determined that the probable cause of the accident was the sagging and breaking of an 8-inch, cast-iron gas main, due to the undetected erosion of the soil support under it, resulting in the migration of the leaking gas into adjacent buildings where it was ignited by an undetermined source.

R&D CONSIDERATIONS

No R&D requirement.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-PAR-79-3	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pipeline Accident Report—Philadelphia Gas Works Natural Gas Pipeline Rupture, Explosion, and Fire, Philadelphia, Pennsylvania, May 11, 1979		5. Report Date September 27, 1979 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 2753 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Pipeline Accident Report May 11, 1979 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

At 3:05 p.m., e.s.t., on May 11, 1979, two almost simultaneous explosions and an ensuing fire destroyed three buildings near the intersection of Tacony and Margaret Streets in Philadelphia, Pennsylvania. Seven persons, including a Philadelphia Gas Works (PGW) employee, were killed, 19 persons were injured, and several adjacent rowhouses were damaged. The explosion also caused a section of Margaret Street to cave in, exposing a large cavern under the paved surface.

The National Transportation Safety Board determines that the probable cause of the accident was the sagging and breaking of an 8-inch, cast-iron gas main, due to the undetected erosion of the soil support under it, resulting in the migration of leaking gas into adjacent buildings where it was ignited by an undetermined source.

17. Key Words	18. Distribution Statement
Cast-iron gas main, low-pressure gas, 8-inch pipe, 6-inch water main, road cave-in, evacuation, liaison with fire department, prompt gas shutoff, "greased off" mains and services.	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

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CONCLUSIONS

Findings

1. The large cavern under Margaret Street, which contained the gas, sewer, and water mains had been created over a period of time by soil erosion.

2. Seepage from the openings in the main sewer caused by the broken laterals contributed to the erosion that caused the cavern.

3. Water escaping from the water main also probably contributed to the erosion.

4. The water main probably had been cracked some time before the accident as revealed by metallurgical analysis which showed adhesive corrosion products on the fracture faces and corrosion of the fracture face itself. Complete severance of the water pipe occurred at the time of the gas main failure.

5. The gas main had been undermined by the soil erosion and had been hanging unsupported for a long time before it broke.

6. The gas main failed at 2:30 p.m. when it broke into three pieces from one or a combination of factors such as the pipe's own weight, traffic vibrations, pavement settling, or other unknown outside forces.

7. Liaison between PGW and the Philadelphia Fire Department resulted in the prompt evacuation and effective ventilation of affected houses in the accident area.

8. Prompt "greasing off" of the gas mains by PGW prevented additional migration of natural gas to the affected area.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the sagging and breaking of an 8-inch, cast-iron gas main, due to the undetected erosion of the soil support under it, resulting in the migration of leaking gas into adjacent buildings where it was ignited by an undetermined source.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board recommendated that the American Gas Association:

"Advise its member companies of the circumstances of this accident and of the prompt and effective coordination betwen the gas company and the fire department and urge them to review their emergency practices and procedures, particularly those concerning evacuation and liaison with fire and police departments to insure that coordination is planned adequately for similar accidents. (Class II, Priority Action) (P-79-59)"

13. SUMMARY

During the period CY-70 to CY-79, a total of 40 pipeline accident reports and special studies have been issued by the National Transportation Safety Board.

A summary of these documents indicating the cause, pipeline type, personal losses or injuries (if any) and property damages follows. This summary is a major component to any data base on pipeline transportation safety.

External forces-damaged regulator	Natural gas	0	0	$80 thousand	PAR-70-1
Pipe rupture along weak zone in resistance weld caused by improper pressure regulation	14-inch natural gas	0	9	$500 thousand	PAR-71-1
Flaw in pipe which failed during period of fluctuating pressure	cast-iron gas main	0	5	None reported	PAR-71-2
Rupture of insufficiently bonded weld weakened by internal corrosion and higher than normal pressure	8-inch uncoated LPG	0	10	Extensive	PAR-72-1
Failure of personnel to shut-off gas while repairing line	Natural gas	6	3	None reported	PAR-72-2
Soil stresses on pipe and galvanic action on pipe threads	Galvanized steel natural gas	4	1	1 house destroyed, 1 garage damaged	PAR-72-3
External force - struck by backhoe	2-inch, wrapped steel gas line	3	1	2 houses destroyed, 1 damaged, $153K	PAR-72-4
Improperly installed tee-connection and external forces of construction equipment and heavy rainfall	Plastic pipe - natural gas	0	1	1 house destroyed	PAR-72-5
External force - struck by bulldozer	3/4-inch steel gas line	6	10	None reported	PAR-73-1
Excessive pressure and corrosion	8-inch steel liquid pipeline	1	2	1 house destroyed, 300,000 gals. oil	PAR-73-2
Uneven soil settlement and corrosion	6-inch, cast-iron gas main	1	7	Not reported	PAR-73-3
External force by too heavy dynamite charges during construction project	8-inch bare steel gas main	5	16	2 buildings destroyed	PAR-74-1
Broken threads in a cast-iron reducer fitting	cast-iron gas main	7	8	7 apt units destroyed	PAR-74-2

Soil stress & vibration from nearby railroad	4-inch, cast-iron gas main	8	7	Not reported.	PAR-74-3
Corrosion in cathodically-unprotected pipe	2-inch, bare steel gas main	3	2	1 house destroyed	PAR-74-4
Stress point created in pipe during manufacture	½-inch plastic pipe	3	1	1 house badly damaged	PAR-74-5
Excess pressure caused by valve failure in pipe weakened by gouge	liquid pipeline - anhydrous ammonia	0	2	None reported	PAR-74-6
Failure of substandard girth weld due to repeated soil stress	30-inch, coated, wrapped, & cathodically protected gas pipeline	0	0	10 acreas of forest burned	PAR-75-1
Hydrogen stress crack at hard-spot in pipe created during mfr	30-inch, coated & wrapped natural gas pipeline	0	0	None reported	PAR-75-2
Brittle fracture of flash weld weakened by crevice corrosion	12-inch natural gas pipeline	3	0	None reported	PAR-75-3
Rupture caused by internal corrosion & hydrogen embrittlement	6-inch, coated & wrapped (cathodically unprotected) gas pipeline	5	1	3 vehicles destroyed, 40 acres forest	PAR-76-1
Break caused by exploding tank in cellar(hydro-pneumatic tank)	6-inch gas service line	0	70	25-story building seriously damaged, other bldgs damaged	PAR-76-2
Excessive pressure caused by inadvertant closing of a motor-operated valve	12-inch liquid pipe	1	0	1 building destroyed	PAR-76-3

Attempted repair of leak in a cracked fillet weld	26-inch liquid pipeline	6	1	None reported	PAR-76-4
Rupture in weakened area of pipe caused by a gouge	8-inch, natural gas liquid pipeline	4	0	Tel.& pwr lines destroyed, RR tracks damaged, forest area burned	PAR-76-5
Contraction of pipe (due to cold temp.) causing it to pull out of compression coupling	2-inch plastic gas line	20	29	1 hotel destroyed	PAR-76-6
Excess pressure in pipe which had been previously dented & gouged	8-inch, liquid pipeline	0	9	4 houses destroyed, 3 damaged, 12 vehicles burned, 2389 barrels propane consumed	PAR-76-7
Rupture by excavation equipment	8-inch liquid pipeline	9	14	Extensive	PAR-76-8
Rupture by construction equipment	20-inch gas transmission	6	1	Extensive	PAR-77-1
Structural weakness by corrosion and soil settling	4-inch, cast-iron, gas main	1	14	4 buildings destroyed, 7 buildings damaged	PAR-77-2
Failure of studs on valve cover caused by overtightening	natural gas compressor	1	2	Over $5 million	PAR-77-3
Thermal contraction (due to cold temp) of a substandard weld stressed by nearby sewer construction	4-inch gas main	2	23	2 houses destroyed	PAR-78-1
Stress-corrosion cracking of pipe subjected to earth subsidence	12-inch liquid propane pipeline	2	0	1 truck destroyed, 57 head of cattle killed, pwr & tel lines destroyed	PAR-78-1

Human error	Pumping station on Alaska pipeline	1	5	$35 million	PAR-78-2
Rupture by construction equipment	12-inch, cast-iron gas main	0	0	None reported	PAR-78-3
Thermal contraction (due to cold temp) caused pipe to pull out of compression coupling	2-inch plastic gas pipe	2	3	1 building destroyed, 1 damaged	BAR-78-4
Rupture by excavation equipment	10-inch gas pipeline	0	2	None reported	PAR-78-5
Failure of pipeline due to combined stresses when it was lowered previously and a dent and gouge	8-inch LPG pipeline	2	3	1 farmhouse & 6 outbuildings destroyed, 2 houses damaged	PAF-79-1
Increase in pressure and corrosion hole in pipe	7-inch bare steel gas	0	2	5 buildings destroyed,2 damaged	PAR-79-2
Erosion of soil under pipe	8-inch, cast-iron gas main	7	19	3 buildings destroyed, 7 damaged	PAR-79-3