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August 15, 2000

FILED
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Missouri Public Service Commission

Mr. Dale Hardy Roberts
Secretary/Chief Regulatory Law Judge
Missouri Public Service Commission
P. O. Box 360
Jefferson City, MO 65102

RE: Union Electric Company d/b/a AmerenUE
Case No. GR-2000-512

Dear Mr. Roberts:

Enclosed for filing in the above referenced case, please find the original and 8 copies of the **Direct Testimonies of James A. Busch (NP and P versions) and Hong Hu.** Please "file stamp" the extra enclosed copy and return it to this office. I have on this date mailed, faxed, or hand-delivered the appropriate number of copies to all counsel of record.

Thank you for your attention to this matter.

Sincerely,

D. E. Micheel

Douglas E. Micheel
Senior Public Counsel

DEM:kh

cc: Counsel of Record

Enclosure

32

Service List
Case No. GR-2000-512
August 15, 2000

Tom Byrne
Union Electric Company d/b/a AmerenUE
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Laclede Gas Company
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Exhibit No.:	____________
Issue(s):	Cost of Service; Rate Design
Witness/Type of Exhibit:	Hong Hu/Direct
Sponsoring Party:	Public Counsel
Case Nos.:	GR-2000-512

DIRECT TESTIMONY

OF

HONG HU

Submitted on Behalf of the Office of the Public Counsel

UNION ELECTRIC COMPANY
D/B/A AMERENUE

Case No. GR-2000-512

August 15, 2000

Exhibit No.:	______________
Issue(s):	Cost of Service; Rate Design
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DIRECT TESTIMONY

OF

HONG HU

Submitted on Behalf of the Office of the Public Counsel

UNION ELECTRIC COMPANY
D/B/A AMERENUE

Case No. GR-2000-512

August 15, 2000

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of Union Electric Company d/b/a AmerenUE for authority to file tariffs increasing rates for gas service provided to customers in the company's Missouri service area.	)))))	Case No. GR-2000-512

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 direct testimony consisting of pages 1 through 33 and Schedules DIR HH-1 through DIR HH-2.

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.

Hu Hong

Hong Hu

Subscribed and sworn to me this 15th day of August, 2000.

Bonnie S. Howard
Notary Public

My Commission expires May 3, 2001.

Table of Contents

DIRECT TESTIMONY
OF
HONG HU

UNION ELECTRIC COMPANY
D/B/A AMERENUE

CASE NO. GR-2000-512

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

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

Q. PLEASE SUMMARIZE YOUR EDUCATIONAL AND EMPLOYMENT BACKGROUND.

A. I hold a Bachelor of Engineering degree in Management of Information Systems from Tsinghua University of Beijing, China and a Masters of Arts degree in Economics from Northeastern University. I have completed the comprehensive exams for a Ph.D. in Economics from the University of Missouri at Columbia. I have been employed as a regulatory economist with the Office of Public Counsel (OPC) since March 1997.

Q. HAVE YOU TESTIFIED PREVIOUSLY BEFORE THIS COMMISSION?

A. Yes.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. I will present OPC's Class Cost of Service (COS) Study and the basis for OPC's rate design recommendations for this case. My testimony will describe how the Class COS results were derived and explain the rationale behind OPC's rate design recommendations. I will also discuss the details of OPC's proposed method for calculating the mains allocator.

I. CLASS COST OF SERVICE STUDY

Q. PLEASE OUTLINE THE BASIC ELEMENTS OF THE CLASS COS STUDY THAT YOU PERFORMED FOR THIS CASE.

A. The main purpose of a Class COS Study is to provide an estimate of the cost of providing service to each of the customer classes to be used as a basis for setting rates to the extent allowed by other rate design goals of the Commission. The three primary steps that must be taken in order to perform a Class COS Study are functionalization, classification, and allocation of costs.

Functionalization of costs involves categorizing accounts by the type of function with which an account is associated. Accounts are categorized as being related to Production, Transmission, Distribution, Customer Accounts, Administrative and General, etc., depending on the Local Distribution Company (LDC) functions of which they are a part. The FERC system of accounts is the starting point in functionalizing accounts since it already has most accounts grouped by functional area.

Once costs have been functionalized, they are classified as being customer (related to the number of customers), demand (related to the class portion of peak usage), commodity (related to annual throughput), or "other" related, depending on the classification with which they are most closely associated. For example, meter, regulator, and service line expenses are considered customer-related, since a certain amount of meter, regulator, and service line expense will be incurred solely for hooking a customer up to the LDC.

Finally, after classifying costs, the analyst chooses allocation factors that will distribute a fair share of jurisdictional costs to each customer class. Allocation factors are based on ratios that reflect the proportion of total units (total number of customers, total annual throughput, etc.) attributable to a certain customer class. These ratios are then used to calculate the proportions of various cost categories for which a class is responsible.

Q. WHICH CUSTOMER CLASSES HAVE YOU USED?

A. I have used customer rate classes that conform to the gas tariff of Union Electric Company (UE): Residential Service (Residential), General Service (GS), Interruptible Service with an Assurance Gas Option (Interruptible), and Transportation Service (Transportation).

Q. ON WHAT DATA IS YOUR CLASS COS STUDY BASED?

A. The Missouri Public Service Commission Staff (Staff) Accounting Schedules that were filed with the Staff's non-rate design testimony on August 8, 2000 were the source of most of the financial data that I utilized in my COS study. This data is from the test year that ended June 30, 1999 and updated through April 30, 2000. Most of the billing determinant information that I utilized was also provided by the Commission Staff. I have also utilized data received from UE in response to OPC Data Requests. My use of this information should not be viewed as an endorsement of either Staff's or UE's methods for calculating accounting costs or billing determinants. I have used this information because it was readily available and contains the level of detail necessary to perform a COS study.

Q. PLEASE DISCUSS THE METHODS THAT YOU USED TO ALLOCATE FUNCTIONALIZED COSTS. FIRST, HOW DID YOU ALLOCATE PLANT AND EXPENSE ACCOUNTS ASSOCIATED WITH MANUFACTURED GAS AND GAS STORAGE FACILITIES?

A. I allocated gas production costs on the basis of estimated peak day coincident sales demand since manufactured gas facilities are used primarily during periods of peak system demand. Gas storage costs were allocated on the basis of weather normalized winter sales volumes.

Q. HOW DID YOU ALLOCATE UNSUCCESSFUL EXPLORATION AND DEVELOPMENT (E & D) COSTS AND OTHER UTILITY PLANT (ACCOUNTS 338 AND 118.3)?

A Since the amounts in these accounts arise from UE's E & D efforts to reduce per unit gas costs, I allocated both of them on a commodity basis (annual gas sales).

Q. PLEASE DESCRIBE HOW OPC ALLOCATED TRANSMISSION AND DISTRIBUTION MAINS.

A. Transmission plant and distribution mains were allocated to all classes based on the modified relative system utilization method (RSUM) allocator. This allocator is developed on the basis of weather-normalized class monthly peak day demands. The underlying data was provided by the Staff. The steps to develop the modified RSUM allocator and the result are shown in Schedule DIR HH-1.1 through DIR HH-1.3. I have also included a separate section in this testimony to explain the rationale of this method.

Q. HOW WERE LAND AND LAND RIGHTS, AND STRUCTURES AND IMPROVEMENTS PLANT (ACCOUNTS 374, AND 375) ALLOCATED?

A. The costs associated with the land and land rights account and the structures and improvements account are mains-related costs and thus are allocated on the same basis as the mains account.

Q. HOW DID YOU ALLOCATE ACCOUNTS 380 THROUGH 383 (SERVICES, METERS, AND REGULATORS)?

A. Costs of service lines, meters and regulators are generally classified as customer-related costs since additional cost in these accounts is incurred with the addition of every customer. However, since larger customers generally use larger and more costly services, meters and regulators, a weighted customer allocation rather than a simple customer allocation is appropriate. The weight should reflect different unit costs of services, meters and regulators, different lengths of service lines, and different numbers of meters or service lines each customer uses for different customer classes. In some cases when detailed customer information is available, partial direct assignment is also possible. The details of how these allocators were calculated can be found in the direct testimony and workpapers of OPC witness James Busch.

Q. PLEASE DESCRIBE THE ALLOCATORS THAT YOU APPLIED TO THE REMAINING DISTRIBUTION ACCOUNTS.

A. I used total annual throughput to allocate Measuring and Regulating Station Equipment (Accounts 378 and 379). I allocated Other Equipment (Account 387) based on the allocation of all other previously allocated distribution plant.

Q. HOW DID YOU ALLOCATE GENERAL PLANT?

A. All General Plant accounts were allocated on the basis of each class' proportion of total non-general net plant.

Q. LET'S TURN NOW TO THE ALLOCATION OF OPERATION AND MAINTENANCE EXPENSES. HOW DID YOU ALLOCATE GAS DISTRIBUTION EXPENSES?

A. I used the "expenses follow plant principle" for allocating most of the accounts in this category. For example, the allocator that I applied to Mains plant (Account 376) was also applied to Mains maintenance (Account 887).

Q. HOW DID YOU ALLOCATE METER READING EXPENSES?

A. I used an allocator based on a weighted customer allocator that the Staff developed in a previous case. The weights developed were 3.42 for Small General Service and 9.04 for all the other large customers.

Q. HOW WERE CUSTOMER SERVICE AND SALES PROMOTION EXPENSES ALLOCATED?

A Customer Service accounts were allocated on the basis of unweighted customer numbers and Sales Promotion expenses were allocated based on my COS allocator. I chose to use the COS allocator for Sales Promotion expenses since these costs are incurred for the purpose of lowering the average margin cost (by increasing sales) of providing service to customers in each of the customer classes. The amount by which customers in each class benefit from a lower average cost will be proportional to the share of overall costs of service per customer that they are responsible for incurring.

Q. HOW DID YOU ALLOCATE ADMINISTRATIVE AND GENERAL (A & G) EXPENSES?

A. I divided these expenses into three categories. I allocated Property Insurance expense (Account 924) on the basis of net plant since this expense is linked to the amount of plant that the Company requires in order to serve each customer class. Injuries and Damages and Employee Pensions and Benefits (Accounts 925 and 926) are both payroll related expenses so they were allocated on the basis of the amount of payroll expense that I had previously allocated to each class. I believe all of the remaining A & G accounts represent expenditures that support the Company's overall operation, so I have allocated them on the basis of each class's share of total Company COS.

Q. HOW DID YOU ALLOCATE PROPERTY AND PAYROLL TAXES?

A. Property taxes were allocated on the basis of the amount of total plant that I had previously allocated to each class. Payroll taxes were allocated on the basis of the amount of payroll expenses that I had previously allocated to each class.

Q. HOW DID YOU ALLOCATE STATE AND FEDERAL INCOME TAXES?

A. These taxes are allocated on the basis of rate base since a utility company's income taxes are a function of the size of its rate base, and thus a class should contribute revenues for income taxes in accordance with the proportion of rate base that is necessary to serve it.

II. ALLOCATION OF MAINS COST - THE MODIFIED RELATIVE SYSTEM UTILIZATION METHOD

- ***Characteristics of Mains Cost***

Q. WHAT ARE THE CHARACTERISTICS OF MAINS COST?

A. First, mains cost is a shared cost. Public utilities such as UE are natural monopolies and have a characteristic called the economies of scope. The term "economies of scope" describes a phenomenon where if one company is the exclusive producer of multiple products or services within a geographic area (e.g. service territory), the total cost of production is less than the sum of stand-alone cost of production by multiple specialized companies each producing only one product or service. In our case, the Company's investment in mains provides the Company with the means to deliver the gas to locations of all customer classes in response to customers' year-round demands for natural gas. All customers benefit from the existence of mains on every day that they use gas. The total costs of mains for UE are much less than the sum of stand-alone costs of mains if there was one company that served industrial customers and another company that served residential customers and so on; or if there was one company that served people's needs for heating and another that served people's needs for cooking and so on.

The second characteristics of mains cost is the presence of economies of scale. The term "economies of scale" describes a phenomenon where average cost declines with increases in the output level. For example, according to various flow formulas, with other factors held constant, a 4" pipe has a flow capacity of about 6 times of that of a 2" pipe. On the other hand, the per foot cost to install the 4" pipe may be less than 2 times the cost to install the 2" pipe. This means that the cost of the incremental capacity needed to serve the peak is less than the average cost of capacity.

For reference, I have attached a table that our former engineer Barry Hall presented in the last UE rate case. This table shows the comparison of available flow capacity for some common sizes of mains based on the flow capacity of a 2" main being equal to one.

Table 1. Relative Flow Capacity vs. Main Diameter[1]

Main Diameter	Relative Flow Capacity (2" Dia. Main = 1.0)
2"	1.0
4"	6.3
6"	18.6
8"	40.0
12"	117.5
24"	742.4

[1] Barry F. Hall, Direct Testimony, Case No. GR-97-393, page 7.

Q. HOW SHOULD ECONOMIES OF SCOPE RELATED TO THE COST OF MAINS BE REFLECTED IN THE ALLOCATION OF MAINS?

A. When economies of scope are present, the total cost of the transmission and distribution system for delivering gas to the residential, general service, industrial and transportation classes are much less than the sum of the stand-alone costs of the separate distribution systems for delivering gas to each of the customer classes. Generally, when allocating shared cost of joint production, no cross subsidization should be present. The term cross subsidization describe a situation when the revenues earned on part of the total output of the industry is more than the stand-alone production cost of that part. The general principle of no cross subsidization means that no group of customers should pay more than they would have paid if they were to provide their own products and services using the best available production techniques. It follows from this that the revenue requirement for any customer class should be at least as large as the incremental cost to provide services to this class because otherwise somebody else will be forced to pay for more than its stand-alone cost.

The implication of this characteristic is that a just and reasonable cost allocation to a customer class ranges from the incremental cost to the stand-alone cost of providing services to that class. A judgement call is required to determine which point in this range is the most just and reasonable cost allocation. Different factors can be bought in to the judgement. In fact, different decisions about whether the stand alone cost, the incremental cost, or a cost that is somewhere in the middle should be allocated to a product or a customer is one of the main reasons why different parties have different cost of service study results and different rate designs to recover the costs. One thing is clear though, a just and reasonable solution should ask each customer class to pay for more than their respective incremental cost. The total cost will not be covered if each class only pays for its incremental cost.

Q. HOW SHOULD ECONOMIES OF SCALE RELATED TO COST OF MAINS BE REFLECTED IN THE ALLOCATION OF MAINS?

A: When economies of scale are present, the incremental cost burden that the system peak load imposes to the transmission and distribution system over average load is not proportionate to the ratio of peak load to average load. In other words, it costs proportionately less to set up a transmission or distribution system that has a larger capacity than one that has a smaller capacity. In fact, the incremental cost is much smaller than what it is commonly believed to be. The implication of this characteristic in cost allocation is that we should not allocate total demand-related cost corresponding to demand as if there is a direct one to one relationship between costs and the level of demand. Instead, we need to translate the demand ratios of each customer class to the corresponding cost ratios according to their non-linear relationship. For example, if the peak demand is twice of the average demand, it is incorrect to simply allocate half of the total mains cost to customers who use gas at the peak period. The correct way would be to find out how much cost would actually be incurred to satisfy the increment of peak demand over average demand and allocate that portion of cost to customers who use gas at the peak period. In this example, when economies of scale are considered, we will find that much less than half of the total cost should be allocated to customers who use gas at the peak period.

- ***Traditional Mains Allocation Methods***

Q. PLEASE COMMENT ON TRADITIONAL MAINS ALLOCATION METHODS.

A. There are a wide variety of alternative methods for allocating and determining capacity-related costs such as mains cost and they produce drastically different cost assignments to the various customer classes. The methods that I've come across in my past experiences includes the following: the peak demand responsibility methods, the average and peak demand allocation method, the average and excess demand method, the minimum-size method and the zero-intercept method.

Q. PLEASE DESCRIBE THE PEAK DEMAND RESPONSIBILITY METHODS.

A: A commonly used group of methods is called the peak demand responsibility method. This group of methods allocates the main costs on coincident or non-coincident peak demand. Among this group, the single system coincident peak (1CP) demand allocation method uses the single annual system peak to measure customer cost responsibility. The assumption of this method is that since the overriding factor that drives the cost of the system is the highest peak demand, the incremental cost of delivering gas on any day other than the peak day is zero. Therefore, this method allocates the total cost to the peak day and allocates zero cost to the other days. This method fails to reflect the fact that the utility system is built to satisfy the customers' daily demand for gas, not only the demand on the peak day and that it is not just to allocate the entire cost of the joint production to one single day. An example of the shortcoming of 1CP method is that no cost will be allocated to the interruptible class because theoretically they would be off the system during the peak day. In other words, these interruptible customers would be receiving a "free ride" to use the distribution main system without paying a fair share of its costs. According to the 1CP method, if a customer always uses gas during non-system-peak period, then the incremental cost to serve this customer is virtually zero. However, the stand-alone cost of serving this customer could be very large. There is no reason why this customer should get a free ride and enjoy annual delivery of gas without paying any transmission or distribution costs.

Another single non-coincident peak demand (1NCP) allocation method attempts to correct the problem with the 1CP method by allocating the cost of the facilities in accordance with each customer's contribution to the sum of the maximum demands of all customers' imposed on the facilities. This method will allocate some cost to the interruptible customers since their non-coincident demand is not zero. However, this method still suffers from the flaw that it does not recognize that the system is built for the joint production to satisfy the everyday usage needs for gas by all customers. It essentially allocates all costs to the one day of usage when the class non-coincident peak happens for the class and allocates nothing to the non-peak usage in the rest of the year.

Improvements to the 1CP demand allocation method also includes multiple CP demand allocation methods. The average seasonal system coincident peak method utilizes the average CP demand for the three or four months in the peak season as the measurement to replace the one single CP. The rational of this method is that because of heating and air conditioning loads, a utility may experience peak demands of comparable magnitude during different seasons of the year. Therefore, it allocates costs according to the customer's share of demands in these peak months and disregards the other months by allocating zero incremental costs to those months.

The 12CP method utilizes the average of the 12 monthly system coincident peak as the measurement of customer's cost responsibility. This method is normally used when a utility installs facilities to maintain a reasonably constant level of reliability throughout the year or when significant variations in monthly peak demands are not present. Thus the total cost is shared among the 12 months of the year and no more weight is given to any month over other months.

Q. PLEASE DESCRIBE THE AVERAGE AND PEAK DEMAND METHOD.

A: The average and peak demand (A&P) method attempts to account for the annual energy supply needs of the company in addition to the capacity needs. Total mains cost are multiplied by the system's load factor to arrive at the capacity costs attributed to average use and these capacity costs are apportioned to the various customer classes on an annual energy usage basis. The rest of the costs are considered to have been incurred to meet the individual peak demands of the various classes of service. For example, if the load factor is 55%, then 45% of the total mains cost is considered to have been incurred because of the peak demand and is allocated to peak users. This method has addressed the issue of economies of scope in joint production by allocating part of the total cost in accordance with annual usage instead of peak demand.

Both the A&P method and the peak responsibility methods suffer from the flaw of allocating too much costs to peak users because they fail to consider economies of scale and assign peak-related cost in direct proportion of the peak demand. As I discussed earlier, the assumption that cost is directly proportionate to demand is wrong and methods based on this assumption will likely to produce an unreasonable allocation of costs.

Q. PLEASE DESCRIBE THE AVERAGE AND EXCESS METHOD.

A: The "average and excess" (A&E) allocation method appears to be similar to the A&P method because both methods divide the total cost into two parts based on the system load factor and both methods allocate the energy portion based on average annual usage. However, this method differs drastically from the A&P method in its allocation of the demand portion. It emphasizes the extent of the use of capacity resulting in allocation of a decreasing proportion of capacity costs to a customer group as its load factor increases. By allocating demand-related cost based on excess demand, this method rewards customers who use the system in a continuous manner and have little excess demand, and penalizes customers with low load factors and high excess demand. The result of this method goes in the opposite direction of a method that considers economies of scale in providing additional capacity. For a customer class that has higher peak demand ratio over average demand, a method that considers economies of scale will allocate less cost to the additional capacity than its proportion of total demand in recognition that it actually costs less to provide that additional cost; while the A&E method will allocate more cost than its proportion of the total demand and panelize the customer's high peak usage. The following example illustrates the results of the four allocation methods for two customers with different load factors.

Table 2. Demand and usage information of two customers with different load factors

Customer	Average demand	Peak demand	Excess demand
Customer 1	100	100	0
Customer 2	100	200	100
Total	200	300	100
System load factor	67%		
Incremental cost for peak demand (assume the economies of scale factor=0.5)	$67\%^{0.5}$ = 82%	1-0.82 = 18%	

Table 2.1 A comparison of different allocation methods

Customer	1 CP/NCP allocation method	A&P allocation method	A&P with consideration of economies of scale	A&E allocation method
Customer 1	0.33	0.5*67%+0.33*33% = 0.44	0.5*82%+0.33*18% = 0.47	0.5*67%+0*33% = 0.33
Customer 2	0.67	0.5*67%+0.67*33% = 0.56	0.5*82%+0.67*18% = 0.53	0.5*67%+1*33%= 0.67
Total	1.00	1.00	1.00	1.00

The above example shows that different cost allocations could be generated by different allocation methods based on the same demand and usage data. As shown in this example, although the A&E method allocates a portion of the total cost based on annual usage, its end result is usually very similar to the result of a 1 CP/NCP method. In this example, the 1CP/NCP method and the A&E method allocate relatively more cost to the customer who has a lower load factor and the A&P method with or without economies of scale modification allocate relatively less cost to the customer who has a lower load factor.

It should be noted that since the A&E allocation method rewards customers with high load factor and penalize customers with low load factor, some people might argue that the adoption of this method would promote better utilization of the system.

Q. DOES THE A&E METHOD PROMOTE BETTER UTILIZATION OF THE SYSTEM?

A: No. It is not likely that adopting this method will promote better utilization of the system. The low load factor customers of the utility are normally the weather sensitive customers such as residential customers and small commercial customers. The fact that they need more gas for heating in the winter and their resulted low load factor is not likely to be changed regardless of whether they are penalized or not. These customers only have limited control over their need for gas in the winter season since heat must be provided for homes, especially during system peaks resulting from cold weather. It is not fair for them to be penalized by paying proportionately more than their fair share of cost.

Q. PLEASE DESCRIBE THE MINIMUM-SIZE METHOD.

A: The minimum-size method assumes that a minimum size distribution system can be built to serve the minimum load requirements of the customer. Once the minimum size of the facility is determined, the corresponding cost of the minimum size distribution system is classified as customer-related costs and allocated based on customer numbers. The difference between the total costs and the customer-related costs is believed to be incurred to satisfy different demands by customers and thus is allocated based on demands. The main flaw with this method is that the minimum size facility has a certain load-carrying capacity.

Therefore, this method results in a double allocation of cost to small users. Small users would be allocated the cost of a minimum size distribution system that already satisfies much of their demand needs. In addition, small users would be allocated another portion of the cost based on their demands. It is likely that this method would result in some small customers receiving an allocated cost that is greater than their stand-alone cost.

Q. PLEASE DESCRIBE THE ZERO-INTERCEPT METHOD.

A: The zero-intercept method is also called the minimum-intercept method. It assumes that a no-load distribution system can be identified and allocated based on customer numbers. The general technique of this method is to relate installed cost to current carrying capacity or demand rating. A curve is created for various sizes of the equipment involved, using regression techniques, and this curve is extended to a zero (no load) intercept. It has been argued that a portion of the distribution mains costs are incurred solely to reach the customer's premise. Then incremental costs are incurred to satisfy different levels of the customer's demands. The problem with this method is that it attempts to identify the cost of something that does not physically exist and cannot actually be measured. The reference of a point that is outside the range that is defined by available data is generally forbidden in statistics because unreliable results can often be obtained. In fact, the zero-intercept method has obtained negative cost for the no load portion of the system in a prior case before this Commission[2].

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[2] Case No. EO-88-158, In the matter of the investigation of the electric class cost of service for St. Joseph Light & Power Company.

- ***The Modified RSUM Method***

Q. PLEASE EXPLAIN THE MODIFIED RELATIVE SYSTEM UTILIZATION METHOD.

A. The RSUM method was developed by Charles Laderoute in a paper that he presented at the 1988 NARUC Biennial Regulatory Information Conference and modified by former OPC economist Philip Thompson in a paper he presented at the 1992 NARUC Biennial Regulatory Information Conference. The modified RSUM method attempts to account for both economies of scale and the fact that all users who receive benefits from the joint production of the system should share its cost. The basic idea of this method is to identify the portion of capacity that corresponds to each month's demand, and allocate the cost that corresponds to that capacity to customers who use gas in the month that this portion of the system is used. For example, if 50% of capacity is used in 12 months of the year and 55% of capacity is used in 11 months, the extra 5% of capacity is not utilized in one month, say, July. Then the cost corresponding to 50% of capacity is allocated to every month, and customers who use gas in every month but July will also receive a share of the cost that is corresponding to the additional 5% capacity. This method attempts to find a way to allocate cost that is between the incremental cost and the stand alone cost for each customer class by weighting the usage share of each customer class on the relative system utilization of each month.

Q. PLEASE PROVIDE A STEP BY STEP DESCRIPTION OF THE MODIFIED RELATIVE SYSTEM UTILIZATION METHOD.

A. Please refer to Schedule DIR HH-1.1. The first table lists the monthly peak demands for all customer classes that were provided by the Staff witness Dan Beck. The second table presents the same information but the data is sorted by total class demands in descending order.

In Schedule DIR HH-1.2, the first and second column repeats the total class demands information that appeared in the second table on Schedule DIR HH-1.1. In column (3) (Months % of Highest Peak), the peak day demands are converted to percentages of the maximum monthly peak day demand. For instance, February, the month having the second highest peak day demand has a peak that is 94.45% of the maximum peak day demand. Another way of stating this is that there is an 5.55% increment of demand separating the two months (January and February).

In column (4), the percentages of peak day are converted to percentages of total capacity costs by raising the capacity percentages to the ***r***th power. Here, I have chosen ***r*** to be 0.3.

Considering columns (3) and (4) it is easy to state what is indicated by the mathematical relationship here. The first 14.53% of capacity requires an expenditure of more than 56% of the costs of the system, i.e. there are substantial fixed costs involved. Likewise, 52.39% or approximately half of the capacity requires over 82% of the total costs to supply. Conversely, adding roughly the <u>last</u> 50% of the capacity accounts for less than 20% of the costs.

The next column, column (5), simply calculates successive differences in percentages of costs from column (4). The top figure is the difference in percentage costs incurred to supply the additional capacity in moving from the second highest monthly peak to the maximum monthly peak day demand. The second figure in this column is the same difference, only moving from the third highest monthly peak to the second highest monthly peak.

Column (6) depicts the number of months over which that cost increment should be spread. The first (highest or top increment) cost increment, occurring only on the peak day of one month is only spread to that month. The next increment of cost/capacity is utilized for two months. The last or base increment is utilized in all the months. In column (7), each cost increment is divided by the number of months in which the corresponding capacity increment is utilized.

In the last column, column (8), partial sums are formed for the cost increments utilized in each month. For instance, the peak month sums all the increments of costs in the previous column, since all increments of capacity are used in that month. The next partial sum for the next lowest month omits the top cost increment in its sum and so on. The result is the percentage of capacity costs attributable to each month.

Refer to Schedule DIR HH-1.3. The top table of numbers is the class peak day demands by month. In the bottom table, class peaks have been converted to percentages of the sum of peak day demands for all the classes each month.

In Schedule DIR HH-1.4, each cell in the top table shows the product of the class share of monthly peaks on bottom table of Schedule DIR HH-1.3 and the portion of total capacity costs in each month in column (8) of Schedule DIR HH-1.2.

Here each customer class's share in the usage of each month is weighted by the relative system utilization of that month. Summing up these numbers for each customer class gives the RSUM allocators at the bottom table of Schedule DIR HH-1.4. These are allocators that are applicable to the shared cost of the transmission and distribution mains.

Q. PLEASE EXPLAIN YOUR CHOICE OF THE ECONOMIES OF SCALE FACTOR IN THE DEVELOPMENT OF THE MODIFIED RSUM ALLOCATOR.

A: The factor ***r*** is a measurement of the degree of the economies of scale. There will be no economies of scale if ***r*** equals to 1. The larger ***r*** is, the less economies of scale is assumed. According to different pipe flow rate formulas that are presented in the Gas Distribution manual that is published by the IGT Home study course, the flow capacity is directly related to the approximate 2.665 power of the diameter of a pipe (See Attachment 1). The empirical studies of our former engineer Barry Hall have also confirmed this number. The number 0.3 stands for a conservative estimate of the economies of scale. By using this number, I have only accounted for the economies of scale due to the fact that pipe capacities increases faster than its size, but have not accounted for the economies of scale due to the fact that pipe cost increases slower than its size.

Q. PLEASE COMMENT ON THE MODIFIED RSUM ALLOCATION METHOD IN COMPARISION WITH OTHER TRADITIONAL ALLOCATION METHODS.

A: In the traditional methods, demand in each month is giving a weight of either 1 or 0. The total system cost is shared among those months that has a weight of 1, and zero cost is allocated to the months with a weight of 0. For example, 1 CP method gives the month with the highest system coincident demand a weight of 1 and allocates the total cost to that month. 12 CP method, on the other hand, assigns a weight of 1 to each of the 12 months. The RSUM method properly address the issue of the economies of scope by assigning different weights to different months according their relative importance in the system costs. Furthermore, unlike the traditional allocation methods, the modified RSUM method gives sufficient recognition to the economies of scale that exist in the transmission and distribution mains system.

III. CLASS COST OF SERVICE STUDY RESULTS AND RATE DESIGN ANALYSIS

- ***Class Cost of Service***

Q. PLEASE DESCRIBE THE RESULTS OF OPC'S CLASS COS STUDY.

A. Schedule DIR HH-2.1 shows the results of OPC's Class COS Study which was based on the assumption that total company revenues remain constant. It is important to note that all of the numbers appearing in this testimony's tables and the attached schedules are in thousands (e.g. $10,000 in testimony tables is actually $10,000,000.) The fourth line from the bottom of this schedule (line number 36) shows the percentage by which margin rate revenues in each class would have to change in order to make the rates of return for all customer classes equal to the Company's overall rate of return. The fifth line from the bottom of this schedule (line number 35) shows the revenue shifts that would be needed to equalize class rates of return. The information from lines 35 and 36 of Schedule DIR HH-2.1 is summarized below in Table 1 for the reader's convenience.

Table 1 – COS Indicated Class Revenue Shifts (000)

	Residential	General Service.	Interruptible	Transportation
Class Shifts	742	(1,523)	169	612
% Change	3.23%	-14.46%	22.19%	15.20%

As line 19 on Schedule DIR HH-2 indicates, the margin rate levels for the Residential class and the GS class are currently producing returns that exceed the total company return. Conversely, the Interruptible and transportation classes are currently producing a return below the level of the total company return. This class rate of return information is summarized below in Table 2.

Table 2 – COS Indicated Customer Class Returns

	Residential	General Service.	Interruptible	Transportation
Returns	6.88%	12.47%	3.25%	4.79%

I will furnish the more detailed workpapers that support OPC's COS study to any party requesting them.

- ***Class Revenue Requirement and Rate Design Analysis***

Q. WHAT IS THE RELATIVE IMPORTANCE OF CLASS COS STUDY RESULTS IN RATE DESIGN?

A. My understanding is that the statutory obligation of the Commission is to set just and reasonable rates. A CCOS study provides the Commission with a general guide as to the just and reasonable rate for the provision of service that corresponds to costs. Other factors must be considered when determining the just and reasonable rate for a service. These factors include the value of service, affordability, rate impact, and rate continuity. The manner in which all these factors are balanced by the Commission in setting the rates can only be determined on a case-by-case basis.

Q. WHAT RATE DESIGN PRINCIPLE IS OPC PROPOSING BASED ON THE REVENUE SHIFTS NEEDED TO EQUALIZE CLASS RATES OF RETURN INDICATED IN TABLE1 FOR THIS CASE?

A. OPC recommends that the Commission adopt a rate design that balances movement towards cost of service with rate impact and affordability considerations. To reach this balance, OPC believes that the Commission should impose, at a maximum, revenue shifts equal to one half of the revenue neutral shifts indicated by OPC's CCOS study. In addition, if the Commission determines that an increase in total company revenue requirements is necessary, then no customer class should receive a net decrease as the combined result of: (1) the revenue neutral shift that is applied to that class, and (2) the share of the total revenue increase that is applied to that class.

Q. WHAT REVENUE NEUTRAL CLASS REVENUE SHIFTS IS OPC RECOMMENDING IN THIS CASE?

A. These shifts are shown in lines 38 and 39 of Schedule DIR HH-2.1 and have also been summarized below in table 3.

Table 3 – OPC Recommended Class Revenue Shifts (000)

	Residential	General Service.	Interruptible	Transportation
Class Shifts	371	(762)	85	306
% Change	1.61%	-7.23%	11.10%	7.60%

Q. PLEASE DESCRIBE THE INFORMATION CONTAINED IN SCHEDULE DIR HH-2.2 AND EXPLAIN HOW IT WAS CALCULATED.

A. Schedule DIR HH-2.2 shows how OPC's rate design principle can be applied assuming the Commission approved total company revenue increase is $2 million. The same series of calculations can be repeated for any revenue requirement increase or decrease that is determined by the Commission. The schedule illustrates the combined impact of spreading the potential revenue requirement increase amounts to customer classes and the revenue neutral class revenue shifts recommended by OPC. Line 14 of this Schedule shows how the revenue requirement increase has been spread to the various customer classes. The spread of the revenue requirement increase amount is based on the percentages that appear in line 12 of Schedule DIR HH-2.1.

Q. HOW WERE THE REVENUE PERCENTAGES IN LINE 12 OF SCHEDULE DIR HH-2.2 CALCULATED?

A. These percentages were calculated by taking the recommended revenue neutral shifts that appear in line 10 of Schedule DIR HH-2.2 (also in line 38 of Schedule DIR HH-2.1) and adding them to total current class revenues (line 12 of Schedule DIR HH-2.1). This percentage is equal to the ratio of the sum of these two amounts to the amount of total company non-gas revenues (see line 12 of Schedule DIR HH-2.1).

Q. PLEASE EXPLAIN HOW THE COMBINED IMPACT AMOUNTS THAT APPEAR IN LINES 17 OF SCHEDULE DIR HH-2.2 WERE CALCULATED.

A. The combined impact was derived by adding each classes' share of the overall revenue requirement increase to the revenue neutral shifts that OPC has recommended for each class. For example, under the residential column in line 14, we see the $1,220 (actually $1,220,000) that results from spreading a revenue requirement increase of $2,000,000 to the residential class. This $1,220,000 amount is then added to the $371,000 revenue neutral shift amount for the residential class that appears in line 9. The sum of these two amounts, $1,591,000, appears in line 19 under the residential column and represents OPC's recommendation for the combined impact of revenue neutral shifts and share of overall revenue requirement increase that should be reflected in rates resulting from this case if the overall revenue requirement is increased by $2 million.

Q. PLEASE EXPLAIN HOW THE ADJUSTED COMBINED IMPACT AMOUNTS THAT APPEAR IN LINES 19 OF SCHEDULE DIR HH-2.2 WERE CALCULATED.

A. Based on rate impact and equity considerations, I believe that no customer class should receive a net class rate revenue increase when there is an overall revenue requirement reduction and no customer class should receive a net class revenue decrease when there is an overall revenue requirement increase. The combined impact of revenue increase and OPC's revenue neutral shift numbers are thus adjusted further to reflect this consideration. For example, for the case of a $2 million increase, line 17 of Schedule DIR HH-2.2 shows that the spread of the overall revenue increase to the GS class is too small to offset its revenue neutral shift thus it ends up with a net decrease. In this case I recommend: (1) keeping the current class rate revenue requirement for this class unchanged; (2) giving the other three classes their share of the increase; and (3) reducing the increase in the class revenue requirement for these three classes by an amount equals to the sum of net decreases for the GS class that were eliminated. Line 25 shows the class revenue percentage results from this series of allocation of total company revenue requirement to each class.

Q. PLEASE SUMMARIZE OPC'S RATE DESIGN RECOMMENDATION FOR THE CLASS REVENUE REQUIREMENTS THAT SHOULD RESULT FROM ANY INCREASE OR REDUCTION IN OVERALL REVENUE REQUIREMENT THAT THE COMMISSION DETERMINES TO BE REASONABLE IN THIS CASE.

A. In this testimony, OPC has proposed and illustrated the application of a method for increasing or decreasing **class** revenue requirements to go along with any increase or reduction in the **overall** revenue requirement. This method could be utilized to calculate class revenue requirements for any level of overall revenue requirement increase or reduction that is ultimately decided in this case. Schedule DIR HH-2.2 shows the result of applying OPC's recommended method for determining class revenue requirements to a potential revenue requirement increase level of $2 million. OPC could supply similar calculations to the Commission for any other amounts of change in the overall revenue requirement if requested to do so.

IV. SPECIFIC RATE DESIGN RECOMMENDATIONS

Q. DID YOU PERFORM ANY ANALYSIS TO SEE IF UE'S PROPOSED RESIDENTIAL CUSTOMER CHARGE INCREASE IS JUSTIFIED BASED ON THE CUSTOMER-RELATED COSTS THAT ARE ATTRIBUTABLE TO THE RESIDENTIAL CLASS?

A. Yes, my analysis showed that the customer-related cost, which is one of the factors considered in the determination of a customer charge level, is $9.76. My customer-related cost calculation was based on the assumption that UE's costs are accurately reflected in the accounting schedules contained in the Staff's direct testimony filing.

Q. WHAT CATEGORIES OF COSTS ARE INCLUDED IN YOUR CUSTOMER CHARGE ANALYSIS?

A. I have included costs that are related to services, meters, regulators, and customer accounts expenses. The costs associated with services, meters, and regulators include the return on rate base for the relevant plant accounts, distribution operation and maintenance expenses associated with services, meters, and regulators, plus the depreciation expense associated with services, meters, and regulators.

Q. WHAT IS OPC'S PROPOSAL FOR THE CUSTOMER CHARGE FOR RESIDENTIAL CUSTOMERS?

A. OPC recommends increasing the residential customer charge from its current level of $8.00 to $8.50. Elevating the customer charge to $8.5 will increase UE's residential customer's customer charge by 15%. OPC believes that this is the largest increase possible without giving the residential customer an unreasonable burden. This 50-cent increase will allow the Company to recover most of its customer related cost through the customer charge.

Q. WHAT IS OPC'S RATE DESIGN PROPOSAL FOR THE OTHER RATE COMPONENTS OF THE RESIDENTIAL CLASS AND FOR THE OTHER CUSTOMER CLASSES?

A: For the residential class, OPC proposes to recover all the rest of revenue requirement increases through an increase in the delivery charge. Assuming a $2 million revenue increase, this will result in the Residential delivery charge being increased from 17.56 cents per ccf to approximately 18.85 cents. This would increase the current delivery charge by approximately 7.37%.

Furthermore, OPC proposes increasing the customer charges for the GS and interruptible classes to be $17.50 and $275 respectively. We are not recommending any changes to the standard transportation and large volume transportation customer rates at this time because OPC's cost of service study does not contain cost breakdowns within the transportation class that are needed to determine separate rate schedules within the transportation class. OPC recommends an equal percentage increase or decrease to all the other demand charges and volumetric charges so that the total class revenue increase will match the recommendation that is shown at Schedule HH DIR-2.2, line 19. The details of this rate design recommendation under an assumed $2 million total revenue requirement increase are shown at Schedule HH DIR-3.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes.

Developing Modified RSUM Mains Allocators

	Residential Service Rate	General Service Rate	Interruptible	Transportation	Total
Jul-98	43,874	35,297	17,969	113,522	210,661
Aug-98	50,932	38,972	24,656	110,134	224,694
Sep-98	177,509	104,295	19,605	117,897	419,305
Oct-98	328,846	182,307	21,527	118,859	651,539
Nov-98	507,683	274,524	26,609	136,471	945,287
Dec-98	722,686	385,541	28,966	159,248	1,296,441
Jan-99	818,274	434,773	28,351	168,594	1,449,992
Feb-99	748,317	398,697	26,998	195,566	1,369,578
Mar-99	533,141	287,706	26,621	158,296	1,005,765
Apr-99	362,267	199,571	23,884	173,928	759,649
May-99	209,249	120,684	17,461	135,114	482,508
Jun-99	79,151	53,629	23,826	119,178	275,784
Annual	818,274	434,773	28,966	195,566	1,477,579

	Residential Service Rate	General Service Rate	Interruptible	Transportation	Total
Jan-99	818,274	434,773	28,351	168,594	1,449,992
Feb-99	748,317	398,697	26,998	195,566	1,369,578
Dec-98	722,686	385,541	28,966	159,248	1,296,441
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Jun-99	79,151	53,629	23,826	119,178	275,784
Aug-98	50,932	38,972	24,656	110,134	224,694
Jul-98	43,874	35,297	17,969	113,522	210,661

Developing Modified RSUM Mains Allocators

Economy of Scale Factor[1]

***r* = 0.3**

(1)	(2) Total	(3) Months % of Highest Peak	(4) % of Cost To Satisfy	(5) % Cost Increment in Month Over Prev	(6) No. Months w/ Increment	(7) Increment/ Months Occuring	(8) Sum Cost Increments Occurring Each Month
Jan-99	1,449,992	100.00%	100.00%	1.70%	1	1.70%	14.39%
Feb-99	1,369,578	94.45%	98.30%	1.61%	2	0.80%	12.69%
Dec-98	1,296,441	89.41%	96.70%	7.09%	3	2.36%	11.89%
Mar-99	1,005,765	69.36%	89.61%	1.65%	4	0.41%	9.52%
Nov-98	945,287	65.19%	87.95%	5.58%	5	1.12%	9.11%
Apr-99	759,649	52.39%	82.37%	3.71%	6	0.62%	8.00%
Oct-98	651,539	44.93%	78.66%	6.78%	7	0.97%	7.38%
May-99	482,508	33.28%	71.89%	2.96%	8	0.37%	6.41%
Sep-98	419,305	28.92%	68.92%	8.14%	9	0.90%	6.04%
Jun-99	275,784	19.02%	60.78%	3.62%	10	0.36%	5.13%
Aug-98	224,694	15.50%	57.16%	1.10%	11	0.10%	4.77%
Jul-98	210,661	14.53%	56.06%	56.06%	12	4.67%	4.67%

Notes:

1 Each months percentage of highest monthly peak is raised to the *rth* power to convert succesive monthly increments of capacity to increments of costs.

Developing Modified RSUM Mains Allocators

	Residential Service Rate	General Service Rate	Interruptible	Transportation	Total
Jan-99	818,274	434,773	28,351	168,594	1,449,992
Feb-99	748,317	398,697	26,998	195,566	1,369,578
Dec-98	722,686	385,541	28,966	159,248	1,296,441
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Sep-98	177,509	104,295	19,605	117,897	419,305
Jun-99	79,151	53,629	23,826	119,178	275,784
Aug-98	50,932	38,972	24,656	110,134	224,694
Jul-98	43,874	35,297	17,969	113,522	210,661

	Residential Service Rate	General Service Rate	Interruptible	Transportation	Total
Jan-99	56.43%	29.98%	1.96%	11.63%	100.00%
Feb-99	54.64%	29.11%	1.97%	14.28%	100.00%
Dec-98	55.74%	29.74%	2.23%	12.28%	100.00%
Mar-99	53.01%	28.61%	2.65%	15.74%	100.00%
Nov-98	53.71%	29.04%	2.81%	14.44%	100.00%
Apr-99	47.69%	26.27%	3.14%	22.90%	100.00%
Oct-98	50.47%	27.98%	3.30%	18.24%	100.00%
May-99	43.37%	25.01%	3.62%	28.00%	100.00%
Sep-98	42.33%	24.87%	4.68%	28.12%	100.00%
Jun-99	28.70%	19.45%	8.64%	43.21%	100.00%
Aug-98	22.67%	17.34%	10.97%	49.02%	100.00%
Jul-98	20.83%	16.76%	8.53%	53.89%	100.00%

Developing Modified RSUM Mains Allocators

	Residential Service Rate	General Service Rate	Interruptible	Transportation	Total
Jan-99	8.12%	4.31%	0.28%	1.67%	14.39%
Feb-99	6.93%	3.69%	0.25%	1.81%	12.69%
Dec-98	6.63%	3.54%	0.27%	1.46%	11.89%
Mar-99	5.05%	2.72%	0.25%	1.50%	9.52%
Nov-98	4.89%	2.65%	0.26%	1.32%	9.11%
Apr-99	3.81%	2.10%	0.25%	1.83%	8.00%
Oct-98	3.72%	2.06%	0.24%	1.35%	7.38%
May-99	2.78%	1.60%	0.23%	1.79%	6.41%
Sep-98	2.56%	1.50%	0.28%	1.70%	6.04%
Jun-99	1.47%	1.00%	0.44%	2.22%	5.13%
Aug-98	1.08%	0.83%	0.52%	2.34%	4.77%
Jul-98	0.97%	0.78%	0.40%	2.52%	4.67%
Total	48.02%	26.79%	3.68%	21.50%	100.00%

	Residential Service Rate	General Service Rate	Interruptible	Transportation	Total
RSUM Allocators	**48.02%**	**26.79%**	**3.68%**	**21.50%**	100.00%

OPC Cost of Service Results and Rate Design Analysis

	TOTAL COST OF SERVICE SUMMARY (000)		TOTAL	Residential	General Service Rate	INTER-RUPTIBLE	Transportation
1	O & M Expenses		15,580	10,175	3,524	342	1,539
2	Depreciation Expenses		4,893	3,075	1,098	116	605
3	Taxes		7,615	4,535	1,851	199	1,029
4							
5	TOTAL - Expenses and Taxes		28,088	17,785	6,472	657	3,174
6							
7	Current Revenue (non-gas)						
8	Rate Revenue (non-gas)		38,314	22,992	10,530	763	4,029
9	Late Payment Charges	20	-	-	-	-	-
10	Other Revenue (reverse S6.5)	20	468	290	110	11	57
11							
12	TOTAL - Current Revenues		38,782	23,282	10,640	774	4,085
13	Current Revenue Percentage		100.00%	60.03%	27.44%	2.00%	10.53%
14							
15	OPERATING INCOME		10,694	5,497	4,168	117	912
16							
17	TOTAL RATE BASE		135,966	79,895	33,430	3,603	19,038
18							
19	Implicit Rate of Return (ROR)		7.87%	6.88%	12.47%	3.25%	4.79%
20							
21	OPC Recommended Rate of Return		8.900%	8.900%	8.900%	8.900%	8.900%
22							
23	Recommended Operating Income With OPC ROR		12,101	7,111	2,975	321	1,694
24							
25	Class COS at OPC's Recommended Rate of Return		40,189	24,896	9,448	978	4,868
26	Revenue Percentage		100.00%	61.95%	23.51%	2.43%	12.11%
27							
28	Allocation of Difference Between Current						
29	Revenue and Recommended Revenue	20	1,407	872	331	34	170
30							
31	Margin Revenue Required to Equalize						
32	Class ROR - Revenue Neutral		38,782	24,024	9,117	943	4,698
33	Revenue Percentage		100.00%	61.95%	23.51%	2.43%	12.11%
34							
35	Rev. Neutral Shift to Equalize Class ROR		(0)	742	(1,523)	169	612
36	Rev. Neutral Shift Percentage to Equalize Class ROR			3.23%	-14.46%	22.19%	15.20%
37							
38	Recommended Revenue Neutral Shift = 1/2 indicated shift			371	(762)	85	306
39	OPC Recommended Revenue Neutral Shift Percentage			1.61%	-7.23%	11.10%	7.60%
40	Class Revenue Percentages After Rec. Rev. Neutral Shift			60.99%	25.47%	2.21%	11.32%

OPC Cost of Service Results and Rate Design Analysis

	Rate Design Analysis (000)	TOTAL	Residential	General Service Rate	INTER-RUPTIBLE	Transportation
1	Revenue Neutral Shifts (RNS) to Equalize Class					
2	Rates of Return (ROR)	($0)	$742	($1,523)	$169	$612
3						
4	Percentage Revenue Change to Equalize Class ROR	0.00%	3.23%	-14.46%	22.19%	15.20%
5						
6	Current Class Revenue Percentages	100.00%	60.03%	27.44%	2.00%	10.53%
7						
8	COS Indicated Class Revenue Percentages	100.00%	61.95%	23.51%	2.43%	12.11%
9						
10	**OPC's Recommended Revenue Neutral Shifts**	$ -	$ 371	$ (762)	$ 85	$ 306
11						
12	OPC's Recommended Revenue Percentages	0.00%	60.99%	25.47%	2.21%	11.32%
13						
14	**Spread of Proposed Revenue Requirement Increases**					
15	$2 Million Revenue Requirement Increase	2,000	1,220	509	44	226
16						
17	**Combined Impact of Revenue Increase and OPC's RNS**	2,000	1,591	(252)	129	533
18						
19	**Adjusted Impact of Revenue Increase and OPC's RNS**	2,000	1,413	-	114	473
20						
21	**Adjusted Percentage Change in Class Rate Revenue**	5.16%	6.07%	0.00%	14.79%	11.58%
22						
23	**RECOMMENDED ADJUSTED CLASS REVENUE**	$ 40,782	$ 24,695	$ 10,640	$ 889	$ 4,558
24						
25	**ADJUSTED REVENUE PERCENTAGE**		60.55%	26.09%	2.18%	11.18%

OPC Rate Design Recommendation

		Residential	General Service	INTER-RUPTIBLE	Transportation	Standard Transportition	Large Transportation
	BILLS	1,165,716	143,520	228	1,008	773	235
(000)	REVENUES	22,992	10,530	763	4,029	1,458	2,570
(000)	SALES & TRANS. VOLUMES	80,248	41,040	26,975	22,907	6,960	15,947
(000)	SALES VOLUMES	80,248	41,040	26,975	22,907		
(000)	WINTER SALES	57,858	31,511	3,057	18,182		

	Residential	General Service	INTER-RUPTIBLE	Transportation	Standard Transportition	Large Transportation
Assuming rev increase $2	$ 1,590,604	$ (252,100)	$ 128,910	$ 532,587	$ 192,783	$ 339,804
Proposed customer charge	$ 8.50	$ 17.50	$ 275.00		$ 44.75	$ 750.00
Current customer charge	$ 8.00	$ 15.25	$ 100.00		$ 44.75	$ 750.00
Total revenue from proposed customer charge	$ 9,908,586	$ 2,511,600	$ 62,700		$ 34,587	$ 176,324
Total revenue from current customer charge	$ 9,325,728	$ 2,188,680	$ 22,800		$ 34,587	$ 176,324
Total current revenue from other charges	$ 13,666,661	$ 8,341,229	$ 739,863		$ 1,423,716	$ 2,394,120
Revenues need to be recovered from other charges	$ 14,674,407	$ 7,766,209	$ 828,873		$ 1,616,499	$ 2,733,924
% increase in other charges	7.37%	-6.89%	12.03%		13.54%	14.19%

TABLE 4-1. Formulas and Transmission Factors for Commonly Used Flow Equations

Equation	Formula[a]	Transmission Factor
Fully Turbulent	$Q_b = (0.4692\,T_b/P_b)\left(\frac{(P_1^2 - P_2^2)\,D^5}{G T_f Z_{avg} L}\right)^{0.500} \log(3.7\,D/k)$	$4 \log(3.7D/k)$
IGT Distribution	$Q_b = (0.6643\,T_b/P_b)\left(\frac{(P_1^2 - P_2^2)}{T_f L}\right)^{5/9} (D^{8/3})/(G^{4/9}\mu^{1/9})$	$4.619\,(N_{Re})^{0.100}$
Mueller Equation	$Q_b = (0.4937\,T_b/P_b)\left(\frac{(P_1^2 - P_2^2)}{T_f L}\right)^{0.575} \frac{D^{2.725}}{G^{0.425}\,\mu^{0.150}}$	$3.35\,(N_{Re})^{0.130}$
Panhandle A Equation[b]	$Q_b = (2.450\,T_b/P_b)\left(\frac{(P_1^2 - P_2^2)}{T_f L}\right)^{0.539} (D^{2.618})/(G^{0.461})$	$6.872\,(N_{Re})^{0.0730}$
Spitzglass (High Pressure)[c]	$Q_b = 3.415\left(\frac{(P_1^2 - P_2^2)\,D^5}{GL\,(1 + 3.6/D + 0.03D)}\right)^{0.500}$	$\left(\frac{354}{1 + 3.6/D + 0..03D}\right)^{0.500}$
Spitzglass (Low Pressure)[c]	$Q_b = 3.550\left(\frac{h_w D^5}{GL\,(1 + 3.6D + 0.03D)}\right)^{0.500}$	$\left(\frac{354}{1 + 3.6/D + 0..03D}\right)^{0.500}$
Weymouth	$Q_b = 1.3124\,(T_b/P_b)\left(\frac{(P_1^2 - P_2^2)\,D^{16/3}}{G T_f L}\right)^{0.500}$	$11.19\,D^{1/6}$

[a] The units of the quantities in all of these equations are:
- D = in.
- h_w = in. wc
- L = ft
- P_1, P_2, P_b = psia
- Q_b = Mcf/hr
- μ = lbm/ft sec
- T_f, T_b = °R

[b] The constant 2.450 includes:
$\mu = 7.0 \times 10^{-6}$ lbm/ft sec

[c] The constants 3.415 and 3.550 include:
- P_b = 14.7 psia
- T_b = 520 °R
- T_f = 522.6 °R

Attachment 1