EXCESS FLOW VALVE BENEFIT/COST ANALYSIS

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December 1994

Prepared for the

U.S. Department of Transportation
Research and Special Programs Administration
Office of Pipeline Safety
Washington, DC 20590

EXECUTIVE SUMMARY

OVERVIEW

Excess Flow Valves (EFVs) are devices designed to shut off the flow of natural gas automatically in a service line when the line is ruptured, thereby reducing the likelihood of deaths, injuries, property damage, or other accident consequences. EFVs do not prevent accidents; instead, they help prevent or mitigate the consequences of accidents where there has been a substantial or catastrophic break. EFVs can be regarded as complementary to damage prevention programs, one-call systems, and other pipeline safety efforts that focus on preventing accidents.

Both the National Transportation Safety Board (NTSB) and the Office of Pipeline Safety (OPS) of the Research and Special Programs Administration have an on-going interest in the installation of EFVs. The interest of both organizations in EFVs began in the 1970's. The NTSB currently considers the installation of EFVs to be one of the top 18 transportation safety improvements that it would like to see taken. The OPS also currently considers EFVs to be one of its top priorities.

PURPOSE

The OPS is adopting rules that require the installation of EFVs on all new or renewed single-family residential gas services that operate at pressures that are always 10 psig (pounds per square inch gauge) or greater. The purpose of this study is to estimate and compare the benefits and costs of installing EFVs on these services to determine whether such installations would be cost beneficial. The OPS is also requiring the marking of all services with newly installed EFVs on them. This study includes this change in the calculation of the costs.

APPROACH

The approach taken in this study was to estimate the expected benefits and costs of installing one EFV and then use these estimates to calculate a benefit/cost ratio. The EFV data used was taken primarily from (1) the responses made by gas distribution companies to the questionnaire included in the Advance Notice of Proposed Rulemaking (ANPRM) on Excess Valve Installation on Service Lines that was issued by the OPS on December 20, 1990 and (2) responses to various Notices of Proposed Rulemaking. Of the 176 companies that responded to the ANPRM, 137 had never used EFVs, 17 had installed EFVs but had discontinued their installation, and 22 currently install EFVs. The incident data used was taken primarily from the incident reports filed with the OPS by gas distribution companies. All dollar figures presented in the Executive Summary are given in constant 1993 dollars, unless otherwise indicated.

PREVIOUS BENEFIT/COST ANALYSES

Three previous benefit/cost analyses have estimated and compared the benefits and costs of installing EFVs on gas services. These were (1) a study performed by Mechanics Research, Inc., for the OPS in 1974, (2) a study performed by Risk & Industrial Safety Consultants, Inc. (RISC), for the Gas Research Institute (GRI) in 1985, and (3) an update of the 1985 RISC study performed by RISC for GRI in 1991. All of the studies concluded that the installation of EFVs would not be cost beneficial.

BACKGROUND

Currently available EFVs either permit the bleed-by of natural gas when tripped (EFVs with bleed-by) or completely shut off the flow of natural gas when tripped (EFVs with positive shut-off). EFVs with bleed-by are automatically resetting. EFVs with positive shut-off must be manually reset. Almost all EFVs installed to date permit the bleed-by of natural gas when tripped.

Approximately one million EFVs are currently in service. Of these, approximately 700,000 are EFVs with bleed-by that use a spring and plunger design; the majority of the remainder are EFVs with bleed-by that use a ball and magnet design. An estimated 45 companies currently use EFVs. The companies that currently or formerly installed EFVs have reported mixed experiences with them. Some, such as Minnegasco, have reported that EFVs did not perform as expected and have regretted their decision to install them. Others, such as Bay State Gas and East Ohio Gas, have been quite satisfied with the performance of the EFVs that have been installed.

New York is the only state to have adopted regulations requiring EFVs on any service line operating at 125 psig or more. The state of California is interested in determining the effectiveness of EFVs in reducing damage to gas systems resulting from seismic events.

BENEFITS

The benefits of installing EFVs on single-family residential natural gas services result from reductions in the deaths, injuries, property damage, fires and explosions, evacuations, and lost gas that can occur when there has been a substantial or catastrophic break in a service line. It was found that the number of injuries not requiring in-patient hospitalization could not be determined. Consequently, the benefits resulting from the reduction in these are not included in the benefits estimated for this study. Instead, these represent additional, but uncalculated, benefits that would result from the installation of EFVs.

The approach taken to estimate the benefits was to (1) estimate the incident and consequence rates in the absence of EFVs, (2) estimate the reduction in consequences expected to result from the installation of EFVs, and (3) estimate the expected benefits using the previously derived estimates. In the calculation of the expected benefits, the reduction in the consequences of both incidents reportable to the OPS (reportable incidents) and incidents not reportable to the OPS (nonreportable incidents) are considered. Reportable incidents are any incidents with a death, an injury requiring hospitalization, $50,000 (nominal) or more in property damage, or an event that the gas distribution system operator considers significant even though it does not meet any other reporting criteria.

Incident Consequences in the Absence of EFVs

Reportable Incidents in the Absence of EFVs--During the 36-month period between March 1991 and February 1994, there were 30 incidents on services (and related appurtenances) reported to the OPS where EFVs could have potentially mitigated the consequences. These were incidents where (1) the nominal diameter of the pipe was less than or equal to 1.25 inches, (2) the operating pressure was greater than or equal to 10 psig, and (3) a substantial break occurred. None of the incidents were reported to have occurred on services with EFVs. All of these incidents occurred on single-family residential services. The 30 incidents resulted in 2 deaths, 16 injuries requiring hospitalization, and $3,249,595 in property damage. Based on property damage figures provided in NTSB gas pipeline accident reports, the property damage figure for the 30 incidents, derived from the incident reports submitted to the OPS, was felt to understate the value of the property damage that actually occurred. Consequently, the property damage figure for the 30 incidents was multiplied by 1.3 in order to get a more realistic estimate of the true value of the property damage.

The estimated incidents, deaths, injuries requiring in-patient hospitalization, and property damage per service per year occurring as a result of the reportable incidents are

- Incidents = 0.00000077
- Deaths = 0.00000005
- Injuries = 0.00000041
- Property damage = $0.11.

The final rule will require the installation of EFVs on an estimated 13 million existing services owned by gas distribution companies when the services are replaced or renewed.

Nonreportable Incidents in the Absence of EFVs--Gas distribution system incidents where property damage is less than $50,000 (nominal) do not have to be reported to the OPS, provided there are no deaths or injuries. Nonreportable incidents whose consequences could potentially be mitigated by EFVs result in property damage that is estimated at $0.36 per service per year.

Fires and Explosions Occurring With Reportable and Nonreportable Incidents--Both reportable and nonreportable incidents sometimes result in fires and explosions. The fires must be put out and the explosions must be responded to. The total cost of fighting fires and responding to explosions that occur during incidents whose consequences could potentially be mitigated by EFVs is estimated to be $0.05 per service per year.

Evacuations in the Absence of EFVs--The cost of an evacuation due to a fire or explosion will be the total value of the lost time and foregone activities of the individuals evacuated multiplied by the amount of time the individuals are away from their residences, plus the cost of alternative housing for those who need temporary substitute housing. The expected cost of evacuation resulting from incidents whose consequences could potentially be mitigated by EFVs is estimated to be $0.16 per service per year.

Lost Gas--During incidents natural gas will be lost. The value of the gas lost due to incidents whose consequences could potentially have been mitigated by EFVs is estimated to be $0.02 per service per year.

Total Consequences in the Absence of EFVs--The total consequences per service per year on gas services where EFVs could be of some benefit are as follows:

- Deaths = 0.00000005
- Injuries = 0.00000041
- Property damage resulting from reportable incidents = $0.11
- Property damage resulting from nonreportable incidents = $0.36
- Cost of fighting fires and responding to explosions = $0.05
- Cost of evacuations = $0.16
- Value of lost gas = $0.02.

Expected Reduction in Consequences

Information on the reduction of consequences that can be expected from the installation of EFVs is sparse. There have been only two incidents reported to the OPS in which an EFV tripped as a result of a break in a service. These incidents occurred on services with a nominal diameter that was less than 1.25 inches that were operating at greater than 10 psig and were the result of third party damage. In both of the incidents a substantial break in the service line occurred. The consequences of these two incidents, are believed by the OPS to have been mitigated by the presence of the EFVs. The average consequences of these two incidents are an estimated 43 percent of the average consequences of the 30 incidents reported to the OPS where EFVs could have potentially mitigated the incident consequences. This represents a 57 percent reduction in incident consequences, which is attributed to the installation of EFVs. Fifty-seven percent is assumed to be the lower bound on the expected reduction in consequences attributable to the installation of EFVs; 100 percent is assumed to be the upper bound. Based on these lower and upper bounds, it is expected that EFVs will reduce incident consequences by 79 percent, the mid-point between 57 percent and 100 percent.

Expected Benefits

Assuming that (1) a life is valued at $2,600,000 and (2) an injury that requires in-patient hospitalization is valued at $490,000, the expected dollar benefits that will result from the installation of EFVs on single-family residential services operating at 10 psig or greater will be $0.81 per installed EFV per year.

Present Value of Benefits

The present value of benefits of installing an EFV is calculated over 50 years, using a 7 percent discount rate. The present value of the benefits is expected to be $11.18 per service.

COSTS

The costs that are expected to result from the installation of EFVs on all new or renewed single-family residential services are (1) the cost of the initial installation of the EFVs, (2) the cost of EFV operation, (3) the costs associated with EFVs that fail to operate properly, (4) the costs associated with marking services with newly installed EFVs, and (5) other costs. Since the final rule allows gas distribution companies to install EFVs with bleed-by, EFVs with positive shut-off, or both, costs are estimated for both EFVs with bleed-by and EFVs with positive shut-off.

EFVS WITH BLEED-BY--

Initial Installation Costs

The cost of installing an EFV with bleed-by on a new or renewed service is expected to be $30. Most of this represents the cost of the EFV; the remainder represents the cost of the labor and materials needed for the installation. The unit cost of an EFV is estimated to be $16, while the other costs of installing the EFV are estimated to be $14.

Operational Costs

The operational cost of an EFV with bleed-by is expected to be $0.

Costs Associated with EFVs That Fail to Operate Properly

EFVs sometimes close when they should not and sometimes fail to close when they should. Corrective actions need to be taken when either of these situations occurs.

<u>False Closure of EFVs</u>--False closure is expected to cost $0.01 per installed EFV per year. This estimate assumes that (1) 0.00016 false closures per installed valve per year occur, (2) the cost of relighting pilot lights that have gone out as a result of the false closure is $26, (3) the rate of failure of EFVs to automatically reset is 0.0000042 per installed EFV per year, (4) all valves that do not automatically reset will need to be replaced, and (5) the cost of digging up and replacing an EFV that has failed to reset is $697. These assumptions are based primarily on information obtained from industry sources.

<u>Failure of EFVs to Close</u>--The failure of EFVs to close in response to a substantial or catastrophic break in a service line is expected to cost $0.01 per installed EFV per year. This estimate assumes that (1) the rate of failure of EFVs to close is 0.00044 per installed EFV per year and (2) the cost of replacing an EFV that has failed to close will be equal to the

estimated cost of installing an EFV on a new or renewed service, $30.

Total for Costs Associated With EFVs That Fail to Operate Properly--The total cost associated with EFVs that fail to operate properly is expected to be $0.02 per installed EFV per year.

Costs Associated with Marking Services with EFVs

The final rule requires that all new services with EFVs be marked. The costs associated with marking services with EFVs are estimated to be $0 per service per year.

Other Costs

Additional costs will be incurred by gas distribution systems installing EFVs, including costs for (1) purchasing and inventory control for EFVs, (2) engineering and related activities, (3) training of employees, and (4) additional excavation required for the installation of EFVs. None of these costs could be quantified with an adequate degree of certainty and, therefore, none were included in the estimate of total cost of EFVs.

Total Expected Cost

The total expected cost is estimated to be $30 per installed EFV plus $0.02 per installed EFV per year. This estimate is the sum of the cost of the initial installation of the EFVs, the cost of EFV operation, the costs associated with EFVs that fail to operate properly, and the costs associated with marking services with EFVs.

Present Value of Cost

The present value of the cost is estimated to be $30.28 per installed EFV. This estimate assumes an operational life for an EFV of 50 years and a 7 percent discount rate.

EFVS WITH POSITIVE SHUT-OFF--

Initial Installation Costs

The cost of installing an EFV with positive shut-off on a new or renewed service is expected to be $30.

Operational Costs

The operational cost of an EFV with positive shut-off is expected to be $6.50 per EFV plus $0.02 per EFV per year. This is the cost of installing a connector on or upstream of the meter set plus the cost of manually resetting an EFV that has properly activated.

Costs Associated with EFVs That Fail to Operate Properly

False Closure of EFVs--False closure is expected to cost $0.01 per installed EFV per year.

Failure of EFVs to Close--The failure of EFVs to close in response to a substantial or catastrophic break in a service line is expected to cost $0.01 per installed EFV per year.

Total for Costs Associated With EFVs That Fail to Operate Properly--The total cost associated with EFVs that fail to operate properly is expected to be $0.02 per installed EFV per year.

Costs Associated with Marking Services with EFVs

The final rule requires that all new services with EFVs be marked. The costs associated with marking services with EFVs are estimated to be $0 per service per year.

Other Costs

Additional costs will be incurred by gas distribution systems installing EFVs, including costs for (1) purchasing and inventory control for EFVs, (2) engineering and related activities, (3) training of employees, and (4) additional excavation required for the installation of EFVs. None of these costs could be quantified with an adequate degree of certainty and, therefore, none were included in the estimate of total cost of EFVs.

Total Expected Cost

The total expected cost is estimated to be $36.50 per installed EFV plus $0.04 per installed EFV per year. This estimate is the sum of the cost of the initial installation of the EFVs, the cost of EFV operation, the costs associated with EFVs that fail to operate properly, and the costs associated with marking services with EFVs.

Present Value of Cost

The present value of the cost is estimated to be $37.05 per installed EFV. This estimate assumes an operational life for an EFV of 50 years and a 7 percent discount rate.

BENEFIT-TO-COST RATIO

For EFVs with Bleed-By

The benefit-to-cost ratio for the installation of EFVs on all new or renewed single-family residences will be $11.18/$30.28, or 0.37.

For EFVs with Positive Shut-Off

The benefit-to-cost ratio for the installation of EFVs on all new or renewed single-family residences will be \$11.18/\$37.05, or 0.30.

CONCLUSION

Because the estimated benefit-to-cost ratios for both EFVs with bleed-by and EFVs with positive shut-off are less than 1.00, the installation of EFVs on all new or renewed single-family residential natural gas services is not expected to be cost beneficial.

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1. INTRODUCTION

1.1 OVERVIEW

Excess flow valves (EFVs) are devices designed to automatically shut off the flow of natural gas through a service line[1] when the line is ruptured. By shutting off the flow of gas, EFVs reduce the likelihood that accidents will result in deaths, injuries, property damage, or other consequences. EFVs do not prevent accidents. Rather, by shutting off the flow of gas when a service line is broken, EFVs help prevent or mitigate the consequences of accidents. Therefore, EFVs can be regarded as complementing pipeline safety efforts that focus on preventing accidents, such as damage prevention programs and one-call systems.

Beginning in the 1970's, the National Transportation Safety Board (NTSB) began recommending that the Office of Pipeline Safety (OPS), part of the Research and Special Programs Administration (RSPA), mandate the use of excess flow valves on gas service lines. The most recent formal NTSB recommendation, made in 1990, stated that the OPS should

> 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. (Recommendation P-90-12)[2]

More recently, the NTSB made the installation of EFVs one of the top 18 transportation safety improvements that it would like to see taken.[3]

Because benefit/cost studies have indicated that installation of EFVs would not be cost beneficial, the OPS has not mandated their use. Nevertheless, the OPS, whose interest in EFVs began in the 1970's, continues to be interested in the safety benefits that could result from the installation of EFVs. The OPS currently considers the EFV to be one of its top priorities.

1.2 PURPOSE

The OPS is adopting regulations requiring the installation of EFVs on all new or

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[1]This study uses the following convention with respect to the terms "service line" and "service": a "service line" is the piping that carries the natural gas from the gas main; a "service" is the piping (i.e., the service line) plus related appurtenances, including the meter set assembly.

[2]NTSB, 1990, p. 61.

[3]Letter to U.S. DOT/RSPA/OPS Docket PS-118 from James L. Kolstad, Chairman, NTSB, March 8, 1991, p. 1.

renewed single-family residential gas services that operate at pressures that are always 10 psig (pounds per square inch gauge) or greater. Ten psig represents an operating pressure at which the OPS believes commercially available EFVs will perform reliably.[4] The purpose of this study is to estimate and compare the benefits and costs of installing the EFVs to determine whether such installations would be cost beneficial. Included in the final rule is a requirement that all services with newly installed EFVs be marked. The analysis includes this requirement in the calculation of the costs.

1.3 APPROACH

The approach taken in this analysis was to estimate the expected benefits and costs of installing one EFV and then to use these estimates to calculate a benefit/cost ratio. This approach will yield the same benefit/cost ratio as an approach that takes the number of EFVs installed in each year into consideration, but is less complicated and cumbersome, since it does not require the estimation of (1) the number of services that can be expected to be renewed each year, (2) the number of new services that can be expected to be installed each year, and (3) the number of existing services that will be discontinued each year. This approach was also used in the benefit/cost analysis of EFVs performed for the OPS by Mechanics Research, Inc. (MRI), in 1974.[5]

A major source of the EFV data used in this analysis was the responses made by gas distribution companies to the questionnaire included in the Advance Notice of Proposed Rulemaking (ANPRM) on Excess Flow Valve Installation on Service Lines issued by the OPS on December 20, 1990.[6] A total of 176 gas distribution companies responded to the questionnaire (all of the responses are included in the U.S. DOT/RSPA/OPS Docket No. PS-118). Six of the responses were made anonymously through trade organizations. Of the 176 companies that responded to the OPS questionnaire, 137 had never used EFVs, 17 had installed EFVs in the past but had discontinued their installation (many of these companies, it might be noted, still have EFVs installed on some of their service lines),[7] and 22 currently install EFVs.[8]

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[4]See the *Federal Register*, April 21, 1993, p. 21532.

[5]See MRI, pp. 110-129, 142-143, 152-153.

[6]See the *Federal Register*, Vol. 55, No. 245, Thursday, December 20, 1990, pp. 52188-52191.

[7]These 17 companies are (1) Atmos Energy, (2) Con Edison, (3) Interstate Power, (4) Lone Star Gas, (5) City of Macon, MO, (6) Michigan Consolidated, (7) Midwest Gas, (8) Minnegasco, (9) Mississippi Valley Gas, (10) Montana-Dakota Utilities, (11) Northern States Power, (12) Pennsylvania Gas and Water, (13) People's Gas System, (14) Union Electric, (15) Washington Water Power, (16) Wisconsin Natural Gas, and (17) an unidentified gas company.

[8]These 22 gas distribution companies are (1) Bay State Gas, (2) Boston Gas, (3) Brooklyn Union Gas, (4) City of Clarence, MO, (5) Colonial Gas, (6) Commonwealth Gas, (7) Connecticut Natural Gas, (8) East Ohio Gas, (9) City of Elberton, GA, (10) Great Plains Natural Gas, (11) KPL Gas Service, (12) Long Island Lighting, (13) Michigan Gas, (14) New Jersey Natural Gas, (15) Niagara Mohawk, (16) Peoples Natural Gas, (17) South

The pipeline incident data used in this analysis was taken primarily from the incident and annual report submissions made to the OPS by gas distribution companies. These submissions are required under Federal pipeline safety regulations.[9]

All dollar figures in the remainder of this study are given in nominal dollars, unless otherwise indicated. Where deflation of nominal dollar figures has been performed, the Producer Price Index, All Commodities, with 1993 as the base, has been used.[10]

1.4 PREVIOUS BENEFIT/COST ANALYSES

Three previous benefit/cost analyses have estimated and compared the benefits and costs of installing EFVs on gas services. The first analysis was performed by Mechanics Research, Inc. (MRI), for the OPS in 1974,[11] while the other two analyses were performed by Risk & Industial Safety Consultants, Inc. (RISC), for the Gas Research Institute (GRI), in 1985[12] and 1991.[13]

The 1974 MRI analysis for the OPS was undertaken, at least in part, in response to two safety recommendations made by the NTSB to the OPS. The MRI analysis considered the installation of EFVs on all new gas services operating at 5 psig or greater.[14] Benefits and costs were calculated assuming both a 10-year useful life for EFVs and a 20-year useful life for EFVs.[15] The MRI analysis determined that EFVs are available, and are technically and economically feasible, but that the installation of EFVs would not be cost beneficial. It found that the installation of EFVs on new medium or high pressure residential services would result in $1of benefits for every $37 of cost, assuming that EFVs last 10 years before needing to be replaced, and would result in $1of benefits for every $31of cost, assuming that EFVs last 20 years before needing to be replaced.[16]

Jersey Gas, (18) UGI, (19) Virginia Natural Gas, (20) Washington Gas Light, (21) Wisconsin Gas, and (22) an unidentified gas company.

[9]Incident reports are required by 49 *CFR* 191.9, while annual reports are required by 49 *CFR* 191.11.

[10]The Producer Price Index, All Commodities, used in this study was derived from the Producer Price Index, All Commodities, with 1982 as the base. The source of these index numbers was computer file BSDH-02.EXE, obtained from the Economic Bulletin Board on the Internet at the University of Michigan. The original source of the index numbers was the U.S. Department of Commerce.

[11]See Platus, et al.

[12]See Atallah and Pape.

[13]See RISC, August 26, 1991.

[14]Platus, et al., p. 122.

[15]Platus, et al., p. 120.

[16]Platus, et al., p. 120.

The 1985 RISC analysis for the GRI, the second of two studies on excess flow valves,[17] was undertaken, at least in part, in response to recommendations made by the NTSB and the Distribution, Construction, and Maintenance Committee of the American Gas Association to the GRI.[18] The 1985 RISC analysis considered the installation of EFVs on new and renewed residential gas services operating at 10 psig or greater.[19] The calculation of benefits was based primarily on a fault tree analysis.[20] Replacement of EFVs was assumed to occur once every 20 years.[21] The analysis determined that the installation of EFVs would not be cost beneficial. It found that the installation of EFVs would, over 50 years, "prevent the occurrence of 6250 accidents, save a total of 28 lives and 284 injuries and reduce the anticipated property damage by $6.87 million" at a cost of $8.82 billion.[22]

The 1991 RISC analysis for the GRI was an update the 1985 analysis. This analysis was undertaken in response to the current interest of the OPS in the installation of EFVs.[23] Like the 1985 RISC analysis, the 1991 RISC analysis considered the installation of EFVs on new or renewed residential gas services operating at 10 psig or greater. The analysis, like the previous one that RISC performed for GRI, determined that the installation of EFVs would not be cost beneficial. It found that, in the "Baseline Case," the installation of EFVs would, over 50 years, generate $13.98 million in benefits for a cost of $207.5 million. The cost-to-benefit ratio for installing EFVs was, therefore, 14.84 (the benefit-to-cost ratio, which was not calculated by RISC, would be 0.07).[24] To test the sensitivity of its results with respect to the values used for the input parameters in the benefit/cost model, RISC calculated cost-to-benefit ratios using various alternative values for selected input parameters, including the discount rate, the cost to society of deaths and injuries, and the unit cost of an EFV. The cumulative cost-to-benefit ratios RISC calculated for 50 years after the start of the EFV installation program varied from a low of 2.15 to a high of 53.52.[25] Hence, in no case did RISC find that the installation of EFVs would be cost beneficial.

There are a number of differences between the previous benefit/cost analyses and the

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[17]The first study, prepared for the GRI by the Institute of Gas Technology (IGT), was *Assessment of Excess Flow Valves in Gas Distribution Service Lines* (see Jasionowski, et al.).

[18]Atallah and Pape, pp. v-vi, 1-2.

[19]Atallah and Pape, p. iii.

[20]See Atallah and Pape, pp. 18-44.

[21]See Atallah and Pape, p. 55.

[22]Atallah and Pape, p. 52. The dollar figures are nominal dollars. In real, 1985 dollars, the estimated value of the reduction in property damage is $365 thousand, while estimated cost of EFVs is $451 million.

[23]RISC, August 26, 1991, p. 1.

[24]RISC, August 26, 1991, p. 9.

[25]RISC, August 26, 1991, pp. 16-22.

current analysis. Prinicipal differences between the MRI analysis and the current analysis include (1) the MRI analysis considered the installation of EFVs on services operating at 5 psig or greater, while the current analysis will consider the installation of EFVs on services operating at 10 psig or greater, (2) a more limited set of benefits were considered in the MRI analysis than will be considered in the current analysis (the MRI analysis did not consider property damage from incidents not reportable to the OPS, the cost of fighting fires and responding to explosions, the cost of evacuations, and the cost of lost gas, all of which will be considered in the current analysis), (3) the benefits in the MRI analysis were developed under the assumption that all deaths, injuries, and property damage resulting from ruptures will be prevented, while the benefits in the current analysis will be developed under the assumption that only some of the deaths, injuries, and property damage will be prevented, and (4) a more limited set of costs were considered in the MRI than will be considered in the current analysis. Principal differences between the RISC analyses and the current analysis include (1) the benefits in the RISC analyses were developed using a fault tree analysis, while the benefits in the current analysis will be developed from historical incident data, (2) a more limited set of benefits were considered in the RISC analyses than will be considered in the current analysis (like the MRI analysis, the RISC analyses did not consider property damage from incidents not reportable to the OPS, the cost of fighting fires and responding to explosions, the cost of evacuations, and the cost of lost gas, all of which will be considered in the current analysis), and (3) a much more conservative set of assumptions concerning EFV failures was used in the RISC analyses than will be used in the current analysis (the assumptions in the current analysis will be based on the reported historical experience of gas distribution companies that currently install EFVs).

1.5 STRUCTURE OF THE REMAINDER OF THIS REPORT

The remainder of the report is organized in the following manner. In Chapter 2, general background information on EFVs is presented. In Chapter 3, the benefits resulting from the installation of EFVs are estimated, and the present value of those benefits is calculated. In Chapter 4, the costs of installing EFVs are estimated, and their present value is calculated. In Chapter 5, the final chapter of the report, the present values of the benefits and costs of installing EFVs are used to calculate a benefit-to-cost ratio. This ratio is evaluated with respect to whether the installation of EFVs would be cost beneficial. The report concludes with a selected bibliography listing the papers and publications reviewed during the preparation of the report.

2. BACKGROUND

2.1 EXCESS FLOW VALVES

EFVs are generally installed at the service tee, which is where a gas service line connects to a gas main (see Figure 2-1). When an EFV trips, it will automatically shut off the flow of gas through the service. An EFV will generally shut off flow of gas when there has been a substantial or catastrophic break in a service. It will not usually trip and shut off the flow of gas when there is a slow leak, such as a pinhole leak caused by corrosion. It will also not usually trip and shut off the flow of gas when there is a break, even a substantial or catastrophic one, downstream of the gas meter.

2.1.1 Performance Considerations

The performance of EFVs can be impacted by the presence of contaminants within the service line. Grit, sand, slag, rust, or other debris such as is sometimes found in older, low pressure distribution systems can foul an EFV and keep it from closing or, alternatively, can cause a false closure, where an EFV closes when there has been no break in the line. Other contaminants that have caused problems with EFVs include pipeline liquids[26] and propane condensates.[27]

To perform properly, an EFV must be properly installed. Furthermore, the EFV must be appropriate for the operating characteristics of the service in which it is installed. These operating characteristics include (1) the maximum potential usage of gas by the consumer, (2) the minimum pressure at which the service operates, and (3) the diameter and length of the service.

The EFV installed in a service must be able to handle a flow of gas that is consistent with the maximum potential usage of the gas customer without tripping. Otherwise, the customer's gas load could, on occasion, exceed the gas flow rate at which the valve will trip, causing it to inappropriately close.

The EFV installed in a service must be capable of operating reliably at the minimum operating pressure of the service line. This means that the pressure differential needed to trip the valve (i.e., the pressure drop across the valve), which is a function of the flow rate, must be less than the minimum operating pressure. If it is greater than the minimum operating

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[26]Conversation of Alicia Distler, U.S. DOT, and Paul Zebe, U.S. DOT, with Paul Oleksa, East Ohio Gas, in Cleveland, Ohio, August 27, 1991. Also, see the submission to U.S. DOT/RSPA/OPS Docket No. PS-118 by Connecticut Natural Gas, pp. 2 and 3. Both East Ohio Gas and Connecticut Natural Gas, it might be noted, currently install EFVs.

[27]See the submission to the U.S. DOT/RSPA/OPS Docket PS-118 by the Colonial Gas Co.

Figure 2-1

pressure, then, when the operating pressure of the line is at its minimum, the EFV will not trip in response to a substantial break in the line. The pressure differential should not be too small, however, or the EFV could trip and shut off the flow of gas through the service line in response to a change in the customer's gas usage. It might be noted that EFVs designed to operate at very low pressures appear to generally be unsuitable for use in single-family residential service lines, because the pressure differential needed to trip them is so small that they can be inadvertently tripped by changes in gas usage.

The minimum operating pressure considered necessary for the installation of EFVs by gas distribution companies that currently install EFVs varies somewhat from company to company. It appears that many of the companies do not consider EFVs to be appropriate on services where the operating pressure will fall below 10 psig.[28] A few companies consider 5 psig to be the appropriate minimum operating pressure.[29] No company appears to consider the installation of EFVs on lines operating at pressures below 5 psig to be appropriate. Some companies, however, appear to feel that the minimum operating pressure on the gas service line should be greater than 10 psig.[30]

The EFV installed in a service should be appropriately sized for the diameter and length of the service line. If it is not, then a substantial break at or near the end of the line that is the farthest away from the EFV may not cause the EFV to trip and shut off the flow of gas through the line. It should be noted that even an inappropriately sized EFV can potentially provide some protection to the service line in which it is installed, since many, if not most, substantial or catastrophic breaks are the result of excavation damage, which will generally occur close to the street, which is where the service tee is usually located.[31]

EFVs are not considered to be appropriate for longer or larger diameter service lines by some gas distribution companies that currently install EFVs. Niagara Mohawk, for instance, believes that EFVs are not suitable for service lines that are greater than 50 feet in length or are over 1 inch in diameter.[32] Washington Gas Light currently installs EFVs only on services with a nominal diameter of 1 inch or less.[33] Colonial Gas believes that EFVs should not be installed on services that are greater than 300 feet in length.[34]

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[28]See, for example, the submissions to the U.S. DOT/RSPA/OPS Docket No. PS-118 by Bay State Gas, East Ohio Gas, KPL Gas Service, Peoples Natural Gas, Virginia Natural Gas, and Washington Gas Light.

[29]See the submissions to the U.S. DOT/RSPA/OPS Docket No. PS-118 by Brooklyn Union Gas and Wisconsin Gas.

[30]See, for example, the submission to the U.S. DOT/RSPA/OPS Docket No. PS-118 by UGI.

[31]Conversation of Alicia Distler, U.S. DOT, and Paul Zebe, U.S. DOT, with Paul Oleksa, East Ohio Gas, Cleveland, Ohio, August 27, 1991.

[32]See the submission to the U.S. DOT/RSPA/OPS Docket No. PS-118 by Niagara Mohawk Power.

[33]See the submission to the U.S. DOT/RSPA/OPS Docket No. PS-118 by Washington Gas Light.

[34]See the submission of Colonial Gas Company to U.S. DOT/RSPA/OPS Docket No. PS-118.

2.1.2 Types of EFVs

The first EFV for use with a gas service line was introduced in 1963.[35] Almost all EFVs currently installed on gas services are designed to automatically reset once the break in the line has been repaired. The automatic resetting of an EFV results from back-pressure created by the small amount of gas that is allowed, by design, to bypass the closed valve. These valves are sometimes referred to as EFVs with bleed-by. EFVs are also available with positive shut-off rather than automatic reset. EFVs with positive shut-off must be manually reset. Only a relatively few EFVs with positive shut-off have been installed on gas services. The primary design difference between an EFV with bleed-by and an EFV with positive shut-off is that the EFV with bleed-by has a means of allowing the gas to by-pass the valve, such as a hole or groove, while the EFV with positive shut-off does not.

The EFVs with bleed-by most commonly used by gas distribution companies are based on either (1) a ball and magnet design (see Figure 2-2) or (2) a spring and plunger design (see Figure 2-3).

The first bleed-by EFVs introduced were based on the ball and magnet design. With the ball and magnet design, a magnet holds the ball in place to permit the normal flow of gas through a service line. If the flow of gas through the line exceeds the design pressure for the valve, the ball is forced from the magnet onto the valve seat and the flow of gas is shut off.[36] When the break in the line has been repaired, the valve automatically resets. Manufacturers of ball and magnet EFVs include Mueller Co. and PLEXCO, Inc.[37] Bleed-by EFVs of the ball and magnet design have been installed by a number of gas distribution companies, including Minnegasco, Brooklyn Union Gas, Illinois Gas, Iowa-Illinois Gas and Electric, Rochester Gas & Electric, Wisconsin Gas, and Northern States Power.[38]

Bleed-by EFVs based on the spring and plunger design (sometimes referred to as the spring and float design) were introduced in 1975. With the spring and plunger design, the spring counters the inlet pressure of the gas. When the pressure on a service line drops to a point that it exceeds the force of the spring, the plunger closes the line.[39] As with the ball and magnet design, when the break in the line has been repaired, the valve automatically resets. Manufacturers of spring and plunger EFVs include Dresser Industries, Phillips Driscopipe, Inc., and UMAC, Inc.[40] Bleed-by EFVs of the spring and plunger design have

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[35]McGowan, p. 3.

[36]McGowan, p. 3.

[37]RISC, July 10, 1991, pp. 1-8; information from various manufacturers.

[38]RISC, July 10, 1991, pp. 2 and 3; submissions of selected gas distribution companies to the U.S. DOT/RSPA/OPS Docket No. PS-118.

[39]McGowan, p. 4.

[40]RISC, July 10, 1991, pp. 1-8; information from various manufacturers.

Figures 2-2 and 2-3

been installed by a variety of gas distribution companies, including Bay State Gas, East Ohio Gas, Rochester Gas & Electric, UGI, and Washington Gas Light.[41]

Based on the information provided by industry to the OPS, the positive shut-off EFVs in use on gas service lines would appear to be based on the spring and plunger design. Manufacturers of EFVs with positive shut-off include UMAC, Inc.[42] Only a few gas distribution companies, such as Midwest Gas,[43] have installed EFVs with positive shut-off.

2.1.3 The Number of EFVs Currently in Service

The exact number of EFVs currently in service is unknown. It is reported that conversations with manufacturers of EFVs indicate that approximately one million EFVs are currently in service in gas distribution systems in the U.S.[44] The majority of EFVs currently in service appear to be of the spring and plunger design. At least 700,000 of the EFVs currently in service are reported to be of this design.[45]

2.1.4 Gas Distribution Companies Using EFVs

A number of gas distribution companies have installed EFVs as part of the safety program for their systems. According to James Kolstad of the NTSB, approximately 45 gas distribution companies currently use EFVs.[46] The experience of gas distribution companies with EFVs has been mixed. Some companies, such as Minnegasco, have regretted the decision to install the valves because they feel that the valves did not perform as expected; other companies, such as Bay State Gas and East Ohio Gas, have been quite satisfied with the performance of the valves that they installed.[47]

Some of the companies that have installed EFVs have done so for field testing purposes (i.e., for the purpose of determining how the valves will function under actual operating conditions), while others have installed EFVs for use, rather than for testing (those

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[41]RISC, July 10, 1991, pp. 2 and 4; submissions from selected gas distribution companies to the U.S. DOT/RSPA/OPS Docket No. PS-118.

[42]Selected manufacturer's literature.

[43]Midwest Gas reports that it has installed 1000 EFVs with positive shut-off in its Des Moines District [see the submission of Midwest Gas to the U.S. DOT/RSPA/OPS Docket No. PS-118, July 2, 1993, p. 2.].

[44]RISC, August 26, 1991, p. 2.

[45]RISC, July 10, 1991, p. 4, 5.

[46]Testimony of James L. Kolstad, Chairman, NTSB, before the Surface Transportation Subcommittee, U.S. Senate Commerce, Science and Transportation Committee, May 15, 1991, p. 6.

[47]Submissions by various gas distribution companies to the U.S. DOT/RSPA/OPS Docket No. PS-118.

that install for use, may have also done some installation for testing). Companies testing EFVs under field conditions do not generally install more than 500 or 1000 valves, and often install fewer.[48] Companies that have installed EFVs for test purposes include KPL Gas Service, Peoples Natural Gas, Public Service of Colorado, South Jersey Gas, and Virginia Gas. Companies that have installed EFVs for use include Bay State Gas, Brooklyn Union Gas, Colonial Gas, East Ohio Gas, Minnegasco, Northern States Power, and UGI.[49] East Ohio Gas, with over 230,000,[50] appears to have the most EFVs installed. Bay State Gas, with 56,000,[51] appears to have the second most EFVs installed.

A number of companies that have installed EFVs either for test purposes or for use have stopped doing so because of perceived problems with the valves. Companies that formerly installed EFVs but no longer do so include Atmos Energy, Con Edison, Interstate Power, Lone Star Gas, Michigan Consolidated Gas, Minnegasco, Mississippi Valley Gas, Montana-Dakota Utilities, Northern States Power, Pennsylvania Gas and Water, People's Gas System, Union Electric, Washington Water and Power, and Wisconsin Natural Gas. Most of the companies listed above, it might be noted, stopped installing EFVs prior to 1980. A number of these companies have removed all of EFVs that were installed.

2.2 GOVERNMENTAL ACTIONS WITH RESPECT TO EFVS

Prior to this final rule, Federal pipeline safety regulations did not require the installation of EFVs on gas service lines. The NTSB, however, has formally recommended on a number of occasions that the OPS mandate the installation of EFVs. Generally, the NTSB recommendations have focussed on the installation of EFVs on new or renewed "high pressure" gas distribution service lines.[52] Because the benefit/cost analyses of EFV installation performed by MRI for the OPS in 1974 and by RISC for GRI in 1985 did not show the installation of EFVs to be cost beneficial, the OPS has not implemented the NTSB recommendations on EFVs.

Only one state, New York, currently has regulations requiring EFVs. These regulations state that

> Any service line operating at 125 psig or more serving customers requiring regulation of the line pressure is to be equipped with either an excess flow valve or must have the first stage regulator located at least 50 feet from the building, or if 50 feet cannot be attained without entering the roadway,

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[48]Submissions by various gas distribution companies to the U.S. DOT/RSPA/OPS Docket No. PS-118.

[49]Submissions by various gas distribution companies to the U.S. DOT/RSPA/OPS Docket No. PS-118.

[50]Submission to U.S. DOT/RSPA/OPS Docket PS-118 by UMAC, Inc., July 6, 1993, p. 10.

[51]Submission to U.S. DOT/RSPA/OPS Docket PS-118 by Bay State Gas, June 21, 1993, p. 1.

[52]For a summary of the NTSB recommendations on EFVs, see NTSB, 1990, pp. 78-86.

located at the property line.[53]

Because of this rule, at least one gas distribution company in New York, Niagara Mohawk Power, has been installing EFVs on new service lines that are to be operated at pressures of 125 psig or greater.[54]

While state pipeline safety regulators in Massachusetts do not require the installation of EFVs, they have allowed one gas distribution company, Bay State Gas, to use EFVs as an alternative to underground curb valves, which are mandated by state pipeline safety regulations,[55] subject to certain conditions.[56] Those conditions are

1. Bay State shall only use the type of excess flow valve described in the attachment to its petition.[57] The Department must approve any other type of excess flow valve.

2. Service line records shall indicate those locations where excess flow valves are installed.

3. Each service line with an excess flow valve must be physically marked or labeled in the field. The labels shall be placed on the service riser pipe or meter assembly and be readily visible to gas company employees.

4. An excess flow valve shall be installed on all steel and plastic service lines, whenever feasible.

5. Bay State must maintain a record system indicating the location, date, time and reason for any shutdown of an excess flow valve on any service line.

6. When a service line has an excess flow valve that does not include an underground curb valve, the manually operated valve located outside at the service riser pipe or meter assembly shall

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[53]New York State Code Rule 255.197(c)(5).

[54]Submission to the U.S. DOT/RSPA/OPS Docket No. PS-118 by Niagara Mohawk Power, March 11, 1991.

[55]See 220 C.M.R. 101.06(4).

[56]See Massachusetts Department of Public Utilities, D.P.U. 88-200, April 6, 1989, which grants Bay State Gas an exception to the provisions of 220 C.M.R. 101.06(4).

[57]Donkin® Flow Limitors by UMAC are described in the attachment to the Bay State petition. The attachment indicates that Bay State uses Donkin® BB (bleed-by) Flow Limitors, which, like all Donkin® Flow Limitors, employ a spring and plunger mechanism to cut off the flow of gas (except for a small bleed-by flow) when there has been a catastrophic rupture on a service.

> be readily accessible. Bay State must develop and implement a written operations and maintenance procedure to determine and eliminate inaccessible valves after the initial service line installation.[58]

The exception granted Bay State Gas, it might be noted, does not apply any other gas distribution company operating in Massachusetts.[59] Other gas distribution companies wanting to substitute EFVs for underground curb valves could apply for their own exceptions.

In 1990, the Public Utility Commission of the State of Colorado began a review of EFVs.[60] As part of this review, the Public Service Company of Colorado (PSC) agreed to report to the Public Utility Commission on the results of a pilot study of EFVs.[61] This pilot study involved installing a minimum of 100 EFVs on gas services in the Highlands Ranch development south of Denver and monitoring their performance, as well as destructive and nondestructive testing of additional EFVs.[62] In April 1992, PSC provided a report to the Public Utility Commission detailing its final conclusions.[63] PSC's conclusions included the following: (1) "[m]odern style EFVs (spring and plunger design) generally perform as stated in the manufacturer's literature," (2) "[f]alse closures are no longer a problem," (3) "[e]xisting EFV designs are not appropriate if service pressure is less than 5 psig," and (4) "[t]he additional pressure drop caused by EFVs will require changes to PSC operating procedures and design standards."[64]

The California Public Utilities Commission (PUC) is reported to be looking into the question of the value of installing EFVs. The California PUC is particularly interested in determining the effectiveness of EFVs in reducing damage to gas systems resulting from "seismic events."[65]

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[58]Massachusetts Department of Public Utilities, D.P.U. 88-200, April 6, 1989, pp. 3-4.

[59]Telephone conversation between Alicia Distler and Chris Bourne, Massachusetts Department of Public Utilities, November 18, 1991.

[60]See Colorado Public Utility Commission Docket No. 90M-644G, "Repository for an Examination of the Safety Aspects of Excess Flow Valves in Various Applications."

[61]Telephone conversation of Paul Zebe with Anthony Karahalios, Director of Safety and Enforcement, Colorado Public Utilities Commission, November 4, 1991.

[62]Public Service Company of Colorado Interoffice Memo from Mike Hanzlick, Manager, Gas Distribution Division, to Joe Heckendorn, Manager, Rates and Regulations, March 4, 1991. This memo is included in the Colorado Public Utility Commission Docket No. 90M-644G.

[63]Submission to the U.S. DOT/RSPA/OPS Docket No. PS-118 by the Colorado Public Utilities Commission, June 17, 1993, p. 1.

[64]See the attachment from the Public Service Company of Colorado to the submission to U.S. DOT/RSPA/OPS Docket PS-118 by the Public Utilities Commission of Colorado, June 17, 1993, pp. 3, 4.

[65]NARUC, pp. 6-1, 6-2, Table 4.

3. BENEFITS

3.1 INTRODUCTION

The benefits that are expected to result from the installation of EFVs on single-family residential gas services are reduced incident consequences when there has been a substantial or catastrophic break in a service line or related appurtenances, such as the meter set assembly. The incident consequences that can be reduced by the installation of EFVs are

- Deaths
- Injuries
- Property damage
- Fires and explosions
- Evacuations
- Loss of gas.

Injuries not requiring in-patient hospitalization are not reported to the OPS when a gas incident occurs. Consequently, the number of injuries not requiring in-patient hospitalization could not be determined with any degree of reliability.[66] As a result, the reduction in the level of these injuries is not included in the estimated benefits of installing EFVs developed in this report. These represent additional benefits that will result from the installation of EFVs. Because these benefits are not included, the estimated benefits will tend to understate the true benefits. This should be kept in mind when considering the benefits estimated in this study for the installation of EFVs.

Potentially, the installation of EFVs might reduce the number of incidents to which police, firefighters, and other emergency personnel respond. Contacts with gas distribution system operators who currently install EFVs, however, indicate that this has not generally been observed to be the case. Furthermore, system operators do not generally expect it to become the case if the use of EFVs expands.[67] The number of fires that must be extinguished and explosions that must be dealt with are expected, of course, to be reduced by the

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[66]The number of injuries requiring in-patient hospitalization, it should be noted, could be determined, and so the reduction in the number of these injuries is included in the expected benefits.

[67]Telephone conversations of Jean Wooster, U.S. DOT, with (1) Walter Klinczak, Connecticut Natural Gas, September 20, 1991, (2) James Adams, City of Elberton, GA, September 23, 1991, (3) Walter Lander, Boston Gas, September 25, 1991, (4) Paul Oleksa, East Ohio Gas, September 23, 1991, (5) Ralph Salazar, Brooklyn Union Gas, September 25, 1991, (6) Joseph O'Connor, Commonwealth Gas, September 25, 1991, (7) Donald Clifton, City of Clarence, MO, September 25, 1991, and (8) Hans Mertens, KPL Gas Service, September 25, 1991, and telephone conversations of Beth Deysher, U.S. DOT, with (1) Gene Pietras, Niagara Mohawk Power, October 1, 1991, (2) Don Madden, Long Island Lighting, September 1991, (3) Mike Reilly, Peoples Natural Gas, September 1991, (4) Scott Lord, Wisconsin Gas, September 1991, (5) W.F. Eckles, New Jersey Natural Gas, September 19, 1991 (6) Mark Wendorff, Washington Gas Light, September 19, 1991, (7) Mike Robertson, Virginia Natural Gas, September 19, 1991, and (8) John Royston, Michigan Gas Utilities, September 23, 1991. Some of the companies contacted, it should be noted, have had fairly limited experience with EFVs.

installation of EFVs.

The approach taken in this study to estimate the benefits that can be expected to result from the installation of EFVs was (1) estimate the incident and consequence rates in the absence of EFVs using historical gas service incident and other data, (2) estimate the reduction in consequences expected to result from the installation of EFVs, and (3) estimate the expected benefits using the previously derived estimates of the consequence rates and the expected reduction in consequences. This approach is discussed in greater detail in the following sections of this chapter.

3.2 INCIDENT AND CONSEQUENCE RATES IN THE ABSENCE OF EFVS

Estimates of the incident and consequences rates in the absence of EFVs for incidents where there has been a substantial or catastrophic break in a gas service were calculated using OPS incident and annual report data, supplemented by selected data and information from other sources. These estimates were generated for both incidents that must be reported to the OPS (i.e., reportable incidents) and incidents that do not have to be reported to the OPS (i.e., nonreportable incidents).[68] For purposes of presentation, fires and explosions arising from gas service incidents are treated separately from the other incident consequences, as are evacuations required because of incidents on services.

Information identifying incidents that occur on single-family residential services is generally not available. On its incident reporting form, the OPS does not ask gas distribution system operators to indicate whether a service line incident occurred on a single-family residential service. Consequently, it was necessary to use a proxy for incidents on single-family residential services. The selected proxy was incidents on services where the nominal diameter of the pipe was less than or equal to 1.25 inches. Most single-family residential services have pipe with a nominal diameter that is 1.25 inches or less. Consequently, use of the proxy will capture most, but not necessarily all, incidents on single-family residential services. Its use may also capture some incidents on small industrial and commercial services, as well as some incidents on multiple-family residential services.

3.2.1 Reportable Incidents

All reported gas service incidents that have occurred in recent years were reviewed to identify the incidents occurring on single-family residential services that could potentially have benefitted from the presence of an EFV. For the period from March 1991 through February 1994, a total of 36 months, 30 incidents were identified where EFVs could

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[68]Gas distribution systems are currently required under Federal pipeline safety regulations to report incidents to the OPS whenever there is a release of gas accompanied by (1) a death, (2) an injury resulting in "in-patient hospitalization," (3) property damage of $50,000 or more, or (4) an event that the gas distribution system operator considers significant even though it does not meet any of the other reporting criteria set out in the regulations (see 49 *CFR* 191.9 and 191.3).

TABLE 3-1. REPORTED GAS INCIDENTS OCCURRING BETWEEN MARCH 1991 AND FEBRUARY 1994 WHERE (1) THE OPERATING PRESSURE WAS 10 PSIG OR GREATER, (2) THE NOMINAL DIAMETER OF THE PIPE WAS 1.25 INCHES OR LESS, AND (3) THERE WAS A SUBSTANIAL BREAK IN THE SERVICE LINE OR RELATED APPURTENANCES

U.S. DOT Report ID No.	Incident Date	Company	City	State	Deaths	Injuries	Property Damage (Nominal $)	Operating Pressure (PSIG)	Nominal Diameter of Pipe (Inches)
910078	3/25/91	Entex	Santa Fe	TX	1	0	150	30	0.75
910085	4/11/91	Northwest Natural Gas	Portland	OR	0	0	100,000	40	0.75
910091	5/3/91	Gas Co. of New Mexico	Santa Fe	NM	0	0	50,000	55	1.25
910102	6/7/91	New Jersey Natural Gas	South Mantoloking Beach	NJ	0	3	150,000	38	0.75
910144	8/22/91	KPL Gas Service	Blue Springs	MO	0	0	63,000	10	1.125
910157	8/29/91	City of Madison	Madison	MO	0	0	45,000	26	0.75
910200	10/8/91	Entex	Gulfport	MS	0	1	0	18	1
910208	10/9/91	City of Jacksonville	Jacksonville	AL	0	1	50,000	20	1
910210	10/7/91	Michigan Consolidated Gas	Elmwood	MI	0	0	125,000	60	0.625
910240	5/5/91	Gulfside Gas	Macdona	TX	0	0	3,745.37	10	1
910241	5/3/91	Entex	Sugar Land	TX	0	0	10,000	45	0.75
920009	12/20/91	Louisiana Gas Service	Hammond	LA	0	0	0	75	1
920010	12/20/91	Louisiana Gas Service	Amite	LA	0	0	0	68	0.75
920051	2/21/92	KPL Gas Service	Blue Springs	MO	0	0	80,000	15	1
920078	5/2/92	Northern Gas of Wyoming	Gillette	WY	0	0	48,000	35	0.75
920080	4/8/92	Northern Illinois Gas	Rockford	IL	0	2	50,000	25	1.25
920116	7/14/92	Pacific Gas & Electric	San Francisco	CA	0	0	355,000	30	0.75
920123	7/11/92	Peoples Natural Gas	Rochester	MN	0	1	0	14	0.625
920158	9/10/92	Two Harbors Municipal	Two Harbors Lake	MN	0	1	0	50	0.5

TABLE 3-1. REPORTED GAS INCIDENTS OCCURRING BETWEEN MARCH 1991 AND FEBRUARY 1994 WHERE (1) THE OPERATING PRESSURE WAS 10 PSIG OR GREATER, (2) THE NOMINAL DIAMETER OF THE PIPE WAS 1.25 INCHES OR LESS, AND (3) THERE WAS A SUBSTANIAL BREAK IN THE SERVICE LINE OR RELATED APPURTENANCES (CONTINUED)

U.S. DOT Report ID No.	Incident Date	Company	City	State	Deaths	Injuries	Property Damage (Nominal $)	Operating Pressure (PSIG)	Nominal Diameter of Pipe (Inches)
920188	12/9/92	Chesapeake Utiltities	Dover	DE	0	0	0	25	0.75
930009	1/22/93	Great Falls Gas	Great Falls	MT	0	1	0	12	0.5
930079	3/20/93	Connecticut Natural Gas	Greenwich	CT	0	1	400,000	35	1.25
930108	6/12/93	Wisconsin Natural Gas	South Milwaukee	WI	0	0	1,000,000	30	1.25
930118	6/17/93	Northern Indiana Public Service	South Bend	IN	1	2	50,000	35	0.75
930122	6/27/93	Florida Public Utilities	Palm Beach	FL	0	0	1,500,000	18	1
930140	3/11/93	Baltimore Gas & Electric	Baltimore	MD	0	1	0	96	0.25
930179	9/15/93	Laurens Public Works	Laurens	SC	0	1	0	30	0.5
930210	11/15/93	Public Service Electric & Gas	Bloomingdale	NJ	0	0	50,000	53	0.75
930213	11/5/93	Northern Indiana Public Service	Valparaiso	IN	0	0	50,000	50	0.75
940002	1/14/94	Peoples Natural Gas	Waterloo	NE	0	0	50,000	25	1
940086	2/2/94	Southern Union Gas	Austin	TX	0	1	0	42	1.25

Note: All incidents in this table were confirmed by the gas distribution companies as having occurred on single-family residential services.

Source of data: U.S. DOT computerized database, "DLEAK". For certain incidents, some information in this table was obtained from the gas distribution company.

potentially have helped (see Table 3-1). The criteria used to identify incidents were (1) the nominal diameter of the pipe was less than or equal to 1.25 inches, (2) the operating pressure was greater than or equal to 10 psig, and (3) a substantial break occurred. The first criteria was the proxy for single-family residential services. The second criteria limited the selection set to incidents where the operating pressure was sufficient for an EFV to operate properly, which is expected by the OPS to be 10 psig or greater. The third criteria further limited the selection set to incidents whose consequences potentially could have been mitigated by an EFV. In applying this third criteria, the OPS excluded all incidents resulting from corrosion, because it is expected that EFVs will not mitigate the consequences of most incidents where corrosion is the cause. After the three criteria were applied, incidents that did not occur on single-family residential services were identified through telephone contact with the reporting gas distribution company and removed. It might be noted that no EFVs were reported to have been present on the services involved in the incidents in Table 3-1.

The incidents in Table 3-1 may include some where the final rule requiring EFVs does not apply. While all of the incidents occurred at pressures of 10 psig or greater, some of the incidents may have occurred on services where the operating pressure sometimes drops below 10 psig. The OPS is not requiring EFVs on these services.

Of the 30 incidents in Table 3-1, 25 were caused by outside forces damage, while the remaining 5 were the result of causes other than outside forces damage, corrosion, construction/operating error, or operator accident. Of the 25 incidents resulting from outside forces damage, 22 were caused by a third party, 1 was caused by earth movement, and 2 were caused by the pipeline operator or an agent of the pipeline operator. Twenty-two of the 30 incidents in Table 3-1 occurred on the service line, 7 occurred at the meter set assembly, and 1occurred on another, unspecified, part of a service.

The 30 incidents in Table 3-1 resulted in the following numbers of deaths and injuries, and amount of property damage:

- Deaths = 2
- Injuries = 16
- Property damage = $3,249,595 (1993 dollars).

The property damage figure for the incidents appears to understate the property damage that actually has occurred. An examination of selected accidents reviewed by the NTSB in its pipeline accident reports indicates that the property damage figures reported to the OPS are often significantly less than the property damage estimates presented by the NTSB for the same gas service line incidents. On average, the property damage figures reported to the OPS may be as much as one-third less than the property damage figures reported by the NTSB. There are a number of possible reasons for this difference, including the fact that incident reports to the OPS are made very soon after an incident occurs, often before the final assessment of the property damage is in, while the property damage figures reported by the NTSB are more likely based on the final assessment of the property damage. Because the property damage figures reported to the OPS may be as much as one-third less than the actual property damage that occurs as a result of an incident, the property damage estimate used in this analysis is the property damage reported to the OPS multiplied by 1.3. That is, the property damage estimate used for the 30 reportable incidents in Table 3-1 is

1.3 x $3,249,595 = $4,224,474 (1993 dollars).

Estimates for the incident and consequence rates per service per year can be derived from the total values by dividing the totals by 3 to get averages per year (March 1991 through February 1994 is 36 months, or 3 years), then dividing the resulting figures by 13 million, the estimated number of services owned by gas distribution companies that (1) have a nominal diameter less than or equal to 1.25 inches, (2) always operate at pressures greater than or equal to 10 psig, and (3) do not currently have an EFV installed.[69] The resulting estimates of the rates per service per year are

- Incidents = 0.00000077
- Deaths = 0.00000005
- Injuries = 0.00000041
- Property damage = $0.11 (1993 dollars).

These are the incident and consequence rates per service per year that would be expected for reportable incidents occurring on single-family residential services that always operate at 10 psig or greater and do not currently have excess flow valves installed.

3.2.2 Nonreportable Incidents

Some nonreportable incidents could potentially benefit from the installation of EFVs. How many, however, is unknown and must, therefore, be estimated. Available data that can be used in this estimation is very sparse. Only the Houston Division of Entex has made information available on nonreportable incidents. This information from Entex is only for one year, 1990. Lacking additional information, the estimation of nonreportable incidents that could have potentially benefitted from the installation of EFVs is based on the data provided by the Houston Division of Entex.

The Houston Division of Entex reports that it had 1,318 nonreportable service line

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[69]The estimated number of services was calculated by subtracting the estimated number of services that currently have EFVs installed, 1 million, from the total number of services owned by gas distribution companies in 1992 (the most recent year for which complete data is available), 50 million, and then multiplying the result, 49 million, by the estimated percentage of services with a nominal diameter of 1.25 inches or less that always operate at 10 psig or greater. The source for the total number of services was the annual reports made by gas distribution companies to the OPS. The information submitted to the OPS in the annual reports can be found in the U.S. DOT's computerized database, "DISTR". The percentage of services with a nominal diameter of 1.25 inches or less that always operate at 10 psig or greater, 27 percent, was calculated by multiplying 32 percent, the estimated percentage of services always operating at 10 psig or greater (see RISC, "Cost Benefit Analysis of Excess Flow Valves: An Update," p. 2), by 85 percent, the percentage of service line incidents on services operating at 10 psig or greater in the U.S. DOT's computerized database, "DLEAK," on November 13, 1994, that occurred on service lines with a nominal diameter of 1.25 inches or less.

incidents during 1990.[70] Entex reported only one service line incident in Texas in 1990 to the OPS.[71] This incident occurred in Houston. Thus, for every reportable service line incident in 1990, the Houston Division of Entex experienced 1,318 nonreportable service line incidents.

Table 3.1 identifies 30 reportable incidents occurring between March 1991 and February 1994 whose consequences could have been mitigated by the presence of EFVs. Assuming that there were 1,318 nonreportable incidents whose consequences could have been mitigated by the presence of EFVs for every reportable incident in Table 3.1, there were an estimated 39,540 nonreportable incidents occurring between March 1991 and February 1994 whose consequences could have been mitigated by the presence of EFVs. This means that, on average during the three-year period, there were an estimated 13,180 nonreportable incidents per year whose consequences could have been mitigated by the presence of EFVs. Dividing the 13,180 estimate by 13 million, the estimated number of services that (1) have a nominal diameter less than or equal to 1.25 inches, (2) always operate at pressures greater than or equal to 10 psig, and (3) do not currently have an EFV installed, yields an estimated 0.00101385 nonreportable incidents per service per year that might benefit from the installation of EFVs.

The Houston Division of Entex reports that the average property damage for the 1,318 nonreportable service line incidents occurring during 1990 was $347 (nominal).[72] For the purposes of this study, it is assumed that the situation of the Houston Division of Entex is typical and the average cost of a nonreportable incident is $347 in 1990 dollars, or $355 in 1993 dollars. This means that the expected cost per service per year for nonreportable incidents will be (in 1993 dollars)

$$\$355 \times 0.00101385 = \$0.36 \text{ per service per year.}$$

3.2.3 Fires and Explosions Occurring With Reportable and Nonreportable Incidents

Both reportable and nonreportable incidents sometimes result in fires and explosions. The fires must be put out and the explosions must be responded to.

To estimate the total cost of fighting fires and responding to explosions per service per year, information is needed on (1) the number of incidents that can be expected to experience fires or explosions and (2) the cost per fire or explosion of fighting fires or responding to explosions.

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[70] Letter from Christopher Glaeser, Entex Houston Division, to Paul Zebe, October 8, 1991.

[71] "DLEAK", October 21, 1994.

[72] Letter from Christopher Glaeser, Entex Houston Division, to Paul Zebe, October 8, 1991.

3.2.3.1 The Number of Incidents That Can Be Expected to Experience Fires or Explosions

Every incident on a service does not result in a fire or explosion. The question of whether a fire or explosion occurred during an incident is not asked on the current incident reporting form that gas distribution systems must submit to the OPS following an incident. On the previous incident reporting form (i.e., on the form used prior to 1984),[73] however, it was asked if gas ignited during the incident. It was also asked on the previous form (1) if an explosion occurred and (2) if the incident induced any secondary fires or explosions.

Examining incident data collected for 1980 through 1983 using the old incident reporting form,[74] it was found that the following was the case for incidents on gas service lines with (1) a nominal diameter of 1.25 inches or less and (2) an operating pressure of 10 psig or greater:

- 95 percent of all incidents with a death, injury, or property damage of $50,000 (nominal) or greater experienced the ignition of gas, an explosion, or secondary fires or explosions.

This percentage is used for the expected incidence of fires or explosions accompanying incidents on gas service lines that had a death, injury, or property damage of $50,000 (nominal) or greater.

The expected frequency of fires or explosions per service per year occurring during reportable incidents with a death, injury, or $50,000 (nominal) or greater in property damage can be calculated by dividing the number of incidents in this category in Table 3-1, 25, by the estimated number of relevant services, 13 million, and then multiplying the result by the percentage of the incidents that are expected to experience a fire or explosion, or

(25 / 13 million) x .95 = 0.00000183 per service per year.

All incidents with a fire or explosion were to be reported to the OPS when the old incident form was in use. Examining the incident data collected for 1980 through 1983 using the old incident reporting form, it was found that the following was the case for incidents on gas service lines with (1) a nominal diameter of 1.25 inches or less and (2) an operating pressure of 10 psig or greater:

- For every incident with a death, injury, or property damage of $50,000 (nominal) or greater, there were 5.3 incidents without a death, injury, or $50,000 in property damage that experienced the ignition of gas, an explosion, or a secondary fire or explosion.

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[73]This reporting form stopped being used during 1984.

[74]This data is maintained in the U.S. DOT's computerized databases, "ALDTN" (for data up to 1982) and "PIP" (for data for 1983 and 1984).

This means that the expected frequency of fires or explosions per service per year occurring during any incident without a death, injury, or $50,000 (nominal) or greater in property damage can be calculated by multiplying the expected frequency of fires or explosions per service per year occurring during reportable incidents with a death, injury, or $50,000 (nominal) or greater in property damage by 5.3, or

0.00000183 x 5.3 = 0.00000970 per service per year.

3.2.3.2 The Cost of Fighting a Fire or Responding to an Explosion

Limited information exists on the cost of fighting a fire or responding to an explosion. One of the few available sources of this type of information is a report for the Center for Fire Research (later the Building and Fire Research Laboratory) at the National Institute of Standards and Technology entitled, "A First Pass at Computing the Cost of Fire Safety in a Modern Society." According to this report, the fully loaded cost of local fire service (i.e., fire fighting and other activities and services provided by local fire departments) was estimated for 1986 to be between $25.8 billion and $46.4 billion, with $39.6 billion being the "Most Likely Estimate".[75] These estimates consist of the total annual cost of local career fire departments, plus an imputed annual cost for the services provided by volunteer fire departments.[76]

In 1986, according to the National Fire Protection Association, there were a total of 11,890,000 fire department calls.[77] These include calls for fires, medical aid, false alarms, mutual aid, hazardous materials, other hazardous conditions, and other. Thus, responses by fire personnel to both fires and explosions are included.

Based on the best estimate (i.e., the "Most Likely Estimate") of the cost of local fire service in 1986 and the total number of fire department calls in 1986, a call cost, on average, $3331 in 1986. For the purposes of this study, the cost of fighting a fire or responding to an explosion is assumed to be equal to the average cost of a fire department call, $3331 in 1986 dollars, or $3951 in 1993 dollars.

3.2.3.3 The Cost of Fighting Fires or Responding to Explosions Per Service Per Year

Multiplying the expected frequency of fires or explosions per service per year by the costs of putting out the fires or responding to the explosions yields the cost of fighting fires or responding to explosions per service per year. The cost per service per year by category of

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[75]Meade, pp. 344-345.

[76]Meade, p. 344.

[77]Fax from Nancy Schwartz, National Fire Protection Association, to Dianne Sutherland, U.S. DOT, July 8, 1994.

incident is as follows:

- Fires or explosions occurring
  during reportable incidents with
  a death, injury, or $50,000 (nominal)
  or greater in property damage =

  0.00000183 x $3951 = $0.01 (1993 dollars) per service per year

- Fires or explosions occurring
  during all other incidents =

  0.00000970 x $3951 = $0.04 (1993 dollars) per service per year.

The total expected cost of fighting fires and responding to explosions per service per year, the sum of the cost of fighting fires and responding to explosions in each of the categories given above, is (in 1993 dollars)

$0.05 per service per year.

3.2.4 Evacuations

Evacuations can occur either when there is a perceived danger (i.e., when there has been an incident, but no fire or explosion) or when there is an immediate danger (i.e., when there has been a fire or explosion). Since the installation of EFVs has not been observed to change the number of incidents to which police and fire personnel respond, it is expected that the installation of EFVs will not cause a change in the number of evacuations that occur when there is a perceived danger. Consequently, when there is perceived danger, no benefits will result from the installation of EFVs, and this evacuations because of perceived danger need be considered no further. Since the number of fires and explosions may go down with the installation of EFVs, however, the number of evacuations that occur when there is an immediate danger may go down, resulting in some benefit to society.

3.2.4.1 Evacuations Caused by Major Fires or Explosions

Major fires or explosions will require the evacuation of everyone in the affected residence, as well as everyone in residences that are put in immediate danger by the fire or explosion. Generally, police and fire departments hope that common sense will prevail and anyone hearing an explosion or seeing a fire at a neighbor's house will evacuate their own house immediately. When this is not the case, the police or firefighters at the scene will generally try to see that everyone in danger is evacuated (the cost of the firefighters doing this is included in the cost of fighting a fire or responding to an explosion).

The cost of an evacuation due to a major fire or explosion will basically be the total value of the lost time and foregone activities of the individuals evacuated multiplied by the amount of time that the individuals are away from their residences, plus the cost of alternative housing for anyone whose residence is destroyed or otherwise made uninhabitable. Assuming that (1) the residence that is on fire or has exploded plus the 8 adjacent residences will need to be evacuated when there is a fire or explosion at a single-family residence,[78] (2) the total value of the lost time and foregone activities of those in the residences that are evacuated is $17 per hour,[79] (3) fires require 2 hours to put out and explosions require a like time to be properly responded to, and, therefore, the residents of the eight neighboring houses will be away from their homes for 2 hours,[80] (4) houses take approximately 6.4 months, or 195 days, to build,[81] and, therefore, the residents of the house that caught fire or suffered an explosion will be away from their home for 195 days, and (5) alternate housing for the residents of the house that caught fire or suffered an explosion costs $40 per day,[82] the total cost of evacuation per major fire or explosion will be (in 1993 dollars)

$$(8 \times 2 \times \$17) + (1 \times 195 \times 24 \times \$17) + (195 \times \$40) = \$87{,}634.$$

This estimate implicitly assumes that the single-family residence at which there is a major fire or explosion is no longer habitable. In actuality, this will not always be the case. It furthermore implicitly assumes that repairs alone will not be sufficient to make the dwelling habitable. This also will not always be the case. Finally, it explicitly assumes that a new residence can be built in 6.4 months. This also will not always be the case, particularly if the owners of the residence that was destroyed must settle with an insurance company before beginning the new construction.

The cost of evacuation per service per year resulting from a major fire or explosion will be the cost of evacuation per major fire or explosion multiplied by the expected

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[78]The housing lots in the vicinity of the fire or explosion are assumed to be laid out in a conventional rectangular grid.

[79]This estimate is based on the recognition of the fact that a person's time has value even when the person is not working. The value of non-working time is assumed to be equal to the wage received when working. The $17 per hour estimate is the weekly median earnings for all families with one or more earners in 1990, $653 (nominal) (see U.S. Department of Labor, p. 219), converted to 1993 dollars, put on an hourly basis (assuming a 40 hour workweek), and rounded to the nearest whole dollar. This figure does not consider the earnings of families where the husband, wife, or householder is self-employed. It might be noted that the $17 per hour estimate for the value of lost time implicitly assumes that the value of the time of those in the household who are not earners is $0. This may understate the true value of their time.

[80]On the incident report form, the OPS asks for amount of time necessary for the vicinity of an incident to be made safe. The average amount of time reported for the 30 incidents in Table 3.1 was 2 hours and 6 minutes.

[81]This is the average time taken to construct a new single family residence in 1990. The information was obtained from the Construction Statistics Division of the U.S. Census Bureau.

[82]This is the current "standard rate" for the maximum amount per day for lodging that Federal employees on travel in the continental U.S. will be reimbursed (see the *Federal Travel Directory*, October 1994, p. E-10).

frequency of major fires or explosions per service per year. For the purposes of this study, the frequency of major fires or explosions per service per year is assumed to be equal to the frequency of fires or explosions during incidents resulting in a death, injury, or property damage of $50,000 (nominal) or greater, 0.00000183 (see Section 3.2.3.1 for the estimation of this number). The cost of evacuation per service per year resulting from a major fire or explosion will consequently be (in 1993 dollars)

$87,634 x 0.00000183 = $0.16 per service per year.

3.2.4.2 Evacuations Caused by Minor Fires or Explosions

Minor fires or explosions may cause evacuations. Minor fires or explosions, however, will not generally result in the loss of a residence. Instead, they will only temporarily require the evacuation of the dwellings in the vicinity of the fire. Assuming that (1) 9 residences will need to be evacuated when there is a fire or explosion on the property at a single-family residence,[83] (2) the total value of the lost time and foregone activities of those in the residences that are evacuated is $17 per hour, and (3) fires require 2 hours to put out and explosions require a like time to be properly responded to, and, therefore, the residents of the 9 houses will be away from their homes for 2 hours, the total cost of evacuation per minor fire or explosion will be (in 1993 dollars)

9 x 2 x $17 = $306.

The cost of evacuation per service per year resulting from a minor fire or explosion will be the cost of evacuation per minor fire or explosion multiplied by the expected frequency of minor fires or explosions per service per year. For the purposes of this study, the frequency of minor fires or explosions per service per year is assumed to be equal to the frequency of fires or explosions during incidents that did not result in a death, injury, or property damage of $50,000 (nominal) or greater, 0.00000970 (see Section 3.2.3.1 for the estimation of this number). The cost of evacuation per service per year resulting from a minor fire or explosion (rounded to the nearest whole cent) will consequently be (in 1993 dollars)

$306 x 0.00000970 = $0.00 per service per year.

3.2.4.3 The Total Cost of Evacuations

The estimated total cost of evacuations per service per year will be the sum of the cost of evacuations resulting from major fires or explosions plus the cost of evacuations resulting from minor fires or explosions, or (in 1993 dollars)

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[83]These 9 residences consist of the residence at which the fire or explosion occurred plus the 8 adjacent residences.

$0.16 + $0.00 = $0.16 per service per year.

3.2.5 Lost Gas

During incidents on single-family residential services, natural gas will be lost. The quantity of gas that is lost in an incident is not collected by the OPS. Consequently, it must be estimated.

There is some difference of opinion as to the expected quantity that will be lost during an incident. The American Gas Association argues that, for incidents with a catastrophic rupture, the average amount of gas lost per incident will be no more than 11,000 cubic feet.[84] The Gas Safety Action Council appears to believe that 60,000 cubic feet is a more appropriate estimate for the amount of gas lost during an incident.[85] The Alabama Gas Corporation, a gas distribution company, appears to feel that, for incidents with a catastrophic rupture, 50,000 cubic feet is the appropriate estimate of the amount of gas lost during an incident.[86] Because Alabama Gas is a gas distribution company, while the other two organizations making estimates are not, the estimate by Alabama Gas is used in this study for the gas lost during a reportable incident.

Assuming that 50,000 cubic feet of gas are lost during a reportable incident and that the value of the lost gas is $3.65 per thousand cubic feet (1993 dollars),[87] the value of the gas lost per service per year due to reportable incidents (rounded to the nearest whole cent) is (in 1993 dollars)

0.00000077 x 50 x $3.65 = $0.00 per service per year.

The quantity of gas is lost during an average nonreportable incident will probably be less than the quantity lost during an average reportable incident. For the purposes of this study, it is assumed that 5000 cubic feet of gas are lost during each nonreportable incident. This is ten percent of the estimated loss of gas associated with reportable incidents. Given that there are an estimated 1,318 nonreportable incidents for each reportable incident (see Section 3.2.2), the value of gas lost per service per year due to nonreportable incidents is expected to be (in 1993 dollars)

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[84]See submission to U.S. DOT/RSPA/OPS Docket PS-118 by the by the American Gas Association, October 3, 1994, p. 27.

[85]See submission to U.S. DOT/RSPA/OPS Docket PS-118 by the Gas Safety Action Council, July 6, 1993, p. 12.

[86]See submission to U.S. DOT/RSPA/OPS Docket PS-118 by the Alabama Gas Corporation, July 1, 1993, p. 2.

[87]This is the average cost of gas to utilities at the city gate in 1991, $3.58 per thousand cubic feet [See submission to U.S. DOT/RSPA/OPS Docket PS-118 by the American Gas Association, October 3, 1994, p. 27.], converted from 1991 dollars to 1993 dollars.

0.00000077 x 5 x \$3.65 x 1318 = \$0.02 per service per year.

The total value of the gas lost per service per year due to all incidents on services is the sum of the total value per service per year for reportable incidents and the total value per service per year for nonreportable incidents, or (in 1993 dollars)

\$0.00 + 0.02 = \$0.02 per service per year.

3.2.6 Total Consequence Rates Per Service Per Year

From the foregoing, the consequence rates per service per year for incidents in the absence of EFVs are as follows:

- Deaths = 0.00000005
- Injuries = 0.00000041
- Property damage resulting from reportable incidents = \$0.11 (1993 dollars)
- Property damage resulting from nonreportable incidents = \$0.36 (1993 dollars)
- Cost of fighting fires and responding to explosions = \$0.05 (1993 dollars)
- Cost of evacuations = \$0.16 (1993 dollars)
- Value of lost gas = \$0.02 (1993 dollars).

3.3 THE EXPECTED REDUCTION IN CONSEQUENCES

Information on the reduction in incident consequences that can be expected to result from the installation of EFVs is sparse. There have been only two incidents reported to the OPS in which an EFV activated as a result of a break in a service. In both incidents, the operating pressure was 10 psig or greater, the nominal diameter of the pipe was 1.25 inches or less, and there was a substantial break in the service line or related appurtenances.[88] Also in both incidents, the cause was outside forces damage (specifically, third party damage). Given the circumstances of the incidents, the OPS believes that the presence of EFVs mitigated the consequences of these incidents.

The two reported incidents in which EFVs activated had 0 deaths, 1 injury, and \$7,300 in property damage (\$7,733 in 1993 dollars). Assuming that a death costs society \$2.6 million (1993 dollars) and an injury requiring hospitalization costs society \$490 thousand (1993 dollars),[89] these two incidents cost society \$500 thousand (1993 dollars), or an average

[88]DOT Report ID Nos. 890083 and 900040. The first incident (890083) occurred on a Northern States Power service in Fargo, ND, on March 2, 1989. The service on which the incident occurred had a nominal diameter of 0.625 inches and was operating at 14 psig at the time of the incident. The second incident (900040) occurred on an East Ohio Gas service in South Russell, OH, on December 19, 1989. The service had a nominal diameter of 0.625 inches and was operating at 60 psig at the time of the incident.

[89]These are the current standard values for deaths and injuries requiring hospitalization used in OPS benefit/cost studies.

of $250 thousand each (1993 dollars).[90] Using the same assumptions, the 30 reported incidents in Table 3.1 cost society an average of $576 thousand each (1993 dollars).[91] Thus, if the two incidents are representative, EFVs can be expected to reduce the cost to society of the incidents by at least 57 percent. At most, of course, they can be expected to reduce the cost to society by 100 percent. For the purposes of this study, EFVs are assumed to reduce the cost to society due to incident consequences by 79 percent, the mid-point between 57 percent and 100 percent.

3.4 THE EXPECTED BENEFITS

The benefits that are expected to result from the installation of EFVs on single-family services are a reduction in the following incident consequences:

- Deaths
- Injuries
- Property damage
- The costs of putting out fires and responding to explosions
- The costs associated with evacuation of residents from the vicinity of an incident
- Lost gas.

3.4.1 Assumptions

To calculate the expected benefits and the present value of the expected benefits, several assumptions need to be made concerning the cost to society of a death or injury, and the expected life of an EFV and the appropriate discount rate for use in calculating the present value of the expected benefits. The assumptions made concerning these things are as follows:

- A life is valued at $2,600,000
- An injury requiring hospitalization is valued at $490,000
- EFVs will last 50 years
- The discount rate is 7 percent.

The valuations of a life at $2,600,000 and an injury requiring hospitalization at

[90]In calculating this estimate, the property damage value for the 2 incidents was multiplied by 1.3. For the rationale behind this adjustment, see Section 3.2.1.

[91]In calculating this estimate, the property damage value for the 30 incidents was multiplied by 1.3. For the rationale behind this adjustment, see Section 3.2.1.

$490,000 are standard assumptions currently used in OPS benefit/cost analyses.[92]

The expected life of a gas service that is used for accounting purposes by gas distribution companies appears to vary from around 50 years to around 100 years.[93] Because EFVs have only been in use on gas services since 1963, it is not really known how long they can reasonably be expected to last. The hope of those currently installing EFVs is, of course, that they will last as long as the services in which they are installed. For the purposes of this study, it is assumed that EFVs will last 50 years, the lower bound on the expected accounting life of a service.

Seven percent per annum is the current standard value mandated for discount rates used in Federal benefit/cost analyses. This rate is felt by the Office of Management and Budget to approximate "...the marginal pretax rate of return on an average investment in the private sector in recent years."[94] The discount rate is used in present value calculations.

3.4.2 Expected Benefits Per Installed EFV Per Year

The expected benefits per installed EFV per year will be the reduction in consequences expected to result from the installation of EFVs (or 79 percent, as determined in Section 3.3) multiplied by the sum of (1) the assumed value of a life multiplied by the expected number of deaths per service per year without EFVs, (2) the assumed value of an injury multiplied by the expected number of injuries per service per year without EFVs, (3) the property damage per service per year without EFVs, (4) the cost of fighting fires and responding to explosions per service per year without EFVs, (5) the cost of evacuation per service per year without EFVs, and (6) the value of lost gas per service per year without EFVs, or (in 1993 dollars), or

0.79 x ((0.00000005 x $2,600,000) + (0.00000041 x $490,000) + ($0.11 + $0.36)
$0.05 + $0.16 + $0.02 = $0.81 per installed EFV per year.

This estimate does not include the benefits that would result from a reduction in the cost of injuries that do not require hospitalization.

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[92]The cost to society of a severe injury is assumed to be equal to 0.1875 times the cost to society of a lost life. Assuming that the societal value of a lost life is $2.6 million, then the societal value of an injury will be approximately $490 thousand.

[93]Conversation of Alicia Distler, U.S. DOT, Jack Willock, U.S. DOT, Robert Walter, U.S. DOT, and Paul Zebe, U.S. DOT, with William St. Cyr, Bay State Gas, Brockton, MA, August 12, 1991. The operational length of life of gas services, it might be noted, is apparently expected to be longer than 50 years. Bay State Gas, for example, expects its services to generally last longer than 50 years. In its submission of March 7, 1991, to the U.S. DOT/RSPA/OPS Docket No. PS-118, New Jersey Natural Gas indicates that the design life of its services is 100 years.

[94]*Federal Register*, November 10, 1992, pp. 53522-53523.

3.4.3 Present Value of Benefits

The present value of the benefits of installing an EFV is the present value of the expected benefits per installed EFV per year calculated over 50 years using a 7 percent discount rate, or (in 1993 dollars)

the present value of \$0.81 = \$11.18 per installed EFV.

4. COSTS

4.1 INTRODUCTION

The costs expected to result from the installation of EFVs on all new or renewed single-family residential gas services that operate at a pressure that is always 10 psig or greater are

- The cost of the initial installation of the EFVs
- The cost of EFV operation
- The costs associated with EFVs that fail to operate properly
- The costs associated with marking services with EFVs
- Other costs.

Under the final rule, gas distribution companies may install EFVs with bleed-by, EFVs with positive shut-off, or both. Consequently, costs are estimated for both EFVs with bleed-by and EFVs with positive shut-off.

Based on information obtained from industry sources, it is not expected that EFVs will be inspected or tested at installation or periodically after they have been installed. Consequently, no inspection or testing costs are expected to result from the installation of EFVs.

4.2 EFVS WITH BLEED-BY

EFVs with bleed-by are the typical EFV currently installed by gas distribution systems on single-family residential gas services. Based on comments received by the OPS, it is expected that, if required to install EFVs, most gas distribution companies will opt to install EFVs with bleed-by.

4.2.1 Cost of Initial Installation

Cost figures for the installation of EFVs on new or renewed services that were provided to the OPS by gas distribution companies that currently or formerly installed EFVs in response to the questionnaire included in the ANPRM are presented in Table 4-1. These figures represent the difference between the cost of installing a service with an EFV and the cost of installing a service without an EFV.

Based on cost figures obtained from gas distribution companies that currently install EFVs, the average installed cost of an EFV on a new or renewed service was $37 in 1991, while the average cost of an EFV was somewhere around $24 in 1991(see Table 4-1). It appears from these figures that the cost of an EFV makes up nearly two-thirds of the cost of

EFV installation on a new or renewed service. The second most important component of the cost of EFV installation appears to be the cost of the labor required. For this study, the current installed cost of an EFV is estimated to be $38 (1993 dollars), which is the $37 average for 1991 changed from 1991 dollars to 1993 dollars, while the average cost of an EFV is estimated to be $24 (1993 dollars), which is the $24 average for 1991 changed from 1991 dollars to 1993 dollars.

If EFVs were to be installed on all new or renewed single-family residential gas services that operate at pressures that never fall below 10 psig, their unit cost would be expected to decline over time from its current level.[95] This would be caused by increased production of EFVs to meet the new and expanded demand that would allow manufacturers to realize reductions in their variable costs, as well as to distribute their fixed costs over a larger number of units. Competition would probably force the manufacturers to pass on much of these cost savings to their customers.

Discussions with an EFV manufacturer indicate that the increase in the production of EFVs resulting from the installation of EFVs on all new or renewed single-family residential services could produce a 30 to 40 percent reduction in the unit cost of EFVs.[96] Thus, if EFVs were to be installed on all new or renewed single-family residential gas services that always operate at pressures of 10 psig or greater, then the average unit cost of an EFV could fall from $24 to $14 or $17 (1993 dollars).

For the purposes of this analysis, the average unit cost of an EFV is assumed to be $16 (1993 dollars), the mid-point of the range for the unit cost of an EFV that could be experienced when the unit cost falls in response to increased production of EFVs. Given that the current unit cost is estimated to be $24, it is assumed that there will be an $8 reduction in the unit cost of EFVs. The incremental cost of installing an EFV on a new or renewed single-family residential service is expected to be $30 (1993 dollars), the estimate of the current installed cost, $38, minus the expected $8 reduction in the unit cost of EFVs.

The Public Service Company of Colorado recently performed a cost analysis of various EFVs under different installation options as part of an EFV evaluation, which includes an on-going EFV pilot program. Table 4-2 shows the incremental costs developed from the installation cost estimates made by the Public Service Company of Colorado. These incremental costs are, in the main, fairly consistent with the $30 estimate of the installed cost of an EFV, indicating that the $30 estimate, which represents the installed cost after a fairly

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[95]See the attachment from the Public Service Company of Colorado to the submission to U.S. DOT/RSPA/OPS Docket PS-118 by the Public Utilities Commission of Colorado, June 17, 1993, p. 25. See also the submission to U.S. DOT/RSPA/OPS Docket PS-118 by UMAC, Inc., July 6, 1993, p. 21. If the installation of EFVs is mandated, EFV prices might increase at first. This would be the result of gas distribution companies bidding up the price of EFVs in an attempt to meet their short-term installation requirements. This price increase would be brief and temporary, however, as new manufacturers enter the market and current manufacturers increase their production in order to meet the demand for valves.

[96]Telephone conversation between Nancy Garrity, U.S. DOT, and John McGowan, UMAC, Inc., November 14, 1991.

significant reduction in the unit cost of EFVs, may be too high.[97]

4.2.2 Operational Costs

EFVs with bleed-by automatically reset after they have tripped due to a catastrophic break in a service line. The only cost associated with the proper operation of an EFV with bleed-by is the relighting of pilots that may have gone out when the EFV tripped. This cost will be relatively small, since a properly operating EFV will only trip if there is an incident, and, if there is an incident, gas company personnel will be on site to repair the damaged service. Furthermore, this cost is actually part of the cost of the incident and will be incurred whether or not there is an EFV present on the damaged service line. Consequently, the operational cost of an EFV with bleed-by is $0 (1993 dollars).

4.2.3 Costs Associated with EFVs That Fail to Operate Properly

It has been found by gas distribution companies that EFVs sometimes close when they should not and sometimes fail to close when they should (see Table 4-3). When EFVs fail to operate properly, gas distribution companies must take action to correct the problem. This corrective action adds to the total cost of using EFVs.

4.2.3.1 False Closure

EFVs will close when the flow of gas through the valve exceeds the valve's trip level. This can occur not only when there is a substantial break in a service line, but also when the flow rate of the valve that has been installed in a line is too small for the gas customer's load. EFVs have also improperly closed upon occasion because of contaminants in the service line. Connecticut Natural Gas, for example, has experienced three false closures over the years that were a direct result of pipeline liquids in services causing rubber washers in EFVs to swell up and block off the flow of gas through the valves.[98] Other reasons for false closures of EFVs include pressure drops on gas mains and "increased gas density due to propane-air mixtures during peak shaving."[99]

A total of 0.00016 false closures per installed valve per year are expected to occur. This estimate was calculated using the information in Table 4-3 on (1) the reported number of false closures between 1980 and 1991 that were experienced by gas distribution companies

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[97]The Public Service Company of Colorado's cost analysis focussed on the installation of EFVs on plastic pipe. Potentially, the cost of installation for steel pipe could be higher than the cost for plastic pipe.

[98]Submission to U.S. DOT/RSPA/OPS Docket PS-118 by Connecticut Natural Gas Corp., March 18, 1991, pp. 2, 3.

[99]Submission to U.S. DOT/RSPA/OPS Docket PS-118 by Minnegasco, U.S. DOT/RSPA/OPS Docket No. PS-118, no date (c. March 1991), p. 4.

that currently install EFVs and (2) the number of valves installed between 1980 and 1991, weighted by the number of years that the valves had been in operation in 1991. It was assumed that, on average, valves installed between 1980 and 1984 had been in operation 8.5 years and valves installed between 1985 and 1991 had been in operation 3 years.

When an EFV experiences a false closure, the pilot lights on the consumer's gas appliances may go out, although this will not necessarily be the case.[100] When the pilot lights do go out, the gas company will have to make a service call to relight the pilots.[101] It appears that the service call to relight pilot lights will take about a half hour. The cost of relighting the pilots, therefore, will equal the total cost of a half hour service call, including wages, materials, and the use of a company truck.[102] The total cost of relighting the pilot lights on consumer appliances is assumed to be $26 (1993 dollars). This is the estimate developed by RISC for the cost of relighting pilots, $25, changed from 1991 dollars to 1993 dollars.[103]

The need to relight pilots, it should be noted, is declining. Many modern gas appliances do not have pilot lights. Furthermore, the bleed-by flow of gas through an EFV that has tripped is believed to be sufficient to keep pilot lights lit.[104] Nevertheless, for the purposes of this study, it is assumed that the pilot lights always go out when there has been a false closure, and, therefore, it is always necessary for the gas company to make a service call to relight the pilots.

When an EFV experiences a false closure, it does not always automatically reset. When this happens, the gas company will have send someone out to the site to (1) try to manually reset the valve by back-pressuring the service with compressed gas or (2) excavate the valve under the assumption that it is defective. Bay State Gas, one of the two largest users of EFVs, has reportedly never had a problem with a valve failing to automatically reset, but if it did, it would probably be assumed that there was a problem with the valve and the valve would be excavated and replaced.[105] For the purposes of this study, it is assumed that EFVs that fail to automatically reset will be excavated and replaced.

A total of 0.0000042 failures to automatically reset per installed EFV per year are

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[100]See submission to U.S. DOT/RSPA/OPS Docket PS-118 by the Iowa Department of Commerce, Utilities Division, June 28, 1993, p. 2.

[101]As ignition devices replace pilot lights in gas appliances, the need for gas companies to have someone go out and relight pilots will diminish, and may eventually end altogether.

[102]Telephone conversation between Alicia Distler and Paul LaShoto, Assistant Vice President, Bay State Gas Co., October 4, 1991.

[103]See RISC, August 26, 1991, p. 4.

[104]Submission to U.S. DOT/RSPA/OPS Docket PS-118 by the Iowa Department of Commerce, Utilities Division, June 28, 1993, p. 2.

[105]Telephone conversation between Dianne Sutherland, U.S. DOT, and Paul LaShoto, Bay State Gas, July 1994.

expected to occur. This is RISC's estimate of the frequency of failure to reset.[106]

The cost of digging up and replacing an EFV is assumed to be $697 (1993 dollars). This estimate is the average cost for removing and replacing an existing EFV reported by the gas distribution companies currently installing EFVs (see Table 4-1), $683, converted from 1991 dollars to 1993 dollars. The estimate covers the cost of labor, equipment, materials, and permits. It does not include overhead charges.

The expected cost of false closure per installed EFV per year is equal to the rate of false closure multiplied by the cost of relighting pilots plus the rate of failure to automatically reset multiplied by the cost of digging up and replacing the EFV, or (in 1993 dollars)

(0.00016 x $26) + (0.0000042 x $697) =

$0.01 per installed EFV per year.

4.2.3.2 Failure to Close

An EFV will fail to close when there has been a substantial or catastrophic break in a service because it (1) is defective, (2) was incorrectly installed, (3) has become stuck open due to contaminants, or (4) is not the proper size for the service. An EFV that fails to close can be repaired, replaced, removed, or ignored.[107] For the purposes of this study, it is assumed all EFVs that fail to close will be replaced.

The rate of failure of EFVs to close is expected to be 0.00044 per installed EFV per year. This estimate was calculated using the information in Table 4-3 on the reported number of failures to close experienced by gas distribution companies that currently install EFVs and the number of valves installed, weighted by the number of years that the valves had been in service in 1991. It was assumed that valves installed between 1980 and 1984 had been in operation 8.5 years, on average, and valves installed between 1985 and the 1991 had been in operation 3 years, on average.

It is assumed that excavation over and above what is necessary to repair the damage to the service will not be required in order to replace an EFV that has failed to close (i.e., it is assumed that only one excavation will be needed to take care of both the repair of the service and the installation of an EFV). Consequently, the cost of replacing an EFV that has failed to close will be equal to the estimated cost of installing an EFV on a new or renewed service, that is, $30 (1993 dollars).

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[106]See RISC, August 26, 1991, p. 5.

[107]Among other reasons, a gas distribution company may choose not to remove, repair, or replace an EFV that has failed to close if (1) the company is confident that the reason that the valve did not close was because it was not the proper size for the service and (2) a more appropriately sized EFV is not available.

The estimated expected cost of failure to close per installed EFV per year is equal to the rate of failure of EFVs to close multiplied by the cost of installing an EFV on a new or renewed service, or (in 1993 dollars)

0.00044 x \$30 = \$0.01 per installed EFV per year.

4.2.3.3 Total for Costs Associated With EFVs That Fail to Operate Properly

The total for the costs associated with EFVs that fail to operate properly equals the cost per installed EFV per year attributable to the failure of EFVs to close plus the cost per installed EFV per year attributable to the improper closure of EFVs, or (in 1993 dollars)

\$0.01 + \$0.01 = \$0.02 per installed EFV per year.

4.2.4 Costs Associated with Marking Services with EFVs

The final rule requires the marking of services in which an EFV is installed. The incremental cost of marking services with EFVs is expected to be nominal. For the purposes of this study, the cost of marking the services is estimated to be \$0 per EFV (1993 dollars). Maintenance of the markers is also expected to be nominal. For the purposes of this study, the cost of maintaining markers is estimated to be \$0 per EFV per year (1993 dollars).

4.2.5 Other Costs

Additional costs will be incurred by gas distribution systems installing EFVs. These include the costs for the following:

- Purchasing and inventory control for EFVs
- Engineering and related activities
- Training of employees
- Additional excavation required for the installation of EFVs.

These costs are discussed below. It should be noted that none of these costs could be quantified with an adequate degree of certainty. Consequently, none were included in the estimate of total cost of EFVs. It is expected, however, that some of these costs may not be insignificant. The fact that these costs are not included in the total costs should be kept in mind when considering the total cost and the benefit/cost ratio.

4.2.5.1 Purchasing and Inventory Control

The cost of purchasing and inventory control can be expected to be relatively small, particularly when viewed on a per EFV per year basis. All gas distribution companies have purchasing and supply departments familiar with the acquisition, storage, and distribution of equipment and parts. It is not expected that additional staff or storage facilities will be needed to accommodate the acquisition, storage, and distribution of EFVs. Existing storage space, of course, will be needed for EFVs. This may require the acquisition of shelving, bins, etc., for EFV storage. It may also require a change in the way existing storage space is used. The costs of additional shelving, bins, etc., and of adjusting storage to accommodate EFVs is expected to be relatively minimal.

4.2.5.2 Engineering and Related Activities

The cost of engineering and related activities includes the costs of (1) identifying appropriate EFV(s), (2) making changes to the way distribution systems are designed and operated in order to accommodate EFVs[108], (3) developing standards, protocols, and guidelines for when and where to install EFVs, (4) developing procedures for field personnel to follow when installing EFVs and when performing maintenance functions on service lines with EFVs installed on them, (5) documenting and distributing all standards, protocols, guidelines, and procedures, as well as revising and updating existing documents impacted by the installation of EFVs, such as Operation and Maintenance (O&M) plans, and (6) setting up and implementing record-keeping procedures for EFVs. Generally, these costs will be incurred only once, at the very start of the EFV installation process. Based on information received by the OPS from gas distribution companies, they are expected to be fairly significant, particularly on a per company basis. The costs may be fairly constant across companies (i.e., the costs may be more or less the same for each and every company). The costs on a per company basis are unknown. The costs on a per EFV per year basis are also unknown, although they will probably not be insignificant, except, perhaps, for the very largest gas distribution companies.

Considerable effort will be necessary to set things up so that EFVs will work properly. In identifying appropriate EFV(s) for use on distribution systems, operators may need to perform some testing to verify manufacturers' performance claims. In some cases, operators may need to work closely with EFV manufacturers to overcome problems. In the early phases of the installation of EFVs by some Massachusetts gas distribution system operators, for example, it is reported that they had to work with the manufacturers to solve at least some of their problems.[109]

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[108]It is argued that this will be needed because of the restriction of gas flow caused by EFVs. [See Attachment from the Public Service Company of Colorado to the submission to U.S. DOT/RSPA/OPS Docket PS-118 by the Public Utilities Commission of Colorado, June 17, 1993, p. 2.]

[109]Submission to U.S. DOT/RSPA/OPS Docket PS-118 by the Department of Public Utilities, Commonwealth of Massachusetts, July 2, 1993, p. 6.

4.2.5.3 Training

The cost of training includes (1) the cost of developing formal training for field and other personnel, (2) the cost of the initial formal training, (3) the cost of formal training after the initial training effort, and (4) the cost of informal training in the field where experienced employees teach the inexperienced or where employees learn by trial and error. The initial formal training is not combined with the other formal training because the initial training will almost certainly provide information that will need to be tested in the field and refined before it reliable enough to be presented on a regular basis. This may involve additional cost (over and above the cost of the other formal training). Training, whether formal or informal, is essential if EFVs are to work properly. The cost of the training (formal and informal) that will be needed as a result of the final rule requiring the installation of EFVs is unknown.[110]

4.2.5.4 Additional Excavation

It is reported by some gas distribution companies that the installation of EFVs on renewed services would necessitate additional excavation. One reason given for the additional excavation is the need to enlarge the bellhole in order to provide enough room to insert an EFV and to make all necessary welds or fusions.[111] The reported cost of the enlargement of the bellhole needed for the installation of an EFV is $106.50.[112] The utility estimating this cost, Southern California Gas, does not currently install EFVs. Another reason given for additional excavation is the need in certain cases to create a bellhole when installing an EFV on a renewed service. When bellholes must be created, it is estimated that they can increase the EFV installation cost by $188.54 to $580.83, depending on the service size (5/8", 3/4", 1", 1 1/4", 1 1/2", or 2"), the service material (plastic or steel), and whether the bellhole is in dirt or pavement.[113] The municipal utility estimating this cost, Memphis Light, Gas and Water,

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[110]It appears that, on a per person basis, the formal training needed will be relatively minor. Bay State Gas, a major user of EFVs, provides an estimated one half-hour of EFV training per person per career. [Telephone conversation between Dianne Sutherland, U.S. DOT, and Paul LaShoto, Bay State Gas, December 1, 1994.] East Ohio Gas, another major user of EFVs, provides an estimated 5 minutes of EFV training per person per career. [Telephone conversation between Dianne Sutherland, U.S. DOT, and Paul Oleksa, East Ohio Gas, December 1, 1994.] Colonial Gas, which currently installs EFVs, provides an estimated one half-hour of EFV training per person per year. [Telephone conversation between Dianne Sutherland, U.S. DOT, and Charles Boyajian, Colonial Gas, December 6, 1994.]

[111]Attachment to the submission to U.S. DOT/RSPA/OPS Docket PS-118 by the Southern California Gas Company, July 6, 1993, pp. 2, 3.

[112]This cost figure is "[b]ased on a hourly cost for a distribution crew of $71 and a time study of a steel replacement service done as part of ... [a limited EFV] field test...." In addition to the cost of increasing the size of the bellhole, it also may be necessary to pay for "non-native backfill and disposal of native soil." [Attachment to the submission to U.S. DOT/RSPA/OPS Docket PS-118 by the Southern California Gas Company, July 6, 1993, p. 3.]

[113]Submission to U.S. DOT/RSPA/OPS Docket PS-118 by the Memphis Light, Gas and Water Division, June 11, 1993, p. 3. The estimated range was developed from estimates in the submission of the "extra cost due to EFV installation and test" for new services subtracted from estimates of the "material, test,

does not currently install EFVs.

It is not clear how many gas distribution companies would actually need to perform any additional excavation in order to install EFVs, or if the companies that believe that they would need to perform additional excavation would actually find that this is the case once they began installing EFVs. It is possible that a less costly alternative could be found or that the companies have overestimated the excavation needed in the installation of an EFV on a renewed service. Alternatively, all companies may need to perform additional excavation.

4.2.6 Total Cost

The total cost per installed bleed-by EFV is the sum of the installation cost for the EFV plus the cost per installed EFV per year attributable to improperly operating EFVs plus the cost of marking services that have EFVs installed on them, or (in 1993 dollars)

$30 per installed EFV + $0.02 per installed EFV per year + $0 per installed EFV =

$30 per installed EFV + $0.02 per installed EFV per year.

As mentioned earlier, this cost estimate does not include any of the costs discussed in Section 4.2.5.

4.3 EFVS WITH POSITIVE SHUT-OFF

EFVs with positive shut-off are occasionally, although rarely, installed on single-family residential services by gas distribution systems.[114] Based on the comments received by the Office of Pipeline Safety to the NPRM (Notice of Proposed Rulemaking; Docket PS-118, Notice 2), it appears that, if required to install EFVs, some gas distribution companies like the perceived safety of the positive shut-off feature and may choose to install EFVs with positive shut-off if the price is right.

4.3.1 Cost of Initial Installation

An EFV with positive shut-off is essentially a bleed-by EFV without the hole or groove that allows the gas to bleed by the valve. The cost of foregoing the hole or groove in

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installation and bellhole" costs for renewed services. The lower end of the range represents the estimated cost of a bellhole for a 5/8" PE service where the bellhole is created in dirt, while the upper end of the range represents the estimated cost of a bellhole for a 2" CWS service where the bellhole is created in pavement.

[114]The Des Moines District of Midwest Gas has approximately 1000 EFVs with positive shut-off installed on a nominal 60 psig system. [Submission to U.S. DOT/RSPA/OPS Docket PS-118 by the Midwest Gas, July 2, 1993, p. 2.]

the manufacturing process is expected to be minimal. Consequently, the cost of initial installation of an EFV with positive shut-off is assumed to be the same as the cost of initial installation of an EFV with bleed-by, or $30 (1993 dollars). This estimate may understate the actual cost somewhat, since it appears that most gas distribution companies will choose to install EFVs with bleed-by, rather than EFVs with positive shut-off. The reduction in the unit cost of an EFV with positive shut-off that results from the realization of production economies of scale by manufacturers may not be as high as the expected $8 reduction in the unit cost of an EFV with bleed-by. However, since the $30 estimate for the installed cost of an EFV with bleed-by may be high, a $30 estimate for the installed cost of an EFV with positive shut-off may be reasonable.

4.3.2 Operational Costs

Because EFVs with positive shut-off require gas company personnel to manually reset the valve whenever it activates properly as a result of damage to a service line, there will be an operational cost associated with the use of EFVs with positive shut-off. This will be the direct cost of manually resetting a valve that has tripped plus the installed cost of connectors necessary for the manual resetting to be accomplished.

In order for an EFV with positive shut-off to be reset, it is necessary to apply back pressure on the service line. This requires (1) a pressurized cylinder containing compressed natural gas and (2) a connector somewhere on or upstream of the meter set that will allow the pressurized cylinder to be connected to the service line. For the purposes of this study, it is assumed that gas companies will not need to acquire any additional pressurized tanks in order to apply back pressure to service lines where the EFV has activated as a result of an incident. Gas companies are assumed to have a sufficient quantity of appropriately configured pressurized tanks currently on hand (since the number of EFV activations per year, both proper and false, that a gas distribution system will experience will be quite small, the number of pressurized tanks needed will be minimal). To facilitate the application of back pressure on service lines, gas companies will need to install a connector on each service line with an EFV. For the purposes of this study, it is assumed that each connector will have an installed cost of $6.50 (1993 dollars).[115] Since this connector will be installed at the time that the service line is installed or renewed, it is assumed that the installation cost of the connector will be nominal.

The direct cost of manually resetting a valve that has properly activated (the cost of manually resetting a valve as a result of improper activation is addressed in Section 4.3.3) is assumed to be $26, which is the cost of attempting to manually reset an EFV that was

[115] Iowa-Illinois Gas and Electric Company estimates that the installed cost of a connection (i.e., the cost of both parts and labor) would be $6. [Attachment to the submission to U.S. DOT/RSPA/OPS Docket PS-118 by Illinois-Iowa Gas and Electric Company, June 18, 1993, p. 2.] Wisconsin Natural Gas estimates that the installed cost of the connection would be $6.50. This consists of $3.56 for materials and $2.94 for labor. [Telephone conversation between Dianne Sutherland, U.S. DOT, and Alice Linders-Olson, Wisconsin Natural Gas, July 8, 1994.] To be conservative, the Wisconsin Natural Gas estimate was selected for use in the analysis.

estimated by RISC,[116] $25, transformed from 1991 dollars to 1993 dollars. The rate at which proper activations of EFVs will occur is estimated to be 0.0009 per EFV per year.[117]

The operational cost of an EFV with positive shut-off is expected to be the one-time installed cost of the connector plus the direct cost of manually resetting a valve, or (in 1993 dollars)

$6.50 + ($26 x 0.0009) =

$6.50 per EFV + $0.02 per EFV per year.

4.3.3 Costs Associated with EFVs That Fail to Operate Properly

The gas industry has little experience with EFVs with positive shut-off. Consequently, there is little information available on the performance of these valves in the field. As mentioned previously, however, an EFV with positive shut-off is essentially a bleed-by EFV without the hole or groove that allows the gas to bleed by the valve. The mere lack of a minuscule hole or groove should not materially affect the performance of the valve. Therefore, it is expected that the performance of EFVs with positive shut-off will be essentially identical to the performance of EFVs with bleed-by. That is, the false closure and failure to close rates for EFVs with bleed-by that have been experienced in the field by gas distribution companies are the rates expected for EFVs with positive shut-off. Because an EFV with positive shut-off requires action by gas company personnel whenever it is activated, the costs associated with EFVs with positive shut-off may prove to be higher than the costs associated with EFVs with bleed-by.

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[116]See RISC, August 26, 1991, p. 19.

[117]Information on the number of proper EFV activations is scarce. Bay State Gas reports that it had 53 proper EFV activations and 56,000 installed EFVs in 1992. [Submission to U.S. DOT/RSPA/OPS Docket PS-118 by Bay State Gas, June 21, 1993, p. 1.] Of the 53 activations, 52 resulted from damage by outside forces and 1 resulted from another unspecified cause. The estimate of the activation rate used in this report is based on the experience of Bay State Gas in 1992. UMAC, in a submission to Docket PS-118, reported that a gas company in New Jersey with 30,000 UMAC valves had experienced 125 proper activations since 1980; that a gas company in Pennsylvania with 50,000 UMAC valves had more than 17 activations annually as a result of third party damage; that a gas company in New York with 4,000 UMAC valves had over 40 activations due to third party damage during the first eight months after starting installation; that a gas company in Ohio with 8,000 UMAC valves experienced 144 activations due to third party damage in the period between January 1992 and June 1993; and that a company in South Carolina with 280 UMAC valves experienced 15 activations due to third party damage between October 1991, when installation of the valves began, and June 1993. [See the submission to U.S. DOT/RSPA/OPS Docket PS-118 by UMAC, Inc., Midwest Gas, July 6, 1993, Exhibit F, pp. 1-2.] These activation figures from UMAC, taken as a whole, are not inconsistent with the activation rate estimate derived from the Bay State Gas activation figures for 1992. (It might be noted that UMAC also gave activation figures resulting from third party damage for a gas company in Massachusetts that was obviously Bay State Gas.)

4.3.3.1 False Closure

EFVs will close when the flow of gas through the valve exceeds the valve's trip level. For EFVs with bleed-by, a total of 0.00016 false closures per installed valve per year are expected to occur. This estimate is also assumed to be representative of the false closure rate for EFVs with positive shut-off.

When an EFV experiences a false closure, the pilot lights on the consumer's gas appliances may go out, and the gas company may have to make a service call to relight the pilots. The total cost of relighting the pilot lights on consumer appliances is assumed to be $26 (1993 dollars). This is the estimate developed by RISC for the cost of relighting pilots, $25, changed from 1991 dollars to 1993 dollars.[118] Although the need to relight pilots is declining, since many modern gas appliances do not have them, for the purposes of this study, it is assumed that the gas company will need to make a service call to relight the pilots whenever there has been a false closure.

When an EFV with positive shut-off experiences a false closure, it will need to be manually reset. The cost of attempting to manually reset an EFV is assumed to be $26 (1993 dollars). This is the estimate developed by RISC for the cost of attempting to manually reset an EFV changed from 1991 dollars to 1993 dollars.[119]

Some attempts to manually reset an EFV are not successful. When an EFV has experienced a false closure, and the attempt to manually reset the valve has failed, the gas company will have to dig up and replace the valve. The rate of failure of EFVs with positive shut-off to manually reset is assumed to be equal to the rate of failure of EFVs with bleed-by to automatically reset, or 0.0000042 per installed EFV per year. The cost of digging up and replacing an EFV with positive shut-off is assumed to be $697 (1993 dollars), the estimated cost of digging up and replacing an EFV with bleed-by.

The expected cost of false closure per installed EFV per year is equal to the rate of false closure multiplied by the cost of relighting pilots plus the rate of false closure multiplied by the cost of manually resetting an EFV plus the rate of failure of manual reset multiplied by the cost of digging up and replacing an EFV, or (in 1993 dollars)

(0.00016 x $26) + (0.00016 x $26) + (0.0000042 x $697) =

$0.01 per installed EFV per year.

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[118]See RISC, August 26, 1991, p. 4.

[119]See RISC, August 26, 1991, p. 19.

4.3.3.2 Failure to Close

An EFV may fail to close for a variety of reasons after there has been a substantial or catastrophic break in a service. When an EFV fails to close, it can be repaired, replaced, removed, or ignored. For the purposes of this study, it is assumed all EFVs that fail to close will be replaced.

The rate of failure of EFVs with bleed-by to close is expected to be 0.00044 per installed EFV per year. This is also the assumed rate of failure of EFVs with positive shut-off to close.

It is assumed that excavation over and above what is necessary to repair the break in the service line will not be required in order to replace an EFV that has failed to close. Consequently, the cost of replacing an EFV that has failed to close will be equal to the estimated cost of installing an EFV on a new or renewed service, $30 (1993 dollars).

The estimated expected cost of failure to close per installed EFV per year is equal to the rate of failure of EFVs to close multiplied by the cost of installing an EFV on a new or renewed service, or (in 1993 dollars)

0.00044 x $30 = $0.01 per installed EFV per year.

4.3.3.3 Total for Costs Associated With EFVs That Fail to Operate Properly

The total for the costs associated with EFVs that fail to operate properly equals the cost per installed EFV per year attributable to the failure of EFVs to close plus the cost per installed EFV per year attributable to the improper closure of EFVs, or (in 1993 dollars)

$0.01 + $0.01 = $0.02 per installed EFV per year.

4.3.4 <u>Costs Associated with Marking EFVs</u>

The final rule requires the marking of services with EFVs. The incremental cost of marking services that have EFVs installed on them is expected to be nominal. For the purposes of this study, the costs of marking the services are estimated to be $0 per EFV (1993 dollars). Maintenance of the markers is also expected to be nominal. For the purposes of this study, the costs of maintaining markers are estimated to be $0 per EFV per year (1993 dollars).

4.3.5 <u>Other Costs</u>

In addition to the costs discussed previously, gas distribution companies can expect to incur a number of other costs. These include costs for the following:

- Purchasing and inventory control for EFVs
- Engineering and related activities
- Training of employees (for other than use of back-pressure equipment)
- Additional excavation.

None of these costs could be quantified with any degree of certainty. Consequently, none were included in the estimate of total cost of EFVs. It is expected, however, that some of these costs may be significant, particularly in the early stages of the EFV installation process.

4.3.6 Total Cost

The total cost per installed EFV with positive shut-off is equal to the installation cost for an EFV plus the cost per installed EFV per year attributable to properly operating EFVs plus the cost per installed EFV per year attributable to improperly operating EFVs plus the cost of marking EFVs, or (in 1993 dollars)

> $30 per installed EFV + ($6.50 per installed EFV + $0.02 per installed EFV per year) + $0.02 per installed EFV per year + $0 per installed EFV =
>
> $36.50 per installed EFV + $0.04 per installed EFV per year.

This cost estimate does not include any of the costs discussed in Section 4.3.5.

4.4 PRESENT VALUE OF COSTS

The present value of the total cost of both EFVs with bleed-by and EFVs with positive shut-off is calculated assuming an operational life for an EFV of 50 years, the reported accounting life of gas service lines for at least some gas distribution companies,[120] and a discount rate of 7 percent. Service lines, like EFVs, are assumed to have a 50-year life. For the purposes of this study, a 50-year time horizon is used in the calculation of the present value of the costs.

It should be noted that no EFV has yet been in place in a gas service line for 50 years.[121] It is possible that EFVs will not last that long. If this proves to be the case, then the actual present value of the total cost of an EFV will be larger than what it has been

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[120]Conversation of Alicia Distler, U.S. DOT, Jack Willock, U.S. DOT, Robert Walter, U.S. DOT, and Paul Zebe, U.S. DOT, with William St. Cyr, Bay State Gas, Brockton, MA, August 12, 1991.

[121]It might be noted that some currently operational EFVs appear to have lasted nearly 30 years. Montana-Dakota Utilities installed 50 EFVs in 1965. As of 1993, 20 were still operational. [See the submission to U.S. DOT/RSPA/OPS Docket PS-118 by the Montana-Dakota Utilities Co., June 17, 1993, p. 1.]

estimated here to be.

The costs used to calculate the present value are not complete. The calculated costs do not include the costs of (1) EFV purchasing and inventory control, (2) engineering and related activities, (3) training of employees, or (4) additional excavation. These costs, taken together, could be fairly significant, particularly in the early years of EFV installation.

4.4.1 EFVs with Bleed-by

The present value of the cost of an EFV with bleed-by is the estimated cost per installed EFV[122] plus the present value of the estimated cost per installed EFV per year calculated over 50 years using a 7 percent discount rate, or (in 1993 dollars)

$30 + the present value of $0.02 per EFV per year =

$30.28 per installed EFV.

4.4.2 EFVs with Positive Shut-Off

The present value of the cost of an EFV with positive shut-off is the estimated cost per installed EFV[123] plus the present value of the estimated cost per installed EFV per year calculated over 50 years using a 7 percent discount rate, or (in 1993 dollars)

$36.50 + the present value of $0.04 per EFV per year =

$37.05 per installed EFV.

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[122]The present value of the estimated cost per installed EFV equals the estimated cost per installed EFV.

[123]The present value of the estimated cost per installed EFV equals the estimated cost per installed EFV.

5.3.1 EFVs with Bleed-By

The benefit-to-cost ratio in the case where all installed valves are EFVs with bleed-by is

$11.18/$30.28 = 0.37.

Because the estimated benefit-to-cost ratio is less than 1.00, the installation of EFVs with bleed-by on all new or renewed single-family residential gas services that always operate at 10 psig or greater is not expected to be cost beneficial.

5.3.2 EFVs with Positive Shut-Off

The benefit/cost ratio in the case where all installed valves are EFVs with positive shut-off is

$11.18/$37.05 = 0.30.

Because the estimated benefit-to-cost ratio is less than 1.00, the installation of EFVs with positive shut-off on all new or renewed single-family residential gas services that always operate at 10 psig or greater is not expected to be cost beneficial.

5.3.3 Conclusions

The benefit-to-cost ratio for the installation of EFVs on all new or renewed single-family residential gas services is expected to be somewhere between 0.37 and 0.30, depending on the mix of EFVs with bleed-by and EFVs with positive shut-off that is installed by gas distribution companies. Consequently, the installation of EFVs on all new or renewed single-family residential gas services that always operate at 10 psig or greater is not expected to be cost beneficial.

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