EVALUATION OF ALTERNATE RATE STRUCTURES
FOR
PHILADELPHIA GAS WORKS

A
Technical Assistance Project
of the
National Regulatory Research Institute
The Ohio State University

Jerome E. Hass, Principal Investigator

Robert H. Smiley, Associate Investigator

Richard T. Curtis, Research Assistant

Graduate School of Business and Public Administration
Cornell University

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The NRRI appreciates the cooperation of the staff of the Philadelphia Gas Works with the contractor in preparing this study.

FOREWORD

The National Regulatory Research Institute (NRRI) was established at the Ohio State University in 1977 by the National Association of Regulatory Utility Commissioners to provide state regulatory commissions with technical assistance and timely, high level policy research on regulatory issues.

This report is one of a series of publications resulting from on-site technical assistance projects supported by the U. S. Department of Energy (DOE) and directed by the NRRI. The purpose of these technical assistance projects is to provide in-depth studies in specific areas of utility regulation as requested by various state regulatory agencies. A concern of the DOE is for the prudent management and conservation of our national energy resources. Accordingly, it is believed that assistance should be provided to state regulatory agencies in husbanding the energy resources within their state boundaries. Funding availability has limited these efforts such that not all state agencies requesting assistance could be served at first. One criterion for selecting a particular state assistance project was the potential for that project to possibly provide guidance to other regulatory agencies with similar or related problems. It is with that thought in mind that the results of several of the individual state technical assistance projects are being published and made available to others.

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PREFACE

This study of the impacts of alternate rate structures on the customers of Philadelphia Gas Works (PGW) was funded by the National Regulatory Research Institute (NRRI) at Ohio State University as a technical assistance project. The study was designed with the assistance of personnel from PGW and PGW provided data and guidance.

The principal investigator was Jerome E. Hass, Professor of Managerial Economics and Finance at Cornell University's Graduate School of Business and Public Administration. Professor Robert H. Smiley, Associate Professor of Economics, assisted in the marginal cost pricing portion of the project and provided guidance throughout the project. Richard Curtis was our very competent and all-purpose research assistant.

We are grateful to Dr. Douglas N. Jones and Audeen Walters from NRRI for their support and encouragement and to the personnel at Cornell's Graduate School of Business and Public Administration, Word Processing Center, for their patience and fortitude in transforming our drafts into polished pieces.

I. INTRODUCTION

Philadelphia Gas Works

A. PGW and the City of Philadelphia.

Philadelphia Gas Works (PGW) is a municipally owned and operated local distribution company serving the City of Philadelphia. The company purchases, stores, manufactures and distributes gas for the residents of the city and is the only natural gas distribution company within the city limits.

Although PGW is truly a municipal operation, it is a separate entity from the city for administrative and financial purposes. The City of Philadelphia owns all the physical plant which it leases to PGW (at a current rate of $15.5 million per year). The City issues revenue bonds to finance plant and equipment. PGW employs approximately 2700 persons under separate labor contracts and is managed by a five-person Board of Managers employed by Philadelphia Facilities Management Corporation, a non-profit corporation with a board of directors appointed by the Mayor.

PGW's rates, rules and regulations are determined by the Philadelphia Gas Commission, (PGC) a five person Commission made up of two mayoral appointees, two city council appointees and the City controller. The Pennsylvania Public Utility Commission has no jurisdictional authority over the company. The PGC sets rates in a manner that reflects cost of service and provides sufficient cash to meet the operating costs of the company, service its debt, and provide sufficient capital to meet the demands for service placed upon PGW by its customers. Aside from benefiting from the low cost of municipal (tax-free) financing, PGW appears to face the same revenue requirements and regulatory constraints as would a privately-owned gas distribution company.

B. PGW's Demand Profile

PGW is one of the larger distribution companies in the U.S. In 1976, annual sales to ultimate customers of 750 M Therms were approximately 0.5 percent of total sales in the country. Revenue share was closer to 1.5 percent of total industry revenue.

Exhibit I-1 displays the various customer classes for PGW. Two customer characteristics are particularly important: the first is the importance of residential load, constituting approximately 77 percent of sales over the year, and the second is the importance of heating load, comprising 76 percent of total annual load and 88 percent of the peak month load. Thus PGW has only a small commercial and industrial load and, because of its high fraction of temperature-sensitive load, has a ratio of peak-to-trough sendout of almost 10-to-1 in a year with a severe winter day, as depicted in Exhibit I-2.

PGW serves approximately 340 thousand residential units with heating and another 180 thousand residential units without heating. While there is substantial residential electric and fuel oil heating and cooking in the city, reflecting both the age of the city and the prohibition of replacement residential gas heating units from November 1973 to April 1978, data taken directly from the Bureau of Census 1975 Housing Survey shows a clear predominance of gas heating and cooking for city residences:

Exhibit I-1. Customer Profile

Load Type and Customer Class	Current Rate Schedule 1/	Sales 7/1/76 - 6/30/77 Bcf Peak Month	Bcf Trough Month	Bcf Yearly Total	Percentage Peak Month	Percentage Trough Month	Percentage Yearly Total
I. Non-Heating							
A. Residential	GS 2/ 3/	0.59	0.39	6.50	4.7	15.0	8.8
B. Commercial & Industrial-Firm	GS 2/ 3/	0.59	0.37	5.52	4.7	14.4	7.5
C. Interruptible	73-100% GS 2/ 5/	0.29	0.43	5.06	2.3	16.4	6.9
D. Municipal	$2.215/mcf 5/	0.06	0.03	0.39	0.5	1.1	0.5
E. Housing Authority	$3.015/mcf 5/	0.01	*	0.06	0.1	0.1	0.1
Total Non-Heating 4/		1.54	1.23	17.53	12.3	47.0	23.8
II. Heating							
A. Residential	GS 2/ 3/	9.20	1.18	47.41	73.5	45.1	64.4
B. Commercial and Industrial	GS 2/ 3/	0.97	0.08	4.44	7.8	3.2	6.0
C. Municipal	$2.215/mcf 5/	0.29	0.04	1.45	2.3	1.5	2.0
D. Housing Authority	$3.015/mcf 5/	0.52	0.08	2.88	4.1	3.2	3.9
Total Heating 4/		10.99	1.38	56.12	87.7	53.0	76.2
Total Sales 4/		12.53	2.61	73.66	100.0	100.0	100.0

1/ All rates subject to raw material adjustment.
2/ GS Rate Schedule (per month):

First	200 cubic feet or less	$1.4761
Next	2,200 cubic feet	35.96¢ per 100 cubic feet
Next	2,100 cubic feet	33.12¢ per 100 cubic feet
All Over	4,500 cubic feet	28.60¢ per 100 cubic feet
Minimum charge for heating only		$6.75

3/ Senior Citizen Discount of 20% is available.
4/ Totals may not add due to rounding.
5/ Weighted average of volumes at various rates.

*Less than 0.01

Exhibit I-2. Max-Min Day Sendout Data
(M Therms)

Supply Source	1975 Max	1975 Min	1976 Max	1976 Min	1977 Max	1977 Min
	Calendar Year					
Pipeline Supply	3872	663	4109	720	5916	688
LNG Storage	897	36	1634	8	130	1
Peak Shaving Facilities	—	—	—	—	398	—
Total	4769	699	5743	728	6444	689
Average Temp. on Max Day	23°F		13°F		6°F	
Max/Min Ratio	6.8		7.9		9.4	

Philadelphia Residential Heating and Cooking Fuels

	Heating	Cooking
Gas	62	90
Electric	2	10
Oil	34	0
Other	2	0
	100%	100%

Gas heating and cooking also dominates the Philadelphia Housing Authority projects, which account for four percent of the PGW load.

Two industries dominate PGW's large industrial gas sales: petroleum refining consumes approximately 40 percent of these sales and food processing accounts for another 20 percent. The former sales are made on a temperature-controlled basis while sales to the latter are made on both a firm and interruptible basis.

C. System Gas Supplies and Curtailments

As depicted in Exhibit I-3 PGW is in more-or-less a steady state with respect to consumption. PGW's gas supply pipelines have been in deep curtailment over the past few years, but except in emergency cases this has not resulted in curtailment of PGW's firm industrial load. It is difficult to assess the impact of the curtailment of interruptible loads on the industrial economics of the City, but most curtailed customers are believed to have available alternate fuels and feedstocks; the alternates may be more costly and less convenient than natural gas.

Given the limited capability of its gas supply pipelines to provide service sufficient to meet a "design" winter load, PGW has

Exhibit I-3. Gas Supply Data

(MM Therms)

	1975	1976	1977	1977 cost per MMBtu
Supplier				
TETCO	310	336	333	$1.30
TRANSCO	419	402	386	1.30
Emergency	1	18	20	2.43
Total	731	756	738	1.33
LPG - Air	10	11	12	3.66
SNG-Oil	2	7	21	2.31
Total	743	774	771	1.39
Average Cost per MMBtu	$1.07	$1.22	$1.39	
Heating Degree Days	4,411	4,927	4,813	

had to develop alternate sources to meet its potential worst winter responsibilities. To that end it has

i) contracted with its pipeline suppliers to provide storage facilities and winter deliverability therefrom;

ii) developed a substantial LNG storage-regasification facility, capable of storing up to four Bcf of gas, with liquefication capacity of 26 MMcfd and a sendout capacity of 500 MMcfd; the sendout capability is approximately 75 percent of PGW's experienced maximum daily sendout;

iii) constructed a new substitute natural gas (SNG) naptha plant to replace its old and "odoriferous" high-BTU oil gas facility for peak-shaving; the new plant has a daily sendout capacity of approximately 10 percent of PGW's experienced maximum daily sendout.

iv) provided LPG-air peaking facilities that have a sendout capacity equal to approximately 4 percent of the experienced maximum daily sendout;

v) undertaken emergency gas purchases.

As shown in Exhibit I-3, these supplemental supplies and delivery capability are expensive compared to "system" gas from their pipleline suppliers. The LNG storage, although using system gas, is also expensive when the cost of the liquefication-regasification facilities are amortized over the anticipated volumes and the 16-18 percent fuel consumption of that system is factored into its cost calculus.

The outlook for PGW is for more of the same. Five year projections, made annually by the company, indicate an increasing importance of temperature-sensitive load and the consequent need for storage and peak-shaving capacity. A graphical summary of the most recent set of projections is shown in Exhibit I-4.

PGW SUPPLY - DEMAND PROJECTION

(ASSUMING REOPENING OF PRIORITY #1 & #2 SALES CATEGORIES)

CHART 2

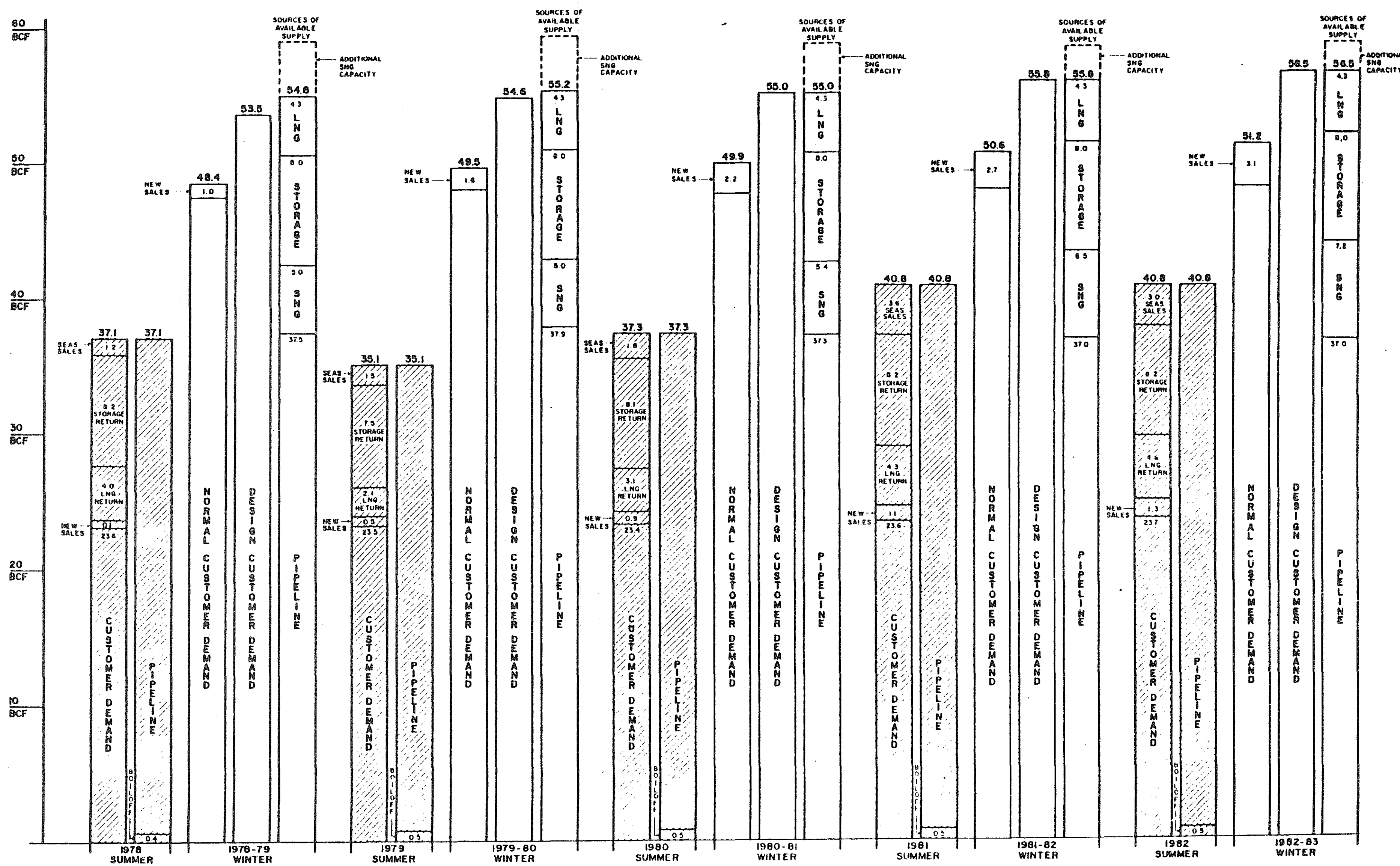


Exhibit I-4

D. Current Rate Structure

PGW's current rate structure is the traditional declining block rate structure for all but its municipal and public housing authority customers. More than 85 percent of its customers fall directly under its General Services rate schedule, described in Exhibit 1; its interruptible rates are discounted off the GS schedule.

One relatively unique aspect of its rate structure is its Senior Citizen Discount of 20 percent for all residential use by customers over age 65 who apply. This discount is used extensively; approximately 15 percent of all residential billings are discounted.

II. ALTERNATE RATE STRUCTURES AND THEIR IMPACT

A. Rationale for Alternate Rate Structures

PGW's current rate structure is the traditional declining block structure predominant in the public utility industry. In recent years such a structure has been called into serious questions on two counts: first, with the rapid increase in the overall cost of electricity and gas service, the impact on that portion of the population of limited means has been substantial, and various groups representing those near or below the poverty level have argued for rate structures that shift more of the overall cost of service for the system to those of greater means. These petitions usually call for some form of "lifeline" rate structure, characterized by a low fixed fee and a low rate for the first block of monthly consumption. Given an overall revenue requirement consistent with a just and reasonable rate, the imposition of such a structure necessarily means that a higher rate must be placed on the remaining block or blocks in order to meet the overall revenue requirement of the system.

Unlike the traditional declining block structure, the lifeline rate structure is "inverted," with the tail blocks having higher charge per unit than the lifeline volume. Such a rate structure has also been characterized as a "conservation" rate structure, with the increasing rate for larger volumes promoting conservation practices to reduce this "costly" consumption.[1/]

The second criticism lodged against traditional declining block rate structures is that they fail to accurately reflect the cost of service. Traditional structures are usually based upon three assumptions: (1) there is an average cost of purchasing or producing the energy to be charged all customers, with some recognition for economies of scale; (2) there is a set of costs associated with maximum demand, that can be attributed to various customers and differ from customer class to customer class; (3) there is a set of costs that are joint and must be allocated in some fashion. The first of these assumptions has been called into question for both electric and gas utilities: (1) new gas or electricity from a new plant costs more than gas already under contract (flowing gas) or electricity from a partially depreciated facility built in the days before rapid inflation and expensive pollution controls; (2) taking storage and peak-shaving into account, gas costs vary over the year just as the cost of producing electricity varies over the daily load curve as base load facilities are augmented with intermediate plants and peakers.

It is generally recognized that market-based economic efficiency is obtained only if price reflects true cost. Given the aforementioned cost difference between historic (embedded or average) cost and marginal (new supply and/or time of demand) cost, those who argue for efficiency call for a departure from traditional declining block rate structures which are applied in a more-or-less uniform fashion throughout the year; instead they call for structures based on marginal costs and reflecting how these costs change over the load curve.[2/]

It should be pointed out that PGW's current rate structure would likely be judged among the best in the country on the first of the two grounds delineated above. Though the current structure is declining block, there are only three blocks and the rates for successive blocks change very little (see footnote 2 of Exhibit I-1); hence, the existing rate structure declines (in marginal rates) only slightly.[3/]

The raw material adjustment (RMA) charge is based on a 12-month moving average of raw material costs and includes not only purchased gas but also feedstock for the substitute natural gas plant. The SNG plant is operated only in winter and storage and emergency gas cost more than summer gas. These seasonal cost differences are reflected only weakly in the current rate schedule via interruptible and temperature-sensitive rates.

In this section we continue to explore alternate rate structures designed independent of the cost considerations, examining a family of "inverted" rate structures and revenue recovery alternatives and the impact on various customers classes of changing from the existing structure to alternatives. In Section III we explore more fully the marginal cost considerations for PGW and develop a cost-based time-dependent rate structure.

B. General Form of Alternate Rates

The general rate structure form we have chosen to examine is:

	Rate
Fixed Charge	$F/mo.
Block #1 (0 to X Mcf/mo)	$\$R_1$/cf
Tail Block (all over X Mcf/mo)	$\$R_2$/cf

This general rate structure allows variations ranging from a strictly linear form from the origin to a two part rate with fixed charge. See Exhibit II-1 for all the possible inverted structure combinations. Hereafter we denote the upper limit of block #1 (X) as the

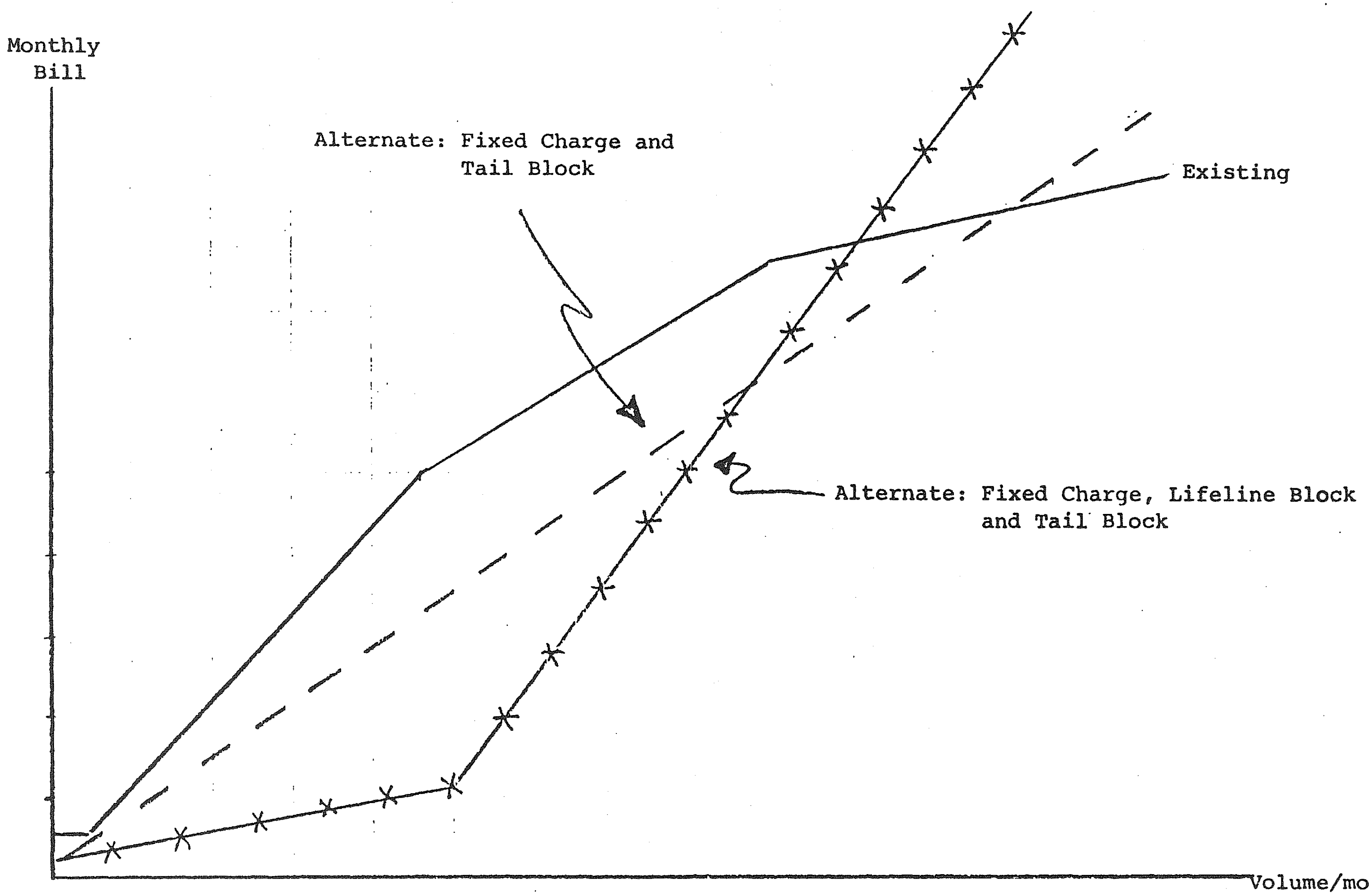


Exhibit II-1. Existing and Hypothetical Alternate Rate Structures "lifeline" volume since, presumably, rate R_1 on the first block is low.

C. Revenue Recovery Alternatives

Switching from the existing rate structure to an inverted alternative results in customers who consume less than the "lifeline" volume per month paying less than they are paying currently. Also customers who consume more than X will pay less on the first X than they did previously. In order to preserve the revenue the company requires to continue operations, these revenue deficits must be recovered over other volumes. These "recovery volumes" may be limited to residential volumes above X only or commercial and industrial volumes only, or a combination of both. Obviously the wider the class of volumes to be used to recover the revenue deficit created by the lifeline portion of the structure, the less onerous the recovery charge.

In examining specific alternate rate structures for PGW we have made three assumptions to facilitate analysis:

1) the volumes of gas sold by PGW to the Philadelphia Housing Authority, to the municipality, and to interruptible commercial and industrial customers will not be considered in the analysis; these customers will not receive the alternate rate and their volumes will not be considered in determining the recovery charge. Historically, the rates charged these customers have been set separately from the "general service" customers and appear to have been influenced by other factors. Excluding these volumes still leaves 85-90 percent of the total PGW volumes subject to the alternate rate structure;

2) senior citizen discounts are assumed to continue at the currently experienced level;

3) demand marginal price elasticity is assumed zero.

The third assumption needs further elaboration. While it is clear that the long run price elasticity of demand for gas is negative, there is considerable uncertainty as to its magnitude and the speed of adjustment.[4/] Furthermore, the impact of the alternate structures reported in this document is not uniform across all customers. For customers with low usage, marginal rates will be lower than currently experienced while for customers with high usage the reverse will prevail; marginal rates may change one way while total bills go in the opposite direction for customers with usage that falls within certain ranges. With all these cross-currents, it is difficult to predict the net change. But it is not likely to be great, at least in the short run; for two reasons: 1) most of the alternatives to be examined are not radically different in marginal rates or total bills from the current situation; 2) there are off-setting factors that tend to cancel each other out.

Finally, insofar as net usage could increase or decrease with the adoption of an alternate rate structure, net revenue requirement also will increase or decrease; insofar as the marginal rate is roughly reflective of marginal cost of providing service, any misspecification of the elasticity will not bias the impact analysis but rather simply net out. Hence we believe a zero elasticity is a workable assumption.

D. Methodology

We assume a uniform rate structure throughout the year, RMA aside. We characterize the annual residential load by three usage patterns: peak, shoulder and trough. Exhibits II-2 and II-3

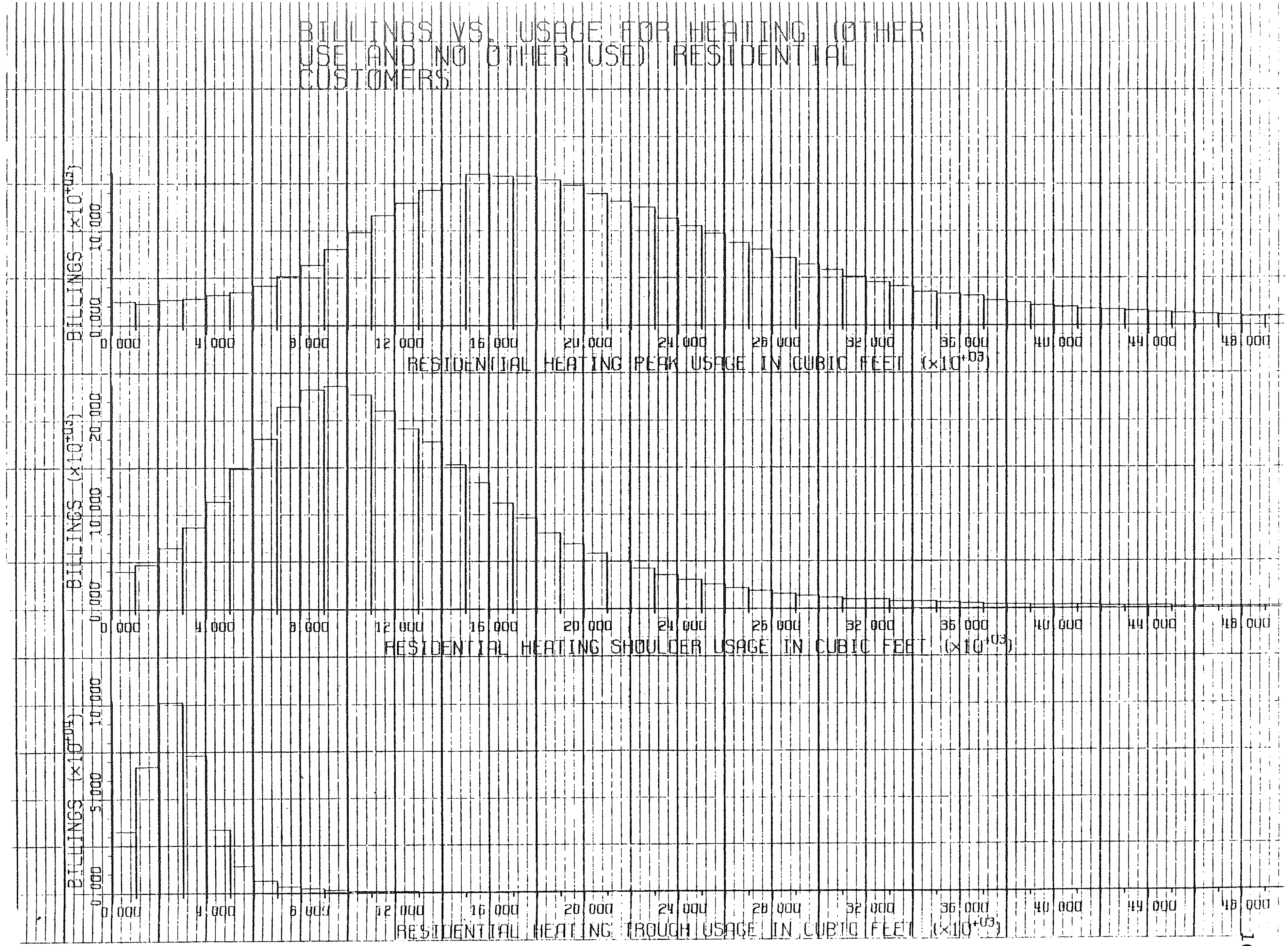

BILLINGS VS. USAGE FOR HEATING (OTHER USE AND NO OTHER USE) RESIDENTIAL CUSTOMERS
BILLINGS (x10^+03)
0.000
10.000
0 000
4 000
8 000
12 000
16 000
20 000
24 000
28 000
32 000
36 000
40 000
44 000
48 000
RESIDENTIAL HEATING PEAK USAGE IN CUBIC FEET (x10^+03)
BILLINGS (x10^+03)
0.000
10.000
20.000
RESIDENTIAL HEATING SHOULDER USAGE IN CUBIC FEET (x10^+03)
BILLINGS (x10^+04)
0.000
5.000
10.000
RESIDENTIAL HEATING TROUGH USAGE IN CUBIC FEET (x10^+03)

Exhibit II-2

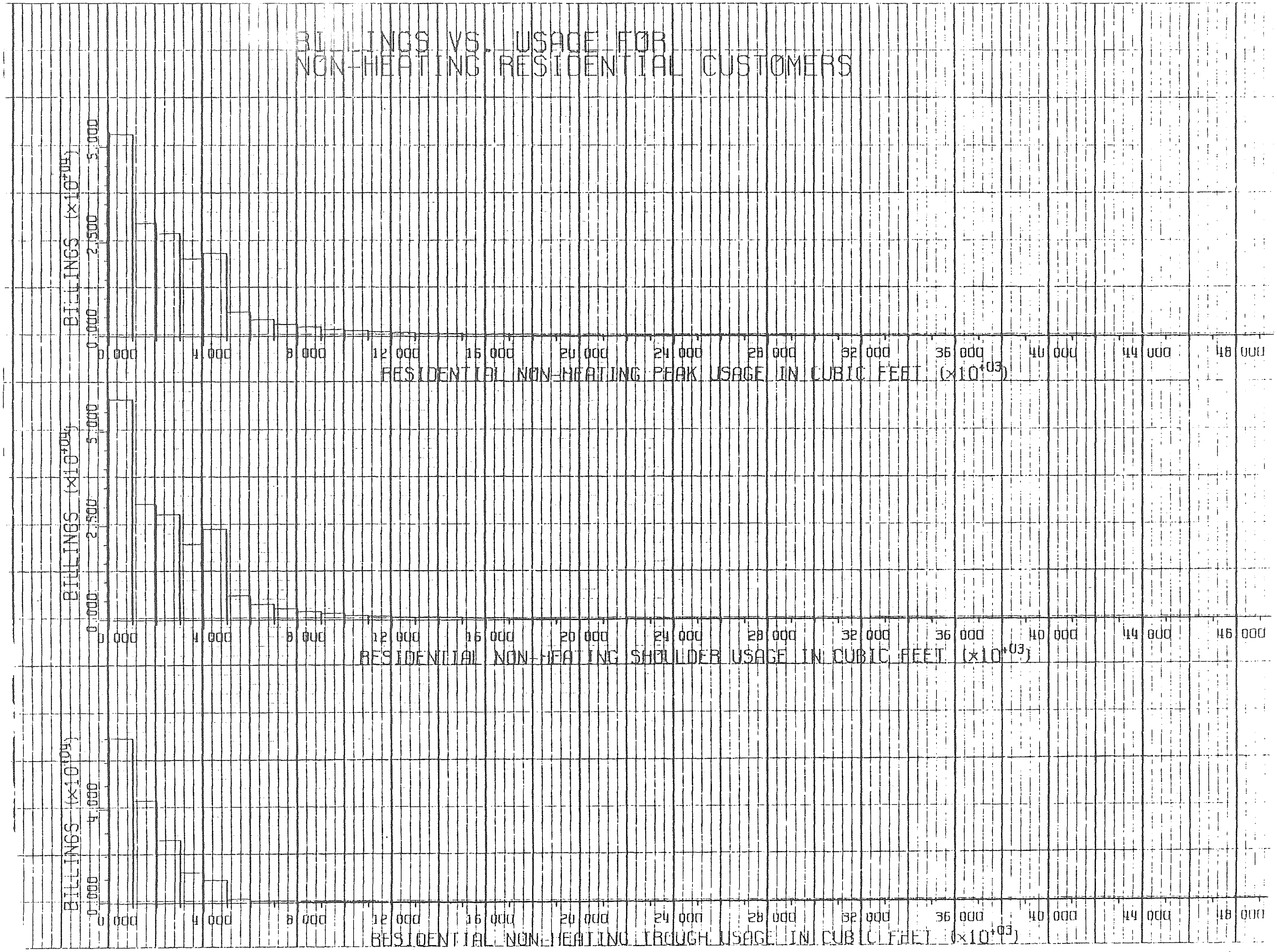

BILLINGS VS. USAGE FOR
NON-HEATING RESIDENTIAL CUSTOMERS
BILLINGS (x10+04)
0.000
2.500
5.000
0 000
4 000
8 000
12 000
16 000
20 000
24 000
28 000
32 000
36 000
40 000
44 000
48 000
RESIDENTIAL NON-HEATING PEAK USAGE IN CUBIC FEET (x10+03)
RESIDENTIAL NON-HEATING SHOULDER USAGE IN CUBIC FEET (x10+03)
4.000
RESIDENTIAL NON-HEATING TROUGH USAGE IN CUBIC FEET (x10+03)

Exhibit II-3

depict the billing profile for months that appear representative of these phases.

Months Chosen for Representative Usage

phase	billing month	total usage (BCF) heating	total usage (BCF) non-heating
peak	March 1978	9.28	1.71
shoulder	April 1978	5.27	1.47
trough	September 1977	1.32	1.30

We have also broken the billing profiles into heating and non-heating residential customers to display the stability of the non-heating consumption over the year in contrast to the extensive shifting of the heating class of residential customers, with their trough profile very similar to that exhibited throughout the year by the non-heating customers. The slightly higher use exhibited by heating customers in the trough is probably attributable to a substantial number of pilot lights not put out for the summer; a pilot light uses approximately .75 mcf per month.

To determine an alternate rate structure we begin by specifying all but one of the parameters of the generalized rate schedule described in Section II-B. For example, F, X, and R_1 are specified. We then proceed to solve for the remaining parameter (R_2 in the example) so as to meet the existing revenue requirement in the following manner:

1) from billing data for the representative months, revenue requirements for the categories of customers to be subject to the alternate rate schedule are obtained (excluding RMA which will be charged under any rate structure).

2) The revenue requirements from (1) are weighted by the number of months to be represented by that usage pattern (e.g., four

months each) to obtain an annual revenue requirement from the target customer class.

3) Given F, X and R_1, the revenues generated by the alternate rate structure on volumes up to X for all the target customers over the year are estimated.

4) The revenue deficiency obtained by subtracting the revenue generation in (3) from the revenue requirement in (2) is then divided by the volumes of gas which will carry a surcharge to recover the revenue deficiency. For those customers subject to the alternate rate structure, the surcharge is the tailblock rate. For those not subject to the alternate structure but chosen to bear part of the burden of revenue recovery, the surcharge is to be added to their existing rates. The procedure is modified in an obvious fashion if the tailblock rate is initially specified and another parameter is left to be determined.

In algebra, this procedure is:

$$\text{Surcharge} = \frac{\text{Revenue Requirement} - \text{Revenue Generation to X}}{\text{Recovery Volume}}$$

E. Impact Analysis

We have taken some care in providing a visual as well as statistical method of ascertaining the impact of various alternative rate structures and revenue recovery schemes on various customers.

We have plotted the line depicting each total monthly bill as a function of volume for each alternate rate structure against the comparable line for the existing rate structure. All affected customers whose total monthly consumption falls to the left of the crossover points benefit in terms of lower monthly bills; those to the right (and those who may not face the alternate structure but be required to pay the surcharge) would face higher monthly bills. Those to the right of lifeline volume almost always face a higher marginal cost than under the existing structure.

To facilitate a further assessment of the impact one merely has to align the billing profile data from Exhibits II-2 and II-3 under any of the bill-vs-volume plots and project the relevant volumes downward; the horizontal axes are chosen to match. Summary statistics are provided in Exhibit II-4.[5/]

F. Specific Alternate Structures and Their Impacts

Rather than generate a large number of alternate structures, we have chosen to examine a limited set of alternatives that span the range of possibilities. The fifteen cases we have chosen to examine are described in Exhibit II-4 and graphed in Exhibits II-5 through II-12. We will refer to these cases by their exhibit numbers as cases 5A through 12B.

Cases 5A and 5B are straightforward inverted rate structures applied to residential users only and with the revenue deficit from the first block made up by charging residential consumers who use more than the lifeline volume. If the lifeline volume is set at 3000 cubic feet and a rate of $1.00 per Mcf is charged on all volumes up to the lifeline volume, the tailblock rate for residential customers required to meet the overall revenue requirement is $3.45 per Mcf, compared to the current tailblock rate of $2.86 per Mcf. Given the low initial and high tailblock rates compared to the existing structure, the breakeven volume is 16,753 cubic feet per month; if a customer consumed less than this volume, the resultant bill would be lower under the alternate than under the existing rate structure. Recent consumption experience taken from bill frequency data indicates that 38.1 percent of all residential heating customers and 97.5 of residential non-heating customers would receive lower bills during the peak period; overall, 58.6

EXHIBIT II-4. ALTERNATE STRUCTURES AND THEIR IMPACT

	REFERENCE EXHIBIT						
	II-5 A	II-5 B	II-6 A	II-6 B	II-7 A	II-7 B	II-8 e/
1. Customer Classes Subject to Alternate a/	R	R	RH	RH	R,C&I	R,C&I	R
2. Customer Classes Subject to Recovery a/	R	R	RH	RH	R,C&I	R,C&I	R
3. Alternate Monthly Rate							
a. Fixed Charge ($)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
b. Initial Block							
1) Rate ($/mcf)	1.00	1.00	1.00	1.00	1.00	1.00	-
2) Upper limit (cf)	3000	8000	5000	10000	5000	10000	-
c. Tail Block Rate ($/mcf) b/	3.45	4.54	3.62	4.77	3.71	4.67	2.85
4. Breakeven Volume c/	16,753	18,304	20,513	21,042	18,842	21,670	NA
5. Percent of Bills Reduced							
a. Residential Heating							
1. Peak	38.1	45.1	54.5	56.6	47.5	58.9	100.0
2. Shoulder	77.7	82.3	87.0	88.0	83.6	88.9	100.0
3. Trough	98.9	99.0	99.2	99.2	99.0	99.2	100.0
b. Residential Non-Heating							
1. Peak	97.5	97.9	NA	NA	98.0	98.4	100.0
2. Shoulder	98.0	98.2	NA	NA	98.3	98.7	100.0
3. Trough	99.3	99.4	NA	NA	99.4	99.5	100.0
c. All Residential							
1. Peak	58.6	63.3	54.5	56.6	64.9	72.5	100.0
2. Shoulder	85.2	88.1	87.0	88.0	89.0	92.5	100.0
3. Trough	99.0	99.1	99.2	99.2	99.1	99.3	100.0

a/ R: All residential
RH: Residential Heating
C&I: All Commercial and Industrial

b/ Tail block rate for existing rate structure is $2.86/mcf.

c/ There may be breakeven volumes at very low levels of consumption. The volume reported here is that uppermost volume. If no relevant crossover occurs, NA (not applicable) is reported. When a range is reported, all bills within that range are lower than they would be under the existing structure.

d/ For Commercial and Industrial customers, GS rate applies with this as surcharge.

e/ The revenue requirement and the bill profile data used in constructing the alternate rate structures were slightly inconsistent. This inconsistency has no material effect on the overall results of this study but does, in Case II-8, lead to the "inexplicable" result that everyone is better off under this case. If the inconsistency were corrected, the tail block rate would be slightly higher and high volume customers would be worse off.

Note: All cases examined herein are based on equal weights for the representative peak, shoulder and trough months. A 5-4-3 weighting scheme produced only slightly different results, which are available upon request from the principal investigator.

EXHIBIT II-4. ALTERNATE STRUCTURES AND THEIR IMPACT (continued)

	REFERENCE EXHIBIT							
	II-9 A	II-9 B	II-10 A	II-10 B	II-11 A	II-11 B	II-12 A	II-12 B
1. Customer Classes Subject to Alternate a/	R	R	R	R	RH	RH	R,C&I	R,C&I
2. Customer Classes Subject to Recovery a/	R,C&I	R,C&I	R	R	RH	RH	R,C&I	R,C&I
3. Alternate Monthly Rate								
a. Fixed Charge ($)	1.00	1.00	5.00	5.00	5.00	5.00	5.00	5.00
b. Initial Block								
1) Rate ($/mcf)	1.00	1.00	1.50	1.50	1.50	1.50	1.50	1.50
2) Upper limit (cf)	3000	3000	3000	8000	5000	10000	5000	10000
c. Tail Block Rate ($/mcf) b/	2.82 d/	3.44 d/	2.75	3.32	2.97	3.62	2.97	3.48
4. Breakeven Volume c/	NA	38,179	2,025	2025-28396	2025-51429	2025-25878	2025-55063	2025-29420
5. Percent of Bills Reduced								
a. Residential Heating								
1. Peak	100.0	91.0	98.5	77.0	94.9	71.0	95.6	79.0
2. Shoulder	100.0	97.7	97.2	92.2	96.1	90.6	96.2	92.6
3. Trough	100.0	99.7	69.9	69.4	69.6	69.3	69.7	69.4
b. Residential Non-Heating								
1. Peak	100.0	99.5	53.4	52.4	NA	NA	53.1	52.5
2. Shoulder	100.0	99.5	51.8	50.9	NA	NA	51.6	51.0
3. Trough	100.0	99.7	32.1	31.7	NA	NA	32.0	31.7
c. All Residential								
1. Peak	100.0	93.9	82.9	68.5	94.9	71.0	80.9	69.9
2. Shoulder	100.0	98.4	80.5	77.0	96.1	90.6	79.8	77.3
3. Trough	100.0	99.7	57.3	56.9	69.6	69.3	57.2	56.9

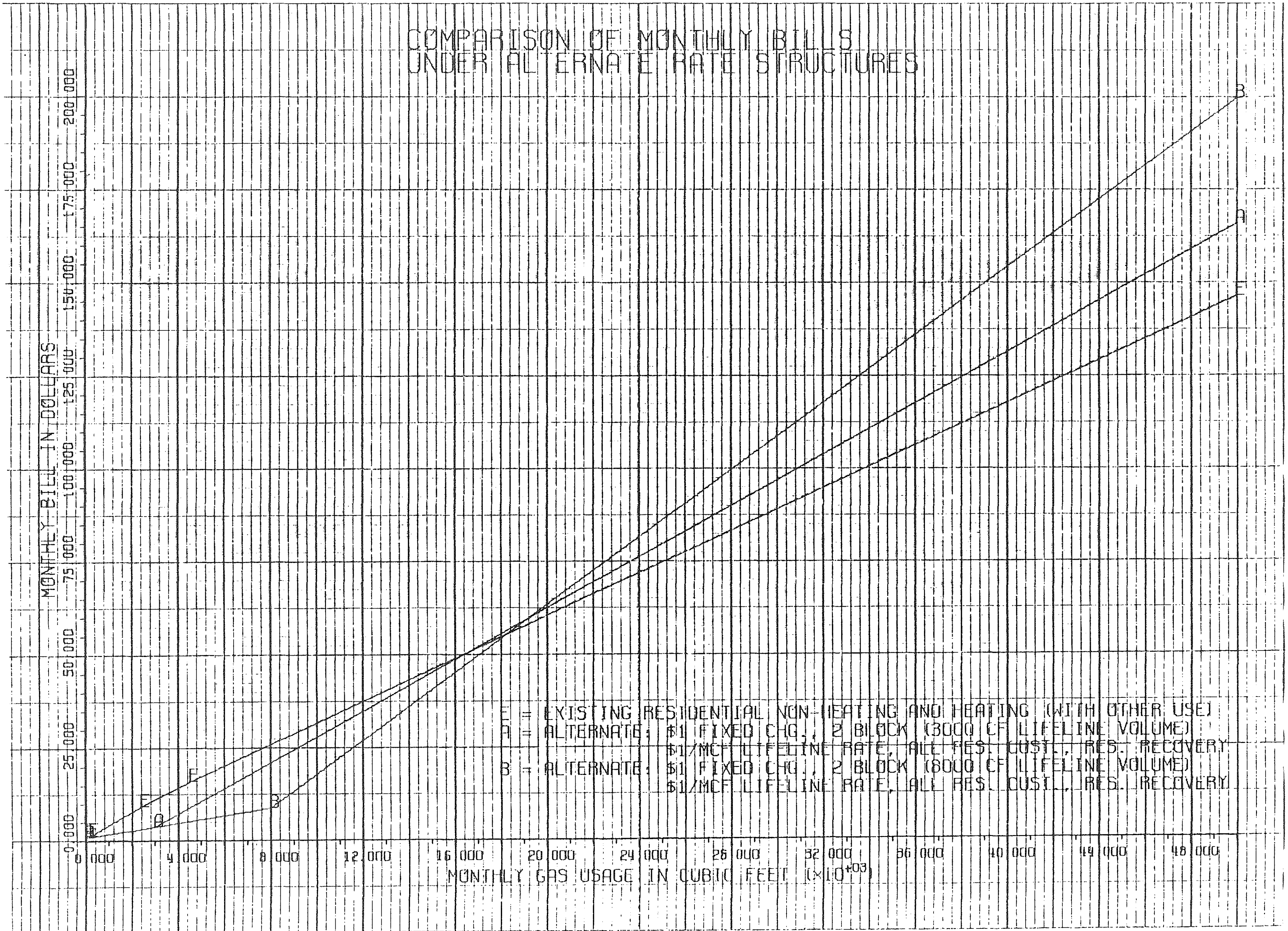
a/ R: All Residential
RH: Residential Heating
C&I: All Commercial and Industrial

b/ Tail block rate for existing rate structure is $2.86/mcf.

c/ There may be breakeven volumes at very low levels of consumption. The volume reported here is that uppermost volume. If no relevant crossover occurs, NA (not applicable) is reported. When a range is reported, all bills within that range are lower than they would be under the existing structure.

d/ For Commercial and Industrial customers, GS rate applies with this as surcharge.

Note: All cases examined herein are based on equal weights for the representative peak, shoulder and trough months. A 5-4-3 weighting scheme produced only slightly different results, which are available upon request from the principal investigator.



COMPARISON OF MONTHLY BILLS
UNDER ALTERNATE RATE STRUCTURES
MONTHLY BILL IN DOLLARS
0.000
25.000
50.000
75.000
100.000
125.000
150.000
175.000
200.000
0.000
4.000
8.000
12.000
16.000
20.000
24.000
28.000
32.000
36.000
40.000
44.000
48.000
MONTHLY GAS USAGE IN CUBIC FEET (×10+03)
E = EXISTING RESIDENTIAL NON-HEATING AND HEATING (WITH OTHER USE)
A = ALTERNATE: $1 FIXED CHG., 2 BLOCK (3000 CF LIFELINE VOLUME)
$1/MCF LIFELINE RATE, ALL RES. CUST., RES. RECOVERY
B = ALTERNATE: $1 FIXED CHG., 2 BLOCK (8000 CF LIFELINE VOLUME)
$1/MCF LIFELINE RATE, ALL RES. CUST., RES. RECOVERY

Exhibit II-5

percent of residential bills would be reduced during the peak period. By examining Exhibit II-5 it can be seen that residential customers using more than approximately 34 Mcf per month would be paying an additional $10 or more per month while those customers using 3 Mcf per month would have their bills decreased from about $11 to about $4.

Alternate 5B differs from 5A only in that it extends the lifeline volume from 3 Mcf to 8 Mcf. This forces the tailblock rate to $4.54 and raises the breakeven volume to over 18 Mcf, greatly extending the dollar benefits for those who consume less than 19 Mcf per month while substantially raising the bills of those who consume large volumes.

Cases 6A and 6B narrow the focus of the alternate rate by applying it only to residential heating customers, with recovery from the residential heating class. With a lifeline volume of 5 Mcf slightly more than half (54.4%) of all peak residential heating customers would experience a lower bill. Doubling the lifeline volume has little effect on the number of customers that would experience lower bills; the added savings on lower volumes are offset by the higher cost of higher volumes for those with consumption around 21 Mcf per month.

Cases 7A and 7B expand the focus of the inverted rate structure by applying to to all customers currently under PGW's GS rate schedule - all residential customers and all firm commercial and industrial customers. Since commercial and industrial customers have higher average volumes per billing the effect on residential

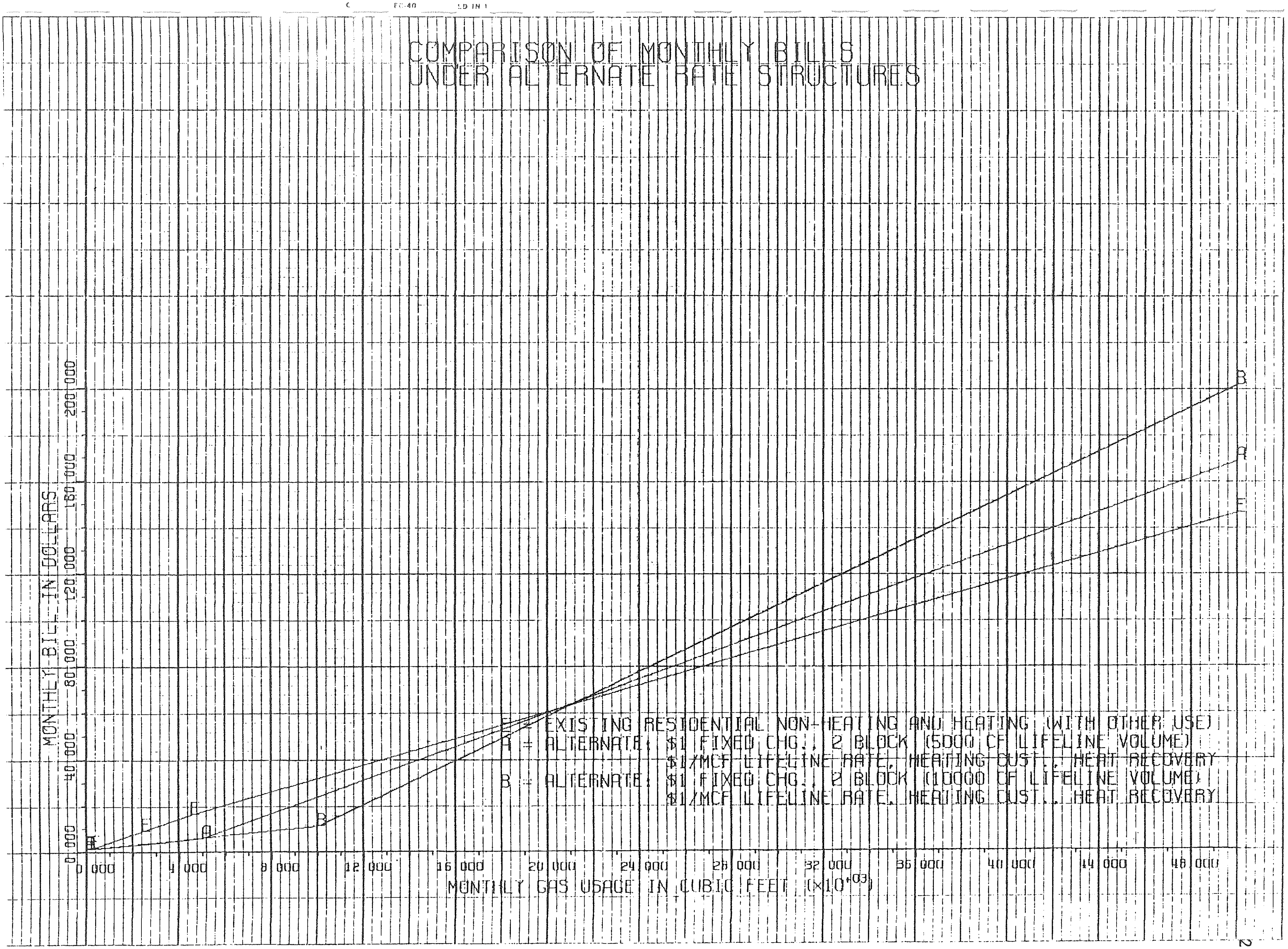

COMPARISON OF MONTHLY BILLS
UNDER ALTERNATE RATE STRUCTURES
MONTHLY BILL IN DOLLARS
0.000
40.000
80.000
120.000
160.000
200.000
E = EXISTING RESIDENTIAL NON-HEATING AND HEATING (WITH OTHER USE)
A = ALTERNATE: $1 FIXED CHG., 2 BLOCK (5000 CF LIFELINE VOLUME)
$1/MCF LIFELINE RATE, HEATING CUST., HEAT RECOVERY
B = ALTERNATE: $1 FIXED CHG., 2 BLOCK (10000 CF LIFELINE VOLUME)
$1/MCF LIFELINE RATE, HEATING CUST., HEAT RECOVERY
0.000
4.000
8.000
12.000
16.000
20.000
24.000
28.000
32.000
36.000
40.000
44.000
48.000
MONTHLY GAS USAGE IN CUBIC FEET (×10^03)

Exhibit II-6

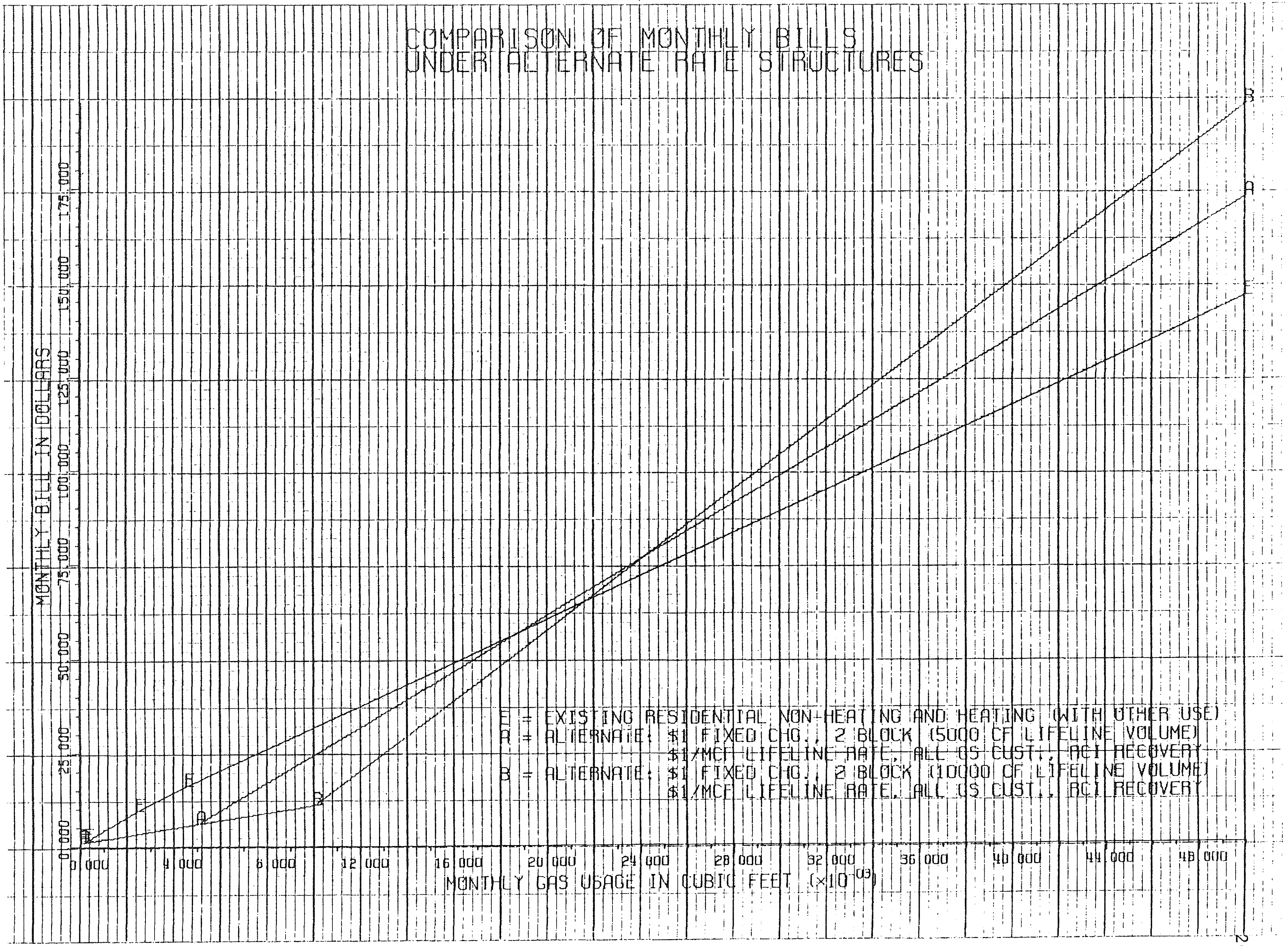

COMPARISON OF MONTHLY BILLS
UNDER ALTERNATE RATE STRUCTURES
MONTHLY BILL IN DOLLARS
0.000
25.000
50.000
75.000
100.000
125.000
150.000
175.000
MONTHLY GAS USAGE IN CUBIC FEET (×10^03)
0.000
4.000
8.000
12.000
16.000
20.000
24.000
28.000
32.000
36.000
40.000
44.000
48.000
E = EXISTING RESIDENTIAL NON-HEATING AND HEATING (WITH OTHER USE)
A = ALTERNATE: $1 FIXED CHG., 2 BLOCK (5000 CF LIFELINE VOLUME)
$1/MCF LIFELINE RATE, ALL GS CUST., RCI RECOVERY
B = ALTERNATE: $1 FIXED CHG., 2 BLOCK (10000 CF LIFELINE VOLUME)
$1/MCF LIFELINE RATE, ALL GS CUST., RCI RECOVERY

Exhibit II-7

customers, compared to Cases 5A and 5B, is to lower the tailblock rate and raise the breakeven volume for any given lifeline volume.

Case 8 demonstrates the effect of applying a single block rate (the first block is also the tailblock) to all residential customers, with recovery from all residential customers. An unusual situation develops under this scheme: the alternate rate structure generates sufficiently greater revenue than the existing rate structure over the lower volumes of the billing range to permit the tailblock rate to be slightly less than the tailblock rate under the existing structure.

Cases 9A and 9B are similar to cases 5A and 5B but extend the recovery to commercial and industrial customers as well as residential customers. As a result, all the residential customers benefit in the "A" case. In the "B" case the breakeven volume increases from about 18 Mcf to 38 Mcf, resulting in 94 percent of all residential units receiving lower bills than they would under the existing rate structures. Commercial and Industrial customers are charged, in addition to their existing bills, \$2.82 per Mcf in the "A" case and \$3.44 in the "B" case.

It is, of course, possible to combine conditions in the above cases to achieve a middle-ground. For example, it is probably infeasible to surcharge commercial and industrial customers anything near the charges in Cases 9A and 9B. It may be, however, feasible to impose a modest surcharge; this would reduce the tailblock rates and increase the breakeven volumes from those estimated in Cases 5A and 5B.

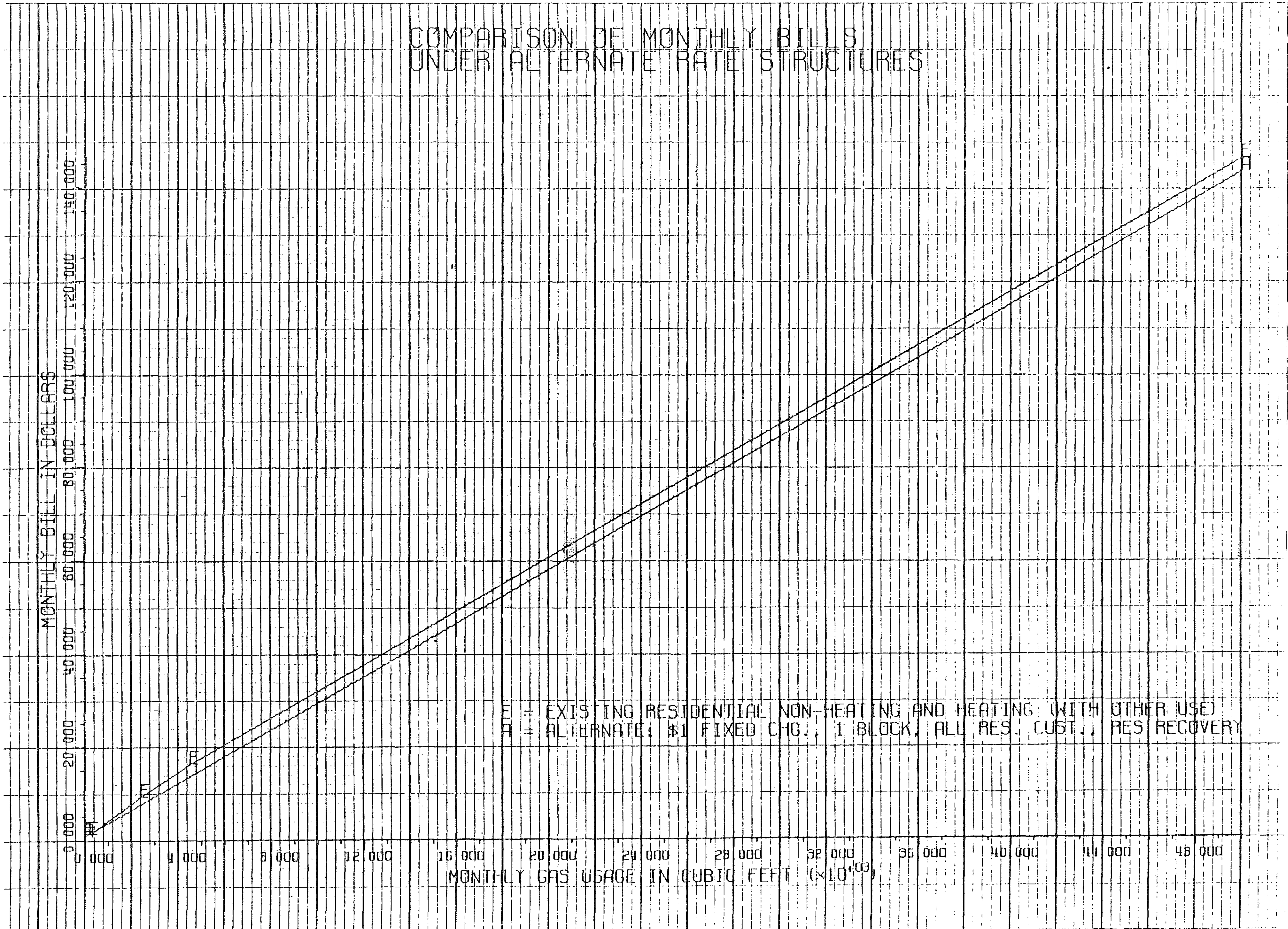
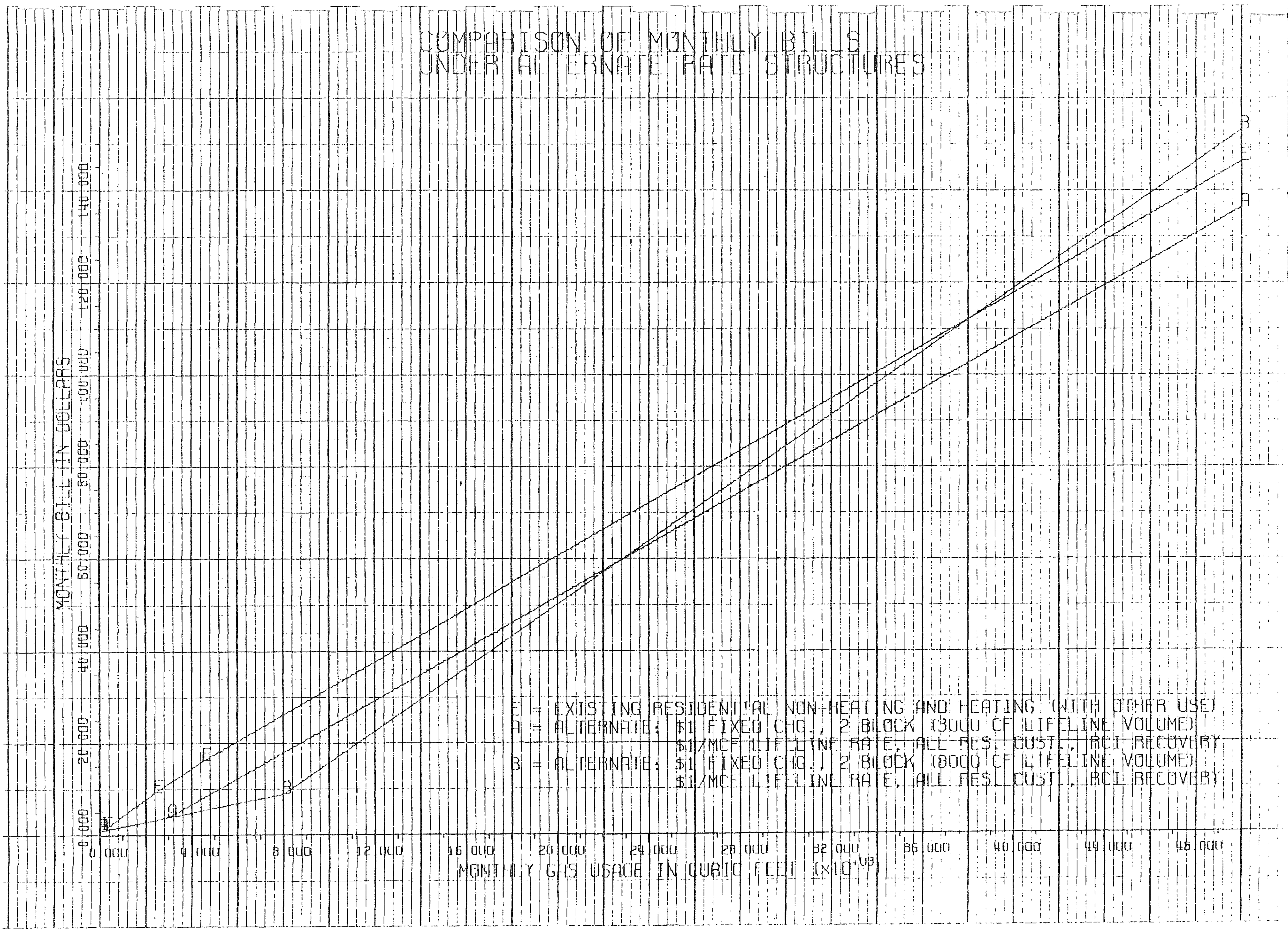

COMPARISON OF MONTHLY BILLS
UNDER ALTERNATE RATE STRUCTURES
MONTHLY BILL IN DOLLARS
0 000
20 000
40 000
60 000
80 000
100 000
120 000
140 000
0 000
4 000
8 000
12 000
16 000
20 000
24 000
28 000
32 000
36 000
40 000
44 000
48 000
MONTHLY GAS USAGE IN CUBIC FEET (x10+03)
E = EXISTING RESIDENTIAL NON-HEATING AND HEATING (WITH OTHER USE)
A = ALTERNATE: $1 FIXED CHG., 1 BLOCK, ALL RES. CUST., RES RECOVERY

Exhibit II-8



COMPARISON OF MONTHLY BILLS
UNDER ALTERNATE RATE STRUCTURES
MONTHLY BILL IN DOLLARS
0 000
20 000
40 000
60 000
80 000
100 000
120 000
140 000
0 000
4 000
8 000
12 000
16 000
20 000
24 000
28 000
32 000
36 000
40 000
44 000
48 000
MONTHLY GAS USAGE IN CUBIC FEET (x10+03)
E = EXISTING RESIDENTIAL NON-HEATING AND HEATING (WITH OTHER USE)
A = ALTERNATE: $1 FIXED CHG., 2 BLOCK (3000 CF LIFELINE VOLUME)
$1/MCF LIFELINE RATE, ALL RES. CUST., RCI RECOVERY
B = ALTERNATE: $1 FIXED CHG., 2 BLOCK (8000 CF LIFELINE VOLUME)
$1/MCF LIFELINE RATE, ALL RES. CUST., RCI RECOVERY

Exhibit II-9

Finally, cases 10, 11, and 12 repeat cases 5, 6, and 7 but use different parameters: the fixed charge is $5.00 rather than $1, an amount closer to that established in a cost of service study currently underway, and the rate for the first block is $1.50 rather than $1.00 per mcf. In Cases 10, 11, and 12 the $5.00 fixed charge with the $1.50 per mcf marginal rate increases the bills for all users with monthly volumes less than 2,025 cubic feet over bills that would prevail under the existing rate structure. Roughly half of the non-heating customers would experience a bill increase while a large fraction of heating customers especially in the peak and shoulder months would experience a reduction in their bills. Also, with the higher fixed charge and initial block rate, the tailblock rates are much lower than those required in Cases 5, 6, and 7. In fact, if the upper limit of the initial block volume is set sufficiently low, than all users with monthly volumes in excess of 2,025 cubic feet would receive a lower bill than under the existing rate structure.

Thus we see that it is possible to reduce the size of monthly bills on residential service by a substantial magnitude, with the number of customers receiving reduced bills depending on the particular parameters chosen for the alternate structure. Whether such an alternate structure and impact will have a positive effect on those customers with lower incomes is the next subject we explore.

G. The Efficacy of Lifeline Rates and Senior Citizen Discounts

The assumption made by those who support lifeline rates and senior citizen discounts is that there is a positive correlation between income and gas consumption and between income and age.

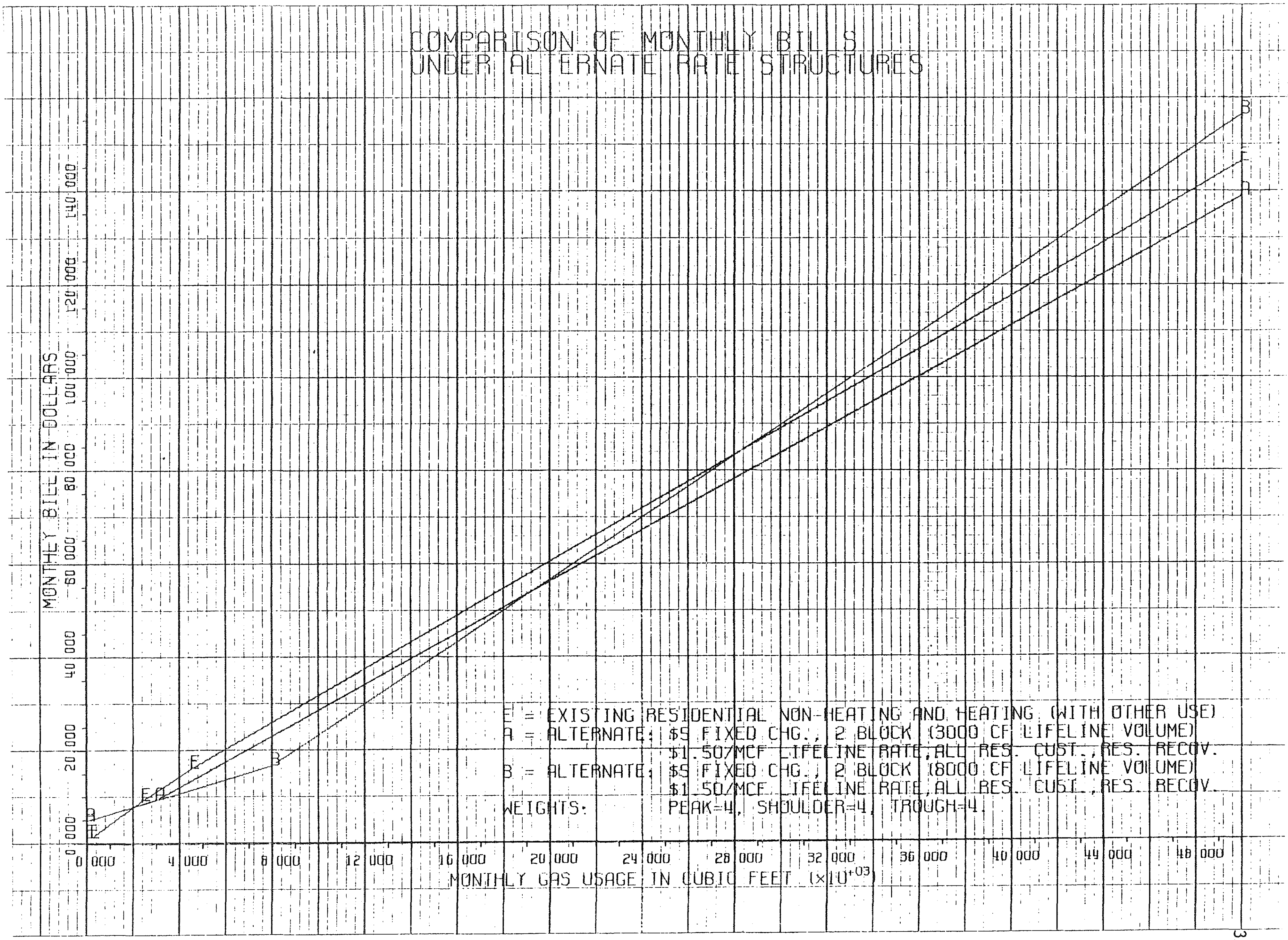


Exhibit II-10

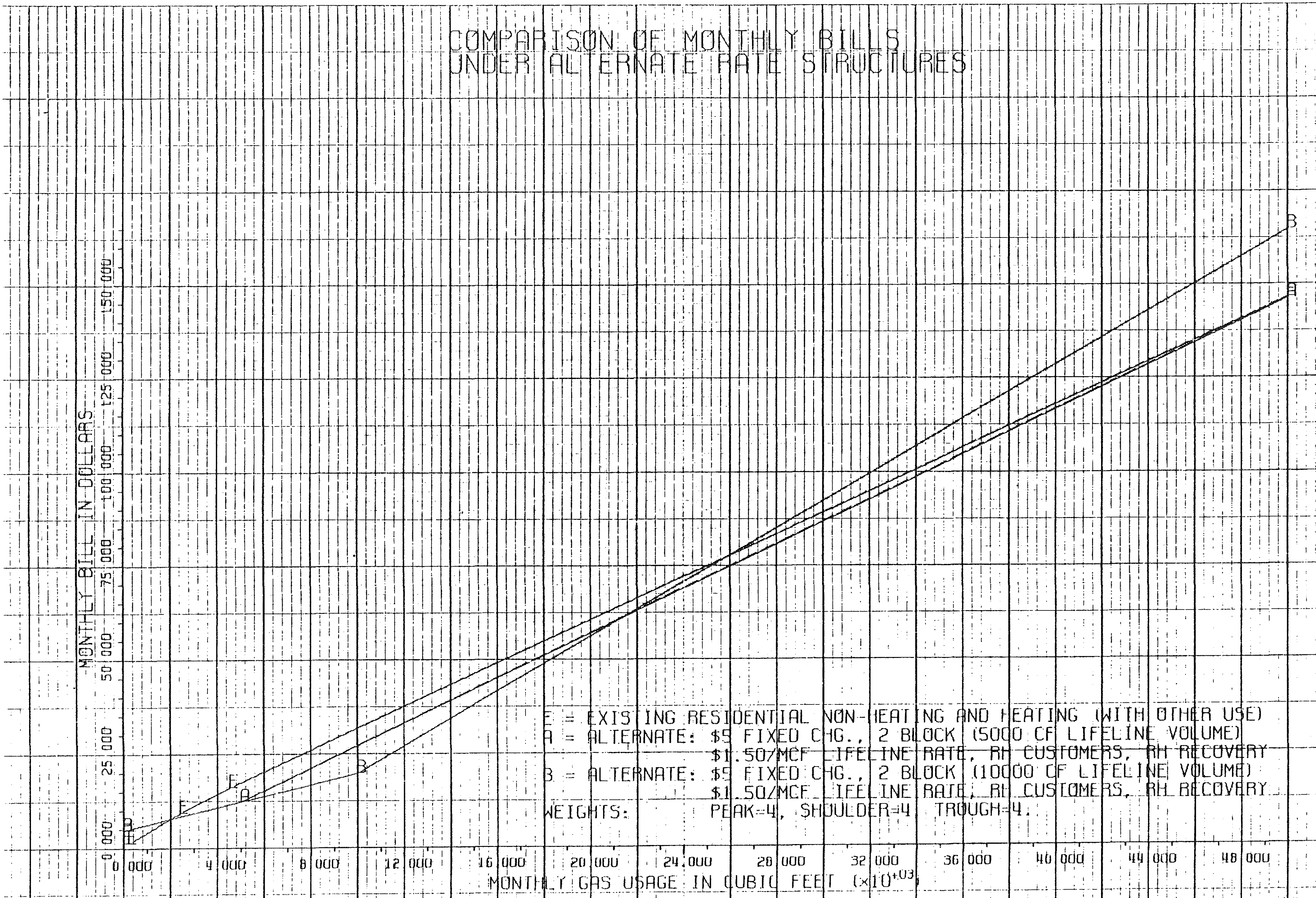


Exhibit II-11

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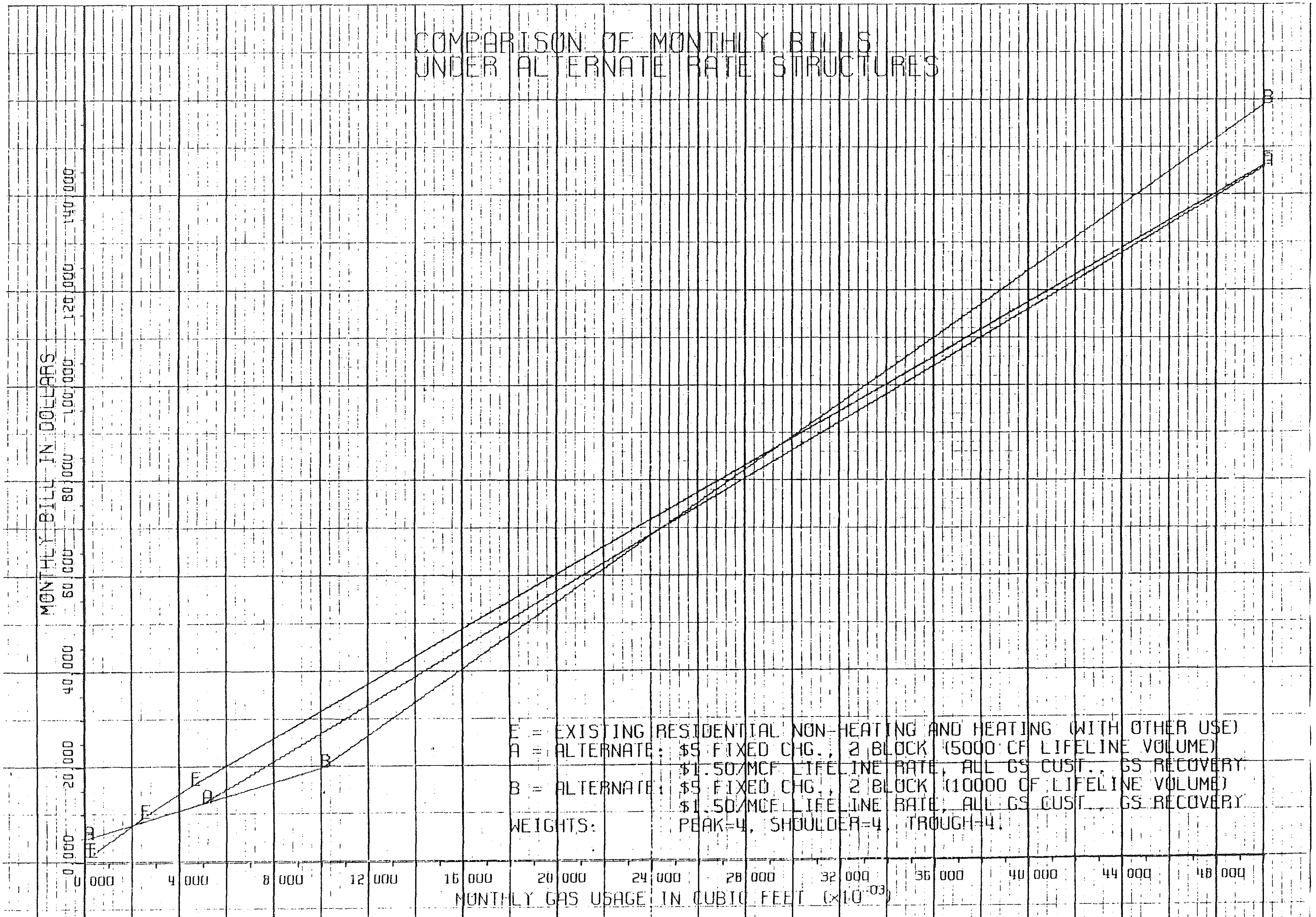

Exhibit II-12

Hence both lifeline rates and senior citizen discounts would tend to reduce monthly bills for a large fraction of that portion of the population with low incomes at, of course, some additional cost to those who are better off.

This assumption is testable if data is available and, in this instance, the 1975 Bureau of Census Housing Survey, which contains this data, included the City of Philadelphia with about a 1-in-100 sample of dwelling units. The 1970 Census also provides some information on age and income.

The 1975 Housing Survey provides data on gas usage, bills, income and age of occupants from 6,021 dwelling units:

Status	Number of Units
Owned Home or Trailer	3394
Rented Unit - Gas Paid For	1100
- Gas Included in Rent	1051
Subtotal	5545
No gas used	215
None of the above	261
Total Units	6021

Depending on whether the "none of the above" are included or excluded from the total, gas is used in between 92 and 96 percent of the dwelling units surveyed.

Exhibit II-13 provides a frequency count of monthly bills by dwelling status. With the one obviously high rental exception, the bill data exhibits some upward bias when compared to company billing data. Using the relative frequency of owned and rental residential units as weights, the weighted average bill from the census data is $22.64 per month; company data on average bills for 1975 is $17.90 per month. This is not unexpected; while the survey was taken

Exhibit II-13. Monthly Gas Cost in 1975 by Dwelling Status
Number of Units and Percent of Total

Average Monthly Bill	Owned Home or Trailer		Rented Unit	
$ 0 - 20.00	1475	(43.5%)	767	(69.7%)
20.01 - 40.00	1622	(47.8%)	275	(25.0%)
40.01 - 60.00	233	(6.9%)	42	(3.8%)
60.01 - 80.00	48	(1.4%)	12	(1.1%)
80.01 - 100.00	11	(0.3%)	3	(0.3%)
100.01 - 120.00	1	(0.0%)	0	
120.01 - 140.00	4	(0.0%)	0	
180.01 - 198.00	0	(0.0%)	1	(0.0%)
	3394	(100.0%)a/	1100	(100.0%)a/
Average Bill	$24.54		$16.77	

a/ May not add due to rounding.

quite evenly over the year, bill overstatement is a natural tendency. There is no reason to believe the bias should be correlated with either usage or income.

We now turn to the relationship between income and gas consumption from the survey data. Exhibit II-14 displays the relationship between average per capita income and usage categories. While renters tend to rely more heavily on gas for cooking and less heavily on gas for heating than owners, within each of the three occupancy classes there is no significant difference in reliance on gas for cooking or heating across per capita income levels.[6/] Poor people rely on gas about as much as rich people for their cooking and heating needs. They are neither more nor less dependent and this data would support the contention that any lifeline rate would help the rich as much or as little as it would help the poor.

Exhibit II-15 displays billing versus income data for dwelling owners and renters who pay their gas bills separately. With some aggregation, the following summary results:

Relative Bill Frequency

Per Capita Income	$0-16	$17-32	$33+	Average Monthly Bill	Sample Size
		A. Owners			
less than $2000	29.3	44.3	26.3	$25.35	645
2000 - 8000	27.2	52.0	20.8	24.20	2247
Above $8000	26.3	51.0	22.7	25.03	502
Overall	27.5	50.4	22.2	24.54	3394
	B. Renters Who Pay for Gas				
less than $2000	53.7	30.5	15.8	$19.36	374
2000 - 8000	60.6	30.5	9.0	15.97	568
Above $8000	63.9	31.0	5.1	13.50	158
Overall	58.7	30.5	10.7	16.77	1100

Exhibit II-14. Per Capita Income vs. Usage Category

Occupancy Class	Per Capita Household Income	Cooking Number	Cooking % of Total Users	Heating Number	Heating % of Total Users	Total Users
Owners:	Less than $200	48	92	41	79	52
	200 - 500	23	92	17	68	25
	501 - 1000	82	92	62	70	89
	1001 - 2000	452	94	327	68	479
	2001 - 4000	1056	91	883	76	1162
	4001 - 8000	995	92	843	78	1085
	8001 - 12000	280	87	250	78	321
	12001 - 16000	106	87	101	83	122
	Above $16000	53	90	46	78	59
	Total	3095	91	2570	75	3394
Renters Who Pay For Gas:	Less than $200	17	94	10	56	18
	200 - 500	18	100	6	33	18
	501 - 1000	85	99	35	41	86
	1001 - 2000	244	97	107	43	252
	2001 - 4000	311	98	158	50	318
	4001 - 8000	244	98	156	62	250
	8001 - 12000	92	99	52	56	93
	12001 - 16000	38	93	23	56	41
	Above 16000	22	92	13	54	24
		1071	97	560	51	1100
Renters With Gas included in rent:	Less than $200	29	91	9	28	32
	200 - 500	16	100	11	69	16
	501 - 1000	90	97	63	68	93
	1001 - 2000	200	97	102	50	206
	2001 - 4000	241	93	104	40	259
	4001 - 8000	222	96	110	48	231
	8001 - 12000	107	96	50	45	112
	12001 - 16000	54	92	22	37	59
	Above 16000	43	100	20	47	43
		1002	95	491	47	1051

Exhibit II-15. Income vs. Average Monthly Bill
(Percent Distribution and Average)

Per Capita Income	Relative Frequencies of Average Monthly Bill a/							Income Class Average
	$0-8	$9-16	$17-24	$25-32	$33-40	$41-60	$60+	
	A. Owners							
less than $200	3.8	19.2	26.9	17.3	23.1	7.7	1.9	$25.96
$200 - 500	4.0	16.0	12.0	8.0	36.0	20.0	4.0	34.16
500 - 1000	12.3	21.4	12.4	27.0	18.0	5.6	3.3	25.38
1000 - 2000	13.5	16.0	22.2	24.7	14.0	7.9	1.9	24.82
2000 - 4000	11.7	14.3	26.8	25.4	12.8	6.8	2.2	24.53
4000 - 8000	11.2	17.4	25.3	26.5	12.5	6.1	1.1	23.84
8000 - 12000	12.8	15.6	25.5	25.3	13.7	5.6	1.5	24.05
12000 - 16000	9.0	12.3	34.4	22.9	10.6	9.8	0.8	25.72
Over $16000	11.9	13.6	18.6	20.3	15.3	10.2	10.2	28.97
Overall	11.6	15.8	25.2	25.2	13.4	6.9	1.8	24.54
	B. Renters Who Pay For Gas							
less than $200	27.8	16.7	16.7	27.8	5.6	5.6	0.0	19.06
$200 - 500	33.3	11.2	11.1	22.2	16.7	5.6	0.0	19.83
500 - 1000	22.1	25.6	17.4	17.4	8.1	7.0	2.3	20.79
1000 - 2000	30.6	26.6	15.5	12.3	8.0	4.8	2.4	18.86
2000 - 4000	38.7	19.5	19.1	11.3	5.4	4.4	1.6	16.34
4000 - 8000	34.0	29.6	16.8	13.6	2.8	2.4	0.8	15.50
8000 - 12000	37.6	25.9	19.4	14.0	2.2	1.1	0.0	13.57
12000 - 16000	46.3	17.1	17.1	9.7	4.8	2.4	2.4	14.90
Over $16000	54.2	12.5	25.0	4.2	4.2	0.0	0.0	10.88
Overall	34.7	24.0	17.5	13.0	5.4	3.8	1.5	16.77

a/ May not add to 100 due to rounding.

Two facts are striking here:

1) the average bill does not vary greatly with per capita income;

2) the variability of bills about the mean is roughly identical for each income class. If anything, there is some indication that lower income users tend to use slightly more gas on average and tend to be at the upper end of the user profile than middle or upper income users, especially in the case of renters who pay their own bills.

This data calls into serious question the efficacy of lifeline rates, especially if the revenue recovery is limited to residential users: the net effect on the poor is likely to be negligible at best or maybe even negative, with the benefits to some of the poor from the lifeline rate being recovered from other poor users through the tail-block charge. Also, non-poor will receive proportionally as large a net benefit, if any, as poor. Hence advocating lifeline rates is not a very effective way of assisting the poor to pay for the increasing cost of energy.

Finally, let us examine the relationship between age and income. PGW offers a 20 percent senior citizen discount to residential customers of age 65 or older who apply. At the present about 15 percent of all residential billings are taking this discount, which is about 60 percent of those apparently eligible, based on the 1975 Housing Survey for Philadelphia:

Potential Percentage of Senior Citizen Discount Billings

	Number	Percent of Total Households
Households with Head 65 or older	1399	23.2%
Households with at least one member 65 or older	1621	26.9%
Households in Survey	6021	100.0%

Turning to the relation between age and income we find only a slight difference in the income distribution of household units with a head age 65 or more, any member age 65 or more, and all members less than 65:

Relative Frequency of Income

per capita income	Age of Head 65 or more	Age of any member 65 or more	Age of all members less than 65
Less than $2000	23.9	23.5	22.4
$2000 - 8000	66.9	67.1	61.0
More than $8000	9.3	9.4	16.6
	100.0	100.0	100.0

This data is very consistent with the 1970 Census data which contained the following data for heads of households:

	Age of Head		
	65 or More	Less than 65	Total
Below Poverty Level	13.5	10.5	11.2
Above Poverty Level	86.5	89.5	88.8
	100.0	100.0	100.0

This data suggests there is very little justification for the senior citizen discount as a means of alleviating the impact of high energy costs on the poor.

In conclusion it can be stated that neither the senior citizen discount nor a lifeline rate structure is an effective method of alleviating the impact of higher energy costs on those with low incomes. While such schemes do help a fraction of those with low income, these subsidies for those receiving the service at a price less than cost must be funded by other users. In PGW's case, with a high proportion of total load being residential, this funding must come largely from other residential units which are headed by elderly or have low incomes in virtually the same proportions as the target population of these schemes. Thus the overall efficacy is virtually zero.

III. A Marginal Cost Based, Time-Dependent Rate Structure

A. Why Should Gas be Priced at Marginal Cost?

Most economists believe that, unless there is some very strong reason to do otherwise, all goods and services should be priced at marginal cost and, in recent years, the call for pricing electricity and gas according to this principle has been steadily increasing. Dr. Paul Joskow (Associate Professor of Economics at the Massachusetts Institute of Technology) stated the case for marginal cost pricing quite eloquently as a witness sponsored by the seven New York Electric Utility Companies in the generic marginal cost pricing case (New York PSC 26806), in a statement that was included by the Commission in its final decision in Case 26806:

> "We can define marginal cost very generally as the cost of society's scarce resources which must be used to produce one additional unit of some commodity or the value of resources that would be saved by producing one less unit of that commodity. As long as our goal is economic efficiency, the notion that prices should be equal to marginal cost is a general economic principle having nothing in particular to do with electricity. The principle derives from the basic operation of an economy where production and consumption decisions are decentralized. Consumers decide how they will divide their incomes among different commodities by looking at the relative prices of these commodities. Prices act as signals to consumers indicating the cost to them of additional consumption of various commodities. To the extent that commodity prices are equal to the marginal social costs of production, these pricing signals indicate simultaneously the cost of commodities to individual consumers and the cost of producing such commodities from the viewpoint of society as a whole. With prices set equal to marginal cost, consumers' decisions regarding the trade-offs associated with the consumption of different commodities are guided by signals which reflect the actual production of these commodities. For example, if the price for some commodity like electricity is set below its marginal cost, consumers will think it is cheaper to purchase an additional unit than it really costs society to produce it. The consumer will then be lead to expand his consumption to the point where the ... value of an additional unit of the commodity is equal to its price. But since the price has been set below the

marginal cost, the value of the last unit of consumption to the consumer is less than what it costs society to produce it. More resources are being devoted to the production of this commodity than is socially efficient."

"There is, I submit, no real argument about whether marginal cost pricing is right or wrong. If our goal is economic efficiency, it is almost definitional that the prices of commodities must reflect the marginal social cost of supplying these commodities."

The case for marginal cost pricing is both simple and extremely forceful: if prices are set at other than marginal costs, consumers are getting incorrect signals regarding the burdens that their consumption places on the rest of society, and they will consume either too much or too little of that service or commodity. Those that do not advocate marginal cost pricing do not disagree with this concern for economic efficiency, but rather express concern about the ability to properly measure marginal costs, the indirect impact of such pricing on long run supply capabilities, the stability of revenues under dramatically changing rates, and the impact of this pricing policy on the welfare and behavior of various customer classes, especially if not adopted uniformly throughout the country.

Decisions regarding the conservation of gas by consumers (including industrial firms) will be strongly affected by price, or more precisely - by the savings that they anticipate through conservation - which depends on the price of gas.

When consumers make decisions about how much gas to use, or how much gas to conserve, they weigh the relative costs and benefits of the various alternatives open to them. On the one hand, conservation of gas may involve turning down the space heating thermostat, preheating the oven less, or turning down the water heater. These conservation methods entail a cost to the consumer of material comfort. There are other conservation methods, however, which involve capital expenditures. Consumers may conserve by installing more insulation in attics, walls, and floors; by purchasing night set-back thermostats which automatically turn down the space heating thermostat during the sleeping hours; by purchasing gas stoves or water heaters which use electronic ignition devices; or by purchasing more energy efficient gas appliances such as better insulated gas water heaters. In these conservation instances, consumers must make a cash outlay in order to conserve gas. Consumers will weigh the amount of this cash outlay against the savings they expect from conserving gas. Although we have not studied the markets for these items in detail, it is our strong expectation that they are priced at or close to marginal cost. The industries which produce them are fairly competitive, and unregulated, and we would thus expect them to price at or above current marginal cost. So the consumer, who must decide whether to maintain current gas consumption or conserve by making a capital investment, is currently comparing the marginal cost of the energy saving devices against the average embedded cost or price of gas.

If we want consumers to consume the correct amount of gas, we must make sure that this trade-off is unbiased, i.e., that consumers are making objective comparisons. It is important, for purposes of energy conservation, to have gas prices to consumers reflect the marginal cost to the utility, if we want these decisions made by individual consumers to be made correctly. If consumers are comparing energy saving devices priced at marginal cost, with savings of gas which reflect average embedded costs, presumably much less than marginal cost, consumers will be given an insufficient incentive to conserve.

In the face of dwindling on-shore gas supplies, uncertain off-shore gas supplies, and supplemental supply projects such as LNG and SNG which are relatively expensive and increase our vulnerability to foreign manipulation such as occurred in 1973, it would be a mistake to give the incorrect conservation signals to consumers. It is wrong to blame consumers for conserving too little when the prices they face are economically incorrect. They are currently making long-term appliance purchase decisions which will be costly to alter in the future, and we should make a strong effort to give them the correct price signals.

B. The Marginal Cost of Gas to PGW

The determination of marginal cost for a utility is a long and complex endeavor. This section does not pretend to be a detailed marginal cost determination. In order to test the impact of something approaching a marginal cost base rates schedule, we must have some idea of what marginal costs might be for PGW. For this reason, we have conferred with the PGW management in an attempt to get some idea of the order of magnitude of marginal cost for their system. This study presents the results of those discussions.[1/]

There are several different ways to determine marginal costs for a utility, and this study uses one of the simplest. The basic question that is asked is: "If PGW experiences a small decrease in demand at a particular time of year, and this decrease in demand is expected to continue indefinitely, what are the changes that PGW will make to its operating procedures? What cost savings will result from these changes?"

There are several things to note about these questions. First, the marginal cost analysis presented in this section presumes that we want to know the savings from a slight decrease in demand, rather than the extra costs of slight increase in demand. The answer to these two different questions are often the same - especially in the long run - but we felt it more appropriate to look at demand decreases, since if rates were to be raised to marginal cost, it is quite likely that demand would decrease in response to these higher rates. The question we wish to address then is, "What are the savings from this decrease in demand?" We also asked the question for decreases in demand for two different times of year, on peak - winter time, and off peak - summer time.

In addition, we also asked what the savings would be were a customer to stop taking gas entirely. This is an attempt to determine the marginal customer costs - the cost imposed on PGW by having to serve a customer, regardless of how much gas that customer actually uses.

The reader will note that the marginal costs as determined by the answers to these questions are entirely different from the traditional cost of service studies. There is no allocation of fixed costs, by any elaborate formula or otherwise, in this type of study. We are attempting to determine the marginal cost to PGW of serving customers, and providing them with natural gas.

The marginal costs to PGW of natural gas in the peak months can be determined in a straightforward manner, though we remind the reader that this is not a detailed marginal cost study. If PGW were to experience a small decrease in demand - that was expected to continue for some time - their response would be to decrease the output of the SNG plants. SNG is the fuel used for peak demand purposes, and is the most expensive natural gas in PGW's system. In order to minimize their costs, SNG production would be reduced first if a decrease in demand is experienced. The savings from running the SNG plant are to a first order of approximation, simply the savings in feed stock costs. PGW calculates these feed stock costs to be \$3.50 per mcf. For small decreases in demand there would not be any other appreciable savings, since maintenance and labor costs at the SNG plant would not be changed.

The picture is a little more complicated if the demand decrease were to come in the off peak period. If that happened, PGW would probably continue to purchase the pipeline gas that was freed up by the decrease in demand, and purchase storage for it. This gas would then be stored for use in the peak period, where it would displace more expensive SNG. Again, this is the response to a decrease in demand off peak that results in the lowest system costs for PGW.

What savings result from this decrease in demand? To begin with, if there is a decrease in demand in the off peak period, and that gas is stored for use in the on peak period, PGW will run its SNG plant less in peak periods. Therefore, an initial savings will be the decrease in SNG costs of \$3.50 per mcf. However, storage costs must be subtracted from those savings, since storage costs will be incurred in order to use the gas in the peak periods. PGW estimates that there is some storage available at $.50 per mcf per year. This storage is in the Southwest, and would not require PGW to purchase additional transportation capacity to get the gas to Philadelphia in peak periods. This storage is limited however, and it is more likely that PGW will have to purchase both storage and transportation capacity, the cost will be approximately $1 per mcf per year. This cost includes storage until needed, and the pipeline capacity which will enable PGW to get the gas from the storage facility to Philadelphia in the peak periods.

So the total savings from a decrease in demand off peak are the SNG savings of $3.50 per mcf, less the incremental storage costs of $.50 or $1 per mcf. Since the amount of $.50 storage is limited, we will assume that - on the margin - $1 storage will eventually have to be purchased. Therefore, the net savings from a decrease in demand off peak to the PGW system are on the order of $2.50 per mcf. This figure will be used in the rate design anaylsis.

The decrease in system costs from a customer who ceases to take service are very problematical. PGW will probably save the cost of a meter, since it will - on balance - have to purchase one less meter to replace those that wear out. The carrying cost of a meter is approximately $1 per month. The other cost savings include savings in billing costs, savings in the expected bad debt expense, and other miscellaneous customer costs. The bad debt expense saving is PGW's estimated expected bad debt cost per customer. To determine the precise magnitude of these savings would require a detailed analysis that is beyond the scope of this study. For purposes of simplicity, we have chosen a $2 per month customer charge savings as illustrative of what might result from a detailed cost study. This customer cost is used in the rate design section below.

C. The Alternate Rate Structure and Its Impact

The marginal cost considerations above suggest the following marginal cost-based rate structure:

Fixed Charge:	\$2.00 per month
Energy Charge:	\$3.50 per mcf, peak period
	\$2.50 per mcf, off-peak period

Discussions with PGW officials indicate their gas storage cycle is reasonably representative of the time periods for which the marginal costs outlined above apply. Thus we have chosen to use the 5 months of storage design utilization, November through March, as the peak period with the 7 months of storage design filling, April through October, as the off-peak period. This rate structure and the current rate structure are depicted in Exhibit III-1. Except for those few very low volume users whose bill is dominated by the fixed charge, everyone would pay more in the peak period and less in the off-peak period.

If PGW were to adopt this rate structure, how would they fare toward meeting their revenue requirement? Will there be excess revenue and, if so, how much? To answer these questions sounds like an extremely complex task for we apparently must factor into our calculations the demand response (elasticity) to the marginal price changes. But a moment's reflection should convince the reader this is unnecessary if the alternate rate structure is reflective of marginal costs. If the \$3.50 peak and \$2.50 off-peak rates are reflective of marginal cost changes over the range of consumption changes likely to occur in response to the new prices,

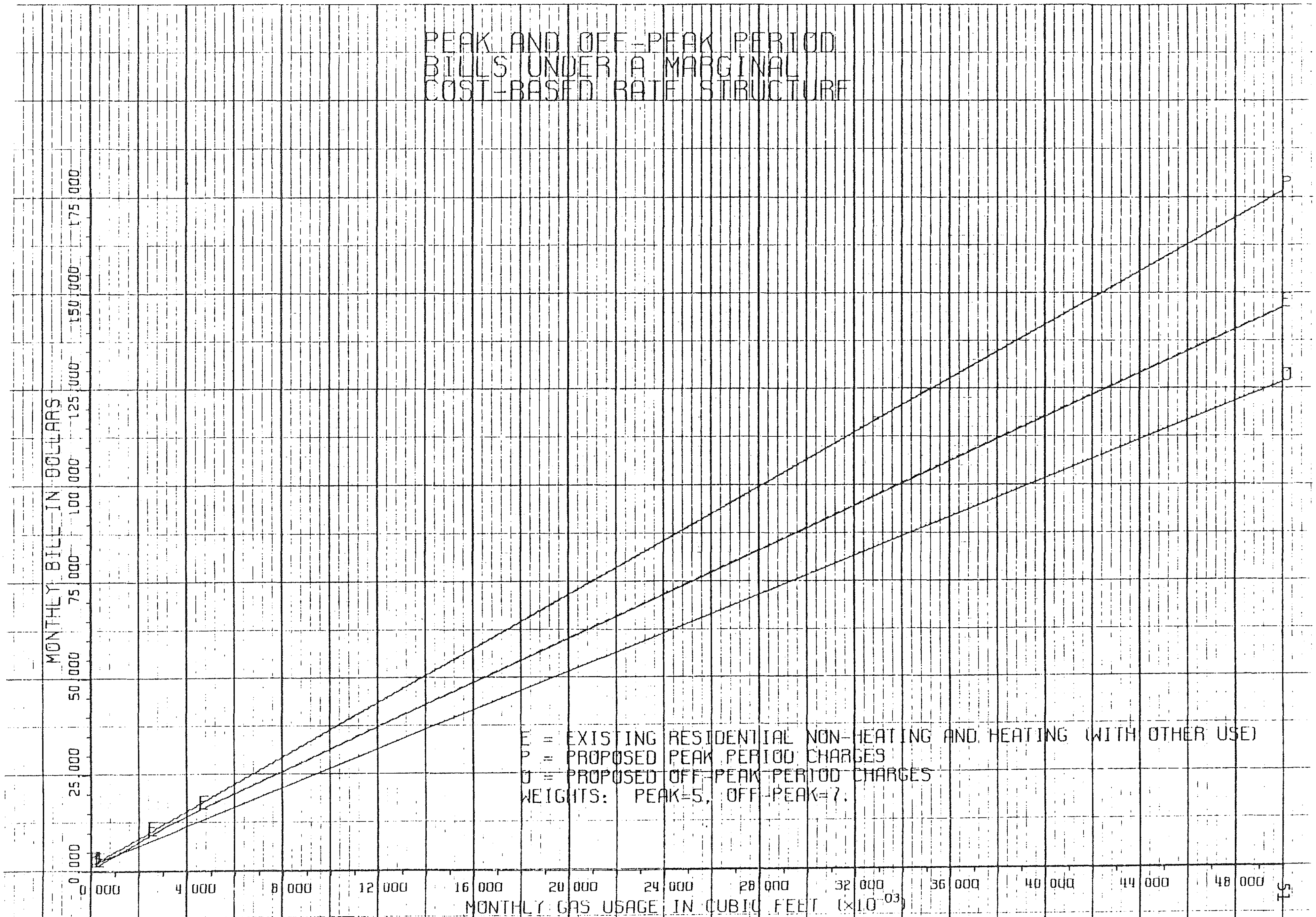

Exhibit III-1

then cost will change precisely by the same amount as revenue changes, resulting in the same excess revenue as that calculated assuming zero elasticity.

If, for sake of argument, we assume a long range price elasticity of -1 and a 20% response rate the first year, increasing the tail block rate from its current $2.86 to $3.50 would result in a decrease of demand in the peak of 4 to 5 percent. We believe the $3.50 marginal cost is appropriate well beyond this change, not only for SNG but also for new gas purchased and stored. Also, any decrease would be partially offset by the modest new load growth projected by PGW. Hence, we believe a rough impact on revenue can be obtained by applying the alternate rate structure directly to the existing use profile.

Using weights of 5, 4 and 3 for the peak, shoulder and trough month profiles described in Section II, we calculated the revenue generated by applying the alternate structure to all GS customers and compared it to the revenue generated by the existing rate structure:

Revenue From Alternate Structure	$268 million
Revenue From Existing Structure	239 million
Excess Revenue	$29 million

D. Disposition of Excess Revenue

A number of alternatives exist for reducing the excess revenue generated by the alternate rate structure to zero. One possibility is to reduce the fixed charge. With approximately one half million customers served under the current GS schedule, if the $2.00 fixed charge per month were reduced to zero, the excess revenue would be reduced $12 million, or from $29 million to $17 million.

A second possibility would be to discount the first X thousand cubic feet per month by an amount sufficient to absorb the excess revenue. Using the existing user profiles we estimate a discount of $1.23 per mcf up to 5 mcf per month per customer would be required. This results in a rate structure that is "inverted" and has the same profile as would a lifeline rate, though the objective is totally different;[2/] rather than alleviate the impact of high energy prices on the poor, we are simply trying to constrain revenues while maintaining the marginal cost-based pricing feature of the system at the higher volumes of usage, where users are most likely to be responsive to price changes. To reduce all rates uniformly would destroy the marginalist value of this alternative.

A third alternative would be to rebate the excess back to customers in some arbitrary fashion, but outside the context of the rate structure. It is imperative that the rebate not be proportional to current usage, or it merely becomes a delayed discount.

There are, of course, other alternatives and then combinations of alternatives, each with its benefits as well as deficiencies, to resolve the problem of excess revenues under a marginal cost-based rate structure. Among all these alternatives we believe that an administratively feasible and politically acceptable solution can be found and that a marginal cost-based pricing system is achievable and workable for PGW and the citizens of the City of Philadelphia.

Notes

Section II

1/ Appendix A contains a listing of articles describing and promoting lifeline or inverted rate structures.

2/ Appendix A contains a list of references which present and evaluate such pricing structures.

3/ PGW has systematically flattened its rate structure over the past few tariff changes. Tariff No. 5, effective February 1, 1974, had seven blocks, with the tail block charge less than half the initial block charge. Tariff No. 6, effective July, 1974, reduced the number of blocks to three, with the tail block charge 72 percent of the initial block charge. The current tariff (No. 7), effective August 1, 1977, has three blocks with the tail block charge almost 80 percent of the intial block charge.

4/ NERA's AGD report, "The Demand-Supply Effect of Varying Gas Price Assumptions on the East Coast Gas Distribution Industry" (January 1978), contains projections which imply a long run price elasticity ranging from -.78 to -1.22 for the Middle Atlantic States.

Tim Mount and Tim Tyrrell, in their National Academy of Science report, "Energy Demand: Conservation, Taxation, and Growth" (August 1977), estimates the long run price elasticity of demand for gas at -1.22 for the residential sector and -1.71 for the industrial sector; they further estimate the residential and commercial percentage of adjustment the first year at 21% and the industrial much higher at 41%.

Wen S. Chern, in his Oak Ridge National Laboratory report "Energy Demand and Interfuel Substitution in the Combined Residential and Commercial Sector" (September 1976), estimates the elasticity at -1.4975.

There is also some question as to whether customers are marginal price or total bill sensitive. While the rational customer, by definition, ought to vary behavior according to marginal price, some customers may respond only to changes in total bill. Hence a rate schedule that increases the marginal rate but lowers the total bill would result in an increase rather than decrease in consumption for these customers.

5/ Some care must be taken in using Exhibits II-2 and II-3. Since they were developed to reflect relative usage, their vertical axes are calibrated differently.

6/ The urban poverty level in 1975 was about $1500 on a per capita basis.

Notes (Continued)

Section III

1/ The marginal costs focused upon were those actually incurred by PGW. We are aware of the broader context in which marginal cost pricing is relevant, but take rolled-in pricing by the pipelines supplying PGW as a given for now. The recent compromise reached by a Congressional Conference on natural gas pricing may never become law and, if it does, will affect PGW's gas prices very little.

2/ Both Coyle and Green have made similar observations. See the references in Appendix A.

Appendix A. Selected References

I. Lifeline Rate Articles

1. Panel on Lifeline Rate Proposals, Hearings before the Subcommittee on Energy and Power of the Committee on Interstate and Foreign Commerce, April 1, 1976; Part I, pp. 614-706.

    a. Dr. Eugene Coyle
    b. Honorable Clifford Allen
    c. Dr. James Marchand
    d. Herbert B. Cohn
    e. Dr. Joe D. Pace
    f. Dr. Jay B. Kennedy

2. Electrical Week, "Popularity of Lifeline Concepts," September 29, 1975, page 1.

3. Everett, Carol T. and J. Robert Malko, "Measuring the Impact of Residential Gas and Electric Rates," Public Utilities Fortnightly, December 22, 1977.

4. Francfort, Alfred and Philip Woo, "Lifeline and Incremental Cost Residential Electric Rates," Public Utilities Fortnightly, February 17, 1977.

5. Frank, Robert H., "Lifeline Proposals and Economic Efficiency Requirements," Public Utilities Fortnightly, May 26, 1977.

6. Mann, Patrick C., "Rate Structure Alternatives for Electricity," Public Utilities Fortnightly, January 20, 1977.

7. National Association of Regulatory Utility Commissioners, Bulletin, "Jacobson of New Jersey Says 'Lifeline' Won't Help Poor," August 25, 1975, NARUC No. 34-1975, page 23.

8. Pace, Joe D., "Lifeline Rates: Will They Do the Job?," Public Power, November-December, 1975.

9. Pace, Joe D., "The Poor, the Elderly and the Rising Cost of Energy," Public Utilities Fortnightly, June 5, 1975.

10. Reed, Daniel J., "Utility Rates Under the National Energy Act, Quo Vadis?," Public Utilities Fortnightly, July 20, 1978.

II. Marginal Cost and Time-dependent Pricing

1. Bierman, Harold, Jr. and Jerome E. Hass, "Inflation, Equity, Efficiency and the Regulatory Pricing of Electricity," Public Policy, Summer 1975 (No. 3).

2. Cudahy, Richard D., "Rate Redesign Today: The Aftermath of Madison Gas," Public Utilities Fortnightly, May 20, 1976.

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4. Doherty, Noel and Gerald M. Oscar, "Will the Rates Produce the Revenues?," Public Utilities Fortnightly, May 12, 1977.

5. Energy Finance Week, "NERA Economists Push Marginal Cost Pricing Before New York PSC," July 9, 1975, Vol. 1, No. 10, pp. 4-5.

6. Joskow, Paul L., "Contributions to the Theory of Marginal Cost Pricing," The Bell Journal of Economics, Spring 1976.

7. Kahn, Alfred E., "Between Theory and Practice: Reflections of a Neophyte Public Utility Regulator," Public Utilities Fortnightly, January 2, 1975.

8. Kahn, Alfred E., "Efficient Rate Design: The Transition from Theory to Practice," Symposium on Rate Design Problems of Regulated Industries, February 23-26, 1975, Kansas City, Missouri.

9. National Association of Regulatory Utility Commissioners, Bulletin, "Maine PUC Proposes Time-of-Day Pricing for Electric Utilities," October 13, 1975, NARUC No. 41-1975, page 13.

10. National Association of Regulatory Utility Commissioners, Bulletin, "Missouri PSC Chairman Says Elec. Rate Changes Necessary," June 23, 1975, NARUC No. 25-1975, page 8.

11. Smiley, Robert H., Testimony in Case 26835, "Long Range Planning for the New York Gas Industry," New York Public Service Commission, 1977.

12. Turvey, Ralph, Optimal Pricing and Investment in the Electricity Supply Industry, MIT Press, Cambridge, Massachusetts, 1968.

13. Tybout, Richard A., "Marginal Cost Versus Rolled-In Pricing for Natural Gas," Public Utilities Fortnightly, March 31, 1977.

14. Wenders, John T., "The Misapplication of the Theory of Peak-Load Pricing to the Electric Utility Industry," Public Utilities Fortnightly, December 4, 1975, pp. 22-27.

15. Wisconsin, State of, Public Service Commission, "Wisconsin Commission Issues Rule on Rate Reform," August 15, 1975.