Best Practices for LDC Construction – A Gas Distribution Construction Cost and Procedure/Process Benchmark Assessment

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Abstract

This document details a two-phase study designed to identify and collect information on critical practices utilized in the construction of natural gas distribution systems. Washington Gas and the Gas Technology Institute (GTI) sponsored this study with the intention of identifying best practices used by the best performing firms. FMI Corp. was retained to complete both phases, collect and then benchmark construction cost, disseminate information, and to identify trends and practices from peer companies that produce superior construction performance.

Introduction

This report contains a list of categories where FMI established a strong relationship between the use of a particular practice and superior construction performance. This performance is measured by relatively low cost to construct and high output of that construction. This study is not designed as an academic exercise. It is structured to present senior management at each of the participating companies with a series of practices to handle the market fulfillment, design, and construction activities and work with the senior management team to take action and improve performance. In the following pages, we detail the practices used by these best performing firms, the characteristics that got them there, and describing how to approach the implementation of these "Best Practices." It is our hope that the organizations will pursue implementation and drive process/performance improvement.

FMI Corporation with partner Hazelden Group conducted a benchmarking/best practices study for GTI at Washington Gas. The objectives of the study were to build distribution construction cost benchmarks, establish the degree of correlation (relationship) between the survey characteristics and the benchmarks, and establish the practices associated with lower costs to construct mains and services.

The overall objectives were:

1. Establish benchmark cost comparisons for three types of distribution construction:
   - New Construction,
   - Market Enhancement,
   - Replacement/Rehabilitation.
2. Analyze components of construction costs and critical processes or procedures to identify cost drivers.
3. Identify opportunities for participants to improve construction performance based on the benchmarks.

To undertake this type of analysis, FMI planned two phases:
Phase I – Initial Survey, Analysis, and Report Presentation
Phase II – In-depth Interviews, Analysis, and Report Presentation.

Phase I Initial Survey and Analysis

Phase I used a survey instrument to gather basic information and firm characteristics from 43 gas distribution utilities. FMI targeted the top 50 gas distribution firms based on number of customers and smaller firms were also invited to

participate. Once a completed survey instrument was received, FMI worked with each organization to ensure that a reasonable level of consistency and accuracy existed between responses. There were, however, differences in how a firm tracks and reports information described in this study.

The analysis of the completed surveys focused on establishing benchmark construction costs for the installation of main and service on a per foot basis and the installation of services on a per service/hook-up basis. The firms were then ranked based on their cost to construct and the level of correlation (relationship) between a relatively low cost to construct and the information requested in the survey. The intention was to begin to identify the characteristics that tend to drive construction costs up or down.

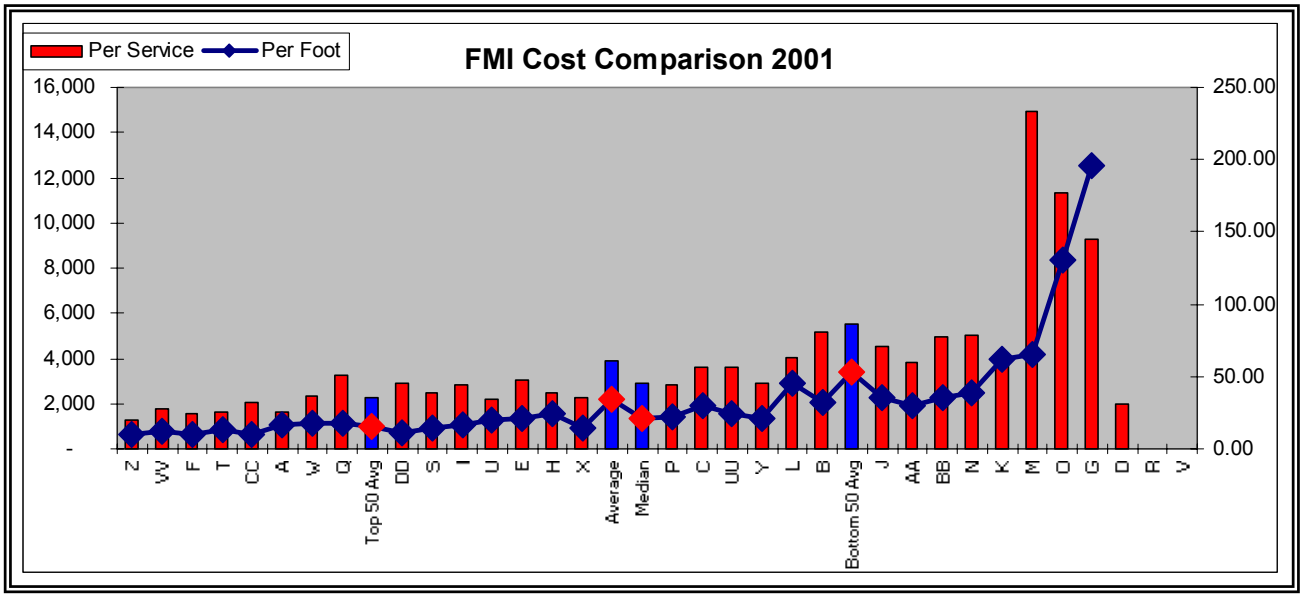
The participating firms in Phase I were headquartered in twenty-five (25) states and operate in thirty-two (32) states. The respondents ranged in size from as few as 3,000 customers to as many as two million. The average customer size was slightly less than 700,000.

A cost comparison index was developed so that we could benchmark the firms versus each other. This cost comparison was made possible by a three-part process:

1. Calculation of an average cost per foot,
2. Calculation of an average cost per service/ hookup,
3. Development of a combined cost index.

To arrive at an average cost per foot (three-year average), the total linear feet of new and replacement main plus new and renewal service pipe installed from 1999 to 2001 was divided into the sum of capital expenditures for the same period. Similarly, the total number of new and renewal services, or hookups was divided into the sum of capital expenditures to reach a three-year average cost. (The capital expenditures figures described above were reduced by dollars spent on special or infrequent construction, as the focus of this research is new construction, market enhancement and replacement / rehabilitation only.)

So that each company or public utility could

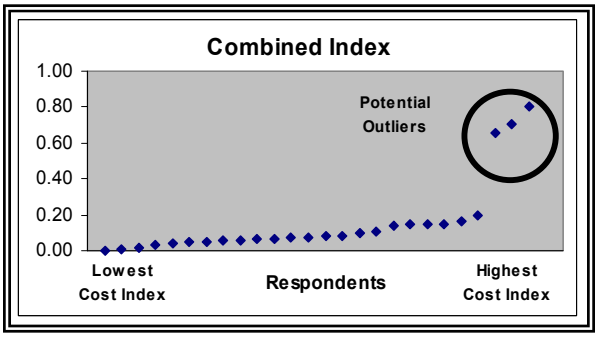


	Per Service	Per Foot
	2001	2001
Top 50 Avg	2,244	15.33
Average	3,865	34.28
Median	2,896	20.91
Bottom 50 Avg	5,504	53.23
Z	1,254	9.95
VV	1,758	12.51
F	1,542	10.47
T	1,657	13.58
CC	2,022	10.39
A	1,651	16.18
W	2,360	18.03
Q	3,243	17.68
DD	2,907	10.71
S	2,454	14.47
I	2,845	16.39
U	2,215	19.36
E	3,010	21.26
H	2,498	23.93
X	2,246	13.97
P	2,843	22.51
C	3,637	29.52
UU	3,603	24.29
Y	2,884	20.57
L	4,054	45.49
B	5,153	31.74
J	4,526	35.58
AA	3,834	29.69
BB	4,955	35.52
N	4,994	38.36
K	3,720	62.30
M	14,967	65.48
O	11,313	130.15
G	9,279	195.62
D	1,996	
R		
V		

be compared by overall construction cost, an index was required to facilitate the wide variance between the average cost per foot and average cost per service/hookup. An initial index ranging from 0.0 to 1.0 was calculated for both the cost per foot and cost per service / hookup to determine the variance between each respondent's result and the lowest cost from the study. An index score of 0.0 represents the lowest cost and an index score of 1.0 represents the highest cost. The firms in both of these indexes are in order of the combined index from lowest to highest.

Due to the characteristics of the survey respondents, they were divided into two groups to attempt to generate consistency of the responses. Group A consisted of companies with greater than 250,000 customers and Group B consisted of firms with less than 250,000 customers.

A total of thirty (30) natural gas providers fell into Group A and serve greater than 250,000 customers. Of this group, twenty-four (24) provided complete survey information. We used the same cost comparison index for these firms and obtained a combined index. Three firms exhibit exceptionally high cost to construct and are potential outliers in comparison to the remainder of the sample. We have not



eliminated these firms from the analysis but in situations where their inclusion may skew the results, we have attempted to point this out.

In the top 50% of firms, four factors bore the highest degree of relationship with relatively low cost to construct. They include growth in number of customers (correlation of (-0.60), percentage of urban construction (correlation of –0.52), percentage of replacement / rehabilitation construction (correlation of 0.45), and growth in service inventory (correlation of –0.43).

The downward correlation of growth in number of customers indicates a relationship describing that as the growth rate of new customers increases, the cost index tends to fall resulting in lower cost to construct. Both

service growth and customer growth demonstrate a downward correlation and move in the same direction. The upward correlation of the percentage of replacement / rehabilitation construction indicates that as the percentage of replacement rises, the index gets larger and construction costs rise. This is intuitive due to the complications and challenges associated with replacement work and it is generally expected to be more costly than new business construction. The downward correlation of percentage of urban construction indicates that at the percentage of urban construction increases, the cost index and the cost to construct will fall. This correlation is unusual and unexpected, but is related to how the data on urbanization was collected. We corrected for this unusual finding in Phase II.

These best performing firms tend to have a higher growth rate of customers, main footage, and number of services than the bottom 50%. At this point in the study, we did not draw direct conclusions about causality (i.e. that the existence of a strong correlation indicates that the characteristic drives construction costs lower or higher). We can, however, demonstrate a relationship and then use judgement to determine if some level of causality might exist. We explore this causality in Phase II.

The relationships demonstrated in Phase I may indicate that top performing firms get higher efficiency out of the overhead management and material procurement process that drives down the overall cost of construction. The top 50% of firms on average use 50% union (either contractor or internal) labor while the bottom 50% of firms use nearly 90% union (either contractor or internal) labor.

The best performing firms also tend to have a slightly higher percentage of construction that is replacement / rehabilitation related. The relatively high use of union labor and similar percentage of replacement construction may indicated that these best performing firms obtain a higher level of productivity from their work forces. This productivity may offset the additional cost of union labor and typically more expensive replacement work while the lowest performing firms are not able to do so.

The bottom 50% of firms exhibit three characteristics with the highest degree of relationship with relatively high cost to construct. These include the percentage of residential installations (correlation of –0.52), main inventory (correlation of -0.39), and service inventory (correlation of -0.40). The three outlier companies dramatically influence the correlation and if these firms are removed, the factors with the highest correlation change. They now include percentage of new construction and market enhancement (correlation of –0.52), percentage of replacement & rehabilitation construction (correlation of 0.40) and customer growth
(correlation of 0.40). In this instance, we have drawn no conclusions as it relates to the bottom 50% of firms.

Phase II In-depth Interviews and Analysis

Phase II involved selecting a group of firms who exhibited characteristics similar to Washington Gas. These firms are expected to make reasonable comparisons in terms of cost and are also be likely to exhibit best practices that could be emulated by Washington Gas. Nineteen (19) LDC's completed a series of in-depth, face-to-face interviews describing their approach to construction, procedure use and effectiveness, as well as supplying detailed information concerning construction costs. It is from this information that FMI worked to determine the practices that hold the strongest relationship to relatively low cost to construct and superior performance.

The Phase II participants were selected based upon matching several criteria such as size (between 400,000 and 1,500,000 customers) type of service area (at least one large urban geography) and construction type (part of the

geography having notable new business activity).

Methodology

The analysis for Phase II focused on re-establishing benchmark construction costs for the installation of main and service on a per foot basis and the installation of services on a per service/hook-up basis. Part of the interview process included a detailed cost breakdown that was reviewed in great detail to ensure a very high degree of comparability regarding costs included and excluded in this portion of the study. Capital expenditures were broken down into the following categories:

- Contractor Billed Construction Cost – Cost invoiced to LDC for the installation of distribution related main and service construction. Bulk materials including sand, gravel, etc. are included in this category. Construction materials including pipe, fittings, valves, etc are excluded and placed in one of the material categories depending on who purchased the item.
- Owner Incurred Construction Cost – Cost incurred by internal construction crews (LDC employees) for the installation of distribution related main and service construction. Internal maintenance crews that may install renewal services were also included in this category when their costs were considered significant. Labor burden and fringes for internal crews were included in this category where it was possible to break them out. When it was not possible, these costs are included as indirect or applied overhead.
- Contractor Supplied Materials – Construction materials including pipe, fittings, valves, etc. when purchased by the contractor for installation in distribution related construction.
- Owner Supplied Materials – Construction materials including pipe, fittings, valves, etc when purchased by the LDC for installation in distribution related construction. Warehouse costs, warehouse labor cost, and warehouse labor burden attributed to capital materials is included in this category where it was possible to break them out. Where it was not possible, these costs are included as indirect or applied overhead. The cost of meters and other non-distribution related materials were excluded.
- Third Party Supplied Materials – Construction materials including pipe, fittings, valves, etc were purchased by a non-vendor third party and held for the use of the LDC.
- Owner Direct Overhead – Salary, labor, and burden costs associated with individuals who are working on one specific project, job, or location at a time. Typical positions included are inspectors, designers, and supervisors.
- Owner Indirect or Applied Overhead – Salary, labor, burden, space cost associated with individuals who are intimately involved in the process of market fulfillment, design, and construction functions but cannot point to one specific project, job or location on which they are working at any point in time. The highest position normally included is frequently a Vice President of Business Development, Design, Engineering, or Construction. All of these costs should be directly controllable by this highest position. Corporately allocated costs for accounting, legal, holding company expense, etc that are generally not directly controllable by this highest position are excluded.
- Owner Cost Reimbursement (from developer, end-user, or third party) – Reimbursements paid by developers, builders, end users, or other third parties to offset the cost of distribution related construction. Generally speaking, these contributions can be tied directly back to a particular project, job, or construction site.

The firms were then ranked based on their cost to construct.

To establish comparable construction costs for each gas utility operating in different geographic markets, a set of cost inflators and deflators were applied to each company's capital expenditures. These factors normalize the varying capital expenditure volumes attributed to main and service construction to create a more "apples to apples" comparison from which better benchmarks are established. This normalization involved obtaining several nationally recognized indicators, most notably RS Means' Square Foot Cost Location Factors-2001, as an applied inflator or deflator.

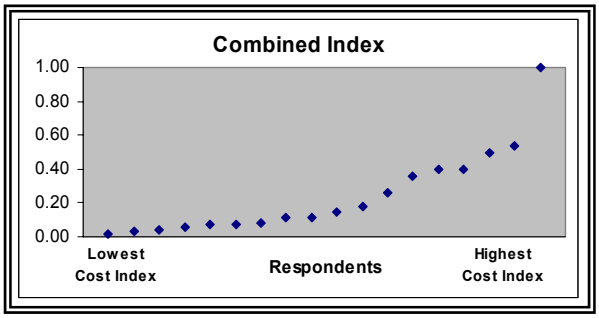
A cost comparison index was developed so that we could benchmark the firms versus each other. This cost comparison was made possible by a three-part process:

1. calculation of an average cost per foot,
2. calculation of an average cost per service/hookup,
3. development of a combined cost index.

To arrive at an average cost per foot, the total linear feet of new and replacement main plus new and renewal service pipe installed during 2001 was divided into capital expenditures for the same period. Similarly, the total number of new and renewal services, or hookups, was divided into capital expenditures. (The capital expenditures figures described above were reduced by dollars spent on special or infrequent construction, as the focus of this research is new construction, market enhancement and replacement/rehabilitation only.)

An initial index ranging from 0.0 to 1.0 was calculated for both the cost per foot and cost per service/hookup to determine the variance between each respondent's result and the lowest cost from the study. An index score of 0.0 represents the lowest cost and an index score of 1.0 represents the highest cost. The firms in both of these indexes are in order of the combined index from lowest to highest. No outliers are believed present in this data set. A firm can have a different index position for the cost per service versus the result of cost per foot.

The combined index is a smooth upward line and was calculated by taking a weighted average of its cost per foot index score (50%) and cost per service/hookup index score (50%)



A positive correlation demonstrates that the cost index and a particular factor move in the same direction. (i.e. as the factor rises in value, the cost index will rise as well indicating increasing cost to construct.) Inversely, a downward correlation demonstrates that the cost index and a particular factor move in the opposite direction of each other. (i.e. as the factor rises in value, the cost index will fall indicating a decreasing cost to construct.) A value of 1.0 or –1.0 is perfect correlation indicating that the factor and index move exactly together in a one to one relationship. Described another way, 100% of the movement in the cost index may be explained by a particular factor. In this particular sample size, we would not expect to find a single factor with a correlation of greater than 0.9 due to the small size of the study and the multitude of factors that impact construction cost.

Average Data

Presented below are the minimum and maximum costs demonstrated by each of the participants of Phase II. These figures are calculated as total capital expenditures divided by total feet installed (main and service) and total capital expenditures divided by total

number of services installed (new and renewal). We used this figure only to index the total construction performance of each participating firm and later calculated more typical benchmark cost comparison of individual cost per service and cost per foot for main and service installations. The total capital expenditures are normalized using the RS Means factor for each region of the country depending on where each utility was located and operated.

Category	Per Foot	Per Service / Hookup
Minimum Average Cost	$11.86	$1,702
Maximum Average Cost	$99.04	$9,050

Company	Quartile Performance
Company T	1st
Company VV	1st
Company CC	1st
Company W	1st
Company F	1st
Company P	2nd
Company S	2nd
Company I	2nd
Company U	2nd
Company C	3rd
Company H	3rd
Company AA	3rd
Company N	3rd
Company UU	4th
Company L	4th
Company J	4th
Company M	4th
Company O	4th

Company Rankings

We divided the respondents into the top 50% and bottom 50% performers to make further comparisons and look for characteristics that tend to have a high degree of relationship with relatively low cost to construct. Presented are the participating firms in order of their indexed construction cost performance. This ranking is after the normalization of the originally supplied capital expenditures. (The lettering assigned in Phase II is the same as that from Phase I for participants in both phases.)

Best Practice Identification

The end result of our analysis identified six critical categories that demonstrate a strong relationship to low cost of construction. Each of these areas is highly controllable. Within each category are specific practices, approaches, conditions, or characteristics that can increase performance, improve productivity, and/or lower cost. A seventh category details characteristics that are difficult to control yet demonstrate a strong relationship to construction cost.

Controllable Practice Areas

- Use of contractors
- Use of internal crews
- Overhead containment and management
- Relationship and approach to third party contracts
- Internal coordination
- Culture
- Outsourcing

Difficult to Control Practice Areas

- Traffic Control
- Population Density
- Local Ordinance

Controllable Practice Areas

Use of contractors

The results of the benchmarking study demonstrate that there is a relationship to having low construction cost and the frequency of use and the type of construction that third-party contractors complete for LDC's. Specifically, utilities that make more frequent use of contractors (as measured by the percentage of capital expenditures spent with contractors) and firms that focus the use of contractors on main (replacement and new) construction are characterized by a lower cost to construct.

Use of internal crews

The best performing firms use internal crews infrequently and the worst performing companies have a much higher use of internal crews. There were no instances where the intensive use of internal crews demonstrates a relationship to very low construction costs. One firm in the study did demonstrate frequent use of internal crews and fell into the top 50% of performers, but was the last firm in this group.

Overhead containment and management

There is a significant cost differential between the amount of overhead carried by the study participants, which drives the resulting productivity measured by feet or services installed. The best performing firms carry much less total overhead, particularly indirect overhead on both a percentage and dollar basis. In addition, the best performing firms achieve much higher output per dollar of overhead than do the bottom performing firms.

Relationship and approach to third party contracts

Two characteristics relating to the relationship between LDC's and contractors demonstrated a moderate degree of correlation to low cost to construct. Both of these characteristics tend to go hand-in-hand at the best performing firms. A high degree of depth and frequency of contractor involvement in the planning process and work release show a relationship with low cost and greater productivity.

Internal coordination

Two characteristics relating to internal coordination between market fulfillment, design, construction, and material management demonstrated a moderately high degree of correlation to low cost to construct. Effective internal project planning (speaks to the level of communication and teamwork between the various units, but specifically design and construction). Project supervision (speaks to the role and responsibility of these individuals). Where this role/responsibility is focused on managing construction or the process of construction, low construction cost is evident.

Culture

To account for the culture of an organization, we developed an "X-Factor" that we subjectively rated to capture the degree of professionalism, breadth of knowledge, level of internal focus, and congruency of goals and actions (teamwork). These characteristics can originate from an effective leader, crisp and lean organizational structure, senior management approach and attitude, as well as being generated by groups of employees from the bottom up. This characteristic demonstrated a moderate degree of relationship to relatively low cost to construct and we believe it is defined at its lowest level as the ability and willingness of various groups to work together. The best performing firms are able to generate the cohesiveness necessary to drive teamwork.

Outsourcing

We found two types of outsourcing in our review. The first was focused on using third-party material suppliers to reduce internal costs associated with managing inventory and reduction in the level of inventory assets. In only one company did we see a full use of this type of material management scheme and this firm was one of the better performing organizations.

Potential cost savings to the gas company emanate from minimal warehouse staff, ability to use the space at the warehouse for other functions, reduction in delivery vehicles, and potential materials cost savings if the third-party vendor serves several gas companies. We were unable to document directly the existence of any cost saving associated with using this approach due to only one firm fully using it. The bottom performing firms actually demonstrate a lower percentage of materials per total capital expenditures. This is due to their higher overhead amounts, which makes materials' dollars smaller. When we look at the percentage of materials per feet installed, a very different picture arises showing that the bottom performing companies have a much higher material cost per foot.

The second form of outsourcing is the purchase of all design and construction functions: order taking, design, planning, scheduling, construction, and inspection externally. Only one firm has attempted this level of outsourcing and we were unable to identify any direct relationship with lower or higher cost to construct. This particular company is one of the better performing organizations.

Difficult to Control Practice Areas

Three areas demonstrated a high degree of correlation with relatively low or high cost to construct yet are considered difficult to influence and control. We present these areas not as best practices, but as areas of which management should be aware and look for opportunity to exert influence where possible through strategic efforts.

Traffic Control and Local Ordinances

Both Traffic Control and Local Ordinance severity and frequency demonstrated high positive correlation indicating that they have a relationship with relatively high cost to construct. In both instances, the FMI team rated the severity and frequency on a five-point scale with 1 being very light and infrequent and 5 being severe and frequent. A high upward or positive correlation exists for this characteristic indicating as severity and frequency of issues rise, cost tends to increase. There are several firms who demonstrate difficult conditions, yet relatively low construction cost performance. The most effective companies in our assessment tended to have an aggressive and proactive approach to managing their relationship with local and municipal authorities.

Author note: Some companies are members of the AGA Gas Industry Right of Way Alliance, which works with agencies such as the APWA to give input to proposed model ordinances. The same group is part of an on-going project by the NRC in Canada and the Army Corps of Engineers in the USA to instrument some restored rights of way and measure any effects of the restoration on the paving. This not a short-term activity. If the Gas Company is to modify or reduce the burden from the imposed activities, it will be a continuous interaction with the appropriate parties.

Population Density

This characteristic demonstrated the highest degree of relationship with relatively low and high cost to construct. The obvious conclusion is that the companies who were operating in the most densely populated areas with high incidence of paved roads, lack of grass parkways and difficult terrain tend to have the higher cost indices. Further review identified several firms with very high densities yet were able to achieve relatively low cost of construction. This positive performance is in our opinion attributable to the factors mentioned previously as being exhibited as best practices by these better performing firms.

Alternative Construction Approaches

The frequency of use of various pipe installation methods was also studied to determine it's impact on the overall cost of

construction. The methods analyzed in the study include:

- Directional Drilling
- Joint Trench
- Plowing/Jacking
- Developer/Builder installed trench
- Open Cut
- Insertion/Other

We were unable to establish a direct relationship between the use of any of these construction techniques and relatively low or high cost of construction. FMI's opinion is that none of these various techniques demonstrated a significant relationship to low cost of construction due to open cut is used greater than 50% of the time for well over half of the participants and it is this method that is driving the overall cost performance.

It is our belief that the ability to use joint trenching and developer/builder installed trench are two techniques where there is wide agreement that they are less costly. The lack of frequent and consistent use by a relatively large number of firms prevented them from demonstrating a high degree of correlation in this study.

Main Pipe Diameter

The diameter of main pipe installation was broken out based on the feet of install for each diameter during 2001. All of the categories of main pipe diameter installation had a slightly negative correlation indicating a relationship that as the feet of pipe installed increased, cost tended to fall. There was not a strong relationship between the various diameters installed and lower or higher cost of construction. We believe this is due to the fact that the vast majority of all main installations are 2", 4", or 6" which can be installed using basic equipment and is not particularly challenging. The installation of diameter of 8" and above typically require special equipment and additional planning but make up such a small percentage of total installations, they do not drive the total cost of construction. In this study, FMI did not differentiate between the footages in these categories that were completed through insertion versus direct bury, which may be impacting the results.

Washington Gas

AGA American Gas Association

Gas Distribution Construction Cost and Procedure/Process Benchmark Assessment

Operations Conference and Exhibition

April 27-29, 2003

FMI

gti SM

Hazelden Group CONSULTANTS

Washington Gas

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Benchmarking & Best Practice Identification

Benchmarking is defined as "The continuous search for and implementation of industry best practices that lead to superior performance." It consists of a formal and intensive process of planning and specific data collection, analysis, integration of results, and development of an action plan resulting in beneficial change. The natural temptation for this type of study is to rely on subjective feedback and ancillary commentary that makes it difficult if not impossible to conduct fair comparisons and establish "Best Practices."

- **Robert C. Camp, Business Process Benchmarking: Finding and Implementing Best Practices**

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Benchmarking & Best Practice Identification

Intended Use	Nice to have information, that is better than nothing.	Comparable information used to assess performance versus similar organizations.	Strategic information used to change culture, processes, and procedures as well as drive improvements in performance.
Activity	Numeric based only with no comparability issues addressed.	Numeric based with comparability issues addressed	Establish relationship between performance and processes used based on numerical comparison addressing comparability.

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Project Overview

Phase I - Initial Survey Screening

Phase II - Best Practice Identification

Phase II Participating LDCs
Atlanta Gas Light
Baltimore Gas & Electric
Cinergy Corp.
Consolidated Edison
Consumers Energy
KeySpan Energy – LI
KeySpan Energy – NYC
Michigan Consolidated Gas Co.
National Fuel Gas Distribution Corp.
New Jersey Natural Gas
Oklahoma Natural Gas Company (Oneok, Inc.)
Oncor (TXU)
PECO Energy Co.
People's Energy
PSE&G
Puget Sound Energy
Reliant Energy - Entex
Southwest Gas Corporation
Washington Gas

Cost Breakdown Details

Type of Cost Definitions - Intended to bring a high degree of consistency to the benchmark comparisons.

- Contractor Billed Construction Cost
- Owner Incurred Construction Cost
- Contractor Supplied Materials
- Owner Supplied Materials
- Third Party Supplied Materials
- Owner Direct Overhead
- Owner Indirect or Applied Overhead
- Owner Cost Reimbursement (from developer, end-user, or third party)

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Normalization of Phase II Results

Normalize the Data

- To establish "apples to apples" comparison of construction costs between regions
- RS Means Square Foot Cost Location Factors

Phase II - Best Practice Identification

- 19 Participants
- Detailed Capital Expenditure Breakdown
- In-Depth Interviews
- Data Analysis
- Report Presentation

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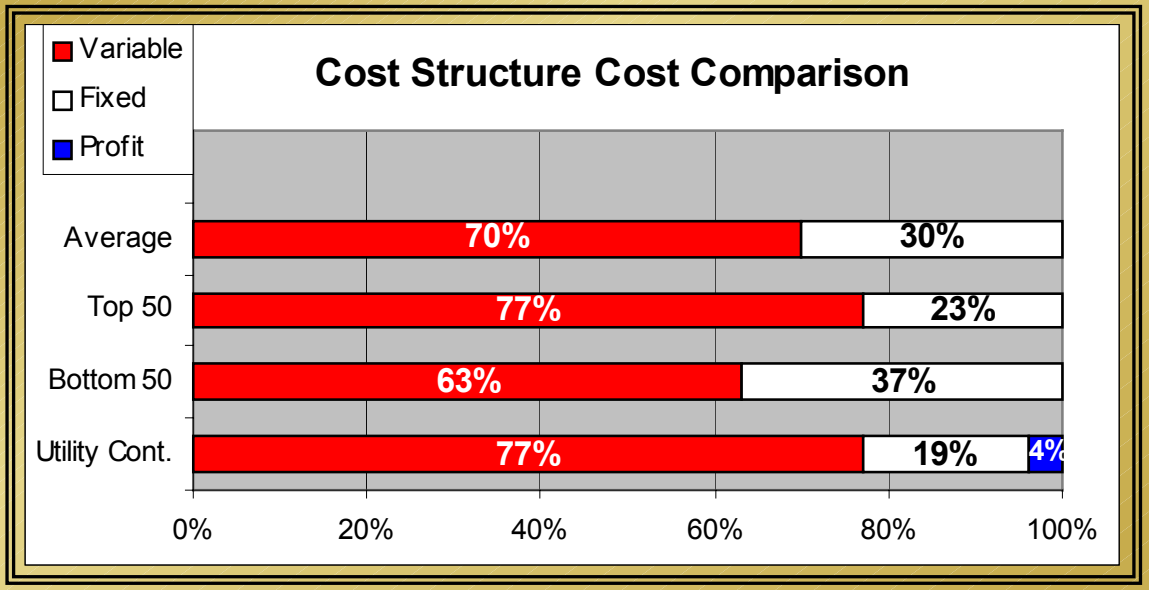
Executive Summary *(1 of 2)*

- **Quartile Comparison**
- **Cost Structure Comparison**



Company	Quartile Performance
Company T	1st
Company VV	1st
Company CC	1st
Company W	1st
Company F	1st
Company P	2nd
Company S	2nd
Company I	2nd
Company U	2nd
Company C	3rd
Company H	3rd
Company AA	3rd
Company N	3rd
Company UU	4th
Company L	4th
Company J	4th
Company M	4th
Company O	4th

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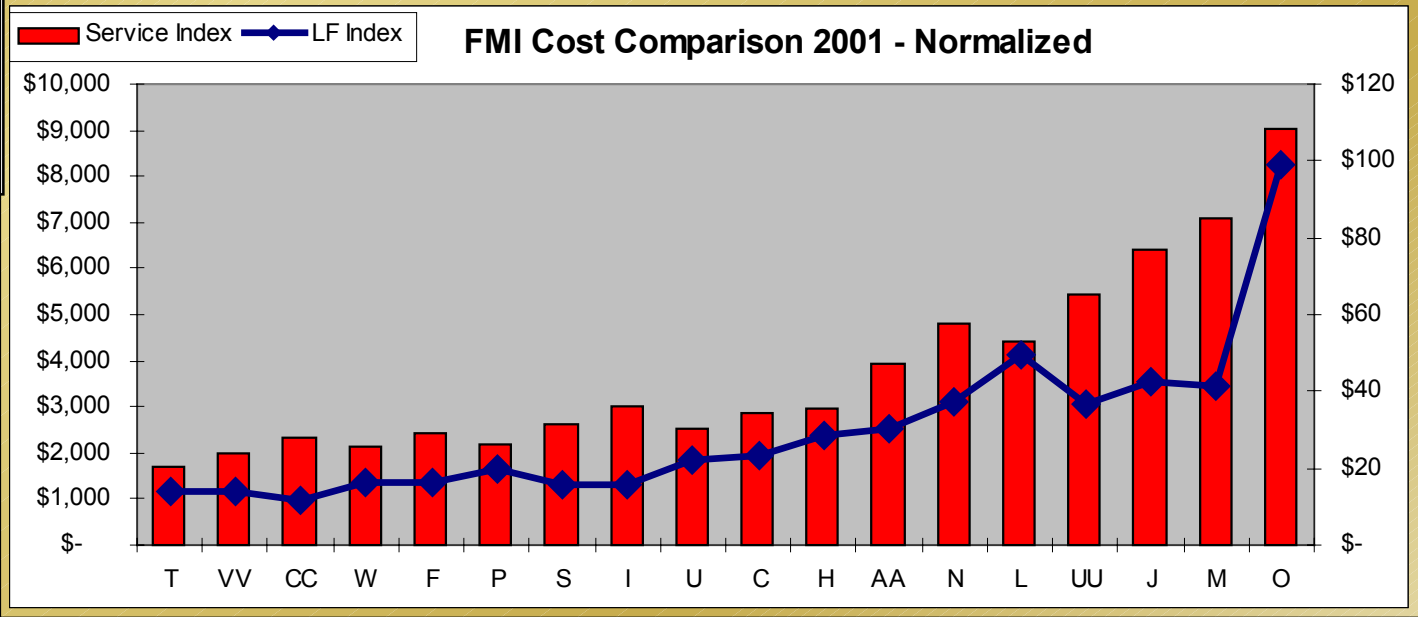
Executive Summary *(2 of 2)*

- **Total Cost To Construct (FMI Index)**

FMI Calculation	Per Service	Per Foot
2001		
Minimum	$1,702	$11.86
Maximum	$9,050	$99.04
Average	$2,590	$18.43
Median	$2,913	$22.87
Std Dev	$2,053	$20.81
Top 50 Avg	$2,193	$14.99
Bottom 50 Avg	$4,327	$35.17



Controllable Practice Areas

- Use of Contractors
- Use of Internal Crews
- Overhead Containment and Management
- Relationship & Approach to 3rd Party Contracts
- Internal Coordination
- Culture
- Outsourcing

Difficult to Control Practice Areas

Each demonstrated a high degree of correlation or relationship to low cost of construction

- **Urban Density**
- **Traffic Control**
- **Local Ordinances**

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Best Practice Detail *(1 of 7)*

Use of Contractors

- High percentage use of contractors has a strong relationship to low cost
- Maximize use of contractors for new and replacement mains
- Use of contractors on new and renewal service installations has only a modest relationship to low cost
- Output and/or productivity is higher for contractors

Contractor Use	Total Capital Expenditures	Contracted Value	CV %	Owner Crew Value	OCV %	Cost Per Foot
Top 50 Avg	$70,149,917	$45,761,638	65%	$6,289,033	9%	$14.99
Bottom 50 Avg	$74,209,015	$33,909,231	46%	$11,507,656	16%	$35.17

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Best Practice Detail *(2 of 7)*

Use of Internal Company Crews

- High percentage use of internal crews has a strong relationship to high cost
- Minimize use of internal crews on replacement mains
- Lowest cost penalty with internal crew use appears on scattered renewal service installations
- Output and/or productivity is lower for internal crews

Internal Crew Use	Total Capital Expenditures	Owner Crew Value	OCV %	Total Overhead	TO %	Urban Density	% Union
Top 50 Avg	$70,149,917	$6,289,033	9%	$13,391,459	19%	1.73	46%
Bottom 50 Avg	$74,209,015	$11,507,656	16%	$21,275,156	29%	7.34	59%

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Best Practice Detail *(3 of 7)*

Overhead Management & Containment

- **Aggressive management of indirect or applied overhead has a strong relationship with low cost.**
- **Best performing companies obtain 4x the production for a dollar of overhead than do worst performing firms.**
- **Focusing overhead spending in the direct category has a strong relationship to low cost or higher value added.**

Overhead Containment	Total Capital Expenditures	Total Overhead	TO %	Direct Overhead	DO %	Indirect Overhead	IDO %
Top 50 Avg	$70,149,917	$13,391,459	19%	$9,036,605	13%	$4,354,854	6%
Bottom 50 Avg	$74,209,015	$21,275,156	29%	$6,681,477	9%	$14,593,679	20%

Productivity TO/Feet	Total Overhead	Feet Installed	Productivity
Top 50 Avg	$13,391,459	4,680,135	$ 2.86
Bottom 50 Avg	$21,275,156	2,109,765	$10.08

Best Practice Detail *(4 of 7)*

Relationship & Approach to 3rd Party Contracts

- Maximize contractor involvement in planning
- Maximize contractor involvement in work release

Potential Best Practices

- Contractor alliance usage
- Technology enabled integration

Productivity CV/Feet	Contracted Value	Feet Installed	Contractor Productivity	Owner Crew Value	Feet Installed	Owner Crew Productivity	Total Const Value	Combined Productivity
Top 50 Avg	$45,761,638	4,680,135	$ 9.78	$6,289,033	4,680,135	$1.34	$52,050,671	$11.12
Bottom 50 Avg	$33,909,231	2,109,765	$16.07	$11,507,656	2,109,765	$5.45	$45,416,887	$21.53

Best Practice Detail *(5 of 7)*

Internal Coordination

- A coordinated process of internal planning has a strong relationship to low cost, specifically high integration between design and construction
- Focusing the responsibility to manage a project or the process of construction has a strong relationship to low cost, specifically, requiring project supervision to manage construction rather than administrative duties

Potential Best Practices

- "Clean" organizational structure
- Contractor self-inspection
- Approach to QA/QC

Best Practice Detail *(6 of 7)*

Culture

- **Individual focus on professionalism, breadth of knowledge, and congruency of goals (teamwork) have a strong relationship to low cost**
- **Organizations focused on process management and continual process improvement demonstrate lower costs**

Best Practice Detail *(7 of 7)*

Outsourcing

Outsourcing Mat. Mgt.	Capital Expenditures	Total Materials $	Materials %	Feet Installed	$/Foot
Company CC	$104,404,845	$14,012,449	13%	8,802,808	$1.59
Average	$72,179,466	$8,934,404	12%	3,394,950	$2.63
Top 50	$70,149,917	$9,537,557	14%	4,680,135	$2.04
Bottom 50	$74,209,015	$8,331,251	11%	2,109,765	$3.95

Potential Best Practices

- **Outsourcing material management and warehousing to 3rd party**
- **Outsourcing entire process of design and construction to contractor or contractor like firm**

Outsourcing Design/Const	Capital Expenditures	Total Overhead	Overhead %	Feet Installed	Productivity
Company P	$71,789,430	$9,253,658	13%	3,674,005	$2.52
Average	$72,179,466	$17,333,308	24%	3,394,950	$5.12
Top 50	$70,149,917	$13,391,460	19%	4,680,135	$2.86
Bottom 50	$74,209,015	$21,275,155	29%	2,109,765	$10.08

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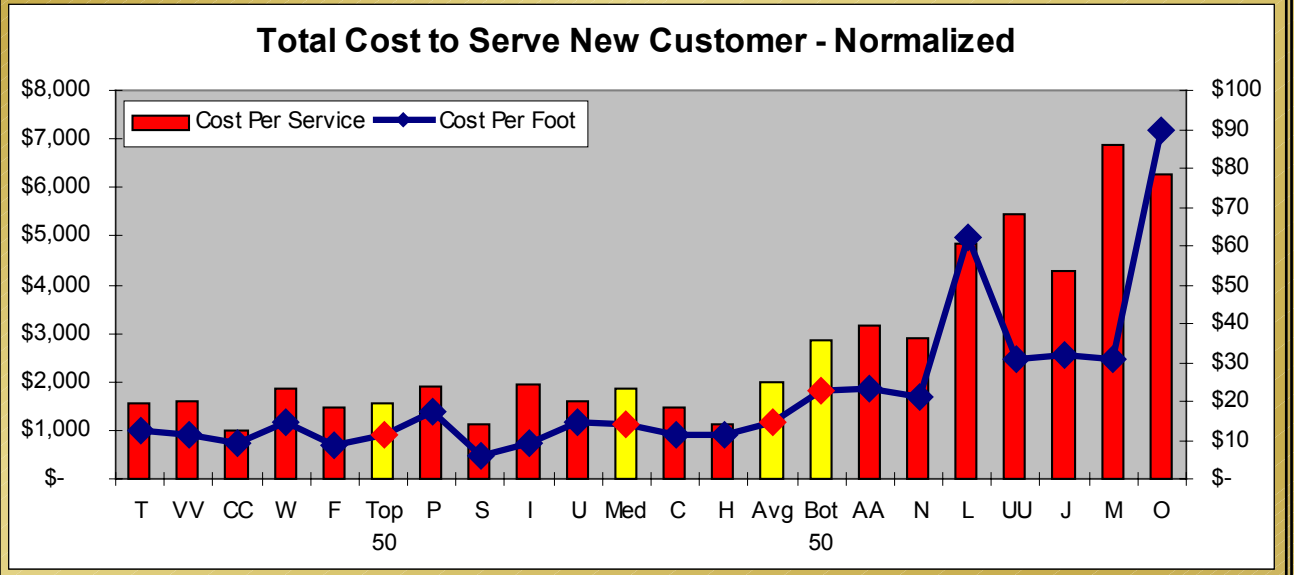
Selected Cost Benchmarks *(1 of 4)*

Cost to Serve	Per Service	Per Foot
2001		
Minimum	$1,004	$6.04
Maximum	$6,876	$89.69
Average	$1,972	$14.79
Median	$1,880	$14.37
Std Dev	$1,899	$21.37
Top 50 Avg	$1,551	$11.36
Bottom 50 Avg	$2,850	$22.51



Firms are in left to right order of lowest to highest total cost of construction - Total Capital Expenditures divided by feet of pipe or number of services.

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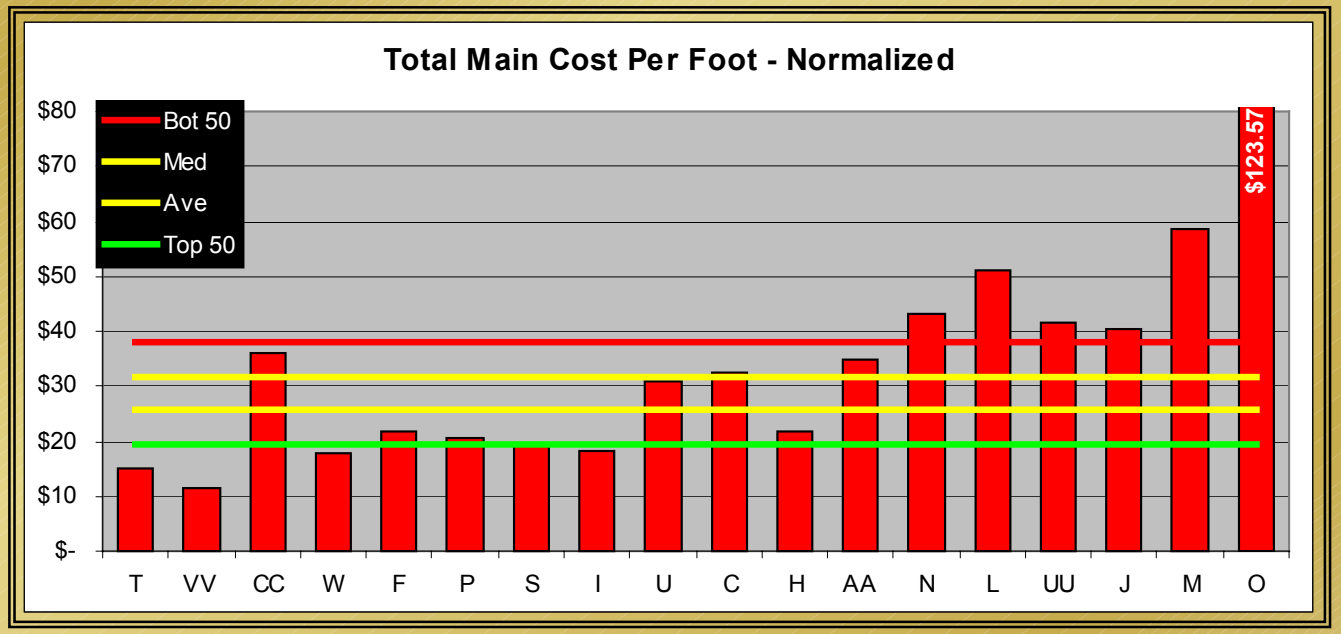
Selected Cost Benchmarks *(2 of 4)*

Total Main	Per Foot
2001	
Minimum	$11.34
Maximum	$123.57
Average	$25.93
Median	$31.58
Std Dev	$25.62
Top 50 Avg	$19.32
Bottom 50 Avg	$38.01



Firms are in left to right order of lowest to highest total cost of construction - Total Capital Expenditures divided by feet of pipe or number of services.

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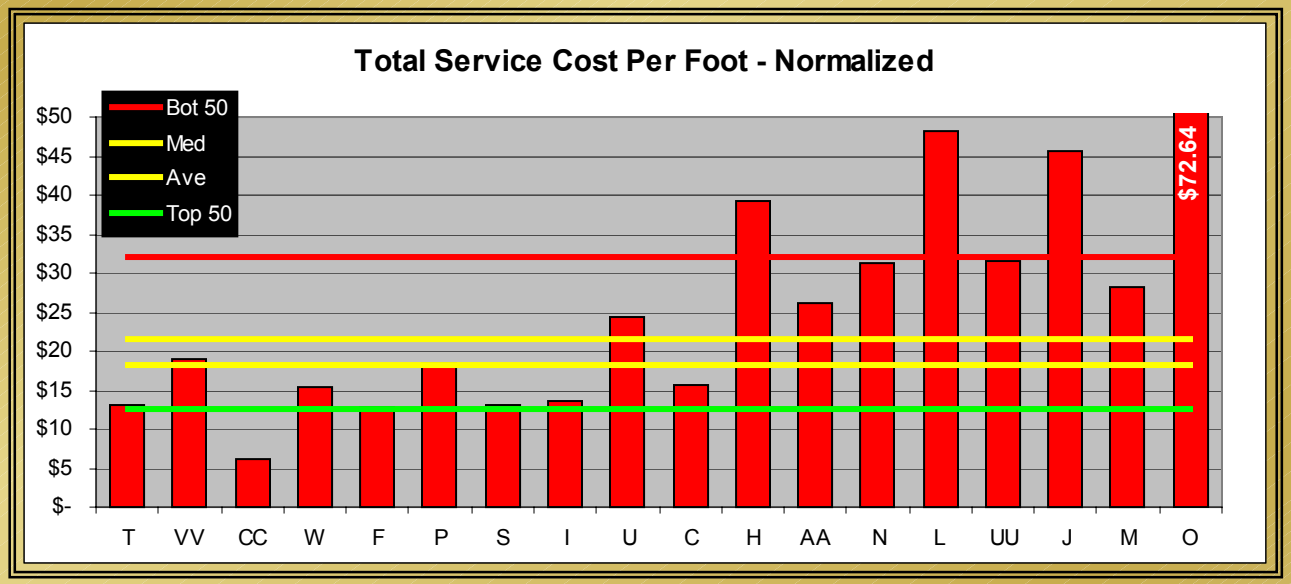
Selected Cost Benchmarks *(3 of 4)*

Total Service	Per Foot
2001	
Minimum	$6.16
Maximum	$72.64
Average	$18.15
Median	$21.66
Std Dev	$16.56
Top 50 Avg	$12.63
Bottom 50 Avg	$32.07



Firms are in left to right order of lowest to highest total cost of construction - Total Capital Expenditures divided by feet of pipe or number of services.

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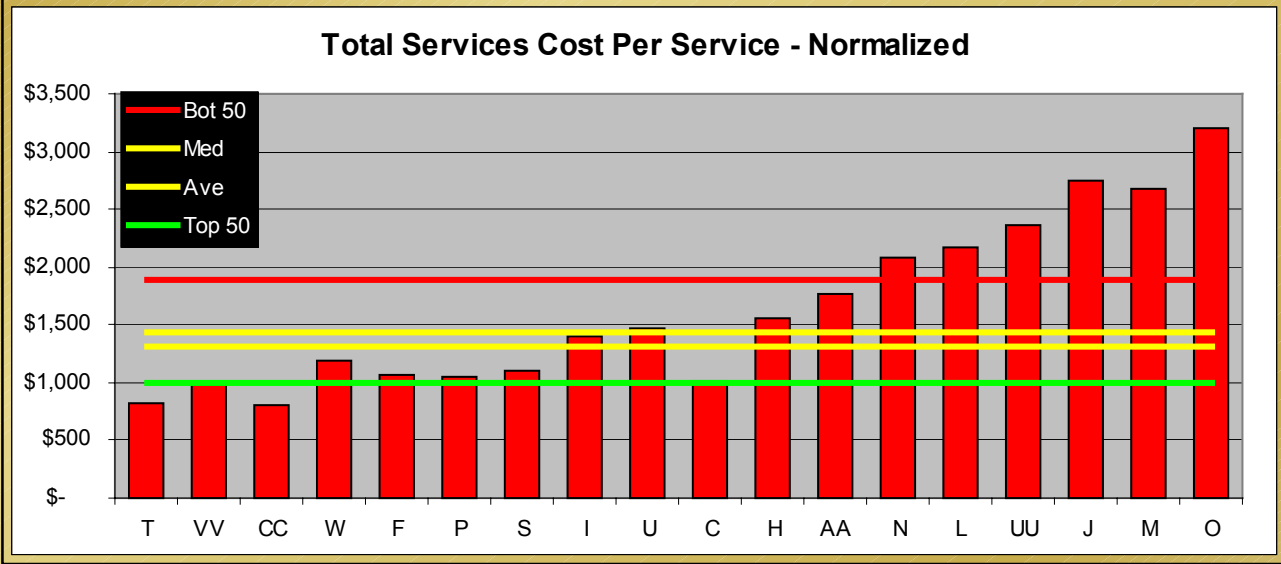
Selected Cost Benchmarks *(4 of 4)*

Total Service	Per Service
2001	
Minimum	$813
Maximum	$3,196
Average	$1,315
Median	$1,435
Std Dev	$735
Top 50 Avg	$1,006
Bottom 50 Avg	$1,891



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Discussion/Questions

FMI is working with 12 of the 19 participants to implement or investigating the best practice areas. If you want to further information, contact:

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Thank you.

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