

NATIONAL TRANSPORTATION SAFETY BOARD

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# **PIPELINE ACCIDENT REPORT**

**LONE STAR GAS COMPANY**

**Fort Worth, Texas  
October 4, 1971**



**NATIONAL TRANSPORTATION SAFETY BOARD**

**Washington, D. C. 20591**

**REPORT NUMBER: NTSB-PAR-72-5**

**SS-P-11**

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TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-PAR-72-5	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle <u>Pipeline Accident Report - Lone Star Gas Company,</u> 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 Lone Star Gas Company; natural gas leak; plastic pipe; service line-gas main connection; installation and inspection of gas distribution systems; migration of gas.		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 20	22. Price

## FOREWORD

The accident described in this report was designated a major accident by the National Transportation Safety Board under the criteria established in the Safety Board's regulations.

This report is based on facts obtained from an investigation conducted by the Safety Board. Cooperation during this investigation was received from the Office of Pipeline Safety, the Lone Star Gas Company, the Railroad Commission of the State of Texas, and the Fort Worth Fire Department.

The conclusions, the determination of probable cause, and the recommendations herein are those of the Safety Board.

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Lone Star Gas Company, Fort Worth,  
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I. SYNOPSIS

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 found the house burning freely. The fire was extinguished by 5:17. 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 failure occurred underneath the sidewalk in front of the house which was destroyed.

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.

II. FACTS

Accident Site

This accident occurred at 2109 Amanda Street, in an older suburb of Fort Worth, Texas. The houses on Amanda Street are generally small, one-story, frame types, with considerable distance between individual units. (See Figure 1.)

About 9 months before the accident, the Lone Star Gas Company hired an independent contractor to install a new 4-inch polyethylene plastic high-pressure gas distribution system in the Amanda Street area. This new system replaced the existing 4-inch coated and wrapped steel pipe which had been installed in 1948.

The contractor, under the direct supervision of Lone Star inspectors, used Lone Star specifications for the installation of plastic pipe. The plastic main, operated at a pressure of 20 p.s.i.g., extended in a north-south direction parallel with Amanda Street at a depth of 4 feet. The 3/4-inch-diameter plastic service lines which connected the main with the customers' houses were heat-fused to the main by means of a special polyethylene saddle. (See Figure 2.)

The Lone Star 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. The work was inspected by the Lone Star inspectors, the connections were tested, and the line was backfilled.

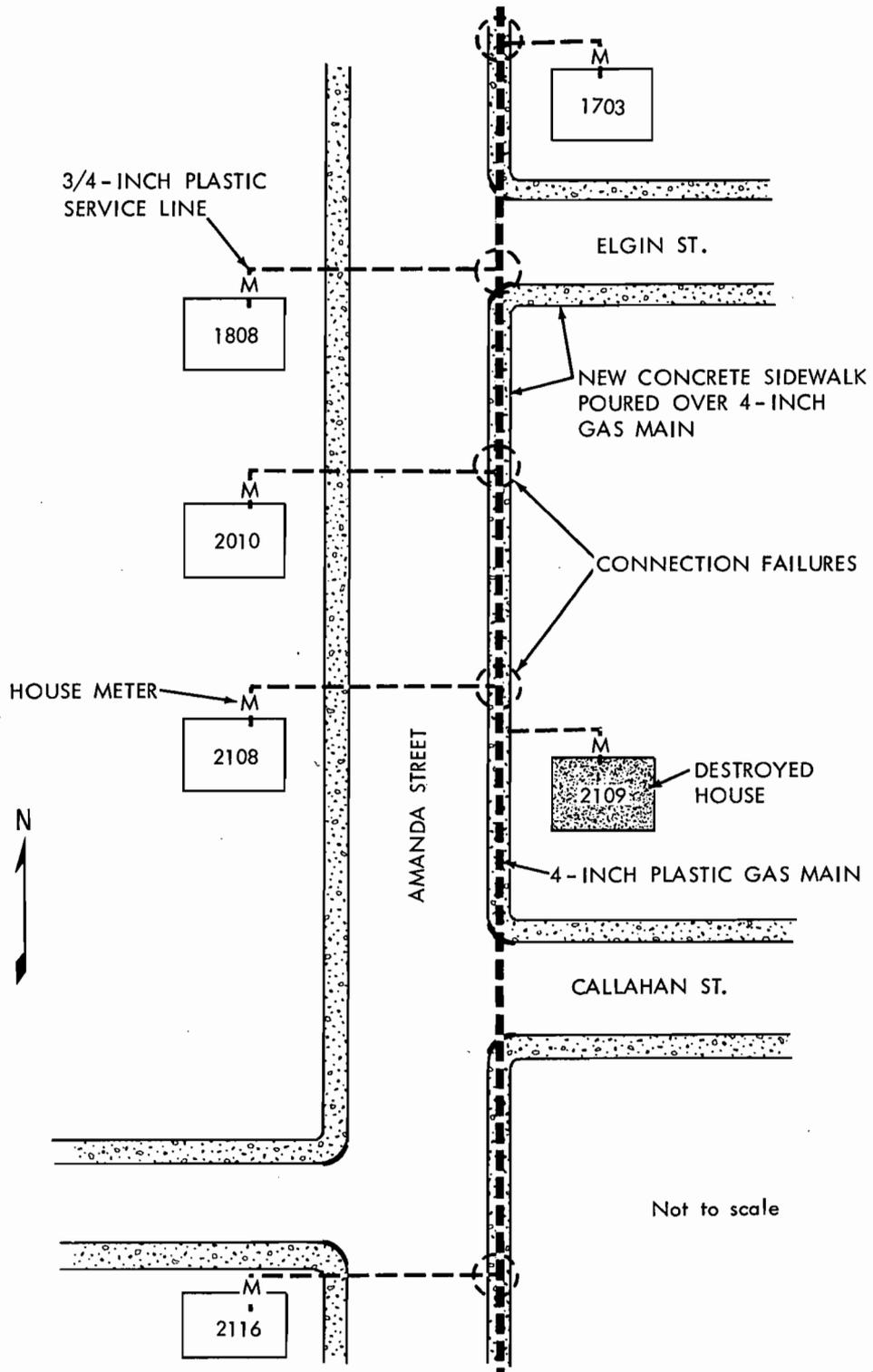


Figure 1.—Plan of the accident site.

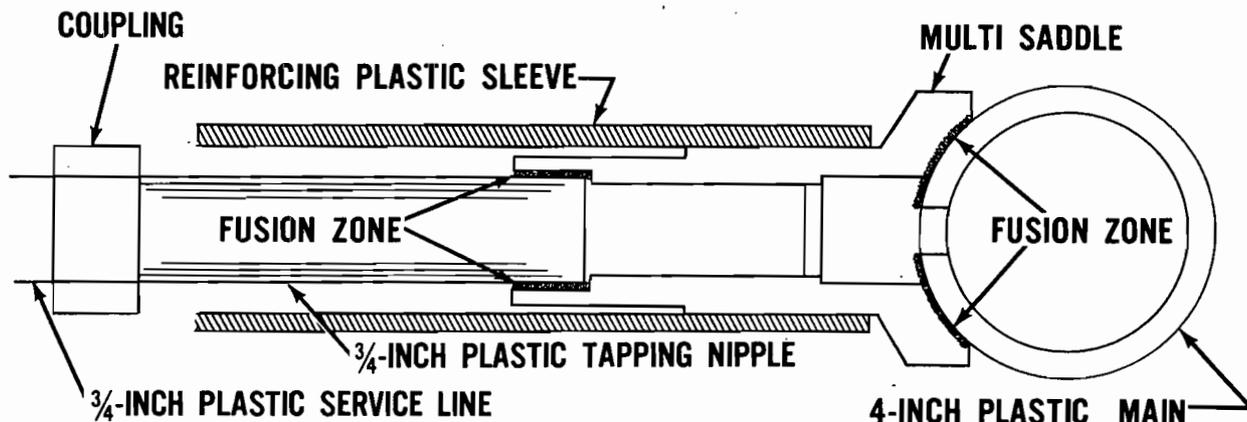


Figure 2.—Plastic service line-gas main connection.

In the spring of 1971, shortly after this new distribution system began operation, Amanda Street was graded, widened, paved with concrete, and edged with curbs and gutters. Heavy road-building equipment passed repeatedly over the newly installed gas facility. The original 4 feet of cover was reduced to about 40 inches. Also, a new 3-foot-wide, 4-inch-thick sidewalk was laid parallel to and directly over the gas main. (See Figure 3.)

A short discussion of the characteristics of plastic pipe and the history of the use of plastic pipe in gas distribution systems is contained in Appendices A and B, respectively.

#### The Accident

Heavy rains fell on the Fort Worth area all day, October 3, 1971. Weather Bureau statistics at the Greater Southwest International Airport indicate that on that day 2.05 inches of rain fell in a 14-hour period extending from 5 a.m. through 7 p.m. Unofficially, even heavier rains were reported to have fallen in the vicinity of Amanda Street.

The soil in the Amanda Street area is tan silty clay and tan sandy clay. This type of soil, when wet, can undergo a volume change causing a shifting or heaving action.

Shortly before 4:30 a.m. on October 4, a woman, who lived in the single-story frame house at 2109 Amanda Street attempted to light a gas stove. An explosion occurred which blew the roof off the house, blasted out the four walls, and kindled an intense fire. The roof fell back into the blazing rubble. The woman, who either ran or was blown out into the street, awakened a neighbor. An ambulance was summoned and the woman was taken to the hospital. She survived the accident, but sustained second- and third-degree burns over 50 percent of her body. The house was completely destroyed. No other houses in the area were seriously affected.

The Fort Worth Fire Department arrived at the site of the accident at 4:38 a.m. The firemen found the remains of the house burning freely. Glass and some small debris had been blown out into the street, into the back yard, and into the nearby trees. Gas flared at the ruptured service line which had been separated from the downstream side of the meter at the side of the house by the force of the explosion. (See Figures 4 and 5.) All of the fire except for the burning gas was extinguished by the firemen at 5:17. Shortly thereafter, gas company personnel completely extinguished the fire by closing the valve at the gas meter and stopping the flow of gas. During

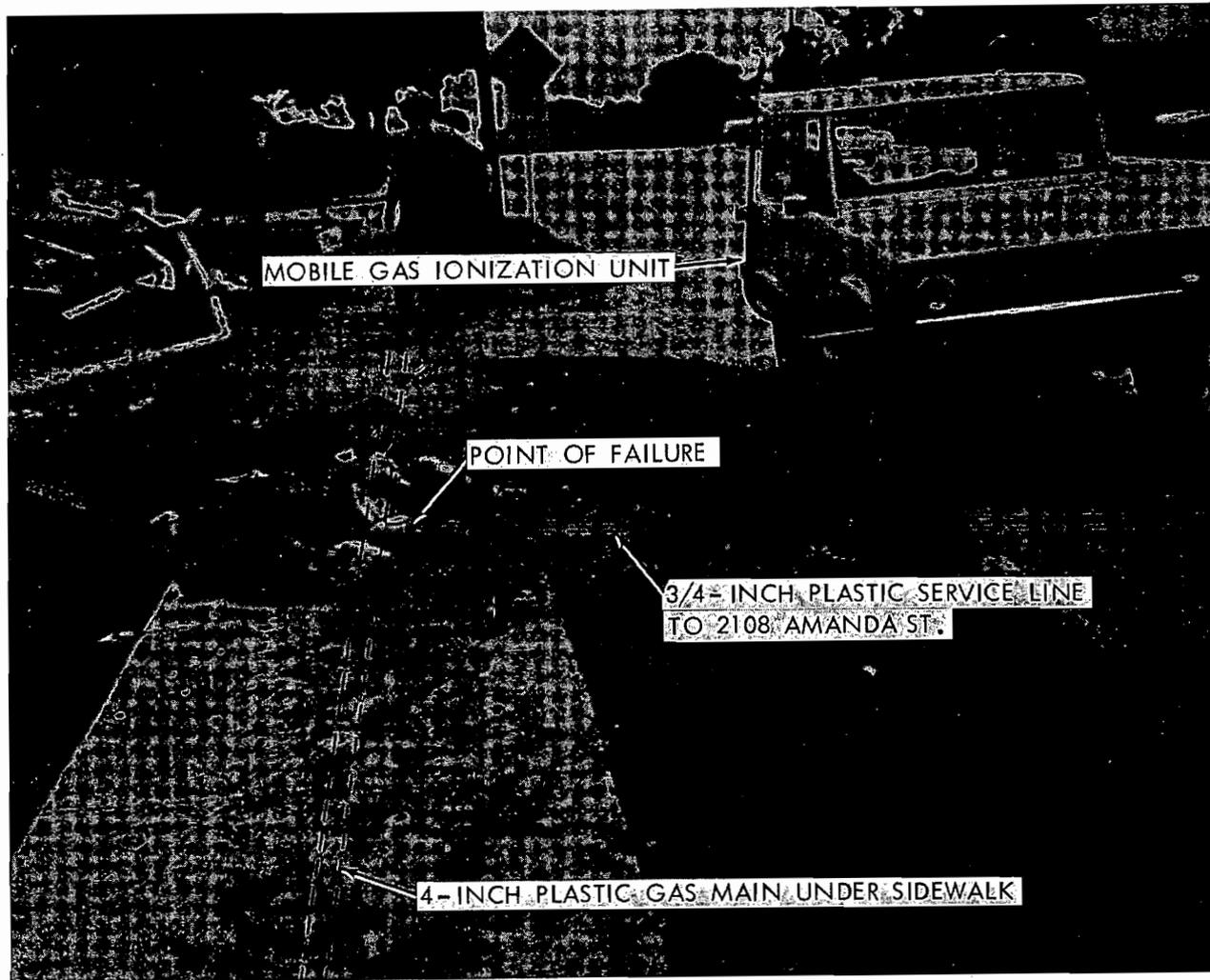


Figure 3.—Sidewalk construction over 4-inch gas main.

the fire some gas odors were quite evident along Amanda Street, but no combustion other than that at the meter was encountered.

Lone Star was notified of the accident by the fire department at 4:34 a.m. The first two Lone Star servicemen arrived on the scene at about 5:10, conferred with the fire chief, and directed the gas company to send additional men and equipment to uncover the gas facilities in the area to check for leakage. These two men began checking for leaks at approximately 5:30, and a three-man emergency crew reached the scene

about 10 minutes later. The crew began bar testing for leaks and, at 7:45, found a cracked service saddle-tapping nipple connection on the service line extending to 2108 Amanda Street. The failure was about 15 feet north of the service line to the house at 2109 Amanda Street. (See Figures 1 and 6.) At approximately 8:30 a.m., the gas main was squeezed off with two hydraulic clamps, one on each side of the service line connection. The failed section was then replaced, the hydraulic clamps removed, and gas service restored to the few houses where service had been interrupted.

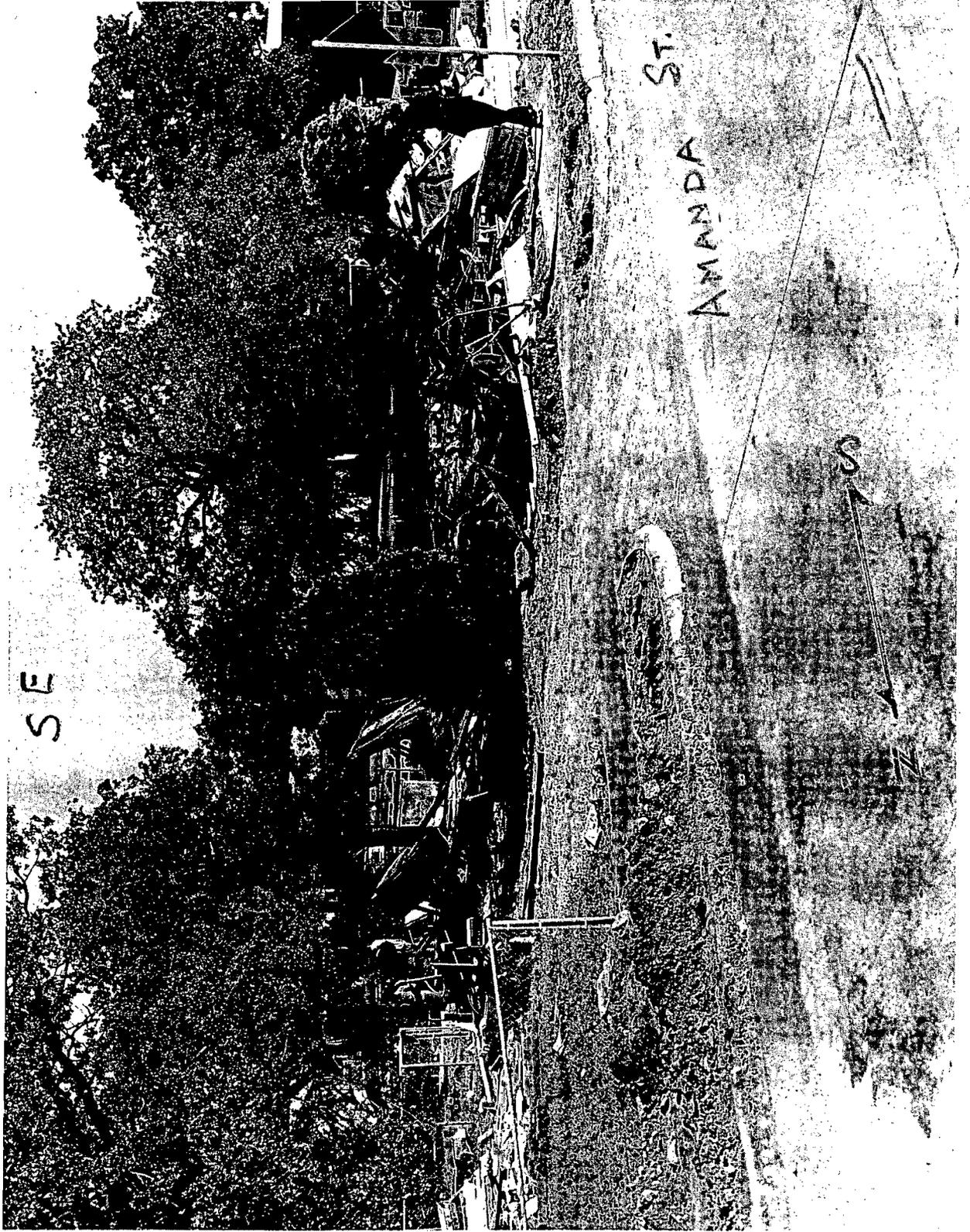


Figure 4.—Remains of the house at 2109 Amanda Street.

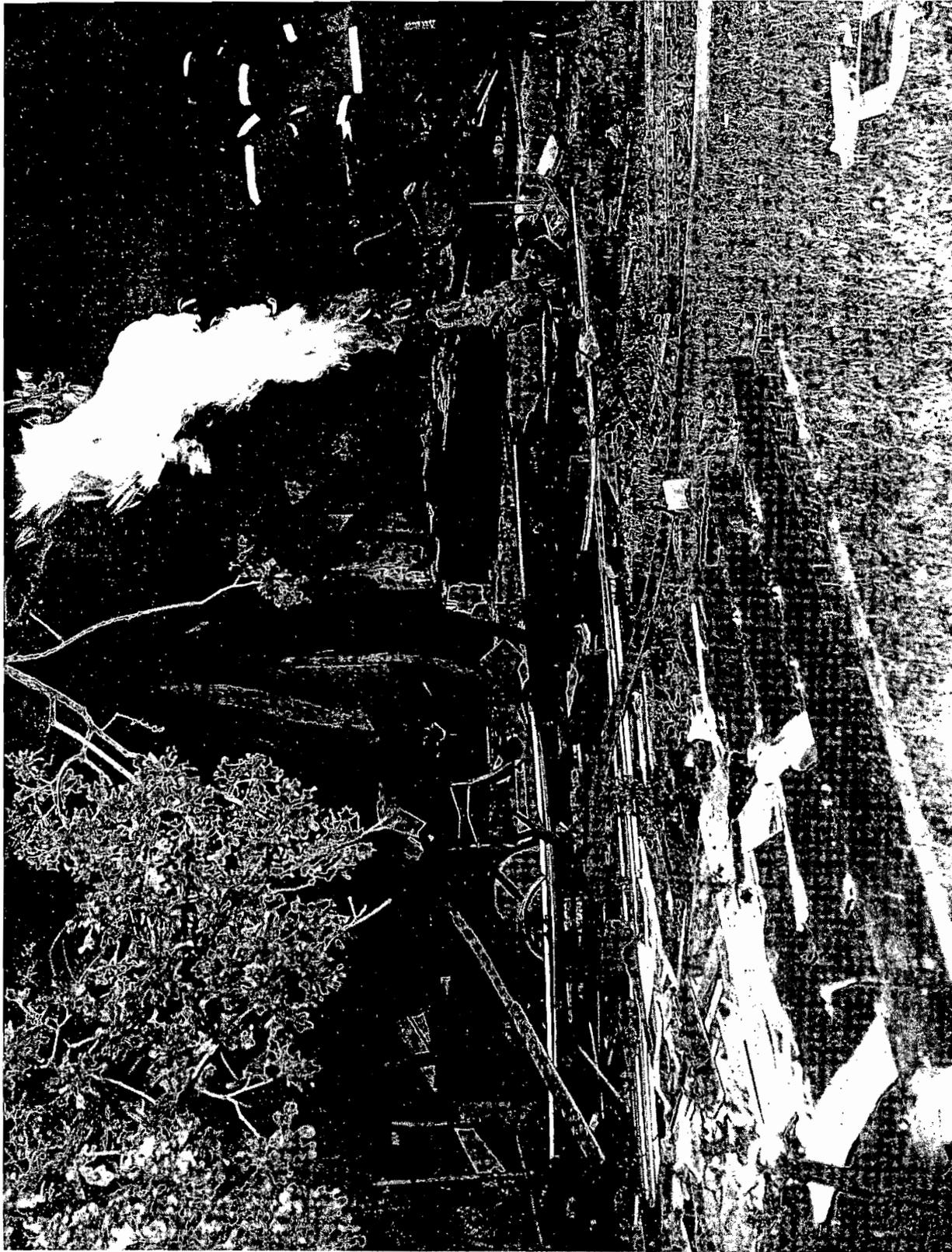


Figure 5.—Gas burning at ruptured service line at 2109 Amanda Street.

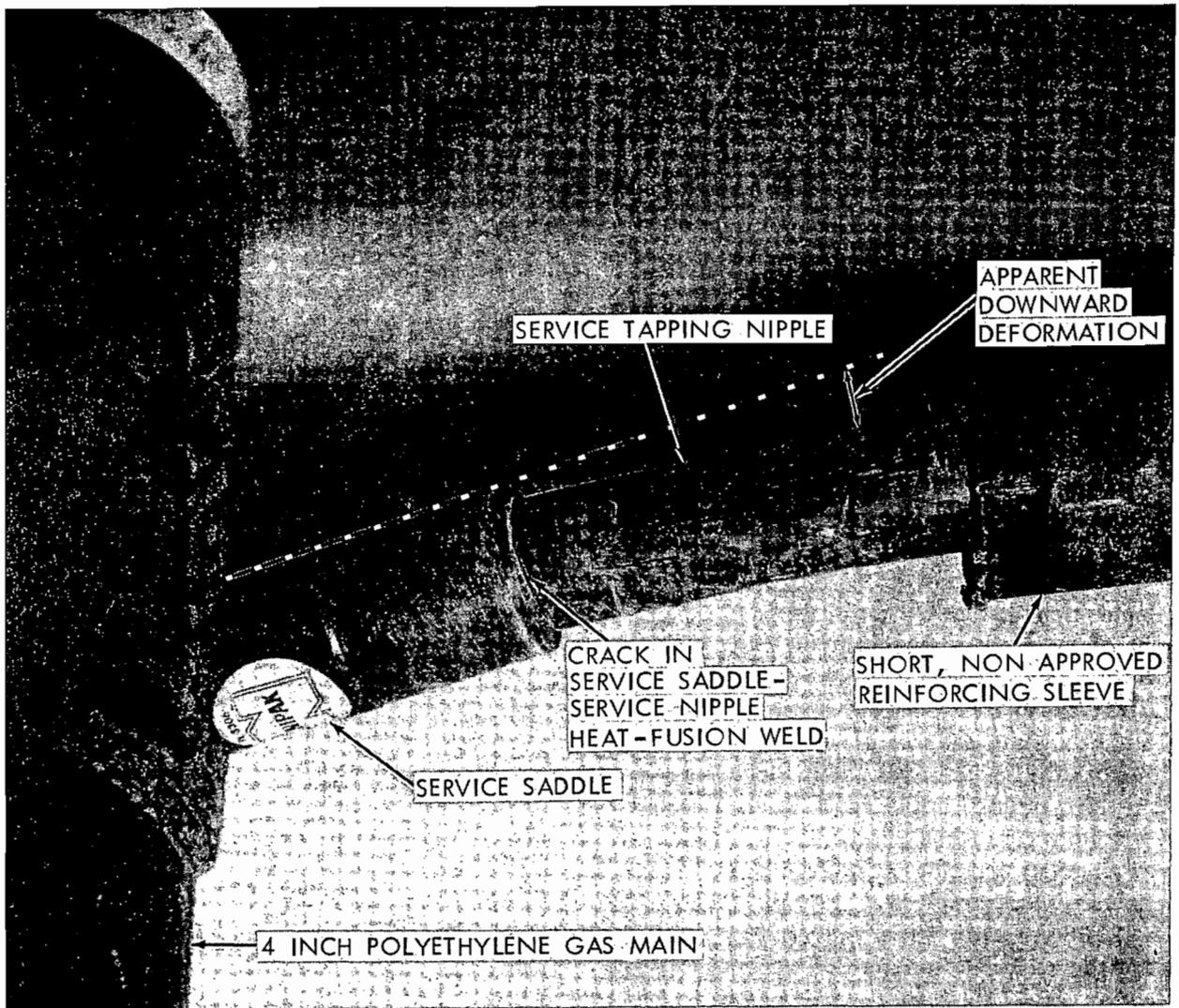


Figure 6.—Broken service saddle-service line connection.

#### Activities After the Accident

Lone Star Gas Company. Lone Star emergency crews continued to test throughout the neighborhood and ultimately found four additional failures on Amanda Street. (See Figure 2.) At various locations along the wet ground between the sidewalk and the curb, strong gas odors were encountered and, at one point, the escaping gas could be heard as well as smelled. The pipe was uncovered at these leaks and the

failures were found to resemble each other, i.e., the breaks occurred across the top half of the 3/4-inch plastic pipe, from the 9 to 3 o'clock position at the fusion point between the service saddle and the tapping nipple. (See Figure 6.) When uncovered, each of these failures was found to have been installed with the short, substitute reinforcing sleeve.

A complete bar test was made in front of and adjacent to the house at 2109 Amanda Street the day after the accident. Gas from the break at

the service-main connection to 2108 Amanda Street was found to have migrated under the sidewalk, down along the main and service line to 2109, and up into the house. In addition to the bar test, Lone Star sent a flame-ionization unit to check the accident area thoroughly for gas leakage. (See Figure 3.) The unit, a mobile leak detector, was driven down the street slowly. Air at street level, drawn up into the analyzing instrument in the unit, was tested for gas content. The several additional leaks that were found by the flame-ionization unit were repaired.

During the month of October 1971, The Fort Worth Fire Department recorded a high incidence of gas alarms reported by area home owners. Of the 72 such alarms recorded, 48 turned out to be actual leaks. Historically, the fire department has noted an increase in the incidence of gas leaks throughout the Fort Worth area after periods of heavy rain.

**Plastic-pipe analysis by the National Bureau of Standards.** Four samples, each consisting of a section of the 4-inch gas main, the service saddle, the tapping nipple (part of the service line), a coupling, and the reinforcing sleeve, were sent to the National Bureau of Standards (NBS) for analysis. One sample was the failed connection at 2108 Amanda Street, which was responsible for the accident, and another was the failed connection at 2116 Amanda Street. The third and fourth samples were the connections serving 2110 and 1916 Amanda Street respectively and had no visible defects.

The results of the NBS analysis are discussed in Section III.

### Standards and Practices

**Lone Star Gas Company specifications.** From May 1969 to the date of the accident, the Lone Star Gas Company installed over 4.4 million feet of polyethylene plastic pipe in its system. The manufacturer of the pipe, NIPAK, Inc., a subsidiary of Lone Star, also sold 139,775 feet of the pipe to other gas distributors.

Lone Star issued specifications to its distribution divisions concerning the installation of plastic pipe. These specifications, titled "Polyethylene Pipe Line Construction Specifications and Procedures - Interim Manual," prescribe the following procedures for joining service lines to mains:

"(11) An external reinforcing sleeve is placed over the service line pipe prior to connection of the service line to the tapping nipple.

"(12) The completed, previously-tested service line is tied into the polyethylene nipple using the Socket Fusion technique.

"(13) The squeeze tool is relaxed and the tie-in fusion joint is soap tested. If the tie-in joint is sound, the squeeze tool is removed, the external reinforcing sleeve is slipped back over the tapping nipple and service saddle and the backfill process begun.

"(14) The backfill material is carefully placed under the main, saddle, nipple, and coupling assembly and compacted to as near original density as possible. Continuous support along the length of this assembly is mandatory. If this cannot be accomplished with compacted backfill material it may be done by placing a split section of steel pipe under the entire length of the assembly, forming a continuous bridge. Refer to section IV.G, 'backfill.'"

The section of the Lone Star specifications which contains the above provisions is presented in its entirety in Appendix C.

**Federal, State, and industry standards.** In February 1971, at the time of the installation of the plastic-pipe gas distribution system involved in this accident, the industry code in effect was the 1968 edition of the USA Standard Code for Pressure Piping, Gas Transmission and Distribution Piping Systems (USAS B31.8 - 1968).<sup>1</sup> Sponsored by the American Society of Mechanical Engineers (ASME); the 1968 edition of the code was the first edition to incorporate requirements for the design, construction, testing, and operation of plastic piping systems for gas.

<sup>1</sup>The USA Standard Code for Pressure Piping is now known as the American National Standard Code for Pressure Piping.

On August 12, 1968, the Natural Gas Pipeline Safety Act was enacted. The interim standards for this act, issued in November 1968 as 49 CFR 190, were, in essence, the 1968 edition of the B.31.8 code. Although most of these interim standards were replaced in November 1970 by 49 CFR 192, the provisions concerning the design, installation, construction, initial inspection, and initial testing of new pipelines remained in effect until March 1971. Thus, at the time of the installation of the main and service lines on Amanda Street, the Lone Star Gas Company was required by Federal standards to conform essentially to the B31.8 code.

The Railroad Commission of the State of Texas also required, in August 1969, that all gas pipeline facilities be constructed, maintained, and operated in accordance with the 1968 edition of the B31.8 code.

In December 1970, ASME published a "Guide for Gas Transmission and Distribution Piping Systems," which relates applicable ASME specifications and recommended practices (such as those contained in the B31.8 code) to the Federal Safety regulations. The sections of this guide which are pertinent to this accident are presented in Appendix D.

### III ANALYSIS

The plastic service saddle-tapping nipple connection for the house at 2108 Amanda Street did not have the required reinforcement needed to protect the heat-fusion weld, because the reinforcing sleeve used was too short for the installation. Although Lone Star's construction specifications call for a reinforcing sleeve to be placed over this fused joint, no details are given concerning the length and inside diameter of the sleeve.

Visual inspection by the NBS revealed that the tapping nipples on the service lines to 2108 and 2116 Amanda Street were permanently deformed downward with respect to the crack location. This creep deformation indicated that the nipples had been subjected to high compressive loadings. The reinforcing sleeves which ac-

companied the samples had been cut from 1¼-inch inside-diameter (I.D.) pipe and were only 3 to 4 inches long.

As a result of the sleeves' being too short, external forces exerted on these connections flexed the fusion welds and were not absorbed by the sleeves.

Examination of all the welds showed that a bead of resin had extended past the end of the nipple near the bottom of the saddle socket on the lines for 2108, 2116 and 2110. The beads from 2108 and 2116 were badly discolored and exhibited evidence of overheating due to higher-than-specified temperature and/or longer-than-specified heating time. The resin bead from 2110 was not discolored, but appeared to have been heated to such a temperature that, when cooled, it shrank and pulled away from the socket wall.

Tests conducted on the beads from 2108 and 2116 showed that the density changed from 0.945 gm/cm<sup>3</sup> (obtained from specimen in another area of the nipple) to 0.95 gm/cm<sup>3</sup>. The polyethylene resin had been thermally degraded with a resultant embrittlement of the weld material. The fact that the resin bead from 2110 shrank and pulled away from the socket wall raises the possibility that either the heating of the joint was improperly performed or that the joint was disturbed after having been set. Because the heat-fusion joint itself at 2108 was poorly made, the resin bead became embrittled and the weld was further weakened.

The heavy equipment used to widen and improve Amanda Street was operated repeatedly over the newly installed plastic pipe and ultimately caused the permanent deformation of the tapping nipples at the fused junctions.

The heavy rain, which caused the soil to heave and exert additional pressure on the already weakened, unsupported fusion welds was the final factor which caused the failures.

The concrete sidewalk which was poured directly over the plastic distribution system acted as a lid and kept much of the gas from escaping to the atmosphere at the break. Additionally, the sidewalk allowed gas traveling below it at a

pressure of 20 p.s.i.g. to migrate under and into the affected house at 2109 Amanda Street.

The distance between houses was large enough so that almost all of the blast and ensuing fire were confined to 2109.

The leaking gas from the four other failures posed a hazard, but Lone Star, forewarned by the explosion, was able to detect these breaks and repair them before additional accidents occurred.

A review of the ASME guidelines, specifically concerning heat fusion joints (849.394) and prevention of damage due to external loading or settling of backfill (849.52), indicates that although Lone Star complied with them in general, the guidelines were not implemented thoroughly enough to prevent the accident. Lone Star did not give proper consideration at the time of the system's installation to both the soil heaving problem and the planned construction work on Amanda Street.

#### 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 in 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 backfill, 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).

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED  
Chairman

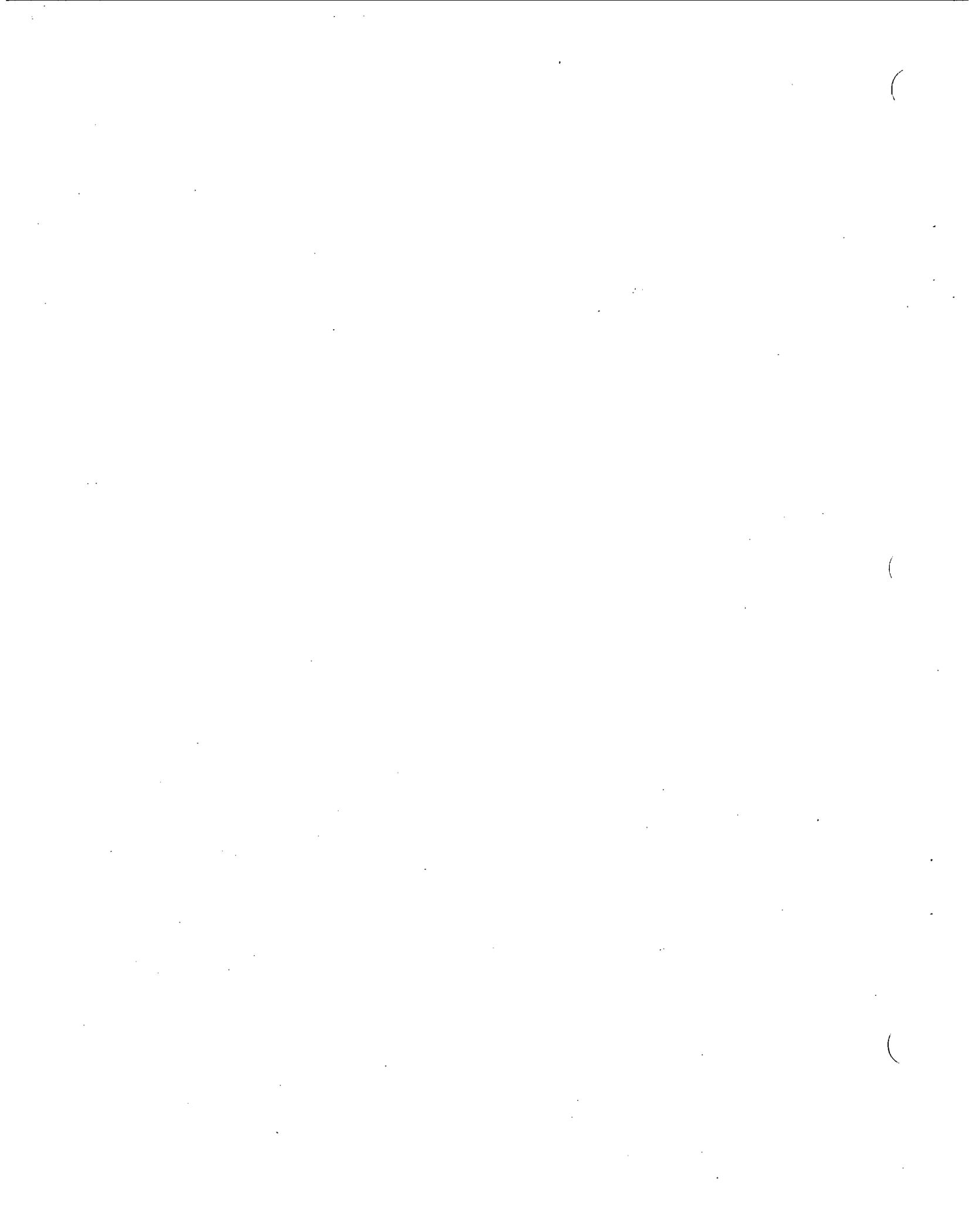
/s/ FRANCIS H. McADAMS  
Member

/s/ ISABEL A. BURGESS  
Member

/s/ WILLIAM R. HALEY  
Member

Louis M. Thayer, Member, was not present and did not participate in the adoption of this report.

December 13, 1972



## APPENDIX A CHARACTERISTICS OF PLASTIC PIPE

The installation of plastic pipe used in gas distribution systems is similar to that generally used with steel pipe. A trench must be dug, the pipe laid without tension, and proper backfill used to prevent damage to the pipe in the ditch. There are, however, major differences between the two kinds of pipe, particularly in the methods of handling, storing, and joining the pipe and the special tools and special employee-training required.

Plastic pipe and tubing must be handled carefully with proper support to minimize movement and to avoid kinking, cutting, gouging, or abraiding the surfaces. This material must be stored carefully to avoid crushing or piercing it. The pipe should be stored indoors, shielded from direct sunlight, and stacked so that no out-of-round, flattening, or "egging" results. Exposure to excessive heat and harmful chemicals must be avoided.

Polyethylene plastic pipe, which was used in the distribution system involved in this accident, has tough, flexible characteristics which enhance its use in gas distribution systems. It is light-weight, easily installed, and relatively trouble-free, if construction specifications are followed closely. Polyethylene has a wide usable-temperature range, is resistant to the additives usually found in natural gas, and is unaffected by natural gas itself.

The joining of polyethylene pipe is accomplished by means of a heat-fusion process. This process is relatively simple, but the special tools necessary must be clean and in good repair, the pipe ends clean and squared, the fusion weld held at the correct temperature for the proper time, and the cooling period adequate before the pipe is moved. The tolerance for mistakes in this heat-fusion procedure is small. In connecting a polyethylene service line to a polyethylene main, an external reinforcing sleeve of specified dimensions is placed over the finished fusion weld to help absorb any stresses exerted on the system.

Polyethylene pipe can also be fused to other compatible, but not necessarily chemically identical plastic pipe, if close attention is given to the preparation of the pipe and to the heat-fusion process. The pipe may be joined to steel, cast-iron, or copper pipe by means of compression couplings and flanges. No corrosion problems result from the connection of polyethylene pipe with dissimilar materials.

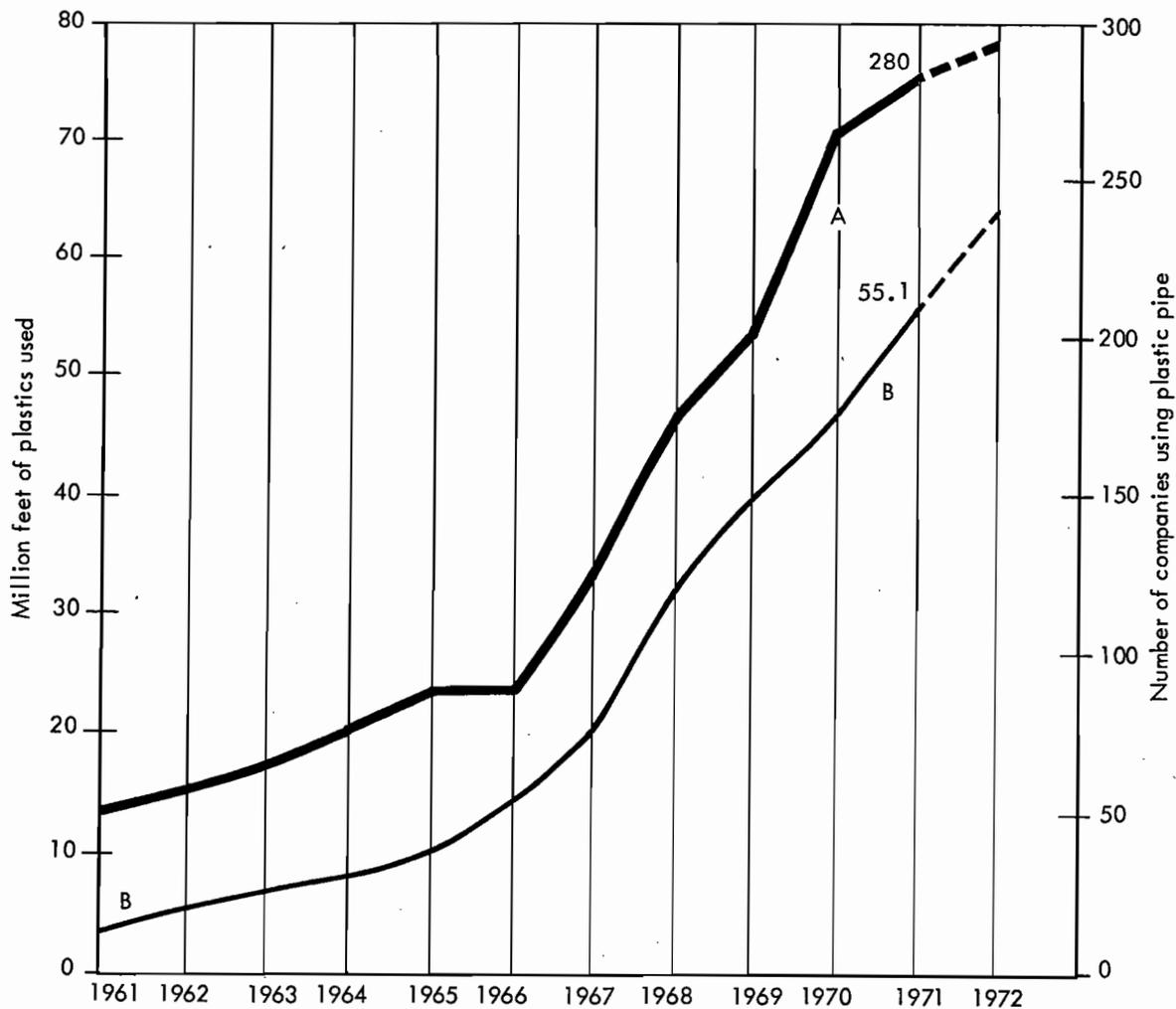
## APPENDIX B HISTORY OF PLASTIC PIPE IN GAS DISTRIBUTION SYSTEMS

Plastic pipe was used in the gas distribution industry in the middle and late 1940's on a very limited, experimental scale. During that period, cellulose acetate butyrate and polyvinyl chloride plastics were used in small amounts by some gas distribution companies. In some instances, this plastic pipe was used as a "liner" to be inserted in existing, corroded metal pipes. In other instances the plastic pipe was joined to existing metal distribution lines as an addition or extension of the system. In a few instances, the plastic pipe was used by itself as a distribution main and service line.

Valuable experience was gained during this early period of experimentation. Gas companies found that pipe stiffeners were sometimes needed and that, occasionally, some connections pulled apart. However, the experience was generally favorable, particularly in regard to the plastic pipe's resistance to corrosion. Research was undertaken which resulted ultimately in a polyethylene plastic pipe that retained the good qualities of the original plastics and developed additional strength, flexibility, and joint-fusion efficiency.

The gas distribution companies were attracted by the economy of using plastic pipe in the construction of new gas distribution facilities, by the economy of repairing existing corroded steel facilities by the insertion of plastic pipe, and by the reduced maintenance costs which resulted from plastic pipes immunity to corrosion attacks. Thus, from virtual obscurity in the early 1940's to widespread popularity today, the use of plastic pipe in the gas distribution industry has grown by geometric progression. (See Figure 7.)

The use of plastic pipe in gas distribution systems is still growing rapidly. In 1971 alone, more than 55 million feet of this material was installed in the United States and Canada. The total amount of plastic pipe installed through the end of 1971 amounted to over 306 million feet and it is estimated that an additional 63.6 million feet will be installed in 1972. If this estimate is correct, a total of 369.8 million feet of plastic pipe will be in service by the end of this year.



A= COMPANIES INSTALLING PLASTIC PIPE EACH YEAR  
 B= TOTAL FOOTAGE OF PLASTIC PIPE USED BY U.S. AND CANADIAN GAS COMPANIES

Figure 7.—Graph of yearly increase in use of plastic pipe.

**APPENDIX C**  
**LONE STAR GAS COMPANY PLASTIC-PIPE INSTALLATION INSTRUCTIONS**

l. The inserted polyethylene replacement may be connected to the old steel main still in use by any of the methods described in section III.C., "Joining Techniques - Polyethylene to Metal."

m. After tie-ins at both ends of the replacement have been completed and the new polyethylene main has been purged of air, service lines may be connected.

**E. Services**

**1. Service Connections**

**a. General**

Polyethylene service lines shall be installed to a minimum depth of 12 inches on private property and a minimum depth of 18 inches in streets or roads. Where this cover cannot be maintained the service line must be able to withstand harmful external loads.

**b. Polyethylene Service to Steel Main**

Polyethylene services may be connected to steel mains by either:

1) Welding a service tee to the main, or by clamping a service saddle on the main, and connecting the service line to the service tee with a compression fitting, or

2) Clamping a polyethylene service saddle to the main and connecting the service line to the saddle by heat fusion. The tapping procedure to be used is that described in Part d of this section, steps 2 - 14.

**c. Polyethylene Service to Cast Iron Main**

Polyethylene services must be connected to a cast iron main by drilling and tapping the main and installing an appropriate main-to-service fitting. If the diameter of the tapped hole is more than 25 percent of the nominal diameter of the main, it must be covered by a reinforcing sleeve, except that 1¼" taps may be made on 4" mains without reinforcement. Existing taps that exceed 25% of the nominal main diameter may be used if there are no cracks and the threads are in good condition. The service line must be connected to the main-to-service fitting with a compression fitting.

**d. Polyethylene Service to Polyethylene Main**

1) Fuse a service saddle to the main following the procedure detailed in section

III.B.3,

2) Cut a polyethylene nipple to the size recommended in Table II, "Saddle Tapping Nipple Sizing Chart."

3) Fuse the end of the polyethylene nipple to the saddle following the procedure in section III.B.1, "Socket Fusion."

TABLE II

SADDLE TAPPING NIPPLE SIZING CHART		
NIPPLE SIZE	MINIMUM LENGTH OF NIPPLE	MAXIMUM LENGTH OF NIPPLE
½"	7½"	8½"
¾"	7½"	8½"
1 ¼"	15½"	18½"
2"	15½"	18½"
3"	17"	18½"
4"	17"	18½"

4) The Tapping and Testing tool is placed on the nipple in the manner of a compression coupling and the safety chain connected around the main.

5) Retract the tapping bit as far as possible and inject air into the fitting on the Tapping and Testing tool. Test all fusion joints with soap solution.

6) After the soap test has been successfully administered, douse the pipe in the work area with water and place a wet rag on the tapping nipple. The rag should be in contact with the tapping tool.

7) Tap the service by applying pressure on the drive knob and rotating the bit clockwise with the speed wrench.

8) After the main has been tapped, the bit is again retracted as far as possible and the squeeze tool placed in position on the nipple.

9) The polyethylene nipple is squeezed-off following the procedures in section V.B., "Squeeze Shut-off Technique." Check the degree of squeeze through the air test fitting in the tapping tool.

10) The Tapping and Testing tool is removed from the nipple and the bit inspected to assure that the wall of the main has been completely penetrated and that the pipe coupon has been retained in the tool.

11) An external reinforcing sleeve is placed over the service line pipe prior to connection of the service line to the tapping nipple.

12) The completed, previously-tested service line is tied into the polyethylene nipple using the Socket Fusion technique.

13) The squeeze tool is relaxed and the tie-in fusion joint soap tested. If the tie-in joint is sound, the squeeze tool is removed, the external reinforcing sleeve is slipped back over the tapping nipple and service saddle and the backfill process begun.

14) The backfill material is carefully placed under the main, saddle, nipple, and coupling assembly and compacted to as near original density as possible. Continuous support along the length of this assembly is mandatory. If this cannot be accomplished with compacted backfill material it may be done by placing a split section of steel pipe under the entire length of the assembly, forming a continuous bridge. Refer to section IV.G., "Backfill."

#### **APPENDIX D APPLICABLE SECTIONS OF THE ASME GUIDE FOR GAS TRANSMISSION AND DISTRIBUTION PIPING SYSTEMS**

##### **842.394 Heat Fusion Joints**

(b) Sound socket heat-fusion joints require the use of a jointing device that heats the mating surface of the joint uniformly and simultaneously to essentially the same temperature. The completed joint must not be disturbed until properly set.

##### **842.41 Construction Specifications**

All construction work performance on piping systems in accordance with the requirements of this guide shall be done under construction specifications. The construction specifications shall cover the requirements of this guide, and shall be in sufficient detail to assure proper installation.

##### **842.43 Installation Provisions**

(c) Plastic piping shall be installed in such a way that shear or tensile stresses resulting from construction, backfill, thermal contraction or external loading are minimized.

##### **842.431 Direct Burial**

(b) Plastic piping shall be laid on undisturbed or well compacted soil. If plastic piping is to be laid in soils which may damage it, the piping shall be protected by suitable rock free materials before backfilling is completed. Plastic piping shall not be supported by blocking. Well tamped earth or other continuous support shall be used.

(e) Backfilling shall be performed in a manner to provide firm support around the piping. The material used for backfilling shall be free of large rocks or pieces of pavement, or any materials that might cause damage to the pipe."

##### **849.11 Installation of Service Lines**

(b) Service lines shall be properly supported at all points on undisturbed or well compacted soil, so that the pipe will not be subject to excessive external loading by the backfill. The material used for the backfill shall be free of rocks, building materials, etc., that might cause damage to the pipe or the protective coating.

#### **849.51 Design of Plastic Service Lines**

(a) Plastic pipe and tubing shall be used for service lines only where the piping strain or external loading will not be excessive.

#### **849.52 Installation of Plastic Service Lines**

(a) Plastic service lines shall be installed in accordance with the applicable requirements of 842.2 (Installation of Plastic Piping) and 849.11. Particular care must be exercised to prevent damage to plastic service line piping at the connection to the main or other facility. Precautions shall be taken to prevent crushing or shearing of plastic piping due to external loading or settling of backfill and prevent damage resulting from thermal expansion or contraction. (See 842.431)