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AN ANALYSIS OF NATURAL GAS MASTER METER SYSTEMS (DEFINITION & PROGRAM) FROM A FEDERAL PERSPECTIVE

Systems & Applied Sciences Corporation

JUNE 1979

FINAL REPORT

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
Materials Transportation Bureau
Washington, D.C. 20590

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Gregory C. Grapsas and Thomas W. Caless

9. Performing Organization Name and Address
Systems and Applied Sciences Corp.
6811 Kenilworth Avenue, Suite 500
Riverdale, MD 20840

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16. Abstract

An analysis of data collected from surveys of gas utility companies and master meter systems owners/operators was performed to determine characteristics of master meter natural gas distribution systems and gain insight about the potential safety hazard of buried or exposed piping owned by customers that is beyond utility company responsibility. Estimates, with confidence limits, were generated for each state, geographic region and nationally. Analysis of the character and makeup of the nation's master meter systems served as input to the formulation of program options available to DOT for future action regarding pipeline safety for master meter systems.

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AN ANALYSIS OF NATURAL GAS MASTER METER SYSTEMS (DEFINITION AND PROGRAM) FROM A FEDERAL PERSPECTIVE

15 JUNE 1979

Prepared for:

MATERIALS TRANSPORTATION BUREAU
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
DEPARTMENT OF TRANSPORTATION
Washington, D.C. 20590

Prepared by:

SYSTEMS AND APPLIED SCIENCES CORPORATION
6811 Xenilworth Avenue, Suite 500
Riverdale, Maryland 20840

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CHAPTER 1

INTRODUCTION

Systems and Applied Sciences Corporation (SASC) conducted a study to gather information from natural gas utility companies, master meter natural gas system operators, and other knowledgeable people to obtain data pertinent to analyzing the master meter safety question nationwide. This report represents the completion of the first phase of a three phase* effort. It identifies the approximate number, location and character of the nation's master metes systems and provides an evaluation of the accuracy, specifications, work plan and budget for the second phase. The work was performed for the Department of Transportation (DOT), Materials Transportation Bureau (MTB), under Contract No. DOT-RC-82038.

1.1 BACKGROUND

The Natural Gas Pipeline Safety Act of 1968 authorized the Department of Transportation to develop regulations specifying requirements for safety in natural gas pipeline systems, and to ensure compliance with the regulations. MTB carries out these functions for DOT.

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* Phase I - Information Exchange with Gas Distribution Systems
Phase II - Full Survey
Phase III - Plaster Meter Safety Communications Strategy

Pipeline systems owned by utility companies fall under the legislation and regulations. Annually, gas utilities report to MTB the status of their distribution system. The report provides data regarding pipeline leaks, accidents, and property/life damage. Pipeline system integrity for these systems is maintained by the appropriate utility, up to the downstream outlet of the customer meter (point of transfer of the ownership of the natural gas), through various corrosion protection techniques, periodic leak surveys, and corrosion protection inspections performed by their maintenance crews and/or qualified corrosion consultants under contract. These reports serve to establish a data base for the utility owned segment of the nation's gas distribution system for DOT.

1.2 DEFINITION

One segment of gas distribution systems, however, does not have a complete data base. This segment comes under the generic heading of "master meter" systems. In general, a master meter system is a gas distribution system supplying gas to more than one user or outlet beyond the meter. Specifically, the data base required for this study pertains to those master meter systems which consist of buried or exterior piping downstream of the meter. Included in this subset of master meter systems are garden apartments, housing authorities, mobile home parks, and shopping centers. The presence of buried pipe that is not properly maintained constitutes a potential safety hazard. However, the extent of the hazard is unknown because of the lack

of adequate data regarding these systems. Furthermore, there is significant reason to believe that elements of this subset of master meter systems may not be regularly inspected and, thus, not in compliance with existing Federal regulations. In light of the above circumstances, a requirement existed to obtain accurate and complete data on these master meter systems. This effort is a preliminary analysis which provides an estimate of the number, location, and character of these master meter systems. In addition, it addresses the level of hazard, if any, present in these systems, provides a framework for a more thorough investigation of the safety question, and provides a selection of program options to resolve the safety question.

1.3 CONTENTS OF REPORT

Chapter 2 discusses the methodology employed by SASC to fulfill the requirements of the Task Statement. A family of "Use Scenarios" which provided the framework for determining appropriate courses of action to the safety question are presented in Chapter 3. Chapter 4 discusses the development of survey instruments and subsequent information collection from regulatory officials, gas utilities, and master meter operators. An estimate of the population of master meter systems nationwide and state-by-state is provided in Chapter 5. Chapter 6 provides a detailed analysis of returned gas utility instruments. The instruments returned by master meter operators contained less than complete information about the nation's master meter systems but was analyzed. The Appendix presents the results of that analysis.

Results of the data analysis were fed back into the original "Use Scenarios" to provide an analysis of program options discussed in Chapter 7. A summary of findings and recommendations for full information exchange specifications, including a work plan and budget for a Phase II effort, are presented in Chapter 8.

CHAPTER 2

METHODOLOGY

The methodology that SASC implemented was designed to follow in parallel with the study statement of work on a task-by-task basis. The following paragraphs discuss the individual tasks in detail. Assumptions made during the study are interspersed throughout the task descriptions.

2.1 DEVELOPMENT OF "USE SCENARIOS"

Following preliminary meetings with DOT officials and after review of existing regulations/legislation, Virginia Research Institute (VRI), under subcontract to SASC, assisted in the formulation of a family of "Use Scenarios" which outlined potential program options to themastermeter situation. These scenarios served throughout the study effort as "straw men" options which would be modified, according to the results of the survey and data analysis.

The "Use Scenarios" presented in Chapter 3 were formulated to: (1) be used as a foundation in the analysis and definition of the master meter safety question; (2) permit the widest probablerange in the data anticipated and the known practicable options for addressing the safety question; (3) be useful in the analysis of data toward formulation of the options as the Information Collection was ongoing, and: (4) be useful in explaining the Information Collection to the participating correspondents in the field.

Having established candidate scenarios which described the master meter system situation, it was felt that information should be gathered from a number of areas before selecting a scenario for indepth program option analysis. This information included:

(1) size of the master meter population

(2) physical characteristics of the master meter classes

(3) magnitude and severity of hazards posed by master meter systems

(4) condition of systems relative to safety compliance

(5) ability of owners to bring systems into compliance with safety regulations

(6) actions and resources to identify all systems and communicate compliance requirement to owners

(7) actions and resources to determine initial compliance status of systems (first national inspection)

(8) resources to inspect master meter systems on a regular basis

(9) awareness of master meter owners/operators to natural gas pipeline safety.

The intent of the effort, therefore, was to clarify the state of the nation's master meter systems. By doing this, the "Use Scenarios" developed could be used to better focus in on program options to the master meter safety question.

2.2 STATE AND REGIONAL INTERVIEWS

Having generated candidate "Use Scenarios" for establishing future program options to analyzing the master meter safety question, the study directed its efforts towards the job of collecting data on the master meter population. The vehicles for collection of the data consisted of two survey instruments with appropriate questions for utility companies and master meter operators. Prior to commencing the survey, however, SASC interviewed Federal, regional, and state officials representing DOT and public service commissions to obtain input towards the development of the instrument.

These officials were queried in a number of areas including the following:

(1) What is the extent of master meter use in your area?

(2) What are the types of natural gas users in your area who are master metered?

(3) What are the physical characteristics of master meter systems in your area?

(4) What has been the leak history of master meter systems vis-a-vis utility owned systems?

(5) What are the solutions to safety problems in master meter system?

2.3 ELEMENTS OF THE SURVEY INSTRUNENTS

After having interviewed appropriate state and regional officials and obtaining general information regarding the nation's master meter population, the study team developed the two information survey instruments. These instruments are discussed in greater detail in Chapter 4. However, the major components for both the utility company and master meter operator instruments are provided below.

For the gas utility company instrument, SASC requested information regarding the utility company such as, number of accounts, natural gas sold, size of distribution system, distribution of user types, numbers and kinds of master meter accounts, availability of data on master meter customers, and corrosion protection/leak history/accident data for master meter systems. In addition, the instrument requested that the utility company provide a list of names and addresses of master meter accounts that it serves. These lists, together with lists obtained from state public service commissions and the DOT Regional Chiefs, served as the mailing list for the second survey.

The survey instrument for master meter operators requested data on the master meter system serving each operator including age of system, number of buildings served, who installed the system, type of pipeline materials and corrosion protection employed, operator's ability to repair the system, leak history and knowledge of system inspection requirements. Answers to

these and other questions established quidelines for determining the intensity of the safety question and awareness of the owners to this situation.

Both survey instruments were constructed to allow for rapid computer processing of the data. Pertinent questions were designed to provide for either yes/no or multiple choice answers.

2.4 INFORMATION SURVEY PROCEDURES

Having developed both utility conpany and master meter operator survey instruments, the next task consisted of sampling the population. This was accomplished via mailings of the instrument to utility companies and master meter operators.

2.4.1 Utility Company Survey

Using Brown's Directory of North American Gas Companies[1/] (91st Edition), utility instruments were mailed to over 1500 companies serving natural gas to customers in all 50 statesand the District of Columbia. As instruments were returned, they were examined to determine accuracy and completeness. Information on number of

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1/Brown's Directory of North American Gas Companies, Zane Chastain (ed.), Harcourt Brace Jovanovich Publication, 1977.

master meter accounts, total number of accounts, and mailing lists of master meter accounts was extracted for future manual analysis. As time permitted, instruments with incomplete or missing data were set aside for clarification by telephone. Due to time constraints, over 50 gas utility and 100 master meter instruments were not clarified and were excluded from the analysis.

In building the data base of utility company information, the goal was to achieve a sample that would represent a microcosm of the United States, even though utility instruments were returned on a voluntary basis. In a pure statistical sense, the data base of utility company information did not constitute an independent random sample. Therefore, a different statistical technique was used to analyze the data. Utility companies had a direct influence in determining the probability of being selected in the sample since they could elect whether or not to fill out the survey instrument. It was felt that if a scientifically designed survey had been employed, however, a lower response total would have been achieved since responses were made voluntarily.

The final tally of returned instruments allowed SASC to provide an estimate of the master meter population based on 344 responses and perform further analysis on 291 responses from utilities. Detailed estimating and analysis procedures and results are presented in Chapters 5 and 6 respectively.

A further point should be emphasized regarding the definition of master meter system. The definition employed by SASC and approved by DOT restricted the study investigation to those gas distribution systems 1) serving gas to more than one user or outlet and 2) possessing buried or exterior pipeline downstream of the meter. The utility industry definition[2] of master meter, however, does not require the presence of buried or exterior pipeline to constitute a master meter. This distinction between the two definitions has contributed to the wide range of estimates that have been made as to the number of master meter systems nationwide. SASC discovered some controversy also during the study and this issue is discussed further in Chapter 5.

2.4.2 Master Meter Operator Survey

Working from name and address lists obtained from returned utility instruments, DOT Regional Chiefs and state public service commissions, plus information gathered from on-site visits by the SASC and VRI study team, master meter survey instruments were mailed to over 4,000 master meter operators. Here again, the difficulty in obtaining a sufficiently large initial mailing list and the anticipated low response rate prevented development of an independent random sample. As in the case of the utility instrument, the responses from this exchange did not necessarily reflect a geographic distribution or type of system distribution similar to that of the population. This "caveat"

2/ This definition is the acknowledged industry definition of a master meter system as relayed to SASC during on-site visits and telephone conversations with a number of gas uitlity companies.

must be emphasized and understood prior to making inferences about the population. The lack of randomness required alternative approaches for analysis.

The sampling of master meter operators resulted in almost 475 responses. Of these, over 100 were returned with incomplete data and hence set aside. Detailed computer analysis of 371 instruments was performed in an attempt to determine the characteristics of the nation's master meter population and, if therewere safety problems, the extent of the problems present. Discussion of the analysis is presented in the Appendix.

2.5 ESTIMATING THE MASTER METER POPULATION

Detailed derivation of the procedures employed to estimate the master meter population nationwide are discussed in Chapter 5 of the report. A brief narrative is presented in the following paragraphs.

After acquiringdata from all responding utilities, the master meter population was estimated for each state using two techniques. The first technique, called the Simple Un-Biased (SUB) estimate, assumed that the fraction of utility companies within each state in the sample was identical to the fraction of master meters within each state in the sample. In other words, if three out of 10 utility companies in a particular state reported 30 master meters, then the SUB estimate for

that state would be (10/3)X(30) or 100 master meters. The second technique, known as the ratio estimate, assumed that the fraction of total accounts of reporting utility companies that were master metered was the same for non-reporting utility companies. That is to say, the ratio estimate assumes a high positive correlation between the number of master meter accounts and total number of accounts. If a sample of five utility companies serves 1,000 master meter accounts out of a total of 20,000 accounts (a 58 fraction) and the entire state had 100,000 natural gas accounts, then the ratio estimate would predict 5% of 100,000 or 5,000 master meter accounts for the state. Note that this estimate does not account for fraction of companies sampled, but only the fraction of accounts.

After examination of the data, results indicated that the SUB estimate could not be used reliably to estimate the master meter population. This was evident for two major reasons. First, with few exceptions, the sample of reporting utilities in each state was not representative of the population of utility companies in that state. State samples tended to be either heavily weighted with small companies or large companies. Second, the states sampled tended to show a strong positive correlation between master meter accounts and total accounts, which indicated that the ratio estimate would produce a more reliable estimate of the master meter population.

Having established estimates for each state, confidence levels were computed. These confidence levels provided upper and lower limits for the estimates centered about the mean estimate. Confidence levels were generated at the 95% level which indicates that, assuming a high correlation between master meter and total accounts exists, the interval presented will contain the population mean with a confidence of 95%.

2.6 ANALYSIS OF THE DATA

Both utility and master meter data were analyzed using the computerized Statistical Package for the Social Sciences **(SPSS)** to provide detailed statistics regarding utility companies and the master meter population they serve. For gas utilities, these statistics included size of distribution system, mix of master meter customers by type, willingness to take over pipelines, leak history for their system, and assessment of capability to perform leak surveys and inspection. Chapter 6 provides detailed analysis of the gas utility instruments received from companies.

For the master meter instruments, similar statistics were tabulated on system size, leak history, desirability of utility company takeover, and other information. More exhaustive cause/effect investigations were done to determine what factors contributed to their leak history and ability to achieve a high degree of safety (contingency analyses).

1

The returned master meter instruments, however, were heavily represented by housing authorities. Furthermore, the geographic mix of instruments was not consistent with the distribution of master meter systems nationwide. Analysis of these instruments, though useful towards establishing general characteristics about master meter systems, was not included in Chapter 6. Since a data base was available, although small and not representative, the instruments were nonetheless analyzed. The results of this analysis are presented in the Appendix.

2.7 ANALYSIS OF PROGRAM OPTIONS

The "straw men" "Use Scenarios" established at the beginning of the study served as guidelines for potential program options. The results of the information survey were fed back and modifications to the original "Use Scenarios" were developed. These improvements became clearer as data was received. The output of this analysis was to provide viable options to serve not as guidelines now, but as foundations for the building of national program options towards the master meter safety question. The option chosen by **DOT** would be predicated on achieving acceptable safety through reasonable cost/time burdens to all concerned parties, with any tradeoffs leaning towards the side of public safety.

2.8 FULL RANGE SPECIFICATIONS FOR PHASE II SURVEY

As a final output of the study, presented in Chapter 8, the methodology for implementing Phase II was developed. This methodology utilizes all the knowledge and analysis obtained during the previous tasks to provide a comprehensive work plan and survey design for Phase 11. The output of Phase II is the population of master meters and exact knowledge of their characteristics, with the complete plans for implementing the appropriate program options, and communicating these options during Phase 111.

CHAPTER 3

"USE SCENARIOS"

3.1 DISCUSSION OF THE PROBLEM

The purpose of this analysis of master meter systems was to obtain data pertinent to analyzing the master meter safety question nationwide. The basic information required from the analysis was an estimation of the extent of problems which may be caused by master meter systems and the difficulty involved should additional procedures be required to maintain compliance and inspection. To determine which data will meet these needs, it was necessary to consider potential program options which could result from various combinations of data from the Information Survey.

The "Use Scenarios" were for the purpose of constructing a priori descriptions of the master meter system situation which would lead to feasible program options, and from that to determine data which ought to be elicited by the Information Survey.

3.2 REQUIREMENTS OF "USE SCENARIOS"

The "Use Scenarios" must consider important parameters of data which describe the master meter situation, permit the widest probable range in the data anticipated and be useful in the analysis of data toward formation of program options.

3.3 IDENTIFYING THE SCENARIOS

One program option may indicate that regular inspection for compliance with the present regulations should be initiated for master meter systems and that the owners of the systems should be the agents for achieving compliance. In this Scenario, the program options would have to include planning for identifying all of the nation's master meter systems, for communicating with the owners of the systems, for inspecting the systems, and for upgrading them as necessary. This could require some change in the legislation, and might require application of resources both by the Federal Government and the states and localities.

A second reasonable Scenario was one in which the present regulations were, for one reason or another, judged to be inappropriate for application to master meter systems. In this Scenario, the program would require that new regulations be developed for specific application to mastermeter systems and, possibly, that new legislation be written applying specifically to master meter systems. In this Scenario, planning for introducing master meter systems into a formal inspection and compliance system and the attendent resources might also be a part of the policy consideration.

A third feasible Scenario would be one in which a separate compliance mechanism for master meter systems was judged to be inappropriate, and in which the current master meter system population would somehow be added to the compliance responsibilities of the utilities or other supplying agent. In this Scenario, it might beappropriatefor the present regulations to be imposed on

master meter systems, as in the first Scenario, or it might be necessary to write new regulations appropriate to these systems, as in the second Scenario. As in the first two Scenarios, program options associated with the third Scenario might include planning for increasing the national inspection and compliance capacity and providing necessary resources.

A fourth Scenario which might have a separate identity would be one in which it was determined that new mechanisms are required to achieve compliance for master meter systems. In this Scenario, compliance responsibility would rest with the present master meter system owners, but a mechanism such as licensing of certified specialists would be developed to allow owners to achieve compliance. In this Scenario, the options might indicate application of present regulations to master meter systems or might require the writing of new regulations. As in the other Scenarios, there would be requirements for planning into full compliance on a national basis.

All of the Scenarios might imply changes in legislation to include a clear, workable definition of "Plaster Meter System". Planning for national phase-in of inspection of master meter systems might include Federal grants to owners for upgrading to compliance.

3.4 SCENARIO DETERMINANTS

3.4.1 Enforce Present Regulations

This Scenario would be indicated if it were determined (1) that the hazards presented by master meter systems are of the same magnitude and severity as those which prompted present Gas Pipeline Safety

Legislation, (2) that the physical condition of most systems is such that it is practical to upgrade them to bring them into compliance, (3) that the owners are in the financial position to achieve compliance, (4) that communication with the owners relative to the requirements for compliance is practical, and (5) that it is practical, using the present system of Federal, state and local inspectors, to inspect the entire master meter system population.

3.4.2 New Regulations Required

This Scenario would be indicated if (1) the hazard presented by master meter systems is judged to be substantially different than that underlying the present legislation and regulations, or (2) that the technical presumptions of the present legislation and regulations do not apply (e.g., inspection of these systems is substantially more difficult than utility systems), or (3) that it is impractical in any case to inspect the entire population of master meter systems under the requirements of the present regulations, or (4) that financial or other constraints suffered by the master meter system owners would not permit them to upgrade the systems.

3.4.3 Supplying Agent Responsible for Compliance

This Scenario would be indicated if (1), the hazard posed by master meter systems indicated the need for inspection and compliance, (2) if financial or other constraints prohibited compliance by owners, or (3) if the definition of master meter systems is *so* complex that enforcement with the master meter system owner population might prove to be extremely difficult, and (4) it is feasible for supplying agents to achieve and maintain

compliance and (5) it is practical to inspect the master meter population using the present national inspection system.

3.4.4 New Mechanisms Reauired to Achieve Compliance

This Scenario would be indicated (1) if the data from the Information Survey showed that the burden of inspection of the entire master meter system population is greater than can be borne by the present Federal, state and local inspection system(s), (2) if the financial requirements of upgrading systems is beyond the capability of the master meter system owner population, and (3) if the hazard posed by master meter systems warrants compliance either to new or existing regulations.

3.5 APPLICATION OF SCENARIOS TO INFORMATION SURVEY

To determine which Scenarios actually described the master meter system situation, it was necessary to get information in the eight categories identified in Chapter 2. The survey was designed to elicit information in these eight categories to allow determination and support of options. It was evident that much of the information which the Information Survey determined was from expert judgement of people in Federal, state and local inspection authorities, from utilities, and from master meter system operators. It was important that the Information Survey include not only written survey instruments to obtain data from a sufficiently large population of utilities and master meter system owners to provide statistical respectability, but to provide discussion of the policy implications with knowledgeable people in states which have dealt with the problem and in states which find the problem difficult to deal with.

CHAPTER 4

DEVELOPMENT OF SURVEY INSTRUMENTS

Prior to commencing the survey of gas utility companies and master meter operators, SASC interviewed Regional/State Officials responsible for gas pipeline safety to gain insight about the potential safety hazard of master meter systems. Questions were formulated to determine estimates of the nopulation, safety problem, public awareness, solutions to problems and problems in implementing solutions. An Interview Instrument for Regional/State Officials was developed (see Exhibit 4-1), scheduled interviews were arranged in both Maryland and the District of Columbia and SASC proceeded with the interviews in October 1978. The project investigators also carried with them to these meetings copies of sample questions of the Utility Company Survey instrument to review with these professionals prior to finalizing, in the interest of maximizing its effectiveness. The FASC investigators also visited four local utility companies with this draft instrument. Constructive criticisms received from all of the above were incorporated into the finalized instrument (see Exhibit 4-2). It contained a definition of master meter gas distribution systems and provisions for indicating the current and projected types of accounts served, awareness to regulations, company policy and records availability, and number of individual and master meter accounts. Mailings of this instrument were made nationallv during October and November 1978.

EXHIBIT 4-1

(Page 1 of 2)

INTERVIEW INSTRUMENT FOR REGIONAL/STATE OFFICIALS

I. ORGANIZATIONAL DATA

Date: Time:

Organization:

Address: Telephone:

Individual(s): Title(s):

****

II. EXTENT OF MASTER METER USE

1. What is your definition of Master Meter System?
2. What fraction of the total natural gas users in your area are Master Meter Systems?
3. What fraction of natural gas consumption (Mcf) is attributed to Master Meter Systems?
4. What are the predominant types of natural gas users who are Master Metered?

III. SAFETY PROBLEMS ARISING OUT OF MASTER METER SYSTEMS

1. What are the physical characteristics of Master Meter Systems in your area (e.g., age, corrosion protection, etc.)?
2. What has been the leak history of Master Meter Systems, including accidents, property damage, and casualties?
3. What have been the major causes of these leaks?
4. Have Master Meter Systems been more susceptible to leaks and accidents than those systems maintained by gas companies?

IV. PUBLIC AWARENESS OF SAFETY PROBLEMS IN MASTER METER SYSTEMS

1. Who is (or should be) informing the users in Master Meter Systems of any safety hazards encountered?
2. What role has your office played in informing the users?
3. Are Master Meter Operators sufficiently aware of the hazards in gas distribution systems?

V. SOLUTIONS TO SAFETY PROBLEMS

1. What is necessary to assure Master Meter compliance with safety regulations?
2. What has your office initiated to correct any Master Meter safety problems?
3. Were these initiatives successful?
4. Are there adequate resources available to inspect Master Meter Systems on a regular basis?

VI. PROBLEMS ENCOUNTERED IN IMPLEMENTING SOLUTIONS

1. What have been the practical problems experienced/expected in implementing solutions?
2. Technical problems?
3. Monetary problems?
4. Political problems?
5. Managerial problems?

VII. RECOMMENDATIONS

1. What alternatives exist in resolving the Master Meter safety problems?
2. How would you implement solutions to VI, 1-5?

EXHIBIT 4-2
(Page 1 of 5)

DEPARTMENT OF TRANSPORTATION
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
WASHINGTON. D.C. 20590

REFER TO:

The subject of master meters has been discussed among those concerned with natural gas pipeline safety for some time. In an effort to clarify our thinking and our actions regarding master meters, we are analyzing several important parameters which collectively tend to define master meter safety.

We have engaged the Systems and Applied Sciences Corporation (SASC) to assist us. Members of SASC, under our guidance, have developed an information exchange instrument which we want to use to help us collect factual data on important parameters. Your consideration in this part of our analysis would be deeply appreciated.

A copy of the instrument is enclosed; we also are sending a copy to approximately 2000 other organizations. We would like for you to answer the statements in the instrument to the best of your ability and return to SASC, 6811 Kenilworth Avenue, Suite 610, Riverdale, Maryland 20840. In this way, we believe that we will have a current, valid data base for our continuing analysis. If you have any questions on the instrument, or on our overall effort, please call me at 755-9247, or Mr. T. W. Caless of SASC at 301/699-5400 Ext. 288. A copy of our report on master meters will be available to interested parties.

Thank you for your interest in pipeline safety, and for your time and effort regarding our analysis of master meters.

Sincerely,

Robert L. Paullin
Associate Director for
Operations and Enforcement

Enclosure

EXHIBIT **4-2**
(Page 2 of 5)

INFORMATION EXCHANGE WITH GAS DISTRIBUTION SYSTEMS

UTILITY COMPANY EXCHANGE

SASC CONTROL NO. [ ][ ][ ][1] (1 - 6)

DATE: [ ][ ] (7 - 10)

I. UTILITY COMPANY DATA (PLEASE COMPLETE ONE FORM FOR EACH STATE SERVED)

COMPANY NAME: _____ PREPARER OF QUESTIONNAIRE: _____

COMPANY ADDRESS: _____ _____

_____ POSITION: _____

BRANCH/SUBSIDIARY NAME: _____ TELEPHONE: ( ) _____ AREA

BRANCH/SUBSIDIARY ADDRESS: _____

_____

TYPE OF COMPANY: (11)

- [ ] 1. DISTRIBUTION
- [ ] 2. CPMBINATION
- [ ] 3. INTEGRATED
- [ ] 4. TRANSMISSION
- [ ] 5. MUNICIPAL GAS SYSTEM

MILES OF NATURAL GAS DISTRIBUTION PIPELINE OWNED IN STATE: [ ][ ][ ][ ] (12-15)

NATURAL GAS SOLD TO CUSTOMERS IN 1978 (OR PROJECTED) IN STATE: [ ][ ][ ][ ][ ][ ][ ][ ] Mcf (17-24)

* *

II. INTRODUCTION AND DEFINITION

Systems and Applied Sciences Corporation (SASC) is currently conducting a study for the Department of Transportation, Materials Transportation Bureau, Office of Pipeline Safety Operations and Enforcement. The purpose of the study **is** to obtain information on the status of master meter gas distribution systems with regard to the potential **for** safety hazards.

To avoid confusion caused by **a** wide variety of labels (e.g. master, bulk, group, multi-meter, etc.), the name Master Meter System, as used in the following questions, is defined as:

> Any gas distribution system, other than one owned **or** operated by a gas utility, serving and/or reselling natural gas to more than one user or outlet, and possessing exterior pipelines. Hence, a single hiyh-rise building with a meter installed would not be considered a Master Meter System for the purposes of this study if no exterior pipeline is present downstream of the utility company-owned meter.

INSTRUCTIONS

NOTE THAT THIS FORM HAS BEEN DESIGNED AS A DATA ENTRY FORM FOR COMPUTER PROCESSING AND EACH MULTIPLE CHOICE QUESTION SHOULD BE ANSWERED WITH THE SINGLE BEST CHOICE, UNLESS OTHERWISE INDICATED.

A. The above definition of Master Meter System is:

- [ ] 1. Adequate for completing this form.
- [ ] 2. Needs some modification (explain below).
- [ ] 3. Totally inadequate (explain below).

(26) _____

_____

_____

_____

_____

_____

_____

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_____

_____

_____

B. Recognizing that DOT/SASC's definition of natural gas Master Meter System is narrow for this study, please indicate the types of accounts that **your** company serves (complete all entries that are appropriate).

[ ][ ] % (27-28) Group Meters - installation of **a** meter serving more than one user and possessing no exterior pipelines downstream of the meter.

[ ][ ] % (29-30) Customer Yard Lines - customer-owned gas pipeline downstream of the meter and exterior to a single family residence.

[ ][ ] % (31-32) Line/Farm Taps - installation of **a** service line and meter from **a** transmission line to an account in a remote area.

[ ][ ] % (33-34) Unit/Customer Meters - installation of a meter serving a single residence (or converted commerical establishment) possessing no exterior pipelines downstream of the meter.

[ ][ ] % (35-36) Master Meter Systems - as defined for this study.

[ ][ ] % (37-38) Others - please define.

_____

_____

_____

Total = 100%

C. At the end of the next five years, the projected change in these percentayes (as defined in II B) will be (complete all entries that are appropriate):

☐☐	% Group Meter Users (39-40)
☐☐	% Customer Yard Lines (41-42)
☐☐	% Line/Farm Taps (43-44)
☐☐	% Unit/Customer Meters (45-46)
☐☐	% Master Meter Systems (47-48)
☐☐	% Others, explain. (49-50)

TOTAL = 100%

D. What are the percentages (by type) of businesses or operations which comprise the natural gas Master Meter Distribution Systems served by your company (complete all entries that are appropriate).

☐☐	% University/Institutional Complexes (51-52)
☐☐	% Trailer Parks (53-54)
☐☐	% Apartment Houses (55-56)
☐☐	% Shopping Centers (57-58)
☐☐	% Housing Authorities (59-60)
☐☐	% Others, explain. (61-62)

TOTAL = 100%

E. Your company's responsibility for maintaining the natural gas distribution system to your customers is regulated by:

☐ 1. Federal Government, only.
☐ 2. Federal and State Governments, only.
☐ 3. Both of the above and local governments.
☐ 4. Federal and local governments, only.
☐ 5. State governments, only.
☐ 6. Local governments, only.
☐ 7. State and local governments, only.

(63)

III. OPERATIONAL INFORMATION

A. Which of the following represents your company's maintenance policy to your customers?

☐ 1. The full distribution system, including exterior pipelines.
☐ 2. Up to and including the outlet of the meter irrespective of the property lines.
☐ 3. Up to and including the outlet of the meter at the property lines, only.
☐ 4. Other, explain:

(64)

B. Assuming that our definition of Master Meter System is acceptable to you (answer all numbered questions):

1. How many natural gas accounts of all types does your company invoice? ☐☐☐☐☐☐ (18-23)
2. Natural gas Master Meter Accounts, only? ☐☐☐☐ (24-27)
3. These figures are:
   ☐ 1. Verifiable by our accounting department.
   ☐ 2. Supplied by our service department.
   ☐ 3. Arrived at by a special analysis of usage records.
   (28) ☐ 4. An estimate, only.
4. We keep natural yes usage records on our customers:
   ☐ 1. More than 3 years
   ☐ 2. 3 years, only
   ☐ 3. 2 years, only
   ☐ 4. 1 year, only

(29)

C. What is the 1978 (or projected) consumption of natural gas attributed to Master Meter Systems (according to our definition) that are served by your company?

☐☐☐☐☐ Mcf
(11-15)

D. Continuous usage records (not to include private information) can conveniently be provided on these customers for:

☐ 1. More than 3 years
☐ 2. 3 years
☐ 3. 2 years
☐ 4. 1 full year, only
☐ 5. None of the above, explain:

(17)

E. If your company were requested to supply continuous usage records on natural gas Master Meter Systems (as defined here) for a specified period, you would be able to furnish:

☐ 1. 1008 of the requested information.
☐ 2. 75% of the requested information.
☐ 3. 50% of the requested information.
☐ 4. Less than 508, explain:

(30)

F. What is the primary pipeline corrosion prevention technique practiced by the owners of the natural gas Master Meter Distribution Systems in your area:

(31)
- ☐ 1. Cathodic Treatment
- ☐ 2. Pipeline Coatings
- ☐ 3. Use of Plastic Pipe
- ☐ 4. Several, no particular technique
- ☐ 5. None
- ☐ 6. Unknown

G. What is the frequency of Leak Surveys that your company conducts as a matterof policy on natural gas Master Meter Distribution Systems (only) per year?

(40)
- ☐ 1. Quarterly, as a minimum
- ☐ 2. Once every 6 months, as a minimum
- ☐ 3. Once per year as a minimum
- ☐ 4. On request, only
- ☐ 5. None of the above, explain:

_____
_____
_____

H. How many exterior pipeline leaks were confirmed in your locale by your company in 1978 for (complete both entries):

Master Meter Systems ☐☐☐☐☐ (41-45)

Other natural gas systems ☐☐☐☐☐☐ (46-51)

I. Can you provide us with a list of reliable independent pipeline inspectors/consultants in your geographical area, if requested?

(72) ☐ 1. Yes ☐ 2. No

J. Does your company neqotiate contracts with natural gas Master Meter Distribution Systems' owners to install/inspect/maintain their pipelines?

(73) ☐ 1. Yes ☐ 2. No

K. If answer to J. was no, is this concept in the planning stage for some time in the future?

(74) ☐ 1. Yes ☐ 2. No.

L. If answer to K was no, would your company be able (and interested) to install/inspect/maintain Master Meter Distribution Systems under contract with the owners?

(75) ☐ 1. Yes ☐ 2. No

M. If answer to L was yes, indicate when:

(76)
- ☐ 1. In 3 years or more
- ☐ 2. In 2 years
- ☐ 3. Next year
- ☐ 4. Now

N. How many individuals are assigned to your Leak Survey/ Safety Inspection staff (complete all entries that are appropriate).

- ☐☐ (32-33) Professionals (holders of engineering or academic degrees as a minimum).
- ☐☐ (34-35) Para-Drofessionals (holders of technical school certificates as a minimum).
- ☐☐ (36-37) Clerical/Non-Professionals (received on the the job training, primarily).
- ☐☐ (38-39) None, explain.

_____
_____

O. How many natural gas accidents resulting in loss of property/life occurred in 1978 in your locale for (complete all appropriate entries).

1. Master Meter Systems?

- ☐☐ (52-53) Personal injury, only.
- ☐☐ (54-55) Loss of life, only.
- ☐☐ (56-57) Property damage, only.
- ☐☐ (58-59) Property damage/injury.
- ☐☐ (60-61) Property damage/fatality(ies).

2. Other Natural Gas Systems?

- ☐☐ (62-63) Personal injury, only
- ☐☐ (64-65) Loss of life, only.
- ☐☐ (66-67) Property damage, only.
- ☐☐ (68-69) Property damage/injury.
- ☐☐ (70-71) Property damage/fatality(ies).

P. PLEASE PROVIDE A CURRENT AND COMPLETE LIST OF NATURAL GAS MASTER METER SYSTEMS THAT YOU SERVE, SHOWING NAMES AND ADDRESSES (BILLING AND USE SITES) AND A DISTRIBUTION SYSTEM MAP WITH THIS COMPLETED QUESTIONNAIRE AND RETURN TO:

SYSTEMS AND APPLIED SCIENCES CORPORATION
6811 KENILHORTH AVENUE, SUITE 610
RIVERDALE, MARYLAND 20840

ATTENTION: T. W. CALESS
TELEPHONE: (301) 699-5400, EXT. 246

IV. Thank you for your assistance. If you have comments concerning this study or the Master Meter problem, please indicate:

SASC then began to study the design of a master meter survey instrument, which would include more general information than the utility instrument so as to draw responses from the smaller mastermeter operators. This instrument also contained a slight modification to the original definition (for clarity); and provisions for entering informationon site characteristics, pipeline materials and corrosion protection, dependence upon utility companies for handling emergencies, leak history, interest in turning over safety responsiblity of their systems to the utility companies, annual consumption and maintenance costs figures, and awareness to federal inspection requirements. This instrument (see Exhibit 4-3) was finalized in December 1973 and mailings were made as name/address lists were received from the sources mentioned earlier.

Both the Utility Company and Master Meter Survey instruments were designed as data entry forms to expedite converting the data into machine readable form as these completed instruments were returned to the Project. The additional self-mailing feature of the master meter survey instrument was designed to facilitate completion and the return of that instrument.

SAS SYSTEMS AND APPLIED SCIENCES CORPORATION
6811 KENILWORTH AVENUE, SUITE 610, RIVERDALE, MARYLAND 20840 301/699-5400

This firm has recently been awarded a research contract by an agency of the federal government to locate and describe natural gas distribution systems serving themselves and/or the general public.

It is our understanding that your company has such a system in operation. Therefore, we have provided you with a data exchange instrument which should require only a few minutes of your tine to complete.

Please understand that voluntary information about your natural gas distribution system is important to this study and we will appreciate your completing all of the questions as accurately as possible. Ultimately, the results of this study will lead to improved safety to your custoners.

If you have any questions concerning this study or need additional information, please contact me at (301) 699-5400, ext. 288.

Thank you for your cooperation.

Sincerely,

Thomas W. Caless

Thomas W. Caless
Information Scientist

TWC :smh

Enclosure: (1)

SASC CONTROL NO. [|] (1-7)

DATE [| |] YR. MO. DAY (9-14)

INFORMATION EXCHANGE REGARDING NATURAL GAS DISTRIBUTION SYSTEMS
ASSOCIATED WITH MASTER METER OPERATORS

I. MASTER METER OPERATOR DATA (PLEASE COMPLETE ONE FORM FOR EACH SITE OWNED/MANAGED WHICH IS MASTER METERED).

COMPANY NAME: ____________________ MANAGER : ____________________

COMPANY ADDRESS: ____________________ TELEPHONE: ( ) ____________________
AREA

____

OWNER'S NAME: ____________________ TELEPHONE: ( ) ____________________
AREA

OWNER'S ADDRESS: ____________________

____

NATURE OF BUSINESS: ____________________ PERSON COMPLETING THIS FORM: ____________________

____

* *

II. INTRODUCTION AND DEFINITION

Systems and Applied Sciences Corporation (SASC) is currently conducting a study for the Department of Transportation, Materials Transportation Bureau, Office of Pipeline Safety Operations and Enforcement. The purpose of the study is to obtain information on the status of master meter gas distribution systems with regard to the potential for safety hazards.

To avoid confusion caused by a wide variety of labels (e.g. master, bulk, group, multi-meter, etc.), the name Master Meter System, as used in the following questions, is defined as:

> Any gas distribution system, other than one owned or operated by a gas utility, serving and/or reselling natural gas to more than one user or outlet having pipelines downstream of the meter which may be buried or exposed outside of the building. Hence, a sinyle high-rise building with a meter installed would not be considered a Master Meter System for the purposes of this study if no exterior pipeline is present downstream of the utility company-owned meter.

This definition adequately describes the natural gas distribution system we operate at this site:

[ ] 1. YES [ ] 2. NO, Explain: ____________________
(16)

____

____

INSTRUCTIONS

THIS FORM HAS BEEN DESIGNED AS A DATA ENTRY FORM FOR COMPUTER PROCESSING AND EACH MULTIPLE CHOICE QUESTION SHOULD BE ANSWERED WITH THE SINGLE BEST CHOICE, UNLESS OTHERWISE INDICATED.

III. PROPERTY PIPELINE DATA

A. How many buildings/lots do you own/manage at this site that are served by natural gas?

[| | |] NO. OF BUILDINGS/LOTS
(17-20)

B. This property was developed (began operation) in:

[| | |] YEAR
(21-24)

C. The Master Meter System was installed in:

[| | |] YEAR
(25-28)

D. The Master Meter system was installed by:

[ ] 1. Owner's maintenance crew
[ ] 2. Local plumbing contractor
[ ] 3. Developer
[ ] 4. Utility company
[ ] 5. Gas pipeline contractor
[ ] 6. Unknown
(29)

(Over)

E. The predominant type of pipeline materials used in your distribution system is:

☐ 1. Steel
☐ 2. Copper
☐ 3. Aluminum
☐ 4. Plastic
☐ 5. Unknown
☐ 6. Other, explain: _____
(30)

F. The principal corrosion protection technique used is:

☐ 1. Cathodic protection
☐ 2. Vinyl coated/wrapped
☐ 3. Coated and wrapped
☐ 4. Galvanized
☐ 5. None
☐ 6. Unknown
(31)

IV. MANAGEMENT DATA

A. Monthly natural gas bills are paid to (name of company):

_____

B. Do you have a map or drawing of your pipeline distribution system?

☐ 1. YES ☐ 2. NO
(32)

C. Please indicate the footage of pipelines in your natural gas distribution system:

☐☐☐☐☐ ft.
(34-38)

D. Do you have a maintenance and operation plan of your gas distribution system in effect with either a utility company or consultant firm?

☐ 1. YES ☐ 2. NO
(39)

E. Would you or your staff be able to safely restore service after an unexpected stoppage?

☐ 1. YES
☐ 2. NO, Explain: _____
(40)

F. Would you or your staff be able to perform an emergency shutdown and pressure reduction in any section of your gas distribution system?

☐ 1. YES
☐ 2. NO, Explain: _____
(41)

G. Year of last gas distribution system inspection:

☐☐☐☐ YEAR
(42-45)

H. Year of last gas distribution system leak survey:

☐☐☐☐ YEAR
(46-49)

I. ... which resulted in identifying:

☐☐ NO. OF LEAKS
(50-51)

J. If the answer to (I) indicated that leaks were found, the action taken by you was:

☐ 1. None, leaks were not hazardous
☐ 2. Arranged for repairs within a reasonable time
☐ 3. Immediate repairs were necessary and performed.
(52)

K. Who regulates gas pipeline safety for master meter systems in your area?

_____

L. Who repairs the leaks in your master meter system?

☐ 1. Owner's maintenance crew
☐ 2. Local plumbing contractor
☐ 3. Developer
☐ 4. Utility company
☐ 5. Gas pipeline contractor
☐ 6. Other, explain: _____
(53)

(Please continue to next page.)

M. Would your company be interested in having the utility company that serves you natural gas assume the full safety responsibility of your distribution system?

☐ 1. YES

☐ 2. NO, Explain: _____

(54)

N. If anawer to (M) was YES, it would be preferable to:

☐ 1. Negotiate the ownership of your entire system.

☐ 2. Develop a maintenance and operation agreement for your system, which would be renewable periodically with no change of ownership.

☐ 3. Contract with them on an "as needed" basis, only.

☐ 4. Inspect and maintain your system independently of the utility company.

(55)

O. What has been the history of the percentage (%) of unaccounted natural gas in your system for (please answer all items):

☐☐ % 1. 1978

☐☐ % 2. 1977

(56-57) ☐☐ % 3. 1976

P. What has been the approximate average annual cost to your company for inspecting and maintaining your natural gas distribution system for the last 3-5 years?

☐☐☐☐☐☐ DOLLARS

(59-64)

Q. What was the consumption of natural gas for your system in 19781

☐☐☐☐☐ Mcf (thousand cubic feet)

(66-70)

R. Are you aware of federal inspection requirements governing master meter distribution systems?

☐ 1. YES ☐ 2. NO

(71)

S. Thank you for your cooperation. We are interested in any further information that you may wish to contribute below:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

THIS DATA COLLECTION INSTRUMENT HAS BEEN PREPARED AND FOLDED AS A SELF-MAILER -- RETURN POSTAGE GUARANTEED -- FOR YOUR CONVENIENCE. UPON COMPLETION, PLEASE REFOLD ACCORDINGLY, STAPLE, AND DROP IN POST OFFICE BOX.
THANK YOU.

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

POSTAGE WILL *BE PAID BY ADDRESSEE*

Systems and Applied *Sciences* Corp.
6811 Kenilworth Avenue
Suite 610
Riverdale, *Md.* 20840

Attn: **Thomas W. Caless**

CHAPTER 5

ESTIMATES OF THE MASTER METER POPULATION

This chapter provides national, regional, and state estimates of the master meter population based on results obtained through the utility company information collection effort. Confidence intervals are provided in these estimates. In addition, a discussion of the technique employed by SASC to estimate the population is presented.

5.1 DATA COLLECTION

The data base used by SASC to estimate the master meter population was constructed from the responses provided by reporting utility companies. Using Brown's Directory of North American Gas Companies, it was determined that 1526 natural gas utility companies operate in the 50 states and the District of Columbia. This number included those companies which served more than one state. It was necessary to treat one company separately for each state served so as to provide a meaningful estimate on a state-by-state basis. Out of 1526 utility companies nationwide, 344 provided meaningful data on the number of master meter systems they serve. This number is larger than the 291 analyzed in greater detail in Chapter 6 since 53 companies, either by information on the questionnaire or through telephone follow up, provided estimates as to the number of master meter systems they serve but were unable to provide meaningful responses to other questions on the instrument.

The intent of the survey was to obtain a sample of utility companies which mirror the population of utility companies nationwide. The 1526 companies serve approximately 45.3 million accounts or an average of slightly under 30,000 accounts per conpany. Ideally, a representative sample of utility companies would also serve approximately 30,000 accounts per responding company. Table 5-1 presents a state-by-state tabulation of responding companies vs. total companies in each state.

TABLE 5-1 - UTILITY ***COMPANY*** DATA BASE FOR ESTIMATING THE MASTER METER POPULATION

STATE	NUMBER OF COMPANIES SAMPLE	POPULATION	%	NUMBER OF ACCOUNTS SAMPLE	POPULATION	%
CT	1	7	14	10,568	390,100	3
ME	1	2	50	14,975	17,200	87
MA	8	12	67	315,097	1,049,600	30
NH	4	5	80	29,801	45,900	65
RI	4	6	67	161,361	165,000	98
VT	1	1	100	10,859	10,900	100
NJ	0	15	0	0	1,828,700	0
NY	11	22	50	2,074,202	3,954,600	52
PA	8	64	13	829,231	2,307,000	36
DE	2	2	100	82,352	82,300	100
DC	1	1	100	152,103	152,100	100
MD	7	9	78	737,164	770,900	96
VA	7	16	44	340,448	523,300	65
WV	3	41	7	9,206	394,600	2
EASTERN	58	203	29	4,767,367	11,692,200	41
FL	16	59	27	175,369	415,500	42
GA	7	75	9	748,464	945,100	79
NC	6	16	38	271,663	344,200	79
SC	4	22	18	56,629	285,900	20
AL	20	112	18	457,638	655,400	70
KY	12	47	26	291,351	623,900	47
MS	7	38	18	233,424	385,700	61
TN	21	101	21	146,605	495,900	30
SOUTHERN	93	470	20	2,381,143	4,151,600	57

TABLE 5-1 - CONTINUED

STATE	NUMBER OF COMPANIES SAMPLE	POPULATION	%	NUMBER OF ACCOUNTS SAMPLE	POPULATION	%
AR	5	24	21	62,411	472,500	13
LA	10	48	21	131,857	955,300	14
OK	6	48	13	18,215	764,600	2
TX	12	98	12	79,979	3,033,200	3
NM	4	20	20	4,927	296,300	2
SOUTHWEST	37	238	16	297,389	5,521,900	5
IL	15	79	19	335,260	3,190,300	11
IN	10	78	13	672,650	1,203,900	56
MI	8	38	21	199,725	2,269,000	9
OH	7	38	18	357,206	2,736,600	13
WI	11	20	55	670,642	970,300	69
IA	11	52	21	208,327	709,300	29
KS	17	83	20	242,099	690,900	35
MN	14	36	39	713,519	740,700	96
MO	12	43	28	193,061	1,182,300	16
NE	6	43	14	254,767	419,700	59
CENTRAL	111	490	23	3,838,256	14,113,000	27
ND	2	3	67	72,563	78,500	92
SD	2	21	10	48,097	96,400	50
AZ	4	16	25	27,735	563,300	5
CO	12	25	48	147,750	745,500	20
ID	2	2	100	107,475	107,500	100
MT	3	14	21	50,257	179,500	28
NV	3	4	75	121,725	128,200	95
UT	2	2	100	356,512	356,500	100
WY	4	13	31	46,832	109,000	43
AK	1	3	33	1,200	33,900	4

TABLE 5-1 - **CONTINUED**

STATE	NUMBER OF COMPANIES SAMPLE	POPULATION	%	NUMBER OF ACCOUNTS SAMPLE	POPULATION	%
CA	4	**11**	36	5,935,178	6,784,500	87
HI	0	1	0	0	33,900	0
OR	1	3	33	211,800	254,300	83
WA	5	7	71	296,301	352,200	84
WESTERN	45	125	36	7,423,425	9,822,500	76
TOTAL U.S.	344	1,526	23	18,707,580	45,301,200	41

As can be seen by the table, response rate nationwide was 23% based on number of companies although it was 41% based on number of accounts. The sample of reporting companies served an average of 54,000 accounts each. Examining the data on a regional and state basis also indicated that the fraction of reporting utility companies tended to be less than the fraction of accounts served by these companies. In other words, the data collected was weighted more with the larger utility companies than with the smaller. A notable exception to this was the Southwest region where 16% of the companies reported, but these companies served only 5% of the total accounts in the region.

Recognizing that the sample was weighted with larger companies, the next question was to determine if geographic region affected response rate. The data in Table 5-1 reveals that the highest response rates, (36 and 76%) based on both number of companies and number of accounts, was achieved in the Western region. The lowest response rates (16 and 5%) occurred in the Southwest region.

Examination of the data on a state-by-state basis indicated a number of observations. These included the following:

- 100% response rates resulted in Vermont, Delaware, the District of Columbia, Idaho, and Utah.
- No useful data was received from New Jersey and Hawaii; hence, no estimates for these states could be made.

- One utility company reported in each of the following states: Connecticut, Maine, Alaska and Oregon; thus, no estimate as to variability of master meter population within each state could be made,
- Responding utility companies in Connecticut, Massachusetts, New Hampshire, West Virginia, Arkansas, Louisiana, Oklahoma, Texas, New Mexico, Michigan, Ohio, Missouri, Illinois, Arizona, Colorado, and Alaska were smaller in size than the average company in the state. In other words, certain large companies in these states did not provide estimates of their master meter accounts.

5.2 ASSUMPTIONS

Before discussing the estimating procedure, a number of assumptions are identified. These assumptions were made by the study team to provide a reliable estimate of the population.

5.2.1 Definition of Master Meter System

As mentioned earlier, the study definition of master meter refers to a subset of what is generally recognized by industry as a master meter system. The gas utility companies nationwide generally acknowledge a master meter system as one serving natural gas to more than one user through a single meter. Examples of such systems include apartment houses (high-rise and garden), housing authorities, mobile home parks, office buildings, shopping centers, and university/hospital complexes. The definition used by the study,

however, addresses only that subset of master meter systems possessing appreciable amounts of underground or exterior piping downstream of the meter and not owned by the utility company serving gas, but rather owned by the master meter customer. Throughout this chapter, the words systems, customers and accounts are assumed identical. The number of users refers to the number of distinct units served gas beyond the master meter. Therefore, the estimates provided in this section do not include systems such as high-rise office buildings and apartment houses which serve gas to many users through a meter located in or adjoining the building served. This restriction was made since it was felt that if no underground or exterior piping was present downstream of the meter, the safety hazard present was not as severe, and in fact, no different from that found in single family homes and other individually metered installations.

5.2.2 A f Uti i any Estimates

For those utility companies that responded with estimates of the number of master meters which they serve, the study assumed that each company's estimate was correct and could be treated as "hard" data. In many instances, data from utility companies was questionable and follow-up telephone calls were made in an attempt to verify accuracy of the data.

Approximately 50 utility company instruments received by SASC indicated: "DATA NOT AVAILABLE." These companies were unable to estimate their master meter population due to the structure of their data base. For these companies, their data base of master meter accounts did not distinguish between those systems with buried piping and those systems

without buried piping. Hence, these companies did not provide SASC with an estimate.

In other instances, utility companies included high-rise buildings and other multiple user systems not possessing underground or exterior piping. In these instances, further follow-up by SASC was done in an attempt to extract the number of systems satisfying the study definition. If this was not possible, then the data was not used.

For the 344 companies included in the estimating analysis, the assumption was made, therefore, that the data provided by each company was an accurate reflection of each company's true master meter population, as defined by the study.

5.2.3 Characteristics of Non-Responding Companies

Almost 1200 utility companies did not return a completed utility company instrument to the Project. Many of these companies were large utilities serving gas accounts in urban areas in the Northeast Midwest and Southwest. However, many companies located in sparsely populated rural areas also did not respond. The net effect of this response mix resulted in a data base comprised of utility companies larger than the average in spite of non-responses from many large companies.

Despite this company size difference and the fact that the rate of non-respondents varied from one geographic region to another, the study was unable to discover any information indicating that the non-respondents contained a different proportion of master meter accounts than the responding utility companies. Rather, it was determined that the major cause of non-responses was attributable

to non-availability of data on the subset of master meter systems containing customer owned buried or exterior piping. The accounting departments of many utility companies simply do not identify their master meter accounts as to presence of customer owned piping. For these companies, the only current method to identify these accounts is through physical on-site inspection of all systems serving multiple users, a very expensive and time consuming effort.

5.2.4 Other Assumptions

In addition to the above, a number of assumptionsrequiredfor use in the statistical analysis of the data were made. As mentioned in Chapter 11, the time constraints of the study prevented the formulation of a truly independent random sample. The responses generated were totally keyed to the ability of companies to respond. This factor significantly affected the selection of an estimating technique.

These assumptions are explored in detail in the following paragraphs and further hone in on the final selection of the technique used in estimating the population of master meters nationwide.

5.3 CANDIDATE ESTIMATING PROCEDURES

As mentioned in Chapter 2, two techniques were available for use in estimating the master meter population nationwide. The following two sections discuss each estimating technique, select the most appropriate and present a general description of the step-by-step procedure employed in determining the number of master meter systems nationwide.

Selection of the most appropriate estimating technique was dependent on the nature of the sample obtained in each state. To ensure uniformity in the analysis and provide accurate confidence about each state's estimate, it was felt that a single technique should be used for all states. This requirement neczssitated compromise since the selected technique was not alway optimal for all states.

5.3.1 Simple Unbiased (SUB) Estimate

The simple unbiased (SUB) estimating technique was originally considered as the classical technique to use in estimating a population total based on the observations of a sample. Given n reporting utility companies, out of N total companies in a state, responding with x master meter systems, the SUB estimate for the state's total population, X, was computed as

$$X = \frac{N}{n} \cdot x \qquad (1)$$

Using (1) to estimate a total for a state assumed that the number of master meters per utility company was a constant and hence the population total could be expressed as a linear multiple of the sample total. This linear multiple was simply the ratio of total companies to responding companies (the reciprocal of the sampling fraction, f = n/N).

5.3.2 Ratio Estimate

The ratio estimate was a technique predicated on the assumption that a total for a characteristic could be estimated accurately by knowing 1.) the ratio of that desired characteristic in the sample to the total of another characteristic in the sample and 2.) the

total of the second characteristic for the population. Hence if one 1.) computed the ratio of master meter systems (x) to total accounts (y) for the state sample of companies and 2.) knew the total number of accounts (Y) for all gas utilities in the state, then the ratio estimate for the total number of master meter systems for that state, $\hat{X}$, would be

$$\hat{X} = \frac{x}{y} \cdot Y \qquad (2)$$

To implement equation (2), it was required that the total number of gas accounts be known for each state and second, and more importantly, that a positive correlation exist between the number of master meter systems and the total number of accounts for each company in the state.

5.4 SELECTION OF ESTIMATING TECHNIQUE

In general, the number of master meter systems per company is not a constant. A company with a large number of gas accounts may be far more likely to have more master meters than a small company. If the sample of observations is weighted heavily with large numbers, then $\hat{X}$, the population estimated total, tends to be an over estimate of the true population total. By the same token, if the sample of observations is weighted heavily with small companies, then $\hat{X}$ tends to be an under estimate of the population total.

The data received by the study team indicated (1) that the number of master meter systems per utility company was not constant and (2) for most regions, the sample of utility companies in each

state was not representative of that state, but tended to be weighted more towards the larger companies. For these reasons, it was felt that the SUB estimate would not prove beneficial in estimating the population of master meter systems for each state.

If a high correlation existed between the number of master meter accounts and total accounts in each state, then the presence of a sample heavily weighted with large or small companies does not pose as great a problem. The presence of high positive correlation indicates that although the absolute number of master meters varies widely from one utility to another, the fraction of accounts that are master metered tends to be similar from one company to the next, within each state.

It should be emphasized at this point that since regional differences in the fraction of total accounts that are master metered were great, the technique would have provided grossly erroneous estimates if used on a national, or even regional basis. For this reason, the state-by-state ratio provided a more accurate indication of the true population in each state.

The data received by the study revealed that in 30 out of 40 states and the District of Columbia, a positive correlation in excess of 0.5 was found. In 23 states this correlation exceeded 0.75. Ten states were either sampled completely, known to have no master meters, or provided the study with insufficient data to determine if a correlation existed. In only two states, West Virginia and Michigan, did a negative correlation occur and this

was attributed to a small sample size with respondents showing data far greater or less than expected. The presence of high positive correlation in the vast majority of states, however, revealed that a relationship between the number of master meter accounts and the total number of accounts did indeea exist and that low correlations in the sample were due to small sample sizes or the presence of outlier data points (companies with a significantly higher or lower ratio of master meter accounts to total accounts.) Based on the data obtained therefore, it was felt that the ratio estimate was the preferred estimate to use in determining the population of master meters for each state, region, and nationwide.

5.5 RESULTS OF ESTIMATION PROCEDURE

Having accepted the ratio estimate as the most appropriate technique to use in determining the number of master meter systems nationwide, the study effort implemented the technique for each state. Given x, the total number of master meters in the sample for a state, y, the total number of accounts in the sample for that state, and Y, the total number of accounts in the particular state, the estimate $\hat{X}$, for the total number of master metered systems for that state was computed as $X = \frac{x}{y} \cdot Y$. This was done for each state.

Table 5-2 presents the results of implementing the ratio estimate on each state's sample. Due to non-availability of data, no estimates were made for Hawaii and New Jersey. Hence, national and appropriate regional estimates may increase if these states do report in at a later time.

As can be seen by the table, estimating the population on a

TABLE 5-2 - ESTIMATE OF MASTER METER POPULATION (BY STATE)

STATE	NUMBER OF MASTER METERS IN SAMPLE	95% CONFIDENCE INTERVAL LOWER LIMIT	EXPECTED	UPPER LIMIT	EXPECTED MASTER METERS PER 1000 ACCOUNTS
CT	0	N/A	0	N/A	0.0
ME	0	0	0	0	0.0
MA	116	241	386	531	0.4
NH	23	27	35	55	0.8
RI	29	29	30	40	0.2
VT	0	0	0	0	0.0
NJ		NO DATA RECEIVED			
NY	181	238	345	715	0.1
PA	421	681	1,171	2,192	0.5
DE	16	16	16	16	0.2
DC	85	85	85	85	0.6
MD	204	207	214	303	0.3
VA	496	588	762	1,362	1.5
WV	12	186	514	1,504	1.3
EASTERN	1,583	2,917	3,558	5,154	0.3
FL	117	172	277	506	0.7
GA	334	365	422	587	0.4
NC	338	369	428	772	1.2
SC	50	166	252	338	0.9
AL	327	376	468	850	0.7
KY	476	484	1,019	1,554	1.6
MS	108	139	178	270	0.5

TABLE 5-2 - CONTINUED

STATE	NUMBER OF MASTER METERS IN SAMPLE	95% CONFIDENCE INTERVAL LOWER LIMIT	EXPECTED	UPPER LIMIT	EXPECTED MASTER METERS PER 1000 ACCOUNTS
TN	127	318	430	542	0.9
SOUTHERN	1,877	2,896	3,474	4,285	0.8
AR	232	888	1,756	2,624	3.7
LA	362	434	2,623	4,812	2.7
OK	55	836	2,309	4,761	3.0
TX	1,039	23,553	39,404	55,255	13.0
NM	7	89	421	753	1.4
SOUTHWEST	1,695	30,276	46,513	62,868	8.4
IL	120	474	1,142	2,388	0.4
IN	64	105	115	125	0.1
MI	100	459	1,136	2,816	0.5
OH	27	89	207	585	0.1
WI	910	1,051	1,317	2,176	1.4
IA	8	15	27	54	<0.1
KS	395	463	1,127	1,791	1.6
MN	69	70	72	166	0.1
MO	40	111	245	359	0.2
NE	727	906	1,242	2,574	3.0
CENTRAL	2,460	5,381	6,630	9,373	0.5
ND	104	107	113	178	1.4
SD	482	591	966	1,341	10.0

TABLE 5-2 - CONTINUED

STATE	NUMBER OF MASTER METERS IN SAMPLE	95% CONFIDENCE INTERVAL LOWER LIMIT	EXPECTED	UPPER LIMIT	EXPECTED MASTER METERS PER 1000 ACCOUNTS
AX	48	527	975	1,423	1.7
CO	718	1,611	3,623	5,635	4.9
ID	3	3	3	3	<0.1
MT	293	1,004	1,046	1,111	5.8
NV	103	105	108	160	0.8
UT	196	196	196	196	0.5
WY	305	459	710	961	6.5
AK	1	N/A	28	N/A	0.8
CA	11,316	11,877	12,935	24,986	1.9
HI		NO DATA RECEIVED			
OR	3	N/A	4	N/A	<0.1
WA	28	29	33	37	0.1
WESTERN	13,600	18,379	20,740	32,975	2.1
TOTAL U.S.	21,215	64,738	80,915	101,901	1.8

state-by-state basis was essential since the fraction of total accounts that were master metered varied significantly from state to state. The highest concentration of expected master meter systems was found in Texas --13.0 per 1000 accounts. In addition, Texas had the highest expected number of master metered systems --39,404. The second highest concentration was found in South Dakota, 10.0 per 1000 accounts, though the estimated total for South Dakota was less than 1000 due to the small number of total accounts served in the state.

Data provided to SASC by DOT indicated no master meters for the states of Maine and Vermont. High response rates, including a 100% sample obtained for Vermont, verified this contention. In addition, no master meters were expected in Connecticut, though this estimate was based on a single reporting utility. The following paragraphs discuss the estimates obtained for each region. Confidence interval estimates are discussed in section 5.6.

5.5.1 Eastern Region

The sample of 58 reporting utility companies revealed 1583 master meter systems in the sample. The expected number of master meter systems for the region was obtained by summing each individual state estimate. The largest expected population of master meters was found in Pennsylvania with 1171. As stated earlier, none were expected in Connecticut, Maine, and Vermont, and no data was available from New Jersey. The estimates for Delaware and the

District of Columbia were based on a 100% sample and thus, assumed exact. Though not the largest number, the highest concentration of master meters was found in Virginia (762) and West Virginia (514), 1.5 and 1.3 master meters per 1000 accounts, respectively.

For the entire region, 3558 master meter systems were expected or an average of 0.3 per 1000 accounts. Approximately 2,450, or almost 69% of these systems were located in Pennsylvania, Virginia and West Virginia. All the other states had either lower estimates, lower concentrations, or both.

5.5.2 Southern Region

The sample of 93 reporting utility companies revealed 1877 master meter systems in the sample. The largest expected population, and concentration, was found in Kentucky with 1019 master meters expected, or 1.6 master meters per 1,000 accounts. The lowest number were found in Mississippi, South Carolina and Florida where the estimates were 178, 252, and 277 respectively. The density across the region was less variable ranging from a low of 0.4 per 1,000 accounts in Georgia to a high of 1.6 per 1,000 accounts in Kentucky.

The estimate for the entire region was 3474 master meters. Though the estimate for the Southern region was lower than the Eastern, the concentration of 0.8 per 1,000 accounts was almost three times as great.

5.5.3 Central Region

The sample of 111 reporting utility companies revealed **2,460** master meter systems in the sample. The largest expected populations of master meter systems were found in Wisconsin **(1317),** Nebraska (1242), Illinois **(1142),** Michigan **(1136),** and Kansas (1127). Kansas and Nebraska had the highest concentration of master meters per 1,000 accounts, **1.6** and **3.0** respectively. The lowest number of master meter systems were expected for Iowa **(27),** Minnesota **(72),** Indiana (115), and Ohio (207). All four of these states had concentrations 0.1 or less per 1,000 accounts.

For the entire region, **6630** master meter systems, or **0.5** per 1,000 accounts were expected. This number was higher than either the Eastern or Southern region, though the concentration of **0.5** was less than the 0.8 per 1,000 accounts predicted in the South.

5.5.4 Western Region

The sample of **45** reporting utility companies reported **13,600** master meter systems in the sample. The largest expected populations were found in California **(12,935),** Colorado (3,623), and Montana (1046). The highest concentration was found in South Dakota, Wyoming, and Montana resulting in densities of 10.0, **6.5** and **5.8** systems per 1,000 accounts respectively. The smallest expected populations were found in Idaho **(3),** Oregon (4), Alaska (28), and Washington **(33).** With the exception of Alaska, these states also had the lowest concentration in the

region, 0.1 systems or less per 1,000 accounts. As mentioned before, no estimate was made for Hawaii due to the non-availability of data. Idaho and Utah estimates were based on 100% samples and assumed exact.

For the entire region, 20,740 master meter systems were expected or 2.1 systems per 1,000 accounts. This was significantly greater in terms of numbers and concentration than that found in the three previous regions. California alone accounted for over 62% of the Western region estimate. Nevertheless, the Western region still had an expected master meter population less than half of that expected in the Southwest.

5.5.5 Southwest Region

The sample of 37 reporting utility companies revealed only 1695 master meter systems in the sample. However, this resulted in the highest estimate of master meter systems in the nation. The highest population expected in the region was found in Texas, 39,404, with a density of 13.0 master meter systems per 1,000 accounts. Texas alone comprised almost 85% of the expected population in the Southwest region. It should be noted that although high correlation was found in the data for Texas, the estimate of master meters for the state was based on a small number of total accounts since several large companies did not respond. The lowest number, and concentration, was found in New Mexico with 421 systems or 1.4 per 1,000 accounts. The other three states all had concentrations higher than 2.5 systems per 1,000 accounts, well above the average for the other four regions.

For the entire Southwest region, 46,513 master meter systems were expected or 8.4 systems per 1,000 accounts. This number was over half of the national estimate of 80,915. The concentration was almost five times that of the national concentration, 10 times that of the Southern region, and over 4 times that found in the Western region.

5.5.6 National Estimate

The state-by-state estimates provided above were summed, by region, to produce the nationwide estimate of 80,915 master meter systems for the entire country. This estimate corresponded to a concentration of 1.8 master meter systems per 1,000 accounts for the nation. As shown in Table 5-2, for each state, regional, and national estimate, a confidence interval indicating the reliability of each estimate was generated. Discussion of these confidence intervals and methodology for computing them is presented in the following sections.

5.6 CONFIDENCE OF THE ESTIMATES

Since almost all of the state estimates were based on samples of utility companies in each state, variability in these estimates was present. Different samples of companies would have generated different estimates. Therefore, it was necessary to provide both an upper and lower limit on each state's expected population of master meter systems. This section discusses the technique for calculating variability in the state, regional and national estimates.

5.6.1 Confidence Intervals for Each State

The calculation of each state's confidence interval was predicated on knowledge concerning the variability of the ratio of master meter systems to total accounts in the state. This ratio, $\bar{r} = \frac{x}{Y}$, existed for each utility company responding in the state and was expressed, for the utility company in each state as $r_i = \frac{x_i}{y_i}$. The variability in estimating any state's estimate increased if there was significant variability among the ratios of each reporting utility company. Note that $x = \sum_{i=1}^{n} x_i$ and $y = \sum_{i=1}^{n} y_i$.

Other factors affecting the variability of $\bar{r}$, the average ratio, included:

- Variability in the number of master meter systems and the total number of accounts from one utility company to another
- The correlation between total accounts and master meter accounts.
- The fraction of utility companies responding and the absolute number of utility companies responding.
- The total number of gas accounts in the state.

The variability in this ratio $\bar{r}$ was designated as the standard error of the estimate $\bar{r}$, $\sigma_{\bar{r}}$. To determine the standard error of the estimate of the expected number of master meters in the state, denoted $\sigma_{\hat{x}}$, it was necessary to calculate the following equation:

$$\sigma_{\hat{x}} = \sqrt{Y^2 \cdot \left(1 - \frac{n}{N}\right) \cdot \left(\frac{x}{y}\right)^2 \cdot \left(\frac{Sx^2}{\bar{x}^2} + \frac{Sy^2}{\bar{y}^2} - \frac{2\rho SxSy}{\bar{x}\,\bar{y}}\right) / n} \qquad (3)$$

where Y is the total number of gas accounts in the state

$S_x = \sqrt{\sum_{i=1}^{n} (x_i - \bar{x})^2 / (n - 1)}$ is the standard deviation of master meter accounts in the sample,

$S_y = \sqrt{\sum_{i=1}^{n} (y_i - \bar{y})^2 / (n - 1)}$ is the standard deviation of total accounts in the sample,

$$\rho = \frac{\left(\sum_{i=1}^{n} (x_i y_i) - \left(\sum_{i=1}^{n} x_i\right)\left(\sum_{i=1}^{n} y_i\right)/n\right)/(n-1)}{S_x \cdot S_y}$$

is the correlation between the number of master meter accounts and total accounts in the sample,

$\bar{X} = x/n$ is the average number of master meters per utility company in the sample,

$\bar{Y} = y/n$ is the average number of total accounts per utility company in the sample,

n is the number of utility companies in the sample,

N is the total number of utility companies in the state

Having determined the variability in the estimate, a 95% confidence interval on the estimate, $\hat{X}$, was computed as:

$$\hat{X} \pm 1.96\ \sigma_{\hat{X}} \qquad (4)$$

The multiple of $\sigma_{\hat{X}}$, 1.96, corresponded to the multiple of standard deviations for 95% of the area under the normal (bell shaped) curve. Although the population of master meters may not be normally distributed, the distribution of population estimates derived from samples is normally distributed. The meaning of the confidence interval is that if 100 samples of size n were taken from a population of N utility companies, 95 out of 100 would result in confidence intervals about $\hat{X}$ that contain the true total of master meter systems.

Table 5-2 presents confidence intervals, where possible, for each state estimate. No variability about the estimate $\hat{X}$ was shown for Connecticut, Alaska, and Oregon since only one utility company provided data and thus, the standard deviations and correlations necessary to compute (4) had no meaning. Maine, Vermont, Delaware, the District of Columbia, Idaho, and Utah did not show variability about the estimate since these states were either known to possess no master meters or had been sampled completely.

In general, those states with only a small fraction of utility companies in the sample and/or low correlations between master meter accounts and total accounts showed wide variability about the estimate. If, however, the ratio of master meter accounts to total accounts did not vary widely from utility company to utility company or a high fraction of the companies in the state had been sampled, then the confidence interval covered a narrower

band about the estimate.

5.6.2 Confidence Intervals for Regional and National Estimates

Looking at the interval estimates, wide variability in the estimate for the entire Southwest and Western regions was evident. These were the two regions where the expected master meter population was greatest. Lower variability was evident in the Eastern and Southern regions.

Two final observations regarding the interval estimates in Table 5-2 should be made. First, (4) defined the interval as symmetric on either side of the estimate. Note that some of the states showed intervals which were skewed to the right of the estimate. This occurred whenever the lower limit of the confidence interval was less than the actual number of master meters in the sample. In those instances, the lower portion of the confidence interval was recomputed based on the actual number in the sample as the minimum value.

The second observation is that although regional estimates were the sum of the state estimates and national estimates were the sum of the regional estimates, confidence limits for the regional and national estimates were less .than the sum of the individual limits. In other words, the standard error of the estimate for a region is smaller than the sum of the individual state standard errors. Regional variability was computed as:

$$\hat{\sigma}_{\bar{x}\ \text{region}} = \sqrt{\hat{\sigma}^2_{\bar{x}_1} + \cdots + \hat{\sigma}^2_{\bar{x}_n}} \qquad (5)$$

where n is the number of states in the region

The concept displayed by (5) applied equally to the national interval estimate constructed from regional intervals. This observation was also intuitively pleasing since one is less likely to believe that all 50 states exceed the upper limit of their respective intervals than only one state exceeding the upper limit of its interval.

Nationally, the **95%** confidence interval estimate on the population was between **64,738** and **101,901**, with an expected total of **80,915**. It should be emphasized, however, that this estimate was predicated on the assumptions indicated earlier. If the unsampled companies in each state had an inordinately high or low density of master meters far different from the sample, then these limits would widen and in fact the actual estimate would change. One is never 100% confident unless one thoroughly samples the population. Homogeneity of the elements of a population is an assumption which is difficult to prove otherwise.

Chapter 6 provides in-depth analysis of the makeup of the gas utilities in the sample. The characteristics of the master meters they serve are discussed in the Appendix. Again, these observations were made only in light of the sample data and thus, any and all extrapolations to the population must keep this fact in mind.