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ANALYSIS OF DUAL MODE SYSTEMS IN AN URBAN AREA

Volume IVA: Program Documentation of the Transportation Economic Analysis Model

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16. Abstract

Various forms of Dual Mode transportation were analyzed in order to assess the economic viability of the Dual Mode concept. A Dual Mode vehicle is one which operates under manual control on a street network for some portion of its trip, and operates under automatic control on an exclusive guideway for some other portion. Specially designed new small Dual Mode vehicles, modifications of existing automobiles, and pallet systems, all operating in conjunction with Dual Mode buses, were examined. The study was conducted in a Boston 1990 scenario, in which an extensive Dual Mode system providing service for the entire urban region was presumed to exist. This study was not intended to be a proposal for Dual Mode in Boston. The following conclusions are considered to be generally applicable to other large urban areas as well: (a) Dual Mode systems appear to be sufficiently attractive to warrant further technological development; (b) for urban-wide applications, a Dual Mode system which includes both buses and personal vehicles is more effective than one consisting of either fleet of vehicles alone; (c) a Dual Mode transportation system benefits from the use of various Dual Mode concepts throughout its development.

An effective first step might be to install a limited network Dual Mode minibus system, with capacity for ultimate growth to a longer guideway network with personal vehicles and buses.

17. Key Words
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PREFACE

This coordinated Department of Transportation program for the analysis of Dual Mode systems was initiated by Dr. Robert H. Cannon, Jr., Assistant Secretary for Systems Development and Technology, in the Spring of 1971. It was undertaken to provide sufficient insight into the benefits, impacts and costs of Dual Mode concepts so that the Department of Transportation could assess (1) the potential of Dual Mode as an urban transportation alternative, and (2) whether further research and development was warranted, and if so, in which areas.

The analysis was conducted using a 1990 Boston scenario in which an extensive Dual Mode system was presumed to exist. The scenario in a specific city was chosen to provide meaningful base data for this analysis. The study is not a proposal for a Dual Mode system for Boston; nor is it a transportation planning analysis for that city. The study was intended to evaluate the Dual Mode concepts in an urbanwide application to assess the relative merits of the various general design types, to determine the economic viability, and to conduct an assessment of technology required.

This report is made up of four volumes having the following general content:

Volume I - Summary
Volume II - Study results
Volume III - Description of the analysis techniques and data sources
Volume IV - Program documentation of the Transportation Economic Analysis Model which was developed and used for the cost/benefit portion of this study*

The study was performed by the Transportation Systems Center under the sponsorship of the Office of the Assistant Secretary for Systems Development and Technology in conjunction with, and including participation by, the Federal Highway Administration, the Federal Railroad Administration and the Urban Mass Transportation

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*Volume IV appears in three parts: IVA, IVB, AND IVC.

Administration. Close coordination was also maintained with the Office of the Assistant Secretary for Policy, Plans and International Affairs, and the Office of the Assistant Secretary for Environment, Safety and Consumer Affairs.

The Office of Systems Engineering in the Office of the Assistant Secretary for Systems Development and Technology was responsible for the management of the study. Overall program direction was provided by R. L. Maxwell; the Program Manager was R. L. Krick. Program coordination was achieved by the Dual Mode Transportation Working Group which reported to the Program Manager. The following Department of Transportation personnel served on the working group: R. Bruton, V. DeMarco, R. Fisher, S. Jackson, N. Kamalian, J. Leep, M. Miller, K. Okano and R. Reymond.

The cost/benefit, economic, and systems analysis portions of this study were conducted by the Systems Analysis Division of TSC, under the direction of C. H. Perrine. The primary contributors to the analysis were: P. Benjamin - task manager, analysis-team leader; J. Barber - performance, system characteristics, network analysis, final report; R. Favout - cost/benefit model; D. Goeddel - cost/benefit model; C. Heaton - impacts, network analysis, final report; R. Kangas - performance; G. Paules - ridership estimation; E. Roberts - network synthesis, scenario definition, ridership estimation; L. Vance - costs, fares, systems comparisons.

TSC direction of the Dual Mode Program and the technology assessment portions of the study were conducted under the guidance of G. Pastor, Chief of the Ground Systems Programs Division. The following persons contributed: J. Marino - task manager; A. Malliaris-technology assessment; S. Pasternack - command and control; C. Toye-command and control.

In addition, D. Glater was responsible for the section on legal and administrative issues, and J. Wesler for the noise analysis. The firm of Peat, Marwick, Mitchell and Co. assisted in the analysis of potential system demand.

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1. Introduction

1.1 Model Definition

The Transportation Economic Analysis Model (TEAM) is a cost accounting model that can be used to quantify the direct costs and impacts of all ground passenger transportation systems in an urban environment. Using system ridership data as input, quantitative units of subsystem and system elements, and corresponding unit cost and unit-impact data, the model computes capital and operating costs and impacts for each transportation system under analysis. To a limited extent, it also sizes some system elements based upon input system descriptors and operating characteristics. All cost and impact data generated by the model are accumulated, organized, and displayed in numerous output forms for subsystem, system and regional analysis.

1.2 Background and Objectives

Once the study objectives of the Dual Mode analysis were identified, a survey of existing transportation cost analysis models was undertaken to determine their applicability to this analysis. The need for a computerized model to aid in the analysis became apparent because of the rather high level of detailed planned for the study, the large number of Dual Mode baselines to be studied, and the anticipation of performing parametric analyses of input data.

To conduct the analysis using manual computation would have been a horrendous task prone to innumerable errors.

The survey identified two models that most closely approximated the study requirements - the General Research Corporation (GRC) Model developed for the HUD study and the Federal Highway Administration TRANS-Urban Model. These models were investigated in depth and it was found that, in both cases, extensive program modifications would be required to increase the level of analysis detail. The GRC model costed transportation systems only at a high level of aggregation; the TRANS model was even more aggregate. The use of either of these models in this analysis was also ruled out for the following reasons in addition to their insufficient analytical detail:

- The TRANS model, available at the time, only considered highway transportation alternatives. A transit portion of this model was being developed but would not be available in the time frame required for the analysis.

- Documentation for both models was highly inadequate. Documentation of the program code and the model assumptions were not available.

- For both models, too many major changes, additions, and modifications were required. To perform these without a complete understanding of the models would have been a most difficult task.

As a result of the examination of these models, it was decided that a new model - the Transportation Economic Analysis Model (TEAM) - should be developed. To meet the objectives of the Dual Mode analysis and to be adaptable for future transportation costs analyses, the model was designed with the following characteristics:

- Capable of performing detailed cost analyses of new and existing ground passenger transportation systems at the regional level.
- Capable of analyzing and distinguishing between vehicle baselines of the same transportation system.
- Capable of automatically performing repeated analysis runs on parametric input data.
- Capable of performing base and parametric runs at low cost by using small amounts of core and low execution times.

1.3 Model Overview

The structure of TEAM model parallels the structure of the Dual Mode analysis procedure. The analysis procedure called for comparing the costs and impacts of each Dual Mode baseline against the corresponding costs and impacts of a base alternative (the 1990 plan). The incremental costs and benefits of each baseline relative to the 1990 plan were then used as the measures of comparison of one Dual Mode baseline against another. Thus for this analysis procedure, two independently executable cost programs were developed: the New System Cost program which computes and outputs costs and impacts related to each Dual Mode transportation system and the complementary highway and transit systems; and the Highway-Transit Cost Program, which calculates costs and impacts for the 1990 plan.

The costs and impacts quantified within each of these programs are:

Highway-Transit Cost Program

- all capital investment costs of highway and transit systems
- all costs associated with the operation and maintenance of the highway and transit facilities
- several impacts (i.e., accidents, pollution, and energy consumption resulting from the operation of the highway and transit systems.*

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*Noise impacted households, displacements, and value changes, and tax losses were tabulated manually. The assignment of dollar values to some of the impacts was also done manually.

New System Cost Program

- all costs of capital investments of the new transportation system
- all costs associated with the operation and maintenance of the new transportation system and the facilities of this system
- several impacts (i.e., air pollution, noise impacted households, displacements, accidents, energy consumption, and tax losses) associated with the new transportation system*
- all costs associated with the operation and maintenance of existing highway and transit facilities
- several impacts (i.e., accidents, air pollution and energy consumption) associated with existing highway and transit systems.

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*Land value changes were calculated manually. The assignment of dollar values to some of the impacts was also done manually.

1.4 Other Model Applications

Although the TEAM model was developed primarily as a tool to aid in the analysis of Dual Mode transportation systems, it was structured such that it could be used (or easily modified for use) in the analysis of other ground transportation systems.

The TEAM model can also be applied to transportation cost analyses at more aggregate levels of detail. Basically, the model's level of analysis detail is determined by the level of input data detail. To understand the extremes, consider the following example. Within the model, a network may be described in a very detailed manner by segmenting the network into links such that each link is uniquely different from any other according to the characteristics a_1, a_2, a_3, and a_4. On the other hand, the same network may be described in a more aggregate manner. The entire network could be conceived as one link; the a_1, a_2, a_3 and a_4 characteristics of this link would be the average characteristics of all possible links of the network.

2. Model Characteristics

The computer, core storage, and execution time requirements of the New System Cost and the Highway-Transit Cost programs are described in the following paragraphs.

2.1 Computer Requirements

All programs of the TEAM model are written in the Fortran IV programming language for execution on a CDC-6600 digital computer. The CDC-6600 is one of the CDC-600 series computers. It has two high-speed central processors and ten peripheral processors. Each peripheral processor has its own memory and is capable of executing programs independent of the other processors. Under the control of its operating system, the CDC-6600 can process up to seven independent jobs concurrently such that each job is sharing the central processor in a multiprogramming manner. The main core storage of the CDC-6600 is 300000_8 60-bit words. It has a memory access time of 100 nanoseconds.

The operating system of the CDC-6600 is called SCOPE (Supervisory Control of Program Execution). It performs the following functions:

- controls all phases of program compilation, assembly and execution.
- assigns storage and performs program segmentation and overlay loading.
- controls all the input/output functions.
- maintains the system library routines and the system day file records.

The New System Cost Program and the Highway-Transit Cost Program are executed independently of each other. They can be submitted for execution in either the "batch" or the "remote-job-entry" mode. Listed below are the CDC-6600 peripheral hardware devices that are required for the execution of these two programs.

<u>New System Cost Program</u>

- Card Reader
- Card Punch (only if punched data output is desired)
- Disk Storage
- Tape Drives (only if program is to be loaded from tape)
- Printer
- Plotter (only if plotted data output is desired)

<u>Highway-Transit Cost Program</u>

- Card Reader
- Disk Storage
- Tape Drives (only if program is to be loaded from tape)
- Printer

2.2 Core Storage Requirements

Since the overall size of the New System Cost Program exceeded the main core storage of the CDC-6600,it was necessary to structure the program into four executable sections called overlays. An overlay program structure is more efficient in core management since it allows designated overlays, wherever in execution, to occupy a common sub-region of core. Thus under this type of program structure, only the main overlay and one other overlay is resident in core at any given time during the execution of the program.

The New System Cost Program was divided into four overlays - a main overlay, named PRMY, and three additional overlays - DMCP, NTWK, and OTHR. The main overlay resides in core throughout the execution of the program and is never destroyed by the loading of any of the other overlays. The DMCP, NTWK and OTHR overlays are dynamically loaded by the SCOPE operating system whenever they are to be executed. These overlays share a common region of core immediately following the storage area of the main overlay. The core size (in octal 60-bit words) of each of these overlays is presented below:

Overlay	Core Size
(0.0) - PRMY	122, 245
(1.0) - DMCP	120, 761
(2.0) - NTWK	34, 402
(3.0) - OTHR	30, 066

For programs having an overlay structure, the size of the main overlay plus the size of the largest overlay, that would reside in core with the main overlay, determines, primarily, the amount of core required for program execution. Thus, a field length of approximately $246{,}000_8$ words

(122, 245 + 120, 761 + system routines + loader) is recommended for the execution of the New System Cost Program.

The Highway-Transit Cost Program is relatively small compared to the size of the New System Cost Program. Since its overall size is well within the available core requirements of the CDC-6600, there was no need to segment this program into overlays. The recommended field length for execution of the Highway-Transit Cost Program is $125,000_8$ sixty-bit words.

2.3 Execution Time Requirements

There are a number of factors that directly affect the amount of time required to execute each of the TEAM model programs. For example, the execution time of the New Cost Program is influenced by the number of executions (or loops) of the program, the amount of data processing required to be performed, and the amount and the types of data to be output. Obviously, parametric runs, involving multiple loops of this program, add to the execution time. The size of the network being analyzed (i.e., the number of guideway links, terminals, interchanges, etc.) contributes heavily to the amount of data processing required to be performed. As the data processing increases so will the program execution time. The amount of printed data output also influences the execution time of the program; a lower execution time can be realized by suppressing a number of the detailed output tables. Whenever punched card or plotted data output is desired, a larger program execution time can be expected.

It is for these reasons that one execution time cannot be identified for this program. Presented below are representative execution times of program runs conducted for the Boston Dual Mode analysis. No times were available, however, for runs conducted with punched card or plotted data output.

	Central Processor (CP) Seconds	Input/Output (I/O) Seconds	System Seconds
Base Program Run (Full printout)	21. - 22.	30. - 31.	44. - 45.
Base Program Run (Suppressed printout)	10. - 11.	26. - 27.	30. - 31.
Base Run + Four Parametric Runs with Suppressed printout	47. - 48.	41. - 42.	78. - 79.

The program execution time of the Highway-Transit Cost Program is affected primarily by the amount of data output that is to be printed. This program normally executes within the following time limits:

	CP Seconds	I/O Seconds	System Seconds
Base Run (Full printout)	6. - 7.	6. - 7.	9. - 10.
Base Run (Suppressed printout)	4. - 5.	5. - 6.	7. - 8.

It should be noted that the system second is time upon which computer charges are determined. The system second is computed as follows:

Total system seconds = Central processor time + I/O channel time x Fraction of core utilized

3. New System Cost Program

In each run of the New System Cost Program, capital and operating costs and impacts of one new transportation system along with operating costs and impacts of the coexisting highway and transit systems are quantified.

A. Capital Costs

Figure 3-1 illustrates the capital costs computed within the program. For the new system guideway, capital costs for land acquisition, track, and construction are quantified. The width of the guideway and the number of lanes required are computed based upon the peak hour directional flow of vehicles. Land acquisition costs, for various land cost and land use areas, are computed in relation to the amount of guideway area required. Track and construction costs are computed based upon the number of lane miles of guideway.

Interchange land acquisition, structure, and track costs are computed for each identified interchange in the network. Terminal capital costs for land, track, and structures are computed for each network terminal according to one of ten terminal design types. The design type of each terminal is determined by the program based upon the number of persons required to be serviced. Land, track, and construction costs for acceleration/deceleration lanes associated with each terminal are also quantified.

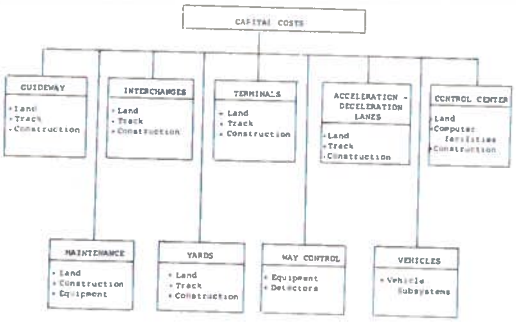

FIGURE 3-1 Capital Costs Computed by the New System Cost Program

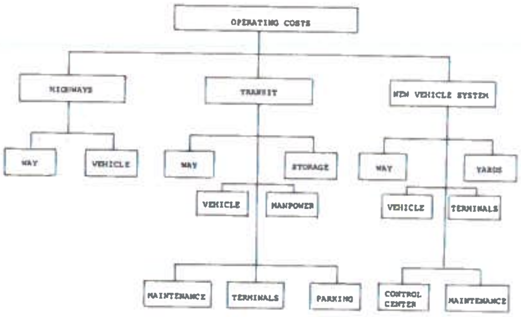

FIGURE 3-2 Operating Costs Computed by the New System Cost Program

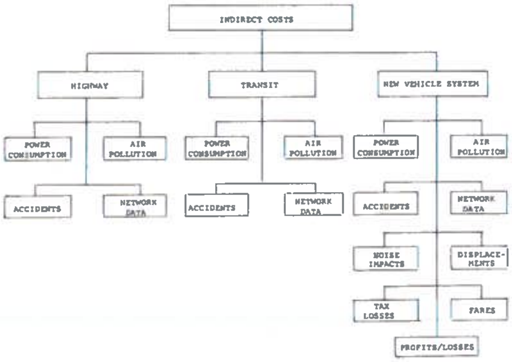

FIGURE 3-3 Indirect Costs Computed by the New System Cost Program

Capital costs for maintenance facilities, yards, and a control center are computed as a combination of costs for land acquisition, construction, and equipment. Way command and control costs for wayside equipment and detectors are computed based upon the number of guideway route miles. Vehicle capital costs are computed as a function of the number of vehicles required.

All capital costs are annualized by the program by means of capital recovery factors computed for each capital element described above.

B. Operating Costs

As shown in Figure 3-2, the New System Cost Program computes operating costs for a new transportation system and for the complementary highway and transit systems. For highways, annual way maintenance and operation costs are computed for freeways and surface arterials based upon the annual vehicle miles traveled (VMT). Vehicle operating costs for depreciation, fuel, insurance, parking, etc. are also computed for auto and trucks as a function of the annual VMT.

Similarly, for each transit system, the following annual operating costs are computed:

- Way
- Vehicle
- Manpower
- Maintenance

- Storage
- Parking
- Terminals

Transit way power operating costs are computed as a function of the annual vehicle miles traveled; way manpower and maintenance costs are computed as a function of the number of route (or track) miles that exists for each transit system. Vehicle operating costs, for vehicle depreciation and maintenance, and transit manpower costs are calculated based upon the annual VMT of the respective transit systems. Transit maintenance, storage, and parking costs are quantified based upon the required number of vehicle spaces; transit terminal operating costs are computed according to the number of terminals required.

For the new transportation systems, annual operating costs are quantified for way, vehicles, terminals, yards, maintenance facilities, and a control center. Annual costs for guideway maintenance and operation are computed based upon the number of lane miles of guideway. Operating costs for vehicle depreciation, maintenance, power, parking, and drivers are computed as a function of the annual vehicle miles traveled on and off the guideway. Annual terminal operating costs are computed according to the number of terminals required. Operating costs of yards, maintenance facilities, and control center are also quantified within the program.

C. Impacts, Network Analysis Data, and Profit/Loss Data

The impact, network analysis data, and profit/loss data identified in Figure 3-3, are computed for a new transportation system and for its complementary highway and transit systems.

Network analysis data such as person miles traveled, vehicle miles traveled, average trip lengths, and average trip times are computed with respect to four temporal periods (peak, off-peak, daily, and annual) and, in the case of the new systems, for operations on and off the guideway. Highway travel data is analyzed separately for freeways and surface arterials.

Power consumption data for each of these transportation systems is computed based upon the type of vehicle propulsion and the amount of vehicle travel (VMT). This data is also stratified with respect to the four temporal periods identified above.

Air pollution emissions from each of these systems are calculated with respect to five pollutant types (CO, HC, NOX, SO_2, and particulates). For internal combustion engine vehicles, the amount of air pollution emitted is computed based on the vehicle miles traveled; for electric vehicles air pollution data is computed based upon the amount of power consumed.

Traffic accidents, fatalities, and injuries are computed by the program based upon the amount of travel (expressed in terms of

VMT and person trips). Accident data is stratified by temporal period (peak, off-peak, daily and annual), by freeways and surface arterials, by transit system type, and, for the new systems by operations on and off the guideway.

The number of dwellings displayed as a result of the construction of each new system's guideway and the number of dwellings that are impacted by noise from the guideway are quantified within this program. Utilizing noise contour areas, construction acreage, and residential densities, these data are generated for each identified land use and land cost area. The types of dwellings displaced or impacted by noise are also identified by various ethnic and income groups.

Tax losses to the urban area are quantified by this program based upon the amount of land area assumed by the new transportation system. This data is computed utilizing input property assessment ratios and tax rates.

Fares, revenues, subsidies, and resulting profits or losses are also quantified for the new transportation systems. Break-even fares, for two fare structures, are computed to cover all operating costs and all non-subsidized capital costs. Revenues and the relative profits (or losses) realized by the system are computed based upon user-input fare rates.

D. Program Structure

The New System Cost Program is comprised of four control programs (DULMODE, DMCAPC, NTWORK, and ALLOTH) and thirty-five subroutines.

By design, the program was structured into modules corresponding to functions that were required to be performed. It is felt that this type of assemblage facilitates program modification, learning, and use. Other features of the program include:

- the capability of multiple program executions (or loops) per run
- the capability to suppress the printing of all intermediate output data tables
- the capability to plot summary data output through the use of CDC-6600 library plot routines and a CALCOMP plotter.

Since the overall size of the program (approximately 330,000 sixty-bit words of core storage) exceeded the main storage capacity of the CDC-6600 computer, it was necessary to divide the program into smaller executable units - called overlays. Four overlays were created with each overlay being controlled by a main program designated below:

Overlay	Main Program	Function
OV.0.0 (PRMY)	DULMODE	Acts as the primary overlay - controls the functions performed by overlays 1.0, 2.0, and 3.0.
OV.1.0 (DMCP)	DMCAPC	Computes all capital costs associated with the new transportation system.
OV.2.0 (NTWK)	NTWORK	Computes all network data for the new system.
OV.3.0 (OTHR)	ALLOTH	Computes network data for the highway and transit systems along with operating costs, impacts and profit/loss data for the highway, transit and new systems.

A general flow diagram of the New System Cost program is presented in Figure 3-4 followed by a description of the functions performed by each of its subroutines in Table 3-1.

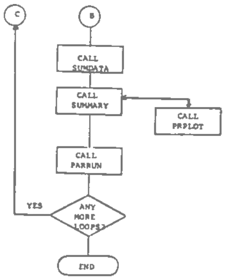

FIGURE 3-4 New System Cost Program (continued)

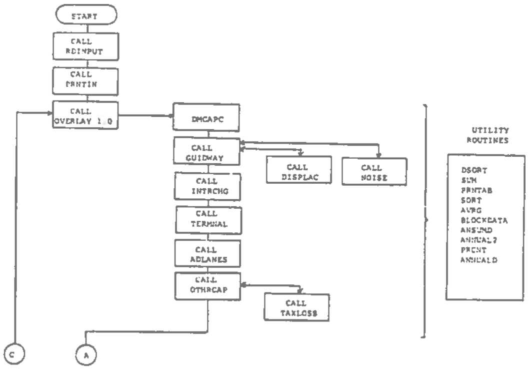

FIGURE 3-4 New System Cost Program

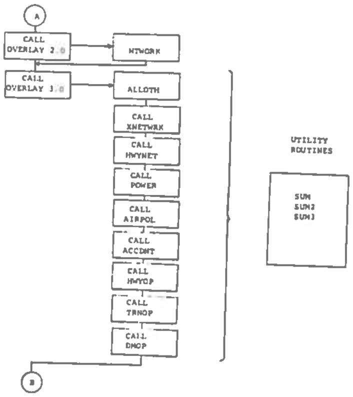

FIGURE 3-4 New System Cost Program (continued)

Program/Subroutine	Function
OV-0.0	
DULMODE	Control program - controls all overlays and all computational subroutines within overlay 0.0.
RDINPUT	Reads all card input data for the entire program.
PRNTIN	Prints all card input data.
SUMDATA	Stores summary data in summary data array.
SUMMARY	Prints and punches summary data output.
PPPLOT	Reads plot input data and calls system plotting routines.
PARRUN	Reads parametric run input data and conditions program for the performance of such runs.
OV-1.0	
DMCAPC	Controls all computational subroutines within Overlay 1.0.
GUIDWAY	Computes all way capital costs associated with the new system vehicle.
INTRCHG	Calculates all interchange capital costs.
TERMNAL	Computes capital costs of terminals.

TABLE 3-1 New System Cost Program

Program/Subroutine	Function
ADLANES	Calculates all capital costs of the acceleration/deceleration lanes.
OTHRCAP	Computes capital costs of yards, maintenance facilities, control center, etc.
DSORT	Sorts capital costs and various units of the new vehicle system into total system grouped tables.
TAXLOSS	Calculates tax loss data.
SUM	Sums all row, column, and depth elements of a three dimensional array that is dimensioned (5,6,12).
DISPLAC	Computes the number and the types of dwellings displaced due to the construction of the new vehicle system guideway.
PRNTAB	Prints grouped tables of subsystem capital costs and subsystem units.
NOISE	Calculates the number and the types of dwellings impacted by noise from the new vehicle system guideway.
SORT	Sorts individual capital costs and units of the new vehicle system into grouped tables by subsystem.
AVRG	Computes average cost per unit for each capital cost element of the new vehicle system.

TABLE 3-1 New System Cost Program (continued)

Program/Subroutine	Function
BLOCKDATA	Stores new vehicle system capital cost data names for output tables.
ANSUMD	Computes and prints annual cost summary data.
ANNUAL2	Computes and prints annual cost data for those output tables that do not contain unit or cost/unit data.
PRCNT	Computes percentages of new vehicle system capital costs.
ANNUALD	Calculates and prints annual cost data for those output tables that contain unit and cost/unit data.
OV-2.0	
NTWORK	Computes all "on-guideway" and "off-guideway" network data for the new system vehicle.
OV-3.0	
ALLOTH	Controls all computational subroutines within Overlay 3.0.
XNETWRK	Calculates all network data for the various transit systems.
HWYNET	Computes all highway vehicle network data.
POWER	Computes power consumption data for the new vehicle system, highway vehicles, and transit systems.

TABLE 3-1 New System Cost Program (continued)

Program/Subroutine	Function
AIRPOL	Calculates amounts of air pollution emitted by the new system vehicle, highway vehicles, and transit systems.
ACCDNT	Computes number of accidents attributed to the new system vehicle, highway vehicles, and transit systems.
HWYOP	Computes all highway operating costs.
TRNOP	Computes all operating costs of transit systems.
DMOP	Calculates new vehicle system operating costs, fares, revenues, and profit/loss data.
SUM	Sums all row, column and depth elements of a three dimensional array dimensioned (5,6,12).
SUM2	Sums all row, column, and depth elements of a three dimensional array dimensioned (6,9,4).
SUM3	Sums all row, column, and depth elements of a three dimensional array dimensioned (5,8,5).

TABLE 3-1 New System Cost Program (continued)

3.1 Overlay 0.0 - PRMY

Overlay 0.0 is controlled by program DULMODE. Within this overlay the following functions are performed:

- All card input data to the New System Cost Program is read.
- All input data stored within common blocks /RDI/ and /RDR/ are printed.
- Overlays 1.0, 2.0, and 3.0 are called, respectively.
- Summary output data is printed.
- Plots of summary data output are generated if desired by user.
- Program is reinitialized for parametric runs if additional runs are to be conducted.

Figure 3-5 illustrates the sequence of subroutine calls within Overlay 0.0.

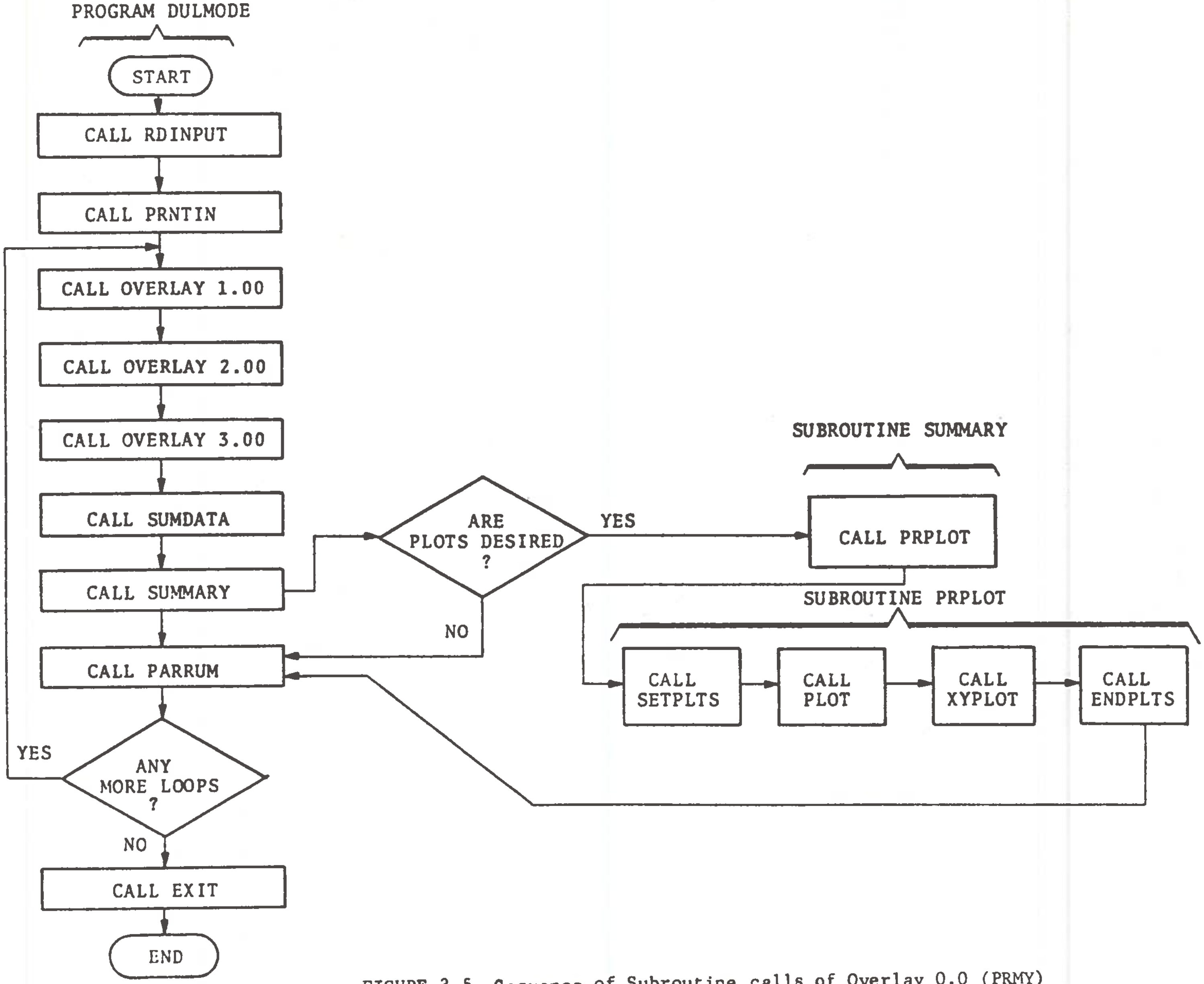

FIGURE 3-5 Sequence of Subroutine calls of Overlay 0.0 (PRMY)

3.1.1 Program DULMODE

Program DULMODE is the control program of OVERLAY 0.00. Its primary purpose is to call the subroutines of OVERLAY 0.00 and to call the remaining three overlays in the appropriate sequence shown in Figure 3-6 . In this capacity it therefore serves as the control program for the entire new systems cost program. Its secondary functions are to:

- initialize the following program counters and arrays:
    - MMINDX = 1
    - NLP = 0
    - LPS = 1
    - IPARDT = 888
    - RPARDT = 0.889
    - ISAVDT = 0
    - RSAVDT = 0.0
    - SMRYDT = 0.0
    - NLPM = 0
- increment MMINDX and LPS in subsequent loops through the model
- print the model title page
- print the run title page
- print headings for title of subsequent loops through the program

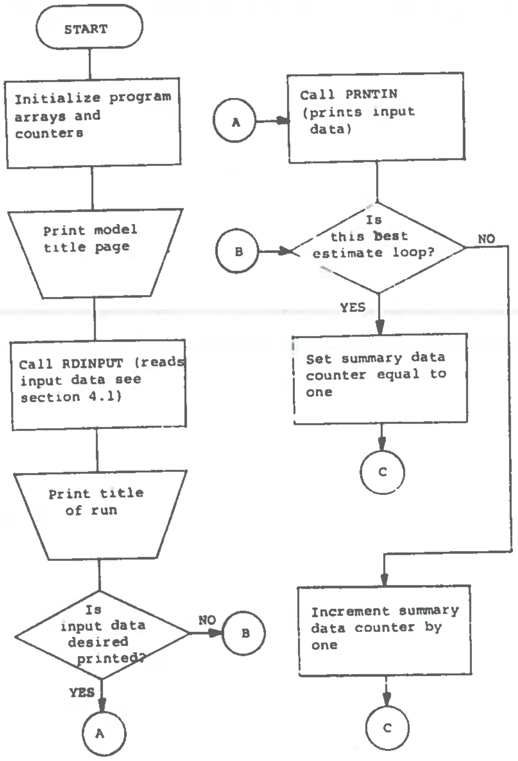

FIGURE 3-6 General Flow Chart - Program DULMODE

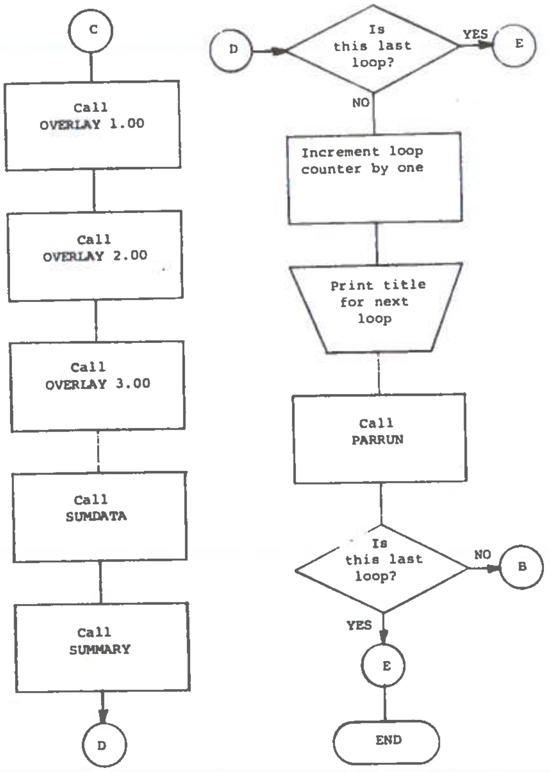

FIGURE 3-6 General Flow Chart - Program DULMODE (continued)

- terminate program execution

Program DULMODE is assisted in its control function by subroutines SUMMARY and PARRUN. Subroutine SUMMARY helps to control the execution of the program at the end of each loop through the program, while subroutine PARRUN assists DULMODE by reading the data and setting up the program for each succeeding parametric loop through the program.

3.1.2 Subroutine RDINPUT and Input Codes

The function of subroutine RDINPUT is to read all the input data described in paragraph 4.1. Since this subroutine is basically self explanatory, the description here is limited to the identification of the numerous input codes which are used and not defined in depth in Chapter 4. The coding approach was used to insure a high degree of user flexibility in defining the analysis procedure. These codes include the following:

- Geographic Area Code
- Construction Type Code
- Land Cost Code
- Land Use Code
- Suppress Print
- Scale Factors
- Life and Interest
- Vehicle Fleet Ownership

The New System Cost program allows for the classification of the analysis area into three geographic areas. These areas can be any three descriptors which together comprise the entire urban area. For example, CBD, Urban, and Suburban were used in the Dual Mode Analysis Study to emphasize city structure (Table 3-2). The model in this case was provided

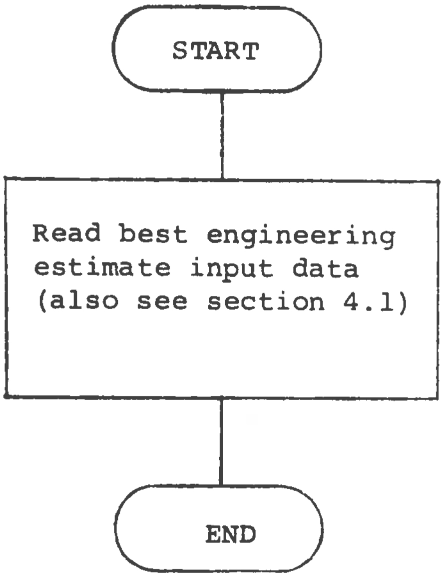

FIGURE 3-7 General Flow Chart - Subroutine RDINPUT

unit and unit-cost information for each of these categories. On the other hand if the analyst were interested in capital cost breakdowns according to the average grade in an area, he might wish to classify the city into Flat, Slight Grades, and Moderate Grades. Or he might wish to subdivide the study area according to three jurisdictional boundaries. The model computes the costs for whatever breakdown selected by the analyst.

Similarly the analyst can subdivide the construction of the new system into as many as four different construction categories. The Dual Mode Study used the four classes shown in Table 3-2 . Other alternative categories could include "open-cut", "cut-and-cover", "bored-tunnel", or any other construction sub-categories.

Geographic Area Codes:

Code	Definition
1	Center City
2	Urban
3	Suburban

Construction Type Codes:

Code	Definition
1	At-grade
2	Below grade

3	Elevated
4	Tunneled

Land Cost Codes:

Code	Definition
1	No Cost Public Lands
2	Not used
3	Not used
4	Not used
5	Not used
6	Cost of railroad R.O.W.
7	Low Cost (Area #3)
8	Medium Cost (Area #2)
9	High Cost (Area #1)
10	Not used

Table 3-2 Codes Used by Dual Mode Study

Each new system capital cost input element which includes land acquisition requirements can be assigned a land cost code. The land cost code serves two functions. It (1) identifies a specific unit cost to be applied to cost the element, and (2) identifies whether the land acquired was or was not previously taxable land. The program allows for ten codes. Codes 1 through 5 apply to non-taxable lands. Codes 6 through 10 refer to taxable lands. A unit cost is defined for each code at the discretion of the user. These unit costs are stored in the ULANDC array. The indices of ULANDC are equivalent to the land cost codes.

A stationary new system element can also be characterized by how the land adjacent to it is employed. The program provides for ten land use codes. Typical land use statifications are residential, commercial, industrial, business, parklands, and educational. The analyst establishes the land use codes through input data. The categories used by the Dual Mode study are identified in Volume II, chapter 8.

One final code which is directly related to the new system elements is the vehicle fleet ownership code (NVC). Through this code, the program is able to distinguish between those vehicle related capital and operating costs which are borne either by the public or by the private domain. There are presently six fleet ownership codes, defined as follows:

Code	Definition
1	Private vehicle using on-guideway power
2	Private vehicle using internal power on-guideway
3	Pallet system
4	Small public auto
5	Small public bus
6	Large public bus

For code 1, the model assumes all vehicle capital and operating costs except for on-guideway parking and on-guideway power to be private costs. For private vehicles which use internal power on the guideway, the only public vehicle operating cost is parking. With pallet systems that carry private vehicles, all the on-guideway operating costs are public while the off-guideway operating costs are private. The remaining three are all public operating costs. Care must be taken to select the appropriate vehicle ownership code. Some additional coding will be required in subroutine DMOP if these codes do not satisfy a specific vehicle ownership condition desired by the analyst.

The program has also been coded to enable demand input data to be scaled. A set of ten scale factors (SCALEF) has been provided as shown in Table 3-3 . These scale factors can be used to affect numerous analyst defined changes related to demand. Care must be exercised when applying demand scale factors since individual system demands are not functionally related within this model.

One final set of codes which requires discussion relates to the supression of output tables. The new system cost program was coded such that almost all output tables (with the exception of the more important summary tables) could be individually or in combination suppressed. This was done because each loop

Scale Factor	Definition
1	New System Vehicle Demand
2	New System Vehicle Link Speed
3	Transit Demand
4	Auto Demand
5	New System Vehicle 1 Splitter
6	New System Vehicle 2 Splitter
7	New System Vehicle 3 Splitter
8	New System Vehicle 4 Splitter
9	New System Vehicle Terminal Sizing
10	New System Vehicle Terminal Demand

TABLE 3-3 Scale Factors

of the program would normally produce over 250 pages of computer printout and quite often the intermediate output is not desired. When all intermediate output tables are suppressed the printout reduces to less than 30 pages per loop.

The tables are suppressed by setting the appropriate locations in the JSPRNT array equal to "1". The suppression code ("1") or non-suppression code ("0") are input to the model on card format type 5 (Figure 4-6). Each column on the card represents a potential table or operation which can be suppressed. The first 75 columns (i.e., the first 75 locations in the JSPRNT array) are reserved to suppress individual output tables. Fifty-five of these are currently being used. The remaining twently are available for future tables. Columns 77 through 80 provide special purpose suppression capabilities including the suppression of punched summary output data, suppression of graphs, suppression of the input data arrays (IPARDT and RPARDT discussed under subroutine PRNTIN), and suppression of all intermediate tables by merely changing one code rather than 55 individual ones. A list of each table or operations suppressed and the card column of card format type 5 which corresponds to it is shown in figure 3-8.

Card Column	Suppressed Table
1	Vehicle Data
2	DM on Guideway Design Hour Link Flows
3	Input Cost Data
4	DM Guideway Segment Statistics
5	DM Guideway Link Statistics
6	System Route Mile Summaries
7	Dual Mode Interchange Statistics
8	DM Terminal Input Data with Totals
9	DM Terminal Units and Costs
10	Terminal Segment Statistics
11	Terminal Accel-Decel Lane Statistics
12	DM Control Center Statistics
13	DM Maintenance Facility Statistics
14	DM Yard Statistics
15	DM Way Command and Control Statistics
16	Grouped Grand Total Capital Data Summaries
17	N.U.
18	Grouped Subtotals of Guideway and Interchanges
19	Grouped Subtotals of Terminals and A/D Lanes
20	DM Guideway Segment Displacement and Noise Statistics
21	Residential Densities - Input
22	Dwellings Displaced by DM Guideway Proper
23	Noise Distance Input Tables
24	Dwellings Affected by Noise From DM Guideway Proper
25	N.U.
26	Grouped Subsystem Capital Data Summaries
27	N.U.
28	N.U.
29	N.U.
30	Transit Network - Input Data
31	Transit Data Output - Table 1
32	Transit Data Output - Table 2
33	Transit Network Average PMT - VMT per Hour
34	Transit Network Trip Statistics
35	Hwy Network - Input Data
36	Auto Network Data Tables
37	Total Hwy VMT Data Tables
38	Auto Trip Statistics
39	N.U.
40	Power Input Data
41	Power - DM Vehicle Data Output
42	Power - Transit Vehicle Data Output
43	Power - Hwy Vehicle Data Output
44	Air Pollution - Input Data
45	Air Pollution - DM Vehicle Data Output

FIGURE 3-8 SUPPRESS PRINT LIST

Card Column	Suppressed Table
46	Air Pollution - Transit Vehicle Data Output
47	Air Pollution - Hwy Vehicle Data Output
48	Accidents - Input Data
49	N.U.
50	Accidents - Hwy Vehicle Data Output
51	Accidents - Transit Vehicle Data Output
52	Accidents - DM Vehicle Data Output
53	Hwy Operating Costs - Input Data
54	Hwy Operating Costs - Output Data
55	Transit Operating Costs - Input Data
56	Transit Operating Costs - Output
57	N.U.
58	N.U.
59	N.U.
60	DM Network - Vehicle Characteristics
61	DM Network - Off-Guideway Link Travel Time and Distance
62	DM Network - On-Guideway Link Data Persons, PMT, PHT, Vehicles, VMT, VHT
63	DM Network - Off-Guideway Link Data Persons, PMT, PHT, Vehicles, VMT, VHT
64	DM Network - On-Guideway Summary Data Off-Guideway Summary Data On + Off-Guideway Summary Data Back Haul Data Loaded Vehicle Data
65	DM Trip Statistics
66	N.U.
67	N.U.
68	N.U.
69	N.U.
70	N.U.
71	N.U.
72	N.U.
73	N.U.
74	N.U.
75	N.U.
76	N.U.
77	Punched Summary Data
78	Plotted Graphs
79	Input Data Tables
80	All Tables from 1 thru 75 above

N.U. - Presently not used; available for model modifications

1 = Suppression of Table
2 = No Suppression

FIGURE 3-8 SUPPRESS PRINT LIST (continued)

3.1.3 Subroutine PRNTIN

Subroutine PRNTIN prints all the input data read by subroutine RDINPUT. All the input data which is read initially into individual variable named arrays is equivalenced to two super arrays by using common statements RDI and RDR. The two super arrays (IPARDT and RPARDT) respectively house all integer input data and real input data.

Both of these arrays are printed immediately after the run title as shown in Figure 3-10 . They may be suppressed by setting JSPRNT(79) equal to 1.

Version II of the TEAM model is dimensioned to permit 199 integer input values and up to 14,340 real input values. The first table in Figure 3- 10 is the IPARDT array. The location of a specific variable can be found by adding the column index to the row index. For example the value of IPARDT(143) is 216 located in column 3, row 140. The location of a value in the RPARDT array (the second table in Figure 3-10) is found in like manner.

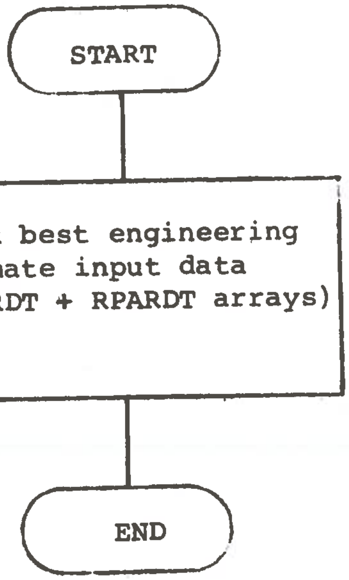

FIGURE 3-9 General Flow Chart - Subroutine PRNTIN

```
BEST ENGINEERING ESTIMATE INPUT DATA

                1           2           3           4           5           6           7           8           9          10
    0           0           0           0           0           0           0           0           0           0           0
   10           0           0           0           0           0           0           0           0           0           0
   20           0           0           0           0           0           0           0           0           0           0
   30           0           0           0           0           0           0           0           0           0           0
   40           0           0           0           0           0           0           0           0           0           0
   50           0           0           0           0           0           0           0           0           0           0
   60           0           0           0           0           0           0           0           0           0           0
   70           0           0           0           0           0           0           1           1           0           1
   80         200          20          50         200          20          50         200          20          50         200
   90          20          50         200          20          50         200          30         200          20          30
  100          20          20           6          12         888         888         888         888         888          -0
  110          10          10          10          10          10          10          10          10          10          10
  120          10          10          10          10          10          10          10          10          10          10
  130          10          10          10          10         888         888         888         888         888          -0
  140           1           2         216         888         888         888         888           1          20           1
  150          93           1           1           1           1           1           1           1           2         888
  160           3           3           3         888         888           3           3         888         888           2
  170           3           3         888         888         888         888         888           1           2         888
  180         888         888         888         888         888           5           1         888           2           2


                1           2           3           4           5           6           7           8           9          10
    0       1.000       1.000       1.000       1.000        .720       1.200       1.000       1.000       1.000       1.000
   10       6.000      12.000        .889        .889      -0.000        .240        .750        .889        .889      -0.000
   20    6000.000    6000.000        .889        .889      -0.000       0.000       0.000       0.000       0.000       0.000
   30   11100.000   32200.000   72500.000  420000.000       0.000  400000.000  500000.000 2700000.000 1100000.000 5000000.000
   40      12.000      24.000      36.000      46.000      56.000      66.000      76.000      86.000      96.000     106.000
   50     116.000     126.000     136.000     146.000     156.000     166.000       1.000       1.000       2.000       0.000
   60       2.0001000000.000 2000000.000        .889        .889        .889        .889  100000.000  100000.000        .889
   70        .889        .889       2.000        .889        .889        .889      -0.000       1.000        .889        .889
   80        .889      -0.000      10.000        .889        .889        .889      -0.000       6.000        .889        .889

14260       0.000       0.000       0.000       0.000       0.000       0.000       0.000      -0.000      56.000      47.000
14270       0.000       0.000       0.000       0.000       0.000       0.000       0.000       0.000      -0.000       0.000
14280       0.000       0.000       0.000       0.000       0.000       0.000       0.000       0.000       0.000       0.000
14290       0.000       0.000       0.000       0.000       0.000       0.000       0.000       0.000       0.000       0.000
14300       0.000       0.000       0.000       0.000       0.000       0.000       0.000       0.000       0.000       0.000
14310       0.000       0.000   10000.000    5000.000    5000.000        .889        .889        .889        .889       0.000
14320        .100        .300        .600       1.000        .500       0.000        .889        .889       0.000       1.120
14330        .889        .889        .128       0.000        .889        .889       0.000        .060        .889-3739573.996
```

FIGURE 3-10 Input Data Printout

The starting location of the individual variables in the IPARDT and RPARDT super arrays are respectively shown in Tables 3-4 and 3-5 . The individual arrays are stored in IPARDT and RPARDT in the order that they are listed in COMMON/RDI/ and COMMON/RDR/ respectively.

The "888"s in the IPARDT array and the ".889"s in the RPARDT arrays indicate that these locations have not been used during this application of the model. The reason that many locations are often not used is because the program is coded to accept a specified maximum number of items per variable, but the user can generally input any number of items up to this maximum. For example, the model can accept up to 224 guideway links but in Figure 3-10 this user used only 216 guideway links. Thus locations related to links 217 through 224 of the DGLKST array will contain .889. Negative zeros indicate that the values were read by subroutine RDINPUT as blank fields. The computer interprets these as zero.

TABLE 3-4 IPARDT ARRAY VARIABLES

Variable Name and Dimension	Number of Locations	Starting Location in IPARDT Array
JSPRNT(80)	80	1
DLIFE(30)	30	81
DINT(30)	30	111
LECCDE	1	141
NVM	1	142
NLM	1	143
NSM	1	144
NIM	1	145
NTM	1	146
NTSM	1	147
NYM	1	148
NDM	1	149
IZ	1	150
JK	1	151
PARCK1(6)	6	152
NH	1	158
NX	1	159
IPRINT	1	160
IXV	1	161
IPOLCD(4,2,3)	24	162
IDACCD(3)	3	186
NHV	1	189
NDTM	1	190
NVC(9)	9	191

TABLE 3-5 RPARDT ARRAY VARIABLES

Variable Name and Dimension	Number of Locations	Starting Location in RPARDT Array
SCALEF(10)	10	1
DVHCAP(5)	5	11
DVHLDF(5)	5	16
DLNCAP(5)	5	21
ULANDC(10)	10	26
UTRAKC	1	36
USTRUC(4)	4	37
DGWDTH(16)	16	41
DCNCEN(11)	11	57
DWAYCC(5)	5	68
DYARDS(5,13)	65	73
DMAINT(10)	10	138
DVHSUC(4,6)	24	148
DVHUC(4)	4	172
DNUMVH(5)	5	176
ASSRAT(4)	4	181
TAXRAT(4)	4	185
DNOISE(20,14,2)	560	189
RESDEN(4,7)	28	749
DONPFL(225,4,4)	3600	777
DGLKST(225,5)	1125	4377
BACKON(225,3,3)	2025	5502
DPKHRF(225,3)	675	7527
DPKDRF(225,3)	675	8202
NPKHRS	1	8877
NUMDA	1	8878
DPKPCT	1	8879
DPTRIP(4,3)	12	8880
DPDLYO(2,3)	6	8892
DVDLAY(2,3)	6	8898
DMVLDF(2,3)	6	8904
XSYSCH(4,5)	20	8910
XPKPCT	1	8930
XPTRIP(4,4)	16	8931
XDELAY(2,4,2)	16	8947

TABLE 3-5 RPARDT ARRAY VARIABLES (continued)

Variable Name and Dimension	Number of Locations	Starting Location in RPARDT Array
HLNDIR(2,2)	4	8963
XVMTPC(4)	4	8967
DVMTPC(3)	3	8971
AUTOCH(11)	11	8974
HNCHAR(4)	4	8985
DPCVCH(3,6,2)	36	8989
XPCVCH(4,6)	24	9025
HPCVCH(2,6)	12	9049
POLRAT(3,3)	9	9061
DMSTAC	1	9070
HACRAT(2,5,2)	20	9071
XACRAT(4,4)	16	9091
DACRAT(2,3)	6	9107
HCPDAT(2,4)	8	9113
HVOPCS(2,6)	12	9121
HWYOPC(2,3)	6	9133
XOPCU(4,7,4)	112	9139
XOPICD(4,7,4)	112	9251
DOFPPL(150,4,4)	2400	9363
DOFLKC(150,3,3)	1350	11763
BACKOP(150,3,2)	900	13113
DYUOPC	1	14013
DCCOPC	1	14014
DMOPC	1	14015
Z(4)	4	14016
DVOPUC(6,9,4)	216	14020
DTROPC(11,7)	77	14236
DGOPC(7)	7	14313
FLOCAP(5)	5	14320
DFARE(4,2,2)	16	14325

3.1.4 Subroutine SUMDATA

The purpose of subroutine SUMDATA is to equate any of the variables listed in the subroutine common blocks which are desired outputs for the grand summary tables. The grand summary table (SMRYDT(320,5)) array houses up to 320 major input and computed variables for up to 5 loops through the new system cost program. Version II presently prints 270 major input and computed variables as shown in Figure 3-12.

The remaining 50 locations are available for defining additional desired summary information. For reasons of program efficiency many of the 270 summary data variables had to be defined in the subroutine where they were computed.

The loop through a parametric variation set (see sections 3.1.5, 3.1.7, and 4.3) is defined by the MM counter. The first column (MM=1) of the SMRYDT array always contains the best engineering estimate values of the summary variables which are computed in the first loop through the program. If an input variable is varied (up to 4 times) in subsequent loops through the program the resulting summary variable values are stored in columns 2 through 5 (MM=2 through MM=5).

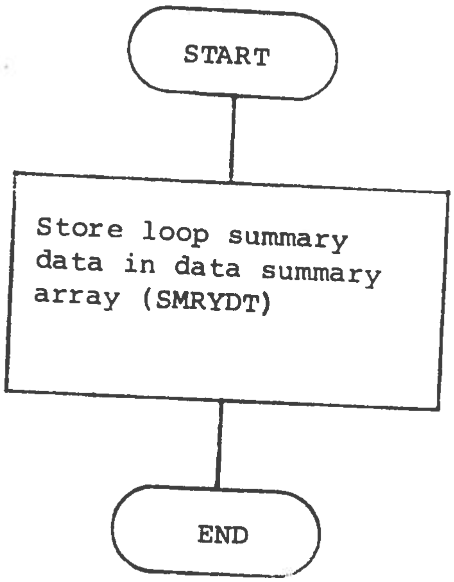

FIGURE 3-11 General Flow Chart - Subroutine SUMDATA

```
THIS IS THE SUMMARY OF A PARAMETRIC RUN WITH A VARIABLE ASSUMING  3 VALUES

CAPITAL COSTS SECTION

 1    NO. OF LINKS                    124.000          124.000          124.000          124.000
 2    NO. OF SEGMENTS                 272.000          272.000          272.000          272.000
 3    NO. OF INTERCHANGES              31.000           31.000           31.000           31.000
 4    NO. OF TERMINALS                 77.000           77.000           77.000           77.000
 5    NO. OF TERM. SEGM.               77.000           77.000           77.000           77.000
 6    TOTAL ROUTE MILES               240.940          240.940          240.940          240.940
 7    TOTAL LANE MILES               1137.043         1137.043         1137.043         1137.043
 8    TOTAL REQUIRED ACRES           3291.070         3291.070         3291.070         3291.070
 9    NO. OF VEHS.-TYPE1            20000.000        20000.000        20000.000        20000.000
10    VEH. CAPACITY TYPE1               6.000            6.000            6.000            6.000
11    VEH. LD-FACT. TYPE 1               .240             .240             .240             .240
12    VEH. LN-CAP. TYPE1             6000.000         6000.000         6000.000         6000.000
13    NO. OF VEHS.-TYPE2             2300.000         2300.000         2300.000         2300.000
14    VEH. CAPACITY-TYPE2              20.000           20.000           20.000           20.000
15    VEH. LD-FACT TYPE2                 .750             .750             .750             .750
16    VEH. LN-CAP. TYPE2              400.000          400.000          400.000          400.000
17    NO. OF YARDS                      1.000            1.000            1.000            1.000
18    TRACK COST     $/LN-MI       900000.000       900000.000       900000.000       900000.000
19    TN CONS. UC    $/LN-MI      7000000.000      7000000.000      7000000.000      7000000.000
20    A-G CONS. UC   $/LN-MI       700000.000       700000.000       700000.000       700000.000
21    B-G CONS. UC   $/LN-MI      3000000.000      3000000.000      3000000.000      3000000.000
22    EL. CONS. UC   $/LN-MI      1300000.000      1300000.000      1300000.000      1300000.000
23    VEH. COST TYPE1 $/VH          30000.000         2500.000         7000.000        10000.000
24    VEH. COST TYPE2 $/VH          35500.000        35500.000        35500.000        35500.000
25    GUIDEWAY LANE MILES             746.820          746.820          746.820          746.820
26    INTERCHANGE LN MILES             64.300           64.300           64.300           64.300
27    TERMINAL LANE MILES              69.413           69.413           69.413           69.413
28    ACCEL/DECEL LN MILES             62.250           62.250           62.250           62.250
29    YARDS LANE MILES                195.000          195.000          195.000          195.000
30                                      0.000            0.000            0.000            0.000
31                                      0.000            0.000            0.000            0.000
32                                      0.000            0.000            0.000            0.000
33                                      0.000            0.000            0.000            0.000
34                                      0.000            0.000            0.000            0.000
35                                      0.000            0.000            0.000            0.000
36                                      0.000            0.000            0.000            0.000
37                                      0.000            0.000            0.000            0.000
38                                      0.000            0.000            0.000            0.000
39                                      0.000            0.000            0.000            0.000
40                                      0.000            0.000            0.000            0.000
```

```
CAPITAL COSTS SECTION

41    TOTAL DM CAP. COST $      2633647004.226   2003647004.226   2173647004.226   2233647004.226
42    TOTAL DM ACC       $/YR    307563594.071    226043771.560    240052469.925    248050260.031
43    TOTAL PUB. ACC     $/YR    307563594.071    226043771.560    240052469.925    248050260.031
44    TOTAL PRIV ACC     $/YR            0.000            0.000            0.000            0.000
45    GUIDEWAY ACC       $/YR    100631056.124    100631056.124    100631056.124    100631056.124
46    INTERCHANGE ACC    $/YR     27907775.003     27907775.003     27907775.003     27907775.003
47    TERMINAL ACC       $/YR     35172440.290     35172440.290     35172440.290     35172440.290
48    A-D LANES ACC      $/YR      8428514.575      8428514.575      8428514.575      8428514.575
49    CONTROL CEN ACC    $/YR      1250010.990      1250010.990      1250010.990      1250010.990
50    YARDS      ACC     $/YR     11434221.644     11434221.644     11434221.644     11434221.644
51    MAINT FACIL ACC    $/YR       320457.745       320457.745       320457.745       320457.745
52    WAY O.C ACC        $/YR     16209101.003     16209101.003     16209101.003     16209101.003
53    VEH. TYPE1 ACC     $/YR     88197040.868      7336165.755     20540844.116     29352463.978
54    VEH. TYPE2 ACC     $/YR     11983224.670     11983224.670     11983224.670     11983224.670
55    VEH. TYPE3 ACC     $/YR            0.000            0.000            0.000            0.000
56    TOTAL VEH. ACC     $/YR    100041213.730     19321390.433     32530000.792     41335007.694
57                                       0.000            0.000            0.000            0.000
58                                       0.000            0.000            0.000            0.000
59                                       0.000            0.000            0.000            0.000
60                                       0.000            0.000            0.000            0.000
61                                       0.000            0.000            0.000            0.000
62                                       0.000            0.000            0.000            0.000
63                                       0.000            0.000            0.000            0.000
64                                       0.000            0.000            0.000            0.000
65    GUIDEWAY       CAP. $      995860874.182    995860874.182    995860874.182    995860874.182
66    INTERCHANGES   CAP. $      273594250.000    273594250.000    273594250.000    273594250.000
67    TERMINALS      CAP. $      343003350.226    343003350.226    343003350.226    343003350.226
68    A-D LANES      CAP. $       78464023.000     78464023.000     78464023.000     78464023.000
69    CONTROL CENTER CAP.$        12145000.000     12145000.000     12145000.000     12145000.000
70    YARDS          CAP.$       107139000.000    107139000.000    107139000.000    107139000.000
71    MAINT FACIL    CAP.$         3022200.000      3022200.000      3022200.000      3022200.000
72    WAY C&C        CAP.$       130670306.010    130670306.010    130670306.010    130670306.010
73    VEH. TYPE1     CAP.$       800000000.000     50000000.000    140000000.000    200000000.000
74    VEH. TYPE2     CAP.$        81650000.000     81650000.000     81650000.000     81650000.000
75    VEH. TYPE3     CAP.$               0.000            0.000            0.000            0.000
76    TOTAL VEH.     CAP.$       881650000.000    131650000.000    221650000.000    281650000.000
77    TOTAL LAND     CAP.$       107961163.317    107961163.317    107961163.317    107961163.317
78    STRUCTURES     CAP.$      1050436000.000   1050436000.000   1050436000.000   1050436000.000
79    TRACK          CAP.$       560921534.091    560921534.091    560921534.091    560921534.091
80                                       0.000            0.000            0.000            0.000
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DUAL MODE, HIGHWAY, AND TRANSIT NETWORK DATA

 81   DM-V1  DAILY    PMT          17036869.050     17036869.050     17036869.050     17036869.050
 82   DM-V1  DAILY  A-PMT            661146.995       661146.995       661146.995       661146.995
 83   DM-V1  DAILY    VMT          12222474.544     12222474.544     12222474.544     12222474.544
 84   DM-V1  DAILY  A-VMT            379619.133       379619.133       379619.133       379619.133
 85   DM-V1 ANNUAL    PMT        5111060714.999   5111060714.999   5111060714.999   5111060714.999
 86   DM-V1 ANNUAL  A-PMT         198344098.650    198344098.650    198344098.650    198344098.650
 87   DM-V1 ANNUAL    VMT        3666742363.122   3666742363.122   3666742363.122   3666742363.122
 88   DM-V1 ANNUAL  A-VMT         113885739.991    113885739.991    113885739.991    113885739.991
 89   DM-V2  DAILY    PMT           1625710.070      1625710.070      1625710.070      1625710.070
 90   DM-V2  DAILY  A-PMT             90219.623        90219.623        90219.623        90219.623
 91   DM-V2  DAILY    VMT            197696.802       197696.802       197696.802       197696.802
 92   DM-V2  DAILY  A-VMT              7432.360         7432.360         7432.360         7432.360
 93   DM-V2 ANNUAL    PMT         487713021.000    487713021.000    487713021.000    487713021.000
 94   DM-V2 ANNUAL  A-PMT          27065886.950     27065886.950     27065886.950     27065886.950
 95   DM-V2 ANNUAL    VMT          59309040.606     59309040.606     59309040.606     59309040.606
 96   DM-V2 ANNUAL  A-VMT           2229707.919      2229707.919      2229707.919      2229707.919
 97   DV1 DAILY   PER TRIP          1132974.000      1132974.000      1132974.000      1132974.000
 98   DV1 DAILY   VEH TRIP           750958.959       750958.959       750958.959       750958.959
 99   DV1 ANNUAL  PER TRIP        339892200.000    339892200.000    339892200.000    339892200.000
100   DV1 ANNUAL  VEH TRIP        225287687.701    225287687.701    225287687.701    225287687.701
101   DV2 DAILY   PER TRIP           182566.000       182566.000       182566.000       182566.000
102   DV2 DAILY   VEH TRIP            22201.200        22201.200        22201.200        22201.200
103   DV2 ANNUAL  PER TRIP         54769800.000     54769800.000     54769800.000     54769800.000
104   DV2 ANNUAL  VEH TRIP          6660360.000      6660360.000      6660360.000      6660360.000
105   DV1 AVE TRIP LENGTH                15.037           15.037           15.037           15.037
106   DV1 TRIP TIME (MIN)                35.013           35.013           35.013           35.013
107   DV2 AVE TRIP LENGTH                 6.005            6.005            6.005            6.005
108   DV2 TRIP TIME (MIN)                29.657           29.657           29.657           29.657
109   DAILY TRANSIT    PMT          2452309.000      2452309.000      2452309.000      2452309.000
110   DAILY TRANSIT    VMT           116620.782       116620.782       116620.782       116620.782
111   DAILY TRANSIT  A-PMT           365071.278       365071.278       365071.278       365071.278
112   DAILY TRANSIT  A-VMT             7440.395         7440.395         7440.395         7440.395
113   ANNUAL TRANSIT   PMT        735692700.000    735692700.000    735692700.000    735692700.000
114   ANNUAL TRANSIT   VMT         34986234.714     34986234.714     34986234.714     34986234.714
115   ANNUAL TRANSIT  APMT        109521383.500    109521383.500    109521383.500    109521383.500
116   ANNUAL TRANSIT  AVMT          2232118.392      2232118.392      2232118.392      2232118.392
117   DAILY TSIT PER TRIP            843798.000       843798.000       843798.000       843798.000
118   ANN. TSIT PER TRIP          253139400.000    253139400.000    253139400.000    253139400.000
119   TSIT TRIP LENGTH                    2.986            2.986            2.986            2.986
120   TSIT TRIP TIME-MIN.                25.959           25.959           25.959           25.959
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DUAL MODE, HIGHWAY, AND TRANSIT NETWORK DATA

121   AVE. PMT SPEED PEAK                50.824           50.824           50.824           50.824
122   AVE. PMT SPEED OPK                 53.100           53.100           53.100           53.100
123   AVE. SA  SPEED PEAK                17.720           17.720           17.720           17.720
124   AVE. SA  SPEED OPK                 24.050           24.050           24.050           24.050
125   AUTO DAILY       PMT         40017334.000     40017334.000     40017334.000     40017334.000
126   AUTO DAILY       VMT         28206481.944     28206481.944     28206481.944     28206481.944
127   AUTO DAILY     A-PMT          2247687.540      2247687.540      2247687.540      2247687.540
128   AUTO DAILY     A-VMT          1185875.947      1185875.947      1185875.947      1185875.947
129   AUTO ANNUAL      PMT      12005200200.000  12005200200.000  12005200200.000  12005200200.000
130   AUTO ANNUAL      VMT       8461944583.333   8461944583.333   8461944583.333   8461944583.333
131   AUTO ANNUAL    A-PMT        674306261.902    674306261.902    674306261.902    674306261.902
132   AUTO ANNUAL    A-VMT        355762784.010    355762784.010    355762784.010    355762784.010
133   DAILY  TRUCK     VMT           204345.491       204345.491       204345.491       204345.491
134   ANNUAL TRUCK     VMT         [illegible]      [illegible]      [illegible]      [illegible]
135   HWY DAILY  AUTO  VMT         28206481.944     28206481.944     28206481.944     28206481.944
136   HWY DAILY  TRUCK VMT          4860903.633      4860903.633      4860903.633      4860903.633
137   HWY DAILY  TSIT  VMT            96997.095        96997.095        96997.095        96997.095
138   HWY DAILY  DM    VMT          5018998.351      5018998.351      5018998.351      5018998.351
139   TOTAL HWY DAILY  VMT         38103383.723     38103383.723     38103383.723     38103383.723
140   HWY ANNUAL AUTO  VMT       8461944583.333   8461944583.333   8461944583.333   8461944583.333
141   HWY ANNUAL TRUCK VMT       1458271089.789   1458271089.789   1458271089.789   1458271089.789
142   HWY ANNUAL TSIT  VMT         29099128.450     29099128.450     29099128.450     29099128.450
143   HWY ANNUAL DM    VMT       1505699505.320   1505699505.320   1505699505.320   1505699505.320
144   TOTAL HWY ANNUAL VMT      11455015116.093  11455015116.093  11455015116.093  11455015116.093
145   AUTO DAILY  PER TRIP          8753938.000      8753938.000      8753938.000      8753938.000
146   AUTO ANNUAL PER TRIP       2626181400.000   2626181400.000   2626181400.000   2626181400.000
147   AVE AUTO TRIP LENGTH                4.640            4.640            4.640            4.640
148   AUTO TRIP TIME -MIN.               15.404           15.404           15.404           15.404
149   TOT. SYS. DAILY  PMT         61732222.120     61732222.120     61732222.120     61732222.120
150   TOT. SYS. DAILY  VMT         45604100.105     45604100.105     45604100.105     45604100.105
151   TOT. SYS. DAILY  PT.         10913276.000     10913276.000     10913276.000     10913276.000
152   TOT. SYS. ANNUAL PMT      18519666635.998  18519666635.998  18519666635.998  18519666635.998
153   TOT. SYS. ANNUAL VMT      13681254031.045  13681254031.045  13681254031.045  13681254031.045
154   TOT. SYS. ANNUAL PT.       3273982800.000   3273982800.000   3273982800.000   3273982800.000
155   SYSTEM TRIP LENGTH                  3.857            3.857            3.857            3.857
156   SYSTEM TRIP TIME-MIN               18.495           18.495           18.495           18.495
157                                       0.000            0.000            0.000            0.000
158                                       0.000            0.000            0.000            0.000
159                                       0.000            0.000            0.000            0.000
160                                       0.000            0.000            0.000            0.000
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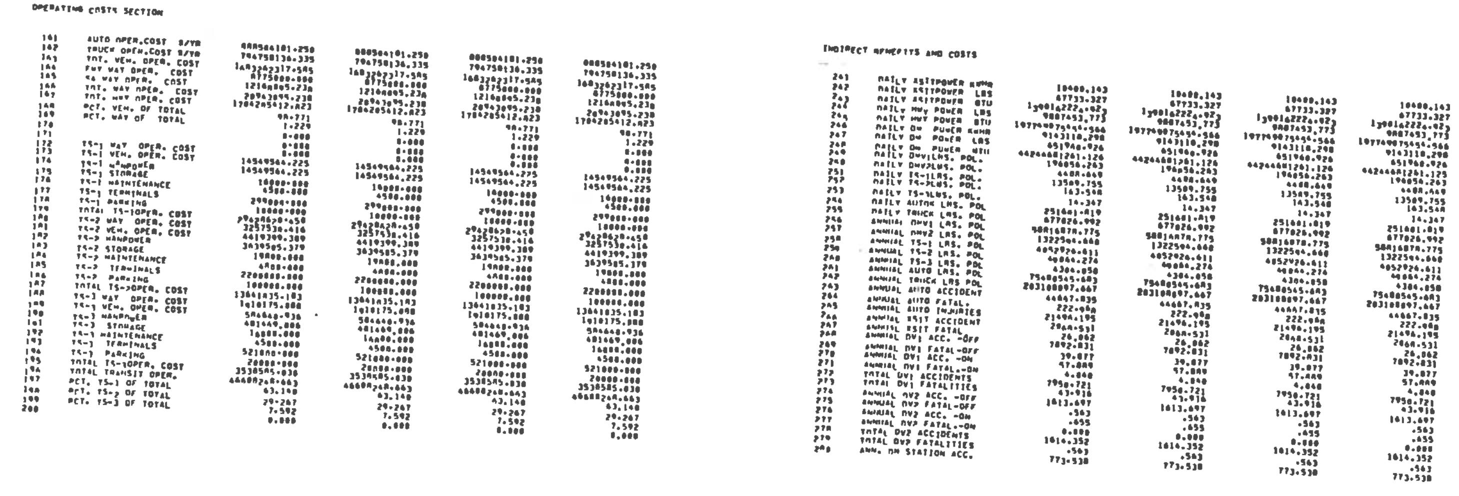
FIGURE 3-12 Summary Data Output Table



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OPERATING COSTS SECTION

161   AUTO OPER.COST $/YR        888504181.250   888504181.250   888504181.250   888504181.250
162   TRUCK OPER.COST $/YR       794758136.335   794758136.335   794758136.335   794758136.335
163   TOT. VEH. OPER. COST      1683262317.585  1683262317.585  1683262317.585  1683262317.585
164   FWY WAY OPER. COST           8775000.000     8775000.000     8775000.000     8775000.000
165   SA WAY OPER. COST           12168095.238    12168095.238    12168095.238    12168095.238
166   TOT. WAY OPER. COST         20943095.238    20943095.238    20943095.238    20943095.238
167   TOT. HWY OPER. COST       1704205412.823  1704205412.823  1704205412.823  1704205412.823
168   PCT. VEH. OF TOTAL                98.771          98.771          98.771          98.771
169   PCT. WAY OF TOTAL                  1.229           1.229           1.229           1.229
170                                      0.000           0.000           0.000           0.000
171                                      0.000           0.000           0.000           0.000
172   TS-1 WAY OPER. COST                0.000           0.000           0.000           0.000
173   TS-1 VEH. OPER. COST        14549564.225    14549564.225    14549564.225    14549564.225
174   TS-1 MANPOWER               14549564.225    14549564.225    14549564.225    14549564.225
175   TS-1 STORAGE                   10000.000       10000.000       10000.000       10000.000
176   TS-1 MAINTENANCE                4500.000        4500.000        4500.000        4500.000
177   TS-1 TERMINALS                299000.000      299000.000      299000.000      299000.000
178   TS-1 PARKING                   10000.000       10000.000       10000.000       10000.000
179   TOTAL TS-1OPER. COST        29422628.450    29422628.450    29422628.450    29422628.450
180   TS-2 WAY OPER. COST          3257530.416     3257530.416     3257530.416     3257530.416
181   TS-2 VEH. OPER. COST         4419399.389     4419399.389     4419399.389     4419399.389
182   TS-2 MANPOWER                3639585.379     3639585.379     3639585.379     3639585.379
183   TS-2 STORAGE                   19800.000       19800.000       19800.000       19800.000
184   TS-2 MAINTENANCE                4800.000        4800.000        4800.000        4800.000
185   TS-2 TERMINALS               2200000.000     2200000.000     2200000.000     2200000.000
186   TS-2 PARKING                  100000.000      100000.000      100000.000      100000.000
187   TOTAL TS-2OPER. COST        13641035.183    13641035.183    13641035.183    13641035.183
188   TS-3 WAY OPER. COST          1010175.000     1010175.000     1010175.000     1010175.000
189   TS-3 VEH. OPER. COST          584640.936      584640.936      584640.936      584640.936
190   TS-3 MANPOWER                 401469.006      401469.006      401469.006      401469.006
191   TS-3 STORAGE                   16000.000       16000.000       16000.000       16000.000
192   TS-3 MAINTENANCE                4500.000        4500.000        4500.000        4500.000
193   TS-3 TERMINALS                521000.000      521000.000      521000.000      521000.000
194   TS-3 PARKING                   20000.000       20000.000       20000.000       20000.000
195   TOTAL TS-3OPER. COST         3538585.030     3538585.030     3538585.030     3538585.030
196   TOTAL TRANSIT OPER.         46602248.663    46602248.663    46602248.663    46602248.663
197   PCT. TS-1 OF TOTAL                63.140          63.140          63.140          63.140
198   PCT. TS-2 OF TOTAL                29.267          29.267          29.267          29.267
199   PCT. TS-3 OF TOTAL                 7.592           7.592           7.592           7.592
200                                      0.000           0.000           0.000           0.000
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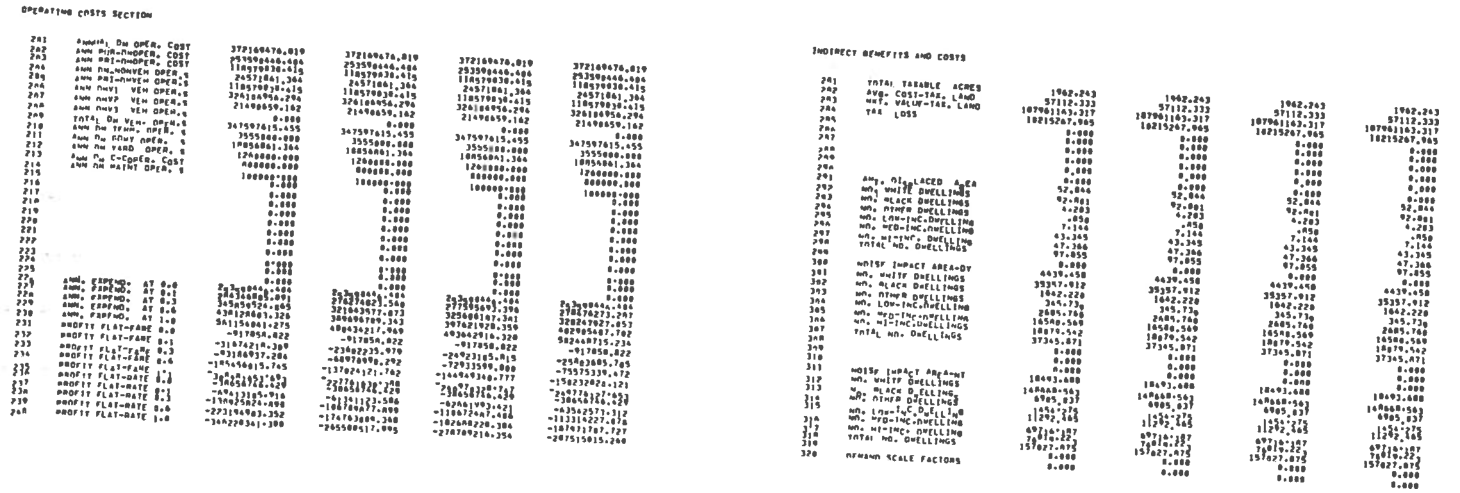
INDIRECT BENEFITS AND COSTS

241   DAILY ASITPOWER KWHR           10400.143           10400.143           10400.143           10400.143
242   DAILY ASITPOWER LBS            67733.327           67733.327           67733.327           67733.327
243   DAILY ASITPOWER BTU       1300142224.023      1300142224.023      1300142224.023      1300142224.023
244   DAILY HWY POWER LBS          9807453.773         9807453.773         9807453.773         9807453.773
245   DAILY HWY POWER BTU     107740075454.566    107740075454.566    107740075454.566    107740075454.566
246   DAILY DM POWER KWHR          9143118.298         9143118.298         9143118.298         9143118.298
247   DAILY DM POWER LBS            651940.926          651940.926          651940.926          651940.926
248   DAILY DM POWER BTU       44244481261.126     44244481261.126     44244481261.126     44244481261.125
249   DAILY DMV1LBS. POL.           194056.263          194056.263          194056.263          194056.263
250   DAILY DMV2LBS. POL.             4408.449            4408.449            4408.449            4408.449
251   DAILY TS-1LBS. POL.            13509.755           13509.755           13509.755           13509.755
252   DAILY TS-2LBS. POL.              163.548             163.548             163.548             163.548
253   DAILY TS-3LBS. POL.               14.347              14.347              14.347              14.347
254   DAILY AUTOS LBS. POL          251601.819          251601.819          251601.819          251601.819
255   DAILY TRUCK LBS. POL          677026.992          677026.992          677026.992          677026.992
256   ANNUAL DMV1 LBS. POL        58016878.775        58016878.775        58016878.775        58016878.775
257   ANNUAL DMV2 LBS. POL         1322504.660         1322504.660         1322504.660         1322504.660
258   ANNUAL TS-1 LBS. POL         4052926.611         4052926.611         4052926.611         4052926.611
259   ANNUAL TS-2 LBS. POL           40844.274           40844.274           40844.274           40844.274
260   ANNUAL TS-3 LBS. POL            4304.050            4304.050            4304.050            4304.050
261   ANNUAL AUTO LBS. POL        75480545.683        75480545.683        75480545.683        75480545.683
262   ANNUAL TRUCK LBS POL       203108097.667       203108097.667       203108097.667       203108097.667
263   ANNUAL AUTO ACCIDENT           44667.835           44667.835           44667.835           44667.835
264   ANNUAL AUTO FATAL.               222.968             222.968             222.968             222.968
265   ANNUAL AUTO INJURIES           21494.195           21494.195           21494.195           21494.195
266   ANNUAL ESIT ACCIDENT            2648.531            2648.531            2648.531            2648.531
267   ANNUAL ESIT FATAL                 26.862              26.862              26.862              26.862
268   ANNUAL DV1 ACC. -OFF            7892.831            7892.831            7892.831            7892.831
269   ANNUAL DV1 FATAL-OFF              39.077              39.077              39.077              39.077
270   ANNUAL DV1 ACC. -ON               57.889              57.889              57.889              57.889
271   ANNUAL DV1 FATAL.-ON               4.840               4.840               4.840               4.840
272   TOTAL DV1 ACCIDENTS             7950.721            7950.721            7950.721            7950.721
273   TOTAL DV1 FATALITIES              43.916              43.916              43.916              43.916
274   ANNUAL DV2 ACC. -OFF            1613.697            1613.697            1613.697            1613.697
275   ANNUAL DV2 FATAL-OFF                .563                .563                .563                .563
276   ANNUAL DV2 ACC. -ON                 .655                .655                .655                .655
277   ANNUAL DV2 FATAL.-ON               0.000               0.000               0.000               0.000
278   TOTAL DV2 ACCIDENTS             1614.352            1614.352            1614.352            1614.352
279   TOTAL DV2 FATALITIES                .563                .563                .563                .563
280   ANN. DM STATION ACC.             773.538             773.538             773.538             773.538
```

FIGURE 3-12 Summary Data Output Table (continued)



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OPERATING COSTS SECTION

201   ANNUAL DM OPER. COST       372169476.819   372169476.819   372169476.819   372169476.819
202   ANN PUR-DMOPER. COST       253590446.404   253590446.404   253590446.404   253590446.404
203   ANN PRI-DMOPER. COST       118579030.415   118579030.415   118579030.415   118579030.415
204   ANN DM-NONVEH OPER.$        24571061.364    24571061.364    24571061.364    24571061.364
205   ANN PRI-NONVEH OPER.$      118579030.415   118579030.415   118579030.415   118579030.415
206   ANN DMV1 VEH OPER.$        326106956.294   326106956.294   326106956.294   326106956.294
207   ANN DMV2 VEH OPER.$         21490659.162    21490659.162    21490659.162    21490659.162
208   ANN DMV3 VEH OPER.$                0.000           0.000           0.000           0.000
209   TOTAL DM VEH. OPER.$       347597615.455   347597615.455   347597615.455   347597615.455
210   ANN DM TERM. OPER. $         3555000.000     3555000.000     3555000.000     3555000.000
211   ANN DM GDWY OPER. $         10856061.364    10856061.364    10856061.364    10856061.364
212   ANN DM YARD OPER. $          1260000.000     1260000.000     1260000.000     1260000.000
213   ANN DM C-COPER. COST          800000.000      800000.000      800000.000      800000.000
214   ANN DM MAINT OPER. $          100000.000      100000.000      100000.000      100000.000
215                                      0.000           0.000           0.000           0.000
216                                      0.000           0.000           0.000           0.000
217                                      0.000           0.000           0.000           0.000
218                                      0.000           0.000           0.000           0.000
219                                      0.000           0.000           0.000           0.000
220                                      0.000           0.000           0.000           0.000
221                                      0.000           0.000           0.000           0.000
222                                      0.000           0.000           0.000           0.000
223                                      0.000           0.000           0.000           0.000
224                                      0.000           0.000           0.000           0.000
225                                      0.000           0.000           0.000           0.000
226                                      0.000           0.000           0.000           0.000
227   ANN. EXPEND. AT 0.0        253590444.404   253590444.404   253590444.404   253590444.404
228   ANN. EXPEND. AT 0.1        264346805.091   270274021.540   277595697.396   278874273.297
229   ANN. EXPEND. AT 0.3        345850524.865   321043977.073   325600187.341   328247027.057
230   ANN. EXPEND. AT 0.6        430129801.326   389496709.343   397621920.359   402905487.702
231   ANN. EXPEND. AT 1.0        581156041.275   480434217.949   493642916.320   502440715.234
232   PROFIT FLAT-FARE 0.0          -917058.022     -917058.022     -917058.022     -917058.022
233   PROFIT FLAT-FARE 0.1        -31874218.309   -23482235.970   -24923185.815   -25803605.765
234   PROFIT FLAT-FARE 0.3        -83186937.284   -68970990.292   -72933599.000   -75575339.472
235   PROFIT FLAT-FARE 0.6       -185456815.745  -137024121.762  -144949340.777  -150232828.121
236   PROFIT FLAT-FARE 1.0        -38650746.420   -38650746.420   -38650746.420   -38650746.420
237   PROFIT FLAT-RATE 0.1        -89413185.916   -61341123.506   -82461903.421   -83542577.312
238   PROFIT FLAT-RATE 0.3       -178925824.898  -108709877.890  -118672487.480  -113314227.878
239   PROFIT FLAT-RATE 0.6       -273194903.352  -174763009.340  -182688220.384  -187971787.727
240   PROFIT FLAT-RATE 1.0       -348220341.300  -265508517.095  -278709214.354  -287515015.240
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INDIRECT BENEFITS AND COSTS

281   TOTAL TAXABLE ACRES             1962.243        1962.243        1962.243        1962.243
282   AVG. COST-TAX. LAND            57112.333       57112.333       57112.333       57112.333
283   MKT. VALUE-TAX. LAND       107961163.317   107961163.317   107961163.317   107961163.317
284   TAX LOSS                    10215267.965    10215267.965    10215267.965    10215267.965
285                                      0.000           0.000           0.000           0.000
286                                      0.000           0.000           0.000           0.000
287                                      0.000           0.000           0.000           0.000
288                                      0.000           0.000           0.000           0.000
289                                      0.000           0.000           0.000           0.000
290                                      0.000           0.000           0.000           0.000
291   AMT. DISPLACED AREA               52.844          52.844          52.844          52.844
292   NO. WHITE DWELLINGS               92.801          92.801          92.801          92.801
293   NO. BLACK DWELLINGS                4.203           4.203           4.203           4.203
294   NO. OTHER DWELLINGS                 .850            .850            .850            .850
295   NO. LOW-INC.DWELLING               7.144           7.144           7.144           7.144
296   NO. MED-INC.DWELLING              43.345          43.345          43.345          43.345
297   NO. HI-INC. DWELLING              47.366          47.366          47.366          47.366
298   TOTAL NO. DWELLINGS               97.855          97.855          97.855          97.855
299                                      0.000           0.000           0.000           0.000
300   NOISE IMPACT AREA-DY            4439.450        4439.450        4439.450        4439.450
301   NO. WHITE DWELLINGS            35357.912       35357.912       35357.912       35357.912
302   NO. BLACK DWELLINGS             1642.220        1642.220        1642.220        1642.220
303   NO. OTHER DWELLINGS              345.739         345.739         345.739         345.739
304   NO. LOW-INC.DWELLING            2685.760        2685.760        2685.760        2685.760
305   NO. MED-INC.DWELLING           16580.569       16580.569       16580.569       16580.569
306   NO. HI-INC.DWELLINGS           18079.542       18079.542       18079.542       18079.542
307   TOTAL NO. DWELLINGS            37345.871       37345.871       37345.871       37345.871
308                                      0.000           0.000           0.000           0.000
309                                      0.000           0.000           0.000           0.000
310                                      0.000           0.000           0.000           0.000
311   NOISE IMPACT AREA-NT           10493.600       10493.600       10493.600       10493.600
312   NO. WHITE DWELLINGS           148668.563      148668.563      148668.563      148668.563
313   NO. BLACK DWELLINGS             6905.037        6905.037        6905.037        6905.037
314   NO. OTHER DWELLINGS             1454.275        1454.275        1454.275        1454.275
315   NO. LOW-INC.DWELLING           11292.465       11292.465       11292.465       11292.465
316   NO. MED-INC.DWELLING           69716.187       69716.187       69716.187       69716.187
317   NO. HI-INC. DWELLING           76019.223       76019.223       76019.223       76019.223
318   TOTAL NO. DWELLINGS           157027.875      157027.875      157027.875      157027.875
319                                      0.000           0.000           0.000           0.000
320   DEMAND SCALE FACTORS               0.000           0.000           0.000           0.000
```

For example, the grand summary table shown in Figure 3-12 presents the results of one parametric variation set. In this case the unit cost of vehicle type 1 (variable #23) was varied 3 times.Column 1 are the results of the best engineering estimate loop. The best estimate of what each vehicle would cost was $30,000. Then it was desired to see what impact less costly vehicle would have upon the system costs. Thus three parametric loops through the program were made changing the vehicle unit cost to $2500, $7000, and $10,000 respectively (see columns 2, 3, and 4).

This variation procedure is controlled primarily by subroutines SUMMARY and PARRUN. Subroutine SUMDATA merely defines the values of the summary data during each loop and stores the data until the grand summary table is printed.

3.1.5 Subroutine SUMMARY

The primary function of subroutine SUMMARY is to control the printing of the loop summary table after each loop through the model and the printing of the grand summary table after each parameter variation set. A typical grand summary table is shown in figure 3-12 for a parameter variation set comprised of 3 variations of vehicle unit cost. The first column is the best engineering estimate summary. Individual loop summaries have only one column of summary data which is the summary for that specific loop through the program.

The determination of the appropriate summary table to be printed at the end of any particular loop through the model is controlled by a complex set of checks on the current values of certain counters. These counters are incremented or re-initialized by subroutine SUMMARY depending on the stage of program execution reached during a given loop.

The other important functions of the subroutine as shown in figure 3-13 are to punch output summary data, and to call subroutine PRPLOT when plotted data output is desired.

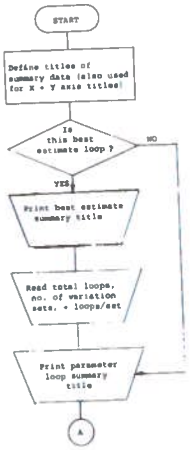


FIGURE 3-13 General Flow Chart - Subroutine SUMMARY

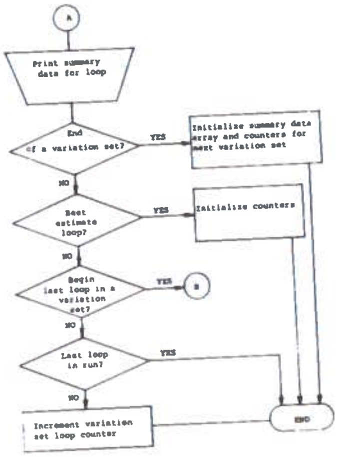


FIGURE 3-13 General Flow Chart - Subroutine SUMMARY (continued)

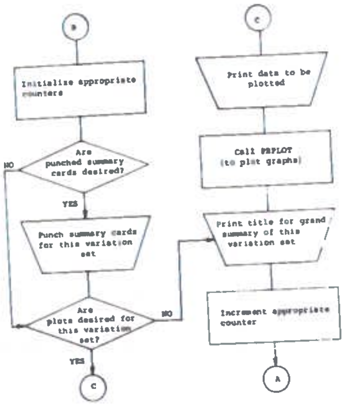


FIGURE 3-13 General Flow Chart - Subroutine SUMMARY (continued)

3.1.6 Subroutine PRPLOT

Subroutine PRPLOT is an on-line plotting control routine used to plot graphs when the new system cost program is run in the parametric analysis (multiple-loop) mode. It is designed to permit any variable in the summary data (SMRYDT) array to be plotted against any other SMRYDT array variable.

If a program user wishes to have one or more graphs plotted at the end of a parameter variation loop he needs only to specify the index location of the X-axis variable, Y-axis variable, the number of points to be plotted, and the title of the graph for each graph to be plotted.

The subroutine then proceeds to prepare the data for plotting one graph at a time (Figure 3-14). It first re-orders the X-variable values in order of increasing magnitude and stores them in XARRAY. Simultaneously it shifts the Y-variable values in the same fashion and stores them in YARRAY. This Y shift insures that the original Y-value

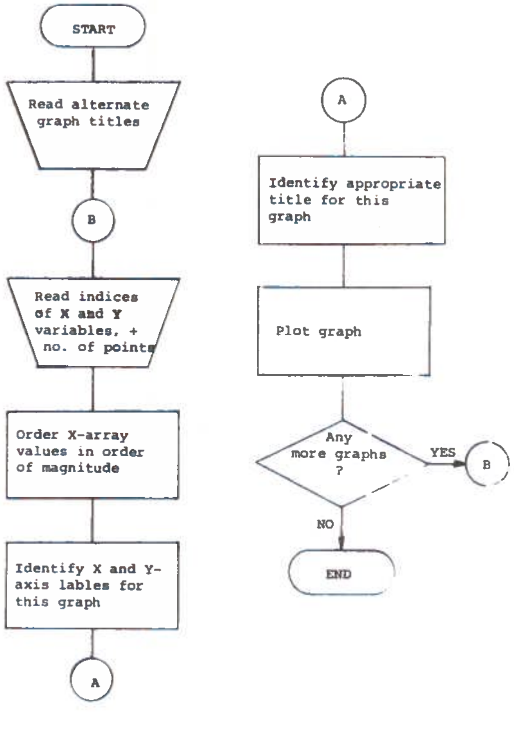


FIGURE 3-14 General Flow Chart - Subroutine PRPLOT

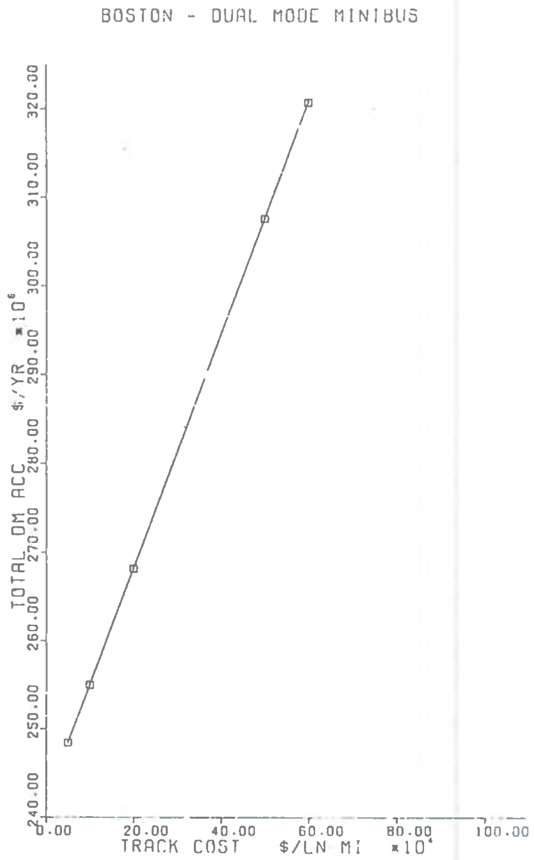


FIGURE 3-15 Typical Plotted Output Graph

associated with a given X-value retains its original relationship between the XARRAY and YARRAY locations. This re-ordering is required because the CALCOMP plotting routines which are called require the data to be ordered in this manner.

Finally, PRPLOT identifies the appropriate labels for the X-axis title, Y-axis title, and title of the graph. It then calls the CALCOMP plot routines to plot the graph. A typical plot is shown in Figure 3-15 . It then checks if any more graphs are desired. If so, the same procedure is repeated for the next graph. If not, control is returned to the calling subroutine (SUMMARY).

Further explanation on the use of on-line plotting is presented in Section 4.3. An off-line plot utility program with much increased capability is documented in APPENDIX H. It permits multiple curves to be plotted on the same graph for baseline and city comparisons.

3.1.7 Subroutine PARRUN

The principal function of subroutine PARRUN is to read parametric input data for each parametric loop of the program. The data that is read represents a change to the input data of the best estimate analysis run (the first loop of the program). A detailed example of this is presented in section 4.3.

Prior to each parametric loop it replaces the temporarily stored best estimate data (stored in ISAVDT and RSAVDT) into IPARDT and RPARDT arrays (Figure 3-16). This insures that each loop starts with the entire best estimate data set. It then reads the integer and real values which are to be changed during the next loop. It simultaneously places these values into the IPARDT and RPARDT arrays while the best estimate values located in the corresponding locations are stored in ISAVDT and RSAVDT arrays. The reason for this shifting process is because the program during execution only uses the values in the IPARDT and RPARDT arrays, and all original best estimate data must be saved from loop to loop. The save data arrays (ISAVDT and RSAVDT) are each dimensioned to store 100 values. Thus a maximum of 200 values can be changed (from the best estimate values) simultaneously during each loop through the program.

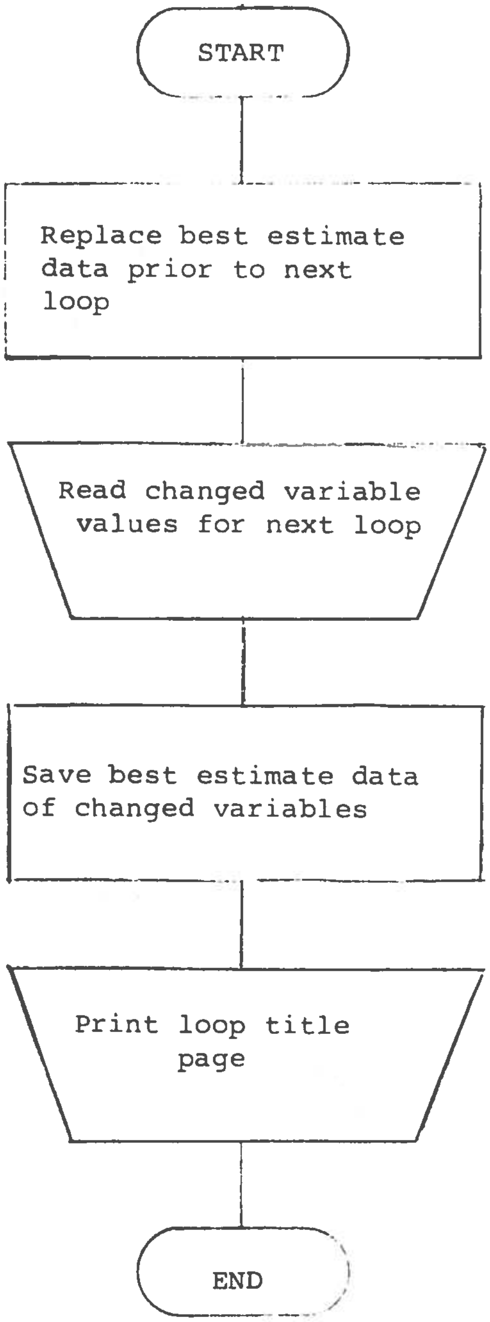


FIGURE 3-16 General Flow Chart - Subroutine PARRUN

3.2 Overlay 1.0 - DMCP

Overlay 1.0 is controlled by program DMCAPC. Within this overlay, all capital costs associated with the new transportation system are quantified and reported. Also, the number of dwellings displaced by the construction of the guideway and the number of dwellings impacted by excessive noise from the guideway are also determined.

The sequence of subroutine calls within this overlay is illustrated in Figure 3-17.

3.2.1 Program DMCAPC

Program DMCAPC controls all functions performed within Overlay 1.0. As shown in Figure 3-17, it sequentially calls the New System capital cost subroutines GUIDEWAY, INTRCHG, TERMNAL, ADLANES, and OTHRCAP. Upon execution of this program, control is returned to program DULMODE within Overlay 0.0.

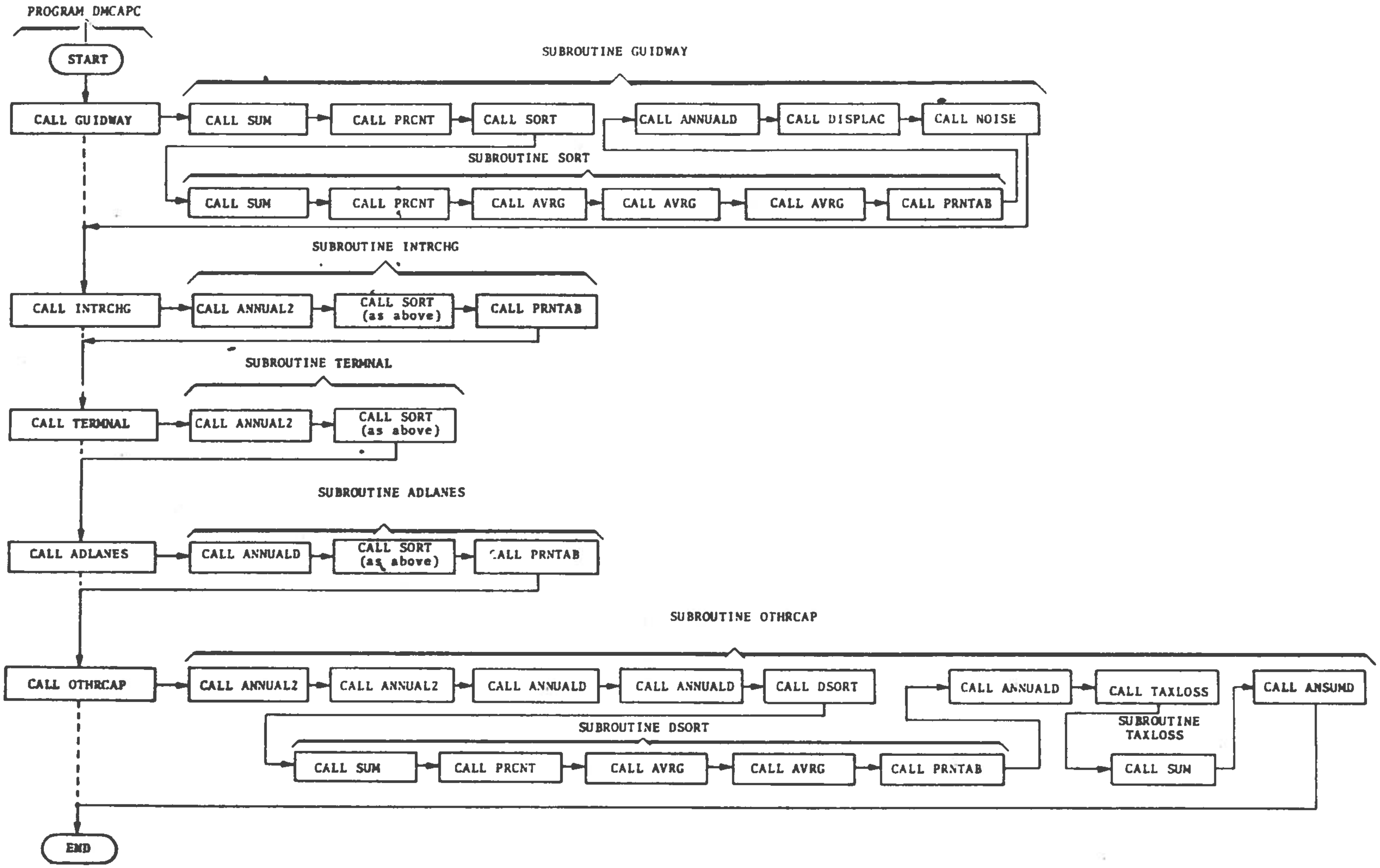


FIGURE 3-17 Sequence of Subroutine Calls of Overlay 1.0 (DMCP)

3.2.2 Subroutine GUIDWAY

Subroutine GUIDWAY performs many calculations that are related to the design, and costing of the mainline portions of the guideway (guideway proper). A typical section of a network is shown in figure 3-18 with the guideway proper shaded and identified by an "A".

The geometrics of the guideway proper is described by link notation. A link is defined as the connection between two nodes where nodes can be either terminals or interchanges. Thus, in the simple network in figure 3-19 there are 11 links connecting the 8 terminals and 2 interchanges. Links, were further subdivided into "link segments" in order to more microscopically describe their characteristics. As shown in figure 3-20 , the link from A to B traverses two geographic areas bounded by the dotted line. Furthermore, the link crossed two different land use boundaries, and one portion of it is expected to be built at-grade while the other is expected to be tunneled. This link is therefore comprised of five unique segments.

The major functions of subroutine GUIDWAY include the following (see figure 3-21):

1. compute design hour expected vehicle loadings.
2. compute design hour person and vehicle flows in each direction of travel and total flows per link

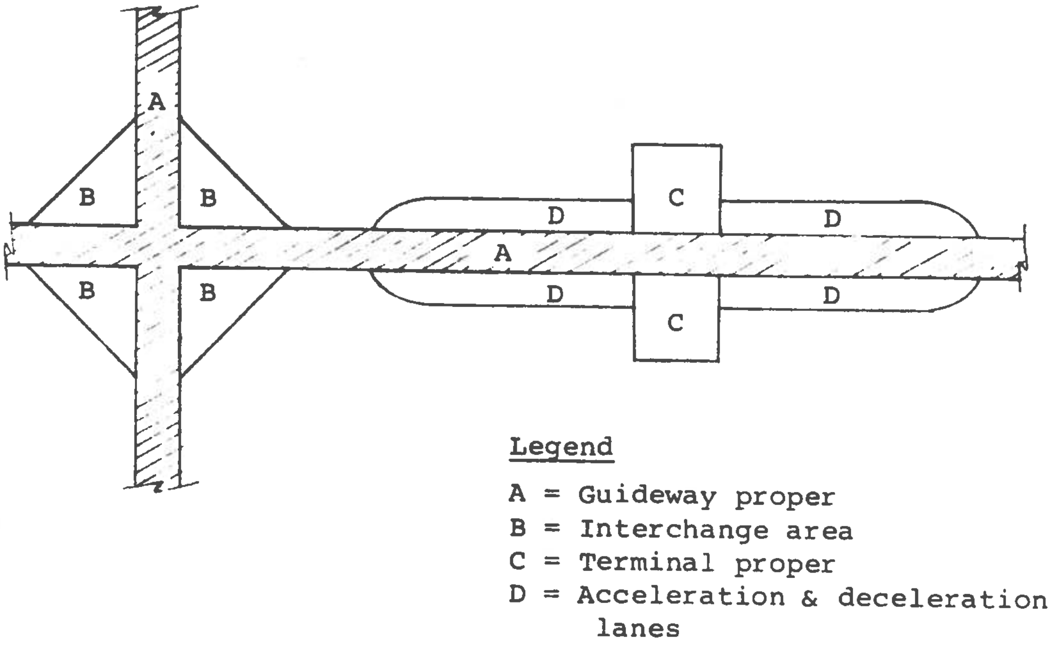


FIGURE 3-18 Components of Network Design Considered by TEAM

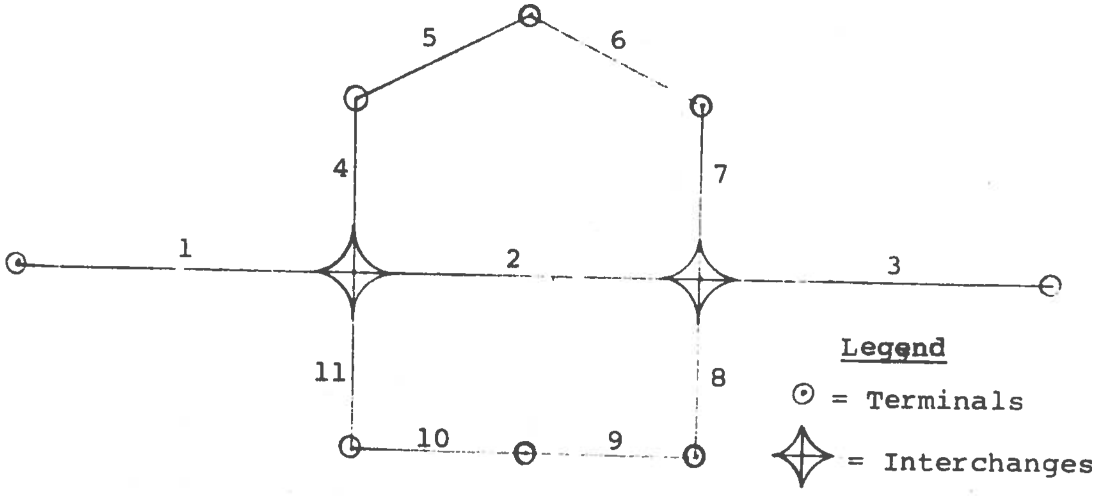
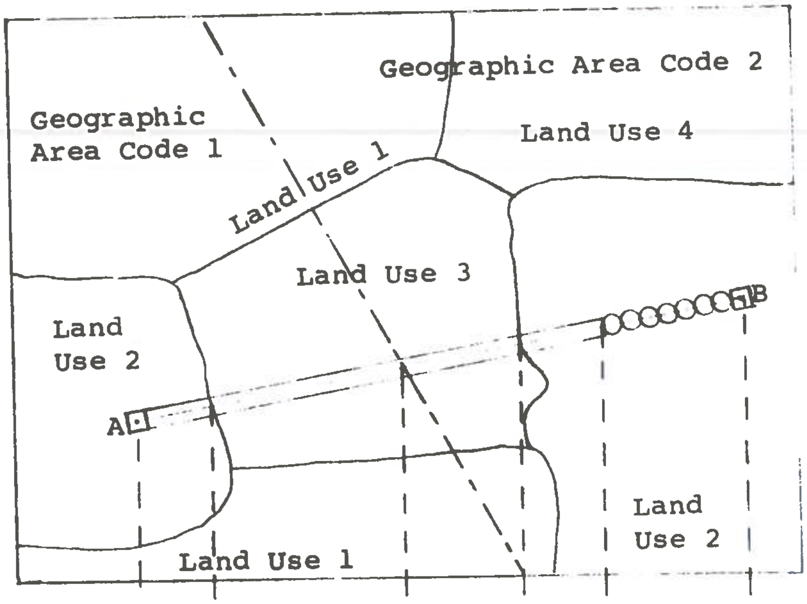


FIGURE 3-19 Network Comprised of Eleven Links



Link A-B Segment No.	1	2	3	4	5
Geographic Area Code	1	1	2	2	2
Construction Type Code	1	1	1	1	4
Land Use Code	2	3	3	2	2

Legend

⊖ = Tunnel construction code
▭ = At-grade construction code
⊡ = Terminal
---- = Boundary of geographic areas
—— = Boundaries of land use zones

FIGURE 3-20 Link-Segment Composition

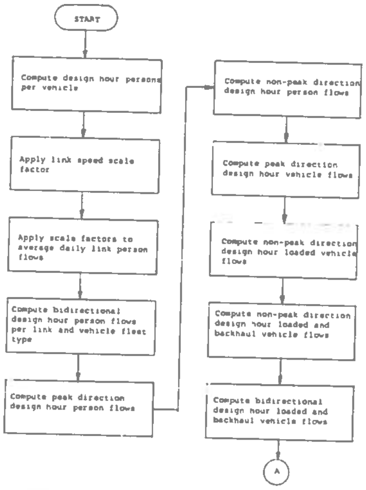


FIGURE 3-2 General Flow Chart - Subroutine GUIDWAY

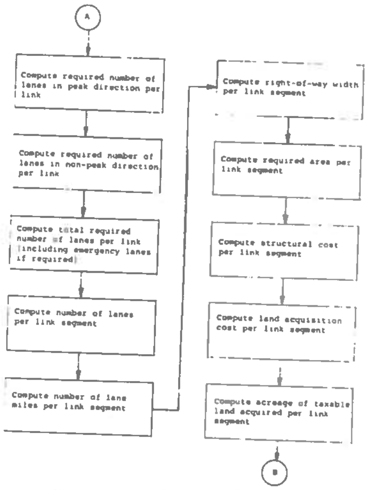


FIGURE 3-2 General Flow Chart - Subroutine GUIDWAY (continued)

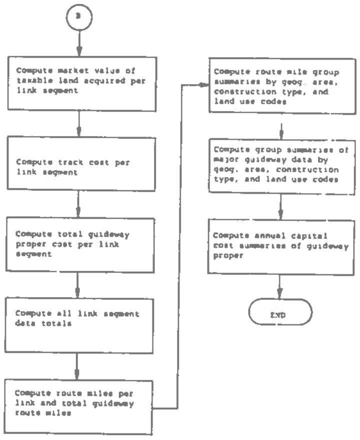


FIGURE 3-2 General Flow Chart - Subroutine GUIDWAY (continued)

3. compute backhaul (empty) vehicle flows.
4. compute the required number of lanes in each direction of flow and total lanes per link segment, including emergency and maintenance lanes.
5. compute number of lane miles of guideway per link segment.
6. compute right-of-way width per link segment
7. compute required area per link segment
8. compute structural cost per link segment
9. compute land acquisition cost per link segment
10. compute acreage of taxable land acquired per link segment
11. compute market value of taxable land acquired per link segment
12. compute track cost per link segment
13. compute total costs per link segment
14. compute route miles per link
15. call SORT to compute system totals and grouped subtotals of major guideway quantities and costs.
16. call ANNUALD to compute annual capital cost summaries of a major guideway proper components.

The inputs to this subroutine come from subroutine RDINPUT and some directly read in from Tape 11.

The first section of the subroutine is designed to compute the total number of lanes required per guideway link. It computes these based upon the expected design hour person flows, the expected vehicle loadings, and the lane capacity. The design hour total (2-directions) person flows per link are obtained by multiplying the daily, two-direction person flows (input) by the appropriate design hour factor for each link (NL).

DONFLO(NL,NV,1) = DONPFL(NL,NV,3) * DPKHRF(NL,NV)

This is done for each vehicle fleet type NV. The design hour two-direction person flows are then separated into peak direction flows, by multiplying the two-direction flows by the appropriate peak direction factor,

DONFLO(NL,NV,2) = DONFLO(NL,NV,1) * DPKDRF(NL,NV);

and into the non-peak direction person flows by subtraction,

DONFLO(NL,NV,3) = DONFLO(NL,NV,1) - DONFLO(NL,NV,2).

These design hour person flows are then converted to design hour vehicle flows per link and vehicle fleet type. In order to do this the expected design hour persons per vehicle (for each vehicle type-NV) is first computed by multiplying the vehicle capacity (persons per vehicle) by the design hour vehicle load factor (percent of vehicle filled), as follows:

DVHLOD(NV) = DVHCAP(NV) * DVHLDF(NV)

The vehicle flows in the peak direction are the person flows in the peak direction divided by the expected persons per vehicle,

DONFLO(NL,NV,5) = DONFLO(NL,NV,2)/DVHLOD(NV)

Similarly the non-peak direction vehicle flows are,

OPFLLD = DONFLO(NL,NV,3)/DVHLOD(NV).

To these <u>loaded</u> vehicle flows in the non-peak direction are added the flows of empty backhaul vehicles (if any). The backhaul flows are a percentage of the flow of vehicles in the peak direction; thus the total vehicle flow in the non-peak direction is,

DONFLO(NL,NV,6) = OPFLLD + BACKON(NL,NV,1) *
DONFLO(NL,NV,5)

The total two-direction vehicle flows per link and vehicle types is the sum of the flows in the peak and non-peak directions.

DONFLO(NL,NV,4) = DONFLO(NL,NV,5) + DONFLO(NL,NV,6)

The number of lanes required per link is the vehicle flow (D=demand) divided by the lane capacity for vehicles of that type and operating characteristics. When more than one vehicle type operates on the system the number of lanes is the sum of the individual number of lanes required for each vehicle system type.

$$\text{Total number of lanes} = \sum_{nv=1}^{nvm} \frac{D_{nv}}{Cnv}$$

where; NVM = maximum number of vehicle fleet types;

D_{nv} = the vehicle demand

C_{nv} = the lane capacity

Fractional number of lanes are rounded up to the next whole number. The number of lanes in the peak direction and in the non-peak direction are computed separately and then added to get the total lanes per link. The model at this point can distinguish if a link is a one or two-way link. It is one-way if the person flow in the non-peak direction is zero.

The model user can elect to design a system which provides for an additional emergency lane under certain circumstances. The logic for adding emergency lanes states that a one-way link requires a minimum of two lanes, and a two-way link requires a minimum of three lanes.

Thus, if repairs have to be made on the guideway or if a vehicle breaks down on a lane, there will be at least one lane available per direction of travel. If a two-way link normally requires 3 or more lanes (or 2 or more for one-way links) no additional emergency lanes are added. The assumption is made that maintenance can be done during off-peak periods; and that if a vehicle breaks down during peak periods service would still be available (at a reduced level) in each direction of travel.

At this point in the subroutine , guideway link-segment calculations are performed. The lane miles per segment are the number of lanes times the segment length.

DGSGST(NS,5) = DGSGST(NS,16) * DGSGST(NS,15)

where, NS = the segment index.

A table of guideway widths (input in feet) as a function of number of lanes is searched to find the width of the guideway.

DGSGST(NS,17) = DGWDTH(LNS)

where, LNS = the number of lanes in the link segment.

The right-of-way (R.O.W.) area (acres) is the length of the segment times its width.

DGSGST(NS,4) = DGSGST(NS,15) * DGSGST(NS,17) * (5280./43560.)

The structural cost of the guideway segment is the number of lane miles times the unit cost per lane mile of that type of construction (K).

DGSGST(NS,6) = DGSGST(NS,5) * USTRUC(K)

The land acquistition cost is the area times the unit cost per acre in land cost category LC.

DGSGST(NS,7) = DGSGST(NS,4) * ULANDC(LC)

The acquired land is then checked to see if it is currently taxable land (i.e., $6 \leq LC \leq 10$). If so, then the taxable land area (acres) and the market value of the land are respectively equal to the R.O.W. area and the acquisition cost.

DGSGST(NS,10) = DGSGST(NS,4),
DGSGST(NS,11) = DGSGST(NS,7).

The track cost per link segment is the number of lane miles times the unit cost of track ($ per lane mile).

DGSGST(NS,8) = DGSGST(NS,5) * UTRAKC

Finally, the total guideway proper cost per link segment is the sum of the structural cost, the land acquisition cost, and the track cost.

DGSGST(NS,9) = DGSGST(NS,6) + DGSGST(NS,7)
+ DGSGST(NS,8)

At this point the subroutine computes the totals of these data types for the entire system, and then computes the route miles of guideway per link by adding the component segment lengths of each link. The link segment data with system totals is printed as shown in Appendix D.

Subroutine GUIDWAY calls subroutine SORT (see section 3.2.13) to sort and sum these major guideway data types with respect to each combination of geographic area code, construction type code, and land use code.

Finally subroutine ANNUALD is called to annualize and sum the costs of the major components (land, track, and structures) of the guideway proper subsystem. The guideway proper annual cost table is shown in Appendix D.

For purposes of program efficiency (in this case to minimize core requirements), subroutine GUIDWAY calls subroutines DISPLAC and NOISE before returning control to program DMCAPC.

3.2.3 Subroutine DISPLAC

Subroutine DISPLAC computes the number of dwellings (or persons, depending on the type of input data) that are displaced due to the construction of the new system guideway (See Figure 3-22). Note, that this subroutine does not compute the displacements due to the construction of interchanges, terminals, acceleration and deceleration lanes, and other miscellaneous land takings.

The routine assumes that there will be no displacements under the following conditions:

- When the system construction is tunneled,
- When the R.O.W. is through open spaces, such as parkland; and
- When the new system's R.O.W. is on an existing system's R.O.W. which is wider than the new system's width.

The displacement area is computed for each link segment in the network as follows (Figure 3-23):

- IF any of the above conditions are met there is no displacement area;

  DGSGST(NS,21) = 0.0,

  where NS = the segment index

- If the new system is on a new R.O.W. (i.e., not on an existing system R.O.W.), then the displacement area is the equal to the

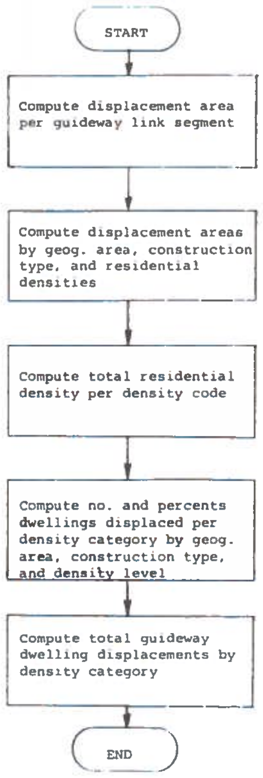


FIGURE 3-22 General Flow Chart - Subroutine DISPLAC

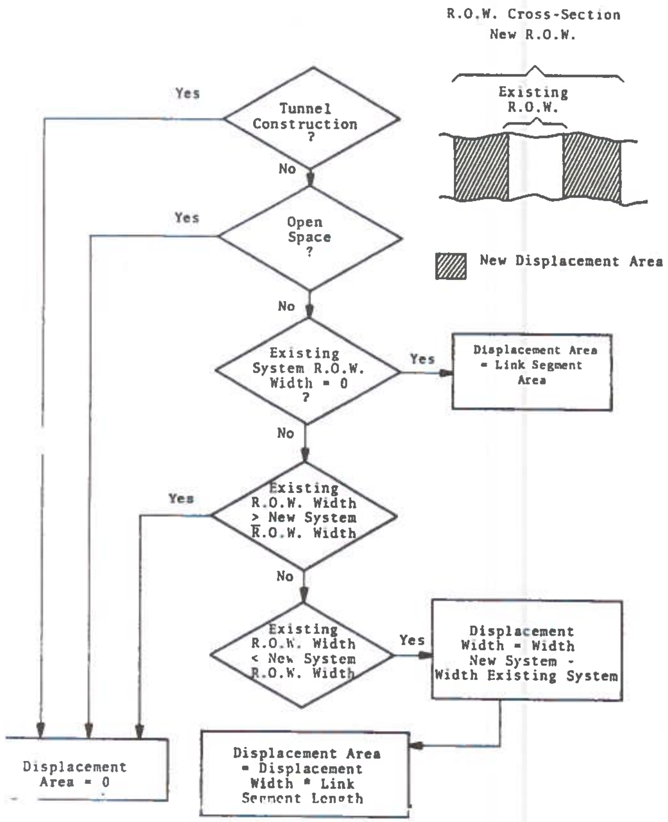


FIGURE 3-23 Calculation of Displacement Area

area of the segment (computed in subroutine GUIDWAY);

```
DGSGST(NS,21) = DGSGST(NS,4)
```

- If the new system's R.O.W. is over the R.O.W. of an existing system whose guideway width is narrower than the width of the new system guideway, then the displacement area is the new system's width (ft.) less the existing system's width (ft.) times the segment length (miles);

```
DGSGST(NS,21) = (DGSGST(NS,17) - DGSGST(NS,18)) *
                       DGSGST(NS,15) * (5280./43560.)
```

The displacement areas of each link are then grouped and summed according to each combination of the following:

- Geographic Area Type,
- Construction Type, and
- Residential Density Category.

Four residential density categories are provided (input - See Appendix, pg. D-11). Each category comprises a different mix and dwelling (or person) density of ethnic and income composition. The ethnic densities (dwellings per acre) in each of the four density categories are subdivided as follows:

- White
- Black
- Other

The income breakdowns are according to:

- Low income
- Medium income
- High income

The grouped displacement areas are then multiplied by the corresponding residential densities to obtain the number of dwellings (or persons) that are displaced per ethnic and income breakdown (See Appendix, page D-12).

3.2.4 Subroutine NOISE

Subroutine NOISE computes the number of dwellings (or persons) that are adversely impacted by noise that emanates from the new system's guideway operation (Figure 3-24). Noise attributable to terminals, interchanges, acceleration and deceleration lanes, and other subsystems are not computed in this subroutine.

The routine assumed that there will be no adverse noise impacts under the following conditions:

- When the new system guideway construction is tunneled,
- When the new system guideway construction is below grade, and
- When the new system guideway passes through open spaces, such as parkland.

Noise impacts (dwellings affected) are computed for both daytime and nighttime system operations. There are two alternative methods of calculating noise impacts, depending on the existing system status code: segments having a code 1 (guideway on new or abandoned R.O.W.) are treated differently from segments having codes 2-11 (guideway on freeway, operating railroad, or rapid transit).

For segments having an existing system status code 1, the routine searches the noise impact distance tables for daytime and nighttime operations (see Appendix, pages D-14 and D-17) to find the distances corresponding to the physical and operational characteristics of

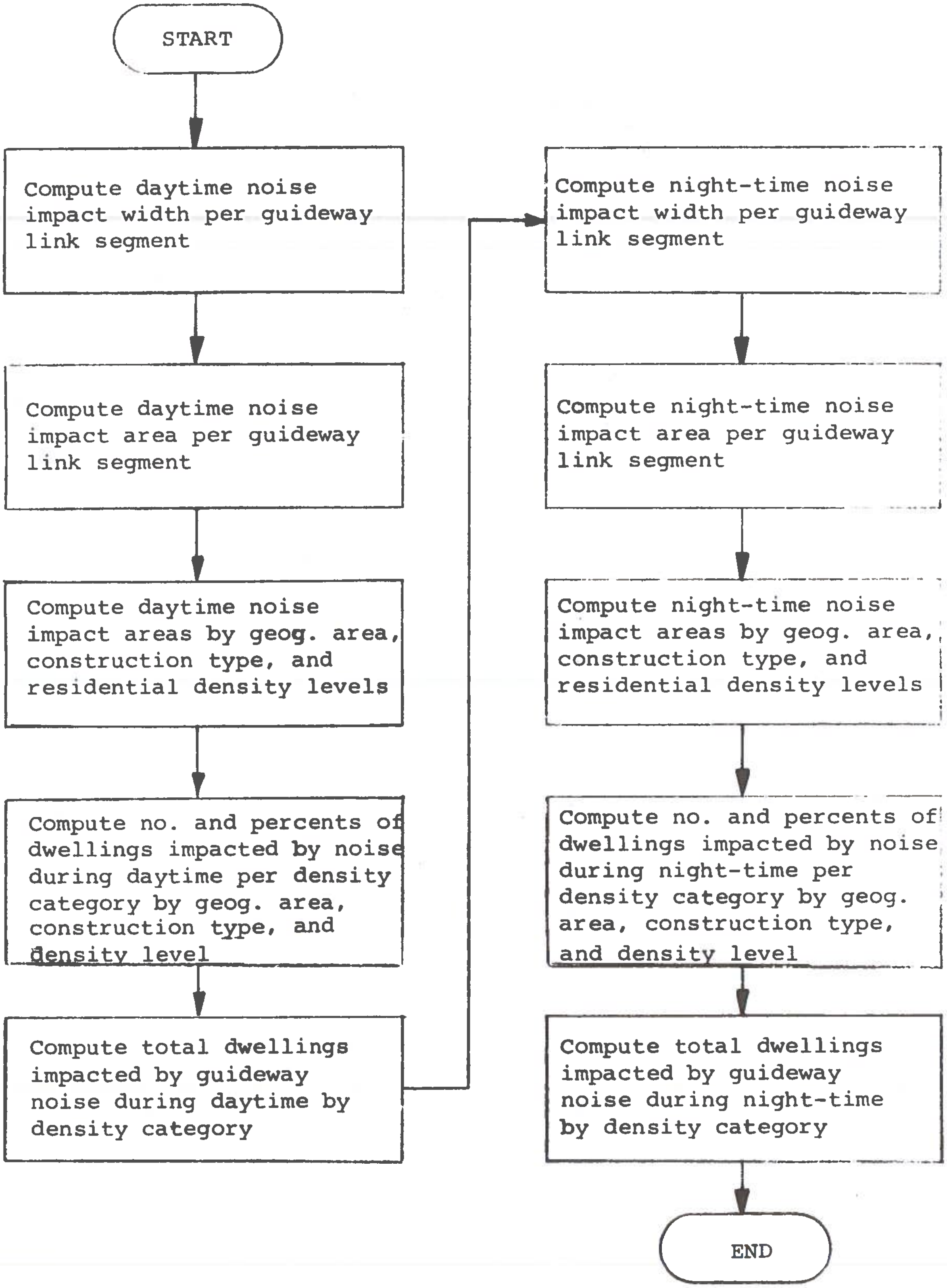


FIGURE 3-24 General Flow Chart - Subroutine NOISE

each link segment. Having found the impact distance (DNOISE) for a segment, the total noise impact impact width (W2) is computed by subtracting the largest of the widths of the existing system (if any) and the new system R.O.W. (See Figure 3-25) from twice the impact distance.

W2 = 2 * DNOISE - W1

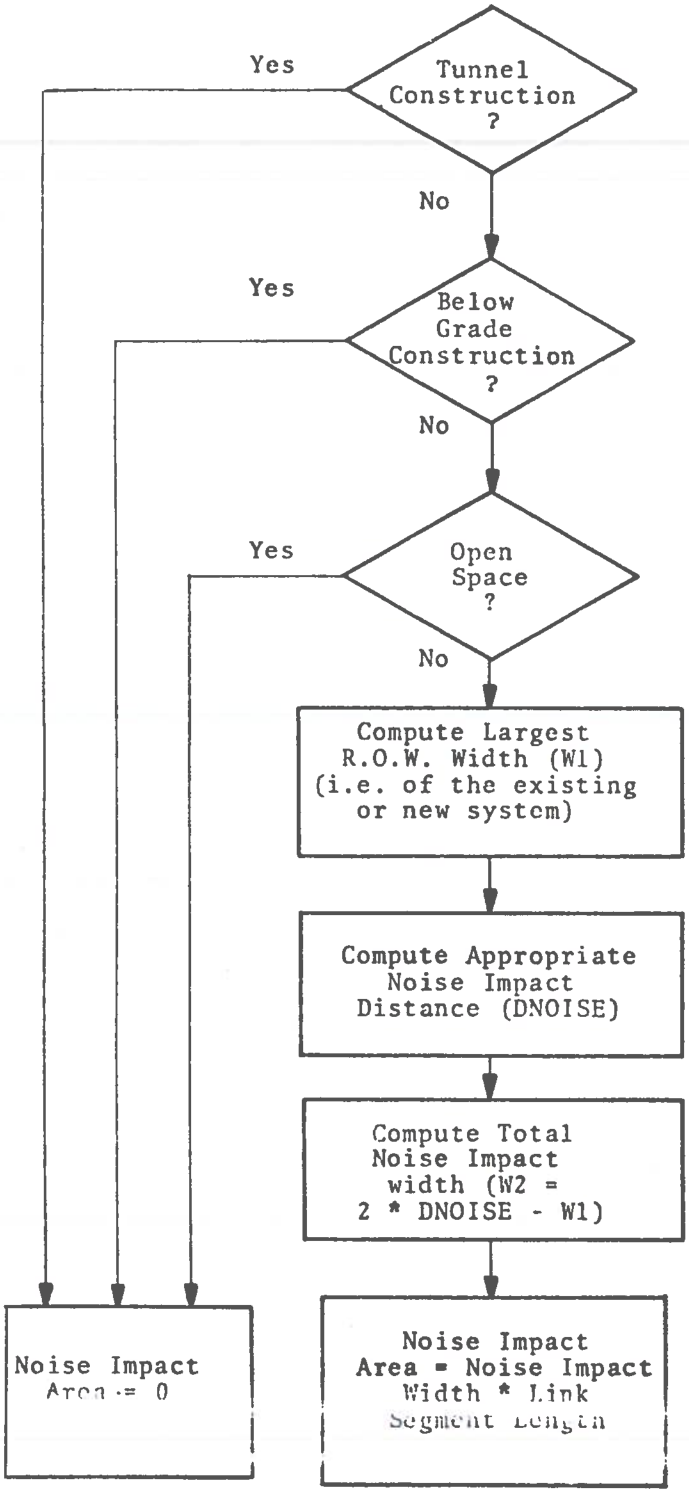
Then the total noise impact area (acres) of the segment is the total noise impact width (feet) times the segment length (miles):

DGSGST(NS,22) = W2 * DGSGST(NS,15) * (5280./43560.)
where, NS is the segment index

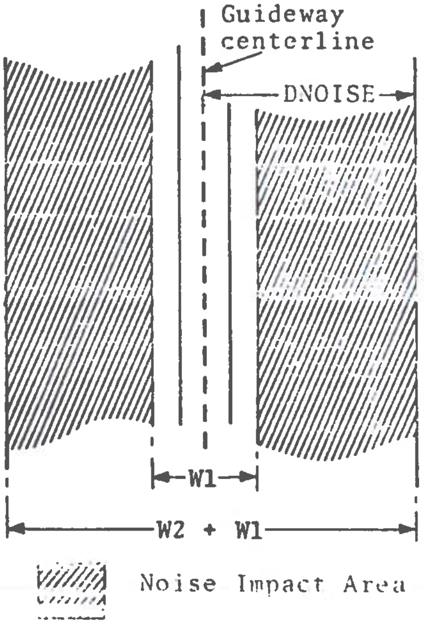
The noise impact areas for daytime and nighttime operation are shown respectively in the Appendix on pages D-13 and D-16.

For segments having codes 2-11, the input data for noise impact calculations consist of the net incremental noise impact distance due to Dual Mode (over and above the noise distance attributable to the existing system), rather than the total noise impact distance (due to the new and existing systems) measured from the centerline of the guideway. Thus, for example, a 4-lane at-grade Dual Mode system with vehicles operating at 60 mph along a 6-lane at-grade freeway would have a daytime noise impact distance of only 10 feet, as opposed to the value shown in the Appendix, page D-14 of 480 feet (because the highway accounts for the first 470 feet of adverse impact).

FIGURE 3-25 Calculation of Noise Impact Area



Cross Section of Noise Impact Zone



DNOISE = Noise Impact Distance
W1 = Width of Widest System
W2 = Noise Impact Width

As indicated in Figure 3-25, the noise impact width for a segment located on highway, operating rail, or rapid transit R.O.W. is computed by multiplying the net incremental noise impact distance (DNOISE) by 2.

The noise impact areas of each link segment are then grouped in each combination of the following three categories:

- Geographic area type,
- Construction type, and
- Residential density category.

These grouped areas are then multiplied by the ethnic and income dwelling (or person) densities which correspond to the identified residential density category of each subgroup. The outputs comprise two tables (day and night) which show the numbers of dwellings impacted by noise according to the ethnic and income breakdowns itemized in Subroutine DISPLAC. These outputs are shown in the Appendix, pages D-15 and D-18.

3.2.5 Subroutine INTRCHG

The purpose of subroutine INTRCHG is to compute all interchange statistics. For computational purposes an interchange is defined as being comprised of those additional quantities required to build an interchange above and beyond those required to build the basic guideway intersecting at ninety degrees. For example, in the one-way by one-way intersection shown in Figure 3-26 the additional track length required is lengths AB plus CD. Similarly the R.O.W. area for the same interchange is shown as the shaded area in Figure 3-26 . The reason for this definition is that the guideway proper quantities were computed between nodes where nodes are either the centers of terminals or centers of interchanges. Thus track lengths AD and CB and the non-shaded areas in Figure 3-26 have already been computed in subroutine GUIDWAY.

Subroutine INTRCHG performs the following functions (see Figure 3-27):

1. Computes the additional R.O.W. cost per interchange
2. Computes the additional cost of track for ramps per interchange
3. Computes the total additional capital cost per interchange
4. Computes the acreage of taxable land acquired per interchange

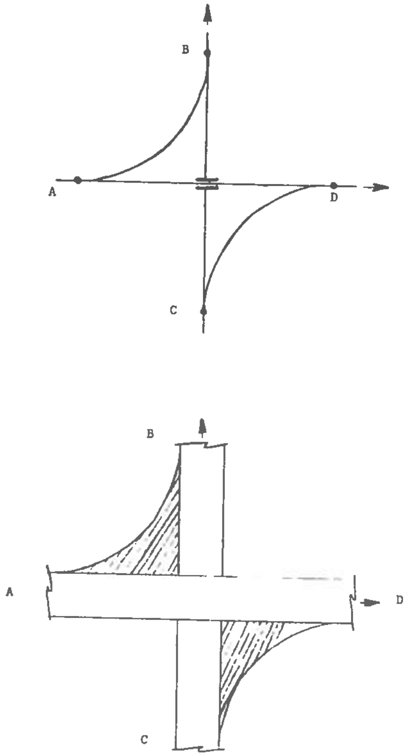


FIGURE 3-26 Interchange Area Definition

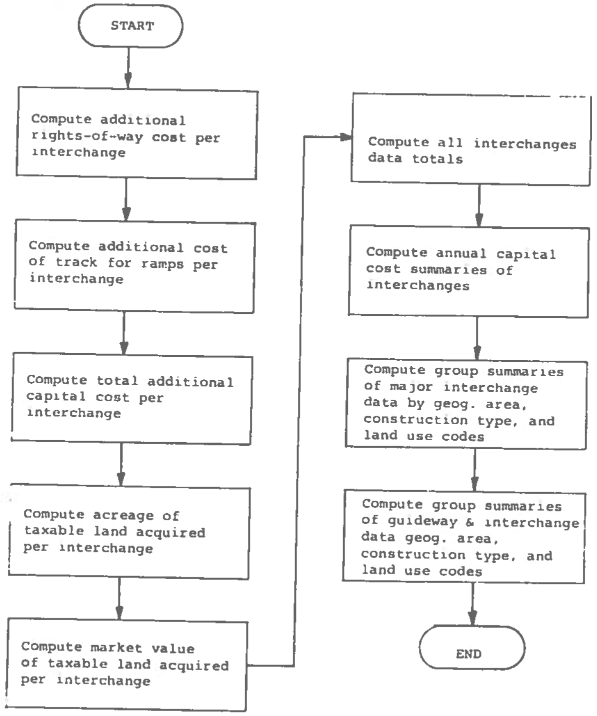


FIGURE 3-27 General Flow Chart - Subroutine INTRCHG

5. Computes the market value of taxable land acquired per interchange
6. Computes the totals of input and computed data for all system interchanges
7. Computes the annual cost summaries for all interchange totals
8. Prints the interchange input and output data

The subroutine first acquires the user input data from subroutine RDINPUT and from Tape 11. The second set of data on Tape 11 houses the interchanges input statistics.

Subroutine INTRCHG then proceeds to compute the first five items listed above, one interchange at a time. First, the additional R.O.W. cost per interchange is computed by searching the appropriate unit land cost which corresponds to the input land cost code (LC) (see section 4.1.2 for a detailed description of land cost codes). The additional R.O.W. cost is then equal to the area times the appropriate cost per area;

```
DINTST(NI,7) = DINTST(NI,4)*ULANDC(LC)
```

Similarly the additional track cost is the additional track length times its unit cost;

$$DINTST(NI,8) = DINTST(NI,5)*UTRAKC$$

The total capital cost of an interchange is the sum of the structural cost, the land cost, and the track cost;

$$DINTST(NI,9) = DINTST(NI,6) + DINTST(NI,7) + DINTST(NI,8)$$

The model then computes the percentage that each component cost is of the total interchange cost.

It then determines if the land acquired is taxable land ($5 < LC \leq 10$).
If so, the taxable acreage and taxable land market value are equal to the land acquisition area and land acquisition cost respectively.

Data items (NID) 4 through 11 (see FIGURE 4-71) are then summed over all guideway interchanges in the system.

$$\sum_{NID=4}^{11} \sum_{NI=1}^{NIM} DINTST(NI,NID)$$

Input and output interchange data are then printed for each interchange and all interchanges (see Table D-19).

Subroutine INTRCHG at this time calls subroutine ANNUAL2 which computes the annual capital cost summaries of the total system interchanges as well as the total system interchange land cost, track cost, and construction cost (see Table D-20).

Finally subroutine SORT is called to sort all interchange data according to the appropriate combination of geographic area, construction type, and land use. The sorted interchange data is added to the sorted guideway data. This data is then printed through calls to subroutine PRNTAB. These summations are stored in GROUP3 array for subsequent entire system data totals of data NID=4 through 11.

At this point control is returned to program DMCAPC which calls the next subroutine TERMNAL.

3.2.6 Subroutine TERMNAL

Subroutine TERMNAL performs sizing and costing computations related to terminals. A terminal is defined to be all physical elements (such as buildings, platforms, parking lots, land, and track) located within an identifiable area for ingress and/or egress of persons and/or vehicles to a new system guideway. Acceleration and deceleration lanes used for systems such as dual-mode and personal rapid transit are not considered by the TEAM model to be part of the terminal except for those portions of track located within the terminal area itself. Sizing and costing of acceleration and deceleration lanes is done by subroutine ADLANES. The TEAM model presently subdivides a terminal into three separate subparts for costing purposes, as follows:

- Parking Area - for parking of off-guideway vehicles,
- Vehicle Storage Area - for parking of on-guideway vehicles, and
- Terminal Proper Area - for vehicle and passenger processing and all other terminal related functions.

The subroutine considers the cost of land, track, and structures for each of these subparts. The parking area, however, has no track cost associated with it. Numerous inputs (from Tape 11) are provided by the user for each terminal at this level of disaggragation (see figure 4-72).

Subroutine TERMNAL proceeds to aggregate this data in a similar manner as the previous two subroutines computed guideway and interchange data. Subroutine TERMNAL also performs a design function. The user needs only to specify a terminal design type (coded) and the worst expected one-way egress or ingress person flows (design hour flows) through the terminal. The subroutine uses this information to compute the area and lane miles of track in the terminal proper area. Ten terminal design types are provided for. Each design type has two unique equations to quantify the area and track length required for the expected design hour demand. These terminal design types and their estimating relationships are described in detail in Volume II, Section 5.6.

The routine then performs the remaining terminal sizing and costing computations (figure 3-28) as follows:

- The area of a terminal (acres) is the sum of the areas of the parking area, vehicle storage area, and the terminal proper area;

  DTERST(NT,4) = DTERST(NT,15) + DTERST (NT,16) + DTERST(NT,21)

  where, NT = terminal number

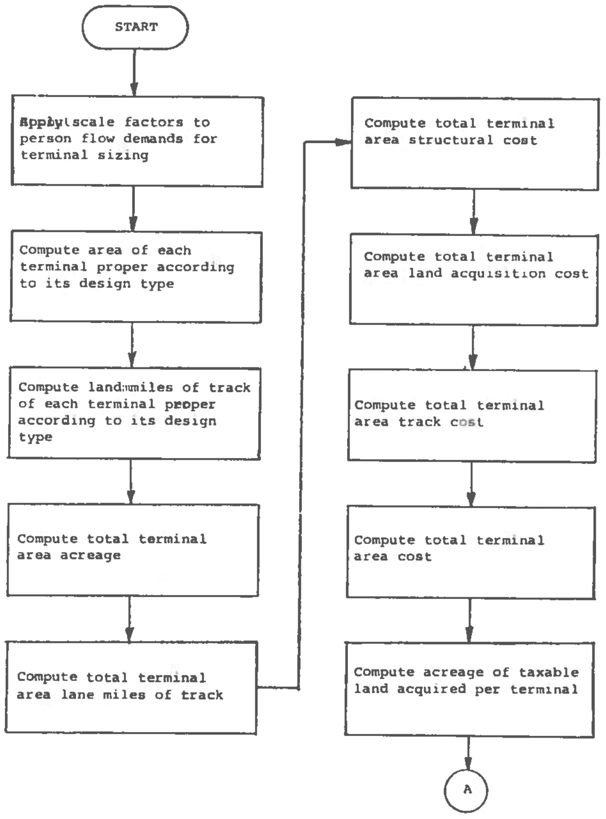


FIGURE 3-28 General Flow Chart - Subroutine TERMNAL

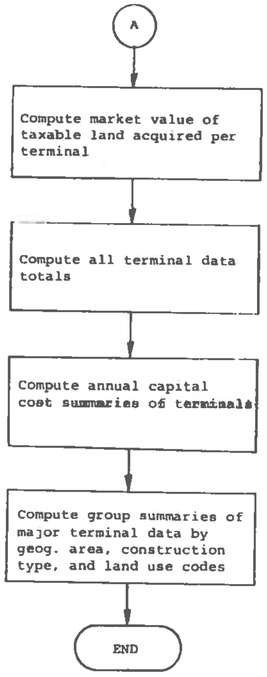


FIGURE 3-28 General Flow Chart - Subroutine TERMNAL (continued)

- The total track length (lane miles) in a terminal is the sum of the lane miles of track in the vehicle storage area, and the terminal proper area;

  DTERST(NT,5) = DTERST(NT,17) + DTERST (NT,22)

- The total structural cost of a terminal is the sum of the structural cost of the parking area, the vehicle storage area, and the terminal proper area;

  DTERST(NT,6) = DTERST(NT,18) + DTERST (NT, 19) + DTERST (NT,20)

- The total land acquisition cost for a terminal is the total area of the terminal times the unit cost of the land ($/acre);

  DTERST(NT,7) = DTERST(NT,4) * ULANDC (LC)

  where, LC = the land cost code

- The total terminal area track cost is the total track length in a terminal times the unit track cost ($/lane mile);

  DTERST(NT,8) = DTERST(NT,5) * UTRAKC

- The total cost of a terminal is the sum of the total structural cost, land acquisition cost, and track cost;

  DTERST(NT,9) = DTERST(NT,6) + DTERST(NT,7) + DTERST(NT,8)

- The taxable land acreage and market value associated with the land acquired for the terminal is computed the same way as described for guideways and interchanges.

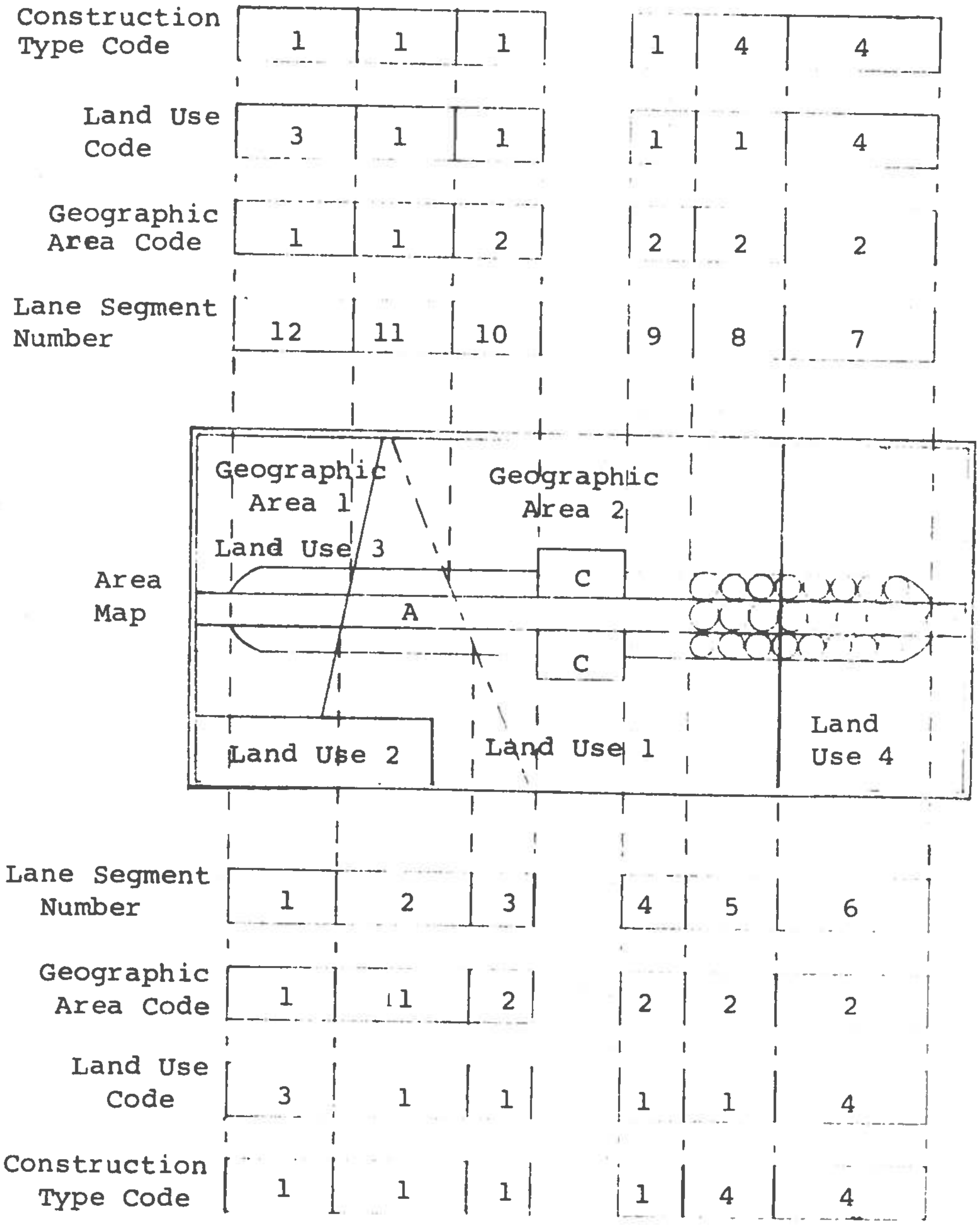
The remainder of the subroutine computes the system totals, calls SORT to group the data by each combination of geographic area code, construction type, and land use, and calls subroutine ANNUALD to annualize the major terminal capital cost components. Control is then returned to Program DMCAFC.

3.2.7 Subroutine ADLANES

The function of subroutine ADLANES is to size and cost all the acceleration and deceleration lanes on the new system guideway (if the new system design requires them). The terminal C shown in figure 3-29 has two acceleration lanes and two deceleration lanes. Since these lanes can be rather long depending upon numerous performance characteristics (principally operating speed and the design limit of acceleration or deceleration), the subroutine provides for the decomposition of all acceleration and deceleration lanes associated with a terminal into lane segments. The lane segment principal is similar to the link segment principal described in subroutine GUIDWAY. This provides the user to more microscopically describe the characteristics associated with different sections (lane segments) of the lanes. In figure 3-29 there are 12 lane segments associated with terminal C. A specific lane segment in a network is identified by the number of the terminal it serves and by a segment number. Segment numbering begins with lane segment number "1" at each terminal, and the remaining segments are numbered sequentially in any desired pattern.

Subroutine ADLANES computes the following quantities and costs for each lane segment:

- The structural cost of a segment is the lane-miles of that segment times the structural unit cost ($ per lane mile),



Legend

A = Guideway proper
C = Terminal
— - — = Boundary of geog. areas
○ = Tunnel construction
▭ = At-grade construction
—— = Boundaries of land use zones

FIGURE 3-29 Accel./Decel. Lane-Segment Codification

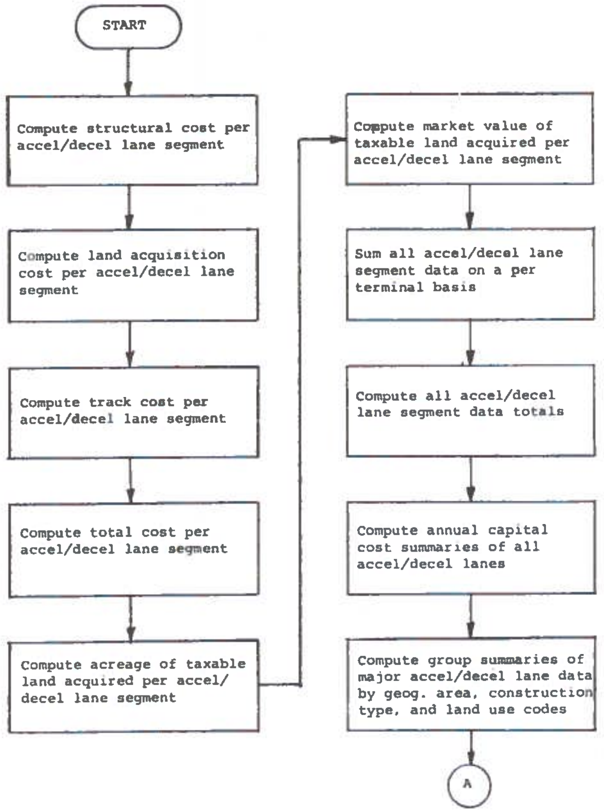


FIGURE 3-30 General Flow Chart - Subroutine ADLANES

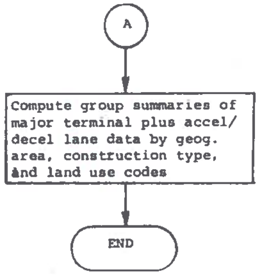


FIGURE 3-30 General Flow Chart - Subroutine ADLANES (continued)

DTSGST(NTS,6) = DTSGST(NTS,5) * USTRUC(K)

where, K = the construction type, and

NTS = the link index counter

- The land acquistion cost is the area of the segment times the cost per acre,

  DTSGST(NTS,7) = DTSGST(NTS,4) * ULANDC(LC)

  where, LC = the land cost code

- The track cost of a segment is the segment length (lane miles) times the cost per lane mile,

  DTSGST(NTS,8) = DTSGST(NTS,5) * UTRAKO

- The total cost of each segment is the sum of the costs of the structures, the land, and the track,

  DTSGST(NTS,9) = DTSGST(NTS,6) + DTSGST(NTS,7) + DTSGST(NTS,8)

- The acreage of taxable land and the market value are respectively equal to the acquired land area, and acquisition cost for land cost codes 6 through 10, or zero for land cost codes 1 through 5,

  DTSGST(NTS,10) = DTSGST(NTS,4)

  DTSGST(NTS,11) = DTSGST(NTS,7)

These data, including the input area and track length, are then summed for all segments in each terminal, and then summed again for all terminals to produce the system totals.

Subroutine ANNUALD is then called to annualize the acceleration and deceleration lanes major component costs (track, land and structures). Finally subroutine SORT is called to group the individual units and costs into each combination of geographic area, construction type and land use. A call to subroutine PRNTAB causes the sums of this grouped data (i.e. the sums of grouped accel/decel lane data and grouped terminals data) to be printed. This intermediate grouped total is added to the intermediate grouped totals of guideways and interchanges data, to be saved for a final <u>all</u> systems totals grouped data summary. At this point control is returned to program DMCAPC.

3.2.8 Subroutine OTHRCAP

Subroutine OTHRCAP computes all other capital costs of the new system. These costs are those of the following subsystems:

- Control center
- Maintenance facility
- Vehicle storage yards
- Way command and control
- Vehicle (s)

Control Center Subsystem -

The control center computations are the following:

- The land acquisition cost is the area of the land (input) times the unit cost per acre;

  DCNCEN(8) = DCNCEN(5) * ULANDC(LC)

  where LC = land cost code

- The total cost of the control center is the sum of the structure cost (input), the computer facilities cost (input), and the land cost;

  DCNCEN(9) = DCNCEN(6) + DCNCEN(7) + DCNCEN(8)

- The acreage of taxable land and its market value, if any, are equal respectively to the land acquisition area and the acquisition cost if the land prior to acquisition is taxable ($6 \leq LC \leq 10$).

Subroutine ANNUAL2 is called to annualize the control center component costs, and print the output shown in Appendix D.

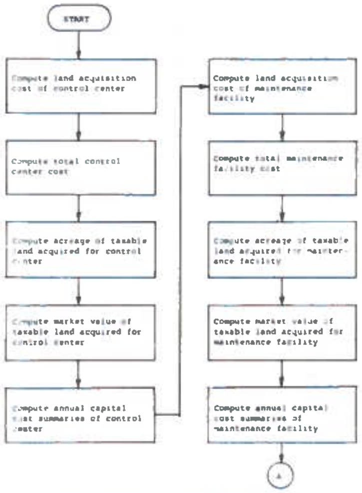


FIGURE 3-31 General Flow Chart - Subroutine CTHRCAP

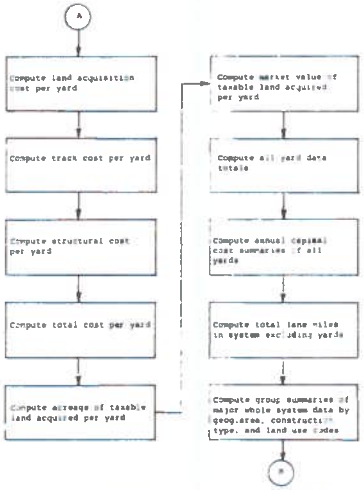


FIGURE 3-31 General Flow Chart - Subroutine CTHRCAP (continued)

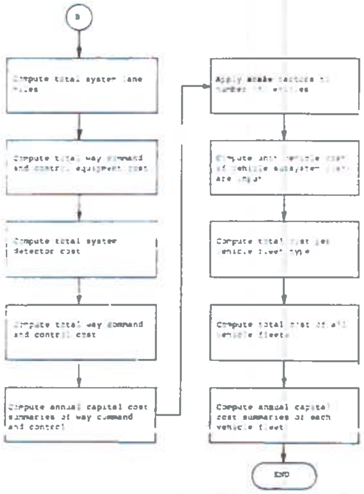


FIGURE 3-31 General Flow Chart - Subroutine CTHRCAP (continued)

Maintenance Facility Subsystem-

The maintenance facility is subdivided into two cost elements - the land, and the structures and related equipment. The following computations are made:

- The land cost of the facility is the area times the cost per acre;

  DMAINT(7) = DMAINT(5) * ULANDC(LC)

- The total maintenance facility cost is the cost of the structures and equipment plus the cost of the land;

  DMAINT(8) = DMAINT(6) + DMAINT(7)

- The taxable acreage and market value of the land are computed as described above.

The maintenance facility data is printed, and then subroutine ANNUAL2 is called to annualize the component cost and to print the annual cost table shown in Appendix D.

Vehicle Storage Yards-

The subroutine provides for a maximum of four different vehicle storage yards in the system. More yards can be analyzed by re-dimensioning the DYARDS (NY, NYD) array such that NY equals one more than the number of yards. The yard computations are the following:

- The land acquisition cost of a yard is the area (acres) of that yard times the unit land cost ($/acre);

  DYARDS(NY,8) = DYARDS(NY,5) * ULANDC(LC)

  where, LC = land cost code
  NY = the yard index number

- The cost of track in a yard is the lane-miles of track times the cost per lane mile;
  DYARDS(NY,9) = DYARDS(NY,7) * UTRAKC
- The structural cost of a yard is the area of the yard times the average cost per acre;
  DYARDS(NY,10) = DYARDS(NY,5) * DYARDS(NY,6)
- The total cost of each yard is the sums of the cost of the land, the track, and the structures;
  DYARDS(NY,11) = DYARDS(NY,8) + DYARDS(NY,9) + DYARDS(NY,10)
- The taxable land area and market value of each yard are computed as described earlier.
- These data are then summed over all yards in the system, and the data is printed as shown in Appendix D, page 29.

Subroutine ANNUALD is called to annualize the yard component costs see Appendix D.

The areas, track lengths, and costs associated with the control center, maintenance facility, and yards are added to the GROUP3 array to produce the total system grouped summary data. This grouped summary data provides system totals for each combination of geographic area, construction type, and land use datagory. Subroutine DSORT sorts, sums, and calls PRNTAB to print this grand total grouped data.

Way Command and Control-

The way command and control capital costs consist of all costs which may most appropriately be costed on a route-mile basis (i.e., equipment), and those elements which may be costed on a lane-mile basis (such as detectors). These two unit costs are input by the user and the following is computed:

- The total system equipment cost is the unit cost of the equipment ($ per route-mile) times the total route-miles in the system;

  DWAYCC(3) = DWAYCC(1) * DTRTMI
- The total detector cost is the unit cost of detectors ($ per lane-mile) times the total lane-miles in the system;

  DWAYCC(4) = DWAYCC(2) * TOLNMI
- The total cost of command and control is the sum of these two costs;

  DWAYCC(5) = DWAYCC(3) + DWAYCC(4)

Subroutine ANNUALD is called to annualize these costs and to print the annual cost table shown in Appendix D.

Vehicle Subsystem-

The subroutine provides for costing as many as three completely different vehicle systems. For example, one might have a dual mode system which permits large dual mode buses, small public rental dual mode vehicles, and private dual mode vehicles all operating on the dual mode guideway simultaneously. Each of these vehicle fleet types can thus have a different number of vehicles and a different unit vehicle cost. The analyst has the option of providing the total unit cost of each vehicle type, or if known he can input the vehicle subsystem unit costs (up to six vehicle subsystems). If the subsystems costs are input, then the routine first computes the total unit vehicle cost for each vehicle type. Then the total cost of each vehicle fleet type is computed by multiplying the unit vehicle cost ($ per vehicle) times the number of vehicles in that fleet;

DVHCST(NV) = DVHUC(NV) * DNUMVH(NV)

where, NV = fleet type index.

Subroutine ANNUALD is called to annualize the costs for each vehicle fleet type and to print the vehicle annual cost table Appendix D.

Subroutine OTHRCAP completes its role by calling subroutine TAXLOSS which computes the annual loss in taxes to the local governments because taxable lands were purchased for the system's deployment, by calling subroutine ANSUMD which summarizes and prints the most important annual cost information from all the individual annual cost tables. Control is then returned to Program DMCAPC which in turn returns control to Program DULMODE in Overlay 0.00.

3.2.9 Subroutine TAXLOSS

Subroutine TAXLOSS computes the revenues lost from taxes on all previously taxable lands acquired for the new system construction. It computes these for each combination of geographic area, construction type, and land use categories as well as for the sums of each category and for the overall system total.

The subroutine uses the market values of the acquired taxable lands which were computed in subroutine OTHRCAP. The market values were stored in array GROUP3 (N, K, L) for N=29 through 32, where;

N = the geographic area code,

K = the construction type code, and

L = the land use code.

The tax loss to the local government agencies is computed for each combination of the above codes by the following equation:

$$\text{TXLOSS}(M,K,L) = \text{GROUP3}(N,K,L) * \text{ASSRAT}(M) * (\text{TAXRAT}(M)/1000.)$$

where;

TXLOSS = the tax loss per code combination (note: M = geographic area code)

GROUP3 = the total market values of acquired taxable lands per code combination

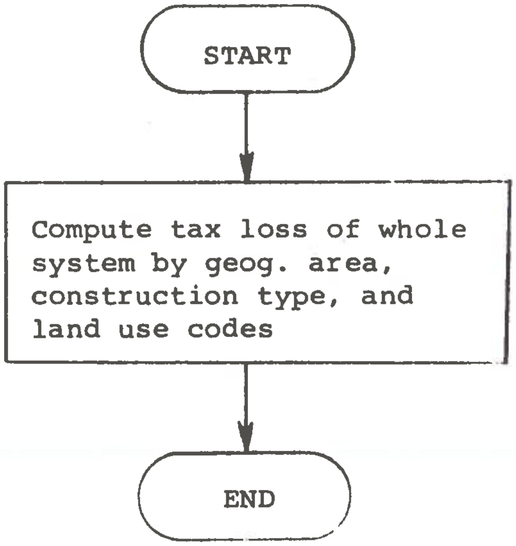


FIGURE 3-32 General Flow Chart - Subroutine TAXLOSS

ASSRAT = the assessment ratio (in decimal percent of full value) applicable to the particular geographic area (M)

TAXRAT = the tax rate (in $ per $1000 of the assessment) applicable to the particular geographic area (M).

Each of the individual tax losses are then summed per code category to provide the overall system tax loss.

Finally, the subroutine prints all the tax loss information as shown in Appendix D.

Note that geographic area 4, construction type 5, and land use 11 represent the sums of the respective categories such that 4, 5, 11 is the overall system total tax loss.

3.2.10 Subroutine DSORT

Subroutine DSORT takes the unsummed grand totals sorted data (from GROUP 3 array) of the eight basic items (see 3.2.13) and sums them according to group code combinations, computes the appropriate percents, and computes the appropriate averages such that the tables in appendix D can be printed for the system grand totals.

3.2.11 SUBROUTINE SUM

The function of this subroutine is to SUM all row, column, and depth elements of a given three-dimensional array. The name of the array to be summed along with the row, column and depth dimensions of that array are specified as arguments in the CALL statement to the SUM subroutine. Since SUM equates the array to be summed to a dummy three-dimensional array, named UNIT, this subroutine can be utilized to sum any three-dimensional array within the program provided that the array has been dimensioned the same as the UNIT array - (5,6,12). Other subroutines (i.e. SUM2, SUM3) exist within the program for the summation of arrays dimensioned other than (5,6,12). SUM2 operates on arrays that are dimensioned by (6,9,4); SUM3 sums arrays that are dimensioned (5,8,5).

The number of rows, columns, and depth layers to be summed are, respectively, the I,J, and M arguments passed to SUM within the CALL statement. The I,J, and M arguments are also utilized to establish the I+1, J+1, and M+1 areas of the array for the storage of the appropriate summations. This is shown in figure 3-33 . Listed below are the seven summations performed by the SUM subroutine:

- Summation of Rows

$$\text{UNIT }(I,J+1,M) = \sum_{J=1}^{J} \text{UNIT }(I,J,M)$$

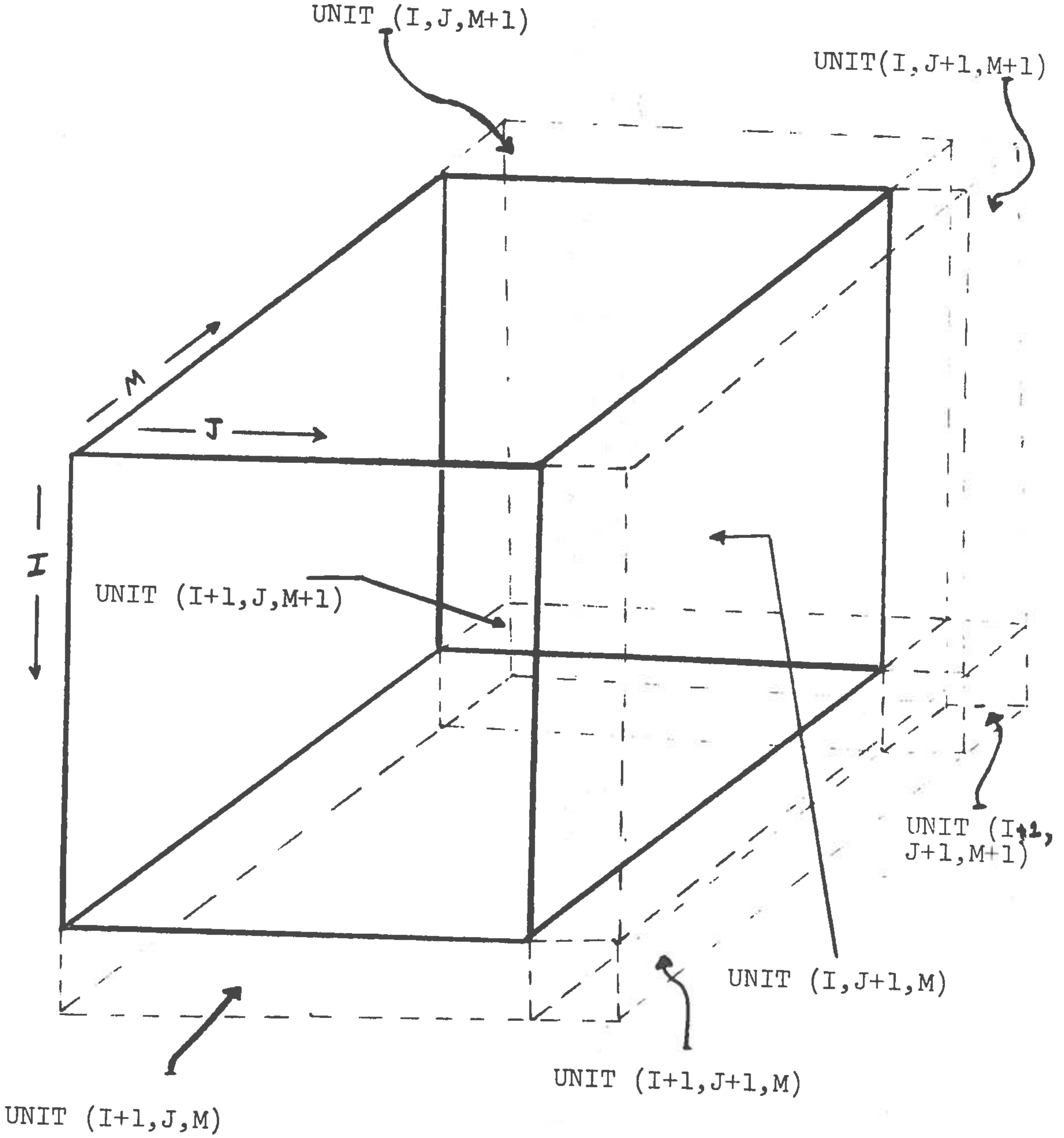


FIGURE 3-33 SUMMATION OF UNIT ARRAY

- <u>Summations of Columns</u>

$$\text{UNIT }(I+1,J,M) = \sum_{I=1}^{I} \text{UNIT }(I,J,M)$$

- <u>Summation Towards Rear</u>

$$\text{UNIT }(I,J,M+1) = \sum_{M=1}^{M} \text{UNIT }(I,J,M)$$

- <u>Summation of Rows and Columns</u>

$$\text{UNIT }(I+1,J+1,M) = \sum_{J=1}^{J} \text{UNIT }(I+1,J,M)$$

- <u>Summation of Rows and Rear Elements</u>

$$\text{UNIT }(I,J+1,M+1) = \sum_{M=1}^{M} \text{UNIT }(I,J+1,M)$$

- <u>Summation of Columns and Rear Elements</u>

$$\text{UNIT }(I+1,J,M+1) = \sum_{M=1}^{M} \text{UNIT }(I+1,J,M)$$

- <u>Summation of All Elements</u>

$$\text{UNIT }(I+1,J+1,M+1) = \sum_{M=1}^{M} \text{UNIT }(I+1,J+1,M)$$

Upon completion of these summations, control is then returned to the calling program or subroutine.

3.2.12 Subroutine PRNTAB

Subroutine PRNTAB is a utility routine used to print the two tables shown in Appendix D. These two tables are each printed seven times (unless suppressed). The first time they are printed the data (Tables A-1 and A-2) represents the summaries associated with the guideway proper, the second time (Tables B-1 and B-2) they represent the summaries associated with all the system interchanges, and the third time (Tables C-1 and C-2) they represent the subtotals of both guideway proper and interchanges (i. e., total guideway related capital costs). The fourth time printed (Tables D-1 and D-2) the data refers to summaries associated with the system terminals, the fifth time (Tables E-1 and E-2) the data reflects the summaries of all acceleration and deceleration lanes in the system, and the sixth time printed (Tables F-1 and F-2) the data is the subtotals of terminal proper statistics plus acceleration and deceleration lanes statistics. This leaves only miscellaneous subsystem costs and quantities computed in subroutine OTHRCAP unaccounted for. Thus the last time the tables are printed (Tables G-1 and G-2) they reflect the grand totals of all the subsystems (including those computed by OTHRCAP).

These tables can be suppressed since quite often the analyst does not need this much detail. Four suppress print codes are used to suppress these seven sets. JSPRNT(26)=1 suppresses the four tables at the subsystem levels (i. e., tables A, B, D, and E).

JSPRNT(18)=1 and JSPRNT(19)=1 suppress table C and F, respectively at the subtotals level, and JSPRNT(16)=1 suppresses the grand total summaries (Table G). The suppression instruction for tables A, B, D, and E is found in subroutine SORT. The suppression statements for Tables C and F are respectively located at the end of subroutines INTRCHG and ADLANES. The suppression statement for the grand summary table (Table F) is in subroutine DSORT.

3.2.13 Subroutine SORT

Subroutine SORT is a utility routine shich sorts and adds eight basic items into each combination of geographic area, construction type, and land use to produce the two tables in appendix D. In this way the analyst can readily identify the subtotals (and grand total) of the eight items associated with each of the three code combinations. The eight computed items so sorted are the following:

- Acreage of all land acquired (IRD = 4)
- Lane miles of guideway (IRD = 5)
- Structrual cost (IRD = 6)
- Acquistion cost of all rights-of-way (R.O.W.) (IRD = 7)
- Track cost (IRD = 8)
- Total cost of R.O.W., track, and structures (IRD = 9)
- Acreage of taxable land acquired (IRD = 10)
- Market value of taxable land acquired (IRD = 11)

This subroutine is called at the end of subroutines GUIDWAY, INTRCHG, TERMNAL, and ADLANES. Each time it sorts the eight items listed for the respective subsystem and stores the sorted data in GROUP1 array until printed by subroutine PRNTAB. Thus the first time SORT is called (in subroutine GUIDWAY) the eight sorted items stored in GROUP1 are all guideway proper related data, and the fourth time SORT is called GROUP1 array consists of all acceleration-deceleration lanes data.

In addition the subroutine computes the subtotals of guideway proper and interchanges, and of terminals and A/D lanes and stores these in GROUP2 array. Thus all the GROUP1 data is stored in GROUP2 at the end of guideway proper computations and at the end of interchange computations, the interchange GROUP1 data is added to the guideway proper GROUP2 data. This subtotal is saved in GROUP3 (in subroutine INTRCHG) for the subsequent grand totals. GROUP2 is then re-initialized (in subroutine TERMNAL) for the subtotals calculations of terminal and A/D lanes data.

Subroutine SORT also calls subroutines SUM, PRCNT, and AVRG to produce the remaining data printed in Appendix D.

3.2.14 Subroutine AVRG

Subroutine AVRG is a utility routine which divides the values of a three-dimensional array by the values in the corresponding locations of another identically dimensioned three-dimensional array. The TEAM model typically uses this subroutine to compute the average unit costs by dividing the total costs arrays by the total units arrays

The example below shows an expanded 2 by 2 by 1 cost array being divided by an expanded 2 by 2 by 1 units array to produce the unit cost array.

Total costs array   Total units array   Unit cost array

$$\begin{array}{|c|c|c|}\hline 50 & 120 & 170 \\ \hline 40 & 200 & 240 \\ \hline 90 & 320 & 410 \\ \hline \end{array} \div \begin{array}{|c|c|c|}\hline 10 & 40 & 50 \\ \hline 20 & 50 & 70 \\ \hline 30 & 90 & 120 \\ \hline \end{array} = \begin{array}{|c|c|c|}\hline 5.0 & 3.0 & 3.4 \\ \hline 2.0 & 4.0 & 3.4 \\ \hline 3.0 & 3.6 & 3.4 \\ \hline \end{array}$$

3. 2. 15 BLOCK DATA

The function of BLOCK DATA is to store the alpha titles used in numerous output tables printed within OVERLAY 1.00.

3.2.16 Subroutine ANSUMD

Subroutine ANSUMD abstracts the summary capital cost data computed in subroutines GUIDWAY, INTRCHG, TERMINAL, ADLANES, and OTHRCAP of each major subsystem and computes the total new system capital cost, annual capital cost without interest, and annual capital cost including interest. It also computes the percentages that each subsystem represents of the total system for each of the cost breakdowns. It prints the annual capital cost summary table shown in Appendix D.

3.2.17 Subroutine ANNUAL2

Subroutine ANNUAL2 is a utility routine used to annualize the capital costs of major subsystem components, and to print the annual cost table for that sybsystem. See examples in Appendix D.

This routine is identical to subroutine ANNUALD (see section 3.2.19) with the exception that the total units of each subsystem component are not calculated.

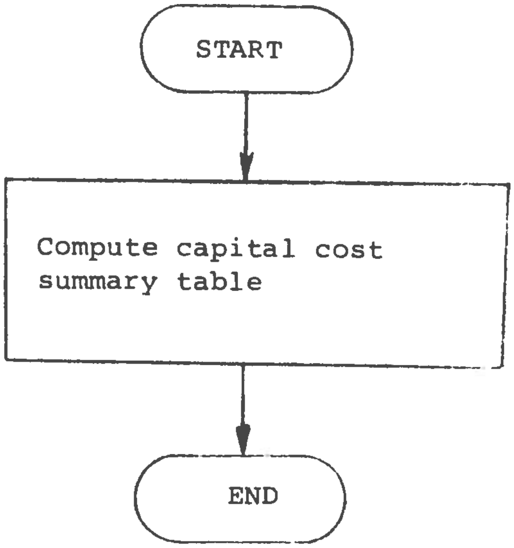


FIGURE 3-34 General Flow Chart - Subroutine ANSUMD

3.2.18 Subroutine PRCNT

Subroutine PRCNT is a utility routine which computes the percentage which each element of an expanded summed three-dimensional array is of the summed total of all elements of the non-expanded three-dimensional array. For example, in the case of a simple 2 x 2 x 1 non-expanded array whose element values are as shown below , the subroutine would compute the corresponding percentages of the grand total sum (in this case 200).

Non-expanded array

80	20	100
40	60	100
120	80	200

Expanded array

Grand total sum

40	10	50
20	30	50
60	40	100

3.2.19 Subroutine ANNUALD

Subroutine ANNUALD is a utility routine which annualizes the capital costs of the major components of each subsystem, and then prints the annual cost table for that subsystem. See examples in appendix D. The user (in the case of the TEAM model--the calling subroutine) must provide the total units , the total capital cost, the interest rate, and the life of each major subsystem component.

The routine proceeds to annualize the capital cost of each major subsystem component in two ways. The first being the annual cost without interest, or the total capital cost of the component divided by its life expectancy.

```
AC(NX) = TCOST(NX) / LIF(NZ)
```

The second way is the normal means of annualizing a capital investment which includes the interest cost for borrowing the money. This is merely the capital cost times the appropriate capital recovery factor (CRF).

```
ACI(NX) = TCOST(NX) * CRF
```

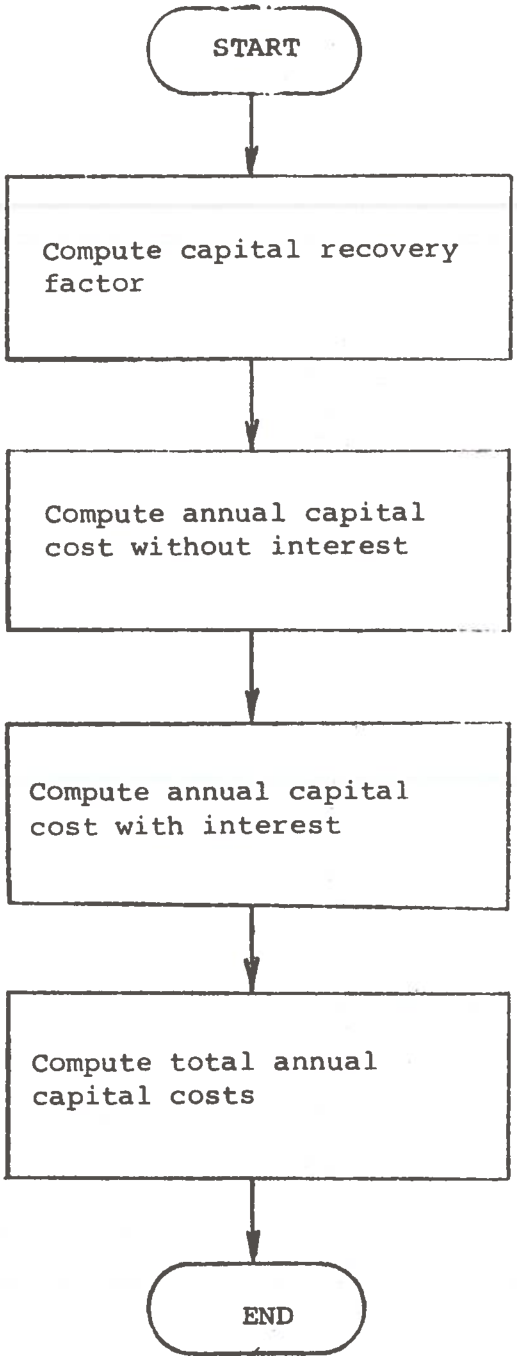


FIGURE 3-35 General Flow Chart - Subroutine ANNUALD

The routine computes the appropriate capital recovery factor for the specified component life (LIF(NZ)) and interest rate (XINT) by the following formula:

```
CRF = (XINT * (1.0 + XINT) ** LIF(NZ)) /
     ((1.0 + XINT) ** LIF(NZ) - 1.0)
```

where: NZ identifies the subsystem component.

The routine then computes the total cost per unit, and the annual costs per unit for each subsystem component. The appropriate subsystem totals are computed, as are the percentages of costs which each subsystem component represents of the total subsystem costs.

3.3 OVERLAY 2.0 NTWK

3.3.1 Program NTWORK

Program NTWORK generates and outputs network analysis data for the new system vehicles. This data is stratified with respect to identified on-guideway and off-guideway links, four temporal periods and with respect to individual vehicle types within a baseline system. Figure 3-36 illustrates the functions performed by this program.

The user input data to this program is comprised primarily of network demand data(link assignments, person trips and trip delays) and network descriptive data (link speeds, link distances). Subroutine RDINPUT reads this data and makes it available to NTWORK through common blocks/RDI/and/RDR/.

Initially, the program computes the average occupancy of the new system vehicles during the peak and the off-peak temporal periods as follows:

DVHOCC(ITP,LV) = DVHCAP(LV) * DMVLDF(ITP,LV)

(vehicle occupancy - persons/vehicle) = (vehicle capacity - person/vehicle) X (load factor - decimal)

The vehicle capacity and the peak/off-peak load factor data are input by the user for each new system vehicle type(LV).

At this point, NTWORK scales the on-guideway and off-guideway link assignments and the person trips by the application of SCALEF(1) and an appropriate vehicle scale factor (SCALEF(5) - SCALEF(8)). These scale factors readily allow the user to vary the demand data without a necessary change to the demand data cards.

On-guideway and off-guideway link loadings (number of persons) for the peak and the off-peak temporal periods are then computed by applying a

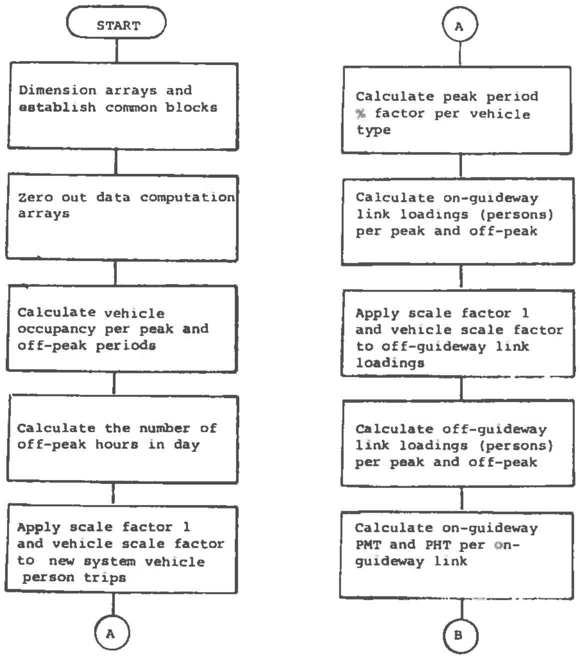


FIGURE 3-36 General Flow Chart - Fortran IV Program NTWORK

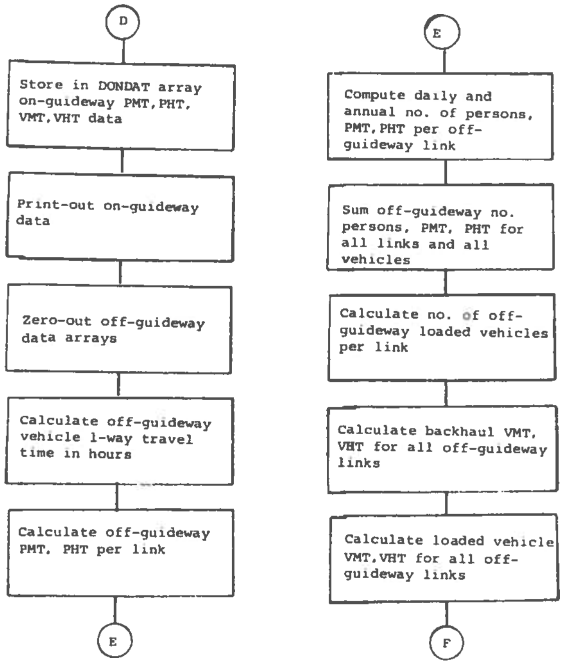


FIGURE 3-36 General Flow Chart - Fortran IV Program NTWORK
(continued)

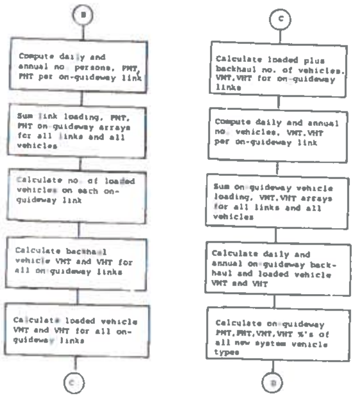


FIGURE 3-36 General Flow Chart - Fortran IV Program NTWORK (continued)

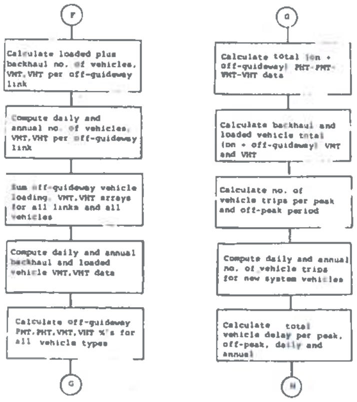


FIGURE 3-36 General Flow Chart - Fortran IV Program NTWORK (continued)

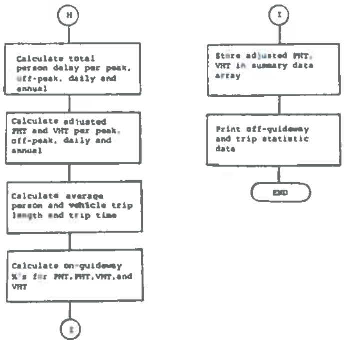


FIGURE 3-36 General Flow Chart - Fortran IV Program NTWORK (continued)

temporal splitter to the daily link assignments. The peak temporal period splitter is defined by (PKPCT); whereas, the variable (1.0 - PKPCT) is the off-peak period temporal splitter.

Utilizing the on-guideway, peak and off-peak link assignments, the on-guideway person-miles travelled (PMT) and person-hours travelled (PHT) are computed for each on-guideway link (LK), each vehicle type (LV), for the peak and off-peak temporal periods as follows:

PMT

DONPMT(LK,LV,ITP) = DONPFL(LK,LV,ITP) * DONLKC(LK,2)

(on-guideway PMT) = (on-guideway link loading - no. of persons) (link distance-miles)

PHT

DONPHT(LK,LV,ITP) = DONPMT(LK,LV,ITP) / DONLKC(LK,1)

(on-guideway PHT) = (on-guideway PMT) / (link speed - mph)

The DONPFL, DONPMT, DONPHT data arrays are then summed for the daily link loadings, the daily PMT, and the daily PHT. Annual data is computed from the daily data by the application of the variable NUMDA (number of days/year).

At this point the amount of on-guideway vehicle travel is determined by NTWORK. The number of loaded vehicles flowing on each on-guideway link (LK) during the peak and the off-peak temporal periods is computed as follows:

DONVFL(LK,LV,ITP) = DONPFL(LK,LV,ITP) / DVHOCC(ITP,LV)

(link loading - vehicles) = (link loading - persons) / (vehicle occupancy - persons/vehicle

Empty (or backhaul) vehicles flowing on each on-guideway link are then accounted for by applying a backhaul factor (BACKON) to the number of loaded vehicles flowing on the system link. On-guideway backhaul factors are input by the user for each link (LK), each vehicle type LV, and for the peak and off-peak temporal periods. The total vehicle miles travelled and vehicle hours travelled on the guideway by the new system vehicles in backhaul are then computed according to the following equations:

Backhaul VMT

DBHDAT(1,LV,ITP) = DBHDAT(1,LV,ITP) + (DONVFL(LK,LV,ITP) * BACKON (LK,LV,ITP) * DONLKC(LK,2))

(Backhaul VMT) = (link loading - no. of loaded vehicles) x (Backhaul factor) x (Link distance - miles)

Backhaul VHT

DBHDAT(2,LV,ITP) = DBHDAT(2,LV,IPT) + ((DONVFL(LK,LV,ITP) * BACKON (LK,LV,ITP) * DONLKC(LK,2)) / DONLKC(LK,1))

(Backhaul VHT) = (Link loading - no. of loaded vehicles) x (Backhaul factor) x (Link distance - miles) / (Link speed - mph)

Similarly, the total on-guideway vehicle miles and vehicle hours travelled by passenger carrying vehicles are computed and stored within the DLVDAT array as follows:

Loaded - Vehicle VMT

DLVDAT(1,LV,ITP) = DLVDAT(1,LV,ITP) + (DONVFL(LK,LV,ITP) * DONLKC (LK,2))

(Loaded vehicle - VMT) = (Link loading - no. of loaded vehicles) x (Link distance - miles)

Loaded - Vehicle VHT

DLVDAT(2,LV,ITP) = DLVDAT(2,LV,ITP) + ((DONVFL(LK,LV,ITP) * DONLKC (LK,2)) / DONLKC(LK,1))

(Loaded vehicle - VHT) = (Link loading - no. of loaded vehicles) x (Link distance - miles) / (Link speed - mph)

At this point, NTWORK then calculates the total vehicle flow (loaded plus backhaul), the total vehicle miles travelled, and the total vehicle hours travelled of each new system vehicle (LV) on each on-guideway link (LK). This data is stored within arrays DONVFL(LK,LV,ITP), DONVMT(LK,LV,ITP), and DONVHT(LK,LV,ITP), respectively. Daily and annual on-guideway vehicle flows, VMT, and VHT data are computed by first summing the peak plus off-peak period data and then multiplying by the factor NUMDA.

All on-guideway network data computed above is then output at this point in the program. This frees the core region "housing" the on-guideway data arrays for reuse in the storage of off-guideway network data. The printout of the on-guideway network data tables can be controlled by the user through the use of the suppress print variables JSPRNT(60), JSPRNT(61), and JSPRNT(62).

Similar to the on-guideway data calculations above, off-guideway network analysis data is stratified by link, by vehicle type, and by four temporal periods. The off-guideway person-miles travelled (PMT) and the person-hours travelled (PHT) during the peak and off-peak temporal periods are computed by NTWORK according to the following equations:

<u>PMT</u>

DOFPMT(JK,LV,ITP) = DOFPFL(JK,LV,ITP) * DOFLKC(JK,LV,1)

(off-guideway PMT) = (off-guideway link loading - no. of persons) (link distance - mile)

<u>PHT</u>

DOFPHT(JK,LV,ITP) = DOFPFL(JK,LV,ITP) * DOFLKC(JK,LV,3)

(off-guideway PHT) = (off-guideway link loading - no. of persons) (link travel time-hours)

Daily and annual PMT and PHT data are then calculated by summing the peak plus off-peak data and then multiplying by the factor NUMDA.

At this point vehicle flows (backhaul and loaded vehicle) are then computed for each off-guideway link. The number of loaded vehicles on each off-guideway link is computed by dividing the total number of persons travelling on the link by the average vehicle occupancy; this data is stored within the DLVDAT data array. The number of empty (or backhaul) vehicles flowing on each off-guideway link is computed by applying an appropriate backhaul factor (BACKOF) to the number of loaded vehicles on the respective link; this data is stored in the DBHDAT data array. The total vehicle flow (loaded plus backhaul), the total vehicle miles travelled, and the total vehicle hours travelled are then computed as follows:

Vehicles

DOFVFL(JK,LV,ITP) = DOFVFL(JK,LV,ITP) + (DOFVFL(JK,LV,ITP) * BACKOF(JK,LV,ITP)

(Link loading - no. of vehicles) = (No. of loaded vehicles) + ((No. of loaded vehicles) (Backhaul factor - decimal %))

VMT

DOFVMT(JK,LV,ITP) = DOFVFL(JK,LV,ITP) * DOFLKC(JK,LV,1)

(Off-guideway VMT) = (Link loading - no. of vehicles) (Link distance - miles)

VHT

DOFVHT(JK,LV,ITP) = DOFVFL(JK,LV,ITP) * DOFLKC(JK,LV,3)

(Off-guideway VHT) = (Link loading - no. of vehicles) (Link travel time - hours)

Daily and annual vehicle flows, VMT data, and VHT data are then computed.

At this point, data calculations with new system vehicle trips are performed. The total vehicle trips occurring in each of the four temporal periods are computed by dividing the total person trips by average vehicle occupancy as follows:

DVTRIP(ITP,LV) = DPTRIP(ITP,LV) / DVHOCC(ITP,LV)

(Vehicle trips) = (Person trips / (Ave. occupancy - persons/vehicle)

The total vehicle and person hours of delay are then determined by multiplying the average delay per trip by the number of trips. This data is then used to compute an adjusted person hours travelled and vehicle hours travelled:

Adjusted PHT = PHT + (Total person hours of delay within vehicle) + (Total person hours of delay outside vehicle)

Adjusted VHT = VHT + (Total vehicle hours of delay)

Average trip length and trip time statistics are then computed as follows:

Average person (or vehicle) trip length = Total PMT (or VMT) / Total person (or vehicle) trips

Average person (or vehicle) trip time = Adjusted PHT (or VHT) / Total person (or vehicle) trips

Finally, all trip data computed above and all off-guideway network data are then output by NTWORK. The printing of this data is controlled by the suppress print variables JSPRNT(63), JSPRNT(64), and JSPRNT(65).

Upon completion of this data printout, control is then returned to the main program DULMODE for the calling of the next overlay.

3.4 OVERLAY 3.0 OTHR

3.4.1 Program ALLOTH

Program ALLOTH is the control program of OVERLAY 3.0. Its primary responsibility is to control the sequence of execution of the following subroutines within OVERLAY 3.0:

- XNETWRK
- HWYNET
- POWER
- AIRPOL
- ACCDNT
- HWYOP
- TRNOP
- DMOP

A general flow diagram of this control program is presented in Figure 3-37. Upon execution of each of the subroutines listed above, control is returned to program DULMODE for the calling of subroutine SUMDATA in OVERLAY 0.0.

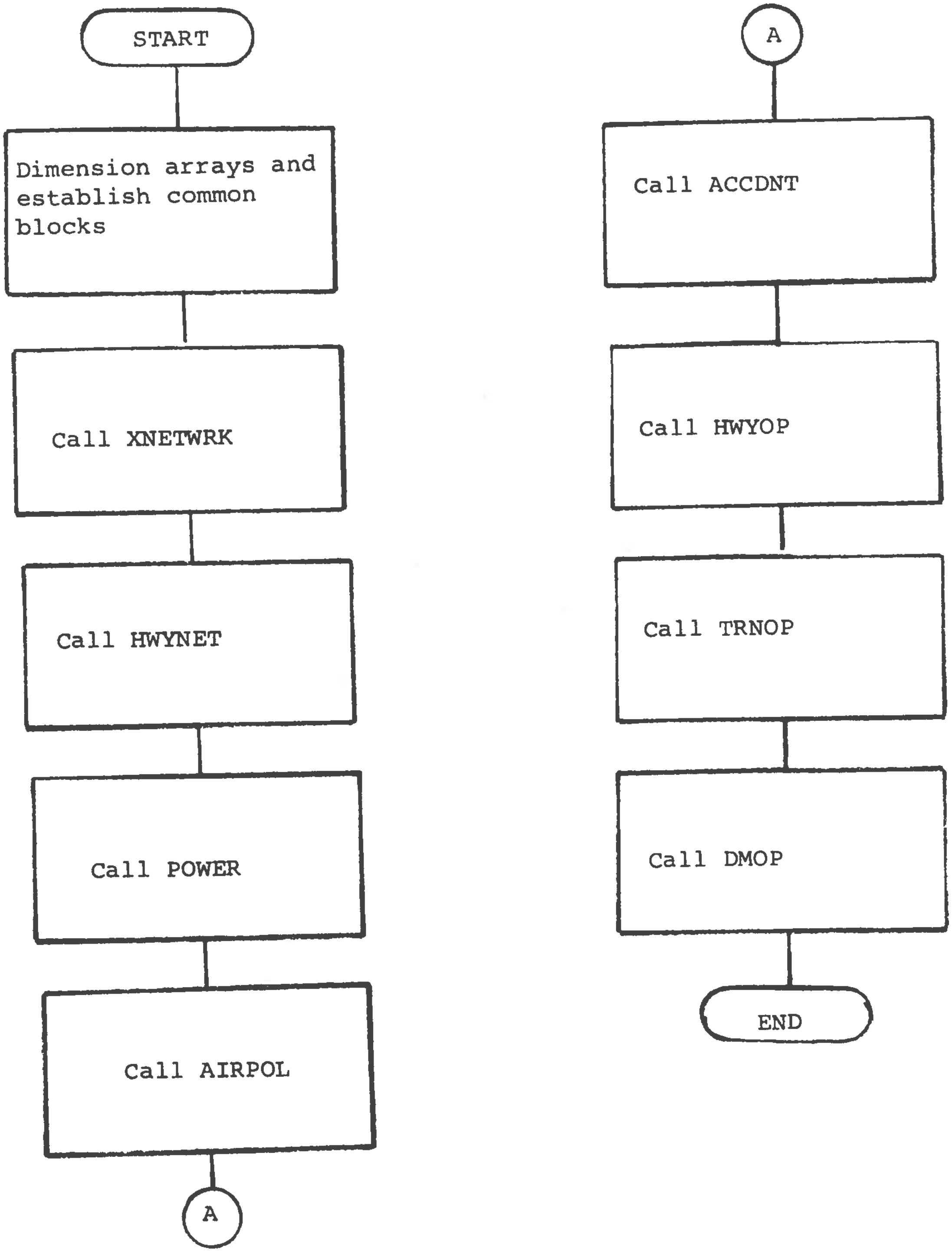


FIGURE 3-37 General Flow Chart - Fortran IV Program ALLOTH

3.4.2 Subroutine XNETWRK

Subroutine XNETWRK computes and outputs all transit network data for the various transit systems under analysis. Network analysis data (i.e., VMT, VHT, average trip lengths, average trip time, etc.) are generated by this routine for individual transit systems with respect to four temporal periods (peak, off-peak, daily and annual). It should be noted however that the data calculations within this subroutine are not carried to the same level of detail as the network data calculations for the new system vehicle. There is no provision within this routine to allow for a definition of a transit network and a transit demand assignment upon the network on a "per link" basis.

Data input to this subroutine consists primarily of data describing the characteristics of the various transit systems and transit demand data. Transit characteristic data includes such variables as vehicles capacity and load factors, average speed and average delays; transit demand data is input in units of person-miles travelled/day

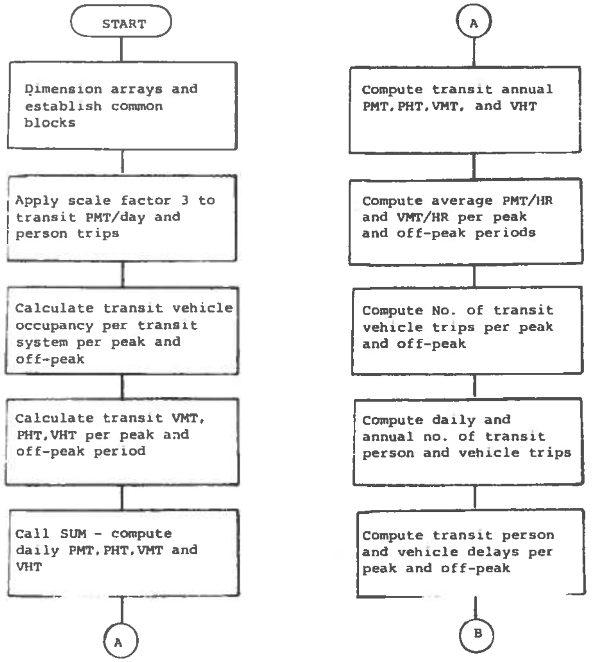


FIGURE 3-38 General Flow Chart - Subroutine XNETWRK

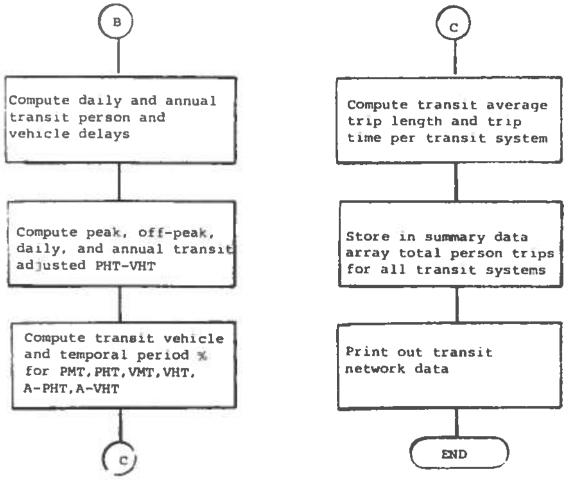


FIGURE 3-38 General Flow Chart - Subroutine XNETWRK (continued)

and person trips. All input data is received from RDINPUT through common blocks /RDI/ and /RDR/.

Initially, XNETWRK applies the transit demand scale factor (SCALEF(3)) to the transit demand data. This scale factor was established to readily allow for the variation of the transit demand data without a necessary change to the demand data cards. Transit daily PMT and transit peak and off-peak person trips are scaled for each transit system (IXV) according to the following equations:

<u>PMT/Day</u>: XSYSCH(IXV,5) = XSYSCH(IXV,5) * SCALEF(3)

<u>Person Trips</u>: XPTRIP(ITP, IXV) = XPTRIP(ITP, IXV) * SCALEF(3)

where ITP = 1 - Peak

ITP = 2 - Off-peak

The subroutine then computes for each transit system the average vehicle occupancy during the peak and the off-peak temporal periods by multiplying the transit vehicle capacity by the appropriate (peak and off-peak) vehicle load factors. Thus, the transit vehicle occupancy data array (XVHOCC) is created as follows:

XVHOCC(IXV,$\genfrac{}{}{0pt}{}{1}{2}$) = XSYSCH(IXV,1) * XSYSCH(IXV,$\genfrac{}{}{0pt}{}{3}{4}$)

Vehicle occupancy (peak & off-peak) = Vehicle capacity X
Vehicle load factor (peak & off-peak)

The person-miles travelled during the peak temporal periods is then computed for each transit system by applying a "peak percentage factor" to the transit system's daily PMT.

XNDATA(IXV,1,1) = XSYSCH(IXV,5) * XPKPCT

PMT - (peak) = PMT/Day X (peak % factor)

The off-peak person-miles travelled is then the daily PMT less the peak period PMT.

XNDATA(IXV,2,1) = XSYSCH(IXV,5) - XNDATA(IXV,1,1)

PMT - (off-peak) = PMT/Day - PMT (peak)

XNETWRK then computes for each transit system (IXV) and for the peak and off-peak temporal periods (ITP = 1,2) transit vehicle-miles travelled (VMT), person-hours travelled (PHT), and vehicle-hours travelled (VHT) as follows:

VMT: XNDATA(IXV,ITP,2) = XNDATA(IXV,ITP,1) / XVHOCC(IXV,ITP)

VMT = PMT / (ave. number of persons/vehicle)

PHT: XNDATA(IXV,ITP,3) = XNDATA(IXV,ITP,1) / XSYSCH(IXV,2)

PHT = PMT / (ave. speed - mph)

VHT: XNDATA(IXV,ITP,4) = XNDATA(IXV,ITP,2) / XSYSCH(IXV,2)

VHT = VMT / (ave. speed - mph)

Daily and annual transit PMT, PHT, VMT and VHT data is computed by first summing (by subroutine SUM) the XNDATA array for the daily amounts and then multiplying by the variable NUMDA - the number of days/year.

Average PMT/hour and VMT/hour data are then computed for each transit system for the peak and off-peak temporal periods as follows:

Peak: XNDPHR(IXV,1,$\frac{1}{2}$) = XNDATA(IXV,1,$\frac{1}{2}$) / NPKHRS

PMT/hr (or VMT/hr) = Peak - PMT (or VMT) / (no. of peak hours/day)

Off-peak: XNDPHR(IXV,2,$\frac{1}{2}$) = XNDATA(IXV,2,$\frac{1}{2}$) / NOPHRS

PMT/hr (or VMT/hr) = off-peak PMT (or VMT) / (no. of off-peak hour/day)

Utilizing the transit peak and off-peak person trip and vehicle occupancy data, the number of transit vehicle trips during the peak and off-peak temporal periods are then calculated.

XVTRIP(ITP,IXV) = XPTRIP(ITP,IXV) / XVHOCC(IXV,ITP)

Vehicle trips = Person trips / (Persons/vehicle)

Daily person and vehicle trips are computed by summing the respective peak and off-peak trips; annual trips are computed by multiplying the daily trips by the number of days/year defined in variable NUMDA.

Transit person delays (occuring within vehicle and outside the vehicle) and transit vehicle delays are then calculated for each transit system for the peak and off-peak temporal periods (ITP = 1,2) according to the following equations:

XPVDLY(ITP,IXV,1) = XPTRIP(ITP,IXV) * XDELAY(ITP,IXV,1) / 60.

(person delay outside vehicle-hrs) = (person trips) X (ave. delay - min/person trip) / 60.

XPVDLY(ITP,IXV,2) = XVTRIP(ITP,IXV) * XDELAY(ITP,IXV,2) / 60.

(vehicle delay-hrs) = (vehicle trips) X (ave. delay-min/veh. trip) / 60.

XPVDLY(ITP,IXV,3) = (XPTRIP(ITP,IXV) * XDELAY(ITP,IXV,2) /
XVHOCC(IXV,ITP)) / 60.

(person delay within vehicle-hrs) = (person trips) X
(ave. delay-min/veh.trip) / (vehicle occupancy)) / 60.

The computed transit PHT and VHT data are then adjusted to account for the delays experienced as follows:

XNDATA(IXV,ITP,5) = XNDATA(IXV,ITP,3) + XPVDLY(ITP,IXV,1) +
XPVDLY(ITP,IXV,3)

Adjusted PHT = PHT + (person delay outside vehicle) +
(person delay within vehicle)

XNDATA(IXV,ITP,6) = XNDATA(IXV,ITP,4) + XPVDLY(ITP,IXV,2)

Adjusted VHT = VHT + (vehicle delay)

At this time, subroutine XNETWRK computes the average trip lengths and the average trip times for transit person trips and vehicle trips:

(average trip length-miles/trip) = PMT(orVMT) / person trips
(or vehicle trips)

that all suppress print codes have initially been set to "1" (suppress mode) in card format type 5, Section 4.1. Card type 7 indicates one real variable value is to be changed in loop 2. The index location of this variable (i.e., the type vehicle unit cost) as shown on card type 8 is 172 in the RPARDT array. Card type 9 indicates the new vehicle unit cost to be used during this loop. Loop 3 is identical to loop 2. In loop 4, however, one integer input value is changed to indicate that a punched deck of the grand summary data for variation set number 1 is desired. Thus card type 4 indicates a "1". Card type 5 indicates the index location of the punched output suppression code which is located in IPARDT(77). Card type 6 is the new value of this code which must be "0" to get punched output. **NOTE:** IPARDT(77) was initially "1". This procedure would have to be repeated in the last loop of each variation set where punched output is desired when IPARDT(77) is initially set at "1". This is required because after each loop the value of the changed variable always reverts back to its initial best estimate value. The change of vehicle cost value in loop 4 is identical to that in loop 2.

Loops 5 through 7 of variation set 2 are similar to loops 2 and 3 with the exception that the index of track cost in in the respective super array (either IPARDT or RPARDT), and by specifying the new value to be assigned to the variable being changed. Card types 4 through 9 provide for the user to make these specifications. Card types 4,5, and 6 are respectively used to specify the number of integer values to be varied, the index location of the value to be varied, and the new value for the variable. Card types 7,8 and 9 serve the same purpose for the real values stored in RPARDT array. Subroutine PRNTIN prints the best engineering estimate input data located in the IPARDT and RPARDT arrays. This printout can be used as the dictionary to locate the index of the variable to be changed during any given loop through the model.

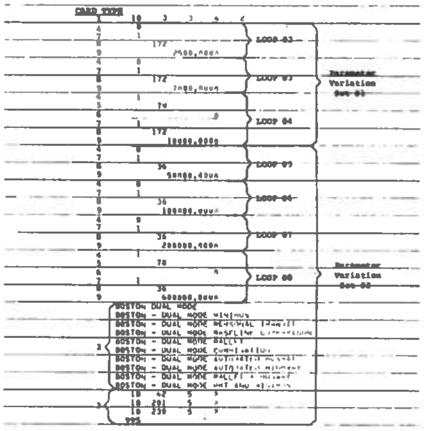
A detail step-through the sample data in Figure 4-85 should clarify the procedure. The first card indicates the total number of loops through the model (10), the number of variation sets (3), and the number of loops per set (3,4, and 2 in the order submitted on the succeeding cards). Card type 4 in loop 2 of the data indicates that no integer input data will be varied during this loop. Thus card type 5 and 6 must not be attached. NOTE: this set of data is based on the fact on the same page (grand summary table) with the summary table for the best estimate loop for ease in analysis (see Figure 3-12).

At the end of each variation set the user must specify whether he wishes punched output of the grand summary table and if he desires any plots for that variation set. In the example, punched grand summary data is requested for variation set number one, as indicated by the first card type 6 of Figure 4-85 The second card type 6 as shown in variation set number 2 indicates that plots are required. Since plots are required for this set, the set variation data must be followed by the plot data (card format types 2 and 3). The plot data is followed by the parameter variation data for set number 3.

For reasons of program coding constraints and efficiency it was required to create two super arrays which house all the input data for the best engineering estimate input from cards (see Section 4.1). One array (IPARDT) houses all the integer input values - a total of 199 values. The second array (RPARDT) houses all the real input values which can be as many as 14340. The user is thus able to vary any one of these 14539 input variable by specifying if the value(s) to be changed during a loop is real or integer, by specifying the index location

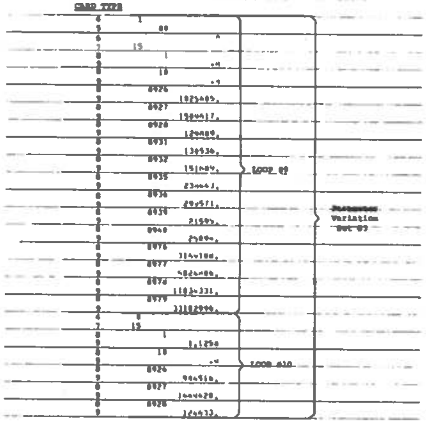
Including the best engineering estimate, the example requires a total of ten loops through the new system cost program. (See first value on card type 1 - Figure 4-85)

Assuming that the best estimate (computed in loop 1) of the vehicle unit cost is $5,000 then the second loop through the program temporarily replaces the $5,000 with $2,500 per vehicle (card type 9). All program computations are performed with $2,500 in loop 2 of the program. Upon completing loop 2 through the program, the program (Subroutine SUMMARY) checks if any more variations of vehicle unit cost is required. It does this by comparing an internal variation set counter with the third value on card type 1 in Figure 4-85 Since this value is 3 (i.e., vehicle cost is to be varied 3 times) the program knows that two more loops through the program are required in this variation set. Thus loop 3 through the program uses the next value of vehicle unit cost which is $7,000 (the second card type 9). As discussed in Section 3.1.5 , at the end of each loop a summary table of approximately 250 key input and output parameters is printed for the input values used and values computed during that loop. At the end of a variation set all previous loop summary tables in that set are printed



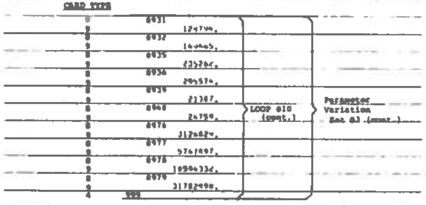
```
CARD TYPE
    1      10    3    3    4    2
    4       8                        ⎫
    7       1                        ⎬ LOOP 02  ⎫
    8            172                 ⎪          ⎪
    9                 2500.0000      ⎭          ⎪
    4       8                        ⎫          ⎪
    7       1                        ⎬ LOOP 03  ⎬ Parameter
    8            172                 ⎪          ⎪ Variation
    9                 7000.0000      ⎭          ⎪ Set 01
    4       1                        ⎫          ⎪
    5            74                  ⎪          ⎪
    6                           9    ⎬ LOOP 04  ⎪
    7       1                        ⎪          ⎪
    8            172                 ⎪          ⎪
    9                10000.0000      ⎭          ⎭
    4       8                        ⎫          ⎫
    7       1                        ⎬ LOOP 05  ⎪
    8            36                  ⎪          ⎪
    9                50000.0000      ⎭          ⎪
    4       8                        ⎫          ⎪
    7       1                        ⎬ LOOP 06  ⎪
    8            36                  ⎪          ⎪
    9               100000.0000      ⎭          ⎪
    4       8                        ⎫          ⎪
    7       1                        ⎬ LOOP 07  ⎪
    8            36                  ⎪          ⎪
    9               200000.0000      ⎭          ⎬ Parameter
    4       1                        ⎫          ⎪ Variation
    5            78                  ⎪          ⎪ Set 02
    6                           9    ⎬ LOOP 08  ⎪
    7       1                        ⎪          ⎪
    8            36                  ⎪          ⎪
    9               600000.0000      ⎭          ⎪
      ⎧ BOSTON DUAL MODE                        ⎪
      ⎪ BOSTON - DUAL MODE MINIMUM              ⎪
      ⎪ BOSTON - DUAL MODE PERSONAL TRANSIT     ⎪
      ⎪ BOSTON - DUAL MODE BASELINE [illegible] ⎪
    2 ⎨ BOSTON - DUAL MODE PALLET               ⎪
      ⎪ BOSTON - DUAL MODE [illegible]          ⎪
      ⎪ BOSTON - DUAL MODE AUTOMATED [illegible]⎪
      ⎪ BOSTON - DUAL MODE AUTOMATED HIGHWAY    ⎪
      ⎪ BOSTON - DUAL MODE PALLET + HIGHWAY     ⎪
      ⎩ BOSTON - DUAL MODE [illegible]          ⎪
      ⎧     10   42    5    2                   ⎪
    3 ⎨     10  201    5    2                   ⎪
      ⎩     10  239    5    2                   ⎪
           999                                  ⎭
```

FIGURE 4-83 Sample Problem Parametric Input Data for New System Cost Program



```
CARD TYPE
    4       1                        ⎫
    5            80                  ⎪          ⎫
    6                           8    ⎪          ⎪
    7      15                        ⎪          ⎪
    8             1                  ⎪          ⎪
    9                          .4    ⎪          ⎪
    8            10                  ⎪          ⎪
    9                          .9    ⎪          ⎪
    8          8926                  ⎪          ⎪
    9                 1025405.       ⎪          ⎪
    8          8927                  ⎪          ⎪
    9                 1900417.       ⎪          ⎪
    8          8928                  ⎪          ⎪
    9                  120480.       ⎪          ⎪
    8          8931                  ⎪          ⎪
    9                  130936.       ⎪          ⎪
    8          8932                  ⎪          ⎪
    9                  151804.       ⎬ LOOP 09  ⎪
    8          8935                  ⎪          ⎪
    9                  230661.       ⎪          ⎪
    8          8936                  ⎪          ⎬ Parameter
    9                  290571.       ⎪          ⎪ Variation
    8          8939                  ⎪          ⎪ Set 03
    9                   21905.       ⎪          ⎪
    8          8940                  ⎪          ⎪
    9                   25090.       ⎪          ⎪
    8          8976                  ⎪          ⎪
    9                 3144100.       ⎪          ⎪
    8          8977                  ⎪          ⎪
    9                 5026000.       ⎪          ⎪
    8          8978                  ⎪          ⎪
    9                11034331.       ⎪          ⎪
    8          8979                  ⎪          ⎪
    9                33182990.       ⎭          ⎪
    4       8                        ⎫          ⎪
    7      15                        ⎪          ⎪
    8             1                  ⎪          ⎪
    9                   1.1250       ⎪          ⎪
    8            10                  ⎪          ⎪
    9                          .4    ⎬ LOOP 010 ⎪
    8          8926                  ⎪          ⎪
    9                  904910.       ⎪          ⎪
    8          8927                  ⎪          ⎪
    9                 1004020.       ⎪          ⎪
    8          8928                  ⎪          ⎪
    9                  124413.       ⎭          ⎭
```

FIGURE 4-83 Sample Problem Parametric Input Data for New System Cost Program (cont.)



```
CARD TYPE
    8          8931                  ⎫          ⎫
    9                  124744.       ⎪          ⎪
    8          8932                  ⎪          ⎪
    9                  144465.       ⎪          ⎪
    8          8935                  ⎪          ⎪
    9                  235264.       ⎪          ⎪
    8          8936                  ⎪          ⎪
    9                  295574.       ⎪          ⎪
    8          8939                  ⎪          ⎪
    9                   21307.       ⎪          ⎪ Parameter
    8          8940                  ⎬ LOOP 010 ⎬ Variation
    9                   26750.       ⎪ (cont.)  ⎪ Set 03 (cont.)
    8          8976                  ⎪          ⎪
    9                 3124024.       ⎪          ⎪
    8          8977                  ⎪          ⎪
    9                 5761407.       ⎪          ⎪
    8          8978                  ⎪          ⎪
    9                10594332.       ⎪          ⎪
    8          8979                  ⎪          ⎪
    9                31782990.       ⎭          ⎪
    4        999                                ⎭
```

FIGURE 4-83 Sample Problem Parametric Input Data for New System Cost Program (cont.)

The program accommodates up to fourteen (14) parameter variation sets and a maximum of four (4) loops per set (note that the program can be modified to accommodate more sets and more loops per set). A parameter variation set is a set of input variables which are to be varied one or more times. Each time one or more variables of the set is varied a new loop through the model is required. A maximum of one hundred (100) variables can be varied simultaneously in a variation set. Normally, for parametric analyses, only one variable is varied at a time.

For purpose of clarity, the sample data shown in Figure 4-85 is used to further explain a parameter variation set and how to structure an input data deck. The illustrated example consists of three parameter variation sets. (See the second value on card type 1 - Figure 4-85). The first set is a variation of dual mode vehicle unit cost. The second set is a variation of track cost, and the third set is a variation of demand input data. To demonstrate the program's flexibility, the example shows vehicle cost being varied three times, track cost being varied four times, and demand being varied twice.

model. All the input data described in Sections 4.1 and 4.2 is permanently stored in the computer for use in subsequent loops through the model.

For each parametric loop through the model the user specifies the variable or variables which he wishes changed from the basic value of those variables which are stored in the computer. The program temporarily uses the new value(s) during the current parametric loop, and upon completing the loop it replaces the temporarily changed value(s) with the basic best engineering estimate value of the variables which were changed for that loop. At this point the user can specify new value(s) to be changed for the same variable(s), or new variables and their respective new values for the next parametric loop.

The new system cost program is presently coded to handle a maximum of 57 loops through the model. It can easily be modified to handle any number of loops if desired. This is not recommended, since it is just as easy to make a separate run if more loops are required. The first loop through the program in a given run is always the best engineering estimate loop. All variation of data in the subsequent loops is expected to be from this data base.

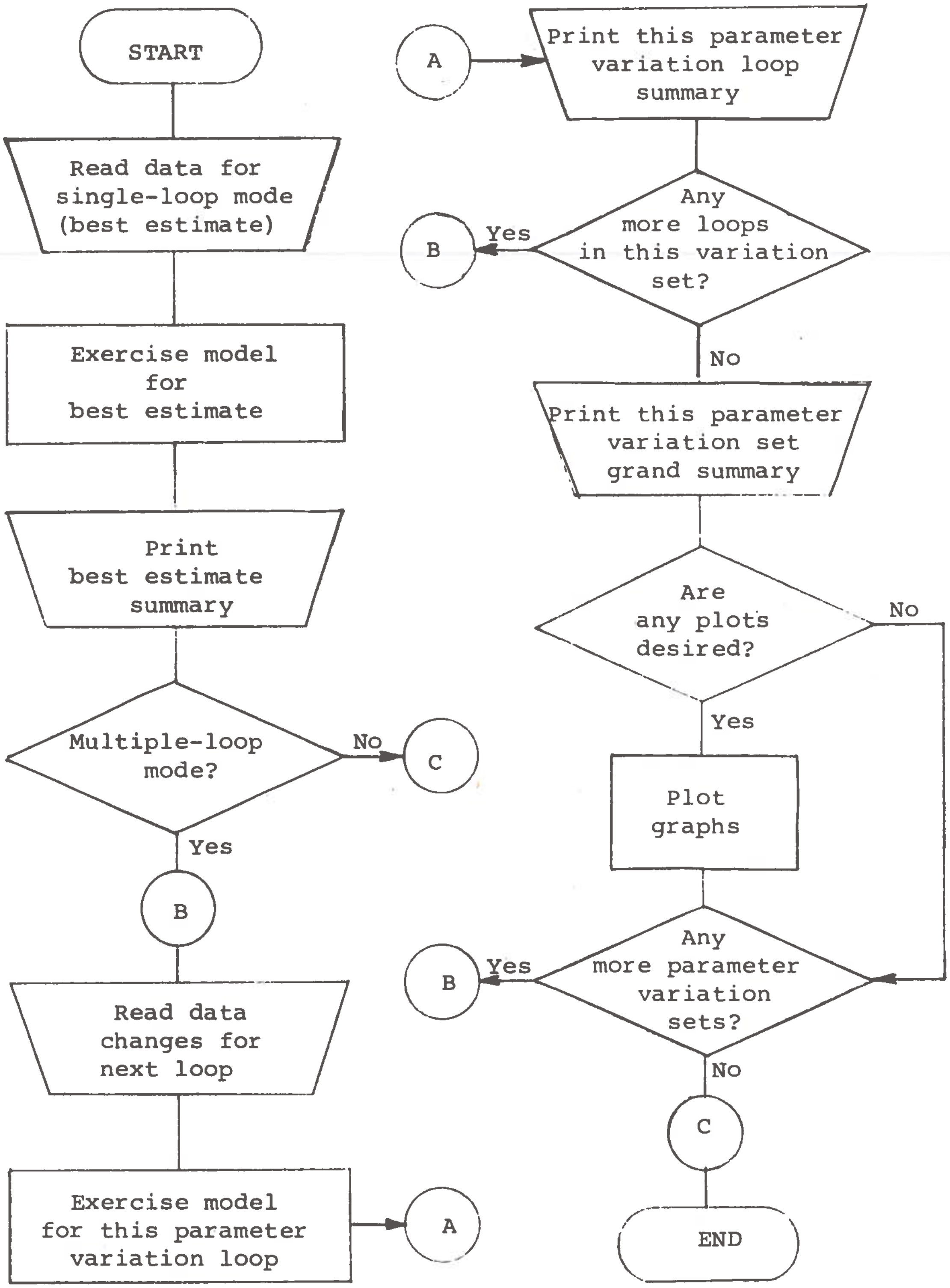


FIGURE 4-84 General Flow of Multiple-Loop Mode Application of the New System Cost Program

Card Columns	Format	Variable Name	Definition	Units
1-10	I10	NR	Index of RPARDT value to be varied	---
11-80	---	---	Not used	---

Number of cards: 1 card per real value being varied during current loop

Comments: No cards should be inserted if no real value is to be varied (i.e., if NPR=0)

FIGURE 4-82 CARD FORMAT TYPE 8

Card Columns	Format	Variable Name	Definition	Units
1-20	F20.4	RPARDT(NR)	New value to be used for next loop	Variable
21-80	---	---	Not used	---

Number of cards: 1 card per real value being varied during current loop

Comments: Each of these cards is placed immediately after its corresponding Type 8 card

FIGURE 4-83 CARD FORMAT TYPE 9

Card Columns	Format	Variable Name	Definition	Units
1-5	I5	NPR	Number of real values to be varied during this loop	---
6-80	---	---	Not used	---

Number of cards: 1 card per parametric loop desired

Comments: Each parametric loop through model must have this card
NPR=0 indicates that no real value is to be varied

FIGURE 4-81 CARD FORMAT TYPE 7

Card Columns	Format	Variable Name	Definition	Units
1-10	I10	NI	Index of IPARDT value to be varied	---
11-80	---	---	Not used	---

Number of cards: 1 card per integer value being varied
during current loop

Comments: no cards should be inserted if no integer value
is to be varied (i.e., if NPI=0)

FIGURE 4-79 CARD FORMAT TYPE 5

Card Columns	Format	Variable Name	Definition	Units
1-20	I20	IPARDT(NI)	New value to be used for next loop	Variable
21-80	---	---	Not used	---

Number of cards: 1 card per integer value being varied
during current loop

Comments: each of these cards is placed immediately after
its corresponding Type 5 card

FIGURE 4-80 CARD FORMAT TYPE 6

Card Columns	Format	Variable Name	Definition	Units
1-5	I5	LPSM	Total number of loops through the model	---
6-10	I5	IBC	Number of sets of parameters to be varied	---
11-80	14I5	NLPM(K)	Number of times each set of parameters is varied	---

Number of cards: 1

Comments: K=1 to IBC
$IBC \leq 14$
$NLPM(K) \leq 4$
Total specified loops through the model = $1 + \sum_{K=1}^{IBC} NLPM(K)$
The first loop through is the best engineering estimate.
Maximum loops through the model = 1 + 14*4 = 57 loops

FIGURE 4-75 CARD FORMAT TYPE 1

Card Columns	Format	Variable Name	Definition	Units
1-40	4A10	ATITLE(NTI,NTIP)	Titles of graphs	---
41-80	---	---	Not used	---

Number of cards: 10

Comments: Up to ten different titles are permitted
One title per card
Maximum of 40 characters per title
These cards and card types 3 should only appear immediately after a set of parametric variation data and only if plots are desired (IPARDT=0) for the summary data on that variation set.
Thus if plots were suppressed (IPARDT=1) on a previous set, one must reset IPARDT to equal 0 on the last loop through the current set to be plotted (i.e., set NI=78 and IPARDT(NI)=0)

FIGURE 4-76 CARD FORMAT TYPE 2

Card Columns	Format	Variable Name	Definition	Units
1-5	I5	INDEXX	The index of summary data which will be the X-variable	---
6-10	I5	INDEXY	The index of summary data which will be the Y-variable	---
11-15	I5	NPTS	Number of points to be plotted on this curve	---
16-20	I5	NTIT	The index of the title for this graph	---
21-80	---	---	Not used	---

Number of cards: 1 card per curve plotted

Comments: Only 1 curve can be plotted per graph using on-line plotting
Note comments for Card Format Type 2

FIGURE 4-77 CARD FORMAT TYPE 3

Card Columns	Format	Variable Name	Definition	Units
1-5	I5	NPI	Number of integer values to be varied during this loop	---
6-80	---	---	Not used	---

Number of cards: 1 card per parametric loop desired

Comments: Each parametric loop through model must have this card
NPI=0 indicates that no integer value is to be varied

FIGURE 4-78 CARD FORMAT TYPE 4

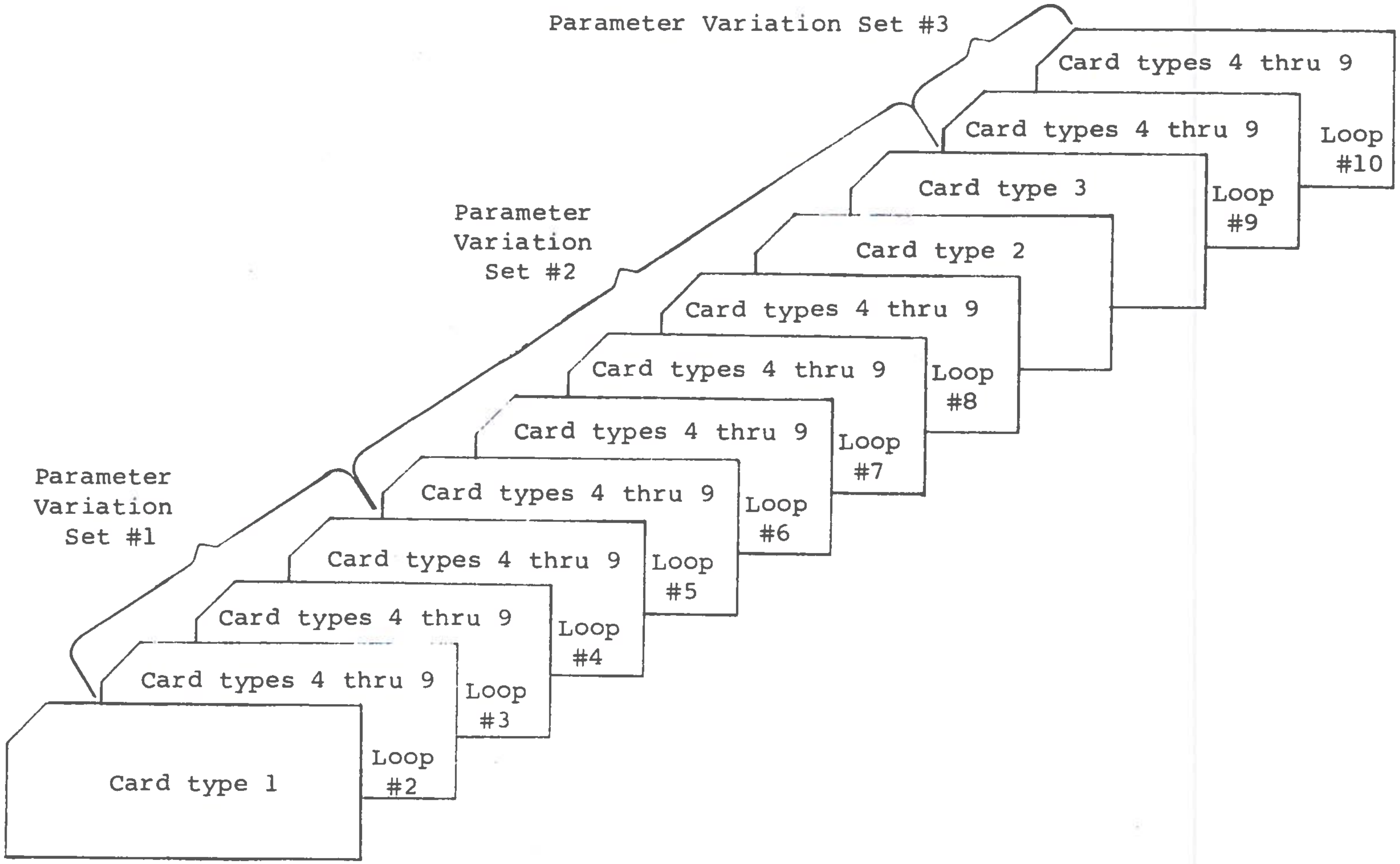


FIGURE 4-74 New System Cost Program - Parameter Variation Input Data Deck Assembly Format for Sample Problem

4.3 Parametric Analysis Input Data

Whenever it is desired to execute the new system cost program in the multiple loop mode (for conducting parametric analyses) an additional deck of data cards must be added after the last card (Format 67) of the card input data previously described in Section 4.1. This additional deck assembly format for multiple loop applications is shown in Figure 4-74 for the sample problem discussed below. Individual card formats types are shown in Figures 4-75 through 4-83.

The new system cost program was designed to provide maximum flexibility to vary a large percentage of model input variables either individually or in combination. The preparation of the parametric variation input data deck had to involve a minimum amount of effort.

The general flow diagram for multiple loop use of the new system cost program is shown in Figure 4-84. It is noted that with the exception of subroutines RDINPUT and PRNTIN the entire program is exercised during each loop through the model.Subroutine RDINPUT (see Section 3.1.2) reads the basic input data described in Section 4.1 for the best engineering estimate loop through

Card Columns	Format	Variable Name	Definition	Units
1-5	I5	NS	Link segment index	---
6-10	F5.0	DGSGST(NS,12)	Link number	---
11-15	F5.0	DGSGST(NS,13)	Segment number	---
16-20	F5.0	DGSGST(NS,1)	Geographic area code	---
21-25	F5.0	DGSGST(NS,2)	Construction type code	---
26-30	F5.0	DGSGST(NS,3)	Land use code	---
31-35	F5.0	DGSGST(NS,14)	Land cost code	---
36-45	F10.2	DGSGST(NS,15)	Segment length	Miles
46-55	F10.2	DGSGST(NS,18)	R.O.W. width of existing system	Feet
56-60	F5.0	DGSGST(NS,19)	Status of existing system code	---
61-65	F5.0	DGSGST(NS,20)	Residential density code	---
66-80	---	---	Not used	---

Number of cards: 1 card per link segment plus last card

Comments: NS ≤ 399
Last card must have a "400" in columns 3-5.
Link segment indices must be sequentially numbered without gaps

FIGURE 4-70 CARD FORMAT TYPE 1

Card Columns	Format	Variable Name	Definition	Units
1-5	I5	NI	Interchange number	---
6-10	F5.0	DINTST(NI,15)	Interchange design type	---
11-15	F5.0	DINTST(NI,1)	Geographic area code	---
16-20	F5.0	DINTST(NI,2)	Construction type code	---
21-25	F5.0	DINTST(NI,3)	Land use code	---
26-30	F5.0	DINTST(NI,16)	Land cost code	---
31-40	F10.2	DINTST(NI,4)	Additional interchange acres	Acres
41-50	F10.2	DINTST(NI,5)	Interchange ramps length	Lane miles
51-60	F10.0	DINTST(NI,6)	Interchange additional structural cost	$
61-80	---	---	Not used	---

Number of cards: 1 card per interchange plus last card

Comments: NI ≤ 399
Last card must have a "400" in columns 3-5.
Interchange numbers must be sequentially numbered without gaps.

FIGURE 4-71 CARD FORMAT TYPE 2

Card Columns	Format	Variable Name	Definition	Units
1-5	I5	NT	Terminal number	---
6-10	F5.0	DTERST(NT,12)	Terminal design type code	---
11-15	F5.0	DTERST(NT,1)	Geographic area code	---
16-20	F5.0	DTERST(NT,2)	Construction type code	---
21-25	F5.0	DTERST(NT,3)	Land use code	---
26-30	F5.0	DTERST(NT,13)	Land cost code	---
31-38	F8.0	DTERST(NT,14)	Terminal demand (worst 1-way egress or ingress flow)	Persons/hr
39-44	F6.2	DTERST(NT,15)	Terminal parking area	Acres
45-50	F6.2	DTERST(NT,16)	Terminal vehicle storage area	Acres
51-56	F6.2	DTERST(NT,17)	Terminal storage track	Lane-miles
57-64	F8.0	DTERST(NT,18)	Parking area construction cost	$
65-72	F8.0	DTERST(NT,19)	Storage area construction cost	$
73-80	F8.0	DTERST(NT,20)	Terminal proper construction cost	$

Number of cards: 1 card per terminal plus last card

Comments: NT ≤ 399
Last card must have a "400" in columns 3-5.
Terminal numbers must be sequentially numbered without gaps

FIGURE 4-72 CARD FORMAT TYPE 3

Card Columns	Format	Variable Name	Definition	Units
1-5	I5	NTS	Terminal segment index	---
6-10	F5.0	DTSGST(NTS,12)	Terminal number	---
11-15	F5.0	DTSGST(NTS,13)	Terminal segment number	---
16-20	F5.0	DTSGST(NTS,1)	Geographic area code	---
21-25	F5.0	DTSGST(NTS,2)	Construction type code	---
26-30	F5.0	DTSGST(NTS,3)	Land use code	---
31-35	F5.0	DTSGST(NTS,14)	Land cost code	---
36-45	F10.2	DTSGST(NTS,4)	Terminal segment area	Acres
46-55	F10.2	DTSGST(NTS,5)	Terminal segment track length	Lane-miles
56-80	---	---	Not used	---

Number of cards: 1 card per terminal segment plus last card

Comments: NTS ≤ 399
Last card must have a "400" in columns 3-5.
Terminal segment indices must be sequentially numbered without gaps.

FIGURE 4-73 CARD FORMAT TYPE 4

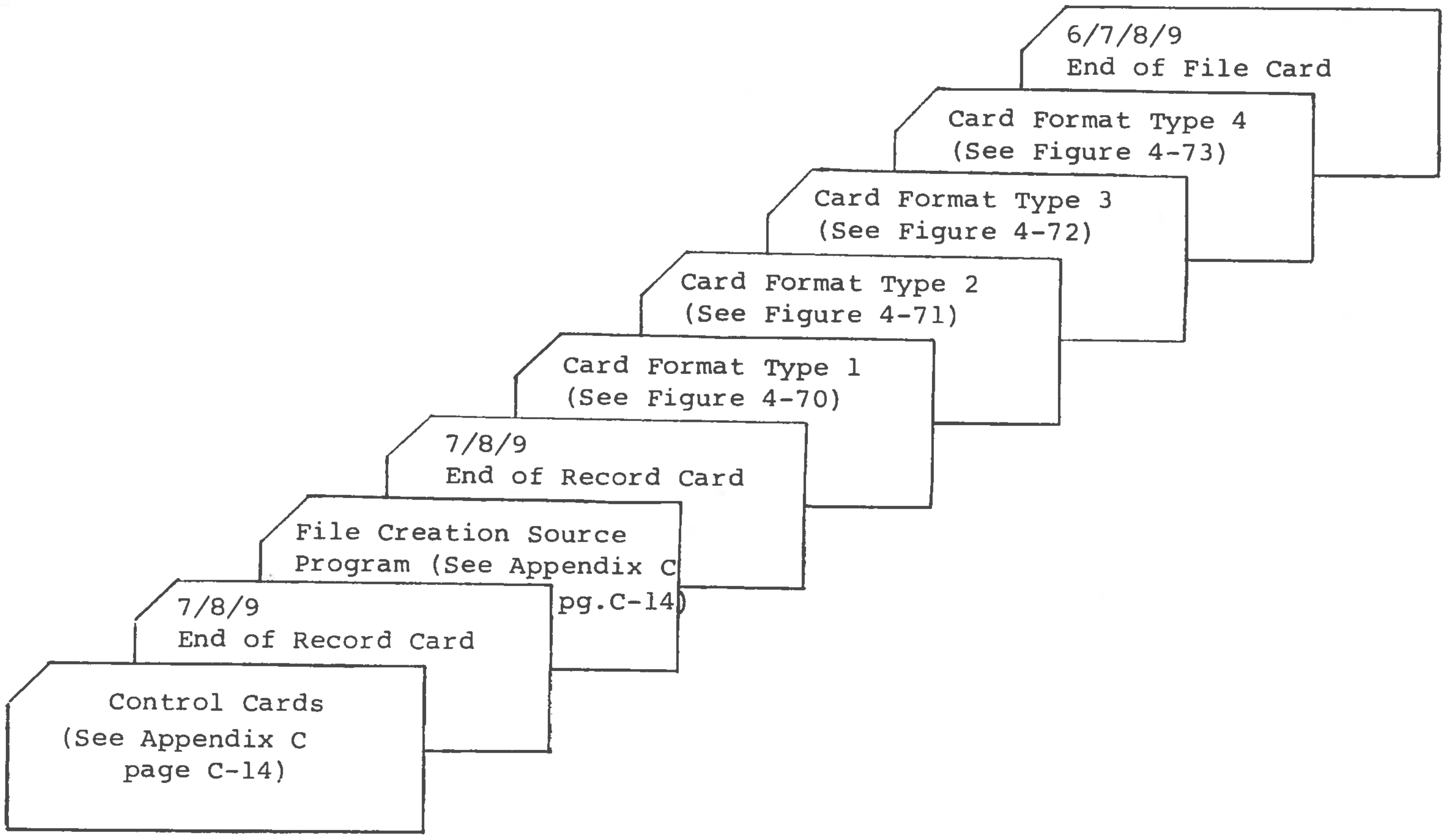


FIGURE 4-69 New System Cost Program Disc File Creation Deck Assembly Format

These four sets of data are loaded onto one disc file prior to executing the new system cost program. An example of this input type data is shown in Appendix C.

Figure 4-69 shows the deck assembly format, and Figures 4-70 through 4-73 show the card formats for the four sets of data. There also are shown the control cards and source deck required to create the desired data file on the disc. The number "400" at the end of each of the four data sets indicates the end of that particular set of data.

4.2 Disc File Input Data (Tape 11)

Four sets of the new system program (version 2) input data are input from a disc file rather than directly from cards. The reason for this was primarily to reduce the total size of the card input deck. These four data sets usually represent more than half of all input data cards. They consist of data which for the dual mode systems application were considered not to be varied very often. On the other hand, data input directly through cards were expected to be varied quite often during parametric analyses. It was determined to be easier to manipulate cards (rather than disc files) while input data was being verified and finalized. Version 3 of the TEAM model is expected to input almost all input data through disc files.

The current four sets of data input from disc files are the following:

a. guideway segment input data
b. interchange input data
c. terminal input data, and
d. acceleration and deceleration lanes input data.

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.2	DYUOPC	Yard operating unit cost	$/yr/acre
11-20	F10.0	DCCOPC	Control center operating unit cost	$/year
21-30	F10.0	DMOPC	Maintenance facility operating unit cost	$/year
31-80	---	---	Not used	---

Number of cards: 1

FIGURE 4-66 CARD FORMAT TYPE 65

Card Columns	Format	Variable Name	Definition	Units
1-20	4F5.0	Z(MV)	Fleet equivalent factor per vehicle type MV	---
21-45	5F5.2	FLOCAP(JLC)	Local capital factors	---
46-80	---	---	Not used	---

Number of cards: 1

Comments: JLC ≤ 4

FIGURE 4-67 CARD FORMAT TYPE 66

Card Columns	Format	Variable Name	Definition	Units
1-10	10X	---	---	---
11-20	F10.3	DFARE(MV,1,1)	Fare rates per vehicle type MV - flat fare	$/vehicle trip
21-30	F10.3	DFARE(MV,2,1)	Fare rates per vehicle type MV - flat fare	$/person trip
31-40	F10.3	DFARE(MV,1,2)	Fare rates per vehicle type MV - flat mileage rate	$/VMT
41-50	F10.3	DFARE(MV,2,2)	Fare rates per vehicle type MV - flat mileage rate	$/PMT
51-80	---	---	Not used	---

Number of cards: 1 card per each vehicle type MV

FIGURE 4-68 CARD FORMAT TYPE 67

Card Columns	Format	Variable Name	Definition	Units
1-5	I5	NVA	Vehicle fleet index	---
6-10	I5	NVC(NV)	Vehicle type code	---
11-15	F5.3	DVOPUC(NV,1,1)	On-guideway vehicle unit operating costs - depreciation	$/VMT
16-20	F5.3	DVOPUC(NV,2,1)	On-guideway vehicle unit operating costs - maintenance	$/VMT
21-25	F5.3	DVOPUC(NV,3,1)	On-guideway vehicle unit operating costs - power	$/VMT
26-30	F5.3	DVOPUC(NV,4,1)	On-guideway vehicle unit operating costs - parking	$/VMT
31-35	F5.3	DVOPUC(NV,5,1)	On-guideway vehicle unit operating costs - insurance	$/VMT
36-40	F5.3	DVOPUC(NV,6,1)	On-guideway vehicle unit operating costs - taxes	$/VMT
41-45	F5.3	DVOPUC(NV,7,1)	On-guideway vehicle unit operating costs - driver	$/VMT
46-50	F5.3	DVOPUC(NV,1,2)	Off-guideway vehicle unit operating costs - depreciation	$/VMT
51-55	F5.3	DVOPUC(NV,2,2)	Off-guideway vehicle unit operating costs - maintenance	$/VMT
56-60	F5.3	DVOPUC(NV,3,2)	Off-guideway vehicle unit operating costs - power	$/VMT
61-65	F5.3	DVOPUC(NV,4,2)	Off-guideway vehicle unit operating costs - parking	$/VMT
66-70	F5.3	DVOPUC(NV,5,2)	Off-guideway vehicle unit operating costs - insurance	$/VMT

FIGURE 4-63 CARD FORMAT TYPE 62

Card Columns	Format	Variable Name	Definition	Units
71-75	F5.3	DVOPUC(NV,6,2)	Off-guideway vehicle unit operating costs - taxes	$/VMT
76-80	F5.3	DVOPUC(NV,7,2)	Off-guideway vehicle unit operating costs - driver	$/VMT

Number of cards: 1 card per vehicle type NV

FIGURE 4-63 CARD FORMAT TYPE 62 (Continued)

Card Columns	Format	Variable Name	Definition	Units
1-5	I5	NDT	Terminal type index code	---
6-10	F5.0	DTROPC(NDT,1)	Terminal design code	---
11-25	F15.0	DTROPC(NDT,2)	Terminal maintenance unit operating cost	$/yr/terminal
26-40	F15.0	DTROPC(NDT,3)	Terminal operation unit cost	$/yr/terminal
41-50	F10.0	DTROPC(NDT,4)	Number of terminals	Terminals
51-80	---	---	Not used	---

Number of cards: 1 card per each terminal type NDT

FIGURE 4-64 CARD FORMAT TYPE 63

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.0	DGOPC(1)	Guideway unit operating cost - maintenance	$/yr/lane-mi
11-20	F10.0	DGOPC(2)	Guideway unit operating cost - operation	$/yr/lane-mi
21-30	F10.0	DGOPC(3)	Guideway unit operating cost - operation of communication and control	$/yr/lane-mi
31-80	---	---	Not used	---

Number of cards: 1

FIGURE 4-65 CARD FORMAT TYPE 64

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.3	HWYOPC(MH,1)	Highway way unit operating cost - power	$/route mile/yr
11-20	F10.3	HWYOPC(MH,2)	Highway way unit operating cost - manpower	$/manyear
21-30	F10.3	HWYOPC(MH,3)	Highway way unit operating cost - maintenance	$/route mile/yr
31-80	---	---	Not used	---

Number of cards: 1 card per highway mode (MH)
MH = 1 Freeways
= 2 Surface arterials

FIGURE 4-59 CARD FORMAT TYPE 58

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.0	XOPCU(IXV,1,1)	Number of route or track miles	Miles
11-20	F10.0	XOPCU(IXV,2,1)	Number of storage vehicle-spaces	Vehicle-spaces
21-30	F10.0	XOPCU(IXV,3,1)	Number of maintenance vehicle-spaces	Vehicle-spaces
31-46	4F4.0	XOPCU(IXV,4,MX)	Number of terminals per terminal type (MX) where MX ≤ 4	Terminals
47-78	4F8.0	XOPCU(IXV,5,MX)	Number of parking vehicle-spaces per parking facility type (MX) where MX ≤ 4	Vehicle-spaces
79-80	---	---	Not used	---

Number of cards: 1 card per each transit system ISV
(IXV ≤ 4)

FIGURE 4-60 CARD FORMAT TYPE 59

Card Columns	Format	Variable Name	Definition	Units
1-6	F6.3	XOPICD(IXV,1,1)	Transit operating unit cost data - way power	$/VMT
7-13	F7.2	XOPICD(IXV,1,2)	Transit operating unit cost data - way manpower	$/route mile/yr
14-22	F9.0	XOPICD(IXV,1,2)	Transit operating unit cost data - way maintenance	$/route mile/yr
23-29	F7.3	XOPICD(IXV,2,1)	Transit operating unit cost data - vehicle depreciation	$/VMT
30-36	F7.3	XOPICD(IXV,2,2)	Transit operating unit cost data - vehicle other	$/VMT
37-43	F7.0	XOPICD(IXV,3,1)	Transit operating unit cost data - manpower	$/VMT
44-50	F7.0	XOPICD(IXV,4,1)	Transit operating unit cost data - storage	$/veh-space/yr
51-57	F7.0	XOPICD(IXV,5,1)	Transit operating unit cost data - maintenance	$/veh-space/yr
58-80	---	---	Not used	---

Number of cards: 1 card per each transit system IXV
(IXV ≤ 4)

FIGURE 4-61 CARD FORMAT TYPE 60

Card Columns	Format	Variable Name	Definition	Units
1-28	4F7.0	XOPICD(IXV,6,KX)	Transit operating terminal unit operating costs per terminal type KX where KX ≤ 4.	$/terminal/yr
29-48	4F5.0	XOPICD(IXV,7,KX)	Transit operating parking unit unit operating costs per parking facility type KX where KX ≤ 4	$/vehicle-space/yr
49-80	---	---	Not used	---

Number of cards: 1 card per each transit system IXV
(IXV ≤ 4)

FIGURE 4-62 CARD FORMAT TYPE 61

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.2	XACRAT(IXV,1)	Accident rate of transit traffic accidents per transit system IXV	No. accidents per million VMT
11-20	F10.2	XACRAT(IXV,2)	Accident rate of passenger accidents per transit system IXV	No. accidents per million person trips
21-30	F10.3	XACRAT(IXV,3)	Accident rate of passenger fatalities per transit system IXV	No. fatalities per million person trips
31-40	F10.3	XACRAT(IXV,4)	Accident rate of non-passenger fatalities per transit system IXV	No. fatalities per million person trips
41-80	---	---	Not used	---

Number of cards: 1 card for each transit system IXV where
IXV ≠ 4

FIGURE 4-55 CARD FORMAT TYPE 54

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.3	DACRAT(1,LV)	On-guideway accident rate of traffic accidents	No. accidents per million VMT
11-20	F10.3	DACRAT(2,LV)	On-guideway accident rate of passenger fatalities	No. passenger fatalities per million VMT
21-60	4F10.3	Same as above except for vehicle type LV =2,3		---

Number of cards: 1

FIGURE 4-56 CARD FORMAT TYPE 55

Card Columns	Format	Variable Name	Definition	Units
1-5	5X	---	---	---
6-15	F10.3	HOPDAT(1,1)	Average number of lanes for freeways	Lanes
16-25	F10.3	HOPDAT(2,1)	Average number of lanes for surface arterials	Lanes
26-35	F10.3	HOPDAT(1,2)	Average number of manyears/route miles for freeways	My/route miles
36-45	F10.3	HOPDAT(2,2)	Average number of manyears/route miles for surface arterials	My/route miles
46-80	---	---	Not used	---

Number of cards: 1

FIGURE 4-57 CARD FORMAT TYPE 56

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.3	HVOPCS(NHV,1)	Highway vehicle unit operating costs - depreciation	$/VMT
11-20	F10.3	HVOPCS(NHV,2)	Highway vehicle unit operating costs - maintenance	$/VMT
21-30	F10.3	HVOPCS(NHV,3)	Highway vehicle unit operating costs - fuel	$/VMT
31-40	F10.3	HVOPCS(NHV,4)	Highway vehicle unit operating costs - insurance	$/VMT
41-50	F10.3	HVOPCS(NHV,5)	Highway vehicle unit operating costs - parking	$/VMT
51-60	F10.3	HVOPCS(NHV,6)	Highway vehicle unit operating costs - other	$/VMT
61-80	---	---	Not used	---

Number of cards: 1 card for each highway vehicle type (NHV)
NHV = 1 Autos
= 2 Trucks

FIGURE 4-58 CARD FORMAT TYPE 57

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.6	POLRAT(2,1)	IC - Diesel pollution rate - CO	Lbs/VMT
11-20	F10.6	POLRAT(2,2)	IC - Diesel pollution rate - HC	Lbs/VMT
21-30	F10.6	POLRAT(2,3)	IC - Diesel pollution rate - NOX	Lbs/VMT
31-80	---	---	Not used	---

Number of cards: 1

FIGURE 4-51 CARD FORMAT TYPE 50

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.6	POLRAT(3,1)	Electric vehicle pollution rate - particulate	Lbs/KWHR
11-20	F10.6	POLRAT(3,2)	Electric vehicle pollution rate - SO_2	Lbs/KWHR
21-30	F10.6	POLRAT(3,3)	Electric vehicle pollution rate - NOX	Lbs/KWHR
31-80	---	---	Not used	---

Number of cards: 1

FIGURE 4-52 CARD FORMAT TYPE 51

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.3	DMSTAC	Station accident rate for new vehicle system	No. Personal acc. per 1 million person trips
11-30	4I5	IDACCD(LV)	Off-guideway accident codes for each new vehicle system (LV)	---
31-80	---	---	Not used	---

Number of cards: 1

Comments: LV ≤ 4
The off-guideway accident codes per vehicle type LV are:
=1. Use transit system 1 accident rates
=2. Use transit system 2 accident rates
=3. Use transit system 3 accident rates
=4. Use transit system 4 accident rates
=5. Use auto accident rates

FIGURE 4-53 CARD FORMAT TYPE 52

Card Columns	Format	Variable Name	Definition	Units
1-8	F8.2	HACRAT(MH,1,ITP)	Accident rate of fatal accidents per MH per peak temporal period (ITP=1)	No. of fatal accidents per 100 million VMT
9-16	F8.2	HACRAT(MH,2,ITP)	Accident rate of injury accidents per MH per peak temporal period (ITP=1)	No. of injury accidents per 100 million VMT
17-24	F8.2	HACRAT(MH,3,ITP)	Accident rate of property damage accidents per MH per peak temporal period (ITP=1)	No. of property damage accidents per 100 million VMT
25-32	F8.2	HACRAT(MH,4,ITP)	Accident rate of fatalities per MH per peak temporal period (ITP=1)	No. of fatalities per 100 million VMT
33-40	F8.2	HACRAT(MH,5,ITP)	Accident rate of injuries per MH per peak temporal period (ITP=1)	No. of injuries per 100 million VMT
41-80	5F8.2	Same as above except for off-peak temporal period (ITP=2)		---

Number of cards: 1 card per MH where MH = 1 - Freeways
MH = 2 - Surface arterial

FIGURE 4-54 CARD FORMAT TYPE 53

Card Columns	Format	Variable Name	Definition	Units
1-3	I3	IPOLCD(LV,1,1)	On-guideway pollution code for new vehicle system (LV)	---
4-6	I3	IPOLCD(LV,2,1)	Off-guideway pollution code for new vehicle system (LV)	---
7-9	I3		Same as above except for vehicle types (LV) equal to 2,3,4	---
10-12	I3			---
13-15	I3			---
16-18	I3			---
19-21	I3			---
22-24	I3			---
25-80	---	---	Not used	---

Number of cards: 1

Comments: Pollution codes (IPOLCD) = 1 IC Gas
= 2 IC Diesel
= 3 Electric

FIGURE 4-47 CARD FORMAT TYPE 46

Card Columns	Format	Variable Name	Definition	Units
1-12	4I3	IPOLCD(IXV,1,2)	Pollution codes for each transit system (IXV)	---
13-80	---	---	Not used	---

Number of cards: 1

Comments: Pollution codes (IPOLCD) = 1 IC - Gas
= 2 IC - Diesel
= 3 Electric

IXV ≤ 4

FIGURE 4-48 CARD FORMAT TYPE 47

Card Columns	Format	Variable Name	Definition	Units
1-6	2I3	IPOLCD(NHV,1,3)	Pollution codes for highway vehicles	---
7-80	---	---	Not used	---

Number of cards: 1

Comments: Pollution codes (IPOLCD) = 1 IC - Gas
= 2 IC - Diesel

NHV ≤ 2 where NHV = 1 - Autos
= 2 - Trucks

FIGURE 4-49 CARD FORMAT TYPE 48

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.6	POLRAT(1,1)	IC - Gas pollution rate - CO	Lbs/VMT
11-20	F10.6	POLRAT(1,2)	IC - Gas pollution rate - HC	Lbs/VMT
21-30	F10.6	POLRAT(1,3)	IC - Gas pollution rate - NOX	Lbs/VMT
31-80	---	---	Not used	---

Number of cards: 1

FIGURE 4-50 CARD FORMAT TYPE 49

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.1	DPCVCH(LVX,1,1)	On-guideway vehicle weight	Lbs
11-20	F10.3	DPCVCH(LVX,2,1)	On-guideway vehicle tire friction coefficient	Unitless
21-30	F10.3	DPCVCH(LVX,3,1)	On-guideway vehicle aerodynamic friction coefficient	Unitless
31-40	F10.1	DPCVCH(LVX,4,1)	On-guideway vehicle height	Ft.
41-50	F10.1	DPCVCH(LVX,5,1)	On-guideway vehicle width	Ft.
51-60	F10.0	DPCVCH(LVX,6,1)	On-guideway vehicle power code	---
61-80	---	---	Not used	---

Number of cards: 1 card for each vehicle type LVX

Comments: DPCVCH(LVX,6,1) - Power code = 1. Electrical
= 0. IC Engine

FIGURE 4-43 CARD FORMAT TYPE 42

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.1	DPCVCH(LVX,1,2)	Off-guideway vehicle weight	Lbs.
11-20	F10.3	DPCVCH(LVX,2,2)	Off-guideway vehicle tire friction coefficient	Unitless
21-30	F10.3	DPCVCH(LVX,3,2)	Off-guideway vehicle aerodynamic friction coefficient	Unitless
31-40	F10.1	DPCVCH(LVX,4,2)	Off-guideway vehicle height	Ft.
41-50	F10.1	DPCVCH(LVX,5,2)	Off-guideway vehicle width	Ft.
51-60	F10.0	DPCVCH(LVX,6,2)	Off-guideway vehicle power code	---
61-80	---	---	Not used	---

Number of cards: 1 card for each vehicle type LVX

Comments: DPCVCH(LVX,6,2) - Power code = 1. Electrical
= 0. IC Engine

FIGURE 4-44 CARD FORMAT TYPE 43

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.1	XPCVCH(IXV,1)	Transit vehicle power characteristics - vehicle weight	Lbs.
11-20	F10.3	XPCVCH(IXV,2)	Vehicle tire friction coefficient	Unitless
21-30	F10.3	XPCVCH(IXV,3)	Vehicle aerodynamic friction coefficient	Unitless
31-40	F10.1	XPCVCH(IXV,4)	Vehicle height	Ft.
41-50	F10.1	XPCVCH(IXV,5)	Vehicle width	Ft.
51-60	F10.0	XPCVCH(IXV,6)	Vehicle power code	---
61-80	---	---	Not used	---

Number of cards: 1 card for each transit system IXV

Comments: XPCVCH(IXV,6) - Power code = 1. Electrical
= 0. IC Engine

FIGURE 4-45 CARD FORMAT TYPE 44

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.1	HPCVCH(NHV,1)	Highway vehicle power characteristics - vehicle weight	Lbs.
11-20	F10.3	HPCVCH(NHV,2)	Vehicle tire friction coefficient	Unitless
21-30	F10.3	HPCVCH(NHV,3)	Vehicle aerodynamic friction coefficient	Unitless
31-40	F10.1	HPCVCH(NHV,4)	Vehicle height	Ft.
41-50	F10.1	HPCVCH(NHV,5)	Vehicle width	Ft.
51-80	---	---	Not used	---

Number of cards: 1 card for each highway vehicle NHV

Comments: The power code for highway vehicles is assumed to be IC
NHV ≠ 2 NHV = 1 Autos
= 2 Trucks

FIGURE 4-46 CARD FORMAT TYPE 45

Card Columns	Format	Variable Name	Definition	Units
1-40	4F10.2	XVMTPC(NH)	Percent of transit VMT that is to be assigned to freeways per transit system (NH)	Decimal %
41-80	---	---	Not used	---

Number of cards: 1

Comments: NH ≤ 4
(1.0 - XVMTPC) = % of transit VMT that will be assigned to surface arterials

FIGURE 4-39 CARD FORMAT TYPE 38

Card Columns	Format	Variable Name	Definition	Units
1-30	3F10.2	DVMTPC(LV)	Percent of new vehicle system VMT that is to be assigned to freeways per vehicle type LV	Demical %
31-80	---	---	Not used	---

Number of cards: 1

Comments: LV ≤ 3
(1.0 - DVMTPC) = % VMT that will be assigned to surface arterials

FIGURE 4-40 CARD FORMAT TYPE 39

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.0	AUTOCH(1)	Auto vehicle capacity	Persons/vehicle
11-15	F5.2	AUTOCH(2)	Auto vehicle load factor	Decimal %
16-25	F10.0	AUTOCH(3)	Auto person trips during peak temporal period of day	Person trip
26-35	F10.0	AUTOCH(4)	Auto person trips during off-peak temporal period of day	Person trips
36-45	F10.0	AUTOCH(5)	Auto person miles travelled/day on freeways	PMT/day
46-55	F10.0	AUTOCH(6)	Auto person miles travelled/day on surface arterials	PMT/day
56-60	F5.2	AUTOCH(7)	Percent auto PMT/day during peak temporal period	Decimal %
61-65-	F5.2	AUTOCH(8)	Percent auto VMT in city	Decimal %
66-69	F4.0	AUTOCH(9)	Person delay outside auto	Minutes/person trip
70-73	F4.0	AUTOCH(10)	Auto vehicle delay	Minutes/vehicle trip
74-80	---	---	Not used	

Number of cards: 1

Comments: Auto person trips (peak and off-peak) are required to be non-zero.
Truck VMT = $\left\{(\text{auto VMT/AUTOCH}(8)) - \text{auto VMT}\right\}$

FIGURE 4-41 CARD FORMAT TYPE 40

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.2	HNCHAR(1)	Lane miles of freeway	Lane miles
11-20	F10.2	HNCHAR(2)	Lane miles of surface arterials	Lane miles
21-30	F10.2	HNCHAR(3)	Average freeway capacity	Veh/hr/lane mi.
31-40	F10.2	HNCHAR(4)	Average surface arterial capacity	Veh/hr/lane mi.
41-80	---	---	Not used	---

Number of cards: 1

FIGURE 4-42 CARD FORMAT TYPE 41

Card Columns	Format	Variable Name	Definition	Units
1-40	4F10.2	XPTRIP(2,IXV)	Transit person trips during off-peak temporal period of day per transit system (IXV)	Person trips
41-80	---	---	Not used	---

Number of cards: 1

Comments: IXV [illegible] 4

FIGURE 4-35 CARD FORMAT TYPE 34

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.2	XDELAY(1,IXV,1)	Average transit person delay outside vehicle during peak temporal period of day	Minutes/person trips
11-20	F10.2	XDELAY(2,IXV,1)	Average transit person delay outside vehicle during off-peak temporal period of day	Minutes/person trips
21-80	---	---	Same as above for transit system (IXV) = 2,3,4	Minutes/person trips

Number of cards: 1

FIGURE 4-36 CARD FORMAT TYPE 35

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.2	XDELAY(1,IXV,2)	Average transit vehicle delay per peak temporal period of day	Minutes/vehicle trips
11-20	F10.2	XDELAY(2,IXV,2)	Average transit vehicle delay per off-peak temporal period of day	Minutes/vehicle trips
21-80	---	---	Same as above for transit system (IXV) = 2,3,4	Minutes/vehicle trips

Number of cards: 1

FIGURE 4-37 CARD FORMAT TYPE 36

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.3	HLNDIR(1,1)	Percentage factor to adjust FWY lane miles during peak temporal period	Decimal %
11-20	F10.3	HLNDIR(1,2)	Percentage factor to adjust FWY lane miles during off-peak temporal period	Decimal %
21-30	F10.3	HLNDIR(2,1)	Percentage factor to adjust surface arterial lane miles during peak temporal period	Decimal %
31-40	F10.3	HLNDIR(2,2)	Percentage factor to adjust surface arterial lane miles during off-peak temporal period	Decimal %
41-80	---	---	Not used	---

Number of cards: 1

FIGURE 4-38 CARD FORMAT TYPE 37

Card Columns	Format	Variable Name	Definition	Units
1-40	4F10.2	XSYSCH(4,IXV)	Vehicle load factor during off-peak temporal period for each transit system (IXV)	Decimal %
41-80	---	---	Not used	---

Number of cards: 1

Comments: IXV ≤ 4

FIGURE 4-31 CARD FORMAT TYPE 30

Card Columns	Format	Variable Name	Definition	Units
1-40	4F10.2	XSYSCH(5,IXV)	Person miles travelled per day for each transit system (IXV)	PMT/day
41-80	---	---	Not used	---

Number of cards: 1

Comments: IXV ≤ 4

FIGURE 4-32 CARD FORMAT TYPE 31

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.2	XPKPCT	Percent PMT/day for transit during peak temporal period of day	Decimal %
11-80	---	---	Not used	---

Number of cards: 1

FIGURE 4-33 CARD FORMAT TYPE 32

Card Columns	Format	Variable Name	Definition	Units
1-40	4F10.2	XPTRIP(1,IXV)	Transit person trips during peak temporal period of day per transit system (IXV)	Person trips
41-80	---	---	Not used	---

Number of cards: 1

Comments: IXV ≤ 4

FIGURE 4-34 CARD FORMAT TYPE 33

Card Columns	Format	Variable Name	Definition	Units
1-5	I5	JKX	Off-guideway link number	---
6-11	F6.3	BACKOF(JKX,1,1)	Backhaul factor - % of vehicles flowing on link JKX per vehicle type 1 during peak period	Decimal %
12-17	F6.3	BACKOF(JKX,1,2)	Backhaul factor - % of vehicles flowing on link JKX for vehicle type 1 during off peak period	Decimal %
18-23	F6.3	BACKOF(JKX,2,1)	Backhaul factor - % of vehicles flowing on link JKX for vehicle type 2 during peak period	Decimal %
24-29	F6.3	BACKOF(JKX,2,2)	Backhaul factor - % of vehicles flowing on link JKX for vehicle type 2 during off-peak period	Decimal %
30-35	F6.3	BACKOF(JKX,3,1)	Backhaul factor - % of vehicles flowing on link JKX for vehicle type 3 during peak period	Decimal %
36-41	F6.3	BACKOF(JKX,3,2)	Backhaul factor - % of vehicles flowing on link JKX for vehicle type 3 during off peak period	Decimal %
42-80	---	---	Not used	---

Number of cards: 1 card for each off guideway link JK

Comments: Data cards are only required for those links that have a flow of backhaul vehicles. These data cards are not required to be in numerical link sequence. A integer 150 in Cols. 3,4,5 is required at the end of backhaul data whether or not there exists backhaul data.

FIGURE 4-27 CARD FORMAT TYPE 26

Card Columns	Format	Variable Name	Definition	Units
1-40	4F10.2	XSYSCH(2,IXV)	Average speed for each transit system (IXV)	Miles/hr
41-80	---	---	Not used	---

Number of cards: 1

Comments: IXV ≤ 4

FIGURE 4-29 CARD FORMAT TYPE 28

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.2	XSYSCH(1,1)	Vehicle capacity - transit system type 1	Persons/veh
11-20	F10.2	XSYSCH(1,2)	Vehicle capacity - transit system type 2	Persons/veh
21-30	F10.2	XSYSCH(1,3)	Vehicle capacity - transit system type 3	Persons/veh
31-40	F10.2	XSYSCH(1,4)	Vehicle capacity - transit system type 4	Persons/veh
41-80	---	---	Not used	---

Number of cards: 1

FIGURE 4-28 CARD FORMAT TYPE 27

Card Columns	Format	Variable Name	Definition	Units
1-40	4F10.2	XSYSCH(3,IXV)	Vehicle load factor during peak temporal period for each transit system IXV	Decimal %
41-80	---	---	Not used	---

Number of cards: 1

Comments: IXV ≤ 4

FIGURE 4-30 CARD FORMAT TYPE 29

Card Columns	Format	Variable Name	Definition	Units
1-5	5X	---	---	---
6-10	F5.0	NPKHRS	Number of peak hours in a day	Hours
11-15	5X	---	---	---
16-20	F5.0	NUMDA	Number of days/year	Days
21-24	4X	---	---	---
25-30	6I1	PARCK3	Variable no longer used in model	---
31-35	5X	---	---	---
36-40	F5.3	DPKPCT	Variable no longer used in model	---
41-80	---	---	Not used	---

Number of cards: 1

Comments: (24.0 - NPKHRS) = Number of off-peak hours in a day
NPKHRS $\leq$ 24

FIGURE 4-23 CARD FORMAT TYPE 22

Card Columns	Format	Variable Name	Definition	Units
1-15	F15.0	DOFPFL(JK,1,3)	Off-guideway link loading - vehicle 1	# of persons/day
16-20	5X	---	---	---
21-30	F10.1	DOFLKC(JK,1,1)	Off-guideway 1-way link distance - vehicle 1	Miles
31-40	F10.0	DOFLKC(JK,1,2)	Off-guideway link 1-way travel time - vehicle 1	Minutes
41-55	F15.0	DOFPFL(JK,2,3)	Off-guideway link loading - vehicle 2	# of persons/day
56-60	5X	---	---	---
61-70	F10.1	DOFLKC(JK,2,1)	Off-guideway 1-way link distance - vehicle 2	Miles
71-80	F10.0	DOFLKC(JK,2,2)	Off-guideway 1-way travel time - vehicle 2	Minutes

Number of cards: 1 card for each link JK. For runs with more than two vehicle types another card of the format defined above is required for the input of vehicle 3 data. In this case, there will exist 2 cards for each link JK.

Comments: All link data cards are required to be in sequential order. Off-guideway 1-way travel time is required to be non-zero.

FIGURE 4-24 CARD FORMAT TYPE 23

Card Columns	Format	Variable Name	Definition	Units
1-15	F15.0	DPTRIP(1,LV)	Person trips during peak period of day	Person trips
16-20	5X	---	---	---
21-35	F15.0	DPTRIP(2,LV)	Person trips during off-peak period of day	Person trips
36-40	5X	---	---	---
41-50	F10.0	DPDLYO(1,LV)	Person delay outside vehicle during peak periods	Minutes/person trip
51-60	F10.0	DPDLYO(2,LV)	Person delay outside vehicle during off-peak periods	Minutes/person trip
61-70	F10.0	DVDLAY(1,LV)	Vehicle delay during peak periods	Minutes/vehicle trip
71-80	F10.0	DVDLAY(2,LV)	Vehicle delay during off-peak periods	Minutes/vehicle trip

Number of cards: 1 card for each vehicle type LV

Comments: Person trips (peak and off-peak) are required to be non-zero.

FIGURE 4-25 CARD FORMAT TYPE 24

Card Columns	Format	Variable Name	Definition	Units
1-4	4X	---	---	---
5-10	F6.1	DVHCAP(1)	Vehicle capacity - vehicle type 1	Persons/veh
11-14	4X	---	---	---
15-20	F6.3	DMVLDF(1,1)	Vehicle load factor during peak periods - vehicle type 1	Decimal %
21-24	4X	---	---	---
25-30	F6.3	DMVLDF(2,1)	Vehicle load factor during off-peak periods - vehicle type 1	Decimal %
31-34	4X	---	---	---
35-40	F6.1	DVHCAP(2)	Vehicle capacity - vehicle type 2	Persons/veh
41-44	4X	---	---	---
45-50	F6.3	DMVLDF(1,2)	Vehicle load factor during peak periods - vehicle type 2	Decimal %
51-54	4X	---	---	---
55-60	F6.3	DMVLDF(2,2)	Vehicle load factor during off-peak periods - vehicle type 2	Decimal %
61-80	---	---	Not used	---

Number of cards: 1 card for each set of two vehicle types

FIGURE 4-26 CARD FORMAT TYPE 25

Card Columns	Format	Variable Name	Definition	Units
1-5	F5.0	DMAINT(1)	Geographic area code	---
6-10	F5.0	DMAINT(2)	Construction type code	---
11-15	F5.0	DMAINT(3)	Land use code	---
16-20	F5.0	DMAINT(4)	Land cost code	---
21-30	F10.2	DMAINT(5)	Land area	Acres
31-40	F10.0	DMAINT(6)	Structure & equipment cost	$
41-80	---	---	Not used	---

Number of cards: 1

FIGURE 4-19 CARD FORMAT TYPE 18

Card Columns	Format	Variable Name	Definition	Units
1-4	I4	NVA	Vehicle fleet number index = NV	---
5-14	F10.2	DVHSUC(NV,1)	Vehicle subsystem #1 unit cost	$/veh.
15-24	F10.2	DVHSUC(NV,2)	Vehicle subsystem #2 unit cost	$/veh.
25-34	F10.2	DVHSUC(NV,3)	Vehicle subsystem #3 unit cost	$/veh.
35-44	F10.2	DVHSUC(NV,4)	Vehicle subsystem #4 unit cost	$/veh.
45-54	F10.2	DVHSUC(NV,5)	Vehicle subsystem #5 unit cost	$/veh.
55-64	F10.2	DVHSUC(NV,6)	Vehicle subsystem #6 unit cost	$/veh.
65-72	F8.2	DVHUC(NV)	Total vehicle unit cost	$/veh.
73-80	F8.0	DNUMVH(NV)	Total number of vehicles in fleet	Vehicles

Number of cards: 1 card per vehicle fleet (NV)

FIGURE 4-20 CARD FORMAT TYPE 19

Card Columns	Format	Variable Name	Definition	Units
1-5	F5.3	ASSRAT(1)	Assessment ratio in geographic area #1	Decimal percent of full value
6-10	F5.3	ASSRAT(2)	Assessment ratio in geographic area #2	Decimal percent of full value
11-15	F5.3	ASSRAT(3)	Assessment ratio in geographic area #3	Decimal percent of full value
16-25	F10.2	TAXRAT(1)	Tax rate in geographic area #1	$/$1000 assess.
26-35	F10.2	TAXRAT(2)	Tax rate in geographic area #2	$/$1000 assess.
36-45	F10.2	TAXRAT(3)	Tax rate in geographic area #3	$/$1000 assess.
46-80	---	---	Not used	---

Number of cards: 1

FIGURE 4-21 CARD FORMAT TYPE 20

Card Columns	Format	Variable Name	Definition	Units
1-10	I10	JK	Number of off-guideway links	---
11-20	I10	NH	Number of highway related transit systems	---
21-30	I10	NX	Number of transit related transit systems	---
31-40	I10	NHV	Number of highway vehicles	---
41-80	---	---	Not used	---

Number of cards: 1

Comments: JK ≦ 149
NH = Highway related transit systems that have a VMT that can be assigned to highways
NX = Non-highway related transit systems
NH + NX = Total number of transit systems (max = 4)
NHV = Number of highway vehicles (max = 2 NHV = 1 - autos
NHV = 2 - trucks)

FIGURE 4-22 CARD FORMAT TYPE 21

Card Columns	Format	Variable Name	Definition	Units
45-50	F6.1	DNOISE(ND,9,2)	Noise impact distance from centerline if new system is adjacent to elevated freeway having 2 lanes	Feet
51-56	F6.1	DNOISE(ND,10,2)	Noise impact distance from centerline if new system is adjacent to elevated freeway having 4 lanes	Feet
57-62	F6.1	DNOISE(ND,11,2)	Noise impact distance from centerline if new system is adjacent to elevated freeway having 6 lanes	Feet
63-68	F6.1	DNOISE(ND,12,2)	Noise impact distance from centerline if new system is adjacent to elevated freeway having 8 lanes	Feet
69-74	F6.1	DNOISE(ND,13,2)	Noise impact distance from centerline if new system is adjacent to railroad	Feet
75-80	F6.1	DNOISE(ND,14,2)	Noise impact distance from centerline if new system is adjacent to rapid transit	Feet

Number of cards: 20

Comments: These are night-time noise input values.

FIGURE 4-15 CARD FORMAT TYPE 14 (continued)

Card Columns	Format	Variable Name	Definition	Units
1-5	F5.0	DCNCEN(1)	Geographic area code	---
6-10	F5.0	DCNCEN(2)	Construction type code	---
11-15	F5.0	DCNCEN(3)	Land use code	---
16-20	F5.0	DCNCEN(4)	Land cost code	---
21-30	F10.2	DCNCEN(5)	Area of land	Acres
31-40	F10.0	DCNCEN(6)	Structural cost	$
41-50	F10.0	DCNCEN(7)	Computer facilities cost	$
51-80	---	---	Not used	---

Number of cards: 1

FIGURE 4-16 CARD FORMAT TYPE 15

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.0	DWAYCC(1)	Command & control equipment cost	$/route mile
11-20	F10.0	DWAYCC(2)	Detectors cost	$/lane mile
21-80	---	---	Not used	---

Number of cards: 1

FIGURE 4-17 CARD FORMAT TYPE 16

Card Columns	Format	Variable Name	Definition	Units
1-5	I5	NY	Yard index number	---
6-10	F5.0	DYARDS(NY,1)	Geographic area code	---
11-15	F5.0	DYARDS(NY,2)	Construction type code	---
16-20	F5.0	DYARDS(NY,3)	Land use code	---
21-25	F5.0	DYARDS(NY,4)	Land cost code	---
26-35	F10.2	DYARDS(NY,5)	Land area	Acres
36-45	F10.0	DYARDS(NY,6)	Structural cost	$/acre
46-55	F10.2	DYARDS(NY,7)	Track length	Lane miles
56-80	---	---	Not used	---

Number of cards: 1 card per yard plus last card

Comments: Last card must have a "5" in column 5

$NY \leq 4$

FIGURE 4-18 CARD FORMAT TYPE 17

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.2	RESDEN(JRD,1)	Residential density - Whites	Dwellings/acre
11-20	F10.2	RESDEN(JRD,2)	Residential density - Blacks	Dwellings/acre
21-30	F10.2	RESDEN(JRD,3)	Residential density - Others	Dwellings/acre
31-40	F10.2	RESDEN(JRD,4)	Residential density - Low income	Dwellings/acre
41-50	F10.2	RESDEN(JRD,5)	Residential density - Medium income	Dwellings/acre
51-60	F10.2	RESDEN(JRD,6)	Residential density - High income	Dwellings/acre
61-80	---	---	Not used	---

Number of cards: 4 (representing four different residential density compositions)

Comments: If data were available, families or persons per acre could be substituted for dwellings per acre

FIGURE 4-13 CARD FORMAT TYPE 12

Card Columns	Format	Variable Name	Definition	Units
1-4	F4.0	DNOISE(ND,1,1)	Construction type code of new system	---
5-9	F5.0	DNOISE(ND,2,1)	Number of lanes of the new system	Lanes
10-14	F5.0	DNOISE(ND,3,1)	Operating speed of the new system	Miles/hour
15-20	F6.1	DNOISE(ND,4,1)	Noise impact distance from centerline if new system is by itself	Feet
21-26	F6.1	DNOISE(ND,5,1)	Noise impact distance from centerline if new system is adjacent to at-grade freeway having 2 lanes	Feet
27-32	F6.1	DNOISE(ND,6,1)	Noise impact distance from centerline if new system is adjacent to at-grade freeway having 4 lanes	Feet
33-38	F6.1	DNOISE(ND,7,1)	Noise impact distance from centerline if new system is adjacent to at-grade freeway having 6 lanes	Feet
39-44	F6.1	DNOISE(ND,8,1)	Noise impact distance from centerline if new system is adjacent to at-grade freeway having 8 lanes	Feet

FIGURE 4-14 CARD FORMAT TYPE 13

Card Columns	Format	Variable Name	Definition	Units
45-50	F6.1	DNOISE(ND,9,1)	Noise impact distance from centerline if new system is adjacent to elevated freeway having 2 lanes	Feet
51-56	F6.1	DNOISE (NC,10,1)	Noise impact distance from centerline if new system is adjacent to elevated freeway having 4 lanes	Feet
57-62	F6.1	DNOISE(ND,11,1)	Noise impact distance from centerline if new system is adjacent to elevated freeway having 6 lanes	Feet
63-68	F6.1	DNOISE(ND,12,1)	Noise impact distance from centerline if new system is adjacent to elevated freeway having 8 lanes	Feet
69-74	F6.1	DNOISE(ND,13,1)	Noise impact distance from centerline if new system is adjacent to freight and commuter railroad	Feet
75-80	F6.1	DNOISE(ND,14,1)	Noise impact distance from centerline if new system is adjacent to rapid transit	Feet

Number of cards: 20

Comments: These are daytime noise input values

FIGURE 4-14 CARD FORMAT TYPE 13 (Continued)

Card Columns	Format	Variable Name	Definition	Units
1-4	F4.0	DNOISE(ND,1,2)	Construction type code of new system	---
5-9	F5.0	DNOISE(ND,2,2)	Number of lanes of the new system	Lanes
10-14	F5.0	DNOISE(ND,3,2)	Operating speed of the new system	Miles/hour
15-20	F6.1	DNOISE(ND,4,2)	Noise impact distance from centerline if new system is by itself	Feet
21-26	F6.1	DNOISE(ND,5,2)	Noise impact distance from centerline if new system is adjacent to at-grade freeway having 2 lanes	Feet
27-32	F6.1	DNOISE(ND,6,2)	Noise impact distance from centerline if new system is adjacent to at-grade freeway having 4 lanes	Feet
33-38	F6.1	DNOISE(ND,7,2)	Noise impact distance from centerline if new system is adjacent to at-grade freeway having 6 lanes	Feet
39-44	F6.1	DNOISE(ND,8,2)	Noise impact distance from centerline if new system is adjacent to at-grade freeway having 8 lanes	Feet

FIGURE 4-15 CARD FORMAT TYPE 14

Card Columns	Format	Variable Name	Definition	Units
48-53	F6.3	BACKON(NL,3,2)	On-guideway backhaul factor - percentage of type 3 vehicles flowing on link NL during peak period	Decimal percent
54-59	F6.3	BACKON(NL,3,3)	On-guideway backhaul factor - percentage of type 3 vehicles flowing on link NL during off-peak period	Decimal percent
60-80	---	---	Not used	---

Number of cards: 1 per link having backhaul flows

Comments: NL ≤ 224
last card must have a "225" in column 5

FIGURE 4-9 CARD FORMAT TYPE 8 (Continued)

Card Columns	Format	Variable Name	Definition	Units
1-40	5F8.0	ULANDC(LC) LC = 1,5	Unit land acquisition costs of non-taxable lands. Up to 5 average unit costs may be provided	$/acre
41-80	5F8.0	ULANDC(LC) LC = 6,10	Unit land acquisition costs of taxable lands. Up to 5 average unit costs may be provided	$/acre

Number of cards: 1

Comments: If land acquired is non-taxable land select appropriate unit cost from first five values

If land acquired is taxable land select appropriate unit cost from last five values

FIGURE 4-10 CARD FORMAT TYPE 9

Card Columns	Format	Variable Name	Definition	Units
1-80	16F5.0	DGWDTH(LNS)	Guideway width as a function of the total number of lanes (LNS)	Feet

Number of cards: 1

Comments: Total lanes ≤ 16

FIGURE 4-11 CARD FORMAT TYPE 10

Card Columns	Format	Variable Name	Definition	Units
1-10	F10.0	UTRAKC	Unit track cost	$/lane mile
11-20	F10.0	USTRUC(1)	Guideway structural cost - at-grade	$/lane mile
21-30	F10.0	USTRUC(2)	Guideway structural cost - below grade	$/lane mile
31-40	F10.0	USTRUC(3)	Guideway structural cost - elevated	$/lane mile
41-50	F10.0	USTRUC(4)	Guideway structural cost - tunnel	$/lane mile
51-80	---	---	Not used	---

Number of cards: 1

FIGURE 4-12 CARD FORMAT TYPE 11

Card Columns	Format	Variable Name	Definition	Units
1-80	80I1	JSPRNT(JSP)	Suppress print codes	---

Number of cards: 1

Comments: 80 suppress print codes provided
(Not all are used)
See list of suppress print codes (Table 3-4)
for individual definitions
A "1" suppresses prints
A "0" is recommended for non-suppression.
However, any other digit may be used for
this purpose.

FIGURE 4-6 CARD FORMAT TYPE 5

Card Columns	Format	Variable Name	Definition	Units
1-5	I5	NV	Vehicle fleet index	---
6-15	F10.0	DVHCAP(NV)	Vehicle capacity	Pers/veh
16-25	F10.2	DVHLDF(NV)	Vehicle load factor	Decimal percent
26-35	F10.0	DLNCAP(NV)	Lane capacity of fleet type NV	Veh/hour
36-80	---	---	Not used	---

Number of cards: 1 card per vehicle fleet plus last card

Comments: Last card must have a "5" in column 5.

NV ≤ 3

FIGURE 4-7 CARD FORMAT TYPE 6

Card Columns	Format	Variable Name	Definition	Units
1-4	I4	NL	Guideway link number	---
5-44	4F10.0	DONPFL(NL,NV,3)	Daily person flows per link for each vehicle fleet type NV	Persons/day per link per fleet type
45-60	4F4.2	DPKHRF(NL,NV)	Design hour factor (percent of daily flow during design hour per link for each vehicle fleet type)	Decimal percent
61-76	4F4.2	DPKDRF(NL,NV)	Design hour peak direction factor (percent of design hour flow going in peak direction per link for each vehicle fleet type)	Decimal percent
77-80	F4.0	DGLKST(NL,1)	Average operating speed per link	miles/hour

Number of cards: 1 card per guideway link plus last card

Comments: NL ≤ 224
Last card must have a "225 in column 4

FIGURE 4-8 CARD FORMAT TYPE 7

Card Columns	Format	Variable Name	Definition	Units
1-5	I4	NL	On-guideway link number	---
6-11	F6.3	BACKON(NL,1,1)	On-guideway backhaul factor - percentage of type 1 vehicles flowing in peak direction on link NL during design hour	Decimal percent
12-17	F6.3	BACKON(NL,1,2)	On-guideway backhaul factor - percentage of type 1 vehicles flowing on link NL during peak period	Decimal percent
18-23	F6.3	BACKON(NL,1,3)	On-guideway backhaul factor - percentage of type 1 vehicles flowing on link NL during off-peak period	Decimal percent
24-29	F6.3	BACKON(NL,2,1)	On-guideway backhaul factor - percentage of type 2 vehicles flowing in peak direction on link NL during design hour	Decimal percent
30-35	F6.3	BACKON(NL,2,2)	On-guideway backhaul factor - percentage of type 2 vehicles flowing on link NL during peak period	Decimal percent
36-41	F6.3	BACKON(NL,2,3)	On-guideway backhaul factor - percentage of type 2 vehicles flowing on link NL during off-peak period	Decimal percent
42-47	F6.3	BACKON(NL,3,1)	On-guideway backhaul factor - percentage of type 3 vehicles flowing in peak direction on link NL during design hour	Decimal percent

FIGURE 4-9 CARD FORMAT TYPE 8

Card Columns	Format	Variable Name	Definition	Units
1-80	8A10	RNTITL	The title desired for the computer run	---

Number of cards: 1

Comments: Any alpha-numeric characters suggested titles:

Cols. 1-4	"CITY"
Cols. 13-30	city name
Cols. 31-40	"BASELINE-"
Cols. 43-80	baseline name

FIGURE 4-2 CARD FORMAT TYPE 1

Card Columns	Format	Variable Name	Definition	Units
1-5	I5	LECODE	Emergency lanes code	---
6-80	---	---	Not used	---

Number of cards: 1

Comments: LECODE = 0 is used for systems not requiring emergency or way maintenance lanes.

LECODE = 1 is recommended (for consistency) for systems that require emergency lanes. However, any other digit can be used for this condition.

FIGURE 4-3 CARD FORMAT TYPE 2

Card Columns	Format	Variable Name	Definition	Units
1-5	I5	IZ	Index of life and interest input values by subsystem	---
6-15	I10	DLIFE(IZ)	Subsystem life	Years
16-25	I10	DINT(IZ)	Subsystem interest rate	Percent
26-80	---	---	Not used	---

Number of cards: 23 + 1 per veh fleet + last card

Comments: IZ = 1 - Guideway land
= 2 - Guideway track
= 3 - Guideway structures
= 4 - Interchange land
= 5 - Interchange track
= 6 - Interchange structures
= 7 - Terminal land
= 8 - Terminal track
= 9 - Terminal structures
=10 - A/D lanes land
=11 - A/D lanes track
=12 - A/D lanes structures

IZ = 13 - Control center land
= 14 - Control center computer
= 15 - Control center structures
= 16 - Maint. facility land
= 17 - Maint. facility struc.+ equip.
= 18 - Storage yards land
= 19 - Storage yards track
= 20 - Storage yards structures
= 21 - Way comm.+ cont. equip.
= 22 - Way comm.+ cont. detect.
= 23 - Vehicle type 1
= 24 - Vehicle type 2
= 25 - Vehicle type 3

Last card must have a "30" in columns 4 and 5

$IZ \leq 29$

FIGURE 4-4 CARD FORMAT TYPE 3

Card Columns	Format	Variable Name	Definition	Units
1-80	10F8.3	SCALEF(JSF)	Scale factors	---

Number of cards: 1

Comments: Ten scale factors provided
See list of scale factors (Table3-3)
for individual definitions
For non-scaling purposes set values at 1.000

FIGURE 4-5 CARD FORMAT TYPE 4

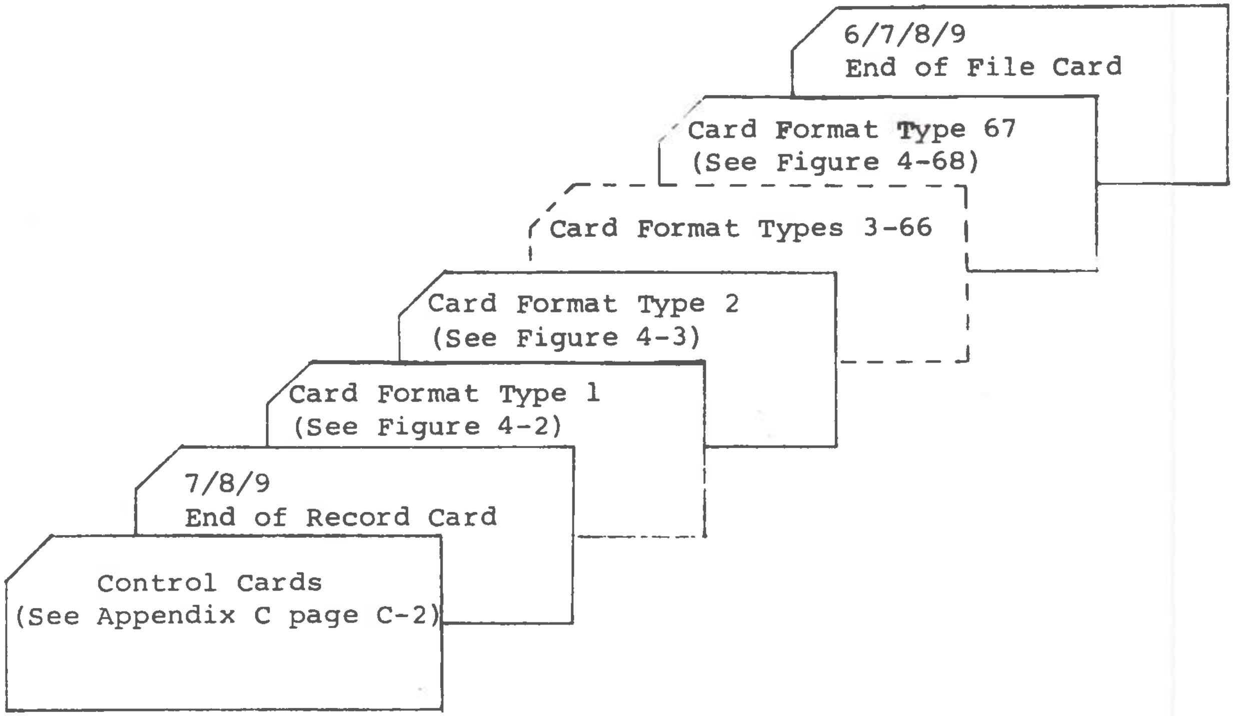


FIGURE 4-1 New System Cost Program Card Data Input Deck Assembly Format

format types) of data are input directly from cards. Figure 4-1 shows the deck assembly format for this type data. It is noted that the control cards in this deck comprise those control cards which loads and executes the program. It is further noted that this deck cannot be loaded and executed until the input data described in the next section is created onto a disc file. Type 1 input data represents approximately half the data required by the program. The total set of this data comprises sixty-seven unique card format types as shown in Figures 4-2 through 4-68. Each card format type may represent one or more cards depending on the type data it contains. The figures in this section (as in the remaining sections) are designed to be self-explanatory. Additional text is provided only where it is considered necessary to eliminate possible misinterpretation. Appendix C (pages C-2 through C-12) shows a typical deck of input type 1 data with its corresponding control cards.

4. New System Cost Program Input Data

Version 2 of the new system cost program can be run in either of two modes;

1. single loop mode, or
2. multiple loop mode.

The single loop mode requires two types of data input; namely,

1. card input data for the basic run, and
2. disc file input data for the basic run.

The multiple loop mode requires both of these data input types and in addition requires a parametric run card input data deck which is combined with the type 1 data deck of mode 1.

These three data deck types are documented separately in the three major sections of this chapter.

4.1 Card Input Data

All input data for single loop application of the new system cost program with the exception of four sets (i.e., four card

3.4.10 Subroutine SUM

This subroutine is identical to the SUM subroutine that exists within OVERLAY 1.0. Since OVERLAY 1.0 and OVERLAY 3.0 do not exist simultaneously in core during the execution of the program, two copies of this subroutine are required within the New System Cost program.

3.4.11 Subroutine SUM2

This subroutine performs the same functions and calculations as the SUM subroutine described in paragraph 3.2.11. Unlike the SUM subroutine, however, this subroutine operates on arrays that are dimensioned by (6, 9, 4).

3.4.12 Subroutine SUM3

This subroutine perfroms the same functions and calculations as the SUM subroutine described in paragraph 3.2.11. Unlike the SUM subroutine, however, this subroutine operates on arrays that are dimensioned by (5, 8, 5).

Subroutine DMOP then proceeds to calculate the revenue acquired from the operation of the new system vehicles. Utilizing fare rates input by the user and the amount of new system vehicle travel, the amount of revenue acquired is computed as follows:

REVENUE(NV,JF) = DFARE(NV,IVP,JF) * DNOM(NV,IVP,JF)

(Annual REVENUE - \$) =

$$\begin{bmatrix} \text{Fare - \$/vehicle trip} \\ \text{- \$/person trip} \\ \text{- \$/VMT} \\ \text{- \$/PMT} \end{bmatrix} \text{X} \begin{bmatrix} \text{Amount of annual travel - vehicle trips} \\ \text{- person trips} \\ \text{- VMT} \\ \text{- PMT} \end{bmatrix}$$

The annual profits (or losses) are then computed by subtracting the total annual capital plus operating costs from the annual revenue acquired. This data is computed and output with respect to various levels of capital subsidy.

At this point, subroutine DMOP returns control to the main program ALLOTH which in turn transfers control to program DULMODE for the calling of subroutine SUMDATA.

Subroutine also computes annual operating costs for yards, maintenance facilities and for the control center. The total annual operating cost for all new system vehicle elements (DTDOPC) is the sum of the annual operating costs for the guideway, terminals, vehicles, yards, maintenance facilities, and the control center. All annual cost data is printed by the routine immediately upon calculation.

At this point subroutine DMOP begins the breakeven fare data calculations. Breakeven fares are computed for each new system vehicle type (NV) according to two fare structures at various levels of capital subsidy. The levels of capital subsidy are specified by the user by data input to the FLOCAP array (FLOCAP = 0.0 - full subsidy; FLOCAP = 1.0 no subsidy). For the flat fare structure, breakeven fares($/person trip of $/vehicle trip) are computed by dividing the total annual capital plus operating costs by the number of annual person trips (or vehicle trips). Similarly, breakeven flat mileage rate fares ($/PMT or $/VMT) are computed by dividing the total annual capital plus operating costs by total annual PMT (or VMT). The capital cost data used in these equations represent only that portion of the total capital cost not subsidized by an outside agency (i.e. federal or local government).

Annual costs for the maintenance and the operation of terminals are computed for each terminal type (NDT). These annual costs,as shown in the following equations,are computed by multiplying the annual unit operating cost by the number of terminals of each particular design type.

DTROPC (NDT,5) = DTROPC (NDT,2) * DTROPC (NDT,4)

(Annual maintenance cost-terminals) = (Terminal maintenance unit cost - $/yr/terminal) (No. of terminals)

DTROPC (NDT,6) = DTROPC (NDT,3) * DTROPC (NDT,4)

(Annual operating cost-terminals) = (Operating unit cost - $/yr./terminal) (No. of terminals)

The total terminal annual operating costs is then computed by summing the costs for maintenance and the costs for terminal operations for each terminal type (NDT).

Similarly, annual costs for guideway maintenance and operation are computed based upon the number of lane-miles of guideway. Annual costs for guideway maintenance, operation, and for the operation of guideway communication and control equipment are computed by multiplying the respective unit costs, in units of $/year/lane-mile, by the total lane miles of guideway (DTLNMI). The total annual guideway operating cost is equal to the summation of these costs.

For new system vehicles, annual operating costs for terminals, guideway, vehicles, and other facilities are quantified. The annual cost of operating the vehicles (i.e., for depreciation, drivers, maintenance, and power) are computed with respect to each vehicle type based upon their operations on and off the guideway. The costs are computed according to the following equations:

On-Guideway:

DVHOPC (NV,NVD,1) = DVOPUC (NV,NVD,1) * DONVMT(LKT,NV,4)

Off-Guideway:

DVHOPC(NV,NVD,2) = DVOPUC(NV,NVD,2) * DOFVMT(JKT,NV,4)

(Annual vehicle operating cost) = (Unit operating cost - $/VMT)
(Annual On-Guideway or Off-Guideway VMT)

where NV = Vehicle ID NVD = 1-Depreciation
2-Maintenance
3-Power (Fuel)
4-Parking
5-Insurance
6-Taxes
7-Drivers
8-All

The total vehicle annual operating cost is then the sum of the on-guideway and the off-guideway operating costs.

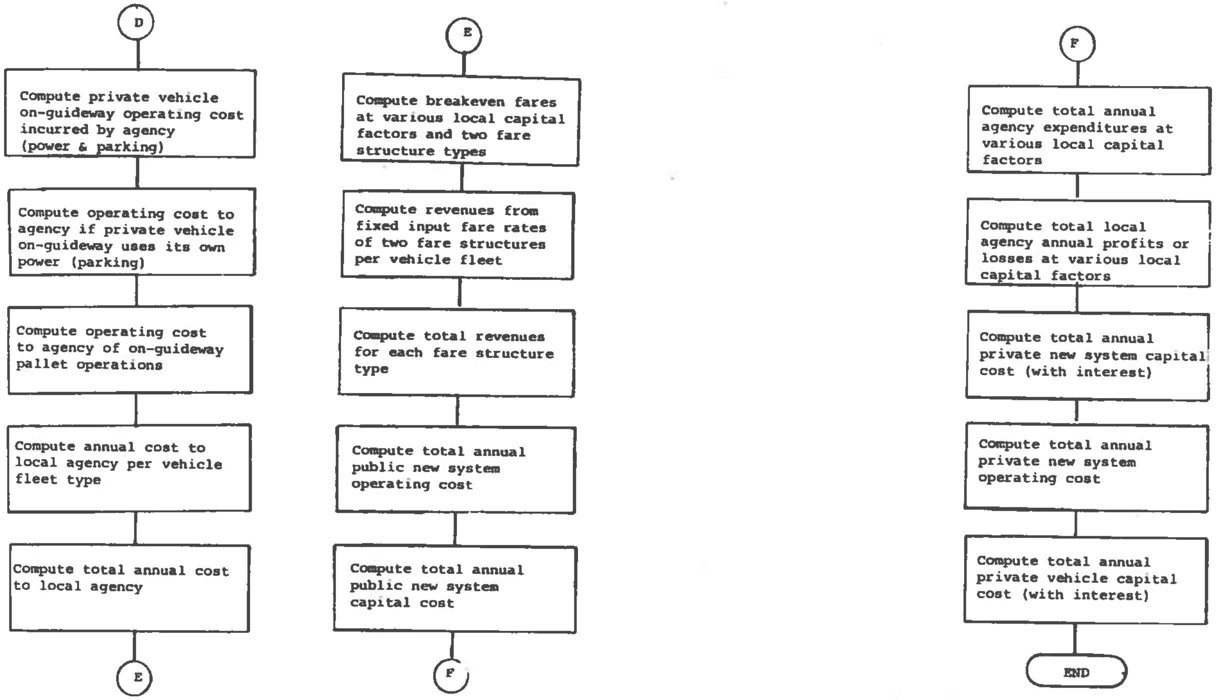


FIGURE 3-46 General Flow Chart - Subroutine DMOP (continued)

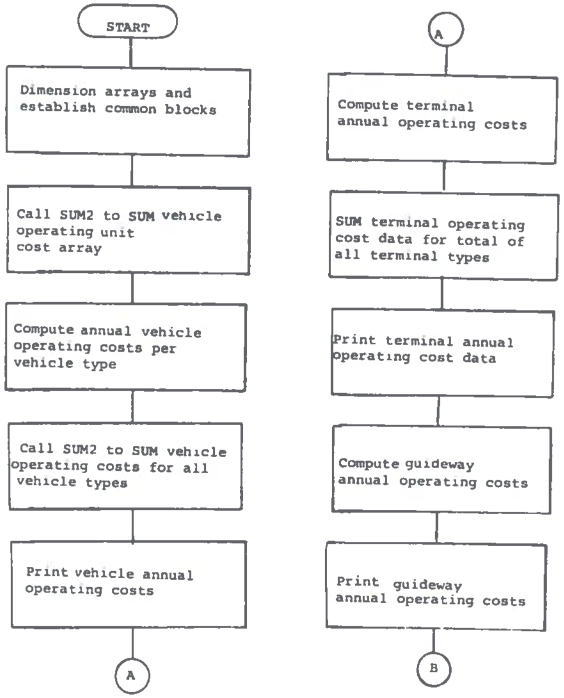


FIGURE 3-46 General Flow Chart - Subroutine DMOP

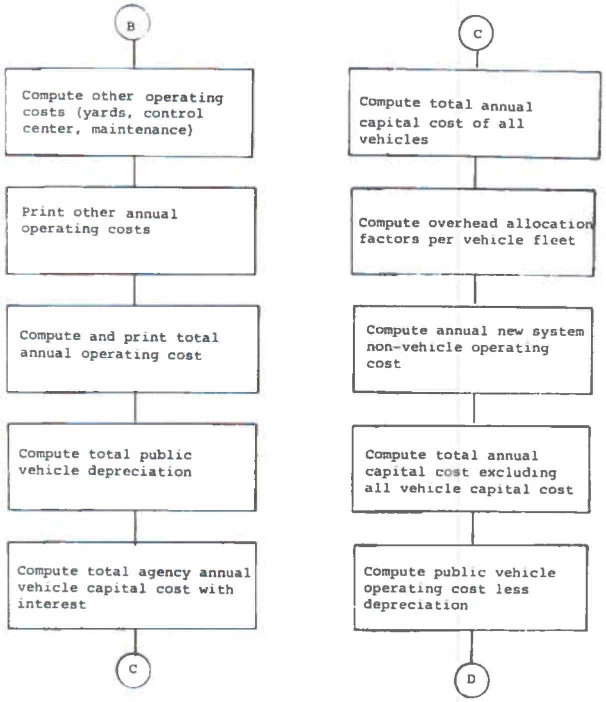


FIGURE 3-46 General Flow Chart - Subroutine DMOP (continued)

3.4.9 Subroutine DMOP

Subroutine DMOP performs the following functions of the New System Cost program:

- Computes and outputs all operating costs associated with the new vehicle system.
- Computes breakeven fares at various levels of capital subsidy according to two fare structures
- Calculates revenue derived based upon two fare rate structures and various levels of capital subsidy.
- Calculates annual cost and profit data.

A general flow diagram illustrating the sequence of functions performed by this routine is presented in Figure 3-46.

Input data to this subroutine is comprised primarily of unit operating costs for the new system vehicle elements (i.e. guiding, vehicles, terminals, etc.,), fare rates,and local capital subsidy factors. This data is read in by subroutine RDINPUT and passed to this routine by means of common blocks /RDI/ and /RDR/.

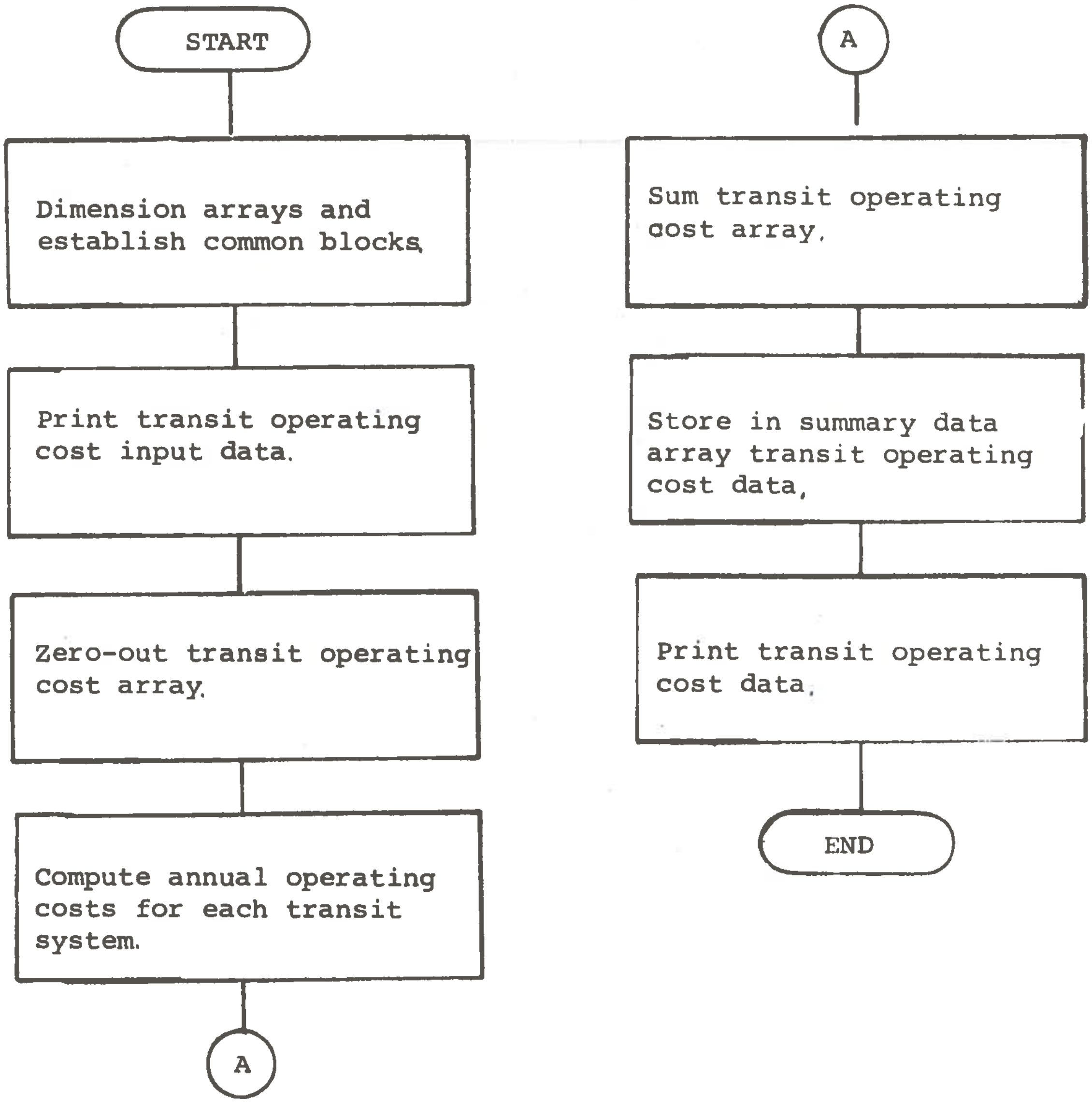


FIGURE 3-45 General Flow Chart - Subroutine TRNOP

3.4.8 Subroutine TRNOP

As outlined in the general flow diagram (FIGURE 3-45), this subroutine performs the following functions of the New System Cost program:

- prints all transit operating cost input data
- calculates annual operating costs for individual transit systems (maximum of four)
- prints transit operating cost output data.

As in the case with subroutine HWYOP, all card input data to this subroutine is read in by subroutine RDINPUT and transferred by means of common blocks /RDI/and/RDR/. TRNOP also utilizes transit VMT data input from the transit network subroutine (XNETWRK) via common block /OV33/.

Before any operating cost calculations are performed, the variable JSPRNT(55) is tested to determine whether or not the input data to this subroutine is to be printed. Input data is only printed whenever the JSPRNT variable is not equal to a logic 1.

The total highway operating cost is then computed by summing the way operating costs and the vehicle operating costs.

$$THWYOC = \sum HVOPCT + \sum HWYOCT$$

At this point, HWYOP prints all operating cost data provided the variable JSPRNT(54) is not equal to a logic 1. Control is then returned to the main program ALLOTH for the calling of the transit operating cost subroutine TRNOP.

The unit operating costs for vehicle depreciation, maintenance, fuel, insurance, etc. are input by the user in units of $/VMT. Total vehicle operating costs for autos and trucks are computed according to the following equations:

Autos: HVOPCT(1,ICTX) = HVOPCS(1,ICTX) * AUTOND(3,4,2)

Trucks: HVOPCT(2,ICTX) = HVOPCS(2,ICTX) * TRCKND(3,4,1)

(operating cost - $) = (unit cost - $/VMT) X (VMT)

Freeway and surface arterial way operating costs are computed for power, manpower, and maintenance. The way power and the way maintenance operating costs are computed based upon the number of route miles; the way manpower operating costs are computed utilizing the number of manyears computed above.

Power: HWYOCT(MHX,1) = HWYOPC(MHX,1) * HOPDAT(MHX,3)

(operating cost - $) = (power unit cost - $/route mile) X (route miles)

Manpower: HWYOCT(MHX,2) = HWYOPC(MHX,2) * HOPDAT(MHX,4)

(operating cost - $) = (manpower unit cost - $/MY) X (manyears)

Maintenance: HWYOCT(MHX,3) = HWYOPC(MHX,3) * HOPDAT(MHX,3)

(operating cost - $) = (maintenance unit cost - $/route mile) X (route miles)

The highway operating cost input data is printed whenever this variable is not equal to a logic 1. Prior to any cost calculations, HWYOP computes for freeways and surface arterials the total number of route miles and the total number of manyears required for the area under analysis. The number of freeway and surface arterial route miles are computed by dividing the total number of freeway (or surface arterial) lane miles by the average number of lanes. Thus, for freeways (MHX = 1) and for surface arterials (MHX = 2) :

HOPDAT(MHX,3) = HNCHAR(MHX) / HOPDAT(MHX,1)

(No. of route miles) = (No. of lane miles) / average no. of lanes

The number of manyears required for way manpower operating costs is computed based upon the number of freeway and surface arterial route miles as follows:

HOPDAT(MHX,4) = HOPDAT(MHX,3) * HOPDAT(MHX,2)

(No. of manyears) = (No. of route miles) X (No. of manyears/route mile)

Annual vehicle operating costs are then computed for autos and trucks based upon the amount of vehicle travel (VMT).

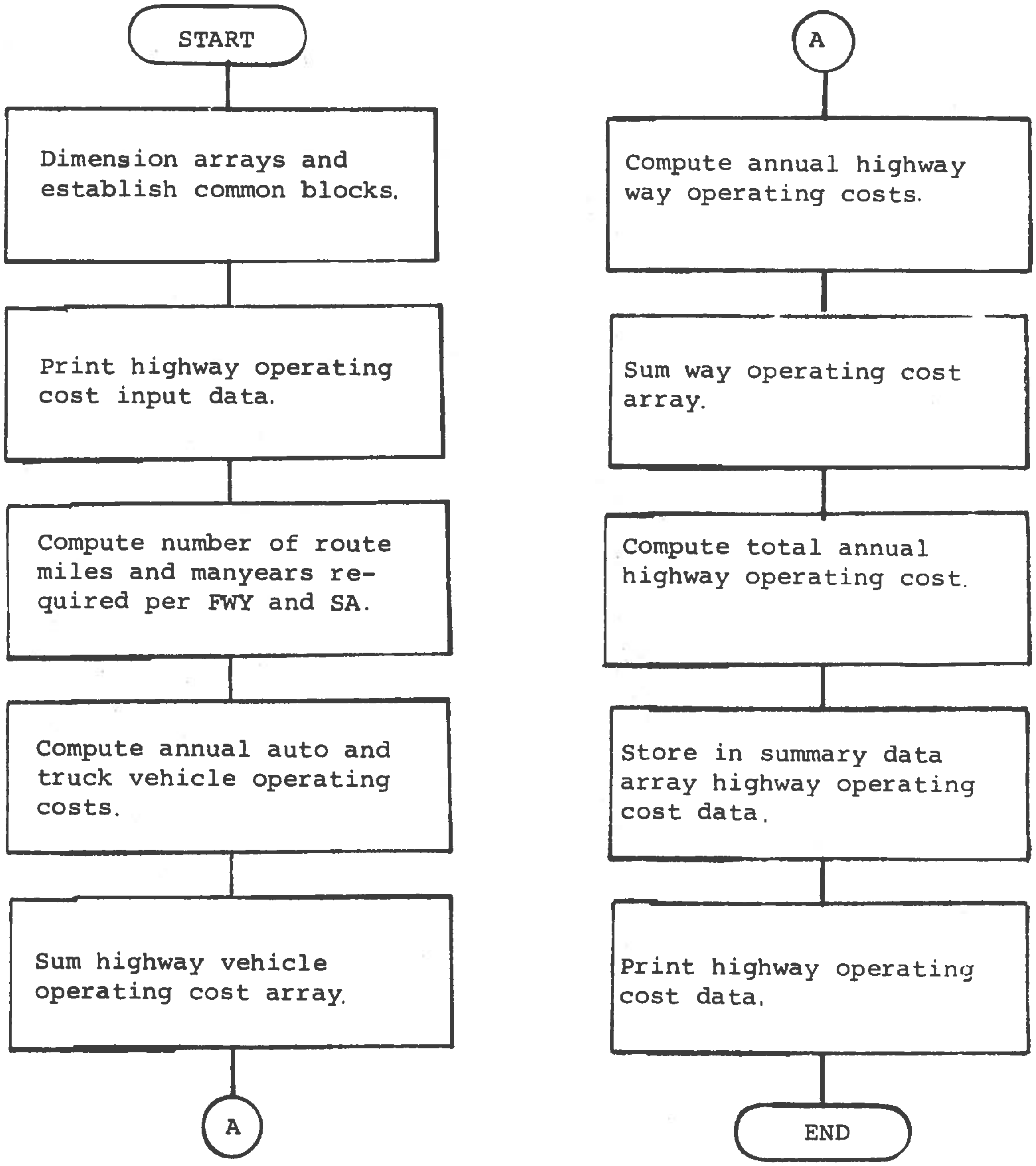


FIGURE 3-44 General Flow Chart - Subroutine HWYOP

3.4.7 Subroutine HWYOP

Subroutine HWYOP performs all operating cost calculations for highways and highway vehicle systems. More specifically, the following functions are performed by this subroutine:

- prints all highway operating cost input data provided the printout of this data has not been suppressed
- computes way annual operating and maintenance costs for freeways and surface arterials
- computes vehicle annual operating costs for autos and trucks
- prints all highway operating cost output data provided the printout of this data has not been suppressed

Figure 3-44 describes the sequence of functions performed by HWYOP. All highway operating cost input data (read in by subroutine RDINPUT) is made available to HWYOP through the common blocks /RDI/ and /RDR/. This subroutine also utilizes auto and truck VMT data which it receives from the highway network (HWYNET) subroutine by means of common block /OV33/.

Initially, the subroutine tests the variable JSPRNT(53) to determine whether or not the input data is to be printed.

DMDSTA (or DMASTA) = (DMSTAC) * Y (or YZ) /1000000.

(Daily (or annual personal accidents) = (Accident rate - $\frac{\#\text{accidents}}{\text{million person trips}}$) X (Daily or annual person trips) /1000000.

At this point, all accident data for the new system vehicles is output by subroutine ACCDNT. Printing of this output data can be controlled by the user through variable JSPRNT (52). Upon completion of all data output, control is returned to the main program ALLOTH for the calling of the next subroutine HWYOP.

It should be noted that in the above equations that the total person trips are adjusted by a factor equal to the ratio of the off-guideway VMT / total (on + off-guideway) VMT. This was done to account for only that portion of the total person trips that were conducted off the guideway.

On-guideway accidents (traffic accidents and passenger fatalities) are computed as a function of the vehicle's on-guideway VMT. For traffic accidents, the total VMT of loaded plus empty vehicles is used; whereas, passenger fatalities are calculated based upon the VMT of only loaded vehicles travelling on the guideway..These data calculations are performed as follows:

VEHACC(LV,1,ITP) = (DACRAT(1,LV) * DONVMT(LKY,LV,ITP)) /1000000.

(Traffic Accidents) = (Accident rate - $\frac{\text{\#accidents}}{\text{million VMT}}$) X

(on-guideway VMT) /1000000.

PERACC(LV,1,ITP) = (DACRAT(2,LV) * DLVDAT(1,LV,ITP)) /1000000.

(Passenger Fatalities) = (Accident rate - $\frac{\text{\#accidents}}{\text{million VMT}}$) X

(On-guideway loaded vehicle VMT) /1000000.

The number of daily and annual station accidents are than computed as a function of the number of new system vehicle person trips:

Transit Accident Rates

VEHACC(1,1,ITP) = (DOFVMT(JKY,LV,ITP) * XACRAT(JDX,1))/1000000.

(Traffic accidents) = (off-guideway VMT)

$$\left(\text{Accident rate - } \frac{\#\text{accidents}}{\text{per million VMT}}\right) /1000000.$$

VEHACC(1,2,ITP) = ((DPTRIP(ITP,LV) * XACRAT(JDX,2))/1000000.) *
(DLVDAT(3,LV,ITP)/DLVDAT(5,LVX,ITP))

(Passenger accidents) = [(Person trips)(Accident rate -

$$\frac{\#\text{accidents}}{\text{million person trips}})/1000000.] \text{ x}$$

(off-guideway loaded vehicle VMT)/

(Total loaded vehicle VMT)

PERACC(1,IBX,ITP) = ((DPTRIP(ITP,LV) * XACRAT(JDX,IVX))/1000000.) *

(DLVDAT(3,LV,ITP)/DLVDAT(5,LV,ITP))

(Personal Accidents) = [(Person trips)(Accident rate -

$$\frac{\#\text{accidents}}{\text{million person trips}})/1000000.] \text{ x}$$

(off-guideway loaded vehicle VMT)/

(Total loaded vehicle VMT)

where IBX = 1 - passenger fatalities

2 - non-passenger fatalities

As indicated above, off-guideway accident data calculations for the new system vehicles are computed using auto or transit accident rate imput data. The accident code, input by the user for each new system vehicle, identifies the type of accident rate data to be used. For accident codes ranging from 1 through 4, transit accident rates for the corresponding transit system (1 through 4) are used; whenever the accident code is equal to a 5 auto accident rates are used. Similar to the auto and transit accident data calculations above, the number of off-guideway accidents are computed as follows:

<u>Auto Accident Rates</u>

VEHACC(IMX,IAX,ITP) = (DHVMT(IMX,ITP,LVX) * HACRAT(IMX,IAX,ITP)))
/1000000.

$$(\text{Vehicle Accidents}) = (\text{Total off-guideway VMT}) \text{ x } (\text{Accident rate - } \frac{\#\text{accidents}}{\text{100 million VMT}}) /1000000.$$

where IAX = 1 - fatal accidents
2 - injury accidents
3 - property damage accidents

PERACC(IMX,IBX,ITP) = (ZZ(IMX,ITP,LV) * HACRAT(IMX,IBX,ITP))
/1000000.

$$(\text{Personal Accidents}) = (\text{off-guideway loaded vehicle VMT}) (\text{Accident rate - } \frac{\#\text{accidents}}{\text{100 million VMT}}) /1000000.$$

where IBX = 1 - fatalities
2 - injuries

Separate on-guideway and off-guideway accident data calculations are performed by this routine for the new system vehicles. On-guideway accidents are computed using on-guideway accident rate data input by the user; off-guideway accident data calculations are performed utilizing either the highway or the transit accident rate data. In either case, accident data is stratified by various types of accidents, vehicle types and four temporal periods.

Prior to the calculation of the off-guideway accident data, ACCDNT computes the total vehicle miles travelled by loaded new system vehicles on freeways and surface arterials. This data is computed and stored within array ZZ as follows:

```
ZZ(IMX,ITP,LV) = DLVDAT(3,LV,ITP) * (DHVMT(IMX,ITP,LV) /
                 (DHVMT(1,ITP,LV) + DHVMT(2,ITP,LV)))
```

$$(\text{Loaded Vehicles - VMT}) = (\text{Total off-guideway loaded vehicle VMT}) \times \frac{(\text{VMT on freeways (or SA)})}{(\text{Total VMT on highways})}$$

VEHACC(IXV,2,ITP) = (XTRIP(ITP,IXV) * XACRAT(IXV,2)) /1000000.

(Passenger accidents) = (Transit person trips)(accident rate - $\frac{\#\text{accident}}{\text{million person trips}}$) /1000000.

PERACC(IXV,IBX,ITP) = (XPTRIP(ITP,IXV) * XACRAT(IXV,IVX)) /1000000.

(Personal Accidents) = (Transit person trips)(accident rate - $\frac{\#\text{accident}}{\text{million person trips}}$) /1000000.

where IBX = 1 passenger fatalities
= 2 non-passenger fatalities

The SUM subroutine is then called to sum the transit VEHACC and PERACC data arrays. This produces the transit daily accidents. Annual transit accidents are then computed by multiplying the transit daily accidents by the factor NUMDA. At this point all transit accident data is output by ACCDNT. The suppress print variable JSPRNT (51) controls the printing of this data.

Daily auto accident data is then calculated by summing the VEHACC and the PERACC data arrays through repeated call of the SUM subroutine. The number of annual auto accidents is then computed by multiplying the daily accident data by the factor NUMDA. All auto accident data is printed at this time. The user has the option to suppress the printout by means of the variable JSPRNT (50).

Subroutine ACCDNT then proceeds to calculate accident data for the various transit systems. Transit accidents are computed with respect to four accident types (traffic accidents, passenger accidents, passenger fatalities and non-passenger fatalities) and with respect to four temporal periods (peak, off-peak, daily, and annual). These data calculations are performed as follows:

$$\text{VEHACC (IXV,1,ITP)} = \text{(XNDATA (IXV,ITP,2) * XACRAT (IXV,1))} \\ \text{/1000000.}$$

$$\text{(Traffic Accidents)} = \text{(Transit VMT) (Accident Rate} - \frac{\text{\#accidents}}{\text{million VMT}}\text{)} \\ \text{/1000000.}$$

VEHACC (IMX, IAX, ITPX) = (AUTOND (IMX, ITPX, 2) * HACRAT (IMX, IAX, ITPX)) / 100000000.

(Vehicle Accidents) = (Auto VMT) (Accident rate - $\frac{\#\ \text{Accidents}}{100\ \text{million VMT}}$) / 100000000.

where: IMX = 1 - Freeways
= 2 - Surface Arterials

IAX = 1 - fatal accidents
2 - injury accidents
3 - property damage accidents

PERACC (IMX, IBX, ITP) = (AUTOND (IMX, ITP, 2) * HACRAT (IMX, IAX, ITP) /100000000.

(Personal accidents) = (Auto VMT) (accident rate - $\frac{\#\text{accidents}}{100\ \text{million VMT}}$) /100000000.

where: IMX = 1 - Freeways
= 2 - Surface Arterials

IBX = 1 - fatalities
2 - injuries

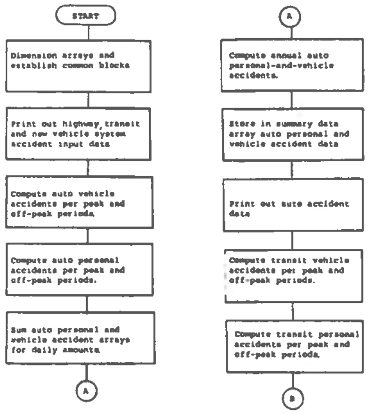


FIGURE 3-43 General Flow Chart - Subroutine ACCDNT

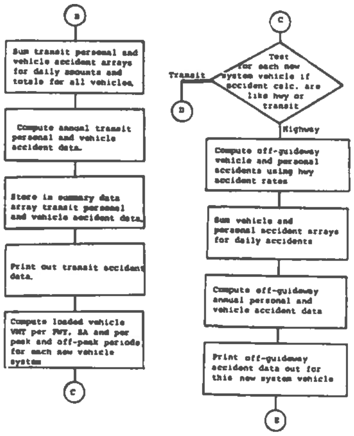


FIGURE 3-43 General Flow Chart - Subroutine ACCDNT (continued)

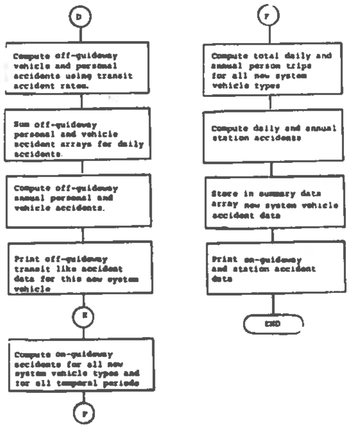


FIGURE 3-43 General Flow Chart - Subroutine ACCDNT (continued)

3.4.6. Subroutine ACCDNT

All accident data calculations for the new system vehicles, the transit systems, and for autos are performed by this subroutine. It also prints all input and output data for each of these vehicle systems. A general flow diagram outlining the sequence of functions performed by this subroutine is presented in Figure 3-43.

Input data to this subroutine is comprised primarily of accident rate data for autos, transit systems, and for the new system vehicles. This data is read in by RDINPUT and made available to this subroutine through common blocks /RDI/ and /RDR/. ACCDNT also utilizes person trip and VMT data in its accident data calculations. This data is received from the network subroutines (NTWORK, NETWRK and HWYNET) through common blocks /OV23/ and /OV33/.

Prior to any data calculations, all input data is printed provided the suppress print variable JSPRNT (48) is not equal to a logic 1.

The calculation of auto accident data is first performed by this subroutine. Auto accidents for a number of accident types, namely: fatal accidents, injury accidents, property damage accidents, fatalities and injuries, are computed with respect to their occurrence on freeways and surface arterials and with respect to four temporal periods (peak, off-peak, daily, and annual). The equations for the calculation of this data are the following:

to determine whether IC gas or IC diesel air pollution data calculations are to be made. Depending upon the setting of this propulsion code, the amount and the types of air pollution emitted by trucks is calculated by means of one of the following equations:

IC GAS:

HWYPOL(2,JTX,ITP) = POLRAT(1,JTX) * TRCKND(3,ITP,1)
(TRUCK Air pollution-LBS) = (Pollution rate--LBS/VMT) X (Truck VMT)

IC DIESEL:

HWYPOL(2,JTX,ITP) = POLRAT(2,JTX) * TRCKND(3,ITP,1)
(Truck Air pollution-LBS) = (Pollution rate--LBS/VMT) X (Truck VMT)

Daily and annual air pollution emission data
is then calculated by AIRPOL

All transit and highway vehicle air pollution data is then output by the subroutine provided the printout of this data has not been suppressed by the setting of the variables JSPRNT (46) and JSPRNT(47) to a logic 1. At this point AIRPOL returns control to the main program ALLOTH for the calling of the next subroutine ACCDNT.

IC GAS:

XPOL(IXV,JTX,ITP) = POLRAT(1,JTX) * XNDATA(IXV,ITP,2)
(Air Pollution-LBS) = (pollution rate--lbs/VMT) X (transit VMT)

IC Diesel:

XPOL(IXV,JTX,ITP) = POLRAT(2,JTX) * XNDATA(IXV,ITP,2)
(Air pollution-LBS) = (pollution rate- lbs/VMT) X (transit VMT)

Electric:

XPOL(IXV,JTX,ITP) = POLRAT(3,JTX) * XPWRC(IXV,ITP,1)
(Air pollution-LBS) = (pollution rate-LBS/KWHR) X (transit power consumed-KWHR)

The transit air pollution data array is then summed by the SUM subroutine for the daily air pollution emission (peak + off-peak) of each transit system and for the total emission of all transit systems. The daily air pollution emission data is then multiplied by the number of days/year (NUMDA) to arrive at the annual transit air pollution data.

AIRPOL then begins the air pollution data calculations for highway vehicles (autos and trucks). Auto air pollution data is computed first according to the following equation. It is assumed that all autos are powered by gas internal combustion engines.

IC GAS

HWYPOL(1,JTX,ITP) = POLRAT(1,JTX) * AUTOND(3,ITP,2)
(Auto Air pollution-LBS) = (Air pollution rate--lbs/VMT) * (Auto VMT)

For trucks, a test is made of the user input propulsion code to determine whether IC gas or IC diesel air pollution data calculations are to be made. Depending upon the setting of this propulsion code, the amount and the types of air pollution emitted by trucks is calculated by means of one of the following equations:

IC GAS:

HWYPOL(2,JTX,ITP) = POLRAT(1,JTX) * TRCKND(3,ITP,1)
(TRUCK Air pollution-LBS) = (Pollution rate--LBS/VMT) X (Truck VMT)

IC DIESEL:

HWYPOL(2,JTX,ITP) = POLRAT(2,JTX) * TRCKND(3,ITP,1)
(Truck Air pollution-LBS) = (Pollution rate--LBS/VMT) X (Truck VMT)

Daily and annual air pollution emission data
is then calculated by AIRPOL

All transit and highway vehicle air pollution data is then output by the subroutine provided the printout of this data has not been suppressed by the setting of the variables JSPRNT (46) and JSPRNT(47) to a logic 1. At this point AIRPOL returns control to the main program ALLOTH for the calling of the next subroutine ACCDNT.

IC GAS:

```
XPOL(IXV,JTX,ITP) = POLRAT(1,JTX) * XNDATA(IXV,ITP,2)
(Air Pollution-LBS) = (pollution rate--lbs/VMT) X (transit VMT)
```

IC Diesel:

```
XPOL(IXV,JTX,ITP) = POLRAT(2,JTX) * XNDATA(IXV,ITP,2)
(Air pollution-LBS) = (pollution rate- lbs/VMT) X (transit VMT)
```

Electric:

```
XPOL(IXV,JTX,ITP) = POLRAT(3,JTX) * XPWRC(IXV,ITP,1)
(Air pollution-LBS) = (pollution rate-LBS/KWHR) X (transit power
                                                   consumed-KWHR)
```

The transit air pollution data array is then summed by the SUM subroutine for the daily air pollution emission (peak + off-peak) of each transit system and for the total emission of all transit systems. The daily air pollution emission data is then multiplied by the number of days/year (NUMDA) to arrive at the annual transit air pollution data.

AIRPOL then begins the air pollution data calculations for highway vehicles (autos and trucks). Auto air pollution data is computed first according to the following equation. It is assumed that all autos are powered by gas internal combustion engines.

IC GAS

```
HWYPOL(1,JTX,ITP) = POLRAT(1,JTX) * AUTOND(3,ITP,2)
(Auto Air pollution-LBS) = (Air pollution rate--lbs/VMT) *
                                                  (Auto VMT)
```

For trucks, a test is made of the user input propulsion code of air pollution emitted is then calculated by multiplying the daily emission levels by the factor NUMDA - the number of days in a year. The total amount of air pollution emitted by the new system vehicles operating on and off the guideway is then computed by summing the on-guideway and off-guideway air pollution arrays:

DTOPOL(LV,ITP) = DONPOL(LV,4,ITP) + DOFPOL(LV,4,ITP)

At this point, all air pollution data calculated above is output by subroutine AIRPOL. This output data is reported with respect to vehicle types, operations on and off the guideway, the various types of pollutants, and with respect to four temporal periods (peak,off-peak, daily and annual). The print-out of this data is controlled by the suppress print variable JSPRNT(45). It should be noted that the new system vehicle air pollution data arrays (DONPOL and the DOFPOL), are printed at this point in the subroutine since these arrays are equivalenced to the transit and the highway vehicle air pollution data arrays (XPOL and HWYPOL).

The transit air pollution data calculations are very much the same as the calculations performed above for the new system vehicle. A propulsion code (input by the user) is tested for each transit system (IXV) and depending whether the respective transit systems are powered by either IC gas, IC diesel, or electric engines the amount and the type of air pollutants emitted are computed utilizing the following equations:

where: JTX = 1 - CO
= 2 - HC
= 3 - NOX

ITP = 1 peak period
= 2 off peak period

Electric

DONPOL(LV,JTX,ITP) = POLRAT(3,JTX) * DONPWR(LV,ITP,1)
(Air Pollution-LBS) = (Pollution rate -LBS/KWHR) X (Power Consumed on-guideway-KWHR)

where: JTX = 1 - Particulates
= 2 - SO_2
= 3 - NOX

ITP = 1 peak period
= 2 off peak period

Similarly, off-guideway air pollution data calculations are performed by first testing the type of off-guideway propulsion (ICgas, IC diesel, and electric) used by the vehicle and then computing the amount and the type of pollutants emitted according to one of the following equations:

IC GAS:

DOFPOL(LV,JTX,ITP) = POLRAT(1,JTX) * DOFVMT (JKY,LV,ITP)
(Air Pollution-LBS) = (Pollution rate-LBS/VMT) (Total off-guideway VMT)

Electric

DOFPOL (LV,JTX,ITP) = POLRAT (2,JTX) * DOFVMT (JKY,LV,ITP)
(Air Pollution-LBS) = Pollution rate-LBS/VMT)x(Total off-guideway VMT)

The on-guideway and the off-guideway pollution arrays (DONPOL and DOFPOL, respectively) are then summed by repeated calls to the SUM subroutine, for the total daily air pollution emission of each new system vehicle type (LV) and for the total air pollution of all new system vehicles. The annual amount calculations performed by subroutine AIRPOL. The amount of air pollution emitted is computed as a function of the amount of vehicle travel; the type of pollutants emitted is based upon the type of propulsion system used by the vehicle. Since the means of propulsion on and off the guideway may be different for the new system vehicles separate on-guideway and off-guideway air pollution data calculations are performed.

Initially, the subroutine tests for each new system vehicle the on-guideway propulsion codes, input by the user within array IPOLCD (LV,1,1), to determine the type of on-guideway air pollution data calculations that are to be made. Depending on whether the type of propulsion is IC-gas, IC-diesel, or electric, the amount and the type of pollutants emitted by the new system vehicle from on the guideway are calculated ulitizing the appropriate equation listed below:

IC-GAS

```
DONPOL(LV,JTX,ITP) = POLRAT(1,JTX)*DONVMT(LKY,LV,ITP)
(AIR POLLUTION-LBS.) = (Pollution Rate - LBS/VMT) x (Total
                                               on-guideway -VMT)

      where: JTX = 1 - CO          ITP = 1 peak period
                   2 - HC              = 2 off-peak period
                   3 - NOX
```

IC-Diesel

```
DONPOL(LV,JTX,ITP) = POLRAT(2,JTX) * DONVMT(LKY,LV,ITP)
(Air Pollution-Lbs.) = (Pollution rate- LBS/VMT) X (Total
                                               on-guideway VMT)
```

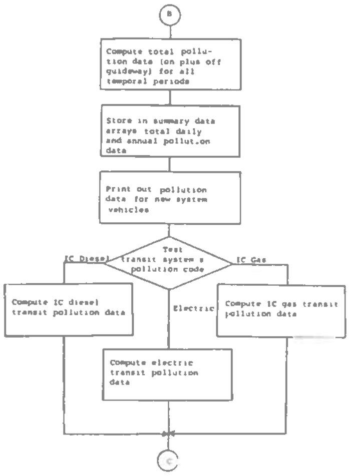


FIGURE 3-42 General Flow Chart - Subroutine AIRPOL (continued)

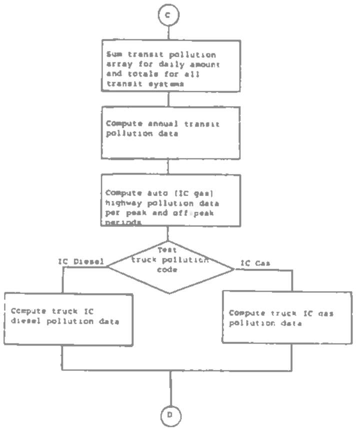


FIGURE 3-42 General Flow Chart - Subroutine AIRPOL (continued)

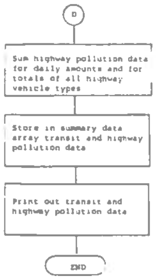


FIGURE 3-42 General Flow Chart - Subroutine AIRPOL (continued)

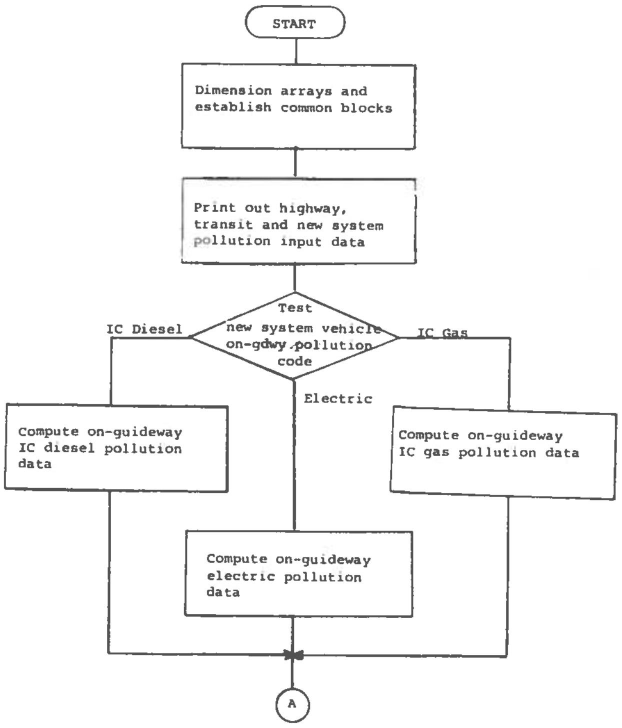


FIGURE3-42 General Flow Chart - Subroutine AIRPOL

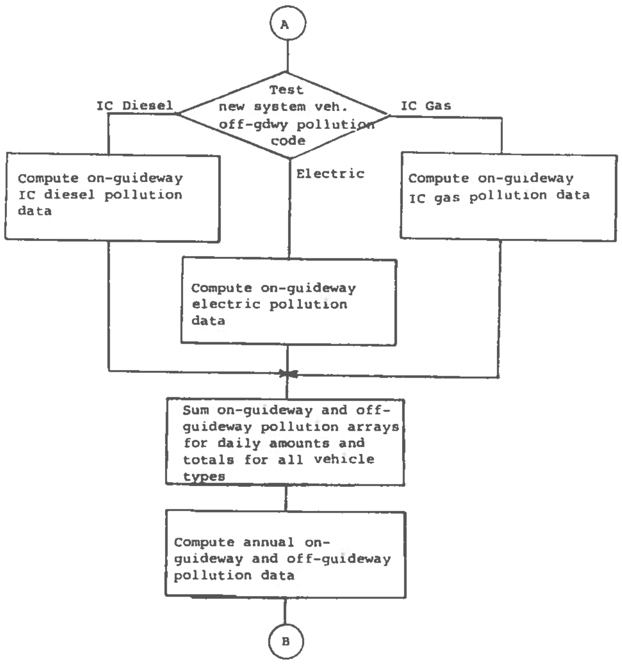


FIGURE3-42 General Flow Chart - Subroutine AIRPOL (continued)

3.4.5 Subroutine AIRPOL

The primary function of this subroutine is to calculate the amount of air pollution emitted by the new system vehicles, the transit systems, and the highway vehicles (autos and trucks). This subroutine also prints all air pollution input and output data. A general flow diagram illustrating the sequence of functions performed by this subroutine is presented in Figure 3-42 .

Air pollution input data is comprised of pollution rates for various types of pollutants and pollution codes for the new system vehicles, the transit systems, and the highway vehicles. All input data to this subroutine is read by subroutine RDINPUT and made available to this routine through common blocks /RDI/and/RDR/. AIRPOL also utilizes in its air pollution data calculations VMT and power consumption data of the various vehicle systems; this data is made available through common blocks /OV23/ and /OV33/.

Prior to any air pollution data calculations, AIRPOL prints all air pollution input data. The printout of this data is capable of being controlled by the user by means of the suppress print variable JSPRNT(44).

Air pollution emitted by the on-guideway and off-guideway operations of the new system vehicle are the first data

Autos

```
HPWRC(NHV,ITP,1) = AUTOND(3,ITP,2)*C
```

Trucks

```
HPWRC(NHV,ITP,1) = TRCKND(3,ITP,1)*C
      (LBS)
```

The highway power consumption array is then summed by the SUM subroutine for the daily power consumption on highways and for the total power consumption of all highway vehicles.

Subroutine POWER then computes the power consumed (in BTU's) for the new vehicle system, transit, and the highway vehicles according to the following equations:

$$\underset{\text{(BTU)}}{\text{Power consumption}} = \left[\underset{\text{(KWHR)}}{\text{Power consumption}}\right] \times 3413$$

$$\underset{\text{(BTU)}}{\text{Power consumption}} = \left[\underset{\text{(LBS)}}{\text{Power consumption}}\right] \times 20000$$

The total power consumption of the new vehicle system is then computed by summing on-guideway and the off-guideway power consumption arrays for each vehicle type LV and for the peak, off-peak, and daily temporal periods.

```
TODPWR(LV,ITP,IT) = DONPWR(LV,ITP,IT)+DOFPWR(LV,ITP,IT)
```

All computed power consumption data is then output by POWER before control is returned to the main program ALLOTH for the calling of the next subroutine AIRPOL.

The transit power consumption array is then summed (through the use of the SUM subroutine) for the daily power consumption and for the total power consumption of all transit systems.

For the calculation of power consumption on highways all highway vehicles (autos and trucks) are assumed to be powered by internal combustion engines. For each of these vehicles the vehicle frontal area is computed as follows:

```
    A(NHV) = HPCVCH(NHV,4)*HPCVCH(NHV,5)
```

The vehicular average speed (in ft/sec) is computed for the peak and off-peak temporal periods and then squared according to the following equations:

Autos

```
  E = (((AUTOND(3,ITP,2)/AUTOND(3,ITP,4)) *1.47) **2)
```

Trucks

```
  E = (((TRCKND(3,ITP,1)/TRCKND(3,ITP,2)) *1.47) **2)
```

The IC power consumption rate (LBS/VMT) and the total power consumed (LBS) is then computed for the peak and the off-peak temporal periods as follows:

```
  C = ((HPCVCH(NHV,1)*HCPVCH(NHV,2)) + (.00134*HPCVCH(NHV,3)
(LBS/VMT)               *A(NHV)*E)) *.00167
```

```
A(IXV) = XPCVCH(IXV,4)*XPCVCH(IXV,5)
```

The average transit speed (in ft/sec) is then computed for the peak and off-peak temporal periods and then squared as follows:

$$\left[\text{speed (ft/sec)}\right]^2 = \left[\frac{\text{transit VMT}}{\text{transit VHT}} \times 1.47\right]^2$$

```
E = (((XNDATA [illegible]V,ITP,2)/XNDATA(IXC,ITP,4)) *1.47) **2)
```

A test is then made [illegible] power code for each transit system to determine whether it [illegible]ropulsion is electric or IC. As in the case of the new system vehicles power consumption rates of either KWHR/VMT or LBS/VMT and total power consumed in units of KWHR or LBS are computed per transit system and for the peak and the off-peak temporal periods utilizing the following equations:

Electric

```
   C = ((XPCVCH(IXV,1)*XPCVCH(IXV,2)) + (.00134*XPCVCH(IXV,3)
(KWHR/VMT)            *A(IXV)*E)) *.00311
```

```
XPWRC(IXV,ITP,1) = XNDATA(IXV,ITP,2)*C
   (KWHR)
```

IC

```
   C = ((XPCVCH(IXV,1)*XPCVCH(IXV,2)) + (.00134*XPCVCH(IXV,3)
(LBS/VMT)             *A(IXV)*E)) *.00167
```

```
XPWRC(IXV,ITP,2) = XNDATA(IXV,ITP,2)*C
    (LBS)
```

vehicle's off-guideway power consumption is computed with respect to the peak and off-peak temporal periods of a day.

Electric

$$\underset{(\text{KWHR/VMT})}{F} = ((\text{DPCVCH}(LV,1,2)*\text{DPCVCH}(LV,2,2)) + (.00134*\text{DPCVCH}(LV,3,2)*A(LV)*E))*.00311 \qquad \text{A-5}$$

$$\underset{(\text{KWHR})}{\text{DOFPWR}(LV,ITP,1)} = \text{DOFPWR}(LV,ITP,1) + \text{DOFVMT}(JK,LV,ITP)*F \qquad \text{A-6}$$

IC

$$\underset{(\text{LBS/VMT})}{F} = ((\text{DPCVCH}(LV,1,2)*\text{DPCVCH}(LV,2,2)) + (.00134*\text{DPCVCH}(LV,3,2)*A(LV)*E))*.00167 \qquad \text{A-7}$$

$$\underset{(\text{LBS})}{\text{DOFPWR}(LV,ITP,2)} = \text{DOFPWR}(LV,ITP,2) + \text{DOFVMT}(JK,LV,ITP)*F \qquad \text{A-8}$$

After all off-guideway power consumption is computed per vehicle type LV for the peak and off-peak temporal periods, the subroutine POWER then sums (by calling the SUM subroutine) the on-guideway and the off-guideway power consumption arrays for the daily power consumption (peak + off-peak) and the total power consumption for all new system vehicle types (LV).

Subroutine POWER then proceeds to compute the power consumed by the various transit systems. For each transit system (IXV) the vehicle frontal area is computed as follows:

After computing the on-guideway power consumption the subroutine then computes the power consumed off the guideway in much the same manner as described above. The vehicle's off-guideway frontal area is computed by multiplying the vehicle's height and width:

$$\text{A(LV)} = \text{DPCVCH(LV,4,2)*DPCVCH(LV,5,2)}$$

The vehicle's average off-guideway link speed (in ft/sec) is computed and then squared for each off-guideway link JK and for the peak and the off-peak temporal periods as follows:

$$\left[\text{speed (ft/sec)}\right]^2 = \left[\left(\frac{\text{off-guideway VMT}}{\text{off-guideway VHT}}\right)*1.47\right]^2$$

$$\text{E} = \left(\left(\left(\text{DOFVMT(JK,LV,ITP)/DOFVHT(JK,LV,ITP)}\right)*1.47\right)**2\right)$$

A test of the vehicle's off-guideway power code is then made to determine if its off-guideway propulsion is electric or IC. If the power code is electric then a KWHR/VMT rate is computed for each off-guideway link JK and the power consumed (KWHR) over all links is computed according to equations A-5 and A-6; if the power code is IC then a LBS/VMT consumption rate and the total power consumed (in lbs) is computed by equations A-7 and A-8 respectively. Like the on-guideway calculations, the

A(LV) = DPCVCH(LV,4,1) * DPCVCH(LV,5,1)

A check is then made of variable DPCVCH(LV,6,1) for each vehicle type LV to determine if the vehicle's on-guideway propulsion system is electric or an internal combustion engine. If the power code is electric then a KWHR/VMT rate is computed per link (LK) and power consumed over all links (in KWHR) is computed according to equations A-1 and A-2 below; if the vehicle's power code is IC then a LBS/VMT rate is computed per link LK and the power consumed over all links (in LBS) is computed according to equations A-3 and A-4. The power consumed is computed for the peak and off-peak temporal periods of a day.

<u>Electric</u>

C = ((DPCVCH(LV,1,1)*DPCVCH(LV,2,1)) + (.00134*DPCVCH(LV,3,1)
(KWHR/VMT) *A(LV)*B(LK))) *.00311 A-1

DONPWR(LV,ITP,1) = DONPWR(LV,ITP,1)+(DONVMT(LK,LV,ITP)*C) A-2
(KWHR)

<u>IC</u>

C = ((DPCVCH(LV,1,1)*DPCVCH(LV,2,1))+(.00134*DPCVCH(LV,3,1)
(LBS/VMT) *A(LV)*B(LK))) *.00167 A-3

DONPWR(LV,ITP,2) = DONPWR(LV,ITP,2)+(DONVMT(LK,LV,ITP)*C)
(LBS) A-4

for the new system vehicle (DPCVCH), the transit systems (XPCVCH), and the highway vehicles (HCPCVCH). These arrays contain the vehicle characteristic data (listed above) that is required as input to the power consumption equations. Subroutine POWER also receives as input

vehicle VMT, vehicle speeds, and vehicle VHT from the new vehicle system, transit, and highway network subroutines NTWORK, XNETWRK, HWYNET, respectively.

Prior to any power consumption calculations, POWER prints the power consumption vehicle characteristic data arrays

provided the suppress print variable JSPRNT(40) is equal to 0. The first power consumption calculations performed by POWER are the on-guideway calculations for the new vehicle system. The vehicle's velocity in ft/sec is computed and then squared for each on-guideway link (LK) using an input of on-guideway speed in miles/hour as follows:

$$\left\{\text{velocity (ft/sec)}\right\}^2 = \left\{\text{speed (mph)} \times 1.47\right\}^2$$

$$\text{B(LK)} = \left\{\text{(DONLKC(LK,1) * 1.47) **2}\right\}$$

The frontal area of the vehicle (in ft^2) is then computed by multiplying the vehicle's height and width for each vehicle type LV:

power consumed:

$$\text{POWER(KWHR)} = \left\{\left\{(W_V \times C_T) + (K_1 \times C_A \times A \times V^2)\right\}\right. \times \left[\text{VMT} \times K_2\right]$$

For internal combustion engine vehicles the power consumed by these vehicles is computed utilizing the following equation:

$$\text{POWER(LBS)} = \left\{\left\{(W_V \times C_T) + (K_1 \times A \times V^2)\right\}\right. \times \left[\text{VMT} \times K_3\right]$$

where in the above equations:

W_V = vehicle weight (lbs)
C_T = tire friction coefficient (unitless)
C_A = aerodynamic friction coefficient (unitless)
A = frontal area of vehicle (ft^2)
V = velocity of vehicle (ft/sec)
VMT = vehicle miles travelled
K_1 = air density (lbm/ft^3) / (2xgravitational constant) ($lbm\ ft/lb_f\ sec^2$)
K_2 = changes VMT to feet, ft-lb_f to kw hrs, and accounts for power transmission and consumption efficiencies and drive train efficiency,= 0.00311
K_3 = changes VMT to feet, ft-lb_f to hp kr, and accounts for vehicle drive train efficiency,= 0.00167

For the new vehicle systems, separate calculations are performed by this subroutine in determining the power consumed on the guideway and off the guideway. This is done because the on-guideway and the off-guideway vehicle characteristics of these systems can be considerably different.

The base user input data to this subroutine (input via RDINPUT) are the power consumption vehicle characteristic data arrays

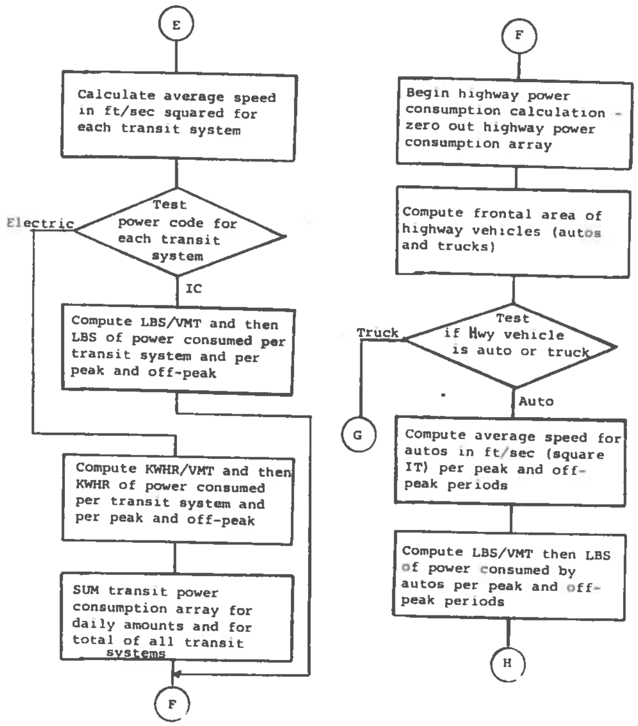


FIGURE 3-41 General Flow Chart - Subroutine POWER (continued)

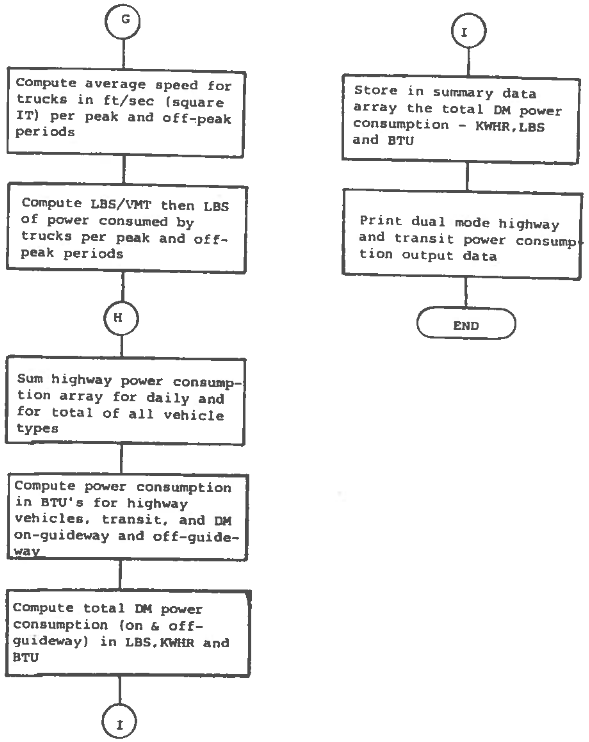


FIGURE 3-41 General Flow Chart - Subroutine POWER (continued)

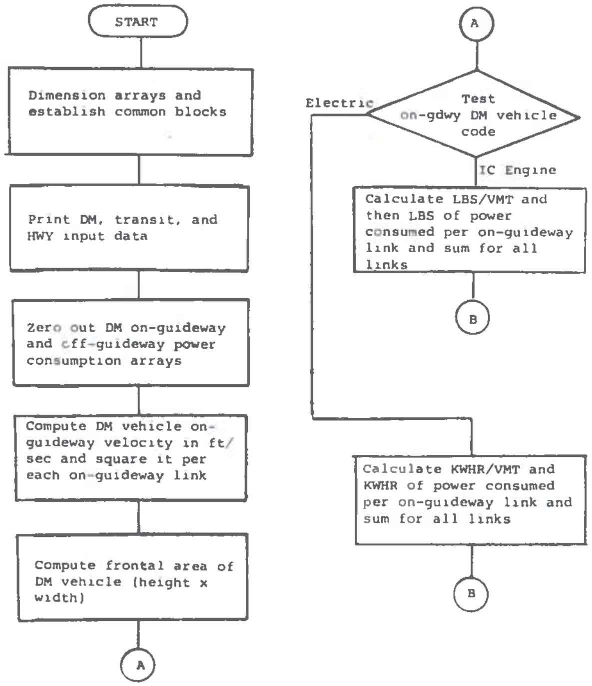


FIGURE 3-41 General Flow Chart - Subroutine POWER

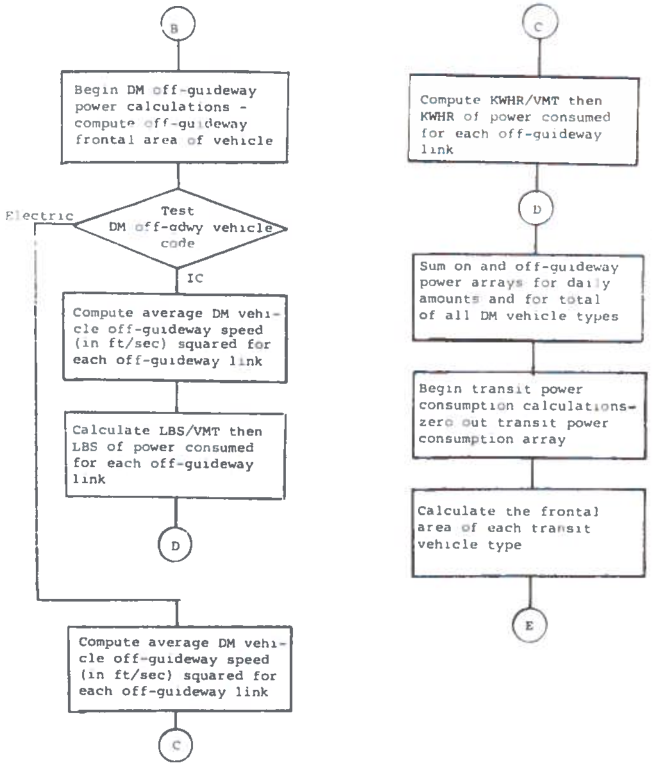


FIGURE 3-41 General Flow Chart - Subroutine POWER (continued)

3.4.4 Subroutine POWER

Subroutine POWER performs all energy consumption calculations related to the new vehicle system, the transit systems, and the highway vehicle systems. More specifically, this subroutine performs the following functions of the model:

1. Prints all energy consumption input data
2. Calculates the energy consumed on the guideway and off the guideway by the new system vehicle
3. Calculates the energy consumed by the various transit systems
4. Calculates the energy consumed by various highway vehicle types (autos and/or trucks)
5. Prints all energy consumption output data

A general flow diagram of the functions performed by this subroutine is presented in Figure 3-41.

In this subroutine the energy consumption of the new system vehicles, the various transit systems, and the highway vehicles are calculated in units of KWHR or pounds.

For electric vehicles the following equation is utilized in the calculation of the

Total vehicle delay:

```
AUTVTR(ITP,2) = (AUTVTR(ITP,1)*AUTOCH(10)) /60.0
Delay(HRS) = (Vehicle trip)(Ave. delay - min./Vehicle trip)/60.0
```

Total passenger delay within vehicle:

```
AUTPTR(ITP,3) = (AUTPTR(ITP,1)*(AUTOCH(10)/AUTOCH(11)))/60.0
Delay (HRS) = (person trips)[(Ave. delay - min/Vehicle trip)/
                              (occupancy-person/vehicle)]/60.0
```

The total passenger hours of delay and the total vehicle hours of delay are then used by HWYNET in the following equations to compute adjusted auto PHT and adjusted auto VHT data:

```
AUTOND(3,ITP,5) = AUTOND(3,ITP,3)+AUTPTR(ITP,2)+AUTPTR(ITP,3)
Adjusted PHT = PHT + (passenger hours of delay outside auto) +
                     (passenger hours of delay within auto)

AUTOND(3,ITP,6) = AUTOND(3,ITP,4) + AUTVTR/ITP,2)
Adjusted VHT = VHT + (total vehicle hours of delay)
```

Average trip lengths and average trip times for auto person trips and vehicle trips are then computed as follows:

```
Average trip length(miles/trip) = PMT(or VMT)/person trips
                                                 (or vehicle trips)

Average trip time(hours/trip) = adjusted PHT(orVHT)/person trips
                                            (or vehicle trips)
```

One of that last data calculations performed by subroutine HWYNET are the network data percentages stored within arrays ANDPC1, ANDPC2, and HVMTPC. All calculated highway network data is then output by this subroutine provided the suppress print variables JSPRNT(35) through JSPRNT (38) are not equal to a logic 1. Upon completion of all data output control is returned to the main control program ALLOTH for the calling of the next subroutine POWER.

The average freeway and surface arterial speeds are then utilized in the following equations to calculate auto PHT, auto VHT, and truck VHT data for the peak and the off-peak temporal periods:

```
AUTOND(MH,ITP,3) = AUTOND(MH,ITP,1)/HAVSPD(MH,ITP)
Auto PHT = Auto PMT/Average speed (mph)
```

```
AUTOND(MH,ITP,4) = AUTOND(MH,ITP,2)/HAVSPD(MH,ITP)
Auto VHT = Auto VMT/Average speed (mph)
```

```
TRCKND(MH,ITP,2) = TRCKND(MH,ITP,1)/HAVSPD(MH,ITP)
Truck VHT = Truck VMT/Average Speed (mph)
```

Daily and annual auto and truck network data is then calculated by first summing the AUTOND and TRCKND data arrays by means of the SUM subroutine, and then multiplying the daily data by the variable NUMDA - number of days/year.

At this point, the number of auto trips, auto trip delays, average auto trip times, and average trip lengths are calculated by HWYNET. The number of auto vehicle trips is computed by dividing the total number of person trips by the average auto vehicle occupancy:

```
AUTVTR(ITP,1) = AUTPTR(ITP,1)/AUTOCH(11)
```

The following total trip delays for autos and passengers within autos are then computed:

<u>Total passenger delay outside auto</u>:

```
AUTPTR(ITP,2) = (AUTPTR(ITP,1)*AUTOCH(9))/60.0
Delay (HRS) = (person trips)(Ave. delay - min./person trip)/
                                                         60.0
```

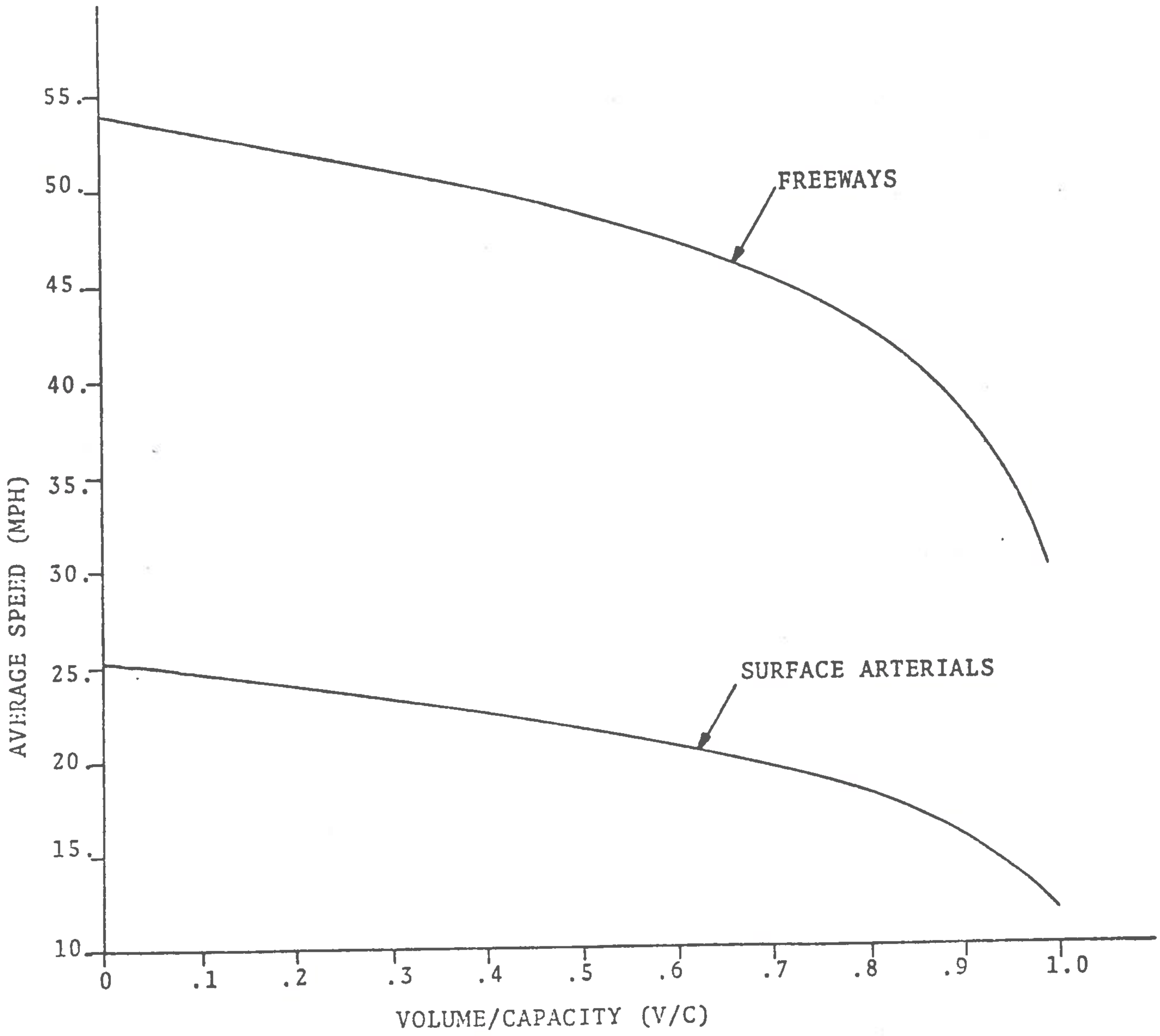


FIGURE 3-40 Average Speed vs. Volume/Capacity

Capacity miles supplied = (Lane miles)(lane mile directional factor-decimal %)(lane mile capacity-vehicles/hour/lane mile)

The lane mile directional factors in the above equations allows the user to adjust the existing lane miles of freeways and surface arterials in the area under analysis to account for directional flow of vehicles during the peak and off-peak temporal periods of the day.

A volume/capacity ratio, equal to the total hourly VMT divided by the capacity miles supplied, is then computed for freeways and surface arterials during the peak and off-peak periods as follows:

PEAK: HVCRAT(MH,1) = (THVMT(MH,1)/NPKHRS/Hcms(MH,1))

OFF-PEAK: HVCRAT(MH,2) = (THVMT(MH,2)/NOPHRS)/Hcms(MH,2))

Using the computed V/C ratios and the 'speed -V/C' relationship shown in Figure 3-40 the average speeds on freeways and surface arterials are then calculated for the peak and off-peak temporal periods.

Freeways:

$$\text{Ave. Speed (mph)} = 54.0 - 10.0\,(V/C) \qquad 0.0 \leq V/C \leq .6$$

$$\text{Ave. Speed (mph)} = (810.0\,(1.0 - V/C))^{1/2} + 30.0 \qquad .6 \leq V/C \leq 1.0$$

Surface Arterials:

$$\text{Ave. Speed (mph)} = (180.0(1.0 - V/C))^{1/2} + 12.0 \qquad 0.0 \leq V/C \leq 1.0$$

arterials by the new system vehicle and by the 'non fixed rail' transit systems. For each of these systems, the VMT on freeways in computed by multiplying the system's total VMT by a '% VMT on freeway' factor input by the user for each system. Similarly, the vehicle miles travelled on surface arterials is computed using a factor equal to (1.0 - '% VMT on freeways'). Since the 'on-guideway' travel by the new system vehicles should not be considered in these data calculations, the total VMT data, referenced above, represents only the 'off-guideway' travel by the new system vehicles.

The total VMT on freeways and surface arterials during the peak and off-peak temporal periods is then calculated by summing the appropriate data from the auto, truck, new system vehicle, and transit VMT data arrays. This total VMT data is later used in the equations that calculate the level of congestion on freeways and surface arterials.

At this point, calculations are begun to determine the level of congestion (V/C ratio) and the average speed on freeways and surface arterials during the peak and off-peak temporal periods. The freeway and surface arterial capacity miles supplied during the peak and off-peak temporal periods are computed according to the following equations:

<u>Freeways:</u> HCMS(1,ITP) = (HNCHAR(1)*HLNDIR(1,ITP))*HNCHAR(3)

<u>Surface Arterials</u>: HCMS(2,ITP) = (HNCHAR(2)*HLNDIR(2,ITP))*HNCHAR(4)

The subroutine then proceeds to calculate auto PMT data for freeways and surface arterials for the peak and off-peak temporal periods. Peak period auto PMT is computed by applying a 'peak period percentage factor' to the auto daily PMT. This decimal percentage factor, input by the user as variable-AUTOCH(7), is defined as the percent of auto daily PMT that occurs during the peak temporal period of the day. Typically, the off-peak auto PMT is equal to the daily PMT times an 'off-peak percentage factor' (1.0 - 'peak period percentage factor'). The vehicle miles travelled by autos on freeways and surface arterials (MH = 1,2) during the peak and off-peak temporal periods (ITP = 1,2) are then computed as follows:

AUTOND(MH,ITP,2) = AUTOND(MH,ITP,1)/AUTOCH(11)
VMT = PMT/ (persons/vehicle)

Using the auto VMT data, the vehicle miles travelled by trucks on freeways and surface arterials is then calculated for the peak and the off-peak temporal periods:

TRCKND(MH,ITP,1) = (AUTOND(MH,ITP,2)/AUTOCH(8)) - AUTOND(MH,ITP,2)

Truck·VMT = (AUTO VMT/% Auto VMT in area) - AUTO VMT

The '% AUTO VMT in area' factor in the above equation should represent the amount of auto travel in the area under analysis; this decimal percentage factor is input by the user within the auto characteristics data card.

HWYNET then accounts for the travel or freeways and surface

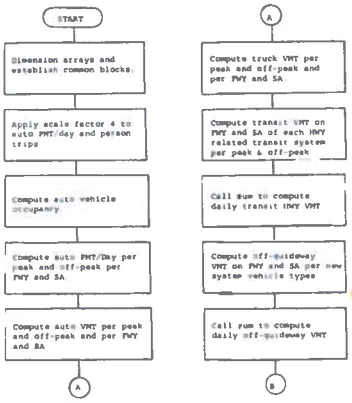


FIGURE 3-39 General Flow Chart - Subroutine HWYNET

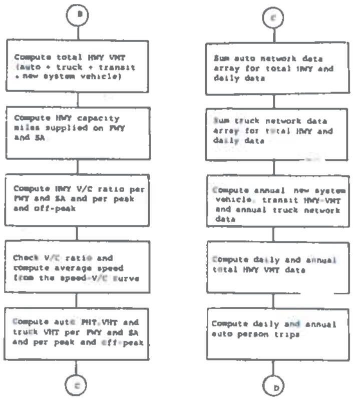


FIGURE 3-39 General Flow Chart - Subroutine HWYNET (continued)

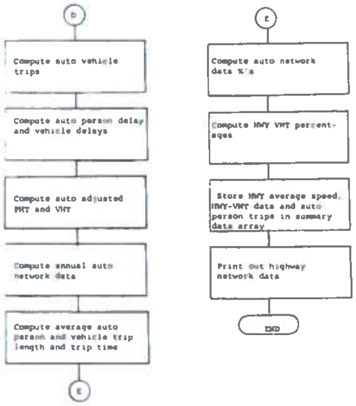


FIGURE 3-39 General Flow Chart - Subroutine HWYNET (continued)

3.4.3 Subroutine HWYNET

The primary function of this subroutine is to calculate and output network analysis data related to highway operations. Considered in the data calculations are operations by autos, trucks, transit vehicles, and new system vehicles. Network data is generated with respect to two classes of highways - freeways and surface arterials and with respect to four temporal periods (peak, off-peak, daily, and annual).

HWYNET acquires all user input data from subroutine RDINPUT through common blocks/RDI/and/RDR/. This data is primarily comprised of highway network characteristic data (i.e. number of lane miles, lane capacity), auto characteristic data (i.e. vehicle capacity and load factors), and auto demand data (i.e. PMT/Day, person trips).

Prior to any data calculations, the auto demand data (PMT/day and person trips) is scaled by the application of the auto demand scale factor [SCALEF (4)]. This scale factor readily allows the user to vary the auto demand data without changing the demand data cards.

The average auto vehicle occupancy is then computed utilizing the input vehicle capacity and vehicle load factor data:

```
     AUTOCH(11) = AUTOCH(1) * AUTOCH(2)
(occupancy - person/vehicle) = (vehicle capacity - persons/vehicle)
                                            (Vehicle load factor)
```

(average trip time-hours/trip) = Adjusted PHT(or VHT)/
Person trips(or Vehicle trips)

Finally, all computed transit network data is output by the subroutine provided the suppress print variables JSPRNT(30) through JSPRNT(34) are not equal to a logic 1. Upon completion of data output, control is returned to the main control program ALLOTH for the calling of the next subroutine HWYNET.