LEAD INDUSTRIES ASSOCIATION

60 EAST 42ND STREET

NEW YORK 17, N. Y.

March 16, 1960

SUBJECT: LEAD-ACID BATTERY POWERED INDUSTRIAL TRUCKS

To Members of the Lead Industries Association:

We are attaching a new brochure just issued by the Lead Industries Association dealing with lead-acid battery powered industrial trucks as compared with similar gasoline powered trucks. Ten thousand copies of this brochure will be distributed by the Association to a selected list of industrial truck users, principally those who have gasoline powered trucks, and in answer to inquiries.

An additional 37,000 brochures have been purchased from us at cost for their own distribution by

Gould-National Batteries, Inc.
C & D Battery Company
Exide Industrial Division
K & W Battery Company

In addition, the Electric Division of the Industrial Truck Association will decide at a board meeting on March 22 whether they will purchase a quantity for their own distribution. We are also planning to circularize 170 electric public utility companies who may be induced to order quantities for their own circulation.

Additional copies in quantities up to 25 are available to members free of charge, and in larger quantities at our cost of approximately $6.00 per hundred.

Please note that the brochure carries our new address, which will be effective about May 1. Any correspondence in the interim should be sent to the address on this letterhead.

Very truly yours,

Secretary

Non members $7.50

members 7.50 per C

Att.

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LEAD INDUSTRIES ASSOCIATION

60 EAST 42ND STREET
NEW YORK 17, N. Y.

March 16, 1960

SUBJECT: COST COMPARISON: GAS VS. ELECTRIC TRUCKS

To the Purchasing and Engineering Personnel, Member Companies:

We're attaching a copy of the "Cost Calculator for Industrial Trucks" just published by Lead Industries Association. We believe that you have two important reasons for being interested in it.

First, as a producer of lead, your company has a stake in promoting lead products. Thus you will be glad to see the evidence of superiority which this analysis presents for lead-acid storage batteries as a source of motive power.

Second, very probably you are in the position of buying industrial trucks yourself and, of course, our brochure was designed to help people like you reach the best purchasing decision. We hope you'll agree with us that the method given by the calculator is a valuable aid in trimming your costs by selecting the best truck and motive power combination.

Very truly yours,

Secretary

Att.

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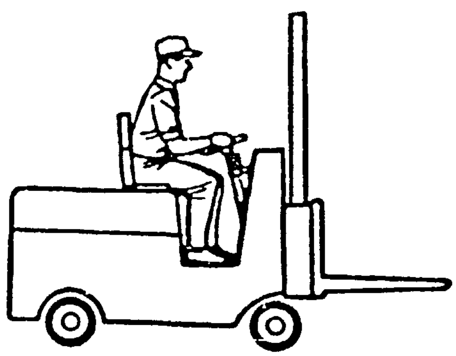
INDUSTRIAL TRUCKS:
What do they cost
—*to own?*
—*to operate?*
—*to maintain?*



With the aid of the handy calculator charts in these pages you can get the complete answers to these questions . . . accurately, and in a jiffy . . . these charts do the paper work that could mean substantial money savings in your operation.

LEAD INDUSTRIES ASSOCIATION
292 MADISON AVENUE, NEW YORK 17, NEW YORK

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A Cost Calculator

Studies of industrial methods have shown what a tremendous contribution to productivity industrial trucks can make. In many industries, a return to manual handling operations could erase the whole profit margin. And perhaps it is because these trucks are so profitable that their own economics are, to some extent, ignored.

Yet there are great differences in the cost of owning and operating trucks of the two main classes — battery powered and gasoline powered. In the calculator charts in this bulletin and the example shown, a battery powered truck is seen to cost less than 2/3 as much as a gasoline truck when all the factors are considered.

But the real purpose of the charts is not to prove a hypothetical example. They are designed to let you arrive at your own cost factors quickly and without any great burden of computation. If your operation is typical of the hundreds surveyed in the study[1] on which this method is based, you have only to locate nine points in the charts on the following pages to learn what your total cost picture is for gas or electric trucks.

If the potential savings of using battery power seem too good to be true, consider some of the changes of the past few years and how they have affected the cost of owning and operating industrial trucks. Obviously the cost of gasoline and lube oil have been rising while the cost of electric power has declined. This, of course, favors battery power. Surprisingly, though, the cost of the energy as it is used at the wheels and forks of the truck amounts to only about one-fifth of the total cost for a gasoline powered truck and about one-third of the total cost for a battery powered truck. While the changing cost of fuel or power is significant, the more important change lies elsewhere.

Studying the cost trend chart (Figure 1) it can be seen that the most rapid of the changing factors has been the cost of labor. Since both gas and electric trucks need drivers of comparable skill there is no advantage or disadvantage for either in the changing labor rate on that point. But when it is realized that the largest single item of expense for either type of truck is maintenance, the effect of labor becomes apparent.

For gasoline trucks, the cost of maintenance today is higher than the sum of all other costs they incur — in general, two thirds of the cost of owning and operating a gasoline powered truck is chargeable to maintenance. The greater part of this expense is in skilled labor where the trend is to advancing wages.

While the largest single item of expense in owning and operating an electric truck is also maintenance, it is far less (about one-half the total cost, as opposed to two-thirds for gas trucks) since the number of moving and wearing parts in an electric truck is reduced to a minimum. In terms of actual dollars per year, the cost of maintaining an electric truck averages about 40 per cent of the cost of maintaining a comparable gasoline truck.

And there are still other factors to consider in comparing overall costs. Accessory equipment is needed with both types of truck, for example. But where standard tools, facilities, and the cost of repairs have risen, the cost of battery chargers, as a specific example, has fallen drastically over the past few years.

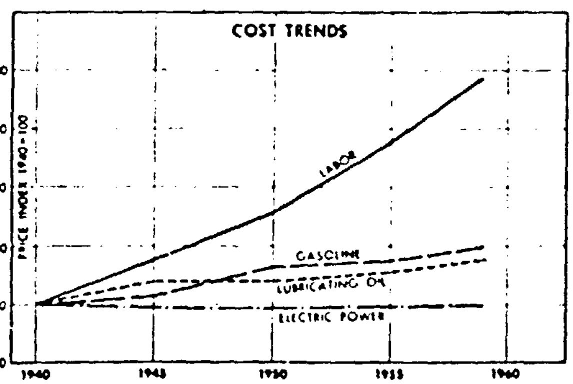

Figure 1—Cost trends source information: Department of Labor figures and earlier published information from several other federal agencies.

Batteries, Too, Have Changed

Just as there has been an enormous change in the economics of battery and gasoline powered industrial vehicles, there has been a change in batteries themselves. Purchasing decisions based on battery performance of ten or even five years ago leads to costly errors.

In the first place, today's heavy-duty industrial battery is not even made in the same way that lead-acid batteries were made a decade ago. In place of simple lead grids with lead oxide paste deposited in them, today's battery makes use of glass fibers and tough plastic internal retaining walls. In some designs the battery is made up of hundreds of individual small tubes which cannot be jarred loose, or bent or broken. And at the same time much of the space formerly needed for separators is saved.

The second outstanding advantage of today's lead acid battery stems from the space saving design

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[1] "Industrial Truck Costs," Exide Industrial Division, The Electric Storage Battery Co., Philadelphia 20, Pa.

for Industrial Trucks

mentioned above. In its more compact form, the modern battery can deliver more ampere hours per cubic inch or alternately, pack a given ampere-hour capacity into a much smaller space than its ancestor of a decade ago. For two batteries of the same size, the one of new design delivers up to 45 per cent more ampere hours of work than the old. And, of course, for the same capacity, the new design is less costly (Fig. 2).

Service records for the new batteries show that they are far exceeding the older design in ruggedness. A greatly increased life is expected.

There is, too, another important factor which is stretching battery life for industrial users. A number of postwar technical developments have made the automatic battery charger as inexpensive as the old equipment had been.

Operating unattended, the automatic chargers in use today feed power to the battery at optimum rates, detecting the exact needs of the battery and tailoring the charge pattern to match them. They have taken the art out of battery charging . . . and with it the guess, and the hunch, and the coffee break. For it is a fact that charging technique is one of the most important factors in the life of lead acid batteries. Indeed, other basic battery systems have largely staked their case on their ability to withstand charging

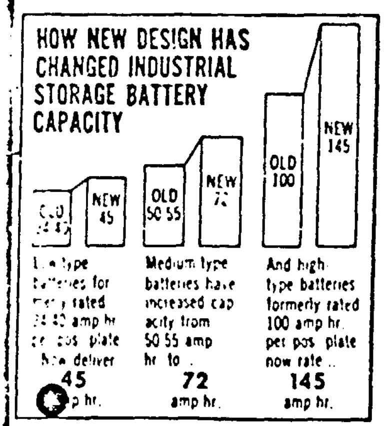

Figure 2

abuse and now they have lost this major point of contention.

YES, BUT . . .

Like politics and baseball the question of which type of industrial truck to use is rarely subject to the sole test of logic. Hence we are all prone to ignore some of the figures or facts, lean on personal experience and say, "Yes, but . . ."

Here are some of the "yes-buts" of the industrial truck question together with what may be a new insight:

"Yes, but gasoline-powered trucks are faster!" As your insurance company can tell you, this is almost invariably true. The internal combustion engine is characteristically able to develop high speed on the straightaway and tests by a manufacturer of both types of truck have shown that when the point to point travel is greater than 800 feet, a gasoline truck will generally get there before an electric.

If your problem is loading and unloading trucks, stacking pallets, etc., you may be interested to know that the same study shows the electric truck to be faster at this sort of work. There is a basically simple reason for this: Just as the internal combustion engine balks at low speeds (hence gear shifts and automatic transmissions) and develops maximum power at high speeds, the series starting DC motor used in electric trucks develops its maximum torque at low speeds. (Fig. 3)

This is why an electric truck uses such a small and comparatively simple mechanism and why it wins the work race even though it loses on a race track.

"Yes, but electric trucks cost more than gasoline trucks!" Based on selling price, this is absolutely true. It is also true that an electric truck has at least twice the life expectancy of a gasoline-powered truck and may last three or more times as long. No matter how you amortize an electric truck, its long life pays for the difference in first cost.

"Yes, but even though the truck may last twenty years, the batteries have to be replaced." Actually the life expectancy of a correctly rated set of batteries cycled once a day is several years greater than that of a

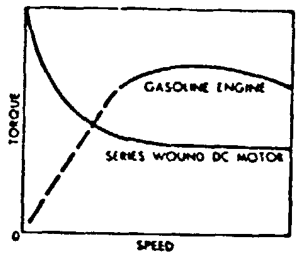

Figure 3—Comparison of characteristics of the internal combustion engine with a DC series motor used in electric trucks. Note the low speed characteristics particularly.

gasoline-powered truck.

In order to avoid guesswork in the calculations in this bulletin, the method now used by many truck users has been followed—the batteries are rented, thus being a predictable expense. Normally, this expense can be reduced, of course, by purchasing the battery. Therefore, in our calculations, electric trucks have been deliberately penalized by the difference between battery rent and actual battery cost if purchased. (The same was done with battery chargers.)

One final word on battery replacement: In the past twenty years, while inflation has forced other industrial prices to double, batteries have risen about 20 per cent in cost . . . and about 50 per cent in life expectancy!

"Yes, but recharging batteries is expensive and troublesome." Electrical power is not expensive and has not increased in price in the inflationary movement generally. Battery chargers are not expensive—even the best fully automatic types cost only about $600. But to prove that point, electric trucks are penalized (see above) by renting rather than purchasing chargers in the calculator charts. Finally, the "trouble" of recharging batteries consists of disconnecting the running plug, inserting the charging plug, and starting the charger. Elapsed time, 30 seconds. When the discharged battery is hoisted out and replaced by a fresh one, changeover time is about two minutes.

HOW TO CALCULATE THE COST OF OWNING AND OPERATING INDUSTRIAL TRUCKS

On this and following pages are calculator charts permitting an accurate and extremely rapid comparison of costs between gasoline-powered and electric industrial trucks. The three charts, or nomographs, perform the complex calculations involved in finding:

The Cost of Owning a Truck

The chart to calculate depreciation of industrial trucks (opposite) takes into account the initial purchase price of the truck and its useful life. If these two factors are known and points corresponding to them on the *left* and *center* scales of the chart are connected by a straight line, that line will cross the right-hand scale at a point corresponding to the cost per year. The calculation is a simple division of first cost or apportioning of it over the useful years of truck life. This calculation does not take into account taxes, interest, sinking fund or any of the other common methods of amortization. It represents only the *cost of owning* the truck.

Where plant experience permits, it is best to use the actual life of trucks that have been tried. If this information is not available, use the indicated points on the center scale. These have been established by a survey of typical industrial operations which verify that an electric truck lasts at least twice as long as a gasoline-powered *truck of the same rating.*

If actual prices of the trucks you use are known, start with them on the scale at the left. If they are not known, Table I gives price ranges and averages of industrial trucks from truck manufacturers' price lists of January, 1959. Note that these are *standard* trucks (special attachments not included) and that the electric truck prices do not include the cost of the batteries.

TABLE I
PRICES OF STANDARD INDUSTRIAL TRUCKS — JANUARY, 1959

Truck Rating lb.	Gasoline-powered Minimum $	Gasoline-powered Maximum $	Gasoline-powered Average $	Electric Minimum $	Electric Maximum $	Electric Average $
2000	3850	4400	4100	5050	6000	5550
3000	4630	5700	5100	6400	7200	6800
4000	5200	6100	5700	7000	7750	7350
5000	5900	6700	6300	7600	8300	7950
6000	6200	7350	6900	8250	8950	8600

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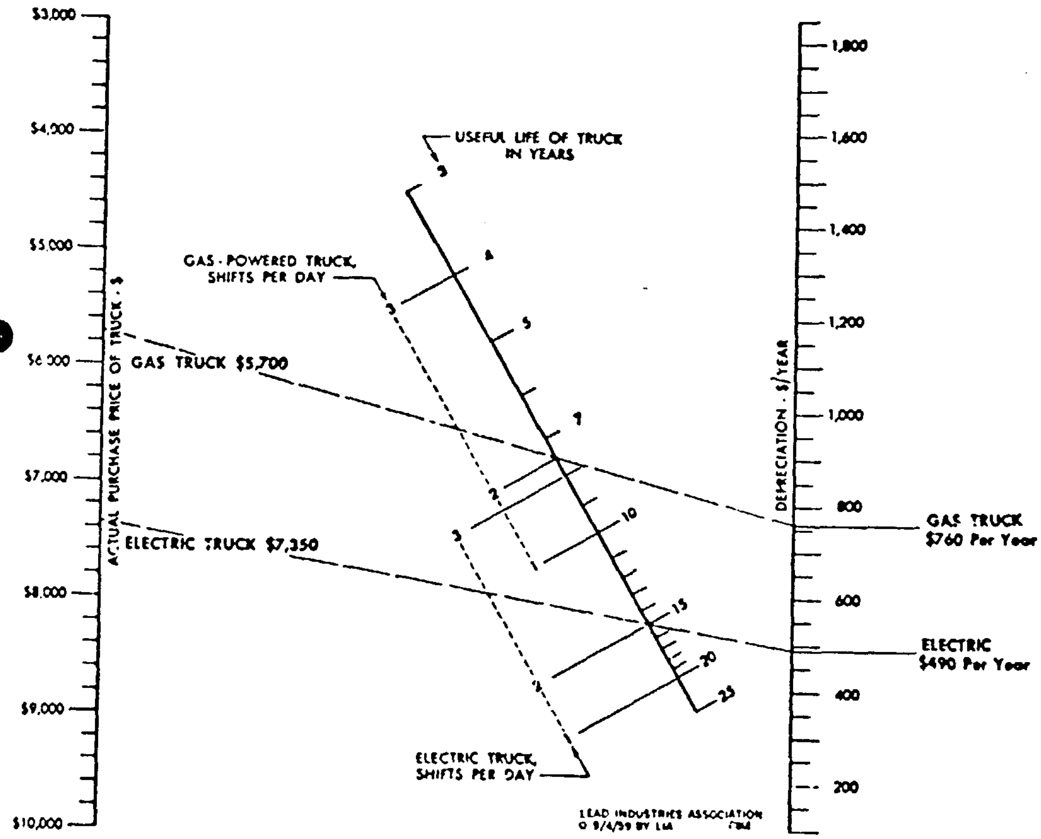
How to Find YOUR Depreciation Cost

A Typical Example

Suppose that an industrial operation working a two-shift day required a new truck rated at 4000 pounds. From Table I, the average price of a 4000-pound gasoline-powered truck is $5700, that of a 4000-pound electric is $7350.

Find $5700, the price of the gas truck, on the scale at left and place a straightedge through this point so that it falls at "Gas-powered truck, 2 shifts per day" on the center scale. As indicated, its life expectancy is 7½ years. Note that the straightedge crosses the righthand scale at $760 per year.

In the same way, connecting $7350 with "Electric truck, 2 shifts per day" (note that life expectancy is taken as 15 years though it may well be far higher) leads to an annual cost of $490.



COST TO OWN A GAS TRUCK

$760 per year

COST TO OWN AN ELECTRIC TRUCK

$490 per year

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The Cost of Operating a Truck

One significant factor is omitted in this calculation of operating costs: the hourly wage rate of the driver plus fringe benefits and overhead. Since, in any plant, the same personnel would drive electric or gas trucks, this cost is not subject to comparison. In studies of total cost, however, it should be added to the final results.

Operating costs for gasoline-powered trucks are defined as the cost of gasoline consumed and cost of oil consumed. (Oil changes are covered under maintenance.) Gasoline is charged at 27.6¢ per gallon, the accepted average industrial bulk cost, and oil is charged at 19.0¢ per quart. Oil and gas consumption figures are given in Table II. These are average figures obtained by surveys of industrial users.

Operating costs for electric trucks include the cost of furnishing batteries, battery charging equipment, and the cost of electric power consumed. Since both batteries and a charger are capital equipment, their cost per hour of operation is a function of their life. In order to eliminate any guesswork, the nomograph for operating costs is therefore based on rented batteries and chargers. The cost of renting these is significantly higher than the cost of owning them, thus indicating the most unfavorable cost performance for electric trucks. The actual rent figures are based on available leasing plans for batteries and chargers of the ratings recommended for the truck size in question. AC power is charged at the commonly accepted industrial average of 1.5¢ per kilowatt-hour.

Because the costs for the batteries and charger are based on a fixed monthly rent, the cost of using them becomes less as they are used more in any month. It is therefore necessary to set some basis of use. The operating cost nomograph is based on a plant operation of five days each week with six annual holidays.

Since it is easier to establish the cost of operating a gas truck, we enter the nomograph with this cost. If the figure is available for your operations and is based solely on gas and oil consumption, use it. If the figure is not available, an average cost figure, can be taken from the last column of Table II.

Locate this figure on the left scale, cost per hour to operate a gas truck, and lay a straightedge through that point so that it passes through the appropriate point in the center of the nomograph.

Note that the nomograph accommodates normal* one and two-shift operations. It also handles three-shift operations where three separate sets of batteries are used where two sets and spares (figured here as $2\frac{1}{2}$ sets), or two sets and no spares are used.

A straight line through the cost of operating a gas truck and the proper number of shifts will locate a point on the right scale corresponding to the cost of operating an electric truck of the same rating in the same service.

*One set of batteries per shift.

TABLE II

OPERATING COSTS OF GASOLINE-POWERED INDUSTRIAL TRUCKS

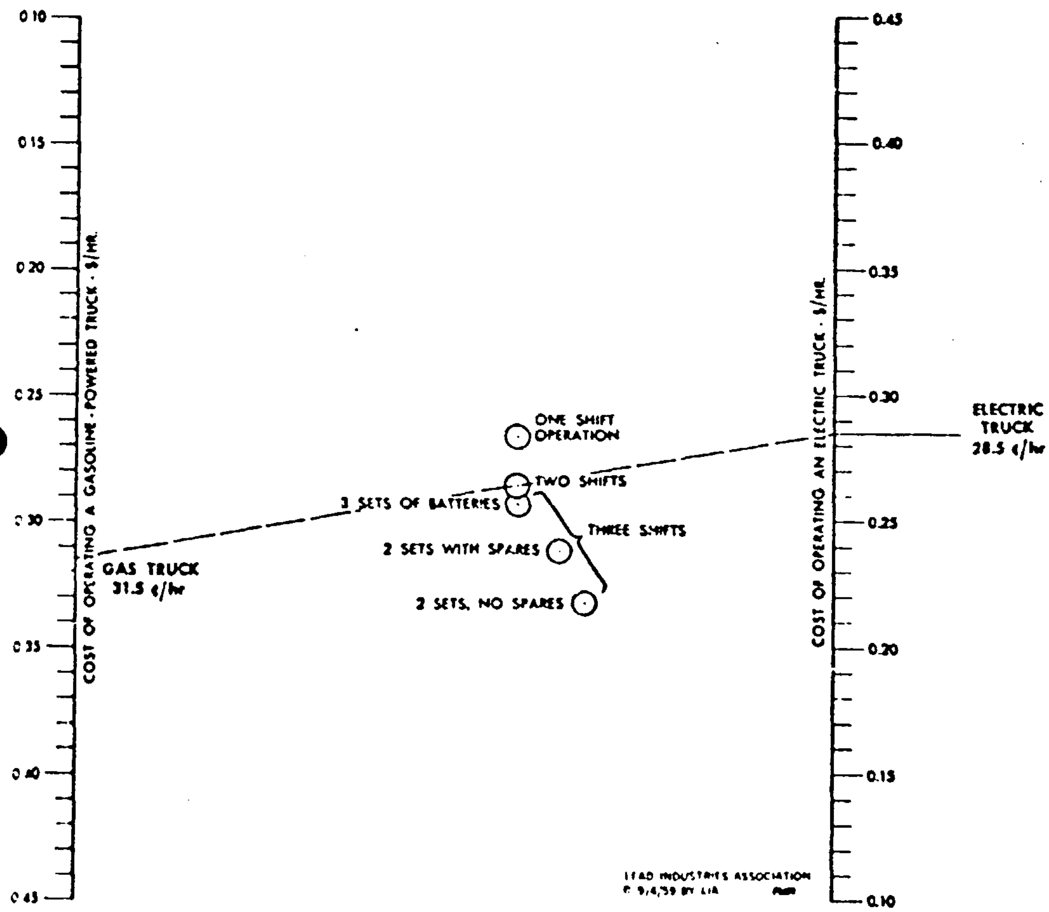
(Gasoline @ 27.6¢/gal, oil @ 19.0¢/qt)

Truck Rating	Average Gasoline Consumption		Average Oil Consumption		Operating Cost
lb.	gal./hr.	$/hr.	qt./hr.	$/hr.	$/hr.
2000	0.63	0.174	0.076	0.014	0.188
3000	0.85	0.234	0.096	0.018	0.252
4000	1.07	0.296	0.100	0.019	0.315
5000	1.20	0.332	0.117	0.022	0.354
6000	1.45	0.400	0.120	0.023	0.423

How to Find YOUR Operating Cost

A Typical Example

In the operation considered in the first example (cost of owning a truck) a 4000-pound truck was used for two shifts a day. If a gas truck were used under normal conditions, the cost per hour to operate it (from Table II) would be \$0.315 per hour or 31.5¢/hour. Find this point on the left scale of the nomograph. Lay a straightedge through this point so that it falls on the center point "two shifts." The straightedge will cross the right scale at 0.285 \$/hour of operation.



COST TO OPERATE A GAS TRUCK
0.315 $/hour

COST TO OPERATE AN ELECTRIC TRUCK
0.285 $/hour

And, in a year of operation,

8 hours/shift × 2 shifts/day × 255* days/year = 4080 hours/year

0.315 $/hour × 4080 hours/year
$1285 per year

0.285 $/hour × 4080 hours/year
$1163 per year

*on a five day week, six annual holidays

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The Costs of Maintaining a Truck

The cost of maintenance found by the third nomograph includes oil changes, replacement parts, the labor costs involved in diagnosing troubles and installing replacement parts, and the costs of charging batteries and maintaining them and their charger.

Both the hours of maintenance and the value of replacement parts attributable to an hour of operation are known for both gasoline-powered and electric trucks. These have been taken from the maintenance records of hundreds of industrial truck users. The values used as the basis of this calculator are average values reported in Table III.

The nomograph is quite simple to use. A known maintenance labor rate plus fringe benefits and overhead on the left scale aligned with the proper point in the center will indicate the *maintenance cost per hour of operation*. If the hourly rate for maintenance labor plus its overhead and fringe benefits is not known, it is common practice to double the hourly rate to allow for these.

Table III

MAINTENANCE TIME AND VALUE OF REPLACEMENT PARTS PER HOUR OF OPERATION

	Maintenance Time hours/hour of operation			Parts $/hour of operation	
Minimum	Maximum	Average (Mean)	Minimum	Maximum	Average (Mean)
All Gasoline-powered Trucks:					
0.080	0.190	0.135	0.150	0.340	0.240
All Electric Trucks:					
0.020	0.081	0.055	0.050	0.130	0.090

How to find YOUR Maintenance Costs

A Typical Example

Continuing with the operation of the two earlier examples, suppose that the hourly wage rate for the mechanics at the plant in question is $3.50 per hour. Since the overhead and fringe benefit costs are not known, the wage rate is doubled and used to enter the left scale of the nomograph at $7.00 per hour. Aligning this with the proper points for gas and electric trucks, we find intersects with the righthand scale at $1.18½ per hour of operation for gas trucks and $0.47½ per hour of operation for electric trucks.

COST TO *MAINTAIN* A GAS TRUCK

$1.185 per hour of operation

COST TO *MAINTAIN* AN ELECTRIC TRUCK

$.475 per hour of operation

and for the same five-day week, 6 annual holiday year,

8 hours/shift × 2 shifts/day × 255 days/year = 4080 hours per year

1.185 $/hour × 4080 hours/year

$4835 per year

.475 $/hour × 4080 hours/year

$1938 per year

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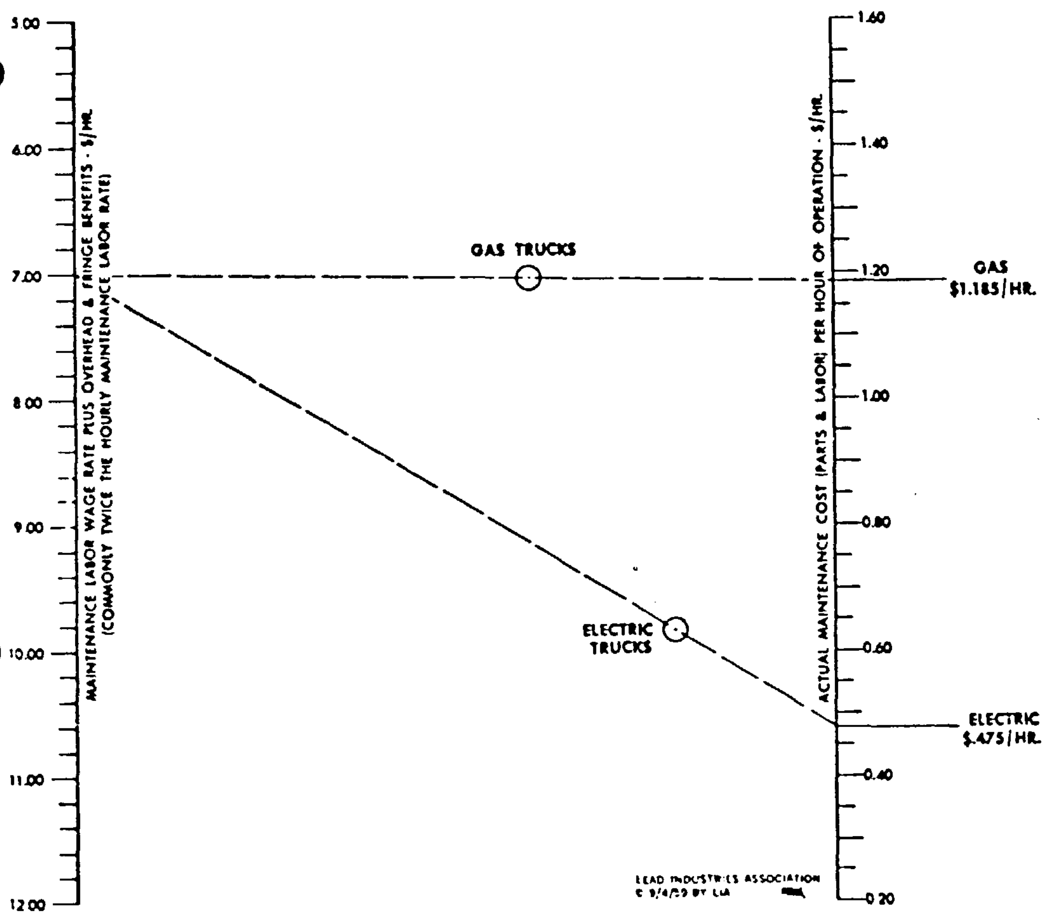

SO, TOTALING UP—

	Typical Example Gas	Typical Example Electric	YOUR PLANT Gas	YOUR PLANT Electric
Cost to own, $/year	760	490	___	___
Cost to operate, $/year	1285	1163	___	___
Cost to maintain, $/year	4835	1938	___	___
TOTAL, $/year	6880	3591		
	3591			
SAVING, $/year	3289 in favor of electric truck			

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WHAT OTHERS HAVE FOUND

While the cost comparison method described in this bulletin will let you estimate costs for gas or electric trucks in your operation, it is based on averages of costs and, tacitly, on average working conditions. What about the special working conditions and problems of your operation? How do they alter the cost picture?

If your particular operation involves one of the specific problems described in the following case histories, you may be interested in what these truck users have found.

CASE II — SAN FRANCISCO WAREHOUSE COMPANY

Operation: General warehousing of palletized grocery products.

Significant job factors: Typical of many palletized operations.

Description: In 1948 at the beginning of a study made by San Francisco Warehouse Company six electric and five gas trucks were operating in two warehouses. Operations encompassed receiving of palletized grocery products, stacking, making up shipments and loading delivery trucks. The study ran from 1948 to 1952.

Results: In the five years covered by the survey, the company found direct annual maintenance and repair costs to average $322.30 for gas trucks, $60.75 for electrics. Vice-president Lloyd Swayne, Jr. believes that these figures are still valid today. On the basis of the study, the company has turned to an increasing portion of electric trucks in its fleet. Today it uses 13 electric trucks, eight gas trucks, and one gas-electric truck. Mr. Swayne explains that "the low repair cost of battery powered trucks and their ability to keep operating without down-time are the reasons why we have been converting from gasoline to electric during the past ten years."

CASE IV — AUTOMOTIVE PLANTS

Operation: Varied—handling everything from heavy castings to containers of small parts and fasteners.

Significant job factors: Round-the-clock operation and the consequent need for reliability; large fleets; close cost control.

Description: Specific details of plant operation have not been divulged but it is known that cost studies have been made at Oldsmobile and Ford.

Results: As reported in *Iron Age**, "Oldsmobile Div. in the last few years has bought almost 400 electric units after a thorough, long term cost study. This started a trend at Fisher body. Sixty electrics were included early this year in plant expansions and equipment replacements. "Ford Motor has also bought about 150 electric trucks after finding a 4 to 1 ratio on maintenance costs."

*"Industrial Trucks: Price vs Upkeep," Dec. 20, 1956

CASE I — THE BOSTON AND MAINE RAILROAD

Operation: Baggage and mail handling at a railroad terminal.

Significant job factors: Heavy loads, fairly long runs including numerous ramps with grades up to 10 per cent.

Description: Previously, 34 gas tractors were used round the clock to load and unload baggage and mail. Though there were minor problems such as extreme heat for the drivers during the summer, gas fumes, and occasional fires, the change to electric trucks was spurred by a cold December morning on which 16 of the trucks would not start.
The 34 gas trucks were replaced by 24 battery powered trucks.

Results: At the end of a year of operations, the Boston and Maine was able to show a reduction of 50 per cent in fuel-power costs, 75 per cent in maintenance part costs, and 60 per cent in maintenance labor. Net out-of-pocket savings for that one year were $32,700.

CASE III — INDUSTRIAL MACHINERY MANUFACTURER

Operation: General handling in heavy machine manufacturing. Three trucks are used to receive, transfer between operations, load for shipping. Loads range from 1500 lb. parts to 6-7 lb. parts palletized.

Significant job factors: Typical of many plant operations where few trucks are involved.

Description: Switch from gasoline-powered to electric trucks was made in 1955. The three trucks are somewhat specialized: one is a high-lift model, one is specifically designed for loading over-the-road trucks, one is a general-duty lift truck.

Results: Management reports that *exclusive of major overhauls* the average monthly maintenance of the trucks has been reduced $26-28. After almost five years of service, the original batteries are still in service. Furthermore, though fumes and noise were accepted as normal with gasoline trucks, they are now noticed by their absence.

CASE V — A PAINT AND VARNISH PLANT

Operation: In-plant handling of paint raw materials, finished products.

Significant job factors: General industrial use; fire and safety factors are important to management.

Description: Prominent paint maker has had experience with both gas and electric in-plant trucks. Trucks are used throughout the manufacturing operation—receiving, transporting materials for processing, handling finished paints, warehousing, shipping.

Results: Based on spot check comparisons, management finds that the use of electric trucks is at least 45 per cent cheaper than gas trucks. In commenting on such a comparison, the assistant superintendent pointed out that, "We have always felt that electric trucks are much better for inside operation and safer, too."