T. DeW. S.

NATIONAL TRANSPORTATION SAFETY BOARD

PIPELINE ACCIDENT REPORT

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

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C. 20591

REPORT NUMBER: NTSB-PAR-70-1

SS - P - 4

PIPELINE ACCIDENT REPORT

LOW-PRESSURE NATURAL GAS DISTRIBUTION SYSTEM

BURLINGTON, IOWA

NOVEMBER 6, 1969

ADOPTED: OCTOBER 14, 1970

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C. 20591
REPORT NUMBER: NTSB-PAR-70-1

For sale by U.S. Department of Commerce, National Technical Information Service, Springfield, Va. 22151

FOREWORD

This report of facts and circumstances and the determination of probable cause by the National Transportation Safety Board is based on facts developed in an investigation conducted by the Safety Board. Cooperation during the investigation was received from the Iowa Southern Utilities Company, the Iowa State Commerce Commission, the Office of Pipeline Safety of the Department of Transportation, the Iowa State Highway Commission, and its contractors and the Burlington Fire and Police Departments.

TABLE OF CONTENTS

I. SYNOPSIS 1

II. FACTS 3

A. Background 3
1. Relationships of Iowa State Highway Commission to Iowa Southern Utilities Company and the Contractors 3
B. Description of the Accident 6
C. Activities after the Accident 13
1. Notification of Iowa State Commerce Commission 13
2. Activities of Iowa Southern Utilities Company 13
D. Government Standards 18
E. Industry and Iowa Southern Utilities Company's Standards and Operating Procedures 19
F. Protection of Underground Facilities from Damage 23
1. Introduction 23
2. ISU's Normal Damage Prevention Activities 24

III. ANALYSIS 26

IV. CONCLUSIONS 32

V. PROBABLE CAUSE 34

VI. RECOMMENDATIONS 35

VII. APPENDICES

Appendix I: Relationship of Events and Causal Factors 38

Appendix II: The Iowa State Highway Commission -- Brief Review of the Scope of Work on the Burlington Freeway and Events Leading to the Gas Regulator Incident 39

Appendix III: Summary of Certain State Laws and Safety Practices Designed to Prevent Damage to Underground Gas Facilities 42

Appendix IV: Discussion of Gas Industry Damage-Prevention Programs and Activities 45

LIST OF FIGURES

Figure

1. Final Construction Plans of Iowa State Highway Commission Showing Gas Regulator Installation 5

2. Photograph of Damaged Regulator 7

3. Photograph of Damaged Regulator 8

4. Photograph of Damaged Regulator Being Repaired 9

5. Map of Area Subjected to the Overpressure Condition 12

6. Photograph of Residence Damaged by Fire 14

7. Photograph of Residence Damaged by Fire 15

8. Sketch of Regulator Station R-5 17

9. Ground Level View of the Area in Which the Damaged Regulator is Located 27

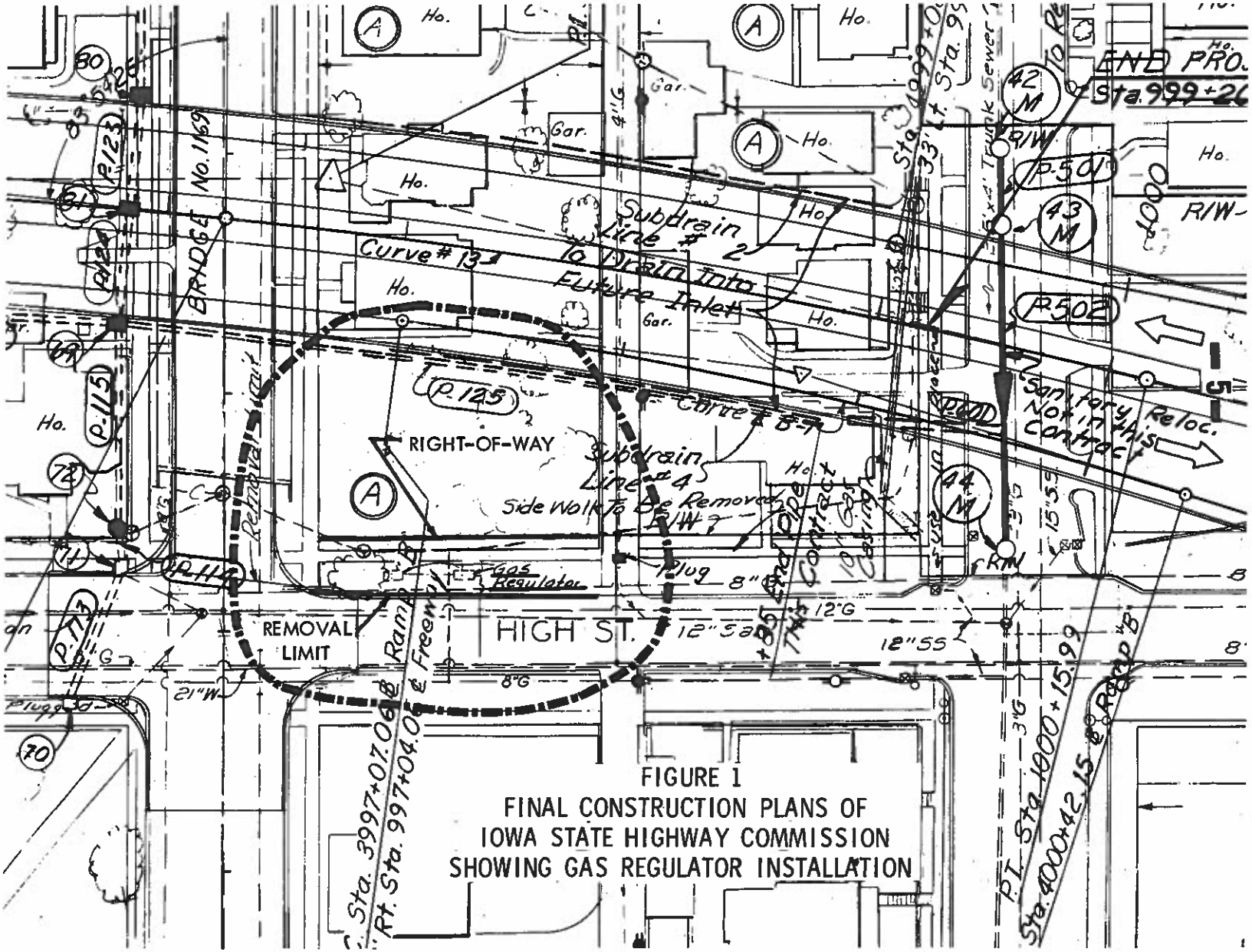


FIGURE 1
FINAL CONSTRUCTION PLANS OF
IOWA STATE HIGHWAY COMMISSION
SHOWING GAS REGULATOR INSTALLATION

In addition to the meetings conducted by the Design Department of the Highway Commission (see Appendix II), a preconstruction conference was conducted at City Hall on October 29, 1969. This meeting was held by the Construction Department of the Highway Commission and was attended by city officials, representatives of all utility services, State and Federal highway representatives, and the contractors' personnel.

The two Highway Commission inspectors assigned to this project did not attend this meeting. Neither the project representative for the contractors, nor the two contractors themselves, who attended the meeting conducted on October 29, 1969, were present when the accident occurred.

Station R-5 was not discussed at this meeting, as ISU stated that it assumed the location and proximity of the station to the construction work had been resolved during prior discussions. There was, however, discussion concerning the location of other gas facilities.

ISU previously discussed the presence of the regulator station with Iowa Highway Commission representatives at the utility meeting held on June 3, 1969. However, since the contract had not as yet been let, the contractors were not present at this meeting.

B. Description of the Accident

On November 6, 1969, an employee of the Jack A. Schroder, Co., Inc., was operating a 70,000-pound bulldozer to remove tree stumps in the area, bounded by 3rd and 4th Streets on the east and west and by High and Arch Streets on the north and south. The stumps to be removed had been marked by an Iowa Highway Commission survey crew. Two of the marked stumps were between the curb and the sidewalk, where the regulator station was also located, 25 feet east and 45 feet west of the primary regulator pit. About 1:30 p.m., the operator backed the bulldozer down an embankment and ran over the steel covers of the concrete regulator pit, not knowing of its existence. He felt one track dip into a large hole or opening in the ground. The heavy bulldozer had partially collapsed the steel cover which was supported by two steel I-beams. The bulldozer met resistance as attempts were made to move it forward out of the pit. After he moved the bulldozer out of the pit, the operator examined the damage. He realized he had hit some pipes and saw that a spring had broken off. The spring extended 10-inches from the top of the regulator and controlled the movement of the regulator valves. (See Figure 2, 3, and 4, pages 7, 8, & 9 .) He did not smell gas or otherwise detect any indication of a leak. He then got in a pick-up truck and went to the newly opened construction trailer about 3 1/2 blocks away--the telephone and electric service had not yet been installed--to report his actions to the two Iowa State Highway Commission inspectors. The operator stated

FIGURE 2

DAMAGED REGULATOR PIT, LOOKING NORTH.
NOTE TREAD MARK OF BULLDOZER.

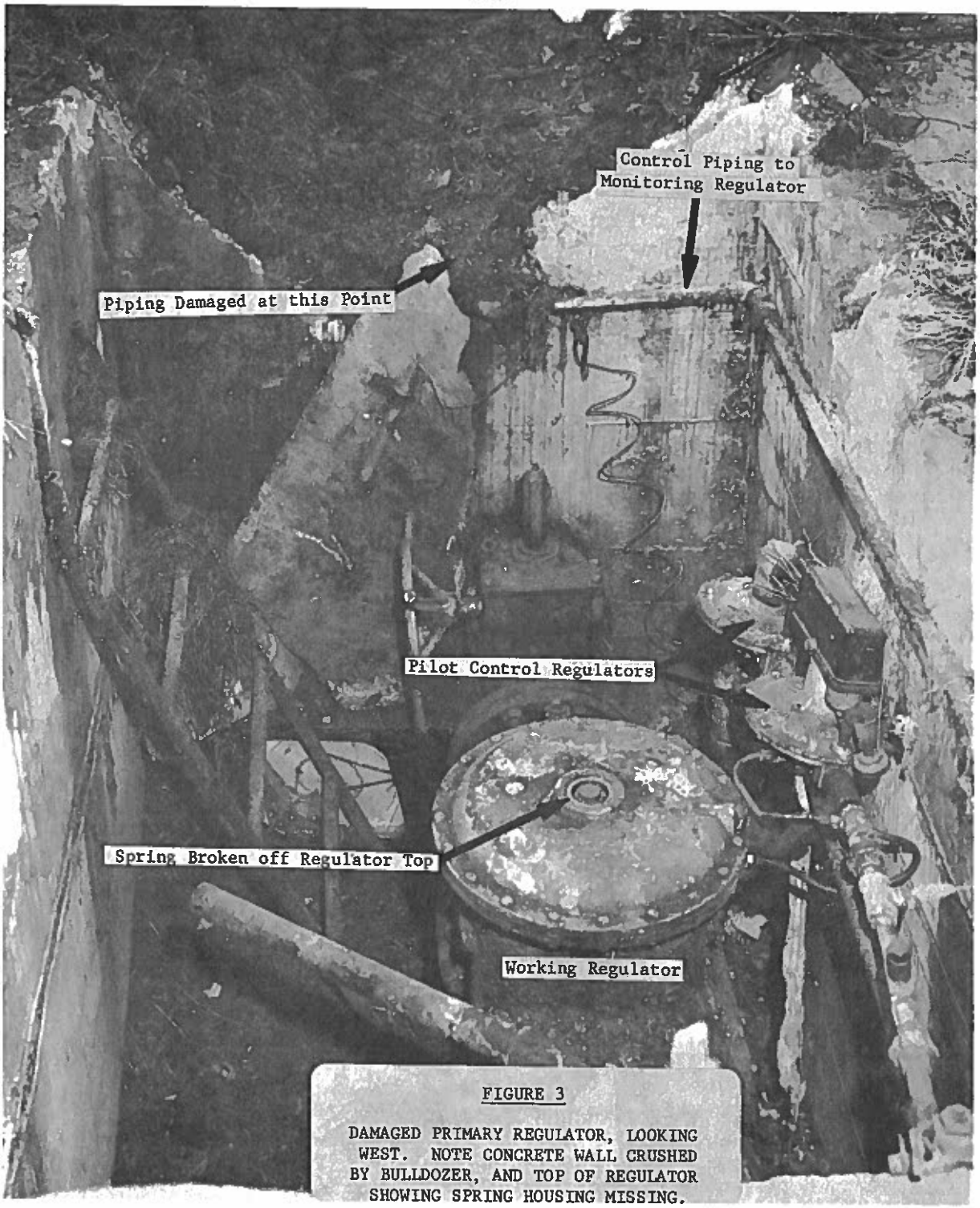


FIGURE 3

DAMAGED PRIMARY REGULATOR, LOOKING WEST. NOTE CONCRETE WALL CRUSHED BY BULLDOZER, AND TOP OF REGULATOR SHOWING SPRING HOUSING MISSING.

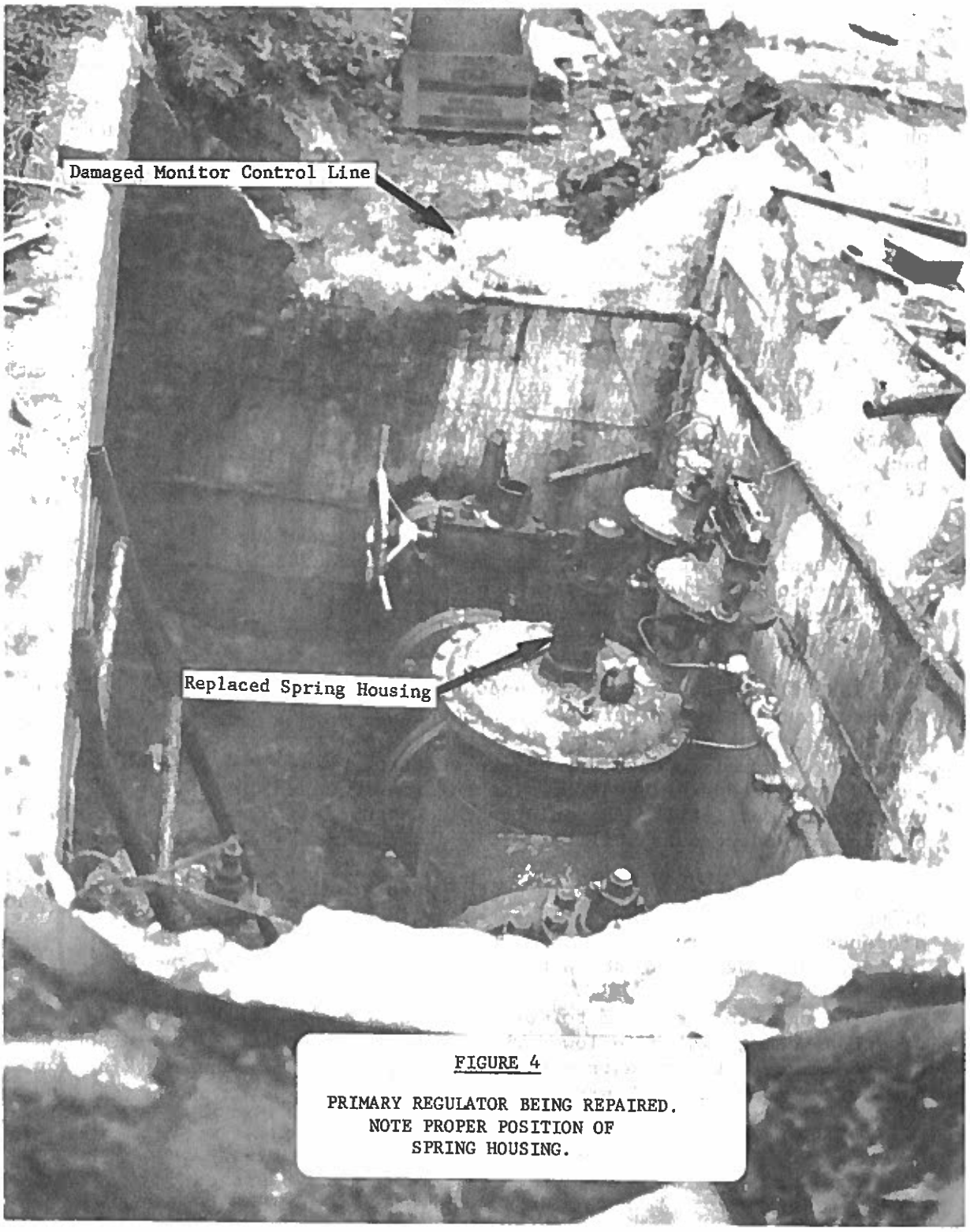


FIGURE 4

PRIMARY REGULATOR BEING REPAIRED. NOTE PROPER POSITION OF SPRING HOUSING.

that he was not aware of what had been hit, but the three men went to observe the damage. After they looked at the broken regulator, the two inspectors did not feel the damage was serious and proceeded by pick-up truck, to the office of the Jack A. Schroder Co., Inc., which is about 10 minutes away from the accident scene.

When they arrived, about 2:15 p.m., Mr. Schroder was not present in his office, but he was reached by car radio. Schroder stated that he thought the pipes were not in use, but he told the State inspectors to contact ISU if they had any question. The clerk in the Schroder office then attempted to contact ISU, but by this time the Utility was receiving many calls from its customers and it was 15 to 20 minutes before the clerk could reach the Utility on the telephone. When he finally did reach ISU, he spoke to a company representative and informed him that a bulldozer had backed into a connection at High Street between 3rd and 4th Street. The ISU employee replied that "this may be part of my trouble."

One of the inspectors stated that, to his knowledge, the existence of the regulator pit and gas lines was never brought to the attention of any inspectors or the contractor's personnel by the gas company. The inspectors also had the impression that all utilities had been removed in the area where the accident occurred.

The bulldozer operator was unaware of the presence of the regulator station in the area in which he was working. He had not received a general briefing on all of the utilities in the area, nor had he been receiving a briefing each day before starting work. However, he was warned by his supervisors from time to time to watch out for specific underground facilities. He said that he assumed if he was not informed to be wary of underground utilities in his work area, that none existed.

The contractors were aware of the regulators on the construction prints, but said they thought they had been taken out of service. Their presence on the prints was compared with other structures, such as houses, which were also shown but which had been removed.

The operator returned to work, not being aware of the significance of actual damage which followed the crushing of the pit. He did not become aware of the catastrophe until after he had finished working for the day -- more than 3 hours later.

Meanwhile ISU, at 1:55 p.m., received a call from a customer about 15 blocks to the south, in the area of Concord and Main Streets. The customer reported a high gas pilot. A serviceman, working only three blocks from the scene of the accident, was dispatched to check this complaint. Soon after that, numerous calls were received from the same area and other areas in the low-pressure distribution system. Since it appeared to be a widespread problem, crews were dispatched to check the 24 regulator stations supplying this large, integrated low-pressure system which serves some 7,500 customers. The area affected is shown in Figure 5, page 12 . Since the regulator which was damaged was the largest serving the area, and since a crew was working nearby, that regulator was checked first. As soon as the crew arrived and observed the situation, they turned off the supply of gas to this station by operating the shutoff valve located 2 feet from the pit housing the monitor. This occurred about 2:25 p.m. Gas supply to the low-pressure system was maintained by the other regulator stations.

At about the same time, ISU started to receive calls; so did the police and fire departments (one central communications center is utilized by both agencies).

The Burlington Fire Chief indicated that the first call was received shortly before 2 p.m. from 404 South Gertrude Street, and that the caller complained about "trouble with the gas." A unit was dispatched to answer that call. The Chief then went to City Hall to attend to other business. As subsequent calls were received, the Chief was called back and took charge of the emergency.

Police and firemen were dispatched to the more than 60 calls received between 2 p.m. and about 4:30 p.m., when the last alarm was sounded.

A special telephone line was connected from ISU to the central communication center for use in emergencies. Even though the line existed, the personnel on duty at the communications center do not recall having been contacted by ISU during the early stages of the accident. However, the police and fire officials indicated that there was no communications problem and that they worked very closely with ISU during the emergency. The fire chief indicated that an ISU representative delivered a note concerning the accident during its early stages. The Utility's offices were a few blocks from the police and fire station.

Because of the unusually large number of calls, many people were unable to get through to ISU or to the fire or police departments. Calls were received by the local radio station which, after a short time, realized the severity of the situation. About 2:10 p.m., on its own initiative, the radio station requested Burlington residents to shut off their gas meters. This was accomplished by many of the homeowners.

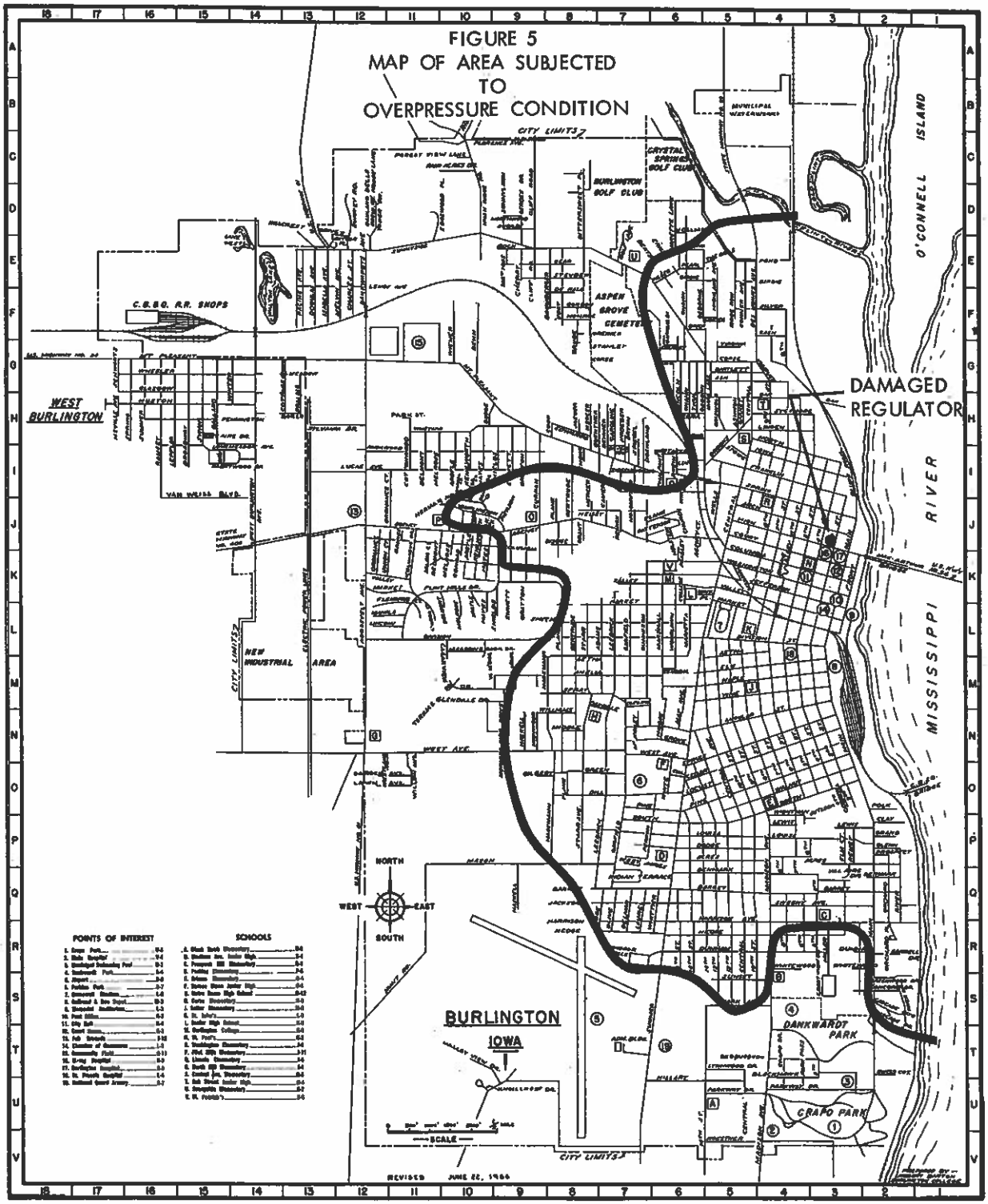


FIGURE 5
MAP OF AREA SUBJECTED
TO
OVERPRESSURE CONDITION
DAMAGED
REGULATOR
O'CONNELL ISLAND
MISSISSIPPI
RIVER
WEST
BURLINGTON
C.B.&Q. R.R. SHOPS
ASPEN
GROVE
CEMETERY
CRYSTAL
SPRINGS
GOLF CLUB
BURLINGTON
GOLF CLUB
CITY LIMITS
NEW
INDUSTRIAL
AREA
BURLINGTON
IOWA
DANKWARDT
PARK
CRAPO PARK
NORTH
WEST
EAST
SOUTH
SCALE
POINTS OF INTEREST
SCHOOLS
REVISED JUNE 22, 1966

About 2:10 p.m., the Civil Defense siren was sounded and a state of emergency was declared. Fire departments from the Iowa Army Ammunition Plant, Mt. Pleasant, Fort Madison, Denmark, Weaver, West Burlington, Danville, and Mediapolis, Iowa, answered the calls for assistance and aided in fighting the fires and in turning off gas meters in houses and other buildings.

There were no fatalities, but two firemen suffered minor injuries. The combined firefighting force answered 54 alarms. There were no explosions, but six houses were damaged by fire to the point where they were uninhabitable, and 42 other houses suffered fire damage exceeding $50. The Burlington Fire Department estimated the property damage at $80,000. The fires were mainly in and around the gas ranges, gas hot water heaters, and heating equipment. The high pilot lights and burner flames caused by the high-pressure gas ignited combustible materials near these appliances, such as kitchen curtains and cabinets. In some of the more badly damaged houses, the fires spread from the immediate area of the ranges and heating units to other parts of the buildings. All of the damage was confined to the inside of the houses. Figures 6 and 7 (Pages 14 and 15.) indicate the damage sustained by the houses.

The ambient temperature at the time of the accident was between 70° F. and 75° F.

C. Activities after the Accident

1. Notification of Iowa State Commerce Commission

The Iowa State Commerce Commission, whose offices are located in Des Moines, first became aware of the accident from radio news reports shortly before 3 p.m. on November 6, 1969. The Commission received a call from ISU about 4 p.m., explaining that there had been an overpressure condition in Burlington but that it had been corrected. However, ISU reported that fires were still burning in the affected area. An engineer from the Commission's Utilities Division was dispatched to the scene of the accident from his office in Des Moines, which is about 160 miles from Burlington. The Commission engineer arrived about 9 p.m.

2. Activities of Iowa Southern Utilities Company

The Utility received thousands of calls from its customers until about 3:30 a.m. on November 7, when the number was reduced. Most callers wanted their gas turned back on and their appliances checked for safety. ISU brought in more than 100 men from Mt. Pleasant, Centerville, Washington, and Grinell, Iowa. It also received assistance from Iowa Electric of Muscatine and Fairfield, North Central Public Service of Fort Madison,

FIGURE 6

FIRE DAMAGE TO RESIDENCE
AT
612 NORTH 8th STREET

FIGURE 7

FIRE DAMAGE TO RESIDENCE
AT
1725 LOUISA STREET

private plumbing and heating men, and Civil Defense volunteers. These men worked through the night restoring services and checking appliances. This task was complicated by the fact that many customers who were not in the affected areas, but who heard the request of the radio station, turned off their gas as a precautionary measure. Even some customers in West Burlington connected to the medium-pressure distribution system shut off their gas supply.

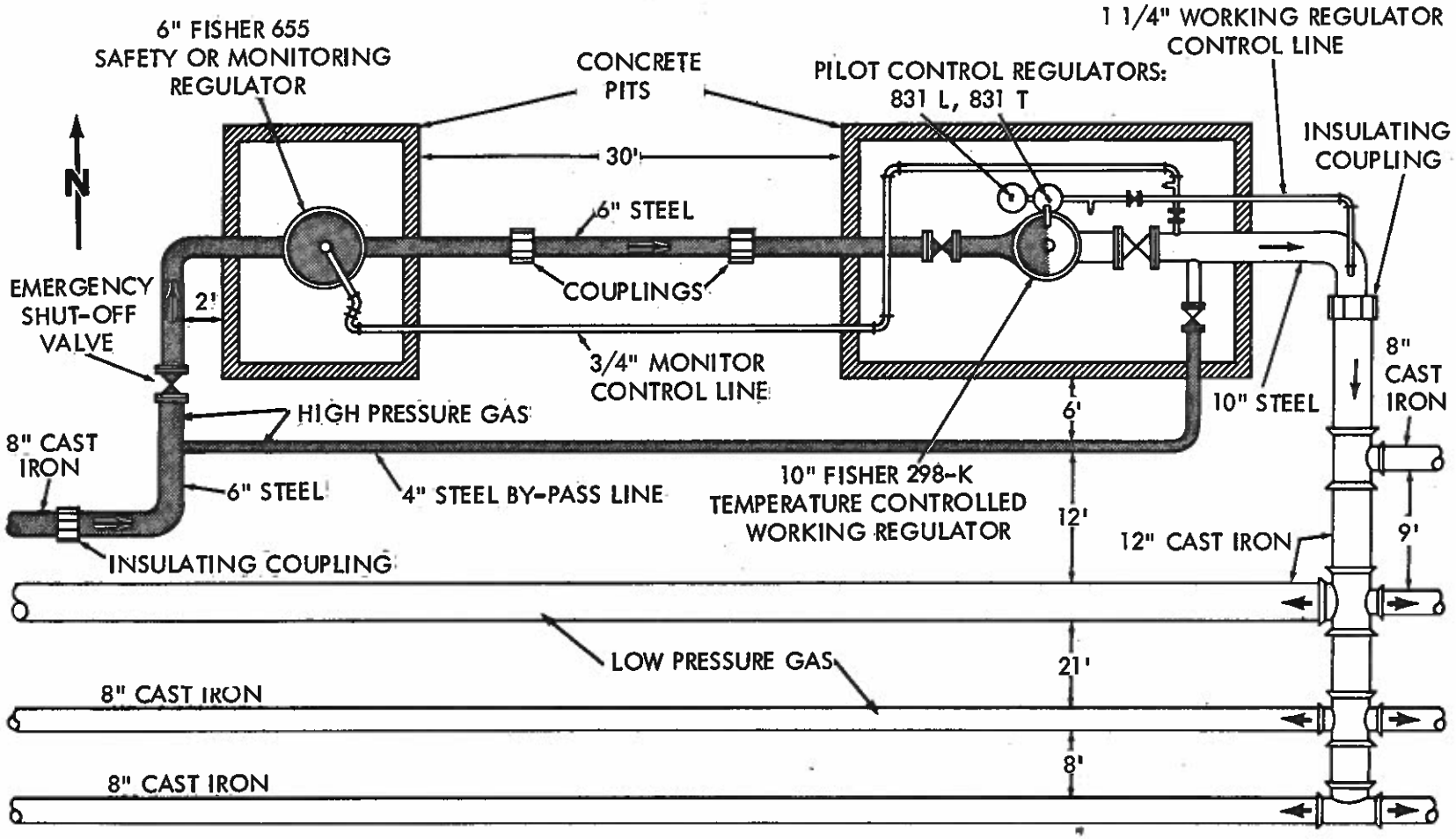
In an attempt to determine what had occurred, the control piping to the monitoring regulator was disconnected and tested by ISU the day following the accident, November 7, 1969. While it had been bent about 10° to 15° by the bulldozer, it was not leaking. A more complete description of the control line is found on page 21. A simulated test was conducted to determine how the monitor would react to a raise in pressure. It started to shut down at about 15 inches water column (1/2 p.s.i.g.) and was completely shut off at 30 inches water column (1 p.s.i.g.). A temporary wooden fence was placed around the working regulator pit to prevent further damage. The damaged regulator was repaired and placed back in service 1 week after the accident occurred.

There were seven recording or indicating pressure gauges located throughout the low-pressure distribution system. These were checked after the accident. The recording gauges have a limit of 20 inches water column. The charts showed that the recording pens went off scale. The nonrecording type of gauges have a scale which can indicate pressure up to 35 inches water column. Neither of the two types of gauges was found to be damaged, indicating that the pressure during the accident had not greatly exceeded the limits of the gauges. If these types of gauges should be subjected to pressures substantially greater than their design limit, permanent damage to the measuring elements would be likely.

Prior to the accident, the working regulator was adjusted for winter operation to deliver gas at a pressure of about 7 1/2 inches water column for normal winter operation, but by use of a temperature-controlled pilot regulator (see Figure 8 on page 17.), the outlet pressure would be automatically raised to 11 to 11 1/2 inches water column if the temperature ranged between +10° F. to -10° F. This was done to allow for greater supply of gas as the temperature dropped, which would increase the needs of ISU consumers for home heating.

After the accident, the monitor was readjusted so that it would completely shut down if the pressure in the low-pressure system reached 15 inches water column. The monitor was set to start to close at about 8 inches water column. However, as the temperature dropped below 10° F. during December 1969 and January 1970, the working regulator automatically commenced delivering gas at 11 to 11 1/2 inches water column, and the monitor started to shut down. ISU had to readjust the monitor during excessive cold

FIGURE 8
REGULATOR STATION R-5
HIGH STREET AND 4th STREET
BURLINGTON, IOWA



NOT TO SCALE

weather so that the monitor would not shut off the supply of gas. As soon as the temperature rose above 10° F., ISU again readjusted the monitor to its original setting (8 inches water column). The Utility is now planning to install a pilot control on the monitor regulator so that it can be more tightly controlled to eliminate the need for continued readjustment. (See sketch of regulator station on page 17.)

All of the 24 regulator stations were inspected after the accident and adjustments made where necessary. Two stations were found not to be equipped with safety regulators or other overprotection devices. ISU indicated that these were small stations and would not cause a hazard if they were to malfunction. However, the Utility planned to install pressure protection devices on these stations in the spring of 1970. These two stations are designated R-17 and R-20 and are located on Acres Street near 5th Street and Des Moines Avenue near Corse Street, respectively. Both stations are equipped with a 2-inch Fisher Series 99 regulator.

D. Government Standards

On August 12, 1968, the Natural Gas Pipeline Safety Act of 1968 (49 U.S.C. 1659, et seq.) became law. Hereafter in this report, it is referred to as the Act. The Secretary of Transportation is authorized, under Section 3 of the Act, to prescribe safety standards for the transportation of natural and other gas by pipeline. A discussion of the Act, in greater detail, as it relates to the intrastate pipeline operations appears in the National Transportation Safety Board's report on a natural gas pipeline accident which occurred in Gary, Indiana, on June 3, 1969. 2/

Federal Interim Standards were published, as required by the Act, on November 12, 1968, as Part 190 "Interim Minimum Federal Safety Standards for the Transportation of Natural and Other Gas by Pipeline," Chapter 1, Title 49, Code of Federal Regulations. For intrastate pipelines, the Office of Pipeline Safety (OPS), Office of the Secretary, adopted for each State those standards which the State had in effect on August 12, 1968, as required by the Act.

A majority of the States adopted this code in such a manner that it would automatically include future changes to the code, with a result that the majority are now using the 1968 edition. Iowa was one such State.

2/ NTSB Pipeline Accident Report of Low-Pressure Natural Gas Distribution System at Gary, Indiana, on June 3, 1969, adopted December 4, 1969.

In a letter dated October 9, 1968, the Iowa State Commerce Commission reported to the Office of Pipeline Safety, that Iowa Departmental Rules (1966), Rule PL. 94, et. seq. applied to distribution lines and facilities. This in effect made the 1968 edition of United States of America Standard B31.8 Code "Gas Transmission and Distribution Piping Systems," the basic standard for all gas transmission and distribution operations, including those of ISU.

Section 5 of the Act also provides for State enforcement of Federal safety standards. On January 30, 1969, the State of Iowa submitted a Certificate to the Office of Pipeline Safety agreeing to assume safety responsibility for all intrastate gas facilities under its jurisdiction. The Office of Pipeline Safety accepted the Iowa Certificate, and it was in effect at the time of the accident.

E. Industry and ISU's Standards and Operating Procedures

ISU has its own standards for the guidance of its operating personnel and also is required to operate its gas system in conformance with the above-mentioned B31.8 Code. The company standard, "Standard Material and Methods of Construction," was first issued in January of 1959. Under the section dealing with Scope, the company standard states, in part:

> "Your Gas Distribution Standards Manual has been assembled to provide you with information on acceptable methods for constructing and maintaining a modern gas distribution system."

Under the section defining Application, it further states,

> "The Standards shall be applied as follows:
>
> (a) Existing facilities shall not be changed solely to conform to the standards except where it is considered necessary to eliminate a hazardous condition.
>
> (b) All new construction shall conform to the Standards.
>
> (c) All replacement of facilities shall be done in accordance with the Standards."

The Standards include a section on Regulator Station Design. These Standards were in effect when the regulator damaged in the accident was installed.

In 1964, regulator station R-5 was relocated to its present location on the north side of High Street between 3rd and 4th Streets, a distance of about two blocks from its original location. At that time, a new 6-

inch monitor or safety regulator was installed in a separate pit about 30 feet upstream to act as an overpressure protection device for the regulator station. This station was the largest of the 24 stations which served 7,500 low-pressure customers.

The district regulator station R-5, which was damaged in the accident, consisted of a 10-inch Model 298-K pilot-controlled working regulator and a 6-inch Model 655-A monitoring or safety regulator. The pilot control on the Model 298 working regulator included a small type 831-T temperature loading regulator. The 831-T automatically adjusted the outlet pressure of the working regulator in relation to the atmospheric temperature changes. This allows more gas to flow into the low-pressure system when the temperature drops to meet increasing requirements of gas consumers. A type 831-L maximum boost limit regulator is also included to allow only a predetermined boost in the outlet pressure by the temperature loading pilot regulator. (See Figure 8 page 17 .) The regulators and pilots were manufactured by the Fisher Governor Company of Marshalltown, Iowa. The station was supplied with 60 p.s.i.g. gas from an 8-inch main, and fed gas reduced to 1/4 p.s.i.g. to three 8-inch mains and one 12-inch main for distribution to gas consumers.

The station was designed so that if the working regulator should fail open, the monitoring safety regulator would activate and maintain the pressure at a slightly higher level. However, after the working regulator was damaged in the accident, the safety regulator was activated to control at a pressure of about 1/2 p.s.i.g., but did not control the 55 p.s.i.g. inlet pressure at the 1/2 p.s.i.g level. It is estimated by ISU that the pressure in the system reached 1 to 1 1/4 p.s.i.g., preceding the fires. This amounts to about a four fold to a five fold increase over normal operating pressure.

The B31.8 Code, in section 845.43, indicates that the maximum allowable operating pressure for a low-pressure distribution system shall not exceed: (1) a pressure of 2 p.s.i.g., or (2) a pressure which would cause the unsafe operation of any connected and properly adjusted low-pressure gas burning equipment.

The safety regulator was essentially a nonworking monitor because it remains in a wide-open position upstream from the working regulator, sensing the pressure reduced by the working regulator via a control line. When the pressure surged through the damaged working regulator, it was sensed by the monitor regulator which started to close down as intended. However, it did not work to reduce the pressure to 1/2 p.s.i.g. as designed.

By utilizing a monitoring regulator at this regulator station, ISU was in compliance with section 845.42 of the B31.8 Code. That section requires that in addition to the pressure regulator, a suitable device be provided to prevent accidental overpressuring. Acceptable devices basically include: relief devices; an automatic shutoff device; a series regulator installed upstream of the primary regulator, set to limit the pressure to the maximum allowable operating pressure or less; or a monitoring regulator installed in series with the primary pressure regulator.

The gas system piping between the two pits was buried about 3 feet underground. However, the control line to activate the monitoring regulator had only 1 foot of ground cover.

The bulldozer, when it hit the top of the regulator, also came in contact with the control line. The control line, from the monitor to a point downstream of the working regulator, ran underground from the pit containing the monitor to the pit housing the regulator, thence along the wall of the regulator pit to a point downstream of the regulator where it was connected to a point where it would sense the pressure being controlled by the working regulator. This line was not severed but it was bent at a point where it passed through the concrete wall of the working regulator pit. The control line was still open and completely functional, even though bent.

The subject of maintenance of pressure limiting and pressure regulating stations is covered in B31.8 Code in Section 855 which states, in part:

> "855.1 All pressure limiting stations, relief devices, and pressure regulating stations and equipment shall be subjected to systematic, periodic inspections and suitable tests to determine that they are:
>
> (a) In good mechanical condition.
> (b) Adequate from the standpoint of capacity and reliability of operation for the service in which they are employed.
> (c) Set to function at the correct pressure.
> (d) Properly installed and protected from dirt, liquids, or other conditions that might prevent proper operation."

In addition, section 845.8, concerning adequacy and performance of pressure limiting devices, states in part:

"845.81 Where the safety device consists of an additional regulator which is associated with or functions in combination with one or more regulators in a series arrangement to control or limit the pressure in a piping system, suitable checks shall be made to determine that the equipment will operate in a satisfactory manner to prevent any pressure in excess of the established maximum allowable operating pressure of the system should any one of the associated regulators malfunction or remain in the wide open position."

Under Monitoring Regulator of ISU's Standard No. REG 2-122, it is stated, in part: "Failure of the operating regulator shall cause the monitor to operate at a slightly higher outlet pressure. (Approximately 2" w.c. /water column/ on low pressure . . .)." ISU indicated that the performance of its 24 regulator stations was checked weekly by examining the seven pressure recording or indicating gauges placed in various locations on the low-pressure distribution system. Twice annually the regulators were required to be checked and examined. The Utility had no record of either the weekly or semiannual inspections; however, the timesheets of the regulator maintenance man indicated that some work may have been performed. ISU did have orignial form records that indicated all regulators were dissassembled, checked, and examined during 1967. However, no inspection form for the safety regulator could be found. The working regulator was checked on June 27, 1967. The inspection form indicated that the diaphragm plate in the 831-T pilot control regulator was replaced at that time.

Sections found in the B31.8 Code concerning the prevention of damage to underground facilities are as follows:

(a) Section 851.1, Pipeline Patrolling, which states, in part:

"Each operating company shall maintain a periodic pipeline patrol program to observe surface conditions on and adjacent to the pipeline right-of-way, indications of leaks, construction activity other than that performed by the company, and any other factors affecting the safety and operation of the pipeline."

(b) Section 851.6, Pipeline Markers, which states:

"Signs or markers shall be installed where it is considered necessary to identify the location of a pipeline to reduce the possibility of damage or interference."

(c) Section 841.161, Cover Requirements for Pipeline and Mains, which states:

> "Buried pipelines and mains shall be installed with a cover not less than 24 inches. Where this cover provision cannot be met, or where external loads may be excessive, the pipeline or main shall be encased, bridged or designed to withstand any anticipated external load. Where farming or other operations might result in deep plowing or in areas subject to erosion or in locations where future grading is likely, such as a road, highway, railroad and ditch crossings, additional protection shall be provided."

The B31.8 Code requirements, in the area of protection of underground facilities from damage, stress action to be taken regarding high-pressure transmission pipelines rather than distribution facilities, such as those involved in this accident. The code does not include requirements for establishing formal programs to prevent damage to underground distribution facilities.

F. Protection of Underground Facilities From Damage

1. Introduction

Damage to underground gas pipelines by the operation of earth-moving equipment, such as bulldozers, ditchers, graders, etc., is one of the major causes of pipeline accidents. Federal Power Commission Report 60-3240, entitled "Safety of Interstate Natural Gas Pipelines," released April 19, 1966, included the actual safety experience of the major natural gas interstate pipeline companies for the 15 1/2-year period from January 1, 1950, to June 30, 1965. The report states:

> "Carelessness in the operation of farming, roadbuilding and excavating equipment caused the largest number of line failures, accounting for 26 percent of such failures reported." 3/

In 1968, the interstate natural gas pipeline companies reported to the Federal Power Commission that 89 accidents and failures had occurred on their facilities. Of these accidents, 33 percent were caused by

3/ Page 12.

earth moving equipment. In 1967, the figure was 38 percent for 86 accidents. 4/ Preliminary figures for 1969 indicate the percentage reached almost 44 percent. 5/

The study of the accidents in the 15 1/2-year period showed that the next highest causes, corrosion and weld failures, were involved in 36 percent of the major accidents (18 percent each). However, while the percentage of accidents caused by excavating equipment has increased, accidents caused by corrosion and weld failures have decreased -- amounting to 14 percent in 1967 and 17 percent in 1968.

There are no comparable figures available for gas distribution systems; however, this problem is magnified where distribution facilities are concerned. There are almost 2 1/2 times as many miles of distribution piping in the ground in this country as there are transmission lines (249,000 miles of transmission and 610,000 miles distribution). In most cases, the population density in proximity to distribution piping is greater. In addition, the competition for underground space is generally a more significant factor for distribution company operators. The problem of damage to gas facilities by others' installing or repairing electric cables, telephone ducts, sewer and water mains, sometimes within inches of gas facilities, is much more acute in the right-of-way utilized by distribution mains.

The problem of damage to underground gas facilities has been recognized by several States, and legislation has been enacted to control it.6/ Iowa does not have such a law.

2. ISU's Normal Damage Prevention Activities

ISU indicates it does not have formalized, written procedures for extracting or receiving notification from contractors planning to excavate near its facilities, or detailing the necessary steps to protect these facilities from damage. However, ISU gas supervisors from ISU's six districts meet once a month during the 6-month period, October through March, and discuss, among other topics, methods by which they may best facilitate the giving of notice to ISU by persons working near its underground installations. ISU considers that contractors working in the area it serves are

4/ Statistics of Interstate Natural Gas Pipeline Companies - 1968, Federal Power Commission, Washington, D. C., 1969, p. VIII.

5/ Second Annual Report of the Secretary of Transportation on the Administration of the Natural Gas Pipeline Safety Act of 1968, Attachment #1B.

6/ Appendix III: Summary of certain State Laws and Safety Practices Designed to Prevent Damage to Underground Gas Facilities.

generally aware that ISU will cooperate in locating its facilities so that they will not be damaged during construction. The procedure varies, but, in general, a contractor's plans are requested by ISU so that the underground facilities can be plotted on them and returned to the contractor, or ISU personnel may stake out the routes of the installations or have a representative present during the critical stages of construction to guide excavation equipment.

The regulator station damaged in the accident had not been staked out to warn of its existence. No ISU representative was at the scene when the accident occurred. However, ISU furnished the Iowa State Highway Commission with the location of the regulator station and the presence of the station was shown on the final plans of the Highway Commission.

A detailed discussion of programs in use by the gas industry and the steps being taken to control this damage problem can be found in Appendix IV.

III. ANALYSIS

Events Prior to the Accident

A number of factors tend to explain why the bulldozer operator was unaware of the presences of the regulator station in the vicinity in which he was working. The area was overgrown, and the visibility of the steel plate covers over the two concrete pits was limited. Figure 9 on page 27 indicates the condition of the area. Moreover, ISU did not mark, stake out, fence, assign an inspector, or take any other precautionary action to prevent damage to the regulators, since preliminary plans for the highway construction project showed that the area to be cleared would not include the regulators, which were not shown on these prints. In addition, based on its discussion with the Highway Commission, ISU assumed construction work would not endanger the regulators. However, the final construction plans changed the limits of the area to be cleared and plainly showed the two regulators within it. These final plans were not given to ISU as required by Highway Commission policy.

The bulldozer operator assumed that if he was not warned by the contractor about particular underground installations in an area, he need not be concerned about their presence. The operator did not receive regular briefings from the contractor, and neither the contractors nor the foreman was present when the accident occurred.

The Iowa State Highway Commission had satisfactory plans to prevent damage to underground facilities. However, in this accident, there was a breakdown in the plan. In this case, the design department of the Highway Commission was aware of the presence of the regulator station, but the Commission's two field inspectors on the job were not. In addition, the contractor had copies of the prints which clearly showed the two regulators, but the bulldozer operator was not informed of their existence. While the activities of the Highway Commission in this case theoretically should have prevented an accident of this type, in reality they did not because of the lack of careful followup of a plan to make certain it was being properly implemented.

Factors Affecting the Magnitude of the Accident

The regulator was damaged about 1:30 p.m., but the first calls reporting problems were not received by ISU or the Fire Department until shortly before 2 p.m. If the damage had been reported promptly to ISU by the bulldozer operator or by the two Iowa State Highway Commission inspectors, who were present in the area, the extensive fire damage could have been prevented. ISU servicemen or crews working nearby could have been dispatched promptly to check the regulator and shut off the supply of gas to this station.

FIGURE 9

VIEW OF OVERGROWN AREA, LOOKING EAST, SHOWING LOCATION OF PRIMARY AND MONITORING REGULATOR PITS.

The ability of ISU to respond to this emergency was also hampered by the Highway Commission's failure to provide the utility with a copy of the final construction plans. Consequently, the presence and danger of the regulator station were not discussed at the Commission's pre-construction meeting on October 29, 1969, 7 days before this accident. The Highway Commission inspectors did not attend the meeting and, while they were provided with the final plans, they did not know that damage to the two regulators, clearly marked, would require their immediate notification of ISU.

The failure to notify ISU may also be accounted for by the fact that no gas leakage was detected at the site when the damage was inspected by the bulldozer operator and the Highway Commission inspectors. In addition, by the time the call was placed, ISU telephone lines were tied up by customers' calling to report gas troubles.

The duration of the overpressure condition was also prolonged by inability of the system to reduce quickly the overpressure. There were no overpressure relief devices on the system nor were any required by the B31.8 Code, so that detection of the overpressure condition by ISU was possible only after its customers made complaints. Then it was necessary for ISU to dispatch crews to each of the 24 regulator stations serving the entire low-pressure system in order to determine where the failure had occurred.

Despite the lack of overpressure relief devices on the regulator station, the overpressure gas could have been vented through other means, such as by disconnecting customers' meter connections or other system piping. However, it appears that this technique was not employed by ISU, although fires were reported for almost 2 hours after the source of high-pressure gas was shut off.

In addition, the weather was reported to be mild (temperature in the low seventies), which would indicate a reduced rate of gas usage. Had more gas been required by ISU's customers, the higher pressure gas would have been more quickly dissipated. If that had occurred, the accident would have been less severe.

Control Piping

The Regulator Station Design section of the company's standards includes a paragraph on Regulator Control Piping which refers to piping used to sense the pressure at various locations at regulator stations and to convey it to the regulator or the monitor. These two devices respond to the changes in pressure by either opening or closing. In normal operation, the control line for the working regulator senses the pressure downstream which indicates whether more or less gas is required

in the distribution system. The control line for the monitor regulator senses the outlet pressure of the working regulator. If the regulator should malfunction and allow gas at a higher pressure than desired into the low-pressure system, the control line would relay this condition to the monitor, which should immediately start to close down and control the gas pressure being allowed into the system.

The absolute integrity of the control piping must be maintained, if the safety device is to be activated in the case of a problem with the working regulator, ISU's Standard No. REG 2-122, states as follows:

> ". . . The arrangement of the regulator control piping and supports shall be designed to provide not only for safety under operating stresses, but also to provide protection for the piping against detrimental sagging, external mechanical injury, abuses and damage due to unusual service conditions."

Similarly worded requirements are included in Sections 845.9(b)(9), 845.66(b), and 847.1(d) of the B31.8 Code.

Since the control line had no more than 1 foot of ground cover, it was more susceptible to damage by external mechanical equipment then the system piping which had nearly 3 feet of earth cover.

When the bulldozer hit the top of the working regulator, causing it to fail in an open position, it also came in contact with the monitor control line; the line was not severed, but it was bent. This damage was a failure of the intention of the ISU and B31.8 standards; however, because the standards are not specific, it is impossible to determine whether it was violated.

Had a safety regulator not been present, as in the Gary, Indiana, accident of June 3, 1969, gas at 200 times the normal pressure would have flowed into the houses, schools, churches, and business establishments of the 7,500 customers, with possible catastrophic results. However, since the safety regulator was present but did not function as would have been desired, the accident did occur, but to a less severe degree.

Regulator Inspection Practices

Because the monitoring (safety) regulator sits idle for long periods of time, it is important that it be inspected and its performance be thoroughly checked to insure that it will operate. This need was described by ISU's own requirement that regulators were to be checked and examined semiannually. The last recorded inspection check on the working regulators was done more than 2 years before the accident, and there is no evidence

that the monitoring regulator received any test or maintenance. The timesheets for maintenance work are only indirect evidence that some inspection work was performed on the regulators. The test method used by ISU to check monitoring regulators of this type simulated a failure of the working regulator by applying pressure from a hand pump to the monitoring line. The pressure at which the monitoring regulator starts to close is measured and noted. This pressure was actually 1/2 p.s.i.g., a pressure twice as high as the normal appliance pressure, but still within a range that would probably not cause fires. In operation, however, the monitoring regulator does not close completely at the set pressure; instead, the regulator closes gradually as the downstream pressure further increases. The maximum pressure permitted in the system is the pressure at which the regulator closes completely.

Since ISU's maintenance procedures were not recorded, there is no way of determining whether ISU's maintenance procedures were followed. The maintenance provisions of B31.8 Code are nonspecific as to the frequency of maintenance or what records are to be kept.

Monitoring Regulator Operating Characteristics and ISU's Standards

Overpressuring of the magnitude produced in this case could be accounted for by the monitoring regulator's becoming stuck because the stem packing was too tight, or if the valve seats had been scored or covered with foreign material so that a tight shutoff was not possible. Also, the monitoring regulator could simply not have been adjusted to control the pressure at a level which would prevent flaring of flames at appliances. Since the Utility did not report any malfunction, but readjusted the monitoring regulator after the accident to a much lower pressure, we may infer that the monitoring regulator had not been adjusted correctly to a pressure which would prevent flaring at appliances. As already mentioned, ISU's test method would not evaluate the maximum pressure produced in the actual system, but only the set pressure.

In addition, the operating characteristics of the monitoring regulator were such that it could not be adjusted to comply with ISU's standards, which indicated that the outlet pressure of the monitoring regulator, upon failure of the primary regulator, be controlled at a point 2 inches water column above normal operating pressure of 7 1/2 inches water column (1/4 p.s.i.g.). The monitoring regulator was adjusted so that when the primary regulator failed, the monitor started to close at about 1/2 p.s.i.g. and was not completely shut off until the outlet pressure was 1 to 1 1/4 p.s.i.g. After the accident, the monitoring regulator was adjusted so that it would start to close if the pressure reached about 8 inches water column, and would completely shut off if the pressure in the low-pressure system reached 15 inches water column. Based on the wide range between the pressure at which the monitoring regulator would commence closing and the pressure at which it would be completely shut off, it could not be adjusted to comply

with ISU's standards. Because of this range, the standard was probably ignored when the monitoring regulator was adjusted. In the same sense, it might be stated that the monitoring regulator, as installed, was not properly designed to comply with ISU's standards.

Even though a monitoring regulator is required by ISU to control the outlet pressure at a level 2 inches water column above the normal operating pressure for a low-pressure system, there is no indication in the standards that 2 inches water column above the norm is considered to be the limit of the safe operating pressure of a low-pressure system.

Industry Standards For Maximum Operating Pressure

The section of the B31.8 Code (845.8) which speaks to the checking of safety devices, such as the one at regulator station R-5, has been cited. The equipment is to operate to prevent any pressure in excess of the established maximum allowable operating pressure of the system should any one of the associated regulators malfunction or remain in the wide-open position. Section 845.43 of the same code defines the allowable operating pressure for low-pressure distribution as "shall not exceed" a pressure of 2 p.s.i.g., or a pressure which would cause unsafe operation of properly adjusted low-pressure gas burning equipment. The code thus does not specify a safe pressure, but, in the 2-p.s.i.g. statement, allows a pressure 8 times the 1/4 p.s.i.g. norm. The pressure during the accident was reported to be 1 to 1 1/4 p.s.i.g., which is well within the 2-p.s.i.g. limit but proved to be higher than a pressure which would cause unsafe operation. Thus a question arises with reference to B31.8 Code as to just what pressure was considered to cause the unsafe operation of customers' appliances. Before a gas system operator can maintain pressure-limiting equipment to function at the correct pressure, that pressure must be specified. The code does not so specify the pressure. Thus the code is vague and does not control safe operation in this respect. Requirements for maximum operating pressure for low-pressure distribution systems issued by OPS for the minimum Federal safety standards are also vague in this respect. Furthermore, the interim Federal Safety Standards would not have provided guidance in adjusting the regulator.

IV. 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.)

V. 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.

A chart showing the relationship of the various events and causal factors in this accident is provided in Appendix I.

VI. 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.

APPENDIX II

Iowa State Highway Commission -- Brief Review of the Scope of Work on the Burlington Freeway and Events Leading to the Gas Regulator Incident

The section of the #534 freeway designated as the Burlington Freeway extends from present U.S. #34 (approximately ½ mile east of Ia. #406) easterly through West Burlington and Burlington to the MacArthur Bridge at the Mississippi River.

This 5.3 mile section includes 6 interchanges, 3 grade separations and 14 bridges. The mainline roadway is 4 lane divided section with a variable width median.

Sverdrup & Parcel and Associates, Inc., Consulting Engineers, St. Louis, Mo. were retained on March 12, 1968 to complete the engineering work on the Burlington Freeway as outlined in the signed agreement of this date.

The firms principal Civil Engineer and Project Engineer are respectively, Mr. F. H. Piepmeir and Mr. Wayne Evenson. The ISHC's Design Project Engineer on this project is Mr. Donald D. Jordison.

The first construction contract was let on October 14, 1969 and awarded jointly to contractors Jack Schroder and Raid Quarries, Inc. This project, was a grading and drainage project in a depressed expressway cross-section extending from Wells St. to Third St. between High and Arch Streets.

The following is a tabular listing of meetings and correspondence on this project up to the time of the gas regulator incident on November 10, 1969.

1. April 23, 1969 - Field Exam.

2. May 1, 1969 - Sent 4 copies of field exam. plans to the City of Burlington. (3 sets of these plans were for the Utility Companies.)

3. June 3, 1969 - Project Utility meeting held in Burlington. See attached meeting notes as recorded in the design project log.

Iowa Southern Utilities, Gas Div., indicated at this meeting that the gas line along 4th St. would be relocated east on Arch St. to 3rd St., thence south of 3rd St. to High St., and thence west on High St. to the pressure regulator station near 4th St. We suggested that I.S.U. submit an application for pipe crossing at 3rd St. to the Maintenance Dept.

4. July 7, 1969 - Above application dated June 10, 1969 forwarded to Design from Maintenance.

   Enclosed was a drawing from I.S.U. showing proposed location of 6" pipe along 3rd St. and approx. location of an existing gas regulator installation in the N.E. corner of the intersection of 4th and High. A copy of this drawing was forwarded to the consultant.

5. August 8, 1969 - Received letter from consultant requesting additional information on the location of existing regulator installation and proposed 6" gas main.

6. August 11, 1969 (approx.) - Phoned I.S.U. Co. in Burlington for the above needed information. Received return call from F.A. Luttengger, I.S.U. on August 12, 1969.

7. August 13, 1969 - Received letter from I.S.U. Co. with drawing which tied down location of regulator installation and proposed gas main.

8. August 18, 1969 - Sent the Gas Co.'s drawing to the Consultant so that these items could be correctly shown on the final plans.

9. August 29, 1969 - Consultant submitted final grading plans to the Design Department. These plans were checked by the Project Engineer and forwarded for printing.

   The gas regulator installation and new 6" gas main were clearly shown on the final construction plans.

10. October 29, 1969 - A pre-construction conference on the first grading project was held in Burlington with City Officials, Utility Company Representatives and the Contractor. The District Office conducted this meeting. The Design Dept. was not represented.

11. October 30, 1969 - Project Utility meeting held in Burlington on the area from the C.B.&Q. tracks west of Roosevelt, east to Wells St. Also, the area between Wells St. and 3rd St. was again reviewed. See attached meeting notes as recorded in the design project log.

12. November 10, 1969 - Arnold Jenison (Urban Design Engineer) and A. M. Hensing (Construction Engineer) flew to Burlington to review the damage to the gas regulator located in the north-east corner of the intersection of High St. and 4th St. See attached report on this accident as written by A. M. Hensing on November 10, 1969.

Prepared by Donald D. Jordison
Iowa State Highway Commission Staff
December 23, 1969

APPENDIX III

Summary of Certain State Laws and Safety Practices Designed to Prevent Damage to Underground Gas Facilities

Laws

New York:

New York State law (Article 20 - General Business Law) requires notice in writing, to the gas utility from a contractor, 72 hours in advance of starting work, but is concerned only with work performed on public streets or highways and exempts State, county, city, town, or village employees engaged in maintenance work from notifying the utility.

Georgia:

The law recently enacted in Georgia (Georgia Laws 1969, page 50, as amended by Act No. 937, approved March 10, 1970) is much broader in scope. 6/ It basically requires each distribution gas utility to file with the county clerk maps showing the general route of any gas pipes or other underground facilities within the county. It also requires each gas utility to supply the name and address of the agent to whom written notices can be delivered. The maps are required to be kept up to date.

Prior to commencing blasting or excavating on any tract or parcel of land in any county in Georgia, a person must: (a) examine the maps referred to above to determine if gas facilities might be within 200 feet of the proposed work area; (b) if gas facilities are within prescribed limits, the person shall deliver personally or by certified or registered mail, return receipt requested, a written notice to the gas utility outlining the nature and location of the construction work and when it will commence, the date of such notice shall be within 5 to 10 days prior to the start of work; (c) have received from the gas utility a written statement that gas facilities are not in the construction area or that the gas facilities have been staked or otherwise marked.

The gas utilities are required to reply to the person planning construction work, in writing in a form similar to the notice received, advising that no facilities exist in the construction area, or, if they do exist, that the location has been marked or staked out.

It is noted that violation of the New York law by a person planning blasting or excavation is considered a misdemeanor, while the Georgia act considered both the contractor and the gas utility guilty of a misdemeanor for violation of the provision of its act.

6/ The law was passed mainly because of an accident at a Hapeville, Georgia, nursery on May 28, 1968, which killed seven children and two adults.

Massachusetts:

Massachusetts law (Section 40 of Chapter 82 of the General Laws as amended by Chapter 403 of the Acts of 1968) requires a person planning to make an excavation in a public way to make written notification to the natural gas pipeline company and other utility companies operating in the city in which the work will take place, at least 48 hours in advance of beginning work, not including Saturdays, Sundays, and legal holidays. The law requires the utilities to inform the person planning the excavation, by return notice, of the location, if any, of its facilities. An important difference in this law is that it requires the person applying for a permit to excavate in a public way to file copies of the notification it gave to the utilities with the authority having the jurisdication over the public way before a permit to excavate may be issued. Violation of this law is punishable by a fine of not more than $50 for the first offense and not less than $50 nor more than $100, for any subsequent offense.

The three laws, while having the same purpose, which is the notification of gas utilities of proposed underground construction, have different features. One law covers excavation on private as well as public property, while the other two are concerned only with public property. The feature requiring proof that the utility companies have been notified before a permit is issued is an excellent idea, and is probably the most effective method of assuring that gas utilities are notified of proposed excavation. The weakest feature of the three laws discussed is the relatively ineffective penalty aspect of each. It is not unreasonable to assume that the laws will be complied with because of the penalty provisions. If that is the intent, then the penalty provisions should be substantially strengthened, thereby serving as a force which will be considered by a person thinking of ignoring or not complying with such laws.

Safety Practices

As an example of what can be done to help achieve the objectives of such a law, the Massachusetts Department of Public Utilities (DPU) has a vigorous followup program. Each gas company submits, on a monthly basis, reports of damage to their facilities to the DPU. The chief engineer of the DPU directs gas company personnel responsible for marking the underground gas line and the contractor's operator causing the damage, plus such other persons either company wishes to bring with them, to appear at a conference with him to discuss the accident. At these meetings, all pertinent items are reviewed and responsiblity for the damage determined. The DPU has a working agreement with the State agency licensing the operators of heavy equipment and users of explosives to revoke their licenses or to take whatever action they deem appropriate. The DPU reports that it has very few cases where persons involved in these conferences cause additional damage. The loss of time and other inconveniences due to the conferences serve as a greater deterrent than fines that might be assessed.

The State of Washington, while it does not have laws requiring notification, does recognize the seriousness of contractor damage and has taken steps to control the problem. The Washington Utilities and Transportation Commission's Rule No. 19, Gas Safety, states that:

> "A definite program shall be adopted by every gas company for obtaining prompt notice and full information concerning the commencement and progress of all construction work in areas in close proximity to pipelines, mains or other gas facilities."

In addition, the Commission advised, by letter, all general contractors and utilities in the state to pay closer attention to this problem and to make certain their programs were operating efficiently and effectively at all times. 7/

The Washington Commission has indicated that a material decrease in the number of contractor damage accidents had taken place during the first half of 1969 and was hopeful that the trend would continue.

The above discussion has highlighted a number of State laws and regulations to point out what is being done to control this problem.

7/ Letter dated January 27, 1969, from Washington Utilities and Transportation Commission to each member of the Association of General Contractors of America, Inc., State of Washington.

t
p
H
problems encountered by each utility. The type of approach a gas utility might take also depends a great deal on local and State regulations and the cooperation of the local government authorities.

Before a gas utility can take action to prevent damage to its underground facilities, it must be informed of planned excavation activities in the proximity of these facilities. The degree of effectiveness of any preventative action taken by a utility depends upon the percentage of the excavation work of which it is informed. Notification of proposed excavation work, and prompt and accurate marking of underground facilities for only half of the excavation jobs actually taking place in a utilities service area, can offer only a chance of preventing 50 percent of potential accidents.

Just because a law requires that a person planning to excavate shall notify the gas utility, there is no reason to believe that he will do so. This is true for a number of reasons. First of all, persons planning to excavate are not always aware of the requirements of the law. Secondly, some choose not to comply, mainly because of the sometimes difficult, annoying, and time-consuming procedures involved in making the notification. This can be appreciated when it is understood that notification must be given, not only to the gas utility, but also to all other utility companies, such as electric, water, telephone, and sewer. Thirdly, the person planning to excavate may not be fully aware of the extent of the catastrophe he might cause if he damaged underground gas installations. Lastly, the relatively weak penalties for violating the laws, and lack of enforcement on the part of State and local authorities, encourage law violations.

Effective programs to prevent construction damage to underground gas distribution facilities are in operation and generally include four specific segments. These include: (1) educating contractors and their machine operators; (2) establishing a system for receiving and processing notices concerning planned construction work; (3) setting up procedures to mark promptly the location of the underground gas facilities before a contractor commences work; and (4) the followup and investigation of accidents which do occur to determine where the program has failed and how it can be strengthened.

The first step in any damage prevention program is the notification of the gas utility by the contractor. The gas utility must encourage the prospective excavator to call or write to inform the utility of its plans. Even though laws require this in some States, a utility should make the contractors working in its service area aware of the dangers involved, the program which the company has set up to receive notification, and that it will promptly mark out its facilities and assist the contractors in any other way so that damage can be avoided. The educational phase of the program could include advertisements in trade journals, at builders' and contractors' conventions, information breakfasts or luncheons, direct contact at contractors' offices or on the job, and information letters to all contractors working in the area prior to and during the construction season. In all contacts with the contractors, and in its advertising, a utility should stress the importance of notification of proposed construction and how such notification can be made. A slogan such as "Call Before You Dig" might be used, with the telephone number to call noted on posters or on ballpoint pens given out to those involved in the construction work.

The second phase of the program is the receipt and processing of the

would be necessary before the permit could be issued. Since permits are issued only for construction work in public streets, the problem of notification of proposed excavation on private property is not covered by this plan. In Portland, Oregon, a program is conducted by the gas utility in conjunction with the local electric and telephone utilities that are contacted by the permit clerk for information regarding their underground facilities. This program was discussed at the 1968 American Gas Association's Distribution Conference held in Houston, Texas, in May, 1968. 8/

In 1969, the City of Rochester received the most construction notifications since the program's inception and had the smallest number of accidents in the past 10 years.

The next step in the prevention program involves the reviewing of maps and records to determine if the contractor's proposed work will endanger underground facilities. The contractor must then be notified in either event. In addition, the gas utility must then have field inspectors mark or stake out the facilities at the construction site. The field inspectors should also discuss any particularly unusual condition with the contractor and his equipment operator, and in some cases, where a critical installation is involved, remain on the scene to assist the contractor during the period of work when the facilities are most vulnerable to damage. It should also be the duty of these inspectors and all utility field personnel to look for unreported construction work in progress as they travel throughout the utilities service area. The job of determining the location of underground installations, informing the contractor, and carrying out the field work must be accomplished promptly, in most cases within 24 to 48 hours, as many of the notifications are not received until just prior to the commencing of the construction work.

The last stage of the program is the followup of the accidents which do occur and the overall evaluation of the program. By reviewing the accidents it can be determined where the system can be strengthened or augmented. This followup usually involves meeting with the contractor involved in the accident.

8/ Howe, Paul., "Portland's Teletype Hotline for Excavation Permits," 1968 Distribution Conference, American Gas Association, Inc., 68-D-55, pp. 183-184.

It is understood that programs of individual utilities will vary, depending on local conditions and problems. However, a program which involves the features discussed above should go a long way in decreasing the number of system failures caused by the damage of underground facilities by construction equipment.

While the above discussion is general in nature, it is basically concerned with the problems encountered by distribution operators. The American Gas Association Pipeline Research Committee sponsored a research project entitled, "Analysis of Causes and Determination of Possible Means

state gas transmission lines rather than gas dist
The report contained conclusions and recommendations. These recommendations will not be discussed in detail in this report because they mainly concern transmission pipelines. However, some of the recommendations are equally important to distribution operations, especially those concerning improved communications to encourage notification and education of the machine operators.

The American Gas Association, Inc., has recently formed a committee to work toward reducing damage to underground facilities. It is called The Task Committee on the Prevention of Substructure Damage. In addition to including representatives of gas utilities on the task committee, it has representatives from the American Right-of-Way Association, American Public Works Association, American Insurance Association, Council of Consulting Engineers and American Telephone and Telegraph. The scope of the task committee is as follows:

> "To develop, present and promote programs for the prevention of substructure damage including intra and inter-industry liaison, cooperation and activities from the local through the national level of operations.
>
> To encourage, endorse and back more effective means of controlling the prevention of damage to substructure facilities for the benefit of the public through greater safety and economy as follows:

9/ Analysis of Causes and Determination of Possible Means for Prevention of External Damage to Pipelines - American Gas Association, Inc., New York, New York, 1968 - No. L30005.

1. Educational programs.
2. Research and development of more accurate locating instruments and equipment
3. Cost evaluation of preventative measures and their relationship to damage expenses.
4. Effect of various phases of construction, including design, planning, letting of contracts, construction and post-construction affecting underground facilities.
5. Studies of legislative codes and practices.
6. Study possible establishment of national awards in various categories for the spheres of operation pertinent to prevention of substructure damage."