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USING THE TI-59 PROGRAMMABLE CALCULATOR TO ESTIMATE OPERATING COSTS AND HAULING RATES FOR BULK MILK ASSEMBLY

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PREFACE

This bulletin is an update of A.E. Research 79-18 published in September 1979. At that time the concept of using a programmable calculator to estimate bulk milk assembly costs was a new one which was unfamiliar conceptually and operationally to both handlers and haulers. In addition the availability and relative ease of access to different units (e.g., annual vs. average daily miles) of information was not known. The need for better information on hauling was nevertheless evident and a decision was made to prepare a simplified program with the expectation that with practice and experience a more suitable and easier to operate program could be developed in the future. The revised program is now available and is included in this bulletin. There are two major changes from the earlier program. First, the data entries have been put in forms which are more readily available for handlers and haulers. For example, route miles are now listed as daily rather than annual averages, the relief driver wage is incorporated in the average driver wage and is removed as a separate entry, and maintenance costs are entered as averages per mile rather than as a gradient. Because of these changes it has been necessary to change the data entry register numbers from those used in the previous program; care should be taken that the figures are placed in the appropriate registers. Second, tax savings to haulers from depreciation allowances and the investment tax credit are now incorporated in the program resulting in estimates of fixed and total costs which will be lower than if the same cost figures were run on the previous program.

A further addition has been made which consists of programming the calculations for determining a stop charge and hundredweight payments to haulers for costs incurred in pumping and transporting milk. The manual calculations for making these cost allocations were described in the original bulletin. This bulletin contains a description of using the program to make these calculations rapidly and without error.

INTRODUCTION AND PURPOSE

The New York State dairy industry is vitally dependent on an efficient and competitive transportation system for assembling and transporting milk from farms to processing plants. Much of the state's milk assembly operation is carried out by independent contract haulers who operate their own truck(s). The independent owner-operator has often proved the best as well as the lowest-cost option for accomplishing the hauling function. The use of a relatively large number of independent haulers over a wide range of route conditions does, however, create significant coordination needs for the participants. This publication is directed to assisting with one aspect of the coordination requirements; the determination of equitable hauling rates.

The rate paid to haulers for bulk milk assembly is, ideally, negotiated on a route-by-route basis. Typically in practice the request for a rate change is initiated by a hauler and justified on the basis of an increase in labor, fuel or other costs. But since many cost increases affect all haulers, what began as a request for a rate change by an individual hauler often becomes a concurrent request by all haulers. If the handler agrees to a rate increase while lacking specific information about the effect of the cost increase on individual routes, the increase is often applied as a flat, across-the-board adjustment. Such uniform rate changes in assembly systems with highly divergent route conditions tend to favor some haulers over others. As a result some assembly routes can be substantially more profitable than others, while the system as a whole is neither efficient nor equitable for either the dairymen or the haulers. A detailed knowledge of assembly costs is essential for operating an efficient system.

At the same time, rapidly rising transportation costs have placed the small contract hauler at a competitive disadvantage to larger operators as the management function becomes more critical. The small operator, who drives and maintains the truck, has less time available for analyzing the business. A quick means of

estimating changing route costs should prove an essential management tool during these inflationary times.

The purpose of this publication is to present a ready means of estimating the effect of a change in the cost of the one factor, like fuel, on overall operating costs. The resultant estimates are useful to both handlers and haulers. Handlers may use the estimates in planning for anticipated future cost changes. Haulers must keep track of costs to be sure that rates are sufficient to accumulate capital for timely replacement of the tank truck fleet. Together the estimates provide a common basis from which rate negotiations can be started.

The estimates are developed using economic engineering techniques by combining individual item costs, from fuel and tires to purchase price and maintenance, into uniform operating costs per unit of product, time and distance. These estimates may be broken out into fixed and variable cost components. To make the calculations speedy and accurate a TI-59 programmable calculator is used*(1). With its assistance the effect of a fuel price increase on total per mile costs, to mention one example, can be determined within seconds.

The program is kept relatively short by omitting much of the detail and special considerations which are a part of day-to-day operations. Thus the results should be viewed as approximations only. The estimates include operating costs only; other factors such as returns to management and risk are not included. The appropriate payments for management and risk vary widely from firm to firm so that no rule-of-thumb figure can be established. Allowances for these factors and other items specific to particular routes must be established during negotiations.

In past years it was common for rates to reflect the haulers out-of-pocket costs plus a premium for management and risk. This meant among other things that

*The bracketed numbers refer to additional information on this point included with the footnotes on page 17 following the text.

haulers were compensated based on what they actually paid for their truck. During periods of relatively stable prices this approach proved adequate but problems began to appear when replacement truck prices started moving up sharply. The hauler who had to replace his truck with a much more expensive new one found that he had no accumulated reserves to use to allow purchase at the higher price and had to drop out of the industry. One solution to this situation would be to raise the rate whenever a new truck is purchased. This would, however, not be equitable and would provide a strong incentive for all haulers to buy new equipment! A second and preferable procedure is to provide on going payments with which the hauler may build some equity for the time when a replacement must be purchased. A reasonable improvement in equity should be assured if the rates are periodically adjusted to reflect the "current replacement" of a similar vehicle. This "replacement cost" approach is used in this bulletin. It will generally give a good approximation to the long term costs faced by a hauler but may not be appropriate in some cases, such as a route which would not be economical once the present truck wears out (2).

Data requirements for the program are substantial. In some cases a considerable initial effort will be required to establish a system for collecting and updating the necessary information. If it is done properly this data collection procedure should lead to better record keeping and an improved understanding of the hauling system and the major factors influencing costs. If not, the estimates provided by the program will be inaccurate and misleading.

This report is organized as follows. The first section involves the estimation of hauling costs and includes a description of the basic program, an example application, suggested procedures for collecting data, and an overview of ways of adapting the model for a range of different conditions. The second section describes the use of the program to calculate stop charges and allocation of costs based on time, distance and volume. The program itself is included in the Appendix.

SECTION I

Estimating Hauling Costs

Steps for operating the TI-59 program are detailed in Figure 1. This figure also includes an example which may be run to check to see that the program has been typed in correctly. The data for the example have been developed from information supplied by a group of handlers and haulers in upstate New York and reasonably accurately represents aggregate cost conditions for that area for early 1980. These data do not, however, necessarily represent actual costs for any one specific route and are not intended to be used in any application of the program to an actual situation.

Definitions and Guidelines for Data Collection

The results of the program are, of course, only as good as the data which are entered by the user. A strict adherence to the definitions and collection guidelines listed below will help to assure that the program results are valid and compatible for cross-firm comparisons.

01. Average Daily Route Miles - Use the total average daily miles traveled from garage to garage. In the case where more miles are traveled one day than another, total the two days and divide by two.

Ex. Day 1 - 75 miles
Day 2 - 105 miles

Total $180/2 = 90$ Avg. miles per day

02. Average CWT Delivered Per Day - Use average daily deliveries over the entire year taking into consideration all routes and the flush period, if any.
03. Truck Costs - Trucks are available with an extremely large selection of optional equipment from engines, axles and transmissions, down to radios, air conditioners and seats. To standardize cost estimates the specifications of a serviceable truck must be agreed upon by haulers and handlers. Examples of such specifications are listed in Figure 2. With these specifications, prices can be collected from cooperating new truck dealers. In most cases, fleet prices will be assumed to apply.

Truck investment costs are frequently lumpy with a large initial investment (down payment), a stream of interest and repayment costs and finally a return in the form of the salvage value (trade-in or scrap value). In order to make a nonuniform series of costs and returns comparable they are converted to an equivalent uniform annual series of payments (3).

Figure 1: Operating Instructions for Part I of the TI-59 Program

Entering the Program from Magnetic Cards:

Turn Calculator off. Turn calculator on.

Press Key 1. insert side 1

Press Key 2. insert side 2

DATA INPUT						
Item*	Example Value	Press Key	Example Display	Your Value	Press Key	Your Display
Fixed Costs						
Average Daily Route Miles	110	STO 01	110	_____	STO 01	_____
Average CWT Delivered Per Day	299	STO 02	299	_____	STO 02	_____
Truck Chassis Cost (\$)	46000	STO 03	46000	_____	STO 03	_____
Chassis Expected Life (years)	7	STO 04	7	_____	STO 04	_____
Chassis Salvage Value (\$)	9200	STO 05	9200	_____	STO 05	_____
Tank Cost (\$)	18000	STO 06	18000	_____	STO 06	_____
Tank Expected Life (years)	10	STO 07	10	_____	STO 07	_____
Tank Salvage Value (\$)	3600	STO 08	3600	_____	STO 08	_____
Insurance	1400	STO 09	1400	_____	STO 09	_____
Registration Fees	280	STO 10	280	_____	STO 10	_____
Highway Tax	120	STO 11	120	_____	STO 11	_____
Interest Rate	.12	STO 12	.12	_____	STO 12	_____
Miscellaneous Costs	1000	STO 13	1000	_____	STO 13	_____
Driver Hourly Wage (\$/hr.)	7.50	STO 14	7.50	_____	STO 14	_____
Hours/Day for Driver(s)	8	STO 15	8	_____	STO 15	_____
Variable Costs						
Miles Per Gallon	5	STO 20	5	_____	STO 20	_____
Fuel Cost (\$/gallon)	1.10	STO 21	1.10	_____	STO 21	_____
Cost New Tire	200	STO 22	200	_____	STO 22	_____
Cost Recapped Tire	85	STO 23	85	_____	STO 23	_____
Number of Tires	10	STO 24	10	_____	STO 24	_____
Bias or Radial Ply Tires - Enter 1 if Radial, 0 if Bias	0	STO 25	0	_____	STO 25	_____
Ton-Mile Tax Rate	.017	STO 26	.017	_____	STO 26	_____
Annual Maintenance	600	STO 27	600	_____	STO 27	_____
Average Annual Repair in \$/Mile	.075	STO 28	.075	_____	STO 28	_____
Miscellaneous Variable Costs	0	STO 29	0	_____	STO 29	_____

OUTPUT			
Press Key	Value Output	Example Display	Your Display
A	Total Annual Fixed Costs (TFC)	33885.96	_____
R/S	TFC/Mile	.844	_____
R/S	TFC/CWT	.310	_____
R/S	TFC/Minute	.193	_____
B	Total Annual Variable Costs (TVC)	15033	_____
R/S	Total Annual Costs (TC)**	48919.88	_____
R/S	TC/CWT	.448	_____
R/S	TC/Mile	1.22	_____
R/S	TVC/CWT	.138	_____
R/S	TVC/Mile	.374	_____

*Definitions of these terms and suggested sources of information are included in the following section.

**TC = TFC + TVC.

Figure 2: Truck Specifications: Single Chassis

Specifications for a Single Chassis Truck
Suitable for a 4,000 Gallon, Farm Pickup Truck

Cab:	151" conventional	
Wheel base:	Approx. 218"	
Engine:	Detroit diesel - 671 N Low oil pressure warning Spin-on oil filter Spin-on water filter Plastic fan blade Jake brake	Engine heater Vertical exhaust Luberfiner - 750 Farr air cleaner Delco Remy H.D. alternator Ammeter
Clutch:	14" double disc	
Transmission:	Fuller R.T.O. 915	
Rear Axle:	Timken 38,000# 4:44 ratio	
Suspension:	Hendrickson spring & saddle mount. Extended leaf, 50" aluminum beam	
Front Axle:	Rockwell FL 901 - 18,000 lb., Shepard power steering	
Brakes:	S-Cam. Rear - 16 1/2" x 7 8" dia. Front - 16 1/2" x 5" Hand valve for all wheels Front wheel limiting valve Alcohol kit	
Tires:	Front - General high miler - 11:00 x 20 Rear - General D.C.L. 10:00 x 20	
Other Options:	Double frame or frame reinforcement Dual 50 gal. step tanks Stemco hubs Tow hooks, front and rear Bostrom Viking driver seat Passenger seat Air horn Electric wiper motor Radiator shutters West Coast mirrors	

Source: Dennis R. Lifferth and Walter C. Wasserman, Milk Transportation and Processing: Analysis of Alternative Milk Marketing Systems USDA Farmer Cooperative Service, mimeograph, undated, p. 139.

04. Truck Life - The expected number of miles of service would be available from service managers. Dividing this figure by the annual route miles will give the expected life in years.
05. Truck Salvage Value - This figure will perhaps be one of the more difficult to estimate accurately. Dealers can give a good indication of what a particular five year old truck is worth today. This, however, will not necessarily indicate future salvage values since new truck prices have been rising rapidly in recent years, carrying used and junk truck prices up with them. The problem of estimating future salvage values is therefore one of projecting the rate of inflation for this equipment. Individual judgment must be used. A 20% of replacement cost rule-of-thumb is being used by some individuals in the industry.
- 06 & 07. Tank Cost and Tank Life - Available from the suppliers. Annual costs are calculated in the same manner as truck costs (see above).
08. Tank Salvage Value - Use current scrap metal values which have remained relatively constant over time, or if tanks are rehabilitated, use expected net value.
09. Insurance - Annual rates for liability and cargo, available from insurance agents and brokers. A standardized policy should be used. Such a policy might include \$300,000 - \$500,000 liability, collision for the value of the truck with \$200 - \$500 deductible and cargo coverage in case of upset. Some states, like New York, mandate other coverage.
10. Registration Fees - Annual fees available from the New York State Department of Motor Vehicles or comparable department in other states.
11. Highway Tax - Listed in New York State Department of Taxation and Finance Highway Tax Law Bulletin, October 1, 1974, or similar bulletins from other states, and in Federal tax codes. The tax should be calculated on an annual basis.
12. Interest Rate - The interest rate reflects the value and cost of capital tied up in the truck and tank over their service lives. For this program the yield for industrial bonds rated "A" is suggested for use (4). This rate is available in major newspapers or by telephoning local banks.
13. Miscellaneous Fixed Costs - These costs should include annual garaging, bookkeeping, heat, office, and other expenses which are necessary to operate the milk hauling business. These items are likely to differ from operator to operator so that the actual costs should be used if available. Other fixed costs which do not fit into the above categories may also be included here. A lease contract on trucks or tanks may be included here on an annual cost basis. See the following section for several examples.
14. Drivers' Wages - The average hourly wage rate including fringe benefits should be used. If a significant number of drivers are unionized the rate stipulated in the contract may be used. Wages should include the value of all fringe benefits and payroll taxes. If the drivers are not unionized or a significant number are independent owner-operators, then the prevailing local rate (including fringes) must be used. In a situation where there is

more than one driver during the day and the hourly rates are different, use a weighted average hourly rate:

$$\begin{array}{r} \text{Ex. Driver 1 - } \$ 7.40/\text{hr.} \times 8 \text{ hrs.} = \$ 60 \\ \text{Driver 2 - } \$ 10.00/\text{hr.} \times 7 \text{ hrs.} = \$ 70 \\ \hline \$ 130 \div 15 \text{ hrs.} = \$ 8.67/\text{hr.} \end{array}$$

Relief driver wages should be included in calculating the average rate.

15. Hours/Day for Driver - An eight-hour day may be assumed unless information from the hauler or contract specifications indicate that a different length of day should be used.
20. Fuel Consumption in MPG - Available from operators or as estimates from truck dealers.
21. Fuel Cost (\$/Gallon) - Use average local pump prices.
- 22 & 23. Cost of New Tire and Cost of Recapped Tire - Use fleet prices collected from local dealer (5).
24. Number of Tires - Part of the specifications under (03) above.
25. Type of Tire (Bias Ply or Radial) - Indicate most common type of tire used by pressing 0 for bias ply or 1 for radials (6).
26. Ton-Mile Tax Rate - Rates are listed in the New York State Department of Taxation and Finance Truck Mileage Tax and Fuel. Use Tax bulletin, Regulations 21, April 1, 1970, or similar publications for other states. If fuel is bought outside the state of operation a fuel use tax must also be paid (not included in program).
27. Annual Periodic Maintenance - This figure includes oil, chassis lubrication, filters, plugs and points (if necessary). This cost is available from local service stations and can be calculated on an annual basis according to expected mileage and service intervals recommended by the manufacturer.
28. Average Annual Repair Cost Per Mile - Repair costs are among the most difficult costs to determine. The rate would be best determined for several trucks over more than one year. Repair costs should include parts and labor on an annual basis divided by annual miles driven. If field data are not available applicable cost information may be collected from fleet service managers with similar type hauls.
29. Miscellaneous Variable Cost - To be used for items related to operating the truck but included elsewhere. Examples included mileage based rental rates for the truck or tank.

After punching in all these values you can easily check to see that the correct numbers were entered by punching in the following sequence of steps:

SBR

CLR

RST

INV

2nd LST

This will cause the calculator to print out a list of values stored in each register beginning with the first. These numbers can be checked with the values you intended to enter. In case of an error simply press the correct figure and STO --. To stop the list once it is running simply press R/S.

ADAPTING THE MODEL FOR DIFFERENT CONDITIONS

The basic program applies to the simplest possible bulk hauling situation; the hauler follows one or more route per day using self-owned equipment. This section contains explanations for adapting the basic program for different conditions such as leased rather than owned equipment. The changes include straightforward modifications in the input data and increase in complexity up to permanent changes in the program itself. The following examples indicate how several kinds of changes may be made. They should be used as guidelines for other modifications of the program to meet specific user requirements.

Changing Constants Incorporated in the Program: Tire Life

To keep the user supplied data inputs down to a reasonable number, several values are stored internally in the program as "constants." Examples are tire life and tax rates. The stored values, however, may not be appropriate for all routes and would need to be changed; routes with many hills and curves, for example, may give tire life below the assumed averages. These changes may be made by following the examples below.

Example: Tire Life

On a rough, curvey route a hauler finds that radial tires last on average only 90,000 miles rather than the 100,000 miles assumed. To make the adjustment the proper program location must first be found and the following changes made:

<u>Press</u>	<u>Display</u>	<u>Object</u>
GTO 243	---	Locate part of program requiring change
LRN	243 004	Put calculator in mode to make changes
23	244 00	Insert new number which reduces life by 10,000 miles. (The calculator automatically shows you the next step, not the one you have just completed. To see it push BST - you should get 243 03).
LRN		Return to operating mode

The way this change works is to reduce 40,000 to 30,000; pushing 3 replaces the 4. The 30,000 is the difference in mileage of a radial over the 80,000 miles assumed for a bias ply. The new total is thus 90,000 rather than 100,000 miles.

If this change is to be permanent it may be stored on a magnetic card by following these steps:

Press 1 2nd WRT - insert card, turn over

Press 2 2nd WRT - insert card

If the display number does not flash the program has been transferred properly.

Incorporating Different Operating Characteristics: Leased Equipment

If equipment is leased rather than owned the lease rate may be included in register 13 or 29, or if the lease includes both fixed and variable aspects both may be used. (If all equipment is leased with a service contract an interest rate - register 12 - still must be entered for the program to operate.) A fixed rental rate should be entered in register 3. If the rate is established on a monthly basis it must be adjusted to reflect the actual annual fee (7). Rates which vary according to distance or other factors should be included as a variable cost in register 29. Costs which are variable by the mile must be multiplied by total annual miles or, if the tank payment is based on the volume of milk delivered, by the cwt. delivered. Instructions for inserting into the program new instructions for calculating variable costs per mile and similar changes are described following the example.

Example

A hauler signs a seven-year lease for a bulk tank which includes a \$1,500 nonrefundable payment plus one-half cent per hundredweight delivered.

There are two steps needed to incorporating these new conditions. First, the initial payment is a partial payment for the tank and should be treated as any other cost by inserting the payment, \$1,500, into register 06 with the life

established at 7 years placed in register 07. Second, the cwt rental rate must be multiplied by hundred pounds delivered to determine the rental fee. Average daily pounds delivered is stored in register 02 which must be multiplied by 365 to calculate the annual total. These steps can be accomplished as follows:

<u>Press</u>	<u>Display</u>	<u>Function Performed</u>
GTO 275	---	Locate appropriate place in the program
LRN	275 95	Put in learn mode
2nd INS	275 00	Clear space (this instruction moves all the following steps ahead by one place)
x	276 95	Multiply rate times capacity (the calculator automatically advances you by one step so that you do not see what was just inserted)
2nd INS	276 00	Clear space
RCL	277 95	Recall average daily cwt delivered
2nd INS	277 00	Clear space
2	278 95	Completes RCL command
2nd INS	278 00	Clear space
x	279 95	Multiply by 365 to give annual value
2nd INS	279 00	Clear space
3	280 95	Begin inserting 365
2nd INS	280 00	Clear space
6	281 95	
2nd INS	281 00	Clear space
5	282 95	
LRN	---	Exit learn mode

When using this modification it is important that register 29 is not used for anything but the rental rate. If it is the entire value stored in this register will be treated as the rental rate, leading to a substantial over-estimate of the cost.

If this change is to be permanent it may be stored on a magnetic card by following these steps:

Press 1 2nd WRT - insert card, turn over

Press 2 2nd WRT - insert card

If the display number is not flashing, the program was transferred properly.

SECTION II

Determining Hauling Rates from the Program Estimates

Hauling costs may be divided into three categories - on-farm, travel, and volume - based on where they are incurred. These categories take account of variable costs of travel (fuel, tires and maintenance) and the fixed costs of the tank, truck, insurance and the scheduled driver. Fixed costs including labor are substantial, comprising approximately two-thirds of total assembly route costs, and must be allocated across a full day's activities on a cost per minute basis.

On-farm costs are fixed costs which include the time required to perform routine chores at each stop. These chores include hooking up, agitating the milk, sampling, and rinsing the farm tank. The driver's personal time for lunch and rest breaks is also included with the on-farm costs.

Travel or mileage costs include both fixed and variable cost segments. The variable costs are related to the miles traveled while the fixed costs include the proportionate share of the overhead costs for the time the truck is traveling. The final category, volume costs, involves pumping time at the farm and plant.

These three components of the hauler rate are summarized in Figure 3 below. For completeness, this figure also indicates how the producer rate is related to hauler payments. Producers are assessed in a slightly different fashion than the haulers are paid so that there is not a direct pass-through of each cost item, as shown in the Figure.

Figure 3: Cost Components Included in the Hauler Rate and Producer Payment

<u>Hauler Rate</u>	<u>Route Costs</u>	<u>Producer Rate</u>
Stop Payment	On-farm labor, excluding pumping time, plus share of fixed cost, plus waiting and personal time	Stop Charge
Mileage Payment	Transport (garage to first farm, last farm to plant and plant to garage) cost	Location Differential
	Assembly (first to last farm) costs plus share of fixed cost and labor	
Volume Payment	Plant pumping and wash time plus farm pumping time	Volume Change

Steps for making these calculations using the TI-59 program are outlined in Figure 4.

This portion of the program uses estimates from the program described above and consequently cannot be run unless steps A and B have been run previously. The steps for this program are included in the Appendix beginning at 336.

Figure 4: Operating Instructions for Part II of the TI-59 Program
After Running Part I:

DATA INPUT						
Item	Example Value	Press Key	Example Display	Your Value	Press Key	Your Display
Number of Farm Stops	9	STO 30	9	_____	STO 30	_____

OUTPUT				
Press Key	Value Output	Example Display	Your Display	
C	Stop Payment	3.54	_____	
R/S	Mileage Payment/Mile	.734	_____	
R/S	Volume Payment/cwt	.071	_____	

The procedure followed in the program can best be explained by manually running through the calculating it makes internally.

Item	Includes	Amount	
Stop Payment	On-farm labor time (excluding pumping time) plus share of waiting and personal time (8)	10	mns. per farm labor time
		$\times 9$	no. farm stops
		90	
		+ 75	waiting and personal time
		165	total stop time
		$\times .193$	FC/Mn (from Figure 1)
		31.84	total stop cost
Mileage Payment	Assembly time plus mileage costs	$\div 9$	stop payment
		\$3.54	
		480	total minutes in day
		-165	stop time
		-53.39	farm pump time (9)
		-27.18	plant pump time (10)
		-30	wash time (11)
204.42	total route time		
$\times .197$	FC/Mn (from Figure 1)		
\$39.59	time cost		

<u>Item</u>	<u>Includes</u>	<u>Amount</u>	
		110	miles
		x.374	VC/mile
		<u>\$41.14</u>	mileage cost
		41.14	
		<u>33.66</u>	
		<u>\$80.68</u>	total cost
		+110	miles
		<u>.733</u>	mileage payment/mile (12)
Volume Payment	Plant pumping and washing time plus on-farm pumping time	53.39	farm pump time (9)
		+27.18	plant pump time (10)
		+30.00	wash time (11)
		<u>110.57</u>	total volume time
		x.193	
		<u>21.34</u>	total volume cost
		<u>÷299</u>	cwt delivered
		<u>.071</u>	volume payment

CONCLUSIONS

The calculated hauling cost of 44½ cents per hundredweight must be used only as a base or guideline rate. There are numerous other factors that should be considered in arriving at an actual rate. The actual rate must include a return for hauler management and risk not included in the cost estimates as well as including differentials for specific route characteristics such as road conditions and grade. Thus each route or group of routes served by a hauler must be analyzed separately with the final rate determined through individual negotiations.

The procedure described above if properly implemented is a means of achieving a closer correlation between hauling rates and actual route costs. It should provide an incentive for both producers and haulers to improve efficiency in the milk assembly system and serve the long-run interests of all participants.

FOOTNOTES

1/ The program is readily transferable to another programming language such as that used on the HP-97 calculator. Some knowledge of programming is needed.

2/ More precisely the appropriate rate should fall somewhere between the replacement cost and the "actual" cost based on current equipment costs. The replacement cost figure is utilized here because there is often a substantial lag in incorporating replacement cost figures in the hauling rate. This lag is a result of the time necessary to assemble the cost figures and negotiate rates, which then remain in effect for a year. At the end of this period during a time when equipment costs are rising rapidly the rate is actually below the true replacement cost rate and is assumed to approximate the minimum rate needed to keep haulers in the industry.

3/ The Annual Equivalent Cost (AEC) formula used in the program is:

$$AEC = EC \frac{i(1+i)^n}{(1+i)^n - 1} - SV \frac{i}{(1+i)^n - 1}$$

EC - equipment cost
SV - salvage value at end of nth year
i - interest rate

Source: Gerald W. Smith, Engineering Economy: Analysis of Capital Expenditures. Iowa State University press, Ames, 1968, p. 99.

For further information see Smith or another book on engineering economy.

From the equivalent cost must be subtracted the appropriate tax savings available to the hauler. These include an investment tax credit (14% is used in the program which includes 10% federal and 4% New York State). Also straightline depreciation tax savings are deducted (a rate of 20% is assumed). Straightline depreciation was chosen because it approximates the method used by many smaller firms. Its use will lead to an underestimate of tax savings and thus a small overestimate of the equivalent cost for firms with sufficiently high incomes which use an accelerated depreciation such as double declining balance. The 20% tax rate is considered to be a good estimate for the entire industry but may be an underestimate for some large or more profitable operations.

4/ With the annual equivalent cost figure the annuity represents partially debt servicing and partially an increase in equity. Thus over the life of the good the interest rate must represent, in different proportions, both the cost of borrowed capital and the value of equity to the owner. Typically for small operators equity has a higher opportunity cost than borrowed capital because the risk is greater, and it should receive a higher return. The interest payments from equity are, however, taxable while debt servicing costs are tax deductible so that the other tax rate for both is applicable. After these adjustments are made and the average rate for debt and equity is calculated the yield of industrial bonds rated "A" is assumed to be a good approximation to the true value.

- 5/ Tire costs are calculated assuming that an average carcass is retreadable once and that a bias ply carcass has a total service life of 60,000 miles and a radial a life of 100,000 miles. These are averages for all the tires on a truck since the actual mileage depends on which axle it is placed on as well as road conditions, etc.
- 6/ Operationally, this entry provides a "switch" which changes the base of the cost from 60,000 miles for bias ply tires to 100,000 miles for radials.
- 7/ Some leases require a substantial payment at the beginning of the contract. If this payment is nonrefundable it should be entered in register 3 or 7 as equipment cost. Even if the payment is refunded at the expiration of the lease the compounded interest figure over the period can be substantial. This amount too, should be entered as a cost.
- 8/ The figures for this example are based on a 1978 study of hauling routes in the New York State order area.
- 9/ On the farm milk is assumed to be pumped at the rate of 560 pounds/minute.
- 10/ At the plant milk is assumed to be pumped at the rate of 1,000 pounds/minute.
- 11/ A truck is assumed to be washed only once a day.
- 12/ Figures may not match exactly these in Figure 4 because of rounding error.

BULK MILK ASSEMBLY PROGRAM

000	76	LBL	053	08	08	106	55	+
001	11	R	054	65	x	107	71	SBR
002	53	(	055	71	SBR	108	35	1/X
003	43	RCL	056	33	X ²	109	95	=
004	03	03	057	75	-	110	99	PRT
005	65	x	058	93	.	111	91	R/S
006	93	.	059	02	2	112	43	RCL
007	08	8	060	65	x	113	50	50
008	06	6	061	53	(	114	55	+
009	54	)	062	53	(	115	53	(
010	65	x	063	43	RCL	116	43	RCL
011	71	SBR	064	06	06	117	02	02
012	89	π	065	65	x	118	65	x
013	75	-	066	93	.	119	03	3
014	43	RCL	067	08	8	120	06	6
015	05	05	068	06	6	121	05	5
016	65	x	069	75	-	122	54)
017	71	SBR	070	43	RCL	123	95	=
018	33	X ²	071	08	08	124	99	PRT
019	75	-	072	54	)	125	91	R/S
020	93	.	073	55	+	126	43	RCL
021	02	2	074	43	RCL	127	50	50
022	65	x	075	07	07	128	55	+
023	53	(	076	54	)	129	53	(
024	53	(	077	85	+	130	43	RCL
025	43	RCL	078	43	RCL	131	15	15
026	03	03	079	09	09	132	65	x
027	65	x	080	85	+	133	02	2
028	93	.	081	43	RCL	134	01	1
029	08	8	082	10	10	135	09	9
030	06	6	083	85	+	136	00	0
031	75	-	084	43	RCL	137	00	0
032	43	RCL	085	11	11	138	54)
033	05	05	086	85	+	139	95	=
034	54	)	087	43	RCL	140	99	PRT
035	55	+	088	13	13	141	42	STD
036	43	RCL	089	85	+	142	41	41
037	07	07	090	43	RCL	143	91	R/S
038	54	)	091	14	14	144	76	LBL
039	85	+	092	65	x	145	89	π
040	53	(	093	03	3	146	53	(
041	43	RCL	094	06	6	147	53	(
042	06	06	095	05	5	148	43	RCL
043	65	x	096	65	x	149	12	12
044	93	.	097	43	RCL	150	65	x
045	08	8	098	15	15	151	71	SBR
046	06	6	099	95	=	152	34	FX
047	54	)	100	42	STD	153	54)
048	65	x	101	50	50	154	55	+
049	71	SBR	102	99	PRT	155	53	(
050	89	π	103	91	R/S	156	43	RCL
051	75	-	104	43	RCL	157	49	49
052	43	RCL	105	50	50	158	75	-

159 01 1
 160 54)
 161 54)
 162 92 INV SBR
 163 76 LBL
 164 33 X²
 165 53 (
 166 43 RCL
 167 12 12
 168 55 +
 169 53 (
 170 43 RCL
 171 49 49
 172 75 -
 173 01 1
 174 54)
 175 54)
 176 92 INV SBR
 177 76 LBL
 178 34 IX
 179 53 (
 180 53 (
 181 01 1
 182 85 +
 183 43 RCL
 184 12 12
 185 54)
 186 45 YX
 187 43 RCL
 188 04 04
 189 54)
 190 42 STD
 191 49 49
 192 43 RCL
 193 07 07
 194 48 EXC
 195 04 04
 196 48 EXC
 197 07 07
 198 43 RCL
 199 49 49
 200 92 INV SBR
 201 76 LBL
 202 35 1/X
 203 53 (
 204 43 RCL
 205 01 01
 206 65 X
 207 03 3
 208 06 6
 209 05 5
 210 54)

211 92 INV SBR
 212 76 LBL
 213 12 B
 214 71 SBR
 215 35 1/X
 216 55 +
 217 43 RCL
 218 20 20
 219 65 X
 220 43 RCL
 221 21 21
 222 85 +
 223 53 (
 224 53 (
 225 53 (
 226 43 RCL
 227 22 22
 228 85 +
 229 43 RCL
 230 23 23
 231 54)
 232 55 +
 233 53 (
 234 06 6
 235 00 0
 236 00 0
 237 00 0
 238 00 0
 239 85 +
 240 43 RCL
 241 25 25
 242 65 X
 243 04 4
 244 00 0
 245 00 0
 246 00 0
 247 00 0
 248 54)
 249 54)
 250 65 X
 251 71 SBR
 252 35 1/X
 253 65 X
 254 43 RCL
 255 24 24
 256 54)
 257 85 +
 258 43 RCL
 259 26 26
 260 65 X
 261 71 SBR
 262 35 1/X

263 85 +
 264 43 RCL
 265 27 27
 266 85 +
 267 43 RCL
 268 28 28
 269 65 X
 270 71 SBR
 271 35 1/X
 272 85 +
 273 43 RCL
 274 29 29
 275 95 =
 276 42 STD
 277 51 51
 278 99 PRT
 279 91 R/S
 280 43 RCL
 281 50 50
 282 85 +
 283 43 RCL
 284 51 51
 285 95 =
 286 99 PRT
 287 42 STD
 288 53 53
 289 91 R/S
 290 43 RCL
 291 53 53
 292 55 +
 293 53 (
 294 03 3
 295 06 6
 296 05 5
 297 65 X
 298 43 RCL
 299 02 02
 300 54)
 301 95 =
 302 99 PRT
 303 91 R/S
 304 43 RCL
 305 53 53
 306 55 +
 307 71 SBR
 308 35 1/X
 309 95 =
 310 99 PRT
 311 91 R/S
 312 43 RCL
 313 51 51
 314 55 +

315	53	(
316	43	RCL			
317	02	02			
318	65	x			
319	03	3			
320	06	6			
321	05	5			
322	54)			
323	95	=			
324	99	PRT			
325	91	R/S			
326	43	RCL			
327	51	51			
328	55	+			
329	71	SBR			
330	35	1/X			
331	95	=			
332	99	PRT			
333	42	STD			
334	42	42			
335	91	R/S			
336	76	LBL			
337	13	C			
338	53	(
339	53	(
340	43	RCL			
341	30	30			
342	65	x			
343	01	1			
344	00	0			
345	85	+			
346	07	7			
347	05	5			
348	54)			
349	65	x			
350	43	RCL			
351	41	41			
352	54)			
353	55	+			
354	43	RCL			
355	30	30			
356	95	=			
357	99	PRT			
358	91	R/S			
359	53	(
360	53	(
361	43	RCL			
362	15	15			
363	65	x			
364	06	6			
365	00	0			
366	75	-			
367	53	(
368	43	RCL			
369	30	30			
370	65	x			
371	01	1			
372	00	0			
373	85	+			
374	07	7			
375	05	5			
376	85	+			
377	71	SBR			
378	23	LNx			
379	85	+			
380	71	SBR			
381	32	X↑T			
382	85	+			
383	03	3			
384	00	0			
385	54)			
386	54)			
387	65	x			
388	43	RCL			
389	41	41			
390	85	+			
391	43	RCL			
392	01	01			
393	65	x			
394	43	RCL			
395	42	42			
396	54)			
397	55	+			
398	43	RCL			
399	01	01			
400	95	=			
401	99	PRT			
402	91	R/S			
403	53	(
404	53	(
405	71	SBR			
406	23	LNx			
407	85	+			
408	71	SBR			
409	32	X↑T			
410	85	+			
411	03	3			
412	00	0			
413	54)			
414	65	x			
415	43	RCL			
416	41	41			
417	54)			
418	55	+			
419	43	RCL			
420	02	02			
421	95	=			
422	99	PRT			
423	91	R/S			
424	76	LBL			
425	23	LNx			
426	53	(
427	53	(
428	43	RCL			
429	02	02			
430	65	x			
431	01	1			
432	00	0			
433	00	0			
434	54)			
435	55	+			
436	05	5			
437	06	6			
438	00	0			
439	54)			
440	92	INV SBR			
441	76	LBL			
442	32	X↑T			
443	53	(
444	53	(
445	43	RCL			
446	02	02			
447	65	x			
448	01	1			
449	00	0			
450	00	0			
451	54)			
452	55	+			
453	01	1			
454	01	1			
455	00	0			
456	00	0			
457	54)			
458	92	INV SBR			