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USER'S MANUAL FOR THE MAINTENANCE COST METHODOLOGY FOR HIGH SPEED PASSENGER TRAIN TRUCKS

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16. Abstract

This document is a user's manual for the simulation cost modeling (SCM) technique as applied to a passenger railcar truck and its component parts. The manual includes application of the technique through the development of an example maintenance schematic diagram, example truck component cost data, and example maintenance procedures. The computer program and its various operating modes are described with the aid of a full set of example data obtained from Amtrak personnel. A complete listing of the FORTRAN IV program and a set of example data for its operation are contained in the appendixes. A set of cost results from the example Amtrak data cover maintenance expenditures by maintenance actions and by component truck subassemblies. Also listed in the example results are a set of cost sensitivities related to the modeled maintenance system.

In addition to the present application, the SCM technique has been employed successfully for other railroad systems, including track maintenance. The technique is generally useful for fleets in which individual cost data are not available, such as a proposed transit system or the introduction of new subsystems or components.

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PREFACE

This manual includes the application of the simulation cost model to a currently used high speed passenger train truck, the Minden Deutz Truck on the Amtrak Superliner. This application is presented for illustrative purposes only. The input data to the model for the truck are typically rough estimates--these data and the associated outputs from the model are SAMPLES ONLY and should not be considered as accurate or as definitive in any sense.

This work was conducted for the Federal Railroad Administration through the Transportation Systems Center (TSC) in Cambridge, Massachusetts. Mr. Kevin W. Yearwood was the TSC Technical Monitor.

Other contributors to this work are also acknowledged. These include Mr. Gregory Gagarin of the Mechanical Department Equipment Engineering Group, Amtrak Washington Office, and Mr. Bernard Fitzgerald, Manager of Superliner Maintenance Facility, of the Amtrak Chicago. Both Mr. Gagarin and Mr. Fitzgerald aided in the formulation and review of the schematic diagram, in the estimation of data values, and in the review of portions of this manual. The production of the manual, particularly of those parts associated with the Minden Deutz example, was facilitated considerably by their participation.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

°F −40 0 32 40 80 98.6 120 160 200 212 °F

°C −40 −20 0 20 37 40 60 80 100 °C

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LIST OF SYMBOLS

A Representative age of units in path, years

C Proportion of arriving units which branches, at a branch node, to the path intended either for defective units or for maintenance

C^* Proportion of arriving subassemblies which branches, at a branch node, to the path intended either for defective units or for maintenance

D Proportion of arriving defective units which branches, at a branch node, to the path intended either for defective units or for maintenance

E Proportion of arriving good units which branches, at a branch node, to the path intended either for defective units or for maintenance

K Number of components in identifiable or distinguishable assembly or subassembly

K$ Denotes components which belong to an identifiable assembly or subassembly at a node

N Number of units in path

Q Quality (proportion defective) of units in path

α Weibull characteristic life, years

β Weibull slope or shape parameter

Π Denotes multiplication (e.g., $\Pi_3 X_i = X_1 \cdot X_2 \cdot X_3$)

Subscript k Denotes component number

Subscript 1 or 2 Denotes path (1 = reference path intended either for defective units or for maintenance, 2 = nonreference path intended either for good units or for units not requiring maintenance)

1. INTRODUCTION

High speed passenger train trucks perform a variety of tasks, including support for the car and origination of braking and traction forces. The truck is a complex electromechanical system with many interrelated components. Because of its complexity, the truck can be expensive to purchase and to maintain. Although the purchase cost of the truck can easily be determined, it is much more difficult to establish the future costs of maintenance. Fleet maintenance costs are a function of (a) maintenance policies of the user, (b) type of service dictated by the truck design, (c) disassembly order of the truck components, and (d) time-varying aspects of certain maintenance costs.

The possibility of determining future maintenance costs with the aid of a computer has motivated the development of an economic maintenance methodology for passenger train trucks. This methodology -- the simulation cost model (SCM) -- is a consistent quantitative technique which provides(1) annual maintenance costs, (2) a means of evaluating alternative maintenance policies, (3) a means of estimating time dependent maintenance costs, and (4) identification of the data used in applying the technique.

In addition to the present railroad application, this methodology has previously been applied to the costs of maintaining roller bearings, journal bearings, wheels, bolsters, side frames, railcar trucks, and tracks. The methodology is also applicable to trucks, buses, and other systems for which fleet rather than individual cost data are available. Typically, the SCM is applicable where the fleet size is on the order of 100 or more individual units.

1.1 PURPOSE OF THE USER'S MANUAL

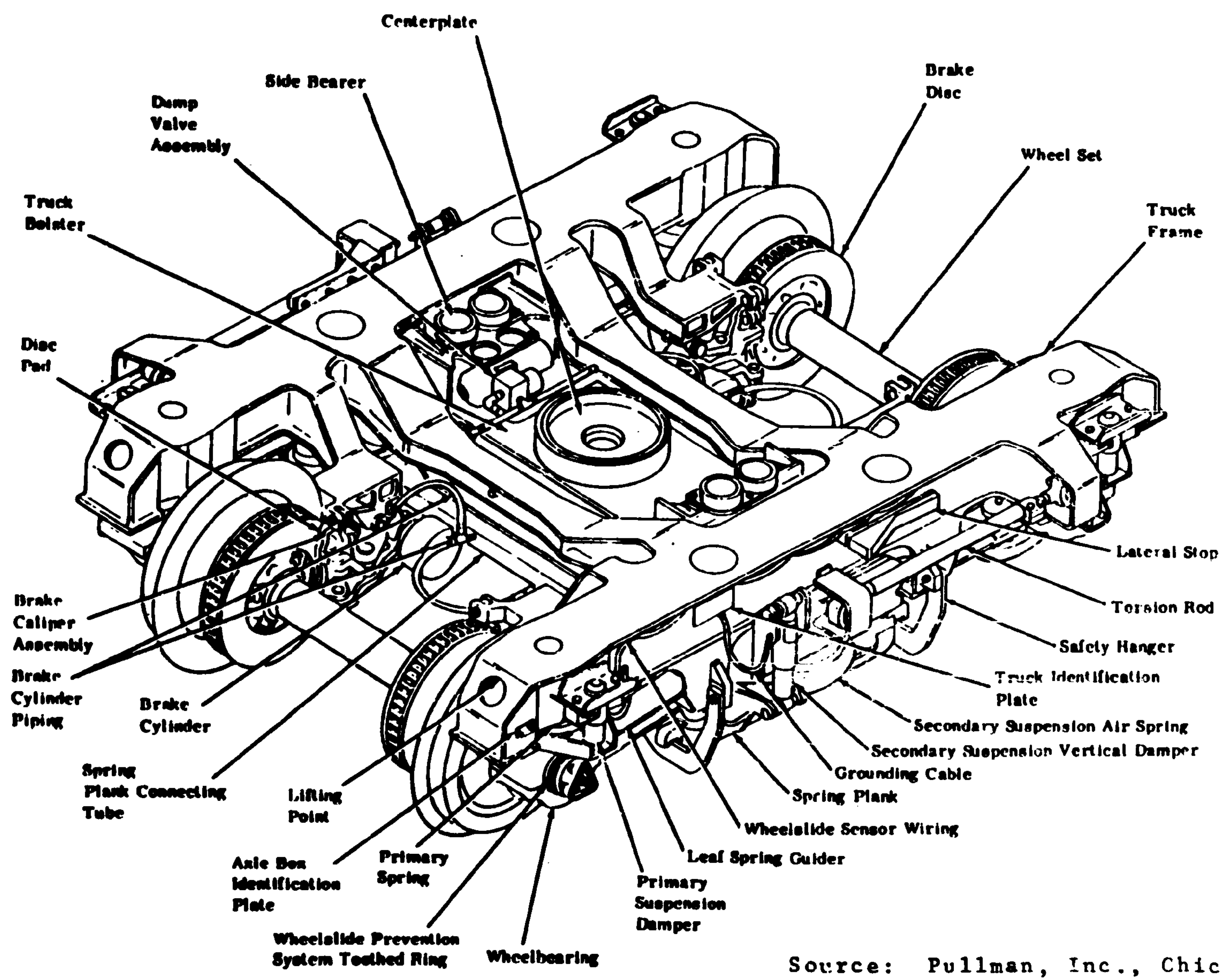
The purpose of this manual is to give the reader a sufficient understanding of the cost methodology to analyze, with the aid of the computer program included, the maintenance costs associated with the operation of a passenger truck. A further purpose is to present an example set of data, descriptions, and results for an existing passenger train truck and, thereby, to illuminate the (SCM) more fully. The truck used for the discussion is shown in Figure 1-1. This truck has been chosen for the presentation of a sample cost and/or repair data set because it is a new addition to the Amtrak fleet and its maintenance costs are important to Amtrak.

Although the report is intended to give the reader an introduction to simulation cost modeling, it is also a guide and manual for the serious user of the methodology and of the computer program contained herein.

1.2 SIMULATION COST METHODOLOGY

The simulation cost modeling (SCM) technique consists of a qualitative and quantitative computerized representation of the maintenance actions associated with the truck being modeled. The qualitative representative is a schematic diagram. This diagram describes the maintenance system. The quantitative representation is the data set associated with the schematic diagram. Linking the schematic diagram and the data set is a computer program. This program quantifies the diagram, implements the associated data set, and provides cost outputs as desired by the user.

The schematic diagram is analagous to an electrical wiring diagram. The schematic identifies the truck-related parts of the maintenance system, the maintenance interactions which involve the truck and its subassemblies, and the associated maintenance decisions that are required. The typical features and construction of the schematic diagram for the Amtrak passenger truck are contained in Section 3. Section 3 also contains the details of the data required to get cost results from the running of the computer program contained in the Appendixes at the end of the report.



Source: Pullman, Inc., Chicago IL

MINDEN DEUTZ TRUCK

Figure 1-1. Overall View of Truck Assembly Used for Sample Data in this Manual

2. APPLYING THE SIMULATION COST METHODOLOGY

2.1 DESCRIPTION

Amtrak uses and maintains the Minden Deutz truck. In order to keep the rolling stock in good working order it employs several repair facilities throughout the United States. In general, each of these facilities consists of a repair site with a Pit, Ground, and Rip Track. The Pit provides the workers with an underside view of the train cars. The ground and Rip Track are needed when additional time or labor must be expended to correct the component failures that occur. Figure 2-1 is a pictorial view of the movements of Minden Deutz cars among the various work areas used in keeping the passenger train trucks in a good state of repair.

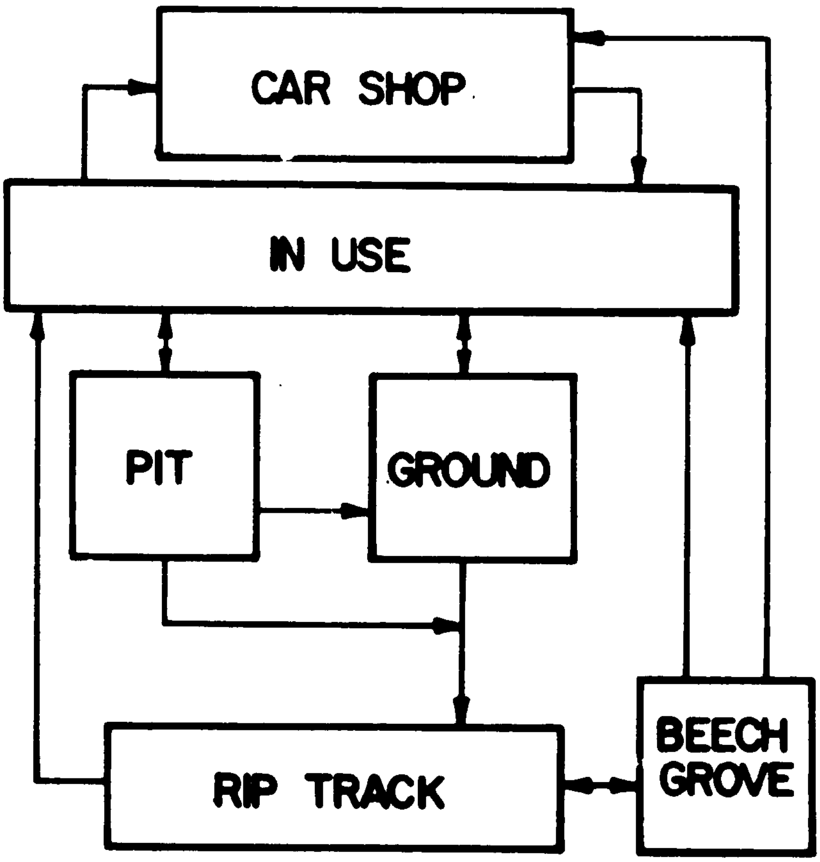
Also included in the pictorial view of the Amtrak maintenance facilities of Figure 2-1 are the Car Shop facility and the central overhaul location labelled as "Beech Grove". In the Car Shop the car is inspected approximately every 120 days. The majority of car repairs are made in this facility. Trucks can also be repaired if necessary.

The overhaul facility at "Beech Grove", Indiana, is used to rework and repair trucks on a periodic basis. In addition, this facility performs bearing rework, wheelset repairs and build-up, and subassembly rebuilding (such as for brake cylinders etc.). Component subassemblies are shipped to this facility from the various Rip Tracks and Car Shops around the country.

In the remainder of this subsection, the user is given a general introduction to the schematic diagram, data requirements, and computer program associated with the cost model. Detailed discussions concerning construction of the diagram, preparation of the data, and use of the computer program are given in Section 3.0 of this manual.

2.1.1 Diagram of Maintenance Simulated

The schematic diagram represents the maintenance actions that affect the truck. The schematic identifies the truck-related repair points of the



SIMPLIFIED SCHEMATIC DIAGRAM

Figure 2-1. Simplified Pictorial View of Maintenance Repair System

maintenance system, and the interactions involving its components. To describe the schematic, a simple diagram can be used. This diagram, Figure 2-1, is a simplified version of the full schematic developed as an example in Section 3.1 of this manual.

The simplified representation of the truck repair system is based on Amtrak's system for the upkeep of the Minden Deutz truck. The picture consists of the In-Use, Pit, Ground, Rip Track, Car Shop, and the major overhaul point shown at "Beech Grove" Indiana.

In-Use represents the productive use of the truck. The Pit or Ground encompasses the places where inspections of the truck are made and where minor maintenance of the truck is performed. The Rip Track is an area located physically in close proximity to the Pit or Ground. At the Rip Track, more substantial truck maintenance, removal of trucks, and removal of truck subassemblies occur. Finally, the major overhaul facility is a central location where major truck disassembly and truck repair takes place.

2.1.2 Overview of Data Requirements

The data requirements for the SCM technique are, for the most part, defined by the schematic diagram. These data requirements consist primarily of three types of information. These are:

1) Maintenance cost information (labor and material),
2) Number of trucks and truck components per year (flow data) associated with paths of the schematic diagram, and
3) Data needed for controlling the computer programs.

The costs associated with a particular path are determined by the operations or actions that occur on the path. For example, the connecting line between the "In-Use" and "Pit" blocks shown in Figure 2-1 is related to the inspection of cars reaching the "Pit" on a daily basis. Consequently, the labor cost required for inspecting each component would be associated with this path. Specifically, 1 data item for this path could be $0.57 per wheel, which would then be the unit cost for inspecting each wheel. For this inspection cost, the amount could be found by first determining the time to inspect the wheel and then multiplying by a labor rate. For other costs, their unit values could be obtained from the vendors (material costs), from carriers (shipping costs), etc. Costs generally obtained in practice are unit costs (e.g., dollars per wheel).

In general, the cost associated with each component on each path will be that for the sum of all activities or actions that occur. Consequently, a given path can incorporate many costs for each component such as from labor, material, subcontract, delay, travel and living, etc.

The connecting lines or paths on the schematic diagram, require additional information beyond costs. This additional information, the "flow" data, is necessary because the paths represent the "movement" of trucks and truck components from 1 point in the repair scheme to another. These flows are the number of trucks or truck components per year that are conceptually being handled by the maintenance action represented by that path of the schematic diagram. Details of specific "flow" data are given in Section 3.2.2.

Data for controlling and operating the computer program are also needed. In order for the simulation cost model to tabulate cost results the schematic diagram and its associated maintenance operations (paths) must be numbered. In addition, the various connecting points of the schematic diagram must be numbered, and the truck components being repaired must be given reference numbers. The technique of numbering the paths, connecting points, and truck component subassemblies is the basis of the example given in Section 3. In addition, a review of how the computer program control numbers are generated and used is given in that section.

2.1.3 Overview of Computer Program

The computer program used for simulation cost modeling is contained in the Appendixes of this report. This program is a FORTRAN version of the original which was written in the BASIC language. This program and its associated sample data files are intended to run in the batch mode. The type of simulation runs, numbers of outputs, and type of cost output one obtains depends upon the numeric values given to the control file variables. Sample data file numbers and typical cost, flow, and summary output results are also given in the Appendixes. A complete set of output information obtainable from the program would consist of:

1) A schematic diagram topology printout,
2) maintenance path flows by path and component,
3) maintenance costs itemized by path and component,
4) maintenance costs by truck component,
5) a set of sensitivity costs,
6) the quality of components over the schematic diagram paths,
7) the age of the components throughout the schematic diagram paths, and
8) the total system cost with time if a time simulation run has been chosen.

Each of these output types are reviewed in the sections that follow.

2.2 OPERATION OF THE COMPUTER PROGRAM

The operation of the program contained in this manual is intended for the serious cost analyst who is familiar with the procedures and methodology described herein. The program can also be employed by the casual observer for the sample problem given in the manual through use of the sample data files supplied. However, the data set supplied with this manual is intended only for implementing the program and to illustrate its operation. Conclusions on the actual cost values for the truck used should not be drawn until the full set of costing data has been thoroughly reviewed by the user who is familiar with the full range of maintenance practices simulated by the program.

2.3 COMPUTER EQUIPMENT DESCRIPTION

The computer program was converted to FORTRAN IV language and test run on a PRIME 350 computer. This computer, in addition to having a control terminal, contained a magnetic disk (12 megabyte) drive and a hard copy printer. The control terminal provided for the program processing, whereas the printer was used for receiving all output cost, flow, and other simulation information. Samples of these output tables are contained in the attached Appendixes.

Further program operating instructions are contained specifically in Appendix A.

2.4 PERFORMANCE OF PROGRAM

The computer program listed operates in the batch mode under the control file set of cards listed in Appendix D. Selection of the appropriate control values will provide the user with many combinations of output results. A single typical program run would normally consist of output results consisting of any 1 of the following:

a) Schematic Diagram Topology,
b) Maintenance Flows and Costs,
c) Time Simulation Runs, or
d) Maintenance Cost Sensitivities.

Normally the control cards would be set up to provide any 1 of the above output types, however, some combinations can be obtained in a single run.

As an example, the topology output (schematic diagram path linkages) can be obtained along with a single flow and cost output, if desired. If a time simulation is chosen, then the user must specify the time step interval for which the flow and costs will be printed. In this way 1 or several outputs can be produced to follow the system "flows and costs" over some desired time span.

If the user wants the sensitivity output, this is exclusive to all other optional outputs. The various meanings of the control card sets and an example test run set are contained in the Appendixes.

2.5 DATA PROCESSING OF PROGRAMS

The data files for the computer program are discussed in the Appendixes; however, some general comments are given here.

All data needed for running the programs are contained in 2 data files (see Appendixes D and E). The control file is read alternately with the base data file which contains the nodal split values, costs, path linkages, and other maintenance-related values.

Portions of the base data file are separated by the delimeter "999", whereas other parts are bounded through the loop indicies found in and set by the control file values. This technique is used so that when modifications in the maintenance schematic diagram are desired, only the data, not the computer program, need to be changed.

3. PROCEDURES AND REQUIREMENTS OF MODEL

This section provides the user with specific details of implementing the simulation cost model. The implementation of the methodology is demonstrated through the use of a sample schematic diagram and its associated set of data. The presentation of the material here follows the logical progression of model development taken for the passenger train truck example given. This progress requires that the model developer:

1) create a schematic diagram representing the maintenance system modeled,
2) generate a data set required by the diagram constructed, and
3) input the data as required by the computer program.

3.1 THE SCHEMATIC DIAGRAM AND ITS CONSTRUCTION

The schematic diagram defines the system (e.g., maintenance) that is being considered by the SCM. As a result, the degree to which the SCM provides accurate and reliable cost and flow output depends on the degree to which the schematic represents the actual maintenance system. It is therefore desirable that the user of the SCM be intimately familiar with the actual or proposed procedures for the truck. Occasionally, the expert in truck maintenance and the person who is applying the SCM are not the same. In that event, it is suggested that a project team be formed so that the necessary experience is provided both during the construction of the schematic and during the subsequent steps in implementing the SCM.

The important features of any schematic diagram are:

a) Major maintenance repair areas (e.g. In-Use, Pit, Ground, Rip Track, etc.),
b) Paths which represent every maintenance action desired in the model simulation, and
c) Branching and Summation points for paths proceeding from or to the various maintenance actions shown in the diagram.

Regardless of the complexity of the truck being considered or the maintenance requirements, every schematic diagram will contain these elements. The only difference between the simple schematic of Figure 2-1 and the full schematic of Figure 3-1 and 3-2 (discussed below) is the detail within the maintenance areas modeled and the complexity of the paths linking these maintenance areas.

Notational conventions for drawing schematic diagrams are discussed in Figure 3-3. This figure gives the meanings associated with the various arrows, triangles, squares, and circles used.

In order to construct a schematic diagram for the maintenance of a passenger train truck, several steps are usually taken. These steps include:

1) Determination of what components and subassemblies are regarded as comprising the truck, in particular those which may have a high failure rate.

2) Identification of the nature and type of maintenance inspection to which the truck is subjected.

3) Identification of the nature and type of maintenance actions which are to be included.

4) Establishment of how many maintenance facilities need be modeled separately and of the relation of each facility to the others in the maintenance system.

5) Characterization of how each maintenance facility operates in repairing the trucks.

6) Characterization of how each facility interrelates with the other facilities.

7) Labelling of the appropriate maintenance actions and of the individual paths of the diagram.

8) Review of the diagram by people who are familiar with the maintenance system being modeled and subsequent modification of the diagram to incorporate comments received.

9) Numbering of the nodes and paths of the diagram for computer implementation.

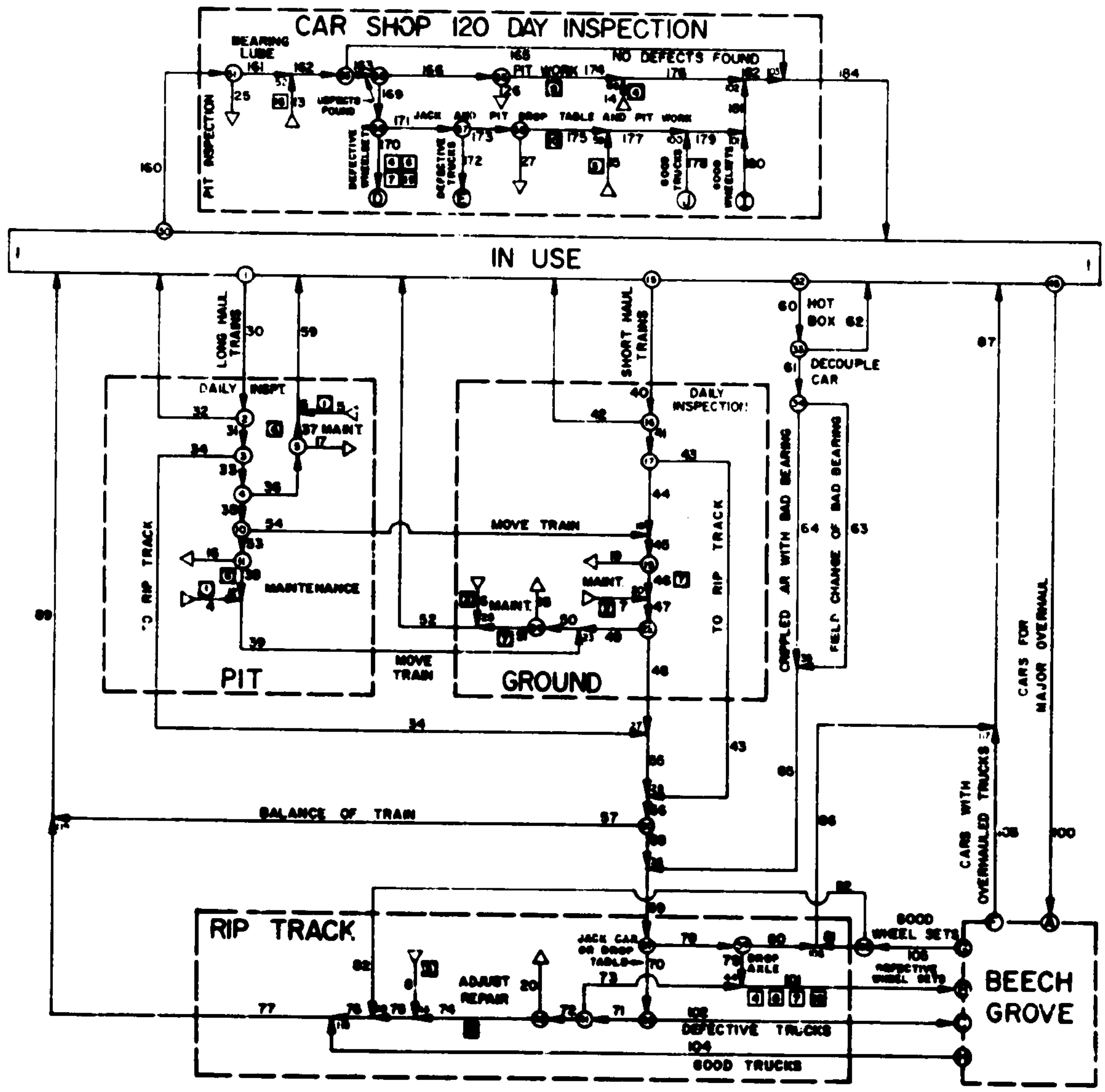


Figure 3-1. Full Diagram of Sample Truck Maintenance Operation

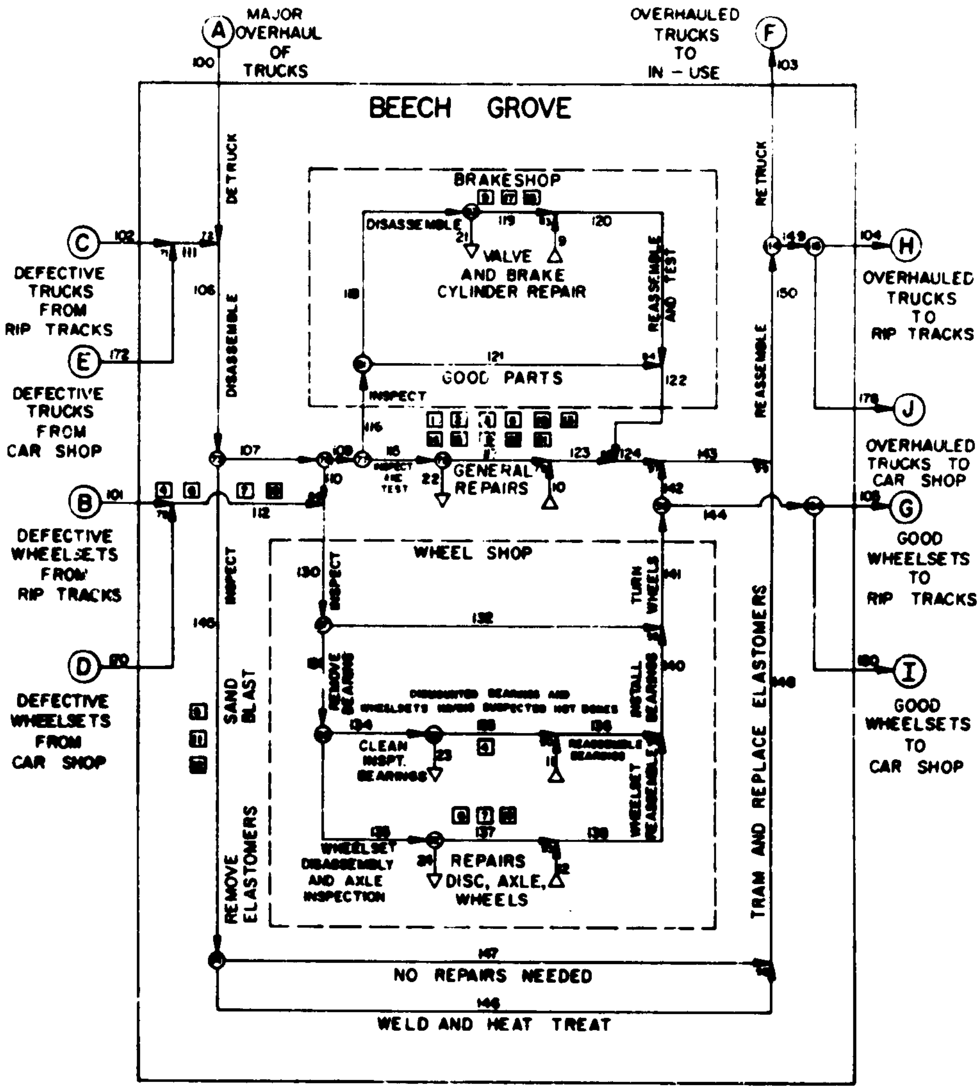
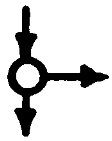


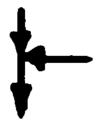
Figure 3-2. Details of "Beech Grove" Maintenance Operation

denotes units to scrap or to renewal

denotes units from manufacturer or from renewal



denotes branch node



denotes summation node

denotes component number
(see component list Table 3-1.)

number is that of branch node (refer to node numbering restrictions)

number is that of summation node (refer to node numbering restrictions)

number is that of path (refer to path numbering restrictions)

denotes a group of components specified in the list of Figure 3-3.

Figure 3-3. Drawing Notations for Diagram Construction

In the following discussion, each of these steps is considered separately. The Minden Deutz truck of the Amtrak Superliner is used as a working example. Execution of the 9 steps for this example was accomplished through meetings that included at least 1 person familiar with:

1) the simulation cost model technique (SCM),
2) the design, performance, and maintenance characteristics of the Minden Deutz truck, and
3) the maintenance policies and procedures that Amtrak is applying or will apply to this truck.

As a result of these meetings, steps 1 - 7 were completed. Steps 8 and 9 were completed subsequent to the meeting.

Step 1 A list of truck components to be considered by the SCM as comprising the truck can be produced in several ways (see sample list in Table 3-1). These include using:

a) maintenance experience involving the truck or similar trucks
b) the manufacturer's maintenance manuals to establish which components need be inspected, serviced, or replaced and how often
c) the maintenance practices anticipated for application to the truck
d) indications from existing accounting records that suggest costly maintenance items, components, or procedures
e) engineering judgment regarding potentially difficult inspection or maintenance operations on specific components.

Care should be taken not to make the component list too complex or uncomprehensive. The complexity of the model increases proportionally with the number of components used in modeling truck maintenance. The schematic diagram may also become more complex if this number increases.

The accuracy of the results obtained from the SCM is not necessarily greater as the number of components is increased. Simulation accuracy will not increase if the additional components have little or no maintenance associated with them.

TABLE 3-1. COMPONENT LIST FOR THE SUPERLINER MINDEN DEUTZ TRUCK

NO.	SUBSYSTEM/COMPONENT	Number per car
1.	PRIMARY SPRINGS (SHIMS)	8
2.	AIR SPRINGS (COILS INSIDE)	4
3.	DAMPERS (VERTICAL PRIMARY VERTICAL SECONDARY AND LATERAL SECONDARY)	14
4.	BEARINGS	8
5.	TRUCK FRAME	2
6.	AXLES	4
7.	WHEELS	8
8.	BRAKE RIGGING	32
9.	LEVELLING VALVES	2
10.	SPEED SENSORS	4
11.	SIDE BEARINGS AND CENTER PLATE LINERS - (BOLSTERS)	16
12.	SAFETY HANGERS - (SPRING PLANK)	8
13.	RADIUS RODS	8
14.	TORSION BARS	2
15.	LEAF SPRING GUIDE BOLTS	40
16.	BRAKE SHOES	8
17.	BRAKE CYLINDERS	8
18.	DUMP VALVE	2
19.	BRAKE DISKS	8
20.	AIR BRAKE AND AIR SPRING PIPING	2
21.	SWING HANGERS	8

The key to keeping the number of components to a minimum is knowing which components will contribute significantly to the cost of the maintenance being simulated. With a new truck the experience of the past designs with similar components can give guidance to which components are the most significant to the maintenance/costing process.

The final number of components used in the simulation model should be consistent with the availability of data and the time required in obtaining that data. Where data exist only for groups of components, consideration should be given to grouping them appropriately.

For the Minden Deutz truck, it was decided to represent the truck in terms of 21 components or subsystems. These components are those in Table 3-1. For this truck, the selection was made primarily on the basis of high-cost items as anticipated from prior maintenance experience on other types of trucks. In addition, the list includes items whose maintenance is called out by the expected maintenance procedure or is anticipated from performance requirements.

<u>Step 2</u> The maintenance inspection to which a truck can be subjected generally fall into 3 categories:

1) Field Inspections - these are typically performed daily either at the terminal or at special facilities in the field. The special facilities include an inspection area (e.g., the "Ground") at or near a terminal and a "Pit". The Pit is a below-track structure which allows a person to look at the truck from below ground level.
2) Rip Track - this is a facility where a more detailed inspection and repair operation can be done. Specifically, wheels can be checked for defects and the amount of wear can be measured.
3) Backshop - this is a central facility to which trucks and truck components are sent for major maintenance and overhaul. At this shop, the most detailed inspection of all truck components occurs.

For the Minden Deutz truck, the Pit inspection, the Ground inspection, or both can occur. These inspections take place at regionally centralized terminals. Most of the components on the Minden Deutz truck can be superficially inspected by visual means at the Pit or Ground. More thorough inspections are accomplished at the Rip Track.

At the Rip Track, wheelsets on the truck can be inspected without jacking the car. If the car is jacked, the rest of the components can be evaluated, some components being evaluated to a greater extent than others.

At Beech Grove, detailed inspection of the wheelsets occurs in the Wheel Shop. This includes evaluation (after disassembly) of the bearings, axles, wheels and brake disks. Dump valves and cylinders are inspected in a similar way at the Brake Shop. In the Heavy Shop, the frame, bolster, and spring planks are checked.

Step 3 The nature and type of maintenance actions that are performed on a truck are partially dependent on the design and operational conditions of the truck. For the Minden Deutz truck, most of the components can be partially maintained at the Pit or Ground. The components which can be so maintained are (Table 3-1) 3, 8, 9, 10, 13, 15, 17, 18, 19, and 20. In addition, components 16 and 17 (brake shoes and brake cylinders) can be replaced at these locations.

At the Rip Track, wheelsets are removed from the truck and sent as wheelset units to Beech Grove for maintenance. In addition, adjustment and repair of components 1, 2, 11 (side bearings), 12, and 21 can take place. Other components, such as 4 (dampers), 9, 10, 16, 17, 18, and 20 can be replaced as necessary.

At Beech Grove, the detailed maintenance of all truck components can take place. In the Wheel Shop, the bearings are removed, cleaned, relubricated, etc. Wheels are turned and disks, axles, or wheels are replaced. In the Brake Shop, valves and cylinders are disassembled, rebored, etc. In the

Heavy Shop, welding, heat treating, and tramming operations are performed on the structural components (5, 11, 12). Elastomers are replaced as necessary. Also, components 1, 2, 3, 8, 10, 13, 14, 15, 20, and 21 are replaced as necessary.

Step 4 The number of maintenance facilities and the role of each can be established by the results of steps 3 and 4. A review of these steps for the Minden Deutz truck suggests that the inspection and maintenance operations are performed by four generic facilities -- the Pit area, the Ground area, the Rip Track -- and by the central overhaul facilities. As a result, an approach for modeling this truck is to include in the schematic diagram these 4 facilities. This approach is taken in the present work, in which the Pit, Ground, and Rip Track facilities each represents a composite of all individual Pit, Ground and Rip Track facilities in the continental US. Since only 1 Beech Grove location exists, that portion of the schematic represents that 1 facility.

One additional facility, the Car Shop, was included in the maintenance of the passenger truck modeled. This facility has its own inspection and review cycle (120 days) associated with it. Some subassemblies are sent from this facility directly to the Back Shop at Beech Grove. The Car Shop was conceived as a maintenance facility with a more elaborate equipment for handling the details of some repairs, especially repairs to the car itself.

Step 5 The result of the previous 4 steps is that for the Minden Deutz truck, 5 major maintenance facilities (or blocks) should be sufficient for the schematic diagram used to model the maintenance of this truck. To characterize how each facility operates one must consider a particular truck. Consequently, the sample schematic diagram for each of the 4 facilities is for the Minden Deutz truck.

Maintenance at the Pit facility starts after a defect or defects are found in a truck during Pit inspection. Two courses of action can take place. The train can be moved to the Rip Track if the defect is serious. If the defect is minor, the course of action depends on the nature of the defect.

For minor defects (e.g., brake shoe replacement, hose connection tightening, or various adjustments) the appropriate maintenance will be done on the spot. More significant maintenance requiring slightly more work but not requiring the services at the Rip Track, will take place either partially or completely at the Ground facility. The amount of maintenance that occurs at the Pit will depend on demand.

Under conditions of high demand, the train will be moved immediately to the Ground facility. Under conditions of low demand, maintenance will commence at the Pit and will typically be completed at the Ground. The Pit maintenance will include brake cylinder replacement as well as service of components 3, 8, 9, 10, 13, 15, 17, 18, 19, and 20.

The above discussion provides enough information for the Pit portion of the schematic diagram to be constructed. Figure 3-4 presents an annotated sketch of the "Pit" operation. The meanings associated with each of the paths in this portion of the full schematic are explained. It should be noted that the diagram of Figure 3-4 is similar to the "Pit" portion of the full schematic. In this case the paths are not numbered but annotated. The symbol ⌼ denotes a group or set of truck components that are replaced or serviced on the indicated paths. See Figure 3-5 for a complete subgroup listing by component. The component numbers are listed in Table 3-1.

The schematic for the Ground portion of the modeled truck maintenance operation is shown in Figure 3-6. The similarity of this figure and the "Ground" part of Figure 3-1 should be noted.

The operation of the Ground facility is similar but not the same as that at the Pit. Defects found during Ground inspection can result, if serious, in direct transfer of the train to the Rip Track. If the defect or defects are not so serious, maintenance will take place at the Ground. The cars subjected to such maintenance can include trains sent to the Ground from the Pit (trains are not sent to the Pit from the Ground). During the maintenance operation, serious defects may be encountered such that the

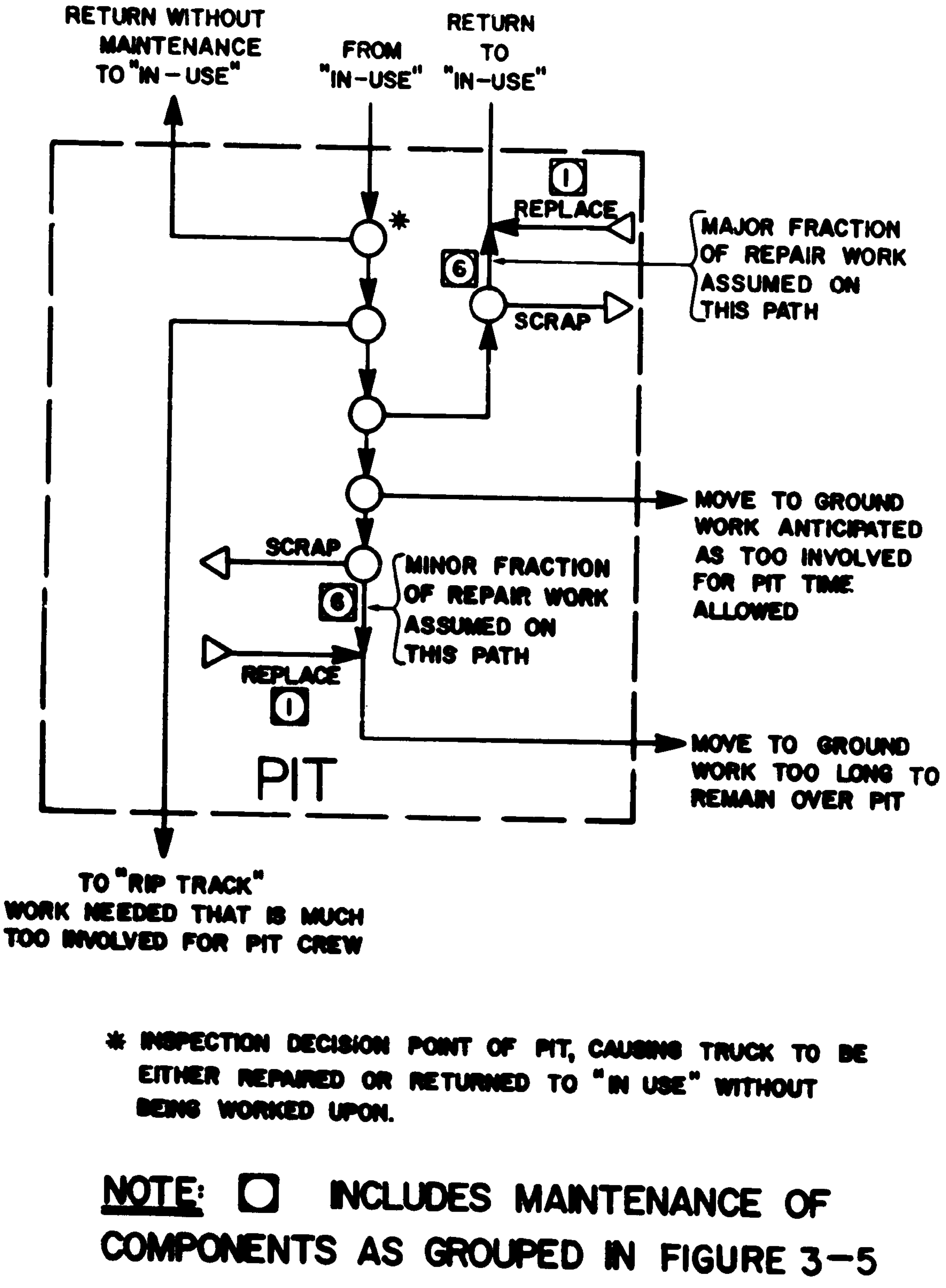


Figure 3-4. Annotated Operation of Pit Facility Maintenance Actions

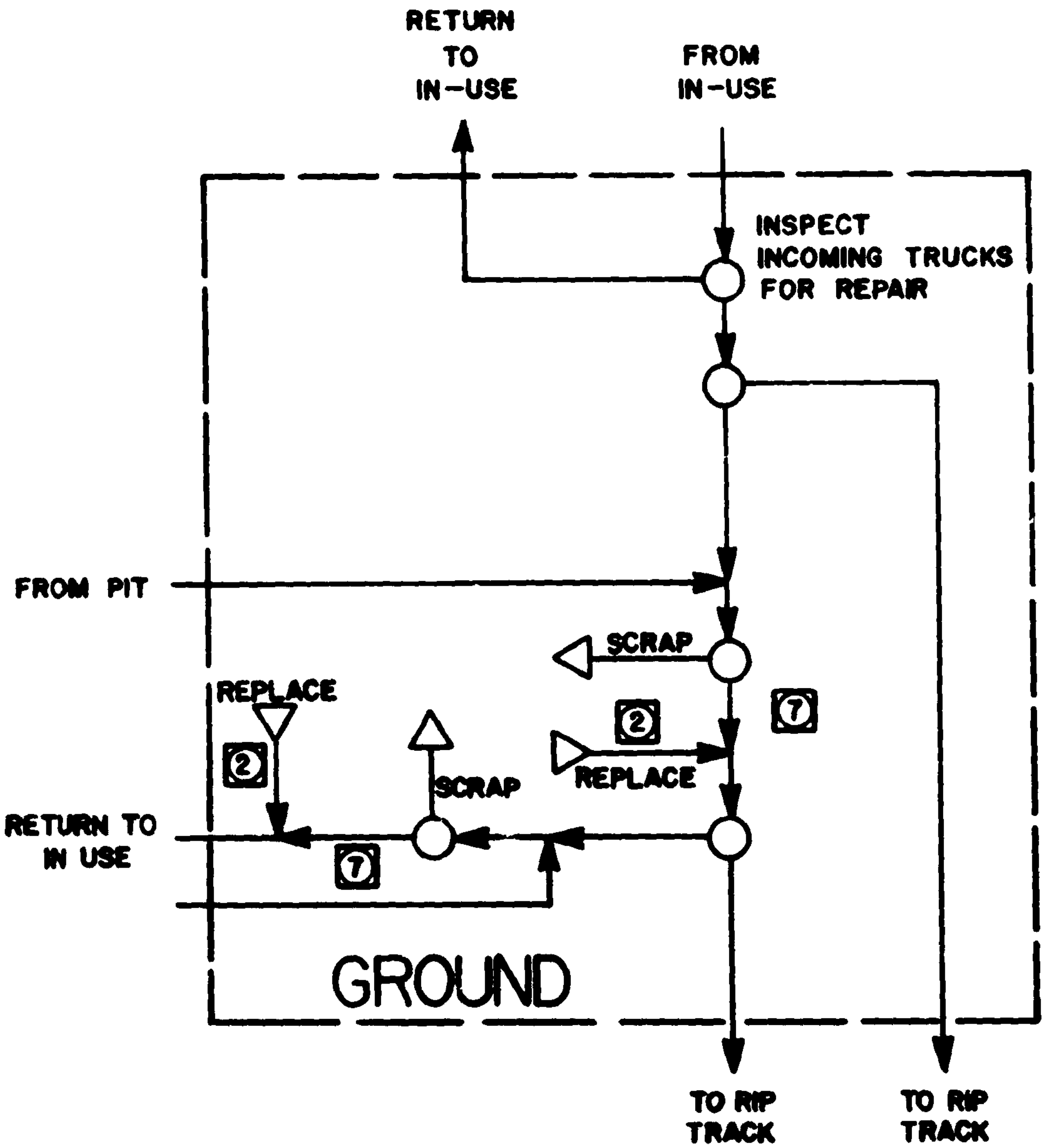
DENOTED ON
SCHEMATIC
DIAGRAM AS

1	Includes replacement of components 3, 8, 9, 10, 12, 13, 15, 16, 17
2	Includes replacement of components 3, 9, 10, 12, 13, 15, 17
3	Includes replacement of components 1, 2, 3, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21
4	Includes replacement of components 3, 8, 9, 10, 12, 13, 15, 16, 17, 20
5	Includes replacement of components 1, 2, 3, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21
6	Includes maintenance of components 3, 4, 8, 9, 10, 12, 13, 14, 15, 17, 20
7	Includes maintenance of components 3, 4, 8, 9, 10, 12, 13, 15, 17
8	Includes maintenance of components 3, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 20, 21
9	Includes maintenance of components 3, 8, 9, 10, 12, 13, 14, 15, 17, 20, 21
10	Includes maintenance of components 3, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 20, 21

1 and 6 see "Pit" of Schematic Diagram
2 and 7 see "Ground"
3 and 8 see "Rip Track"

4, 5, 9, 10 see "Car Shop"

Figure 3-5. List of Components Repaired or Replaced at Denoted Points on the Diagram



NOTE: ☐ **INCLUDES MAINTENANCE OF COMPONENTS AS GROUPED IN FIGURE 3-5**

Figure 3-6. Annotated Operation of Ground Facility Maintenance Actions maintenance operation has to be completed at the Rip Track. In that event the train will be moved to the Rip Track after the defect is uncovered. If no serious defects are uncovered, the maintenance operation will be completed at the Ground facility. This maintenance could include the final items of work on those trucks that have already undergone some work at the Pit.

Rip Track maintenance occurs after cars are received from either the Pit, Ground, or directly from the In-Use field. Cars which are sent to the Rip Track from the field consist of those which had hot box indications.

At the Rip Track, cars with just wheelset maintenance requirements have their wheelsets replaced. Of the other cars, some have trucks which have sufficiently serious defects that the trucks must be replaced. The remainder of the trucks require adjustment and repair of components 1, 2, 11, 12, and 21. This set of maintenance operations is shown in Figure 3-7.

The operation of the Beech Grove facility was described in general terms in Step 3. In the present step, additional details of the operation need to be specified. The operation typically involves detrucking of trucks arriving with their cars. Truck disassembly follows, after which the structural parts are inspected and serviced as necessary. The remaining parts are divided into three general groups — the wheelset assembly, the valve and brake cylinders, and the group of items consisting of component numbers 1, 2, 3, 8, 10, 13, 14, 15, 16, 20, 21.

The characterization of the Beech Grove facility incorporates the features described above and in Step 3. This characterization, Figure 3-2 shows two main maintenance areas which are identified as the Brake Shop and the Wheel Shop. Trucks and wheelsets enter the facility at the left and left top. Overhauled trucks leave at the top right. Wheelsets leave at the right. The truck frame and associated components (components 5, 11, and 12) conceptually move along the bottom paths. Wheelsets are separated

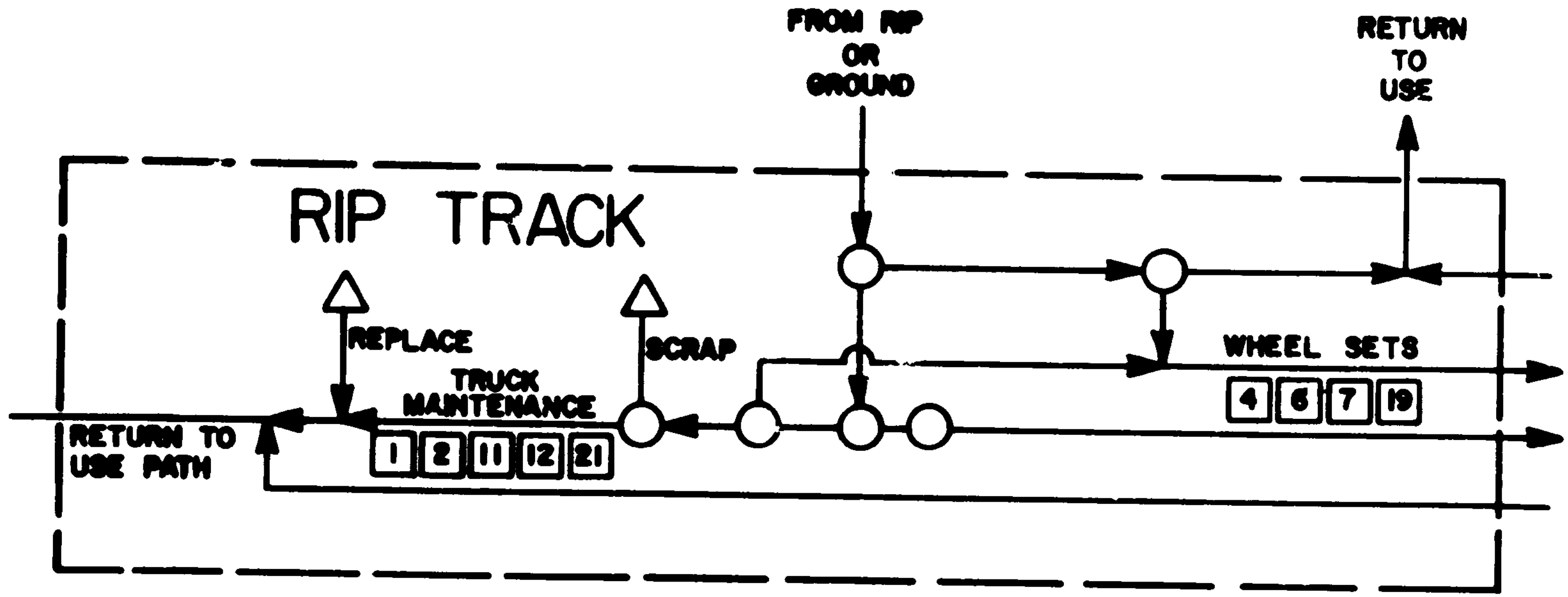


Figure 3-7. Operations of the Rip Track Facility

from the remaining components. These wheelsets and other arriving whee sets are sent to the Wheel Shop. Dump valves and brake cylinders are the Brake Shop. General repairs are performed on the rest of the car at the center of the diagram.

Step 6 Figures (3-4, 3-6, 3-7) describe the internal operations of the Ground, and Rip Track. These facilities and other blocks of the schematic diagram are completed by the addition of the interconnections among ... These interconnections are already shown in Figures 3-1 and 3-2.

Some details of Figures 3-1 are worth noting. In-Use provides the source of flow to the Pit, to Ground, and 2 other paths. The first of these other paths is for hot box callouts. The 2 return paths to the In-Use are provided to allow for false hot box indications. The second of these other paths is for major truck overhaul. Such overhaul is scheduled on a periodic basis for the truck and the path leads to the Brake Shop at Beech Grove.

At the point where all the Pit-to-Rip Track paths and Ground-to-Rip track paths have joined, an additional path to In-Use has been provided. This path contains the nondefective trucks on the train. Only the defective trucks and those nondefective trucks on the cars with defective trucks are received at the Rip Track.

The remainder of the interconnections among facilities is straightforward. Provision has to be made such that each "sending" path has a corresponding "receiving" path (e.g., the good wheelsets sent from Beech Grove must actually be received at the Rip Track). Scrap paths and replacement paths are an exception. In addition, paths must balance for each facility. For example, wheelsets sent from the Rip Track on one path must be balanced by wheelsets sent to the Rip Track on another path. As another example, the total of all trucks received at the Pit must be balanced by the total of all trucks sent from the Pit.

Step 7 As a result of completing Step 6, the basic construction of the schematic diagram has been completed. In Step 7, the important parts of the diagram are labelled.

It is desirable that the following be labelled so that the diagram facilitates easy use:

1) the maintenance facilities (including In-Use),
2) the important paths (including those with inspection maintenance operations) and
3) the components associated with various paths (some of this component path labelling has already been completed in Step 5).

Step 8 Review of the schematic diagram by persons knowledgeable in maintenance of the truck being considered is perhaps 1 of the most important steps in diagram construction. Omission of this step can readily lead to misrepresentation of the maintenance of the truck and to inaccurate or misleading SCM results. In addition, a poor representation of how the truck is maintained can produce awkward and unrealistic data requirements. In the case of the Minden Deutz truck, the schematic was reviewed by a representative of Amtrak's engineering department and of Amtrak's maintenance department. Changes to first versions of the diagram have already been incorporated in the final versions of the schematics shown in Figure 3-1 and 3-2.

Step 9 The final step in preparing the schematic diagram is that of path and node numbering. When this step is complete, the diagram is ready for computer implementation and for development of the data requirements.

In the diagrams of Figure 3-1 and 3-2, path numbers were placed near their associated paths and made slightly larger than the node numbers. The node numbers are, for branch nodes, placed in the branch node circles. For summation nodes, the node numbers are placed between the arrowheads of the 2 arriving paths.

Although there is considerable flexibility in path and node numbering, certain conventions must be followed. For path numbers, the conventions are as follows:

a) In-Use must be numbered Path 1.

b) If trucks are being added to the population and are not directly replacing scrapped trucks, this net increase of trucks must occur via the flow on a path labelled Path 2.

c) If trucks are being removed from the population and are not directly being replaced by new or overhauled trucks, this net decrease of trucks must occur via the flow on a path labelled Path 3.

d) Paths 4 - 15 are reserved for component or subsystem flows from manufacturers or from reworking facilities. The corresponding scrap yard flows are 16 - 27. Each path numbered 16 - 27 must have an associated replacement path and the identifying numbers for these 2 paths must differ by 12. For example, Path 4 is associated with 16 and so on through 15 and 27.

e) All path numbers greater than 27 can be assigned arbitrarily to the remaining paths in the diagram.

f) Path numbers need not be sequential -- gaps in the path numbers on the diagram can and do occur. This is for the convenience of adding paths at a later time.

For node numbers, the following constraints apply:

1) Nodes must be numbered in a downstream manner; so that at a given node, the path or paths entering the node originate from lower numbered nodes.

2) For the determination of the node numbering order, the downstream direction starts at In-Use.

3) Path 1 (In-Use) can be associated with an arbitrary number of branch nodes.

4) Paths 3 - 27 have numbered nodes at one end only.

5) Points at which paths return to In-Use do not have to have node numbers.

6) Node numbers need not be sequential -- gaps in the node numbers on the diagram can occur.

7) No distinction need be made between branch and summation nodes for the purpose of node numbering.

During the numbering process, the user should attempt to foresee changes that might eventually have to be made to the diagram. Typical changes involve the addition of paths. Consequently, it is desirable that sufficient gaps be left in the node numbers for the later insertion of additional nodes. In numbering, it should be remembered, however, that SCM results are printed out by the computer program in path order. If the user wants results grouped by facility, he should set aside a contiguous set of numbers for exclusive use with the paths of that facility.

Completion of the schematic diagram allows development of the data requirements. These data requirements are considered in the next subsection.

3.2 DATA REQUIREMENTS

3.2.1 What Data Are Needed

The numeric data needed for running the simulation cost model are basically four types:

1) Diagram numbers, paths and nodes.

2) Flow related numbers (how many of each component for each path).

3) Cost numbers, labor rates, etc.

4) Control information.

Samples of these data are given fully in Appendixes D and E in the format required for running the sample cases for the truck modeled. An explanation of the original form of the data, the restricting of the data for the program, and examples of the data in program format are given below.

3.2.2 How to Collect Data Needed

Once the schematic diagram has been constructed, the various operations in the maintenance system are well enough defined to gather data. The maintenance actions such as inspections, scrapping, replacement of parts and their relationships to 1 another are known.

The questions of how many trucks (and truck components) are handled (observed, worked on, etc.) by each path of the maintenance model can be established by either counting or going to the points in the field of maintenance work and by observing or recording what is done.

3.2.2.1 By Counting Flows. Take inspection as an example. The "Pit" in the presently modeled truck repair system contains an inspection action. This inspection is represented by circled node two ② shown previously in the full schematic diagram of Figure 3-1. If one were to record the number of cars (trucks or components) reviewed annually by the inspectors of the various "Pits" throughouc the repair system, he would have "by count" the actual flow data required for this point in the model. Likewise, every other maintenance action can be tabulated from field data, if desired. The numbers flow of "how many" would then be available for input to the program.

In the present case a set of field data could not be obtained. One reason for this is that the full fleet of cars was not deployed during the period of the present contract. For the present example, therefore, another method of getting the appropriate data for each path of the diagram was used. This method, involving estimating the appropriate flows and numbers needed is discussed below.

3.2.2.2 Estimation Techniques. By discussing the modeled maintenance system with a few key people, the path flows and some of the cost data can be estimated from their knowledge of the system. This was the method, along with life estimations on the component parts, that was used for determining how many parts are treated at various points in the diagram.

Reference is made to the diagram and tables of Figure 3-8. The maintenance cycles and scrap life cycles listed in that figure are estimates of how long each component will survive its service environment before needing either replacement or maintenance. With the assumption that the total system contains 284 cars, the total number of components that must be either replaced or maintained can be estimated. These estimates are also shown in Figure 3-8.

After establishing the total number of components either replaced or repaired, this total has to be broken down and then assigned to appropriate places in the modeled system. To do this, the repairs were distributed on the frequency rate at which they were inspected. For instance, component 1 is repaired either in the Rip Track or in the Car Shop (see previous Figure 3-5). Since the cars going to the Car Shop are inspected only every 120 days (whereas cars through the Pit or Ground are reviewed every day), there should be more repairs of component 1 in the Rip Track than in the Car Shop. For the present example, roughly 1/120th of the 227 repairs on component 1 were assigned to the Car Shop and the balance assigned to the Rip Track.

Estimates for the repairs handled by the "Beech Grove" facility were obtained by assuming that roughly 25% of the fleet of 284 cars would be sent to that facility every year for major overhaul. This corresponds to a major overhaul cycle time of 4 years per truck. Hot box setouts were assumed at 4 cars per year sent for overheated bearing repairs.

CP = Component #

CP	N	MAINT CYCLE*	TOTAL NUM/YR*
1	8	10.00	227
2	4	##.##	0
3	14	2.00	1988
4	8	2.00	1136
5	2	4.00	142
6	4	4.00	284
7	8	0.67	3391
8	32	4.00	2272
9	2	4.00	142
10	4	1.00	1136
11	16	1.00	4544
12	8	##.##	0
13	8	##.##	0
14	2	4.00	142
15	40	2.00	5680
16	8	##.##	0
17	8	3.00	757
18	2	1.00	568
19	8	##.##	0
20	2	4.00	142
21	8	4.00	568

N = Number Per Car

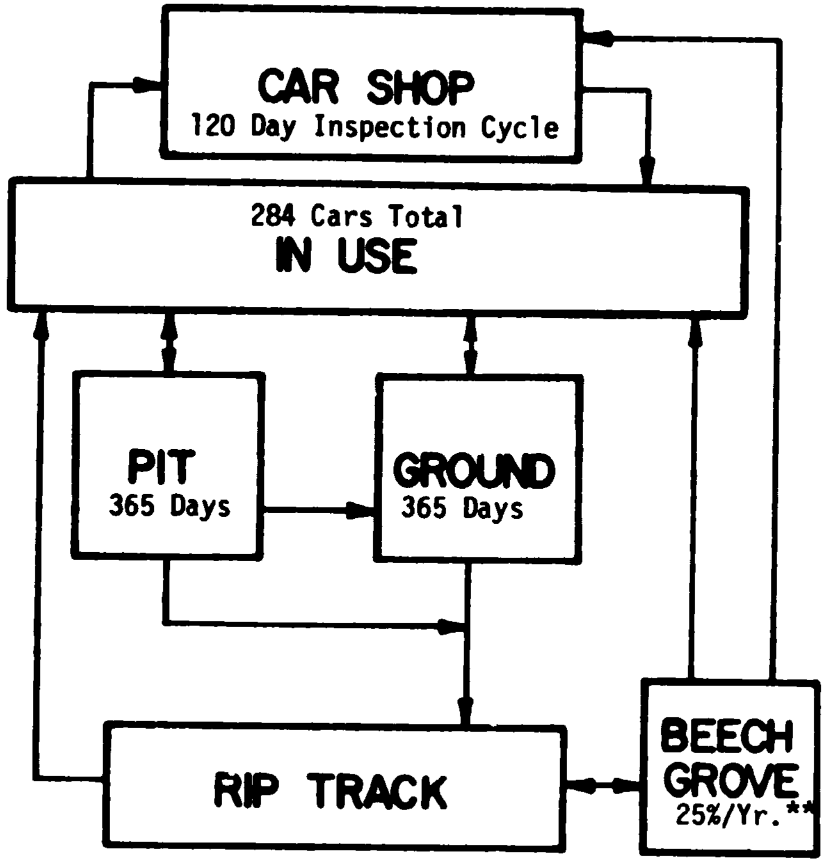


Figure 3-8. Simplified Diagram

CP = Component #

CP	N	SCRAP CYCLE*	TOTAL* NUM/YR
1	8	10.00	227
2	4	2.00	568
3	14	6.00	662
4	8	12.00	189
5	2	##.##	0
6	4	12.00	94
7	8	2.00	1136
8	32	8.00	1136
9	2	12.00	47
10	4	5.00	227
11	16	1.00	4544
12	8	##.##	0
13	8	2.00	1136
14	2	##.##	0
15	40	2.00	5680
16	8	0.12	18933
17	8	9.00	252
18	2	10.00	56
19	8	5.00	454
20	2	4.00	142
21	8	12.00	189

N = Number Per Car

* Data to be used for example purposes only
Total Num/Yr based on 284 car system.

** Based on a 4-year major overhaul cycle.
The 4-year period is a management decision.

3.2.2.3 Cost by Hours and Component. Costs for the present model were also developed through an estimation procedure rather than from gathering actual field information. The Tables shown in Appendix K were generated at a meeting with key personnel from Amtrak and Shaker Research. Each path cost by component was estimated in terms of the amount of unit labor hours and/or unit replacement cost. These amounts (such as new parts and scrap values) with comments are listed in tabular form in Appendix K at the end of the report.

3.2.3 Data Forms for Truck Example

The following sections discuss the format of the data as needed for the computer.

3.2.3.1 Node-Path Numbering. Once the schematic diagram paths and notes have been numbered, the various connections can be entered in the computer file. A sample of the file which is used for entering those numbers in the computer during running is shown in Figure 3-9. The complete file is contained in Appendix E.

The first column of this file is associated with the node number of the schematic diagram. This number can be -1, 0, or any positive number which has an associated branch node on the schematic diagram. Note that the sequential numbers that are entered in this column refer to branch nodes only. The line or row of this file (not explicitly entered) are the node numbers shown within circles on the schematic diagram.

3.2.3.2 Node Split Values. For each branch node of the modeled system the program requires at least 1 split value. This split value is entered in a file as shown in Figure 3-10. The split value represents the fractional amount of truck

(Partial Listing of Complete File Shown in Appendix E)

Node Numbers — Path Numbers

```
 1   1  30   1   /   GSTR( ) NODE INFO
 2  30  31  32   /   GSTR( ) NODE INFO
 3  31  33  34   /   GSTR( ) NODE INFO
 4  33  36  35   /   GSTR( ) NODE INFO
 5  36  17  37   /   GSTR( ) NODE INFO
 0  37   5  59   /   GSTR( ) NODE INFO
-1   0   0   0   /   GSTR( ) NODE INFO
-1   0   0   0   /   GSTR( ) NODE INFO
-1   0   0   0   /   GSTR( ) NODE INFO
 6  35  53  54   /   GSTR( ) NODE INFO
 7  53  16  39   /   GSTR( ) NODE INFO
```

Optional Commentary After Slash (/)

Path Number Leaving Node

Path Number (Entering if Summation Node, Leaving Reference Path if This is a Branch Node)

Path Number Entering Node

Node Number

<u>Note</u>: Branch Nodes are Numbered Sequentially. The "6" in This Column Refers to Node (10) on the Schematic Diagram. It is Also the 10th Row in this Data File

"0" in this Column Indicates a Summation Node

"-1" in This Column Indicates a Gap in the Node Numbering and Can Be Used for Additional Nodes if Needed Later.

Figure 3-9. Input Data Computer Format of Diagram Node and Path Numbers

(Partial Listing of Complete File Shown in Appendix E)

```
1   1  308.45      0 0  0 0  1    /  NODE SPLIT VALUES
2   1   .229156    0 0  0 0  1    /  NODE SPLIT VALUES
3   1   .971007    0 0  0 0  1    /  NODE SPLIT VALUES
4   1   .900000    0 0  0 0  1    /  NODE SPLIT VALUES
5   3   .00102179  0 0  0 0  0    /  NODE SPLIT VALUES
5   8   .0008304   0 0  0 0  0    /  NODE SPLIT VALUES
5   9   .00051091  0 0  0 0  0    /  NODE SPLIT VALUES
5  10   .0012262   0 0  0 0  0    /  NODE SPLIT VALUES
5  13   .0030654   0 0  0 0  0    /  NODE SPLIT VALUES
5  15   .0030654   0 0  0 0  0    /  NODE SPLIT VALUES
5  16   .C55359    0 0  0 0  0    /  NODE SPLIT VALUES
5  17   .00068113  0 0  0 0  0    /  NODE SPLIT VALUES
6   1   .994466    0 0  0 0  1    /  NODE SPLIT VALUES
7   3   .00102749  0.0  0.0  0    /  NODE SPLIT VALUES
```

Optional Commentary After Slash (/)

- Apply Split Value to all Components 1 = YES 0 = NO
- Quality Split (E) Value
- Quality Split (D) Value (See Section 3.3.2)
- Node Split (C) Value (Enter -1 if D and E Values to be Used)
- Component Number
- Branch Node Number

Figure 3-10. Input Data Format of Node Split Values components arriving at the node that continue down the reference path. This reference path at each branch node is the second path number shown in Figure 3-9. The split values are computed from either data gathered in the actual maintenance operation being simulated or from estimates of the flows made from repair knowledge of the system.

The first column shown in Figure 3-10 is the branch node number used in the sequence of numbers entered in Figure 3-9. The second column is the component to which the split value will be applied. The third column of Figure 3-10 is the node split value. Columns 4 and 5 are used when the fractional split value is based on the quality of the components arriving at this node. The last or sixth column is 1 if the split value given is to be applied to all components passing this node. A 0 in this column requires a split value for all nonzero component flows passing the given branch node.

The last card of this part of the data entry file must contain a "999" which indicates to the program that all necessary split values have been entered.

3.2.3.3 Path Cost Information. For each component and each path that has a nonzero cost, there is 1 line entered to this part of the data input file. Each line will contain 6 numbers to be read by the program. (See Figure 3-11 for an example of the format.) The commentary after the slash (/) is optional and is used only for visual scanning of the file listing.

The first 2 numbers of each row of this part of the file are the path number (from the schematic diagram) and the component number to which the costs are to be attached. Immediately following these will be the hourly labor rate and the hours needed

(Partial Listing of Complete File Shown in Appendix E)

```
46   3 18.40  0.075      0.00 0.0131438 /   CØST DATA
46   8 18.40  0.500     10.00 0.009072  /   CØST DATA
46   9 18.40  0.300      1.00 0.009099  /   CØST DATA
46  10 18.40  0.050      0.00 0.036553  /   CØST DATA
46  15 18.40  0.025      0.00 0.0[illegible]  /   CØST DATA
46  17 18.40  0.325      1.00 0.021449  /   CØST DATA
51   3 18.40  0.075      0.00 0.0004395 /   CØST DATA
51   8 18.40  0.500     10.00 0.0002197 /   CØST DATA
51   9 18.40  0.300      1.00 0.0002197 /   CØST DATA
51  10 18.40  0.050      0.00 0.0008789 /   CØST DATA
51  15 18.40  0.025      0.00 0.0004395 /   CØST DATA
51  17 18.40  0.325      1.00 0.0002929 /   CØST DATA
60   4 18.40  0.000    150.00 1.0           /   CØST DATA
61   4 18.40  0.000   5000.00 1.0           /   CØST DATA
63   4 18.40  0.000   5000.00 1.0           /   CØST DATA
64   4 18.40  0.000    800.00 1.0           /   CØST DATA
70   1 18.40  0.1875     0.00 1.0           /   CØST DATA
77   4 20.80   .3750     0.00 1.0           /   CØST DATA
74   3 20.80   .0750     0.00 0.1           /   CØST DATA
74   8 20.80  0.250     10.00 0.1           /   CØST DATA
```

Optional Commentary After Slash (/)

Fraction Multiplier on Flow (1.0) indicates all of this component is being costed

Cost Per Unit of Components Being Replaced or Repaired

Hours Labor Applied to Repair Each Unit on This Path

Labor Rate (Dollars Per Hour)

Component Number

Path Number

Figure 3-11. Input Data Format of Path Cost Information by Component

to repair (replace, fix, etc.) each unit of the component represented on this data line. The fifth column of this part of the file contains the unit cost of items replaced or materials needed to fix this 1 component on this path.

The sixth and last numeric entry required for this part of the data file will normally be a "1.0". However, if some fractional part of the number of the components represented by this data are to be costed then that fraction is entered.

3.2.3.4 In-Use State Variables. Figure 3-12 shows the complete portion of the data file which lists the number of each of the 21 components modeled by the sample data for this handbook. There is 1 line entry for each component. The entry order corresponds to the component number. For this example there were 2272 components number 1 (primary springs). See previous Table 3-1 for a complete tabulation of components and their names.

3.2.4 Data Output Formats

The full output files for the example of this manual are contained in Appendixes E, F, G, and H. Contained in the present section is a sample set of output tables with some explanatory notes on the type of outputs obtained. These output tables contain information of:

1) Annual number of components handled on each path of the schematic diagram;
2) Annual cost associated with each path of the schematic diagram;
3) Annual cost associated with each component listed by component number and ranked by expense of component; and
4) Cost sensitivity associated with small changes in component flows associated with the branch points in the schematic diagram.

(Partial Listing of Complete File Shown in Appendix E)

2272	0.0	0.0	/	ZAR( ) STATE VALUES
1136	0.0	0.0	/	ZAR( ) STATE VALUES
3976	0.0	0.0	/	ZAR( ) STATE VALUES
2272	0.0	0.0	/	ZAR( ) STATE VALUES
568	0.0	0.0	/	ZAR( ) STATE VALUES
1136	0.0	0.0	/	ZAR( ) STATE VALUES
2272	0.0	0.0	/	ZAR( ) STATE VALUES
9088	0.0	0.0	/	ZAR( ) STATE VALUES
568	0.0	0.0	/	ZAR( ) STATE VALUES
1136	0.0	0.0	/	ZAR( ) STATE VALUES
4544	0.0	0.0	/	ZAR( ) STATE VALUES
2272	0.0	0.0	/	ZAR( ) STATE VALUES
2272	0.0	0.0	/	ZAR( ) STATE VALUES
568	0.0	0.0	/	ZAR( ) STATE VALUES
11360	0.0	0.0	/	ZAR( ) STATE VALUES
2272	0.0	0.0	/	ZAR( ) STATE VALUES
2272	0.0	0.0	/	ZAR( ) STATE VALUES
568	0.0	0.0	/	ZAR( ) STATE VALUES
2272	0.0	0.0	/	ZAR( ) STATE VALUES
568	0.0	0.0	/	ZAR( ) STATE VALUES
2272	0.0	0.0	/	ZAR( ) STATE VALUES

Not Used

Not Used

Optional Commentary After Slash (/)

Number of Components in System Being Maintained in Order of Component Numbering. In This Case--There Are 21 Lines, One For Each of the 21 Components.

Figure 3-12. Input Data Format of In-Use Maintenance System Component Populations

Figure 3-13 is a partial output of the annual number of components handled by each path of the schematic diagram. The complete set of path flows is contained in Appendix F. The output is listed numerically in order of path and for each path in component order for all nonzero flows. Zero path flows are automatically deleted from the output and do not appear in the tabulated information.

Figure 3-14 is a sample portion of the annual expense associated with maintaining each component listed for each cost path of the schematic diagram. Paths with no cost associated with them are automatically deleted from the output. The total cost of all components on a given path comes at the end of the individual component costs for that path. The paths are numbered as shown on the schematic diagram.

Figure 3-15 shows all systems annual costs attributed to each of the components. The output lists these costs in numeric order by component and in rank order by the magnitude of the expense associated with each component. The number of each component is as defined previously in Table 3-1.

The cost sensitivities associated with small changes in component flows from each branch node of the schematic diagram are shown in the partial output of Figure 3-16. The complete output is tabulated by component in Appendix I; that output is for the majority of the branch nodes shown on the schematic diagram of the modelled maintenance system. The output quantities of Figure 3-16 are in the units of annual dollars per percent change in flow. This set of units comes from the fact that the flow from each node along the reference output path is increased by 1 percent and the total downstream system cost effects from this small change are tabulated. Since nodes represent decision factors of sending components to various points in the modelled maintenance system, the sensitivity output shows the cost effect of changing each decision. For example, changing the path component flow to the Pit area will result in a variety of costs depending upon which component flow is changed. An increase in flow of 1 percent of component number 1 on this path will result in an annual cost increase of $1,623.73.

```
PATH   4   COMPONENT  3   NUM/YR =      27.88
PATH   4   COMPONENT  8   NUM/YR =      51.51
PATH   4   COMPONENT  9   NUM/YR =       1.99
PATH   4   COMPONENT 10   NUM/YR =       9.56
PATH   4   COMPONENT 13   NUM/YR =      47.80
PATH   4   COMPONENT 15   NUM/YR =     239.00
PATH   4   COMPONENT 16   NUM/YR =     863.28
PATH   4   COMPONENT 17   NUM/YR =      10.62

PATH   5   COMPONENT  3   NUM/YR =     250.95
PATH   5   COMPONENT  8   NUM/YR =     466.16
PATH   5   COMPONENT  9   NUM/YR =      17.93
PATH   5   COMPONENT 10   NUM/YR =      86.04
PATH   5   COMPONENT 13   NUM/YR =     430.21
PATH   5   COMPONENT 15   NUM/YR =    2151.03
PATH   5   COMPONENT 16   NUM/YR =    7769.22
PATH   5   COMPONENT 17   NUM/YR =      95.60
```

Figure 3-13. Sample Portion of Output Form of Annual Number of Components Handled by Each Path of the Diagram

```
PATH  37  COMPONENT  3   PATH COST =$      1038 94
PATH  37  COMPONENT  8   PATH COST =$     12562 23
PATH  37  COMPONENT  9   PATH COST =$       202 19
PATH  37  COMPONENT 10   PATH COST =$       391.44
PATH  37  COMPONENT 14   PATH COST =$       160 83
PATH  37  COMPONENT 15   PATH COST =$       989.47
PATH  37  COMPONENT 17   PATH COST =$      1580 74
PATH  37  COMPONENT 20   PATH COST =$        26 80
                         TOTAL PATH  37 COST = $        16952.62

PATH  38  COMPONENT  3   PATH COST =$       115 96
PATH  38  COMPONENT  8   PATH COST =$      1401 65
PATH  38  COMPONENT  9   PATH COST =$        22.55
PATH  38  COMPONENT 10   PATH COST =$        44 17
PATH  38  COMPONENT 14   PATH COST =$        17.95
PATH  38  COMPONENT 15   PATH COST =$       110.43
PATH  38  COMPONENT 17   PATH COST =$       179 26
PATH  38  COMPONENT 20   PATH COST =$         2.99
                         TOTAL PATH  38 COST = $         1894.96
```

Figure 3-14. Sample Portion of Output Form of Annual Expense Associated with Maintaining Each Component for Each Path of the Diagram

```
COMPONENT  1 TOTAL COST = $   415961.26
COMPONENT  2 TOTAL COST = $   164704.75
COMPONENT  3 TOTAL COST = $    73624.72
COMPONENT  4 TOTAL COST = $  1060596.29
COMPONENT  5 TOTAL COST = $   162507.68
COMPONENT  6 TOTAL COST = $    88317.53
COMPONENT  7 TOTAL COST = $   575953.79
COMPONENT  8 TOTAL COST = $   186161.09
COMPONENT  9 TOTAL COST = $     4804.39
COMPONENT 10 TOTAL COST = $    12650.69
COMPONENT 11 TOTAL COST = $   922583.26
COMPONENT 12 TOTAL COST = $     8972.21
COMPONENT 13 TOTAL COST = $    12505.98
COMPONENT 14 TOTAL COST = $    17081.53
COMPONENT 15 TOTAL COST = $    99858.91
COMPONENT 16 TOTAL COST = $   615930.59
COMPONENT 17 TOTAL COST = $    18050.67
COMPONENT 18 TOTAL COST = $     9278.54
COMPONENT 19 TOTAL COST = $   291302.60
COMPONENT 20 TOTAL COST = $    23710.69
COMPONENT 21 TOTAL COST = $    33270.57

TOTAL COMPONENT COSTS IN ORDER OF COST
    COMPONENT  4 TOTAL COST = $  1060596.29
    COMPONENT 11 TOTAL COST = $   922583.26
    COMPONENT 16 TOTAL COST = $   615930.59
    COMPONENT  7 TOTAL COST = $   575953.79
    COMPONENT  1 TOTAL COST = $   415961.26
    COMPONENT 19 TOTAL COST = $   291302.60
    COMPONENT  8 TOTAL COST = $   186161.09
    COMPONENT  2 TOTAL COST = $   164704.75
    COMPONENT  5 TOTAL COST = $   162507.68
    COMPONENT 15 TOTAL COST = $    99858.91
    COMPONENT  6 TOTAL COST = $    88317.53
    COMPONENT  3 TOTAL COST = $    73624.72
    COMPONENT 21 TOTAL COST = $    33270.57
    COMPONENT 20 TOTAL COST = $    23710.69
    COMPONENT 17 TOTAL COST = $    18050.67
    COMPONENT 14 TOTAL COST = $    17081.53
    COMPONENT 10 TOTAL COST = $    12650.69
    COMPONENT 13 TOTAL COST = $    12505.98
    COMPONENT 18 TOTAL COST = $     9278.54
    COMPONENT 12 TOTAL COST = $     8972.21
    COMPONENT  9 TOTAL COST = $     4804.39
                 TOTAL COST = $  4797927.72
```

Figure 3-15. Output of Annual System Maintenance Costs Attributed to Each Component and Total Cost for the System

NODE	1	COMPONENT	1	SENSITIVITY = $	1623.73	/ PERCENT
NODE	1	COMPONENT	2	SENSITIVITY = $	1534.38	
NODE	1	COMPONENT	3	SENSITIVITY = $	518.74	
NODE	1	COMPONENT	4	SENSITIVITY = $	6648.40	
NODE	1	COMPONENT	5	SENSITIVITY = $	546.41	
NODE	1	COMPONENT	6	SENSITIVITY = $	738.67	
NODE	1	COMPONENT	7	SENSITIVITY = $	4818.99	
NODE	1	COMPONENT	8	SENSITIVITY = $	1295.88	
NODE	1	COMPONENT	9	SENSITIVITY = $	33.55	
NODE	1	COMPONENT	10	SENSITIVITY = $	76.74	
NODE	1	COMPONENT	11	SENSITIVITY = $	5826.50	
NODE	1	COMPONENT	12	SENSITIVITY = $	62.00	
NODE	1	COMPONENT	13	SENSITIVITY = $	106.04	
NODE	1	COMPONENT	14	SENSITIVITY = $	62.75	
NODE	1	COMPONENT	15	SENSITIVITY = $	826.21	
NODE	1	COMPONENT	16	SENSITIVITY = $	6089.84	
NODE	1	COMPONENT	17	SENSITIVITY = $	154.15	
NODE	1	COMPONENT	18	SENSITIVITY = $	82.54	
NODE	1	COMPONENT	19	SENSITIVITY = $	2435.54	
NODE	1	COMPONENT	20	SENSITIVITY = $	164.75	
NODE	1	COMPONENT	21	SENSITIVITY = $	268.30	

FIGURE 3-16. Partial Output of Sensitivities—Total System Cost Effects of a One-Percent Change in Component Flow at the Node Indicated

3.3 PROGRAM CAPABILITIES AVAILABLE TO USER AND NOT EXERCISED IN PRESENT STUDY

The computer program listed in Appendix C has several capabilities that were not explicitly exercised for the present example. These are detailed for future reference in the following sections.

3.3.1 Modeled System Topology

Through appropriate choices of control card values as explained in Appendix D, the path linkages of the schematic diagram can be printed out. The main purpose of this optional choice is to check, during the initial period when the data files are being set up, the numbers that define a schematic diagram which has just been drawn. With this output the user can backcheck the various nodes and paths to see that the data file is correct.

3.3.2 Component Qualities, Ages, and Whole Trucks

The presently modeled maintenance system uses only simple split decisions at each branch node of the schematic diagram. Each of the split values for the branching nodes is listed in Appendix E. These numeric values were labelled as "C" values in the previous report (Reference 1). The numbers represent the fraction of the component arriving at the node that leaves along the reference path from that node. (See Figure 3-9 for explanation of reference path numbering.)

The program also allows more general decisions at the branch nodes. To use these, the user employs at least one of 2 additional scalar quantities that can be attached to each path of the schematic diagram. These scalars are "quality" and "age".

Quality is defined as the proportion of components on a given path that is categorized to be "defective" or in need of maintenance. Age is defined as the average age of the units for the component on each path.

The characterization of each component on each path in terms of quantity (number per year), age, and quality (proportion defective) allows relatively general decisions to occur at each branch point. The decisions can be nonlinear functions of time, of the number of units in the arriving path, of the representative ages in the path, and of the qualities in the path. From the set of possible decisions, 4 are deemed to be representative of actual events which involve the truck. These are:

1) The decision made for a component (component k) is not dependent on its quality in the arriving stream. Specifically, if N_k units per year arrive at the node, $C_k N_k$ units branch to 1 of the outgoing paths and $(1-C_k)\cdot N_k$ units branch to the other outgoing path. The C_k value defines the decision and can be obtained either directly or indirectly from available data. In general C_k can be a known function of time.

2) The decision made for a component (component k) is dependent on its quality in the arriving stream. Specifically, a proportion D_k of the arriving defective units are correctly classified as defective and a proportion E_k of the arriving good units are incorrectly identified as defective. If N_k units per year having a quality of Q_k arrive at the node, then the proportion C_k of arriving units which branches to the path intended for the defective units is given by $D_k Q_k + E_k \cdot (1 - Q_k)$. In addition, the quality Q_{1k} on that departing path is $D_k Q_k / (D_k Q_k + E_k \cdot (1 - Q_k))$. The proportion which branches toward the other departing path and the quality on that path are obtained from conservation-of-flow requirements at the branch point. The values of D_k and E_k define the decision and can be obtained either directly or indirectly from available data. In general, D_k and E_k can be known functions of time.

3) The decision made for a component (component k) is dependent on the representative age, A_k, of the component in the arriving stream. Specifically, the decision to switch the majority of the flow from 1 of the outgoing paths to the other outgoing path is made when A_k is equal co G_k. If N_k units per year arrive at the node, then the proportion C_k of arriving units which branches to the path

intended for defective units is given by $A_k/(2G_k)$. In addition, the representative age A_{1k} on that departing path is $2 \cdot G_k$. The constant G_k defines the decision and can be obtained directly or indirectly from available data. In general, G_k can be a known function of time.

4) The decision made for a component (component k) is affected by the decision made for other components at the branch point. The interelationship arises because these components, identified in the nodal data by the parameter K$, are part of a distinguishable subassembly. For any such component, if N_k units per year having a representative age of A_k and a quality of Q_k arrive at the node, the proportion C^* of <u>each</u> which branches to the path intended for defective units is $C^* = 1-\Pi_K(1-C_k)$. The product is taken over all K components in the subassembly. The representative age and quality on that departing path are respectively

$$A_{1k} \cdot C_k/C^* + \frac{A_k - C_k A_{1k}}{A_k} (1-C_k/C^*) \qquad \text{and}$$

$$Q_{1k} \cdot C_k/C^* + \frac{Q_k - C_k Q_{1k}}{Q_k} (1-C_k/C^*).$$

The quantity C_k is that of 1 (or the equivalent C_k of 2 or 3) and is evaluated prior to the coupling of the decision for component k with those for the other components in the subassembly.

The expressions in 1 and 2 are easily obtained by considering Figure 3-17. This figure shows an arriving stream having a flow of N_k units per year and a quality of Q_k. The flow towards path 1 must be

$$N_{1k} + D_k Q_k N_k + E_k \cdot (1-Q_k) \cdot N_k.$$

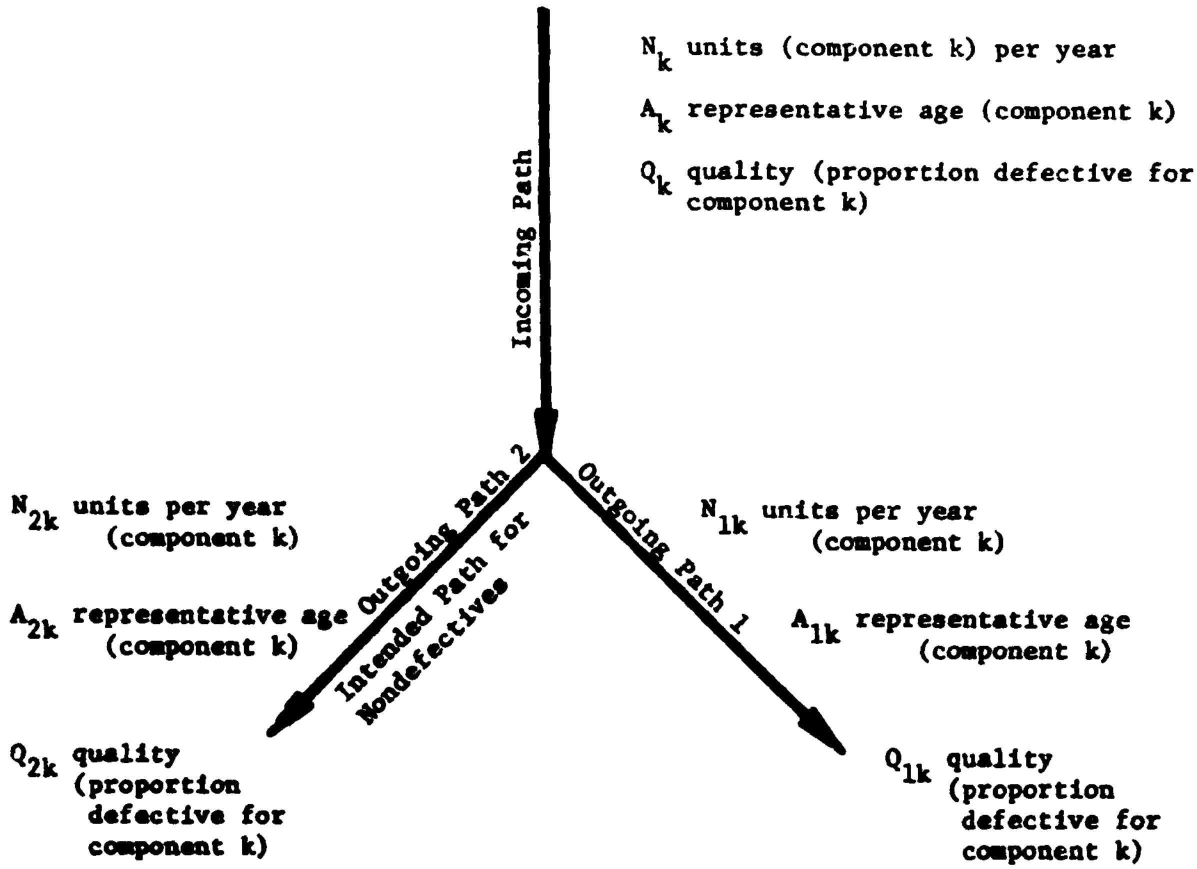


Figure 3-17. Branch Node Decisions

The proportion which branches towards Path 1 is then

$$C_k = \frac{N_{1k}}{N_k} = \frac{D_k Q_k N_k + E_k \cdot (1-Q_k) \cdot N_k}{N_k} = D_k Q_k + E_k \cdot (1-Q_k)$$

The flow of defective components on path 1 is $D_k Q_k N_k$. Consequently the quality on Path 1 is

$$Q_{1k} = \frac{D_k Q_k N_k}{N_{1k}} = \frac{D_k Q_k N_k}{D_k Q_k N_k + E_k \cdot (1-Q_k) \cdot N_k}$$

$$= \frac{D_k Q_k}{D_k Q_k + E_k \cdot (1-Q_k)}$$

The expression in 3 above arises from the requirements that the flow be equally split to the 2 outgoing paths when $A_k = G_k$ and that the flow to the path intended for defective units be 0 when $A_k = 0$. These requirements are satisfied by the straight line $C_k = (1/2\ G_k) \cdot A_k$.

The straight line also gives $C_k = 1$ at $A_k = 2 \cdot G_k$. Consequently, if the age on the path intended for defective units is set to $2 \cdot G_k$, the C_k values at the downstream age decision nodes are equal to 1. Consequently, downstream age decisions (e.g. - reworking or discarding) are properly produced by upstream age decisions (e.g. - identification of trucks with an over-age component).

The first expression in 4 can be obtained by regarding the C_k decisions for the K components in the subassembly to be statements of probability. For component k, the probability that a given unit will branch to the path intended for good units is $1-C_k$. For all components in the subassembly, the probability that, <u>treated individually</u>, all units will branch to that path is $\Pi_K(1-C_k)$. Because these components are part of the same subassembly, all must be intended for that path if the subassembly is to branch to that path.

As a result, the proportion of arriving subassemblies branching to the path intended for good units is $\Pi_K (1-C_k)$ and the proportion of arriving subassemblies branching to the path intended for defective units is $1 - \Pi_K (1-C_k)$.

The relationships for age and quality in 4 can be obtained by considering the additional units required to produce complete subassemblies. For component k, the number of units branching to the path intended for defective units is $C_k N_k$ if the component is <u>treated individually</u>. The associated age and quality for the component on the path are A_{1k} and Q_{1k}. The increase in the number of units on the path to maintain integral subassemblies is $(C^* - C_k) \cdot N_k$. This increased number has an age and a quality equal to the ones in the outgoing Path 2 (see Figure 3-17). Consequently, the age and quality on the departing path intended for defective units are changed from

$$\frac{A_{1k} C_k N_k}{C_k N_k} \quad \text{and} \quad \frac{Q_{1k} C_k N_k}{C_k N_k}$$

to

$$\frac{A_{1k} C_k N_k + A_{2k} (C^* - C_k) N_k}{C_k N_k + (C^* - C_k) N_k} \quad \text{and} \quad \frac{Q_{1k} C_k N_k + Q_{2k} (C^* - C_k) N_k}{C_k N_k + (C^* - C_k) N_k}$$

where $C^* N_k$ is the total number of units on the path. The quantities A_{2k} and Q_{2k} are the age and quality on the outgoing Path 2 before coupling of the decision for component k with those for other components in the subassembly. The quantities A_{2k} and Q_{2k} can be eliminated from the above expressions as follows. The number of units on the outgoing Path 2 for component k, treated individually, is $N_k (1-C_k)$. The representative age and quality of these units are determined by the ages and qualities on the input path and on the outgoing Path 1 (see Figure 3-17). These are:

$$A_{2k} = \frac{A_k N_k - A_{1k} N_{1k}}{N_{2k}}$$

$$Q_{2k} = \frac{Q_k N_k - Q_{1k} N_{1k}}{N_{2k}} .$$

Or, after using $N_{1k} = C_k N_k$ and $N_{2k} = N_k(1 - C_k)$

$$A_{2k} = \frac{A_k N_k - A_{1k} C_k N_k}{N_k (1-C_k)}$$

$$Q_{2k} = \frac{Q_k N_k - Q_{1k} C_k N_k}{N_k (1 - C_k)} .$$

3.3.3 Time Simulation Concepts

The capability to simulate (or predict) truck costs with time is a powerful feature of the SCM technique. In the present section, the time simulation feature is discussed in order to illustrate this mode of SCM operation.

In order to produce the time varying simulation, data beyond those needed for the base case analysis are required. These data include:

a) the known fixed rate of change of population size (see Figure 3-18).
b) the two Weibull parameters for each component (see Figure 3-18).
c) the length of time for the simulation and the time step size. (see Control Card Entries Appendix D)

(Inputs Needed for Time Based Simulations Only)

```
0.0    2   1.82998        / RATE POP.,WEIB.,LIFE
0.0    2   1.82998        / RATE POP.,WEIB.,LIFE
0.0    2   1.82998        / RATE POP.,WEIB.,LIFE
0.0    2   2.32138        / RATE POP.,WEIB.,LIFE
0.0    2   2.16651        / RATE POP.,WEIB.,LIFE
0.0    2   2.78818        / RATE POP.,WEIB.,LIFE
0.0    2   0.14307        / RATE POP.,WEIB.,LIFE
0.0    2   0.03243        / RATE POP.,WEIB.,LIFE
0.0    2   1.53289        / RATE POP.,WEIB.,LIFE
0.0    2   2.51896        / RATE POP.,WEIB.,LIFE
0.0    2   1.82998        / RATE POP.,WEIB.,LIFE
0.0    2   1.09577        / RATE POP.,WEIB.,LIFE
0.0    2   1.82998        / RATE POP.,WEIB.,LIFE
0.0    2   1.82998        / RATE POP.,WEIB.,LIFE
0.0    2   1.82998        / RATE POP.,WEIB.,LIFE
0.0    2   2.32138        / RATE POP.,WEIB.,LIFE
0.0    2   2.16651        / RATE POP.,WEIB.,LIFE
0.0    2   2.78818        / RATE POP.,WEIB.,LIFE
0.0    2   0.14307        / RATE POP.,WEIB.,LIFE
0.0    2   0.03243        / RATE POP.,WEIB.,LIFE
0.0    2   1.53289        / RATE POP.,WEIB.,LIFE
999                       / END OF DATA
99999                     / END OF FILE          /
```

OPTIONAL COMMENTARY AFTER SLASH (/)

- Weibull Characteristic Life (Years)
- Weibull Slope
- Annual Fixed Increase in Component Population
  Zero Indicates Fixed Population Size
  "999" Indicates End of This Part of File
  "99999" Indicates End of Total Data File

Figure 3-18. Input Data Format of Population Growth Rates and Weibull Parameters

The Weibull parameters (2) required for each component are β (the Weibull slope) and α (the characteristic life) for the defect mode associated with the component. The value of the quantity β determines whether the component has an "infant mortality" defect behavior or a "wearout" defect behavior. Infant mortality, which occurs when $\beta < 1$, means a decrease with time in the rate at which defects occur. However, mechanical components typically have wearout behavior. For this behavior, the rate at which defects occur increases with time. For example, defects such as those produced by spalling, fatigue, and wear are associated with β values of about 2 or larger. Various values of α are shown in Figure 3-18 but were not those of the present sample system. Characteristic lives can only be obtained from a mechanical system which has a "history" of failures as a result of being in operation for several years. No history of use is available for the truck used in the present discussion.

4. REFERENCES

1. Krauter, A. I., ard Smith, R. L., "A Methodology for Evaluating the Maintenance of High Speed Passenger Train Trucks," Final Report Number FRA/ORD-78/73, December 1978.

2. Nelson, W., "Hazard Plotting for Incomplete Failure Data," Journal of Quality Technology, Vol. 1, No. 1, January 1969.

APPENDIX A

PROGRAM OPERATIONS MANUAL

1. GENERAL INFORMATION

1.1 SUMMARY

The SCM program as used in this application is designed to simulate the operation of a railroad truck maintenance system and predict the changes in population and cost over a desired time period. The program has the capability of producing a base case for the system, a sensitivity analysis for the base case, and the state of the system at selected time steps.

1.2 ENVIRONMENT

This program was developed for AMTRAK by Shaker Research Corporation from a BASIC program for cost modeling.

1.3 REFERENCES

"A Methodology for Evaluating the Maintenance of High Speed Passenger Train Trucks", Krauter, A., Smith, R., Shaker Research Corporation, Ballston Lake, New York, Final Report Prepared for U. S. Department of Transportation Federal Railroad Administration, December 1978.

2. OVERVIEW

2.1 PROBLEM AND SOLUTION METHOD

See Program Maintenance Manual Section 4.5

2.2 PROGRAM INVENTORY

2.2.1 Main Program

SCM: Reads in, sorts, and stores data in holding arrays for selected run.

2.2.2 Subroutine

DEFFNA: Assigns decision parameters for node split calculation. Also, sets up to make Sensitivity Analysis modifications when necessary; called in DEFFNE.

2.2.3 Subroutine

DEFFNB: Similar to DEFFNA but handles path cost values and functions. Also designed to make sensitivity changes; called in DEFFNF.

2.2.4 Subroutine

DEFFNC: Handles component subassembly computations. Equipped to make sensitivity changes; called in DEFFNE.

2.2.5 Subroutine

DEFFND: Takes path data from holding arrays and assigns to small temporary arrays for calculating purposes elsewhere. Also takes data from small arrays and puts into the holding arrays; called in SCM, DEFFNE, and DEFFNF.

2.2.6 Subroutine

DEFFNE: Does the actual node sweep and flow calculations; called in SCM.

2.2.7 Subroutine

DEFFNF: Controls path flow and cost output. Also computes total cost. Called in SCM.

2.2.8 Subroutine

DEFFG: Controls sensitivity analysis both for nodes and paths. It outputs the results also. Called by SCM.

2.2.9 Subroutine

DEFFNH: Along with DEFFNI and DEFFNJ it assigns population state changes to temporary arrays and updates state for Runge-Kutta calculations. Called by SCM.

2.2.10 Subroutine

DEFFNI: See 2.2.9 DEFFNH

2.2.11 Subroutines

DEFFNJ: See 2.2.9 DEFFNH

2.3 FILE INVENTORY

2.3.1 SCM: Source Program

2.3.2 B+SCM: Compiled Program

2.3.3 DATA5: Data File

2.3.4 CIFILE: Data File

3. DESCRIPTION OF RUNS

3.1 RUN INVENTORY

Base run: Given a system flow input and the node decision parameters, the run will produce the corresponding system flows and costs by path component.

Sensitivity run: By changing node decision parameters 1 at a time and on just 1 component at a time and running a node sweep, the run determines which nodes and components have the greatest influence on total cost. (cannot be run with time simulation).

Time simulation run: Given a starting population state, a time step, and an ending time the run will use the Runge-Kutta method to determine the change in state and the associated costs for each time step. The technique requires small time steps to maintain accuracy.

3.2 RUN PROGRESSION

In all cases the Base run is done first. To select the desired second run, the control index values stored in the CIFILE file must be altered to the necessary values ahead of time.

3.3 RUN DESCRIPTION

3.3.1 Control Inputs

DATA5 file is opened to be read on FORTRAN unit #5. CIFILE file is opened to be read on FORTRAN unit #6. Output files are opened to write on FORTRAN units #7 and #8.

3.3.2 Operating Information

3.3.2.1 Base run.

3.3.2.2 In CIFILE set:

#15 A7 to Ø

#17 TØ to Ø.Ø

#18 T1 to 1.Ø

#19 T2 to 1.Ø

#14 A to 1 if node map wanted

#12 PRNGB to 2

#13 PRNGB to # of paths

In DATA5 set ZAR values to that of the population to be run.

All other values are set according to the model used in the run.

3.3.2.3 RUN Times: 1.Ø minutes of CPU time. Turnaround time: 3.5 minutes exclusive of printing time through CIFILE.

3.3.2.5 Trouble Shooting. Call Joseph Betor or Allan Krauter (518)877-8581.

APPENDIX B

PROGRAM MAINTENANCE MANUAL

1. GENERAL INFORMATION

1.1 SUMMARY

This program was written under standard FORTRAN IV conventions and consists of a main program, subroutines called by the main program only, subroutines called by the main program and by other subroutines, and subroutines accessed solely from other subroutines. There are no recursive calls. The program is supported by 2 data files the first contains program control values, the other contains calculation data. The software package of main program, subroutines, and data files is completely self-contained except for the standard FORTRAN functions for absolute value and sign determination.

1.2 ENVIRONMENT

This program was developed for AMTRAK by Shaker Research Corporation under sponsorship of the Federal Railroad Administration, from a BASIC program for cost modeling written by Dr. Allan Krauter.

1.3 REFERENCES

"A Methodology for Evaluating the Maintenance of High Speed Passenger Train Trucks", Krauter, A., Smith, R., Shaker Research Corporation, Ballston Lake, NY, Final Report prepared for US Department of Transportation, Federal Railroad Administration, December 1978.

2. PROGRAM DESCRIPTIONS

2.1 PROGRAM DESCRIPTION - SCM

2.1.1 Problem and Solution Method. The problem was to set up a mathematical model to simulate the economics of the maintenance system for rail trucks. The solution involves a computer program which implements a schematic diagram of maintenance nodes and paths. The paths represent various steps and operations of the maintenance process. The nodes, depending on type, either combine the flows on 2 incoming paths and send the combined flow down the single outgoing path, or determine how to split up the flow of an incoming path between 2 outgoing paths. Beginning with the information from some starting path, the program sweeps through the diagram, filling in the flows and the associated "qualities" for all downstream paths. There are 4 basic path types: start, internodal, scrap-manufacture, and expansion-contraction. There is only 1 start path. It contains the system population, average age, and quality for all components. Internodal paths represent maintenance operations or movement of components between nodes. Scrap-manufacture paths leave or enter the system and are always paired, with the flow on the manufacturer path set equal to that of the corresponding scrap path. The 2 expansion-contraction paths control system growth. Any path that leaves, enters, or in any way alters the system quantity or population, is monitored to keep track of total system change.

A single sweep through the diagram, using known values for the start path, will produce a Base run. Changing the flow at a node or the cost on a particular path for a single component gives the sensitivity of the system at that point for that component. By taking the system change in state from a sweep, and applying the Runge Kutta technique, the program simulates operation through time.

2.1.2 Input: (see Section 4.5 for input listings). Input is from 2 data files, DATA5 and CIFILE. DATA5 contains data for filling in the node diagram, cost data for paths and components, Weibull constants, rework indicators, and subassembly indicators. DATA5 derived its name from the FORTRAN unit #5 that the program uses to read it. All DATA5 is read with a free format and, depending on the data section, may have 2 to 16 values per line. CIFILE contains values for control indices used in the program. These control loop sizes, output type and run type. CIFILE was derived from Control Index FILE and contains both reals and integers. CIFILE holds 1 value per line in the first 5 columns followed by the variable name and a small description. Both files may be renamed as required without affecting the program. Do not alter the order of the data unless a thorough understanding of the program and the appropriate program modifications have been developed.

2.1.3 Processing:

a) Processing Logic:

Data are read in, sorted, and stored in the first part of the main program. This is done once per run. All data pertaining to components are placed in arrays where the row number is referenced by the component type number. Data that are classified by component and node or path are read into 2 dimensional arrays with columns corresponding to nodes or paths as the case might be. See section 2.1.6 for more detail on arrays. Loops concerning components are normally nested inside path and node oriented loops.

The actual running of the model is controlled by the second part of the program. The main program calls subroutines in the appropriate order to do the calculations and output. Depending on the type of run, the program will call different subroutines in different sequences.

b) Linkages:

Linked lists are not featured in this program. All data structures are sequential.

c) Variables and constants:

Most names for reals and integers are declared. Any nondeclared names come under the control of the IMPLICIT statement at the beginning of the main program and each subroutine. This program was translated from a BASIC program utilizing real numbers for all variables and constants. The departure from usual FORTRAN naming conventions stems from the effort to keep the translation as close as possible to the original BASIC.

IMPORTANT VARIABLES AND CONSTANTS

Name	Description	Where Used
S7	Indicates node being analyzed for sensitivity if positive and path being analyzed if negative	SCM, DEFFNA, DEFFNB, DEFFNL, DEFFNG
C9	Indicates that the value of CAR(1) should be assigned to the whole CAR array	SCM, DEFFNA
K7	Indicates component being analyzed for sensitivity	SCM, DEFFNA DEFFNB, DEFFNL DEFFNG
M2	Number of different components handled by system	SCM, DEFFNA, DEFFNB, DEFFNL, DEFFND, DEFFNE, DEFFNF, DEFFNG
Z1	Total number of nodes in system	DEFFNE, DEFFNF, DEFFNG, SCM
Z2	Number of branch nodes in system	SCM, DEFFNE, DEFFNF, DEFFNG
Z3	Total number of paths in system	SCM, DEFFNE, DEFFNF, DEFFNG

Name	Description	Where Used
Z4	Number of cost paths in system	SCM, DEFFNF
NR	Number of reworkings	SCM
M1	Number of components (M2) times number of path properties. In this case there are 3 path properties: flow, age, and quality	SCM, DEFFNE, DEFFNH, DEFFNI, DEFFNJ
A7	Sensitivity analysis run indicator	SCM
I9	Flow and cost output indicator	SCM
TØ	Time simulation end time.	SCM, DEFFNG
T1	Time simulation time step	SCM, DEFFNH, DEFFNI
T2	Time simulation printout indicator	SCM
T9	Current time in simulation	SCM, DEFFNF
PRNGB	Lower index for path flow output loop	SCM, DEFFNF
PRNGT	Upper index for path flow output loop	SCM, DEFFNF
A9	Cost path output suppressor	SCM, DEFFNF
NKDT	KDT1 READ Loop parameter	SCM
I,K	DO loop indices	Global
J	IF/GOTO loop index	Global

The preceding variables and constants do not necessarily occur in this order in the program.

d) Formulas:

Formulas and a full explanation of each may be found in the body of this report.

e) In the event of a recognizable error, the program will halt.

f) Limits:

The program, as set up, cannot handle more than: 30 components, 200 nodes, 200 branch nodes, 200 paths, 3 path properties (flow, age, quality). To exceed these limits, the affected arrays must be expanded. If more path properties are desired, the program will have to be redesigned.

The program is also limited to 1 run type at a time. To change run type, the user must alter the control values in CIFILE to the appropriate run set up.

2.1.4 Output: Output is primarily done through subroutines DEFFNF and DEFFNG. DEFFNF handles path flow and cost outputs. Output is to a disk file through unit #7. DEFFNG writes sensitivity analysis to a disk file using unit #8. See section 4.5 for output listings. If other output devices are required, only the write statements need to be changed.

2.1.5 Interfaces: This program as is must work with 4 other units. The data files, DATA5 and CIFILE must be opened for reading on FORTRAN unit numbers 5 and 6 respectively. Two output files for flows/cost and sensitivity output must be opened for writing on unit number 7 and 8 respectively.

2.1.6 Arrays: Arrays are dimensioned somewhat oversized to allow system expansion without changing the program. Arrays, taken from the original BASIC program, have either an "AR" or "STR" suffix. New arrays, created to hold data from the input files, incorporate "DAT" or DATA" in their names.

INTEGER ARRAYS

Name	Description	Where Used
GSTR(34,200)	GSTR contains node type and the 3 path numbers in the first 4 rows. The remaining 30 rows hold rework indicators for the components	SCM, DEFFNE
CSTR(200)	Contains cost path and function indicators	SCM, DEFFNB
KDAT1(30,200)	Contains all component subassembly indicators	SCM, DEFFNA
KSTR(30)	Holds component subassembly indicator for single path	DEFFNA
K7STR(30)	Same as KSTR but used in sensitivity analysis	DEFFNA, DEFFNL, DEFFNG
C9DAT(200)	Holds C9 values for all nodes	SCM, DEFFNA

REAL ARRAYS

Name	Description	Where Used
NDATA, QDATA, ADATA(30,200)	Holding arrays for path flows, qualities and ages, respectively	SCM, DEFFND
ZAR(90)	Holding array for start path population	SCM, DEFFNE, DEFFNH, DEFFNI DEFFNJ
SAR(90)	Holding array for ZAR during Runge Kutta calculations	SCM, DEFFNH, DEFFNI, DEFFNJ
DATC1(30,200)	Holding array for node "C" split values	SCM, DEFFNA
DATC2(30,200)	Holding array for path/component costs	SCM, DEFFNB

Name	Description	Where Used
DDAT1(30,200)	Holding array for node "D" split values	SCM, DEFFNA
EDAT1(30,200)	Holding array for node "E" split values	SCM, DEFFNA
NAR, N8AR, N9AR(30)	Hold flows for single paths during node/path computations	SCM, DEFFNA, DEFFNB, DEFFNC, DEFFND, DEFFNE, DEFFNF
AAR, A8AR, A9AR(30)	Same as above but for ages	Same as above
QAR, Q8AR, Q9AR(30)	Same as above but for qualities	Same as above
Bar(30)	Component Weibull slope values	SCM, DEFFNE
B1AR(30)	Holding array for component characteristic life span	SCM, DEFFNE
D1AR(90)	Accumulative array for system populational changes during a node sweep	SCM, DEFFNE, DEFFNH, DEFFNI, DEFFNJ
KAR, LAR, MAR(90)	Temporary repositories for D1AR values during Runge Kutta computations	SCM, DEFFNH, DEFFNI, DEFFNJ, respectively
CAR, DAR, EAR(30)	"C", "D", and "E" values for each component at a branch node to determine the node split factors.	DEFFNA, DEFFNE, DEFFNF (CAR only)
RAR(30,3)	Holding array for rework parameters	SCM, DEFFNA

3.1 HARDWARE

a) Processor:

The program was developed to run in double precision mode utilizing 64 bits per number. The CPU used was a PRIME 350 with 16 bits/word, 2 words/number in single precision. There are 2 bytes/word. The internal memory required for running is approximately 640 K bytes. The greater part of this is reserved for the large common block.

b) Output and Input Files:

The 2 input files require about 15K bytes of memory. The data may be stored in sequential files on disk or magnetic tape without alteration. Card storage require the 2 files to be integrated according to the program reading order.

Output files, for a base run, would require up to 16K bytes of memory. Direct output to a printer is optional, requiring a small change to the output subroutines.

c) Data transmission devices:

None; the program and data files are noninteractive and self-contained.

3.2 SUPPORT SOFTWARE:

3.2.1 Operating System: The program is run in batch mode and should be compatible with any system equipped to run FORTRAN programs.

3.2.2 Compiler/Assembler: Requires a compiler for standard FORTRAN IV.

3.2.3 Other software: If FORTRAN functions such as DABS() are not inserted by the compiler, then a FORTRAN IV math library will also be required.

3.3 DATA BASE:

See Operations Manual: Section 2.3
Program Maintenance: Section 2.1.2, and 4.5

4. MAINTENANCE PROCEDURES

4.1 PROGRAMMING CONVENTIONS

The program consists of a main program, SCM, and 10 subroutines.

Subroutine names all begin with "DEFFN" and have a single letter suffix, "A" through "J", to differentiate them. (e.g. DEFFNE). Subroutines follow the main program in the listing (Section 4.5) in the order they are first called, not in the order they are lettered.

Variable and constants that were taken directly from the original BASIC program retain their original 1 letter or 1 digit names. Added variables may range from 2 to 6 characters per name. Mnemonic attributes may be found in some names, but this should not be assumed to be the rule as many names were generated at random.

Strings in the BASIC were transformed to integer arrays in the translation. Former strings have an "STR" suffix to distinguish them from other arrays. All other arrays taken from the BASIC, have an "AR" suffix. The remaining arrays, most of which serve to hold large amounts of data, will incorporate the letters "DAT" in their names. As with single variables, mnemonic properties should not be assumed for names and similar names often serve different purposes.

4.2 VERIFICATION PROCEDURES

Tested and verified data are provided with the program, along with the corresponding output. After installation and whenever the program becomes suspect, this data set can be run to verify the integrity of the program.

4.3 ERROR CORRECTION PROCEDURES

Most errors will be data related. Be sure that data values read through free formats are separated by blanks or commas. Carefully check the control file to insure against improper indicator and control parameters. If the data set is correct, confirm that the data files have been opened on the proper reading unit. Also, check the following features of the program:

a) Are the arrays too small?

b) Are there the correct number of repetitions in the loops?

c) Are reals and integers being mixed?

d) Are all the subroutines present?

e) Are all the subroutine arguments present?

f) Is the program compiled correctly?

4.4 SPECIAL MAINTENANCE PROCEDURES

Data modifications are necessary for different types of runs. Their modifications are specified in the Operations Manual.

APPENDIX C

COMPUTER PROGRAM LISTING

```
C***********************************************************************
C***********************************************************************
C                                                                      *
C                     SIMULATION COST MODEL                            *
C                                                                      *
C***********************************************************************
C                                                                      *
C   THIS PROGRAM WAS DEVELOPED FOR COSTING MAINTENANCE RELATED         *
C TO HIGHSPEED RAILROAD PASSENGER TRUCKS. THIS MODEL PROVIDES          *
C FOR COSTING THE UPKEEP OF ALL TRUCK SUBCOMPONENTS AS DESIRED         *
C BY THE PROGRAM USER. THIS PROGRAM WAS DEVELOPED BY SHAKER RE-        *
C SEARCH CORPORATION UNDER CONTRACT FROM THE TRANSPORTATION            *
C SYSTEMS CENTER, DEPARTMENT OF TRANSPORTATION CAMBRIDGE, MASS         *
C                                                                      *
C***********************************************************************
C                                                                      *
C   U. S. DEPARTMENT OF TRANSPORTATION                                 *
C   RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION                       *
C   TRANSPORTATION SYSTEMS CENTER                                      *
C   KENDAL SQ.                                                         *
C   CAMBRIDGE  MA 02142                                                *
C                                                                      *
C   MAINTAINABILITY METHODOLOGY FOR THE EVALUATION OF ALTERNA-         *
C   TIVE HIGH SPEED PASSENGER TRUCKS                                   *
C                                                                      *
C   YEARWOOD K. W.                                                     *
C                                                                      *
C***********************************************************************
C                                                                      *
C   SHAKER RESEARCH CORPORATION                                        *
C   NORTHWAY 10 EXECUTIVE PARK                                         *
C   BALLSTON LAKE  NY 12065                                            *
C                                                                      *
C   KRAUTER, A. I.   TEL (518)-977-8581                                *
C                                                                      *
C***********************************************************************
C                                                                      *
C                  TRANSLATION/REVISION HISTORY                        *
C                                                                      *
C***********************************************************************
C                                                                      *
C   INITIAL BASIC VERSION   -  KRAUTER  A. I    SHAKER 02/01/79        *
C   FORTRAN TRANSLATION     -  BARTLETT  J  A.  SHAKER 08/01/79        *
C   WORKING VERSION         -  BETOR, J         SHAKER 11/16/79        *
C   REVISION 1              -  BETOR, J.        SHAKER 12/05/79        *
C   REVISION 2              -  BETOR, J         SHAKER 02/04/80        *
C   REVISION 3              -  BETOR, J         SHAKER 02/11/80        *
C                                                                      *
C***********************************************************************
C***********************************************************************
```

```
      IMPLICIT REAL*8(A-E,O-F,M-Z),INTEGER*2(I-L)
C
      COMMON/I1/GSTR(34,200)
      COMMON/I2/CSTR(200)
      COMMON/I3/C9DAT(200)
C
      COMMON/R1/HDATA(30,200)
      COMMON/R2/ADATA(30,200)
      COMMON/R3/QDATA(30,200)
      COMMON/R4/ZAR(90)
      COMMON/R5/SAR(90)
      COMMON/R6/DATC1(30,200)
      COMMON/R7/DDAT1(30,200)
      COMMON/R8/EDAT1(30,200)
      COMMON/R9/DATC2(30,200)
      COMMON/R10/KDAT1(30,200)
C
      INTEGER*2 KSTR(30),ISTR(2),K7STR(30)
      INTEGER*2 H,A7,C9,K,K7,I,J,M1,M2,S7,V7,Z1,Z2,Z3,NR,[illegible],T7
      INTEGER*2 Y,IPOS,N1,I7STR,J7,A9,PRNGB,PRNGT,NKDT
C
      REAL*8 AAR(30),BAR(30),B1AR(30),CAR(30),D1AR(30)
      REAL*8 GAR(30),NAR(30),QAR(30)
      REAL*8 RAR(30,3),KAR(90),LAR(90)
      REAL*8 MAR(90)
      REAL*8 C7,C0,U7,T0,T1,T2,I9
C
C-------------------------------------------------------------------
C READ CONTROL INDICES AND INITIATE DATA ARRAYS
C-------------------------------------------------------------------
      READ(6,102) S7,C9,T7,K7,NR
      READ(6,112) NKDT
      READ(6,102) M2,Z1,Z2,Z3,Z4
102   FORMAT(4(I3,/),I3)
112   FORMAT(I3)
      DO 100 I=1,Z1
         READ(5,*)(GSTR(K,I),K=1,4)
         DO 101 K = 1,M2
            K4 = K + 4
            GSTR(K4,I) = 0.000 00
            DATC1(K,I) = 0.000 00
            DDAT1(K,I) = 0.000 00
            EDAT1(K,I) = 0.000 00
            KDAT1(K,I) = 0
101      CONTINUE
100   CONTINUE
         C9DAT(I) = 0
      DO 103 I = 1,Z3
         DO 1014 K = 1,M2
            DATC2(K,I) = 0.000 00
```

```
1014     CONTINUE
103   CONTINUE
      DO 105 K = 1,M2
         GAR(K) = 0.00D 00
105   CONTINUE
106   READ(5,*)X,K,VALC,DVAL,EVAL,C9
      IF(X .GT. Z1)GO TO 64
      IF(VALC .GE. 0.00D 00)GO TO 107
      DDAT1(K,X) = DVAL
      EDAT1(K,X) = EVAL
107   DATC1(K,X) = VALC
      C9DAT(X) = C9
      GO TO 106
64    DO 67 K = 1,NKDT
         READ(5,*)X,(KDAT1(J,X),J=1,15)
         READ(5,*)X,(KDAT1(J,X),J=16,30)
C         WRITE(1,186)X,(KDAT1(X,J),J=1,12)
186      FORMAT(I2,12(1X,I1))
67    CONTINUE
104   FORMAT(I3)
108   READ(5,*)X,K,VALC,VALC1,VALC2,VALC3
      IF(X .GT. Z3)GO TO 109
      DATC2(K,X) = VALC3 * ((VALC * VALC1) + VALC2)
      GO TO 108
109   IF(NR .EQ. 0) GO TO 111
      DO 110 J=1,NR
         READ(5,*) K,I,A,ISTR(1),ISTR(2),RAR(K,I)
         RAR(K,I)=RAR(K,I)+1.0D-25
         IF(ISTR(2) .EQ. 3) GO TO 9370
         RAR(K,I)=-RAR(K,I)
9370     IF(ISTR(1) .EQ. 2) GO TO 9380
         I=I+3
         IF(ISTR(1) .EQ. 7) GO TO 9380
         I=I+3
9380     ISTR(2) = I
         IPOS=4+K
         GSTR(IPOS,A) = ISTR(2)
110   CONTINUE
C      WRITE(1,1113)((GSTR(K,J),K=1,16),J=1,75)
1113  FORMAT(' GSTR:',/,75(16(1X,I4),/))
111   READ(6,102)PRNGB,PRNGT,A,A7,V7
      IF(A .EQ. 0) GO TO 9460
      K4 = 4 + M2
      DO 120 I=1,Z1
C         WRITE(1,9440)I,(GSTR(J,I),J=1,K4)
9440     FORMAT(5HNODE=,I3,2X,3HBN=,I3,2X,3HFP=,I3,2X,
     *   6HBP/FP=,I3,2X,6HGP/TP=,I3,/,6HREWORK,21I2)
120   CONTINUE
9460  DO 9462 K=1,Z3
         CSTR(K) = 1
```

```
9462   CONTINUE
9464   READ(5,*) I,INVO
       IF(I GT Z3)GO TO 123
       CSTR(I) = INVO
       GO TO 9464
123    IF(A7 EQ  0) GO TO 9580
       V7 = V7-1
9580   M1 = 3*M2
       DO 125 K = 1,M2
          K2 = K * 3
          N1 = K2 - 2
          READ(5,*) (ZAR(I),I=N1,K2)
125    CONTINUE
       DO 126 K=1,M2
          READ(5,*)NAR(K),BAR(K),B1AR(K)
          AAR(K)=0.0D 00
          QAR(K)=0.0D 00
126    CONTINUE
       Y = 2
       ISTR(1) = 6
       CALL DEFFND(Y,ISTR(1),NAR,AAR,QAR,M2)
C
C      SET N MATRIX TO ZERO
C
       DO 150 K=1,M2
          NAR(K)=0.0D 00
150    CONTINUE
       DO 160 I=3,Z3
          CALL DEFFND(I,ISTR(1),NAR,AAR,QAR,M2)
160    CONTINUE
       READ(6,164) T0,T1,T2,A9
164    FORMAT(2(F4.1,/),F4.1,/,I3)
C       WRITE(1,166)T1
166    FORMAT(' T1 : ',F7.3)
       T9=0.0D 00
       I9 = T2
C-------------------------------------------------------------
C START INDICATED RUN.
C-------------------------------------------------------------
       GO TO 9770
C
C      START OF COMPUTATION
C
9710   CALL DEFFNE(GAR,RAR,D1AR,BAR,B1AR,M1,M2,Z1,Z2,Z3,C9,S7,K7,
     *             KSTR,I7STR,U7,J7,K7STR,T7)
C       WRITE(1,9711)
9711   FORMAT(1HE)
C-------------------------------------------------------------
C      SET S MATRIX TO ZERO.
C-------------------------------------------------------------
```

```
169   DO 170 K=1,M1
          SAR(K) = ZAR(K)
170   CONTINUE
      IF(I9 .GT. 0.0D 00) GO TO 9720
      CALL DEFFNF(A9,M1,Z3,C0,S7,K7,T9,J7,PRNGP,PRNGT)
C      WRITE(1,9712)
9712  FORMAT(1HF)
C-----------------------------------------------------------------------
C CHECK FOR SENSITIVITY ANALYSIS RUN
C-----------------------------------------------------------------------
9720  IF(A7 .EQ. 0) GO TO 9730
      CALL DEFFNG(S7,C0,A9,K7STR,M2,I7STR,V7,U7,J7,C7,K7,Z2,T7,
     *            T9,T0,Z4)
      IF(T9 .EQ. 0.0D 00) GO TO 9710
C      WRITE(1,166)T0
C-----------------------------------------------------------------------
C CHECK FOR TIME SIMULATION RUN.
C-----------------------------------------------------------------------
9730  IF(T9 .GE. T0) GO TO 9999
      CALL DEFFNH(KAR,D1AR,M1,T1)
C      WRITE(1,9713)
9713  FORMAT(1HH)
      T9 = T9+(T1/2.0D 00)
      CALL DEFFNE(GAR,RAR,D1AR,BAR,B1AR,M1,M2,Z1,Z2,Z3,C9,S7,K7,
     *            KSTR,I7STR,U7,J7,K7STR,T7)
      CALL DEFFNI(LAR,D1AR,M1,T1)
      CALL DEFFNE(GAR,RAR,D1AR,BAR,B1AR,M1,M2,Z1,Z2,Z3,C9,S7,K7,
     *            KSTR,I7STR,U7,J7,K7STR,T7)
      CALL DEFFNJ(MAR,D1AR,M1,T1)
      T9 = T9+(T1/2.0D 00)
      CALL DEFFNE(GAR,RAR,D1AR,BAR,B1AR,M1,M2,Z1,Z2,Z3,C9,S7,K7,
     *            KSTR,I7STR,U7,J7,K7STR,T7)
      DO 180 I=1,M1
         ZAR(I)=SAR(I)+((T1*(KAR(I)+2.0D 00*LAR(I)+2.0D 00*
     *   MAR(I)+D1AR(I))))/6.0D 00)
180   CONTINUE
C-----------------------------------------------------------------------
C CHECK FOR OUTPUT.
C-----------------------------------------------------------------------
9770  I9 = I9 + 1.00D 00
C      WRITE(1,9771)I9
9771  FORMAT('I9:',I2)
      IF(I9 .LT. T2) GO TO 9710
      I9 = 0.0D 00
      GO TO 9710
9999  CALL EXIT
      END
C*********************************************************************
C*********************************************************************
      SUBROUTINE DEFFNA(X,R,S,T,N1AR,A1AR,Q1AR,GAR,AAR,M1,M2,Z1,
```

```
     *                     Z2,Z3,KSTR,I,K9,K7,S7 [illegible]
     *                     J7,T7)
      IMPLICIT REAL*8(A-B,D-F,M-Z),INTEGER*2(C,G-L)
C
      COMMON/R3/C9DAT(200)
C
      COMMON/R6/DATC1(30,200)
      COMMON/R7/DDAT1(30,200)
      COMMON/R8/EDAT1(30,200)
      COMMON/R10/KDAT1(30,200)
C
      REAL*8 CAR(30),DAR(30),EAR(30),N1AR(30),A1AR(30),G1AR(30)
      REAL*8 AAR(30),QAR(30),GAR(30)
      REAL*8 U7
C
      INTEGER KSTR(30),K7STR(30)
      INTEGER M1,M2,Z1,Z2,Z3,J,J7,I7STR,C9,K7,S7,X,R,S,T,Q8,T7
C-----------------------------------------------------------------
C ASSIGN APPROPRIATE NODE VALUES AND DECISION PARAMETERS
C-----------------------------------------------------------------
C      WRITE(1,1)
1     FORMAT(' A')
      DO 100 I = 1,M2
         CAR(I) = DATC1(I,X)
         DAR(I) = DDAT1(I,X)
         EAR(I) = EDAT1(I,X)
         C9 = C9DAT(X)
         KSTR(I) = KDAT1(I,X)
100   CONTINUE
C-----------------------------------------------------------------
C
C-----------------------------------------------------------------
 1860 IF(C9.EQ.0) GO TO 1870
      DO 1862 I=1,M2
      CAR(I)=CAR(1)
      C9=0
1862  CONTINUE
 1870 IF(S7.LE.0.) GO TO 1920
      IF(X.NE.S7) GO TO 1920
      J7=J
C-----------------------------------------------------------------
C SENSITIVITY ANALYSIS MODIFICATIONS.
C-----------------------------------------------------------------
      DO 1875 Q8=1.M2
      K7STR(Q8)=KSTR(Q8)
 1875 CONTINUE
      I7STR=1
      IF(K7STR(K7).EQ.1) GO TO 1920
      IF(GAR(K7).EQ.0) GO TO 1890
      U7=1.0D 00
```

```
      [illegible]
      T7=1
      I7STR=2
      GO TO 1920
 1890 IF(CAR(K7).LT.0.) GO TO 1900
      U7 = 0.5+([illegible]E-06)-QAR(K7)
      IF(U7.NE.0.00D00)U7 = DSIGN(1.0D00,U7)
      [illegible]
      T7=1
      I7STR=11
      GO TO 1920
 1900 IF(T7.EQ.2) GO TO 1910
      U7 = 0.5+(1.0E-06)-DHR(K7)
      IF(U7.NE.0.00D00)U7 = DSIGN(1.0D00,U7)
      DAR(K7)=DAR(K7)+U7*.01*DHR(K7)
      T7=2
      I7STR=3
      GO TO 1920
 1910 U7 = 0.5+(1.0E-06)-EHR(K7)
      IF(U7.NE.0.00D00)U7 = DSIGN(1.00D00,U7)
      EAR(K7)=EAR(K7)+U7*0.01*EAR(K7)
      T7=1
      I7STR=4
C-----------------------------------------------------------------------
C ASSIGN NODE SPLIT VALUES.
C-----------------------------------------------------------------------
 1920 DO 1980 K=1,M2
      IF(GAR(K).EQ.0) GO TO 1950
      N1AR(K)=AAR(K)/(2.*GAR(K))
      IF(AAR(K).EQ.0.) GO TO 1950
      A1AR(K)=2.*GAR(K)/AAR(K)
      Q1AR(K)=1.
      GAR(K)=0
      GO TO 1980
 1950 IF(CAR(K).LT. 0.00) GO TO 1960
      Q1AR(K)=1.
      N1AR(K) = CAR (K)
      N1AR(K)=CAR(K)
      GO TO 1980
 1960 N1AR(K)=(DAR(K)*QAR(K))+(EHR(K)*(1.0-QHR(K)))
      IF(N1AR(K).NE.0.) GO TO 1970
      Q1AR(K)=1
      GO TO 1980
 1970 Q1AR(K)=DAR(K)/N1AR(K)
 1980 CONTINUE
      RETURN
      END
C***********************************************************************
C***********************************************************************
      SUBROUTINE DEFFNB(CAR,HAR,QAR,M2,I,J,S7,K7,J7)
```

```
      IMPLICIT REAL*8(A-B,D-F,M-Z),INTEGER*2(C,G-L)
C
      COMMON/I2/CSTR(200)
      COMMON/I3/C9DAT(200)
C
      COMMON/R8/DATC2(30,200)
C
      REAL*8 CAR(30),NAR(30),QAR(30)
C
      INTEGER*2 I,J,S7,K7,M2
C
      IF(CSTR(I) .NE. 0)GO TO 2020
C-----------------------------------------------------------------
C COMPUTE PATH/COMPONENT COSTS.
C-----------------------------------------------------------------
      J  = J + 1
      GO TO 3920
2020  J2 = I - J
      DO 200 K = 1,M2
         CAR(K) = NAR(K)*DATC2(K,I)
         IF(CSTR(I) .NE. 2)GO TO 100
         CAR(K) = CAR(K)*QAR(K)
100      IF(CSTR(I) .NE. 3)GO TO 150
         CAR(K) = CAR(K)*(1-(1-QAR(1))*(1-QAR(2))*(1-QAR(4))*
     *            (1-QAR(5))*(1-QAR(6))*(1-QAR(7))*(1-QAR(11))*
     *            (1-QAR(12)))
150      IF(CSTR(I) .NE. 4)GO TO 200
         CAR(K) = DATC2(K,I)
200      CONTINUE
      IF(S7 .GE. 0)GO TO 3920
      IF(J2 .NE. -S7)GO TO 3920
C-----------------------------------------------------------------
C SENSITIVITY ANALYSIS MODIFICATIONS.
C-----------------------------------------------------------------
      J7 = I
      CAR(K7) = CAR(K7) + 0.01 * DABS(CAR(K7))
3920  RETURN
      END
C****************************************************************
C****************************************************************
      SUBROUTINE DEFFNC(KSTR,N1AR,A1AR,Q1AR,S7,M2,X,R,S,T,K7,
     *                  K7STR,U7)
      IMPLICIT REAL*8(A-B,D-F,M-Z),INTEGER*2(C,G-L)
C
      REAL*8 N1AR(30),A1AR(30),Q1AR(30)
      REAL*8 P6,Q8,X1,U7,DIV,N2,N3,SGNR,SGNR2
C
      INTEGER KSTR(30),K7STR(30)
      INTEGER S7,M2,X,R,S,T,K,K7
C-----------------------------------------------------------------
```

```
C CHECK FOR START PATH
C-----------------------------------------------------------------------
      R6=1
      IF(R  .NE.  1) GO TO 210
      RETURN
C-----------------------------------------------------------------------
C CHECK SUBASSEMBLY
C-----------------------------------------------------------------------
210   DO 230 K=1,M2
         IF(KSTR(K) .NE. 1) GO TO 230
         R6=R6*(1.-N1AR(K,)
230   CONTINUE
C-----------------------------------------------------------------------
C IF SUBASSEMBLY ON PATH, DO SPLIT COMPUTATIONS. ELSE RETURN
C-----------------------------------------------------------------------
      IF(R6 .EQ. 1.) GO TO 335
240   R6=1.-R6
      Q8=R6
      X1=R6
      IF(X  NE. S7) GO TO 250
      IF(K7STR(K7) .NE. 1) GO TO 250
C-----------------------------------------------------------------------
C IF INDICATED DO SENSITIVITY MODIFICATIONS.
C-----------------------------------------------------------------------
      U7 = 0.5+(1.0E-06)-R6
      IF(U7 .NE. 0.0D 00)U7 = DSIGN(1.0D 00,U7)
      R6=R6+(U7*.01*R6)
      X1=R6
C-----------------------------------------------------------------------
C SUBASSEMBLY COMPUTATIONS
C-----------------------------------------------------------------------
250   DO 330 K=1,M2
         IF(KSTR(K)  NE. 1) GO TO 330
         SGNR = 1.000 00
         SGNR2 = -0.5 + N1AR(K)
         SGNR = 1.0D-25 * DSIGN(SGNR,SGNR2)
         N2=1.00-N1AR(K)
         N2 = N2 + SGNR
         SGNR = 1.000 00
         SGNR2 = 0.5 - N1AR(K)
         N3=N1AR(K)+1.0D-25*DSIGN(SGNR,SGNR2)
         DIV=1./N3
         IF(A1AR(K) .LT. DIV) GO TO 280
         A1AR(K)=DIV
280      IF(Q1AR(K) .LT. DIV) GO TO 290
         Q1AR(K)=DIV
290      R6=Q8
         A1AR(K)=A1AR(K)*N1AR(K)/R6+((1.-N1AR(K)*A1AR(K))/N2)*
     *   (1.0-N1AR(K)/R6)
         Q1AR(K)=Q1AR(K)*N1AR(K)/R6+((1.-N1AR(K)*Q1AR(K))/N2)*
```

```
     *    (1.0-N1AR(K))/R6)
          R6=X1
          N1AR(K)=R6
330    CONTINUE
335    RETURN
       END
C**********************************************************************
C**********************************************************************
       SUBROUTINE DEFFND(Y,ISTR,NAR,AAR,QAR,M2)
       IMPLICIT REAL*8(A-C,D-F,M-Z),INTEGER*2(G-L)
C
       COMMON/R1/NDATA(30,200)
       COMMON/R2/ADATA(30,200)
       COMMON/R3/QDATA(30,200)
C
       REAL*8 NAR(30),AAR(30),QAR(30)
       INTEGER ISTR,Y,I,M2
C
C-------------------------------------------------------------------
C CHECK FOR LOAD OR SAVE.
C-------------------------------------------------------------------
       IF(ISTR.EQ.6) GO TO 160
C-------------------------------------------------------------------
C LOAD PATH DATA.
C-------------------------------------------------------------------
  130 DO 132 I=1,M2
          NAR(I) = NDATA(I,Y)
          AAR(I) = ADATA(I,Y)
          QAR(I) = QDATA(I,Y)
  132 CONTINUE
      GO TO 800
C-------------------------------------------------------------------
C SAVE PATH DATA.
C---------- --------------------------------------------------------
  160 DO 172 I=1,M2
          NDATA(I,Y) = NAR(I)
          ADATA(I,Y) = AAR(I)
          QDATA(I,Y) = QAR(I)
  172 CONTINUE
  800 RETURN
      END
C**********************************************************************
C**********************************************************************
      SUBROUTINE DEFFNE(GAR,RAR,D1AR,B,B1,M1,M2,Z1,Z2,Z3,C9,S7,
     *                  K7,KSTR,I7STR,U7,J7,K7STR,T7)
      IMPLICIT REAL*8(A-B,D-F,M-Z),INTEGER*2(C,G-L)
C-------------------------------------------------------------------
      COMMON/I1/GSTR(34,200)
      COMMON/I2/CSTR(200)
      COMMON/I3/C9DAT(200)
```

```
C
      COMMON/R1/NDATA(30,200)
      COMMON/R2/ADATA(30,200)
      COMMON/R3/QDATA(30,200)
      COMMON/R4/ZAR(90)
      COMMON/R5/SAR(90)
      COMMON/R6/DATC1(30,200)
      COMMON/R7/DDAT1(30,200)
      COMMON/R8/EDAT1(30,200)
      COMMON/R10/KDAT1(30,200)
C
      REAL*8 Q1AR(30),NAR(30),AAR(30),N8AR(30),N9AR(30),A8AR(30)
      REAL*8 A9AR(30),Q8AR(30),Q9AR(30),RAR(30,3),QAR(30)
      REAL*8 D1AR(90),GAR(30),B(30),B1(30),N1AR(30),CAR(30)
      REAL*8 EAR(30),DAR(30),A1AR(30)
      REAL*8 N1,N2,N3,N81,Q81,A81,Q91,A91,SGN,ONEN3,U7
C
      INTEGER KSTR(30),K7STR(30)
      INTEGER X,R9,S,T,P,P9,Z1,Z2,Z3,M1,M2,K,I,J,P1,K7,S7,Y,R,C9
      INTEGER J7,ISTR,T7
C---------------------------------------------------------------------
C PATH 1 IDENTIFIES THE STATE VARIABLES.  PATH 2 PROVIDES FOR
C EXPANSION OF EACH COMPONENT'S POPULATION.
C---------------------------------------------------------------------
      DO 100 K = 1,M2
         K1 = (-2)+3*K
         IF(ZAR(K1) .GT. 0.0D 00) GO TO 6050
         ZAR(K1) = 0.0D 00
6050     K1P1 = K1+1
         IF(ZAR(K1P1) .GT. 0.0D 00) GOTO 6060
         ZAR(K1P1) = 0.0D 00
6060     K1P2 = K1+2
         IF(ZAR(K1P2) .LT. 1.0D 00) GO TO 6070
         ZAR(K1P2) = 1.0D 00
6070     NAR(K) = ZAR(K1)
         AAR(K) = ZAR(K1P1)
         QAR(K) = ZAR(K1P2)
C         WRITE(1,6071)NAR(K),AAR(K),QAR(K)
6071     FORMAT(' NAR:',PD10.2,' AAR:',PD10.2,' QAR:',PD10.2)
100   CONTINUE
C      ZAR(24) = 0.152459
C      QAR(8)  = 0.152459
      ISTR = 6
      CALL DEFFND(1,ISTR,NAR,AAR,QAR,M2)
C      DO 101 K = 1,M2
C         WRITE(1,6071)NDATA(1,K),ADATA(1,K),QDATA(1,K)
C101   CONTINUE
C---------------------------------------------------------------------
C SET D1 TO ZERO.
C---------------------------------------------------------------------
```

```
      DO 110 I = 1,M1
         D1AR(I) = 0 0D 00
110   CONTINUE
C---------------------------------------------------------------
C BEGIN NODE SWEEP LOOP
C---------------------------------------------------------------
      J = 0
6110  J = J+1
C      WRITE(1,1) J
    1 FORMAT(I5)
      X = GSTR(1,J)
      R = GSTR(2,J)
      S = GSTR(3,J)
      T = GSTR(4,J)
C---------------------------------------------------------------
C GO TO SUM OR BRANCH COMPUTATIONS OR DROP THROUGH ACCORDING TO
C NODE TYPE.
C---------------------------------------------------------------
      IF(X.EQ.0) GO TO 6190
      IF(X .EQ. -1) GO TO 6730
      IF(X .GT. 22) GO TO 6180
      GO TO 6380
6180  WRITE(1,6182)
6182  FORMAT(' ERROR IN BRANCH POINT DATA')
      GO TO 9999
C---------------------------------------------------------------
C SUM NODE COMPUTATIONS.
C---------------------------------------------------------------
6190  ISTR = 5
      CALL DEFFND(R,ISTR,N8AR,A8AR,Q8AR,M2)
      CALL DEFFND(S,ISTR,N9AR,A9AR,Q9AR,M2)
      DO 120 K = 1,M2
         K1 = (-2)
         K1 = K1+3*K
         NAR(K) = N8AR(K)+N9AR(K)
         N3 = NAR(K)+1.0D-25
         AAR(K) = ((N8AR(K)*A8AR(K))+(N9AR(K)*A9AR(K)))/N3
         QAR(K) = (N8AR(K)*Q8AR(K)+N9AR(K)*Q9AR(K))/N3
         Q8 = QAR(K)
         A8 = AAR(K)
         KP12 = K+4
C---------------------------------------------------------------
C CHECK IF REWORK IS NECESSARY.
C---------------------------------------------------------------
         IF(GSTR(KP12,J) .EQ. 0) GO TO 120
         P = GSTR(KP12,J)
6260     P1 = P-3
         IF(P1 .LT. 0) GO TO 6270
         P = P-3
         GO TO 6260
```

```
6270      AAR(K) = (1.0D 00 - QAR(K))*AAR(K)
          QAR(K) = DABS(RAR(K,P))
          IF(RAR(K,P) .GT. 0.0D 00) GO TO 6280
          AAR(K) = 0.0D 00
6280      K1P1 = K1+1
          D1AR(K1P1) = D1AR(K1P1)-(A8-AAR(K))*NAR(K)/ZAR(K1)
          K1P2 = K1+2
          D1AR(K1P2) = D1AR(K1P2)-(Q8-QAR(K))*NAR(K)/ZAR(K1)
          INM = 1
C          WRITE(1,9998)K1P2,D1AR(K1P2),INM
120   CONTINUE
      ISTR = 6
      CALL DEFFND(T,ISTR,NAR,AAR,QAR,M2)
C-----------------------------------------------------------------
C SCRAP NODE DETERMINATION AND MFG. PATH  SETTING.
C-----------------------------------------------------------------
      IF(T.LT.16) GO TO 6730
      IF(T .GT. 27) GO TO 6730
      DO 130 K = 1,M2
         N8AR(K) = NAR(K)
         A8AR(K) = 0.0D 00
         Q8AR(K) = 0.0D 00
130   CONTINUE
      Y = T-12.
      CALL DEFFND(Y,ISTR,NA8AR,A8AR,Q8AR,M2)
      GO TO 6730
C-----------------------------------------------------------------
C BRANCH NODE COMPUTATIONS.
C-----------------------------------------------------------------
6380  DO 140 K = 1,M2
         CAR(K) = 0.0D 00
         A1AR(K) = 1.0D 00
140   CONTINUE
      ISTR = 5
      CALL DEFFND(R,ISTR,NAR,AAR,QAR,M2)
      CALL DEFFNA(X,R,S,T,N1AR,A1AR,Q1AR,CAR,AAR,M1,M2,Z1,Z2,Z3,
     *           KSTR,J,C9,K7,S7,QAR,K7STR,I7STR,U7,J7,T7)
      CALL DEFFNC(KSTR,N1AR,A1AR,Q1AR,S7,M2,X,R,S,T,K7,K7STR,U7)
C      WRITE(7,149)X,(N1AR(K),K=1,12),(NAR(K),K=1,12)
C-----------------------------------------------------------------
C CHECK INCOMING PATH FOR START PATH.
C-----------------------------------------------------------------
      IF(R .NE. 1) GO TO 6440
      DO 150 K = 1,M2
         N8AR(K) = N1AR(K)*NAR(K)
         A8AR(K) = A1AR(K)*AAR(K)
         Q8AR(K) = Q1AR(K)*QAR(K)
C         WRITE(1,17)N8AR(K)
150   CONTINUE
      ISTR = 6
```

```
      CALL DEFND(S,ISTR,N8AR,A8AR,Q8AR,M2
      GO TO 6730
C---------------------------------------------------------------------
C INCOMING PATH NOT START PATH
C---------------------------------------------------------------------
6440  DO 6660 K = 1,M2
C      WRITE(1,17)NAR(K)
17    FORMAT(' NAR(K)-',PD12.6)
         K1 = (-2)
         K1 = K1+3*K
         K1P1 = K1 + 1
         K1P2 = K1 + 2
         IF(N1AR(K) .GT. 0.0D 00) GO TO 6460
         N1AR(K) = 0.0D 00
6460     IF(N1AR(K) .LT. 1.0D 00) GO TO 6470
         N1AR(K) = 1.0D 00
6470     SGN = N1AR(K)+(-5.0D-01)
         IF(SGN .NE. 0.0D 00)SGN = DSIGN(1.0D 00,SGN)
190      N2 = (1.0D 00 - N1AR(K))+((1.0D-25)*SGN)
         SGN = 5.0D-01 - N1AR(K)
         IF(SGN .NE. 0.0D 00)SGN = DSIGN(1.0D 00,SGN)
220      N3 = N1AR(K)+(1.0D-25 * SGN)
         ONEN3 = 1.0D 00/N3
         IF(A1AR(K) .LT. ONEN3) GO TO 6520
         A1AR(K) = 1.0D 00/N3
6520     IF(Q1AR(K) .LT. ONEN3) GO TO 6530
         Q1AR(K) = 1.0D 00/N3
6530     N8AR(K) = N1AR(K)*NAR(K)
         A8AR(K) = A1AR(K)*AAR(K)
         Q8AR(K) = Q1AR(K)*QAR(K)
         N9AR(K) = NAR(K)-N8AR(K)
         A9AR(K) = (1.0D 00 - N1AR(K)*A1AR(K))*AAR(K)/N2
         Q9AR(K) = (1.0D 00 - N1AR(K)*Q1AR(K))*QAR(K)/N2
C       TRACE 6641
         Q81 = Q8AR(K)
         Q91 = Q9AR(K)
         A81 = A8AR(K)
         A91 = A9AR(K)
         KP12 = K + 4
C         WRITE(1,13)GSTR(KP12,J)
13       FORMAT(' GSTR-',I10)
         IF(GSTR(KP12,J) .EQ. 0) GO TO 6660
         P = GSTR(KP12,J)
         P9 = P
6580     P1 = P9-3
         IF(P1 .LE. 0) GO TO 6590
         P9 = P9-3
         GO TO 6580
6590     IF(P .LT. 4) GO TO 6630
         A8AR(K) = (1.0D 00 - QAR(K))*A8AR(K)
```

```
          Q8AR(K) = DABS(RAR(K,P8))
142       IF(RAR(K,P9) .GT. 0.0D 00) GO TO 6600
          A9AR(K) = 0.0D 00
6600      D1AR(K1P1) = D1AR(K1P1)-(A81-A8AR(K))*N8AR(K)/ZAR(K1)
          D1AR(K1P2) = D1AR(K1P2)-(Q81-Q8AR(K))*N8AR(K)/ZAR(K1)
          INM = 2
C          WRITE(1,9999)K1P2,D1AR(K1P2),INM
          IF(P .LT. 7) GO TO 6660
6630      A9AR(K) = (1.0D 00 - Q9AR(K))*A9AR(K)
          Q9AR(K) = DABS(RAR(K,P9))
          IF(RAR(K,P9) .GT. 0.0D 00) GO TO 6640
          A9AR(K) = 0.0D 00
6640      D1AR(K1P1) = D1AR(K1P1)-(A91-A9AR(K))*N9AR(K)/ZAR(K1)
C          WRITE(1,19)N8AR(K),N9AR(K)
19        FORMAT('N8AR-',PD12.6,2X,'N9AR-',PD12.6)
          D1AR(K1P2) = D1AR(K1P2)-(Q91-Q9AR(K))*N9AR(K)/ZAR(K1)
          INM = 3
C          WRITE(1,9999)K1P2,D1AR(K1P2),INM
6660   CONTINUE
       ISTR = 6
C       WRITE(7,167)S,(N8AR(K),K=1,12),T,(N9AR(K),K=1,12)
167    FORMAT(I3,'1',/,2(6(2X,PD10.2),/),I3,'1',/,2(6(2X,PD10.2),
     *        /),/)
       CALL DEFFND(S,ISTR,N8AR,A8AR,Q8AR,M2)
       CALL DEFFND(T,ISTR,N9AR,A9AR,Q9AR,M2)
C----------------------------------------------------------------
C SCRAP NODE DETERMINATION AND MFG. PATH SETTING.
C----------------------------------------------------------------
       IF((S .LT. 16) .OR. (S .GT. 27)) GO TO 6730
       DO 300 K = 1,M2
          NAR(K) = N8AR(K)
          AAR(K) = 0.0D 00
          QAR(K) = 0.0D 00
300    CONTINUE
       Y = S-12
       CALL DEFFND(Y,ISTR,NAR,AAR,QAR,M2)
C----------------------------------------------------------------
C IF MORE NODES TO BE COVERED GO BACK AND DO AGAIN. IF DONE, DO
C WEIBULL DISTRIBUTION.
C----------------------------------------------------------------
6730   IF(J .NE. Z1) GO TO 6110
       ISTR = 5
       CALL DEFFND(2,ISTR,N8AR,A8AR,Q8AR,M2)
       CALL DEFFND(3,ISTR,N9AR,A9AR,Q9AR,M2)
       DO 6800 K = 1,M2
          K1 = (-2)+3*K
          D1AR(K1) = N8AR(K)-N9AR(K)
          K1P1 = K1+1
          D1AR(K1P1)=D1AR(K1P1)+1.0D 00 - (N8AR(K)-N9AR(K))*
     *    ZAR(K1P1)/ZAR(K1)
```

```
         Q8 = (B(K)/B1(K))*(ZAR(K1P1)/B1(K))**(B(K)-1.0D 00)
         K1P2 = K1+2
         D1AR(K1P2) = D1AR(K1P2)+Q8*(1.0D 00 - ZAR(K1P2))-
      *  (N8AR(K)-N9AR(K))*ZAR(K1P2)/ZAR(K1)
         INM = 4
C         WRITE(1,9998)K1P2,D1AR(K1P2),INM
6800     CONTINUE
      DO 6875 I = 16,28
         L = I
         IF(L .LT. 28) GO TO 6820
         L = 3
6820     ISTR = 5
         CALL DEFFND(L,ISTR,N8AR,A8AR,Q8AR,M2)
         DO 6870 K = 1,M2
            K1 = (-2)+3*K
            K1P1 = K1 + 1
            K1P2 = K1 + 2
            D1AR(K1P1) = D1AR(K1P1)-(A8AR(K)*N8AR(K)/ZAR(K1))
            D1AR(K1P2) = D1AR(K1P2)-(Q8AR(K)*N8AR(K)/ZAR(K1))
            INM = 5
C            WRITE(1,9998)K1P2,D1AR(K1P2),INM
6870     CONTINUE
6875  CONTINUE
C      WRITE(1,9997)(D1AR(K),K=1,M1)
9997  FORMAT(' D1AR:',/,6(6(PD12.4,2X),/),/)
9998  FORMAT(' D1AR(',I2,'):',PD12.4,2X,I2)
 9999 RETURN
      END
C*********************************************************************
C*********************************************************************
      SUBROUTINE DEFFNF(A9,M2,Z3,C0,S7,K7,T9,J7,PRNGB,PRNGT)
C
      IMPLICIT REAL*8(A-B,D-F,M-Z),INTEGER*2(C,G-M)
C
      COMMON/I1/GSTR(34,200)
      COMMON/I2/CSTR(200)
      COMMON/I3/C9DAT(200)
C
      COMMON/R1/NDATA(30,200)
      COMMON/R2/ADATA(30,200)
      COMMON/R3/QDATA(30,200)
      COMMON/R9/DATC2(30,200)
C
      REAL*8 CAR(30),NAR(30),QAR(30),AAR(30),COAR(30)
      REAL*8 C0,POCT
C
      INTEGER*2 ISORT(30)
      INTEGER*2 M2,Z3,A9,I,K1,J,S7,K7,J7,PRNGB,PRNGT,ITEMP
      INTEGER*4 NUMB
C
```

```
      IF(S7 .EQ. 0) WRITE(7,7000) T9
7000  FORMAT(1H1,1X,'YEAR',F5.1/)
      CALL DEFFND(1,5,NAR,AAR,QAR,M2)
      DO 7090 K=1,M2
         IF(S7 .EQ. 0) WRITE(7,7080) K,NAR(K),AAR(K),QAR(K)
7080     FORMAT(1X,'PATH   1   COMPONENT ',I2,'   NUM     =',F11.2,
     *   ' AV. AGE = ',F7.3,' QUAL = ',F6.4)
7090  CONTINUE
      IF(S7 .EQ. 0) WRITE(7,7095)
7095  FORMAT(1H )
      DO 7150 I=PRNGB,PRNGT
         K1=0
         CALL DEFFND(I,5,NAR,AAR,QAR,M2)
         DO 7140 K=1,M2
            IF(NAR(K) .LT. 0.01) GO TO 7140
            IF(S7 .EQ. 0) WRITE(7,7130) I,K,NAR(K),AAR(K),QAR(K)
            K1=K1+1
7130        FORMAT(1X,'PATH ',I3,'  COMPONENT ',I2,'  NUM/YR =',
     *       F11.2,' AV.AGE = ',F7.3,' QUAL = ',F6.4)
7140     CONTINUE
         IF(K1.EQ.0) GO TO 7150
         IF(S7 .EQ. 0) WRITE(7,7095)
7150  CONTINUE
7160  J=0
      CO=0
      IF(A9.EQ.1) GO TO 7180
      IF(S7 .EQ. 0) WRITE(7,7095)
7180  DO 7240 I=1,Z3
         DO 7242 JX=1,12
            CAR(JX) = 0.00D 00
7242     CONTINUE
         CALL DEFFND(I,5,NAR,AAR,QAR,M2)
         K1=0
         CALL DEFFNB(CAR,NAR,QAR,M2,I,J,S7,K7,J7)
         DO 7230 K=1,M2
            COAR(K) = COAR(K) + CAR(K)
            POCT = POCT + CAR(K)
            CO = CO + CAR(K)
            IF(A9.EQ.1) GO TO 7230
            IF(CAR(K).EQ.0.) GO TO 7230
            IF(S7 .EQ. 0) WRITE(7,7220) I,K,CAR(K)
            K1=K1+1
7220        FORMAT(1X,' PATH ',I3,'  COMPONENT ',I2,'   PATH C',
     *      'OST =$'F12.2)
7230     CONTINUE
         IF(K1.EQ.0) GO TO 7240
         IF(S7 .EQ. 0)WRITE(7,7235)I,POCT
7235     FORMAT(22X,'TOTAL PATH ',I3,' COST = $'F14.2)
         POCT = 0.00
         IF(S7 .EQ. 0) WRITE(7,7095)
```

```
7240  CONTINUE
      IF(S7 .EQ. 0) WRITE(7,7095)
      DO 7250 K =1,M2
         ISORT(K) = K
         IF(S7 .EQ. 0) WRITE(7,7255) K,COAR(K)
7255     FORMAT(12X,'COMPONENT ',I2,' TOTAL COST = $',F14.2)
7250  CONTINUE
      ML = M2 - 1
500   ISORTF = 0
      DO 2000 I = 1,ML
         I2 = I + 1
         K = ISORT(I)
         K2 = ISORT(I2)
         IF(COAR(K) .GE. COAR(K2))GO TO 2000
         ISORT(I) = K2
         ISORT(I2) = K
         ISORTF = 1
2000  CONTINUE
      IF(ISORTF .EQ. 1) GO TO 500
      IF(S7 .EQ. 0) WRITE(7,7258)
      IF(S7 .EQ. 0) WRITE(7,7095)
7258  FORMAT(//,'           TOTAL COMPONENT COSTS IN ORDER OF COST')
      DO 2500 I = 1,M2
         K = ISORT(I)
         IF(S7 .EQ. 0) WRITE(7,7255)K,COAR(K)
2500  CONTINUE
      IF(S7 .EQ. 0) WRITE(7,7260)CO
      IF(S7 .EQ. 0) WRITE(7,7095)
7260  FORMAT(24X,'TOTAL COST = $',F14.2)
      RETURN
      END
C**********************************************************************
C**********************************************************************
      SUBROUTINE DEFFNG(S7,CO,A9,K7STR,M2,I7STR,V7,U7,J7,C7,K7,
     *                 Z2,T7,T9,TO,Z4)
      IMPLICIT REAL*8(A-B,D-F,M-Z),INTEGER*2(C,G-L)
C
      COMMON/I1/GSTR(34,200)
C
      COMMON/R1/NDATA(30,200)
      COMMON/R2/ADATA(30,200)
      COMMON/R3/QDATA(30,200)
C
      REAL*8 R7,U7,C7,CO,T9,TO
C
      INTEGER*2 K7STR(30)
      INTEGER*2 S7,A9,M2,V7,I7STR,P7,S7M,Q8,K7,J7,Z2,T7,Z4,Z4M
      IF(S7 .NE. 0)GO TO 8030
      S7=V7+1
      V7=S7
```

```
      K7=1
      P7=0
      C7=C0
      GO TO 8170
 8030 IF(S7 .LT. 0) GO TO 8110
      R7=(C0-C7)/C7
      WRITE(1,8050) S7,J7,K7,R7,I7STR
      P7=P7+1
 8050 FORMAT(1X,'BRANCH NODE ',I3,'  NODE ',I3,'   COMPONENT ',
     *'      I2,'SENSITIVITY = $',F16.2,'%',3X,I5)
      IF(T7 .EQ. 2 ) GO TO 8170
 8070 K7=K7+1
      IF(K7 .GT. M2) GO TO 8080
      Q8=1
      IF(K7STR(K7) .EQ. 1) GO TO 8075
      GO TO 8170
 8075 IF(K7STR(Q8) .EQ. 1) GO TO 8070
      Q8=Q8+1
      IF(Q8 .LT. K7) GO TO 8075
      GO TO 8170
 8080 DO 8082 K=1,12
         K7STR(K)=0
 8082 CONTINUE
      IF(P7 .EQ. 0) GO TO 8090
      WRITE(1,8085)
 8085 FORMAT(1H )
      P7=0
 8090 S7=S7+1
      K7=1.
      IF(S7 .LE. Z2) GO TO 8170
      WRITE(1,8085)
      S7=(-1)
      K7=1
      P7=0
 8110 R7=(C0-C7)/1.0
      IF(R7 .EQ. 0) GO TO 8130
      S7M=S7*(-1)
      WRITE(1,8120)S7M,J7,K7,R7
      P7=P7+1
 8120 FORMAT(3X,'COST PATH ',I3,'  PATH ',I3,'  COMPONENT ',I2,
     *        ' SENSITIVITY = $',F16.2/'%')
 8130 K7=K7+1.
      IF(K7 .LE. M2) GO TO 8170
      IF(P7 .EQ. 0) GO TO 8150
      WRITE(1,8085)
      P7=0
 8150 S7 = S7-1
      K7=1.
      Z4M=Z4*(-1)
      IF(S7 .LT. Z4M) GO TO 8160
```

```
      GO TO 8170
8160  S7=0
      T9=T0
      WRITE(1,8085)
8170  RETURN
      END
C*********************************************************************
C*********************************************************************
      SUBROUTINE DEFFNH(KAR,D1AR,M1,T1)
      IMPLICIT REAL*8(A-B,D-F,M-Z),INTEGER*2(C,G-L)
C
      COMMON/R4/ZAR(90)
      COMMON/R5/SAR(90)
C
      REAL*8 KAR(90),D1AR(90)
      REAL*8 T1
C
      INTEGER*2 M1,I
C
      DO 100 I=1,M1
      KAR(I)=D1AR(I)
      ZAR(I)=(T1/2.0)*D1AR(I)
      ZAR(I)=ZAR(I)+SAR(I)
  100 CONTINUE
      RETURN
      END
C*********************************************************************
C*********************************************************************
      SUBROUTINE DEFFNI(LAR,D1AR,M1,T1)
      IMPLICIT REAL*8(A-B,D-F,M-Z),INTEGER*2(C,G-L)
C
      COMMON/R4/ZAR(90)
      COMMON/R5/SAR(90)
C
      REAL*8 LAR(90),D1AR(90)
      REAL*8 T1
C
      INTEGER*2 M1,I
C
      DO 100 I=1,M1
      LAR(I)=D1AR(I)
      ZAR(I)=(T1/2.0)*D1AR(I)
      ZAR(I)=ZAR(I)+SAR(I)
  100 CONTINUE
      RETURN
      END
C*********************************************************************
C*********************************************************************
      SUBROUTINE DEFFNJ(MAR,D1AR,M1,T1)
      IMPLICIT REAL*8(A-B,D-F,M-Z),INTEGER*2(C,G-L)
```

```
C
      COMMON/R4/ZAR(90)
      COMMON/R5/SAR(90)
C
      REAL*8 MAR(90),D1AR(90)
      REAL*8 T1
C
      INTEGER*2 M1,I
C
      DO 100 I=1,M1
      MAR(I)=D1AR(I)
      ZAR(I)=T1*D1AR(I)
      ZAR(I)=ZAR(I)+SAR(I)
  100 CONTINUE
      RETURN
      END
```

APPENDIX D

CONTROL FILE LISTING

0	1	S7	
0	2	C9	
1	3	T7	
1	4	K7	
0	5	NR	# OF REWORKINGS
21	6	M2	# OF COMPONENTS
120	7	Z1	# OF NODES
47	8	Z2	# OF BRANCH NODES
184	9	Z3	# OF PATHS
184	10	Z4	# OF COST PATHS
1	11	PRNGB	BOTTOM OF PATH FLOW OUTPUT RANGE
184	12	PRNGT	TOP OF PATH FLOW OUTPUT RANGE
0	13	A	TOPOLOGY PRINTOUT INDICATOR
1	14	A7	SENSITIVITY ANALYSIS INDICATOR
1	15	V7	SENSITIVITY INITIATOR
0.0	16	T0	SIMULATION TIME CONTROL
1.0	17	T1	SIMULATION TIME CONTROL
1.0	18	T2	SIMULATION TIME CONTROL
0	19	A9	COST PATH PRINT OUT INDICATOR
0	20		AVAILABLE
0	21		AVAILABLE
0	22		AVAILABLE

Entry Description

Program Variable Designator

Row Number

File Entry Value

CIFILE:

CIFILE contains 1 data value per line in the first 5 columns. Integers should be right or left justified according to the conventions of the machine used. Following the data is a line number, the variable name used, and a short description of the purpose of the data. The data, real or integer in this file is used for control indices in the program.

Line #1: S7 - positive values of S7 indicate the branch node where sensitivity analysis is being done. Negative values indicate the path where analysis is concerned. Value read in here, initiates the indicator to 0.

Line #2: C9 - "C" - split parameter reassignment indicator. C9 indicates the "C" split value of the first component of a given node should be assigned to all the components passing through that node. This line initiates C9 to 0.

Line #3: T7 - T7 indicates the presence of a "D" and "E" decision. A value of 2 will cause the sensitivity analysis to repeat for a node/component. The second time around though, the "E" split parameter is altered instead of the "D". This line initiates T7 to 1.

Line #4: K7 - Component sensitivity indicator. Set here to 1 for base run. It is reset in DEFFNG.

Line #5: NR - The number of lines of rework data. Used in loop to read in data.

Line #6: NKDT - The number of nodes needing KSTR() data.

Line #7: M2 - The number of components in the system. Used to control loops.

Line #8: Z1 - The total number of nodes in the system, sums, nulls and branches.

Line #9: Z2 - The total number of branch nodes.

Line #10: Z3 - The total number of paths in the system.

CIFILE Continued

Line #11: Z4 - The number of paths with associated costs.

Line #12: PRNGB - The low end of the path flow output loop PRNGB and PRNGT (line 12) are used to screen out excessive output.

Line #13: PRNGT - See line 11. The high end of the path flow output loop.

Line #14: A - Indicator to print out node topology guide.

Line #15: A7 - The sensitivity analysis indicator, A7 activates DEFFNG. Note when A7 is set to 1 (activate), to (line 16) should be set to 0.

Line #16: V7 - The sensitivity analysis initiator. V7 indicates the first node for sensitivity analysis.

Line #17: TØ - The end time of a time simulation run. TØ is a real number read with a F4.1 format.

Line #18: T1 - The time step for a time simulation run. T1 is a real and is read with a F4.1 format.

Line #19: T2 - Is the time simulation output frequency. T2 indicates the number of time steps per output. T2 is also a real. Read with a F4.1 format.

Line #20: A9 - The cost output suppressor. Used to limit the quantity of output generated by a time simulation.

Line #21: Available for future modifications.

Line #22: Available for future modifications.

APPENDIX E

DATA FILE LISTING - AMTRAK EXAMPLE

AMTRAK DATA FILE DESCRIPTIONS

Data File Description

DATA5:

DATA5 is divided up into sections that the main program, SCM, reads sequentially and stores in several holding arrays. All sections are read through a free format. Each line in the file is appended with a short description common to the section to which that line belongs. Some sections end with a "999 / END OF_____" This is an indicator for loops without a DO statement. Data sections are as follows:

GSTR() NODE INFO:

This section uses 4 numbers -- each separated by 1 or more blanks. The first number indicates node type. If less than 0, the node is a null. Nulls are node numbers that do not appear on the schematic diagram. They remain in the model as available for modifications. If the first number is 0, the node is a sum node. For a sum node, the second and third numbers are the incoming paths and the fourth is the outgoing path number. A first number greater than 0 indicates a branching node. In this case the number is also the Branch Node number, used to assign the appropriate node split parameters in DEFFNA (see next section). The second number indicates the incoming path while the third and fourth indicate the outgoing paths. The first outgoing path (third number) is the reference path for the split parameters. This section is read through a DO loop and has no end of section data line. All data are in integer form.

NODE SPLIT DATA:

This section contains 6 numbers per line, 2 integers, 3 reals, and a single integer respectively. The first number is the Branch Node number that the data concerns. The second number indicates the component concerned. The next 3 numbers are the "C", "D", and "E" decision split parameters. If the "C" value is greater than or equal to 0, the "D" and "E" values will be equal to 0. The sixth and final number will be the C9 value for the given Branch Node. A C9 value of 1 indicates that

The "C" value of the first component will be assigned to all the components of that node. This applies only if "C" is not less than 0. The section ends with a "999" data line.

REWORK DATA -- (see Appendix M for Example Input and Explanation of Use)

This section has 6 numbers per line: 5 integers and a real. The first indicates the component needing work. The second number indicates which rework number this data line is associated with. The third number is upstream from the node from which this rework path emanates. The fourth and fifth numbers indicate whether the rework path is on a reference path and to what portion of the component his data are applied.

The sixth number is the component "quality" after rework. The data are read with a DO loop and has no end of data line. If there is no rework data (NR = Qual Ø) the program will skip around the READ statement.

KSTR() DATA:

These data are subassembly indicators. The section consists of the Branch Node number followed by ones and zeros. There are 2 lines per node number required. The first line holds indicators for components 1 through 15, the second for components 16 through 30. Enter a "1" for each component that is part of the subassembly for the particular branch node given. Data are read in through a DO loop. There is no end of data line.

COST PATH FACTORS:

There are 6 numbers per line, 2 integers and 4 reals. The first number is the path to which these cost factors are to be applied. The second number is the component involved. The next 4 are cost factors (i.e., hourly labor rate, hours per unit, unit cost, and a special cost factor). This data section ends with a "999" end of data line.

COST FUNCT INDIC: (see Appendix M for Example Input and Explanation of Use)

There are only 2 integers per line. The first is the schematic diagram path number involved. The second indicates the function to be used in calculating the path costs. The section has a "999" end of section indicator.

STATE VALUES ZAR():

There are 3 numbers per line, 1 line per component. These are the starting population state values. The first number is the total component population, the second is the average age for the component and the last is the quality for the component.

RATE POP WEIB:

There are 3 numbers per line, all real, 1 line per component. The first number is the rate at which the component population expands. The second is the Weibull slope. The third is the characteristic life of the component.

A "99999" indicates the end of the file.

1	1	30	1	/	GSTR( )	NØDE INFØ
2	30	31	32	/	GSTR( )	NØDE INFØ
3	31	33	34	/	GSTR( )	NØDE INFØ
4	33	36	35	/	GSTR( )	NØDE INFØ
5	36	17	37	/	GSTR( )	NØDE INFØ
0	37	5	59	/	GSTR( )	NØDE INFØ
-1	0	0	0	/	GSTR( )	NØDE INFØ
-1	0	0	0	/	GSTR( )	NØDE INFØ
-1	0	0	0	/	GSTR( )	NØDE INFØ
6	35	53	54	/	GSTR( )	NØDE INFØ
7	53	16	38	/	GSTR( )	NØDE INFØ
0	38	4	39	/	GSTR( )	NØDE INFØ
-1	0	0	0	/	GSTR( )	NØDE INFØ
-1	0	0	0	/	GSTR( )	NØDE INFØ
8	1	40	1	/	GSTR( )	NØDE INFØ
9	40	41	42	/	GSTR( )	NØDE INFØ
10	41	44	43	/	GSTR( )	NØDE INFØ
0	44	54	45	/	GSTR( )	NØDE INFØ
11	45	19	46	/	GSTR( )	NØDE INFØ
0	46	7	47	/	GSTR( )	NØDE INFØ
-1	0	0	0	/	GSTR( )	NØDE INFØ
12	47	48	49	/	GSTR( )	NØDE INFØ
0	49	39	50	/	GSTR( )	NØDE INFØ
13	50	18	51	/	GSTR( )	NØDE INFØ
0	51	6	52	/	GSTR( )	NØDE INFØ
-1	0	0	0	/	GSTR( )	NØDE INFØ
0	48	34	55	/	GSTR( )	NØDE INFØ
0	55	43	56	/	GSTR( )	NØDE INFØ
-1	0	0	0	/	GSTR( )	NØDE INFØ
14	56	58	57	/	GSTR( )	NØDE INFØ
-1	0	0	0	/	GSTR( )	NØDE INFØ
15	1	60	1	/	GSTR( )	NØDE INFØ
16	60	61	62	/	GSTR( )	NØDE INFØ
17	61	64	63	/	GSTR( )	NØDE INFØ
0	64	63	65	/	GSTR( )	NØDE INFØ
0	58	65	59	/	GSTR( )	NØDE INFØ
18	59	70	78	/	GSTR( )	NØDE INFØ
-1	0	0	0	/	GSTR( )	NØDE INFØ
19	78	79	80	/	GSTR( )	NØDE INFØ
20	70	71	102	/	GSTR( )	NØDE INFØ
21	71	72	73	/	GSTR( )	NØDE INFØ
22	72	20	74	/	GSTR( )	NØDE INFØ
0	74	8	75	/	GSTR( )	NØDE INFØ
0	79	73	101	/	GSTR( )	NØDE INFØ
23	1	100	1	/	GSTR( )	NØDE INFØ
-1	0	0	0	/	GSTR( )	NØDE INFØ
-1	0	0	0	/	GSTR( )	NØDE INFØ
-1	0	0	0	/	GSTR( )	NØDE INFØ
-1	0	0	0	/	GSTR( )	NØDE INFØ
24	1	160	1	/	GSTR( )	NØDE INFØ
25	160	25	161	/	GSTR( )	NØDE INFØ
0	161	13	162	/	GSTR( )	NØDE INFØ

[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
-1	0	0	0	/	GSTR( ) NODE INFO
27	163	169	166	/	GSTR( ) NODE INFO
29	169	170	171	/	GSTR( ) NODE INFO
29	171	172	173	/	GSTR( ) NODE INFO
30	173	27	175	/	GSTR( ) NODE INFO
0	175	15	177	/	GSTR( ) NODE INFO
-1	0	0	0	/	GSTR( ) NODE INFO
-1	0	0	0	/	GSTR( ) NODE INFO
-1	0	0	0	/	GSTR( ) NODE INFO
-1	0	0	0	/	GSTR( ) NODE INFO
-1	0	0	0	/	GSTR( ) NODE INFO
31	166	26	174	/	GSTR( ) NODE INFO
0	174	14	176	/	GSTR( ) NODE INFO
-1	0	0	0	/	GSTR( ) NODE INFO
-1	0	0	0	/	GSTR( ) NODE INFO
-1	0	0	0	/	GSTR( ) NODE INFO
-1	0	0	0	/	GSTR( ) NODE INFO
0	102	172	111	/	GSTR( ) NODE INFO
0	111	100	106	/	GSTR( ) NODE INFO
32	106	107	145	/	GSTR( ) NODE INFO
33	145	146	147	/	GSTR( ) NODE INFO
0	101	170	112	/	GSTR( ) NODE INFO
34	107	110	109	/	GSTR( ) NODE INFO
35	109	116	115	/	GSTR( ) NODE INFO
36	115	22	117	/	GSTR( ) NODE INFO
0	117	10	123	/	GSTR( ) NODE INFO
-1	0	0	0	/	GSTR( ) NODE INFO
37	116	118	121	/	GSTR( ) NODE INFO
38	118	21	119	/	GSTR( ) NODE INFO
0	119	9	120	/	GSTR( ) NODE INFO
0	120	121	122	/	GSTR( ) NODE INFO
0	123	122	124	/	GSTR( ) NODE INFO
0	110	112	130	/	GSTR( ) NODE INFO
39	130	131	132	/	GSTR( ) NODE INFO
40	131	134	133	/	GSTR( ) NODE INFO
41	134	23	135	/	GSTR( ) NODE INFO
0	135	11	136	/	GSTR( ) NODE INFO
-1	0	0	0	/	GSTR( ) NODE INFO
42	133	24	137	/	GSTR( ) NODE INFO
0	137	12	138	/	GSTR( ) NODE INFO
0	136	138	140	/	GSTR( ) NODE INFO
0	132	140	141	/	GSTR( ) NODE INFO
43	141	142	144	/	GSTR( ) NODE INFO
0	124	142	143	/	GSTR( ) NODE INFO
0	147	146	148	/	GSTR( ) NODE INFO
0	148	143	150	/	GSTR( ) NODE INFO
0	177	178	179	/	GSTR( ) NODE INFO
0	179	180	181	/	GSTR( ) NODE INFO
0	176	181	182	/	GSTR( ) NODE INFO
0	182	165	184	/	GSTR( ) NODE INFO
44	144	105	180	/	GSTR( ) NODE INFO

EXAMPLE
FOR ILLUSTRATION ONLY
DATA

45	[illegible]	[illegible]	[illegible]				GSTR( ) NØDE INFØ
0	80	21	86			/	GSTR( ) NØDE INFØ
-1	0	0	0			/	GSTR( ) NØDE INFØ
-1	0	0	0			/	GSTR( ) NØDE INFØ
-1	0	0	0			/	GSTR( ) NØDE INFØ
0	75	82	76			/	GSTR( ) NØDE INFØ
-1	0	0	0			/	GSTR( ) NØDE INFØ
-1	0	0	0			/	GSTR( ) NØDE INFØ
-1	0	0	0			/	GSTR( ) NØDE INFØ
46	150	149	103			/	GSTR( ) NØDE INFØ
47	149	104	178			/	GSTR( ) NØDE INFØ
-1	0	0	0			/	GSTR( ) NØDE INFØ
0	86	103	87			/	GSTR( ) NØDE INFØ
0	76	104	77			/	GSTR( ) NØDE INFØ
0	77	57	89			/	GSTR( ) NØDE INFØ
-1	0	0	0			/	GSTR( ) NØDE INFØ
1	1	308.45	0 0	0 0	1	/	NØDE SPLIT VALUES
2	1	229156	0 0	0 0	1	/	NØDE SPLIT VALUES
3	1	.971007	0.0	0 0	1	/	NØDE SPLIT VALUES
4	1	900000	0.0	0.0	1	/	NØDE SPLIT VALUES
5	3	00102179	0.0	0.0	0	/	NØDE SPLIT VALUES
5	8	0008304	0 0	0.0	0	/	NØDE SPLIT VALUES
5	9	00051091	0 0	0 0	0	/	NØDE SPLIT VALUES
5	10	0012262	0 0	0 0	0	/	NØDE SPLIT VALUES
5	13	.0030654	0 0	0.0	0	/	NØDE SPLIT VALUES
5	15	.0030654	0 0	0.0	0	/	NØDE SPLIT VALUES
5	16	055359	0 0	0 0	0	/	NØDE SPLIT VALUES
5	17	00068119	0.0	0.0	0	/	NØDE SPLIT VALUES
6	1	994466	0 0	0 0	1	/	NØDE SPLIT VALUES
7	3	00102749	0.0	0.0	0	/	NØDE SPLIT VALUES
7	8	.0008304	0.0	0 0	0	/	NØDE SPLIT VALUES
7	9	00051374	0.0	0.0	0	/	NØDE SPLIT VALUES
7	10	00123298	0.0	0 0	0	/	NØDE SPLIT VALUES
7	13	.00308247	0 0	0.0	0	/	NØDE SPLIT VALUES
7	15	00309247	0 0	0 0	0	/	NØDE SPLIT VALUES
7	16	.0556689	0 0	0.0	0	/	NØDE SPLIT VALUES
7	17	0006849	0.0	0.0	0	/	NØDE SPLIT VALUES
8	1	56.549	0.0	0.0	1	/	NØDE SPLIT VALUES
9	1	0339975	0.0	0 0	1	/	NØDE SPLIT VALUES
10	1	9755036	0 0	0.0	1	/	NØDE SPLIT VALUES
11	3	0060475	0 0	0.0	0	/	NØDE SPLIT VALUES
11	9	.00302378	0.0	0 0	0	/	NØDE SPLIT VALUES
11	10	00725704	0.0	0.0	0	/	NØDE SPLIT VALUES
11	13	018144	0.0	0.0	0	/	NØDE SPLIT VALUES
11	15	01814272	0 0	0.0	0	/	NØDE SPLIT VALUES
11	17	0040319	0 0	0 0	0	/	NØDE SPLIT VALUES
12	[illegible]	[illegible]	0 0	0 0	0	/	NØDE SPLIT VALUES
12	9	00007356	0 0	0 0	0	/	NØDE SPLIT VALUES
12	10	00017655	0 0	0.0	0	/	NØDE SPLIT VALUES
12	13	00044178	0 0	0 0	0	/	NØDE SPLIT VALUES
12	15	00044178	0 0	0 0	0		NØDE SPLIT VALUES
12	17	00009809	0 0	0 0	0	/	NØDE SPLIT VALUES

EXAMPLE
FOR ILLUSTRATION ONLY
DATA

[illegible]							[illegible]
[illegible]	1	[illegible]	0 0	0 0	1		NØDE SPLIT VALUES
16	1	2500	0 0	0 0	1	/	NØDE SPLIT VALUES
17	1	50000	0 0	0 0	1	/	NØDE SPLIT VALUES
18	1	1 0	0 0	0 0	1	/	NØDE SPLIT VALUES
20	1	.952	0 0	0 0	1	/	NØDE SPLIT VALUES
21	1	1 0	0 0	0 0	0		NØDE SPLIT VALUES
21	2	1 0	0 0	0 0	0	/	NØDE SPLIT VALUES
21	[illegible]	1 0	0 0	0 0	0	/	NØDE SPLIT VALUES
21	[illegible]	1 0	0 0	0 0	0		NØDE SPLIT VALUES
21	8	1 0	0 0	0 0	0		NØDE SPLIT VALUES
21	9	1 0	0 0	0 0	0	/	NØDE SPLIT VA
21	10	1 0	0 0	0 0	0	/	NØDE SPLIT
21	11	1.0	0 0	0 0	0	/	NØDE SP
21	12	1.0	0 0	0 0	0	/	NØD
21	13	1.0	0 0	0 0	0		
21	14	1 0	0 0	0.0	0		
21	15	1 0	0 0	0 0	0		ES
21	16	1 0	0 0	0 0	0	/	ALUES
21	17	1 0	0 0	0 0	0		T VALUES
21	18	1 0	0 0	0.0	0	/	SPLIT VALUES
21	20	1.0	0.0	0.0	0	/	ØDE SPLIT VALUES
21	21	1 0	0 0	0 0	0	/	NØDE SPLIT VALUES
22	1	04946377	0 0	0 0	0	/	NØDE SPLIT VALUES
22	2	2473188	0 0	0 0	0	/	NØDE SPLIT VALUES
22	11	.4946375	0 0	0 0	0	/	NØDE SPLIT VALUES
22	18	0494637	0.0	0.0	0	/	NØDE SPLIT VALUES
22	20	.123659	0.0	0.0	0	/	NØDE SPLIT VALUES
22	21	.041219	0 0	0.0	0	/	NØDE SPLIT VALUES
23	1	.2500	0.0	0.0	1	/	NØDE SPLIT VALUES
24	1	3.04137	0.0	0.0	1	/	NØDE SPLIT VALUES
26	1	.76512	0 0	0 0	1	/	NØDE SPLIT VALUES
27	1	.24569	0.0	0.0	1	/	NØDE SPLIT VALUES
28	4	.065435	0.0	0.0	0	/	NØDE SPLIT VALUES
28	6	.065435	0.0	0.0	0	/	NØDE SPLIT VALUES
28	7	.065435	0 0	0.0	0	/	NØDE SPLIT VALUES
28	19	065435	0.0	0.0	0	/	NØDE SPLIT VALUES
29	1	100	0 0	0 0	1	/	NØDE SPLIT VALUES
30	1	00160616	0 0	0.0	0	/	NØDE SPLIT VALUES
30	2	.00401556	0.0	0.0	0	/	NØDE SPLIT VALUES
30	3	00188169	0 0	0.0	0	/	NØDE SPLIT VALUES
30	8	.0034953	0.0	0.0	0	/	NØDE SPLIT VALUES
30	9	.00013438	0.0	0.0	0	/	NØDE SPLIT VALUES
30	10	00064508	0 0	0.0	0	/	NØDE SPLIT VALUES
30	11	.032125	0 0	0 0	0	/	NØDE SPLIT VALUES
30	13	0032257	0 0	0 0	0	/	NØDE SPLIT VALUES
30	15	0161280	0 0	0 0	0	/	NØDE SPLIT VALUES
30	16	072822	0 0	0 0	0	/	NØDE SPLIT VALUES
30	17	00071676	0.0	0.0	0	/	NØDE SPLIT VALUES
30	18	0004015	0 0	0 0	0	/	NØDE SPLIT VALUES
30	20	0008031	0 0	0 0	0	/	NØDE SPLIT VALUES
30	21	[illegible]	0 0	0 0	[illegible]		NØDE SPLIT VALUES

EXAMPLE FOR ILLUSTRATION ONLY
DATA

31	8	000677[illegible]		0		0	0	[illegible]
31	9	00003[illegible]	0	0	0	0	0	NODE SPLIT VALUES
31	10	00016129	0	0	0	0	0	NODE SPLIT VALUES
31	13	00020[illegible]48	0	0	0	0	0	NODE SPLIT VALUES
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]
31	16	0[illegible]3E4[illegible]		0	0			[illegible]
31	17	0000[illegible]1	0	0	0	0	0	NODE SPLIT VALUES
31	20	00010079	0	0	0	0	0	NODE SPLIT VALUES
31	21	00026770	0	0	0	0	0	[illegible]
32	1	1.0	0	0	0	0	0	NODE SPLIT
32	2	1.0	0	0	0	0	0	NODE SPLIT
32	3	1.0	0	0	0	0	0	NODE
32	4	1.0	0	0	0	0	0	
32	6	1.0	0	0	0	0	0	
32	7	1.0	0	0	0	0	0	
32	8	1.0	0	0	0	0	0	VALUES
32	9	1.0	0	0	0	0	0	VALUES
32	10	1.0	0	0	0	0	0	VALUES
32	13	1.0	0	0	0	0	0	NODE SPLIT VALUES
32	14	1.0	0	0	0	0	0	NODE SPLIT VALUES
32	15	1.0	0	0	0	0	0	NODE SPLIT VALUES
32	16	1.0	0	0	0	0	0	NODE SPLIT VALUES
32	17	1.0	0	0	0	0	0	NODE SPLIT VALUES
32	18	1.0	0	0	0	0	0	NODE SPLIT VALUES
32	19	1.0	0	0	0	0	0	NODE SPLIT VALUES
32	20	1.0	0	0	0	0	0	NODE SPLIT VALUES
32	21	1.0	0	0	0	0	0	NODE SPLIT VALUES
33	5	.02444	0	0	0	0	0	NODE SPLIT VALUES
33	11	.02444	0	0	0	0	0	NODE SPLIT VALUES
33	12	.02444	0	0	0	0	0	NODE SPLIT VALUES
34	4	1.0	0	0	0	0	0	NODE SPLIT VALUES
34	6	1.0	0	0	0	0	0	NODE SPLIT VALUES
34	7	1.0	0	0	0	0	0	NODE SPLIT VALUES
34	19	1.0	0	0	0	0	0	NODE SPLIT VALUES
35	9	1.0	0	0	0	0	0	NODE SPLIT VALUES
35	17	1.0	0	0	0	0	0	NODE SPLIT VALUES
35	18	1.0	0	0	0	0	0	NODE SPLIT VALUES
36	1	.6279	0	0	0	0	0	NODE SPLIT VALUES
36	2	.6789	0	0	0	0	0	NODE SPLIT VALUES
36	3	.6160	0	0	0	0	0	NODE SPLIT VALUES
36	8	.6160	0	0	0	0	0	NODE SPLIT VALUES
36	10	.6160	0	0	0	0	0	NODE SPLIT VALUES
36	13	.6160	0	0	0	0	0	NODE SPLIT VALUES
36	14	.6160	0	0	0	0	0	NODE SPLIT VALUES
36	15	.6160	0	0	0	0	0	NODE SPLIT VALUES
36	16	.6260	0	0	0	0	0	NODE SPLIT VALUES
36	20	.6460	0	0	0	0	0	NODE SPLIT VALUES
36	21	.6260	0	0	0	0	0	NODE SPLIT VALUES
38	5	.610	0	0	0	0	0	NODE SPLIT VALUES
38	17	.610	0	0	0	0	0	NODE SPLIT VALUES
38	18	.861	0	0	0	0	0	NODE SPLIT VALUES

```
39  6    .6974       0.0  0.0  0     NODE SPLIT VALUES
39  7    .6974       0.0  0.0  0     NODE SPLIT VALUES
39       .6974       0.0  0.0  0     NODE SPLIT VALUES
40  4   1.0          0.0  0.0  0     NODE SPLIT VALUES
41  4    .1154       0.0  0.0  0     NODE SPLIT VALUES
42  6    .1156       0.0  0.0  0   / NODE SPLIT VALUES
42  7    .1250       0.0  0.0  0     NODE SPLIT VALUES
42 19    .1190       0.0  0.0  0   /
43  4    .1672       0.0  0.0  0
43  6    .1672       0.0  0.0  0
43  7    .1672       0.0  0.0  0
43 19    .1672       0.0  0.0  0                 VALUES
44  4    .9815       0.0  0.0  0               T VALUES
44  6    .9615       0.0  0.0  0           SPLIT VALUES
44  7    .9515       0.0  0.0  0   /  NODE SPLIT VALUES
44 19    .9215       0.0  0.0  0   /  NODE SPLIT VALUES
45  4   1.0          0.0  0.0  0   /  NODE SPLIT VALUES
45  6   1.0          0.0  0.0  0   /  NODE SPLIT VALUES
45  7   1.0          0.0  0.0  0   /  NODE SPLIT VALUES
45 19   1.0          0.0  0.0  0   /  NODE SPLIT VALUES
46  1     .383947    0.0  0.0  1   /  NODE SPLIT VALUES
47  1     .635595    0.0  0.0  1   /  NODE SPLIT VALUES
999                                /END OF NODE SPLIT
   1 0 0 0 0 0 0 0 0 0 0 0 0 0 0   /  KSTR[illegible] DATA
   1 0 0 0 0 0 0 0 0 0 0 0 0 0 0   /  KSTR[illegible] DATA 2ND
   4  3 18.40   .8333     2.50 1.0 /  COST DATA
   4  8 18.40  1.500      1.20 1.0 /  COST DATA
   4  9 18.40  1.000      3.16 1.0 /  COST DATA
   4 10 18.40   .2500     1.50 1.0 /  COST DATA
   4 12 18.40   .5000      .73 1.0 /  COST DATA
   4 13 18.40   .5000     1.05 1.0 /  COST DATA
   4 15 18.40   .5000     2.62 1.0 /  COST DATA
   4 16 18.40   .2500    65.64 1.0 /  COST DATA
   4 17 18.40  1.000      1.50 1.0 /  COST DATA
   5  3 18.40   .8333     2.50 1.0 /  COST DATA
   5  8 18.40  1.500      1.20 1.0 /  COST DATA
   5  9 18.40  1.000      3.16 1.0 /  COST DATA
   5 10 18.40   .2500     1.50 1.0 /  COST DATA
   5 12 18.40   .5000      .73 1.0 /  COST DATA
   5 13 18.40   .5000     1.05 1.0 /  COST DATA
   5 15 18.40   .5000     2.62 1.0 /  COST DATA
   5 16 18.40   .2500    65.64 1.0 /  COST DATA
   5 17 18.40  1.000      1.50 1.0 /  COST DATA
   6  3 18.40   .8333     2.50 1.0 /  COST DATA
   6  9 18.40  1.250      3.16 1.0 /  COST DATA
   6 10 18.40   .2500     1.50 1.0 /  COST DATA
   6 12 18.40   .5000      .73 1.0 /  COST DATA
   6 13 18.40   .5000     1.05 1.0 /  COST DATA
   6 15 18.40   .5000     2.62 1.0 /  COST DATA
   6 17 18.40  2.000      1.50 1.0 /  COST DATA
   7  3 18.40   .8333     2.50 1.0 /  COST DATA
```

EXAMPLE
FOR ILLUSTRATION ONLY
DATA

7	[illegible]	[illegible]	1.[illegible]	[illegible]	[illegible]		[illegible]
7	10	18.40	.2500	1.50	1.0		CØST DATA
7	12	18.40	.5000	.73	1.0	/	CØST DATA
7	13	18.40	.5000	1.05	1.0	/	CØST DATA
7	15	18.40	.5000	2.62	1.0	/	CØST DATA
7	17	18.40	1.000	1.50	1.0	/	CØST DATA
8	1	20.80	1.500	1.43	1.0	/	CØST DATA
8	2	20.80	12.00	3.80	1.0	/	CØST DATA
8	3	20.80	.8333	2.50	1.0	/	CØST DATA
8	8	20.80	1.500	1.20	1.0	/	CØST DATA
8	9	20.80	1.000	3.16	1.0	/	CØST DAT
8	10	20.80	.2500	1.50	1.0	/	CØ[illegible]
8	11	20.80	1.250	90.00	1.0	/	
8	12	20.80	.2500	.73	1.0		
8	13	20.80	.5000	1.05	1.0		
8	14	20.80	4.000	6.52	1.0		
8	15	20.80	.5000	2.62	1.0		
8	16	20.80	.2500	65.64	1.0		DATA
8	17	20.80	1.000	1.50	1.0		CØST DATA
8	18	20.80	3.000	3.20	1.0	/	CØST DATA
8	20	20.80	4.000	2.50	1.0	/	CØST DATA
8	21	20.80	4.000	.70	1.0	/	CØST DATA
10	1	22.05	0.000	1.43	1.0	/	CØST DATA
10	2	22.05	0.000	3.80	1.0	/	CØST DATA
11	4	22.05	0.000	4.12	1.0	/	CØST DATA
12	6	22.05	0.000	11.68	1.0	/	CØST DATA
12	17	22.05	0.000	8.03	1.0	/	CØST DATA
12	19	22.05	0.000	6.91	1.0	/	CØST DATA
13	16	20.81	.2500	65.64	1.0	/	CØST DATA
14	1	20.80	1.500	1.43	1.0	/	CØST DATA
14	2	20.80	12.00	3.80	1.0	/	CØST DATA
14	3	20.80	.8333	2.50	1.0	/	CØST DATA
14	8	20.80	1.500	1.20	1.0	/	CØST DATA
14	9	20.80	1.000	3.16	1.0	/	CØST DATA
14	10	20.80	.2500	1.50	1.0	/	CØST DATA
14	11	20.80	1.250	90.00	1.0	/	CØST DATA
14	12	20.80	.2500	.73	1.0	/	CØST DATA
14	13	20.80	.5000	1.05	1.0	/	CØST DATA
14	14	20.80	4.000	6.52	1.0	/	CØST DATA
14	15	20.80	.5000	2.62	1.0	/	CØST DATA
14	16	20.80	.2500	65.64	1.0	/	CØST DATA
14	17	20.80	1.000	1.50	1.0	/	CØST DATA
14	18	20.80	3.000	3.20	1.0	/	CØST DATA
14	20	20.80	4.000	2.50	1.0	/	CØST DATA
14	21	20.80	4.000	.70	1.0	/	CØST DATA
15	1	20.80	1.500	1.43	1.0	/	CØST DATA
15	2	20.80	12.00	3.80	1.0	/	CØST DATA
15	3	20.80	.8333	2.50	1.0	/	CØST DATA
15	8	20.80	1.500	1.20	1.0	/	CØST DATA
15	9	20.80	1.000	3.16	1.0	/	CØST DATA
15	10	20.80	.2500	1.50	1.0	/	CØST DATA
15	11	20.80	1.250	90.00	1.0	/	CØST DATA

EXAMPLE FOR ILLUSTRATION ONLY DATA

15	12	20.80	.2500	.70	1.0	/	COST DATA
15	13	20.80	.5000	1.05	1.0	/	COST DATA
15	14	20.80	4.000	6.52	1.0	/	COST DATA
15	15	20.80	.5000	2.62	1.0	/	COST DATA
15	16	20.80	.2500	65.64	1.0	/	COST DATA
15	17	20.80	1.000	1.50	1.0	/	COST DATA
15	18	20.80	3.000	3.20	1.0	/	COST DAT
15	20	20.80	4.000	2.50	1.0	/	COST
15	21	20.80	4.000	.70	1.0	/	
16	3	18.40	0.000	-25.00	1.0		
16	8	18.40	0.000	-12.00	1.0		
16	9	18.40	0.000	-31.60	1.0		
16	17	18.40	0.000	-15.00	1.0		
17	3	18.40	0.000	-25.00	1.0		DATA
17	8	18.40	0.000	-12.00	1.0		ST DATA
17	9	18.40	0.000	-31.60	1.0		COST DATA
17	17	18.40	0.000	-15.00	1.0	/	COST DATA
18	3	18.40	0.000	-25.00	1.0	/	COST DATA
18	9	18.40	0.000	-31.60	1.0	/	COST DATA
18	17	18.40	0.000	-15.00	1.0	/	COST DATA
19	3	18.40	0.000	-25.00	1.0	/	COST DATA
19	9	18.40	0.000	-31.60	1.0	/	COST DATA
19	17	18.40	0.000	-15.00	1.0	/	COST DATA
20	1	20.80	0.000	-2.00	1.0	/	COST DATA
20	3	20.80	0.000	-25.00	1.0	/	COST DATA
20	8	20.80	0.000	-12.00	1.0	/	COST DATA
20	9	20.80	0.000	-31.60	1.0	/	COST DATA
20	11	20.80	0.000	-9.00	1.0	/	COST DATA
20	14	20.80	0.000	-1.70	1.0	/	COST DATA
20	17	20.80	0.000	-15.00	1.0	/	COST DATA
20	18	20.80	0.000	-32.00	1.0	/	COST DATA
20	21	20.80	0.000	-0.20	1.0	/	COST DATA
22	1	22.05	0.000	-2.00	1.0	/	COST DATA
22	3	22.05	0.000	-25.00	1.0	/	COST DATA
22	8	22.05	0.000	-12.00	1.0	/	COST DATA
22	14	22.05	0.000	-1.70	1.0	/	COST DATA
22	21	22.05	0.000	-0.20	1.0	/	COST DATA
23	4	22.05	0.000	-1.60	1.0	/	COST DATA
24	6	22.05	0.000	-48.00	1.0	/	COST DATA
24	7	22.05	0.000	-24.00	1.0	/	COST DATA
24	9	22.05	0.000	-8.00	1.0	/	COST DATA
30	1	18.40	0.0042	0.00	1.0	/	COST DATA
30	2	18.40	0.0021	0.00	1.0	/	COST DATA
30	3	18.40	0.0021	0.00	1.0	/	COST DATA
30	4	18.40	0.0008	0.00	1.0	/	COST DATA
30	5	18.40	0.0063	0.00	1.0	/	COST DATA
30	6	18.40	0.0021	0.00	1.0	/	COST DATA
30	7	18.40	0.0125	0.00	1.0	/	COST DATA
30	8	18.40	0.0013	0.00	1.0	/	COST DATA
30	9	18.40	0.0008	0.00	1.0	/	COST DATA
30	10	18.40	0.0008	0.00	1.0	/	COST DATA

30	11	18.40	0.0004	0.00	1.0		COST DATA
30	12	18.40	0.0004	0.00	1.0	✓	COST DATA
30	13	18.40	0.0004	0.00	1.0	✓	COST DATA
30	14	18.40	0.0008	0.00	1.0	✓	COST DATA
30	15	18.40	0.0008	0.00	1.0	✓	COST DATA
30	16	18.40	0.0002	0.00	1.0		COST DATA
30	17	18.40	0.0008	0.00	1.0	✓	COST DATA
30	18	18.40	0.0008	0.00	1.0	✓	COST DATA
30	19	18.40	0.0008	0.00	1.0	✓	COST DATA
30	20	18.40	0.0008	0.00	1.0	✓	COST DATA
30	21	18.40	0.0003	0.00	1.0	✓	COST DATA
37	3	18.40	0.075	0.00	0.0030685	✓	COST
37	8	18.40	0.250	10.00	0.0015340	✓	
37	9	18.40	0.150	1.00	0.0015334		
37	10	18.40	0.050	0.00	0.0060708		
37	14	18.40	0.150	0.00	0.0016608	✓	
37	15	18.40	0.025	0.00	0.0030748	✓	
37	17	18.40	0.250	1.00	0.0020127	✓	DATA
37	20	18.40	0.025	0.00	0.0016608	✓	COST DATA
38	3	18.40	0.075	0.00	0.0030995	✓	COST DATA
38	8	18.40	0.250	10.00	0.001549	✓	COST DATA
38	9	18.40	0.150	1.00	0.001548	✓	COST DATA
38	10	18.40	0.050	0.00	0.006200	✓	COST DATA
38	14	18.40	0.150	0.00	0.0016775	✓	COST DATA
38	15	18.40	0.025	0.00	0.0031058	✓	COST DATA
38	17	18.40	0.250	1.00	0.0020656	✓	COST DATA
38	20	18.40	0.025	0.00	0.0016775	✓	COST DATA
40	1	18.40	0.0042	0.00	1.0	✓	COST DATA
40	2	18.40	0.0021	0.00	1.0	✓	COST DATA
40	3	18.40	0.0021	0.00	1.0	✓	COST DATA
40	4	18.40	0.0008	0.00	1.0	✓	COST DATA
40	5	18.40	0.0063	0.00	1.0	✓	COST DATA
40	6	18.40	0.0021	0.00	1.0	✓	COST DATA
40	7	18.40	0.0125	0.00	1.0	✓	COST DATA
40	8	18.40	0.0013	0.00	1.0	✓	COST DATA
40	9	18.40	0.0008	0.00	1.0	✓	COST DATA
40	10	18.40	0.0008	0.00	1.0	✓	COST DATA
40	11	18.40	0.0004	0.00	1.0	✓	COST DATA
40	12	18.40	0.0004	0.00	1.0	✓	COST DATA
40	13	18.40	0.0004	0.00	1.0	✓	COST DATA
40	14	18.40	0.0008	0.00	1.0	✓	COST DATA
40	15	18.40	0.0008	0.00	1.0	✓	COST DATA
40	16	18.40	0.0002	0.00	1.0	✓	COST DATA
40	17	18.40	0.0008	0.00	1.0	✓	COST DATA
40	18	18.40	0.0008	0.00	1.0	✓	COST DATA
40	19	18.40	0.0008	0.00	1.0	✓	COST DATA
40	20	18.40	0.0008	0.00	1.0	✓	COST DATA
40	21	18.40	0.0008	0.00	1.0	✓	COST DATA
46	3	18.40	0.075	0.00	0.0181438	✓	COST DATA
46	8	18.40	0.500	10.00	0.009072	✓	COST DATA
46	9	18.40	0.300	1.00	0.009099	✓	COST DATA
46	10	18.40	0.050	0.00	0.036553	✓	COST DATA

EXAMPLE
FOR ILLUSTRATION ONLY
DATA

46	15	18.40	0.025	0.00	0.0194782		COST DATA
46	17	18.40	0.325	1.00	0.0121448	/	COST DATA
51	3	18.40	0.075	0.00	0.0004395	/	COST DATA
51	8	18.40	0.500	10.00	0.0002197	/	COST DATA
51	9	18.40	0.300	1.00	0.0002197	/	COST DATA
51	10	18.40	0.050	0.00	0.0008789	/	COST DATA
51	15	18.40	0.025	0.00	0.0004395	/	COST DATA
51	17	18.40	0.325	1.00	0.0002929	/	COST DATA
60	4	18.40	0.000	150.00	1.0	/	COST DATA
61	4	18.40	0.000	5000.00	1.0	/	COST DATA
63	4	18.40	0.000	5000.00	1.0	/	COST
64	4	18.40	0.000	600.00	1.0	/	
70	1	18.40	0.1875	0.00	1.0		
73	4	20.80	.3750	0.00	1.0		
74	3	20.80	.0750	0.00	0.1		
74	8	20.80	0.250	10.00	0.1		
74	9	20.80	0.150	1.00	0.1		ATA
74	10	20.80	0.050	0.00	0.1		ST DATA
74	13	20.80	0.050	0.00	0.1	/	COST DATA
74	12	20.80	0.050	0.00	0.1	/	COST DATA
74	14	20.80	0.050	0.00	0.1	/	COST DATA
74	15	20.80	0.025	0.00	0.1	/	COST DATA
74	17	20.80	0.250	1.00	0.1	/	COST DATA
74	18	20.80	0.083	5.00	0.5263	/	COST DATA
74	20	20.80	0.025	0.00	0.1	/	COST DATA
79	4	20.80	0.375	0.00	1.0	/	COST DATA
81	4	20.80	0.375	0.00	1.0	/	COST DATA
82	4	20.80	0.375	0.00	1.0	/	COST DATA
100	1	22.05	1.000	0.00	1.0	/	COST DATA
101	4	0.00	0.000	13.45	1.0	/	COST DATA
102	1	20.80	1.000	30.00	1.0	/	COST DATA
103	1	22.05	1.250	0.00	1.0	/	COST DATA
104	1	20.80	1.250	30.00	1.0	/	COST DATA
105	4	0.00	0.000	13.45	1.0	/	COST DATA
106	1	22.05	6.000	0.00	1.0	/	COST DATA
115	1	22.05	0.500	0.00	1.0	/	COST DATA
115	8	22.05	0.0167	0.00	1.0	/	COST DATA
115	10	22.05	0.0333	0.00	1.0	/	COST DATA
115	14	22.05	0.250	0.00	1.0	/	COST DATA
115	20	22.05	0.500	0.00	1.0	/	COST DATA
115	21	22.05	0.250	0.00	1.0	/	COST DATA
117	2	22.05	0.500	0.00	1.0	/	COST DATA
117	3	22.05	2.000	15.00	1.0	/	COST DATA
117	8	22.05	1.000	30.00	1.0	/	COST DATA
118	9	22.05	0.250	0.00	1.0	/	COST DATA
118	17	22.05	0.250	0.00	1.0	/	COST DATA
118	18	22.05	0.250	0.00	1.0	/	COST DATA
119	9	22.05	0.083	5.00	1.0	/	COST DATA
119	17	22.05	0.333	50.00	1.0	/	COST DATA
119	18	22.05	0.083	5.00	1.0	/	COST DATA
120	9	22.05	0.333	0.00	1.0	/	COST DATA
120	17	22.05	0.333	0.00	1.0	/	COST DATA

120	18	22.05	0.333	0.00	1.0	/	CØST DATA
130	7	22.05	0.250	0.00	1.0	/	CØST DATA
130	19	22.05	0.250	0.00	1.0	/	CØST DATA
131	4	22.05	0.667	0.00	1.0	/	CØST DATA
133	6	22.05	1.000	0.00	1.0	/	CØST DATA
133	7	22.05	0.667	0.00	1.0	/	CØST DATA
133	19	22.05	0.667	0.00	1.0	/	CØST DATA
134	4	22.05	1.500	0.00	1.0	/	CØST DATA
135	4	22.05	0.500	0.00	1.0	/	CØST
136	4	22.05	0.500	30.64	1.0	/	
137	19	22.05	1.000	0.00	1.0		
138	6	22.05	0.500	0.00	1.0		
138	7	22.05	1.000	0.00	1.0		
138	19	22.05	0.667	0.00	1.0		
140	4	22.05	0.667	0.00	1.0		ATA
141	7	22.05	1.500	0.00	1.0		ST DATA
145	5	22.05	20.00	0.00	1.0	.	CØST DATA
145	11	22.05	10.00	0.00	1.0	/	CØST DATA
148	5	22.05	0.000	2000.00	1.0	/	CØST DATA
150	1	22.05	6.000	2.50	1.0	/	CØST DATA
150	2	22.05	0.000	5.00	1.0	/	CØST DATA
150	3	22.05	0.000	2.86	1.0	/	CØST DATA
150	4	22.05	0.000	1.25	1.0	/	CØST DATA
150	5	22.05	0.000	100.00	1.0	/	CØST DATA
150	8	22.05	0.000	0.63	1.0	/	CØST DATA
150	9	22.05	0.000	5.00	1.0	/	CØST DATA
150	10	22.05	0.000	10.00	1.0	/	CØST DATA
150	11	22.05	0.000	3.13	1.0	/	CØST DATA
150	12	22.05	0.000	2.50	1.0	/	CØST DATA
150	14	22.05	0.000	54.00	1.0	/	CØST DATA
150	15	22.05	0.000	.02	1.0	/	CØST DATA
150	16	22.05	0.000	25	1.0	/	CØST DATA
150	18	22.05	0.000	2.00	1.0	/	CØST DATA
150	20	22.05	0.000	25.00	1.0	/	CØST DATA
160	1	18.40	0.0042	0.00	1.0	/	CØST DATA
160	2	18.40	0.0021	0.00	1.0	/	CØST DATA
160	3	18.40	0.0021	0.00	1.0	/	CØST DATA
160	4	18.40	0.0008	0.00	1.0	/	CØST DATA
160	5	18.40	0.0063	0.00	1.0	/	CØST DATA
160	6	18.40	0.0021	0.00	1.0	/	CØST DATA
160	7	18.40	0.0125	0.00	1.0	/	CØST DATA
160	8	18.40	0.0013	0.00	1.0	/	CØST DATA
160	9	18.40	0.0008	0.00	1.0	/	CØST DATA
160	10	18.40	0.0008	0.00	1.0	/	CØST DATA
160	11	18.40	0.0004	0.00	1.0	/	CØST DATA
160	12	18.40	0.0004	0.00	1.0	/	CØST DATA
160	13	18.40	0.0004	0.00	1.0	/	CØST DATA
160	14	18.40	0.0008	0.00	1.0	/	CØST DATA
160	15	18.40	0.0008	0.00	1.0	/	CØST DATA
160	16	18.40	0.0002	0.00	1.0	/	CØST DATA
160	17	18.40	0.0008	0.00	1.0	/	CØST DATA
160	18	18.40	0.0008	0.00	1.0	/	CØST DATA

```
160 19 18.40  0.0008    0.00 1.0           /  COST DATA
160 20 18.40  0.0008    0.00 1.0           /  COST DATA
160 21 18.40  0.0008    0.00 1.0           /  COST DATA
161  4 20.81  0.050     0.00 1.0           /  COST DATA
170  4 20.81  0.375    13.45 1.0           /  COST DATA
172  1 20.81  1.000    30.00 1.0           /  COST DATA
174  3 20.81   .0750    0.00 0.0029975     /  COST DATA
174  8 20.81  0.250    10.00 0.0014560     /  COST DATA
174  9 20.81  0.150     1.00 0.0014556     /  COST DATA
174 10 20.81  0.050     0.00 0.0058262     /  COST
174 14 20.81  0.050     0.00 0.0015764     /
174 15 20.81  0.025     0.00 0.0021817     /
174 17 20.81  0.250     1.00 0.0019458     /
174 20 20.81  0.025     0.00 0.0015809     /
175  3 20.81  0.075     0.00 0.0004395     /       DATA
175  8 20.81  0.250    10.00 0.0016428     /  COST DATA
175  9 20.81  0.150     1.00 0.0016135     /  COST DATA
175 10 20.81  0.050     0.00 0.0064598     /  COST DATA
175 14 20.81  0.050     0.00 0.0017748     /  COST DATA
175 15 20.81  0.025     0.00 0.0032362     /  COST DATA
175 17 20.81  0.250     1.00 0.0021520     /  COST DATA
175 20 20.81  0.025     0.00 0.0017531     /  COST DATA
178  1 20.81  1.250    30.00 1.0           /  COST DATA
180  4 20.81  0.375    13.45 1.0           /  COST DATA
999                                        /  END OF COST DATA
999                                        /  END OF QAR FUNCTIONS
 2272      0.0      0.0                    /  ZAR() STATE VALUES
 1136      0.0      0.0                    /  ZAR() STATE VALUES
 3976      0.0      0.0                    /  ZAR() STATE VALUES
 2272      0.0      0.0                    /  ZAR() STATE VALUES
  568      0.0      0.0                    /  ZAR() STATE VALUES
 1136      0.0      0.0                    /  ZAR() STATE VALUES
 2272      0.0      0.0                    /  ZAR() STATE VALUES
 9088      0.0      0.0                    /  ZAR() STATE VALUES
  568      0.0      0.0                    /  ZAR() STATE VALUES
 1136      0.0      0.0                    /  ZAR() STATE VALUES
 4544      0.0      0.0                    /  ZAR() STATE VALUES
 2272      0.0      0.0                    /  ZAR() STATE VALUES
 2272      0.0      0.0                    /  ZAR() STATE VALUES
  568      0.0      0.0                    /  ZAR() STATE VALUES
11360      0.0      0.0                    /  ZAR() STATE VALUES
 2272      0.0      0.0                    /  ZAR() STATE VALUES
 2272      0.0      0.0                    /  ZAR() STATE VALUES
  568      0.0      0.0                    /  ZAR() STATE VALUES
 2272      0.0      0.0                    /  ZAR() STATE VALUES
  568      0.0      0.0                    /  ZAR() STATE VALUES
 2272      0.0      0.0                    /  ZAR() STATE VALUES
   0.0    2  1.82998                       /  RATE POP.,WEIB.,LIFE
   0.0    2  1.82998                       /  RATE POP.,WEIB.,LIFE
   0.0    2  1.32995                       /  RATE POP.,WEIB.,LIFE
   0.0    2  2.32138                       /  RATE POP.,WEIB.,LIFE
   0.0    2  2.16651                       /  RATE POP.,WEIB.,LIFE
   0.0    2  2.78816                       /  RATE POP.,WEIB.,LIFE
```

EXAMPLE FOR ILLUSTRATION ONLY DATA

```
 0.0      2   0.03243
 0.0      2   1.53289
 0.0      2   2.51896
 0.0      2   1.82998
 0.0      2   1.09577
 0.0      2   1.82998
 0.0      2   1.82938
 0.0      2   1.22998
 0.0      2   2.32138
 0.0      2   2.16651
 0.0      2   2.78818
 0.0      2   0.14307
 0.0      2   0.03243
 0.0      2   1.53289
999
99999
```

EXAMPLE FOR ILLUSTRATION ONLY DATA

```
                              .FE
RATE FOR  WE              .FE
RATE POP                     FE
RATE                          E


                             LIFE
                     .G     .LIFE
                WEIB     .LIFE
          .OP   WEIB     .LIFE
    TE   POP    WEIB     .LIFE
RATE  FOR    WEIB     .LIFE
RATE  POP    WEIB     .LIFE
RATE  FOP    WEIB      LIFE
RATE  POP    WEIB     .LIFE
END OF DATA
END OF FILE
```

APPENDIX F

SAMPLE OUTPUT PATH FLOWS BY COMPONENT

```
1 YEAR   0.0
 PATH   1   COMPONENT   1   NUM      =      2272.00
 PATH   1   COMPONENT   2   NUM      =      1136.00
 PATH   1   COMPONENT   3   NUM      =      3976.00
 PATH   1   COMPONENT   4   NUM      =      2272.00
 PATH   1   COMPONENT   5   NUM      =       568.00
 PATH   1   COMPONENT   6   NUM      =      1136.00
 PATH   1   COMPONENT   7   NUM      =      2272.00
 PATH   1   COMPONENT   8   NUM      =      9088.00
 PATH   1   COMPONENT   9   NUM      =       568.00
 PATH   1   COMPONENT  10   NUM      =      1136.00
 PATH   1   COMPONENT  11   NUM      =      4544.00
 PATH   1   COMPONENT  12   NUM      =      2272.00
 PATH   1   COMPONENT  13   NUM      =      2272.00
 PATH   1   COMPONENT  14   NUM      =       568.00
 PATH   1   COMPONENT  15   NUM      =     11360.00
 PATH   1   COMPONENT  16   NUM      =      2272.00
 PATH   1   COMPONENT  17   NUM      =      2272.00
 PATH   1   COMPONENT  18   NUM      =       568.00
 PATH   1   COMPONENT  19   NUM      =      2272.00
 PATH   1   COMPONENT  20   NUM      =       568.00
 PATH   1   COMPONENT  21   NUM      =      2272.00

 PATH    1   COMPONENT   1   NUM/YR  =      2272.00
 PATH    1   COMPONENT   2   NUM/YR  =      1136.00
 PATH    1   COMPONENT   3   NUM/YR  =      3976.00
 PATH    1   COMPONENT   4   NUM/YR  =      2272.00
 PATH    1   COMPONENT   5   NUM/YR  =       568.00
 PATH    1   COMPONENT   6   NUM/YR  =      1136.00
 PATH    1   COMPONENT   7   NUM/YR  =      2272.00
 PATH    1   COMPONENT   8   NUM/YR  =      9088.00
 PATH    1   COMPONENT   9   NUM/YR  =       568.00
 PATH    1   COMPONENT  10   NUM/YR  =      1136.00
 PATH    1   COMPONENT  11   NUM/YR  =      4544.00
 PATH    1   COMPONENT  12   NUM/YR  =      2272.00
 PATH    1   COMPONENT  13   NUM/YR  =      2272.00
 PATH    1   COMPONENT  14   NUM/YR  =       568.00
 PATH    1   COMPONENT  15   NUM/YR  =     11360.00
 PATH    1   COMPONENT  16   NUM/YR  =      2272.00
 PATH    1   COMPONENT  17   NUM/YR  =      2272.00
 PATH    1   COMPONENT  18   NUM/YR  =       568.00
 PATH    1   COMPONENT  19   NUM/YR  =      2272.00
 PATH    1   COMPONENT  20   NUM/YR  =       568.00
 PATH    1   COMPONENT  21   NUM/YR  =      2272.00
```

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	4	COMPONENT	3	NUM/YR =	27.88
PATH	4	COMPONENT	8	NUM/YR =	51.51
PATH	4	COMPONENT	9	NUM/YR =	1.99
PATH	4	COMPONENT	10	NUM/YR =	9.56
PATH	4	COMPONENT	13	NUM/YR =	47.80
PATH	4	COMPONENT	15	NUM/YR =	239.00
PATH	4	COMPONENT	16	NUM/YR =	863.28
PATH	4	COMPONENT	17	NUM/YR =	10.62
PATH	5	COMPONENT	3	NUM/YR =	250.95
PATH	5	COMPONENT	8	NUM/YR =	466.16
PATH	5	COMPONENT	9	NUM/YR =	17.93
PATH	5	COMPONENT	10	NUM/YR =	86.04
PATH	5	COMPONENT	13	NUM/YR =	430.21
PATH	5	COMPONENT	15	NUM/YR =	2151.03
PATH	5	COMPONENT	16	NUM/YR =	7769.22
PATH	5	COMPONENT	17	NUM/YR =	95.60
PATH	6	COMPONENT	3	NUM/YR =	5.11
PATH	6	COMPONENT	9	NUM/YR =	0.37
PATH	6	COMPONENT	10	NUM/YR =	1.75
PATH	6	COMPONENT	13	NUM/YR =	8.76
PATH	6	COMPONENT	15	NUM/YR =	43.82
PATH	6	COMPONENT	17	NUM/YR =	1.95
PATH	7	COMPONENT	3	NUM/YR =	46.01
PATH	7	COMPONENT	9	NUM/YR =	3.29
PATH	7	COMPONENT	10	NUM/YR =	15.77
PATH	7	COMPONENT	13	NUM/YR =	78.88
PATH	7	COMPONENT	15	NUM/YR =	394.36
PATH	7	COMPONENT	17	NUM/YR =	17.53
PATH	8	COMPONENT	1	NUM/YR =	225.32
PATH	8	COMPONENT	2	NUM/YR =	563.31
PATH	8	COMPONENT	11	NUM/YR =	4506.44
PATH	8	COMPONENT	18	NUM/YR =	56.33
PATH	8	COMPONENT	20	NUM/YR =	140.83
PATH	8	COMPONENT	21	NUM/YR =	187.76
PATH	10	COMPONENT	1	NUM/YR =	588.75
PATH	10	COMPONENT	2	NUM/YR =	318.28
PATH	10	COMPONENT	3	NUM/YR =	1010.78
PATH	10	COMPONENT	8	NUM/YR =	2318.36
PATH	10	COMPONENT	10	NUM/YR =	208.00
PATH	10	COMPONENT	13	NUM/YR =	577.59
PATH	10	COMPONENT	14	NUM/YR =	144.40
PATH	10	COMPONENT	15	NUM/YR =	2887.96
PATH	10	COMPONENT	16	NUM/YR =	586.97
PATH	10	COMPONENT	20	NUM/YR =	151.43
PATH	10	COMPONENT	21	NUM/YR =	586.97

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	11	COMPONENT	4	NUM/YR	=	576.77
PATH	12	COMPONENT	6	NUM/YR	=	288.89
PATH	12	COMPONENT	7	NUM/YR	=	624.75
PATH	12	COMPONENT	19	NUM/YR	=	589.77
PATH	14	COMPONENT	3	NUM/YR	=	3.28
PATH	14	COMPONENT	8	NUM/YR	=	13.94
PATH	14	COMPONENT	9	NUM/YR	=	0.03
PATH	14	COMPONENT	10	NUM/YR	=	0.32
PATH	14	COMPONENT	13	NUM/YR	=	3.22
PATH	14	COMPONENT	15	NUM/YR	=	80.40
PATH	14	COMPONENT	16	NUM/YR	=	3.41
PATH	14	COMPONENT	17	NUM/YR	=	0.71
PATH	14	COMPONENT	20	NUM/YR	=	0.20
PATH	14	COMPONENT	21	NUM/YR	=	1.07
PATH	15	COMPONENT	1	NUM/YR	=	1.00
PATH	15	COMPONENT	2	NUM/YR	=	2.35
PATH	15	COMPONENT	3	NUM/YR	=	3.05
PATH	15	COMPONENT	8	NUM/YR	=	16.34
PATH	15	COMPONENT	9	NUM/YR	=	0.04
PATH	15	COMPONENT	10	NUM/YR	=	0.30
PATH	15	COMPONENT	11	NUM/YR	=	75.11
PATH	15	COMPONENT	13	NUM/YR	=	3.77
PATH	15	COMPONENT	15	NUM/YR	=	94.28
PATH	15	COMPONENT	16	NUM/YR	=	85.13
PATH	15	COMPONENT	17	NUM/YR	=	0.84
PATH	15	COMPONENT	18	NUM/YR	=	0.12
PATH	15	COMPONENT	20	NUM/YR	=	0.23
PATH	15	COMPONENT	21	NUM/YR	=	1.25
PATH	16	COMPONENT	3	NUM/YR	=	27.00
PATH	16	COMPONENT	8	NUM/YR	=	51.51
PATH	16	COMPONENT	9	NUM/YR	=	1.99
PATH	16	COMPONENT	10	NUM/YR	=	9.56
PATH	16	COMPONENT	13	NUM/YR	=	47.00
PATH	16	COMPONENT	15	NUM/YR	=	239.00
PATH	16	COMPONENT	16	NUM/YR	=	863.28
PATH	16	COMPONENT	17	NUM/YR	=	10.62
PATH	17	COMPONENT	3	NUM/YR	=	250.95
PATH	17	COMPONENT	8	NUM/YR	=	466.16
PATH	17	COMPONENT	9	NUM/YR	=	17.93
PATH	17	COMPONENT	10	NUM/YR	=	86.04
PATH	17	COMPONENT	13	NUM/YR	=	430.21
PATH	17	COMPONENT	15	NUM/YR	=	2151.03
PATH	17	COMPONENT	16	NUM/YR	=	7769.22
PATH	17	COMPONENT	17	NUM/YR	=	95.60

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	18	COMPONENT	3	NUM/YR	=	5.11
PATH	18	COMPONENT	9	NUM/YR	=	0.37
PATH	18	COMPONENT	10	NUM/YR	=	1.75
PATH	18	COMPONENT	13	NUM/YR	=	8.76
PATH	18	COMPONENT	15	NUM/YR	=	43.82
PATH	18	COMPONENT	17	NUM/YR	=	1.95
PATH	19	COMPONENT	3	NUM/YR	=	46.01
PATH	19	COMPONENT	9	NUM/YR	=	3.29
PATH	19	COMPONENT	10	NUM/YR	=	15.77
PATH	19	COMPONENT	13	NUM/YR	=	78.88
PATH	19	COMPONENT	15	NUM/YR	=	394.36
PATH	19	COMPONENT	17	NUM/YR	=	17.53
PATH	20	COMPONENT	1	NUM/YR	=	225.32
PATH	20	COMPONENT	2	NUM/YR	=	563.31
PATH	20	COMPONENT	11	NUM/YR	=	4506.44
PATH	20	COMPONENT	18	NUM/YR	=	56.33
PATH	20	COMPONENT	20	NUM/YR	=	140.83
PATH	20	COMPONENT	21	NUM/YR	=	187.76
PATH	22	COMPONENT	1	NUM/YR	=	508.75
PATH	22	COMPONENT	2	NUM/YR	=	318.28
PATH	22	COMPONENT	3	NUM/YR	=	1010.78
PATH	22	COMPONENT	8	NUM/YR	=	2310.36
PATH	22	COMPONENT	10	NUM/YR	=	288.80
PATH	22	COMPONENT	13	NUM/YR	=	577.59
PATH	22	COMPONENT	14	NUM/YR	=	144.40
PATH	22	COMPONENT	15	NUM/YR	=	2887.96
PATH	22	COMPONENT	16	NUM/YR	=	506.97
PATH	22	COMPONENT	20	NUM/YR	=	151.43
PATH	22	COMPONENT	21	NUM/YR	=	506.97
PATH	23	COMPONENT	4	NUM/YR	=	576.77
PATH	24	COMPONENT	6	NUM/YR	=	288.89
PATH	24	COMPONENT	7	NUM/YR	=	624.75
PATH	24	COMPONENT	19	NUM/YR	=	589.77
PATH	26	COMPONENT	3	NUM/YR	=	3.28
PATH	26	COMPONENT	8	NUM/YR	=	13.94
PATH	26	COMPONENT	9	NUM/YR	=	0.03
PATH	26	COMPONENT	10	NUM/YR	=	0.32
PATH	26	COMPONENT	13	NUM/YR	=	3.22
PATH	26	COMPONENT	15	NUM/YR	=	80.40
PATH	26	COMPONENT	16	NUM/YR	=	3.41
PATH	26	COMPONENT	17	NUM/YR	=	0.71
PATH	26	COMPONENT	20	NUM/YR	=	0.20
PATH	26	COMPONENT	21	NUM/YR	=	1.07

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	27	COMPONENT	1	NUM/YR	=	1.88
PATH	27	COMPONENT	2	NUM/YR	=	2.35
PATH	27	COMPONENT	3	NUM/YR	=	3.85
PATH	27	COMPONENT	8	NUM/YR	=	16.34
PATH	27	COMPONENT	9	NUM/YR	=	0.04
PATH	27	COMPONENT	10	NUM/YR	=	0.38
PATH	27	COMPONENT	11	NUM/YR	=	75.11
PATH	27	COMPONENT	13	NUM/YR	=	3.77
PATH	27	COMPONENT	15	NUM/YR	=	94.28
PATH	27	COMPONENT	16	NUM/YR	=	85.13
PATH	27	COMPONENT	17	NUM/YR	=	0.84
PATH	27	COMPONENT	18	NUM/YR	=	0.12
PATH	27	COMPONENT	20	NUM/YR	=	0.23
PATH	27	COMPONENT	21	NUM/YR	=	1.25
PATH	30	COMPONENT	1	NUM/YR	=	700798.40
PATH	30	COMPONENT	2	NUM/YR	=	350399.20
PATH	30	COMPONENT	3	NUM/YR	=	1226397.20
PATH	30	COMPONENT	4	NUM/YR	=	700798.40
PATH	30	COMPONENT	5	NUM/YR	=	175199.60
PATH	30	COMPONENT	6	NUM/YR	=	350399.20
PATH	30	COMPONENT	7	NUM/YR	=	700798.40
PATH	30	COMPONENT	8	NUM/YR	=	2803193.60
PATH	30	COMPONENT	9	NUM/YR	=	175199.60
PATH	30	COMPONENT	10	NUM/YR	=	350399.20
PATH	30	COMPONENT	11	NUM/YR	=	1401596.80
PATH	30	COMPONENT	12	NUM/YR	=	700798.40
PATH	30	COMPONENT	13	NUM/YR	=	700798.40
PATH	30	COMPONENT	14	NUM/YR	=	175199.60
PATH	30	COMPONENT	15	NUM/YR	=	3503992.00
PATH	30	COMPONENT	16	NUM/YR	=	700798.40
PATH	30	COMPONENT	17	NUM/YR	=	700798.40
PATH	30	COMPONENT	18	NUM/YR	=	175199.60
PATH	30	COMPONENT	19	NUM/YR	=	700798.40
PATH	30	COMPONENT	20	NUM/YR	=	175199.60
PATH	30	COMPONENT	21	NUM/YR	=	700798.40
PATH	31	COMPONENT	1	NUM/YR	=	160592.16
PATH	31	COMPONENT	2	NUM/YR	=	80296.08
PATH	31	COMPONENT	3	NUM/YR	=	281036.28
PATH	31	COMPONENT	4	NUM/YR	=	160592.16
PATH	31	COMPONENT	5	NUM/YR	=	40148.04
PATH	31	COMPONENT	6	NUM/YR	=	80296.08
PATH	31	COMPONENT	7	NUM/YR	=	160592.16
PATH	31	COMPONENT	8	NUM/YR	=	642368.63
PATH	31	COMPONENT	9	NUM/YR	=	40148.04
PATH	31	COMPONENT	10	NUM/YR	=	80296.08
PATH	31	COMPONENT	11	NUM/YR	=	321184.32
PATH	31	COMPONENT	12	NUM/YR	=	160592.16
PATH	31	COMPONENT	13	NUM/YR	=	160592.16

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

```
PATH  31  COMPONENT 14  NUM/YR =   40148.04
PATH  31  COMPONENT 15  NUM/YR =  802960.79
PATH  31  COMPONENT 16  NUM/YR =  160592.16
PATH  31  COMPONENT 17  NUM/YR =  160592.16
PATH  31  COMPONENT 18  NUM/YR =   40148.04
PATH  31  COMPONENT 19  NUM/YR =  160592.16
PATH  31  COMPONENT 20  NUM/YR =   40148.04
PATH  31  COMPONENT 21  NUM/YR =  160592.16

PATH  32  COMPONENT  1  NUM/YR =  540206.24
PATH  32  COMPONENT  2  NUM/YR =  270103.12
PATH  32  COMPONENT  3  NUM/YR =  945360.92
PATH  32  COMPONENT  4  NUM/YR =  540206.24
PATH  32  COMPONENT  5  NUM/YR =  135051.56
PATH  32  COMPONENT  6  NUM/YR =  270103.12
PATH  32  COMPONENT  7  NUM/YR =  540206.24
PATH  32  COMPONENT  8  NUM/YR = 2160824.97
PATH  32  COMPONENT  9  NUM/YR =  135051.56
PATH  32  COMPONENT 10  NUM/YR =  270103.12
PATH  32  COMPONENT 11  NUM/YR = 1080412.48
PATH  32  COMPONENT 12  NUM/YR =  540206.24
PATH  32  COMPONENT 13  NUM/YR =  540206.24
PATH  32  COMPONENT 14  NUM/YR =  135051.56
PATH  32  COMPONENT 15  NUM/YR = 2701031.21
PATH  32  COMPONENT 16  NUM/YR =  540206.24
PATH  32  COMPONENT 17  NUM/YR =  540206.24
PATH  32  COMPONENT 18  NUM/YR =  135051.56
PATH  32  COMPONENT 19  NUM/YR =  540206.24
PATH  32  COMPONENT 20  NUM/YR =  135051.56
PATH  32  COMPONENT 21  NUM/YR =  540206.24

PATH  33  COMPONENT  1  NUM/YR =  155936.11
PATH  33  COMPONENT  2  NUM/YR =   77968.05
PATH  33  COMPONENT  3  NUM/YR =  272888.19
PATH  33  COMPONENT  4  NUM/YR =  155936.11
PATH  33  COMPONENT  5  NUM/YR =   38984.03
PATH  33  COMPONENT  6  NUM/YR =   77968.05
PATH  33  COMPONENT  7  NUM/YR =  155936.11
PATH  33  COMPONENT  8  NUM/YR =  623744.44
PATH  33  COMPONENT  9  NUM/YR =   38984.03
PATH  33  COMPONENT 10  NUM/YR =   77968.05
PATH  33  COMPONENT 11  NUM/YR =  311872.22
PATH  33  COMPONENT 12  NUM/YR =  155936.11
PATH  33  COMPONENT 13  NUM/YR =  155936.11
PATH  33  COMPONENT 14  NUM/YR =   38984.03
PATH  33  COMPONENT 15  NUM/YR =  779680.55
PATH  33  COMPONENT 16  NUM/YR =  155936.11
PATH  33  COMPONENT 17  NUM/YR =  155936.11
PATH  33  COMPONENT 18  NUM/YR =   38984.03
```

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	33	COMPONENT	19	NUM/YR	=	155936.11
PATH	33	COMPONENT	20	NUM/YR	=	38984.03
PATH	33	COMPONENT	21	NUM/YR	=	155936.11
PATH	34	COMPONENT	1	NUM/YR	=	4656.05
PATH	34	COMPONENT	2	NUM/YR	=	2328.02
PATH	34	COMPONENT	3	NUM/YR	=	8148.08
PATH	34	COMPONENT	4	NUM/YR	=	4656.05
PATH	34	COMPONENT	5	NUM/YR	=	1164.01
PATH	34	COMPONENT	6	NUM/YR	=	2328.02
PATH	34	COMPONENT	7	NUM/YR	=	4656.05
PATH	34	COMPONENT	8	NUM/YR	=	18624.19
PATH	34	COMPONENT	9	NUM/YR	=	1164.01
PATH	34	COMPONENT	10	NUM/YR	=	2328.02
PATH	34	COMPONENT	11	NUM/YR	=	9312.10
PATH	34	COMPONENT	12	NUM/YR	=	4656.05
PATH	34	COMPONENT	13	NUM/YR	=	4656.05
PATH	34	COMPONENT	14	NUM/YR	=	1164.01
PATH	34	COMPONENT	15	NUM/YR	=	23280.24
PATH	34	COMPONENT	16	NUM/YR	=	4656.05
PATH	34	COMPONENT	17	NUM/YR	=	4656.05
PATH	34	COMPONENT	18	NUM/YR	=	1164.01
PATH	34	COMPONENT	19	NUM/YR	=	4656.05
PATH	34	COMPONENT	20	NUM/YR	=	1164.01
PATH	34	COMPONENT	21	NUM/YR	=	4656.05
PATH	35	COMPONENT	1	NUM/YR	=	15593.61
PATH	35	COMPONENT	2	NUM/YR	=	7796.81
PATH	35	COMPONENT	3	NUM/YR	=	27288.82
PATH	35	COMPONENT	4	NUM/YR	=	15593.61
PATH	35	COMPONENT	5	NUM/YR	=	3898.40
PATH	35	COMPONENT	6	NUM/YR	=	7796.81
PATH	35	COMPONENT	7	NUM/YR	=	15593.61
PATH	35	COMPONENT	8	NUM/YR	=	62374.44
PATH	35	COMPONENT	9	NUM/YR	=	3898.40
PATH	35	COMPONENT	10	NUM/YR	=	7796.81
PATH	35	COMPONENT	11	NUM/YR	=	31187.22
PATH	35	COMPONENT	12	NUM/YR	=	15593.61
PATH	35	COMPONENT	13	NUM/YR	=	15593.61
PATH	35	COMPONENT	14	NUM/YR	=	3898.40
PATH	35	COMPONENT	15	NUM/YR	=	77968.05
PATH	35	COMPONENT	16	NUM/YR	=	15593.61
PATH	35	COMPONENT	17	NUM/YR	=	15593.61
PATH	35	COMPONENT	18	NUM/YR	=	3898.40
PATH	35	COMPONENT	19	NUM/YR	=	15593.61
PATH	35	COMPONENT	20	NUM/YR	=	3898.40
PATH	35	COMPONENT	21	NUM/YR	=	15593.61

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	36	COMPONENT	1	NUM/YR	=	140342.50
PATH	36	COMPONENT	2	NUM/YR	=	70171.25
PATH	36	COMPONENT	3	NUM/YR	=	245599.37
PATH	36	COMPONENT	4	NUM/YR	=	140342.50
PATH	36	COMPONENT	5	NUM/YR	=	35085.62
PATH	36	COMPONENT	6	NUM/YR	=	70171.25
PATH	36	COMPONENT	7	NUM/YR	=	140342.50
PATH	36	COMPONENT	8	NUM/YR	=	561369.99
PATH	36	COMPONENT	9	NUM/YR	=	35085.62
PATH	36	COMPONENT	10	NUM/YR	=	70171.25
PATH	36	COMPONENT	11	NUM/YR	=	280685.00
PATH	36	COMPONENT	12	NUM/YR	=	140342.50
PATH	36	COMPONENT	13	NUM/YR	=	140342.50
PATH	36	COMPONENT	14	NUM/YR	=	35085.62
PATH	36	COMPONENT	15	NUM/YR	=	701712.49
PATH	36	COMPONENT	16	NUM/YR	=	140342.50
PATH	36	COMPONENT	17	NUM/YR	=	140342.50
PATH	36	COMPONENT	18	NUM/YR	=	35085.62
PATH	36	COMPONENT	19	NUM/YR	=	140342.50
PATH	36	COMPONENT	20	NUM/YR	=	35085.62
PATH	36	COMPONENT	21	NUM/YR	=	140342.50
PATH	37	COMPONENT	1	NUM/YR	=	140342.50
PATH	37	COMPONENT	2	NUM/YR	=	70171.25
PATH	37	COMPONENT	3	NUM/YR	=	245348.42
PATH	37	COMPONENT	4	NUM/YR	=	140342.50
PATH	37	COMPONENT	5	NUM/YR	=	35085.62
PATH	37	COMPONENT	6	NUM/YR	=	70171.25
PATH	37	COMPONENT	7	NUM/YR	=	140342.50
PATH	37	COMPONENT	8	NUM/YR	=	560903.83
PATH	37	COMPONENT	9	NUM/YR	=	35067.70
PATH	37	COMPONENT	10	NUM/YR	=	70085.21
PATH	37	COMPONENT	11	NUM/YR	=	280685.00
PATH	37	COMPONENT	12	NUM/YR	=	140342.50
PATH	37	COMPONENT	13	NUM/YR	=	139912.29
PATH	37	COMPONENT	14	NUM/YR	=	35085.62
PATH	37	COMPONENT	15	NUM/YR	=	699561.46
PATH	37	COMPONENT	16	NUM/YR	=	132573.28
PATH	37	COMPONENT	17	NUM/YR	=	140246.90
PATH	37	COMPONENT	18	NUM/YR	=	35085.62
PATH	37	COMPONENT	19	NUM/YR	=	140342.50
PATH	37	COMPONENT	20	NUM/YR	=	35085.62
PATH	37	COMPONENT	21	NUM/YR	=	140342.50
PATH	38	COMPONENT	1	NUM/YR	=	15507.32
PATH	38	COMPONENT	2	NUM/YR	=	7753.66
PATH	38	COMPONENT	3	NUM/YR	=	27109.92
PATH	38	COMPONENT	4	NUM/YR	=	15507.32

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	38	COMPONENT	5	NUM/YR	=	3876.83
PATH	38	COMPONENT	6	NUM/YR	=	7753.66
PATH	38	COMPONENT	7	NUM/YR	=	15507.32
PATH	38	COMPONENT	8	NUM/YR	=	61977.75
PATH	38	COMPONENT	9	NUM/YR	=	3874.84
PATH	38	COMPONENT	10	NUM/YR	=	7744.10
PATH	38	COMPONENT	11	NUM/YR	=	31014.63
PATH	38	COMPONENT	12	NUM/YR	=	15507.32
PATH	38	COMPONENT	13	NUM/YR	=	15459.52
PATH	38	COMPONENT	14	NUM/YR	=	3876.83
PATH	38	COMPONENT	15	NUM/YR	=	77297.58
PATH	38	COMPONENT	16	NUM/YR	=	14644.04
PATH	38	COMPONENT	17	NUM/YR	=	15496.69
PATH	38	COMPONENT	18	NUM/YR	=	3876.83
PATH	38	COMPONENT	19	NUM/YR	=	15507.32
PATH	38	COMPONENT	20	NUM/YR	=	3876.83
PATH	38	COMPONENT	21	NUM/YR	=	15507.32
PATH	39	COMPONENT	1	NUM/YR	=	15507.32
PATH	39	COMPONENT	2	NUM/YR	=	7753.66
PATH	39	COMPONENT	3	NUM/YR	=	27137.80
PATH	39	COMPONENT	4	NUM/YR	=	15507.32
PATH	39	COMPONENT	5	NUM/YR	=	3876.83
PATH	39	COMPONENT	6	NUM/YR	=	7753.66
PATH	39	COMPONENT	7	NUM/YR	=	15507.32
PATH	39	COMPONENT	8	NUM/YR	=	62029.26
PATH	39	COMPONENT	9	NUM/YR	=	3876.83
PATH	39	COMPONENT	10	NUM/YR	=	7753.66
PATH	39	COMPONENT	11	NUM/YR	=	31014.63
PATH	39	COMPONENT	12	NUM/YR	=	15507.32
PATH	39	COMPONENT	13	NUM/YR	=	15507.32
PATH	39	COMPONENT	14	NUM/YR	=	3876.83
PATH	39	COMPONENT	15	NUM/YR	=	77536.58
PATH	39	COMPONENT	16	NUM/YR	=	15507.32
PATH	39	COMPONENT	17	NUM/YR	=	15507.32
PATH	39	COMPONENT	18	NUM/YR	=	3876.83
PATH	39	COMPONENT	19	NUM/YR	=	15507.32
PATH	39	COMPONENT	20	NUM/YR	=	3876.83
PATH	39	COMPONENT	21	NUM/YR	=	15507.32
PATH	40	COMPONENT	1	NUM/YR	=	128479.33
PATH	40	COMPONENT	2	NUM/YR	=	64239.66
PATH	40	COMPONENT	3	NUM/YR	=	224838.82
PATH	40	COMPONENT	4	NUM/YR	=	128479.33
PATH	40	COMPONENT	5	NUM/YR	=	32119.83
PATH	40	COMPONENT	6	NUM/YR	=	64239.66
PATH	40	COMPONENT	7	NUM/YR	=	128479.33
PATH	40	COMPONENT	8	NUM/YR	=	513917.31

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	40	COMPONENT	9	NUM/YR	=	32119.83
PATH	40	COMPONENT	10	NUM/YR	=	64239.66
PATH	40	COMPONENT	11	NUM/YR	=	256958.66
PATH	40	COMPONENT	12	NUM/YR	=	128479.33
PATH	40	COMPONENT	13	NUM/YR	=	128479.33
PATH	40	COMPONENT	14	NUM/YR	=	32119.83
PATH	40	COMPONENT	15	NUM/YR	=	642396.64
PATH	40	COMPONENT	16	NUM/YR	=	128479.33
PATH	40	COMPONENT	17	NUM/YR	=	128479.33
PATH	40	COMPONENT	18	NUM/YR	=	32119.83
PATH	40	COMPONENT	19	NUM/YR	=	128479.33
PATH	40	COMPONENT	20	NUM/YR	=	32119.83
PATH	40	COMPONENT	21	NUM/YR	=	128479.33
PATH	41	COMPONENT	1	NUM/YR	=	4367.98
PATH	41	COMPONENT	2	NUM/YR	=	2183.99
PATH	41	COMPONENT	3	NUM/YR	=	7643.96
PATH	41	COMPONENT	4	NUM/YR	=	4367.98
PATH	41	COMPONENT	5	NUM/YR	=	1091.99
PATH	41	COMPONENT	6	NUM/YR	=	2183.99
PATH	41	COMPONENT	7	NUM/YR	=	4367.98
PATH	41	COMPONENT	8	NUM/YR	=	17471.90
PATH	41	COMPONENT	9	NUM/YR	=	1091.99
PATH	41	COMPONENT	10	NUM/YR	=	2183.99
PATH	41	COMPONENT	11	NUM/YR	=	8735.95
PATH	41	COMPONENT	12	NUM/YR	=	4367.98
PATH	41	COMPONENT	13	NUM/YR	=	4367.98
PATH	41	COMPONENT	14	NUM/YR	=	1091.99
PATH	41	COMPONENT	15	NUM/YR	=	21839.88
PATH	41	COMPONENT	16	NUM/YR	=	4367.98
PATH	41	COMPONENT	17	NUM/YR	=	4367.98
PATH	41	COMPONENT	18	NUM/YR	=	1091.99
PATH	41	COMPONENT	19	NUM/YR	=	4367.98
PATH	41	COMPONENT	20	NUM/YR	=	1091.99
PATH	41	COMPONENT	21	NUM/YR	=	4367.98
PATH	42	COMPONENT	1	NUM/YR	=	124111.35
PATH	42	COMPONENT	2	NUM/YR	=	62055.68
PATH	42	COMPONENT	3	NUM/YR	=	217194.87
PATH	42	COMPONENT	4	NUM/YR	=	124111.35
PATH	42	COMPONENT	5	NUM/YR	=	31027.84
PATH	42	COMPONENT	6	NUM/YR	=	62055.68
PATH	42	COMPONENT	7	NUM/YR	=	124111.35
PATH	42	COMPONENT	8	NUM/YR	=	496445.41
PATH	42	COMPONENT	9	NUM/YR	=	31027.84
PATH	42	COMPONENT	10	NUM/YR	=	62055.68
PATH	42	COMPONENT	11	NUM/YR	=	248222.70

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	42	COMPONENT	12	NUM/YR	=	124111.35
PATH	42	COMPONENT	13	NUM/YR	=	124111.35
PATH	42	COMPONENT	14	NUM/YR	=	31027.84
PATH	42	COMPONENT	15	NUM/YR	=	620556.76
PATH	42	COMPONENT	16	NUM/YR	=	124111.35
PATH	42	COMPONENT	17	NUM/YR	=	124111.35
PATH	42	COMPONENT	18	NUM/YR	=	31027.84
PATH	42	COMPONENT	19	NUM/YR	=	124111.35
PATH	42	COMPONENT	20	NUM/YR	=	31027.84
PATH	42	COMPONENT	21	NUM/YR	=	124111.35
PATH	43	COMPONENT	1	NUM/YR	=	107.00
PATH	43	COMPONENT	2	NUM/YR	=	53.50
PATH	43	COMPONENT	3	NUM/YR	=	107.25
PATH	43	COMPONENT	4	NUM/YR	=	107.00
PATH	43	COMPONENT	5	NUM/YR	=	26.75
PATH	43	COMPONENT	6	NUM/YR	=	53.50
PATH	43	COMPONENT	7	NUM/YR	=	107.00
PATH	43	COMPONENT	8	NUM/YR	=	428.00
PATH	43	COMPONENT	9	NUM/YR	=	26.75
PATH	43	COMPONENT	10	NUM/YR	=	53.50
PATH	43	COMPONENT	11	NUM/YR	=	214.00
PATH	43	COMPONENT	12	NUM/YR	=	107.00
PATH	43	COMPONENT	13	NUM/YR	=	107.00
PATH	43	COMPONENT	14	NUM/YR	=	26.75
PATH	43	COMPONENT	15	NUM/YR	=	535.00
PATH	43	COMPONENT	16	NUM/YR	=	107.00
PATH	43	COMPONENT	17	NUM/YR	=	107.00
PATH	43	COMPONENT	18	NUM/YR	=	26.75
PATH	43	COMPONENT	19	NUM/YR	=	107.00
PATH	43	COMPONENT	20	NUM/YR	=	26.75
PATH	43	COMPONENT	21	NUM/YR	=	107.00
PATH	44	COMPONENT	1	NUM/YR	=	4260.98
PATH	44	COMPONENT	2	NUM/YR	=	2130.49
PATH	44	COMPONENT	3	NUM/YR	=	7456.71
PATH	44	COMPONENT	4	NUM/YR	=	4260.98
PATH	44	COMPONENT	5	NUM/YR	=	1065.24
PATH	44	COMPONENT	6	NUM/YR	=	2130.49
PATH	44	COMPONENT	7	NUM/YR	=	4260.98
PATH	44	COMPONENT	8	NUM/YR	=	17043.91
PATH	44	COMPONENT	9	NUM/YR	=	1065.24
PATH	44	COMPONENT	10	NUM/YR	=	2130.49
PATH	44	COMPONENT	11	NUM/YR	=	8521.95
PATH	44	COMPONENT	12	NUM/YR	=	4260.98
PATH	44	COMPONENT	13	NUM/YR	=	4260.98
PATH	44	COMPONENT	14	NUM/YR	=	1065.24
PATH	44	COMPONENT	15	NUM/YR	=	21304.88
PATH	44	COMPONENT	16	NUM/YR	=	4260.98
PATH	44	COMPONENT	17	NUM/YR	=	4260.98
PATH	44	COMPONENT	18	NUM/YR	=	1065.24
PATH	44	COMPONENT	19	NUM/YR	=	4260.98

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	44	COMPONENT	20	NUM/YR	=	1065.24
PATH	44	COMPONENT	21	NUM/YR	=	4260.98
PATH	45	COMPONENT	1	NUM/YR	=	4347.27
PATH	45	COMPONENT	2	NUM/YR	=	2173.64
PATH	45	COMPONENT	3	NUM/YR	=	7607.72
PATH	45	COMPONENT	4	NUM/YR	=	4347.27
PATH	45	COMPONENT	5	NUM/YR	=	1086.82
PATH	45	COMPONENT	6	NUM/YR	=	2173.64
PATH	45	COMPONENT	7	NUM/YR	=	4347.27
PATH	45	COMPONENT	8	NUM/YR	=	17389.09
PATH	45	COMPONENT	9	NUM/YR	=	1086.82
PATH	45	COMPONENT	10	NUM/YR	=	2173.64
PATH	45	COMPONENT	11	NUM/YR	=	8694.54
PATH	45	COMPONENT	12	NUM/YR	=	4347.27
PATH	45	COMPONENT	13	NUM/YR	=	4347.27
PATH	45	COMPONENT	14	NUM/YR	=	1086.82
PATH	45	COMPONENT	15	NUM/YR	=	21736.36
PATH	45	COMPONENT	16	NUM/YR	=	4347.27
PATH	45	COMPONENT	17	NUM/YR	=	4347.27
PATH	45	COMPONENT	18	NUM/YR	=	1086.82
PATH	45	COMPONENT	19	NUM/YR	=	4347.27
PATH	45	COMPONENT	20	NUM/YR	=	1086.82
PATH	45	COMPONENT	21	NUM/YR	=	4347.27
PATH	46	COMPONENT	1	NUM/YR	=	4347.27
PATH	46	COMPONENT	2	NUM/YR	=	2173 64
PATH	46	COMPONENT	3	NUM/YR	=	7561.72
PATH	46	COMPONENT	4	NUM/YR	=	4347.27
PATH	46	COMPONENT	5	NUM/YR	=	1086.82
PATH	46	COMPONENT	6	NUM/YR	=	2173.64
PATH	46	COMPONENT	7	NUM/YR	=	4347.27
PATH	46	COMPONENT	8	NUM/YR	=	17389.09
PATH	46	COMPONENT	9	NUM/YR	=	1083.53
PATH	46	COMPONENT	10	NUM/YR	=	2157.86
PATH	46	COMPONENT	11	NUM/YR	=	8694.54
PATH	46	COMPONENT	12	NUM/YR	=	4347.27
PATH	46	COMPONENT	13	NUM/YR	=	4268.39
PATH	46	COMPONENT	14	NUM/YR	=	1086.82
PATH	46	COMPONENT	15	NUM/YR	=	21342.88
PATH	46	COMPONENT	16	NUM/YR	=	4347.27
PATH	46	COMPONENT	17	NUM/YR	=	4329.74
PATH	46	COMPONENT	18	NUM/YR	=	1086.82
PATH	46	COMPONENT	19	NUM/YR	=	4347.27
PATH	46	COMPONENT	20	NUM/YR	=	1086.82
PATH	46	COMPONENT	21	NUM/YR	=	4347.27

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	47	COMPONENT	1	NUM/YR	=	4347.27
PATH	47	COMPONENT	2	NUM/YR	=	2173.64
PATH	47	COMPONENT	3	NUM/YR	=	7607.72
PATH	47	COMPONENT	4	NUM/YR	=	4347.27
PATH	47	COMPONENT	5	NUM/YR	=	1086.82
PATH	47	COMPONENT	6	NUM/YR	=	2173.64
PATH	47	COMPONENT	7	NUM/YR	=	4347.27
PATH	47	COMPONENT	8	NUM/YR	=	17389.09
PATH	47	COMPONENT	9	NUM/YR	=	1086.82
PATH	47	COMPONENT	10	NUM/YR	=	2173.64
PATH	47	COMPONENT	11	NUM/YR	=	8694.54
PATH	47	COMPONENT	12	NUM/YR	=	4347.27
PATH	47	COMPONENT	13	NUM/YR	=	4347.27
PATH	47	COMPONENT	14	NUM/YR	=	1086.82
PATH	47	COMPONENT	15	NUM/YR	=	21736.36
PATH	47	COMPONENT	16	NUM/YR	=	4347.27
PATH	47	COMPONENT	17	NUM/YR	=	4347.27
PATH	47	COMPONENT	18	NUM/YR	=	1086.82
PATH	47	COMPONENT	19	NUM/YR	=	4347.27
PATH	47	COMPONENT	20	NUM/YR	=	1086.82
PATH	47	COMPONENT	21	NUM/YR	=	4347.27
PATH	49	COMPONENT	1	NUM/YR	=	4347.27
PATH	49	COMPONENT	2	NUM/YR	=	2173.64
PATH	49	COMPONENT	3	NUM/YR	=	7607.72
PATH	49	COMPONENT	4	NUM/YR	=	4347.27
PATH	49	COMPONENT	5	NUM/YR	=	1086.82
PATH	49	COMPONENT	6	NUM/YR	=	2173.64
PATH	49	COMPONENT	7	NUM/YR	=	4347.27
PATH	49	COMPONENT	8	NUM/YR	=	17389.09
PATH	49	COMPONENT	9	NUM/YR	=	1086.82
PATH	49	COMPONENT	10	NUM/YR	=	2173.64
PATH	49	COMPONENT	11	NUM/YR	=	8694 54
PATH	49	COMPONENT	12	NUM/YR	=	4347.27
PATH	49	COMPONENT	13	NUM/YR	=	4347.27
PATH	49	COMPONENT	14	NUM/YR	=	1086.82
PATH	49	COMPONENT	15	NUM/YR	=	21736.36
PATH	49	COMPONENT	16	NUM/YR	=	4347.27
PATH	49	COMPONENT	17	NUM/YR	=	4347.27
PATH	49	COMPONENT	18	NUM/YR	=	1086.82
PATH	49	COMPONENT	19	NUM/YR	=	4347.27
PATH	49	COMPONENT	20	NUM/YR	=	1086.82
PATH	49	COMPONENT	21	NUM/YR	=	4347.27
PATH	50	COMPONENT	1	NUM/YR	=	19854.59
PATH	50	COMPONENT	2	NUM/YR	=	9927.29
PATH	50	COMPONENT	3	NUM/YR	=	34745.53
PATH	50	COMPONENT	4	NUM/YR	=	19854.59

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	50	COMPONENT	5	NUM/YR	=	4963.65
PATH	50	COMPONENT	6	NUM/YR	=	9927.29
PATH	50	COMPONENT	7	NUM/YR	=	19854.59
PATH	50	COMPONENT	8	NUM/YR	=	79418.35
PATH	50	COMPONENT	9	NUM/YR	=	4963.65
PATH	50	COMPONENT	10	NUM/YR	=	9927.29
PATH	50	COMPONENT	11	NUM/YR	=	39709.17
PATH	50	COMPONENT	12	NUM/YR	=	19854.59
PATH	50	COMPONENT	13	NUM/YR	=	19854.59
PATH	50	COMPONENT	14	NUM/YR	=	4963.65
PATH	50	COMPONENT	15	NUM/YR	=	99272.94
PATH	50	COMPONENT	16	NUM/YR	=	19854.59
PATH	50	COMPONENT	17	NUM/YR	=	19854.59
PATH	50	COMPONENT	18	NUM/YR	=	4963.65
PATH	50	COMPONENT	19	NUM/YR	=	19854.59
PATH	50	COMPONENT	20	NUM/YR	=	4963.65
PATH	50	COMPONENT	21	NUM/YR	=	19854.59
PATH	51	COMPONENT	1	NUM/YR	=	19854.59
PATH	51	COMPONENT	2	NUM/YR	=	9927.29
PATH	51	COMPONENT	3	NUM/YR	=	34748.42
PATH	51	COMPONENT	4	NUM/YR	=	19854.59
PATH	51	COMPONENT	5	NUM/YR	=	4963.65
PATH	51	COMPONENT	6	NUM/YR	=	9927.29
PATH	51	COMPONENT	7	NUM/YR	=	19854.59
PATH	51	COMPONENT	8	NUM/YR	=	79418.35
PATH	51	COMPONENT	9	NUM/YR	=	4963.28
PATH	51	COMPONENT	10	NUM/YR	=	9925.54
PATH	51	COMPONENT	11	NUM/YR	=	39709.17
PATH	51	COMPONENT	12	NUM/YR	=	19854.59
PATH	51	COMPONENT	13	NUM/YR	=	19845.02
PATH	51	COMPONENT	14	NUM/YR	=	4963.65
PATH	51	COMPONENT	15	NUM/YR	=	99229.12
PATH	51	COMPONENT	16	NUM/YR	=	19854.59
PATH	51	COMPONENT	17	NUM/YR	=	19852.64
PATH	51	COMPONENT	18	NUM/YR	=	4963.65
PATH	51	COMPONENT	19	NUM/YR	=	19854.59
PATH	51	COMPONENT	20	NUM/YR	=	4963.65
PATH	51	COMPONENT	21	NUM/YR	=	19854.59
PATH	52	COMPONENT	1	NUM/YR	=	19854.59
PATH	52	COMPONENT	2	NUM/YR	=	9927.29
PATH	52	COMPONENT	3	NUM/YR	=	34745.53
PATH	52	COMPONENT	4	NUM/YR	=	19854.59
PATH	52	COMPONENT	5	NUM/YR	=	4963.65
PATH	52	COMPONENT	6	NUM/YR	=	9927.29
PATH	52	COMPONENT	7	NUM/YR	=	19854.59
PATH	52	COMPONENT	8	NUM/YR	=	79418.35

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	52	COMPONENT	9	NUM/YR	=	4963.65
PATH	52	COMPONENT	10	NUM/YR	=	9927.29
PATH	52	COMPONENT	11	NUM/YR	=	39709.17
PATH	52	COMPONENT	12	NUM/YR	=	19854.59
PATH	52	COMPONENT	13	NUM/YR	=	19854.59
PATH	52	COMPONENT	14	NUM/YR	=	4963.65
PATH	52	COMPONENT	15	NUM/YR	=	99272.94
PATH	52	COMPONENT	16	NUM/YR	=	19854.59
PATH	52	COMPONENT	17	NUM/YR	=	19854.59
PATH	52	COMPONENT	18	NUM/YR	=	4963.65
PATH	52	COMPONENT	19	NUM/YR	=	19854.59
PATH	52	COMPONENT	20	NUM/YR	=	4963.65
PATH	52	COMPONENT	21	NUM/YR	=	19854.59
PATH	53	COMPONENT	1	NUM/YR	=	15507.32
PATH	53	COMPONENT	2	NUM/YR	=	7753.66
PATH	53	COMPONENT	3	NUM/YR	=	27137.80
PATH	53	COMPONENT	4	NUM/YR	=	15507.32
PATH	53	COMPONENT	5	NUM/YR	=	3876.83
PATH	53	COMPONENT	6	NUM/YR	=	7753.66
PATH	53	COMPONENT	7	NUM/YR	=	15507.32
PATH	53	COMPONENT	8	NUM/YR	=	62029.26
PATH	53	COMPONENT	9	NUM/YR	=	3876.83
PATH	53	COMPONENT	10	NUM/YR	=	7753.66
PATH	53	COMPONENT	11	NUM/YR	=	31014.63
PATH	53	COMPONENT	12	NUM/YR	=	15507.32
PATH	53	COMPONENT	13	NUM/YR	=	15507.32
PATH	53	COMPONENT	14	NUM/YR	=	3876.83
PATH	53	COMPONENT	15	NUM/YR	=	77536.58
PATH	53	COMPONENT	16	NUM/YR	=	15507.32
PATH	53	COMPONENT	17	NUM/YR	=	15507.32
PATH	53	COMPONENT	18	NUM/YR	=	3876.83
PATH	53	COMPONENT	19	NUM/YR	=	15507.32
PATH	53	COMPONENT	20	NUM/YR	=	3876.83
PATH	53	COMPONENT	21	NUM/YR	=	15507.32
PATH	54	COMPONENT	1	NUM/YR	=	86.30
PATH	54	COMPONENT	2	NUM/YR	=	43.15
PATH	54	COMPONENT	3	NUM/YR	=	151.02
PATH	54	COMPONENT	4	NUM/YR	=	86.30
PATH	54	COMPONENT	5	NUM/YR	=	21.57
PATH	54	COMPONENT	6	NUM/YR	=	43.15
PATH	54	COMPONENT	7	NUM/YR	=	86.30
PATH	54	COMPONENT	8	NUM/YR	=	345.18
PATH	54	COMPONENT	9	NUM/YR	=	21.57
PATH	54	COMPONENT	10	NUM/YR	=	43.15
PATH	54	COMPONENT	11	NUM/YR	=	172.59

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	54	COMPONENT	12	NUM/YR	=	86.30
PATH	54	COMPONENT	13	NUM/YR	=	86.30
PATH	54	COMPONENT	14	NUM/YR	=	21.57
PATH	54	COMPONENT	15	NUM/YR	=	431.48
PATH	54	COMPONENT	16	NUM/YR	=	86.30
PATH	54	COMPONENT	17	NUM/YR	=	86.30
PATH	54	COMPONENT	18	NUM/YR	=	21.57
PATH	54	COMPONENT	19	NUM/YR	=	86.30
PATH	54	COMPONENT	20	NUM/YR	=	21.57
PATH	54	COMPONENT	21	NUM/YR	=	86.30
PATH	55	COMPONENT	1	NUM/YR	=	4656.05
PATH	55	COMPONENT	2	NUM/YR	=	2328.02
PATH	55	COMPONENT	3	NUM/YR	=	8148.08
PATH	55	COMPONENT	4	NUM/YR	=	4656.05
PATH	55	COMPONENT	5	NUM/YR	=	1164.01
PATH	55	COMPONENT	6	NUM/YR	=	2328.02
PATH	55	COMPONENT	7	NUM/YR	=	4656.05
PATH	55	COMPONENT	8	NUM/YR	=	18624.19
PATH	55	COMPONENT	9	NUM/YR	=	1164.01
PATH	55	COMPONENT	10	NUM/YR	=	2328.02
PATH	55	COMPONENT	11	NUM/YR	=	9312.10
PATH	55	COMPONENT	12	NUM/YR	=	4656.05
PATH	55	COMPONENT	13	NUM/YR	=	4656.05
PATH	55	COMPONENT	14	NUM/YR	=	1164.01
PATH	55	COMPONENT	15	NUM/YR	=	23280.24
PATH	55	COMPONENT	16	NUM/YR	=	4656.05
PATH	55	COMPONENT	17	NUM/YR	=	4656.05
ATH	55	COMPONENT	18	NUM/YR	=	1164.01
PATH	55	COMPONENT	19	NUM/YR	=	4656.05
PATH	55	COMPONENT	20	NUM/YR	=	1164.01
PATH	55	COMPONENT	21	NUM/YR	=	4656.05
PATH	56	COMPONENT	1	NUM/YR	=	4763.05
PATH	56	COMPONENT	2	NUM/YR	=	2381.52
PATH	56	COMPONENT	3	NUM/YR	=	8335.33
PATH	56	COMPONENT	4	NUM/YR	=	4763.05
PATH	56	COMPONENT	5	NUM/YR	=	1190.76
PATH	56	COMPONENT	6	NUM/YR	=	2381.52
PATH	56	COMPONENT	7	NUM/YR	=	4763.05
PATH	56	COMPONENT	8	NUM/YR	=	19052.19
PATH	56	COMPONENT	9	NUM/YR	=	1190.76
PATH	56	COMPONENT	10	NUM/YR	=	2381.52
PATH	56	COMPONENT	11	NUM/YR	=	9526.10
PATH	56	COMPONENT	12	NUM/YR	=	4763.05
PATH	56	COMPONENT	13	NUM/YR	=	4763.05
PATH	56	COMPONENT	14	NUM/YR	=	1190.76
PATH	56	COMPONENT	15	NUM/YR	=	23815.24

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	56	COMPONENT	16	NUM/YR	=	4763.05
PATH	56	COMPONENT	17	NUM/YR	=	4763.05
PATH	56	COMPONENT	18	NUM/YR	=	1190.76
PATH	56	COMPONENT	19	NUM/YR	=	4763.05
PATH	56	COMPONENT	20	NUM/YR	=	1190.76
PATH	56	COMPONENT	21	NUM/YR	=	4763.05
PATH	58	COMPONENT	1	NUM/YR	=	4763.05
PATH	58	COMPONENT	2	NUM/YR	=	2381.52
PATH	58	COMPONENT	3	NUM/YR	=	8335.33
PATH	58	COMPONENT	4	NUM/YR	=	4763.05
PATH	58	COMPONENT	5	NUM/YR	=	1190.76
PATH	58	COMPONENT	6	NUM/YR	=	2381.52
PATH	58	COMPONENT	7	NUM/YR	=	4763.05
PATH	58	COMPONENT	8	NUM/YR	=	19052.19
PATH	58	COMPONENT	9	NUM/YR	=	1190.76
PATH	58	COMPONENT	10	NUM/YR	=	2381.52
PATH	58	COMPONENT	11	NUM/YR	=	9526.10
PATH	58	COMPONENT	12	NUM/YR	=	4763.05
PATH	58	COMPONENT	13	NUM/YR	=	4763.05
PATH	58	COMPONENT	14	NUM/YR	=	1190.76
PATH	58	COMPONENT	15	NUM/YR	=	23815.24
PATH	58	COMPONENT	16	NUM/YR	=	4763.05
PATH	58	COMPONENT	17	NUM/YR	=	4763.05
PATH	58	COMPONENT	18	NUM/YR	=	1190.76
PATH	58	COMPONENT	19	NUM/YR	=	4763.05
PATH	58	COMPONENT	20	NUM/YR	=	1190.76
PATH	58	COMPONENT	21	NUM/YR	=	4763.05
PATH	59	COMPONENT	1	NUM/YR	=	4795.05
PATH	59	COMPONENT	2	NUM/YR	=	2397.52
PATH	59	COMPONENT	3	NUM/YR	=	8391.33
PATH	59	COMPONENT	4	NUM/YR	=	4795.05
PATH	59	COMPONENT	5	NUM/YR	=	1198.76
PATH	59	COMPONENT	6	NUM/YR	=	2397.52
PATH	59	COMPONENT	7	NUM/YR	=	4795.05
PATH	59	COMPONENT	8	NUM/YR	=	19180.19
PATH	59	COMPONENT	9	NUM/YR	=	1198.76
PATH	59	COMPONENT	10	NUM/YR	=	2397.52
PATH	59	COMPONENT	11	NUM/YR	=	9590.10
PATH	59	COMPONENT	12	NUM/YR	=	4795.05
PATH	59	COMPONENT	13	NUM/YR	=	4795.05
PATH	59	COMPONENT	14	NUM/YR	=	1198.76
PATH	59	COMPONENT	15	NUM/YR	=	23975.24
PATH	59	COMPONENT	16	NUM/YR	=	4795.05
PATH	59	COMPONENT	17	NUM/YR	=	4795.05
PATH	59	COMPONENT	18	NUM/YR	=	1198.76

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	59	COMPONENT	19	NUM/YR	=	4795.05
PATH	59	COMPONENT	20	NUM/YR	=	1198.76
PATH	59	COMPONENT	21	NUM/YR	=	4795.05
PATH	60	COMPONENT	1	NUM/YR	=	128.00
PATH	60	COMPONENT	2	NUM/YR	=	64.00
PATH	60	COMPONENT	3	NUM/YR	=	224.00
PATH	60	COMPONENT	4	NUM/YR	=	128.00
PATH	60	COMPONENT	5	NUM/YR	=	32.00
PATH	60	COMPONENT	6	NUM/YR	=	64.00
PATH	60	COMPONENT	7	NUM/YR	=	128.00
PATH	60	COMPONENT	8	NUM/YR	=	512.00
PATH	60	COMPONENT	9	NUM/YR	=	32.00
PATH	60	COMPONENT	10	NUM/YR	=	64.00
PATH	60	COMPONENT	11	NUM/YR	=	256.00
PATH	60	COMPONENT	12	NUM/YR	=	128.00
PATH	60	COMPONENT	13	NUM/YR	=	128.00
PATH	60	COMPONENT	14	NUM/YR	=	32.00
PATH	60	COMPONENT	15	NUM/YR	=	640.00
PATH	60	COMPONENT	16	NUM/YR	=	128.00
PATH	60	COMPONENT	17	NUM/YR	=	128.00
PATH	60	COMPONENT	18	NUM/YR	=	32.00
PATH	60	COMPONENT	19	NUM/YR	=	128.00
PATH	60	COMPONENT	20	NUM/YR	=	32.00
PATH	60	COMPONENT	21	NUM/YR	=	128.00
PATH	61	COMPONENT	1	NUM/YR	=	32.00
PATH	61	COMPONENT	2	NUM/YR	=	16.00
PATH	61	COMPONENT	3	NUM/YR	=	56.00
PATH	61	COMPONENT	4	NUM/YR	=	32.00
PATH	61	COMPONENT	5	NUM/YR	=	8.00
PATH	61	COMPONENT	6	NUM/YR	=	16.00
PATH	61	COMPONENT	7	NUM/YR	=	32.00
PATH	61	COMPONENT	8	NUM/YR	=	128.00
PATH	61	COMPONENT	9	NUM/YR	=	8.00
PATH	61	COMPONENT	10	NUM/YR	=	16.00
PATH	61	COMPONENT	11	NUM/YR	=	64.00
PATH	61	COMPONENT	12	NUM/YR	=	32.00
PATH	61	COMPONENT	13	NUM/YR	=	32.00
PATH	61	COMPONENT	14	NUM/YR	=	8.00
PATH	61	COMPONENT	15	NUM/YR	=	160.00
PATH	61	COMPONENT	16	NUM/YR	=	32.00
PATH	61	COMPONENT	17	NUM/YR	=	32.00
PATH	61	COMPONENT	18	NUM/YR	=	8.00
PATH	61	COMPONENT	19	NUM/YR	=	32.00
PATH	61	COMPONENT	20	NUM/YR	=	8.00
PATH	61	COMPONENT	21	NUM/YR	=	32.00

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	62	COMPONENT	1	NUM/YR	=	96.00
PATH	62	COMPONENT	2	NUM/YR	=	48.00
PATH	62	COMPONENT	3	NUM/YR	=	168.00
PATH	62	COMPONENT	4	NUM/YR	=	96.00
PATH	62	COMPONENT	5	NUM/YR	=	24.00
PATH	62	COMPONENT	6	NUM/YR	=	48.00
PATH	62	COMPONENT	7	NUM/YR	=	96.00
PATH	62	COMPONENT	8	NUM/YR	=	384.00
PATH	62	COMPONENT	9	NUM/YR	=	24.00
PATH	62	COMPONENT	10	NUM/YR	=	48.00
PATH	62	COMPONENT	11	NUM/YR	=	192.00
PATH	62	COMPONENT	12	NUM/YR	=	96.00
PATH	62	COMPONENT	13	NUM/YR	=	96.00
PATH	62	COMPONENT	14	NUM/YR	=	24.00
PATH	62	COMPONENT	15	NUM/YR	=	480.00
PATH	62	COMPONENT	16	NUM/YR	=	96.00
PATH	62	COMPONENT	17	NUM/YR	=	96.00
PATH	62	COMPONENT	18	NUM/YR	=	24.00
PATH	62	COMPONENT	19	NUM/YR	=	96.00
PATH	62	COMPONENT	20	NUM/YR	=	24.00
PATH	62	COMPONENT	21	NUM/YR	=	96.00
PATH	63	COMPONENT	1	NUM/YR	=	16.00
PATH	63	COMPONENT	2	NUM/YR	=	8.00
PATH	63	COMPONENT	3	NUM/YR	=	28.00
PATH	63	COMPONENT	4	NUM/YR	=	16.00
PATH	63	COMPONENT	5	NUM/YR	=	4.00
PATH	63	COMPONENT	6	NUM/YR	=	8.00
PATH	63	COMPONENT	7	NUM/YR	=	16.00
PATH	63	COMPONENT	8	NUM/YR	=	64.00
PATH	63	COMPONENT	9	NUM/YR	=	4.00
PATH	63	COMPONENT	10	NUM/YR	=	8.00
PATH	63	COMPONENT	11	NUM/YR	=	32.00
PATH	63	COMPONENT	12	NUM/YR	=	16.00
PATH	63	COMPONENT	13	NUM/YR	=	16.00
PATH	63	COMPONENT	14	NUM/YR	=	4.00
PATH	63	COMPONENT	15	NUM/YR	=	80.00
PATH	63	COMPONENT	16	NUM/YR	=	16.00
PATH	63	COMPONENT	17	NUM/YR	=	16.00
PATH	63	COMPONENT	18	NUM/YR	=	4.00
PATH	63	COMPONENT	19	NUM/YR	=	16.00
PATH	63	COMPONENT	20	NUM/YR	=	4.00
PATH	63	COMPONENT	21	NUM/YR	=	16.00
PATH	64	COMPONENT	1	NUM/YR	=	16.00
PATH	64	COMPONENT	2	NUM/YR	=	8.00
PATH	64	COMPONENT	3	NUM/YR	=	28.00

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	64	COMPONENT	4	NUM/YR	=	16.00
PATH	64	COMPONENT	5	NUM/YR	=	4.00
PATH	64	COMPONENT	6	NUM/YR	=	8.00
PATH	64	COMPONENT	7	NUM/YR	=	16.00
PATH	64	COMPONENT	8	NUM/YR	=	64.00
PATH	64	COMPONENT	9	NUM/YR	=	4.00
PATH	64	COMPONENT	10	NUM/YR	=	8.00
PATH	64	COMPONENT	11	NUM/YR	=	32.00
PATH	64	COMPONENT	12	NUM/YR	=	16.00
PATH	64	COMPONENT	13	NUM/YR	=	16.00
PATH	64	COMPONENT	14	NUM/YR	=	4.00
PATH	64	COMPONENT	15	NUM/YR	=	80.00
PATH	64	COMPONENT	16	NUM/YR	=	16.00
PATH	64	COMPONENT	17	NUM/YR	=	16.00
PATH	64	COMPONENT	18	NUM/YR	=	4.00
PATH	64	COMPONENT	19	NUM/YR	=	16.00
PATH	64	COMPONENT	20	NUM/YR	=	4.00
PATH	64	COMPONENT	21	NUM/YR	=	16.00
PATH	65	COMPONENT	1	NUM/YR	=	32.00
PATH	65	COMPONENT	2	NUM/YR	=	16.00
PATH	65	COMPONENT	3	NUM/YR	=	56.00
PATH	65	COMPONENT	4	NUM/YR	=	32.00
PATH	65	COMPONENT	5	NUM/YR	=	8.00
PATH	65	COMPONENT	6	NUM/YR	=	16.00
PATH	65	COMPONENT	7	NUM/YR	=	32.00
PATH	65	COMPONENT	8	NUM/YR	=	128.00
PATH	65	COMPONENT	9	NUM/YR	=	8.00
PATH	65	COMPONENT	10	NUM/YR	=	16.00
PATH	65	COMPONENT	11	NUM/YR	=	64.00
PATH	65	COMPONENT	12	NUM/YR	=	32.00
PATH	65	COMPONENT	13	NUM/YR	=	32.00
PATH	65	COMPONENT	14	NUM/YR	=	8.00
PATH	65	COMPONENT	15	NUM/YR	=	160.00
PATH	65	COMPONENT	16	NUM/YR	=	32.00
PATH	65	COMPONENT	17	NUM/YR	=	32.00
PATH	65	COMPONENT	18	NUM/YR	=	8.00
PATH	65	COMPONENT	19	NUM/YR	=	32.00
PATH	65	COMPONENT	20	NUM/YR	=	8.00
PATH	65	COMPONENT	21	NUM/YR	=	32.00
PATH	70	COMPONENT	1	NUM/YR	=	4795.05
PATH	70	COMPONENT	2	NUM/YR	=	2397.52
PATH	70	COMPONENT	3	NUM/YR	=	8391.33
PATH	70	COMPONENT	4	NUM/YR	=	4795.05
PATH	70	COMPONENT	5	NUM/YR	=	1198.76
PATH	70	COMPONENT	6	NUM/YR	=	2397.52

FOR ILLUSTRATION ONLY

RESULTS

PATH	70	COMPONENT	7	NUM/YR	=	4795.05
PATH	70	COMPONENT	8	NUM/YR	=	19180.19
PATH	70	COMPONENT	9	NUM/YR	=	1198.76
PATH	70	COMPONENT	10	NUM/YR	=	2397.52
PATH	70	COMPONENT	11	NUM/YR	=	9590.10
PATH	70	COMPONENT	12	NUM/YR	=	4795.05
PATH	70	COMPONENT	13	NUM/YR	=	4795.05
PATH	70	COMPONENT	14	NUM/YR	=	1198.76
PATH	70	COMPONENT	15	NUM/YR	=	23975.24
PATH	70	COMPONENT	16	NUM/YR	=	4795.05
PATH	70	COMPONENT	17	NUM/YR	=	4795.05
PATH	70	COMPONENT	18	NUM/YR	=	1198.76
PATH	70	COMPONENT	19	NUM/YR	=	4795.05
PATH	70	COMPONENT	20	NUM/YR	=	1198.76
PATH	70	COMPONENT	21	NUM/YR	=	4795.05
PATH	71	COMPONENT	1	NUM/YR	=	4555.30
PATH	71	COMPONENT	2	NUM/YR	=	2277.65
PATH	71	COMPONENT	3	NUM/YR	=	7971.77
PATH	71	COMPONENT	4	NUM/YR	=	4555.30
PATH	71	COMPONENT	5	NUM/YR	=	1138.82
PATH	71	COMPONENT	6	NUM/YR	=	2277.65
PATH	71	COMPONENT	7	NUM/YR	=	4555.30
PATH	71	COMPONENT	8	NUM/YR	=	18221.18
PATH	71	COMPONENT	9	NUM/YR	=	1138.82
PATH	71	COMPONENT	10	NUM/YR	=	2277.65
PATH	71	COMPONENT	11	NUM/YR	=	9110.59
PATH	71	COMPONENT	12	NUM/YR	=	4555.30
PATH	71	COMPONENT	13	NUM/YR	=	4555.30
PATH	71	COMPONENT	14	NUM/YR	=	1138.82
PATH	71	COMPONENT	15	NUM/YR	=	22776.48
PATH	71	COMPONENT	16	NUM/YR	=	4555.30
PATH	71	COMPONENT	17	NUM/YR	=	4555.30
PATH	71	COMPONENT	18	NUM/YR	=	1138.82
PATH	71	COMPONENT	19	NUM/YR	=	4555.30
PATH	71	COMPONENT	20	NUM/YR	=	1138.82
PATH	71	COMPONENT	21	NUM/YR	=	4555.30
PATH	72	COMPONENT	1	NUM/YR	=	4555.30
PATH	72	COMPONENT	2	NUM/YR	=	2277.65
PATH	72	COMPONENT	3	NUM/YR	=	7971.77
PATH	72	COMPONENT	5	NUM/YR	=	1138.82
PATH	72	COMPONENT	8	NUM/YR	=	18221.18
PATH	72	COMPONENT	9	NUM/YR	=	1138.82
PATH	72	COMPONENT	10	NUM/YR	=	2277.65
PATH	72	COMPONENT	11	NUM/YR	=	9110.59
PATH	72	COMPONENT	12	NUM/YR	=	4555.30
PATH	72	COMPONENT	13	NUM/YR	=	4555.30
PATH	72	COMPONENT	14	NUM/YR	=	1138.82
PATH	72	COMPONENT	15	NUM/YR	=	22776.48
PATH	72	COMPONENT	16	NUM/YR	=	4555.30
PATH	72	COMPONENT	17	NUM/YR	=	4555.30

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	72	COMPONENT	18	NUM/YR	=	1138.82
PATH	72	COMPONENT	20	NUM/YR	=	1138.82
PATH	72	COMPONENT	21	NUM/YR	=	4555.30
PATH	73	COMPONENT	4	NUM/YR	=	4555.30
PATH	73	COMPONENT	6	NUM/YR	=	2277.65
PATH	73	COMPONENT	7	NUM/YR	=	4555.30
PATH	73	COMPONENT	19	NUM/YR	=	4555.30
PATH	74	COMPONENT	1	NUM/YR	=	4329.97
PATH	74	COMPONENT	2	NUM/YR	=	1714.34
PATH	74	COMPONENT	3	NUM/YR	=	7971.77
PATH	74	COMPONENT	5	NUM/YR	=	1138.82
PATH	74	COMPONENT	8	NUM/YR	=	10221.18
PATH	74	COMPONENT	9	NUM/YR	=	1138.82
PATH	74	COMPONENT	10	NUM/YR	=	2277.65
PATH	74	COMPONENT	11	NUM/YR	=	4604.15
PATH	74	COMPONENT	12	NUM/YR	=	4555.30
PATH	74	COMPONENT	13	NUM/YR	=	4555.30
PATH	74	COMPONENT	14	NUM/YR	=	1138.82
PATH	74	COMPONENT	15	NUM/YR	=	22776.48
PATH	74	COMPONENT	16	NUM/YR	=	4555.30
PATH	74	COMPONENT	17	NUM/YR	=	4555.30
PATH	74	COMPONENT	18	NUM/YR	=	1002.49
PATH	74	COMPONENT	20	NUM/YR	=	998.00
PATH	74	COMPONENT	21	NUM/YR	=	4367.53
PATH	75	COMPONENT	1	NUM/YR	=	4555.30
PATH	75	COMPONENT	2	NUM/YR	=	2277.65
PATH	75	COMPONENT	3	NUM/YR	=	7971.77
PATH	75	COMPONENT	5	NUM/YR	=	1138.82
PATH	75	COMPONENT	8	NUM/YR	=	10221.18
PATH	75	COMPONENT	9	NUM/YR	=	1138.82
PATH	75	COMPONENT	10	NUM/YR	=	2277.65
PATH	75	COMPONENT	11	NUM/YR	=	9110.59
PATH	75	COMPONENT	12	NUM/YR	=	4555.30
PATH	75	COMPONENT	13	NUM/YR	=	4555.30
PATH	75	COMPONENT	14	NUM/YR	=	1138.82
PATH	75	COMPONENT	15	NUM/YR	=	22776.48
PATH	75	COMPONENT	16	NUM/YR	=	4555.30
PATH	75	COMPONENT	17	NUM/YR	=	4555.30
PATH	75	COMPONENT	18	NUM/YR	=	1138.82
PATH	75	COMPONENT	20	NUM/YR	=	1138.82
PATH	75	COMPONENT	21	NUM/YR	=	4555.30
PATH	76	COMPONENT	1	NUM/YR	=	4555.30
PATH	76	COMPONENT	2	NUM/YR	=	2277.65

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH 76	COMPONENT 3	NUM/YR = 7971.77
PATH 76	COMPONENT 4	NUM/YR = 4552.42
PATH 76	COMPONENT 5	NUM/YR = 1138.82
PATH 76	COMPONENT 6	NUM/YR = 2276.21
PATH 76	COMPONENT 7	NUM/YR = 4552.42
PATH 76	COMPONENT 8	NUM/YR = 18221.18
PATH 76	COMPONENT 9	NUM/YR = 1138.82
PATH 76	COMPONENT 10	NUM/YR = 2277.65
PATH 76	COMPONENT 11	NUM/YR = 9110.59
PATH 76	COMPONENT 12	NUM/YR = 4555.30
PATH 76	COMPONENT 13	NUM/YR = 4555.30
PATH 76	COMPONENT 14	NUM/YR = 1138.82
PATH 76	COMPONENT 15	NUM/YR = 22776.48
PATH 76	COMPONENT 16	NUM/YR = 4555.30
PATH 76	COMPONENT 17	NUM/YR = 4553.30
PATH 76	COMPONENT 18	NUM/YR = 1138.82
PATH 76	COMPONENT 19	NUM/YR = 4552.42
PATH 76	COMPONENT 20	NUM/YR = 1138.82
PATH 76	COMPONENT 21	NUM/YR = 4555.30
PATH 77	COMPONENT 1	NUM/YR = 4704.11
PATH 77	COMPONENT 2	NUM/YR = 2392.06
PATH 77	COMPONENT 3	NUM/YR = 8372.20
PATH 77	COMPONENT 4	NUM/YR = 4779.67
PATH 77	COMPONENT 5	NUM/YR = 1196.03
PATH 77	COMPONENT 6	NUM/YR = 2389.84
PATH 77	COMPONENT 7	NUM/YR = 4779.67
PATH 77	COMPONENT 8	NUM/YR = 19136.46
PATH 77	COMPONENT 9	NUM/YR = 1196.03
PATH 77	COMPONENT 10	NUM/YR = 2392.06
PATH 77	COMPONENT 11	NUM/YR = 9568.23
PATH 77	COMPONENT 12	NUM/YR = 4784.11
PATH 77	COMPONENT 13	NUM/YR = 4784.11
PATH 77	COMPONENT 14	NUM/YR = 1196.03
PATH 77	COMPONENT 15	NUM/YR = 23920.57
PATH 77	COMPONENT 16	NUM/YR = 4784.11
PATH 77	COMPONENT 17	NUM/YR = 4784.11
PATH 77	COMPONENT 18	NUM/YR = 1196.03
PATH 77	COMPONENT 19	NUM/YR = 4779.67
PATH 77	COMPONENT 20	NUM/YR = 1196.03
PATH 77	COMPONENT 21	NUM/YR = 4784.11
PATH 82	COMPONENT 4	NUM/YR = 4552.42
PATH 82	COMPONENT 6	NUM/YR = 2276.21
PATH 82	COMPONENT 7	NUM/YR = 4552.42
PATH 82	COMPONENT 19	NUM/YR = 4552.42

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	87	COMPONENT	1	NUM/YR	=	577.64
PATH	87	COMPONENT	2	NUM/YR	=	288.82
PATH	87	COMPONENT	3	NUM/YR	=	1010.87
PATH	87	COMPONENT	4	NUM/YR	=	573.68
PATH	87	COMPONENT	5	NUM/YR	=	144.41
PATH	87	COMPONENT	6	NUM/YR	=	286.84
PATH	87	COMPONENT	7	NUM/YR	=	573.68
PATH	87	COMPONENT	8	NUM/YR	=	2310.56
PATH	87	COMPONENT	9	NUM/YR	=	144.41
PATH	87	COMPONENT	10	NUM/YR	=	288.82
PATH	87	COMPONENT	11	NUM/YR	=	1155.28
PATH	87	COMPONENT	12	NUM/YR	=	577.64
PATH	87	COMPONENT	13	NUM/YR	=	577.64
PATH	87	COMPONENT	14	NUM/YR	=	144.41
PATH	87	COMPONENT	15	NUM/YR	=	2888.20
PATH	87	COMPONENT	16	NUM/YR	=	577.64
PATH	87	COMPONENT	17	NUM/YR	=	577.64
PATH	87	COMPONENT	18	NUM/YR	=	144.41
PATH	87	COMPONENT	19	NUM/YR	=	573.68
PATH	87	COMPONENT	20	NUM/YR	=	144.41
PATH	87	COMPONENT	21	NUM/YR	=	577.64
PATH	89	COMPONENT	1	NUM/YR	=	4784.11
PATH	89	COMPONENT	2	NUM/YR	=	2392.06
PATH	89	COMPONENT	3	NUM/YR	=	8372.20
PATH	89	COMPONENT	4	NUM/YR	=	4779.67
PATH	89	COMPONENT	5	NUM/YR	=	1196.03
PATH	89	COMPONENT	6	NUM/YR	=	2389.84
PATH	89	COMPONENT	7	NUM/YR	=	4779.67
PATH	89	COMPONENT	8	NUM/YR	=	19136.46
PATH	89	COMPONENT	9	NUM/YR	=	1196.03
PATH	89	COMPONENT	10	NUM/YR	=	2392.06
PATH	89	COMPONENT	11	NUM/YR	=	9568.23
PATH	89	COMPONENT	12	NUM/YR	=	4784.11
PATH	89	COMPONENT	13	NUM/YR	=	4784.11
PATH	89	COMPONENT	14	NUM/YR	=	1196.03
PATH	89	COMPONENT	15	NUM/YR	=	23920.57
PATH	89	COMPONENT	16	NUM/YR	=	4784.11
PATH	89	COMPONENT	17	NUM/YR	=	4784.11
PATH	89	COMPONENT	18	NUM/YR	=	1196.03
PATH	89	COMPONENT	19	NUM/YR	=	4779.67
PATH	89	COMPONENT	20	NUM/YR	=	1196.03
PATH	89	COMPONENT	21	NUM/YR	=	4784.11
PATH	100	COMPONENT	1	NUM/YR	=	569.00
PATH	100	COMPONENT	2	NUM/YR	=	284.00

PATH	100	COMPONENT	3	NUM/YR =	994.00
PATH	100	COMPONENT	4	NUM/YR =	568.00
PATH	100	COMPONENT	5	NUM/YR =	142.00
PATH	100	COMPONENT	6	NUM/YR =	284.00
PATH	100	COMPONENT	7	NUM/YR =	568.00
PATH	100	COMPONENT	8	NUM/YR =	2272.00
PATH	100	COMPONENT	9	NUM/YR =	142.00
PATH	100	COMPONENT	10	NUM/YR =	284.00
PATH	100	COMPONENT	11	NUM/YR =	1136.00
PATH	100	COMPONENT	12	NUM/YR =	568.00
PATH	100	COMPONENT	13	NUM/YR =	568.00
PATH	100	COMPONENT	14	NUM/YR =	142.00
PATH	100	COMPONENT	15	NUM/YR =	2840.00
PATH	100	COMPONENT	16	NUM/YR =	568.00
PATH	100	COMPONENT	17	NUM/YR =	568.00
PATH	100	COMPONENT	18	NUM/YR =	142.00
PATH	100	COMPONENT	19	NUM/YR =	568.00
PATH	100	COMPONENT	20	NUM/YR =	142.00
PATH	100	COMPONENT	21	NUM/YR =	568.00
PATH	101	COMPONENT	4	NUM/YR =	4555.30
PATH	101	COMPONENT	6	NUM/YR =	2277.65
PATH	101	COMPONENT	7	NUM/YR =	4555.30
PATH	101	COMPONENT	19	NUM/YR =	4555.30
PATH	102	COMPONENT	1	NUM/YR =	239.75
PATH	102	COMPONENT	2	NUM/YR =	119.88
PATH	102	COMPONENT	3	NUM/YR =	419.57
PATH	102	COMPONENT	4	NUM/YR =	239.75
PATH	102	COMPONENT	5	NUM/YR =	59.94
PATH	102	COMPONENT	6	NUM/YR =	119.88
PATH	102	COMPONENT	7	NUM/YR =	239.75
PATH	102	COMPONENT	8	NUM/YR =	959.01
PATH	102	COMPONENT	9	NUM/YR =	59.94
PATH	102	COMPONENT	10	NUM/YR =	119.88
PATH	102	COMPONENT	11	NUM/YR =	479.50
PATH	102	COMPONENT	12	NUM/YR =	239.75
PATH	102	COMPONENT	13	NUM/YR =	239.75
PATH	102	COMPONENT	14	NUM/YR =	59.94
PATH	102	COMPONENT	15	NUM/YR =	1198.76
PATH	102	COMPONENT	16	NUM/YR =	239.75
PATH	102	COMPONENT	17	NUM/YR =	239.75
PATH	102	COMPONENT	18	NUM/YR =	59.94
PATH	102	COMPONENT	19	NUM/YR =	239.75
PATH	102	COMPONENT	20	NUM/YR =	59.94
PATH	102	COMPONENT	21	NUM/YR =	239.75

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	103	COMPONENT	1	NUM/YR	=	577.64
PATH	103	COMPONENT	2	NUM/YR	=	288.82
PATH	103	COMPONENT	3	NUM/YR	=	1010.87
PATH	103	COMPONENT	4	NUM/YR	=	573.68
PATH	103	COMPONENT	5	NUM/YR	=	144.41
PATH	103	COMPONENT	6	NUM/YR	=	286.84
PATH	103	COMPONENT	7	NUM/YR	=	573.68
PATH	103	COMPONENT	8	NUM/YR	=	2310.56
PATH	103	COMPONENT	9	NUM/YR	=	144.41
PATH	103	COMPONENT	10	NUM/YR	=	288.82
PATH	103	COMPONENT	11	NUM/YR	=	1155.28
PATH	103	COMPONENT	12	NUM/YR	=	577.64
PATH	103	COMPONENT	13	NUM/YR	=	577.64
PATH	103	COMPONENT	14	NUM/YR	=	144.41
PATH	103	COMPONENT	15	NUM/YR	=	2888.20
PATH	103	COMPONENT	16	NUM/YR	=	577.64
PATH	103	COMPONENT	17	NUM/YR	=	577.64
PATH	103	COMPONENT	18	NUM/YR	=	144.41
PATH	103	COMPONENT	19	NUM/YR	=	573.68
PATH	103	COMPONENT	20	NUM/YR	=	144.41
PATH	103	COMPONENT	21	NUM/YR	=	577.64
PATH	104	COMPONENT	1	NUM/YR	=	228.82
PATH	104	COMPONENT	2	NUM/YR	=	114.41
PATH	104	COMPONENT	3	NUM/YR	=	400.43
PATH	104	COMPONENT	4	NUM/YR	=	227.25
PATH	104	COMPONENT	5	NUM/YR	=	57.20
PATH	104	COMPONENT	6	NUM/YR	=	113.62
PATH	104	COMPONENT	7	NUM/YR	=	227.25
PATH	104	COMPONENT	8	NUM/YR	=	915.28
PATH	104	COMPONENT	9	NUM/YR	=	57.20
PATH	104	COMPONENT	10	NUM/YR	=	114.41
PATH	104	COMPONENT	11	NUM/YR	=	457.64
PATH	104	COMPONENT	12	NUM/YR	=	228.82
PATH	104	COMPONENT	13	NUM/YR	=	228.82
PATH	104	COMPONENT	14	NUM/YR	=	57.20
PATH	104	COMPONENT	15	NUM/YR	=	1144.09
PATH	104	COMPONENT	16	NUM/YR	=	228.82
PATH	104	COMPONENT	17	NUM/YR	=	228.82
PATH	104	COMPONENT	18	NUM/YR	=	57.20
PATH	104	COMPONENT	19	NUM/YR	=	227.25
PATH	104	COMPONENT	20	NUM/YR	=	57.20
PATH	104	COMPONENT	21	NUM/YR	=	228.82
PATH	105	COMPONENT	4	NUM/YR	=	4552.42
PATH	105	COMPONENT	6	NUM/YR	=	2276.21
PATH	105	COMPONENT	7	NUM/YR	=	4552.42
PATH	105	COMPONENT	19	NUM/YR	=	4552.42

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	106	COMPONENT	1	NUM/YR	=	937.65
PATH	106	COMPONENT	2	NUM/YR	=	468.82
PATH	106	COMPONENT	3	NUM/YR	=	1640.88
PATH	106	COMPONENT	4	NUM/YR	=	929.15
PATH	106	COMPONENT	5	NUM/YR	=	234.41
PATH	106	COMPONENT	6	NUM/YR	=	464.57
PATH	106	COMPONENT	7	NUM/YR	=	929.15
PATH	106	COMPONENT	8	NUM/YR	=	3750.59
PATH	106	COMPONENT	9	NUM/YR	=	234.41
PATH	106	COMPONENT	10	NUM/YR	=	468.82
PATH	106	COMPONENT	11	NUM/YR	=	1875.30
PATH	106	COMPONENT	12	NUM/YR	=	937.65
PATH	106	COMPONENT	13	NUM/YR	=	937.65
PATH	106	COMPONENT	14	NUM/YR	=	234.41
PATH	106	COMPONENT	15	NUM/YR	=	4688.24
PATH	106	COMPONENT	16	NUM/YR	=	937.65
PATH	106	COMPONENT	17	NUM/YR	=	937.65
PATH	106	COMPONENT	18	NUM/YR	=	234.41
PATH	106	COMPONENT	19	NUM/YR	=	929.15
PATH	106	COMPONENT	20	NUM/YR	=	234.41
PATH	106	COMPONENT	21	NUM/YR	=	937.65
PATH	107	COMPONENT	1	NUM/YR	=	937.65
PATH	107	COMPONENT	2	NUM/YR	=	468.82
PATH	107	COMPONENT	3	NUM/YR	=	1640.88
PATH	107	COMPONENT	4	NUM/YR	=	929.15
PATH	107	COMPONENT	6	NUM/YR	=	464.57
PATH	107	COMPONENT	7	NUM/YR	=	929.15
PATH	107	COMPONENT	8	NUM/YR	=	3750.59
PATH	107	COMPONENT	9	NUM/YR	=	234.41
PATH	107	COMPONENT	10	NUM/YR	=	468.82
PATH	107	COMPONENT	13	NUM/YR	=	937.65
PATH	107	COMPONENT	14	NUM/YR	=	234.41
PATH	107	COMPONENT	15	NUM/YR	=	4688.24
PATH	107	COMPONENT	16	NUM/YR	=	937.65
PATH	107	COMPONENT	17	NUM/YR	=	937.65
PATH	107	COMPONENT	18	NUM/YR	=	234.41
PATH	107	COMPONENT	19	NUM/YR	=	929.15
PATH	107	COMPONENT	20	NUM/YR	=	234.41
PATH	107	COMPONENT	21	NUM/YR	=	937.65
PATH	109	COMPONENT	1	NUM/YR	=	937.65
PATH	109	COMPONENT	2	NUM/YR	=	468.82
PATH	109	COMPONENT	3	NUM/YR	=	1640.88
PATH	109	COMPONENT	8	NUM/YR	=	3750.59
PATH	109	COMPONENT	9	NUM/YR	=	234.41
PATH	109	COMPONENT	10	NUM/YR	=	468.82
PATH	109	COMPONENT	13	NUM/YR	=	937.65

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	109	COMPONENT	14	NUM/YR	=	234.41
PATH	109	COMPONENT	15	NUM/YR	=	4688.24
PATH	109	COMPONENT	16	NUM/YR	=	937.65
PATH	109	COMPONENT	17	NUM/YR	=	937.65
PATH	109	COMPONENT	18	NUM/YR	=	234.41
PATH	109	COMPONENT	20	NUM/YR	=	234.41
PATH	109	COMPONENT	21	NUM/YR	=	937.65
PATH	110	COMPONENT	4	NUM/YR	=	929.15
PATH	110	COMPONENT	6	NUM/YR	=	464.57
PATH	110	COMPONENT	7	NUM/YR	=	929.15
PATH	110	COMPONENT	19	NUM/YR	=	929.15
PATH	111	COMPONENT	1	NUM/YR	=	369.65
PATH	111	COMPONENT	2	NUM/YR	=	184.82
PATH	111	COMPONENT	3	NUM/YR	=	646.88
PATH	111	COMPONENT	4	NUM/YR	=	361.15
PATH	111	COMPONENT	5	NUM/YR	=	92.41
PATH	111	COMPONENT	6	NUM/YR	=	180.57
PATH	111	COMPONENT	7	NUM/YR	=	361.15
PATH	111	COMPONENT	8	NUM/YR	=	1478.59
PATH	111	COMPONENT	9	NUM/YR	=	92.41
PATH	111	COMPONENT	10	NUM/YR	=	184.82
PATH	111	COMPONENT	11	NUM/YR	=	739.30
PATH	111	COMPONENT	12	NUM/YR	=	369.65
PATH	111	COMPONENT	13	NUM/YR	=	369.65
PATH	111	COMPONENT	14	NUM/YR	=	92.41
PATH	111	COMPONENT	15	NUM/YR	=	1848.24
PATH	111	COMPONENT	16	NUM/YR	=	369.65
PATH	111	COMPONENT	17	NUM/YR	=	369.65
PATH	111	COMPONENT	18	NUM/YR	=	92.41
PATH	111	COMPONENT	19	NUM/YR	=	361.15
PATH	111	COMPONENT	20	NUM/YR	=	92.41
PATH	111	COMPONENT	21	NUM/YR	=	369.65
PATH	112	COMPONENT	4	NUM/YR	=	4640.29
PATH	112	COMPONENT	6	NUM/YR	=	2320.15
PATH	112	COMPONENT	7	NUM/YR	=	4640.29
PATH	112	COMPONENT	19	NUM/YR	=	4640.29
PATH	115	COMPONENT	1	NUM/YR	=	937.65
PATH	115	COMPONENT	2	NUM/YR	=	468.82
PATH	115	COMPONENT	3	NUM/YR	=	1640.88
PATH	115	COMPONENT	8	NUM/YR	=	3750.59
PATH	115	COMPONENT	10	NUM/YR	=	468.82
PATH	115	COMPONENT	13	NUM/YR	=	937.65
PATH	115	COMPONENT	14	NUM/YR	=	234.41
PATH	115	COMPONENT	15	NUM/YR	=	4688.24
PATH	115	COMPONENT	16	NUM/YR	=	937.65
PATH	115	COMPONENT	20	NUM/YR	=	234.41
PATH	115	COMPONENT	21	NUM/YR	=	937.65

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	116	COMPONENT	9	NUM/YR	=	234.41
PATH	116	COMPONENT	17	NUM/YR	=	937.65
PATH	116	COMPONENT	18	NUM/YR	=	234.41
PATH	117	COMPONENT	1	NUM/YR	=	348.90
PATH	117	COMPONENT	2	NUM/YR	=	150.54
PATH	117	COMPONENT	3	NUM/YR	=	630.10
PATH	117	COMPONENT	8	NUM/YR	=	1440.23
PATH	117	COMPONENT	10	NUM/YR	=	180.03
PATH	117	COMPONENT	13	NUM/YR	=	360.06
PATH	117	COMPONENT	14	NUM/YR	=	90.01
PATH	117	COMPONENT	15	NUM/YR	=	1800.28
PATH	117	COMPONENT	16	NUM/YR	=	350.68
PATH	117	COMPONENT	20	NUM/YR	=	82.98
PATH	117	COMPONENT	21	NUM/YR	=	350.68
PATH	121	COMPONENT	9	NUM/YR	=	234.41
PATH	121	COMPONENT	17	NUM/YR	=	937.65
PATH	121	COMPONENT	18	NUM/YR	=	234.41
PATH	122	COMPONENT	9	NUM/YR	=	234.41
PATH	122	COMPONENT	17	NUM/YR	=	937.65
PATH	122	COMPONENT	18	NUM/YR	=	234.41
PATH	123	COMPONENT	1	NUM/YR	=	937.65
PATH	123	COMPONENT	2	NUM/YR	=	468.82
PATH	123	COMPONENT	3	NUM/YR	=	1640.88
PATH	123	COMPONENT	8	NUM/YR	=	3750.59
PATH	123	COMPONENT	10	NUM/YR	=	468.82
PATH	123	COMPONENT	13	NUM/YR	=	937.65
PATH	123	COMPONENT	14	NUM/YR	=	234.41
PATH	123	COMPONENT	15	NUM/YR	=	4688.24
PATH	123	COMPONENT	16	NUM/YR	=	937.65
PATH	123	COMPONENT	20	NUM/YR	=	234.41
PATH	123	COMPONENT	21	NUM/YR	=	937.65
PATH	124	COMPONENT	1	NUM/YR	=	937.65
PATH	124	COMPONENT	2	NUM/YR	=	468.82
PATH	124	COMPONENT	3	NUM/YR	=	1640.88
PATH	124	COMPONENT	8	NUM/YR	=	3750.59
PATH	124	COMPONENT	9	NUM/YR	=	234.41
PATH	124	COMPONENT	10	NUM/YR	=	468.82
PATH	124	COMPONENT	13	NUM/YR	=	937.65
PATH	124	COMPONENT	14	NUM/YR	=	234.41
PATH	124	COMPONENT	15	NUM/YR	=	4688.24
PATH	124	COMPONENT	16	NUM/YR	=	937.65
PATH	124	COMPONENT	17	NUM/YR	=	937.65
PATH	124	COMPONENT	18	NUM/YR	=	234.41

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH 124	COMPONENT 20	NUM/YR =	234.41
PATH 124	COMPONENT 21	NUM/YR =	937.65
PATH 130	COMPONENT 4	NUM/YR =	5569.44
PATH 130	COMPONENT 6	NUM/YR =	2784.72
PATH 130	COMPONENT 7	NUM/YR =	5569.44
PATH 130	COMPONENT 19	NUM/YR =	5569.44
PATH 131	COMPONENT 4	NUM/YR =	4998.02
PATH 131	COMPONENT 6	NUM/YR =	2499.01
PATH 131	COMPONENT 7	NUM/YR =	4998.02
PATH 131	COMPONENT 19	NUM/YR =	4998.02
PATH 132	COMPONENT 4	NUM/YR =	571.42
PATH 132	COMPONENT 6	NUM/YR =	285.71
PATH 132	COMPONENT 7	NUM/YR =	571.42
PATH 132	COMPONENT 19	NUM/YR =	571.42
PATH 133	COMPONENT 6	NUM/YR =	2499.01
PATH 133	COMPONENT 7	NUM/YR =	4998.02
PATH 133	COMPONENT 19	NUM/YR =	4998.02
PATH 134	COMPONENT 4	NUM/YR =	4998.02
PATH 135	COMPONENT 4	NUM/YR =	4421.25
PATH 136	COMPONENT 4	NUM/YR =	4998.02
PATH 137	COMPONENT 6	NUM/YR =	2210.12
PATH 137	COMPONENT 7	NUM/YR =	4373.26
PATH 137	COMPONENT 19	NUM/YR =	4408.25
PATH 138	COMPONENT 6	NUM/YR =	2499.01
PATH 138	COMPONENT 7	NUM/YR =	4998.02
PATH 138	COMPONENT 19	NUM/YR =	4998.02
PATH 140	COMPONENT 4	NUM/YR =	4998.02
PATH 140	COMPONENT 6	NUM/YR =	2499.01
PATH 140	COMPONENT 7	NUM/YR =	4998.02
PATH 140	COMPONENT 19	NUM/YR =	4998.02
PATH 141	COMPONENT 4	NUM/YR =	5569.44
PATH 141	COMPONENT 6	NUM/YR =	2784.72
PATH 141	COMPONENT 7	NUM/YR =	5569.44
PATH 141	COMPONENT 19	NUM/YR =	5569.44

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	142	COMPONENT	4	NUM/YR	=	931.21
PATH	142	COMPONENT	6	NUM/YR	=	465.61
PATH	142	COMPONENT	7	NUM/YR	=	931.21
PATH	142	COMPONENT	19	NUM/YR	=	931.21
PATH	143	COMPONENT	1	NUM/YR	=	937.65
PATH	143	COMPONENT	2	NUM/YR	=	468.82
PATH	143	COMPONENT	3	NUM/YR	=	1640.88
PATH	143	COMPONENT	4	NUM/YR	=	931.21
PATH	143	COMPONENT	6	NUM/YR	=	465.61
PATH	143	COMPONENT	7	NUM/YR	=	931.21
PATH	143	COMPONENT	8	NUM/YR	=	3750.59
PATH	143	COMPONENT	9	NUM/YR	=	234.41
PATH	143	COMPONENT	10	NUM/YR	=	468.82
PATH	143	COMPONENT	13	NUM/YR	=	937.65
PATH	143	COMPONENT	14	NUM/YR	=	234.41
PATH	143	COMPONENT	15	NUM/YR	=	4688.24
PATH	143	COMPONENT	16	NUM/YR	=	937.65
PATH	143	COMPONENT	17	NUM/YR	=	937.65
PATH	143	COMPONENT	18	NUM/YR	=	234.41
PATH	143	COMPONENT	19	NUM/YR	=	931.21
PATH	143	COMPONENT	20	NUM/YR	=	234.41
PATH	143	COMPONENT	21	NUM/YR	=	937.65
PATH	144	COMPONENT	4	NUM/YR	=	4638.23
PATH	144	COMPONENT	6	NUM/YR	=	2319.12
PATH	144	COMPONENT	7	NUM/YR	=	4638.23
PATH	144	COMPONENT	19	NUM/YR	=	4638.23
PATH	145	COMPONENT	5	NUM/YR	=	234.41
PATH	145	COMPONENT	11	NUM/YR	=	1875.30
PATH	145	COMPONENT	12	NUM/YR	=	937.65
PATH	146	COMPONENT	5	NUM/YR	=	5.73
PATH	146	COMPONENT	11	NUM/YR	=	45.83
PATH	146	COMPONENT	12	NUM/YR	=	22.92
PATH	147	COMPONENT	5	NUM/YR	=	228.60
PATH	147	COMPONENT	11	NUM/YR	=	1829.46
PATH	147	COMPONENT	12	NUM/YR	=	914.73
PATH	148	COMPONENT	5	NUM/YR	=	234.41
PATH	148	COMPONENT	11	NUM/YR	=	1875.30
PATH	148	COMPONENT	12	NUM/YR	=	937.65
PATH	149	COMPONENT	1	NUM/YR	=	360.01
PATH	149	COMPONENT	2	NUM/YR	=	180.00

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	149	COMPONENT	3	NUM/YR	=	630.01
PATH	149	COMPONENT	4	NUM/YR	=	357.54
PATH	149	COMPONENT	5	NUM/YR	=	90.00
PATH	149	COMPONENT	6	NUM/YR	=	178.77
PATH	149	COMPONENT	7	NUM/YR	=	357.54
PATH	149	COMPONENT	8	NUM/YR	=	1440.03
PATH	149	COMPONENT	9	NUM/YR	=	90.00
PATH	149	COMPONENT	10	NUM/YR	=	180.00
PATH	149	COMPONENT	11	NUM/YR	=	720.01
PATH	149	COMPONENT	12	NUM/YR	=	360.01
PATH	149	COMPONENT	13	NUM/YR	=	360.01
PATH	149	COMPONENT	14	NUM/YR	=	90.00
PATH	149	COMPONENT	15	NUM/YR	=	1800.04
PATH	149	COMPONENT	16	NUM/YR	=	360.01
PATH	149	COMPONENT	17	NUM/YR	=	360.01
PATH	149	COMPONENT	18	NUM/YR	=	90.00
PATH	149	COMPONENT	19	NUM/YR	=	357.54
PATH	149	COMPONENT	20	NUM/YR	=	90.00
PATH	149	COMPONENT	21	NUM/YR	=	360.01
PATH	150	COMPONENT	1	NUM/YR	=	937.65
PATH	150	COMPONENT	2	NUM/YR	=	468.82
PATH	150	COMPONENT	3	NUM/YR	=	1640.88
PATH	150	COMPONENT	4	NUM/YR	=	931.21
PATH	150	COMPONENT	5	NUM/YR	=	234.41
PATH	150	COMPONENT	6	NUM/YR	=	465.61
PATH	150	COMPONENT	7	NUM/YR	=	931.21
PATH	150	COMPONENT	8	NUM/YR	=	3750.59
PATH	150	COMPONENT	9	NUM/YR	=	234.41
PATH	150	COMPONENT	10	NUM/YR	=	468.82
PATH	150	COMPONENT	11	NUM/YR	=	1875.30
PATH	150	COMPONENT	12	NUM/YR	=	937.65
PATH	150	COMPONENT	13	NUM/YR	=	937.65
PATH	150	COMPONENT	14	NUM/YR	=	234.41
PATH	150	COMPONENT	15	NUM/YR	=	4688.24
PATH	150	COMPONENT	16	NUM/YR	=	937.65
PATH	150	COMPONENT	17	NUM/YR	=	937.65
PATH	150	COMPONENT	18	NUM/YR	=	234.41
PATH	150	COMPONENT	19	NUM/YR	=	931.21
PATH	150	COMPONENT	20	NUM/YR	=	234.41
PATH	150	COMPONENT	21	NUM/YR	=	937.65
PATH	160	COMPONENT	1	NUM/YR	=	6909.99
PATH	160	COMPONENT	2	NUM/YR	=	3455.00
PATH	160	COMPONENT	3	NUM/YR	=	12092.49
PATH	160	COMPONENT	4	NUM/YR	=	6909.99
PATH	160	COMPONENT	5	NUM/YR	=	1727.50

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	160	COMPONENT	6	NUM/YR	=	3455.00
PATH	160	COMPONENT	7	NUM/YR	=	6909.99
PATH	160	COMPONENT	8	NUM/YR	=	27639.97
PATH	160	COMPONENT	9	NUM/YR	=	1727.50
PATH	160	COMPONENT	10	NUM/YR	=	3455.00
PATH	160	COMPONENT	11	NUM/YR	=	13819.99
PATH	160	COMPONENT	12	NUM/YR	=	6909.99
PATH	160	COMPONENT	13	NUM/YR	=	6909.99
PATH	160	COMPONENT	14	NUM/YR	=	1727.50
PATH	160	COMPONENT	15	NUM/YR	=	34549.96
PATH	160	COMPONENT	16	NUM/YR	=	6909.99
PATH	160	COMPONENT	17	NUM/YR	=	6909.99
PATH	160	COMPONENT	18	NUM/YR	=	1727.50
PATH	160	COMPONENT	19	NUM/YR	=	6909.99
PATH	160	COMPONENT	20	NUM/YR	=	1727.50
PATH	160	COMPONENT	21	NUM/YR	=	6909.99
PATH	161	COMPONENT	1	NUM/YR	=	6909.99
PATH	161	COMPONENT	2	NUM/YR	=	3455.00
PATH	161	COMPONENT	3	NUM/YR	=	12092.49
PATH	161	COMPONENT	4	NUM/YR	=	6909.99
PATH	161	COMPONENT	5	NUM/YR	=	1727.50
PATH	161	COMPONENT	6	NUM/YR	=	3455.00
PATH	161	COMPONENT	7	NUM/YR	=	6909.99
PATH	161	COMPONENT	8	NUM/YR	=	27639.97
PATH	161	COMPONENT	9	NUM/YR	=	1727.50
PATH	161	COMPONENT	10	NUM/YR	=	3455.00
PATH	161	COMPONENT	11	NUM/YR	=	13819.99
PATH	161	COMPONENT	12	NUM/YR	=	6909.99
PATH	161	COMPONENT	13	NUM/YR	=	6909.99
PATH	161	COMPONENT	14	NUM/YR	=	1727.50
PATH	161	COMPONENT	15	NUM/YR	=	34549.96
PATH	161	COMPONENT	16	NUM/YR	=	6909.99
PATH	161	COMPONENT	17	NUM/YR	=	6909.99
PATH	161	COMPONENT	18	NUM/YR	=	1727.50
PATH	161	COMPONENT	19	NUM/YR	=	6909.99
PATH	161	COMPONENT	20	NUM/YR	=	1727.50
PATH	161	COMPONENT	21	NUM/YR	=	6909.99
PATH	162	COMPONENT	1	NUM/YR	=	6909.99
PATH	162	COMPONENT	2	NUM/YR	=	3455.00
PATH	162	COMPONENT	3	NUM/YR	=	12092.49
PATH	162	COMPONENT	4	NUM/YR	=	6909.99
PATH	162	COMPONENT	5	NUM/YR	=	1727.50
PATH	162	COMPONENT	6	NUM/YR	=	3455.00
PATH	162	COMPONENT	7	NUM/YR	=	6909.99
PATH	162	COMPONENT	8	NUM/YR	=	27639.97

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	162	COMPONENT	9	NUM/YR	=	1727.50
PATH	162	COMPONENT	10	NUM/YR	=	3455.00
PATH	162	COMPONENT	11	NUM/YR	=	13819.99
PATH	162	COMPONENT	12	NUM/YR	=	6909.99
PATH	162	COMPONENT	13	NUM/YR	=	6909.99
PATH	162	COMPONENT	14	NUM/YR	=	1727.50
PATH	162	COMPONENT	15	NUM/YR	=	34549.96
PATH	162	COMPONENT	16	NUM/YR	=	6909.99
PATH	162	COMPONENT	17	NUM/YR	=	6909.99
PATH	162	COMPONENT	18	NUM/YR	=	1727.50
PATH	162	COMPONENT	19	NUM/YR	=	6909.99
PATH	162	COMPONENT	20	NUM/YR	=	1727.50
PATH	162	COMPONENT	21	NUM/YR	=	6909.99
PATH	163	COMPONENT	1	NUM/YR	=	5286.97
PATH	163	COMPONENT	2	NUM/YR	=	2643.49
PATH	163	COMPONENT	3	NUM/YR	=	9252.20
PATH	163	COMPONENT	4	NUM/YR	=	5286.97
PATH	163	COMPONENT	5	NUM/YR	=	1321.74
PATH	163	COMPONENT	6	NUM/YR	=	2643.49
PATH	163	COMPONENT	7	NUM/YR	=	5286.97
PATH	163	COMPONENT	8	NUM/YR	=	21147.89
PATH	163	COMPONENT	9	NUM/YR	=	1321.74
PATH	163	COMPONENT	10	NUM/YR	=	2643.49
PATH	163	COMPONENT	11	NUM/YR	=	10573.95
PATH	163	COMPONENT	12	NUM/YR	=	5286.97
PATH	163	COMPONENT	13	NUM/YR	=	5286.97
PATH	163	COMPONENT	14	NUM/YR	=	1321.74
PATH	163	COMPONENT	15	NUM/YR	=	26434.87
PATH	163	COMPONENT	16	NUM/YR	=	5286.97
PATH	163	COMPONENT	17	NUM/YR	=	5286.97
PATH	163	COMPONENT	18	NUM/YR	=	1321.74
PATH	163	COMPONENT	19	NUM/YR	=	5286.97
PATH	163	COMPONENT	20	NUM/YR	=	1321.74
PATH	163	COMPONENT	21	NUM/YR	=	5286.97
PATH	165	COMPONENT	1	NUM/YR	=	1623.02
PATH	165	COMPONENT	2	NUM/YR	=	811.51
PATH	165	COMPONENT	3	NUM/YR	=	2840.28
PATH	165	COMPONENT	4	NUM/YR	=	1623.02
PATH	165	COMPONENT	5	NUM/YR	=	405.75
PATH	165	COMPONENT	6	NUM/YR	=	811.51
PATH	165	COMPONENT	7	NUM/YR	=	1623.02
PATH	165	COMPONENT	8	NUM/YR	=	6492.08
PATH	165	COMPONENT	9	NUM/YR	=	405.75
PATH	165	COMPONENT	10	NUM/YR	=	811.51
PATH	165	COMPONENT	11	NUM/YR	=	3246.04

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH 165	COMPONENT 12	NUM/YR =	1623.02
PATH 165	COMPONENT 13	NUM/YR =	1623.02
PATH 165	COMPONENT 14	NUM/YR =	405.75
PATH 165	COMPONENT 15	NUM/YR =	8115.10
PATH 165	COMPONENT 16	NUM/YR =	1623.02
PATH 165	COMPONENT 17	NUM/YR =	1623.02
PATH 165	COMPONENT 18	NUM/YR =	405.75
PATH 165	COMPONENT 19	NUM/YR =	1623.02
PATH 165	COMPONENT 20	NUM/YR =	405.75
PATH 165	COMPONENT 21	NUM/YR =	1623.02
PATH 166	COMPONENT 1	NUM/YR =	3988.02
PATH 166	COMPONENT 2	NUM/YR =	1994.01
PATH 166	COMPONENT 3	NUM/YR =	6979.03
PATH 166	COMPONENT 4	NUM/YR =	3988.02
PATH 166	COMPONENT 5	NUM/YR =	997.00
PATH 166	COMPONENT 6	NUM/YR =	1994.01
PATH 166	COMPONENT 7	NUM/YR =	3988.02
PATH 166	COMPONENT 8	NUM/YR =	15952.07
PATH 166	COMPONENT 9	NUM/YR =	997.00
PATH 166	COMPONENT 10	NUM/YR =	1994.01
PATH 166	COMPONENT 11	NUM/YR =	7976.03
PATH 166	COMPONENT 12	NUM/YR =	3988.02
PATH 166	COMPONENT 13	NUM/YR =	3988.02
PATH 166	COMPONENT 14	NUM/YR =	997.00
PATH 166	COMPONENT 15	NUM/YR =	19940.09
PATH 166	COMPONENT 16	NUM/YR =	3988.02
PATH 166	COMPONENT 17	NUM/YR =	3988.02
PATH 166	COMPONENT 18	NUM/YR =	997.00
PATH 166	COMPONENT 19	NUM/YR =	3988.02
PATH 166	COMPONENT 20	NUM/YR =	997.00
PATH 166	COMPONENT 21	NUM/YR =	3988.02
PATH 169	COMPONENT 1	NUM/YR =	1298.96
PATH 169	COMPONENT 2	NUM/YR =	649.48
PATH 169	COMPONENT 3	NUM/YR =	2273.17
PATH 169	COMPONENT 4	NUM/YR =	1298.96
PATH 169	COMPONENT 5	NUM/YR =	324.74
PATH 169	COMPONENT 6	NUM/YR =	649.48
PATH 169	COMPONENT 7	NUM/YR =	1298.96
PATH 169	COMPONENT 8	NUM/YR =	5195.83
PATH 169	COMPONENT 9	NUM/YR =	324.74
PATH 169	COMPONENT 10	NUM/YR =	649.48
PATH 169	COMPONENT 11	NUM/YR =	2597.91
PATH 169	COMPONENT 12	NUM/YR =	1298.96
PATH 169	COMPONENT 13	NUM/YR =	1298.96
PATH 169	COMPONENT 14	NUM/YR =	324.74
PATH 169	COMPONENT 15	NUM/YR =	6494.78
PATH 169	COMPONENT 16	NUM/YR =	1298.96
PATH 169	COMPONENT 17	NUM/YR =	1298.96
PATH 169	COMPONENT 18	NUM/YR =	324.74
PATH 169	COMPONENT 19	NUM/YR =	1298.96

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	169	COMPONENT	20	NUM/YR	=	324.74
PATH	169	COMPONENT	21	NUM/YR	=	1298.96
PATH	170	COMPONENT	4	NUM/YR	=	85.00
PATH	170	COMPONENT	6	NUM/YR	=	42.50
PATH	170	COMPONENT	7	NUM/YR	=	85.00
PATH	170	COMPONENT	19	NUM/YR	=	85.00
PATH	171	COMPONENT	1	NUM/YR	=	1298.96
PATH	171	COMPONENT	2	NUM/YR	=	649.48
PATH	171	COMPONENT	3	NUM/YR	=	2273.17
PATH	171	COMPONENT	4	NUM/YR	=	1213.96
PATH	171	COMPONENT	5	NUM/YR	=	324.74
PATH	171	COMPONENT	6	NUM/YR	=	606.98
PATH	171	COMPONENT	7	NUM/YR	=	1213.96
PATH	171	COMPONENT	8	NUM/YR	=	5195.83
PATH	171	COMPONENT	9	NUM/YR	=	324.74
PATH	171	COMPONENT	10	NUM/YR	=	649.48
PATH	171	COMPONENT	11	NUM/YR	=	2597.91
PATH	171	COMPONENT	12	NUM/YR	=	1298.96
PATH	171	COMPONENT	13	NUM/YR	=	1298.96
PATH	171	COMPONENT	14	NUM/YR	=	324.74
PATH	171	COMPONENT	15	NUM/YR	=	6494.78
PATH	171	COMPONENT	16	NUM/YR	=	1298.96
PATH	171	COMPONENT	17	NUM/YR	=	1298.96
PATH	171	COMPONENT	18	NUM/YR	=	324.74
PATH	171	COMPONENT	19	NUM/YR	=	1213.96
PATH	171	COMPONENT	20	NUM/YR	=	324.74
PATH	171	COMPONENT	21	NUM/YR	=	1298.96
PATH	172	COMPONENT	1	NUM/YR	=	129.90
PATH	172	COMPONENT	2	NUM/YR	=	64.95
PATH	172	COMPONENT	3	NUM/YR	=	227.32
PATH	172	COMPONENT	4	NUM/YR	=	121.40
PATH	172	COMPONENT	5	NUM/YR	=	32.47
PATH	172	COMPONENT	6	NUM/YR	=	60.70
PATH	172	COMPONENT	7	NUM/YR	=	121.40
PATH	172	COMPONENT	8	NUM/YR	=	519.58
PATH	172	COMPONENT	9	NUM/YR	=	32.47
PATH	172	COMPONENT	10	NUM/YR	=	64.95
PATH	172	COMPONENT	11	NUM/YR	=	259.79
PATH	172	COMPONENT	12	NUM/YR	=	129.90
PATH	172	COMPONENT	13	NUM/YR	=	129.90
PATH	172	COMPONENT	14	NUM/YR	=	32.47
PATH	172	COMPONENT	15	NUM/YR	=	649.48
PATH	172	COMPONENT	16	NUM/YR	=	129.90
PATH	172	COMPONENT	17	NUM/YR	=	129.90

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	172	COMPONENT	18	NUM/YR	=	32.47
PATH	172	COMPONENT	19	NUM/YR	=	121.40
PATH	172	COMPONENT	20	NUM/YR	=	32.47
PATH	172	COMPONENT	21	NUM/YR	=	129.90
PATH	173	COMPONENT	1	NUM/YR	=	1169.06
PATH	173	COMPONENT	2	NUM/YR	=	584.53
PATH	173	COMPONENT	3	NUM/YR	=	2045.86
PATH	173	COMPONENT	4	NUM/YR	=	1092.56
PATH	173	COMPONENT	5	NUM/YR	=	292.27
PATH	173	COMPONENT	6	NUM/YR	=	546.28
PATH	173	COMPONENT	7	NUM/YR	=	1092.56
PATH	173	COMPONENT	8	NUM/YR	=	4676.24
PATH	173	COMPONENT	9	NUM/YR	=	292.27
PATH	173	COMPONENT	10	NUM/YR	=	584.53
PATH	173	COMPONENT	11	NUM/YR	=	2338.12
PATH	173	COMPONENT	12	NUM/YR	=	1169.06
PATH	173	COMPONENT	13	NUM/YR	=	1169.06
PATH	173	COMPONENT	14	NUM/YR	=	292.27
PATH	173	COMPONENT	15	NUM/YR	=	5845.30
PATH	173	COMPONENT	16	NUM/YR	=	1169.06
PATH	173	COMPONENT	17	NUM/YR	=	1169.06
PATH	173	COMPONENT	18	NUM/YR	=	292.27
PATH	173	COMPONENT	19	NUM/YR	=	1092.56
PATH	173	COMPONENT	20	NUM/YR	=	292.27
PATH	173	COMPONENT	21	NUM/YR	=	1169.06
PATH	174	COMPONENT	1	NUM/YR	=	3988.02
PATH	174	COMPONENT	2	NUM/YR	=	1994.01
PATH	174	COMPONENT	3	NUM/YR	=	6975.75
PATH	174	COMPONENT	4	NUM/YR	=	3988.02
PATH	174	COMPONENT	5	NUM/YR	=	997.00
PATH	174	COMPONENT	6	NUM/YR	=	1994.01
PATH	174	COMPONENT	7	NUM/YR	=	3988.02
PATH	174	COMPONENT	8	NUM/YR	=	15938.13
PATH	174	COMPONENT	9	NUM/YR	=	996.97
PATH	174	COMPONENT	10	NUM/YR	=	1993.69
PATH	174	COMPONENT	11	NUM/YR	=	7976.03
PATH	174	COMPONENT	12	NUM/YR	=	3988.02
PATH	174	COMPONENT	13	NUM/YR	=	3984.80
PATH	174	COMPONENT	14	NUM/YR	=	997.00
PATH	174	COMPONENT	15	NUM/YR	=	19859.68
PATH	174	COMPONENT	16	NUM/YR	=	3984.61
PATH	174	COMPONENT	17	NUM/YR	=	3987.30
PATH	174	COMPONENT	18	NUM/YR	=	997.00
PATH	174	COMPONENT	19	NUM/YR	=	3988.02
PATH	174	COMPONENT	20	NUM/YR	=	996.80
PATH	174	COMPONENT	21	NUM/YR	=	3986.95

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	175	COMPONENT	1	NUM/YR	=	1167.18
PATH	175	COMPONENT	2	NUM/YR	=	582.18
PATH	175	COMPONENT	3	NUM/YR	=	2042.01
PATH	175	COMPONENT	4	NUM/YR	=	1092.56
PATH	175	COMPONENT	5	NUM/YR	=	292.27
PATH	175	COMPONENT	6	NUM/YR	=	546.28
PATH	175	COMPONENT	7	NUM/YR	=	1092.56
PATH	175	COMPONENT	8	NUM/YR	=	4659.90
PATH	175	COMPONENT	9	NUM/YR	=	292.23
PATH	175	COMPONENT	10	NUM/YR	=	584.15
PATH	175	COMPONENT	11	NUM/YR	=	2263.01
PATH	175	COMPONENT	12	NUM/YR	=	1169.06
PATH	175	COMPONENT	13	NUM/YR	=	1165.29
PATH	175	COMPONENT	14	NUM/YR	=	292.27
PATH	175	COMPONENT	15	NUM/YR	=	5751.03
PATH	175	COMPONENT	16	NUM/YR	=	1083.93
PATH	175	COMPONENT	17	NUM/YR	=	1168.22
PATH	175	COMPONENT	18	NUM/YR	=	292.15
PATH	175	COMPONENT	19	NUM/YR	=	1092.56
PATH	175	COMPONENT	20	NUM/YR	=	292.03
PATH	175	COMPONENT	21	NUM/YR	=	1167.81
PATH	176	COMPONENT	1	NUM/YR	=	3988.02
PATH	176	COMPONENT	2	NUM/YR	=	1994.01
PATH	176	COMPONENT	3	NUM/YR	=	6979.03
PATH	176	COMPONENT	4	NUM/YR	=	3988.02
PATH	176	COMPONENT	5	NUM/YR	=	997.00
PATH	176	COMPONENT	6	NUM/YR	=	1994.01
PATH	176	COMPONENT	7	NUM/YR	=	3988.02
PATH	176	COMPONENT	8	NUM/YR	=	15952.07
PATH	176	COMPONENT	9	NUM/YR	=	997.00
PATH	176	COMPONENT	10	NUM/YR	=	1994.01
PATH	176	COMPONENT	11	NUM/YR	=	7976.03
PATH	176	COMPONENT	12	NUM/YR	=	3988.02
PATH	176	COMPONENT	13	NUM/YR	=	3988.02
PATH	176	COMPONENT	14	NUM/YR	=	997.00
PATH	176	COMPONENT	15	NUM/YR	=	19940.09
PATH	176	COMPONENT	16	NUM/YR	=	3988.02
PATH	176	COMPONENT	17	NUM/YR	=	3988.02
PATH	176	COMPONENT	18	NUM/YR	=	997.00
PATH	176	COMPONENT	19	NUM/YR	=	3988.02
PATH	176	COMPONENT	20	NUM/YR	=	997.00
PATH	176	COMPONENT	21	NUM/YR	=	3988.02
PATH	177	COMPONENT	1	NUM/YR	=	1169.06
PATH	177	COMPONENT	2	NUM/YR	=	584.53
PATH	177	COMPONENT	3	NUM/YR	=	2045.86

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	177	COMPONENT	4	NUM/YR	=	1092.56
PATH	177	COMPONENT	5	NUM/YR	=	292.27
PATH	177	COMPONENT	6	NUM/YR	=	546.28
PATH	177	COMPONENT	7	NUM/YR	=	1092.56
PATH	177	COMPONENT	8	NUM/YR	=	4676.24
PATH	177	COMPONENT	9	NUM/YR	=	292.27
PATH	177	COMPONENT	10	NUM/YR	=	584.53
PATH	177	COMPONENT	11	NUM/YR	=	2338.12
PATH	177	COMPONENT	12	NUM/YR	=	1169.06
PATH	177	COMPONENT	13	NUM/YR	=	1169.06
PATH	177	COMPONENT	14	NUM/YR	=	292.27
PATH	177	COMPONENT	15	NUM/YR	=	5845.30
PATH	177	COMPONENT	16	NUM/YR	=	1169.06
PATH	177	COMPONENT	17	NUM/YR	=	1169.06
PATH	177	COMPONENT	18	NUM/YR	=	292.27
PATH	177	COMPONENT	19	NUM/YR	=	1092.56
PATH	177	COMPONENT	20	NUM/YR	=	292.27
PATH	177	COMPONENT	21	NUM/YR	=	1169.06
PATH	178	COMPONENT	1	NUM/YR	=	131.19
PATH	178	COMPONENT	2	NUM/YR	=	65.59
PATH	178	COMPONENT	3	NUM/YR	=	229.58
PATH	178	COMPONENT	4	NUM/YR	=	130.29
PATH	178	COMPONENT	5	NUM/YR	=	32.80
PATH	178	COMPONENT	6	NUM/YR	=	65.14
PATH	178	COMPONENT	7	NUM/YR	=	130.29
PATH	178	COMPONENT	8	NUM/YR	=	524.75
PATH	178	COMPONENT	9	NUM/YR	=	32.80
PATH	178	COMPONENT	10	NUM/YR	=	65.59
PATH	178	COMPONENT	11	NUM/YR	=	262.38
PATH	178	COMPONENT	12	NUM/YR	=	131.19
PATH	178	COMPONENT	13	NUM/YR	=	131.19
PATH	178	COMPONENT	14	NUM/YR	=	32.80
PATH	178	COMPONENT	15	NUM/YR	=	655.94
PATH	178	COMPONENT	16	NUM/YR	=	131.19
PATH	178	COMPONENT	17	NUM/YR	=	131.19
PATH	178	COMPONENT	18	NUM/YR	=	32.80
PATH	178	COMPONENT	19	NUM/YR	=	130.29
PATH	178	COMPONENT	20	NUM/YR	=	32.80
PATH	178	COMPONENT	21	NUM/YR	=	131.19
PATH	179	COMPONENT	1	NUM/YR	=	1169.06
PATH	179	COMPONENT	2	NUM/YR	=	584.53
PATH	179	COMPONENT	3	NUM/YR	=	2045.86
PATH	179	COMPONENT	4	NUM/YR	=	1092.56
PATH	179	COMPONENT	5	NUM/YR	=	292.27
PATH	179	COMPONENT	6	NUM/YR	=	546.28

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	179	COMPONENT	7	NUM/YR	=	1092.56
PATH	179	COMPONENT	8	NUM/YR	=	4676.24
PATH	179	COMPONENT	9	NUM/YR	=	292.27
PATH	179	COMPONENT	10	NUM/YR	=	584.53
PATH	179	COMPONENT	11	NUM/YR	=	2338.12
PATH	179	COMPONENT	12	NUM/YR	=	1169.06
PATH	179	COMPONENT	13	NUM/YR	=	11[illegible]9.06
PATH	179	COMPONENT	14	NUM/YR	=	292.27
PATH	179	COMPONENT	15	NUM/YR	=	5845.30
PATH	179	COMPONENT	16	NUM/YR	=	1169.06
PATH	179	COMPONENT	17	NUM/YR	=	1169.06
PATH	179	COMPONENT	18	NUM/YR	=	292.27
PATH	179	COMPONENT	19	NUM/YR	=	1092.56
PATH	179	COMPONENT	20	NUM/YR	=	292.27
PATH	179	COMPONENT	21	NUM/YR	=	1169.06
PATH	180	COMPONENT	4	NUM/YR	=	85.01
PATH	180	COMPONENT	6	NUM/YR	=	42.90
PATH	180	COMPONENT	7	NUM/YR	=	85.01
PATH	180	COMPONENT	19	NUM/YR	=	85.01
PATH	181	COMPONENT	1	NUM/YR	=	1169.06
PATH	181	COMPONENT	2	NUM/YR	=	584.53
PATH	181	COMPONENT	3	NUM/YR	=	2045.86
PATH	181	COMPONENT	4	NUM/YR	=	1092.56
PATH	181	COMPONENT	5	NUM/YR	=	292.27
PATH	181	COMPONENT	6	NUM/YR	=	546.28
PATH	181	COMPONENT	7	NUM/YR	=	1092.56
PATH	181	COMPONENT	8	NUM/YR	=	4676.24
PATH	181	COMPONENT	9	NUM/YR	=	292.27
PATH	181	COMPONENT	10	NUM/YR	=	584.53
PATH	181	COMPONENT	11	NUM/YR	=	2338.12
PATH	181	COMPONENT	12	NUM/YR	=	1169.06
PATH	181	COMPONENT	13	NUM/YR	=	1169.06
PATH	181	COMPONENT	14	NUM/YR	=	292.27
PATH	181	COMPONENT	15	NUM/YR	=	5845.30
PATH	181	COMPONENT	16	NUM/YR	=	1169.06
PATH	181	COMPONENT	17	NUM/YR	=	1169.06
PATH	181	COMPONENT	18	NUM/YR	=	292.27
PATH	181	COMPONENT	19	NUM/YR	=	1092.56
PATH	181	COMPONENT	20	NUM/YR	=	292.27
PATH	181	COMPONENT	21	NUM/YR	=	1169.06
PATH	182	COMPONENT	1	NUM/YR	=	5[illegible]57.08
PATH	182	COMPONENT	2	NUM/YR	=	2578.54
PATH	182	COMPONENT	3	NUM/YR	=	9024.89
PATH	182	COMPONENT	4	NUM/YR	=	5080.58

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	102	COMPONENT	5	NUM/YR	=	1289.27
PATH	102	COMPONENT	6	NUM/YR	=	2540.29
PATH	102	COMPONENT	7	NUM/YR	=	5080.58
PATH	102	COMPONENT	8	NUM/YR	=	20628.31
PATH	102	COMPONENT	9	NUM/YR	=	1289.27
PATH	102	COMPONENT	10	NUM/YR	=	2578.54
PATH	102	COMPONENT	11	NUM/YR	=	10314.16
PATH	102	COMPONENT	12	NUM/YR	=	5157.08
PATH	102	COMPONENT	13	NUM/YR	=	5157.08
PATH	102	COMPONENT	14	NUM/YR	=	1289.27
PATH	102	COMPONENT	15	NUM/YR	=	25785.39
PATH	102	COMPONENT	16	NUM/YR	=	5157.08
PATH	102	COMPONENT	17	NUM/YR	=	5157.08
PATH	102	COMPONENT	18	NUM/YR	=	1289.27
PATH	102	COMPONENT	19	NUM/YR	=	5080.58
PATH	102	COMPONENT	20	NUM/YR	=	1289.27
PATH	102	COMPONENT	21	NUM/YR	=	5157.08
PATH	104	COMPONENT	1	NUM/YR	=	6780.10
PATH	104	COMPONENT	2	NUM/YR	=	3390.05
PATH	104	COMPONENT	3	NUM/YR	=	11865.17
PATH	104	COMPONENT	4	NUM/YR	=	6703.60
PATH	104	COMPONENT	5	NUM/YR	=	1695.02
PATH	104	COMPONENT	6	NUM/YR	=	3351.80
PATH	104	COMPONENT	7	NUM/YR	=	6703.60
PATH	104	COMPONENT	8	NUM/YR	=	27120.39
PATH	104	COMPONENT	9	NUM/YR	=	1695.02
PATH	104	COMPONENT	10	NUM/YR	=	3390.05
PATH	104	COMPONENT	11	NUM/YR	=	13560.19
PATH	104	COMPONENT	12	NUM/YR	=	6780.10
PATH	104	COMPONENT	13	NUM/YR	=	6780.10
PATH	104	COMPONENT	14	NUM/YR	=	1695.02
PATH	104	COMPONENT	15	NUM/YR	=	33900.48
PATH	104	COMPONENT	16	NUM/YR	=	6780.10
PATH	104	COMPONENT	17	NUM/YR	=	6780.10
PATH	104	COMPONENT	18	NUM/YR	=	1695.02
PATH	104	COMPONENT	19	NUM/YR	=	6703.60
PATH	104	COMPONENT	20	NUM/YR	=	1695.02
PATH	104	COMPONENT	21	NUM/YR	=	6780.10

APPENDIX G

SAMPLE COST OUTPUT BY PATH AND COMPONENT

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	4	COMPONENT	3	PATH COST	=$	497.24	
PATH	4	COMPONENT	8	PATH COST	=$	1483.46	
PATH	4	COMPONENT	9	PATH COST	=$	42.94	
PATH	4	COMPONENT	10	PATH COST	=$	58.32	
PATH	4	COMPONENT	13	PATH COST	=$	489.96	
PATH	4	COMPONENT	15	PATH COST	=$	2825.03	
PATH	4	COMPONENT	16	PATH COST	=$	60636.45	
PATH	4	COMPONENT	17	PATH COST	=$	211.36	
			TOTAL PATH 4 COST = $				66244.76
PATH	5	COMPONENT	3	PATH COST	=$	4475.14	
PATH	5	COMPONENT	8	PATH COST	=$	13425.46	
PATH	5	COMPONENT	9	PATH COST	=$	386.48	
PATH	5	COMPONENT	10	PATH COST	=$	524.87	
PATH	5	COMPONENT	13	PATH COST	=$	4409.61	
PATH	5	COMPONENT	15	PATH COST	=$	25425.17	
PATH	5	COMPONENT	16	PATH COST	=$	545710.04	
PATH	5	COMPONENT	17	PATH COST	=$	1902.44	
			TOTAL PATH 5 COST = $				596259.20
PATH	6	COMPONENT	3	PATH COST	=$	91.16	
PATH	6	COMPONENT	9	PATH COST	=$	9.55	
PATH	6	COMPONENT	10	PATH COST	=$	10.69	
PATH	6	COMPONENT	13	PATH COST	=$	89.83	
PATH	6	COMPONENT	15	PATH COST	=$	517.92	
PATH	6	COMPONENT	17	PATH COST	=$	74.59	
			TOTAL PATH 6 COST = $				793.74
PATH	7	COMPONENT	3	PATH COST	=$	820.44	
PATH	7	COMPONENT	9	PATH COST	=$	85.97	
PATH	7	COMPONENT	10	PATH COST	=$	96.22	
PATH	7	COMPONENT	13	PATH COST	=$	808.49	
PATH	7	COMPONENT	15	PATH COST	=$	4661.30	
PATH	7	COMPONENT	17	PATH COST	=$	348.80	
			TOTAL PATH 7 COST = $				6821.22
PATH	8	COMPONENT	1	PATH COST	=$	7352.26	
PATH	8	COMPONENT	2	PATH COST	=$	142741.52	
PATH	8	COMPONENT	11	PATH COST	=$	522747.06	
PATH	8	COMPONENT	18	PATH COST	=$	3695.28	
PATH	8	COMPONENT	20	PATH COST	=$	12068.77	
PATH	8	COMPONENT	21	PATH COST	=$	15753.46	
			TOTAL PATH 8 COST = $				704358.35
PATH	10	COMPONENT	1	PATH COST	=$	841.91	
PATH	10	COMPONENT	2	PATH COST	=$	1209.48	
			TOTAL PATH 10 COST = $				2051.39

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

```
PATH  11  COMPONENT  4   PATH COST =$     2376.30
                     TOTAL PATH  11 COST = $         2376.30

PATH  12  COMPONENT  6   PATH COST =$     3374.18
PATH  12  COMPONENT 19   PATH COST =$     4075.28
                     TOTAL PATH  12 COST = $         7449.46

PATH  14  COMPONENT  3   PATH COST =$       65.11
PATH  14  COMPONENT  8   PATH COST =$      451.65
PATH  14  COMPONENT  9   PATH COST =$        0.80
PATH  14  COMPONENT 10   PATH COST =$        2.15
PATH  14  COMPONENT 13   PATH COST =$       36.82
PATH  14  COMPONENT 15   PATH COST =$     1046.84
PATH  14  COMPONENT 16   PATH COST =$      241.67
PATH  14  COMPONENT 17   PATH COST =$       15.94
PATH  14  COMPONENT 20   PATH COST =$       17.16
PATH  14  COMPONENT 21   PATH COST =$       89.57
                     TOTAL PATH  14 COST = $         1967.72

PATH  15  COMPONENT  1   PATH COST =$       61.27
PATH  15  COMPONENT  2   PATH COST =$      594.78
PATH  15  COMPONENT  3   PATH COST =$       76.35
PATH  15  COMPONENT  8   PATH COST =$      529.57
PATH  15  COMPONENT  9   PATH COST =$        0.94
PATH  15  COMPONENT 10   PATH COST =$        2.53
PATH  15  COMPONENT 11   PATH COST =$     8713.01
PATH  15  COMPONENT 13   PATH COST =$       43.18
PATH  15  COMPONENT 15   PATH COST =$     1227.50
PATH  15  COMPONENT 16   PATH COST =$     6030.85
PATH  15  COMPONENT 17   PATH COST =$       18.69
PATH  15  COMPONENT 18   PATH COST =$        7.70
PATH  15  COMPONENT 20   PATH COST =$       20.12
PATH  15  COMPONENT 21   PATH COST =$      105.02
                     TOTAL PATH  15 COST = $        17431.50

PATH  16  COMPONENT  3   PATH COST =$     -697.10
PATH  16  COMPONENT  8   PATH COST =$     -618.11
PATH  16  COMPONENT  9   PATH COST =$      -62.94
PATH  16  COMPONENT 17   PATH COST =$     -159.31

                     TOTAL PATH  16 COST = $        -1537.46

PATH  17  COMPONENT  3   PATH COST =$    -6273.77
PATH  17  COMPONENT  8   PATH COST =$    -5593.94
PATH  17  COMPONENT  9   PATH COST =$     -566.45
PATH  17  COMPONENT 17   PATH COST =$    -1434.00
                     TOTAL PATH  17 COST = $       -13868.16
```

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

```
PATH  18  COMPONENT  3   PATH COST =$     -127.80
PATH  18  COMPONENT  9   PATH COST =$      -11.54
PATH  18  COMPONENT 17   PATH COST =$      -29.21
                   TOTAL PATH  18 COST = $          -168.55

PATH  19  COMPONENT  3   PATH COST =$    -1150.19
PATH  19  COMPONENT  9   PATH COST =$     -103.85
PATH  19  COMPONENT 17   PATH COST =$     -262.92
                   TOTAL PATH  19 COST = $         -1516.96

PATH  20  COMPONENT  1   PATH COST =$     -450.64
PATH  20  COMPONENT 11   PATH COST =$   -40557.96
PATH  20  COMPONENT 18   PATH COST =$    -1802.57
PATH  20  COMPONENT 21   PATH COST =$      -37.55
                   TOTAL PATH  20 COST = $        -42848.73

PATH  22  COMPONENT  1   PATH COST =$    -1177.50
PATH  22  COMPONENT  3   PATH COST =$   -25269.62
PATH  22  COMPONENT  8   PATH COST =$   -27724.38
PATH  22  COMPONENT 14   PATH COST =$     -245.48
PATH  22  COMPONENT 21   PATH COST =$     -117.39
                   TOTAL PATH  22 COST = $        -54534.36

PATH  23  COMPONENT  4   PATH COST =$     -922.83
                   TOTAL PATH  23 COST = $          -922.83

PATH  24  COMPONENT  6   PATH COST =$   -13866.50
PATH  24  COMPONENT  7   PATH COST =$   -14994.05
                   TOTAL PATH  24 COST = $        -28860.55

PATH  30  COMPONENT  1   PATH COST =$    54157.70
PATH  30  COMPONENT  2   PATH COST =$    13539.43
PATH  30  COMPONENT  3   PATH COST =$    47387.99
PATH  30  COMPONENT  4   PATH COST =$    10315.75
PATH  30  COMPONENT  5   PATH COST =$    20309.14
PATH  30  COMPONENT  6   PATH COST =$    13539.43
PATH  30  COMPONENT  7   PATH COST =$   161183.63
PATH  30  COMPONENT  8   PATH COST =$    67052.39
PATH  30  COMPONENT  9   PATH COST =$     2578.94
PATH  30  COMPONENT 10   PATH COST =$     5157.88
PATH  30  COMPONENT 11   PATH COST =$    10315.75
PATH  30  COMPONENT 12   PATH COST =$     5157.88
PATH  30  COMPONENT 13   PATH COST =$     5157.88
PATH  30  COMPONENT 14   PATH COST =$     2578.94
PATH  30  COMPONENT 15   PATH COST =$    51578.76
PATH  30  COMPONENT 16   PATH COST =$     2578.94
```

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	30	COMPONENT	17	PATH COST =$	10315.75		
PATH	30	COMPONENT	18	PATH COST =$	2578.94		
PATH	30	COMPONENT	19	PATH COST =$	10315.75		
PATH	30	COMPONENT	20	PATH COST =$	2578.94		
PATH	30	COMPONENT	21	PATH COST =$	10315.75		
			TOTAL PATH 30 COST = $				508695.54
PATH	37	COMPONENT	3	PATH COST =$	1038.94		
PATH	37	COMPONENT	8	PATH COST =$	12562.23		
PATH	37	COMPONENT	9	PATH COST =$	202.19		
PATH	37	COMPONENT	10	PATH COST =$	391.44		
PATH	37	COMPONENT	14	PATH COST =$	160.83		
PATH	37	COMPONENT	15	PATH COST =$	989.47		
PATH	37	COMPONENT	17	PATH COST =$	1580.74		
PATH	37	COMPONENT	20	PATH COST =$	26.80		
			TOTAL PATH 37 COST = $				16952.62
PATH	38	COMPONENT	3	PATH COST =$	115.96		
PATH	38	COMPONENT	8	PATH COST =$	1401.65		
PATH	38	COMPONENT	9	PATH COST =$	22.55		
PATH	38	COMPONENT	10	PATH COST =$	44.17		
PATH	38	COMPONENT	14	PATH COST =$	17.95		
PATH	38	COMPONENT	15	PATH COST =$	110.43		
PATH	38	COMPONENT	17	PATH COST =$	179.26		
PATH	38	COMPONENT	20	PATH COST =$	2.99		
			TOTAL PATH 38 COST = $				1894.96
PATH	40	COMPONENT	1	PATH COST =$	9920.00		
PATH	40	COMPONENT	2	PATH COST =$	2482.22		
PATH	40	COMPONENT	3	PATH COST =$	8687.77		
PATH	40	COMPONENT	4	PATH COST =$	1891.22		
PATH	40	COMPONENT	5	PATH COST =$	3723.33		
PATH	40	COMPONENT	6	PATH COST =$	2482.22		
PATH	40	COMPONENT	7	PATH COST =$	29550.25		
PATH	40	COMPONENT	8	PATH COST =$	12292.90		
PATH	40	COMPONENT	9	PATH COST =$	472.00		
PATH	40	COMPONENT	10	PATH COST =$	945.61		
PATH	40	COMPONENT	11	PATH COST =$	1891.22		
PATH	40	COMPONENT	12	PATH COST =$	945.61		
PATH	40	COMPONENT	13	PATH COST =$	945.61		
PATH	40	COMPONENT	14	PATH COST =$	472.00		
PATH	40	COMPONENT	15	PATH COST =$	9456.00		
PATH	40	COMPONENT	16	PATH COST =$	472.00		
PATH	40	COMPONENT	17	PATH COST =$	1891.22		
PATH	40	COMPONENT	18	PATH COST =$	472.00		
PATH	40	COMPONENT	19	PATH COST =$	1891.22		
PATH	40	COMPONENT	20	PATH COST =$	472.00		
PATH	40	COMPONENT	21	PATH COST =$	1891.22		
			TOTAL PATH 40 COST = $				93260.57

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

PATH	46	COMPONENT	3	PATH COST =$	189.33
PATH	46	COMPONENT	8	PATH COST =$	3028.87
PATH	46	COMPONENT	9	PATH COST =$	64.28
PATH	46	COMPONENT	10	PATH COST =$	72.57
PATH	46	COMPONENT	15	PATH COST =$	181.41
PATH	46	COMPONENT	17	PATH COST =$	367.04
				TOTAL PATH 46 COST = $	3903.50
PATH	51	COMPONENT	3	PATH COST =$	21.07
PATH	51	COMPONENT	8	PATH COST =$	335.01
PATH	51	COMPONENT	9	PATH COST =$	7.11
PATH	51	COMPONENT	10	PATH COST =$	8.03
PATH	51	COMPONENT	15	PATH COST =$	20.06
PATH	51	COMPONENT	17	PATH COST =$	40.59
				TOTAL PATH 51 COST = $	431.86
PATH	60	COMPONENT	4	PATH COST =$	19199.99
				TOTAL PATH 60 COST = $	19199.99
PATH	61	COMPONENT	4	PATH COST =$	159999.92
				TOTAL PATH 61 COST = $	159999.92
PATH	63	COMPONENT	4	PATH COST =$	79999.96
				TOTAL PATH 63 COST = $	79999.96
PATH	64	COMPONENT	4	PATH COST =$	12799.99
				TOTAL PATH 64 COST = $	12799.99
PATH	70	COMPONENT	1	PATH COST =$	16542.92
				TOTAL PATH 70 COST = $	16542.92
PATH	73	COMPONENT	4	PATH COST =$	35531.31
				TOTAL PATH 73 COST = $	35531.31
PATH	74	COMPONENT	3	PATH COST =$	1243.60
PATH	74	COMPONENT	8	PATH COST =$	27696.20
PATH	74	COMPONENT	9	PATH COST =$	469.20
PATH	74	COMPONENT	10	PATH COST =$	236.88
PATH	74	COMPONENT	12	PATH COST =$	473.75
PATH	74	COMPONENT	13	PATH COST =$	473.75
PATH	74	COMPONENT	14	PATH COST =$	118.44
PATH	74	COMPONENT	15	PATH COST =$	1184.38
PATH	74	COMPONENT	17	PATH COST =$	2824.28
PATH	74	COMPONENT	18	PATH COST =$	3832.14
PATH	74	COMPONENT	20	PATH COST =$	51.90
				TOTAL PATH 74 COST = $	38604.50

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

```
PATH  81  COMPONENT  4   PATH COST =$        0.00
                     TOTAL PATH  81 COST = $          0.00

PATH  82  COMPONENT  4   PATH COST =$    35509.90
                     TOTAL PATH  82 COST = $      35508.90

PATH 100  COMPONENT  1   PATH COST =$    12524.40
                     TOTAL PATH 100 COST = $      12524.40

PATH 101  COMPONENT  4   PATH COST =$    61268.73
                     TOTAL PATH 101 COST = $      61268.73

PATH 102  COMPONENT  1   PATH COST =$    12179.42
                     TOTAL PATH 102 COST = $      12179.42

PATH 103  COMPONENT  1   PATH COST =$    15921.23
                     TOTAL PATH 103 COST = $      15921.23

PATH 104  COMPONENT  1   PATH COST =$    12813.85
                     TOTAL PATH 104 COST = $      12813.85

PATH 105  COMPONENT  4   PATH COST =$    61230.09
                     TOTAL PATH 105 COST = $      61230.09

PATH 106  COMPONENT  1   PATH COST =$   124050.84
                     TOTAL PATH 106 COST = $     124050.84

PATH 115  COMPONENT  1   PATH COST =$    10337.57
PATH 115  COMPONENT  8   PATH COST =$     1381.10
PATH 115  COMPONENT 10   PATH COST =$      344.24
PATH 115  COMPONENT 14   PATH COST =$     1292.28
PATH 115  COMPONENT 20   PATH COST =$     2584.39
PATH 115  COMPONENT 21   PATH COST =$     5168.78
                     TOTAL PATH 115 COST = $      21108.28

PATH 117  COMPONENT  2   PATH COST =$     1659.78
PATH 117  COMPONENT  3   PATH COST =$    37238.88
PATH 117  COMPONENT  8   PATH COST =$    74963.84
                     TOTAL PATH 117 COST = $     113862.41

PATH 130  COMPONENT  7   PATH COST =$    30781.54
PATH 130  COMPONENT 19   PATH COST =$    30781.54
                     TOTAL PATH 130 COST = $      61403.09

PATH 131  COMPONENT  4   PATH COST =$    73587.58
                     TOTAL PATH 131 COST = $      73507.58
```

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

```
PATH 133  COMPONENT  6   PATH COST =$     55103.13
PATH 133  COMPONENT  7   PATH COST =$     73507.58
PATH 133  COMPONENT 19   PATH COST =$     73507.58
                    TOTAL PATH 133 COST = $     202118.29

PATH 134  COMPONENT  4   PATH COST =$    165309.40
                    TOTAL PATH 134 COST = $     165309.40

PATH 135  COMPONENT  4   PATH COST =$     48744.23
                    TOTAL PATH 135 COST = $      48744.23

PATH 136  COMPONENT  4   PATH COST =$    208242.36
                    TOTAL PATH 136 COST = $     208242.36

PATH 137  COMPONENT 19   PATH COST =$     97201.93
                    TOTAL PATH 137 COST = $      97201.93

PATH 138  COMPONENT  6   PATH COST =$     27551.57

PATH 138  COMPONENT  7   PATH COST =$    110206.27
PATH 138  COMPONENT 19   PATH COST =$     73507.58
                    TOTAL PATH 138 COST = $     211265.41

PATH 140  COMPONENT  4   PATH COST =$     73507.58
                    TOTAL PATH 140 COST = $      73507.58

PATH 141  COMPONENT  7   PATH COST =$    184209.27
                    TOTAL PATH 141 COST = $     184209.27

PATH 145  COMPONENT  5   PATH COST =$    103375.70
PATH 145  COMPONENT 11   PATH COST =$    413502.79
                    TOTAL PATH 145 COST = $     516878.49

PATH 146  COMPONENT  5   PATH COST =$     11458.06
                    TOTAL PATH 146 COST = $      11458.06

PATH 150  COMPONENT  1   PATH COST =$    126394.96
PATH 150  COMPONENT  2   PATH COST =$      2344.12
PATH 150  COMPONENT  3   PATH COST =$      4692.93
PATH 150  COMPONENT  4   PATH COST =$      1164.01
PATH 150  COMPONENT  5   PATH COST =$     23441.20
PATH 150  COMPONENT  8   PATH COST =$      2362.87
PATH 150  COMPONENT  9   PATH COST =$      1172.06
PATH 150  COMPONENT 10   PATH COST =$      4688.24
PATH 150  COMPONENT 11   PATH COST =$      5869.60
PATH 150  COMPONENT 12   PATH COST =$      2344.12
PATH 150  COMPONENT 14   PATH COST =$     12658.25
```

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

```
PATH 150  COMPONENT 15   PATH COST =$        93.76
PATH 150  COMPONENT 16   PATH COST =$       234.41
PATH 150  COMPONENT 18   PATH COST =$       460.02
PATH 150  COMPONENT 20   PATH COST =$      5060.30
                    TOTAL PATH 150 COST = $        193789.74

PATH 160  COMPONENT  1   PATH COST =$       534.00
PATH 160  COMPONENT  2   PATH COST =$       133.50
PATH 160  COMPONENT  3   PATH COST =$       467.25
PATH 160  COMPONENT  4   PATH COST =$       101.72
PATH 160  COMPONENT  5   PATH COST =$       200.25
PATH 160  COMPONENT  6   PATH COST =$       133.50
PATH 160  COMPONENT  7   PATH COST =$      1589.30
PATH 160  COMPONENT  8   PATH COST =$       661.15
PATH 160  COMPONENT  9   PATH COST =$        25.43
PATH 160  COMPONENT 10   PATH COST =$        50.86
PATH 160  COMPONENT 11   PATH COST =$       101.72
PATH 160  COMPONENT 12   PATH COST =$        50.86
PATH 160  COMPONENT 13   PATH COST =$        50.86
PATH 160  COMPONENT 14   PATH COST =$        25.43
PATH 160  COMPONENT 15   PATH COST =$       508.58
PATH 160  COMPONENT 16   PATH COST =$        25.43
PATH 160  COMPONENT 17   PATH COST =$       101.72
PATH 160  COMPONENT 18   PATH COST =$        25.43
PATH 160  COMPONENT 19   PATH COST =$       101.72
PATH 160  COMPONENT 20   PATH COST =$        25.43

PATH 160  COMPONENT 21   PATH COST =$       101.72
                    TOTAL PATH 160 COST = $          5015.03

PATH 161  COMPONENT  4   PATH COST =$      7189.05
                    TOTAL PATH 161 COST = $          7189.05

PATH 170  COMPONENT  4   PATH COST =$      1806.51
                    TOTAL PATH 170 COST = $          1806.51

PATH 172  COMPONENT  1   PATH COST =$      6600.00
                    TOTAL PATH 172 COST = $          6600.00

PATH 174  COMPONENT  3   PATH COST =$        32.63
PATH 174  COMPONENT  8   PATH COST =$       352.79
PATH 174  COMPONENT  9   PATH COST =$         5.98
PATH 174  COMPONENT 10   PATH COST =$        12.09
PATH 174  COMPONENT 14   PATH COST =$         1.64
PATH 174  COMPONENT 15   PATH COST =$        22.54
PATH 174  COMPONENT 17   PATH COST =$        48.12
PATH 174  COMPONENT 20   PATH COST =$         0.82
                    TOTAL PATH 174 COST = $           476.61

PATH 175  COMPONENT  3   PATH COST =$         1.48
PATH 175  COMPONENT  8   PATH COST =$       116.38
PATH 175  COMPONENT  9   PATH COST =$         1.94
```

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

```
PATH 175  COMPONENT 10   PATH COST =$         3.93
PATH 175  COMPONENT 14   PATH COST =$         0.54
PATH 175  COMPONENT 15   PATH COST =$         9.68
PATH 175  COMPONENT 17   PATH COST =$        15.59
PATH 175  COMPONENT 20   PATH COST =$         0.27
                    TOTAL PATH 175 COST = $             149.73

PATH 178  COMPONENT  1   PATH COST =$      7348.19
                    TOTAL PATH 178 COST = $            7348.19

PATH 180  COMPONENT  4   PATH COST =$      1823.73
                    TOTAL PATH 180 COST = $            1823.73


          COMPONENT  1 TOTAL COST = $      415961.26
          COMPONENT  2 TOTAL COST = $      164704.75
          COMPONENT  3 TOTAL COST = $       73624.72
          COMPONENT  4 TOTAL COST = $     1060596.29
          COMPONENT  5 TOTAL COST = $      162507.68
          COMPONENT  6 TOTAL COST = $       88317.53
          COMPONENT  7 TOTAL COST = $      575953.79
          COMPONENT  8 TOTAL COST = $      186161.09
          COMPONENT  9 TOTAL COST = $        4804.39
          COMPONENT 10 TOTAL COST = $       12650.69
          COMPONENT 11 TOTAL COST = $      922583.26
          COMPONENT 12 TOTAL COST = $        8972.21
          COMPONENT 13 TOTAL COST = $       12505.98
          COMPONENT 14 TOTAL COST = $       17081.53
          COMPONENT 15 TOTAL COST = $       99858.91
          COMPONENT 16 TOTAL COST = $      615930.59
          COMPONENT 17 TOTAL COST = $       18050.67
          COMPONENT 18 TOTAL COST = $        9278.54
          COMPONENT 19 TOTAL COST = $      291302.60
          COMPONENT 20 TOTAL COST = $       23710.69
          COMPONENT 21 TOTAL COST = $       33270.57
                     TOTAL COST = $     4797827.72
```

APPENDIX H

SAMPLE COST OUTPUT BY COMPONENT/RANKED

COMPONENT	1	TOTAL COST = $	415961.26
COMPONENT	2	TOTAL COST = $	164704.75
COMPONENT	3	TOTAL COST = $	73624.72
COMPONENT	4	TOTAL COST = $	1060596.29
COMPONENT	5	TOTAL COST = $	162507.68
COMPONENT	6	TOTAL COST = $	88317.53
COMPONENT	7	TOTAL COST = $	575953.79
COMPONENT	8	TOTAL COST = $	186161.09
COMPONENT	9	TOTAL COST = $	4804.39
COMPONENT	10	TOTAL COST = $	12650.69
COMPONENT	11	TOTAL COST = $	922583.26
COMPONENT	12	TOTAL COST = $	8972.21
COMPONENT	13	TOTAL COST = $	12505.96
COMPONENT	14	TOTAL COST = $	17081.53
COMPONENT	15	TOTAL COST = $	99858.91
COMPONENT	16	TOTAL COST = $	615930.59
COMPONENT	17	TOTAL COST = $	18050.67
COMPONENT	18	TOTAL COST = $	9278.54
COMPONENT	19	TOTAL COST = $	291302.60
COMPONENT	20	TOTAL COST = $	23710.69
COMPONENT	21	TOTAL COST = $	33270.57

TOTAL COMPONENT COSTS IN ORDER OF COST

COMPONENT	4	TOTAL COST = $	1060596.29
COMPONENT	11	TOTAL COST = $	922583.26
COMPONENT	16	TOTAL COST = $	615930.59
COMPONENT	7	TOTAL COST = $	575953.79
COMPONENT	1	TOTAL COST = $	415961.26
COMPONENT	19	TOTAL COST = $	291302.60
COMPONENT	8	TOTAL COST = $	186161.09
COMPONENT	2	TOTAL COST = $	164704.75
COMPONENT	5	TOTAL COST = $	162507.68
COMPONENT	15	TOTAL COST = $	99858.91
COMPONENT	6	TOTAL COST = $	88317.53
COMPONENT	3	TOTAL COST = $	73624.72
COMPONENT	21	TOTAL COST = $	33270.57
COMPONENT	20	TOTAL COST = $	23710.69
COMPONENT	17	TOTAL COST = $	18050.67
COMPONENT	14	TOTAL COST = $	17081.53
COMPONENT	10	TOTAL COST = $	12650.69
COMPONENT	13	TOTAL COST = $	12505.96
COMPONENT	18	TOTAL COST = $	9278.54
COMPONENT	12	TOTAL COST = $	8972.21
COMPONENT	9	TOTAL COST = $	4804.39
		TOTAL COST = $	4797927.72

EXAMPLE
FOR ILLUSTRATION ONLY
RESULTS

APPENDIX I

SAMPLE SENSITIVITY OUTPUT

NODE	1	COMPONENT	1	SENSITIVITY = $	1623.73 / PERCENT
NODE	1	COMPONENT	2	SENSITIVITY = $	1534.38
NODE	1	COMPONENT	3	SENSITIVITY = $	518.74
NODE	1	COMPONENT	4	SENSITIVITY = $	6648.40
NODE	1	COMPONENT	5	SENSITIVITY = $	546.41
NODE	1	COMPONENT	6	SENSITIVIT[illegible]	738.67
NODE	1	COMPONENT	7	SENS[illegible]	4818.99
NODE	1	COMPONENT	8	[illegible]	1295.08
NODE	1	COMPONENT	9	[illegible] $	33.55
NODE	1	COMPONENT	10	S[illegible]VITY = $	76.74
NODE	1	COMPONENT	11	SENSITIVITY = $	5826.50
NODE	1	COMPONENT	12	SENSITIVITY = $	62.00
NODE	1	COMPONENT	13	SENSITIVITY = $	106.04
NODE	1	COMPONENT	14	SENSITIVITY = $	62.75
NODE	1	COMPONENT	15	SENSITIVITY = $	826.21
NODE	1	COMPONENT	16	SENSITIVITY = $	6089.84
NODE	1	COMPONENT	17	SENSITIVITY = $	154.15
NODE	1	COMPONENT	18	SENSITIVITY = $	82.54
NODE	1	COMPONENT	19	SENSITIVITY = $	2435.54
NODE	1	COMPONENT	20	SENSITIVITY = $	164.75
NODE	1	COMPONENT	21	SENSITIVITY = $	268.30
NODE	2	COMPONENT	1	SENSITIVITY = $	1082.15
NODE	2	COMPONENT	2	SENSITIVITY = $	1398.98
NODE	2	COMPONENT	3	SENSITIVITY = $	44.86
NODE	2	COMPONENT	4	SENSITIVITY = $	6545.24
NODE	2	COMPONENT	5	SENSITIVITY = $	343.31

NODE	2	COMPONENT	6	SENSITIVITY = $	603.28
NODE	2	COMPONENT	7	SENSITIVITY = $	3207.15
NODE	2	COMPONENT	8	SENSITIVITY = $	625.36
NODE	2	COMPONENT	9	SENSITIVITY = $	7.76
NODE	2	COMPONENT	10	SENSITIVITY =	25.16
NODE	2	COMPONENT	11	SENSITIVI	5723.35
NODE	2	COMPONENT	12	SENS	10.42
NODE	2	COMPONENT	13		54.46
NODE	2	COMPONENT	14	= $	36.96
NODE	2	COMPONENT	15	S VITY = $	310.42
NODE	2	COMPONENT	16	SENSITIVITY = $	6064.05
NODE	2	COMPONENT	17	SENSITIVITY = $	50.99
NODE	2	COMPONENT	18	SENSITIVITY = $	56.75
NODE	2	COMPONENT	19	SENSITIVITY = $	2332.39
NODE	2	COMPONENT	20	SENSITIVITY = $	138.96
NODE	2	COMPONENT	21	SENSITIVITY = $	165.15
NODE	3	COMPONENT	1	SENSITIVITY = $	-36242.38
NODE	3	COMPONENT	2	SENSITIVITY = $	-46853.38
NODE	3	COMPONENT	3	SENSITIVITY = $	-1798.51
NODE	3	COMPONENT	4	SENSITIVITY = $	-219207.25
NODE	3	COMPONENT	5	SENSITIVITY = $	-11497.95
NODE	3	COMPONENT	6	SENSITIVITY = $	-20204.40
NODE	3	COMPONENT	7	SENSITIVITY = $	-107410.89
NODE	3	COMPONENT	8	SENSITIVITY = $	-13016.44
NODE	3	COMPONENT	9	SENSITIVITY = $	-249.75
NODE	3	COMPONENT	10	SENSITIVITY = $	-485.13

NODE	3	COMPONENT	11	SENSITIVITY = $		-191681.03
NODE	3	COMPONENT	12	SENSITIVITY = $		-348.99
NODE	3	COMPONENT	13	SENSITIVITY = $		-104.20
NODE	3	COMPONENT	14	SENSITIVITY = $		-1176.33
NODE	3	COMPONENT	15	SENSITIVITY = $		-94.27
NODE	3	COMPONENT	16	SENSITIVIT		6043.97
NODE	3	COMPONENT	17	SENSI		-894.89
NODE	3	COMPONENT	18			-1900.72
NODE	3	COMPONENT	19	$		-78114.16
NODE	3	COMPONENT	20	S ITY = $		-4643.57
NODE	3	COMPONENT	21	SENSITIVITY = $		-5530.89
NODE	4	COMPONENT	1	SENSITIVITY = $		0.00
NODE	4	COMPONENT	2	SENSITIVITY = $		0.00
NODE	4	COMPONENT	3	SENSITIVITY = $		1.30
NODE	4	COMPONENT	4	SENSITIVITY = $		0.00
NODE	4	COMPONENT	5	SENSITIVITY = $		0.00
NODE	4	COMPONENT	6	SENSITIVITY = $		0.00
NODE	4	COMPONENT	7	SENSITIVITY = $		0.00
NODE	4	COMPONENT	8	SENSITIVITY = $		-29.18
NODE	4	COMPONENT	9	SENSITIVITY = $		-0.45
NODE	4	COMPONENT	10	SENSITIVITY = $		-1.69
NODE	4	COMPONENT	11	SENSITIVITY = $		0.00
NODE	4	COMPONENT	12	SENSITIVITY = $		0.00
NODE	4	COMPONENT	13	SENSITIVITY = $		-7.79
NODE	4	COMPONENT	14	SENSITIVITY = $		-0.01
NODE	4	COMPONENT	15	SENSITIVITY = $		-46.72

NODE	4	COMPONENT	16	SENSITIVITY = $	-0.18
NODE	4	COMPONENT	17	SENSITIVITY = $	-7.21
NODE	4	COMPONENT	18	SENSITIVITY = $	0.0C
NODE	4	COMPONENT	19	SENSITIVITY = $	0.00
NODE	4	COMPONENT	20	SENSITIVITY = $	-0.00
NODE	4	COMPONENT	21	SENSITIVITY	0.00
NODE	5	COMPONENT	1	SENS	0.00
NODE	5	COMPONENT	2		0.00
NODE	5	COMPONENT	3	= $	-18.00
NODE	5	COMPONENT	4	S ITY = $	0.00
NODE	5	COMPONENT	5	SENSITIVITY = $	0.00
NODE	5	COMPONENT	6	SENSITIVITY = $	0.00
NODE	5	COMPONENT	7	SENSITIVITY = $	0.00
NODE	5	COMPONENT	8	SENSITIVITY = $	78.21
NODE	5	COMPONENT	9	SENSITIVITY = $	-1.80
NODE	5	COMPONENT	10	SENSITIVITY = $	5.24
NODE	5	COMPONENT	11	SENSITIVITY = $	0.00
NODE	5	COMPONENT	12	SENSITIVITY = $	0.00
NODE	5	COMPONENT	13	SENSITIVITY = $	44.10
NODE	5	COMPONENT	14	SENSITIVITY = $	0.00
NODE	5	COMPONENT	15	SENSITIVITY = $	254.22
NODE	5	COMPONENT	16	SENSITIVITY = $	5457.10
NODE	5	COMPONENT	17	SENSITIVITY = $	4.67
NODE	5	COMPONENT	18	SENSITIVITY = $	0.00
NODE	5	COMPONENT	19	SENSITIVITY = $	0.00
NODE	5	COMPONENT	20	SENSITIVITY = $	0.00

NODE	5	COMPONENT	21	SENSITIVITY = $	0.00
NODE	10	COMPONENT	1	SENSITIVITY = $	0.00
NODE	10	COMPONENT	2	SENSITIVITY = $	0.00
NODE	10	COMPONENT	3	SENSITIVITY = $	4.17
NODE	10	COMPONENT	4	SENSITIVITY = [illegible]	0.00
NODE	10	COMPONENT	5	SENSIT[illegible]	0.00
NODE	10	COMPONENT	6	[illegible]	0.00
NODE	10	COMPONENT	7	[illegible]	0.00
NODE	10	COMPONENT	8	[illegible]Y = $	-85.37
NODE	10	COMPONENT	9	SE[illegible]SITIVITY = $	-1.63
NODE	10	COMPONENT	10	SENSITIVITY = $	-5.00
NODE	10	COMPONENT	11	SENSITIVITY = $	0.00
NODE	10	COMPONENT	12	SENSITIVITY = $	0.00
NODE	10	COMPONENT	13	SENSITIVITY = $	-23.94
NODE	10	COMPONENT	14	SENSITIVITY = $	0.18
NODE	10	COMPONENT	15	SENSITIVITY = $	-143.39
NODE	10	COMPONENT	16	SENSITIVITY = $	606.36
NODE	10	COMPONENT	17	SENSITIVITY = $	-13.84
NODE	10	COMPONENT	18	SENSITIVITY = $	0.00
NODE	10	COMPONENT	19	SENSITIVITY = $	0.00
NODE	10	COMPONENT	20	SENSITIVITY = $	0.03
NODE	10	COMPONENT	21	SENSITIVITY = $	0.00
NODE	11	COMPONENT	1	SENSITIVITY = $	0.00
NODE	11	COMPONENT	2	SENSITIVITY = $	0.00
NODE	11	COMPONENT	3	SENSITIVITY = $	-2.00

NODE	11	COMPONENT	4	SENSITIVITY = $	0.00
NODE	11	COMPONENT	5	SENSITIVITY = $	0.00
NODE	11	COMPONENT	6	SENSITIVITY = $	0.00
NODE	11	COMPONENT	7	SENSITIVITY = $	0.00
NODE	11	COMPONENT	8	SENSITIVITY =	8.64
NODE	11	COMPONENT	9	SENSIT[illegible]	-0.20
NODE	11	COMPONENT	10	S[illegible]	0.58
NODE	11	COMPONENT	11	[illegible]	0.00
NODE	11	COMPONENT	12	[illegible]Y = $	0.00
NODE	11	COMPONENT	13	SE[illegible]ITIVITY = $	4.90
NODE	11	COMPONENT	14	SENSITIVITY = $	0.00
NODE	11	COMPONENT	15	SENSITIVITY = $	28.25
NODE	11	COMPONENT	16	SENSITIVITY = $	606.36
NODE	11	COMPONENT	17	SENSITIVITY = $	0.52
NODE	11	COMPONENT	18	SENSITIVITY = $	0.00
NODE	11	COMPONENT	19	SENSITIVITY = $	0.00
NODE	11	COMPONENT	20	SENSITIVITY = $	0.00
NODE	11	COMPONENT	21	SENSITIVITY = $	0.00
NODE	15	COMPONENT	1	SENSITIVITY = $	124.16
NODE	15	COMPONENT	2	SENSITIVITY = $	56.97
NODE	15	COMPONENT	3	SENSITIVITY = $	86.70
NODE	15	COMPONENT	4	SENSITIVITY = $	169.33
NODE	15	COMPONENT	5	SENSITIVITY = $	45.12
NODE	15	COMPONENT	6	SENSITIVITY = $	38.69
NODE	15	COMPONENT	7	SENSITIVITY = $	369.21
NODE	15	COMPONENT	8	SENSITIVITY = $	162.42

NODE	15	COMPONENT	9	SENSITIVITY = $	5.37
NODE	15	COMPONENT	10	SENSITIVITY = $	11.49
NODE	15	COMPONENT	11	SENSITIVITY = $	150.44
NODE	15	COMPONENT	12	SENSITIVITY = $	9.70
NODE	15	COMPONENT	13	SENSITIV	17.68
NODE	15	COMPONENT	14	SE	5.54
NODE	15	COMPONENT	15		143.45
NODE	15	COMPONENT	16	= $	4.74
NODE	15	COMPONENT	17	SE..ITIVITY = $	24.17
NODE	15	COMPONENT	18	SENSITIVITY = $	6.03
NODE	15	COMPONENT	19	SENSITIVITY = $	72.51
NODE	15	COMPONENT	20	SENSITIVITY = $	7.91
NODE	15	COMPONENT	21	SENSITIVITY = $	22.71
NODE	16	COMPONENT	1	SENSITIVITY = $	24.87
NODE	16	COMPONENT	2	SENSITIVITY = $	32.15
NODE	16	COMPONENT	3	SENSITIVITY = $	-0.18
NODE	16	COMPONENT	4	SENSITIVITY = $	150.41
NODE	16	COMPONENT	5	SENSITIVITY = $	7.89
NODE	16	COMPONENT	6	SENSITIVITY = $	13.86
NODE	16	COMPONENT	7	SENSITIVITY = $	73.70
NODE	16	COMPONENT	8	SENSITIVITY = $	39.50
NODE	16	COMPONENT	9	SENSITIVITY = $	0.64
NODE	16	COMPONENT	10	SENSITIVITY = $	2.03
NODE	16	COMPONENT	11	SENSITIVITY = $	131.53
NODE	16	COMPONENT	12	SENSITIVITY = $	0.24
NODE	16	COMPONENT	13	SENSITIVITY = $	8.22

NODE 16	COMPONENT 14	SENSITIVITY = $		0.81
NODE 16	COMPONENT 15	SENSITIVITY = $		48.89
NODE 16	COMPONENT 16	SENSITIVITY = $		0.01
NODE 16	COMPONENT 17	SENSITIVITY = $		5.25
NODE 16	COMPONENT 18	SENSITIVITY = $		1.30
NODE 16	COMPONENT 19	SENSITIVITY = $		53.60
NODE 16	COMPONENT 20	SENSITIVIT		3.19
NODE 16	COMPONENT 21	SEN		3.80
NODE 17	COMPONENT 1			-990.33
NODE 17	COMPONENT 2	S	TY = $	-1280.28
NODE 17	COMPONENT 3	SENSITIVITY = $		-50.32
NODE 17	COMPONENT 4	SENSITIVITY = $		-5989.87
NODE 17	COMPONENT 5	SENSITIVITY = $		-314.18
NODE 17	COMPONENT 6	SENSITIVITY = $		-552.09
NODE 17	COMPONENT 7	SENSITIVITY = $		-2935.02
NODE 17	COMPONENT 8	SENSITIVITY = $		-331.55
NODE 17	COMPONENT 9	SENSITIVITY = $		-6.37
NODE 17	COMPONENT 10	SENSITIVITY = $		-11.84
NODE 17	COMPONENT 11	SENSITIVITY = $		-5237.71
NODE 17	COMPONENT 12	SENSITIVITY = $		-9.54
NODE 17	COMPONENT 13	SENSITIVITY = $		3.91
NODE 17	COMPONENT 14	SENSITIVITY = $		-32.19
NODE 17	COMPONENT 15	SENSITIVITY = $		37.88
NODE 17	COMPONENT 16	SENSITIVITY = $		-0.53
NODE 17	COMPONENT 17	SENSITIVITY = $		-20.47
NODE 17	COMPONENT 18	SENSITIVITY = $		-51.94

NODE	17	COMPONENT	19	SENSITIVITY = $	-2134.48
NODE	17	COMPONENT	20	SENSITIVITY = $	-126.89
NODE	17	COMPONENT	21	SENSITIVITY = $	-151.13
NODE	19	COMPONENT	1	SENSITIVITY	0.00
NODE	19	COMPONENT	2	SENSIT[illegible]	0.00
NODE	19	COMPONENT	3	[illegible]	-3.31
NODE	19	COMPONENT	4	[illegible]	0.00
NODE	19	COMPONENT	5	S[illegible]TY = $	0.00
NODE	19	COMPONENT	6	SENSITIVITY = $	0.00
NODE	19	COMPONENT	7	SENSITIVITY = $	0.00
NODE	19	COMPONENT	8	SENSITIVITY = $	0.00
NODE	19	COMPONENT	9	SENSITIVITY = $	-0.18
NODE	19	COMPONENT	10	SENSITIVITY = $	0.96
NODE	19	COMPONENT	11	SENSITIVITY = $	0.00
NODE	19	COMPONENT	12	SENSITIVITY = $	0.00
NODE	19	COMPONENT	13	SENSITIVITY = $	8.08
NODE	19	COMPONENT	14	SENSITIVITY = $	0.00
NODE	19	COMPONENT	15	SENSITIVITY = $	46.58
NODE	19	COMPONENT	16	SENSITIVITY = $	0.00
NODE	19	COMPONENT	17	SENSITIVITY = $	0.84
NODE	19	COMPONENT	18	SENSITIVITY = $	0.00
NODE	19	COMPONENT	19	SENSITIVITY = $	0.00
NODE	19	COMPONENT	20	SENSITIVITY = $	0.00
NODE	19	COMPONENT	21	SENSITIVITY = $	0.00
NODE	22	COMPONENT	1	SENSITIVITY = $	0.00

NODE 22 COMPONENT 2 SENSITIVITY = $ 0.00

NODE 22 COMPONENT 3 SENSITIVITY = $ 0.00

NODE 22 COMPONENT 4 SENSITIVITY = $ 0.00

NODE 22 COMPONENT 5 SENSITIVITY = $ 0.00

NODE 22 COMPONENT 6 SENSITIVITY = $ 0.00

NODE 22 COMPONENT 7 SENSITI 0.00

NODE 22 COMPONENT 8 0.00

NODE 22 COMPONENT 9 0.00

NODE 22 COMPONENT 10 Y = $ 0.00

NODE 22 COMPONENT 11 SENSITIVITY = $ 0.00

NODE 22 COMPONENT 12 SENSITIVITY = $ 0.00

NODE 22 COMPONENT 13 SENSITIVITY = $ 0.00

NODE 22 COMPONENT 14 SENSITIVITY = $ 0.00

NODE 22 COMPONENT 15 SENSITIVITY = $ 0.00

NODE 22 COMPONENT 16 SENSITIVITY = $ 0.00

NODE 22 COMPONENT 17 SENSITIVITY = $ 0.00

NODE 22 COMPONENT 18 SENSITIVITY = $ 0.00

NODE 22 COMPONENT 19 SENSITIVITY = $ 0.00

NODE 22 COMPONENT 20 SENSITIVITY = $ 0.00

NODE 22 COMPONENT 21 SENSITIVITY = $ 0.00

NODE 24 COMPONENT 1 SENSITIVITY = $ 0.00

NODE 24 COMPONENT 2 SENSITIVITY = $ 0.00

NODE 24 COMPONENT 3 SENSITIVITY = $ -0.37

NODE 24 COMPONENT 4 SENSITIVITY = $ 0.00

NODE 24 COMPONENT 5 SENSITIVITY = $ 0.00

NODE	24	COMPONENT	6	SENSITIVITY	= $	0.00
NODE	24	COMPONENT	7	SENSITIVITY	= $	0.00
NODE	24	COMPONENT	8	SENSITIVITY	= $	0.00
NODE	24	COMPONENT	9	SENSITIVITY	[illegible]	-0.02
NODE	24	COMPONENT	10	SENSIT[illegible]	[illegible]	0.11
NODE	24	COMPONENT	11	[illegible]	[illegible]	0.00
NODE	24	COMPONENT	12	[illegible]	[illegible]	0.00
NODE	24	COMPONENT	13	S[illegible]TY	= $	0.90
NODE	24	COMPONENT	14	SENSITIVITY	= $	0.00
NODE	24	COMPONENT	15	SENSITIVITY	= $	5.18
NODE	24	COMPONENT	16	SENSITIVITY	= $	0.00
NODE	24	COMPONENT	17	SENSITIVITY	= $	0.45
NODE	24	COMPONENT	18	SENSITIVITY	= $	0.00
NODE	24	COMPONENT	19	SENSITIVITY	= $	0.00
NODE	24	COMPONENT	20	SENSITIVITY	= $	0.00
NODE	24	COMPONENT	21	SENSITIVITY	= $	0.00
NODE	30	COMPONENT	1	SENSITIVITY	= $	1107.02
NODE	30	COMPONENT	2	SENSITIVITY	= $	1431.13
NODE	30	COMPONENT	3	SENSITIVITY	= $	54.67
NODE	30	COMPONENT	4	SENSITIVITY	= $	6695.66
NODE	30	COMPONENT	5	SENSITIVITY	= $	351.20
NODE	30	COMPONENT	6	SENSITIVITY	= $	617.14
NODE	30	COMPONENT	7	SENSITIVITY	= $	3280.85
NODE	30	COMPONENT	8	SENSITIVITY	= $	404.61
NODE	30	COMPONENT	9	SENSITIVITY	= $	7.64
NODE	30	COMPONENT	10	SENSITIVITY	= $	15.13

NODE	30	COMPONENT	11	SENSITIVITY = $	5854.87
NODE	30	COMPONENT	12	SENSITIVITY = $	10.66
NODE	30	COMPONENT	13	SENSITIVITY = $	4.71
NODE	30	COMPONENT	14	SENSITIVITY = $	35.99
NODE	30	COMPONENT	15	SENSITIVITY = $	12.00
NODE	30	COMPONENT	16	SENSITIVITY [illegible]	0.60
NODE	30	COMPONENT	17	SENSIT[illegible]	28.05
NODE	30	COMPONENT	18	[illegible]	58.06
NODE	30	COMPONENT	19	[illegible]	2385.99
NODE	30	COMPONENT	20	[illegible]TY = $	141.85
NODE	30	COMPONENT	21	SENSITIVITY = $	168.94
NODE	32	COMPONENT	1	SENSITIVITY = $	7.44
NODE	32	COMPONENT	2	SENSITIVITY = $	9.61
NODE	32	COMPONENT	3	SENSITIVITY = $	0.37
NODE	32	COMPONENT	4	SENSITIVITY = $	2764.98
NODE	32	COMPONENT	5	SENSITIVITY = $	2.36
NODE	32	COMPONENT	6	SENSITIVITY = $	4.15
NODE	32	COMPONENT	7	SENSITIVITY = $	22.04
NODE	32	COMPONENT	8	SENSITIVITY = $	2.72
NODE	32	COMPONENT	9	SENSITIVITY = $	0.05
NODE	32	COMPONENT	10	SENSITIVITY = $	0.10
NODE	32	COMPONENT	11	SENSITIVITY = $	39.34
NODE	32	COMPONENT	12	SENSITIVITY = $	0.07
NODE	32	COMPONENT	13	SENSITIVITY = $	0.03
NODE	32	COMPONENT	14	SENSITIVITY = $	0.24
NODE	32	COMPONENT	15	SENSITIVITY = $	0.08

NODE	32	COMPONENT	16	SENSITIVITY = $		0.00
NODE	32	COMPONENT	17	SENSITIVITY = $		0.19
NODE	32	COMPONENT	18	SENSITIVITY = $		0.39
NODE	32	COMPONENT	19	SENSITIVITY = $		16.03
NODE	32	COMPONENT	20	SENSITIVITY = $		0.95
NODE	32	COMPONENT	21	SENSITIV[illegible]		1.14
NODE	33	COMPONENT	1	[illegible]		7.44
NODE	33	COMPONENT	2	[illegible] $		9.61
NODE	33	COMPONENT	3	S[illegible]TY = $		0.37
NODE	33	COMPONENT	4	SENSITIVITY = $		2572.98
NODE	33	COMPONENT	5	SENSITIVITY = $		2.36
NODE	33	COMPONENT	6	SENSITIVITY = $		4.15
NODE	33	COMPONENT	7	SENSITIVITY = $		22.04
NODE	33	COMPONENT	8	SENSITIVITY = $		2.72
NODE	33	COMPONENT	9	SENSITIVITY = $		0.05
NODE	33	COMPONENT	10	SENSITIVITY = $		0.10
NODE	33	COMPONENT	11	SENSITIVITY = $		39.34
NODE	33	COMPONENT	12	SENSITIVITY = $		0.07
NODE	33	COMPONENT	13	SENSITIVITY = $		0.03
NODE	33	COMPONENT	14	SENSITIVITY = $		0.24
NODE	33	COMPONENT	15	SENSITIVITY = $		0.08
NODE	33	COMPONENT	16	SENSITIVITY = $		0.00
NODE	33	COMPONENT	17	SENSITIVITY = $		0.19
NODE	33	COMPONENT	18	SENSITIVITY = $		0.39
NODE	33	COMPONENT	19	SENSITIVITY = $		16.03
NODE	33	COMPONENT	20	SENSITIVITY = $		0.95

NODE	33	COMPONENT 21	SENSITIVITY = $	1.14
NODE	34	COMPONENT 1	SENSITIVITY = $	0.00
NODE	34	COMPONENT 2	SENSITIVITY = $	0.00
NODE	34	COMPONENT 3	SENSITIVITY = $	0.00
NODE	34	COMPONENT 4	SENSITIVITY =	-672.00
NODE	34	COMPONENT 5	SENSIT[illegible]	0.00
NODE	34	COMPONENT 6	S[illegible]	0.00
NODE	34	COMPONENT 7	[illegible] = $	0.00
NODE	34	COMPONENT 8	[illegible]SITIVITY = $	0.00
NODE	34	COMPONENT 9	SENSITIVITY = $	0.00
NODE	34	COMPONENT 10	SENSITIVITY = $	0.00
NODE	34	COMPONENT 11	SENSITIVITY = $	0.00
NODE	34	COMPONENT 12	SENSITIVITY = $	0.00
NODE	34	COMPONENT 13	SENSITIVITY = $	0.00
NODE	34	COMPONENT 14	SENSITIVITY = $	0.00
NODE	34	COMPONENT 15	SENSITIVITY = $	0.00
NODE	34	COMPONENT 16	SENSITIVITY = $	0.00
NODE	34	COMPONENT 17	SENSITIVITY = $	0.00
NODE	34	COMPONENT 18	SENSITIVITY = $	0.00
NODE	34	COMPONENT 19	SENSITIVITY = $	0.00
NODE	34	COMPONENT 20	SENSITIVITY = $	0.00
NODE	34	COMPONENT 21	SENSITIVITY = $	0.00
NODE	37	COMPONENT 1	SENSITIVITY = $	1114.46
NODE	37	COMPONENT 2	SENSITIVITY = $	1440.75
NODE	37	COMPONENT 3	SENSITIVITY = $	55.04

NODE	37	COMPONENT	4	SENSITIVITY = $	6740.64
NODE	37	COMPONENT	5	SENSITIVITY = $	353.56
NODE	37	COMPONENT	6	SENSITIVITY = $	621.29
NODE	37	COMPONENT	7	SENSITIVITY = $	3302.89
NODE	37	COMPONENT	8	SENSITIVITY [illegible]	407.32
NODE	37	COMPONENT	9	SE[illegible]	7.69
NODE	37	COMPONENT	10	[illegible]	15.24
NODE	37	COMPONENT	11	[illegible] = $	5894.21
NODE	37	COMPONENT	12	S[illegible]ITIVITY = $	10.73
NODE	37	COMPONENT	13	SENSITIVITY = $	4.74
NODE	37	COMPONENT	14	SENSITIVITY = $	36.23
NODE	37	COMPONENT	15	SENSITIVITY = $	12.08
NODE	37	COMPONENT	16	SENSITIVITY = $	0.60
NODE	37	COMPONENT	17	SENSITIVITY = $	28.24
NODE	37	COMPONENT	18	SENSITIVITY = $	58.45
NODE	37	COMPONENT	19	SENSITIVITY = $	2402.02
NODE	37	COMPONENT	20	SENSITIVITY = $	142.80
NODE	37	COMPONENT	21	SENSITIVITY = $	170.08
NODE	39	COMPONENT	1	SENSITIVITY = $	0.00
NODE	39	COMPONENT	2	SENSITIVITY = $	0.00
NODE	39	COMPONENT	3	SENSITIVITY = $	0.00
NODE	39	COMPONENT	4	SENSITIVITY = $	0.00
NODE	39	COMPONENT	5	SENSITIVITY = $	0.00
NODE	39	COMPONENT	6	SENSITIVITY = $	0.00
NODE	39	COMPONENT	7	SENSITIVITY = $	0.00
NODE	39	COMPONENT	8	SENSITIVITY = $	0.00

NODE	39	COMPONENT	9	SENSITIVITY	= $	0.00
NODE	39	COMPONENT	10	SENSITIVITY	= $	0.00
NODE	39	COMPONENT	11	SENSITIVITY	= $	0.00
NODE	39	COMPONENT	12	SENSITIVITY	= $	0.00
NODE	39	COMPONENT	13	SENSITIVITY	=	0.00
NODE	39	COMPONENT	14	SENSIT		0.00
NODE	39	COMPONENT	15			0.00
NODE	39	COMPONENT	16			0.00
NODE	39	COMPONENT	17	S ...TY	= $	0.00
NODE	39	COMPONENT	18	SENSITIVITY	= $	0.00
NODE	39	COMPONENT	19	SENSITIVITY	= $	0.00
NODE	39	COMPONENT	20	SENSITIVITY	= $	0.00
NODE	39	COMPONENT	21	SENSITIVITY	= $	0.00
NODE	40	COMPONENT	1	SENSITIVITY	= $	-16651.19
NODE	40	COMPONENT	2	SENSITIVITY	= $	1174.14
NODE	40	COMPONENT	3	SENSITIVITY	= $	-797.05
NODE	40	COMPONENT	4	SENSITIVITY	= $	968.00
NODE	40	COMPONENT	5	SENSITIVITY	= $	-6717.69
NODE	40	COMPONENT	6	SENSITIVITY	= $	0.00
NODE	40	COMPONENT	7	SENSITIVITY	= $	0.00
NODE	40	COMPONENT	8	SENSITIVITY	= $	-2199.92
NODE	40	COMPONENT	9	SENSITIVITY	= $	-52.25
NODE	40	COMPONENT	10	SENSITIVITY	= $	-243.12
NODE	40	COMPONENT	11	SENSITIVITY	= $	-15552.12
NODE	40	COMPONENT	12	SENSITIVITY	= $	-109.14
NODE	40	COMPONENT	13	SENSITIVITY	= $	4.74

NODE	40	COMPONENT	14	SENSITIVITY = $	-664.63
NODE	40	COMPONENT	15	SENSITIVITY = $	7.29
NODE	40	COMPONENT	16	SENSITIVITY = $	-11.39
NODE	40	COMPONENT	17	SENSITIVITY = $	28.24
NODE	40	COMPONENT	18	SENSITIVITY = $	34.47
NODE	40	COMPONENT	19	SENSITIVITY = $	0.00
NODE	40	COMPONENT	20	SENSITIVITY = $	-289.05
NODE	40	COMPONENT	21	SENSITIVITY = $	-88.25
NODE	41	COMPONENT	1	SENSITIVITY = $	69.02
NODE	41	COMPONENT	2	SENSITIVITY = $	1427.42
NODE	41	COMPONENT	3	SENSITIVITY = $	12.44
NODE	41	COMPONENT	4	SENSITIVITY = $	0.00
NODE	41	COMPONENT	5	SENSITIVITY = $	0.00
NODE	41	COMPONENT	6	SENSITIVITY = $	0.00
NODE	41	COMPONENT	7	SENSITIVITY = $	0.00
NODE	41	COMPONENT	8	SENSITIVITY = $	276.96
NODE	41	COMPONENT	9	SENSITIVITY = $	4.69
NODE	41	COMPONENT	10	SENSITIVITY = $	2.37
NODE	41	COMPONENT	11	SENSITIVITY = $	4821.89
NODE	41	COMPONENT	12	SENSITIVITY = $	4.74
NODE	41	COMPONENT	13	SENSITIVITY = $	4.74
NODE	41	COMPONENT	14	SENSITIVITY = $	1.18
NODE	41	COMPONENT	15	SENSITIVITY = $	11.84
NODE	41	COMPONENT	16	SENSITIVITY = $	0.00
NODE	41	COMPONENT	17	SENSITIVITY = $	28.24
NODE	41	COMPONENT	18	SENSITIVITY = $	57.25

NODE	41	COMPONENT	19	SENSITIVITY = $	0.00
NODE	41	COMPONENT	20	SENSITIVITY = $	121.21
NODE	41	COMPONENT	21	SENSITIVITY = $	157.16
NODE	42	COMPONENT	1	SENSITIVITY = $	69.02
NODE	42	COMPONENT	2	SENSITIVI[illegible]	1427.42
NODE	42	COMPONENT	3	[illegible]	0.00
NODE	42	COMPONENT	4	[illegible]	0.00
NODE	42	COMPONENT	5	[illegible] = $	0.00
NODE	42	COMPONENT	6	SENSITIVITY = $	0.00
NODE	42	COMPONENT	7	SENSITIVITY = $	0.00
NODE	42	COMPONENT	8	SENSITIVITY = $	0.00
NODE	42	COMPONENT	9	SENSITIVITY = $	0.00
NODE	42	COMPONENT	10	SENSITIVITY = $	0.00
NODE	42	COMPONENT	11	SENSITIVITY = $	4821.89
NODE	42	COMPONENT	12	SENSITIVITY = $	0.00
NODE	42	COMPONENT	13	SENSITIVITY = $	0.00
NODE	42	COMPONENT	14	SENSITIVITY = $	0.00
NODE	42	COMPONENT	15	SENSITIVITY = $	0.00
NODE	42	COMPONENT	16	SENSITIVITY = $	0.00
NODE	42	COMPONENT	17	SENSITIVITY = $	0.00
NODE	42	COMPONENT	18	SENSITIVITY = $	16.93
NODE	42	COMPONENT	19	SENSITIVITY = $	0.00
NODE	42	COMPONENT	20	SENSITIVITY = $	120.61
NODE	42	COMPONENT	21	SENSITIVITY = $	157.16
NODE	45	COMPONENT	1	SENSITIVITY = $	1921.54
NODE	45	COMPONENT	2	SENSITIVITY = $	31.58

NODE	45	COMPONENT	3	SENSITIVITY = $	100.93
NODE	45	COMPONENT	4	SENSITIVITY = $	683.80
NODE	45	COMPONENT	5	SENSITIVITY = $	837.63
NODE	45	COMPONENT	6	SENSITIVITY = $	73.59
NODE	45	COMPONENT	7	SENSITIVITY = $	391.25
NODE	45	COMPONENT	8	SENSITIVITY = $	308.84
NODE	45	COMPONENT	9	SENSITIV[illegible]	7.10
NODE	45	COMPONENT	10	[illegible]	30.49
NODE	45	COMPONENT	11	[illegible]	2540.44
NODE	45	COMPONENT	12	[illegible] = $	14.20
NODE	45	COMPONENT	13	SENSITIVITY = $	0.00
NODE	45	COMPONENT	14	SENSITIVITY = $	83.02
NODE	45	COMPONENT	15	SENSITIVITY = $	0.57
NODE	45	COMPONENT	16	SENSITIVITY = $	1.42
NODE	45	COMPONENT	17	SENSITIVITY = $	0.00
NODE	45	COMPONENT	18	SENSITIVITY = $	2.84
NODE	45	COMPONENT	19	SENSITIVITY = $	284.53
NODE	45	COMPONENT	20	SENSITIVITY = $	51.16
NODE	45	COMPONENT	21	SENSITIVITY = $	30.60
NODE	50	COMPONENT	1	SENSITIVITY = $	482.75
NODE	50	COMPONENT	2	SENSITIVITY = $	14.51
NODE	50	COMPONENT	3	SENSITIVITY = $	29.51
NODE	50	COMPONENT	4	SENSITIVITY = $	339.45
NODE	50	COMPONENT	5	SENSITIVITY = $	193.56
NODE	50	COMPONENT	6	SENSITIVITY = $	28.08
NODE	50	COMPONENT	7	SENSITIVITY = $	158.06

NODE	50	COMPONENT	8	SENSITIVITY = $	91.74
NODE	50	COMPONENT	9	SENSITIVITY = $	1.97
NODE	50	COMPONENT	10	SENSITIVITY = $	7.69
NODE	50	COMPONENT	11	SENSITIVITY = $	669.12
NODE	50	COMPONENT	12	SENSITIVITY = [illegible]	3.76
NODE	50	COMPONENT	13	SENSITI[illegible]	1.31
NODE	50	COMPONENT	14	SE[illegible]	19.26
NODE	50	COMPONENT	15	[illegible] = $	28.28
NODE	50	COMPONENT	16	[illegible]SITIVITY = $	63.30
NODE	50	COMPONENT	17	SENSITIVITY = $	2.00
NODE	50	COMPONENT	18	SENSITIVITY = $	0.98
NODE	50	COMPONENT	19	SENSITIVITY = $	104.41
NODE	50	COMPONENT	20	SENSITIVITY = $	12.34
NODE	50	COMPONENT	21	SENSITIVITY = $	9.96
NODE	51	COMPONENT	1	SENSITIVITY = $	0.00
NODE	51	COMPONENT	2	SENSITIVITY = $	0.00
NODE	51	COMPONENT	3	SENSITIVITY = $	0.00
NODE	51	COMPONENT	4	SENSITIVITY = $	0.00
NODE	51	COMPONENT	5	SENSITIVITY = $	0.00
NODE	51	COMPONENT	6	SENSITIVITY = $	0.00
NODE	51	COMPONENT	7	SENSITIVITY = $	0.00
NODE	51	COMPONENT	8	SENSITIVITY = $	0.00
NODE	51	COMPONENT	9	SENSITIVITY = $	0.00
NODE	51	COMPONENT	10	SENSITIVITY = $	0.00
NODE	51	COMPONENT	11	SENSITIVITY = $	0.00
NODE	51	COMPONENT	12	SENSITIVITY = $	0.00

NODE	51	COMPONENT	13	SENSITIVITY = $	0.00
NODE	51	COMPONENT	14	SENSITIVITY = $	0.00
NODE	51	COMPONENT	15	SENSITIVITY = $	0.00
NODE	51	COMPONENT	16	SENSITIVITY = $	0.00
NODE	51	COMPONENT	17	SENSITIVITY = $	0.00
NODE	51	COMPONENT	18	SENSITIVIT[illegible]	0.00
NODE	51	COMPONENT	19	[illegible]	0.00
NODE	51	COMPONENT	20	[illegible]ITY = $	0.00
NODE	51	COMPONENT	21	SENSITIVITY = $	0.00
NODE	53	COMPONENT	1	SENSITIVITY = $	477.41
NODE	53	COMPONENT	2	SENSITIVITY = $	13.17
NODE	53	COMPONENT	3	SENSITIVITY = $	24.84
NODE	53	COMPONENT	4	SENSITIVITY = $	266.54
NODE	53	COMPONENT	5	SENSITIVITY = $	191.56
NODE	53	COMPONENT	6	SENSITIVITY = $	26.74
NODE	53	COMPONENT	7	SENSITIVITY = $	142.17
NODE	53	COMPONENT	8	SENSITIVITY = $	85.13
NODE	53	COMPONENT	9	SENSITIVITY = $	1.72
NODE	53	COMPONENT	10	SENSITIVITY = $	7.18
NODE	53	COMPONENT	11	SENSITIVITY = $	668.10
NODE	53	COMPONENT	12	SENSITIVITY = $	3.25
NODE	53	COMPONENT	13	SENSITIVITY = $	0.80
NODE	53	COMPONENT	14	SENSITIVITY = $	19.01
NODE	53	COMPONENT	15	SENSITIVITY = $	23.20

APPENDIX J

COMPUTER PROGRAM FLOW CHARTS

Main Program Flow Chart

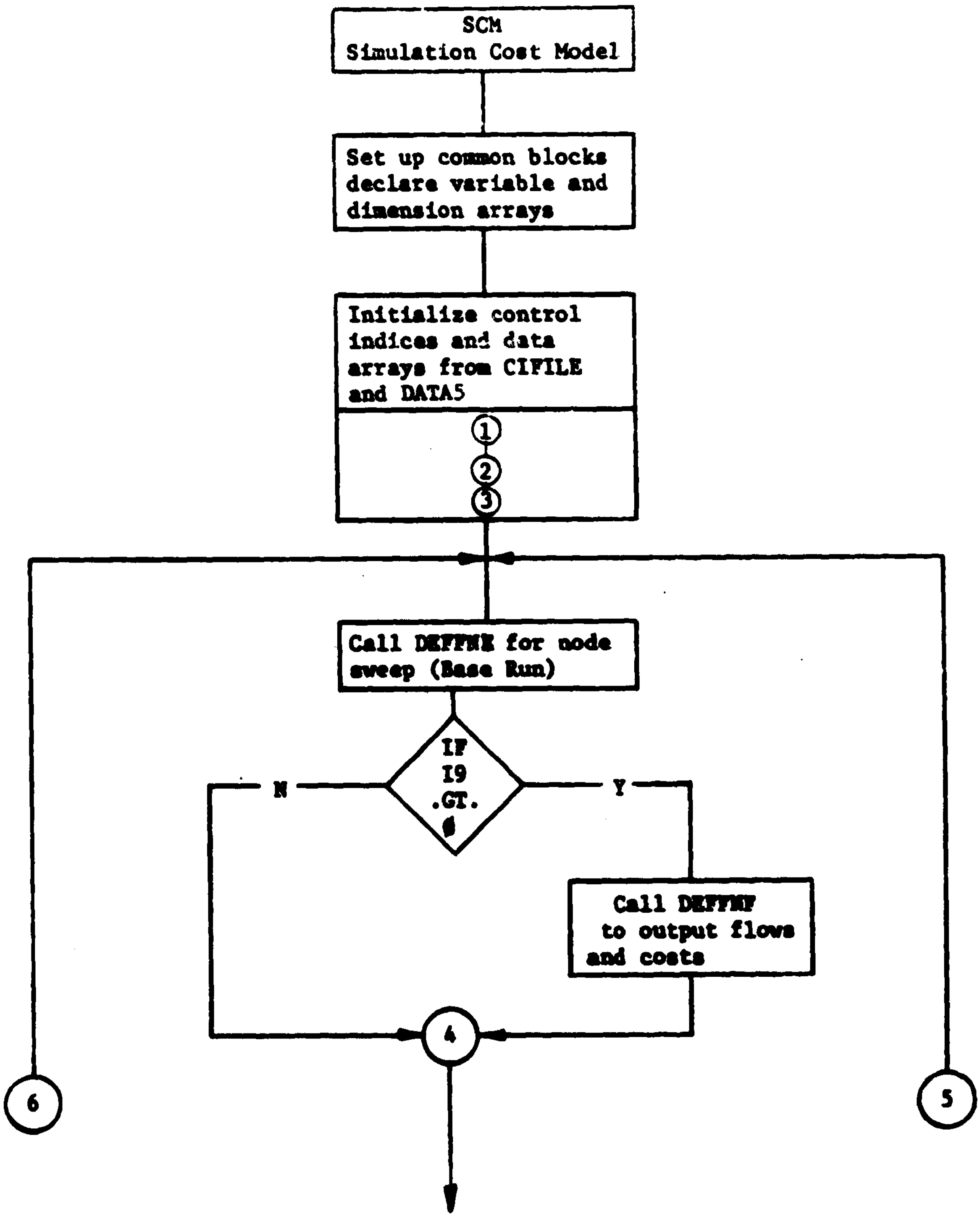


Figure J.1-a

Main Program Continued

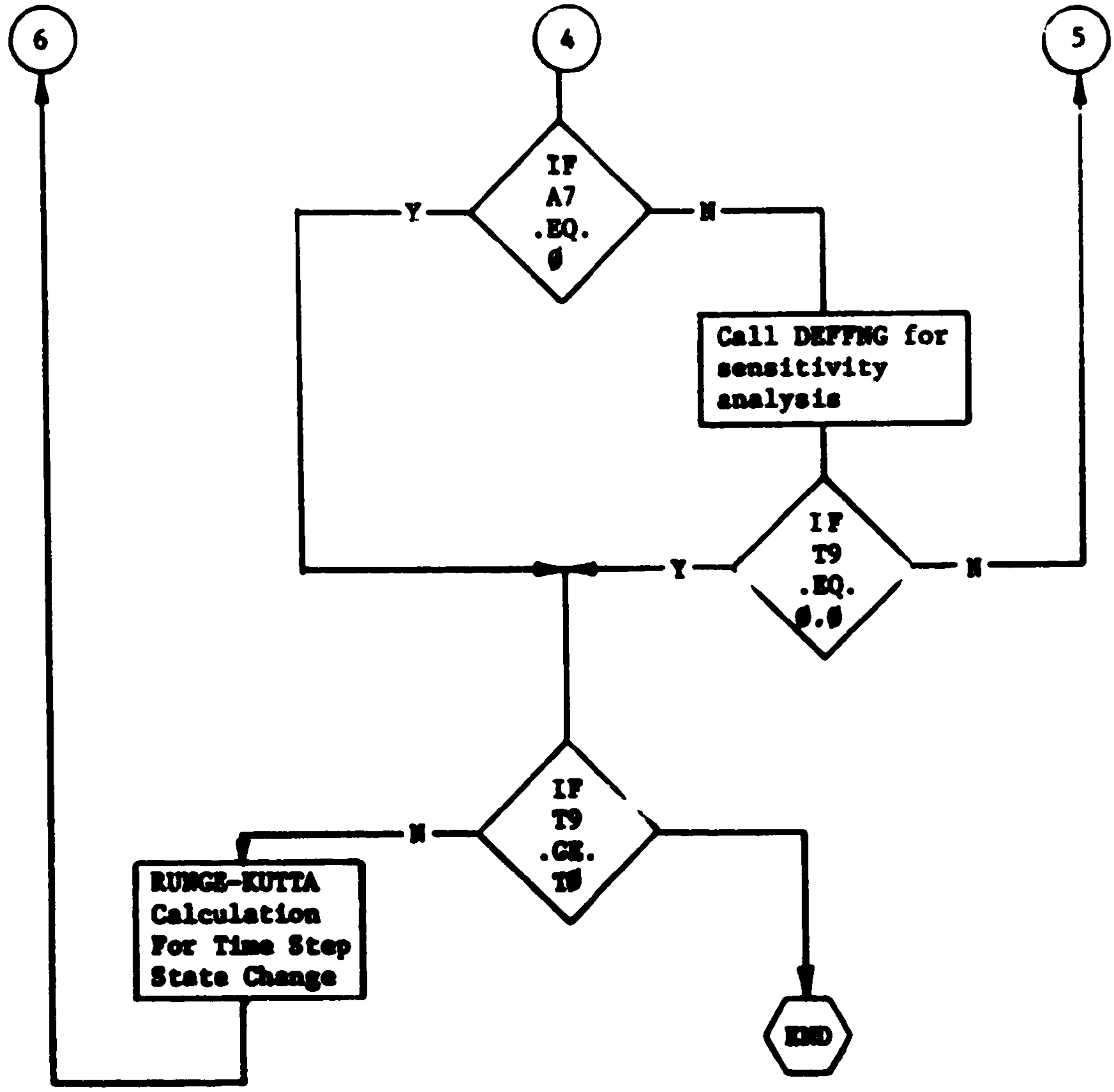


Figure J.1-b

Detail from Figure J.1-a

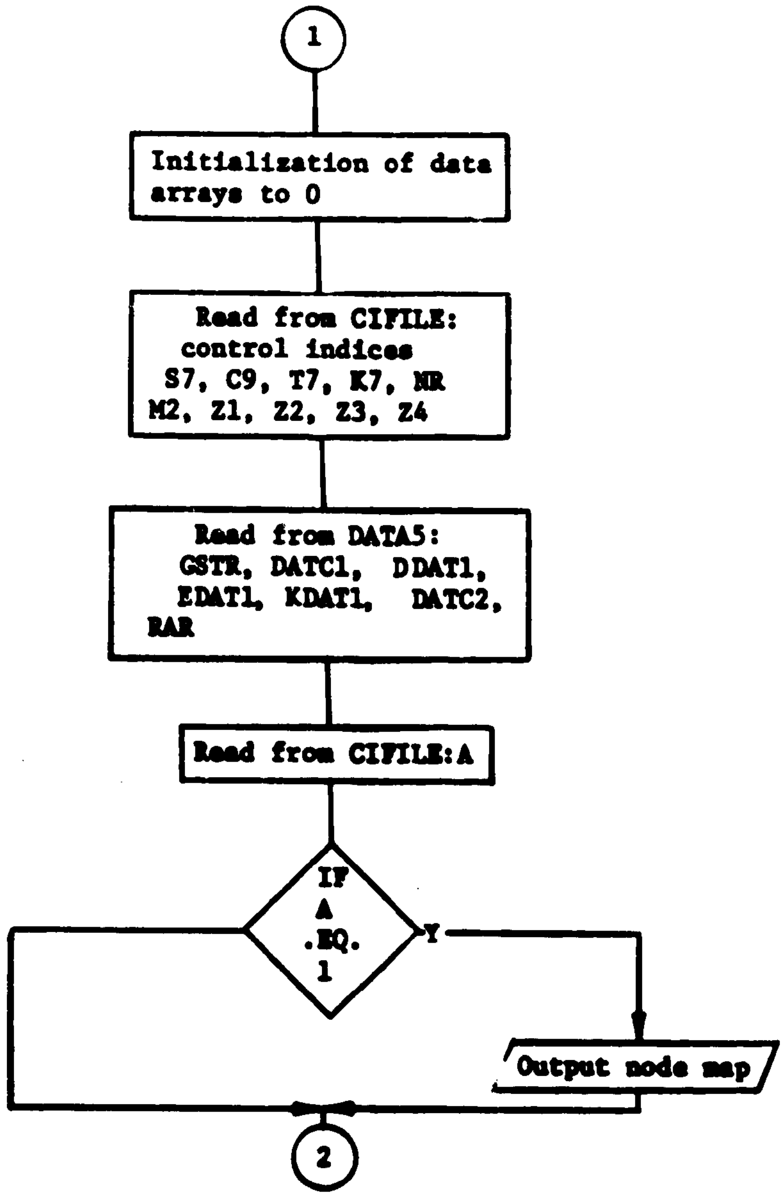


Figure J.1-c

Detail from
Figure J.1-a
(continued)

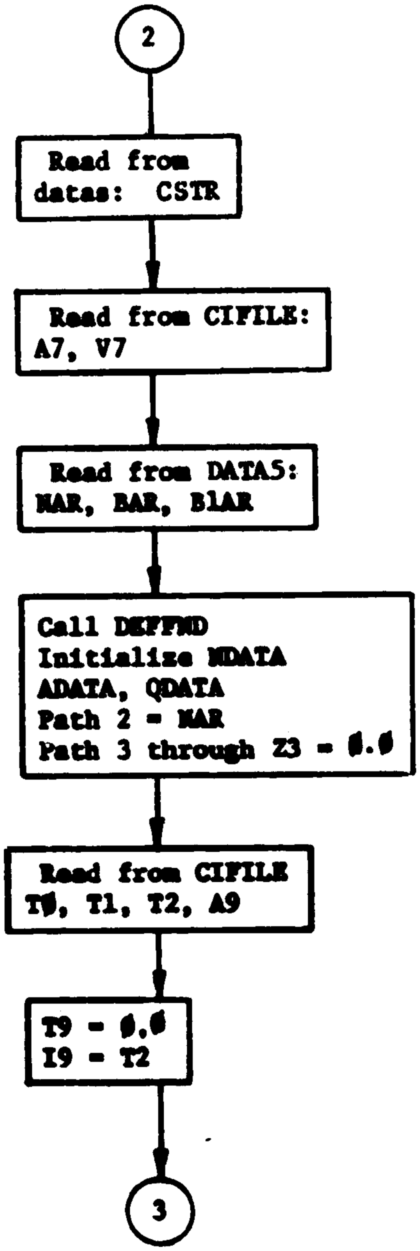


Figure J.1-d

Detail of
Runge Kutta Calculation
Figure J.1-b

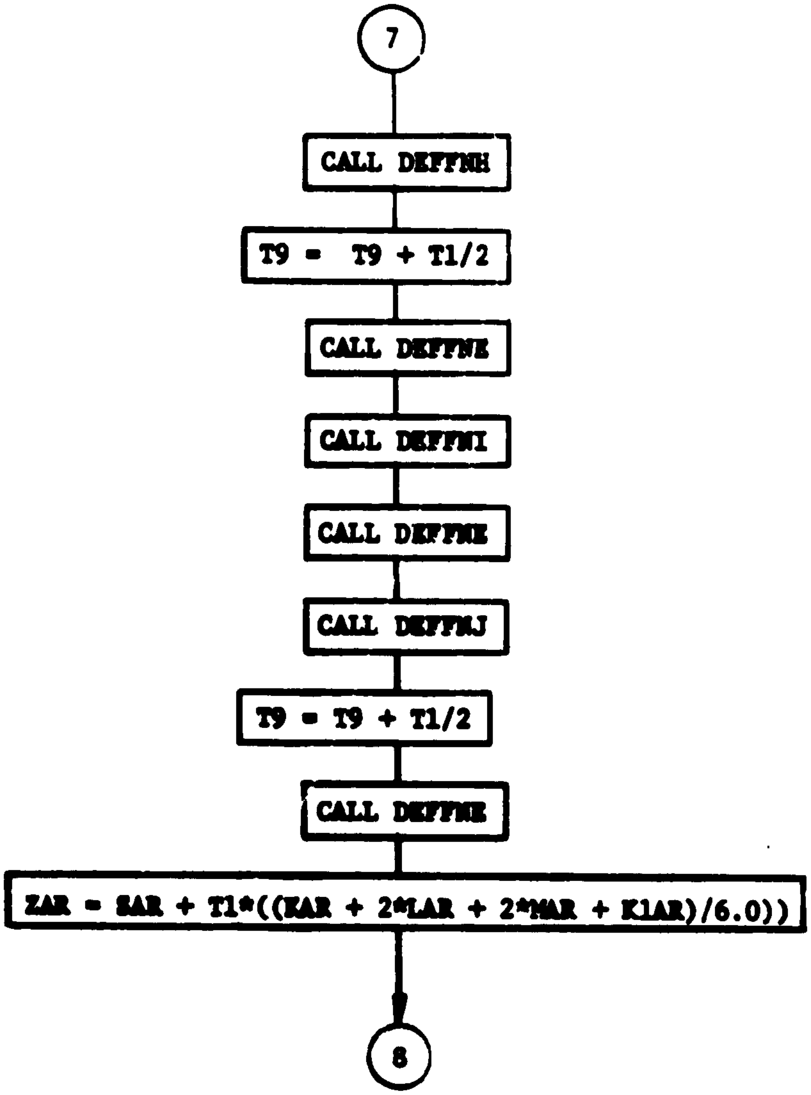
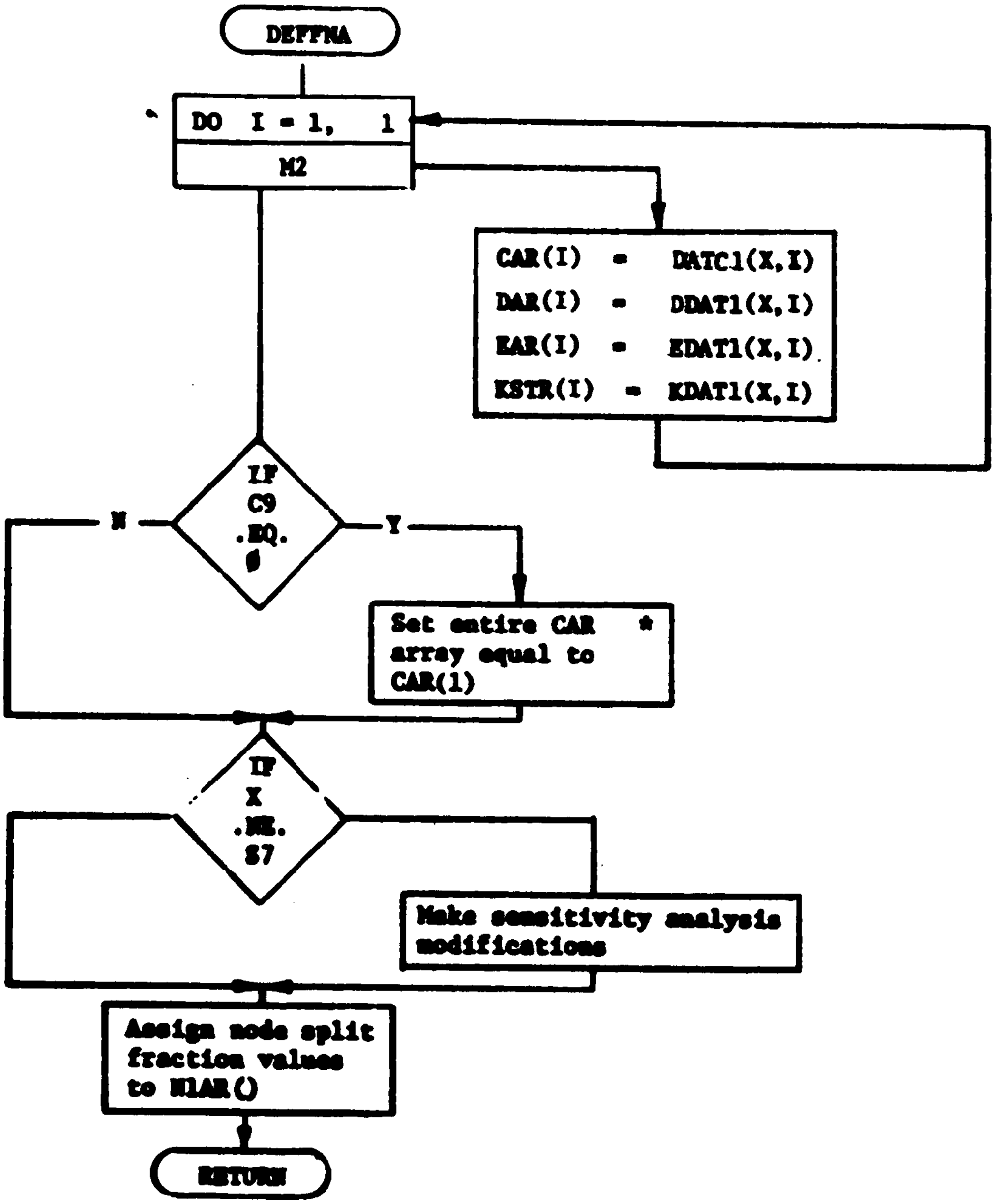


Figure J.1-e

Subroutine DEFFNA
for Calculate Node
Split Values



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* contained within a [DO X = 1, M2] loop

Figure J.2

Subroutine DEFFNB
for Computing Costs

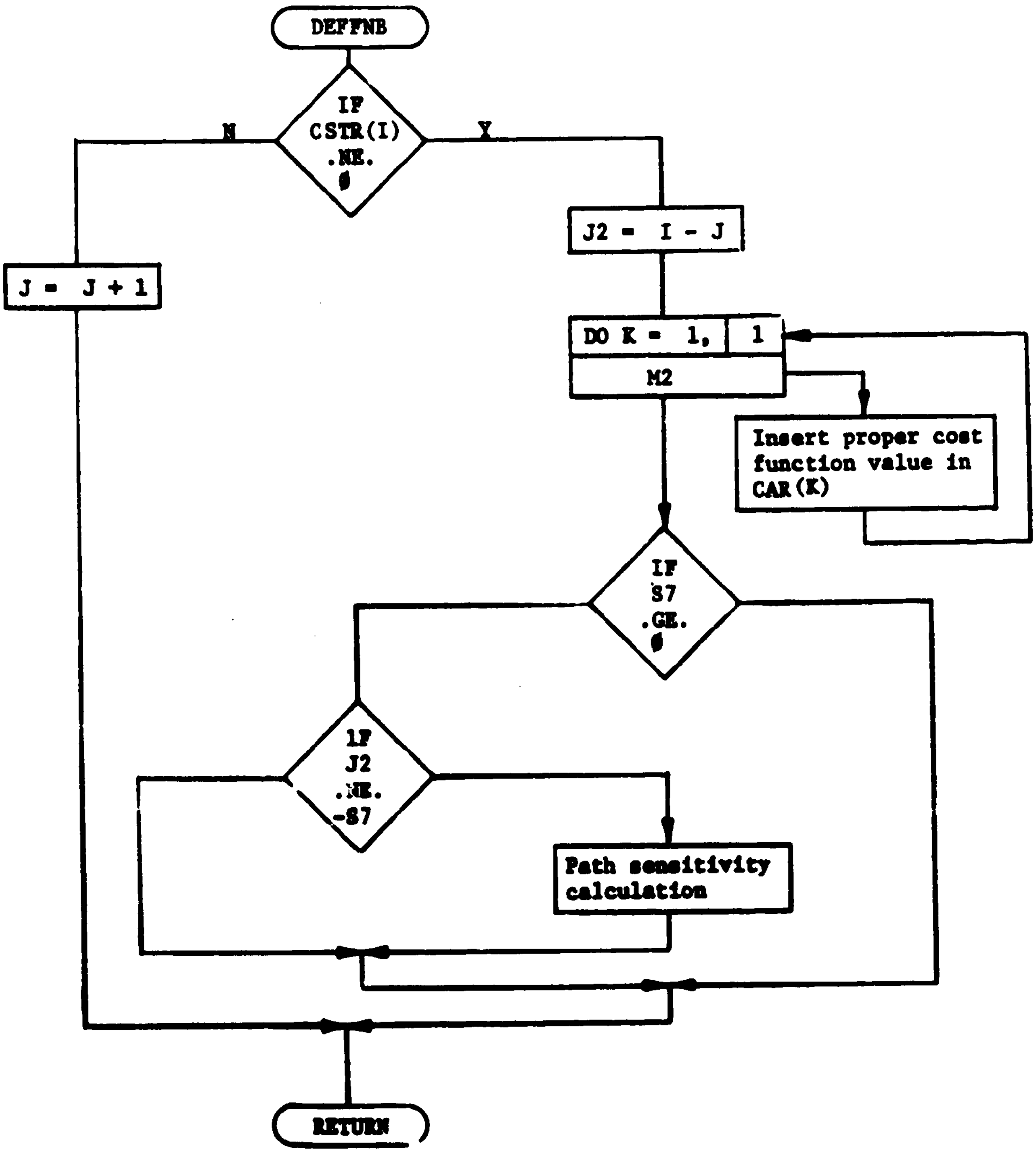


Figure J.3

Subroutine DEFFNC

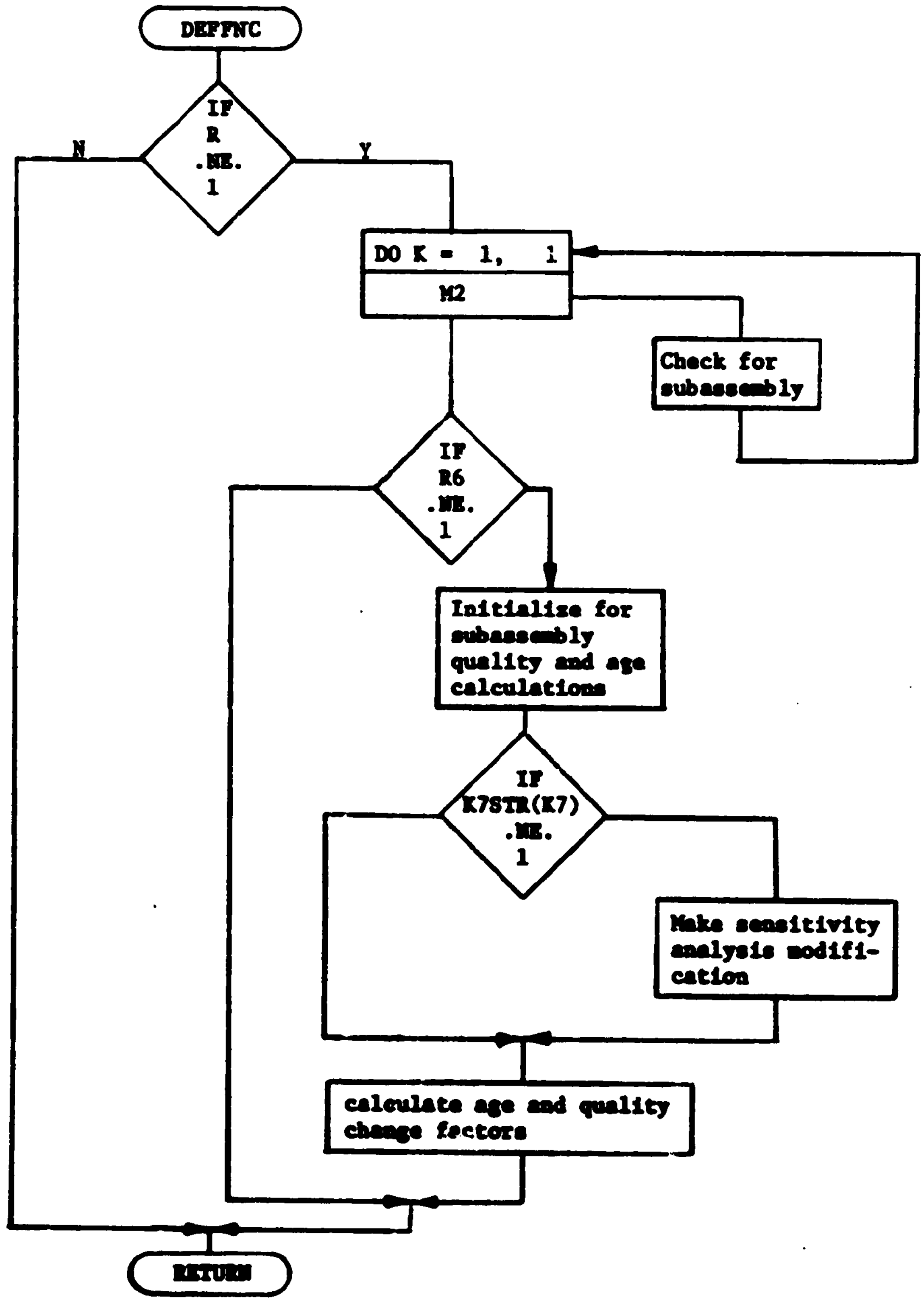


Figure J.4

Subroutine DEFFND
for Retrieving and
Storing Path Data

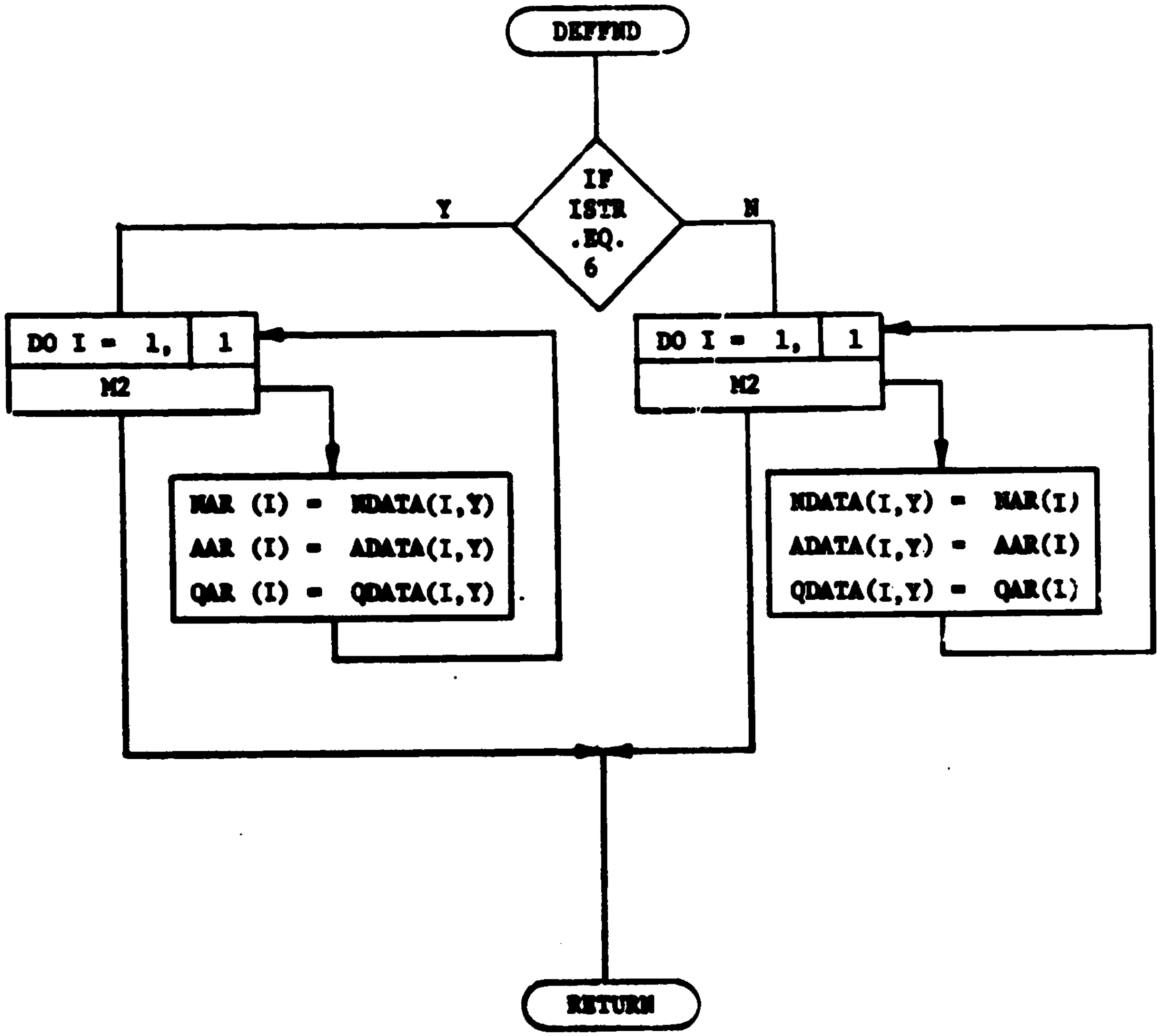


Figure J.5

Subroutine DEFFNE
for Calculating Path Flows,
Qualities, and Ages

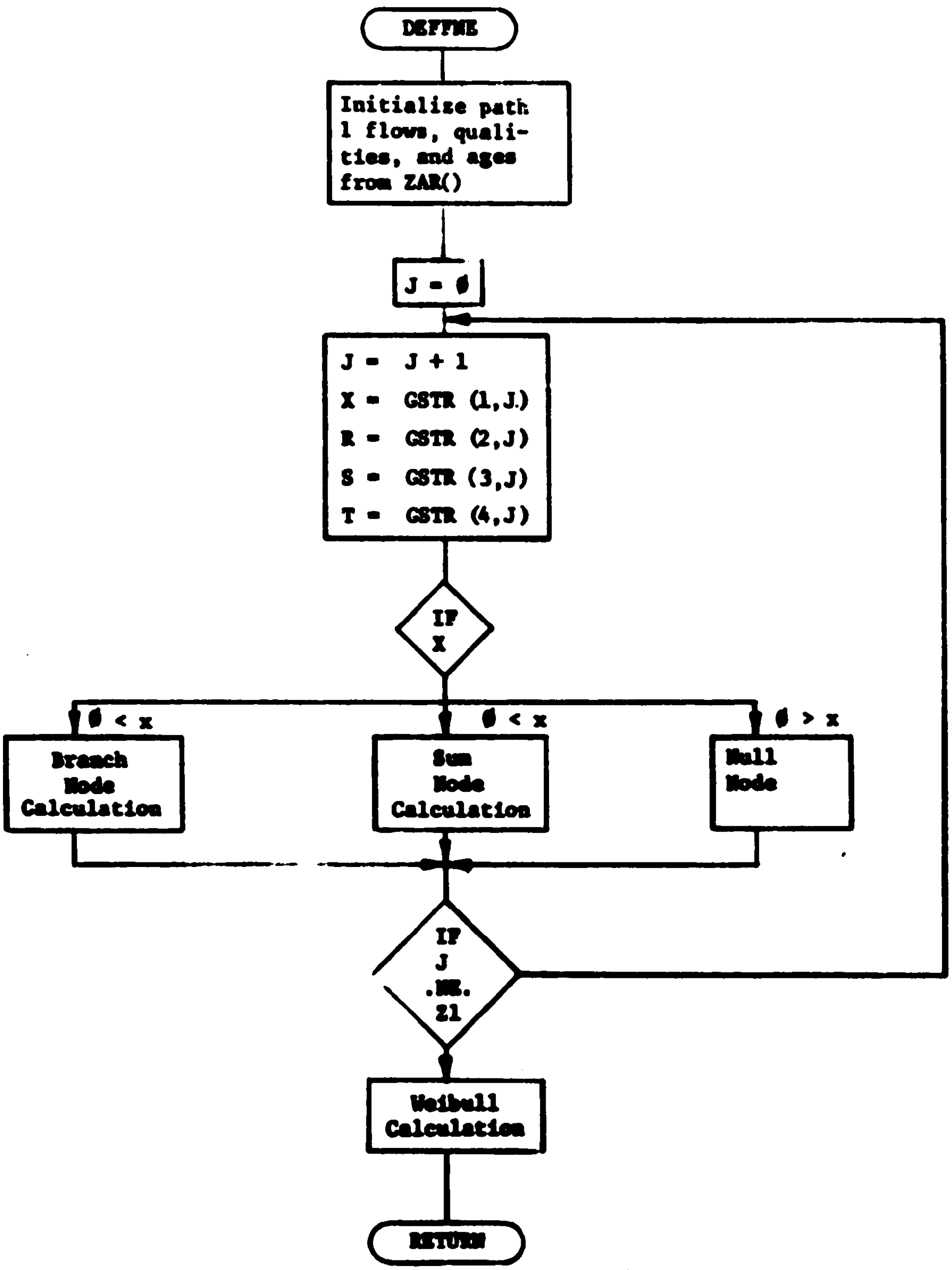
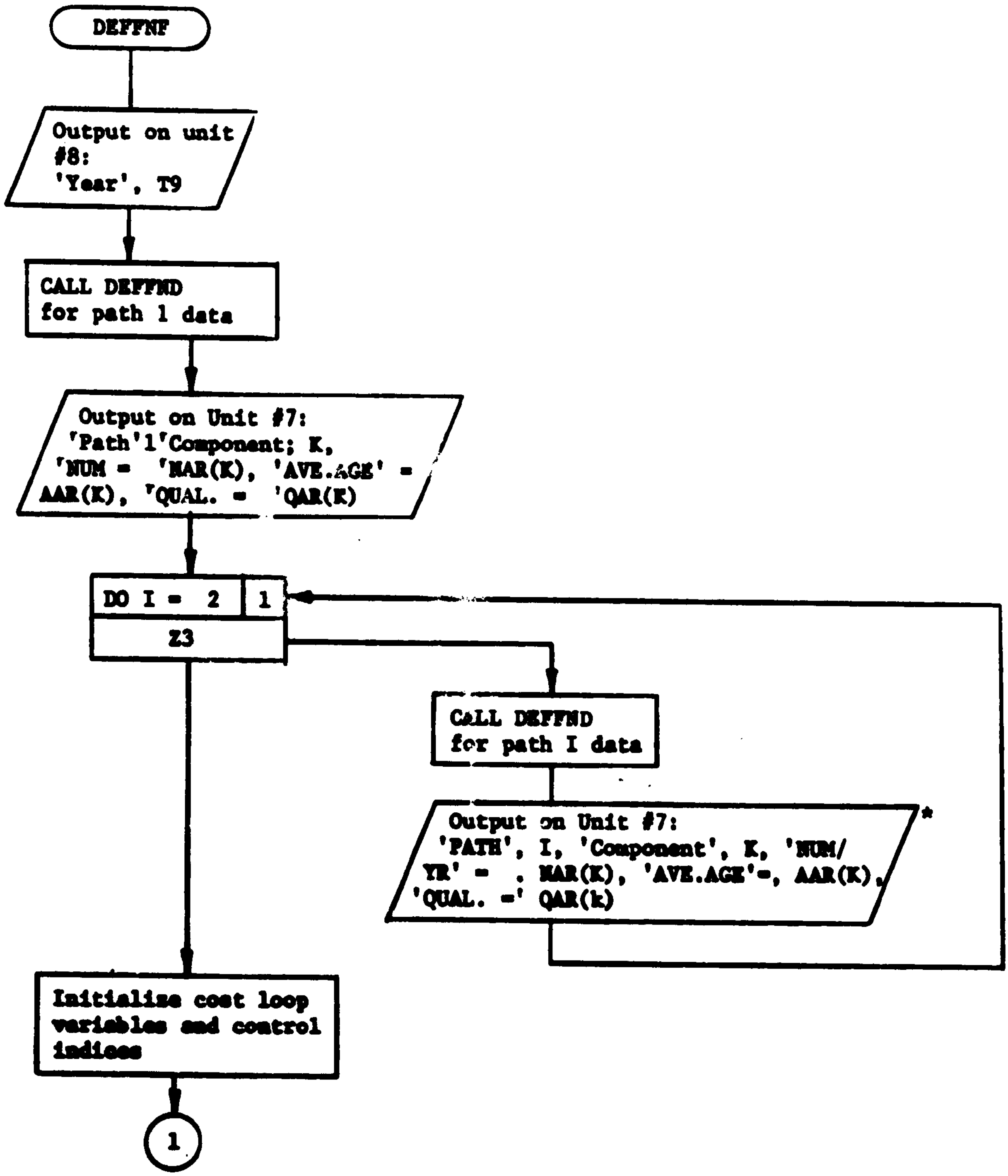


Figure J.6

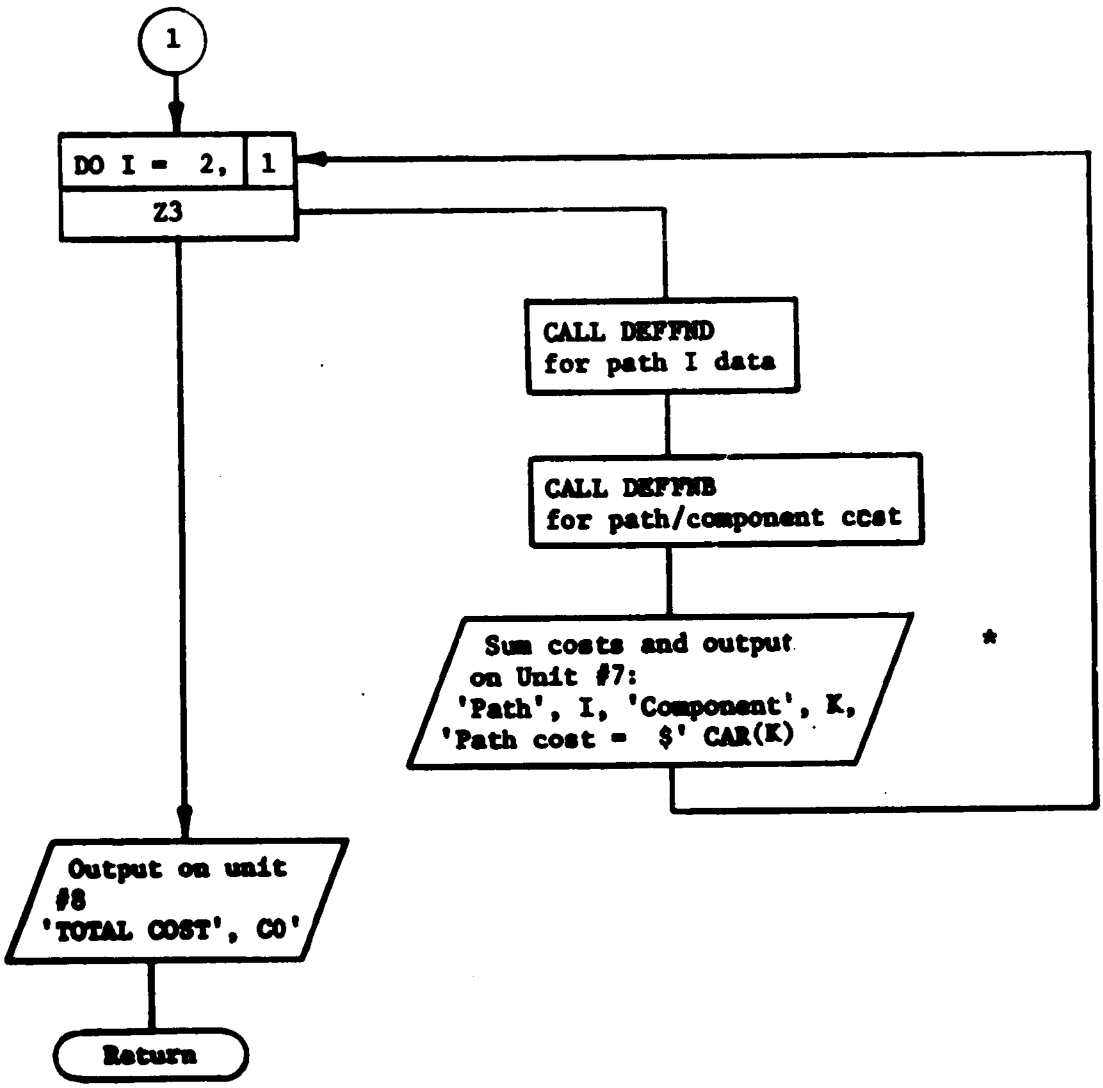
Subroutine DEFFNF
for Outputting Path Flow and
Cost Data



* contained within a [DO K = 1, M2] loop

Figure J.7-a

Subroutine DEFFNF
(Continued)



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* Contained within a [DO K = 1, M2] loop.

Figure J.7-b

Subroutine DEFFNG
for Controlling Sensitivity
Runs and Outputting Results

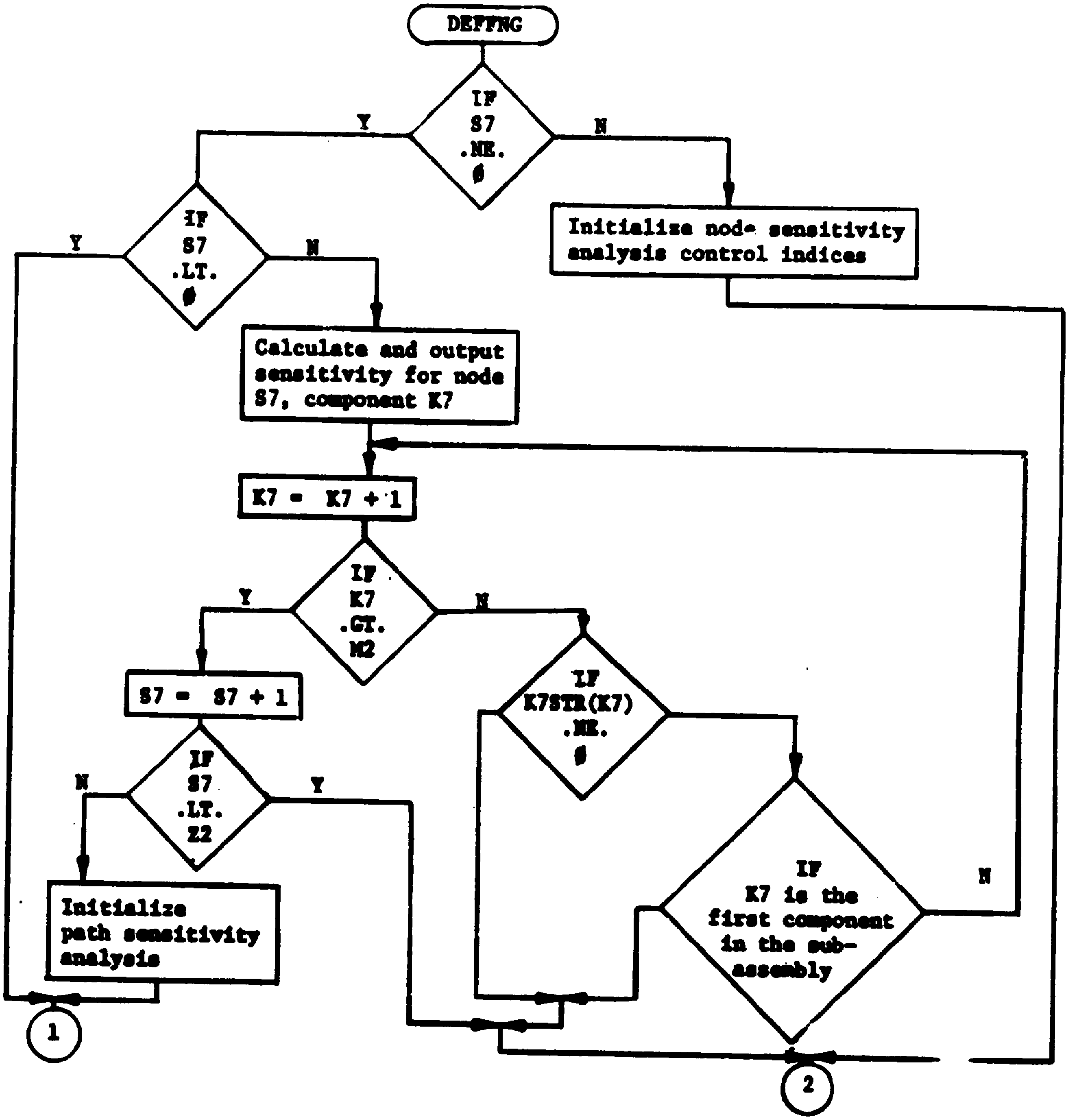


Figure J.8-a

Subroutine DEFFNG
(Continued)

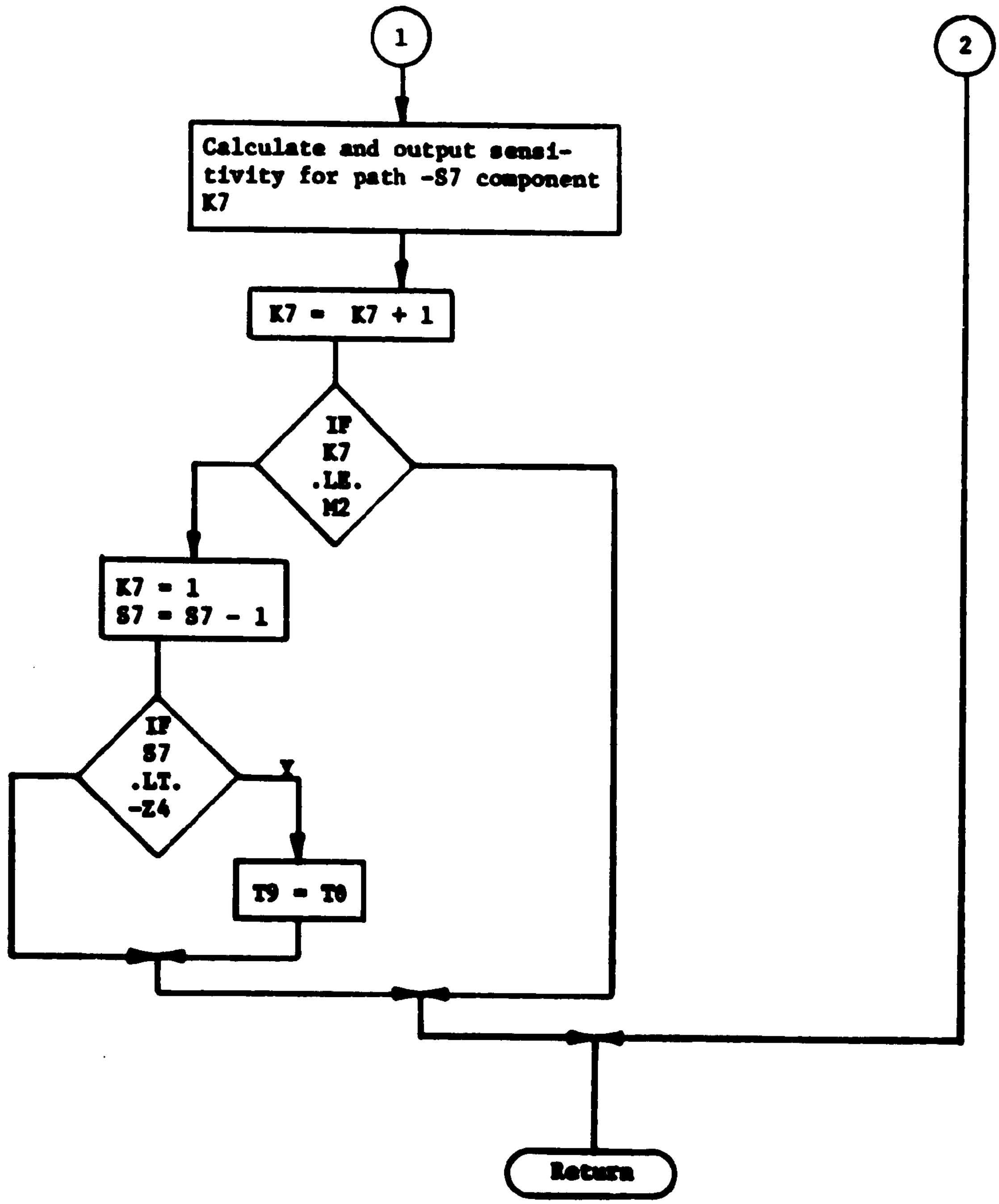


Figure J.8-b

APPENDIX K

COST DATA TABLES FOR EXAMPLE TRUCK

COST DATA FOR MINDEN DEUTZ TRUCK**

COST DATA AND COMMENTS FOR EXAMPLE TRUCK

LABOR RATES: 1 = $18.40/HR; 2 = $20.80/HR; 3 = $22.05/HR

PATH #	COMPONENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	NOTES AND COMMENTARY
4,5	3	Installation	1	5/6	250*	All cost data from purchase orders averaged, as appropriate, for individual items considered as constituting the component.
4,5	8	Installation	1	1.5	120	Average of lever, brakehead, caliper bridge, suspension strip.
4,5	9	Installation	1	1	316	
4,5	10	Installation	1	1/4	150	Cables and sensors treated together as unit.
4,5	12	Installation	1	1/2	73	
4,5	13	Installation	1	1/2	105	
4,5	15	Installation	1	1/2	2.62	
4,5	16	Installation	1	1/4	65.64	
4,5	17	Installation	1	1	150	
6,7	3	Installation	1	5/6	250	
6,7	9	Installation	1	1 1/4	316	
6,7	10	Installation	1	1/4	150	
6,7	12	Installation	1	1/2	73	
6,7	13	Installation	1	1/2	105	

* UNDERLINED NUMBERS ARE APPROXIMATE

** EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK						
PATH #	COM-PO-NENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES 1 = $18.40/HR 2 = $20.90/HR 3 = $22.05/HR NOTES AND COMMENTARY
6,7	15	Installation	1	1/2	2.62	
6,7	17	Installation	1	2	150	
8	1	Installation	2	1.5	143	
8	2	Installation	2	12	380	
8	3	Installation	2	5/6	250	
8	8	Installation	2	1.5	120	
8	9	Installation	2	1	316	
8	10	Installation	2	1/4	150	
8	11	Installation	2	1 1/4	90	$35 per liner plus $150 per side bearing. Replace side bearings and centerplate liners.
8	12	Installation	2	1/4	73	
8	13	Installation	2	1/2	105	
8	14	Installation	2	4	652	
8	15	Installation	2	1/2	2.62	
8	16	Installation	2	1/4	65.64	
8	17	Installation	2	1	150	

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK						
PATH #	COM-PO-NENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES: 1 = $18.40/HR, 2 = $20.80/HR, 3 = $22.05/HR NOTES AND COMMENTARY
8	18	Installation	2	3	320	
8	20	Installation	2	4	250	
8	21	Installation	2	4	70	
9	9 17 18	Cylinder Installation	3			No cost - no flow; do not replace valve; just replace expendable items. That cost on path 119.
10	1	Replacement	3		143	Labor cost not needed since truck already dis-assembled.
10	2	Replacement	3		380	Labor cost not needed since truck already dis-assembled.
10	3	Replacement	3		250	Labor cost not needed since truck already dis-assembled.
10	8	Replacement	3		120	"
10	10	Replacement	3		150	"
10	13	Replacement	3		105	"
10	14	Replacement	3		652	"
10	15	Replacement	3		2.62	"
10	16	Replacement	3		65.64	"

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK

PATH #	COMPONENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES: 1 = $18.40/HR, 2 = $20.80/HR, 3 = $22.05/HR — NOTES AND COMMENTARY
10	20	Replacement	3		250	Labor cost not needed since truck already disassembled.
10	20	Replacement	3		70	"
11	4	Bearing Installation	3		412	No labor hours needed.
12	6	Installation	3		1168	No labor hours needed.
12	17	Installation	3		803	No labor hours needed.
12	19	Installation	3		691	No labor hours needed.
13	16	Installation of Brake Shoes	4	1/4	65.64	
14	All	Installation				Rates and costs same as for appropriate components on path 8.
15	All	Installation				Rates and costs same as for path 8.
16,17	3	Scrapping	1		-25	Labor on installation path 10% of new cost.
16,17	8	Scrapping	1		-12	10% of new cost.
16,17	9	Scrapping	1		-31.60	10% of new cost.
16,17	10	Scrapping	1		0	No scrap value.
16,17	12	Scrapping	1		0	No scrap value.

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK

LABOR RATES: 1 = $18.40/HR; 2 = $20.80/HR; 3 = $22.05/HR

PATH #	COMPONENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	NOTES AND COMMENTARY
16,17	13	Scrapping	1		0	No scrap value.
16,17	15	Scrapping	1		0	No scrap value.
16,17	16	Scrapping	1		0	No scrap value.
16,17	17	Scrapping	1		-15	10% of new cost.
18,19	3	Scrapping	1		-25	Labor on installation path 10% of new cost.
18,19	9	Scrapping	1		-31.60	10% of new cost.
18,19	10	Scrapping	1		0	No scrap value.
18,19	12	Scrapping	1		0	No scrap value.
18,19	13	Scrapping	1		0	No scrap value.
18,19	15	Scrapping	1		0	No scrap value.
18,19	17	Scrapping	1		-15	10% of new cost.
20	1	Scrapping	2		- 2	Labor on installation path $0.02/pound * 100 lbs.
20	2	Scrapping	2		0	No scrap value.
20	3	Scrapping	2		-25	10% of new cost.
20	8	Scrapping	2		-12	10% of new cost.

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK						
PATH #	COM-PO-NENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES: 1 = $18.40/HR, 2 = $20.80/HR, 3 = $22.05/HR NOTES AND COMMENTARY
20	9	Scrapping	2		-31.60	10% of new cost.
20	10	Scrapping	2		0	No scrap value.
20	11	Scrapping	2		- 9	10% of new cost.
20	12	Scrapping*	2		0	No scrap value.
20	13	Scrapping	2		0	No scrap value.
20	14	Scrapping	2		-1.70	$0.02/pound * 85 lbs.
20	15	Scrapping	2		0	No scrap value.
20	16	Scrapping	2		0	No scrap value.
20	17	Scrapping	2		-15	10% of new value.
20	18	Scrapping	2		-32	10% of new value.
20	20	Scrapping	2		0	No scrap value.
20	21	Scrapping	2		-0.20	$0.02/pound * 10 lbs.
21	All	Scrapping	3		0	See comment for path 9.
22	1	Scrapping	3		- 2	See path 20.
22	2	Scrapping	3		0	"

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK						
PATH #	COM-PO-NENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES: 1 = $18.40/HR, 2 = $20.80/HR, 3 = $22.05/HR NOTES AND COMMENTARY
22	3	Scrapping	3		-25	See path 20.
22	8	Scrapping	3		-12	"
22	10	Scrapping	3		0	"
22	13	Scrapping	3		0	"
22	14	Scrapping	3		-1.70	$0.02/pound * 85 lbs.
22	15	Scrapping	3		0	No scrap value.
22	16	Scrapping	3		0	See path 20.
22	20	Scrapping	3		0	See path 20.
22	21	Scrapping	3		-0.20	$0.02/pound * 10 lbs.
23	4	Scrapping	3		-1.60	$0.02/pound * 80 lbs.
24	6	Scrapping	3		-48	$0.04/pound * 1200 lbs.
24	7	Scrapping	3		-24	$0.04/pound * 600 lbs.
24	19	Scrapping	3		- 8	$0.04/pound * 200 lbs.
30	1	Pit Inspection	1	120/3600		Estimated as seconds per individual unit times number of units considered as comprising SCM component.

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK

PATH #	COM-PO-NENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES 1 = $18.40/HR 2 = $20.80/HR 3 = $22.05/HR NOTES AND COMMENTARY
30	2	Pit Inspection	1	30/3600		Estimated as seconds per individual unit times number of units considered as comprising SCM component.
30	3	Pit Inspection	1	105/3600		"
30	4	Pit Inspection	1	24/3600		"
30	5	Pit Inspection	1	45/3600		"
30	6	Pit Inspection	1	30/3600		"
30	7	Pit Inspection	1	360/3600		"
30	8	Pit Inspection	1	144/3600		"
30	9	Pit Inspection	1	6/3600		"
30	10	Pit Inspection	1	12/3600		"
30	11	Pit Inspection	1	240/3600		"

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK						
PATH #	COM-PO-NENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES 1 = $18.40/HR 2 = $20.80/HR 3 = $22.05/HR NOTES AND COMMENTARY
30	12	Pit Inspection	1	12/3600		Estimated as seconds per individual unit times number of units considered as comprising SCM component.
30	13	Pit Inspection	1	12/3600		"
30	14	Pit Inspection	1	6/3600		"
30	15	Pit Inspection	1	120/3600		"
30	16	Pit Inspection	1	60/3600		"
30	17	Pit Inspection	1	24/3600		"
30	18	Pit Inspection	1	6/3600		"
30	19	Pit Inspection	1	24/3600		"
30	20	Pit Inspection	1	6/3600		"
30	21	Pit Inspection	1	24/3600		"

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK						
PATH #	COM-PO-NENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES 1 = $18.40/HR 2 = $20.80/HR 3 = $22.05/HR NOTES AND COMMENTARY
34	All	Movement of Train to Up Track	1			No cost - switch engine is there anyway.
36	All	Delay of Train on Pit for Maintenance	1			No cost - train time on pit not increase if problem is found.
37,38	3	Pit Maintenance	1	4.5/60		Tighten.
37,38	8	Pit Maintenance	1	15/60	10	Material consists of pins, washers, cotter keys, nuts.
37,38	9	Pit Maintenance	1	9/60	1	Material consists of arm of valve. Tighten nuts, bolts; replace arm.
37,38	10	Pit Maintenance	1	3/60		Adjust gap on sensors and tighten cable clamps.
37,38	14	Pit Maintenance	1	3/60		Tighten nuts.
37,38	15	Pit Maintenance	1	1.5/60		Tighten bolts.
37,38	17	Pit Maintenance	1	15/60	1	Tighten bolts. Parts consist of miscellaneous clamps and bolts.
37,38	20	Pit Maintenance	1	1.5/60		Tighten unions.
39	All	Move Train to Ground Area	1			No cost - switch engine is there anyway.
40	All	Ground Inspection	1	1.5 x hrs in path 30		15% increase compared to hours in path 30 is for additional time required to perform tasks.

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK						
PATH #	COM-PO-NENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES 1 = $18.40/HR 2 = $20.80/HR 3 = $22.05/HR NOTES AND COMMENTARY
43	All	Move Train to Rip Track	1			No cost - switch engine is there anyway.
45	All	Delay of Train on Ground for Maintenance	1			No cost - train time on ground not increased if problem is found.
46,51	3	Ground Maintenance	1	4.5/60		Tighten.
46,51	8	Ground Maintenance	1	30/60		Material consists of pins, washers, cotter keys, nuts.
46,51	9	Ground Maintenance	1	18/60		Material consists of arm of valve. Tighten nuts, bolts; replace arm.
46,51	10	Ground Maintenance	1	3/60		Adjust gap on sensors and tighten cable clamps.
46,51	12	Ground Maintenance	1	3/60		Tighten bolts.
46,51	13	Ground Maintenance	1	3/60		Tighten nuts.
46,51	15	Ground Maintenance	1	1.5/60		Tighten bolts.
46,51	17	Ground Maintenance	1	19.5/60		Tighten bolts. Parts consist of miscellaneous clamps and bolts.
48	All	Move Train to Rip Track	1			No cost - switch engine is there anyway.

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK

LABOR RATES: 1 = $18.40/HR; 2 = $20.80/HR; 3 = $22.05/HR

PATH #	COMPONENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	NOTES AND COMMENTARY
53	All	Delay of Train on Pit for Maintenance	1			No cost - train time on pit not increased if problem is found.
54	All	Move Train to Ground Area	1			No cost - switch engine is there anyway.
60	4	Hotbox Callout	1		150	Cost to stop train and investigate hotbox. Passenger inconvenience.
61	4	Cutting Car Out of Consist	1		500	Cost of passenger delay, special movement of cars
63	4	Field Change of Bad Bearing	1		5000	Wreck train, crew, time and labor, replacement of wheelset.
64	4	Crippled Car with Bad Bearing	1		800	Bring crippled car into maintenance facility (special move).
70	All	Jacking Car	2	1.5		Jacking and inspection of job.
73	4, 6, 7, 19	Wheelset Removal	2	3/4 per wheelset		Same as path 29.
74	3	Rip Track Maintenance	2	4.5/60		Tighten.
74	8	Rip Track Maintenance	2	15/60		Same as path 37,38.
74	9	Rip Track Maintenance	2	9/60		Same as path 37,38.

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK						
PATH #	COM-PO-NENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES 1 = $18.40/HR 2 = $20.80/HR 3 = $22.05/HR NOTES AND COMMENTARY
74	10	Rip Track Maintenance	2	3/60		Same as path 37,38.
74	12	Rip Track Maintenance	2	3/60		Tighten bolts.
74	13	Rip Track Maintenance	2	3/60		Tighten nuts.
74	14	Rip Track Maintenance	2	3/60		Tighten nuts.
74	15	Rip Track Maintenance	2	1.5/60		Tighten bolts.
74	17	Rip Track Maintenance	2	15/60		See path 37.
74	20	Rip Track Maintenance	2	1.5/60		Tighten unions.
79	4, 6, 7, 19	Wheelset Removal	2	3/4 per wheelset		Same as path 29.
81,82	4, 6, 7, 19	Wheelset Installation	2	3/4 per wheelset		Same as path 29.
100	Car	Major Overhaul	3	4/ Truck		No cost - shipping charge attributable to car, not truck. Cost is for detrucking.
101	4, 7, 9, 19	Shipping Wheel Set to B.G.			per wheelset	Cost is per wheelset.

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK

PATH #	COM-PO-NENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES 1 = $18.40/HR 2 = $20.80/HR 3 = $22.05/HR NOTES AND COMMENTARY
102	All	Shipping Truck to B.G.	2	4/ truck	/ truck	Shipping and detrucking.
103	All	Shipping of Truck to Field	3	5/ truck		Retrucking, extra hour compared to that on 100 is for adjustments.
104		Shipping of Truck to Rip Track	2	5/ truck		Shipping and retrucking.
105		Shipping of Wheelsets to Rip Track				
106	All	Truck Disassembly	3	24/ truck		
115	1	Inspection and Test	3	1/2		
115	2	Inspection and Test	3	0		Not inspected.
115	3	Inspection and Test	3	0		Not inspected - will be rebuilt.
115	8	Inspection and Test	3	1/60		Check for breakage and wear.
115	10	Inspection and Test	3	2/60		Check condition of sensors and wiring.
115	13	Inspection and Test	3	0		These will be scrapped.
115	14	Inspection and Test	3	15/60		Check for cracks.
115	15	Inspection and Test	3	0		Bolts will be scrapped.

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK						
PATH #	COMPONENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES 1 = $18.40/HR 2 = $20.80/HR 3 = $22.05/HR NOTES AND COMMENTARY
115	16	Inspection and Test	3	0		Will be scrapped.
115	20	Inspection and Test	3	30/60		Check for leaks, cracks, bad joints.
115	21	Inspection and Test	3	15/60		Check for good threads.
116	9	Inspection and Test	3	0		No inspection needed since all are serviced.
116	17	Inspection and Test	3	0		No inspection needed since all are serviced.
116	18	Inspection and Test	3	0		No inspection needed since all are serviced.
117	1	General Repairs at Beech Grove	3	0	0	No repairs performed.
117	2	General Repairs at B.G.	3	1/2		Clean.
117	3	General Repairs at B.G.	3	2	15	Take apart, replace seals, reassemble, and test.
117	6	General Repairs at B.G.	3	1	30	Bushing and pin replacement. Levers sandblasted; and inspect for cracks. Reassemble.
117	10	General Repairs at B.G.	3	0	0	No maintenance performed here.
117	13	General Repairs at B.G.	3	0	0	No maintenance performed here.
117	14	General Repairs at B.G.	3	0	0	No maintenance performed here.
117	15	General Repairs at B.G.	3	0	0	Bolts are scrapped.

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK						
PATH #	COM-PO-NENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES 1 = $18.40/HR 2 = $20.80/HR 3 = $22.05/HR NOTES AND COMMENTARY
117	16	General Repairs at B.G.	3	0	0	Brake shoes are scrapped.
117	20	General Repairs at B.G.	3	0	0	No maintenance performed here.
117	21	General Repairs at B.G.	3	0	0	No maintenance performed here.
118	9	Disassembly	3	1/4		
118	17	Disassembly	3	1/4		
118	18	Disassembly	3	1/4		
119	9	Valve and Brake Cylinder Repair	3	5/60	5	Replace miscellaneous small parts.
119	17	Valve and Brake Cylinder Repair	3	1/3	50	Replace air hoses. Material cost: $30 for air hose and $20 for miscellaneous small parts.
119	18	Valve and Brake Cylinder Repair	3	5/60	5	Replace miscellaneous small parts.
120	9	Reassembly and Test	3	1/3		Additional time compared to that on path 118 is for testing.
120	17	Reassembly and Test	3	1/3		"
120	18	Reassembly and Test	3	1/3		"
130	4	Inspection of Wheelset	3	0	0	No bearing inspection done here.

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK						
PATH #	COMPONENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES 1 = $18.40/HR, 2 = $20.80/HR, 3 = $22.05/HR NOTES AND COMMENTARY
130	6	Inspection of Wheelset	3	0	0	No axle inspection performed here.
130	7	Inspection of Wheelset	3	15/60	0	Inspection time.
130	19	Inspection of Wheelset	3	15/60	0	Visual inspection.
131	4	Bearing Removal	3	2/3	0	
133	6	Disassembly and Axle Inspection	3	1	0	Do not disassemble axle. Time is for axle inspection.
133	7	Disassembly and Axle Inspection	3	2/3		Time is for dismounting of the wheel.
133	19	Disassembly and Axle Inspection	3	2/3		Time is for dismounting of the disc.
134	4	Bearing Inspection	3	1 1/2		
134	6, 7, 19	No Operations to Components 6, 7, 19				Wheelsets having suspected hotboxes have no bearings. These wheelsets have passed inspection on path 130.
135	4	Bearing Repairs	3	1/2		Grinding and polishing of races.
136	4	Reassemble Bearings	3	1/2		Material: seals and grease.
137	6	Repairs to Discs, Axles, Wheels	3	0	0	Components are already disassembled on this path. No repairs to axles that pass inspection in path 133.

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK

PATH #	COMPONENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES: 1 = $18.40/HR, 2 = $20.80/HR, 3 = $22.05/HR — NOTES AND COMMENTARY
137	7	Repairs to Discs, Axles, Wheels	3	0	0	No repairs possible on wheels.
137	19	Repairs to Discs, Axles, Wheels	3	1	0	Disc turning.
138	6	Wheelset Reassembly	3	1/2	0	Reassembly requires selective matching (boring of wheels usually is required). Axle work is measurement and turning. Wheel work is measurement and boring. Time includes remounting.
138	7	Wheelset Reassembly	3	1/3 + 2/3	0	"
138	19	Wheelset Reassembly	3	2/3	0	"
140	4	Remount Bearings	3	2/3	0	"
141	7	Turn Wheels	3	1 1/2	0	Time is per wheel.
145	5	Inspection, Sand	3	20	0	"
145	11	Blast, Removal of Elastomers	3	10	0	"
145	12	Blast, Removal of Elastomers	3	0	0	"
146	5	Weld and Heat Treat	3			Cost is estimate for welding operations.

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK						
PATH #	COM-PO-NENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES: 1 = $18.40/HR, 2 = $20.80/HR, 3 = $22.05/HR NOTES AND COMMENTARY
148	5	Tram and Replace Elastomers	3	0	0	Time is shown on path 150.
148	11	Tram and Replace Elastomers	3	0	0	Time is shown on path 150.
150	1	Truck Reassembly	3	24	10	Time and material is for reassembly of one whole truck. Shims for all springs.
150	2	Truck Reassembly	3	24	10	Miscellaneous parts.
150	3	Truck Reassembly	3	24	20	" "
150	4	Truck Reassembly	3	24	5	Locking tabs for bearing housing bolts.
150	5	Truck Reassembly	3	24	100	Elastomers and miscellaneous hardware.
150	8	Truck Reassembly	3	24	10	Locking tabs.
150	9	Truck Reassembly	3	24	5	Miscellaneous hardware.
150	10	Truck Reassembly	3	24	20	Clamps and cables.
150	11	Truck Reassembly	3	24	25	Miscellaneous parts.
150	12	Truck Reassembly	3	24	10	New bolts.
150	13	Truck Reassembly	3	24	0	No parts necessary.
150	14	Truck Reassembly	3	24	54	Bushings.

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK						
PATH #	COM-PO-NENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	LABOR RATES 1 = $18.40/HR 2 = $20.80/HR 3 = $22.05/HR NOTES AND COMMENTARY
150	15	Truck Reassembly	3	24	3	Lock tabs.
150	16	Truck Reassembly	3	24	1	Cotter pins.
150	17	Truck Reassembly	3	24	0	None required.
150	18	Truck Reassembly	3	24	2	Locking tabs.
150	19	Truck Reassembly	3	24	0	No material required.
150	20	Truck Reassembly	3	24	25	Clamps.
150	21	Truck Reassembly	3	24	0	No material required.
160	All	Pit Inspection	4			Same as on path 30.
161	4	Pit Maintenance	4			See path 37. Divide by three since lube bearings only once per year.
170	4, 6, 7, 19	Remove Wheelset and Ship to B.G.	4	34	26.90	Time and cost are per wheelset.
172	All	Ship Truck to B.G.	4	4/ truck	120	Cost is per truck. Remove truck and ship to B.G.
174	All	Pit Work	4			Times and costs are the same as for path 74 for approximate components.
175	All	Jack and Pit Drop Table and Pit Work	4			Times and costs are the same as for path 74.

* EXAMPLE DATA FOR ILLUSTRATION ONLY

COST DATA FOR MINDEN DEUTZ TRUCK*

COST DATA AND COMMENTS FOR EXAMPLE TRUCK

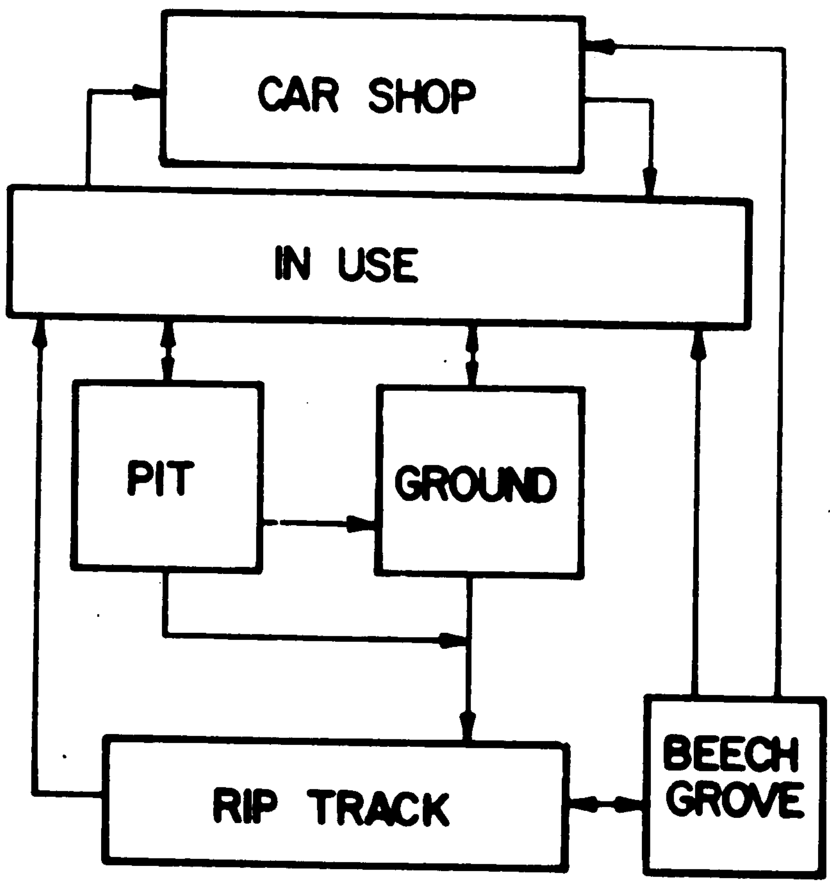
LABOR RATES: 1 = $18.40/HR; 2 = $20.80/HR; 3 = $22.05/HR

PATH #	COMPONENT #	OPERATION	LABOR RATE $/HR	HOURS PER UNIT	UNIT PRICE	NOTES AND COMMENTARY
178	All	Shipping Trucks from B.G.	4	5/truck	120/truck	Shipping and retrucking.
180	4, 6, 7, 19	Shipping of Wheelsets from B.G.	4	3/4 per wheelset	26.90 per wheelset	

* EXAMPLE DATA FOR ILLUSTRATION ONLY

APPENDIX L

SCHEMATIC DIAGRAMS - AMTRAK SAMPLE



SIMPLIFIED SCHEMATIC DIAGRAM

Figure L-1. Simplified Pictorial View of Maintenance Repair System

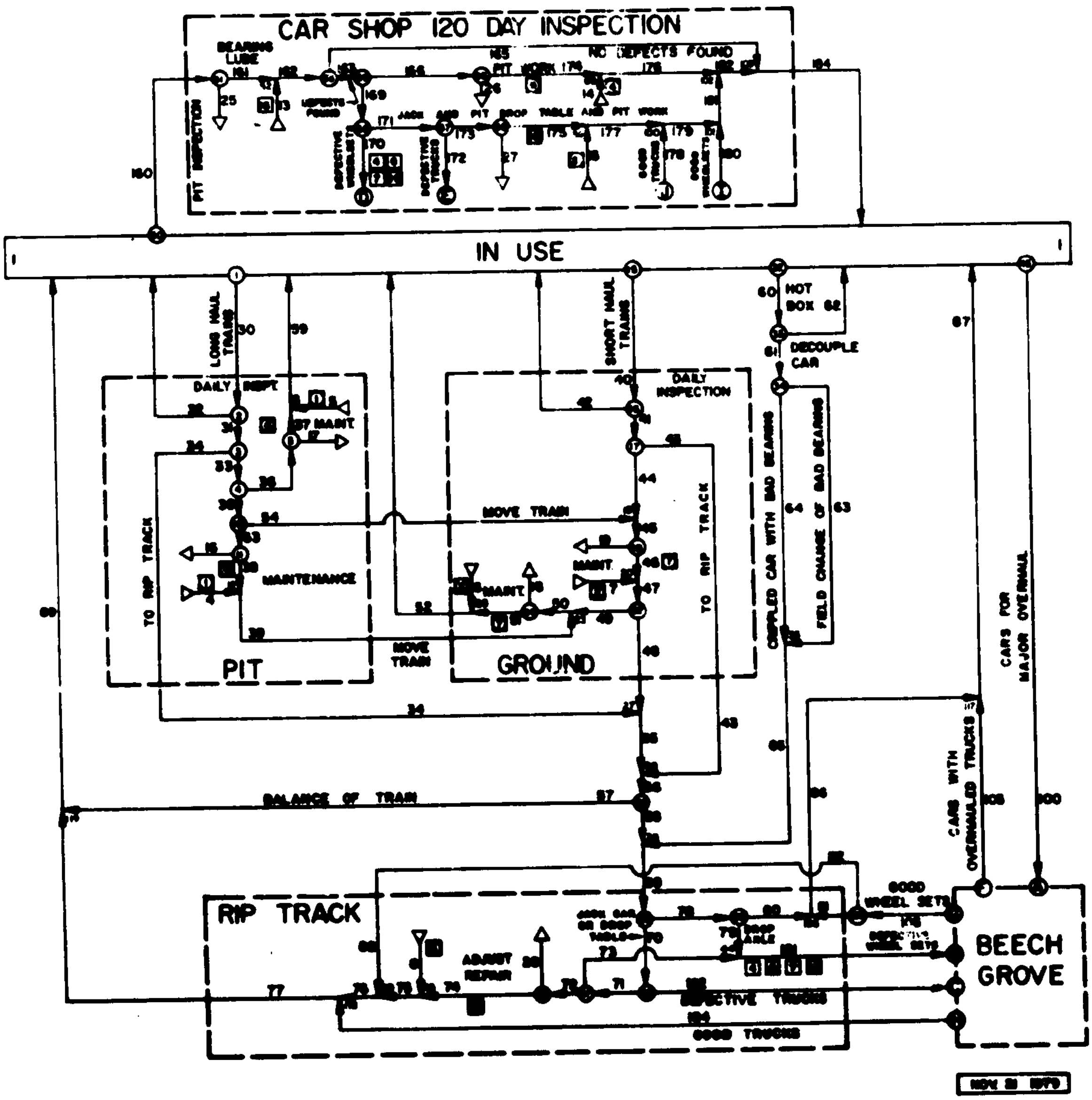


Figure L-2. Full Schematic Diagram of Sample Truck Maintenance Operation

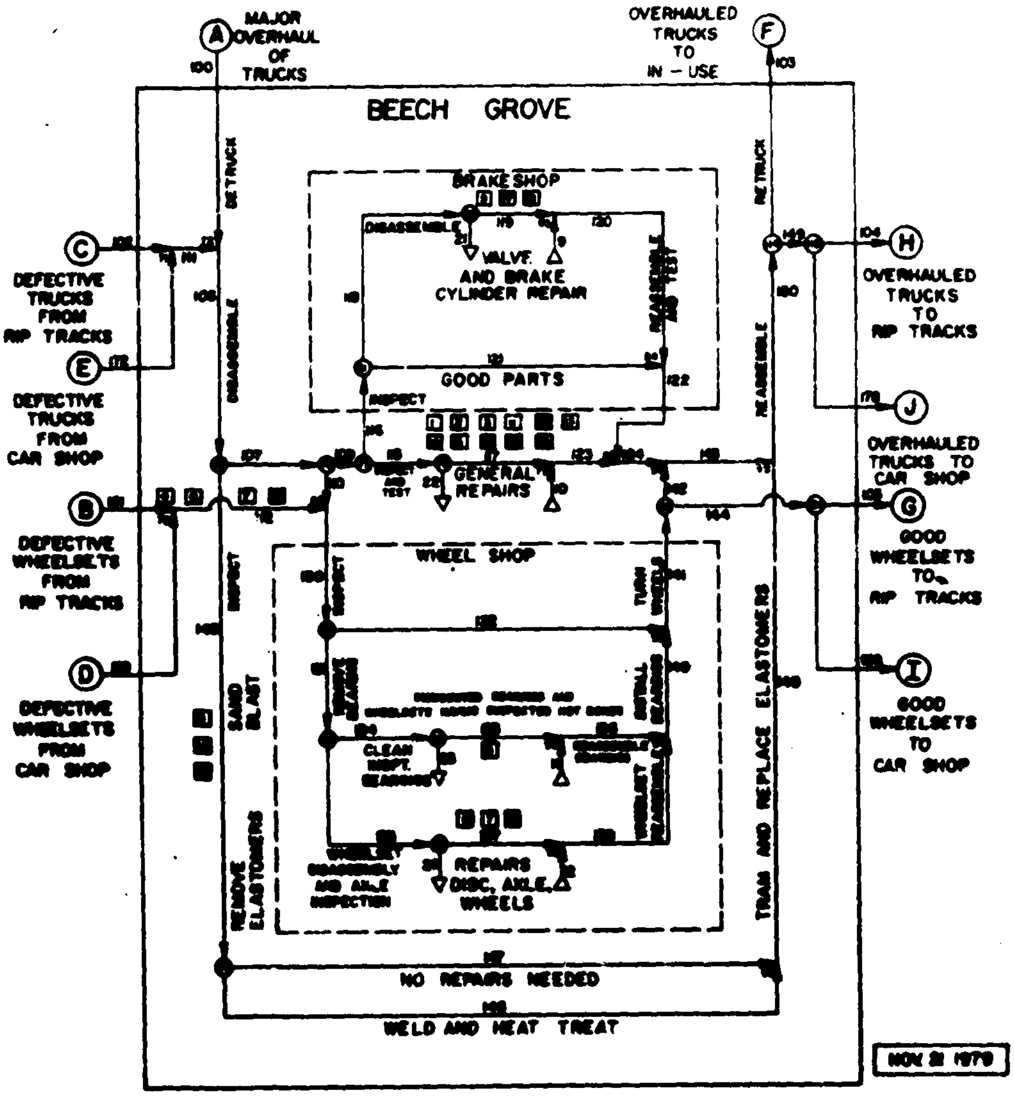


Figure L-3. Details of "Beech Grove" Maintenance Operation Modelled in Figure 3-1

APPENDIX M

EXAMPLE DATA FORMAT INPUTS FOR PROGRAM CAPABILITIES NOT EXERCISED IN THE PRESENT STUDY

Section 3.3.2 discusses the use of maintenance features of component quality, age, and whole subassembly combinations. Although the program can accept and use these features in the computation of maintenance costing, example data were not available to employ these in the test runs made for this manual.

This Appendix explains the input data formats required in order to make use of the additional program features. Maintenance costing in general could employ these if:

1) Nodal split decisions must be based upon the "defective" component population arriving at a branch node in the schematic diagram,
2) Costs must be based upon the "defective" component population on a path of the schematic diagram,
3) A time simulation run is being made, or
4) "Whole truck subassemblies" (2 or more numbered truck components) are to be kept through the schematic diagram branch points either in a time based run or when item one (1) above is being used.

Using "Quality" to Compute Costs

The concept of component "quality" allows cost values to be related to the defective components within the maintenance network being processed. Quality is a scalar attached to each component throughout the maintenance network and is allowed values between 0 and 1. These values represent the defective fraction of that component at the referenced path in the schematic diagram.

The upper part of Figure M-1 shows an example of 5 lines of input data which would make use of "quality" in computing maintenance costs. The 2 numbers entered on each line are the path number of the schematic diagram and a function number. The function refers to 4 functions used by the program and listed in subroutine "DEFFNB" of Appendix C.

```
32  4                    /   QAR COST FACTOR
40  2                    /   QAR COST FACTOR
42  3                    /   QAR COST FACTOR
43  2                    /   QAR COST FACTOR
44  2                    /   QAR COST FACTOR
```

Optional Comments

Function Number 1, 2, 3, or 4 Allowed. Functions Reside in Subroutine "DEFFNB"

Path Number from Schematic Diagram

```
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0     /   KSTR( ) DATA
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0     /   KSTR( ) DATA 2ND
```

Optional Comments

"0" or "1" Code for Each Component. Column of Entry is Component Referred to by Entry. Up to 30 Components Allowed

Branch Node Number

Two Rows for Each Branch Node Using this Data

Figure M-1. Sample Data Entry Formats
Upper Portion for Use When Costing Needs "Quality" for Computation
Lower Portion for Use in Keeping "Whole Subassemblies" Through Branching Opera ions

The 4 operating functions can be described as follows for each component:

Function #1 Multiply Cost and Flow Only

Function #2 Multiply Cost and Flow and Quality

Function #3 Multiply Cost and Flow and Another Function

Function #4 Use Cost Only (No Products Necessary)

If a cost of a path is derived from the unit cost, path flow, and the defective fractions of the components ("quality"), then Function #2 would be used and the data entered as shown in Figure M-1. An example of this is the case where maintenance is performed only on the defective units of a component on a path (as opposed to performing maintenance on all the units of a component on the path).

Keeping "Whole Subassemblies"

If one wants to make sure that "whole" subassemblies are transferred downstream from a certain branch node, then the coding must be entered as shown in the lower portion of Figure M-1. Two lines of 16 integers must be passed as a unit. The first number on each row of data entered refers to the branch node number. The remaining 15 numbers will be either 0 or 1 with the following meaning:

1 = this component is part of the subassembly

0 = this component is not part of the subassembly

The column (after the node number) of the "0" or "1" entry counting from left to right is the component number being referred to. Thus, up to 30 components in a truck could be handled with the entries depicted here.

Maintenance Rework and the Resetting of "Quality" and "Age"

In some maintenance operations the act of fixing a given component does not completely put that component in an "as new" condition. For instance, roller bearings are disassembled and reassembled periodically as a result of wheel removal. Small "defects" are often left in bearing cups since they do not limit their performance in any way. As a result, there is occasion to fix or set the quality of the component reworked to some value other than 0 which represents 0 defects or "like new" condition.

If age is being used in the modeling process, its change during rework must also be considered. The model automatically resets the age to 0 when the defective units of a component are reworked on a path. If the maintenance procedure is such that both the good and defective units of a component are reworked, the user may want to reset the age of all (not just the defective units of a component) on the path to 0. The computer program also allows the user to do this.

Figure M-2 is a display of the input data formats needed for the above procedures. As shown, there are 6 numeric values needed for each "rework". By column entry these numbers have the following significance and program use:

Column 1 - Used for entering the component number with which the next 5 entries are to be associated.

Column 2 - Defines the rework number for a component "reworked" in more than one place in the maintenance system. The number of reworks start at "1" and increases by one to as many reworks as required. Each rework must have a separate line of data entered.

Column 3 - Is the upstream branch number node from which this rework action path emanates.

Column 4 - Designates whether this rework path is the reference path (if so, input a "1" here) from the upstream node or the nonreference path (input a "2").

Column 5 - Codes of "0" or "3" entered here have various program meanings.

Code "0" - will reset or give all the referenced component the quality entered in Column 6. In addition, the representative "age" for the component on this path will be reset to 0.

Code "3" - will reset only the quality for the defective portion of the units on this path to the quality entered

```
 9  1 12  2  3  0.0                  /   REWORK DATA - K,I,A,ISTR,RAR( )
10  1 12  2  3  0.0                  /   REWORK DATA - K,I,A,ISTR,RAR( )
 2  1 15  2  3  0.0                  /   REWORK DATA - K,I,A,ISTR,RAR( )
11  1 15  2  3  0.0                  /   REWORK DATA - K,I,A,ISTR,RAR( )
12  1 50  2  3  0.0                  /   REWORK DATA - K,I,A,ISTR,RAR( )
12  2 51  2  3  0.0                  /   REWORK DATA - K,I,A,ISTR,RAR( )
 1  1 24  2  3  0.0                  /   REWORK DATA - K,I,A,ISTR,RAR( )
 5  1 24  2  3  0.0                  /   REWORK DATA - K,I,A,ISTR,RAR( )
```

OPTIONAL COMMENTARY

- Quality of Component After Rework
- Reset 0 = All Units 3 = Only the Defectives
- Node Output Path Code 1 = Reference Path 2 = Nonreference Path
- Upstream Node Number
- Which Rework for this Component 1, 2 ...?
- Component Number

Figure M-2. Input Data Format for Setting Quality and Age After Rework Operations in Column 6. In addition, the representative "age" of only the defective units for the component on this path will be reset to 0.

Column 6 - The value placed here is the "quality assigned to that portion of the component flow designated by the Column 5 code entered.

APPENDIX N

REPORT OF NEW TECHNOLOGY

The work described in this report concerns the application of a methodology, the simulation cost model (SCM), to the economic aspects of maintaining high speed passenger train trucks. No inventions were developed because the work was not concerned with devices. However, a methodology did result which can be applied to economic systems beyond those associated with passenger train truck maintenance. The systems most appropriately treated by the SCM consist of large fleets of individual units. Each unit contains several components and each component is interrelated with the other components in its unit through cost or system actions. For such a system, the SCM technique provides a consistent means for its characterization, a process for determining the data requirements, a developed computer program, and a set of specific useful outputs. These outputs include a quantitative description of current (present time) annual system operation and annual costs, a sensitivity analysis which indicates quantitatively the most costly portions of the system, and projections of future system operation and costs.

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