April 1985

A.E. Res. 85-9

A COST-BASED RATE SYSTEM FOR BULK MILK ASSEMBLY

by

David R. Lee, Walter C. Wasserman, William H. Lesser,
Thomas H. Stafford, and Robert D. Boynton

Department of Agricultural Economics
Cornell University Agricultural Experiment Station
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York, 14853

It is the policy of Cornell University actively to support equality of educational and employment opportunity. No person shall be denied admission to any educational program or activity or be denied employment on the basis of any legally prohibited discrimination involving, but not limited to, such factors as race, color, creed, religion, national or ethnic origin, sex, age or handicap. The University is committed to the maintenance of affirmative action programs which will assure the continuation of such equality of opportunity.

PREFACE

This report is one of three issued by the Department of Agricultural Economics, Cornell University in conjunction with the Agricultural Cooperative Service of the U.S.D.A. as part of a joint project on developing computer software for use in cost analysis by the milk hauling industry. This report describes the background and basic methodology involved in the development of a cost-based system for hauling cost analysis. The other reports in this series are: "Milk Hauling Cost Analysis Program - User's Manual;" and "Truck Maintenance and Repair Cost Record - User's Manual." Requests for copies of all three reports should be directed to either of the addresses below:

Publications Office
Dept. of Agricultural Economics
442 Warren Hall
Cornell University
Ithaca, NY 14853

Cooperative Marketing and
Purchasing Division
Agricultural Cooperative Service
U.S. Dept. of Agriculture
Washington, D.C. 20250

David R. Lee, Walter C. Wasserman and William H. Lesser are Assistant Professor, Milk Marketing Extension Specialist, and Associate Professor, respectively, in the Department of Agricultural Economics, Cornell University. Thomas H. Stafford is an Agricultural Economist with the Cooperative Marketing and Purchasing Divsion, Agricultural Cooperative Service, U.S. Department of Agriculture. Robert D. Boynton is Executive Director, Dairy Institute of California, and formerly an Associate Professor in the Department of Agricultural Economics, Cornell University.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

A COST-BASED RATE STRUCTURE FOR BULK MILK ASSEMBLY

I. INTRODUCTION

Milk assembly performs a vital function in the marketing system which delivers fluid milk and dairy products from farms to consumers. Many changes have occurred in bulk milk assembly in recent years. Dairy production has become consolidated on fewer, larger farms. Small dairy cooperatives have consolidated into larger regional cooperatives. Tractor trailers and larger capacity tanks are being used with increasing frequency to transport fluid milk. Despite these changes, producer charges for milk hauling from farm to processing plant continue to represent one of the principal off-farm costs for dairy operators. Furthermore, in many areas, the prevailing hauling rate structure still reflects the old can route relationships, rather than the costs associated with today's specialized bulk milk trucks.

In many parts of the country, the dairy industry is dependent on independent contract haulers to fulfill the assembly function. Hauling payment rates are generally negotiated between handlers (typically farmer cooperatives) and haulers based on the costs involved in the assembly operation. All too often, however, only incomplete or imperfect information is available to both haulers and handlers in the negotiation process. For example, due to the lack of adequate records, haulers may have incomplete information on individual route operating costs. This may be a particular problem in cases where two or more routes are operated with different trucks under differing conditions. Changes in the prices of hauling inputs (fuel, tires, labor, trucks, tanks) frequently lead to requests by haulers for rate increases without accurate analysis of how these price changes affect actual route operating costs. Yet, rapidly rising input costs have made improved truck productivity and sound business management crucial for survival of the independent contract hauler.

Cooperative and proprietary handlers often have even less information on milk assembly costs than do haulers. Moreover, because handlers often deal with two or more haulers, handlers must cope with costs that vary from hauler to hauler depending on the number and size of pickups, geographic terrain on the route, the ratio of assembly to over-the-road transport miles, and many other factors. Handlers are challenged to pay haulers adequately and often uniformly. At the same time, handlers must also devise a system to charge farmers for the costs of assembling their milk, costs which, in fact, may vary across routes and may not be equivalent to the rate at which a hauler or group of haulers is paid. These and other problems make negotiated rate-making and the establishment of a system of hauling rates fair to haulers, producers, and handlers often difficult. This report offers a framework to help haulers and handlers develop a cost-based charge and rate system for milk assembly.

Outlined below is a charge and payment system for bulk milk assembly[1] which is based on allocating the actual costs of route operations.

---

[1]Unless noted otherwise, in this report, "assembly" refers to bulk milk collection and transportation to the plant of first receipt; "charge" refers to the cost structure levied on producers; "payment" refers to the structure of revenues paid to haulers.

Attempts at defining milk assembly rate structures, in general, are not new. Previous studies have included those of Moede (1971), Roof and Tucker (1972), Nolte and Koller (1975), Lough (1977), and Karpoff, Webster, and Saunders (1981). The current study is closest in principle to that of Roof and Tucker, and indeed, uses many of the concepts they developed and subsequently used in designing actual rate structures.

After a discussion of representative route and truck cost specifications, this report proceeds in three steps. First, the component costs involved in bulk milk assembly operations are identified and divided into three categories: fixed truck and overhead costs, variable truck costs, and labor costs. Second, these cost categories are allocated according to the specific route activities performed, with an emphasis on the allocation of fixed truck and overhead costs. Third, the costs of route activities are aggregated into a three-tier producer charge and hauler payment system consisting of stop, volume, and mileage charges/payments. The implications of the proposed cost structure for the determination of charges and payments on multiple route systems are then addressed. In particular, the application of the proposed system to a hauling pool or set of routes is discussed.

The widespread use of a cost-based rate structure would have several desirable effects:

(1) Both haulers and cooperatives or other handlers could have access to a consistent cost-justified rate structure in their negotiations. While other issues having to do with specific routing problems and equity considerations will no doubt continue to enter the negotiation process, a consistent cost-based system of rates could be used as a yardstick by which to measure other proposed rate structures.

(2) Widespread adoption could provide generally accepted uniform guidelines for cost analysis, rather than the informal record-keeping and cost analysis systems often used at present.

(3) Use of such a system would enhance the management effectiveness of individual hauling businesses through increased cost-awareness and enhanced productivity. This would help insure the maintenance of an efficient and competitive independent milk hauling industry in the future.

Before turning to the specification of the proposed system, two qualifications concerning the usefulness of a cost-justified rate structure must be noted. First, designing both producer charge and hauler payment systems based on actual current costs of operation does not assure improved efficiency. Excessive costs due to existing inefficiencies could simply be continued. It is hoped, though, that current system inefficiencies, once made more noticeable and measurable, in turn may lead to efficiency improvements. However, a cost-based rate system can continue to incorporate operational inefficiencies which are reflected in higher than optimal cost levels.

Second, a cost-justified assembly rate structure will not necessarily fit everyone's definition of an equitable rate system. A cost-based structure attempts to bill producers for the actual costs they impose on the system. That is one definition of equity, but there may be other plausible definitions as well. For example, smaller producers may consider it equitable for the larger farms on a route to pay a greater share of costs since the larger more profitable operator may be better able to afford it. Alternatively, larger producers may think volume discounts are equitable because of the lower assembly mileage costs[2] incurred on a route with one or more large producers compared to a route with many small producers. Alternative rate structures to the cost-based one proposed here may be preferable in certain cases, and in fact may more closely resemble actual negotiated rate structures in some instances. Nonetheless, we believe that the system proposed here is both justifiable and, in the long term, would lead to greater efficiencies in milk assembly to the benefit of producers, haulers, and handlers.

II. TRUCK AND ROUTE SPECIFICATIONS

A variety of different milk assembly systems are used for farm pickup and delivery to processing plants. The types of systems in use include: single, double, or tri-axle straight chassis trucks with tank capacities ranging from 1,800 to 5,000 gallons; straight chassis trucks used in combination with four-wheel tank (or "pup") trailers; and tractor trailer units with tanks ranging from 4,000 to 6,000 gallons or more. In recent years, "double bottom" or twin trailer systems have become increasingly common for over-the-road milk hauling, as vehicle size and weight restrictions have been liberalized throughout the country.

In New York State, a 1980 survey of milk haulers showed straight chassis vehicles with tank capacities of 4,000-4,500 gallons and tractor trailer combinations with tank capacities of at least 6,000 gallons to be the most commonly used vehicles (Anderson). Yet, the usage of different types of truck and tank combinations tends to be highly variable across the country and dependent on such factors as the average distance from farm to plant, the average size of farms and frequency of pickup, and the geographic terrain and road conditions existing in specific localities. Even on a single route, different assembly systems may be used for farm pickup and over-the-road hauling.

Average route specifications also vary considerably from region to region. The 1980 New York hauler survey reported that the number of farm stops on the typical sample route averaged 14.2 per day; the average number of loads per day equaled 1.5; the average number of miles traveled per day was 216 miles; and the average pounds of milk hauled per day equaled 49,800 pounds. A 1978 survey of Wisconsin milk haulers (Lamb) showed a somewhat different situation. The average number of farm pickups per day was 17.0; the average number of loads per day equaled 2.0; the average daily route mileage was 104 miles; and the average volume of

---

[2]As explained further below, "assembly mileage" refers in this report to the route mileage from first farm pickup to last farm; "transport" or "over-the-road" mileage refers to plant-to-first farm route mileage and last farm-to-plant mileage.

milk hauled equaled 34,816 pounds. Similar route data for many Southern and Western routes would likely show the average number of farm stops per day to be lower and the average daily route mileage and hauling volume to be higher due to the generally larger and less densely located farms in those parts of the country.

Despite the considerable variation in typical truck and route specifications and the resultant differences in costs of operation, the principles behind a cost-justified rate structure remain similar. For that reason, and for simplicity of exposition, two representative truck and route specifications are described here and are used in this report to illustrate the proposed system of charges and rates. Actual route structures often differ considerably from the two examples examined here, but the basic procedures involved in determining a producer charge and hauler payment system are unchanged.

These two cases are outlined in detail in Table 1. Case 1 involves a straight chassis 10-wheel vehicle with a 4,000 gallon capacity tank being driven approximately 51,000 miles annually.[3] It is assumed that the truck and tank together cost $85,000 new and that the truck can be driven six years or approximately 300,000 miles before major reconditioning. The assumed salvage value of the chassis is $16,000. The tank has an expected life of 10 years, and a salvage value of $4,000. The typical hauling route for this vehicle involves, on average, 14 farm stops and 1.4 loads per day and 139 daily miles. This amounts to total annual route mileage of roughly 51,000 miles. The average quantity of milk hauled daily is approximately 47,700 pounds.

Case 2 is a tractor trailer combination with a 6,000 gallon tank and an average annual mileage of 126,000 miles. Initial truck and tank costs are assumed to total $100,000 and the truck can be driven three years or 400,000 miles before major costs for reconditioning are incurred. The assumed chassis salvage value is $20,000. The tank has an expected life of 10 years as in Case 1 and a salvage value of $7,000. The typical route served by this vehicle involves a much greater proportion of over-the-road mileage. An average daily mileage of 346 miles is assumed, which includes 13 farm stops and one load per day. Approximately 51,300 pounds of milk are hauled daily. Over the course of a year, total route mileage would be roughly 126,000 miles.

For Case 1 and Case 2, farms are assumed to be located four and five miles apart, respectively. This means that, on average, the hauling route for Case 1 consists of 52 assembly (or farm-to-farm) miles and 87 transport (plant-to-first farm and last farm-to-plant) miles. For Case 2, only 60 of the total of 346 route miles are assembly miles, while 286 transport miles are involved. Clearly, this case involves the transport of fluid milk to processing plants at considerable distance from the farms on the route. In New York, this situation is akin to transporting milk from upstate farms to fluid processing plants in the metropolitan New York City area.

---

[3]These figures and most of those describing Cases 1 and 2 approximate averages from the New York hauler survey reported by Anderson and described in more detail in Lesser and Wasserman (1982).

Table 1

Representative Truck and Route Specifications

	Case 1	Case 2
Truck and Tank:		
Vehicle type	straight chassis (10-wheel)	tractor trailer
Tank capacity	4,000 gal.	6,000 gal.
Annual mileage	51,000 miles	126,000 miles
Cost of new truck and tank	$85,000	$100,000
Mileage before major reconditioning	300,000 miles	400,000 miles
Chassis: expected life	6 years	3 years
salvage value	$16,000	$20,000
Tank: expected life	10 years	10 years
salvage value	$4,000	$7,000
Fuel mileage	5 m.p.g.	5 m.p.g.
Route:		
Total daily mileage	139 miles	346 miles
assembly mileage	52 miles	60 miles
transport mileage	87 miles	286 miles
Milk hauled daily	47,700 lbs.	51,300 lbs.
Loads per day	1.4 loads	1 load
Daily farm pickups	14 stops	13 stops
Average distance farm-to-farm	4 miles	5 miles
Average daily operating hrs.	9.6 hours	14 hours
assembly	5.8 hours	6.3 hours
transport	3.8 hours	7.7 hours

III. SPECIFICATION OF COST COMPONENTS

The rate structure system proposed here disaggregates overall route hauling expenses into three major cost categories: (1) fixed truck and overhead costs; (2) variable truck costs; and (3) labor costs. This section defines each of these three cost categories and details the individual cost components included under each.

Fixed Truck and Overhead Costs

Fixed truck costs and the overhead costs of the hauling operation consist of those expenses which are incurred by the hauling operation and which are not proportional to miles driven or volume of milk hauled. These costs include the following expense categories: insurance; taxes; licenses and registration; depreciation and interest; and miscellaneous fixed costs. Each of these costs is discussed in detail below.

(1) Insurance. This includes liability, collision, and cargo coverage, as well as other mandated coverage, where applicable.

(2) Taxes. Only highway use taxes are included here. Recent changes in federal highway use tax legislation, specifically the 1982 Highway Revenue Bill, mandated annual increases in highway use taxes paid by heavy trucks through 1988. Other taxes paid by milk hauling operations are not included in this cost category. Fuel and tire taxes are included in variable truck costs; sales taxes paid at the time of vehicle purchase are included in the initial purchase price; property taxes are included under miscellaneous administrative costs.

(3) Licenses and registration. This includes state vehicle registration and licensing fees.

(4) Depreciation and interest. Annual truck and tank depreciation and interest costs represent a large proportion of the total fixed costs of milk assembly operations. A number of different methods for calculating equipment depreciation (straight line, declining balance, etc.) are available, each of which gives a different estimate of depreciation costs in a given year.

The depreciation calculations adopted in this report use the concept of "useful vehicle life," which is based on the number of years before major reconditioning is required. Useful vehicle life (UVL) is simply defined as:

$$\text{UVL} = \frac{\text{no. of service miles before major reconditioning}}{\text{ave. no. of miles driven annually}}$$

For example, in the Case 1 situation depicted above,

$$\text{UVL} = \frac{300{,}000 \text{ miles}}{51{,}000 \text{ miles/year}} = 5.88 \text{ years}$$

or approximately six years.

For each year the vehicle is used, vehicle ownership (depreciation and interest) costs are calculated on the basis of "annual equivalent costs." This method was used by Lesser and Wasserman (1980, 1982) and is described in more detail in Smith (1968). Annual equivalent cost (AEC) is defined as:

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

where:

EC = equipment (vehicle or tank) cost, current replacement cost
SV = salvage value at time of sale
n = years of vehicle life
i = interest rate.

The use of the UVL and AEC concepts permit the calculation of separate annualized cost figures for both truck (cab and chassis) and tank. This is desirable as trucks generally depreciate more quickly than tanks. The use of current replacement cost as the equipment cost (EC) figure in the AEC calculation recognizes that truck and tank costs have continued to increase along with general inflation. By integrating current replacement costs into the calculation of depreciation costs, total fixed vehicle costs are higher than they would be if actual costs were used. However, since the hauler must accumulate out of hauling payments enough equity to repurchase equipment at the end of its useful vehicle life, this technique serves to increase the likelihood that haulers will have sufficient capital to purchase a replacement vehicle at a later date.

The salvage value component of the AEC calculation is related to the value of the equipment cost (EC) component and so also varies with the rate of inflation. The interest rate (i) incorporated into the AEC calculation represents the cost of the capital invested in the hauling operation.

As an example of the calculation of AEC, consider the Case 1 situation outlined above, and the AEC associated with the operation of a truck and tank under Case 1 specifications. At an interest rate of 13 percent, the AEC for the truck would be:

$$AEC = (\$65,000)\frac{.13(1.13)^6}{(1.13)^6-1} - (16,000)\frac{.13}{(1.13)^6-1}$$

$$= \$14,338.$$

For the tank, the figure is:

$$AEC = (\$20,000)\frac{.13(1.13)^{10}}{(1.13)^{10}-1} - (4,000)\frac{.13}{(1.13)^{10}-1}$$

$$= \$3,469.$$

Thus, the total AEC is $14,338 + $3,469 = $17,807 per year.

For the Case 2 example, also assuming a 13 percent interest rate, the AEC estimates are as follows:

$$\text{Truck: AEC} = (65{,}000)\frac{(.13)(1.13)^3}{(1.13)^3 - 1} - (20{,}000)\frac{.13}{(1.13)^3 - 1}$$

$$= \$21{,}658$$

$$\text{Tank: AEC} = (35{,}000)\frac{(.13)(1.13)^{10}}{(1.13)^{10} - 1} - (7{,}000)\frac{.13}{(1.13)^{10} - 1}$$

$$= \$6{,}070$$

The total AEC for Case 2 is, then, \$21,658 + \$6,070 = \$27,728 per year.

The annual equivalent cost formula explicitly allows for changes in equipment costs, salvage values and interest rates. It also adjusts equipment and salvage values for the "true" cost of money. The calculation represents an understandable and explicit method for the determination of the ownership costs of milk hauling equipment, specifically those costs associated with depreciation and interest charges. It differs from depreciation costs computed for income tax purposes. Tax depreciation procedures are intended to accomplish specific objectives such as the stimulation of investment and do not generally represent actual ownership costs.

(5) Miscellaneous fixed costs. This category includes a share of the remaining fixed or overhead costs of the hauling operation which are not specifically allocable to individual trucks. Typical milk hauling operations use from one or two to twenty and more vehicles. Individual route numbers are even greater since every-other-day pickups are common. The costs incurred in operating a hauling business generally exceed the direct costs associated with individual trucks and routes. Administrative, labor and garage expenses, for example, must be covered, as must the costs of backup trucks and tanks. Thus, to the direct costs of operating hauling routes (such as those described in Table 1) must be added an allowance for firm-level overhead costs not directly attributable to individual route operations.

Specific costs included in this category vary with the hauling operation but might include the expenses associated with heating and utilities, management, bookkeeping, property taxes, advertising, and other office and garage overhead costs. Again, only those labor costs for vehicle maintenance and repair which are not allocable to specific vehicles would be included under this category. The share of miscellaneous overhead costs which is allocable to each vehicle will depend on the number of vehicles in the hauling operation.

Overhead costs may also include an allowance for backup equipment. Reserve trucks and tanks are required in many hauling operations to handle the spring flush and unforeseen equipment breakdowns. This backup equipment may be more antiquated than that commonly used and may remain unused during much of the year. Nevertheless, the costs of maintaining this equipment must be covered by hauling charges. One option is for these costs to be treated as overhead expenses and charged to the entire hauling operation. Alternatively, when a spare truck is used on a seasonal basis in support of a particular hauling contract, the route cost can be determined and allocated to that contract using the general procedures outlined in this report.

Variable Truck Costs

Variable truck costs are those costs which vary directly with the number of route miles driven and may thus be charged accordingly. They include costs for:

(1) Fuel (including fuel taxes).

(2) Tires (including tire taxes).

(3) Preventive maintenance. This includes oil, filters, and other parts and labor required for routine maintenance.

(4) Repair. This category of costs includes standard repair costs but not major reconditioning costs. Repair costs are difficult to calculate since they vary considerably from truck to truck and from year to year. It is preferable to use a repair cost gradient approach and estimate the average repair costs over a fleet of trucks for several years, rather than base repair cost estimates on those for a single truck. This should minimize extreme variability in repair cost estimates and represent the average actual cost of vehicle repair.

The sum of cost components (1)-(4) can be divided by the number of annual route miles to calculate per mile variable truck costs.

Labor Costs

Although labor may be paid on a fixed or "semi-fixed" basis, labor costs including fringe benefits should be charged as they are incurred, that is, to the individual components of route operations. This means that total route labor costs must be disaggregated according to the time spent on individual route activities.

On the typical hauling route, driver time is spent on seven different activities:

(1) Transport driving: includes route preparation time, the time spent driving from the garage (or plant) to the first farm for each load, and the time spent driving from the last farm (or plant) to the plant (or garage) for each load.

(2) Assembly driving: includes time spent driving between farms on the assembly route and the time positioning the truck at each farm.

(3) On-farm routine activities: includes time spent hooking up and unhooking hose, agitating milk, sampling, reading dipstick, and rinsing tank.

(4) On-farm pumping: The time spent is directly proportional to the volume of milk pumped. In the cases considered here, a pumping rate of 560 pounds per minute is assumed.

(5) Plant waiting: includes the time spent positioning the truck at the plant and waiting to unload.

(6) Plant pumping: The time spent is proportional to the volume of milk unloaded (like (4)). A pumping rate of 1200 pounds per minute is assumed here.

(7) Tank washing: The tank must be washed after unloading, regardless of volume hauled.

If a proportion of driver time is spent in the office or garage completing duties not allocable to a specific hauling route, then the costs incurred in these activities should be allocated to system-wide overhead costs and not to the costs associated with a particular route. The same principle applies to the allocation of costs of employing relief drivers. Those costs incurred in performing actual route operations should be charged accordingly, while relief driver time spent doing general garage or administrative work should be charged to overhead costs.

As described in detail in the next section, the manner in which the labor costs incurred in milk assembly are finally allocated depends on whether the costs of the specific activities in which labor is engaged are allocable to system overhead or are proportional to volume shipped or route mileage traveled. The costs associated with assembly driving time (category (2)), on-farm routine activities (3), waiting at the plant (5), and tank washing (7) are incurred by the hauling operation regardless of volume or distance. Thus, all of these costs are allocable to the hauling system as a whole. Both on-farm pumping time and plant pumping time (categories (4) and (6)), however, are directly proportional to quantity pumped and thus are allocable according to volume. Finally, transport time (1) is directly proportional to transport mileage and thus its associated costs are allocable according to transport mileage.

Previous surveys of hauling operations have provided detailed breakdowns of the time spent performing the various assembly route activities. The 1978 survey of Wisconsin milk haulers, for example, revealed the average driver time allocation shown in Table 2. However, driver time allocation will vary considerably depending on the characteristics of the specific route(s) driven. To assess accurately labor costs on any given hauling route, similar breakdowns of time spent on various route activities should be measured periodically.

Examples: Cases 1 and 2

Table 3 presents hypothetical time allocations for completion of the various route activities for the two representative hauling routes

Table 2

Time Allocation for Wisconsin Hauling Routes

Route Activity	Time (minutes)	Percent of Total
On-farm non-pumping time	181	38%
On-farm pumping time	66	14%
Plant waiting time Plant washing time Plant pumping time	74	15%
Assembly driving time Transport driving time	155	33%
Total time available	476 min.	100%

Source: Lamb (1980).

described previously. These data are consistent with representative hauling operations. The transport driving times assume an average of 45 m.p.h. in Case 1 and 50 m.p.h. in Case 2. An assembly driving speed of 25 m.p.h. is assumed for both cases. On-farm routine time is assumed to amount to ten minutes for each of the fourteen stops in Case 1, and eleven minutes for each of the thirteen stops in Case 2. An assumed on-farm pumping rate of 560 pounds of milk per minute results in an average time allocation of six minutes per farm for each of the 14 farms in Case 1 for on-farm pumping, for a total of 85 minutes. For Case 2, the same pumping rate yields an average allocation of seven minutes per farm for each of the thirteen farms for a total on-farm pumping time of 92 minutes. At the plant, an assumed pumping rate of 1200 pounds per minute results in pumping time allocations of 40 and 43 minutes for Cases 1 and 2, respectively. Plant waiting time is assumed to average 30 minutes per load. Assumptions of representative tank washing times are also made in Table 3. These data are used below in the allocation of fixed hauling costs and in the calculation of the hauling charge system.

Table 4 presents annual cost estimates for the two representative hauling routes, based on the truck, tank and route specifications given in Table 1, the total route time requirements in Table 3, and additional representative route cost estimates. For Case 1, these additional cost assumptions include: fuel requirements of 10,200 gallons at a cost of $1.20 a gallon; purchase of 10 bias tires at $225 per tire and recapping cost of $100 per tire; expected tire life, including one recap, of 60,000 miles; maintenance costs of $.03 per mile; repair costs of $.10 per mile; and labor costs of $7.50 per hour, including fringe benefits. For the Case 2 example, the assumptions differ as follows: fuel requirements of 25,200 gallons of fuel at $1.20 per gallon; purchase of 18 radial tires at $325 per tire and recapping cost of $100 per tire; expected tire life, including one recap, of 90,000 miles; maintenance costs of $.025 per mile; and repair costs of $.07 per mile. Total annual route operation costs for Cases 1 and 2 are $70,965 and $127,963, respectively.

Table 3

Time Allocations for Cases 1 and 2

Route Activity	Time (minutes) Case 1	Case 2
Transport driving time	116	343
Assembly driving time	125	144
On-farm routine time	140	143
On-farm pumping time	85	92
Plant waiting time	42	30
Plant pumping time	40	43
Tank washing time	30	40
Total Time Requirement	578 min. (9.6 hrs.)	835 min. (14 hrs.)

Table 4

Annual Cost Estimates for Two Representative Hauling Routes

Cost Category	Case 1		Case 2
(1) Fixed truck and overhead costs:			
Insurance	$ 2,300		$ 3,600
Taxes (Federal Highway Use Tax)	0		550
Licenses & registration	435		840
Depreciation & interest (AEC)	17,807		27,728
Miscellaneous	2,500		4,000
Total Fixed Costs:	$23,042		$36,718
(2) Variable truck costs:			
Fuel (@ $1.20/gal.)	$12,240		$30,240
Tires (@ $225)	2,763	(@ $325)	10,710
Maintenance (@.03/mi.)	1,530	(@ $.025/mi.)	3,150
Repair (@ $.10/mi.)	5,110	(@ $.07/mi.)	8,820
Total Variable Truck Costs:	$21,643		$52,920
(3) Labor Costs (@ $7.50/hr.)	$26,280		$38,325
Est. Total Annual Costs	$70,965		$127,963

IV. COST ALLOCATION PROCEDURES

The cost-based charge and payment system developed here requires that the individual costs of route operation are allocated, to the greatest extent possible, to the specific route activities performed. In general, the hauling costs described above vary according to (1) volume of milk shipped, (2) distance from farm to plant, or (3) are attributable to the system as a whole. Accordingly, this section describes methods by which specific categories of hauling costs can be allocated by either volume, distance, or time, or attributed to the total hauling system. The allocation of variable truck costs and labor costs is considerably less complicated than for fixed costs, and is reviewed after the discussion of fixed cost allocation.

The allocation of fixed truck and overhead costs has been the subject of considerable debate in the past, as different justifications have been offered to allocate fixed costs on the basis of volume, distance, or the number of farms or "stops" on the route.[4] Roof and Tucker, for example, arbitrarily allocated one-third of fixed costs to each of time, volume, and mileage as a proposed solution to the problem.

The rate structure system proposed here allocates fixed truck and overhead costs over the time spent performing route activities. The justification for this procedure lies in the fact that fixed costs (depreciation and interest, primarily) are incurred by the hauling operation regardless of the specific volume hauled or distance travelled. However, the time spent in performing many individual route activities is proportional to volume of milk shipped or transport mileage. For example, pumping time, both at the farm and plant, is directly proportional to the quantity of milk pumped. Transport driving time, as a second example, is directly proportional to the total distance from the plant to first farm on the route and last farm to the plant. Other examples could be given.

One result of allocating system-wide costs across the time dimension is that these costs are also allocated over volume and distance components through measurement of the times involved in completing volume and mileage-dependent route activities. This procedure has the additional desirable effect of charging a higher per mile rate for route assembly mileage compared to transport mileage due to the slower speed of farm assembly.

To understand specifically how this procedure works, consider Table 5 which is based on the route time allocations for Cases 1 and 2 presented in Table 3. The first column lists the specific route activities according to whether they are proportional to volume shipped, mileage traveled from the plant, or neither. As mentioned above, on-farm and plant pumping time (and costs) are directly proportional to volume shipped. Transport driving time and costs are directly proportional to distance from farm to plant. Assembly driving costs, on-farm routine

---

[4]See references mentioned on page 2 for discussions of alternative treatments of fixed cost allocation.

costs, plant waiting and tank washing costs are all incurred regardless of the specific volume shipped or transport distance, and thus these costs are allocated as overall systemwide costs. In Table 5, the second and third columns give the proportions of total route time accounted for by each activity individually and by each group of activities in Cases 1 and 2.

The principle of allocating fixed costs over time means that since, for Case 1, 22 percent of total route time is spent completing volume-dependent route activities, then 22 percent of fixed costs are to be allocated to the volume-related costs. Similarly, 20 percent of fixed costs are allocated to distance-related costs and 58 percent of fixed costs are shared by the system in a manner not directly related to either volume or distance. For Case 2, the procedure is similar. Sixteen percent of fixed costs are allocated to volume, 41 percent to distance, and 43 percent are system-wide costs. The much greater proportion of fixed costs allocated to distance-related costs in Case 2 is due to the significantly greater over-the-road or transport mileage characterizing this representative route.

Fixed cost charges for specific route activities can be calculated either by multiplying the appropriate percentage of total route time by total fixed costs or they can be expressed on an hourly basis, by dividing total fixed costs by total hours of operation (which is equivalent to total labor requirements). The hourly fixed cost charge can then be directly applied to the actual time spent completing the abovementioned activities to arrive at the appropriate fixed cost charges.

Table 5

Percentage Time Allocations for Cases 1 and 2

Route Activity Categories	Percent of Total Route Time*	
	Case 1	Case 2
Costs Proportional to Volume:		
On-farm pumping	15%	11%
Plant pumping	7%	5%
Total	22%	16%
Costs Proportional to Distance:		
Transport driving	20%	41%
System-wide Operation Costs:		
Assembly driving	22%	17%
On-farm routine	24%	17%
Plant waiting	7%	4%
Tank washing	5%	5%
Total	58%	43%
Overall	100%	100%

*See route time allocations in Table 3.

The allocation of variable truck costs and labor costs is much more straightforward. Variable truck costs are incurred in either assembly driving or transport driving and can be allocated accordingly either as a system-wide cost (assembly costs) or on a per mile basis (transport costs). Labor cost shares can be allocated, based on the percentages in Table 5, directly to volume, distance, or system-related costs. For example, in Case 1, 22 percent of annual labor costs are allocated to volume, 20 percent to distance, and 58 percent to the system as a whole.

V. PRODUCER CHARGE SYSTEM

Having disaggregated the entire cost structure for a typical assembly route, it is now possible to reaggregate those costs according to how they are charged to producers, whether on the basis of stop charges, volume (per hundredweight) charges, or distance (per hundredweight per mile) charges. Table 6 summarizes the resulting producer charge system[5].

Producer stop charges cover those costs which are borne by the route as a whole and which are not allocable to volume or distance. Variable truck costs associated with assembly mileage are included in the stop charge as these costs are assumed to be incurred by the overall route. Also included are the labor costs associated with assembly driving time, on-farm routine time, plant waiting time and tank washing time. (In Cases 1 and 2, these labor costs included in the producer stop charge were 58 percent and 43 percent, respectively, of total labor costs.) Finally, the shares of fixed truck costs allocated to these four labor cost components are included in the stop charge (in Cases 1 and 2, 58 percent and 43 percent of fixed truck costs, respectively). Total stop charge costs are divided by the number of stops to obtain the per stop charge. Although the final stop charge is equal across producers on the route, higher volume producers will pay a lower per hundredweight stop charge because these charges will be spread over a greater volume of milk.

The volume charge to producers is determined by the sum of those costs which are directly proportional to the volume of milk hauled. These costs include labor costs for on-farm and plant pumping time. The share of labor time or costs accounted for by these activities (22 percent and 16 percent for Cases 1 and 2, respectively) is applied to the total fixed truck costs as well and the resulting fixed cost share is included in the total volume charge. Total volume-related costs are divided by the average number of hundredweight hauled in determining the constant per hundredweight volume charge to producers.

The mileage charge to producers (measured in \$/cwt./mile) covers those costs associated with transporting milk from farm pickups to the processing plant. Because these costs rise in direct proportion to the distance between each farm on a given route and the plant, mileage charges to producers increase proportionately with distance to the plant, which may vary substantially within a single route or across routes. In

[5]For a discussion of alternative rate structure systems, see the Appendix.

Table 6

Summary of Producer Charge System

Where Costs are Incurred	Type of Producer Charge		
	Stop Charge	Volume Charge	Mileage Charge
Assembly	Truck assembly mileage variable costs + assembly labor costs + assembly driving share of fixed truck costs	--	--
Transport	--	--	Truck transport mileage variable costs + transport driving labor costs + transport driving of fixed truck costs
On-farm	Routine time labor costs + routine time share of fixed truck costs	Pumping time labor costs + pumping time share of fixed truck costs	--
Plant	Plant waiting time and tank washing labor costs + plant waiting and tank washing share of fixed truck costs	Plant pumping labor costs + plant pumping share of fixed truck costs	

Cases 1 and 2, for example, transport mileages were 87 miles and 286 miles, respectively. The mileage charge to producers could, then, be calculated as the transport cost above, divided by volume times miles transported.

However, to facilitate the calculation of mileage-related charges, a zone structure to a given route can be applied. A zone structure loses a slight degree of accuracy in measuring transport costs for a large gain in ease of calculation (and, presumably, a lowering of administrative costs). A zone structure is depicted in Figure 1. All farms on the route are assumed to lie within a zone. The first zone includes farms within 20 miles of the plant, but to facilitate calculation of mileage or zone charges all farms are assumed to lie 15 miles from the plant. Zone 1 and all other zones are defined by concentric rings 30, 40, etc. miles from the plant. In each case, all farms located within the zone are assumed to lie at the zone's midpoint, e.g., 25, 35, etc. miles from the plant, as indicated in Figure 1.[6]

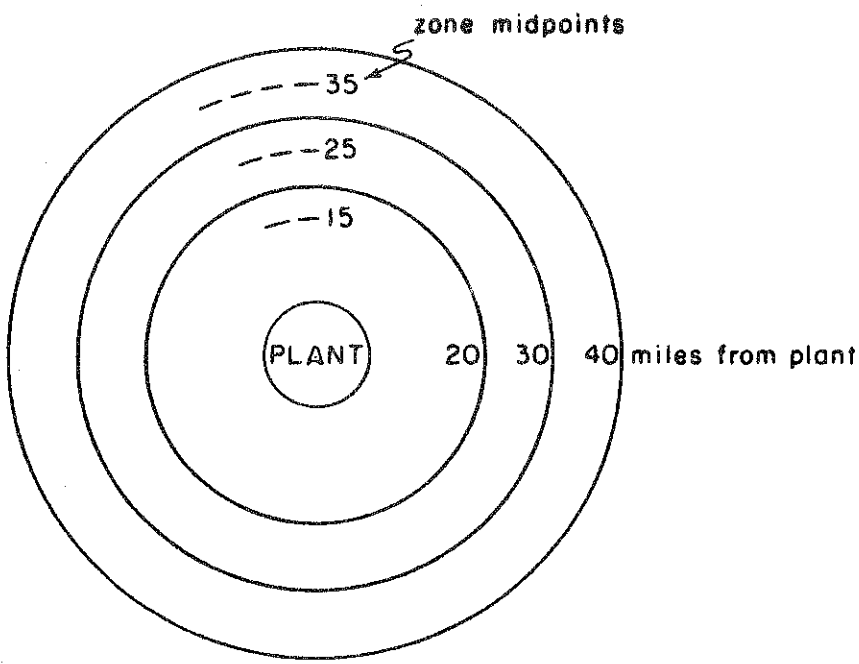

Figure 1. Hauling Zone Structure

[6]The zone structure described here might be akin to that involving the transportation of milk to a fluid processing plant. A zone structure for a manufacturing plant might include an additional inner zone if large numbers of farms are located close to the plant.

The determination of the actual zone charges applicable to a specific route is based on covering the costs incurred in the transport function. The costs incurred in over-the-road milk hauling consist of variable truck costs, labor costs, and a share of fixed truck and overhead costs, as indicated in Table 6. Variable truck costs are incurred in direct proportion to transport mileage and so can be calculated for each zone on the basis of average number of miles from the processing plant. The labor costs associated with serving each zone will be directly proportional to the relevant transport mileage and inversely proportional to truck speed. Similarly, because fixed truck and overhead costs are allocated across time, charges for hourly fixed costs will rise with increasing distance from the plants, just as with labor costs. Finally, it is assumed that transport mileage includes mileage both <u>to and from</u> the plant.

To sum up, the following equation is used in calculating per hundredweight zone charges for zone i:

$$(\text{Zone Charge})_i = \frac{(\text{VC/mile})(\text{ave. transport miles})_i + (\text{LC/hr} + \text{FC/hr})\dfrac{(\text{ave. transport miles})_i}{\text{ave. speed}}}{\text{Total Hundredweight}}$$

Variable truck costs (VC) per mile, labor costs (LC) per hour, fixed costs (FC) per hour and average truck speed are each equivalent across all zones. For each <u>ith</u> zone, total zone charges will increase proportionately with average transport mileage. Total zone charges are put on a hundredweight basis by dividing total charges by the total hundredweight shipped. Examples of the determination of zone charges are given in the following section.

<u>Examples of Rate Structure Determination: Cases 1 and 2</u>

The three-tier rate structure outlined above can be applied to the two representative routes discussed earlier. Table 7 summarizes the rate structure for Case 1 assuming the truck and route characteristics specified in Tables 1, 3 and 4. Total annual <u>stop charges</u> are composed of shares of variable truck costs, labor costs, and fixed truck and overhead costs as indicated in Column 1. An annual total cost of $36,811, when distributed over (14 stops/day times 365 days/year equals) 5,110 stops per year, yields an average stop charge of $7.20 per stop. <u>Volume charges</u> for a farm and plant pumping labor costs and their appropriate share of fixed costs total $10,795 annually. When allocated over (447 hundredweight/day x 365 days/year equals) 174,105 hundredweight per year, this results in a volume charge of $.062 per hundredweight.

The calculation of zone <u>mileage charges</u> for the Case 1 example is slightly more complicated. It is assumed here that milk is hauled to the plant from farms located only in the first four zones (see Figure 1) and that an average of 477 hundredweight are shipped daily. For each zone, it is assumed that: variable truck costs are $.424 per mile; labor costs equal $7.50 per hour; fixed costs average $6.58 per hour; and vehicle speed is 45 miles per hour. Round trip transport mileage is assumed to average 30, 50, 70 and 90 miles for Zones 1-4, respectively. For each zone, the

Table 7

Case 1 Hauling Cost Structure

Charge	Calculation	Annual Cost
Stop Charge		
1) Variable truck costs for assembly mileage	52 mi/day x 365 days x 42.4¢/mile	$ 8,048
2) Labor costs for assembly driving, on-farm routine activities, plant waiting, and tank washing	5.6 hrs/day x 365 days x $7.50/hr	15,330
3) Share of fixed truck costs due to labor activites in (2)	.583 x $23,042 (or 5.6 hrs/day x 365 days x $6.58/hr)	13,433
		$36,811
	(÷ 5,110 stops/yr = $7.20/stop)	
Volume Charge:		
1) Labor costs for on-farm and plant pumping	2.1 hrs/day x 365 days x $7.50/hr	$ 5,749
2) Share of fixed truck costs due to labor activities in (1)	.219 x $23,042 (or 2.1 hrs/day x 365 days x $6.58/hr)	5,046
		$10,795
	(÷ 174,105 cwt./yr = $.062/cwt.)	
Mileage Charge:		
1) Variable truck costs for transport mileage	87 mi/day x 365 days x 42.4¢/mi.	$13,464
2) Labor costs for transport driving	1.9 hrs/day x 365 days x $7.50/hr	5,201
3) Share of fixed truck costs due to transport driving	.20 x $23,042 (or 1.9 hrs/day x 365 days x $6.58/hr)	4,428
		$22,776
TOTAL CHARGE:		$70,879*

*Total calculated charge is not exactly equivalent to that in Table 4 due to rounding of time and cost components in cost calculations.

total mileage-related costs incurred in hauling milk from that zone are distributed over the entire volume hauled, under the assumption that mileage or zone charges to producers should only reflect those costs attributable to farm location and not other route characteristics such as the proportionate distribution of milk production throughout the route.

Based on these assumptions, zone charges per hundredweight are calculated as follows:

Zone 1: Z_1 = \$.424(30) + (\$7.50 + \$6.58)(30/45) = \$22.11 ÷ 477 cwt. = \$.046/cwt.

Zone 2: Z_2 = \$.424(50) + (\$7.50 + \$6.58)(50/45) = \$36.84 ÷ 477 cwt. = \$.077/cwt.

Zone 3: Z_3 = \$.424(70) + (\$7.50 + \$6.58)(70/45) = \$51.58 ÷ 477 cwt. = \$.108/cwt.

Zone 4: Z_4 = \$.424(90) + (\$7.50 + \$6.58)(90/45) = \$66.32 ÷ 477 cwt. = \$.139/cwt.

Because of the way in which zone charges are calculated, there is no guarantee that total zone charges will cover the mileage charges indicated in Table 7 under a multiple truck and route hauling system. How closely the two agree will be highly dependent on additional characteristics of the route and hauling operation, specifically, the proportion of milk being shipped from each zone within the route, and the nature of other trucks and routes in the hauling pool. The balancing of aggregate mileage and zone charges is discussed further in Section VII.

The system of producer charges can also be calculated for Case 2 (Table 8), under the truck and route characteristics assumed in Tables 1, 3 and 4. Total annual stop charges of \$41,375, when distributed over (13 stops/day x 365 days equals) 4745 stops, results in a charge of \$8.72 per stop. Total volume charges of \$12,318 allocated over (513 hundredweight/day x 365 days equals) 187,245 hundredweight yields a volume charge of \$.066 per hundredweight. Finally, assuming variable truck costs of \$.42 per mile, fixed costs of \$7.19 per hour, an average daily haul of 513 hundredweight, and average vehicle transport speed of 50 miles per hour, the following zone charge structure for mileage-related costs can be calculated:

Zone 1: Z_1 = \$.420(30) + (\$7.50 + \$7.19)(30/50) = \$21.41 ÷ 513 cwt. = \$.042/cwt.

Zone 2: Z_2 = \$.420(50) + (\$7.50 + \$7.19)(50/50) = \$35.69 ÷ 513 cwt. = \$.070/cwt.

Zone 3: Z_3 = \$.420(70) + (\$7.50 + \$7.19)(70/50) = \$49.97 ÷ 513 cwt. = \$.097/cwt.

.
.
.

Zone 12: Z_{12} = \$.420(250) + (\$.750 + \$7.19)(250/50) = \$178.45 ÷ 513 cwt. = \$.348/cwt.

Table 8

Case 2 Hauling Cost Structure

Charge	Calculation	Annual Cost
Stop Charge		
1) Variable truck costs for assembly mileage	60 mi./day x 365 days x 42.0¢/mile	$ 9,198
2) Labor costs for assembly driving, on-farm routine activities, plant waiting and tank washing	6.0 hrs./day x 365 days x $7.50/hr	16,425
3) Share of fixed truck costs due to labor activities in (2)	.429 x $36,718 (or 6.0 hrs/day x 365 days x $7.19/hr)	15,752
		$41,375
	(÷ 4,745 stops/yr = $8.72/stop)	
Volume Charge:		
1) Labor costs for on-farm and plant pumping	2.3 hrs/day x 365 days x $7.50/hr	$ 6,296
2) Share of fixed truck costs due to labor activities in (1)	.164 x $36,718 (or 2.3 hrs/day x 365 days x $7.19/hr)	6,022
		$12,318
	(÷ 187,245 cwt./yr = $.066/cwt.)	
Mileage Charge:		
1) Variable truck costs for transport mileage	286 mi/day x 365 days x 42.0¢/mi	$43,844
2) Labor costs for transport driving	5.7 hrs/day x 365 days x $7.50/hr	15,604
3) Share of fixed truck costs due to transport driving	.407 x $36,718 (or 5.7 hrs/day x 365 days x $7.19/hr)	14,944
		$74,392
TOTAL CHARGES:		$128,085*

*Total calculated charge is not exactly equivalent to that in Table 4 due to rounding of time and cost components in cost calculations.

It is assumed that all farms in the Case 2 example are located within the first twelve zones. Zone charges for additional zones could be calculated by adding $.028 per hundredweight for each successive zone.

These examples are for illustrative purposes only. The actual producer charge structure for a particular hauling route must be determined from truck, route, and cost data specific to that route. In addition, because most hauling businesses operate two or more routes, producer charge systems involve averaging cost data from several routes before determining the actual charges.

VI. HAULER PAYMENT SYSTEM

Determination of a producer charge structure for milk assembly is only one part of a general charge and payment system. Haulers must also be paid for their hauling services on a cost-justified basis as well. In a one-truck one-route situation, such as those described above, the total charges collected from the producers on the route would cover the costs of route operation. However, when multiple routes and/or trucks are added or when a temporary variation occurs in a route, the charges collected based on a predetermined schedule may not fairly compensate a hauler for the costs incurred on a particular route. Thus, it is necessary to re-examine route costs and allocate them on a basis that would reflect an individual hauler's costs.

Fortunately, with only minor modifications, the producer charge structure described above can be easily translated into a cost-justified hauler payment system. The three major cost components - labor, fixed truck and overhead, and variable truck costs - are allocated to the route activities on the same basis as described above for the producer charge system. However, the costs of the route activities are recombined into stop, volume, and distance payments in a slightly different manner to reflect haulers' actual route conditions.

For an individual load of milk, hauler costs for completing transport and assembly activities are not necessarily related to specific farms' locations or to the exact volume hauled. Therefore, rather than allocate the costs of assembly to the entire system as was the case with the producer charge structure, assembly costs should be allocated on the basis of actual miles travelled. Thus, in the calculation of hauler payments, the variable truck costs, labor costs, and proportionate share of fixed truck and overhead costs associated with the assembly function are reallocated from the stop payment to the mileage payment. Hauler compensation for transport activities also should not vary significantly according to volume hauled on a given load nor across different zones. Therefore, hauler payments for transport costs incurred are calculated simply on a per mile basis rather than on a hundredweight per mile basis or based on a zone structure (as with producer charges). The calculation of volume payments is unchanged. In sum, then, the hauler payment structure consists of: (1) a per farm stop payment; (2) a per hundredweight volume payment; and (3) a mileage payment.

The changes in moving from the producer charge structure to the hauler payment system are best illustated by example. Table 9 summarizes the hauler payment systems derivable from the producer charge structures calculated for Cases 1 and 2. Hauler payments, in these examples, are equal to producer charges (within rounding error). In general, however, the balancing between charges and payments will be done on a pool-wide basis and, for a specific route, they need not necessarily equate.

Table 9

Hauler Payment Structures: Cases 1 and 2

Payment Category	Estimated Annual Payments			
	Case 1		Case 2	
Stop Payment				
1) Labor costs for on-farm routine activities, plant waiting and tank washing	$ 9,581		$9,855	
2) Share of fixed costs due to (1)	8,456		9,363	
Total	$18,037	($3.53/stop)	$19,218	($4.05/stop)
Volume Payment (same as Producer Charge System)	$10,795	($.062/cwt.)	$12,318	($.066/cwt.)
Mileage Payment				
1) Variable truck costs for assembly and transport mileage	$21,643		$52,920	
2) Labor costs for assembly and transport driving	10,950		22,174	
3) Share of fixed costs due to (2)	9,609		21,407	
Total	$42,202	($.827/mi)	$96,501	($.766/mile)
TOTAL HAULER PAYMENTS	$71,034*		$128,037*	

*Total calculated payments are not exactly equal to total costs in Tables 4, 7, and 8 due to rounding of time and cost components in payment calculations.

In Case 1, allocation to the mileage charge of the variable, fixed and labor costs associated with assembly mileage results in a decrease in stop charge payments to $18,037 ($3.53 per stop), and an increase in mileage charges and payments to $42,202 ($.827 per mile). Volume charges both on an aggregate and hundredweight basis, are unchanged. In Case 2, stop charge payments decrease to $19,218 ($4.05 per stop) and mileage-related payments increase to $96,501 (or $.766 per mile). Volume based payments are also unchanged here.

VII. A MULTIPLE ROUTE HAULING STRUCTURE

The preceding discussion has been confined to the determination of a hauling rate structure for a single truck and route. Most hauling operations, however, are comprised of two or more trucks and a variety of hauling routes. What implications does the rate structure proposed here have for a multiple truck and route hauling operation?

Since the central precept of the rate structure described here has been the development of a cost-based system, the final rate structure is a product of how individual cost components are defined and allocated. For a single truck and route, these components are definable in a fairly straightforward manner, and the resulting cost structure accurately reflects the costs incurred in the operation of that one truck and route. Moreover, as indicated in the two examples discussed above, it is also straightforward to equilibrate route costs, producer charges, and hauler payments in the single truck-single route case.

For a multiple truck and route system, however, average cost calculations are generally used in determining the component costs of route operations. Averaging costs across all trucks and routes in the hauling operation has the advantage of smoothing out extreme fluctuations that may exist in cost levels for one truck or route, especially the determination of truck repair costs, for instance. However, a major disadvantage of cost averaging is that cost figures will apply to the "average" truck in a fleet or to the "average" route, but may not reflect costs of operation for individual trucks or routes in those cases where costs may be high (or low) and where producers should be charged and haulers paid accordingly. In fact, the larger the hauling pool, the less likely it is that the producer charge structure applied to a representative route will accurately reflect the actual costs incurred in operating that route.

The problem of "balancing the pool" can be resolved by using an incremental volume charge (or discount) to balance producer charges and hauler payments. For example, if a case similar to that depicted in Case 1 were included in a multiple route system, it is entirely possible that the combination of stop charges, volume charges, and zone charges could still leave uncovered a small proportion of total route hauling costs. That residual could be allocated to either stop, volume or zone charges, or a combination of the three. Both stop and zone charges, however, are tied directly to the underlying overhead and distance-related costs of route operation. It can be argued that the most logical way of allocating residual costs, and the one least likely to move the system away from equity, is to distribute these costs over volume hauled, and thus add or subtract an incremental volume charge for each hundredweight hauled. Allocating over volume also facilitates the frequent recomputation of hauling charges necessary in balancing the pool.

Thus, a hauling pool rate structure can be formulated to contain a producer stop charge and a per hundredweight differential zone charge that would remain constant for as long as the basic routes and their underlying costs remain constant. The volume charge could vary slightly on a monthly basis, in order to balance the pool. The rate paid to a hauler would remain constant and be based on the actual stops made, the miles driven, and the volume hauled. Since each of these three factors will vary over time, the total dollars paid the haulers will also vary over time even with the rates fixed.

VIII. CONCLUSIONS

This report has decribed a cost-justified system for the determination of producer charges and hauler payments in bulk milk assembly. The rate structure system was developed as a result of a three-step process: (1) the disaggregation of total bulk assembly and transport costs into fixed truck and overhead cost, variable truck cost, and labor cost components; (2) the allocation of labor and fixed cost components across the time spent completing various route activities and the allocation of variable truck costs over assembly and transport mileage; and (3) the reaggregation of the costs of individual route activities into a three-tiered producer charge and hauler payment system comprised of stop, volume, and mileage-related components.

Two representative truck and route specifications and associated cost assumptions were used to illustrate the hauling rate structure. These cases represent two hauling situations commonly encountered in New York State, and do not necessarily reflect hauling structures common to other parts of the country. Whatever the representative examples that might be used, though, the principles behind the development of similar rate structures remain the same, that is, the basing of producer charges and hauler payments on the actual costs incurred in hauling operations.

It should be noted again that the primary use of a cost-justified rate structure is in providing a basis for rate negotiations. Since changes in negotiated hauling rates often revolve around the extent to which proposed charges are cost-justified, the rate structure system proposed here should help in establishing a consistent method of determining cost-based rates. In the end, however, the final rate structure that may result from negotiation may differ from that described here as a result of equity and policy considerations.

References

Anderson, Bruce L. The Structure and Characteristics of the Milk Assembly System in New York State, Cornell University, A.E. Res. 81-16, September 1981.

Karpoff, Edward., Fred C. Webster, and Ernest T. Saunders. Bulk Milk Hauling and Rate Structure in Vermont. Vermont Agr. Expt. Sta. Bull. 689, August 1981.

Lamb, Leslie F. Analysis of the Farm to Plant Transportation of Milk in Wisconsin. Wisconsin Dept. of Agriculture, Trade and Consumer Protection, Madison, Wisconsin. January 1980.

Lesser, William, and Walter Wasserman. Using the TI-59 Programmable Calculator to Estimate Operating Costs and Hauling Rates for Bulk Milk Assembly. Cornell University A.E. Ext. 80-12, 82-26. June, 1980 (revision, August 1982).

Lough, Harold W. Truck Transportation Costs of Bulk Milk. USDA Economic Research Service, Publication AGERS-13. August 1977.

Moede, Herbert. Over-the-Road Costs of Hauling Bulk Milk. USDA-ERS Marketing Research Report No. 919. January 1971.

Nolte, G. M., and E. Fred Koller. Economic Analysis of Farm-to-Plant Milk Assembly. Minnesota Agr. Expt. Sta. Bull. 512. 1975.

Roof, James B., and George C. Tucker. An Equitable Change and Payment System for Least-Cost Milk Assembly in Indiana. USDA-FCS Report No. 127. July 1972.

Smith, Gerald W. Engineering Economy: Analysis of Capital Expenditures. Ames: Iowa State University Press, 1968.

APPENDIX:

Alternative Rate Structure Systems

It can be argued that some of the cost components that are suggested above as not being volume or distance related are to a degree related to volume and/or distance. To the extent that they are related they could be allocated in another manner.

For instance, if a route is structured in basically a direct path between the plant and the most distant farm, then only the distance deviating from this direct path could be counted as assembly miles, as all other miles are directly related to the transport mileage from plant to most distant farm. Karpoff, Webster and Saunders used the concept of a "spur" charge to allocate costs incurred in serving producers located on these "spurs" off a direct route. This concept has the practical disadvantage of determining what is the main route and what is a spur. This becomes an especially acute problem if, as is common, routes are changed when producers go out of business or seasonal route adjustments are made.

Another method to deal with the question of what is transport and what is assembly distance is to take two times the volume-weighted average distance of producers from the plant as the transport distance. Subtracting this transport distance from the total mileage leaves the extra "assembly" miles necessary to assemble a full route. Theoretically this method determines transport miles for each producer and not for the whole route. Although this concept may be theoretically better than the first to last farm concept, it is difficult to explain to producers. In addition, as a practical matter, it will make very little difference in the calculated rate structure if the routes are reasonably compact.

Transport costs can also be allocated on an alternative hundredweight per mile basis. In this procedure, the proportion of transport mileage is weighted by the volume transported. The implicit assumption underlying this type of arrangement is that costs associated with transport mileage are related to both volume and miles. Variable truck mileage cost may indeed be partially related to both, since it usually takes more fuel, tires, etc. to haul a full load than to run the truck empty. However, it is difficult to see how labor costs would vary whether the tank was full or empty, and other costs are at least partially not related to volume. In addition, the actual measurement of cost components would be problematic.

The suggested way of charging producers for transport-related costs is by a zone differential (see Section V). If the mileage charge is based on distance from plant to farm then a way of expressing the charge system would be to use different stop charges for each zone. The difference in stop charges would approximate the difference in cost for the extra transport mileage. On the other hand, if the mileage charge is based on the volume-zone concept, one would expect to see variable per hundredweight charges per zone instead of variable stop charges. While this latter method may not be as accurate as the first method, it may be more acceptable to producers, and it effectively charges producers at least partially on a cost-justified basis.