PROVINCE OF ALBERTA

BEFORE THE ALBERTA ENERGY AND UTILITIES BOARD

ATCO Electric Ltd.	**)**	
2008 Distribution Tariff Application	**)**	**Application No. 1500878**

DIRECT TESTIMONY OF

PAUL CHERNICK

ON BEHALF OF

THE ASSOCIATION OF MUNICIPAL DISTRICTS & COUNTIES

AND

THE ALBERTA FEDERATION OF REAS LTD

Resource Insight, Inc.

MAY 18, 2007

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I. Identification and Qualifications

Q: Mr. Chernick, please state your name, occupation and business address.

A: I am Paul L. Chernick. I am the president of Resource Insight, Inc., 5 Water Street, Arlington, Massachusetts.

Q: Summarize your professional education and experience.

A: I received an SB degree from the Massachusetts Institute of Technology in June 1974 from the Civil Engineering Department, and an SM degree from the Massachusetts Institute of Technology in February 1978 in technology and policy. I have been elected to membership in the civil engineering honorary society Chi Epsilon, and the engineering honour society Tau Beta Pi, and to associate membership in the research honorary society Sigma Xi.

I was a utility analyst for the Massachusetts Attorney General for more than three years, and was involved in numerous aspects of utility rate design, costing, load forecasting, and the evaluation of power supply options. Since 1981, I have been a consultant in utility regulation and planning, first as a research associate at Analysis and Inference, after 1986 as president of PLC, Inc., and in my current position at Resource Insight. In these capacities, I have advised a variety of clients on utility matters.

My work has considered, among other things, the cost-effectiveness of prospective new generation plants and transmission lines, retrospective review of generation-planning decisions, ratemaking for plant under construction, ratemaking for excess and/or uneconomical plant entering service, conservation program design, cost recovery for utility efficiency programs, the valuation of environmental externalities from energy production and use, allocation of costs

of service between rate classes and jurisdictions, design of retail and wholesale rates, and performance-based ratemaking and cost recovery in restructured gas and electric industries.

Q: Have you testified previously in utility proceedings?

A: Yes. I have testified approximately one hundred and ninety times on utility issues before various regulatory, legislative, and judicial bodies, including the Ontario Energy Board, Arizona Commerce Commission, Connecticut Department of Public Utility Control, District of Columbia Public Service Commission, Florida Public Service Commission, Maryland Public Service Commission, Massachusetts Department of Public Utilities, Massachusetts Energy Facilities Siting Council, Michigan Public Service Commission, Minnesota Public Utilities Commission, Mississippi Public Service Commission, New Mexico Public Service Commission, New Orleans City Council, New York Public Service Commission, North Carolina Utilities Commission, Public Utilities Commission of Ohio, Pennsylvania Public Utilities Commission, Rhode Island Public Utilities Commission, South Carolina Public Service Commission, Texas Public Utilities Commission, Utah Public Service Commission, Vermont Public Service Board, Washington Utilities and Transportation Commission, West Virginia Public Service Commission, Federal Energy Regulatory Commission, and the Atomic Safety and Licensing Board of the U.S. Nuclear Regulatory Commission.

II. Introduction

Q: On whose behalf are you testifying?

A: My testimony is sponsored by the Alberta Association of Municipal Districts & Counties ("AAMDC") and Alberta Federation of REAs Ltd ("AFREA").

Q: What is the purpose of your direct testimony?

A: My sponsors have asked me to evaluate the basis for the large increase in streetlighting revenue requirements that result from changes in direct assignment and cost allocations. To accomplish this task, I reviewed the analyses performed by ATCO Electric ("AE" or "the Company") and Foster Associates ("Foster") in response to Directions of the Board.

Q: Which of the Company's analyses does your testimony address?

A: I address the following analyses:

- direct assignments to streetlighting in response to Direction 11;
- the classification of all components of the distribution system, in particular overhead lines, in response to Direction 13;
- definition and calculation of streetlighting customer counts, in response to Direction 20;
- re-estimation of the customer weighting factors used in the cost-of-service study (COSS), in response to Direction 24.

Each of these studies was conducted by Foster Associates, apparently under the supervision of James J. Sarikas.

Q: What is the result of these analyses?

A: The Company's allocation of costs to streetlighting increases drastically from the 2004 COSS as shown in the revised Technical Session slides 13 and 14 dated March 16, 2007.

Q: What do you conclude from your evaluation?

A: The Company has not provided adequate documentation for its responses to the Board's Directions; as a result, the responses cannot be fully reviewed and therefore cannot be relied upon for setting rates. To the extent that I have been able to review portions of the studies by AE and Foster, those analyses are riddled with errors and overstate the costs of streetlighting. More specifically, the following list describes the problems with the response to each of these four directions:

- **Direction 11: direct assignments to streetlighting**: The direct-assignment analysis started with work orders that include equipment serving non-streetlighting loads, but neither AE nor Foster systematically identified or excluded investments that served non-streetlighting at the time of installation or today. Foster converts the work-order data to assignment factors by misinterpreting regression analyses that are largely undocumented and conceptually suspect, using incorrect and nonsensical data.
- **Direction 13: classification of non-assigned distribution costs**: Foster's treatment of some minimum equipment size as being customer-related is conceptually flawed and inconsistent with the considerations that determine the number of units and cost of distribution equipment. Foster also makes computational errors in this zero-intercept computations.
- **Direction 20: streetlighting customer counts**: Foster estimates a customer number for streetlighting that has no obvious relevance to the causation of any cost. The number of streetlight customers for customer-service purposes should be set at the number of entities requesting separate bills and retailer choice. Any distribution costs driven by the number of

streetlights are directly assigned, so the number of streetlighting customers for allocation of distribution costs should be set to zero.

- **Direction 24: customer weighting factors for transformers:** Foster's analysis is entirely hypothetical and unrelated to the actual distribution of customers served by various size transformers, or to the percentage of customers in each class who require an additional transformer. Streetlights are lumped together with the largest customers, resulting in a vast underestimate of the number of customers sharing a transformer with the typical streetlight.

Q: What are your recommendations to the Board on these issues?

A: I recommend that the Board should take the following steps:

- Reject AE's responses on all four of the issues discussed in this testimony;
- Not increase the share of revenue requirements borne by streetlighting in this proceeding;
- Direct AE to correct the errors discussed in this testimony;
- Direct AE to file corrected analyses addressing Directions 11, 13, 20 and 24, in its next rate application.

III. Direction 11: Direct Assignments to Streetlighting

Q: How substantial is AE's proposed direct assignment to streetlighting?

A: Even this information is not easily determined. AE does not even specify the total direct assignment in the explanation of its response to Direction 11. (Application, Section 4-Attachment 2, pp. 1-5). The parties to this proceeding have been told variously as follows:

- The total costs tabulated from the "streetlighting" work orders are $30M in Account Street Light 47-810 and $10.9M in non-streetlighting accounts (AAMDC/AFREA-ATCO-14(b)).
- Out of a total of $74.9 million of gross plant (including General Plant) that is allocated to streetlighting, $72.2 million was directly assigned, of which $66.9 million is non-rural and $4.5 million is rural. (PICA-ATCO-2(a), rbas43, " midyr_gross_PP&E").
- The assignable assets are $48.1M, $43.7M for non-rural and $4.5M for rural streetlighting (Mif3, "Assignable Assets")
- The plant capitalized to Street Light Account 47-810 is $46.4M, more than the total of all costs tabulated in the work-order study (March 9 2007 Technical Session, Slide 13, revised March 16 2007)

Without a clear statement of the amount of the direct assignment and how it was derived, the parties and the Board cannot separate the effects of changes in direct-assignment methodologies, allocation approaches and total distribution rate base.

Q: What is your understanding of the Company's direct-assignment method?

A: The documentation is inadequate and inconsistent. Most of the calculations have not been provided, despite our requests for the information. As best as I could determine, the data was derived from a detailed review of work orders dating back to 1950. It selected the 4,475 work orders that included at least some plant capitalized to Street Light Account 47-810 (AAMDC/AFREA-ATCO-8, Supplemental response, p. 1; Application, Section 4, Attachment 1, p. 3).[1] The

[1]The Company asserts, "ATCO Electric identified and analyzed all work orders where any capital was closed to streetlighting" (AAMDC/AFREA-ATCO-8 Attachment 1). This suggests that many of the work orders must have contained work for non-streetlighting customers, unless AE

Company summarized data from each work order, including plant by street-lighting (No. 47-810) and non-streetlighting account, number of existing and new poles by size, number of davits installed and other information useful for analysis of streetlighting costs (Application, Section 4, Attachment 2, pp. 2–3).

The Company provided the data summary, but not the individual work orders, to Foster Associates for further analysis. Foster performed some regressions, and perhaps some other analyses, and recommended that AE directly assign about 38 cents of non-streetlight plant to streetlighting for each dollar of actual streetlighting equipment (AAMDC/AFREA-ATCO-8, Attachment 1, p. 7). The Company claims to have used Foster's results to assign directly to streetlights much more than a dollar of non-lighting plant for each dollar of lighting plant.

Q: How did AE use the work orders and Foster's direct-assignment analysis in the cost-of-service study?

A: I do not know. The Company has not explained how the costs attributed to streetlighting in the Cost-of-Service Study were derived from AE's work-order analysis and Foster's direct-assignment analysis. In response to a request to "document the derivation of the overall direct assignment to streetlighting in the Cost of Service Study from the assignments by work order," AE refers only to the place in the cost-of-service study in which the final result appears as an input (AAMDC/AFREA-ATCO-12).

Also, AE has not demonstrated that the large contributions in aid of construction collected from customers were subtracted from the non-streetlighting plant assigned to streetlighting. In the work-order database, about

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was in the habit of issuing one work order to install poles, transformers, primary and secondary lines, and service drops, and a second work order just for streetlights on the same poles.

90% of Account 47-810 and 10% of the other accounts are covered by customer contributions.

A. The Work-Order Analysis

Q: In their direct-assignment methodology, how did AE and Foster treat work orders that include a mix of streetlighting and non-streetlighting investments?

A: The parties in this proceeding have been variously told as follows:

- One hundred percent of costs in the 4,475 work orders are directly assigned to streetlighting (Company statement on May 4, 2007 teleconference call);
- Only the portion of the non-Account 47-810 work order investments "that can be shown to be street light-related" are directly assigned to street-lighting (Application, Section 4, Attachment 2, pp. 3–4);
- The work order study "did not assign plant between streetlight and non-streetlight categories" (AAMDC/AFREA-ATCO-9(a));
- The work-order study did assign plant between streetlight and non-streetlight categories: The purpose of the study was to review "plant that was installed at the same time and in conjunction with streetlight plant…to determine if the plant (non-streetlight) should be directly assigned to the streetlight function" (AAMDC/AFREA-ATCO-9(a)).

In short, we do not even know whether the plant costs that serve a mix of customers are properly assigned between streetlighting and non-streetlighting categories.

Q: How did AE account for plant that originally served only streetlights but has subsequently been used to serve other customers?

A: It does not appear that AE identified such plant in the work-order study. Hence some unknown amount of plant now serving non-lighting load was included in the assignment to streetlights.

B. Foster Associates' Analysis

Q: What was the contribution of Foster Associates to the development of the direct assignment?

A: Foster was responsible for determining what portion of non-streetlighting costs should be assigned directly to streetlighting. It is not clear whether the analysis assigned the non-streetlighting investment included in the 4,475 work orders, a portion of secondary distribution backbone costs, or both. Foster recognized that the analysis should make the following two adjustments to the streetlighting assignment:

- A portion of the non-streetlighting plant that serves streetlighting is in the work orders and has been assigned to streetlighting,
- The work orders include plant that currently "supports" other rate classes, or "over time, may be used by other rate classes" (Application, Section 4, Attachment 2, pp. 3–4).

While AE does not explain how it increased the $30.1M of investment in Account 47-810 in the work orders to $72.2M directly assigned to streetlights in the cost-of-service study, the Foster assignment analysis appears to have been important.[2] The Company has not clearly explained the Foster assignment study and has not provided the study's data and calculations despite its huge role in

[2]The work orders included streetlighting plant that was since retired, but excluded streetlights added since 2003, so the other costs that AE assigned directly to streetlights may be more or less than $72.2 million.

the cost allocation. Until May 10, the only documentation that Foster Associates had provided to the parties, and apparently to the Company as well, were the six pages in the Application and the seven-page explanation in the response to AAMDC/AFREA-ATCO-8 Supplemental. On May 10, AE provided some of the data and a few calculations described in AAMDC/AFREA-ATCO-8.[3]

Q: How did Foster derive the direct assignments?

A: Despite multiple requests, AE has not provided a derivation of the direct assignments.[4] The assignment results, in some manner, from work-order data, regressions, and a 50% reduction in demand and customer allocators. [5]

The Company has offered general explanations of its regressions, such as that the "work orders were analyzed to determine a relationship between the number of lamps installed, the number and size of poles installed and the level of plant capitalized by account. The result of the review supported the determination that the primary reason for the installation of the poles was for streetlight function" (AAMDC/AFREA-ATCO-11(a)). In AAMDC/AFREA-ATCO-8, Foster indicates that it ran some regressions, and provides brief descriptions of those analyses, but leaves more questions than it resolves. Among other things, AE and Foster have not provided the following information:

- the data used in the regressions;

[3]The Company has provided an Excel workbook that appears to have data from AE (some of which was redacted) on 4,472 work orders, as well as various computations and other additions from Foster.

[4]See, for example, AAMDC/AFREA-ATCO-5, and 8

[5]It is my understanding that the 50% reduction in the customer and demand allocators affects only the $2.7M of non-assigned plant. Foster intends to adjust for the use by other customers of the $72.2M of plant directly assigned to streetlighting. The adjusted allocators may also be used in deriving the direct assignment.

- adjustments to the data, including the price adjustments, and the basis for those adjustments;
- an account of how the regression analyses were used in the direct assignment;
- the numerical effect of the regression results on the direct assignment;
- whether and how the regression analyses were used in "further allocation of non-street light secondary distribution infrastructure costs" (Technical Session, Slide12, Revised March 16 2007);
- the total effect Foster's regression analyses had on the final streetlighting cost allocation.

In discovery, AAMDC/AFREA requested the following information that would have allowed the parties to understand and evaluate Foster's analysis:

- an electronic copy of all spreadsheets used in the preparation of the direct assignment of distribution plant and expenses to streetlighting, including all formulas, lookup tables, tables of functionalization, classification and allocation factors, and supporting calculations (AAMDC/AFREA-ATCO-5).
- an electronic copy of all spreadsheets used in the preparation of the partial allocation of distribution plant and expenses to streetlighting (AAMDC/ AFREA-ATCO-5).
- the derivation of the direct assignment to streetlighting (AAMDC/AFREA-ATCO-5).
- the methodological rules and calculations for assignments of these investments between streetlighting and non-streetlighting (AAMDC/ AFREA-ATCO-7).
- the data drawn from the work order on which the calculation relies.

- how the data for the calculation is derived from the work order (AAMDC/AFREA-ATCO-7).
- how AE and the Foster analysis determine which non-streetlighting investments that are considered to "support" streetlighting (AAMDC/AFREA-ATCO-8).
- the methodological rules and calculations for assignments of investments between streetlighting and general distribution plant (requested for different descriptions of the AE-Foster methodology in AAMDC/AFREA-ATCO-8; -9).
- the work-order-derived data on which the calculation relies (AAMDC/AFREA-ATCO-9).
- other data used in the assignment and the source of that data (AAMDC/AFREA-ATCO-9).
- the methodological rules for determining whether underground service lines and conduits serve as the foundation for davits, and the methodological rules and calculations for the assignment of this investment to streetlighting (AAMDC/AFREA-ATCO-10).
- how AE determined from work orders which wooden poles were built to serve streetlighting only, and the methodological rules and calculations for the assignment of this investment to streetlighting (AAMDC/AFREA-ATCO-11).

Until May 10, none of the information requested had been provided. The Company had not even provided a copy of the data it provided to Foster.[6]

[6]In addition, Foster's explanations are often incomprehensible, or so vague as to be subject to widely varying interpretation.

In addition to all of the problems listed above, The Company has still not provided *any* documentation for the following analyses Foster claims to have performed and relied upon (Attachment 1, p. 5):

- "The pole work identified several work orders which were excluded from the study due to a [de] minimus streetlighting investment coupled with a major (e.g., greater than 5%) total non-streetlighting investment."
- "Several work orders where no new lamps were installed but seemed to represent a shifting of existing facilities associated with the widening of roads."[7]
- "A sample of work orders [for which] Foster requested ATCO Electric to perform a detailed analysis of facilities installed. Foster reviewed the analysis and used it to confirm both ATCO Electric's and Foster's assumptions."

Q: Does AE appear to understand what Foster did on its behalf?

A: No. In our telephone conversation of May 4, the AE staff claimed not to have received any documentation of the Foster study other than what few pages were provided in the Application. Hence, Foster had not even given AE the documentation that the Company would need to evaluate the analysis.

Q: What questions about the data used in the regressions were not answered in the Application or in responses to discovery?

A: The Company and Foster did not provide, for example, the following information:

- Which of the sixty-some data categories (Foster Report, pp. 2–3) were regressed against what other data. In AAMDC/AFREA-ATCO-8

[7]It is not clear what Foster intended to do with these costs.

Supplemental, AE provides three graphs, two of which (pp. 4 and 5) have identical labels ("Investment in Conductors vs. Number New Poles Non-Rural") but show different data.[8] Foster suggests that it performed additional regressions, and the ten assignment factors it recommends would require additional analyses, but no documentation of those have been provided.

- Which regressions were performed for rural installations, which for non-rural installations, and which for both.
- Whether the data used for the regression of conductor investment against the number of poles consist of (a) all poles and conductors on the system, (b) just the equipment in the 4,475 work orders, or (c) a subset of those work orders.[9]
- Whether Foster used 4,475 data points (one for each work order) or whether Foster aggregated the work orders by year. The small number of data points shown on the graph seems to suggest that Foster aggregated the data by year, which would result in the loss of about 99% of the data.[10]

Q: Has Foster explained how the regression analyses were used in "further allocation of non–street-light secondary distribution infrastructure costs."

[8]On May 10, less than a week before the due date of this evidence, AE finally provided us with some of Foster's work papers, which includes the figure on p. 5 of Attachment 1 labelled "Rural." As I discuss below, these two graphs represent neither investment in conductors nor the number of new poles.

[9]The file received May 10 suggests that at least a few of the regressions were performed for subsets of the work-order data. Foster provided only one of the three regressions it reported in AAMDC/AFREA-ATCO-8 Attachment 1.

[10]That conclusion was reinforced by worksheets provided on May 10.

A: Not in the Report. In AAMDC/AFREA-ATCO-8, Attachment 1, Foster introduces an entirely new step in its computations:

> The non-streetlight plant, by account, was compared with the streetlight plant to determine the average level of streetlight related plant investment in each non-street light account over the last ten years that occurs from each dollar of investment in the streetlight account. (P. 7)

Foster then lists the adders it applies to streetlighting, for five accounts, with different values for non-rural and rural lighting. For each dollar of street-light investment over "the last ten years," Foster claims to have found 38.2¢ of non-streetlight investment for non-rural lights and 36.1¢ for rural lights. Foster says, "These percentages…were multiplied by rural and non-rural streetlighting investment (Account 47-810) to calculate forecasted additions. These additions were directly assigned to the streetlighting function" (p. 7).

This discovery response was the first time that Foster mentioned the use of a ten-year period for a portion of the direct-assignment analysis. Neither the Company nor Foster has explained why, if the work orders included all the streetlighting investments from 1950 through 2002, Foster needed to use selected data for ten years and extrapolate to the entire streetlighting investment.[11] Consistent with its practice in other parts of the streetlighting assignment, AE has not provided a single computation regarding that important step in the analysis.

Q: Given the limited information available from Foster, can you form any opinion regarding the use of the regressions?

A: Yes, to a limited extent. It appears that Foster

[11]This step may account for how Foster and AE managed to inflate $10 million (in 2002 dollars) in non-streetlighting plant in work orders with streetlights, into about $40 million in mixed nominal dollars.

- set up the analysis in a manner that would be likely to produce spurious correlations,
- clearly used the wrong and meaningless data, and
- may have misinterpreted the results of the regressions.

Q: What was wrong with the structure of Foster's regression analysis?

A: While no one other than Foster knows all the regressions that Foster performed, we do have two examples: underground service investment as a function of the number of davits, and conductor investment as a function of the number of new poles.[12] In neither case has Foster revealed what the data comprise (all the work orders, a selection of work orders, total work orders for a year, or total annual book investment). I assume for this discussion that each data point is a work order, but the critique would be the same for any of the data sources.

Foster finds that years with more davits have greater investment in underground services. That is not surprising, since davits are used with lights served from underground distribution. In any underground distribution project, the services will be underground, whether they are services for a house, a store, a traffic light, or a streetlight.[13] A year with underground projects serving many houses (as in a large residential development) or many stores (as in a major redevelopment of a town center) and hence including many services, is also

[12]Foster provides two graphs labelled identically (as conductor investment as a function of the number of new poles, non-rural), with different data and data ranges. The text suggests that one of the regressions was intended to estimate conductor investment as a function of the number of "site/lamps" (whatever a site/lamp might be), but the graph matches results in the May 10 file for rural conductor investment as a function of the number of new poles.

[13]Overhead-served streetlights are generally served directly from the secondary lines, but some underground-served streetlights may be far enough from the secondary lines to require a service drop.

likely to include many streetlights, and hence require many davits. A year with few davits will have few new underground-served streetlights, and thus likely serve little additional areas with underground distribution and few new buildings with few services. Hence, the number of davits in a work order is likely to be correlated with the investment in services, even were none of the services actually serving the streetlights.

Similarly, Foster's conclusion that the years with more poles have more conductors would be true regardless of whether the poles or conductors are required for streetlights or some other customer type. Conductors run between poles; years in which many poles were added would require lots of conductor to span them. This correlation would not tell Foster anything useful about how streetlights cause the installation of conductors (even had Foster not made so many errors in the regressions).

Foster's correlations here may be entirely spurious, just as would the likely correlation of the number of burglaries in a city and the number of cars registered in the city. Both burglaries and cars rise with the size of the city; neither causes the other.

Q: Where did Foster use wrong and meaningless data?

A: In the two pole regressions described in Attachment 1, Foster claims to regress conductor investment on the number of new poles. In the May 10 file, the graphs provided in Attachment 1 are derived from regressions of inflation-adjusted annual values labelled "Sum of TotalSites" as a function of the sum of values labelled "Sum of Existing pole" and "Sum of TotalPoles." From other sheets in the May 10 file, it appears "Sum of TotalSites" has nothing to do with the sites identification numbers in the work-order database, and is simply the sum of "Sum of Existing pole" and "Sum of TotalPoles." The "Sum of Existing

pole" value appears to be the total number of existing poles used in any way in the work orders for that year, and "Sum of TotalPoles" appears to be the total number of new poles added in the work orders for that year. In other words, Foster regressed the number of poles used in the work orders, times an inflation factor, against the number of poles. Neither the conductor investment nor the number of new poles was an input to this regression.

Q: Did Foster really regress the number of poles times an inflation factor against the number of poles, and claim the result was a regression of conductor investment versus new poles?

A: Yes.[14]

Q: Is there any possible justification for applying an inflation adjustment to the number of poles, or for performing the regression Foster performed?

A: No. Foster probably intended to perform completely different regressions.

Q: How may Foster have misinterpreted the results of the regressions?

A: In AAMDC/AFREA-ATCO-8, Attachment 1, Foster claims that regressing

> the price-level adjusted underground services and conduit investments in relation to the number of davits installed by year…. explained over 75% of underground services and conduit investments were related to the streetlighting function. (P. 3)

and that regressing

> price-level adjusted conductors…[against] the number of new poles and davits installed, as well as between price-level adjusted conductors and the number of site/lamps. These models seemed to explain that about 55–70% of conductor investment was related to the streetlighting function. (P. 4)

[14]Foster did not even get the inflation adjustment right. The inflator Foster applied for 1950 was the inflator Foster computed for 2001. For rural investment, the inflators used for 1962–2002 were computed for five years earlier, and the inflators for 1954–60 were off by one to four years.

Foster did not provide any explanation of how it derived the percentages of plant that it assigned to streetlights. The appropriate approach would be to use the regression analyses (were those were performed properly, and without spurious correlations) to estimate the streetlight-related non-streetlight costs, and divide that estimate by the total streetlight investment. There is no evidence that Foster did anything of the sort.

It may be coincidental, but the regression that Foster provided for underground services had an R^2 of 0.7437, very close to Foster's claimed 75% of underground services and conduit attributable to streetlights.[15] Foster reported that the two regressions it thought were for conductors had R^2 values of 0.5658 and 0.7119, which would round off to the 55%–70% of conductor investment Foster claimed was related to streetlighting.[16] Hence, it appears that Foster may have confused the R^2, a measure of goodness of fit, with the portion of the other investments that would be explained by the coefficients of the regression equations.

Q: What additional steps would Foster have needed to convert regressions of the sort it reports in AAMDC/AFREA-ATCO-8, Attachment 1, pp. 3–5 to the assignment factors on page 7 of Attachment 1?

A: The description provided so far is missing at least three steps. First, Foster would have needed to perform the remainder of the regressions (or whatever other statistical analyses Foster refers to on page 3 of Attachment 1) for 1950–2002. At page 7 of Attachment 1, Foster provides ten ratios of various accounts to Account 48-710, for either rural or non-rural plant. Foster has only provided

[15]Perhaps Foster had another regression for conduit with an R^2 slightly over 0.75.

[16]The workbook provided on May 10 included the graphs that Foster used on pages 4 and 5 of AAMDC/AFREA-ATCO-8, Attachment 1, but not the actual regression results.

three regressions, and one of those ("Investment in UG Services ($2002) vs. Number of Davits") does not differentiate between rural and non-rural areas.[17] Hence, eight additional regressions would be needed to do what Foster claims it did.

Second, all three of the regressions Foster has provided attempted to compare dollars of some category of non-lighting plant to physical units of lighting equipment (davits) or general distribution equipment (poles). In order to get to the assignment factors on page 7 of Attachment 1, which are in dollars on non-lighting plant per dollar of lighting plant. Foster would need another set of analyses to determine how dollars of each category of non-lighting plant vary with dollars of lighting plant.

Third, Foster claims to have done some analyses of costs over the past ten years, in some way modifying or supplementing the longer-term analyses. (Attachment 1, p. 7) Given the emphasis in the Application on the use of all the streetlighting work orders since 1950, it would be strange if Foster were to rely entirely on post-1992 data.

Foster has not documented any of these steps.

Q: Did Foster claim to do any other analyses to support its regressions?

A: Yes. Foster claims that

> an analysis of the number of poles installed in comparison to the number of site/lamps was undertaken. The pole work was done on a work order by work order basis to ensure consistency. A tight relationship of one pole per site/lamp was found. This analysis insured no statistical outliers existed to counter-balance each other. (AAMDC/AFREEA-ATCO-8, Attachment 1, p. 5)

[17]The other two regressions, as described above, are nonsense.

While it is not clear what a site/lamp might be, the spreadsheet the Company provided on May 10 shows a total of 30,480 new lamps and 16,103 conversions, but only 6,427 new poles installed. Hence, no "tight relationship of one pole per site/lamp" could have been "found."

Q: Are the magnitudes of the assignment factors on p. 7 of Attachment 1 consistent with the data AE has provided?

A: No. Each assignment factor cannot be greater than the ratio in the work-order database of investment in the non-streetlighting account to streetlight investment. Foster seems to recognize the following costs in the work order database should not be treated as related to streetlights:

- portions of the conductors, conduit and underground services identified in the regression analyses (AAMDC/AFREA-ATCO-8, Attachment 1, pp. 3–5).
- several work orders with "a [de] minimus streetlighting investment coupled with a major non-streetlighting investment" (p. 5).
- "several work orders where no new lamps were installed but seemed to represent a shifting of existing facilities associated with the widening of roads" (p. 5).

Hence, the assignment ratios should be somewhat lower than the ratios in the database.

Yet the assignment ratios are *higher* than the investment ratios in the database. The following table compares the assignment factor for each account, averaged over non-rural and rural factors, to the database investment ratio,

unadjusted and adjusted for the non-streetlight portions of conductor, conduit and services Foster reports from its regressions.[18]

Account	Foster Ratio	Database Ratio	
		All	*Modified*
Poles 47300	7.9%	7.5%	
Conductor 47400	4.6%	3.7%	2.0%–2.6%
Conduit 47500	16.3%	9.5%	7.1%
U/G Services 47510	6.0%	10.6%	8.0%
Line X'mers 47900	3.4%	2.3%	
Total	38.1%	33.6%	26.9%–27.4%

Only the underground service ratio could conceivably be correct. The Foster ratios for the other accounts range from 5% to 71% above the unadjusted ratios from the database and are more than double the adjusted rations for conductor and conduit. In other words, Foster somehow concludes that more than 100% of the non-streetlight costs in the database are due to the streetlights.

C. Reducing Streetlight Allocators to Reflect Assigned Plant

Q: How did AE adjust the amount of non-streetlight plant allocated to streetlighting, to recognize the fact that a large amount of secondary plant was directly assigned to this class?

A: In the Application, Foster states:

> Using professional judgment and the work order analysis, Foster Associates recommends street lighting billing determinants used to allocate secondary distribution system investments (e.g., non-Account 47-810) to street lighting be reduced by 50%. (Application, Section 4, Attachment 2, p. 4)

[18]I weighted the rural and non-rural assignment factors using the non-rural percentage (94.5%) of streetlight investment in the work orders whose location is identified. More than 20% of the streetlight investment in the work-order database is not identified in the "Rural/Non-rural" column.

> The non-street lighting investments do not suffice to totally displace the need for an allocation of secondary distribution costs to street lighting. (P. 5)

Foster expanded on its approach in discovery, where it said that this

> issue was more difficult to analyze. If such non-streetlighting directly assigned assets were found to be a complete substitute for the secondary distribution system (i.e., thus attaching to the primary distribution system), then such plant assets would not require the use of the secondary distribution system and no secondary distribution system costs should be apportioned to the streetlighting function.
>
> To answer this complex question, an analysis was performed for each plant account or asset. The following rationale was applied to each of the 4,475 work orders. If any non-streetlight work order, not included within Account 47-810, *contained a job which was not a complete substitute for the secondary distribution system*, then that non-streetlight plant, represented in that work order, would, by necessity, have to use a portion of the secondary distribution system and could not be a substitute for the secondary distribution system. Following this reasoning, some level of secondary distribution system costs would need to be allocated to streetlight Rate 61 customers. (AAMDC/AFREA-ATCO-8, Attachment 1, p. 6, emphasis in original)

Q: Does this description seem reasonable?

A: For the most part. The one problematic point in the description is the focus on the work order containing *a complete substitute for the secondary distribution system.* Any equipment that substitutes for any part of the secondary distribution system should be credited to the streetlighting class, whether or not the work order contains the entire secondary system. From this description, it is not clear whether Foster intended to count (properly) all plant that substitutes for any part of the secondary distribution system, or (improperly) only plant in work orders that included all the secondary equipment that the streetlights required.

Q: Did Foster's subsequent discussion of its method clarify this point?

A: No. The discussion on pages 6–7 of AAMDC/AFREA-ATCO-8, Attachment 1, regarding the rationale for determining which secondary costs are redundant with direct-assigned transformers, poles and lines is largely incomprehensible, and frequently incorrect. For example, Foster states as follows:

- "Only a minority of the work orders contained an investment in line transformers greater than $100. We termed this level of investment 'significant' meaning the investment was not de minimus and was at least $100." Foster's statement that investments "greater than $100" are "at least $100" is certainly true, but not very helpful in computing the portion of streetlighting that is served by direct-assigned transformers.
- Direct-assigned "line transformers comprise non-streetlight plant and could not be a substitute for the secondary distribution system," when clearly they could substitute for allocated transformers.
- "If the streetlights…with no new poles and…those only with davits were directly attached to the primary distribution system, then these streetlights would not utilize the secondary distribution system and thus could not be a substitute for the secondary distribution system." Again, Foster's assertion is false; if the streetlights do not use secondary distribution, the direct-assigned plant has replaced the general secondary system.
- "Streetlights…with new poles would utilize some level of secondary distribution pole system costs and would need to be allocated to streetlight Rate D61 customers." Of course, the streetlights would be allocated to Rate D61. However, if the new poles serve other classes, or the new pole has a transformer on it, or is adjacent to the pole with the transformer, not other secondary poles would be used by the streetlights and no pole costs would need to be allocated for those streetlights.

- "The analysis of lines was consistent with the apportionment of secondary distribution system costs for poles. This meant that some level of secondary distribution system costs for wires would need to be allocated to streetlight Rate D61 customers." It is not clear what Foster means by "consistent with." Perhaps Foster believes that streetlights with new poles should be allocated line costs, or that streetlights with new lines should be allocated line costs. Or something else.

Q: Has Foster provided any other detail on its determination of the share of streetlighting that can be served by the direct-assigned plant?

A: In the Application, Foster provides some information about its approach for line transformers.

> The ratio of total wattage of street lamps fed by the secondary distribution system's line transformers (e.g., where such line transformer investment was significant) to the total wattage of all street lamps was calculated. The result showed approximately one-third of street light wattage was identified and corresponds to work orders showing significant line transformer investment. Thus, one-third of line transformer-supported street lamp investment did not require any additional allocation of secondary distribution system investment. (Section 4, Attachment 2, p. 4)

Foster does not provide its computation of the one-third values. Nor does Foster provide any comparable explanation for other accounts (conductor, conduit, services, poles).

Q: Did AE provide any work papers or computations showing how Foster progressed from the discussion you summarized above to the 50% reduction in streetlight allocators?

A: No.

D. Plant Assigned to Streetlighting that Also Serves Other Classes

Q: Does Foster acknowledge that the non-streetlight plant it assigns to streetlighting also serves other customers?

A: Yes. Foster makes that point very clearly:

> Foster recognizes this direct assignment includes some distribution investments that, overtime, may be used by other rate classes…. The analysis of total street lighting-related work orders provided evidence that plant investment in street lighting also serviced other secondary distribution system functions. For example, a certain level of line transformer investment was directly assigned to street lighting. Additionally, both poles and conductors used in street lights also may be used for other non-street lighting secondary distribution system functions. (Application, Section 4, Attachment 2, p. 4)

> A review of a sample of work orders showed the related secondary distribution system investment contained capacity investments that could be used to serve other rate classes. (P. 5)

Q: How did Foster reduce the assignments of non-streetlighting plant to streetlighting customers, to reflect the use of that plant to serve other classes?

A: Foster asserts that "an adjustment made prior to the allocation of related secondary distribution system investments to street lighting corrects for this and will be explained below" (Application, Section 4, Attachment 2, p. 4). I cannot find any such adjustment in the Application. The only adjustment following the promise quoted above turns out to be Foster's recommendation that the streetlighting allocators be reduced 50% to reflect the fact that assigned plant reduces the streetlights' need for allocated plant, as discussed in the previous section of this testimony.

Q: Could the 50% reduction in the streetlight allocators include a credit for the non-streetlight plant that AE assigns to streetlighting but also serves other customers?

A: No, for two reasons. First, the reduction in streetlight allocators is entirely the wrong type of computation to reflect this credit. Reducing the streetlight allocators to reflect the first consideration (the fact that assigned plant substitutes for allocated plant) would properly vary the adjustment in proportion to the amount of plant that would otherwise be allocated to streetlighting. But for this second consideration—the adjustment for streetlight-assigned plant that serves other classes—adjusting the streetlight allocators makes no sense. Foster recognizes that some assigned plant serves other customer classes but fails to follow through by reducing the plant assigned to streetlights. This second adjustment would properly vary with the amount of plant that would otherwise be assigned to streetlighting.

Second, the allocated plant is probably too small to reflect the amount of streetlight-assigned plant that serves other classes. Depending on which of the Company's data one starts with, at least $20 million (and perhaps as much as $40 million) in non-streetlighting plant is assigned to streetlighting. In contrast, only about $2.7 million in non-streetlighting plant is allocated to streetlighting (PICA-ATCO-2(a)). If as little as 14% of the non-lighting plant assigned to streetlighting serves other classes, even reducing the lighting allocators to zero could not capture that effect.

Q: Are there other peculiar results in the direct assignments or allocations to streetlighting?

A: Yes. One example would be Foster's attribution of $4.2 million of service drops to streetlighting in the current cost-of-service study (Schedule 4-Bs, p. 22). I say

"attribution" because I cannot tell whether these costs are assigned or allocated. $3.2 million of service drops, of which Foster concludes only 75%, or $2.4 million, are assignable to streetlights.

Q: What is your recommendation to the Board regarding the direct assignments to streetlighting?

A: Directly assigning costs is desirable, where it is possible to identify the costs that are incurred for only one rate class and are dedicated to that rate class, and the assignment is not duplicative of allocations of plant used by multiple classes. When investments serve a mix of customers, they should be allocated, not assigned.

The Board cannot rely on the Foster study for direct assignment of distribution plant to streetlighting. The Company and Foster Associates have not been able to document most of the analyses, some of the few computations Foster provided are incorrect and nonsensical, Foster's explanations and reasoning are frequently incomprehensible, and Foster's recommended assignments require that more than 100% of the distribution plant in its database be directly assigned to streetlighting.

IV. Direction 13: Classification of Non-Assigned Distribution Costs

Q: What is the Foster study's approach to deriving distribution plant classification factors?

A: In Foster Associates' view, customer-related costs and demand-related costs are separable:

> In classifying the distribution function, the demand and customer relatedness split is based on the two distinct purposes of the distribution system. The first is to attach customers to the system and, from a cost of service perspective, such costs clearly are customer-related. The second purpose is to meet existing customers' demands beyond their minimum load. These costs clearly are demand-related. (Foster, p. 8)

In other words, Foster conceptualizes the division in cost causation between load and customer number by rules that amount to:

- The number of units (feet of line, number of meters) is due to the number of customers.
- The size of units is due to the load.

Q: Are these rules based on a realistic view of an electric distribution system?

A: No. This view is overly simplistic, for three reasons. First, much of the cost of a distribution system is required to cover an area, and is not really sensitive to either load or customer number. For example, serving many customers in one multi-family building is no more expensive than serving one commercial customer of the same size, other than metering. Extensions to span areas should not be allocated to streetlighting. Adding lights to an existing system will not add much more to the costs of the system other than the sum of the Streetlight Account and dedicated streetlighting expenditures.

The distribution cost of serving a geographical area for a given load is roughly the same whether that load is from concentrated commercial or disbursed residential customers.[19]

Second, load levels help determine the number of units, as well as their size. As load grows, utilities add distribution feeders and transformers in parallel with existing equipment, such as adding a transformer to serve one end of a

[19]See Bonbright, James C., Albert L. Danielsen, and David R. Kamerschen, *Principles of Public Utility Rates*, Arlington, VA: Public Utilities Reports, 1988., p. 491.

block, as load grows beyond the capability of the transformer originally serving the block. Indeed, large customers may be served by multiple transformers to increase reliability.

In general, more small electric customers than large customers can be served from one transformer. Higher loads require larger service drops and secondary wires, so more transformers are added to reduce the length of the wires. This multiplication of transformer number is expensive because (1) transformers show large economies of scale in dollars of investment per kVA of capacity, and (2) dispersed transformers have lower diversity than transformers serving many customers, increasing the total installed kVA required to meet customer load.

Third, load can determine the type of equipment installed, in addition to size and number. Electric distribution systems are often relocated from overhead to more expensive underground because the weight of lines required to meet load makes overhead service infeasible. Voltages may also be increased to carry more load, increasing the costs of equipment (e.g., insulation requirements for transformers and lines).

Q: Will these minimum-system approaches produce a reasonable classification of costs?

A: No. As Bonbright, Danielsen & Kamerschen explain, these approaches attempt to classify costs that are fundamentally "unassignable":

> the inclusion of the costs of a minimum-sized distribution system among the customer-related costs seems to us clearly indefensible….[cost analysts are] under impelling pressure to fudge their cost apportionments by using the category of customer costs as a dumping ground…. (Pp. 491–492)

Small customers are especially burdened when a high percentage of costs are assumed to be customer-related; allocations should not rely on these flawed methods.

Q: How is the cost of the minimum distribution system generally derived?

A: The most common methods used are:

- The Minimum-System Method,
- The Zero-Intercept Method.

Foster uses both approaches and averages their results

Q: Please describe the Minimum-System Method.

A: A minimum-system analysis attempts to calculate the cost (in constant dollars) of the utility's installed units (transformers, poles, conductor-feet, etc.), were each of them the minimum-sized unit of that type of equipment that would ever be used on the system. The analysis asks, How much would it have cost to install the same number of units (poles, conductor-feet, transformers), but with the size of the units installed limited to the current minimum unit normally installed? This cost will be customer-related, and the remaining cost will be demand-related.[20]

The ratio of the costs of the minimum system to the actual system (in the same year's dollars) produces a percentage of plant that is claimed to be customer-related.

Q: Please describe the Zero-Intercept Method.

[20]The customer-related portion (which is computed in constant dollars) must be compared to the actual installed cost of the entire account (in mixed dollars); translating actual mixed dollars into constant dollars can be difficult, especially under conditions of technical change and different inflation rates for large and small installations (small installations are often more related to labour costs than are large ones, for example).

A: The Zero-Intercept Method attempts to extrapolate the cost of equipment below the size of the minimum system, to the cost of equipment that carries zero load, as in 0-kVA transformers, or the smallest units legally allowed (as 25-foot poles), or the smallest units physically feasible (e.g., the thinnest conductors that will support their own weight in overhead spans). The idea is that this procedure identifies the amount of equipment required to connect existing customers, even if they had virtually no load.

Q: Does the minimum-system method exclude all demand-related investment?

A: No, for the following reasons:

- The minimum system includes equipment that would carry a large portion of the average customer's load. Foster recognizes that the minimum system it classifies as "clearly customer-related" does carry load (Application, Section 4-Attachment 2, pp. 2-3). For example, on the AE system, its minimum-sized 10 kVA transformer is adequate to serve many street lights. Since the minimum system probably carries all of the streetlighting load, the $1 million of non-assigned demand-related plant allocated to streetlighting is double-counting (rbast43, "Mid-yr_GrossPP+E").
- The current minimum unit is sized to carry expected demand. Consequently, as demand has risen over time, so has the minimum size of equipment installed. In fact, utilities usually stop stocking some less-expensive small equipment because rising demand has resulted in very rare use of the small equipment and the cost of maintaining stock was no longer warranted.
- Minimum-system analyses usually ignore the effect of loads on the number of units installed, or the type of equipment installed. Hence, a portion of the costs allocated to customer number is really driven by demand.

- Minimum systems analyses fundamentally assume that all area-spanning investment is caused by the number of customers. As described above, this is not true.

Q: How should the number of units installed be categorized as customer or demand-related?

A: A type of equipment (e.g., transformer, conductor, pole, service drop or meter) should be considered dedicated investment and therefore customer-related only if the removal of one customer eliminates the unit. The number of meters and services (although not the size) are customer-related, while transformers, conductors and poles should be largely demand-related, especially in non-rural areas. Reducing the number of customers, without reducing the demand in an area, will

- occasionally eliminate a transformer, for an isolated customer, whose transformer serves no other customers.
- sometimes eliminate a span of secondary conductor, if the customer is the furthest one from the transformer on that secondary.
- rarely eliminate a pole, if the customer is at the end of the primary line.

In many situations, additional transformers and conductors are added to increase capacity, rather than to reach an additional customer.

Q: Can the zero-intercept method be relied on to determine the customer-related portion of plant?

A: No. The determination of the number of units required for a zero-demand system are far from simple. A system designed to connect customers but provide zero load would look very different from the existing system. For example, a zero-capacity electric system would not use the overlapping primary and secondary systems and line transformers, that the real system uses. Street

lighting, with its very low loads, uses a single distribution voltage, which eliminates a large number of conductor-feet, reduces the required height of many poles, and eliminates the need for line transformers, implying that all line-transformer costs are demand-related.

The zero-intercept method is so abstract that it can be interpreted in many ways, and can produce a wide range of results. Any use of this method must be grounded in a firm understanding of the purpose and conceptual framework for defining a zero-intercept.

Q: Have you identified any calculational errors in Foster Associates' zero-intercept system analysis?

A: Yes. In its zero-intercept analysis of each of the three distribution components, Foster incorrectly calculated the customer-related portion as the ratio of the zero-intercept to the cost (derived from the regression line) of the average-sized unit. The zero-intercept should instead be compared to the actual system average cost per unit, a larger number. As a result, the Foster analysis overstates the percentage of plant that is customer-related.

Q: Would correction of this error be enough to make the minimum system analysis a reliable basis for classification?

A: No. For the reasons discussed, the methods used by Foster are fundamentally flawed.

V. Direction 20: Definition and Calculation of Street Lighting Customer Counts for Allocation

Q: How did AE determine the number of streetlighting customers for allocation?

A: The Company delegated this determination to Foster Associates. In the Application, Foster points out that streetlighting "customers are no longer the Utility's direct customers" and asserts that, as a result, it has no "accurate count of the number of street lighting customers" (Application, Section 4, Attachment 2, p. 59).

I find it surprising that AE cannot determine the number of streetlighting customers it serves, since AE would need to know, for each light, who to contact if that light needs to be relocated for distribution-system work; who has authorization to add, remove or convert lights; and who is authorized to request information on streetlight counts for particular customers.[21]

The fact that AE does not know the number of streetlighting customers it serves strongly suggests that the number of streetlighting customers on AE's system does not impose any costs on AE, and should be set to zero for cost-allocation purposes.

Q: How many streetlighting customers does Foster estimate AE serves?

A: Foster claims that there are 1,046 "unique accounts," although these do not seem to be separate accounts that AE uses for any purpose. In Foster's view, a unique account is characterized by any "locational names representing the municipality's subcategories (i.e., school districts and departments of park and recreation) where such locations would also connect to AE's system" (Application, Section 4, Attachment 2, p. 59).

Q: Does Foster know how many streetlights the Company has on its system?

[21]The Company was so protective of customer privacy that it redacted all customer identifiers from the streetlighting work orders and the summary of those orders.

A: In Table 20.1 of the Application (Section 4, Attachment 2), Foster reports a "sum of customer count" of 28,989, a "count of customer count" of 29,640 and 35,800 lamps.[22] The "sum" is the average number of lights served each month, while the "count" is the total number of lights served at any time during the year (or whatever period Foster used in its analysis). Foster does not explain why the number of lamps is so much larger than the number of lights.[23] In the Application, Section 4, Attachment 4, Foster reports 34,400 streetlighting sites.

Q: When Foster uses the term "customer" in Table 20.1, does it mean "customer" in any sense relevant to cost allocation?

A: No. In various places, Foster uses "customer" to identify (1) a municipal entity with an identification number on AE's data system, (2) any identifiable "additional locational names representing the municipality's subcategories (i.e., school districts and departments of park and recreation)," and (3) any light.

Foster recognizes that each of the streetlights on the system is not a separate customer, but does not appear to have any specific cost-based definition of a streetlighting customer.

Q: What definition of "customer" is relevant for the allocation of costs to streetlighting?

A: Counts of customers (or similar measures) are used in several ways in AE's COSS, but those can be simplified to two basis cost-allocation issues: (1) billing, load-settlement, and other customer-service costs and (2) the portion of the secondary distribution system deemed to be customer-related.

[22]Table 20.1 consists of only the first few lines and last few lines of a much larger table.

[23]Foster sometimes refers to lamps as "sites," further confusing the nomenclature.

Q: What definition of "customer" is relevant for the allocation of the customer-service group of costs?

A: For these categories, costs vary with the number of entities for which AE (and sometime other entities, such as I-Tek) must track and respond to usage, retailer choice, billing inquiries, and similar interactions. For streetlights, the relevant unit would appear to be the municipality, unless the municipality elects to split its streetlights as separate customers for billing and customer-choice purposes. For each municipality, the number of streetlights of various sizes is analogous to the number of kilowatts of billing demand and the kilowatt-hours of energy used by a commercial customer. Just as a store is treated as a single customer, regardless of how many kW and kWh it uses, a municipality is a single customer, regardless of how many streetlights it pays for. The store has a meter, gets a single bill, selects a single retailer, and is a single entity for the purpose of requesting data, upgrades, and other services. The municipal streetlighting load has a list of lights (which should be easier to administer and explain than meter reports), gets a single bill, elects a single retailer, and is a single entity for the purpose of requesting data, upgrades, and other services.[24]

Q: How many streetlighting customers should AE count for purposes of allocating load settlement and other customer-service costs?

A: The complete version of Table 20.1, which AE provided in response to AAMDC/AFREA-ATCO-22, lists a total of 204 municipalities. Unless some those municipalities choose to split into two streetlighting customers for billing and retailer choice, the streetlighting customer count should be 204. If the "Site Customer" column of Table 20.1 actually represents independent entities for

[24]Again, unless the municipality wishes to be treated as multiple customers.

billing and retailer choice, the streetlighting customer count could be as great as 321.

One temporary exception to this rule may be the allocation of costs under the Master Service Agreement (MSA) with ATCO I-Tek. From the Application, Section 4, Attachment 4, it appears that the MSA specifies a price per delivery site for the "Service Accounts" portion of the customer billing charge. Foster's applies that charge to 34,400 streetlighting sites (which is of the same order of magnitude as the number of lights or lamps, but not the same as any other measure of streetlights in the Application). That treatment may be rational, given the current MSA. As noted above, the number of sites is irrelevant for determining the real billing cost of a non-metered lighting customer. The bill is a number of lights of various sizes; so long as that bill is sent to a single customer, only a single billing fee should apply. The Company should be instructed to change the MSA to treat all non-metered usage on a single bill as a single unit for billing purposes. That charge should be no larger than the charge for billing a single metered customer.

Q: What definition of "customer" is relevant for the allocation of distribution costs?

A: As I discuss with reference to Direction 13, customer count is often used as a poor proxy for the effect of each class on the costs required to cover the service territory. The reasoning is that the number of poles and transformers and the kilometres of conductor are (to some extent) driven by the need to have the secondary system run to every occupied corner of the service territory, and that classes with more customers require service to more locations than classes with fewer customers. In this view, since there are many more residential customers than commercial customers, there are likely to be many more poles added to

reach a residential customer at the end of a line, and many more transformers added to serve a residential customer who is too far from any existing transformer, compared the commercial class.

This argument does not apply for streetlighting, since Foster directly assigns to streetlighting the cost of every meter of line, every pole, and every transformer added to serve a streetlight (and probably much more). If AE must use customer number for allocating distribution plant, it should set streetlighting customer count to zero for this purpose.

VI. Direction 24: Re-estimation of Customer Weighting Factors

Q: What customer weighting factors did Foster derive?

A: Foster developed demand and customer weighting factors for transformers, service drops, and meters. For streetlighting, weighting factors were derived only for transformers, since streetlighting is not allocated any share of meters and non-assigned service drops. As I discuss in relation to Direction 20, customer number has a very small effect on the number of transformers.

Q: How did Foster derive the demand weights and customer weights to be applied to transformers?

A: First, Foster placed transformers into service categories. The service categories were defined by meter type and rate class. The transformers in each category vary in size according to the range set in Foster's analysis. The categorizations and transformer size ranges are provided on page 65 of Section 4, Attachment 2.

Second, Foster calculated the demand and customer weighting factors as the total transformer number and total kVa capacity assigned to each customer category divided by the category's customer number and total kW, respectively.

Q: Is the basis for the assignments adequately documented?

A: No. Foster omits the following information essential to the evaluation of the weighting factors:

- the source of the total number and kVa of transformers,
- the streetlighting customer number used in the derivation of the street-lighting weighting factors,
- a disaggregation of the number and kW of assigned customers by class,
- the basis for the maximum kVa transformer size for each service group,
- the number of transformers of each specific size assigned to each customer class,
- the number of transformers by kVa size that end up being assigned to the residual group, including streetlighting,
- The basis for these assignments.

Q: Have you identified specific problems with Foster's analysis?

A: Yes. Despite the limited documentation, I have identified two problems in the analysis. First, Foster's derivation of the weighting factors, especially the assignment of particular transformers to particular customer groups, is essentially a hypothetical exercise, not tied to how the system actually works. Foster simply assumes that certain types of customers are served by certain sizes of transformers. A large transformer can serve a cluster of residential customers; a bank of smaller transformers can serve one large customer, and a single transformer can serve a mix of customer types. The mix of transformer sizes serving each customer class is not as simple as Foster assumes. If AE wants to know the size of transformers serving various classes of customers, it should select a representative sample of customers and determine the size of transformer serving each customer by checking its records or the actual

equipment. The same study would allow AE to determine how often a customer is critical in determining the need for an additional transformer, which would greatly improve AE's classification of transformer costs.

Second, Foster chose to group streetlights, the smallest of loads, with the large demand-metered customers, including the Large General Service customers. Foster computed a single hypothetical ratio of customers per transformer for this wildly heterogeneous group. As a result, the smallest customers are assumed to use as much of a transformer as the largest customers.

Q: Does this conclude your testimony?

A: Yes.