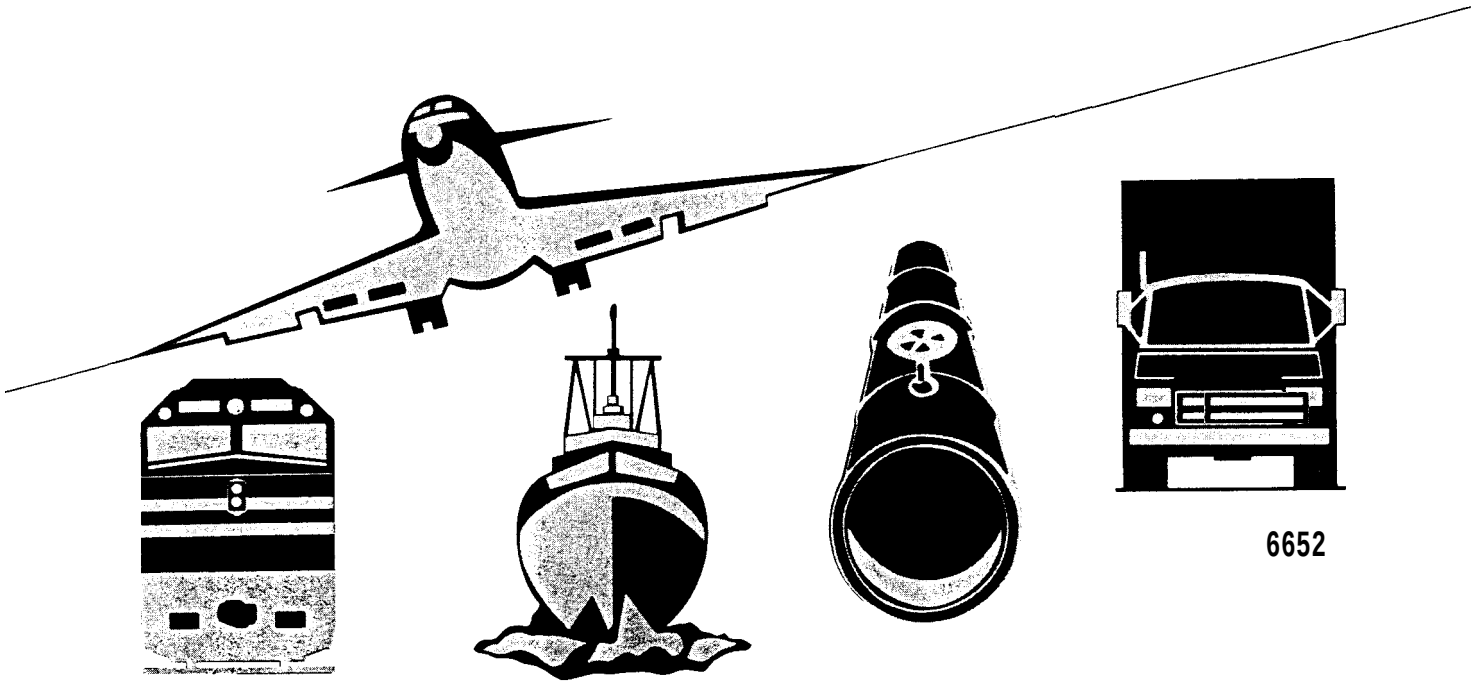
PB96-916501
NTSB/PAR-96/01

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

PIPELINE ACCIDENT REPORT

**UGI UTILITIES, INC., NATURAL GAS DISTRIBUTION
PIPELINE EXPLOSION AND FIRE
ALLENTOWN, PENNSYLVANIA
JUNE 9, 1994**



6652

Abstract: On June 9, 1994, a 2-inch-diameter steel gas service line that had been exposed during excavation separated at a compression coupling about 5 feet from the wall of a retirement home in Allentown, Pennsylvania. The escaping gas flowed underground, passed through openings in the building foundation, migrated to other floors, and exploded. The accident resulted in 1 fatality, 66 injuries, and more than $5 million in property damage.

In its investigation of this accident, the Safety Board identified safety issues relating to pipeline excavation damage prevention and rapid shut down of failed gas service lines.

As a result of its accident investigation, the National Transportation Safety Board issued safety recommendations to the Research and Special Programs Administration, the Sates and the District of Columbia, UGI Utilities, Inc., Environmental Preservation Associates, Inc., the Governor of the Commonwealth of Pennsylvania, the city of Allentown, the International Association of Fire Chiefs, the Department of Housing and Urban Development, the Allentown Housing Authority, the Associated General Contractors, and the National Utility Contractors Association.

UGI UTILITIES, INC., NATURAL GAS DISTRIBUTION PIPELINE EXPLOSION AND FIRE ALLENTOWN, PENNSYLVANIA JUNE 9, 1994

PIPELINE ACCIDENT REPORT

Adopted: February 26, 1996
Notation 6652

NATIONAL TRANSPORTATION SAFETY BOARD

Washington, DC 20594

this page intentionally left blank

CONTENTS

EXECUTIVE SUMMARY

About 6:45 p.m. on June 9, 1994, a 2-inch-diameter steel gas service line that had been exposed during excavation separated at a compression coupling about 5 feet from the north wall of John T. Gross Towers, an eight-story retirement home operated by the Allentown Housing Authority at Allentown, Pennsylvania. The failed UGI Utilities, Inc., service line released natural gas at 55 psig pressure, and the escaping gas flowed underground to Gross Towers. The gas passed through openings in the building foundation, entered the mechanical room through floor vents, and migrated to other building floors.

An Environmental Preservation Associates, Inc., employee, who had been using a backhoe to excavate fuel-contaminated soil from the area, detected the odor of gas and heard a third-floor resident shout that she smelled a strong gas odor. The employee went to a building entrance and encountered a very strong odor of natural gas. He told his foreman, who, after having the backhoe shut down, telephoned the gas company and the housing authority, telling them of the gas odor. The foreman then instructed other employees to locate and shut off the gas line valve.

About 6:58 p.m., the natural gas that had accumulated within the building was ignited, causing an explosion. A second explosion occurred about 5 minutes later. At the time of the explosion, many of the Gross Towers and Towers East residents were out of the building. The accident resulted in 1 fatality, 66 injuries, and more than $5 million in property damage.

The National Transportation Safety Board determines that the probable cause of the natural gas explosion and fire at Gross Towers in Allentown, Pennsylvania, was the failure of the management of Environmental Preservation Associates, Inc., to ensure compliance with OSHA's and its own excavation requirements through project oversight. Contributing to the accident was the failure of the workmen from Environmental Preservation Associates, Inc., to notify UGI Utilities, Inc., that the line had been damaged and was unsupported.

Contributing to the severity of the accident was the absence of an excess flow valve or a similar device, which could have rapidly stopped the flow of gas once the service line was ruptured. Also contributing to the severity of the accident was the absence of a gas detector, which could have alerted the fire department and residents promptly when escaping gas entered the building.

In its investigation of this accident, the Safety Board identified safety issues relating to pipeline excavation damage prevention and rapid shut down of failed gas service lines.

As a result of its accident investigation, the Safety Board issued safety recommendations to the Research and Special Programs Administration, the Sates and the District of Columbia, UGI Utilities, Inc., Environmental Preservation Associates, Inc., the Governor of the Commonwealth of Pennsylvania, the city of Allentown, the International Association of Fire Chiefs, the Department of Housing and Urban Development, the Allentown Housing Authority, the Associated General Contractors, and the National Utility Contractors Association.

INVESTIGATION

The Accident

About 6:45 p.m. on June 9, 1994, a 2-inch-diameter steel gas service line that had been exposed during excavation separated at a compression coupling[1] about 5 feet north of the north wall of the John T. Gross Towers (Gross Towers), an eight-story retirement home. Gross Towers, located at 14th and Allen Streets (1339 Allen Street), is one of several subsidized-rent residence buildings operated by the Allentown Housing Authority (housing authority) in Allentown, Pennsylvania. Towers East, a 13-story building that is connected to Gross Towers, is also a rent-subsidy building for senior citizens that is operated by the housing authority. (See figure 1.)

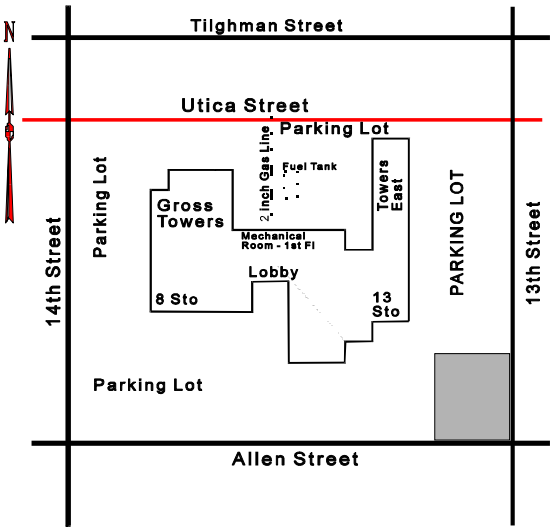


Figure 1. Accident Location

The separated service line, which was owned by UGI Utilities, Inc., (UGI) released natural gas at 55 psig pressure. The escaping gas flowed underground to Gross Towers, where it passed through openings in the building's foundation and filled the space beneath the mechanical room, which served as a combustion air intake reservoir for boilers. (See figure 2.) Gas then entered the mechanical room through openings in the floor. The gas then migrated to the building's other floors through an adjacent tower that housed the boiler exhaust stacks, through a trash chute, and through floor openings for electrical and other building services.

At the same time, a backhoe operator, an employee of the Environmental Preservation Associates, Inc., (EPAI), was removing fuel-contaminated soil from the excavation site and detected the odor of gas coming from the building. He heard a woman in a third-floor apartment shout to him about a heavy gas odor. The loader, another EPAI employee, opened a

[1]A compression coupling joins lengths of pipe by applying mechanical pressure through a gasket to the end surfaces of pipe lengths sufficient to retain the pipe lengths against movement for a specific internal gas pressure and to seal the joint against gas leakage. If the forces on the pipe are expected to be greater than the retaining capability of the coupling, the pipes are to be anchored or otherwise prevented from moving out of the coupling.

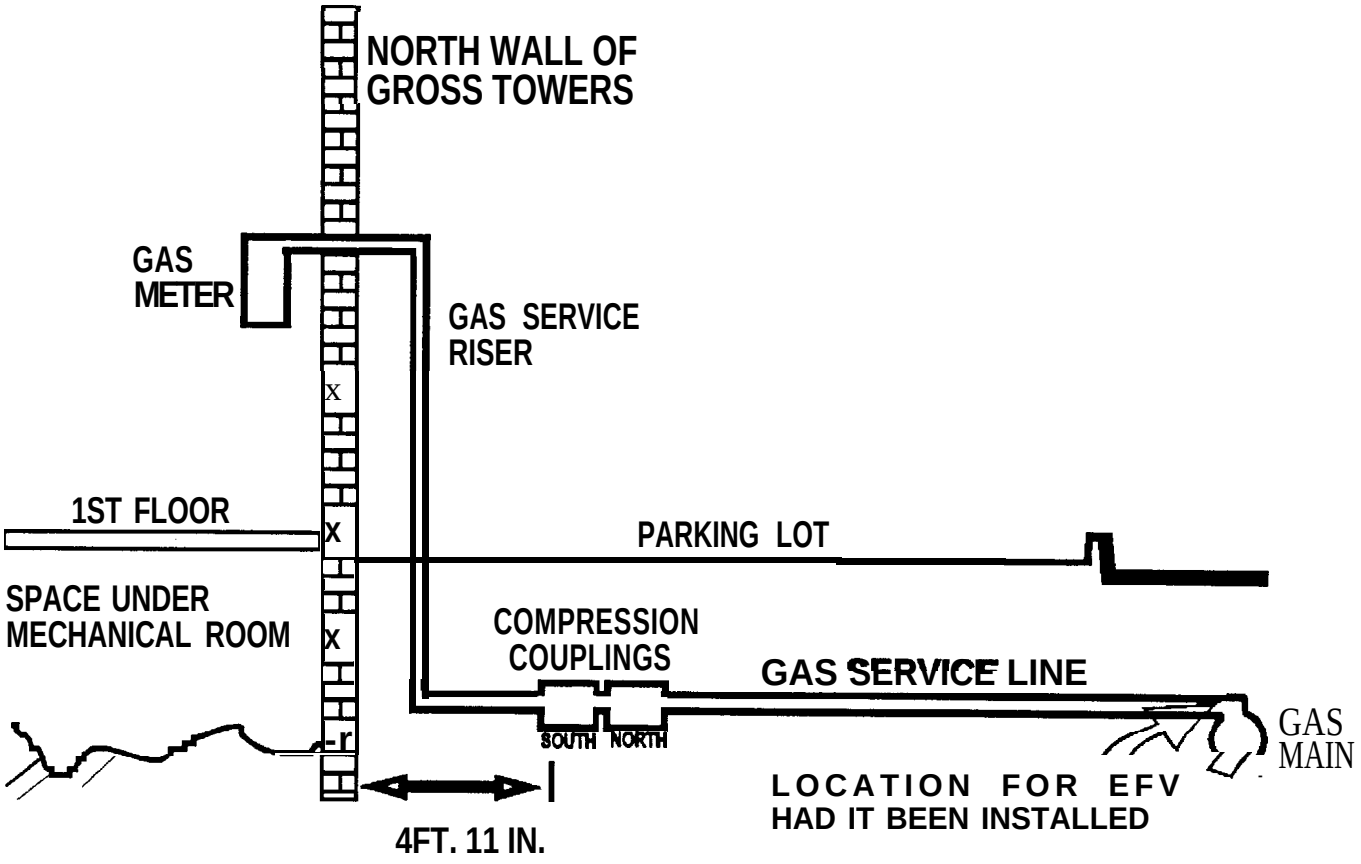


Figure 2. Schematic of Gas Service Line

side door to the building that led to the boiler room and encountered a very heavy gas odor that "took my breath away." He told his foreman of his observation, and the foreman told the backhoe operator to shut off the machine.

The foreman said that he then went to his pickup truck and, using his cellular phone,[2] called the gas company and the housing authority, telling them that he was excavating near the gas line and smelled gas. He stated that he next made three attempts to phone "911." He said that each time he called, there was no answer. He said he then moved his truck to another spot in the parking lot in case the phone signal to his cellular phone was being blocked. He said that at the new location he again tried unsuccessfully to call "911."

According to the UGI's records, the foreman's call was answered at 6:48 p.m. by UGI's Central Gas Control at Reading, Pennsylvania. According to the UGI's records, the foreman said that there was a gas leak at 1337 (Allen Street) Gross Towers in Allentown and that the gas line had been hit during digging. (The foreman acknowledged telling the UGI that he was digging near the gas line and had detected the odor of gas, but said that he did not tell the UGI that he had "hit" the gas line.) At 6:52, the UGI received a second call, which was apparently from the foreman. The call was recorded as "Cust [customer] just called back, said they definitely hit gas line and broke it." The UGI's procedures did not require Gas Control to notify the Allentown fire department or any other emergency-response agency of either report about the release of gas because the caller did not indicate there was an imminent threat; consequently the fire department was not called.

According to the housing authority's records, the foreman called the housing authority at 6:55 and was connected to the after-hours answering service. The answering service's records show that the foreman advised that "they [the EPAI] were digging and they think they got the gas line." At 7:06, according to the answering service, the foreman's message was relayed to one of the housing authority's maintenance employees, who promptly went to Gross Towers.

The records of both the UGI and the housing authority of the foreman's calls do not show that he said anything about detecting a strong odor of gas within the building.

While he was making the calls, the foreman said, he instructed the operator and the loader to trace the gas line back toward Utica Street until they found the shutoff valve. They found the valve near the north edge of the parking lot, but were unable to close it. They lacked the necessary tools to operate the below-ground valve. (Later, when the fire department representatives arrived, the EPAI workmen did not tell them they had been unable to close the valve.)

[2]Details of the calls to and from the foreman's telephone appear later in the report.

About 6:50, the UGI telephoned its on-call serviceman for the Lehigh Division, which includes the Allentown area, who was at his residence about seven blocks from Gross Towers. At 6:55, he left for Gross Towers.

The foreman's calls to Gas Control were relayed electronically to the Lehigh Division Office, which is staffed by two employees. When the office received the report, an alarm sounded to tell the office employees that the message was urgent. One of the employees radioed a construction and maintenance crew that was working about 7 to 8 miles north of Gross Towers. He directed the crew to respond to the emergency.

About 6:58, the natural gas within the building was ignited by one of several possible sources common in apartment buildings, such as the electrical arcs that are created when an electrical appliance or a piece of equipment is turned on or off. The EPAI employees stated that after the initial explosion, a second one occurred about 5 minutes later. After the second explosion, they observed fire within the building. The loader said that he thought the explosion and fire originated in the area of the boiler room.

Figure 3. Back of Gross Towers after Accident

At the time of the explosion, many of the residents of Gross Towers and Towers East were out of the building, either attending a nearby Bingo game, walking around the adjacent shopping center, or sitting on the front lawn at the entrance of the building, which was on the south side.

Postaccident Events

A UGI employee at 12th and Gordon Streets, about 2 1/2 blocks from Gross Towers, was in his truck completing work reports when he heard an explosion and saw a cloud of dust rising into the air. Although he was not on call to respond to emergencies, he began driving in the direction of the dust cloud and radioed his dispatcher to find out whether he had received a report on the explosion. The dispatcher replied that a gas release had been reported and that a serviceman was en route. The employee arrived at Gross Towers about 7:03. About a minute

later, the UGI on-duty serviceman arrived. The two men met with the fire department's emergency onscene coordinator and received his approval to shut off the gas line.

The UGI employees made their way through the debris to the rear of Gross Towers, where a natural gas-fed fire burned from the back of the mechanical room. They located the shutoff valve, near Utica Street, and, about 7:15, closed it. As a precaution, they also closed the service-line valves at two gas meters just north of Gross Towers and then helped the emergency-response personnel. The fire in the mechanical room, which had spread through building utility chutes up to the fourth floor, died out from lack of fuel.

Postaccident surveys of 115 residents show that three Towers East occupants, in units 108, 408, and 902, had smelled gas immediately before the explosion and that two other occupants had smelled gas shortly before the explosion while they were in the mail room on the first floor. The occupant of unit 108 stated that he had reported the gas odor to "911," but after the explosion.

Community Response

Police--At 6:58,[3] a policeman working an extra job at a store at 14th and Allen Streets heard a loud explosion and radioed that information to the city's Communication Center. He then ran to Gross Towers and, to avoid the flames, entered the building through the windows to the right of the front entrance. As he entered, several bystanders apparently followed him in and helped escort survivors out. Within minutes, a second, smaller explosion occurred within the building. The officer told the people who were helping him to put any injured residents on the front lawn as close as possible to the corner of 14th and Allen Streets and to take uninjured residents to the corner of Madison and Allen Streets, an empty parking lot.

Other police officers arrived from areas within a mile of Gross Towers. They helped transport handicapped and elderly people from the stairways and, after putting on self-contained breathing apparatus, did a room-by-room search for victims and survivors. When the officer who had been the first to arrive decided that enough people were working to efficiently evacuate the building, he began to triage the injured. As more officers arrived to help remove victims from the building, he stayed outside to direct arriving emergency medical-service units. A total of 50 police officers, 8 members of the police reserves, and 12 fire police officers responded to the incident.

Fire--When the Communication Center alerted the fire department, at 6:59, it dispatched three engine companies, one aerial unit, and one command car. When they arrived, the emergency onscene coordinator (coordinator), an assistant fire chief, learned that occupants were trapped by heavy smoke on the seventh floor and that several residents were trapped in an

[3]His call was the first to reach the Communication Center. The Center received its second call 45 seconds later. It came from a customer at a nearby restaurant.

elevator. After UGI personnel shut off the valve, emergency-response personnel searched each floor to ensure that all residents had been evacuated.

The fire department used the city's mass casualty incident plan, and the coordinator used the fire department's incident command system. The command post was established on the front lawn of Gross Towers at 7:03; and at 7:04, the emergency-response staging area and emergency shelter were established at the Allentown Fairgrounds, about 1/2 mile southwest of Gross Towers, where approximately 200 residents and 150 family members were helped. At 7:21, a MedEvac helicopter was requested to transport burn victims. Buses were requested at 7:40 to transport victims to the shelter at the fairgrounds, and by 7:49, the preliminary search of Gross Towers for victims was complete. The last injured resident was transported to a local hospital at 8:45.

Throughout the emergency, local agencies worked with each other to provide food and shelter for the displaced residents. The agencies included the housing authority; the Allentown police, emergency medical-services, and public-works departments; the Lehigh Valley County Emergency Management Administration; the American Red Cross; the Pennsylvania Power and Light Company; and the UGI.

Medical--The Communication Center notified Allentown's emergency medical services at 6:59, and it dispatched two Allentown and three Cetronia emergency medical-services units. The first medical unit arrived at Gross Towers at 7:03. The total time for triage was 1 1/2 hours.

A total of 15 emergency medical-services agencies dispatched 35 vehicles, including one MedEvac helicopter. The injured people were transported to seven area acute-care hospitals.

Housing Authority--The housing authority's answering service called the EPAI foreman at 7:03, telling him that the housing authority had been notified of his 6:55 report. The housing authority’s executive director arrived at Gross Towers about 7:25. He directed the identification and relocation of the more than 300 residents and the site security operations. Additionally, 30 to 40 other housing authority employees were notified and went to Gross Towers to help.

Preaccident Events

The housing authority decided to eliminate potential future fuel-leak problems by removing a buried tank at Gross Towers and two more that were no longer needed at other locations. The authority receives approximately $3 million in grant funds for stock modernization each year from the U.S. Department of Housing and Urban Development (HUD), and the authority used a portion of the money to pay for removing the tanks.

The housing authority solicited contract proposals from three engineers who it believed capable of the work. The authority selected the least-cost proposal. The owner and principal of the selected engineering firm (consultant) was a mechanical engineer registered as a professional engineer in Pennsylvania. He had had some experience in removing buried tanks and was aware of, but not thoroughly knowledgeable about, the excavation safety requirements of the Occupational Safety and Health Administration (OSHA), a part of the U.S. Department of Labor that establishes safety standards to protect workers. The consultant did not seek advice or support from an engineer qualified in structures and soils engineering.

The consultant prepared plans, dated November 17, 1993, for removing the tanks. The plans consisted of a drawing showing the layout of the three sites and a work specification document applicable to all three. The drawing showed the approximate location of the buried fuel tanks but did not show the locations of other buried facilities even though it was known that Gross Towers had a buried natural gas line. The plan and specifications included among other provisions, the following ones:

- The pavement in areas to be excavated was to be saw cut before the tanks were removed.

- All work was to be performed in accordance with the latest requirements of the Pennsylvania Department of Environmental Resources and the U.S. Environmental Protection Agency.

- Bidders were to examine the specifications, drawings, and the construction sites. In signing the contract, the successful bidder was to be considered as having made a reasonable attempt to ascertain the nature and location of the work and to learn of the general and local conditions that could affect the work and its costs. In signing the contract he was also to be considered as having acknowledged that he was as knowledgeable of the character, quality, and quantity of surface and subsurface materials or obstacles to be encountered as was reasonable after inspecting the site. He was to notify the housing authority promptly, before conditions were disturbed, of subsurface or latent physical conditions at the site that differed materially from those indicated.

- The consultant was to be allowed to visit the work site, inspect it, and issue written reports to the housing authority on observed deficiencies.

- The contractor was to ensure that no laborer or mechanic was required to work in surroundings or under conditions that were hazardous or dangerous to his/her safety as determined under OSHA safety and health standards. The contractor was to protect the lives, health, and safety of other people, to prevent damage to property, materials, supplies, and equipment, and to comply with regulations and standards of 29 *CFR* 1926.

- The contractor was to protect from damage all existing improvements and utilities at or near the work site.

- The contractor was to employ a competent supervisor who would be responsible for all the construction practices and workmanship of all people employed by the contractor or subcontractor so that the contractor, rather than the consultant, would be obligated to exercise responsible control over the construction practices and workmanship.

- Side slopes of excavations were to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shoring and bracing, which was to be supplied by the successful bidder, would be required where sloping was not possible. Excavation sides were to be maintained in safe condition until completion of backfilling.

The consultant stated in the specifications that he would review the on-site work in process to identify deficient conditions or instances of noncompliance with the contract's requirements. His contract with the housing authority called for him to attend the preconstruction meeting with the successful bidder and to conduct periodic job conferences to ensure that the work was performed in accordance with the contract.

In February 1994, using the consultant's plan and specifications, the housing authority advertised for bids to remove each of the buried fuel tanks and to replace one tank. The fuel tank at Gross Towers was an 8,000-gallon one buried beneath the north parking lot and used to store heating fuel. The housing authority's executive director served as the contracting officer on construction procurement, and its construction coordinator had project oversight responsibility to ensure that the work was completed. The executive director had worked for the housing authority for 33 years, of which he had spent 4 in his present position. He had had no construction experience. The construction coordinator had worked for the housing authority for 15 years and had been involved with construction before being employed by the housing authority.

The EPAI won the contract to remove the tank at Gross Towers. According to the minutes of the meeting that was held when the contract was signed, such matters as compliance with the U.S. Department of Labor standards regarding payrolls were discussed. OSHA job safety requirements were not discussed, and the consultant did not attend.

On May 18, the EPAI obtained a permit from Allentown to remove the tank at Gross Towers. The permit issued by the building department, which is staffed to perform building-construction inspections, did not require on-site inspection by a building inspector because no building construction was involved. Also, the Building Officials and Code Administrator's (BOCA's) building code adopted by the city did not require or recommend on-site inspections of excavation work. However, the permit was forwarded to the fire department for action

because the city requires on-site safety inspections of work that includes the handling of flammable liquids.

At 1:26 p.m., on May 19, an EPAI employee told the Pennsylvania one-call notification center[4] that it planned to begin excavating at Gross Towers at 8:00 a.m. on May 23. He said the purpose was to remove an underground storage tank in the rear parking lot of the housing authority, and he noted that the proposed excavation would be 12 feet deep. The notice center disseminated the information to its member facility operators. The EPAI did not identify the approximate location of the proposed excavation with white paint, as is now done in some States, nor was it required to do so.

On May 23, the housing authority issued the EPAI a Notice to Proceed. The notice stated that the EPAI was to "carefully [note] and fulfill the requirements of the general conditions relative to the submittal and approval of Workmen's Compensation and Manufacturers' and Contractors' Public Liability Insurance." No mention was made of OSHA safety standards. The housing director and the consulting engineer recognized that the site drawings did not include information on the locations of buried facilities and that they were depending on the contractor identifying the locations by notifying the excavation-damage notification system so that the facility owners would mark the locations before excavation was begun. Even though there were provisions for the consultant to oversee the work project, he did not.

When they received the EPAI's excavation notice, the UGI's Lehigh Division[5] employees checked the UGI's records for the address the EPAI had given for Gross Towers and concluded that the address should have been given as 1339 Allen Street. At 2:25 p.m. on May 19, a UGI employee telephoned the EPAI, using the telephone number the EPAI had given the one-call center, and left a recorded message that the UGI had a gas service line to Gross Towers. At 8:21 a.m. on May 20, a UGI employee marked the location of the service line on the asphalt paving with yellow spray paint. He did not talk with any EPAI employees about the gas line's location as none were at Gross Towers while he was there.

On May 23, the EPAI moved its equipment to the Gross Towers north parking lot. It removed the asphalt paving in the area to be excavated and began removing the soil above the tank. The foreman evaluated the soil being excavated as OSHA Type A, which is cohesive soil with an unconfined compressive strength of 1.5 tons per square foot. (OSHA's postaccident evaluation indicated that a visual evaluation of the soil should have shown that it was OSHA Type C, which is a cohesive soil with an unconfined compressive strength of 0.5 ton or less per square foot.)

[4]A one-call notification center is one part of an overall excavation-damage prevention program that is used by excavators for communicating with buried-facility operators about planned excavations to allow the facility operators to mark the locations of their facilities in the area of planned excavation.

[5]UGI's Lehigh Division is responsible for the gas system and its operations in Allentown, Bethlehem, Easton, and adjacent areas.

While an Allentown fire inspector was inspecting the EPAI's work, he saw the excavation's west sidewall slide into the excavation, exposing the gas line, which was about 3 to 4 feet[6] west of the tank. The collapsed sidewall removed the soil support from about 30 feet of the gas line, causing it to sag. (See figure 4.)

Figure 4. Gas Service Line after Explosion

The fire inspector said that he questioned the EPAI foreman about the need to secure the gas line. He said that the foreman told him that the condition presented no problem because the gas line was an all welded system. (The foreman later stated that based on his experience, he believed all gas systems were welded.) The foreman said that his crew had used a backhoe to excavate the soil above the fuel tank, but that all excavating next to the gas line had been done with hand tools. He stated that he and his loader-helper watched all the mechanized excavation done near the gas line and observed that the line was never touched by a machine. After the soil above the tank was removed, the EPAI employees made the interior of the tank inert by injecting it with nitrogen. They then sealed the tank fill and vent lines.

The fire inspector, the EPAI crewmembers, and an EPAI management representative saw a piece of asphalt paving fall about 4 feet and strike the gas pipe. The piece was large (3 by 5 feet and 3 to 4 inches thick), and the pipe was not supported. The fire inspector said that the paving permanently deflected the pipe by about a foot. He stated that before the paving hit it, the pipe was sagging, but still fairly straight.

The fire inspector was relieved by a second fire inspector because of a shift change. The second inspector viewed the unsupported gas line and also commented to the foreman about the need to safeguard it. The inspector said that he suggested to the EPAI employees that

[6]In a July 12, 1994, deposition, the EPAI foreman estimated that the tank and the gas service line were within 1 1/2 feet of each other.

the pipe be supported or braced and that the EPAI foreman and another EPAI employee went into the excavation and attempted to brace the sagging pipe by putting three or four saw horses under it. The inspector said that he did not consider the support effective because the soil beneath the saw horses was not firm. However, he did not take any further action.

Neither the EPAI employees nor the fire inspectors notified the UGI that the service line was unsupported and damaged. Later on May 23, the EPAI crew placed a cable sling around the tank and attached it to a chain that was attached to the backhoe. When the crew tried to lift the tank, the chain broke. Those who witnessed the event, including the second fire inspector, stated that they did not believe the tank struck the gas line.

The tank was successfully removed from the excavation, and samples of soil were taken adjacent to the tank's concrete support, which remained in the excavation. The soil was to be tested to determine whether fuel had leaked from the tank and contaminated the surrounding soil. The EPAI foreman stated that before he and the other crewmembers left the site, they tried to support the pipe with saw horses, surrounded the excavation with orange plastic barrier fencing, put plastic sheeting over the excavation slopes, including the soil that lay beneath the pipe, and removed the equipment from the site. They left the excavation open to await the result of the tests. Housing authority employees who frequently passed the excavation between May 23 and June 9 stated they observed that the exposed pipe was not supported.

Fifteen days later, on June 9, after the EPAI received the test results, which showed that the soil around and beneath the concrete tank support had been contaminated, EPAI employees returned to remove the concrete support and contaminated soil. At 8:00 a.m., the EPAI foreman arrived. He stated that the area looked unchanged from the way it had been left and that nothing appeared unusual. According to a housing authority employee, the foreman mentioned to him that the pipe needed to be shored up. The backhoe (a track-mounted excavator) arrived about 12:30 p.m., and a hydraulic hammer was installed on the backhoe bucket to break up and remove the tank's concrete support. The foreman stated that he and his crewmembers removed the saw horses from beneath the pipe as the first step in removing the concrete support. He said they did not notice any movement of the pipe and did not smell any gas. The equipment operator, not the same person who had excavated the tank in May, used the backhoe to break up and remove the concrete and to excavate the fuel-contaminated soil.

It took about 6 hours for the hydraulic hammer to break the concrete up. According to the EPAI employees, the impact of the hammer caused the ground to vibrate significantly. The backhoe bucket was used to remove the broken concrete and to load the pieces into a dump truck. The path of the backhoe bucket crossed over the pipe. The backhoe operator said that about 6:40 p.m. he moved the backhoe from a spot south of the excavation to one on the west. In moving it, he crossed a buried section of pipeline that was between the excavation and the north wall of Gross Towers. The odor of gas was first detected about 6:45 p.m.

Injuries

The following table summarizes the injuries.[7]

Injuries	Pipeline	Contractor	Residents	Responders	Bystanders	Total
FATAL	0	0	1	0	0	1
SERIOUS	0	0	2	0	3	5
MINOR	0	0	54	5	1	60
TOTAL	0	0	57	5	4	66

Medical and Pathological

The Allentown emergency medical services transported 88 survivors to seven local hospitals, where they were examined and, if necessary, treated. The last patient was transported at 10:45 p.m.

The fatality was a 73-year-old occupant of the third floor. He died from the cranial cerebral injuries he received when he was struck by a door propelled by the force of the explosion.

Pipeline Damage

The plastic coating of the suspended pipe segment, predominately on the top half, had numerous gouges and cuts. The damage appeared to be recent, as corrosion was not evident on the exposed metal. The configuration and orientation of the damage were typical of the kind made by such mechanized excavation equipment as a backhoe. (See *Postaccident Tests and Inspections*.)

The service pipe segment to the meter in the equipment room was separated below ground from the south end of the south coupling (electrically insulated-type) that was near the wall of the building. (See figure 5.)

[7] 49 *CFR* 830.2 defines *fatal injury* as: "Any injury which results in death within 30 days of the accident" and *serious injury* as: An injury which: (1) Requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; (2) Results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, muscle, or tendon damage; (4) involves any internal organ; or (5) involves second or third degree burns, or any burn affecting more than 5 percent of the body surface."

Postaccident Site Inspection

On the day after the accident, the pipe was surveyed to determine its location and alignment. According to the survey, the pipe sagged a maximum of 1.6 feet and was moved horizontally to the west a maximum of 1.2 feet.

The soil next to and west of the service line was excavated by machine to pipe depth and then excavated horizontally by hand tools until the pipe's location was revealed. Next, the soil around the pipe was removed by hand. When fully exposed, two compression couplings were found in the service line about 5 feet north of the building wall. The service riser assembly pipe was separated about 2 5/8 inches from the south end of the south coupling. While there was no other separation, the pipe in the north end of the south coupling had been pulled out about 1/4-inch, and the pipe in the south end of the north coupling had been pulled

Figure 5. Service Line Separation from the Compression Coupling

out about 1/8-inch. (See figure 5.) The end of the service riser pipe that had separated was misaligned with the coupling by 13/16-inch to the east and 5/8-inch upward. The initial insert depth of the pulled-out pipe end was 2 5/16 inches. Using the measured distance of 1/4-inch between the outside edge of the compression nut and the outer edge of the compression ring, the movement of the service line pipe was calculated to be 4 15/16 inches to the north.

Other Damage

Gross Towers was severely damaged. Its walls, both exterior and interior, and its windows were damaged, and the first floor concrete slab over the crawl space was pushed

upward. The majority of the damage was in the north portion of the building, with the worst damage occurring on the first and seventh floors. The apartments next to the tower that housed the trash chute and boiler stacks were heavily damaged by overpressure, and the cinder block wall enclosing the tower was blown outward, fragmenting the adjacent exterior walls. The exhaust ducting on at least two boilers was pushed outward. Towers East sustained minor damage, primarily broken windows. According to the insurance carrier for the housing authority, the damage was $4.3 million. The explosion also caused moderate damage to other area buildings, including a sports bar, automobile dealership, and tire dealership. Total damages exceeded $5 million.

Personnel

The EPAI employees involved with the work at Gross Towers had each had a physical examination earlier in the year, and none had been found to have any physical problems. According to their statements, none were taking any prescribed medications. A review of their activities for the 48 hours before the accident revealed nothing that should have affected their work on the day of the accident.

The employees working on the day of the accident had worked together on excavation projects for the past 3 to 4 years. The EPAI's records showed that none of them had received training in the applicable EPAI health and safety requirements.

The foreman had had about 7 years of construction-work experience and had been with the EPAI full time since April 1990. He had begun work with the EPAI as a laborer and had progressed to his present position. Since being employed by the EPAI, his training had included 40 hours about hazardous materials, for which he was granted a certificate in 1989, and 8 hours hazardous-materials refresher training in 1993, as required by OSHA (29 *CFR* 1910.120). He held a State certificate authorizing him to remove buried fuel tanks and a certificate from the University of Maryland for a 16-hour hazardous-materials and on-scene incident commander course, and he was a volunteer firefighter specializing in hazardous materials. The training records showed no training in OSHA's requirements. He said that he did not recall receiving instructions from the EPAI on how to support gas lines in an excavation, but he did remember receiving instructions on how to support other utilities, such as sanitary sewers. He said that as a result of his work experience, he was familiar with the stability of soils.

The loader/driver had worked for the EPAI for 5 years. He held a valid Pennsylvania State commercial driver's license, issued in 1993, a State inspection license, and a State emissions inspection license. During his time with the EPAI, his training had included 40 hours about hazardous materials, for which he was granted a certificate, and 8 hours hazardous-materials refresher training, as required by OSHA.

The heavy-equipment, or backhoe, operator working June 9 had worked for the EPAI during the past 5 years, of which 2 had been full time. He had a total of 32 years experience in construction, and he had worked as a backhoe operator for the 2 years before the accident. He had no formal training in excavation or working in trenches. He had learned to operate heavy construction equipment, including backhoes, through on-the-job training. He had about 200 to 300 hours of experience in operating the type of backhoe used on the day of the accident and stated that he was "very comfortable" operating such equipment. He had been trained in mine safety about 10 years before the accident.

Pipeline System Information

System Ownership--The UGI, a wholly-owned subsidiary of UGI Corporation, provides natural gas through its gas distribution systems to about 258,000 customers in 14 eastern and southeastern Pennsylvania counties, including the cities of Allentown, Bethlehem, Easton, Harrisburg, Hazleton, Lancaster, Lebanon, and Reading. It operates both high- and low-pressure distribution systems, offering gas service to residential, commercial, and industrial customers. Since 1975, the UGI has installed excess flow valves (EFVs)[8] on more than 61,000 gas services. The UGI Corporation also provides electric power service near Wilkes-Barre, Pennsylvania, and is one of the nation's largest retail suppliers of liquefied petroleum gas.

Length: 133 feet
Diameter: 2 inches
Thickness: 0.154 inch
Material: Steel
Coating: Plastic (X-Tru-Coat)
Impressed Cathodic Protection
Tie-in: welded to 4 inch coated steel main in Utica St.
Meter in Boiler Room
Max. Op. Pres: 60 psig

Gas Service Line Specifications

Gas Service Line History--Gas service was provided to Gross Towers on July 7, 1966. The gas service line began at its connection to a 4-inch-diameter steel gas main beneath Utica Street and ran about 135 feet south, to the north wall of Gross Towers. (See figure 2.) There it left the ground and ran through the building wall into the mechanical room. For the most part, the line was under an asphalt parking lot. The line was laid about 3 feet beneath the surface on fine soil and was sloped upward from Utica Street about 6 percent. It was covered first with fine soil and then with fill dirt. The surface above the pipe trench was crushed stone overlaid with asphalt pavement. The line was designed to provide 15,000 to 20,000 cubic feet of natural gas an hour for boiler fuel.

A note on the UGI's original service record stated that the line was "Tied in Solid," meaning that the pipe lengths were welded. However, to comply with 1971 Federal requirements on protecting steel pipelines against corrosion, the UGI began installing corrosion-protection systems on segments of its pipeline systems that had been installed before the requirements were adopted. The UGI's records show that on September 27, 1973, an

[8]An EFV automatically stops the flow of gas into the customer's service line when his maximum gas use rate is exceeded by a predetermined percentage.

electrically insulating compression coupling[9] was installed in the service line. Although there is no documentation of the instructions given the crewmembers about the work, records and physical evidence show that they installed an insulating compression coupling in the service line north of the wall next to the boiler room. That coupling was installed just inches south of a noninsulating compression coupling for which there are no records and which was apparently installed at the same time as the insulating coupling to obtain adequate space to install the insulating coupling. Neither compression coupling was anchored or otherwise protected against movement relative to the service pipe, nor were there any requirements for doing so.

An EFV was not installed in the gas service line, nor were any other modifications made after 1973.

Applicable UGI Operations

EFVs--The UGI's *Manual of Standard Procedures* requires the installation of EFVs on new and renewed services that operate at a pressure of more than 20 psig at all times and have a maximum gas flow through the customer meter of 425 cubic feet per hour or less. To ensure a minimum of 10 psig pressure at each gas service line equipped with an EFV when the system is operating at maximum flows, the UGI established its 20-psig pressure minimum to provide system capacity so it could add customers and meet their service requirements without affecting the activation of the EFVs.

Of the approximate 152,000 gas services the UGI considers suitable, about 61,000 have EFVs. The UGI added the EFVs when the services lines were being installed or renewed. Eighty-two percent of its EFVs are installed on residential service lines and 18 percent on service lines to stores and other commercial buildings. During 1993, the UGI reported that 28 of its EFVs activated. The company attributed 23 activations to the proper operation of the valves (9 activated when service lines were ruptured, and 14 activated when company activities caused conditions similar to a line rupture). The company attributed five to unintended activation (the UGI believes three were activated because distillates in gas swelled an O-ring and could not determine the reason for the other two activations).

For several years, the UGI has been proactive about using EFVs to enhance customer safety. Since 1993, it has used EFVs on services with more than one meter and on farm taps, if approved by the area distribution engineer. It has also extended the use of EFVs to other types of residential services and to some commercial services. The UGI stated that while it does not have a specific program for using EFVs on services to high-occupancy or public-assembly buildings, during the past 2 years it has begun allowing the use of EFVs on commercial services without limitations as to the type of user. It stated that if current and/or future load

[9]An electrically insulating compression coupling prevents the flow of electrical current between the pipe lengths that are joined. These types of couplings are installed to separate corrosion-protection systems and to isolate protected pipe lengths from unprotected lengths.

conditions are not an issue, it considers installing an EFV, subject to the above listed operating parameters. Its policy on EFVs does not include informing customers about the safety benefits of using EFVs, nor does it include giving customers the chance to have EFVs installed at their own expense.

As is the case with all pipeline operators, it is the UGI's decision whether to use EFVs since using them is not required. Also, to achieve maximum effectiveness, an EFV must be installed in the pipe owned by the gas operator. The UGI stated that the housing authority had not asked the UGI about using or installing EFVs or about using gas detector equipment for alerting building residents.

Excavation-Damage Prevention Plan--The UGI uses customer-bill inserts, media ads, and discussions at meetings with contractors to make the public aware of the danger of damaging pipelines during excavation. The information the UGI provides informs the public and excavators about the importance of notifying the Pennsylvania One Call System (a one-call center) before excavating. Also it informs excavators of the precautionary measures they should take both before and during excavations to maintain the integrity of the pipelines.

Type of customer load (boiler or process, surging or level)
Potential for additional gas demand
Customer's fuel line pressure requirements
Length and size of required service lateral
Current system pressure at customer's location
Impact of planned and projected load growth on system pressure in the customer's vicinity
Variance between network analysis balance run pressure versus actual pressure in the customer's vicinity
Potential for liquids or dirt in the gas system at the customer's location.

What UGI Considers in Deciding Whether to Install an EFV

Because the UGI is a member of the Pennsylvania One Call System, a contractor can notify it by making a single toll-free call to tell all member facility operators of his intent to excavate anywhere in Pennsylvania. When the UGI receives an excavation notification, its employees check its maps and other records to determine whether any of its pipelines are in the area of planned excavation and whether they could be damaged by the excavation. The UGI tells the excavator either that it has no facilities in the area of the planned excavation or of the action the UGI will take in response to the notice.

UGI procedures call for marking the locations of its lines and area shutoff valves in the area of the planned excavation. The UGI uses high-visibility yellow paint in paved areas and yellow stakes or flags that have *GAS* printed on them in unpaved areas. The UGI encourages its employees who mark the locations to warn the excavator, whenever possible, that the marks show only the approximate location of the lines and that the excavator must verify the actual location by hand digging.

If the UGI determines that an excavation project is likely to damage a UGI gas main, or if damage could cause a major unplanned shutdown of 50 or more customers, UGI's procedures call for the area engineers or the area construction and/or maintenance superintendents to consider developing an emergency plan for shutting down the potentially affected main in an orderly way.

Although not included in its procedures, the UGI expects its personnel to consider several factors in determining whether to develop a written emergency plan for an excavation project, including:

Scope and nature of the project;
Contractor's proposed mode of operation;
Type of distribution system in the project area;
Location and material of facilities within the project area;
Number of potential conflicts between UGI facilities and contractor activities;
Type of area (city, suburban, rural); and
Density of customers located within the project area.

The UGI also expects the on-site representatives of the excavator and the UGI area personnel to decide together how often UGI employees need to inspect the site. In making the decision, UGI employees are supposed to consider the following factors: how long it will take to do the excavation, how close the excavation is to UGI facilities, the size and extent of the excavation, the type of excavation activities that will be necessary, and the UGI's previous experience with the excavator.

Provides for locating all gas mains, service lines, main-line valves, and service-line valves in the area of excavation.

Requires inspections to ensure that all valves can be operated.

Identifies the number of customers in each main section that may be shut down due to an emergency.

Identifies how the UGI will monitor the excavation project on a scheduled basis until all work in the area of its pipelines is finished.

Components of UGI's Excavation Emergency Plan

When UGI employees see contractors operating in ways that are inconsistent with UGI requirements about supporting gas facilities, that violate Department of Environmental Resources blasting requirements (15 *CFR* 211), or that are negligent regarding due care of gas facilities, the UGI's locator or inspector is to notify the contractor's job superintendent. If the situation is not corrected, the UGI's area human-resources specialist meets with the contractor's job superintendent or project engineer to discuss the seriousness of the situation and to remind the contractor of his responsibility for protecting the UGI's facilities. The meeting and its results are to be confirmed by letter, with copies being sent to the operating head of the contracting company, the contractor's insurance carrier, the person or municipality authorizing the excavation, the UGI's area human-resources superintendent, and, if appropriate, to the UGI's local attorney. If the situation is still not corrected, the UGI declares that the situation constitutes an emergency and applies to the courts for a temporary restraining order that will force the excavator to suspend the project.

In 1994, the UGI was asked more than 55,000 times (about 15,000 times in the Lehigh Division) to locate its facilities in areas of planned excavations. This was a 20 percent increase over the requests for 1993. Of that total, the UGI physically marked facilities at 47,786 locations (14,043 in the Lehigh Division) and assessed the other requests as not involving gas lines. In 1994, the UGI's facilities were damaged 199 times (93 in the Lehigh Division). Of the 199 times, 87 of them (32 in the Lehigh Division), or 44 percent (35 percent in the Lehigh Division), were caused by excavators who had not notified the UGI that they were planing an excavation.

Emergency Plan--The UGI's emergency plan establishes, as required by 49 *CFR* 192.615, operating guidelines applicable to various emergency situations.

The types of emergencies addressed by the procedures include gas leaks, fires, gas explosions, overpressure of distribution systems, loss of distribution system pressure, natural disasters, civil disorders, and national emergencies. The area superintendent of construction and maintenance and/or the area superintendent of customer service is in charge of directing all emergency field operations. The manager of distribution operations takes charge of operations upon his arrival, if he deems it necessary. Other UGI areas help should the magnitude of a situation exceed an area's resources.

Provisions for responding to various emergencies;

Emergency operations;

Education of employees, customers, the public, and officials;

Provisions for maintaining personal contact with public officials of local government and their fire and police departments; and

Training of employees in emergency procedures.

Subjects Addressed in UGI's Emergency Plan

According to the UGI's procedures, the first UGI employee on scene is to act immediately to protect property, the public, and the welfare of the people involved in the emergency. If the report is one of escaping gas, as it was on June 9, when the UGI first learned of the emergency, the on-scene employees are to take precautionary measures: ventilate enclosed areas that contain gas, shut off automatic furnaces and appliances, warn occupants to avoid using open flames and electrical switches, urge occupants to evacuate the building, shut down gas lines, and find the source of the gas. If the report is one of fire or explosion, as it was on June 9 just before the first UGI employee arrived on the scene, the first on-scene employee is to assess the situation, radio his assessment to the UGI dispatcher, check for the presence of gas in all buildings in the immediate area, take appropriate action to protect people and property, and monitor all buildings in the immediate area for gas until the source of the released gas is located and blocked. The procedures also describe the preparedness and response assignments for each position held by a UGI employee who might be involved in the emergency response.

Employee Training for Emergencies--The UGI's emergency plan requires each employee who is responsible for responding to emergencies to participate in annual simulation board exercises. Each exercise is prepared by the UGI's distribution engineering personnel and

includes scenarios about a system shutdown or loss of a major gas supply line, a shutdown or loss of a district regulator station, or a major line break within the distribution network. The scenario may be based on previous incidents or on incidents described in Safety Board reports. Each exercise must include a step-by-step analysis of the procedures for investigating, pinpointing, and repairing leaks and of the procedures for taking emergency actions and protecting people and property.

Each employee who is responsible for responding to emergencies is also required to attend at least two presentations a year of preprogrammed emergency training selected by his superintendent.

Every 5 years, the UGI's employees in its customer-service, engineering, and corrosion-control divisions are trained in fighting fires. The UGI's employees in its construction-and-maintenance, gas-supply, plant, and liquefied-natural-gas divisions are trained every 2 years.

Emergency Preparedness

According to the Allentown Emergency Operations Plan, its purpose is to train emergency-response personnel, minimize fatalities and injuries, enhance coordination between all responding units, and ensure that everyone involved knows enough about preparedness to avoid any confusion at an emergency site. The mayor, the emergency management director, and the emergency management coordinator approved the plan in August 1992.

The fire department employees had trained with the UGI a month before the accident. The UGI briefed them on numerous types of responses to natural-gas emergencies and on using gas shutoff keys to close service-line valves. Also, all fire and police department personnel had had first-responder training, and all Allentown Emergency Medical Services personnel had had mass casualty incident management training. During the year before the accident, Allentown had conducted four emergency exercises, and the UGI had given wrenches to the fire department employees that allowed them to operate the smaller buried service-line valves, which are typically used on residential service lines. The UGI had also trained the fire department employees in using the valves correctly.

When the fire department responds to a report of a gas odor or leak, its first priority is to notify the UGI through its communication center. The department also has procedures for preventing accidental ignition, evacuating buildings, locating the source of escaping gas using combustible-gas indicators, ventilating buildings of accumulated gas, shutting off service lines at the meter or at the curb valve if possible, and communicating with the UGI representative as soon as one is on scene.

Housing Authority

Operations--The housing authority houses about 800 residents in the Allentown area. Gross Towers was constructed during 1965 and 1966 as rental housing for seniors and as headquarters for the housing authority. Gross Towers and Towers East were connected by a lobby. Gross Towers had 8 stories, 147 apartments, and 163 residents. Towers East had 13 stories, 129 apartments, and 147 residents. Both buildings were constructed to comply with the then current BOCA codes adopted by Allentown. Since 1992, the housing authority has been working to modernize all of its buildings so that the buildings' fire water sprinklers and fire communication systems comply with the 1993 BOCA code.

The energy for heat and hot water used in Gross Towers came from equipment in the mechanical room on the first floor. The equipment included two conventional gas-fed boilers, which were not operating at the time of the explosion, and a fast recovery boiler, which supplied hot water during periods of low use. It was operating at the time of the accident.

Several openings between floors were not protected against the upward flow of gases. A separate tower, which was next to the gas-fired boilers and housed a trash chute and the boiler exhaust stacks, connected every floor. The floors were also connected to each other and the mechanical room by chase openings for electrical cables and other facilities. The openings were uninterrupted, or nonfire-stopped. Gases could also enter the mechanical room from the outside air and from the soil through a combustion-air system that consisted of a 3-foot-high airspace beneath the mechanical room that was connected to subsurface trenches that ran to outside ground-level vents located along the building's north wall.

Emergency Preparedness--The explosion happened during nonworking hours, when no housing-authority personnel were on duty. An answering service received the emergency calls. The service could page on-call maintenance personnel or other housing-authority employees.

The executive director stated that the housing authority had procedures for evacuating the occupants and that the residents practiced the routines. For example, every 6 months the fire department conducted fire inspections and drills that also tested the evacuation procedures and emphasized how important it was for the residents to respond promptly. The drills included special precautions for the elderly and handicapped; and after a drill was held, all residents participated in a critique. Placards were posted on the windows and doors of apartments that had handicapped occupants and of rooms in which occupants were using pressurized oxygen.

Gross Towers, like all other housing complexes operated by the housing authority, had an internal fire alarm system that had alarm bells on each floor. When the system was activated, the company that monitored it promptly called the Allentown Communications Center.

Gross Towers had a gas-powered emergency generator that started automatically whenever the flow of electricity to the building was interrupted. As long as the building's gas supply was uninterrupted, the generator provided emergency lighting in the stairwells and exit lights. During this emergency, however, the generator did not operate because the gas supply had been interrupted when the service line separated.

EPAI Procedures

Drug and Alcohol Policy--The EPAI employees who worked at the accident site were not tested after the accident for drugs or alcohol; Federal regulations did not require such testing. The EPAI's policy was to test potential employees for drugs and alcohol and to test employees at random intervals and after an event suggesting reasonable cause. (*Reasonable cause* is a visual observation that an employee might be under the influence of drugs or alcohol.) The EPAI now forbids an employee to possess, use, sell, or trade illegal drugs or alcohol during working hours. Also, he cannot report to work while he is under the influence of illegal drugs or alcohol. The EPAI states that this policy is in accordance with the Drug-Free Workplace Act of 1988 and the U.S. Department of Transportation's (DOT's) regulations at 49 *CFR* Part 40. After discussions with Safety Board investigators, the EPAI now has a better understanding of the merits of postaccident toxicological testing and is developing a policy to test its workers postaccident/mishap to determine drug or alcohol involvement. Though policy specificity is lacking at this time, the Safety Board encourages the EPAI's efforts in this area.

Health and Safety Program--In May 1993, the EPAI issued its Health and Safety Program "to protect the health and safety of all employees while on the job." The project management starts with the job superintendent and rises upward through the project manager to the vice president of operations and then to the president. Each project is to have a health, safety, and compliance director. He alone is responsible for approving work plans and health and safety plans for all projects and for conducting periodic audits and reviews that ensure the health and safety of all employees. He may halt operations if there is any threat to the health of employees or to the environment. Each project must have a work plan that describes in detail all aspects of the job and the measures that are necessary to ensure the safety and health of all employees on the job. The Health and Safety program states that every effort will be made to anticipate and prevent emergency situations in all projects and that a responsible plan will enable personnel to effectively handle any occurrence.

Before excavation begins, utility companies must be notified so that they can mark the position of any hidden pipelines or cables.

Excavations deeper than 5 feet into which employees must enter will be sloped, shored up, or contained to protect the employees from collapsing soil.

Excavation sites will be inspected for proper precautions.

Activity will cease if employee health and safety are endangered.

EPAI's Excavation Requirements

The work plan must address the specific prevention and response procedures to be taken to protect the environment and the health and safety of all people in the area. The site supervisor is responsible for implementing and overseeing emergency-response procedures on the site, and the work plan must fit in with the client's emergency-response plan, as well as with the capabilities and procedures of all local emergency agencies (such as fire and rescue companies).

The work plan must list any specific training and skills necessary for the total completion of the project to ensure that the employees who are assigned to specific tasks are fully qualified to carry them out. Before the start of any project, the EPAI must give a written copy of the emergency-response plan to all employees, contractors, subcontractors, and other officials involved in the project. The plan must specify preemergency planning, personnel roles, lines of authority and communication, emergency-recognition and -prevention procedures, safe distances and places of refuge, site security and control, evacuation routes and procedures, emergency-alert and -response procedures, critique or response and follow-up, and personal protective equipment and emergency equipment available.

Under the program, the EPAI is to conduct scheduled and unscheduled inspections of each project site to ensure that the project plan is being followed, and the EPAI is to notify any utility that has facilities that interfere with tank removal operations.

The EPAI did not prepare an emergency response plan for the Gross Towers project.

Regulations and Oversight

The statutory requirements for rent-subsidized housing that is to be shared by the elderly are included in 42 U.S.C. 1437. That section charges the Secretary of HUD with issuing “minimum habitability standards for the purpose of assuring decent, safe, and sanitary housing for such families while taking into account the special circumstances of shared housing.”

Title 24 *CFR* Part 882 lists HUD's requirements for shared housing. It specifies that such housing be "decent, safe, and sanitary" and then defines in paragraph 882.109 standards that have to be met before the housing can qualify as decent, safe, and sanitary. This paragraph includes criteria that have to be met for structure and materials, space and security, sanitary facilities, water supplies, lead-based paints, smoke detectors, and numerous other items. Part 882 also establishes HUD's right to periodically inspect project operations to ensure that the project is in full compliance with the HUD requirements.

When HUD accepted these buildings for rent subsidies, it did not require gas detectors and alarms or EFVs for single, multifamily, or high-rise buildings. According to HUD staff members, the agency has not evaluated whether gas detectors with alarms or EFVs enhance the safety of tenants of shared housing.

The Philadelphia office of HUD, which is responsible for periodically inspecting housing authority projects, has consistently found that the housing authority complies with HUD requirements. HUD inspected the housing authority about every 3 years; the last inspection was about 2 years before the accident.

Pennsylvania

Damage-Prevention Statute--Since 1974, Pennsylvania has had an Underground Utility Line Protection Law intended to reduce accidents and promote cooperation among excavators and users of the underground. The law was revised in 1987 and 1991. The effective date of the current law is December 31, 1991, and under Pennsylvania's "sunset" provision, the law will expire on December 31, 1996.

Requirements for Excavators	Requirements for Buried Facility Operators
Notify the one-call center not less than 3 nor more than 10 working days before excavating (any use of powered equipment or explosives in the movement of earth, rock, or other mineral). Exercise due care and take all reasonable steps necessary to avoid injury to or otherwise interfere with all lines where positions have been provided to the contractor by the users. Use prudent techniques for determining the precise location of buried facilities, such as hand digging to expose buried lines. Report immediately to the user any break or leak on its lines, or any dent, gouge, groove, or other damage to such lines or to their coating or cathodic protection, made or discovered in the course of the excavation or demolition work. Immediately alert the occupants of premises about any emergency that such person may create or discover at or near such premises.	File notice in each county by voting wards in which it has facilities. Respond within 2 days to each excavation notice, either by marking with approved colors the locations of its facilities or by notifying the caller that it has no facilities in the area of proposed excavation. Respond to designer notifications either orally or by mail within 10 working days of the notice. Be a member of the one-call notice center.

Selected Provisions of Pennsylvania's Underground Utility Line Protection Law

The law includes requirements for buried facility operators and any excavator (any person except the Pennsylvania DOT or people engaged in agricultural or resource extraction) who excavates for himself or for others.

The law specifies several monetary and criminal penalties. The penalties can be imposed only by the Pennsylvania Attorney General, the local district attorney, or a person successfully petitioning those offices. In the case of the Gross Towers accident, neither the UGI, the local District Attorney, nor the Attorney General has initiated an enforcement action.

Pipeline Safety Oversight.--The Pennsylvania Public Utilities Commission (PUC) certifies to the U.S. DOT that its authority and requirements for intrastate natural gas pipelines classified as public utilities are essentially the same as the DOT's. (*Public utilities* does not include municipal gas operations or liquefied petroleum gas systems.) The PUC has the primary responsibility for the safety of the intrastate pipelines over which it has jurisdiction. Those intrastate natural gas pipeline systems in Pennsylvania that are not subject to the PUC's jurisdiction are subject to the DOT's.

Operators, including the UGI, are required to meet the excavation-damage prevention requirements at 49 *CFR* 192.614.

On November 29, 1994, after it had investigated the UGI's operations, the PUC said that the UGI's damage-prevention program violated several Federal pipeline safety requirements. The PUC noted, for example, that the UGI did not inspect the service line during the course of the excavation, even though the notification had advised that the excavation was to be about 12 feet deep and even though the UGI's service line was near the area of the proposed excavation. The PUC also noted that except for the initial marking of the service line location, the UGI had had no communication about the excavation with either the EPAI or the housing authority. The PUC contended that had the UGI contacted either the EPAI or the housing authority, it might have found out that its service line had been uncovered and thus would have known that it had to take additional action.

Operators must carry out a written program that complies with the Federal regulations to prevent damage to its pipeline by excavation activities. *Excavation activities* include excavation, blasting, boring, tunneling, backfilling, the removal of aboveground structures by either explosive or mechanical means, and other earth moving operations. Any of the duties required may be performed through participation in a public service program, such as a "one-call" system, but such participation does not relieve UGI of the responsibility for compliance with those requirements.

According to subparagraph (b), the damage prevention program must, at a minimum:

(1) Include the identity, on a current basis, of persons who normally engage in excavation activities in the area in which the pipeline is located.

(2) Provide for notification of the public in the vicinity of the pipeline and actual notification of the persons identified in (1) above of the following as often as needed to make them aware of the damage prevention program:

(i) The program's existence and purpose; and
(ii) How to learn the location of underground pipelines before excavation activities are begun.

(3) Provide a means of receiving and recording notification of planned excavation activities.

(4) If an operator has buried pipelines in the area of excavation activity, provide for actual notification of persons who give notice of their intent to excavate of the type of temporary marking to be provided and how to identify the markings.

(5) Provide for temporary marking of buried pipelines in the area of excavation activity before, as far as practical, the activity begins.

(6) Provide as follows for inspection of pipelines that an operator has reason to believe could be damaged by excavation activities:

(i) The inspection must be done as frequently as necessary during and after the activities to verify the integrity of the pipeline; and
(ii) In the case of blasting, any inspection must include leakage surveys.

Selected Excavation-Damage Prevention Provisions of 49 *CFR* 192.614

On December 28, 1994, the UGI responded to the PUC, acknowledging that its damage-prevention plan did not comply fully with paragraph 192.614 (b)(1) and (b)(2) and that the plan was being revised. The UGI stated that its practices and procedures complied with paragraph 192.614(b)(6)(i), but agreed that enhanced communications would improve the

program's effectiveness. The UGI stated that it was exploring with the one-call system the possibility of informing all excavators that they should notify the one-call center should they expose buried facilities.

On April 3, 1995, the PUC told the UGI it disagreed about the UGI's procedures and practices meeting the requirements of paragraph 192.614 (b)(6)(i). The PUC noted that the UGI's practices failed to identify the excavation at Gross Towers as being hazardous to the service line despite the information the EPAI provided in its excavation notification. The PUC stated that the UGI should have recognized that the 12-foot-deep excavation would be likely to affect the service line and that the company should have either made follow-up site inspections to verify the integrity of the pipeline or should have asked the EPAI or the housing authority for additional information concerning the precise location of the excavation. The PUC asked the UGI to report the plans it had for eliminating the deficiencies in its procedures.

On May 3, 1995, the UGI told the PUC that it would continue its efforts to promote enhanced communications through the one-call system. The UGI stated that after further evaluation of the PUC's opinion, it had decided to incorporate more prescriptive procedures into appropriate sections of its damage-prevention program. It said that it planned to use the procedures outlined in the Gas Piping Technology Committee's[10] guide material, specifically section 2.8, "Inspecting Pipelines," which provides guidance on complying with paragraph 192.614.

The PUC told the UGI during a May 24, 1995, meeting that it did not consider the May 3 letter responsive because the UGI had not described specific steps it would take to eliminate the deficiencies that the PUC had identified. On June 12, 1995, the UGI asked the PUC to review a letter it proposed to send to the Pennsylvania One Call System. The letter asked the one-call system to maintain an effective, proactive approach towards substructure-damage prevention, including recommending that excavators premark areas of planned excavations.

On October 4, 1995, the PUC told the UGI that its proposal was again not adequate to comply with paragraph 192.614(b)(6)(i) concerning inspections during and after excavation activities that could damage the integrity of the pipeline. The PUC asked the UGI to give it written revisions to the damage-prevention program by October 31, 1995, and to describe how the new plans would be implemented.

On November 1, 1995, the UGI and PUC staffs met to discuss UGI's damage-prevention practices and procedures. This meeting resulted in the UGI filing a November 21, 1995, letter with the PUC stating that although the UGI did not believe its current practices

[10]The Gas Piping Technology Committee (GPTC) is a technical committee that was established in 1970 pursuant to an agreement between the Office of Pipeline Safety and the American Society of Mechanical Engineers (ASME). In 1990, the administrative support for the GPTC was transferred from the ASME to the American Gas Association. The GPTC's main purpose is developing and publishing the *Guide for Gas Transmission and Distribution Piping Systems*, which assists pipeline operators in their efforts to comply with Federal pipeline safety regulations, to comment on proposed rulemakings, and to propose amendments to those Federal rules.

caused the accident on June 9, 1994, it would revise its substructure damage-prevention program to mirror the guidelines in the Gas Piping Technology Committee Guide ANSI 2380.1. (See appendix E.) Additionally, the letter said, the UGI plans to supplement its procedures by including specific examples where follow-up inspections of excavation projects should be considered, including:

> premarked excavations extending through or close to UGI facilities,
> major excavations, such as building foundations, near UGI facilities, and
> deep, lengthy sewer projects near UGI facilities.

The UGI advised that on completion of the new procedures, it would train all appropriate personnel on them.

On January 3, 1996, the PUC advised the UGI that its April 3, 1995, position was unchanged. The PUC said it would assess the UGI's revised damage-prevention program when it received it.

OSHA Requirements

Excavation-Damage Prevention--Title 29 *CFR* 1926, Subpart P, contains several worker safety requirements on excavation activities. In 1990, OSHA developed and issued a booklet, *Excavation*, to assist excavation firms and contractors in protecting workers from excavation hazards. The booklet is based on the requirements of 29 *CFR* 1926 and gives specific advice on preventing cave-ins and providing protective support systems. OSHA employs several methods of providing information to people subject to its regulations; its latest information system uses the Internet via the World Wide Web to provide assistance to excavators and contractors on complying with OSHA requirements. Responses to frequently asked questions, statistical data, news releases, OSHA pamphlets and publications, and a listing of available training materials can be obtained using a personal computer.

Investigation Findings and Enforcement--OSHA determined that the EPAI foreman did not meet OSHA's definition of competence, as stated in 26 *CFR* 1926.650 (b). Among the failures OSHA attributed to the foreman were that he had classified the soil type incorrectly, had improperly supported the gas line, did not recognize the hazard of the gas line, did not know the lifting capacity of the chain used in the failed attempt to lift the fuel tank, did not know the lifting capacity of the backhoe, and did not keep spoil from the excavation from the top edge of the excavation. On September 30, 1994, OSHA issued a Citation and Notification Penalty to the EPAI alleging, among other deficiencies, that:

> 1. EPAI employees had been exposed on May 23, to a fall hazard when they were riding on a backhoe bucket to enter an excavation that was 10 to 12 feet deep.

2. The EPAI had not had a competent person inspect the jobsite, materials, and equipment, frequently and regularly; the EPAI's designated competent person did not take prompt corrective measures on May 23 to eliminate or control hazardous practices.

3. On May 23, the EPAI did not properly protect and support the natural gas pipeline, thus exposing employees to injury and contributing to the Gross Towers accident.

OSHA fined the EPAI $54,300. At an informal conference held on October 13, 1994, EPAI officials advised OSHA that the EPAI had implemented a proactive employee safety and health program agreement, that the EPAI's employees would attend a 1-day conference on removing underground storage tanks, that the EPAI's management would frequently audit jobsites for safety and health compliance, and that supervisory personnel would be held accountable for any violations found. OSHA accepted the EPAI's modifications and reduced its fine by 40 percent.

Paragraph 1926.650 (b) defines *competent person* as one "who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them." (The preamble to the final rule for 26 *CFR* 1926 advises that a "competent person" must have had training in, and be knowledgeable about, soils analysis, the use of protective systems, the use of protective systems, and the requirements of standard 1926

Paragraph 1926.651 (b) requires that the estimated location of utility installations, including gas lines, must be determined before opening an excavation. Consistent with local time constraints, such as those in Pennsylvania Act 38 and before beginning an excavation, excavators are required to contact utility companies/owners, advise them of the proposed work, and ask them to establish the locations of underground installations. When the excavator is approaching the estimated location of a marked buried facility, he is required to determine the exact location by safe and acceptable means. While the excavation is open, underground installations must be protected, supported, or removed as necessary to safeguard employees and people that live or work in the vicinity.

Paragraph 1926.651 (i) requires protection of adjacent structures by support systems such as shoring if the excavation operations endanger them.

Paragraph 1926.651 (k) requires daily inspections of excavations when employee exposure can be reasonably anticipated of the adjacent areas and of protective systems by a competent person for evidence of a situation that could result in cave-ins, failure of protective systems, hazardous atmospheres, or other hazardous conditions. That paragraph requires also that employees be removed from any hazardous condition until proper corrective action has been taken.

Paragraph 1926.652 (a) requires protection of employees from cave-ins when in excavations 5 or more feet in depth. The protective system may be one of several described in the regulation, such as sloping, benching, or shoring.

Selected OSHA Requirements from Title 29 *CFR*

Postaccident Tests and Inspections

Gas Leakage Tests--Two days after the accident, the soil near the gas service line was tested for the presence of natural gas. Holes approximately as deep as the pipe were made in the soil next to the service line at approximate distances of 6, 10, 15, and 20 feet north of the building wall and at one location about 6 feet west of the service line and 10 feet north of the north building wall. Gas concentrations of 2, 18, 40, 40, and 36 percent of the lower explosive limit, respectively, were detected.

At 10:55 p.m. on the day of the accident, workmen separated the service line at the meter in the boiler room and sealed the openings. They also severed the line just downstream of the service-line valve at Utica Street and sealed those openings. On the next day, they injected the closed off segment of the line with compressed air at 120 psig pressure. The pipe could not be pressured higher than 10 psig because the air was escaping from a then undetermined location. While continuing to pump air into the service line, the workmen inspected the vacant space beneath the first floor, and they found that air under pressure was entering the vacant space through the soil. They also found that air under pressure was escaping the soil around the service line meter riser pipe where it exited the ground at the north wall.

The service line segment containing the compression couplings was cut about 1 foot north of the north compression coupling, removed, and preserved for further documentation. The end of the service line from which the compression couplings were removed was sealed. Air under 60 psig pressure was applied to the still-buried service line. After allowing the temperature to become stable, the pipe maintained the 60 psig pressure without variation.

Pipe Inspection--The service line segment suspended over the excavation was removed for inspection and documentation. About 50 feet of the service line, including the suspended section, were removed. Examination revealed that the length of the suspended pipe segment was about 29 feet. Within several of the cuts in the pipe coating, the pipe metal appeared to have been mechanically damaged. There was no definitive pattern of damage from which to determine the precise spacing of the device or the devices that had damaged the coating. However, in two small areas, measurement between damages was 0.3 foot. The majority of the damage on the exposed pipe was found between 12 and 16 feet south of the north edge of the excavation.

Metallurgy--The damaged pipe sections, including the compression couplings, were taken to the Energy Research Center at Lehigh University for laboratory examination. In its September 5, 1995, report, the Center documented 31 gouges in the surface of the pipe; 30 of the gouges were on the top half of the pipe. Fourteen of the 30 gouges were caused by an object traveling perpendicular to the pipe. The force that caused one of the deep gouges was strong enough to induce a localized surface stress that exceeded the yield strength of the pipe metal and, as a result, deformed the surface of the pipe permanently.

Phone Records--Safety Board investigators reviewed the computer records for the telephone used by the EPAI's foreman. The investigators were trying to confirm the calls made or received within 15 minutes of the explosion. Calls were made and received as indicated on the following table.

Approx. Time[11] (p.m.)	**Call In/Out/Complete**	**Call Duration** (secs.)	**Connection Time**[12] (secs.)	**Interval Between Call**s (secs.)	**Phone Location**
6:46:41	Out/Complete	13	25	9	UGI Switchboard
6:47:15	Out/Complete	87	95	5	UGI Emergency No.
6:48:55	Out/Complete	70	82	15	Home, EPAI V. P.
6:50:32	Out/Complete	39	47	173	UGI Emergency No.
6:54:10	Out/Complete	84	121	170	Housing Authority Answering Service.
6:59:01	Out/Incomplete	0	55	2	911/Allentown
7:00:02	Out/Complete	162	175	3	Home, EPAI V.P.
7:03	In/Complete	120	120	40	[13]
7:05:40	Out		540		Residential Phone
7:14	In/Complete	180	180		See footnote 13

[11]While the time interval between listed times is accurate, the cellular phone carrier believes that the clock times may be in error by as much as 30 seconds.

[12]The connect time is the time interval between originating and disconnecting a call.

[13]Incoming calls not traced back to phone location.

ANALYSIS

The issues related directly to the accident are discussed first. Then follow discussions of using EFVs to mitigate the consequences of ruptured gas service lines and of various measures that can and should be taken to help prevent underground pipeline damage.

Exclusions

The Safety Board examined several aspects (fatigue, medical fitness, toxicological testing, and training) of human performance to see whether any of them might have affected the excavation crewmembers enough to have caused or contributed to the accident. Based upon the evidence in the factual section of this report, all areas except training can reasonably be excluded.

The Safety Board concludes that fatigue was not a factor. Each crewmember was found to have had a normal amount of rest, to have conducted normal activities during the 48 to 72 hours before the accident, and to have showed no evidence of circadian rhythm desynchronosis, which means that normal sleeping patterns had not been disrupted. Each had had a physical examination within the past year and had been found fit for duty.

Although the on-scene emergency medical, fire, and police personnel did not report any behavior on the part of the EPAI crewmembers that could be construed as evidence of alcohol or drug use, the Safety Board is unable to positively conclude that drugs or alcohol use was not a factor because the EPAI did not test its employees after the accident.

The Accident

Two things protected the service line pipe from being pulled out of the compression coupling longitudinally: the pressure of the soil around the pipe and the resistance from the coupling gasket. The pipe separated from the coupling when longitudinal pipe forces in the northerly direction became greater than the resistance from the soil and the coupling gasket.

The EPAI's excavation on May 23 and June 9 caused the pipe to move partially out of the coupling and reduced the resistance to movement provided by the soil. (See appendix C, "Time Line of Events.") When the excavation's side wall collapsed, the pipe was no longer supported from beneath, and the weight of the pipe was added to the forces the soil and coupling had to resist if they were to prevent separation. The pipe deformation caused by the asphalt pavement striking the line probably caused the pipe to be pulled out partially from the coupling because of the reduction in the effective length of the pipe. However, because there was no evidence that gas was escaping from the pipe/coupling connection before June 9, it is

apparent that the activities of May 23 did not cause the pipe and coupling to separate completely.

When the excavator resumed on June 9, its activities near the service line probably reduced the amount of restraint provided by the soil even more and increased the longitudinal force enough to cause the pipe to separate fully from the coupling. Using the impact tool to break the concrete tank support and moving the backhoe over the pipeline caused the soil to vibrate and probably further reduced the soil's restriction of pipe movement. Also, the backhoe probably struck the line when being operated across it; the foreman's reports to both the UGI and the housing authority indicated that the pipe had been struck during recent excavation activities. Although the foreman denied after the accident that the backhoe had struck the line, the coating of the pipe showed evidence of mechanical damage, as did the pipe steel at one location. Also, the foreman's calls both to the housing authority and to the UGI show that at the time he believed his crew had hit the gas line while excavating.

The Safety Board concludes that the excavating reduced the ability of the soil and compression coupling to restrain the pipe's movement and exerted excessive longitudinal forces on the service line. Also, the numerous contacts the pipe had with the mechanized equipment stressed the pipe compression coupling joint. These excavation-induced stresses caused the pipe separation, which released natural gas into Gross Towers.

Emergency Response

Allentown and the housing authority recognized the unique challenges presented by having to respond to an emergency involving a densely populated high-rise building inhabited by elderly and handicapped people. The city and the authority worked together closely in developing and testing preparedness plans. The Safety Board attributes the efficient evacuation of the building to the preparedness of the city agencies and the authority. Because the city and the authority had been so careful about preparing the residents, they knew what to do before and during the evacuation. For example, the residents were able to instruct the untrained volunteer responders about how to evacuate people requiring assistance. The emergency responders put the fire out and took care of the displaced residents efficiently. The Safety Board concludes that the emergency response was well coordinated and effective in reducing further injury.

Human Performance and the EPAI Workcrew

General--The EPAI had several opportunities to prevent the separation of the service line. It could have supported (shored up) the excavation's side walls during the excavation, as it was required to do by both its own health and safety program and OSHA. Had the walls been shored up, the one next to the service line would not have collapsed and undermined the line's support. The EPAI would have known that the walls were not shored up had it had a

supervisor overseeing the project, as its own procedures required it to. Even after the wall collapsed, the EPAI still could have prevented the accident by telling the UGI that the service line was no longer supported, thus giving the company a chance to protect the line.

The Safety Board concludes that the EPAI could have avoided the accident by shoring up the excavation, by having effective supervisory oversight, or by reporting the lack of pipe support and the damage to the UGI. The EPAI needs to ensure that the requirements of its health and safety program are followed on all future work projects, including the requirement that damage be reported to the owners of buried facilities.

Once the line and coupling separated, the EPAI could have limited the consequences. When the EPAI foreman was told about the strong odor of gas within the building, he should have immediately called "911." Contrary to his postaccident statement, telephone records show that he did not attempt to call "911" until after the explosion. Had he immediately reported the emergency to the fire department, it would have known almost 15 minutes before the explosion, giving it enough time to respond, notify the UGI, initiate evacuations and building ventilation, and, using the UGI responders**, s**hut off the flow of gas into the building, which would have either prevented the explosion or reduced its force. The Safety Board concludes that the consequences of this accident could have been significantly reduced had the foreman promptly called "911" and had his helper promptly told the occupants of the building to evacuate.

Although it was after normal business hours, the foreman first called the UGI's Lehigh Division business office (the EPAI had not obtained and provided the foreman with the UGI's 24-hour emergency telephone number). Even after contacting the UGI, he did not say, and the UGI did not question, whether the odor of gas had been detected within the building. Had the UGI known that gas was already in the building, it probably would have told him to evacuate the occupants, which he could have done with the help of his crew and the bystanders. The UGI probably also would have notified the fire department, thus giving it more time to respond.

The Safety Board's report[14] on a July 22, 1993, pipeline accident, which cost 2 lives and injured 12 persons, also involved excavation damage and issues similar to the ones in this accident. The report discussed how important it is for excavators to notify local emergency-response agencies promptly. In that accident, the excavator notified the pipeline operator promptly after gas was released, but he did not notify the local response agencies until more than 20 minutes later. Had the fire department been notified earlier, it might have been able to save lives and prevent injuries. As a result of that accident, the Safety Board recommended that the American Public Works Association (APWA):

[14]*Brief of Pipeline Accident: Northern States Power Company Gas Pipeline Accident, July 22, 1993, St. Paul, Minnesota* (DCA-93-MP-011).

Advise your members of the circumstances of the July 22, 1993, explosion in St. Paul, Minnesota, and urge them to develop and implement written procedures and training to prevent excavation-caused pipeline damage. (P-95-24)

Urge your members to call “911” immediately, in addition to calling the gas company, if a natural gas line has been severed. (P-95-25)

On June 2, 1995, the APWA told the Safety Board that it would incorporate the lessons learned from the report on the St. Paul accident in its publication *Public Works Management Practices*, which it was in the process of rewriting. Also, the report and recommendations would be discussed at the September 1995 International Public Works Congress and Exposition. On July 2, 1995, the Safety Board thanked the APWA for its timely and effective response to the recommendations. The Board added that it looked forward to reviewing the APWA’s revised practices. Safety Recommendations P-95-24 and -25 were classified "Open--Acceptable Response."

The Associated General Contractors and the National Utility Contractors Association, two organizations that represent the interests of most contractors, give contractors extensive guidance on excavation issues affecting employee safety. The Safety Board believes these associations should also support the APWA initiative by encouraging their members to notify the owners of damaged buried facilities, to notify local response agencies of emergencies, and to take initial lifesaving actions when a damaged buried facility endangers public safety.

Training--Before the accident, the workcrew had not had any formal training in excavation and trenching or in actions to take as a unit to protect lives and property in an emergency. The lack of training may account for why the crew did not shore the excavation site or tell the UGI that the gas line was unsupported. The crew foreman, despite not having any information about the construction of the gas line, said that he thought the entire line was welded tubular steel. His assumption may have led him to believe that the line could be adequately supported by crossbucks. In any event, he made a critical choice in assuming that it would be safe to leave the gas line uncovered and exposed for 2 weeks. A more prudent course of action would have been to immediately inform the UGI that the line was exposed.

Since the accident, the crew foreman and the heavy equipment (backhoe) operator, as well as other employees, have each received 8 hours of training in trench construction and safety and 24 hours of training in confined-space entry and rescue training from the Maryland Fire and Rescue Institute, a part of the University of Maryland. However, the EPAI has not developed procedures to guide the actions of its workcrews, nor has it given emergency-responder training to those of its employees who excavate. The Safety Board believes that the EPAI and all other contractor excavators should train their employees in notifying local response agencies of emergencies and in what to do to save lives, such as evacuating endangered members of the public, while waiting for the representatives of the response agencies to arrive.

The Safety Board concludes that the excavation crewmembers did not evacuate the residents and the foreman did not call the fire department before the explosion because they had not been trained in handling an emergency.

Preaccident Events--The EPAI had detailed, written procedures based on OSHA's requirements. Had the procedures been followed, the accident would not have happened. The EPAI's procedures, as well as Federal regulations and the provisions of the housing authority's contract with the EPAI, required the EPAI to take specific protective measures, such as protecting the wall from collapsing by shoring it up or sloping it; yet, the EPAI did not take the protective measures. It obviously did not incorporate the procedures in its work project since its workcrew had had no formal training in excavation and trenching safety or in protecting buried facilities within the excavation. Also, the EPAI's management did not inspect the project every day, as it was supposed to. The inspector should have been a "competent person" who could identify and eliminate any hazardous worksite conditions or remove the company's employees if he decided the site was dangerous.

Because the EPAI's management failed to prepare the workcrew properly, the crew foreman did not notify the UGI about the unsupported line, left it unsupported for 2 weeks, and did not protect the line while performing operations that could damage it. The Safety Board believes that only the facility operator can assess the safety of gas lines and other buried facilities once they have been damaged or otherwise disturbed and that he can make the assessment only after investigating thoroughly, including reviewing his construction information. Consequently, the EPAI, as well as other excavators, should instruct its employees to notify the facility operator promptly any time excavating alters the support of a buried facility, deforms its structure, or harms its coating.

UGI Operations and Procedures

General--The UGI also had a chance to prevent the accident. Given the depth stated in the planned-excavation notice, the UGI should have viewed the proposed work as potentially endangering the integrity of the line. It could then have acted to protect the line from damage.

Excavation-Damage Prevention--The UGI's procedures did not require it to review excavations next to service lines as it did excavations next to gas mains. Had the UGI identified the threat the proposed excavation posed to the service line, the UGI would have had ample time to get more information from the EPAI on the precautions the EPAI planned and to instruct the EPAI on the precautions it should take and the need to report any damage promptly. The UGI also would have been able to inspect the excavation and to take whatever actions were necessary to protect the line. The Safety Board concludes that by failing to recognize the potential hazards posed by the EPAI project, the UGI lost the opportunity to preserve the integrity of the service line. The Safety Board believes that the UGI should broaden its procedures to require the assessing of any proposed excavation that could cause damage that might significantly endanger public safety.

Damage Notification--Had the EPAI or the fire inspectors told the UGI about the damage, it would have had an opportunity to take corrective action. Additionally, the information probably would have convinced the UGI that it needed to inspect the project and tell the EPAI foreman about the need to take precautions and use the UGI's emergency telephone number if he had an emergency. However, neither the EPAI workcrew nor the fire inspectors were trained in what damage should be reported to a buried-facility owner. It is apparent that the UGI's efforts to increase the public's awareness of the dangers of damaging its system during excavations has not been effective in encouraging people to report damage to the UGI immediately.

Because city inspectors often see a construction activity on a daily basis and because contractors excavate next to UGI facilities so often, the Safety Board believes the UGI needs to convince the local governments and contractor groups that public safety is endangered when damage is not promptly reported. The UGI should also encourage contractors and inspectors to report any damage they see or suspect to facility owners immediately.

Because the city's fire inspectors saw on May 23 that the service line was unsupported, they could have prevented the accident. They showed proper concern about the safety of the line, especially after a piece of asphalt pavement fell on it and deformed it. However, not having been instructed to do otherwise, both inspectors relied on the EPAI foremen's assessment that the line was safe. It would have been more prudent of them to ask the pipeline owner for the assessment. The Safety Board concludes that the likely reason the fire inspectors did not tell the operator that its service line was damaged was because the inspectors did not understand the importance of notifying operators so the effects on a facility could be assessed by the operators and necessary action taken. Had the inspectors notified the UGI, it, the Safety Board believes, would have taken the necessary corrective actions, and the accident would not have happened.

The Safety Board believes that the city should encourage its inspectors to report any damage to the facility owner and thus ensure that the potential effect on public safety is assessed by a qualified person. Consequently, the Safety Board encourages Allentown to cooperate with the UGI by instructing its inspectors to report observed or suspected damage to the facility owners. Additionally, the Safety Board believes that the International Association of Fire Chiefs, which represents most community fire departments, should likewise encourage its members to instruct their inspectors to report observed or suspected damage directly to buried-facilities owners.

Rapid Shutdown of Failed Service Lines--The Gross Towers gas line was fully separated, and the gas under 55 psig pressure flowed essentially unobstructed from the service line into the building. An EFV would have operated quickly to stop the gas flow into the separated portion of the service line, thereby preventing the accumulation of enough gas to fuel an explosion. The Safety Board concludes that the consequences of the separation could have been significantly reduced and that probably no one would have been hurt or killed had the UGI installed an EFV in the service line.

When Gross Towers was reconstructed after the accident, the UGI did not offer the housing authority an opportunity to have an EFV installed. Even though the UGI voluntarily installs EFVs in some of its service lines, like most gas operators nationwide, it does not usually tell customers what an EFV is, what its benefits are, or that a customer can pay to have one installed. The UGI did not install an EFV in the reconstructed Gross Towers service line because it does not routinely assess the merits of installing EFVs in large service lines or in large gas services that incorporate the use of compression couplings installed in the line near the wall of a building. The use of an EFV in such lines would minimize the consequences of an accident in which the coupling separates from the line, allowing the release of a large amount of gas right next to the foundation of the building.

Pennsylvania's Pipeline Safety Operations

Premarking Proposed Excavations--Pennsylvania can reduce the chance of a gas line being damaged by excavation by requiring the excavator to use paint or flags to mark the area that he proposes to excavate before the facility operator marks the locations of buried facilities. Had the area of proposed excavation been marked when the UGI's employee marked the location of the service line, he could have seen how close the service line was to the proposed excavation. Had he known how close the line was, he probably would have told his supervisor that there was a potential problem. The Safety Board believes that Pennsylvania should make its excavation-damage prevention program more effective by requiring that the excavator mark the area to be excavated before the facility operators mark the locations of their facilities.

Excavation-Damage Prevention Program--The Safety Board is concerned because Pennsylvania has not initiated any enforcement action under the State's excavation-damage program. The Safety Board's investigation shows that the gas line was severely damaged during excavation activities, that the damage had not been reported to the UGI for a period up to 2 weeks before the explosion, and that the EPAI did not warn the occupants of Gross Towers about the emergency conditions. The Pennsylvania program addresses each of these issues.

Several States, including Connecticut and Massachusetts, require all excavators and buried-facility operators to participate in their damage-prevention programs. Also, they have recognized the ineffectiveness of trying to enforce damage-prevention laws through the courts. Both Connecticut and Massachusetts have a single agency that has the authority to administer the program for its State. The agency is responsible for overseeing compliance, assessing penalties, and educating related industries and the public about the program's purpose, requirements, and penalties. The two States report that since converting to an administrative program, they have achieved effective compliance with their excavation-damage prevention programs and significant reductions in the amount of excavation-caused damage.

In its first year of operating under administratively enforced sanctions, excavation notifications in Massachusetts increased 100 percent, and the number of pipeline-damage inci-

dents decreased from 1,200 to 300. The State reported that it had collected more than $300,000 in violation fines, which more than paid for its safety enforcement efforts. The manager of Connecticut's Call Before You Dig, the State's one-call excavation-notification program, reported that improved publicity and enforcement of its damage-prevention program resulted in a 60-percent decrease in the number of excavation-caused accidents.

In Pennsylvania, however, not all excavators and buried-facility operators are required to participate in the damage-prevention program, and enforcing the program is the responsibility of the attorney general's office, an office that must devote much of its time to prosecuting far more serious violations. The Safety Board concludes that Pennsylvania is unable to effectively prevent excavation-caused damage because not all excavators and buried-facility operators are required to participate in the State's program, because excavators are not required to premark proposed excavations, and because the State does not have an effective way of overseeing and enforcing compliance with the program.

Housing Authority Standards

Detection of Released Gas--The Safety Board concludes that the consequences of the accident might have been significantly reduced had the room in which the service line entered the building had a gas detector capable of alerting the occupants and the fire department.

Had there been a gas detector in the room in which the service line entered, the occupants of the building and the fire department would have had 15 extra minutes in which to react. The fire department would have had time to communicate with the UGI, which might have been able to close the gas line valve soon after the separation occurred, thus preventing the accident. More likely, the accident would have happened, but much less gas would have been available to fuel the explosion, which might have substantially reduced the number of casualties and extent of the damage. The Safety Board believes that the consequences of the service line separation might have been reduced had HUD or the housing authority required the installation of a detector.

The Safety Board addressed in a 1976 report[15] the benefit of using gas detectors to provide early warnings of gas leaks in buildings. It noted that gas detectors were available and in use and that although they were relatively expensive at that time, work was being done to produce dependable, moderately priced detectors. The report noted that many commercial buildings were then required to have smoke or heat detectors at strategic interior locations and that some of them, when activated, also activated fire sprinklers. The report stated that it seemed logical for similar requirements to be adopted for installing gas detectors in buildings. It therefore recommended that HUD:

[15]National Transportation Safety Board Pipeline Accident, *Consolidated Edison Company Explosion at 305 East 45th Street, New York, New York, April 22, 1974* (NTSB/PAR-76/02).

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

On June 28, 1976, HUD advised that gas detectors were technically possible but that it did not believe them to be practical. It advised that it would continue to review developments in the field and when a practical, cost effective detection system was developed, it would reevaluate its position. The Safety Board did not consider HUD's review of gas detectors adequate and classified Safety Recommendation P-76-12 "Closed--Unacceptable Action."

Since 1976, much improvement has been made in gas detectors. Today area gas detectors, much like smoke detectors, can be purchased at hardware stores for less than $35.00 Like smoke detectors, these gas detectors have alarms that can be heard in adjacent offices and throughout most homes. More sophisticated equipment that is capable of sampling various locations within a room or building to detect low levels of gas and of activating building fire alarms if gas is detected are also available for a few hundred dollars to about $1,500. The cost for a gas detector with alarms suitable for commercial buildings is dependent on many factors, such as detection sensitivity, whether a building already has an alarm system to activate, and the number of locations to be monitored. In the case of Gross Towers, where only one room needed to be monitored and a building alarm system was present, a gas detector system to alert building residents and the housing authority's answering service probably could have been installed at a reasonable cost.

HUD needs to assess the safety benefit of requiring that all buildings in its rent subsidy programs that use natural gas have gas detectors that are capable of alerting both occupants and the local emergency-response agencies.

Rapid Shutoff of Failed Service Lines--Although the building could have had features, such as exterior vented trash chutes, designed to impede the flow of gas through vertical openings, an EFV would have been a far more cost-effective method of preventing the massive release of gas into the building. However, neither HUD nor the housing authority was aware of the potential benefits of using EFVs, and HUD did not require EFVs for buildings that received Federal subsidies.

Because HUD had never assessed the safety benefits that occupants of subsidized rental buildings would receive from EFVs, it did not require that an EFV be installed on the service line when the building was reconstructed. The Safety Board believes that HUD should now assess the benefits of requiring EFVs on all service lines to buildings it accepts into its rent subsidy programs. Also, working with the gas distribution operators that supply gas to HUD-approved buildings, HUD should determine the feasibility of installing EFVs on buildings that are already in its subsidy program.

Rapid Shutdown of Failed Service Lines

When Gross Towers was built, systems already existed that could detect either a drop in pressure or an excessive flow of gas and respond by closing a valve on the gas supply line. Today, off-the-shelf EFVs suitable for a wide range of pipe sizes, pressures, and sensitivities and suitable for residential, small-commercial, and large-commercial service lines are available. Several EFV manufacturers have EFV systems also for large-use commercial services that can be adapted easily to meet increasing or decreasing gas flow volumes simply by changing an orifice. It is this kind of EFV probably that would be necessary to protect the service line to Gross Towers, since the amount of gas the building requires is both large and variable. Such an EFV would cost between $1,200 and $1,500; an off-the-shelf EFV suitable for protecting high-pressure residential service lines costs about $10 to $20. Even so, the cost per apartment in Gross Towers would be about $8 to $10, less than the cost of an off-the-shelf EFV for a single-family residential customer.

The Safety Board believes that an EFV should have been installed in the service line before gas service was reestablished to the reconstructed building. Since it was not, the Safety Board believes that an EFV should be installed now. RSPA, the Federal agency that is responsible for the safety of pipelines and is regarded by the public as the leader on such issues, should have required the installation of EFVs on all new and renewed service lines with operating parameters that were consistent with those of commercially available EFVs. Regardless, however, of what RSPA did or did not require, it would have been prudent for the UGI, a company that recognizes the benefit of using EFVs, to have installed the EFV. At the least, the UGI should have told the housing authority about the benefits of using an EFV and offered the housing authority the chance to pay for having one installed.

The use of EFVs for gas distribution-system service lines has generated considerable debate within the gas pipeline industry and within both State and Federal governments. (For the history of activities to foster the use of EFVs and for factual support of comments included below, see appendix B.) In 1971, the Safety Board first identified the need for gas operators to provide a means of rapidly detecting and shutting down failed pipeline segments. RSPA did not require EFVs in the 1970s even though several gas operators were using them successfully and studies showed that EFVs could enhance public safety and were technically and economically feasible and commercially available.

The Safety Board initially advocated using EFVs on service lines to such buildings as schools and other buildings in which a large number of people gathered. Later, because EFVs became cheaper and more available, the Safety Board began advocating the installation of EFVs on all service lines.

During the 1980's, RSPA took no action on requiring EFVs. Consequently the Safety Board included the use of EFVs on its 1990 list of most wanted safety recommendations, a list the Safety Board keeps of the safety recommendations that offer the greatest potential for saving lives.

In December 1990, RSPA issued an Advanced Notice of Proposed Rulemaking about requiring EFVs, but for almost 2 years did not complete the rulemaking. In October 1992, Congress passed Public Law 102-508 (106 STAT. 3290), which allowed the DOT Secretary 18 months to prescribe the circumstances in which natural-gas distribution-system operators would have to install EFVs. Under the same law, Congress gave the Secretary 2 years in which to require gas operators to tell their customers about the benefits of using EFVs and to offer them the chance to have EFVs installed at their own expense**.**

In April 1993, RSPA issued a Notice of Proposed Rulemaking (NPRM). The NPRM proposed mandating the installation of EFVs in new and renewed single-family high-pressure service lines and cited the positive benefit/cost ratio that it had determined in its 1991 study would result from using EFVs. After reviewing the comments he received, the OPS director said in an August 1993 meeting with people interested in EFV use that the rulemaking process had not produced enough information for the OPS to proceed with a final rule. He suggested that the representatives of agencies and associations attending the meeting might want to participate in a negotiated rulemaking process. Because he would not agree to follow the results of a negotiated rulemaking, several representatives stated their desire to develop a consensus agreement. He agreed that if such an agreement were reached, he would publish the proposal as a supplemental rulemaking with a 30-day comment period.

The AGA and the Safety Board staffs jointly held meetings with interested people to formulate an alternative proposal. Sixteen parties of interest, which later became known as the Joint Commenters, developed a consensus proposal that EFVs be required. They submitted the proposal to the OPS on December 14, 1993. They included the AGA, the American Public Gas Association (APGA), the Interstate Natural Gas Association of America, the National Association of Pipeline Safety Representatives (NAPSR), the National Association of Regulatory Utility Commissioners, the Gas Safety Action Council, the International Association of Fire Chiefs, eight EFV manufacturers, and the Safety Board. The Safety Board concurred with the proposal and through a letter filed with the Joint Commenters' proposal made its position known to RSPA and urged that prompt action be taken to implement the proposal.

The Joint Commenters' proposal said that the organizations endorsing the proposal represented the most identifiable interests in this matter. The Commenters said that the 1991 OPS study contained many errors that biased it in favor of using EFVs. The proposal said:

> Much of the information necessary to accurately assess the costs and benefits of EFVs is incomplete or unavailable; therefore we support a cooperative effort between the American Gas Association and EFV manufacturers to begin collecting data on the in-service performance of the approximately 1 million EFVs that will be installed annually if the rule we propose is promulgated.

The OPS published a Notice of Reopening Comment Period (Docket PS-118, Notice 4) on August 2, 1994, asking whether it should adopt the Joint Commenters’ proposal. The

Notice, however did not include the proposal; instead it said that the proposal could be reviewed in the public docket. The Notice also requested comments on the safety of the EFV bypass feature, on the effect of contaminants on EFVs, and on whether RSPA should wait for industry-sponsored committees to complete their standards before the OPS proceeded with the rulemaking. The Notice acknowledged that an OPS regulatory evaluation indicated that the use of EFVs would reduce the number of deaths, injuries, fires, explosions, and evacuations enough to result in an aggregate annual savings of $19 to $31 million. The Safety Board responded to the Notice, urging RSPA to accept the proposal and to expedite the issuance of a final rule.

The majority of comments favored adopting the proposal; the OPS and RSPA disregarded that. They also disregarded the Joint Commenters' counsel that there was too little data to do a proper cost/benefit study. Instead, in 1995, the OPS developed another cost/benefit study, which was done by the same Transportation Safety Center staff that had done the 1991 study. The new study corrected some of the errors made in the old one, but included new ones. (See appendix B.) The new study concluded that using EFVs is not cost effective.

On April 4, 1995, RSPA's Administrator sent letters to the chairmen of the Senate and House committees and subcommittees that oversee pipeline safety, notifying them of RSPA's decision to not require EFVs. The letters said that RSPA had found no circumstance under which it should issue a Federal rule requiring the universal installation of EFVs and that, as required by 49 U.S.C. section 60110, the agency was planning to issue performance standards and customer-notification requirements for EFVs, thus encouraging a greater use of EFVs only where local conditions were appropriate.

In a September 28, 1995, letter (see appendix D), the Safety Board told RSPA's Administrator that the Board was extremely disappointed with RSPA's decision to not require EFVs. The Board noted that most of the 70 responses to RSPA's Notice of Reopening Comment Period supported adopting the Joint Commenters' proposal. The letter noted that RSPA had again lost an excellent opportunity to increase the safety of gas customers and the public. The letter said that in investigations of distribution-pipeline accidents, the Safety Board continued to find strong evidence supporting the need for requiring that there be a way to quickly shut off the flow of gas to a failed pipe segment. While such a requirement would not prevent accidents, it would significantly reduce their consequences. Therefore, the Safety Board classified Safety Recommendation P-90-12 "Closed--Unacceptable Action." The Safety Board concludes that RSPA was grossly ineffective during the previous 20 years in objectively assessing the benefits of EFVs and in advancing public safety through their use.

The Board also addressed RSPA's plans to issue performance standards and customer-notification requirements for EFVs. The Board noted that the Natural Gas Pipeline Safety Act does not limit RSPA's consideration of EFV use by type of customer, size of service pipe, or

operating pressure and urged RSPA to address in its performance standards only those parameters that relate to EFV operating capabilities, such as pressure drop, ability to reset after activation, bleed-by flow rate, and so forth, which are addressed in the Manufacturers Standardization Society's recently approved standard "Excess Flow Valves for Natural Gas Service." Further, the performance standards should not address such factors as service-line diameter, operating pressure, or type of customer because RSPA should not limit EFV use on the basis of the customer's classification or the service line's diameter. This point is particularly true when service line operating parameters are similar and commercial or residential service lines can be protected using the same style or model of EFV.

The Board urged RSPA to ensure that information given to customers be accurate, straightforward, and easy to understand. The Board said that RSPA should require operators to give prospective EFV users the names, addresses, and telephone numbers of alternative sources of information, such as EFV manufacturers or consumer advocacy groups.

The AGA, on July 14, 1995, petitioned RSPA to include certain limitations in its regulations about notifying customers: the customer should not be able to select the type or manufacturer of the EFV installed on his service line, and the gas system operator's responsibilities for the functioning of the EFV should be limited.

Additionally, the AGA is seeking to further limit the effect of the congressionally-mandated customer-notice requirement. Even so, the Safety Board believes that the voluntary installation of EFVs by the gas industry will continue to increase as it has historically, primarily because of the positive experiences of pipeline operators that now use more than 1 million EFVs. Also, the Safety Board is confident that the number of gas operators that use EFVs will increase as the controversy over EFVs diminishes and as more operators begin learning for themselves the value of EFVs to their operations and to public safety. The Safety Board finds it unfortunate that EFVs have not been required for the more than 20 years since their use was first recommended. Had EFVs then been required, between one third and one half of today's almost 60 million gas customers would now be protected by EFVs.

Problems the AGA Believes Operators May Face if EFVs Are Required

The operator as the seller of EFVs could be liable.

The operator may not know who to notify about EFVs because the occupant may not be the owner.

The local jurisdiction might limit the amount an operator could charge for an EFV; the jurisdiction might even forbid the operator to accept pay for installing the EFV.

The operator must notify only single-residence customers whose service line pressures never fall below 10 psig pressure.

The operator must install an EFV only if the customer agrees to pay all costs associated with its installation, maintenance, and replacement.

Even when a customer wants an EFV and agrees to pay for it, the operator does not have to install one when

a. The operator is not able to get an EFV that meets the performance standards.

b. The service line has been installed under emergency or short-notice conditions.

c. The operator determines that installing an EFV would interfere with necessary operation or maintenance activities.

d. The service regulator and meter are visible and located within 12 feet of the gas main and at least 12 feet from the residence.

e. The operator is under a jurisdiction that prohibits him from recovering all costs associated with EFVs.

AGA's Proposed Limitations

Excavation-Damage Prevention

The accident at Allentown again demonstrates how devastating it can be when a pipeline is damaged by excavation. Since 1970, when the OPS first required that pipeline accidents be reported, the largest single cause of all pipeline accidents, including distribution-system accidents, has been excavation damage. Minimizing the consequences of excavation-caused accidents was the primary reason the gas industry began using EFVs. Based on the reports filed with the OPS in the last 10-year period for which data are available, 1985 to 1994, gas distribution fatalities have ranged from 5 to 21, or an average of 14, a year. The injury rate during the same time has ranged from 50 to 94 per year, or an average of 77 injuries a year. The number of reported distribution accidents has varied from 103 to 204 per year, or an average of 147.

Distribution accidents account for a majority of the fatalities and injuries in the pipeline industry. Gas operators report excavation-caused accidents as *outside force* accidents, a category that includes damage to pipelines from any activity outside the control of the operator, such as fire or lightning. In 1993,[16] 26.9 percent of all reported distribution accidents

[16]The latest year for which this data has been determined. Development of this statistic requires manual review of all reports made to the OPS to identify those that occurred due by excavation activity because OPS's accident reporting forms do not include a classification for excavation-caused accidents.

were caused by excavation, and these accidents accounted for 29.3 percent of the distribution injuries and 43.8 percent of the distribution fatalities.

The Safety Board's reports have consistently addressed the need to reduce the excavation-caused damage to pipelines and other buried facilities. Between 1968 and 1972, the Safety Board investigated a number of excavation-caused pipeline accidents having tragic consequences. In April 1972, the Board sponsored a pipeline damage-prevention symposium, inviting industry and government representatives to discuss the prevention of such accidents. Many proposals developed at the 1972 symposium led to Safety Board recommendations that resulted in the concepts and systems, such as one-call notification centers, now used to minimize excavation-caused damage to pipelines. The Safety Board also recommended that RSPA require pipeline operators to establish excavation-damage prevention programs. In 1982, RSPA required natural-gas pipeline operators to do so; and in 1995, RSPA required liquid pipeline operators to join in. The regulations allow operators to comply with portions of the requirements by participating in one-call notification systems

Since the 1972 symposium, the Safety Board has continued to support the efforts of the APWA, the States, and the national organizations dedicated to reducing excavation damage to pipelines. It has advocated improving prevention in testimony before Congress and State legislatures, before groups interested in pipeline safety, and before such trade associations as the Interstate Natural Gas Association of America, the APGA, the AGA, and the API.

The combined efforts of industry, State commissions, and the Safety Board and other Federal agencies during the 1970s led to a decrease in the number of accidents during the 1980s, despite an increase in pipeline construction and in urban development near pipeline right-of-ways. Even so, excavation-caused damage remains the largest single cause of pipeline accidents.

Mandatory participation by all affected parties, whether private or public.

A true one-stop notification system in which excavators can alert all operators of buried systems.

Swift, effective sanctions against violators of State damage-prevention laws.

An effective education program for the public, contractors, excavation machine operators, and operators of underground systems that stresses the importance of notifying before excavating, accurately marking buried facilities, and protecting marked facilities when excavating.

Common Elements of Effective State Damage-Prevention Programs

Because of the number of excavation-caused accidents in recent years, the Safety Board reviewed several State damage-prevention programs in 1994 and identified several recurring unresolved problems. The Safety Board also identified some innovative State programs that show promise of significantly reducing excavation-caused damage. Arizona, Connecticut, Massachusetts, Minnesota, and Utah require universal compliance with their damage-prevention laws and impose sanctions through

administrative rather than judicial action. While the programs differ from one another, they all contain similar provisions that contribute to their effectiveness.

To foster improvements in State excavation-damage prevention programs, on September 8 and 9, 1994, the Safety Board and RSPA jointly sponsored an excavation-damage prevention workshop attended by more than 375 government and industry representatives. The workshop provided a forum in which participants could identify and recommend ways of improving prevention programs. Four panels designated by industry and government associations deliberated and achieved consensus on the following: the essential elements of an effective one-call notification system, the responsibilities of buried-facility operators, the responsibilities of excavators, and the ways in which a damage-prevention program should be administered. The Board published the proceedings of the workshop[17] and is now analyzing the findings, its previous reports on excavation-damage accidents, comments filed by interested parties, and other related documents to develop recommendations for improving excavation-damage prevention programs nationwide.

[17]National Transportation Safety Board, *Proceedings of the Excavation Damage Prevention Workshop*, September 8-9,1994, Washington, DC (NTSB/RP-95/01).

CONCLUSIONS

1. Fatigue was not a causal or contributing factor.

2. Whether drugs or alcohol was a factor cannot be established because the workmen were not tested after the accident; the excavator's management did not observe cause for tests, and Federal regulations did not require tests.

3. By reducing the soil's capacity to restrain the movement of the pipe and by exerting forces on the service line that resulted in excessive longitudinal stress, the excavator caused the line to separate at a compression coupling.

4. The Allentown Housing Authority and the city of Allentown's emergency response was well coordinated and effective.

5. The excavator could have prevented the accident by shoring up the excavation, by providing effective supervisory oversight, by ensuring that the excavation was properly shored, by telling its employees to notify owners when buried facilities were damaged, or by training its employees in the requirements of its own health and safety program and in the excavation, trenching, and shoring requirements of the Occupational Safety and Health Administration.

6. The gas company lost the opportunity to preserve the integrity of the service line because its procedures did not require a review of any unusual excavation near a gas service line that might damage the line and threaten public safety.

7. The likely reason the fire inspectors did not notify the gas company that its service line was damaged was because the inspectors did not understand the importance of notifying operators so the effects on a facility could be assessed by the operators and necessary action taken.

8. Had the service line had an excess flow valve, the consequences of the accident could have been substantially reduced; the likely result would have been no injuries or deaths.

9. Pennsylvania's excavation-damage program could be more effective if it (1) required each excavator and buried-facility operator to participate in the program, (2) required the excavator to mark the area he proposes to excavate, and (3) had an effective means of overseeing and enforcing the program's provisions.

10. The consequences of this accident could have been significantly reduced had the excavator's foreman promptly called "911" and had his helpers promptly told the occupants of the building to evacuate.

11. Before the explosion, the excavation crewmembers did not evacuate the residents and the foreman did not call the fire department because they had not been trained in handling an emergency.

12. The consequences of this accident might have been substantially reduced had a gas detector capable of alerting people throughout the building and at the nearest fire station been installed in the room where the service line entered the building.

13. In the past 20 years, the Research and Special Programs Administration has failed to effectively assess the benefits of excess flow valves and has failed to promote their use.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the natural gas explosion and fire at Gross Towers in Allentown, Pennsylvania, was the failure of the management of Environmental Preservation Associates, Inc., to ensure compliance with OSHA's and its own excavation requirements through project oversight. Contributing to the accident was the failure of the workmen from Environmental Preservation Associates, Inc., to notify UGI Utilities, Inc., that the line had been damaged and was unsupported.

Contributing to the severity of the accident was the absence of an excess flow valve or a similar device, which could have rapidly stopped the flow of gas once the service line was ruptured. Also contributing to the severity of the accident was the absence of a gas detector, which could have alerted the fire department and residents promptly when escaping gas entered the building.

RECOMMENDATIONS

As a result of its investigation, the National Transportation Safety Board makes the following recommendations:

--to the Research and Special Programs Administration

Require gas-distribution operators to notify all customers of the availability of excess flow valves; any customer to be served by a new or renewed service line with operating parameters that are compatible with any commercially available excess flow valve should be notified; an operator should not refuse to notify a customer because of the customer's classification or the diameter or operating pressure of the service line. (Class II, Priority Action) (P-96-2)

--to the States and the District of Columbia.:

Require gas distribution operators to install excess flow valves in all new or renewed gas service lines, when operating conditions are compatible with commercially available valves, including service lines supplying schools, churches, and other places of public assembly. (Class II, Priority Action) (P-96-3)

--to the UGI Utilities, Inc.:

Require that people handling emergency calls determine whether escaping gas is likely to enter a structure, and if so, require that the information be quickly conveyed to "911." (Class II, Priority Action) (P-96-4)

Modify its excavation-damage prevention program to include the review and close monitoring of any proposed excavation near a gas service line, including any line with unanchored compression couplings, that is installed near a building and that, if damaged, might endanger public safety significantly. (Class II, Priority Action) (P-96-5)

Instruct members of local governments and contractor groups in its service area about the threat to public safety posed by a gas line that is unsupported or damaged, and emphasize the importance of reporting such information immediately to the facility owner. (Class II, Priority Action) (P-96-6)

--to Environmental Preservation Associates, Inc.:

Instruct its employees on actions to take when buried facilities, such as gas lines, are unsupported or damaged; such actions should include alerting local response agencies and residents of threatened buildings, initiating evacuations, and notifying facility owners. (Class II, Priority Action) (P-96-7)

--to the Governor of the Commonwealth of Pennsylvania:

Require any person or entity that excavates to participate in the State's excavation-damage prevention program. (Class II, Priority Action) (P-96-8)

Designate a single State agency responsible for the State's excavation-damage prevention program; give the agency the power to levy administrative penalties. (Class II, Priority Action) (P-96-9)

Require each contractor to outline the area of the proposed excavation before asking the facility operators to mark the locations of their facilities. (Class II, Priority Action) (P-96-10)

--to the city of Allentown

Instruct fire and other city inspectors to advise facility owners, such as gas companies, immediately about any suspected damage to their buried facilities or any lack of structural support. (Class II, Priority Action) (P-96-11)

Require as an excavation-permit condition that the excavator instruct his workmen in how to help members of the public in the immediate vicinity of an emergency, how to notify the local response agencies and the owner of a damaged facility, and how to evacuate anyone who might be in danger. (Class II, Priority Action) (P-96-12)

--to the International Association of Fire Chiefs:

Urge its members to instruct their inspectors to report observed or suspected damage to a buried facility, including lack of support, to the owner immediately. (Class II, Priority Action)(P-96-13)

--to the Department of Housing and Urban Development:

Require the installation of excess flow valves in new and renewed gas services to buildings that the Department has approved for Federal rent subsidies. (Class II, Priority Action) (P-96-14)

Evaluate the safety benefit of requiring the installation of excess flow valves in gas services to existing buildings and, where feasible, require their installation. (Class II, Priority Action) (P-96-15)

Evaluate the safety benefits of using gas detectors in buildings approved by the Department for Federal rent subsidies as a means of providing building occupants and local emergency-response agencies with early notice of released natural gas within buildings; require that gas detectors be used in buildings in which the Department has determined that a gas detector would be cost effective and beneficial. (Class II, Priority Action) (P-96-16)

--to the Allentown Housing Authority:

Encourage UGI Gas Services, Inc., to install an excess flow valve in the gas service to any building the housing authority owns or manages. (Class II, Priority Action) (P-96-17)

Evaluate the safety benefits of using gas detectors in buildings that it owns or manages that are served with gas as a means of providing emergency-response agencies with early notice of released gas within buildings; install gas detectors in buildings in which it is determined that they would be cost effective and beneficial. (Class II, Priority Action) (P-96-18)

--to the Associated General Contractors:

Inform its members about the 1994 Allentown accident and encourage them to train their excavation employees in: (a) notifying local emergency-response agencies of any emergency conditions immediately; (b) helping members of the public who are in the immediate vicinity of an emergency, including evacuating anyone who is in danger; (c) notifying the buried-facility owner of any changes in the work plan; (d) notifying the buried-facility owner of any damage to or lack of support for his facility promptly and relying on the buried-facility operator to decide whether corrective action is needed. (Class II, Priority Action) (P-96-19)

--to the National Utility Contractors Association

Inform its members about the 1994 Allentown accident and encourage them to train their excavation employees in: (a) notifying local emergency-response agencies of any emergency conditions immediately; (b) helping members of the public who are in the immediate vicinity of an emergency, including evacuating anyone who is in danger; (c) notifying the buried-facility owner of any changes in the work plan; (d) notifying the buried-facility owner of any damage to or lack of support for his facility promptly and relying on the buried-facility operator to decide whether corrective action is needed.(Class II, Priority Action) (P-96-20)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

JAMES E. HALL
Chairman

ROBERT T. FRANCIS II
Vice Chairman

JOHN A. HAMMERSCHMIDT
Member

JOHN J. GOGLIA
Member

February 26, 1996

APPENDIX A

Investigation

The National Transportation Safety Board was notified on June 9, 1994, by the National Response Center of a gas explosion damaging an eight-story building at Allentown, Pennsylvania. Upon being notified, the Safety Board dispatched an investigation team from Washington, D.C., comprising investigative groups for pipeline operations, survival factors, human performance, and site documentation.

Hearing

The Safety Board did not conduct a public hearing in conjunction with this investigation.

this page intentionally left blank

APPENDIX B

Rapid Shutdown of Failed Service Lines

Since the early 1950s, some manufacturers have offered excess flow valves for large gas service loads, such as industrial facilities, schools, and hospitals. Gas-distribution system operators, who recognized the need to rapidly shut down smaller gas service lines after a rupture to improve public and customer safety, asked the Mueller Company of Decatur, Illinois, to develop a valve that could stop the gas flow on smaller service lines when the flow was excessive. In 1965, Mueller introduced an automatic safety shutoff valve, which became known as an excess flow valve (EFV). Since the mid-1960s, the use of EFVs on gas-distribution system service lines has generated considerable debate within the gas industry and within both State and Federal governments.

The Safety Board has recognized since 1968 that pipeline operators need to be able to shut off the gas flow from a failed pipeline segment rapidly as a means of providing reasonable public safety. The Board advocated installing EFVs in gas service lines as near as practicable to their connections to gas mains. Its 1970 report[1] cited an accident that would have likely had substantially less serious consequences had an EFV been installed in the gas service line:

> On May 29, 1968, a bulldozer working at the front of a children's nursery in Hapeville, Georgia, broke a 1-inch medium pressure gas service line. The bulldozer operator reportedly was unable to locate the buried shutoff valve. In a few minutes, an explosion occurred in the nursery. The ensuing fire engulfed the frame dwelling. Nine people, including seven children, lost their lives. Three other children were seriously injured.

The Board recognized that an EFV, although not then commercially available, had been developed and could function on high- and low-pressure gas service lines. Based on that study, the Safety Board recommended that the Office of Pipeline Safety (OPS):

> P-71-1
> Conduct a study to develop standards for the rapid shutdown of failed natural gas pipelines and work in conjunction with the Federal Railroad Administration

[1] *Special Study of Effects of Delay in Shutting Down Failed Pipeline Systems and Methods of Providing Rapid Shutdown*, National Transportation Safety Board, December 30, 1970 (NTSB/PSS-71/1).

> [the agency that then had safety regulatory jurisdiction over liquid pipelines] to develop similar standards for liquid pipelines.

On October 30, 1972, a bulldozer struck and ruptured a 3/4-inch gas service line in a downtown area of Lake City, Minnesota. A department store adjacent to the ruptured service line, but not served by gas, exploded and later caught fire. Six people were killed, and 10 were injured. The Safety Board concluded that if a fail-safe device, such as an inexpensive EFV, had been installed on the service line, the flow of gas would have been stopped promptly. The Safety Board concluded that EFVs should be installed universally, and it recommended that the OPS:

> P-73-2
> Undertake a study of fail-safe devices which will stop the flow of gas from ruptured lines. Based on the results of this study, OPS should consider amending 49 *CFR* 192 to require the installation of such devices at appropriate locations in gas distribution systems.

On July 20, 1973, the OPS advised the Safety Board that it had contracted for a study on the rapid shutdown of failed pipeline facilities and on the pressure limiting of pipeline systems.

The OPS study was completed in October 1974.[2] The study recommended installing EFVs on all new gas service lines and service lines undergoing repair. Reasons included in the study in support of the recommendations were:

- EFVs will improve public safety by reducing accident effects in gas service line ruptures, e.g. excavation and other damages.

- EFVs are commercially available, technically feasible, and are being used by gas distribution facilities.

- EFVs are economically feasible because they add less than 1 percent to the installation and maintenance costs of the gas distribution system.

On April 22, 1974, a massive, low-order explosion demolished the west wall of a 25-story high-occupancy commercial building in New York City. The structure of the adjacent building was damaged, and glass was broken in other buildings in the area. No one was killed,

[2]"Rapid Shutdown of Failed Pipeline Systems and Limiting of Pressures to Prevent Pipeline Failure Due to Overpressure," Research Conducted by Mechanics Research, Incorporated of Los Angeles, California, for the Office of Pipeline Safety, U.S. DOT, October 1974 (PB 241-325).

but more than 70 people were injured. The Safety Board found that an overpressured pneumatic tank had rocketed upward, breaking an overhead, 6-inch-diameter, 1/4 psig pressure service line at a threaded joint. Gas escaped unabated into the building through elevator shafts until it was ignited by an undetermined source. The Safety Board's report[3] on the accident recognized that the consequences could have been substantially reduced if an EFV had been installed in the service line. The report acknowledged that EFVs then commercially available were limited to gas systems operating at 3 or more psig pressure, that some valve manufacturers claimed to have EFVs that could function correctly at 1/4 psig pressure and higher, that the OPS had contracted a study to develop standards for rapid shutdown of failed pipelines, that the study was at that time complete and being reviewed by the OPS, and that the study concluded that the use of EFVs would benefit public safety. The Board noted that "The practicality of these EFVs has been argued, but the theory is sound, research is continuing, and work in this area should be expedited." Consequently, it recommended that the OPS:

> P-76-9A
> Determine the availability, the practicability, and the state of the art in the manufacture of EFVs for use on low-pressure gas distribution systems. Based upon the results of these findings, amend 49 *CFR* 192 to incorporate the use of these valves in commercial buildings.

A November 1975 Department of Transportation report[4] recommended that EFVs be installed on customer service lines because they are inexpensive.

On July 30, 1976, the OPS advised that its study had reviewed the state of the art of the rapid shutdown of failed distribution systems and that its preliminary evaluation indicated that EFVs might be practical safety devices for certain conditions. However, the OPS also advised that the results of the study were not conclusive concerning the use of EFVs. On April 3, 1978, the OPS advised the Safety Board that its study on EFVs showed that they might have safety potential and that rulemaking action would be considered for its 1979 programs. In a December 1978 letter, the Chairman of the Safety Board urged the DOT's Materials Transportation Bureau (The OPS's parent DOT organization) Director to act on the Board's 1971, 1973, 1975, 1976, and 1978 recommendations that the MTB require the use of EFVs on all natural gas services.

In an October 1979 letter, the Safety Board Chairman asked the DOT/RSPA (RSPA became the OPS's parent DOT organization) Administrator to provide a status report on

---

[3]Pipeline Accident Report, *Consolidated Edison Company Explosion at 305 East 45th Street, New York, New York, April 22, 1974* (NTSB/PAR-76/2).

[4]*Study on Current Practices, Technologies, Problems, and Recommendations Relating to the Overall Safety of Gas Pipeline Distribution Systems*, November 1975 (DOT/MTB/OPSO-76/01).

APPENDIX B

RSPA's response to the Board's numerous recommendations that RSPA require the installation of EFVs on all customer service lines. RSPA responded on November 30, 1979, saying that EFVs had too many problems associated with them to be effective. The letter advised that RSPA planned to hold a conference with major manufacturers of EFVs in January 1980 to discuss problems with the valves. RSPA advised that the Safety Board would be kept aware of the progress made.

On October 24, 1979, an explosion and fire destroyed the Greene County Clerk's office building and the Greene County Courthouse in Stanardsville, Virginia, gutted a connecting building under construction, and damaged nearby buildings. Thirteen people were injured, and the property damage was extensive. The Safety Board's report[5] stated that an excavator's backhoe had struck and broken the gas service line at the wall of the office building. Gas under 15 psig pressure had flowed unabated into the building until the gas was ignited by an undetermined source. The report reviewed the Safety Board's previous recommendations to RSPA about EFVs and discussed the OPS's October 1974 study on EFVs. The Board's report noted that the OPS was still reviewing the regulatory action it might take concerning EFVs and that consequently the Safety Board was recommending that the OPS:

> P-80-55
> Expedite rulemaking to require the installation of EFVs on all newly installed and renewed high-pressure gas distribution system service lines.

On January 29, 1980, RSPA conducted a 1-day conference in Washington, D.C., to gather information about EFVs. A February 26, 1980, OPS internal memorandum from the Technical Division to the Associate Director for Pipeline Safety Regulation reported on the meeting, saying that:

> Unintended EFV closures cited by operators as being a serious problem is not supported by evidence.
>
> The argument that foreign matter in existing gas systems could cause sticking and unintended closure is not especially significant, as such occurrences have been extremely rare. Furthermore, such conditions would probably cause a greater problem in meter assemblies, regulators, or customer safety-related equipment. An EFV would trap materials in the gas stream and prevent a more serious problem down line.

[5]Pipeline Accident Report, *Columbia Gas of Virginia, Inc., Natural Gas Explosion and Fire, Stanardsville, Virginia, October, 24, 1979* (NTSB/PAR-80/3).

The memorandum called for further review of the EFV's ability to operate properly after being dormant in a service line for several years and of the EFV's reliability and serviceability. However, the Technical Division concluded that "the potential safety benefits to be gained from installing EFVs where needed appear to outweigh the cited problem possibilities." The Associate Director for Pipeline Safety Regulation was advised that should the Office issue an Advance Notice of Proposed Rulemaking (ANPRM) to gather comments and information on using EFVs, it should also ask the following question:

> At what locations should EFVs be required on service lines, e.g., service lines to public places of assembly (schools, churches, hospitals, theaters), commercial, high rise office buildings and apartments, and multifamily units, particularly those located in business districts where subsidence is a problem or in other high risk areas; service lines to mobile homes subject to high winds, tornadoes, hurricanes, or other drastic movements; or temporary service lines?

On September 19, 1980, the Safety Board issued its report[6] that analyzed OPS accident data on plastic pipe distribution systems. Analyses of the data indicated essentially no difference in the incident rate for plastic and steel service lines. The Safety Board encouraged the installation of EFVs in all new service lines, stating that "these valves cannot prevent damage to plastic pipe, but in some circumstances can minimize the consequences of the damage."

On October 9, 1980, a 2-inch compression coupling on the upstream side of a gas meter set assembly in the boiler room of the Simon Kenton High School in Independence, Kentucky, separated from the gas service line. Gas at 165 psig pressure flowed into the room, ignited, and exploded, killing a student in an adjacent classroom. About 30 minutes later, there was a second explosion, which injured 37 people and extensively damaged the high school building. The Safety Board's report[7] found that had an EFV been installed on the service line, the severity of the explosion might have been lessened and the second explosion might have been avoided. The Safety Board noted that it had investigated 13 other pipeline accidents since 1972 in which EFVs could have lessened the severity of the losses. Because the OPS still had not determined what action it might take on requiring the use of EFVs, the Safety Board initiated a special study[8] to better define the potential uses of the valves, and it recommended that RSPA:

---

[6]National Transportation Safety Board Special Study, *Analysis of Accident Data From Plastic Pipe Natural Gas Distribution Systems,* (NTSB/PSS-80/1).

[7]Pipeline Accident Report, *Union Light, Heat, and Power Company, Natural Gas Explosion and Fire, Simon Kenton High School, Independence, Kentucky, October 9, 1980* (NTSB/PAR-81/01).

[8]Special Study, *Pipeline Excess Flow Valves,* September 1981 (NTSB/PSS-81/01).

APPENDIX B

P-81-9
Initiate rulemaking to require the installation of EFVs on all newly installed and renewed high-pressure gas distribution service lines with priority given to service lines supplying schools, churches, and other places of public assembly.

Almost 10 years after the Safety Board first recommended developing a way of rapidly stopping the flow of gas from failed pipelines, the OPS had taken virtually no action to require the use of EFVs. During those years the Safety Board investigated many accidents in which it found that fatalities, injuries, and property damage probably would not have occurred or would have been substantially less severe had the service line had an EFV. Consequently, to motivate action by the OPS on EFVs, in 1981 the Safety Board performed a study[9] to characterize the conditions under which the installation of EFVs appeared to have safety potential. Among other things, the study found that:

In 23 percent of the distribution-system accidents reported to the OPS, an EFV could have been used and would have been effective. This included 8 percent of the accidents involving fatalities and 20 percent of those that caused personal injury.

The reasons most often given by company managements for not using EFVs were concerns about their cost effectiveness, the potential of false valve closure, and the belief that current gas system designs were inherently safe.

The Safety Board concluded that EFVs save lives, protect property, and generally enhance public safety. Based on its findings, the Safety Board concluded that additional documentation on EFV effectiveness should be undertaken, and it recommended that the Gas Research Institute (GRI):

P-81-35
Plan and conduct a test and evaluation of existing EFVs to determine and document, on a comparable basis, their operating and design characteristics, such as reliability, service pipe size and length, operating pressure range, maximum service load, and susceptibility to contamination.

P-81-36
Determine the conditions and locations (other than those for which the Safety Board is recommending immediate regulatory action--i.e., high pressure single-family residential services) for which EFVs can be effective in preventing or minimizing the potential for various types of accidents resulting from leaks on high pressure service lines. Among the conditions which should be evaluated are

[9]Special Study, *Pipeline Excess Flow Valves*, September 1981 (NTSB/PSS-81/01).

gas demand variations, minimum operating pressure, service line size, length, and configuration, major leaks on house piping, cleanliness of gas, and effect on peak shaving operations.

The Safety Board also recommended that RSPA:

P-81-38

Initiate rulemaking to require the installation of EFVs on new and renewed single-family residential high-pressure services which have operating conditions compatible with the rated performance parameters of at least one model of commercially available EFV.

P-81-39

Using the findings of the GRI concerning additional locations where effective use can be made of EFVs to prevent various types of accidents, extend the requirements for the use of EFVs.

On August 11, 1982, RSPA responded that it had reviewed the Safety Board's 1981 study and was interested in the safety benefits of EFVs. It also informed the Safety Board that the GRI had agreed to undertake the test and evaluation program recommended by the Safety Board and that the results would probably be available within the next year. RSPA stated that it appeared prudent to await the results of the GRI's work before addressing the entire EFV question in one broad, comprehensive action if rulemaking were deemed justified.

On October 25, 1982, the Safety Board agreed that it was reasonable for RSPA to wait. The Safety Board also said that in the interest of consolidating efforts on safety-recommendation activity, the Board would classify Safety Recommendations. P-73-2, P-76-9A, P-80-55, and P-81-9 "Closed-Superseded" and assess RSPA's actions on EFVs under two more recent recommendations: Safety Recommendations P-81-38 and -39.

The GRI study was not immediately forthcoming. It was not until September 6, 1984, that the Safety Board received a copy of a GRI's draft final report and a request for comments. Among others receiving the draft final report for comment were the American Gas Association (AGA), EFV manufacturers, and the OPS. All but the OPS commented, and all except the AGA and one EFV manufacturer identified numerous errors and other deficiencies in the report and said that the GRI needed to rework the project and to produce a factual, accurate, and objective report. The deficiencies the commenters mentioned included the EFV costs, which were unrealistic because the GRI had averaged costs reported by all responding gas operators with no independent verification, the use of inaccurate averaging procedures in

assessing performance and costs, and serious flaws in the GRI's assessment of the role of EFVs in service line accidents.

The GRI issued a report[10] in 1985 that documented the characteristics and performance of commercially available EFVs for residential applications and described the conditions that held potential for using EFVs. In developing the report, the GRI had ignored most of the comments, including the technical ones. The report's recommendations primarily addressed the need for additional tests and research.

In a June 21, 1985, memorandum, Safety Board staff advised the Board Members of its interactions with the GRI. The memorandum reported that GRI staff had provided progress reports to Safety Board staff since the beginning of the GRI EFV project. Safety Board staff had consistently advised the GRI project manager about how important it was to public safety that his work be objective, statistically valid, and well documented. After a review of the GRI's quarterly report, Safety Board staff was concerned about the objectivity of GRI's work products; and in a May 9, 1984, letter Safety Board staff pointed out its concern about the GRI's lack of objectivity and about the GRI's inappropriate and unsupported statements in its seventh quarterly report. On June 22, 1984, the project manager acknowledged Safety Board staff's concerns and gave his assurance that the problems would be corrected in the study while others would be properly treated in another study report. After reviewing GRI's September 1984 *Draft Final Report,* Safety Board staff advised the GRI project manager on October 17, 1984, that although only limited time had been allotted for review and comment, staff had easily identified 30 areas that needed attention. Safety Board staff supplied examples in support of its findings. Staff stated in its response that the GRI report was severely deficient and much improvement was needed for it to be viewed as unbiased, comprehensive, and useful. The project manager acknowledged the concerns raised by Safety Board staff and advised that he would stress the need for objectivity in the report rewrite. On May 17, 1984, Safety Board staff received by mail a copy of the GRI report rewrite and minutes later received a telephone call from the project manager urging prompt review and comment. To expedite the review, staff began checking the report against concerns previously voiced. It became immediately obvious that the GRI project manager had not addressed concerns expressed by Safety Board staff or by others who had responded to GRI's *Draft Final Report*. Safety Board staff advised the Board Members that it was obvious that the GRI had no intention of providing an objective document for use by the industry, the public, or the Safety Board.

In December 1985, the GRI published its report *Cost and Benefits of Excess Flow Valves in Gas Distribution Services*. The stated objective of the report was to compare the cost and benefits of installing EFVs in gas distribution services operating at pressures equal to or

[10]Final Report (April 1982 - August 1984), *Assessment of Excess Flow Valves in Gas Distribution Service Lines*, Gas Research Institute, Chicago, Illinois 60631, August 1985.

greater than 10 psig. Many of the report's conclusions were based on the GRI's August 1985 report. Among the findings were the following:

> Certain EFVs available today are reliable and require a minimum of maintenance. The problems that occasionally arise with new EFVs are largely attributable to human error.
>
> Although it may not be justifiable on the basis of a cost-benefit analysis basis, societal perception of risk suggests that it would be prudent for the gas distribution industry to utilize a specially designed reliable gas detection/alarm/shut-off system to protect buildings designed for public assembly against all combustible gas leaks. Existing EFVs are not adequate for this purpose, but a reliable system can be developed from existing technology.[11]
>
> The potential for a large volumetric loss of gas from a ruptured farm tap suggests that it would be economically prudent to install an EFV on farm taps even though the risk to the public from such an event is small.
>
> The use of EFVs having low bleed-by flow rates on service stubs attached to medium- and high-pressure mains intended for new housing developments should be considered by the gas industry from economic, convenience and employee safety standpoints.

On March 17, 1986, RSPA advised the Safety Board that since the GRI report did not demonstrate a definite cost benefit or confirm the reliability of EFVs, it was not practical or reasonable to propose safety regulations that could impose significant economic or operating burdens on the industry with questionable benefits to the public. RSPA did not address the adequacy of the GRI report or the numerous comments GRI received concerning deficiencies in its work.

On August 11, 1986, the Safety Board told RSPA about the numerous deficiencies in the GRI report. The Board said that it was clear that the GRI work did not satisfy the intent of Safety Recommendations P-81-35 and -36 and that consequently, RSPA would not receive the guidance it needed to accomplish the intent of Safety Recommendation P-81-39. The Board classified Safety Recommendation P-81-39 "Closed--Reconsidered" and advised RSPA that it had not tied compliance with Safety Recommendation P-81-38 to the findings of the GRI study and did not believe that the GRI study was relevant. Because RSPA's letter did not include plans for acting on the recommendation, the Safety Board classified it "Closed--Unacceptable Action" and urged RSPA to take the actions necessary for requiring the installation of EFVs on all new and renewed single-family residential high-pressure services.

[11]Since the late 1950s, MAXITROL has manufactured a valve suitable for use as an EFV for large-volume gas flows that could be installed in gas service lines to buildings that are used for public assembly and for multi-tenant dwellings.

APPENDIX B

After much study of the GRI reports and many discussions between GRI and Safety Board management during the development of the reports, on October 26, 1987, the Safety Board told the GRI that the Board had rejected the GRI reports as biased. The Board said Safety Recommendations P-81-35 and -36 were classified "Closed--Unacceptable Action." In the GRI's November 13, 1987, response the president suggested that the Board had not been fair when it classified the safety recommendations and that the Safety Board and the GRI have a meeting.

On November 25, 1988, a residence in Kansas City, Missouri, exploded, killing a 2-year-old boy and injuring five other persons. An attempt was made to repressure the 1 1/4-inch-diameter steel service line to the house, but it would not hold pressure. A meter was connected to the service line, gas at 28 psig pressure was fed into the service line, and the rate of gas escape was measured and determined to be 1,200 cubic feet per hour. Uncovering the service line revealed a large opening at the bottom of the pipe at a threaded joint. The opening had been caused by a combination of joint weakening from corrosion and downward pressure from soil settlement. Because of the documented gas flow rate from the undisturbed, failed pipe joint, the Safety Board concluded that the consequences of the accident would have been substantially reduced had the service line been equipped with an EFV.[12]

On March 21, 1988, GRI management met with Safety Board management to discuss the Safety Board's concerns about the GRI's lack of objectivity and accuracy. Although GRI management acknowledged the merits of many Safety Board concerns, it stated that further work to correct deficiencies would not be performed because the GRI had already devoted too much time and money to the project. After reconsidering the GRI's work, on September 27, 1988, the Safety Board Chairman advised the GRI that the Board had concluded that the GRI had not met the objective of Safety Recommendation P-81-36 and that the report was biased and not at all objective regarding where EFVs could be used to improve public safety and prevent death, injury, and property damage. The status of the recommendation remained "Closed-Unacceptable Action."

On February 10, 1989, a residence in Oak Grove, Missouri, exploded, killing two people.[13] An attempt was made to repressure the steel service line, but, like the Kansas City service line, it would not hold pressure. Uncovering the service line revealed a large opening at the bottom of the pipe at a threaded joint similar to the November 25, 1988, pipe rupture at Kansas City, Missouri, in failure opening size and failure mechanism. The Safety Board,

[12]National Transportation Safety Board Pipeline Accident Report, *Kansas Power and Light Company, Natural Gas Pipeline Accidents, September 16, 1988 to March 29, 1989*, (NTSB/PAR-90/01).

[13]National Transportation Safety Board Pipeline Accident Report, *Kansas Power and Light Company, Natural Gas Pipeline Accidents, September 16, 1988 to March 29, 1989*,(NTSB/PAR-90/01).

because of the similarities in these two accidents, concluded that the consequences of this accident would have been substantially reduced had the service line been equipped with an EFV.

On October 10, 1990, the Safety Board approved the development of a "Most Wanted" safety recommendation list to highlight recommendations that, if implemented, offered the greatest potential for saving lives. Included on the list was the need to use EFVs in gas service lines. The two safety recommendations cited were Safety Recommendations P-90-6 and -12, calling for the American Gas Association and the American Public Gas Association to encourage their members to advise their customers of the safety benefits of EFVs and offer them an opportunity to have an EFV installed in their high-pressure gas service line and calling for RSPA to require the installation of EFVs in new and renewed single-family residential high-pressure service lines.

Soon after EFVs were included on the "Most Wanted" list, on December 20, 1990, RSPA issued its first rulemaking on EFVs (55 *FR* 52188). The Advanced Notice of Proposed Rulemaking (ANPRM) requested information to aid RSPA in choosing (1) to require the installation of EFVs in all new and existing service lines over an appropriate period of time, (2) to require the installations of EFVs in all new and replaced service lines operating at 5 psig pressure or above, or (3) to make no changes to the existing regulations. The ANPRM asked for information about gas operators who had used EFVs but no longer were, operators who were then using EFVs, and operators who had never used EFVs. Contrary to RSPA's claim to Congress, the 1991 cost/benefit study did not accompany the NPRM. Rather, the study, dated November 22, 1991, was placed in the public docket without notice on September 12, 1992. While some people learned of the study by searching the public docket and made the study known to others, RSPA made no public comment about the study until it issued its April 21, 1993, NPRM.

RSPA's files indicate 177 responses to the ANPRM; however, several entries were not rulemaking responses; rather they were RSPA staff memorandums to document RSPA employee conversations on EFV-related questions. Thirty-three of the responses entered in the docket were form letters sent in from Georgia municipalities in response to a Georgia Public Service Commissioner’s request, and 71 responses were photocopies of RSPA's ANPRM questionnaire with blanks filled in with handwritten numbers on service-line operating pressure ranges and numbers of services installed new or renewed; seldom was there any response to the many questions RSPA had asked, and most often those filings were not signed.

Except for the few users of EFVs who had provided detailed information, the responses were not informative enough to aid RSPA in deciding which of the three alternatives it should pursue.

APPENDIX B

RSPA's April 1993 preamble in its later NPRM characterized the commenters to this ANPRM as:

Category/Description	**No. of Operators**	**Total No. Services**
1a-Never used EFVs	139	22.4 million
1b-Once used EFVs but no longer use	16	5.6 million
1c-Now use EFVs	22	4.7 million
Total	177	32.7 million

On February 20, 1991, H.R. 977, the Pipeline Safety Act of 1991 was introduced in the House by Representative Curt Weldon. Included in that bill was a mandate for RSPA to require gas operators to install EFVs on all new and renewed gas service lines used to serve single family high-pressure gas service lines. Among his many comments supporting the bill, Representative Weldon stated, "Until now, natural gas safety has never been publicly questioned because natural gas accidents have been poorly catalogued by the Federal Government...The costs associated with natural gas explosions are also grossly underestimated, as are the actual number of deaths." He said that accident cost estimates are generally made by an official at the scene based on his first observations and the deaths that occur instantly are the only ones reported. He said that the expenses of the following are generally not included: what insurance companies pay claimants, the cost of the firemen, policemen, and equipment at the scene; the cost of evacuating residents; the cost of lost business and destroyed personal goods, the cost of the gas lost in fire or to the atmosphere; and the cost of repairing the gas line. He stated that the importance of these facts to the welfare and safety of the public is that if a Federal regulation is to be issued, it must first pass the test of a cost/benefit analysis.

On October 5, 1991, S. 16628, the Pipeline Safety Bill of 1992 was introduced in the Senate by Senator Lautenberg of New Jersey. Included in that bill was a mandate for RSPA to require gas operators to install EFVs on all new and renewed gas service lines used to serve single family high-pressure gas service lines.

On November 22, 1991, RSPA completed its report *Excess Flow Valve Benefit/Cost Analysis*, which had been prepared by the Volpe National Transportation Systems Center. Without noting exceptions to the procedures or data used, RSPA's report cited an August 26,

1991, EFV cost/benefit study[14] performed for the GRI. RSPA reported that using the figures developed in that study, the benefit-to-cost ratio would be 0.07, i.e. less than beneficial. Even in light of the study cited, RSPA's study found that the estimated benefit-to-cost ratio of installing EFVs was between 1.04 to 1.73. It concluded that since the benefit-to-cost ratio was greater than 1.00, the installation of EFVs on all new or renewed single-family residential natural gas services was expected to be cost beneficial. On review of the RSPA report, the Safety Board found it to be replete with errors and unsupported assumptions. A September 4, 1992, Safety Board staff memorandum cited several deficiencies with the RSPA study and said that the Board can not "endorse or use RSPA's analysis in support of mandatory installation of EFVs any more that we could endorse use of the GRI's report that was replete with unsupported assumptions."

RSPA's lack of action on requiring the use of EFVs was recognized by Congress. On October 24, 1992, Public Law 102-508 (106 STAT. 3290) became law and required the DOT Secretary to issue regulations within 18 months prescribing the circumstances, if any, under which operators of natural gas distribution systems had to install EFVs. The law also required the Secretary to issue within 2 years requirements for gas-distribution system operators to notify, in writing, their customers with lines in which EFVs were not required by law, but could be installed in accordance with performance standards prescribed by the Secretary, of the availability of EFVs and the benefits to be derived from installing them.

Reacting to the requirements of Public Law 102-508, on April 21, 1993, RSPA issued its Notice of Proposed Rulemaking (NPRM), "Excess Flow Valve Installation on Service Lines; Proposed Rule." The NPRM proposed mandating the installation of EFVs in new and renewed single-family high-pressure gas service lines, citing the positive benefit/cost ratio determined in the Volpe Center's 1991 report and the fact that EFVs would cost only $20. There were more than 160 docket entries for the April 1993 notice. Most of the responses addressed the deficiencies in RSPA's cost benefit study and criticized RSPA's proposal to allow use of positive shutoff EFVs only, rather than commenting on whether EFVs should be required. In general, it appears that a majority of the commenters acknowledged the usefulness of EFVs and at the same time expressed the belief that their use should be voluntary rather than mandatory. As with the previous notice, it was not possible to categorize most comments as being favorable to using or not using EFVs or to differentiate the comments according to companies that did use, those that had used but no longer did, and those that had never used EFVs. Also as with the previous notice, there were many form-letter responses, primarily from municipal-owner gas systems. Several companies were innovative with their filings: they submitted comments under as many as four different names.

[14]Risk and Industrial Safety Consultants, Inc., *Cost Benefit Analysis of Excess Flow Valves: An Update*, A topical report prepared for the Environmental and Safety Research Department, Gas research Institute, Chicago, August 26, 1991.

APPENDIX B

Comments to the NPRM advised RSPA that EFVs were commercially available and were being used for nonresidential as well as residential gas services. RSPA was told that EFVs could operate properly down to 5 psig pressure and that EFVs for protecting higher capacity gas service lines for multiple residential, commercial, and industrial facilities had been available for many years The same information had been given to RSPA in responses to its 1990 ANPRM. EFVs ranged from 1 1/4-inch to 8 inches in diameter and could be used on gas pressures up to 100 psig at the EFV inlet. RSPA was informed that EFVs were available also for multiple meter applications and for small commercial applications that had service lines up to 1 inch in diameter. Additionally, some manufacturers had since the early 1950s offered large EFVs for such large commercial gas service loads as schools, hospitals, and industrial facilities.

The GRI commented on deficiencies and errors in RSPA's cost benefit study and supported its contentions by citing information in the GRI reports already characterized as deficient by the Safety Board and others.

A State regulatory agency commenting on RSPA's characterization of the comments to the ANPRM took exception to RSPA's statement that all commenters were opposed to the mandatory use of EFVs. It then separated the comments into two categories: those opposed to EFV use (155), and those endorsing EFV use by being proactive in their use (22). The agency then stated that RSPA had received responses from 155 operators who were anti-EFV and intended to oppose mandatory use of EFVs rather than to create a better regulation. The agency characterized the 22 EFV-user commenters as also opposing mandated use, but as having sent their comments with the intent of helping in the drafting of viable, palatable requirements on using EFVs. The agency then stated that it appeared that RSPA had overlooked the constructive comments of the 22 EFV user commenters and had instead constructed the proposed rule around the negative comments of those non-user operators. The agency then provided comments based on information obtained from a survey of gas system operators in its State representing more than 90,000 service lines equipped with EFVs. In closing, the agency said:

> The intent of the EFV mandate is to protect the public from incidents arising from excavation damage. Based on the above evidence, it is evident that devices are presently in use that meet that goal. Those devices have never failed to act in a model employing 90,000 units over a span of 18 years. The cost-effectiveness is manifested in the voluntary usage of EFVs in a State with a decline in third-party damage to gas pipelines.

The agency then provided comments for improving the proposed EFV requirement it had obtained from gas operators in its State. The agency characterized the gas operators as favoring the use of EFVs even though there was an effective excavation-damage prevention program in the State, as opposed to favoring any mandatory requirement for using EFVs and as

opposed to favoring the proposed rule, which seemed to neglect the performance standards the gas operators had used and proven by experience to be successful.

One company's response characterized its system as the nation's largest user of EFVs with about 20 years experience in their use. Its comments advised that it did not support mandatory use of EFVs, but that an EFV was a "good, inexpensive, relatively unsophisticated device which can add significantly to the group of safety features in a natural gas distribution system." Its detailed comments criticized RSPA's rulemaking proposal for adding nonessential requirements that tended to make the use of EFVs less desirable or unnecessarily costly. The response advised that in nearly 20 years it had had only one or two instances that might be attributable to a defective EFV and that it used more than 200,000 EFVs of the bleed-by type.

An individual with many years experience in using EFVs called RSPA's proposal counterproductive because, he said, it had taken a relatively simple concept and created a very broad proposal that was far more sophisticated and costly than necessary.

A Congressman said he was worried that the proposal could restrict rather than encourage the use of EFVs. He stated his belief that the proposal did not reflect existing technology and therefore did not provide the utmost in safety for firefighters and rescue personnel. He stated that many of the more than 9,000 fires annually resulted in firefighters being exposed unnecessarily to the dangers of uncontrolled gas escaping from piping where it connects to the building because manual shutoff valves were inaccessible and frequently valuable time was lost while firefighters waited for the gas company to reach the scene to shut off the flow of gas. He commented that RSPA's proposal ignored data gathered in previous rulemaking proposals, including RSPA's cost/benefit analysis on EFVs with a by pass feature, and that the stringent performance standards RSPA proposed to impose added significant costs unnecessarily. To emphasize his point, he noted RSPA's improper use of data from one company on EFV high false closure rates resulting from improper installation and from human error. He stated that if operator error was a problem, the solution was not to require added performance standards for the EFVs; rather, it was to require the appropriate education and training of the operators.

The International Association of Fire Chiefs (IAFC) commented in support of the proposal to use EFVs on new and renewed services and expressed its support for requiring the retroactive installation of EFVs on all gas services. The IAFC commented that its members believed that the estimated 1,000,000 plus EFVs to be installed annually would help validate the effectiveness of EFVs while initiating their widespread use as a welcome safety feature, especially to firefighters.

A valve manufacturer advised RSPA that of the approximate 800,000 of its valves installed in gas systems, about 900 activated each year and turned potential fires and explosions into routine repair situations causing little or no damage. Additionally, this commenter advised

APPENDIX B

RSPA of the experiences of several gas company operators: EFVs installed in their systems had activated and significantly reduced the losses that would have occurred had an EFV not been installed. The companies were:

A New Jersey gas operator advised that it had installed 18,000 EFVs since 1980. Since that time, 125 EFVs had activated to prevent incidents.

A Pennsylvania gas operator advised that it had installed 50,000 EFVs and that more than 17 activated annually in response to outside-force damage events.

A Massachusetts gas operator advised that it had installed more than 40,000 EFVs and that more than 40 activated annually in response to outside-force damage events.

A New York gas operator advised that it had installed 4,000 EFVs since October 1990. In the first 8 months, 40 had activated in response to outside-force damage events.

An Ohio-based gas operator advised that it had installed 8,000 EFVs in a four-State area. Between January 1992 and June 1993, 144 EFVs had activated in response to outside-force damage events.

A South Carolina gas operator advised that it had installed 280 EFVs since October 1991. Through June 1993, 15 EFVs had activated in response to outside-force damage events. On June 14, 1993, a motorist struck a high-pressure (450 psig) farm tap, breaking the service pipe. The EFV in the service immediately stopped the flow of gas. According to the gas system superintendent, without the EFV, a house would have been destroyed by fire, and several gas operator employees would have been severely injured or killed.

A Massachusetts gas operator reported that during a hurricane in October 1991, 22 houses were moved on their foundations, breaking their gas lines. All EFVs activated properly to stop the flow of gas into the houses, where it could have exploded.

An Ohio gas operator reported it had installed only 150 EFVs. An automobile struck a high-pressure farm tap equipped with an EFV, shearing the service line at ground level. The EFV activated properly, stopping the flow of the escaping gas and preventing an explosion.

Another Ohio gas operator advised that it had installed over 200,000 EFVs. When an electric-utility employee burned through an exposed plastic service line equipped with an EFV, the escaping gas ignited; but the prompt activation of the EFV shut off the flow of gas, causing the fire to extinguish. According to the gas operator, had the EFV not been installed, the employee would probably have been killed.

A valve manufacturer cited statistics indicating that gas operators responded annually to more than 30,000 instances of damage to pipelines caused by excavators who had not notified the gas operators in advance so the location of the pipelines could be marked before excavation. The commenter advised that EFVs could prove quite useful in minimizing gas releases in such instances.

In a 2-month period, the Safety Board investigated two fatal accidents with consequences that could have been reduced significantly if an EFV had been installed. On June 9,1993, a house in Aberdeen, New Jersey, exploded, killing three people and injuring three others.[15]A contractor excavating to replace a 2-inch-diameter gas main struck and ruptured at two locations an unused service-line segment. The contractor repaired the ruptured pipe segment near the excavation, but was unaware of the second rupture. Gas flowed into an old house foundation that lay beneath asphalt paving and into the residence, where it exploded. The Safety Board determined that the potential for the building to have exploded would have been minimal had the service line been equipped with an EFV. The report noted also that the Safety Board has recommended the use of EFVs for more than 20 years and continues to believe that EFVs should be installed on all new and renewed gas service lines.

On July 22, 1993, a backhoe hooked and pulled apart a 1-inch high-pressure, plastic service line, breaking it at an elbow fitting within a foot of the building's foundation wall.[16] Venting gas rapidly flapped the canvas entry awning over the doorway, damaged lighting under the canopy, and migrated through the foundation wall into the building. About 20 minutes after the service line was damaged, an explosion occurred, followed by a natural gas-fueled fire. The explosion force caused part of the building to land on and flatten an automobile traveling on an nearby street, and the driver died instantly. The explosion and ensuing fire also killed a building occupant and a person outside the building, and they injured 12 people.

On August 13, 1993, the OPS director met with people and representatives of associations interested in the EFV rulemaking to discuss entering into a rulemaking negotiation. Representatives of the Safety Board, congressional staffs, pipeline companies, State pipeline safety regulatory bodies, pipeline industry trade associations, consumer groups, and EFV manufacturers attended. The OPS director stated that the rulemaking process had not yielded sufficient information for the OPS to proceed with a final rule. The director of the OPS said that it appeared that a negotiated process was needed due to the contentious nature of the proposed EFV rule. He suggested that interested parties might want to participate in a negotiated

[15]Pipeline Accident Brief Report, *Northern States Power Company Explosion and Fire at St. Paul, Minnesota, on July 22, 1993* (DCA-93-MP-011).

[16]Pipeline Accident Brief Report, *New Jersey Natural Gas Company Explosion and Fire at Cliffwood Beach, New Jersey, on June 9, 1993* (DCA-93-FP-008).

rulemaking process, and he then explained the procedures. After much discussion, those in attendance expressed concern that their participation would be unproductive since RSPA would not be bound by the results of the negotiations. Many also said that the process was unnecessarily lengthy and cumbersome. The OPS director then stated that the negotiation process probably would be too long to meet RSPA's statutory time frame for issuing a final rule. None in attendance supported OPS's proposed negotiated rule process. Several people suggested that those who were interested should meet to develop a consensus agreement on using EFVs. The OPS director agreed that the OPS would publish an alternative proposed consensus rule developed by a group of "interested parties" (gas industry, State regulators, congressional committee staff, and the Safety Board) as a supplemental rulemaking and said he would provide a 30-day period for comments.

Consistent with the OPS director's agreement, the American Gas Association (AGA) and the Safety Board staffs jointly held meetings to determine whether there was sufficient interest to formulate an alternative proposal for submission to the OPS. Sixteen parties of interest, which later became known to the OPS as the Joint Commenters, expressed their desire to unite in a common effort to develop a unified, supportable position. Participants in the effort included the AGA, the American Public Gas Association (APGA), the Interstate Natural Gas Association of America (INGAA), the National Association of Pipeline Safety Representatives (NAPSR), the National Association of Regulatory Utility Commissioners (NARUC), the Gas Safety Action Council (GSAC), the International Association of Fire Chiefs (IAFC), eight EFV manufacturers, and the Safety Board. These interest groups, as well as several gas distribution operators, held several meetings and corresponded on proposals by FAX, mail, and telephone to develop a proposal as a means of ending the OPS's many years of unproductive deliberations.

On December 14, 1993, the Joint Commenters filed their proposal with the OPS. Those comments were endorsed by the AGA, APGA, INGAA. GSAC, five EFV manufacturers, and, by separate letters, by the Safety Board. The Joint Commenters said that the organizations endorsing the proposal represented most identifiable interests in the matter and that the proposed-rule language was a consensus agreement. The commenters also told the OPS:

> Much of the information necessary to accurately assess the costs and benefits of EFVs is incomplete or unavailable; therefore we support a cooperative effort between the American Gas Association and EFV manufacturers to begin collecting data on the in-service performance of the approximately 1 million EFVs that will be installed annually if the rule we propose is promulgated.

RSPA published its Notice of Reopening Comment Period (Docket PS-118, Notice 4) on August 2, 1994. RSPA requested comments on whether it should adopt the Joint Commenters' proposal but, contrary to the commitment made by the OPS director, did not include the proposal in the Notice. Instead, the Notice said the proposal had been placed in the

public docket for review. Other than a mere mention of the Joint Commenters' proposal and a statement that RSPA desired to receive comments on it, RSPA devoted the rulemaking discussion to eliciting comments on the safety of the EFV bypass feature, the effect of contaminants on EFVs, and whether RSPA should await completion by industry-sponsored standard committees before proceeding with the EFV rulemaking--items not mention in the Joint Commenters' proposal. The Notice stated that RSPA's regulatory evaluation indicated that an aggregate annual savings of $19 to $31 million would result from reduced deaths, injuries, fires, explosions, and evacuations. The Safety Board urged RSPA to accept the Joint Commenters' proposal and to expedite issuance of a final rule.

A review of RSPA's docket index indicated that there were 74 responses to Notice 4, but only 70 responses were included. Of the 70 responses, 38 supported the Joint Commenters' proposal, 3 neither supported nor opposed EFVs, 5 opposed requiring EFVs (but 2 of the 5 urged RSPA to use the Joint Commenters' proposal if EFVs were mandated, and 1 advised that it was developing an EFV standard), and 24 (one company filed two opposing responses) either did not support using EFVs because they were not convinced that enough research had been performed or because they were strongly opposed to using EFVs. The AGA and the APGA, (the two industry associations that represent most of the more than 1,400 gas-distribution pipeline operators) agreed to accept the Joint Commenters' proposal. Many commenters stated again their objection to RSPA requiring the installation of EFVs; but overwhelmingly, the commenters continued to disagree with RSPA's characterizations of problems RSPA associated with using automatic-reset valves versus manual-reset valves and with RSPA's obvious desire to allow the use only of manual-reset EFVs.

On September 27, 1994, 17 congressional representatives cosigned a letter to the DOT Secretary, expressing their extreme disappointment with the DOT's response to the serious problem of pipeline safety in this country and then criticizing RSPA for languishing rather than making a decision about EFVs. The cosigners said that the EFV issue was of great importance to them and urged the Secretary to look into their concerns.

RSPA disregarded the counsel of the Joint Commenters that the data necessary to perform an objective, effective cost/benefit study was not available, as well as the counsel of those who responded to the Notice of Reopening of Comment. In 1994/95, again using the same Volpe National Transportation Safety Institute employees who performed the flawed 1991 EFV benefit/cost study, RSPA developed what it termed a "cost/benefit study."[17] The new study did not acknowledge the extent and severity of criticism from the AGA, CSAC, and others of RSPA's incorrect use of data in the 1991 study. The AGA found the 1991 study flawed enough to cause irreparable harm to the gas industry, and it seriously considered suing RSPA to prevent it from releasing the study.

[17]"Excess Flow Valve Benefit/Cost Analysis," January 1995.

APPENDIX B

Although not much had changed about EFVs since RSPA's previous study, except that EFV manufacturers had lowered the price, the new study reported that the benefit-to-cost ratios for the installation of automatic-reset and manual-reset EFVs were 0.25 and 0.20, respectively. The report concluded that because the benefit-to-cost ratios were less than 1.00, the installation of EFVs on all new or renewed single-family residential natural gas services was not expected to be cost beneficial.

The 1995 cost/benefit study corrected some of the errors in the 1991 study, but added new ones. RSPA's 1995 study used only two accidents to determine the benefits of using EFVs, even though RSPA was aware of many other accidents in which EFVs had operated to minimize the consequences. In addition to the published articles on EFV activations that minimized accident consequences in Bay State Gas's system, the Popular Grove Utility District in Atoka, Tennessee, described in its comments to RSPA's Docket No. 118, Notice 4, two incidents that had occurred recently in which EFVs had significantly reduced potential losses. They were as follows:

> In the winter of 1993 in the western part of our district, the local fire department was called to a house fire at 799 Grimes Road. When they arrived, the house was fully involved, and the gas meter and regulator were about to be melted by the intense heat. According to a fireman at the scene, as soon as the meter and regulator melted down, the EFV activated and shut the gas flow down to where there was only a small flame on the riser pipe.
>
> This past summer, the driver of a car lost control of his vehicle, left the road and ran under a house located at 7590 Mt. Carmel Road. Our gas meter was located on the same side of the house and was clipped off by the car, leaving only the riser, which was only releasing a small amount of gas because the EFV was activated by the sudden surge of gas. The occupant of the car was unconscious and had to be removed by the E.M.T.s, as I understand. When the valve closed, this greatly reduced the danger to the occupant and the emergency personnel that were working the accident.

The gas system manager added that although the system had been operating only a short time (since September 1993), his experience with EFVs had always been positive and EFVs had saved his system money and helped to save lives and property.

On March 9, 1995, the OPS director, testifying before the Subcommittee on Energy and Power of the House Committee on Commerce, announced that the DOT had decided not to issue a final rule requiring the installation of EFVs on gas service lines. Instead, the DOT elected to comply with the provisions of the Gas Pipeline Safety Act of 1992 (106 STAT. 3290) that require it to issue technical specifications on using EFVs and require pipeline

operators to notify their customers of the availability of EFVs. The OPS director stated that the RSPA Administrator believed that this approach contributed to a sensible regulatory system that protected the American people without imposing an unnecessary cost on society.

The two-accident sample RSPA used in its 1995 study to assess EFV effectiveness is statistically insignificant. Even so, RSPA incorrectly assessed what happened in the two accidents it did use. Although a life was saved when an EFV operated properly in one of the accidents, RSPA attributed its benefit as only 1/5 of the $2.6 million used by the study as the value of a life. That error was further compounded by using 57 percent as an assumed EFV effectiveness percentage. When Safety Board representatives met with RSPA on March 16, 1995, it questioned RSPA about the basis for the effectiveness percentage. A RSPA economist explained that 95 percent effectiveness was initially used, but that number was reduced because a National Highway Traffic Safety Administration (NHTSA) analyst, not knowledgeable about EFVs, said he believed the number was to high. RSPA stated that even though it had no justification for a different percentage, it offered 57 percent as the effectiveness percentage, and the NHTSA analyst accepted it, saying that it seemed about right. Other parts of RSPA's study appear to include similar insupportable numbers and assumptions.

Safety Board representatives asked RSPA ones why RSPA insisted on performing a cost/benefit study even after being advised by the Joint Commenters that data sufficient to perform an valid study did not exist. RSPA acknowledged that the available data was insufficient, but then stated that it was obliged by Department rules to produce a study. The Safety Board suggested that with RSPA's persistence on performing some type of cost/benefit study, that it should perform a sensitivity analysis of the data used to assess the effects of the large variances on costs and other information submitted by EFV users and EFV non-users and, as well, the potential effects of various assumptions that RSPA could make rationally to fill the information gaps where data was not available. RSPA acknowledged that the cost/benefit ratio could vary widely, depending on the cost selections and assumptions; but it insisted that operators who provided data were obliged to provide accurate, unbiased data in response to rulemakings. Although it had done nothing to test the extent of variance, RSPA stated that it did not believe such an analysis was necessary. RSPA's 1991 and 1995 cost/benefit studies already show that the cost/benefit ratio can range from positive to negative when assumptions are used as a substitute for data.

On April 4, 1995, the RSPA Administrator sent letters to chairmen of Senate and House committees and subcommittees that had oversight responsibility on pipeline safety. Those letters advised that the RSPA found no circumstance under which RSPA should issue a Federal rule requiring the universal installation of EFVs and that, as required by 49 U.S.C. section 60110, RSPA was planning to issue performance standards and customer-notification requirements for EFVs. The Administrator advised that each of these actions was designed to encourage the increased use of EFVs where appropriate, based on local conditions. A report entitled *Excess Flow Valves,* prepared by RSPA and dated March 1995, was attached to each

letter as support for RSPA's decision. The report contained many inaccurate and/or misleading statements, including the following: *(*Safety Board response follow each statement.)

1. Neither RSPA nor the Sate pipeline programs in Missouri and Kansas believe that any of the accidents addressed in the Safety Board's report on service line failures in the Kansas City, Missouri, area were of the type that could have been mitigated by EFVs since they involved corrosion leaks, not ruptures.

Comment: Two of the three Kansas City service-line accidents were ruptures at pipe joints that had been weakened by corrosion and failed due to earth settlement. In the first case, before the joint was repaired, Missouri Public Service Commission personnel measured the rate at which gas was being released from the failed joint. They determined, based on leakage rate, the service line length and the location of the failure and that one of several commercially available EFVs would have activated to promptly stop the flow of escaping gas. The second corroded-joint failure was also judged to have released gas at a rate sufficient to have activated an EFV, promptly stopping the gas flow. In the third accident, gas flowed from corrosion holes in the service line. Although EFVs are not normally considered to be effective in stopping the flow of gas from corrosion holes, the size of these holes permitted the release of gas at a rate that *might* have activated an EFV.

2. There were 190 comments to RSPA's December 1990 Advance Notice of Proposed Rulemaking that requested information on EFVs.

Comment: See pages 65-66 for comments on ANPRM docket contents.

3. There were 140 written comments in response to RSPA's April 1993 Notice of Proposed Rulemaking [Notice 2] proposing to require the installation of EFVs.

Comment: See pages 67-71 for comments on NPRM docket contents.

4. A group calling itself the Joint Commenters, representing previously adversarial positions, advised that it would support a rule incorporating the alternative regulatory language that it recommended. RSPA issued a Notice of Reopening Comment Period in August 1994 and received 70 comments. That rulemaking language was supported by NTSB, several members of Congress, EFV manufacturers, the Gas Safety Action Council, and the pipeline programs in New York and Massachusetts. However, the rulemaking has been opposed by virtually the entire gas distribution industry, the American Gas Association, and its member companies, the National Association of Pipeline Safety Representatives (NAPSR) (our State partners), and the National Association of Regulatory Utility Commissioners (NARUC).

Comment: See pages 65-66 for information on the Joint Commenters proposal and RSPA's Notice of Reopening of Comment Period.

5. In preparing the 1991 cost/benefit analysis of RSPA's proposal to require the installation of EFVs on new and renewed single family residential gas service lines operating at 10 psig or more, the Volpe National Transportation Systems Center (Volpe Center) used all available data, including data from the questionnaire in RSPA's ANPRM and response thereto. The analysis resulted in a positive cost/to benefit ratio.

   As anticipated, the responses received during the rulemaking proceeding provided considerable new information and data for the cost/benefit analysis, and commenters highlighted problems with various aspects of the cost/benefit analysis that had accompanied the NPRM.

   Comment: See pages 66-71 for information on RSPA's cost benefit studies.

this page intentionally left blank

APPENDIX C

TIME LINE of EVENTS

February 1994	Allentown Housing Authority advertised for bids to remove 8,000-gallon buried fuel tank.
March 21, 1994	Housing authority signed contract with EPAI for tank removal.
May 18, 1994	Allentown issued permit to Environmental Preservation Associates, Inc. (EPAI) for removal of tank.
May 19, 1994	
1:26 p.m.	EPAI provided notice of proposed excavation at Gross Towers on May 23, 1994, to Pennsylvania one-call notification center.
2:25 p.m.	UGI Utilities, Inc. (UGI) employee telephoned EPAI, leaving the message that it had a gas service line to Gross Towers.
May 20, 1994	
8:21 a.m.	UGI employee marked the location of its service line to Gross Towers.
May 23, 1994	EPAI moved equipment to Gross Towers to begin tank removal operations.
	During excavation to remove tank, the west side of EPAI's unshored excavation collapsed, exposing and undermining the support for 20 - 25 feet of the Gross Towers gas service line.
	City inspector observed portion of asphalt parking lot pavement fall onto and deform a portion of the undermined Gross Towers gas service line.
	Two city inspectors at different times commented to the EPAI foreman about the safety of the unsupported gas line.

While the EPAI crew was attempting to lift the tank from the excavation, the cable/chain sling broke, allowing the tank to fall toward the unsupported gas line. Witnesses to this event believed that the tank did not strike the gas line.

The EPAI crew took soil samples for later testing from locations around the concrete support that remained in the excavation.

Without notice to UGI, the EPAI crew placed cross bucks on end between the unsupported service pipe and the soil, placed plastic sheeting on the excavation slopes, placed a plastic barrier around the excavation, and left Gross Towers.

No one reported smelling the odor of gas.

June 9, 1994

8:00 a.m. The EPAI foreman arrived at Gross Towers to complete the tank removal project, which now also required removal of the concrete support and soil from beneath it because tests showed that the soil contained fuel. The foreman observed that the area looked unchanged.

9:00 a.m. The EPAI foreman mentioned to a housing authority employee that the gas line needed to be supported.

12:30 p.m. The EPAI backhoe arrived at Gross Towers.

1:30 p.m. The crossbuck supports earlier placed beneath the unsupported gas line were removed. The foreman noticed no movement of the pipe on removing the crossbucks.

A hydraulic hammer attached to the backhoe bucket was used to break up the concrete support within the excavation.

The backhoe bucket was used to remove the broken pieces of concrete and load them into a dump truck. In so doing, the path of the backhoe to the dump truck was across the unsupported pipe.

6:40 p.m.	The backhoe was repositioned to the west side of the excavation. To reach the west side, the tread-mounted backhoe was driven across the buried portion of the gas pipe near its connection to a compression coupling.
6:45 p.m	The gas service line separated from a compression coupling near the north wall of Gross Towers.
	An EPAI employee smelled the odor of gas, heard a woman on the third floor shout that she smelled a heavy odor of gas, ran to and opened the boiler room door, smelled a heavy odor of gas, and informed the EPAI foreman of his observations.
	The foreman told the backhoe operator to shut off his machine.
6:46 p.m.	The EPAI foreman dialed the UGI switchboard telephone number, which connected him to a recording that provided the UGI after-hours emergency telephone number.
6:47 p.m.	The EPAI foreman called the UGI emergency telephone number (Central Gas Control), advising of a gas leak at Gross Towers and that the gas line had been hit during digging.
6:48 p.m.	The EPAI foreman called the home of the EPAI Vice President.
6:?? p.m.	The foreman instructed his crew to trace the gas line back toward Utica Street to shut off the gas valve.
6:50 p.m.	The EPAI foreman called the UGI emergency telephone number, advising that they definitely hit the gas line and broke it.
6:54 p.m.	The EPAI foreman called the housing authority telephone number, which was routed to an answering service. He advised that they were digging and think they "got" the gas line.
6:58 p.m.	A city policeman working near Gross Towers reported by radio to the Allentown Communication Center that an explosion had just occurred.
6:59 p.m.	The EPAI foreman dialed "911" but was unable to be connected.
7:00 p.m.	The EPAI foreman called the home of the EPAI Vice President.

this page intentionally left blank

APPENDIX D

September 28, 1995, Letter from Safety Board to Research and Special Programs Administration on Excess Flow Valve Recommendation

APPENDIX D

SEP 28 1995

Honorable D. K. Sharma
Administrator
Research and Special Programs Administration
U.S. Department of Transportation
400 Seventh Street, S.W.
Washington, D.C. 20590

Dear Dr. Sharma:

The National Transportation Safety Board has reviewed your April 4, 1995, letter to the chairmen of several U.S. House and Senate committees and subcommittees concerning a proposal to require installation of excess flow valves (EFV). In that letter, you state that the Research and Special Programs Administration (RSPA) identified no circumstances that warrant a Federal regulation mandating universal installation of EFVs.

Your decision not to require installation of EFVs also directly affects the objective of Safety Recommendation P-90-12, which urged RSPA to:

> Require the installation of excess flow valves on new and renewed single-family, residential high pressure service lines which have operating conditions compatible with the rated performance parameters of at least one model of commercially available excess flow valve.

The Safety Board is extremely disappointed in your decision. For more than 20 years, RSPA has failed to objectively assess the benefits of EFVs, and we believe RSPA has again lost an excellent opportunity to provide increased safety for gas customers and the public. Most of the 70 responses to RSPA's Docket No. PS-118, Notice No. 4, supported adoption of a joint commenters' alternate proposal requiring the use of EFVs; supporters included the American Gas Association and the American Public Gas Association, which represent almost all of the Nation's approximately 1,400 gas distribution pipeline operators. In our investigations of distribution pipeline accidents, the Safety Board continues to find strong evidence that supports requiring a means to rapidly shut off gas flow to failed pipe segments. While such a requirement would not prevent accidents, it would significantly reduce their negative consequences. Therefore, the Safety Board classifies Safety Recommendation P-90-12 "Closed–Unacceptable Action."

Your letter also noted that RSPA plans to issue performance standards and customer notification requirements for EFVs, as required by 49 U.S.C., Section 60110, and that these actions are intended to encourage use of EFVs where appropriate, based on local conditions. In so doing, RSPA should recognize that the Congress did not limit RSPA's scope of authority

to use of EFVs on residential service lines or to systems that operate at 10 psig pressure or more. Rather, the Congress deliberately authorized RSPA to consider all possible EFV applications.

RSPA's most recent deliberations on EFV use were based on conditions specified in Safety Recommendation P-90-12; previous Safety Board recommendations to RSPA addressed use of EFVs for service lines to churches, schools, public-use buildings, and other circumstances in which public exposure is significant. (See Safety Recommendations P-73-2; P-76-9A; P-80-38, -39, and -55; and P-81-9.) Moreover, the Natural Gas Pipeline Safety Act does not limit RSPA's consideration of EFV use by type of customer, size of service pipe, or operating pressure.

The Safety Board encourages RSPA to address in its performance standards only those parameters that relate to EFV operating capabilities, such as pressure drop, ability to reset after activation, bleed-by flow rate, and so forth, which are addressed in the Manufacturers Standardization Society's recently approved standard, "Excess Flow Valves for Natural Gas Service." The performance standards should not address factors such as service line diameter, operating pressure, or type of customer served. The Safety Board believes RSPA should not limit EFV use on the basis of customer classifications or service line diameter, especially when service line operating parameters are similar and service lines can be protected using the same style or model of EFV. Nor should RSPA deny customers access to the protection afforded by EFVs based on gas-use volume, since certain EFVs have been designed for and are used by large-volume customers.

In developing its requirements that gas pipeline operators notify customers whose service line operating parameters permit use of EFVs, RSPA should ensure that the information provided to prospective users is easily understandable, straightforward in presentation, and accurate. To achieve this objective, the Safety Board believes that RSPA should require that operators provide prospective EFV users with the names, addresses, and telephone numbers of alternate sources of information about EFVs, such as EFV manufacturers or consumer advocacy groups.

I appreciate your telephone call to ensure that I learned promptly of your decision not to require EFVs. More important, I welcome your offer to work with the Safety Board on encouraging increased use of EFVs to enhance public safety. I look forward to our cooperation in developing a program to further this objective.

Sincerely,

ORIGINAL SIGNED BY
JIM HALL

Jim Hall
Chairman

this page intentionally left blank

APPENDIX E

Gas Piping Technical Committee Excavation Damage Prevention Guidelines

shall carry out in accordance with this section a written program to prevent damage to that pipeline by excavation activities. For the purpose of this section, "excavation activities" include excavation, blasting, boring, tunneling, backfilling, the removal of above ground structures by either explosive or mechanical means, and other earth moving operations. An operator may perform any of the duties required by paragraph (b) of this section through participation in a public service program, such as a "one-call" system, but such participation does not relieve the operator of responsibility for compliance with this section.

(b) The damage prevention program required by paragraph (a) of this section must, at a minimum-

(1) Include the identity, on a current basis, of persons who normally engage in excavation activities in the area in which the pipeline is located.

(2) Provide for notification of the public in the vicinity of the pipeline and actual notification of the persons identified in paragraph (b)(l) of the following as often as needed to make them aware of the damage prevention program:

(i) The program's existence and purpose; and

(ii) How to learn the location of underground pipelines before excavation activities are begun.

(3) Provide a means of receiving and recording notification of ptenned excavation activities.

(4) If the operator has buried pipelines in the area of excavation activity, provide for actual notification of persons who give notice of their intent to excavate of the type of temporary marking to be provided and how to identify the markings.

(5) Provide for temporary marking of buried pipelines in the area of excavation activity before, as far as practical, the activity begins.

(6) Provide as follows for inspection of pipelines that an operator has reason to believe could be damaged by excavation activities:

(i) The inspection must be done as frequently as necessary during and after the activities to verify the integrity of the pipeline; and

(ii) In the case of blasting any inspection must include leakage surveys.

(c) A damage prevention program under this section is not required for the foilowing pipelines:

(1) Pipelines in a Class 1 or 2 location.

(2) Pipelines in a Class 3 location defined by § 192.5(d)(2) that are marked in accordance with § 192.707.

(3) Pipelines to which access is physically controlled by the operator.

(4) Pipelines that are part of a petroleum gas system subject to § 192.11 or part of a distribution system operated by a person in connection with that person's leasing of real property or by a condominium or cooperative association.

GUIDE MATERIAL

1 SCOPE

Note 192.614(c) which lists pipelines excluded from the requirements related to damage prevention programs.

2 WRITTEN PROGRAM

Written procedures should state the purpose and objectives of the damage prevention program, and provide methods and procedures to achieve them. Applicable state and local requirements should be reviewed. The procedures should also include the following.

2.1 *Definition of excavation activities.*

In defining excavation activities to be covered by the damage prevention program, the operator should review the definition in 192.614(a) and applicable state and local requirements.

2.2 *One-call systems.*

The operator should consider participation in an existing one-call system or establishing a one-call system. Applicable state and local requirements should be reviewed. The operator is cautioned that a one-call system may not satisfy all the requirements of 192.614.

2.3 *Identifying entities to be informed of the program.*

(a) Excavators. The sources listed below may be helpful when preparing the list of entities engaged in construction activities. The procedure should provide for a periodic review of the list to Insure that it is current.

(1) One-call center.
(2) Contractor licensing agencies.
(3) Contractor associations.
(4) Local utilities.
(5) Pipeline companies.
(6) Insurance carriers.
(7) State, county, and local road maintenance offices.
(8) Company records.
(9) Farmers and adjacent landowners.
(10) State, county, and local permitting agencies.
(11) Telephone yellow page directory listing such as the following:
(i) Excavating and earth moving contractors.
(ii) Construction contractors.
(iii) Blasting contractors.
(iv) Well drilling and boring contractors.
(v) Landscaping contractors.
(vi) Land leveling and subsoiling contractors.
(vii) Dredging companies.
(viii) Plumbers.
(ix) Fence erectors.
(x) Power line contractors.

(b) The public. The public in the vicinity of the pipeline should be identified.

2.4 *Methods of informing entities of the program.*

Methods of informing entities should Include one or more of the following.

(a) Excavators.
(1) Mailing addressed to the excavator.
(2) Telephone.
(3) Telegram.
(4) Personal visit.

The Operator should consider documenting these actions. Procedures for periodic renotification of excavators should be established based upon utilization of the program.

(b) The public
(1) Mailings.
(2) Bill stuffers.

(3) **Handouts.**
(4) Newspaper, magazine, television and radio advertisements.
(5) Speakers supplied to local groups.
(6) Utilizing permitting authorities and public officials to disseminate information.
(7) Joint mailings with other utilities.
(8) Vehicle advertising sign boards.
(9) Bumper stickers.
(10) Notices in telephone directories.
(11) Public education programs related to 192.615(d).
(12) School programs.

2.5 *Information to be communicated.*
Entities that may engage in excavation activities should be informed of the purpose of the program and how they can learn the location of underground pipelines before commencing excavation activities.

2.6 *Receiving excavation notification,*
The operator should establish a telephone number and mailing address for receiving notifications of planned excavation activities. Provisions should be made for recording all notifications received (such as log, form or memo) and for the retention of such records.

The notification should include the following.
(a) Name of person giving notification.
(b) Name of entity which will be conducting excavation activities.
(c) Telephone number for contacting the entity.
(d) Location of the planned excavation activities.
(e) Date and time of commencement of excavation activities.
(f) Type and scope of excavation activities.

2.7 *Responding to excavation notification.*
(a) Preparation. The operator should deveiop procedures for responding to notifications of intent to excavate. Consideration should be given to the following.
(1) Information about the location of facilities may be obtained from maps, records or field investigation.
(2) Standards should be developed for marking facilities consistent with the field conditions (Including items such as the use of paint on paved areas and stakes, signs or flags in unpaved areas).
(3) Trained personnel should be available to mark facilities as necessary,
(b) Response. Where facilities exist in the area of excavation activity, the operator should respond to the notification prior to the planned commencement of the excavation activity. The operator should consider documenting the responses. The response should Include the following.
(1) The entity should be advised how and when the facilities will be marked.
(2) If there is a potential for misunderstanding concerning the location of facilities or the procedure for marking, an on-site meeting should be suggested.
(3) The operator should point out that the marking represents only the approximate horizontal position of the facilities and that the facilities should be exposed by hand excavation to verify their location.
(4) Any maps, drawings, or records supplied to an excavator to assist in locating underground facilities should be reviewed for accuracy. Unless field checked, it is suggested that they be marked with a note such as "Not responsible for accuracy, verify by hand digging".

(5) When time permits, a pre-excavation meeting may be held with the excavator to discuss all aspects of the planned excavation activities and marking schedules, and to establish lines of communication.

(6) The operator should advise the excavator of the excavator's responsibility to provide support and protection for exposed piping and the need to properly backfill to prevent settlement.

2.8 *Inspecting pipelines.*

(a) Need and schedule. Each notification should be evaluated to determine the need for and the extent of the inspection. Where required, the inspection may include periodic or full-time surveillance and may include leakage surveys. The operator should consider maintaining field contact with the excavator during the excavation activities to avoid potential problems and to promptly resolve any problems that may arise. The following factors should be considered in determining the need for and extent of inspections.

(1) The type and duration of the excavation activity involved.

(2) The proximity to the operator's facilities.

(3) The type of excavating equipment involved.

(4) The importance of the operator's facilities.

(5) The type of area in which the excavation activity is being performed.

(6) The potential for a serious incident should darnage occur.

(7) The past experience of the excavator.

(8) The potential for damage occurring which may not be easily recognized by the excavator such as improper support during excavation and backfill.

(b) Settlement. The operator should pay particular attention, during and after excavation activities, to the possibility of joint leaks and breaks due to settlement when excavation activities occur, especially in threaded-coupled steal and mechanical compression joints.

(c) Cast Iron pipelines. See Guide Material Appendix G-18, "Cast Iron Pipe."

(d) Plastic and steal pipelines. The operator should inspect plastic pipelines for gouges and steel pipelines for coating damage and gouges, when necessary, before the exposed pipeline is back-filled.

(e) Blasting. Leakage surveys should be conducted on pipefines that could have been affected by blasting. For additional guidelines related to blasting activities, see Guide Material Appendix G-16.

192.615 FEDERAL STANDARD

192.615 Emergency plans. (10-1-76)

(a) Each operator shall establish written procedures to minimize the hazard resulting from a gas pipeline emergency. At a minimum, the procedures must provide for the following:

(1) Receiving, identifying, and classifying notices of events which require immediate response by the operator.

(2) Establishing and maintaining adequate means of communication with appropriate fire, police, and other public officials.

(3) Prompt and effective response to a notice of each type of emergency, including the following:

(i) Gas detected inside or near a building

(ii) Fire located near or directly involving a pipeline facility.

this page intentionally left blank

APPENDIX F

Abbreviations Used in this Report

AGA: American Gas Association

APGA: American Public Gas Association

APWA: American Public Works Association

ASME: American Society of Mechanical Engineers

BOCA: Building Officials and Code Administrator

DOT: U.S. Department of Transportation

EFV: excess flow valve

EPAI: Environmental Preservation Associates, Inc., company that was excavating

GPTC: Gas Piping Technology Committee

GSAC: Gas Safety Action Council

housing authority: Allentown Housing Authority

HUD: U.S. Department of Housing and Urban Development Administration

IAFC: International Association of Fire Chiefs

INGAA: Interstate Natural Gas Association of America

NAPSR: National Association of Pipeline Safety Representatives

NARUC: National Association of Regulatory Utility Commissioners

NPRM: Notice of Proposed Rulemaking

OPS: Office of Pipeline Safety, an office within RSPA

OSHA: Occupational Safety and Health Administration, a part of the U.S. Department of Labor that establishes safety standards

PUC: Pennsylvania Public Utilities Commission

RSPA: Research and Special Programs Administration, the part of DOT that is responsible for pipeline safety

UGI: UGI Utilities, Inc., company that owned gas service line that was damaged