USING VALUE-FOCUSED THINKING TO

EVALUATE THE EFFECTIVENESS OF

AIR FORCE UTILITY PRIVATIZATION

THESIS

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Abstract

The majority of the Air Force's stateside utility systems are old, obsolete, and unreliable. The cost to upgrade and repair these systems is currently estimated at over $4 billion. In response, the Air Force began efforts to convey ownership of these utility systems to the private sector through privatization efforts. However, privatization critics believe that newly privatized entities of government will cost the public more money and provide a lower level of service. Therefore, independent audits are a necessity to ensure government initiatives, meet their intended goals. However, the Air Force currently lacks an effective auditing tool to ensure the efficiency and lower cost associated with utility privatization are balanced with the desired increases in quality, reliability, and responsiveness of its utility systems.

The Value-Focused Thinking methodology was used to create a multi-objective decision analysis model to determine the effectiveness of Air Force utility privatization efforts by evaluating the performance of privatized utility systems. Consisting of 28 bottom-tier values and 47 measures, the model captures the majority of the Air Force's objectives and concerns regarding its privatized utility systems. Using notational data, the utility systems at eight simulated Air Force installations were evaluated and rank ordered to validate the model. Sensitivity analysis was also performed to provide further insight into the decision making process. The results of this research prove that the model can be an effective decision analysis tool that provides the Air Force insight on the performance of its privatized utility systems.

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Captain Carlos Braziel

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Chapter 1. Introduction

1.1 General Background

With an increased emphasis on decreasing bureaucracy and improving efficiency, world governments are using or seriously considering privatization as solution to both decrease the size of the government and provide better efficiency. Privatization has been broadly regarded as "…the act of reducing the role of government, or increasing the role of the private sector, in an activity or in the ownership of assets..." (Savas, 1987:3). This management concept is rapidly being incorporated into many local and national government operations across the globe. For example, the World Bank has financed the privatization ventures of over 8,500 state-owned enterprises in over 200 countries since the early 1990s (Kikeri et al, 1992).

Today, almost every country has a privatization program or at least a sector of activity susceptible to private management if not ownership. For instance, the countries of Bolivia, Great Britain, and Malaysia have privatized their water system, electrical system, and National Lottery program, respectively. These countries, along with many others, believe that switching publicly owned enterprises to privately owned firms will lead to greater economic efficiency, reduced public debt, and improved budgetary management (Hartley et al, 1991; Letwin, 1988).

1.2 Specific Background

In the United States, many states and cities have incorporated privatization into their public operations as well. Some states are privatizing utilities, prisons, child foster care, and numerous other items. Similarly, major cities in the United States are using privatization strategies for a discernable share of municipal services (Dilger et al, 1997). However, there has been little progress at the federal level. The change in political climate in the late 1980s and early 1990s, namely the fall of the Soviet Union and the American voters' clear discontent with an oversized government, has forced the federal government to take a more active role in privatization (Savas 2000:38). Inevitably, the once plentiful Department of Defense budget established by the Reagan administration was shrunk tremendously. Thus, a situation was created in which the Air Force and other military services had to make enormous program and manning cuts in order to compensate for the smaller Department of Defense budget.

As the numbers of trained Air Force utility system technicians were voluntarily or involuntarily lowered, the aging infrastructure at most Air Force installations placed increased demands on the ever-shrinking operations and maintenance budget. With the lack of sufficient infrastructure dollars and trained technicians to maintain them, the utility systems at many Air Force installations quickly became liabilities instead of reliable entities used to support the mission. As a result, the Air Force realized it must find a better and inexpensive way to provide installations with quality utility service without sacrificing mission support. The Department of Defense and the Air Force looked to utility privatization as the way to provide military installations with lower life-cycle costs while increasing the reliability of utility service through modernization. In the late 1900s, the Air Force initiated the process to privatize its electric, gas, and water utilities at various stateside Air Force installations. The Air Force's objective in this process was, and continues to be, to divest itself of those utility systems that do not directly support the war-fighting mission (Department of Defense, 2002). On those Air

Force installations with utility systems that are not considered a core operational requirement, the Air Force plans to turn over the business of operation and maintenance to the private sector for better efficiency (Department of Defense, 2002).

Even though the federal and local state governments view privatization as a means to a more efficient and less costly provision of government services, there is considerable opposition to its use. In fact, there is criticism in the public sector about the way privatization decisions have been made and how cost and performance measurements were created. This criticism has contributed to the belief that newly privatized entities of government will cost the public more money and provide a lower level of service. Furthermore, skeptics of privatization caution that it is important to treat privatization, as with any new government policy, as an experiment (Wallin, 1997:19).

1.3 Problem Statement

Independent audits on federal and state policies, such as utility privatization, are instrumental in helping to avoid potential bias, limit errors, and alleviate the fears of critics. To date, there does not appear to be a strong body of knowledge in the area of utility privatization evaluation, thus creating a research gap. This research gap can be filled by combining the lessons learned from previous privatization initiatives with sound quantitative/qualitative measurement techniques. The combination of these two dimensions is essential to the creation of an effective audit tool for utility privatization. Careful oversight and monitoring of the Air Force utility privatization process will help ensure that the efficiency and lower cost associated with private business is balanced with the desired increases in quality, reliability, and responsiveness of its utility systems.

Therefore, the purpose of this thesis is to develop a mathematical model to audit utility privatization by means of examining and comparing specific characteristics or values of Air Force utility systems. This model must be capable of facilitating the evaluation of utility privatization by providing a clear structure for the multiple objectives associated with utility privatization. In addition, this model must be capable of not only capturing the values (what is important to the Air Force) of a utility system but be able to use the values to evaluate the effectiveness of Air Force utility systems. Furthermore, the model must be capable of balancing the "hard" quantitative and "soft" qualitative factors of utility privatization. Finally, the model must be reliable, repeatable, and defendable.

1.4 Research Objective and Investigative Questions

The Department of Defense and the Air Force have invested a considerable amount of resources on studies and contracting actions to make utility privatization happen. Examining, comparing, and identifying the values comprising the operation of privatized and non-privatized utility systems at Air Force installations will provide insight into the important factors impacting the utility privatization process. Therefore, the objective of this thesis is to create a valid mathematical model to determine the effectiveness of Air Force utility privatization by evaluating the performance of privatized Air Force utility systems. To do this, the following investigative questions will be addressed during this research.

1. Given that quantitative data (performance) will be collected, what is a suitable method to evaluate and measure the overall effectiveness of a utility system? In order to accomplish this, the "hard" quantitative and the "soft" qualitative factors of utility privatization must be balanced.

2. What are the major factors and sub-factors that should be considered when evaluating the performance of Air Force utility privatization?

3. How do the major factors and sub-factors compare to each other in terms of importance?

1.5 Methodology

Value-focused thinking (VFT), as developed by Keeney (1992), is a modeling technique that has been frequently used to assist organizations with making decisions. The civilian sector has successfully applied VFT in the automotive, oil, and pharmaceutical industries. In particular, VFT has been very instrumental in structuring the critical decisions of the National Aeronautics and Space Administration, the Department of Energy, and the Department of Defense (Keefer et al, 2000).

VFT is a decision analysis technique that provides an objective view of a subjectively-based decision. Even though this concept is not new, it will be applied differently in this thesis. Normally, the VFT approach is used to guide and solve a decision problem such as utility privatization evaluation. However, in this thesis, the VFT approach will be used to identify both new and existing values associated with the utility system evaluation and privatization process. These values will be incorporated into a quantitative structure or VFT model, which will be used to evaluate various alternatives for a privatized utility system. The VFT methodology consists of the ten-step process outlined by Shoviak (2001).

1.6 Research Scope and Limitations

This research will focus on providing insight to decision makers responsible for selecting and evaluating privatized utility providers to maintain Air Force utility systems. However, there are two primary limitations associated with this research. First, this research deviates from the traditional VFT hierarchy weighting step. Since, the researcher initially generated suggested weights for each of the values and the decision maker adjusted them accordingly. Second, sufficient real world data to validate the model is unavailable; therefore this thesis will use notional data to validate the audit model.

1.7 Document Structure

The literature review, presented in Chapter 2, provides an in-depth examination of relevant literature and defines a focus (basis) for the reader regarding the questions posed in this introduction. Chapter 2 also introduces the decision analysis methodology and defines the VFT process. A presentation of the value of a utility system, how this value is measured using VFT, and how it can be applied to decision makers evaluating utility privatization is provided in Chapter 3. Also, Chapter 3 provides a step-by-step breakdown of values and measures used in the evaluation model. Data Analysis, Chapter 4, presents the results from the model's deterministic and sensitivity analysis. Chapter 5 presents a summary of the research results and offers conclusions and recommendations regarding the utility privatization process

Chapter 2. Background of the Problem/Literature Review

This chapter explains the concept of utility privatization and discusses the need to evaluate its effectiveness. The chapter initially establishes a working definition for privatization and provides a brief history of its use. It then defines the term utility system and establishes a more specific working definition for utility privatization. This definition is followed by a brief history of utility privatization efforts in the Air Force. With this foundation established, the chapter examines the current laws and directives that guide Air Force utility privatization and reviews the general contracting process. To help justify this research, the chapter explores the current privatization debate and reviews previous research in privatization evaluation. The chapter concludes by presenting a ten-step value-focused thinking process for conducting this type of decision analysis; it describes what is involved in the methodology and how it can be used in this research.

2.1 Privatization in General

Privatization is a management practice used throughout the world to lower operating costs in organizations and governments (Savas, 2001). Privatization can take many forms; it can represent the complete removal of government from the production and delivery of services or it can simply mean to outsource (contract out) (Greene, 1996). Many governments in developed and developing countries are using this management initiative to reinvent and reengineer their government to achieve the effectiveness and efficiency of businesses in the private sector (Korosec et al, 1996).

2.1.1 Privatization Defined

The concept of privatization and its use can be difficult to define. Therefore, it is very important to understand the theory behind it. Although many definitions have been used to describe privatization, Barnekov et al (1990:136) best summarized it by explaining:

> … Part of the problem of any discussion of privatization is that the meaning of the term is confusing because it has been used to refer to several types of policy initiatives, this is to include the shift from public to private provision of goods or services (through contracting out or voucher arrangements….

Management guru Peter Drucker coined the privatization term in the late 1960s. He argued that government was good at making decisions, but bad at executing them (Hodge, 2000:13). Therefore, he contended that the execution of government services should be separated from public policy and "reprivatized" (Hodge, 2000:13). Since then, Savas (1987:3) expanded Drucker's definition by stating "…privatization is the act of reducing the role of government, or increasing the role of the private sector, in an activity or in the ownership of assets…" Savas (2001) further expanded the term's meaning by stating that privatization means having greater reliance on private institutions in the civilian sector and less dependence on government to satisfy the important needs of society. For the purposes of this research, privatization will be defined as "conveying or transferring responsibility for a government function to the civilian sector in order to provide better efficiency."

2.1.2 History of Privatization

Privatization is not a new concept in the United States; it is as old as the federal government. Governments have always hired private businesses to manage or deliver services through a contract. For example, the nineteenth century gave us the pony express as an example of privatization, although it was not labeled as such at the time (Johnson et al, 2000:2). For centuries, federal and state governments have used private builders to construct and maintain roads, streets, and highways (Johnson et al, 2000:2). Clearly, history has shown that the federal government has relied on the private sector to provide important necessities from time to time.

For more than half a century, privatization slowly integrated itself into federal government processes. In 1955, President Eisenhower first applied it in the Bureau of the Budget by establishing a policy of increasing reliance on the private sector for goods and services (Wheeler, 1987:30). In 1966, privatization was further incorporated in the federal government during President Johnson's administration when the Bureau of the Budget issued Circular A-76, the first authoritative guide for all privatization initiatives in the federal government (Pope, 1990:9). This document was designed to increase efficiency in producing government-financed commercial services through the promotion of better management initiatives and fair competition. Also, the document provides guidance for distinguishing between "inherently government functions" and other functions, which can be contracted out (Prager et al, 1996:187).

In the late 1960s and early 1970s, support for privatization increased due primarily to the American voter's preference for lower taxes and smaller government (Savas, 2000:38). As a result, lower tax revenues applied pressure to privatize in order for the federal government to balance limited resources with the demands of American society. However, the federal government did not give privatization major consideration until the 1980s.

In the 1980s, the Reagan Administration and the conservative movement to reduce the size of government created a major impetus for implementing privatization (Johnson et al, 2000:5). Many supporters, both in and out of Congress, believed privatization to be the remedy for fiscal pressure because of the lower costs assumed with the private sector (Greene, 1996). The supporters of privatization believed that using the experience of businesses would cause the federal government to become more efficient.

The fall of the Soviet Union and the end of the Cold War were responsible for giving privatization a major thrust in the 1990s. Faced with the burden of a shrinking military budget, the Department of Defense initiated a major move to privatize functions or components that the federal government had historically conducted or performed (Hargett, 2003:21). These components included, but were not limited to, management responsibility; assets and their operation and maintenance; personnel; and capital investments for upgrades, renewals, and improvements (Hargett, 2003:21). By privatizing service functions and housing assets, the Department of Defense believed the superior market strategies of the private sector would help reduce big government and eliminate waste, thus achieving greater efficiency (Hargett, 2003:21).

2.2 Utility Privatization

As competition for the ever-shrinking defense budget increased during the 1990s, the number of Air Force personnel continued to decline because of force reduction efforts and massive budget cuts. At the same time, the aging infrastructure at many Air Force installations was placing increased demands on increasingly scarce operations and maintenance dollars (James, 1999). After years of inadequate funding and a shortage of trained utility system technicians, it was revealed that military utility systems were not meeting industry standards (Robbins, 2001). The Department of Defense believed that by taking advantage of the private sector's efficiencies, entrepreneurship, economies of scale, innovations, and financing, they would provide military installations with safe, reliable energy supplies and utility services essential to supporting the mission (Krachman et al, 2003:23).

2.2.1 Utility System and Utility Privatization Defined

A utility system can be defined as any system used for the generation of electric power, treatment or supply of water, collection or treatment of wastewater, and supply of natural gas. This definition includes the distribution system, equipment, fixtures, structures, and other improvements to the utility system. A member of an Army utility privatization team best defined the utility privatization concept by explaining that it is the transfer of the distribution system to include "…the buildings, the pipes, and the wires, but not the energy commodity itself…" (James, 1999). Under the utility privatization concept, the methodology is to "convey government-owned utility systems to the private sector" (Sayeed, 2002:B-2). According to the Department of Defense, this partnership between the Air Force and private sector makes economical and operational sense. To state it more simply, utility privatization is considered to be getting the military out of the utility operation business and more into the energy management business.

2.2.2 History of Air Force Utility Privatization

The infrastructure at many Air Force installations, which includes utility components such as electrical, natural gas, raw water, potable water, and wastewater systems, has been inadequately funded (Robbins, 2001). This has prevented military installations from being able to upgrade and maintain their utility systems. This lack of attention has led to dilapidated utility systems at many installations. The cost to upgrade and repair these systems is currently estimated at over $4 billion (Sayeed, 2002: B-3). Therefore, the Department of Defense and the Air Force are looking to the efficiencies produced by privatization as a means to fund and improve their utility systems. The assumption is that the use of private utility companies will bring military utility infrastructures up to current codes and standards.

2.2.3 Air Force Utility Privatization Laws and Directives

Several policies are responsible for charting the path towards Air Force utility privatization; however, the four most important ones were three Defense Reform Initiative Directives (DRIDs) and one Legislative Authority Title, 10 United States Code Section 26888 (10 U.S.C. 26888). For utility privatization to work, the guidance from these policies must be fully implemented in all planning stages. These policies direct military service departments to reengineer business practices, explain what utility systems can be exempted, explain how to report progress, and establish milestones.

The DRIDs consists of four principle areas that have guided and shaped the privatization initiative for the Department of Defense. These areas are defined as reengineering, consolidating, competing, and eliminating. The goal of the reengineering principle is to urge the Department of Defense to adopt modern business practices to achieve world-class standards of performances. The consolidating principle attempts to streamline organizations in the Department of Defense to remove redundancy and maximize synergy. For the competing principle, market mechanisms are applied to business practices to help improve quality, reduce costs, and respond to customer needs. Finally, the eliminating principle strives to reduce excessive support structures to free resources and focus on core competencies.

Issued in December 1997, DRID #9 (Privatizing Utility Systems) was the first privatization-based DRID. This reform declared that the Department of Defense would privatize all utility systems, except those needed for unique security reasons or considered uneconomical to privatize, by 1 January 2000. The military departments were directed to present their strategy for privatization to the Defense Management Utility Privatization Council no later than 13 March 1998 (Deputy of Secretary of Defense—DRID #9, 1997).

DRID #21 (Formation of the Defense Energy Support Center) was issued a year later. This directive was responsible for the formation of the Defense Energy Support Center (DESC) (Deputy of Secretary of Defense—DRID #21, 1998). According to this directive, the DESC is responsible for assisting the Air Force with contracting actions in support of utility privatization (Deputy of Secretary of Defense—DRID #21, 1998).

Finally, DRID #49 (Privatizing of Utility Systems) was issued in December 1998. This directive established quarterly reporting, implementation plans, and milestones for utility privatization (Deputy of Secretary of Defense—DRID #49, 1998). To ensure progress towards the privatization goal, three milestones were established. The first milestone was 30 September 2000; it required the completion of a “go/no-go” determination as to which utility systems would privatization be pursued. For those systems that were considered appropriate for privatization consideration, the second milestone required solicitations to be released no later than 30 September 2001. The last milestone required installations to make plans to accommodate the award of privatization contracts no later than 30 September 2003 (Deputy of Secretary of Defense—DRID #49, 1998).

In November 1998, the Legislative Authority Title 10 USC Section 2688 was passed. Part (a) of this legislation detailed authority for utility conveyance in the Department of Defense (Congress, 1997). This legislation allowed military department secretaries to convey utility systems, which are not core mission requirements. Also, the legislation explains the utility system conveyance selection process as well as payment treatments to the privatized utility provider. This legislation was later amended in fiscal year 2000 with the National Defense Authorization Act. This act extended the authority for military departments to enter utility system service contracts for up to 50 years and the use of the Military Construction (MILCON) program to fund utility privatization initiatives.

2.2.4 Contracting Process

As mentioned in DRID #49, the Secretary of Defense established milestones for accomplishing privatization actions (Deputy of Secretary of Defense—DRID #49, 1998). As a result, the Air Force Utilities Privatization Process was created to help analyze and track all Air Force utility systems being considered for privatization. According to the Air Force Civil Engineer Support Agency (AFCESA), the entire process takes approximately two years from start to finish (AFCESA Home Page, 2003). This process has three phases that facilitate the transition of Air Force utility systems to the private sector: Phase I, Projection Plan and Feasibility Analysis; Phase II, Comprehensive Analysis; and Phase III, Implementation.

2.2.4.1 Phase I – Feasibility Analysis and Market Review

The first phase of the utility privatization process is composed of two main components—feasibility analysis and market review. These components are responsible for helping establish the "go/no-go" decision before an installation's utility system proceeds with Phase II actions or seeks exemption from privatization. During the feasibility component of Phase I, a preliminary analysis is used to determine if a utility system should be exempted. DRID #49 exempts utility systems that are uneconomical to privatize or have unique security reasons (Deputy of Secretary of Defense—DRID #49, 1998).   "Unique security reasons" are those situations in which ownership of the system by a private utility or other entity would substantially impair the mission of the department concerned or would compromise operations or property (Sayeed, B-9:2002). A utility system can also be exempted if there is a lack of interest or response from any utility company during the market review component. The market review component consists of a military installation placing an announcement of the intention to privatize their utility system in the Federal Business Opportunities/Commerce Business Daily (FBO/CBD) federal government solicitation publication (AFCESA Home Page, 2003).

2.2.4.2 Phase II – Comprehensive Analysis

The second phase of the process requires the installation to accomplish an environmental impact assessment, develop real estate documents for easements, and collect technical and cost data (Sayeed, D-2:2002). A life cycle cost analysis and cost of service study is also completed to provide the information necessary to help the installation with its source selection plan (AFCESA Home Page, 2003). If more than one interested provider is identified in Phase I, the Federal Acquisition Regulation requires the Air Force to conduct a full and open competition. Consequently, normal competitive utility service contract procedures must be implemented when establishing the evaluation criteria and drafting the Request for Proposal (RFP).

2.2.4.3 Phase III – Implementation

During the third phase, the RFP is finalized and issued by the installation's Contracting Squadron (Sayeed, D-2:2002) . The final RFP is placed in the FBO/CBD federal government solicitation publication, and all ensuing proposals are reviewed and evaluated by a source selection board using technical capability, past performance, and cost/price as determined by the evaluation criteria. Negotiations are then conducted with potential utility providers before a recommendation is made to the installation. The recommendation by the source selection board will be for a provider who can give the best technical support to the installation at a cost equal to or below the independent government estimate (AFCESA Home Page, 2003) . Once the appropriate higher headquarters reviews the privatization packages, they are forwarded to the Secretary of the Air Force for approval of award (AFCESA Home Page, 2003). After the contract had been awarded, the installation begins the process of transferring responsibility of the utility; the utility provider then begins to operate, maintain, upgrade, and improve the system to industry standards for the installation. However, the Air Force's responsibility does not end with the award of the contract. Since utilities are critical to the operation and readiness of the Air Force's mission, the installation and the Air Force still have a responsibility to monitor the performance of contracted utility providers (AFCESA Home Page, 2003).

2.3 Privatization Debate

Even though privatization is very common in governments around the globe, there is still considerable opposition to its use. According to Savas (1982:89), "…much debate, with a great deal of heat but relatively little light…has been generated on the issue of which is best…public or private production of service." Since the boom of the privatization movement in the early 1990s, there have been significant community concerns about its effectiveness (Hodge, 2000:8). Concerns in the areas of performance and economics are just some of the issues contributing to the debate (Hodge, 2000:8).

Opponents of privatization argue that it is naive to believe that privatization will decrease operating costs. They support this statement by explaining that organizations that only focus on the expected "cost savings and efficiency improvements of privatization overlook the tendency of private providers to service only the easy and profitable customers, while the difficult and unprofitable are neglected" (Barnekov et al, 1990:137). Furthermore, they believe opportunities for bribery or kickbacks are created when the government allows services and functions to be performed by the private sector (Barnekov et al, 1990:138). To prevent these outcomes, opponents believe that governments should allocate resources to "regulate and monitor" contractors providing services and goods for the federal government (Barnekov et al, 1990:138).

On the other hand, privatization supporters dismiss the critic's concerns by arguing that privatization provides better services and improves accountability; they point out that "careful writing of contracts and monitoring" can ensure that the private sector efficiently provides services to governments with minimal discrepancies (Barnekov et al, 1990:138). The following list summarized by Savas (1982:89) best presents the arguments in favor of privatization:

1) Contracting is more efficient because
   (a) It harnesses competitive forces and brings the pressure of the marketplace to bear on inefficient producers.
   (b) It permits better management, free of most of the distractions characteristics of overtly political organizations.
   (c) The costs and benefits of managerial decisions are felt more directly by the decision maker, whose own rewards are directly at stake.
2) Contracting makes it possible for government to take advantage of specialized skills lacking in its own work force; it overcomes obsolete salary limitations and antiquated civil service restrictions.
3) Contracting allows flexibility in adjusting the size of a program up or down in response to changing demand and to changing availability of funds.
4) Contracting permits a quicker response to new needs and facilitates experimentation in new programs.
5) Contracting is a way of avoiding large capital outlays; it spreads costs over time at a relatively constant and predictable level.
6) Contracting permits economies of scale regardless of the scale of the government entity involved.
7) Contracting a portion of the work offers a yardstick for comparison; the cost of the service is highly visible in the price of the contract, unlike most government services.
8) Contracting can reduce dependence on a single supplier (a government monopoly) and so lessens the vulnerability of the service to strikes, slowdowns, and inept leadership.
9) Contracting limits the size of government, at least in terms of the number of employees.

Nevertheless, both sides agree that constant monitoring and evaluation of privatization efforts can be quite beneficial

The opposition’s clear discontent with privatization is evident throughout the world. In New Zealand, there have been complaints over the Department of Labour’s implementation of privatization actions (Hodge, 2000:8). Similarly, interest groups in the United Kingdom have expressed their dissatisfaction with the privatization program of the Thatcher Conservative administration. Former British Prime Minister Harold Macmillan best characterized the growing British opposition to privatization by describing it as “selling the family silver” (Hodge, 2000:8). Although the previous examples summarize the opposition’s attitude toward privatization, the growing debate in the state of Massachusetts provides the basis for understanding the opposition’s argument.

In 1997, Wallin analyzed the privatization dispute in Massachusetts between Governor Weld’s initiatives and the legislative body representing the interests of state employees. Wallin’s analysis of the state’s privatization program found that the Weld administration’s eagerness to privatize state services produced many errors. In particular, Wallin highlighted the state’s failure to adequately measure and document the cost and performance variables of proposed privatization initiatives before privatizing them. As a consequence, the state of Massachusetts did not receive the projected cost savings and performance levels as predicted. Wallin explains, “…cost and performance must be carefully measured before privatization so that proper evaluation of privatization’s effects can be made” (Wallin, 1997:11). Wallin’s analysis emphasizes the importance of viewing privatization, like any new government policy, as an experiment (Wallin, 1997:11). For that reason, Wallin urged organizations to use independent checks on privatization decisions and constant monitoring of privatized service providers in order to improve the privatization process as well as to prevent problems like those experienced by the state of Massachusetts.

The Massachusetts’ privatization debate forced Governor Weld’s administration to revise its privatization guidelines. In November 1993, Weld’s Office of Administration and Finance released a seven-point guide for “mitigating imperfect conditions” of privatization (Wallin, 1997:12). The following strategy from the guideline emphasizes the need for oversight and continuous monitoring of the privatization process: “…to ensure quality and responsiveness – develop reliable measures of service quality, strengthen in-house monitoring capacity, and write contracts with periodic performance reporting...” (Wallin, 1997:12).

Wallin suggests that the lessons learned from Massachusetts’ privatization experience could provide useful information for organizations new to the world of privatization. After much criticism and learning from their mistakes, the state of Massachusetts was forced to adopt a bill regulating the state’s privatization process (Wallin, 1997:1). According to Wallin, the “inherent difficulty in measuring performance in most government services and in documenting cost savings from a change of service provider is a strong argument for careful consideration of privatization initiatives” (Wallin, 1997:17). Therefore, Wallin stresses that careful independent checks on the cost and performance variables of privatization decisions can prevent attempts to “stack the deck” in favor of privatization, whether intentional or not; avoid backlash from the critics; and provide legitimacy to the process (Wallin, 1997:16). The problems experienced by Massachusetts and other government entities indicate that the Air Force should evaluate its utility privatization process to prevent similar problems.

2.4 Previous Research

The literature review indicates a research gap in the measurement and evaluation of privatization effectiveness. Hodge (2000:7) attempted to fill this gap by synthesizing empirical data on existing privatization studies from the previous 20 years. One of

Hodge's research questions was very similar to a question of this research. His question states, "Does privatization usually improve service provision, and at lower cost, or are such generalities misleading and inappropriate?" Since the scope of Hodge's research is somewhat similar to the scope of this research effort, and to avoid research redundancy, the literature review will delve into Hodge's analysis in great detail.

Using internationally recognized privatization goals and other suggested goals from the public sector, Hodge (1999:457) identified five different areas or dimensions to be used to construct the framework for making privatization decisions on government services. These five dimensions were economic performance, social performance, democratic performance, legal performance, and political performance. The economic and social performance dimensions were highly relevant to this research effort. The economic dimension uses several economic indicators to look at the areas of economic efficiency, financial returns, and economy (Hodge, 1999:458). The social dimension is responsible for reviewing "the promised benefits to the community" of lower prices and equal or better service (Hodge, 1999:458).

Hodge used the meta-analysis review technique to analyze 129 studies possibly containing privatization empirical evidence. According to Hodge (1999:459), "this technique uses as its data the statistical measurements found in all available reports that have investigated the effectiveness of contracting." Normally, this type of research will use the t-test to determine whether the mean of a test group is statistically different from the control group. The t-test can help distinguish a possible relationship between the two groups in terms of "an estimate of the magnitude of the relationship (the effect size) and an indication of the accuracy or reliability of the estimated effect size (as in a confidence interval placed around the estimate)" (Hodge, 1999:459). Therefore, the meta-analysis technique can use the effect size variable to help exclude studies with deficiencies that are likely to distort the analysis' outcome. After excluding the majority of studies because of insufficient reporting of statistical data, only 28 remained for analysis. Hodge's (1999:460) analysis produced over 66 effect-size estimates for a data set spanning 1976 to 1994. The meta-analysis concluded that the largest economic improvements were found in services such as maintenance, cleaning, and refuse collection. These services showed the highest effect sizes, ranging from 19 to 30.5 percent (Hodge, 2000:128). As for the social performance, the analysis indicated that there was no discernable relationship to determine if privatization reduces or increases the service level (Hodge, 2000:156).

Hodge's analysis of privatization initiatives assists this research effort in many ways. First, it details the contextual background of the community's expectations (or values) when making privatization decisions, thus providing this research with values that help construct the framework for a standardized analysis model used to evaluate utility privatization effectiveness. Second, Hodge's analysis gives a breakdown of international empirical evidence relevant to the effectiveness of privatization. Lastly, the analysis provides a wide range of quantitative data in relationship to privatization's effectiveness.

However, Hodge's analysis also fails to support this research effort in many other areas. First, Hodge's research provides very little data on the effectiveness of utility privatization. In fact, a water treatment study was the only indication of a utility privatization study being used in his analysis. Second, Hodge's research fails to detail the methodologies used by the public and private sector to evaluate the effectiveness of privatization. Lastly, Hodge's analysis fails to recommend the most effective method to evaluate the effectiveness of privatization initiatives. Therefore, this research will attempt to fill the gaps in Hodge's research by answering the investigative questions as stated in the previous chapter.

2.5 Decision Analysis

Determining whether to privatize a utility system at an Air Force installation, and then evaluating the effectiveness of that decision, is hard for many reasons. For starters, the complex nature of the decision makes it a difficult one. Identifying the values associated with the goals of privatization and organizing them are the primary reasons for the complexity. Decision analysis can provide an effective method for the Air Force to structure this complex problem for analysis (Clemen et al, 2001:2). Similarly, the competing and subjectively based multiple objectives are another reasons for this decision's difficulty. Again, decision analysis is a tool the Air Force can use to clearly establish the variables and objectives of utility privatization, thereby making it less confusing to stakeholders involved in the decision.

2.5.1 Introduction to Decision Analysis

Decision analysis uses a set of quantitative methods to analyze and make decisions. These quantitative methods are designed to help the decision maker systematically make better decisions. As a result, the decision making process becomes more normative, rather than descriptive. Furthermore, the structuring tools of decision analysis (such as influence diagrams, value hierarchies, and decision trees) provide the decision maker with indispensable evaluation insight (Clemen et al, 2001:2). In summary, decision analysis allows the decision maker to translate hard-to-define goals and measures of a decision into a clear, defendable structure for better insight and facilitation.

2.5.2 Alternative-Focused Thinking versus Value-Focused Thinking

Normally, there are two approaches that can be applied to the decision analysis methodology: Alternative-Focused Thinking (AFT) and Value-Focused Thinking (VFT). The default approach for many decision makers is the AFT approach. As illustrated in Figure 1, the AFT approach first identifies the potential alternatives of a decision and then evaluates these alternatives based on the objectives and criteria of the decision.

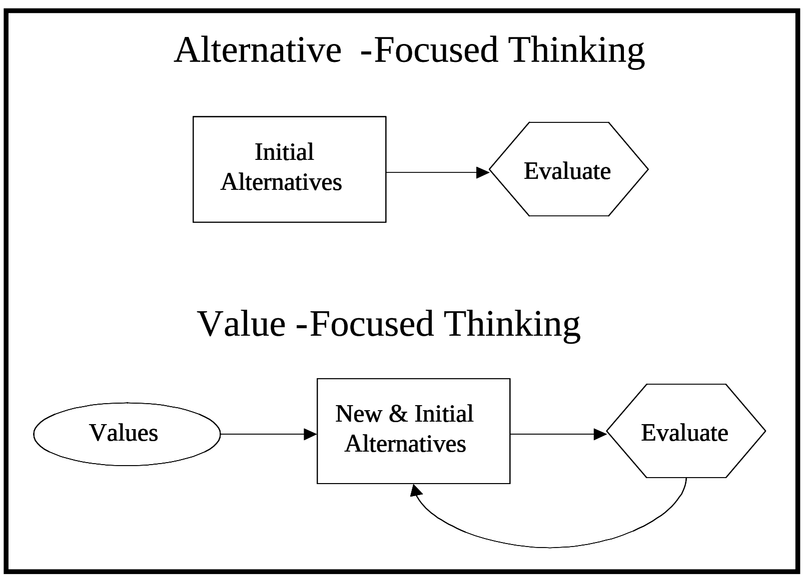

Figure 1. Alternative and Value-Focused Thinking Approaches (Clark, 2001: 2-36)

Keeney (1994:33) describes the AFT approach as putting the cart (alternatives) before the horse (values). He argues that the approach may or may not solve the problem because the decision maker is merely selecting the "best" of readily available alternatives (Keeney, 1992:47). In other words, if all readily available alternatives are bad, then the AFT approach will only assist the decision maker in selecting the "best" of the worst alternatives, thus failing to solve the problem. By contrast, the VFT approach helps solve the decision problem by establishing a list of alternatives based on the values of the decision maker. Therefore, the VFT approach uses values to help identify alternatives appropriate for the decision.

2.6 Value-Focused Thinking

VFT is a multiple objective decision analysis process that reverses the AFT approach by first defining the values that are important to the decision maker. Numerous decision makers in the public and private sectors have successfully used the VFT approach. In 2000, Keefer et al (2000:12) listed the applications of decision analysis methods from 1990 to 1999. Their literature review indicated that VFT and various other decision analysis methods have been successfully used in a wide variety of areas: energy, services and manufacturing, medical, military, public policy, and various general categories. The authors concluded that their literature review indicated that decision analysis, including VFT, is a commonly used approach to help make strategic and tactical decisions throughout the world (Keefer et al, 2000:28).

Since the values are identified and structured before the alternatives, VFT can offer the decision maker several advantages. First, the VFT process prompts the decision maker to clarify the problem. When problems are clearly defined, the likelihood of the decision maker solving the problem increases. Second, VFT can improve the likelihood of solving the decision problem by identifying value conflicts. The explicit nature of values structured in the VFT hierarchy can generate discussions that "separate disagreements about possible consequences (values) from disagreements about the relative desirability of those consequences (values)" (Keeney, 1992:26). Once the value conflicts are identified, the decision maker and stakeholders can constructively discuss how to reduce them (Keeney, 1992:26). Finally, VFT compels the decision maker to use the values in a consistent manner. In VFT, the decision maker must apply all relevant values in a consistent manner to properly evaluate alternatives. However, the values do not have to be weighted equally, just applied to every alternative in the same manner. This in turn reduces the likelihood of creating bias in the evaluation process while creating a decision evaluation model that is defendable and repeatable. Figure 2 provides an overview of these benefits and others as defined by Keeney.

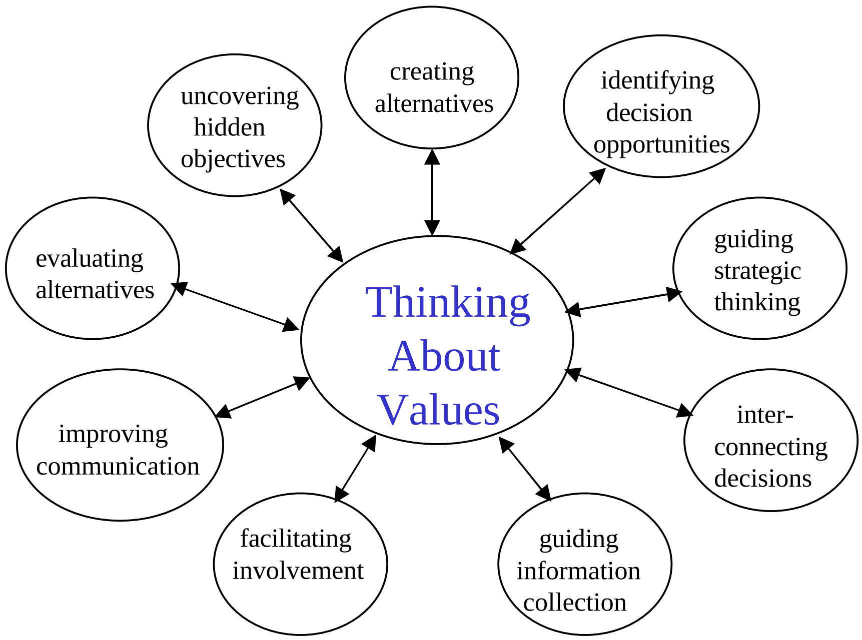

Figure 2. Benefits of Value-Focused Thinking (Clark, 2001: 2-36)

2.7 Ten-Step Value-Focused Thinking Process

The VFT process is mainly derived from the methodology instituted by Keeney (1992) and Kirkwood (1997). Shoviak (2001:63) incorporated the ideas and principles of the previous authors into the ten-step process shown in Figure 3. The remainder of this section will discuss these steps and examine their applicability to this research effort.

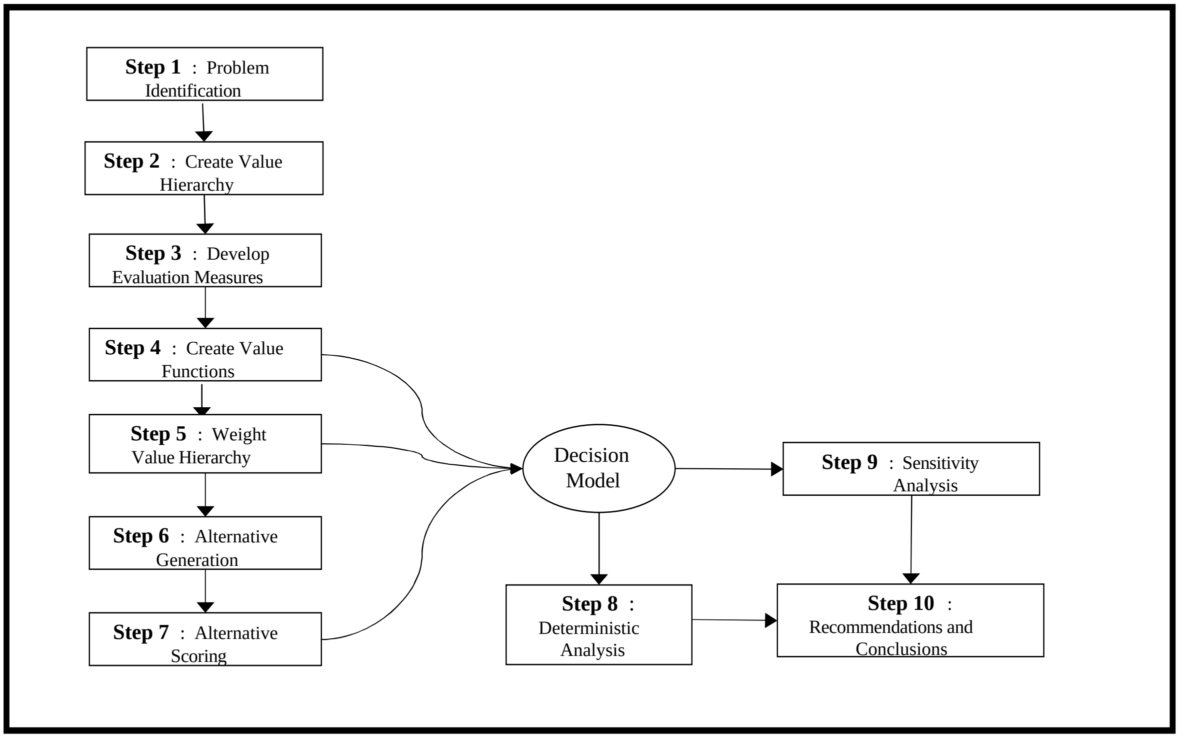

Figure 3. VFT: Ten-Step Process (Shoviak et al, 2001)

2.7.1 Step 1 – Problem Identification

Before VFT can begin, the decision maker must clearly define the exact nature of decision problem. According to Keeney (1992:55), the decision maker usually fails to fully understand the problem and the objectives used to solve the problem. This failure not only results in wasted effort and resources; it also renders the model useless. Therefore, it is very important that the decision maker, and any other stakeholders associated with the problem, give the appropriate time and effort to fully identify and define the decision problem. To do this, the decision maker should ask the following questions to begin constructing a value hierarchy: What is important to me in terms of this decision? What is it that I value in a solution?

The answers to these questions help ensure proper identification of the decision problem by forcing the decision maker to examine the decision context, objective, and direction/preference (Weir, 2003). The decision context is the setting in which the decision occurs. For instance, a decision maker having an old and unreliable truck with constant costly repairs would be an example of a decision context or a decision setting. Accordingly, the decision maker's objective would be to replace the truck. In addition, replacing the old truck with a new truck would be an example of the decision maker's direction/preference. Thus, the fundamental objective for this particular decision problem would be to "Buy the Best Truck."

2.7.2 Step 2 – Value Hierarchy Construction

Once the fundamental objective is defined, the construction of the value hierarchy can begin. Structuring the values of the decision maker into a hierarchical format creates the value hierarchy. This format serves as a graphical representation of the values important to the decision problem facing the decision maker. Thus, the graphical format allows the decision maker and stakeholders to visualize how their values impact the decision making process. Thus, the decision maker is able to identify missing values or "holes" in the value hierarchy (Keeney, 1992:69). Ultimately, the goal is to fill in as many "holes" as possible in order to construct a clear and comprehensive value hierarchy, which will aid in the defensibility and facilitation of the VFT process.

2.7.2.1 Desired Properties of Value Hierarchies

According to Kirkwood (1997:16), value hierarchies should include the following desirable properties: completeness, nonredundancy, decomposability, operability, and small size. When each tier of a value hierarchy is "collectively exhaustive," the value hierarchy is considered to encompass completeness. To achieve this property, the decision maker must ensure the value hierarchy adequately covers all values important to the decision problem (Kirkwood, 1997:16). Furthermore, the evaluation measures for the lowest-tier must "adequately measure the degree of attainment of their associated objectives" (Kirkwood, 1997:16). By ensuring completeness in the value hierarchy, decision alternatives are adequately evaluated and ranked accordingly.

The principle of nonredundancy is the second desired property of value hierarchies. When value hierarchies are nonredundant, the values in the hierarchies are considered "mutually exclusive" (Kirkwood, 1997:17). This means that none of the values in any given tier overlap. When evaluation considerations overlap, objectives are subjected to being "double counted," thus giving certain objectives "more weight than was intended when the weights were assigned to the various evaluation measures" (Kirkwood, 1997:17). The application of nonredundancy in the value hierarchy prevents the overlap of evaluation considerations.

The third desired property of value hierarchies is decomposability or "independence." This principle ensures that the score of one value's measure is not dependent upon the score of another value's measure. For instance, Kirkwood's example uses a decision maker with a value hierarchy consisting of the following values: salary, pension benefits, and medical coverage (Kirkwood, 1997:17). Despite the appearance of nonredundancy, the value hierarchy may still lack decomposability. For example, the value of an additional $5,000 increase in salary may depend on pension benefits. The $5,000 increase may not be as valuable to a person with good pension benefits as it is to a person with poor pension benefits who can use the additional $5,000 to build his/her own retirement plan. Consequently, the lack of decomposability of values makes the value hierarchy more complex (Kirkwood, 1997:18).

The fourth desired property of value hierarchies can be defined as operability. The application of this principle ensures that the value hierarchy is understandable to the stakeholders who will use the model (Kirkwood, 1997:18). The operability principle assists the value hierarchy in better facilitating communication and improving its defensibility.

Small size is the fifth and last desired property of value hierarchies. This principle stresses the need to make the value hierarchy as small as possible while balancing defensibility and practicality. Smaller value hierarchies are easier to communicate to stakeholders and use fewer resources. The "test of importance" ensures a small hierarchy size by filtering out superfluous values; it states that an "evaluation consideration should be included in a value hierarchy only if possible variations among the alternatives with respect to the proposed evaluation consideration could change the preferred alternative" (Kirkwood, 1997:19). In other words, the test identifies values that do not contribute to a difference in the top ranked alternative (Kirkwood, 1997:18-19).

2.7.2.2 Generation of Values

Normally, the decision maker is ultimately responsible for specifying the objectives or values important to the decision problem. However, the decision maker should also solicit input from "individuals interested in and knowledgeable" (i.e., stakeholders) about the decision problem (Keeney, 1992:56). As recommended by Kenney (1992:56), "the most obvious way to identify objectives is to engage in a discussion of the decision situation." Keeney (1994:35) identified the following list of techniques to help identify objectives and recommended the use of a facilitator. The questions after each technique are used to guide the decision maker during the process (Shoviak, 2001:48).

1. Develop a wish list. What do you want? What do you value? What should you want?

2. Identify alternatives. What is a perfect alternative, a terrible alternative, and a somewhat reasonable alternative?

3. Consider problems and shortcomings. What needs fixings?

4. Predict consequences. What has occurred that was good or bad? What might occur that you care about?

5. Identify goals, constraints, and guidelines. What are your aspirations? What limitations are place on you?

6. Consider different perspectives. What would your competitor or constituency be concerned about? At sometime in the future, what would concern you?

7. Determine strategic objectives. What are your ultimate objectives? What are your values that are absolutely fundamental?

8. Determine generic objectives. What objectives do you have for your customers, your employees, your shareholders, and yourself? What environmental, social, economic, or health and safety objectives are important?

In addition to Keeney's list of techniques, the gold, silver, and platinum standards are supplementary methods used to help the decision maker and stakeholders generate values/objectives. The gold standard deductively develops the value model by examining an organization's strategic objectives, vision, or plan. The organization's senior leadership then validates the constructed hierarchy. The silver standard provides a simpler and more logical value model than the gold standard. With the silver standard, discussions with a large number of stakeholders are used to generate values/objectives. During these group discussions, affinity diagrams are used to help inductively build the value model. Interviews with senior leadership and key technical personnel are used to create the value model with the platinum standard. This method provides a more insightful structure because of the stakeholders' direct involvement.

2.7.2.3 Structuring the Value

A value hierarchy is constructed by structuring the values of a decision problem in a hierarchical fashion. At the very top of the value hierarchy is the overarching fundamental objective. The fundamental objective is then divided into sub-objectives that better define the decision problem. When sub-objectives are established below the fundamental objective, a layer or tier is created. As the value hierarchy structure grows, the values of the lower-tiers are used to define "the important attributes of those values higher in the hierarchy" (Jurk, 2002:35). Creation of tiers in this manner continues until the values are subdivided to a level at which measurement and evaluation is possible. To assist with understanding value hierarchies, consider the following example in Figure 4. The root of the hierarchy is the fundamental objective, "Buy the Best Truck," with first-tier values of *performance*, *practicality*, and *safety* (Jurk, 2002:37).

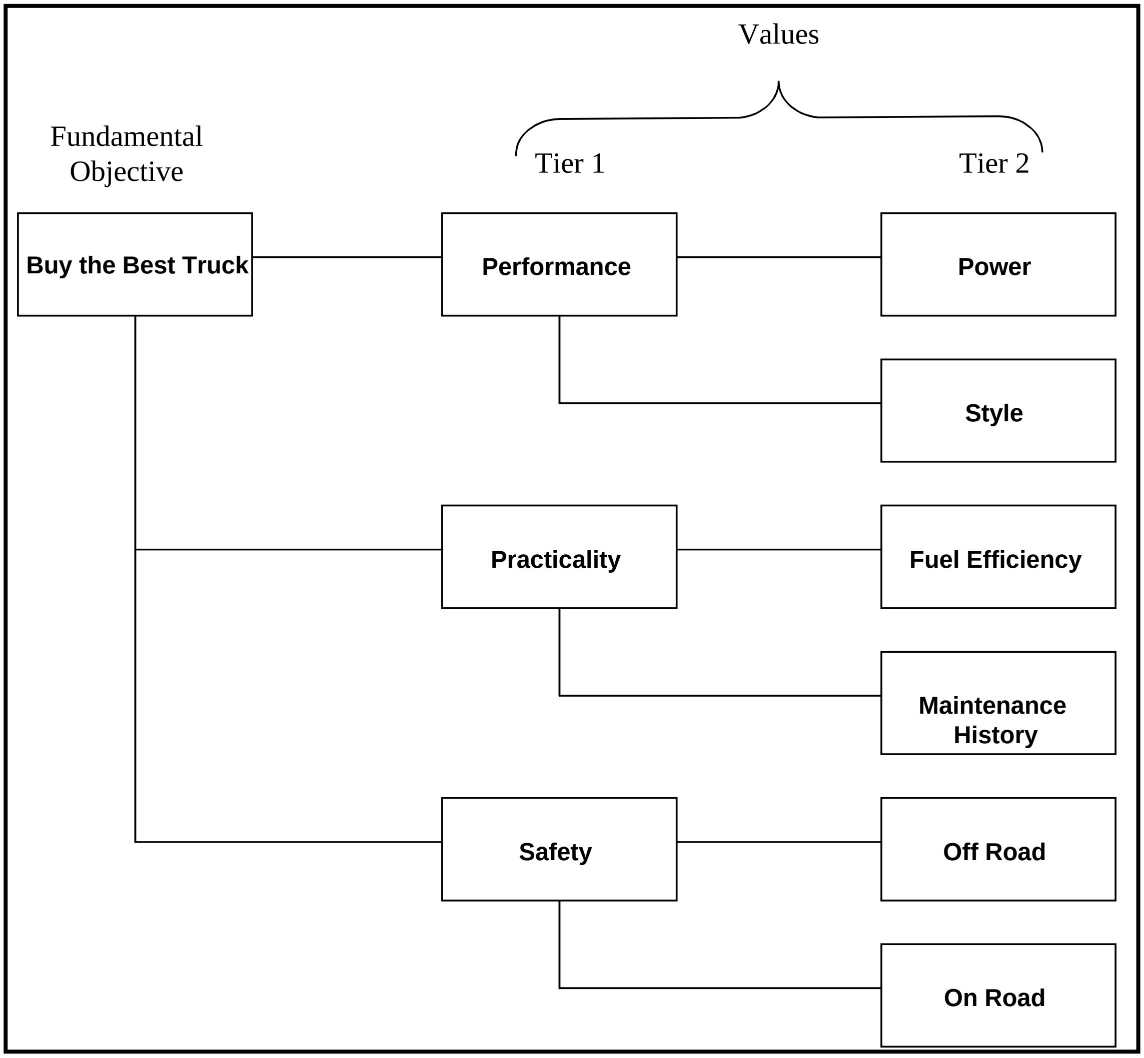

Figure 4. “Buy the Best Truck” Hierarchy (Jurk, 2001:36)

2.7.3 Step 3 – Evaluation Measure Development

When the values can no longer be subdivided, the decision maker must determine the type of measures that can adequately capture the values. According to Kirkwood (1997:24), an evaluation measure specifies the “…degree of attainment of [an] objective.” Thus, an evaluation measure can help quantify the degree of attainment by allowing an “unambiguous rating of how well an alternative does with respect to each objective” (Kirkwood, 1997:24). As a result, the degree of attainment is converted from a subjective platform to a more objective platform, which allows for an easier measurement of attainment for a particular objective.

2.7.3.1 Types of Evaluation Measure Scales

Evaluation measure scales are classified as being either natural or constructed and either direct or proxy. A natural scale is a scale “that is in general use with a common interpretation by everyone” (Kirkwood, 1997:24). For example, price in dollars would be a natural scale for the cost value for the “Buy the Best Truck” decision. A constructed scale “is one that is developed for a particular decision problem to measure the degree of attainment of an objective” (Kirkwood, 1997:24). In other words, constructed scales are used “when there is no existing natural scale” available (Kirkwood, 1997:24). In the “Buy the Best Truck” decision, an example of a constructed scale would be the categorical levels of two door, extended cab, and crew cab for the style value.

In addition to having a natural or constructed scale, an evaluation measure can also have either a direct or proxy scale. According to Kirkwood (1997:24), “a direct scale directly measures the degree of attainment of an objective, while a proxy scale reflects the degree of attainment of its associated objective, but does not directly measure this.” Thus, cost in dollars would be an example of a direct scale and the number of championships to measure a football team’s success would be an example of a proxy scale.

2.7.3.2 Desired Properties of Value Hierarchies

When selecting evaluation measure scales, there are three desirable properties decision makers should consider: measurability, operationality, and understandability (Keeney, 1992:112-116). The property of measurability "defines the associated objective (value) in more detail than that provided by the objective alone" (Keeney, 1992:113). Thus, measurability ensures the evaluation measure scale precisely measures the value envisioned by the decision maker. Operationality "express(es) relative preferences for different levels of achievement of an objective (value) as indicated by attribute levels" (Keeney, 1992:114). The property of understandability eliminates ambiguity in describing and interpreting consequences in terms of attributes (Keeney, 1992:116). The incorporation of these properties in value hierarchies aides in clarifying respective objectives (values) and facilitating VFT (Keeney, 1992:112).

2.7.4 Step 4 – Value Function Creation

Once the evaluation measure scales are determined, the evaluation measures must have the capability of converting differing units and scales into a common scale, which helps with being able to score and compare alternatives. The Single-Dimension Value Function (SDVF) provides this capability by combining "the multiple evaluation measures into a single measure of the overall value of each evaluation alternative" (Kirkwood, 1997:53).   Thus, the SDVF converts units of an evaluation measure into "value units" by assigning a value from 0 to 1. The SDVF is composed of two axes, the x-axis and the y-axis. The x-axis consists of a set of points used to represent the evaluation of a particular measure. The value for the measure is represented on the y-axis. When a decision maker assigns each point on the x-axis a value on the y-axis, a function is created. As a result, the decision maker has the capability of placing all measures on the same "unit-less" scale (Weir, 2003).

There are two different types of value functions: piecewise linear and exponential linear. The piecewise linear function is "made up of segments of straight lines that are joined together," whereas the exponential linear function "uses a specific mathematical form" to help convert each individual measure's units into value units. For these functions, the least preferred score for a particular evaluation measure will have a value of zero while the most preferred score will have a value of one (Kirkwood, 1997:61). In both cases, value functions can take on monotonically increasing or decreasing shapes. A monotonically increasing function will have an increase in value on the y-axis as the score increases on the x-axis. Conversely, a monotonically decreasing function will have a decrease in value on the y-axis as the score increases on the x-axis. Examples of monotonically increasing and decreasing value functions are shown in Figures 5 and 6, respectively.

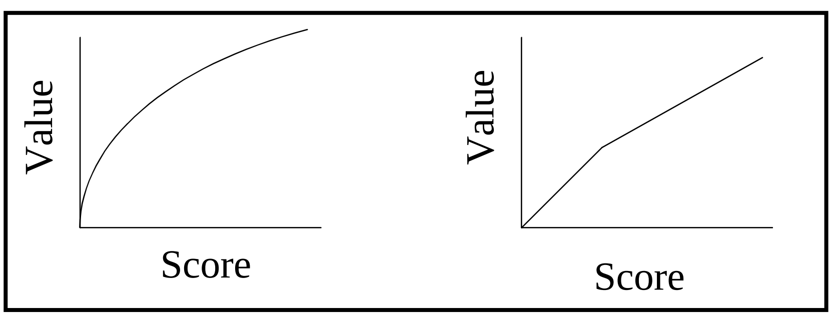

Figure 5. Monotonically Increasing Exponential (left) and Piecewise Linear (right) Value Functions

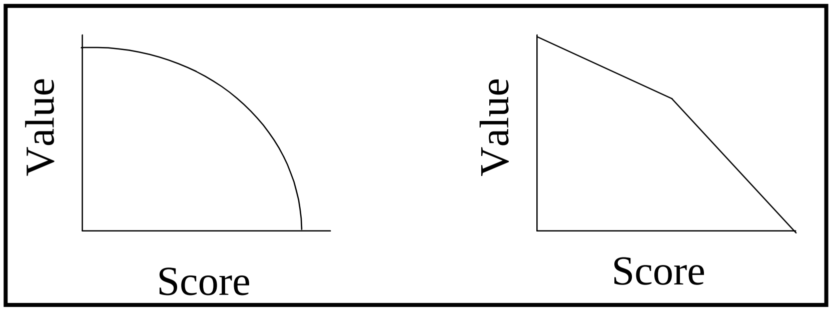

Figure 6. Monotonically Decreasing Exponential (left) and Piecewise Linear (right) Value Functions

2.7.5 Step 5 – Value Hierarchy Weighting

Once the value functions are created, each value must be differentiated according to its relative importance. The decision maker can accomplish this by assigning weights to each value in the value hierarchy, with the entire value hierarchy usually receiving a total weight of one. This concept is illustrated in the "Buy the Best Truck" hierarchy shown in Figure 7 (Shoviak, 2001:57). Accordingly, each value in the hierarchy is assigned a portion of the total weight. This score or weight reflects the decision maker's preference for each value. The weights can be assigned on a local and global basis

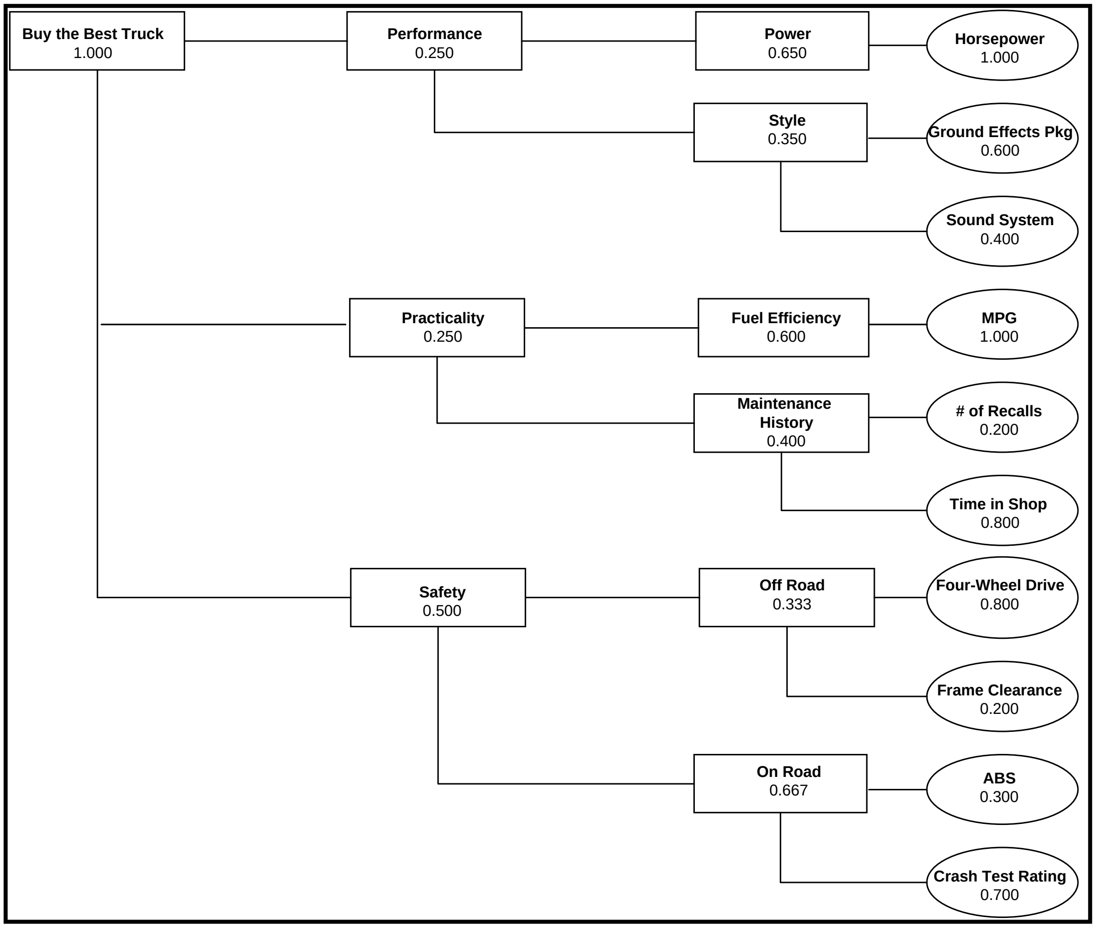

Figure 7. "Buy the Best Truck" Value Hierarchy with Local Weights (Jurk, 2002:45)

2.7.5.1 Local Weighting

Local weighting deals with the differentiation of values on the same tier within a single branch of the value hierarchy. The sum of all the local weights within a tier of a branch must sum to one. For example, Figure 8 shows the first-tier values of *Performance*, *Practicality*, and *Safety* (Jurk, 2002:44). Since the weights on the first-tier sum to one, the weights are considered to be local. In a similar manner, the weights for the branch of the second-tier values of *Safety* (i.e., *Off-Road* and *On-Road*) and *On Road* (i.e., *ABS* and *Crash Test Rating*) are considered local weights since they sum to one.

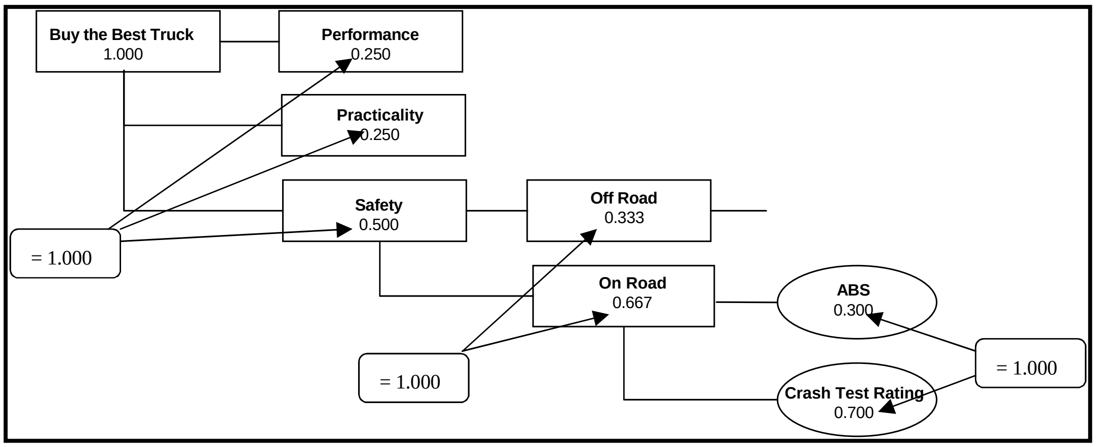

Figure 8. “Buy the Best Truck” Local Weights Example (Jurk, 2002:46)

2.7.5.2 Global Weighting

Once the local weighting for all values and measures is complete, the global weights can be determined. The global weights are derived from the local weights by “multiplying the local weights for each successive tier above it” (Katzer, 2002:43). The global weights are used in the overall calculation of the value hierarchy. As illustrated in Figure 9, the global weights on any given tier of the hierarchy must sum to one.

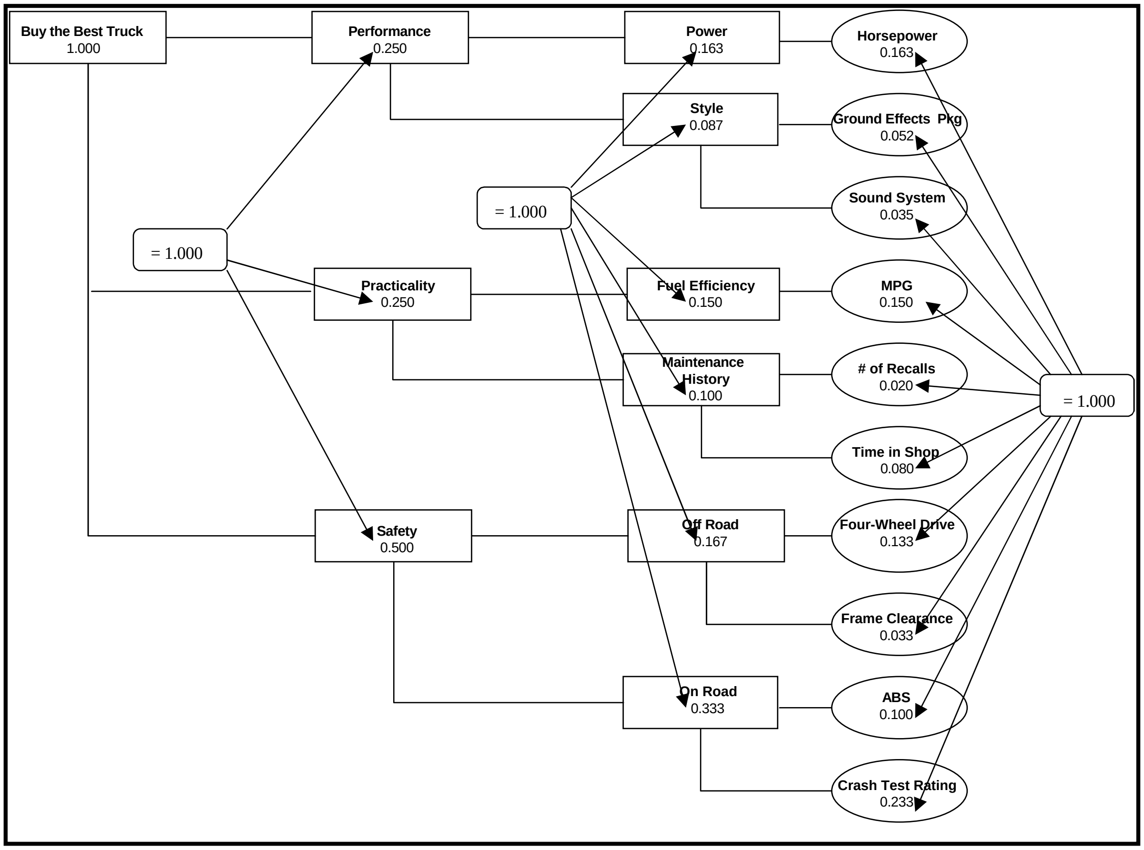

Figure 9. "Buy the Best Truck" Global Weights Example (Jurk, 2002:46)

2.7.6 Step 6 – Alternative Generation

After completing the hierarchy and weighting the values, alternatives for the decision problem are generated. Normally, the value hierarchy is used as a starting point for generating alternatives. If too many alternatives are generated, the value functions of the hierarchy can serve as the screening criterion. Thus, if a measure for a particular alternative returns a score of "zero" in the value function, it may give motivation to eliminate the alternative containing this measure from the model. By contrast, when too few alternatives are generated, the hierarchy can identify value gaps. Identifying value gaps is instrumental in modifying the hierarchy in order for alternatives to score better in critical areas.

2.7.7 Step 7 – Alternative Scoring

After generating alternatives, data must be collected and translated into each measure's SDVF. As mentioned in Step 4, the SDVF assigns a value (or score) from 0 to 1 based on where the data is positioned on the SDVF's x-axis. Since the x-axis is the driving force behind alternative scoring, the y-axis is often hidden from stakeholders. This method, termed "blind scoring," eliminates any potential scoring bias by removing any ties to the hierarchy weighting. Each measure is scored one at a time. As an ultimate goal, the decision maker should ensure the data collected for each measure is clearly defined, understandable to everyone, and has proper documentation.

2.7.8 Step 8 – Deterministic Analysis

The deterministic analysis consists of a mathematical equation that combines a particular alternative's respective SDFVs (Step 4), and associated weights (Step 5). As a result, the combination of data creates an aggregated score or weighted sum score for each alternative. Thus, the weighted sum score provides insight for the decision maker to rank order the VFT model results.

The additive value function is a mathematical equation used by many in decision analysis for the rank ordering of alternatives (Shoviak, 2001:60). This simplistic mathematical equation provides the decision maker with the means to conduct detailed sensitivity analysis of alternatives (Kirkwood, 1997:230; Shoviak, 2001:60). There are several prerequisites before a decision maker can use this equation. First, each evaluation measure must have an SDVF with an assigned weight. Next, the SDVFs must be constructed with the objective of calculating values between 0 (lowest score) and 1 (highest score). Finally, the combined weights for a particular alternative must sum to one. Once all prerequisites are met, the decision maker can "construct a strategically equivalent additive value function" which takes the following form (Kirkwood, 1997:230):

$$v(x) = \sum_{i=1}^{n} \lambda_i v_i(x_i)$$

The value function is represented by $v(x)$, where $v_i(x_i)$ is the translated score from the alternative's SDVF and λ_i is the scaling constant or associated weight.

2.7.9 Step 9 – Conduct Sensitivity Analysis

After completing the deterministic analysis, the decision maker can perform sensitivity analysis. The sensitivity analysis expands on the deterministic analysis by answering the following question for the decision maker: "How would this decision change if another interested party had weighted the hierarchy or provided the data for the SDVFs?" (Clemen et al, 2001:175; Katzer, 2002:46). Since there is little change in the SDVFs, the sensitivity analysis is performed with the model's weights. When the weights are used for sensitivity analysis, the value of the weight under consideration is varied from 0.000 to 1.000 while the other dependent weights remain proportionally constant. Thus, the variation of relative importance for the weight under consideration can be explored and presented on a breakeven chart.

2.7.10 Step 10 – Recommendations and Conclusions

After completing the deterministic analysis, the decision maker can perform sensitivity analysis. The sensitivity analysis expands on the deterministic analysis by answering the following question for the decision maker: "How would this decision change if another interested party had weighted the hierarchy or provided the data for the SDVFs?" (Clemen et al, 2001:175; Katzer, 2002:46). Since there is little change in the SDVFs, the sensitivity analysis is performed with the model's weights. When the weights are used for sensitivity analysis, the value of the weight under consideration is varied from 0.000 to 1.000 while the other dependent weights remain proportionally constant. Thus, the variation of relative importance for the weight under consideration can be explored and presented on a breakeven chart.

Chapter 3. Methodology

This chapter explains how the value model was developed to help determine Air Force Utility Privatization effectiveness. The chapter details the first seven steps of the 10-step process discussed in Chapter 2 and present the elements of the model.

3.1 Step 1 – Problem Identification

Before the problem can be solved, the exact nature of the problem or the overall fundamental objective must be defined. For this thesis, the fundamental objective is to determine the effectiveness of Air Force utility privatization. In order to accomplish this objective, a mathematical model must be built to evaluate Air Force utility privatization from a post-award point of view. Thus, the model must be capable of evaluating, scoring, and ranking all privatized Air Force utility systems based on the values important to Air Force decision makers. Once created, the model, along with a privatized utility system database containing measurable data, will serve as a decision support model. It will provide Air Force decision makers with the oversight and insight needed to make its utility privatization program successful. The Value-Focused Thinking (VFT) process was used to help create this mathematical model to solve the decision problem.

The decision maker for this problem is the Air Force's Utility Privatization Program Manager at the Air Force Civil Engineer Support Agency (AFCESA) at Tyndall Air Force Base, Florida. The Program Manager's objective for this thesis is to have a detailed listing of all the major values and sub-values that should be considered when evaluating the performance of a privatized utility system. In addition, the decision maker wants to know how the values compare to each other in terms of level of importance. Furthermore, the decision maker desires to have the capability to identify and present the distinct differences among the privatized utility systems being evaluated. Thus, the problem statement is "Determine the effectiveness of each privatized Air Force utility system." This problem statement represents the basis for the fundamental objective of this decision problem.

3.2 Step 2 – Value Hierarchy Construction

After clearly defining the problem, the next step was constructing the value hierarchy to solve it. For this step, the fundamental objective was iteratively divided into specific values until they could be measured. To begin the process, the researcher and a stakeholder used the gold standard to construct a preliminary structure known as the "strawman" hierarchy. The purpose of the "strawman" hierarchy is to assist the decision maker in generating values for the decision problem. The Air Force utility privatization Request for Proposal (RFP) template document was used to generate and list all values relating to the fundamental objective. Next, an affinity grouping exercise was used to logically determine the values and sub-values of the "strawman" hierarchy. The "strawman" hierarchy organized the values into hierarchical format starting with the overarching value at the top and working down to measurable values at the bottom. A total of 18 values were grouped into two headings, which are *Cost* and *Performance*. Figure 10 illustrates the "strawman" hierarchy with seven-tiers of values and/or measures.

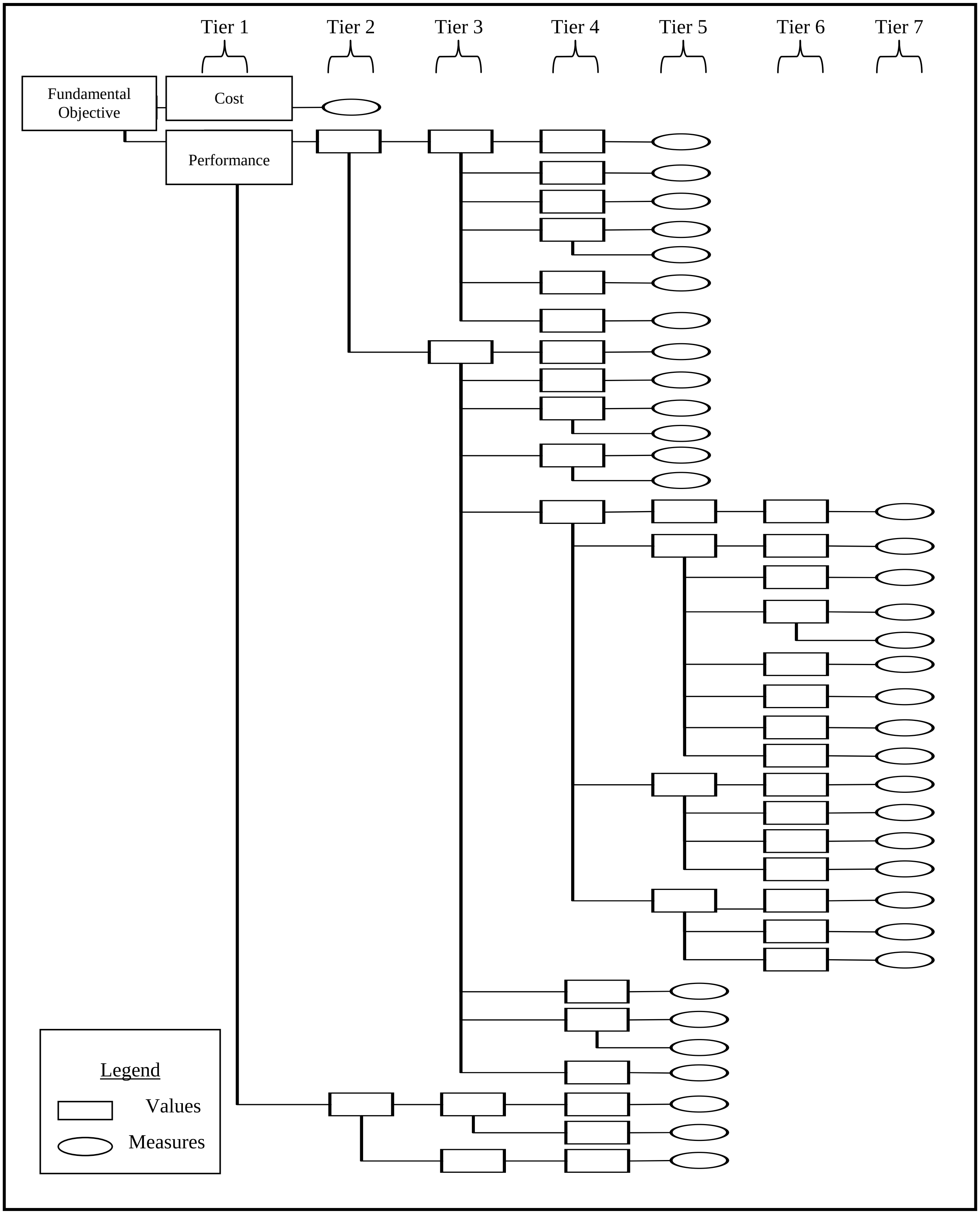

Figure 10. Strawman Hierarchy

After completing the "strawman" hierarchy, the platinum standard was used during a two-day meeting with the researcher, the proxy decision maker from AFCESA, and several subject matter experts to help identify overlooked values imperative to the hierarchy. The "strawman" hierarchy was presented in order to prompt the generation of values essential to the problem statement. Each meeting attendee provided what he or she believed to be important considerations for privatized utility system evaluation. During the meeting, the proxy decision maker directed that the *Cost* value be removed from the hierarchy because AFCESA is only concerned with performance at this time. One of the subject matter experts supported the proxy decision maker's suggestion by explaining that the lack of tier depth in the *Cost* value would create weighting problems for the entire hierarchy. After the removal of the *Cost* value, the remaining values underneath the *Performance* value were grouped into three main headings—*Quality*, *Reliability*, and *Responsiveness*.

The values making up the *Quality* and *Responsiveness* branches remained unaltered; however, one value, *System Efficiency*, was removed from the *Reliability* branch. The difficulty in differentiating the amount of contribution a privatized utility provider (contractor) is actually contributing to overall utility system efficiency was the main reason for the removal of this value. The proxy decision suggested that further research should be conducted to determine a reliable method to account for a contractor's system efficiency. Therefore, the *System Efficiency* value can be incorporated into the model at a later time. Figure 11 illustrates the complete value hierarchy for Air Force utility privatization evaluation. The details of the hierarchy will be explained in the remainder of this section.

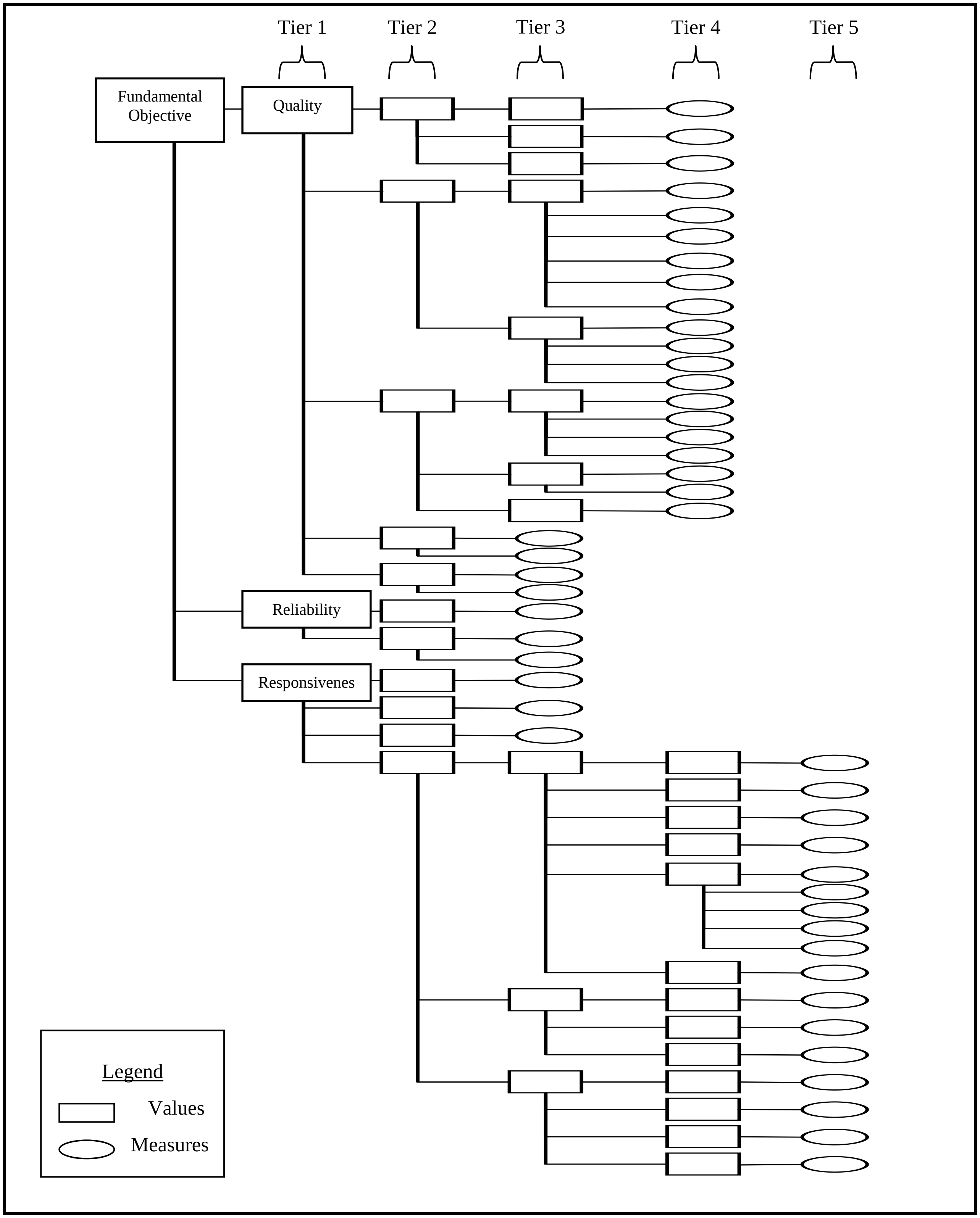

Figure 11. Final Utility Privatization Evaluation Value Hierarchy

3.2.1 Decompose Fundamental Objective

The main objective of the Air Force utility privatization evaluation hierarchy is to determine the effectiveness of the Air Force's privatized utility systems. To understand how utility system privatization effectiveness can be evaluated, the fundamental objective was decomposed into three distinct branches: (1) *Quality*, (2) *Reliability*, and (3) *Responsiveness*. The hierarchy illustrating the values comprising the first and second-tier is shown in Figure 12.

3.2.2 *Quality* Branch

The first of the three branches in the first-tier of the hierarchy is the *Quality* branch. *Quality* for Air Force privatized utility systems is obtained when the contracted utility provider (contractor) provides a safe, secured, and environmentally sound utility system. In addition, the contractor must provide the Air Force with the capability to measure the amount of utility commodity (i.e., electricity, water, and natural gas) being consumed by its installations. The second-tier values of *Effective Administration*, *Environmental Stewardship*, *Utility System Safety*, *Sub-Metering Capability*, and *Utility System Security* further define the *Quality* branch by providing more detailed information. The values comprising the first and second-tier of the *Quality* branch are shown in Figure 13.

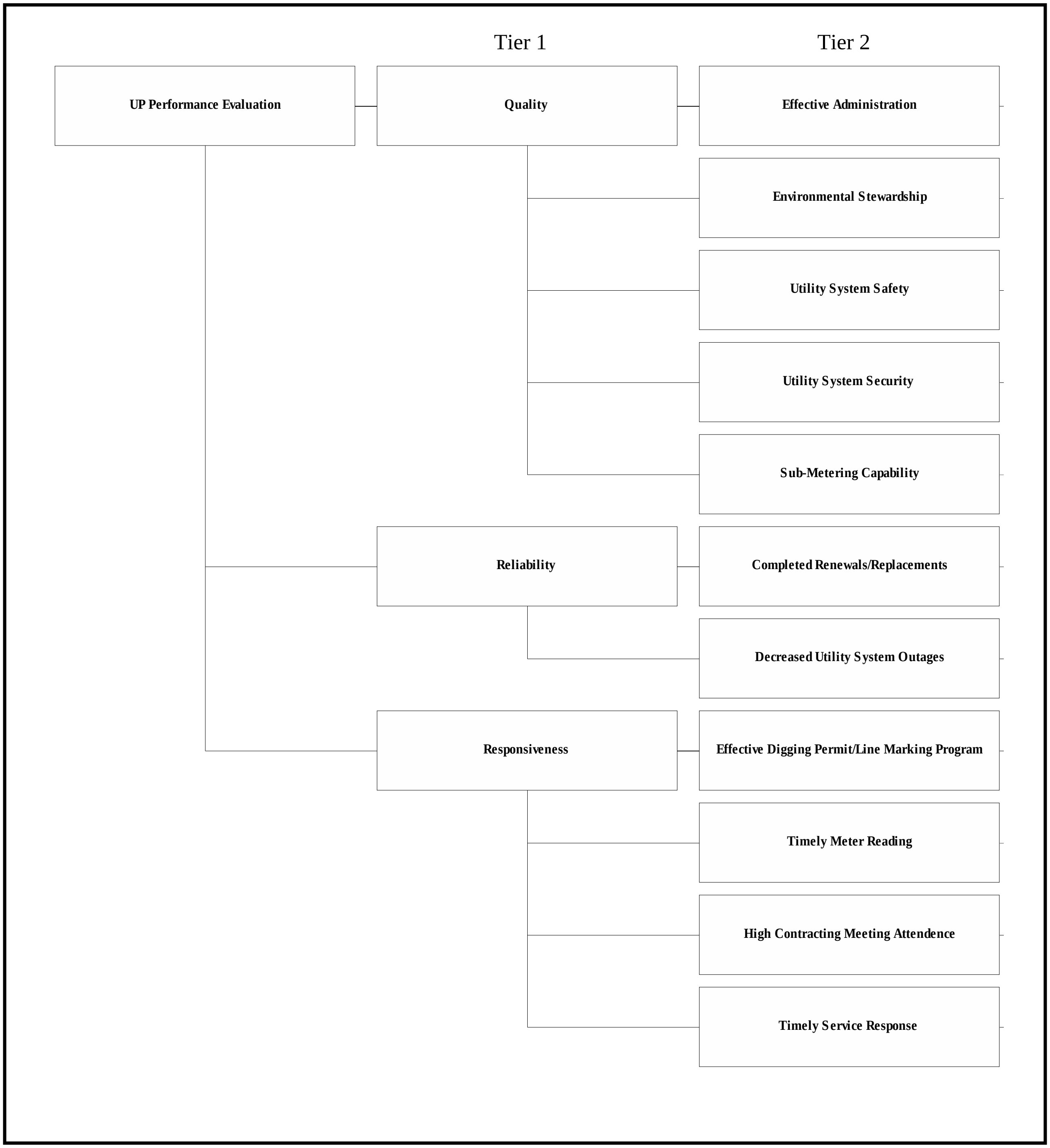

Figure 12. Utility Privatization Evaluation Hierarchy Showing Tiers 1 and 2

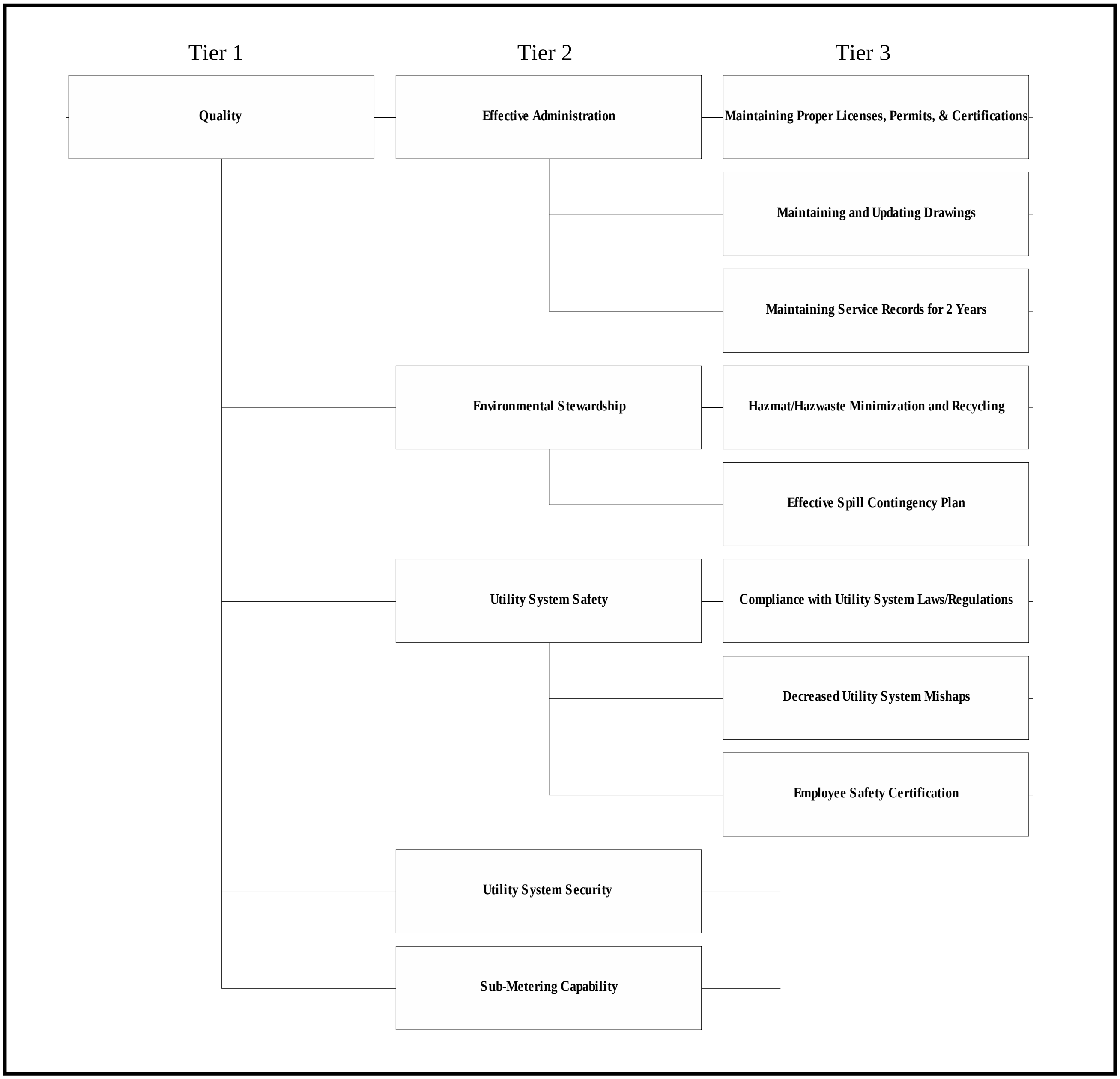

Figure 13. Utility Privatization Evaluation Hierarchy for *Quality* Branch

3.2.2.1 Effective Administration

The first of the five values in the second-tier of the *Quality* branch is *Effective Administration*, which is obtained when a contractor maintains, updates, and stores documents essential to the operation of an Air Force's utility system. The third-tier of values *Maintaining Proper Licenses, Permits, & Certification; Maintaining Service Records for Two Years;* and *Maintaining and Updating Drawings* further define the *Effective Administration* value by providing more detailed information.

3.2.2.1.1 Maintaining Proper Licenses, Permits, & Certifications

Maintaining Proper Licenses, Permits, & Certifications are requirements for all contractors providing utilities to Air Force installations. This value reflects the Air Force's desire to have all of its utility systems in compliance with federal, state, and local regulations and laws. Also, the contractor is "responsible for obtaining any new or revised permits, [licenses], or [certifications] needed to operate and maintain the utility system" (Department of the Air Force, 2003:19). To ensure this compliance, contractors are required to ensure their operations "meet all applicable federal, state, local, and installation certification, licensing, and medical requirements to perform all assigned tasks and functions as defined in the contract" (Department of the Air Force, 2003:13). This value does not include safety requirements.

3.2.2.1.2 Maintaining Service Records for Two Years

Maintaining Service Records for Two Years is a requirement for all contractors providing utilities to Air Force installations. This value reflects the Air Force's desire to retrieve service records from contractors in order to measure their ability to provide utility service to the installation. The contractor must ensure that their operations "record all service request calls, documenting the time of the call, time of service response, cause of request, and action taken (including time and date completed)" (Department of the Air Force, 2003:17). The contractor must maintain these records for at least a two-year time period. These records "may be reviewed by the Administrative Contracting Officer upon reasonable request and with reasonable notice" (Department of the Air Force, 2003:17).

<u>3.2.2.1.3 Maintaining and Updating Drawings</u>

The contractor must "maintain record drawings for all existing and new facilities installed by the [c]ontractor within the service area" (Department of the Air Force, 2003:13). This value reflects the Air Force's desire to request these drawings from the contractor in order to use them and make copies for its own purposes. In addition, the contractor must provide the Air Force with these drawings "in the form of CAD-CAM disks…using the latest release software compatible" with Air Force systems (Department of the Air Force, 2003:13). Furthermore, "the contractor will also provide information to allow for updates to the installation Geographical Information System (GIS), as appropriate" (Department of the Air Force, 2003:13).

3.2.2.2 Environmental Stewardship

The second of the five values in the second-tier of the *Quality* branch is *Environmental Stewardship*. This value is obtained when a contractor provides an effective contingency plan for spills, minimizes hazardous waste and materials, and increases the installation's solid waste diversion rate by recycling appropriate materials used in its daily operations. The third-tier values of *Effective Spill Contingency Plan* and *Hazardous Material/ Waste Minimization and Recycling* provide more detailed information about the *Environmental Stewardship* value.

3.2.2.2.1 Effective Spill Contingency Plan

The *Effective Spill Contingency Plan* value reflects the Air Force's desire to have the contractor's spill contingency plan reflect the installation's spill contingency plan. In addition, the contractor's spill contingency plan should "be developed in accordance with the National Response Team's Integrated Contingency Plan Guidance" (Department of the Air Force, 2003:19).

3.2.2.2.2 Hazardous Material/Waste Minimization and Recycling

The *Hazardous Material/Waste Minimization and Recycling* value reflects the Air Force's desire to have contractors handle hazardous materials and recycle reusable materials according to applicable laws and regulations. For hazardous materials used on the installation, the contractor is required to have appropriate Material Safety Data Sheets (MSDDs). In addition, the contractor is required to "maintain a viable hazardous waste minimization program that includes making every effort to identify non-hazardous or less hazardous materials than those currently in use" (Department of the Air Force, 2003:19). As for recycling, the contractor is required to divert all reusable materials from the installation's waste stream by recycling it according to applicable laws and regulations.

3.2.2.3 Utility System Safety

The third of the five values in the second-tier of the *Quality* branch is *Utility System Safety*. *Utility System Safety* is obtained when a contractor performs utility system distribution, construction, and maintenance within the guidelines of applicable laws and regulations. The third-tier values of *Compliance with Utility System Laws/Regulations, Decreased Utility System Mishaps,* and *Employee Safety Certification* provide more detailed information about the *Utility System Safety* value.

3.2.2.3.1 Compliance with Utility System Laws/Regulations

The *Compliance with Utility System Laws/Regulations* value reflects the Air Force's desire to have all its utility systems in compliance with federal, state, and local safety, fire prevention, and health codes. The contractor is required to adhere to all federal, state, and local safety, fire prevention, and health codes.

3.2.2.3.2 Decreased Utility System Mishaps

The *Decreased Utility System Mishaps* value reflects the Air Force's desire to have the least amount of utility system mishaps as possible. A utility system mishap is defined as an event that causes the loss of man-hours or resources due to poor safety practices.

3.2.2.3.3 Employee Safety Certification

The *Employee Safety Certification* value reflects the Air Force's desire to have contractors fully certified in safety procedures. Unlike the value in the *Effective Administration* branch, the value focuses on the employee safety requirements. Thus, contractors are required to have their employees "meet all applicable federal, state, local, and installation [safety] certification, licensing, and medical requirements (i.e., CPR)" (Department of the Air Force, 2003:13).

3.2.2.4 Utility System Security

The fourth of the five values in the second-tier of the *Quality* branch is *Utility System Security*, which reflects the Air Force's desire to have safe and secured utility systems. Also reflected in this value is the Air Force's desire to have contractors ensure their employees do not present "a potential threat to the health, safety, security, general well being, or operational mission of the Installation or population" (Department of the Air Force, 2003:13).

3.2.2.5 Sub-Metering Capability

The last of the five values in the second-tier of the *Quality* branch is *Sub-Metering Capability*. This value reflects the Air Force's desire to have its contractor provide the capability to measure the utility system's commodity consumption on the installation through the use of sub-metering. The Air Force "will use sub-meters for internal installation billing purposes and for commodity management and energy conservation purposes" (Department of the Air Force, 2003:11). The contractor is responsible reading, maintaining, and calibrating all sub-meters on the installation. In addition, the contractor is responsible for installing, reading, maintaining, and calibrating any future sub-meters as requested by the Air Force.

3.2.3 *Reliability* Branch

The second of the three branches in the first-tier of the hierarchy is the *Reliability* branch. *Reliability* for Air Force privatized utility systems is obtained when the contractor provides continuous and dependable utility service with minimal interruptions. The second-tier values of *Completed Renewals/Replacements* and *Decreased Utility*

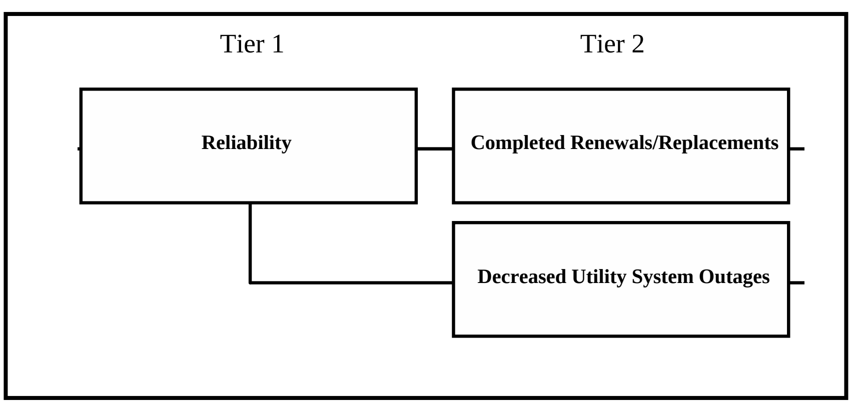

Figure 14. Utility Privatization Evaluation Hierarchy for *Reliability* Branch

3.2.3.1 Completed Renewals/Replacements

The first of the two values in the second-tier of the *Reliability* branch is *Completed Renewals/Replacements*. This value reflects the Air Force's desire to have "continuing maintenance, repairs, and upgrades that will permit the long-term safe and reliable operation of utility system[s]" (Department of the Air Force, 2003:20). Completed renewals and replacements will help keep Air Force utility systems in compliance "with all requirements and standards imposed by law as well as the standards typically applied by the Contractor to its other utility systems" (Department of the Air Force, 2003:20).

3.2.3.2 Decreased Utility System Outages

The second of the two values in the second-tier of the *Reliability* branch is *Decreased Outages*, which reflects the Air Force's desire to minimize unscheduled service interruptions for its utility systems. When there is an unscheduled service interruption, the contractor is required to record the following at a minimum: cause of interruption, detailed contingency plan of action, estimated time for reestablishment of temporary service, and estimated time for reestablishment of permanent service.

3.2.4 *Responsiveness* Branch

The last of the three branches in the first-tier of the hierarchy is the *Responsiveness* branch. *Responsiveness* for Air Force privatized utility systems is obtained when the contractor is able to timely respond to service requests and other requests, as designated by the Air Force and installation. The second-tier values of *Effective Digging Permits/Line Marking Program, High Contracting Meeting Attendance, Timely Meter Reading, and Timely Service Response* provide more detailed information about the *Responsiveness* branch. Unlike the previous two branches, the *Responsiveness* branch has a third and fourth level of tiers. The second, third, and fourth-tier values comprising the *Responsiveness* branch are shown in Figure 15.

3.2.4.1 Effective Digging Permits/Line Marking Program

The first of the four values in the second-tier of the *Responsiveness* branch is *Effective Digging Permits/Line Marking Program*. This value reflects the Air Force's desire to have the contractor effectively assist installation organizations and personnel with digging permits and marking underground utility lines.

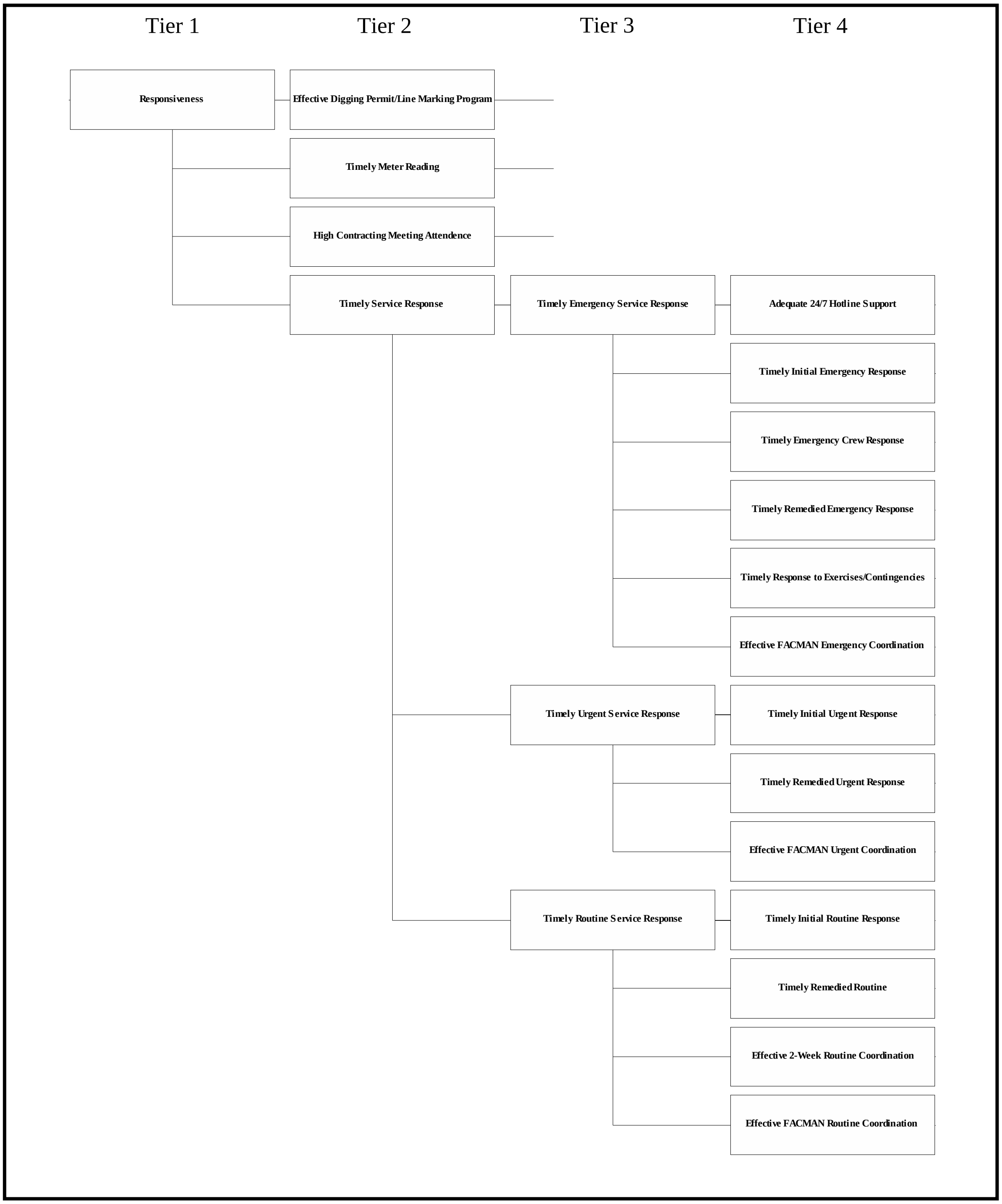

Figure 15. Utility Privatization Evaluation Hierarchy for *Responsiveness* Branch

3.2.4.2 High Contracting Meeting Attendance

The second of the four values in the second-tier of the *Responsiveness* branch is *High Contracting Meeting Attendance*, which reflects the Air Force's desire to have contractors "available for meetings as reasonably required by the Administrative Contracting Officer" (Department of the Air Force, 2003:18). The meetings are held to discuss matters concerning the contractor's performance and needs.

3.2.4.3 Timely Meter Readings

Timely Meter Readings is the third of the four values in the second-tier of the Responsiveness branch. The Timely Meter Readings value reflects the Air Force's desire to have the contractor read meters and submit meter-reading reports in a timely matter. Timely submission of meter reading reports by the contractor will allow the Air Force to accurately bill installation reimbursable customers.

3.2.4.4 Timely Service

The last of the four values in the second-tier of the *Responsiveness* branch is *Timely Service*. *Timely Service* is obtained when the contractor responds to all emergency, urgent, and routine service requests in a timely manner. The third-tier values of *Timely Emergency Service Response, Timely Urgent Service Response,* and *Timely Routine Service Response* provide more detailed information about the *Timely Service* value.

3.2.4.4.1 Timely Emergency Service Response

The first of the three values in the third-tier of the *Timely Service* branch is *Timely Emergency Service Response*, which reflects the Air Force's desire to have the contractor respond to emergency conditions in a timely manner. "An emergency condition is one that is detrimental to the mission of the [installation], significantly impacts operational effectiveness, or compromises the safety, health, and life of personnel" (Department of the Air Force, 2003:16). Therefore, emergency service requests can include inoperative airfield lighting, water outages, electrical outages, and downed natural gas/power lines. The forth-tier values listed below provide more detailed information about the *Timely Emergency Service Response* value.

> *Adequate 24/7 Hotline Support*: This value reflects the Air Force's desire to have the contractor available to respond to emergency service requests 24 hours a day, every day (24/7). The contractor is required to have a service request line in place for base personnel to call.
>
> *Timely Initial Emergency Response*: This value reflects the Air Force's desire to have the contractor send "a representative knowledgeable of the [utility] system and the service [interruption procedures] on the site of the emergency within 1 hour" (Department of the Air Force, 2003:16).
>
> *Timely Emergency Crew Response*: This value reflects the Air Force's desire to have the contractor send "repair crews appropriately trained to eliminate the condition" on the site of the emergency within two hours.
>
> *Timely Remedied Emergency Response*: This value reflects the Air Force's desire to have the contractor remedy or downgrade the emergency condition in a timely manner. The contractor is required to remedy or downgrade all emergencies "to a non-emergency status within 24 hours" (Department of the Air Force, 2003:16). "For regulated utilities, the service and its restoration in times of outage for emergency service requests shall be at least equivalent to the service provided to other similar customers" (Department of the Air Force, 2003:16).
>
> *Timely Response to Exercises/Contingencies*: This value reflects the Air Force's desire to have the contractor "respond to installation emergency and crisis situations and exercises for emergency and crisis situations that require utility support" (Department of the Air Force, 2003:18). The contractor is required to respond to exercises and contingencies "with qualified personnel and equipment as soon as possible after notification during normal duty" (Department of the Air Force, 2003:18).
>
> *Effective Emergency FACMAN Coordination*: This value reflects the Air Force's desire to have the contractor coordinate with installation facility managers (FACMAN) if the emergency request affects their facility. If the emergency request affects building operations, the contractor is

> required to coordinate all work with the person responsible for the building or facility.

3.2.4.4.2 Timely Urgent Service Response

Timely Urgent Service Response is the second of the three values in the third-tier of the *Timely Service* branch. This value reflects the Air Force's desire to have the contractor respond to urgent conditions in a timely manner. "An urgent condition is not an emergency but significantly hinders performance of installation activities and requires elimination of potential fire, health, and safety hazards" (Department of the Air Force, 2003:16). Therefore, urgent service requests can include downgraded emergency responses; environmental controls; and special requests and events. The fourth-tier values listed below provide more detailed information about the *Timely Urgent Service Response* value.

> *Timely Initial Urgent Response*: This value reflects the Air Force's desire to have the contractor send "a representative knowledgeable of the [utility] system and the service [interruption procedures] on the site of the [urgent] request within 24 hours" (Department of the Air Force, 2003:16).

> *Timely Remedied Urgent Response*: This value reflects the Air Force's desire to have the contractor remedy the urgent condition in a timely manner. The contractor is required to remedy the urgent condition within five calendar days. "For regulated utilities, the service and its restoration in times of outage for urgent service requests shall be at least equivalent to the service provided to other similar customers" (Department of the Air Force, 2003:16).

> *Effective Urgent FACMAN Coordination*: This value reflects the Air Force's desire to have the contractor coordinate with FACMAN if the urgent request affects their facility. If the urgent request affects building operations, the contractor is required to coordinate all work with the person responsible for the building or facility.

3.2.4.4.3 Timely Routine Service Response

The last of the three values in the third-tier of the *Timely Service* branch is *Timely Routine Service Response,* which reflects the Air Force's desire to have the contractor respond to routine conditions in a timely manner. “A routine service request is one that does not pose an immediate threat to public health, safety, or property, or to a mission or operation conducted at the installation” (Department of the Air Force, 2003:19). Therefore, routine service requests can include, “but are not necessarily limited to requests for new or relocated service connections” (Department of the Air Force, 2003:19). The fourth-tier values listed below provide more detailed information about the *Timely Routine Service Response* value.

> *Timely Initial Routine Response*: This value reflects the Air Force’s desire to have the contractor respond to routine service requests within a timely manner. “The contractor is not required to respond to the Installation’s routine service requests outside normal duty hours. The contractor may respond to routine service requests outside of normal duty hours at its option and with appropriate coordination” (Department of the Air Force, 2003:17). However, the contractor is required to initially respond to any routine service request within five calendar days. “For regulated utilities, the service and its restoration in times of outage for routine service requests shall be at least equivalent to the service provided to other similar customers” (Department of the Air Force, 2003:17).

> *Timely Remedied Routine Response*: This value reflects the Air Force’s desire to have the contractor remedy the routine condition in a timely manner. The contractor is required to remedy the routine condition within 30 calendar days. “For regulated utilities, the service and its restoration in times of outage for routine service requests shall be at least equivalent to the service provided to other similar customers” (Department of the Air Force, 2003:17).

> *Effective Two-Week Coordination*: This value reflects the Air Force’s desire to have the contractor coordinate at least two weeks prior to commencing work for a routine service request. The contractor is required to coordinate “with the Contracting Officer’s Representative at least two weeks prior to commencing” routine work, “such as the scheduled repair, replacement, or removal of system components that require service interruption” (Department of the Air Force, 2003:19).

> *Effective Routine FACMAN Coordination*: This value reflects the Air Force’s desire to have the contractor coordinate with FACMAN if the routine request affects their facility. If the routine request affects building operations, the contractor is required to coordinate all work with the person responsible for the building or facility.

3.3 Step 3 – Develop Evaluation Measures

Developing measures is the next step in constructing the hierarchy. As discussed in Chapter 2, evaluation measures are used to capture the degree of attainment for values in a hierarchy. In addition, evaluation measures allow the decision maker to convert the degree of attainment from a subjective platform to a more objective platform, which allows for easier measurement of attainment for values. The initial measures were developed with the aid of a subject matter expert; during the process, it was kept in mind that the evaluation measures should be easily understood and have data readily available. This approach made the task of developing evaluation measures simple.

After developing the suggested measures, they were presented at a two-day meeting for validation. The proxy decision maker agreed with a majority of the measures, except for the measures under the *Environmental Stewardship*, *Utility System Safety*, and *Timely Response to Exercises/Contingencies* values. The proxy decision maker stressed that the degree of attainment for these measures did not directly reflect the impact to the installation's mission. In order to reflect the desires of the decision maker, the measures in question were later verified and revamped with subject matter experts in the fields of safety, environmental compliance, and inspection programs.

As discussed in Chapter 2, the desirable evaluation measure properties of measurability, operability, and understandability were incorporated during the measure development process. As a result, a total of 47 evaluation measures were developed for the hierarchy. The evaluation measures were grouped into two measure types—natural/direct and constructed/direct. The natural/direct measure type uses natural attributes to measure quantities that directly reflect a value. Natural/direct measures generally have known and common measure units. An example of a natural/direct measure developed for this hierarchy is the *Average Number of Days to Update* measure, which uses the measure unit of days. The constructed/direct measure type is used when no natural attribute exists to measure quantities that directly reflect a value. Constructed/direct measures are generally based on combinations of information that pertain to the value. As a result, a subjective qualitative rating is created to help capture the degree of attainment for constructed/direct measures. An example of a constructed/direct measure developed for this hierarchy is the *Rating from Exercises/Contingencies* measure, which uses the measure unit of rating. The measures and measure definitions for each first-tier value are displayed in Tables 1 and 2, respectively. The remaining measures and definitions are contained in Appendices A and B, respectively.

Table 1. Examples of Measures

Branch	**Value**	**Associated Measure**	**Measure Unit**	**Measure Type**	**Lower Bound**	**Upper Bound**
Quality	Maintaining Proper Licenses, Permits, & Certification	Percentage of Up-to-Date Licenses, Permits, and Certifications	Percentage	Natural/Direct	0%	100%
Reliability	Completed Renewals/ Replacements	Percentage of Items Actually Renewed or Replaced	Percentage	Natural/Direct	0%	100%
Responsiveness	Effective Digging Permits/Line Marking Program	Number of Utility Line Hits	Hits	Natural/Direct	0	20

Table 2. Example of Definitions

Measure	Definition
Percentage of Up-to-Date Licenses, Permits, and Certifications	The percentage of all licenses, permits, and certifications the contractor is keeping up-to-date. The percentage is determined by the ratio of actual number of licenses, permits, and certifications held by the contractor to the number of up-to-date licenses, permits, and certifications held by the contractor.
Percentage of Items Actually Renewed or Replaced	The percentage of items actually renewed or replaced by the contractor. A renewal/replacement list is normally created by the contractor with the consent of the Air Force a year in advance to help schedule continuing maintenance, repairs, and upgrades for the installation utility system. The list is normally executed a year later. The percentage is determined by the ratio of the actual number of completed renewals and replacements for a one-year period to the number of scheduled renewals and replacements for that same one-year period.
Number of Utility Line Hits	The number of utility line hits. The number of line hits is an indicator of the effectiveness of the contractor's digging permit and line marking program.

3.4 Step 4 – Create Value Functions

The next step in the VFT process is to define a value function for each evaluation measure developed in Step 3. As mentioned in Chapter 2, Single Dimension Value Functions (SDVF) are developed to convert differing units and scales of evaluation measures for a hierarchy into a common scale, which can help score and rank alternatives. The value for each evaluation measure is set to a range of 0.000 (least preferred) to 1.000 (most preferred) along the y-axis. The set of points used to represent the evaluation of a particular measure is set to a range of the decision maker’s most desirable preference to least desirable preference (or vice-versa) along the x-axis.

The SDVFs for this hierarchy were developed by proxy decision makers using a direct assessment technique. The direct assessment technique involves the proxy decision makers adjusting the curves and scales for each SDVF. For this step, a document was created and electronically mailed to the proxy decision makers to facilitate the development of the SDVFs. The document consists of several EXCEL spreadsheets, which allow the proxy decision makers to assign preference on the x-axis and adjust the shape of each measure's SDVF. After several iterations, 47 SDVFs were developed under three value function categories—discrete, monotonically increasing exponential, and monotonically decreasing exponential. Examples of these SDVF are discussed below. The remaining SDVFs are displayed in Appendix C.

Discrete SDVFs are normally used when evaluation measures have a small number of possible scoring levels. An example of a discrete SDFV developed for this hierarchy is the *Average Number of Days to Update* function shown in Figure 16, which measures how long it takes a contractor to update drawings. The most preferred score is for a contractor that is able to update drawings under 60 days, and it receives a value of 1.000. The second most preferred score is a contractor that was able to update drawings between 60 to 65 days, thereby receiving a value of 0.838. The third most preferred score is for a contractor that is able to update drawings between 66 to 70 days, and it receives a value of 0.420. The least preferred score is for a contractor that updates the drawings in more than 75 days, thereby receiving a value of 0.000. The second least preferred score is for a contractor that is only able to update drawings between 71 to 75 days, and it receives a value of 0.180.

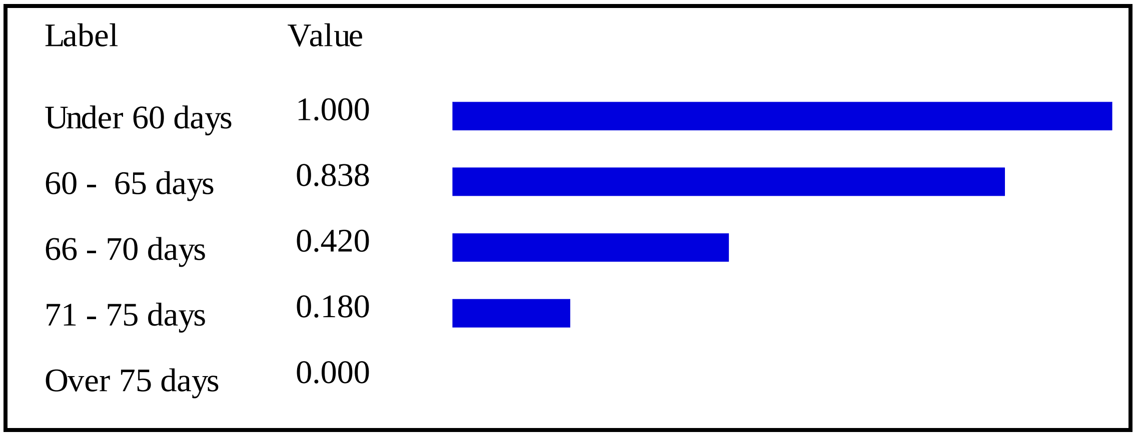

Figure 16. Average Number of Days to Update SDVF

Monotonically increasing exponential SDFVs are normally used when there is a preference for increases to the score on the x-axis. For every increase in score on the x-axis, the value on the y-axis will increase exponentially. An example of a monotonically increasing exponential SDVF developed for this hierarchy is the *Percentage of Up-to-Date Licenses, Permits, and Certifications* function shown in Figure 17 measures the contractor's percentage of up-to-date licenses, permits, and certifications. The most preferred score is for a contractor that is able to keep all licenses, permits, and certifications up-to-date, thereby receiving a value of 1.000. The least preferred score is for a contractor that is unable to keep any licenses, permits, and certifications up-to-date, and it receives a value of 0.000. As illustrated in Figure 17, the contractor's value on the y-axis exponentially increases for every increase in percentage on the x-axis.

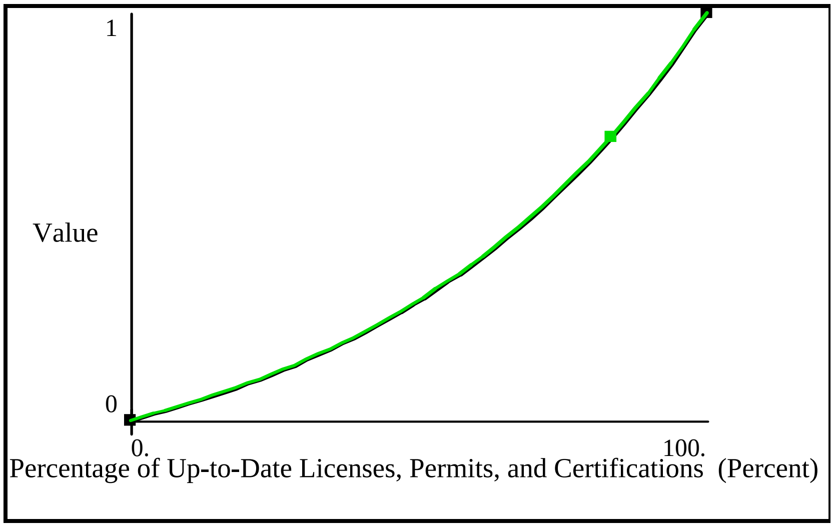

Figure 17. Percentage of Up-to-Date Licenses, Permits, Permits, and Certifications SDVF

Monotonically decreasing exponential SDVFs are normally used when there is a preference for decreases to the score on the x-axis. For every decrease in score on the x-axis, the value on the y-axis will decrease exponentially. An example of a monotonically decreasing exponential SDVF developed for this hierarchy is the *Number of Minor Findings for Spill Contingency Plan* function shown in Figure 18, measures the number of minor findings the contractor received for its spill contingency plan. The most preferred score is for a contractor that received no minor findings, thereby receiving a value of 1.000. The least preferred score is for a contractor that received up to 20 minor findings, and it receives a value of 0.000. As illustrated in Figure 18, the contractor's value on the y-axis exponentially increases for every decrease in percentage on the x-axis.

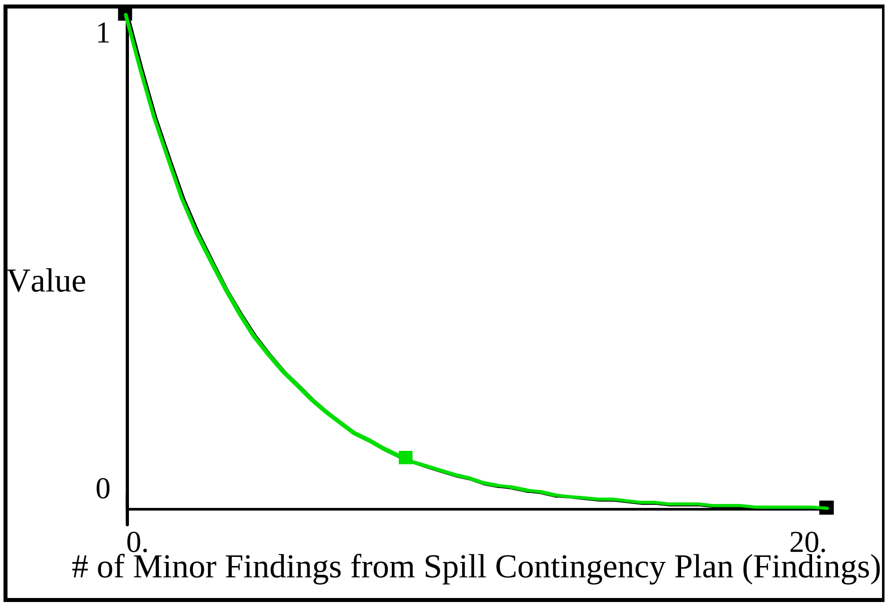

Figure 18. Number of Minor Findings for Spill Contingency Plan SDVF

3.5 Step 5 – Weight the Value Hierarchy

As explained in Chapter 2, each value in the hierarchy must be differentiated according to how the decision maker perceives its relative importance. This step of the VFT process is accomplished by having the decision maker assign weights to each value in the hierarchy. For this step, a document was created and electronically mailed to the decision maker to facilitate weighting the values. This document consisted of a detailed drawing of the value hierarchy with text boxes for each value. These text boxes allowed the decision maker to use the direct weighting technique to adjust the suggested local weights to reflect his preference for each value. Once all the local weights were assigned, the document was sent back to the researcher for calculation of global weights. The resulting local and global weights for the hierarchy are described in the remainder of this section.

3.5.1 Assignment of Local Weights

Using the direct weighting technique as previously discussed, the decision maker first assigned local weights to the values comprising the first-tier of the hierarchy. The following values of *Quality*, *Reliability*, and *Responsiveness* were assigned weights of 0.300, 0.350, and 0.350 respectively. The weights for the first-tier are shown in Figure 19. The following sections will discuss the weights assigned to the values comprising the branches for each of the first-tier values.

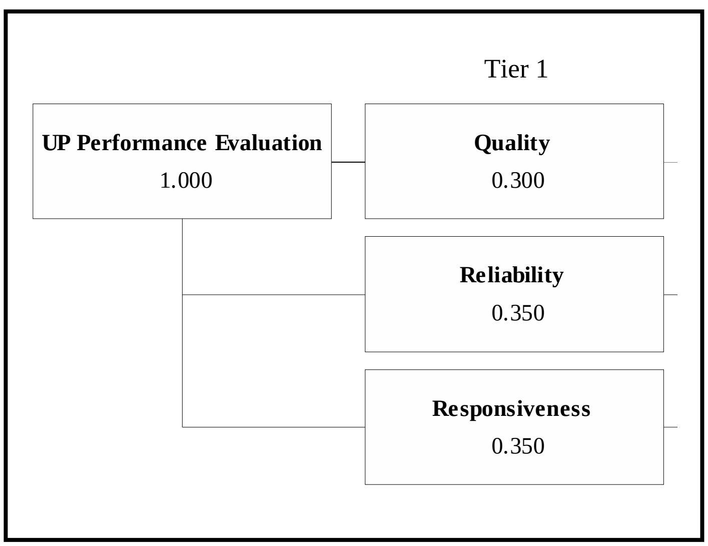

Figure 19. Local Weights for the First-Tier Values

3.5.1.1 Local Weights for Quality Branch

The direct weighting technique was used to assign local weights to every value comprising the *Quality* branch. First, local weights were assigned to the second-tier values of the *Quality* branch. The highest weight of 0.350 was assigned to the *Utility System Security* value. Due to the United States' ongoing war with terrorism and the Air Force's desire to keep their utility systems secured from terrorist attacks, the decision maker felt that the *Utility System Security* value should receive the most emphasis. The remaining values, *Utility System Safety*, *Effective Administration*, *Environmental Stewardship*, and *Sub-Metering Capability*, received weights of 0.250, 0.150, 0.150, and 0.100, respectively. The weights for the remaining values and measures in each tier of the *Quality* branch are shown in Figures 20 and 21. Note: the *Quality* branch is divided between these two figures because of its size.

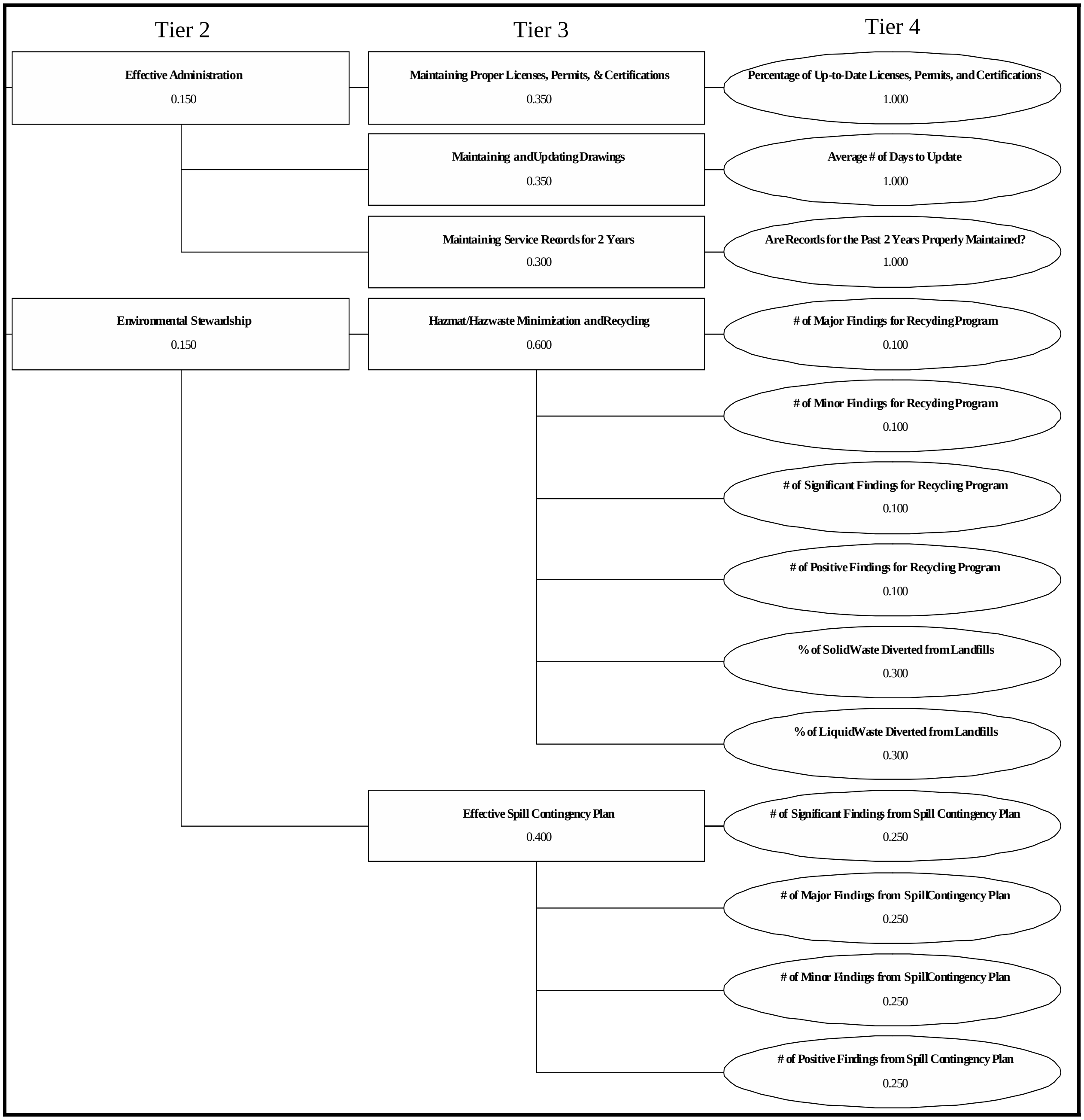

Figure 20. Local Weights for *Quality* Branch

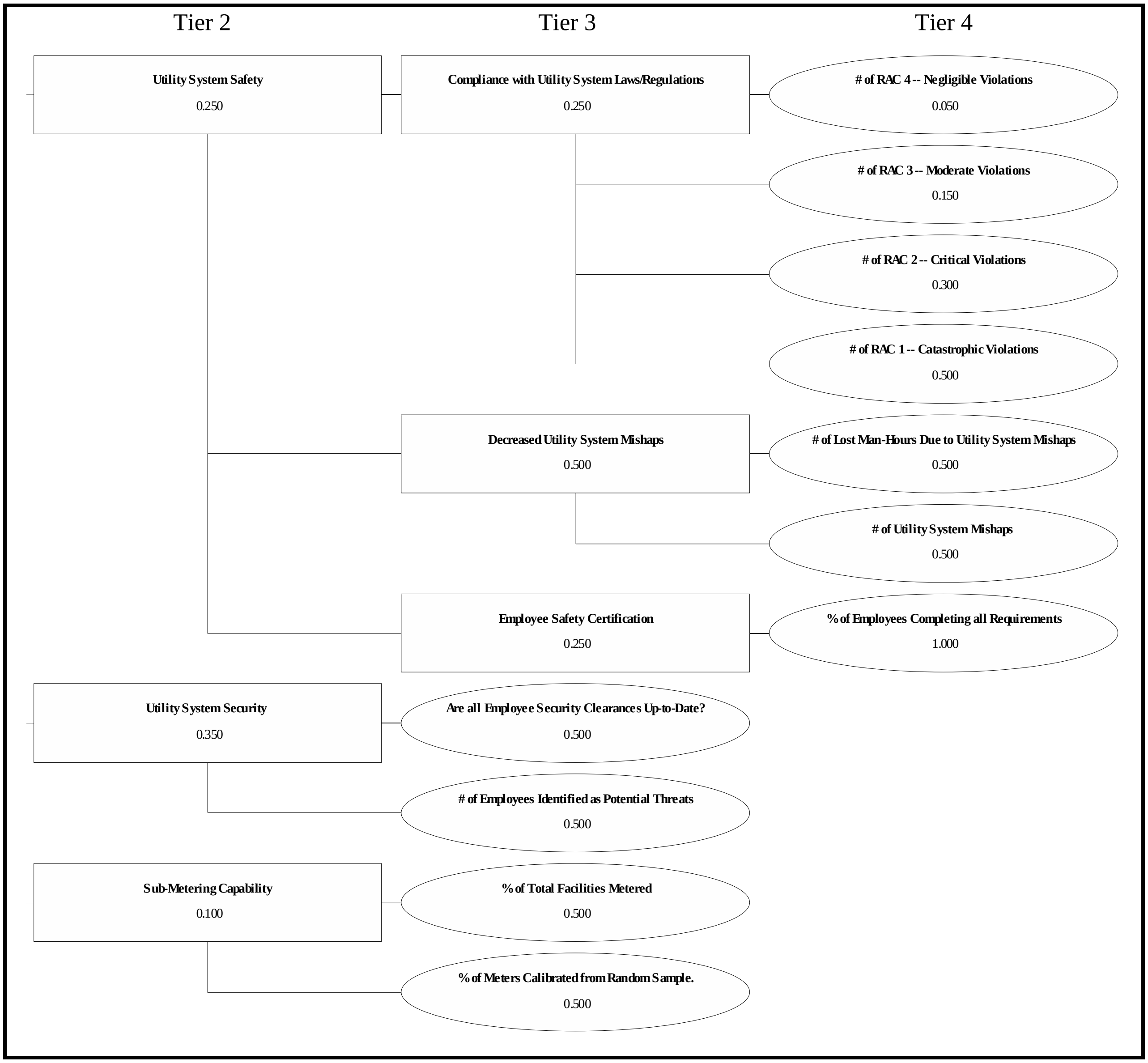

Figure 21. Local Weights for *Quality* Branch (Continued)

3.5.1.2 Local Weights for Reliability Branch

For the Reliability branch, the second-tier values of Completed Renewals/Replacements and Decreased Utility System Outages received weights of 0.400 and 0.600, respectively. The Decreased Utility System Outages received the highest weight because of the Air Force's desire to have the contractor lower the numbers of utility system outages an Air Force installation experiences each year. The weights for every value and measure in the Reliability branch are shown in Figure 22.

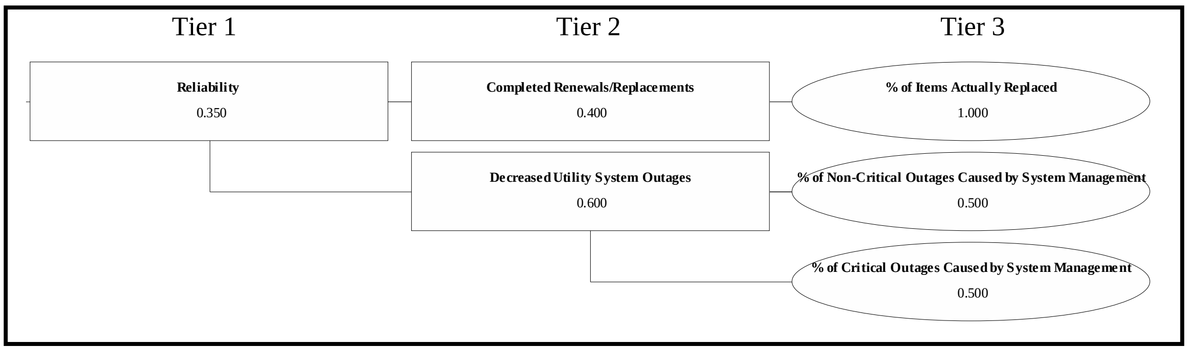

Figure 22. Local Weights for *Reliability* Branch

3.5.1.3 Local Weights for Responsiveness Branch

For the Responsiveness branch, the second-tier values of *Effective Digging Permits/Line Marking Program*, *High Contracting Meeting Attendance*, *Timely Meter Reading*, and *Timely Service Response* received weights of 0.100, 0.100, 0.100, and 0.700, respectively. The Timely Service Response value received the highest weight because of the decision maker's desire to have contractor's respond to service calls in a timely manner. The remaining values in the second-tier of the *Responsiveness* branch were of equal importance; therefore, these values received the same weight. The weights for every value and measure in the *Responsiveness* branch are shown in Figures 23 and 24. Note: The *Reliability* branch is divided between the two figures because of its size.

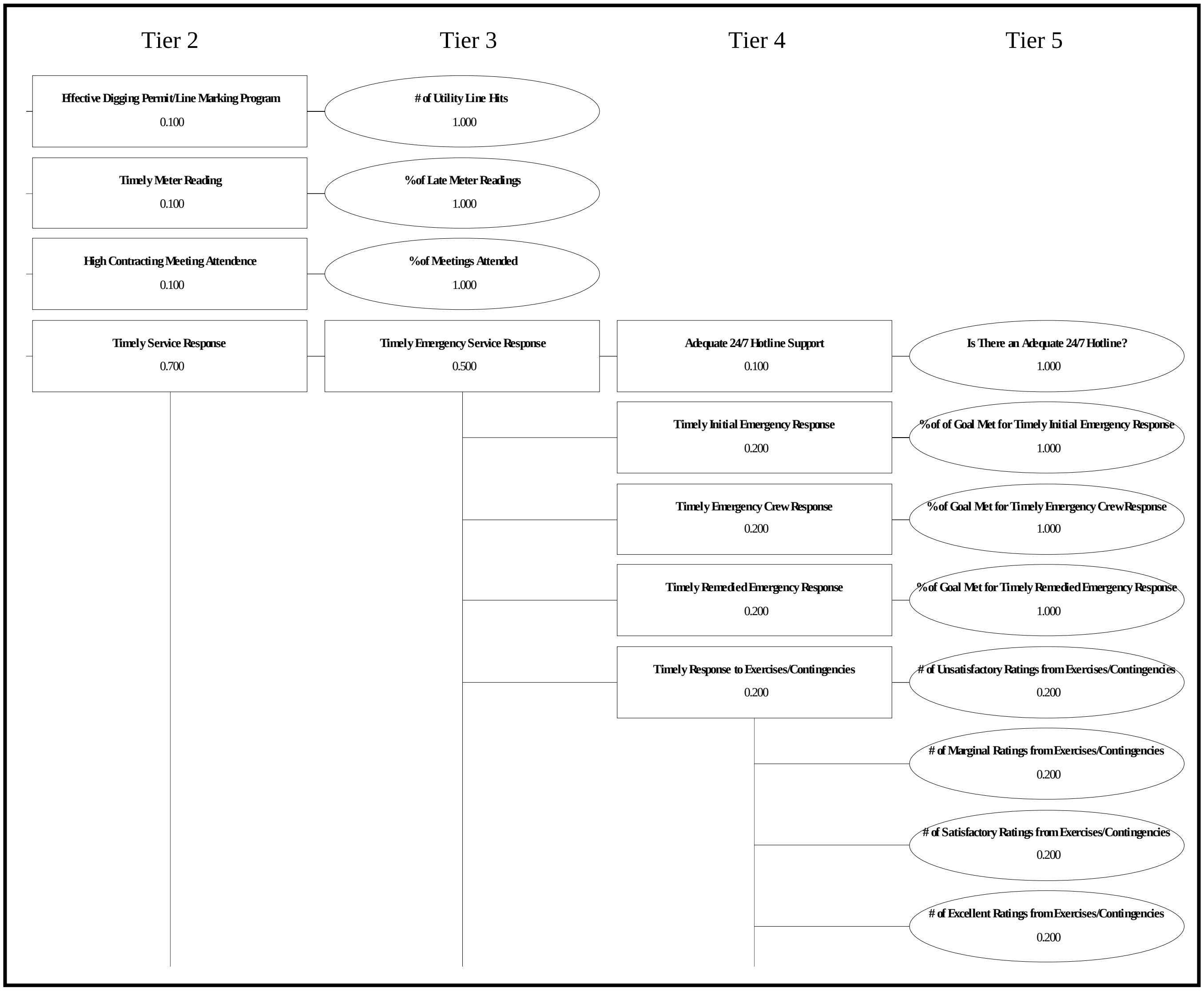

Figure 23. Local Weights for *Responsiveness* Branch

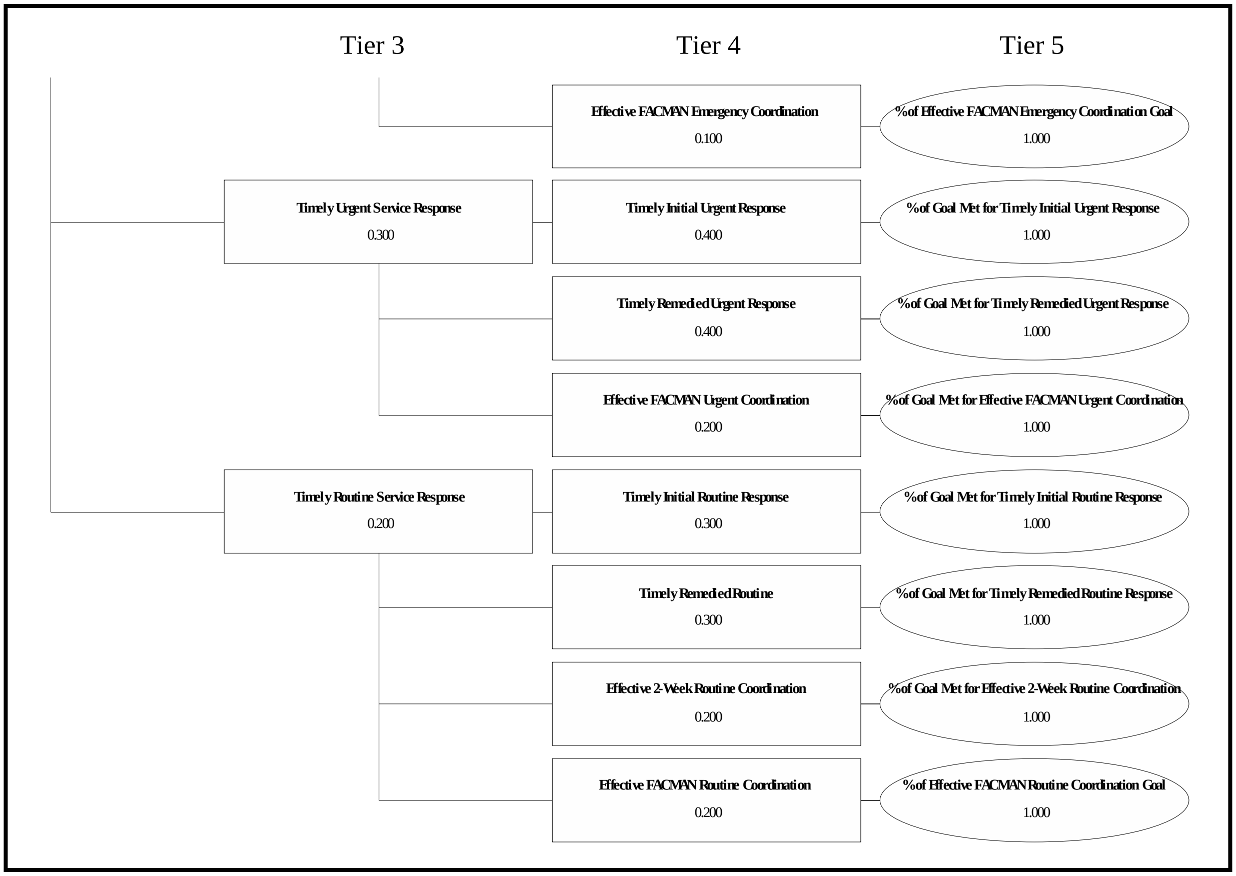

Figure 24. Local Weights for *Responsiveness* Branch (Continued)

3.5.2 Assignment of Global Weights

The global weights for the hierarchy are obtained by multiplying the local weight of the value (or measure) being looked at by the local weight of each value in the branch above the value (or measure) until the fundamental objective is reached. For example, as illustrated in Figure 25, the global weight of the *Percentage of Items Actually Replaced* measure (0.140) is calculated by multiplying the local weight of *Percentage of Items Actually Replaced* (1.000) by the local weight of the *Completed Renewals/Replacements* value (0.400) and by the local weight of the *Reliability* value (0.350). The calculations of global weights for the remaining values are in Appendix D. The rank order of the measures by global weight is shown in Appendix E.

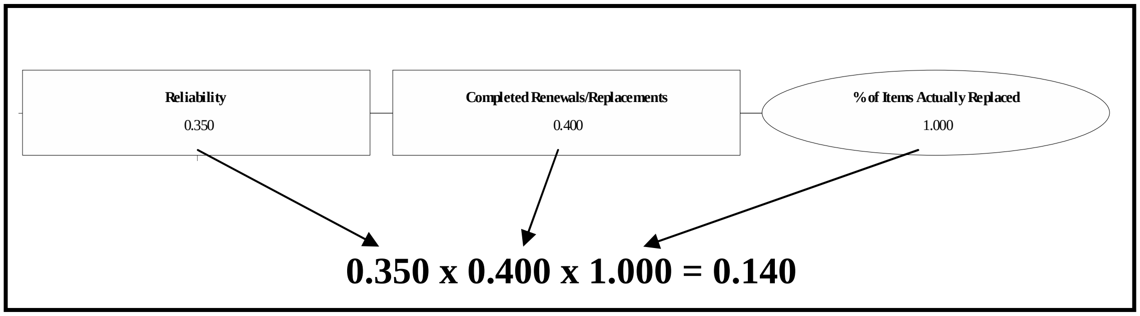

Figure 25. Global Weight Calculation Example

3.6 Summary

This chapter covered how the values and measures comprising the utility privatization evaluation hierarchy were created. The characteristics valued by the decision maker and stakeholders associated with the decision problem were used to guide the development of the evaluation model. Alternative generation and scoring, along with deterministic and sensitivity analyses (i.e., Steps through 9) are conducted in Chapter 4.

Chapter 4. Results and Analysis

This chapter presents Steps 6 through 9 of the Value-Focused Thinking (VFT) process. In Step 6, notional data is generated to create alternatives for comparison in the evaluation model. In Step 7, the evaluation model scores the alternatives created in Step 6. Deterministic analysis of the alternatives is conducted in Step 8; this provides the decision maker a rank ordering of the alternatives and insight into the performance of the alternatives. In Step 9, sensitivity analysis is performed on the local weights of first-tier values to investigate their impact on the alternative rankings.

4.1 Step 6 – Alternative Generation

Once weighting the hierarchy is complete, the next step in the VFT process is to identify alternatives that can be evaluated with the hierarchy. For this research problem, Step 6 of the standard VFT process was modified slightly. Since the Air Force has only recently made the decision to privatize non-essential utility systems, few systems were available for evaluation. Consequently, there was not enough data to adequately reflect the performance of these utility systems. Therefore, notational data was generated to represent a variety of privatized utility systems operating in the near future.

The notional data created for this research represents a variety of privatized Air Force utility systems operating in the near future. An EXCEL spreadsheet was used to randomly generate over 500 possible alternatives representing a privatized utility system. From the generated notional data, eight alternatives were selected that best represent privatized utility systems with overall scores in the following categories: above average (90% - 100%), average (70% to 80%), and below average (40% to 50%). These categories were established to help demonstrate how the model could be used to analyze and compare actual utility system data. The notional data used to create the alternatives is provided in Appendix F.

4.2 Step 7 – Alternative Scoring

Before any analysis of the alternatives could be accomplished, the alternatives were evaluated (i.e., scored). For this step, the evaluation measures, value functions, and weights were used to create an aggregate value for each simulated alternative. Using the "blind scoring" technique, the notational data for each alternative was collected and scored using the single dimension value functions (SDVFs) for the measures. The scoring results are presented in Table 3.

Table 3. Scoring Results for Alternatives

Alternative	**Category**	**Score**
Base 7	Above Average	0.960
Base 5	Average	0.795
Base 2	Average	0.734
Base 8	Average	0.717
Base 4	Below Average	0.553
Base 1	Below Average	0.533
Base 6	Below Average	0.467
Base 3	Below Average	0.441

4.3 Step 8 – Deterministic Analysis

The deterministic analysis was used to examine the initial results of the evaluation model and provide insight to the decision maker regarding the ranking of the privatized utility systems. For this step, the additive value function was used to incorporate hierarchy weights with the alternative scores. As a result, a weighted sum value was created that can be used to rank order the alternatives. A bar graph of the deterministic analysis results for the notional data is provided in Figure 26.

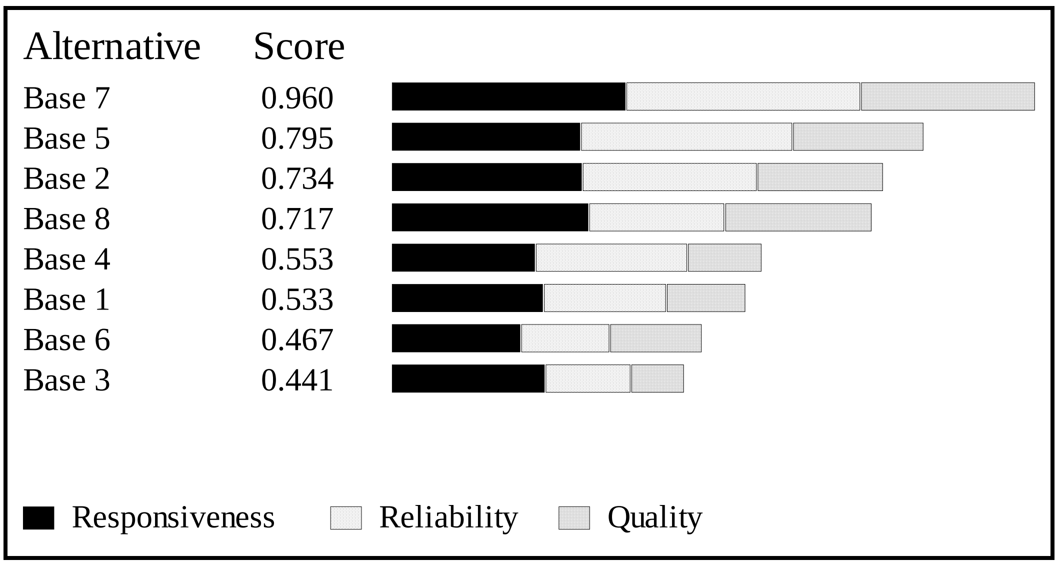

Figure 26. Alternative Score Ranking and Deterministic Analysis Results

The bar graph demonstrates how the model can rank order the performance of Air Force privatized utility systems. Equally important, this graph provides insight into which privatized utility systems are performing well or need improvement. Moreover, the graph presents each alternative's value in a cumulative bar. The bars representing each alternative's score is partitioned to show the amount of value each first-tier value. Accordingly, the partitions facilitate the deterministic analysis by providing the decision maker with a clear and easy way to analyze how well each privatized utility system is performing in the areas of *Quality*, *Reliability*, and *Responsiveness*. A decision maker can use the graph to guide the investigation in determining why certain privatized utility systems are performing below standards. For instance, the graph in Figure 26 illustrates that Base 8's low score in the *Reliability* branch is the reason for its ranking below Base 2. This can prompt a decision maker to further analyze the scores Base 8 received for the measures within the *Reliability* branch in order to target the exact areas that need improvement.

4.4 Step 9 – Sensitivity Analysis

Sensitivity analysis was conducted on the local weights of each of the first-tier values to determine how changes in the value weights can impact the ranking of the alternatives. In other words, sensitivity analysis is used to provide the decision maker with insight into how the alternative rankings might change if another stakeholder (senior Air Force leadership) had weighted the hierarchy. Also, the slope of the line for each alternative generated by the sensitivity analysis can be used to determine a privatized utility system's performance strength in achieving a particular area of evaluation. This can be determined by calculating the difference between the alternative's slopes when the value receives weights of 0.000 and 1.000, respectively. For example, a steep upward sloping line with a slope calculation of +33% is a strong indicator that a privatized utility system is most likely performing well in a particular first-tier value compared to the other first-tier values. However, a steep downward sloping line with a slope calculation of -

37% is normally a strong indicator that a privatized utility system is not performing well in a particular first-tier value compared to the other first-tier values. Ultimately, the insight provided from the sensitivity analysis provides the decision maker with a more informed decision. Sensitivity analysis was accomplished by varying the weight of one of the first-tier values while adjusting the weights of the remaining values to maintain their original proportionate weighting

4.4.1 *Quality* Branch Sensitivity Analysis

The first-tier value of *Quality* was assigned an initial local weight of 0.300. Sensitivity analysis was accomplished by varying the local weight from 0.000 to 1.000 while proportionally holding the weights of the other first-tier values steady. The sensitivity analysis in Figure 27 illustrates that Base 7 is the most dominant alternative because it is insensitive to changes in weight. This means the ranking for Base 7 would remain unchanged regardless of the weight assigned to the *Quality* branch. However, as the local weight is increased from 0.000 to 1.000, the overall ranking for the remaining bases change. For example, Base 6 is the least preferred alternative when the local weight for the *Quality* branch is at 0.000. Nevertheless, as the weight steadily increases to 0.200, Base 3 becomes the least preferred alternative. Once the weight reaches 0.400, Base 8 outranks Base 2, becoming the third most preferred alternative. As the weight reaches 0.650, the ranking for several alternatives change for a final time. Base 2 moves from being the third most preferred alternative to the second most preferred alternative. Also, Base 6, which was originally the least preferred alternative at weight 0.000, becomes the fifth most preferred alternative. Furthermore, Base 4 falls from the fifth most preferred alternative at weight 0.000 to the second least preferred alternative.

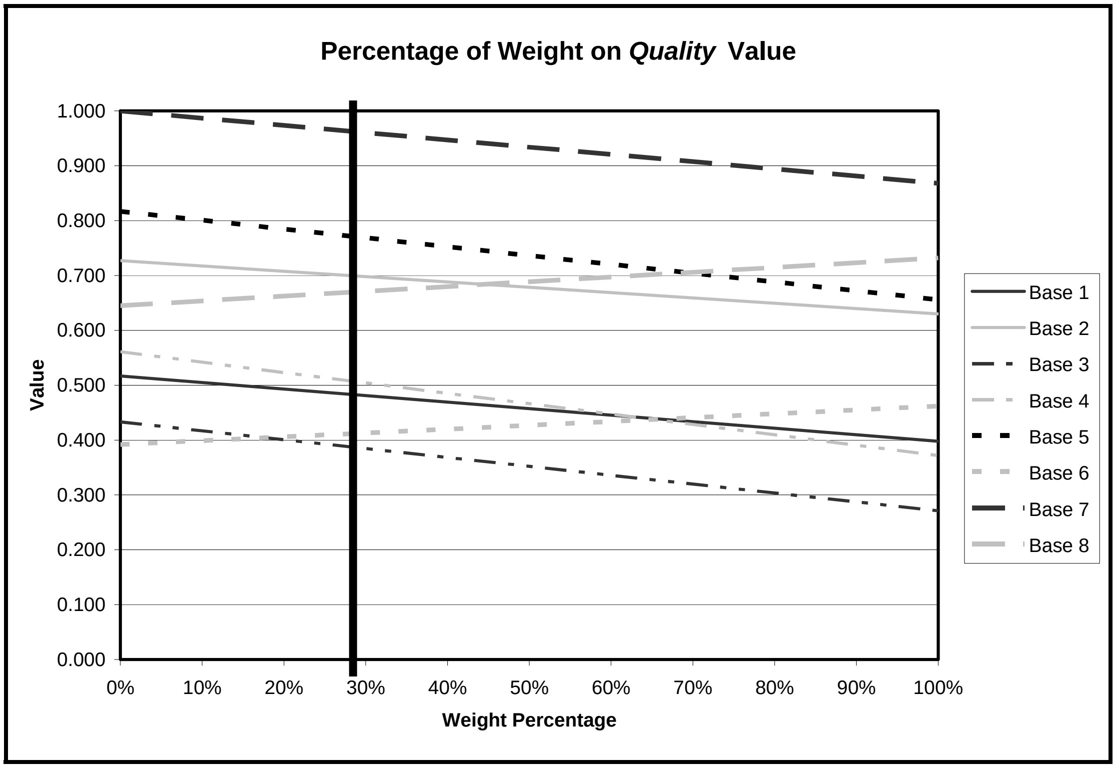

Figure 27. *Quality* Branch Sensitivity Analysis

The results for the slope calculations used to determine each alternative's performance strength in the *Quality* first-tier value are displayed in Table 4. Although Base 7 is recognized as the most dominant alternative, its slightly downward sloping line with a calculation of -13% suggests that it is not performing as well the other two values in the first-tier. The downward sloping lines for Bases 5, 2, 1, 4, and 3, with slope calculations of -16%, -10%, -12%, -19%, and -16%, respectively, suggest that their privatized utility systems have a lower level of performance in this first-tier value as well. This variance should prompt further investigation into the individual scores comprising the *Quality* branch for each of these low performing privatized utility systems. In contrast, the slightly upward sloping lines representing Base 8 and 6 with slope calculations of 9% and 7%, respectively suggest that their privatized utility systems are performing better in the area of *Quality* compared to their performance in the other two areas of evaluation.

Table 4. Slope Calculations for *Quality* Value

Alternative	**0% Quality Value Weight Applied**	**100% Quality Value Weight Applied**	**Slope**
Base 1	52%	40%	-12%
Base 2	73%	63%	-10%
Base 3	43%	27%	-16%
Base 4	56%	37%	-19%
Base 5	82%	66%	-16%
Base 6	39%	46%	7%
Base 7	100%	87%	-13%
Base 8	65%	73%	9%

4.4.2 *Reliability* Sensitivity Analysis

The first-tier value of *Reliability* was assigned an initial local weight of 0.350. To perform sensitivity analysis, the local weight was varied from 0.000 to 1.000 while proportionally holding the weights of the other first-tier values steady. As illustrated in Figure 28, Base 7 is still recognized as the most dominant alternative for every variation of weight in for the first-tier value of *Reliability*. However, as the local weight is increased from 0.000 to 1.000, the overall ranking for the remaining bases change. For example, Base 4 is the second least preferred alternative when the local weight for the *Reliability* branch is at 0.000. Conversely, as the weight steadily increases to 0.030, Base 4 becomes the third least preferred alternative. Once the weight reaches 0.150, Base 5 outranks Base 8, becoming the second most preferred alternative. As the weight reaches 0.220, Base 4's ranking moved it up to the fifth most preferred alternative. Once the weight reaches 0.300, Base 8's ranking decreases it from the third most preferred alternative to the fourth most preferred alternative. Finally, Base 8's ranking falls to the fifth most preferred alternative as the weight is increased to 0.800.

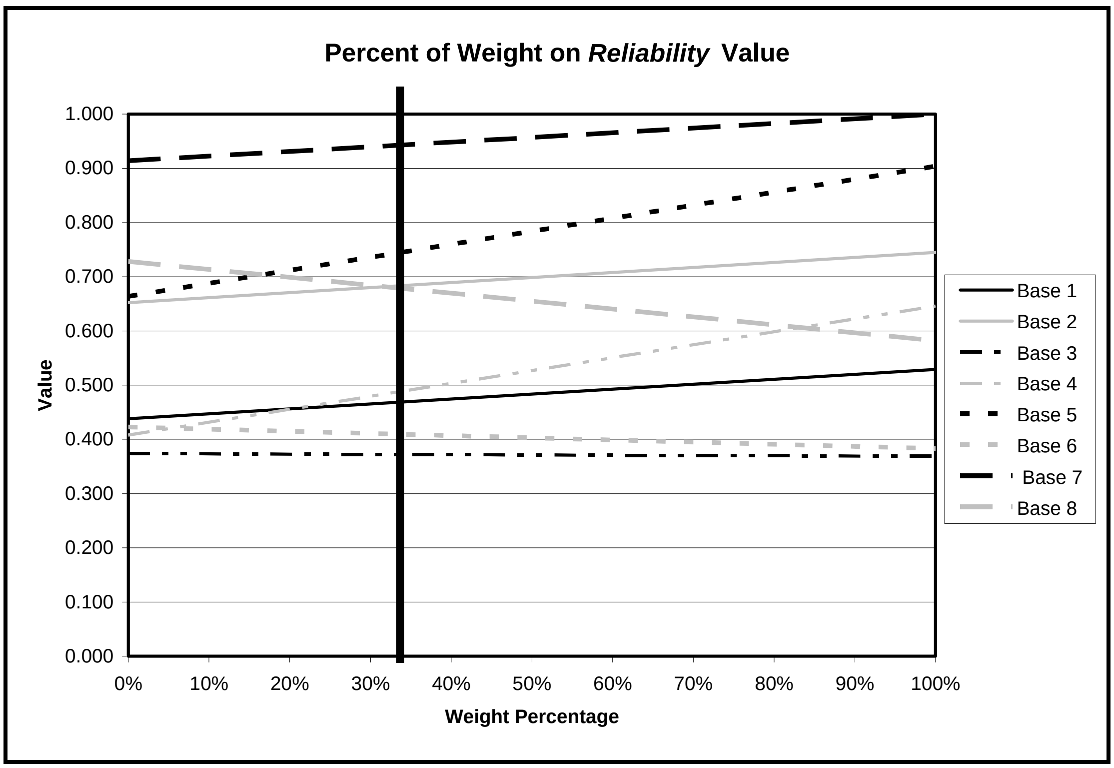

Figure 28. *Reliability* Branch Sensitivity Analysis

The results for the slope calculations used to determine each alternative's performance strength in the *Reliability* first-tier value are displayed in Table 5. The downward sloping lines for Bases 8, 6, and 3, with slope calculations of -15%, -4%, and -1%, respectively, suggest that their privatized utility systems have a lower level of performance in the first-tier value of *Reliability* compared to their performance in the other first-tier values. This variance should prompt investigation into the individual scores comprising the *Reliability* branch for each low performing privatized utility system. The steep upward sloping lines for Bases 5 and 4 with slope calculations of 24, suggest that their privatized utility systems are performing extremely well in the area of *Reliability* compared to their performance in the other first-tier values. The slightly upward sloping lines for Bases 1, 2, and 7, all with slope calculations of 9%, are indicators that their level of performance in the area of *Reliability* is slightly better compared to their performance in the other two areas of evaluation.

Table 5. Slope Calculations for *Reliability* Value

Alternative	**0% Reliability Value Weight Applied**	**100% Reliability Value Weight Applied**	**Slope**
Base 1	44%	53%	9%
Base 2	65%	75%	9%
Base 3	37%	37%	-1%
Base 4	41%	65%	24%
Base 5	66%	90%	24%
Base 6	42%	38%	-4%
Base 7	91%	100%	9%
Base 8	73%	58%	-15%

4.4.3 *Responsiveness* Sensitivity Analysis

The first-tier value of *Responsiveness* was assigned an initial local weight of 0.350. To perform sensitivity analysis, the local weight was varied from 0.000 to 1.000 while proportionally holding the weights of the other first-tier values steady. As illustrated in Figure 29, Base 7 is still recognized as the most dominant alternative. However, as the local weight is increased from 0.000 to 1.000, the overall ranking for the remaining bases change. For example, Base 3 is the second least preferred alternative when the local weight for the *Responsiveness* branch is at 0.500. Once the weight reaches 0.150, Base 5 outranks Base 8, becoming the second most preferred alternative. As the weight reaches 0.220, Base 4's ranking moves it up to the fifth most preferred alternative. Once the weight reaches 0.300, Base 8's ranking decreases from the third most preferred alternative to the fourth most preferred alternative. Finally, Base 8's ranking falls to the fifth most preferred alternative as the weight is increased to 0.800.

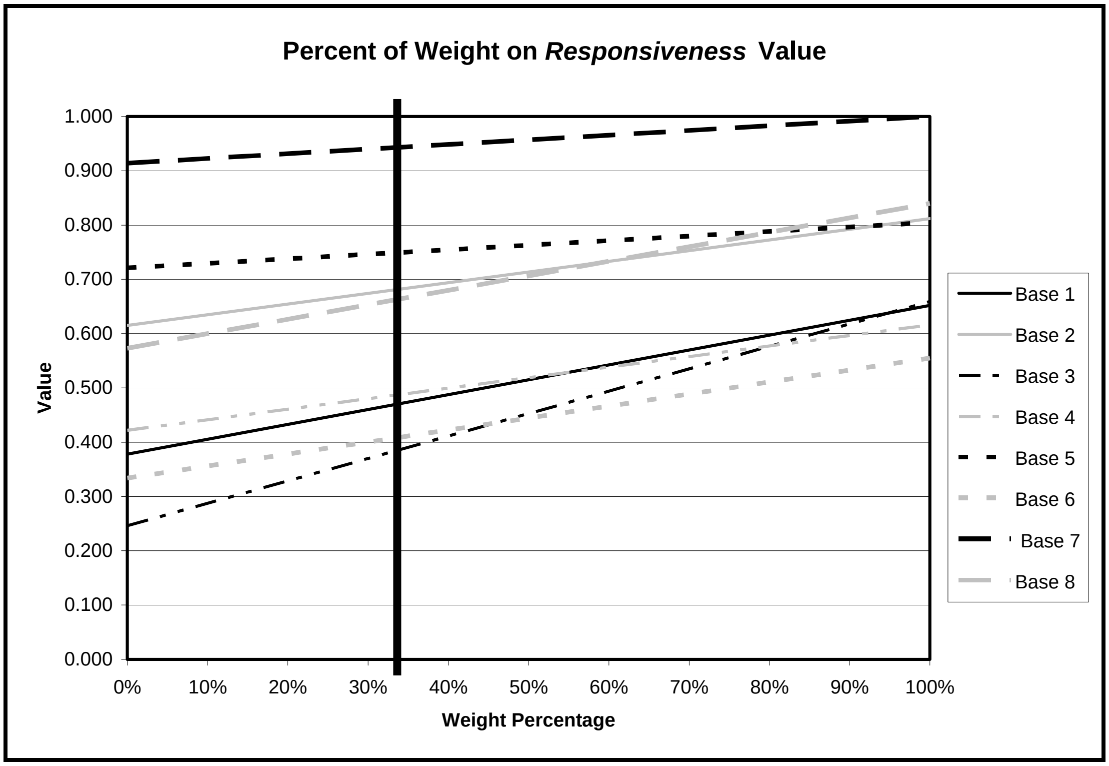

Figure 29. *Responsiveness* Branch Sensitivity Analysis

The results for the slope calculations used to determine each alternative's performance strength in the *Responsiveness* first-tier value are displayed in Table 6. Since there are no downward sloping lines, this is a good indicator that all utility systems are performing adequately well in the area of *Responsiveness* compared to their performance in the other first-tier values. However, the steep upward sloping lines for Bases 8 and 3, with slope calculations of 27% and 41%, respectively, are indicators that their utility systems are performing extremely well in the area of *Responsiveness* compared to the other first-tier values. The slightly upward sloping lines for the other bases, with slope calculations ranging from 8% to 27%, are indicators that their level of performance in the area of *Responsiveness* is slightly better compared to their performance in the other two areas of evaluation.

Table 6. Slope Calculations for *Responsiveness* Value

Alternative	0% Responsiveness Value Weight Applied	100% Responsiveness Value Weight Applied	Slope
Base 1	38%	65%	27%
Base 2	62%	81%	20%
Base 3	25%	66%	41%
Base 4	42%	62%	19%
Base 5	72%	81%	8%
Base 6	33%	56%	22%
Base 7	91%	100%	9%
Base 8	57%	84%	27%

Chapter 5. Findings and Conclusions

Chapter 5 provides a brief review of this research effort while answering the research questions that were initially put forth in Chapter 1. It then explains how the evaluation model created in this research can be used by the Air Force to improve its utility privatization process. Also, the evaluation model's strengths and limitations are discussed. The chapter concludes by presenting recommendations for future research in this area.

5.1 Review

This is the first documented use of Value-Focused Thinking (VFT) to assist organizations and governments in evaluating the performance of their privatized utility systems. The resulting model can be used by various organizations at the federal and state levels of government. To achieve the objective of creating a valid mathematical model to evaluate the performance of Air Force utility privatization, the research answered the following investigative questions addressed in Chapter 1:

1. Given that quantitative data (performance) will be collected, what is a suitable method to evaluate and measure the overall effectiveness of a utility system? In order to accomplish this, the "hard" quantitative and the "soft" qualitative factors of utility privatization must be balanced.

Finding. The VFT methodology was identified as a suitable approach for solving a complex decision problem such as utility system evaluation. The research effort applied the VFT methodology to produce a multi-objective decision analysis evaluation model for the decision maker. The model allows a decision maker to quantitatively evaluate qualitative factors of a decision problem.

2. What are the major factors and sub-factors that should be considered when evaluating the performance of Air Force utility privatization?

Finding. Step 2 of the VFT methodology, Value Hierarchy Construction, was used to identify the major factors and sub-factors for evaluating the performance of Air Force privatized utility systems. This was accomplished by having the decision maker define "what is important to them in terms of utility system evaluation." In order to determine what is important, the decision maker had to generate and define the major factors and sub-factors, known as values, which are fundamental to the decision problem. The values were structured in a hierarchical fashion to facilitate the evaluation process by helping the decision maker and stakeholders visualize how these values impact the performance of utility systems.

3. How do the major factors and sub-factors compare to each other in terms of importance?

Finding. Step 5 of the VFT methodology, Value Hierarchy Weighting, was used to illustrate how the values compared to each other in terms of importance. To account for the varying degrees of importance, the decision maker assigned a weight to each value. The decision maker was instructed to distribute a portion of 100 points to each value within a tier of each branch of the hierarchy. The portion of the points each value received serves an indicator of relative importance.

5.2 Model Strengths

The evaluation model developed in this research was created using a combination of the "gold and platinum standards." In other words, written guidance from the Department of Defense and the stated objectives of the Air Force's utility privatization program were used. The model captured 28 values and 47 measures relating to the Air Force utility privatization program's objective of improving the overall quality, reliability, and responsiveness of its utility systems. Sensitivity analysis on the weights assigned to each value explored how variations in weight can impact the overall final ranking of utility systems being evaluated. Furthermore, results from sensitivity analysis can help identify potential problems of a particular utility system. In others words, a utility system's slope during sensitivity analysis can serve as an indicator of how well the utility system is performing in a particular area of evaluation.

Another strength of this evaluation model is the fact that it remains general enough for implementation, with few adjustments, at all military installations and with any utility system. This is based on the fact that the values captured in the model can be linked to general Department of Defense utility privatization guidance. Other military departments will undoubtedly make changes to the model to fit their needs; however, the model will still provide a defendable, objective, and repeatable process for evaluating the performance of utility systems.

5.3 Model Limitations

The evaluation model lacks a value and measure to evaluate how well a utility system is saving energy. Since it is very difficult to determine the amount of energy savings contributed by a privatized utility provider and an installation's energy program, this should be considered as a separate research effort. Also, the traditional method of weighting the hierarchy in the VFT process was modified slightly at the request of the decision maker, weights reflecting the level of importance for each value were created by the researcher and various subject matter experts. These weights were later adjusted by the decision maker. Finally, the research did not evaluate real world alternatives.

5.4 Conclusions

The research has demonstrated that VFT can be used to determine the effectiveness of Air Force utility privatization. An evaluation model was developed to help the Air Force evaluate the performance of its utility systems. In addition, this study provides the Air Force with an effective decision analysis tool which provides insight into the performance of its privatized utility systems.

5.5 Recommendations for Future Work

Follow up research could be conducted to create a measure for the “Energy Savings” value. Also, to truly reflect the Air Force’s level of importance for each value, senior leadership should weight the model. Finally, the model should be further validated using real world data. This will provide the Air Force with insight on the current state of its privatized utility systems.

Appendix A. Value Hierarchy Measures

Table 7. Summary of Measures for the *Quality* Branch

Tier	Value	Associated Measure	Measure Unit	Measure Type	Lower Bound	Upper Bound
Third	Maintaining Proper Licenses, Permits, & Certification	Percentage of Up-to-Date Licenses, Permits, and Certifications	Percentage	Natural/Direct	0%	100%
Third	Maintaining Service Records for 2 Years	Are Records for the Past 2 Years Properly Maintained?	Yes or No	Constructed/Direct	No	Yes
Third	Maintaining and Updating Drawings	Average Number of Days to Update	Days	Natural/Direct	Under 60 Days	Over 75 Days
Third	Effective Spill Contingency Plan	Number of Positive Findings for Spill Contingency Plan	Findings	Constructed/Direct	0	20
Third	Effective Spill Contingency Plan	Number of Minor Findings for Spill Contingency Plan	Findings	Constructed/Direct	20	0
Third	Effective Spill Contingency Plan	Number of Major Findings for Spill Contingency Plan	Findings	Constructed/Direct	20	0
Third	Effective Spill Contingency Plan	Number of Significant Findings for Spill Contingency Plan	Findings	Constructed/Direct	20	0
Third	Hazmat/Hazwaste Minimization and Recycling	Percentage of Liquid Waste Diverted from Landfills	Percentage	Natural/Direct	0%	100%
Third	Hazardous Material/Waste Minimization and Recycling	Percentage of Solid Waste Diverted from Landfills	Percentage	Constructed/Direct	0%	100%

Table 7. Summary of Measures for the *Quality* Branch (Continued)

Tier	Value	Associated Measure	Measure Unit	Measure Type	Lower Bound	Upper Bound
Third	Hazardous Material/Waste Minimization and Recycling	Percentage of Solid Waste Diverted from Landfills	Percentage	Constructed/Direct	0%	100%
Third	Hazardous Material/Waste Minimization and Recycling	Number of Positive Findings for Recycling Program	Findings	Constructed/Direct	0	20
Third	Hazardous Material/Waste Minimization and Recycling	Number of Minor Findings for Recycling Program	Findings	Constructed/Direct	20	0
Third	Hazardous Material/Waste Minimization and Recycling	Number of Major Findings for Recycling Program	Findings	Constructed/Direct	20	0
Third	Hazardous Material/Waste Minimization and Recycling	Number of Significant Findings for Recycling Program	Findings	Constructed/Direct	20	0
Third	Decreased Utility System Mishaps	Number of Lost Man-Hours Due to Utility System Mishaps	Man-Hours	Natural/Direct	0	150
Third	Decreased Utility System Mishaps	Number of Utility System Mishaps	Mishaps	Natural/Direct	0	15
Third	Compliance with Utility System Laws/Regulations	Number of RAC 1 -- Catastrophic Violations	Violations	Constructed/Direct	0	10
Third	Compliance with Utility System Laws/Regulations	Number of RAC 2 -- Critical Violations	Violations	Constructed/Direct	0	10
Third	Compliance with Utility System Laws/Regulations	Number of RAC 3 -- Moderate Violations	Violations	Constructed/Direct	0	10

Table 7. Summary of Measures for the *Quality* Branch (Continued)

Tier	Value	Associated Measure	Measure Unit	Measure Type	Lower Bound	Upper Bound
Third	Compliance with Utility System Laws/Regulations	Number of RAC 4 -- Negligible Violations	Violations	Constructed/Direct	0	10
Third	Safety/Employee Certification	Percentage of Employees Completing all Requirements	Percentage	Natural/Direct	0%	100%
Second	Sub-Metering Capability	Percentage of Meters Calibrated from Random Sample	Percentage	Natural/Direct	0%	100%
Second	Sub-Metering Capability	Percentage of Total Facilities Metered	Percentage	Natural/Direct	0%	100%
Second	Utility System Security	Number of Employees Identified as Potential Threats	Employees	Natural/Direct	None	More than 1
Second	Utility System Security	Are all Employee Security Clearances Up-to-Date?	Yes or No	Constructed/Direct	No	Yes

Table 8. Summary of Measures for the *Reliability* Branch

Tier	Value	Associated Measure	Measure Unit	Measure Type	Lower Bound	Upper Bound
Second	Completed Renewals/ Replacements	Percentage of Items Actually Replaced	Percentage	Natural/Direct	0%	100%
Second	Decreased Utility System Outages	Percentage of Critical Outages Caused by System Management	Percentage	Natural/Direct	100%	0%
Second	Decreased Outages	Percentage of Non-Critical Outages Caused by System Management	Percentage	Natural/Direct	100%	0%

Table 9. Summary of Measures for the *Responsiveness* Branch

Tier	Value	Associated Measure	Measure Unit	Measure Type	Lower Bound	Upper Bound
Second	Effective Digging Permits/Line Marking Program	Number of Utility Line Hits	Hits	Natural/Direct	0	20
Second	High Contracting Meeting Attendance	Percentage of Meetings Attended	Percentage	Natural/Direct	0%	100%
Second	Timely Meter Readings	Percentage of Late Meter Readings	Percentage	Natural/Direct	0%	100%
Fourth	Adequate 24/7 Hotline	Is There an Adequate 24/7 Hotline?	Yes or No	Natural/Direct	No	Yes
Fourth	Timely Initial Emergency Response	Percentage of Goal Met for Timely Initial Emergency Response	Percentage	Natural/Direct	0%	100%

Table 9. Summary of Measures for the *Responsiveness* Branch (Continued)

Tier	Value	Associated Measure	Measure Unit	Measure Type	Lower Bound	Upper Bound
Fourth	Timely Emergency Crew Response	Percentage of Goal for Timely Emergency Crew Response	Percentage	Natural/Direct	0%	100%
Fourth	Timely Remedied Emergency Response	Percentage of Goal Met for Timely Remedied Emergency Response	Percentage	Natural/Direct	0%	100%
Fourth	Timely Response to Exercises/ Contingencies	Number of Outstanding Ratings for Exercises/ Contingencies	ORI or Exercise Rating	Constructed/Direct	0	20
Fourth	Timely Response to Exercises/ Contingencies	Number of Excellent Ratings for Exercises/ Contingencies	ORI or Exercise Rating	Constructed/Direct	0	20
Fourth	Timely Response to Exercises/ Contingencies	Number of Satisfactory Ratings for Exercises/ Contingencies	ORI or Exercise Rating	Constructed/Direct	0	20
Fourth	Timely Response to Exercises/ Contingencies	Number of Marginal Ratings for Exercises/ Contingencies	ORI or Exercise Rating	Constructed/Direct	20	0
Fourth	Timely Response to Exercises/ Contingencies	Number of Unsatisfactory Ratings for Exercises/ Contingencies	ORI or Exercise Rating	Constructed/Direct	20	0
Fourth	Effective FACMAN Emergency Coordination	Percentage of Goal Met for Effective FACMAN Emergency Coordination	Percentage	Natural/Direct	0%	100%

Table 9. Summary of Measures for the *Responsiveness* Branch (Continued)

Tier	**Value**	**Associated Measure**	**Measure Unit**	**Measure Type**	**Lower Bound**	**Upper Bound**
Fourth	Timely Initial Urgent Response	Percentage of Goal Met for Timely Initial Urgent Response	Percentage	Natural/Direct	0%	100%
Fourth	Timely Remedied Urgent Response	Percentage of Goal Met for Timely Remedied Urgent Response	Percentage	Natural/Direct	0%	100%
Fourth	Effective FACMAN Urgent Coordination	Percentage of Goal Met for Effective FACMAN Urgent Coordination	Percentage	Natural/Direct	0%	100%
Fourth	Timely Initial Routine Response	Percentage of Goal Met for Timely Initial Routine Response	Percentage	Natural/Direct	0%	100%
Fourth	Timely Remedied Routine Response	Percentage of Goal Met for Timely Remedied Routine Response	Percentage	Natural/Direct	0%	100%
Fourth	Effective 2-Week Coordination	Percentage of Goal Met for Effective 2-Week Coordination	Percentage	Natural/Direct	0%	100%
Fourth	Effective FACMAN Routine Coordination	Percentage of Goal Met for Effective FACMAN Routine Coordination	Percentage	Natural/Direct	0%	100%

Table 9. Summary of Measures for the *Responsiveness* Branch (Continued)

Tier	Value	Associated Measure	Measure Unit	Measure Type	Lower Bound	Upper Bound
Third	Compliance with Utility System Laws/Regulations	Number of RAC 1 -- Catastrophic Violations	Violations	Constructed/Direct	0	10
Third	Compliance with Utility System Laws/Regulations	Number of RAC 2 -- Critical Violations	Violations	Constructed/Direct	0	10
Third	Compliance with Utility System Laws/Regulations	Number of RAC 3 -- Moderate Violations	Violations	Constructed/Direct	0	10
Third	Compliance with Utility System Laws/Regulations	Number of RAC 4 -- Negligible Violations	Violations	Constructed/Direct	0	10
Third	Safety/Employee Certification	Percentage of Employees Completing all Requirements	Percentage	Natural/Direct	0%	100%
Second	Sub-Metering Capability	Percentage of Meters Calibrated from Random Sample	Percentage	Natural/Direct	0%	100%
Second	Sub-Metering Capability	Percentage of Total Facilities Metered	Percentage	Natural/Direct	0%	100%
Second	Utility System Security	Number of Employees Identified as Potential Threats	Employees	Natural/Direct	None	More than 1
Second	Utility System Security	Are all Employee Security Clearances Up-to-Date?	Yes or No	Constructed/Direct	No	Yes

Appendix B. Value Hierarchy Definitions

Table 10. Definitions of *Quality* Measures

Measure	Definition
Percentage of Up-to-Date Licenses, Permits, and Certifications	The percentage of all licenses, permits, and certifications the contractor is keeping up-to-date. The percentage is determined by the ratio of actual number of licenses, permits, and certifications held by the contractor to the number of up-to-date licenses, permits, and certifications held by the contractor.
Are Service Records for the Past 2 Years Properly Maintained?	Whether the contractor is maintaining all service call request and safety records for at least a two-year period. A random inspection of the contractor's records is used to determine whether the service records are maintained properly. The random inspection inspects for several service request calls requirements: time of the service call, time of response to service call, cause of service call, and action taken. If an inspection of one record does not contain the required information, then the contractor's records are not considered to be properly maintained. A sufficient service call request sample size for the random inspection is based on the number of service call requests the installation received for a year time period.
Average Number of Days to Update	The average number of days the contractor would take to update drawings. The average number of days is determined by calculating the number of days between the completions of a service call request or construction project to the time the contractor provides the Air Force with the updated drawing. Also, the average number of days to update is determined by summing the total number of days for all drawing updates and dividing it by the number of drawing updates.
Number of Positive Findings for Spill Contingency Plan	The degree of effectiveness of the contractor's spill contingency plan. The ECAMP finding serves as an indicator of effectiveness for the contractor's spill contingency plan. Positive findings are an observed condition, or management practice in which the contractor has met or exceeded the compliance requirements.
Number of Minor Findings for Spill Contingency Plan	The degree of effectiveness of the contractor's spill contingency plan. The ECAMP finding serves as an indicator of effectiveness for the contractor's spill contingency plan. Minor findings are observed administrative or procedural conditions that are out of compliance with Department of Defense or Air Force Instructions at any level.
Number of Major Findings for Spill Contingency Plan	The degree of effectiveness of the contractor's spill contingency plan. The ECAMP finding serves as an indicator of effectiveness for the contractor's spill contingency plan. Major findings are observed conditions that must be corrected in order to avoid future threats to human health, safety, the environment, or the installation. These findings are normally out of compliance with federal, state, or local laws.
Number of Significant Findings for Spill Contingency Plan	The degree of effectiveness of the contractor's spill contingency plan. The ECAMP finding serves as an indicator of effectiveness for the contractor's spill contingency plan. Significant findings are observed conditions that pose or have the likelihood of posing an immediate and direct threat to human health, safety, the environment, or the installation's mission.

Table 10. Definitions of *Quality* Measures (Continued)

Measure	Definition
Percentage of Liquid Waste Diverted from Landfills	The percentage of liquid waste the contractor diverted from landfills. The contractor is required to report liquid waste data to the installation's environmental representative. The percentage is determined by the ratio of the total liquid waste diverted by the contractor to the total liquid waste generated by the contractor.
Percentage of Solid Waste Diverted from Landfills	The percentage of solid waste the contractor diverted from landfills. The contractor is required to report solid waste data to the installation's environmental representative. The percentage is determined by the ratio of the total solid waste diverted by the contractor to the total solid waste generated by the contractor.
Number of Positive Findings for Recycling Program	The degree of contractor's contribution to the installation's recycling program. The ECAMP finding serves as an indicator of contractor's contribution to the installation's recycling program. Positive findings are an observed condition, or management practice in which the contractor has met or exceeded the compliance requirements.
Number of Minor Findings for Recycling Program	The degree of contractor's contribution to the installation's recycling program. The ECAMP finding serves as an indicator of contractor's contribution to the installation's recycling program. Minor findings are observed administrative or procedural conditions that are out of compliance with Department of Defense or Air Force Instructions at any level.
Number of Major Findings for Recycling Program	The degree of contractor's contribution to the installation's recycling program. The ECAMP finding serves as an indicator of contractor's contribution to the installation's recycling program. Major findings are observed conditions that must be corrected in order to avoid future threats to human health, safety, the environment, or the installation. These findings are normally out of compliance with federal, state, or local laws.
Number of Significant Findings for Recycling Program	The degree of contractor's contribution to the installation's recycling program. The ECAMP finding serves as an indicator of contractor's contribution to the installation's recycling program. Significant findings are observed conditions that pose or have the likelihood of posing an immediate and direct threat to human health, safety, the environment, or the installation's mission.
Recycling ECAMP Finding	The degree of effectiveness of the contractor's recycling program. The ECAMP finding serves as an indicator of effectiveness for the contractor's hazardous material/waste minimization and recycling program.
Number of Lost Man-Hours Due to Utility System Mishaps	The number of lost man-hours due to utility system mishaps caused by the contractor's safety practices.
Number of Utility System Mishaps	The number of lost man-hours due to utility system mishaps caused by the contractor's safety practices.
Number of RAC 1 -- Catastrophic Violations	The number of RAC 1, catastrophic violations caused by the contractor by the contractor's safety practices. Catastrophic violations are electrical safety violations that would result in mission failure, death, or loss of system. This data can be retrieved from the installation's safety office.

Table 10. Definitions of *Quality* Measures (Continued)

Measure	Definition
Number of RAC 2 -- Critical Violations	The number of RAC 2, critical violations caused by the contractor's safety practices. Critical violations are electrical safety violations that would result in a major mission degradation, injury, minor occupational illness, or damage. This data can be retrieved from the installation's safety office.
Number of RAC 3 -- Moderate Violations	The number of RAC 3, moderate violations caused by the contractor's caused by the contractor's safety practices. Moderate violations are electrical safety violations that would result in a minor mission degradation, injury, minor occupational illness, or damage. This data can be retrieved from the installation's safety office.
Number of RAC 4 -- Negligible Violations	The number of RAC 4, negligible violations caused by the contractor's safety practices. Negligible violations are electrical safety violations that would result in less than minor mission degradation, injury, occupational illness, or system damage. This data can be retrieved from the installation's safety office.
Percentage of Employees Completing all Safety Certification Requirements	The percentage of contractor employees completing all safety certification requirements. The percentage is determined by the ration of the actual number of contractor employees whom completed all safety certification requirements to the number of contractor employees required to complete safety certification requirements.
Percentage of Meters Calibrated from Random Sample	The percentage of meters calibrated by the contractor. The percentage is determined by taking a sufficient meter sample size (based on the number of meters on the installations) and inspecting their calibration due date. If the date is past due, then the meter is considered to be uncalibrated. Also, the percentage is determined by dividing the number of calibrated meters in the sample size by the sample size.
Percentage of Total Facilities Metered	The percentage of total facilities on the installation metered by the contractor. The percentage is determined by the ratio of the actual number of facilities on the installation metered by the contractor to the number of facilities on the installation.
Number of Employees Identified as Potential Threats	The number of contractor employees identified as potential threats. This data can be retrieved from the installation's security forces organization.
Are all Employee Security Clearances Up-to-Date?	Whether the contractor's employees have required up to date security clearances. If an inspection of one employee's record reveals that the employee's security clearance is not up to date, then the contractor's employees are considered to not have up to date security clearances. A sufficient employee record sample size for the random inspection is based on the number of employee records maintained by the contractor.

Table 11. Definitions of *Reliability* Measures

Measure	Definition
Percentage of Items Actually Renewed or Replaced	The percentage of items actually renewed or replaced by the contractor. A renewal/replacement list is normally created by the contractor with the consent of the Air Force a year in advance to help schedule continuing maintenance, repairs, and upgrades for the installation utility system. The list is normally executed a year later. The percentage is determined by the ratio of the actual number of completed renewals and replacements for a one-year period to the number of scheduled renewals and replacements for that same one-year period.
Percentage of Critical Outages Caused by System Management	The percentage of critical outages caused by poor system management. The percentage is determined by the ratio of the actual number of hours critical facilities were without service to the total number of hours critical facilities should be with service.
Percentage of Non-Critical Outages Caused by System Management	The percentage of non-critical outages caused by poor system management. The percentage is determined by the ratio of the actual number of hours non-critical facilities were without service to the total number of hours non-critical facilities should be with service.

Table 12. Definitions of *Responsiveness* Measures

Measure	Definition
Percentage of Items Actually Renewed or Replaced	The percentage of items actually renewed or replaced by the contractor. A renewal/replacement list is normally created by the contractor with the consent of the Air Force a year in advance to help schedule continuing maintenance, repairs, and upgrades for the installation utility system. The list is normally executed a year later. The percentage is determined by the ratio of the actual number of completed renewals and replacements for a one-year period to the number of scheduled renewals and replacements for that same one-year period.
Percentage of Critical Outages Caused by System Management	The percentage of critical outages caused by poor system management. The percentage is determined by the ratio of the actual number of hours critical facilities were without service to the total number of hours critical facilities should be with service.
Percentage of Non-Critical Outages Caused by System Management	The percentage of non-critical outages caused by poor system management. The percentage is determined by the ratio of the actual number of hours non-critical facilities were without service to the total number of hours non-critical facilities should be with service.

Table 12. Definitions of *Responsiveness* Measures (Continued)

Measure	**Definition**
Number of Utility Line Hits	The number of utility line hits. The number of line hits is an indicator of the effectiveness of the contractor's digging permit and line marking program.
Percentage of Meetings Attended	The percentage of meetings attended by the contractor. The percentage is determined by the ratio of the actual number of meetings attended by the contractor by the number of meetings scheduled to the Air Force.
Percentage of Late Meter Readings	The percentage of times the Air Force received late monthly meter readings from the contractor. The percentage is determined by the ratio of the actual number of months the meter readings were late to 12 months.
Is there an Adequate 24/7 Hotline?	Whether the contractor has adequate 24 hour 7 days a week service request line support for base personnel to call. If the contractor does not have an established telephone available for all base personnel to call 24 hours a day, 7 days a week, then the contractor is considered to not have an adequate 24/7 hotline.
Percentage of Goal Met for Timely Initial Emergency Response	The percentage of goal met for timely initial emergency response. A representative for the contractor is required to be on the site of the emergency response within one hour. The time the emergency request is received by the contractor to the time the contractor sends a representative is normally documented. The percentage is determined by the ratio of the actual number of times the representative was on site within one-hour time period to the number of documented emergency requests.
Percentage of Goal for Timely Emergency Crew Response	The percentage of goal met for timely emergency crew response. A repair crew consisting of qualified technicians working for the contractor is required to be on the site of the emergency response within two hours. The time the emergency request is received by the contractor and the time the contractor sends a repair crew are normally documented. The percentage is determined by the ratio of the actual number of times the repair crew was on site within a two-hour time period to the number of documented emergency requests.
Percentage of Goal Met for Timely Remedied Emergency Response	The percentage of goal met for remedied emergency response. A repair crew consisting of qualified technicians working for the contractor is required to remedy or downgrade the emergency response within 24 hours. The time the emergency request is received by the contractor to the time the repair crew remedies or downgrades the emergency response is normally documented. The percentage is determined by the ratio of the actual number of times the repair crew remedies or downgrades the emergency response within a 24 hour time period to the number of documented emergency requests.
Number of Outstanding Ratings for Exercises/Contingencies	The degree of the effectiveness for the contractor's response to exercises and contingencies. The rating serves as an indicator of the effectiveness of the contractor's response to exercises and contingencies. Outstanding ratings are observed contractor performance or operations that far exceed mission requirements. The contractor's procedures and activities are executed in a far superior manner with very few deficiencies, if any.
Number of Excellent Ratings for Exercises/Contingencies	The degree of the effectiveness for the contractor's response to exercises and contingencies. The rating serves as an indicator of the effectiveness of the contractor's response to exercises and contingencies. Excellent ratings are observed contractor performance or operations that exceed mission requirements. The contractor's procedures and activities are executed in a superior manner, with very little deficiencies.

Table 12. Definitions of *Responsiveness* Measures (Continued)

Measure	Definition
Number of Satisfactory Ratings for Exercises/Contingencies	The degree of the effectiveness for the contractor’s response to exercises and contingencies. The rating serves as an indicator of the effectiveness of the contractor’s response to exercises and contingencies. Satisfactory ratings are observed contractor performance or operations that meet mission requirements. The contractor’s procedures and activities are executed in a competent manner, with minor deficiencies that so not impede or limit the mission.
Number of Marginal Ratings for Exercises/Contingencies	The degree of the effectiveness for the contractor’s response to exercises and contingencies. The rating serves as an indicator of the effectiveness of the contractor’s response to exercises and contingencies. Marginal ratings are observed contractor performance or operations that meet mission requirements. The contractor’s procedures and activities are executed in an inefficient manner with deficiencies that impede or limit the mission.
Number of Unsatisfactory Ratings for Exercises/Contingencies	The degree of the effectiveness for the contractor’s response to exercises and contingencies. The rating serves as an indicator of the effectiveness of the contractor’s response to exercises and contingencies. Unsatisfactory ratings are observed contractor performance or operations that do not meet mission requirements. The contractor’s procedures and activities are executed in an inadequate manner that has significant deficiencies that seriously impede or limit the mission.
Percentage of Goal Met for Effective FACMAN Emergency Coordination	The percentage of goal met for effective FACMAN emergency coordination. The contractor is required to coordinate with facility managers if work associated with emergency requests will affect the buildings. The names of facility managers or facility manager representatives whom were contacted are normally documented. The percentage is determined by the ratio of the actual number of times the contractor contacted all facility managers or facility manager representatives associated with an emergency request to the number of documented emergency requests.
Percentage of Goal Met for Timely Initial Urgent Response	The percentage of goal met for timely initial urgent response. A representative for the contractor is required to be on the site of the urgent response within 24 hours. The time the urgent request is received by the contractor to the time the contractor sends a representative is normally documented. The percentage is determined by the ratio of the actual number of times the representative was on site within a 24 hour time period to the number of documented urgent requests.
Percentage of Goal Met for Timely Remedied Urgent Response	The percentage of goal met for remedied urgent response. A repair crew consisting of qualified technicians working for the contractor is required to remedy or downgrade the emergency response within five calendar days. The time the urgent request is received by the contractor to the time the repair crew remedies or downgrades the urgent response is normally documented. The percentage is determined by the ratio of the actual number of times the repair crew remedies or downgrades the urgent response within a five calendar day time period to the number of documented urgent requests.

Table 12. Definitions of *Responsiveness* Measures (Continued)

Measure	Definition
Percentage of Goal Met for Effective FACMAN Urgent Coordination	The percentage of goal met for effective FACMAN emergency coordination. The contractor is required to coordinate with facility managers if work associated with emergency requests will affect the buildings. The names of facility managers or facility manager representatives whom were contacted are normally documented. The percentage is determined by the ratio of the actual number of times the contractor contacted all facility managers or facility manager representatives associated with an emergency request to the number of documented urgent requests.
Percentage of Goal Met for Timely Initial Routine Response	The percentage of goal met for timely initial routine response. A representative for the contractor is required to be on the site of the emergency response within five calendar days. The time the routine request is received by the contractor to the time the contractor sends a representative is normally documented. The percentage is determined by the ratio of the actual number of times the representative was on site within a one-hour time period to the number of documented routine requests.
Percentage of Goal Met for Timely Remedied Routine Response	The percentage of goal met for remedied routine response. A repair crew consisting of qualified technicians working for the contractor is required to remedy or downgrade the emergency response within 30 calendar days. Both the time the routine request is received by the contractor and the time the repair crew remedies the routine response are normally documented. The percentage is determined by the ratio of the actual number of times the repair crew remedies the routine response within a five calendar day time period to the number of documented routine requests.
Percentage of Goal Met for Effective 2-Week Coordination	The percentage of goal met for effective two-week coordination with contracting office representative. The contractor is required to coordinate with the installation's contracting office representative at least two weeks prior to commencing work for a routine service request. The names of contracting office representatives contacted are normally documented. The percentage is determined by the ratio of the actual number of times the contractor contacted a contracting office representative associated with a routine service request to the number of routine service requests.
Percentage of Goal Met for Effective FACMAN Routine Coordination	The percentage of goal met for effective FACMAN routine coordination. The contractor is required to coordinate with facility managers if work associated with routine requests will affect the buildings. The names of facility managers or their representatives contacted are normally documented. The percentage is determined by the ratio of the actual number of times the contactor contacted all facility managers or facility manager representatives associated with a routine request to the number of routine requests.

Appendix C. Single Dimension Value Functions (SDVFs)

SDVF # 1—Percentage of Up-to-Date Licenses, Permits, and Certifications

The SDVF for *Percentage of Up-to-Date Licenses, Permits, and Certifications* is a monotonically increasing function that measures the contractor's percentage of up-to-date licenses, permits, and certifications. The most preferred score is for a contractor that was able to keep all licenses, permits, and certifications up-to-date. This score receives a value of 1.000. The least preferred score is for a contractor that unable to keep none licenses, permits, and certification up-to-date. That score receives a value of 0.000. As illustrated in Figure 30, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

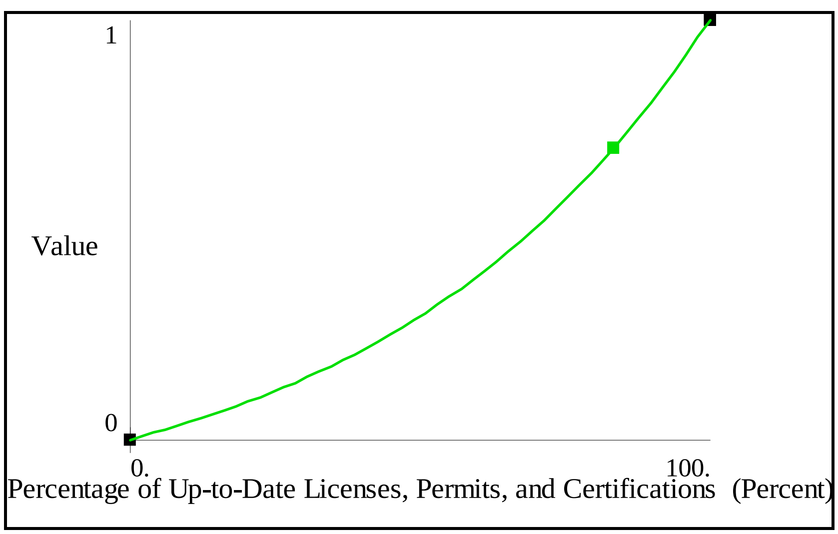

Figure 30. Percentage of Up-to-Date Licenses, Permits, and Certifications SDVF

SDVF # 2—Are Records for the Past 2 Years Maintained Properly

The SDVF for *Are Records for the Past 2 Years Maintained Properly* is a discrete function that measures if a contractor is properly maintaining service records for the past two years. The most preferred score is for a contractor that was able to properly maintain all service records for the past two years. This score receives a value of 1.000. The least preferred score is for a contractor that unable to properly maintain all service records for the past two years. That score receives a value of 0.000. The *Are Records for the Past 2 Years Maintained Properly* SDVF is illustrated in Figure 31.

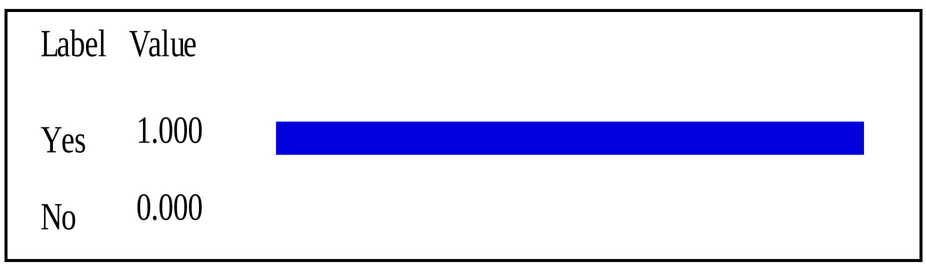

Figure 31. Are Records for the Past 2 Years Maintained Properly SDVF

SDVF # 3—Average Number of Days to Update Drawings

The SDVF for *Average Number of Days to Update Drawings* is a discrete function that measures how long it takes a contractor to update drawings. The most preferred score is for a contractor that was able to update drawings under 60 days. This score receives a value of 1.000. The second most preferred score is for a contractor that was able to update drawings between 60 to 65 days. That score receives a value of 0.838. The third most preferred score is for a contractor for a contractor that was able to update drawings between 66 to 70 days. This score receives a value of 0.420. The least preferred score is for a contractor that was only able to update drawings over 75 days. That score receives a value of 0.000. The second least preferred score is for a contractor that was only able to update drawings between 71 to 75 days. This score receives a value of 0.180. The *Average Number of Days to Update Drawings* SDVF is illustrated in Figure 32.

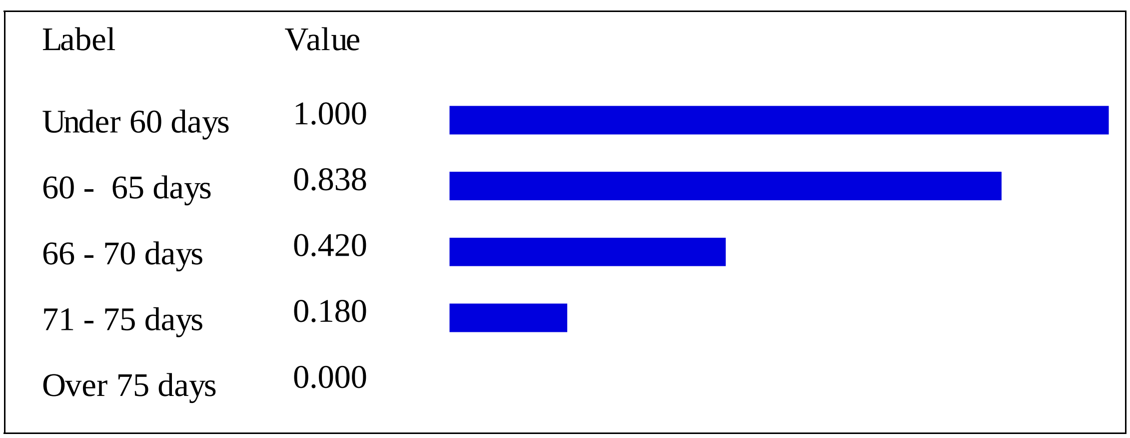

Figure 32. Average Number of Days to Update Drawings SDVF

SDVF # 4—Number of Positive Findings for Spill Contingency Plan

The SDVF for *Number of Positive Findings for Spill Contingency Plan* is a monotonically increasing function that measures the number of positive findings the contractor received for its spill contingency plan. The most preferred score is for a contractor that received over up to 20 positive findings. This score receives a value of 1.000. The least preferred score is for a contractor that received no positive findings. That score receives a value of 0.000. As illustrate in Figure 33, the contractor's value on the y-axis increases for every increase in the number of findings on the x-axis.

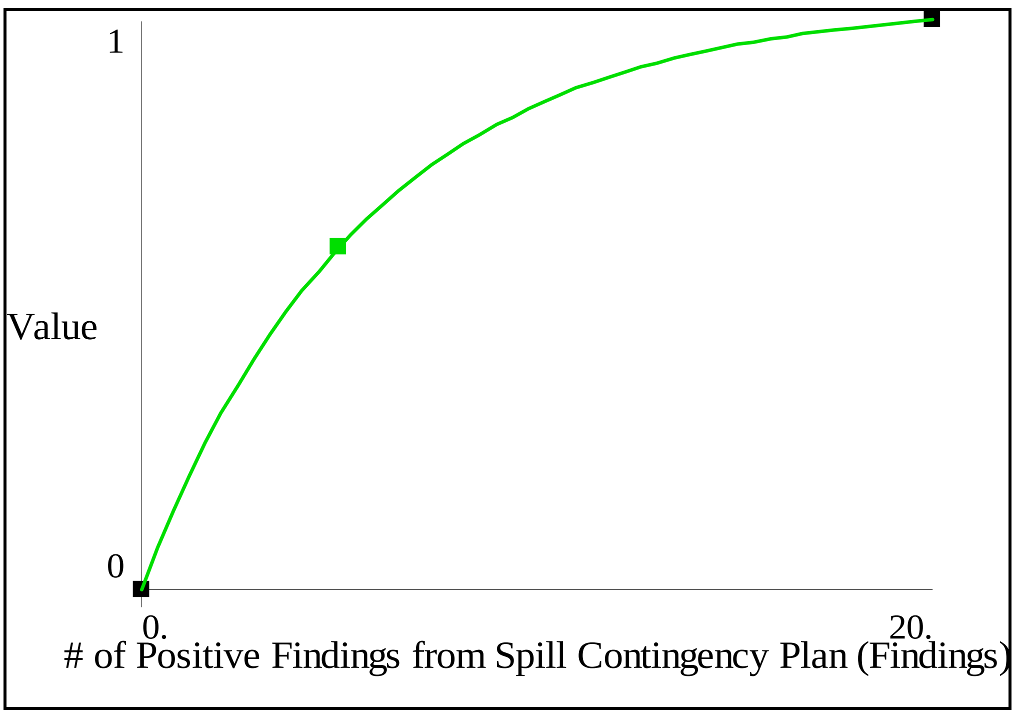

Figure 33. Number of Positive Findings for Spill Contingency Plan SDVF

SDVF # 5—Number of Minor Findings for Spill Contingency Plan

The SDVF for *Number of Minor Findings for Spill Contingency Plan* is a monotonically decreasing function that measures the number of minor findings the contractor received for its spill contingency plan. The most preferred score is for a contractor that received no minor findings. This score receives a value of 1.000. The least preferred score is for a contractor that received up to 20 minor findings. That score receives a value of 0.000. As illustrate in Figure 34, the contractor's value on the y-axis decreases for every increase in the number of findings on the x-axis.

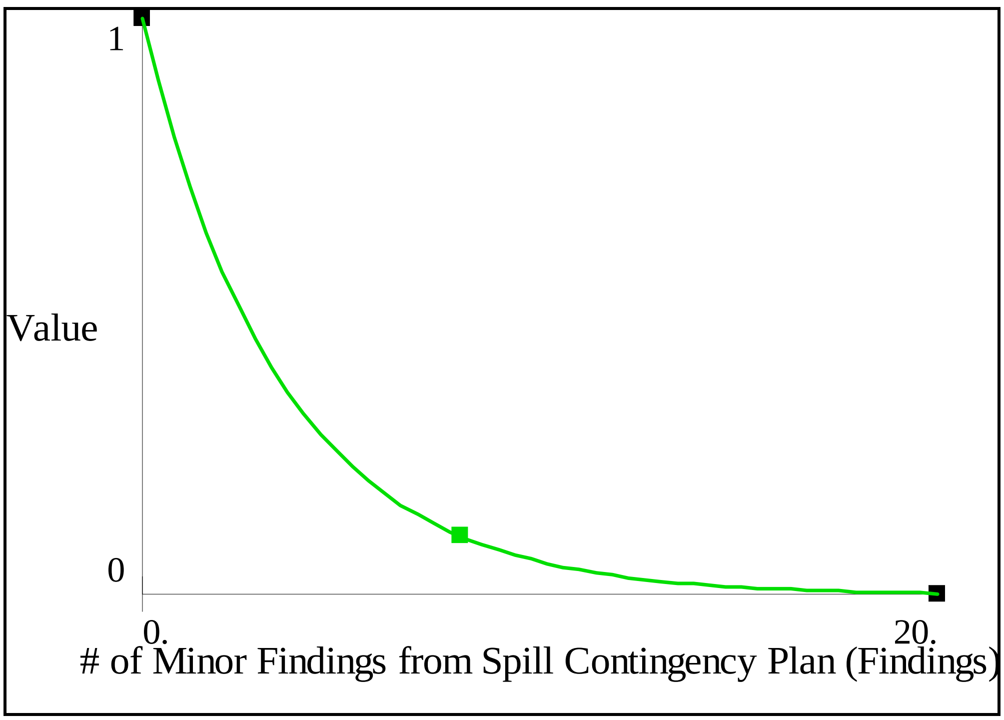

Figure 34. Number of Minor Findings for Spill Contingency Plan SDVF

SDVF # 6—Number of Major Findings for Spill Contingency Plan

The SDVF for *Number of Major Findings for Spill Contingency Plan* is a monotonically decreasing function that measures the number of major findings the contractor received for its spill contingency plan. The most preferred score is for a contractor that received no major findings. This score receives a value of 1.000. The least preferred score is for a contractor that received up to 20 major findings. That score receives a value of 0.000. As illustrate in Figure 35, the contractor's value on the y-axis decreases for every increase in the number of findings on the x-axis.

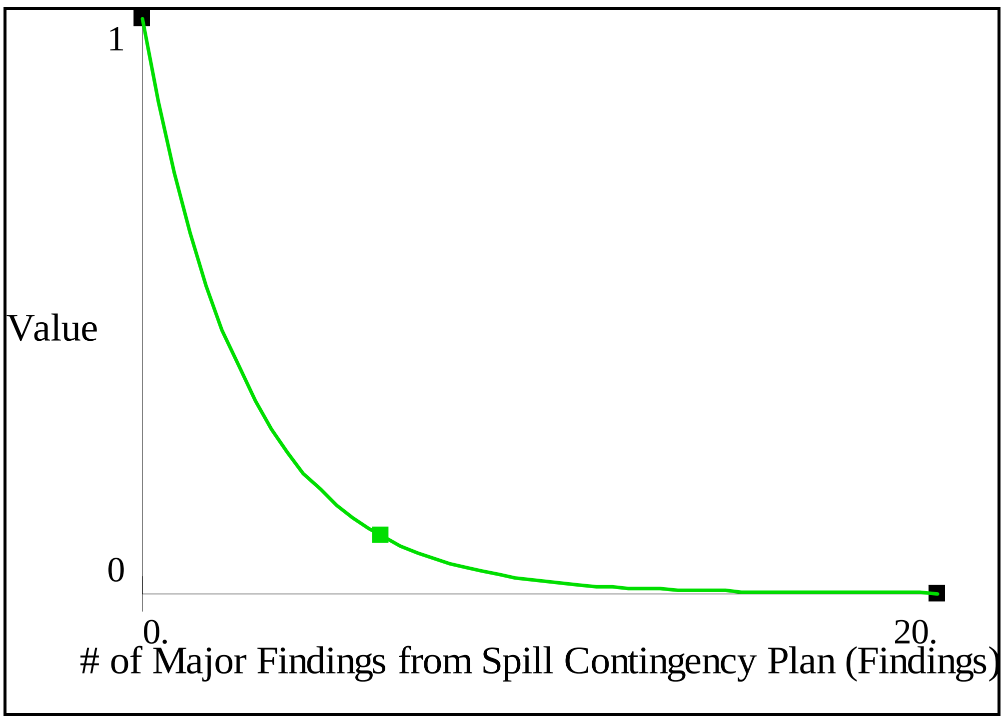

Figure 35. Number of Major Findings for Spill Contingency Plan SDVF

SDVF # 7—Number of Significant Findings for Spill Contingency Plan

The SDVF for *Number of Significant Findings for Spill Contingency Plan* is a monotonically decreasing function that measures the number of significant findings the contractor received for its spill contingency plan. The most preferred score is for a contractor that received no significant findings. This score receives a value of 1.000. The least preferred score is for a contractor that received up to 20 significant findings. That score receives a value of 0.000. As illustrate in Figure 36, the contractor's value on the y-axis decreases for every increase in the number of findings on the x-axis.

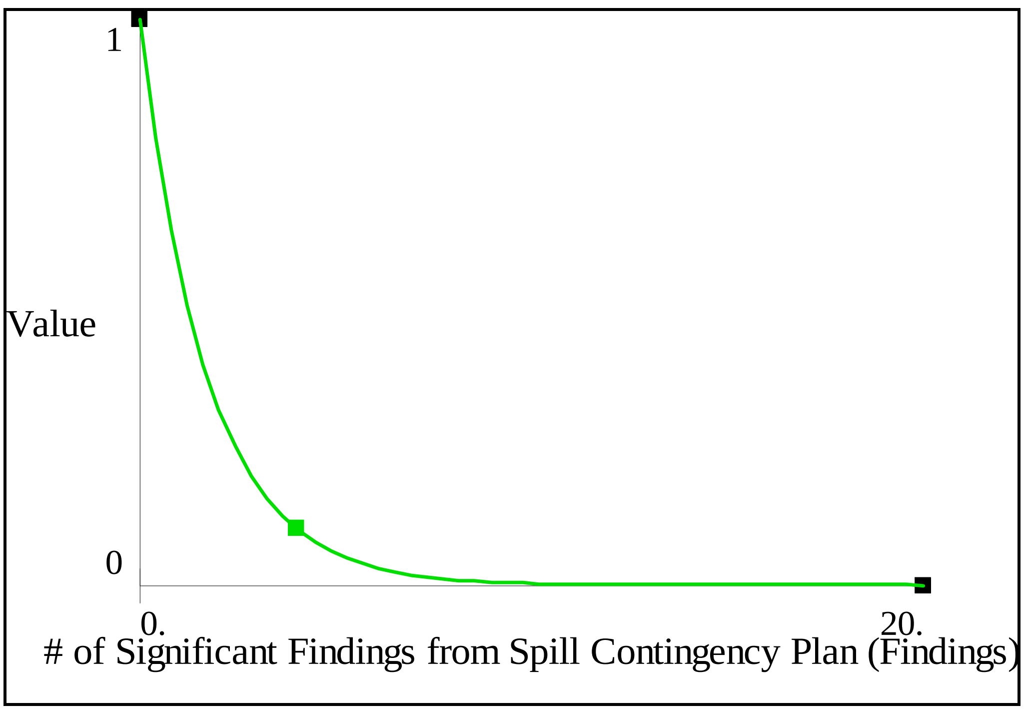

Figure 36. Number of Significant Findings for Spill Contingency Plan SDVF

SDVF # 8—Percentage of Liquid Waste Diverted from Landfills

The SDVF for *Percentage of Liquid Waste Diverted from Landfills* is a monotonically increasing function that measures the contractor's percentage of its liquid waste diverted from landfills. The most preferred score is for a contractor that was able to divert all of its liquid waste from landfills. This score receives a value of 1.000. The least preferred score is for a contractor that was not able to divert any of its liquid waste from landfills. That score receives a value of 0.000. As illustrate in Figure 37, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

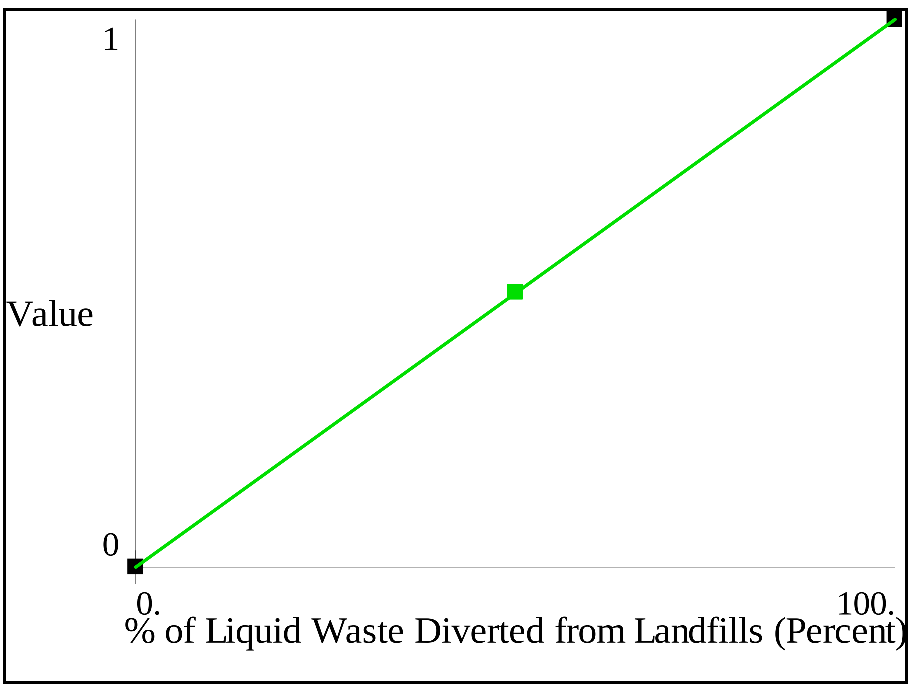

Figure 37. Percentage of Liquid Waste Diverted from Landfills SDVF

SDVF # 9—Percentage of Solid Waste Diverted from Landfills

The SDVF for *Percentage of Solid Waste Diverted from Landfills* is a monotonically increasing function that measures the contractor's percentage of its solid waste diverted from landfills. The most preferred score is for a contractor that was able to divert all of its liquid waste from landfills. This score receives a value of 1.000. The least preferred score is for a contractor that was unable to divert any of its liquid waste from landfills. That score receives a value of 0.000. As illustrate in Figure 38, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

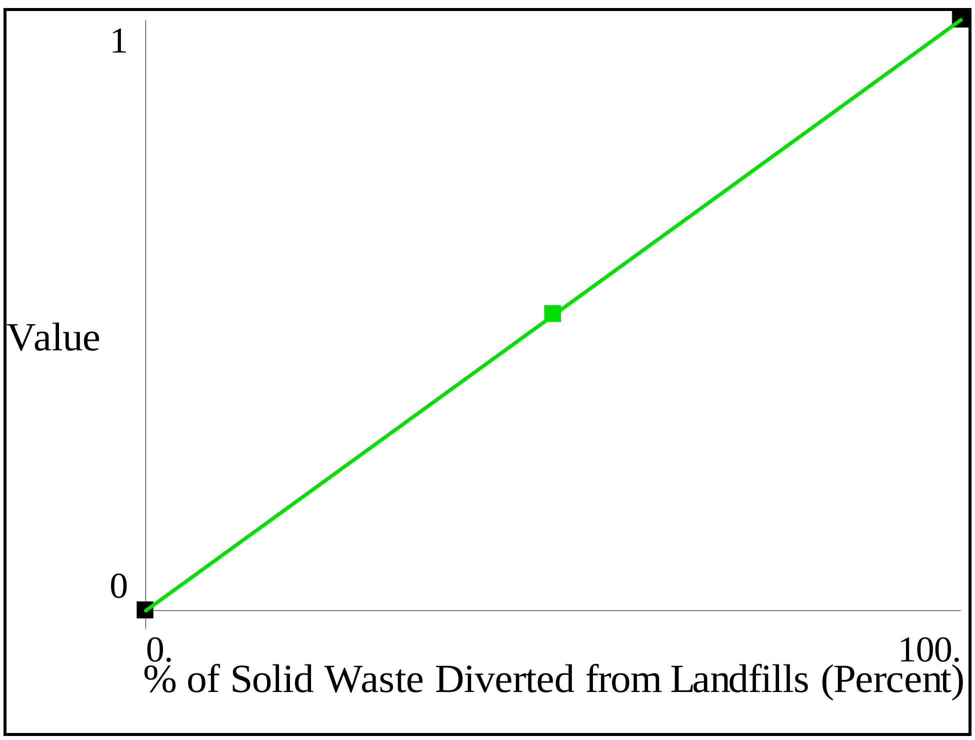

Figure 38. Percentage of Solid Waste Diverted from Landfills SDVF

SDVF # 10—Number of Positive Findings for Recycling

The SDVF for *Number of Positive Findings for Recycling* is a monotonically increasing function that measures the number of positive findings the contractor received for its contribution to the installation's recycling program. The most preferred score is for a contractor that received up to 20 positive findings. This score receives a value of 1.000. The least preferred score is for a contractor that received no positive findings. That score receives a value of 0.000. As illustrate in Figure 39, the contractor's value on the y-axis increases for every increase in the number of findings on the x-axis.

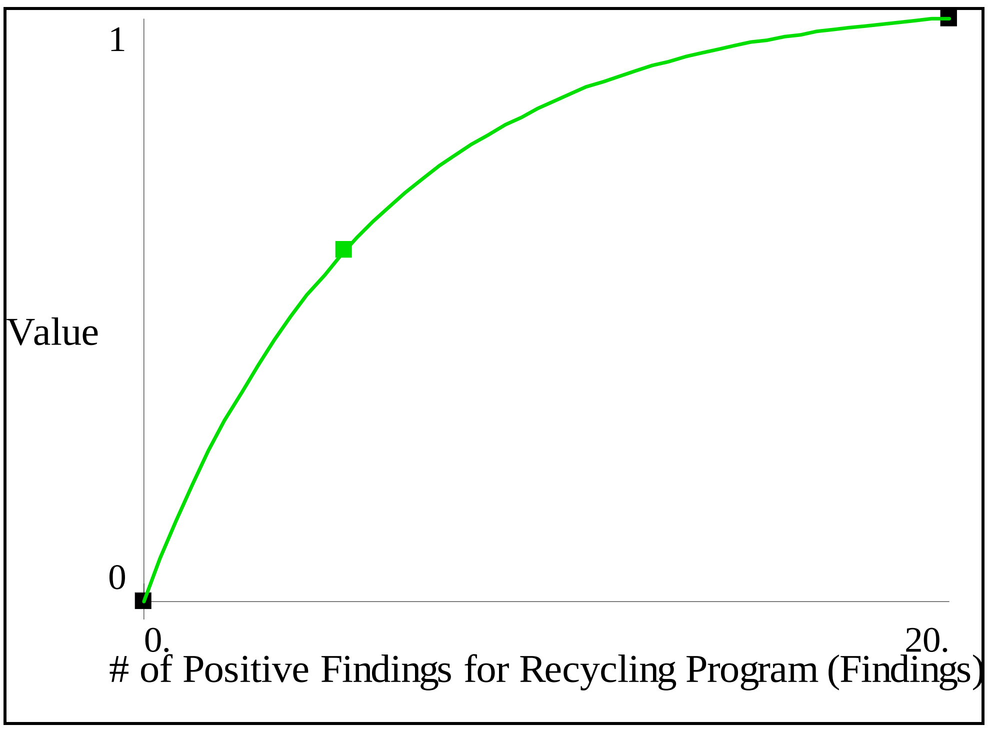

Figure 39. Number of Positive Findings for Recycling SDVF

SDVF # 11—Number of Minor Findings for Recycling

The SDVF for *Number of Minor Findings for Recycling* is a monotonically decreasing function that measures the number of minor findings the contractor received for its contribution to the installation's recycling program. The most preferred score is for a contractor that received no minor findings. This score receives a value of 1.000. The least preferred score is for a contractor that received up to 20 minor findings. That score receives a value of 0.000. As illustrate in Figure 40, the contractor's value on the y-axis decreases for every increase in the number of findings on the x-axis.

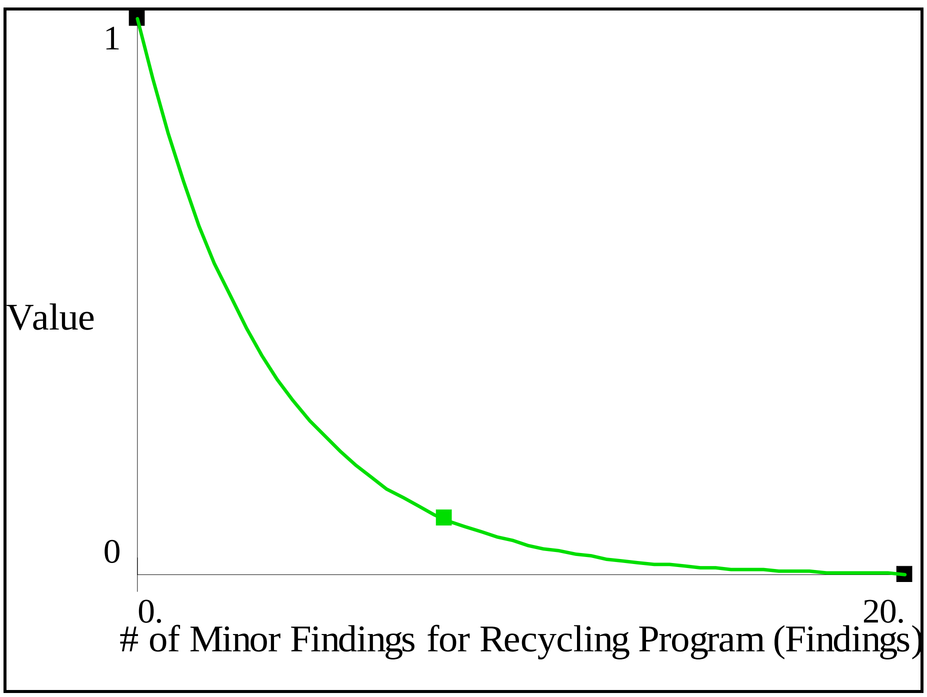

Figure 40. Number of Minor Findings for Recycling SDVF

SDVF # 12—Number of Major Findings for Recycling

The SDVF for *Number of Major Findings for Recycling* is a monotonically decreasing function that measures the number of major findings the contractor received for its contribution to the installation's recycling program. The most preferred score is for a contractor that received no major findings. This score receives a value of 1.000. The least preferred score is for a contractor that received up to 20 major findings. That score receives a value of 0.000. As illustrate in Figure 41, the contractor's value on the y-axis exponentially decreases for every increase in the number of findings on the x-axis.

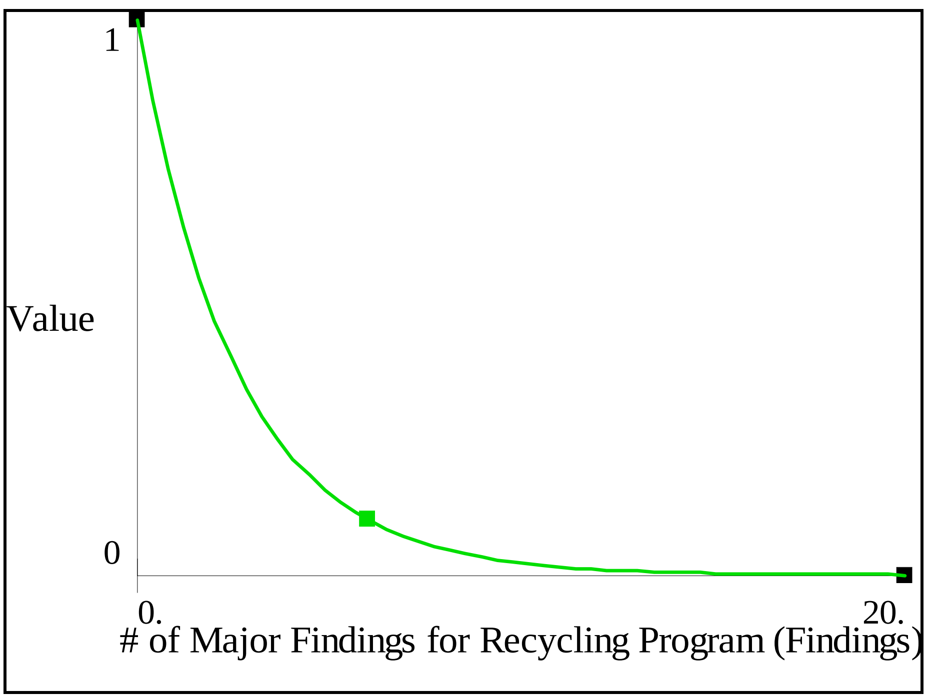

Figure 41. Number of Major Findings for Recycling SDVF

SDVF # 13—Number of Significant Findings for Recycling

The SDVF for *Number of Significant Findings for Recycling* is a monotonically decreasing function that measures the number of significant findings the contractor received for its contribution to the installation's recycling program. The most preferred score is for a contractor that received no significant findings. This score receives a value of 1.000. The least preferred score is for a contractor that received up to 20 significant findings. That score receives a value of 0.000. As illustrate in Figure 42, the contractor's value on the y-axis decreases for every increase in the number of findings on the x-axis.

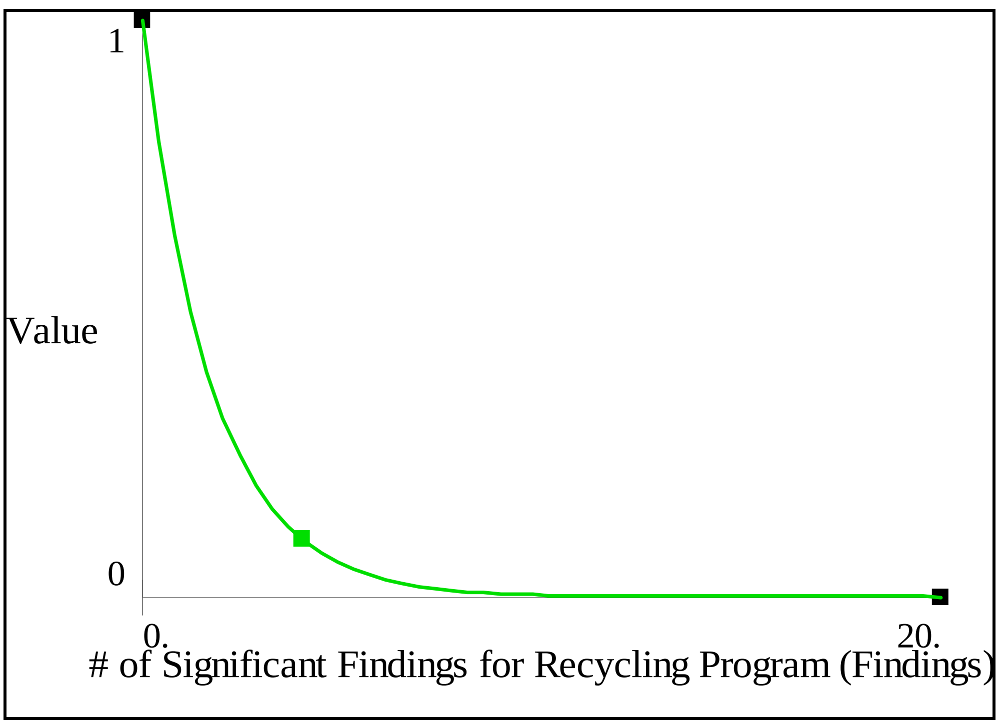

Figure 42. Number of Significant Findings for Recycling SDVF

SDVF # 14—Number of Lost Man-Hours Due to Utility System Mishaps

The SDVF for *Number of Lost Man-Hours Due to Utility System Mishaps* is a monotonically decreasing function that measures the number of lost man-hours due to the contractor's utility system mishaps. The most preferred score is for a contractor with a utility system that caused no lost in man-hours. This score receives a value of 1.000. The least preferred score is for a contractor with a utility system that caused up to 150 lost man-hours. That score receives a value of 0.000. As illustrate in Figure 43, the contractor's value on the y-axis decreases for every increase in the number of man-hours on the x-axis.

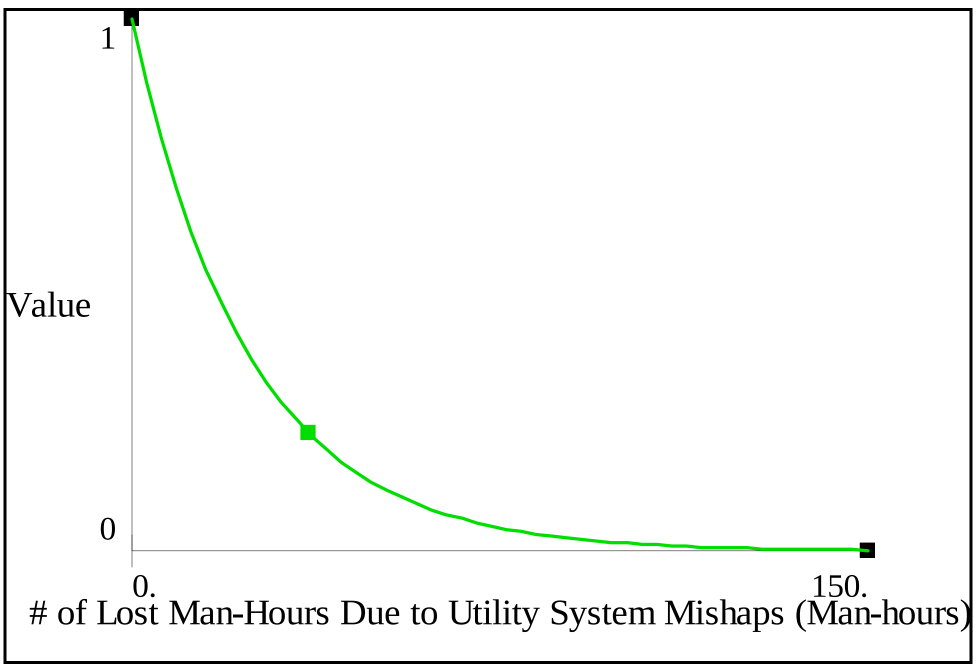

Figure 43. Number of Lost Man-Hours Due to Utility System Mishaps SDVF

SDVF # 15—Number of Utility System Mishaps

The SDVF for *Number of Utility System Mishaps* is a monotonically decreasing function that measures the number of utility system mishaps caused by the contractor's safety practices. The most preferred score is for a contractor whose safety practices caused no utility system mishaps. This score receives a value of 1.000. The least preferred score is for a contractor whose safety practices caused up to 15 utility system mishaps. That score receives a value of 0.000. As illustrate in Figure 44, the contractor's value on the y-axis decreases for every increase in the number of mishaps on the x-axis.

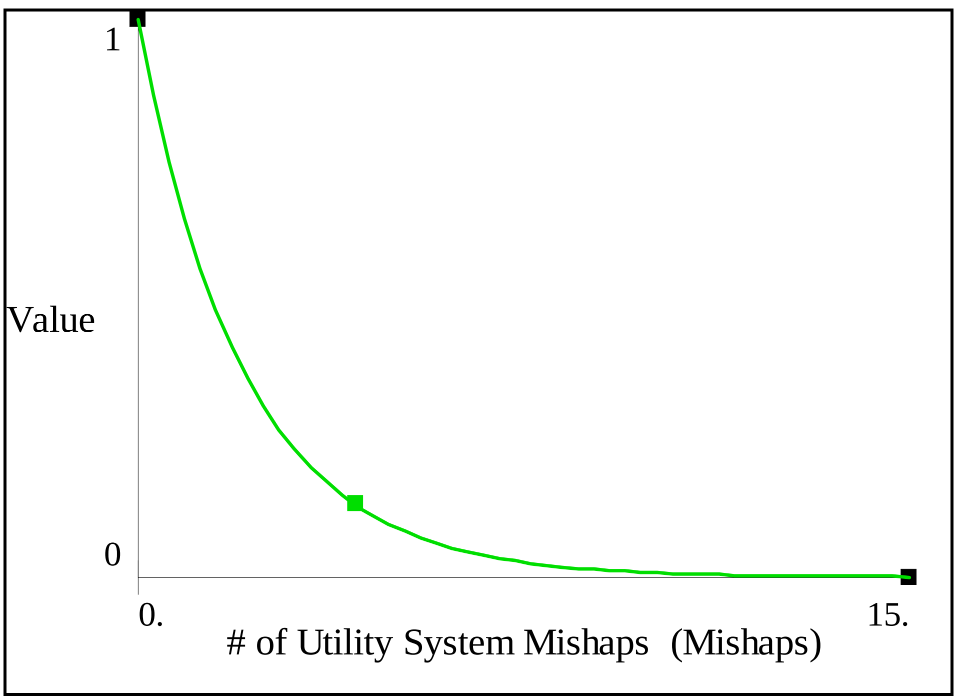

Figure 44. Number of Utility System Mishaps SDVF

SDVF # 16—Number of RAC 1 – Catastrophic Violations

The SDVF for *Number of RAC 1 – Catastrophic Violations* is a monotonically decreasing function which measures the number of catastrophic violations caused by the contractor's safety practices. The most preferred score is for a contractor whose safety practices caused no catastrophic violations. This score receives a value of 1.000. The least preferred score is for a contractor whose safety practices caused up to 10 catastrophic violations. That score receives a value of 0.000. As illustrate in Figure 45, the contractor's value on the y-axis decreases for every increase in the number of violations on the x-axis.

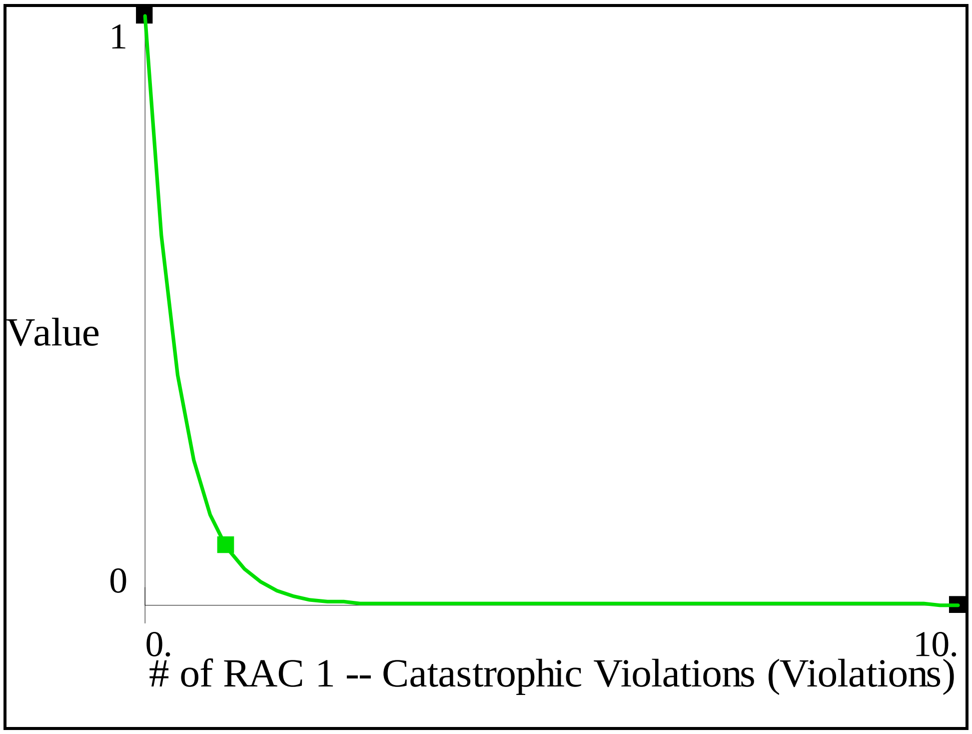

Figure 45. Number of RAC 1 – Catastrophic Violations SDVF

SDVF # 17—Number of RAC 2 – Critical Violations

The SDVF for *Number of RAC 2 – Critical Violations* is a monotonically decreasing function which measures the number of critical violations caused by the contractor's safety practices. The most preferred score is for a contractor whose safety practices caused no critical violations. This score receives a value of 1.000. The least preferred score is for a contractor whose safety practices caused up to 10 critical violations. That score receives a value of 0.000. As illustrate in Figure 46, the contractor's value on the y-axis decreases for every increase in the number of violations on the x-axis.

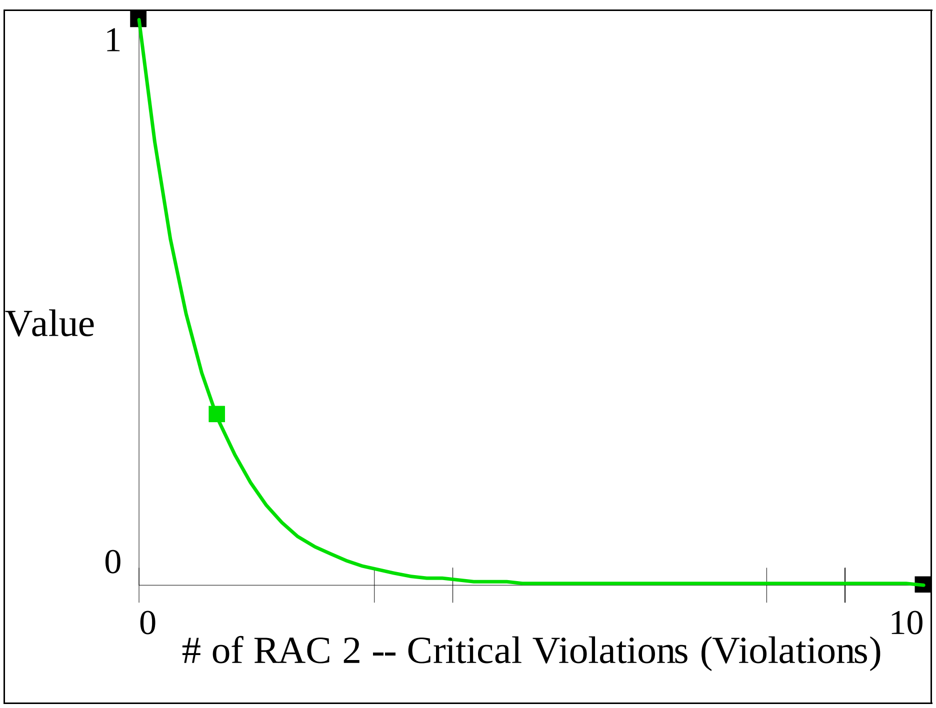

Figure 46. Number of RAC 2 – Critical Violations SDVF

SDVF # 18—Number of RAC 3 – Moderate Violations

The SDVF for *Number RAC 3 – Moderate Violations* is a monotonically decreasing function which measures the number of moderate violations caused by the contractor's safety practices. The most preferred score is for a contractor whose safety practices caused no moderate violations. This score receives a value of 1.000. The least preferred score is for a contractor whose safety practices caused up to 10 moderate violations. That score receives a value of 0.000. As illustrate in Figure 47, the contractor's value on the y-axis decreases for every increase in the number of violations on the x-axis.

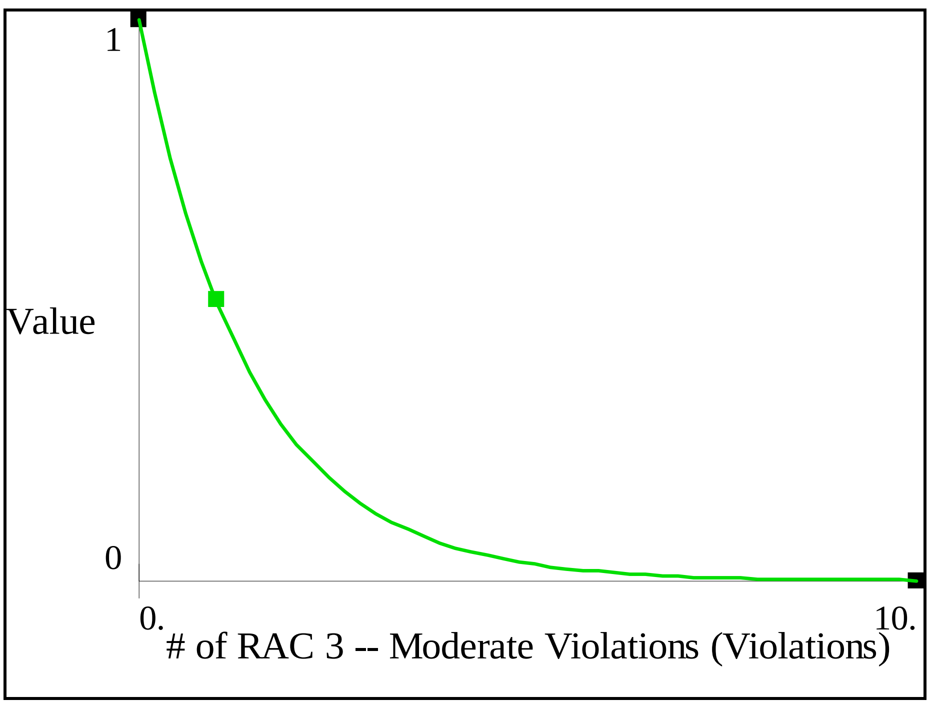

Figure 47. Number of RAC 3 – Moderate Violations SDVF

SDVF # 19—Number of RAC 4 – Negligible Violations

The SDVF for *Number of RAC 4 – Negligible Violations* is a monotonically decreasing function which measures the number of negligible violations caused by the contractor's safety practices. The most preferred score is for a contractor whose safety practices caused no negligible violations. This score receives a value of 1.000. The least preferred score is for a contractor whose safety practices caused up to 10 negligible violations. That score receives a value of 0.000. As illustrate in Figure 48, the contractor's value on the y-axis decreases for every increase in the number of violations on the x-axis.

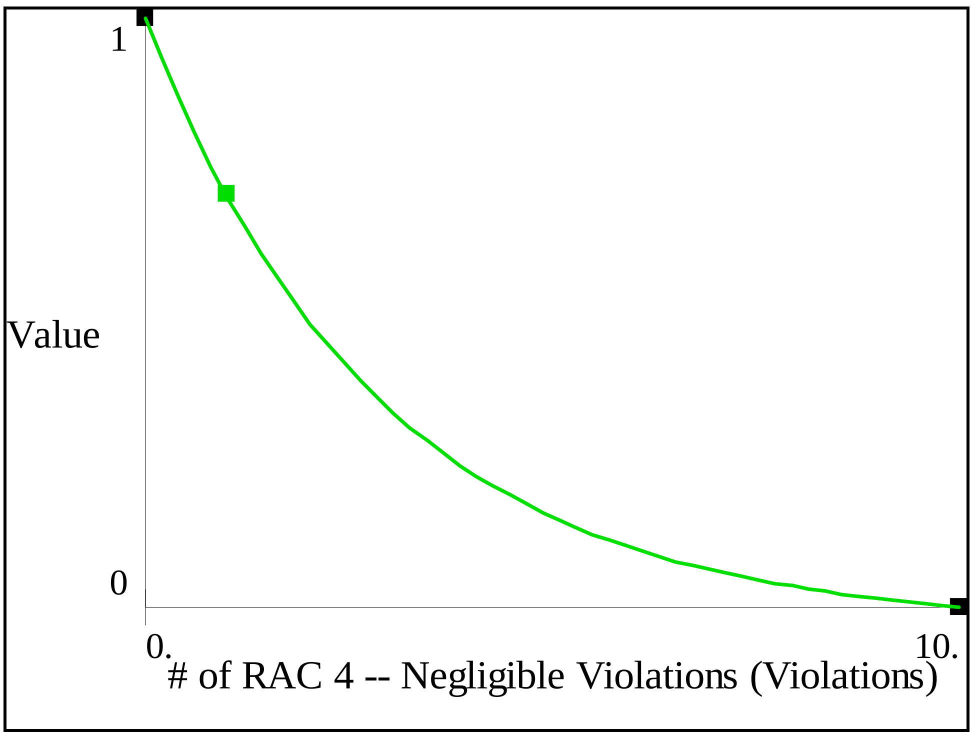

Figure 48. Number of RAC 4 – Negligible Violations SDVF

SDVF # 20—Percentage of Employees Completing all Requirements

The SDVF for *Percentage of Employees Completing all Requirements* is a monotonically increasing function that measures the percentage employees working for the contractor whom completed all safety certification requirements. The most preferred score is for a contractor whose required employees are fully certified. This score receives a value of 1.000. The least preferred score is for a contractor whose required employees are not fully certified. That score receives a value of 0.000. As illustrate in Figure 49, the contractor’s value on the y-axis increases for every increase in percentage on the x-axis.

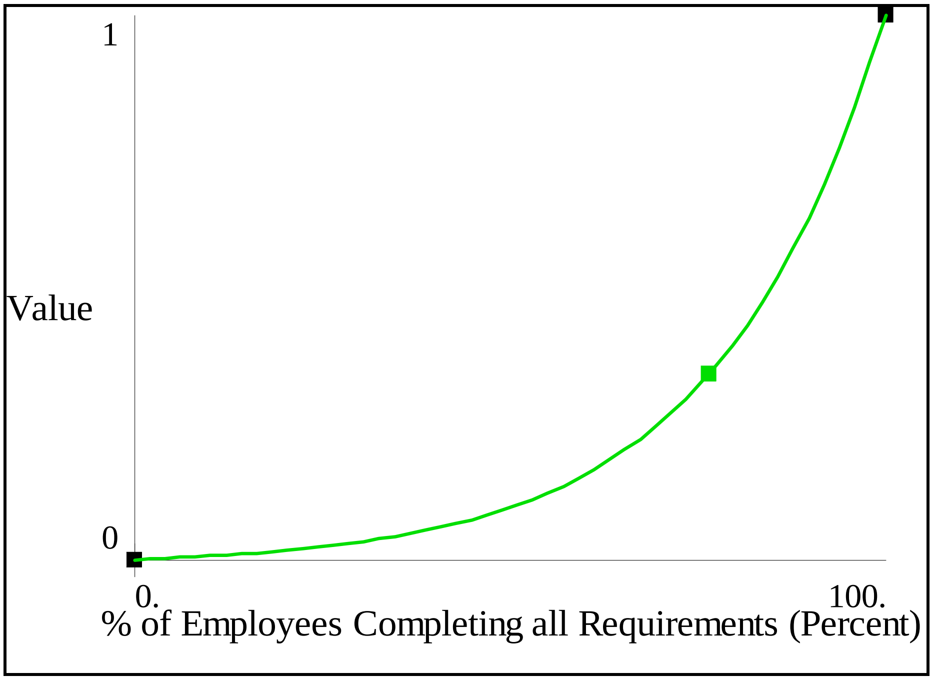

Figure 49. Percentage of Employees Completing all Requirements SDVF

SDVF # 21—Percentage of Meters Calibrated from Random Sample

The SDVF for *Percentage of Meters Calibrated from Random Sample* is a monotonically increasing function which measures the percentage of a random sample of meters maintained by the contractor that are calibrated. The most preferred score is for all meters in the random sample to be calibrated. This score receives a value of 1.000. The least preferred score is for none of the meters in the random sample to be calibrated. That score receives a value of 0.000. As illustrate in Figure 50, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

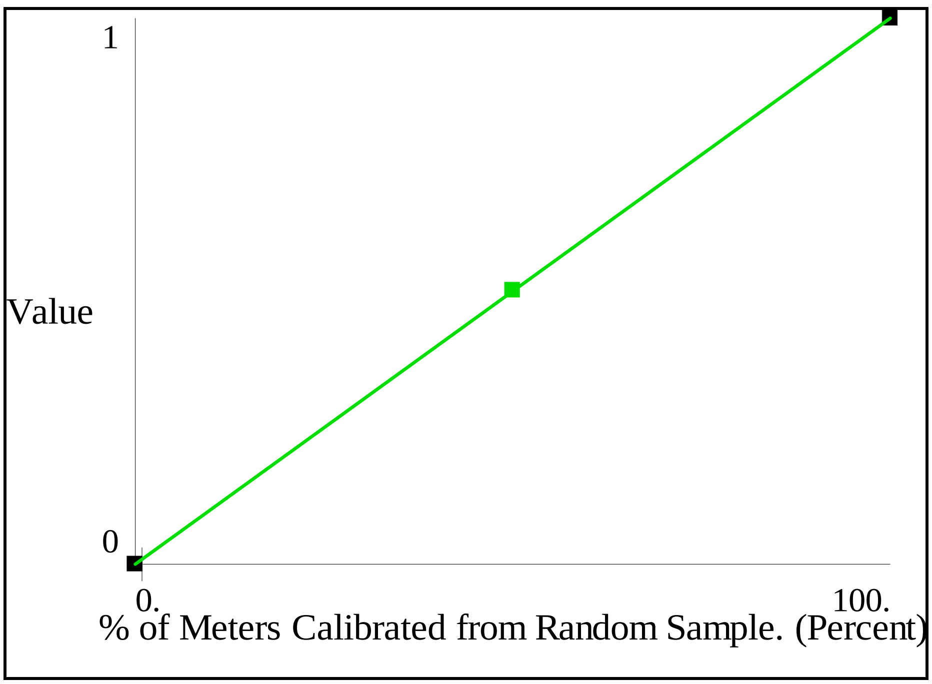

Figure 50. Percentage of Meters Calibrated from Random Sample SDVF

SDVF # 22—Percentage of Total Facilities Metered

The SDVF for *Percentage of Total Facilities Metered* is a monotonically increasing function that measures the percentage of facilities on the installation that are metered. The most preferred score is for all the facilities on the installations to be metered. This score receives a value of 1.000. The least preferred score is for none of the facilities on the installation to be metered. That score receives a value of 0.000. As illustrate in Figure 51, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

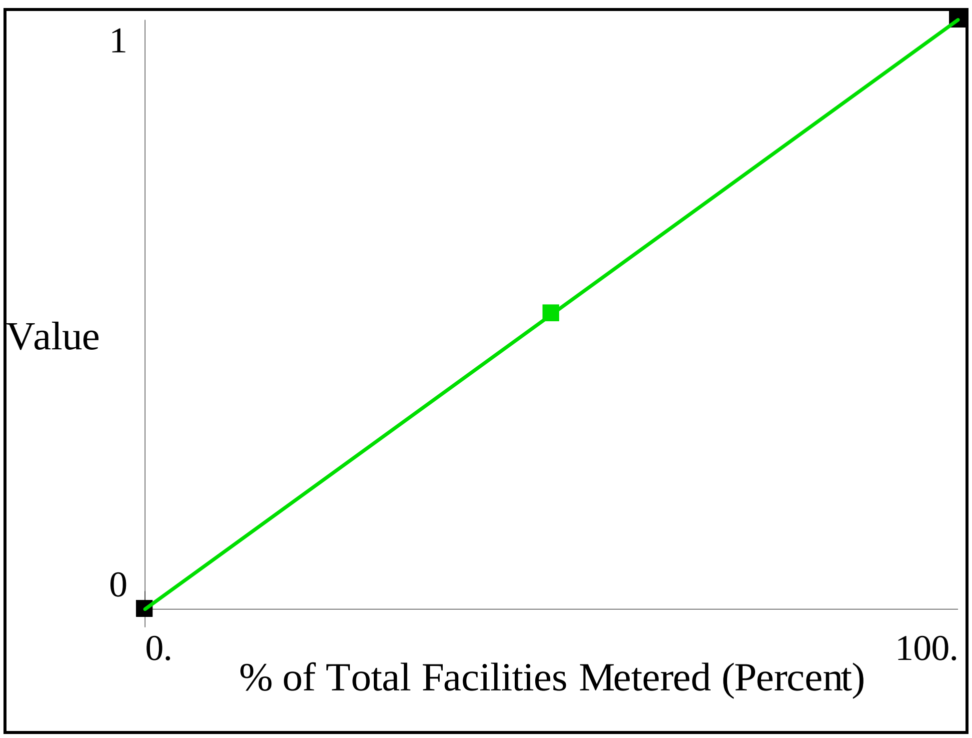

Figure 51. Percentage of Total Facilities Metered SDVF

SDVF # 23—Number of Employees Identified as Potential Threats

The SDVF for *Number of Employees Identified as Potential Threats* is a discrete function that measures number of contractor employees that are potential security threats to the installation. The most preferred score is for a contractor with no employees identified as a potential security threat. This score receives a value of 1.000. The least preferred score is for a contractor with more than one employee identified as a potential security threat. That score receives a value of 0.000. The second least preferred score is for a contractor that has only one employee identified as a potential security threat. This score receives a value of 0.400. The *Number of Employees Identified as Potential Threats* SDVF is illustrated in Figure 52.

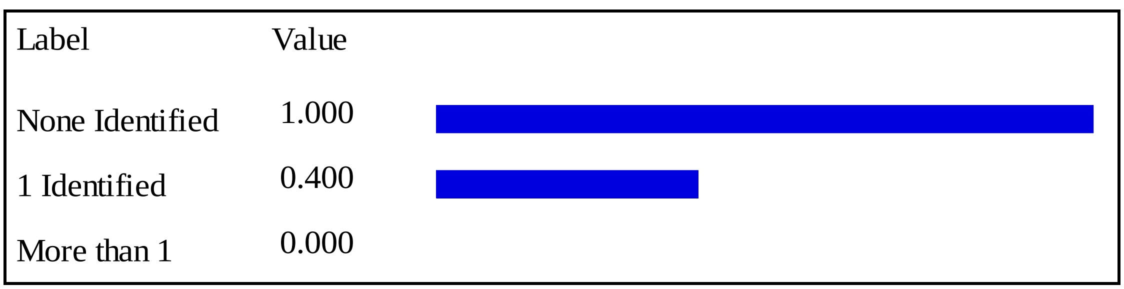

Figure 52. Number of Employees Identified as Potential Threats SDVF

SDVF # 24—Are all Employee Security Clearances Up-to-Date

The SDVF for *Are all Employee Security Clearances Up-to-Date* is a discrete function, which measures whether all required contractor employees have up-to-date security clearances. The most preferred score is for a contractor with employees requiring security clearances have them up-to-date. This score receives a value of 1.000. The least preferred score is for a contractor with employees requiring security clearances not have them fully up-to-date. That score receives a value of 0.000. The *Are all Employee Security Clearances Up-to-Date* SDVF is illustrated in Figure 53.

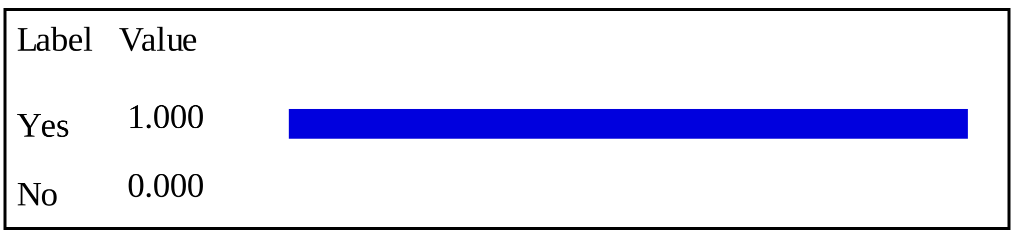

Figure 53. Are all Employee Security Clearances Up-to-Date SDVF

SDVF # 25—Percentage of Items Actually Replaced

The SDVF for *Percentage of Items Actually Replaced* is a monotonically increasing function that measures the percentage of items on the renewals/replacement list actually completed by the contractor. The most preferred score is for the contractor that completed all items on the list. This score receives a value of 1.000. The least preferred score is for contractor that completed no items on the list. That score receives a value of 0.000. As illustrate in Figure 54, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

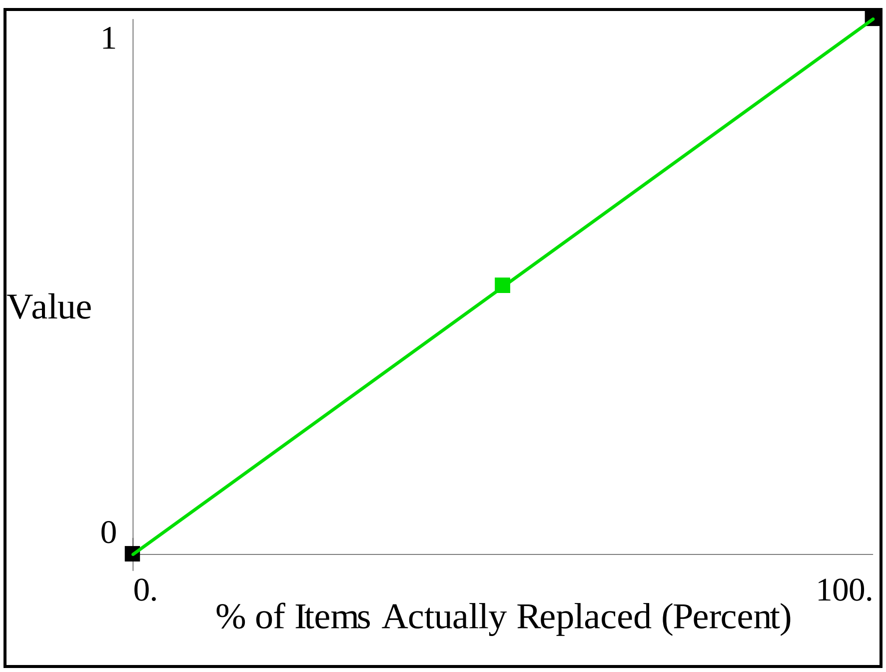

Figure 54. Percentage of Items Actually Replaced SDVF

SDVF # 26—Percentage of Critical Outages Caused by System Management

The SDVF for *Percentage of Critical Outages Caused by System Management* is a monotonically decreasing function that measures the percentage of critical facility outages caused by the contractor's system management. The most preferred score is for a contractor with no critical facility outages caused by its system management. This score receives a value of 1.000. The least preferred score is for a contractor with all critical facility outages caused by its system management. That score receives a value of 0.000. As illustrate in Figure 55, the contractor's value on the y-axis decreases for every increase in percentage on the x-axis.

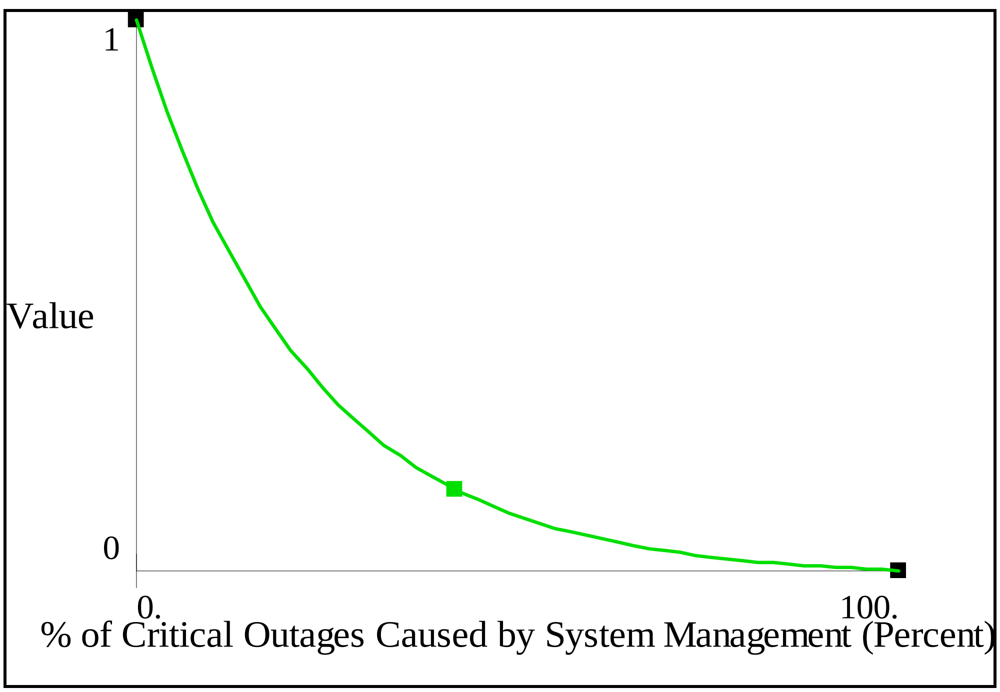

Figure 55. Percentage of Critical Outages Caused by System Management SDVF

SDVF # 27—Percentage of Non-Critical Outages Caused by System Management

The SDVF for *Percentage of Non-Critical Outages Caused by System Management* is a monotonically decreasing function that measures the percentage of non-critical facility outages caused by the contractor's system management. The most preferred score is for a contractor with no non-critical facility outages caused by its system management. This score receives a value of 1.000. The least preferred score is for a contractor with all non-critical facility outages caused by its system management. That score receives a value of 0.000. As illustrate in Figure 56, the contractor's value on the y-axis decreases for every increase in percentage on the x-axis.

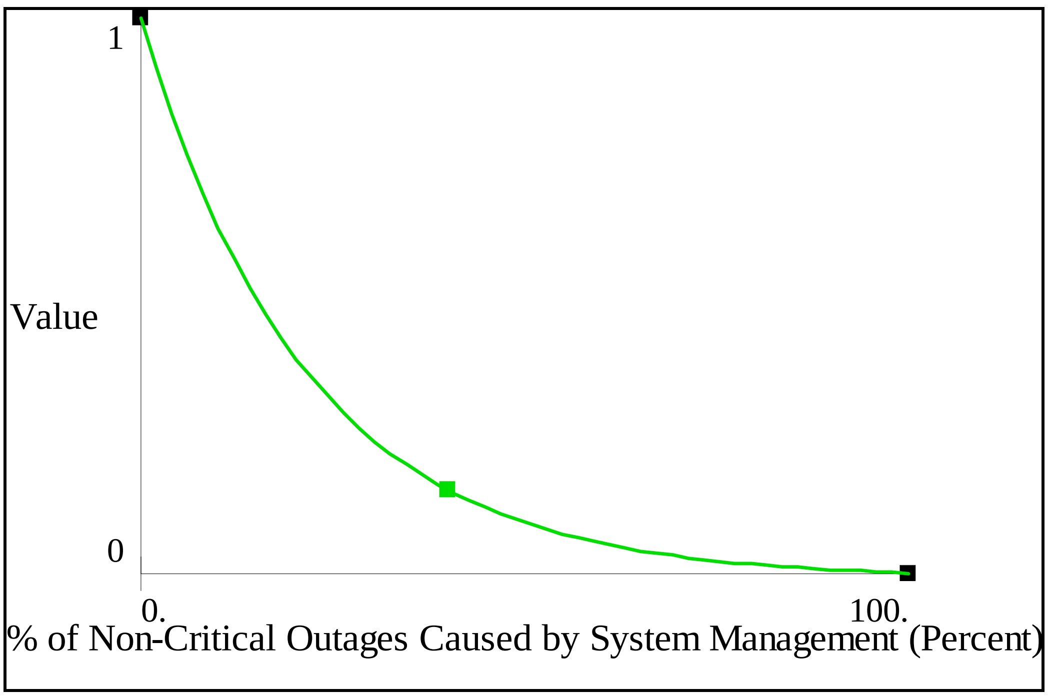

Figure 56. Percentage of Non-Critical Outages Caused by System Management SDVF

SDVF # 28—Number of Utility Line Hits

The SDVF for *Number of Utility Line Hits* is a discrete function which measures how number of utility line hits caused by the contractor's digging permit and line marking program. The most preferred score is for a contractor to have no utility line hits. This score receives a value of 1.000. The second most preferred score is for a contractor to have between 1 to 5 utility line hits. That score receives a value of 0.670. The least preferred score is for a contractor to have more than 10 utility line hits. That score receives a value of 0.000. The second least preferred score is for a contractor to have between 6 to 10 utility line hits. This score receives a value of 0.333. The *Number of Utility Line Hits* SDVF is illustrated in Figure 57.

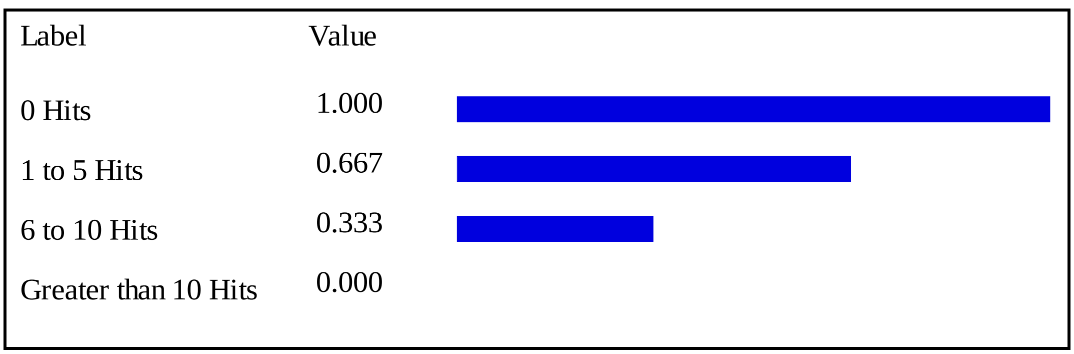

Figure 57. Number of Utility Line Hits SDVF

SDVF # 29—Percentage of Meetings Attended

The SDVF for *Percentage of Items Actually Replaced* is a monotonically increasing function which measures the percentage of Air Force requested meetings attended by the contractor. The most preferred score is for the contractor that attended all meetings. This score receives a value of 1.000. The least preferred score is for contractor that was unable to attend meetings. That score receives a value of 0.000. As illustrate in Figure 58, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

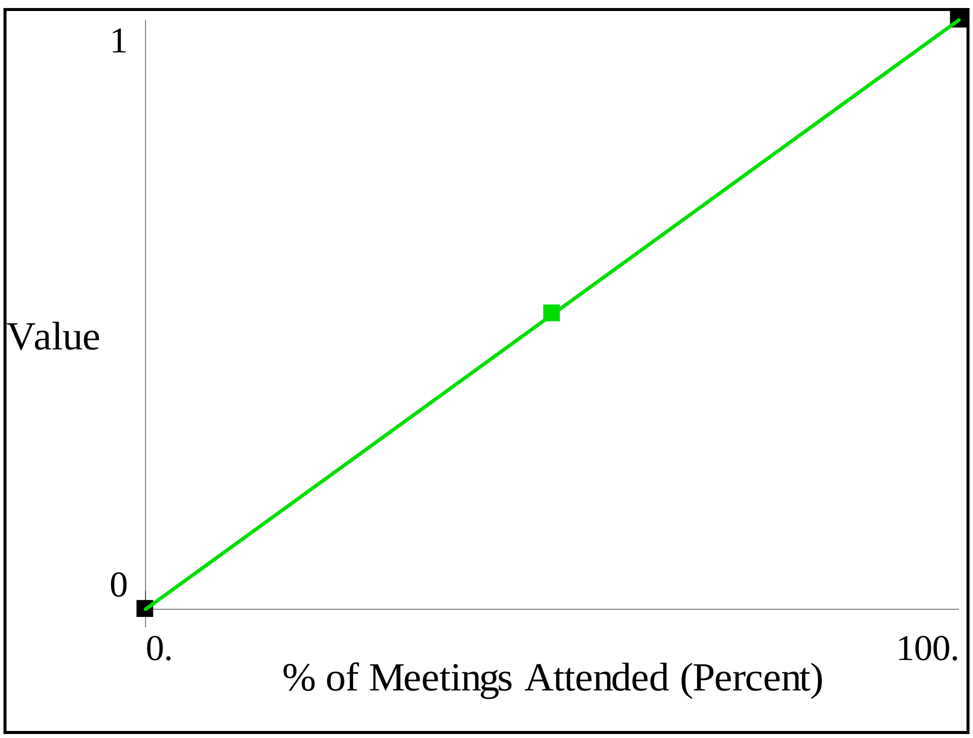

Figure 58. Percentage of Meetings Attended SDVF

SDVF # 30—Percentage of Late Meter Readings

The SDVF for *Percentage of Late Meter Readings* is a monotonically decreasing function that measures the percentage of times the Air Force received late meter readings from the contractor. The most preferred score is for a contractor to provide all meter readings on time to the Air Force. This score receives a value of 1.000. The least preferred score is for a contractor to provide the Air Force with consistently late meter readings. That score receives a value of 0.000. As illustrate in Figure 59, the contractor's value on the y-axis exponentially decreases for every increase in percentage on the x-axis.

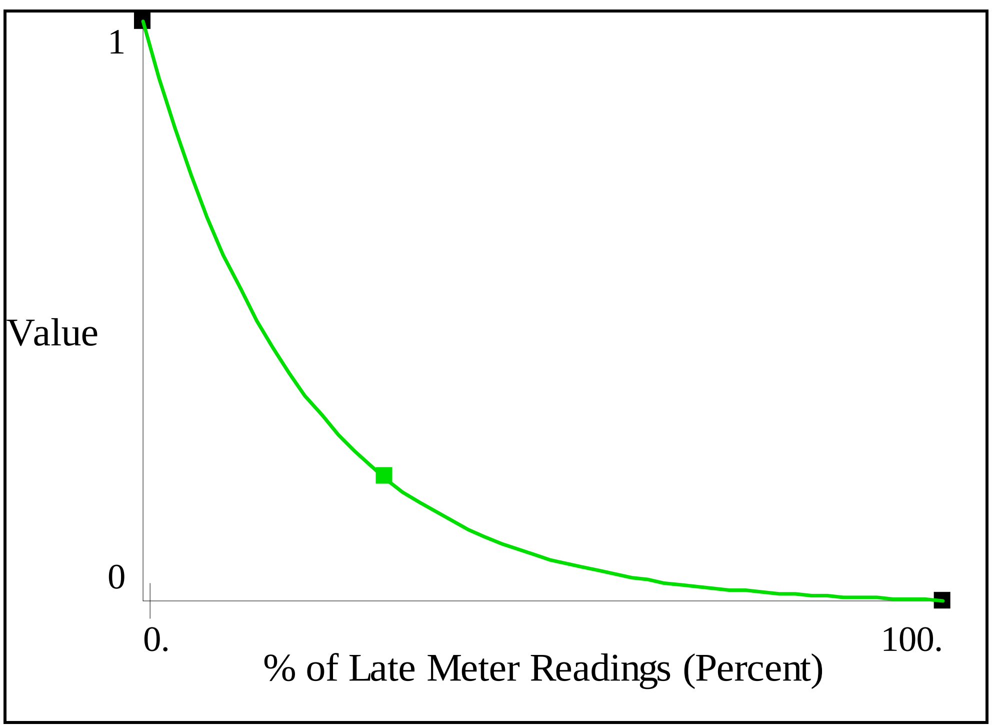

Figure 59. Percentage of Late Meter Readings SDVF

SDVF # 31—Is There an Adequate 24/7 Hotline

The SDVF for *Is There an Adequate 24/7 Hotline* is a discrete function which measures if a contractor has adequate hotline support for base personnel to call 24 hours a day, 7 days a week. The most preferred score is for a contractor has adequate hotline support for base personnel to call 24 hours a day, 7 days a week. This score receives a value of 1.000. The least preferred score is for a contractor that is unable to provide base personnel with adequate hotline support 24 hours a day, 7 days a week. That score receives a value of 0.000. *The Is There an Adequate 24/7 Hotline* SDVF is illustrated in Figure 60.

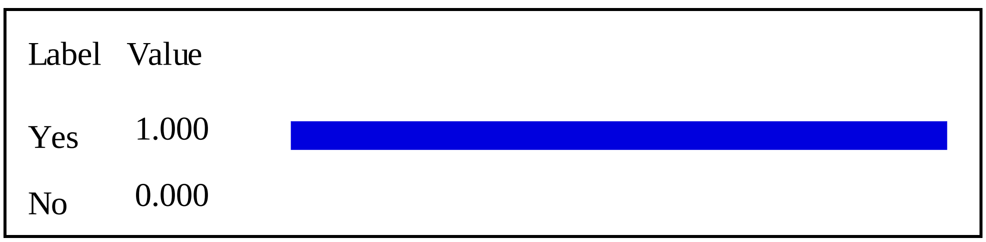

Figure 60. Is There an Adequate 24/7 Hotline SDVF

SDVF # 32—Percentage of Goal Met for Timely Initial Emergency Response

The SDVF for *Percentage of Goal Met for Timely Initial Emergency Response* is a monotonically increasing function that measures the percentage of time the contractor met the initial emergency response goal. The most preferred score is for a contractor that was able to have a representative on site to respond to every initial emergency response in a timely manner. This score receives a value of 1.000. The least preferred score is for a contractor that was unable to have a representative on site to respond to initial emergency responses in a timely manner. That score receives a value of 0.000. As illustrate in Figure 61, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

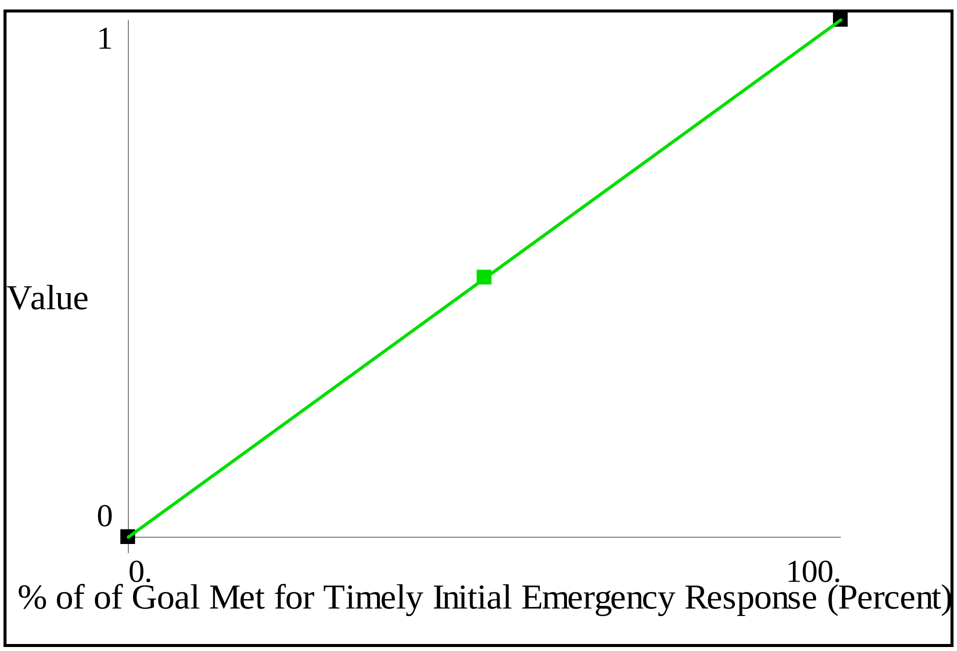

Figure 61. Percentage of Goal Met for Timely Initial Emergency Response SDVF

SDVF # 33—Percentage of Goal Met for Timely Emergency Crew Response

The SDVF for *Percentage of Goal Met for Timely Emergency Crew Response* is a monotonically increasing function that measures the percentage of time the contractor met the emergency crew response goal. The most preferred score is for a contractor whose crews were able to respond to all emergency responses in a timely manner. This score receives a value of 1.000. The least preferred score is for a contractor whose crews were unable to respond to emergency responses in a timely manner. That score receives a value of 0.000. As illustrate in Figure 62, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

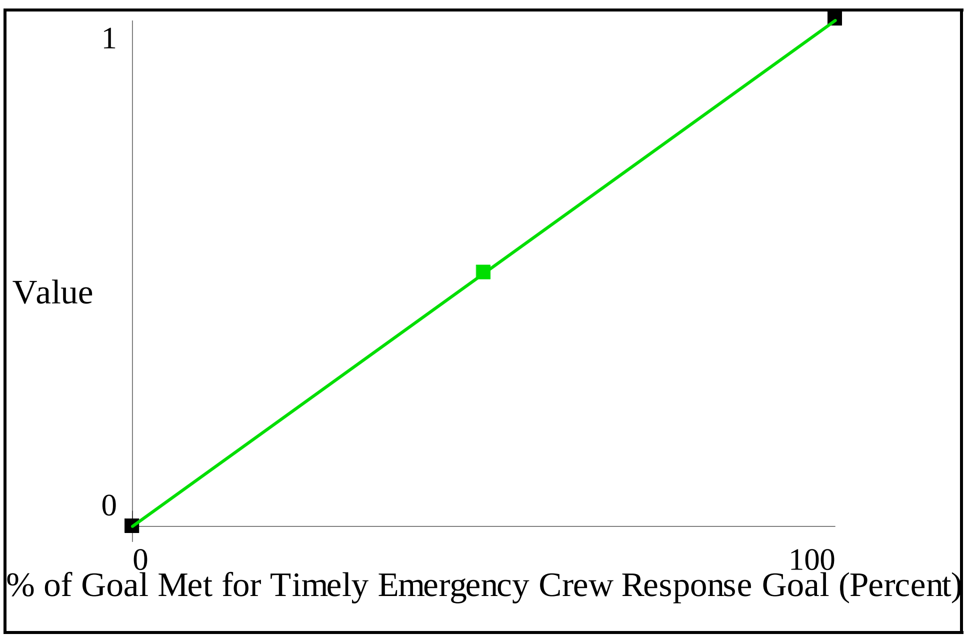

Figure 62. Percentage of Goal Met for Timely Emergency Crew Response SDVF

SDVF # 34—Percentage of Goal Met for Timely Remedied Emergency Response

The SDVF for *Percentage of Goal Met for Timely Remedied Emergency Response* is a monotonically increasing function that measures the percentage of time the contractor met the remedied emergency response goal. The most preferred score is for a contractor whose crews were able to remedy all emergency responses in a timely manner. This score receives a value of 1.000. The least preferred score is for a contractor whose crews were unable to remedy emergency responses in a timely manner. That score receives a value of 0.000. As illustrate in Figure 63, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

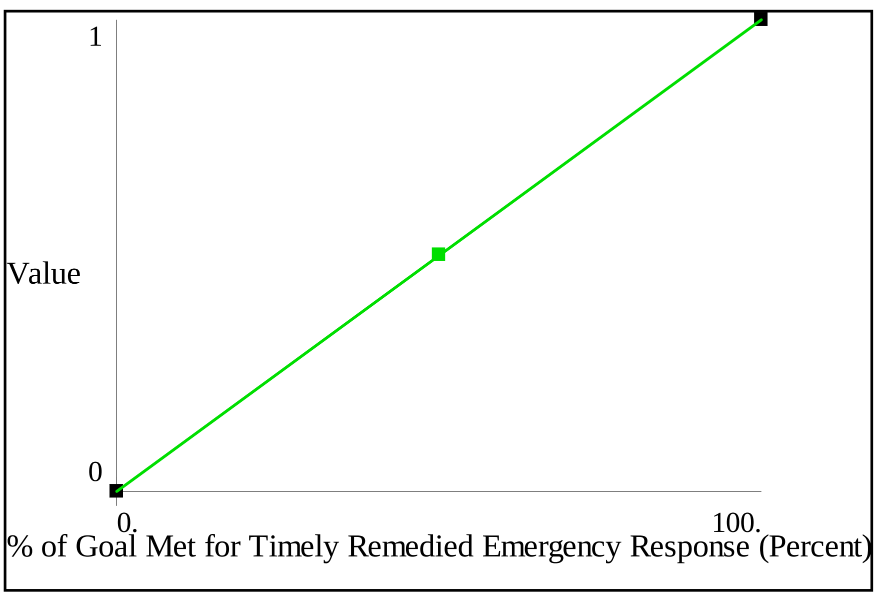

Figure 63. Percentage of Goal Met for Timely Remedied Emergency Response SDVF

SDVF # 35—Number of Outstanding Ratings for Exercises/Contingencies

The SDVF for *Number of Outstanding Ratings for Exercise/Contingencies* a monotonically increasing function that measures the number of outstanding ratings the contractor received for its responsiveness to installation exercises and contingencies. The most preferred score is for a contractor that received up to 20 outstanding ratings. This score receives a value of 1.000. The least preferred score is for a contractor that received no outstanding ratings. That score receives a value of 0.000. As illustrate in Figure 64, the contractor's value on the y-axis increases for every increase in the number of ratings on the x-axis.

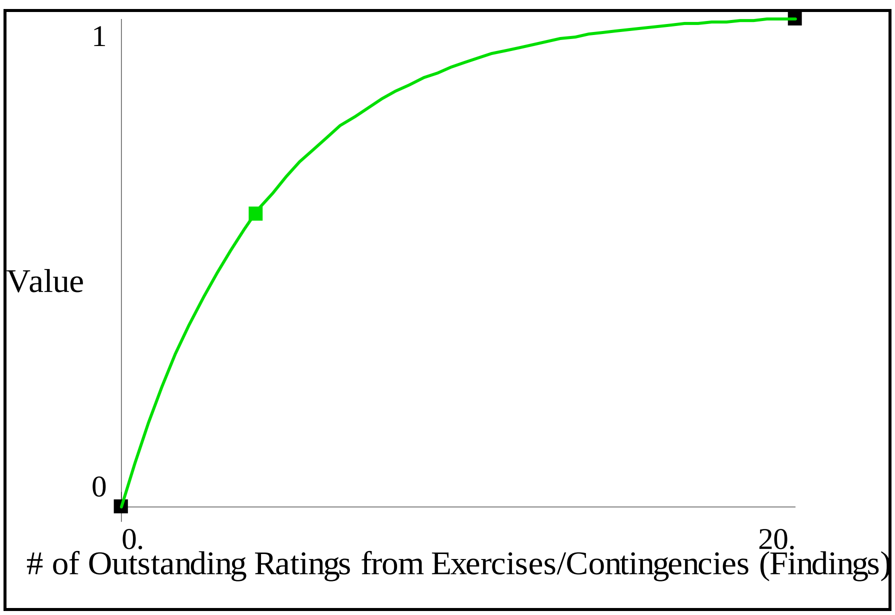

Figure 64. Number of Outstanding Ratings for Exercises/Contingencies SDVF

SDVF # 36—Number of Excellent Ratings from Exercises/Contingencies

The SDVF for *Number of Excellent Ratings for Exercise/Contingencies* a monotonically increasing function that measures the number of excellent ratings the contractor received for its responsiveness to installation exercises and contingencies. The most preferred score is for a contractor that received up to 20 excellent ratings. This score receives a value of 1.000. The least preferred score is for a contractor that received no excellent ratings. That score receives a value of 0.000. As illustrate in Figure 65, the contractor's value on the y-axis increases for every increase in the number of ratings on the x-axis.

Figure 65. Number of Excellent Ratings from Exercises/Contingencies SDVF

SDVF # 37—Number of Satisfactory Ratings from Exercises/Contingencies

The SDVF for *Number of Satisfactory Ratings for Exercise/Contingencies* a monotonically increasing function that measures the number of satisfactory ratings the contractor received for its responsiveness to installation exercises and contingencies. The most preferred score is for a contractor that received up to 20 satisfactory ratings. This score receives a value of 1.000. The least preferred score is for a contractor that received no satisfactory ratings. That score receives a value of 0.000. As illustrate in Figure 66, the contractor's value on the y-axis increases for every increase in the number of ratings on the x-axis.

Figure 66. Number of Excellent Ratings from Exercises/Contingencies SDVF

SDVF # 38—Number of Marginal Ratings from Exercises/Contingencies

The SDVF for *Number of Marginal Ratings from Exercises/Contingencies* is a monotonically decreasing function that measures the number of marginal ratings the contractor received for its responsiveness to installation exercises and contingencies. The most preferred score is for a contractor that received no marginal ratings. This score receives a value of 1.000. The least preferred score is for a contractor that received up to 20 marginal ratings. That score receives a value of 0.000. As illustrate in Figure 67, the contractor's value on the y-axis decreases for every increase in the number of ratings on the x-axis.

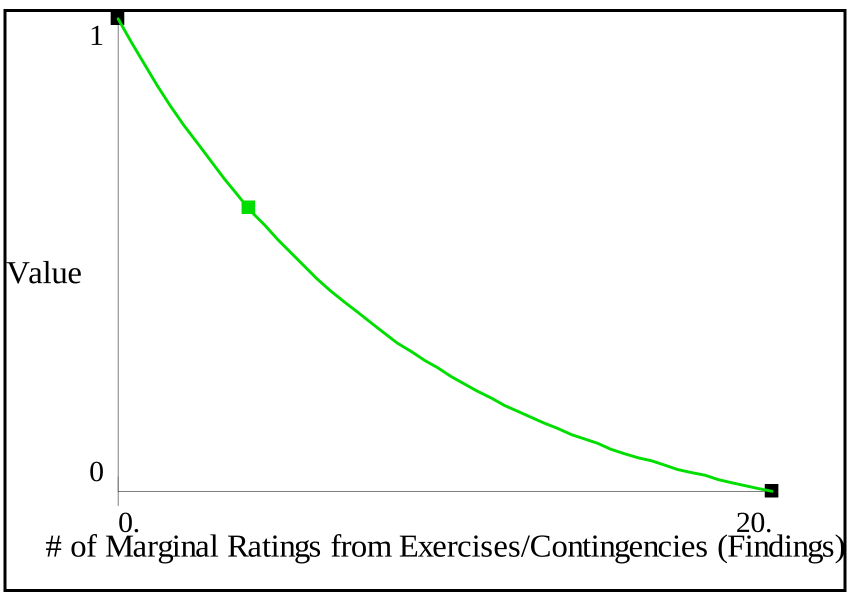

Figure 67. Number of Marginal Ratings from Exercises/Contingencies SDVF

SDVF # 39—Number of Unsatisfactory Ratings from Exercises/Contingencies

The SDVF for *Number of Unsatisfactory Ratings from Exercises/Contingencies* is a monotonically decreasing function that measures the number of unsatisfactory ratings the contractor received for its responsiveness to installation exercises and contingencies. The most preferred score is for a contractor that received no unsatisfactory ratings. This score receives a value of 1.000. The least preferred score is for a contractor that received up to 20 unsatisfactory ratings. That score receives a value of 0.000. As illustrate in Figure 68, the contractor's value on the y-axis decreases for every increase in the number of ratings on the x-axis.

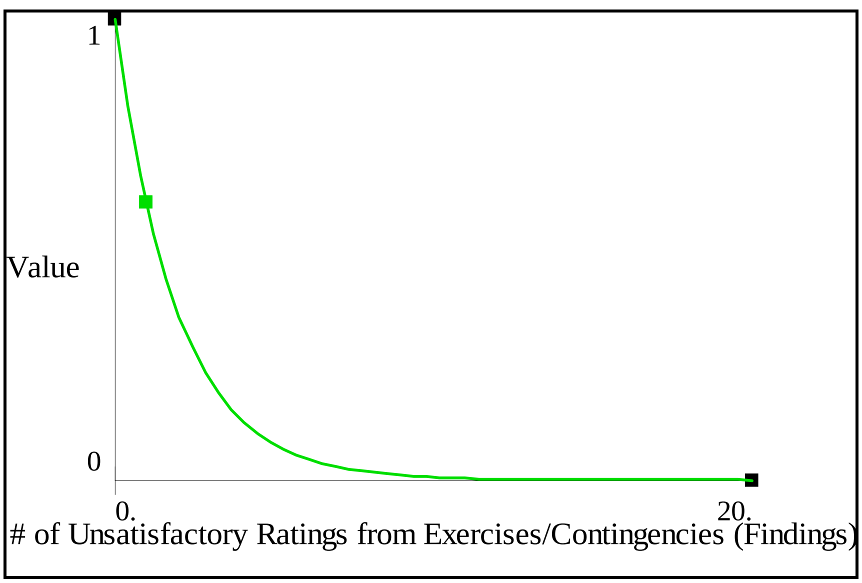

Figure 68. Number of Unsatisfactory Ratings from Exercises/Contingencies SDVF

SDVF # 40—Percentage of Goal Met for Effective FACMAN Emergency Coordination

The SDVF for *Percentage of Goal Met for Effective FACMAN Emergency Coordination* is a monotonically increasing function that measures the percentage of time the contractor met the FACMAN emergency coordination goal. The most preferred score is for a contractor that was able to coordinate every emergency response with the person responsible for the building or facility it affects. This score receives a value of 1.000. The least preferred score is for a contractor that was unable to coordinate emergency responses with the person responsible for the building or facility it affects. That score receives a value of 0.000. As illustrate in Figure 69, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

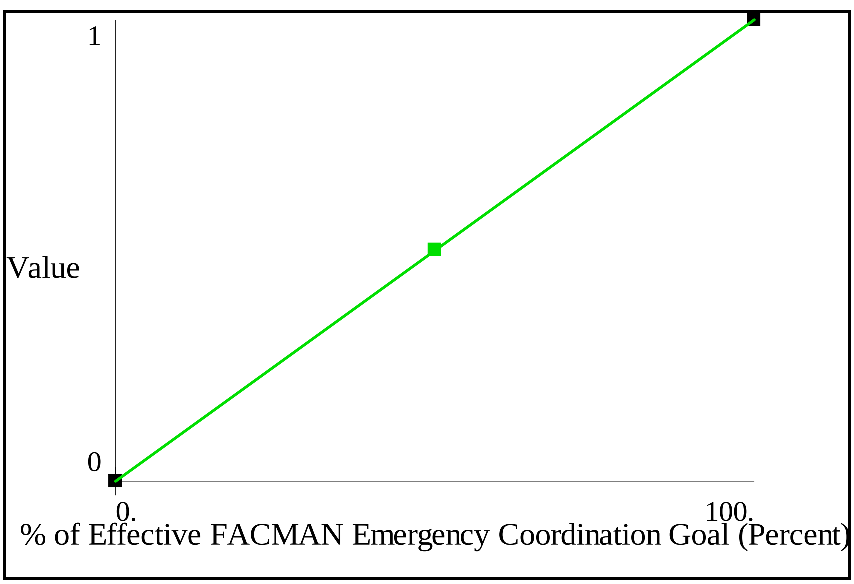

Figure 69. Percentage of Goal Met for Effective FACMAN Emergency Coordination SDVF

SDVF # 41—Percentage of Goal Met for Timely Initial Urgent Response

The SDVF for *Percentage of Goal Met for Timely Initial Urgent Response* is a monotonically increasing function that measures the percentage of time the contractor met the initial urgent response goal. The most preferred score is for a contractor that was able to have a representative on site to respond to every initial urgent response in a timely manner. This score receives a value of 1.000. The least preferred score is for a contractor that was unable to have a representative on site to respond to initial urgent responses in a timely manner. That score receives a value of 0.000. As illustrate in Figure 70, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

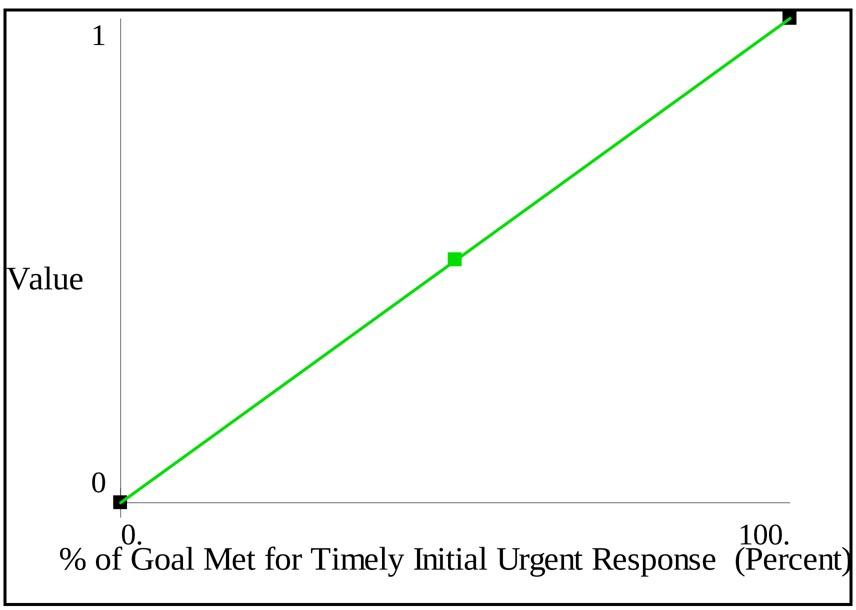

Figure 70. Percentage of Goal Met for Timely Initial Urgent Response SDVF

SDVF # 42—Percentage of Goal Met for Timely Remedied Urgent Response

The SDVF for *Percentage of Goal Met for Timely Remedied Urgent Response* is a monotonically increasing function that measures the percentage of time the contractor met the remedied urgent response goal. The most preferred score is for a contractor whose crews were able to remedy all urgent responses in a timely manner. This score receives a value of 1.000. The least preferred score is for a contractor whose crews were unable to remedy urgent responses in a timely manner. That score receives a value of 0.000. As illustrate in Figure 71, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

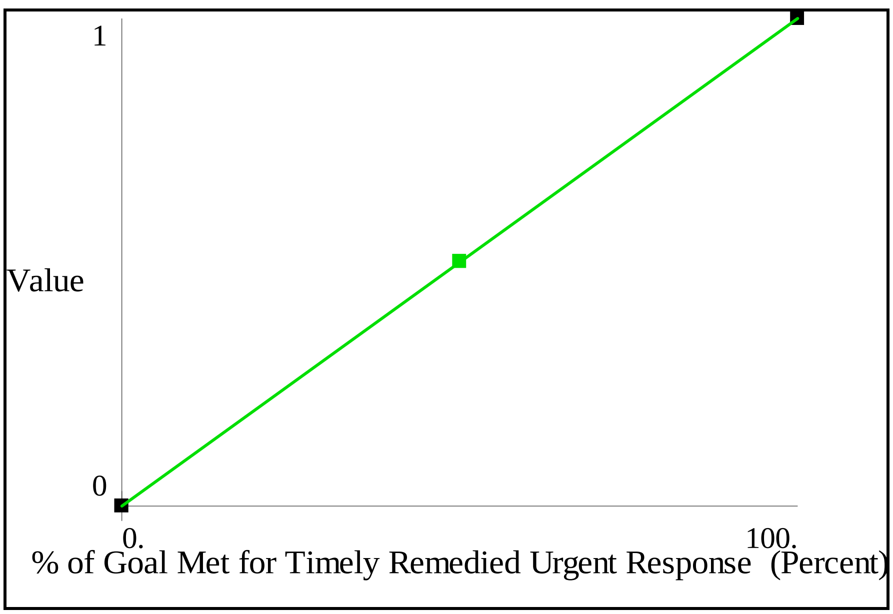

Figure 71. Percentage of Goal Met for Timely Remedied Urgent Response SDVF

SDVF # 43—Percentage of Goal Met for Effective FACMAN Urgent Coordination

The SDVF for *Percentage of Goal Met for Effective FACMAN Urgent Coordination* is a monotonically increasing function that measures the percentage of time the contractor met the FACMAN urgent coordination goal. The most preferred score is for a contractor that was able to coordinate every urgent response with the person responsible for the building or facility it affects. This score receives a value of 1.000. The least preferred score is for a contractor that was unable to coordinate urgent responses with the person responsible for the building or facility it affects. That score receives a value of 0.000. As illustrate in Figure 72, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

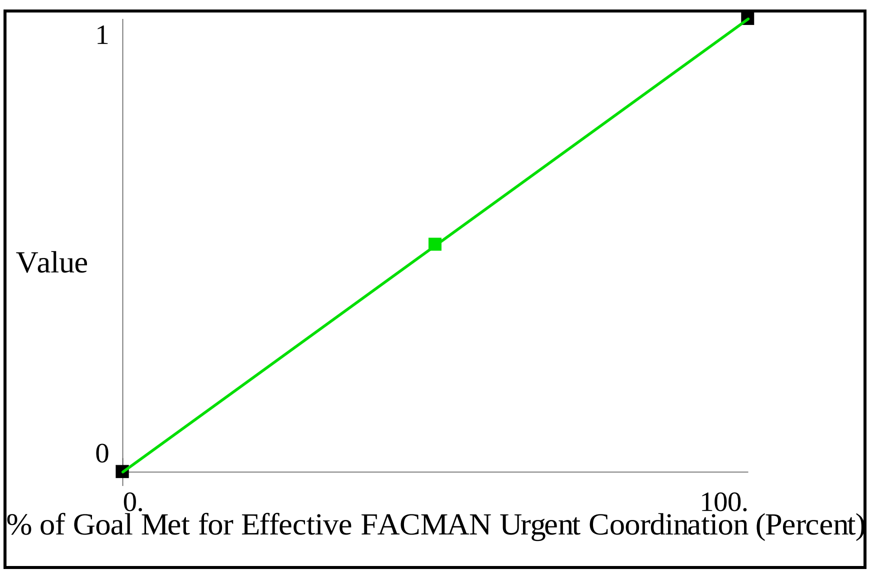

Figure 72. Percentage of Goal Met for Effective FACMAN Urgent Coordination SDVF

SDVF # 44—Percentage of Goal Met for Timely Initial Routine Response

The SDVF for *Percentage of Goal Met for Timely Initial Routine Response* is a monotonically increasing function that measures the percentage of time the contractor met the initial routine response goal. The most preferred score is for a contractor that was able to have a representative on site to respond to every initial routine response in a timely manner. This score receives a value of 1.000. The least preferred score is for a contractor that was unable to have a representative on site to respond to initial routine responses in a timely manner. That score receives a value of 0.000. As illustrate in Figure 73, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

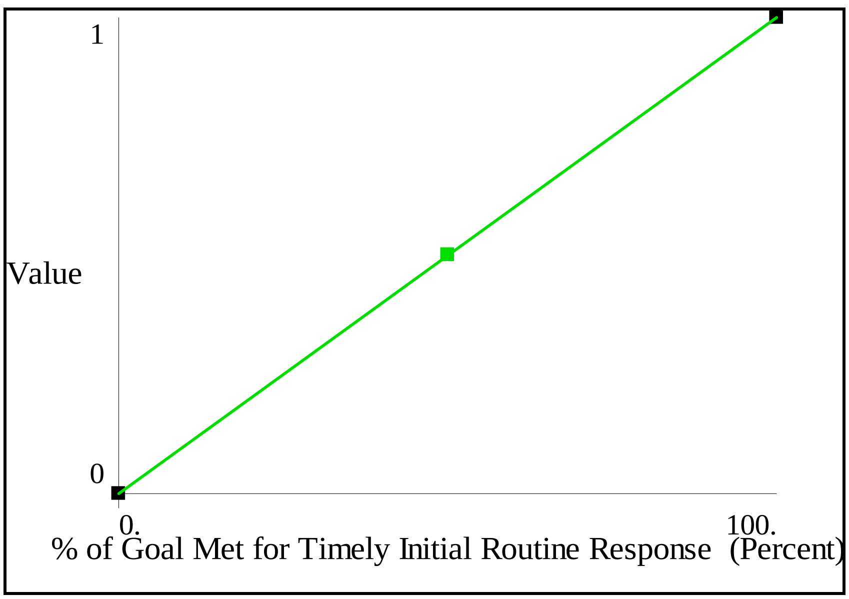

Figure 73. Percentage of Goal Met for Timely Initial Routine Response SDVF

SDVF # 45—Percentage of Goal Met for Timely Remedied Routine Response

The SDVF for *Percentage of Goal Met for Timely Remedied Routine Response* is a monotonically increasing function that measures the percentage of time the contractor met the remedied routine response goal. The most preferred score is for a contractor whose crews were able to remedy all routine responses in a timely manner. This score receives a value of 1.000. The least preferred score is for a contractor whose crews were unable to remedy routine responses in a timely manner. That score receives a value of 0.000. As illustrate in Figure 74, the contractor's value on the y-axis exponentially increases for every increase in percentage on the x-axis.

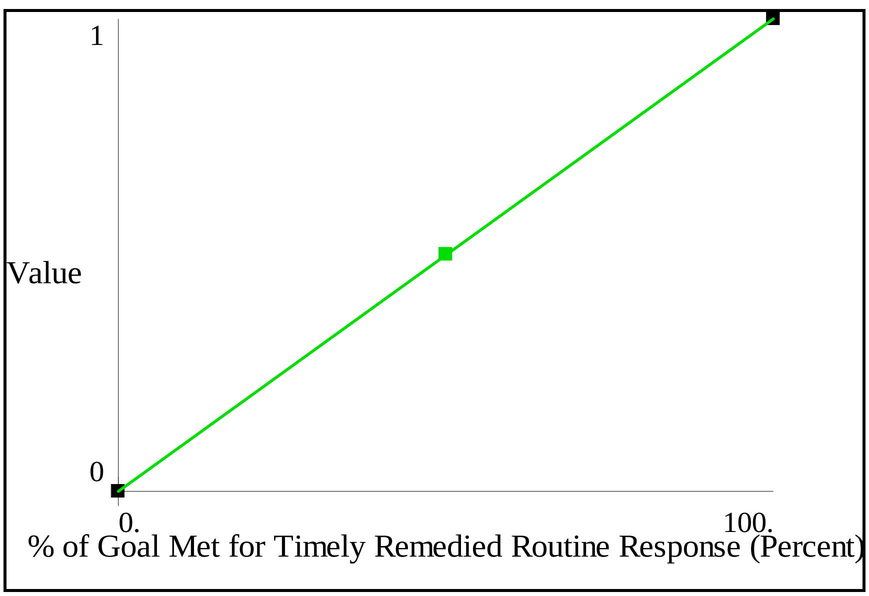

Figure 74. Percentage of Goal Met for Timely Remedied Routine Response SDVF

SDVF # 46—Percentage of Goal Met for Effective 2-Week Coordination

The SDVF for *Percentage of Goal Met for Effective 2-Week Coordination* is a monotonically increasing function that measures the percentage of time the contractor met the two-week coordination goal. The most preferred score is for a contractor to coordinate with a contracting office representative at least two weeks in advance for every routine response. This score receives a value of 1.000. The least preferred score is for a contractor to not coordinate with a contracting office representative at least two weeks in advance for any routine response. That score receives a value of 0.000. As illustrate in Figure 75, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

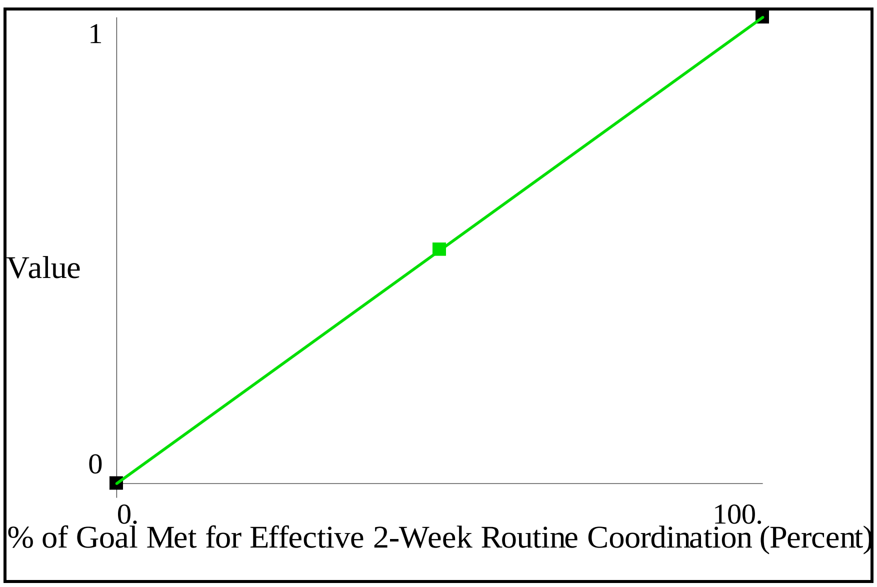

Figure 75. Percentage of Goal Met for Effective 2-Week Coordination SDVF

SDVF # 47—Percentage of Goal Met for Effective FACMAN Routine Coordination

The SDVF for *Percentage of Goal Met for Effective FACMAN Routine Coordination* is a monotonically increasing function that measures the percentage of time the contractor met the FACMAN routine coordination goal. The most preferred score is for a contractor that was able to coordinate every routine response with the person responsible for the building or facility it affects. This score receives a value of 1.000. The least preferred score is for a contractor that was unable to coordinate routine responses with the person responsible for the building or facility it affects. That score receives a value of 0.000. As illustrate in Figure 76, the contractor's value on the y-axis increases for every increase in percentage on the x-axis.

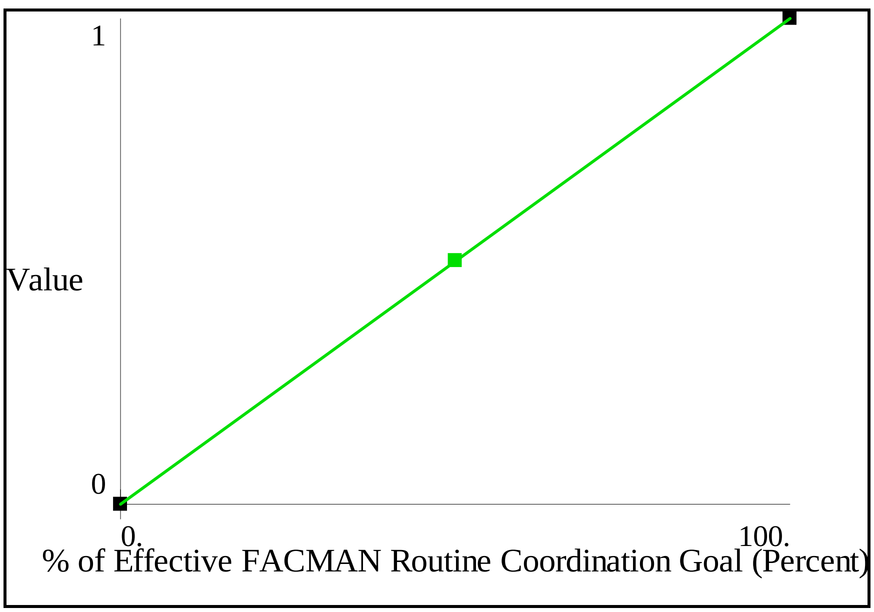

Figure 76. Percentage of Goal Met for Effective FACMAN Routine Coordination SDVF

Appendix D. Global Weights for Utility Privatization Evaluation Hierarchy

1st-Tier Values	2nd-Tier Values	3rd-Tier Values or Measures	4th-Tier Values or Measures	5th-Tier Values or Measures	Global Weights	Measure #
Quality	Effective Administration	Maintaining Proper Licenses, Permits, & Certification	% of Up-to-Date Licenses, Permits, and Certifications		0.016	1
		Maintaining Service Records for 2 Years	Are Records for the Past 2 Years Maintained Properly?		0.014	2
		Maintaining and Updating Drawings	Average # of Days to Update Drawings		0.016	3
	Environmental Compliance	Effective Spill Contingency Plan	# of Positive Findings for Spill Contingency Plan		0.005	4
			# of Minor Findings for Spill Contingency Plan		0.005	5
			# of Major Findings for Spill Contingency Plan		0.005	6
			# of Significant Findings for Spill Contingency Plan		0.005	7

1st-Tier Values	2nd-Tier Values	3rd-Tier Values or Measures	4th-Tier Values or Measures	5th-Tier Values or Measures	Global Weights	Measure #
Quality	Environmental Compliance	Hazmat/Hazwaste Minimization and Recycling	% of Liquid Waste Diverted from Landfill		0.008	8
			% of Solid Waste Diverted from Landfill		0.008	9
			# of Positive Findings for Recycling Program		0.003	10
			# of Minor Findings for Recycling Program		0.003	11
			# of Major Findings for Recycling Program		0.003	12
			# of Significant Findings for Recycling Program		0.003	13
	Safety	Compliance with Utility System Laws/Regulations	# of Lost Man-Hours Due to Utility System Mishaps		0.019	14

1st-Tier Values	2nd-Tier Values	3rd-Tier Values or Measures	4th-Tier Values or Measures	5th-Tier Values or Measures	Global Weights	Measure #
Quality	Safety	Compliance with Utility System Laws/Regulations	# of Utility System Mishaps		0.019	15
		Decreased Utility System Mishaps	# of RAC 1 -- Catastrophic Violations		0.009	16
			# of RAC 2 -- Critical Violation		0.006	17
			# of RAC 3 -- Moderate Violations		0.003	18
			# of RAC 4 -- Negligible Violations		0.001	19
		Safety/Employee Certification	% of Employees Completing all Requirements		0.019	20
	Sub-Metering Capability	% of Meters Calibrated from Random Sample			0.015	21
		% of Total Facilities Metered			0.015	22

1st-Tier Values	**2nd-Tier Values**	**3rd-Tier Values or Measures**	**4th-Tier Values or Measures**	**5th-Tier Values or Measures**	**Global Weights**	**Measure #**
Quality	Utility System Security	# of Employees Identified as Potential Threats			0.053	23
		Are all Employee Security Clearances Up-to-Date?			0.053	24
Reliability	Completed Renewals/Replacements	% of Items Actually Replaced			0.140	25
	Decreased Utility System Outages	% of Critical Utility System Outages caused by System Management			0.105	26
		% of Non-Critical Utility System Outages caused by System Management			0.105	27
	Effective Digging Permits/Line Marking Program	# of Utility Line Hits			0.035	28

1st-Tier Values	2nd-Tier Values	3rd-Tier Values or Measures	4th-Tier Values or Measures	5th-Tier Values or Measures	Global Weights	Measure #
Response	High Contracting Meeting Attendance	% of Meetings Attended			0.035	29
	Timely Meter Reading	% of Time Meter Readings were Late			0.035	30
	Timely Service Response	Timely Emergency Service Response	Adequate 24/7 Hotline	Is There an Adequate 24/7 Hotline?	0.012	31
			Timely Initial Emergency Response	% of Goal Met for Timely Initial Emergency Response	0.025	32
			Timely Emergency Crew Response	% of Goal Met for Timely Emergency Crew Response	0.025	33
			Timely Remedied Emergency Response	% of Goal Met for Timely Remedied Emergency Response	0.025	34

1st-Tier Values	2nd-Tier Values	3rd-Tier Values or Measures	4th-Tier Values or Measures	5th-Tier Values or Measures	Global Weights	Measure #
Response	Timely Service Response	Timely Emergency Service Response	Timely Response to Exercises/Contingencies	# of Outstanding Ratings from Exercises/Contingencies	0.005	35
				# of Excellent Ratings from Exercises/Contingencies	0.005	36
				# of Satisfactory Ratings from Exercises/Contingencies	0.005	37
				# of Marginal Ratings from Exercises/Contingencies	0.005	38
				# of Unsatisfactory Ratings from Exercises/Contingencies	0.005	39

1st-Tier Values	2nd-Tier Values	3rd-Tier Values or Measures	4th-Tier Values or Measures	5th-Tier Values or Measures	Global Weights	Measure #
Response	Timely Service Response	Timely Emergency Service Response	Effective FACMAN Emergency Coordination	% of Goal Met for Effective FACMAN Emergency Coordination	0.012	40
		Timely Urgent Service Response	Timely Initial Urgent Response	% of Goal Met for Timely Initial Urgent Response	0.029	41
			Timely Remedied Urgent Response	% of Goal Met for Timely Remedied Urgent Response	0.029	42
			Effective FACMAN Urgent Coordination	% of Goal Met for Effective FACMAN Urgent Coordination	0.015	43
		Timely Routine Service Response	Timely Initial Routine Response	% of Goal Met for Timely Initial Routine Response	0.015	44
			Timely Remedied Routine Response	% of Goal Met for Timely Remedied Routine Response	0.015	45

1st-Tier Values	2nd-Tier Values	3rd-Tier Values or Measures	4th-Tier Values or Measures	5th-Tier Values or Measures	Global Weights	Measure #
Response	Timely Service Response	Timely Routine Service Response	Effective 2-Week Coordination	% of Goal Met for Effective 2-Week Coordination	0.010	46
			Effective FACMAN Routine Coordination	% of Goal Met for Effective FACMAN Routine Coordination	0.010	47

Appendix E. Ranked Ordered Global Weights

Measure	Global Weight
% of Items Actually Replaced	0.140
% of Critical Outages Caused by System Management	0.105
% of Non-Critical Outages Caused by System Management	0.105
# of Employees Identified as Potential Threats	0.052
Are all Employee Security Clearances Up-to-Date?	0.052
% of Late Meter Readings	0.035
# of Utility Line Hits	0.035
% of Meetings Attended	0.035
% of Goal Met for Timely Initial Urgent Response	0.029
% of Goal Met for Timely Remedied Urgent Response	0.029
% of Goal Met for Timely Initial Emergency Response	0.025
% of Goal Met for Timely Emergency Response	0.025
% of Goal Met for Timely Remedied Emergency Response	0.025
% of Employees Completing all Requirements	0.019
# of Utility System Mishaps	0.019
# of Lost Man-Hours Due to Utility System Mishaps	0.019
Percentage of Up-to-Date Licenses, Permits, and Certifications	0.016
Average # of Days to Update	0.016
% of Meters Calibrated from Random Sample	0.015
% of Total Facilities Metered	0.015
% of Goal Met for Timely Initial Routine Response	0.015
% of Goal Met for Timely Remedied Routine Response	0.015
% of Goal Met for Effective FACMAN Urgent Coordination	0.015
Are Records for the Past 2 Years Properly Maintained?	0.014
% of Effective FACMAN Emergency Coordination Goal	0.012
Is There an Adequate 24/7 Hotline?	0.012
% of Goal Met for Effective 2-Week Routine Coordination	0.010
% of Effective FACMAN Routine Coordination Goal	0.010
# of RAC 1 -- Catastrophic Violations	0.009
% of Liquid Waste Diverted from Landfills	0.008

Measure	Global Weight
% of Solid Waste Diverted from Landfills	0.008
# of RAC 2 -- Critical Violations	0.006
# of Outstanding Ratings from Exercises/Contingencies	0.005
# of Excellent Ratings from Exercise/Contingencies	0.005
# of Satisfactory Ratings from Exercises/Contingencies	0.005
# of Marginal Ratings from Exercises/Contingencies	0.005
# of Unsatisfactory Ratings from Exercises/Contingencies	0.005
# of Positive Findings from Spill Contingency Plan	0.005
# of Significant Findings from Spill Contingency Plan	0.005
# of Minor Findings from Spill Contingency Plan	0.005
# of Major Findings from Spill Contingency Plan	0.005
# of RAC 3 -- Moderate Violations	0.003
# of Positive Findings for Recycling Program	0.003
# of Significant Findings for Recycling Program	0.003
# of Minor Findings for Recycling Program	0.003
# of Major Findings for Recycling Program	0.003
# of RAC 4 -- Negligible Violations	0.001

Appendix F. Notional Data Scoring Results

Branch	Measure #	Measure Title	Base 1	Base 2	Base 3	Base 4	Base 5	Base 6	Base 7	Base 8
Quality	1	% of Up-to-Date Licenses, Permits, and Certifications	98%	98%	99%	82%	86%	67%	89%	100%
	2	Are Records for the Past 2 Years Maintained Properly?	No	Yes	No	Yes	Yes	No	Yes	Yes
	3	Average # of Days to Update Drawings	72	74	76	64	79	69	57	61
	4	# of Positive Findings for Spill Contingency Plan	13	11	3	6	12	1	14	13
	5	# of Minor Findings for Spill Contingency Plan	19	13	11	16	18	12	0	13
	6	# of Major Findings for Spill Contingency Plan	14	2	12	19	0	16	0	0
	7	# of Significant Findings for Spill Contingency Plan	14	3	12	9	11	18	0	8
	8	% of Liquid Waste Diverted from Landfill	93%	100%	79%	93%	83%	84%	100%	91%

Branch	Measure #	Measure Title	Base 1	Base 2	Base 3	Base 4	Base 5	Base 6	Base 7	Base 8
Quality	9	% of Solid Waste Diverted from Landfill	63%	99%	92%	87%	78%	90%	100%	89%
	10	# of Positive Findings for Recycling Program	14	14	2	8	13	19	20	15
	11	# of Minor Findings for Recycling Program	14	6	17	2	12	5	0	11
	12	# of Major Findings for Recycling Program	8	0	16	4	17	18	0	13
	13	# of Significant Findings for Recycling Program	7	19	13	1	10	10	2	2
	14	# of Lost Man-Hours Due to Utility System Mishaps	46	13	12	11	21	85	20	15
	15	# of Utility System Mishaps	8	1	9	3	3	7	1	12
	16	# of RAC 1 -- Catastrophic Violations	5	8	0	8	5	7	0	2
	17	# of RAC 2 -- Critical Violation	9	9	4	8	4	9	0	3
	18	# of RAC 3 -- Moderate Violations	8	5	8	3	3	8	0	3

Branch	Measure #	Measure Title	Base 1	Base 2	Base 3	Base 4	Base 5	Base 6	Base 7	Base 8
Quality	19	# of RAC 4 -- Negligible Violations	1	9	0	3	8	7	0	7
	20	% of Employees Completing all Requirements	77%	73%	71%	80%	68%	64%	89%	100%
	21	% of Meters Calibrated from Random Sample	63%	97%	79%	81%	82%	97%	65%	0%
	22	% of Total Facilities Metered	63%	65%	69%	75%	86%	85%	60%	87%
	23	# of Employees Identified as Potential Threats	4	1	5	3	0	1	0	0
	24	Are all Employee Security Clearances Up-to-Date?	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Reliability	25	% of Items Actually Replaced	65%	72%	70%	89%	95%	77%	100%	78%
	26	% of Critical Utility System Outages caused by System Management	5%	4%	37%	11%	4%	45%	0%	15%

Branch	Measure #	Measure Title	Base 1	Base 2	Base 3	Base 4	Base 5	Base 6	Base 7	Base 8
Reliability	27	% of Non-Critical Utility System Outages caused by System Management	49%	8%	46%	22%	2%	44%	0%	20%
Responsiveness	28	# of Utility Line Hits	15	0	11	16	3	7	0	2
	29	% of Meetings Attended	63%	100%	89%	91%	92%	40%	100%	100%
	30	% of Time Meter Readings were Late	6%	97%	81%	77%	97%	12%	0%	100%
	31	Is There an Adequate 24/7 Hotline?	Yes	Yes	No	Yes	Yes	No	Yes	Yes
	32	% of Goal Met for Timely Initial Emergency Response	74%	69%	95%	63%	93%	78%	100%	94%
	33	% of Goal Met for Timely Emergency Crew Response	86%	81%	87%	65%	99%	89%	100%	99%
	34	% of Goal Met for Timely Remedied Emergency Response	96%	96%	85%	82%	100%	67%	100%	100%
	35	# of Outstanding Ratings from Exercises/Contingencies	20	19	9	18	5	7	23	19

Branch	Measure #	Measure Title	Base 1	Base 2	Base 3	Base 4	Base 5	Base 6	Base 7	Base 8
Responsiveness	36	# of Excellent Ratings from Exercises/Contingencies	2	19	10	19	5	14	20	20
	37	# of Satisfactory Ratings from Exercises/Contingencies	8	18	2	14	4	5	20	15
	38	# of Marginal Ratings from Exercises/Contingencies	13	9	5	15	3	11	0	2
	39	# of Unsatisfactory Ratings from Exercises/Contingencies	8	18	2	14	0	5	0	0
	40	% of Goal Met for Effective FACMAN Emergency Coordination	80%	93%	79%	83%	100%	66%	100%	100%
	41	% of Goal Met for Timely Initial Urgent Response	73%	91%	100%	77%	92%	61%	100%	94%

Branch	Measure #	Measure Title	Base 1	Base 2	Base 3	Base 4	Base 5	Base 6	Base 7	Base 8
Responsiveness	44	% of Goal Met for Timely Initial Routine Response	67%	96%	81%	86%	95%	54%	100%	96%
	42	% of Goal Met for Timely Remedied Urgent Response	65%	94%	96%	72%	94%	51%	100%	95%
	43	% of Goal Met for Effective FACMAN Urgent Coordination	76%	91%	100%	77%	92%	61%	100%	94%
	45	% of Goal Met for Timely Remedied Routine Response	65%	95%	79%	73%	94%	70%	100%	96%
	46	% of Goal Met for Effective 2-Week Coordination	85%	100%	71%	97%	91%	70%	100%	94%
	47	% of Goal Met for Effective FACMAN Routine Coordination	61%	90%	96%	64%	100%	52%	100%	100%

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Vita

Captain Carlos Braziel graduated from Benjamin O. Davis Aerospace Jr. Vocational Technical High School Center in Detroit, MI. He enlisted in the United States Air Force in September 1989. After basic training, he was assigned to Clark AB, Republic of the Philippines from February 1990 through May 1991, where he served in the 3rd Civil Engineering Squadron as an exterior power line specialist. In July 1992, he served as an exterior electrician in the 366th Civil Engineering Squadron, Mountain Home AFB, ID. From September 1992 through July 1997, he served as an electrical power line craftsman and alarms technician at the 35th Civil Engineering Squadron at Misawa AB, Japan. In August 1997, he served as an electrical systems training instructor at the 82nd Training Wing, Sheppard AFB, TX. In May 1999, he graduated with a Bachelor of Science degree in Occupational Education/Computer Science from Wayland Baptist University at Wichita Falls, TX. He was commissioned through the Officer Training School at Maxwell Air Force Base, AL in August 1999.

In September 1999, he was assigned to the 12th Transportation Squadron at Randolph AFB, TX, where he served as the Combat Readiness, Training and Resources Flight Commander. In May 2000, he was reassigned to the 12th Civil Engineer Squadron where he served as an environmental officer and the base deputy maintenance engineer.

In August of 2002 he entered the Graduate School of Engineering and Management, Air Force Institute of Technology, Wright-Patterson AFB, OH. Upon graduation, Captain Braziel will join the Headquarters Air Force Materiel Command Civil Engineer's Staff at Wright-Patterson Air Force Base, OH.

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USING VALUE-FOCUSED THINKING TO EVALUATE THE EFFECTIVENESS OF AIR FORCE UTILITY PRIVATIZATION

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14. ABSTRACT

The majority of the Air Force's stateside utility systems are old, obsolete, and unreliable. The cost to upgrade and repair these systems is currently estimated at over $4 billion. In response, the Air Force began efforts to convey ownership of these utility systems to the private sector through privatization efforts. However, privatization critics believe that newly privatized entities of government will cost the public more money and provide a lower level of service. Therefore, independent audits are a necessity to ensure government initiatives, meet their intended goals. However, the Air Force currently lacks an effective auditing tool to ensure the efficiency and lower cost associated with utility privatization are balanced with the desired increases in quality, reliability, and responsiveness of its utility systems.

The Value-Focused Thinking methodology was used to create a multi-objective decision analysis model to determine the effectiveness of Air Force utility privatization efforts by evaluating the performance of privatized utility systems. Consisting of 28 bottom tier values and 47 measures, the model captures the majority of the Air Force's objectives and concerns regarding its privatized utility systems. Using notational data, the utility systems at eight simulated Air Force installations were evaluated and rank ordered to validate the model. Sensitivity analysis was also performed to provide further insight into the decision making process. The results of this research prove that the model can be an effective decision analysis tool that provides the Air Force insight on the performance of its privatized utility systems.

15. SUBJECT TERMS

Decision Analysis, Value-Focused Thinking, VFT, Privatization, utility system evaluation

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