Exhibit No.: _____

Issue(s):	Cost of Service Study
Witness/Type of Exhibit:	Busch/Surrebuttal
Sponsoring Party:	Public Counsel
Case No.:	GR-2001-292

SURREBUTTAL TESTIMONY

OF

JAMES A. BUSCH

Submitted on Behalf of the Office of the Public Counsel

MISSOURI GAS ENERGY

Case No. GR-2001-292

June 12, 2001

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the matter of tariff revisions of Missouri Gas Energy, a division of Southern Union Company, designed to increase rates for natural gas service to customers in the Missouri service area of the company.	)))))	Case No. GR-2001-292

AFFIDAVIT OF HONG HU

STATE OF MISSOURI)
) ss
COUNTY OF COLE)

Hong Hu, of lawful age and being first duly sworn, deposes and states:

1. My name is Hong Hu. I am a Public Utility Economist for the Office of the Public Counsel.

2. Attached hereto and made a part hereof for all purposes is my surrebuttal testimony consisting of pages 1 through 24 and Schedule SUR HH-1.

3. I hereby swear and affirm that my statements contained in the attached testimony are true and correct to the best of my knowledge and belief.

Hong Hu

Subscribed and sworn to me this 12th day of June, 2001.

Bonnie S. Howard, Notary Public

BONNIE S. HOWARD NOTARY SEAL MY COMMISSION EXPIRES OCT. 03, 2005 COUNTY OF MONITEAU NOTARY PUBLIC STATE OF MISSOURI

My commission expires May 3, 2005.

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SURREBUTTAL TESTIMONY
OF
HONG HU

MISSOURI GAS ENERGY COMPANY

CASE NO. GR-2001-292

Q. PLEASE STATE YOUR NAME, TITLE, AND BUSINESS ADDRESS.

A. Hong Hu, Public Utility Economist, Office of the Public Counsel (Public Counsel, OPC), P. O. Box 7800, Jefferson City, Missouri 65102.

Q. HAVE YOU TESTIFIED PREVIOUSLY IN THIS CASE?

A. Yes, I submitted direct testimony and rebuttal testimony on the issues of Mains allocation and rate design.

Q. WHAT IS THE PURPOSE OF YOUR SURREBUTTAL TESTIMONY?

A. OPC witness James Busch has updated his cost of service study. Therefore, I will present OPC's updated rate design proposal in my surrebuttal testimony. In addition, my surrebuttal testimony will present Public Counsel's response to Midwest Gas Users' Association (MGUA) witness Mr. Charles D. Laderoute's comments on mains cost allocation and rate design issues. I will also comment on a study presented by Missouri Gas Energy Company (MGE) witness Dr. Philip B. Thompson regarding the relationship between residential gas consumers' income levels and their usage of natural gas in MGE's service territory.

I. OPC's Rate Design Proposal

Q. PLEASE EXPLAIN WHAT CHANGES ARE INCLUDED IN OPC'S UPDATED RATE DESIGN PROPOSAL.

A. OPC's position and rate design methodology has not changed. I'm only updating specific numbers in the rate design proposal so that it reflects the updated result of OPC's cost of service study. I have also included an example of class revenue requirement allocation at the total revenue increase level of $9.9 million to reflect the proposed revenue settlement result. At a $9.9 million total revenue increase (a 7.11% increase in average), OPC recommends that the residential class should get a 6.74% increase. The updated rate design proposal is shown as Schedule SUR HH-1.

II. Mains Cost Allocation

Q. IN PAGE 35 OF HIS REBUTTAL TESTIMONY, MGUA WITNESS MR. CHARLES D. LADEROUTE STATED THAT HE IS CRITICAL OF USING THE RELATIVE SYSTEM UTILIZATION METHOD IN ALLOCATING MAINS COST BECAUSE "WHEN DIRECTLY APPLIED, RSUM DOES NOT RESULT IN A FAIR APPROTIONMENT OF DEMAND RELATED MAINS COST." WHAT REASONS DID HE GIVE IN ARRIVING THAT CONCLUSION?

A. Mr. Laderoute believes that the RSUM method "imputes loads that simply do not exist in terms of cost causation" and that "[i]t results in costs being borne by others than who caused the cost in the first place." From his testimony, he seems to imply that the Mains cost are caused by loads in the peak month only. He

appears to believe that loads in other months "simply do not exist in terms of cost causation" and customer who consume power in the non-peak months should not bear any Mains cost for their usage in those months.

Q. IS IT TRUE THAT MGE INCURS COST TO INSTALL THE MAINS SYSTEM ONLY FOR THE PURPOSE OF SERVING THE PEAK MONTH LOADS?

A. Absolutely not. The Company incurs cost to install the Mains system for the purpose of satisfying customers' loads throughout the year. Keep in mind that the Mains system constitutes the largest proportion of facilities owned by a local gas distribution company. The net book value of Mains plant in service may exceed 1/3 of the net book value of company's total plant in service. If loads in other months do not exist, there may very well be other more cost-efficient ways to serve the loads in one month only. For example, the Company may be able to satisfy customers' loads in one month by setting up propane tanks near the customers' locations. It is only because the Company can utilize the Mains system for all months in a year and can spread its investment in Mains over all loads throughout the year, that makes incurring large fixed cost to install a Mains system an economically-efficient action.

Q. IF THE DISTRIBUTION MAINS COST IS INCURRED TO DELIVER LOADS IN ALL MONTHS, SHOULD LOADS IN ALL MONTHS (INCLUDING BOTH THE PEAK MONTH AND NON-PEAK MONTHS) BEAR A PORTION OF THE MAINS COST?

A. Yes. The Mains cost is incurred to deliver loads in all months, and should be spread to those loads in all months.

Q. DID MR. LADEROUTE APPEAR TO SUPPORT ALLOCATING A PORTION OF MAINS COSTS TO BOTH ON PEAK AND OFF PEAK PERIODS?

A. Yes. On page 36 of his rebuttal testimony, Mr. Laderoute stated that after the demand-related mains cost is allocated to rate classes on the basis of "some notion of peak responsibility", these costs then "could be allocated to say, an On Peak and Off Peak period". Mr. Laderoute seems to indicate that the off peak period is one of the "costing periods" and should be allocated with some Mains cost. These statements are ironically contrary to his own assertion on page 35 about how off peak loads do not exist "in terms of cost causation" and should not be allocated any Mains cost. It seems that Mr. Laderoute does acknowledge the desirability of allocating Mains cost to off peak hours. However, he opposes allocating any of the costs associated with these off peak hours to customer classes. Mr. Laderoute didn't indicate whether this approach that he advocates would result in different peak rates and off-peak rates for different customer classes, or whether he cares about it, for that matter.

Q. WHAT OTHER EVIDENCE DID MR. LADEROUTE PRESENT IN SUPPORT OF A PEAK RESPONSIBILITY METHOD INSTEAD OF THE RSUM METHOD IN THE ALLOCATION OF MAINS COST?

A. In page 36 of his rebuttal testimony, Mr. Laderoute cited Professor Bonbright's comments on various demand allocation methods. Professor Bonbright stated that he believes the system-peak responsibility method is the one method, among three methods he previously discussed, "that would probably come closest to receiving support from the economists, at least viewed from the standpoint of cost analysis."

Q. WHEN DID PROFESSOR BONBRIGHT MAKE THIS STATEMENT?

A. As indicated in Mr. Laderoute's testimony, Professor Bonbright made this statement in the year 1969.

Q. WAS THE RSUM METHOD AMONG THOSE CONSIDERED IN YEAR 1969?

A. No. As indicated in page 34 of his rebuttal testimony, Mr. Laderoute himself developed the RSUM method in the early 1980s.

Q. CAN IT BE INFERRED THAT PROFESSOR BONBRIGHT BELIEVED THAT THE SYSTEM-PEAK RESPONSIBILITY METHOD IS PREFERABLE TO THE RSUM METHOD FROM HIS STATEMENT?

A. No. One cannot reasonably assume that Professor Bonbright would find another method is preferable to the RSUM method when he didn't even know about the RSUM method since it had not yet been created.

Q. DOES PROFESSOR BONBRIGHT'S STATEMENT SUPPORT MR. LADEROUTE'S CRITICISM OF USING THE RSUM METHOD TO ALLOCATE MAINS COST?

A. No.

Q. HAS MR. LADEROUTE OFFERED ANY VALID CRITICISM TO USING THE RSUM METHOD TO ALLOCATE OF MAINS COST?

A. No. Mr. Laderoute failed to support his assertion that the RSUM method is not a reasonable method for the allocation of demand related Mains cost. The only

criticisms that Mr. Laderoute provided in his rebuttal testimony regarding the RSUM method are self-contradictory and meaningless.

III. Rate Design

Q. IN PAGE 39 OF HIS REBUTTAL TESTIMONY, MR. LADEROUTE INDICATED THAT "THE COST OF SERVICE STUDY SHOULD WEIGH NO LESS THEN 80 TO 90% IN THE FINAL BALANCING OF FACTORS. THE OTHER FACTORS MIGHT BE WEIGHTED AT 10 TO 20% OF THE FINAL DECISION." DO YOU HAVE ANY COMMENTS?

A. Yes. First, I welcome Mr. Laderoute's recognition that other factors "might" be given some weight in the final decision. That is a step forward from Mr. Laderoute's initial position in his direct testimony that rates should be set solely on the basis of costs. His alternative proposal presented in Schedule DDL-Reb-6, where Mr. Laderoute attempted to change rates gradually, should be considered as an improvement from his original proposal, although it still falls far short of what OPC believes to be just and reasonable.

My second comment on Mr. Laderoute's quantification of weights for different factors is that unfortunately rate design cannot be simply achieved through a formula such as A times 80% plus B times 20%. In most cases, factors that are important in rate design such as affordability, value of service or rate continuity cannot be easily quantified. Further, in different circumstances, different factors may have different importance and require different weights. The Commission is charged with determining the importance of the factors in designing rates on a case by case basis. Mr. Laderoute himself did not attempt to offer an example

how his 80-90% or 10-20% weight should be utilized in a rate design. Mr. Laderoute also did not explain in his alternative proposal, how much weight is given to which factor and how the weights are applied to each factor.

Q. IN PAGE 40 OF HIS TESTIMONY, MR. LADEROUTE EXPLAINED HIS UNDERSTANDING OF THE TERM "VALUE OF SERVICE". DO YOU HAVE ANY COMMENTS?

A. Yes. Mr. Laderoute indicated that the term "value of service" "is of most importance when there are competitive alternatives." He seems to imply that for the residential customers and most of the small general service customers who do not have a competitive alternative, there's no value of service to them, or value of service is not important to them. I believe that Mr. Laderoute's meaning of the term "value of service" is too narrow.

Q. MR. LADEROUTE COMMENTED IN PAGE 41 OF HIS REBUTTAL TESTIMONEY THAT THE ISSUE OF AFFORDABILITY "HAS NO PLACE IN REGULATION" AND THAT IT "IS A POLITICAL ISSUE THAT SHOULD BE LEFT TO THE LEGISLATORS." DO YOU HAVE ANY COMMENTS?

A. Yes. I would like to offer a citation from the Gas Distribution Rate Design Manual prepared by NARUC Staff Subcommittee on Gas in June 1989, page 57.

> [R]ate designers should be aware of the social and political implications of their work. Gas rate design is not an abstract application of economic principles, but rather a practical exercise which affects customers in their daily lives. The rate designer should be aware that people need affordable gas to heat their

> homes and businesses need energy supplies which enable them to remain competitive. The rate designer should be sympathetic to these concerns while continuing to follow the basic rate design principles.

The Missouri Public Service Commission has consistently determined that other factors including affordability and effect on low-income customers should be considered when establishing rates[1]. In the Report and Order issued on February 1, 2001, in Case No. GR-96-285, pages 52-53, the Commission stated:

> In addition to the class cost of service study, the Commission will consider all of the relevant evidence presented in this case, including facts and circumstances such as consumption characteristics (effects on low income customers), current rate structures, rate affordability, historical rates, the concept of gradualism to avoid or minimize potentially disruptive rate shifts or rate shock, and the magnitude of the required increases or the overall rate impact of the increase in the revenue requirement.

Q. DO YOU HAVE ANY COMMENTS ON MR. LADEROUTE'S DISCUSSION OF THE TERM "RATE IMPACT" IN PAGES 41 THROUGH 42 OF HIS REBUTTAL TESIMONY?

A. Yes. Mr. Laderoute's implies that if the costs are caused by a certain customer class, then it should bear the costs even if the rate impact may be significant to that customer class. The problem with a gas local distribution company is that unlike the AMR costs mentioned by Mr. Laderoute, most costs of a local gas distribution company are common cost and cannot be directly assigned to each customer class. All customer classes are benefiting from the utilization of the common facilities by being allocated less cost than their stand-alone cost. This leaves room for mitigation of large rate impact on one customer class without

[1] See Report and Order, Case No. GR-96-285, (issue date: February 1, 2001) page 48 for more citing.

subsidy. Also, ratemakers can apply other methods such as phase-in in cases of substantial rate impact on all customer classes.

Q. DO YOU HAVE ANY COMMENTS ON MR. LADEROUTE'S DISCUSSION ON THE TERM "RATE CONTINUITY" IN PAGES 42 THROUGH 43 OF HIS REBUTTAL TESIMONY?

A. Yes. Mr. Laderoute's understanding of the term "rate continuity" seems to be incomplete when he stated that "Rate Continuity is a term that is more appropriate in view of the actual rate structure - not the rate level." The term rate continuity is often used in referring to the issue of whether a new rate design will provoke excessive rate shifting between customer classes. Both the actual rate structure and the rate level may be important for rate continuity.

Q. IN LINE 6, PAGE 43 THROUGH LINE 8, PAGE 44, MR. LADEROUTE INDICATED THAT HE IS CRITICAL OF OPC'S PROPOSAL THAT "NO CUSTOMER CLASS SHOULD RECEIVE A NET DECREASE AS THE COMBINED RESULT OF THE REVENUE NEUTRAL SHIFT THAT IS APPLIED TO THAT CLASS AND THE SHARE OF THE TOTAL REVENUE INCREASE THAT IS APPLIED TO THAT CLASS." DO YOU HAVE ANY RESPONSE TO HIS COMMENTS?

A. Yes. Mr. Laderoute's first criticism of this principle is that it is "premised on accepting someone's definition of a revenue neutral shift in concert with a revenue increase." He further stated that it is based on OPC's study. Mr. Laderoute seems to be confusing OPC's rate design principle with OPC's proposed rate design methodology to achieve that principle. OPC's principle that nobody should get a decrease in a case with a revenue requirement deficiency and nobody should get an increase in a case with a revenue requirement surplus can be based on any

revenue neutral shift that the Commission deems to be just and reasonable, not just the shifts recommended by OPC. Further, to achieve that policy goal, OPC proposed a rate design methodology that moves rate levels half way toward cost of service.

Mr. Laderoute's second criticism to OPC's rate design principle is that "it depends on how one approaches the revenue neutral shift." Mr. Laderoute is mistaken here also. OPC believes no matter how one approaches the revenue neutral shift, it would not be reasonable for one customer class to receive a revenue decrease, while other customer classes have to shoulder the entire burden of the total revenue increase plus an additional revenue increase in order to provide one customer class with some revenue decrease.

Mr. Laderoute further commented on the OPC's proposal to move halfway toward the cost of service study result by stating that "there is nothing magic about this 50%. " 50% is what we feel appropriate to serve the purpose of moving toward cost of service while considering the impact of other factors in this case and the inherent lack of precision in class cost of service study results. Mr. Laderoute did not propose any other percentage that he feels more appropriate or more "magical" than the 50% proposed by OPC.

Mr. Laderoute's last criticism to OPC's rate design methodology is that "the overall approach is illogical." He seems to indicate that this methodology would fail if there were only two customer classes. Again, Mr. Laderoute is mistaken. In the case where there are only two customer classes, OPC's methodology may result in different percentage of increase (or decrease) in class revenue for these

two classes, and will cap the revenue increase (or decrease) for any one customer class to the extent that it does not lead to a revenue decrease (or increase) for the other customer class. Let me use an example to illustrate how OPC's methodology would work if there were only two classes. Please refer to Table 1 shown below:

Table 1. Example of OPC's Rate Design Methodology in Case of Two Customer Classes

(Unit: million dollars)

Customer Class	A	B	Total
Current Revenue	30	10	40
Revenue Neutral Shift Indicated by COS	-5	5	0
Halfway to COS	-2.5	2.5	0
Revenue After Revenue Neutral Shift	27.5	12.5	40
Spread of Additional Increase to the Total Revenue	6.875	3.125	10
Total Revenue	34.375	15.625	50

Suppose the current revenues of customer classes A and B are $30 and $10 million, respectively. Also suppose the revenue neutral shift indicated by OPC's cost of service study is that 5 million should be shifted from customer class A to customer class B. In other words, half way to revenue neutral shifts indicated by the study would mean customer class A should receive a $2.5 million decrease and customer class B should receive a $2.5 million increase. This step moves the class proportion of total system revenue responsibility more in line with cost. After the revenue neutral shift, if the Commission decided that there should be an additional revenue increase of 10 million, then the combined effect of OPC's recommended revenue neutral shift and the spread of total revenue increase would be that class A gets $4.375 million increase and class B gets $5.625 million

increase. If the total revenue increase is sufficiently small, however, for example, if the total revenue increase is only $2 million, then the spread of total revenue increase for class A would not be big enough to offset its revenue neutral shift (-$2.5 million). In this case, OPC's methodology would leave class A's revenue unchanged and give the entire $2 million increase to class B. This would still move the rates closer to costs.

OPC believes that its rate design principle is just and reasonable. OPC's rate design methodology works in every case no matter how many customer classes there are. It is consistent with the economic concept of Pareto efficiency. Mr. Laderoute's assertion about this methodology being "illogical" is completely unfounded.

Q. MR. LADEROUTE STATED THAT "[S]OCIAL CONSIDERATIONS HAVE NO PLACE IN REGULATION" BECAUSE "[C]USTOMERS DO NOT HAVE A CHANCE TO VOTE FOR COMMISSION MEMBERS." DO YOU HAVE ANY COMMENTS ON THAT?

A. Yes. In page 57 of the Gas Distribution Rate Design Manual published by NARUC in 1989, it states:

> By its very nature, the ratemaking process is subject to considerable public and political scrutiny. Commissioners are either appointed by elected officials or are elected themselves. The Commission itself is typically a creature of the Legislature -- created for a specific purpose and existing until dissolved by the Legislature. ... Broad governmental policy goals, such as business climate development, can have a significant impact. ... Consideration also needs to be given to designing rates which are responsive to the social needs of our society.

Q. IN LINE 15, PAGE 49 THROUGH LINE 5, PAGE 51, MR. LADEROUTE PRESENTED A RATE DESIGN PROPOSAL TO REPLACE HIS ORIGINAL PROPOSAL. DO YOU HAVE ANY COMMENTS ABOUT HIS LATEST PROPOSAL?

A. Yes. Mr. Laderoute proposed a 3-year phase-in of "cost based rates" based on his cost study. According to Mr. Laderoute's proposal, the residential customers would be getting the greatest percentage of revenue increase in the first year while the LGS and LVS customers possibly get a rate reduction. Then in the second and third year, the residential customers will continue to suffer large rate increases while the other customer classes will continue to get rate reductions. At the end of this three-year phase-in period, depending on the level of the total system increase, the residential class is asked to shoulder between 130% to nearly twice the total revenue increase in order to provide the LVS customers with a rate reduction of about $2 to $2.6 million. This happens in a case where both the Staff and OPC presented analysis that the LVS class is paying too little to cover its cost of service. OPC urges the Commission to reject this proposal since it is unjust and unreasonable.

IV. Income-Consumption Relationship Study

Q. PLEASE BRIEFLY EXPLAIN THE STUDY THAT MGE WITNESS DR. PHILIP B. THOMPSON OFFERED ON THE ISSUE OF THE INCOME-CONSUMPTION RELATIONSHIP.

A. In his rebuttal testimony, Dr. Philip B. Thompson presented the results of a study he performed in an effort to ascertain the relationship between residential gas consumers' income levels and their usage of natural gas in MGE's service territory. The study includes a series of annual models and monthly models. The study attempts to examine the effects of various factors on average natural gas consumption for all customers who reside within a single zip code. The factors being examined include weather, income, gas price, housing characteristics (e.g., age of house, number of rooms), and household characteristics (e.g., employment status, education status, own or rent the house, etc.). Dr. Thompson stated that the results of his study suggest that the income-consumption relationship in MGE's service territory has a "U"-shape, and that gas consumption "at first declines as income rises, then turns upward with further increases in income."

Q. HAS OPC WITNESS MR. COLTON PROVIDED A RESPONSE TO DR. THOMPSON'S CONCLUSION ABOUT THE RELATIONSHIP BETWEEN INCOME LEVEL AND GAS CONSUMPTION LEVEL?

A. Yes. In his surrebuttal testimony, OPC witness Mr. Roger D. Colton provides a number of survey based studies including studies conducted by the US Department of Entergy, The Federal LIHEAP Office, The US Department of Labor, and the US Department of Housing and Urban Development on the same

issue. Mr. Colton demonstrates that Dr. Thompson's study results are inconsistent in many respects with empirical evidence regarding the causal relationships and correlation between variables hypothesized by Dr. Thompson.

Q. DOES MR. COLTON'S EVIDENCE RAISE CONCERNS REGARDING DR. THOMPSON'S METHOD AND CONCLUSIONS?

A. Yes. His hypothetical model and the results it produces directly conflict with detailed empirical studies from authoritative sources, therefore it should be questioned.

Q. DOES OPC HAVE ANY OVER-ARCHING CONCERNS REGARDING DR. THOMPSON'S STUDY?

A. Yes. A primary concern is that Dr. Thompson attempts to project observations resulting from high levels of aggregation and averaging down to very specific observations regarding rate design impacts on customers based on income. His use of data averaged over zip codes does not appear to lend itself well to this purpose when compared to the "real world". This weakness results from relying on information at an insufficient level of detail and frustrates any ability to draw meaningful policy conclusions regarding the more granular impact of higher customer charges on individual low-income consumers.

Q. WHAT WILL THIS PORTION OF YOUR TESTIMONY ADDRESS?

A. I will provide some technical insights that are related to statistics principles and regression techniques underlying Dr. Thompson's study. I will attempt to

describe possible causes for the inconsistencies resulting from Dr. Thompson's study. In addition, I will explain some of the reasons that OPC believes it would be misleading to draw policy inferences from the conclusions of Dr. Thompson's study.

Q. WHAT SPECIFIC ISSUES WILL YOU ADDRESS?

A. Dr. Thompson's study is based on multivariate regressions containing potentially interrelated independent variables in a non-experimental research environment. When conducting a regression based study in such an environment, a number of factors are beyond the control of the person conducting the study but may have significant impacts on its outcome. In a textbook on multiple regression analysis, Professor Elazar J. Pedhazur describes regression analysis and some of the hazards related to its ability to explain causal relationships:

> [T]he partial regression coefficient (i.e., a regression coefficient obtained in the regression of a dependent variable on a set of interrelated independent variables) indicates the expected change in the dependent variable associated with a unit change in a given independent variable while controlling for the other independent variables. This interpretation of the regression coefficient has great appeal for many researchers because it holds the promise for unraveling complex phenomena and for effecting desired changes in them. It is necessary, however, to take a closer look at the properties of the regression coefficients, paying particular attention to factors that may lead to their biased estimation or instability, as well as to the restrictive conditions under which they can be validly interpreted as indices of the effects of the variables with which they are associated. A sober examination of the properties of the regression equation is particularly pressing because its apparent

> simplicity is deceptive and can lead an unwary user to serious misconceptions, misinterpretations, and misapplications.[2]

I will address Dr. Thompson's study in the context of the following topics: (1) non-experimental research vs. experimental research, (2) specification errors, and (3) the role of theory in modeling.

Q. PLEASE EXPLAIN THE IMPORTANCE OF EXPERIMENTAL RESEARCH VS. NON-EXPERIMENTAL RESEARCH AND ITS IMPLICATIONS REGARDING DR. THOMPSON'S STUDY.

A. The interpretation of regression equations and regression coefficients has different implications in experimental research versus non-experimental research. From Professor Elazar J. Pedhazur's text,

> In an experimental research, the researcher not only manipulates the independent variables but is also better able to control extraneous variables, directly or by randomization. Under such circumstances, the researcher may feel reasonably confident in interpreting regression coefficients as indices of the effects of the independent variables on the dependent variable. ... [T]he situation is considerably more complex and more ambiguous when the regression equation is obtained in non-experimental research. ... [S]uch equations reflect average relations between a dependent and a set of independent variables, not necessarily the process by which the latter produce the former. [3]

[2] Elazar J. Pedhazur, (1997) Multiple Regression in Behavioral Research, Explanation and Prediction. Page 283.
[3] Same as above. Page 284.

Q. DO YOU HAVE CONCERNS THAT IN SOME CASES DR. THOMPSON'S STUDY EXHIBITS A NON-CAUSITIVE RELATIONSHIP BETWEEN THE DEPENDENT VARIABLE AND THE INDEPENDENT VARIABLES?

A. Yes. For example, Dr. Thompson has included price as one of the explanatory variables of gas consumption because he believes that the "law of demand" would predict that higher price causes lower consumption, illustrated by a negative coefficient. On page 11 of his testimony, Dr. Thompson seems to be surprised by obtaining the wrong sign (a "positive" coefficient) for his price variable. Dr. Thompson struggled with the interpretation of this result by first saying that "higher prices tend to coincide with colder weather." However, as Dr. Thompson himself would agree, by definition the effect of cold weather should have been filtered out already by his inclusion of the weather variable (HDD) and the coefficient of the price variable should represent the effect of price and price only. Dr. Thompson tried to include a lagged price variable but he still could not obtain the right sign (a negative coefficient) for this lagged price variable. At last, Dr. Thompson explained this apparently counter intuitive sign by stating that "consumer generally are unaware of the price of natural gas at the time of consumption." I might note that if this were the case, we should expect the price variable should be statistically insignificant, while Dr. Thompson certainly did not obtain that result.

What Dr. Thompson did not appear to consider is that the causative relationship between market price and the gas usage can actually go the other way - when people use more gas, the market price of gas goes up. The positive relationship we observe is not very surprising if one considers that the demand curve is relatively inelastic while the supply curve likely plays a more important role in

determining market price. This example illustrates one of the difficulties of postulating a causative conclusion from a non-experimental regression equation without really considering the theoretical basis of the regression model. Many statistics experts and researchers have studied the difficulties related to data obtained in non-experimental research and its application in regression analysis. For example, Finney, D. J. commented:

> To analyse such data uncritically as though they come from a planned experiment invites fallacious argument and misleading conclusions. Although the same types of calculation may be required, more intensive examination of non-experimental data is commonly needed; the inferential problems contain many additional difficulties.[4]

Q. WHAT OTHER PROBLEMS COULD EXIST IN NON-EXPERIMENTAL RESEARCH?

A. One other problem in non-experimental research is that variables in non-experimental research tend to be inter-correlated. Implications of regression coefficients for policy decisions are questionable if we do not attempt to identify and consider the inter-correlation among the independent variables.

If a regression equation contains highly correlated independent variables, the idea of changing one of the variables while holding the others constant is neither theoretically meaningful nor practically feasible. In the case of polynomial regression, especially, Professor Elazar J. Pedhazur indicates that the correlation between a variable and its squared value tend to be very high. This point appeared to be true for the polynomial models in Dr. Thompson's study. Other

[4] Finney, D. J. (1982) The questioning statistician. Statistics in Medicine, Vol. 1, pages 5-13.

correlated independent variables can be found in Dr. Thompson's study. For example, both room size and house age are correlated with income. This could lead to a number of problems with the accuracy of a coefficient in reflecting the total effect of an explanatory variable. There may also be a indirect effect that should be considered. Therefore, extreme caution is needed when attempting to make inferences in the presence of inter-correlation. I believe this effect should be considered in evaluating the conclusions of Dr. Thompson's study. For example, income not only directly affects gas usage but also indirectly affects gas usage through other variables such as home size and house age.

Q. ARE THERE OTHER PROBLEMS THAT COULD EXIST IN NON-EXPERIMENTAL RESEARCH?

A. Yes. A third problem that is associated with non-experimental research is that often proxies for causal variables are included in the regression equation instead of the causal variables themselves. For example, in Dr. Thompson's study, median age of housing and the percentage of owner-occupied houses are used as proxy variables for the energy efficiency of homes, and average number of rooms is used as a proxy variable for home size. In the real world, it is likely that the more energy efficient a house is, the less gas will be needed to heat the house. Also, the bigger a house is, the more gas is needed to heat the house. These variables are hard to obtain, however, thus the use of proxies. Unfortunately, these proxies have reduced explanatory power. For example, an old house can still be energy efficient, if the owner takes extra steps such as installing a new energy efficient furnace and improving insulation. Another example is that two houses that have 3 rooms may have very different heating area sizes. Compared to their proxies, the actual energy efficiency of a house and the actual heating area

of a house are likely to have stronger correlation with both gas usage and the income level. If all of the true causal variables are included, there may not be any explanatory power left to the income variable. Consider two similar-sized households with exactly the same houses with the same heating area and with the same number of appliances and level of energy efficiency. If the only difference between these households is that one household is a low-income household while the other is a mid-income household, then what theoretical basis or practical reason is there to expect that the lower income household will consume more gas? The statistically significant result of an income variable may very well due to the reduced explanatory power of the proxy variables.

Q. PLEASE EXPLAIN THE CONCEPT OF SPECIFICATION ERRORS.

A. The term "specification errors" refers to the use of a wrong or inappropriate model. Examples of such errors are: omitting relevant variables from the regression equation, including irrelevant variables in the regression equation, and postulating a wrong functional form for the regression equation. Professor Elazar J. Pedhazur suggests that when relevant variables omitted from the regression equation are correlated with variables in the equation, estimation of the coefficients is biased. When irrelevant variables are included in the equation, the efficiency of the tests of significance of the coefficients of the relevant variables may be decreased. Finally, when an incorrect functional form is used for regression analysis, the regression results would be meaningless.

Q. DO DR. THOMPSON'S REGRESSION MODELS CONTAIN ANY SPECIFICATION ERRORS?

A. They may. A relevant variable that is possibly missing from all of Dr. Thompson's regression models is fuel use or the number of gas appliances by zip code. Clearly whether a house uses an electric heater or gas heater, an electric range or a gas stove, and an electric dryer or a gas dryer, will definitely have an impact on that household's gas usage.

Dr. Thompson presented five (5) annual models and five (5) monthly models, each with a different number of explanatory variables. Dr. Thompson has not drawn any conclusions about which annual model and which monthly model is the "best" model. He is silent about whether some of the variables should or should not be included in the model. Statisticians have established methods for detecting the inclusion of irrelevant variables. The basic idea is that we can add a possible variable to the model, then test whether the change to the model's explanatory power is significant. Dr. Thompson did not give us much insight as to whether, in his opinion, variables such as PCTNOWRK (proportion of persons over 15 who did not work in pervious year), PCTBACH (proportion of persons over 24 who have at least a bachelor's degree), PCTHPAST (Proportion of households with public assistance income), and PRICE or PLAG1 are truly relevant or irrelevant to the level of gas consumption. He did not even tell us, for that matter, whether he believes income is a relevant or irrelevant variable to explain the level of gas consumption. He simply provides multiple models he has tried. In fact, from the results presented in the table in Schedule PBT-2-6, by including the variables of PCTNOWRK, PCTOWNOC (proportion of housing

units that are owner-occupied), PCTBACH, PCTHPAST, and HDDINCMN (HDD x MNHSY99), models 3M, 4M, 5M actually have produced R^2s that are lower than a model that excludes these variables. Dr. Thompson has not presented an annual model or a monthly model that excludes the income variable so I cannot examine the regression results to assess for the relevance of it.

Q. ARE THERE ALTERNATIVES TO A SINGLE REGRESSION EQUATION MODEL THAT MAY BETTER DESCRIBE THE INTERRELATIONSHIP BETWEEN VARIABLES?

A. Yes. The most prevalent type of model in the application of multiple regression analysis in the social sciences is a single regression equation that is used to study the effects of a set of independent variables on a dependent variable such as the following:

(a) $$CCF = b_{0y} + b_{1y}HDD + b_{2y}AGEMED + b_{3y}RMAVG + b_{4y}MNHSY99 + e_y$$

All the explanatory variables are assumed to be exogenous in this model. If you believe that AGEMED and RMAVG are actually correlated with MNHSY99, then a preferable model might be as follows:

(b) $$AGEMED = b_{01} + b_{11}MNHSY99 + e_1$$
$$RMAVG = b_{02} + b_{12}MNHSY99 + e_2$$
$$CCF = b_{0y} + b_{1y}HDD + b_{2y}AGEMED + b_{3y}RMAVG + b_{4y}MNHSY99 + e_y$$

The last equation is the same as the single equation given earlier. However, the difference between the two models is that in the first model relations among AGEMED, RMAVG, and MNHSY99 are left unanalyzed, whereas the second model specifies the causes for the relations among these variables. In model (b), b_{4y} represents the direct effect of MNHSY99 on CCF, which is the same as model (a). However, according to model (b), MNHSY99 also has indirect effects on

CCF through AGEMED and RMAVG. The total effect of MNHSY99 on CCF would then reflect both its direct effects and its indirect effects. Clearly, radically different conclusions would be reached about the effect of MNHSY99 on CCF based on different model specifications and the corresponding underlying theories.

Q. WHAT CONCLUSIONS DO YOU HAVE REGARDING DR. THOMPSON'S STUDY?

A. Since we are still waiting for part of Dr. Thompson's workpapers, a complete analysis is not possible at this time. After preliminary analysis, I found that Dr. Thompson's study might have some defects. I would recommend the Commission not rely on this study in making any policy decisions. I may provide additional testimony in response to Dr. Thompson's workpapers once they become available.

Q. DOES THIS CONCLUDE YOUR SURREBUTTAL TESTIMONY?

A. Yes.

OPC Rate Design Proposal
MGE Case No. GR-2001-292

		TOTAL	RESIDENTIAL	SMALL GS	LARGE GS	LARGE VOLUME	UMGL
1	Revenue Neutral Shifts (RNS) to Equalize Class						
2	Rates of Return (ROR)	$0	($498,590)	($2,308,082)	($644,726)	$3,451,416	($18)
3							
4	Percentage Revenue Change to Equalize Class ROR	0.00%	-0.54%	-8.10%	-21.27%	31.80%	-0.62%
5							
6	Current Class Revenue Percentages	100.00%	68.58%	21.07%	2.23%	8.12%	0.00%
7							
8	COS Indicated Class Revenue Percentages	100.00%	68.22%	19.41%	1.77%	10.60%	0.00%
9							
10	**OPC's Recommended Revenue Neutral Shifts**	$ 0	$ (249,295)	$ (1,154,041)	$ (322,363)	$ 1,725,708	$ (9)
11							
12	OPC's Recommended Revenue Percentages	100.00%	68.40%	20.24%	2.00%	9.36%	0.00%
13							
14	**Spread of Proposed Revenue Requirement Increases**						
15	MGE's Proposed Revenue Requirement Increase	39,882,006	27,279,716	8,071,582	797,156	3,732,669	883
16	Revenue Requirement Increase of 1mil	1,000,000	684,011	202,387	19,988	93,593	22
17	Revenue Requirement Increase of 9.9mil	9,900,000	6,771,705	2,003,627	197,880	926,569	219
18							
19	**Combined Impact of Revenue Increase and OPC's RNS**						
20	MGE's Proposed Revenue Requirement Increase	39,882,006	27,030,421	6,917,541	474,793	5,458,377	874
21	Revenue Requirement Increase of 1mil	1,000,000	434,715	(951,654)	(302,375)	1,819,301	13
22	Revenue Requirement Increase of 9.9mil	9,900,000	6,522,410	849,586	(124,483)	2,652,277	210
23							
24	**Adjusted Impact of Revenue Increase and OPC's RNS**						
25	MGE's Proposed Revenue Requirement Increase	39,882,006	27,030,421	6,917,541	474,793	5,458,377	874
26	Revenue Requirement Increase of 1mil	1,000,000	192,861	-	-	807,133	6
27	Revenue Requirement Increase of 9.9mil	9,900,000	6,441,416	839,036	-	2,619,341	207
28							
29	**Adjusted Percentage Change in Class Rate Revenue**						
30	MGE's Proposed Revenue Requirement Increase	28.63%	28.29%	23.57%	15.28%	48.24%	28.24%
31	Revenue Requirement Increase of 1mil	0.72%	0.20%	0.00%	0.00%	7.13%	0.19%
32	Revenue Requirement Increase of 9.9mil	7.11%	6.74%	2.86%	0.00%	23.15%	6.70%
33							
34	**ADJUSTED REVENUE PERCENTAGE**						
35	MGE's Proposed Revenue Requirement Increase	100.00%	68.40%	20.24%	2.00%	9.36%	0.00%
36	Revenue Requirement Increase of 1mil	100.00%	68.23%	20.92%	2.21%	8.64%	0.00%
37	Revenue Requirement Increase of 9.9mil	100.00%	68.35%	20.23%	2.08%	9.34%	0.00%