APPENDIX M

Review of Leak and Unaccounted For Gas Data As Submitted To the Office of Pipeline Safety By Gas Distribution Operators In Their Annual Report for Calendar Years 1985, 1990, 1994, 1998 and 2002

1.0 Summary and Introduction

The basis of the Safety Tech Note - Safety Performance of Natural Gas Distribution Pipeline Systems 1985 – 2002 is review and analysis of the Office of Pipeline Safety's (OPS) reportable incident data base. On direction of the Distribution Infrastructure Government Industry Team (DIGIT), the contractor was asked to review leaks and unaccounted for gas, for the same time period with a view to perhaps gleaning additional useful indications as to any trends in the integrity of the system.

The leaks and unaccounted for gas data reviewed was submitted by Gas Distribution System operators in their Annual Reports to OPS (under Form RSPA F7100.1-1, as shown in Attachment 1). This was obtained from OPS by request, through a download from their data base for calendar years 1985, 1990, 1994, 1998 and 2002.

Analysis of the data and a discussion of considerations and qualifications in the data submitted by operators[1] to OPS are summarized below.

2.0 Representation of the Data

The data is graphically represented in three groupings

1. Leaks eliminated / repaired during the calendar year (Mains and Services)
2. Known system leaks pending at year end scheduled for repair
3. Percent of unaccounted for gas

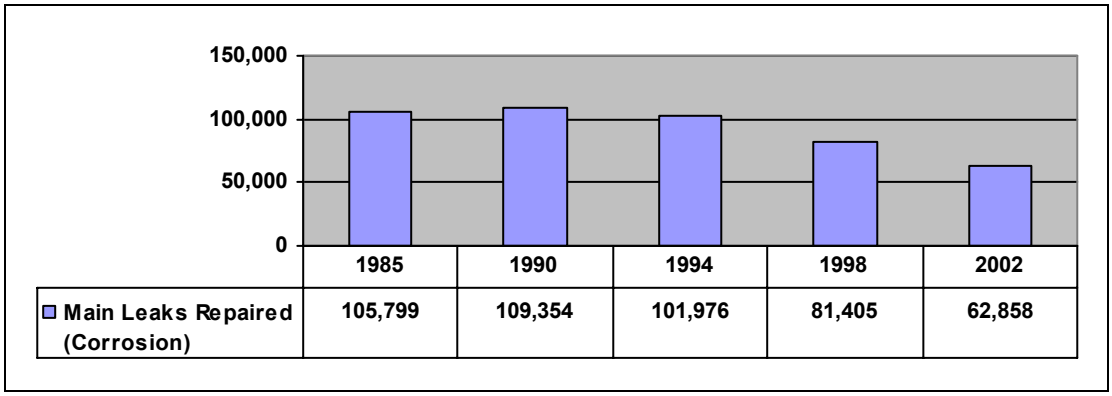
The first two data were reported by operators in the DOT annual reports under Parts C – Total Leaks and the fourth data is reported under Part E – Percent of Unaccounted for Gas. See Exhibits A and B for Form and Instructions, respectively.

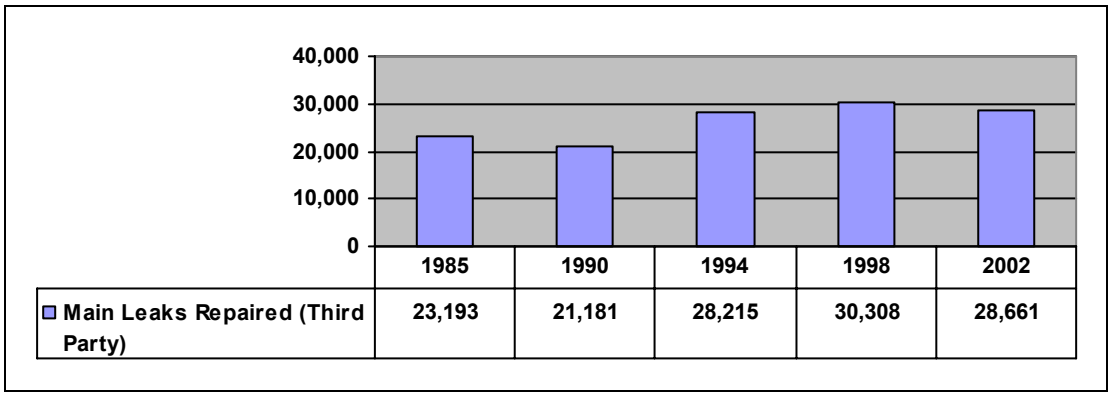
The following is a graphical representation of the data.

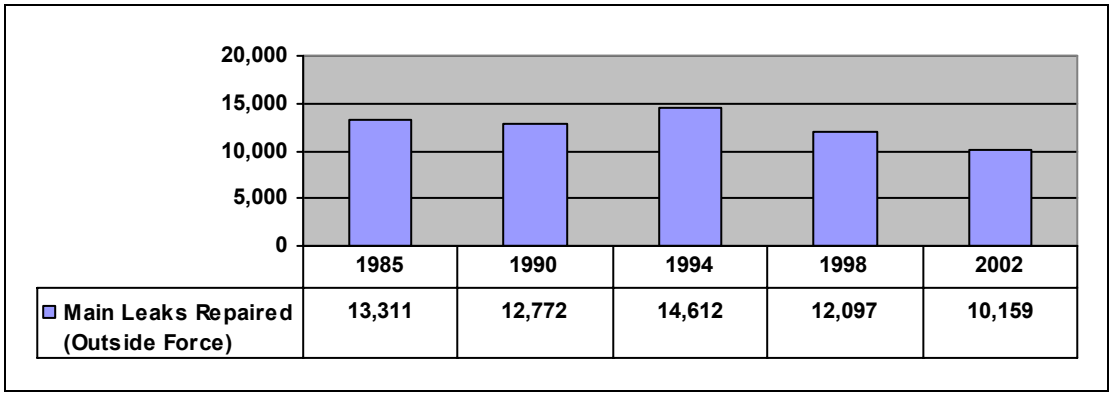
2.1 Main Leaks Eliminated / Repaired During the Calendar Year

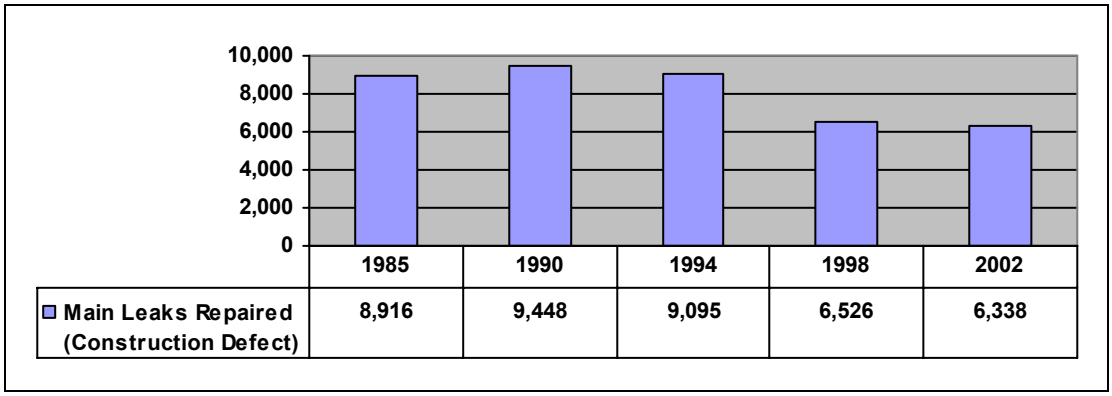
The following six graphs represents the information provided by operators on the total number of main leaks eliminated or repaired during the calendar years 1985, 1990, 1994, 1998 and 2002 by six threat categories (corrosion, third party, outside force, construction defect, material defect and other). The seventh graph gives a graphical representation of the total number of main leaks eliminated / repaired (all six threat categories combined).

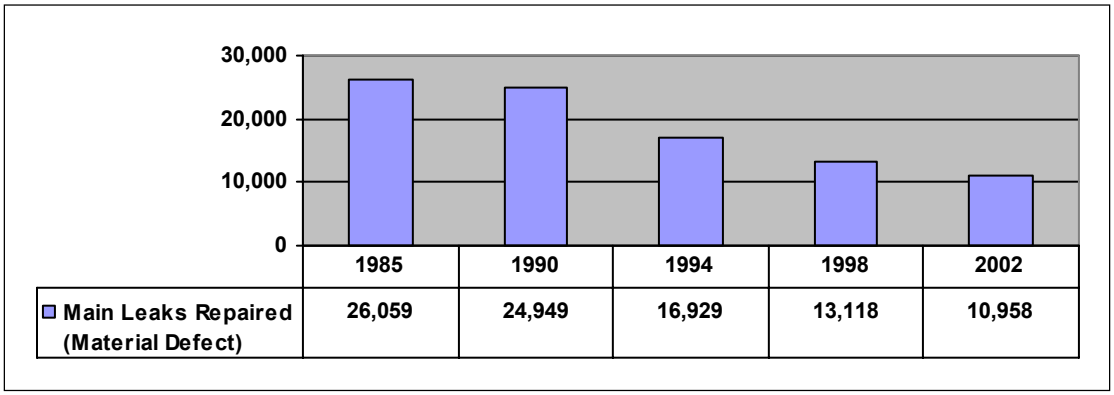
[1] Analysis involved all operators who submitted annual data to OPS.

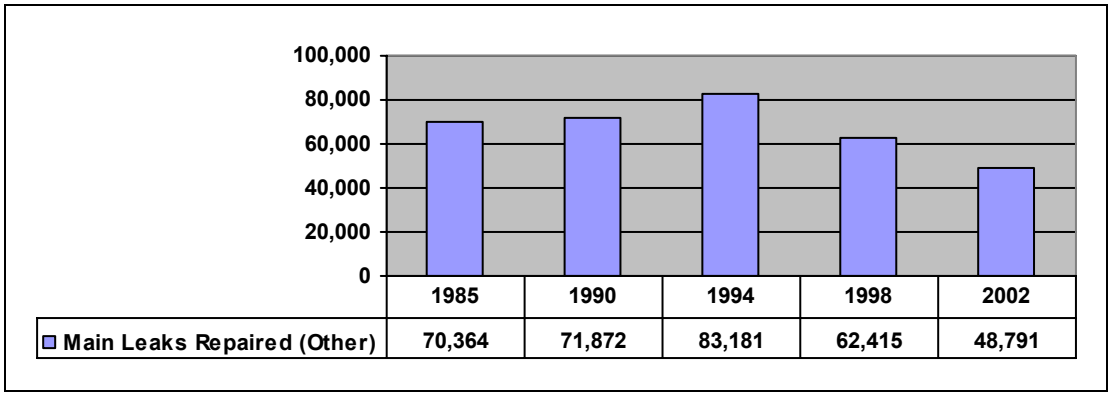

150,000
100,000
50,000
0
1985
1990
1994
1998
2002
Main Leaks Repaired (Corrosion)
105,799
109,354
101,976
81,405
62,858

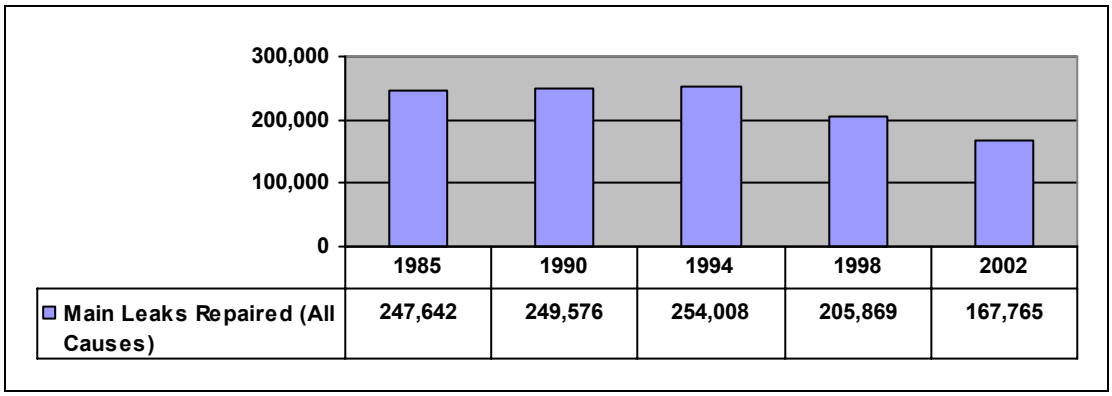

40,000
30,000
20,000
10,000
0
1985
1990
1994
1998
2002
Main Leaks Repaired (Third Party)
23,193
21,181
28,215
30,308
28,661


20,000
15,000
10,000
5,000
0
1985
1990
1994
1998
2002
Main Leaks Repaired (Outside Force)
13,311
12,772
14,612
12,097
10,159


10,000
8,000
6,000
4,000
2,000
0
1985
1990
1994
1998
2002
Main Leaks Repaired (Construction Defect)
8,916
9,448
9,095
6,526
6,338

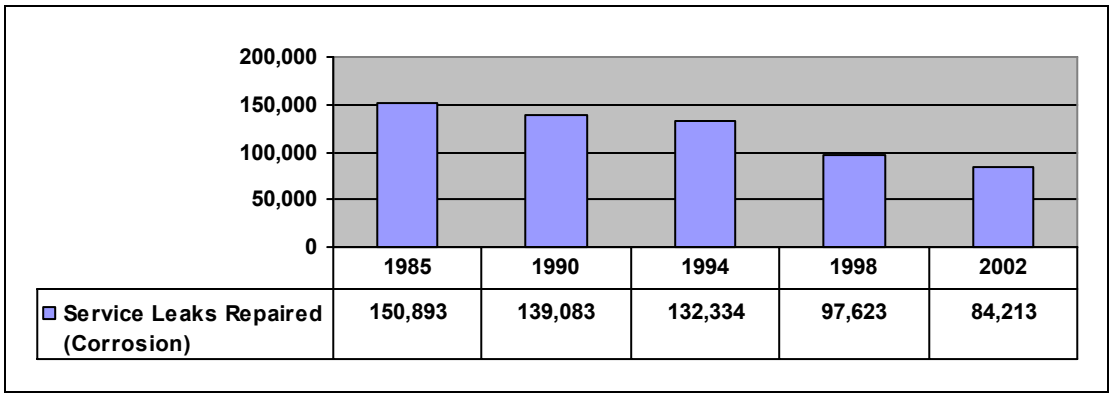

30,000
20,000
10,000
0
1985
1990
1994
1998
2002
Main Leaks Repaired (Material Defect)
26,059
24,949
16,929
13,118
10,958

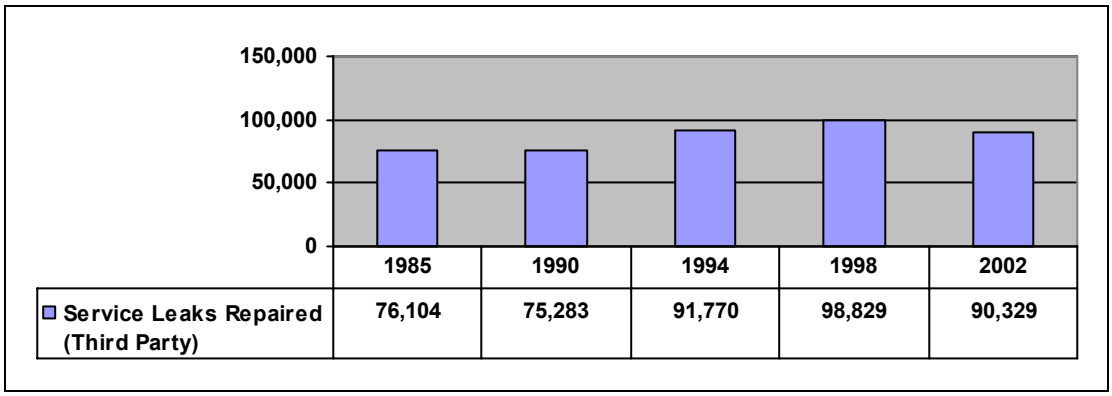

100,000
80,000
60,000
40,000
20,000
0
1985
1990
1994
1998
2002
Main Leaks Repaired (Other)
70,364
71,872
83,181
62,415
48,791

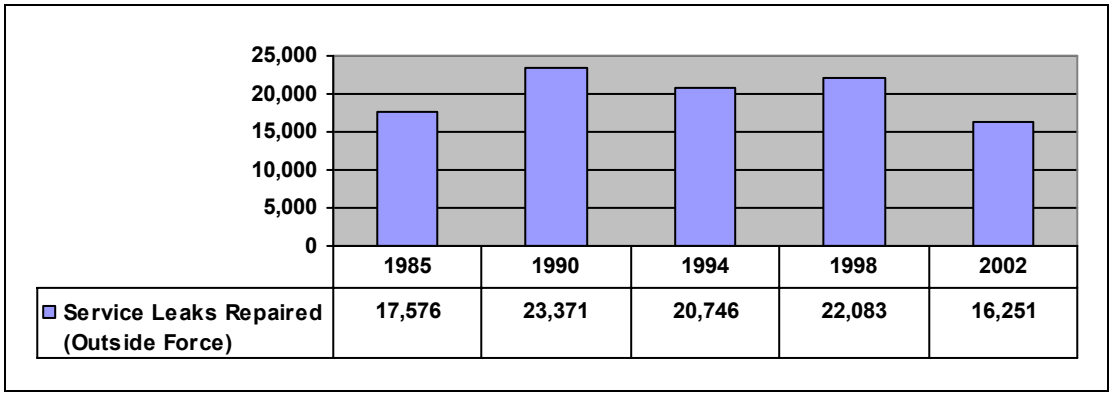

300,000
200,000
100,000
0
1985
1990
1994
1998
2002
Main Leaks Repaired (All Causes)
247,642
249,576
254,008
205,869
167,765

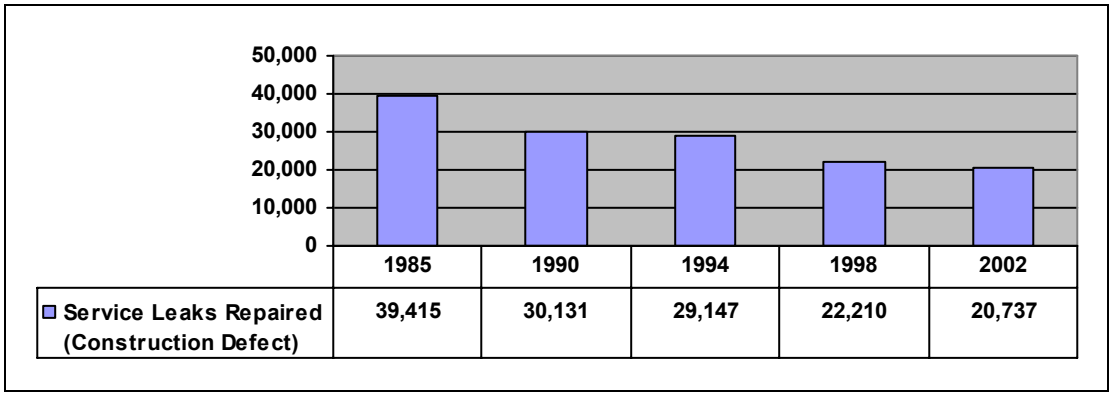
2.2 Service Leaks Eliminated / Repaired During the Calendar Year

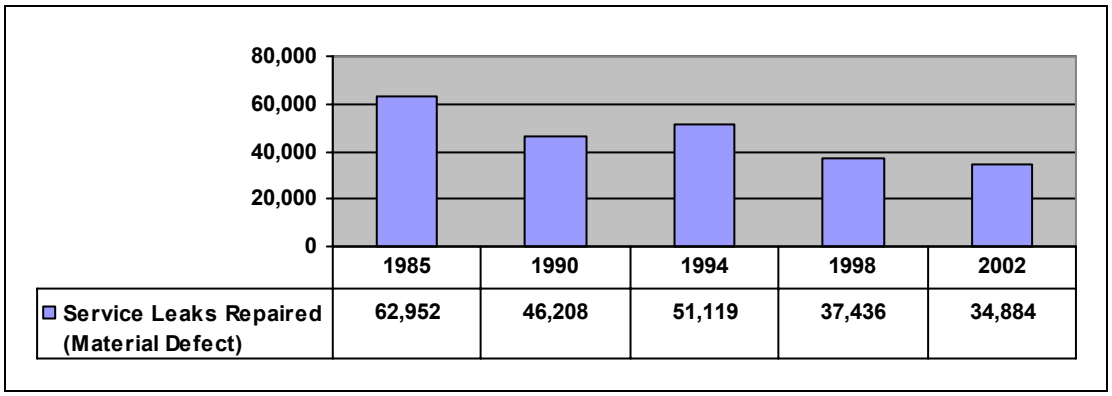
The following six graphs represents the information provided by operators on the total number of service leaks eliminated or repaired during the calendar years 1985, 1990, 1994, 1998 and 2002 by six threat categories (corrosion, third party, outside force, construction defect, material defect and other). The seventh graph gives a graphical representation of the total number of service leaks eliminated / repaired (all six threat categories combined).

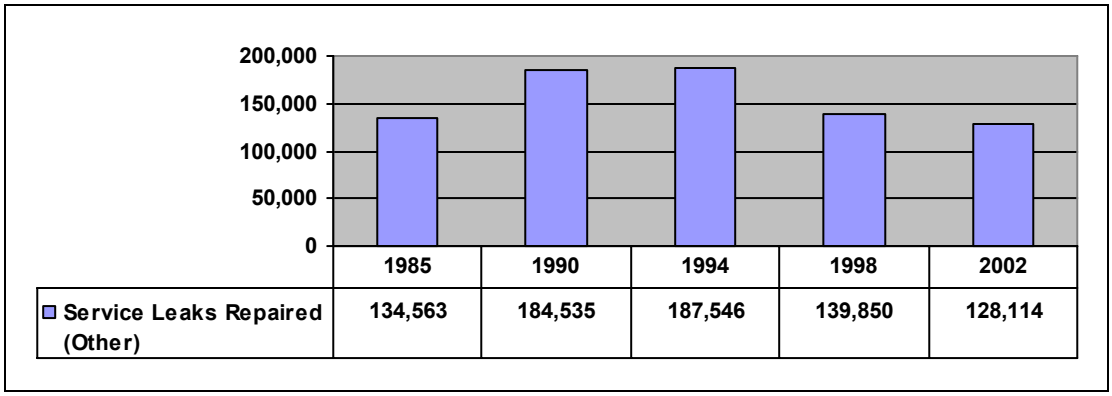


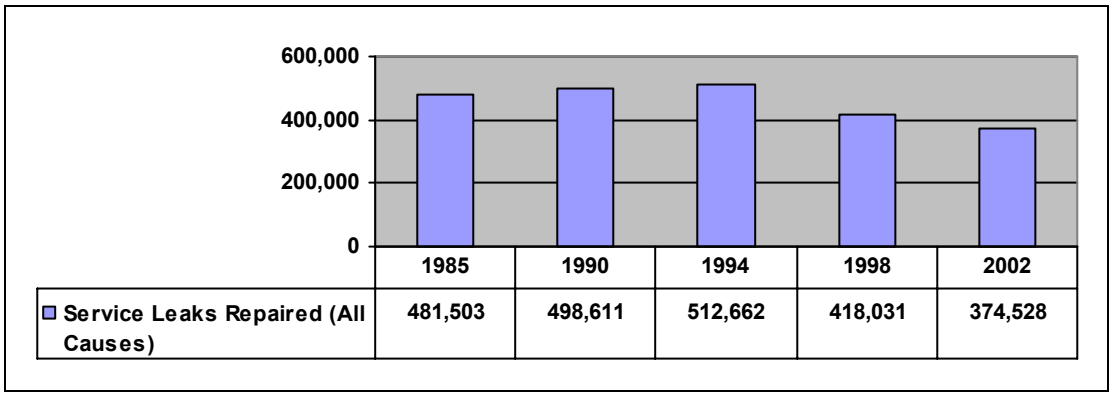





50,000
40,000
30,000
20,000
10,000
0
1985
1990
1994
1998
2002
Service Leaks Repaired (Construction Defect)
39,415
30,131
29,147
22,210
20,737

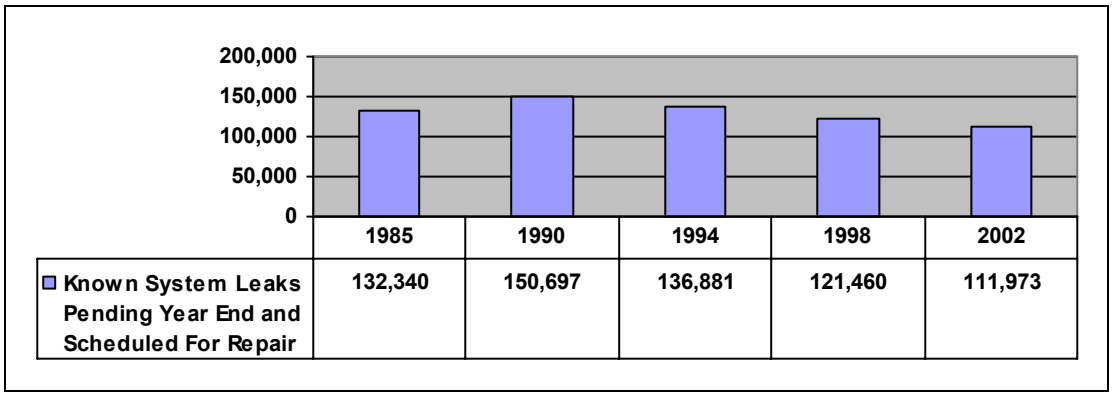

80,000
60,000
40,000
20,000
0
1985
1990
1994
1998
2002
Service Leaks Repaired (Material Defect)
62,952
46,208
51,119
37,436
34,884


200,000
150,000
100,000
50,000
0
1985
1990
1994
1998
2002
Service Leaks Repaired (Other)
134,563
184,535
187,546
139,850
128,114


600,000
400,000
200,000
0
1985
1990
1994
1998
2002
Service Leaks Repaired (All Causes)
481,503
498,611
512,662
418,031
374,528

2.3 Number of Known System Leaks at End of Year Scheduled For Repair

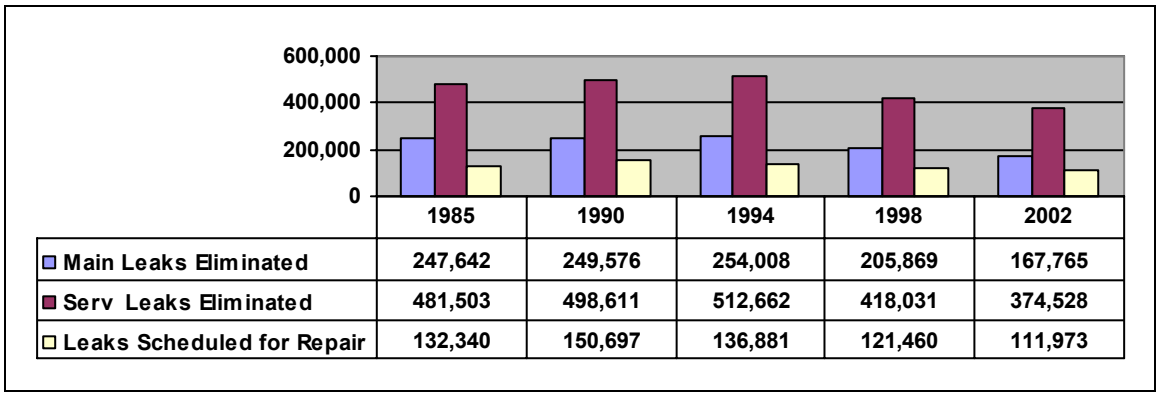
The following graph represents the information provided by operators on the total number of leaks (mains and services) that were pending at year end scheduled for repair for the calendar years 1985, 1990, 1994, 1998 and 2002.

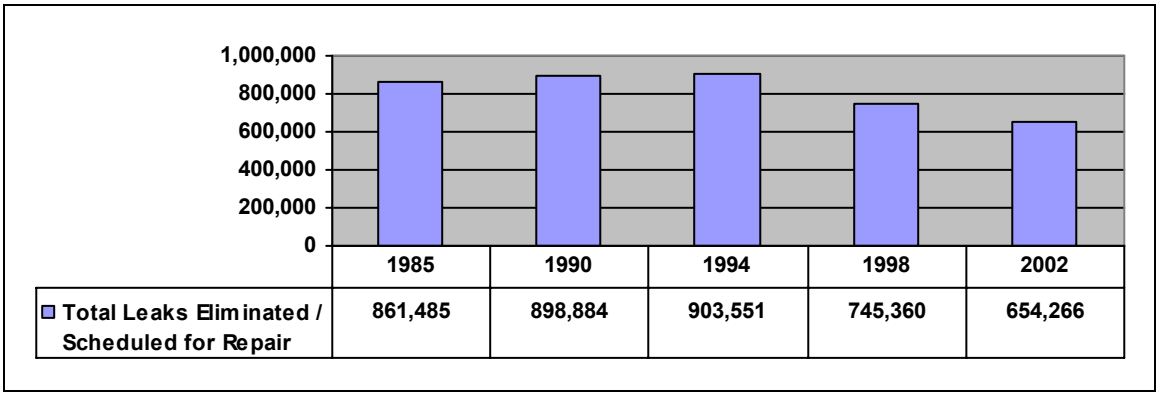


2.4 Total Leaks (Eliminated and Scheduled for Repair)

The bar graph below shows the total mains and services eliminated data combined with leaks pending year end scheduled for repair.

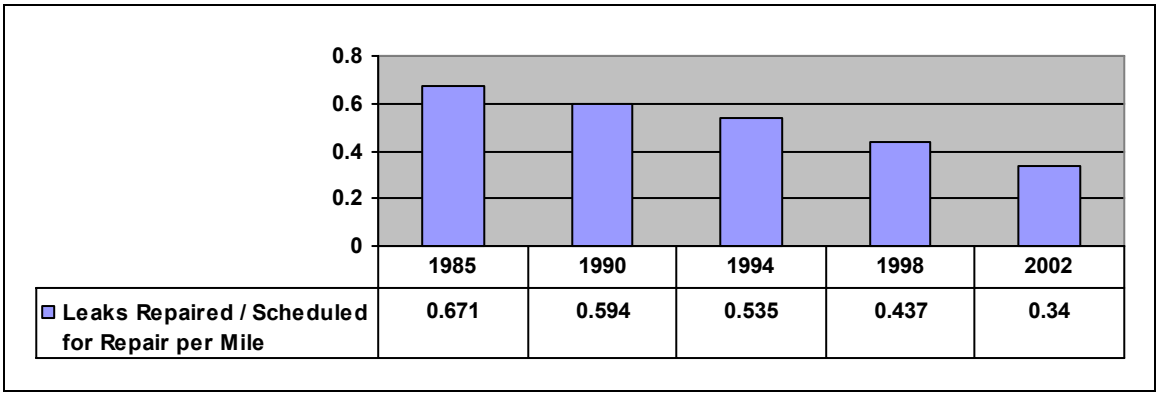
	1985	1990	1994	1998	2004
Main Leaks Eliminated	247,642	249,576	254,008	205,869	167,765
Serv Leaks Eliminated	481,503	498,611	512,662	418,031	374,528
Total Leaks Eliminated	729,145	748,187	766,670	623,900	542,293
Leaks Scheduled for Repair	132,340	150,697	136,881	121,460	111,973
Total Leaks Eliminated / Scheduled for Repair	861,485	898,884	903,551	745,360	654,266





The data in subsections 2.1 through 2.3 was not normalized to total mileage. Normalizing the data in this subsection shows the effect of system growth from 1985 through 2002.

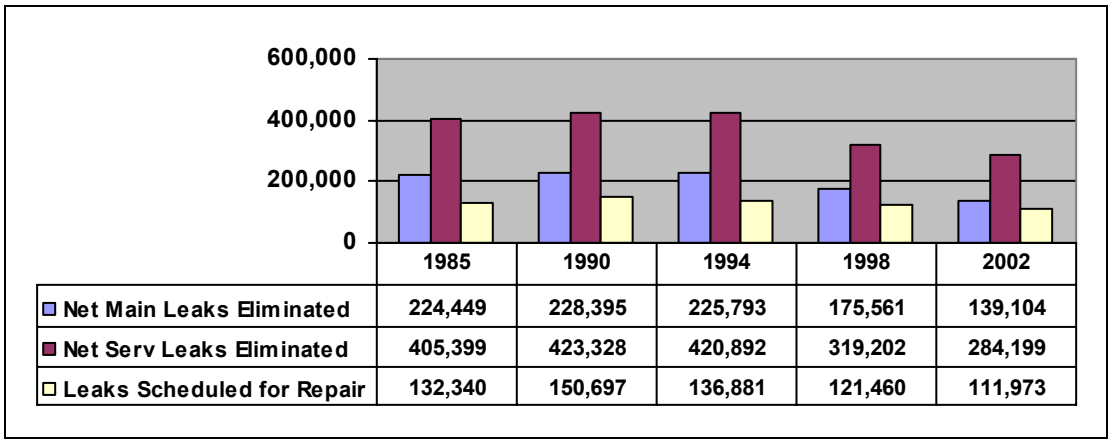
	1985	1990	1994	1998	2004
Main Leaks Eliminated	247,642	249,576	254,008	205,869	167,765
Serv Leaks Eliminated	481,503	498,611	512,662	418,031	374,528
Total Leaks Eliminated	729,145	748,187	766,670	623,900	542,293
Total Leaks Scheduled for Repair	132,340	150,697	136,881	121,460	111,973
Total Leaks Eliminated / Scheduled for Repair	861,485	898,884	903,551	745,360	654,266
Total Main Mileage	784,852	945,964	1,002,669	1,040,424	1,144,407
Total Service Mileage	498,697	566,763	685,161	666,506	778,970
Total Mileage	1,283,549	1,512,727	1,687,830	1,706,930	1,923,377
Total Leaks Eliminated / Scheduled for Repair per Mile	0.671	0.594	0.535	0.437	0.340

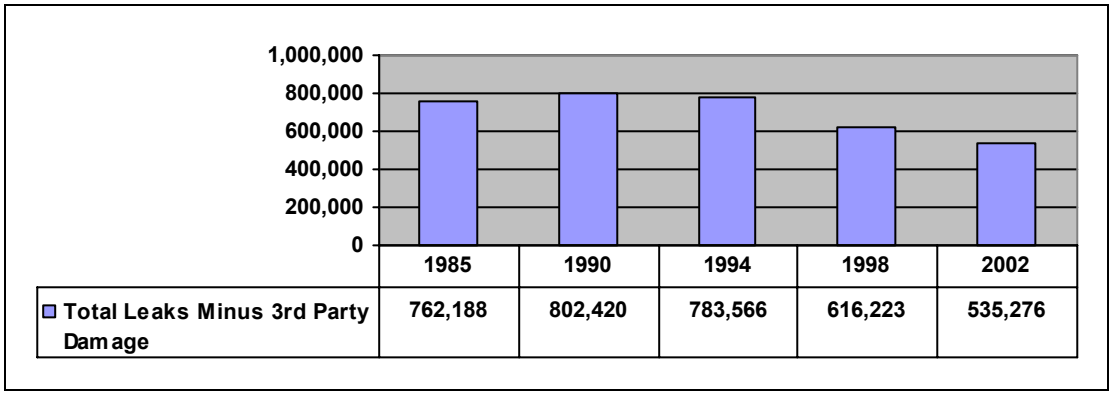


2.5 Total Leaks (Eliminated and Scheduled for Repair) Exclusive of Third Party Damages

Because third party damage includes a number of factors that may not be under the direct control of gas utility operators (factors relating to the behavior of third parties), trends in leaks not including third party damage more closely reflect the direct results of efforts by operators on physical facilities or in connection with their own practices and procedures. The final numbers, in both spreadsheets below, are not adjusted for any pending leaks attributable to third party damage as pending leaks are not identified by cause.

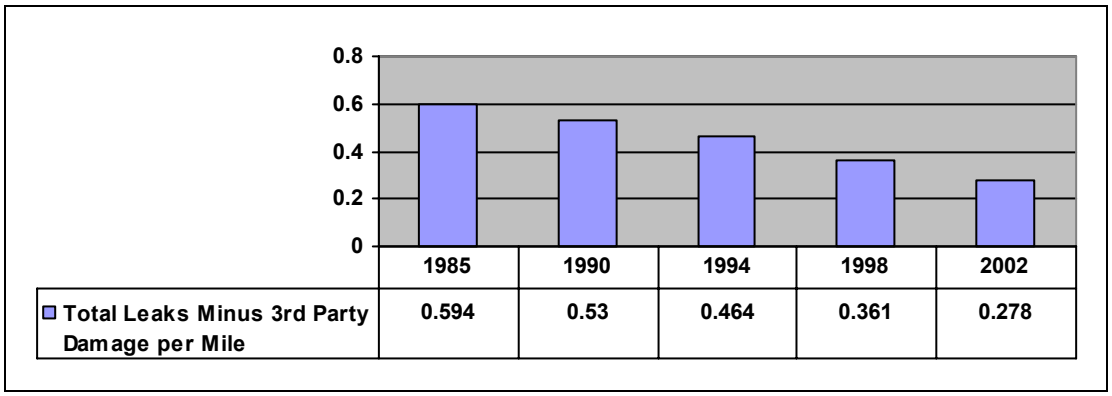
	1985	1990	1994	1998	2004
Main Leaks Eliminated	247,642	249,576	254,008	205,869	167,765
Main Leaks Eliminated - 3rd Party Damage	23,193	21,181	28,215	30,308	28,661
Net Main Leaks Eliminated	224,449	228,395	225,793	175,561	139,104
Serv Leaks Eliminated	481,503	498,611	512,662	418,031	374,528
Serv Leaks Eliminated - 3rd Party Damage	76,104	75,283	91,770	98,829	90,329
Net Serv Leaks Eliminated	405,399	423,328	420,892	319,202	284,199
Net Total Leaks Eliminated	629,848	651,723	646,685	494,763	423,303
Total Leaks Scheduled for Repair	132,340	150,697	136,881	121,460	111,973
Total Leaks Eliminated (Minus 3rd Party Damage) / Scheduled for Repair	762,188	802,420	783,566	616,223	535,276





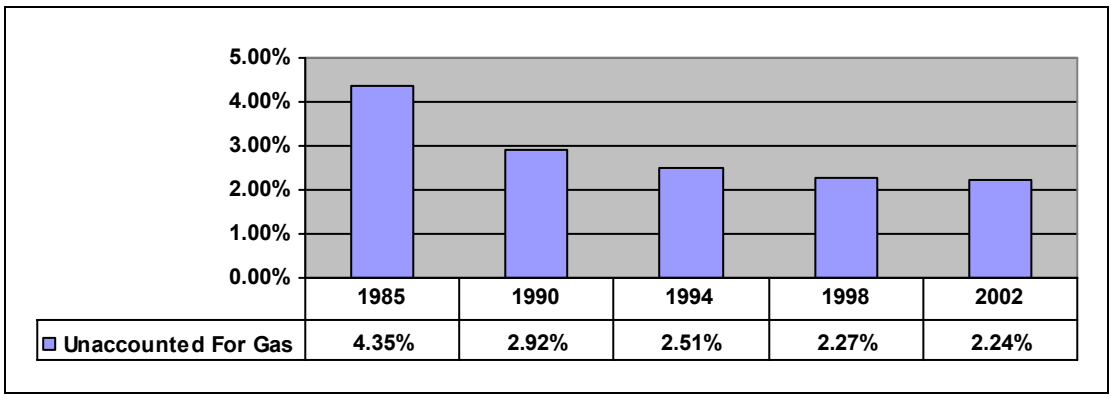
As in subsection 2.4, the total leaks excluding Third Party Damage were normalized for total mileage.

	1985	1990	1994	1998	2004
Main Leaks Eliminated	247,642	249,576	254,008	205,869	167,765
Main Leaks Eliminated - 3rd Party Damage	23,193	21,181	28,215	30,308	28,661
Net Main Leaks Eliminated	224,449	228,395	225,793	175,561	139,104
Serv Leaks Eliminated	481,503	498,611	512,662	418,031	374,528
Serv Leaks Eliminated - 3rd Party Damage	76,104	75,283	91,770	98,829	90,329
Net Serv Leaks Eliminated	405,399	423,328	420,892	319,202	284,199
Net Total Leaks Eliminated	629,848	651,723	646,685	494,763	423,303
Total Leaks Scheduled for Repair	132,340	150,697	136,881	121,460	111,973
Leaks Eliminated (Minus 3rd Party Damage) / Scheduled for Repair	762,188	802,420	783,566	616,223	535,276
Total Main Mileage	784,852	945,964	1,002,669	1,040,424	1,144,407
Total Service Mileage	498,697	566,763	685,161	666,506	778,970
Total Mileage	1,283,549	1,512,727	1,687,830	1,706,930	1,923,377
Total Leaks Eliminated (Minus 3rd Party Damage) / Scheduled for Repair per Mile	0.594	0.530	0.464	0.361	0.278



2.6 Percent of Unaccounted for Gas

The following graph represents the information provided by operators on the percent of unaccounted for gas for the calendar years 1985, 1990, 1994, 1998 and 2002.



3.0 Observations

3.1 Main Leaks Eliminated / Repaired During the Calendar Year

In reviewing the graphical representations, all of the data, except that relating to main leaks attributed to third party damage that were repaired or eliminated, indicate a downward trend during the period of the five years documented. The data relating to main leaks attributed to third party damage that were repaired or eliminated indicates an upward trend.

3.2 Service Leaks Eliminated / Repaired During the Calendar Year

As with main leaks, the graphical representations of the data, except that relating to service leaks attributed to third party damage that were repaired or eliminated, indicate a downward trend during the period of the five years documented. The data relating to service leaks attributed to third party damage that were repaired or eliminated indicates an upward trend.

3.3 Number of Known System Leaks at End of Year Scheduled For Repair

The graphical representation of the data indicates a slight downward trend for the period of the five years documented.

3.4 Total leaks

The graphical presentations show a 24% decrease in 2002 form 1985 in total leaks.

3.5 Leaks per mile

The graphical representation shows a decreasing trend in the yearly total leaks per mile by 47% in 2002 from 1985 and a steeper decreasing trend (52%) in the leaks per mile exclusive of third party damage.

3.6 Percent of Unaccounted for Gas

The graphical representation of the data indicates a downward trend for the period of the five years documented.

4.0 Considerations and Qualifications

As noted in Section 3, all of the data, except that data related to main and service leaks attributed to third party damage that were repaired or eliminated, indicate a downward trend for the period of 1985 through 2002.

Before any conclusions can be drawn on safety trends indicated by this data, the following qualifications should be considered:

1. Repaired / eliminated leaks include only leaks that have been eliminated and do not reflect the outstanding leakage inventory. It is allowable to monitor certain inventoried leaks, rather than repair or eliminate during a set period of time. As such, factors, like budget and resource constraints, have an impact on the timing and the number of leaks repaired / eliminated during a calendar year. Also, if during more prosperous economic times, gas utilities in the U.S. may choose to replace entire portions of their distribution systems, the leaks repaired/eliminated figure for the year would go up when inventoried leaks are eliminated. This would certainly suggest a safer system. As it stands, it is not possible to make such a distinction from the DOT report data. Worse, because of the lack of specificity in the instructions for this part in the DOT annual report, operators have not consistently reported the number of leaks eliminated on occasion of pipeline replacement; some have counted it as 0 or 1 repair, while a few may count all the individual leaks on the replaced segments.

2. Leaks identified in a calendar year are a more appropriate indicator of the integrity of the nation's distribution infrastructure. An increase in newly identified leaks could also be a positive safety indicator if operators' leak survey programs are becoming more effective. However, because in the DOT annual report, operators are not required to report newly identified leaks during the year, this data was not available.

3. No direction is given to operators, via the DOT's "Instructions For Completing Form RSPA F 7100.1-1 (Annual Report For Calendar Year XXXX – Gas Distribution System)", as to what to report under Part C – Number of Known System Leaks At End of Year Scheduled For Repair (see Exhibit B). Therefore it is not possible to distinguish between various grades of leaks (frequently 3 grades, according to potential hazard posed), from the more hazardous requiring immediate or future repair, to those least hazardous, that can be monitored for a long time before they are repaired. As a result, the associated reporting under this entry is left for an operator to interpret and as such, subject to a number of variations.

4. Starting in 2005, operators will begin reporting additional data under Part C of the DOT annual report form. The categories of leaks have been changed, but the number of new leaks found during the year is not an item sought in the revised report.

5. Only five discrete data points were reviewed for the eighteen-year period of 1985 through 2002. Like the analysis of the reportable incident data, all eighteen data points should be reviewed to provide a more statistically valid trend line.

6. Previous studies done by the Gas Technology Institute [2]and as a result of a 2004 AGA Benchmarking study involving 5 years of data[3] have shown that the predominant amount of unaccounted for (UAF) gas experienced by operators is due to measurement inaccuracies and accounting errors, not gas leakage from the system. Most distribution sales meters are not temperature-compensated, whereas virtually all distribution purchase meters do compensate for temperature. This creates a positive bias for UAF since more gas is sold when ambient temperatures are below the standard measurement temperature of 60 degrees F than when temperatures are above

[2] Frank Ahrens, *Finders of Lost Gas*, American Gas Magazine, May 1991.
[3] AGA 2004 Best Practices Benchmarking Study.

60 degrees F. Further, since the instructions for RSPA Form F 7100.1-1 do not specify what should be included under the "appropriate adjustments" factor in the % unaccounted for gas formula, it becomes impossible to extract the gas lost through leakage to the atmosphere. As such, the % unaccounted for gas data from the DOT reports appears not to be a useful indicator.