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ABSTRACT

This publication series of five booklets presents a summary of tips for saving energy in pupil transportation. The first booklet offers guidelines and suggestions to assist school transportation administration in achieving better fuel economy and cost management goals. The second presents purchasing tips and shows ways to use benefit cost analysis to provide a comprehensive measure of investment performance in selecting school busses. The third booklet contains a pocket mileage record for driver use. The fourth offers tips for planning, training personnel, purchasing, and operation that lead to greater fuel economy, and the fifth booklet addresses some of the basic scientific principles involved in saving fuel. (Author/MLF)

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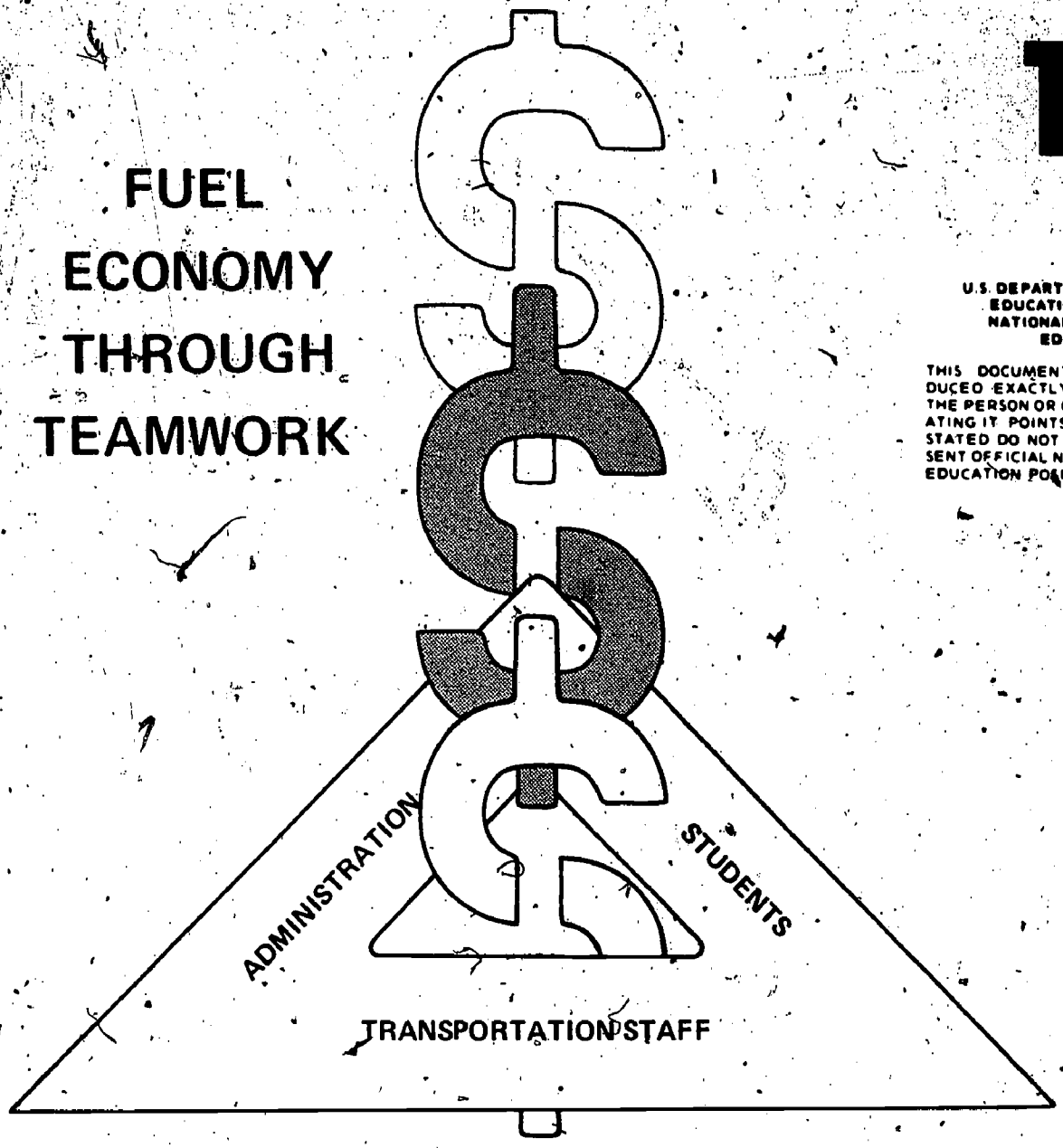
FUEL ECONOMY THROUGH TEAMWORK



PUPIL TRANSPORTATION AND ENERGY CONSERVATION

PREPARED BY:
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PHOENIX, ARIZ. 85068

OCTOBER 7, 1977

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ENERGY SAVINGS IN SCHOOL TRANSPORTATION PUBLICATION SERIES

PREFACE

"Energy Savings in School Transportation" has been prepared for the Office of the Secretary, U.S. Department of Transportation by BRI Systems, Inc. Its purpose is to present a summary of tips for saving energy in pupil transportation.

The publication series consists of five booklets entitled "Fuel Economy Through Teamwork" addressing the subjects of:

1. Pupil Transportation & Energy Conservation
2. Purchasing For Fuel Economy
3. Driving For Fuel Economy
4. Operating For Fuel Economy
5. The Science Of Saving Fuel

This booklet, Volume 1 of the series, offers guidelines and suggestions to assist school transportation administrators in achieving better fuel economy and cost management goals.

Acknowledgement is made to the school administrators, directors of pupil transportation, members of the transportation community, and government organizations who were so willing to share ideas during the preparation of this publication so that it can be of benefit to all school districts.

CONTENTS

A REFERENCE GUIDE OF QUESTIONS AND ANSWERS ABOUT FUEL ECONOMY AND ITS IMPORTANCE TO THE SCHOOL DISTRICT

A BASIC UNDERSTANDING OF ENERGY

WHAT IS ENERGY?

Energy is the capacity to do work. The rate at which energy is generated to perform the work is called "power." Energy can take many forms: mechanical, chemical, electrical, thermal, and nuclear. It can also be transformed from one form into another.

WHERE DOES ENERGY COME FROM?

Petroleum, natural gas, coal, solar, wind, and geothermal energy are natural energy sources. Electricity is generated by fossil-fueled, nuclear, and hydroelectric power plants. Together, these resources provide the ingredients that are necessary for our standard of living.

HOW MUCH WORK WILL ENERGY DO?

Energy is measured in terms of British Thermal Units (BTU's). A BTU is the amount of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit. Energy may also be measured in terms of barrels of oil. The following tables show the amount of energy required for typical activities in our economy and BTU equivalent values of common energy and fuel sources.

ENERGY WORK EQUIVALENTS OF OIL

1 BARREL	DRIVE A SCHOOL BUS FROM AMARILLO, TEXAS TO TULSA, OKLAHOMA; A DISTANCE OF 350 MILES
100 BARRELS	TAKE A LOADED JETLINER FROM CHICAGO TO WASHINGTON, D.C.
1,000 BARRELS	RUN THE CITY OF BALTIMORE, MD. FOR ABOUT 10 MINUTES

BTU EQUIVALENTS

1 BARREL OF OIL	5,800,000 BTU's
1 GALLON NO. 2 OIL	140,000 BTU's
1 GALLON GASOLINE	125,000 BTU's
1 KILOWATT-HOUR OF ELECTRICITY	3,413 BTU's
1 CUBIC FOOT OF NATURAL GAS	1,031 BTU's

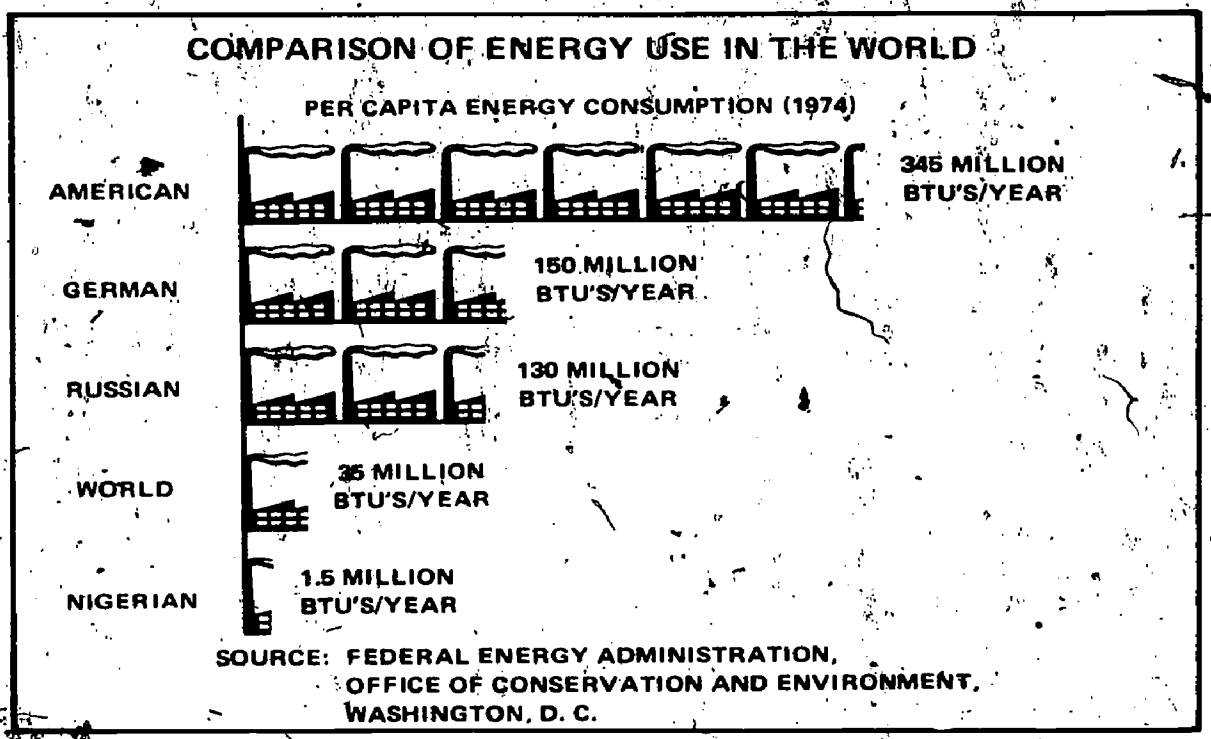
TRANSPORTATION IN THE U.S. USES ALMOST 9 MILLION BARRELS OF OIL EACH DAY

1. HOW MUCH ENERGY DOES AMERICA USE?

America has 6 percent of the world's population. Our nation produces over 30 percent of the world's goods; we consume nearly 31 percent of the world's energy.

To supply our entire national energy needs, America uses over 33 million barrels of oil equivalent energy (i.e., energy in all forms) each day. Oil provides 46 percent of this energy--about 15 million barrels each day. The balance comes from coal, natural gas, nuclear power, hydropower, and geothermal energy sources.

Per capita energy consumption in the U.S. was nearly ten times greater than the world average in 1974 as shown below.



2. WHERE DOES THE ENERGY GO?

Industry consumes about 40 percent of the energy in the U.S. The transportation sector uses another 30 percent. The balance is consumed by the residential and commercial sectors of the economy.

Nearly 50 percent of the energy consumed is non-productive energy. This energy is lost in the form of waste heat and to overcome forces such as friction in processes.

No process is 100 percent energy efficient. Energy is always lost. Electric motors, for example, convert electrical energy into mechanical energy. They generally have efficiencies ranging between 58-92 percent. The average boiler's efficiency is about 74 percent. Electric generators have efficiencies of about 25 percent. EPA(1) studies have shown that the efficiency of a motor vehicle--that fraction of combustion heat which ends up as mechanical power--can be as high as [redacted] percent; it can also be as low as 5-10 percent--depending upon how it is operated, where it is used, and how well it is maintained.

> ONE WOULD HOPE THAT SOME DAY SATISFACTORY ENERGY SOLUTIONS WILL BE FOUND.
> THE PROBLEM OF UNCERTAINTY IS CLOUDED BY UNCERTAINTY.
>
> ROBERT DORFMAN
> DESIGN OF WATER RESOURCE SYSTEMS
> HARVARD UNIVERSITY PRESS

(1) U. S. ENVIRONMENTAL PROTECTION AGENCY

3. WHAT CAN BE DONE TO REDUCE ENERGY USE?

The most important step that can be undertaken is to use energy more wisely:

- o Purchase products that use less energy.
- o Use equipment that offers energy savings.
- o Construct buildings and facilities using principles that conserve energy.
- o Practice energy conservation in every day activities as a way of life.

Take advantage of available equipment and fuel saving practices that save energy and hold down costs. Operate for energy savings. Make such practices a permanent part of your school district's management program.

Fuel savings are obtainable in every school district's transportation fleet. This was demonstrated during the days of the oil embargo. Become knowledgeable about fuel saving techniques and keep practicing them. We can do something about eliminating energy waste, increasing energy efficiency, and controlling energy costs.

BTU'S CONSUMED BY ONE MOTOR VEHICLE EACH YEAR

MILES DRIVEN EACH YEAR	VEHICLE MILES-PER-GALLON 3	5	10	20
6,000 MILES	250 MILLION	150 MILLION	75 MILLION	38 MILLION
18,000 MILES	750 MILLION	450 MILLION	225 MILLION	113 MILLION

4. WHY IS ENERGY CONSERVATION IMPORTANT TO THE SCHOOL DISTRICT?

The energy crisis following the oil embargo of October, 1973 demonstrated the vulnerability of all operations, including school districts, to increased fuel prices, and in instances the unavailability of fuel at any price. There is no assurance that yet another embargo could not take place in the future.

The sharp rise in fuel costs has placed a burden upon school districts. As prices go up, business may pass on these increases to its customers. The school district on the other hand has to work within its limited budget. Its principal alternatives to rising costs are to lay off personnel, reduce the level of services, or otherwise find additional funds.

A school district has one other alternative. It can use energy more wisely by implementing fuel conservation techniques. Some techniques are relatively easy to implement and require little effort and cost; others require an investment--sometimes it takes money to save money.

> THE PRACTICE OF ENERGY CONSERVATION IS ONE OF UNDERSTANDING, INVESTMENT OPPORTUNITY, SKILL APPLICATION, AND COOPERATION.
>
> ANONYMOUS

5. WHY IS ENERGY CONSERVATION IN PUPIL TRANSPORTATION A MAJOR AREA OF CONCERN?

Pupil transportation is among the important services that are provided in America's communities. Yet, all too often it is taken for granted.

Everyone expects daily schedules to be met and extra-curricular activity trip needs to be accommodated--in a safe, dependable, and economic manner. Each pupil transportation director must fulfill a mission which can be described as providing the best possible service at the least possible cost in a manner which offers no compromise for safety.

The U.S. National Center for Education Statistics show that in the U.S. nearly 268,000 school buses travel 2.6 billion miles to transport 21 million children attending grades K through 12. School buses use over 350 million gallons of fuel annually to transport about 52 percent of all pupils in our country. This represents an energy consumption of 43,750 billion BTU's each year--about 7.5 million barrels of oil.

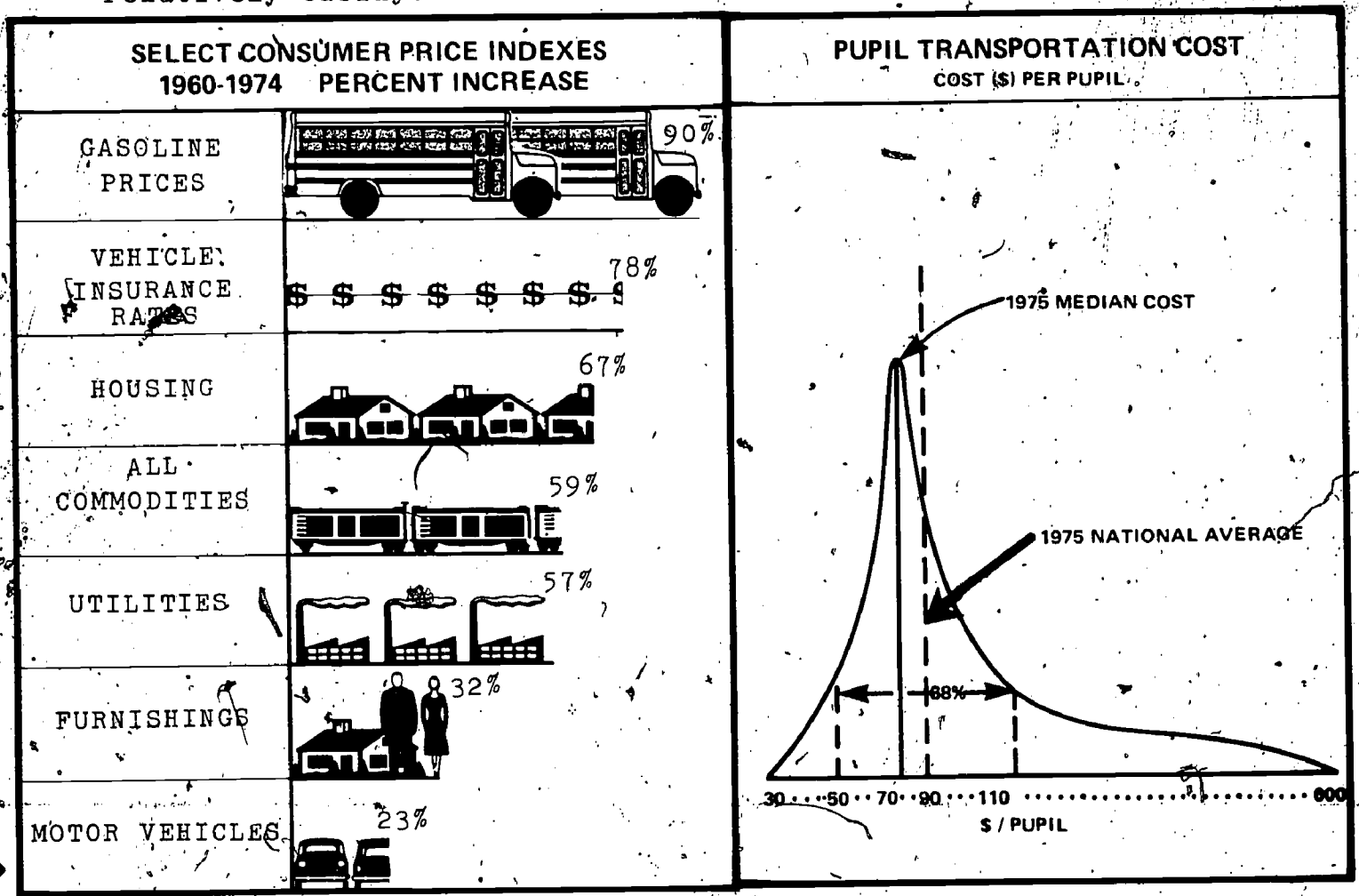
> THE WAY PEOPLE TALK ABOUT COSTS, ANYONE WOULD THINK THAT TO SAVE FUEL ON ONE SCHOOL BUS WAS A MATTER OF LIFE AND DEATH. THEY DON'T UNDERSTAND. IT'S MUCH MORE SERIOUS THAN THAT!
>
> ANONYMOUS

6. WHAT MOTIVATION IS THERE FOR CONSERVING FUEL?

Rapidly escalating prices and limited school budgets are among the principal forces for implementing fuel conservation actions. The satisfaction in knowing that the community is being provided the best service at the lowest possible cost is also important.

All commodities have increased significantly in price over the years. Gasoline prices alone increased 90 percent between 1960 and 1974. In 1975, school districts had to purchase gasoline at a cost which amounted to a 17-20 percent increase over the 1974 fuel price levels. These costs are still on the increase.

The average cost to transport a pupil in 1975 ranged between $43-$210 throughout the nation; the costs in some districts serving a small population over a wide area were as high as $600. Saving fuel and dollars has to be important to every school district. Furthermore, these goals can be achieved relatively easily.

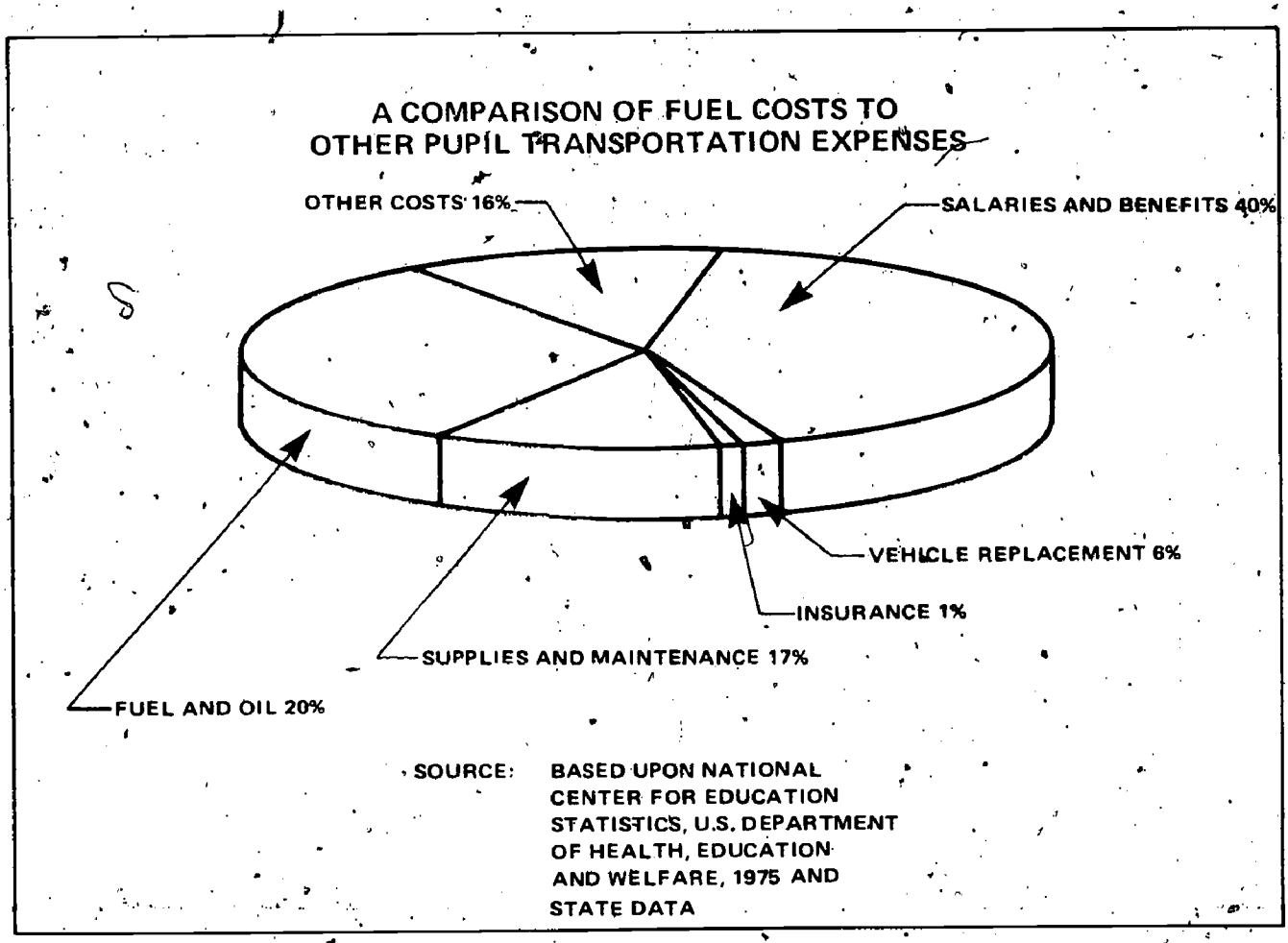


SOURCES: U. S. BUREAU OF THE CENSUS, "STATISTICAL ABSTRACT OF U. S.," DEPARTMENT OF COMMERCE, 1975
NATIONAL CENTER FOR EDUCATION STATISTICS, 1976

7. HOW CAN PUPIL TRANSPORTATION COSTS BE REDUCED?

Each dollar spent for pupil transportation pays for salaries and benefits, fuel and oil, supplies, maintenance, equipment purchases, insurance, and other needed items.

School transportation policies, purchasing practices, maintenance programs, vehicle use, school bus operation, driver skills, scheduling, and routing are representative of areas that can be investigated to obtain more pupil-miles-per-gallon. Look at ways to increase fuel economy, reduce transportation costs, and increase servicing efficiency. A cooperative fuel economy management program involving school administrators, staff, teachers, students, and parents working with the transportation department can generally increase the effectiveness of every district's service to the community.



8. WHAT IS A FUEL ECONOMY MANAGEMENT PROGRAM?

Fuel is an easily identifiable operating expense. Fuel economy is a measure of the pupil-miles-per-gallon that each school vehicle obtains from the fuel that is consumed--school buses and school district automobiles. It represents a measure of the effectiveness of a school district's service to provide efficient and safe pupil transportation for the least amount of money using the minimum amount of fuel. School bus fuel economy is obtained by transporting the maximum allowable number of pupils the shortest necessary distance in a vehicle offering the greatest miles-per-gallon for the task.

A fuel economy management program is an individual strategy--individual for each school district--consisting of identifying goals for reducing fuel use, deciding on how to implement them, and devoting the time and effort necessary to achieve results. It is based upon sound business practices.

The success of a fuel economy management program depends upon people--administrators, management, staff, bus drivers, shop personnel, and students. Everyone can and should contribute. Take advantage of the resources that are available. The energy of people is immense. It is generally too vast to be curtailed and immeasurable, if inspired. Use this available energy to initiate a fuel economy management program to increase the overall effectiveness of pupil transportation in your school district.

9. HOW IS A FUEL ECONOMY MANAGEMENT PROGRAM ORGANIZED?

A sound organizational plan is basic to success. The fuel economy management program should be organized within existing management functions. Place emphasis upon identifying goals and objectives, policies, fuel saving practices, responsibilities, and authorities to achieve better fuel and cost management. Involvement, commitment, communication, feedback, results measurement, and teamwork are key elements in your program:

1. Designate an individual to have the responsibility for heading the program.
2. Identify school district fuel saving goals.
3. Review policies, programs, and practices that affect pupil transportation fuel use and costs.
4. Develop recommendations to save fuel by performing tasks more efficiently.
5. Evaluate fuel saving measures that look promising.
6. Develop a plan to carry out the recommendations that appear to be the most promising for meeting the district's fuel saving goals.
7. Obtain administration endorsement and total commitment to carry out the plan.
8. Initiate the efforts required to implement the program; don't forget public relations activities and communication of the district's goals to the community.
9. Implement management controls to achieve the district's goals and objectives; measure and evaluate results during program operation.

PLAN · COMMIT · COMMUNICATE · INVOLVE · ACT

10. WHY ARE ADMINISTRATIVE POLICIES IMPORTANT IN SAVING FUEL?

Policies provide the setting for obtaining fuel savings--they represent the mechanism for achieving goals. No one person or department can carry out the entire program successfully. It requires teamwork. Policies offer a framework for directing the team. Examples of fuel saving policies that can be investigated include:

- ☐ Coordinate school calendars, (e.g., dates along with start-and-dismissal times), among all schools serviced to increase pupil transportation servicing effectiveness.
- ☐ Stagger hours, when practical to do so, based upon bus load levels.
- ☐ Consolidate special education start-and-dismissal times to coordinate more closely with the school program.
- ☐ Increase the walking distance to school and bus stops. Strictly enforce walking distance regulations.
- ☐ Avoid unnecessary service. Combine field and athletic trips. Use public mass transit when feasible for older students.
- ☐ Initiate programs that encourage students and staff to walk to school or ride bikes.
- ☐ Develop fuel economy incentives.
- ☐ Offer assistance to carry out the fuel economy program. Provide skills and resources--people, computer access, materials--to assist the transportation department to increase service efficiency.
- ☐ Establish maximum distances and department budgets for school travel.
- ☐ Consider a maximum miles-per-hour speed limit for all school vehicles. Enforce it.
- ☐ Promote actions that save fuel.
- ☐ Encourage the purchasing of equipment that saves fuel.

11. WHAT CAN BE DONE TO SAVE FUEL IN VEHICLE OPERATION?

Operation offers many areas for increasing fuel economy. Consider the following recommendations for your program:

1. Keep accurate records on vehicle fuel consumption and use this data in making transportation servicing, maintenance, and purchasing decisions.
2. Use "zone loading" practices with stops spaced as far apart as feasible and safe to do so.
3. Use the smallest practical vehicle for long distance light-load runs.
4. Match equipment to service needs; don't use a 66 passenger bus when a 30 passenger bus will do the job.
5. Reduce "dead heading." Use this as a training period for new drivers.
6. When drivers have split shifts, consider parking near their homes between runs when feasible to avoid "dead heading."
7. Consider the use of satellite bus parking stations to avoid "dead heading."
8. Scrutinize current bus routes. Look at how many avoidable stops the buses are faced with--stops that result in fuel waste while the vehicle is idling in congested traffic.
9. Encourage and promote good driving habits--starting and stopping smoothly, turning off the ignition when the bus will be stopped for more than one minute, avoiding full throttle, driving at steady speeds, and looking far enough ahead to avoid dangerous and fuel wasting situations.
10. Reduce warm up periods. Let drivers dress warmer and drive slower until the engine is heated.
11. Route buses to stay on main roads as much as possible.
12. Maintain for greater fuel economy.

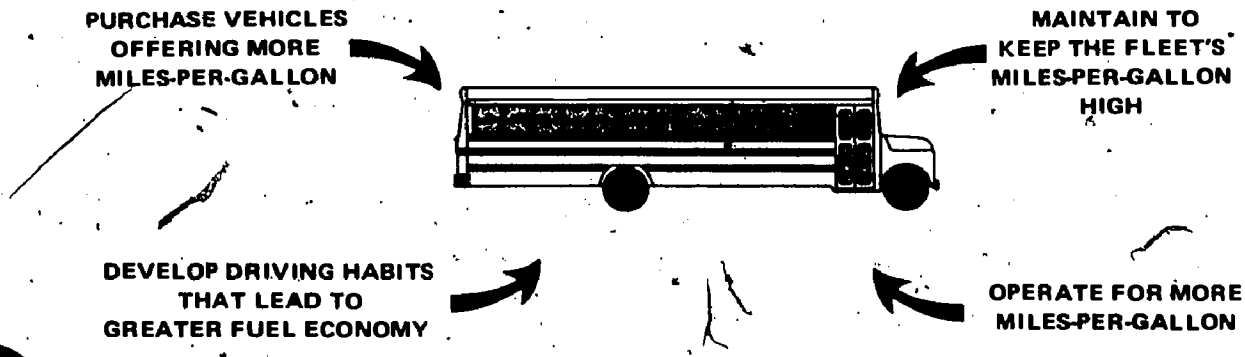
12. WHAT ELSE CONTRIBUTES TO BETTER FUEL ECONOMY?

A preventive maintenance program that emphasizes maximum efficiency from each bus in the fleet is a very important part of the fuel economy program. A sound program which takes advantage of state-of-the-art equipment and fuel saving practices to maintain the school bus fleet offers numerous benefits. Many efforts can increase fuel economy. Only a good preventive maintenance program can insure that this fuel economy is maintained on a day-to-day basis.

Purchase with fuel economy in mind. Maintain the fleet using equipment that allows mechanics to keep efficiency high. Instill an environment that supports close coordination between school bus drivers and the maintenance staff. Correct problems now, do not put them off.

Re-educate drivers when necessary to use fuel saving techniques. Make sure that fuel economy practices are followed by all drivers. This can be done by keeping track of each vehicle's performance--fuel and oil consumption, miles driven, and pupils transported.

Purchase, plan, operate, drive, and maintain for better fuel economy. These practices allow the district to get the most out of each dollar spent for pupil transportation.



13. WHERE DO "PEOPLE" FIT INTO THE PROGRAM?

Personnel morale, motivation, growth, and development are important parts of obtaining and maintaining increased fuel economy. Recommendations that lead to fuel savings include:

1. Promote an environment of self-improvement. Offer incentives for staff education and skill development.
2. Keynote performance in the staff.
3. Introduce "competitive driving" for maximum fuel economy.
4. Include a unit on "fuel economy" in the district's driver training program.
5. Send mechanics to "engine tune-up" schools, workshops, and seminars to keep up with the state-of-the-art.
6. Initiate a "more-miles-per-gallon" campaign; promote it.
7. Hold joint workshops with drivers and maintenance personnel on a frequent basis to share fuel economy knowledge.
8. Hold workshops with other districts. Take advantage of what others are doing to save fuel and reduce expenses.
9. Request information from drivers in route planning. Provide incentives for ideas that can save fuel.
10. Obtain staff and teacher participation in your fuel economy program. Get them involved; solicit ideas from them.
11. Get school organizations involved in the program. Have the science club or auto shop conduct a contest to promote fuel saving ideas. Have students design posters which can be used to promote the program. Place these posters in buses and throughout the school and community.
12. Use the PTA as a medium to promote the district's fuel economy program throughout the community.
13. Have members of the staff, faculty, student body, and PTA be a part of the team. Let them participate in program planning and implementation.

14. CAN ALL SCHOOL DISTRICTS TAKE ADVANTAGE OF A FUEL ECONOMY PROGRAM, EVEN SMALLER ONES?

The battle against wasted fuel is being fought by large and small bus fleet operations in school districts of all sizes and by private operators. "More miles-per-gallon" is a national goal--a goal that can translate into saved dollars for every school district.

Fuel economy savings have significance for every pupil transportation operation. The transportation department that services many pupils with a large fleet may obtain large dollar savings.

If $58,000 is invested in fuel saving equipment having a 7-year life that could return fuel and maintenance cost savings of $15,000 annually, this investment would offer a return on investment of 25.9 percent and a payback period of 3.9 years(2). The equipment would pay for itself, based upon these savings, and offer the district additional dollars that could be used for other needs. Similar types of sayings, proportionate to scale, are available to smaller fleets. Evaluate opportunities for obtaining savings in your school district. Consider fuel savings, reduced maintenance costs, labor savings, and other benefits that can be obtained from actions taken to increase fleet performance.

FUEL ECONOMY DOES NOT NECESSARILY MEAN TO RUSH OUT AND INVEST. ALL TOO OFTEN SCHOOL DOLLARS ARE TOO SCARCE. FUEL ECONOMY IS OBTAINED BY DEVELOPING AND IMPLEMENTING SOUND DECISION CRITERIA. WHEN YOU MUST SPEND DOLLARS, MAKE SURE THAT YOU'RE OBTAINING THE BEST RETURN FROM THEM. ALSO LOOK AT EQUIPMENT IN THE FLEET THAT IS OFFERING LOW FUEL ECONOMY. DETERMINE IF THE COST TO UPGRADE IT CAN SAVE THE DISTRICT DOLLARS.

ANONYMOUS

(2) REFER TO THE ESTEEM HANDBOOK FOR GUIDANCE IN CALCULATING RETURN ON INVESTMENT

15. WHAT STEPS SHOULD BE TAKEN TO INITIATE THE DISTRICT'S PROGRAM?

The first step is to make a commitment that fuel is going to be saved in school transportation. Plan a "more miles-per-gallon" program. Get everyone involved, including students and parents. Saving fuel can be exciting. It is rewarding. Identify fuel saving goals. Develop a plan of actions for achieving these goals:

- Provide incentives for increased fuel economy.
- Chart fuel economy; let everyone know who the best drivers are and give them recognition.
- Get the PTA involved to promote the program in the community.
- Involve school organizations; initiate student projects for ideas on increasing fuel economy.
- Prepare fuel economy posters. Place them on buses. Instill fuel economy competition.
- Promote the program throughout the community.
- Publicize program results for the community to see.

See if it is necessary to update policies to help the school district save fuel. Agree upon practical goals that can save fuel, establish programs to carry out the plan, and get everyone involved in its implementation.

16. WHERE DOES ONE START IN INITIATING FUEL ECONOMY MANAGEMENT?

Consult the other publications in the "Energy Savings In School Transportation" series for additional ideas to save fuel. The Department of Transportation also offers the handbook entitled "ESTEEM--Encouraging School Transportation - Effective Energy Management." Request it and consult it.

For additional information on how to save fuel and set up a fuel economy management program request:

"ESTEEM--Encouraging School Transportation Effective Energy Management."

The ESTEEM Handbook and additional copies of this booklet are available from:

Voluntary Truck and Bus Fuel Economy Program
U. S. Department of Energy
Washington, D.C. 20461

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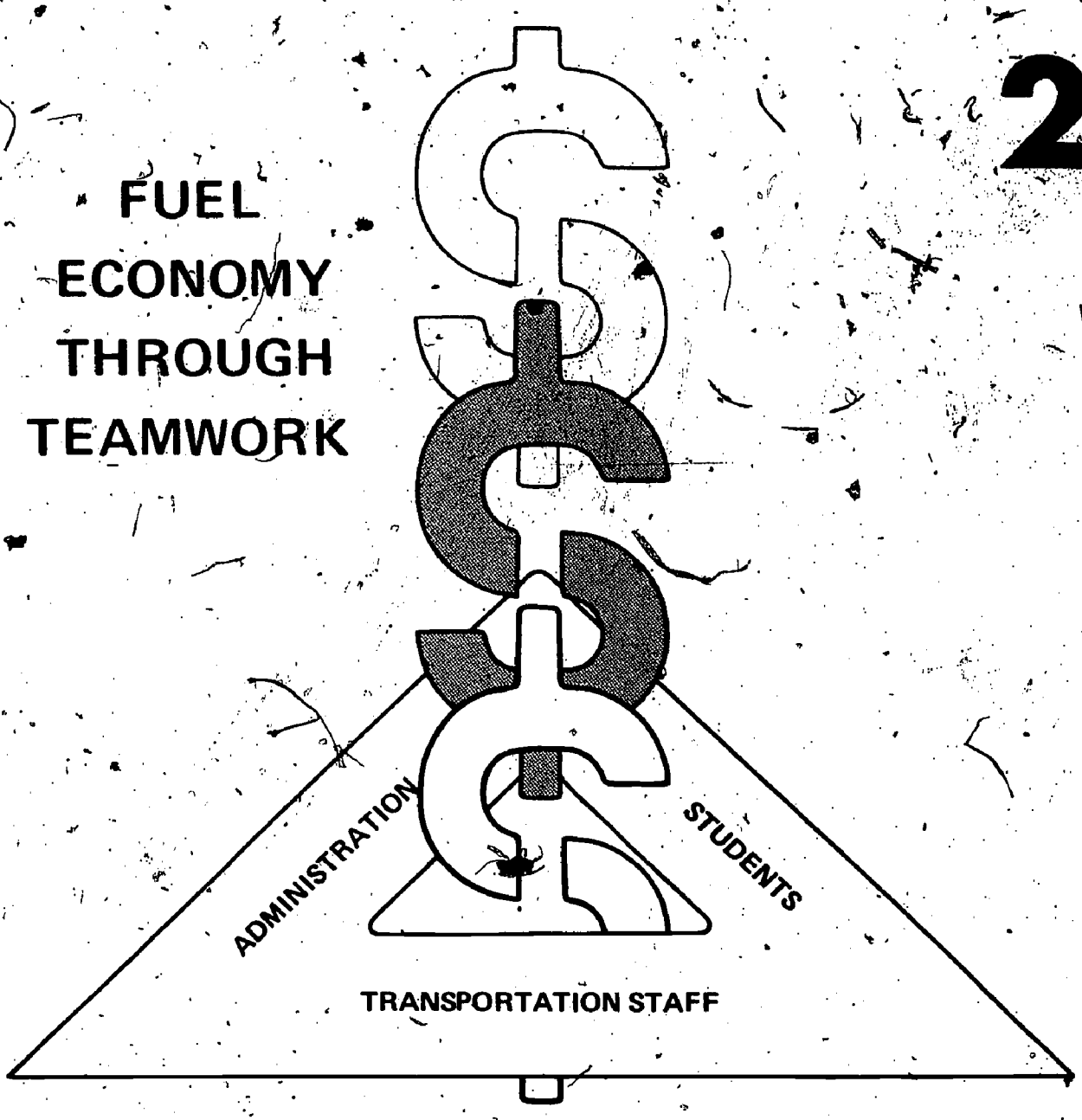
FUEL ECONOMY THROUGH TEAMWORK



PURCHASING FOR FUEL ECONOMY

PREPARED BY:
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ENERGY SAVINGS IN SCHOOL TRANSPORTATION PUBLICATION SERIES

ER 7, 1977

WHAT RETURNS ARE YOU GETTING FROM YOUR PURCHASING DOLLARS?

Follow sound business practices in purchasing. Recognize the benefits of fuel and dollar savings to the district and the community. Every dollar saved in pupil transportation means that one extra dollar is available for providing a quality education for the community's children.

The gambling casinos in Las Vegas operate on a percentage basis and in games such as roulette will win at least 5 percent of the time. Percentages are also important in saving fuel.

Purchase for fuel economy. Equipment that reduces the fuel consumption of a school bus by 10 percent offers the school district a 10 percent savings on its fuel costs. The equipment may also offer additional savings in maintenance and operation. Purchase equipment which will help the transportation department obtain and maintain better fuel economy performance.

Sound economic criteria are important for evaluating fuel economy opportunities. Before any investment is undertaken, a measure of its profitability should be computed so that the investment's expected return to the school district can be compared to alternative investment opportunities that may exist. This booklet offers tips in purchasing equipment that saves fuel.

PURCHASING TIPS

1. Purchase school buses that offer good fuel economy. The national average is 7.4 miles-per-gallon. Does your fleet obtain this fuel economy? More important, is it possible to purchase vehicles that offer even better fuel economy for your district's driving environment?

2. Use sound economic policy to evaluate purchases. Do not overpurchase. Match the bus to your servicing requirements. Give consideration to such factors as fuel savings, equipment service life, maintenance savings, and operating cost savings in evaluating purchases.

3. Purchase equipment that will help school bus drivers to drive for fuel economy. Consider using vehicle performance recording charts and alarms that indicate when hazardous or poor engine efficiency conditions exist. Find out what other school districts are doing to save fuel.

4. Consider options that offer fuel economy in your purchases. Diesel-powered engines, lower numerical rear axle ratios, radial tires, speed-governors, temperature-modulated fans, and turbochargers are examples of fuel saving equipment. An automatic transmission can also save fuel (and maintenance costs) if the bus is driven by drivers unskilled in operating a manual transmission.

5. Purchase equipment that will allow the maintenance staff to do a better job in keeping the efficiency of the school bus fleet at its maximum potential.

6. Consider options such as 2-way radios. Their use may save the district many dollars in bus rescheduling. They are also invaluable in emergencies.

7. Purchase wisely and purchase for fuel economy.

FIRST ORDER MEASURE OF PURCHASE BENEFITS

An investment's payback period (years) provides a first order measurement of its potential for recoupment. Make use of this analysis method in evaluating investments and purchases. A payback period of less than one-half an investment's lifetime is generally considered very profitable when the lifetime of the investment (e.g., equipment) is ten years or less.

The payback period is defined as the investment's first cost to the school district divided by the net annual savings, ignoring depreciation and working capital considerations.

$$\text{Payback Period (Years)} = \frac{\text{First Cost (\$)} - \text{Salvage Value (\$)}}{\text{Annual Savings (\$)}}$$

Maintenance equipment costing $600 that is estimated to save the district 1,500 gallons of fuel annually because of improved preventive maintenance for example, has a payback period of less than 1 year if the district purchases fuel at a cost of 50¢ per gallon.

$$\text{Payback Period} = \frac{\$600}{(1{,}500 \text{ Gallons}) \times (50¢/\text{Gallon})} = 0.8 \text{ Years}$$

If this equipment has a 15 year service life, the district can obtain fuel savings of $11,250 from this purchase, based upon savings of $750 annually considering current fuel prices.

Similarly, the school district can well afford to spend $20,000 or more for a computerized routing program if program implementation can result in first year savings of $40,000 including such cost-savings as an additional school bus, fuel, salary expenditures, fringe benefits, and maintenance expenses. These savings would pay for the program in its very first year of operation.

Take the time and effort to analyze pupil transportation investments. Use principles of economic analysis that are relevant to school district financial objectives.

SECOND ORDER MEASURE OF PURCHASE BENEFITS

Problems that arise in using the payback period as an indicator of investment value include: all proceeds received before the payback period are treated as equals, all proceeds received after the payback period are ignored, and the technique considers future year dollars to be the same as present year dollars. This is not true. A dollar held in hand today is worth more than the promise of a dollar in the future. Inflation and interest costs must be given consideration in the economic analysis.

Benefit-cost analysis, making use of discounted cash flow measures to show the time value of money, should be used to provide a more comprehensive measure of investment performance. Present Value (PV) analysis offers one such basis for investment evaluation as shown below using the tables on page 6.

$$\text{Present Value} = \left\{\text{Annual \$ Savings}\right\} \left\{\frac{\text{Present Worth Factor}}{\text{Value Of Money Based Upon Time And Discount Rate}}\right\}$$

Refer to tables on page 6.

As an example in the use of this technique, assume your district is considering the purchase of a new school bus that is to be driven 15,000 miles annually. The district compares diesel versus gasoline powered vehicles and finds that annual fuel savings of $550 and maintenance cost-savings of $720 can be obtained from the diesel-powered bus for a premium or additional first cost of $4,500. The present value of the net annual savings, assuming a discount (cost of money) factor of 9 percent over a 10 year period is $8,150.

$$\text{Present Value} = (\$550 + \$720)\ (6.4177)^{*} = \$8,150.48 \text{ or } \$8,150$$

The benefit-cost ratio for this purchase is 1.81, a profitable investment as discussed on page 5. It returns $1.81 for each $1 invested over the 10-year life of the vehicle.

* REFER TO PAGE 6.

INVESTMENT BENEFIT–COST ANALYSIS

The benefit-cost (B/C) ratio is computed by dividing the investment's present value by the first cost. In the example given on page 4, the present value is equal to $8,150 and the first cost premium was $4,500. This results in a B/C ratio of 1.81. This analysis assumed that fuel prices would remain the same over the period of investment. This is not true as discussed below.

$$\text{Benefit/Cost} = \frac{\text{Present Value (\$)}}{\text{First Cost (\$)}}$$

Use the following equation to give consideration to future fuel cost increases.

$$\begin{Bmatrix}\text{Average Annual Fuel Cost Over Investment Period (\$)}\end{Bmatrix} = \begin{Bmatrix}\text{Average Fuel Price This Year (\$/Gallon)}\end{Bmatrix}\begin{Bmatrix}\text{Fuel Price Increase Multiplier}\end{Bmatrix}$$

The fuel price increase multiplier is computed as follows:

$$\begin{Bmatrix}\text{Fuel Price Increase Multiplier}\end{Bmatrix} = \frac{(1+f)^N - 1}{f \cdot N} \begin{Bmatrix}\text{Refer to Page 6 for values.}\end{Bmatrix}$$

where f = estimated annual fuel price increase (%)
N = analysis period (years)

Assuming fuel price increases of 15 percent each year in the example on page 4, the present value would be $11,788.

$$\begin{Bmatrix}\text{Present Value}\end{Bmatrix} = \left[\begin{Bmatrix}\text{Average Fuel Savings/Year}\end{Bmatrix}\cdot\begin{Bmatrix}\text{Fuel Price Multiplier}\end{Bmatrix} + \begin{Bmatrix}\text{Total Of Other Annual Savings}\end{Bmatrix}\right]\cdot\begin{Bmatrix}\text{Present Worth Factor}\end{Bmatrix}$$

$$= \left[\{(\$550)\cdot(2.0304)\} + (\$720)\right]\cdot(6.4177)$$

$$= \$11,788$$

A more realistic B/C ratio is computed to be 2.62, a very profitable purchasing decision.

$$\text{B/C} = \frac{\$11,788}{\$4,500} = 2.62$$

PRESENT WORTH FACTORS FOR PRESENT VALUE ANALYSIS

LIFETIME (YRS.) N	DISCOUNT RATE (i) 3%	6%	9%	12%
1	0.9709	0.9434	0.9174	0.8929
2	1.9135	1.8334	1.7591	1.6901
3	2.8286	2.6730	2.5313	2.4018
4	3.7171	3.4651	3.2397	3.0373
5	4.5797	4.2124	3.8897	3.6048
6	5.4172	4.9173	4.4859	4.1114
7	6.2303	5.5824	5.0330	4.5638
8	7.0197	6.2098	5.5348	4.9676
9	7.7861	6.8017	5.9952	5.3282
10	8.5302	7.3601	6.4177	5.6502
15	11.9379	9.7122	8.0607	6.8109
20	14.8775	11.4699	9.1285	7.4694
25	17.4132	12.7834	9.8226	7.8431
30	19.6004	13.7648	10.2737	8.0552
35	21.4872	14.4982	10.5668	8.1755
40	23.1148	15.0463	10.7574	8.2438
45	24.5187	15.4558	10.8812	8.2825
50	25.7298	15.7619	10.9617	8.3045

BASED UPON PRESENT WORTH FACTOR = $\frac{(1+i)^N - 1}{i(1+i)^N}$

i = DISCOUNT RATE FOR THE UNIT OF TIME (N) IN YEARS.

FUEL PRICE INCREASE MULTIPLIER VALUES

PERIOD (N YEARS)	PROJECTED ANNUAL FUEL PRICE INCREASE 5%	10%	15%	20%
2	1.0250	1.0500	1.0750	1.1000
4	1.0775	1.1603	1.2483	1.3420
6	1.1337	1.2859	1.4590	1.6550
8	1.1936	1.4295	1.7159	2.0624
10	1.2578	1.5937	2.0304	2.5959

WHERE
FUEL PRICE MULTIPLIER = $\frac{(1+f)^N - 1}{f \cdot N}$

f = AVERAGE RATE (%) INCREASE OVER TIME (N)
N = PERIOD OF ANALYSIS IN YEARS.

PURCHASING IS AN IMPORTANT PART OF FUEL ECONOMY MANAGEMENT.

PURCHASE WISELY.

For additional information on how to save fuel and set up a fuel economy management program request:

"ESTEEM--Encouraging School Transportation Effective Energy Management."

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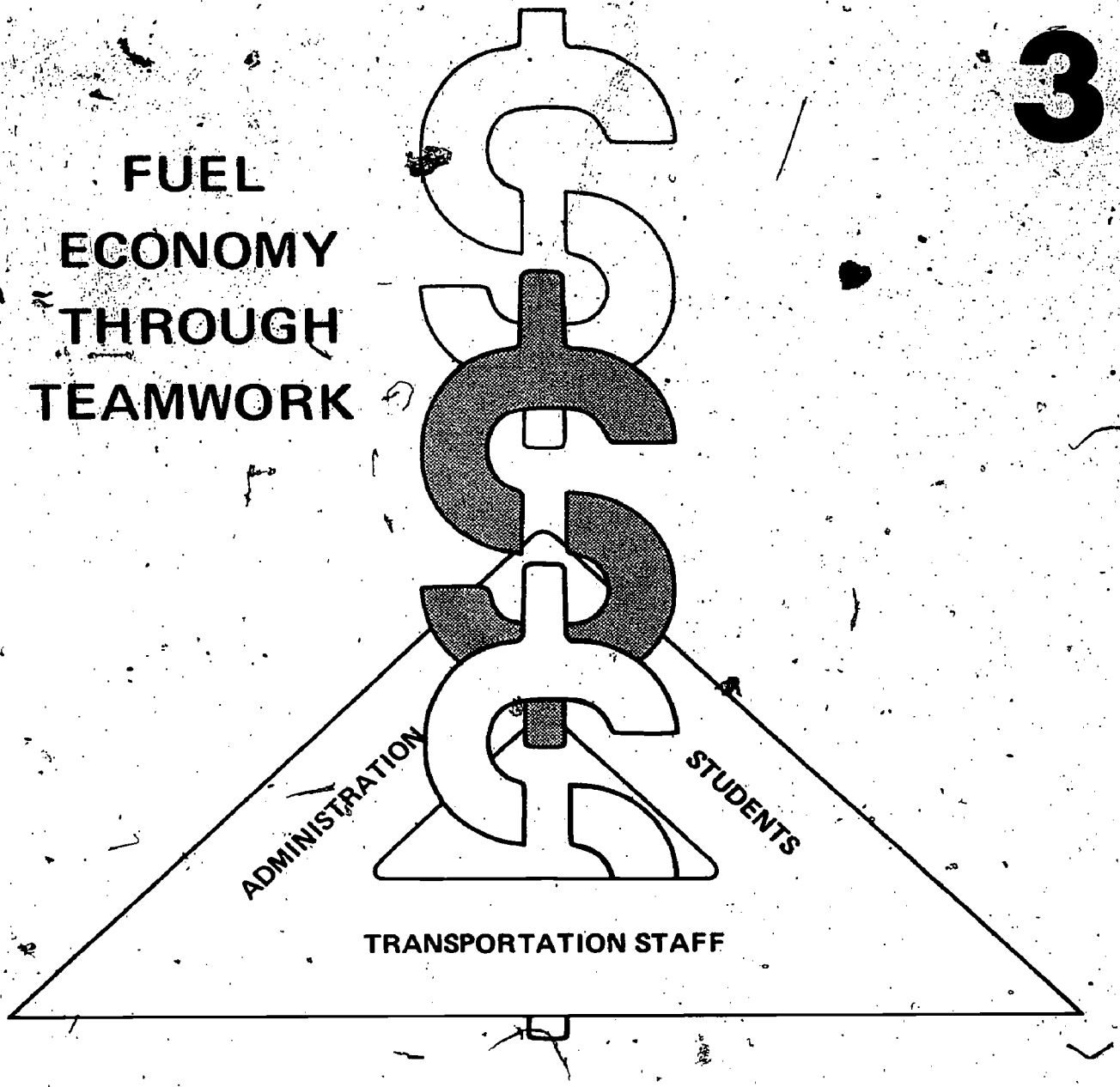
Voluntary Truck and Bus Fuel Economy Program
U. S. Department of Energy
Washington, D.C. 20461

3

FUEL ECONOMY THROUGH TEAMWORK



DRIVING FOR FUEL ECONOMY

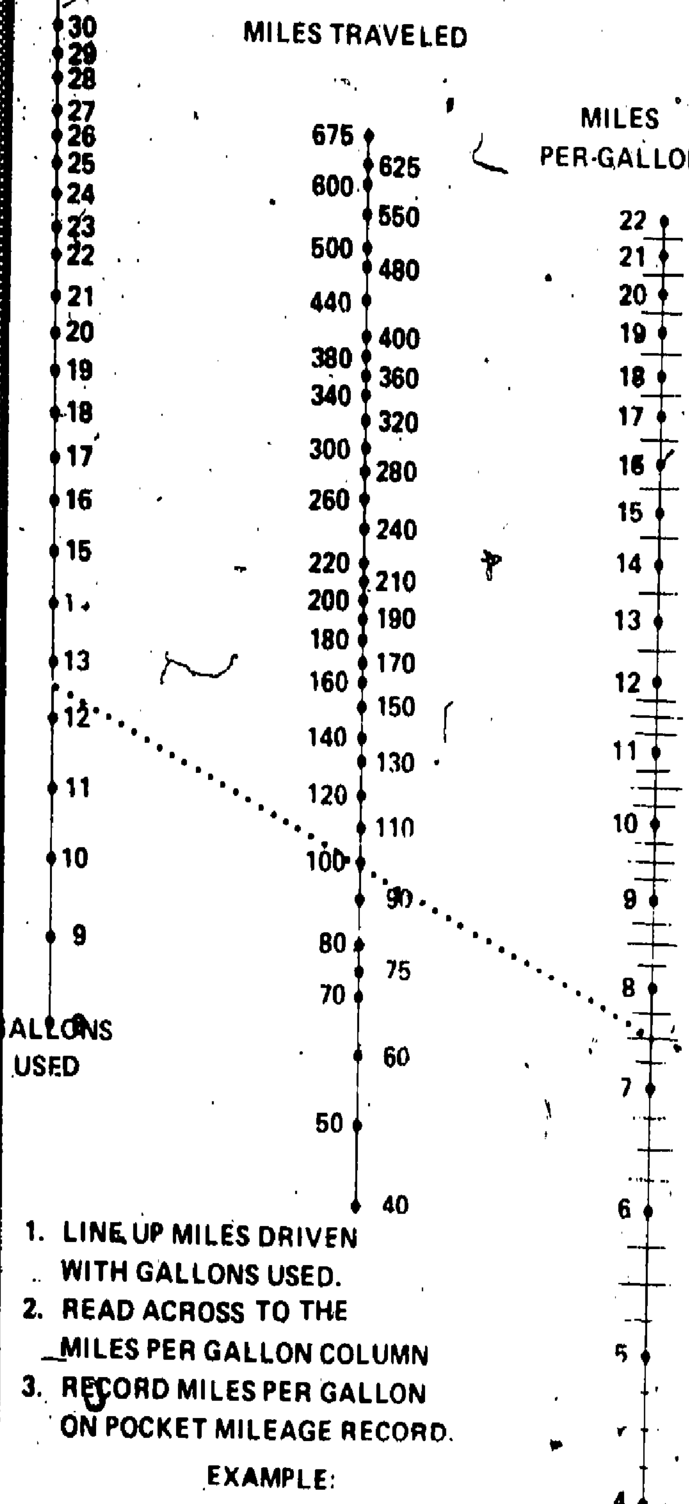
PREPARED BY:
BRI SYSTEMS, INC.
PHOENIX, ARIZ. 85068

OCTOBER 7, 1977

ENERGY SAVINGS IN
SCHOOL TRANSPORTATION
PUBLICATION SERIES

U. S. DEPARTMENT OF TRANSPORTATION

SCHOOL BUS MILEAGE CALCULATOR



1. LINE UP MILES DRIVEN WITH GALLONS USED.
2. READ ACROSS TO THE MILES PER GALLON COLUMN
3. RECORD MILES PER GALLON ON POCKET MILEAGE RECORD.

EXAMPLE:
DOTTED LINE SHOWS 12 GALLONS OF FUEL WERE USED TO DRIVE 90 MILES. THE FUEL ECONOMY OF THE SCHOOL BUS IS 7.5 MPG.

POCKET MILEAGE RECORD

BUS NO.______ DRIVER______________

DATE	GALS	ODOMETER READING	MILES TRAVELED	MILES PER GALLON

POCKET MILEAGE RECORD

DATE	GALS	ODOMETER READING	MILES TRAVELED	MILES PER GALLON

U. S. DEPARTMENT OF TRANSPORTATION
WASHINGTON, D.C. 20590

18 FUEL SAVING TIPS

1. CHECK THAT OIL, WATER LEVELS, AND TIRE INFLATION PRESSURE ARE PROPER EACH TIME YOU FILL UP.
2. GRADUALLY ACCELERATE THE BUS TO THE DESIRED SPEED.
3. DRIVE SLOWER WHEN THE ENGINE IS COLD.
4. LOOK AHEAD AND ANTICIPATE STOPS.
5. DRIVE AT STEADY SPEEDS. USE THE BRAKES AS LITTLE AS POSSIBLE.
6. ACCELERATE AND DECELERATE SMOOTHLY WHEN CHANGING SPEEDS.
7. PLAN YOUR TRAFFIC MOVES EARLY.
8. ADJUST THE VEHICLE SPEED TO THE ROAD AND WEATHER CONDITIONS.
9. SHIFT INTO HIGH GEAR AS SOON AS POSSIBLE, BUT DON'T LUG THE ENGINE.
10. TURN CORNERS SLOWLY AND CHANGE LANES SMOOTHLY.
11. TURN OFF THE IGNITION IF THE BUS IS TO BE STOPPED FOR MORE THAN 1 MINUTE.
12. DO NOT SPEED UP THE ENGINE BEFORE TURNING OFF THE IGNITION.
13. REDUCE IDLE ENGINE WARM-UP TIME.
14. DON'T START THE ENGINE UNTIL EVERYONE IS READY TO GO.
15. SMELL FOR TROUBLE, LOOK FOR TROUBLE, LISTEN FOR TROUBLE, FEEL FOR TROUBLE --REPORT ANY PROBLEMS IMMEDIATELY.
16. MAINTAIN PATIENCE, COURTESY, AND GOOD HUMOR.
17. KEEP ACCURATE RECORDS OF FUEL CONSUMPTION.
18. TRY AS MANY FUEL ECONOMY TECHNIQUES AS POSSIBLE TO INCREASE YOUR VEHICLE'S MILES-PER-GALLON.

IT'S TIME FOR COOL HEADS NOT HEATED DISCUSSIONS

Fuel economy performance (miles-per-gallon) is a yardstick of how well a bus is driven. Thousands of gallons of fuel are saved each year by school transportation departments that have become serious and professional about fuel economy. Increased fuel economy just does not happen--it requires skill--the skill to drive safely and save fuel.

There are certain factors that are beyond a driver's control. Yet, each school bus will offer a range of fuel economies--depending on how well the bus is maintained and driven. Where you drive and how you drive affects the fuel economy that can be obtained.

Get in the habit of keeping track of fuel economy, calculate it, and compare it during fill ups. Inform maintenance personnel when the vehicle's miles-per-gallon is decreasing. It may be time for a tune up or other corrective actions.

Learn to avoid practices that cost extra fuel--extended idling, bursts of speed, and excessive braking.

Take advantage of fuel saving techniques--some important ones are listed on the attached insert.

GOOD PERFORMANCE RESULTS IN INCREASED SAFETY AND LOWER FUEL BILLS

FOR FURTHER INFORMATION ON HOW TO SAVE FUEL REQUEST:
"ESTEEM -- ENCOURAGING SCHOOL TRANSPORTATION EFFECTIVE ENERGY MANAGEMENT"

INCREASING YOUR MILES PER GALLON

Fuel economy savings are based upon percentages. The more skillful drivers can increase these percentages.

Record keeping is an important step in increasing fuel economy. Keeping track of the vehicle's miles-per-gallon indicates when it is time for a tune up or when equipment is not operating properly. Use the charts provided in the insert to keep track of your vehicle's miles-per-gallon. Record this information and use it as a yardstick for measuring school bus fuel economy.

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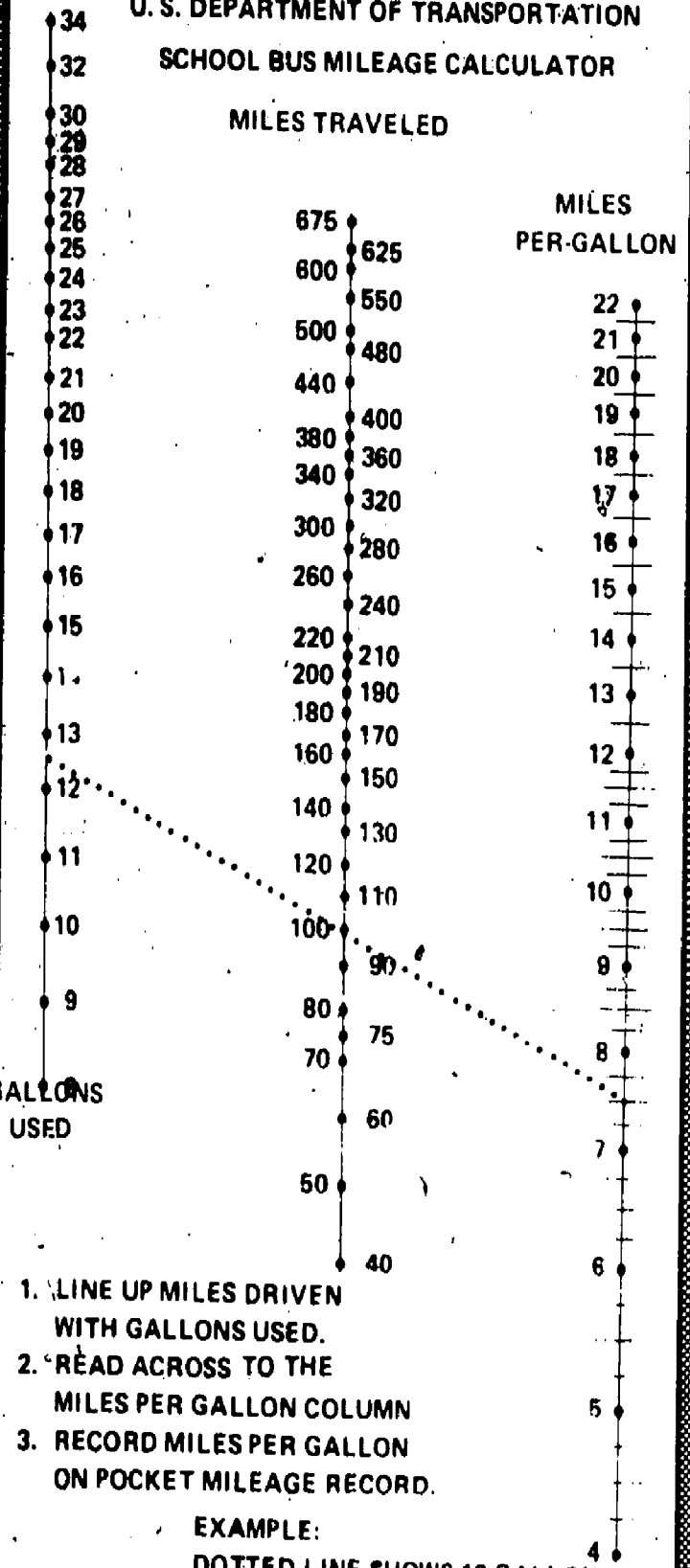
U. S. DEPARTMENT OF TRANSPORTATION
SCHOOL BUS MILEAGE CALCULATOR



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U. S. DEPARTMENT OF TRANSPORTATION
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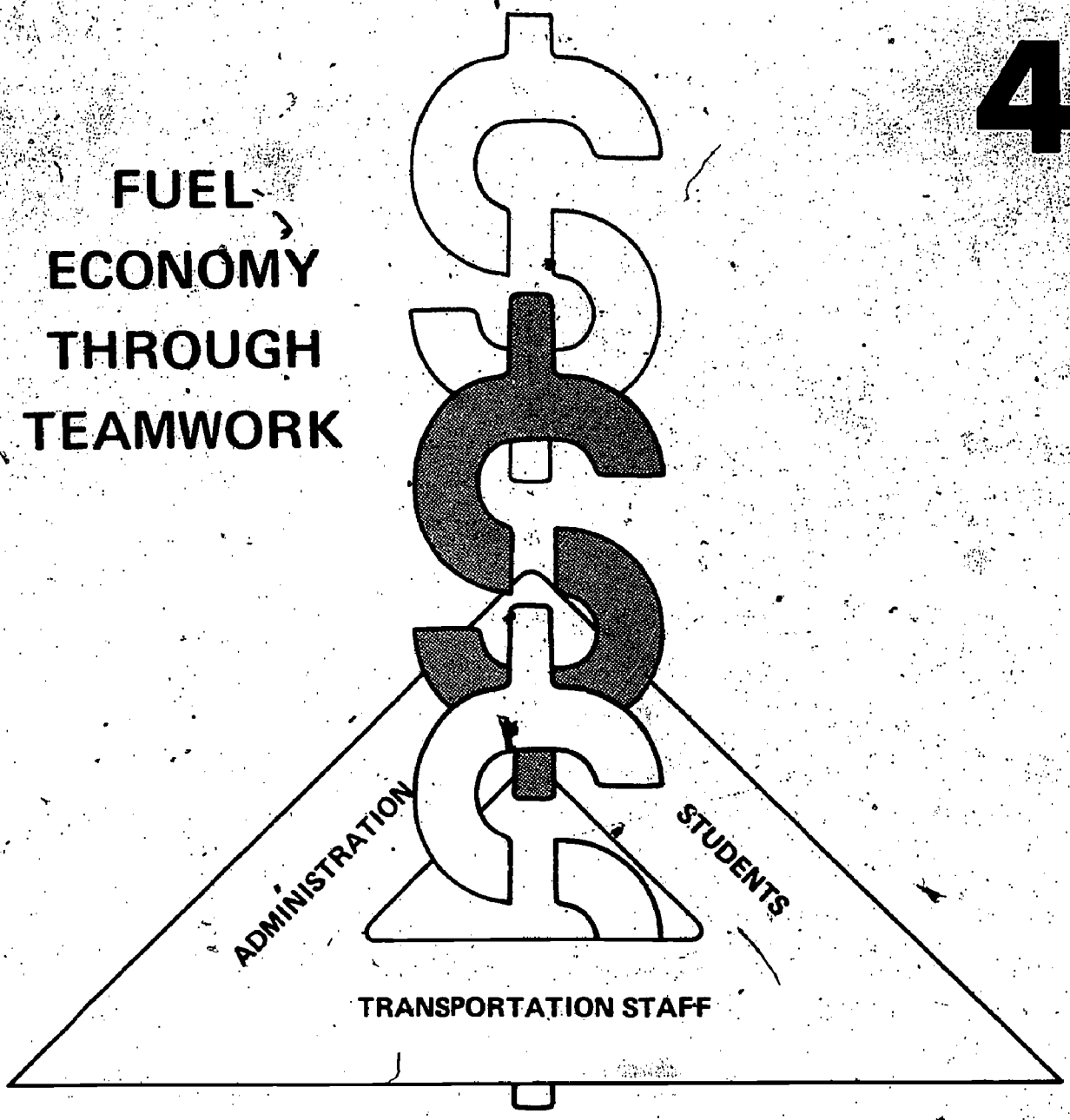
4

FUEL ECONOMY THROUGH TEAMWORK



OPERATING FOR FUEL ECONOMY

DEPARTMENT OF TRANSPORTATION
UNITED STATES OF AMERICA

PREPARED BY:
BRI SYSTEMS, INC.
PHOENIX, ARIZ. 85008

ENERGY SAVINGS IN
SCHOOL TRANSPORTATION
PUBLICATION SERIES

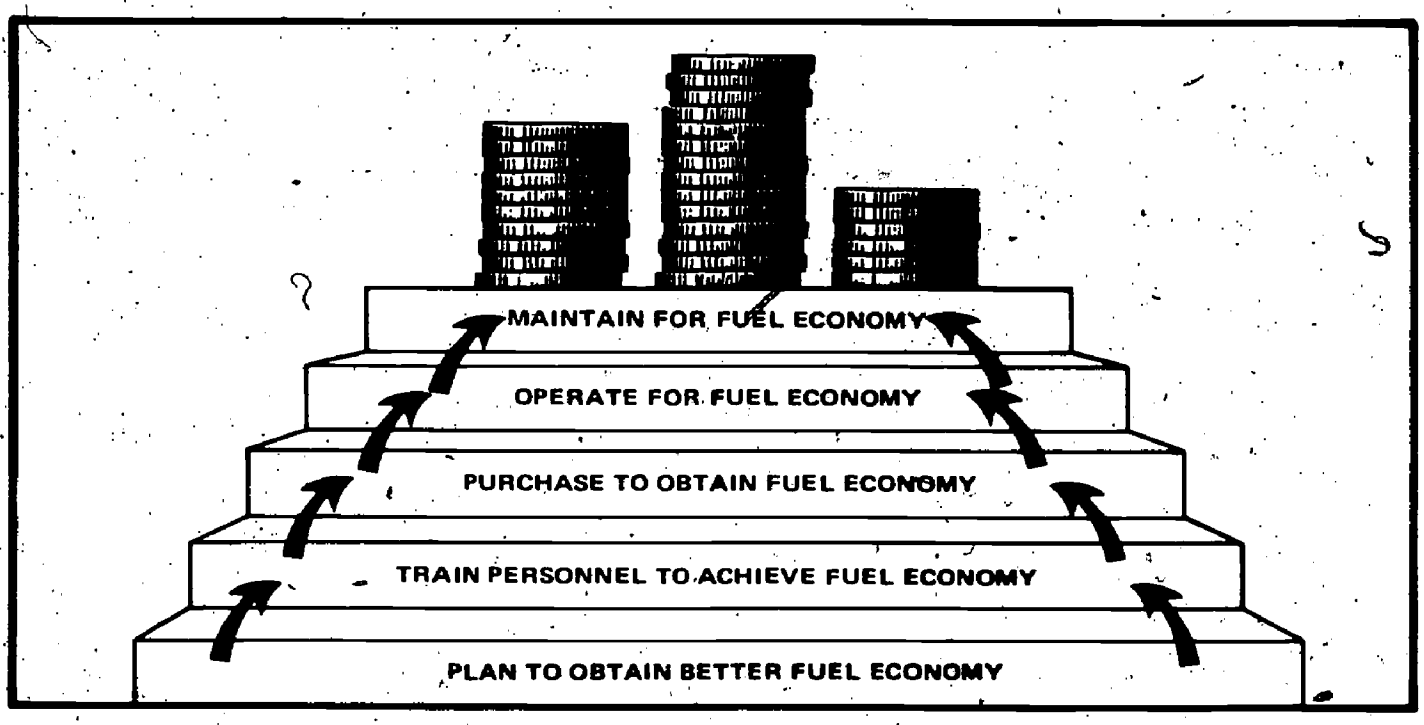
BER 7, 1977

THE STEPS TO GREATER FUEL ECONOMY

A small school district and a large district have different problems which require different solutions. Nevertheless, the objectives of the pupil transportation directors should be the same. Each must provide the proper equipment to do assigned tasks at the right time. Furthermore, each must provide the safest service at the lowest possible net cost.

The achievement of low net operating cost can be accomplished by taking advantage of fuel economy management principles. These principles are based upon performance criteria--maximize vehicle use and operating productivity. Effective pupil transportation servicing is evidenced by making good use of available vehicles, getting the most out of each gallon of fuel consumed through planning, scheduling, training, purchasing, and maintenance operations that are based upon sound management principles.

This booklet offers tips for increasing school district transportation effectiveness along each step of the path that leads to greater fuel economy.



Performance just does not happen, it is planned. The transportation director that can transport the district's pupils at 40¢ per bus-mile is not lucky. He has achieved this cost as a result of management planning and actions.

Objectively review the factors that lead to greater fuel economy on the following pages. Remember, the recommendations presented are not a panacea for any ills that exist. They serve to highlight areas that may require additional attention to increase pupil servicing effectiveness.

Conduct a survey of the transportation operation and use it as a framework for formulating and molding a district fuel economy management program.

Develop a plan to achieve the district's fuel economy goals; have it reviewed to get the "kinks" out of it. Initiate the groundwork that is required to implement your district's plan. Consult the ESTEEM* Handbook for guidelines in implementing a fuel economy management program in the district. You have now taken the first crucial step towards increasing fuel economy.

*Encouraging School Transportation Effective Energy Management. This handbook is available from the U.S. Department of Transportation, Washington, D.C.; refer to page 7.

TRAIN PERSONNEL TO ACHIEVE INCREASED FUEL ECONOMY

"A GOOD MANAGER IS A MAN WHO ISN'T WORRIED ABOUT HIS CAREER BUT RATHER THE CAREERS OF THOSE WHO WORK FOR HIM."

H. S. BURNS, PRESIDENT
SHELL OIL COMPANY

Equipment is carefully designed to perform specific tasks. Yet achieving its potential to perform the task efficiently is dependent upon those who operate it. A purpose of personnel training is to make sure that they know how to obtain maximum performance from their equipment. Evaluate the opportunities for increasing personnel skills. This is an important second step in obtaining increased fuel economy.

QUESTIONS TO BE ADDRESSED	POTENTIAL SOLUTION	DISTRICT PRIORITY
Do drivers recognize the factors that lead to more miles-per-gallon?	Driver Re-education	
Do drivers have a thorough knowledge of defensive driving practices which result in greater fuel economy?	Driver Fuel Economy Training	
Are mechanics familiar with equipment that can pinpoint and correct engine efficiency problems?	In-Service Training Schools	
Are mechanics making use of specialized services that exist to increase the effectiveness of the maintenance program?	Conferences And Workshops To Increase Knowledge	
Can operating costs be identified if bus routes or vehicle use are changed?	State-Of-The-Art Planning Tools And Professional Seminars	
Can the location of every bus be pinpointed at any time?	Dispatcher Training	
Does it pay to modernize the fleet or replace equipment?	Fuel Economy Management	
Do operation records indicate the level of performance of each vehicle in the fleet?	Records Management	

PURCHASE TO OBTAIN GREATER FUEL ECONOMY

In an era of extremely tight budgets, the school district must obtain the most benefit from each dollar that is spent. Each major equipment purchase must be based upon sound economic principles. It is not necessary for the purchasing manager to be a master mechanic or engineer, but he must know what contributes to fuel savings and have an appreciation of the equipment suited for the operation. The following table offers criteria that lead to better purchasing decisions. The use of these criteria should be a part of every purchasing decision.

SELECTION CRITERIA	CRITERION DEFINITION	DISTRICT PRIORITY
SERVICE	The vehicle should be designed to do the job that it is purchased for--no more and no less.	
QUALITY	The vehicle should provide economical, trouble-free service over a relatively long life-expectancy.	
RELIABILITY	The vehicle should be constructed to allow for necessary preventive maintenance to be performed readily and relatively easily.	
FUEL SAVINGS	The vehicle should offer fuel and oil savings.	
COST	Considering all the above factors, purchase of the vehicle should offer the district a good Benefit-Cost ratio.	

The development of purchasing specifications to obtain greater fuel economy is an important third step in achieving mpre pupil-miles-per-gallon.

OPERATE FOR FUEL ECONOMY

Pupil transportation has many complexities; it offers numerous challenges for increasing efficiency. Each area of the operation is important and contributes to overall program effectiveness.

Review the elements within the transportation operation to determine if they can be performed better. There is always room for improvement. Take advantage of modern practices and equipment that are available to improve performance.

TRANSPORTATION OPERATIONAL AREA	IMPORTANT QUESTIONS TO BE ADDRESSED IN EACH OPERATIONAL AREA
ORGANIZATION	o Is the current organizational plan served by good channels of communication? o Is the workload excessive for the staff to properly perform?
ROUTING	o Are bus loads and schedules analyzed? o Is a comparative analysis performed? o Are vehicles properly matched to the route?
SCHEDULING	o Do guidelines govern vehicle use? o Is equipment used for its intended purpose?
DISPATCHING	o Is the dispatcher sufficiently advised of traffic problems in advance? o Can the dispatcher reschedule vehicles that are on their runs?
LOADING & UNLOADING	o Can the distance be lengthened between student pick up points?
VEHICLE PERFORMANCE AND COST CONTROLS	o Is a periodic analysis of vehicle performance made? o Is historical information available on each vehicle in the fleet?
MAINTENANCE	o Is maintenance equipment adequate to support servicing requirements? o Is management by exception practiced? Do the jobs get done?

MAINTAIN FOR FUEL ECONOMY

Dollars spent to upgrade the maintenance program are among the most important in obtaining increased fuel economy. There are no compromises in effective maintenance from a standpoint of safety or fuel economy. If the district's program is not adequate, it will penalize all other areas of the operation because the potential for achieving fuel savings will be diminished.

SOME FINAL COMMENTS

Take advantage of what other school districts are doing to increase the performance of their fleets. Ask the following questions?

- When was the last time that district personnel attended a workshop on fuel economy?
- How often does the staff communicate with other districts to exchange fuel economy information?
- Does the administration promote these exchanges?
- Does the driver training program contain a unit on fuel economy?
- Are in-service training programs offered for the staff?
- Does management recognize the benefits of computerized routing and scheduling?
- Does management recognize why specific problems have arisen and how they can be resolved?

Address each of these areas to improve fuel economy. As the late President Kennedy stated in a message to Congress in 1961 "The human mind is our fundamental resource." Capitalize upon it in your school district.

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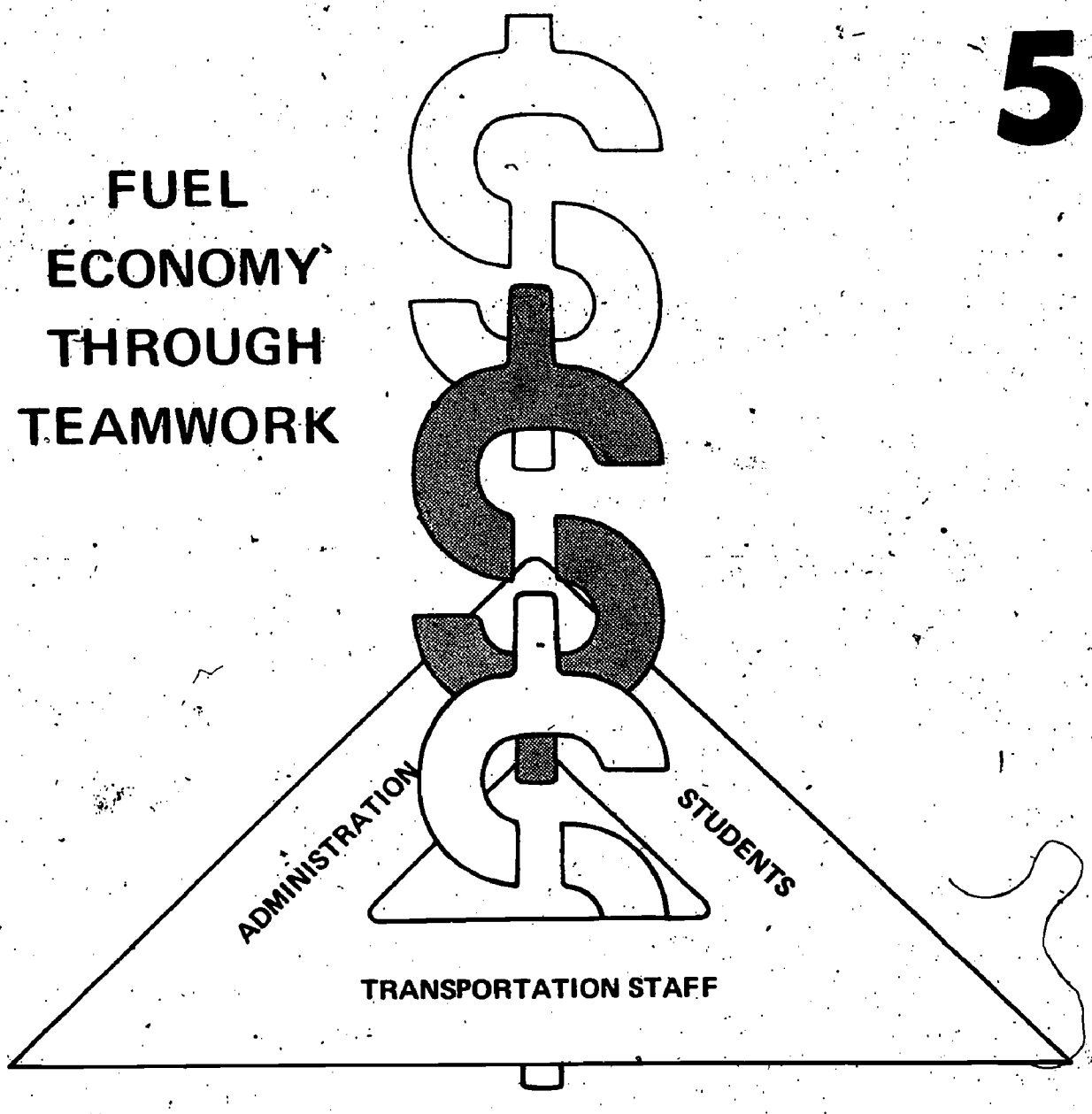
FUEL ECONOMY THROUGH TEAMWORK



THE SCIENCE OF SAVING FUEL

PREPARED BY:
BRI SYSTEMS, INC.
PHOENIX, ARIZ. 85068

ENERGY SAVINGS IN
SCHOOL TRANSPORTATION
PUBLICATION SERIES

SAVING FUEL: A REWARDING CHALLENGE

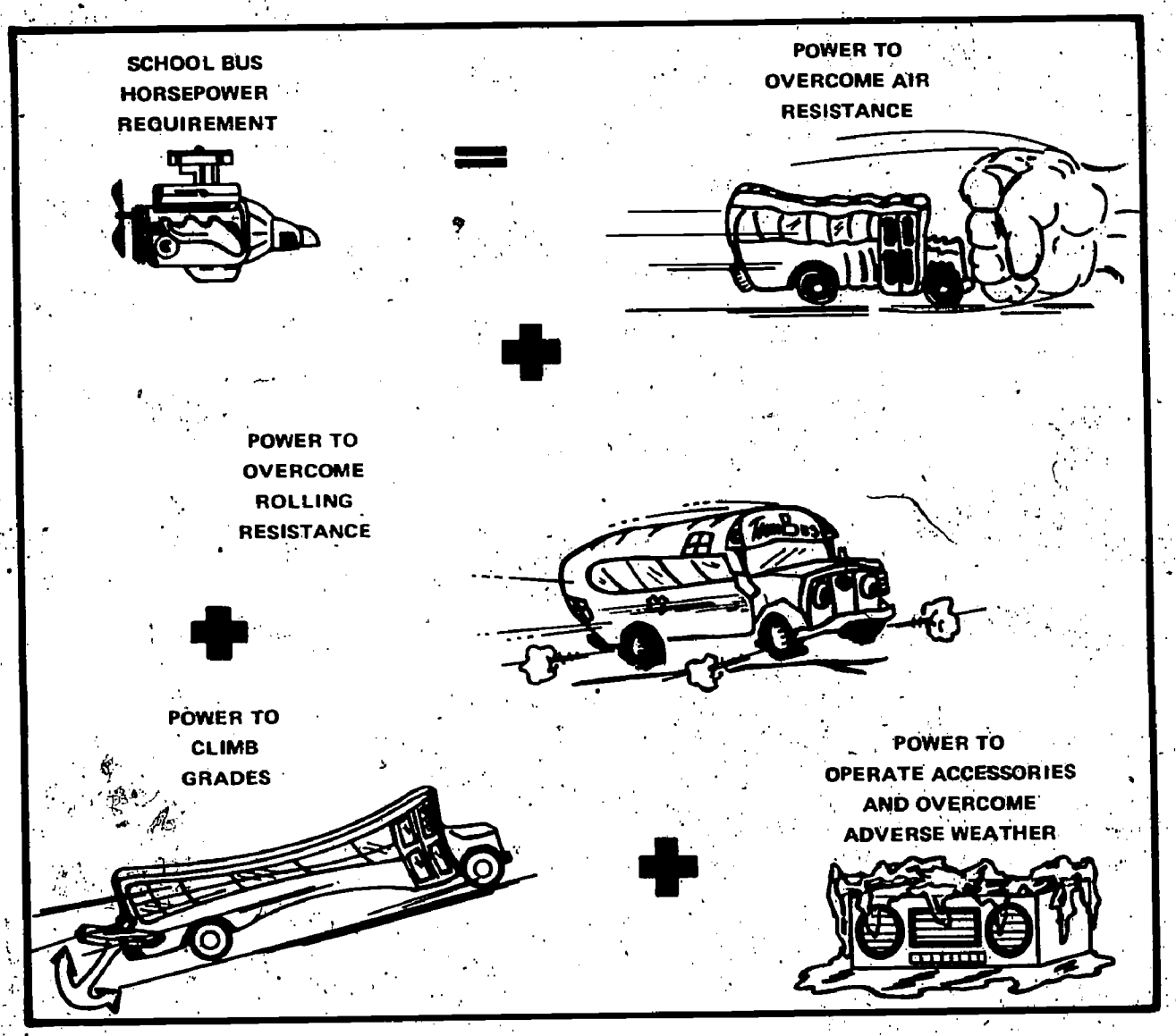
If you see a thief siphoning gas from a school bus, chances are that you will bring it to someone's attention. Fuel pirates operate in a way which doesn't always allow us to see the fuel being taken. These pirates do not use a siphon. They operate under the laws of science.

Saving fuel is a science--a science based upon proven concepts. One must have an understanding of the basic laws of this science to prevent fuel piracy.

This booklet addresses some of the basic principles of this science. Its intent is to provide information about the factors which influence fuel consumption. A number of important factors are addressed on the following pages. Further information about improving fuel economy can be obtained by requesting the handbook "Encouraging School Transportation Effective Energy Management (ESTEEM)" from the U.S. Department of Transportation; refer to page 7.

HORSEPOWER AND FUEL ECONOMY

Fuel economy is related to the horsepower needed to power a school bus and the efficiency of the vehicle's engine that provides the power. The total power to operate a school bus is dependent upon the following basic elements:



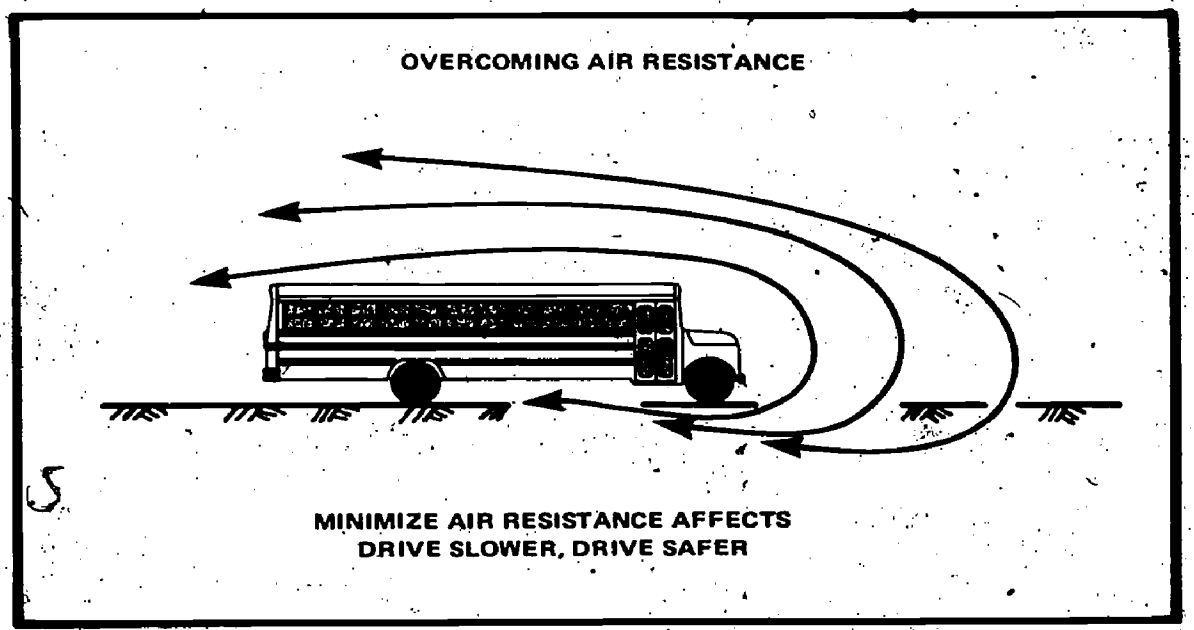
The following pages describe the importance of these elements in your driving environment. Each school district transportation operation can do something about controlling many of them.

OVERCOMING AIR RESISTANCE

Air resistance is a force that is exerted on the school bus when it is being driven. Engine horsepower must overcome this resistance--the greater the resistance, the more horsepower that is needed to do the job. Horsepower is obtained from fuel combustion in the engine. Additional horsepower demands result in the consumption of greater amounts of fuel.

A streamlined vehicle offers advantages in overcoming air resistance. The forces are reduced considerably as the school bus moves more smoothly through the air.

Vehicle speed is a major factor in air resistance. A vehicle traveling at 25 miles-per-hour will require only one-eighth of the horsepower to overcome wind resistance as compared to the same vehicle traveling at a speed of 50 miles-per-hour. As a rule of thumb, doubling school bus speed increases the horsepower needed to overcome air resistance by a factor of 8. That's why high speeds result in greater fuel consumption. The type of vehicle you drive and how you drive greatly affect fuel economy.



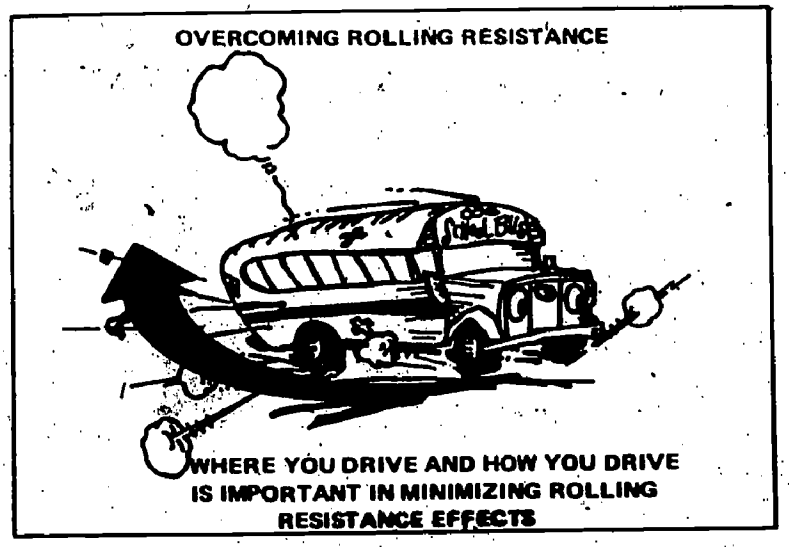
OVERCOMING ROLLING RESISTANCE

As a tire rolls, it flexes. This results in a heat buildup or resistance which must be overcome. The engine has to work harder to overcome this resistance. The greater the resistance, the more fuel that is required by the engine to overcome it.

Road conditions affect rolling resistance. U.S. Environmental Protection Agency studies have shown that a gravel road can reduce fuel economy by as much as 35 percent. This means that the school bus that obtains 7 miles-per-gallon on good pavement can get as little as 4.5 miles-per-gallon when it is driven on a gravel road.

Keeping tire inflation pressures at recommended levels will reduce rolling resistance. This practice can extend tire life, offering more miles-per-tire, and increase vehicle fuel economy.

Steel-belted radial tires are constructed so that they offer less rolling resistance. Such practices as the use of radial tires and route planning to keep buses on good roads are important in obtaining greater fuel economy from the district's fleet.



GRADES AND HILLS

ROUTE TO INCREASE VEHICLE FUEL ECONOMY

Hills also have an effect on fuel economy. A 36,000 pound bus traveling at 50 miles-per-hour will increase its fuel consumption by almost 30 percent to climb a continuous 1 percent grade. This means that the bus offering 7 miles-per-gallon under the best of conditions will only get 5 miles-per-gallon when it climbs this small grade. Fuel economy suffers more at lower speeds when climbing grades. This is another reason why route planning and driving skills are important in increasing fuel economy.

WEATHER EFFECTS

DRIVE SLOWER IN INCLEMENT WEATHER

Cold weather reduces a vehicle's fuel economy. Lubricants do not flow easily; the vehicle's engine cannot reach its rated efficiency. Fuel economy will drop off about 2 percent for each 10°F drop of temperature.

Winds also reduce fuel economy. When driving into a strong headwind or crosswind, the school bus is further penalized and its fuel economy is decreased.

ACCESSORIES

USE ACCESSORIES THAT CAN HELP TO SAVE FUEL

Accessories such as the engine fan and compressor require additional power from the engine; thus, they make additional power demands which lead to greater fuel consumption. A fan clutch is an example of options that are available to reduce fuel economy penalties. The fan clutch cuts the horsepower drain from the fan when it is not needed for cooling--this occurs about 95 percent of the time under normal driving operation.

PUTTING IT ALL TOGETHER

Many other factors are also important in getting increased fuel economy. Engine performance is obtained by selecting the smallest and most efficient engine for the job and maintained by placing emphasis upon preventive maintenance programs to keep the efficiency high. Vehicle size, design, and weight, along with how it is maintained are important. What you drive, where you drive, when your drive, and how you drive affects fuel economy. The combination of the wrong set of conditions--high speed, excessive idling, bad weather, poor roads, rough terrain, excessive starting and stopping, underinflated tires, pumping the gas pedal, and poor shifting habits -- can increase a school bus' fuel useage by as much as 100 percent or more. On top of this, if the vehicle has not been maintained properly to achieve its maximum efficiency under the best of conditions, fuel useage further suffers -- maybe as little as 10 percent or as much as another 100 percent, depending upon the engine's condition.

Operating for fuel economy means to give consideration to all of the factors mentioned. Dollars are just too scarce to throw them out the vehicle's exhaust thru additional fuel purchases. Remember these tips and make sure the district's transportation staff understands them. Every member of the transportation organization plays an important role in increasing the fleet's pupil-miles-per-gallon.

Consult the ESTEEM Handbook, "Encouraging School Transportation Effective Energy Management," for further tips to increase fuel economy and for guidance in implementing fuel economy management--a management program that offers fuel and dollar savings to every school district.

A PROFESSIONAL BUS DRIVER KNOWS ALL HE CAN ABOUT HIS VEHICLE, ROUTE, AND EQUIPMENT.

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