IN THE TENNESSEE REGULATORY AUTHORITY
AT NASHVILLE, TENNESSEE

IN RE:	)	
	)	
ATMOS ENERGY CORPORATION PETITION FOR ADJUSTMENT OF RATES	)	**DOCKET NO. 08-00197**
	)	
	)	

MOTION TO SUPPLEMENT TESTIMONY OF DR. STEPHEN BROWN

Robert E. Cooper, Jr., Attorney General and Reporter for the State of Tennessee, by and through the Consumer Advocate and Protection Division of the Office of the Attorney General ("Consumer Advocate"), pursuant to TRA Rule 1220-1-2-.11(5)(a), hereby moves for leave to supplement the testimony of Dr. Stephen Brown with more specific information regarding his qualifications. For cause, the Consumer Advocate states that Dr. Stephen Brown has updated information regarding his qualifications as an expert witness in response to discovery requests from Atmos Energy Corporation ("Atmos"). Although the Consumer Advocate will submit proper discovery responses if necessary, supplementation of the testimony may assist the panel reviewing this matter by presenting the information in a more complete form rather than what would be required if referenced from the subject discovery requests. Atmos does not object to this request. Dr. Stephen Brown's resume and attachments are attached herewith as Exhibit A.

WHEREFORE, the Consumer Advocate requests the Hearing Officer to approve its motion to supplement the testimony of Dr. Stephen Brown.

RESPECTFULLY SUBMITTED,

ROBERT E. COOPER, JR. (BPR #10934)
Attorney General and Reporter
State of Tennessee

TIMOTHY C. PHILLIPS (BPR #12751)
Senior Counsel
Office of the Attorney General
Consumer Advocate and Protection Division
P.O. Box 20207
Nashville, Tennessee 37202-0207
(615) 741-3533

CERTIFICATE OF SERVICE

I hereby certify that on February 20, 2009, a true and correct copy of the foregoing was served via U.S. Mail or electronic mail upon:

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Vice President
Rates & Regulatory Affairs
Mid-States Division
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Atmos Energy Corporation
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Dallas, TX 75265-0205

TIMOTHY C. PHILLIPS

Dr. Steve Brown
Professional Experience and Educational Background

Dr. Brown's educational background includes receiving a Bachelor of Arts Degree from Colorado State University (1971), a Master of Science Degree in Regulatory Economics from the University of Wyoming (1979), and a Master of Arts and a PhD in International Relations with a specialty in International Economics from the University of Denver (1975).

Since his professional career began in 1979, Dr. Brown has benefited from 28 years of experience with the Public Utility Industry, including cost of service studies, rate design issues, telecommunications issues, and matters related to the disposal of nuclear waste.

From 1979 to 1982, Dr. Brown worked for Tri-State Generation and Transmission Association as a Power Requirements Supervisor and Rate Specialist. The positions required Dr. Brown to forecast customer and load growth for the company as a whole, which included overseeing a team responsible for gathering and analyzing the requisite data. Additionally, Dr. Brown was tasked with presenting rate proposals regarding increases in wholesale rates, which included performing rate design, distribution of the revenue requirement between fixed and variable charges, and distribution of the rate increases across areas of Colorado, Wyoming, and Nebraska.

In 1982, Dr. Brown began working for Arizona Electric Power Cooperative, a company regulated by the Arizona Corporation Commission, as a Rate Analyst. While in this position, Dr. Brown was solely responsible for presenting rate proposals regarding an increase of wholesale rates. He performed forecasting and rate design, analyzed cost of service and revenue requirements, and wrote computer programs in association with this position.

Dr. Brown left this position in 1984, where he began working for Houston Lighting & Power as a Supervisor of Rate Design. This supervisory position included determining fixed and variable charges in regard to rate allocations among the various class distinctions, computer programming, and preparing quarterly rate design for future rate cases.

From 1986 to 1994, Dr. Brown was employed by the Iowa Utilities Board as Chief of the Bureau of Energy Efficiency, Auditing and Research, wherein he advised on long term energy planning, legislative and policy matters including demand-side management, management and financial auditing, the introduction of new technology in regulated industry and rate setting for regulated electric, gas and telephone utilities.

In 1991 Dr. Brown was appointed by the Governor to serve as the Utility Specialist and State Liaison Officer to the U.S. Nuclear Regulatory Commission, making him the main contact between the Nuclear Regulatory Commission and the Iowa state government regarding all policy issues concerning nuclear power plants.

Dr. Brown joined the Consumer Advocate and Protection Division (CAPD) of the Tennessee Attorney General's Office as an Economist in 1995. He has provided expert oral and written testimony in numerous rate proceedings before the Tennessee Public Service Commission (TPSC) and the Tennessee Regulatory Authority (TRA), covering all aspects related to determining cost of capital and other regulatory issues. Dr. Brown has participated in the following dockets, many of which are available on the TRA website. Docket captions have been summarized.

TRA #08-00039 Tennessee American Water Company - Petition Of Tennessee American Water Company to Change and Increase Certain Rates and Charges
Direct Testimony: http://www.state.tn.us/tra/dockets/0800039.htm

TRA #07-00224 Docket to Evaluate Chattanooga Gas Company's Gas Purchase and Related Sharing Incentives
Direct Testimony: http://www.state.tn.us/tra/dockets/0700224.htm

TRA #07-00105 Atmos Energy Corporation for Approval of a General Rate Increase
Testimony Address: http://www.state.tn.us/tra/orders/2007/0700105cg.pdf

TRA # 06-00290 Petition of Tennessee American Water to Change and Increase Rates
Testimony Address: http://www.state.tn.us/tra/orders/2006/0600290by.pdf
Supp. Testimony Address: http://www.state.tn.us/tra/orders/2006/0600290fm.pdf

TRA # 06-00175 Petition of Chattanooga Gas Company to Change and Increase Rates
Testimony Address: http://www.state.tn.us/tra/orders/2006/0600175jn.pdf

TRA # 05-00258 Petition of the Consumer Advocate to Open an Investigation and Require ATMOS to Show Cause that the Company is not over-earning.
Testimony Address: http://www.state.tn.us/tra/orders/2005/0500258cd.pdf
Rebuttal Testimony: http://www.state.tn.us/tra/orders/2005/0500258hs.pdf

TRA# 04-00288 Petition of Tennessee American Water Co. to adjust rates
Testimony Address: http://www.state.tn.us/tra/orders/2004/0400288bk.pdf

TRA # 04-00034 Petition of Chattanooga Gas to Adjust Rates
Testimony Address: http://www.state.tn.us/tra/orders/2004/0400034dm.pdf

TRA# 03-00491 F.C.C. T.R.O. Review
Testimony Address: http://www.state.tn.us/tra/orders/2003/0300491ib.pdf
Rebuttal Address: http://www.state.tn.us/tra/orders/2003/0300491kn.pdf

TRA# 03-00391 Petition of BellSouth Telecommunications for Exemption of Certain Services
Testimony Address: http://www.state.tn.us/tra/orders/2003/0300391bz.pdf

TRA# 03-00313 Petition of Nashville Gas to Adjust Rates
Testimony Address: http://www.state.tn.us/tra/orders/2003/0300313z.pdf

TRA# 03-00118 Petition of Tennessee American Water to Adjust Rates
Testimony Address: http://www.state.tn.us/tra/orders/2003/0300118bm.pdf
Rebuttal Address: http://www.state.tn.us/tra/orders/2003/0300118ca.pdf

TRA# 01-00704 / 02-002258 (consolidated docket) Audit of Atmos/U.C.G. IPA
Testimony Address: http://www.state.tn.us/tra/orders/2001/0100704cp.pdf

TRA# 98-00559 BellSouth, C.S.A. Docket
Rebuttal Testimony: http://www.state.tn.us/tra/orders/1999/980055916.pdf

TRA# 97-01364 United Cities Gas / Establishment of PBR
Copy Attached (A)

TRA# 97-01262 Bellsouth Telecommunications Inc. - Permanent Prices
http://www.state.tn.us/tra/dockets/9701262.htm

TRA# 97-00982 Chattanooga Gas -Petition to Revise Tariff
Copy Attached (B)

TRA # 96-00977 Nashville Gas Company – Petition for Adjustment of its rates and charges.
Copy Attached (C)

TRA # 95-01134 United Cities Gas Company – Application to Establish an Experimental Performance-Based Ratemaking Mechanism.
Copy Attached (D)

TRA # 95-02258 United Cities Gas Company – Petition to Place Into Effect a Revised Natural Gas Tariff
Copy Attached (E)

Publications

Dr. Brown has also authored several articles relating to his profession. These publications include:

1. **Publication:** Science and Technology
   Title of Publication: So Long, Calvin Coolidge, Meter Reading Approaches the 1990s Promising a Pivotal market for Communications Infrastructure
   Date of Publication: 11/1992

2. **Publication:** AMRA Opinion
   Title of Publication: No Second Time Around for AMR
   Date of Publication: 03/1994

3. **Publication:** AMRA Opinion
   Title of Publication: DOE Proposal Trivializes AMR
   Date of Publication: 11/1993

4. **Publication:** Economic Incentives for Nuclear Plan Performance:
   Title of Publication: A State Perspective
   Date of Publication: 09/1988

5. **Publication:** Electric Potential Bubble Memory Technology
   Title of Publication: Its Impact on Metering and Rate Structure
   Date of Publication: 12/1985

6. **Publication:** The Sine Qua Non of Order 636
   Title of Publication: Cooperative Competition, Information Flow, and Rate Design
   Date of Publication: 09/1992

7. **Publication:** Presentation at 'Integrating Microelectronics into Gas Distribution'
   Title of Publication: Opportunities for Inter-Industry Cooperation: A Regulatory View of Automation
   Date of Publication: 10/1987

8. **Publication:** Electric Potential
   Title of Publication: Focus: Nuclear Prudence Cases
   Date of Publication: 12/1985

9. **Publication:** Presentation at 'The Pennwell Conference on TELCOS, POWERCOS & CABLECOS – Partners or Rivals in the Local Loop?'
   Title of Publication: Financing Electric (& Other) Utilities' Shares in Local Loop Fiber Networks: Economic and Political Considerations
   Date of Publication: 09/1991

10. **Publication:** Presentation at ' Meeting of the NARUC Staff Subcommittee on Technology'
    Title of Publication: From Automatic Meter Reading to Fiber Optics: Creating a Locally Oriented Universal Data Transmission Service
    Date of Publication: 02/1990

11. **Publication:** Presentation at 'AMRA'S Symposium 91'
    Title of Publication: Strategic Planning Considerations for the AMR Industry in the 1990s
    Date of Publication: 09/1991

12. **Publication:** Blackwell Publishing on behalf of ISA
    Title of Publication: Public-Good Theory and Bargaining between Large and Small Countries
    Date of Publication: 09/1976

Affiliations

In addition to Dr. Brown's employment and education experience, he has served as a member in several professional organizations. These memberships include being a past member of the National Association of Regulatory Utility Commissioners Staff Committee on Management Analysis, a past trustee of and a member of the Board for the Automatic Reading Association, and as a current member of the National Association of Business Economists.

STATE OF TENNESSEE
OFFICE OF THE
ATTORNEY GENERAL
404 JAMES ROBERTSON PARKWAY
PARKWAY TOWERS - SUITE 1504
NASHVILLE, TENNESSEE 37243-0500

February 20, 1996

Mr. Eddie Roberson, Executive Director
Tennessee Public Service Commission
460 James Robertson Parkway
Nashville, TN 37243-0505

IN RE: Application of United Cities Gas Company to Establish an Experimental Performance-based Ratemaking Mechanism.
Docket No. U-95-01134

Dear Mr. Roberson:

Attached are an original and ten (10) copies of the direct testimony of Consumer Advocate Division witness Stephen N. Brown in the above-styled cause. Copies are being furnished to parties of record.

Sincerely,

L. Vincent Williams
Consumer Advocate

Attachment

BEFORE THE

TENNESSEE PUBLIC SERVICE COMMISSION

IN RE: APPLICATION OF UNITED CITIES GAS COMPANY TO ESTABLISH AN EXPERIMENTAL PERFORMANCE-BASED RATEMAKING MECHANISM

DOCKET NO. U-95-01134

****

Direct Testimony
of

Stephen N. Brown

****

February 20, 1996

Q. **What is your name?**

A. Stephen N. Brown.

Q. **What is your position?**

A. I am a Senior Economist in the Consumer Advocate Division, Office of the Attorney General.

Q. **What experience do you have regarding utilities?**

A. From 1986 to 1995 I was employed by the Iowa Utilities Board as Chief of the Bureau of Energy Efficiency, Auditing and Research, and Utility Specialist and State Liaison Officer to the U.S. Nuclear Regulatory Commission. From 1984 to 1986 I worked for Houston Lighting & Power as Supervisor of Rate Design. From 1982 to 1984 I worked for Arizona Electric Power Cooperative as a Rate Analyst. From 1979 to 1982 I worked for Tri-State Generation and Transmission Association as Power Requirements Supervisor and Rate Specialist. From 1979 through 1995 my work spanned many issues including cost of service studies, rate design issues, telecommunication issues and matters related to the disposal of nuclear waste.

Q. **What is your educational background?**

A. I have an M.S. in Regulatory Economics from the University of Wyoming, an M.A. and Ph.D. in

International Relations with a specialty in International Economics from the University of Denver, and a B.A. from Colorado State University.

Q. Have you authored any articles relating to your profession?

A. Yes, I've written and published more than thirty articles dealing with issues in the gas, electric, and telecommunications industries. My articles have appeared in Public Utilities Fortnightly, the Electricity Journal, and Lightwave Magazine. I've given several public presentations and authored many in-house documents.

Q. Are you and have you been a member of any professional organizations?

A. I was a member of the NARUC Staff Committee on Management Analysis, a past trustee of and a member of the Board for the Automatic Meter Reading Association, and a current member of the National Association of Business Economists.

Q. Have you studied mathematics and statistics as part of your education?

A. Yes.

Q. Have you used mathematics and statistics as well as part of your profession?

A. Yes.

Q. What will you be explaining in this docket?

A. I will explain an unusual aspect of the company's gas procurement incentive and that aspect's negative impact on consumers.

Q. What is unusual about the procurement incentive?

A. It allows the contract prices determined under a seven year commitment to be compared to contract prices entailing a one month commitment. When long term prices are sufficiently lower than the short term prices, the difference is called "earnings" by the company and is then split equally between the company and consumers.

Q. Why is that practice unusual?

A. Assessments of purchase practices for any commodity, whether it is natural gas, a bond, a house or car, are usually based on a comparison of similar terms and similar conditions. The gas procurement incentive relies on a comparison of dissimilar terms and conditions. If this unusual practice is affirmed as an allowable procedure, it may be applied to other aspects of a utility.

A debt procurement incentive, for example, would call for a comparison of interest rates on short term debt to the interest rates on the company's long term debt. If short term rates were higher than the company's long term rates, the company could say the difference was earnings and raise consumers' prices to recover a portion of the earnings. If such an incentive were fairly applied, the situation could be reversed. If short term rates were lower than the company's long term rates, the difference may be interpreted as excess earnings and consumers' prices would be lowered to refund a portion of the excess earnings to consumers.

Q. Do you know if the practice you describe is followed by other companies or other regulatory commissions?

A. I do not know of any other company or regulatory agency that compares long term and short term prices as a means to assess a company's performance. The practice appears to be limited to this company and to its gas procurement activities. To my knowledge the practice is not applied to other companies nor to the aspects of the gas utilities' where long term and short term prices could be compared for such things as debt or the ownership of vehicles versus the leasing of vehicles.

Q. Do you know if the incentive plan changed the company's behavior regarding gas procurement?

A. Yes, the plan appears to have changed the company's behavior with regard to short term purchases. Schedules 1 and 2 of my testimony respectively show the company's actual record and the hypothesized one based on data from 1993 to 1994. Mr. McCormac used the 1993-1994 data in last year's hearing where the plan was approved. A comparison of Schedule 1, row 3 column 6 with Schedule 2, row 3 column 6 shows that the company stopped purchasing gas priced above 102% of the index. Row 1 of each schedule shows the continuing importance of the Nora contract.

Q. Do you believe consumers have benefited from the plan?

A. No. The plan has no lasting benefits to consumers. The plan demonstrates that buying high-priced short term gas, or the threat of such purchases, is a means for a company to capture a portion of the economic benefits that consumers enjoy from low-priced long-term contracts, even if those contracts were in effect before the plan. The role of short term gas purchases, shown by the difference between Schedule 2, row 3 and Schedule 1, row 3, demonstrates this point. United Cities' low-priced 7 year contract with Nora commenced nearly 18 months before the incentive plan's inception. As long as short term prices sufficiently exceed the Nora contract's long term price, United Cities has an incentive to refrain from gas purchases that cost more than 102% of the index. However, the plan's "experimental" nature suggests it is not permanent. Therefore, if short term prices are ever below those of the Nora contract, or if the contract terminates or the terms change unfavorably, the company may face the prospect of losing money. To avoid this situation the company could immediately discontinue the "experiment." Additionally, other gas companies with good long term contracts may view the incentive plan as a way to capture additional economic benefits that would normally flow to consumers. Therefore, the incentive plan has little upside potential for consumers.

Q. **Could the company make the same amount of earnings as it does now if the Nora contract were excluded form the gas procurement mechanism?**

A. No. Schedule 3 shows the difference between 98% of the index and the average price of the transactions. Row 1 column 3 shows a 15 cent spread between the Nora contract and 98% of the index. The other entries in column 3 show the remaining transactions. If the Nora contract were removed, the company would probably have little incentive to continue with the experiment. If that were the case, then it would emphasize the incentive plan's dependence on the Nora contract.

Q. **Do you recommend that the Nora contract be excluded from the gas procurement mechanism?**

A. Yes, for two reasons. First, the Nora contract was in effect 18 months before the incentive plan began, which suggests the incentive plan may have been developed to take advantage of the current contract with Nora rather than being a plan to apply to all prospective long term contracts. Second, the Nora contract prices have absolutely nothing to do with market prices reflected by the data from Inside FERC, Natural Gas Intelligence, and NYMEX, which are the indices used in the gas procurement mechanism. Therefore, it is inappropriate to compare Nora's prices to those of the short term market.

A discussion of what constitutes appropriate comparisons appears in Schedule 4, a copy of Natural Gas Intelligence's (NGI) explanation of how that publication derives its index. The NGI index is included in the incentive plan's index. NGI excludes prices not based on market factors. NGI says:

"we poll sources from all branches of the industry to determine a price that is a product of factors faced by the entire market. Occasionally, however, sources will report prices that substantially differ from the others within the sample survey...Often times outliers result from circumstances unique to that party, such as... a <u>price based on predetermined contract language</u> [emphasis added]. If we discover that these deals were based on factors that were not experienced by the remainder of the market, then they will be removed from the data sample."

It is clear that incentive plan's index does not include long term contracts. Thus the Nora contract is clearly not based on factors experienced by the rest of the market. It is inappropriate to compare the Nora prices to those of the short term market.

Q. How do you know that the Nora prices are not related to the market and that they are based on factors not experienced by the remainder of the market?

A. Schedule 5 provides the answer. The gas procurement mechanism works, as I mentioned earlier, by comparing the Nora price to the so-called market price. For example, column (6) shows the Nora price and column (5) shows the sum of the market index, the avoided capacity costs and the so called historical adjustment. The gas procurement mechanism works as follows: If column (6) is less than 98% of column (5) then the company is judged to be doing a good job in facing the market and the company gets a reward. There is a problem with that comparison.

Take April for example. The Nora price in column (6) is $1.72, and the so-called index in column (5) is 1.91, but the comparison does not indicate how the Nora price compares to the market. To get that perspective the calculation process has to be reversed. To do that, from the Nora price subtract the sum of the avoided capacity costs and the so called historical adjustment. The result is $1.32 in column (1). Compare that to $1.52 in column (3). The difference between column (1) and column (3) is the same as the difference between column (5) and column (6). The gas procurement mechanism could be reworded as follows: If column (1) is less than 98% of column (3) then the company is judged to be doing a good job in facing the market and the company gets a reward. However, the price in column (1) is below the price in column (2), which is the lowest price faced by the market. The Nora contract prices are lower than the market's lowest price. No other company on the Tennessee Pipeline could have gotten prices as good as Nora's. That is true for the months of April through November. It is a virtual certainty that the company will always be judged to be doing a good job and rewarded when it comes to the predetermined rate of the Nora contract. Using NGI's words, the Nora contract "is [not] a product of factors faced by the entire market."

Q. Do you recommend that all long term contracts be excluded from the gas procurement mechanism?

A. No. I do recommend excluding the Nora contact as previously discussed. But depending on a company's gas supply mix, consumers' may benefit from a plan that places future long term contracts into a pool with short term contracts.

Q. Does this conclude your testimony?

A. Yes.

BEFORE THE

<u>TENNESSEE PUBLIC SERVICE COMMISSION</u>

IN RE: APPLICATION OF UNITED CITIES GAS COMPANY TO ESTABLISH AN EXPERIMENTAL PERFORMANCE-BASED RATEMAKING MECHANISM

DOCKET NO. U-95-01134

****

EXHIBITS
of

Stephen N. Brown

****

February 20, 1996

Docket No. 95-01134
Exhibit CA-SNB____
Schedule 1 ______
Page 1 of 1______

UCG's Actual Performance: March - December 1995
Analysis of Gas Procurement Transactions

	CATEGORY OF TRANSACTION	# OF TRANS-ACTIONS	% OF TRANS-ACTIONS	MMBTU (1000)	% OF MMBTU	TOTAL $ BELOW 98% Of INDEX	% OF GRAND TOTAL $	AVERAGE $ PER TRANSACTION
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Row #								
(1)	NORA TRANSACTIONS:(7 YEAR CONTRACT OF NOV. 1993) - ALL BELOW 98% OF INDEX	9	5%	1,764	13%	$265,773	71%	$29,530
(2)	OTHER TRANSACTIONS BELOW 98 % OF INDEX	69	39%	5,903	41%	$109,339	29%	$1,585
(3)	TRANSACTIONS ABOVE 98% OF INDEX	100	56%	7,662	46%	$0 Losses on Purchases Above 102% of Index	0%	$0
(4)	GRAND TOTAL	178	100%	15,329	100%	$375,113	100%	$2,107

Docket No. 95-01134
Exhibit CA-SNB____
Schedule 5 _______
Page 1 of 1_______

UCG's Actual Performance: March - December 1995
Analysis of Gas Procurement Transactions

Month	Nora 7 Year Contract: Invoice Price Less Historical Adj And Avoided Costs (1)	Lowest Price Experienced By the Market On Tennessee Gas Pipeline *The Minimum Of Prices Published By Inside FERC, NGI, and NYMEX (2)	Average of Indices From Inside FERC NGI, and NYMEX (3)	Sum Of Historical Adj And Avoided Costs (4)	Sum Of Columns (3) and (4) (5)	Nora Invoice Price (6)
Apr-95	1.32	1.38	1.52	0.39	1.91	1.72
May-95	1.42	1.50	1.62	0.40	2.02	1.82
Jun-95	1.47	1.57	1.66	0.40	2.06	1.86
Jul-95	1.24	1.30	1.45	0.47	1.92	1.71
Aug-95	1.12	1.23	1.32	0.47	1.79	1.59
Sep-95	1.33	1.44	1.52	0.47	1.99	1.80
Oct-95	1.40	1.50	1.59	0.47	2.07	1.87
Nov-95	1.57	1.67	1.74	0.45	2.19	2.02
Dec-95	2.02	1.93	2.20	0.46	2.66	2.48

NGI:
"If we discover that these deals were based on factors that were not experienced by the remainder of the market, then they will be removed from the data sample."

NGI:
"We poll sources from all branches of the industry to determine a price that is a product of factors faced by the entire market."

Before the

TENNESSEE REGULATORY AUTHORITY

IN RE:

PETITION OF CHATTANOOGA GAS COMPANY TO PLACE INTO EFFECT A REVISED NATURAL GAS TARIFF

DOCKET NO. 97-00982

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DIRECT TESTIMONY
OF
STEVE BROWN

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INTRODUCTION

Q. Please state your name.

A. Stephen N. Brown.

Q. Where do you work and what is your job title?

A. I am a Senior Economist in the Consumer Advocate Division, Office of the Attorney General.

Q. What are your responsibilities as Senior Economist?

A. I review companies' petitions for rate changes and follow the economic conditions that affect the companies.

Q. What experience do you have regarding utilities?

A. From 1986 to 1995 I was employed by the Iowa Utilities Board as Chief of the Bureau of Energy Efficiency, Auditing and Research, and Utility Specialist and State Liaison Officer to the U.S. Nuclear Regulatory Commission. From 1984 to 1986 I worked for Houston Lighting & Power as Supervisor of Rate Design. From 1982 to 1984 I worked for Arizona Electric Power Cooperative as a Rate Analyst. From 1979 to 1982 I worked for Tri-State Generation and Transmission Association as Power Requirements Supervisor and Rate Specialist. From 1979 through 1995 my work spanned many issues including cost of service studies, rate design issues, telecommunications issues and matters related to the disposal of nuclear waste.

Q. What is your educational background?

A. I have an M.S. in Regulatory Economics from the University of Wyoming, an M.A. and Ph.D. in International Relations with a specialty in International Economics from the University of Denver, and a B.A. from Colorado State University.

Q. Dr. Brown, have you authored any articles relating to your profession?

A. Yes, my articles have appeared in Public Utilities Fortnightly and the Electricity Journal.

Q. Are you and have you been a member of any professional organizations, Dr. Brown?

A. Yes, I am a past member of the NARUC Staff Committee on Management Analysis, a past trustee of and a member of the Board for the Automatic Meter Reading Association, and a current member of the National Association of Business Economists.

Q. Have you studied mathematics and statistics as part of your education?

A. Yes.

Q. Dr. Brown, do you use mathematics and statistics in combination with economics as part of your profession?

A. Yes.

Q. What were you asked to do with respect to this

case?

A. I was asked to form an opinion on the appropriate market-based common equity return, the appropriate overall cost of capital and the appropriate capital structure for Atlanta Gas Light(AGL) Company's wholly owned subsidiary in Tennessee, Chattanooga Gas (CG)Company, as well as to evaluate and assist in the evaluation of the rate of return proposed by other witnesses in this docket.

OPINION ON EQUITY RETURN

Q. In your opinion what rate of equity return is just and reasonable?

A. In my opinion an equity return of 10.55% is just and reasonable.

Q. Dr. Brown, what did you do to identify this just and reasonable return?

A. I examined a group of natural gas companies comparable to AGL.

AGL IS THE APPROPRIATE COMPANY FOR COMPARISON

Q. Why did you consider AGL the appropriate company for deriving the equity return?

A. CG's common equity is owned completely by AGL and is not publicly traded or available over the counter. Investors who desire a common equity interest in CG have only one way to obtain that interest--acquire common stock in AGL Resources, whose financial fate is determined by its prime subsidiary, AGL.

These facts alone suggest that AGL is central to the equity analysis. Also, in this docket AGL's management is well-represented. The company's witnesses -- Messrs. Thompson, Hinesley, and Overcast and Lisa Wooten -- are employed by AGL directly and none of them ever worked for CG directly. This is ample evidence that AGL management strongly directs CG's activities thus making AGL rather than CG the focus of equity analysis.

The direct involvement of AGL's management in this docket clearly indicates that CG's operations are completely intermingled with AGL's, to the point that CG is an operating company under AGL's management in much the same way that Savannah Gas is an operating company under AGL. When AGL has a rate case in Georgia, Savannah Gas is not singled out as a stand-alone investment of funds which forms the basis for a rate of return. Likewise, CG is not a stand-alone investment that forms the basis for a rate of return. The company's cost-of-capital witness, Dr. Andrews, concedes this point very early in his testimony at page 4 lines 12-13, where he says "I undertake the analysis of CGC **as if it were** [emphasis added by Dr. Brown] a stand-alone investment of funds." To me, the wording "**as if it were**" means one of two things: either CG **is not in fact** a stand-alone investment or he does not know if it is a stand-alone investment.

Finally, Dr. Andrews, at page 48 lines 6-8 of his direct testimony, suggests the capital structure of AGL Resources be used to compute CG's weighted cost of capital. These aspects of the rate filing make it appropriate to determine the cost of capital by using AGL and companies that are comparable to AGL.

Q. **Does Dr. Andrews base his cost-of-capital analysis on AGL and companies comparable to AGL?**

A. No, but his recommended return includes a premium meant to compensate AGL Resources.

Q. **What companies form the basis for Dr. Andrews' cost-of-equity analysis?**

A. He selects 22 "small" companies that have actively traded stock, that issue bonds and stocks, and which complete and file regular reports with the Securities and Exchange Commission. In contrast to CG, which is a subsidiary of AGL, many of the 22 companies are parent companies themselves with subsidiaries underneath them. Several of the 22 companies also operate in multi-state jurisdictions.

Q. **In your opinion do these "small" companies are a rational basis for a cost-of-equity analysis in this docket?**

A. No, I do not. On their face the 22 companies markedly differ from CG, and there is no objective basis for adjusting them so that they would somehow be comparable to CG. Because I focus on AGL, my cost-of-equity analysis uses a completely different set of companies than Dr. Andrews' analysis. A cost-of-equity analysis starts with the selection of comparable companies. To the extent the parties in this docket disagree about the starting point of an analysis, the TRA's job of assessing each analysis becomes more difficult. However, I have other sound and objective reasons for disagreeing with Dr. Andrews' analysis and results, as I will discuss at a later point in my testimony.

COMPARABLE COMPANIES SELECTED BY DR. BROWN

Q. Dr. Brown, what comparable companies did you use in your analysis?

A. I selected a group of companies composed of AGL Resources, Bay State Gas Company, Brooklyn Union Gas Company, Indiana Energy, Laclede Gas, Northwest Natural Gas, Peoples Energy, and Washington Gas Light Company. Like AGL, all of these companies have subsidiaries.

Q. What evidence do you offer to substantiate your assertion that AGL is comparable to the other eight companies?

A. The proof of comparability appears in Schedule 1. The top portion is titled "Market Statistics" and the bottom portion is titled "Financial Behavior." The market statistics show the strong similarity of the companies. For example, as of December 1996 the ratios of the market price to the book value are similar, and so are the equity ratios, dividend yields, the value of the holdings per shareholder and the average number of years the stock is held. However, the market values have a large spread. The smallest value, $343 million, is about only one-fourth of the largest market value.

Q. Dr. Brown, is the difference in market values of the comparables you selected meaningful?

A. No. My examination of the companies shows that they exhibit similar financial behavior, as indicated by the way they responded to the publication *Value Line*'s criticism of the gas distribution industry. That criticism is quoted in Schedule 1. In early 1995 *Value Line* warned investors to be wary of gas companies that paid out more than 80% of their earnings to dividends. Prior to Value Line's warning many payout ratios exceeded 80%. From 1995 to 1996, however, every company lowered its payout ratio to levels below 80%. This deliberate response by all the companies makes it clear that they have comparable financial behavior.

Q. Is your opinion of the equity return different from the equity return recommended by Dr. Andrews?

A. Yes, he recommends a higher, speculative range of 11.5% to 12.5% and prefers 12.25%, a much higher, speculative rate.

Q. Upon what do you base your equity return opinion?

A. I base my opinion on my analysis of AGL's market-based cost of common equity, which is supported by my analysis of comparable companies.

Q. In your opinion what rate of equity return should the Tennessee Regulatory Authority allow in this docket?

A. My opinion is that the Tennessee Regulatory Authority (TRA) adopt the equity return of

10.55%.

TESTS OF RECOMMENDED EQUITY RETURN

Q. Dr. Brown, did you compare your equity return to those of independent sources?

A. Yes. Chart One summarizes the tests I made. I compared my results to the information published by Merrill Lynch regarding the required rates of return for gas distribution companies in general. I also compared my results with the equity returns recently granted by the Illinois Commerce Commission and the Virginia State Corporation Commission to United Cities, a company currently under the TRA's jurisdiction and one that is included in Dr. Andrews' analysis. The Merrill Lynch returns are shown in Schedule 2. Press releases announcing the Illinois and Virginia decisions are attached as Schedules 3 and 4 respectively.

Q. What was your reason for using Merrill Lynch's data?

A. Merrill Lynch's data reflects the marketplace for gas distribution companies, and I have used their data as a basis of comparison in prior rate cases. From January 1995 through May 1997 Merrill Lynch's equity-return estimates have ranged from a high of 11% to a low of about 9%. My recommendation of 10.55% approximates Merrill Lynch's upper limit of recent equity returns for the natural gas distribution industry.

Q. What was your reason for comparing the recent equity awards by two state commissions?

A. My reason for comparison was to consider independent sources. The comparison merely demonstrates that my recommended return is consistent with recent regulatory decisions regarding equity returns in other jurisdictions.

Q. Did you compare the data from Merrill Lynch and from the various states to Dr. Andrews' recommended return to equity?

A. Yes. Dr. Andrews' recommended return substantially exceeds any reasonable return for the industry, and therefore is more than just and reasonable.

Q. Dr. Brown, is the return you are presenting a fair return?

A. Yes. It is a fair return because it compensates the company for ordinary financial risks it is taking to be in the gas distribution business.

Q. What are the sources of ordinary financial risk to the company?

A. The major risk is that the company's expenses would increase faster than its revenues. However, in this case that risk is negligible. The company's rate base, expenses, and sales are based on projected amounts for a 12-month period ending September 1998. These factors are the basis for the prices that come out of this docket. However, the company's prices are likely to be applied almost a full year before the projections are realized.

For there to be any risk, the company's projected expenses would have to be far less than what actually occurs, or the company's projected sales of gas would have to very different from the actual sales. I know of no substantial evidence suggesting that the company's forecasts will create a financial hardship.

Q. **Dr. Brown, is your rate of return sufficiently high to allow the company to attract capital and to maintain creditworthiness?**

A. Yes. An annual return of 10.55% is certainly high enough to attract capital and to maintain creditworthiness. The rate-of-return principles of capital attraction and maintenance of credit were set in the *Bluefield* decision, and the rate of return I recommend considers these factors.

Also, 10.55% is an understatement of the amount that the company actually has an opportunity to earn because the actual annual return is achieved through monthly compounding, which raise the return by approximately one-half a percent to 11%.

<u>DISCUSSION OF MONTHLY COMPOUNDING</u>

Q. **Is the monthly compounding process typical of the financial world?**

A. Yes.

Q. **Do monthly earnings have to be constant for monthly compounding to operate?**

A. No. Schedule 6 shows that compounding occurs with income-losses and with income-gains. The Schedule is based on the actual monthly income and losses of AGL for the fiscal year 1996. The far right-hand column clearly shows that monthly compounding of $1 at an allowed annual return of 10.55% leads to an effective return of 11.0%. With regard to column (6), at the bottom, the total return is shown as 11.02 cents. The total return would equal 10.55 cents only if the monthly return in column (6) is not added into the cumulative balances in columns (5) and (7), i.e., the cumulative balance would have to be $1 throughout the entire year. But this is not how financial processes work - cumulative balances are maintained on a monthly basis and changes to the balances are recorded monthly - not just annually.

Q. Dr. Brown, are you this docket's only cost-of-capital witness who believes that compounding is a typical financial process?

A. No. Dr. Andrews has made several statements indicating his opinion that compounding is a typical financial process:

1. Dr. Andrews, in his direct testimony page 27, line 5 says that "financial processes occur continuously." Therefore, his discounted cash flow (DCF) analysis is predicated on dividends continuously compounding, indicated at page 26 line 18 of his testimony, a situation

where compounding goes on moment-by-moment, a far more rapid rate of compounding than a monthly rate.

2. Dr. Andrews' direct testimony, page 28, lines 15-17, suggests that compounding a return of 9.53% leads to an effective return of 10%, clearly indicating that compounding adds approximately one-half percent to the return. This is the same point that I have made about compounding.

3. Dr. Andrews was cross-examined in Docket 95-02116 and stated that "Financial processes occur smoothly and continuously. They go -- if this makes the point for you -- minute by minute, hour by hour, day by day and they are not interruptible." His statement occurs at page 8, lines 20-23 of the transcript. A copy of the transcript's cover page and page 8 of the transcript are attached to my testimony as Schedule 7, pages 1 and 2 respectively.

4. His statements under cross-examination are consistent with his direct testimony page 28 lines 10-11, where the question is asked if there is "complete equivalency between

the continuous" rate, such as 9.53%, and a so-called "finite" rate, such as 10%. He answers "Yes."

5. His responses in his deposition of September 9 are also consistent with his testimony. For example, at page 58 line 16 of the deposition he was asked how often compounding occurred:

> "Q. Right, and it doesn't even have to be a series of years, it can be series of months, can't it?"

To which Dr. Andrews responded:

> "A. It could be done months, weeks, days."

He was also asked in the deposition, at page 59 line 10, whether he concurred that compounding is typical of financial processes:

> "Q. ...compounding is essentially accepted by all of our financial markets?"

To which he responded:

> "A. Sure."

Q. What does the term "compounding" mean?

A. The term compounding refers to a process that begins with a certain financial resource, generally called the base or the principal, and then the changes in that are added back into the base or the principal to create a new balance. The changes can be either positive or negative, meaning that the principal is either growing or declining.

Two things affect compounding.

> The time-frame of compounding -- how quickly is the change added back to the base? It could occur once a decade, once a year, once a month, every day or every second.

> The size of the change during the time frame -- does the base change by 1% a month each month or does it change by 2% in some months and 3% in other months?

The financial community puts these concepts together to say things like "your investment is growing at a rate of 10% per year this year, but last year it lost money at annual rate of 3%." Therefore, compounding describes financial gains as well as financial losses and does not have to occur at the same rate from one moment to the next.

Q. Is compounding process related to concept of working capital?

A. No. Working capital encompasses only the funds needed by the company to meet its current liability, i.e., the company has to have the funds available to meet its demands for cash flows.

Q. **Why are you referring to working capital?**

A. I raise it now to assure the TRA does not view monthly compounding as akin to working capital, where positive and negative cashflows are balanced by short-term lending and short-term borrowing.

Q. **Is monthly compounding an accurate description of how a distribution company accumulates annual return even when the company experiences seasonal variations in sales, revenues and expenses?**

A. Yes. The returns in the months when sales are high balance the returns in the months when sale are low. This is true whether the annual return is viewed as a sum of compounded monthly returns or as just the sum of twelve monthly returns that are not compounded. However, monthly compounding reflects the true nature of financial transactions. Revenues flow in every working day and are available for immediate reinvestment. The company's stocks and bonds can be bought and sold every working day of the year. The best indication that the compounding process underlies the company's financial transactions is the company's late fee, which is applied to consumers' monthly bills if they are not paid by the past due date. The late fee truly shows that "time is money." The quicker the company has the money, the quicker it can be invested to achieve additional returns. This is a perfect fit with the monthly compounding cycle that typifies financial transactions in our economy. If monthly compounding were not how a gas company accumulated its annual return, there would be no economic basis for charging a late fee.

Q. When Dr. Andrews' recommended equity return of 12.25% is compounded monthly, what return is the company being given an opportunity to earn?

A. The company is being given an opportunity to earn about 12.8%

MORE EVIDENCE THAT AGL IS THE APPROPRIATE COMPANY FOR COMPARISON

Q. If Dr. Andrews' recommended return of 12.25% a just and reasonable return?

A. No. His preference for 12.25% is meant to compensate AGL Resources (the parent of AGL) for the premium the company paid when it purchased CG. At page 3, lines 5-8 of his testimony Dr. Andrews states. "The point estimate is slightly off center in an upward direction in recognition of AGL Resources' long-run inability to earn on a rate base that includes the acquisition premium it paid as part of the price for CGC."

Q. What inferences do you make from Dr. Andrews' statement?

A. The statement confirms that this rate case is about AGL's return and that AGL and companies comparable to AGL should form the basis for an equity analysis. Dr. Andrews' statement also contradicts his later statement at page 4 lines

9-10 where he states: "the source of an investment's financing does not dictate its fair rate of return." His recommendation of 12.25% clearly aims at achieving a return for AGL, the owner of CG.

Q. Is Dr. Andrews choice of 12.25% as his preferred return consistent with his statement: "I treat CGC as if it were a stand-alone investment of funds?"

A. No. If CG were a stand-alone investment there would be no reason for Dr. Andrews to consider the acquisition premium as a factor or justification for choosing 12.25%. This justification is Dr. Andrews' tacit recognition that CG is not a stand-alone investment.

Q. How does Dr. Andrews' supposition of CG as a "stand-alone" investment compare with the testimony of other witnesses for AGL?

A. His supposition is contrary to the facts presented by Mr. Thompson, whose direct testimony, pages 11 through 22, describes the various support services that AGL provides to CG. For example, at page 17 line 6 Mr. Thompson lists several functions provided by AGL. At page 16 lines 4-15 Mr. Thompson indicates that AGL's Treasury and Corporate Accounting departments handle many transactions for CG. At lines 7-8 he says, "All checks for Chattanooga Gas Company are written by AGL." At page 13 line 11 he describes the various departments that have been eliminated at CG.

Q. Do you agree with Dr. Andrews' testimony, at page 6 line 8, that CG has "sharply expanded

demands for financing."

A. No. His statement is contradicted by the capital structure information the company supplied in this docket and in its prior rate case. In docket 95-02116, the company submitted a capital structure of $96.846 million. That structure is attached to my testimony as Schedule 8. In the current docket the company submitted a capital structure of $95.843 million, shown in the company's filing as Exhibit 5 Schedule 9. AGL is withdrawing its investment from Tennessee rather than suffering from a sharply expanded demand for financing

Q. **What is the implication of the $1 million decline regarding CG as a "stand-alone investment?"**

A. If a stand-alone company's capital dropped by $1 million, there would be an accounting trail, but in this instance there is no trail at all for CG. Therefore, the $1 million difference has to be the result of AGL's decisions and way it adds and subtracts funds to its Tennessee operations.

<u>DERIVATION OF DR. BROWN'S EQUITY RETURN: DCF ANALYSIS</u>

Q. **Did you perform an analysis to determine what the return to equity should be for AGL's wholly owned subsidiary?**

A. Yes. I performed two analyses: one based on the Discounted Cash Flow (DCF) model and another based on the risk premium model.

Q. What is the Discounted Cash Flow model?

A. The DCF model is a standard way that investors evaluate their potential returns. The model defines the cost of common equity as the dividend yield plus the dividend's expected growth rate.

Q. What is the advantage of using the DCF model?

A. It does exactly what every investor does. It pays close attention to the company's dividend per share of common stock and to the company's ability to raise or lower the dividend and the dividend yield.

Q. What is the dividend yield?

A. Dividend yield is measured as the company's annual dividend divided by the price for the company's stock. I've used the average dividend yield of the comparable companies as a proxy for AGL's dividend yield. The calculations are shown in my Schedule 9. In this instance the calculated dividend yield is 5.17%.

Q. What did you use to measure dividend growth?

A. Since AGL's current dividend growth rate is barely above zero, I used the growth rate derived from Value Line's projection of AGL's dividend in the year 2000, which suggests a growth rate of 5.23% in the near future. Thus my estimated DCF equity return is 10.40%, shown in Schedule 9.

Q. Does the DCF Model account for capital gains that may occur when an investor sells stock?

A. No. The DCF model avoids entanglement with either capital gain or capital loss because the model is tied directly to dividend yield and dividend growth. In addition, losses and gains are a matter of the investor timing the stock's purchase and sale. The DCF model neither protects investors from risk nor penalizes them for what happens in the stock market.

DERIVATION OF EQUITY RETURN: RISK PREMIUM ANALYSIS

Q. In addition to your DCF model, did you use another method to determine the market based cost of common equity?

A. Yes. I used the risk premium method which defines the cost of equity as the market's current debt yield plus an estimated risk premium. For example, a current debt yield of 7% plus an estimated market wide risk premium of 3% produces an estimated common equity cost of 10%.

Q. Is a risk premium analysis different from a DCF analysis?

A. Yes, the two analyses are completely different. For example, dividend growth and dividend yield are crucial to the DCF analysis, but they have no role whatsoever in a risk premium analysis.

Q. What is the rationale of risk premium analysis?

A. Investors require extra payments to assume additional risk. Economists call this extra payment a risk premium. Equity investments are riskier than debt because equity investments occasionally lose money, thus equity investors require a risk premium or a higher return than debt. For example, equity holders are last in line for the distribution of earnings and also last in line for distribution of liquidation proceeds. In both cases the debt holders are paid first. Any funds left are distributed to the equity holders. Therefore, the cost of equity is the debt yield plus a risk premium for the company.

Q. **How did you derive your risk premium model?**

A. The model is derived as follows:

$$K_e = R_f + (R_m - R_f) * B_e \quad (1)$$

where

K_e is the cost of equity

R_m is the market rate of return

R_f is the risk free rate of return

B_e is the beta for common stock

and

$$K_d = R_f + (R_m - R_f) * B_d \quad (2)$$

where

K_d is the cost of debt

R_m and R_f are defined above

B_d is the beta for debt

Subtract equation (2) from equation (1) and the result is

$$K_e = K_d + (R_m - R_f) * (B_e - B_d)$$

I treat the beta for debt, B_d, as if it were zero. Since B_d is zero, this raises the cost of common equity that can be derived from this model. Since B_d is zero, the final result is

$$K_e = K_d + (R_m - R_f) * (B_e) \qquad (3)$$

Q. What is the procedure for deriving the cost of equity from this risk premium model?

A. The procedure has six steps:

1. Estimate the market's current cost of debt - K_d.
2. Estimate market-wide rate of return for common equity -R_m.
3. Estimate the market-wide risk-free investment - R_f.
4. Take the difference between steps 2 and 3
5. Multiply the difference by a so-called "Beta" - B_e.
6. Add the result of step 5 to the debt cost in step 1. The result is the estimated cost

of equity from the risk premium model

RISK PREMIUM MODEL: CURRENT COST OF DEBT

Q. What do you use as the current cost of debt - K_d?

A. Since AGL's bonds retain an A rating, I use the monthly average of A-rated bonds for May 1996 through April 1997. Those are shown in Schedule 10 and represent the current trend in capital cost for debt issues of A-rated utility bonds.

Q. What is the value of the K_d?

A. The value of K_d is 7.95%.

Q. Are the A-rated bonds long-term bonds?

A. Not necessarily. For example, the source for this information is the Federal Reserve Board which says these bonds have a maturity of 30 years but call-protection for only 5 years, i.e, after 5 years and depending on the issuing company's discretion, the bonds can be repurchased from the investor.

Q. Is it typical for companies to have call provisions in their bonds?

A. Yes.

Q. What is the purpose of a call provision?

A. It gives the company control and flexibility regarding the disposition of its funds and transfers the risk of interest rate changes from the company to the investor. For example, if a company issues bonds at 10% and six years later interest rates drop to 7%, the company has the option of "calling" the bond from the investor, who then has to find an alternative use for the funds. Continuing with this example, if the company issues bonds at 7% and six years later interest rates rise to 10%, the company has no need to repurchase the bond from the investor, who has the choice of either holding the bond or taking a loss in principal if it is sold.

Q. **Why do you use the A rates as a measure of debt cost instead of AGL's embedded debt cost?**

A. Risk premium analysis is based on market wide indicators of current debt cost instead of a company-specific embedded cost. Using a company-specific embedded cost would mean that the company with the highest debt cost would also receive the highest return to equity. Conversely, the company with the lowest debt cost would receive the lowest return to equity. Thus using a company-specific debt cost to establish a risk premium would introduce incentives for companies to raise their debt cost as much as possible. That is unreasonable logic and unreasonable financial management. Fortunately, the markets don't work that way. A company's return to equity is not guaranteed to be a certain amount higher than the company's debt cost.

Q. **Why do you use the A bond rates as a measure of debt cost instead of the average debt cost of**

the comparable companies?

A. The company average would not necessarily reflect current market rates for bonds rated as A, the current rating for AGL's bonds.

RISK PREMIUM MODEL: MARKET RETURN TO COMMON EQUITY

Q. What do you use to estimate R_m, market-wide rate of return for common equity?

A. I use 10.7%, the compound annual growth rate for large company stocks from the period 1925-through 1996. This figure is taken from Ibbotson Associates 1997 Yearbook- Stocks Bonds, Bills and Inflation (SBBI-1997) page 118.

Q. Why are using large company stocks?

A. The comparable companies that I use in my analysis fit into the large company category, defined in SBBI-1997 page 136 as any company exceeding $197.4 million in market value as of September 1996. The smallest market value for my comparable companies is $343 million.

Q. Why are you using historical data to estimate the risk premium?

A. Historical data provides a way to smooth out the wild fluctuations in the risk premium, which is the difference between the risk-free return and market return to common equity. Since return to debt is fairly stable, the fluctuations are caused by the wide swings in the return to equity. For example, if the return to common equity is large in one year, so is the premium, if the return is small the next year, the premium will be negative.

Q. **Why are you using the years from 1925 through 1996 to measure the risk premium?**

A. Ibbotson provides historical information on the risk premium from 1925 through 1996, and these years represent the entire term for which information is available. Using the entire data avoids any element of subjectivity that may influence the selection of only a portion of the data. Neither Ibbotson nor anyone else I know of recommends using just a portion of the data. SBBI-1997 discusses this issue at pages 152-153: "A proper estimate of the expected risk premium requires a long data series, long enough to give a reliable average without being unduly influenced by very good and very good and very poor short term returns ... More generally, the 71 year period starting with 1926 is representative of what can happen. SBBI-97 also warns: "Some analysts calculate the expected equity risk premium over a shorter, more recent time period...this view is suspect."

Q. **Why are you using 10.7% as the estimate of the market-wide rate of return to common equity?**

A. I use that figure because it represents normal performance in the market. I have two reasons for saying so.

The first reason is a plain and simple one: 10.7% is the actual compound rate of growth in the value of large companies' common stocks. SBBI-1997, at page 49 states: "One dollar invested in large company stocks at year end 1925, with dividends reinvested, grew to $1370.95 by year end 1996; this represents a compound annual growth rate of 10.7 percent." The year-by-year change in the large companies' value is shown in Schedule 11 column (2).

The second reason is also simple. Not all large companies' stocks have advanced at a compound rate 10.7%. Some companies have earned more than 10.7% and others have earned less. In the 71 year period covered by data, there are literally millions of possible outcomes. But out of the millions of possibilities, the number of possibilities below 10.7% are exactly equal to the number of possibilities above 10.7%. Thus 10.7% is the exact middle of all the possibilities that could have occurred. This idea may be expressed another way: there is a 50% chance that the compound return will be 10.7% and a 50% chance that a $1 investment in 1925 would be worth $1370.95 in 1996. Returns higher than 10.7% have a smaller chance of being achieved.

Schedule 12 and Charts 2 and 3 show the exact odds of achieving 10.7% versus the other possibilities.

Q. **How did you derive Schedule 12?**

A. I have provided the mathematical details in Appendix A. But the heart of the concept is simple. A $1 investment today has two possible outcomes next year -- a gain or a loss. But in the year after next, there are four possibilities because each possibility in the first year has two possibilities in the second year. The number of possibilities doubles each year. Thus an investment that begins with $1 has 8 possible values three years later, 16 possible values four years later and so forth. The SBBI-97 data on large companies covers seventy one years and literally millions of possibilities. But the odds of each possibility can be easily calculated. I have done that in Schedule 12.

Q. **Why have you highlighted certain portions of Schedule 12 and Charts 2 and 3?**

A. I highlighted those portions to show the tie-ins of the schedule and the charts back to Schedule 11 and to emphasize the difference between the actual rate of 10.7%, which appears at the bottom of column (2) in Schedule 11 and the figure of 12.7%, which appears at the bottom of column (3), the so-called average of the returns, which I describe as a "biased average."

Q. **Why do you consider the average to be biased?**

A. The average is biased in the sense that it overstates market returns and leads unwary investors into the mistaken notion that an "average" return has a 50% chance of being achieved, when it does not. The growth rate of 12.7% means that a $1 investment in 1925 is now worth $4768 instead of $1371. Thus the rate of 12.7% is biased.

The bias is created in a very simple way: <u>No one can ever lose more than 100% of their investment, i.e., 100% is the mathematical limit for losses.</u> **However, there is no mathematical limit for an investment's gain.** Therefore, when percentage gains are combined with percentage losses the resulting average is mathematically biased to overstate the true gain in value. An excellent example is provided by Roger Ibbotson, the principal of Ibbotson Associates and the author of SBBI-97. In the July-August 1979 issue of <u>*Financial Analysts Journal*</u>, at page 44, he wrote::

> "Suppose that $1.00 were invested in a common stock portfolio that experienced 100 percent price appreciation in the first year and 50 percent depreciation in the succeeding year. At the end of the first year the portfolio would be worth $2.00; at the end of the second year the portfolio would be $1.00. The [average]...return on the portfolio would be 25 percent ..."

By adding a gain of +100% to a loss of -50%, the net is +50% and the average is 25%. Since the portfolio's value is again $1.00, the actual return is obviously zero, not 25%. Thus, the "average return" is clearly a biased and misleading estimate of the return to equity. This example also shows that the actual return is computed by comparing numbers that represent actual values rather than by averaging numbers expressed as rates of return.

Q. **Is there any situation in which the average return is not biased?**

A. Yes. If the market always gains, then the average is not biased. In this situation the average return and the actual return are identical. A divergence between the actual return and the average return indicates that losses have occurred. The greater the divergence, the greater the losses in the market.

Q. Is 10.7% derived by comparing two actual values?

A. Yes, it is derived by comparing the market value of large companies' common stock in 1925 with the their value in 1996, which I show in Schedule 11.

Q. Is 12.7%, the biased average in your terms, derived by averaging numbers expressed as rates of return?

A. Yes, it is derived by averaging all the rates of return from 1925 through 1996.

Q. Does the figure 12.7% result from the mathematical bias you described?

A. Yes because there have been several years where the market lost value. This is indicated in Schedule 11 column (2) when the value for an earlier year is greater than the value of a later year. For example, the market index fell from 534.46 in 1989 to 517.5 in 1990.

Q. What are the odds of a company achieving at least a 12.7% return?

A. The odds are less than 1 in 5 or less than 20%, indicating the return represents superior performance rather than normal performance.

Q. What are the odds of a company achieving at least a 10.7% return?

A. The odds are 1 in 2 or 50%, indicating that the return represents normal performance.

Q. Why have you made the effort to explain the differences underlying 10.7% and 12.7%?

A. Market returns vary widely over time, and when people are confronted with extremes the first step in clarifying the situation is to take an average. But with regard to a rate of return, it is a mistake to assume that an average is the mid-point between the extremes and that the average represents a typical value. I want to make this fact clear. In addition, I have not seen any direct testimony presented to the TRA or its predecessor agency where the differences are explained in terms of probability. Without a probability analysis the difference between 10.7% and 12.7% may seem tiny and unimportant. However, when the probability of achieving 12.7% is considered, it is clear that 12.7% is a return representing superior performance in the market rather than normal performance. Thus 12.7% is not a rational basis to set a risk premium rate.

Q. Is it reasonable to describe the risk premium in terms of a probability analysis?

A. Yes. SBBI-97 at page 155 states: "in the investment markets...returns are described by a probability distribution..."

Q. Is the return of 10.7% certain to be achieved?

A. No, there is a 50% chance that it will not be achieved.

Q. Is there disagreement about whether a risk premium should be derived from 10.7% or 12.7%?

A. Yes. The disagreement is generally discussed in terms of a debate about the merits of using the "geometric mean" of market returns versus using the "arithmetic mean" of market returns. The 10.7% figure is the geometric mean of large companies' historical returns, and 12.7% is the arithmetic mean.

Q. Are you using the geometric mean or the arithmetic mean in your risk premium analysis?

A. I use the geometric mean, but I prefer the phrase "actual return." I prefer to call the arithmetic return the "average return."

Q. Do you have support for your choice of the geometric mean over the arithmetic mean?

A. Yes. In addition to the all the reasons I have already described for using the geometric mean, it is also preferred by scholars in statistics and finance as well as professional investment firms. In 1990, Thomas Copeland, et. al. published _Valuation: Measuring and Managing the Value of Companies_. At page 193 they state: "Our opinion is that the best forecast of the risk premium is its long run geometric average." Irving Fisher, considered to be one of the world's greatest statisticians, wrote a book called _The Making of Index Numbers._ In the

1967 edition of the book at pages 29 and 30 Fisher says, "The simple arithmetic average produces one of the very worst index numbers. And if this book has no other effect than to lead to the total abandonment of the simple arithmetic type of index number, it will have served a useful purpose." In 1981 Richard Stevenson and Edward Jennings published, *Fundamentals of Investment 2sd ed.*. At page 272 they say, "Why not simply average the rates of return? Indeed, in certain instances, such a procedure would be satisfactory. However, such an average would generally be meaningless." On March 13, 1990 at page C1 the Wall Street Journal ran the following story, "When Figuring the Rate of Return Don't Be Confused By The Sales Hype." The story compares the average return with the so-called compound return, another common name for the geometric return. The WSJ story says the compound return is "more widely used by investment firms."

There is plenty of support for using the actual market return (the geometric mean) in the risk premium model.

Q. What portions of the risk premium model have you identified thus far?

A. I have identified the debt and equity portions. In terms of the model -- $K_e = K_d + (R_m - R_f) * (B_e)$ --I thus far identified K_d as 7.95% and R_m as 10.7%. I still have to identify R_f, the risk free return and B_e, the beta.

RISK PREMIUM MODEL: RISKFREE RATE

Q. What represents the market-wide risk-free investment, R_f?

A. In this case I am using the three-month U.S. Treasury bills. I will show that the three-month rate is based on a long term perspective of the riskless rate and that it is a better concept to use in this case than a long-term bond.

Q. What is the market-wide risk free rate of return, R_f, based on three-month bills?

A. The risk free rate is 3.7%, which is the compound annual growth rate in the value of the three-month treasury bills from 1926 to 1996. Schedule 13 shows the 71 year history for returns to Treasury bills, and in the entire time there is no loss. The compound rate of 3.7% is the center of all possible outcomes from a $1 investment in three-month bills in 1925. The average rate is 3.8%. It is slightly higher than the actual rate because there were no gains in several years. The three-month rate is the best measure of a riskless rate.

Q. Why is the three-month treasury bill the best measure of a riskless rate?

A. There are three reasons:

1. The three-month bill is a debt instrument. This fits with the risk premium's basic premise: the return to debt is less than the equity return and equity return is determined by referencing debt.

2. Of all the other debt instruments

measures that could be used -- long-term corporate bonds, long-term government bonds, the income portion of long-term government bonds and intermediate term government bonds -- the three-month bill provides the lowest rate. This is consistent with the financial concept that a risk free rate should be lower than rates that reflect risk.

3. A three-month bill is free from losses but the other debt instruments are not, i.e., they are riskier forms of investment than the three-month bill, which is why their rates are higher. Schedule 14 shows the actual return and the average return 1925 to 1996 for each of the debt instruments. For each kind of debt, the difference between columns (2) and (3) indicates the degree to which the losses occur in that particular debt market. Of all the debt instruments, the three-month bill is the safest. Investors are absolutely certain of what cash flows will be received and when they will be received. Unlike the other debt instruments, the three-month bill carries no risk of default or loss of principal.

Q. **Is there a contradiction between using the three-month bill as the risk free rate while you are using the cost of A rated bonds in your model?**

A. No. I have already said those bonds are not necessarily long-term notes. They have call provisions that transfer the risk of interest rate changes from the company to the investor. The three-month bill allows the investor to do the same thing the company does: avoid the risk of interest-rate changes.

Q. **Is there a way to avoid the risk of losing principal and still use long term bonds?**

A. No. SBBI-97 at page 151 suggests that long-term bonds have so-called "income returns." This return is the income an investor would receive if the bond were purchased and held to maturity rather than selling it. SBBI-97 considers the income return to be the "riskless portion" of an investment in long term bonds. I disagree with this concept because it is irrational.

Q. **Why is the concept irrational?**

A. It is irrational because it assumes an investor can divide a long term bond into a riskless portion and a risky portion. This separation is not credible because a bond is not severable into distinct portions. The purchase of a long term bond always carries the risk that changes in interest rates will cause a change in the bond's value. The concept of "income returns" also suggests that once a long term bond is purchased, the investor will take no action until the bond matures and do nothing in the face of interest rate changes. This behavior is just the opposite of the behavior assumed in a call provision, which gives the issuer the flexibility to act when interest rates change. It is irrational to assume that the issuer of a bond is free to respond to interest rate changes but that the bond's buyer is not.

Q. What portions of the risk premium model have you identified thus far?

A. In terms of the model -- $K_e = K_d + (R_m - R_f) * (B_e)$ -- I have identified K_d as 7.95%, R_m as 10.7% and R_f as 3.7%. The term $(R_m - R_f)$ is equal to 7%. This amount would be smaller, as would my recommended rate of return, if I were to use any debt instrument other than the three-month bill. For example, if I were to use long-term government bonds, the term $(R_m - R_f)$ would be (10.7%-5.1%), which equals 5.6%. This lowers the risk premium equity return by 1.4%, which is the difference between 7% and 5.6%. I still have to identify B_e, the beta.

RISK PREMIUM MODEL: THE BETA

Q. What does beta measure?

A. Beta measures how an individual company's market value changes relative to the change in the value of the entire market. For example, if a company's market value increases from $11 to $11, then the company's value increases by 10%. If the entire market's value increased from $1000 to $1200, then the entire market's value increases by 20%. The beta is calculated as .5, which is the ratio of 10% divided by 20%.

The market itself has a beta of 1. If the company's beta is one, then the company risk premium is the same as the market-wide risk premium. Thus if a company's beta is less than 1, then the company is judged less risky than the market. Beta is also used to compare the relative riskiness. For example, a beta of 0.4

is less risky than a beta of 0.6.

Q. Did you calculate betas for AGL and the comparable companies?

A. Yes, and I also calculated the betas' accuracy. The betas and their tests of statistical accuracy, the T-statistic, appear in Schedule 15, pages 1 and 2 respectively. The average beta shown at the bottom of page 1 Schedule 15 is transferred to Schedule 16, which provides results of the risk premium analysis.

Q. What is the beta's value in your model?

A. The value is .458 and is shown in Schedule 16 at the bottom of column (b).

Q. What is the estimated equity rate of return that is derived from your risk premium model?

A. The model gives a value of 11.14%. In terms of the model -- $K_e = K_d + (R_m - R_f) * (B_e)$ -- the equity return is 11.14% = 7.95 + (10.7%-3.7%)*.458.

Q. Do you use all the betas in Schedule 15 to develop the figure of .458?

A. Yes. I used the average betas that have an average T-statistic greater than 1.

Q. Why did you use the T-statistic and T-statistic greater than 1?

A. In general, the T-statistic indicates how well a summary number represents the group from which the summary number comes. In this case the summary number is a beta, which few people are familiar with. But the T-statistic can also be explained in terms of an average, a summary number which everyone uses almost everyday.

For example, I may know that a certain group of people are, on average, 40 years old. But the average is just a short-hand description of the group. The average alone does not indicate anything about the group's composition. The group could be composed of children younger than 10 and elderly people over 70. The group as a whole just happens to have an average age of 40 even though 40 <u>is not at all representative of anyone in the group</u>. In this case the T-statistic is likely be low, about 1 or less. On the other hand the group could be composed of people between 36 and 42, who as a group, just happen to have an average age of 40, but in this case 40 is fairly representative of anyone in the group. In this case the T-statistic is likely to be high, about 2 or more. The higher the T-statistic, the more likely it is that a group's summary number or average is a good representation of the parts that make up the group. Statisticians express the same idea by saying "the beta is statistically different from zero."

Q. **What is the economic significance of the betas' values you found?**

A. All the values are far less than 1, which means that AGL and the comparable companies are far less risky investments than the market as a whole. In addition, the values do not vary much for any particular company, which means that investors **<u>do not</u>** perceive any substantial change in risk for these companies.

Q. How did you derive the betas?

A. I used the monthly percentage change in the S&P 500 index to represent the market-wide return and the monthly percentage change in the company's stock price to represent the company's return. The change is calculated as: Price at the end of the month divided by price at the beginning of the month -- the result is converted to a natural logarithm and then the beta is calculated.

Q. Did you compare your betas to those estimated by anyone else?

A. Yes. My betas are larger than those estimated by Dr. Andrews for his companies, shown at Schedule 9 of his direct testimony. The average for his betas is .27. This figure includes 5 negative betas. When Dr. Andrews implements his model he excludes the negative betas and raises his average to .41, which is still lower than the average of my betas, .458.

Q. Is the value of .458 a reasonable value?

A. Yes.

<u>THE APPROPRIATE RETURN OF 10.55%
COMPENSATES FOR MONTHLY COMPOUNDING</u>

Q. What is the range of annual equity returns that you have established?

A. I have established a range of 10.4% to 11.14%.

Q. In your opinion, within the range of 10.4% to

11.14% what value is appropriate?

A. In my opinion the appropriate annual value is 10.55% because this compensates for monthly compounding that creates annual returns. Even though the range's mid point is about 10.8%, this can be converted into a return of 11.3%, an amount well-beyond my upper limit of 11.14%.

Q. Are there other experts who believe that annual returns are achieved by compounding monthly returns?

A. Yes. This financial principle pervades the data in SBBI-97, Ibbotson's 1997 Yearbook. For example, my Schedule 12, column (3) for the year 1996 shows a value of .2307 or 23.07%. My Schedule 17 shows exactly how .2307 is derived. This process is exactly the same as the one shown in my Schedule 6. Monthly compounding is the basis for all the annual returns shown in Dr. Andrew's Schedule 10 and my Schedule 11. But this is normal because SBBI-97 at page 49 explicitly says: "Annual total returns...for each asset class are formed by compounding the monthly returns." Thus in my Schedule 12, column (2) for the year 1996, the amount of 1370.95 equals 1.2307*1113.92, or stated in words:

Annual Return This Year Equals:
12 Most Recent Monthly Returns Multiplied Together, Which Are Then Multiplied by Annual Return Last Year.

Returning to Schedule 17, it is important to notice that .2307 is larger than the sum of the monthly returns in column (2). If those returns were added together they would sum to only

.2148. This is further proof that annual returns are actually achieved by multiplying monthly returns together, i.e., monthly compounding. This also substantiates the findings in my Schedule 6, where an allowed annual return of 10.55% is subdivided into monthly returns that actually yield 11.0% over a 12 month period.

Q. **Isn't it true that monthly compounding introduces an upward bias to a prospective annual rate of return?**

A. Yes, and here is how the bias occurs. Lets say that TRA surveillance form 3.03 line 27 for a month shows an annual return of 11% for a certain company. If there is agreement that annual returns are formed by monthly compounding, then we know that the sum of the monthly returns is 10.55%, but when the returns are multiplied together the annual return is 11%. Now suppose that the company files a rate case and asks for an 11.5% return. If the proposed rate of return were subdivided on a monthly basis, the sum of the proposed monthly returns should be 11% to ensure that when they are compounded monthly, the result does not exceed 11.5%. If the monthly returns sum to 11.5%, then in effect, the allowed rate of return is 12%.

Another way to understand the compounding effect is to consider how the test year rate base is calculated. The rate base is actually an average of the rate base at the beginning of the test year and the rate base at the end of the test year. Thus the value of rate base already includes 6 months of reinvested earnings. Therefore, when a rate of return is applied to the rate base, the company is actually earning on its earnings. This is another way to achieve monthly compounding. If this aspect were implemented in terms of Schedule 6, the beginning balance would not be $1 but about $1.06.

Q. **Is there any document in this docket where a proposed annual return is subdivided on a monthly basis?**

A. The only one I know of is my Schedule 6.

Q. **What equity return do you recommend in this case?**

A. I recommend a rate of 10.55%, an amount between my DCF rate of 10.4% and 11.14%, the risk premium rate. I choose 10.55% because I know that monthly compounding gives the company the opportunity to earn a higher return. I also choose 10.55% because I know that the rate base already includes 6 months of reinvested earnings before the rate of return is applied to the rate base, thus giving the company another opportunity to earn a higher return

Q. **What compounded return can the company earn with an annual rate of 10.55%?**

A. The monthly compounding process gives the company an opportunity to earn approximately 11.0%.

<u>CAPITAL STRUCTURE AND OVERALL RATE OF RETURN</u>

Q. **What are your findings regarding capital structure?**

A. The capital structure in this case appears in the company's filing as Exhibit 5, Schedule 9. Since the amounts in that schedule are derived from AGL's capital structure, CA data request 42 asked the company to provide support for the calculations. The company's response is attached to my testimony as Schedule 18. None of the projected balances in that document are explained or supported by the company. For example, the preferred stock balance in 1997 is $58.4 but the projected balance in 1998 is $70 million. Despite this hefty increase, no explanation is provided. Continuing with this example, AGL's long term debt is shown as $659.5 million in 1997 and 1998. However, the company's response to CA data request 24 showed a balance of $584.5 million as of April 1997. This is an unexplained difference of $75 million. In addition, the new debt's interest rate is not provided. Also, according to the company's response to CA data request 23, all long term debt and preferred stock is held by AGL instead of its parent holding company, AGL Resources. Therefore, the $75 million cannot be attributed to debt issues by the holding company. Finally, AGL's response to data request 42 does not show how the amount of the CG capital structure, $95.8 million, is derived. Instead, the response shows how $95.8 is allocated to the different aspects of the capital structure.

In sum, the amounts shown in Schedule 18 are different than what I expected, but I do not believe the differences are material to my analysis, which relies on the portions and the estimated costs. However, my recommended overall return is neither an endorsement nor an acceptance of the rate base that will be applied to the overall return. To the extent that the projections in Schedule 18 are not supported, the company's filed rate base is questionable.

Q. What weighted overall capital cost do you recommend?

A. In my opinion a cost of 8.85% before compounding, shown in Schedule 19.

Q. What compounded overall return can the company earn with an annual rate of 8.85%.

A. The company has an opportunity to earn about 9.3%.

ANALYSIS OF METHODS EMPLOYED BY THE COMPANY'S COST OF CAPITAL WITNESS

Q. You have stated that you disagree with Dr. Andrews' analysis, can you explain your reasons?

A. Yes. At page 4 lines 22-23 of his direct testimony he states: "I measure the costs of equity capital of ...small publicly held gas distributing companies and impute their cost of equity to CGC." I have already pointed out an obvious difference between these companies and CG -- they are independent financial entities who have actively traded stock while CG has no actively traded stock because it is a wholly owned subsidiary of AGL. This alone suggests that his analysis is inappropriate. However, after scrutinizing his testimony and his data sources, I conclude that his equity returns -- 14.39%, 14.38%, 14.23% , 12.5%, 12.17% and 11.06% shown at page 47 of his testimony -- are based on an irrational analysis.

SMALL COMPANY APPROACH IS IRRATIONAL

Q. **Why is the analysis irrational?**

A. The small company data base that he uses does not represent the performance of small companies. Instead, the data base represents the performance of one particular mutual fund out of more than 200 funds that specialize in buying and selling small company stocks. The particular mutual fund used by SBBI-97, the very same one that Dr. Andrews uses, is named the *Dimensional Fund Advisors 9-10 Small Company Mutual Fund* (DFA 9-10 fund). SBBI-97 at page 51 says; "...the small company stock returns series is the total return achieved by the Dimensional Fund Advisors (DFA) Small Company 9-10 Fund."

However, the fund requires an initial purchase of $2 million dollars. This is well beyond the means of stockholders who own the companies used by Dr. Andrews. The fund also has a highly unusual ownership concentration, one that is certainly not representative of a gas distribution utility. In 1996 the fund had assets of $1.18 billion with over $625 million held by five owners that are actually pension funds:

OWNER	OWNERSHIP PERCENTAGE

Charles Schwab & Company Inc.	31.44%
State Farm Insurance	10.76%
Pepsico Inc. Master Trust	8.87%
Owens-Illinois	5.48%
National Electrical Benefit Fund	5.26%

This ownership pattern and the $2 million minimum investment clearly indicates that the so-called "returns to small companies" are actually returns to well-financed pension groups rather than being a return that is accessible to ordinary investors. There would be no incentive for anyone to make a $2 million minimum investment and buy into the DFA 9-10 fund if such returns were accessible to ordinary investors. Also, these returns are derived from the capital gains made by the constant buying and selling of stock, a far different process than the way in which a gas distribution company makes money.

However, even the returns themselves are open to question because the methods used to calculate the fund's return are not equivalent to the *return-on-assets concept used in utility regulation*. *In 1996 the fund's return on assets was 8.75%*. Dr. Andrews' Schedule 6, page 1, the far-left column titled "Small Company Stocks" shows the return as 17.62%. He uses this amount and the remaining figures in that column to develop the return differentials of 9.16%, 7.57% and 6.86% shown on the right side of the schedule. Those amounts are repeated in Schedule 6 page 2 and in his direct testimony, at the bottom of page 45 under the column titled "Equity Diff" and lead to a huge cost of equity, 14.3%.

These figures are not credible, not only for the reasons I have just discussed, but also for *__the overlapping directorates of the DFA 9-10 fund and SBBI-97__*. Mr. Robert G. Ibbotson is the Chairman and President of Ibbotson Associates, and the publisher and author of SBBI-97. He is also on the Board of Directors of the DFA 9-10 fund. This strongly implies that the small company data used in SBBI-97 is not derived from an independent source and that the data may overstate the actual returns. This possibility is already substantiated by the difference between 8.75%, the return on assets, and the so called return of 17.62% used by Dr. Andrews. Mr. Ibbotson's dual role is indicated in the __Statement of Additional Information__ published March 28, 1997, as a supplement to a prospectus issued the same date by DFA Investment Dimensions Group, Inc.

These factors demonstrate the extraordinary weakness in the small company analogy that Dr. Andrews uses to estimate the cost of equity. But there is another contradiction in the data: in 1994 only 9 of Dr. Andrew's companies were owned by the fund, in 1995 and 1996 only 11 of the companies were owned by the fund. Thus half of Dr. Andrews' companies are not considered "small" by the fund itself.

Taken as whole these factors make it plain that the small company analogy is an irrational approach to setting the equity return in this docket. In my opinion the TRA should disregard the results of Dr. Andrews' small company analysis, shown in his direct testimony at the bottom of page 45.

Q. What are sources of data that support the assertions you have made?

A. My data is taken from four different sources:

1. DFA Investment Dimensions Group Annual Reports for the Years Ended November 30, 1996 and November 30, 1994 and DFA's SEC10K filing for 1995.

2. Statement of Additional Information, Supplement to DFA's Investment Dimensions Group, Inc. Prospectus of March 28, 1997.

3. Morningstar, Inc.'s Reports on Mutual Funds, as of May 31, 1997.

4. SEC Form 10Ks and 10Ka-1 for Dr. Andrews' companies and the DFA Group.

Q. What is Morningstar Inc.?

A. Morningstar is a software and data base firm that maintains records on over 8000 mutual funds and tracks their performance. The company is located in Chicago.

Q. What schedules have you set up from this data?

A. Schedule 20 is a summary of Morningstar's reports on 230 mutual funds that specialize in buying and selling small company stocks. About 30 concentrate on foreign stocks and the remainder focus on domestic stocks. The funds are arranged in descending order according to the amount of the initial minimum investment. The funds managed by the DFA group are among the most expensive funds to purchase. Nearly all of DFA's funds require $2 million minimum investment. For all 230 funds taken as a group, there is a systematic difference between the rate of return on assets and the 1996 return as reported by the funds. The return on assets is much lower than the other so-called return.

This discrepancy was so large that I was compelled to cross-check the accuracy of the Morningstar report on the DFA 9-10 fund against the data in the DFA 1996 annual report. The Morningstar report is Schedule 21 and the DFA report on the fund is Schedule 22. Although the data is not identical they are close enough to be substantially the same. For example, Morningstar reports assets of $1107 billion and the DFA annual report shows assets of $1181 billion. In Schedule 21 I have highlighted the portfolio statistics showing an exact match between Morningstar's data and DFA's. This suggests that Morningstar's calculation of a return on assets is credible even though the DFA report does not provide this measure. Also, the DFA report, the line titled "Net Gain (Losses) on Securities (Realized and Unrealized)" represents capital gains and losses by the fund. Clearly, the fund is completely dependent on capital gains to make a return, unlike a gas distribution company that sells a product and a service. This, too, makes the fund an unreasonable basis to develop returns for a gas distribution company.

Schedule 23 shows DFA's <u>Statement of Additional Information</u>, the cover page and pages 20-22. The fund's method of calculating a return is shown from Schedule 23 page 3, at the bottom, to the schedule's page 4 at the top. The description is vague and not articulated through any readily understood example. This sharply contrasts with the way all parties calculate the return on assets that a gas distribution utility receives. Therefore, returns to mutual funds, such as the amounts in Dr. Andrews' Schedule 6, page 1, the far-left column titled "Small Company Stocks," cannot be used to estimate the *return-on-assets* that is granted to a gas distribution company.

Schedule 24 shows DFA's Statement of Additional Information, pages 10, 11 and 15, which respectively list the company directors and the major owners of the fund. Mr. Ibbotson's name appears at the second page, the third listing from the top. This confirms that the DFA 9-10 fund and SBBI-97 have overlapping directorates. Page 15 confirms the ownership pattern of the fund.

Q. How do you know that investors in Dr. Andrews' 22 small companies would be unable to buy into the DFA fund?

A. My opinion is based on the data I gathered about Dr. Andrews' companies. Schedule 25 column (6) shows the average value of the holdings per shareholder for Dr. Andrews' companies. The maximum value is $53,171 and the average value is $28,195. The DFA fund's initial investment is $2 million, about 50 to 100 times larger than the values shown in column (6). It is impossible for stockholders of Dr. Andrews' companies to buy into the DFA fund.

Q. How do you know that the DFA fund included only half of Dr. Andrews' small companies?

A. I acquired DFA's annual reports for 1994 and 1996 and the company's SEC 10K filing for 1995. Those reports list the companies in the fund.

Schedule 26 shows the results.

Q. Is it your opinion that Dr. Andrews actually used the 22 "small publicly held companies" to estimate the equity returns of 14.3%?

A. No, Dr. Andrews did not use those companies. In my opinion he used the concept of "small companies" to make a link with the purported returns of the DFA fund, which is the real source of the huge equity-return estimates that appear in his direct testimony at the bottom of page 45. Also, nine of Dr. Andrews' companies do not fit the definition of a small company that is given by SBBI-97 at page 136: A small company is one with a market value less than $197.4 million as of September 1996. My Schedule 25 shows 9 of Dr. Andrews' companies exceeding that value on April 30, 1997. This strongly suggests that Dr. Andrews' companies are composed of two dissimilar groups that are viewed differently by the market.

<u>RETURNS OF 12.5% AND 12.17% ARE BASED ON LARGE COMPANY DATA, MISUSE OF DATA AND IRREGULAR, UNSUPPORTED PROCEDURES</u>

Q. Are Dr. Andrews' other returns derived from the small company concept and the DFA fund?

A. No. He uses large companies to derive the returns of 12.5% and 12.17%. The returns appear in his testimony at page 44 lines 21-22 and at page 45 lines 1-2 and are derived from his Schedule 10. The schedule's left side has a column titled "Common Stock Total Returns." This name is wrong. In his note at the bottom of the schedule he says data for the years

1987-1995 is drawn from "Exhibit A-1" of Ibbotson's 1996 yearbook. The correct name is "Table A-1 Large Company Stocks: Total Returns." A portion of the table from the 1996 yearbook is attached to my testimony as Schedule 27. Note the title of column (3) in my Schedule 11 and the exact match between the amounts in column (3) from 1988-1996 and the amounts listed in Dr. Andrews' so-called "Common Stock Total Returns."

Contrary to his assertion, "I measure the costs of equity capital of ... small publicly held gas distributing companies," Dr. Andrews uses large companies without acknowledging the fact nor explaining why he has done so. This undermines his entire analysis, making it an irrational basis to determine a return to equity.

Q. **Does Dr. Andrews use the data correctly?**

A. No. He limits Schedule 10 to a history of 10 years instead of a 71 year history recommended by SBBI-97.

Q. **Are you suggesting that every recommendation of SBBI-97 has to be followed?**

A. No. Although SBBI-97 is a useful tool and an authoritative source for some aspects of developing a rate of return, its authors are fallible, as I have already demonstrated with regard to the small company issue. However, it is contradictory to invoke an authoritative source to justify one position and then depart from the source's recommendations in other positions without explaining the reasons for the departure.

Dr. Andrews has departed from the standard practice of using a 71 year history to derive the risk premium differential. His direct testimony offers neither a justification nor an explanation of his reasoning. In their absence, his choice of a 10 year history appears arbitrary and calculated to increase the estimated cost of equity.

For example, his Schedule 10, the line titled "Averages" shows that: .1604 - .0778 = .0826. These values appear in his direct testimony at page 44 line 21:

$$K_e = .0133 + .0778 + (.41)*(.1604-.0778)$$

$$K_e = .125 = 12.5\%$$

However, if Dr. Andrews had taken the data for the 71 year period, as the source recommends, the averages would be different than what he shows in Schedule 10.

The figure of 16.04% would decrease to 12.7%, which is the average return to large companies and which is shown in my Schedule 11 at the bottom of column 3. The figure of 7.78% would decline to 5.2%, which is shown in my Schedule 14 in the line titled "Income Portion of Long-Term Government Bonds" and under the column titled "Biased Average." If these new figures were applied to his equation at page 44 line 21, the new result would be:

$$K_e = .0133 + .052 + (.41)*(.127-.052)$$

$$K_e = .0961 = 9.61\%$$

A similar result occurs in the equation at line 1 of page 45 of his direct testimony, where the new value would be 9.31%.

The use of a 10 year history is vital to Dr. Andrews' results. However, the exact reason he chose this period is not discussed in his testimony. Therefore, I recommend that the TRA disregard the estimates of 12.5% and 12.17% because they are arbitrary and unreasonable.

In fact, his formulation of the risk premium model is irrational.

Q. **Why is his risk premium model irrational?**

A. Dr. Andrews' model is irrational because it is not tied to the debt markets faced by AGL, the "A" rated bond market, despite his lengthy discussion of AGL's debt quality at page 18 of his testimony. The only place in his analysis where he uses "A" rated corporate debt is in a DCF analysis appearing in his testimony at page 46 lines 16-17, which shows returns of 8.98% and 9.35%. These figures are repeated at page 47 lines 7-8, where he describes these numbers as "DCF Over Various Debt Instruments."

This portion of his testimony contradicts a statement in his deposition of September 9. In that deposition, from page 43 line 24 to page 44 line 3, he states: "One of the lines of analysis that I pursue is the equity over debt cost approach, risk premium approach; and I used some of the costs of the debt that Atlanta Gas had outstanding and found differentials of equity cost over that." However, Dr. Andrews has not used AGL's debt or "A" rated bonds in any risk premium analysis, but only in the DCF analysis he describes at pages 46 and 47 line 7 of his testimony. His highest set of returns --

14.23%, 14.38% and 14.39% derived from his small company analogy, and his second highest set of returns -- 12.5% and 12.17% -- are completely unrelated to the "A" bond market or to AGL's debt.

Q. Is your risk premium model rational?

A. Yes. My risk premium model is based on the general principle that equity returns have to be compared to and exceed corporate debt. In this particular case the debt in question is the "A" bond market. If I expressed the principle instead of the numbers, the model would be:

$$K_e = \text{Current Cost of A Rated Utility Bonds} + (R_m - R_f) * (B_e)$$

Dr. Andrews' model does not begin with corporate debt. Instead, his model begins with the concept of "Long-Term U.S. Govt. Bonds Income Component Returns." If I expressed his idea instead of the numbers, his model would look like:

$$K_e = 1.33\% + \text{Long-Term U.S. Govt. Bonds Income Component Returns} + (R_m - R_f) * (B_e)$$

Therefore, Dr. Andrews' model is based on the idea that equity returns have to be compared to and exceed the returns of long term government bonds instead of corporate debt. This is an irrational basis to begin an analysis because returns to government bonds are always lower than returns to corporate bonds. My Schedule 14 clearly shows that corporate bonds outperform government bonds. Therefore, Dr. Andrews' model has a starting point that is bound to be lower than the starting point in my model. However, he raises the starting point of his model by resorting to a figure of 1.33%. This amount is not related to debt, corporate or government; nor is it related to equity returns of either large or small companies.

Q. What does the 1.33% relate to?

A. The figure is not related to anything because it is a nonsense-number.

Q. How is 1.33% a nonsense-number?

A. Dr. Andrews explains the derivation of 1.33% in his direct testimony, page 44 lines 13-14. The derivation is irrational for two reasons:

1. Dr. Andrews is dealing with numbers that cannot be treated as if they are "per day, per week, per month or per year" numbers. Just as the assertion -- "You are 6 feet tall per month, so in 12 months you will be 6X12=72 feet tall per year" -- is nonsense, so too is Dr. Andrews' number of 1.33%.

   This point becomes clear by examining his derivation of 1.33%. In his Schedule 9 under the "Alpha" column, there is a number, .0011, which is the average of the alphas that have a positive beta. Thus .0011 is the basis for deriving .0133 by the formula at page 44 lines 12-13 of Dr. Andrews' direct testimony:

$$.0133 = (1 + .0011)^{12} - 1$$

Although he does not say that he is deriving his alphas from five years of monthly data, he is. At page 42 lines 6-12 of his testimony Dr. Andrews explains that he derives his betas with five years of monthly data, but every time a statistical regression produces a beta an alpha is created too. This is why his work and mine both have alphas as well as betas.

He treats the value .0011 as if it were a monthly value that can be compounded into an annual figure. This is why he uses 12 in his formula:

$$.0133 = (1 + .0011)^{12} - 1$$

The alphas and betas are derived from the same data and the same months. If the alpha is a monthly rate, isn't the beta a monthly rate, too? If the beta is not a monthly rate, how can the alpha be a monthly rate? If his beta of .41 were compounded monthly the result would be:

$$60.75 = (1 + .41)^{12} - 1$$

If this value were placed into Dr. Andrews' original formula the cost of equity would be:

$$K_e = .0133 + .0778 + (60.75)*(.1604-.0778)$$

$$K_e = 5.10 = 510\%$$

60.75 is produced in exactly the same way as Dr. Andrews' produced .0133. If

60.75 is dismissed as incredible or fictitious, then its counterpart, the "annualized" alpha, is an unreasonable number and .0133 should be rejected, too. Both numbers are unreasonable. It is irrational for Dr. Andrews to treat the alpha as a monthly figure that can be compounded to an annual one. His treatment further suggests that the alpha can be compounded according to the time frame of the data used, i.e., if the alpha and beta are derived from monthly data then the alpha can be compounded monthly, but if the data is weekly, then the alpha can be compounded weekly. This too is irrational.

For example, if I took the weight of 22 people each month for 60 months and then took an average, I can say "based on monthly data the average weight *per person* is 150 pounds" but it would be wrong to say "because I collected my data on a monthly basis each person weighs 150 pounds *per month* and 1800 pounds *per year*." This is the exact logic that Dr. Andrews employs. The difference between this example and Dr. Andrews' irrational procedure is the size of the numbers.

If the beta is .41, as in Dr. Andrews' results, then the value of the company's stock changes 41 cents *per $1 change in the market's value*, whether the market's change is measured over a day, a week, a month or a year -- .41 is not compounded to a higher figure nor reduced to a lower one. The same logic applies to the alpha.

In my opinion the TRA should disregard Dr. Andrews' figure of 1.33% because it is irrational.

2. Dr. Andrews' direct testimony does not provide any tests of statistical accuracy for the alphas in his Schedule 9. In the absence of this data, my opinion is that the alpha should be presumed to be zero.

Earlier I said that every time a statistical regression produces a beta a so-called "alpha" is created too. Since his overall positive beta is .41 while mine is .458, I expected this similarity to be carried through to the alphas, and it is. The values of his alphas are very close to zero, just as they are in my analysis, at Schedule 15 page 3. However, page 4 of Schedule 15 shows the alphas' statistical measures of accuracy, the T-statistics. They are tiny, meaning the alphas are no different than zero.

The typical pattern of alphas, betas and their statistical accuracy are provided in the table below.

Betas	Alphas
Positive Values	Very Close to Zero- May Be Positive or Negative

High T-Statistics Indicate Accuracy	Low T-Statistics Indicate Inaccuracy

Schedule 15 fits this pattern. Dr. Andrews' data should show the same pattern, at least for his positive betas.

When the alphas are no different than zero, they do not add anything to the cost of equity, and there is no need to use the alphas. In this case the formula looks like:

$$0 = (1 + .0000)^{12} - 1$$

The alpha is zero. This is why alphas are thought of as having no value and no meaningful economic interpretation and why they never appear with betas.

I do not know of any financial publication that provides betas <u>and alphas</u> nor do I know of any model that treats the alphas the way Dr. Andrews does.

Q. Did you ask Dr. Andrews to provide the tests of statistical significance for the alphas and betas that he calculated?

A. Yes. He did not supply them, consequently his conclusions are not supported by material and substantial evidence. His response is attached to my testimony as Schedule 28.

Q. Do you have any comment regarding his response?

A. Yes. Since Dr. Andrews has not provided the tests of statistical significance, I am even more concerned that his alphas are really no different than zero. In my analysis the alphas are zero and they are not statistically significant. Also, it is contradictory for Dr. Andrews to calculate sums and averages for the betas and alphas, as he does in his Schedule 9, and then state in his response: "Tests of significance, such as T-statistics from the regressions related to individual stocks cannot be summed or averaged across the composite." I have done exactly that in my analysis. In fact, its results are appropriate.

Q. Why are your results appropriate?

A. All my betas are positive. They are estimated over twelve contiguous 60 month periods, with the first period ending in May 1996 and the last one ending in April 1997. This procedure captures any change in how the company's beta value is responding to the market. I provide tests of statistical significance, and the tests are reasonable. The alphas are zero, their tests of statistical significance indicate the true values are zero, and they play no role at all in my return. All of these factors taken together reinforce the implications of my Schedule 1, which demonstrates the comparability of my group of companies.

In comparison, Dr. Andrews' analysis has 5 negative betas, which he dismisses as "analytically indefensible" at page 43 line 18 of his direct testimony. Dr. Andrews does not explain why the results are "indefensible," but it is clear that if he did not exclude the negative values, his estimated return of 12.5% would be lower. Therefore, the negative betas appear to be indefensible because they would lower the company's return. He relies on the alpha to raise his estimated returns and performs an irrational procedure to boost an estimated return by 1.33%. In addition, he does not provide tests of statistical significance, even when asked to do so. Taken together, these factors indicate that Dr. Andrews' companies do not form a comparable group that is a rational basis for estimating a rate of return. These factors further reinforce what my Schedules 25 and 26 already suggest -- his companies are composed of two dissimilar groups that cannot be a rational basis to set a rate of return in this docket.

Q. What is your opinion regarding Dr. Andrews' statistical analysis is shown in Schedule 9 of his testimony?

A. In my opinion the TRA should disregard the conclusory analysis because it is arbitrary, irrational and unsupported by material and substantial evidence. Therefore, his analysis cannot constitute a basis for a decision.

<u>DCF ANALYSIS IS BIASED UPWARDS</u>

Q. What is your opinion of Dr. Andrews' DCF analysis?

A. His DCF recommendation of 11.06% is derived from Schedule 8, page 2, of his testimony. My opinion is that his result is biased upward by approximately 2% because his rate of 11.06% is based on only 4 companies instead 21. He ignores the results of the 17 other companies that he considers as comparables. Therefore, his recommendation of 11.06% is not representative of the group that he has designated as comparables. On the other hand, if his companies are composed of two groups not comparable to each other, then his decision to ignore some would be rational. However, if this is why he has ignored 17 companies, then this makes all his other analyses irrational, too. For example, of the 17 companies ignored in Schedule 8, 12 of them are used in his Schedule 9 to derive the returns of 12.5% and 12.17%. On its face this is clearly an irrational procedure, and Dr. Andrews offers no explanation. It is my opinion that the TRA should disregard his recommended DCF rate because it is biased and not supported by material and substantial evidence.

<u>RANGE OF 11.5% TO 12.5% IS IRRATIONAL</u>

Q. **Do you have any concluding opinions regarding the equity returns suggested by the company's cost-of-capital witness?**

A. Yes. In his direct testimony, at page 47 lines 14 and 23, Dr. Andrews concludes his analysis by recommending a range of 11.5% to 12.5%. Dr. Andrews suggests this is a reasonable range because he has found returns that are well above the range. At page 47 lines 18-22 Dr. Andrews says "The Small Stock equity risk premiums...over 14%...cannot be dismissed."

The "small company" premiums can and should be dismissed because:

They are based on 1 mutual fund out of 200;

The fund has a minimum investment requirement of $2 million;

The stockholders of Dr. Andrews' companies cannot afford to buy into such a fund;

The directorates of the Ibbotson Associates and the DFA 9-10 fund overlap - suggesting that the funds' return is not calculated by an independent source;

The fund's return on assets is only 8.75%, an amount provided by Morningstar Inc., a source that is independent of Ibbotson Associates and DFA Investment Dimensions Group - the manger of the DFA 9-10 fund;

The difference between the fund's return on assets and its so-called annual return means that a mutual fund's return cannot and should not be used to grant a utility's return on assets;

The fund relies exclusively on capital gains as the source of its return.

The small-company fund approach is an unfit and irrational method to develop a rate of return that must be supported by ratepayers.

The returns of 12.5% and 12.17%, both are predicated on data that is specific to large companies - not small ones. This invalidates both returns because Dr. Andrews' analysis is based on "small publicly held" companies. Also, I have pointed to several places in the derivation of 12.5% and 12.17%, where Dr. Andrews is silent about the logic that led him to perform crucial procedures or where the procedure is irrational. Considering all these factors, Dr. Andrews' recommended range of 11.5% to 12.5% emerges as irrational.

Q. **What is your opinion regarding Dr. Andrews' returns of 14.39%, 14.38%, 14.23%, 12.5%, 12.17% and 11.06%?**

A. In my opinion, the returns of 14.39%, 14.38%, 14.23%, 12.5%, 12.17% and 11.06% are unsubstantiated, speculative and more than just and reasonable. They cannot be a basis for the TRA to set the equity return in this docket.

Q. **How is your testimony different from that of the company's cost-of-capital witness?**

A. In my opinion my testimony is different because I have used reasonable methods and achieved reasonable results. I have explained my methods in pain-staking detail, giving all parties an accurate and true description of all the factors and sources I considered when forming my opinion on the rate of return. Therefore, the equity return of 10.55% is neither confiscation nor extortion an is equitable to ratepayers and the company alike.

Q. **Does this conclude your direct testimony?**

A. Yes.

Proof of Comparability

Market Statistics

NAME	Ratio of Market Price to Book Price Dec 1996	Equity Ratio Dec 1996	Dividend Yield Dec 1996	Value of Holdings Per Share Holder 4/30/97	Average Number Of Years Stock Is Held By Investor	Market Value 4/30/97 $(Millions)
AGL RESOURCES INC	180%	48 9%	5 40%	$63,334	3 36	1061
BAY ST GAS CO	150%	53 1%	5 61%	$30,949	3 86	343
BROOKLYN UN GAS CO	149%	55 8%	5 05%	$42,951	2 26	1352
INDIANA ENERGY INC	184%	62 5%	4 49%	$58,122	4 25	548
LACLEDE GAS CO	161%	57 1%	5 45%	$35,410	3 98	388
NORTHWEST NAT GAS CO	159%	52 5%	5 05%	$44,355	2 98	545
PEOPLES ENERGY CORP	171%	56 4%	5 42%	$34,172	2 21	1167
PIEDMONT NAT GAS INC	178%	49 7%	4 84%	$37,664	3 37	687
WASHINGTON GAS LT CO	174%	59 4%	5 19%	$45,226	2 98	972
AVERAGE	166%	55 0%	5 50%	$42,958	2 94	792

Financial Behavior

Value Line March 31, 1995
"We advise staying with top quality stocks with payout ratios below 80% We'd be wary of payout ratios above 80%"

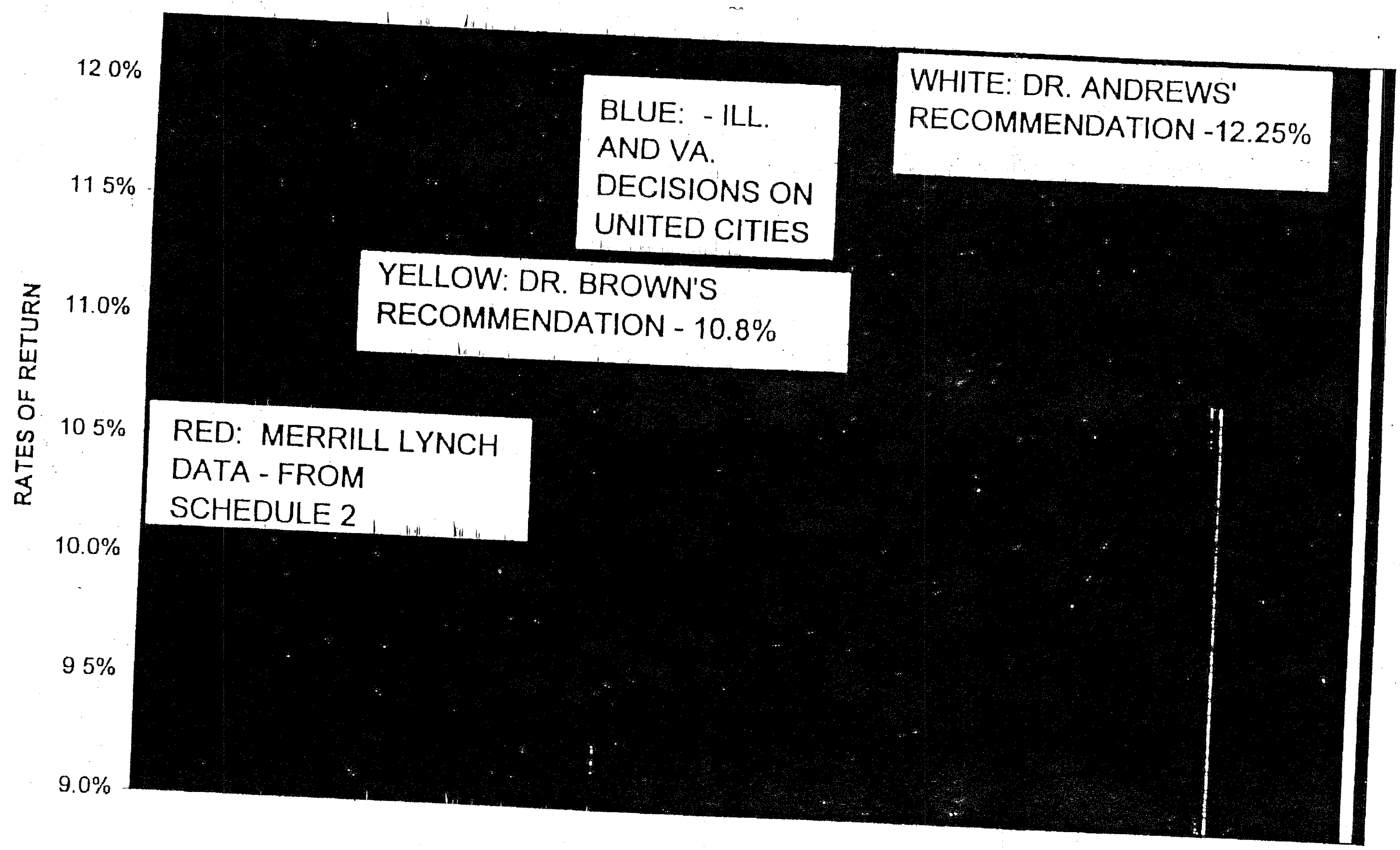
▶ Companies Respond In Similar Way To Concerns Of The Financial Community

Dividends Payout Ratios As a Percent of Earnings

	1991	1992	1993	1994	1995	1996
AGL RESOURCES INC	98 1%	91 2%	96 3%	88 9%	78 2%	77 4%
BAY ST GAS CO	99 2%	96 5%	80 0%	77 8%	86 5%	76 0%
BROOKLYN UN GAS CO	87 6%	95 6%	76 3%	73 0%	73 2%	72 4%
INDIANA ENERGY INC	82 9%	82 8%	77 3%	66 7%	73 3%	59 4%
LACLEDE GAS CO	93 8%	102 6%	75 8%	85 9%	97 6%	67 4%
NORTHWEST NAT GAS CO	167 3%	155 0%	67 0%	72 1%	73 1%	60 9%
PEOPLES ENERGY CORP	83 4%	85 4%	84 4%	84 5%	101 1%	61 8%
PIEDMONT NAT GAS INC	97 8%	65 0%	65 5%	74 8%	73 8%	68 9%
WASHINGTON GAS LT CO	92 1%	84 3%	83 2%	78 2%	77 2%	61 6%
AVERAGE	97 9%	97 9%	80 7%	80 1%	83 3%	66 7%

Chart 1

ESTIMATIONS OF REQUIRED RATES OF RETURN TO EQUITY FOR AGL'S SUBSIDAIRY - CHATTANOOGA GAS



Merrill Lynch Data

MONTH	DCF RATE	RISK PREMIUM RATE	MAXIMUM OF THE TWO RATES
Jan-95	11.0%	10.4%	11.0%
Feb-95	10.6%	10.3%	10.6%
Mar-95	10.3%	10.2%	10.3%
Apr-95	10.2%	10.1%	10.2%
May-95	10.1%	10.0%	10.1%
Jun-95	10.1%	9.5%	10.1%
Jul-95	10.3%	9.3%	10.3%
Aug-95	10.5%	9.4%	10.5%
Sep-95	10.3%	9.3%	10.3%
Oct-95	10.3%	9.4%	10.3%
Nov-95	9.4%	9.6%	9.6%
Dec-95	9.8%	9.6%	9.8%
Jan-96	8.8%	9.2%	9.2%
Feb-96	8.8%	9.3%	9.3%
Mar-96	9.1%	9.3%	9.3%
Apr-96	9.9%	9.7%	9.9%
May-96	9.9%	9.6%	9.9%
Jun-96	10.0%	9.8%	10.0%
Jul-96	9.7%	9.7%	9.7%
Aug-96	10.0%	9.7%	10.0%
Sep-96	9.6%	9.9%	9.9%
Oct-96	9.6%	9.7%	9.7%
Nov-96	9.5%	9.5%	9.5%
Dec-96	10.4%	9.4%	10.4%
Jan-97	10.2%	10.6%	10.6%
Feb-97	10.2%	10.0%	10.2%
Mar-97	10.5%	10.1%	10.5%
Apr-97	10.5%	10.3%	10.5%
May-97	10.5%	10.1%	10.5%

Source *Merrill Lynch Quantitative Profiles* [Published Monthly]
January 1995 through May 1997 Issues, page 11

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Direct Testimony___
Schedule 3______
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United Cities granted rate increase in Illinois

03:24 p.m Jun 26, 1997 Eastern

BRENTWOOD, Tenn.--(BUSINESS WIRE)--June 26, 1997--**United Cities Gas** Co. (NASDAQ:**UCIT**), a multistate distributor of natural and propane gas, announced today that the Illinois Commerce Commission has granted the company a rate increase of $428,000 in annual revenues.

An overall rate increase of 2.09 percent was granted for approximately 23,000 customers in or near Harrisburg, Metropolis, Vandalia, Virden and Salem, Ill. The rate increase provides **United Cities** with a 9.85 percent return on rate base and a 10.94 percent return on common equity. The increase is the result of an application filed before the Commission in November 1996.

The net rate increase is part of an agreement reached by **United Cities**, **Atmos Energy** Corporation and the Commission in approving the merger of **United Cities** and **Atmos**. In addition, the rate increase will be followed by a three year rate moratorium.

United Cities Gas Company distributes natural and propane gas to approximately 350,000 customers in 10 states. The company is also engaged in other energy-related businesses (See also http://www.businesswire.com)

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Docket No. 97-00982
Exhibit CA-SNB____
Direct Testimony___
Schedule 4______
Page 1 of 1____

United Cities granted rate increase in Virginia
05 03 p m Jun 02 1997 Eastern

BRENTWOOD Tenn --(BUSINESS WIRE)--June 2 1997--United Cities Gas Co NASDAQ UCIT) a multistate distributor of natural and propane gas announced today that the Virginia State Corporation Commission has granted the company a rate increase of $102 838 in annual revenues by order dated May 27 1997

An overall rate increase of less than one percent was granted for approximately 18 000 current regulated customers The rate increase provides United Cities with a 10 percent return on rate base and an 11 percent return on common equity The increase is the result of an application filed before the Commission in April 1995

Due to the Commission's decision, money over-collected from customers since Sept. 28, 1995, when United Cities began charging interim rates based on its original 3 percent rate increase request, will be credited to customers' accounts with interest The credit amount for customers will vary according to their gas usage during the period interim rates were in effect

United Cities' last rate increase in Virginia was granted in 1989 Since that time rate reductions were implemented in both 1991 and 1994

United Cities Gas Company distributes natural and propane gas to approximately 350,000 customers in 10 states The company is also engaged in other energy-related businesses (See also http //www businesswire com)

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Docket No 97-00982
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Direct Testimony___
Schedule 6 ______
Page 1 of 1______

Effect of Monthly Compounding

(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Monthly Net Income for Atlanta Gas-FY 1996 *	Monthly Income as a Percentage of Annual Income	Pattern of Monthly Return Based on Monthly Pattern of Income	Cumulative Equity Balance at Start of Month	Monthly Return on Equity	Cumulative Month End Equity Balance
			[col (3) X Allowed Annual Return of 10.55%]		[col (4) X col (5)]	
Oct-95	3,272	4 1%	0 43%	$1.000	$0 0043	$1 004
Nov-95	9,492	11 8%	1 24%	$1.004	$0 0125	$1 017
Dec-95	17,476	21 7%	2 29%	$1.017	$0.0232	$1 040
Jan-96	18,120	22.5%	2 37%	$1.040	$0.0247	$1 065
Feb-96	14,495	18.0%	1.90%	$1 065	$0 0202	$1 085
Mar-96	13,797	17.1%	1 80%	$1.085	$0 0196	$1 104
Apr-96	5,232	6 5%	0 68%	$1 104	$0.0076	$1 112
May-96	0,836	1 0%	0 11%	$1 112	$0.0012	$1 113
Jun-96	-1,122	-1.4%	-0.15%	$1.113	-$0 0016	$1 112
Jul-96	2,226	2 8%	0.29%	$1.112	$0 0032	$1 115
Aug-96	-0,253	-0.3%	-0.03%	$1.115	-$0 0004	$1 114
Sep-96	-2,918	-3 6%	-0.38%	$1 114	-$0.0043	$\boxed{\$1.110}$
Total	80,653	100 0%	10.55%		$0 1102	

*From CA Data Request 39

BEFORE THE TENNESSEE PUBLIC SERVICE COMMISSION

IN THE MATTER OF: Docket No. 9502116

CHATTANOOGA GAS COMPANY

Tuesday, September 26, 1995
Hamilton County Board of Education
Chattanooga, Tennessee 37402

CROSS EXAMINATION OF DR. VICTOR L. ANDREWS

APPEARANCES:

COMMISSION MEMBERS:

Keith Bissell, Chairman,
Steve Hewlett and Sara Kyle

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COPY

dividends --

A Where are we?

Q I'm sorry, I've got the wrong page citations here. You can tell me whether you remember saying this or not. I can't find it through your testimony right now. In the case of public utilities dividends paid are constant for certain periods and are increased at irregular intervals even though financial processes underlying their movement may be progressing much more smoothly and constantly; does that sound correct?

A I think I would say smoothly and continuously, but whatever, but yes, that is true.

Q Do you agree --

A It's true as a general rule.

Q So you would agree that a public utility and natural gas public utility, their financial activity is basically smooth and continuous?

A Well, what I said, I think if we had the complete quotation would be that earnings and cash flows progress smoothly and continuously. Financial processes occur smoothly and continuously. They go -- if this makes the point for you -- minute by minute, hour by hour, day by day and they're not interruptable.

Q Just to clarify for the record we found the first segment that we didn't really dispute. It starts

CAPITAL STRUCTURE SUBMITTED IN DOCKET 95-02116
AS EXHIBIT 3 SCHEDULE 9

Docket No 97-00982
Exhibit CA-SNB____
Direct Testimony___
Schedule 8______
Page 1 of 1____

CHATTANOOGA GAS COMPANY
Cost of Capital
For the 12 Months Ending September 30 1996

Line No		Amount	Ratio	Cost	Weighted Cost
1	Short Term Debt	5 190 953	5 36%	8 00%	0 43%
2	Long Term Debt	43 096 531	44 50%	7 96%	3 54%
3	Preferred Stock	4 183 753	4 32%	7 56%	0 33%
4	Common Stock Equity	44 374 900	45 82%	12 50%	5 73%
5	Total	96 846 137	100 00%		10 03%

DCF Recommended Return

DCF SUGGESTED RATE OF RETURN

Company	12/96. Annual Dividend	Average Daily closing Price: 5/1/96 - 4/30/97	Annual Dividend Yield
Atlanta Gas	$1 06	$19.63	**5.40%**
Bay State	$1.52	$27.08	**5.61%**
Brooklyn Union	$1 42	$28.14	**5.05%**
Indiana Energy	$1 11	$24.70	**4.49%**
LaClede	$1 26	$23 11	**5.45%**
Northwest Natural	$1 20	$23 77	**5.05%**
Peoples	$1 83	$33.79	**5.42%**
Piedmont	$1.15	$23.76	**4.84%**
Washington Gas Light	$1 14	$21 94	**5.19%**
	Average Div. Yield		5.17%

	Year of AGL Dividend	
Actual	1996	**$1.06**
Value-Line Projection	2000	**$1.30**

AGL DIVIDEND GROWTH RATE	5.23%

DCF Suggested Rate of Return	10.40%

Exhibit CA-SN8____
Direct Testimony____
Schedule 10 ______
Page 1 of 1______

History of A Rated Bonds

1992		1993		1994		1995		1996		1997	
Jan 92	8 72%	Jan-93	8 13%	Jan 94	7 24%	Jan 95	8 75%	Jan-96	7 09%	Jan 97	7 93%
Feb	8 83%	Feb	7 80%	Feb	7 45%	Feb	8 55%	Feb	7 31%	Feb	7 81%
Mar	8 89%	Mar	7 61%	Mar	7 82%	Mar	8 40%	Mar	7 75%	Mar	8 08%
Apr	8 87%	Apr	7 66%	Apr	8 20%	Apr	8 31%	Apr	7 90%	Apr	8 23%
May	8 81%	May	7 75%	May	8 37%	May	7 71%	May	8 20%	May	
Jun	8 70%	Jun	7 59%	Jun	8 30%	Jun	7 60%	Jun	8 13%	Jun	
Jul	8 64%	Jul	7 43%	Jul	8 45%	Jul	7 72%	Jul	8 07%	Jul	
Aug	8 65%	Aug	7 18%	Aug	8 36%	Aug	7 84%	Aug	7 87%	Aug	
Sep	8 62%	Sep	6 94%	Sep	8 62%	Sep	7 55%	Sep	8 06%	Sep	
Oct	8 84%	Oct	6 91%	Oct	8 80%	Oct	7 36%	Oct	7 83%	Oct	
Nov	8 58%	Nov	7 25%	Nov	8 95%	Nov	7 30%	Nov	7 54%	Nov	
Dec	8 37%	Dec	7 28%	Dec	8 78%	Dec	7 10%	Dec	7 63%	Dec	
Average	8 727%	Average	7 459%	Average	8 278%	Average	7 562%	Average	7 782%	Average	8 01%

Average Most Recent 12 Months 7 948%

Sources Federal Reserve Bulletin, Table A26 Subtable 1 35, line 38
Federal Reserve Publications H15(519) and G13(415)

Risk Premium Data for Large Companies: 1925-1996

YEAR	Large Company Total Return Index For Year	Year-To-Year Percentage Change In Large Company Total Return Index
(1)	(2)	(3)
1925	$\boxed{1\ 00}$	
1926	1.12	11.60%
1927	1 54	37.54%
1928	2 20	43 58%
1929	2 02	-8.44%
1930	1 52	-24 88%
1931	0 86	-43.34%
1932	0 79	-8 15%
1933	1.21	53.87%
....	.. .. ..	....
....	....	. ...
....	....	... .. .
1988	406 46	16 81%
1989	534 46	31 49%
1990	517 50	-3.17%
1991	675 59	30 55%
1992	727 41	7 67%
1993	800.08	9 99%
1994	810 54	1 31%
1995	1113 92	37.43%
1996	$\boxed{1370\ 95}$	23 07%
	$\boxed{10\ 7\%}$	$\boxed{12\ 7\%}$

If $1 Were Invested in 1925 and the Investment Grew by 10.7% Every Year, the Result Would Be $1370.95.

ACTUAL RETURN

BIASED RETURN

The Average Return, 12.7%, Says the Wealth Accumulated Since 1925 should be $4768. This is Inaccurate.

*Source: Ibbotson Associates 1997 Yearbook:
Column (2) - From Table B-1
Column (3) - From Table A-1

The Table Below Shows The Odds In 1996 Of Achieving The Actual Return
And The Biased Average Return From A $1 Investment In 1925 In A Large Company

	NUMBER OF POSSIBILITIES	ALL POSSIBLE VALUES OF INVESTMENT	ALL POSSIBLE RETURNS	ODDS OF ACHIEVING A RETURN EXACTLY EQUAL TO THE RETURN IN COLUMN (3)	ODDS OF ACHIEVING A RETURN LESS THAN THE RETURN IN COLUMN (3)	ODDS OF ACHIEVING A RETURN MORE THAN THE RETURN IN COLUMN (3)
	(1)	(2)	(3)	(4)	(5)	(6)
	1 0E+0	$0 00	-8 3%	0%	0%	100%
	71 0E+0	$0 00	-7 8%	0%	- 0%	100%
	2 5E+3	$0 00	-7 3%	0%	0%	100%
	57 2E+3	$0 01	-6 8%	0%	0%	100%
	46 2E+18	$82	6 4%	2%	3%	95%
	68 5E+18	$119	7 0%	3%	5%	92%
	95 8E+18	$173	7 5%	4%	8%	88%
	126 8E+18	$253	8 1%	5%	12%	83%
	158 5E+18	$368	8 7%	7%	17%	76%
	187 3E+18	$536	9 3%	8%	24%	68%
	209 3E+18	$780	9 8%	9%	32%	59%
	221 3E+18	$1,136	10 4%	9%	41%	50%
ACTUAL RETURN	------------	$1,370.95	10.7%	------------	50%	50%
	221 3E+18	$1,654	11 0%	9%	50%	41%
	209 3E+18	$2,409	11 6%	9%	59%	32%
	187 3E+18	$3,508	12 2%	8%	68%	24%
BIASED AVERAGE	------------	$4,768.40	12.7%	7%	75%	18%
	158 5E+18	$5,109	12 8%	7%	76%	17%
	126 8E+18	$7,440	13 4%	5%	83%	12%
	95 8E+18	$10,835	14 0%	4%	88%	8%
	68 5E+18	$15,778	14 6%	3%	92%	5%
	46 2E+18	$22,977	15 2%	2%	95%	3%
	29 4E+18	$33,460	15 8%	1%	97%	2%
	17 6E+18	$48,727	16 4%	1%	98%	1%
	10 0E+18	$70,959	17 0%	0%	99%	0%
	1 0E+0	$854,908,330	33 6%	0%	100%	0%

Chart 2

THE CUMULATIVE PROBABILITY DISTRIBUTION FOR IBBOTSON'S RETURNS TO LARGE COMPANY STOCKS

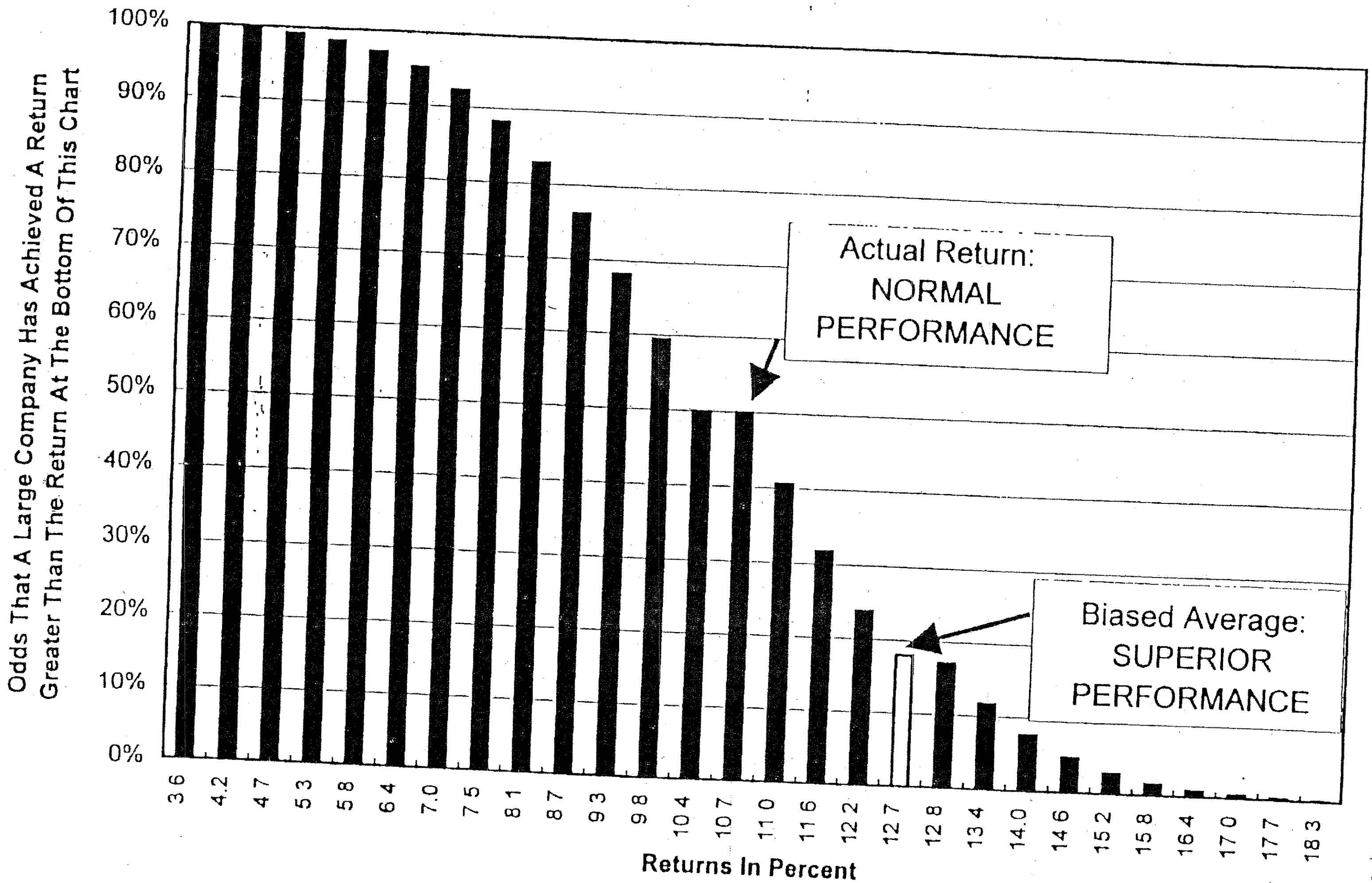
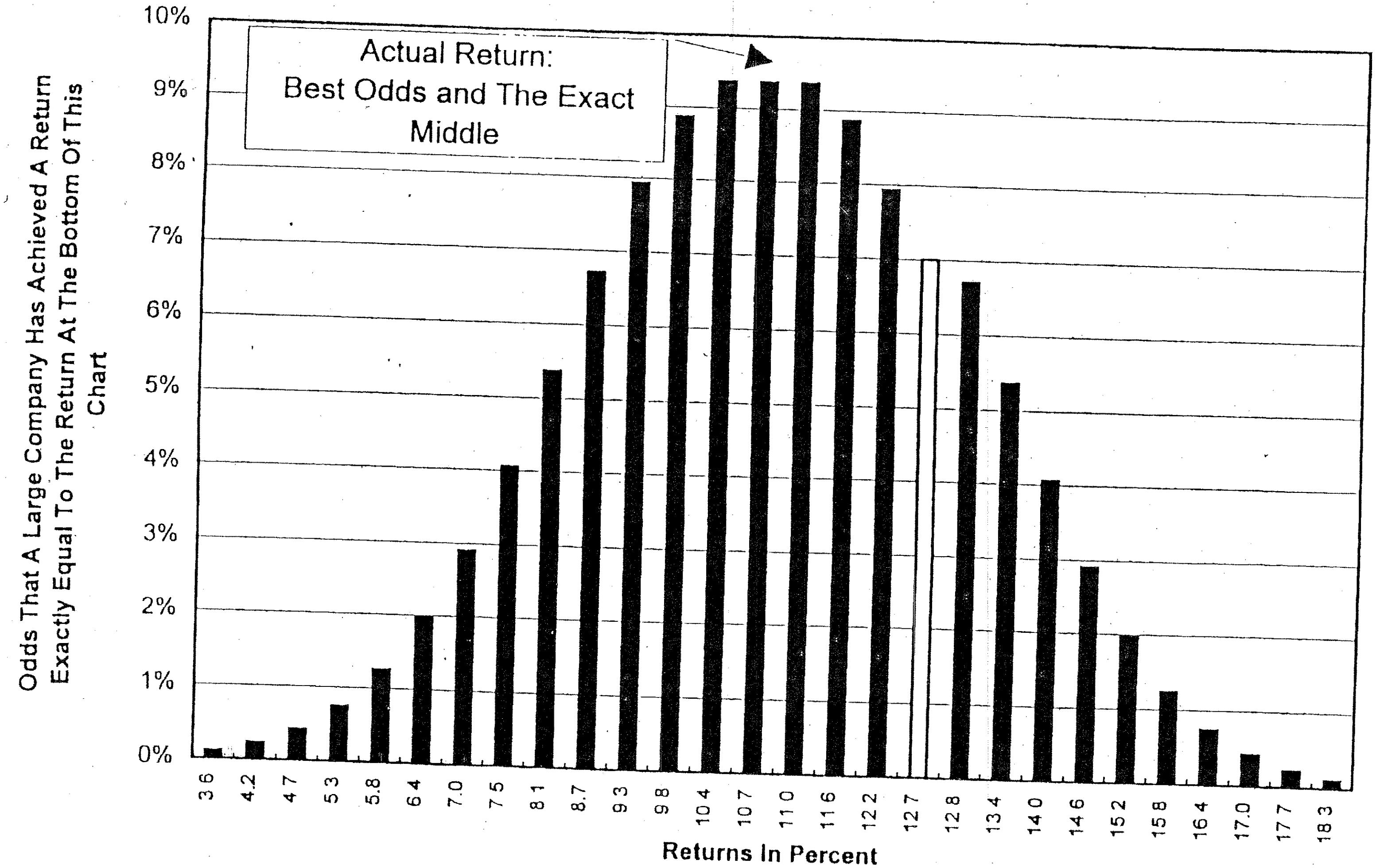


Chart 3

Docket No 97-00982
Exhibit CA-SNB____
Direct Testimony____
Chart 3 of 3________

THE PROBABILITY DISTRIBUTION FOR IBBOTSON'S RETURNS TO LARGE COMPANY STOCKS



YEAR	T-Bill Total Return Index For Year	Year-To-Year Percentage Change In T-Bill Total Return Index	YEAR	T-Bill Total Return Index For Year	Year-To-Year Percentage Change In T-Bill Total Return Index
(1)	(2)	(3)	(4)	(5)	(6)
1925	1 00000		1961	1 60400	2 10%
1926	1 03300	3 30%	1962	1 64800	2 74%
1927	1 06500	3 10%	1963	1 70000	3 16%
1928	1 10300	3 57%	1964	1 76000	3 53%
1929	1 15500	4 71%	1965	1 82900	3 92%
1930	1 18300	2 42%	1966	1 91600	4 76%
1931	1 19600	1 10%	1967	1 99700	4 23%
1932	1 20700	0 92%	1968	2 10100	5 21%
1933	1 21100	0 33%	1969	2 23900	6 57%
1934	1 21300	0 17%	1970	2 38500	6 52%
1935	1 21500	0 16%	1971	2 49000	4 40%
1936	1 21700	0 16%	1972	2 58500	3 82%
1937	1 22100	0 33%	1973	2 76400	6 92%
1938	1 22100	0 00%	1974	2 98600	8 03%
1939	1 22100	0 00%	1975	3 15900	5 79%
1940	1 22100	0 00%	1976	3 31900	5 06%
1941	1 22200	0 08%	1977	3 48900	5 12%
1942	1 22500	0 25%	1978	3 74000	7 19%
1943	1 22900	0 33%	1979	4 12800	10 37%
1944	1 23300	0 33%	1980	4 59200	11 24%
1945	1 23700	0 32%	1981	5 26700	14 70%
1946	1 24200	0 40%	1982	5 82200	10 54%
1947	1 24800	0 48%	1983	6 33500	8 81%
1948	1 25800	0 80%	1984	6 95900	9 85%
1949	1 27200	1 11%	1985	7 49600	7 72%
1950	1 28700	1 18%	1986	7 95800	6 16%
1951	1 30600	1 48%	1987	8 39300	5 47%
1952	1 32800	1 68%	1988	8 92600	6 35%
1953	1 35200	1 81%	1989	9 67300	8 37%
1954	1 36400	0 89%	1990	10 42900	7 82%
1955	1 38500	1 54%	1991	11 01200	5 59%
1956	1 41900	2 45%	1992	11 39800	3 51%
1957	1 46400	3 17%	1993	11 72800	2 90%
1958	1 48600	1 50%	1994	12 18600	3 91%
1959	1 53000	2 96%	1995	12 87000	5 61%
1960	1 57100	2 68%	1996	13 54000	5 21%

Actual Return	3 74%	3 79%	Average Return

*Source Ibbotson Associates 1997 Yearbook
Column (2) - From Table B-5
Column (3) - From Table A-14
Column (5) - From Table B-5
Column (6) - From Table A-14

Debt Instruments: Actual and Average Returns

Returns of Debt Instruments 1925-1996

	Actual	Biased Average
Long-Term Corporate Bonds	5 60%	6 00%
Long-Term Government Bonds	5 10%	5.40%
Income Portion of Long-Term Government Bonds	5.10%	5.20%
Intermediate Term Government Bonds	5 20%	5 40%
U S. Treasury Bills	3 70%	3 80%

*Source: Ibbotson Associates 1997 Yearbook Page 118

Risk Premium Results

RISK PREMIUM ANALYSIS BETAS – FOR AGL AND COMPARABLE COMPANIES REGRESSED AGAINST S&P 500

BETA FOR 60 MONTH PERIOD ENDING	ATLANTA GAS LIGHT (ATG)	BAY ST GAS CO	BROOKLYN UN GAS CO	INDIANA ENERGY INC	LACLEDE GAS CO	NORTHWEST NAT GAS CO	PEOPLES ENERGY CORP	WASHINGTON GAS LT CO	PIEDMONT NATURAL GAS CO	AVERAGE FOR GROUP
May-96	0 532	0 448	0 490	0 087	0 169	0 289	0 764	0 441	0 389	0 401
Jun-96	0 568	0 397	0 456	0 075	0 170	0 198	0 758	0 430	0 392	0 382
Jul-96	0 584	0 422	0 539	0 171	0 141	0 168	0 785	0 300	0 474	0 398
Aug-96	0 590	0 422	0 561	0 178	0 154	0 168	0 806	0 308	0 470	0 406
Sep-96	0 519	0 416	0 618	0 170	0 205	0 158	0 781	0 328	0 438	0 404
Oct-96	0 545	0 429	0 623	0 171	0 189	0 185	0 785	0 329	0 440	0 411
Nov-96	0 520	0 428	0 703	0 272	0 198	0 100	0 773	0 333	0 515	0 427
Dec-96	0 517	0 521	0 886	0 450	0 323	0 287	0 977	0 437	0 479	0 540
Jan-97	0 433	0 397	0 731	0 481	0 364	0 358	0 915	0 422	0 417	0 502
Feb-97	0 439	0 395	0 735	0 475	0 368	0 361	0 912	0 425	0 418	0 503
Mar-97	0 488	0 386	0 717	0 503	0 427	0 311	0 886	0 404	0 347	0 497
Apr-97	0 506	0 383	0 677	0 464	0 463	0 318	0 858	0 394	0 342	0 490
AV RECENT 12 MTHS	0 520	0 420	0 677	0 333	0 283	0 241	0 848	0 368	0 434	0 458

Risk Premium Results

RISK PREMIUM ANALYSIS T-STATISTICS OF BETAS – FOR AGL AND COMPARABLE COMPANIES REGRESSED AGAINST S&P 500

T-STATISTIC OF BETA FOR 60 MONTH PERIOD ENDING	ATLANTA GAS LIGHT (ATG)	BAY ST GAS CO	BROOKLYN UN GAS CO	INDIANA ENERGY INC	LACLEDE GAS CO	NORTHWEST NAT GAS CO	PEOPLES ENERGY CORP	WASHINGTON GAS LT CO	PIEDMONT NATURAL GAS CO	AVERAGE FOR GROUP
May-96	2 569	2 402	2 305	0 361	0 930	1 483	3 222	2 276	1 875	1 934
Jun-96	2 609	2 039	2 073	0 276	0 897	0 988	3 064	2 110	1 791	1 761
Jul-96	2 739	2 203	2 463	0 625	0 764	0 874	3 231	1 468	2 160	1 836
Aug-96	2 712	2 200	2 525	0 652	0 831	0 871	3 261	1 496	2 152	1 856
Sep-96	2 355	2 213	2 935	0 636	1 129	0 828	3 184	1 678	2 033	1 888
Oct-96	2 428	2 280	3 005	0 644	1 036	0 958	3 223	1 669	2 044	1 923
Nov-96	2 321	2 284	3 417	1 069	1 094	0 522	3 189	1 720	2 413	2 003
Dec-96	2 113	2 559	3 935	1 656	1 670	1 406	3 747	2 035	2 047	2 352
Jan-97	1 813	1 870	3 442	1 820	2 025	1 821	3 525	2 006	1 798	2 236
Feb-97	1 842	1 869	3 438	1 791	2 035	1 829	3 515	2 016	1 804	2 238
Mar-97	2 087	1 880	3 435	1 934	2 362	1 612	3 482	1 975	1 535	2 256
Apr-97	2 208	1 929	3 286	1 810	2 591	1 761	3 435	1 970	1 544	2 282
AV RECENT 12 MTHS	2 316	2 129	3 188	1 264	1 554	1 248	3 379	1 805	1 853	2 093

Risk Premium Results

RISK PREMIUM ANALYSIS ALPHAS – FOR AGL AND COMPARABLE COMPANIES REGRESSED AGAINST S&P 500

ALPHA FOR 60 MONTH PERIOD ENDING	ATLANTA GAS LIGHT (ATG)	BAY ST GAS CO	BROOKLYN UN GAS CO	INDIANA ENERGY INC	LACLEDE GAS CO	NORTHWEST NAT GAS CO	PEOPLES ENERGY CORP	WASHINGTON GAS LT CO	PIEDMONT NATURAL GAS CO	AVERAGE FOR GROUP
May-95	-0 003	0 000	0 001	0 007	0 004	0 000	-0 003	0 002	0 004	0 001
Jun-95	-0 003	0 002	0 002	0 009	0 003	0 003	-0 002	0 003	0 005	0 002
Jul-95	-0 003	0 001	0 000	0 005	0 003	0 002	-0 003	0 005	0 002	0 001
Aug-95	-0 002	0 001	0 002	0 006	0 004	0 002	-0 002	0 005	0 002	0 002
Sep-95	-0 003	-0 001	-0 001	0 004	0 003	0 001	-0 003	0 003	0 002	0 001
Oct-95	-0 002	-0 001	-0 001	0 004	0 002	0 001	-0 003	0 003	0 002	0 001
Nov-95	-0 003	-0 001	-0 002	0 001	0 002	0 002	-0 004	0 003	0 001	0 000
Dec-95	-0 002	-0 001	-0 003	0 000	0 002	0 001	-0 005	0 001	0 001	-0 001
Jan-96	-0 001	-0 002	-0 001	-0 001	0 000	0 000	-0 008	0 002	0 000	-0 001
Feb-96	-0 001	-0 002	-0 002	0 000	-0 001	-0 001	-0 008	0 001	0 000	-0 001
Mar-96	-0 003	-0 002	-0 001	0 000	-0 002	0 000	-0 005	0 002	0 002	-0 001
Apr-96	-0 002	-0 001	-0 001	0 000	-0 001	0 002	-0 005	0 002	0 002	-0 001
AV RECENT 12 MTHS	-0 002	-0 001	-0 001	0 003	0 002	0 001	-0 004	0 003	0 002	0 000

Risk Premium Results

RISK PREMIUM ANALYSIS T-STATISTICS OF ALPHAS – FOR AGL AND COMPARABLE COMPANIES REGRESSED AGAINST S&P 500

T-STATISTIC OF ALPHA FOR 60 MONTH PERIOD ENDING	ATLANTA GAS LIGHT (ATG)	BAY ST GAS CO	BROOKLYN UN GAS CO	INDIANA ENERGY INC	LACLEDE GAS CO	NORTHWEST NAT GAS CO	PEOPLES ENERGY CORP	WASHINGTON GAS LT CO	PIEDMONT NATURAL GAS CO	AVERAGE FOR GROUP
May-96	-0.452	-0.034	0.131	0.905	0.697	0.083	-0.447	0.337	0.577	0.200
Jun-96	-0.408	0.308	0.289	1.180	0.615	0.488	-0.324	0.508	0.705	0.373
Jul-96	-0.410	0.158	0.032	0.845	0.632	0.324	-0.488	0.822	0.335	0.228
Aug-96	-0.323	0.154	0.258	0.702	0.785	0.322	-0.287	0.902	0.302	0.313
Sep-96	-0.453	-0.118	-0.100	0.447	0.620	0.172	-0.381	0.466	0.346	0.111
Oct-96	-0.355	-0.111	-0.206	0.531	0.428	0.189	-0.437	0.473	0.360	0.097
Nov-96	-0.399	-0.098	-0.360	0.068	0.407	0.398	-0.497	0.439	0.215	0.019
Dec-96	-0.358	-0.218	-0.500	0.063	0.421	0.181	-0.717	0.152	0.082	-0.099
Jan-97	-0.191	-0.333	-0.207	-0.141	-0.050	-0.074	-0.822	0.270	0.067	-0.164
Feb-97	-0.189	-0.368	-0.310	0.036	-0.098	-0.165	-0.738	0.171	0.014	-0.183
Mar-97	-0.378	-0.290	-0.208	-0.040	-0.293	0.076	-0.659	0.309	0.313	-0.130
Apr-97	-0.344	-0.189	-0.229	-0.059	-0.269	0.278	-0.685	0.267	0.333	-0.100
AV RECENT 12 MTHS	-0.355	-0.095	-0.117	0.361	0.325	0.189	-0.540	0.426	0.304	0.055

Risk Premium Suggested Rate Of Return

COMPANY	Debt Yield (a)	Beta (b)	Market Risk Premium = 10 7% - 3 7% (c)	Company Risk Premium (d)=(b)X(c)	Company Equity Cost (e)=(a)+(d)
AGL RESOURCES INC (HLDG CO)	7 95%	0 520	6 97%	3 62%	11 57%
BAY ST GAS CO	7 95%	0 420	6 97%	2 93%	10 88%
BROOKLYN UN GAS CO	7.95%	0 677	6 97%	4 72%	12 67%
INDIANA ENERGY INC	7 95%	0 333	6 97%	2 32%	10 27%
LACLEDE GAS CO	7 95%	0 283	6 97%	1 98%	9 92%
NORTHWEST NAT GAS CO	7 95%	0 241	6 97%	1 68%	9 63%
PEOPLES ENERGY CORP	7 95%	0 848	6 97%	5 91%	13 86%
WASHINGTON GAS LT CO	7 95%	0 368	6 97%	2 57%	10 51%
PIEDMONT NATURAL GAS CO	7 95%	0 434	6 97%	3 02%	10 97%
** Av of Comparable Cos	7 95%	0 458	6 97%	0 032	11 14%

**Average Includes All Betas for All Companies Because the Average T-Statistics Are Greater Than 1 T-Statistics Are Shown In The Prior Schedule

Risk Premium Suggested Rate Of Return	11.14%

Any Model Relying on Ibbotson's Data Uses Monthly Compounding

Ibbotson's Annual Returns Are Based on Monthly Compounding

ROW	Month (1)	Monthly Return (2)*	Monthly Return Relative to the Value "1" (3)	Cumulative Return in the Year Relative to the Value "1" (4) col (3) x prior entry in col (3)	Cumulative Return in the Year (5)
-	-	-	100 00%		
1	1/1/96	3.44%	103 44%	103 44%	3.44%
2	2/1/96	0.96%	100 96%	104.43%	4.43%
3	3/1/96	0 96%	100 96%	105 44%	5 44%
4	4/1/96	1.47%	101.47%	106.99%	6 99%
5	5/1/96	2 58%	102.58%	109.75%	9.75%
6	6/1/96	0.41%	100.41%	110 20%	10.20%
7	7/1/96	-4 45%	95.55%	105 29%	5 29%
8	8/1/96	2.12%	102.12%	107 52%	7 52%
9	9/1/96	5.62%	105 62%	113 57%	13 57%
10	10/1/96	2.74%	102 74%	116 68%	16.68%
11	11/1/96	7.59%	107.59%	125 53%	25 53%
12	12/1/96	-1 96%	98 04%	123.07%	$\boxed{23.07\%}$

*Source: Ibbotson Associates 1997 Yearbook Page 181, Table A-1 for 1996

Docket No. 97-00982
Exhibit CA-SNB____
Direct Testimony____
Schedule 18____
Page 1 of 2____

CHATTANOOGA GAS COMPANY

Office of the Consumer Advocate Interrogatory/Data Request - June 4, 1997

Item 42

42. Q. With regard to Exhibit 5 Schedule 9 of the company's filing, show the calculations and provide the data used to develop the figures shown under the column headings "Amount", "Ratio" and "Cost".

A. See attached documentation.

Docket No. 97-00982
Exhibit CA-SNB____
Direct Testimony____
Schedule 18____
Page 2 of 2____

AGL Resources
Projected Capitalization Ratios

	1997	1998	Average	Ratio
Short Term Debt	69,620	81,537	75,579	5.28%
Long Term Debt	659,500	659,500	659,500	46.07%
Preferred Stock	58,469	70,090	64,280	4.49%
Common Stock Equity	619,302	644,902	632,102	44.16%
	1,406,891	1,456,029	1,431,461	100.00%

Chattanooga Gas Company
Test Year Projected Capitalization

	Ratio	Amount
Short Term Debt	5.28%	5,060,518
Long Term Debt	46.07%	44,154,936
Preferred Stock	4.49%	4,303,357
Common Stock Equity	44.16%	42,324,333
	100.00%	95,843,144

AGL Resources
Projected Cost of Capital Components

Long Term Debt	
Projected Balance	659,500,000
Less: Unamortized Loss on Repurchase	1,585,136
Less: Unamortized Debt Discount & Expense	3,702,500
Net Projected Balance	654,212,364
Projected Interest Cost	50,730,000
Projected Cost Rate	7.75%
Short Term Debt	
Projected Average Monthly Balance	49,900,000
Projected Interest Cost	2,892,000
Projected Cost Rate	5.80%
Preferred Stock	
Projected Balance	64,280,000
Projected Dividend Accrual	4,525,000
Projected Cost Rate	7.04%
Common Stock Equity	
Projected Cost Rate	
See Cost of Equity Testimony & Exhibits	12 25%

Recommended Over All Return

		Ratio	Cost	Weighted Cost
1	Short-Term Debt	5 28%	5 80%	0.31%
2	Long-Term Debt	46 07%	7 75%	3 57%
3	Preferred Stock	4 49%	7.04%	0.32%
4	Common Equity	44 16%	10 55%	4.66%
5	Total	100.00%		8 85%

Data on Mutual Funds Specializing in Small Company Stocks; 5-31-97

Company name	Objective	Ticker	Minimum Initial Purchase	Return on Assets %	96 Rtrn %
Standish Small Cap Equity	Small Company	SDSCX	$Closed	9 51	17 36
T Rowe Price Small-Cap Val	Small Company	PRSVX	$Closed	10 36	24 61
MAS Small Cap Value	Small Company	MPSCX	$Closed	9 47	35 15
Montgomery Small Cap R	Small Company	MNSCX	$Closed	12 11	18 69
MFS Aggr Small Cap Eq A	Small Company	MASCX	$Closed	14 24	15 45
Artisan Small Cap	Small Company	ARTSX	$Closed	10 68	11 86
Pioneer Small Company A	Small Company	PSCFX	$Closed	5 07	24 15
Pioneer Small Company B	Small Company	PBSCX	$Closed	5 07	23 21
Pioneer Small Company C	Small Company	PCSCX	$Closed	5 07	n/a
PIMCo Small Cap Growth Instl	Small Company	PSCIX	$Closed	11 07	16 83
GMO Small Cap Value III	Growth	GMSVX	$35,000,000	0	20 16
UAM ICM Small Company	Small Company	ICSCX	$5,000,000	8 89	23 01
Benchmark Small Co Index A	Small Company	BSCAX	$5,000,000	9 37	15 97
Bear Stearns Small Cap Val Y	Small Company	BSVYX	$2,500,000	7 57	15 87
DFA United Kingdom Small Co	Europe Stock	DFUKX	$2,000,000	19 98	29 81
DFA U S Small Cap Value	Small Company	DFSVX	$2,000,000	7 01	22 33
DFA Japanese Small Company	Pacific Stock	DFJSX	$2,000,000	4 35	-22 78
DFA Pacific Rim Small Compny	Pacific Stock	DFRSX	$2,000,000	25 72	14 36
DFA Continental Small Compny	Europe Stock	DFCSX	$2,000,000	14 28	14 32
DFA U S 6-10 Small Company	Small Company	DFSTX	$2,000,000	9 11	17 68
DFA U.S. 9-10 Small Company	Small Company	DFSCX	$2,000,000	8.75	17 65
DFA Intl Small Cap Value	Foreign Stock	DISVX	$2,000,000	10 57	0 95
Lazard Small Cap Instl	Small Company	LZSCX	$1,000,000	8 3	23 93
JPM Instl U S Small Company	Small Company	JUSSX	$1,000,000	9 6	20 84
Crabbe Huson Small Cap Instl	Small Company	CHISX	$1,000,000	3 97	n/a
Lazard Intl Small Cap Instl	Foreign Stock	LZISX	$1,000,000	16 2	15 65
ITT Hartford Small Company Y	Small Company	n/a	$1,000,000	0	n/a
Enterprise Small Co Value Y	Small Company	EIGYX	$1,000,000	7 81	11 83
Munder Small Company Grth Y	Small Company	MULYX	$500,000	11 25	37 17
Compass Small Cap Grth Instl	Small Company	PSGIX	$500,000	11 64	31 58
Compass Small Cap Val Instl	Small Company	PNSEX	$500,000	8 25	19 87
Nations Small Cap Gr Prim A	Small Company	PSCPX	$500,000	9 34	20 72
TCW Galileo Small Cap Growth	Small Company	n/a	$250,000	10 8	17 54
Emerald Small Cap Instl	Small Company	EMSCX	$250,000	10 14	10 69
Hancock Small Cap Equity	Small Company	n/a	$250,000	12 49	13 48
PIMCo Small Cap Value Instl	Small Company	PSVIX	$200,000	9 19	27 72
PIMCo Small Cap Value Admin	Small Company	n/a	$200,000	9 19	27 37
PIMCo Small Cap Growth Admin	Small Company	n/a	$200,000	11 41	16 71
JPM Pierpont U S Small Co	Small Company	PPCAX	$100,000	9 63	20 75
Parkstone Small Cap Instl	Small Company	PKSCX	$100,000	11 45	27 7

Docket No 97-00982
Exhibit CA SNB____
Direct Testimony____
Schedule 20 ______
Page 2 of 6______

Data on Mutual Funds Specializing in Small Company Stocks; 5-31-97

Company name	Objective	Ticker	Minimum Initial Purchase	Return on Assets %	96 Rtrn %
Standish Small Cap Tax-Sen	Small Company	SDCEX	$100,000	11 06	21 23
Turner Small Cap Equity	Small Company	TSCEX	$100,000	11 24	28 85
Avesta Small Capitalization	Small Company	n/a	$100,000	10 78	30 95
Berger Small Cap Value Inst	Small Company	OMNIX	$100,000	8 28	25 6
Kent Small Co Growth Instl	Small Company	KNEEX	$100,000	8 95	19 61
SEI Instl Small Cap Growth A	Small Company	SSCGX	$100,000	10 96	19 14
SEI Instl Small Cap Growth A	Small Company	SSCGX	$100,000	10 96	19 14
59 Wall St Small Company	Small Company	FNSMX	$100,000	10 42	19 12
SEI Instl Small Cap Value A	Small Company	SESVX	$100,000	8	22 13
DLB Global Small Cap	World Stock	DLBSX	$100,000	15 07	9 85
Pictet Intl Small Companies	Foreign Stock	PTSCX	$100,000	14 65	n/a
Rainier Small/Mid Cap Equity	Growth	RIMSX	$25,000	9 37	22 56
Glenmede Small Cap Equity	Small Company	GTCSX	$25,000	9 33	25 1
Target Small Cap Value	Small Company	TASVX	$25,000	9 17	21 84
Target Small Cap Growth	Small Company	TASGX	$25,000	12 36	18 88
Schroder Small Cap	Small Company	WSCVX	$25,000	8 92	23 91
UAM FMA Small Company	Small Company	FMACX	$25,000	8 52	26 2
Quaker Small-Cap Value	Small Company	n/a	$25,000	0	n/a
Hotchkis & Wiley Small Cap	Small Company	HWSCX	$10,000	9 34	14 27
Longleaf Partners Small-Cap	Small Company	LLSCX	$10,000	8 12	30 64
LKCM Small Cap Equity	Small Company	LKSCX	$10,000	8 61	26 95
LKCM Small Cap Equity	Small Company	LKSCX	$10,000	8 61	26 95
CRM Small Cap Value	Small Company	CRMSX	$10,000	5 46	38 95
RCM Small Cap	Small Company	n/a	$10,000	9 71	34 41
Brazos/JMIC Small Cap Growth	Small Company	BJSCX	$10,000	0	n/a
Stratton Small-Cap Yield	Small Company	STSCX	$5,000	9 7	14 97
Compass Small Cap Grth Svc	Small Company	PCGEX	$5,000	11 64	31 39
Compass Small Cap Val Svc	Small Company	PSESX	$5,000	8 25	19 56
Prudential Small Companies C	Small Company	n/a	$5,000	9 09	22 97
Tocqueville Small Cap Val A	Small Company	TSCVX	$5,000	9 78	25 03
PBHG Strategic Small Co PBHG	Small Company	PSSCX	$5,000	0	n/a
Vanguard Index Small Cap Stk	Small Company	NAESX	$3,000	9 32	18 12
Galaxy II Small Co Index Ret	Small Company	ISCIX	$2,500	10 27	19 66
Vista Small Cap Equity A	Small Company	VSEAX	$2,500	10 4	28 8
Vista Small Cap Equity B	Small Company	VSEBX	$2,500	10 4	27 93
T Rowe Price Small Cap Stk	Small Company	OTCFX	$2,500	10 41	21 05
Dreyfus Small Company Value	Small Company	DSCVX	$2,500	7 65	34 15
Galaxy Small Co Equity Ret A	Small Company	GASEX	$2,500	11 05	20 84
BT Investment Small Cap	Small Company	BTSCX	$2,500	11 18	6 9
Scudder Small Company Value	Small Company	SCSUX	$2,500	8 61	23 84

Data on Mutual Funds Specializing in Small Company Stocks; 5-31-97

Company name	Objective	Ticker	Minimum Initial Purchase	Return on Assets %	96 Rtrn %
Warburg Pincus Small Val Com	Small Company	WPSVX	$2,500	8 52	56 2
Galaxy Small Cap Value Ret A	Small Company	SSCEX	$2,500	9 21	26 84
Fidelity Small Cap Stock	Small Company	FDSCX	$2,500	11 18	13 63
Northern Small Cap	Small Company	NOSGX	$2,500	6 92	18 93
Strong Small Cap	Small Company	SCAPX	$2,500	10 12	22 7
Fidelity Japan Small Co	Pacific Stock	FJSCX	$2,500	7 67	-24 59
PIC Small Cap Growth	Small Company	PISCX	$2,000	11 78	18 2
Bridgeway Ultra-Small Co	Small Company	BRUSX	$2,000	10 44	29 74
Sit Small Cap Growth	Small Company	SSMGX	$2,000	12 65	14 97
AARP Small Company Stock	Small Company	ASCSX	$2,000	0	n/a
Columbia Small Cap	Small Company	CMSCX	$2,000	9	n/a
FBR Small Cap Financial	Sp -Financial	n/a	$2,000	8	n/a
FBR Small Cap Growth/Value	Small Company	n/a	$2,000	16 61	n/a
Crabbe Huson Small Cap Prim	Small Company	CHSCX	$2,000	3 97	n/a
Rembrandt Small Cap Inv	Small Company	n/a	$2,000	13 9	19 18
Clover Capital Small Cap Val	Small Company	n/a	$2,000	5 92	n/a
Fremont Intl Small Cap	Foreign Stock	FRISX	$2,000	11 81	12 15
Berger Small Company Growth	Small Company	BESCX	$2,000	11 14	16 77
Federated Small Cap Strat B	Small Company	SMCBX	$1,500	13 04	34 16
Federated Small Cap Strat C	Small Company	SMCCX	$1,500	13 04	33 99
Federated Intl Small Co B	Foreign Stock	ISCBX	$1,500	13 73	n/a
Federated Intl Small Co C	Foreign Stock	ISCCX	$1,500	13 73	n/a
Norwest Advant Small Co Gr I	Small Company	NVSCX	$1,000	8 48	19 82
Colonial Small Cap Value A	Small Company	CSMIX	$1,000	11 02	18 35
Colonial Small Cap Value B	Small Company	CSSBX	$1,000	11 02	17 84
Heritage Small Cap Stock A	Small Company	HRSCX	$1,000	11 71	27 46
Parkstone Small Cap Inv A	Small Company	PKSAX	$1,000	11 45	27 59
Heritage Small Cap Stock C	Small Company	HSCCX	$1,000	11 71	26 45
Parkstone Small Cap Inv C	Small Company	n/a	$1,000	11 45	26 24
Parkstone Small Cap Inv B	Small Company	PKSBX	$1,000	11 45	26 62
Westcore Small-Cap Opport	Small Company	WTSCX	$1,000	8 28	25 58
Goldman Sachs Small Cap Eq A	Small Company	GSSMX	$1,000	6 13	21 84
Goldman Sachs Small Cap Eq B	Small Company	GSQBX	$1,000	6 13	n/a
Gabelli Small Cap Growth	Small Company	GABSX	$1,000	7 54	11 88
Accessor Small to Mid Cap	Small Company	ASMCX	$1,000	11 8	24 74
Munder Small Company Grth A	Small Company	MULAX	$1,000	11 25	36 83
Norwest Advant Small Cap I	Small Company	NVSOX	$1,000	0	n/a
Munder Small Company Grth C	Small Company	n/a	$1,000	11 25	36 23
Munder Small Company Grth B	Small Company	MULBX	$1,000	11 25	35 9
Kemper-Dreman Small Cap A	Small Company	KDSAX	$1,000	8 94	29 6

Data on Mutual Funds Specializing in Small Company Stocks; 5-31-97

Company name	Objective	Ticker	Minimum Initial Purchase	Return on Assets %	96 Rtrn %
ESC Strategic Small Cap A	Small Company	ESCAX	$1,000	9 67	27 43
Kemper-Dreman Small Cap C	Small Company	KDSCX	$1,000	10	29 94
Kemper-Dreman Small Cap B	Small Company	KDSBX	$1,000	8 94	28 54
ESC Strategic Small Cap D	Small Company	ESCDX	$1,000	9 67	26 83
SSgA Small Cap	Small Company	SVSCX	$1,000	11 43	28 79
Bear Stearns Small Cap Val A	Small Company	BSVAX	$1,000	7 57	15 43
Bear Stearns Small Cap Val C	Small Company	BSVCX	$1,000	7 57	14 83
BB&T Small Company Growth A	Small Company	BBBSX	$1,000	11 59	30 77
BB&T Small Company Growth B	Small Company	n/a	$1,000	11 59	30 98
Montgomery Intl Small Cap R	Foreign Stock	MNISX	$1,000	23 45	14 97
Oakmark Small Cap	Small Company	OAKSX	$1,000	8 82	39 79
Kent Small Co Growth Invmt	Small Company	KNEMX	$1,000	8 95	19 15
TCW/DW Small Cap Growth	Small Company	TCSCX	$1,000	11 33	13 71
Invesco European Small Co	Europe Stock	IVECX	$1,000	21 04	31 03
Harris Ins Small-Cap Instl	Small Company	HSCIX	$1,000	10 57	n/a
Harris Ins Small-Cap A	Small Company	n/a	$1,000	10 57	n/a
HSBC Small Cap	Small Company	MSCFX	$1,000	11 9	15 29
Prudential Small Companies A	Small Company	PGOAX	$1,000	9 09	23 92
Schwab Small Cap Index	Small Company	SWSMX	$1,000	9 72	15 49
SEI Instl Small Cap Growth D	Small Company	n/a	$1,000	10 96	18 75
PIMCo Small Cap Value A	Small Company	PCVAX	$1,000	0	n/a
PIMCo Small Cap Value B	Small Company	PCVBX	$1,000	0	n/a
PIMCo Small Cap Value C	Small Company	PCVCX	$1,000	0	n/a
Pegasus Small Cap Opport I	Growth	PSOPX	$1,000	10 56	25 63
Pegasus Small Cap Opport A	Growth	n/a	$1,000	10 56	24 59
Pegasus Small Cap Opport B	Growth	n/a	$1,000	10 56	24 42
Prudential Small Companies B	Small Company	CHNDX	$1,000	9 09	22 97
Evergreen Small Cap Eq Inc Y	Small Company	ESCEX	$1,000	11 29	22 38
Value Line Small-Cap Growth	Small Company	VLSCX	$1,000	11 24	10 35
Evergreen Small Cap Eq Inc A	Small Company	n/a	$1,000	11 29	22 01
Evergreen Small Cap Eq Inc B	Small Company	n/a	$1,000	11 29	21 1
Evergreen Small Cap Eq Inc C	Small Company	n/a	$1,000	11 29	21 1
Norwest Advant Small Co StkA	Small Company	NCSAX	$1,000	12 77	25 98
Norwest Advant Small Co StkI	Small Company	NSCTX	$1,000	12 77	26 03
Norwest Advant Small Co StkB	Small Company	NCSBX	$1,000	12 77	24 91
Arch Small Cap Equity Inv A	Small Company	EMGRX	$1,000	9 87	10 5
Invesco Small Company Value	Small Company	IDSCX	$1,000	9 18	12 46
Preferred Small Cap	Small Company	PSMCX	$1,000	11 78	20 46
Heartland Small Cap Contrar	Small Company	HRSMX	$1,000	10	18 86
Arch Small Cap Equity Inv B	Small Company	n/a	$1,000	9 87	9 82

Data on Mutual Funds Specializing in Small Company Stocks; 5-31-97

Company name	Objective	Ticker	Minimum Initial Purchase	Return on Assets %	96 Rtrn %
North American Small/Mid A	Growth	NSMAX	$1,000	11 94	n/a
North American Small/Mid C	Growth	NSMCX	$1,000	11 94	n/a
North American Small/Mid B	Growth	NSMBX	$1,000	11 94	n/a
Aetna Small Company Sel	Small Company	AESGX	$1,000	10 1	13 62
Gateway Small Cap Index	Small Company	GSCIX	$1,000	9 13	17 04
Invesco Small Company Growth	Small Company	FIEGX	$1,000	12 21	11 62
Aetna Small Company Adv	Small Company	AESAX	$1,000	10 1	12 79
Safeco Small Co Stock NoLoad	Small Company	SFSCX	$1,000	8 08	n/a
PaineWebber Small Cap A	Small Company	PSCAX	$1,000	10 94	17 16
Eastcliff Regional Small Cap	Small Company	EARSX	$1,000	10 12	n/a
PaineWebber Small Cap B	Small Company	PSCBX	$1,000	10 94	16 2
PaineWebber Small Cap C	Small Company	PSCDX	$1,000	10 94	16 22
AAL Small Cap Stock A	Small Company	AASMX	$1,000	9 21	n/a
ITT Hartford Small Company A	Small Company	IHSAX	$1,000	11 36	n/a
ITT Hartford Small Company B	Small Company	n/a	$1,000	0	n/a
Marshall Small-Cap Growth	Small Company	MRSCX	$1,000	0	n/a
Emerald Small Cap Ret	Small Company	n/a	$1,000	10 14	10 05
Keystone Small Co Grth II A	Small Company	KSGAX	$1,000	10 34	n/a
Keystone Small Co Grth II B	Small Company	KSGBX	$1,000	10 34	n/a
Keystone Small Co Grth II C	Small Company	KSGCX	$1,000	10 34	n/a
Dean Witter Intl Small Cap	Foreign Stock	DWISX	$1,000	21 66	1 01
Keystone Small Co Grth (S-4)	Aggressive Growth	KSFOX	$1,000	12 67	0 82
Enterprise Small Co Value A	Small Company	ENSPX	$1,000	7 81	11 28
Kemper Small Cap Equity A	Small Company	KSCAX	$1,000	10 41	14 09
Enterprise Small Co Value B	Small Company	ESCBX	$1,000	7 81	10 77
Kemper Small Cap Equity B	Small Company	KSCBX	$1,000	10 41	12 84
Kemper Small Cap Equity C	Small Company	KSCCX	$1,000	10 41	12 86
Sentinel Small Company A	Small Company	SAGWX	$1,000	10 49	21 3
Sentinel Small Company B	Small Company	n/a	$1,000	10 49	n/a
SunAmerica Small Co Grth A	Small Company	SEGAX	$500	10 23	14 92
SunAmerica Small Co Grth B	Small Company	SEGBX	$500	10 23	14 12
Compass Small Cap Grth Inv A	Small Company	CSGEX	$500	11 64	31 13
Compass Small Cap Val Inv A	Small Company	PSEIX	$500	8 25	19 34
Phoenix Small Cap A	Small Company	PHSAX	$500	12 38	29 96
Federated Small Cap Strat A	Small Company	SMCAX	$500	13 04	35 04
Qualivest Small Comps Val A	Small Company	QSVAX	$500	9 89	20 07
Phoenix Small Cap B	Small Company	PHSCX	$500	12 38	28 93
Qualivest Small Comps Val C	Small Company	n/a	$500	9 89	19 35
RIMCo Monument Small Cap Eq	Small Company	RISCX	$500	10 1	21 92
Federated Intl Small Co A	Foreign Stock	ISCAX	$500	13 73	n/a

Data on Mutual Funds Specializing in Small Company Stocks; 5-31-97

Company name	Objective	Ticker	Minimum Initial Purchase	Return on Assets %	96 Rtrn %
ONE Fund Small Cap	Small Company	n/a	$500	9 34	17 01
GT Global Amer Small Cap Adv	Small Company	n/a	$500	8 85	14 22
GT Global Amer Small Cap A	Small Company	GTSAX	$500	8 85	13 81
GT Global Amer Small Cap B	Small Company	GTSBX	$500	8 85	13 14
First Omaha Small Cap Value	Small Company	n/a	$500	8 52	n/a
Alger Small Capitalization A	Small Company	n/a	$500	12 59	n/a
Alger Small Capitalization B	Small Company	ALSCX	$500	12 59	4 17
Winthrop Small Company Val A	Small Company	WFAGX	$250	9 6	14 58
Keeley Small Cap Value	Small Company	KSCVX	$250	7 83	25 99
Piper Small Company Growth A	Small Company	PJSCX	$250	9 2	11 65
Franklin Small Cap Grth I	Small Company	FRSGX	$100	10 31	27 07
Franklin Small Cap Grth II	Small Company	FRSIX	$100	10 31	26 07
Templeton Global Small Co I	World Stock	TEMGX	$100	18	22 09
Templeton Global Small Co II	World Stock	TESGX	$100	18	21 35
Munder Small Company Grth K	Small Company	MULKX	$0	11 25	36 89
Landmark Small Cap Equity A	Small Company	LSCEX	$0	9 44	37 8
Alger Small Cap Retirement	Small Company	ALSRX	$0	12 02	14 83
Galaxy Small Co Equity Tr	Small Company	GSETX	$0	11 05	21 59
BB&T Small Company Growth Tr	Small Company	BBCGX	$0	11 59	31 19
DFA U S Small Cap Value II	Small Company	DFAVX	$0	7 01	22 07
Warburg Pincus Adv Small Val	Small Company	n/a	$0	8 52	57
Qualivest Small Comps Val Y	Small Company	QSVYX	$0	9 89	20 36
Prudential Small Companies Z	Small Company	PSCZX	$0	9 09	n/a
Pacific Advisors Small Cap	Small Company	PASMX	$0	10 89	43 7
Galaxy Small Cap Value Tr	Small Company	SMCEX	$0	9 21	27 19
Arch Small Cap Equity Tr	Small Company	n/a	$0	9 87	10 98
Arch Small Cap Equity Instl	Small Company	n/a	$0	9 87	10 62
Rembrandt Small Cap Tr	Small Company	RSMCX	$0	13 9	19 42
SEI Instl Inv Small Cap	Small Company	n/a	$0	9 56	n/a
Kemper Small Cap Equity I	Small Company	n/a	$0	10 41	14 54
Brown Capital Small Co Instl	Small Company			10 44	

Morning Star Report on DFA 9-10 Fund

DFA U.S. 9-10 Small Company
(Data as of 05-31-97)

Investment Objective	Rating	Load	Yield	Assets ($mil)	NAV
Small Company	**	None	0 21%	1107.8	11.65

DFA U.S. 9-10 Small Company Portfolio seeks long-term capital appreciation.

The fund invests in a diverse group of small companies with readily marketable securities. These companies may be traded on the NYSE, the AMEX, or the over-the-counter market, but their market capitalizations must be comparable with those in the smallest quintile of the NYSE The portfolio is rebalanced at least semiannually.

The fund is designed primarily for institutional investors Prior to April 10, 1989, the fund was named DFA Investment Dimensions Small Company Prior to 1983, the fund was named DFA Small Company.

Performance: Annual Return %

	YTD	1996	1995	1994	1993
DFA U S. 9-10 Small Company	4.02	17.65	34.48	3.09	20.97
S&P 500 Index	15.43	22 95	37 53	1 32	10 06

These Figures Match DFA's and Dr. Andrews' Numbers in his Schedule 6, page 1, Far-left Column

Performance: Trailing Return %

	1 Mo	3 Mo	1 Yr	3 Yr Avg	5 Yr Avg
DFA U.S 9-10 Small Company	10 22	1.92	-1.33	18 60	18 41
S&P 500 Index	6.08	7.80	29 40	25.92	18.36

Risk Measures

Morningstar Risk: Above Avg. Beta (3 Yr) 0 78

Morning Star Report on DFA 9-10 Fund

Morningstar Return: Average   Std. Deviation (3 Yr) 16 59
R-Squared: 32

Top Ten Portfolio Holdings
(Data as of 02-28-97)

Ticker	Amount 000	Security	Value $000	% Net Assets
KUH	186	Kuhlman	4380	0.38
GLE	117	Gleason	4187	0 36
INVX	179	Innovex	3844	0.33
FRC	157	First Republic Bancorp	3654	0.32
ROG	128	Rogers	3459	0 30
HEI	133	HEICO	3430	0.30
CULP	179	Culp	3214	0.28
CDSI	105	Computer Data Systems	3193	0.28
ELMG	142	Electromagnetic Sciences	3173	0.27
APR	160	American Precision Inds	3027	0.26

Portfolio Statistics

Price/Earnings Ratio:	21.64	Income Ratio %:	0.22
Price/Book Ratio.	2 80	Turnover Ratio %:	23 68
Return on Assets %:	8.75	Expense Ratio %.	0 61
Median Market Cap ($mil)	123.29		

This figure, 8.75%, is not provided in DFA's Annual Report See Schedule 22, page 2.

These figures are the same as those reported in DFA's 1996 Annual Report

Expenses and Fees

Front-End Load:	0.00	12b-1 Fee:	0 00
Deferred Sales Charge:	0 00	Management Fee	0 50
Redemption Fee:	0.00		

Operations

Ticker Symbol: DFSCX

Morning Star Report on DFA 9-10 Fund

Fund Family: DFA Investment Dimensions Group
Address: 1299 Ocean Avenue 11th Floor
Santa Monica, CA 90401
Telephone: 310-395-8005

Fund Manager: Management Team
Manager Tenure NA years
Min. Initial Purchase $2000000

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225 W. Wacker Dr. Chicago, IL 60606, 312-696-6000
Although data are gathered from reliable sources,
completeness and accuracy cannot be guaranteed

Docket No. 97-00982
Exhibit CA-SNB
Direct Testimony
Schedule 22
Page 1 of 2

DFA Investment Dimensions Group Inc.
and
The DFA Investment Trust Company

ANNUAL REPORT

Year Ended November 30, 1996

Docket No. 97-00982
Exhibit CA-SNB____
Direct Testimony____
Schedule 22____
Page 2 of 2____

DFA INVESTMENT DIMENSIONS GROUP INC.

FINANCIAL HIGHLIGHTS

for a share outstanding throughout each year

	The U.S. 9-10 Small Company Portfolio									
	Year Ended Nov 30, 1996	Year Ended Nov. 30, 1995	Year Ended Nov. 30, 1994	Year Ended Nov. 30, 1993	Year Ended Nov 30, 1992	Year Ended Nov. 30, 1991	Year Ended Nov 30, 1990	Year Ended Nov 30, 1989	Year Ended Nov 30, 1988	Year Ended Nov 30, 1987
Net Asset Value Beginning of Period	$ 11.03	$ 8.49	$ 8.69	$ 7.75	$ 6.33	$ 5.34	$ 7.74	$ 7.66	$ 7.50	$ 8.94
Income From Investment Operations										
Net Investment Income	0.03	0.05	0.01	0.03	0.04	0.04	0.07	0.07	0.10	0.09
Net Gain (Losses) on Securities (Realized and Unrealized)	1.85	2.61	0.40	1.67	1.53	1.64	(1.77)	0.98	1.48	(1.53)
Total From Investment Operations	1.88	2.66	0.41	1.70	1.57	1.68	(1.70)	1.05	1.58	(1.44)
Less Distributions										
Net Investment Income	(0.01)	(0.04)	(0.03)	(0.05)	(0.05)	(0.07)	(0.08)	(0.09)	(0.11)	—
Net Realized Gains	(0.76)	(0.08)	(0.58)	(0.71)	(0.10)	(0.62)	(0.62)	(0.88)	(1.31)	—
Total Distributions	(0.77)	(0.12)	(0.61)	(0.76)	(0.15)	(0.69)	(0.70)	(0.97)	(1.42)	—
Net Asset Value, End of Period	$ 12.14	$ 11.03	$ 8.49	$ 8.69	$ 7.75	$ 6.33	$ 5.34	$ 7.74	$ 7.66	$ 7.50
Total Return	18.05%	31.37%	5.08%	23.91%	25.24%	39.08%	(24.09)%	16.09%	24.36%	(16.04)%
Net Assets End of Period (thousands)	$1,181,804	$925,474	$659,221	$630,918	$651,313	$722,289	$581,102	$949,291	$912,518	$788,821
Ratio of Expenses to Average Net Assets	0.61%	0.62%	0.65%	0.70%	0.68%	0.64%	0.62%	0.62%	0.62%	0.61%
Ratio of Net Investment Income to Average Net Assets	0.22%	0.45%	0.16%	0.26%	0.53%	0.75%	0.99%	0.86%	1.19%	0.92%
Portfolio Turnover Rate	23.68%	24.65%	16.56%	9.87%	9.72%	10.13%	3.79%	7.86%	25.98%	23.05%
Average Commission Rate (1)	$ 0.0604	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(1) Computed by dividing the total amount of brokerage commissions paid by the total shares of investment securities purchased and sold during the period for which commissions were charged, as required by the SEC for fiscal years beginning after September 1, 1995

See accompanying Notes to Financial Statements

DFA INVESTMENT DIMENSIONS GR(

1299 Ocean Avenue, 11th Floor, Santa Monica, California 90401
Telephone: (310) 395-8005

STATEMENT OF ADDITIONAL INFORMATION

March 28, 1997

DFA Investment Dimensions Group Inc. (the "Fund") offers thirty series of shares. This statement of additional information relates to twenty-four of those series (collectively, the "Portfolios"):

U.S. 9-10 Small Company Portfolio
U.S. 6-10 Small Company Portfolio
Enhanced U.S. Large Company Portfolio
U.S. Small Cap Value Portfolio
U.S. Large Cap Value Portfolio
DFA Real Estate Securities Portfolio
Japanese Small Company Portfolio
Pacific Rim Small Company Portfolio
United Kingdom Small Company Portfolio
Emerging Markets Portfolio
Emerging Markets Small Cap Portfolio
DFA Intermediate Government Fixed Income Portfolio
Continental Small Company Portfolio
Large Cap International Portfolio
U.S. Large Company Portfolio
DFA International Small Cap Value Portfolio
International Small Company Portfolio
DFA One-Year Fixed Income Portfolio
DFA Two-Year Corporate Fixed Income Portfolio
DFA Two-Year Global Fixed Income Portfolio
DFA Two-Year Government Portfolio
DFA Five-Year Government Portfolio
DFA Global Fixed Income Portfolio
RWB/DFA International High Book to Market Portfolio

This statement of additional information is not a prospectus but should be read in conjunction with the Portfolios' prospectus dated March 28, 1997, as amended from time to time, which can be obtained from the Fund by writing to the Fund at the above address or by calling the above telephone number.

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from the Series to satisfy the Portfolio's redemption request. Any such redemption t the Portfolio would be in accordance with Rule 18f-1 under the Investment Cor Investors may incur brokerage charges and other transaction costs selling securities t payment of redemptions. The International Equity, DFA Two-Year Global Fixed In... Global Fixed Income Portfolios reserve the right to redeem their shares in the currencies in which their investments (and, in respect of the Feeder Portfolios and International Small Company Portfolio, the currencies in which the corresponding Series' investments) are denominated. Investors may incur charges in converting such securities to dollars and the value of the securities may be affected by currency exchange fluctuations.

Shareholders may transfer shares of any Portfolio to another person by making a written request therefore to the Advisor who will transmit the request to the Fund's Transfer Agent. The request should clearly identify the account and number of shares to be transferred, and include the signature of all registered owners and all stock certificates, if any, which are subject to the transfer. The signature on the letter of request, the stock certificate or any stock power must be guaranteed in the same manner as described in the prospectus under "REDEMPTION OF SHARES." As with redemptions, the written request must be received in good order before any transfer can be made.

CALCULATION OF PERFORMANCE DATA

Following are quotations of the annualized percentage total returns for the one-, five-, and ten-year periods ended November 30, 1996 (as applicable) using the standardized method of calculation required by the SEC, which is net of the cost of any current reimbursement fees charged to investors and paid to the Portfolios. Also included is a quotation of the annualized percentage total return for the DFA Two-Year Global Fixed Income Portfolio (for the period from February 9, 1996, the date of commencement of operations), the Enhanced U.S. Large Company Portfolio (for the period from July 3, 1996, the date of commencement of operations) and the International Small Company Portfolio (for the period from October 1, 1996, the date of commencement of operations) to November 30, 1996 using the standardized method of calculation required by the SEC. Reimbursement fees of 1%, 1.5% and 1.5% were in effect from the inception of the Japanese, United Kingdom and Continental Small Company Portfolios, respectively, until June 30, 1995. A reimbursement fee of 1% was in effect from the inception of DFA International Small Cap Value Portfolio until June 30, 1995. Effective June 30, 1995, the amount of the reimbursement fee was reduced with respect to Continental Small Company, Pacific Rim Small Company, Japanese Small Company, Emerging Markets and DFA International Small Cap Value Portfolios, and eliminated with respect to the United Kingdom Small Company Portfolio. The current reimbursement fee for each Portfolio, expressed as a percentage of the net asset value of the shares of the Portfolios, is as follows: Continental Small Company, Pacific Rim Small Company and Emerging Markets Small Cap Portfolios - 1.00%; Japanese Small Company and Emerging Markets Portfolios - .50%; DFA International Small Cap Value Portfolio - .70%; and International Small Company Portfolio - .70%.

A reimbursement fee of 1% was charged to investors in The U.S. 9-10 Small Company Portfolio from December 9, 1986 through June 17, 1988. A reimbursement fee of 0.75% was charged to investors in The Large Cap International Portfolio from the date of its inception until March 5, 1992. In addition, for those Portfolios in effect for less than one, five, or ten years, the time periods during which the Portfolios have been active have been substituted for the periods stated (which in no case extends prior to the effective dates of the Portfolios' registration statements).

	One Year	Five Years	Ten Years
U.S. 9-10 Small Company Portfolio	18.03	20.38	12.35
U.S. 6-10 Small Company Portfolio	18.73	57 Months 13.42	n/a
U.S. Large Company Portfolio	27.48	17.88	71 Months 17.97

U.S. Small Cap Value Portfolio	21.77		
U.S. Large Cap Value Portfolio	22.26	46 Months 16.04	n/a
Enhanced U.S. Large Company Portfolio	4 Months 73.24	n/a	n/a
DFA Real Estate Securities Portfolio	28.24	47 Months 9.63	n/a
Japanese Small Company Portfolio	-6.74	-1.07	8.58
Pacific Rim Small Company Portfolio	17.87	47 Months 18.01	n/a
United Kingdom Small Company Portfolio	26.74	10.30	10.73
Emerging Markets Portfolio	12.61	31 Months 5.89	n/a
Continental Small Company Portfolio	12.83	5.39	103.5 Months 8.31
Large Cap International Portfolio	12.68	64 Months 8.27	n/a
RWB/DFA International High Book to Market Portfolio	14.60	42 Months 10.62	n/a
DFA One-Year Fixed Income Portfolio	5.91	5.28	6.70
DFA Five-Year Government Portfolio	7.54	6.25	114 Months 7.79
DFA Global Fixed Income Portfolio	11.13	8.40	72 Months 8.83
DFA Intermediate Government Fixed Income Portfolio	4.98	7.89	73 Months 9.37
DFA International Small Cap Value Portfolio	7.24	23 Months 2.08	n/a
DFA Two-Year Global Fixed Income Portfolio	10 Months 7.14	n/a	n/a
International Small Company Portfolio	2 Months -0.40	n/a	n/a

As the following formula indicates, the average annual total return is determined by finding the average annual compounded rates of return over the stated time period that would equate a hypothetical initial purchase order of $1,000 to its redeemable value (including capital appreciation/depreciation and dividends and distributions paid and reinvested less any fees charged to a shareholder account) at the end of the stated time period. The calculation assumes that all dividends and distributions are reinvested at the public offering price on the reinvestment dates during the period. The quotation assumes the account was completely redeemed at the end of each period and the deduction of all applicable charges and fees. According to the SEC formula:

$$P(1 + T)^n = ERV$$

where:

P = a hypothetical initial payment of $1,000

T = average annual total return

n = number of years

ERV = ending redeemable value of a hypothetical $1,000 payment made at the beginning of the one-, five-, and ten-year periods at the end of the one-, five-, and ten-year periods (or fractional portion thereof).

Following are quotations of the annualized total returns for the one-, five-, and ten-year periods ended November 30, 1996 (as applicable) using a non-standardized method of calculation which is used in communicating performance data in addition to the standardized method required by the SEC. Also included is a quotation of the annualized percentage total return for the DFA Two-Year Global Fixed Income Portfolio (for the period from February 9, 1996, the date of commencement of operations), the Enhanced U.S. Large Company Portfolio (for the period from July 3, 1996, the date of commencement of operations) and the International Small Company Portfolio (for the period from October 1, 1996, the date of commencement of operations) to November 30, 1996 using a non-standardized method of calculation. The non-standardized quotations differ from the standardized in that they are calculated without deduction of any reimbursement fees charged to investors and paid to the Portfolios which would otherwise reduce return quotations for the Portfolios with such fees. Additionally, the non-standardized quotations are presented over time periods which extend prior to the initial investment in the Portfolios (except for The Continental Small Company (and Large Cap International) Portfolios) by using simulated data for the investment strategies of the Portfolios for that portion of the period prior to the initial investment dates. The simulated data excludes the deduction of Portfolio expenses which would otherwise reduce the returns quotations. Non-standardized quotations are also presented for the United Kingdom and Japanese Small Company Portfolios calculated assuming the local currencies of the corresponding Series are invested and redeemed at the beginning and ending dates of the period. The local currency calculations ignore the effect of foreign exchange rates on the investment and only express the returns of the underlying securities of the Series.

	Effective Date/ Initial Investment	One Year	Five Years	Ten Years
U.S. 9-10 Small Company Portfolio	12/22/81 12/22/81	18.03	20.38	12.46
U.S. 6-10 Small Company Portfolio	03/06/92 03/20/92	18.73	17.00	11.57
U.S. Large Company Portfolio	02/26/90 12/31/90	27.48	17.88	15.02
U.S. Small Cap Value Portfolio	09/18/92 03/01/93	21.77	22.14	14.88
U.S. Large Cap Value Portfolio	09/18/92 02/18/93	22.26	20.47	15.32

...res and forward contracts is generally governed by Section 1256 of the Code. ...positions generally include listed options on debt securities, options on broad-based ...on futures contracts, regulated futures contracts and certain foreign currency contracts and options thereon.

Absent a tax election to the contrary, each such Section 1256 position held by a Portfolio or Series will be marked-to-market (i.e., treated as if it were sold for fair market value) on the last business day of a Portfolio's or Series' fiscal year, and all gain or loss associated with fiscal year transactions and marked-to-market positions at fiscal year end (except certain currency gain or loss covered by Section 988 of the Code) will generally be treated as 60% long-term capital gain or loss and 40% short-term capital gain or loss. The effect of Section 1256 marked-to-market rules may be to accelerate income or to convert what otherwise would have been long-term capital gains into short-term capital gains or short-term capital losses into long-term capital losses within a Portfolio or Series. The acceleration of income on Section 1256 positions may require a Portfolio or Series to accrue taxable income without the corresponding receipt of cash. In order to generate cash to satisfy the distribution requirements of the Code, a Portfolio or Series may be required to dispose of portfolio securities that it otherwise would have continued to hold or to use cash flows from other sources such as the sale of a Portfolio's or Series' shares. In these ways, any or all of these rules may affect both the amount, character and timing of income distributed to shareholders by a Portfolio.

When a Portfolio (or in the case of a Feeder Portfolio, the corresponding Series) holds an option or contract which substantially diminishes a Portfolio's or Series' risk of loss with respect to another position of a Portfolio or Series (as might occur in some hedging transactions), this combination of positions could be treated as a "straddle" for tax purposes, resulting in possible deferral of losses, adjustments in the holding periods of a Portfolio's or Series' securities and conversion of short-term capital losses into long-term capital losses. Certain tax elections exist for mixed straddles (i.e., straddles comprised of at least one Section 1256 position and at least one non-Section 1256 position) which may reduce or eliminate the operation of these straddle rules.

The Portfolios and those Series taxable as regulated investment companies are also subject to the requirement that less than 30% of their annual gross income be derived from the sale or other disposition of securities and certain other investments held for less than three months ("short-short income"). This requirement may limit a Portfolio's (or in the case of a Feeder Portfolio, the corresponding Series') ability to engage in options, straddles, hedging transactions and forward or futures contracts because these transactions are often consummated in less than three months, may require the sale of portfolio securities held less than three months and may, as in the case of short sales of portfolio securities, reduce the holding periods of certain securities within a Portfolio or Series, resulting in additional short-short income for a Portfolio or Series.

A Portfolio (or in the case of a Feeder Portfolio, the corresponding Series) will monitor its transactions in such options and contracts and may make certain other tax elections in order to mitigate the effect of the above rules and to prevent disqualification of a Portfolio or Series as a regulated investment company under Subchapter M of the Code.

DIRECTORS AND OFFICERS

The names and addresses of the directors and officers of the Fund and a brief statement of their present positions and principal occupations during the past five years is set forth below.

Directors

David G. Booth*, 50, Director, President and Chairman-Chief Executive Officer, Santa Monica, CA. President, Chairman-Chief Executive Officer and Director, Dimensional Fund Advisors Inc., DFA Securities Inc., DFA Australia Ltd., Dimensional Investment Group Inc. (registered investment company) and Dimensional Emerging Markets Fund Inc. (registered investment company). Trustee, President and Chairman-Chief Executive Officer of The DFA Investment Trust Company. Chairman and Director, Dimensional Fund Advisors Ltd.

George M. Constantinides, 49, Director, Chicago, IL. L Graduate School of Business, University of Chicago. Trustee, Th Director, Dimensional Investment Group Inc. and Dimensional Eme

John P. Gould, 58, Director, Chicago, IL. Steven G. Rothmeier Distinguished Service Professor of Economics, Graduate School of Business, University of Chicago. Trustee, The DFA Investment Trust Company and First Prairie Funds (registered investment companies). Director, Dimensional Investment Group Inc., Dimensional Emerging Markets Fund Inc. and Harbor Investment Advisors. Executive Vice President, Lexecon Inc. (economics, law, strategy and finance consulting).

Roger G. Ibbotson, 53, Director, New Haven, CT. Professor in Practice of Finance, Yale School of Management. Trustee, The DFA Investment Trust Company. Director, Dimensional Investment Group Inc., Dimensional Emerging Markets Fund Inc., Hospital Fund, Inc. (investment management services) and BIRR Portfolio Analysis, Inc. (software products). Chairman and President, Ibbotson Associates, Inc., Chicago, IL (software, data, publishing and consulting).

Merton H. Miller, 73, Director, Chicago, IL. Robert R. McCormick Distinguished Service Professor Emeritus, Graduate School of Business, University of Chicago. Trustee, The DFA Investment Trust Company. Director, Dimensional Investment Group Inc. and Dimensional Emerging Markets Fund Inc. Public Director, Chicago Mercantile Exchange.

Myron S. Scholes, 55, Director, Greenwich, CT. Limited Partner, Long-Term Capital Management L.P. (money manager). Frank E. Buck Professor of Finance, Graduate School of Business and Professor of Law, Law School, Senior Research Fellow, Hoover Institution, (all) Stanford University (on leave). Trustee, The DFA Investment Trust Company. Director, Dimensional Investment Group Inc., Dimensional Emerging Markets Fund Inc., Benham Capital Management Group of Investment Companies and Smith Breedon Group of Investment Companies.

Rex A. Sinquefield*, 52, Director, Chairman and Chief Investment Officer, Santa Monica, CA. Chairman-Chief Investment Officer and Director, Dimensional Fund Advisors Inc., DFA Securities Inc., DFA Australia Ltd., Dimensional Investment Group Inc. and Dimensional Emerging Markets Fund Inc. Trustee, Chairman-Chief Investment Officer of The DFA Investment Trust Company. Chairman, Chief Executive Officer and Director, Dimensional Fund Advisors Ltd.

* Interested Director of the Fund.

Officers

Each of the officers listed below hold the same office in the following entities: Dimensional Fund Advisors Inc., DFA Securities Inc., DFA Australia Ltd., Dimensional Investment Group Inc., The DFA Investment Trust Company, Dimensional Fund Advisors Ltd., and Dimensional Emerging Markets Fund Inc.

Arthur Barlow, 41, Vice President, Santa Monica, CA.

Maureen Connors, 60, Vice President, Santa Monica, CA.

Truman Clark, 55, Vice President, Santa Monica, CA. Consultant until October 1995 and Principal and Manager of Product Development, Wells Fargo Nikko Investment Advisors, San Francisco, CA from 1990-1994.

Robert Deere, 39, Vice President, Santa Monica, CA.

Irene R. Diamant, 46, Vice President and Secretary (for all entities other than Dimensional Fund Advisors Ltd.), Santa Monica, CA.

Margaret East, 56, Secretary, Dimensional Fund Advisors Ltd.

The Fund commenced offering shares of Emerging Mark International Small Cap Value Portfolio in December, 1994; DFA Two- in February, 1996; Enhanced U.S. Large Company Portfolio in July, 1996, and International Small Company Portfolio in October, 1996. The DFA Two-Year Corporate Fixed Income, DFA Two-Year Government and Emerging Markets Small Cap Portfolios had not commenced operations as of November 30, 1996.

Until September, 1995, The DFA Intermediate Government Fixed Income Portfolio was named The DFA Intermediate Government Bond Portfolio, The DFA Global Fixed Income Portfolio was named The DFA Global Bond Portfolio, The Pacific Rim Small Company Portfolio was named The Asia-Australia Small Company Portfolio, The U.S. Large Cap Value Portfolio was named The U.S. Large Cap High Book to Market Portfolio, The U.S. Small Cap Value Portfolio was named The U.S. Small Cap High Book to Market Portfolio, The U.S. 9-10 Small Company Portfolio was named the Small Company Shares, The DFA One-Year Fixed Income Portfolio was named The DFA Fixed Income Shares, and The Continental Small Company Portfolio was named the Continental European Portfolio. Until February, 1996, RWB/DFA International High Book to Market Portfolio was named DFA International High Book to Market Portfolio. From September, 1995 until December, 1996, The DFA Real Estate Securities Portfolio was named DFA/AEW Real Estate Securities Portfolio.

Coopers and Lybrand L.L.P., the Fund's independent accountants, audits the Fund's financial statements.

PRINCIPAL HOLDERS OF SECURITIES

As of February 28, 1997, the following stockholders owned beneficially at least 5% of the outstanding stock of the Portfolios, as set forth below.

THE U.S. 9-10 SMALL COMPANY PORTFOLIO

Charles Schwab & Company, Inc. - REIN* 101 Montgomery Street San Francisco, CA 94104		25.44%
State Farm Insurance Companies One State Farm Plaza Bloomington, IL 61710		10.76%
Pepsico Inc. Master Trust The Northern Trust Company Trustee P.O. Box 92956 801 South Canal Chicago, IL 60675		8.87%
Charles Schwab & Company, Inc. - REIN*	(see address above)	5.97%
Owens-Illinois Master Retirement Trust 34 Exchange Place Jersey City, NJ 07302		5.48%
National Electrical Benefit Fund 1125 15th Street NW Washington, DC 20005		5.26%

THE U.S. 6-10 SMALL COMPANY PORTFOLIO

McKinsey & Company Master Retirement Trust 55 E. 52nd Street New York, NY 10055	26.43%

Data on Dr. Andrews' Companies

Docket No 97-00982
Exhibit CA-SNB____
Direct Testimony___
Schedule 25 ______
Page 1 of 1______

COMPANY NAME * (1)	PRICE AS OF 4/30/97 (2)	STOCK OUTSTANDING (000) (3)	NUM OF SHARE HOLDERS (4)	SHARES PER STOCKHOLDER (5) [col (3) / col (4)]	VALUE OF HOLDINGS PER SHAREHOLDER 4/30/97 (6) [col (2) X col (5)]	MARKET VALUE 4/30/97 $(Millions) (7) [col (2) X col (3)]
Atmos Energy Corporation	$22 63	16135	28,624	564	$12,753	365
Berkshire Gas Company	$15 13	2177	1,881	1157	$17,505	33
Bay State Gas Company	$25 50	13439	10,820	1242	$31,671	343
Cascade Natural Gas Corporation	$16 38	10824	10840	999	$16,351	177
Colonial Gas Company	$20 00	8518	5931	1436	$28,724	170
Chesapeake Utilities Corporation	$16 75	4453	2213	2012	$33,704	75
Delta Natural Gas Company, Inc	$16 63	2325	2,382	976	$16,227	39
Essex County Gas Company	$24 25	1667	1,336	1248	$30,258	40
Energen Corporation	$30 50	13027	7,700	1692	$51,600	397
Energy North Inc	$21 75	3244	2,300	1410	$30,677	71
Energy West Incorporated	$8 50	2357	1,600	1473	$12,522	20
Mobile Gas Service Corporation	$26 75	3228	1,624	1988	$53,171	86
North Carolina Natural Gas Corporation	$29 63	6613	5,094	1298	$38,459	196
Northwest Natural Gas Company	$24 25	22566	10,859	2078	$50,394	547
Public Service Company of North Carolina, Incorporated	$17 25	19296	11,500	1678	$28,945	333
Pennsylvania Enterprises, Inc *	$22 13	9608	6,627	1450	$32,077	213
Providence Energy Corporation	$17 75	5767	6,052	953	$16,914	102
Southeastern Michigan Gas Enterprises, Inc	$17 58	13020	8,509	1530	$26,892	229
United Cities Gas Company	$21 50	13221	7681	1721	$37,007	284
Valley Resources, Inc	$12 25	4266	2824	1511	$18,505	52
Yankee Energy System, Inc	$21 13	10450	28,499	367	$7,746	221
Average	$20 39	8867	7,852	1371	$28,195	190

* Excludes Washington Gas Company
It Merged With an Electric Power Company

Gas Company Stocks Owned by the DFA 9-10 Fund

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Exhibit CA-SNB____
Direct Testimony___
Schedule 26 ______
Page 1 of 1_______

COMPANY	Did the U S 9-10 Small Company Mutual Fund Own Stock in Dr Andrews' Comparable Companies? YEAR 94	95	96
Atmos Energy Corporation	NO	NO	NO
Berkshire Gas Company	YES	YES	YES
Bay State Gas Company	NO	NO	NO
Cascade Natural Gas Corporation	YES	YES	YES
Chesapeake Utilities Corporation	YES	YES	YES
Colonial Gas Company	YES	YES	YES
Delta Natural Gas Company, Inc.	YES	YES	YES
Energen Corporation	NO	NO	NO
Energy North Inc	YES	NO	YES
Energy West Incorporated	NO	NO	NO
Essex County Gas Company	NO	YES	YES
Mobile Gas Service Corporation	YES	YES	YES
North Carolina Natural Gas Corporation	NO	NO	YES
Northwest Natural Gas Company	NO	NO	NO
Pennsylvania Enterprises, Inc.	NO	NO	NO
Providence Energy Corporation	YES	YES	YES
Public Service Company of North Carolina, Incorporated	NO	NO	NO
Southeastern Michigan Gas Enterprises, Inc	NO	NO	NO
United Cities Gas Company	NO	NO	NO
Washington Energy	NO	NO	NO
Valley Resources, Inc.	YES	YES	YES
Yankee Energy System, Inc.	NO	NO	NO
TOTAL *NOT* INCLUDED IN PORTFOLIO	13	13	11
TOTAL INCLUDED IN PORTFOLIO	9	9	11

SOURCE 1994 & 1996 - DFA ANNUAL REPORT
SOURCE 1995 1OK REPORT

Table A-1 Large Company Stocks: Total Returns

(continued)

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Exhibit CA-SNB____
Direct Testimony___
Schedule 27_____
Page 1 of 1____

From January 1971 to December 1995

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	JAN–DEC*
1971	0.0419	0.0141	0.0382	0.0377	-0.0367	0.0021	-0.0399	0.0412	-0.0056	-0.0404	0.0027	0.0877	1971	0.1431
1972	0.0194	0.0299	0.0072	0.0057	0.0219	-0.0205	0.0036	0.0391	-0.0036	0.0107	0.0505	0.0131	1972	0.1898
1973	-0.0159	-0.0333	-0.0002	-0.0395	-0.0139	-0.0051	0.0394	-0.0318	0.0415	0.0003	-0.1082	0.0183	1973	-0.1466
1974	-0.0085	0.0019	-0.0217	-0.0373	-0.0272	-0.0128	-0.0759	-0.0828	-0.1170	0.1657	-0.0448	-0.0177	1974	-0.2647
1975	0.1251	0.0674	0.0237	0.0493	0.0509	0.0462	-0.0659	-0.0144	-0.0328	0.0637	0.0313	-0.0096	1975	0.3720
1976	0.1199	-0.0058	0.0326	-0.0099	-0.0073	0.0427	-0.0068	0.0014	0.0247	-0.0206	-0.0009	0.0540	1976	0.2384
1977	-0.0489	-0.0151	-0.0119	0.0014	-0.0150	0.0475	-0.0151	-0.0133	0.0000	-0.0415	0.0370	0.0048	1977	-0.0718
1978	-0.0596	-0.0161	0.0276	0.0870	0.0136	-0.0152	0.0560	0.0340	-0.0048	-0.0891	0.0260	0.0172	1978	0.0656
1979	0.0421	-0.0284	0.0575	0.0036	-0.0168	0.0410	0.0110	0.0611	0.0025	-0.0656	0.0514	0.0192	1979	0.1844
1980	0.0610	0.0031	-0.0987	0.0429	0.0562	0.0296	0.0676	0.0131	0.0281	0.0187	0.1095	-0.0315	1980	0.3242
1981	-0.0438	0.0208	0.0380	-0.0213	0.0062	-0.0080	0.0007	-0.0554	-0.0502	0.0528	0.0441	-0.0265	1981	-0.0491
1982	-0.0163	-0.0512	-0.0060	0.0414	-0.0288	-0.0174	-0.0215	0.1267	0.0110	0.1126	0.0438	0.0173	1982	0.2141
1983	0.0348	0.0260	0.0365	0.0758	-0.0052	0.0382	-0.0313	0.0170	0.0136	-0.0134	0.0233	-0.0061	1983	0.2251
1984	-0.0065	-0.0328	0.0171	0.0069	-0.0534	0.0221	-0.0143	0.1125	0.0002	0.0026	-0.0101	0.0253	1984	0.0627
1985	0.0768	0.0137	0.0018	-0.0032	0.0615	0.0159	-0.0026	-0.0061	-0.0321	0.0447	0.0716	0.0467	1985	0.3216
1986	0.0044	0.0761	0.0554	-0.0124	0.0549	0.0166	-0.0569	0.0748	-0.0822	0.0556	0.0256	-0.0264	1986	0.1847
1987	0.1343	0.0413	0.0272	-0.0088	0.0103	0.0499	0.0498	0.0385	-0.0220	-0.2152	-0.0819	0.0738	1987	0.0523
1988	0.0427	0.0470	-0.0302	0.0108	0.0078	0.0464	-0.0040	-0.0331	0.0424	0.0273	-0.0142	0.0181	1988	0.1681
1989	0.0723	-0.0249	0.0236	0.0516	0.0402	-0.0054	0.0898	0.0193	-0.0039	-0.0233	0.0208	0.0236	1989	0.3149
1990	-0.0671	0.0129	0.0263	-0.0247	0.0975	-0.0070	-0.0032	-0.0903	-0.0492	-0.0037	0.0644	0.0274	1990	-0.0317
1991	0.0442	0.0716	0.0238	0.0028	0.0428	-0.0457	0.0468	0.0235	-0.0164	0.0134	-0.0404	0.1143	1991	0.3055
1992	-0.0186	0.0128	-0.0196	0.0291	0.0054	-0.0145	0.0403	-0.0202	0.0115	0.0036	0.0337	0.0131	1992	0.0767
1993	0.0073	0.0135	0.0215	-0.0245	0.0270	0.0033	-0.0047	0.0381	-0.0074	0.0203	-0.0094	0.0123	1993	0.0999
1994	0.0335	-0.0270	-0.0435	0.0130	0.0163	-0.0247	0.0331	0.0407	-0.0241	0.0229	-0.0367	0.0146	1994	0.0131
1995	0.0260	0.0388	0.0296	0.0291	0.0395	0.0235	0.0333	0.0027	0.0419	-0.0035	0.0440	0.0185	1995	0.3743

* Compound annual return

Office of the Consumer Advocate Interrogatory/Data Request-7/8/97

Q.47. Regarding the results of Dr. Andrew's regression analysis shown in Schedule 9, produce the T-statistic for each company's alpha and the T-statistic for each company's beta.

A.47. The results of regressions performed on the data for each company listed in Schedule 9 are employed only in summary, aggregated form as average alphas and betas. The average alpha and average beta are analogous to the alpha and beta of a portfolio of common stocks, in this case a "portfolio" of 22 small gas LDC's. Tests of significance, such as T-statistics, from the regressions related to individual stocks intrinsically cannot be summed or averaged across the composite (or portfolio). Accordingly, they were not found in company with the individual regressions and, hence, cannot be supplied as requested.

Victor L. Andrews

Signature

Victor L. Andrews, President, Andrews Financial Associates, Inc.

APPENDIX A

IBBOTSON YEARBOOK'S HYPOTHETICAL DISTRIBUTION OF RETURNS

The derivation of Schedule 12 and Charts two and three is based on the same probability principles used in the example shown in SBBI-97 at pages 154-155. Those pages are attached to and are part of this appendix as Attachments 1 and 2. The hypothetical distribution in the example assumes:

10% is the size of the loss

30% is the size of the gain

50% is the probability of a loss

50% is the probability of a gain.

Starting with an investment of $1, after 1 year there are two possible values, the investment will be worth either $1.3 or 90 cents. After two years there are 4 possibilities, one at $1.69, two outcomes at $1.17 and one at $.81. This shows that the number of possibilities double each year. The example is well-grounded in mathematics and is a simple illustration of a mathematical formula that is over 500 years old. If $1.3 is treated as X and $.9 is treated as Y, the first year after the investment the possible outcomes are:

$$(X + Y)^1 = \underline{1}(\$1.3) + \underline{1}(\$.9)$$

In the second year after the investment the possible outcomes are:

$$(X + Y)^2 = \underline{1}(X^2) + \underline{2}(XY) + \underline{1}(Y^2)$$

$$(\$1.3 + \$.9)^2 = \underline{1}(\$1.69) + \underline{2}(\$1.17) + \underline{1}(\$.81)$$

The underlined values -- 1 and 1 in the first year and 1, 2 ,1 in the second year -- match the total number of possibilities - 2 in the first year and 4 in the second, and the values in the parentheses -- $1.3 and $.9 in the first year and $1.69 ,$1.17, $.81 in the second -- represent the values of the possibilities. There are two important aspects of the example especially in the second year: the geometric mean is the middle value, $1.17, which has a corresponding annual return of 8.2%, is the most likely outcome - 2 chances out of four. Three out of the four chances, 75% of the possibilities, are at or below the middle value. The odds are only 25% that the investment will reach the average of $1.21, which has a corresponding return of 10%.

The heart of the example can be restated.

This information about a distribution:

10% is the size of the loss

30% is the size of the gain

50% is the probability of a loss

50% is the probability of a gain.

Leads to these facts about the distribution:

an 8.2% return is the distribution's middle

a 10% return is the distribution's average

And

the number of possibilities doubles as the years increase: in the first year there are 2 possibilities, 4 in the second, 8 in the third and so forth.

By the time 71 years elapse from 1925 to 1996 the equation above changes to:

$$(X + Y)^{71}$$

Although this term is huge it can be calculated easily with computers, giving the total number of possibilities and the possibilities for each outcome. Attachments 3 and 4 show the possibilities each year, the symmetrical pattern each year and the distribution in percentage terms. The patterns do not depend on the values of X and Y. No matter what values X and Y are, the pattern of possibilities is the same. This is why Chart 3 in my direct testimony is also symmetrical.

ACTUAL DISTRIBUTION OF LARGE COMPANY RETURNS: 1925-1996

Ibbotson's data on large companies covers 71 years. It shows a return of 10.7% as being in the middle of the distribution and an average of return of 12.7%. This is different than the example in the sense that the order of the information is reversed from the example.

The information about the actual distribution:

a 10.7% return is the distribution's middle

a 12.7% return is the distribution's average

50% is the probability of a loss

50% is the probability of a gain.

Leads to these questions about the actual distribution:

What percentage is the size of the loss?

What percentage is the size of the gain?

I calculated the size of the loss to be 8.3% and the size of the gain to be 33.6%. These are the first and last values in column (3) of Schedule 12. I then applied these two figures to the formula

$$(X + Y)^{71}$$

This gives the total number of possible returns, the value of each return ,and the probability of each return in 1996 - given a $1 investment in 1925. This is the data shown in Schedule 12.

The Schedule indicates that the average return, 12.7%, has a less then 20% chance of being achieved in 1996. If the odds were looked at in 1927, the second year after the investment, the chance of achieving the average return would be no more than 25%. The point here is that as time progresses, the average return has a little less of a chance of being achieved. Its odds shrink from no more than 25% in the second year to less than 20% in the 71st year. This is not much of a change, but it highlights why the average return is not considered a useful measure by the sources I quoted. The average return is not the midpoint of the distribution, and the average return gets further and further away from the midpoint as time progresses.

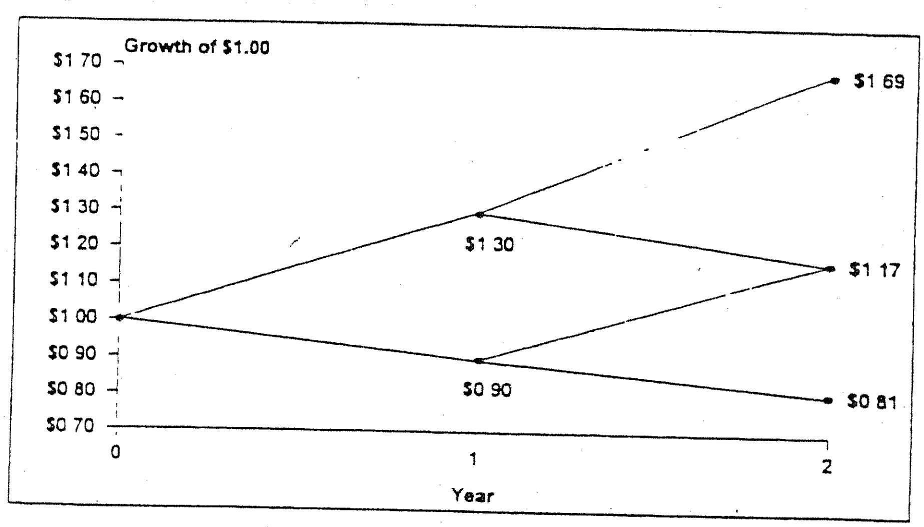
Appendix A of _____
Direct Testimony
Docket No. 97-00982
Exhibit CA-SNB___
Attachment 1

where the cost of capital is the sum of its parts Therefore, the CAPM expected equity risk premium must be derived by arithmetic, *not geometric*, subtraction.

Arithmetic Versus Geometric Means

The expected equity risk premium should always be calculated using the arithmetic mean. The arithmetic mean is the rate of return which, when compounded over multiple periods, gives the mean of the probability distribution of ending wealth values. (A simple example given below shows that this is true.) This makes the arithmetic mean return appropriate for computing the cost of capital. The discount rate that equates expected (mean) future values with the present value of an investment is that investment's cost of capital. The logic of using the discount rate as the cost of capital is reinforced by noting that investors will discount their expected (mean) ending wealth values from an investment back to the present using the arithmetic mean, for the reason given above. They will, therefore, require such an expected (mean) return prospectively (that is, in the present looking toward the future) to commit their capital to the investment.

For example, assume a stock has an expected return of +10 percent in each year and a standard deviation of 20 percent. Assume further that only two outcomes are possible each year— + 30 percent and -10 percent (that is, the mean plus or minus one standard deviation), and that these outcomes are equally likely. (The arithmetic mean of these returns is 10 percent, and the geometric mean is 8.2 percent.) Then the growth of wealth over a two-year period occurs as shown below.



Appendix A of ____
Direct Testimony
Docket No. 97-00982
Exhibit CA-SNB____
Attachment 2

Note that the median (middle outcome) and mode (most common outcome) are given by the geometric mean, 8.2 percent, which compounds up to 17 percent over a 2-year period (hence a terminal wealth of \$1.17). However, the *expected value*, or probability-weighted average of all possible outcomes, is equal to:

	(.25	×	1.69)	=	0.4225
+	(.50	×	1.17)	=	0.5850
+	(.25	×	0.81)	=	0.2025
TOTAL					1.2100

Now, the rate that must be compounded up to achieve a terminal wealth of \$1.21 after 2 years is 10 percent; that is, the expected value of the terminal wealth is given by compounding up the *arithmetic*, not the geometric mean. Since the arithmetic mean equates the expected future value with the present value, it is the discount rate.

Stated another way, the arithmetic mean is correct because an investment with uncertain returns will have a higher expected ending wealth value than an investment that earns, with certainty, its compound or geometric rate of return every year In the above example, compounding at the rate of 8.2 percent for two years yields a terminal wealth of \$1.17, based on \$1.00 invested. But holding the uncertain investment, with a possibility of high returns (two +30 percent years in a row) as well as low returns (two -10 percent years in a row), yields a higher expected terminal wealth, \$1.21 In other words, more money is gained by higher-than-expected returns than is lost by lower-than-expected returns. Therefore, in the investment markets, where returns are described by a probability distribution, the arithmetic mean is the measure that accounts for uncertainty, and is the appropriate one for estimating discount rates and the cost of capital.

Arbitrage Pricing Theory

APT is a model of the expected return on a security. It was originated by Stephen A Ross, and elaborated by Richard Roll. APT treats the expected return on a security (*i.e.*, its cost of capital) as the sum of the payoffs for an indeterminate number of risk factors, where the amount of each risk factor inherent in a given security is estimated. Like the CAPM, APT is a model that is consistent with equilibrium and does not attempt to outguess the market. APT

Distribution of Possibilities for (X + Y)

Center of the Distribution

Distribution	Total Possibilities Each Year	Year
1		0
1 1	2	1
1 2 1	4	2
1 3 3 1	8	3
1 4 6 4 1	16	4
1 5 10 20 10 5 1	32	5
1 6 15 20 15 6 1	64	6
1 7 21 35 35 21 7 1	128	7
1 8 28 56 70 56 28 8 1	256	8
1 9 36 84 126 126 84 36 9 1	512	9
.	.	
.	.	
.	.	
2 E+18	2 E+21	71

Ibbotson Example

Distribution of Possibilities for (X + Y)
As a Percent of Possibilities
Center of the Distribution

Ibbotson Example

Distribution	Total Possibilities Each Year	Year
100%		0
50% 50%	1	1
25% 50% 25%	4	2
13% 38% 38% 13%	8	3
6% 25% 38% 25% 6%	16	4
3% 16% 31% 31% 16% 3%	32	5
2% 9% 23% 31% 23% 9% 2%	64	6
1% 5% 16% 27% 27% 16% 5% 1%	128	7
0% 3% 11% 22% 27% 22% 11% 3% 0%	256	8
0% 2% 7% 16% 25% 25% 16% 7% 2% 0%	512	9
.	.	.
.	.	.
9%	2. E+21	71

Before the

TENNESSEE REGULATORY AUTHORITY

In Re: Nashville Gas Company

Docket No. 96-00977

****

REBUTTAL TESTIMONY

of

STEPHEN N. BROWN

****

NOVEMBER 1, 1996

Q. Please state your name.

A. Stephen N. Brown.

Q. Have you prefiled testimony in this case?

A. Yes. I filed written, direct testimony.

Q. What is the purpose of this additional testimony?

A. My purpose is to comply with the TRA's request to file written rebuttal testimony regarding Dr. Murry's direct testimony offered on behalf of the company.

Q. What does your rebuttal testimony provide?

A. My rebuttal testimony provides substantial and material evidence that the 14 non-regulated companies listed in Schedule 24 in Dr. Murry's Exhibit (DAM-1) are not comparable to Piedmont and are, in fact, much more risky investments than Piedmont and its comparables, the Moody Companies. Therefore, it is unreasonable to consider Dr. Murry's companies as comparable to Piedmont or to the Moody Companies.

My rebuttal testimony also provides substantial and material evidence that Dr. Murry's use of the arithmetic mean to form a rate of return for Piedmont constitutes unjust and unreasonable preferential treatment because the arithmetic mean of market returns mean is much higher than what is normally and commonly experienced in the market. Referring to my direct testimony, page 32 lines 2 to 13, and to Schedule 9 of my direct testimony, the arithmetic mean is derived from the market-performance of the 1360 large companies followed by Ibbotson Associates. Less than 20% of them achieve an equity return at least equal to the arithmetic mean of 12.5%. More than 80% of those companies achieve returns less than the arithmetic mean. Therefore, Dr. Murry is basing his risk premium return on those companies that are superior performers in the market rather than on the normal performers. Therefore, his risk premium analysis renders a rate of return that is not just and reasonable.

Q. Why are the 14 non-regulated companies listed in Schedule 24 of Exhibit (DAM-1) more risky than and not comparable to both Piedmont and the Moody Companies?

A. Dr. Murry's companies start off as incomparable, and he never makes adjustments to cause them to approximate reasonably the conditions and environment affecting Piedmont. None of those 14 companies are in the natural gas distribution business. They are engaged in such activities as the provision of building maintenance and janitorial services, worldwide petroleum exploration and production, the manufacture of airplane and aerospace parts, the recycling of steel and metal products, the making of paper and special paper products, maintaining railways, commercial food preparation and food distribution, selling pharmaceutical drugs, making and selling power tools, and making electronic equipment. Rebuttal Exhibit CA-SNB, Schedule 1 is a listing of those businesses and their activities.

Q. **What is the source of the information in Schedule 1?**

A. The information was obtained from those companies' recent annual reports and *Value Line*.

Q. **If the companies are not in the natural gas distribution business and no rational, verifiable adjustments are made to make the companies comparable, then is it reasonable to conclude that the companies are not financially comparable?**

A. Yes. My conclusion of no comparability is especially valid because there are substantial and material dissimilarities, which are depicted in Rebuttal Exhibit CA-SNB, Rebuttal Charts 1 through Rebuttal Chart 8.

Q. **What is each chart composed of?**

A. The left side of each chart shows data for 12 of Dr. Murry's companies, as well as an average for those 12 companies. The data is arranged in ascending order from left to right. The right side of each chart shows data for the 8 Moody Companies, as well as an average for those 8 companies. The data is arranged in ascending order from left to right. The far right side of each chart shows data for Piedmont. The individual company names appear at the bottom of each chart.

Q. Why are you using only 12 of Dr. Murry's companies instead of all 14?

A. I took into account the change in Dr. Murry's explanation of how he selected the 14 companies. In his direct testimony he said he eliminated European companies from consideration, but in response to a discovery request he said he eliminated companies that were primarily foreign.

For example, in his direct testimony, page 18 line 2, Dr. Murry explains how he picked the 14 companies: "I selected companies *Value Line* identified a group of companies as 'conservative stocks,' based on a set of criteria of timeliness, beta and the price earnings ratio. Subsequently, I removed from that list regulated companies, companies with only financial assets, and European companies."

In Consumer Advocate discovery request 86, I asked Dr. Murry to provide the criteria he used to make the determination that a company was European. Dr. Murry answered: "After eliminating all other companies based on the previous criteria identified in Direct Testimony, page 18, Dr. Murry applied the primarily-foreign criterion which removed only

Cadbury Schweppes, a European company." A copy of the request and Dr. Murry's response is attached as Schedule 2 to my rebuttal testimony.

Two of the 14 companies, the Oshawa Group and George Weston, are Canadian-owned, operate mostly in Canada, and are traded on the Toronto stock exchange instead of any stock exchange in the United States. Therefore, these 2 companies are primarily foreign, so I eliminated those 2 companies from the list.

Q. What does Rebuttal Chart 1 show?

A. Rebuttal Chart 1 shows a comparison of equity ratios among the various companies. Even a quick look at the chart shows a huge difference in the capital structure of the groups. Dr. Murry's companies have very high equity ratios. The group average is over 75%, with lowest being 50% and the highest being 100%. The gas companies have an average ratio of about 53%, with lowest being 46% and the highest being about 61%. The substantial and material difference in equity ratios is clear evidence that Dr. Murry's non-regulated companies are not comparable to Piedmont or the Moody Companies.

Q. What does the difference in equity ratios mean?

A. In comparison to Piedmont and the Moody companies, Dr. Murry's companies have significantly higher portions of equity and lower proportions of debt. Since the cost of debt is much cheaper than the cost of equity, Dr. Murry's companies have to achieve a higher overall rate of return to attract capital than do the Moody Companies and Piedmont. Since a higher return is always more difficult to achieve than a lower return, the differing capital structures necessarily make Dr. Murry's companies more risky investments than the Moody Companies and Piedmont.

Q. What other evidence do you have to support your assertion that Dr. Murry's companies are substantially and materially more risky investments than the Moody Companies and Piedmont?

A. Rebuttal Exhibit CA-SNB, Rebuttal Charts 2 though 4 prove that investors perceive greater risk in Dr. Murry's companies.

Rebuttal Chart 2 shows the average number of years a stockholder holds each company's stock. The period of time a stockholder keeps a stock indicates the holder's assessment of risk. The shorter the hold time, the greater the risk. For example, on average Dr. Murry's companies are held 2.5 years, the Moody Companies are held 3.5 years and Piedmont' stock is held over 4 years. In comparison to Piedmont and the Moody Companies, Dr. Murry's companies are speculative investments, where an investor buys stock in the hope of a quick profit through a capital gain rather than settling in for a longer holding period where income is derived through dividends.

Rebuttal Charts 3 and 4 confirm that the investors in Dr. Murry's companies look to capital gains rather than dividends as the source of income. Rebuttal Chart 3 shows that in 1995 the average dividend yield was 3% for Dr. Murry's companies, 5.5% for the Moody Companies and about 4.9% for Piedmont. The Moody Companies' and Piedmont's dividend yields are nearly twice the size of Dr. Murry's companies. A dividend yield is the company's annual dividend divided by the company's stock price. The lower the yield, the more likely it is that the investors look to capital gains rather than dividends as the source of income.

Rebuttal Chart 4 shows the 1995 payout ratios for the groups. A payout ratio indicates what proportion of a company's profits is passed on to stockholders. Once again there is a stark contrast between the groups. Dr. Murry's companies pass on less then 40% of the profits. The Moody Companies pass on more than 80% of the profits and Piedmont passes on more than 70%. This is conclusive proof that investors in Piedmont and the Moody Companies rely on dividends for their income while investors in Dr. Murry's companies rely primarily on capital gains for their income.

The substantial and material differences shown in Rebuttal Charts 2 though 4 are further clear evidence that Dr. Murry's non-regulated companies are not comparable to Piedmont or the Moody Companies.

Q. What other evidence shows that Dr. Murry's companies are more likely to provide income from capital gains?

A. Rebuttal Exhibit CA-SNB, Rebuttal Charts 5 though 7 prove, with regard to capital gains and losses, that investors in Dr. Murry's companies are playing for much higher stakes than the investors in the Moody Companies. The stakes are higher for Dr. Murry's companies' because they are held by relatively few people in comparison to the Moody Companies and Piedmont.

Rebuttal Chart 5 shows the number of shareholders for each company. All but one of Dr. Murry' companies have less than 10,000 shareholders. The minimum is about 1000 and the maximum is about 9,800, with the exception of Atlantic Richfield Oil Company (ARCO) which has about 100,000 shareholders. ARCO makes the average number of stockholders swell to about 13,000, which is not representative of the group. The Moody Companies and Piedmont are more widely held. All the companies have more than 10,000 shareholders. The maximum is about 34,000, the minimum is about 11,000 and the average is about 18,000, which is reasonably representative of the group.

Rebuttal Chart 6 show the shares per

stockholder for each company. There is a huge difference between Dr. Murry's companies and the Moody Companies and Piedmont. On average an investor in Dr. Murry's companies owns about 4,200 shares while an investor in the Moody Companies owns about 1,800 shares.

Rebuttal Chart 7 shows the value of holdings per shareholder for Dr. Murry's companies and the Moody Companies and Piedmont. Once again there is a huge difference between Dr. Murry's companies and the others. The average value of holdings for Dr. Murry's companies is about $175,000 while the averages for the Moody Companies and Piedmont are about $50,000. The chart makes it abundantly clear that the investors in Dr. Murry's companies stand to make or lose huge amounts of capital depending on the price of the stock. Rebuttal Chart 7 reinforces the notion that Dr. Murry's companies are indeed far more risky investments than natural gas distribution companies.

Q. Is there any measure by which the Dr. Murry's non-regulated companies are comparable to Piedmont and the Moody companies?

A. Yes. As shown in Rebuttal Chart 8, eleven of the nonregulated companies had a market value exceeding $171, the threshold that distinguishes between large and small companies, which I referred to in my direct testimony, pages 31 and 32.

Q. What is significant about Dr. Murry' use of

large companies in this instance?

A. It demonstrates the inconsistency and unreasonableness of his development of the risk premium rate of return. In my direct testimony, pages 41 and 42, I explained my disagreement with his risk premium analysis by pointing out that he mixes Murry's mixes large and small companies to develop his return. However, when Dr. Murry seeks to compare Piedmont and the Moody Companies with unregulated companies, he switches back to the large companies as the basis of his comparison.

Q. Why do you disagree with Dr. Murry's development of his risk premium rate?

A. In my direct testimony I explain that mixing small and large companies, is unreasonable because the comparable companies are large not small. In my direct testimony, at page 42 lines 13-16 I stated: "To be consistent with the comparable companies, Dr. Murry should have used 12.5% instead of 15.1% to estimate the risk premium."

Q. Do you disagree with any other aspect of Dr. Murry's risk premium analysis?

A. Yes. Even if Dr. Murry had used 12.5%, I would still disagree with his use of Ibbotson Associate's so-called "arithmetic mean" in the his risk premium model. Schedule 8 of my direct testimony and Schedule 3 of rebuttal testimony are both copies of copy of Table 6-7 of

Ibbotson's 1996 yearbook. Most people do not use the term "arithmetic mean". Instead, people use the term "average," but statisticians use the term "arithmetic mean" to distinguish it from the so-called "geometric mean", which is a term describing the midpoint of a group.

Q. Why do you disagree with Dr. Murry's use of the arithmetic mean?

A. The arithmetic mean of 12.5% is an unreasonable basis for a risk premium analysis because the arithmetic mean overestimates the normal returns to equity and does not reflect the full impact of the losses which occur in the market. In the real world people and companies occasionally lose money. The loss makes financial risk real, palpable and tangible. Without the occasional loss, there would be no true risk. The loss also lowers the return to equity for investors. Their return is not as high as it would be if there were no losses. However, the arithmetic mean embodies the arbitrary and unrealistic notion that when gains and losses are weighed against each other, the net result is always a gain. This hides the effect of losses and misleads the investor into thinking that the return on an investment is higher than it truly is.

Q. Do you have an example from financial literature showing how the arithmetic mean of equity returns can mislead an investor and those people making rate of return decisions?

A. Yes. In the July-August 1979 issue of *Financial Analysts Journal* Roger Ibbotson, the principal of Ibbotson Associates, provided a revealing example of the arithmetic mean:

> "Suppose that $1.00 were invested in a common stock portfolio that experienced 100 percent price appreciation in the first year and 50 percent depreciation in the succeeding year. At the end of the first year the portfolio would be worth $2.00; at the end of the second year the portfolio would be $1.00. The annual arithmetic mean return on the portfolio would be 25 percent..."

Since the portfolio's value is again $1.00, the real return is obviously zero, not 25%. It just so happens that the geometric mean is zero, as well. Thus, the arithmetic mean clearly misleads investors and overestimates the market's return to equity, but the geometric mean does not.

Q. How does the arithmetic mean mislead investors about the market's return to equity?

A. As my example just showed, the arithmetic mean is calculated by adding the positive return, in terms of percent, to the negative return, in terms of percent, and getting a net amount, also in terms of percent. Since the value of the investment can never get below zero dollars, the loss in percentage terms can never be more than 100%. On the other hand, since the value of the investment has no upper limit, the percent gain has no limit either, it could be 1000% or more, for example. Therefore, the calculation of an arithmetic mean <u>for a rate of return always leads to an overestimate of the market's return to equity.</u> With regard to a rate of return, the arithmetic mean is not representative of the market's return to equity.

Q. Why do you object to the use of the arithmetic mean in determining the rate of return?

A. Due to its mathematical nature the arithmetic mean does not render a just, reasonable and fair return. The notion of just, reasonable and fair suggests that the middle position is the most reasonable one to take. With regard to market returns, the middle position has the highest probability of occurring. In the example I just gave, the true middle is zero not 25%. In risk premium analysis, the arithmetic mean is not the true middle of the returns experienced by the market. The true middle divides the group so that the odds of achieving a return below the midpoint equals the odds of achieving a return above the midpoint. The true midpoint is the geometric mean.

The arithmetic mean by its logical nature is not the midpoint of the returns experienced by the market. Therefore, the arithmetic mean inaccurately represents the source-group whether the group is based on rates of returns to large companies, peoples' ages or the number of shareholders in a company. Allowing the rates of return to be influenced in any manner by the arithmetic mean is unjust and unreasonable.

Q. Do you have an example of how an arithmetic mean inaccurately represents its source?

A. Yes. Dr. Murry's sample of 12 nonregulated companies provides an excellent example. The left side of Rebuttal Chart 5 shows the data for the number of shareholders in each of the nonregulated companies. For example, at the bottom left corner of the chart, Lawson Products has approximately 1,000 shareholders. The next company, Commercial Metals, has about 1300 shareholders. Moving to the right, each nonregulated company has more shareholders. The very last nonregulated company, Atlantic Richfield, has 100,000 shareholders. The average number of shareholders per nonregulated company is about 13,000 because Atlantic Richfield has skewed the average.

The midpoint of the group is about 4,900 shareholders per company. One half of the companies have more than 4,900 shareholders and one half of them have less than 4,900. If you think of this in terms of statistical probability, there is a 50% chance that one of Dr. Murry's companies has more than 4,900 shareholders and a 50% chance that the company has less than 4,900 shareholders. However, it would be very inaccurate to say that there is a 50% chance that one of Dr. Murry's companies has more than the average number of shareholders, which is 13,000. In fact, the odds are only 1 in 12, about 8%.

Q. What do you conclude from your example?

A. In cases where the arithmetic mean poorly represents a group, the arithmetic mean is an unreasonable basis for making decisions. This is especially accurate when the group is composed of the historical returns to common equity and the arithmetic mean does not reasonably represent the group of companies.

Q. Is a fair representation of large companies' rates of return the mid-point of the returns?

A. Yes. There is no good reason for moving away from the midpoint, otherwise the risk premium is biased one way or the other.

Q. Is Ibbotson's arithmetic mean of 12.5% the mid point of the returns experienced by the large companies?

A. No, the mid point is 10.5%, the so-called geometric mean. I have drawn a large arrow at this amount in Rebuttal Schedule 3. With regard to Ibbotson's data, the odds of achieving a return below 10.5% equal the odds of achieving a return above 10.5%.

Q. Does the arithmetic mean of 12.5% represent a balance between the high and low returns to large companies?

A. No. It would be very inaccurate to say that Ibbotson's arithmetic mean represents such a balance because less than 20% of the market returns are above the arithmetic mean and more than 80% are below. Ibbotson's arithmetic mean is a poor representation of the returns to large companies. This situation is very similar to my earlier observation about the average number of stockholders for Dr. Murry's noncomparable companies, which I refer to in Rebuttal Chart 5.

Q. What does Ibbotson say about the arithmetic and geometric means?

A. Over the years Ibbotson has said several things. Early in his career he correctly suggested that the use of arithmetic mean was misleading. I have already discussed the example he provides in the July-August 1979 issue of *Financial Analysts Journal*.

Q. What does Ibbotson say today about the arithmetic mean?

A. He advocates the use of the arithmetic mean to determine the cost of capital. In his 1996 yearbook at page 155 he makes contradictory statements regarding the geometric and arithmetic means. He says, "...the median (middle outcome) and mode (most common outcome) are given by the geometric mean...the arithmetic return is correct because an investment with uncertain returns will have a higher expected ending value than an investment that earns with certainty its compound or geometric rate of return...in the investment markets, where returns are described by a probability distribution, the arithmetic mean is the measure that accounts for uncertainty, the arithmetic mean is the appropriate one for estimating...the cost of capital"

Q. Why do you believe Ibbotson's statement is contradictory?

A. Ibbotson describes the geometric mean as the middle outcome and as the most common outcome for equity return, but then he suggests that a geometric rate of return is the return that is "certain" while the arithmetic return is the return that is "uncertain."

Q. Is the basis for Ibbotson's explanation reasonable?

A. No. It as if he left a step out of his reasoning process. For example, Ibbotson agrees the geometric return is precisely in the middle of all the market returns. But that does not mean that the geometric return is a "certain" return. In my direct testimony, page 22 lines 1-3, I point out that returns to equity are not guaranteed. <u>The only return that I know of which is certain is the return to debt</u>. I have already pointed out in my direct testimony that it is the potential loss of principal that justifies a higher return to equity capital than to debt capital. But all returns to equity are not identical to each other, and the issue here is the return to equity, not the return to debt. In fact, there is a substantial chance that a large company will not achieve the market's geometric return.

With regard to the market's arithmetic mean return, it is higher than the geometric return, Clearly, a company is more likely to achieve the geometric mean return rather than arithmetic mean return. However, this does not mean that the geometric return is a "certain" return and that the arithmetic mean is the "uncertain" return.

Also, Ibbotson's statement, "in the investment markets, where returns are described by a probability distribution, the arithmetic mean is the measure that accounts for uncertainty" is completely misleading. Someone not familiar with these ideas may mistakenly think: "1. the geometric mean is certain; 2. the arithmetic mean is uncertain; 3. the returns in the investment market are described by probability; 4. since probability is another way of saying uncertainty, the arithmetic mean must be the right measure to use and the geometric mean must be the wrong one." This reasoning would be quite wrong and a misunderstanding of probability.

Q. Why would that reasoning be wrong?

A. That reasoning is wrong because every group, whether it is stock market returns, peoples' ages or the number of stockholders in a company, has an arithmetic mean and a geometric mean. Once you know these values for a group, the group's probability distribution can be always be found. This provides the exact odds of achieving the geometric and arithmetic means.

With regard to the market's rate of returns for large companies, I have already pointed out that the geometric mean is not a return that is guaranteed or "certain." It is the midpoint of the probability distribution of returns, i.e., the odds of achieving a return below the midpoint equals the odds of achieving a return above the midpoint. The arithmetic mean is always greater than the geometric mean. In the case of Ibbotson's data, the odds are more than 80% that a large company will not achieve the arithmetic mean return and less than 20% that the company will achieve the arithmetic mean.

Q. How do you know that the odds of a large company achieving the arithmetic mean are only 20%?

A. Schedules 4 and 5 of my rebuttal testimony show where I got those figures. Schedule 4 is a copy of Ibbotson's 1996 yearbook, page 50. The top portion shows a graph depicting the growth of a $1 investment in a large company from 1925 to 1995. The graph indicates that a $1 investment in a large company in 1925 is now worth

$1113.92 in 1995. The annual return to equity for the 70 year period is 10.54%, which is also the geometric mean that I have already shown in Schedule 3.

Schedule 5 of my rebuttal testimony shows the probability distribution of Ibbotson's data on returns to large companies. I was able to construct this distribution because Ibbotson has provided the geometric and arithmetic means for his data.

Q. Why did you construct the distribution?

A. I pointed out earlier that Ibbotson's justifies his preference for the arithmetic mean by saying, "in the investment markets... returns are described by a probability distribution." This begs the question: "What distribution?" I wanted to see what Ibbotson was referring to, so I derived the distribution from the values he provides for the geometric and arithmetic means for his data.

Q. What does Schedule 5 show?

A. The schedule shows how I arrive at my conclusion that a large company has only a 20% chance of achieving the arithmetic mean return of 12.5%. Column (2) shows all the possible outcomes in 1995 from a $1 investment in 1925. The outcomes range from $0 to $618.8 million. Each of these has a corresponding annual market return, shown in column (3). The returns range from -8.5% to 33.53%. Columns (4) through (6) respectively show the odds of exactly achieving the return in column (3), the odds of achieving a return less than the return in column (3), and the odds of achieving a return more than the return in column (3). The data in columns (3) and (4) are depicted in Rebuttal Chart 9, which shows the return at the bottom of the chart. The data in columns (3) and (6) are depicted in Rebuttal Chart 10.

Q. Does the probability distribution confirm Ibbotson's statement that "...the median (middle outcome) and mode (most common outcome) are given by the geometric mean?"

A. Yes, the distribution's true middle return is 10.54%, which is the geometric mean of column (3). Column (4) shows that of all possible outcomes, the geometric mean has the highest odds, which are 9.5%. Columns (5) and (6) also show that the odds of achieving a return below 10.54% are 45%, which equals the odds of achieving a return above 10.54%. In sum, Ibbotson's statement is absolutely correct. However, it is also clear that the geometric mean is not a "certain return." There is only one thing that is certain in Schedule 5: Since 1925 the odds are 100% that a large company has earned somewhere between -8.5% and 33.53% annually.

Q. What is your opinion about Ibbotson's recommendation that the arithmetic mean be used in risk premium analyses?

A. I disagree because it is not representative of normal returns to large companies. Schedule 5 shows that the arithmetic mean has less than a 20% chance of being achieved. Therefore, a risk premium analysis that uses the arithmetic mean, such as Dr. Murry's, is not based on a reasonable standard. Moreover, it suggests that Dr. Murry is seeking unjust preferential treatment for Piedmont because the arithmetic mean represents a large company's superior performance in the market rather than a large company's normal and common performance.

Q. What do think is a reasonable standard for a risk premium analysis?

A. I believe the reasonable standard is the geometric mean because it is precisely in the middle of the probability distribution of market returns. There is no good reason to depart from it. Moving from the midpoint of 10.54%, which has a 50-50 chance of being achieved, to the arithmetic mean of 12.5%, which has less than a 20% chance of being achieved is no more justified than moving down to 8.18%, which has an 80% chance of being achieved.

Q. Are there people who do not agree with Ibbotson's preference for the arithmetic mean?

A. Yes. There is substantial criticism of it, and Ibbotson's preference is contrary to all the recommendations of scholars in statistics and finance that I know of. For example, in 1967

Irving Fisher, considered to be one of the world's greatest statisticians, wrote a book called _The Making of Index Numbers._ Fisher says, "*The simple arithmetic average produces one of the very worst index numbers. And if this book has no other effect than to lead to the total abandonment of the simple arithmetic type of index number, it will have served a useful purpose.*" In 1981 Richard Stevenson and Edward Jennings published, _Fundamentals of Investment_. They say, "*Why not simply average the rates of return? Indeed, in certain instances, such a procedure would be satisfactory. However, such an average would generally be meaningless.*" In 1990, Thomas Copeland, et. al. published _Valuation: Measuring and Managing the Value of Companies_. "*Our opinion is that the best forecast of the risk premium is its long run geometric average.*"

Ibbotson's recommendation also runs counter to the general practice of investment firms. On March 13, 1990 at page C1 the Wall Street Journal ran the following story, "When Figuring the Rate of Return Don't Be Confused By The Sales Hype." The story compares the simple average with the so-called compound return, another common name for the geometric return. The WSJ story says the compound return is "more widely used by investment firms."

Q. Why do investment firms prefer the geometric mean to the arithmetic mean?

A. The firms recognize the fundamental weakness of the arithmetic mean as a guide to assessing investments.

Q. What is the fundamental weakness of the arithmetic mean as a tool to assess investments?

A. It fails to alert investors to precarious investments. It blinds investors to their own economic vulnerability and lures them into making investments that are likely to be destroyed.

Q. How does the arithmetic mean fail to alert investors to a precarious investment?

A. It fails to alert the investor because two different investments can have the same arithmetic mean even though the investments have much different odds of being successful. Therefore, a rational investor would not rely on the arithmetic mean as a tool to guide decisions about investments. As an investment gets more risky, the investor should reassess the situation, but reassessment is not possible with the arithmetic mean. In contrast, the geometric mean alerts the investor to increased risk and allows reassessment of a changing situation. This is why investment firms use the geometric mean instead the arithmetic mean.

To prove this point I'll begin with Ibbotson's example that appears on pages 154-155 of his 1996 yearbook. Those pages are attached as

Schedule 6 of my rebuttal testimony. Schedules 7 through 9 of my rebuttal testimony provide the details of my proof. Whereas he use $1 to illustrate the situation I use $1000.

For example, a stockbroker who follows Ibbotson's methods advises you to invest in a stock because every year it has a 50% chance of rising by 30% and a 50% chance of falling by 10%. You say to the stockbroker:

> "I want to build a small trust fund for my granddaughter. After 30 years how much money will the stock be worth if I buy $1000 worth of shares today?"

The stockbroker who follows Ibbotson's methods says:

> "If everything goes perfectly, your stock will be worth $2.6 million. If everything goes wrong, your stock will be worth $42. That's a broad range, but the most likely value is $17449."

You ask:

> "How did you get that number?"

The stockbroker says:

> "Since the odds of a loss are the same as the odds of a gain, your stock will grow by 10% a year. It grows by 10% because when you take a positive 30%

and a negative 10%, they net to 20% but divide that by 2 because there are two possibilities, a loss or a gain, therefore, the arithmetic average is 10%. Then multiply \$1000 by 1.1 for 30 years, the formula is easy: \$1000 X $(1.1)^{30}$ = \$17449."

You think about buying the stock, but first you check with a rational stockbroker who is skeptical of Ibbotson's methods. You get a different answer:

"You have a 50% chance of getting \$10,539, that is the most likely value after 30 years. Your odds of getting \$17,449 are less than 30%.

You ask:

"How did you get that number? I am supposed to make an average of 10% each year."

The rational stockbroker says:

"Your investment is not going to grow by 10% each year. The chances are that 15 years your stock is going to lose 10% of its value and in the other 15 years it will gain 30%. When you combine those ups and downs you are going to make some money but not at the rate of 10% a year. The formula is easy: \$1000 X $(1.3)^{15}$ X $(.9)^{15}$ =

> $10,539, which is the midpoint of the distribution. You have about a 50% chance of getting $10,539, but you have less than a 30% chance of getting $17,449."

Clearly, the arithmetic mean overestimates how quickly wealth is accumulated in comparison to the geometric mean. The arithmetic mean also fails to alert investors to a dangerous situation.

Continuing with the example, the Ibbotson follower comes back to you and says:

> "I did not hear from you about the first stock, but now I have a different stock for you. It has a 50% chance of rising by 60% each year and a 50% chance of falling by 40% each year."

You say:

> "What is in it for my granddaughter's trust fund? After 30 years how much money will the stock be worth if I buy $1000 worth of shares today?"

The stockbroker who follows Ibbotson answers:

> "There is plenty in this for the trust fund. If everything goes perfectly, your stock will be worth $1.3 billion. If everything goes wrong, your stock

will be worthless. But compare that to the first stock, its high is only \$2.6 million and its low is \$42, which is practically worthless. So in either case, the lows are about the same but the highs are very different. Besides, the most likely value is \$17,449. This investment is just as good as the first one, if not better. You can't lose."

You ask:

"How did you get that number?"

The stockbroker, always careful to follow Ibbotson's method, says:

"I did it just the same way as I did last time. Since the odds of a loss the odds of a gain are equal to each other, your stock will grow by 10% a year. It grows by 10% because when you take a positive 60% and a negative 40%, they net to 20% but divide that by 2 because there are two possibilities, a loss or a gain, therefore, the arithmetic mean is 10%. Then multiply \$1000 by 1.1 for 30 years, the formula is easy: \$1000 X $(1.1)^{30}$ = \$17449."

You ask:

"Since both stocks have an arithmetic

mean of $17449, which one should I buy"?

The Ibbotson follower says:

"Buy the second one. You can't lose."

You think about buying the second stock, but something does not seem right to you. Just to be safe you go back to the rational stockbroker, who says:

"The second stock is not as good as the first one. The midpoint of this distribution is much less than $10,539. The new midpoint is $542. The trust fund will probably be worth only $542 after 30 years. In addition, your odds of getting $17,449 have dropped from less than 30% to less than 10%."

You ask:

"How did you get that number? I am supposed to make an average of 10% each year."

The rational stockbroker says:

"Your investment is not going to grow by 10% each year. If things go as expected, in 15 years your stock is going to lose 40% of its value and in the other 15 it will gain 60%, but a

> 60% gain does not make up for 40% loss. When you combine those ups and downs you are going to lose a lot of money. The formula is easy: \$1000 X $(1.6)^{15}$ X $(.6)^{15}$ = \$542. You have about a 50% chance of getting \$542, but you have less than a 10% chance of getting \$17,449."

The example makes it crystal clear that the arithmetic mean misleads investors and harms them as well. Schedules 7 through 9 of my rebuttal testimony lay out the steps in this example. The first stock I mentioned is represented in Schedule 7 by columns (b), (c) and (d) and (e). Taken as a group these columns represent Ibbotson's method. The second stock I mentioned is represented by columns (f), (g) and (h). Column (e) is the arithmetic mean for both stocks. Schedules 8 and 9 provide the probability distributions for each stock.

Q. What does your example prove?

A. It proves several things: The arithmetic mean return sheds no light whatsoever on an investment's riskiness; a rational investor would never rely on the arithmetic mean return as a guide to select investments; investors who rely on the arithmetic mean will be lead into risky investments and end up the poorer for it; the arithmetic mean return is not the most likely return; the arithmetic return embodies the arbitrary and unrealistic notion that when gains and losses are weighed against each other, the net result is always a gain -- an assertion I make in this rebuttal testimony at page 11 lines 23-26.

Q. Is your risk premium analysis based on the geometric mean?

A. Yes. My risk premium analysis is based on the geometric return. The test of the reasonableness of my method is available in Chart 1 of my direct testimony. My risk premium yields a 10.64% return, an amount that fits in with all the other data appearing in that chart.

Q. What do you recommend to the TRA regarding the arithmetic mean?

A. I recommend that the TRA disregard the arithmetic mean as a reasonable basis of a risk premium because the arithmetic mean is an arbitrary, unreasonable and excessive estimate of the markets' return to equity. I also recommend that the TRA disregard Dr. Murry's risk premium analysis because it is arbitrarily and unreasonably based on the arithmetic mean return, a return that represents superior market-performance, a return achieved by less than 1 in 5 companies, a return that constitutes unjust preferential treatment for Piedmont.

Q. What do you recommend to the TRA regarding the geometric mean?

A. I recommend the TRA use the geometric mean as the basis for risk premium analyses because it is the midpoint of the returns to equity actually experienced by the market, and the midpoint is the best representation of a just, reasonable and fair return for use in risk premium analyses.

Q. Does that conclude your rebuttal testimony?

A. Yes.

COMPANY	BUSINESS TYPE	RECENT ACQUISITIONS/PLANNED ACQUISITIONS
ABM Industries[1]	Janitorial services and janitorial supplies in US and Canada. Technical div includes elevator maintenance, engineering services, HVA, comm'l lighting maintenance and outdoor signage installation. Public Service div inc security services and parking.	
ARCO Chemical	Global corp. operating in all aspects of the energy business, exploration, production and marketing of crude oil, natural gas and natural gas liquids, and the refining, marketing and transportation of petroleum products. ARCO has interests in two petrochemical companies, mines and markets coal, and has created a variety of businesses ancillary to its operations, including retail convenience stores, cogeneration of steam and electricity, and electronic payment systems.	Jan 1996 first natural gas sales to Hong Kong from ARCO field in South China Sea - this was discovered 1983 and is the first and largest offshore natural gas field for China. Feb. 1996 signed production-sharing agreement with Algeria's national oil company - expect yield of > 500 M incremental barrels of crude oil over 25 yr life. Has begun engineering for production of propylene oxide in US by 1998.
Barnes Group	In 3 businesses: Bowman Dist. - a dist of consumable repair and replacement products for the industrial, heavy equipment, and transportation maintenance mkts.; Associated Spring - mfg and dist of custom springs and other close-tolerance engineered metal components; and Barnes Aerospace - a mfg of precision machined and fabricated assemblies for aircraft and aerospace industry and refurbisher of jet engine components	
Commercial Metal	Manufacturers, recycles and markets steel and metal products and related materials through a network of over 90 locations	Acquisition of Owen Steel Company in SC which increased the production and fabrication capacity of the CMC Steel Group and providing the Company with a solid and strategic position in the SC and mid-Atlantic states

[1] Formerly American Building Maintenance Industries, Inc.

COMPANY	BUSINESS TYPE	RECENT ACQUISITIONS/PLANNED ACQUISITIONS
Consolodated Papers, Inc.	N. Am. Largest manufacturer of coated printing papers and a leading producer of supercalendered papers. The company is also the nations largest maker of light-weight coated specialty papers. Other products manufactured by Consolidated include paperboard and paper board products, corrugated displays and containers, kraft pulp from virgin wood fiber, and recycled pulp from post-consumer office wastepaper. Sales up 54% in 1995 compared to 1994. Earnings per share increased by 162% in 1995, rising to a record $5.16 per share, compared with $1.97 per share in 1994.	Purchased Niagara of Wisconsin Paper corporation, Lake Superior Paper Industries and Superior Recycled Fiber Industries in 1995.
Harsco Corp.	Diversified industrial services and manufacturing company: industrial mill services that are provided to steel producers by 28 companies; scaffolding services to the construction and industrial maintenance markets primarily in N.A.; railway maintenance equipment and services that are provided to US RR and other intl. customers; gas control and containment products for customers world wide, and several other lines of business including grating, pipe fittings, process equipment and roofing gananles. Has over 175 major facilities in 29 countries, including US. Owns 40% of United Defense, L.P. which manufactures ground combat vehicles for the US and intl. gov'ts.	Ceased all school bus operations in June 1995. Truck operations were ended in 1994.
Lawson Prod.	Distributor of approx. 33,000 expandable maintenance, repair and replacement products, chemical specialities, welding rods and supplies. Products are used for repair maintenance of capital equipment of all types in the industrial, heavy-duty equipment, in -plant, buildings and grounds maintenance and transportation fields.	
Luby's Cafeterias	Operates 190 cafeterias under the name "Luby's" in suburban shopping areas in AZ, AR, FL, KS, LA, MS, MI, NM, OK, TN and TX. Caters to shoppers and office or store personnel for lunch and families for dinner.	During fiscal year ended 8/95, relocated one cafeteria and opened 11 new ones. Eight are under construction. During fiscal 1996, expects to open 16-18 new cafeterias.

COMPANY	BUSINESS TYPE	RECENT ACQUISITIONS/PLANNED ACQUISITIONS
Oshawa Group	Canadian company engaged in the marketing of food and pharmaceuticals through a network of distribution centers and retail stores throughout Canada.	
Snap-On, Inc.	Single line of business as leading manufacturer and distributor of high-quality hand tools, power tools, tool storage products, diagnostic equipment, shop equipment, and diagnostic software and other services primarily for use by professional technicians in automotive service and other industries.	Acquisitions contributed more than one-third of 1995 sales gains. Increased stake in Edge Diagnostics (developer of software-based diagnostic systems); acquired Herramientas Eurotools, S.A. of Spain late in year; acquired Consolidated Devices; and earlier in 1996 signed preliminary agreement to purchase Automotive service quipment division of FMC Corp which would bring Snap-On another step toward building a complete under-car service capability.
Tennant Co.	Industrial floor maintenance equipment - 73% revenue Commercial floor maintenance equipment 20% revenue Floor coatings 7%	
Thomas & Betts	Thomas & Betts and subsidiaries design, manufacture and market on a global basis electrical and electronic connectors and components as well as other related products and accessories, with manufacturing facilities and the marketing activities in North America, Europe and the Far East. Products are sold worldwide through electrical electronic and HVAC distributors, mass merchandisers, catalogs and home centers, and directly to original equipment manufacturer markets.	Late 1995 acquired 2 regional operations - makers of cable ties and wire connectors and certain assets of Bowers Mfg, CA source of outlet boxes, in early 1996. Acquisition of Amerace Corp in Jan 1996 brings 3 well known brands of industrial electronic connectors with combined annual sales of more than $60 M.
Universal Foods Corp.	Prinicpal products of Company include food, beverage and dairy flavors; certified and natural colors for foods, cosmetics and pharmaceuticals; dehydrated vegetable products, a diverse line of yeast products; and flavor enhancers, secondary flavorings and othe bioproducts.	Exited the frozen potato business during Fiscal 1994.

COMPANY	BUSINESS TYPE	RECENT ACQUISITIONS/PLANNED ACQUISITIONS
George Weston[2]	Broadly based Canadian company founded in 1882, which conducts food processing, food distribuiton and resource operations in North America. Operates through:n Weaton Foods, a fresh and frozen baker, a dairy processor and biscuit manufacturere; Loblow companiesk the largest food distributor in Canada; and Weston Resources, avalue added forest products and fish processor.	

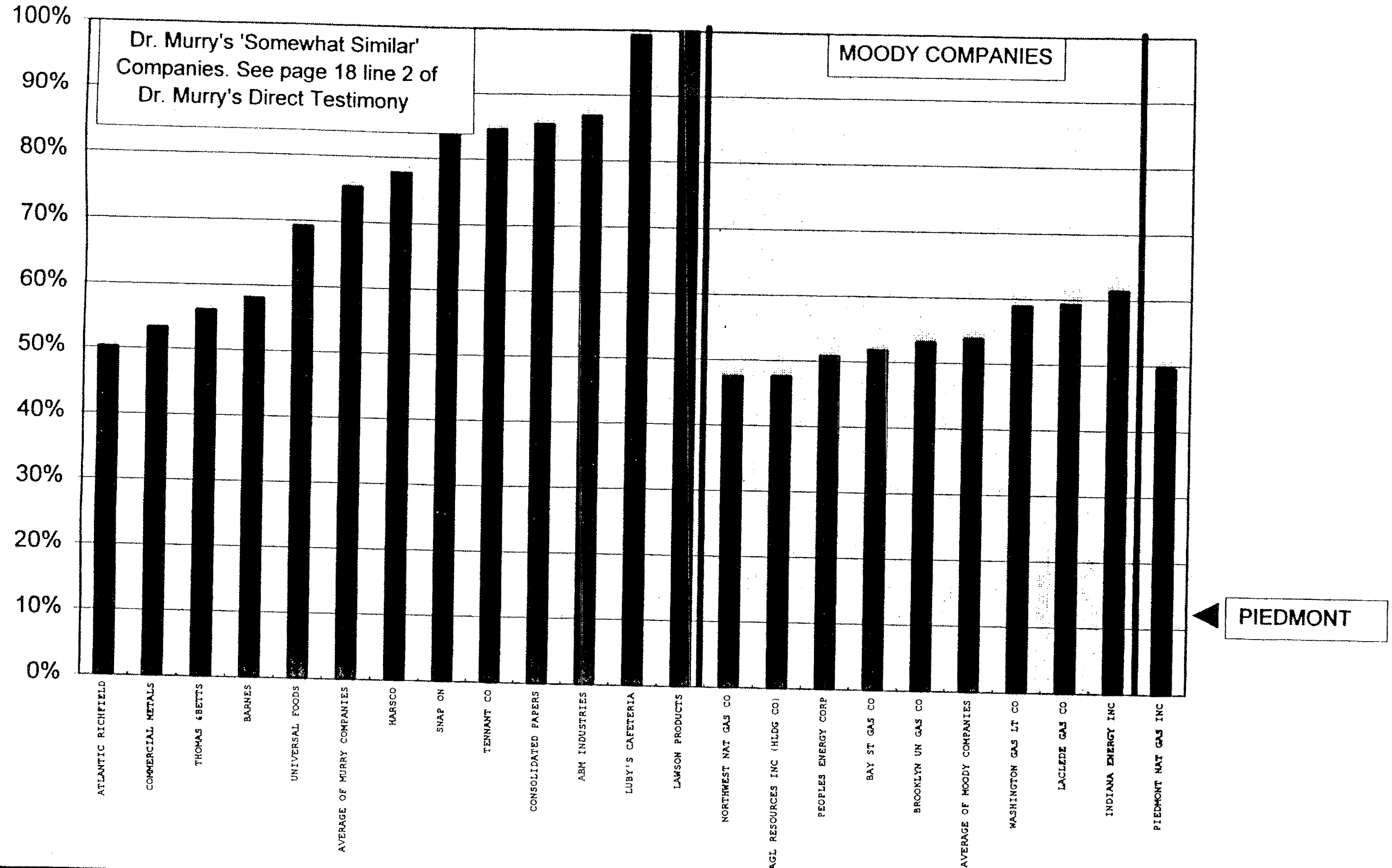
2 Owns directly or through subsidiaries 100% of voting shares of Loblaws Companies Ltd.

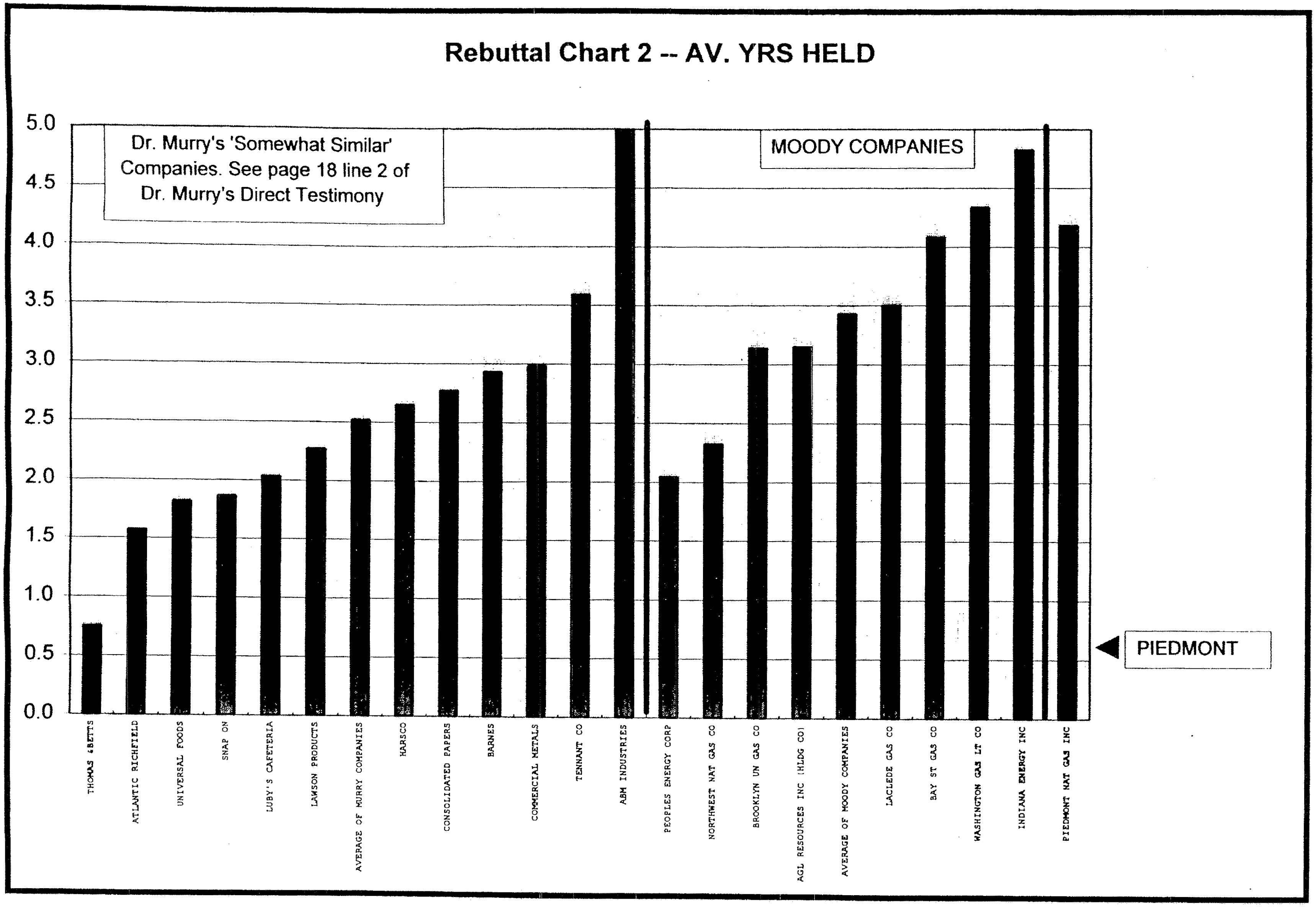
Question 86: With regard to Dr. Murr(a)y's[sic] direct testimony page 18, lines 2-9, which refer to conservative stocks, and with regard to the list of Value Line's conservative stocks used by Dr. Murry, identify which companies on that list are regulated utilities, identify which companies are the ones with only financial assets, identify which companies are European companies, indicate what criteria Dr. Murry uses to identify a "European company." For each company identified as a regulated utility, or as one with only financial assets or as one that is European, provide Value Line's ratings for timeliness, the beta and the price earnings ratio. If this data is in an electronic format, then provide the data on disk in a format readable by Excel 5.0, along with a record layout of the data.

Response After eliminating all other companies based on the previous criteria identified in Direct Testimony, page 18 Dr. Murry applied the primarily-foreign criterion which removed only Cadbury Schweppes, a European company. Please see the Response to Question 85.

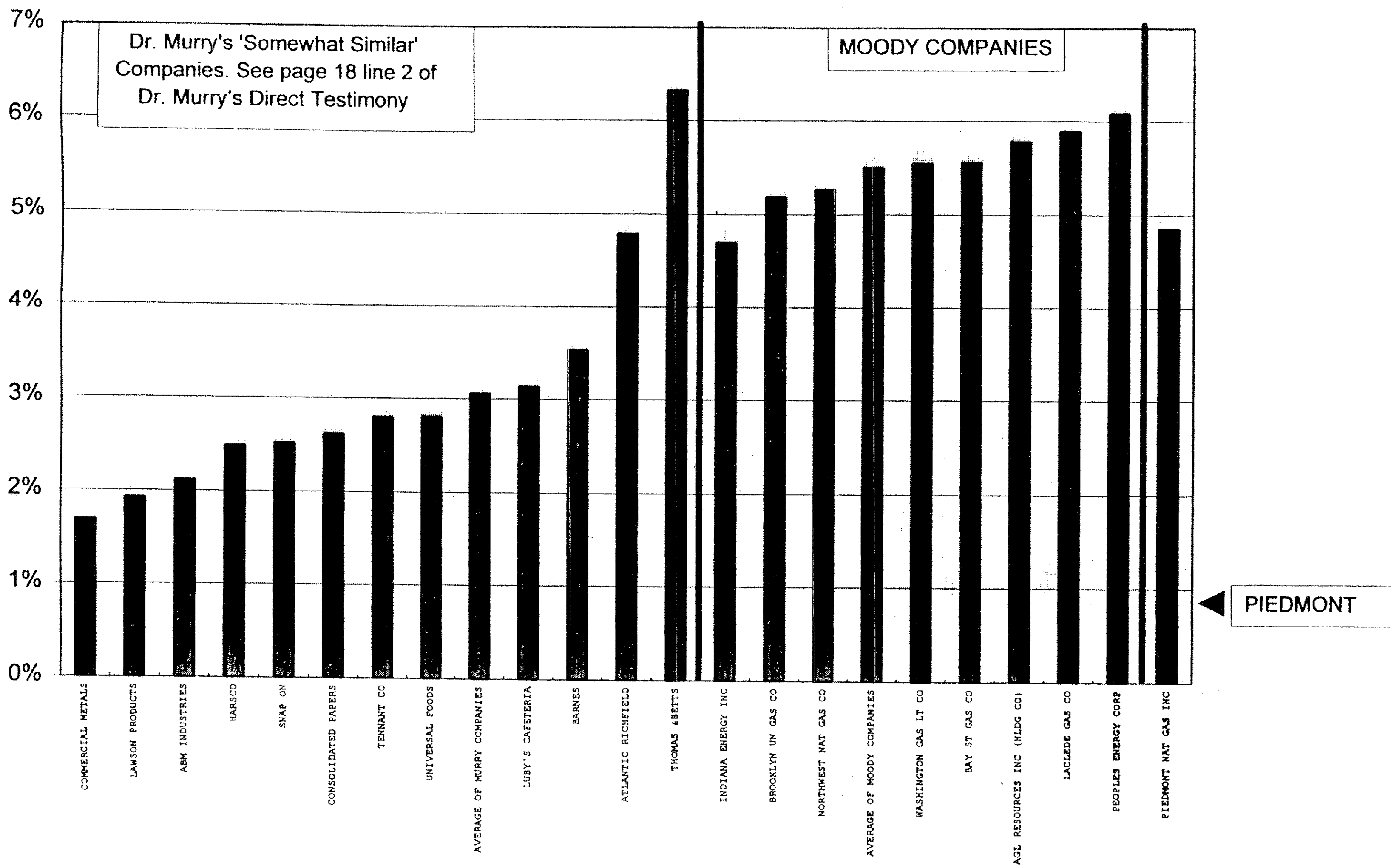
Sponsored by: Donald A. Murry, Ph.D.

Rebuttal Chart 1 -- EQUITY RATIO:1995




Rebuttal Chart 2 -- AV. YRS HELD
Dr. Murry's 'Somewhat Similar' Companies. See page 18 line 2 of Dr. Murry's Direct Testimony
MOODY COMPANIES
PIEDMONT
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
THOMAS &BETTS
ATLANTIC RICHFIELD
UNIVERSAL FOODS
SNAP ON
LUBY'S CAFETERIA
LAWSON PRODUCTS
AVERAGE OF MURRY COMPANIES
HARSCO
CONSOLIDATED PAPERS
BARNES
COMMERCIAL METALS
TENNANT CO
ABM INDUSTRIES
PEOPLES ENERGY CORP
NORTHWEST NAT GAS CO
BROOKLYN UN GAS CO
AGL RESOURCES INC (HLDG CO)
AVERAGE OF MOODY COMPANIES
LACLEDE GAS CO
BAY ST GAS CO
WASHINGTON GAS LT CO
INDIANA ENERGY INC
PIEDMONT NAT GAS INC

Rebuttal Chart 3 -- DIVIDEND YIELD DEC 1995



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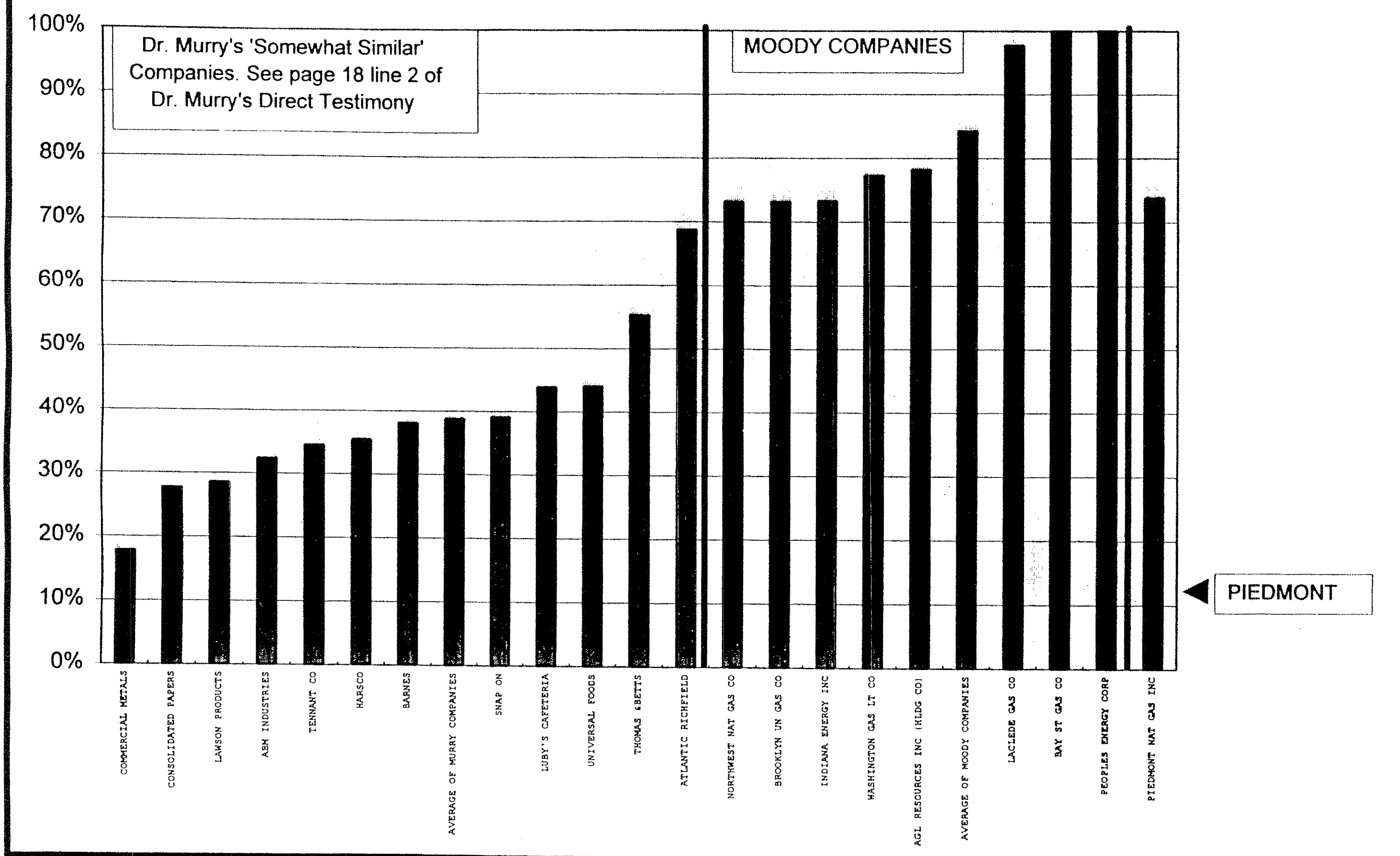
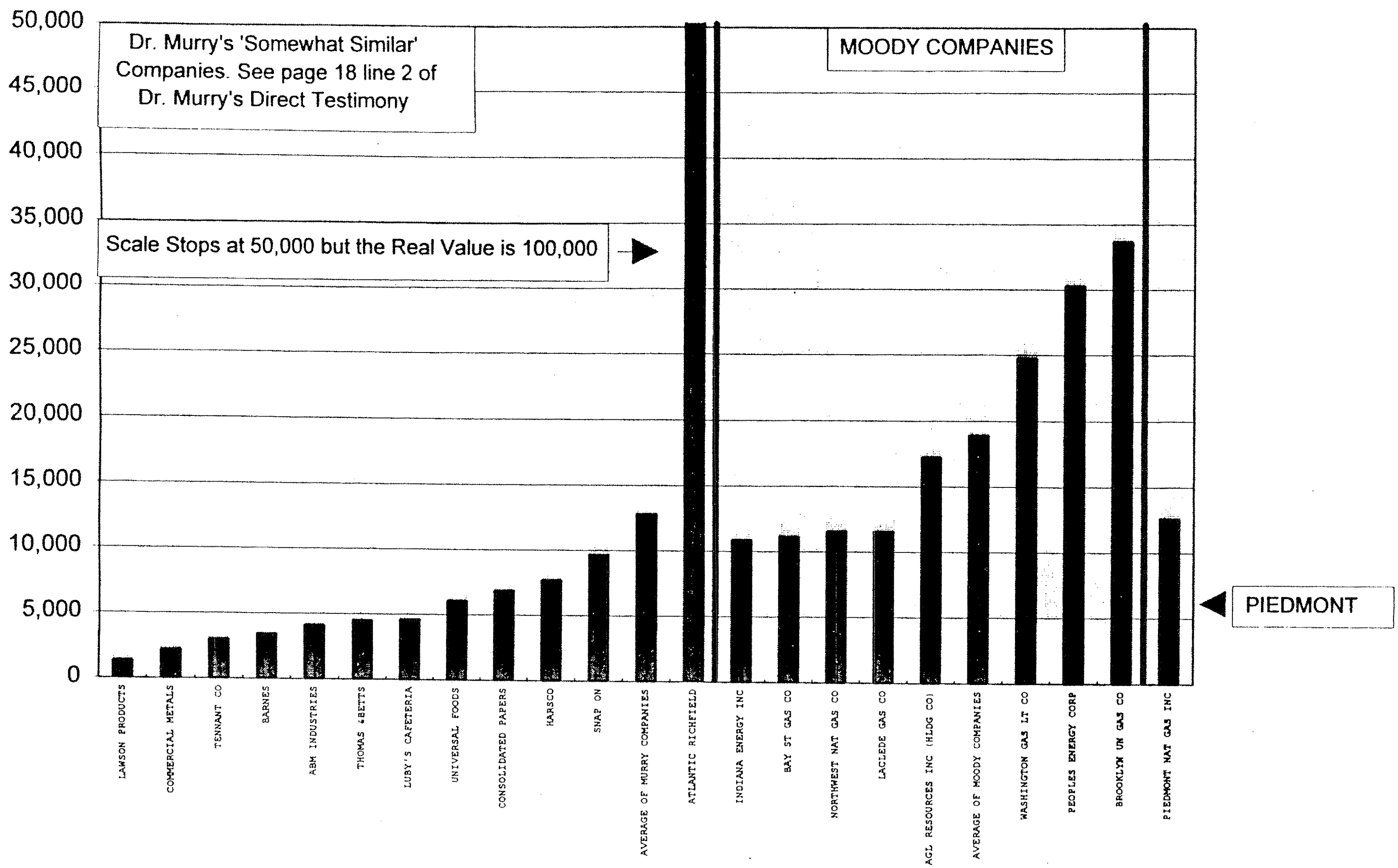
Rebuttal Exhibit CA-SNB
Rebuttal Chart 4 of 10 __

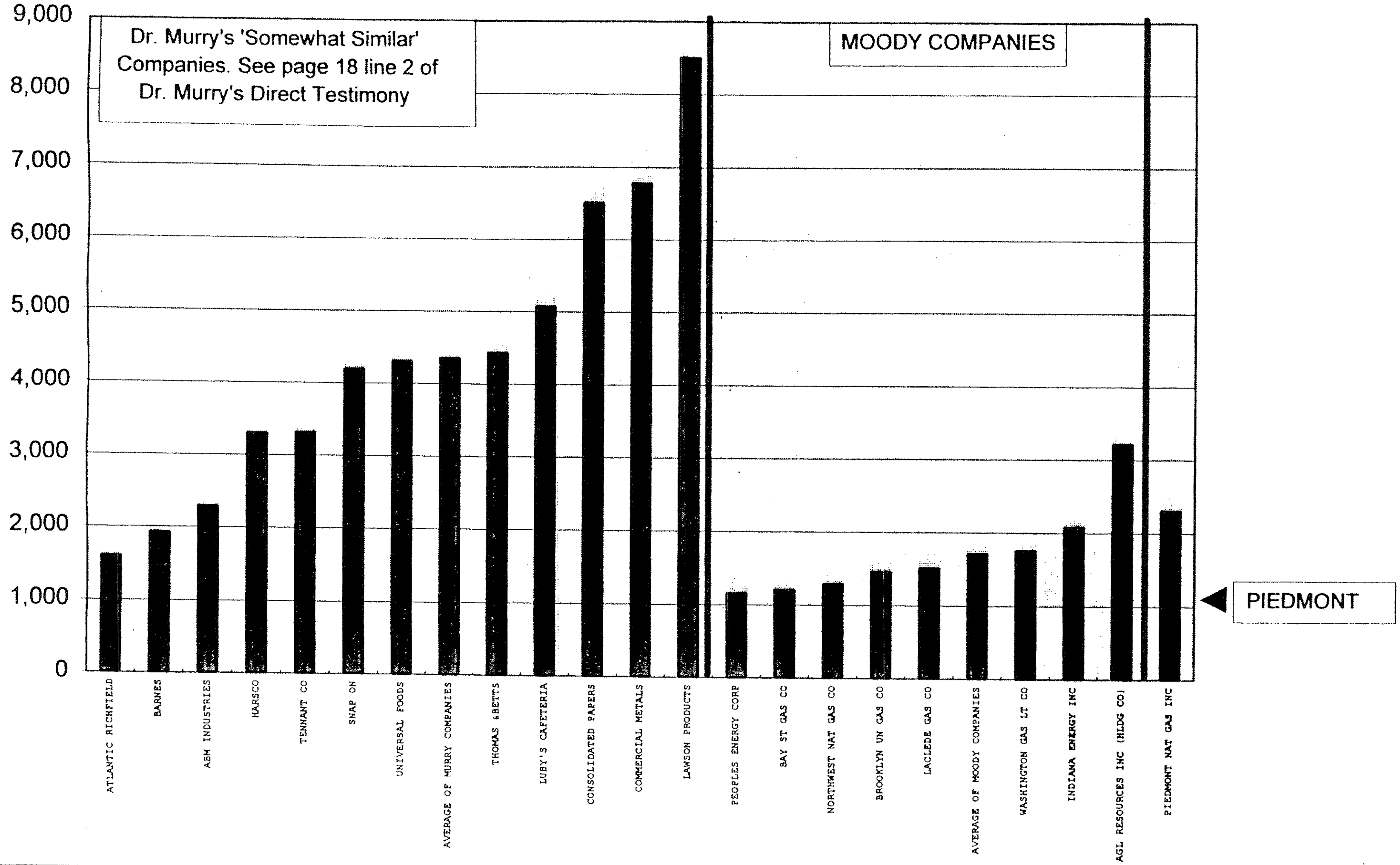
Rebuttal Chart 4 -- PYOUT RATIO1995



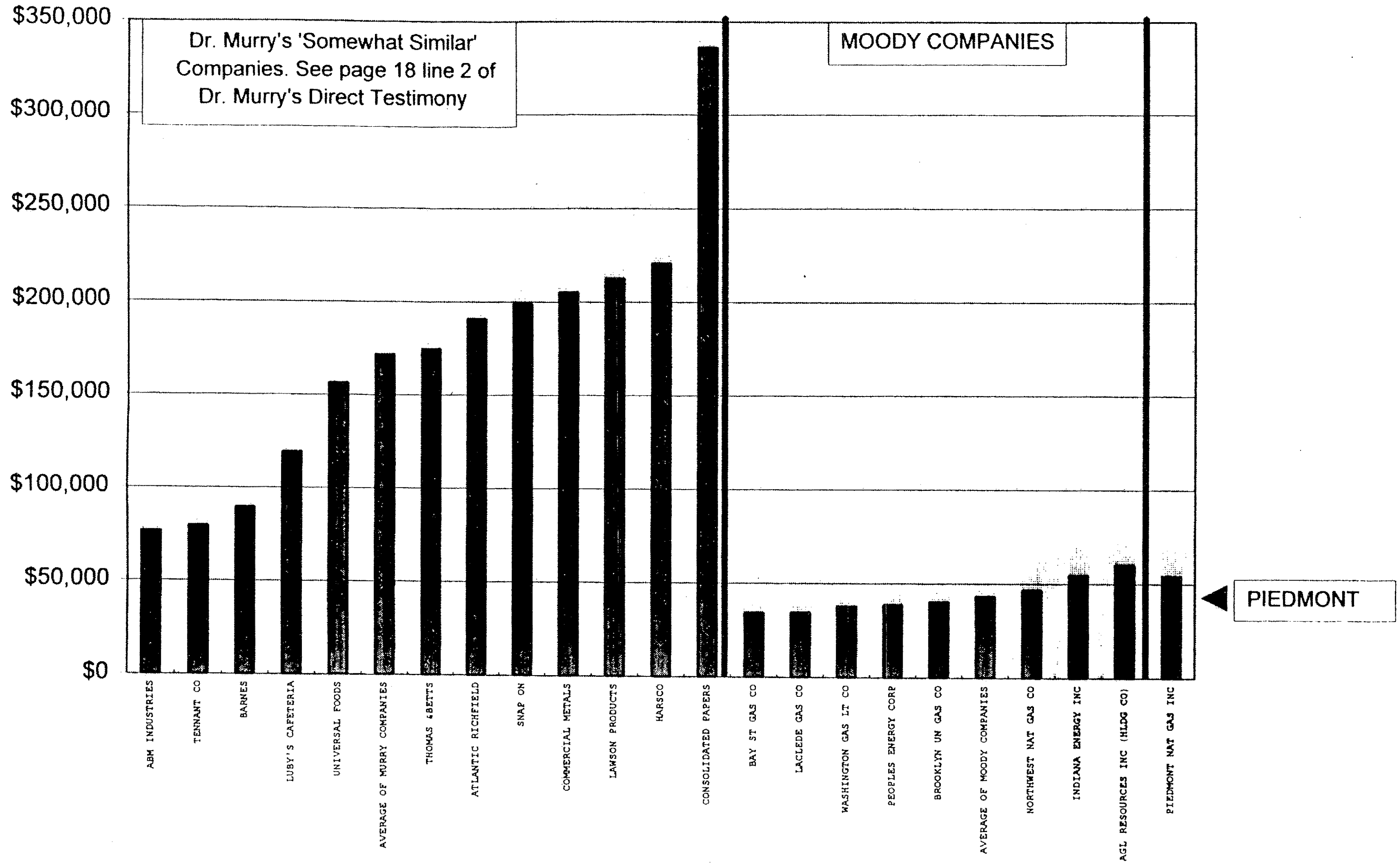
Rebuttal Chart 5 -- NUM OF SHARE HOLDERS



Rebuttal Chart 6 -- SHR/STKHLDER



Rebuttal Chart 7 -- VALUE OF HOLDINGS PER SHAREHOLDER 7/1/96



Rebuttal Chart 8 -- MARKET VALUE 7/1/96 $(Millions)

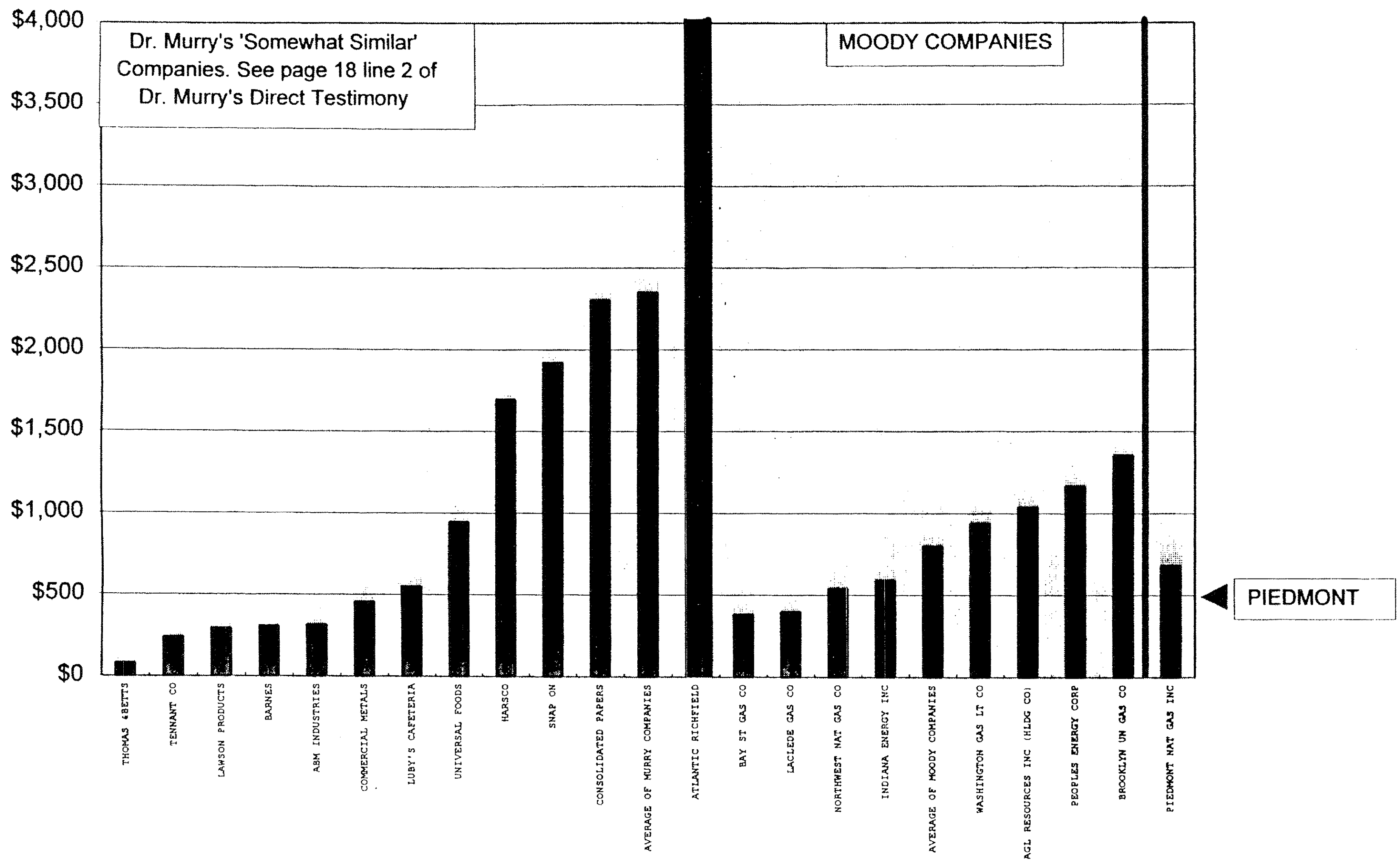


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Table 6-7

Total Returns, Income Returns, and Capital Appreciation of the Basic Asset Classes

Summary Statistics of Annual Returns

From 1926 to 1995

Series	Geometric Mean	Arithmetic Mean	Standard Deviation	Serial Correlation
Large Company Stocks:				
Total Returns	10.5%	12.5%	20.4%	-0.02%
Income	4.6	4.6	1.3	0.81
Capital Appreciation	5.7	7.6	19.7	-0.02
Small Company Stocks:				
Total Returns	12.5	17.7	34.4	0.09
Long-Term Corporate Bonds:				
Total Returns	5.7	6.0	8.7	0.12
Long-Term Government Bonds:				
Total Returns	5.2	5.5	9.2	0.01
Income	5.1	5.2	2.9	0.96
Capital Appreciation	-0.1	0.2	8.0	-0.13
Intermediate-Term Government Bonds:				
Total Returns	5.3	5.4	5.8	0.20
Income	4.7	4.8	3.1	0.96
Capital Appreciation	0.4	0.5	4.4	-0.16
U.S. Treasury Bills:				
Total Returns	3.7	3.8	3.3	0.92
Inflation	3.1	3.2	4.6	0.64

Total return is equal to the sum of three component returns: income return, capital appreciation return, and reinvestment return. Annual reinvestment returns for select asset classes are provided in Table 2-6.

Ave M Return
15.17

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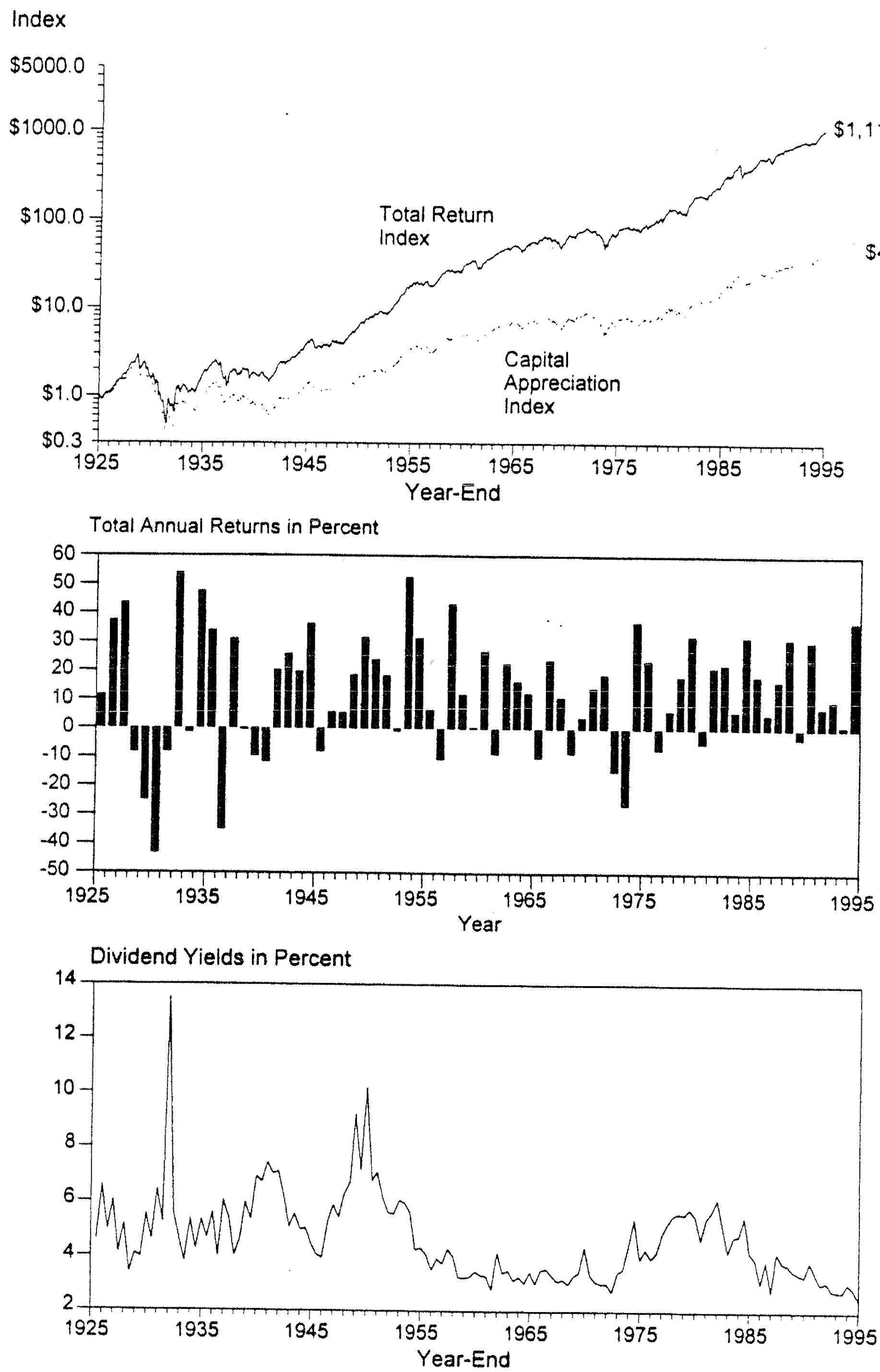
Graph 3-1 **Large Company Stocks** Return Indices, Returns, and Dividend Yields

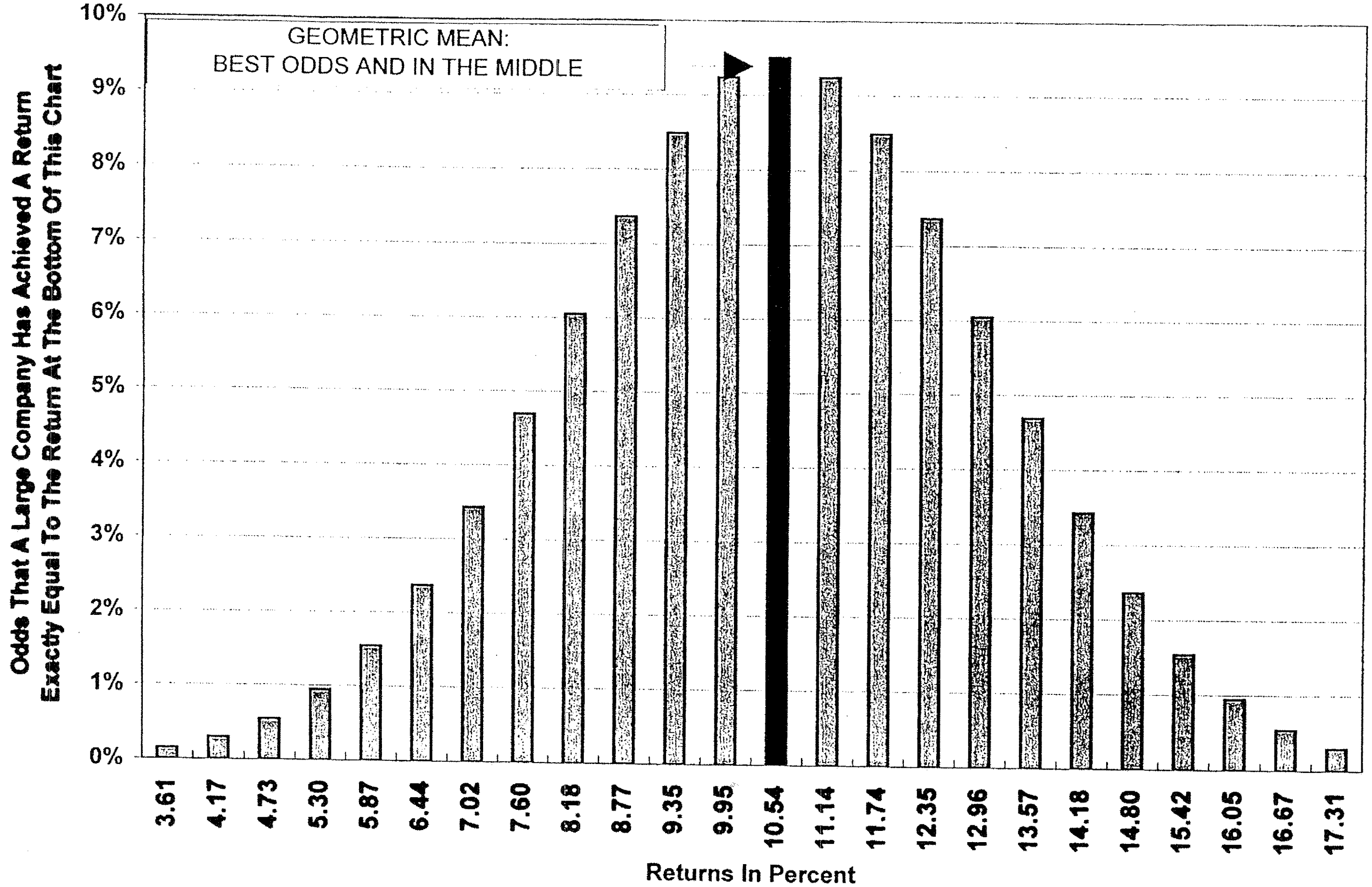


THE PROBABILITY DISTRIBUTION FOR IBBOTSON'S RETURNS TO LARGE COMPANY STOCKS:

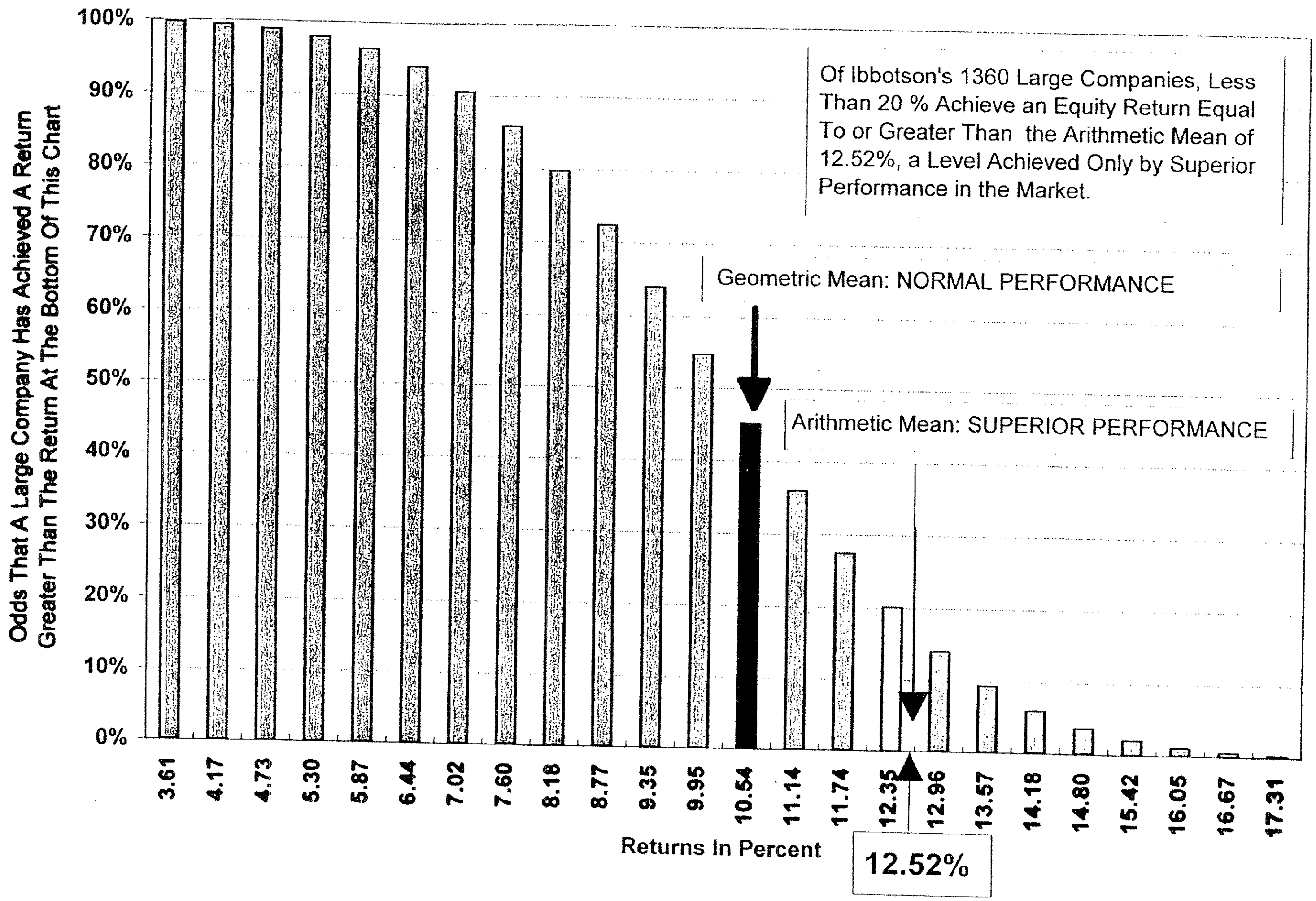
The Table Below Shows The Odds In 1995 Of Achieving The Geometric Return And The Arithmetic Return Given A $1 Investment In 1925 In A Large Company

	NUMBER OF POSSIBILITIES	ALL POSSIBLE VALUES OF INVESTMENT	ALL POSSIBLE RETURNS	ODDS OF ACHIEVING A RETURN EXACTLY EQUAL TO THE RETURN IN COLUMN (3)	ODDS OF ACHIEVING A RETURN LESS THAN THE RETURN IN COLUMN (3)	ODDS OF ACHIEVING A RETURN MORE THAN THE RETURN IN COLUMN (3)
	(1)	(2)	(3)	(4)	(5)	(6)
	1.0E+0	$0.00	-8.50%	0.00%	0.00%	100.00%
	70.0E+0	$0.00	-8.01%	0.00%	0.00%	100.00%
	2.4E+3	$0.00	-7.49%	0.00%	0.00%	100.00%
	------------	------------	------------	------------	------------	------------
	------------	------------	------------	------------	------------	------------
	------------	------------	------------	------------	------------	------------
	11.2E+18	$37.12	5.30%	0.95%	1.12%	97.93%
	18.2E+18	$54.17	5.87%	1.54%	2.07%	96.39%
	28.0E+18	$79.05	6.44%	2.37%	3.61%	94.02%
	40.5E+18	$115.36	7.02%	3.43%	5.98%	90.59%
	55.3E+18	$168.34	7.60%	4.69%	9.41%	85.90%
	71.4E+18	$245.65	8.18%	6.05%	14.10%	79.85%
	87.0E+18	$358.47	8.77%	7.37%	20.15%	72.48%
	100.2E+18	$523.10	9.35%	8.49%	27.52%	63.99%
	109.1E+18	$763.34	9.95%	9.24%	36.01%	54.75%
GEOMETRIC	112.2E+18	$1,113.92	10.54%	9.50%	45.25%	45.25%
	109.1E+18	$1,625.51	11.14%	9.24%	54.75%	36.01%
	100.2E+18	$2,372.04	11.74%	8.49%	63.99%	27.52%
	87.0E+18	$3,461.44	12.35%	7.37%	72.48%	20.15%
ARITHMETIC	----------	$3,858.63	12.52%	----------	----------	----------
	71.4E+18	$5,051.17	12.96%	6.05%	79.85%	14.10%
	55.3E+18	$7,371.00	13.57%	4.69%	85.90%	9.41%
	40.5E+18	$10,756.25	14.18%	3.43%	90.59%	5.98%
	28.0E+18	$15,696.22	14.80%	2.37%	94.02%	3.61%
	18.2E+18	$22,904.96	15.42%	1.54%	96.39%	2.07%
	11.2E+18	$33,424.43	16.05%	0.95%	97.93%	1.12%
	6.5E+18	$48,775.14	16.67%	0.55%	98.88%	0.58%
	3.5E+18	$71,175.89	17.31%	0.30%	99.42%	0.28%
	1.8E+18	$103,864.56	17.94%	0.15%	99.72%	0.13%
	------------	------------	------------	------------	------------	------------
	------------	------------	------------	------------	------------	------------
	------------	------------	------------	------------	------------	------------
	1.0E+0	$618,813,389.73	33.53%	0.00%	100.00%	0.00%

THE PROBABILITY DISTRIBUTION FOR IBBOTSON'S RETURNS TO LARGE COMPANY STOCKS



THE CUMULATIVE PROBABILITY DISTRIBUTION FOR IBBOTSON'S RETURNS TO LARGE COMPANY STOCKS



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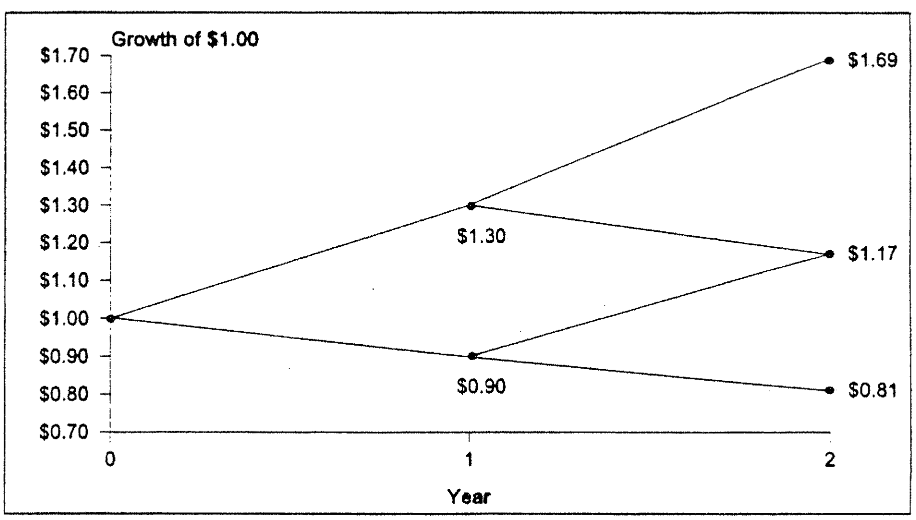
where the cost of capital is the sum of its parts. Therefore, the CAPM expected equity risk premium must be derived by arithmetic, *not geometric*, subtraction.

Arithmetic Versus Geometric Means

The expected equity risk premium should always be calculated using the arithmetic mean. The arithmetic mean is the rate of return which, when compounded over multiple periods, gives the mean of the probability distribution of ending wealth values. (A simple example given below shows that this is true.) This makes the arithmetic mean return appropriate for computing the cost of capital. The discount rate that equates expected (mean) future values with the present value of an investment is that investment's cost of capital. The logic of using the discount rate as the cost of capital is reinforced by noting that investors will discount their expected (mean) ending wealth values from an investment back to the present using the arithmetic mean, for the reason given above. They will, therefore, require such an expected (mean) return prospectively (that is, in the present looking toward the future) to commit their capital to the investment.

For example, assume a stock has an expected return of +10 percent in each year and a standard deviation of 20 percent. Assume further that only two outcomes are possible each year— + 30 percent and -10 percent (that is, the mean plus or minus one standard deviation), and that these outcomes are equally likely. (The arithmetic mean of these returns is 10 percent, and the geometric mean is 8.2 percent.) Then the growth of wealth over a two-year period occurs as shown below:



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Note that the median (middle outcome) and mode (most common outcome) are given by the geometric mean, 8.2 percent, which compounds up to 17 percent over a 2-year period (hence a terminal wealth of $1.17). However, the *expected value*, or probability-weighted average of all possible outcomes, is equal to:

	(.25	×	1.69)	=	0.4225
+	(.50	×	1.17)	=	0.5850
+	(.25	×	0.81)	=	0.2025
TOTAL					1.2100

Now, the rate that must be compounded up to achieve a terminal wealth of $1.21 after 2 years is 10 percent; that is, the expected value of the terminal wealth is given by compounding up the *arithmetic*, not the geometric mean. Since the arithmetic mean equates the expected future value with the present value, it is the discount rate.

Stated another way, the arithmetic mean is correct because an investment with uncertain returns will have a higher expected ending wealth value than an investment that earns, with certainty, its compound or geometric rate of return every year. In the above example, compounding at the rate of 8.2 percent for two years yields a terminal wealth of $1.17, based on $1.00 invested. But holding the uncertain investment, with a possibility of high returns (two +30 percent years in a row) as well as low returns (two -10 percent years in a row), yields a higher expected terminal wealth, $1.21. In other words, more money is gained by higher-than-expected returns than is lost by lower-than-expected returns. Therefore, in the investment markets, where returns are described by a probability distribution, the arithmetic mean is the measure that accounts for uncertainty, and is the appropriate one for estimating discount rates and the cost of capital.

Arbitrage Pricing Theory

APT is a model of the expected return on a security. It was originated by Stephen A. Ross, and elaborated by Richard Roll. APT treats the expected return on a security (*i.e.*, its cost of capital) as the sum of the payoffs for an indeterminate number of risk factors, where the amount of each risk factor inherent in a given security is estimated. Like the CAPM, APT is a model that is consistent with equilibrium and does not attempt to outguess the market. APT

HOW THE ARITHMETIC MEAN MISLEADS AND HARMS INVESTORS

From Ibbotson's 1996 Yearbook, Pages 154-155

Dr. Brown's Example

BOTH STOCKS HAVE THE SAME ARITHMETIC MEAN

	THE FIRST STOCK				THE SECOND STOCK		
Initial Investment	$1,000	$1,000	$1,000		$1,000	$1,000	$1,000
Growth Rate	30 % Gain	10 % Loss	Median Value: Geometric Mean	10 % Gain: Arithmetic Mean	60 % Gain	40 % Loss	Median Value: Geometric Mean
Year							
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
1	$1,300	$900	$1,082	$1,100	$1,600	$600	$980
2	$1,690	$810	$1,170	$1,210	$2,560	$360	$960
3	$2,197	$729	$1,266	$1,331	$4,096	$216	$941
4	$2,856	$656	$1,369	$1,464	$6,554	$130	$922
5	$3,713	$590	$1,481	$1,611	$10,486	$78	$903
6	$4,827	$531	$1,602	$1,772	$16,777	$47	$885
7	$6,275	$478	$1,732	$1,949	$26,844	$28	$867
8	$8,157	$430	$1,874	$2,144	$42,950	$17	$849
9	$10,604	$387	$2,027	$2,358	$68,719	$10	$832
10	$13,786	$349	$2,192	$2,594	$109,951	$6	$815
11	$17,922	$314	$2,371	$2,853	$175,922	$4	$799
12	$23,298	$282	$2,565	$3,138	$281,475	$2	$783
13	$30,288	$254	$2,775	$3,452	$450,360	$1	$767
14	$39,374	$229	$3,001	$3,797	$720,576	$.7836	$751
15	$51,186	$206	$3,246	$4,177	$1,152,922	$.4702	$736
16	$66,542	$185	$3,511	$4,595	$1,844,674	$.2821	$721
17	$86,504	$167	$3,798	$5,054	$2,951,479	$.1693	$707
18	$112,455	$150	$4,108	$5,560	$4,722,366	$.1016	$693
19	$146,192	$135	$4,444	$6,116	$7,555,786	$.0609	$679
20	$190,050	$122	$4,807	$6,727	$12,089,258	$.0366	$665
21	$247,065	$109	$5,199	$7,400	$19,342,813	$.0219	$651
22	$321,184	$98	$5,624	$8,140	$30,948,501	$.0132	$638
23	$417,539	$89	$6,083	$8,954	$49,517,602	$.0079	$625
24	$542,801	$80	$6,580	$9,850	$79,228,163	$.0047	$613
25	$705,641	$72	$7,117	$10,835	$126,765,060	$.0028	$600
26	$917,333	$65	$7,699	$11,918	$202,824,096	$.0017	$588
27	$1,192,533	$58	$8,327	$13,110	$324,518,554	$.001	$576
28	$1,550,293	$52	$9,007	$14,421	$519,229,686	$.0006	$565
29	$2,015,381	$47	$9,743	$15,863	$830,767,497	$.0004	$553
30	$2,619,996	$42	$10,539	$17,449	$1,329,227,996	$.0002	$542

THE PROBABILITY DISTRIBUTION OF VALUES FOR A GRANDAUGHTER'S TRUST FUND
BASED ON INVESTING IN THE FIRST STOCK OF SCHEDULE 7

For A $1000 Investment Today In A Stock Having A 30% Chance Of Gain And A 10% Chance Of Loss
The Table Below Shows The Odds Of The Trust Fund Attaining The Values In Column (2)
30 Years From Now

NUMBER OF POSSIBILITIES	ALL POSSIBLE VALUES OF THE TRUST FUND	ALL POSSIBLE RETURNS TO THE FUND	ODDS OF ACHIEVING A RETURN EXACTLY EQUAL TO THE RETURN IN COLUMN (3)	ODDS OF ACHIEVING A RETURN LESS THAN THE RETURN IN COLUMN (3)	ODDS OF ACHIEVING A RETURN MORE THAN THE RETURN IN COLUMN (3)
(1)	(2)	(3)	(4)	(5)	(6)
1.0E+0	$42	-10.00%	0.00%	0.00%	100.00%
30.0E+0	$61	-8.89%	0.00%	0.00%	100.00%
435.0E+0	$88	-7.77%	0.00%	0.00%	100.00%
4.1E+3	$128	-6.63%	0.00%	0.00%	100.00%
27.4E+3	$185	-5.48%	0.00%	0.00%	100.00%
142.5E+3	$267	-4.31%	0.01%	0.00%	99.98%
593.8E+3	$385	-3.13%	0.06%	0.02%	99.93%
2.0E+6	$556	-1.94%	0.19%	0.07%	99.74%
5.9E+6	$803	-0.73%	0.55%	0.26%	99.19%
14.3E+6	$1,160	0.50%	1.33%	0.81%	97.86%
30.0E+6	$1,676	1.74%	2.80%	2.14%	95.06%
54.6E+6	$2,421	2.99%	5.09%	4.94%	89.98%
86.5E+6	$3,497	4.26%	8.06%	10.02%	81.92%
119.8E+6	$5,051	5.55%	11.15%	18.08%	70.77%
145.4E+6	$7,296	6.85%	13.54%	29.23%	57.22%
155.1E+6	$10,539	8.17%	14.45%	42.78%	42.78%
145.4E+6	$15,223	9.50%	13.54%	57.22%	29.23%
119.8E+6	$21,988	10.85%	11.15%	70.77%	18.08%
86.5E+6	$31,761	12.22%	8.06%	81.92%	10.02%
54.6E+6	$45,877	13.60%	5.09%	89.98%	4.94%
30.0E+6	$66,266	15.00%	2.80%	95.06%	2.14%
14.3E+6	$95,718	16.42%	1.33%	97.86%	0.81%
5.9E+6	$138,259	17.86%	0.55%	99.19%	0.26%
2.0E+6	$199,708	19.31%	0.19%	99.74%	0.07%
593.8E+3	$288,467	20.78%	0.06%	99.93%	0.02%
142.5E+3	$416,674	22.27%	0.01%	99.98%	0.00%
27.4E+3	$601,862	23.78%	0.00%	100.00%	0.00%
4.1E+3	$869,357	25.31%	0.00%	100.00%	0.00%
435.0E+0	$1,255,738	26.85%	0.00%	100.00%	0.00%
30.0E+0	$1,813,843	28.42%	0.00%	100.00%	0.00%
1.0E+0	$2,619,996	30.00%	0.00%	100.00%	0.00%

THE PROBABILITY DISTRIBUTION OF VALUES FOR A GRANDAUGHTER'S TRUST FUND BASED ON INVESTING IN THE SECOND STOCK OF SCHEDULE 7

For A $1000 Investment Today In A Stock Having A 60% Chance Of Gain And A 40% Chance Of Loss
The Table Below Shows The Odds Of The Trust Fund Attaining The Values In Column (2)
30 Years From Now

NUMBER OF POSSIBILITIES	ALL POSSIBLE VALUES OF THE TRUST FUND	ALL POSSIBLE RETURNS TO THE FUND	ODDS OF ACHIEVING A RETURN EXACTLY EQUAL TO THE RETURN IN COLUMN (3)	ODDS OF ACHIEVING A RETURN LESS THAN THE RETURN IN COLUMN (3)	ODDS OF ACHIEVING A RETURN MORE THAN THE RETURN IN COLUMN (3)
(1)	(2)	(3)	(4)	(5)	(6)
1.0E+0	$0	-40.00%	0.00%	0.00%	100.00%
30.0E+0	$0	-38.01%	0.00%	0.00%	100.00%
435.0E+0	$0	-35.95%	0.00%	0.00%	100.00%
4.1E+3	$0	-33.82%	0.00%	0.00%	100.00%
27.4E+3	$0	-31.62%	0.00%	0.00%	100.00%
142.5E+3	$0	-29.34%	0.01%	0.00%	99.98%
593.8E+3	$0	-26.44%	0.06%	0.02%	99.93%
2.0E+6	$0	-24.72%	0.19%	0.07%	99.74%
5.9E+6	$1	-21.91%	0.55%	0.26%	99.19%
14.3E+6	$2	-19.49%	1.33%	0.81%	97.86%
30.0E+6	$4	-16.81%	2.80%	2.14%	95.06%
54.6E+6	$11	-14.04%	5.09%	4.94%	89.98%
86.5E+6	$29	-11.17%	8.06%	10.02%	81.92%
119.8E+6	$76	-8.22%	11.15%	18.08%	70.77%
145.4E+6	$203	-5.17%	13.54%	29.23%	57.22%
155.1E+6	$542	-2.02%	14.45%	42.78%	42.78%
145.4E+6	$1,446	1.24%	13.54%	57.22%	29.23%
119.8E+6	$3,855	4.60%	11.15%	70.77%	18.08%
86.5E+6	$10,280	8.08%	8.06%	81.92%	10.02%
54.6E+6	$27,412	11.67%	5.09%	89.98%	4.94%
30.0E+6	$73,099	15.38%	2.80%	95.06%	2.14%
14.3E+6	$194,931	19.21%	1.33%	97.86%	0.81%
5.9E+6	$519,816	23.18%	0.55%	99.19%	0.26%
2.0E+6	$1,386,176	27.27%	0.19%	99.74%	0.07%
593.8E+3	$3,696,469	31.50%	0.06%	99.93%	0.02%
142.5E+3	$9,857,251	35.87%	0.01%	99.98%	0.00%
27.4E+3	$26,286,003	40.39%	0.00%	100.00%	0.00%
4.1E+3	$70,096,008	45.05%	0.00%	100.00%	0.00%
435.0E+0	$186,922,687	49.87%	0.00%	100.00%	0.00%
30.0E+0	$498,460,498	54.85%	0.00%	100.00%	0.00%
1.0E+0	$1,329,227,996	60.00%	0.00%	100.00%	0.00%

BEFORE THE TENNESSEE REGULATORY AUTHORITY

AT NASHVILLE, TENNESSEE

IN RE: PETITION OF NASHVILLE GAS COMPANY, A DIVISION OF PIEDMONT GAS COMPANY, INC. FOR AN ADJUSTMENT OF ITS RATES AND CHARGES	)))))	DOCKET NO. 96-00977

AFFIDAVIT

I , Stephen N. Brown, Economist for the Consumer Advocate Division of the Attorney General's office, hereby certify that the attached rebuttal testimony represents my opinion in the above referenced case and the opinion of the Consumer Advocate Division.

Stephen N. Brown

Sworn to and subscribed before me
this 1st day of November, 1996.

Levon A. Harris
NOTARY PUBLIC

My commission expires on: 1/20/99

Ag-100134/96-00977

CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the foregoing rebuttal testimony of Stephen N. Brown was served on parties of record via U.S. Mail, postage prepaid, this 1 day of November, 1996.

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Before the

TENNESSEE REGULATORY AUTHORITY

IN RE: APPLICATION OF UNITED CITIES GAS TO ESTABLISH AN EXPERIMENTAL PERFORMANCE BASED RATEMAKING MECHANISM
DOCKET NO. 97-01364

****

DIRECT TESTIMONY
of
STEPHEN N. BROWN

****

March 6, 1998

15999

Q. Please state your name.

A. Stephen N. Brown.

Q. Where do you work and what is your job title?

A. I am a Senior Economist in the Consumer Advocate Division, Office of the Attorney General.

Q. What are your responsibilities as Senior Economist?

A. I review companies' petitions for rate changes and follow the economic conditions that affect the companies.

Q. What experience do you have regarding utilities?

A. From 1986 to 1995 I was employed by the Iowa Utilities Board as Chief of the Bureau of Energy Efficiency, Auditing and Research, and Utility Specialist and State Liaison Officer to the U.S. Nuclear Regulatory Commission. From 1984 to 1986 I worked for Houston Lighting & Power as Supervisor of Rate Design. From 1982 to 1984 I worked for Arizona Electric Power Cooperative as a Rate Analyst. From 1979 to 1982 I worked for Tri-State Generation and Transmission Association as Power Requirements Supervisor and Rate Specialist. From 1979 through 1995 my work spanned many issues including cost of service studies, rate design issues, telecommunications issues and matters related to the disposal of nuclear waste.

Q. What is your educational background?

A. I have an M.S. in Regulatory Economics from the University of Wyoming, an M.A. and Ph.D. in International Relations with a specialty in International Economics from the University of Denver, and a B.A. from Colorado State University.

Q. Dr. Brown, have you authored any articles relating to your profession?

A. Yes, my articles have appeared in Public Utilities Fortnightly and the Electricity Journal.

Q. Are you and have you been a member of any professional organizations, Dr. Brown?

A. Yes, I am a past member of the National Association of Regulatory Utility Commissioners Staff Committee on Management Analysis, a past trustee of and a member of the Board for the Automatic Meter Reading Association, and a current member of the National Association of Business Economists.

Q. Have you studied mathematics and statistics as part of your education?

A. Yes.

Q. Dr. Brown, do you use mathematics and statistics in combination with economics as part of your profession?

A. Yes.

Q. What were you asked to do with respect to this case?

A. I was asked to form an opinion with regard to United Cities Gas(UCG) gas purchasing practices from April 1996 through March 1997, a time which includes a 12 month period where the company's purchased substantial amounts of natural gas through a contract with its affiliate, Woodward Marketing L.L.C. (WMLLC), a corporation formed when UCG Energy took a 45% ownership share of WMLLC. I was also asked to form an opinion on UCG's assertion that the WMLLC contract "is a direct response" to the proposed Performance Based Regulation (PPBR) plan. I was further asked to form an opinion on whether the "Nora" contract is a direct response to the PPBR plan. I was further asked to form an opinion on whether the "Nora" contract should be included in the PPBR plan.

Q. What is your opinion of UCG's gas purchasing practices implemented through the contract with WMLLC?

A. Based on the data supplied by the company and data acquired through UCG's form 10Q filed with the Securities and Exchange Commission in March 1997, my opinion is:

1. The WMLLC contract has resulted in UCG purchasing higher cost gas than would otherwise be the case;

2. The published indices tend to overstate the cost of gas;

3. WMLLC is losing money on its sales to UCG but the losses do no mean that consumers are receiving the lowest prices;

4. There is a probability that WMLLC has, can or will earmark low cost gas for customers other than UCG;

5. WMLLC is profitable in its overall operations;

6. Because WMLLC's overall profitability is established in the SEC report, the data supplied by company is erroneous.

Based on these factors *in toto*, I conclude that the company has not established that the PPBR is beneficial to consumers and that the PPBR plan has failed to motivate WMLLC to find least-cost supplies for UCG.

Q. **What is your opinion, regarding UCG's assertion that the WMLLC contract is a direct response to the PPBR?**

A. UCG's intent to enter into a long-term business relationship with Woodward was clearly evident at least as early as October 1994, 18 months before the WMLLC contract was implemented, and 6 months before the PPBR plan was reviewed in the TPSC hearing of March 1995. Therefore, the WMLLC contract is not and never could be a direct response to the PPBR.

Q. **What is the "Nora" contract?**

A. It is a 7 year gas-supply contract that UCG committed to in 1993.

Q. **What is your opinion regarding whether the "Nora" contract is a direct response to the PPBR plan.**

A. My opinion is that the Nora contract is not a response to the PPBR because the 7 year contract with "Nora" commenced nearly 18 months before the PPBR's inception.

Q. **What is the basis for your opinion that the PPBR plan is not the economic cause for the company entering into the WMLLC contract?**

A. I have that opinion because from August 1995 through March of 1996, UCG purchased gas independently of WMLLC from approximately 30 different suppliers who provided gas for periods ranging from a few days to five months to one year. Woodward was one of those suppliers. During those 8 months 7 suppliers provided gas at cheaper rates than Woodward and in volumes comparable to Woodward's, as indicated in Chart 1. Two other suppliers provided gas in larger volume than Woodward's and at nearly comparable prices. Economic rational suggests that one of the 7 suppliers would be a better partner than Woodward.

Q. **Does the company assert that it is acquiring the least-cost gas supply through the WMLLC contract?**

A. Yes. UCG's witness Mr. McDowell makes the assertion in his direct testimony. For example at page 15 lines 21-22, he quotes the WMLLC contract: "If the incentive mechanism is changed to the detriment of either party, the parties agree to renegotiate the Purchase Price." From this language Mr. McDowell draws the conclusion that renegotiation can have only one outcome: "Renegotiation would surely result in more favorable terms (a higher price) for Woodward and increase rates to ratepayers." [Mr. McDowell's testimony, page 16 lines 1-4]

Q. **How is the WMLLC price determined?**

A. The WMLLC contract sets a monthly **benchmark** price that is 8 cents below the average of the average prices published for a specific pipeline. Three different publications provide average prices -- *Inside FERC, NGI* and *NYMEX*. For example, in the month of February for 1997 UCG purchased gas that was shipped through the Columbia Pipeline. The Inside FERC average price for the Columbia Pipeline was \$2.89, NGI's was \$2.87, and NYMEX was \$2.986. The average of these 3 prices is \$2.9153. The WMLLC **benchmark** price is \$2.8353, or \$2.84 in rounded numbers. But prices vary by pipeline, therefore, gas purchased through the Columbia Pipeline would not necessaryily have the same the price as gas purchased through the Tennessee Pipeline, for example.

Q. **Is the WMLLC price lowest market price available?**

A. No. There is no good reason to assume that an "8-cents-below-the-average" price gives consumers the lowest priced gas. For example, if WMLLC is conducting business with two different pipelines offering gas supply at different prices, nothing in the WMLLC contract specifies that gas from the lower cost pipeline must flow to UCG. Therefore, the PPBR plan allows WMLLC to allocate lower priced gas to buyers other than UCG and at the same time meet UCG's gas demand by using the higher priced pipeline, provided the higher priced gas is sold to UCG at 8 cents below the average of the higher cost pipeline. In fact, this is exactly what happened after the WMLLC contract was implemented, as shown in Schedules 1 and 2.

Q. Please explain Schedule 1.

A. Schedule 1 is divided into 6 matrices of monthly data which compare UCG's prices and gas purchases <u>before</u> the WMLLC contract took effect, with UCG's prices and gas purchases <u>after</u> the WMLLC contract took effect. On the left side of each matrix there is a column titled "M*." Underneath the title there are numbers ranging from 1 to 12 and 13 to 24. "1" represents April 1995, 2 is for May 1995 and so forth. Thus 12 stands for March 1996, 13 for April 1996 and 24 for March 1997.

Matrix A shows the average price UCG paid for gas from five different pipelines for the 12 month period of April 1995 through March 1996. For example, in April 1995 UCG purchased gas from the Texas Gas Pipeline for $1.52 per MCF. Matrix A reveals that gas purchased through the Columbia Pipeline was considerably more expensive for UCG than gas purchased through the Tennessee Pipeline.

Matrix B shows the prices UCG paid after the WMLLC contract began in April 1996. Thus in April 1996 UCG paid $2.65 per MCF. Matrix C represents the differences between Matrix A and Matrix B.

On the right side of Schedule 1, Matrix D through Matrix E show the volumes UCG purchased by pipeline before and after the WMLLC contract was implemented. Matrix F shows the differences in volumes and reveals a major increase in purchases through the Columbia pipeline and a major decrease in purchases through the Tennessee Pipeline. Therefore, the WMLLC contract has had the effect of shifting UCG's source of gas from lower cost sources to higher cost ones.

Q. Did WMLLC make a profit because of shifting UCG's purchases from Tennessee to Columbia?

A. Not necessarily because the data provided by the company regarding WMLLC's gas purchases appears to be inaccurate, as shown Schedule 2. Matrix A lists the invoice prices paid by UCG to WMLLC. Matrix B lists the average prices paid by WMLLC to its suppliers. Matrix B, just like Matrix A in Schedule 1, clearly shows that gas purchased through the Tennessee Pipeline is less expensive than gas purchased through Columbia. Returning to Schedule 2, Matrix C shows WMLLC's profit margin, which is difference between the entries in Matrix A and Matrix B. Matrix D shows the dollar loss for each month and each pipeline. The entries in Matrix D are derived by multiplying the entries in Matrix C by the entries in Matrix E, UCG's monthly purchases from WMLLC by pipeline. Matrix D in particular reveals that WMLLC lost money nearly every month on its sales to UCG from April 96 through March 97 and that the total losses exceeded $1.5 million, most of which occurred from December 96 to March 97 on Columbia. This completely contradicts the PPBR's bedrock notion that gas marketers will make profit by searching out low cost supplies and selling them at a markup.

Matrix F shows WMLLC's monthly volume of purchases from its sources by pipeline. Matrix

G is the difference between the entries in Matrix E and Matrix F. Matrix G shows in several months UCG purchased more gas from Columbia Gulf than WMLLC had bought from its sources on Columbia Gulf, as indicated by the negative sign and the boxes around the negative amounts in Matrix G.

This is literally impossible, therefore, while WMLLC may have lost money on its sale of gas to UCG, it is also possible that WMLLC earmarked the low priced gas from the Tennessee pipeline for buyers other than UCG, possibly allowing WMLLC to compensate for the losses on sales to UCG. This may have been a financially viable strategy because, as shown in Matrix F, there were substantial amounts of low cost gas available on the Tennessee line, especially from December 96-March 97. Unfortunately none of that gas made it to UCG, a major contrast with the period December 95-March 96, shown in Schedule 1 Matrix D, when UCG purchased substantial amounts of gas through Tennessee Pipeline.

Q. **Is there evidence that WMLLC could lose money on its sales to UCG and still make a profit on overall sales?**

A. Yes. Schedule 3 is a listing of invoices with prices and volumes purchased for the Tennessee Pipeline during February 1997. The far right column shows that 990,137 MCF, 41% of the WMLLC's purchases in that month, were below the minimum published price for the pipeline. The average and minimum prices for each pipeline are shown in Schedules 4 and 5 respectively. Schedule 3 suggests that Inside FERC. NGI and NYMEX averages tend to overstate market price because low cost transactions are unreported, which further implies a profit potential greater than what the benchmark prices indicate. This is reinforced by Schedule 6, cash flow data from UCG's March 1997 10Q. For the 12 month period ending March 1997, the data shows that UCG received over $2.6 million of investment income from the company's 45% share in WMLLC, which suggests a net profit near $5.8 million for WMLLC's April 96-March 97 operations.

Q. Is the company claiming that the PPBR instead of PGA, is supposed to lead to consumers paying the lowest possible price for gas supply?

A. Yes. In the current docket, 97-01364, UCG's witness Harrington advocates the PPBR as a superior alternative to prudency reviews. In his direct testimony at page 16 lines 18-19 he says "prudence reviews do not guarantee that consumers pay the lowest possible price for supply."

Q. Isn't it true that company witness McDowell suggests that the WMLLC contract is a "direct response" to the PPBR?

A. Yes. In his direct testimony from page 8 line 16 to page 9 line 3 he says: "The Woodward marketing gas supply contract ...is a direct response" to the PPBR. I am not persuaded.

Q. Why are you not persuaded?

A. There are several reasons. His language is misleading. For example, from page 8 line 22 to page 9 line 2, he says: "Establishing incentives for our suppliers [emphasis added] in response to the incentives we receive is now a very important tool in our efforts to achieve the lowest possible cost of gas. This change is a direct response to the Tennessee [PPBR] mechanism." He implies that the company has multiple suppliers of gas in Tennessee. This is not the case.

From April 1996 through March 1997 there were only two major suppliers -- Equitable(also known as ERI resources), which supplies the "Nora" gas through a seven year contract -- and WMLLC, the supplier for nearly all remaining gas supply. Clearly, the Nora contract is unaffected by the PPBR. Thus the only supplier who might be affected by the PPBR is WMLLC, which is 45% owned by UCG. Mr. McDowell's' emphasis on incentives is further contradicted by the $1.5 million loss on WMLLC's sales to UCG.

Additionally, neither Mr. McDowell nor any of the company's other witnesses mention or allude to the very important fact that UCG's intent to form a business relationship with Woodward predated the PPBR by several months.

Q. **What is the significance of the fact that UCG's intent to form a business relationship with Woodward predated the PPBR?**

A. It is significant because it is now clear that WMLLC, as it was conceived and formed in October 1994, was meant to draw a portion of its income from UCG's regulated operations or from services provided to the company's regulated operations.

Q. What evidence supports your opinion?

A. My assertion is supported by documents the company filed in Docket 94-03007 and by Mr. McDowell's testimony in the current docket, 97-01364. The file in Docket 94-03007 contains a letter dated October 19, 1994. The letter was addressed to Woodward Marketing and was sent by UCG Energy, a wholly owned subsidiary of UCG. The letter's very last page has the phrase "Exhibit A" in the upper right corner and the phrase "UCGE/WOODWARD MARKETING EARNOUT SCHEDULE" at the top of the page. Underneath the heading is an estimate of WMLLC's annual operating income from 1995 through 1999. During that period the total operating income was estimated to be $23 million. I have attached the letter to my testimony as Schedule 7.

Q. What business activity would the parties be engaged in to earn the $23 million?

A. It is likely that the income was predicated on the business activity of selling of natural gas, an activity clearly described in item 5 of the October 19, 1994 letter: "the non-competition agreements would not restrict the ability of Woodward Pipeline, Inc., which is primarily engaged in the business of owning and operating gas gathering and gas pipeline systems and conducting gas marketing activities related thereto, to engage in such activities as they presently exist or may develop in the future."

Q. Do the income estimates you refer to in the October 19, 1994 letter contain estimates of revenues and earnings from the WMLLC contract?

A. I think it is likely. UCG and Woodward are experienced companies skilled in the intricacies of natural gas marketing. It is not likely they would enter a partnership and be blind to the potential revenues and earnings from something as large as the WMLLC contract. The timeline of events should also be considered.

The October 19, 1994 letter sets out the general terms of the relationship between the two companies. Then in March 1995 the TPSC held its first hearing on the PPBR plan. In this docket, 97-01364, it now appears that the PPBR, the WMLLC contract and WMLLC's profitability are intertwined and entangled with each other.

Q. What evidence shows that the profitability of WMLLC is now tied to and entangled with the PPBR?

A. The ties and the entanglements are established very clearly in Mr. McDowell's testimony. For example, in his testimony at pages 15 and 16 he describes the various links between the PPBR and WMLLC's income. At page 15, lines 12-14 he says "the Woodward contract is directly dependent on the **original** [emphasis added] basket of [indices] in the incentive mechanism..." However, the October 19, 1994 letter shows that as early as October 1994 UCG was intent on investing in a business relationship with Woodward. Because the original terms of the PPBR were proposed by UCG, the terms of the WMLLC contract may have been understood by both parties in late 1994.

Continuing with Mr. McDowell's' testimony, at lines 21-22 he quotes from the WMLLC contract: "If the incentive mechanism is changed to the detriment of either party, the parties agree to renegotiate the Purchase Price." From this language he draws the conclusion that renegotiation can have only one outcome: "Renegotiation would surely result in more favorable terms (a higher price) for Woodward and increase rates to ratepayers." [Mr. McDowell's testimony, page 16 lines 1-4]

Q. Do you agree with his conclusion?

A. Not necessarily because there is the alternative of terminating the contract, thus freeing UCG to pursue a wider field of gas suppliers. However, if the company is precluded from terminating its contract, then the company appears to have made an imprudent gas purchase contract.

Q. How would the contract be imprudent?

A. The contract would be imprudent under the following conditions. If Mr. McDowell is correct that any "detrimental" change in the PPBR triggers renegotiations, and that renegotiations can have only one result -- increased prices for consumers -- and the company is precluded from searching out other competitive suppliers, then clearly the company has been imprudent, especially considering the historical performance of Woodward versus other suppliers, as shown in Chart 1.

Q. Isn't it true that historical data does not necessarily predict the future?

A. Yes, it is true that the future is not necessarily a duplication of the past.

Q. Isn't it true that the seven suppliers which performed better than Woodward from August 1995 through March 1996, would not necessarily have performed better than Woodward in the future?

A. Yes, that is possible, and UCG has taken this position in the past. For example, on February 27, 1996 in docket 95-01134 company witness McDowell filed rebuttal testimony, and at page 2 lines 14-17 of the rebuttal testimony he says: "I might add that looking at purchases on a historical basis is not always instructive as to how things will be in the future because the gas market is constantly changing partly because more people are becoming more experienced in purchasing gas efficiently."

Q. Do you agree with Mr. McDowell's statement?

A. I agree that historical data "is not always" instructive of the future but if historical data is ignored as a tool to guide decisions and make company policy, then some other tool has to be used. For example, if UCG did not use historical data to assist the company's decision process in committing to the WMLLC contract, then what other reasons, knowledge and information that caused the company to sign the WMLLC contract?

For example, UCG's load factor has been cited as a reason for using the PPBR. In Docket 95-01134, Mr. Harrington addressed the load-factor issue in his rebuttal testimony and during cross examination.

His rebuttal testimony of March 3, 1995, at page 4, says that UCG's load factor was 31.8% and "therefore UCG must pay more for their gas supply because of this lower load factor." During cross-examination in the TPSC hearing of March 7, 1995, Mr. Harrington returned to the load factor and cost issue.

In the transcript at page 121 lines 18-24 he says: "UCG is buying gas that requires more flexibility in takes from the producer, is buying gas that has seasonal different take requirements and because of that the market is going to require an adjustment to the market price compared to the average purchaser and that is what I am referring to." In the transcript at page 156 lines 19-25 he says: "because of the way it [the company] must buy gas for consumers in terms of the load factor, in terms of the demands that the consumers require in the winter, it is going to have to go to the market and buy gas that has flexibility of take, that **has longer term firm requirements**, that are going to be **priced by the market at index plus** [emphasis added]."

Q. **What is a load factor?**

A. A load factor refers to the ratio of a gas system's average consumption divided by peak consumption. The ratio ranges from 0% to 100% and is measure of the idle capacity in a system. The closer the load factor is to zero, the more capacity is unused. Lower load factor systems typically are more expensive than higher load factor systems.

Q. Isn't it possible that UCG selected WMLLC for a three-year contract because WMLLC just happened to have supplies that fit the load factor of UCG?

A. I am not persuaded WMLLC was the only supplier that could have matched UCG's load factor. In the past the company has suggested that its relatively low load factor would drive up the cost of gas if it were purchased for a long term period.

Despite Mr. Harrington's' concern about UCG's low load factor causing the company to purchase long term firm requirements gas above the index, the company is obtaining gas from WMLLC at 8 cents below the benchmark price. However, before the contract went into effect, Woodward had supplied natural gas at 11 cents below the benchmark.

Q. Why are you calling attention to Mr. Harrison's emphasis on the company's low load factor?

A. I call attention to it because it is not a consideration in his direct testimony in this docket, 97-01364. At page 23 lines 13-17, he describes why the company is buying gas below the index but never mentions how the company overcame the disability of its load factor. He does mention the PPBR as "leverage" in making "supply deals." This is further evidence that WMLLC could lose money on sales to UCG but still use the PPBR as a tool to improve WMLLC's overall profitability. He also suggests that the PPBR is one of a kind in the entire gas industry when he says in his testimony, at page 18 lines 14-15, "the link between a [PPBR] and a supply contract [the WMLLC contract] is unique in my experience."

Q. Has the company's load factor materially improved since Mr. Harrington's testimony in March 1995?

A. To my knowledge it has not.

Q. Does the company consider the WMLLC contract to be providing firm long term gas?

A. Yes. Mr. McDowell says in his testimony, page 8 lines 21-22: "By providing an incentive to Woodward to better manage our upstream capacity, we were able to negotiate a price for firm long term gas at 8 cents below the market price [benchmark]."

Q. Does Mr. McDowell indicate if the company negotiated with anyone else besides WMLLC to acquire a 3 year commitment to supply firm requirements gas?

A. No.

Q. Did WMLCC enter into a 3 year contract with any one else besides UCG for the purpose of delivering gas to that customer?

A. Yes. WMLLC also entered into a 3 year contract to deliver gas to another pipeline.

Q. Is that contract priced in the same way as the WMLLC contract?

A. No. In this contract the price is set as 7 cents below the Inside FERC average price, but buyer can acquire the gas at the NYMEX price if it is lower than 7 cents below the Inside FERC average. Therefore, this gas is priced below what UCG pays to WMLCC. The cover page and the final page of that contract are attached to my testimony as Schedule 10.

Q. What is the significance of the three year contract with the other pipeline?

A. It corroborates that WMLCC may be earmarking lower cost for customers other than UCG.

Q. Isn't it true that the company had the opportunity to negotiate with other suppliers?

A. I know of nothing which precluded UCG from shopping around for suppliers for firm requirements gas before settling on Woodward.

Q. Did the company shop around for other suppliers before it settled on Woodward?

A. I am not aware of anything in the record indicating that the company looked at suppliers other than Woodward. Therefore, I cannot accept the proposition that WMLLC's 8 cents below benchmark price was the best deal UCG could have reached.

Q. What do you conclude about the time line of events and entanglements of the PPBR, WMLLC and UCG?

A. The timeline of events, especially the company's "UCGE/WOODWARD MARKETING EARNOUT SCHEDULE" created three months before filing the PPBR, is substantial and material evidence that UCG devised the PPBR plan as an *expost* *facto* response to the company's intent to form a business relationship with Woodward Marketing. Other substantial and material evidence are:

1. The company's apparent ability to obtain firm requirements gas supplies at 8 cents below the benchmark despite -- A) Mr. Harrington's expert opinion that such supplies could only be obtained at prices above the index, and B) the apparent lack of improvement in the company's load factor.

2. The WMLLC contract's contingencies for the TRA's regulatory decisions that are a "detriment to either party" and that apparently hold consumers hostage, since in Mr. McDowell's words, any detrimental change "would surely...increase rates to ratepayers."

3. If Mr. McDowell is correct that a "detrimental change" has only one effect -- raising prices for consumers -- then UCG apparently has a contractual liability forcing the company to continue making purchases from WMLLC even in the face of detrimental regulatory decisions.

I am not persuaded the PPBR is a prospective plan intended to induce changes in the gas-purchasing practices of the company. I am even more convinced of the PPBR's retrospective nature when the "Nora" contract is considered.

Q. **Does anyone from the company claim that the "Nora" contract is the direct result of the PPBR plan?**

A. No. However, the company has attempted to justify its inclusion of "Nora" in the PPBR.

Q. What is the justification?

A. In TPSC Docket 95-001134, UCG's witness Ron McDowell filed rebuttal testimony claiming that the inclusion of the Nora contract in the PPBR plan was beneficial to consumers. In that docket and in his testimony at page 3 lines 18-20 he says " If United Cities had not been aggressive and pursued this cost avoidance ...the customer would be paying higher rates today." However, this justification is based on the assumption of ineffective prudence reviews by regulatory authorities and the absence of disallowances of gas costs.

Q. What is your opinion on excluding the Nora contract from the gas procurement mechanism?

A. The contract should be excluded for two reasons. It predates the PPBR and the prices of the Nora contract are not at all related market prices reflected by the data from Inside FERC, Natural Gas Intelligence, and NYMEX, which are the indices used in the gas procurement mechanism. Therefore, it is inappropriate to compare Nora's prices to those of the short term market.

A discussion of what constitutes appropriate comparisons appears in Schedule 8, a copy of Natural Gas Intelligence's (NGI) explanation of how that publication derives its index. The NGI index is included in the incentive plan's index. NGI excludes prices not based on market factors. NGI says:

"we poll sources from all branches of the industry to determine a price that is a product of factors faced by the entire market. Occasionally, however, sources will report prices that substantially differ from the others within the sample survey...Often times outliers result from circumstances unique to that party, such as... a price based on predetermined contract language [emphasis added]. If we discover that these deals were based on factors that were not experienced by the remainder of the market, then they will be removed from the data sample."

The Nora contract is clearly not based on factors experienced by the rest of the market and should be excluded from the PPBR.

Q. **How do you know that the Nora prices are not related to the market and that they are based on factors not experienced by the remainder of the market?**

A. I made an analysis, the results of which are in Schedule 9. For 16 out of 24 months since April 1995, the Nora price has been lower the minimum price published for any pipeline. The gas procurement mechanism works, as I mentioned earlier, by comparing the Nora price to the so-called market price. For example, column (6) shows the Nora price and column (5) shows the sum of the market index, the avoided capacity costs and the so called historical adjustment. The gas procurement mechanism works as follows: If column (6) is less than 98% of column (5) then the company is judged to be doing a good job in facing the market and the company gets a reward. There is a problem with that comparison.

Take April 1995 for example. The Nora price in column (6) is $1.72, and the so-called index in column (5) is 1.91, but the comparison does not indicate how the Nora price compares to the market. To get that perspective the calculation process has to be reversed: From the Nora price subtract the sum of the avoided capacity costs and the so called historical adjustment. The result is $1.32 in column (1). Compare that to $1.52 in column (3). The difference between column (1) and column (3) is the same as the difference between column (5) and column (6). The gas procurement mechanism could be reworded as follows: If column (1) is less than 98% of column (3) then the company is judged to be doing a good job in facing the market and the company gets a reward. However, the price in column (1) is below the price in column (2), which is the market's minimum price. In April 1995 the Nora contract price was lower than the market's minimum price. No other company on the Tennessee Pipeline could have gotten prices as good as Nora's for 16 of the 24 months from April 1995 through March 1997. Therefore, it is a virtual certainty that the company will always be judged to be doing a good job with regard to the pre-PPBR rate of the Nora contract because, using NGI's words, the Nora contract "is [not] a product of factors faced by the entire market."

Q. **Does this conclude your testimony?**

A. Yes, but I may supplement it after discovery is complete.

BEFORE THE TENNESSEE REGULATORY AUTHORITY
AT NASHVILLE, TENNESSEE

IN RE:APPLICATION OF UNITED CITIES GAS TO ESTABLISH AN EXPERIMENTAL PERFORMANCE BASED RATEMAKING MECHANISM	)	DOCKET NO. 97-01364

AFFIDAVIT

I, Stephen N. Brown, Economist for the Consumer Advocate Division of the Attorney General's Office, hereby certify that the attached Direct Testimony represents my opinion in the above referenced case and the opinion of the Consumer Advocate Division.

Stephen N. Brown

Sworn to and subscribed before me
this 6th day of March, 1998.

Ronald Wallace McNutt
NOTARY PUBLIC

My commission expires on: March 27, 1999

15999

Certificate of Service

I hereby certify that a true and correct copy of the foregoing Direct Testimony of Stephen N. Brown was served on parties of record via U.S. Mail, postage prepaid, this 6th day of March, 1998.

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Before the

TENNESSEE REGULATORY AUTHORITY

IN RE: APPLICATION OF UNITED CITIES GAS TO ESTABLISH AN EXPERIMENTAL PERFORMANCE BASED RATEMAKING MECHANISM
DOCKET NO. 97-01364

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EXHIBITS

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March 6, 1998

Comparison Of UCG's Prices and Purchases Before and After the Woodward Contract: By Pipeline By Month

MATRIX A

UC's Weighted Invoice Price (Excludes NORA) *BEFORE* WW Contract

M*	Texas Gas	Texas Eastern	Tennessee Gas	Columbia Gulf	SoNat	ROW
1	1.52	1.49	1.50	1.56		(1)
2	1.61	1.60	1.60	1.67		(2)
3	1.65	1.66	1.63	1.74		(3)
4	1.45	1.44	1.41	1.51		(4)
5	1.32	1.32	1.29	1.37		(5)
6	1.53	1.53	1.48	1.58		(6)
7	1.61	1.58	1.57	1.64		(7)
8	1.77	1.70	1.75	1.80	1.77	(8)
9	2.25	2.17	2.24	2.29	2.25	(9)
10	3.36	2.35	2.91	3.40	2.93	(10)
11	4.13	2.08	2.32	3.30	6.07	(11)
12	2.76	1.96	2.55	2.84	3.02	(12)

MATRIX D

UC's Volume of Purchases *(Excludes NORA) BEFORE* WW Contract

ROW	M*	Texas Gas	Texas Eastern	Tennessee Gas	Columbia Gulf	SoNat	
(1)	1	531,276	325,376	1,427,770	138,384		
(2)	2	331,621	331,196	1,279,955	146,500		
(3)	3	370,990	249,940	1,282,480	71,194		
(4)	4	368,168	258,329	880,275	5,554		
(5)	5	75,423	260,588	871,423	7,728		
(6)	6	60,916	279,983	866,788	18,000		
(7)	7	86,583	213,920	920,288	121,824		
(8)	8	61,650	177,166	1,462,933	323,580	75,980	
(9)	9	63,705	361,866	1,873,257	406,751	68,120	
(10)	10	63,705	271,013	1,867,722	334,366	75,695	
(11)	11	34,657	250,730	2,010,523	357,138	47,200	
(12)	12	111,471	155,513	2,009,877	482,512	32,162	
(13)	T	2,160,165	3,135,620	16,753,291	2,413,531	299,157	24,761,764
(14)	P	8.7%	12.7%	67.7%	9.7%	1.2%	100.0%

MATRIX B

UC's Weighted Invoice Price From WW Per MCF

M*	Texas Gas	Texas Eastern	Tennessee Gas	Columbia Gulf	ROW
13	2.65	2.55	2.51	2.64	(15)
14	2.12	2.12	2.06	2.15	(16)
15	2.25	2.27	2.22		(17)
16	2.55	2.54	2.51		(18)
17	2.22	2.19	2.17	2.24	(19)
18	1.74	1.69	1.68	1.75	(20)
19	1.74	1.71	1.69	1.77	(21)
20	2.57	2.57	2.55	2.61	(22)
21	3.78	3.75		3.77	(23)
22	3.94	3.81		3.88	(24)
23	2.83	2.79		2.84	(25)
24	1.69	1.63		1.67	(26)

MATRIX E

UC's Volume of Purchases From WW

ROW	M*	Texas Gas	Texas Eastern	Tennessee Gas	Columbia Gulf	SoNat	
(15)	13	286,450	385,578	1,858,702	218,760	0.000	
(16)	14	237,815	258,841	1,363,745	149,338	0.000	
(17)	15	221,512	299,430	1,298,043		0.000	
(18)	16	316,072	274,106	1,176,893		0.000	
(19)	17	283,951	298,706	1,236,587	47,151	0.000	
(20)	18	222,055	321,863	1,161,851	3,719	0.000	
(21)	19	213,394	341,948	1,622,867	43,271	0.000	
(22)	20	65,429	530,425	1,895,010	184,633	0.000	
(23)	21	40,433	370,164		2,330,910	0.000	
(24)	22	43,416	343,678		2,431,585	0.000	
(25)	23	81,405	269,157		1,871,195	0.000	
(26)	24	10,186	77,376		1,073,206	0.000	
(27)	T	2,022,118	3,771,272	11,613,698	8,353,768	0.000	25,760,856
(28)	P	7.8%	14.6%	45.1%	32.4%		100.0%

MATRIX C

$ Difference In Price (Positive Indicates Increase)

M*	Texas Gas	Texas Eastern	Tennessee Gas	Columbia Gulf	ROW
13-1	1.13	1.06	1.01	1.08	(29)
14-2	0.51	0.52	0.46	0.47	(30)
15-3	0.60	0.61	0.60		(31)
16-4	1.10	1.11	1.10		(32)
17-5	0.90	0.87	0.88	0.87	(33)
18-6	0.21	0.16	0.20	0.17	(34)
19-7	0.13	0.13	0.12	0.13	(35)
20-8	0.80	0.86	0.80	0.82	(36)
21-9	1.53	1.58		1.48	(37)
22-10	0.58	1.46		0.49	(38)
23-11	-1.29	0.72		-0.47	(39)
24-12	-1.07	-0.33		-1.17	(40)
					(41)

MATRIX F

Change In Volumes (Excludes NORA) - *BEFORE AND AFTER* WW Contract

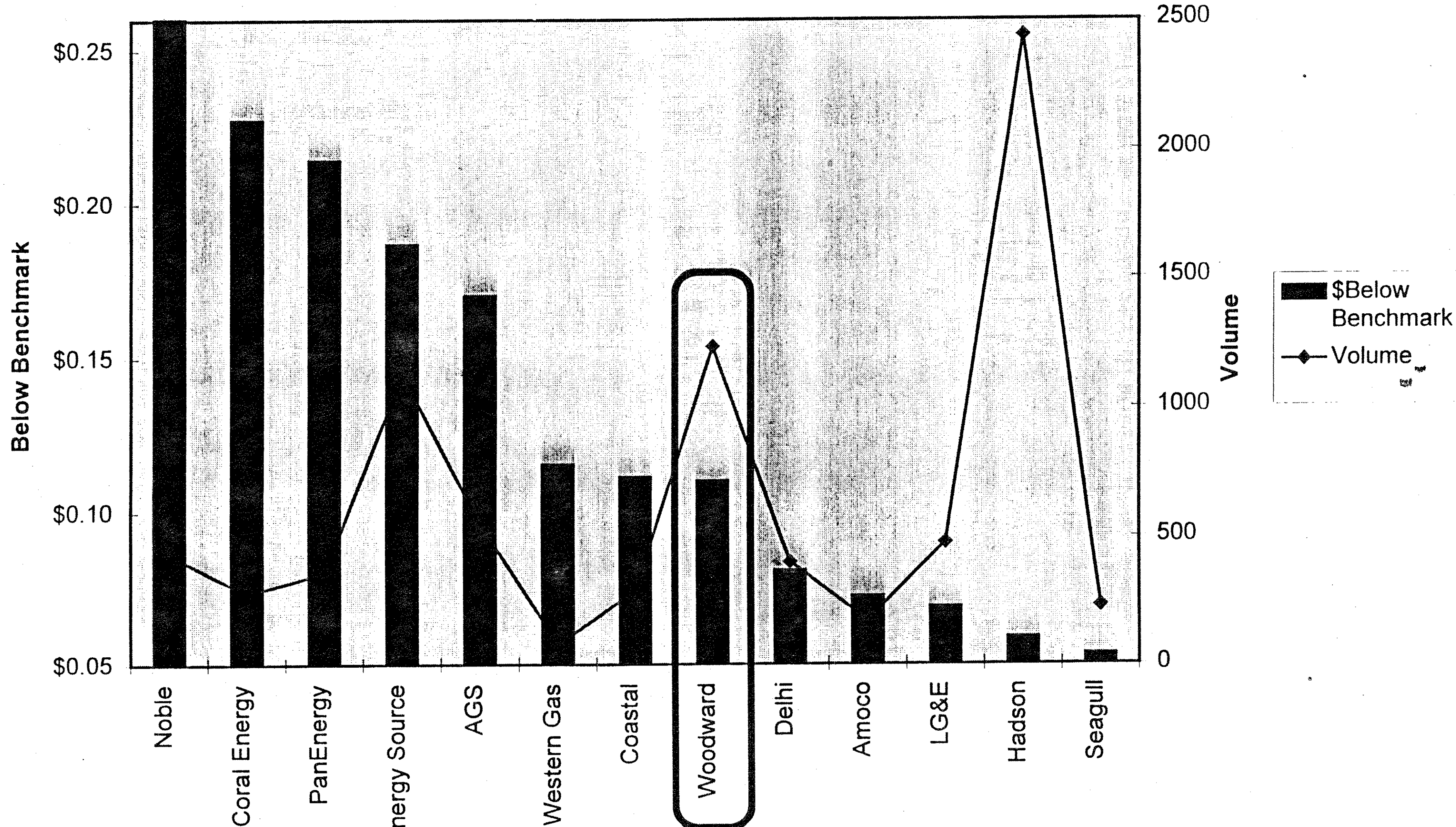
ROW	M*	Texas Gas	Texas Eastern	Tennessee Gas	Columbia Gulf	
(29)	13-1	-244,826	60,202	430,932	80,376	
(30)	14-2	-93,806	-72,355	83,790	2,838	
(31)	15-3	-149,478	49,490	15,563	-71,194	
(32)	16-4	-52,096	15,777	296,618	-5,554	
(33)	17-5	208,528	38,118	365,164	39,423	
(34)	18-6	161,139	41,880	295,063	-14,281	
(35)	19-7	126,811	128,028	702,579	-78,553	
(36)	20-8	3,779	353,259	432,077	-138,947	
(37)	21-9	-23,272	8,298	-1,873,257	1,924,159	
(38)	22-10	-20,289	72,665	-1,867,722	2,097,219	
(39)	23-11	46,748	18,427	-2,010,523	1,514,057	
(40)	24-12	-101,285	-78,137	-2,009,877	590,694	Net Change
(41)	T	-138,047	635,652	-5,139,593	5,940,237	1,298,249

*M Stands for Months: 1 is Apr 95, 2 is May 95 etc. ... 12 is Mar 96
13 is Apr 96 ... 24 is Mar 97 etc. as defined in Schedule 2

Docket No. 97-01364
Exhibit CA-SNB____
Direct Testimony____
Chart 1 of 1________

Chart 1

UCG's PPBR: 13 Least Expensive Suppliers From 08/95 - 03/96 (Excludes NORA): 7 Suppliers Were Less Costly Than Woodward and Provided Comparable Volume



Comparison Of UCG's Prices and Volumes To Woodward's Prices and Volumes

MATRIX A

UC's Weighted Invoice Price From WW Per MCF By Pipeline By Month

M*	Texas Gas	Texas Eastern	Tennessee Gas	Columbia Gulf	ROW
13	2.65	2.55	2.51	2.64	(1)
14	2.12	2.12	2.06	2.15	(2)
15	2.25	2.27	2.22		(3)
16	2.55	2.54	2.51		(4)
17	2.22	2.19	2.17	2.24	(5)
18	1.74	1.69	1.68	1.75	(6)
19	1.74	1.71	1.69	1.77	(7)
20	2.57	2.57	2.55	2.61	(8)
21	3.78	3.75		3.77	(9)
22	3.94	3.81		3.88	(10)
23	2.83	2.79		2.84	(11)
24	1.69	1.63		1.67	(12)
					(13)
					(14)

MATRIX E

UC's Volume of Purchases From WW: By Pipeline By Month

M*	Texas Gas	Texas Eastern	Tennessee Gas	Columbia Gulf	
13	286,450	385,578	1,858,702	218,760	
14	237,815	258,841	1,363,745	149,338	
15	221,512	299,430	1,298,043		
16	316,072	274,106	1,176,893		
17	283,951	298,706	1,236,587	47,151	
18	222,055	321,863	1,161,851	3,719	
19	213,394	341,948	1,622,867	43,271	
20	65,429	530,425	1,895,010	184,633	
21	40,433	370,164		2,330,910	
22	43,416	343,678		2,431,585	
23	81,405	269,157		1,871,195	
24	10,186	77,376		1,073,206	
T	2,022,118	3,771,272	11,613,698	8,353,768	25,760,856
P	7.8%	14.6%	45.1%	32.4%	100.0%

MATRIX B

Weighted Average Price Paid By WW to its Suppliers: By Pipeline By Month

M*	Texas Gas	Texas Eastern	Tennessee Gas	Columbia Gulf	ROW
13	2.46	2.40	2.23	2.39	(15)
14	2.34	2.16	2.07	2.16	(16)
15	2.42	2.32	2.25	4.05	(17)
16	2.70	2.62	2.50	2.67	(18)
17	2.38	2.30	2.18	2.30	(19)
18	1.88	1.77	1.79	1.83	(20)
19	1.78	1.80	1.78	2.02	(21)
20	2.71	2.71	2.64	2.71	(22)
21	3.61	3.89	3.53	3.88	(23)
22	3.55	3.90	3.50	4.05	(24)
23	2.84	2.96	2.54	2.95	(25)
24	1.68	1.80	1.74	1.88	(26)
					(27)
					(28)

MATRIX F

WW's Volume of Purchases From Its Suppliers: By Pipeline By Month

M*	Texas Gas	Texas Eastern	Tennessee Gas	Columbia Gulf	
13	121,832	953,047	2,944,711	630,596	
14	187,860	641,224	2,066,407	119,714	
15	307,490	752,854	2,081,951	2,104,700	
16	412,743	990,511	2,934,376	200,584	
17	449,719	720,222	3,871,371	248,552	
18	403,890	287,995	3,206,188	102,000	
19	180,823	757,911	2,957,481	97,665	
20	423,020	1,656,538	3,798,788	1,098,881	
21	348,755	2,191,875	2,358,965	1,860,000	
22	179,248	2,597,665	2,567,178	2,104,700	
23	82,599	1,838,084	2,410,331	1,820,000	
24	56,823	1,812,261	3,637,094	2,036,824	
T	3,154,802	15,200,187	34,834,841	12,424,216	65,614,04
P	4.8%	23.2%	53.1%	18.9%	100.0%

MATRIX C

$Per Unit Margins

M*	Texas Gas	Texas Eastern	Tennessee Gas	Columbia Gulf	ROW
13	0.19	0.15	0.28	0.25	(29)
14	-0.21	-0.04	-0.01	-0.01	(30)
15	-0.17	-0.05	-0.03		(31)
16	-0.16	-0.08	0.01		(32)
17	-0.16	-0.11	-0.01	-0.05	(33)
18	-0.14	-0.08	-0.11	-0.08	(34)
19	-0.04	-0.09	-0.09	-0.25	(35)
20	-0.14	-0.14	-0.10	-0.09	(36)
21	0.17	-0.14		-0.11	(37)
22	0.38	-0.09		-0.17	(38)
23	-0.01	-0.17		-0.11	(39)
24	0.02	-0.17		-0.21	(40)

MATRIX G

Difference Between WW's Volume and UC's Volumes

M*	Texas Gas	Texas Eastern	Tennessee Gas	Columbia Gulf
13	-164,618	567,469	1,086,009	411,836
14	-49,955	382,383	702,662	-29,624
15	85,978	453,424	783,908	2,104,700
16	96,671	716,405	1,757,483	200,584
17	165,768	421,516	2,634,784	201,401
18	181,835	-33,868	2,044,337	98,281
19	-32,571	415,963	1,334,614	54,394
20	357,591	1,126,113	1,903,778	914,248
21	308,322	1,821,711	2,358,965	-470,910
22	135,832	2,253,987	2,567,178	-326,885
23	1,194	1,568,927	2,410,331	-51,195
24	46,637	1,734,885	3,637,094	963,618

MATRIX D

WW's $Margin on Sales to UC: By Pipeline By Month

M*	Texas Gas	Texas Eastern	Tennessee Gas	Columbia Gulf		ROW
13	53,771	59,177	511,561	55,200		(41)
14	-50,515	-9,325	-8,170	-1,795		(42)
15	-38,036	-15,221	-37,918			(43)
16	-49,016	-20,832	9,375			(44)
17	-44,880	-32,227	-15,645	-2,441		(45)
18	-31,103	-25,906	-131,464	-0,281		(46)
19	-9,602	-32,375	-147,538	-10,901		(47)
20	-9,069	-76,537	-184,324	-17,484		(48)
21	7,005	-52,814		-250,456		(49)
22	16,551	-30,380		-405,392		(50)
23	-0,460	-45,649		-207,875		(51)
24	0,177	-12,771		-226,864		(52)
T	-155,177	-294,861	-4 125	-1,068,290	-1,522,454	(53)
P	10.2%	19.4%	0.3%	70.2%	100.0%	(54)

* Each "M" Column Stands for Months: Code is Given Below

M*	Month
13	Apr-96
14	May-96
15	Jun-96
16	Jul-96
17	Aug-96
18	Sep-96
19	Oct-96
20	Nov-96
21	Dec-96
22	Jan-97
23	Feb-97
24	Mar-97

WMLLC's Invoices of Purchases on Tennessee Pipeline - Feb 97

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Direct Testimony____
Schedule 3 ______
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Date (1)	Volume (2)	$ (3)	Price (4)	Price As Percent of Min. Published Price On TN Pipeline in Feb 97 $2.59 (5)	Date (6)	Volume (7)	$ (8)	Price (9)	Price As Percent of Min. Published Price On TN Pipeline in Feb 97 $2.59 (10)	Cumulative Volume Purchased Below Minimum Price of $2.59 (11)
Feb-97	5,000	8,425	$1.68500	65%	Feb-97	5,000	11,400	$2.28000	88%	
Feb-97	4,300	7,289	$1.69500	65%	Feb-97	6,000	13,920	$2.32000	90%	
Feb-97	5,700	9,662	$1.69500	65%	Feb-97	10,000	23,250	$2.32500	90%	
Feb-97	10,000	16,950	$1.69500	65%	Feb-97	15,000	34,875	$2.32500	90%	
Feb-97	3,500	6,055	$1.73000	67%	Feb-97	2,000	4,680	$2.34000	90%	
Feb-97	10,000	17,350	$1.73500	67%	Feb-97	3,000	7,020	$2.34000	90%	
Feb-97	3,500	6,160	$1.76000	68%	Feb-97	3,000	7,050	$2.35000	91%	
Feb-97	7,500	13,275	$1.77000	68%	Feb-97	5,000	11,750	$2.35000	91%	
Feb-97	3,000	5,370	$1.79000	69%	Feb-97	10,000	23,500	$2.35000	91%	
Feb-97	3,500	6,265	$1.79000	69%	Feb-97	10,000	23,500	$2.35000	91%	
Feb-97	7,500	13,425	$1.79000	69%	Feb-97	685	1,612	$2.35328	91%	
Feb-97	11,200	20,048	$1.79000	69%	Feb-97	2,500	5,900	$2.36000	91%	
Feb-97	40,000	72,052	$1.80130	70%	Feb-97	5,000	11,800	$2.36000	91%	
Feb-97	6,900	12,489	$1.81000	70%	Feb-97	10,000	23,600	$2.36000	91%	
Feb-97	2,565	4,668	$1.81988	70%	Feb-97	4,700	11,139	$2.37000	92%	
Feb-97	5,000	9,100	$1.82000	70%	Feb-97	5,000	11,850	$2.37000	92%	
Feb-97	10,000	18,200	$1.82000	70%	Feb-97	10,000	24,500	$2.45000	95%	
Feb-97	30,000	54,600	$1.82000	70%	Feb-97	5,000	12,300	$2.46000	95%	
Feb-97	435	792	$1.82069	70%	Feb-97	1,000	2,470	$2.47000	95%	
Feb-97	10,000	18,250	$1.82500	70%	Feb-97	5,000	12,650	$2.53000	98%	
Feb-97	5,000	9,150	$1.83000	71%	Feb-97	3,000	7,680	$2.56000	99%	
Feb-97	5,000	9,150	$1.83000	71%	Feb-97	377,392	966,510	$2.56102	99%	990,137
Feb-97	15,000	27,450	$1.83000	71%	Feb-97	140,000	369,250	$2.63750	102%	
Feb-97	55,460	102,030	$1.83970	71%	Feb-97	140,000	384,300	$2.74500	106%	
Feb-97	3,500	6,475	$1.85000	71%	Feb-97	140,000	386,400	$2.76000	107%	
Feb-97	5,000	9,250	$1.85000	71%	Feb-97	140,000	386,400	$2.76000	107%	
Feb-97	10,000	18,500	$1.85000	71%	Feb-97	53,676	148,146	$2.76000	107%	
Feb-97	1,500	2,805	$1.87000	72%	Feb-97	89,025	246,599	$2.77000	107%	
Feb-97	41,800	82,850	$1.98205	77%	Feb-97	140,000	388,500	$2.77500	107%	
Feb-97	5,000	9,950	$1.99000	77%	Feb-97	1,955	5,454	$2.78977	108%	
Feb-97	8,000	16,160	$2.02000	78%	Feb-97	2,522	7,036	$2.78985	108%	
Feb-97	20,000	40,400	$2.02000	78%	Feb-97	5,598	15,618	$2.79000	108%	
Feb-97	15,000	30,375	$2.02500	78%	Feb-97	84,000	234,360	$2.79000	108%	
Feb-97	40,000	81,000	$2.02500	78%	Feb-97	112,000	312,760	$2.79250	108%	
Feb-97	40,000	81,000	$2.02500	78%	Feb-97	42,000	117,600	$2.80000	108%	
Feb-97	10,000	21,350	$2.13500	82%	Feb-97	9,294	26,023	$2.80000	108%	
Feb-97	5,000	10,750	$2.15000	83%	Feb-97	40,124	112,949	$2.81500	109%	
Feb-97	10,000	21,700	$2.17000	84%	Feb-97	280,000	788,900	$2.81750	109%	
Feb-97	2,000	4,360	$2.18000	84%	Total	2,410,331	6,121,629	$2.53975		

Exhibit CA-SNB____
Direct Testimony___
Schedule 4 _______
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Average of Published Prices for Pipelines by Zone by Month

Pipeline & Zone:	4/1/96 Average	5/1/96 Average	6/1/96 Average	7/1/96 Average	8/1/96 Average	9/1/96 Average	10/1/96 Average	11/1/96 Average	12/1/96 Average	1/1/97 Average	2/1/97 Average	3/1/97 Average
Columbia Gulf (NGI)												
Onshore	$2.66	$2.19	$2.34	$2.62	$2.28	$1.77	$1.81	$2.67	$3.83	$3.95	$2.87	$1.74
RAYNE	$2.71	$2.22	$2.38	$2.66	$2.33	$1.82	$1.86	$2.73	$3.88	$4.00	$2.91	$1.78
Tennessee Gas (Inside FERC)												
LA & OffShore (zone 1)	$2.58	$2.10	$2.28	$2.57	$2.22	$1.72	$1.75	$2.63	$3.73	$3.84	$2.79	$1.66
Texas - TX	$2.22	$2.11	$2.26	$2.53	$2.19	$1.69	$1.73	$2.59	$3.68	$3.82	$2.73	$1.62
Texas Eastern (Inside FERC)												
East Louisiana - ELA	$2.65	$2.18	$2.34	$2.61	$2.25	$1.73	$1.78	$2.65	$3.83	$3.90	$2.85	$1.70
West Louisiana - WLA	$2.56	$2.16	$2.31	$2.58	$2.22	$1.72	$1.77	$2.64	$3.81	$3.87	$2.83	$1.68
East Texas - ETX	$2.23	$2.13	$2.25	$2.56	$2.19	$1.69	$1.73	$2.61	$3.69	$3.92	$2.75	$1.63
South Texas - STX	$2.22	$2.12	$2.24	$2.54	$2.20	$1.69	$1.73	$2.60	$3.68	$3.80	$2.73	$1.62
Texas Gas (Inside FERC)												
Zone 1 - ZN 1	$2.70	$2.17	$2.30	$2.61	$2.28	$1.81	$1.80	$2.62	$3.81	$4.01	$2.88	$1.76
Zone SL - ZN SL	$2.72	$2.19	$2.32	$2.62	$2.30	$1.79	$1.81	$2.64	$3.84	$4.02	$2.88	$1.77

Exhibit CA-SNB____
Direct Testimony___
Schedule 5 _______
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Minimum of Published Prices for Pipelines by Zone by Month

Pipeline & Zone:	4/1/96 Min	5/1/96 Min	6/1/96 Min	7/1/96 Min	8/1/96 Min	9/1/96 Min	10/1/96 Min	11/1/96 Min	12/1/96 Min	1/1/97 Min	2/1/97 Min	3/1/97 Min
Columbia Gulf (NGI)												
Onshore	$2.28	$2.14	$2.28	$2.59	$2.18	$1.72	$1.76	$2.62	$3.70	$3.20	$2.75	$1.70
RAYNE	$2.42	$2.18	$2.33	$2.65	$2.23	$1.77	$1.81	$2.66	$3.74	$3.30	$2.79	$1.73
Tennessee Gas (Inside FERC)												
LA & OffShore (zone 1)	$2.02	$2.03	$2.23	$2.50	$1.82	$1.62	$1.70	$2.40	$3.40	$2.75	$\boxed{\$2.59}$	$1.59
Texas - TX	$2.04	$2.07	$2.20	$2.46	$1.95	$1.60	$1.69	$2.40	$3.30	$2.90	$2.60	$1.58
Texas Eastern (Inside FERC)												
East Louisiana - ELA	$2.15	$2.13	$2.27	$2.56	$2.16	$1.66	$1.72	$2.46	$3.32	$3.15	$2.69	$1.60
West Louisiana - WLA	$2.12	$2.10	$2.26	$2.54	$2.00	$1.62	$1.71	$2.48	$3.29	$3.08	$2.70	$1.63
East Texas - ETX	$2.15	$2.07	$2.22	$2.52	$2.11	$1.65	$1.69	$2.45	$3.43	$3.20	$2.65	$1.60
South Texas - STX	$2.15	$2.06	$2.15	$2.47	$2.02	$1.62	$1.68	$2.41	$3.48	$3.16	$2.60	$1.58
Texas Gas (Inside FERC)												
Zone 1 - ZN 1	$2.45	$2.02	$2.27	$2.55	$2.23	$1.71	$1.73	$2.45	$3.61	$3.88	$2.73	$1.64
Zone SL - ZN SL	$2.45	$2.06	$2.29	$2.51	$2.24	$1.69	$1.74	$2.42	$3.38	$3.63	$2.71	$1.66

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Schedule 6 ________
Page 1 of 1________

UCG's CashFlow - From SEC Form 10Q - March 31, 1997

UNITED CITIES GAS COMPANY AND SUBSIDIARIES
CONSOLIDATED STATEMENTS OF CASH FLOWS

	THREE MONTHS ENDED MARCH 31,		TWELVE MONTHS ENDED MARCH 31,	
(Unaudited, in thousands)	1997	1996	1997	1996
CASH FLOWS FROM OPERATING ACTIVITIES:				
Net income	$ 16,114	$ 17,523	$ 15,793	$ 14,131
Adjustments to reconcile net income to net cash provided by (used in) operating activities:				
Depreciation and amortization	5,395	5,258	20,964	20,383
Deferred taxes	(45)	(46)	1,579	1,728
Investment tax credits, net	(90)	(90)	(362)	(363)
Investment income from Woodward Marketing, LLC	(1,868)	(1,267)	(2,599)	(2,047)
Changes in current assets and current liabilities:				
Receivables	17,005	(6,698)	9,287	(24,923)
Materials and supplies	79	(70)	(359)	435
Gas in storage	12,322	9,367	(9,100)	9,437
Gas costs to be billed in the future	4,528	4,432	2,688	(48)
Prepayments and other	640	843	(1,562)	(204)
Accounts payable	(29,542)	1,863	(15,367)	10,065
Customer deposits and advance payments	(2,953)	(4,600)	446	(3,481)
Accrued interest	3,257	2,744	380	808
Supplier refunds due customers	7,285	2,912	(1,280)	(1,697)
Accrued taxes	7,689	13,015	1,198	5,730
Other, net	43	2,011	(1,230)	2,215
Total adjustments	23,745	29,674	4,683	12,038
Net cash provided by operating activities	39,859	47,197	20,476	26,169
CASH FLOWS FROM INVESTING ACTIVITIES:				
Additions to property - utility	(7,426)	(7,106)	(33,087)	(32,553)
Additions to property - non-utility	(1,236)	(1,607)	(6,201)	(5,385)
Investment in Woodward Marketing, LLC, net	125	215	705	(617)
Net cash used in investing activities	(8,537)	(8,498)	(38,583)	(38,555)

Docket No. 97-01364
Exhibit CA-SNB____
Direct Testimony____
Schedule 7______
Page 1 of 7____

UCG Energy Corporation

October 19, 1994

J. D. Woodward, III
James Kifer
Woodward Marketing, Inc.
11251 Northwest Freeway
Suite 400
Houston, TX 77092-6513

RE: Proposed Transaction between Woodward Marketing, Inc., a Texas corporation ("*Woodward Corporation*") and UCG Energy Corporation, a Delaware corporation ("*Energy*") and a wholly-owned subsidiary of United Cities Gas Company, an Illinois and Virginia corporation ("*Cities*")

Gentlemen:

Based upon our recent discussions with you and our respective review of the financial information and other materials and information we have furnished to each other, this letter is intended as an expression of interest by Cities and Engery in pursuing a proposed transaction with Woodward Corporation, as follows:

1. *Sale of Interest in Certain Assets*. At the closing of the transactions contemplated hereby ("Closing"), Woodward Corporation would sell to Energy an undivided [44%] interest in the gas contracts related to the gas marketing business of Woodward Corporation and an undivided [44%] interest in executory obligations of continued performance under, and identified liabilities with respect to, the transferred gas contracts pursuant to an assignment and assumption agreement identifying the transferred assets and liabilities (the "Undivided 44%"). Pending the transaction described in paragraph 2, Woodward Corporation would retain its remaining undivided [55%] interest in the gas contracts related to its gas marketing business and remaining undivided [55%] interest in executory obligations of continued performance under, and identified liabilities with respect to, the transferred gas contracts (the "Undivided 55%"). The consideration for the sale of the Undivided 44% would be as follows:

5300 Maryland Way Brentwood TN ... 615/...

(a) A number of shares of Cities common stock, without par value (*"Cities Common Stock"*) issued in a private placement at Closing having an aggregate Value (as hereinafter defined) equal to Five Million Dollars ($5,000,000);

(b) A cash payment at Closing in the amount of Seven Hundred Fifty Thousand Dollars ($750,000); and

(c) Up to an aggregate additional cash payment of One Million Dollars ($1,000,000) in annual increments of twenty percent (20%) per year based upon a cumulative earnout formula with earnings targets over a five year period following Closing as generally described in Exhibit A attached hereto.

As used herein, the "Value" of Cities Common Stock, for the purpose of determining the amount of Cities Common Stock to be issued on the Closing, shall be the average closing (close) price per share of Cities Common Stock for the ten (10) trading days preceding the date five (5) days prior to the Closing (i.e. if the Value of the Cities Common Stock determined as of the Closing was $16.25 per share, Cities would issue three hundred seven thousand six hundred ninety-two (307,692) whole shares of Cities Common Stock upon the Closing). Cash will be paid for any fractional shares. The number of shares of Cities Common Stock will be subject to customary antidilution adjustments for any stock splits, reverse stock splits, stock dividends, reclassifications, recapitalizations, mergers, consolidations or other changes in capital structure occurring after the determination of the Value. In the event the Value of Cities Common Stock should exceed $17.50 per share Woodward Corporation would have the option to terminate the transaction by written notification to Energy prior to the Closing. In the event the Value of Cities Common Stock should be less than $15.50 per share Energy would have the option to terminate the transaction by written notice to Woodward Corporation prior to the Closing.

2. *Formation of LLC and Transfer of Assets.* Woodward Corporation and Energy would form a Delaware limited liability company (*"LLC"*). The LLC would be structured by the parties so as to be classified as a partnership for federal tax purposes. Woodward Corporation would contribute the Undivided 55% to the LLC pursuant to an assignment and assumption agreement identifying the transferred assets and liabilities in exchange for a 55% interest in the LLC. Energy would contribute to the LLC (i) the Undivided 44% pursuant to an assignment and assumption agreement identifying the transferred assets and liabilities in exchange for an interest in the LLC and ... relating to its gas marketing

business [1%] known as United Cities Energy Marketing ("*Marketing Division*") and executory obligations of continued performance under, and liabilities with respect to the transferred gas contracts pursuant to an assignment and assumption agreement identifying the transferred assets and liabilities. Woodward Corporation and J. D. Woodward, III, and James Kifer, the shareholders of Woodward Corporation ("*Shareholders*"), would idemnify Energy as to liabilities of Woodward Corporation not assumed by the LLC. Energy would indemnify Woodward Corporation and Shareholders as to liabilities of Energy and its subsidiaries not assumed by the LLC.

The transaction would be structured so that the economic benefits of the LLC would inure to Woodward Corporation and Energy effective as January 1, 1995, notwithstanding the fact that the actual Closing may occur thereafter.

3. *Tax Classification and Tax Election.* The LLC will be structured so as to be classified as a partnership for federal tax purposes. Woodward Corporation and the Shareholders shall be responsible for all taxes associated with the sale of the undivided 45% LLC interest to Energy.

4. *Employment Agreements.* Each of the Shareholders would enter into an employment agreement with the LLC for a term of five years (annually extended by an additional year in the absence of notice to the contrary). The terms, conditions and compensation would be as mutually agreed upon by the parties as part of the definitive documentation for the transaction.

5. *Non-Competition Agreements.* Woodward Corporation, Shareholders, and Energy would enter into non-competition agreements with each other and the LLC containing customary restrictions against competition with the gas marketing business conducted by the LLC for the lesser of ten (10) years after Closing or five (5) years following the date on which Woodward Corporation or Energy, as the case may be, ceases to be a member of the LLC or the Shareholders cease to be employees of the LLC, as the case may be. The non-competition agreements would not restrict the ability of Woodward Pipeline, Inc., which is primarily engaged in the business of owning and operating gas gathering and gas pipeline systems and conducting gas marketing activities related thereto, to engage in such activities as they presently exist or may develop in the future.

6. *Operating Agreement.* The affairs of the LLC would be governed by an operating agreement by and among the LLC, Woodward Corporation and Energy which would provide for management of the LLC by a board of managers consisting of four persons, two of whom would be designated by Woodward Corporation and two of whom would be designated by Energy, subject to certain provisions requiring super-majority approval for major business transactions and other transactions outside the ordinary course of business. Subject to such super-majority provisions, the Shareholders would be delegated sole responsibility for the management of the day-to-day affairs, business, administration and operation of the LLC and all decisions of the LLC, and would have the sole authority on behalf of the LLC for the conduct of the business of the LLC.

7. *Transfer Restriction Agreement.* The members of the LLC would enter into a transfer restriction agreement providing for restrictions on transfers of the LLC interests and certain rights and obligations with respect to the sale and purchase of the LLC interests upon certain events. The Shareholders will also agree not to transfer their shares in Woodward Corporation except in compliance with the transfer restriction agreement. Energy would also agree not to transfer its shares in except in compliance with the transfer restriction agreement.

8. *Other Woodward Corporation Assets.* Prior to the Closing, Woodward Corporation would have distributed to its Shareholders (or, in the absence of a distribution, retained and not transferred to Energy or the LLC) all of its assets not described in Section 1 including without limitation cash and accounts receivable through the Closing.

9. *Representation, Warranties, Covenants and Indemnification.* The definitive purchase documentation will contain usual and customary representations, warranties, covenants and indemnification regarding the contracts of Woodward Corporation referred to in Section 1 and the liabilities associated therewith to be made jointly and severally by Woodward Corporation. Energy will make usual and customary representations, warranties, covenants and indemnifications regarding the Energy contracts assigned to the LLC referred to in Section 2 and the liabilities associated therewith.

10. *Conditions.* The continued interest of the parties in pursuing the transactions set forth herein shall be subject to customary conditions of Closing, including the following: (a) execution of mutually acceptable definitive documentation among the parties; (b) approval of the terms set forth herein by the Boards of Directors of Cities and Energy, and Woodward

approvals of all federal, state and local governmental authorities having jurisdiction over the parties or the transactions contemplated hereby; (d) expiration of any waiting periods required by law; (e) obtaining all necessary third party consents to transfer the properties including all contracts; (f) that there will be no material adverse change in the business, assets or the financial condition of Woodward Corporation or Energy since September 30, 1994; (g) satisfactory completion of the respective parties' due diligence reviews and such related matters (including, without limitation, tax matters) as they may deem appropriate; and (h) the occurrence the Closing on or before December 31, 1994 (unless another date is provided for in the executed definitive documentation).

11. *Operation of the Business*. Except for the transactions contemplated by this letter (a) Woodward Corporation will operate its business in the ordinary course through the Closing (or termination of negotiations) and will not make any material change in the business or operations or enter into any material agreements without Energy's prior consent and (b) Energy will operate the business of the Marketing Division in the ordinary course through the Closing (or termination of negotiations) and will not make any material change in the business or operations, or enter into any material agreement without Woodward Corporation's prior consent.

12. *Miscellaneous*.

(a) The Closing shall take place at the offices of Chapman and Cutler in Chicago, Illinois upon the satisfaction of all closing conditions no later than December 31, 1994, unless such date is extended by mutual agreement.

(b) No party will make any public announcement of the transaction contemplated hereby except as required by law without the prior consent of the other party, and each will cooperate with the other with respect to such public announcements.

(c) The parties shall bear their own expenses in connection with the proposed transaction.

The purpose of this letter is to outline the broad terms of the proposed transaction and to confirm the intention of the parties to proceed further. This letter does not constitute an offer by Energy and will not, following acceptance hereof, constitute a contract among the parties; no one shall have any binding obligation under this letter to enter into any definitive agreements providing for the proposed transaction or to of the parties must await the execution and delivery of the definitive documentation. This letter does not purport to cover all of the matters that will be set forth in the definitive documents.

The acceptance of this letter by Woodward Corporation and the Shareholders will, however, constitute an assurance to each other that, in absence of mutual written termination of negotiations, any pending acquisition discussions with other parties concerning Woodward Corporation, Energy Marketing Division, the capital stock of the Woodward Corporation or Energy Marketing Division or their assets, will either be terminated or held in abeyance and that no new acquisition discussions concerning Woodward Corporation, Energy Marketing Division, the capital stock of Woodward Corporation, Energy Marketing Division or their assets, with other parties will be undertaken prior to December 31, 1994; provided that this paragraph shall not restrict Energy from conducting negotiations regarding a transfer of its assets other than the Marketing Division contracts referred to in Section 2.

If you approve in principle the basic terms of the proposed transaction as outlined above, we would appreciate your signing the enclosed copy of this letter and returning the same to us prior to the close of business on October 20, 1994, at which time this proposal will terminate unless so approved. As soon as we receive an executed counterpart of the letter, we will direct our attorneys to prepare drafts of a definitive documentation for review by all parties.

Very truly yours,

UCG ENERGY CORPORATION

By_______________
President & CEO

WOODWARD MARKETING, INC.

By_______________
President

____
James Kifer

____
J. D. Woodward, III

Docket No. 97-01364
Exhibit CA-SNB____
Direct Testimony___
Schedule 7______
Page 7 of 7____

UCGE/WOODWARD MARKETING
EARNOUT SCHEDULE

Year	Operating Income From Williamette Study
1995	$3,286,000
1996	$4,117,000
1997	$4,767,000
1998	$5,226,000
1999	$5,686,000
**Total	$23,083,000

*Any short fall in operating income in one year may be made up in a later year, however, an overage in the current year may not be applied to a future year, but may be applied to year 1999 to achieve the cumulative operating income target.

**Operating income shall be calculated in accordance with Williamette Study.

Checking the Data for Accuracy

As stated in the survey description, we poll sources from all branches of the industry in order to determine a price that is a product of factors faced by the entire market. Occasionally, however, sources will report prices that substantially differ from the others within the survey sample. These outliers will certainly change the range, and could potentially skew the average, which would make the published prices unrepresentative of the actual trading activity.

As an example, suppose that we included into our previous data range a report of 25MMcf/d purchased at $1.34. This would make the range $1.19-$1.34, and change the average price from $1.22 to $1.25 ($1.252 = $1.25). If we feel that a price report is questionable, we will call that source back and ask if there were any special circumstances behind the deal. Often times outliers result from circumstances unique to that party, such as a deal completed early in the bid period when prices were at a different level, a premium paid to ensure delivery, or a price based upon predetermined contract language. If we discover that these deals were based on factors that were not experienced by the remainder of the market, then they will be removed from the data sample.

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Ellen Beswick, Editor/Publisher, has devoted the last 16 of her 30 years in journalism to the energy field. She served for three years as associate editor of *London Oil Reports* before starting *Natural Gas Intelligence* in 1981. Before that she served as a general and political reporter for *United Press International, the Boston Herald,* and *American Metal Markets.* She has a B.A. in English from Wilson College, Chambersburg, PA.

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Roger Tanner, Markets Editor, has been compiling the market report for the *NGI's Gas Price Index* and contributing to NGI since March, 1988. He had earlier worked for the *Shreveport (LA) Times, Houston Chronicle,* Pennwell Publications' *Offshore Magazine,* and *Gas Daily.* He has a bachelor's degree from Louisiana State University in journalism.

Our regular staff is also supplemented by the work of contributing journalists in other parts of the United States and Canada.

BEFORE THE

TENNESSEE PUBLIC SERVICE COMMISSION

In Re: Petition of United Cities Gas Company to Place Into Effect a Revised Natural Gas Tariff

Docket No. 95-02258

****

DIRECT TESTIMONY

OF

STEPHEN N. BROWN

****

September 25, 1995

Q. Please state your name.

A. Stephen N. Brown.

Q. What is your position?

A. I am a Senior Economist in the Consumer Advocate Division, Office of the Attorney General.

Q. What experience do you have regarding utilities?

A. From 1986 to 1995 I was employed by the Iowa Utilities Board as Chief of the Bureau of Energy Efficiency, Auditing and Research, and Utility Specialist and State Liaison Officer to the U.S. Nuclear Regulatory Commission. From 1984 to 1986 I worked for Houston Lighting & Power as Supervisor of Rate Design. From 1982 to 1984 I worked for Arizona Electric Power Cooperative as a Rate Analyst. From 1979 to 1982 I worked for Tri-State Generation and Transmission Association as Power Requirements Supervisor and Rate Specialist. From 1979 through 1995 my work spanned many issues including cost of service studies, rate design issues, telecommunication issues and matters related to the disposal of nuclear waste.

Q. What is your educational background?

A. I have an M.S. in Regulatory Economics from the University of Wyoming, an M.A. and Ph.D. in International Relations with a speciality in

International Economics from the University of Denver, and a B.A. from Colorado State University.

Q. Have you authored any articles relating to your profession?

A. Yes, I've written and published more than thirty articles dealing with issues in the gas, electric, and telecommunications industries. My articles have appeared in Public Utilities Fortnightly, the Electricity Journal, and Lightwave Magazine. I've given several public presentations and authored many in-house documents.

Q. Are you and have you been a member of any professional organizations?

A. Yes, I am a past member of the NARUC Staff Committee on Management Analysis, a past trustee of and a member of the Board for the Automatic Meter Reading Association, and a current member of the National Association of Business Economists.

Q. Have you studied mathematics and statistics as part of your education?

A. Yes.

Q. Have you used mathematics and statistics as part of your profession?

A. Yes.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to determine the appropriate market-based common equity return that United Cities (UC) should be given the opportunity to earn and to determine UC's appropriate overall cost of capital.

Q. What common equity cost and overall cost of capital should UC have the opportunity to earn?

A. UC should be given the opportunity to earn 11.48% on common equity and an opportunity to earn 10.04% for the company's overall cost of capital. My recommendation is based on two considerations: My analyses of UC's test year market-based cost of common equity, which is supported by my analysis of UC's comparable companies that are shown in Schedule 1 of my testimony; my analyses of the proposals, models, data and sources provided by Dr. Murray in his testimony and exhibits.

Q. How did you arrive at your cost of equity recommendation?

A. I used a standard Discounted Cash Flow (DCF) model and a Risk Premium model.

Q. Is your recommendation similar to Dr. Murray's cost estimate?

A. No. Although he also uses the DCF model, he recommends a return of 13.5%.

Q. Why is there such a broad difference in the recommendations?

A. The DCF analysis that I use is based on the normal assumption that the cost of equity is based on dividend yield plus dividend growth. Dr. Murray's analysis is based on the unusual assumption that the cost of equity is based on dividend yield plus earnings growth, indicated in his testimony at page 12 line 9. His earnings growth is always larger than his dividend growth. Therefore, his analysis produces an upwardly biased cost of equity. The upward bias is confirmed by Schedules 2 and 3 of my testimony. In Schedule 2 I reproduced Dr. Murray's Schedule DAM-15 but modified it by adding comments to show the basis of Dr. Murray's recommendations. Out of 18 rates that he summarizes, 12 are based on earnings growth and 6 are based on dividend growth. The far left side of Schedule 3 page 1 shows the method that Dr. Murray employed to arrive at his recommendations. Out of 12 estimates based on earnings growth, 11 are higher than the estimates based on dividend growth. It is also clear that the earnings growth rates are substantially larger than the dividend growth rates. Schedule 3 page 2 groups the recommendations according to the time period of the yield, with Dr. Murray's so-called "current yield(s)" appearing first. Even in that case, the equity cost based on dividends is lower than the equity cost based on earnings.

Q. **Is it inappropriate to use earnings growth rather than dividend growth to estimate United Cities' cost of equity?**

A. Yes. Current and potential investors get their return in the form of dividends not earnings. The two are equivalent only in the case where all earnings are paid out as dividends. That is not the case for either UC or for the sample companies that Dr. Murray uses to estimate the cost of equity. For example, referring to Schedule 3 page 2 the "current yield" category, the forecasted earnings growth rate for the small companies is 6.13% but the forecasted dividend growth is 2.53%. Comparable figures for UC are 5% for earnings growth and 4.49% for dividend growth. However, the latter figure represents historical growth not forecasted growth.

As shown in Schedule 3, dividend growth rates for the comparable companies are 3 and one-half percent below the growth rates for earnings. UC's historical dividend growth rate also lags UC's projected earnings growth. Earnings growth is not an accurate estimate of dividend growth for these companies because the projected improvement in earnings will not be matched by a corresponding improvement in dividends.

Q. **Why is there a difference between the growth rates of earnings and the growth rate of dividends?**

A. Dividends are less than the earnings because companies normally save and retain a certain portion of their earnings. That savings portion is normally referred to as a retention ratio. Dividend policy is a matter of business judgment ordinarily left to the discretion of the company's board. When dividend growth rates are substantially below earnings growth rates, the company is intent on improving its retained earnings and cash position. When dividends are nearly equal to earnings, the company is signaling that its cash need not come from retained earnings but from other sources.

Q. Do UC and the companies in Dr. Murray's cost of equity sample have similar policies with regard to dividends and the proportion of earnings saved?

A. No, my review shows that UC's policy is quite different from those companies. The five charts in Schedule 4 of my testimony show great differences in the policies and in investors' perception of the policies. For example, Chart 1 shows the historical dividend growth rates for each company, as well as the average for the group. UC's growth rate of 4.49% is higher than the average of 4.09%. Out of the 6 companies in the sample, 4 of them have lower growth rates than UC.

Q. Are the differences between UC's policies and those of the other sample companies important for establishing the cost of equity?

A. Yes, when they are taken in the context of *Value Line's* recent advice to investors. *Value Line*'s recent investment advice appears on Chart 2 of Schedule 4 and clearly suggests that UC's low retention ratio is a negative factor for any investor. UC has raised its dividends at the expense of its retained earnings ratio, which means that UC cannot possibly raise its future dividends at a rate faster than the historical growth rate of 4.49%. Therefore, Dr. Murray's cost of equity estimates that incorporate growth rates larger than 4.49% are clearly erroneous. In addition, UC's retention ratio does not compare favorably with the those of the sample companies. Chart 3 shows that for the period 1991 through 1994 UC's retention ratio was about one-half of the other companies' retention ratios. Chart 4 shows year by year comparisons of UC's retention ratio and the average retention ratio for the sample companies. Chart 4 also displays UC's stated goal of improving its equity ratio by improving its retained earnings position.

Chart 4 is a dramatic illustration of how UC's actions have departed not only from its stated policy but also from the policies of the sample companies. From 1993 to 1994 UC actually lowered its retention ratio while the sample companies raised theirs. Chart 5 displays the actual percentage changes from 1993 to 1994. For example, UC's earnings <u>declined</u> by 2.52%, but the company <u>raised</u> its dividend and actually lowered its retention ratio by 22%

from the prior year. UC's behavior stands out in stark contrast to the behavior of the sample companies. Their earnings went down by 7.7%, but they actually raised their retention ratios. The sample companies are increasing their retained earnings at a much faster pace than UC.

Q. What does the difference in retained earnings policy indicate about the means by which UC will raise its equity ratio?

A. The difference indicates that the company intends to improve its equity ratio primarily through price increases rather than through improved retention ratios.

Q. Why is UC's equity ratio important in this case?

A. UC and Dr. Murray have made the equity ratio the centerpiece of the justification to seek a price increase. However, Schedule 4 in my testimony clearly shows that the company's equity ratio owes much to its own dividend policy, where the company pays out a much higher portion of earnings to stockholders than do the other sample companies. Dr. Murray has not mentioned UC's dividend policy nor compared it to the rest of the sample companies.

Q. Are you certain that Schedule 4 of your testimony uses the same sample companies as Dr. Murray?

A. Yes. I use the same ones used by Dr. Murray.

Q. Why do you use the same companies as Dr. Murray?

A. I reviewed Dr. Murray's information on his sample companies as well as information for other gas companies. I concluded that Dr. Murray's sample was appropriate at this time because of the issues he raises in his testimony. Those issues relate directly to just and reasonable rates for Tennessee consumers who are served by UC.

Q. What are those issues?

A. There are two issues, the UC's cost of equity and UC's overall cost of capital, which takes into account UC's cost of debt. Dr. Murray asserts that UC should be given a high return on equity in comparison to the sample companies because UC has a low equity ratio in comparison to the sample companies. For example, in his testimony at page 9, lines 20-21, Dr. Murray states "...the common equity ratios for United Cities are much lower than [the ratios]... of the comparable companies." Dr. Murray believes this observation justifies a high return for UC's equity. He also links the equity return to the overall cost of capital. At page 10, lines 20-21, he states; "The low equity ratio will, all things equal, lower the total cost of capital even though the cost of common stock will be higher. Since common stock is more expensive capital than debt, the lower the common equity ratio, the lower the overall cost of capital."

Q. Do you agree with Dr. Murray's statement?

A. Yes. However, Dr. Murray qualifies his statement with the caveat "all things equal." My review of the sample companies shows that Dr. Murray's caveat does not apply to them because they are very dissimilar to UC.

Q. How is UC different than the sample companies?

A. I have already shown how the so called "cost of equity" sample companies' retention ratios and dividend policies differ from UC's policies. Those 6 companies do not represent all companies used by Dr. Murray. Referring to Schedule 1 of my testimony, he has two sets of companies. The set of companies shown at the top half of Schedule 1 are the ones he uses to develop the cost of equity. He has used those companies in addition to the ones shown at the bottom of Schedule 1 to make comparisons to UC's equity ratio and to UC's common stock returns.

I combined all those companies into one group to provide a broader and better picture of UC. Schedule 5 shows the entire group. The companies' names appear on the far left side of the schedule, and they appear in order according to their 1994 equity ratio. Schedule 5 shows a different picture of UC than the one presented by Dr. Murray.

Q. What does Schedule 5 show?

A. Descriptions of the major findings appear in text boxes to the right and to the left of the data. The most important finding regards UC's cost of debt. According to UC's filing, at the end of 1994 the company's debt cost was 9.8%, a cost well above the sample's average and a cost approached only by one other company, LaClede Gas. UC's debt cost is far, far out of line with the debt costs of other companies. Therefore, Dr. Murray's assertion, "The low equity ratio will, all things equal, lower the total cost of capital," is invalidated because all things are not equal.

Q. Have you gathered information on UC's debt and the terms and conditions of that debt?

A. Yes. I acquired information on UC's first mortgage notes.

Q. How did you acquire the information?

A. I issued CA data requests #106 and #108. In #106 I asked the company to provide copies of the current redemption and call provisions of their notes. In #108 I asked the company to provide copies of any analysis where the company considered achieving interest savings by retiring bonds before their maturity date.

Q. Why did you make those requests?

A. When I prepared Schedule 5 I noticed UC's debt cost was much higher than the debt cost of other companies. I also know from other ongoing dockets before the Commission that other companies within the Commission's jurisdiction have extensively refinanced their debt.

Q. **What are your findings from CA data requests #106 and #108?**

A. My findings appear in Schedule 6. It is a summary of the UC's debt and the debt terms that UC has agreed to. The company has agreed to terms that preclude the company from refinancing its debt when interest rates decline.

Q. **Is there something wrong with that?**

A. Yes. It is not a fair and just sharing of interest rate risk between the company and consumers.

Q. **What risk are you referring to?**

A. The risk I refer to is the additional economic burden UC imposed on consumers when the company agreed to preclude the refinancing of its notes at lower interest rates. People and companies in debt normally have an opportunity to alleviate their economic burden when interest rates decline. UC has precluded that option in the terms and conditions that govern the early redemption of Notes P through V. In December 1989, for example, UC issued Note R to the John Hancock insurance company and agreed never to refinance that debt. By agreeing to terms that preclude refinancing, UC took a risk that it would never have to pay for because every penny of UC's interest costs for these notes is passed on to consumers.

Q. Has UC's preclusion of refinancing had any benefits for consumers?

A. None that I know of.

Q. Do you believe that UC took a risk when it agreed to preclude refinancing of its notes?

A. Yes, as I indicated earlier.

Q. Do you know of anyone else who share's your opinion?

A. Yes. UC's debt financing was reviewed by the Liberty Consulting Group in its *Management Audit of United Cities Gas Company*. At the bottom of page II-13 of its report Liberty states: "This calculated risk assumed by UCG at the time of the bond issuance did not pay off during the recent declining interest rate environment."

Q. What did Liberty say about the redemption provisions in UC's notes?

A. At the top of page II-14 of its report, Liberty commented on the redemption terms of UC's notes: "In such make-whole [redemption] and non-call provisions, the bondholder takes no future interest rate risk, which is passed to the bond issuer through such an agreement."

Q. Do you agree with Liberty's comment that the interest rate risk is passed to the bond issuer, UC in this case?

A. No. UC bears no risk because it passes 100% of the notes' interest costs directly to consumers. Consumers are bearing all risk, not UC.

Q. In situations where UC passes 100% of the interest cost to consumers, does the UC have any incentive to seek more favorable debt provisions?

A. No, none at all.

Q. If the company is allowed to continue to pass 100% of such costs on to consumers, does the company have any incentive to seek more favorable debt provisions for any note the company may issue in the future?

A. No, none at all.

Q. Do you believe consumers are well served and treated fairly by the redemption terms of UC's bonds?

A. No.

Q. Is your opinion influenced by Liberty's finding?

A. No.

Q. Why not?

A. In the course of my review of UC's filing and my subsequent data requests of the company, I had already become well aware of UC's debt terms before I knew of Liberty's audit. After I reviewed the company's responses to CA data requests #106 and #108, I discussed the issues with Mr. Hickerson. He then informed me of Liberty's report.

Q. What is the impact of UC's debt terms on consumers?

A. On the face of it, UC has abandoned its consumers for the next 10 to 20 years to bear the burden of interest rates that are now 2 to 3 points above the market cost of capital. UC has agreed to terms that literally turn upside-down the common sense notion that if interest rates decline enough, then companies, individuals and homeowners should refinance their debt. The heart of UC's problem is demonstrated in a March 26, 1993 letter from PaineWebber to Ms. Stephanie Castle of United Cities. A copy of that letter, acquired in CA data request 108, is attached to my testimony. The very last line of the letter's first page says: "Therefore, as...yields decline, it will be more **uneconomical** to refinance [emphasis added]." This is just the opposite of saying: "As interest rates decline, consider refinancing." The refinancing opportunities and lightened economic burden that have been offered to consumers and companies all over the country in the past three years are denied to UC's consumers now and for at least the next 10 years. I believe this is unfair to UC's consumers and places a burden on them that they cannot escape from, as if they were locked up in a debtor's prison for the duration of the bonds' life.

Q. Were the rates that UC achieved, at the time it issued the bonds, comparable to market rates?

A. Not necessarily. The answer depends on the bond rating UC may have had at the time it issued the bonds. UC's current bond rating is Baa. Schedule 7 of my testimony provides a history of market rates by grade of bond for nearly all months from January 1987 through May 1995. UC's bond rate and month of issue are also shown. In the case of Note R, UC's rate was definitely not comparable. Page 2 of the Schedule shows that comparable Baa rates were approximately 9.8% when UC agreed to issue an 11.32% bond directly to the John Hancock insurance company. In the case of Notes P and Q, issued at 10.43% and 9.75% respectively, the rates were similar to market rates but not below them and not low enough to abandon any and all hope of refinancing.

Q. Is it typical for note issuers to abandon completely the opportunity for refinancing?

A. No. It is typical to have "no call" provisions for the first five years of a note's life. That means a company agrees not to refinance for five years, after which it may or may not refinance depending on prevailing interest rates. Five years is considered a typical holding period to capture the long-term perspective of a bondholder. For example, every week Federal Reserve publication G15 publishes the rates for A rated utility bonds that have a maturity of 30 years and a "no call" provision for five years.

Q. **What are the implications of UC's debt cost and UC's retention ratio for the rate of return that may granted to UC's common equity?**

A. Any link between the company's rate of return and its equity ratio should be severed. Raising UC's equity return to compensate for its low equity ratio is not justified because the equity ratio is caused by UC's poor retention ratio and extremely high cost of debt. Raising UC's equity return to compensate for its low equity ratio would reward the company for its poor retention ratio and for its extremely high cost of debt.

Q. **What alternative do you recommend?**

A. UC's rate of return to common equity should be based on the normal DCF model where the cost of equity is the sum the company's current dividend yield and dividend growth.

Q. **What are the values UC's of current dividend yield and dividend growth?**

A. Schedules 8 and 9 respectively show the current dividend yield as 6.41% and the current dividend growth rate as 4.49%. These sum to 10.90%, my recommended cost of equity based on the DCF model.

Q. In addition to your DCF model, did you use another method to determine the market based cost of common equity?

A. Yes. I used the risk premium method which defines the cost of equity as the market's current debt yield plus an estimated risk premium. For example, a current debt yield of 7% plus an estimated risk premium of 3% produces an estimated common equity cost of 10%.

Q. What is the rationale of a risk premium?

A. Investors require a premium to assume additional risk. Equity investment is thought to be riskier than debt, thus equity investors require a higher return than debt. For example, equity holders are residual for distribution of earnings and also last in line for distribution of liquidation proceeds. Therefore, the cost of equity is the debt yield plus a risk premium for the company.

Q. What do you use as debt yield?

A. Because UC's bonds currently retain a Baa rating, I use the monthly average of Baa-rated bonds for the most recent 12 months prior to this hearing, September 1994 through August 1995.

Q. **Why do you use these months instead of the test year?**

A. Current data indicates the current trend in capital cost. In this instance capital cost has been declining steadily since December 1994. Schedule 10 in my testimony provides information on Baa-rated bonds from January 1993 through August 1995.

Q. **Why do you use the Baa rates as a measure of debt yield instead of UC's embedded debt cost?**

A. Risk premium analysis is based on market wide indicators of current debt cost instead of a company specific embedded cost. Using a company specific embedded cost would mean that the company with the highest debt cost would also receive the highest return to equity. Conversely, the company with the lowest debt cost would receive the lowest return to equity. Thus using a company specific debt cost to establish a risk premium would introduce incentives for companies to raise their debt cost as much as possible. That is bad logic and bad financial management. Fortunately, the markets don't work that way. A company's return to equity is not guaranteed to be a certain amount higher than the company's debt cost.

Q. **Why do you use the Baa rates as a measure of debt yield instead of the average debt cost of**

the sample companies shown in Schedule 5?

A. That average would not reflect current market rates for Baa bonds markets, the current market that UC is in.

Q. What is a risk premium?

A. It is the difference of required returns between two specific securities with different risks. It is generally thought of as the difference between a market wide risk free investment and the market wide rate of return for common equity.

Q. What do you use as the market wide risk free investment?

A. In this case I use three-month U.S. Treasury bills.

Q. Why is it appropriate to use that measure?

A. Investors are absolutely certain what cash flows will be received and when they will be received. There is no risk of default or loss of principal in a three month period. The nearness of maturity eliminates the risk of price depreciation and loss of principal. In the stock market, principal loss and price drops can occur overnight and be permanent if the stock price is heavily influenced by expectations of a change in interest rates. Chart 1 of Schedule 11 shows the interest rates for Baa-rated bonds and UC's stock price from January 1993 through July 1995. UC's stock price is very sensitive to interest rates. Its price dropped well over 20% from November 1993 to November 1994. When a company's stock price is heavily influenced by the expectation of and the actual changes in interest rates, as in UC's case, the risk free investment is the three month bill.

Q. Are there other reasons why UC's stock prices have declined?

A. There may be, but I know of nothing to indicate that I should use something other than the three-month Treasury Bill to derive a risk premium.

Q. Is it always appropriate to use a three month bill as a measure of the risk free rate?

A. No. If a company's stock price is not heavily influenced by interest rates, then another measure would be more appropriate. If a major technological change is imminent in the industry or if it is expected to get access to markets that have been denied to it previously as a matter of law, a longer term measure would be more appropriate.

Q. What do you use as the market rate of return?

A. The market wide rate of return to common stock.

Q. How do you measure these items?

A. I use *Ibbotson Associates'* data. To measure the market wide rate of return to common stock, I use *Ibbotson*'s common stock total return index from 1925 through 1994. To measure the risk-free rate of return, I use the three-month Treasury total return index from 1925 through 1994. These are shown as the first two columns in Schedule 11. From these I develop the market wide normal and lognormal risk premiums, the last two columns of the schedule.

Q. Which market wide risk premium do you use?

A. I use the lognormal risk premium.

Q. Why did you make that choice?

A. *Ibbotson Associates* recommends the lognormal model as a better method for estimating market behavior. In its *1995 Yearbook* at page 169, *Ibbotson Associates* states "the lognormal distribution ... [is] a more accurate characterization of the behavior of market returns than ... the normal distribution."

Q. What would happen if the so-called normal risk premiums were used?

A. If the normal premiums were used the risk premium would be overestimated and the resulting cost of equity would be overstated. For example, the risk premium estimate would jump by two full percentage points from 6.08% to 8.25%, indicated by the arithmetic averages near the bottom of Schedule 11.

Q. What is the calculation to derive the lognormal risk premium?

A. To calculate the lognormal risk premium, take the normal risk premium and add 1, then calculate the natural logarithm of that total. For example, referring to Schedule 11, in 1993 common stocks had a risk premium 6.89% higher than Treasury Bills. To calculate the lognormal risk premium for 1993, I found 6.67% as the natural logarithm of 1.0689.

Q. Why did you calculate the natural logarithm?

A. I followed the procedure described in *Ibbotson Associates* 1995 Yearbook at page 168-169, which states "In the lognormal model the natural logarithms of asset *return relatives* are assumed to be normally distributed... if an asset has return of 15 percent in a given period its *return relative* is 1.15." The natural logarithm of 1.15 is 13.98%. It is clear that there is systematic difference between the normal and lognormal distribution. It is also clear that *Ibbotson Associates* recommends the lognormal model as the better estimator of market behavior.

Q. Is the market wide risk premium the same thing as a company risk premium?

A. Not necessarily. Risk premium analysis requires estimating the statistical relationship between returns to the company stock and market wide-returns, a relationship commonly represented by the Greek letter "Beta", β.

Q. What does it measure?

A. The company's risk relative to the market as whole. The market itself has a beta of 1. If the company's beta is one, then the company risk premium is the same as the market wide risk premium. Thus if a company's beta is less than 1, then the company is judged less risky than the market. Beta is also used to compare the relative riskiness. For example, a beta of 0.4 is less risky than a beta of 0.6.

Q. Did you calculate betas for the sample companies?

A. Yes. They appear in Schedule 12. The analysis includes those companies in Schedule 1, the same ones used by Dr. Murray. The betas are calculated in succeeding intervals for a 60 month periods from August of 1994 through the most recent data available before this hearing.

Q. How did you derive the betas?

A. I used the monthly percentage change in the S&P 500 index to represent the market wide return and the monthly percentage change in the company's stock price to represent the company's return. The change is calculated as:

Price at the end of the month divided by price at the beginning of the month -- the result is converted to a natural logarithm and then the beta was calculated.

Q. Why did you use natural logarithms?

A. To be consistent with *Ibbotson Associates'* recommendation about lognormal returns being a better representation of market behavior. In addition, my procedure follows *Value Line's* method, which also uses natural logarithms to calculate betas. *Value Line* adjusts its calculated betas. The formula is: adj beta = .35 + .67(calculated beta). I do not adjust the betas.

Q. Why not?

A. *Value Line* believes all betas tend towards the value of 1. However, this pattern does not characterize the calculated betas, which tend to move away from 1 for the twelve month period from August of 1994 through July of 1995. *Value Line* bases its adjustment on an article titled "On The Assessment Of Risk" which was authored by Marshall Blume of the University of Pennsylvania. Professor Blume's article was published in the March 1971 issue of the *Journal of Finance*. The portfolios in Blume's article were formed between the years 1926 and 1968. His most recent portfolio is now thirty years old. His inquiry has not been updated. Given the antiquity of Blume's research and the fact that my results do not conform to his findings, there was no good reason to adjust the betas.

Q. **What are the results of your risk premium analysis?**

A. Schedule 13 shows an equity cost of 10.84%.

Q. **Have you compared your DCF and risk premium results with any other estimate of the gas industry?**

A. Yes. Merrill Lynch provides DCF and risk premium results for various industry groups. The estimates for the gas distribution industry from January 1995 through August 1995 are shown in Schedule 14. Their estimates are similar to those in my testimony.

Q. **What cost of equity are you recommending that the Commission grant?**

A. Based on my DCF and risk premium analyses I recommend the Commission grant a return of 10.87%, which is the midpoint between the DCF model's result, 10.9%, and the risk premium model's result, 10.84%. Based on my knowledge of the continuous nature of a utility's financial processes, this rate gives the company an opportunity to earn a rate of 11.48% on equity. This rate is independent of UC's equity ratio and UC's embedded cost of debt. Neither the equity ratio nor the debt cost play any role in the derivation of the rates, unlike Dr. Murray who predicates his rate recommendations on UC's equity ratio.

Q. Does that conclude your cost of equity testimony?

A. Yes.

CAPITAL STRUCTURE AND COST OF DEBT

Q. Have you prepared an estimate of the capital structure and debt costs for UC?

A. Yes. Schedule 15 page 1 shows those items.

Q. Is that structure and debt cost the same as what UC filed?

A. No. My estimated capital structure and debt cost are very different from what UC filed.

Q. Why did you make your own estimates instead of using UC's filed information?

A. I do not agree with UC's representation of capital structure and debt cost.

Q. What has UC represented as its capital structure?

A. In its filing UC represents it capital structure as the amounts shown in UC's exhibit work papers, page 170, which the company designates as Exhibit 10 page 1 of 2. The exhibit and its supporting data in pages 172-184 of UC's work papers constitute the supporting information for Dr. Murray's schedule DAM-1. At page 6 line 18 of his testimony Dr. Murray describes the capital amounts and capital costs shown in DAM-1 as "the total capital appropriate for this proceeding."

Q. Do you agree with Dr. Murray that Schedule DAM-1 is appropriate for UC?

A. No. Schedule DAM-1 and its supporting documentation, Exhibit 10 of UC's work papers, do not match the capital that the company says it has.

For example, at page 40 of UC's annual report for 1994 the company shows capital as $262.4 million, with 45% as equity and 55% as long term debt. However, Exhibit 10 shows that as of December 31, 1994 the company's so called utility operations had total capital of $248.4 million, with 39% as equity, 52% as long term debt and 8% as short term debt. In addition, Dr. Murray's Schedule DAM-1 is based on a projected capital structure for UC's so called utility operations as of November 30, 1996. In that structure total capital is $289.3 million with 44% as equity, 49% as long term debt and 7% as short term debt. Thus there are three very different capital structures to choose from: One for the entire company as of December 1994; one for the so called utility operations as of December 1994; and one for the so called utility operations as as of November 1996.

Q. Which one do you use?

A. I use the equity and long term debt amounts for the total company as of December 1994. I also factor in a short term debt amount based on the average short term debt ratio for UC's sample companies for the period 1990 - 1994. I also adjust the cost of long term debt.

Q. Why do use the equity and the long term debt amounts for the total company as of December 1994?

A. Those figures are more reliable than the information in the other two capital structures. For example, the so called utility capital structure for November 1996 is clearly the ultimate result of the company's allocation of capital between the company's so called utility operations and its subsidiaries. To assess the reasonableness of the allocation it is necessary to know what the entire company's capital structure would be as of November 30, 1996. In CA data request 104 I asked the company to provide such a structure. The company responded, "The information does not exist." Therefore, I was reluctant to use the projected November 1996 capital structure as the structure in this case.

Q. Is that the only reason you were reluctant to use that structure?

A. No. There were others. The company's projected utility capital structure for November 1996 includes a bond for $20 million at 8.5% that UC expects to issue between now and the end of 1996. Given the problems I have already discussed regarding the company's willingness to preclude the refinancing of its notes, I excluded the projected note from the debt. Regarding the company's current debt, I reviewed the company's most recent 10-K form, a report the company files regularly with the Securities and Exchange Commission. That document shows that about $20 million of debt has been excluded from the debt amounts filed by UC in this docket. The cost of that debt is much lower than the cost of debt in the company's filing.

Q. Do you know if UC has filed any testimony that explains the company's decision to exclude low cost debt from its filing?

A. No. I have not read nor have I seen any such testimony.

Q. What are your other reasons for using the entire company's capital structure?

A. There is no substantive distinction between utility operations and nonutility operations. For example, the company's gas storage field represents a goodly portion of the debt that UC excluded from the so called utility structure. However, the expenses for that field are priced out at the rate of return granted to UC in

Docket No. 92-02987. Pages 137-139 in the company's work papers for rate base accounting adjustments show the procedures. The company identifies the storage field as utility plant. Thus the company identifies the storage field as utility plant while excluding the storage field's debt from the overall debt structure it filed in this docket. UC also calculates the field's expenses on the basis of the return granted to UC in Docket No. 92-02987. That return to my knowledge does not distinguish between so called utility and nonutility operations.

UC's inconsistent treatment of the storage field's debt shows there is no substantive distinction between so called utility and nonutility operations. This is confirmed by other factors: The company's dividends and dividend growth are not subdivided between utility and nonutility groups; Dr. Murray's cost of equity analysis is based almost entirely on UC's total capital structure rather than a "utility only" structure; the earnings forecast of 5%, used by Dr. Murray in his DCF analysis, is not subdivided between utility and nonutility groups; his schedules DAM-4 to DAM-15 do not make any distinction between utility and nonutility groups; UC's historical growth rate of 4.49% is not subdivided between utility and nonutility groups. In sum, the company has provided no good reason to maintain the distinctions presumed in Dr. Murray's schedule DAM-1 and in Exhibit 10 of its work papers.

Q. Why did you change the company's short term debt amount?

A. I took into account the observation offered by Dr. Murray at page 9 lines 10-12 of his testimony where he states: "...in this proceeding the capital structure used for rate making included short-term debt...even though they are arguably not part of the permanent capital structure." I agree with his sentiment about short term debt, but I do not exclude it entirely from UC's structure. However, the proportion of UC's short term debt, 7% in the overall capital structure, is excessive when compared to the short term debt proportions of UC's sample companies. To determine the appropriate proportion, I examined the capital structure ratios of Dr. Murray's sample companies and calculated an average proportion of short term debt. The calculated result is 2.63%, shown on page 1 of Schedule 15. The supporting calculations are shown in Schedule 16.

Q. What cost do you recommend for short term debt?

A. I recommend a cost of 5.75%, the mid point of short term rates prevailing in July for commercial paper, directly placed financial paper and bankers acceptances. In UC's form 10-K the company says it uses banker's acceptance notes for interim financing. The current rate for banker's acceptance notes is much lower than the rate of 8.5%, the company's suggested cost of short term debt.

Q. What is the cost of long term debt in your capital structure?

A. I use a cost of 8.69%. It is based on adjustments to the interest rates for UC's P, Q and R notes, as well as an adjustment to the issue expenses for the R Note.

Q. What adjustments have you made to the company's interest cost of long term debt?

A. The adjustments appear on Schedule 15 page 2. The adjustments to Notes P and Q are based exclusively on the Baa rates available in the market five years after the note was issued. The five year lag takes into account the typical "no-call for five years" standard I mentioned earlier. The procedure I used to derive the estimate of the prudent rates appears on page 5 of the schedule. There are two adjustments to Note R. The first one reflects the prevailing Baa rates at the time Note R was issued. Note R's rate of 11.32% is well above the Baa rate of 9.82% that prevailed in November and December of 1989. The R Note's rate is also much higher than the Q Note's rate which UC issued just four months later, in April 1990.

Q. Why did you make the adjustments?

A. I made the adjustments to take into account what the prudently incurred interest rates would be today for those notes if UC had not precluded refinancing.

Q. Do you believe UC acted imprudently when it precluded refinancing?

A. Yes.

Q. Why do you believe UC acted imprudently?

A. The company has provided no analysis or study that is contemporary to its decision to preclude refinancing, where the analysis explains or justifies that decision in terms of the impact on consumers.

Q. Do you believe UC made a mistake by relying on private placement for its bonds instead of issuing the bonds in the public market?

A. Yes. In the private markets the bondholders typically dictate terms that prevent refinancing. When bonds are issued in the public market the issuer becomes publicly known as a purveyor of sound securities. Private placement reduces the visibility of the issuer makes it a virtual unknown in the public market, which tends to reinforce the issuer's dependence on institutional lenders regarding future debt. Institutional lenders, such as the insurance companies that hold UC's notes, are very sophisticated investors who have the ability to extract terms that make illusory any economies of private placement. This is amply demonstrated by the preclusion of refinancing for UC's notes.

Q. Are you aware that the Tennessee Public Service

Commission approved UC's issue of the notes you are referring to?

A. Yes. The Commission approves a bond issue in accordance with T.C.A.§ 65-4-109. As a lay person who has read that Code, it appears to me the TPSC can withhold such approval only under two conditions. The Commission can withhold approval if the proposed issue is not in accordance with the law. The Commission can withhold its approval if the Commission does not approve of the bond issue's purpose. As a lay person, it seems to me that the Commission's approval of the bond issue does not mean that the Commission implicitly or explicitly approved of the bond's terms and conditions.

Q. Do you know if the Commission was aware of the redemption terms for UC Notes P and Q?

A. I do not know of any evidence showing that the Commission was aware of the redemption terms.

Q. Do you know if the Commission was aware that UC's redemption terms for Notes P and Q precluded retirement of those bonds in the case where interest rates declined?

A. I do not know of any evidence showing that the Commission was aware that Notes P and Q could not be economically redeemed in the case where interest rates declined.

Q. Did you review the Commission's orders

approving UC's issue of Notes P, Q and R?

A. Yes.

Q. What did you find?

A. With regard to Note P, I found nothing in the order, issued September 22, 1987 in Docket U-87-7523, indicating that the preclusion of refinancing was brought to the Commission's attention. With regard to Note Q, I found nothing in the order, issued November 15, 1989 in Docket 89-12434, indicating that the preclusion of refinancing was brought to the Commission's attention. With regard to Note R, I found in the order, issued November 15, 1989 in Docket 89-12434, the following Commission staff analysis which was incorporated into the order: "... Due to the restrictive covenants on Union's debt, UCGC must maintain Union's interest rate of 11.32% rather than refinance the debt at a lower rate. Hence UCGC's cost of capital may increase to the detriment of Tennessee rate payers...
The Commission may wish to revisit this matter in UCGC's next rate case...and...reduce the interest rate on this portion of UCGC's debt for rate making purposes..." In Note R's instance it is clear the Commission knew refinancing was precluded, thus the Commission reserved its right to reconsider the note's interest rate in future rate cases. I believe had the Commission known that Notes P and Q precluded refinancing, the Commission would have reserved its right to reconsider those

notes' interest rates in future rate cases.

Q. Based on your lay reading of T.C.A.§ 65-4-109 and your review of the orders approving the issue of UC's Notes P, Q and R, if the Commission cannot prevent a company from issuing a bond issue on the basis of its terms and conditions, does the Commission have to accept those terms and conditions when determining the cost of money?

A. As a lay person I believe the correct answer is "No." While the Commission may be required to approve the issuance of the bond, the Commission does not have to accept imprudently incurred costs when setting rates.

Q. What is your recommendation to the TPSC regarding UC's interests cost for Notes P, Q and R?

A. For the purpose of setting UC's cost of long term debt, I recommend that the TPSC disallow the imprudently incurred interest expense for Notes P and Q. I recommend the Commission reduce interest costs for Note R in accordance with the reservations the Commission expressed in its order approving the issue of Note R. For the P note the imprudent expense is approximately $508,000 annually, based on Note P's apparent prudent rate appearing at the bottom of Schedule 15 page 5. For the Q Note the imprudent expense is approximately $290,000 annually, based on Note P's apparent prudent rate appearing at the bottom of Schedule 15 page 5. For the R Note the expense reduction is approximately $388,000 annually. That amount is derived in two adjustments. The first is based on Note R's rate at the time the note was issued. Note R's rate of 11.32% is well above the Baa rate of 9.82% that prevailed in November and December of 1989. The Baa rates at that time appear in Schedule 7 page 2 near the top of the page. The second adjustment is based on difference between the prevailing Baa rates in December 1989 and Note R's rate appearing at the bottom of Schedule 15 page 5.

Q. Why are you making this recommendation?

A. I make this recommendation because I believe the available evidence shows the company agreed to financial contracts without understanding them, indicated by PaineWebber's March 26, 1993 letter. In the letter PaineWebber explains to the company the nature of private placement investors and the terms governing the early redemption of Notes O through V. Just before closing its letter PaineWebber informs the company that as interest rates decline "it will become more uneconomical for an issuer to refinance" the notes. On the face of it the letter is the act of a teacher educating and instructing a student who is not knowledgeable about the subjects of private-placement bond markets and the redemption terms mandated by such markets. The company's education came too late. It should have had such knowledge before it issued the notes and well before 1993. Therefore, UC agreed to the notes' terms without prudently assessing alternatives between public and private placement at the time the bonds were issued and without prudently assessing what private placement would do to the economic welfare of consumers. I further believe the evidence strongly suggests that the burden of such terms fall squarely and totally on consumers. They must pay a higher price for gas service than they would otherwise have to pay if UC had not precluded refinancing when it issued the notes. I also believe it is in the best interests of consumers for the Commission to reduce the interest expense of the R Note.

Q. What other disallowance are you proposing?

A. For the purpose of setting UC's long term debt cost, I am also proposing that a portion of Note R's issue expense be disallowed from the company's amortization balances and net annual amortization. Note R had an issue expense of 5.88% of the note's value. Schedule 17 shows issue expenses for Notes N through V. Note R's issue expense, like its interest rate, is far out of line with the issue expense for the other notes. On Schedule 15 pages 3 I have proposed to reduce that expense from 5.88% to 2.18%, the maximum expense incurred for the remaining notes.

Q. Why are you making this recommendation?

A. The expenses are an enormous portion of the note and drive up the effective cost of that note. For example, according to the column titled "cost of money" in Schedule DAM-2 of Dr. Murray's testimony, the issue expense raises the real cost of Note R from 11.32% to 12.298%. The increase from 11.32% to 12.298% is much higher than the increases in the other notes when their issue expenses are rolled into the interest cost. This adjustment lowers Note R's interest costs.

Q. Did you make an adjustment to the issue expense of the other notes?

A. No. Their expenses as a proportion of the note were consistent with each other.

Q. What overall cost of capital are you recommending the Commission grant?

A. I recommend the Commission grant a cost of 9.57%. Based on the continuous nature of a utility's financial processes, this rate gives the company an opportunity to earn a rate of 10.04% on the overall cost of equity.

Q. Are there other issues that could be raised concerning this company's cost of capital?

A. Yes, if I had more time I would have raised more fully the issue of a utility's financial processes which I discuss in Docket 95-02116.

Q. Does that conclude your testimony?

A. Yes.

PaineWebber Incorporated
1285 Avenue of the Americas
New York, NY 10019
212 713-4736

Mark I. Bernstein
Vice President

PaineWebbe

March 26, 1993

Ms. Stephanie Castle
United Cities Gas Company
5300 Maryland Way
Brentwood, TN 37027

Re: Make-Whole Provision

Dear Stephanie:

Please find attached seven separate schedules detailing the make-whole premiums which would be due to the holders of each specific series of bonds should United Cities opt to prepay them. We have calculated the premium for the Series O, R, S, T, U ,V of United Cities and the Series J of Greeley. Keep in mind that these premiums will fluctuate with any increases or declines in Treasury Yields. For the 10.43% Series of 2017, we have forwarded a refunding analysis under a separate letter to Jim Ford.

Typical private placement investors can be described as "buy and hold" investors. The investor has purchased an asset which is "matched" against a liability, whether directly or indirectly, and expects the asset or in this case, the bond to remain outstanding for the life of the issue. The investor always gives the best pricing (at the time of circle) for issues with either a non-call or make-whole provision. The make-whole provision is better than a non-call provision since it gives the issuer the flexibility to prepay the bonds at any time. The investor will grant this flexibility to the issuer because the make-whole provision insures that the investor is economically indifferent or "made-whole" in the event of prepayment.

The make-whole premium will fluctuate with moves in Treasury yields. As yields increase, the premium will decrease and conversely, as yields decrease, as has been the case in recent years, the premium will increase. The reason for this is that the investor must purchase more (face amount) Treasuries at a lower yield to maintain the same cash flow as the higher yielding bonds in order to be "made-whole". Therefore, as Treasury yields decline, it will become more uneconomical for an issuer to refinance.

When Treasury yields approximate or exceed the coupon on the Bonds, the investor can purchase the same amount of Treasuries at the same or higher yield to replace prepaid bonds and therefore there is no make-whole premium and the bonds are prepayable at par.

If you have any questions or comments please feel free to call me at (212) 713-4786.

Sincerely,

Mark

Attachments

UNITED SAMPLE COMPANIES

SAMPLE OF SMALL COMPANIES USED BY DR. MURRAY FOR ESTIMATING COST OF EQUITY AND FOR MAKING COMPARISONS OF EQUITY RATIOS AND COMMON STOCK RETURNS

Companies Appear In Order By Market Value

	Price Per Share Dec 31,1994	Shares at Year End (Millions)	Market Value ($ Millions)
Atmos Energy Corp (ATO)	17.00	15.35	260.90
Conn. Nat. Gas (CTG)	24.38	9.93	242.07
Energen (EGN)	22.00	10.91	240.04
Conn. Energy (CNE)	19.50	8.76	170.72
Cascade Nat Gas Corp (CGC)	13.75	8.91	122.53
Providence (PVY)	15.88	5.60	88.93

ADDITIONAL SAMPLE COMPANIES USED BY DR. MURRAY FOR MAKING COMPARISONS OF EQUITY RATIOS AND COMMON STOCK RETURNS

Companies Appear In Order By Market Value

	Price Per Share Dec 31,1994	Shares at Year End (Millions)	Market Value ($ Millions)
Brooklyn Un Gas Co (BUG)	22.25	48.06	1069.36
Peoples Energy Corp (PGL)	26.13	34.90	911.91
Washington Gas Lt Co. (WGL)	33.50	23.39	783.54
Atlanta Gas Light Co. (AGL)	30.00	25.60	768.00
Indiana Energy Inc. (IEI)	20.50	22.56	462.40
Northwest Natural Gas (NWNG)	29.56	13.30	393.00
Bay St Gas Co (BSG)	24.00	13.39	321.31
LaClede (LG)	19.88	15.71	312.20

REPRODUCTION OF UNITED CITIES SCHEDULE DAM-15 WITH ADDED COMMENTS FROM CA WITNESS BROWN

Comments added to explain basis of Dr. Murray's summary.

UNITED CITIES GAS COMPANY

SUMMARY OF DISCOUNTED CASH FLOW ANALYSIS

	– DCF RANGE –			
	HIGH	BASED ON	LOW	BASED ON
CURRENT YIELDS				
UNITED CITIES GAS COMPANY-HISTORICAL	12.41%	Earnings Growth	10.89%	Dividend Growth
UNITED CITIES GAS COMPANY-FORECAST	11.57%	Earnings Growth	11.40%	Earnings Growth
SMALL GAS DISTRIBUTION COMPANIES' AVERAGE	12.33%	Earnings Growth	8.63%	Dividend Growth
1995 YIELDS				
UNITED CITIES GAS COMPANY-HISTORICAL	12.53%	Earnings Growth	10.77%	Dividend Growth
UNITED CITIES GAS COMPANY-FORECAST	11.69%	Earnings Growth	11.28%	Earnings Growth
SMALL GAS DISTRIBUTION COMPANIES' AVERAGE	12.83%	Earnings Growth	8.39%	Dividend Growth
1994 YIELDS				
UNITED CITIES GAS COMPANY-HISTORICAL	12.54%	Earnings Growth	9.78%	Dividend Growth
UNITED CITIES GAS COMPANY-FORECAST	11.70%	Earnings Growth	10.29%	Earnings Growth
SMALL GAS DISTRIBUTION COMPANIES' AVERAGE	12.74%	Earnings Growth	7.46%	Dividend Growth

Exhibit CA-SNB____
Schedule 3 ______
Page 1 of 2______

UNITED CITIES' DCF ESTIMATE OF ITS COST OF EQUITY IS HEAVILY INFLUENCED BY THE USE OF EARNINGS GROWTH RATES. A DCF MODEL IS NORMALLY BASED ON DIVIDEND GROWTH RATHER THAN EARNINGS GROWTH.

An upward bias in Dr Murray's analysis

EARNINGS GROWTH RATES TREATED AS IF THEY ARE **DIVIDEND** GROWTH RATES

METHOD	DR MURRAY'S GROWTH RATE	DIVIDEND YIELD	DR MURRAY'S ESTIMATED EQUITY COST Highest to Lowest	TIME PERIOD OF YIELD	COMPANY	IS DIVIDEND GROWTH RATE HISTORICAL OR FORECAST?
Dividend Yield + ***Earnings*** Growth Rate	6.13%	6.70%	12.83%	1995 Yield	Average of Small Companies	Forecast
Dividend Yield + ***Earnings*** Growth Rate	6.13%	6.61%	12.74%	1994 Yield	Average of Small Companies	Forecast
Dividend Yield + ***Earnings*** Growth Rate	5.84%	6.70%	12.54%	1994 Yield	United Cities	Historical
Dividend Yield + ***Earnings*** Growth Rate	5.84%	6.69%	12.53%	1995 Yield	United Cities	Historical
Dividend Yield + ***Earnings*** Growth Rate	5.84%	6.57%	12.41%	Current Yield	United Cities	Historical
Dividend Yield + ***Earnings*** Growth Rate	6.13%	6.20%	12.33%	Current Yield	Average of Small Companies	Forecast
Dividend Yield + ***Earnings*** Growth Rate	5.00%	6.70%	11.70%	1994 Yield	United Cities	Forecast
Dividend Yield + ***Earnings*** Growth Rate	5.00%	6.69%	11.69%	1995 Yield	United Cities	Forecast
Dividend Yield + ***Earnings*** Growth Rate	5.00%	6.57%	11.57%	Current Yield	United Cities	Forecast
Dividend Yield + ***Earnings*** Growth Rate	5.00%	6.40%	11.40%	Current Yield	United Cities	Forecast
Dividend Yield + ***Earnings*** Growth Rate	5.00%	6.28%	11.28%	1995 Yield	United Cities	Forecast
Dividend Yield + ***Earnings*** Growth Rate	5.00%	5.29%	10.29%	1994 Yield	United Cities	Forecast
Dividend Yield + ***Dividend*** Growth Rate	4.49%	6.40%	10.89%	Current Yield	United Cities	Historical
Dividend Yield + ***Dividend*** Growth Rate	4.49%	6.28%	10.77%	1995 Yield	United Cities	Historical
Dividend Yield + ***Dividend*** Growth Rate	4.49%	5.29%	9.78%	1994 Yield	United Cities	Historical
Dividend Yield + ***Dividend*** Growth Rate	2.53%	6.10%	8.63%	Current Yield	Average of Small Companies	Forecast
Dividend Yield + ***Dividend*** Growth Rate	2.53%	5.86%	8.39%	1995 Yield	Average of Small Companies	Forecast
Dividend Yield + ***Dividend*** Growth Rate	2.53%	4.93%	7.46%	1994 Yield	Average of Small Companies	Forecast

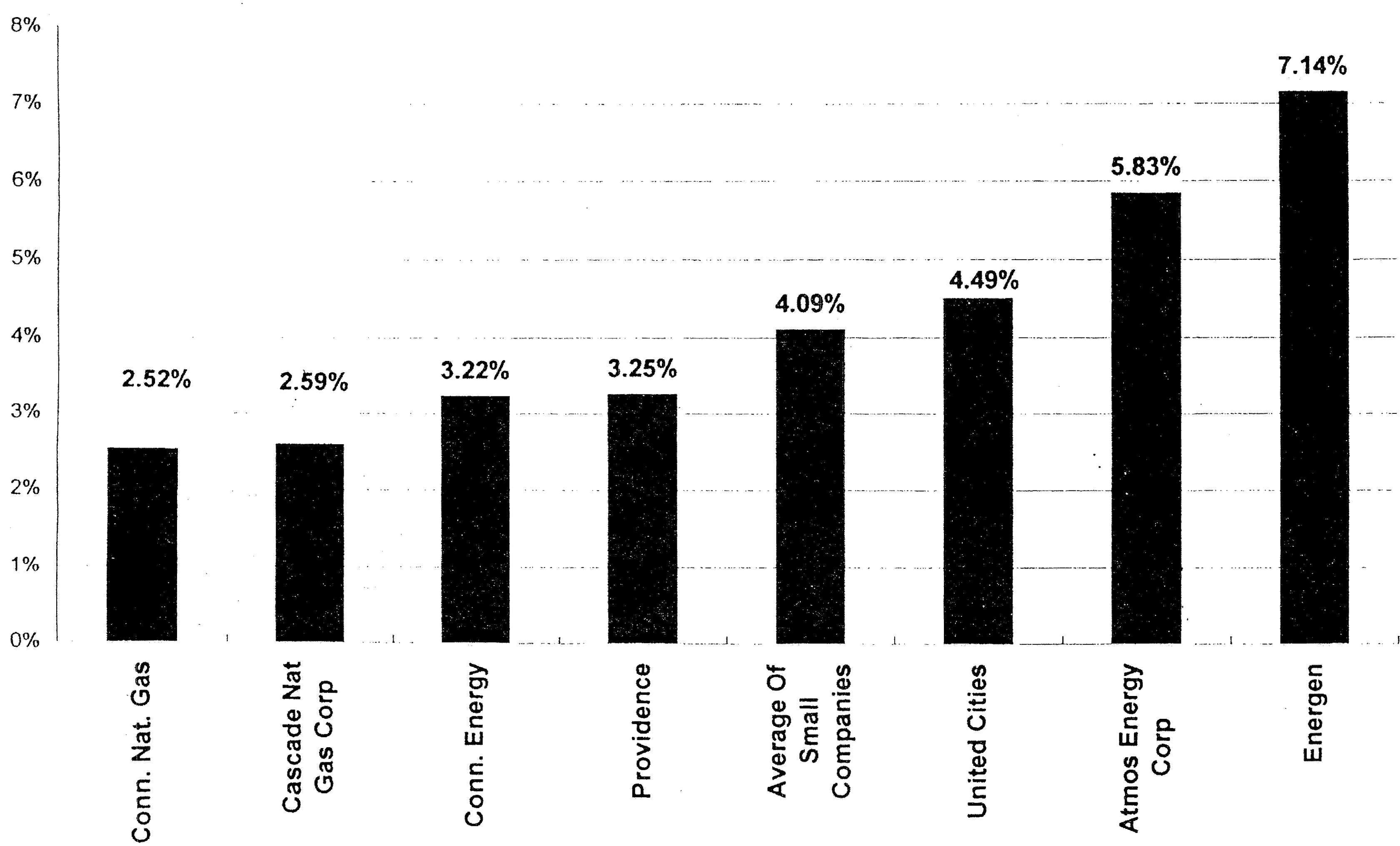
SUMMARY OF SCHEDULE DAM15

SUMMARY RESULTS APPEAR IN ORDER BY THE TIME PERIOD OF YIELD

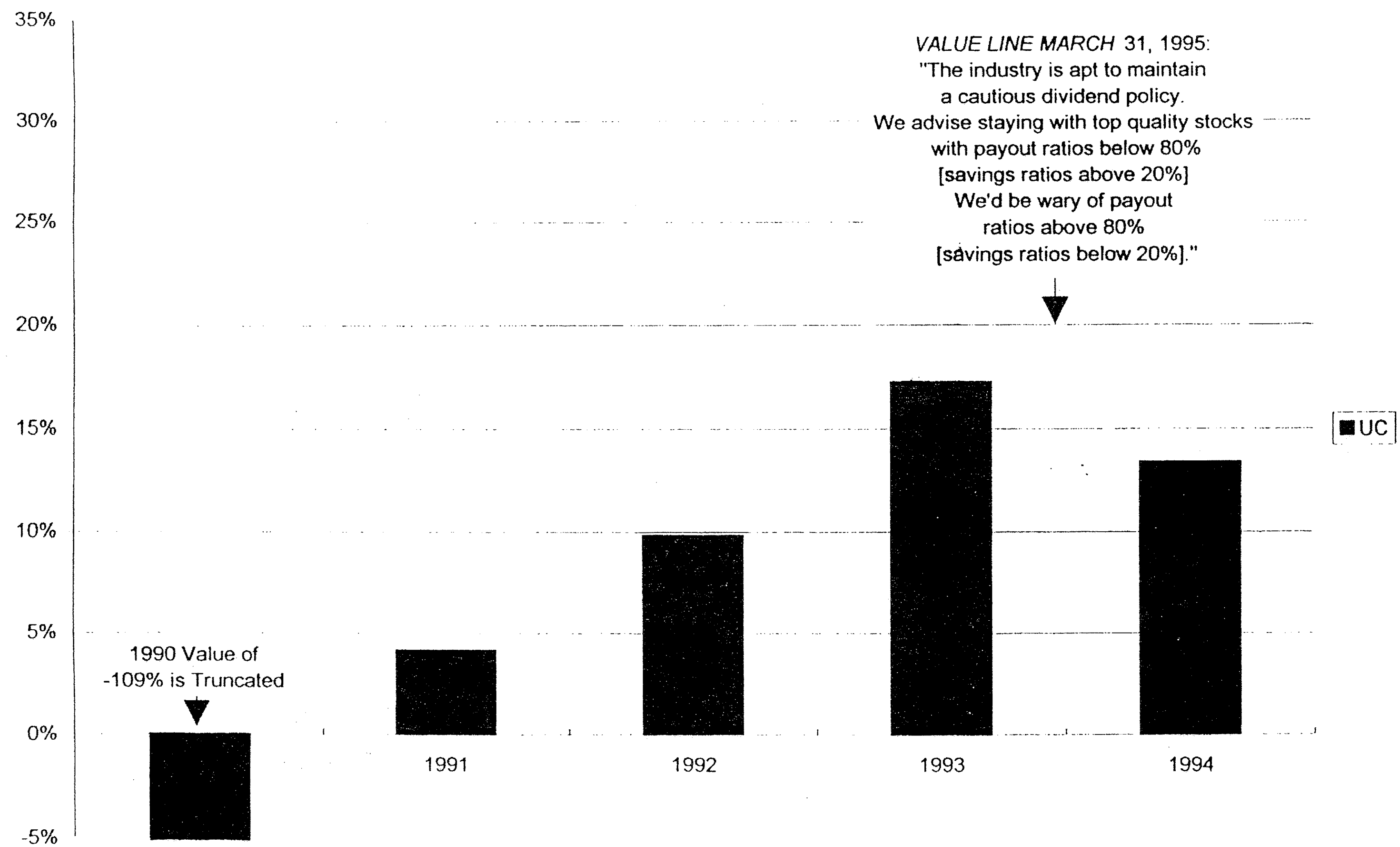
METHOD	DR. MURRAY'S GROWTH RATE	DIVIDEND YIELD	DR MURRAY'S ESTIMATED EQUITY COST Highest to Lowest	TIME PERIOD OF YIELD Dr. Murray's Direct Testimony p 15 line 8: "In general, the more current estimates are likely to be most relevant for rate making."	COMPANY	IS DIVIDEND GROWTH RATE HISTORICAL OR FORECAST?
Dividend Yield + ***Earnings*** Growth Rate	5.84%	6.57%	12.41%	Current Yield	United Cities	Historical
Dividend Yield + ***Earnings*** Growth Rate	6.13%	6.20%	12.33%	Current Yield	Average of Small Companies	Forecast
Dividend Yield + ***Earnings*** Growth Rate	5.00%	6.57%	11.57%	Current Yield	United Cities	Forecast
Dividend Yield + ***Earnings*** Growth Rate	5.00%	6.40%	11.40%	Current Yield	United Cities	Forecast
Dividend Yield + ***Dividend*** Growth Rate	4.49%	6.40%	10.89%	Current Yield	United Cities	Historical
Dividend Yield + ***Dividend*** Growth Rate	2.53%	6.10%	8.63%	Current Yield	Average of Small Companies	Forecast
Dividend Yield + ***Earnings*** Growth Rate	6.13%	6.70%	12.83%	1995 Yield	Average of Small Companies	Forecast
Dividend Yield + ***Earnings*** Growth Rate	5.84%	6.69%	12.53%	1995 Yield	United Cities	Historical
Dividend Yield + ***Earnings*** Growth Rate	5.00%	6.69%	11.69%	1995 Yield	United Cities	Forecast
Dividend Yield + ***Earnings*** Growth Rate	5.00%	6.28%	11.28%	1995 Yield	United Cities	Forecast
Dividend Yield + ***Dividend*** Growth Rate	4.49%	6.28%	10.77%	1995 Yield	United Cities	Historical
Dividend Yield + ***Dividend*** Growth Rate	2.53%	5.86%	8.39%	1995 Yield	Average of Small Companies	Forecast
Dividend Yield + ***Earnings*** Growth Rate	6.13%	6.61%	12.74%	1994 Yield	Average of Small Companies	Forecast
Dividend Yield + ***Earnings*** Growth Rate	5.84%	6.70%	12.54%	1994 Yield	United Cities	Historical
Dividend Yield + ***Earnings*** Growth Rate	5.00%	6.70%	11.70%	1994 Yield	United Cities	Forecast

Chart 1

HISTORICAL DIVIDEND GROWTH RATES
UC VS. SMALL COMPANIES



UC: PERCENT OF EARNINGS SAVED (RETENTION RATIO) - 1990-1994



AVERAGE RETENTION RATIOS FOR THE FOUR YEAR PERIOD 1991-1994: UC VS. SMALL COMPANIES

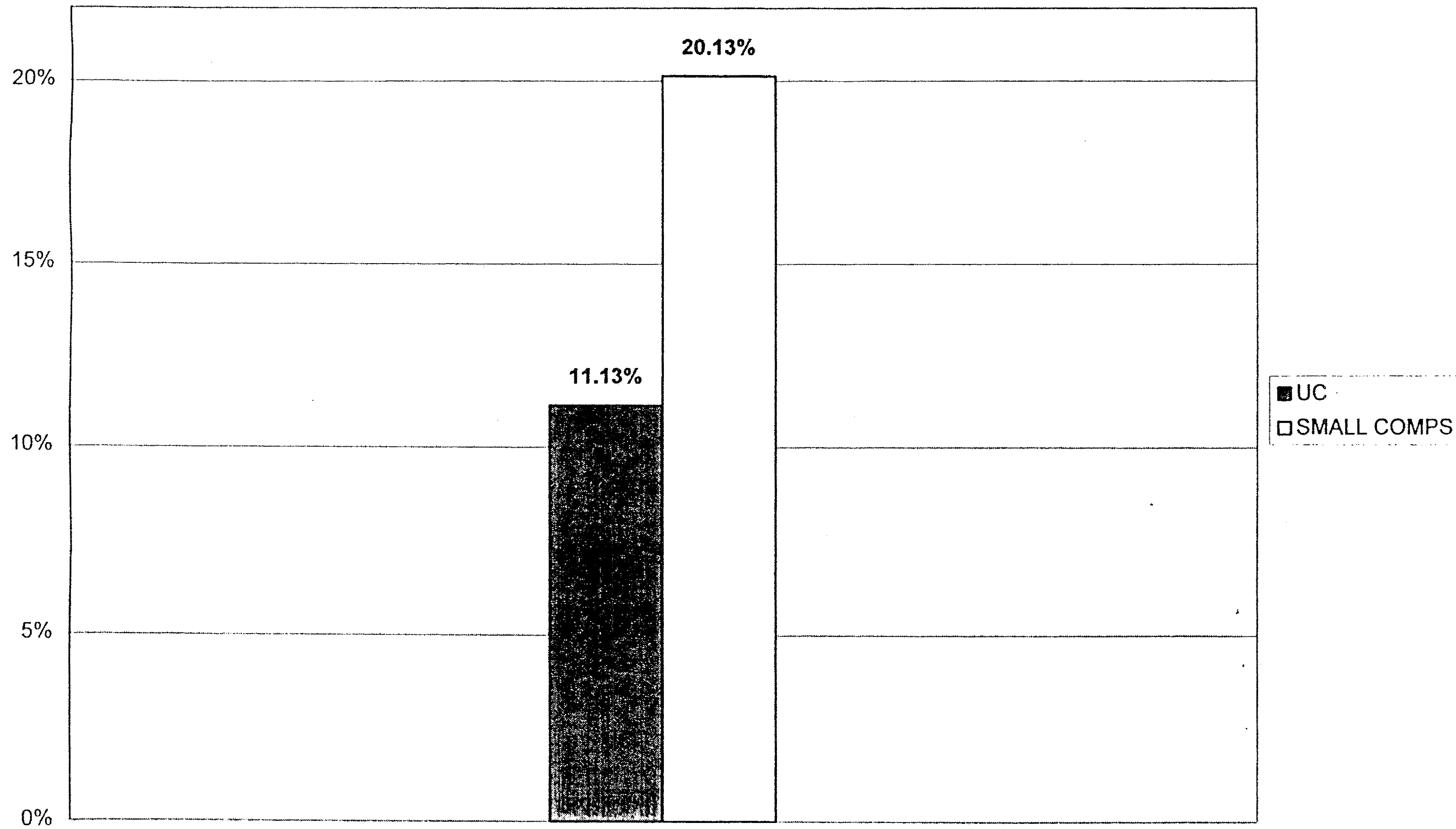
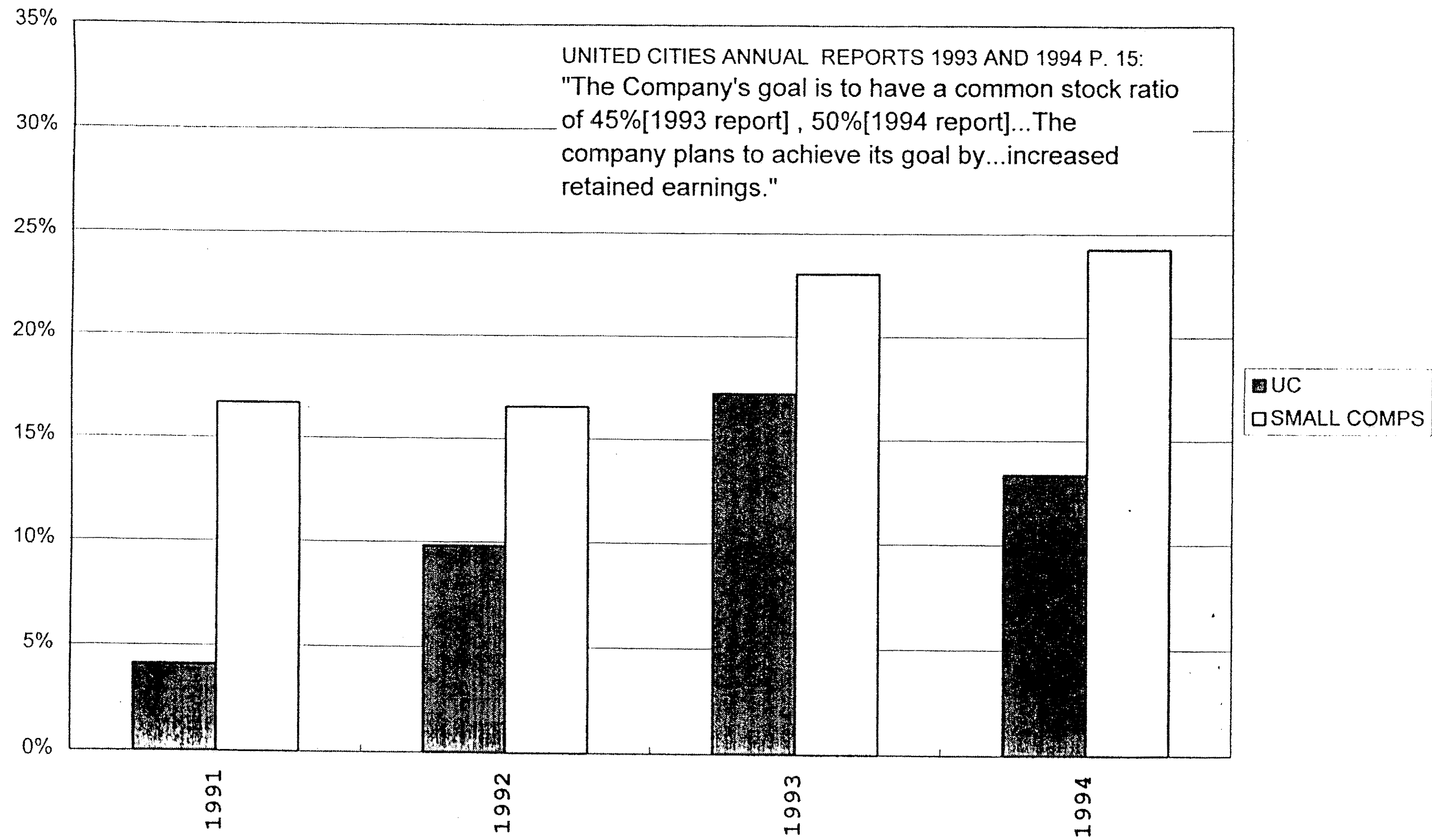
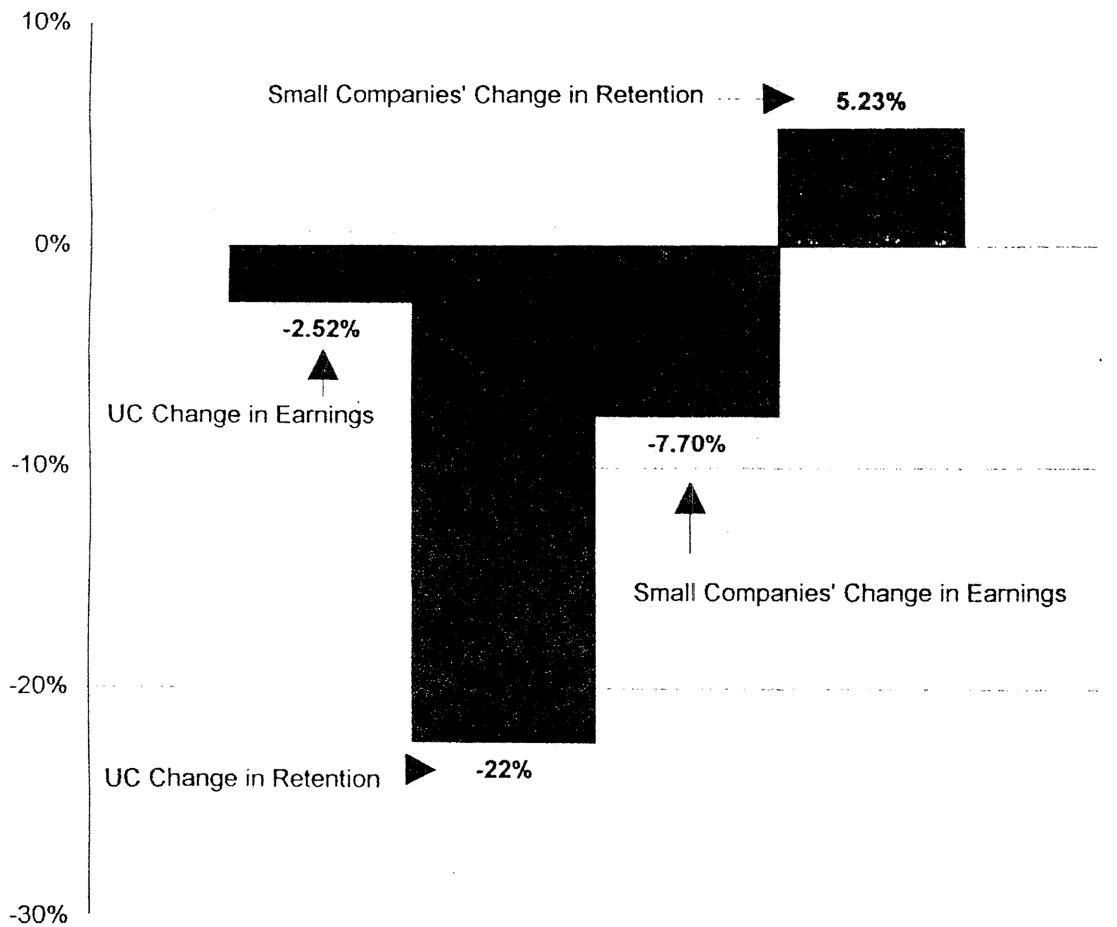


Chart 4

**AVERAGE ANNUAL RETENTION RATIOS [EXCLUDES NEGATIVE VALUES]:
UC VS. SMALL COMPANIES - 1991-1994**



CHANGE IN EARNINGS AND CHANGE IN RETENTION RATIOS 1993 TO 1994: UNITED CITIES VS. SMALL COMPANIES



Summary of Comparative Information For
United Cities And All Sample Companies:
Companies Appear In Order by 1994 Equity Ratio

DIVIDEND GROWTH

UC has increased dividends as if the company has a high equity ratio.
Out of 15 companies, UC ranks 6th in dividend growth. UC has raised its dividends faster than 8 other companies and faster than the average. The company's dividend growth is 4.49%, the average is 4.43%. Companies with higher growth rates have an equity ratio of at least 50.6%, except Atlanta Gas

DEBT COST

UC has the highest cost, 9.8%. The average is 8.21%.

		PER DR. MURRAY'S METHOD OF CALCULATING DIVIDEND GROWTH	ESTIMATED 1994 LONG TERM DEBT COST	ESTIMATED 1994 LONG TERM DEBT RATIO	1994 COMMON STOCK EARNINGS	1994 EQUITY RATIO	1994 OVERALL COST OF CAPITAL
Cascade Nat Gas Corp		2.59%	7.70%	51.20%	5.90%	44.90%	6.59%
► United Cities		4.49%	9.80%	55.00%	10.50%	45.00%	10.12% ◄
Atlanta Gas Light Co.		8.24%	7.79%	49.00%	11.30%	45.80%	8.99%
Northwest Natural Gas	*	3.04%	7.70%	47.50%	12.00%	46.00%	9.18%
Conn. Nat. Gas		2.52%	8.03%	52.30%	12.60%	47.30%	10.16%
Peoples Energy Corp		6.51%	7.72%	49.40%	11.60%	50.60%	9.68%
Conn. Energy	*	3.22%	8.84%	48.80%	10.20%	51.20%	9.54%
Atmos Energy Corp		5.83%	9.01%	48.10%	9.80%	51.90%	9.42%
► Average of Sample Cos.		4.43%	8.21%	46.12%	11.11%	52.08%	9.61%
Brooklyn Un Gas Co	*	3.44%	6.80%	47.30%	11.20%	52.20%	9.06%
Bay St Gas Co		6.08%	8.03%	48.40%	11.20%	52.30%	9.74%
Providence	*	3.25%	8.90%	41.40%	10.50%	53.10%	9.26%
LaClede	*	2.59%	9.53%	43.90%	11.30%	55.50%	10.46%
Washington Gas Light	*	4.33%	7.61%	40.00%	12.20%	56.70%	9.96%
Energen		7.14%	8.88%	41.50%	13.10%	58.50%	11.35%
Indiana Energy Inc.	*	3.22%	8.35%	36.90%	12.70%	63.10%	11.09%

* Companies with dividend growth rates less than UC and equity ratios higher than UC

OVERALL COST OF CAPITAL

United Cities has the 5th highest cost, 10.12%, because its debt cost is much larger than the other companies' debt cost.

Ratepayers receive no benefit from UC's low equity ratio because it is more than offset by UC's debt cost.

EQUITY RATIO

Out of 15 companies, United Cities ranks 14th. The company's equity ratio is 45%, the average is 52.08%.

EARNINGS

Out of 15 companies, United Cities ranks 13th. The company's return is 10.5%, the average is 11.11%.

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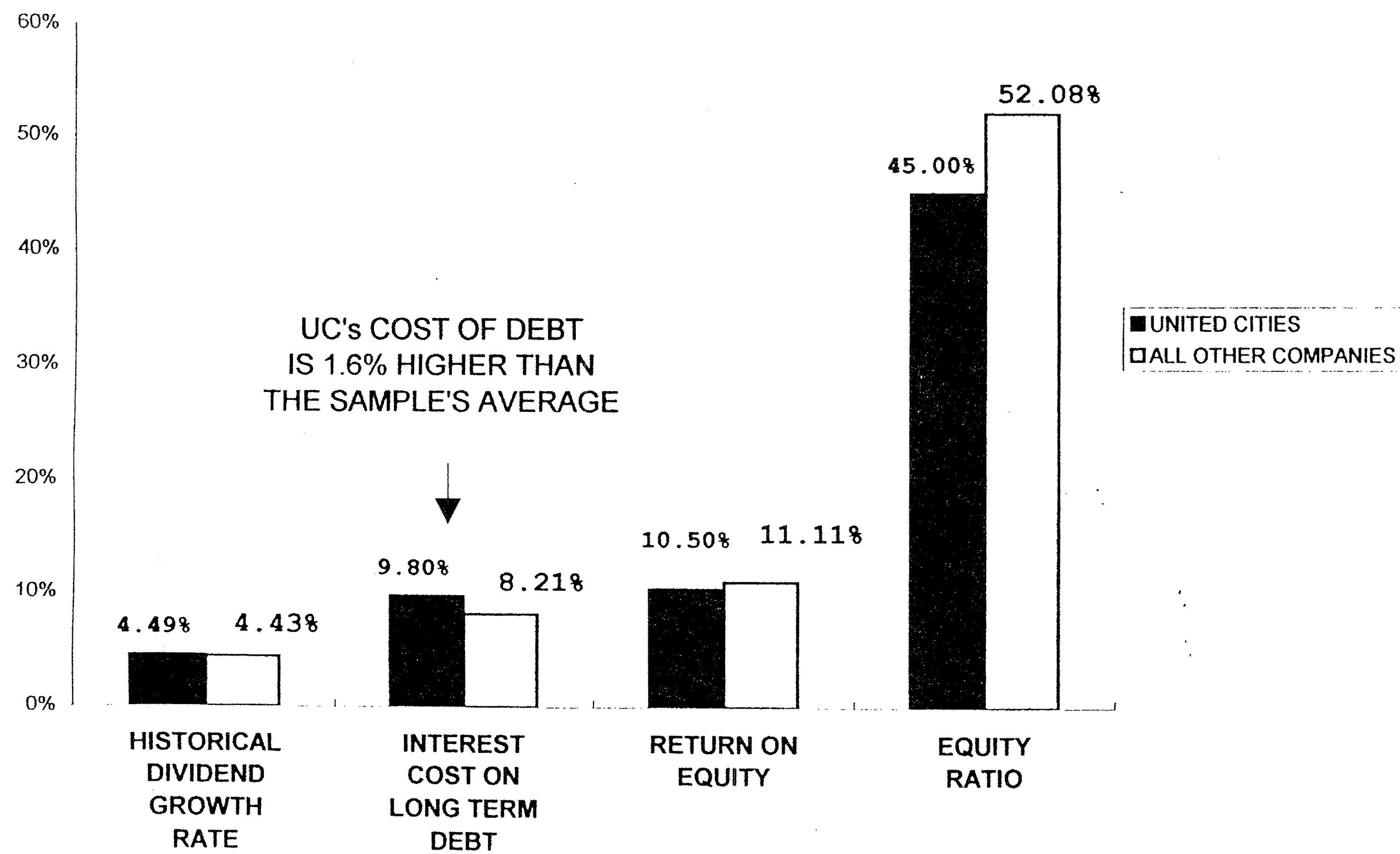
Exhibit CA-SNB ___
Schedule 5 ______
Chart 1 of 1 _____

UNITED CITIES AND ALL SAMPLE COMPANIES COMPARED: 1994



Debt Terms

Docket No. 95-02258
Exhibit CA-SNB____
Schedule 6 _______
Page 1 of 1_______

SUMMARY OF UNITED CITIES PRIVATE PLACEMENT DEBT FINANCING
REDEMPTION TERMS PREVENT REFINANCING FOR OVER 70 % OF COMPANY'S DEBT

SERIES	Issue Date Mo - Yr	Maturity Date Mo - Yr	UC Bond Rate At Time of Issue	Redemption Terms	Percent Of Note's Life Under No Call Or "Make Whole"	Note's Amount: $Millions	Refinancing Prevented?	Was UC's Bond Rate Comparable To Market Rates At Time Of Issue?	Did The Rate UC Received For Its Notes Justify Preclusion Of Refinancing?	Was UC's Bond Rate Within 100 To 120 Basis Points Of Treasury Notes? *
N	Mar-1987	Mar-2002	8.69%	Call After 1 Year		20	NO	YES	NA	YES
P	Nov-1987	Nov-2017	10.43%	No Call Until 2007	67.0%	25	YES	NO	NO: UC's Rate Only .8% To 1.2% Lower Than Baa Rate In Issue Month & Month Prior To Issue	NO
R	Dec-1989	Dec-2004	11.32%	Make Whole Until 2004	100.0%	15	YES	NO	NO: UC's Rate 1.45% Higher Than Baa Rate In Issue Month & Month Prior To Issue	NO
Q	Apr-1990	Apr-2020	9.75%	Make Whole Until 2011	67.0%	20	YES	YES	NO: UC's Rate Only .45% To .55% Lower Than Baa Rate In Issue Month & Month Prior To Issue	YES
S	Jun-1991	Jun-1997	8.70%	Make Whole Until 1997	83.3%	7	YES	YES	NOT MATERIAL: Note Length Too Short	YES
T	Jun-1991	Jun-2021	9.32%	Make Whole Until 2013	67.0%	18	YES	YES	NO: UC's Rate Only .35% To .60% Lower Than Baa Rate In Issue Month & Month Prior To Issue	YES
U	Jun-1992	Jun-1922	8.77%	Make Whole Until 2014	67.0%	20	YES	YES	NO: UC's Rate Only .10% To .30% Lower Than Baa Rate In Issue Month & Month Prior To Issue	YES
V	Dec-1992	Dec-2007	7.50%	Make Whole Until 2004	67.0%	10	YES	YES	NO CONTRARY EVIDENCE	YES

* Judgement Standard Applied By Liberty Consulting: Page II-13 of Liberty's Management Audit Report

MARKET INTEREST RATES
AT TIME OF UNITED CITIES' BOND ISSUE

Docket No. 95-02258
Exhibit CA-SNB____
Schedule 7 _______
Page 1 of 3_______

	Corporate Bond Rates			Treasury Constant Maturities			UC Bond Rate And Month of Issue	Moving 6 Month Average Of Baa Rates	Moving 3 Month Average Of Baa Rates
	Aaa	A	Baa	10 Yr	20 Yr	30 Yr			
Jan-87	8.36%	9.23%	9.72%	7.08%		7.39%			
Feb-87	8.38%	9.20%	9.65%	7.25%		7.54%			
Mar-87	8.36%	9.13%	9.61%	7.25%		7.55%	8.69%		
Apr-87	8.85%	9.36%	10.04%	8.02%		8.25%			
May-87									
Jun-87	9.32%	9.98%	10.52%	8.40%	8.60%	8.57%			
Jul-87	9.42%	10.00%	10.61%	8.45%	8.70%	8.64%			
Aug-87	9.67%	10.20%	10.80%	8.76%	8.97%	8.97%			
Sep-87	10.18%	10.07%	11.31%	9.42%		9.59%			
Oct-87	10.52%	10.98%	11.62%	9.52%		9.61%			
Nov-87	10.01%	10.63%	11.23%	8.86%		8.95%	10.43%	10.97%	11.24%
Dec-87	10.11%	10.62%	11.29%	8.99%	9.12%	9.12%		11.02%	11.39%
Jan-88	10.37%	10.43%	11.07%	8.67%	8.82%	8.83%		11.25%	11.26%
Feb-88	9.89%	9.94%	10.62%	8.21%	8.41%	8.43%		11.30%	11.18%
Mar-88	9.86%	9.89%	10.57%	8.37%	8.61%	8.63%		11.17%	10.85%
Apr-88	10.15%	10.17%	10.90%	8.72%	8.91%	8.95%		10.96%	10.75%
May-88	9.90%	10.41%	11.04%	9.09%	9.24%	9.23%		10.89%	10.70%
Jun-88	9.86%	10.42%	11.00%	8.92%	9.04%	9.00%		10.84%	10.84%
Jul-88	9.96%	10.55%	11.11%	9.06%	9.20%	9.14%		10.87%	10.98%
Aug-88	10.11%	10.63%	11.21%	9.26%	9.33%	9.32%		10.87%	11.05%
Sep-88	9.82%	10.34%	10.90%	8.98%	9.06%	9.06%		10.97%	11.11%
Oct-88	9.51%	9.90%	10.41%	8.80%	8.89%	8.89%		11.03%	11.07%
Nov-88	9.45%	9.90%	10.48%	8.96%	9.07%	9.02%		10.95%	10.84%
Dec-88	9.57%	10.11%	10.65%	9.11%	9.13%	9.01%		10.85%	10.60%
Jan-89	9.62%	10.10%	10.65%	9.09%	9.07%	8.93%		10.73%	10.57%
Feb-89	9.64%	10.13%	10.61%	9.17%	9.16%	9.01%		10.62%	10.65%
Mar-89	9.80%	10.26%	10.67%	9.36%	9.33%	9.17%		10.56%	10.63%
Apr-89	9.79%	10.20%	10.61%	9.18%	9.18%	9.03%		10.61%	10.64%
May-89	9.59%	10.01%	10.48%	8.86%	8.95%	8.83%		10.64%	10.63%
Jun-89	9.10%	9.59%	10.03%	8.28%	8.40%	8.27%		10.60%	10.59%
Jul-89	8.93%	9.42%	9.87%	8.02%	8.19%	8.08%		10.51%	10.37%
Aug-89	8.96%	9.45%	9.88%	8.11%	8.26%	8.12%		10.38%	10.13%
Sep-89	9.01%	9.51%	9.91%	8.19%	8.31%	8.15%		10.26%	9.93%
Oct-89	8.92%	9.44%	9.81%	8.01%	8.15%	8.00%		10.13%	9.89%
Nov-89	8.89%	9.42%	9.81%	7.87%	8.03%	7.90%		10.00%	9.87%
Dec-89	8.86%	9.39%	9.82%	7.84%	8.02%	7.90%	11.32%	9.89%	9.84%

MARKET INTEREST RATES
AT TIME OF UNITED CITIES' BOND ISSUE

	Corporate Bond Rates			Treasury Constant Maturities			UC Bond Rate And Month of Issue	Moving 6 Month Average Of Baa Rates	Moving 3 Month Average Of Baa Rates
	Aaa	A	Baa	10 Yr	20 Yr	30 Yr			
Jan-90	8.99%	9.54%	9.94%	8.21%	8.39%	8.26%		9.85%	9.82%
Feb-90	9.22%	9.75%	10.14%	8.47%	8.66%	8.50%		9.86%	9.88%
Mar-90	9.37%	9.82%	10.21%	8.59%	8.74%	8.56%		9.90%	10.04%
Apr-90	9.46%	9.89%	10.30%	8.79%	8.92%	8.76%	**9.75%**	9.98%	10.10%
May-90	9.47%	9.89%	10.41%	8.76%	8.90%	8.73%		10.08%	10.22%
Jun-90	9.26%	9.70%	10.22%	8.48%	8.61%	8.46%		10.20%	10.31%
Jul-90	9.24%	9.69%	10.20%	8.47%	8.64%	8.50%		10.20%	10.31%
Aug-90	9.41%	9.89%	10.41%	8.75%	8.97%	8.86%		10.25%	10.28%
Sep-90	9.56%	10.09%	10.64%	8.89%	9.11%	9.03%		10.29%	10.28%
Oct-90	9.53%	10.06%	10.74%	8.72%	8.93%	8.86%		10.36%	10.42%
Nov-90	9.33%	9.88%	10.62%	8.39%	8.60%	8.54%		10.44%	10.60%
Dec-90	9.05%	9.64%	10.43%	8.08%	8.31%	8.24%		10.47%	10.67%
Jan-91	9.04%	9.61%	10.45%	8.09%	8.33%	8.27%		10.57%	10.53%
Feb-91	8.83%	9.38%	10.07%	7.85%	8.12%	8.03%		10.58%	10.44%
Mar-91	8.93%	9.50%	10.09%	8.11%	8.38%	8.29%		10.46%	10.26%
Apr-91	8.86%	9.39%	9.94%	8.04%	8.29%	8.21%		10.33%	10.20%
May-91	8.86%	9.41%	9.86%	8.07%	8.33%	8.27%		10.20%	10.03%
Jun-91	9.01%	9.55%	9.96%	8.28%	8.54%	8.47%	**8.70%**	10.08%	9.96%
Jul-91	9.00%	9.51%	9.89%	8.27%	8.50%	8.45%	**9.32%**	10.06%	9.92%
Aug-91	8.75%	9.26%	9.65%	7.90%	8.17%	8.14%		9.97%	9.90%
Sep-91	8.61%	9.11%	9.51%	7.65%	7.96%	7.95%		9.90%	9.83%
Oct-91	8.55%	9.08%	9.49%	7.53%	7.88%	7.93%		9.80%	9.68%
Nov-91	8.48%	9.01%	9.45%	7.42%	7.83%	7.92%		9.73%	9.55%
Dec-91	8.31%	8.82%	9.26%	7.09%	7.58%	7.70%		9.66%	9.48%
Jan-92	8.20%	8.72%	9.130%	7.03%	7.48%	7.58%		9.47%	9.36%
Feb-92	8.29%	8.83%	9.230%	7.34%	7.78%	7.85%		9.37%	9.20%
Mar-92	8.35%	8.89%	9.250%	7.54%	7.93%	7.97%		9.31%	9.18%
Apr-92	8.33%	8.87%	9.210%	7.48%	7.88%	7.96%		9.26%	9.20%
May-92	8.28%	8.81%	9.130%	7.39%	7.80%	7.89%		9.22%	9.23%
Jun-92	8.22%	8.70%	9.050%	7.26%	7.72%	7.84%		9.19%	9.20%
Jul-92	8.07%	8.84%	8.840%	6.84%	7.40%	7.60%	**8.77%**	9.17%	9.13%
Aug-92	7.95%	8.65%	8.650%	6.59%	7.19%	7.39%		9.12%	9.01%
Sep-92	7.92%	8.62%	8.620%	6.42%	7.08%	7.34%		9.02%	8.85%
Oct-92	7.99%	8.84%	8.840%	6.87%	7.26%	7.53%		8.92%	8.70%
Nov-92	8.10%	8.58%	8.960%	6.77%	7.43%	7.61%		8.86%	8.70%

MARKET INTEREST RATES
AT TIME OF UNITED CITIES' BOND ISSUE

	Corporate Bond Rates			Treasury Constant Maturities			UC Bond Rate And Month of Issue	Moving 6 Month Average Of Baa Rates	Moving 3 Month Average Of Baa Rates
	Aaa	A	Baa	10 Yr	20 Yr	30 Yr			
Dec-92	7.98%	8.37%	8.810%	6.77%	7.30%	7.44%	**7.50%**	8.83%	8.81%
Jan-93	7.91%	8.13%	8.67%	6.60%	7.17%	7.34%		8.78%	8.89%
Feb-93	7.71%	7.80%	8.39%	6.26%	6.89%	7.09%		8.78%	8.74%
Mar-93	7.58%	7.61%	8.15%	5.98%	6.65%	6.82%		8.73%	8.53%
Apr-93	7.46%	7.66%	8.14%	5.97%	6.64%	6.85%		8.60%	8.40%
May-93	7.43%	7.75%	8.21%	6.04%	6.68%	6.92%		8.43%	8.23%
Jun-93	7.33%	7.59%	8.07%	5.96%	6.55%	6.81%		8.31%	8.17%
Jul-93	7.17%	7.43%	7.93%	5.81%	6.34%	6.63%		8.27%	8.14%
Aug-93	6.85%	7.16%	7.60%	5.68%	6.18%	6.32%		8.15%	8.07%
Sep-93	6.66%	6.94%	7.34%	5.36%	5.94%	6.00%		8.02%	7.87%
Oct-93	6.67%	6.91%	7.31%	5.33%	6.07%	5.94%		7.88%	7.62%
Nov-93	6.93%	7.25%	7.66%	5.72%	6.38%	6.21%		7.74%	7.42%
Dec-93	6.93%	7.28%	7.69%	5.77%	6.40%	6.25%		7.65%	7.44%
Jan-94	6.92%	7.24%	7.65%	5.75%	6.39%	6.29%		7.52%	7.68%
Feb-94	7.08%	7.45%	7.66%	5.97%	6.57%	6.49%		7.53%	7.67%
Mar-94	7.48%	7.82%	8.13%	6.48%	7.00%	6.91%		7.59%	7.66%
Apr-94	7.88%	8.20%	8.52%	6.97%	7.40%	7.27%		7.76%	7.81%
May-94	7.99%	8.37%	8.62%	7.18%	7.54%	7.41%		7.93%	8.10%
Jun-94	7.97%	8.30%	8.65%	7.10%	7.51%	7.40%		8.12%	8.42%
Jul-94	8.11%	8.45%	8.80%	7.30%	7.67%	7.58%		8.21%	8.60%
Aug-94	8.07%	8.36%	8.74%	7.24%	7.62%	7.49%		8.40%	8.69%
Sep-94	8.34%	8.62%	8.98%	7.46%	7.87%	7.71%		8.58%	8.73%
Oct-94	8.57%	8.80%	9.20%	7.74%	8.08%	7.94%		8.72%	8.84%
Nov-94	8.68%	8.95%	9.32%	7.96%	8.20%	8.08%		8.83%	8.97%
Dec-94	8.46%	8.78%	9.10%	7.81%	7.99%	7.87%		8.95%	9.17%
Jan-95	8.46%	8.75%	9.08%	7.78%	7.97%	7.85%		9.07%	9.21%
Feb-95	8.26%	8.55%	8.85%	7.47%	7.73%	7.61%		9.14%	9.09%
Mar-95	8.12%	8.40%	8.70%	7.20%	7.57%	7.45%		9.11%	8.97%
Apr-95	8.03%	8.31%	8.60%	7.06%	7.45%	7.36%		9.01%	8.88%
May-95	7.65%	7.71%	8.20%	6.63%	7.01%	6.95%		8.87%	8.72%

UNITED CITIES:
DIVIDEND YIELD

Docket No. 95-02258
Exhibit CA-SNB____
Schedule 8 ______
Page 1 of 1______

WEEKDAY	DATE	CLOSING PRICE	ANNUAL DIVIDEND	YIELD	52 WEEK MOVING AVERAGE OF YIELD
Monday	15-May-95	$ 15.25	$1.02	6.69%	6.36%
Tuesday	16-May-95	$ 15.25	$1.02	6.69%	6.36%
Wednesday	17-May-95	$ 15.75	$1.02	6.48%	6.36%
Thursday	18-May-95	$ 15.25	$1.02	6.69%	6.36%
Friday	19-May-95	$ 15.63	$1.02	6.53%	6.36%
Monday	22-May-95	$ 15.63	$1.02	6.53%	6.36%
Tuesday	23-May-95	$ 15.75	$1.02	6.48%	6.36%
Wednesday	24-May-95	$ 15.75	$1.02	6.48%	6.36%
Thursday	25-May-95	$ 15.75	$1.02	6.48%	6.36%
Friday	26-May-95	$ 15.50	$1.02	6.58%	6.36%
Tuesday	30-May-95	$ 15.75	$1.02	6.48%	6.36%
Wednesday	31-May-95	$ 15.50	$1.02	6.58%	6.36%
Thursday	1-Jun-95	$ 15.50	$1.02	6.58%	6.36%
Friday	2-Jun-95	$ 15.25	$1.02	6.69%	6.36%
Monday	5-Jun-95	$ 14.75	$1.02	6.92%	6.37%
Tuesday	6-Jun-95	$ 15.25	$1.02	6.69%	6.37%
Wednesday	7-Jun-95	$ 15.25	$1.02	6.69%	6.37%
Thursday	8-Jun-95	$ 14.50	$1.02	7.03%	6.37%
Friday	9-Jun-95	$ 14.75	$1.02	6.92%	6.37%
Monday	12-Jun-95	$ 15.00	$1.02	6.80%	6.37%
Tuesday	13-Jun-95	$ 15.00	$1.02	6.80%	6.38%
Wednesday	14-Jun-95	$ 15.00	$1.02	6.80%	6.38%
Thursday	15-Jun-95	$ 15.00	$1.02	6.80%	6.38%
Friday	16-Jun-95	$ 15.00	$1.02	6.80%	6.38%
Monday	19-Jun-95	$ 15.00	$1.02	6.80%	6.38%
Tuesday	20-Jun-95	$ 14.75	$1.02	6.92%	6.38%
Wednesday	21-Jun-95	$ 15.00	$1.02	6.80%	6.38%
Thursday	22-Jun-95	$ 15.00	$1.02	6.80%	6.39%
Friday	23-Jun-95	$ 15.00	$1.02	6.80%	6.39%
Monday	26-Jun-95	$ 15.00	$1.02	6.80%	6.39%
Tuesday	27-Jun-95	$ 15.25	$1.02	6.69%	6.39%
Wednesday	28-Jun-95	$ 15.50	$1.02	6.58%	6.39%
Thursday	29-Jun-95	$ 15.00	$1.02	6.80%	6.39%
Friday	30-Jun-95	$ 15.00	$1.02	6.80%	6.39%
Monday	3-Jul-95	$ 15.50	$1.02	6.58%	6.39%
Wednesday	5-Jul-95	$ 15.13	$1.02	6.74%	6.40%
Thursday	6-Jul-95	$ 15.50	$1.02	6.58%	6.40%
Friday	7-Jul-95	$ 15.25	$1.02	6.69%	6.40%
Monday	10-Jul-95	$ 15.38	$1.02	6.63%	6.40%
Tuesday	11-Jul-95	$ 15.50	$1.02	6.58%	6.40%
Wednesday	12-Jul-95	$ 16.25	$1.02	6.28%	6.40%
Thursday	13-Jul-95	$ 15.63	$1.02	6.53%	6.40%
Friday	14-Jul-95	$ 15.50	$1.02	6.58%	6.40%
Monday	17-Jul-95	$ 15.50	$1.02	6.58%	6.40%
Tuesday	18-Jul-95	$ 15.75	$1.02	6.48%	6.40%
Wednesday	19-Jul-95	$ 15.75	$1.02	6.48%	6.40%
Thursday	20-Jul-95	$ 15.75	$1.02	6.48%	6.40%
Friday	21-Jul-95	$ 15.25	$1.02	6.69%	6.40%
Monday	24-Jul-95	$ 15.38	$1.02	6.63%	6.40%
Tuesday	25-Jul-95	$ 15.75	$1.02	6.48%	6.41%
Wednesday	26-Jul-95	$ 15.75	$1.02	6.48%	6.41%
Thursday	27-Jul-95	$ 15.75	$1.02	6.48%	6.41%
Friday	28-Jul-95	$ 15.75	$1.02	6.48%	6.41%
Monday	31-Jul-95	$ 15.25	$1.02	6.69%	6.41%

DCF RECOMMENDED RETURN UC

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RECOMMENDED COST OF CAPITAL BASED ON DCF MODEL

YEAR	DIVIDEND
1982	$0.640
1983	$0.650
1984	$0.690
1985	$0.740
1986	$0.790
1987	$0.800
1988	$0.840
1989	$0.880
1990	$0.920
1991	$0.930
1992	$0.965
1993	$0.985
1994	$1.005
HISTORICAL GROWTH	4.49%
AVERAGE DIVIDEND YIELD	6.41%
RECOMMENDED COST OF EQUITY	$\boxed{10.90\%}$

BOND DATA AS MEASURE OF DEBT YIELD

Recently offered "Baa" Rated Bonds

1993		1994		1995	
Jan-93	8.670%	Jan-94	7.650%	Jan-95	9.080%
Feb	8.390%	Feb	7.660%	Feb	8.850%
Mar	8.150%	Mar	8.130%	Mar	8.700%
Apr	8.140%	Apr	8.520%	Apr	8.600%
May	8.210%	May	8.620%	May	8.200%
Jun	8.070%	Jun	8.650%	Jun	7.900%
Jul	7.930%	Jul	8.800%	Jul	8.040%
Aug	7.600%	Aug	8.740%	Aug	8.190%
Sep	7.340%	Sep	8.980%		
Oct	7.310%	Oct	9.200%		
Nov	7.660%	Nov	9.320%		
Dec	7.690%	Dec	9.100%		
Average:	7.930%	Average:	8.948%	Average:	8.445%
				Average: Most Recent 12 Months	8.680%

Sources: Federal Reserve Bulletin, Table A26, Subtable 1.35
Federal Reserve Publications H15(519) and G13(415)

RISK PREMIUM DATA

Effective And Continuous Risk Premiums Based On Total Return To Common Stock vs. Total Return To Treasury Bills

	Common Stock Total Return Index For Year Ended	T-Bill Total Return Index For Year Ended		Normal Risk Premium		Lognormal Risk Premium
1925	1.00	1.00				
1926	1.12	1.03		8.03%		7.73%
1927	1.54	1.07		33.41%		28.83%
1928	2.20	1.10		38.64%		32.67%
1929	2.02	1.16		-12.56%		-13.42%
1930	1.52	1.18		-26.65%		-31.00%
1931	0.86	1.20		-43.95%		-57.90%
1932	0.79	1.21		-8.99%		-9.42%
1933	1.21	1.21		53.36%		42.76%
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
1986	330.67	7.96		11.59%		10.97%
1987	347.97	8.39		-0.22%		-0.22%
1988	406.46	8.93		9.83%		9.38%
1989	534.46	9.67		21.34%		19.34%
1990	517.50	10.43		-10.19%		-10.75%
1991	675.59	11.01		23.64%		21.22%
1992	727.41	11.40		4.02%		3.95%
1993	800.08	11.73		6.89%		6.67%
1994	810.54	12.19		-2.50%		-2.53%

Ibbotson Associates: "The lognormal distribution ... [is] a more accurate characterization of the behavior of market returns than ... the normal distribution

Arithmetic Average: Effective Risk Premium: 8.25%

Arithmetic Average: Lognormal Risk Premium: 6.08%

Source: For the years 1925-1991, *Ibbotson Associates* 1992 Yearbook, Tables B-1, B-9
Source: For the years 1992-1994, *Ibbotson Associates* 1994 Yearbook, Tables B-1, B-9

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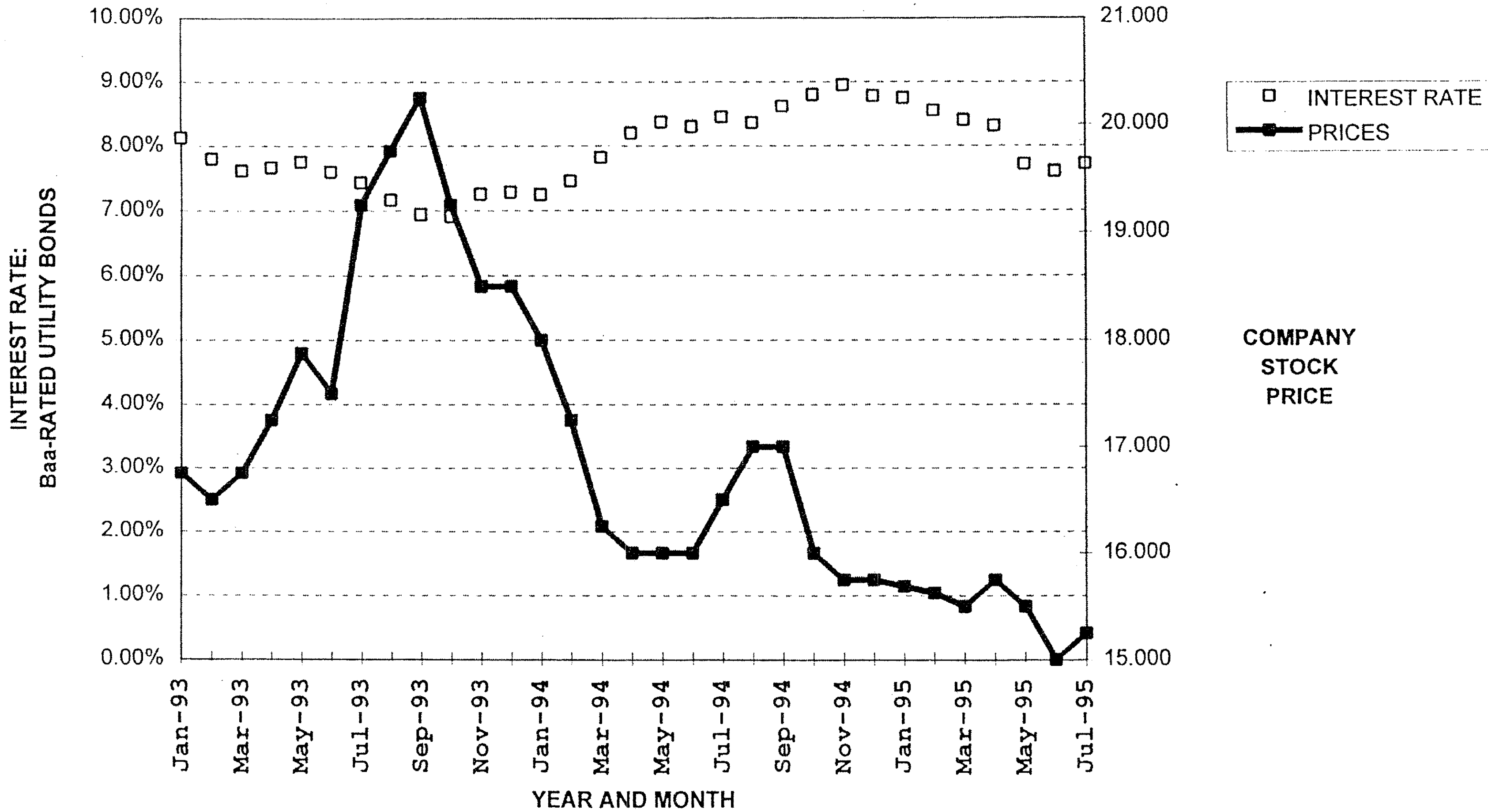
Schedule 11 Cont._
Chart 1 of 1 _____

United Cities Gas Co. (UCIT)
STOCK PRICE AND INTEREST RATES:
JAN '93 - JULY '95



RISK PREMIUM ANALYSIS: MARKET BETAS -- FOR THE UNITED CITIES SAMPLE COMPANIES REGRESSED AGAINST S&P 500

BETA FOR 60 MONTH PERIOD ENDING	Atlantic Gas Light Co. (ATG)	Bay ST GAS CO (BSG)	Brooklyn Un Gas Co (BUG)	Indiana Energy Inc. (IEI)	LaClede Gas (LG)	Northwest Natural Gas (NNG)	Peoples Energy Corp (PEC)	Washington Gas Lt Co. (WGL)	Atmos Energy Corp (ATO)	Cascade Nat Gas Corp (CNG)	Conn. Energy (CNE)	Conn. Nat. Gas (CTG)	Energen (EGN)	Providence (PVY)
Aug-94	0.452	0.515	0.427	0.184	0.553	0.201	0.583	0.355	0.392	0.259	0.352	0.086	0.500	0.558
Sep-94	0.489	0.475	0.424	0.174	0.565	0.185	0.577	0.380	0.376	0.283	0.349	0.090	0.481	0.514
Oct-94	0.501	0.473	0.426	0.171	0.592	0.159	0.618	0.372	0.348	0.273	0.189	0.088	0.443	0.495
Nov-94	0.540	0.487	0.433	0.224	0.563	0.179	0.679	0.400	0.306	0.245	0.240	0.110	0.504	0.526
Dec-94	0.527	0.468	0.417	0.239	0.553	0.191	0.677	0.388	0.289	0.237	0.247	0.120	0.511	0.513
Jan-95	0.470	0.290	0.390	0.137	0.549	0.198	0.688	0.362	0.278	0.135	0.182	0.064	0.411	0.508
Feb-95	0.485	0.306	0.384	0.126	0.552	0.192	0.677	0.398	0.315	0.135	0.189	0.049	0.417	0.541
Mar-95	0.483	0.295	0.385	0.114	0.532	0.204	0.683	0.408	0.313	0.131	0.165	0.044	0.437	0.541
Apr-95	0.487	0.308	0.364	0.099	0.515	0.196	0.664	0.387	0.279	0.110	0.117	0.022	0.444	0.533
May-95	0.547	0.394	0.390	0.035	0.575	0.235	0.645	0.701	0.280	0.079	0.101	0.035	0.472	0.585
Jun-95	0.536	0.359	0.395	-0.019	0.574	0.313	0.549	0.628	0.281	0.005	0.081	-0.009	0.471	0.472
Jul-95	0.534	0.364	0.363	-0.015	0.578	0.274	0.556	0.613	0.281	-0.002	0.074	-0.002	0.462	0.474
AV: RECENT 12 MTHS	0.504	0.394	0.400	0.122	0.558	0.211	0.633	0.449	0.311	0.157	0.191	0.058	0.463	0.522

RISK PREMIUM RECOMMENDED RETURN

Risk Premium Model: Results For 12 Month Period Ending July 1995

COMPANY	Debt Yield (a) *	Beta (b) **	Market Continuous Risk Premium (c)	Company Risk Premium (d)=(b)X(c)	Company Equity Cost (e)=(a)+(d)
Atlantic Gas Light Co. (AGL)	8.68%	0.504	6.08%	3.07%	11.75%
Bay ST GAS CO (BSG)	8.68%	0.394	6.08%	2.40%	11.08%
Brooklyn Un Gas Co (BUG)	8.68%	0.400	6.08%	2.43%	11.11%
Indiana Energy Inc. (IEI)	8.68%	0.122	6.08%	0.74%	9.42%
LaClede Gas (LG)	8.68%	0.558	6.08%	3.40%	12.08%
Northwest Natural Gas (NNG)	8.68%	0.211	6.08%	1.28%	9.96%
Peoples Energy Corp (PEC)	8.68%	0.633	6.08%	3.85%	12.53%
Washington Gas Lt Co. (WGL)	8.68%	0.449	6.08%	2.73%	11.41%
Atmos Energy Corp (ATO)	8.68%	0.311	6.08%	1.89%	10.57%
Cascade Nat Gas Corp (CNG)	8.68%	0.157	6.08%	0.96%	9.64%
Conn. Energy (CNE)	8.68%	0.191	6.08%	1.16%	9.84%
Conn. Nat. Gas (CTG)	8.68%	0.058	6.08%	0.35%	9.03%
Energen (EGN)	8.68%	0.463	6.08%	2.81%	11.49%
Providence (PVY)	8.68%	0.522	6.08%	3.17%	11.85%
				Average	10.84%

* DEBT YIELD BASED ON 12 MONTHS ENDING AUGUST
** BASED ON MONTHLY CLOSING PRICES FOR EACH COMPANY: SEPT. 1989- JULY 1995

MERRILL LYNCH DATA

MONTH	DCF RATE	RISK PREMIUM RATE
Jan-95	11.00%	10.40%
Feb-95	10.60%	10.30%
Mar-95	10.30%	10.20%
Apr-95	10.20%	10.10%
May-95	10.10%	10.00%
Jun-95	10.10%	9.50%
Jul-95	10.30%	9.30%
Aug-95	10.50%	9.40%

Source: *Merrill Lynch Quantitative Profiles*: [Published Monthly] January through August Issues, page 11.

UNITED CITIES' CAPITAL STRUCTURE

CAPITAL STRUCTURE SUMMARY

	AMOUNT (Millions)	RATIO	COST	WEIGHTED COST
Short Term Debt	7.09	2.63%	5.75%	0.15%
Long Term Debt	144.30	53.56%	8.69%	4.66%
Common Equity	118.03	43.81%	10.87%	4.76%
Total	269.42	100.00%		9.57%

UNITED CITIES' CAPITAL STRUCTURE

MORTGAGE BONDS:	SERIES	Note's Rate Per $10,000	**BALANCE YR END 94** ($Millions)	**Required Interest** ($Millions)
	N	869	14.00	1.217
	P	1043	25.00	2.608
	Q	975	20.00	1.950
	R	1132	15.00	1.698
	S	871	7.00	0.610
	T	932	18.00	1.678
	U	877	20.00	1.754
	V	750	10.00	0.750
PROPOSED MED TERM		819	0.00	0.000
		TOTAL	**129.00**	**12.263**
				9.51%
PRUDENT RATES:				
PRUDENT COST OF P NOTE @ PREVAILING Baa REFINANCING RATE		840	25.00	2.100
PRUDENT COST OF Q NOTE @ PREVAILING Baa REFINANCING RATE		830	20.00	1.660
COST OF R NOTE @				
ADJ1:	PREVAILING Baa RATE AT TIME OF ISSUE	986	15.00	1.479
ADJ2:	ADDITIONAL REDUCTION BASED ON THE DIFFERENCE BETWEEN THE Baa RATE AT TIME OF ISSUE, 986, AND PREVAILING Baa REFINANCING RATE, 873	-113	15.00	-0.170
	TOTAL APPROPRIATE COST FOR NOTE R			1.310
SUM OF PRUDENT COST FOR NOTES P, Q, AND APPROPRIATE COST FOR NOTE R				5.070
REDUCTION OF INTERST EXPENSE TO CAPTURE REDUCED COSTS				-1.186
TOTAL ADJUSTED FOR CURRENT RATES			**129.00**	**11.077**
				8.59%
OTHER LONG TERM DEBT:				
Senior Secured		887	10.44	0.926
Rental		730	6.84	0.499
Other		730	4.14	0.302
		TOTAL	**21.41**	**1.727**
				8.07%
		GRAND TOTAL	**150.41**	**12.804**
				8.51%

UNITED CITIES' CAPITAL STRUCTURE:
ADJUSTED BALANCES FOR AMORTIZATION
OF ISSUANCE EXPENSES

SERIES	Note's Rate Per $10,000	Mar-94	Apr-94	May-94	Jun-94	Jul-94	Aug-94	Sep-94	Oct-94
N	869	(124,804)	(123,490)	(122,176)	(120,862)	(119,548)	(118,234)	(116,920)	(115,606)
P	1043	(289,305)	(288,286)	(287,267)	(286,248)	(285,229)	(284,210)	(283,191)	(282,172)
Q	975	(312,200)	(311,214)	(310,228)	(309,242)	(308,256)	(307,270)	(306,284)	(305,298)
R	1132	(622,528)	(617,340)	(612,152)	(606,964)	(601,776)	(596,588)	(591,400)	(586,212)
S	871	(77,688)	(75,696)	(73,704)	(71,712)	(69,720)	(67,728)	(65,736)	(63,744)
T	932	(139,713)	(139,284)	(138,855)	(138,426)	(137,997)	(137,568)	(137,139)	(136,710)
U	877	(415,097)	(413,865)	(412,633)	(411,401)	(410,169)	(408,937)	(407,705)	(406,473)
V	750	(202,370)	(201,138)	(199,906)	(198,674)	(197,442)	(196,210)	(194,978)	(193,746)
	TOTAL	(2,183,705)	(2,170,313)	(2,156,921)	(2,143,529)	(2,130,137)	(2,116,745)	(2,103,353)	(2,089,961)
PROPOSED MED TERM	819								
AVERAGE ISSUE EXPENSE FOR MORTGAGE NOTES	2.11%	2.11%	2.11%	2.11%	2.11%	2.11%	2.11%	2.11%	2.11%
NOTE R ISSUE EXPENSE	5.88%	5.88%	5.88%	5.88%	5.88%	5.88%	5.88%	5.88%	5.88%
MAXIMUM ISSUE EXPENSE FOR OTHER NOTES	2.18%	2.18%	2.18%	2.18%	2.18%	2.18%	2.18%	2.18%	2.18%
NOTE R ISSUE EXPENSE	37.17%	37.17%	37.17%	37.17%	37.17%	37.17%	37.17%	37.17%	37.17%
NOTE R AMORTIZATION BALANCE		(231,417)	(229,489)	(227,560)	(225,632)	(223,703)	(221,774)	(219,846)	(217,917)

UNITED CITIES' CAPITAL STRUCTURE:
ADJUSTED BALANCES FOR AMORTIZATION
OF ISSUANCE EXPENSES

	SERIES	Note's Rate Per $10,000	Nov-94	Dec-94	Jan-95	Feb-95	Mar-95	AVERAGE	AMORT
	N	869	(114,292)	(112,978)	(111,664)	(110,350)	(109,036)	(116,920)	15768
	P	1043	(281,153)	(280,134)	(279,115)	(278,096)	(277,077)	(283,191)	12228
	Q	975	(304,312)	(303,326)	(302,340)	(301,354)	(300,368)	(306,284)	11832
	R	1132	(581,024)	(575,836)	(570,648)	(565,460)	(560,272)	(591,400)	62256
	S	871	(61,752)	(59,760)	(57,768)	(55,776)	(53,784)	(65,736)	23904
	T	932	(136,281)	(135,852)	(135,423)	(134,994)	(134,565)	(137,139)	5148
	U	877	(405,241)	(404,009)	(402,777)	(401,545)	(400,313)	(407,705)	14784
	V	750	(192,514)	(191,282)	(190,050)	(188,818)	(187,586)	(194,978)	14784
		TOTAL	(2,076,569)	(2,063,177)	(2,049,785)	(2,036,393)	(2,023,001)	(2,103,353)	160,704
PROPOSED MED TERM		819						0	0
AVERAGE ISSUE EXPENSE FOR MORTGAGE NOTES		2.11%	2.11%	2.11%	2.11%	2.11%	2.11%		
NOTE R ISSUE EXPENSE		5.88%	5.88%	5.88%	5.88%	5.88%	5.88%		
MAXIMUM ISSUE EXPENSE FOR OTHER NOTES		2.18%	2.18%	2.18%	2.18%	2.18%	2.18%		
NOTE R ISSUE EXPENSE		37.17%	37.17%	37.17%	37.17%	37.17%	37.17%		
NOTE R AMORTIZATION BALANCE			(215,989)	(214,060)	(212,131)	(210,203)	(208,274)	(219,846)	23143
						ADJUSTMENT		(371,554)	(39,113)
						TOTAL ADJUSTED FOR PRUDENT ISSUE EXP		(1,731,799)	121591

Required Interest Plus Amortization of Debt (Millions)		12.93
Net Balance Long Term Debt (Millions)	148.68	
COST		8.69%

UNITED CITIES' CAPITAL STRUCTURE:
DETERMINATION OF CURRENT RATES
FOR NOTES P, Q, R

UNITED CITIES' NOTES OLDER THAN 5 YEARS AND Baa RATES

NOTE P COST	NOTE R COST	NOTE Q COST
10.43%	11.32%	9.75%
Nov-92	Jan-95	Jul-95

MONTH WHEN NOTES BECAME 5 YRS OLD

Month	Moving 6 Month Averag Of Baa Rates	Moving 3 Month Average Of Baa Rates	DIFFERENCES BETWEEN UC NOTES AND PREVAILING Baa RATES 5 YRS LATER P	R	Q
Nov-92	8.86%	8.70%	1.65%		
Dec-92	8.83%	8.81%	1.61%		
Jan-93	8.78%	8.89%	1.60%		
Feb-93	8.78%	8.74%	1.67%		
Mar-93	8.73%	8.53%	1.80%		
Apr-93	8.60%	8.40%	1.93%		
May-93	8.43%	8.23%	2.10%		
Jun-93	8.31%	8.17%	2.19%		
Jul-93	8.27%	8.14%	2.22%		
Aug-93	8.15%	8.07%	2.32%		
Sep-93	8.02%	7.87%	2.49%		
Oct-93	7.88%	7.62%	2.68%		
Nov-93	7.74%	7.42%	2.85%		
Dec-93	7.65%	7.44%	2.89%		
Jan-94	7.52%	7.68%	2.83%		
Feb-94	7.53%	7.67%	2.83%		
Mar-94	7.59%	7.66%	2.81%		
Apr-94	7.76%	7.81%	2.64%		
May-94	7.93%	8.10%	2.41%		
Jun-94	8.12%	8.42%	2.16%		
Jul-94	8.21%	8.60%	2.03%		
Aug-94	8.40%	8.69%	1.89%		
Sep-94	8.58%	8.73%	1.78%		
Oct-94	8.72%	8.84%	1.65%		
Nov-94	8.83%	8.97%	1.53%		
Dec-94	8.95%	9.17%	1.37%		
Jan-95	9.07%	9.21%	1.29%		
Feb-95	9.14%	9.09%	1.32%	2.21%	
Mar-95	9.11%	8.97%	1.39%	2.28%	
Apr-95	9.01%	8.88%	1.49%	2.38%	
May-95	8.87%	8.72%	1.64%	2.53%	
Jun-95	8.69%	8.50%	1.84%	2.73%	
Jul-95	8.56%	8.23%	2.04%	2.93%	1.36%
Aug-95	8.38%	8.05%	2.22%	3.11%	1.54%

	P	R	Q
AVERAGE ADDITIONAL FINANCING COST PER NOTE WHEN UC AGREED TO PRECLUDE REFINANCING	**2.03%**	**2.59%**	**1.45%**
UC NOTE RATES	**10.43%**	**11.32%**	**9.75%**
APPARENT RATE FOR CURRENT AND FUTURE EXPENSE	**8.40%**	**8.73%**	**8.30%**

UC COMPARATIVE RATIOS

	DEBT RATIOS									
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Atmos Energy Corp (ATO)	12.00%	45.20%	48.30%	51.40%	54.20%	51.70%	52.30%	49.70%	43.30%	48.10%
Cascade Nat Gas Corp (CGC)	53.50%	55.50%	56.20%	55.70%	52.40%	51.50%	46.60%	49.20%	48.30%	51.20%
Conn. Energy (CNE)	44.10%	47.00%	48.50%	46.40%	51.23%	54.90%	49.40%	50.20%	54.50%	48.80%
Conn. Nat. Gas (CTG)	48.50%	49.20%	50.10%	48.50%	53.20%	50.60%	50.00%	50.90%	50.10%	52.30%
Energen (EGN)	28.00%	40.10%	44.30%	36.70%	42.70%	40.40%	38.60%	40.80%	36.00%	41.50%
Providence (PVY)	41.20%	45.30%	42.20%	43.20%	44.50%	47.70%	41.60%	49.40%	43.30%	41.40%
Atlanta Gas Light Co. (AGL)	49.80%	49.40%	46.20%	49.30%	47.90%	50.20%	49.60%	40.20%	40.50%	49.00%
Bay St Gas Co (BSG)	40.10%	45.80%	49.10%	47.10%	43.00%	38.30%	45.20%	36.80%	46.70%	48.40%
Brooklyn Un Gas Co (BUG)	43.40%	44.20%	44.70%	47.20%	51.00%	49.00%	51.20%	51.60%	48.60%	47.30%
Indiana Energy Inc. (IEI)	41.10%	44.20%	43.80%	43.00%	43.10%	31.80%	41.60%	39.30%	38.90%	36.90%
LaClede (LG)	31.20%	36.50%	37.10%	39.70%	38.70%	41.20%	46.90%	44.10%	46.30%	43.90%
Northwest Natural Gas (NWNG)	41.50%	44.30%	45.50%	48.00%	47.90%	46.10%	50.60%	46.10%	47.50%	47.50%
Peoples Energy Corp (PGL)	39.00%	41.90%	45.20%	46.90%	45.00%	47.10%	46.30%	43.80%	45.70%	49.40%
Washington Gas Lt Co. (WGL)	43.60%	40.00%	39.50%	38.00%	42.00%	39.50%	38.90%	38.90%	41.70%	40.00%
AVERAGE	39.79%	44.90%	45.76%	45.79%	46.92%	45.71%	46.34%	45.07%	45.10%	46.12%

UC COMPARATIVE RATIOS

EQUITY RATIOS

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Atmos Energy Corp (ATO)	88.00%	54.80%	51.70%	48.60%	45.80%	48.30%	47.70%	50.30%	56.70%	51.90%
Cascade Nat Gas Corp (CGC)	42.80%	41.00%	40.70%	41.30%	45.10%	46.30%	46.70%	45.60%	47.30%	44.90%
Conn. Energy (CNE)	45.70%	46.50%	46.00%	49.20%	48.20%	44.60%	50.10%	49.40%	45.20%	51.20%
Conn. Nat. Gas (CTG)	50.00%	49.50%	48.80%	50.50%	46.10%	48.70%	49.50%	48.70%	49.50%	47.30%
Energen (EGN)	68.50%	57.00%	53.40%	61.60%	56.10%	58.70%	60.60%	58.40%	62.00%	58.50%
Providence (PVY)	58.80%	54.70%	57.80%	56.80%	55.50%	52.30%	50.70%	44.10%	51.10%	53.10%
Atlanta Gas Light Co. (AGL)	45.50%	46.90%	50.30%	48.20%	49.80%	47.80%	48.80%	58.10%	53.10%	45.80%
Bay St Gas Co (BSG)	52.50%	47.90%	47.80%	49.90%	49.10%	53.70%	48.00%	57.00%	51.90%	52.30%
Brooklyn Un Gas Co (BUG)	47.00%	48.90%	49.10%	47.70%	44.70%	46.80%	45.40%	47.80%	50.80%	52.20%
Indiana Energy Inc. (IEI)	55.00%	52.30%	56.20%	49.50%	49.70%	62.10%	53.20%	55.50%	61.10%	63.10%
LaClede (LG)	66.00%	59.10%	61.50%	59.30%	60.60%	58.10%	52.50%	55.30%	53.10%	55.50%
Northwest Natural Gas (NWNG)	49.00%	47.90%	48.10%	45.10%	44.80%	47.00%	43.20%	43.90%	45.00%	46.00%
Peoples Energy Corp (PGL)	53.90%	53.90%	51.20%	50.10%	52.50%	51.00%	52.10%	55.10%	54.30%	50.60%
Washington Gas Lt Co. (WGL)	51.30%	54.80%	55.50%	57.60%	54.00%	56.40%	56.90%	57.30%	54.90%	56.70%
AVERAGE	55.29%	51.09%	51.29%	51.10%	50.14%	51.56%	50.39%	51.89%	52.57%	52.08%

UC COMPARATIVE RATIOS

	TOTAL									
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Atmos Energy Corp (ATO)	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Cascade Nat Gas Corp (CGC)	96.30%	96.50%	96.90%	97.00%	97.50%	97.80%	93.30%	94.80%	95.60%	96.10%
Conn. Energy (CNE)	89.80%	93.50%	94.50%	95.60%	99.43%	99.50%	99.50%	99.60%	99.70%	100.00%
Conn. Nat. Gas (CTG)	98.50%	98.70%	98.90%	99.00%	99.30%	99.30%	99.50%	99.60%	99.60%	99.60%
Energen (EGN)	96.50%	97.10%	97.70%	98.30%	98.80%	99.10%	99.20%	99.20%	98.00%	100.00%
Providence (PVY)	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	92.30%	93.50%	94.40%	94.50%
Atlanta Gas Light Co. (AGL)	95.30%	96.30%	96.50%	97.50%	97.70%	98.00%	98.40%	98.30%	93.60%	94.80%
Bay St Gas Co (BSG)	92.60%	93.70%	96.90%	97.00%	92.10%	92.00%	93.20%	93.80%	98.60%	100.70%
Brooklyn Un Gas Co (BUG)	90.40%	93.10%	93.80%	94.90%	95.70%	95.80%	96.60%	99.40%	99.40%	99.50%
Indiana Energy Inc. (IEI)	96.10%	96.50%	100.00%	92.50%	92.80%	93.90%	94.80%	94.80%	100.00%	100.00%
LaClede (LG)	97.20%	95.60%	98.60%	99.00%	99.30%	99.30%	99.40%	99.40%	99.40%	99.40%
Northwest Natural Gas (NWNG)	90.50%	92.20%	93.60%	93.10%	92.70%	93.10%	93.80%	90.00%	92.50%	93.50%
Peoples Energy Corp (PGL)	92.90%	95.80%	96.40%	97.00%	97.50%	98.10%	98.40%	98.90%	100.00%	100.00%
Washington Gas Lt Co. (WGL)	94.90%	94.80%	95.00%	95.60%	96.00%	95.90%	95.80%	96.20%	96.60%	96.70%
AVERAGE	95.07%	95.99%	97.06%	96.89%	97.06%	97.27%	96.73%	96.96%.	97.67%	98.20%

UC COMPARATIVE RATIOS

	SHORT TERM DEBT									
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Atmos Energy Corp (ATO)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Cascade Nat Gas Corp (CGC)	3.70%	3.50%	3.10%	3.00%	2.50%	2.20%	6.70%	5.20%	4.40%	3.90%
Conn. Energy (CNE)	10.20%	6.50%	5.50%	4.40%	0.57%	0.50%	0.50%	0.40%	0.30%	0.00%
Conn. Nat. Gas (CTG)	1.50%	1.30%	1.10%	1.00%	0.70%	0.70%	0.50%	0.40%	0.40%	0.40%
Energen (EGN)	3.50%	2.90%	2.30%	1.70%	1.20%	0.90%	0.80%	0.80%	2.00%	0.00%
Providence (PVY)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.70%	6.50%	5.60%	5.50%
Atlanta Gas Light Co. (AGL)	4.70%	3.70%	3.50%	2.50%	2.30%	2.00%	1.60%	1.70%	6.40%	5.20%
Bay St Gas Co (BSG)	7.40%	6.30%	3.10%	3.00%	7.90%	8.00%	6.80%	6.20%	1.40%	-0.70%
Brooklyn Un Gas Co (BUG)	9.60%	6.90%	6.20%	5.10%	4.30%	4.20%	3.40%	0.60%	0.60%	0.50%
Indiana Energy Inc. (IEI)	3.90%	3.50%	0.00%	7.50%	7.20%	6.10%	5.20%	5.20%	0.00%	0.00%
LaClede (LG)	2.80%	4.40%	1.40%	1.00%	0.70%	0.70%	0.60%	0.60%	0.60%	0.60%
Northwest Natural Gas (NWNG)	9.50%	7.80%	6.40%	6.90%	7.30%	6.90%	6.20%	10.00%	7.50%	6.50%
Peoples Energy Corp (PGL)	7.10%	4.20%	3.60%	3.00%	2.50%	1.90%	1.60%	1.10%	0.00%	0.00%
Washington Gas Lt Co. (WGL)	5.10%	5.20%	5.00%	4.40%	4.00%	4.10%	4.20%	3.80%	3.40%	3.30%
AVERAGE	4.93%	4.01%	2.94%	3.11%	2.94%	2.73%	3.27%	3.04%	2.33%	1.80%

SHORT TERM DEBT AS PERCENT OF CAPTAL STRUCTURE 1990-1994	2.63%
PERMANENT EQUITY AND LONG TERM DEBT AS PERCENT OF CAPITAL STRUCTURE	97.37%
RATIO OF SHORT TERM DEBT TO PERMANENT CAPITAL STRUCTURE	0.027041

Docket No. 95-02258
Exhibit CA-SNB____
Schedule 17 ______
Page 1 of 1_______

ISSUE EXP

UC BOND SERIES LETTER

	N	P	Q	R	S	T	U	V	TOTAL	
BOND AMOUNT (Millions)	20	25	20	15	7	18	20	10	135	
ISSUE EXP (000)	236.5	422.0	357.6	**881.4**	146.1	154.7	436.9	215.3	2850.4	
ISSUE EXPENSE AS % OF BOND AMOUNT	1.18%	1.69%	1.79%	**5.88%**	2.09%	0.86%	2.18%	2.15%	2.11%	AVERAGE
ISSUE DATE	3/1/87	10/1/87	4/1/90	12/1/89	6/1/91	6/1/91	5/1/92	12/1/92		
MATURITY DATE	3/1/02	11/1/17	4/30/20	5/1/04	6/1/97	6/1/21	5/1/22	12/1/07		
LENGTH-YRS	15	30	30	14	6	30	30	15		
LENGTH-MNTHS	180	360	360	168	72	360	360	180		
MONTHLY AMORTIZATION ON STRAIGHT LINE BASIS (000)	1.314	1.172	0.993	5.246	2.029	0.430	1.213	1.196	13.594	
AMORTIZATION FROM UNITED CITIES DATA RESPONSE (000)	1.314	1.019	0.986	5.188	1.992	0.429	1.232	1.232	13.392	
DIFF (000)	0.000	0.153	0.007	0.058	0.037	0.001	-0.019	-0.036	0.202	

NOTE R'S ISSUE EXPENSES, 5.88% OF THE NOTE, ARE NEARLY THREE TIMES LARGER THAN ANY OTHER NOTE

So Long, Calvin Coolidge

Meter Reading Approaches the 1990s Promising a Pivotal Market for Communications Infrastructure

By Stephen N. Brown

Federal and state regulators must become knowledgeable about Automatic Meter Reading (AMR) and all that it entails. After all, AMR is a pivotal market that will shape the nation's communications infrastructure by determining whether energy and water industries move toward an intelligent, public-switched communication network or toward radio-based personalized communication networks.

The junction lies in the eventual replacement of roughly 250 million electric, gas, and water meters in the United States, nearly all of which reflect the technology of the 1920s: they must be read manually, they are incapable of implementing time-differentiated rates, they cannot communicate with anything, and their information storage capability is nil. They will be replaced by devices embodying today's technology, and that will be compatible with the nation's communication infrastructure.

Radio Networks or Wired Networks?

The infrastructure is being shaped by the century-old competition between radio networks and wired networks. Radio-based cellular and microwave technology use the electromagnetic spectrum and offer the promise of personalized communication networks (PCNs) along with decentralized ownership and splintered control of the nation's communication infrastructure.

The AMR market already reflects the struggle over market position and the dichotomies between radio and wired technologies, and between unilateral control and integrated control. AMR products available today encompass various radio offerings, including one combination of spread-spectrum signalling with a power line carrier, as well as telephone-inbound/outbound strategies.Telephone-based products require cooperation between the local exchange carriers and the utility; the spread-spectrum/power-line device is unilaterally operated by the utility. However, there is no dominant AMR strategy or product in the electric, gas, and water industries; also, they have no organized strategy on how to migrate from a 1920's-vintage metering technology to the 1990s. The AMR market today is still immature, disorganized, and untapped, but loaded with potential.

Why?

Because replacing 250 million meters, not to mention possible markets abroad, represents a major demand for new manufactured products that embody new communication technology.

Capable Networks for Energy Industries

More capable networks are needed by the electric utility industry, which is under intense pressure to adopt energy efficiency strategies requiring load monitoring, load management, incentive rates, and perhaps eventually real-time pricing.AMR is essential for all these strategies. Therefore, regulators should advocate AMR investments in energy-utility networks, whether radio or cable-based, that:

- have scale economies;
- possess multi-functionality;
- can easily implement rate structure changes;
- are consistent with open-architecture principles;
- avoid redundancy and duplication of another local utility's investments.

The regulatory community should take the lead in advocating economic cooperation between different utility industries—not only for the potential economic benefits but also because the utilities and American business in general do not value economic cooperation.

Shorter Replacement Cycles

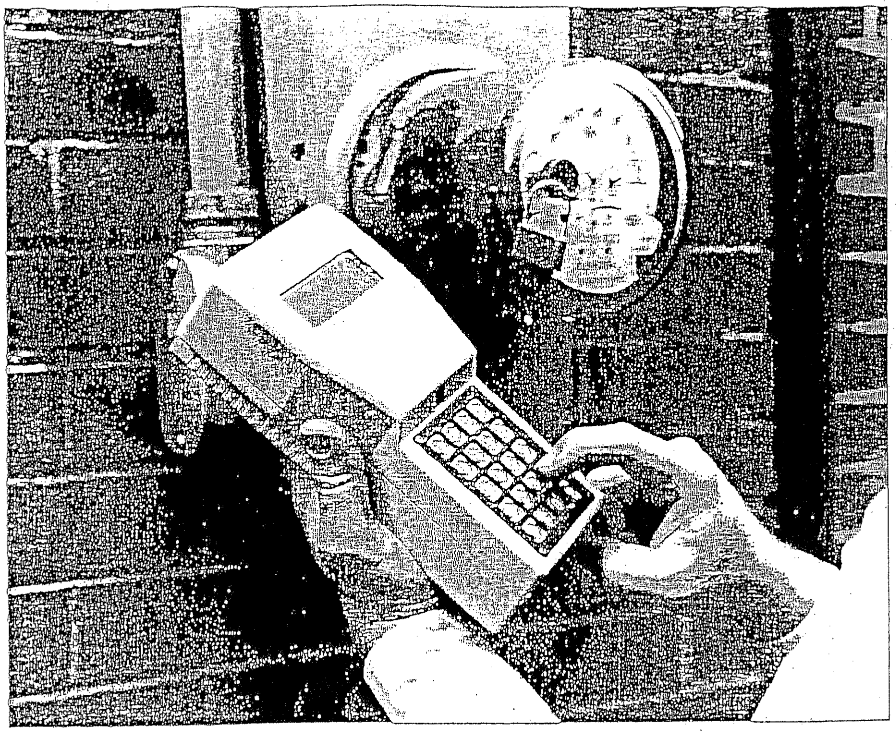
The application to AMR and the regulatory process is this: Regulated industries should be responsive to continual product improvements in AMR. Regulators should not expect AMR products to have a 30- to 40-year depreciation schedule, nor should they expect utilities to make automation investments and then not replace them for decades. Product replacements are likely to occur in shorter cycles such as eight to twelve years.This is true for either radio or wired technologies.

An important feature of continual product improvement is the role of customer feedback in guiding incremental improvements to the product after it has been introduced. This suggests a need for continual cooperation between utilities and AMR manufacturers. In an intelligent network, product improvement means software improvements to create and access data bases that are centralized with regard to a local access transport area (LATA). Without an intelligent network, data bases are located in each local exchange. There are approximately 120-150 LATAs in the country along with several thousand local exchanges. Centralizing data bases in LATAs rather than local exchanges reduces the development cycle for new services from years to months.

However, the communications industry has no plans to develop processing capability in digital central office switches. An intelligent network offering speed but lacking distributed processing may have little value to electric utilities. Their long-term planning is evolving toward the distributed utility concept: the electrical distribution system becomes the focus of planning, processing, reliability, and power quality control. Distribution control was a sideline issue when central station economies of scale dominated the electric power industry, but this situation has changed.

The new emphasis is on the distribution sector, which is ready for massive applications of technology that control and manage the end user's consumption. AMR software and hardware are aimed at the distribution sector; load management is a distribution function. AMR products will also have load management capability. Consequently, there's a clear need for processing capability. But where will that capability be located, at the company's headquarters or at selected points in the field, such as a central office?

The processing capability should be located in the field, making the logical choice for processing in an intelligent network digital central office switches. All organizations, including utilities, would probably recoil at the idea of a digital central office that processes data, fearing for the data's privacy and reliability. Appropriate encryption and validation procedures would make pro-



cessing viable at the central switch, and provide two separate opportunities for cooperation between a phone company and an energy utility: where the local company does not have a digital switch, coordination between the two utilities could result in the installation of a new digital switch. Where a digital switch already exists, joint investment in its distributed processing capability will expand the intelligent network's scope. A utility's data bases could be placed in the central switch and accessed on a LATA basis. Without this capability, the intelligent network may be a case of bandwidth overkill for AMR and load management functions, with no thought given to the network's potential for time differentiated pricing or other add-on services for utilities.

Property and Profit

An intelligent network's product improvement is tied directly to software, a concrete, easily recognized aspect of the intelligent network. But in a radio network product improvement is amorphous because a frequency cannot be "owned", and there are no codified private property rights regarding the spectrum. Government steps in to allocate the spectrum. In a competitive setting, lack of property rights in the spectrum makes the innovator's profit stream far less secure than for the intelligent network's innovator. In a competitive setting property rights protect the profit stream created by the innovator. For this reason, an intelligent network is more likely to sustain a high rate of innovation than a radio network. In fact, one of the more notable innovations in radio technology thrives on the absence of property rights. Spread spectrum technology hops across adjacent radio frequencies to mask the content of a radio message. While this is successful in military applications, the technology has not yet penetrated the commercial markets to a significant degree.

Product improvement is important for radio-based AMR manufacturers. They will have to demonstrate their product's potential for broad application over time before they can capture the utility industry as a long-term AMR customer.

Dr. Stephen N. Brown is Chief, Bureau of Energy Efficiency, Auditing, and Research Utilities Division, Iowa Department of Commerce. This paper was presented at the New Mexico State University's Center for Public Utilities: Current Issues Challenging the Regulatory Process held in Santa Fe, New Mexico March 11, 1992.

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Opinion

No Second Time Around for AMR

By Stephen Brown, AMRA Treasurer
Iowa Department of Commerce

David Gorton's editorial in AMRA's January newsletter ["Looking Back to See the Future," p. 2] conveyed the notion that AMR's problems are no different today than they were 30 years ago. To an extent, he is right. AMR's problems are perennial because the utility industry's retail business environment has been remarkably stable. But the time will come when the environment changes, allowing a permanent fix for the infirmities of the AMR market.

Utilities have a growing need for accurate and prompt measurement of consumption. This is not caused by a sense of righteous conversion to AMR. Cold, hard self-interest is the reason. The electric and gas utilities, in particular, are more interested in AMR today because they face the prospect of competition in all phases of their business. Competition implies uncertainty about profit margins and a need for detailed knowledge of the retail market. Good information acquired through AMR will make the difference between success and failure in a competitive market.

Standard and Poor's Corp., a major financial ratings firm, believes that competition is making the electric business very risky. Consequently, the firm set new financial standards that may reduce credit ratings for one-third of the nation's electric utilities. This has never happened before. The industry's new competitive environment may compel utilities to install AMR equipment that embodies rapid communication and sophisticated measurement. Thus, the recycling of AMR's familiar problems may truly come to a final end.

However, Gorton's editorial shows the same thought being voiced in 1967: "AMR has been a 'want' of the electric utilities for many years but now is rapidly becoming a 'must.'" That statement was wrong in 1967, but it's right today. If you want to know why, read an insightful article by AMRA member Roger Levy. He cowrote *Re-engineering DSM: Opportunities Through Information and Integration*, which appears in last November's issue of *The Electricity Journal*. Levy explains why the electric utility industry failed, in general, to implement automation procedures regarding measurement and communication in the retail market. The dominant reason, says Levy, is "most ... technical and procedural designs incorporate implicit and explicit compromises to make sure that programs cause little disruption and conform as closely as possible to the operating practices and features of existing utility company business management and information systems."

In short, AMR and all automation systems have the potential to create ripple effects throughout a company. If unwilling to live with these or take advantage of them, the company constrains the automation project, cutting it here and tweaking it there until the project is reduced to a shadow, drained of its promise and potential.

In Levy's words, "What starts out as a 'logical compromise' ... artificially limits how ... communication, measurement and control technologies might be used to modernize existing utility systems and practices."

In today's market, many industries depend on rapid information flow for marketing, cost cutting and competing, including: the overnight package delivery industry, the vending machine business, the liquid fuels business of propane and butane delivery, and all "just-in-time" production and inventory businesses. These enterprises have made every effort to automate because it's vital to their success.

In 1967, automation at the retail level didn't mean anything to the utility industry, and AMR was a nonevent. That era is over. The AMR industry should take advantage of the present, push on all fronts and think big.

The advice of Daniel Burnham is appropriate. He was a urban planner who, in 1900, redesigned the cities of Chicago and Washington, D.C. He told the cities' leaders, "Make no small plans, they do not stir men's imagination."

AMR pilot projects have seen their day. The technology won't mature if it's forever limited to trials. Its true potential lies in full-scale, utilitywide projects, and now is the time to pursue them.

Stephen Brown works for the Iowa Department of Commerce, which is based in Des Moines. He also serves as the treasurer of AMRA.

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Opinion

DOE Proposal Trivializes AMR

By Stephen Brown
Iowa Department of Commerce

Automatic meter reading (AMR) received much needed attention when Congress enacted the Telephone Disclosure and Dispute Resolution Act of 1992. It directed the U.S. Department of Energy (DOE) to consider a government demonstration project involving utility communications and AMR.

Last March, the DOE opened docket CE-NOI-93-001, an inquiry meant to implement Congress' directive. After consultation with the U.S. Commerce Department, the DOE released its final report, *Proposal for Demonstrating the Potential of Innovative Communications Equipment and Services for Utility Applications*, on Sept. 2. [See related article on page 3.] In it, the DOE recommends against a "use of federal funds" to develop an AMR or energy-management demonstration project because "it would duplicate demonstrations already planned by utilities."

Despite this reasonable conclusion, the final document is disappointing. It could have been a means for the DOE to show Congress that meter reading and utility communication are vital functions in the American economy. Instead, the DOE sent Congress a message that trivializes AMR.

The report accepts without question a cliched, moss-backed argument used for years to stifle innovation in metering, utility pricing and communication: "Presently the main limitation on automatic meter reading is cost. According to the Edison Electric Institute in their response, a survey of their members shows that it only costs between 30 cents and 60 cents per customer per month to read the meter manually for typical customers...". When Congress reads this, they will wonder why anyone would bother with AMR since manual reading is cheaper than a phone call.

The report is flawed because the agency's worldview is confined to the Washington Beltway. Twenty-seven respondents filed comments on CE-NOI-93-001. The DOE apparently thinks only two had opinions that are worthy of Congress' attention. The DOE highlights the filings of the Edison Electric Institute and the Utility Telecommunications Council, two of the oldest guards in Washington. The report does not refer to the opinions of the other 25 respondents — vendors, phone companies, cable companies, utilities and consultants. A balanced report would have drawn from many respondents, not just two. It would have shown the fallacy of the "manual meter reading is cheap" argument.

Manual meter reading is cheap because it is an almost worthless service. It gives practically nothing to consumers and utilities. The inadequacy of meter reading and its failure to facilitate economic decision making by consumers is shown by the popularity of balanced-billing for gas, water and electric utilities.

In balanced-billing, a customer's annual bill is estimated and divided by 12. The result is the customer's monthly bill. At the end of one year, the difference between actual and estimated consumption is reconciled, the customer receives a credit or debit, and the cycle starts again. Millions of consumers use balanced-billing. In short, the payment for consumption of gas, water and electricity in the United States is little different from making a premium payment for insurance. The success of balanced-billing shows the only effective use of manual meter reading — reconciling the customer's estimated annual consumption against actual consumption once a year in order to balance a company's annual cash flow.

It is a mystery why the DOE gladly accepts the cheap meter-read argument and then passes it on to Congress as an unquestioned truth. Consumers need the opportunity and the tools to treat their energy and water purchases like any other commodity or service. AMR is the tool, and a time-sensitive utility price is the opportunity. These will create new patterns of energy and water use, perhaps allowing the next generation of Americans to mitigate and avoid costs for such things as the safe disposal of nuclear fuel used in power plants, which is now estimated at $45 billion.

With AMR, the next generation will shop for the right time to buy energy, from the right source and at the right price — just like it shops for the right groceries and right times to travel. It's time for the utility industry's metering practices to measure up to the 1990s and the next century.

The DOE's report could have sent these messages to Congress while still arriving at the same conclusions. Instead, Congress will now dismiss the issue as trivial.

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ECONOMIC INCENTIVES FOR NUCLEAR PLANT PERFORMANCE: A STATE PERSPECTIVE

BY

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STATE OF IOWA

DELIVERED AT THE NRC'S STATE LIAISON OFFICERS' MEETING: REGION III
GLEN ELLYN, ILL., SEPTEMBER 29, 1988

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INTRODUCTION

I had the opportunity to listen to Nuclear Regulatory Commissioner Ken Rogers' presentation at the July 25th meeting of NARUC's subcommittee on nuclear issues. Commissioner Rogers clearly takes the position that capacity factors can be a disincentive to the safe operation of a nuclear power plant when they are used as a sole measure of the plant's overall economic performance. Of course, the Commissioner's stance accurately represents the Nuclear Regulatory Commission's (NRC's) basic opinion regarding target capacity factors and their role in the incentive programs established by state regulatory bodies.

I'm a senior staff member of a state regulatory body, the Iowa Utilities Division, a group that provides line and staff support to the Iowa Utilities Board, a body composed of three appointed officials, the decision-makers who set policy. I do not speak for their policy views on incentive programs. But I am in the position to describe why nuclear plant performance is becoming an issue in Iowa, to make my own professional assessment of the capacity factor issue, and to offer a compromise measure, one that may satisfy the concerns of the NRC and those of state regulatory agencies engaged in economic incentive programs.

NUCLEAR POWER IN IOWA

Nuclear power plants provide approximately 25% of the net electrical generation devoted to consumption in Iowa. The plants are: Cooper, wholely owned and operated by Nebraska Public Power, but one-half of the net output is committed to the Iowa Power & Light Company; Duane Arnold, operated by Iowa Electric Light & Power Company, but jointly owned with two rural electric organizations; and Quad Cities Units 1 and 2, operated by Commonwealth Edison, but jointly owned with Iowa-Illinois Gas & Electric Company.

Nuclear plants are normally operated at a nearly constant level of output during most on-line hours, the exception being those on-line hours either immediately prior to a planned shut-down or during coast-down at the end of the fuel cycle. But the Utilities Division Staff found that Cooper and Duane Arnold substantially deviated from this pattern; from 1983 through

1986 both plants appeared to swing with load rather than operating in the base-load fashion characteristic of most other nuclear plants in the country. Table 1 is a comparison of Duane Arnold and Cooper utilization to utilization of nuclear plants in states adjacent to Iowa. For all four years these two plants were consistently near the bottom of the scale. Table 2 is a similar comparison for nuclear plants in the Mid-Continent Area Power Pool (MAPP), and Cooper and Duane Arnold again fall to the bottom of the scale. Tables 3 and 4 are similar comparisons using all the nuclear plants.[1]

All of this descriptive information substantiates the idea that these two plants, unlike most others in the country, were not being extensively base loaded. This is significant because of the very low fuel costs involved: between 6 and 9 mills per kilowatt-hour at both plants in comparison to costs of 13 to 15 mills at the large coal-fired plants in the state. The very obvious question is: why not increase the output at the nuclear plants as a substitute for the more expensive coal output? This issue is even more puzzling because one of the state's base-load coal fired plants has greater utilization than either Cooper or Duane Arnold during the same time frame. The Iowa Utilities Board ordered an investigation into this issue; interrogatories were sent to the two Iowa companies involved, and responses are expected in mid-October.

This approach appears to be retrospective, but it should also be viewed as a planning consideration. Federal acid rain legislation could have a negative impact on eight major generating plants in Iowa. If and when such legislation becomes law, compliance would most likely require curtailed output at some or all of these plants. As a group, the plants provide 4,600 megawatt hours (MWH) of the state's net electrical output, about 21 percent of the total net output. In addition, the plants' average number of annual service hours exceed 7,000, and the average hourly output is 82 megawatts (MW). Improved performance at the nuclear plants will alleviate some of the negative consequences of compliance with the new legislation. This is a primary reason why nuclear power plant performance in Iowa will be more important in the future.

THE CAPACITY FACTOR ISSUE

Given the scenario just described, how should a regulatory body proceed with the development performance evaluation? A quick answer, but one that would disturb the NRC, would be to use capacity factors. As most of you know, a capacity factor is a composite measure of a plant's availability and output level. If availability falls or if output declines, the capacity factor drops. The NRC's objection to capacity factors is simple but cogent: use of the factor encourages a company to run a nuclear plant when it should be shut down for periodic and preventive maintenance. Therefore, capacity factors lead to incremental deterioration of the plant with a cumulative effect on safety. New York Attorney General Robert Abrams expressed this sentiment when criticizing the New York PSC's incentive program: "A company striving to meet a capacity-factor target would be tempted to ignore or downplay the seriousness of safety problems."

This argument is aimed at state regulatory agencies. These organizations have a direct and large effect on the financial well-being of the utilities involved with the nuclear plants. From a financial view, the state bodies have a much greater impact on the companies than does the NRC. For this reason, state agencies can have substantial influence on how the companies manage nuclear plants. In fact, several states have chosen to exercise their influence, and despite the concerns of the NRC, have adopted incentive programs that include capacity factors. These states include New York, New Jersey, Florida, Virginia, and North Carolina among others. The contention and fractiousness over economic incentives and regulation is quite visible.

For example, a July 1988 Electrical World article summarized a nuclear plant survey conducted by the Reliability Engineering Department of Westinghouse Electric:

> ...organizational and external factors have a far stronger effect on availability of US reactors than physical attributes, such as age, reactor type, or nuclear-steam-supply-system vendor...Economic regulation sometimes hinders preventive-maintenance initiatives and plant equipment upgrades, the report concluded. "On the state level, there appears to be a widespread lack of understanding by utility commissions of the importance of nuclear power..."

The other side of the coin is illustrated by a December 1985 article appearing in the New York Times:

> ...(S)tate regulators seem unimpressed with the NRC's concerns and suggestions. "This is a political process," said one state regulator, adding that the NRC's protestations about the deleterious effect of financial incentive programs on reactor safety are "a nice smokescreen."

There appears to be disagreement between many state regulatory authorities, the nuclear power industry, and the NRC over the use of incentive programs and capacity factors. The most important question here is not who's right, but is there an alternative, one that is tenable for all concerned parties?

I believe that the answer lies in a composite measure that incorporates three ideas: (1) the utilization ratio concept illustrated in Tables 1 through 4; (2) service hours; and (3) reactor trip rates, referred to more formally as Reactor Protection System Actuation Rates.

DEVELOPING A COMPOSITE MEASURE

The utilization ratios in Tables 1 through 4 exclude hours when the plant is not in service, and therefore provide a simple indication about the kind of loading that prevails at the nuclear plant. The ratios are useful because they indicate if an economic dispatch problem is present. An economic dispatch problem is clearly not a plant performance problem, but this distinction would be hidden by capacity factors. By mixing availability and output level, capacity factors fail to pinpoint and isolate system problems from plant problems.

However, utilization ratios shed no light on plant availability; they are useless in this regard. Plant availability should be synonymous with service hours; this method is simple, clear, and avoids any confusion that might be caused by using capacity factors as a surrogate measure for availability. But there is an important point here; if capacity factors should not be used in an economic incentive program, then how can the capacity factor concept be legitimately used by generation planners when they're assessing the economic feasibility of a new plant? The link between capacity factors used for planning and actual capacity factors is shown in a February 1987 decision by the New Jersey Board of Public Utilities. The following is taken from the decision and order in Docket ER85121163.

> Nuclear plants are constructed with the expectation that their high capital costs will be offset by their low operating costs, thereby providing an economical, year-round energy supply to ratepayers. At the time the decisions were made to construct each of the Company's five operating nuclear plants - Salem I, Salem II, Peach Bottom II, Peach Bottom III and Hope Creek I- they were projected to perform at approximately 80% capacity factors. These projections were subsequently revised downward at the time construction commenced and again at the time of initial commercial operation. Despite these projections, the plants (exclusive of Hope Creek) have not met performance expectations and have been plagued with prolonged outages. The Company reported that the lifetime cumulative capacity factor for Salem I is 51.3%, Salem II - 47.7%, Peach Bottom II - 53.8% and Peach Bottom III - 60%. Further, plant operations have been characterized by wide swings in performance as evidenced by Salem II's 8% capacity factor in 1983 and Salem I's 95% capacity factor in 1985. Thus, ratepayers have been saddled with the cost burden of the plants' high fixed costs in base rates and expensive replacement power costs incurred as a result of substandard nuclear performance ... It is this history of uneven and substandard nuclear performance, its attendant cost burden to ratepayers and the Company's increasing reliance on nuclear generation that gives rise to the need for nuclear performance standards.

Repudiating capacity factors in an economic incentive program also means repudiating them in the generation planning and economic feasibility stage. How is this contradiction resolved to create a workable incentive program, one that also addresses the concerns of the NRC and the criticism of capacity factors voiced by New York State Attorney General, Robert Abrams, mentioned earlier? I believe the answer lies in the use of reactor trip rates.

The concept is clearly explained in a well-documented paper authored by David Dietrich of Technical Analysis Corporation. He makes several points in his paper, and I'm going to highlight just two of them because they're useful in this forum. The author makes this statement:

> An "RPS actuation with control rod motion" -- the standard terminology meaning reactor scram or shutdown -- results in lower economic efficiency because the plant is taken off line. Such an RPS actuation also results in a lower level of safety because the event presents a challenge to safety systems and operating staff that must bring the reactor to a safe condition.

With this comment Mr. Dietrich is establishing a connection between a reactor trip and economic efficiency; the greater the number of trips the lower the overall efficiency. In the next statement the author points out how well reactor trip rates coincide with the NRC's policy goals.

> The NRC has had a formal program to reduce trip frequency since 1984 and every year has seen a gradual reduction in trip rates. The NRC has concluded that "a reduction in the frequency of challenges to plant safety systems should be a prime goal of each licensee." It also finds that large reductions in the risk of an anticipated transient without scram (ATWS) can be achieved by reducing the frequency of transients that call for RPS operation. A reduction in the RPS actuation rate, the goal of the proposed incentive program criterion, is not only consistent with formal NRC policy. It is formal NRC policy.

However, reactor trip rates are not complete substitutes for capacity factors; although the two items are inversely correlated with each other, the correlation is not perfect. David Dietrich points out that while low trip rates are accompanied by high capacity factors and vice-versa, there are also instances where high capacity factors and high trip rates accompany each other. Based on this observation, my conclusion is that reactor trip rates alone should not be the only criteria to evaluate the economic performance of a nuclear plant.

CONCLUSION

In my opinion an economic incentive program should explicitly include reactor trip rates because they are useful and prudent, as well as being responsive to the concerns of the NRC. But I continue to believe that utilization levels and the number of plant service hours should also be a part of an incentive program. The exact weight given to each component would be a matter for the policy makers. The conceptual framework provided here represents a middle road, one that does not rely on a single measure to evaluate performance. An incentive program focusing on reactor trip rates, utilization levels, and service hours provides a workable alternative to reliance on target capacity factors and is a solution to the problem I mentioned earlier: where a company or industry repudiates capacity factors as a method of economic evaluation even though generation planners used capacity factors to justify economic feasibility for the plants in question. Use of the composite measure put forth in this paper would certainly recognize the interests of the ratepayers, the companies, and the concerns for safety expressed by the NRC.

TABLE 1

Comparison of Cooper and Duane Arnold Utilization to
Utilization of Nuclear Plants in States Adjacent to Iowa for 1983-1986.

Plant No.	Year	Plant Name	State	Total Plant Name Plate (A)	Maximum Dependable Capacity (Net MW) (B)	Total MWH Generation (C)	Service Hours (D)	Estimated Avg. MW Generated (E)=(C)/(D)	Percentage of Capacity Utilized (F)=(E)/(B)
1.	1983	Palisades	MI	812.00	635.00	3,769,958	5,283.60	713.52	112.37%
2.	1986	Kewaunee	WI	560.00	503.00	3,854,674	7,515.20	512.92	101.97%
3.	1985	Kewaunee	WI	560.00	503.00	3,699,176	7,214.70	512.73	101.93%
4.	1984	Kewaunee	WI	560.00	503.00	3,810,000	7,528.40	506.08	100.61%
5.	1984	Point Beach #1	WI	524.00	485.00	3,109,208	6,380.00	487.34	100.48%
6.	1983	Kewaunee	WI	560.00	503.00	3,706,928	7,335.80	505.32	100.46%
7.	1985	Point Beach #1	WI	524.00	485.00	3,354,176	6,919.30	484.76	99.95%
8.	1986	Point Beach #1	WI	524.00	485.00	3,770,070	7,787.60	484.11	99.82%
9.	1985	Point Beach #2	WI	524.00	485.00	3,603,081	7,491.30	480.97	99.17%
10.	1985	Palisades	MI	812.00	730.00	5,301,797	7,344.40	721.88	98.89%
11.	1986	Point Beach #2	WI	524.00	485.00	3,417,550	7,188.30	475.43	98.03%
12.	1984	Point Beach #2	WI	524.00	485.00	3,512,373	7,406.60	474.22	97.78%
13.	1983	Point Beach #2	WI	524.00	495.00	3,016,298	6,247.60	482.79	97.53%
14.	1984	Cook #2	MI	1,133.00	1,060.00	5,364,363	5,198.70	1,031.87	97.35%
15.	1983	Cook #2	MI	1,133.00	1,060.00	7,013,579	6,838.40	1,025.62	96.76%
16.	1986	Wolf Creek #1	KS	1,250.00	1,128.00	6,966,063	6,418.50	1,085.31	96.22%
17.	1986	Zion #2	IL	1,098.00	1,040.00	7,334,233	7,372.00	994.88	95.66%
18.	1984	Palisades	MI	812.00	635.00	811,549	1,336.30	607.31	95.64%
19.	1984	Callaway #1	MO	1,188.00	1,120.00	323,023	302.50	1,067.84	95.34%
20.	1986	Big Rock Pt. #1	MI	60.00	64.00	506,148	8,361.70	60.53	94.58%
21.	1985	Wolf Creek #1	KS	1,250.00	1,128.00	2,942,100	2,771.60	1,061.52	94.11%
22.	1984	La Crosse	WI	65.00	48.00	318,604	7,067.30	45.08	93.92%
23.	1984	Zion #2	IL	1,098.00	1,040.00	5,986,311	6,180.00	968.66	93.14%
24.	1983	Zion #2	IL	1,098.00	1,040.00	6,181,965	6,406.60	964.94	92.78%
25.	1984	Cook #1	MI	1,152.00	1,020.00	7,550,755	8,017.80	941.75	92.33%
26.	1983	Cook #1	MI	1,152.00	1,020.00	5,286,839	5,630.80	938.91	92.05%
27.	1985	Cook #2	MI	1,133.00	1,060.00	5,683,634	5,855.00	970.73	91.58%
28.	1985	Callaway #1	MO	1,236.00	1,120.00	8,045,764	7,884.90	1,020.40	91.11%
29.	1984	Zion #1	IL	1,098.00	1,040.00	5,692,090	6,030.40	943.90	90.76%
30.	1985	Zion #1	IL	1,098.00	1,040.00	4,813,949	5,107.40	942.54	90.63%
31.	1984	Dresden #2	IL	828.00	772.00	4,460,360	6,403.70	696.53	90.22%
32.	1986	Callaway #1	MO	1,236.00	1,120.00	7,199,113	7,124.50	1,010.47	90.22%
33.	1985	Lasalle #2	IL	1,078.00	1,036.00	3,430,898	3,699.90	927.29	89.51%
34.	1986	Dresden #2	IL	828.00	772.00	4,648,539	6,763.50	687.30	89.03%
35.	1985	La Crosse	WI	65.00	48.00	322,909	7,597.60	42.50	88.54%
36.	1983	Big Rock Pt. #1	MI	60.00	64.00	348,591	6,222.80	56.02	87.53%
37.	1984	Lasalle #2	IL	1,078.00	1,036.00	1,392,117	1,537.40	905.50	87.40%
38.	1986	Cook #1	MI	1,152.00	1,020.00	6,650,074	7,466.00	890.71	87.32%
39.	1986	Palisades	MI	812.00	730.00	841,244	1,324.40	635.19	87.01%
40.	1983	Dresden #2	IL	828.00	772.00	3,397,514	5,080.30	668.76	86.63%
41.	1986	Zion #1	IL	1,098.00	1,040.00	4,904,664	5,452.00	899.61	86.50%
42.	1984	Big Rock Pt. #1	MI	60.00	70.00	417,523	6,906.20	60.46	86.37%
43.	1985	Dresden #3	IL	828.00	773.00	4,390,064	6,621.30	663.02	85.77%
44.	1985	Dresden #2	IL	828.00	772.00	3,087,488	4,680.40	659.66	85.45%

TABLE 1 (Cont.)

Comparison of Cooper and Duane Arnold Utilization to Utilization of Nuclear Plants in States Adjacent to Iowa for 1983-1986.

Plant No.	Year	Plant Name	State	Total Plant Name Plate (A)	Maximum Dependable Capacity (Net MWe) (B)	Total MWH Generation (C)	Service Hours (D)	Estimated Avg. MW Generated (E)=(C)/(D)	Percentage of Capacity Utilized (F)=(E)/(B)
45.	1986	Lasalle #2	IL	1,078.00	1,036.00	5,717,014	6,534.50	874.90	84.45%
46.	1986	Bryon #1	IL	1,175.00	1,129.00	7,396,003	7,761.30	952.93	84.41%
47.	1983	Dresden #3	IL	828.00	773.00	4,147,939	6,403.10	647.80	83.80%
48.	1986	Lasalle #1	IL	1,078.00	1,036.00	2,018,117	2,331.90	865.44	83.54%
49.	1985	Zion #2	IL	1,098.00	1,040.00	5,114,186	5,901.30	866.62	83.33%
50.	1985	Cook #1	MI	1,152.00	1,020.00	2,116,062	2,491.10	849.45	83.28%
51.	1985	Lasalle #1	IL	1,078.00	1,036.00	4,809,395	5,584.90	861.14	83.12%
52.	1984	Lasalle #1	IL	1,078.00	1,036.00	5,206,209	6,055.00	859.82	82.99%
53.	1984	D.A.E.C.	*	597.15	515.00	2,717,563	6,405.00	424.29	82.39%
54.	1984	Dresden #3	IL	828.00	773.00	2,105,646	3,311.10	635.94	82.27%
55.	1983	D.A.E.C.	*	597.15	515.00	2,324,318	5,508.00	421.99	81.94%
56.	1986	La Crosse	WI	65.00	48.00	157,179	3,998.10	39.31	81.90%
57.	1985	Big Rock Pt. #1	MI	60.00	69.00	362,428	6,441.70	56.26	81.54%
58.	1986	D.A.E.C.	*	597.15	515.00	3,008,073	7,181.00	418.89	81.34%
59.	1986	Cooper	*	836.00	764.00	4,052,138	6,546.20	619.01	81.02%
60.	1983	La Crosse	WI	65.00	48.00	201,267	5,232.60	38.46	80.13%
61.	1985	D.A.E.C.	*	597.15	515.00	1,940,485	4,712.00	411.82	79.96%
62.	1983	Cooper	*	836.00	764.00	3,343,199	5,546.00	602.81	78.90%
63.	1984	Cooper	*	836.00	764.00	3,469,953	5,902.00	587.93	76.95%
64.	1986	Dresden #3	IL	828.00	773.00	1,456,025	2,457.10	592.58	76.66%
65.	1986	Cook #2	MI	1,133.00	1,060.00	4,335,567	5,389.70	804.42	75.89%
66.	1985	Bryon #1	IL	1,175.00	1,129.00	1,012,898	1,192.40	849.46	75.24%
67.	1985	Cooper	*	836.00	764.00	1,067,748	1,885.00	566.44	74.14%
68.	1983	Point Beach #1	WI	524.00	495.00	2,384,844	6,499.20	366.94	74.13%
69.	1983	Zion #1	IL	1,098.00	1,040.00	4,016,176	5,742.20	699.41	67.25%
70.	1983	Lasalle #1	IL	1,078.00	1,036.00	1,639,809	3,085.90	531.39	51.29%
71.	1986	Fermi #2	MI	1,215.00	1,093.00	-23,926	437.70	-54.66	-5.00%
72.	1983	Bryon #1	IL	--	--	--	--	--	--
73.	1984	Bryon #1	IL	--	--	--	--	--	--
74.	1983	Callaway #1	MO	--	--	--	--	--	--
75.	1983	Fermi #2	MI	--	--	--	--	--	--
76.	1984	Fermi #2	MI	--	--	--	--	--	--
77.	1985	Fermi #2	MI	--	--	--	--	--	--
78.	1983	Lasalle #2	IL	--	--	--	--	--	--
79.	1983	Wolf Creek #1	KS	--	--	--	--	--	--
80.	1984	Wolf Creek #1	KS	--	--	--	--	--	--

Note: Information taken from The Licensed Operating Reactors Status Summary Report from the USNRC.

1983-1986 Est. Average MW Generation and Utilization of Nuclear Plants Participating in Mapp

No.	Year	Plant Name	Total Plant Name Plate (A)	Maximum Dependable Capacity (Net MW) (B)	Total MWH Generation (C)	Service Hours (D)	Estimated Avg. MW Generated (E)=(C)/(D)	Percentage of Capacity Utilized (F)=(E)/(B)
1.	1983	D.A.E.C.	597.15	515.00	2,324,318	5,508.00	421.99	81.94%
1.	1984	D.A.E.C.	597.15	515.00	2,717,563	6,405.00	424.29	82.39%
1.	1985	D.A.E.C.	597.15	515.00	1,940,485	4,712.00	411.82	79.96%
1.	1986	D.A.E.C.	597.15	515.00	3,008,073	7,181.00	418.89	81.34%
2.	1983	Quad Cities #1	828.30	769.00	5,776,352	8,261.00	699.23	90.93%
2.	1984	Quad Cities #1	828.30	769.00	3,349,735	4,687.00	714.69	92.94%
2.	1985	Quad Cities #1	828.30	769.00	6,072,319	8,244.00	736.57	95.78%
2.	1986	Quad Cities #1	828.30	769.00	4,420,669	5,880.00	751.81	97.77%
3.	1983	Quad Cities #2	828.30	769.00	3,151,307	5,622.00	560.53	72.89%
3.	1984	Quad Cities #2	828.30	769.00	4,983,925	6,840.00	728.64	94.75%
3.	1985	Quad Cities #2	828.30	769.00	4,556,866	6,248.00	729.33	94.84%
3.	1986	Quad Cities #2	828.30	769.00	4,722,778	6,401.50	737.76	95.94%
4.	1983	Cooper	836.00	764.00	3,343,199	5,546.00	602.81	78.90%
4.	1984	Cooper	836.00	764.00	3,469,953	5,902.00	587.93	76.95%
4.	1985	Cooper	836.00	764.00	1,067,748	1,885.00	566.44	74.14%
4.	1986	Cooper	836.00	764.00	4,052,138	6,546.20	619.01	81.02%
5.	1983	Monticello	569.00	525.00	4,147,725	8,439.00	491.49	93.62%
5.	1984	Monticello	569.00	525.00	263,119	808.80	325.32	61.97%
5.	1985	Monticello	569.00	536.00	4,286,986	8,030.60	533.83	99.60%
5.	1986	Monticello	569.00	536.00	3,375,350	6,927.10	487.27	90.91%
6.	1983	Prairie Island #1	593.00	503.00	3,888,853	7,624.20	510.07	101.40%
6.	1984	Prairie Island #1	593.00	503.00	4,159,389	8,286.80	501.93	99.79%
6.	1985	Prairie Island #1	593.00	503.00	3,677,016	7,334.60	501.32	99.67%
6.	1986	Prairie Island #1	593.00	503.00	3,819,563	7,871.30	485.25	96.47%
7.	1983	Prairie Island #2	593.00	500.00	3,716,220	7,578.10	490.39	98.08%
7.	1984	Prairie Island #2	593.00	500.00	3,905,956	7,831.10	498.77	99.75%
7.	1985	Prairie Island #2	593.00	500.00	3,608,478	7,378.20	489.07	97.81%
7.	1986	Prairie Island #2	593.00	500.00	3,860,117	7,932.30	486.63	97.33%
8.	1983	Fort Calhoun #1	502.00	438.00	2,749,832	6,405.00	429.33	98.02%
8.	1984	Fort Calhoun #1	502.00	478.00	2,331,771	5,264.90	442.89	92.65%
8.	1985	Fort Calhoun #1	502.00	478.00	3,066,254	6,455.50	474.98	99.37%
8.	1986	Fort Calhoun #1	502.00	478.00	3,605,563	8,264.20	436.29	91.27%
9.	1983	Total MAPP	5,346.75	4,783.00	29,097,806	54,983.30		
9.	1984	Total MAPP	5,346.75	4,823.00	25,181,411	46,025.60		
9.	1985	Total MAPP	5,346.75	4,834.00	28,276,152	50,287.90		
9.	1986	Total MAPP	5,346.75	4,834.00	30,864,251	57,003.60		

Note: Information taken from The Licensed Operating Reactors Status Summary Report from the USNRC.
Northwest Power Cooperative has Genoa #2 listed as a nuclear plant in the 1986 MAPP Load and Capacity Report, but Genoa was not listed in the The Licensed Operating Reactors Status Summary Report for 1983-1986.

TABLE 3

1986 ESTIMATED AVERAGE MW GENERATION AND UTILIZATION OF NUCLEAR PLANTS – SORTED BY UTILIZATION PERCENTAGE

No.	Plant Name	State Location	Total Plant Name Plate (A)	Maximum Dependable Capacity (Net MWe) (B)	Total MWH Generation (C)	Service Hours (D)	Estimated Avg. MW Generated (E)=(C)/(D)	Percent of Capacity Utilized (F)=(E)/(B)
1.	Calvert Cliffs #1	Maryland	918.00	825.00	5,830,738	6,856.40	850.41	103.08%
2.	Robinson #2	South Carolina	769.00	665.00	4,798,026	7,030.10	682.50	102.63%
3.	Kewaunee	Wisconsin	560.00	503.00	3,854,674	7,515.20	512.92	101.97%
4.	Calvert Cliffs #2	Maryland	911.00	825.00	7,006,666	8,408.70	833.26	101.00%
5.	St. Lucie #2	Florida	850.00	839.00	6,146,561	7,255.50	847.16	100.97%
6.	St. Lucie #1	Florida	890.00	839.00	7,052,031	8,353.60	844.19	100.62%
7.	Ginna	New York	517.00	470.00	3,610,266	7,659.90	471.32	100.28%
8.	Yankee-Rowe #1	Massachusetts	185.00	167.00	1,392,716	8,322.30	167.35	100.21%
9.	Maine Yankee	Maine	864.00	810.00	6,241,756	7,694.80	811.17	100.14%
10.	Three Mile Island #1	Pennsylvania	871.00	776.00	4,818,263	6,212.30	775.60	99.95%
11.	Point Beach #1	Wisconsin	524.00	485.00	3,770,070	7,787.60	484.11	99.82%
12.	Turkey Point #3	Florida	760.00	666.00	4,513,059	6,820.50	661.69	99.35%
13.	Palo Verde #2	Arizona	1,403.00	1,221.00	2,654,603	2,195.00	1,209.39	99.05%
14.	Arkansas #2	Arkansas	943.00	858.00	5,305,213	6,276.00	845.32	98.52%
15.	Millstone #1	Connecticut	662.00	654.00	5,247,940	8,176.20	641.86	98.14%
16.	Waterford #3	Louisiana	1,153.00	1,075.00	7,301,595	6,924.80	1,054.41	98.08%
17.	Point Beach #2	Wisconsin	524.00	485.00	3,417,550	7,188.30	475.43	98.03%
18.	Limerick #1	Pennsylvania	1,138.00	1,055.00	6,848,850	6,636.00	1,032.08	97.83%
19.	Prairie Island #2	Minnesota	593.00	500.00	3,860,117	7,932.30	486.63	97.33%
20.	Farley #2	Alabama	860.00	824.00	5,959,872	7,458.30	799.09	96.98%
21.	Summer #1	South Carolina	900.00	885.00	7,160,639	8,350.90	857.47	96.89%
22.	Prairie Island #1	Minnesota	593.00	503.00	3,819,563	7,871.30	485.25	96.47%
23.	McGuire #2	North Carolina	1,305.00	1,150.00	6,209,772	5,604.60	1,107.98	96.35%
24.	Wolf Creek #1	Kansas	1,250.00	1,128.00	6,966,063	6,418.50	1,085.31	96.22%
25.	Farley #1	Alabama	860.00	825.00	5,726,616	7,216.80	793.51	96.18%
26.	Palo Verde #1	Arizona	1,403.00	1,221.00	5,851,048	4,988.80	1,172.84	96.06%
27.	Quad Cities #2	Illinois	828.00	769.00	4,722,778	6,401.50	737.76	95.94%
28.	Millstone #3	Connecticut	1,253.00	1,142.00	5,861,760	5,355.90	1,094.45	95.84%
29.	Zion #2	Illinois	1,098.00	1,040.00	7,334,233	7,372.00	994.88	95.66%
30.	Surry #1	Virginia	848.00	781.00	4,488,628	6,015.80	746.14	95.54%
31.	Fitzpatrick	New York	883.00	794.00	6,015,605	7,932.20	758.38	95.51%
32.	Vermont Yankee #1	Vermont	563.00	504.00	2,058,426	4,281.20	480.81	95.40%
33.	Quad Cities #1	Illinois	828.00	769.00	4,420,669	6,037.10	732.25	95.22%
34.	Beaver Valley #1	Pennsylvania	923.00	810.00	4,778,500	6,196.50	771.16	95.21%
35.	San Onofre #2	California	1,127.00	1,070.00	6,361,900	6,267.70	1,015.03	94.86%
36.	Surry #2	Virginia	848.00	781.00	4,498,941	6,075.00	740.57	94.82%
37.	Millstone #2	Connecticut	910.00	857.00	5,160,945	6,354.20	812.21	94.77%
38.	Oconee #1	South Carolina	934.00	860.00	4,784,795	5,872.60	814.77	94.74%
39.	Oconee #2	South Carolina	934.00	860.00	5,801,065	7,124.50	814.24	94.68%
40.	Trojan	Oregon	1,216.00	1,075.00	7,090,231	6,985.30	1,015.02	94.42%
41.	Susquehanna #1	Pennsylvania	1,152.00	1,032.00	5,830,291	5,995.20	972.49	94.23%
42.	Hatch #1	Georgia	850.00	750.00	3,645,387	5,164.40	705.87	94.12%
43.	North Anna #1	Virginia	947.00	915.00	6,310,739	7,330.90	860.84	94.08%
44.	Brunswick #1	North Carolina	867.00	790.00	5,973,813	8,069.90	740.26	93.70%
45.	Peach Bottom #2	Pennsylvania	1,152.00	1,051.00	6,896,565	7,014.00	983.26	93.55%
46.	Pilgrim #1	Massachusetts	678.00	670.00	1,027,531	1,646.00	624.26	93.17%
47.	Turkey Point #4	Florida	760.00	666.00	1,721,504	2,792.10	616.56	92.58%
48.	Salem #1	New Jersey	1,170.00	1,106.00	7,079,276	6,923.80	1,022.46	92.45%
49.	Susquehanna #2	Pennsylvania	1,152.00	1,032.00	5,448,219	5,734.20	950.13	92.07%
50.	Brunswick #2	North Carolina	867.00	790.00	2,911,036	4,029.60	722.41	91.44%
51.	McGuire #1	North Carolina	1,305.00	1,150.00	5,164,769	4,916.00	1,050.60	91.36%
52.	North Anna #2	Virginia	947.00	915.00	6,022,050	7,210.50	835.18	91.28%
53.	Fort Calhoun #1	Nebraska	502.00	478.00	3,605,563	8,264.20	436.29	91.27%
54.	Indian Point #2	New York	1,013.00	849.00	3,810,597	4,926.80	773.44	91.10%
55.	Monticello	Minnesota	569.00	536.00	3,375,350	6,927.10	487.27	90.91%
56.	Oyster Creek #1	New Jersey	674.00	620.00	1,301,476	2,310.90	563.19	90.84%
57.	Oconee #3	South Carolina	934.00	860.00	6,064,306	7,782.80	779.19	90.60%
58.	Callaway #1	Missouri	1,236.00	1,120.00	7,199,113	7,124.50	1,010.47	90.22%

Note: Information taken from The Licensed Operating Reactors Status Summary Report from USNRC.

TABLE 3 (Cont.)

1986 ESTIMATED AVERAGE MW GENERATION AND UTILIZATION OF NUCLEAR PLANTS - SORTED BY UTILIZATION PERCENTAGE

No.	Plant Name	State Location	Total Plant Name Plate (A)	Maximum Dependable Capacity (Net MWe) (B)	Total MWH Generation (C)	Service Hours (D)	Estimated Avg. MW Generated (E)=(C)/(D)	Percent of Capacity Utilized (F)=(E)/(B)
59.	Diablo Canyon #2	California	1,164.00	1,079.00	6,548,174	6,730.50	972.91	90.17%
60.	Nine Mile Point #1	New York	642.00	610.00	3,146,883	5,724.10	549.76	90.12%
61.	Dresden #2	Illinois	828.00	772.00	4,648,539	6,763.50	687.30	89.03%
62.	Salem #2	New Jersey	1,162.00	1,106.00	5,312,561	5,416.90	980.74	88.67%
63.	San Onofre #3	California	1,127.00	1,080.00	6,760,591	7,070.80	956.13	88.53%
64.	Crystal River #3	Florida	890.00	821.00	2,653,212	3,661.30	724.66	88.27%
65.	Catawba #1	South Carolina	1,305.00	1,145.00	5,182,492	5,155.00	1,005.33	87.80%
66.	Big Rock Point #1	Michigan	60.00	69.00	506,148	8,361.70	60.53	87.73%
67.	Cook #1	Michigan	1,152.00	1,020.00	6,650,074	7,466.00	890.71	87.32%
68.	Palisades	Michigan	812.00	730.00	841,244	1,324.40	635.19	87.01%
69.	Zion #1	Illinois	1,098.00	1,040.00	4,904,664	5,452.00	899.61	86.50%
70.	Indian Point #3	New York	1,013.00	1,000.00	5,525,581	6,432.40	859.02	85.90%
71.	Diablo Canyon #1	California	1,137.00	1,073.00	5,293,267	5,758.20	919.26	85.67%
72.	Catawba #2	South Carolina	1,305.00	1,145.00	1,297,202	1,325.80	978.43	85.45%
73.	Peach Bottom #3	Pennsylvania	1,152.00	1,035.00	4,849,352	5,545.30	874.50	84.49%
74.	Lasalle #2	Illinois	1,078.00	1,036.00	5,717,014	6,534.50	874.90	84.45%
75.	Bryon #1	Illinois	1,175.00	1,129.00	7,396,003	7,761.30	952.93	84.41%
76.	Lasalle #1	Illinois	1,078.00	1,036.00	2,018,117	2,331.90	865.44	83.54%
77.	La Crosse	Wisconsin	65.00	48.00	157,179	3,998.10	39.31	81.90%
78.	Duane Arnold	Iowa	597.00	515.00	3,008,073	7,181.10	418.89	81.34%
79.	Cooper Station	Nebraska	836.00	764.00	4,052,138	6,546.20	619.01	81.02%
80.	Haddam Neck	Connecticut	600.00	569.00	2,132,316	4,698.90	453.79	79.75%
81.	Arkansas #1	Arkansas	903.00	836.00	3,573,159	5,447.70	655.90	78.46%
82.	Washington Nuc. #2	Washington	1,201.00	1,095.00	5,183,198	6,134.40	844.94	77.16%
83.	Hatch #2	Georgia	850.00	761.00	3,618,712	6,172.70	586.24	77.04%
84.	Dresden #3	Illinois	828.00	773.00	1,456,025	2,457.10	592.58	76.66%
85.	Cook #2	Michigan	1,133.00	1,060.00	4,335,567	5,389.70	804.42	75.89%
86.	River Bend #1	Louisiana	990.00	936.00	2,995,439	4,225.70	708.86	75.73%
87.	San Onofre #1	California	450.00	436.00	874,187	2,731.50	320.04	73.40%
88.	Grand Gulf #1	Mississippi	1,373.00	1,142.00	4,098,054	5,330.50	768.79	67.32%
89.	Hope Creek #1	New Jersey	1,118.00	1,067.00	1,030,793	1,679.00	613.93	57.54%
90.	Fort St. Vrain	Colorado	343.00	330.00	52,007	1,087.10	47.84	14.50%
91.	Davis-Besse #1	Ohio	962.00	860.00	3,486	116.60	29.90	3.48%
92.	Browns Ferry #1	Alabama	1,152.00	1,065.00	-36,374	0.00	0.00	0.00%
93.	Browns Ferry #2	Alabama	1,152.00	1,065.00	-47,061	0.00	0.00	0.00%
94.	Browns Ferry #3	Alabama	1,152.00	1,065.00	-41,625	0.00	0.00	0.00%
95.	Fermi #2	Michigan	1,215.00	1,093.00	-23,916	437.70	0.00	0.00%
96.	Rancho Seco #1	California	963.00	873.00	-32,157	0.00	0.00	0.00%
97.	Sequoyah #1	Tennessee	1,220.00	1,148.00	-40,178	0.00	0.00	0.00%
98.	Sequoyah #2	Tennessee	1,220.00	1,148.00	-64,434	0.00	0.00	0.00%
	Total		90,675.00	83,271.00	407,666,034	538,038.70		

Note: Information taken from The Licensed Operating Reactors Status Summary Report from USNRC.

TABLE 4

1987 ESTIMATED AVERAGE MW GENERATION AND UTILIZATION OF NUCLEAR PLANTS - SORTED BY UTILIZATION PERCENTAGE

No.	Plant Name	State Location	Total Plant Name Plate (A)	Maximum Dependable Capacity (Net MWe) (B)	Total MWH Generation (C)	Service Hours (D)	Estimated Avg. MW Generated (E)=(C)/(D)	Percent of Capacity Utilized (F)=(E)/(B)
1.	Calvert Cliffs #1	Maryland	918.00	825.00	5,268,477	6,237.00	844.71	102.39%
2.	Robinson #2	South Carolina	769.00	665.00	4,230,329	6,226.30	679.43	102.17%
3.	Three Mile Island #1	Pennsylvania	871.00	776.00	5,034,307	6,353.60	792.36	102.11%
4.	Kewaunee	Wisconsin	560.00	503.00	4,008,624	7,811.00	513.20	102.03%
5.	Prairie Island #2	Minnesota	593.00	500.00	4,429,989	8,760.00	505.71	101.14%
6.	Ginna	New York	517.00	470.00	3,797,701	7,994.00	475.07	101.08%
7.	Arkansas #2	Arkansas	943.00	858.00	6,605,168	7,681.70	859.86	100.22%
8.	Point Beach #1	Wisconsin	524.00	485.00	3,567,092	7,350.30	485.30	100.06%
9.	St. Lucie #1	Florida	890.00	839.00	5,715,344	6,814.10	838.75	99.97%
10.	Calvert Cliffs #2	Maryland	911.00	825.00	4,831,976	5,861.60	824.34	99.92%
11.	San Onofre #3	California	1,127.00	1,080.00	7,519,728	6,987.80	1,076.12	99.64%
12.	Point Beach #2	Wisconsin	524.00	485.00	3,606,145	7,481.10	482.03	99.39%
13.	Susquehanna #2	Pennsylvania	1,152.00	1,032.00	8,598,435	8,431.60	1,019.79	98.82%
14.	Prairie Island #1	Minnesota	593.00	503.00	3,590,268	7,234.20	496.29	98.67%
15.	St. Lucie #2	Florida	850.00	839.00	5,950,184	7,209.70	825.30	98.37%
16.	Millstone #2	Connecticut	910.00	857.00	6,892,531	8,180.10	842.60	98.32%
17.	Millstone #1	Connecticut	662.00	654.00	4,377,008	6,827.10	641.12	98.03%
18.	Fort Calhoun #1	Nebraska	502.00	478.00	3,060,620	6,531.70	468.58	98.03%
19.	Palo Verde #2	Arizona	1,403.00	1,221.00	8,190,044	6,858.20	1,194.20	97.80%
20.	Waterford #3	Louisiana	1,153.00	1,075.00	7,425,710	7,087.80	1,047.67	97.46%
21.	Oconee #3	South Carolina	934.00	860.00	5,084,967	6,069.90	837.73	97.41%
22.	Surry #1	Virginia	848.00	781.00	4,633,405	6,116.90	757.48	96.99%
23.	Vermont Yankee #1	Vermont	563.00	504.00	3,536,411	7,290.60	485.06	96.24%
24.	Hatch #1	Georgia	850.00	750.00	5,076,654	7,046.00	720.50	96.07%
25.	San Onofre #2	California	1,127.00	1,070.00	6,230,341	6,068.30	1,026.70	95.95%
26.	Wolf Creek #1	Kansas	1,250.00	1,128.00	6,504,145	6,013.00	1,081.68	95.89%
27.	Palo Verde #1	Arizona	1,403.00	1,221.00	5,268,268	4,504.50	1,169.56	95.79%
28.	Yankee-Rowe #1	Massachusetts	185.00	167.00	1,135,611	7,100.70	159.93	95.77%
29.	Indian Point #2	New York	1,013.00	849.00	5,146,333	6,333.00	812.62	95.72%
30.	Grand Gulf #1	Mississippi	1,373.00	1,142.00	7,726,991	7,100.00	1,088.31	95.30%
31.	Farley #1	Alabama	860.00	825.00	6,444,862	8,203.10	785.66	95.23%
32.	McGuire #1	North Carolina	1,305.00	1,150.00	7,348,715	6,715.80	1,094.24	95.15%
33.	Surry #2	Virginia	848.00	781.00	4,790,953	6,457.90	741.87	94.99%
34.	Summer #1	South Carolina	900.00	885.00	5,151,897	6,136.90	839.50	94.86%
35.	Beaver Valley #1	Pennsylvania	923.00	810.00	5,620,890	7,322.90	767.58	94.76%
36.	Millstone #3	Connecticut	1,253.00	1,142.00	6,742,317	6,234.60	1,081.44	94.70%
37.	McGuire #2	North Carolina	1,305.00	1,150.00	7,572,577	6,957.10	1,088.47	94.65%
38.	Haddam Neck	Connecticut	600.00	569.00	2,527,207	4,700.50	537.65	94.49%
39.	Quad Cities #1	Illinois	828.00	769.00	4,456,087	6,141.70	725.55	94.35%
40.	Quad Cities #2	Illinois	828.00	769.00	4,952,988	6,836.20	724.52	94.22%
41.	Catawba #1	South Carolina	1,305.00	1,145.00	6,377,839	5,928.60	1,075.77	93.95%
42.	Susquehanna #1	Pennsylvania	1,152.00	1,032.00	6,127,879	6,333.00	967.61	93.76%
43.	Monticello	Minnesota	569.00	536.00	3,533,357	7,052.90	500.98	93.47%
44.	Lasalle #2	Illinois	1,078.00	1,036.00	4,542,494	4,700.20	966.45	93.29%
45.	Nine Mile Point #1	New York	642.00	610.00	4,615,169	8,130.50	567.64	93.06%
46.	Farley #2	Alabama	860.00	824.00	4,902,626	6,397.80	766.30	93.00%
47.	Diablo Canyon #1	California	1,137.00	1,073.00	8,284,201	8,342.80	992.98	92.54%
48.	Oyster Creek #1	New Jersey	674.00	620.00	3,110,919	5,422.90	573.66	92.53%
49.	Vogtle #1	Georgia	1,157.00	1,084.00	3,921,520	3,920.40	1,000.29	92.28%
50.	Maine Yankee	Maine	864.00	810.00	4,042,901	5,415.40	746.56	92.17%
51.	Diablo Canyon #2	California	1,164.00	1,079.00	5,715,218	5,754.50	993.17	92.05%
52.	Callaway #1	Missouri	1,236.00	1,120.00	6,321,776	6,143.90	1,028.95	91.87%
53.	Turkey Point #4	Florida	760.00	666.00	2,636,070	4,318.90	610.36	91.65%
54.	Hope Creek #1	New Jersey	1,118.00	1,067.00	7,277,090	7,457.10	975.86	91.46%
55.	Zion #2	Illinois	1,098.00	1,040.00	5,114,145	5,384.50	949.79	91.33%
56.	North Anna #2	Virginia	947.00	915.00	5,653,448	6,785.50	833.17	91.06%
57.	Harris #1	North Carolina	950.00	860.00	3,378,829	4,323.60	781.49	90.87%
58.	River Bend #1	Louisiana	990.00	936.00	4,964,440	5,837.70	850.41	90.86%
59.	Brunswick #1	North Carolina	867.00	790.00	4,046,631	5,652.30	715.93	90.62%

Note: Information taken from The Licensed Operating Reactors Status Summary Report from USNRC.

1987 ESTIMATED AVERAGE MW GENERATION AND UTILIZATION OF NUCLEAR PLANTS - SORTED BY UTILIZATION PERCENTAGE

No.	Plant Name	State Location	Total Plant Name Plate (A)	Maximum Dependable Capacity (Net MWe) (B)	Total MWH Generation (C)	Service Hours (D)	Estimated Avg. MW Generated (E)=(C)/(D)	Percent of Capacity Utilized (F)=(E)/(B)
60.	Palisades	Michigan	812.00	730.00	2,634,430	3,983.10	661.40	90.60%
61.	Hatch #2	Georgia	850.00	761.00	5,755,607	8,390.40	685.98	90.14%
62.	Zion #1	Illinois	1,098.00	1,040.00	6,058,385	6,482.40	934.59	89.86%
63.	Indian Point #3	New York	1,013.00	1,000.00	4,850,586	5,399.90	898.27	89.83%
64.	Fitzpatrick	New York	883.00	794.00	4,198,340	5,894.80	712.21	89.70%
65.	Duane Arnold	Iowa	597.00	515.00	2,540,837	5,514.80	460.73	89.46%
66.	Catawba #2	South Carolina	1,305.00	1,145.00	7,169,495	7,019.00	1,021.44	89.21%
67.	Perry #1	Ohio	1,250.00	1,205.00	828,484	773.40	1,071.22	88.90%
68.	Big Rock Point #1	Michigan	60.00	69.00	374,931	6,132.20	61.14	88.61%
69.	Salem #1	New Jersey	1,170.00	1,106.00	6,211,441	6,363.20	976.15	88.26%
70.	Salem #2	New Jersey	1,162.00	1,106.00	6,172,052	6,343.40	972.99	87.97%
71.	Brunswick #2	North Carolina	867.00	790.00	5,694,104	8,205.80	693.91	87.84%
72.	Beaver Valley #2	Pennsylvania	923.00	885.00	738,104	949.80	777.12	87.81%
73.	Oconee #1	South Carolina	934.00	860.00	5,028,061	6,694.70	751.05	87.33%
74.	Trojan	Oregon	1,216.00	1,075.00	4,347,772	4,631.60	938.72	87.32%
75.	Cooper Station	Nebraska	836.00	764.00	5,522,126	8,292.40	665.93	87.16%
76.	Dresden #3	Illinois	828.00	773.00	4,395,502	6,595.70	666.42	86.21%
77.	North Anna #1	Virginia	947.00	915.00	3,568,907	4,525.50	788.62	86.19%
78.	Peach Bottom #2	Pennsylvania	1,152.00	1,051.00	1,552,256	1,724.00	900.38	85.67%
79.	Limerick #1	Pennsylvania	1,138.00	1,055.00	5,318,987	5,926.70	897.46	85.07%
80.	Peach Bottom #3	Pennsylvania	1,152.00	1,035.00	1,460,062	1,659.60	879.77	85.00%
81.	San Onofre #1	California	450.00	436.00	2,708,001	7,323.40	369.77	84.81%
82.	Oconee #2	South Carolina	934.00	860.00	6,228,692	8,567.10	727.05	84.54%
83.	Crystal River #3	Florida	890.00	821.00	3,620,784	5,263.80	687.87	83.78%
84.	Cook #1	Michigan	1,152.00	1,020.00	5,033,767	5,918.80	850.47	83.38%
85.	Washington Nuc. #2	Washington	1,201.00	1,095.00	5,397,981	5,981.00	902.52	82.42%
86.	Turkey Point #3	Florida	760.00	666.00	856,146	1,567.70	546.12	82.00%
87.	Clinton #1	Illinois	NA	933.00	684,103	898.30	761.55	81.62%
88.	Dresden #2	Illinois	828.00	772.00	3,342,347	5,345.30	625.29	81.00%
89.	Davis-Besse #1	Ohio	962.00	860.00	5,063,984	7,312.40	692.52	80.53%
90.	Bryon #1	Illinois	1,175.00	1,129.00	5,330,576	6,007.30	887.35	78.60%
91.	Bryon #2	Illinois	1,175.00	1,120.00	1,970,901	2,280.40	864.28	77.17%
92.	Cook #2	Michigan	1,133.00	1,060.00	5,026,564	6,251.60	804.04	75.85%
93.	Arkansas #1	Arkansas	903.00	836.00	4,763,342	7,723.10	616.77	73.78%
94.	Lasalle #1	Illinois	1,078.00	1,036.00	4,073,067	5,456.80	746.42	72.05%
95.	Braidwood #1	Illinois	NA	1,120.00	1,456,651	2,610.70	557.95	49.82%
96.	Palo Verde #3	Arizona	1,403.00	1,221.00	319,661	620.70	515.00	42.18%
97.	Fermi #2	Michigan	1,215.00	1,093.00	1,392,801	4,084.20	341.02	31.20%
98.	Fort St. Vrain	Colorado	343.00	330.00	180,922	2,030.40	89.11	27.00%
99.	Nine Mile Point #2	New York	1,214.00	1,080.00	260,995	1,059.00	246.45	22.82%
100.	Browns Ferry #1	Alabama	1,152.00	1,065.00	-12,718	0.00	0.00	0.00%
101.	Browns Ferry #2	Alabama	1,152.00	1,065.00	-34,470	0.00	0.00	0.00%
102.	Browns Ferry #3	Alabama	1,152.00	1,065.00	-50,980	0.00	0.00	0.00%
103.	Pilgrim #1	Massachusetts	678.00	670.00	0	0.00	0.00	0.00%
104.	Rancho Seco #1	California	963.00	873.00	-56,759	0.00	0.00	0.00%
105.	Sequoyah #1	Tennessee	1,220.00	1,148.00	-48,236	0.00	0.00	0.00%
106.	Sequoyah #2	Tennessee	1,220.00	1,148.00	-59,378	0.00	0.00	0.00%
	Total		98,682.00	92,731.00	449,087,064	584,375.40		

Note: Information taken from The Licensed Operating Reactors Status Summary Report from USNRC.

END NOTES

1 Tables 1 and 2 are drawn from a report authored by Shari Cameron of Utilities Division, Department of Commerce, State of Iowa. A full reference appears in the Bibliography. Tables 3 and 4 were prepared by Leighann O'Tool of the Utilities Division, Department of Commerce, State of Iowa.

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Bubble Memory Technology: Its Impact on Metering and Rate Structure

By Stephen N. Brown, Ph.D.
Supervisor of Rate Design
Houston Lighting & Power

Bubble memory will replace magnetic tape as the principal means of implementing product differentiation and rate structures within the electric utility industry for two reasons: first, research and commercial development of bubble memory technology is moving forward after the technology was abandoned by several U.S. producers. Advances in the technology will reduce the importance of silicon and increase the importance of ferrous magnetic substances by achieving very high density rates of bit storage, which in turn will bring economies of scale and rapidly declining average costs for the storage of information. Second, bubble memory's performance already exceeds that of magnetic tape, and the difference between these levels of performance will become even greater.

The remainder of this discussion is divided into three parts: the first is a brief explanation of how product differentiation in the electric utility industry creates a need for efficient information storage; the second is a comparison of magnetic tape and bubble memories; and the third section explains why bubble memory technology is viable, marketable, and dependable.

I

In the context of an electric utility, product differentiation means that electric power sales represent several different services that are distinguished from one another by such criteria as the time of the sale, the customer making the purchase, whether the sale is short-term, long-term, intermittent, or continuous, and any other criteria that would be relevant. Product differentiation naturally entails different prices for different commodities. For example, electric power subject to interruption is clearly a different commodity than power not subject to interruption; similarly, electric power sold at the time of the system's peak demand is different from power sold at another time.

A utility that charges for its product on a time-of-day basis has to know the moment-by-moment purchases of a customer; such information becomes voluminous in a matter of hours and must be processed, evaluated, and stored. Since charging for power sales on a time-of-day basis is now a regular feature of many utilities' rate structures and since interruptable and standby power sales are becoming more common both to industrial customers and to other utilities, even more information (and storage) will be required. These needs will rapidly exceed the capabilities of magnetic tape as a sales recording device.

II

Bubble memory is a storage medium in solid state form, in which the presence or absence of a "bubble" in a submicroscopic magnetic domain on a chip represents respectively a 0 or a 1, so that data can be stored in binary form. Unlike other kinds of memory, bubble memory has no moving parts and is nonvolatile (i.e., not power-dependent): it retains recorded data even if the power supply is interrupted. [1] Although magnetic tape also retains data when the power supply is interrupted, measurement of consumption using magnetic tape entails a mechanical system installed and reset manually, the shortcomings of which make possible inaccurate measurement of consumption and concomitantly lower revenue. This is readily demonstrated by an examination of the steps required for magnetic tape to measure power consumption by an industrial customer on a time-of-day rate.

The tape of a magnetic tape meter is usually divided into two or more tracks: one track always records time pulses sent from an external clock, while the other tracks record data pulses that represent power consumption. The time pulses are recorded according to a predetermined interval length. Consumption within a time period is determined by adding up the number of data pulses recorded between two adjacent time pulses. Once an initial start time is determined, all time pulses will occur at those regular intervals that subdivide the billing period. For example, if the start time is 9:00 and the interval length is 15 minutes, the time pulses occur at 9:15, 9:30, 9:45, and so on

While this may seem simple to implement theoretically, practically it poses several problems. Magnetic tape metering requires extensive training of the personnel that install, maintain, and remove the tapes from the metering site. A tape metering system is essentially a mechanical system insofar as it relies on the tape drive gears to operate properly and move the tape at the required number of inches per second; otherwise the space between adjacent time pulses may not represent the time interval specified by the utility. Referring to the example above, the interval could represent 9:03 to 9:12, or 9:03 to 9:20 depending on the speed of the tape drive.

The metering tapes also have nonmagnetic leaders and trailers which record nothing [2] so that when the tape begins, it must be positioned properly for the initial time and data pulses to fall on the magnetic portion. Otherwise there is a mismatch between tape start time and recorded information, causing a loss of information, and in metering situations, loss of information usually means loss of revenues.

There is another possibility for error. The tape must be replaced before the magnetic trailer is reached, or billing information is lost at this stage, too. This means that the tape must be physically replaced: therefore, the utility must follow a precise schedule not only to read the tapes but to replace them as well.

There are other problems. The initial start time of the first interval on the tape must be set from an external clock, one that runs independently of the tape. The interval length can only be changed by changing the external clock. While this is not a problem for a single meter, it would be a very expensive problem, in terms of labor costs, where several hundred meters are involved. So once a utility selects an interval's starting point and its length, change is a problem.

All of these points underscore the importance of trained personnel in maintaining, setting, and reading the meters. But this also highlights the vulnerability of billing in the event of a labor strike.

Performance characteristics are particularly important in metering situations because the storage medium is subject to the extremes of weather: heat, cold, humidity, and dust. How does magnetic tape hold up compared with bubble memory under these conditions?

Magnetic tape expands with heat and contracts with cold, ages, wrinkles, and develops ripples. The recording head is subject to oxide buildup and must be regularly cleaned [3] Any of these can cause data loss or data error, so that the tape is incorrectly read and translated to a mainframe computer. Bubble memories produced by Intel Magnetics can operate within a range of 0 to 70 Celsius [4] the limits of the range will expand to -20 and 85 Celsius in the very near future [5] Bubble memory is minimally affected by dust, vapor,vibration [6] and hard radiation [7] even in very harsh environments, it maintains data integrity.

Furthermore, the reliability of bubble memory is a distinct advantage to a utility's metering capability. The failure rate for a 128K bubble memory device is 1 in 10 to the 15th power: this is about once in every 100 years of operation [8] The mean repair time (i.e., for replacement) of a bubble memory unit is only a few minutes [9] The reliability of a magnetic tape system is far less simply because it is a mechanical system [10] a major portion of any magnetic tape storage system involves mechanically operated systems-control and drive hardware.

Another point of comparison is storage capacity, and magnetic tape used in metering situations has a maximum capacity of 3 M bits square inch [11] in 1983, Intel Magnetics introduced a 4M bit chip measuring 1.46 x 1.35 centimeters with a storage capacity of slightly more than 2 M bits per square centimeter or 5 M bits per square inch [12] On this basis, bubble memory has a 60capability of magnetic tape does not apply in metering situations because increasing data storage on tape at a metering site requires decreasing the speed at which the tape moves and because there is a limit to how slow a tape can be set to move [13] For example, for data collected on a 15-minute interval basis, tapes used in metering situations have a practical storage limit of 90 days. Bubble memory, on the other hand, has no moving parts: its full storage capacity can always be utilized as this capacity continues to increase with technological advances. Bubble memory already has a capacity in the range of 6 months for 15-minute intervals and 2 months for 5-minute intervals. Unlike magnetic tape, bubble memory technology offers the possibility of remote readings over telephone lines or other data transmission paths. Telephone interrogation of magnetic tapes is not practical. Remote data access and bubble memory technology also offer the possibility of automatic reprogramming from a central source of all interval lengths and start times for all meters simultaneously.

The foregoing clearly implies that the use of bubble memory would be substitution of capital for labor, thereby providing greater management control over the entire process. More important, however, is the flexibility (that does not now exist) in a utility's rate structure that bubble memory can provide. Consider the following as a case in point. For billing purposes, the practical minimum interval length on a magnetic tape is 15 minutes. This interval length cannot accurately measure power used in time periods that are shorter than the interval and that overlap interval boundaries.

For example, given the 15-minute interval beginning at 9:00, there is no way to measure the power flow from 9:07 to 9:22, and this is particularly important where large inductive loads operate intermittently and where the operation of these loads is timed to circumvent the real measure of the power flow: for example, if an electric drag line or an electric furnace is used between 9:07 and 9:22, the power flow measure on a magnetic tape meter with 15-minute intervals described above would only capture half the actual power flow. In this situation, the unmeasured power sales become system-demand losses to the utility. These losses usually range from 5 percent to 10 percent of a utility's net generation.

However, a bubble memory using a one-minute or five-minute interval would solve this problem by recording a higher sales volume, leading to lower system-demand losses and to either greater revenue for a given sales price or lower prices because of a given revenue requirement. This could have a substantial industry-wide effect by bringing in several hundred millions of dollars that are otherwise lost or by keeping electrical price levels lower. Furthermore, bubble memory's capability to record power usage accurately no matter how short the duration will also provide for more precise cost-of-service studies, enhance the utility's ability to sell interruptible power, and thereby more fully utilize spinning reserve. The last point of comparison to be made here between bubble memory and magnetic tape is data access. At one time, both magnetic tape and bubble memory entailed sequential access to data: the only way to access data in the middle of stored information was by accessing all information leading up to what was desired. Improvements in chip architecture for bubble memories now make data access time two to four times faster than either hard or floppy disk drive access times [14] Of course, data access time on a magnetic tape cannot be improved by manipulating the medium, and this further demonstrates that bubble memory storage is superior to tape storage.

III

Major factors in adopting any new technology are expected life and serviceability. Bubble memory is not new, but it is still a fairly recent development. The driving force behind the discovery of magnetic bubbles was a group of scientists at Bell Laboratories, prominent among them A.H. Bobeck, U.F. Gianola, R.C. Sherwood, H.E.D. Scovil, and W. Shockley [15] Theoretical discoveries in the late 1960's by the Bell group gave impetus to further research and attempts at commercial development throughout the 1970's. Research has been conducted along several lines of development: materials analysis, chip architecture, and chip fabrication, to mention a few. At one time in the late 1970's, development programs were underway at Texas Instruments, National Semiconductor, Rockwell International, Motorola, Intel, and Signetics. Bell Labs developed an experimental 11.5 M bit bubble device only 1.3 inches square; even Hewlett Packard developed applications in desktop calculators [16] All of this is sufficient indication that the bubble memory market was perceived as one that would grow and be viable. In the late seventies, there was a consensus that the annual sales volume in the United States would approach 1 billion dollars and that the technology would cost only 10 millicents per bit [17] but by 1981 Intel was the only domestic producer of bubble memory: all the others had abandoned the market.

Far from being sidelined in terms of research and development, bubble memory remains viable because it is ideally suited for portable applications and because of its radiation- hardness. For example, in the mid-1970's it was considered for inclusion as a component for an on-board attitude control computer for spacecraft [18] Research on magnetic bubbles continues in Japan, Britain, France, West Germany, and the Soviet Union. From the standpoint of development in the United States: Intel negotiated a "second source" agreement with Motorola in 1982, so that technological research, product development and manufacture of bubble memory will be shared between the two firms [19]. This is significant because bubble memory will have a full line of support electronics, the lack of which had previously hampered commercial development. Furthermore, research done by IBM at San Jose determined that "magnetic bubble memories must have a capacity of at least 4 M bits to challenge RAM devices on the basis of cost." [20] It is no coincidence, therefore, that Intel introduced a 4 M bit chip in 1983. This is a clear signal that further commercial development of bubble memory is anticipated: A 16 M bit device is the next logical step [21] and it could be available by the early 1990's. Research is under way at Hitachi, Fujitsu, Sagem [22] IBM, and Bell Labs [23] It must not be forgotten that the original corporate developer of the bubble memory, Bell Labs and its parent AT&T, were prevented from entering the computer technology market. But this has all changed with the recent divestiture of AT&T. It is only logical to conclude that the founder of the technology would seek to commercialize and expand it now that legal restrictions are removed from commercial competition in the industry.

Further development of the technology can be expected because of the tremendous potential for miniaturization and scale economies in bubble fabrication. In fact, scale economies are already occuring. In 1979 Intel published a series of guaranteed prices for bubble devices purchased in quantities of 25,000. The prices of devices were $1000 in 1980, $600 in 1981, and $300 in August of 1982. By January of 1983, the prices fell below $250 in lots of 10,000 [24] The price of the 4 M bit device is expected to approach $150 by 1986 [25] Achieving low-cost chips requires high device density and large chip capacity. The complementary technologies to achieve this are either in place or undergoing advancement themselves. For example, the Intel 4 M chip referred to earlier in this essay was fabricated using x-ray lithography [26] this is the production tool that enabled the achievement of 4 M bit density, but as time and research continue, x-ray lithography can be expected to give way to electron beam lithography [27] the ultimate key to bubble miniaturization and scale economies.

The ongoing research and commercial development makes a myth of the notion that bubble memory is a dead technology. The complexities of the utility industry are already outdistancing the capabilities of the magnetic tape, and new avenues must be investigated. Bubble memory is a viable and superior option to develop for the long term.

Conclusion

Some of the technological differences between magnetic tape and magnetic bubble memory have been discussed and policy implications briefly outlined. The industry cannot ignore the technological changes that are coming in the 1980's and 1990's. The limitations of magnetic tape necessitate a vigorous search for a suitable substitute, one that does not allow data error/loss in metering, one that can measure interruptible and standby power and insure against revenue erosion by means of interval adjustment, one that allows for remote monitoring using data communications technology, and one that makes for greater flexibility in the development of rate structures.

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The Sine Qua Non of Order 636: Cooperative Competition, Information Flow, and Rate Design

Stephen N. Brown

The FERC completed a remarkable turnaround in regulatory philosophy in its gas pipeline restructuring order.

Competition for natural gas supply will promote the nation's economic growth. That idea describes the essence of Federal Energy Regulatory Commission (FERC) Order No. 636 and provides the driving force behind the commission's effort to restructure the natural gas industry. But the FERC's eventual success ultimately depends on the spirit of "cooperative competition": The willingness of individual players to share information about day-to-day pipeline operations and the vital conditions that determine rate design and prices.

The FERC itself is acutely aware of this vulnerability. That is why the commission framed Order 636 with language that simultaneously coaxes, cajoles, and urges the industry to do its patriotic duty (see box).

This language makes FERC's order 636 truly remarkable. It tells the pipelines that their traditional way of doing business blocks the spread of competition within the natural gas industry. This finding was unthinkable twenty years ago. The natural gas industry was built on the principle of bundled, city-gate, firm sales service. During the industry's early years, certificates of convenience and necessity were issued to pipelines only if they offered such service to distribution companies. The industry's building block is now an unlawful restraint of trade.

The pipelines' old virtue is now a vice because the merchant function is gradually fading away. In the first quarter of 1984 pipeline sales made up 94 percent of throughput. By the second quarter of 1991 pipeline sales totaled only 12 percent of throughput. Nevertheless, in 1991 pipeline sales consumed over 60 percent of peak-day capacity. This surprising mismatch between throughput and capacity told the FERC that pipeline sales enjoy a clear advantage over the open-access firm transportation of nonpipeline natural gas:

Free-flowing Information

The FERC intends to solve the fairness problem by establishing equivalency between bundled, city-gate firm sales by the pipeline and open-access firm transportation of nonpipeline natural gas. The solution lies with the idea of "No-Notice Transportation Service." Success will depend on cooperation between the various segments of the industry, as the FERC is quite aware:

> [We] expect the pipelines and all interested participants to craft . . . the operating conditions needed to

The Spirit of 636

Drawing on Patriotism:

"[We] . . . remind the industry that it is in the nation's best interest and the industry's interest . . . to keep gas flowing and deliverable when and where needed and . . . not unreasonably inhibit the meeting of gas purchasers and gas sellers in a competitive market." [Order No. 636, p. 96.]

From Virtue to Vice:

"[The] pipelines' bundled, city-gate, firm sales service is operating, and will continue to operate, in a manner that causes considerable competitive harm to all segments of the natural gas industry . . . this harm has an unreasonable impact on gas sellers and is an unlawful restraint of trade." [Order No. 636, p. 39.]

To Level the Field:

"Pipelines and other gas suppliers are not competing on an even basis for sales customers, even where firm transportation is available to move the gas sold by the pipelines' competitors." [Order No. 636, p. 32.]

An Open Book, But Who Will Read It?

Pipelines In a Fishbowl:

Pipelines will retain operational control, but will perform in a fishbowl, since all buyers and sellers must now constantly monitor pipeline operations.

Second-guessing by Customers:

Buyers and sellers are likely to develop "shadow" operations groups that not only will monitor operating conditions, but are also likely to second-guess the pipelines from time to time.

Information Overload:

A tremendous need will arise for accurate, speedy, and voluminous information on storage facilities, receipt and delivery points, pressure, pumping stations, capacity reallocations, and anything else that might be viewed as relevant.

> ensure that the pipelines can provide a "no-notice" transportation service pursuant to which firm shippers can receive delivery of gas on demand up to their firm entitlement on a daily basis without incurring daily balancing and scheduling penalties.

To its lasting credit, the FERC recognizes that "no-notice" markets will not be fully competitive without another simultaneous development — the rapid and free flow of information. The FERC clearly says "that pipelines must provide timely and equal access to any and all information necessary for buyers and sellers to arrange gas sales and capacity reallocations." This policy will work only if all players cooperate. Any effort to tilt the scales by withholding or disguising relevant information may easily subvert the FERC's goal of uniting gas purchasers and gas sellers in a competitive market place. The importance of good and timely information cannot be overestimated for a competitive market, whether it's the New York Stock Exchange, the Chicago Board of Trade, or the natural gas industry.

The FERC's policy on information flow has major implications. The pipelines may not yet have realized that the order lays out their operations for all to see. It's just like letting one person cut the cake while others choose which piece they want. For example, the pipelines must make electronic bulletin boards accessible to all users and no one will be granted preferential access to the boards:

> The pipelines must keep daily back-up records of the information displayed on their bulletin boards for at least three years and permit users to review those records . . . pipelines must also periodically purge transactions from current files when transactions have been completed, so that users do not have to sift through massive amounts of historical data to find current information.

The FERC is right to be cautious, considering the impending modernization of the nation's telecommunications infrastructure and uncertain behavior of the players in the natural gas industry. How will the new infrastructure affect the competitiveness of the natural gas industry? Will the pipelines really want to give up their advantage of occupying 60 percent of the peak-day capacity, particularly when their sales are less than 20 percent of annual throughput? Do local distribution companies (LDCs) really want to jump into a competitive market with complexities that rival those of a major stock exchange? Will the upstream and downstream pipelines really cooperate with one another?

Rate Design

The restructuring hearings will not deal with the single biggest rate design issue for pipelines: transportation cost recovery through the "straight fixed-variable method" (SFV). This rate design definitely affects the central feature of the FERC's restructuring proposal: The presumed willingness of gas buyers to participate in "no-notice transportation service."

The SFV method removes all fixed costs from the pipeline's commodity charge for transporting gas. For years the FERC allowed significant amounts of fixed costs in the pipeline's commodity charge. The commission now believes such practice inhibits competition by preventing gas purchasers from making accurate comparisons of prices, terms, and conditions offered by various gas sellers. The SFV method corrects this mistake and promotes "head-to-head, gas-on-gas competition."

The FERC prefers the SFV rate design but suggests that it may be avoided by any particular pipeline if the parties agree on an alternative costing method. If the parties can't persuade the FERC to deviate from its preference, or if they lack a consensus on rate design, the SFV method will prevail. The odds favor SFV, since rate design is rarely characterized by harmony. It's an impossible goal because the customers' load factors are too diverse. In fact, the SFV method reduces costs for customers with high annual load factors, and increases costs for customers with poor load factors. This explains both the support and the opposition to SFV — with a rate design consensus unlikely, there will be no viable alternative.

The SFV method will increase costs for some customer groups. The FERC has agreed to limit such increases to 10 percent and to phase in the increase over a four-period after the pipeline's initial compliance filing. But after four years, the phase-in terminates and the limitations expire for SFV-related cost increases. After that customers are on their own; they must adapt to changed circumstances. The burden cannot be laid at the door of producers or pipelines. It falls exclusively on gas consumers and perhaps their agents acting as gas purchasers.

What does this mean for hot new designer rates? It means that "no-notice" transportation rates must strongly reflect the prevailing operating conditions on the pipeline.

I'm not advocating a different price for every hour of the year on every different section of the line. But I am advocating that the industry get far away from the idea that "one rate fits all." The nature of a competitive market place allows for some tailoring and customizing of individual prices and contract terms. Indeed, if the market doesn't exhibit these characteristics at all, then it's not really a competitive market. Customizing may be one way to develop a "no-notice" competitive transportation market. There's certainly room for this market considering that interruptible transportation now accounts for 51 percent of pipeline deliveries to market.

Tailored rate designs ought to reflect a match between the customers needs, the producer's supply, and the pipeline's operating conditions. This brings me back to my emphasis on the need for good information. More than ever before, there will be an emphasis on the optimal scheduling of pipeline flows, storage, maintenance, controlling, and shifting consumer demand. In this situation command and control of information is paramount because a competitive market inevitably reduces profit margins for the poorly organized and inefficient party. To be effective negotiators, gas purchasers and sellers must have the ability to recognize and act on the opportunities offered by the ebb and flow of a pipeline's operating conditions. FERC clearly understands this and accordingly has decided to make pipeline operations an open book for both gas buyers and sellers.

I hope LDCs and their customers are ready for the responsibilities of a competitive natural gas market. The LDCs fit the national pattern already noted by the FERC: Buying a lot of gas on the spot market, using interruptible transportation, and relying on pipeline sales for peak-day purchases, while keeping overall bills below the potential cost of exclusive reliance on pipeline gas. The LDCs have had an extended learning opportunity. It's up to them to take this experience and skillfully apply it the emerging market that the FERC is now creating.

The competitive market certainly raises uncertainties at the federal and state levels. How will the FERC draw the boundary between proprietary information and information required to make the market competitive? How does state regulation establish risk-sharing between the core customers and an LDC making a gas purchase on their behalf? Will a purchased gas adjustment (PGA) clause continue to serve a useful purpose once pipelines comply with Order 636?

These questions don't exhaust the possibilities, but sooner or later, perhaps in a rate case setting or in a notice of inquiry, the LDCs will have to show their state regulatory body that they've read the open book on pipeline operations and made good use of it. This would serve everyone's interest, and the LDCs should avoid putting truth to old sayings: "You can lead a horse to water but you can't make it drink," or, in the case of pipeline operations, "seeing a book open does not make its reader think."

Order 636-A: A Short-term Solution?

On July 30 the FERC met and voted to approve Order No. 636-A, in which it slightly relaxed its effort to push the natural gas industry into the information age. Pipeline capacity released for less than one calendar month will now require neither advanced posting on electronic bulletin boards nor bidding.

But the practicality of omitting short-term transactions from posting and bidding requirements will diminish as the industry learns better how to handle transactions of various sizes and duration. These short-term events cause a nuisance only when the players in the market are not ready to use or interpret the information that they provide. Any competitive market features short-term, low-volume transactions, and there is no inherent reason why such transactions should hinder a competitive market in its allocative efficiency. Thus, we can likely expect that the FERC will eventually withdraw Order 636-A and replace it in a subsequent rule making.

Competition Versus Reliability

The importance of pipeline operations cannot be overstated because major changes in public policy towards regulated industry are constrained by technical considerations. The FERC's restructuring efforts are no exception. At the inception of the "Mega-NOPR," pipeline system reliability was incompatible with competition — one condition precluded the other. With the industry's help, the FERC resolved this apparent contradiction and found that system reliability and competition coexist. Neither one preempts the other.

With a little imagination, the FERC might apply this reasoning to the issue of transmission access in the electric power industry. All that's needed is to substitute "electric utility" for "pipeline" and "no-notice transmission" for "no-notice transportation". Can the FERC make competition in the electric industry compatible with system reliability? Perhaps not, but the electric industry may soon be hard pressed to explain why system reliability and competition cannot coexist in the power industry.

The FERC has offered a number of individual steps that, if taken quickly and cooperatively, will speed the gas industry's adoption of competitive market practices. But I emphasize the *fragility* of the FERC's proposal and the need for cooperation to make the system work. Hot new designer rates won't sell in the market place if the players torpedo the restructuring. I agree with the unspoken sentiment expressed by the FERC: Restructuring the industry will work only if the players adopt the spirit of "cooperative competition." That should characterize all bargaining between sellers, buyers, and pipelines.

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OPPORTUNITIES FOR INTER-INDUSTRY COOPERATION: A REGULATORY VIEW OF AUTOMATION

by

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OPPORTUNITIES FOR INTER-INDUSTRY COOPERATION:
A REGULATORY VIEW OF AUTOMATION

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ABSTRACT

Automation of distribution functions in gas, electric, and water industries will occur at customer premises. Achievement of industry-wide and nationwide acceptance depends upon cooperation between utilities and other industries that have a major interest in the upgrading of the nation's appliance, housing, and commercial building stock. Automation planners must design their product to enhance the consumer's ability for energy management and to permit a company to segment its market by offering different prices for peak and off-peak periods and other time-of-use combinations. Integrity of information collected by automatic means must meet not only the needs of a company but must also meet the concerns of consumers and regulatory bodies about accuracy. Selection of a method to transmit data is a critical issue: point-to-point digital communication offers the highest accuracy level, but implementation lies well into the future. However, point-to-point digital communication offers the greatest potential for growth, multi-industry application, and nationwide standardization. The possibility of common carriage by phone companies argues against complete deregulation of local phone services. Radio is today's most readily available technology but has limited potential and does not offer multi-industry application promised by point-to-point digital communication. The method of transmitting data from customer's premises to the utility is not dependent on the energy source and is not part of the competitive relationship between the gas and electric industries. Recent changes in the federal tax code have eliminated investment tax credits, a financial tool that had automatically tied a company's investment to a reduction in federal income taxes. The tax change means that a utility's investment in automation will need more capital on a per dollar basis than any of the utility's past projects. Automation projects undertaken solely by a utility could be hampered by a shortage of capital. However, the multi-industry aspects of automation mean that capital can be supplied through joint ventures. Therefore, the gas, electric, and water industries should not develop competing systems for automation at the customer's premises.

OPPORTUNITIES FOR INTER-INDUSTRY COOPERATION: A REGULATORY VIEW OF AUTOMATION

INTRODUCTION

Automation of distribution functions in gas, electric, and water industries is a part of the current trend toward technological innovation throughout Western Europe, North America, and Japan. Common elements of this innovation involve technological advancements in microprocessing and data transmission. Successful automation at the distribution level requires not only technological feasibility but economic viability as well. However, economic viability on a large scale will not be forthcoming without cooperation between the various public utilities and other industries that have a strong interest in the general upgrading of the nation's appliance, housing, and commercial building stock, the end-users of the various utilities' distribution systems.

Technological competence always precedes the economic aspects in the earliest stage of any product's development, but the initial economic success of a product loops back to its design. Technology and economy are very quickly joined together as complementary aspects of a successful integrated product. Failure in either aspect means an early demise for the product and stagnation for the underlying technology. Economic and service considerations will determine the conversion rate from manual and mechanical methods to the full automation of distribution functions.

ECONOMIC AND SERVICE ISSUES

The most likely targets for automation are customer premises in those markets characterized by regulation at the state level: electric, gas, and water utilities. Economic and service issues will be of paramount importance, and proponents of automation will have to deal with them.

Important economic factors are:

1) Proper identification of areas for cost savings.
2) The automation project's rate of return.
3) Allowable depreciation rates for new high technology equipment.
4) The product's ability to take advantage of scale economics in production.
5) The product's ability to incorporate the utility's rate structure.

Service factors of particular importance are:

1) The integrity of information acquired through remote and automatic means.
2) The likelihood of the product being adapted for multi-use and multi-industry functions.
3) The development of industry-wide standard communications protocol.
4) Reliability of component supply and related support electronics.

Prevailing Attitude and Current Activity

A complete industry-wide conversion to automation will not be immediate, but there is a prevailing attitude that automation is inevitable. A recent article in Business Week provides an illustration:

> It will take years for automatic meter reading to blanket the country. Utilities are 'a very conservative industry,' . . . they will have to convince regulators that sinking capital into the new technology is justified. Still, it now seems certain that the meter reader's knock will slowly join the clop-clop of horse-drawn milk wagons as a memory of bygone times. (1)

This is a complacent and rosy outlook. There is no certainty that automation will gradually replace the meter reader's knock; there are major obstacles to overcome before automation becomes the dominant method of data collection and control at the distribution level. This may seem implausible at first, particularly in light of the current activity around the country by utilities, vendors, and utility commissions.

For example, there are two projects currently underway in Iowa: a centralized meter reading experiment involving Northwestern Bell and the Des Moines Water Works, using a product manufactured by Neptune Information Systems; there's also a remote metering project by Iowa Power using an Itron product. Other projects are being carried on by Minnegasco, Southern California Edison, Connecticut Natural Gas, and the Hackensack Water Company. In late 1984 Sangamo introduced its Data Star System, one capable of remote interrogation. Philadelphia Electric Company is also involved with remote interrogation; EPRI has invested $7 million at Carolina Power and Light in a demonstration project of an automated distribution system. In July 1986 the New York Public Service Commission issued an order directing New York Telephone to submit cost-based rates for application to phone-based automated meter reading services. All of these activities involve a very small number of meter installations in comparison to the country's total meter population of approximately 200 million. Automation is still at the earliest development stage; the industry as a whole is not yet committed to any particular technology or procedure. Consequently, there is ample time for careful planning and anticipation of problems. The economic and service factors mentioned earlier suggest the kinds of issues that must be faced before implementation can sweep the rest of the country.

Economic Issues

Cost Savings and Rate of Return. Cost savings have to be found not only in the elimination of estimated bills and in accounts 901 through 905 of the uniform system of accounts but also in reduced manpower expenses for pensions and insurance, reduced expenses for auto and truck fuel usage, maintenance, and insurance, and reduction of expenses related to inventory and the need for working capital. The project's rate of return must meet a company's minimum level; this will vary by company, type of service, region, and will be affected by the general inflation rate. The holding company concept is particularly important here; it provides an easy way for utility capital to exit from the industry. Automated distribution projects will compete not only against other company projects but also against any non-utility application that promises a high rate of return.

Depreciation. With regard to a rate case and the setting of a company's revenue requirement, depreciation rates for new equipment will be set by state authorities, not federal. Recently the Federal Communications Commission tried to pre-empt the states' authority to set depreciation rates for the telephone industry. However, the United States Supreme Court overruled the FCC and reaffirmed the states' authority to set depreciation rates for property used in intra-state service. This always raises the fear on management's part that any savings created by technological progress at the distribution level would not be retained by the stockholders but passed through to the consumers in the form of rate reductions ordered by regulatory bodies.

Scale Economics. Scale economy, a declining average cost of production, must characterize manufacturing costs of automation devices if they are to serve a population of 200 million meters. Scale economies are important because as production costs drop a greater number of automation projects will achieve the required rate of return and be implemented. Otherwise a minimal number of projects, only those with the highest rates of return, will be adopted. Therefore, long-term strategic planning should include detailed analyses of the supplier's capability to expand production in a cost-effective manner.

Rate Structure. Automation must reflect the utility's rate structure because that structure represents product differentiation. To the extent that any utility can segment its market and sell a different commodity in each, the utility must also have the capability to measure the commodity's sales and apply an appropriate price.

For example, electric power subject to interruption is clearly a different commodity than power not subject to interruption; local measured service by a phone company is quite different from paying a flat monthly charge with no limit on the number and length of phone calls. Natural gas consumption in peak periods is the determining factor for the size of distribution lines and the need for compression substations.

Distinguishing consumption by season is no problem at all, but eventually utilities will want to distinguish consumption by peak and off-peak periods in a given month, week, or day. This is already a common practice among industrial customers served by large electric utilities. Automation should give companies the same flexibility at the distribution level and not preclude these options. Obtaining a simple kwh reading or a simple ccf reading should not be the only goal. At a minimum long-term strategies should include the use of clock-controlled switching in multi-register meters that can be remotely interrogated.

Service Issues

The economic issues lead directly to the service factors, the first being the integrity of the information acquired through automatic means. In this regard everyone wants accuracy and no one wants to lose information. Therefore, data transmission methods require particular attention.

Information Integrity. Communication has always been an obstacle to automation of the distribution level because in this situation several thousand remote sights are sending information to a central point. Data transmission can occur through power-line carriers, point-to-point cable (coaxial or fiber optic), common carriers, and radio. The mix chosen depends on the particular aspect of the distribution system that's being measured and the challenges that can be made to that measurement.

For example, an electric company collects information on such things as amperage, phase angles, and tap positions for various feeder lines; a gas company wants information on pressure in various mains and substations. In both cases, the data is used internally to the company and not likely to be challenged by anyone; therefore, the data path can be of the company's choosing without regard for an audience external to the company. However, customer billing is a different matter. Every consumer has the right to challenge a bill on the basis of inaccurate measurement. Therefore, at some future date regulatory bodies will be compelled to do a shadow evaluation of all phases of automated meter reading, a double-checking and verification of the company's claims of accuracy. With regard to customer billing information, companies should select the data transmission path that minimizes these challenges.

Power-line carriers would invite challenges because the carriers are not suitable to the billing methods of any industry, even electric. The superior technology for accuracy is point-to-point digital communication, an inherent feature of fiber optics. Digital information transfer differs from analog information flow, in which data is sent in wave form from a source to a receiver and reamplified in the transmission route. The analog wave form may pick up and carry extraneous information on the way to the receiver so that the data content changes and becomes inaccurate. Digital communication is based on sending, regenerating, and receiving binary code, a series of zeroes and ones, so that extraneous information is not picked up and carried by the original data; hence a digital information path is far less likely to lose information integrity than an analog path. Fiber optics will take advantage of the Integrated Services Digital Network (ISDN) that is now being expanded by A.T.&T. and the various telephone operating companies. ISDN is intended to offer the widest span of consumer services imaginable: banking, shopping, televideo conferencing, television reception, electronic mail, burglar alarm systems, and computer-to-computer data transfer for banks and utilities are just a few examples. The ISDN system is expected to be fully in place within two decades and to that end A.T.&T. began selling ISDN chips in 1986; in addition, the data transmission rates can vary over a wide range according to the user's specifications. Optical static groundwire provides an opportunity for electric utilities to create their own networks on their own right-of-way, but the utilities' general lack of expertise in the technology is a disincentive to this strategy. They are unlikely to invest heavily in fiber optics for distribution purposes.

Common carriage by phone companies is another possibility, either through fiber optics or conventional means. But fiber optics is barely beginning to penetrate the subscriber loop primarily because the telephone companies still have large investments in copper networks, an investment that will not be fully depreciated for 20 to 30 years. Transmission by conventional methods is an option, but that depends in large part on the prices charged for data transmission. The New York case mentioned earlier suggests an emerging regulatory policy in that state to make common carriage more price competitive. A contrast is provided by Nebraska where prices for phone service have been completely deregulated. This could have a long-term negative effect on automation in that state in view of Omaha Public Power District's experience; in 1984 the District abandoned an automatic meter reading project and referred to expensive telephone tariffs as a reason.

Radio transmission appears to be an early favorite of some companies. It avoids dependence on a common carrier, has a low start-up cost, and is today's most readily available technology. Its major drawbacks are a slow data transmission rate, coverage limitation by line-of-sight, interference from large objects and low power operations, and lack of growth potential. Radio is an older technology and has no promise of yielding a broad number of benefits to various sections of our society, thus automation by radio has no potential of multi-use or multi-industry application.

Multi-Use and Multi-Industry Aspects. Automation must be considered in light of additional developments being carried out by the electronics industry, appliance manufacturers, and housing industry groups, such as the National Association of Homebuilders. In early 1986 thirty companies representing electronic, appliance, and chemical firms initiated a joint venture to develop "smart houses," futuristic houses in which energy management and appliance use are controlled from a home computer. The joint venture's participants are major companies: Apple Computer Inc., the General Electric Company, Whirlpool Corporation, the Carrier Corporation of United Technologies, Honeywell, Du Pont, Shell Oil, Bell Communications Research, National Semiconductor, and Signetics Corporation are examples.

This group has developed inside wiring that transmits not only electricity but also information for audio, visual, and computer needs. Full acceptance of this wiring scheme by the National Electrical Code will have a dramatic impact on various aspects of day-to-day living and energy usage in particular. Another well-known joint venture with the same target market is Transtext, a product combining the efforts of Integrated Communication Systems, Bell South, Westinghouse, and several other companies.

Of comparable importance in the gas industry is the continued development of flexible cable as a substitute for the standard black pipe that carries natural gas into the home and commercial buildings. This broadens the market for gas by making it a more attractive option for such things as home refrigeration and air conditioning or other new applications for appliances. This development, along with an expansion of gas-fired cogeneration and open access to gas supplies by current retail customers, will create new needs for load balancing and load control because the distribution system's capacity will gradually be absorbed and become a scarce resource.

But whether the energy source is gas or electric, energy management by all types of consumers is here to stay. The new technologies just mentioned make energy management easier while simultaneously giving the utilities an opportunity to provide different services, i.e., peak and off-peak service, weekend-weekday service, or other conceivable combinations. As long as such services can be measured, they can be priced. Automation planners must be conscious of how their designs fit with the overall energy management scheme at the consumers' level and with the company's desire to sell its products.

To reiterate an earlier point, the best fit will be found with a strategy that takes advantage of ISDN, the Integrated Services Digital Network, and its potential use of fiber optics that's coming to the country as a truly nationwide system. Selecting ISDN over radio does not mean selecting electric over gas as an energy source. (The development of flexible cable in place of black pipe and the continued expansion of cogeneration activity are the things that will broaden the gas market.) The choice involves different methods for transmission of data. The new inside wiring scheme described earlier is a natural complement to ISDN and a clear example of its potential.

The joint venture group coordinated by the National Association of Homebuilders expects eight million homes to be equipped with its computerized system and wiring in approximately ten years. Disbelief may be the first reaction to these figures and the ideas behind them, but they are no more preposterous than was the idea of universal utility service at the turn of this century.

Automation at the distribution level is a growing part of the country's economic infrastructure--a building block upon which many other services and industries will be based. The general public will depend on automation and its hidden benefits in the same way that railroads, highways, damns, and utilities are depended on today. But utilities cannot develop this system by themselves, nor can they risk divergent patterns of capital expenditure on automation systems that will not be generalizable and extend well into the future. Automation at the customer's premises should not require one system for gas, a different one for electric, and still another for water. Combination companies, those engaged in gas and electric sales, would readily agree with this. Both industries have a large stake in the future of automation, but they are only part of the picture. The most effective way for them to protect their interests is by forming joint ventures with phone companies, electronic groups, and appliance manufacturers for a common, unified approach to distribution level automation.

Communication Protocol and Support Electronics. There are sound reasons for this strategy. A multi-industry approach inherently reduces the number of opportunities for an individual company to develop its own unique communications protocol from remote units to intermediate collection points and from these points to master stations. This is already a problem for producers of energy management systems used in large commercial buildings and homes. The multi-industry approach increases the probability that there will be a nationwide standard communication protocol and a reliable system of component supply and support electronics.

Additional Advantages

Financial. The technical benefits are augmented by additional advantages. Joint ventures provide a larger capital pool and spread the investment risk among various participants. The need for a larger capital pool is the result of the new federal tax legislation that eliminated investment tax credits (ITCs) and reduced the rate of depreciation for plants and equipment that had normally depreciated at accelerated rates. These two items were beneficial to a utility. The ITC tied investment directly to a tax reduction without regard for a company's net income. Even if the company didn't make profits in a given year the ITC could be carried into future and applied against income until the ITC was used up. Accelerated depreciation reinforced the financial benefits of the investment. This combination was a hefty stimulus to capital investments by utilities. If the total cost of automation is $10 billion, a 25 percent ITC would mean a reduction of $2.5 billion in federal tax liability. Imagine how this would affect your project's chance for success. But that link has been broken. Investment in automated distribution systems will not bring with it any of the tax advantages that characterize past investments. The effect of the tax change is to increase the amount of capital needed for a given project. This is one more reason not to assume that automation is inevitable. But a joint venture enlarges the funds pool and compensates for the capital lost to federal taxes.

Organizational. Risk spreading is important because recurring technological innovation in any industry creates a fundamental problem for financial decision makers. Investing in a particular kind of plant or equipment too early always brings the risk that technological improvements will make current assets economically obsolete well before physical obsolescence sets in. Of course, no one wants to be "locked in," and everyone wants maximum flexibility. The natural tendency is to wait and let someone else take the risk and to learn from their mistakes.

The risk-taking function for new products is normally shouldered by the vendors, they take the initiative to develop and market a new product. But there is a subtle relationship between vendors and utilities with regard to technological change; neither will admit to being the driving force. Vendors will usually take the position that they are responding to a perceived demand by the utilities for the product; hence, the utilities are the controlling force. But utilities disavow that description. They picture themselves as a practical group, playing no role in product development and taking the best that each vendor has to offer in order to provide utility services to the general public.

These philosophical positions should be abandoned because they easily lead to a lack of coordination, miscommunication, and unproductive investment by both parties. Joint ventures will keep all parties fully apprised of critical information and minimize opportunities for the negative aspects just mentioned.

SUMMARY

There is a risk that the gas and electric industries will take divergent paths to automation at the customer's premises. This would be a mistake. Whenever possible the industries should standardize, piggyback on each other's systems, and avoid duplication of investment. Automation inherently involves data transmission and energy management. Therefore, do not think of ISDN as a technology that supports electric consumption and radio as a technology that supports gas consumption. The choice between ISDN and radio involves data transmission routes rather than a choice between competing energy sources. There is no obvious reason why ISDN would not be just as applicable to the needs of gas distribution systems as it would be to electric systems. The ability to apply load control to air conditioners, water heaters, refrigerators, and other appliances should not depend on the energy source. Companies will make their decision based on their ability to segment their market, and to apply appropriate prices as well as finding cost savings in meter reading. The common carriage option for data transmission argues against complete deregulation of local phone service. Joint ventures will be the principal means of establishing industry-wide and nationwide automation systems for distribution services.

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Focus: Nuclear Prudence Cases

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Editor's Notes

This second issue of ELECTRIC POTENTIAL provides the reader a bounty of ideas on where we are going in electricity. If this is truly to become a provocative journal, we're off to a good start.

The contributed articles provoked some ideas on our part. There are two articles on nuclear prudence cases, by Michael B. Rosenzweig and Tracy Alden Funk, and Robert A. Webb. The first discusses the regulatory definition of prudence and the second the challenges utilities face when encountering a "roving, all purpose anti-utility witness." We wonder how witnesses are defining prudence, and how the definition will evolve; and the resulting impact on utility incentives and policy.

Ronald W. Melicher and William G. Mister warn us about a potential crisis associated with nuclear accident insurance. How adequately are we preparing for all the effects of a nuclear accident (of Three Mile Island scale or worse), even though the probability of such an occurence is not very high?

There are two articles on the impact of technology on electricity metering, by Stephen N. Brown and Robert M. Keith. This is quite a promising area for utility investment. What is holding us back?

Two letters came in for this issue. One, by Hethie Parmesano, discusses alternative approaches for reconciling marginal cost rates with the revenue requirement. Doesn't the complexity of this controversy suggest that marginal cost rates are impractical in the regulatory environment of today? The second letter was from Alan Friedberg and William G. Mister. We wonder how much customer rates are affected by changes in the cost of debt, and methods of regulatory treatment.

Finally, we recommend the reader to the articles by our staff, Peggy Schnarr, Kenneth W. Costello and David M. Boonin. They are guaranteed to stimulate some ideas.

The Role of Electric Utilities in the Development of Fiber Optics Markets

By Stephen N. Brown, Ph.D.
Supervisor of Rate Design
Houston Lighting & Power

In the next two decades the electric utility industry will be in a pivotal position to influence the expansion and refinement of fiber optics technology because electric utilities can provide the mass markets that fiber optics producers need to reach, for high volumes of production and declining unit costs. These steps are required if fiber optics is to displace current data- transmission technology rapidly. A rapid conversion from the current technology is by no means guaranteed; in fact, a slow conversion rate could have a negative impact by keeping volumes of fiber optics production low and unit-costs high. But the conversion rate will accelerate when electric utilities recognize that fiber optics provides them with a major opportunity for investment at the distribution level: dwindling investment opportunities at the generation and transmission levels require new investment avenues within the industry.

I

Fiber optics technology is used as a high-speed digital communication path from one point to another, and both points can receive and send information over the fiber optics path. Far from being limited to voice communication, fiber optics is intended to offer the widest span of consumer services imaginable: banking, shopping, televideo conferencing, television reception, electronic mail, burglar alarm systems, and computer-to-computer data transfer are just a few examples.

Initially, fiber optics would seem to win any competition with copper-wire data transmission plant, the basis of current communication paths. But two factors militate against this: cost and consumer preference.

On a mile-per-mile basis, fiber optics and all its support devices cost from ten to twenty times as much as copper-wire communication plant and all of its support devices. To be economically viable, the number of circuits carried by fiber optics must be proportionally more than the cost-multiple. But the current plant can have its capacity expanded at little extra cost; the introduction of fiber optics at the long-distance level could be piece-meal or delayed for some time [Personick, pp. 163- 165]. Successful application at the local level requires a solution to the cost problem and a means to overcome consumers' resistance to change.

With regard to consumer preference, the average telephone user may not want to pay for the extra services offered with fiber optics. "We are still trying to figure out what this stuff does for the ordinary telephone user...its higher quality and lower maintenance...but I think that we are going to have copper pairs in the business at least through the year 2000 or even 2100 ...so you will have copper pairs where they are useful for telephone service and low speed data and fiber for video and high speed data...the telephone companies may be able to compete with the cable tv people...the telephone companies are extremely interested in that..." [Bernstein, pp. 171-172]. But to provide video transmission to a customer's premises would require that the customer's telephone loop service be replaced directly with a fiber optics cable, and "the challenge here is very severe since not only must the fiber be more economical than the wire pair it replaces" but it must also provide the same functions as regular telephone service. "This implies, amongst other things, a more complicated telephone or terminal at the customer's premises" [Personick p. 166]. These statements do not support the premise that fiber optics technology has universal application in the data-communication field, and they suggest a slow conversion rate from the existing technology. Fiber optics producers and developers could be in the position of limiting investment to very secure markets, such as communications applications between large cities or international underwater cables.

For example, A.T.&T. is currently in the process of establishing a high-volume fiber optics path between Boston, New York, and Washington D.C. because there is a clear need for increased information-carrying capacity in that area [Bernstein, p. 160]. In 1988 A.T.&T also expects to install a transatlantic fiber optics cable that will handle 40,000 simultaneous telephone calls [Bernstein, p. 185].

These are investments with minimal risk because they are trunk applications, i.e., the traffic on these data paths is so high that the data path's capacity is shared between users on a need- to-use basis, and the path is almost always in use to its full extent. This differs from what is known as the telephone loop or line application, the telephone line running from a telephone carrier to a customer's premises. In this case, the line is almost always a private one used only when the customer needs it. While use of this line is relatively low, this is exactly the place where fiber optics could have its largest market. Fiber optics developers must create a large volume market in the loop system to insure that revenues recover the investment. In the 1990's fiber optics producers can be expected to launch a major sales drive offering consumers bundled services: for a flat monthly or annual fee the homeowner or small business will receive as wide a variety of services as can be offered over the fiber optics network. The success of this strategy depends on the identification of customers most likely to buy the service.

The problem of incorporating fiber optics into the loop system is circular: limited investment preceding the development of the market may very well jeopardize development of the technology; investment following market development insures high unit-costs that prevent effective competition with copper-wire data paths. The marketing solution to this problem requires that fiber optics technology embrace as many consumer uses as possible; otherwise, copper-wire data paths may indeed be alive, well, and dominant in the year 2100.

II

The marketing solution in the prior section does not consider the idea of electric utilities being the major institutional user of fiber optics data paths. All the consumer functions formerly referred to could be "add ons" to a more fundamental service if electric utilities were to invest in fiber optics.

The distribution and transmission lines of electric utilities go nearly everywhere that telephone lines go, telephone companies and electric companies very often have common rights of way. There is a harmony of interests here that can benefit both industries and the consumer. If electric utilities shared in the investment of fiber optics at the telelphone loop level, this investment would legitimately become a part of the electric utilities' distribution plant. Electric utilities could use the data communication capability of fiber optics for a number of things: remotely reading electronic meters rapidly and accurately; implementing load control programs by substituting the fiber optics for all radio-frequency-based load control programs; achieving better cash flow through the electronic transfer of funds from the customer to the utility; offering rate incentives to customers who agree to new rate features implemented through fiber optics.

All of this can be done for two reasons: fiber optics paths do not conduct electricity and are unaffected by proximity to voltage carriers; fiber optics use digital information transfer. These two aspects mean that the information sent from the customer to the company and vice-versa will be accurate to as high a degree as might be imposed by a regulatory commission.

Digital information transfer differs from analog information flow, in which data is sent in wave form from a source to a receiver. but the analog wave form may pick up and carry extraneous information on the way to the receiver so that the data content changes and becomes inaccurate. When this occurs there is no way to separate the extraneous data from the original. Copper-wire data paths are almost always analog paths. the exception being "dedicated" telephone lines which are very expensive and therefore not widely used. Digital communication is based on sending and receiving a series of zeroes and ones so that extraneous information is not picked up and carried by the original data; hence a digital information path is far less likely to lose information integrity than an analog path. Therefore, because fiber optics is not easily challenged with regard to accuracy, it can be a very power (or any other kind of power that could be categorized). This capability would provide the company a position of strength and flexibility when bargaining with potential power suppliers. Viewed in terms of a planning horizon, fiber optics technology can be the electric utility industry's long term practical response to a changing regulatory and economic environment.

IV

The foregoing discussion has pointed out the advantages of cooperation between the two industries; moreover, the discussion suggests that joint ventures between the industries are probably the best avenues to promote universal application of the technology. But what would be the price of noncooperation? If fiber optics does not displace current technology, then the public will be denied access to a demonstrably superior technology, and the electric utilities will be hard-pressed to find other investments as relevant and as beneficial to itself in the long run outside the business. On the other hand, if the developers adopt a successful "go it alone strategy", then they will be in a position to dictate price and terms just as an unregulated monopolist would be. The electric utility industry could not treat these services as capital investments but rather as expenses, which would require higher annual revenues. This would certainly be a set-back to wide-spread application of fiber optics.

The advantages of cooperation are clear: greater certainty, less risk, and quicker implementation than any other option. The developers continually work to reduce production cost, and there is no doubt of continued progress in fiber optics technology. Bell Communications Research recently announced the success of a new semiconductor growth process with direct application in fiber optics communication. According to a spokesman, the process would help bring costs down and "hasten the day" when the benefits of fiber optics are routinely brought into homes and businesses. [Public Utilities Fortnightly, July 11, 1985, vol. 115, Number 14.; pp. 59 - 60].

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FINANCING ELECTRIC (& OTHER) UTILITIES' SHARES IN LOCAL LOOP FIBER NETWORKS: ECONOMIC AND POLITICAL CONSIDERATIONS

by

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THE PENNWELL CONFERENCE ON
TELCOS, POWERCOS, & CABLECOS - PARTNERS OR RIVALS IN THE LOCAL LOOP?
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ABSTRACT

The United States, through electric utilities, can successfully finance local-loop fiber optic networks and incorporate this technology into our economy. Private investors in United States require a 20.3 percent rate-of-return to finance research and development projects while in Japan investors require only an 8.7 percent rate-of-return. In America civilian development of technology is financed almost exclusively by equity/venture capital that demands high returns. In Japan, debt capital plays a large role in the financing of new technology and lowers the overall capital cost of technological innovation.

Electric utilities' capital structure uses large amounts of debt which can be directed towards the financing and commercialization of fiber optic networks in the local loop. The states and local utilities can achieve economic development through technological innovation, but success requires support by a broad-based political coalition so the public associates innovation with job creation rather than abandonment of ordinary people in ordinary jobs. Consensus creates an orderly sharing of risk between consumers and utilities regarding the commercialization of fiber optics in local and statewide economies.

Cooperation between state regulatory agencies and local utilities should not be identified as central planning. The United States government is planning; the White House selected 22 technologies as being critical to the national prosperity and to national security. Three critical technologies (micro and optoelectronics, high-performance computing/networking, and energy technologies) need mass markets to achieve substantial cost reductions. Working together, state regulatory bodies and utilities can develop a fiber-based communications infrastructure thereby creating mass markets and complementing federal policy on technology development.

A state program which brings fiber to the loop may spark federal activity if the government considers the overall needs of the business community to establish a level playing field between small and large business that rely on a speedy flow of information. Electric utilities have long-had the potential to take fiber initiatives but have delayed because of the utility's inability to spread risk.

Consensus spreads risk and changes the public's image of technology as something that doesn't give ordinary men and women the means to make a decent living, to get an education, and to have a future. Only a tiny fraction of the adult population is computer or technology literate, but don't underestimate the ability of America's people. A fiber-based local loop **is not** too complex or practically useless for the public. Human resources adapt to and develop with technological resources.

The federal government's vision of fiber, S. 272 - the High Performance Computing Act of 1991, is dominated by national defense priorities and does not consider fiber's potential for economic development; nor does the legislation consider the issue of transferring fiber technology to state and local governments. The federal government's role in fiber optics must be supplemented by efforts of the states and local utilities to bring technology to the general population.

The High Performance Computing Act of 1991 will create an "Information Superhighway." The highway analogy conveys the image of equal access for all. It should not be a road traveled only by the defense establishment. The supporters of the information superhighway must do their absolute best to involve the states wherever possible and to communicate all the lessons learned.

Title IV of the Clean Air Act Amendments of 1990 places energy efficiency and least cost planning issues before state regulators and local utilities. The utilities' efforts to develop an energy efficiency strategy will be the first opportunity for the widespread commercialization of fiber optics at the local level. These investments can easily be a part of a utility's rate base if state regulators and the utilities establish mutually acceptable criteria and incentives for making fiber optics a prudent investment. Success requires cooperation from the local exchange telephone companies (telcos) and the CATV companies. Perhaps the federal government can lead in fashioning a compromise between these competing economic interests. How long must the public wait for affordable fiber optics - 10 years or 50? Japan intends to invest $126 billion in a national fiber network reaching every home, office, and factory in Japan by the year 2015.

This country needs economic growth and revamped human capital. Local communication needs and services are splintered into tiny pieces where electric, gas, water, telephone, CATV, and microwave-wireless tv companies are delivering "innovative" services to and collecting information from the same consumers. This diversity **is not** economically efficient. Growth of business niches in local and statewide communication markets are signs of foregone scale economies and near-duplication of physical plant. Now is the opportune time to reverse these trends by forming partnerships that bring fiber to the local loop.

FINANCING ELECTRIC (& OTHER) UTILITIES' SHARES IN LOCAL LOOP FIBER NETWORKS: ECONOMIC AND POLITICAL CONSIDERATIONS

LOWERING THE CAPITAL COST OF COMMERCIALIZING FIBER OPTICS

The United States, through electric utilities, can successfully finance local-loop fiber optic networks and incorporate this technology into our economy.[1] The nation's ability to commercialize fiber optics in the local-loop is central to reversing our country's decline in economic productivity and global competitiveness. The importance of this ability cannot be overestimated.

For example, the demise of the Soviet Union's economy is attributed largely to that political system's failure to integrate new technology into production [13,30].[2] Japan is held out as a counter example, a country where quasi-governmental agencies promote joint ventures between private firms that seize opportunities offered by new technology [13,34].

According to Richard Mahoney, Chairman and CEO of Monsanto, America's technology-commercialization efforts are hampered by the country's regulatory system and by extremely high capital costs. The regulatory system neither stimulates nor rewards innovation and retards it by slow-approval processes. Mahoney also points out that private investors in United States require a 20.3 percent rate-of-return to finance research and development projects while in Japan investors require only an 8.7 percent rate-of-return [9].

The spread between the American and Japanese rates is striking and attributable to the different kinds of capital employed. In the United States, the development and commercialization of new civilian-oriented technology is financed almost exclusively by equity capital that demands high returns in compensation for high risk [4] [5]. The high returns are captured in the form of capital gains which are linked to unending debates in our country about capital-gains taxes and their impact on technological change and economic growth [10]. In Japan, where banks can own equity in businesses (unlike American banks), debt capital plays a very large role in the financing of new technology [4] [5]. The use of debt capital, with its lower overall cost, improves the long range economics of any undertaking.

Electric utilities have a traditional capital structure of 50 percent equity and 50 percent debt. They can direct massive amounts of debt capital towards the financing and commercialization of fiber optic networks in the local loop. The network's electric-utility-applications would be integrated resource planning, spot pricing [14], and telemetry functions in general including items such as breaker status and meter

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[1] The opinions expressed in this paper do not necessarily reflect those of the Iowa Utilities Board.

[2] The first number in the brackets refers to the item in the reference list; if a second number appears it refers to page numbers.

reading [3]. The investments would be secure because electric utilities will retain their monopolies in the local distribution network regardless of changes in the transmission and generation sectors of the industry.

The investment's safety means that local loop fiber networks can be created without seeking any special treatment from the federal government's fiscal or tax systems. Safety also means that fiber networks do not need financing from venture capital markets. Through cooperation of state regulatory agencies and local utilities, this country can create a new, all purpose communications infrastructure without getting mired in the debate over fiscal and tax policy.

COMBINING FIBER WITH ECONOMIC DEVELOPMENT AND POLITICAL COALITIONS

The states can take the economic-development-initiative, they have the power and the imagination to change the nation's economic landscape. This is the theme of David Osborne, author of Laboratories Of Democracy, who begins his book with an appropriate quote from Justice Louis Brandeis:

> "*There must be power in the States and the Nation to remould, through experimentation, our economic practices and institutions to meet changing social and economic needs. . . .It is one of the happy incidents of the federal system that a single courageous state may, if its citizens choose, serve as a laboratory; and try novel social and economic experiments without risk to the rest of the country* [12,vi]."

State regulatory agencies and local utilities, working together, have the power to experiment and speed the deployment of fiber in the local loop, making it a tool for economic development and integrated resource planning. The benefits will be:

* An increase in the capital/labor ratio of local economies;
* An increase in productivity;
* An increase in capital accumulation;
* An increase in jobs.

Economic development can be achieved through technological innovation, but success requires this policy to be supported by a broad-based political coalition. Otherwise, the public does not associate innovation with job creation.

For example, Osborne cites the case of the Ben Franklin Partnership, the economic development program of Richard Thornburgh, Pennsylvania's governor from 1979-1986. Thornburgh, a republican, appointed a democratic state representative from Pittsburgh to sit on the Board of the Ben Franklin Partnership. The democrat was heavily criticized by his constituents for his participation:

'In the kinds of districts most of us represent in Pittsburgh, technology is in some ways a threat. . .It causes antagonism. It's killing jobs. They don't want to hear that four years from now there's going to be a wonderful software industry in Pittsburgh. Both my democratic opponents in the last election used the technology issue as a criticism of me. They would say I spend too much time worrying about technology, that I should be more interested in creating traditional jobs [12,79-80].'

Osborne also says economic development efforts "must be complemented by programs to bring . . . the disadvantaged, and the dislocated into the growth process [12,80]." The lesson, for those of us who advocate partnership rather than rivalry in the local loop, is that no one can be elitist. No one should say to the public, consumer groups, and legislatures "trust me, I have a plan." Creating a broad-based political coalition that supports fiber in the loop requires the state commissions and the utilities to make a commitment to universal service. Limiting fiber's service to a certain group would ensure failure. In turn, the regulators must assure utilities that the security of their investments will not be weakened through second-guessing.

A true partnership in the local loop requires consensus on the orderly sharing of risk between consumers and utilities regarding the commercialization of fiber optics in local and statewide economies. Establishing consensus does not mean establishing central planning, and the terms should not be confused with each other. "Central planning" is reminiscent of the defunct Soviet economy. But consensus does mean planning in some form because commercialization of fiber is a large enterprise. As Robert Reich says: "Every industrialized government is in the business of technology planning, development, and transfer. The critical question is not whether such planning occurs, but how it is carried out [13,34]." The United States' government is doing just that, planning.

COORDINATING STATE AND FEDERAL POLICIES ON TECHNOLOGY AND ECONOMIC DEVELOPMENT

In April of 1991, the White House selected 22 technologies as being "'critical to the national prosperity and to national security [15].'" The selections were made under the direction of William Phillips, chairman of the National Critical Technologies Panel and associate director of the White House Office of Science and Technology. Three critical technologies are directly relevant to our conference: micro and optoelectronics, high-performance computing/networking, and energy technologies [15]. All of these have application to fiber networks in the local loop.

For example, an important question is whether the loop should be active or passive. If active, the fiber is lined with electronics, or if passive, the fiber has only a bare minimum of electronics at installation time. A decision-maker might say "List the micro and optoelectronic components, tell me their cost and average mean time between failures." The answer might be, "the initial cost will be high, but if a mass market is found scale economies should follow with a consequent decrease in cost."

How are the mass markets found? They're not found; they're created by state regulatory bodies and utilities developing a fiber-based communications infrastructure. This is clearly an example of how state regulatory and economic development policy can complement federal policy on technology development.

Publicly identifying the critical technologies represents a policy change by the White House, which had considered any designation a form of economic predestination and governmental interference in the markets. The change in direction begs the question, what would be the federal government's interest in technological change, such as a state-sponsored program for a fiber-based local loop? There are several answers.

Ralph Landau, well known for his views on the interaction between economics and technological innovation, says that the federal government should have no interest. He suggests that the federal government is most astute when it limits its activities to "establishing the right macroeconomic climate for long-term economic growth." The goal of macroeconomic policy should be "to increase investment in both capital and technology in all sectors of the U.S. economy . . ." Landau feels that government is not capable of directing "the private sector through the rapidly changing conditions imposed by the pace of technological innovation." He succinctly states his worry about a government role: "Many in Government and elsewhere are already using the concept of 'competitiveness' as a code word for old-fashioned manipulation of industry [7,52]."

David Osborne expresses a similar but not identical view. He suggests it's possible for any state sponsored program to become a model for a federally sponsored national program, depending on the relative merits of the program.

> If in a rush of enthusiasm for American 'competitiveness' we simply round up the best state programs and legislate them into federal law, without a careful sorting of the appropriate level for each form of intervention, the results will be inevitably disappointing.
>
> Our goal should be a new partnership between the state and federal governments, in which each level of government acts in ways that are appropriate to its capacities and responsibilities.
>
> When the appropriate model differs from one region to another the programs should be run by the states . . . when the problems transcend the problems of the individual states the federal government should administer the program [12,283-285].

Michael Boskin, the Chairman of the Council of Economic Advisors, has written, "Obviously there is a substantial case for some government involvement at least in the financing of [research and development] because of the potential . . . that . . . private firms . . . under invest in [research and development] [1,195]."

A state program which successfully brings fiber to the local loop while offering universal service may spark federal activity if the government considers the overall needs of the business community, which is now split into a new type of "haves" and "have-nots." "The critical difference between the groups: Whether a company can gain access to complex new information networks that provide up-to-the-minute data on customers, suppliers, and operations [3]." This dichotomy was highlighted in Technology and the American Economic Transition, a 1988 publication by the Congressional Office of Technology Assessment (OTA). The OTA's study also said that "40 percent of all new investment in plant and equipment in the United States now goes to purchase information technology [11]." Harnessing this investment to a fiber-based local loop network would have far reaching implications for economic competition throughout American business.

For example, fiber in the local loop could instantly become part of a marketwide information network that would put small companies on par with larger competitors. Many of the smaller airlines that started up after the 1978 Airline Deregulation Act were unable to compete because American and United dominate the computerized reservation system [3]. Fiber in the local loop would do a lot to establish a level playing field between small and large business that rely on a speedy flow of information.

Another example lies in the local markets for information transfer. Local telephone exchange companies (LECs) now face competition from alternative local transport (ALT) providers. The ALTs are fiber-based, and the FCC has recently decided to permit ALTs to collocate at the LECs central offices. The collocation will give ALTs the opportunity to offer broad band service to large-volume users in the local loop and perhaps serve as the link between the end user and its designated interexchange carrier. Expansion of the ALT industry is predicated on access to a large revenue stream, which will supposedly enable the ALTs to attract capital [6]. However, long-term capital would not flow to the ALT industry if local utilities were able to cooperate and bring fiber to the local loop. With electric utilities as anchor tenants [14], a fiber-based local loop could be applied to integrated resource planning, video-conferencing, remote medical diagnostics, banking, and other retail services. The diversity of uses and customers would create a sufficient volume of service and cost reductions per service to make the ALT the highest-price provider.

Electric utilities, through their own telecommunication initiatives, have the potential to improve our communication infrastructure and change our economy. This potential is not new. It was highlighted in October, 1985 by one of the electric industry's major trade journals, ELECTRICAL WORLD. Over six years ago the magazine said:

> Are electric utilities poised on the edge of a new market? Right now, some have entered or are carefully investigating the fiercely competitive business of telecommunications. There are several potent reasons

> for this. The development of fiber optics technology is one [16,59].

What's happened since then? The commercial initiatives have focused almost entirely in the long-lines arena. Local efforts have focused strictly on using fiber for internal communication such as headquarter to field offices and communication between substations. With the exception of Georgia Power, there's been little effort by electrics to apply fiber to local or regional information flows. One reason for delay is the "Alphonse-Gaston" problem: learning by waiting - waiting for someone else to make the mistakes and take their lumps. Utility executives don't push far-reaching projects that bring new technology to the market because of the utility's inability to spread risk, and the uncertainties of cost and consumer reaction. The risk can be spread and the uncertainties overcome by establishing a broad-base of political support for technological change in local economies.

HUMAN RESOURCES AND FIBER OPTICS

I emphasize the value of broad political support because technological change under the auspices of regulated utilities is really a form of risk sharing with the general public and cannot be successful without consensus. Consensus is important because it's the only way to change the public's image of technology as something that doesn't give ordinary men and women the means to make a decent living, to get an education, and to have a future. Far less than half of the adult population in this country is college educated, and an even smaller fraction is computer or technology literate. Does this mean that a fiber-based local loop will be too complex, too sophisticated, and practically useless for much of our population? Absolutely not. Let's not do ourselves the disservice of underrating our own abilities and our own ingenuity. A 1986 campaign speech by Arkansas Governor Bill Clinton shows that ordinary people adapt to technological change.

> The other day I was at the Arkansas Eastman plant . . . it's a modern high-tech plant. I went up to this plant and I toured around and looked at all the antipollution equipment, and the guy was tellin me, 'All this is run by computers, and I want you to see the man who's runnin the computers.'. . . I didn't want to meet the guy running the computer because I didn't think I'd have anything in common with him . . . I thought he'd be some Einstein sitting up there like the wizard of OZ in some mysterious room . . .
>
> And there was the man running the computer, wearin' cowboy boots, Levi jeans, a western shirt, baseball cap, and . . . chewin Red Man. The first thing he said to me was ' I'm glad to see you . . . because we need more jobs like this.'
>
> That guy . . . was pure Arkansas but he was smart enough to know that his future depended on what he knew, not [on] what he could do with his back or hands [12,110].

Human resources adapt to and develop along with technological resources. In 1985 the Commission on Industrial Competitiveness submitted a report to the President regarding the decline in America's global competitiveness. According to the Commission, one cause for the decline is the United States' failure to develop our human resources as well as other nations [18,313]. One remedy for this problem would be a fiber-based local loop because it holds a tremendous potential for two-way interactive educational instruction between a teacher and a class, between a central station and multiple reception points. This has implications for public education via the size of school districts, budgeting, teaching methods, transportation, and other aspects yet to be identified.

When we think of partnership in the local loop, we should think of a new communications infrastructure, local as well as national, in the United States. The goal should be defined and agreed on today, and should be accomplished within 20 years time across the nation.

THE HIGH PERFORMANCE COMPUTING ACT OF 1991

My remarks focus on the local aspects of commercializing fiber networks and the role of states because they are the players that will develop mass markets, bring the technology to the ordinary person, and drive economic development. These aspects need emphasis because the federal government's vision of fiber is dominated by national defense priorities, basic research, and by concerns about basic research needed to support national defense. The federal government is not yet thinking about its role in transferring fiber technology to state and local governments; nor is there any recognition of fiber's potential contribution to economic development.

This is quite clear in Senate Bill 272, the High Performance Computing Act of 1991. It would authorize $1 billion for the development and use of new supercomputers, advanced software, and the creation of a national computer network. Of that $1 billion, $650 million is earmarked for the National Science Foundation (NSF), $338 million is designated for the National Aeronautics and Space Administration (NASA), and $31 million is earmarked for the National Institute of Standards and Technology (NIST). Other federal agencies involved are the Department of Defense (DOD), the Defense Advanced Research Projects Agency (DARPA), and the Department of Energy (DOE) [17,1].

In May of 1991, the Senate Committee on Commerce, Science, and Transportation issued its report on S. 272. The report envisions fiber as a part of a national high speed computer network linking universities, libraries, scientific agencies, defense agencies and the like. The computer network will be named the National Research and Education Network (NREN), an "industry-government-academia-partnership . . . for the rapid development of networking technology and its rapid dissemination [17,22]." The report explains the rationale for the federal funding of the NREN:

> By creating a national high-speed computer network, this bill would provide a demonstration of the

> potential of high-speed fiber optic computer networks. . . . At present, the private sector is reluctant to make the multi-billion-dollar investment needed to build a national multi-gigabit network, in part because the technology has not been demonstrated and the market has not been proven [17,7-8].

This is the "Alphonse-Gaston" syndrome again: The federal government will take the initiative and the lumps while private industry watches and learns. Regarding local applications of fiber the report says:

> In the future, this technology will be as commonplace and ubiquitous as the telephone is today. Fiber optic cable will reach every city and town, every school and business, large and small [17,7-8].

How will the commonplace come to be? Won't local and state governments face the same problem in developing local networks that the federal government recognizes at the national level? The report does not even hint at how and when ubiquity will be achieved. Unfortunately, the legislation does not direct the NSF to use any of the $650 million to fund projects that might identify and solve technological problems associated with fiber's applications in the local loop.

For example, long distance applications depend on single-mode fiber because of its speed. But multi-mode fiber, which is slower, might be more appropriate for local loop applications and perhaps more suited to the rapid transfer of information over short distances in a heavily congested area. The NSF is most likely to fund projects that move gigabits across the country, for example, from Edwards Air Force Base to NASA's Houston Center to the Cray computer at the University of Illinois. Without some expression of self interest on the part of the states, there won't be funding for fiber-projects that speedily accumulate bits into gigabits and then ship the accumulation from one side of a metropolitan area to a metropolitan energy control center. Optimal applications of fiber to the problems of sparsley populated states are unlikely to be developed.

Apparently Japan has made a commitment to universal fiber optic service, including the local loop, because the report on S. 272 also says:

> Japan's Nippon Telegraph and Telephone Corporation has announced that it intends to invest $126 billion to install a national fiber optic network which would reach every home, office, and factory in Japan by the year 2015 [17,8] . . .

Unfortunately, nowhere in S. 272 is there any reference that this country should make a similar commitment or how it could be achieved. The federal government's role in fiber optics must be supplemented by efforts of the states and local utilities to bring the technology to the general population.

Senator Albert Gore, the prime sponsor of The High Performance Computing Act of 1991, describes the bill as creating an "Information Superhighway." The psychology of selling a new idea, of persuading the skeptics, is always revealed by the words chosen to convey the idea. The highway analogy brings up the image of many users, all kinds of users, all types of uses, and equal access for all. It doesn't mean a royal road used by a king and courtiers, or a road travelled only by the defense establishment. The supporters of the information superhighway must do their absolute best to involve the states wherever possible and to communicate all the lessons learned. This certainly provides an opportunity for the federal government to assist state and local governments with technology transfer. Without broad-based political support, efforts to improve our nation's infrastructure through technology can easily appear as abandonment of ordinary people in ordinary jobs. I hope this image does not settle upon The High Performance Computing Act of 1991.

THE FIRST ENERGY-OPPORTUNITIES FOR FIBER OPTICS

The states would benefit from the federal government's information superhighway if the lessons learned could be applied to energy efficiency activities of the states and the local energy utilities. Title IV of the Clean Air Act Amendments of 1990 has placed energy efficiency and least cost planning issues directly before state regulators and local utilities. These issues will be argued over and resolved at the state level, not at the federal level. I say this because any effective energy efficiency and least cost planning program requires a sound knowledge and understanding of local conditions. This is where the local distribution companies and the power companies enter the picture. They know their own locale's energy consumption patterns and energy supply sources. The state utility commissions, state energy offices, and state environmental agencies also have a good understanding of these conditions. The federal government could never fashion a generic plan that would fit the variety of conditions in the different states.

The utilities' efforts to develop an energy efficiency strategy will be the first opportunity for the widespread commercialization of fiber optics at the local level. These investments can easily be a part of a utility's rate base if state regulators and the utilities establish mutually acceptable criteria and incentives for making fiber optics a prudent investment.

The other parts of the solution are cooperation from the local exchange telephone companies (telcos) and the CATV companies. Each has the opportunity to advance or impede the spread of fiber through the loop. The telcos have a large amount of copper plant that is not yet depreciated, and the industry prefers price-cap incentive regulation rather than rate base regulation. CATV has an established market that is not regulated. There's no reason to expect either industry to join any cooperative effort bring fiber to the loop even though fiber would provide the same functions while greatly expanding the capability for new services and economic growth. What's needed at the federal level is way of fashioning a compromise between these competing economic interests.

Industry, political, and community leaders have to ask themselves how long they're willing to wait before affordable fiber optics reaches their towns, their businesses, and their homes - 10 years or 50? The watchword in today's economy is "innovate": Large firms, small firms, government, education. A true partnership in the local loop means innovation, starting a process in which the players change, merge, and dissolve until there's a new local loop and a new controlling organization. As long as we continue to push for beneficial change in our economy, there's no reason to keep the local loop sacrosanct, to keep it the same.

CONCLUSION

This country needs economic growth, revamped human capital, and innovation. Right now our local communication needs and services are splintered into tiny pieces where electric, gas, water, telephone, CATV, and microwave-wireless tv companies are delivering "innovative" services to and collecting information from the same consumers. No single company can unify this market. Is this diversity economically efficient, and can the country afford the capital investment for all of these operations? The answer is no in both cases. The editor of the Harvard Business Review recently expressed the right cautionary sentiment about innovation when he wrote: "Nothing is more wasteful than doing with great efficiency that which should not be done [8]."

The continued service unbundling and the simultaneous growth of business niches in local and statewide communication markets are signs of foregone scale economies and near-duplication of physical plant. Now is the opportune time to reverse these trends by forming partnerships that bring fiber to the local loop.

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FROM AUTOMATIC METER READING TO FIBER OPTICS: CREATING A LOCALLY ORIENTED UNIVERSAL DATA TRANSMISSION SERVICE

by

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FROM AUTOMATIC METER READING TO FIBER OPTICS: CREATING A LOCALLY ORIENTED UNIVERSAL DATA TRANSMISSION SERVICE

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INTRODUCTION

I am an advocate of Automatic Meter Reading (AMR) because I believe this service naturally calls forth a multi-utility and, therefore, a comprehensive approach to the development of an emerging industry in the United States: localized data transmission services to and from the customers' premises. AMR is the working laboratory that will guide an infant industry to maturity. The remote meter reading project in Des Moines, Iowa, which involved common efforts by the local water, gas, electric, and telephone companies, provides an opportunity to accumulate experience about cooperative behavior of different utilities.

I've always supported the idea of joint activity across different kinds of utilities, but the experience in Des Moines has persuaded me that a multi-utility approach will not come easily. The major roadblocks in order of importance are organizational, economic, and technological. For your information, I've provided copies of staff's summary report, a summary letter by the local water company, the electric company's interim and final reports, and the gas company's interim and final reports. The information provides technical detail that may be useful to you, but it also conveys two important organizational behavior messages:

1) Top management must be committed to the project for it to succeed; and

2) Even though the goals of the different companies may overlap, each utility tends to emphasize that its own problems are unique and therefore require a unique solution that only the utility itself can provide.

These attitudes make or break a multi-utility project. Despite these barriers it's clear that the electric, gas, water, telephone, and cable TV companies have a common need for data transmission services, both to and from the customers' premises. This common need should be the basis for developing a local-purposed unified data transmission service. It could be provided on a localized or regional basis by a specialized organization representing the interests of all the companies without changing the nature of the services received by the customers. I believe this would benefit the companies and the consumer for two reasons:

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[1]The opinions expressed in this paper do not necessarily reflect those of the Iowa Utilities Board.

1) Intensive use of a single service should create a large enough demand to create scale economies for the service's inputs thus leading to lower input costs and a declining marginal cost of service; and

2) There should be collective savings achieved across the utilities and the cable TV companies when duplicative services are eliminated.

These two goals can be reached through fiber optic deployment in the local telephone loop. Fiber would replace the loop's existing copper plant. I'm going to explain why digital service offerings based on the copper plant will be unacceptable to energy utilities, why telephone companies (telcos) will be subject to conflicting forces about the advisability of fiber deployment, how multi-utility ownership of a local fiber system would promote its deployment, and what the regulatory community can do in a positive way to promote a local-purposed unified data transmission service.

SOURCES OF RESISTANCE TO COOPERATIVE BEHAVIOR ACROSS UTILITIES

Multi-company ownership of electric transmission lines and electric generating plants are examples of joint cooperation between companies within the same industry. Although there are multiple owners, normally only one is designated as the operating or managing partner. Joint ownership is an effective way of spreading the risks of investment across several companies' services rather then letting the risk accrue to a single company. The same principles would apply to joint ownership of fiber optics deployed in the local telephone loop. The risks of investment would be spread across all utilities that would use the fiber rather then letting the risk accrue only to the telephone company.

<u>Current and Near Term Digital Service Offerings by Telcos Will Not Be Used by Energy Utilities.</u> Replacing the loop's existing copper plant with fiber optics will lead to a broad band Integrated Services Digital Network (ISDN), a service that provides "universal, extremely flexible very high speed transmission of voice, data, and broadcast quality video."[2] The ISDN in place today <u>is not</u> broad band. The ISDN that we hear about today is actually a narrow band type, with two different kinds of services, Basic ISDN and Primary ISDN. In practice and with regard to AMR, today's ISDN is simply a data transmission method that competes with the AMR technologies utilized by gas and electric companies: radio signalling devices and electric power line carriers. Today's ISDN stands little chance of capturing the energy utilities as major and long term institutional users. The Des Moines project demonstrated that the local energy utilities wanted not only AMR but other things as well.

[2] Block, Ellen G., "ISDN: The Telcos Are Ready, But Are The Users?" <u>Telecommunications</u>, 31-40 (1989) May.

For example, in its final evaluation the gas company stated "... [the] system presently will only obtain gas usage data. Other considerations such as gas leak or carbon monoxide detection, pipe-to-soil potential data, tamper detection, or operation of valves are not possible..." The company also wanted "encryption techniques to protect against unauthorized use and [to] assure data privacy ... [in order to] eliminate potential problems associated with access to customer data by several users of shared automatic equipment."[3] The power company's final evaluation contains these statements: "... [the] system will obtain only energy usage data. The system is not capable of such functions as direct load control, time-of-use metering and feeder status ... [the] service territory is served by numerous telephone companies and not all have the capability to operate and maintain a Subscriber Line Access Controller Unit (SLAC) ... [the company is] leasing telephone service [and] is not in a position to control costs associated with the communication system ... in an automated distribution system which uses power lines as a carrier, remote metering is just one function of a multi-functional system. Automated distribution is attractive ... because of the possibilities of remote metering, load management, capacitor control, etc."[4]

These examples demonstrate the strong reluctance by both of Des Moines' utilities to cooperative undertakings; the power company in particular objected to any kind of dependence on the phone companies. The phone company's price derivation methodology was filed on a confidential basis as were the costs and revenues. I've read this information, and I can't tell you anything more than that. The water company has never had the opportunity to examine the phone company's price derivation.

However, I can tell you about the following information that's taken from nonconfidential documents written before the project got underway. The telephone call to the water company's meter was to be made during the evening or late night hours and with an estimated duration of approximately 15 seconds. The phone company was considering the following rates: a special one time charge of $5750, a monthly charge of $405, and time of day rates of 20 cents per minute in the peak period, 15 cents per minute in the evening period, and 10 cents per minute in the late night. The per minute figures translate into hourly rates ranging from $6 to $12. This at least gives you a basis of comparison.

The confidentiality aspects certainly make cost comparisons difficult, lend substance to the power company's fear about uncontrolled communication costs, and explain why the energy utilities will continue to ignore narrow band ISDN. But this fear of cooperative behavior can be overcome by

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[3] Midwest Gas, "Neptune Information System Central Meter Reading Pilot Program Final Report," Utilities Division, Iowa Department of Commerce, Docket No. PRP-86-9. The final report was filed January 12, 1990.

[4] Iowa Power and Light Company, "Neptune Information System Central Meter Reading Pilot Program Final Report," Utilities Division, Iowa Department of Commerce, Docket No. PRP-86-9. The final report was filed August 21, 1989.

developing a new and local technological infrastructure based on joint ownership of fiber optics deployed in the local telephone loop. Yet this strategy could upset the established interests of those organizations most familiar and most enamored with fiber optics -- the cable TV companies and the telcos. Deployment of fiber optics would do two things simultaneously:

1) It would permit entry into the home entertainment currently monopolized by cable TV companies; and

2) It would be a threat to the narrow band ISDN investments already made by the telco industry.

I'm going to elaborate on each of these points.

Resistance of Cable TV Companies and Telcos to Fiber Optic Deployment in the Local Loop. The emergence of fiber into the local loop could be retarded or prevented by incipient competition between the cable and the telephone companies. Even though telephone companies are prevented, by law, from owning cable TV firms and developing TV programming, the cable industry sees deployment of fiber in the local loop as a step towards eventual TV programming by telephone companies and as the telco's main bargaining chip for a quid pro quo: if the telco offers common-carriage fiber optic transport to all users, then in return the telcos expect to have free entry into TV programming. To stop this development, the cable industry warns that local telephone users will end up subsidizing programming. Therefore, the cable industry takes the position that video service by itself is an insufficient justification to substitute fiber optics for coaxial cables.[5]

However, before anyone jumps to the conclusion that telcos immediately intend to capture the cable TV market by offering broad band ISDN, let me tell you what I believe their current strategy is with regard to deployment of ISDN services and how this connects to their vision of AMR services.

Currently offered ISDN services work on today's existing local loop: the dedicated pair of copper wires running from the subscriber to the serving central office. The companies do not necessarily want to change out this wire pair to a fiber cable. Perpetuating the usefulness of copper plant in an ISDN framework is achieved through what the telcos refer to as Basic ISDN service, commonly referred to as the 2B + D package. The B channels operate at 64 kilo bits per second (kbps) carrying digital information, while the D channel operates at 16 kbps carrying signaling information, packetized data, and low speed telemetry (100 bits per second) at times when no signalling information is required.

Telcos Hypothesize that Energy Utilities' Data Transmission Needs Will Be Low Speed and Therefore Be Met by Telcos Cooper Loop Plant. From the presentations that I've heard, it's clear the telcos are hypothesizing that

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[5] These points were made by Mr. Michael Schooler of the National Cable Television Association in his presentation at the Mid-America Regulatory Commissioners Conference, June 26, 1989, in Chicago.

AMR and a whole host of other services, such as alarm monitoring and smart-house services, will be low speed telemetry-type services and that these services will never challenge the data carrying capacity of Basic ISDN. All of this is clearly laid out in a Bellcore Special Report SR-NPL-001108 entitled, "How to Make Telemetry Transport Compatible with ISDN." This report, in addition to a very good presentation by Bellcore's Mr. Howard Scott which he gave at the Automatic Meter Reading Association's First National Symposium on September 9, 1988, is now a good indicator of industry thinking. The theme of the report and the presentation is to lay out the technical steps necessary to ensure compatibility between Basic ISDN and AMR.

However, I disagree with the report's fundamental assumption that AMR needs can be met by low speed data transmission. My own opinion is that high transmission rates will be needed. The rate design needs of electric, gas, and water utilities are supposed to let people's reactions to prices determine the timing and quantity of resource consumption. A good example of a data-intensive rate design need is a dynamic peak load charge: a dynamic capacity charge captures a customer's contribution to the utility's peak, daily or monthly, coincidental or noncoincidental, even though the peak may shift to different hours on different days. The least-cost-planning mode for electric utilities will lead to extensive and perhaps even intricate demand control programs that far exceed the need for mere monitoring of the on-off profile of appliances and machinery. Finally, while alarm monitoring requires only low speed bit rates, is it safe to assume that smart-house technology will always be a low speed data transfer user?

<u>Consequences of Low Speed Telemetry Assumption - No Fiber Optic Deployment and Prolonged and Ineffective Competition Between Alternative Data Transmission Services.</u> The assumption that AMR and other utility data transmission needs will never evolve beyond low speed applications removes a major incentive for deployment of fiber optic cables in the local telephone loop. Thus, private markets may never deliver the potential technological and economic progress achievable through fiber optics. This progress will occur only if industries and regulators adopt an integrated approach towards data transmission services to and from the customers' premises. Otherwise high speed transmission will be held hostage to a wasteful economic competition, one that fritters away data transmission scale-economies while each industry pursues its own goal to promote such technologies as:

1) AMR through Basic ISDN offered by the telcos;

2) AMR through power line carriers owned by the electric companies;

3) AMR through radio signaling devices owned by the gas companies; and

4) AMR through coaxial lines owned by the cable TV companies.

There is no assurance that the competitive struggle between these services will be short, sweet, and painless. It could go on for years with different technologies capturing different regional, industrial, and residential markets. The net result would be a lack of uniformity across the country and a crazy-quilt pattern of services and compatibility issues. This would be a set back for the common carriage data transmission business because transmission capabilities of these technologies are tiny. Fiber optics will have a transmission capacity of 150 mega-bits per second (mbps); this is nearly 150 times greater than Primary ISDN capacity and nearly 1500 times greater than Basic ISDN capacity. The examples I've referred to above are already in place and spreading across the country. There will be financial and political pressure exerted to prevent such investments from becoming economically obsolete, from becoming "stranded investment."

Economic Obsolescence of Basic ISDN. The possibility of economic obsolescence for Basic ISDN has already been raised by at least one telephone industry observer. An article authored by Ellen G. Block and appearing in the May 1989 edition of Telecommunications led with this theme statement: "As narrowband ISDN gears up for delivery, many are questioning whether the massive investments in time, manpower, and capital it necessitates might not be better spent on broadband ISDN." I think this sentiment will grow among the state regulatory bodies and among those companies that have not yet made major commitments to narrow band ISDN. There will be forces in the marketplace and in regulatory institutions that will applaud the telco industry for shifting its long term capital investment to broad band ISDN additions in the local loop. If this shift occurs, and if all local utilities provided capital input, there would be no economic or technological reason for the electric, gas, water, and cable TV companies to retain their separate data transmission systems to and from customers' premises.

Resolving Consumer Advocates' Fears. Fiber optics in the local loop would definitely improve the technical capability of the telephone infrastructure. But there are consumer protection arguments against this improvement:

1) No one knows what practical benefits fiber optics bring to the ordinary telephone user;

2) Improving the telephone infrastructure without clear benefits to the captive users is nothing more than gold-plating and a detriment to the nation's economy; and

3) Improving the telephone infrastructure provides an easy opportunity for the regulated sector to subsidize nonregulated or nontraditional functions [the cable TV industry's fear].

These arguments could be resolved if all of the various data transmission functions for utilities and cable companies were achieved through a fiber-based ISDN that was supported by capital investments from all of the affected companies. This is the heart of a cooperative approach. Thus, the financial risk of fiber optic investment in the local loop would be spread from the telcos to the other parties as well. The investment would be economically viable because of the collective savings achieved across the utilities and the cable TV companies. This approach means that the data acquisition and transmission activities of the different service providers would have to be combined into a centrally managed consortium or jointly owned subsidiary, where each service provider contributed investment capital in specific portions while sharing expenses in the same proportion. Profits could be shared in a similar way.

POSITIVE ACTION BY REGULATORY BODIES

The regulatory community could take a positive leadership role in the following ways:

1) By establishing the legal presumption that jointly owned fiber-based data transmission services are prudent investments;

2) By treating local loop fiber optic additions as rate base items for all participating utilities;

3) By awarding higher rates of return to jointly owned data transmission investments;

4) By encouraging broad band ISDN services to embrace every conceivable user and every possible use;

5) By imposing no limitations on the kinds of uses and kinds of users that would employ broad band ISDN;

6) By agreeing with the industries before hand which services would be regulated and which would not; and

7) By agreeing that regulated services pay for a reserve margin bandwidth.

A specially organized local or regional consortium of companies offers several organizational advantages:

1) Duplicative data transmission functions and single purpose networks would be eliminated;

2) Standard communication protocols and standard manufacturing specifications consistent with the principles of Open Network Architecture would be enforced at the local level;

3) The companies or the consortium would easily attract capital for long term investments because a monopoly market would be free from the cyclical swings and insecurities that typify competitive situations; and

4) A reduction in financial risk.

The quid pro quo for the utilities, the telcos, and the cable TV companies is a nearly guaranteed share of profits from the development of a new technology infrastructure within the country that would last for decades. The payoff for local economies is the availability of new technology to all segments of the public -- a return to the utility concept of universal service. I hope that each of you will take some time to mull over these ideas as your subcommittee work progresses. In the meantime, we should all watch the developments of ISDN and data transmission services by utilities.

STRATEGIC PLANNING CONSIDERATIONS FOR THE AMR INDUSTRY IN THE 1990s

by

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INTRODUCTION

Today the automatic-meter-reading (AMR) industry is a loose collection of vendors and utilities from the gas, electric, telephone, and water industries.[1] AMR is not yet dominated by any single firm, industry, or particular method of remotely acquiring metered data. This lack of dominance will end within the decade. By then, a firm, an industry, and a data retrieval method will emerge to dominate the AMR industry; a number of today's players will disappear, especially those who believe that AMR means reading a meter once a month and nothing more. If you think of AMR in this way and dismiss a bigger picture as "futuristic, an egg-head's way of wasting time," then your AMR future is truly a dead-end. If you want a long-term future, then you'll have to adapt to the changes in the technical and economic environment surrounding the AMR industry.

Successful adaptation requires vendors and utilities to consider and take action on these strategic items:

integrate AMR with load management to take advantage of the load management market in the electric utility industry;

recognize that a recent U.S. court decision has given local exchange telephone companies a competitive edge in the AMR market;

plan for the possibility that capital funds will be in short supply to finance AMR vendors which seek expansion of production and marketing;

understand AMR's role as an aspect of technological innovation that creates economic growth.

All of these will affect the AMR industry, particularly load management.

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[1]The opinions expressed in this paper do not necessarily reflect those of the Iowa Utilities Board nor those of the Automatic Meter Reading Association.

THE LOAD MANAGEMENT MARKET IN THE ELECTRIC UTILITY INDUSTRY

There will be a long-term and secure market for load management in the electric utility industry because America's power-plant technology has stagnated. The production and delivery of electric power is composed of three distinct phases: Generation, transmission, and distribution. The generation sector was the main source of scale-economies and cost reductions that characterized the electric industry from 1900-1965. Since 1965 the electric industry has been unable to increase the efficiency and size of power plants; the industry cannot look forward to power plants as a source of cost reductions. This stagnation cannot be offset by improvements in transmission technology. Consequently, the distribution sector is ready for massive applications of technology that control and manage the end user's consumption. AMR software and hardware is aimed at the distribution sector; load management is a distribution function. AMR products should include load management capability. The need for load management is evident from electric industry statistics about power plant operations.

For example, power-plant thermal-efficiency, the rate at which fuel input is converted to electric output, has not improved for 25 years. In 1947 the nation's stock of power plants had an average thermal efficiency of 21.7 percent, which improved to 32.7 percent in 1965 and then leveled off. The improvement meant an efficiency gain and a cost reduction of one-third. The same pattern applies to the best new power plants. In 1961 the best new plant in the country had a thermal efficiency of 40 percent. By 1977 the best new plant had a thermal efficiency of 36 percent [5,90-91].[2] Achieving a thermal efficiency of 40 percent requires a plant's boiler to produce steam at temperatures above 1200 degrees fahrenheit. But those temperatures cause metallurgical problems in boiler pipes and turbine blades. They corrode quickly, breakdown, and cause plants to be out-of-service. Throughout the 1970s and into the 1980s large power plants of 600-1000 MW operating at high steam temperatures were out-of-service much longer than smaller plants operating at lower temperatures [5,96-97].

These technological limits are permanent; they will continue to prevent the electric utility industry from achieving any scale-economies from new power plants. The electric industry cannot promote electrical consumption while simultaneously lowering average costs. In fact, the overriding goal of new-power-plant design is not improve efficiency, but to minimize the plant's impact on the environment. Therefore, the market for load control will not be threatened by new power plants, and the electric industry will always be called on to manage consumption at the distribution level. This is exactly where load control is cost effective and explains why AMR software and hardware should incorporate load management capabilities. Although power-plant technology is stagnate, it's not the only force behind load management; federal environmental legislation and state energy policies are also pushing the electric utility industry to manage the public's consumption of electricity.

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[2] The first number in the brackets refers to the item in the reference list; if a second number appears it refers to page numbers.

Title IV of the 1990 Clean Air Amendment Act is aimed at reducing acid-rain precursors. This is common knowledge. What isn't widely known is the congressional effort to tax all fuel consumption on the basis of the fuel's carbon emissions. Any productive enterprise that depends directly or indirectly on coal for energy input, such as electric utilities and their customers, would bear a substantial burden from a carbon tax. Although the carbon tax legislation was stalled last year in a congressional subcommittee, a carbon tax in some form is likely to gain eventual acceptance. This is one more reason to engage in load management.

State utility commissions and local utilities provide another incentive. They're dealing with energy efficiency and integrated resource planning issues for their own locales. State commissions definitely consider load management as part of integrated resource planning. It's not far-fetched to imagine AMR and load management equipment being an approved part of an electric utility's rate base. Approval of a combined AMR-load management package is more likely than approval of AMR as a stand alone product.

In sum, there are three factors that build a strong case for combining AMR and load management capabilities: The stagnation of America's power-plant technology, the federal government's environmental legislation, and state energy policies. However, none of these factors relate to the actual communication method used to transfer information between the energy producer and the end user. To address communication methods, the AMR industry has to understand and adjust to the revolution in the local communications markets.

THE REVOLUTION IN LOCAL COMMUNICATION MARKETS

The AMR industry will be significantly affected by the July 25th, 1991 decision of Harold Greene, the U.S. District Judge in Washington D.C. He gave the nation's seven regional telephone companies, the so-called Baby Bells, permission to sell information over the companies' own telephone lines. There's no limit to the kinds of information that can be sold: Home shopping, home banking, stock quotes, classified advertising, electronic Yellow Pages, and anything else you can think of. If the telephone companies succeed in developing a large volume of traffic in their local loop, it's entirely possible that AMR services would be added to that traffic at a low incremental cost. This gives the local telephone exchange companies a competitive edge in the AMR market. How could this edge be exploited?

I believe the first reaction of vendors and the water, electric and gas industries would be to say that there is no competitive advantage; they would strengthen their reliance on radio and power-line carriers as transmission mediums. You might say to yourself that the net result will be no change; the status quo will be maintained, my company can outlast this. But think again.

Imagine a situation in which a Baby Bell, seeking higher profits and opportunity for expansion, becomes a controlling owner of a meter manufacturer. With just a little effort and innovation, by the year 2000 the Baby Bell's company could make a device, not necessarily a meter, that measures electric, gas, and water consumption by time of day. Perhaps the device stores the information while waiting for remote interrogation by phone. Maybe the device has some load control capability as well, serving as a relay point for signals between appliances and a district energy control center. Why can't the Baby Bell's company sell the device to the utilities; why wouldn't they buy it? Would the best of all worlds be where the telephone company sells meter-like devices to utilities which then use telephone lines to conduct load management and measure consumption? Just because this hasn't happened in the past, doesn't mean it can't happen in the future. A Baby Bell would definitely have the potential to dominate the AMR market if the company acquired a meter manufacturer.

If you don't think the situation I've just described is the best of all worlds, then you'd better start saying why, and you'd better have some alternative scenarios ready for the policy-makers at the state and federal levels of government. Here's why. There's going to be increasing pressure to centralize communication functions in local and regional economies, whether those functions are for electric, water, gas, video, or voice quality communications. The pressure for centralization will increase for financial reasons.

FINANCIAL REASONS FOR CENTRALIZING LOCAL COMMUNICATION FUNCTIONS

Since the mid 1970s there's been a growing shortage of domestic capital relative to investment demand. The gap is being met by foreign banks and investors. They provided 21 percent of all debt funds during 1988; in 1979 they provided only 4 percent of debt funds [2]. If these lenders had not been willing to invest in the United States' markets, the country's recession in the early 1980s would have been prolonged. As the Federal government's budget deficit grew in the 1980s, foreign governments and investors saw the security of their investments threatened. They played a major role in convincing the Bush Administration to adopt the tax increase of 1990. Higher taxes and an increased wariness by foreign investors means that capital funds are becoming scarce.

What does this mean for an AMR vendor trying to finance a major expansion of production and sales? Unless the company already has plenty of equity capital and a nearly guaranteed revenue stream, banks and potential bond holders will be very unlikely to lend capital to the company. Consequently, the vendor burdened with a lot of debt and trying to position itself to take advantage of growth in the AMR market will have a very hard time raising capital for expansion of production and marketing. There will be insufficient private capital to finance a multitude of single-purpose communication investments.

In addition, don't expect the Federal Reserve Board (Fed) to make capital funds any more accessible. Even though long-term government bond rates have dropped in the past six months, the Fed considers its primary goals as price stability and low inflation rates. Under Alan Greenspan, "money growth has averaged slightly more than 4 percent annually, the lowest level in 30 years [7]." This policy will certainly continue if the

Bush Administration is reelected. Expect capital funds to be in short supply through 1996 and probably longer.

Given the shortage, our domestic capital markets cannot support a continuing proliferation of business niches in local and statewide communication markets - where electric, gas, water, telephone, CATV, and microwave-wireless tv companies deliver service to and collect information from the same customers. Decision-makers in regulatory agencies, when confronted with a stream of separate requests to approve single-purpose local communication networks, will ask each utility a series of questions: Can scale-economies be achieved by centralizing communication functions over a common path? Is the current diversity of communication paths economically efficient? Have you performed any studies that compare the cost of the single purpose network with the incremental cost of adding your functions to a common network? Can the local economy afford the capital investment for all of these single purpose networks? These questions will be asked with increasing frequency because of the country's poor performance on economic growth and because AMR technology has been commercialized much too slowly.

ECONOMIC GROWTH AND THE SLOW COMMERCIALIZATION OF AMR TECHNOLOGY

Economic growth stems from cost savings, from finding a more efficient and cheaper way to accomplish a task. The utility industries will adopt AMR technology on a broad scale when the technology is judged to be a cost saver. You've seen what's happened in power-plant technology; don't expect cost savings from new power plants. There could be cost savings by applying AMR and load management technologies to the electric distribution network. But nothing's definite yet about the transmission medium for these technologies. It could be radio, power line, or phone. Remember Judge Harold Greene; he's given the Baby Bells permission to increase local loop traffic by selling all kinds of services. There's a definite possibility for cost reductions through intensified use of the local loop.

This potential has a great appeal for policy-makers. They know that the United States has fared badly in terms of economic growth. Since 1973 America's average rate of business productivity growth has ranged from 0.3 to 0.6 percent annually, while Japan's has ranged from 2.8 to 3.2 percent annually. Western Europe's growth rates have ranged from 1.2 to 3.5 percent [3,10]. Western Europe's lowest productivity growth rate is twice that of the United States' best performance. Paul Krugman, who works right here in Boston and who is also one of the nation's most prominent economists, says "The two decades since 1970 have seen the worst U.S. productivity performance of the century [6, p. 12]." Productivity growth is important because it is the only way to raise living standards [6, p. 10].

Economic growth and productivity are important issues because they affect living standards, profitability, and the ability to compete. There's no doubt in my mind that AMR issues will reach government and regulatory arenas. To prepare for this, vendors and the electric, gas, and water industries should ask themselves this question: Do the regulatory institutions associate my product and my functions with cost savings and economic growth? If not, then who is associated with cost savings and economic growth? You may not have the same answer I do, but here's my opinion. After 8 years in the power business and 5 years on the regulatory side, there's no question in my mind. More than any other player in the AMR market, the telephone companies are strongly associated with economic growth and productivity because much of the nation's capital investment flows to them and because they are major users of new technology.

I am not saying that this image is correct in fact. I'm just saying that's the impression. I started off my discussion by saying that AMR is not yet dominated by any single firm, industry, or particular method of transmitting data. I also said this lack of dominance will end within the decade. The proponents of power-line and radio-based AMR technology are going to have an uphill battle to capture or expand their AMR market share. This doesn't mean that they should stop their efforts before they start, but they need to send a message to the policy-makers. Here's one that might be useful.

Using the telephone companies to centralize communication functions in local and regional economies is like putting all your eggs in one basket. There's not much information available to judge the quality and performance level of the telephone company's local loop. While it's sufficient for voice grade communications, there's absolutely no assurance that the loop can provide the reliability needed to ensure a steady and accurate flow of information to the water and the energy utilities regarding time-of-day consumption and load management. If the goal is to apply cost-effective technologies to the distribution sectors of the energy and water utilities, these utilities will be more effective if they bypass the local exchange telephone company. Why? Because there's no assurance that the telephone industry will continue to apply new technology in the local loop.

For example, John Coleman of the New York Commission recently completed a report on AMR. Near the end of the report he cites a July 1972 article from _*Public Utilities Fortnightly*_ that said: "'Automatic remote meter reading systems using the switched telephone network are presently in an advanced stage of technological maturity [3,IV-16].'" From 1972 until the middle 1980s the telephone industry expended little effort to commercialize AMR technology or promote an AMR market. Why should telephone industry have a permanent change of heart now?

The Baby Bells commitment to the AMR market is indeterminate. Their current activities **may or may not** indicate their intent to upgrade the local loop and apply new technology. This typifies a larger problem in our economy. Contrary to popular belief, American business is really quite slow and reluctant to apply new technology to business problems. This reluctance is a major reason for the country's slow economic growth. In 1988 the Brookings Institution published a major study on America's economy titled, _Innovation and the Productivity Crisis_. The authors said:

> Our research strongly supports the idea that productivity slowdowns took place . . . because . . . industries failed to take advantage of technology that

> was potentially available. Slow growth in the United States has reflected missed opportunities [1,105]

The authors also suggest a way to resolve the problem. Encourage coalitions of private companies to commercialize technology, ease government obstacles to joint ventures, and provide some public funding [1,v]. This idea received support from a powerful figure in the high-tech industry, Robert Noyce (now deceased), co-inventor of the computer microchip and CEO of Sematech, a consortium of 14 semiconductor manufacturers and the U.S. Defense Department.

In testimony before the Senate Judiciary Committee's Subcommittee on Technology and the Law, Noyce cited the National Cooperative Research Act as an example of the government fostering a cooperative business environment. Noyce further suggested that antitrust laws be changed to reflect contemporary economic conditions.

> Industry is taking the lead in identifying and developing joint production ventures in the United States and I believe government should support those efforts. An essential element of support should and must come in the form of revised, updated antitrust laws [8,10].

The message for the players in the AMR industry is that you don't necessarily have to fight each other for a market share. Market domination by one industry is not inevitable. If you're willing to cooperate with each other through joint ventures, you'll improve your odds for surviving the transition coming to the AMR industry. Joint ventures are an appropriate way to reduce everybody's risk, and to let all players have a share of the expected growth in local and regional communication markets, whatever information-transmission medium prevails.

CONCLUSION

Don't think of AMR as remotely reading a meter once a month and nothing more. If you do, AMR technology will never have the constituency needed to support broad application and acceptance throughout the United States. AMR technology has been around since 1972, but a group of supporters has emerged in only the past five years. The inactivity in the 1970s and early 1980s is evidence of what a small perspective can do. There's no interest, no research, no investment, and no economic growth.

AMR is an opportunity to bring technological improvement to the American economy under the auspices of utilities. But this is also a form of risk sharing with the general public and cannot be successful without consensus within the AMR industry. Standards must be agreed on to stop the endless diversity of products and protocols. This highlights the importance of the AMRA/IEEE standards committee; its success is vitally important to establishing consensus within the AMR industry. Without consensus, the industry will continue to drift and never gain general acceptance from utilities and the public.

John Coleman's report again provides an appropriate example. He cites a 1989 study by the Long Island Water Corporation regarding AMR:

> 'with the lack of technological maturity in the various [AMR] options analyzed[,] combined with the inability to obtain adequate assurance of vendor reliability and viability over the long[-]term, and the substantial financial impact on the Company, regardless of the option chosen . . . the company should continue to monitor and review developments in this area until the automated meter reading industry is stabilized [3,IV-16]'

This kind of judgment will stop only when there's a consensus within the AMR industry, whether it's accomplished through cooperation by many firms or by domination of one firm or industry. If the industry does not pick cooperation, then regulatory institutions will step in to assure dominance and integrate the technology into the nation's economy. The alternative is a painfully slow commercialization of AMR technology and another missed opportunity for efficiency gains, cost savings, and economic growth. That's not a future anyone should look forward to.

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Public-Good Theory and Bargaining Between Large and Small Countries

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Olson's theory of exploitation in public-good situations says that large countries are exploited by small ones with regard to the cost-benefit ratio of public goods. The policy implication of this theory is that small countries need not cooperate with large ones about the provision of public goods. With regard to groups that are formed to increase the supply of public goods, the larger the size of the group, the more it will fall short of providing optimal amounts of public goods. This theory has been applied to international organization and supposedly explains why small groups are more successful than large ones in providing themselves with public goods. However, the analysis here shows that large and small countries may exploit one another. This is shown by concentrating on the reaction process in public-good theory, a concept that permits testing of the exploitation thesis. The results demonstrate that mutual exploitation may lead to economic cooperation between large and small countries about public-good supplies. Economic cooperation requires the presence of several public goods; therefore, an organization's success in providing public goods may not necessarily be a function of group size. Instead, success may be a function of the number of public goods the organization supplies.

The economic theory of public goods has been applied to the study of various topics. One notable application is that of Olson and Zeckhauser (1966), who use the theory to investigate the pattern of countries' defense expenditures related to their membership in the NATO alliance. To the member countries,

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this alliance provides a public good: deterrence of armed attack by the Soviet Union on any and all NATO members. However, in public-good theory there is a concept known as the reaction process, whereby one country reduces its production of the public good when another country produces the same good. This process is mutual on the part of all countries that provide the good.

In the model that guides the investigation of the NATO alliance, Olson maintains that the country with the relatively larger output prior to the reaction process always bears a disproportionately larger share of the cost of providing the public good relative to a country with a smaller output before the process. According to Olson (Olson and Zeckhauser, 1966: 270; Olson, 1971: 29, n. 46), this is necessarily correct, despite the income effects of public goods that alleviate the degree of disproportionate burden sharing.

Thus, Olson (1971: 29) concludes that in a public-good situation "there is a systematic tendency for 'exploitation' of the great by the small." By "exploitation" Olson means that the larger country's ratio of cost to benefit is higher than that of a smaller country. The policy implication of Olson's model is that small countries have no incentive to cooperate with large ones when providing a public good. Thus, any cooperation elicited from small countries is likely to be induced rather than voluntary.

From his model, Olson draws a corollary about group size and the relationship between group size and optimal supplies of public goods: "The larger the group size, the farther it will fall short of providing an optimal amount of the collective good" (Olson, 1971: 29). Of course, this implies that the smaller the group, the closer it will be to providing itself with the optimal supplies of public goods. Russett and Sullivan (1971: 859) have applied this corollary of public goods theory to international organizations. They write that group size "may explain the apparent greater success of many small, especially regional international organizations" when compared to big ones. Furthermore, they emphasize that this supports traditional theories of international organization, which stress a role for regional units as "constituent and permanent elements of a World Government structure" (Russett and Sullivan, 1971: 859).

These conclusions about reasons for the success of international organizations are based on Olson's public-good model. However, we will show that Olson's ideas about burden sharing are not completely accurate. Under certain conditions, the income effect of a public good reverses the disproportionality of burden sharing, i.e., the country with the relatively smaller output prior to the reaction process may bear a disproportionately larger share of the public good's cost after the process. Thus, in contrast to Olson's model, the cost-benefit public good ratio of the smaller country may be greater than that of the larger country. Hence a public good's cost may weigh more heavily on the smaller country. To minimize these unexpected costs, or to introduce certainty with regard to costs, a smaller country may bargain and voluntarily engage in economic cooperation with a larger nation about what constitutes the proper supply of various public goods. (In Olson's model a small country can never be exploited; therefore, it never has incentive to bargain.) Bargaining can occur because the country with the relatively larger isolation output can have a very weak interest in marginal increments of the public good, while the country with the relatively smaller isolation output can have an extremely strong interest in marginal increments of the public good. A corollary that flows from this finding is that an organization is more likely to supply itself with an optimal quantity of public goods if the group members have correspondingly different interests in marginal increments of public goods.

This analysis implicitly assumes the existence of many public goods; the presence of several goods reveals the variety in preferences. The policy implication is that an organization must be formed to supply several goods rather than just one. The greater the number of public goods, the greater the chances for mutually advantageous exchange and economic cooperation.

Therefore, the success and viability of an organization providing itself with optimal supplies of public goods may depend not on the smallness of the group, but on the recognition of varied preferences which bring forth bargaining.

In this essay our intent is twofold: the first is to demonstrate how the public-good reaction process determines equilibrium public-good output; the second is to show that in a two-commodity, two-country economic model a smaller country may produce more of the public good in equilibrium than a larger one, thus giving the smaller country incentive to bargain with the larger one.

The Economic Model

The economic model uses a production constraint that enables the analysis to include income effects and to refer to private goods as the numeraire to measure the opportunity cost of providing the public good in terms of the private good. The model postulates two countries, identical production functions in both countries, independent adjustment, the absence of cooperation between countries, the absence of comparative advantage (hence the absence of trade),[1] and the existence of a pure public good. A pure public good possesses two properties: the first property is *nonexcludability,* which means that if one country consumes the good, then all countries automatically consume equal amounts of the good; the second property is *jointness of supply,* which means that consumption of the good by one country does not reduce the supply of the good. Finally, the public good is homogeneous and is supplied by a government that maximizes welfare.

1. Comparative advantage plays no role in a public-good analysis because there is no price attached to the amount of public good that is consumed but not domestically produced. Trade, as explained by the Heckscher-Ohlin theory, is stimulated by the differences in relative cost with regard to private goods. Therefore, the theory is not applicable to public goods.

MAXIMIZATION OF BENEFITS WITH TWO PRIVATE GOODS

A purely private good is the opposite of a purely public good. Within one country, optimal provision of two private goods requires that the ratio of marginal utilities of the goods equals the ratio of marginal costs of the goods. Thus, optimal provision in one country of two private goods, v and x, means that

$$U_v/U_x = C_v/C_x \qquad [1]$$

where U represents marginal utility
C represents marginal costs
v and x represent the goods

Optimal provision of the same two private goods in country two requires meeting the same condition as in country one in equation 1; optimal provision of private goods in one country means no cost and no benefit to another country.

MAXIMIZATION OF BENEFITS WITH ONE PRIVATE GOOD AND ONE PUBLIC GOOD

Optimal provision of one private good, v, and one public good, p, when one country is considered again requires meeting the condition of equation 1. However, that condition does not describe optimality when two countries produce the same public good. The optimization condition in this situation is

$$U_{v_1}/U_{p_1} + U_{v_2}/U_{p_2} = C_v/C_p \qquad [2]$$

where U represents marginal utility
C represents marginal costs
v and p represent the different goods
1 and 2 represent countries one and two

Optimal provision of a private good and a public good when two countries produce the same public good requires that the sum of the ratio of marginal utilities in each country equals the ratio of marginal costs in both countries (Buchanan, 1968: 22-28).

The condition shown in equation 2 accounts for the two properties of a public good and means that the provision of the public good by one country clearly affects another country's well-being. The impact of country one's public-good production on country two is usually interpreted as increased income.[2] When governments are aware of an increase in income, it affects their decision about how much of the public good they should provide through their own efforts. Hence, governments adjust their own provision of the public good to account for the amount of spillover, which is the amount of another country's public-good production. This constitutes the reaction process in public-goods theory.

The Reaction Process

The reaction process in public-goods theory is similar to the Cournot solution of the duopoly problem (Henderson and Quandt, 1972: 222-228). However, the Cournot solution and the public-good reaction process are not identical. The Cournot solution assumes a homogeneous product and a profit function that entail the knowledge of both a demand function and absolute production costs. The solution demands that the first duopolist treats the quantity produced by the second duopolist as constant, i.e., although the first duopolist reacts to the production of the second, the first believes that the second will

2. Public-good spillover is usually interpreted as increased income (Breton, 1970: Loehr, 1973; Olson and Zeckhauser, 1966; Pauly, 1970). This interpretation means that the country's income is varied but that preferences and domestic prices are held constant. Since the income expansion path, also known as the income consumption curve, always has a positive slope, a public-good reaction function may always be derived from the income consumption curve. If public-good spillover is interpreted as changing domestic prices, then income is assumed to be constant. In this case a price consumption curve must be used in the analysis. However, this curve may have either a positive or negative slope; therefore, a price consumption curve does not always permit derivation of a reaction function.

not react to the first's change in production and vice versa. The public-good reaction process requires that a product be homogeneous, that a community preference function exists, and that each country treats the amount of spillover as constant.

Prior studies always assume the presence of reaction curves in public-goods theory and the existence of an equilibrium solution. However, these studies do not derive the slope of the reaction curve and the value of the equilibrium solution.[3] Consequently, a method must be established to derive a public-good reaction curve; this can be done with the aid of Figures 1 and 2.

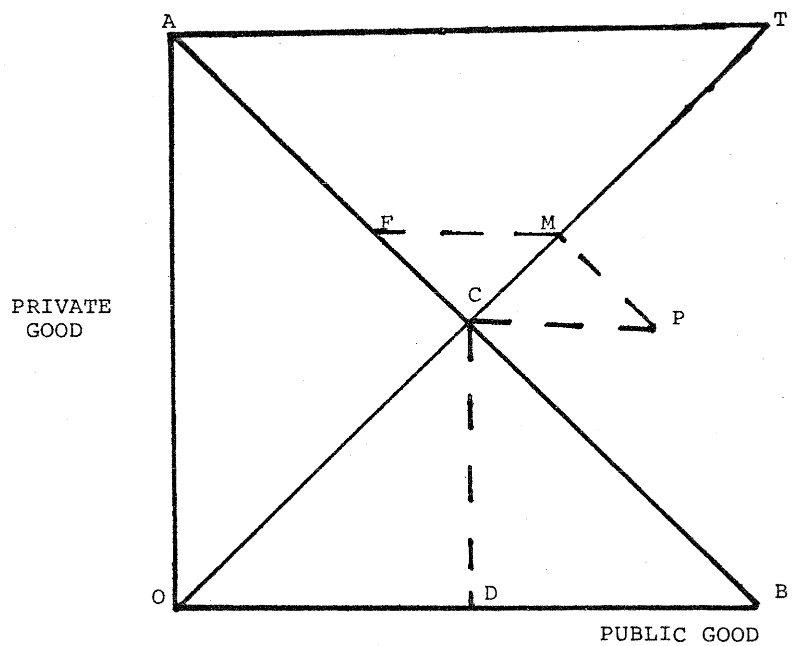

Figure 1: A Production Possibilities Frontier in a Country Producing Two Goods

3. Public-good theorists are well acquainted with the reaction process, and derivation of the reaction curves has always been relatively simple (Breton, 1970: 888-892; Connolly, 1970: 285-289; Williams, 1966: 20-24). However, previous studies emphasize that the reaction process leads to suboptimality. The studies do

Figure 1 is a linear production possibilities curve; the horizontal axis measures the amount of public good that may be produced, the vertical axis measures the amount of private good that may be produced, and the line AB represents the different combinations of the two goods that may be produced. Line OT is the income expansion path (it is assumed to be linear), and every point on the path represents utility maximization for lines parallel to AB.

Figure 2 illustrates the public-good reaction process for one country. The vertical axis measures the amount of public-good production, and the horizontal axis measures the amount of spillover. Before the values of the slope of the reaction curve and the value of an equilibrium solution can be found, the public-good reaction curve must describe at least two condi-

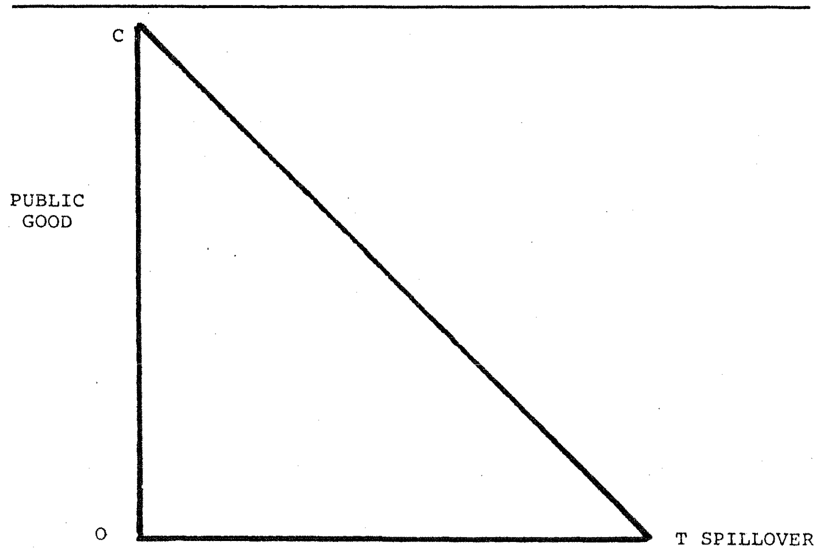

Figure 2: Public Good Reaction Curve for One Country

not focus attention on the process as a concept which permits testing of the "exploitation" theory. Therefore, a step-by-step derivation of the reaction curve is necessary to understand clearly the role of the reaction process in testing the theory.

tions: (1) the amount of public-good production when spillover is zero, and (2) the nature of the relationship between spillover and adjustment in a country's public-good production.

In Figure 1, point C on line AB is a country's isolated optimum. Point C represents a particular production combination of private and public goods that maximizes benefits when spillover is zero. Of course, spillover is equal to zero only when no other country produces the same public good, so point C in Figure 1 is plotted in Figure 2 on the vertical axis. OC in Figure 2 represents the actual amount of public-good production (this is OD in Figure 1).

Aware of spillover, the country in Figure 1 consumes not at point C but at point P, which is to the right of C and below line OT. This is only a consumption spillover, and there is no resource transfer; therefore, the production possibilities line is stationary. The country treats the amount of spillover, CP, as constant. To maximize benefits, the country must consume on line OT. To do this, the country must reduce its own public-good production. Therefore, it reduces its public-good production to point F on line AB. Point F on the production possibilities line enables the country to maximize its benefits, since spillover of the amount CP = FM enables the country to consume at point M on the income expansion path. It is apparent that the country is producing less of the public good after the adjustment than it was before. This establishes the nature of the relationship between public-good production and spillover. The relationship is inverse, and therefore a sufficient amount of spillover could reduce public-good production to zero.

For a country to reduce its public-good production to zero and still maximize utility, there must be an amount of spillover greater than the amount of public-good production when the spillover is zero. In the context of a production constraint, the production of the maximum amount of one good and no production of the other good is a corner solution. A corner solution and maximization of utility exist in the reaction process when, as in Figure 1, the country produces at point A but consumes at point T. Thus, the amount of spillover necessary to create the above situation must equal AT. AT in Figure 1 is plotted on Figure 2 on the horizontal axis as OT. The length of AT in Figure 1 is found through the process of triangulation.

In Figure 2, joining points C and T establishes a slope. Since OT is greater than OC, the slope is greater than zero, less than one, and is constant. The slope of line CT is the marginal rate of adjustment in a country's public-good production for every unit of spillover.

A formula now exists to predict the amount of public-good production in any country given the income effect of spillover. The formula for country A is

$$Q_A = C_A - OC/OT\,(Q_B) \qquad [3]$$

where C_A equals the public-good output of country A prior to spillover
Q_B equals the amount of spillover from country B
OC/OT equals the slope of the reaction curve
Q_A equals the equilibrium output of public goods in country A

Spillover, of course, refers to the amount of public-good production in another country. The formula for country B's adjusted production is similar to that shown in equation 3:

$$Q_B = C_B - OC/OT\,(Q_A) \qquad [4]$$

where C_B equals the public-good output of country B prior to spillover
Q_A equals the amount of spillover from country A
OC/OT equals the slope of the reaction curve
Q_B equals the equilibrium output of public goods in country B

Equations 3 and 4 represent a system of two linear equations in two variables, and the solution of the system renders the equilibrium value of the public-good production (production when the reaction process stops) in each country.

The Effects of the Production Curve and the Income Expansion Path on the Reaction Curve

We make the assumptions of a linear income expansion path and a constant transformation function to simplify the derivation of the reaction curve. However, the actual value of the curve is affected by the contour of the transformation function and the shape of the income expansion path. Figures 3A and 3B illustrate the effect of this contour on the reaction function. In both figures the income expansion path is linear, but in Figure 3B the function is curvilinear. The reaction curve derived from Figure 3A is a straight line, but the curve derived from Figure 3B is curvilinear. To illustrate these assertions, assume that spillover in Figure 3A increases from VX to VY and that the spillover in Figure 3B increases from V′X′ to V′Y′. In each instance, the increase clearly reduces public-good production. However, the rate of decrease in public-good production, given by the ratio of consecutive projections on the horizontal axis, is constant in Figure 3A but increasing in Figure 3B. That is, in Figure 3A,

$$VX/RQ = VY/SQ \qquad [5]$$

but in Figure 3B

$$V'X'/R'Q' > V'Y'/S'Q' \qquad [6]$$

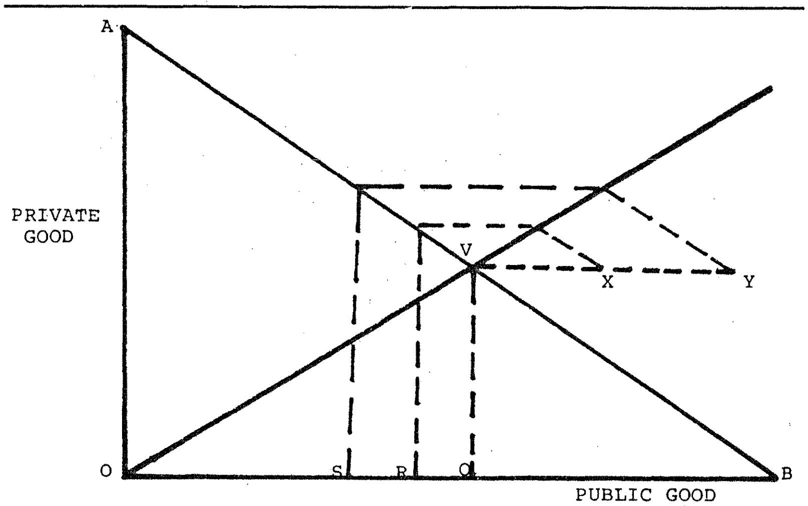

Figure 3A: The Effect of a Linear Transformation Function on Public Good Production

A curvilinear transformation function, therefore, increases the rate of reduction in public goods.

The income expansion path also affects the reaction function. Figures 4 and 5 illustrate this. In Figure 4 the transformation function is linear, but there are three income expansion paths: DE, DS, and DW. Figure 5 shows the reaction curves that are derived from the income expansion paths. If the income expansion path in Figure 4 is linear, such as DS, then the reaction curve in Figure 5 is also linear, such as D′S′. If the path in Figure 4 indicates income inelasticity for the public good, as represented by DE, then the reaction curve in Figure 5 is convex toward the origin and takes the form of D′E′. Conversely, if the path indicates income elasticity for the public good, as shown by DW in Figure 4, then the reaction curve in Figure 5 is concave toward the origin and takes the form of D′W′.

Even if the production possibilities curve and the income expansion path are not linear, an observer can still construct an algebraic system that will predict equilibrium values of public-good production. However, the assumptions of a linear trans-

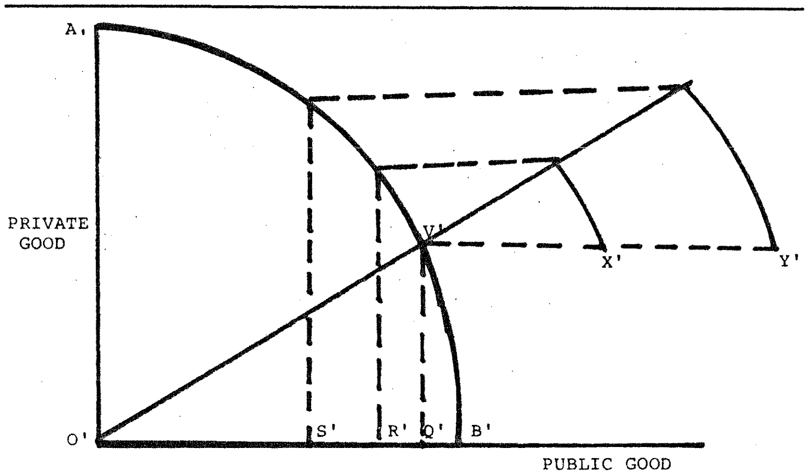

Figure 3B: The Effect of Curvilinear Transformation Function on Public Good Production

formation function and a linear expansion path do not detract from the analytical insights provided by the application of the reaction process to public-goods theory. In fact, of the two elements that affect the reaction curve, the contour of the production curve and the income expansion path, only the latter clarifies the differences in nations' reaction functions. This may be shown by closely examining the components of the algebraic system.

The Relationship Between the Components of the Formula

The determinants of the slope of the reaction curve are the first concern. The slope of each country's reaction curve is the ratio of OC to OT in Figure 2. However, OT in Figure 2 is equal to AT in Figure 1. But AT is a function of each country's factor endowments, which in turn determines each country's private-good productive capacity. This is illustrated as OA of Figure 1,

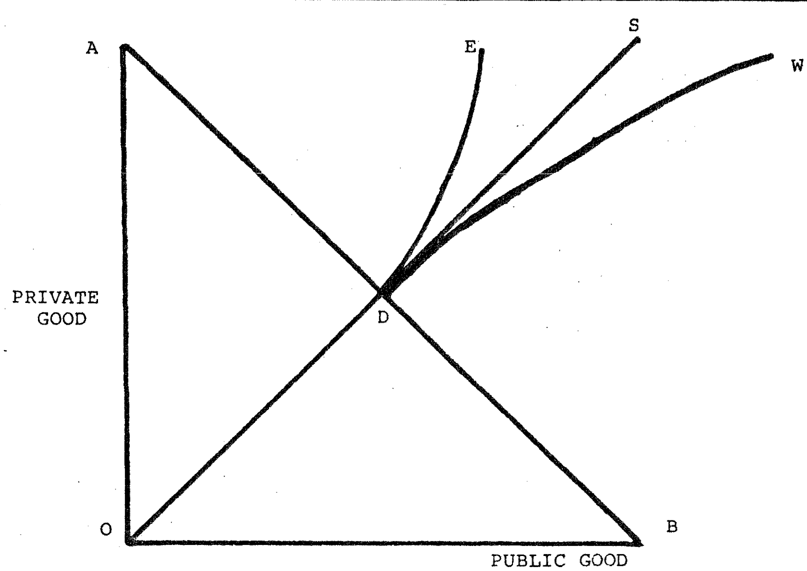

Figure 4: Three Possible Income Expansion Paths for a Country

the vertical axis. AT is also a function of each country's marginal rate of substitution of the private good for the public good when each country is in an isolated optimum. This condition is represented in Figure 1 as the ratio of the length of CD, the amount of private-good production, to the length of OD, the amount of public-good production. Thus, the actual slope of the reaction curve is dependent on each country's marginal rate of substitution or preferences in an isolated optimum.

The assumptions of identical production functions and the absence of comparative advantage mean that two countries' transformation functions are either identical or parallel to one another. Therefore, the effect of the production possibilities curve on the reaction curve is the same in both countries. Hence, the transformation function plays no role in distinguishing one country's reaction function from that of another country.

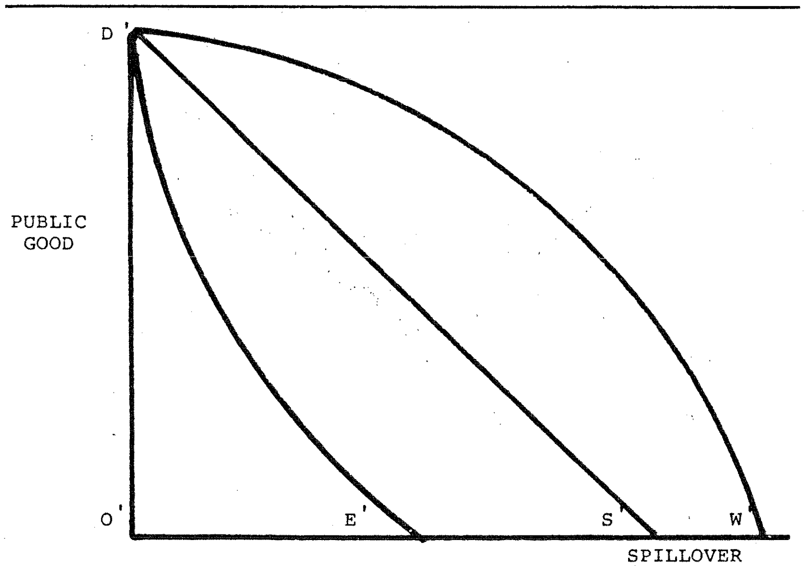

Figure 5: Reaction Curves for Three Different Income Expansion Paths

With these conditions in mind, we can examine in a two-country model the relationship between the slope of the reaction curve, factor endowments, and preference functions.

Case I: 1. Assume that each country's factor endowments are equal but that the countries have different preference functions.

Referring to Figures 6A and 6B, equal factor endowments mean that OA_A in Figure 6A is equal to OA_B in 6B, but different preference functions mean that the ratio of CD_A, the amount of private-good production in A, to OD_A, the amount of public-good product on in A, is not equal to the same ratio in B. OT_A and OT_B are country A's and country B's income expansion paths, and AT_A and AT_B are the amounts of spillover necessary to force A and B into a corner solution. By inspection it is obvious that AT_A is greater than AT_B; thus the

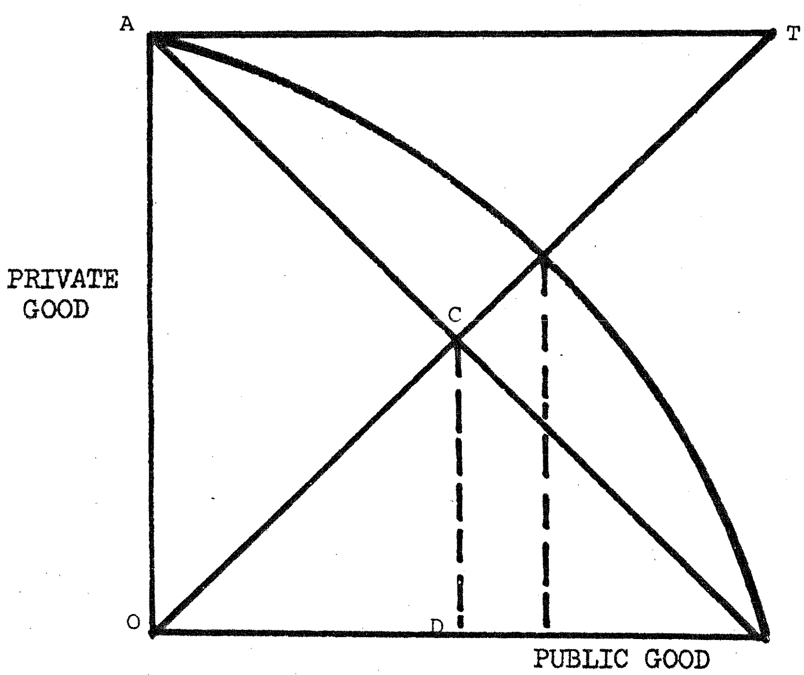

Figure 6A: Country with a Strong Preference for Public Good

slope of A's reaction curve is less than B's. This example shows that the greater a country's preference for the private good relative to the public one, the greater the slope of the reaction curve, and vice versa. This is true regardless of the shape of the transformation functions.

Case I: 2. Assume that each country's factor endowments are different, but that the countries have equal preference functions.

Figures 7A and 7B show linear and curvilinear production possibilities frontiers for two countries with different factor endowments. In each case the frontiers are parallel to each other. As a result, the income expansion path is the same for both countries; thus, the slope of each country's reaction curve is equal to that of the other. Again, this is true regardless of the slope of the transformation function.

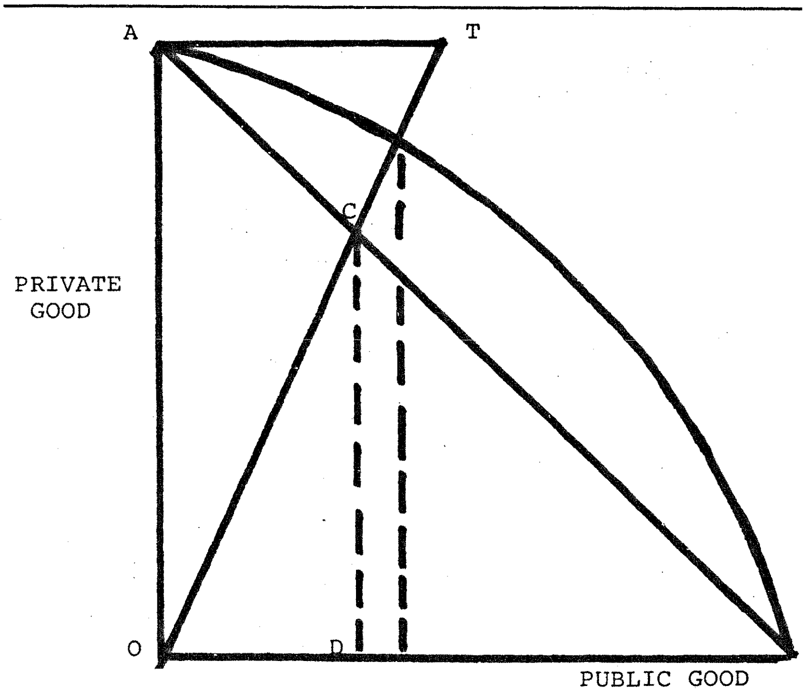

Figure 6B: Country with a Weak Preference for Public Good

The previous examples show that the value of the reaction curve is dependent on preferences rather than factor endowments. However, the amount of spillover necessary to ensure a corner solution is proportional to factor endowments as they are reflected by private-good productive capacity. This indicates that public-good productive capacity is irrelevant to an equilibrium solution. Therefore, public-good productive capacity, even though it might be construed as an ability to produce or pay for the public good, cannot be a tool to analyze cost distribution of public goods.

We move now from the discussion of the determinants of the reaction curve in particular to the system's equilibrium conditions in general.

Equations 3 and 4 may be expressed as

$$Q_A + aQ_B = C_A \qquad [7]$$

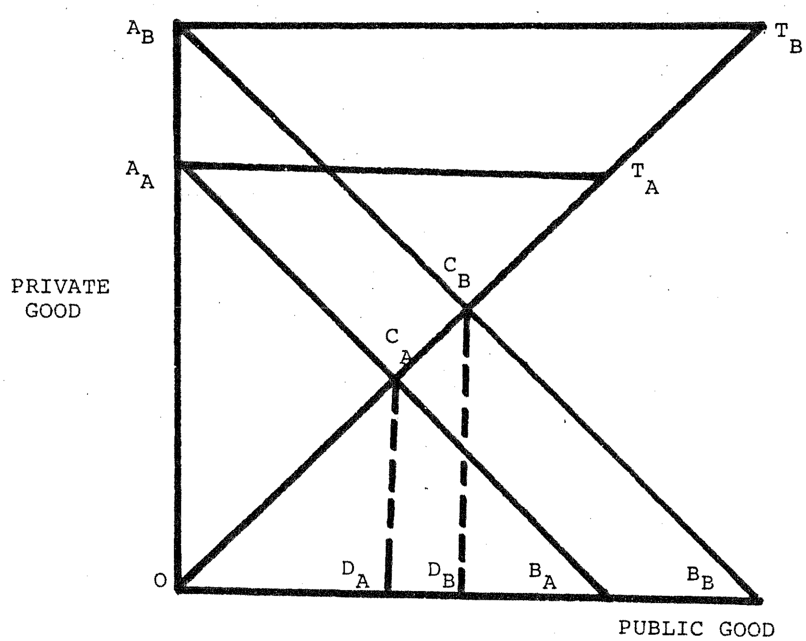

Figure 7A: The Effect of Identical Preference Functions on Public Good Production in a Linear Transformation Function

$$bQ_A + Q_B = C_B \qquad [8]$$

where a and b are the slopes of the reaction curves

The system may be solved by the standard method of comparison. Multiplying equation 8 by a yields

$$abQ_A + aQ_B = aC_B \qquad [9]$$

Subtracting equation 9 from equation 7 yields

$$Q_A - abQ_A = C_A - aC_B \qquad [10]$$

$$Q_A\,(1-ab) = C_A - aC_B \qquad [11]$$

$$Q_A = \frac{C_A - aC_B}{1 - ab} \qquad [12]$$

By the same method

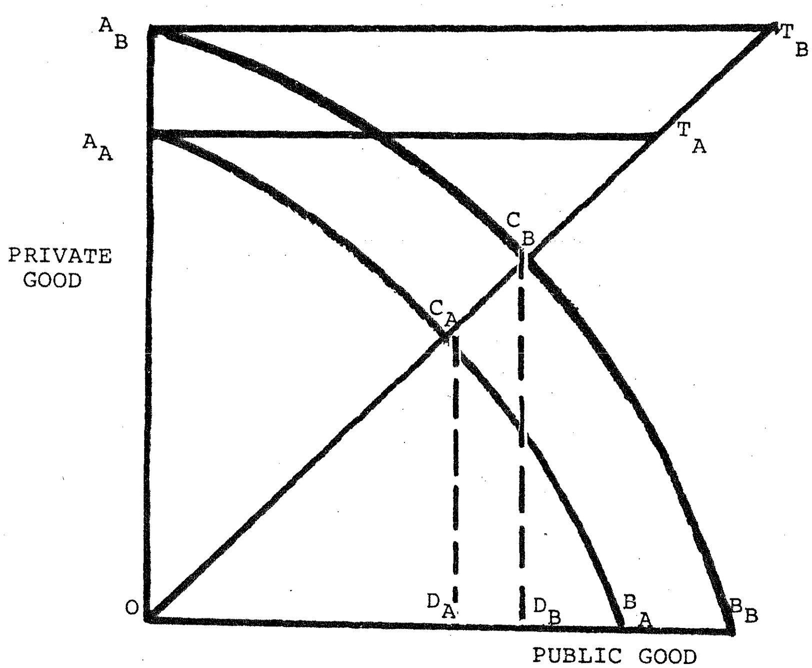

Figure 7B: The Effect of Identical Preference Functions on Public Good Production in a Curvilinear Transformation Function

$$Q_B = \frac{C_B - bC_A}{1 - ab} \qquad [13]$$

Since the denominators of the right side of equations 12 and 13 are identical, the numerator of the right side gives the equilibrium conditions. Transferring the components of the numerator yields

$$C_A - C_B \gtreqless aC_B - bC_A \qquad [14]$$

$$aC_B - bC_A = k \qquad [15]$$

$$\text{if } C_A - C_B = k \quad \text{then } Q_A = Q_B \qquad [15.1]$$

$$\text{if } C_A - C_B > k \quad \text{then } Q_A > Q_B \qquad [15.2]$$

$$\text{if } C_A - C_B < k \quad \text{then } Q_A < Q_B \qquad [15.3]$$

With equilibrium conditions for references, we can examine the relationship between Q_A and Q_B, given the relationship between C_A and C_B and that between a and b. However, assume that the ordinal values of the constants are known but that the cardinal or continuous measures are unknown.

Case II: Assume that the slope of country A's reaction curve, a, is greater than country B's slope, b.

Case II: 1. Assume that C_A is less than C_B.
It is obvious from equation 14 that Q_A is less than Q_B.

Case II: 2. Assume that C_A is greater than C_B.
The equilibrium output in this case is indeterminate, i.e., Q_A may be greater than, equal to, or less than Q_B.

The ambiguity of Case II: 2 reveals that theory requires continuous measures rather than ordinal ones to predict cost distribution. Assuming that continuous measures are available, equation 15.2 indicates that if the difference of pre-spillover production is greater than the difference of A's reaction to B's output and B's reaction to A's output, then the country producing a larger amount of public good before the reaction process bears in equilibrium a larger proportion of the public good's cost. This is the cost distribution that Olson predicts. However, Olson's prediction does not obtain when equations 15.1 and 15.3 characterize the two-country model. Indeed, it is possible that C_A may be much larger than C_B, but in equilibrium country B may produce more of the public good than country A.

Case III: The slope of a, country A's reaction curve, is less than the slope of b, country B's reaction curve.

Country A's preference function is biased toward the public good relative to country B's welfare function. The reader may test that the results obtained for Case III: 1 and III: 2 are consistent with those of Case II.

All the possible outcomes for Cases II and III are summarized in Table 1. Note that the ambiguity in cells 1 and 4 can be resolved by referring to equations 15.1 to 15.3.

It is apparent that knowledge of size alone is insufficient to analyze cost distribution of a public good. One country may have a much larger factor endowment than another, but this does not mean that the former necessarily has a greater

TABLE 1
Equilibrium Conditions for Public Good Output

	$a < b$	$a > b$
$C_A < C_B$	$Q_A = Q_B$ $Q_A > Q_B$ $Q_A < Q_B$ (1)	$Q_A < Q_B$ (2)
$C_A > C_B$	$Q_A > Q_B$ (3)	$Q_A = Q_B$ $Q_A > Q_B$ $Q_A < Q_B$ (4)

public-good production than the latter. A preference function is necessary to know the proportion of public good to private good that a country produces, and knowledge of a preference function is available only within the context of a constraint. Furthermore, a reaction curve is necessary to solve for the equilibrium value of the public good, but derivation of a reaction curve is possible only when preferences are known. Therefore, derivation of a reaction curve is possible only within a constraint. This highlights the importance of incorporating a constraint into a public-good analysis.

Conclusion

The analysis clearly demonstrates that a small country's cost-benefit ratio for a public good can be higher than that of a large country. This implies that different states place correspondingly different evaluations on the consumed amount of public good that is not domestically produced. Put another way, the public-good spillover from nation X to nation Y may be extremely valuable to nation Y, but spillover in the opposite direction may be relatively unimportant to the recipient. A state's evaluation of spillover is reflected in the slope of the reaction curve: if the slope approaches zero, then the state highly values the marginal increments of public-good consumption; if the slope approaches one, then the state pays little heed to additional consumption. Thus a country's bargaining power with respect to a single public good stems directly from the relative importance of the good's marginal increments. A nation with a weak preference may say to a nation with a strong preference: "Provide more of public good A, or we will provide less of public good B; your relative decrease in welfare will be greater than ours." Of course, this tactic may be used with regard to different public goods. Therefore, increased output of one public good may be contingent upon increased output of another.

However, this bargaining tactic is efficacious within an international organization only if the members' interests extend to several public goods. Only the presence of many such goods engenders bargaining and therefore increased supply. Consequently, the organization increasing the volume of one public good simultaneously provides many public goods. A multipurposed organization, one with members having several different interests, creates an environment facilitating the recognition of varied preferences; this recognition stimulates bargaining. A multipurposed organization, rather than a single-purposed one, is more likely to enlarge supply.

This essay's contribution to theory is the discovery of conditions that bring forth bargaining and economic cooperation. If an organization's primary purpose is to provide greater amounts of public goods, then the organization must be structured in such a way that the disadvantages of noncooperation are readily apparent to members. Public-good theory identifies bargaining as a tool to manipulate supply and suggests the type of organization that is most likely to optimize the public-good supply. Thus in public-good analyses, theory is extremely important because it can unveil new perspectives on policy.

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Dr. Steve Brown
Professional Experience and Educational Background

Dr. Brown's educational background includes receiving a Bachelor of Arts Degree from Colorado State University (1971), a Master of Science Degree in Regulatory Economics from the University of Wyoming (1979), and a Master of Arts and a PhD in International Relations with a specialty in International Economics from the University of Denver (1975).

Since his professional career began in 1979, Dr. Brown has benefited from 28 years of experience with the Public Utility Industry, including cost of service studies, rate design issues, telecommunications issues, and matters related to the disposal of nuclear waste.

From 1979 to 1982, Dr. Brown worked for Tri-State Generation and Transmission Association as a Power Requirements Supervisor and Rate Specialist. The positions required Dr. Brown to forecast customer and load growth for the company as a whole, which included overseeing a team responsible for gathering and analyzing the requisite data. Additionally, Dr. Brown was tasked with presenting rate proposals regarding increases in wholesale rates, which included performing rate design, distribution of the revenue requirement between fixed and variable charges, and distribution of the rate increases across areas of Colorado, Wyoming, and Nebraska.

In 1982, Dr. Brown began working for Arizona Electric Power Cooperative, a company regulated by the Arizona Corporation Commission, as a Rate Analyst. While in this position, Dr. Brown was solely responsible for presenting rate proposals regarding an increase of wholesale rates. He performed forecasting and rate design, analyzed cost of service and revenue requirements, and wrote computer programs in association with this position.

Dr. Brown left this position in 1984, where he began working for Houston Lighting & Power as a Supervisor of Rate Design. This supervisory position included determining fixed and variable charges in regard to rate allocations among the various class distinctions, computer programming, and preparing quarterly rate design for future rate cases.

From 1986 to 1994, Dr. Brown was employed by the Iowa Utilities Board as Chief of the Bureau of Energy Efficiency, Auditing and Research, wherein he advised on long term energy planning, legislative and policy matters including demand-side management, management and financial auditing, the introduction of new technology in regulated industry and rate setting for regulated electric, gas and telephone utilities.

In 1991 Dr. Brown was appointed by the Governor to serve as the Utility Specialist and State Liaison Officer to the U.S. Nuclear Regulatory Commission, making him the main contact between the Nuclear Regulatory Commission and the Iowa state government regarding all policy issues concerning nuclear power plants.

Dr. Brown joined the Consumer Advocate and Protection Division (CAPD) of the Tennessee Attorney General's Office as an Economist in 1995. He has provided expert oral and written testimony in numerous rate proceedings before the Tennessee Public Service Commission (TPSC) and the Tennessee Regulatory Authority (TRA), covering all aspects related to determining cost of capital and other regulatory issues. Dr. Brown has participated in the following dockets, many of which are available on the TRA website. Docket captions have been summarized.

TRA #08-00039 Tennessee American Water Company - Petition Of Tennessee American Water Company to Change and Increase Certain Rates and Charges
Direct Testimony: http://www.state.tn.us/tra/dockets/0800039.htm

TRA #07-00224 Docket to Evaluate Chattanooga Gas Company's Gas Purchase and Related Sharing Incentives
Direct Testimony: http://www.state.tn.us/tra/dockets/0700224.htm

TRA #07-00105 Atmos Energy Corporation for Approval of a General Rate Increase
Testimony Address: http://www.state.tn.us/tra/orders/2007/0700105cg.pdf

TRA # 06-00290 Petition of Tennessee American Water to Change and Increase Rates
Testimony Address: http://www.state.tn.us/tra/orders/2006/0600290by.pdf
Supp. Testimony Address: http://www.state.tn.us/tra/orders/2006/0600290fm.pdf

TRA # 06-00175 Petition of Chattanooga Gas Company to Change and Increase Rates
Testimony Address: http://www.state.tn.us/tra/orders/2006/0600175jn.pdf

TRA # 05-00258 Petition of the Consumer Advocate to Open an Investigation and Require ATMOS to Show Cause that the Company is not over-earning.
Testimony Address: http://www.state.tn.us/tra/orders/2005/0500258cd.pdf
Rebuttal Testimony: http://www.state.tn.us/tra/orders/2005/0500258hs.pdf

TRA# 04-00288 Petition of Tennessee American Water Co. to adjust rates
Testimony Address: http://www.state.tn.us/tra/orders/2004/0400288bk.pdf

TRA # 04-00034 Petition of Chattanooga Gas to Adjust Rates
Testimony Address: http://www.state.tn.us/tra/orders/2004/0400034dm.pdf

TRA# 03-00491 F.C.C. T.R.O. Review
Testimony Address: http://www.state.tn.us/tra/orders/2003/0300491ib.pdf
Rebuttal Address: http://www.state.tn.us/tra/orders/2003/0300491kn.pdf

TRA# 03-00391 Petition of BellSouth Telecommunications for Exemption of Certain Services
Testimony Address: http://www.state.tn.us/tra/orders/2003/0300391bz.pdf

TRA# 03-00313 Petition of Nashville Gas to Adjust Rates
Testimony Address: http://www.state.tn.us/tra/orders/2003/0300313z.pdf

TRA# 03-00118 Petition of Tennessee American Water to Adjust Rates
Testimony Address: http://www.state.tn.us/tra/orders/2003/0300118bm.pdf
Rebuttal Address: http://www.state.tn.us/tra/orders/2003/0300118ca.pdf

TRA# 01-00704 / 02-002258 (consolidated docket) Audit of Atmos/U.C.G. IPA
Testimony Address: http://www.state.tn.us/tra/orders/2001/0100704cp.pdf

TRA# 98-00559 BellSouth, C.S.A. Docket
Rebuttal Testimony: http://www.state.tn.us/tra/orders/1999/980055916.pdf

TRA# 97-01364 United Cities Gas / Establishment of PBR
Copy Attached (A)

TRA# 97-01262 Bellsouth Telecommunications Inc. - Permanent Prices
http://www.state.tn.us/tra/dockets/9701262.htm

TRA# 97-00982 Chattanooga Gas -Petition to Revise Tariff
Copy Attached (B)

TRA # 96-00977 Nashville Gas Company – Petition for Adjustment of its rates and charges.
Copy Attached (C)

TRA # 95-01134 United Cities Gas Company – Application to Establish an Experimental Performance-Based Ratemaking Mechanism.
Copy Attached (D)

TRA # 95-02258 United Cities Gas Company – Petition to Place Into Effect a Revised Natural Gas Tariff
Copy Attached (E)

Publications

Dr. Brown has also authored several articles relating to his profession. These publications include:

1. **Publication:** Science and Technology
   Title of Publication: So Long, Calvin Coolidge, Meter Reading Approaches the 1990s Promising a Pivotal market for Communications Infrastructure
   Date of Publication: 11/1992

2. **Publication:** AMRA Opinion
   Title of Publication: No Second Time Around for AMR
   Date of Publication: 03/1994

3. **Publication:** AMRA Opinion
   Title of Publication: DOE Proposal Trivializes AMR
   Date of Publication: 11/1993

4. **Publication:** Economic Incentives for Nuclear Plan Performance:
   Title of Publication: A State Perspective
   Date of Publication: 09/1988

5. **Publication:** Electric Potential Bubble Memory Technology
   Title of Publication: Its Impact on Metering and Rate Structure
   Date of Publication: 12/1985

6. **Publication:** The Sine Qua Non of Order 636
   Title of Publication: Cooperative Competition, Information Flow, and Rate Design
   Date of Publication: 09/1992

7. **Publication:** Presentation at 'Integrating Microelectronics into Gas Distribution'
Title of Publication: Opportunities for Inter-Industry Cooperation: A Regulatory View of Automation
Date of Publication: 10/1987

8. **Publication:** Electric Potential
Title of Publication: Focus: Nuclear Prudence Cases
Date of Publication: 12/1985

9. **Publication:** Presentation at 'The Pennwell Conference on TELCOS, POWERCOS & CABLECOS – Partners or Rivals in the Local Loop?'
Title of Publication: Financing Electric (& Other) Utilities' Shares in Local Loop Fiber Networks: Economic and Political Considerations
Date of Publication: 09/1991

10. **Publication:** Presentation at ' Meeting of the NARUC Staff Subcommittee on Technology'
Title of Publication: From Automatic Meter Reading to Fiber Optics: Creating a Locally Oriented Universal Data Transmission Service
Date of Publication: 02/1990

11. **Publication:** Presentation at 'AMRA'S Symposium 91'
Title of Publication: Strategic Planning Considerations for the AMR Industry in the 1990s
Date of Publication: 09/1991

12. **Publication:** Blackwell Publishing on behalf of ISA
Title of Publication: Public-Good Theory and Bargaining between Large and Small Countries
Date of Publication: 09/1976

Affiliations

In addition to Dr. Brown's employment and education experience, he has served as a member in several professional organizations. These memberships include being a past member of the National Association of Regulatory Utility Commissioners Staff Committee on Management Analysis, a past trustee of and a member of the Board for the Automatic Reading Association, and as a current member of the National Association of Business Economists.