CLASS I CARRIER LIGHT DENSITY COSTING METHODOLOGY

by

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I. INTRODUCTION

Rail transportation is critical to North Dakota's economy. During the last three crop years, railroads transported 76 percent of the state's grains and oilseeds to market. Nearly 50 percent of these shipments originated on branch lines.[1]

As the shipment data suggest, North Dakota's branch line network is essential to the state's agricultural economy, and to the maintenance of a viable transportation system. Thus, the cost of branch-line traffic has always been an important issue to railroads, shippers, and state agencies. Branch-line costs are particularly important for rail planning, policy analysis, and regulatory oversight.

Each year, the state of North Dakota invests millions of dollars in rail-line rehabilitation. For each project, rail costs must be estimated both before and after rehabilitation. So, costing methods are an important part of the line analysis process.

Recent changes in the industrial organization of American railroads is impacting branch-line operations and costs. Since 1980, over 200 new local and regional railroads have been formed, most from parts of Class I carrier systems. These sales are primarily a result of branch-line economics. Short-line carriers can operate light-density lines more efficiently than Class I railroads.

Changes in branch-line ownership, coupled with an on-going need for policy analysis and planning, make rail costing methods important to research and analysis in North Dakota. The purpose of this report is to document a methodology for light-density cost analysis which is used in Phases I and II of the North Dakota Rail Services Planning (RSP) Study, as well as in line rehabilitation projects. The report describes a set of procedures for calculating Class I Carrier line-segment unit costs, and for applying them to light-density lines or networks.

[1]The exact percent for 1987 and 1988 was 49.89.

The report is organized as follows. In section II, a theoretical model of line-segment costs is formulated. In section III, a method is devised for computing on-branch unit costs from a carrier's R-1 annual report, and applying the costs to a line or set of lines. In section IV, a procedure for calculating the expense of moving traffic to and from the junction points or interchange points of a line is described.

II. THEORETICAL FRAMEWORK

2.1 Basic Propositions

Many transportation analysts are familiar with the Interstate Commerce Commission's (ICC) costing formulas which compute "shipment costs." However, line-segment costing differs significantly from shipment costing. In the case of the latter, costs are estimated for a typical movement, normally between a single origin and destination. In the case of the former, costs are estimated for all classes of traffic originating and/or terminating on a line segment. So, the traffic base typically entails an array of origins and destinations.

From a systems perspective, a line segment may be envisioned as a subsystem of a carrier's overall network. As a subsystem, a line segment possesses (on a smaller scale) many of the same attributes or characteristics of the larger system of which it is a part. However, each line or network of lines is somewhat unique in terms of traffic mix, density, track quality, condition, and other physical or geographic characteristics.

Some basic propositions regarding line segments are set forth below. The propositions underscore many of the assumptions and definitions found in the theoretical model.

1. A line has certain physical assets associated with its operation and existence (such as land, track, other roadway materials, roadway buildings and structures, etc.) which can be directly assigned to the segment.

2. A line-segment has a production function which is somewhat similar to that

of the railway as a whole, in that the same factor inputs (i.e., track, equipment, labor, materials and supplies) are needed to generate output.

3. Because the production functions of the various subsystems utilize the same factors of production, the variable inputs such as locomotives, freight cars, containers, engineers, firemen, brakemen, and conductors can almost always be utilized on another subsystem of the carrier's network.

4. A line segment, as a subsystem of a carrier's network, is subject to short run economies of utilization or density in much the same manner as the rail network as a whole.

5. A line segment is not a self-contained subsystem of a carrier's network but interacts with other subsystems, interchanging freight cars, locomotives, and crews.

2.2 Cost Classifications and Definitions

Costs are frequently defined or classified in more than one manner, or according to several criteria. Four categories of cost are especially useful in developing a theory of light-density line analysis. In the following discussion, railroad costs are classified according to: (1) subsystem or function, (2) traceability, (3) behavior with output, and (4) accountability.

2.2.1 On-Line Versus Off-Line Costs

Two broad categories of cost may be defined according to subsystem function:

1. On-line or on-network costs;[2]
2. Off-line or off-network costs.

On-line costs comprise the operating, capital, and opportunity costs associated with serving and maintaining a set of light-density lines. Off-line costs represent the variable expense associated with moving traffic to and from the junction points, over other subsystems of a carrier's network.

[2]These costs are frequently referred to as "on-branch" and "off-branch", particularly within the context of branch-line analysis.

2.2.2 Line-Specific Versus Allocated Costs

As proposition 1 states, a line or network of lines has certain clearly assignable physical assets associated with its existence. Items such as land, track, structures, roadway materials, and buildings are "line-related" or "line-specific" costs. The annual expense for each item can be directly assigned to a line or network.

Other factors of production such as equipment or train and engine crew labor may be used on several different networks or lines. The annual expenses for these items cannot be directly and solely attributed to any given line segment. Instead, they must be allocated among the various lines or networks in the carriers' system based on the level of activity on each. Such expenses are referred to as "allocated" costs.

2.2.3 Fixed Capacity Versus Variable Costs

On-line costs may also be classified according to behavior with output. Certain line-related costs are fixed in nature and do not vary with traffic. For example, a large proportion of maintenance of way (MOW) expenditures on light-density lines are constant per mile of track. Items such as superintendence, vegetation control, and time-related deterioration of track and roadway assets are largely independent of the level of traffic. Similarly, the opportunity cost of roadway investment is incurred regardless of whether 100 or 5,000 carloads are handled.

Other on-line costs such as locomotive ownership, fuel, and train crew labor vary directly with the level of activity on a line. If no traffic is generated or handled during the year, then no locomotive or freight car costs are incurred. Instead, the equipment is utilized on other subsystems.

2.2.4 Accounting Classifications

On-line expenses are normally classified according to four broad functional categories found in railroad accounting systems. These are:

1. Maintenance of Way

2. Maintenance of Equipment
   a) Locomotives
   b) Freight Cars

3. Transportation
   a) Train Operations
   b) Yard Operations
   c) Common Operations
   d) Specialized Service Operations
   e) Administrative Support Operations

4. General and Administrative

Each classification contains a range of individual cost items. For example, locomotive fuel, train and engine crew, train inspection, and dispatching costs constitute individual line items under the general heading of train operations.

2.3 Cost Finding Process

Estimating costs for a network of lines is a three step process. First, a series of on-branch and off-branch unit costs are calculated. The unit costs reflect the variable expense per unit of output (e.g., fuel cost per locomotive hour), or the fixed capacity cost per mile of track (e.g., opportunity cost on net liquidation value). Second, the number of annual output units or "service units" consumed in serving the branch lines and the number of track miles in the network are calculated. Third, the level of annual expenses attributable to the line or lines is computed by multiplying the service units by the related unit costs.

2.3.1 Sources of the Unit Costs

Fixed capacity on-branch unit costs are derived primarily from economic-engineering models or direct data sources. There are three primary unit costs in this group:

1. Normalized maintenance of way

2. Opportunity cost on net liquidation value (NLV)

3. Property taxes.

All are line-specific items which can be directly computed for a set of lines.

"Normalized" MOW per mile is estimated from asset deterioration models and railroad productivity factors.[3] NLV per mile is computed from resale or scrap value of track materials, alternative land-use values, and engineering estimates of recovery cost.[4] Variable and/or untraceable cost elements are estimated from accounting expenses and operating data contained in the carrier's R-1 report. The R-1 unit costs are "allocated" unit costs. They represent the cost per unit of output for items such as locomotive depreciation and return on investment which cannot be directly assigned to a particular line segment.

Off-line unit costs are derived from R-1 expense and operating data using the ICC's cost finding formula, Rail Form A (RFA). The most current Burlington Northern and Soo Line RFA's are used to generate a file of off-line cost coefficients each year. A more detailed explanation of the off-branch methods is provided in Section III of the report.

2.3.2 Operating Models

The second step in the cost-finding process (the estimation of annual service units for the line or lines) is accomplished with a set of operating models. The models predict the service units accumulated in consolidation and gathering activities on light-density lines. The models also predict the number of service units generated by the traffic as it moves to and from the junction points of the line.

Three concepts are of primary importance in operations modeling: (1) train class or service, (2) shipment service level, and (3) the scheduled frequency of service. Train service consists of way or local train service, through train service, or unit train service. Way service reflects typical train operations on light-density networks. Way trains operate

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[3]For a description of the detoriation models see: Tolliver and Lindamood. An Analysis of the Benefits of Rehabilitating the Wahpeton-to-Independence Rail Line, UGPTI, 1989.

[4]See: Mittleider, Tolliver, and Vreugdenhil (1983).

between classification yards and stations, spotting empty cars and pulling loaded ones. Through trains operate primarily between classification yards, and do not normally switch cars at individual stations. Through trains on light-density networks usually consist of bridge or overhead traffic which neither originates nor terminates on the lines. Unit trains provide direct service between stations and do not require yard classification.

Shipment service level is a composite variable which reflects the type and extent of activities that occur at individual stations, as well as the degree of classification off-line. There are four basic service levels: (1) single car, (2) multiple car, (3) trainload, and (4) unit train. A true unit train is a direct, cyclical, continuous movement between an origin and destination, normally involving a dedicated locomotive and freight car set. A trainload shipment also involves direct origin-destination service. But a trainload shipment is not a cyclical, continuous movement. Trainload shipments may be sporadic and spread out during the year. There are other operational differences between unit train and trainload service which are documented in: Tolliver (1984).

There are few, if any, unit train shipments originating or terminating on light-density networks. However, there may be trainload shippers. From a modeling perspective, a trainload shipment is treated as a separate, solid train. Multiple-car shipments are treated in one of two ways, depending on the service frequency.

Way trains typically operate between a classification yard and outlying stations along a designated route, according to a general timetable and schedule. Single-car, three-car, and other small multiple-car shipments are generally handled in scheduled way train service. The frequency of service is determined by the demand for cars along the route and by the operating condition of the lines. Light-density lines, because of low demand and poor operating conditions, typically receive service once or twice a week.

If large multiple-car shippers are located on a line, the scheduled frequency of way train service may be inadequate. If the frequency of service is less than three times per week, the detention/waiting time at stations will exceed tariff free time significantly. In such instances, large, multiple-car shipments may be handled in direct or shuttle way trains. Shuttle way trains operate between classification yards and large multiple-car shippers, providing expedited service where the frequency of scheduled way train service is low.[5] If the service frequency is twice a week or less, large multiple-car shipments are assumed to be handled in direct way train service.

2.4 Cost-Output Relationships

In calculating R-1 unit costs, accounts or groups of accounts are correlated with the output measures to which they are most closely related. Cost-output relationships may be derived through statistical analysis, engineering analysis, or operational knowledge. For the most part, the relationships adopted in this study reflect the ICC's cost-output relationships that are used in abandonment or light-density surcharge analysis. The most important ones are discussed in the following sections of the report.

2.4.1 Locomotive Operations and Ownership

Road locomotive repairs and maintenance are a function of the weight of the units and the distance traveled. This relationship is most appropriately represented by the output variable "road locomotive gross ton-miles." Unlike repairs, the servicing of road locomotives is not related to the weight of the unit, but is a function of distance. So, servicing expenses are correlated with road locomotive unit miles.

Locomotive depreciation, rentals, leases, and opportunity costs are more closely related to time than to distance or use. The logical output measure for these expenses is the hours of road locomotive operation. Locomotive fuel is primarily use-related. On light-density networks, locomotives operate much of the time at low speeds, idling, or switching cars at stations. These are fuel-intensive activities. Thus, the hours of operation

[5]Direct way trains may also handle other traffic that is ready for the pickup on the day of the service.

is a better measure of branch-line fuel consumption than miles or gross ton-miles.

Yard locomotive activities involve the switching of cars over short distances. The principal measure of activity is yard locomotive hours. Unlike road locomotives which engage in running and switching activities under a variety of conditions, yard locomotive expenses are all directly related to the yard hours.

2.4.2 Transportation Expenses

Train operating expenses (other than fuel) are related to both train-hours and train-miles. Crews are paid on a dual basis, reflecting both mileage and time. During light-density operations, crews spend a large proportion of their time running at low speeds, or switching at industry sidings. Thus, the basic day is determined most often on the basis of hours instead of miles. For this reason, on-branch crew wages are computed on a train-hour basis.

Most other train operating expenses are related to train-miles. They include train inspection and lubrication, operating signals and interlockers, operating highway grade crossings, and train dispatching. All yard operating expenses are developed on a yard switching-hour basis.

2.4.3 Other Equipment Costs

Freight car repairs and depreciation are a function of time and usage. The ICC has developed factors for the apportionment of each expense among car-days and car-miles. Freight car opportunity costs are solely time-related, and are expressed on a car-day basis.

Trailer and container ownership costs are primarily time-related. While on the rail leg of an intermodal shipment, most of the repairs and maintenance are due to weather, environment, or time instead of use. All TOFC/COFC ownership costs are computed on a trailer- or container-day basis.

2.4.4 General and Administrative Expenses

General and administrative expenses involve items such as marketing, sales, legal and secretarial services, accounting and finance, and research and development. These expenses are primarily related to the level of activity for the system as a whole. However, they are partially related to the level of activity on individual subsystems. Certain accounting, financial, and other functions are required whenever carloads are originated or terminated, regardless of the size of the load. So, these expenses are more closely related to car-miles than gross ton-miles.

This section of the report has presented an overview of the theory and methods of light-density cost analysis. First, some basic propositions were introduced. Second, definitions were given for allocated, fixed capacity, variable, off-line, and on-line costs. Third, a cost-finding process was introduced, which features unit cost calculations and operations model. And fourth, some basic cost-output relationships were formulated.

The report now turns to a more detailed description of the costing methods and procedures.

III. ON-LINE COSTING METHODOLOGY

3.1 Locomotive Operating, Maintenance, and Ownership Unit Costs

Road locomotive unit costs reflect all direct and indirect expenses associated with the activity of units outside of classification yards. Road locomotive operating and maintenance costs include: (1) repairs, (2) fuel or power, (3) servicing, (4) machinery, and (5) overhead. Ownership costs include: depreciation, rentals, and leases (DRL) and return on investment (ROI).

3.1.1 Road Locomotive Repairs and Ownership

Road locomotive repairs, DRL, and ROI are calculated directly from expenses contained in Line 2 of Schedule 415. Table 1 shows the location of each expense item within Schedule 415, as well as the related output measure.

As Table 1 depicts, all but one of the unit costs have been developed on a locomotive-hour basis. This is consistent with the theoretical model constructed in Section II, wherein the depreciation, repairs, and fuel consumption of locomotive units operating over light-density lines were felt to be more closely related to locomotive hours than unit miles.

TABLE 1. ROAD LOCOMOTIVE OPERATING, MAINTENANCE AND INVESTMENT UNIT COSTS.

Unit Costs	Schedule 415 Columns	Production or Output Measure
Repairs	(b)	Locomotive Gross Ton-Miles
Depreciation, Rentals and Leases	(c)+(d)+(e)+(f)	Locomotive Hours
Net Investment Base	[(g)+(h)]-[(i)+(j)]	Locomotive Hours

Locomotive repairs for each class of unit are obtained directly from column (b) of Schedule 415. Locomotive depreciation, rentals, and leases (DRL) are calculated by adding the expenses for depreciation [Schedule 415, col. (c) + col. (d)], retirements [Schedule 415, col. (e)], and leases and rentals [Schedule 415, col. (f)]. Locomotive investment (the net investment base) is calculated for each type of unit by subtracting accumulated depreciation [Schedule 415, col. (i) + col. (j)] from the investment base [Schedule 415, col. (g) + col. (h)]. The unit cost for locomotive ROI is computed by multiplying the net investment base by the current cost of capital.

3.1.2 Locomotive Machinery

Locomotive machinery costs include maintenance and ownership expenses for machinery used exclusively in the upkeep of locomotives. The Schedule 415 expenses reflect both yard and road locomotive activities. So, some allocation of expenses among road and yard units must be performed.

Total locomotive machinery repairs, DRL, and net investment base are calculated from line 38 of Schedule 415 using the same columns as shown in Table 1. The expenses are then allocated to each class of locomotive on the basis of the ratio of the repair expenses for that class to total repairs for all locomotive types. For example, the allocation ratio for diesel yard locomotives is determined by dividing the repair expenses for yard diesel locomotives [Schedule 415, col. (b)] by the total repair expenses for all locomotives. The logic behind this procedure is that the costs associated with locomotive machinery are proportional to the repairs for each type of unit.

The production or output unit for road locomotive machinery is road locomotive gross ton-miles. The output measure for yard locomotive machinery is yard locomotive switching hours.

3.1.3 Locomotive Fuel and Power Unit Costs

Locomotive fuel and power expenses are computed on a locomotive-hour basis. The expenses for locomotive fuel are taken from Schedule 410 of the carriers' R-1 report. Table 2 documents the source of the expenses and the output measures used.

TABLE 2. LOCOMOTIVE FUEL AND POWER UNIT COSTS.

Unit Costs	Schedule 410 Line Number	Production or Output Measure
Road Locomotive Fuel	409	Diesel Road Locomotive Hrs
Yard Locomotive Fuel	425	Diesel Yard Locomotive Hrs
Road Locomotive Power	410	Other Road Locomotive Hrs
Yard Locomotive Power	426	Other Yard Locomotive Hrs

Road locomotive hours are developed from Schedule 755 as follows. First, the average road train speed (running) is calculated as: [(Line 115) - (Line 116)] / Line 5. Second, using the average train speed, the number of road locomotive-hours (running) is calculated as the quotient of the annual road locomotive unit miles and the average speed. Third, the number of train switching locomotive-hours is computed by dividing the number of locomotive switching miles (Line 12) by the average switching speed (6 MPH).[6] The sum of the running hours and the train switching hours gives the annual road locomotive hours of operation.

3.1.4 Locomotive Servicing and Overhead Unit Costs

The unit cost of servicing road locomotives is calculated by dividing the annual expenses (Schedule 410, Line 411) by the number of road locomotive-miles (Schedule 755, Line 11). Road locomotive-miles is used instead of road locomotive hours, because the servicing of road locomotives is more closely related to the miles of operation than to time.[7]

Locomotive overhead costs consist of administrative and other expenses which result from maintaining, servicing, and managing the fleet. Overhead expenses vary with the level of activity on a given subsystem. So, they are allocated to various subsystems on the basis of the primary activity measure: locomotive hours.

The various elements of locomotive overhead are displayed in Table 3.

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[6]This constant was developed and is used by the Interstate Commerce Commission.

[7]The road locomotive unit mile service unit was stipulated by the ICC in Ex Parte 402.

TABLE 3. ROAD LOCOMOTIVE OVERHEAD EXPENSE ITEMS.

Item	Schedule 410 Line Number
Administration	201
Equipment Damage	204
Fringe Benefits	205
Other Casualties and Insurance	206
Dismantling Road Property	217
Other	218

3.2 Transportation Unit Costs

Train and engine crew wages are developed on an hourly basis from the ICC's Quarterly Wage Statistics, Form B. The remaining transportation expenses are organized into four classifications: (1) train operations, (2) yard operations, (3) common train and yard expenses, and (4) specialized service operations.

Train operating and overhead costs reflect administration, dispatching, and other activities related to road train operations. The various components of train operating and overhead costs are shown in Table 4. With the exception of fringe benefits and administration, all items are computed on a train-mile basis. Fringe benefits and administration are more closely related to the hours of operation than to the distance traveled.

TABLE 4. TRAIN OPERATING EXPENSE ITEMS.

Item	Schedule 410 Line Number
Administration	401
Dispatching Trains	404
Operating Signals & Interlockers	405
Highway Crossing Protection	407
Train Inspection & Lubrication	408
Clearing Wrecks	413
Fringe Benefits	414
Other Casualties & Insurance	415
Joint Facilities	416 & 417
Other	418

The components of yard operating and overhead cost are depicted in Table 5. All yard operating and overhead items are computed on a yard switching-hour basis.

Specialized services and common train and yard expenses are typically not relevant to branch-line operations. So, unit costs are not computed for these items. Instead, they are handled individually during each line analysis. For example, if marine facilities are located on a line, the pickup, delivery, and marine line-haul costs are calculated directly. Otherwise, they are excluded.

TABLE 5. YARD OPERATING EXPENSE COMPONENTS.

Item	Schedule 410 Line Number
Administration	420
Controlling Operations	422
Yard Terminal Clerical	423
Operating Switches, Signals, Retarders and Humps	424
Clearing Wrecks	429
Fringe Benefits	430
Other Casualties and Insurance	431
Joint Facilities	432-433
Other	434

3.3 General and Administrative Expenses

General and administrative expenses, with the exception of property taxes, are developed from Schedule 410, Lines 601-618. Property taxes are treated as a line-related expense, and are developed from state tax records on a track-mile basis.

The various elements of general and administrative expenses are enumerated in Table 6. As noted in Section II, these expenses are computed on a car-mile basis. They represent an allocation of common system costs to a line in proportion to the annual level of revenue-generating activity.

TABLE 6. GENERAL AND ADMINISTRATIVE COST ELEMENTS.

Item	Schedule 410 Line Number
Officers-General & Administrative	601
Accounting, Auditing & Finance	602
Management Services & Date Processing	603
Marketing	604
Sales	605
Industrial Development	606
Personnel & Labor Relations	607
Legal & Secretarial	608
Public Relations & Advertising	609
Research & Development	610
Fringe Benefits	611
Casualties & Insurance	612
Writedown of Uncollectibles	613
Other Taxes	615
Joint Facility	616 & 617
Other	618

3.4 Freight Car Expenses

Car repairs, depreciation, and ROI unit costs are developed from Schedules 415, 710, and 755. The process is somewhat analogous to the locomotive procedure. It involves an economic-engineering approach set forth by the ICC in Ex Parte 334. The method uses the replacement value of a particular type of freight car and its anticipated usage to derive a cost per car-mile and car-day. The procedures are detailed later in the report.

3.5 Service Unit Calculations

Annual service units are calculated for a given network of lines in accordance with the theoretical model described in Section II. As noted previously, operations models are used to predict the number of way trains per year on each line.

3.5.1 Trip Mileages

Round trip way train miles are estimated directly for each route from carrier timetables or distance tariffs. The estimates account for the actual movement of the train as closely as possible.

In addition to round-trip miles, the distance from each station to the division point, and from each division point to each major market are computed.

3.5.2 Calculation of Annual Trains

The number of scheduled way trains per year is calculated as follows:

$$SCWT_i = 365/SERV_i \tag{1}$$

where:

$SCWT_i$ = Scheduled way trains on route "i"

$SERV_i$ = Weekly service frequency, route "i"

If the scheduled service frequency is < = 2, each large multiple-car or trainload shipment is assumed to constitute a separate shuttle way train. Otherwise, all multiple-car and trainload shipments are assumed to be handled in scheduled way train service.

3.5.3 Calculation of Train-Miles and Train-Hours

The annual train-miles on each route are calculated from the estimated number of scheduled and shuttle way trains. Scheduled way trains are assumed to run the length of the route each trip. Shuttle way trains are assumed to run directly between a given station and the classification yard. Shuttle way train-miles reflect the distance between the station and the division point, rather than the branch-line length.

Train-hours on-branch include two components: (1) train-hours running, and (2) train-hours switching. The annual train-hours running on a given route are calculated as follows:

$$THR_i = TM_i/MPH_i \qquad (2)$$

where:

THR_i = Train-Hours Running, Route "i"

TM_i = Annual Train Miles, Route "i"

MPH_i = Average Train Speed, Route "i"

The average train speed reflects the operating conditions and any speed limitations that might exist on a route.

Train-hours switching reflect the total switching time at each station during the year. The minutes required at each station are a function of the number of cars switched and the shipment service level. A separate calculation must be performed for each level of service.

$$LSM_{ij} = CS_{ij} * ASM * SMR_j * SPR \qquad (3)$$

where:

LSM_{ij} = Locomotive switching minutes at station "i", for service class "j"

CS_{ij} = Cars switched at station "i", service level "j".

ASM = Average switching minutes in single-car service (11 minutes)

SMR_j = Switching minute ratio for service level "j"

SPR = Spotted-to-pulled ratio

Each service level corresponds to a shipment class size. So, there are twelve possible classes or values for "$_j$." The switching efficiency ratio expresses the relative switching time for a given service in comparison to the single-car average.[8] The spotted-to-pull ratio indicates the frequency with which an empty car must be spotted for every load which is pulled. The SPR is 2 for most car types.

Total train-hours switching at a given station are computed as:

$$LSM_i = \sum_j LSM_{ij} \tag{4}$$

3.5.4 Calculation of Road Locomotive Service Units

Road locomotive-miles (RLM) are computed separately for each train class, as follows:

$$RLM_{ij} = TM_{ij}{*}ALU_j \tag{5}$$

where:

ALU_j = Average locomotives required for service class.

The number of units required for each train class will vary with the average train weight and network conditions. On North Dakota branch lines, a 26-car shuttle way train will usually require a single unit, while a 52-car train typically requires two. Scheduled way trains normally need at least one unit. Two or more units are required for heavier trains or under extreme conditions.

The road locomotive unit hours consumed at each station on a line are a function of the switching time and the number of units required. For a given class of service, the

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[8]From previous analysis, it has been determined that approximately 10-12 minutes are required to spot a cut of one-to-three cars at a branch-line station.

locomotive unit hours required at a particular station are computed as:

$$LHS_{ij} = LSM_{ij}*ALU_j. \tag{6}$$

Individual class totals are summed to obtain the station total.

Road locomotive hours running (LHR) are calculated on each route from the annual RLM, as:

$$LHR_i = RLM_i/MPH_i. \tag{7}$$

3.5.5 Calculation of Car-Miles and Car-Days

Car-miles on-line are calculated for each station as follows:

$$CM_i = SW_i*CS_i*SPR \tag{8}$$

where:

SW_i = Station way train miles

CS_i = Cars switched at station "i".

Network car-miles are given by:

$$CM = \sum_i *CM_i \tag{9}$$

Car days on-line consist of four elements:

1. Running,
2. Loading and unloading,
3. Spotting and pulling,
4. Waiting.

Car days running depend on the distance from the yard and the average train speed (both running and switching). They are computed as follows:

$$CDR = SW_i \ / \ TS \qquad (10)$$

where:

CDR = Car days running

TS = Average train speed, running and switching

The average train speed is computed via a three-step process. First, the mean number of cars consigned at each station is estimated, and divided by the trains per year. Second, the raw switching time at each station (per train trip) is adjusted for the frequency of multiple cars and trainloads consigned. Third, the cumulative mean switching time for each route is added to the running time, and divided by the distance to yield the average train speed. This set of calculations, it should be noted, also generates the spotting and pulling times (the actual switching activities at each station).

Waiting time is the interval during which the car is loaded, but is waiting to be pulled. The waiting time is a function of the service frequency and direct train service. For direct multiple-car and trainload shipments, a maximum of two days is assumed for both loading (or unloading) and waiting. In scheduled train service, multi-car waiting times may be somewhat higher, depending on the service frequency.

Waiting time for single-car traffic is computed as follows:

$$WT_i = (365/SERV_i * 52) - 2 \qquad (11)$$

Once the service units have been calculated for all categories, annual expenses are obtained by multiplying the network service units by the unit costs.

IV. OFF-LINE PROCEDURE

Off-line costing is a variant of shipment costing. The objective of off-line costing is to estimate the average variable cost associated with the transportation of all network traffic from the point of origin to the junction point, or from the junction point to the destination (in the case of outbound traffic). This section of the report describes the principal off-line unit costs and service units.

4.1 Cost Estimation Procedures

The cost coefficients used in the off-branch procedure are derived from Rail Form A (RFA), a cost-finding formula developed by the Interstate Commerce Commission (ICC). Rail Form A is a computer program which generates unit costs for a variety of output measures, for individual railroads or groups of railroads (Table 7).

TABLE 7. RAIL FORM A UNIT COSTS AND OUTPUT MEASURES

Expense Item	Output Measure
Gross Ton Mile	Gross Ton Miles of Cars, Contents, & Caboose
Locomotive Unit Mile	Locomotive Unit Miles
Crew Wages	Train Miles
Other Train Mile	Train Miles
Station Clerical	Carload Shipments Originated/Terminated
TOFC Clerical	TOFC Shipments Originated/Terminated
Intraterminal Clerical	Cars Switched Intraterminal
Interterminal Clerical	Cars Switched Interterminal
Station Employee Special Services	Carload Shipments Originated/Terminated
TOFC Special Services	TOFC Shipments Originated/Terminated
Train Supplies, Running	Revenue Car Miles, Including Mileage Cars, Loaded & Empty
Train Supplies, Terminal	Carload Shipments Originated/Terminated
Loss & Damage	Carload Tons Originated/Terminated
Carload Claims Clerical	Carload Tons Originated/Terminated
TOFC Claims Clerical	TOFC Tons Originated/Terminated
Interterminal Claims Clerical	Cars Switched Interterminal
Intraterminal Claims Clerical	Cars Switched Intraterminal
Mileage Cars Inspection	Car Miles, Mileage Cars, Loaded & Empty
Car Mile Costs	Car Miles, Less Mileage Cars, Loaded & Empty
Car Day Costs	Car Days, Total
Engine Minute Expense	Total Switching Minutes, Yard & Way Switching
Heating and Refrigeration	Refrigerator Car Miles, Loaded & Empty

RFA utilizes railroad accounting and operating data to produce estimates of variable costs. Many railroad costs are common or joint in nature. A series of allocation ratios are contained within the formula for distributing common expenses. The results of the ICC regression studies are contained in a separate file.

The manner in which the data flow through the formula is depicted in Figure 2. As illustrated, several independent but interrelated steps are involved in the process. Determination of cost variability is not performed within the formula, but is developed external to Rail Form A. The coefficient file containing regression results is read into the formula for use in later application.

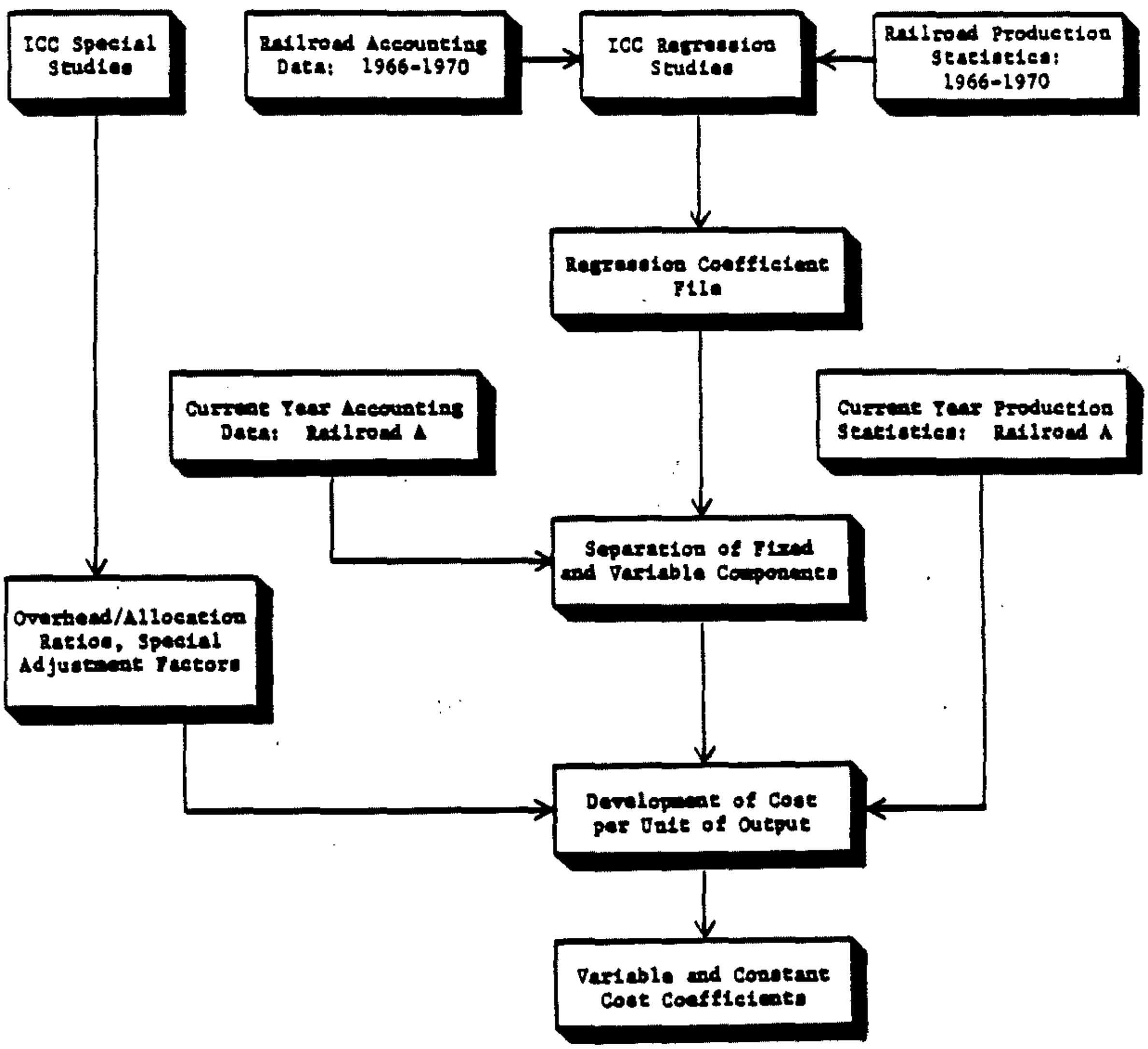

Figure 2. Rail Costing Finding Process

Within the cost-finding formula, accounting expenses and production data are transformed into unit costs via a multi-step process. Each group of accounts (e.g. maintenance of running track) is separated into fixed and variable components on the basis of the variability ratios developed through regression analysis. If the accounting expenses must be allocated to more than one output measure, this allocation is performed in a related step.[9] The total expenses are divided by the number of productive units consumed during the year to produce a cost per unit of output or "unit cost" for each of the categories depicted in Table 8. This process is illustrated below using the gross ton mile service unit as an example.

$$UC = (AC \times APV) \;/\; TGM \tag{12}$$

where:

UC = Unit cost per gross ton mile

AC = Total expenses for groups of accounts

APV = Annual percent variable of the account or group

TGM = Total system gross ton miles

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[9]For example, maintenance of roadway expenditures are primarily allocated between gross ton mile and train mile service units, with a small residual allocated to locomotive unit mile.

TABLE 8. RAILROAD SERVICE UNITS AND COST ELEMENTS.

Service Unit	Cost Elements
Car miles running	Ownership and non-ownership costs running
Car days	Daily ownership cost: running and switching
Car miles switching	Ownership costs switching
Locomotive switching minutes	Ownership, and non-ownership costs due to way and/or yard switching
Carloads originated/ terminated	Station clerical, terminal supplies and expenses, specialized terminal services
Carload tons originated/ terminated	Loss and damage, carload claims clerical
Road locomotive unit miles	Ownership and non-ownership costs: running
Train miles	Labor and non-labor expenses
Gross ton miles	Running track and various operating costs.

The derivation of the principal Rail Form A (RFA) off-branch unit costs are shown in Tables 9 through 14. As the tables depict, the unit costs are actually compilations of detailed cost elements. Most of the summary unit costs contain transportation, maintenance of way, maintenance of equipment, and traffic and general administrative elements. In addition, most of them include a return on roadway or equipment investment.

TABLE 9. DERIVATION OF VARIABLE LOCOMOTIVE SWITCHING MINUTE COST: B(3281).

Account Number	Item or Account Title	Rail Form A Core No.
	Transportation:	
377	Yard masters and yard clerks	B(482)
378	Yard conductors and yard brakemen	B(490)
379	Yard switching and signal tenders	B(498)
380	Yard enginemen	B(506)
382	Yard switching fuel	B(514)
383	Yard switching power produced	B(522)
384	Yard switching power purchased	B(530)
388	Servicing yard locomotives	B(538)
389	Yard supplies and expenses	B(570)
392	Train enginemen	B(626)
394	Train fuel	B(651)
395	Train power produced	B(678)
396	Train power purchased	B(681)
400	Servicing train locomotives	B(703)
401	Trainmen	B(754)
404	Signal and interlocker operation	
405	Crossing protection	
406	Drawbridge operation	
415	Clearing wrecks	
	Total Accts. 404, 405, 406, 415	B(782)
371	Superintendence	B(852)
390,391	Operating joint yards and terminals	B(874)
409	Employee H, W & Payroll taxes	
410	Stationery and printing	
411	Other expenses	
414	Insurance	
420	Injuries to persons	
	Total Accts. 409,410,411,414,420	B(903)
416	Damage to property	B(916)
	Total Transportation	B(945)
	Maintenance of Equipment	
311	Diesel locomotive repairs, yard	B(1100)
311	Diesel locomotive repairs, road	B(1124)
311	Other locomotive repairs, yard	B(1132)
311	Other locomotive repairs, road	B(1143)
	Total Acct. 311	B(1154)

Table 9 - continued

Account Number	Item or Account Title	Rail Form A Core No.
331	Locomotive depreciation, yard	B(1286)
331	Locomotive depreciation, road	B(1296)
330	Locomotive retirements	B(1351)
301	Superintendence	
332	Injuries to persons	
333	Insurance	
384	Stationery and printing	
335	Employee H, W & Payroll taxes	
339	Other expenses	
	Total Acct. 301,332,333,334,335,339	
302	Shop machinery	
304	Power plant machinery	
305	Depreciation of S&P plant machinery	
306	Dismantling retired S&P plant mach.	
329	Dismantling retired equipment	
336	Joint maintenance of equip.-debit	
337	Joint maintenance of equip.-credit	
	T.Accts.302,304,305,306,329,336,337	B(1541)
504,537	Net locomotive rents	B(1617)
	Total Maintenance of Equipment	B(1637)
	<u>Maintenance of Way and Structure</u>	
202	Yd. & way switching tracks: roadway main	B(1670)
206	Yard and way switching tracks: tunnels and subways	B(1679)
208	Yard and way switching tracks: bridges, trestles & culverts	B(1688)
210	Yard and way switching tracks: elevated structures	B(1697)
221	Yard and way switching tracks: fences, snowsheds & signs	B(1706)
	Total Accts. 202,206,208,210,221	B(1717)
212	Yield & way switching tracks: ties	B(1734)
214	Yard & way switching tracks: rails	B(1743)
216	Yard & way switching tracks: other track material	B(1752)
218	Yd. & way switching tracks: ballast	B(1761)
220	Yard and way switching tracks: track laying and surfacing	B(1770)
	T Acts. 202,206,212,214,216,218,220	B(1781)

Table 9 - continued

Account Number	Item or Account Title	Rail Form A Core No.
229	Roadway buildings	B(1857)
233	Fuel stations	B(1870)
235	Shops & enginehouses	B(1885)
241	Wharves and docks	B(1895)
249	Signals and interlockers	B(1907)
253,266	Power plants	B(1932)
257,266	Power transmission systems	B(1943)
	Total Accts.229,233,235,241,249	
201	Superintendence	B(2013)
266,267	Engineering	B(2042)
266	Road property depreciation	
267	Retirement of road property	
270	Dismantling retired road property	
271,268	Small tools and supplies	
278,279	Maintenance of joint tracks and other facilities	
274	Injuries to persons	
275	Insurance	
276	Stationery and printing	
277	Employer H,W & payroll taxes	
282	Other expenses	
	Total Accts. 274,275,276,277,282	B(2100)
269,266	Roadway machines	
272-3,266	Removing snow, ice, etc.	
267	Public improvements-maintenance of right of way expenses	
281	Right of way expenses	
	Total Accts. 296,266,272,273,267,281	B(2112)
	Total Accts. 229,233,235,241,249, 253,266,257,201,267,274,269,272,273,281	B(2139)
	Work Equipment	B(2167)
	Total Maintenance of Way & Structures, Accts. 229,233,235,241,249,253,266,257,201,267,274, 269,272,272,273,281,and Core No. B(2167)	B(2196)
	<u>Traffic and General Overhead</u>	
	Distribution of General Overhead	B(2296)
	Class I Switching and Terminal Co.	
	Railway Operating Expense	B(2365)
	Railway tax accrual, excluding FIT	B(2373)
	Net equipment rents	B(2381)
	Tot Core No B(2365),B(2373),B(2381)	B(2389)

Table 9 - continued

Account Number	Item or Account Title	Rail Form A Core No.
	<u>Cost of Capital Road, Other Than Switching & Terminal Co.</u>	
2.5-13,17 26-45	Road property other than land: switching, includes train switching	B(2765)
2	Land: switching, including train switching	B(2744)
18	Water stations	B(2812)
19	Fuel stations	B(2823)
20	Shops and enginehouses	B(2833)
23	Wharves and docks	B(2841)
	Total Road	B(2852)
	<u>Cost of Capital Equipment, Other Than Switching and Terminal Company</u>	
52	Locomotives	B(2868)
57,58	Work & miscellaneous equipment	B(2922)
	Total Equipment	B(2955)
	<u>Cost of Capital Road: Switching & Terminal Company</u>	
2.5-13,17, 26-45	Road property, excluding land	B(2972)
2	Land	B(2980)
16	Stations and office buildings	B(2988)
18	Water stations	B(2996)
19	Fuel stations	B(3004)
20	Shops and enginehouses	B(3012)
23	Wharves and docks	B(3020)
	Total Road	B(3030)
	<u>Cost of Capital Equipment: Switching & Terminal Co.</u>	
52	Locomotives	B(3038)
53	Freight train cars	B(3040)
54	Passenger train cars	B(3041)
56	Floating equipment	B(3042)
57,58	Work & miscellaneous equipment	B(3043)
	Total Equipment	B(3052)

Table 9 - continued

Account Number	Item or Account Title	Rail Form A Core No.
	<u>Total Cost of Capital</u>	
	Total Road, Core Numbers B(2852, B(3030)	B(3096)
	Total Equipment, Core Numbers B(2955), B(3052)	B(3106)
	Total Cost of Capital, Core Numbers B(3096), B(3106)	B(3116)
	<u>Variable Unit Cost Calculation</u>	
	Variable Operating Expenses, Rents and Taxes	B(2399)
	Number of Service Units	B(346)
	Unit Cost: Operating Expenses, Rents & Taxes B(2399)/B(346)	B(3198)
	Unit Cost: Cost of Capital Road: B(3096)/B(346)	B(3232)
	Unit Cost: Cost of Capital Equipment: B(3106)/B(346)	B(3245)
	Unit Cost: Total Expenses, Rents & Taxes, Including Cost of Capital	B(3281)

TABLE 10. DERIVATION OF RAIL FORM A OTHER TRAIN MILE EXPENSE: B(3263).

Account Number	Item or Account Title	Rail Form A Core No.
	<u>Transportation Portion</u>	
372	Dispatching trains	B(411)
373,421	Station exp. TOFC, COFC Term.	B(449)
376	Station supplies & expenses	B(471)
402	Remainder of Acct. 402	B(764)
404	Sig. & interlocker operator	
405	Crossing protection	
406	Drawbridge operation	
415	Clearing wrecks	
	Total Accts. 404,405,406,415	B(781)
371	Superintendence	B(836)
390,391	Operating jt. yd. & term.	B(863)
409	Employee H, W & payroll taxes	
410	Stationery & printing	
411	Other expenses	
414	Insurance	
420	Injuries to persons	
	Total Acct. 409,410,411,414,420	B(887)
412,413	Oper. jt. tracks & facilities	B(913)
416	Damage to property	B(915)
417	Damage to livestock	B(924)
	Total Transportation	B(929)
	<u>Maintenance of Equipment</u>	
314	Freight train car repairs	
	-mileage	B(1183)
	-time	B(1208)
331(53)	Freight train cars - mileage	B(1324)
	- time	B(1337)
330(53)	Freight train cars - mileage	B(1390)
	- time	B(1403)
301	Superintendence	
332	Injuries to persons	
333	Insurance	
334	Stationery & printing	
335	Employee H, W, & payroll taxes	
339	Other expenses	
	Total Acts. 301,332,333,334,335,339	B(1506)

Table 10 - continued

Account Number	Item of Account Title	Rail Form A Core No.
302	Shop machinery	
304	Power plant machinery	
305	S & P plant machinery-depr.	
306	Dism. ret. S&P plant machinery	
329	Dism. ret. equipment	
336	Jt. maint. of equip.-debit	
337	Jt. maint. of equip.-credit	
	Total Accts. 302,304,305,306,329,336,337	B(1535)
503,536	Per diem cars - mileage	B(1561)
	- time	B(1574)
	Cars on other basis - mileage	B(1588)
	- time	B(1601)
	Total maintenance of equipment	B(1603)
	<u>Maintenance of Way & Structure</u>	
227,266-16	Station & office buildings	B(1838)
249,266-27	Signals & interlockers	B(1906)
201	Superintendence	B(1997)
266-1 267-1	Engineering	B(2026)
266	Road Prop. depr. - all other	
267	Ret. road - all other accts.	
270	Dism. retired road property	
271,267-38	Small tools and supplies	
278,279	Maint. jt. tracks & other fac.	
	Total Accts. 266,267,270,271, 267(38),278,279	B(2055)
274	Injuries to persons	
275	Insurance	
276	Stationery & printing	
277	Employee H, W & payroll taxes	
282	Other expenses	
	Total Accts. 274,275,276,277,282	B(2084)
	Work Equipment	B(2151)
	Tot. Maintenance of Way & Structure	B(2180)
	<u>Traffic and General Administration</u>	
	Distribution of general overhead	B(2272)
	Total Traffic	B(2317)
	<u>Cost of Capital: Road</u>	
16	Station-other, including running	B(2794)
	Total Road	B(2794)

Table 10 - continued

Account Number	Item of Account Title	Rail Form A Core No.
	Cost of Capital: Equipment	
53	Freight train cars	B(2894)
54	Passenger train cars	B(2906)
	Total Equipment	B(2932)
	Unit Cost Calculation:	
	Total Expenses, Rents & Taxes	B(2317)
	Number of Service Units	A(178)
	Unit Cost-Expenses, Rents & Taxes B(2317)/A(178)	B(3174)
	Unit Cost-Cost of Capital Road: B(2794)/A(178)	B(3242)
	Variable Unit Cost / Sum of Expenses, Road & Equipment	B(3263)

TABLE 11. DERIVATION OF RAIL FORM A GROSS TON MILE EXPENSE: B(3261).

Account Number	Account Title		Rail Form A Core No.
	Transportation Portion:		
394	Train fuel		B(649)
395	Train power produced		B(676)
396	Train power purchased		B(679)
400	Servicing train locomotives		B(98)
371	Superintendence		B(833)
407	Employee H, W, & payroll taxes		
410	Stationery and printing		
411	Other expenses		
414	Insurance		
420	Injuries to persons		
	Total Accts., 409,410,411,414,420		B(884)
	Total Transportation		B(926)
	Maintenance of Equipment:		
311	Diesel locomotive repairs	(road)	B(1122)
311	Other locomotive repairs (road)		B(1141)
314	Freight train car repairs -	mileage	B(1182)
		time	B(1207)
331-53	Freight train cars	- mileage	B(1323)
		- time	B(1336)
330-53	Freight train cars	- mileage	B(1389)
		- time	B(1402)
301	Superintendence		
332	Injuries to persons		
333	Insurance		
334	Stationary and printing		
335	Employee H, W & payroll taxes		
339	Other expenses		
	T. Accts. 301,332,333,334,335,339		B(1504)
302	Shop machinery		
304	Power plant machinery		
305	S & P plant machinery-depr.		

Table 11 - continued

Account Number	Account Title	Rail Form A Core No.
306	Dism. Ret. S&P plant machinery	
329	Dism. Ret. Equipment	
336	Joint maintenance of equipment -debit	
337	-credit	
	T.Acts. 302,204,205,206,219,336,337	B(1533)
503-536	Per diem cars - mileage	B(1560)
	- time	B(1573)
	Cars on other basis - mileage	B(1587)
	- time	B(1600)
	Locomotive rent (net)	B(1615)
	Total Maintenance of Equipment	B(1628)
	<u>Maintenance of Way & Structures</u>	
202	Roadway Maintenance - running	B(1678)
206	Tunnels & Subways - running	B(1687)
208	Bridges, Trestles & Culverts - running	B(1696)
210	Elevated Structures - running	B(1705)
221	Fences, snowsheds, & signs - running	B(1714)
212	Ties - running	B(1742)
214	Rails - running	B(1751)
216	Other track material - running	B(1760)
218	Ballast - running	B(1769)
220	Track Laying & Surfacing - running	B(1778)
226/2.5-13	Road property - depreciation	B(1799)
267/2.5-12	Retirements - roads	B(1809)
229,266/17	Roadway buildings	B(1856)
233,266/19	Fuel stations	B(1868)
235,266/20	Shops & enginehouses	B(1884)
253,266/29	Power plants	B(1930)
257,266/31	Power trans. system	B(1941)
201	Superintendence	B(1995)
266,267/1	Engineering	B(2024)
266	Road prop. - depr. all other	
267	Retire. road - all other	
270	Dism. retired road property	
271,267/38	Small tools & supplies	
278,279	Maint. J.T. tracks & other facilities	
	Total Acct. 266,267,270,271,267/38,278,279	B(2053)
274	Injuries to persons	
275	Insurance	
276	Stationery & printing	

Table 11 - continued

Account Number	Account Title	Rail Form A Core No.
277	Employee H, W & payroll taxes	
282	Other expenses	
	Total Accts. 274,275,276,277,282	B(2082)
269,266/37	Roadway machines	
272	Removing snow, ice	
267/39	Public improvements - maint.	
281	Right of way expenses	
	T. Accts. 269,266/37,272,267/39,281	B(2111)
	Work equipment	B(2149)
	Total NW&S Incl. Work Equipment	B(2178)
	<u>Traffic and General Administration</u>	
	Distribution of general overhead	B(2269)
	<u>Cost of Capital: Road</u>	
2.5-13,17, 26-45	Other road property - running	B(2773)
2	Land - running	B(2782)
18	Water stations	B(2810)
19	Fuel stations	B(2821)
20	Shops & enginehouses	B(2832)
	Total Road Cost of Capital	B(2851)
	<u>Cost of Capital: Equipment</u>	
53	Freight train cars	B(2893)
54	Passenger train cars	B(2905)
57-58	Work & misc. equipment	B(2921)
	Total Equipment Cost of Capital	B(2930)
	<u>Unit Cost Calculation:</u>	
	Total Expenses, Rents & Taxes	B(2314)
	Number of Service Units	B(86)
	Unit Cost/Expenses, Rents & Taxes: B(2314/B(86)	B(3171)
	Unit Cost-Cost of Capital Road: B(2851)/B(86)	B(3214)
	Unit Cost-Cost of Capital Equipment B(2930)/B(86)	B(3240)
	Variable Unit Cost: Sum of Expenses, Road & Equipment	B(3261)

TABLE 12. DERIVATION OF RAIL FORM A LOCOMOTIVE UNIT MILE COST: B(3262).

Account Number	Item of Account Title	Rail Form A Core No.
	<u>Transportation</u>	
394	Train fuel	B(650)
395	Train power produced	B(677)
396	Train power purchased	B(680)
400	Servicing train locomotives	B(99)
409	Employee H & W & payroll taxes	
410	Stationery & printing	
411	Other expenses	
414	Insurance	
420	Injuries to persons	
	Total Acct. 409,410,411,414,420	B(885)
	Total Transportation	B(927)
	<u>Maintenance of Equipment:</u>	
311	Diesel locomotive repairs, road	B(1123)
311	Other locomotive repairs, road	B(1142)
331	Locomotive depreciation	B(1295)
330	Locomotive retirements	B(550)
301	Superintendence	
332	Injuries to persons	
333	Insurance	
334	Stationery & printing	
335	Employee H, W & payroll taxes	
339	Other expenses	
	Total, Line 117 to 122	B(1505)
302	Shop machinery	
304	Power plant machinery	
305	Depreciation of S&P plant machinery	
306	Disman. retired S&P plant machinery	
329	Dismantling retired equipment	
336	Joint maintenance of equip.-debit	
337	Joint maintenance of equip.-credit	
	Total lines 124-130	B(1534)
504,537	Net locomotive rents	B(1616)
	Total Maintenance of Equipment	B(1629)

Table 12 - continued

Account Number	Item or Account Title	Rail Form A Core No.
	Maintenance of Way and Structures	
233,266	Fuel stations	B(1869)
253,266	Power plants	B(1931)
257,266	Power transmission system	B(1942)
201	Superintendence	B(1996)
266,267	Engineering	B(2025)
266	Road property depreciation	
267	Retirement of road property	
270	Dismantling retired property	
271,267	Small tools and supplies	
278,279	Maintenance of joint tracks and other facilities	
	T. Accts. 266,267,270,271,278,279	B(2054)
274	Injuries to persons	
275	Insurance	
276	Stationery and printing	
277	Employee H, W & payroll taxes	
282	Other expenses	
	Total, Line 297 to 201	B(2083)
	Work Equipment	B(2150)
	Total Maintenance of Way Structures	B(2179)
	Traffic and General Administration	
	Distribution of general overhead	B(2270)
	Total expenses, rents and taxes	B(2315)
	Cost of Capital	
20	Fuel Stations	B(2580)
21	Shops and enginehouses	B(2581)
	Total road	B(2822)
52	Locomotive	B(2668)
	Variable Unit Cost Calculation:	
	Number of Service Units	A(230)
	Unit Cost: Operating Expenses, Rents & Taxes B(2315)/A(230)	B(3172)
	Unit Cost: Cost of Capital Road B(2822)/A(230)	B(3215)
	Unit Cost: Cost of Capital Equipment B(2668)/A(230)	B(3241)
	Unit Cost: Total Expenses, Rents, Taxes & Cost of Capital, Line 9 + Line 10 + Line 11	B(3262)

TABLE 13. DERIVATION OF RAIL FORM A STATION CLERICAL UNIT COST: B(3265).

Account Number	Item or Account Title	Rail Form A Core No.
	Transportation	
373 other	Current actual station expense: other than platform	B(450)
376	Station supplies and expense	B(472)
	Total Accts. 373,376	B(581)
371	Superintendence	B(839)
390,391	Operating joint yards & terminals	B(864)
409	Employee H, W & payroll taxes	
410	Stationery & printing	
411	Other expenses	
414	Insurance	
420	Injuries to persons	
	Total Accts. 409-411,414,420	B(890)
	Total: B(581),B(839),B(864),B(890)	B(932)
452	Current year variable cost	B(988)
	Total Transportation Including Acct. 452	B(1040)
	Maintenance of Way:	
227,266/16	Station and office buildings	B(1839)
201	Superintendence	B(1998)
266-67/1	Engineering	B(2027)
266	Road property depreciation-all oth.	
267	Retire. of rd. property-all other	
270	Dismant. of retired roadway prop.	
271,267/38	Small tools & supplies	
278,279	Maint. of joint tracks & facilities	
	Total Accts. 266-271,278,279	B(2056)
274	Injuries to persons	
275	Insurance	
276	Stationery & printing	
277	Employee H, W & payroll taxes	
282	Other expenses	
	Total Accts. 274-277,282	B(2085)
	Total Maintenance W & S Excluding Work Equipment	B(2124)
	Work Equipment	B(2152)
	T. Maintenance of Way & Structure: B(2152) & B(2124)	B(2181)

Table 13 - continued

Account Number	Item or Account Title	Rail Form A Core No.
	<u>Traffic and General Administration:</u>	
	Distribution of General Overhead	B(2275)
16	<u>Cost of Capital: Road</u>	B(2795)
	<u>Variable Unit Cost Calculation</u>	
	Total Expenses, Rents & Taxes	B(2320)
	Cost of Capital Road	B(2795)
	Number of Service Units	B(3165)
	Unit Cost: Expenses, Rents & Taxes B(2320)/B(3165)	B(3176)
	Unit Cost: Cost of Capital, Road: B(2795)/B(3165)	B(3217)
	Unit Cost: Total Expense & Cost of Capital: B(3176)/B(3217)	B(3265)

TABLE 14. DERIVATION OF RAIL FORM A STATION SPECIAL SERVICES UNIT COST: B(3273).

Account Number	Item or Account Title	Rail Form A Core No.
373	Current actual station expense: other than platform	B(455)
376	Station supplies & expenses	B(480)
	Total Accts. 373,376	B(589)
371	Superintendence	B(847)
390,391	Operating joint yards & terminals	B(872)
409	Employee H, W & payroll taxes	
410	Stationery & printing	
411	Other expenses	
414	Insurance	
420	Injuries to persons	
	Total Accts. 409-411,414,420	B(898)
	Total Transportation, Including Acct. 452	B(898)
	<u>Maintenance of Way & Structure</u>	
277,266/16	Station & office buildings	B(1847)
201	Superintendence	B(2006)
266-67/1	Engineering	B(2035)
266	Road property depreciation-all oth.	
267	Retire. of road property-all other	
270	Dismant. of retired road property	
271,267/38	Small tools & supplies	
278,279	Maint. of joint track & facilities	
	Total Accts. 266-271,278,279	B(2065)
274	Injuries to persons	
275	Insurance	
276	Stationery & printing	
277	Employee H, W & payroll taxes	
282	Other expenses	
	Total Accts. 274-277,282	B(2093)
	Total Maintenance of W & S Excluding Work Equipment	B(2132)
	Work Equipment	B(2160)
	Total Maintenance of Way & Structures: B(2132) + B(2160)	B(2189)

Table 14 - continued

Account Number	Item or Account Title	Rail Form A Core No.
	<u>Traffic and General Administration:</u>	
	Distribution of General Overhead	B(2283)
	<u>Cost of Capital: Road</u>	
16	Other road capital, including running	B(2800)
	<u>Variable Unit Cost Calculation:</u>	
	Total Expense, Rents & Taxes	B(2328)
	Cost of Capital, Road	B(2800)
	Number of Service Units	B(3165)
	Unit Cost: Expenses, Rents & Taxes B(2328)/B(3165)	B(3184)
	Unit Cost: cost of Capital Road B(2800)/B(3165)	B(3225)
	Unit Cost: Expenses & Cost of Capital B(3184)+B(3225)	B(3273)

The raw RFA gross ton mile (GTM) expense is adjusted for the type of train service off-branch. Table 15 illustrates the process, using regional RFA data. However, individual railroad data are used in actual analyses.

The adjustment process accounts for the fact that different train performance factors (e.g. locomotive units and average trailing weights) result in different costs per train-mile. Logically, unit train gross ton-mile costs will be lower than way train.

The raw RFA GTM core number is B(3261). The average train weights and locomotive units for each class of train service are computed from Schedule 755 of the carrier's latest R-1 report.

TABLE 15. DEVELOPMENT OF RAIL FORM A ADJUSTED WAY TRAIN GROSS TON MILE EXPENSE.

Item	Source	Amount
1. Cost per revenue and non-revenue gross ton	RFA, B(3261)	0.00292072
2. Train weight	RFA, B(3298)	1780.7222
3. Cost per train mile and gross ton mile (Line 1 * Line 2)	RFA, B(3311)	5.20098603
4. Cost per locomotive unit mile	RFA, B(3262)	1.93196982
5. Locomotive units per train	RFA, B(3303)	2.22108209
6. Cost per train mile and gross ton mile (Line 4 * Line 5)	RFA, B(3314)	4.29106355
7. Train mile expense, other than wages	RFA, B(3263)	1.09699082
8. Train mile expense, crew wage	RFA, B(3173)	5.93536532
9. Ratio, way train to average train wages	RFA, B(3308)	1.21620546
10. Total variable cost per train mile (L3 + L6 + L7 + (L7 * L8))	RFA, B(3319)	17.80766420
11. Variable cost per revenue and non-revenue	RFA, B(3861)	1.00002483
12. Ratio, revenue to total gross ton miles	RFA, B(88)	.98817889
13. Variable cost per revenue gross ton mile (Line 11/Line 12)	RFA(3325)	1.01198764

4.2 Calculation of Off-Line Service Units

Off-line service units may be classified as:

1. line-haul, distance-related service units;
2. line-haul, switching service units; and
3. terminal service units.

Three fundamental operating/performance factors must be computed prior to the determination of line-haul service units. These are: (1) the average freight train speed, running; (2) the actual (route) mileage for the shipment; and (3) the number of intermediate yard switching events. The average train speed for the Burlington Northern and Soo Line is computed from data contained in Schedule 755 of their R-1 reports. Loaded train miles are calculated from distance tariffs and timetables.

4.2.1 Intermediate Yard Switching Events

There are two types of classification yard switching: (1) intertrain/intratrain (I & I), and (2) interchange (IC). Off-branch IC switches are estimated directly for some carriers and markets. Where direct estimation is not possible, the number of IC events is estimated using an average distance interval. This interval is calculated from the current North Dakota waybill sample.

I & I switches are estimated differently for each service level. Unit train shipments, by definition, do not require yard classification. So, the number of I & I events is assumed to be zero. For trainload and large multiple-car shipments, one I & I switch normally occurs at the regional classification yard serving the line. A second one is usually required at the destination yard to declassify the block. Additional I & I switching is generally not needed, as these shipments typically travel in solid trains between origin and destination yards. So, two I & I switches are normally assumed for single-line multi-car or trainload shipments.

If the traffic is interline in nature, the frequency of events cannot be specified with certainty. So, the originating and terminating carrier are each given at least one I & I switch. Additional I & I switches are computed on a mileage basis. A distance interval of 400 miles is assumed.

I & I switches in single-car service are assumed to be distance-related. An interval of 200 miles between switches is used.

4.2.2 Car Day Cycle

The car day cycle contains three basic components: (1) car-days running, (2) car-days terminal switching, and (3) car-days switching, intermediate yards. Car-days running (CDR) are computed from the train speed and the line-haul mileage (13).

$$CDR = TM \;/\; Speed \;/\; 24 \qquad (13)$$

where:

CDR = Car days running

TM = Off-branch train miles

The number of car-days per terminal switch, as well as the number of car-days switching at intermediate yards, are computed from Rail Form A operational factors. On the average, one day is consumed in the delivery of the empty (or loaded) freight car to the shipper's siding. Rail tariffs normally require loading and unloading within 48 hours of constructive placement. Once the freight car is loaded (or unloaded) and is ready for pick-up, it is "pulled" back to the classification yard for blocking and classification. This usually occurs on the fourth day of the cycle at origin or destination.

The total car-days at origin and destination differ among car-types. Because of its versatility, the inbound boxcar can be reloaded twenty percent of the time. Thus, there is no need for the spotting of an empty at origin, as a suitable empty car is already available from the previous shipment.

To account for this occurrence, a different "spotted-to-pulled" ratio is used. For most car-types a spotted-to-pulled ratio (SPR) of 2.0 is used. But, for a boxcar, the ratio is 1.8.

The estimation of intermediate yard events are as described in Section 4.2.1. Once the number of events is determined, the number of car days is computed as follows:

$$CDY = (CDIC * IC * ERR) + (CDII * II * ERR) \tag{14}$$

where:

CDY = car days intermediate yard switching

CDIC = car days per interchange switch: 1/2 day

CDII = car days per intertrain or intratrain switch: 1/2 day

ERR = ratio of total to load miles for the particular car-type

IC = the number of loaded interchange switches

II = the number of loaded intertrain and/or intratrain switches

The days per intermediate yard switch (CDIC and CDII) are engineering estimates developed by the ICC.

4.2.3 Locomotive Switching Minutes

Locomotive switching minutes are the result of both line-haul and terminal activities. Line-haul LSM result from intermediate yard switching events, and are computed as follows:

$$LSMLH = (LSMII * II * ERR) + (LSMIC * IC * ERR) \qquad (15)$$

where:

LSMLH = total line-haul switch engine minutes

LSMII = average minutes per intertrain/intratrain switch

LSMIC = average minutes per interchange switch

The average number of LSM per event are developed from ICC formulas which equate the number of carloads originated and terminated with each class of switching. Similar estimates are developed for LSM at origin and destination. They are used to compute terminal switching minutes as depicted below.

$$LSMOD = LSMLE * SPR * 2 \qquad (16)$$

where:

LSMOD = locomotive switching minutes: origin-destination

LSMLE = average LSM per loaded or empty car at origin or destination

4.2.4 Car Miles Switching

Car miles running can be calculated directly from distance tariffs, using circuity and empty-return factors. Car miles switching, however, rely upon ICC engineering estimates for various classes of switching.

Car miles switching are computed as follows:

$$CMS = (CMII * II * ERR) + (CMIC * IC * ERR) + (CMTS * SPR * 2) \quad (17)$$

where:

CMS = total car miles switching

CMII = car miles, intertrain-intratrain switching: 1.00, RFA -- A(105)

CMIC = car miles, interchange switch: 2.75, RFA -- A(104)

CMTS = car miles per terminal switch: 4, RFA -- A(100)

4.3 Calculation of Multi-Car Service Units and Costs

A series of adjustments are built into the off-line procedure to account for the efficiencies associated with multiple-car and trainload handling. The methodology calls for a reduction of origin/destination switching minutes per car, based on a sliding scale of adjustment factors (Table 16). This scale results in a 60 percent reduction from the single-car base for a 26-car shipment.

The number of car-days at origin and destination are reduced by 25 percent for multiple-car shipments. In addition, station clerical (billing) costs are adjusted downward for multiple-car shipments by assuming that 25 percent of the costs are associated with the shipment and 75 percent with the carloads.

TABLE 16. ORIGIN-DESTINATION ENGINE MINUTE ADJUSTMENT FACTORS

CUTSIZE*	PERCENT REDUCTION PER CAR
6	12
7	19
8	24
9	28
10	31
11	34
12	37
13	39
14	41
15	43
16-17	45
18-20	47
21-25	54
26-30	60
31-40	66
41-49	72
50 or more	75

*The term cutsize refers to the number of cars switched at each station.

4.4 Procedure for Computing Car Ownership Unit Costs

Car ownership costs are computed annually for each railroad and car-type. Most of the source data come from Schedules 414, 415, 710, and 755 of the R-1 report.

Two car ownership costs are computed for railroad cars: a car-day cost and a car mile cost. In addition, a private-line mileage rent is computed for shipper-owned cars. The process is illustrated in Table 17.

TABLE 17. COMPUTATION OF CAR-DAY AND CAR-MILE UNIT COSTS

Item	Source
1. Net Repairs	Sch. 415, L. 11, Col. (b)
2. Depreciation	Sch. 415, L. 11, Col. (c) + Col. (d)
3. Lease & Rentals	Sch. 415, L. 11, Col. (f)
4. Investment Base	Sch. 415, L. 11, Col. (g) + Col. (h)
5. Accumulated Depreciation	Sch. 415, L. 11, Col. (i) + Col. (j)
6. Net Investment Base	Line 4 - Line 5
7. Units Owned/Leased: Beg. of Year	Sch. 710, L. 41, Col (b)
8. Units Owned/Leased: End of Year	Sch. 710, L. 41, Col (k)
9. Units Owned/Leased: Average	(Line 7 + Line 8)/2
10. Car Miles: Loaded (RR Owned/Leased)	Sch. 755, L. 20, Col. (b)
11. Car Miles: Empty (RR Owned/Leased)	Sch. 755, L. 36, Col. (b)
12. Total Car Miles (RR Owned/Leased)	Line 10 + Line 11
13. Car Miles: Loaded (Private)	Sch. 755, L. 52, Col. (b)
14. Car Miles: Empty (Private)	Sch. 755, L. 70, Col. (b)
15. Total Car Miles (Private)	Line 13 + Line 14
Railroad Owned and Leased	
16. Active Car Days Per Car	Ex Parte 334 or AAR
17. Average Annual Miles Per Car	Line 12/Line 9
18. Average Annual Repairs per Car	Line 1/Line 9
19. Mileage Portion of Repairs	Ex Parte 334
20. Mileage Portion of Depreciation	Ex Parte 334
21. General Overhead Ratio	RFA= 1.0 + B(2268)
22. Rail Form A Variability Ratio-Repairs	RFA= A(150)
23. Rail Form A Variability Ratio-Depr.	RFA= A(151)
24. Rail Form A Variability Ratio-Taxes	RFA= A(159)
25. Property Tax Ratio	AAR: Ex Parte 334
26. Variable Repair Cost Per Car Mile	(Line 18 * Line 19)/Line 17 * Line 22 * Line 21
27. Variable Depreciation Cost Per Car Mile	(Line 2 * Line 20)/Line 12 * Line 23 * Line 21
28. Variable Cost/Car Mile	Line 26 + Line 27
29. Average Book Value	Line 6/Line 9
30. Cost of Capital	RFA= A(338)
31. Freight Car ROI	Line 29 * Line 30 * Line 21
32. Variable Property Taxes	(Line 29 * Line 24 * Line 25) Line 16 * Line 21
33. Variable Depreciation Per Car Day	(Line 2/Line 4)/Line 16 * Line 23 * Line 21
34. Leases & Rentals ROI Per Car Day	(Line 3/ Line 9)/Line 16 * Line 21 Line 31/Line 16
35. Leases & Rentals Per Car Day	Line 2/Line 9/352/Line 21
36. Variable Repair Cost Per Car Day	Line 18/352 *Line 22 * Line 21
37. Cost Per Car Day	Line 33 + Line 35 + Line 36 + Line 37 Traffic and General Administration:
38. Gross Per Diem Payable	Sch. 414, Col. (e)
39. Cost Per Car Mile: Private	Line 39 + Line 13
40. Loaded to Empty Ratio RR Cars	Line 12/Line 10
41. Loaded to Empty Ratio (Private)	Line 15/Line 13

V. CONCLUSION

The purpose of this report has been to explain and document a Class I carrier costing procedure that can be used to estimate costs for North Dakota branch-lines. The methods utilize data from each railroad's R-1 report and Rail Form A. These inputs can be obtained from public sources each year. The unit costs are used in conjunction with branch-line operating models to project annual expenses for a line or set of lines under Class I ownership.