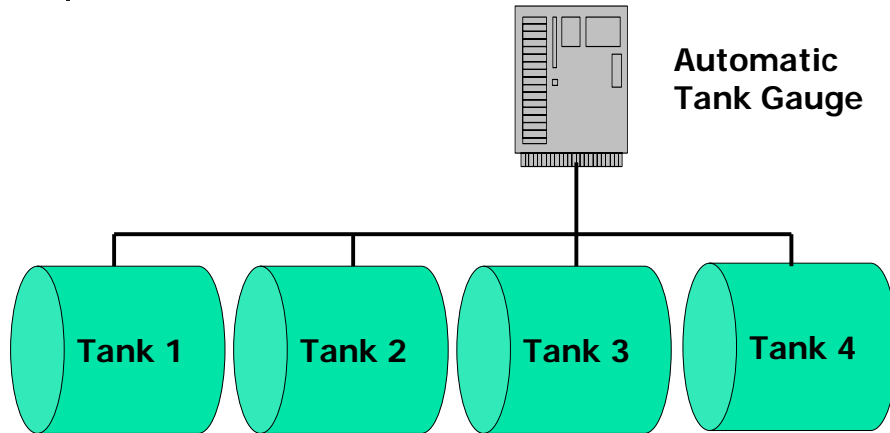




## Design of a UST Management System

---



Joshua Holtgrewe

MAESC 2005

## DESIGN OF A REPLACEMENT UST MANAGEMENT SYSTEM FOR MLGW

### Abstract

Underground storage tanks, (USTs) contain diesel and gasoline, which must be constantly monitored as required by the regulations of the Tennessee Department of Environment and Conservation (TDEC). Automatic tank gauges (ATGs), which are able to track the tank's inventory and detect leaks in the tank, monitor these tanks. The results of the ATG tests are printed daily in the form of paper receipts that must be collected by employees at each of the eleven sites. The compliance manager then collects these receipts. Without proper communication among employees, the collection of receipts can be overlooked. In addition, there are problematic factors associated with the current UST management system, which make it very difficult to ensure regulatory compliance, and it is necessary to improve the existing system.

Memphis Light, Gas and Water serves Shelby County, Tennessee with 11 service depots that include twenty USTs. With the system approaching the end of its life cycle and the problems associated with maintaining compliance, it is imperative that upgrades be considered. This paper addresses these concerns and contains three components: analysis of current equipment and operations associated with the MLGW UST management system, which includes twenty USTs monitored by 11 ATGs; analysis of all viable alternatives, with a special emphasis on the environmental and economic impacts; and finally a pilot design that automates recording procedures by providing vital product information through MLGW's intranet in real time. The project will examine commercially available ATGs, especially the communication features of the devices that allow each site to communicate with a central location. The pilot design, when implemented, will demonstrate that the selected plan meets system constraints and will guide designers in determining problems not anticipated before implementation.

## Table of Contents

Abstract	ii
Table of Contents	iii
1. Introduction to the UST Management System	1
1.1 Memphis Light, Gas and Water	1
1.2 UST Management System	1
1.3 Technical Aspects of ATGs	3
1.4 Difficulties with Current UST Management System	4
2. Alternatives to the Current UST Management System	5
2.1 Goals and Constraints for Alternatives to UST Management System	5
2.2 Alternative A	6
2.3 Alternative B	7
2.4 Comparison of Alternatives	9
2.5 Economic Benefits Analysis	9
3. Pilot Design	10
3.1 Recommendation	10
3.2 Communication Equipment	11
3.3 Present Worth Analysis	12
3.4 Pilot Design	13
4. Conclusion	15
5. Appendices	16
6. Sources and References	19
6.1 Sources	19
6.2 References	19

## List of Figures

Figure 1 – Map of Site Locations in Shelby County, TN	1
Figure 2 – The ATG	3
Figure 3 – Tank Cross Section	4
Figure 4 – Block Diagram of Pilot Design	14

## List of Tables

Table 1 – Comparison of Alternative A to Alternative B	9
Table 2 – Alternative A Cost Analysis	9
Table 3 – Alternative B Cost Analysis	10
Table 4 – Traditional Networking Cost Analysis	11
Table 5 – Wireless Networking Cost Analysis	12
Table 6 – Present Worth Analysis based on Various MARRs	13

## List of Appendices

Appendix A – List of Sites	16
Appendix B – Typical Site Plan with ATG and Tanks	17
Appendix C – Guides for UST Monitoring from TDEC	18

# 1. Introduction to the UST Management System

## 1.1 Memphis Light, Gas and Water

Memphis Light, Gas and Water (MLGW), the largest three-service municipal utility company in the United States, was founded in 1939. A team of more than 2,600 employees works to achieve its vision in the competitive 21st century. More importantly, MLGW is concerned with providing quality, personalized utility service. The Tennessee Valley Authority (TVA) is a federal agency that sells electricity on a nonprofit basis to 159 distributors. MLGW is TVA's largest distributor, purchasing approximately 11 percent of TVA's power. MLGW serves more than 400,000 electric customers in Memphis and Shelby County and has a strong electric reliability ratio of two outages per 100 miles per year [1].

## 1.2 UST Management System

The Memphis Light, Gas, and Water UST Management System is made up of twenty USTs in 11 locations throughout Shelby County, Tennessee. Each location contains an automatic tank gauge that can monitor up to eight tanks. With these ATGs, MLGW is able to monitor any leaks within the tank, while maintaining inventory levels on gasoline and diesel fuel levels that are used in their trucks and equipment that help to ensure MLGW's reliability rating. Figure 1 is a map of Shelby County (approximately 800 square miles), in which a star denotes the locations of the fueling facilities.



Figure 1-Map of Site Locations in Shelby County, TN

The ATGs examined in the project contain several common features. These features include the ability to detect a leak in a tank. A leak has economic and environmental impacts; and for this reason, leak detection is available on all of the various models of the ATGs. The ATGs allow a line leak test on any of the tanks being monitored. Another common feature is the ability to change the frequency with which the tank is monitored. Monitoring procedures can run as often as every day, or if desired, weekly, monthly, or annually. They can also be programmed to run on a specific date. Each location within the UST Management System runs a daily test. These tests are automatically performed at 6:00 AM each day. A complete list of the sites is found in Appendix A.

Another important feature of these automatic tank gauges is their ability to measure ullage, which is an industry term for the volume of vacant container space. These readings are vital to the management of MLGW's operations throughout Shelby County. Each tank at every location is individually monitored to determine its inventory on a daily basis. This allows the MLGW purchasing agents to order the fuel needed at each location before the fuel in the tanks is depleted. The only tests being utilized currently by the various automatic tank gauges are inventory control and line leak detection. Line leak detection includes a liquid sensor that can detect the presence of liquid in a tank's interstitial space or piping sumps, a vapor sensor that can detect fuel vapor levels that may exceed pump specifications, and a groundwater sensor that can detect water within a tank. A complete listing of the sites, site locations, fuel tanks on site, volume of fuel tanks are found in Appendix A. These ATGs are generally housed within 50 feet of the tanks in an above ground waterproof enclosure. These enclosures are located in gasoline dispensing areas and, therefore, must follow Article 514 of the National Electrical Code (NEC) [2]. Most of the ATG models used by MLGW are capable of monitoring up to eight tanks; however, the largest site currently only monitors four tanks. Each ATG operates on a standard 120VAC circuit. The ATGs are on dedicated circuits with emergency power protection. Figure 2 is a typical control panel of an automatic tank gauge. Additionally, Appendix B depicts a typical site plan with the ATG and the connections between the ATG and UST.

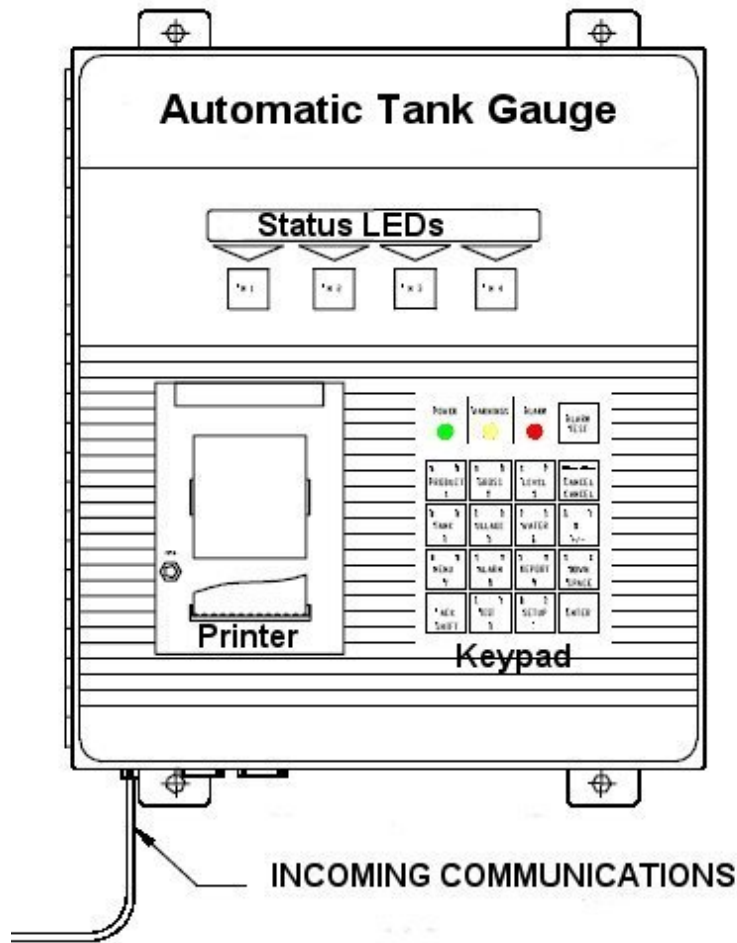


Figure 2-The ATG

### 1.3 Technical Aspects of ATGs

An ATG uses a microcontroller that monitors the tank through a series of probes and sensors within the double-walled tanks. These probes monitor the tank's inventory, any water in the fuel, and any major shifts in volume that would result from a leak within the tank. The user can also enter times or alarm settings with the keypad on the face of the unit. The probes and the keypad are the inputs of the microcontroller. The microcontroller then reports the information to the user via a backlit LCD

(liquid-crystal diode) or through a printout on the internal 40-column plain paper printer. The ATG's sensors and probes gather information for the microcontroller. The microcontroller is programmed with the ability to perform certain calculations. One such calculation that may be used by the microcontroller is finding the volume of the liquid in the tank [3]. Equations relating the liquid volume present and ullage to tank parameters are as follows for the underground storage tanks:

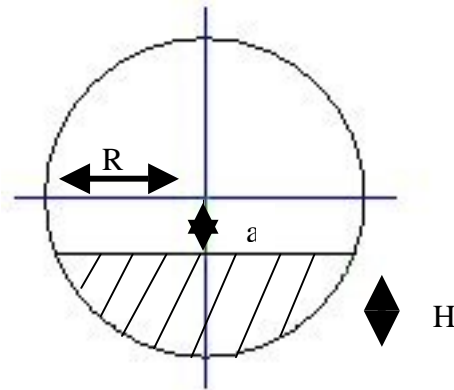


Figure 3-Tank Cross Section

$$V_{unfilled} = 2L \int_{-R}^{R-H} R \sin \cos^{-1} \frac{a}{R} da$$

$$V_{unfilled} = \frac{\pi R^2 L}{2} + RL \left( (R-H) \sqrt{\frac{H(2R-H)}{R^2}} + R \sin^{-1} \left( 1 - \frac{H}{R} \right) \right)$$

$$V_{filled} = \frac{\pi R^2 L}{2} - RL \left( (R-H) \sqrt{\frac{H(2R-H)}{R^2}} + R \sin^{-1} \left( 1 - \frac{H}{R} \right) \right)$$

These equations model a tank, as shown in Figure 3, with a length of L and radius R. The height of the liquid is denoted as H, and is measured from the bottom of the tank. The distance, a, represents the distance from the center of the tank to the top of the liquid.

#### 1.4 Difficulties with Current UST Management System

A problem with the current UST management system is that it can only be monitored through the collection of paper receipts. These receipts must be collected by MLGW employees weekly or monthly at each site. These employees are brought in on frequent job rotations, and the responsibility of collecting the receipts is not always communicated to the various employees. Failure to collect data in a timely manner can result in a failure to comply with regulations set forth by TDEC 1200-1-15-.03 [4]. The general guidelines set forth by TDEC are found in Appendix C. These problematic factors associated with the current underground storage tank management system have made it very difficult for MLGW to ensure regulatory compliance; therefore, alternatives to the current underground storage tank management system at MLGW will be considered.

## 2. Alternatives to Current UST Management System

### 2.1 Goals and Constraints for Alternatives to UST Management System

The goal of the system upgrade is an online management system that can be monitored through MLGW's intranet, in real-time, if possible. This design will require meeting economic; health and safety; social; political; and, most importantly for this project, environmental constraints. The alternative must also attempt to preserve as much of the existing system as possible. The replacement of these probes, sensors, and applicable control wire will be costly due to the amount of labor and materials it will require to replace these devices. Thus, the design must do everything it can to preserve the existing devices, while still accomplishing the goals of this design project. Industry provides automatic tank gauges that offer solutions for underground storage tank management, and a description of these alternatives follows. Some of the constraints of this project are as follows:

#### 2.1.1 Economic

The use of the existing probes will reduce new equipment costs. The price of the new system must include all new equipment and site modifications, as well as the implementation of the intranet connections where possible. The proposed system will reduce the probability of a failure to meet TDEC regulation that could result in fines. Additionally, the new system will relieve on-site labor responsibility and the cost associated with this labor.

#### 2.1.2 Health and Safety

These gauges monitor highly explosive fuels such as gasoline and diesel fuel; therefore, health and safety constraints exist. In the event of using new control wire in this project, it would be necessary to install the new equipment while being exposed to harmful and explosive fumes. Proper safety precautions and personal protective equipment would be required. An additional safety constraint is the implementation of the new tank gauges. The proper installation of the automatic tank gauges by trained technicians will help to ensure the proper and safe operation of the equipment and the protection of the users of the equipment. The engineers and technicians must ensure that the control wiring meets Article 514 of the NEC.

#### 2.1.3 Social

MLGW is a public utility, and the new monitoring system must assist in maintaining the current reliability ratios of MLGW. The inventory data collection of these automatic tank gauges ensures that maintenance crews are able to perform their required tasks for the benefit of the community. Another social benefit of the proposed system is the lowering of the probability of a failure to comply with TDEC regulation that would reduce the confidence in MLGW by its customer.

#### 2.1.4 Political

The political constraints of this project are very similar to the social constraints previously mentioned. Whenever taxpayer monies are involved, any design project should be completed as comprehensively as possible, including a thorough cost and safety analysis. Thus, the political constraints are an understanding that the needs and safety of the citizens of Shelby County should always be considered.

#### 2.1.5 Environmental

The last constraint is the most important constraint involved in this product. A fuel leak from one of these tanks is not only costly, but could potentially cause years of harmful damage to the environment. The newly designed system must be able to alert MLGW of any fuel leaks. This design will be able to meet this constraint by reporting line leaks in real time so that a potential environmental disaster can be avoided.

#### 2.1.6 Goals

The first goal of this project is to upgrade the existing UST monitoring system in order to enhance MLGW's ability to meet the regulatory requirements of the TDEC. The second goal is to improve its current data acquisition abilities and reduce labor costs.

## 2.2 Alternative A

Alternative A is an automatic tank gauging system that provides environmental compliance, inventory, and leak detection information for up to eight underground storage tanks. This system has several communications abilities, such as the ability to monitor the tank via modem, serial connection, or Ethernet network. The tank gauge has many user-friendly features, such as an expanded backlit LCD that guides the user through a programmable menu. Alternative A supports multiple languages, such as Spanish, French and Dutch and a variety of units, including the English and Metric Systems. The device is able to report system warnings and tank alarms to notify the user of any potential problems occurring in any of the monitored tanks. These alarms communicate via warning sirens or lights at the site. This alternative consists of an ATG housed in a weatherproof enclosure. A set of probes are then connected from the ATG to the underground storage tanks. The primary feature of Alternative A is that it uses a software system that allows remote fuel management that can communicate with a variety of makes and models of automatic tank gauges. The software has broad communication capabilities using modem, local area network, wide area network, satellite, DSL, cable, or other high-speed internet-based methods. The system allows remote access to all fueling sites and the individual tanks at that site. The system can gather the desired testing and inventory information real-time or in a user-defined schedule. Alternative A's software allows a manager the flexibility in precise scheduling of inventories through a variety of consumption projection graphs, as well as usage statistics. A wide variety of reports can be printed or faxed by the software. The following reports are available real-time:

- Alarm History
- Delivery
- Leak Test
- Tank Test
- Detail and Summary Inventory
- Monthly and Daily Reconciliation
- Alarm Status
- Average Daily Usage
- Cathodic Protection

## 2.3 Alternative B

Alternative B is an automatic tank gauging system that provides environmental compliance, inventory, and leak detection information for up to four underground storage tanks. This tank monitoring system can be configured to provide in-tank leak detection either in a static or dynamic mode. In the static mode, the automatic tank gauges can be manually programmed to run the various tests at certain time intervals, such as weekly, daily, etc. In the dynamic mode, a continuous statistical leak detection operation may be run. In this mode, the automatic tank gauge constantly monitors its fuel volume to detect for line leakage. It also contains interstitial sensors between the double walls of the tank that are able to detect a leak within the tank before it reaches outside of the tank's outer wall. Some of the standard features include the ability for the automatic tank gauges to be connected to an emergency power system. The automatic tank gauges are able to accept up to eight float-switch sensors. These float sensors are compatible with a variety of manufacturers of fuel monitoring equipment. These sensors include interstitial leak sensors for steel and fiberglass tanks. Additional supported sensors include piping sump sensors, hydrostatic sensors, and containment sump sensors. This type of automatic tank gauge has a printer and LCD interface for communication between the device and the user. An additional similarity between the two alternatives includes the primary feature of using a software system that allows remote fuel management that can communicate with a variety of makes and models of automatic tank gauges. This software program has broad communication capabilities using modem, local area network, wide area network, satellite, DSL, cable, or other high-speed internet-based methods. This system allows remote access to all fueling sites and the individual tanks at that site. The software can gather the desired testing and inventory information real-time or in a user-defined schedule. This software package allows the user to have the ability to be in control of the fuel storage systems at all times. The software is designed to automate data collection and couple this data with flexible reporting methods. The features of the software are as follows:

- E-mail alerts from any compatible automatic tank gauge
- The software supports a variety of manufacturers
- Online diagnostics of tank and monitoring system
- Leak Test
- Tank Test
- Detail and Summary Inventory

- Month and Daily Reconciliation
- Alarm Status

## 2.4 Comparison of Alternatives

The use of either of these alternatives would be beneficial to the fuel monitoring operations of MLGW. Each of these alternatives is capable of meeting MLGW's design criterion; however, it is necessary to compare some of the characteristics of these alternatives. Table 1 is a chart highlighting abilities of each alternative.

Design Criterion	Alternative	Alternative
	A	B
Real-time monitoring	X	X
Printer for on-site data collection	X	X
Software for off-site monitoring	X	X
E-mail alerts from ATGs		X
Ability to monitor 8 tanks	X	X
Continuous testing ability	X	X
Use of existing probes/sensors		X
Multiple language support	X	

Table 1-Comparison of Alternative A to Alternative B

## 2.5 Economic Benefits Analysis

The cost analysis includes the comparison of prices for software, hardware, and installation. Table 2 and 3 show a cost analysis for Alternatives A and B. These costs are based on the one time purchase of all equipment from a manufacturer. The cost of the network equipment that will be required for the automatic tank gauges to be monitored off-site and site preparation is not included in this cost analysis, but is covered later in this paper.

ALTERNATIVE A - COST ANALYSIS FOR MLGW				
Qty	Item		Unit Price	Total Price
11	ATG Console-PC Version		\$ 1,870.00	\$ 20,570.00
11	Ethernet TCP/IP Module		\$ 795.00	\$ 8,745.00
11	Static Probe		\$ 162.50	\$ 1,787.50
20	Magnetic 8' Probe		\$ 1,040.00	\$ 20,800.00
8	Probe Install Kit		\$ 145.00	\$ 1,160.00
12	Diesel Probe Install Kit		\$ 145.00	\$ 1,740.00
20	Interstitial Sensor		\$ 245.00	\$ 4,900.00
20	Piping Sump Sensor		\$ 135.00	\$ 2,700.00
20	4" Cap and Ring Kit		\$ 85.00	\$ 1,700.00
20	Sensor Cap Kit		\$ 55.00	\$ 1,100.00
1	Remote Software		\$ 1,295.00	\$ 1,295.00
1	Installation Fee		\$ 3,000.00	\$ 3,000.00
1	Freight Fee		\$ 2,000.00	\$ 2,000.00
1	Sales Tax @ 9.25%		\$ 6,613.52	\$ 6,613.52
			<b>TOTAL</b>	<b>\$ 78,111.02</b>

Table 2-Alternative B Cost Analysis

<b>ALTERNATIVE B - COST ANALYSIS FOR MLGW</b>				
<b>Qty</b>	<b>Item</b>		<b>Unit Price</b>	<b>Total Price</b>
11	ATG Console-PC Version		\$ 1,395.00	\$ 15,345.00
11	Ethernet TCP/IP Module		\$ 535.00	\$ 5,885.00
11	Static Probe		\$ 162.50	\$ 1,787.50
17	Magnetic 8' Probe		\$ 990.00	\$ 16,830.00
8	Probe Install Kit		\$ 145.00	\$ 1,160.00
9	Diesel Probe Install Kit		\$ 145.00	\$ 1,305.00
17	Interstitial Sensor		\$ 235.00	\$ 3,995.00
17	Piping Sump Sensor		\$ 135.00	\$ 2,295.00
17	4" Cap and Ring Kit		\$ 48.82	\$ 829.94
17	Sensor Cap Kit		\$ 65.00	\$ 1,105.00
1	Inform Software		\$ 1,150.00	\$ 1,150.00
1	Installation Fee		\$ 4,400.00	\$ 4,400.00
1	Freight Fee		\$ 1,500.00	\$ 1,500.00
1	Sales Tax @ 9.25%		\$ 5,326.84	\$ 5,326.84
			<b>TOTAL</b>	<b>\$ 62,914.28</b>

Table 3-Alternative B Cost Analysis

The cost analysis in the two tables indicates that Alternative B has a lower installed cost than Alternative A. Alternative B has the ability to use some of the existing probes and sensors, which allows it to be even more cost effective than indicated.

### 3. Pilot Design

#### 3.1 Recommendation

From the analysis of the existing monitoring system, a decision was made by MLGW to choose Alternative B. This decision was made for the following reasons:

- Alternative B met all requirement specifications more economically than Alternative A
- A vendor for Alternative B is located in Memphis
- The manufacturer of Alternative B is also the manufacturer of the existing equipment
- Some existing consoles may not have to be replaced by using Alternative B
- The vendor for Alternative B and MLGW already have an established relationship
- Excellent customer service by the vendor of Alternative B

Even though Alternative A has some features that are desirable, the economic advantages of Alternative B, in addition to the location in Memphis of the vendor for this equipment, override these features. This design will allow MLGW to eliminate much of the employee cost associated with the current monitoring system since the new system is automated. Upgrading the system with Alternative B will reduce the probability of a failure to maintain compliance with the TDEC.

#### 3.2 Communications Equipment

Now that the equipment has been chosen, the infrastructure for connecting these sites to the software at the MLGW offices in downtown Memphis must be considered. The consoles of Alternative B require a standard Ethernet connection that can be connected to the local area network, or LAN, at the local facility. The LAN is connected to the corporate offices through MLGW's intranet, thus allowing the consoles to have connectivity to the software, accomplishing a goal of this design. The traditional method of connecting computer hardware in a network is by using category 5 cable. Although this method is routine and requires little technical knowledge to install and implement, the installation of this cable is quite expensive. A weatherproof enclosure houses the ATG and is located at a distance of approximately one hundred feet from the office containing MLGW's intranet. The use of a traditional network cable would require that it be routed underground in ½" conduit. The installation of this conduit would require extensive site work. A thorough examination of the site plans would be required to determine the exact locations of any underground lines, including fuel lines, control wire for the automatic tank gauge and the possibility of

underground utilities. This examination would have to occur at each of the eleven sites. A detailed analysis of the cost of routing the wired solution is found below in Table 4 for the Covington Pike Facility.

<b>TRADITIONAL NETWORKING - COST ANALYSIS FOR MLGW</b>				
<b>Qty</b>	<b>Units</b>	<b>Item</b>	<b>Unit Price</b>	<b>Total Price</b>
125	LF	Concrete Demolition/Replacement	\$ 17.00	\$ 2,125.00
125	LF	PVC Schedule 40 1/2" Conduit	\$ 1.70	\$ 212.50
8	20' Sect	Category 5e Networking cable	\$ 8.95	\$ 71.60
1		Sales Tax @ 9.25%	\$ 234.89	\$ 234.89
			<b>TOTAL</b>	<b>\$ 2,643.99</b>

Table 4-Traditional Networking Cost Analysis

This analysis was performed using the RSMMeans Electrical Cost Data, 28<sup>th</sup> Annual Edition, in conjunction with experienced, licensed professional engineers [7]. This cost analysis only applies to the Covington Pike location. Each of the sites would have to be examined to determine the necessary costs of the site work. Assuming that each site modeled the Covington Pike location, the entire cost of the traditionally networking method would be \$29,083.90.

In lieu of the traditional networking solution, it is more economical to use a wireless network for the connectivity of the consoles with the centrally located software. Wireless networking is a newer technology that can be used in the pilot design of this solution. The recommended wireless protocol for this design is IEEE 802.11b, which supports bandwidth up to 11 megabytes per second (Mbps), which is comparable to the speeds of traditional Ethernets. IEEE 802.11b uses 2.4GHz radio signaling and because it is an unregulated frequency, an 802.11b device runs the risk of incurring interference from appliances that use the same 2.4 GHz range, such as microwaves and cordless phones. However, the power output of IEEE 802.11b devices are limited to 15dBm +/- 2dB; and if it is installed out of range of other appliances, one can avoid the interference [8]. An obvious concern of using wireless networking is security. WEP or wired equivalent privacy is a software algorithm that encrypts outgoing data and decrypts it when it is received, maintaining its integrity while en route. Additionally, the wireless access point, which is the "controller" of the wireless network, can be set to allow access by preset IP addresses. An IP address or Internet Protocol address is a digital identifier of a networked computer hardware device. The access points should be used as hardware access points. Hardware access points are used as an extension of an existing wired network, and this is the most effective method of connecting the automatic tank gauges to the intranet. The major advantage of using the wireless network is the cost benefit of using the equipment. Using the wireless equipment provides a savings of \$27,765.80 as compared to the wired solution. This list of equipment is found in Table 5.

<b>WIRELESS NETWORKING - COST ANALYSIS FOR MLGW</b>				
<b>Qty</b>	<b>Item</b>	<b>Unit Price</b>	<b>Total Price</b>	
11	D-Link / DWL-810+/ Ethernet Wireless Bridge	\$ 64.99	\$ 714.89	
11	D-Link / Air / DI-514/ Cable/DSL / Wireless Router	\$ 44.19	\$ 486.09	
1	Sales Tax @ 9.25%	\$ 117.10	\$ 117.10	
		<b>TOTAL</b>	<b>\$ 1,318.08</b>	

Table 5-Wireless Networking Cost Analysis

### 3.3 Present Worth Analysis

This design will eliminate many of the hours associated with information collection associated with the current system. MLGW stated that an estimated 250 hours at a cost of \$25 dollars an hour are currently expended monthly towards the monitoring of this system. This design will eliminate the need for 200 hours of labor, which is a savings of \$5,000 a month during the ten-year life cycle of the equipment. The total cost of the ATGs, probes, sensors and the wireless internet infrastructure costs a total of \$64,232.40; however, the economic impact on MLGW does not end at the initial cost of the equipment. A present worth analysis was performed to evaluate the economic feasibility of this design [9]. Its purpose is to include future costs and savings of the project and transform them into present equivalent costs. The MARR, or minimum attractive rate of return, is the interest rate at which one can expect to receive due to the time value of money. For a corporation the size of MLGW, the MARR

is different depending on the size of a project, thus a table of values is found in Table 6. The values associated with a present worth analysis over the life cycle of ten years are as follows:

MARR	Present Worth of Alternative
4%	\$416,338.43
5%	\$393,177.60
6%	\$371,853.53
7%	\$351,915.90
8%	\$333,341.03
9%	\$316,016.33

**Table 6-Present Worth Analysis Based on Various MARRs**

It is clear from Table 6 that this new alternative is much more economical than the current monitoring system. The new solution will eliminate \$5,000 a month in labor costs. This savings as compared to the existing system will allow MLGW to profit from the implementation of this design, in that the new equipment will pay for itself in a little over 10% of its life cycle. The money saved during the remainder of the life cycle of the new equipment should be sufficient for the replacement of this new equipment sometime around the year 2016.

### 3.4 Pilot Design

The wireless pilot design will be implemented at the Covington Pike facility. The Covington Pike facility is the facility featured in the calculation of the cost of the traditional networking solution. This facility is also the largest in terms of the amount of fuel volume being monitored. The site currently hosts four underground storage tanks, two of them for diesel fuel and the other two for gasoline. The pilot design consists of the new console from Alternative B and all the necessary connections. The console will be connected inside the existing weatherproof enclosure using the existing control wiring. Technicians of the manufacturer of Alternative B will make the necessary installation of probes and equipment without the need of site work or the routing of new control wire between the console and the underground storage tanks. MLGW will be responsible for the installation of the network equipment necessary for the site to be monitored offsite at MLGW's headquarters in downtown Memphis. The information technology department of MLGW can install the wireless network. The output signals from the ATGs are then transmitted by the software to the computer terminal at MLGW. Figure 4 below shows a block diagram of the operation of this pilot design.

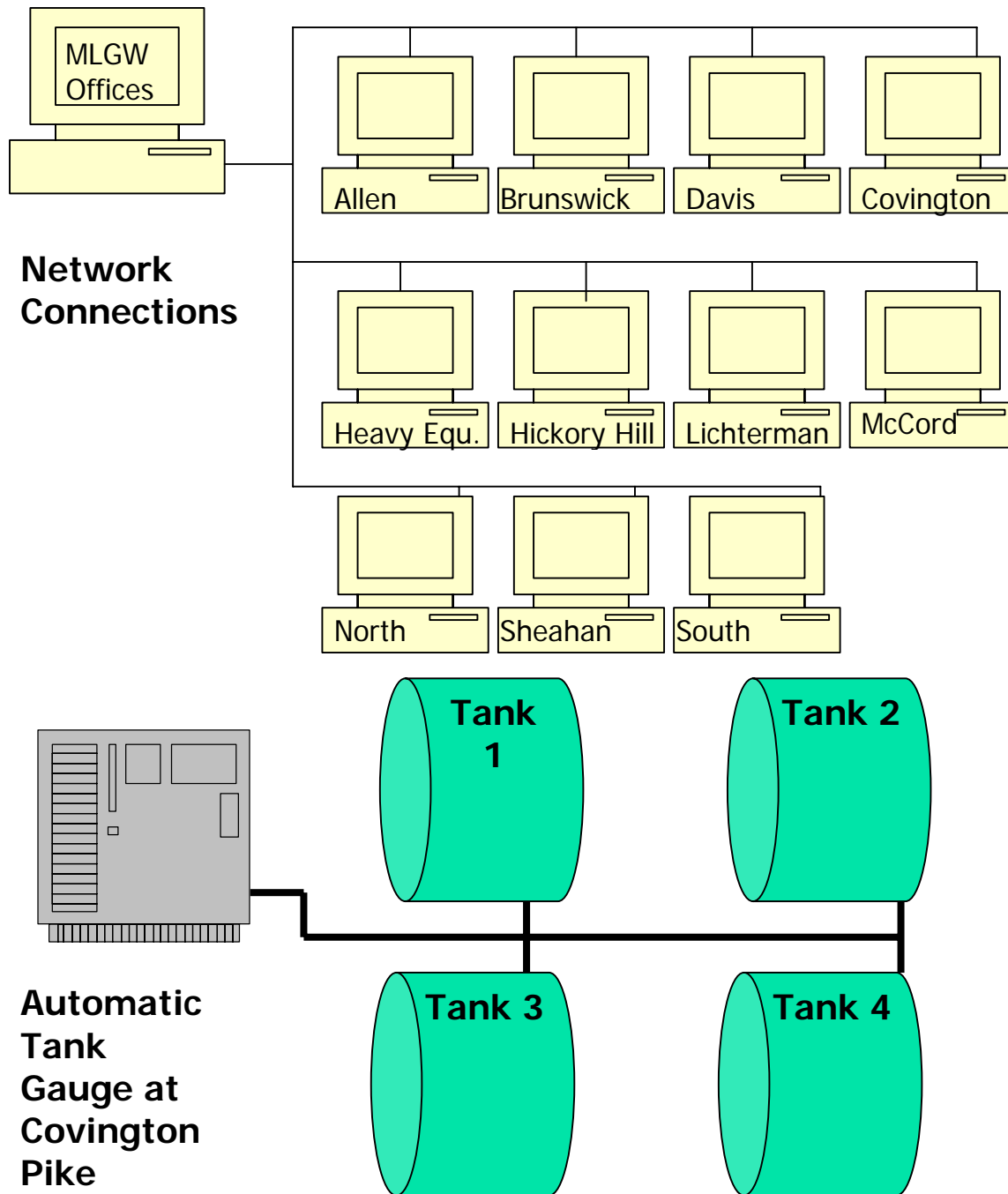


Figure 4-Block Diagrams of Pilot Design

#### 4. Conclusion

The monitoring of fuel stored by MLGW is vital to the operation of the utility. The fuel inventory levels must be maintained to ensure an adequate supply of fuel for applicable maintenance equipment and personnel. More importantly, it is necessary to monitor underground storage tanks for any possible leakage. Underground fuel leaks can be an environmental disaster. For this reason, TDEC requires an extensive database of test results on each of the underground storage tanks used by MLGW. These

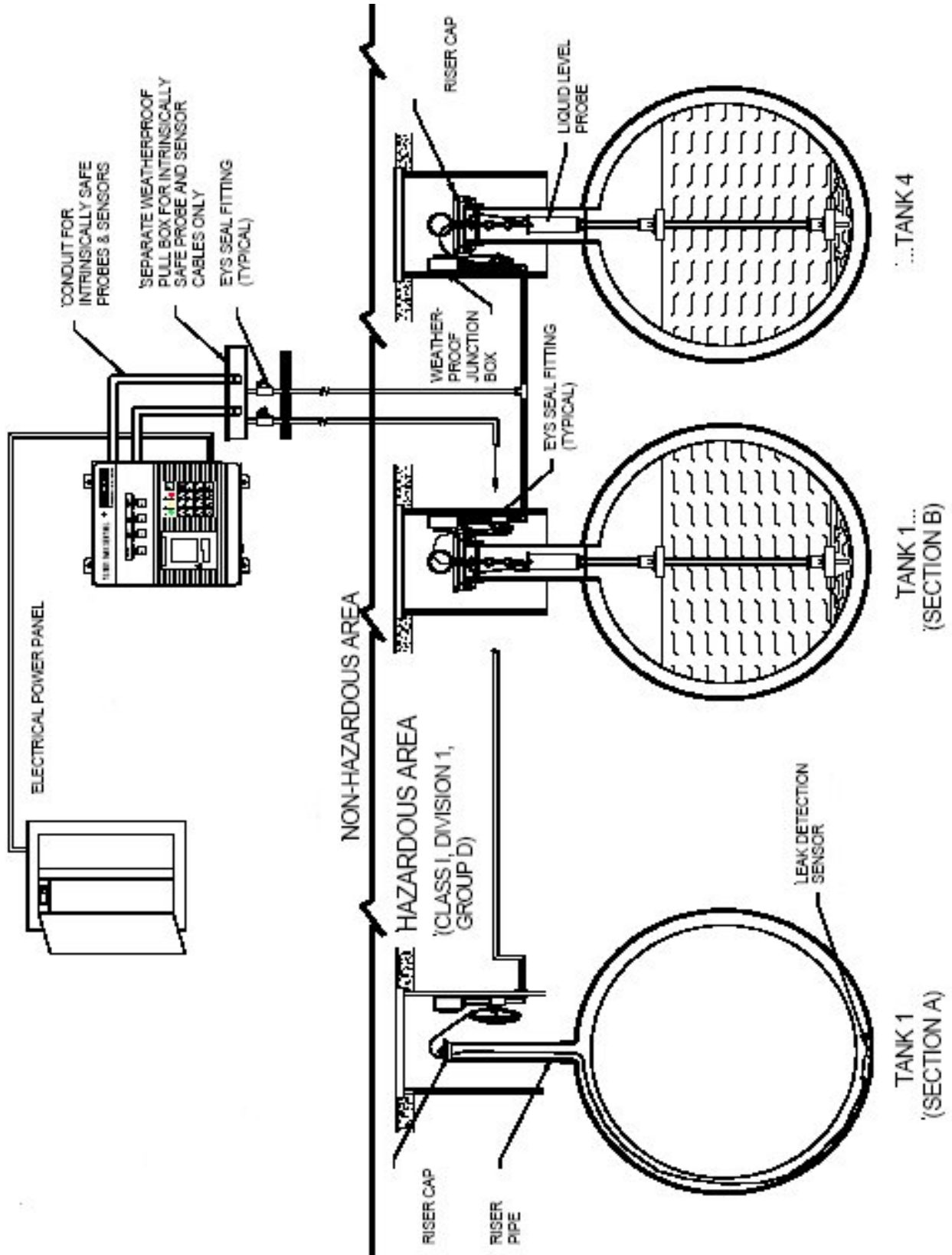
tests can be generated and reported by a UST management system. Automatic tank gauges are consoles that monitor pertinent data of underground storage tank systems. The current system of automatic tank gauges requires a user to retrieve a paper receipt from each console at 11 different sites throughout Shelby County Tennessee, but this system is inefficient and costly when compared to the proposed system.

The primary goal of this project was to evaluate the existing systems and to research commercially available alternatives to this system. MLGW's primary design goal was for the new consoles to have the ability to be monitored off-site through MLGW's intranet. This project presents a pilot design, which, when implemented, will demonstrate that the selected alternative meets the selected constraints while remaining a profitable endeavor. It was found that long-term implementation of this design is cost-effective, in that the project pays for itself in a few months. A new underground tank management system will lead to an overall reduction in operating costs for the Safety Engineering and Environmental Affairs division of MLGW, as well as help to automate the monitoring process and ensure regulatory compliance.

Appendix A: List of Sites

Facility	Address	Product	Capacity (in gal.)	ATG
Allen Pumping Station	709 Dison Avenue	Diesel	10,000	Veeder-Root TLS 300C
		Diesel	10,000	
Brunswick Service Center	3773 Brunswick Rd	Diesel	15,000	Gilbarco MDE2691b
		Gasoline	15,000	
Davis Pumping Station	1800 W Shelby	Diesel	20,000	Gilbarco PA02620100020
Electric & Systems Operations	2425 Covington Pike	Diesel	6,000	Gilbarco MDE2691b
		Diesel	6,000	
		Gasoline	12,000	
		Gasoline	12,000	
Heavy Equipment	214 S Orleans	Diesel	2,500	Gilbarco MDE2691b
		Gasoline	8,000	
Hickory Hill Service Center	6012 Winchester	Diesel	15,000	Gilbarco MDE2691b
		Gasoline	25,000	
Lichterman Pumping Station	3426 Hickory Hill	Diesel	20,000	Gilbarco PA02620100020
McCord Pumping Station	6230 Summer Ave.	Diesel	20,000	Veeder-Root TLS 350
North Service Center	1060 Tupelo	Diesel	20,000	Gilbarco MDE2691b
		Gasoline	12,000	
Sheahan Pumping Station	3941 Grandview	Gasoline	12,000	Gilbarco PA02620100020
South Service Center	2981 South Center Dr	Diesel	15,000	Gilbarco MDE2691b
		Gasoline	25,000	

Appendix B: Typical Site Plan with ATG and Tanks



## Appendix C: Guides for UST Monitoring from TDEC

### Records you must keep and how long you must keep them (paraphrase from 1200-1-15-03)

Owners and/or operators shall maintain records of the following:

#### Corrosion Protection

1. A corrosion expert analysis of site corrosion potential if corrosion protection equipment is is not used must be kept for the remaining life of the UST system.
2. For UST systems using cathodic protection:
  - a. The results of the last three inspections for UST systems using impressed current cathodic protection and/or
  - b. The results of testing from the last two inspections for UST systems using sacrificial anode (galvanic) cathodic protection.

You should be able to document the required CP testing has been done (within 6 months of installation and every 3 years thereafter) by a qualified CP tester.

#### Repairs

3. Documentation of each UST system repair must be kept for the remaining life of the UST system.

#### Release Detection

4. All written performance claims pertaining to any release detection system used, and the manner in which these claims have been justified or tested by the equipment manufacturer of installation, shall be maintained for 5 years from the date of installation.
5. The results of any release detection sampling, testing, or monthly monitoring shall be maintained for at least 1 year except that the results of tank tightness testing shall be retained until the next test is conducted. (This means you should have at least 12 consecutive monthly records available for review at any time.)
6. Written documentation of all calibration, maintenance, and repair of release detection equipment permanently located on-site shall be maintained for at least one year after the servicing work is completed.
7. Any schedules required calibration and maintenance provided by the release detection equipment manufacturer shall be retained for 5 years from the date of installation.

#### Closure

8. Records that are capable of demonstrating compliance with closure requirements and results of the excavation zone assessment required prior to permanent closure or change-in-service must be maintained for at least 3 years after completion in one of the following ways:
  - a. By the owners and/or operators who took the UST system out of service; or
  - b. By the owners and/or operators of the UST system site; or
  - c. By mailing these records to the division if they cannot be maintained at the closed facility.

(Source: <http://www.state.tn.us/environment/>)

## Sources and References

### Sources

Robert Cochran, P.E., Project Manager/Civil Engineer, Allen and Hoshall, Inc.

Monica Darby, P.E., REM, Environmental Engineer, Memphis Light, Gas & Water

Michael Dudas, P.E., Senior Electrical Engineer, Allen and Hoshall, Inc.

Robert Fairchild, The Southern Company

### References

- [1] "Memphis Light, Gas & Water," [www.mlgw.org/](http://www.mlgw.org/) Accessed Feb. 3, 2005.
- [2] NFPA Board of Directors, *National Electrical Code*. 2004 Ed.
- [3] D. Hughes-Hallett, *Single Variable Calculus*. New York: John Wiley & Sons, Inc., 1998
- [4] "The Tennessee Department of Environment and Conservation," <http://www.state.tn.us/environment/UST>
- [5] "Incon," [www.incon.com](http://www.incon.com) Accessed Dec. 15, 2004.
- [6] "Veeder Root," [www.veeder.com](http://www.veeder.com) Accessed Dec. 18, 2004.
- [7] RS Means Construction Publishers, *RSMeans Electrical Cost Data*, 28<sup>th</sup> Ed., 2004.
- [8] "IEEE", <http://www.ieee802.org/> Accessed Jan 29, 2005.
- [9] L. Blank and A. Tarquin. *Engineering Economy*. Boston: McGraw Hill. 2002. 164-196.
- [10] J. Salt, R. Rothery. *Design for Electrical and Computer Engineers*. New York: John Wiley & Sons, Inc., 2002.
- [11] D-Link, <http://www.dlink.com/>