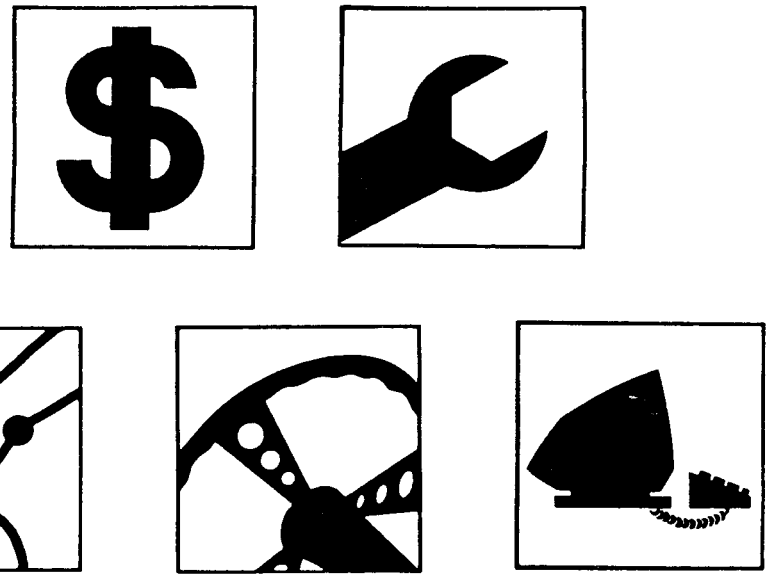
ENERGY-EFFICIENT FLEET MANAGEMENT



TEXAS ENERGY EFFICIENCY

ENERGY-EFFICIENT FLEET MANAGEMENT

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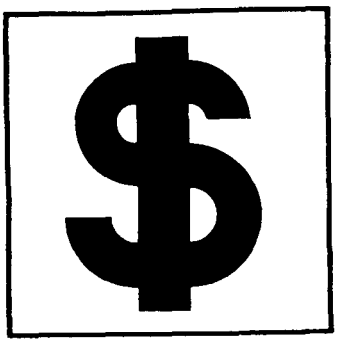
INTRODUCTION

As a service to state agencies, local governments, school districts, and public utilities, the Energy Efficiency Division of the Public Utility Commission of Texas (PUC) intends to provide expert guidance to fleet administrators and managers throughout the State. This self-instructional booklet documents a wide range of actions, techniques, and strategies for reducing energy consumption in the day-to-day management and operation of vehicle fleets.

This booklet is being published in conjunction with a State-wide program of educational workshops sponsored by the PUC Energy Efficiency Division and conducted by consultants from Ernst & Whinney and the Center for Transportation Research at the University of Texas at Austin. It is also designed, however, to be distributed as a stand-alone document to fleet administrators and to other appropriate officials who are unable to attend one of the PUC-sponsored seminars. The workshops and booklet are part of the continuing effort by the PUC and the State of Texas to reduce energy consumption in the transportation sector and thereby make more funds available for the delivery of other vital services.

The booklet is organized into five sections and covers all major fleet management and operation areas that offer opportunities for improving energy efficiency: vehicle procurement, vehicle maintenance, trip planning, vehicle operation, and performance monitoring. Each section describes

specific policies, practices, and actions the fleet administrator can implement in order to improve energy efficiency, and explains how computers can frequently assist in implementing new, energy efficiency-related procedures. Each section concludes with a checklist of basic actions and practices that should be pursued by all fleet managers in order to improve energy efficiency.



VEHICLE PROCUREMENT

WHY IS IT IMPORTANT?

Energy efficiency begins with vehicle procurement. In addition to reducing fleet fuel consumption, decisions regarding what equipment to buy, when to buy it, and when to rebuild or replace it can achieve significant savings in fleet capital and operating costs.

WHAT SHOULD IT INCLUDE?

- Energy-Efficient Equipment Purchase
- Efficient Fleet Complement
- Life Cycle Costing Analysis

ENERGY-EFFICIENT EQUIPMENT PURCHASE

Deciding what equipment to buy is the most fundamental way a fleet administrator can achieve energy efficiency. In view of the fact that the equipment needs of a single fleet may run the gamut from passenger automobiles to dump trucks, it is difficult to discuss specific energy-saving devices. However, several general considerations should be kept in mind when making equipment purchase decisions.

- Vehicle Size and Weight--Size and weight are the principal determinants of a vehicle's fuel consumption rate. Fleet energy efficiency can be increased through down-sizing which simply involves purchasing smaller, more fuel-efficient

vehicles. Underutilized transit buses, for example, can often be replaced with smaller buses or vans without impairing transit service.

- Fuel--Several motor fuels have been shown to be more efficient than gasoline. These include diesel fuel, gasohol, propane, compressed natural gas, methanol, and ethanol. Since most of these fuels burn much more cleanly and completely than gasoline, they reduce engine wear and maintenance requirements significantly. Long Beach, California, for instance, has been operating 100 vehicles on compressed natural gas for over 10 years, and currently replaces motor oil only once a year and spark plugs every 50,000 miles. The equipment needed to convert gasoline-powered vehicles to alternate fuels is usually relatively inexpensive, and fuel prices are often much lower than gasoline prices.

- Transmissions--Despite recent improvements to automatic transmissions, such as torque converters and lower gear ratios, manual transmissions are still more energy efficient.

- Tires--Steel-belted radial tires offer less rolling resistance and, hence, greater fuel efficiency than conventional bias-ply tires.

- Power Accessories--Accessories such as power steering and power brakes increase fuel consumption both by using power themselves, and by adding to vehicle weight.

- Governors--Engine rpm governors can reduce fuel consumption substantially by establishing a maximum engine speed while still allowing a maximum road speed of 60 mph.

- Tachometers--Tachometers can save fuel by assisting drivers in shifting gears according to engine rather than road speeds.

EFFICIENT FLEET COMPLEMENT

Fleet complement refers to the size of a fleet and the types of vehicles in it. For example, municipal government fleets typically contain a wide variety of vehicle types, including automobiles, vans, buses, dump trucks, fire trucks, garbage trucks, and miscellaneous road repair equipment.

In deciding what equipment to purchase, one of the fleet administrator's primary goals should be to obtain a sufficient array of vehicles to meet service needs in his jurisdiction or service area while ensuring that all equipment purchases are fully utilized.

To a certain extent, purchase decisions can be based on past experience or on the experiences of other fleets. However, because factors that affect the demand for fleet-related services, e.g., population, are continually changing, it is often difficult to determine fleet equipment needs precisely. Thus there is a strong temptation to guess about equipment needs or to simply maintain the status quo.

Since both of these approaches to vehicle procurement virtually ensure inefficient and ineffective fleet operations, it is essential that fleet administrators develop a systematic framework for making decisions regarding fleet complement. Such a framework should include performance standards (e.g., minimum and maximum tonnages of garbage collected per truck per week), and a performance monitoring system which enables administrators to detect overutilization or underutilization of fleet vehicles and to adjust fleet complement (or operations) accordingly.

For example, the relatively simple procedure of monitoring the amount of garbage collected per vehicle per route can achieve substantial fuel savings by revealing underutilization and opportunities for route consolidation which would allow a reduction in fleet size.

In similar fashion, ongoing monitoring of route-by-route ridership on a municipal transit system might detect underutilized routes or route segments. Eliminating such segments, consolidating them with other routes, reducing service frequency, using smaller vehicles, or securing service from a private provider on a contractual basis would free up fleet vehicles for

disposal, or for use elsewhere in the system, thereby eliminating the need to purchase additional equipment.

LIFE CYCLE COSTING ANALYSIS

It would be unrealistic to suggest that fuel efficiency should be the sole criterion for making vehicle procurement decisions. Other factors such as purchase price, maintenance requirements, and vehicle performance are clearly important considerations in deciding what equipment to buy.

One technique for making equipment purchase decisions that has received considerable attention recently is life cycle costing (LCC). Life cycle costing is an analytical tool that can assist fleet administrators in choosing from among alternative pieces of equipment by calculating the total cost of owning and operating each option over its entire lifetime. While the technique is not specifically concerned with improving fuel efficiency, it does provide a framework for comparing the energy-saving potential of different vehicles.

The life cycle cost of a vehicle is the sum of the costs of purchasing, operating, and maintaining a vehicle over its life, less its salvage (or trade-in) value. These costs include:

- Purchase price
- Subsequent capital investments, including rehabilitation
- Fuel
- Maintenance
- Down time
- Taxes and fees.

The objective of LCC is to find the equipment option having the lowest life cycle cost.

Opportunity Cost

Included in the cost of owning a vehicle, at any given point in time, is an opportunity cost. This arises whenever a vehicle is kept in service, since the opportunity to sell the vehicle and receive revenue is postponed. This is important in comparisons of rebuilding versus replacement, because replacement permits selling the old vehicle immediately, while rebuilding does not. To ensure that the cost of rebuilding (and other alternatives involving vehicles already owned) is not understated, the income the fleet owner would have received were the vehicle sold instead of rebuilt should be included. For example, if rebuilding a vehicle would require an expenditure of $6,000, and the market value of the vehicle without rebuilding is $14,000, then the total cost of the rebuilt vehicle is $20,000.

Annualized Cost

Costs for fuel and maintenance as well as the effects of investment tax credits and depreciation occur throughout the life of a vehicle. The stream of these costs over time is often referred to as "cash flow." Because of the effects of inflation and the cost of capital, the point at which costs occur during the cash flow is important. For example, a dollar today is worth more than a dollar next year, for two reasons: (1) inflation will have eroded the purchasing power of the dollar; and (2) the dollar could be invested to produce more income the next year.

To avoid such confusion, particularly when comparing alternatives with unequal cash flows, the standard practice is to convert all future dollars to their present value by means of a discount rate reflecting the corporate cost of capital. The result is a single amount expressed in terms

of today's dollars. Given correct assumptions concerning the rate of inflation and the cost of capital, a company should perceive the present value as being equivalent to the corresponding stream of future costs.

Once the present value of a cost is known, an amount x can be found such that spending x in every year of a vehicle's life gives the same present value. The amount x is referred to as the "annualized or levelized cost." It is analogous to an annual cost of owning, operating, and maintaining the vehicle. In other words, the annualized cost is the total life cycle cost expressed on a per-year basis.

Annualized costs establish a common basis on which alternatives can be compared, especially those with unequal lifetimes. For example, one can compare:

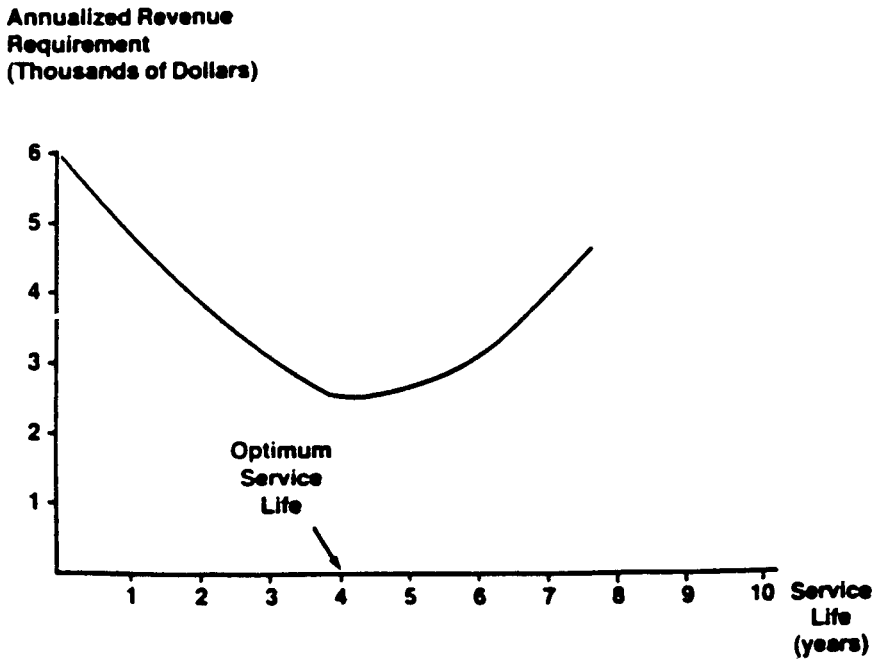
- Replacing an automobile after three years or five years
- Replacing or rebuilding a truck
- Purchasing a gasoline or comparable diesel-powered vehicle.

In each of the above cases, annualized costs permit the identification of the least cost option.

Optimal Vehicle Life

The annualized cost for a vehicle depends on how long the vehicle is kept in service. Annualized costs will be different, for example, depending on whether a five- or a fifteen-year vehicle life is assumed. Shown below is a graphic representation of how annualized costs change vehicle life. As the service life of a vehicle is extended, capital-related costs on an annualized basis decrease; at the same time, annualized operating and maintenance costs increase. The results of these trade-offs is the classic U-shaped curve shown below. To determine the optimal service

life, the annualized revenue requirement at each point along the curve is computed and the service life providing the minimum annualized revenue requirement identified.



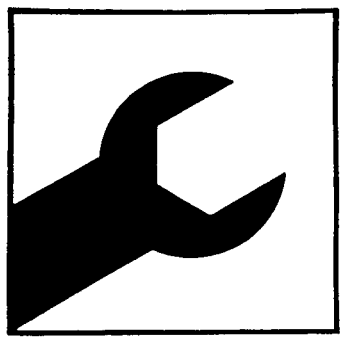
This feature is valuable when comparing two different vehicles that are candidates for the same purpose. Suppose a choice had to be made between a diesel and a gasoline pickup truck. Suppose further that the optimal life for the gasoline pickup were four years with an annualized cost of $5,000. If the annualized cost for the diesel over four years were $5,500, one might conclude that the gasoline pickup was the best buy, since it has the lower annual cost. But this approach is correct only if four years is also the optimal life for the diesel. If the diesel's optimal life were, say, six years, then the six-year annualized diesel cost should be compared to the four-year cost of the gasoline pickup.

CAN A COMPUTER HELP?

As described above, the concept of life cycle cost is relatively straightforward; however, life cycle costing analysis is complicated and requires considerable financial expertise. Fortunately, there are commercially available microcomputer software packages for performing these analyses. However, the models in these packages usually must be tailored to the needs of a particular fleet owner because of differences in tax laws and other governmental regulations which affect publicly and privately owned fleets.

FLEET ADMINISTRATOR'S CHECKLIST — VEHICLE PROCUREMENT

- ☐ Fuel-efficient vehicles and energy-saving devices for maximizing energy efficiency.
- ☐ Performance monitoring system for detecting underutilization and overutilization of fleet vehicles.
- ☐ Fleet complement that maximizes vehicle utilization.
- ☐ Vehicle procurement decision framework such as life cycle costing analysis that facilitates procurement of most economical equipment (which satisfies service requirements).



VEHICLE MAINTENANCE

WHY IS IT IMPORTANT?

A maintenance program that maximizes energy efficiency saves money and makes more funds available for other phases of fleet operation. Other benefits include:

- Greater vehicle reliability
- Longer vehicle lives
- Less downtime
- Lower maintenance costs
- More effective service.

WHAT SHOULD IT INCLUDE?

- A Management Information System
- General Preventive Maintenance
- Fuel Efficiency-Related Maintenance
- Worker Training and Productivity Standards

MANAGEMENT INFORMATION REQUIREMENTS

The foundation of a successful fleet maintenance program is a good management information system (MIS). Current information on vehicle

usage and performance, spare parts inventory, maintenance history, and manufacturer operating and maintenance specifications is essential for scheduling both preventive maintenance and vehicle repair in a timely and effective manner.

A systematic data collection program consisting of daily driver trip reports and frequent vehicle inspections is essential for monitoring vehicle usage and performance and for identifying repair needs. For example, a management information system should enable the fleet administrator or maintenance superintendent both to detect changes in a vehicle's performance (such as increased fuel consumption) and to determine whether such changes are due to variations in vehicle use (such as increased idling) or to some mechanical malfunction which requires repair.

An MIS should also enable a mechanic to determine quickly and conclusively whether a particular part is in stock or must be ordered before repairs are made. Without reliable information and communication between vehicle users and mechanics, it is virtually impossible to ensure timely repairs and maximum vehicle and fuel efficiency.

GENERAL PREVENTIVE MAINTENANCE

Although much of the literature on vehicle maintenance and fuel efficiency focuses on tune-ups, tire care, and the use of certain lubricants, the best way for a fleet maintenance manager to improve energy efficiency is through general preventive maintenance. In a recent survey of 100 transit systems in the United States and Canada, ongoing general preventive maintenance was cited, more than any other maintenance activity, as the most successful means of improving energy efficiency.

SAMPLE INSPECTION CHECKLIST

INSTRUCTIONS:

1. Every item on the form should be inspected on the scheduled inspection day.
2. All full time in service vehicles should have engine oil changed & lubrication performed every 8 weeks.
3. Check to see that assigned crew is properly lubricating & cleaning unit.
4. Inspection items requiring explanation should be numbered in Ref. column and corresponding number with explanation written in Reference section.

Vehicle No.	Make	Model	Location	Mileage	Date

LUBRICATION

Oil Changed At _____ Miles _____ Date _____ Lubrication At _____ Miles _____ Date _____

	OK	R	Ref.
DRIVING INSPECTION			
Hand Brake			
Starter			
Engine Noise			
Transmission Shifting			
Gauges			
Service Brakes & Spring Brakes			
ENGINE COMPARTMENT			
Mountings & Brackets			
Belts			
Plugs, Wires, Dist., Timing, Dwell.			
Radiator, Water Pump & Hoses			
Heater & Heater Hose			
Check Anti-Freeze			
Battery & Battery Cables			
Leaks: Oil, Gas, Exhaust, Water			
Power Steering Pump & Hoses			
PCV			
Carburetor, Choke System, Idle Adjustment			
Fuel Filters			
Alternator & Regulator			
Air Compressor & Air Compressor Filter			
Air Filter & Crankcase Vent Filter			
Water Separator			
Turbo Charger: Mountings, Leaks & Noise			
Injectors & Valve Clearance			
Governor: High & Low Idle			
AUXILIARY ENGINE: (OPTIONAL)			
Starting System			
Oil Level			
Air Filter			
Fuel System			
Running Condition			

	OK	R	Ref.
AUXILIARY ENGINE: (OPTIONAL) (Con't.)			
Anti-Freeze			
Charging System			
CHASSIS			
Steering Gear & Linkage			
Front Suspension			
Springs & Shock Absorbers			
Tires, Alignment, Wheels, Rims, Lugs			
Transmission Diff. & Drive Lines			
Transfer, Frt. Drive Axle			
Back Up Alarm			
Scotch Blocks			
Exhaust System & Shield			
Brake System: Linings, Fluid & Booster			
Drain Air Tanks			
Spring Brake Operation			
Glad Hands			
Compressor Pressure			
Fuel Tanks & Mounts			
Diesel Fuel Tanks (Drain Water)			
BODY & MISCELLANEOUS			
Body Mountings			
Lights & Reflectors			
Speedometer, Hour Meter			
Horn, Radio			
Mirrors: Inside & Outside			
Windshield Wipers & Washer			
Body & Fenders			
Doors, Seats, Windows			
Locker Doors & Latches			
Sliding Drawers & Latches			
Seat Belts, Shoulder Belts			
Trailer Hitch			
Fire Extinguishers			
Accident Report Forms			

REFERENCE SECTION (Use back for additional space)

_____

_____

_____

_____

_____

OK; R for Repair; Ref. for Reference **Mechanic** _____ **Date** _____

The key to good fuel economy is efficient engine performance. There are numerous mechanical deficiencies--a thermostat stuck in the open position, a too-tight drive belt, front wheels that are not in alignment, to name a few--that can increase fuel consumption. Consequently, energy-efficient fleet management requires a preventive maintenance program that ensures that all mechanical systems of fleet vehicles operate properly. In developing such a program, it must be kept in mind that maintenance requirements vary with respect to such factors as vehicle type, vehicle usage, and climatic conditions. A maintenance program for police cruisers, for example, would be inappropriate for school buses or garbage trucks. Thus, the maintenance manager should tailor his maintenance program to different categories or classes of vehicles, each of which has its own set of monitoring, inspection, and maintenance requirements.

FUEL EFFICIENCY-RELATED MAINTENANCE

Although it is impossible to delineate a single set of maintenance activities that will maximize fuel efficiency of all vehicle types, it is possible to identify several basic procedures that could form the core of an energy efficiency maintenance program.

Cooling System

A properly operating cooling system is essential for dispersing engine heat (burning gases inside engine cylinders typically reach 4500°F) and for ensuring efficient engine performance.

- Hoses and Clamps--Check for leaking or collapsed hoses and loose clamps which can affect cooling system performance.
- Water Pump--Use a water pump lubricant to reduce friction and rust scale formation.

- Thermostat--A properly working thermostat helps the engine warm up quickly and maintains economical coolant temperatures. A nine-degree (Fahrenheit) drop in temperature cuts fuel efficiency by one percent.

- Radiator Cap--Check for cracks and leaks which prevent proper pressurization and reduce water pump efficiency.

- Cooling Fan--Install a fan clutch that prevents the fan from running at high road speeds when it is not needed.

Fuel System

- Carburetor--Adjust idle speed, idle mixture, the stroke of the accelerator pump, and the float level to ensure proper idling and air-fuel mixture.

- Fuel Lines and Tank--Check for leaks which waste fuel before it gets to the engine.

- Fuel Filter--Replace at recommended intervals in order to avoid carburetor clogging which can prevent proper air-fuel mix.

- Air Filter--Replace at recommended intervals to prevent clogging and overly rich combustion mixture that increases fuel consumption. Use air filters with indicators which show exact level of air restriction to ensure timely filter changes.

Lubrication System

- Engine Oil--Use proper multiviscosity motor oil for various climatic and driving conditions to minimize engine resistance. Consider using extended-life synthetic engine lubricants.

- Oil Filter--Replace at proper intervals to reduce friction and engine wear.

- PCV Valve--Replace at recommended intervals to ensure proper combustion mixture.

Ignition System

A tune-up can improve fuel efficiency by as much as 11 percent. It has been reported that installation of new spark plugs alone can achieve a fuel efficiency increase of more than three percent.

- Spark Plugs--Replace at recommended intervals; a single damaged plug can reduce gas mileage by two miles per gallon.

- Adjust dwell angle (conventional ignition systems) and ignition timing at regular intervals for maximum efficiency. Check condenser, rotor, distributor cap, and wires periodically to ensure that the proper voltage is available to spark plugs.

Transmission and Drive Line

- Rear Axle--Use a high-quality lubricant to reduce friction. Consider using an additive such as molybdenum sulfate (MOS_5) to increase fuel efficiency.

- Automatic Transmission--At recommended intervals, change fluid, replace filters, and clean screens in order to prevent transmission slippage.

- Manual Transmission and Clutch--Lubricate at recommended intervals with conventional or synthetic gear oil. Consider using an additive such as MOS_5. Adjust clutch to prevent slippage.

Wheels And Tires

- Wheel Bearings--Check and repack/replace as needed to prevent wobble.

- Brakes--Check and adjust as needed to prevent break drag.

- Tires--Replace bias-ply tires with radials.

- Tire Pressure--Keep pressure near upper limit of manufacturer's recommendation to reduce friction and tire wear.

- Rotation and Balancing--Rotate and balance tires at recommended intervals to ensure even wear and to reduce friction.

- Wheel Alignment--Maintain proper toe-in, camber, and caster to minimize rolling resistance.

Other Mechanical Checks

- Drive Belts--Inspect periodically to ensure proper tension. A too-tight belt will increase fuel consumption.

- Electrical System--Check periodically for defects in the electrical system which will cause the alternator to work harder and waste fuel.

- Hydraulic System--Lubricate at recommended intervals to minimize friction and wear.

These are just a few of the fuel efficiency-related maintenance measures which might be incorporated in a general preventive maintenance program. Obviously, not all of these procedures are appropriate for every vehicle type (such as those with diesel engines), and their timing will depend on such factors as usage, climatic conditions, and actual vehicle performance.

WORKER PERFORMANCE

No matter how sophisticated its management information system, or how timely its preventive maintenance scheduling effort, a maintenance program without sufficient worker training and guidance cannot ensure proper vehicle performance and maximum energy efficiency. Three ingredients essential to effective fleet maintenance are training, supervision, and productivity standards.

- Training--Because of the growing sophistication and complexity of much fleet equipment, it is important that mechanics be knowledgeable of the latest maintenance techniques and developments. This is especially true of expensive diesel and hydraulic equipment. This should be accomplished through a formal program of basic training and refresher courses which ensures that mechanics' skills are consistent with industry standards.

- Supervision--Since fleet vehicles are "tools" which, like typewriters or photocopiers, are employed to accomplish primary agency missions such as road repair or police protection, their maintenance is usually viewed as being of secondary importance. As a result, maintenance operations are often characterized by inadequate management and control. The supervision of a garage foreman or maintenance superintendant is essential to ensure proper inspection and maintenance scheduling, and to monitor mechanic training and performance.

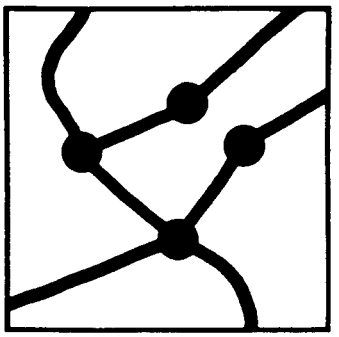
- Productivity Standards--Standards should be formulated delineating the amount of time to be spent performing each maintenance activity. In addition to manufacturers' specifications, information from such sources as Chilton Book Company and the American Trucking Association's Recommended Maintenance Practices Manual can assist the maintenance superintendent in developing such standards, which greatly facilitate work scheduling and mechanic performance monitoring.

CAN A COMPUTER HELP?

There are numerous commercially available software packages for the microcomputer which can assist the fleet administrator. These range from basic electronic spreadsheet packages which can perform most recordkeeping and performance monitoring chores, to fleet management packages which can be used to automate preventive maintenance scheduling, work order preparation, and parts inventory control.

FLEET ADMINISTRATOR'S CHECKLIST — VEHICLE MAINTENANCE

- ☐ Daily and weekly inspections of each fleet vehicle.
- ☐ Daily driver trip logs for reporting usage and mechanical problems.
- ☐ Vehicle-specific records containing:
  - ☐ Maintenance history
  - ☐ Usage trends (e.g., miles, hours of service)
  - ☐ Performance trends (e.g., mpg).
- ☐ Preventive maintenance specifications and schedule for each vehicle type or class.
- ☐ Energy efficiency-related maintenance checklist for each vehicle type or class.
- ☐ Up-to-date records on spare parts inventory.
- ☐ Formal mechanic training program and refresher courses.
- ☐ Productivity or time standards for all maintenance activities.



TRIP PLANNING

WHY IS IT IMPORTANT?

Trip planning offers fleet administrators several opportunities to reduce fuel consumption by providing more efficient utilization of fleet vehicles. Efficient vehicle use can, in turn, lower fleet capital and operating costs by facilitating disposal of underutilized vehicles, or by eliminating the need to purchase additional vehicles to expand fleet-related services.

WHAT SHOULD IT INCLUDE?

- Route Planning
- Scheduling
- Efficient Vehicle Utilization

ROUTE PLANNING

The use of route planning techniques can achieve significant energy savings in the provision of fixed-route services, such as garbage collection, student transportation, and public transit.

- Minimum Path Algorithms--There are many microcomputer software packages for vehicle routing which can assist fleet administrators in constructing energy-efficient routes. These packages employ algorithms which use a computer-coded representation of a community's road network to find the minimum path (usually expressed in terms of time rather than

distance) between, say, a cluster of students in a subdivision and the school to which they must be transported.

These minimum path algorithms can improve energy efficiency in other ways--for example, by routing an entire fleet of garbage trucks throughout a community in such a way that total vehicle driving time is minimized (and all garbage is collected), or by finding the location for a new maintenance facility which would result in the largest reduction or the smallest increase in fleet vehicle driving times.

- Manual Route Layout--Energy efficiency can often be increased by attempting to minimize driving time rather than distance. The shortest distance between two points may not be the most energy-efficient route if it is plagued by heavy traffic and stop-and-go driving conditions. In planning new routes or adjusting existing ones manually, every effort should be made to reduce driving time and fuel consumption by taking advantage of multiple-lane thoroughfares, traffic signal synchronization, and low traffic volumes.

- Vehicle Stop Frequency--Energy efficiency can be improved by reducing the frequency of vehicle stops. In the case of school bus and public transit operations, a simple bus stop inventory will frequently reveal route segments where the distance between stops can be increased without impairing service. While such factors as terrain, traffic signalization, the presence of elderly and handicapped riders and small school children, and the location of major ridership generators must be taken into account, a general rule of thumb for bus stop placement is one stop every 400 yards or one-quarter mile (i.e., approximately every two blocks in a typical residential neighborhood).

- Service Policy--Policies regarding how or to whom fleet-related services are provided constitute another opportunity to increase efficiency. For example, service can be reduced by establishing minimum walk distance policies requiring that bus transportation not be provided to school children who live within a certain distance of school.

  Limiting refuse collection to curbside pickup reduces the amount of time needed to service a given number of households or businesses, thereby reducing idling time and fuel consumption.

  Fuel savings also can be achieved by restructuring or eliminating underutilized routes or route segments (e.g., where average ridership is less than one passenger per revenue mile).

- Duplication, Deadhead Mileage--Energy efficiency can be increased by minimizing deadhead mileage and duplication of

services, e.g., two transit routes operating in the same general direction within one-half mile of each other.

SCHEDULING

Fleet administrators can often improve energy efficiency through changes in the timing and frequency of fleet vehicle use.

- Timing--In some cases, such as the provision of certain demand-responsive services, energy efficiency can be improved by limiting the use of fleet vehicles during peak periods when traffic congestion is likely to result in lower driving speeds and greater fuel consumption.

  Fuel savings can also be realized through the use of "flex-time" or staggered work hours which enable employees who use motor pool vehicles to avoid rush-hour congestion by traveling to and from work during off-peak periods.

- Service Frequency--Fleet administrators can frequently improve energy efficiency without impairing service effectiveness by reducing both the frequency and the hours of operation of such fleet-related services as public transit and human services transportation.

EFFICIENT VEHICLE UTILIZATION

There are several vehicle utilization policies and practices that can increase fleet energy efficiency.

- Ridesharing--One such opportunity for improving efficiency involves implementing an employee ridesharing program wherein motor pool vehicles are assigned only to those employees who rideshare; or ridesharing incentives such as preferential parking spaces or rates can be provided to those employees who are assigned fleet vehicles.

- Vehicle Assignment--Efficient vehicle utilization can be encouraged by assigning motor pool vehicles to several employees rather than to a single individual, thereby reducing fleet complement and capital and operating costs.

- Vehicle Use Restrictions--Substantial fuel savings may be achieved by means of a policy which prohibits employees from using fleet vehicles for non-business-related purposes. Such a policy must be accompanied by a vigorous monitoring and enforcement program.

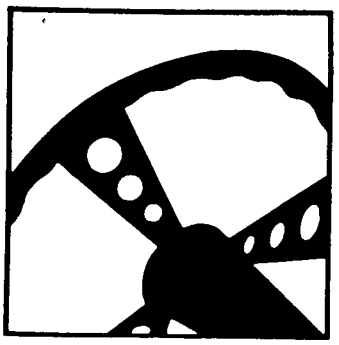
- Vehicle Storage--In the case of such fleet-related services as student transportation, rural public transit, and human services transportation, energy efficiency can be improved by allowing drivers to keep their vehicles with them overnight. This substantially reduces fuel consumption and other costs associated with routinely driving between a centralized storage location and individual routes or service areas.

CAN A COMPUTER HELP?

In addition to the microcomputer software packages discussed above, which can assist fleet administrators in planning routes and making fleet facility location decisions, there are many relatively inexpensive schedule-writing and run-cutting packages available from private vendors and government agencies.

FLEET ADMINISTRATOR'S CHECKLIST — TRIP PLANNING

- ☐ Route alignments that minimize driving time, deadhead mileage, and service duplication.
- ☐ Bus stop spacing of one-quarter mile or more except where there are mitigating factors, like steep terrain.
- ☐ Service policies minimizing underutilization of fleet-related services and unnecessary idling and stop-and-go driving.
- ☐ Service schedules and vehicle assignment policies minimizing peak-period vehicle use (without detracting from service effectiveness).
- ☐ Ridesharing incentives for fleet vehicle users.
- ☐ Assignment policies that require employees to share fleet vehicles.
- ☐ Restrictions on vehicle use for non-business-related purposes.
- ☐ Vehicle storage policies that minimize deadhead mileage.



VEHICLE OPERATION

WHY IS IT IMPORTANT?

Energy-efficient vehicle operation can reduce fleet fuel consumption by 10 percent or more. Additional benefits of efficient operating practices include:

- Good driver habits
- Improved driver and vehicle safety
- Lower maintenance costs
- Longer vehicle lives.

WHAT SHOULD IT INCLUDE?

- Driver Training Program
- Fuel-Efficient Driving Techniques

DRIVER TRAINING

A formal program of training and refresher courses is essential for developing energy-efficient driving habits among fleet vehicle operators. One way to implement such a program is through participation in the U.S. Department of Energy (DOE) Driver Energy Conservation Awareness Training (DECAT) program. Under this program, the fleet administrator (or

other designated staff member) is trained by DOE to teach energy-efficient driving techniques to fleet vehicle operators.

The DECAT program focuses on four main elements:

- Trip planning--how to reduce unnecessary driving
- Vehicle care and maintenance--how to protect your investment by maximizing mileage
- Behind-the-wheel techniques--how to drive safely and save gas
- The purchase decision--what to consider in choosing a vehicle.

DOE reports that individuals participating in the DECAT program can achieve fuel savings of 5-15 percent, and that fleets can improve overall fuel economy by 10-20 percent. Potential monetary savings resulting from DECAT implementation are shown below. Additional information on the DECAT program can be obtained from:

DOE - DECAT
P.O. Box 14100
Las Vegas, Nevada 89114
(702) 295-6535

ANNUAL FUEL COST SAVINGS PER VEHICLE
RESULTING FROM DECAT IMPLEMENTATION

Percentage of Fuel Saved	Initial Fuel Consumption Rate = 10 mpg			Initial Fuel Consumption Rate = 15 mpg		
	5,000 mi/yr	10,000 mi/yr	15,000 mi/yr	5,000 mi/yr	10,000 mi/yr	15,000 mi/yr
5	$29	$ 57	$ 86	$19	$ 38	$ 57
10	24	109	164	36	73	109
15	78	157	235	52	104	157

*Assumes $1.20/gallon fuel cost.

Development of driver understanding, motivation, cooperation, and participation is vital to the success of any fuel conservation effort. Accordingly, a driver training program should include an energy conservation awareness element consisting of such measures as:

- An employee suggestion program for conserving energy
- Distribution of brochures and articles describing ways to save energy via employee newsletters
- In-house competition among employees at different bases or operating facilities to save energy
- Recognition of the most efficient driver as the "Energy Conservation Driver of the Month"
- Positive reinforcement of driver achievement through other symbolic rewards.

FUEL-EFFICIENT DRIVING TECHNIQUES

The principal objective of a driver training program should be to foster fuel-efficient behind-the-wheel techniques. The American Automobile Association estimates that fuel efficiency can be improved by more than 40 percent if all stop-and-go driving techniques are improved. The techniques discussed below are not difficult to implement or practice; their success merely depends on driver participation and cooperation.

- Minimize unnecessary idling--At stops longer than two or three minutes, the engine should be shut down. Drivers should not use idling to help maintain warm or cool interior temperatures. Too much idling may lead to premature wear and sludge formation in gasoline engines and to injection problems in diesels. Automatic idling shutdown devices are available.
- Never exceed 55 mph speed limit--Vehicles consume more energy at greater speeds. Drivers must be trained to keep rpm down and not "drive against the governor" as learned in the past. Maintenance and tire costs also increase if speed exceeds 55 mph. Today's engines will not be damaged by lower rpm.

- Use progressive shifting, shift gears only when necessary, and skip shift where possible--In progressive shifting, drivers use the lowest rpm they need to make their shifts each time to maximize fuel savings with high torque-rise engines. Excessive shifting is particularly common in heavy traffic and should especially be avoided with high torque-rise engines.

- Avoid sudden ("jack rabbit") starts and stops--Avoiding sudden starts and stops requires careful observation of other vehicles, choosing a lane that will let the vehicle keep moving, and keeping an adequate distance from the vehicle in front. Steady acceleration and gradual deceleration save fuel. It has been reported that a fast start can cost as much as eight miles per gallon for the first four miles.

- Maintain constant speed--Maintaining constant speed where possible reduces fuel used for acceleration and deceleration. The ideal situation for fuel efficiency is driving in a straight line at cruising speed while maintaining a steady foot on the accelerator.

- Monitor fuel consumption--Electronic instruments, such as vacuum gauges, are available with readout devices to provide information to the driver on fuel use during trips. These devices also provide guidance for tune-up and other maintenance scheduling. With these devices, a driver could monitor the fuel consumption of his vehicle and make adjustments to save fuel.

- Supervise outside fueling to avoid "over-fills"--This involves training and monitoring of personnel who fill tanks. It also reduces damage to parking areas and reduces fire hazards.

- Drive to coast into stops--To maintain a fuel-efficient speed and flow smoothly through traffic, the driver must anticipate changes in conditions ahead. An alert driver saves gas by anticipating conditions twelve seconds ahead of every stop (about one city block or about 1/4 mile on open freeway).

- Limit engine warm-up--A thirty-second warm-up for a cold engine is generally recommended before driving. However, excessive idling wastes a lot of fuel. Since it takes up to twenty minutes for a vehicle to reach peak efficiency (that is, when all moving parts are warm), it is recommended to drive the first few miles at a low speed to assure proper engine warm-up.

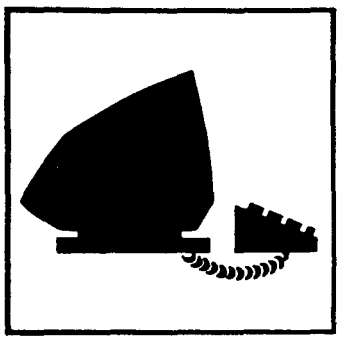
- Turn off air conditioning when climbing hills--The more power-consuming options a vehicle has, the more fuel it will consume. Therefore, it is advisable to turn off air conditioning and any other irrelevant power-consuming options when climbing hills to increase fuel efficiency.

CAN A COMPUTER HELP?

Fleet managers now have access to various microcomputer software packages which can be utilized by management, ranging from scheduling worker training to monitoring of fuel consumption by individual drivers. With the aid of computers, improvement in fuel economy could be monitored speedily, and further measures could be taken immediately.

FLEET ADMINISTRATOR'S CHECKLIST — VEHICLE OPERATION

- ☐ Implementation of energy conservation awareness program.
- ☐ Incentives for employees who contribute significantly to energy conservation.
- ☐ Development of new energy-efficient driving techniques pertinent to particular fleet characteristics.
- ☐ Designation of suitable staff for DECAT program and layout of training schedule for other operators.
- ☐ Monitoring of operators' driving efficiency.



PERFORMANCE MONITORING

WHY IS IT IMPORTANT?

Substantial fleet fuel savings can be realized through the use of an accurate up-to-date fuel consumption and maintenance reporting system. Systematic monitoring of vehicle performance also can yield savings in terms of better fuel mileage, lower maintenance costs, and longer vehicle lives and provide improved management and control of fleet operations.

WHAT SHOULD IT INCLUDE?

- Fuel Dispensing and Monitoring System
- Performance Standards
- Routine Calculation of Performance Indicators

FUEL DISPENSING AND MONITORING SYSTEM

An effective fuel dispensing and monitoring system should enable the fleet administrator to detect abnormal fuel consumption patterns and to determine the effectiveness of fuel conservation measures. Such a system can significantly improve management and control of fleet operations by alerting the fleet administrator to changes in fuel consumption resulting from mechanical malfunctions, inefficient vehicle operating practices, and/or unauthorized use of fleet vehicles for non-business-related purposes.

The appropriate type of dispensing and monitoring system for a given fleet largely depends on the size and complexity of that fleet's complement of vehicles. For small fleets, a manual system consisting of weekly or monthly calculation of selected performance measures such as miles per gallon of fuel consumed will usually suffice. Larger fleets, however, may benefit from a semi- or fully automated system such as those described below.

Semi-Automated System

This system is designed to handle only a moderate volume of traffic. The most basic semi-automated system electronically activates a pump when a driver presents a credit card. All transactions and accounting are normally performed by an island attendant. A pump-activated automated system, on the other hand, is activated by the insertion of a pre-assigned code, generally in the form of an identification card. The system does not require an island attendant if equipped with counters that record the amount of fuel dispensed.

Fully Automated System

This type of system is best-suited for fleets which consume large amounts of fuel. It can usually be programmed either to authorize fuel disbursements to individual drivers or to dispense a specific amount of fuel which is predetermined by each vehicle's fuel consumption history. When adequately programmed, a fully automated dispensing and monitoring system can virtually eliminate pilferage by storing transaction data in computer memory or on hard copy printout.

There is a wide variety of commercially available fuel dispensing and monitoring systems. Many large fleets develop their own software to

suit their particular operating and reporting requirements. In deciding what type of system to install, the fleet administrator should carefully weigh the potential benefits of a system, in terms of fuel cost savings and improved management control, against the cost of its installation and operation.

PERFORMANCE STANDARDS AND INDICATORS

Performance indicators are essential for monitoring fleet fuel consumption as well as overall vehicle and driver performance. Performance indicators should be computed and compared on a routine basis to performance standards which reflect the fleet administrator's goals and objectives with respect to vehicle and driver performance.

To illustrate, the typical measure of vehicle fuel consumption is miles driven per gallon of fuel consumed, i.e., mpg. A fuel consumption performance standard or goal for a given vehicle can be established by determining, from the manufacturer or other sources of industry statistics, the average fuel consumption rate for that type of vehicle. This standard can then be compared to the vehicle's actual consumption rate on a regular (e.g, weekly or monthly) basis.

Such monitoring of vehicle performance can detect significant fluctuations in each fleet vehicle's fuel consumption rate. A downturn in mpg might indicate a mechanical problem, a change in an operator's driving habits, or unauthorized use of a vehicle for non-business-related purposes. Conversely, the effectiveness of a new conservation awareness or driver training program would be reflected in increases in mpg.

Clearly, as simple a task as the weekly or monthly computation of each vehicle's fuel consumption rate provides the fleet administrator with

valuable fleet operations information, which can be used to identify opportunities for improving vehicle and driver performance and reducing costs.

This same process for monitoring performance can be extended to all areas of fleet operation. For example, a decrease in the average number of miles driven between road calls might indicate inadequate preventive maintenance or vehicle inspection procedures. Or an increase in bus ridership on a given route, measured in terms of the percentage of available seating capacity, might indicate the need for additional vehicles and shorter headways on that route.

Needless to say, different fleets have different service requirements, operating characteristics, and reporting procedures. Performance standards and monitoring techniques should be established with these factors in mind.

CAN A COMPUTER HELP?

Use of computers by large fleets for dispensing fuel and monitoring performance has become common. Computers can provide timely, accurate, and reliable information on a wide range of activities and transactions. Computer software for fuel dispensing and monitoring can be purchased from private vendors or custom developed to reflect the particular requirements of individual fleets. "Canned" electronic spreadsheet packages for the microcomputer are often ideally suited to the performance monitoring and reporting requirements of small fleets. Larger fleets may wish to develop their own performance monitoring software in house in order to integrate it with existing maintenance scheduling and inventory control programs. It also is possible to lease computer systems to assist the fleet

administrator in effective fuel conservation performance monitoring and management.

FLEET ADMINISTRATOR'S CHECKLIST — PERFORMANCE MONITORING

- ☐ Performance standards reflecting desired fuel efficiency levels and other fleet operating and service objectives.
- ☐ Routine computation and comparison of performance indicators with performance standards.
- ☐ Systematic procedure, whether manual, semi-automated, or fully automated, for monitoring fuel disbursements and consumption.

SUGGESTIONS FOR FURTHER READING

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