An Overview of Semiautomatic Fueling Systems

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ABSTRACT

An overview of the options to be considered in procuring a semiautomatic fueling system is provided. The system options are divided into three areas: software, system access and data entry, and hardware. The pros and cons are discussed for common options in each of the three areas.

Of the costs associated with operating and maintaining vehicle fleets, fuel generally has the conspicuous distinction of being the second largest single item. Labor costs (driver and mechanic wages) are generally highest. Further, even though fuel prices in real dollars (dollars discounted for inflation) have risen only marginally in the last 10 years (1), the rising price of fuel in absolute dollars since the 1973 Arab oil embargo has had significant psychological impacts on budget analysts of energy-intensive industries. Both the size of fuel costs in operating budgets and increasing fuel prices (in absolute dollars) have made fuel a likely candidate for cost cutting by agencies facing pressures to economize.

A popular option to aid in the control of fuel costs is the use of semiautomatic fueling systems. Although the capabilities of these systems vary dramatically, at a minimum they record, through automatic data entry at the fuel pump, the quantity of fuel use by individual vehicles and the dates on which vehicles are fueled. This allows the fleet manager to track quantities of fuel delivered and used.

Because the capabilities of such systems vary, the options to be considered in buying them are many, which makes the purchase decision complex. This paper is designed to be a first step in the information-gathering process for an agency contemplating the procurement of a system. The paper covers system planning and design options that are available and briefly covers the pros and cons of each option. The options are divided into three areas: software, system access and data entry, and hardware.

SYSTEM PLANNING AND DESIGN

During the system planning stage, the performance specification is developed, and during the design stage the physical configuration is determined. The possible choices to select from during the planning stage are many. For example, the agency must decide which level of sophistication of the system's performance will most efficiently meet their needs. The performance may vary from simple transaction recording to provision of sophisticated management information. The physical configuration must be chosen from numerous possibilities. For example, the agency has the option of buying or leasing a system, and the system may operate on separate hardware or be tied in to existing hardware and even integrated with existing software.

The semiautomatic fueling system's ability to meet the agency's needs is largely constrained by the computer programs (software) used. Regardless of the sophistication of the hardware or of the system access devices, if the software is unable to prepare information required by the performance specification or the system cannot be integrated with existing hardware or software or both, the system will not meet the agency's needs. Therefore, when the system performance specification and design are being developed, it is important to first consider the performance of the software. The next most important consideration in constraining the abilities of the system is the access and data entry system. This system will control the types of data collected and limit the flexibility of the system. The last in importance is the selection of data-processing equipment (hardware). Because the performance of software has been selected, hardware choices are largely constrained to those that are compatible with the performance of the selected software.

In the order of their importance in the selection of a system, semiautomatic fueling system software, system access and data entry, and hardware are discussed in the following subsections.

Software

The key element in the planning and design of a semiautomatic fueling system is the capabilities of the software selected. Software performance requirements should not be made to meet the capabilities of commonly available (or inexpensive) software. They should be designed according to the current and projected needs of the agency. For example, the tracking and control of fuel storage quantities, delivery quantities, and transfer quantities are difficult when multiple storage tanks are used to hold the same fuel product and very difficult if multiple tanks are dispensed through one pump. If the agency plans to use multiple tanks, the software specification must take this factor into account.

Software with flexibility and the ability to be custom tailored is generally more capable of fulfilling the agency's needs for two reasons. First, flexibility will allow the software to change through time as the agency's needs change. Second, software that can be custom tailored will conform to the agency's needs rather than the reverse.

Simple software systems will store and report transaction lists. For each time that fuel is accessed, the transaction list will generally indicate the vehicle identification code, the date, number of gallons delivered, the fueling location (if there is more than one), and the employee's identification code. More sophisticated systems can provide management summary information, send messages to drivers and fuelers, control the quantity of fuel delivered to vehicles, and analyze fuel consumption statis-

tics. More specifically, some of the more sophisticated systems include the following options:

1. Validation: Data validated include
   a. Current mileage (or hours) entered (for example, the system should not accept a mileage that is less than the one entered in a prior transaction or a mileage that indicates that the vehicle has traveled an unrealistic distance since the last transaction),
   b. Vehicle codes and employee authorization codes,
   c. Fuel products used and the quantities delivered (for example, the system should not allow the delivery of diesel fuel to a vehicle that is listed in the master file as a gasoline engine automobile nor should it allow the delivery of more fuel to a vehicle than the maximum the vehicle could have used given the mileage traveled since the last transactions or more fuel than the capacity of the vehicle's fuel tank);
2. Management information: The fueling system can provide information to assist the fleet manager in better managing his fleet. If properly utilized, the fueling system can provide high-level fleet management information that can involve substantial payoffs for the entire organization. The information that can be provided includes
   a. Comparative statistics identifying fuel consumption trends and traits of the fleet, vehicle models, and individual vehicles (vehicle operating costs are highly dependent on fuel costs; thus this information can be used in such high-level management activities as determining vehicle economic replacement intervals and life-cycle costing);
   b. Billing and expense reports; and
   c. Exception reports, which identify the occurrence of fuel consumption (or consumption of other fluids) outside of normal tolerances; these reports are an important element in determining bus performance and in diagnosing impending mechanical problems;
3. Messages: When a particular driver, fueler, or vehicle is identified at the fuel access point, the system may provide messages indicating some special characteristic (for example, the message may tell the fueler that the vehicle is due for preventative maintenance and needs to be positioned in a special location or that the vehicle is part of a special test and should not receive normal lubricants).

When a software system is purchased, it is important that it be able to meet the agency's information requirements. However, it is a complex task to plan and design a fueling system so that the full potential of the system's capability to provide management information is realized. It requires a full understanding of the information needs and the flow of information within the agency. Therefore, care must be taken in developing the software's performance specification.

System Access, Data Entry, and Fueling Control

The device allowing access to the system is the primary point of control and security. Because of its importance, the type of system used to permit access should be carefully selected to meet the needs of the agency. There are a variety of access systems with varying degrees of sophistication and each has good and bad points.

The system chosen for access control can also constrain the types of data collected at the access point. For example, the primary purpose for key and card systems is to control access to fuel. If the fueling system is intended to collect more than simple transaction information (e.g., current vehicle mileage and other fluids used) the key or card system must be augmented with a data entry pad and information display. However, once a data entry pad is available, it may be possible to control access to the system by typing in authorization codes, thus relieving the need for the key- or card-controlled system. Therefore, key and card systems may not be appropriate if the system performance specification calls for higher-level information.

In the following paragraphs the good and bad points of popular access systems are discussed.

Popular Access Systems

Plastic Card Systems

Plastic card systems use hole patterns punched through the cards or a magnetic strip on the card. Encoded in the holes or on the magnetic strip is the identity of the vehicle. Card systems are inexpensive and functional; however, the integrity of these systems can be easily jeopardized through misuse and abuse of the cards.

The cards are extremely susceptible to misuse. For example, they can be used to open locked doors, as ice scrapers in the winter, and to fuel unauthorized vehicles. Further, they become brittle in extreme heat or cold, thus making it easy for them to become bent or broken. Also, the punched cards can be easily duplicated by punching holes in the same pattern into another card or through a piece of paper.

Individual Key Systems

In key systems, a key is encoded with the identity of each vehicle. This system is inexpensive and can be efficient if only one driver is given responsibility for a key and always drives the same vehicle. However, if many individuals drive many different vehicles, a key system can become cumbersome and clumsy. The key can be easily lost or forgotten and therefore a backup set of keys is generally maintained.

Keylike Memory Devices

Plastic data keys are made that contain microchips. Information can be read from and written on these chips. Each vehicle is assigned a key and the key's chip contains the vehicle's authorization code. Keys can be coded at the user's site, thus making it easy to replace lost ones. Lost keys are automatically disabled, which reduces unauthorized fueling.

Keypad Systems

Many systems use a keypad for data entry at the fueling island. Keypads are either the standard raised mechanical-key type or touch-sensitive pads. In keypad systems there are no devices to bend or lose, there is no chance of reproducing a card, and most people are familiar with similar systems (such as automated teller machines at banks and supermarkets). These systems are more expensive to purchase than card and key systems; however, the security and the system integrity are higher.

Bar-Code Readers

Although the technology used in bar-code readers has been applied to other systems, its use in semiautomatic fueling systems is recent. The bar-code strips resemble those used on food products in grocery stores. Some bar codes are mounted on the inside of the fuel door. Others are mounted on the side of the vehicle. These can be read with a hand-held bar-code reader wand or a wall-mounted reader.

Access and Control Systems in Development

Because the access and control points determine the integrity of the systems, efforts are currently under way to make access systems more tamperproof while improving the reliability of the data entered into the fueling system's data base. Some of the systems currently under development are as follows:

1. Microwave data communication between fueling trucks and the fueling system at the home base. Microwave communications will allow the mobile truck system to perform like a fixed on-line system.
2. Data storage devices that contain information regarding the vehicle mounted in a rubber seal inside the vehicle's fuel inlet. A matching device is sealed onto the pump nozzle, which, when it is inserted into the vehicle's inlet, exchanges the information and allows the vehicle to be fueled.
3. Sensor systems in the fueling tank that permit the system to identify how much fuel is dispensed from the storage tank. The identification of the tank from which the fuel is drawn becomes a problem when multiple tanks are used to feed one pump.

All types of access systems, to some extent, have difficulties with harsh weather and other environmental conditions. For example, moisture from humidity, snow, rain, and sleet can hamper the accuracy of card and key systems. Dirt and oil can block a bar code, making it impossible to read. To mitigate these problems, enclosures and other protective devices should be provided.

System Hardware

By the time hardware planning and designing have been reached, the hardware choices have been dramatically narrowed by prior software and access system choices. However, there is still some latitude in the choice of hardware configuration, of which there are three distinctly different types.

Local Microprocessor at the Fueling Site

This is a stand-alone system that allows one-way communication from the pump to a local microprocessor. Because the microprocessor is designed to control a specific pump type and to provide specific types of information, it is difficult to make system updates and software changes without replacing the microprocessor.

A stand-alone system allows each garage to be independent in the control of its own fuel. There may be advantages to this type of system if each garage manages its own fuel. However, each vehicle must be assigned to a specific site for fueling. If a vehicle were to fuel at another location, the system security would have to be overridden and management information data would have to be manually entered at the vehicle's home fueling system.

Central Processor Off Site

Control of the pumps from a centralized processor, which generally is capable of being programmed, permits software updates. Further, if the central processor has the capability to manage data bases, the system can be used to provide higher-level management information.

The difficulty in using a centralized system lies in problems encountered with system failures. A failure of either the central processor or of the data communication lines will result in an inability to deliver fuel at remote sites. The possibility of a system failure necessitates manual overrides at remote locations, which reduces the integrity of the system.

Centralized Processor Off Site with Communication to On-Site Microprocessors

Combination of the previously described system with an on-site microprocessor allows centralized control and centralized processing of information while allowing each remote fueling site to operate independently. This system creates fault tolerance in the system control and thereby increases the system's reliability (the probability of operating normally over a specific time interval).

CONCLUSIONS

This paper is intended to provide a brief overview of available semiautomatic fueling system planning and design options. It is recommended that the potential buyer first investigate the agency's fuel-related current and projected information needs. Next, the system performance specification should be planned followed by the design of the system's physical configuration. The planning and design stages should first consider software, next system access and data entry, and last hardware.

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