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Communications Network Design and Costing Model

Programmer's Manual

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Programmer's Reference Manual

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16 Abstract

A Communications Network Design and Costing (CNDC) computer model provides the capability for analyzing long-haul communications networks. The model is well-suited for market assessment studies involving the integration of developing satellite communication systems into the environment of existing service offerings of licensed domestic and specialized interstate communications common carriers. A capability is provided for analyzing long-haul trunking networks comprising a set of user-defined cities, traffic conditions, and tariff rates. Networks may consist of all terrestrial connectivity, all satellite connectivity, or a combination of terrestrial and satellite connectivity. Network solutions provide the least-cost routes between all cities, the least-cost network routing configuration, and terrestrial and satellite service cost totals. The CNDC model allows analyses involving three specific FCC-approved tariffs, which are uniquely structured and representative of most existing service connectivity and pricing philosophies. User-defined tariffs that can be variations of these three tariffs are accepted as input to the model and allow considerable flexibility in network problem specification.

The resulting model extends the domain of network analysis from traditional fixed link cost (distance-sensitive) problems to more complex problems involving combinations of distance- and traffic-sensitive tariffs. A heuristic algorithm is developed to determine minimum cost network routing solutions specifying the location of satellite access cities and their hubbing terrestrial extensions for typical customer premise services.

This manual presents a detailed description of the CNDC computer model from the programmer's point of view.

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1.0 INTRODUCTION

This report contains a detailed description of the NASA Communications Network Design and Costing (CNDC) Model from the programmer's point of view. As such, it contains descriptions of all system program modules, the data structures within the model, and the files which make up the data base.

The CNDC Model is a computer program which may be used to model and analyze communication trunking networks. The model provides full connectivity among as many as 600 service nodes using either terrestrial systems, satellite systems or a combination of terrestrial and satellite systems for voice services. The program determines the traffic routing and associated costs which provide the least cost over the tariffs and network specified by the user. The user may specify for the terrestrial tariff the American Telephone and Telegraph Tariff (as described in FCC #260, #264) or for the satellite tariff either that of the Western Union Telegraph Company (as described in FCC #261) or the Satellite Business System Incorporated (as described in FCC #2). In addition, he may specify tariffs postulated by NASA which have the same connectivity philosophy of the above mentioned FCC approved tariffs. The output from the model enables a direct determination of the least cost route network based upon the lowest tariffed costs per set of input traffic assumptions.

The CNDC program has two main functions:

1) allow the user to define networks and tariffs

2) determine the traffic routing and costs which provide the least cost over the network and tariffs specified.

The optimization algorithm selected (described in Section 2) solves the least cost route problem for terrestrial only, satellite only, and mixed terrestrial and Western Union like tariff cases. However, the mixed terrestrial-SBS like tariff problem cannot be solved with this algorithm since the two tariff types involved are defined by very different philosophies. The terrestrial like tariff is distance sensitive while the SBS like tariff is volume sensitive As a result, a separate optimization algorithm was defined for the terrestrial-SBS mixed problem. (Section 2.3)

The CNDC program was implemented on the Lewis Research Center IBM 3033AP Computer system running under the TSS/370 operating system. CNDC was written in TSS/370 FORTRAN IV. The program requires computer operator involvement only if the user chooses to operate in batch mode using a card deck. However, since batch mode can be invoked from the terminal or the user may operate in interactive mode, operator involvement can be avoided.

Any changes to the tariffs are set forth in the Addendum.

2.0 OPTIMIZATION ALGORITHMS

2.1 NETWORK OPTIMIZATION TECHNIQUES

2.1.1 Introduction

The CNDC model provides solutions to two different network problems. The first problem deals with the least-cost routes connecting unique pairs of network nodes exclusive of other network traffic. The second problem considers the entire network to find the set of links connecting the nodes so that the overall network cost is a minimum. This section provides definitions of the two network optimization problems, discusses the optimization algorithm implemented in the CNDC, and explains the method used to provide solutions to each of the two problems.

2.1.2 Network Terminology

A network (or graph) consists of a finite set of nodes (or vertices) and a finite set of links (or arcs) connecting pairs of nodes. The network nodes are assigned numbers from 1 to N where N is the number of nodes. The arcs of the network are described by ordered pairs of vertices. The first element in the ordered pair is the number of the originating node for the link and the second element of the ordered pair indicates the node at which the link terminates. The ordered pair (i, j) denotes the arc that connects node i to node j ($1 \le [i,j] \le N$). Values of a measure such as cost, distance or energy level are generally assigned to arcs of the network. Network optimization techniques seek to maximize or minimize with respect to the measure used.

A network is said to be directed if the value associated with arc (i,j) is in general not equal to the value associated with arc (j,i). A path is a finite sequence of arcs connecting two nodes. The terminating vertex of each arc in the path except the last is the originating vertex of the next arc in the path. For example, the set of arcs (x,y), (y,z), (z,w), (w,t) is a path from node x to node t. A path can be described by listing the nodes it includes. The above example is then determined by the sequence of nodes x,y, z,w,t. The path is denoted x-y-z-w-t.

Network optimization algorithms generally assume that link values are additive. This assumption is necessary for the comparison of alternative paths. The value of the link from node x to node y can be compared to the sum of values of the links through a third node. The shortest-path connecting two nodes, then, is a path between the two nodes such that the sum of the values of the links comprising the path is a minimum. The algorithms thus assume that the addition of link values is meaningful. If link values represent distance, for example, the total distance covered in traversing a path is equal to the sum of the lengths of the links. The measure of interest must be transformed so as to be additive or otherwise expressed in a way that satisfies this assumption.

2.1.3 Networks in the CNDC Model

In the communications networks modeled for the CNDC program, up to 600 rate centers define the network nodes. Directed links are assumed to connect all ordered pairs of nodes. The links represent single voice circuits providing voice communications between rate centers. The criteria being optimized is cost. In order to satisfy the additivity assumption of the network algorithm, link costs must be expressed as costs per circuit. The cost to run a single voice circuit from node x to node y to node z is then equal to the sum of the cost of a circuit connecting node x to node y plus the cost of a circuit from node y to node z. When the link costs are a function of traffic volumes as in the case of the SBS tariff, the cost is calculated based on the appropriate traffic volume and then expressed as a cost per circuit. After the execution of the network algorithm, the number of voice circuits required on each link is multiplied by the cost of a single voice circuit on the link to determine total link costs.

The cost per circuit associated with each link represents a minimum over all tariffs in a given run. This fact is transparent to the optimization algorithm. Except for the SBS mixed problem, costs are minimized over all tariffs prior to network optimization. (The SBS mixed problem will be discussed in section 2.3.) The tariffs supplying the minimum costs are stored separately. Although the overall CNDC Model may consider multiple services on all links, the network that is input to the optimization algorithm has at most a single direct link between each ordered pair of nodes.

2.1.4 The Least Cost Routing Problem

Research in the field of shortest-path methods has resulted in the development of several efficient computer codes (see references 5, 7 in Appendix G). These codes solve for the shortest path tree originating from a given root node. The following is an example of a tree rooted at node 1.

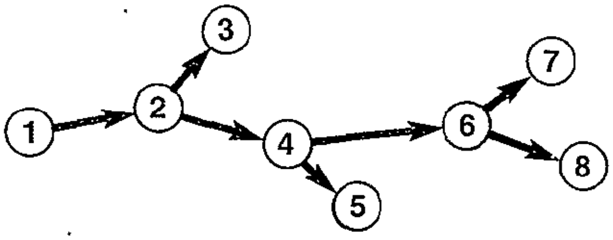


Figure 2-1. A Tree with Root at Node 1

All of the paths in the tree are directed outward from the root. All nodes in the network are included in the tree. Note also that each node has a unique predecessor node in the tree. Each node is the terminating node of exactly one arc in the tree. The corresponding predecessor node is the originating node of that arc. The least-cost tree for a given root defines the least-cost paths from the root to all other nodes in the network.

The CNDC Model does not implement any of the above-mentioned codes. If these codes are repeated N times with each node as the root, the union of the resulting least-cost trees is the least-cost network. The CNDC Model implements a network algorithm that maintains information about the least-cost routes while it solves the least-cost network problem. The results of the network algorithm are used by submodules of the OUTPUT module to generate information about both (1) the least-cost routes between all pairs of nodes in the network and (2) the least-cost network.

2.1.5 The Least-Cost Network Problem

In contrast to the activity surrounding current research to improve on the implementation of shortest-path methods, the problem of finding the least-cost network has received very little attention. The solutions that have been found are definitive and there is good reason to believe that the number of computer operations that must be performed cannot be reduced further (see reference 4 in Appendix G). The implementation used in the CNDC Model is based on an algorithm of Floyd (see reference 12 in Appendix G). The code has been expanded to maintain information about the least-cost routes as the model executes.

The least-cost network problem involves finding the set of links that provides connectivity between all pairs of nodes such that the total network cost is a minimum. The least-cost network includes the least-cost routes connecting all pairs of nodes in the network.

2.1.6 The Network Optimization Algorithm

The algorithm used by the CNDC model to find the least-cost network (and least-cost routes) is based on an algorithm of Floyd (see reference 12 in Appendix G). The algorithm defines paths between all pairs of nodes. The paths are initialized to single direct links between the nodes. If a given link does not exist, it is assigned an infinite cost. The algorithm considers all network nodes for inclusion in all paths. Whenever the inclusion of a node reduces the cost of a path, the path is rerouted through that node. If no combination of links results in a lower cost than the direct link, it will never be replaced.

The network nodes are numbered from 1 to N. The minimum cost of links between each pair of nodes are stored in an array, call it M°. The i,j^{th} element of the array represents the cost associated with the optimal link from node i to node j. If no link exists between any pair of nodes, the corresponding cost is infinite. The diagonal elements in the array are all zero since there is no cost to connect a node to itself. The optimization algorithm constructs N additional arrays where each array is determined from the entries in the preceding array. Let $C^{n}{}_{ij}$ represent the entry in row i and column j of the array M^n constructed at the n^{th} iteration $(1 \leq i, j < N, 2 < n < N)$. Then the recursion equation used to determine the entry in cell i, j of the $(n+1)^{st}$ array, M^{n+1} is

$$C_{ij} = \min \left\{ C_{in} + C_{nj}, C_{ij} \right\}.$$

This equation is applied for all pairs i, j where neither i nor j is equal to n. It can be interpreted as testing whether routing the traffic from node 1 to node j via node n reduces the associated cost per circuit. If so, node n is included in the path from node i to node j. A second array, O^n is constructed at each interation to record the second node in each path.

An intermediate node in a path is any node in the path except the initial or terminal node. The n^{th} array, M^n, contains costs to connect all pairs of nodes where only the first n nodes appear in any path. The $(n+1)^{st}$ array M^{n+1} is constructed by considering the $(n+1)^{st}$ node for inclusion in each path. Upon termination, the entry in row i and column j of the final array M^n represents the cost associated with the least-cost path from node i to node j. The assurance that the final cost is a minimum follows inductively from the fact that at the n^{th} iteration, the least-cost path from node i to node j that includes only intermediate nodes with numbers from 1 to n must be the smaller of (1) the cost of the least-cost path from node i to node j that includes only intermediate nodes with numbers from 1 to n-1 and (2) the cost of the least-cost path that includes only the intermediate nodes with numbers from 1 to n with node n appearing once as an intermediate vertex.

Example

Consider the four node directed network shown in figure 2-2.

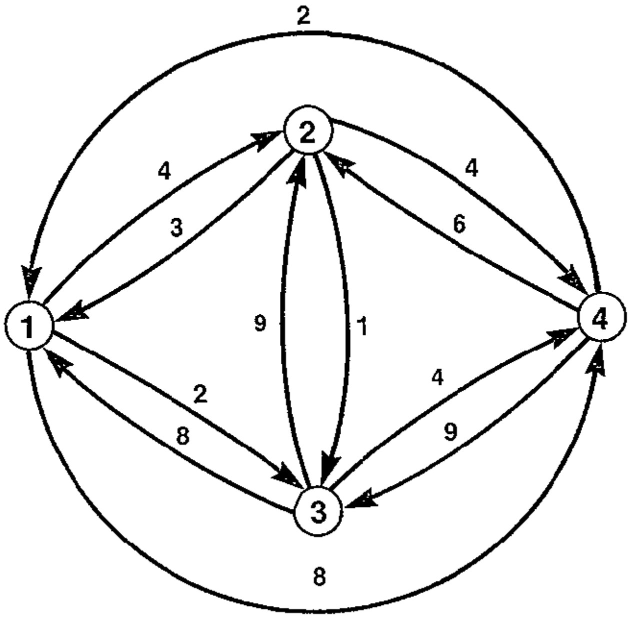


Figure 2-2. A Sample Network

The costs of direct links are indicated by the numbers attached to the links. The network contains direct links between all pairs of nodes. The initial arrays are:

M°

	1	2	3	4
1	0	4	2	8
2	3	0	1	4
3	8	9	0	4
4	2	6	9	0

0°

	1	2	3	4
1	1	2	3	4
2	1	2	3	4
3	1	2	3	4
4	1	2	3	4

Figure 2-3. M° and 0° Matrices of Sample Network

Row indices correspond to the numbers of originating nodes and column indices correspond to the numbers of terminating nodes. Cell i,j of the M^n array indicates the cost per circuit of traffic from node i to node j. Cell i,j of the O^n array indicates the second node in the path from node 1 to node j.

M^1 is constructed from M° as follows:

	Path Selected
$M^1(2,3) = C^1_{23} = \min\{C_{21}° + C_{13}°, C_{23}°\} = \min\{3+2, 1\} = 1$	2-3
$M^1(2,4) = C^1_{24} = \min\{C_{21}° + C_{14}°, C_{24}°\} = \min\{3+8, 4\} = 4$	2-4
$M^1(3,2) = C^1_{32} = \min\{C_{31}° + C_{12}°, C_{32}°\} = \min\{8+4, 9\} = 9$	3-2
$M^1(3,4) = C^1_{34} = \min\{C_{31}° + C_{14}°, C_{34}°\} = \min\{8+8, 4\} = 4$	3-4
$M^1(4,2) = C^1_{42} = \min\{C_{41}° + C_{12}°, C_{42}°\} = \min\{2+4, 6\} = 6$	4-2
$M^1(4,3) = C^1_{43} = \min\{C_{41}° + C_{13}°, C_{43}°\} = \min\{2+2, 9\} = 4$	4-1-3

$C_{11} = C_{22} = C_{33} = C_{44} = 0$ on all iterations and $C^n{}_{in} = C^{n-1}{}_{in}$ and $C^{n-1}{}_{ni} = C^{n-1}{}_{ni}$ on all iterations.

Entries in row and column 1 retain their previous values. The originating and terminating nodes of a path need not be considered for inclusion as intermediate nodes in the path. M^2, M^3, M^4, O^2, O^3, and O^4 are calculated in a similar manner. Figure 2.5 contains the resulting tables. The least cost network defined by M^4 and O^4 is represented in Figure 2-4.

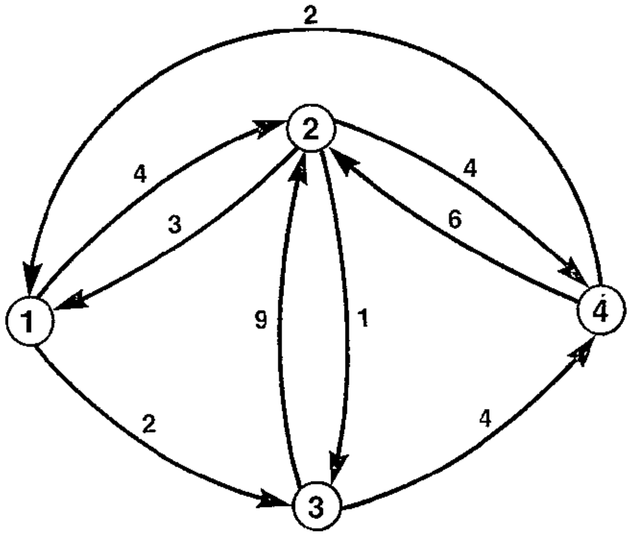


Figure 2-4. Least Cost Network

The paths connecting pairs of nodes in the least-cost network are traced from the O array. The second node on the path from node 1 to node 4 is node 3 since O(1,4) = 3. The second node on the path from node 3 to node 4 is node 4 since O(3,4) = 4. The path from node 1 to node 4 is 1-3-4.

The paths connecting all pairs of network nodes and the associated costs are as follows:

	Least-Cost Path	Cost
node 1 to node 2	1-2	4
node 1 to node 3	1-3	2
node 1 to node 4	1-3-4	6
node 2 to node 1	2-1	3
node 2 to node 3	2-3	1
node 2 to node 4	2-4	4
node 3 to node 1	3-4-1	6
node 3 to node 2	3-2	9
node 3 to node 4	3-4	4
node 4 to node 1	4-1	2
node 4 to node 2	4-2	6
node 4 to node 3	4-1-3	4

2.1.7 The Determination of Least-Cost Routes

The output of the network optimization algorithm includes a data structure that contains linked lists defining the least-cost paths between all pairs of nodes in the network (the O array in the example). In order to describe a given least-cost route, the traffic between all pairs of nodes in the route is added to the appropriate link. Consider for example, a least-cost route from node x to node y via nodes v and w (see figure 2-6).

M^1

	1	2	3	4
1	0	4	2	8
2	3	0	1	4
3	8	9	0	4
4	2	6	4	0

0^1

	1	2	3	4
1	1	2	3	4
2	1	2	3	4
3	1	2	3	4
4	1	2	1	4

M^2

	1	2	3	4
1	0	4	2	8
2	3	0	1	4
3	8	9	0	4
4	2	6	4	0

0^2

	1	2	3	4
1	1	2	3	4
2	1	2	3	4
3	1	2	3	4
4	1	2	1	4

M^3

	1	2	3	4
1	0	4	2	6
2	3	0	1	4
3	8	9	0	4
4	2	6	4	0

0^3

	1	2	3	4
1	1	2	3	3
2	1	2	3	4
3	1	2	3	4
1	1	2	1	4

M^4

	1	2	3	4
1	0	4	2	6
2	3	0	1	4
3	6	9	0	4
4	2	6	4	0

0^4

	1	2	3	4
1	1	2	3	3
2	1	2	3	4
3	4	2	3	4
4	1	2	1	4

Figure 2-5. M^N and O^N Matricies of Sample Network

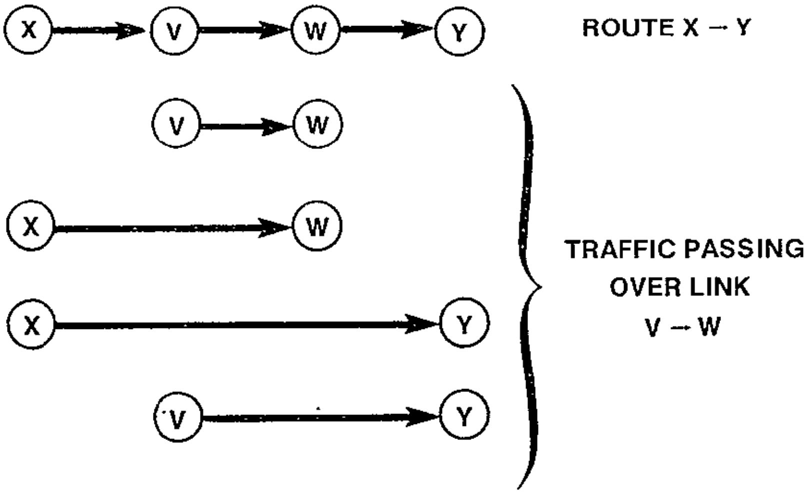


Figure 2-6. Traffic Volumes Along Least Cost Route Contributing to Link Costs

The link between node v and w must be sized to accomodate the sum of the following traffic volumes:

traffic from node x to node y
traffic from node x to node w
traffic from node v to node w
traffic from node v to node y

The results of the network optimization algorithm are used by the CNDC Model to describe each least-cost route in the network. The appropriate traffic volumes traversing each link in the route are summed. The corresponding costs per circuit on each link are used to calculate the cost of each link. The link costs are summed to determine the total cost of circuits on the route.

2.1.8 Determination of the Least-Cost Network

The output of the network optimization algorithm defines a path in the least-cost network connecting each pair of network nodes. In order to describe the least-cost network, it is necessary to determine the total network traffic traversing each link in the least-cost network. Consider the simple example described in figure 2-7. Suppose the least-cost network

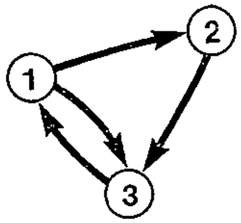


Figure 2-7. A Least Cost Network

for the three nodes consists of the links as shown. To determine the total traffic on each link, the CNDC model traverses the least-cost path connecting each pair of network nodes, adding the traffic volume for the pair to the total volume for each link in the path. While all pairs of nodes have been considered, the link totals represent the total network traffic on the links. The pairs of nodes in the least-cost network in figure 2-7 are (1,2), (1,3), (2,1), (2,3), (3,1), and (3,2).

Denote the traffic volume from node x to node y by T_{xy}. Denote the total network traffic volume on link (i,j) by T(i,j). Traversing the paths connecting each pair of nodes yields the link volumes

$$\begin{aligned} T(1,2) &= T_{12} + T_{32} \\ T(1,3) &= T_{13} \\ T(2,3) &= T_{21} + T_{23} \\ T(3,1) &= T_{21} + T_{31} + T_{32} \end{aligned}$$

The paths from node 1 to node 2 and node 1 to node 3 are direct so T_{12} is added to T(1,2) and T_{13} is added to T(1,3). The path from node 2 to node 1 is via node 3 so T_{21} is added to T(2,3) and T(3,1). The path from node 2 to node 3 is direct so T_{23} is only added to T(2,3). The path from node 3 to node 1 is direct so T_{31} is added to T(3,1). The path from node 3 to node 2 is via node 1 so T_{32} is added to T(3,1) and T(1,2).

The procedure outlined in the above example is executed by the CNDC for the least-cost network based on the outputs of the network optimization algorithm. The link volumes thus obtained are multiplied by the minimum cost per circuit associated with each link to determine the total cost of the link. The sum of the costs for each link is the overall network cost.

2.2 OPTIMIZATION TECHNIQUE USED FOR EACH PROBLEM TYPE

There are five problem types for which CNDC must determine the optimal solution:

1. All terrestrial tariffs
2. All Western Union like tariffs
3. All SBS like tariffs
4. Mixture of one terrestrial tariff and one Western Union like tariff
5. Mixture of one terrestrial tariff and one SBS like tariff

In problem types 1 through 4, the tariff providing the least cost service for each link is determined. For satellite only problems (problem types 2 and 3) optimization is complete at this point since all satellite routes must be direct, that is, double hopping is not permitted. When the problem is of type 1 or 4, there is an additional step of determining the least cost path between each pair of nodes in the network. The network optimization technique described in section 2.1 performs this function.

As indicated earlier, the SBS Mixed Problem cannot be solved using the optimization technique described above because the two tariffs are defined by very different philosophies. A discussion of the mixed SBS/terrestrial network optimization technique is included in section 2.3.

2.3 MIXED SBS/TERRESTRIAL NETWORK OPTIMIZATION

This section discusses the algorithm implemented in CNDC to determine the least-cost network solution for a mixed SBS/Terrestrial type network. While the proposed algorithm cannot guarantee an optimal solution, the assumptions made with the algorithm should produce a near minimum cost network. The determination of an optimal solution is hindered by a usage sensitive nonlinear SBS cost function with many local extreme points. A heuristic approach is developed to:

1) Place SBS facilities in locations with sufficient traffic to yield the lowest possible satellite costs per circuit within the network,

2) Partition the network around SBS satellite cities such that the intrapartition network is optimally configured, and

3) Determine which services (terrestrial or satellite) yield the least-cost interpartition links between all network cities.

2.3.1 Statement of the Problem

The solution of the general least-cost network problem has received substantial discussion in the literature. Algorithms have been presented which are efficient and fairly straight forward. All of these algorithms require a set of known and fixed link costs for their solution. Networks involving tariffs which are distance sensitive, such as AT&T and WU, can be analyzed quite readily with these general algorithms. This results from the fact that for a given set of cities specified as a network, the distance between any two cities is known and the associated link cost can be determined from a table look up. For other types of networks involving usage sensitive tariffs, such as SBS, the link costs are a variable function of the traffic volume transmitted over the link. In general, the cost per circuit is quantity discounted and decreases as the traffic volume increases. In order to determine the link costs for these types of tariffs, the traffic volume over the link must be known. For any pair of cities in the network, the two-way traffic between the cities is supplied by the CNDC Model user. However, the actual traffic over these links will depend on the number of cities which send their traffic indirectly over the links, instead of transmitting on some other links. The capability to share satellite facilities among several cities is permitted by the SBS tariff and the usage costs are prorated among the users on the basis of their proportion of the total traffic volume over the link. In order to calculate the cost per circuit for SBS satellite links (or CPS tariffs in general), the total traffic volume over the link must be known. Based on this traffic level, the facility can be sized and costed. In a mixed terrestrial/SBS type of network, two alternatives exist for communicating voice traffic:

1) terrestrial links, and
2) satellite links.

For each city in the network, the costs of each alternative must be compared to determine the least cost link for the distance and traffic volume under consideration. The basic problem in performing such a comparison is in fixing the satellite link costs. A method is required to determine which cities will share a single satellite facility and how much traffic will be transmitted over the satellite link.

2.3.2 Methodology

The general methodology incorporated into the algorithm is as follows:

1) Select locations for SBS satellite facilities.

2) Partition the network around the individual satellite facility locations.

3) Perform cost decisions regarding terrestrial and satellite services between partitions.

4) Determine the number of satellite cities and the network configuration which yields the minimum cost network.

The selection of cities in which SBS satellite facilities will be installed is based on the determination of those cities with the heaviest traffic requirements. SBS facilities include Network Access Centers (NACs) and cities having these will be denoted as NAC cities.

Once NAC cities have been selected, the entire network will be divided into partitions, with each partition containing exactly one NAC city. Each partition has two categories of traffic:

1) intrapartition traffic, and
2) interpartition traffic.

Intrapartition traffic is defined as the traffic between any two cities within the same partition. The actual link between these two cities may include segments inside and/or outside of the partition. It will be assumed that all intrapartition traffic will use terrestrial links. Interpartition traffic is defined as the traffic between any two cities not members of the same partition. The choice of service (satellite or terrestrial) for interpartition links will be decided upon within the algorithm on the basis of cost comparisons. An initial assumption is made that all interpartition traffic will be routed through the NAC cities in the respective partitions. This will have the effect of producing the lowest possible cost per circuit for satellite links, since these are volume-sensitive costs. A determination is then made as to what proportion of the initially assumed traffic volume through the NAC can cost justify the use of the satellite link versus the terrestrial alternative. The algorithm will iteratively calculate the SBS cost per circuit based on total traffic through the NAC cities. During each iteration, it will perform cost comparisons of satellite versus terrestrial costs for each city pair. The total traffic volume of those cities favoring terrestrial links will be removed from the assumed total, routed through the NAC city, and a new satellite cost per circuit will be calculated. This process is repeated until no further cities change service. At this point, a network solution is obtained.

2.3.3 Detailed Discussion of Algorithm

There are four main subprograms contained in the algorithm:

1) NAC city selection,
2) Network partitioning,
3) Service decisionmaking, and
4) Cost response tracking.

Each of these will be described in detail. The least-cost network solution for an all terrestrial network is used as an input by the algorithm.

2.3.3.1 NAC City Selection

The basic assumption of the NAC city selection scheme is that the SBS service is more cost effective for high volume users than for low volume users. This is shown, in fact, by plotting SBS costs per circuit versus traffic volume (figure 2-8). Figure 2-8 shows that although there are spikes in the SBS cost function at specific volume levels, the general trend is for lower per circuit costs as volume increases. Based on the underlying structure of the SBS tariff, this trend will always be the case, regardless of the rates of the individual SBS cost components. Given this general characteristic, the NAC city selection scheme places NACs in those cities with the highest traffic volumes on their communications links. This should ensure the lowest possible costs for satellite links with the network. Note that no mention has yet been made of whether the satellite link is more cost effective than an alternate terrestrial link.

In this NAC city selection scheme, called the cluster algorithm, it is initially assumed that there are satellite facilities at all NNODES nodes in the network. Using the terminology of this algorithm, there are initially NNODES clusters. Links in the network are then investigated one at a time in ascending order of terrestrial cost. The first link investigated would then be that which has the least terrestrial cost. This link is defined by two nodes. The node with the least total traffic, A, is merged into the node

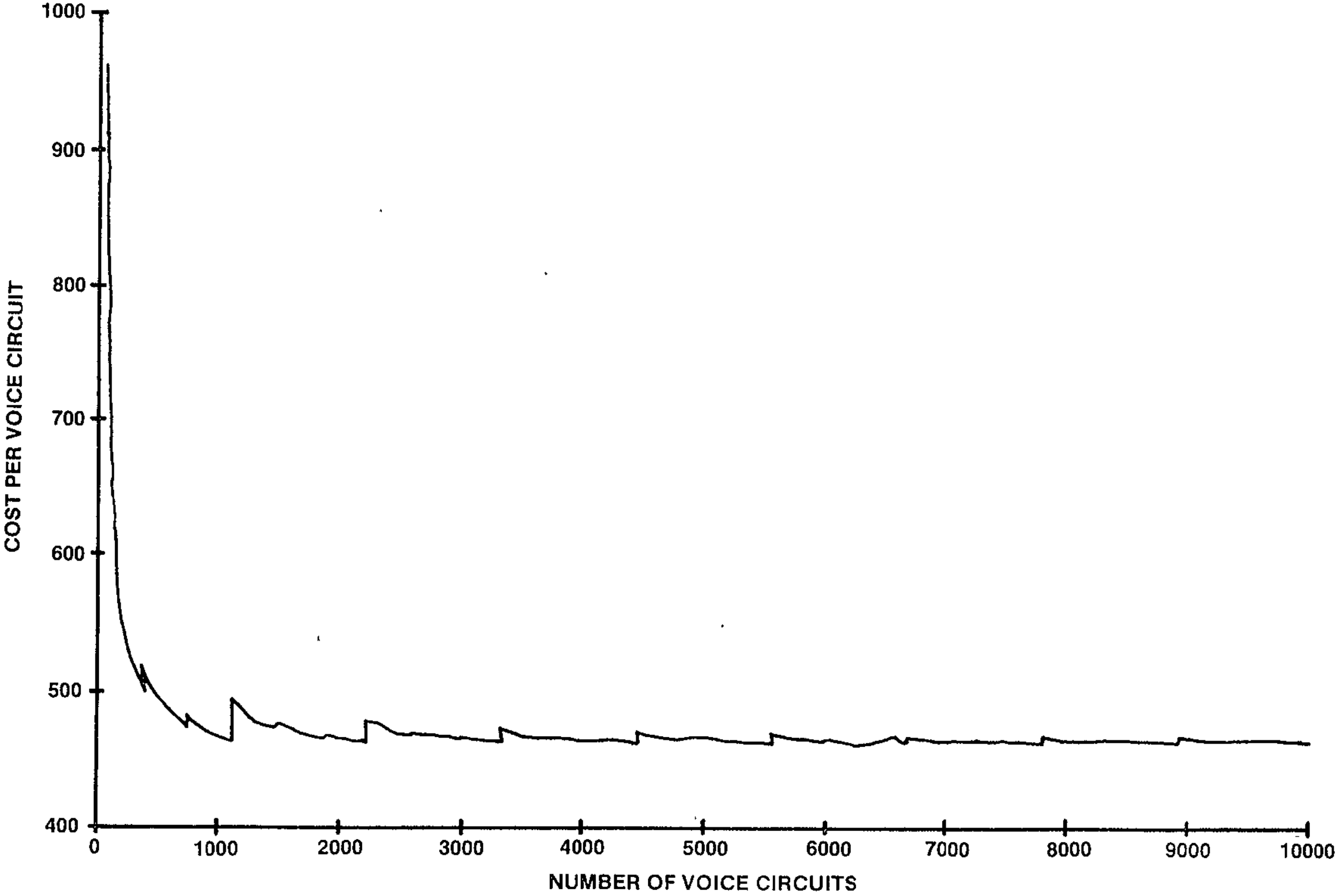


Figure 2-8. Baseline SBS Cost Function (Actual Rates)

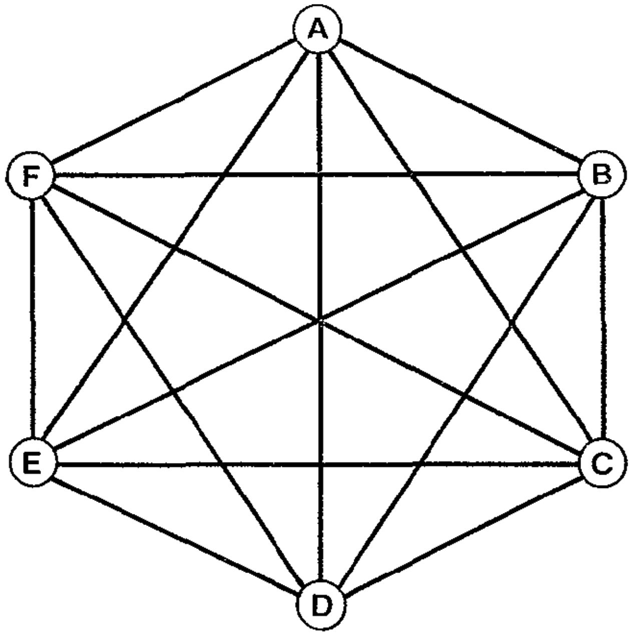
with the most traffic, B, to form a cluster in which node B would have satellite facilities and node A could send any of its traffic via satellite through B. At this point there are NNODES-1 clusters since A has now lost its satellite facilities. This procedure of investigating links is repeated until there are only two clusters. As each link is investigated (in ascending order of terrestrial cost) its two defining nodes are identified. If both nodes still possess satellite facilities, the less busy node (with all nodes in its cluster) will be merged into the more busy node (with all the other nodes in its cluster) to form one larger cluster from two smaller clusters. The list of nodes resulting from this scheme is arranged in such a fashion that the first N names in the list represent the best placement of satellite facilities if only N such facilities were to exist in the network. This list is then used to iteratively assign NACs to those cities which represent the best location for satellite facilities, starting with three NAC locations. (A minimum configuration of three NAC locations is required by the SBS tariff.) Within this first iteration, the algorithm will then partition the network around these three NAC cities, determine the least-cost service for each interpartition link in the network, and calculate the total network cost. A second iteration will be performed in which the next city in the list will be assigned NACs. The algorithm will then repartition the entire network around each of the NAC cities and calculate a new network cost solution.

In general, if the new solution is less than that resulting from the previous iteration, the process is repeated by assigning NACs to that city next in the list. When the new solutions are consistently greater than the previous solutions, then the process is terminated and some previous solution provides the minimum cost network solution found by the algorithm. Due to the spikes in the SBS cost function, it is possible that total network cost solution resulting from any particular iteration may be higher than that of the previous iteration, yet the previous solution does not represent the true minimum cost network. With a one-step ahead comparison (i.e., the $(I+1)^{th}$ solution is compared to the I^{th} solution), there is a danger in terminating the algorithm prematurely. In order to avoid this, the algorithm must proceed through several iterations in order to determine the minimum network solution. For clarity, this process will be discussed under cost response tracking.

An example will help to illustrate the NAC city selection scheme. Consider the network shown in figure 2-9. Its traffic and cost tables are also shown. The network consists of six cities labeled A, B, C, D, E, F. The sorted list of link costs and list of total traffic for each node are shown below.

LINK	COST	NODE	VOLUME
EF	19	A	1500
AB	25	B	1160
AE	28	C	1550
CF	32	D	1960
BE	43	E	1310
CE	47	F	1140
AD	51		
BF	53		
BD	55		
DF	58		
DE	61		
BC	63		
AF	76		
AC	88		
CD	96		

Initially, it is assumed there are satellite facilities at all six nodes. Link EF is investigated first. Since both have satellite facilities and E has more traffic than F, F is merged into E and there are now satellite facilities at the 5 nodes A, B, C, D, E. With link AB, both nodes have satellite facilities. B is merged into A leaving the 4 nodes A, B, D, E with satellite facilities. Both nodes in link AE, the next link in the list, have satellite facilities. E is merged into A leaving satellite facilities at the three nodes A, C, D. The next three links CF, BE, CE are skipped because not both nodes in these links have satellite facilities. Link AD is investigated next. A is merged into D leaving two nodes with satellite facilities C and D. The list generated by the cluster algorithm would be D, C, A, E, B, F. The first three in the list represent NAC placement with three NAC locations, the first four the NAC placement with four nodes.



	A	B	C	D	E	F
A		100	150	250	100	50
B	100		100	110	150	100
C	200	150		200	100	120
D	300	150	300		200	150
E	150	100	110	150		150
F	100	100	120	150	100	

TRAFFIC TABLE

	A	B	C	D	E	F
A		25	88	51	28	76
B			63	55	43	53
C				96	47	32
D					61	58
E						19
F						

COST TABLE

Figure 2-9. Sample Network, Traffic and Cost Tables

The algorithm will enable the user to specify the placement of NACS. In this case the algorithm will not sort the nodes by traffic volume but will use the list of NACs specified and perform the partitioning around this set.

It is conceivable that the all terrestrial solution will be optimal. If this is the case, the solution will indicate that no NACs were placed and the all terrestrial solution has been selected.

2.3.3.2 Network Partitioning

The network partitioning component of the algorithm requires a set of NAC cities as its input. The total network is divided into non-overlapping partitions, with the number of partitions equal to the number of NAC cities. A partition is defined as a NAC city and an associated set of non-NAC cities within the network having the following characteristics:

For each non-NAC city within the network, its nearest (in a cost-wide sense) NAC neighbor is identified and the non-NAC city is assigned to that NAC city's partition. Only terrestrial costs are considered since it has been assumed that all intrapartition traffic will use terrestrial services. The intent in constructing the network partitions is to configure each intrapartition network such that its traffic costs are a minimum. Since terrestrial services are being considered, there are three factors which will determine the link costs. These are:

1) Distance of link,

2) Listed/unlisted status of cities on link, and

3) Tariff rate structure.

The minimum cost links for intrapartition traffic will be identical to those resulting from a solution of the terrestrial-only least cost network problem. The network partitioning component of the algorithm will require this solution as an input. This solution will also be used in the service decision-making component.

2.3.3.3 Service Decisionmaking

The service decision making component of the algorithm will process through each partition to determine the service to be used (terrestrial or satellite) for its traffic links to all other partitions. The specific decision criteria for choosing a service for any particular interpartition link will be the crossover cost associated with the link. The crossover cost is defined as that total cost per circuit associated with terrestrial services between two nodes which will determine whether satellite or terrestrial services are employed. If the associated satellite cost per circuit between two nodes is less than the corresponding crossover cost, then satellite service will be used to link the nodes. An example of a crossover cost is illustrated in figure 2-10. In this example, the service decision for the link between city A in partition I and city D in partition J will be made. There are two alternatives to consider:

1) Via the terrestrial link AD (assumed least-cost terrestrial path), or

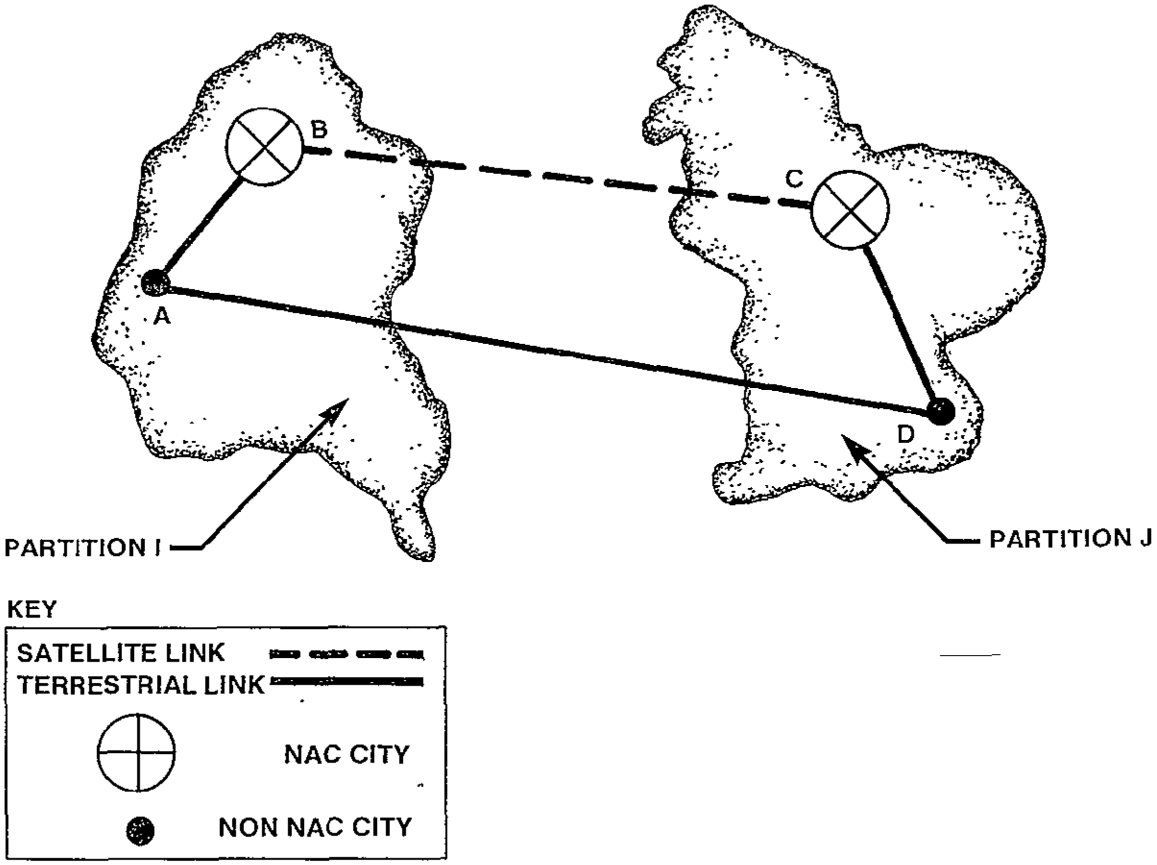
2) Via terrestrial link AB to satellite link BC to terrestrial link CD.

In order for the satellite alternative to be cost effective, the following relationship must hold:

$$C_{AB} + C_{BC} + C_{CD} < C_{AD}, \text{ or equivalently} \quad (1)$$

$$C_{BC} < C_{AD} - (C_{AB} + C_{CD}) \quad (2)$$

In words, the satellite cost must be less than the difference between the least-cost terrestrial link and the sum of the tail costs in each partition ($C_{AB} + C_{CD}$). The expression on the right side of the inequality (2) is defined as the crossover cost. Others studying similar problems have defined and used crossover distances. They have assumed some constant satellite cost in doing so. Since we are dealing with usage sensitive satellite tariffs with a variable cost per circuit function, cost per circuit must be used as the service decision criterion.



CROSSOVER $\text{COST}_{AD} = C_{AD} - C_{AB} - C_{CD}$

Figure 2-10. Example of a Crossover Cost

For any partition, the crossover costs associated with links to all other partitions can be calculated. Each partition will have its own set of crossover costs, with each crossover cost having an associated traffic volume. The set of crossover costs for any partition can be ordered from some minimum value to some maximum value. In making the service decision, there are three possibilities regarding the value of the satellite cost. (See figure 2-11).

Case 1 - the satellite cost is less than the minimum crossover cost.

Case 2 - the satellite cost is greater than the maximum crossover cost.

Case 3 - the satellite cost is between the minimum and maximum crossover costs.

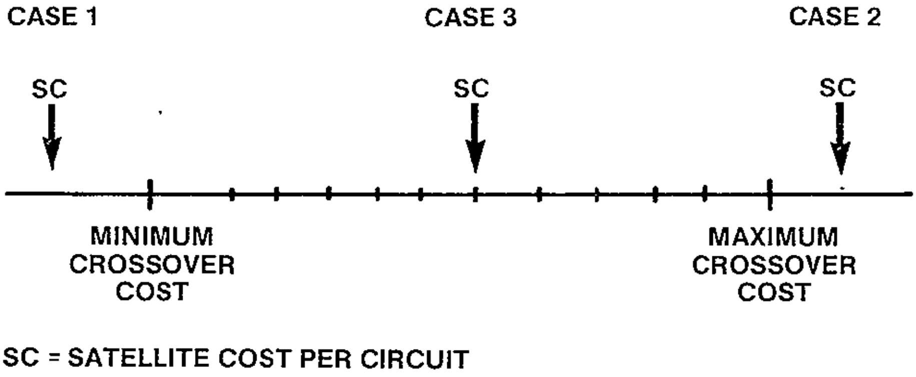


Figure 2-11. An Ordering of Crossover Costs for Any Partition

For cases 1 and 2, the decisions are clearcut. In case 1, since the cost of the satellite link is less than the costs of all competing terrestrial links, all interpartition traffic originating in the partition under consideration will be routed via satellite. In case 2, the exact opposite is true and all traffic is routed terrestrially. Case 3 involves a situation in which satellite routes are cost effective for some links and not for others.

Before proceeding with a discussion of case 3, the assumptions regarding the calculation of the satellite cost per circuit should be stated. As previously mentioned, each partition has associated with it a set of ordered pairs of crossover costs and traffic volumes corresponding to directional links to other partitions. To calculate the satellite cost per circuit, it will be initially assumed that all nodes within any partition will use the satellite link. The total volume of originating interpartition traffic for all nodes within a partition is used to determine satellite cost per circuit. This cost may produce one of the three possibilities previously discussed. If case 3 occurs, the initial satellite cost will need to be adjusted in some iterative manner to complete the service decisionmaking process.

When the initial satellite cost (SC_0) falls somewhere in between the minimum and maximum crossover costs, two groups of links result: one terrestrial and one satellite (see figure below).

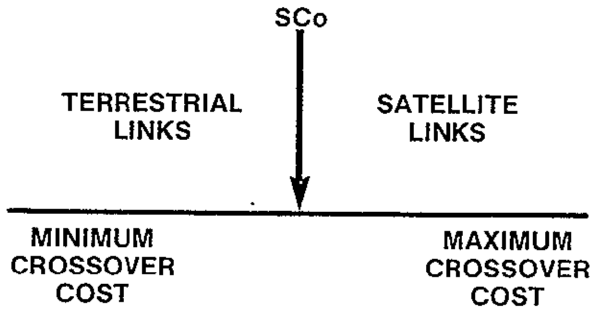


Figure 2-12. Grouping of Partition Links with Initial Satellite Cost

Since the value of SC_0 was determined on the basis of the traffic from both groups, the total traffic associated with the links in the terrestrial group must be removed from the total originating partition traffic in order to calculate a new satellite cost (SC_1). The new cost, SC_1, should be higher than the previous cost and may result in terrestrial service becoming more cost effective for some links. If this be the case, the volume associated with those links is removed from the remaining satellite total and a new satellite cost is again calculated. The process is repeated until either:

1) the new satellite cost results in no further service changes, or

2) the new satellite cost exceeds the maximum crossover cost, in which case all links are terrestrial service.

In general, the following will be true of the calculated satellite costs:

$$SC_I < SC_{I+1}$$

Since the process is started with the minimum possible satellite cost per circuit, this cost can only increase. It is possible however, due to the nature of the SBS cost function, that particularly if the satellite traffic volume associated with SC_I was incrementally enough to exceed the existing SCU or NAC capacities. The difference will increase as volume decreases toward the stable (high volume) portion of the SBS cost curve. In order to avoid instability in the algorithm, an assumption is made that once links have decided upon terrestrial service, this decision is final. There will be no re-evaluating procedure for these links if the satellite cost comes down below the link crossover cost. This assumption is reasonable since:

- SBS cost function generally decreases as volume increases.

- For high volume links, the magnitude of increases in SBS cost associated with decreases in volume will be small.

- The effect of the difference between the new satellite cost and the alternate terrestrial cost on the total network cost will be small for any one link.

2.3.3.4 Cost Response Tracking

Since the objective of the algorithm is to determine the least-cost network, some method of examining the total network cost solutions is needed. The functions of the cost response tracking component of the algorithm are:

- to monitor the total network cost for the various solutions as additional satellite cities are included in the network,
- to determine when the sequence of total network costs begins to diverge,
- to terminate the algorithm's solution iteration process, and
- to identify the minimum solution in the sequence.

Figure 2-13 illustrates the expected behavior of total network costs as the number of NAC cities within the network increases. The figure is a plot of total network costs versus the number of NAC cities for an N node network. The solution space ranges from an all terrestrial network with no satellite links to an all satellite network with no terrestrial links. Although the behavior of a total network cost function will depend on the topology of the network under consideration and the tariffs used, this concave cost curve is realistic and characteristic of the SBS and AT&T tariffs. Note that the all terrestrial case wil be the least-cost network solution for a "terrestrial only" network.

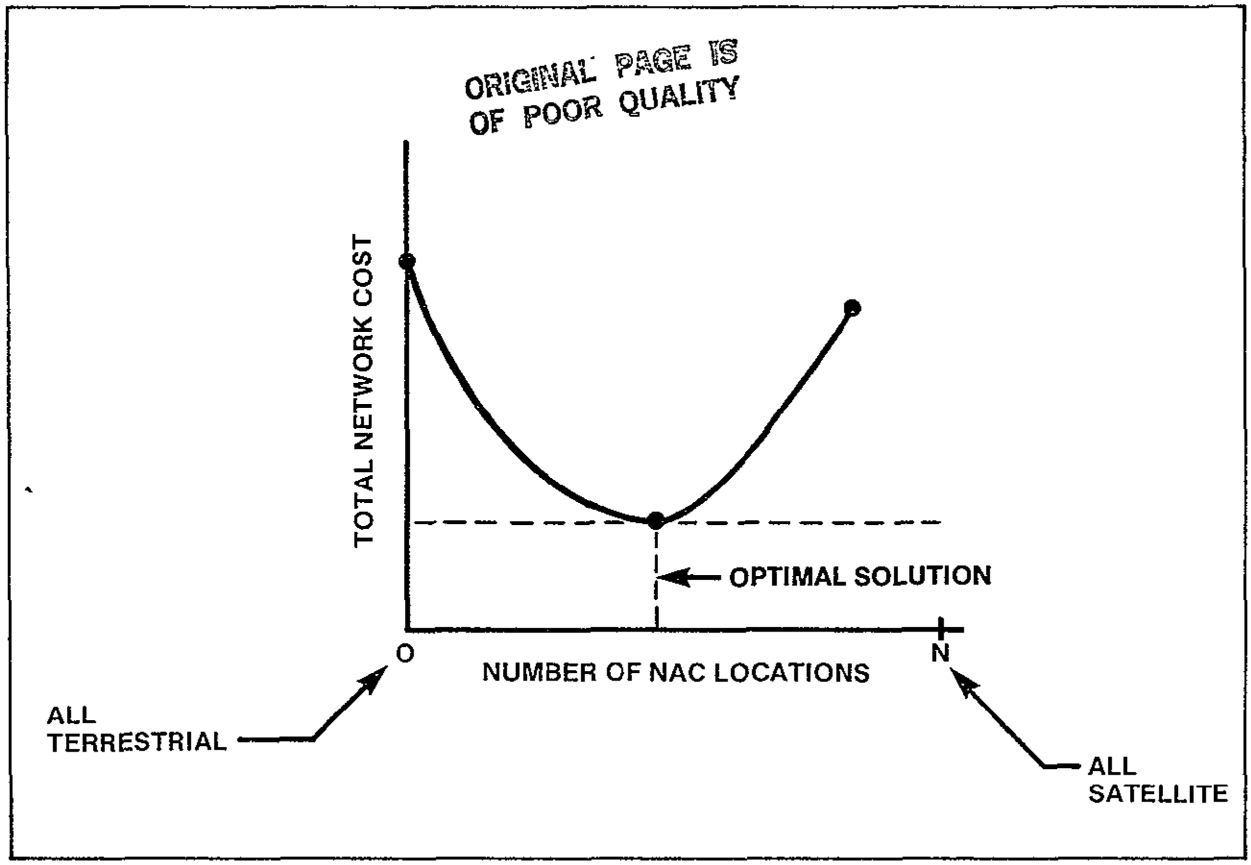


Figure 2-13. Expected Total Network Cost Function

The general methodology of the cost tracking component will be to first store off the total network cost solution resulting from each iteration of the NAC selection, partitioning, and service decisionmaking components as well as that for the all terrestrial solution. As each new network solution is generated, it wil be compared to the stored file of previous solutions. The algorithm will be terminated when the cost tracking component becomes "reasonably confident" that the total network cost solutions are diverging (i.e., the minimum solution has been reached). At this point, stored solutions can be examined and the minimum solution identified. The solution will correspond to a network with a specific number of NAC nodes (for partitions) which were selected from the highest volume nodes in the stored node list or the all terrestrial situation. The number of NAC nodes is effectively a pointer into this sorted list and will allow the minimum cost network to be easily reconstructed without iterative processing through the list.

The objective of the termination scheme will be to detect a divergent trend in the sequence of total network costs and to signal the algorithm to halt its iterative generation of solutions. It is appropriate to terminate the algorithm when it can be reasonably assured that further partitioning of the network will only result in higher cost network solutions. There are many possible schemes which can be developed to terminate the algorithm, ranging from the very simple to the complex.

The termination scheme selected is very simple. The iterative generation of solutions will terminate when the most recent solution generated is a factor larger than the best solution. This factor may be adjusted to meet the user's needs as one studies the cost response behavior of the system's output.

3.0 CNDC PROGRAM MODULES

3.1 Executive Program

3.1.1 General Description

The Executive Program (CNDC) is the main program which controls the execution of the Communications Network Design and Costing Model. Program execution is initiated and terminated from CNDC which performs a logical sequence of program module calls. Called program modules include the following:

INPUT
INIT
COSTNG
NETWRK
SBSMIX
OUTPUT

A hierarchy chart of the CNDC program is illustrated in Figure 3-1. The overall program flow is illustrated in Figure 3-2. A brief description of each of the called modules is provided in the following paragraphs.

INPUT MODULE

All user input necessary for execution of the CNDC Model is controlled through the INPUT module. Specifically, the user has the capability to construct one or more networks for analysis, select the desired common carrier tariffs to be used or select and define his own, and set parameters controlling program execution. The INPUT module is described in more detail in sections 3.3 to 3.5

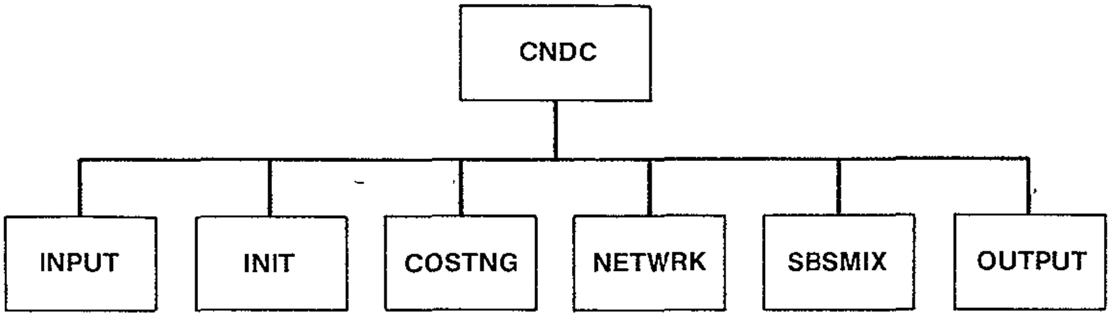


Figure 3-1. CNDC Hierarchy Chart

INIT MODULE

This module performs all the initialization of data structures required for program execution. The INIT module is described completely in section 3.6.

COSTNG MODULE

This module uses the network and tariff data specified as input to determine link costs between all nodes of the specified network for all tariffs. It then determines the service which provides the least cost for every link in the network. The COSTNG module is described in this section.

NETWRK MODULE

This module contains the algorithm which solves the least cost routing and least cost network problems for terrestrial only or mixed terrestrial - Western Union satellite cases. It generates the information needed by the OUTPUT module. NETWRK is described in this section.

SBSMIX MODULE

This module performs the optimization for the problem which contains one terrestrial and one SBS tariff. The SBSMIX module is described in section 3.2.

OUTPUT MODULE

The OUTPUT module controls all report generation from an execution of the program. The user is provided the capability to select various output reports. The OUTPUT module is described in detail in section 3.7.

During the input session, the user is allowed to specify multiple problem input sets. This capability allows several program runs to be batched together to be run in succession without operator/user intervention. At the end of each problem set, the CNDC determines if there are any additional problems to be run. If there are, CNDC branches back to the INIT module and performs the next run. This process continues until there are no further runs to be made. At this time the program terminates.

Following is a description of the CNDC, COSTNG, and NETWRK modules. Each description contains a list of all the data structures referenced or changed within the specific module. With each structure name is the common block to which it belongs. Error conditions encountered within the module are also described. Each error is assigned a number. A further listing of errors, by error numbers is contained in appendix B.

A fatal error describes a condition which would prevent the model from completing its task. These errors should not occur. If a fatal error occurs, there is a problem with the model or a file in the data base. For this reason an error message is printed and the model is terminated.

A non-fatal error is one from which the program can recover and continue to run. When a non-fatal error occurs, an error message is written and the program continues.

3.1.3 CNDC Module

```
        NASA COMMUNICATIONS NETWORK DESIGN AND COSTING MODEL
         MAIN PROGRAM -- CNDC -- 22 NOVEMBER 1982

      PURPOSE
           DIRECT OVERALL PROCESSING OF CNDC MODEL

      INPUT ARGUMENTS
           NONE

      OUTPUT ARGUMENTS
           NONE

      DATA STRUCTURES
           (U - USED, S - DEFINED, R - READ)
           NCASE        /RUN/      S
           OPTION       /RUN/      U

      LOCAL VARIABLES
           FLAG        LOGICAL        FLAG THAT INDICATES WHETHER TO
                                      CONTINUE PROCESSING OR TERMINATE
                                      . TRUE.     CONTINUE
                                      . FALSE.    TERMINATE

      SUBPROGRAMS CALLED
           INPUT
           INIT
           COSTNG
           NETWRK
           OUTPUT
           SBSMIX

      ERRORS
           FATAL
             NONE
           NONFATAL
             NONE
```

NASA MODEL EXECUTIVE PROGRAM

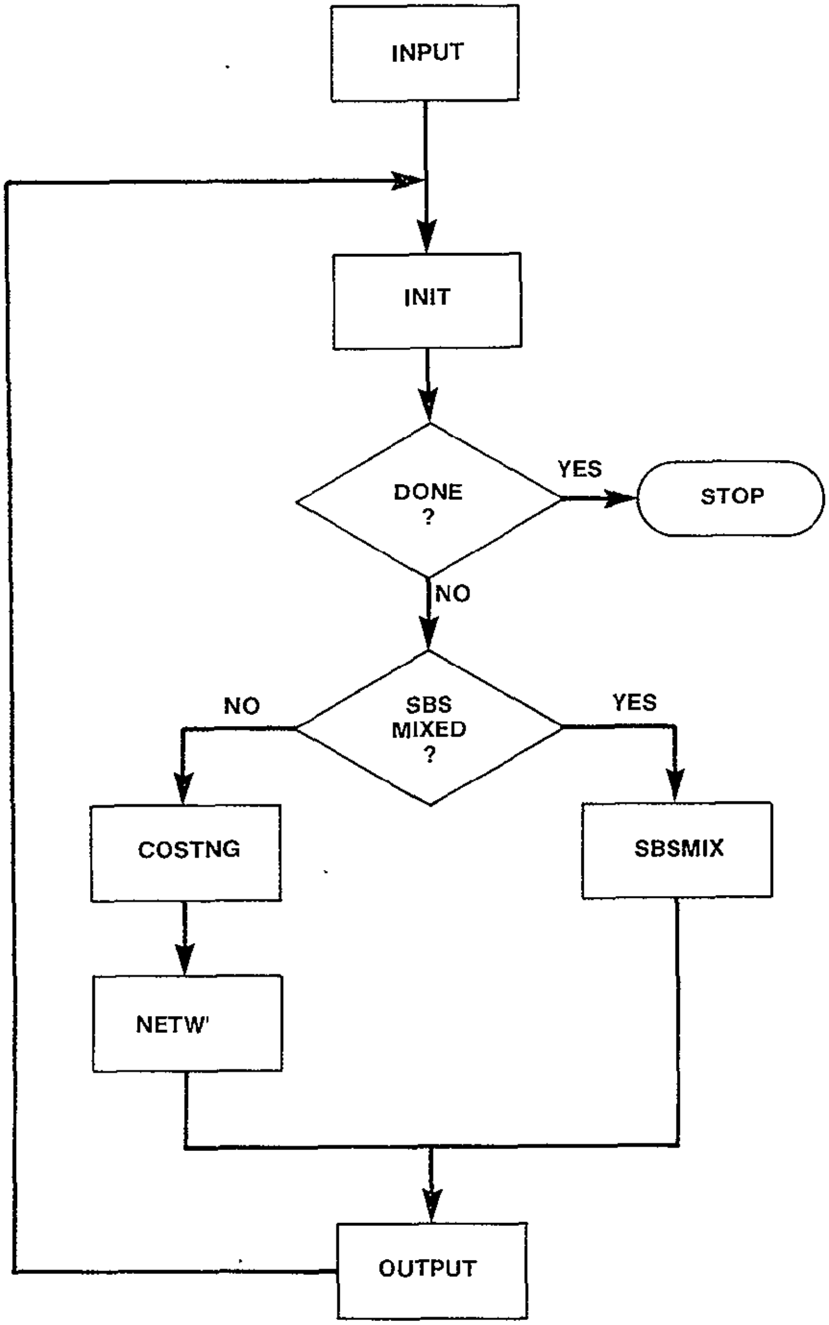


Figure 3-2. Nasa CNDC Model Program Flow

3.1.4 COSTNG Module

SUBROUTINE COSTNG

PURPOSE

CALCULATE THE MINIMUM COST OF A DIRECT CIRCUIT BETWEEN ALL PAIRS OF NODES IN THE NETWORK ACROSS TARIFFS

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

COST	/CSTOUT/	S
NNODES	/RUN/	U
NTARIF	/RUN/	U
OPTION	/RUN/	U
SVC	/CSTOUT/	S
DEBUG	/LUN/	U
SATNVC	/SBSMX2/	S

LOCAL VARIABLES

BIGNUM	R*4	CONSTANT /16.0**62/ LARGE REAL NUMBER TO REPRESENT INFINITY
CPC	R*4	TEMPORARY COST FOR SBS-TYPE TARIFF CANDIDATE FOR MINIMUM
I	I*4	LOOP INDEX - FROM CITIES
J	I*4	LOOP INDEX - TO CITIES
K	I*4	LOOP INDEX - TARIFFS
KTEMP	I*2	TEMPORARY TARIFF INDEX
TEMP	R*4	TEMPORARY COST - CANDIDATE FOR MINIMUM
DIST	I*4	DISTANCE BETWEEN TWO NODES

SUBPROGRAMS CALLED

ATCOST
CATEG
LISTED
MILES
ROWTOT
SBCOST
WUCOST

ERRORS

FATAL

NONE

NONFATAL

NONE

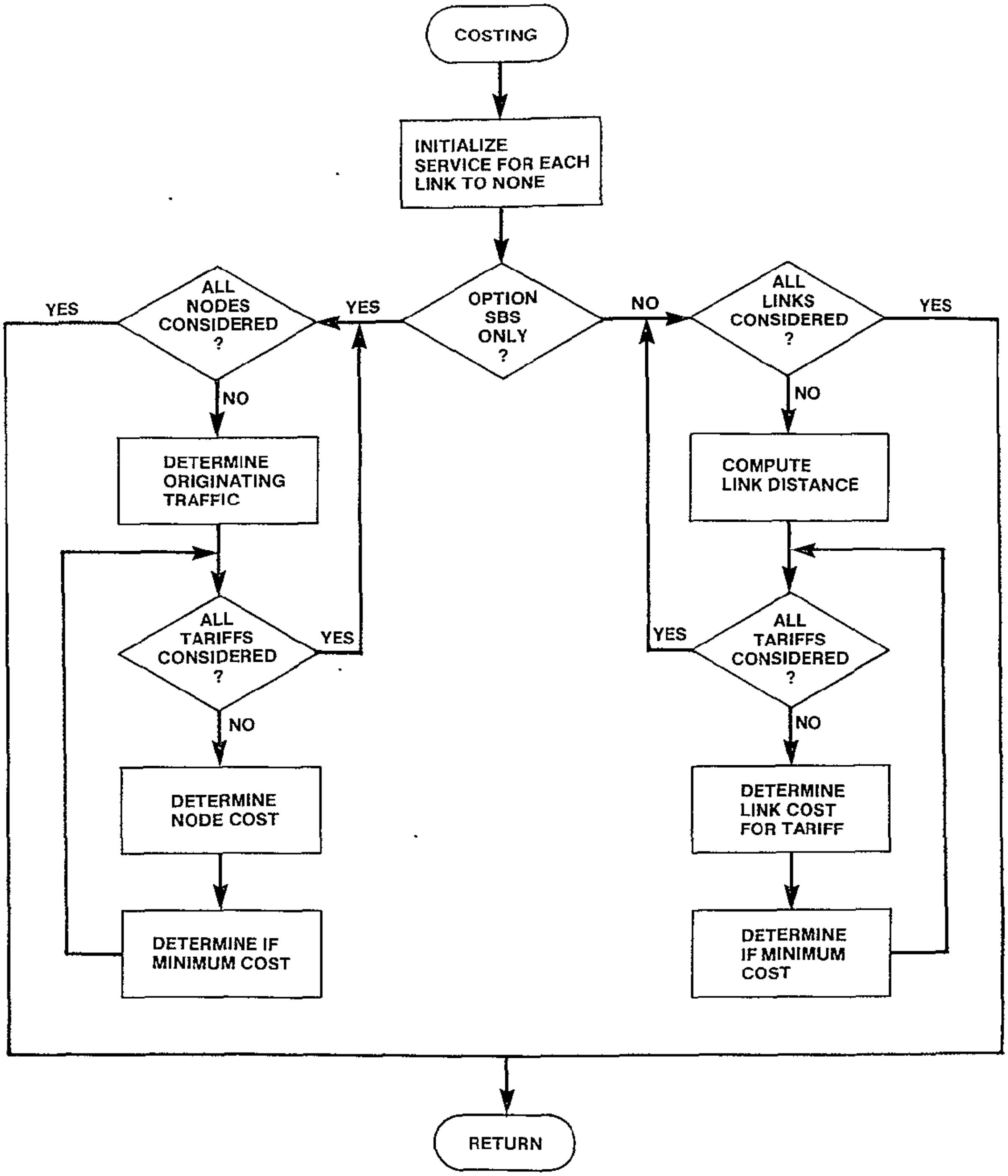


Figure 3-3 Costing Logic Flow

3.1.5 NETWRK Module

```
     SUBROUTINE NETWRK

PURPOSE
     DETERMINE THE COMBINATION OF LINKS AND SERVICES THAT WILL PROVIDE
     VOICE COMMUNICATION BETWEEN ALL CITY PAIRS AT MINIMUM COST
     FOR ALL BUT SBS MIXED OPTION

INPUT ARGUMENTS
     NONE

OUTPUT ARGUMENTS
     NONE

DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
       COST     /CSTOUT/     U
       MINCPC   /CSTOUT/     S
       NNODES   /RUN/        U
       OROUTE   /CSTOUT/     S
       DEBUG    /LUN/        U
       OPTION   /RUN/        U

LOCAL VARIABLES
     BIGNUM         R*4        CONSTANT /16.0**62/ LARGE REAL NUMBER TO
                               REPRESENT IN
     I              I*4        LOOP INDEX FOR INTERMEDIATE NODE
     J              I*4        LOOP INDEX FOR FROM CITIES
     K              I*4        LOOP INDEX FROM TO CITIES
     S              R*4        TEMPORARY COST - CANDIDATE FROM MINIMUM
     NUMNDS         I*4        NUMBER OF NODES
     MINIK          R*4        MINIMUM COST PER CIRCUIT FROM I TO K
     MINJI          R*4        MINIMUM COST PER CIRCUIT FROM J TO I

SUBPROGRAMS CALLED
     NONE

ERRORS
     FATAL
       NONE
     NONFATAL
       NONE
```

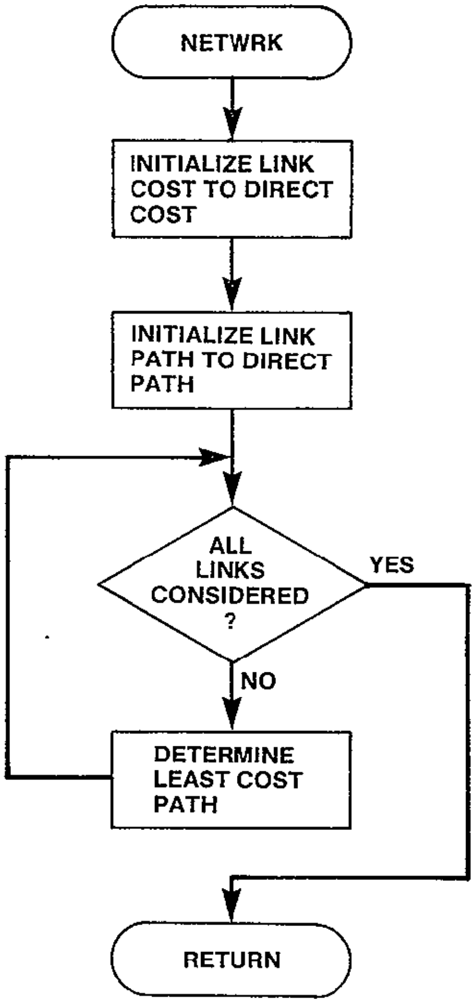

NETWRK
INITIALIZE LINK COST TO DIRECT COST
INITIALIZE LINK PATH TO DIRECT PATH
ALL LINKS CONSIDERED ?
YES
NO
DETERMINE LEAST COST PATH
RETURN

Figure 3-4. Network Logic Flow

3.2 SBSMIX DESCRIPTION

The user has the option within the SBS mixed problem to specify the placement of NACs or to have the model, through an iterative process (starting with three NAC locations) determine the optimal location of NACs. In either case, if the all terrestrial solution turns out to be optimal, no NACs will be placed.

If the user selects to have the model select the optimal NAC location, there must be a scheme to choose where to place the NACs. All nodes in the network are arranged in a list such that the first N names in the list would represent the optimal placement of satellite facilities if only N such facilities were to exist in the network. NACs are initially placed at the first three nodes in the list and a system cost is determined. NACs are then placed at the first four nodes in the list, and again a system cost is computed. This process is continued, adding one node at a time, until it appears that the solutions are no longer improving. At this point the iterative process is terminated and the NAC arrangement which yielded the lowest system cost is selected as optimal.

Within the iterative procedure once a trial NAC configuration is known, the entire network is partitioned so that each non-NAC node is associated with that NAC to which the node can communicate at the least terrestrial cost. Once the network is partitioned, the initial service configuration is established where by each node sends all intrapartition traffic via terrestrial links and all interpartion traffic via satellite links. This defines the maximum use of each NAC location. The cost associated with this configuration is computed.

Each node is then given the opportunity to choose to send portions of its traffic by terrestrial links if these prove to be of less cost. Once traffic has been removed, the cost for each NAC location is again computed. Again the nodes may remove traffic from the satellite based on the new cost. This process is repeated until the system stabilizes and no more traffic is removed from satellite service. A more complete description of this algorithm is contained in section 2.3. A description of the SBSMIX module follows in the next section. The logic flow diagram is Figure 3-6. The hierarchy chart for SBSMIX is contained in Figure 3-5.

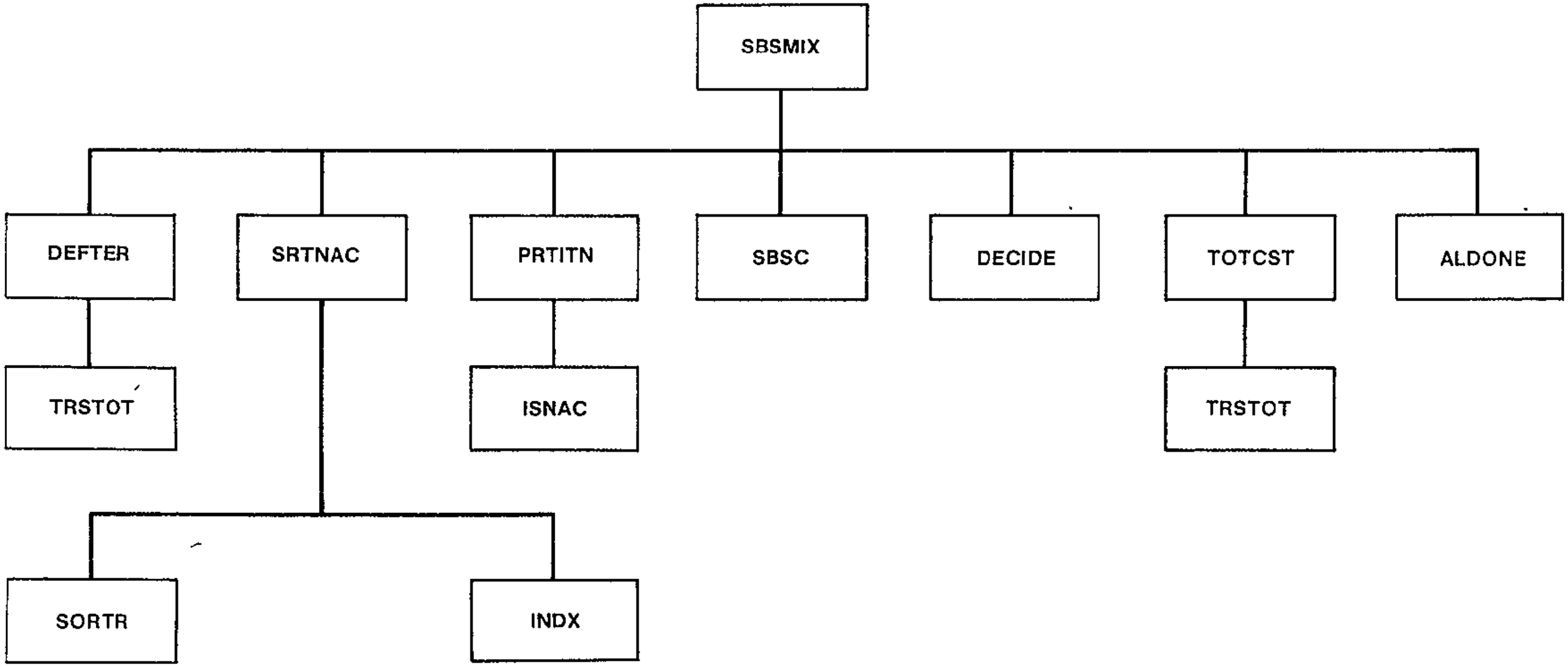


Figure 3-5. SBSMIX Hierarchy Chart

3.2.1 SBSMIX Module

SUBROUTINE SBSMIX

PURPOSE

DETERMINE OPTIMAL SBSMIX SOLUTION FOR THE CURRENT NETWORK

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

SBMX	/SBSMXD/	U
NACNMB	/SBSMXD/	U
SYSTBL	/SBSMX2/	U
SVC	/CSTOUT/	S
NNODES	/RUN/	U
TOTSAT	/SBSMX2/	S
DEBUG	/LUN/	U
NODPTR	/SBSMXD/	U
NACLOC	/SBSMXD/	U
SATNVC	/SBSMX2/	U

LOCAL VARIABLES

USRDEF	I*4	CONSTANT /1/ USER HAS SPECIFIED NAC PLACEMENT
FINISH	L	PROGRAM NAC PLACEMENT COMPLETE
SYSCST	R*4	COST OF SYSTEM WITH NACNMB NACS
I,J	I*4	LOOP INDICES
PRT1	I*4	PARTITION TO WHICH FROM NODE BELONGS
PRT2	I*4	PARTITION TO WHICH TO NODE BELONGS
BSTSOL	I*4	NUMBER OF NACS IN OPTIMAL SOLUTION
CODE	I*4	FOUR CHARACTER CODE OF USER SPECIFIED NAC
SKIP	L	BSTSOL WAS THE LAST SOLUTION COMPUTED NO NEED TO REPEAT COMPUTATIONS
ALTERR	I*4	CONSTANT /2/ ALL TERRESTRIAL SOLUTION

SUBPROGRAMS CALLED

DEFTER
SRTNAC
PRTITN
SBSC
DECIDE
TOTCST
ALDONE
MNMPTR

ERRORS

FATAL

NONE

NONFATAL

NONE

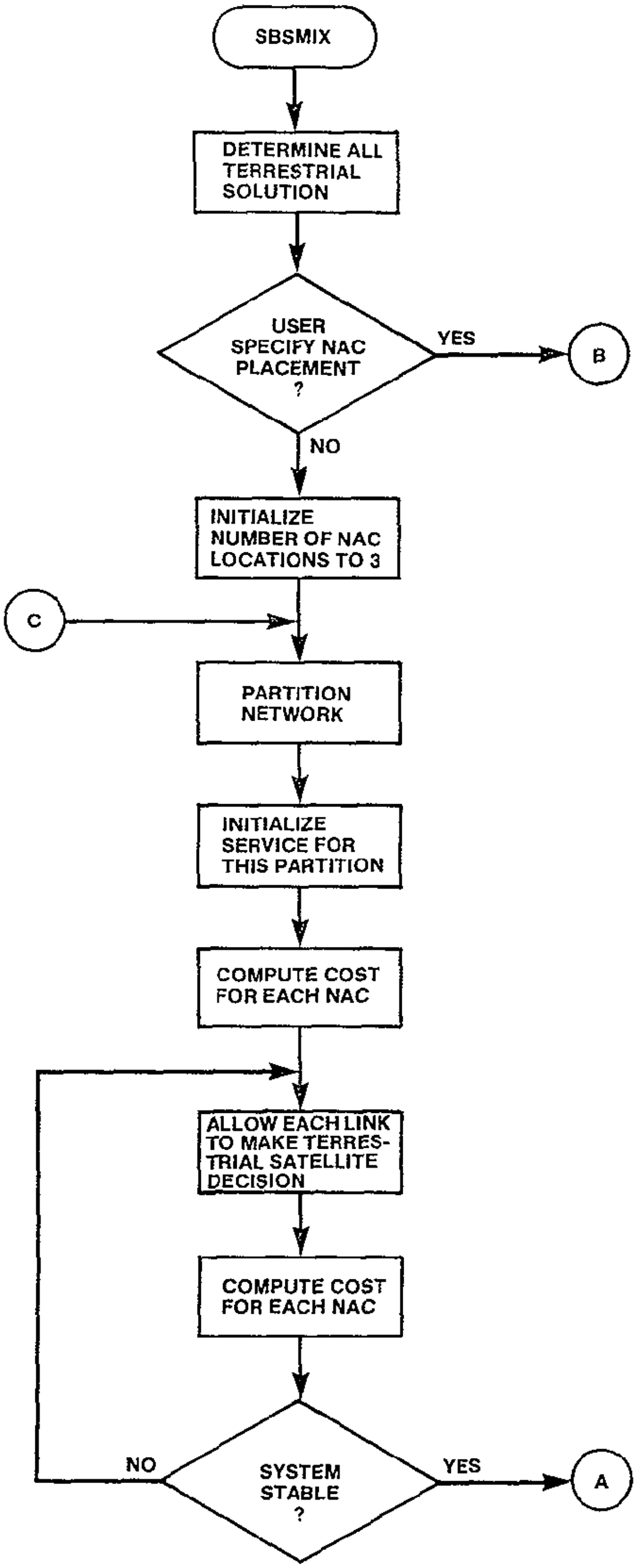

SBSMIX
DETERMINE ALL TERRESTRIAL SOLUTION
USER SPECIFY NAC PLACEMENT ?
YES
B
NO
INITIALIZE NUMBER OF NAC LOCATIONS TO 3
C
PARTITION NETWORK
INITIALIZE SERVICE FOR THIS PARTITION
COMPUTE COST FOR EACH NAC
ALLOW EACH LINK TO MAKE TERRES-TRIAL SATELLITE DECISION
COMPUTE COST FOR EACH NAC
NO
SYSTEM STABLE ?
YES
A

Figure 3-6. SBSMIX Logic Flow (Sheet 1 of 2)

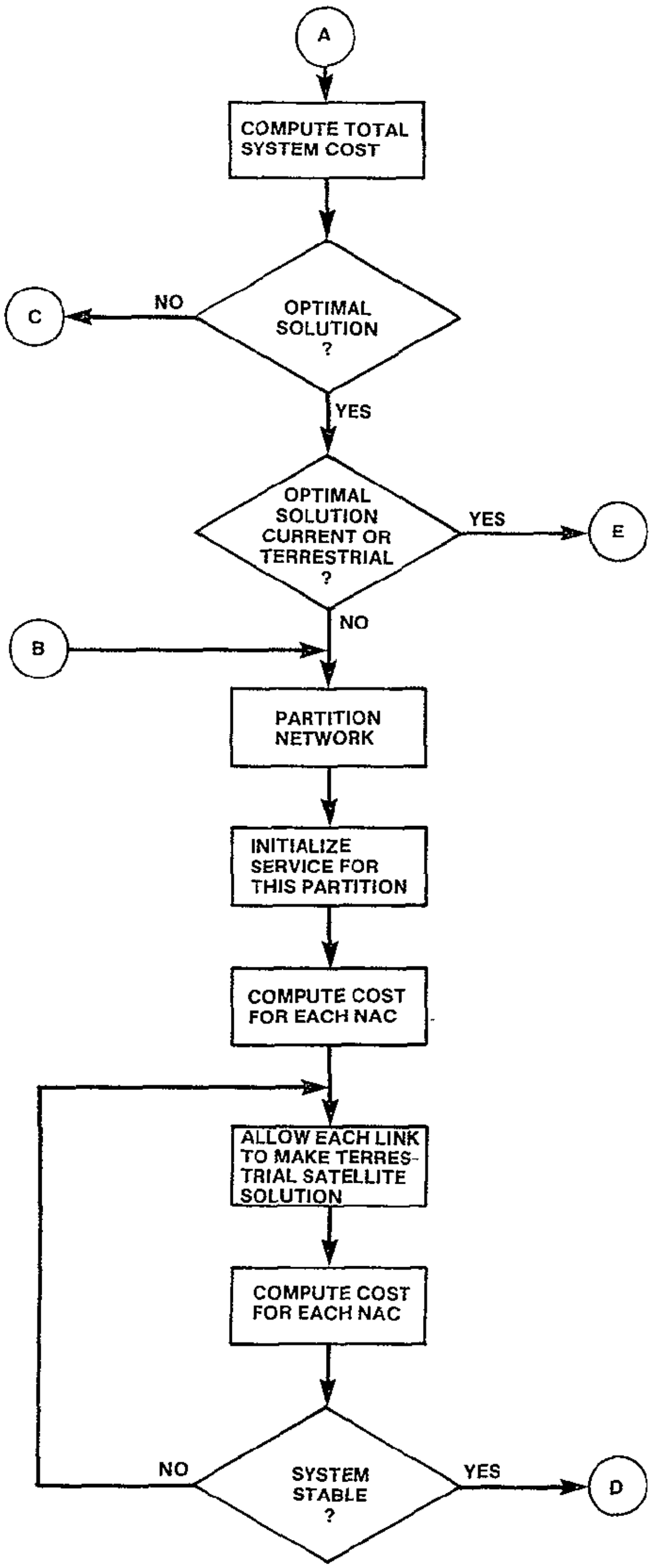

A
COMPUTE TOTAL SYSTEM COST
OPTIMAL SOLUTION ?
NO
C
YES
OPTIMAL SOLUTION CURRENT OR TERRESTRIAL ?
YES
E
NO
B
PARTITION NETWORK
INITIALIZE SERVICE FOR THIS PARTITION
COMPUTE COST FOR EACH NAC
ALLOW EACH LINK TO MAKE TERRES- TRIAL SATELLITE SOLUTION
COMPUTE COST FOR EACH NAC
SYSTEM STABLE ?
NO
YES
D

Figure 3-6. SBSMIX Logic Flow (Sheet 2 of 2)

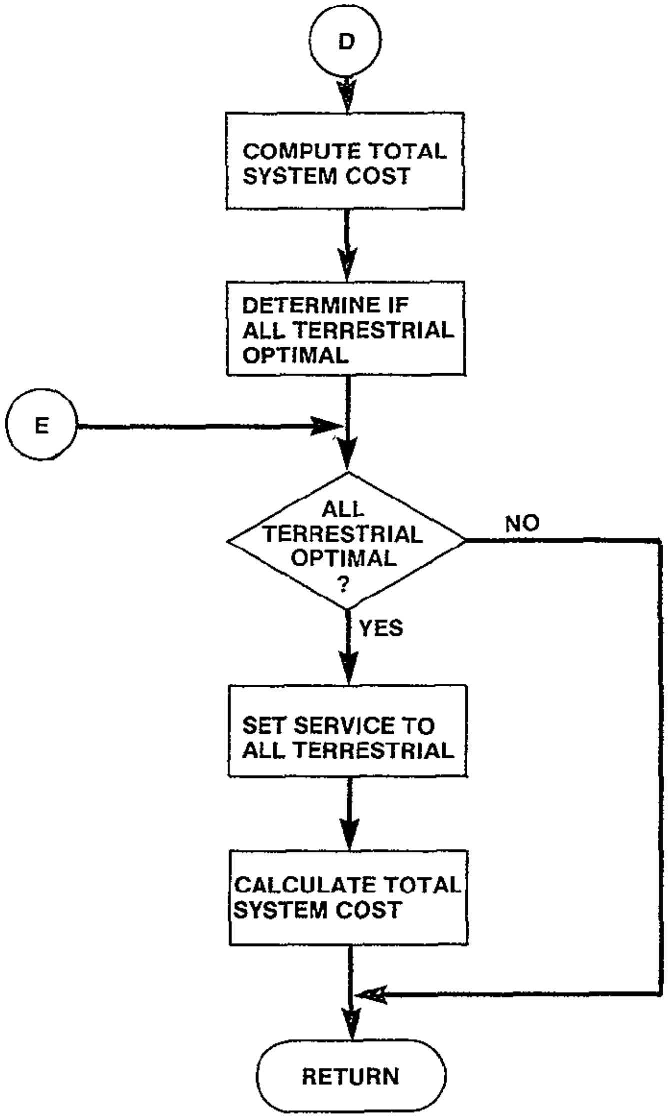

D
COMPUTE TOTAL SYSTEM COST
DETERMINE IF ALL TERRESTRIAL OPTIMAL
E
ALL TERRESTRIAL OPTIMAL ?
NO
YES
SET SERVICE TO ALL TERRESTRIAL
CALCULATE TOTAL SYSTEM COST
RETURN

Figure 3-6. SBSMIX Logic Flow (Sheet 3 of 3)

3.2.2 DEFTER Module

SUBROUTINE DEFTER

PURPOSE

DETERMINE LINKS THAT WILL PROVIDE TERRESTRIAL COMMUNICATION BETWEEN ALL CITY PAIRS AT MINIMUM COST AND TOTAL SYSTEM COST OF ALL TERRESTRIAL SOLUTION

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NNODES	/RUN/	U
COST	/CSTOUT/	S
SVC	/CSTOUT/	S
TRAFIC	/TRFC/	U
NETOTL	/CSTOUT/	U
MINCPC	/CSTOUT/	U
TOTSAT	/SBSMX2/	S
DEBUG	/LUN/	U

LOCAL VARIABLES

FROM	I*4	NODE FROM WHICH TRAFFIC ORIGINATES
TO	I*4	NODE AT WHICH TRAFFIC TERMINATES
DIST	I*4	AIRLINE MILEAGE BETWEEN TWO NODES
ISCHED	I*4	TERRESTRIAL TARIFF SCHEDULE BETWEEN TWO NODES
TARIF	I*4	NUMBER OF TERRESTRIAL TARIFF
TRAFC	I*4	ORIGINAL TRAFFIC BETWEEN NODAL PAIR
TRRCST	R*4	TOTAL TERRESTRIAL COST
NETFT	I*4	TOTAL TRAFFIC ACROSS LINK
MINFT	R*4	MINIMUM COST FOR EACH LINK
LSTDTO	I*4	CATEGORY A STATUS OF TO NODE

SUBPROGRAMS CALLED

MILES
LISTED
ATOST
NETWRK
MTPY
TRSTOT

ERRORS

FATAL
NONE
NONFATAL
NONE

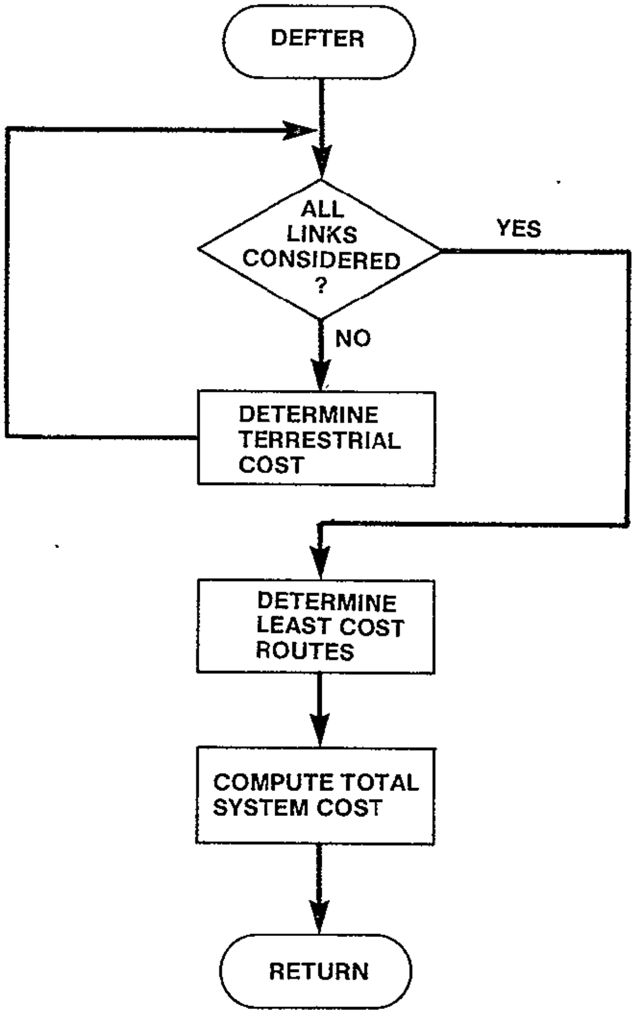

DEFTER
ALL LINKS CONSIDERED ?
YES
NO
DETERMINE TERRESTRIAL COST
DETERMINE LEAST COST ROUTES
COMPUTE TOTAL SYSTEM COST
RETURN

Figure 3-7. DEFTER Logic Flow

3.2.3 SRTNAC Module

SUBROUTINE SRTNAC

PURPOSE

DETERMINE THE ORDER OF THE NODES IN WHICH NACs WILL BE PLACED IN THE NETWORK

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NACLOC	/SBSMXD/	S
NNODES	/RUN/	U
TRAFIC	/TRFC/	U
DEGUG	/LUN/	U
MINCPC	/CSTOUT/	U

LOCAL VARIABLES

I,J,K	I*4	LOOP INDICES
NVAL	I*4	NUMBER OF ITEMS IN LIST OF DISTANCES BETWEEN PAIRS OF NODES
NACPTR	I*4	POSITION OF EACH NODE IN NAC LIST
NCLUST	I*4	NUMBER OF CLUSTERS
NLINK	I*4	ITEM IN DISTANCE ARRAY BEING REFERENCED
POS	I*4	POSITION IN ORDER ARRAY
POS A	I*4	POSITION OF FROM NODE IN NAC LOCATION LIST
POS B	I*4	POSITION OF TO NODE IN NAC LOCATION LIST
LSTTOP	I*4	LAST ITEM TO BE SHIFTED DOWN IN NACLOC LIST
FSTTOP	I*4	FIRST ITEM TO BE SHIFTED UP IN NACLOC LIST
MCST	R*4	ARRAY OF LINK COSTS
ORDER	I*4	POSITIONS OF LINK DISTANCES SORTED IN ASCENDING ORDER
END	I*4	END INDEX OF LOOP
A	I*4	FROM NODE
B	I*4	TO NODE
NAC	I*4	NUMBER OF NAC
SHIFT	L	INDICATES IF ORDER OF NACs ACTUALLY CHANGED BY MERGING A NODE INTO A PARTITION
TOTFC	I*4	TOTAL TRAFFIC AT NODE
MAX	R*4	MAXIMUM COST IN CURRENT SET OF LINKS
MIN	R*4	MINIMUM COST IN CURRENT SET OF LINKS
KK,II	I*4	LOOP INDICES
NEL	I*4	NUMBER OF LINK COSTS IN SET

MXPTR	I*4	LOCATION IN CURRENT LINK SET OF MAX COST
NITM	I*4	NUMBER OF ITEMS IS LIST TO BE SORTED

SUBPROGRAMS CALLED
    SORTR
    INDX

ERRORS
    FATAL
      NONE
    NONFATAL
      NONE

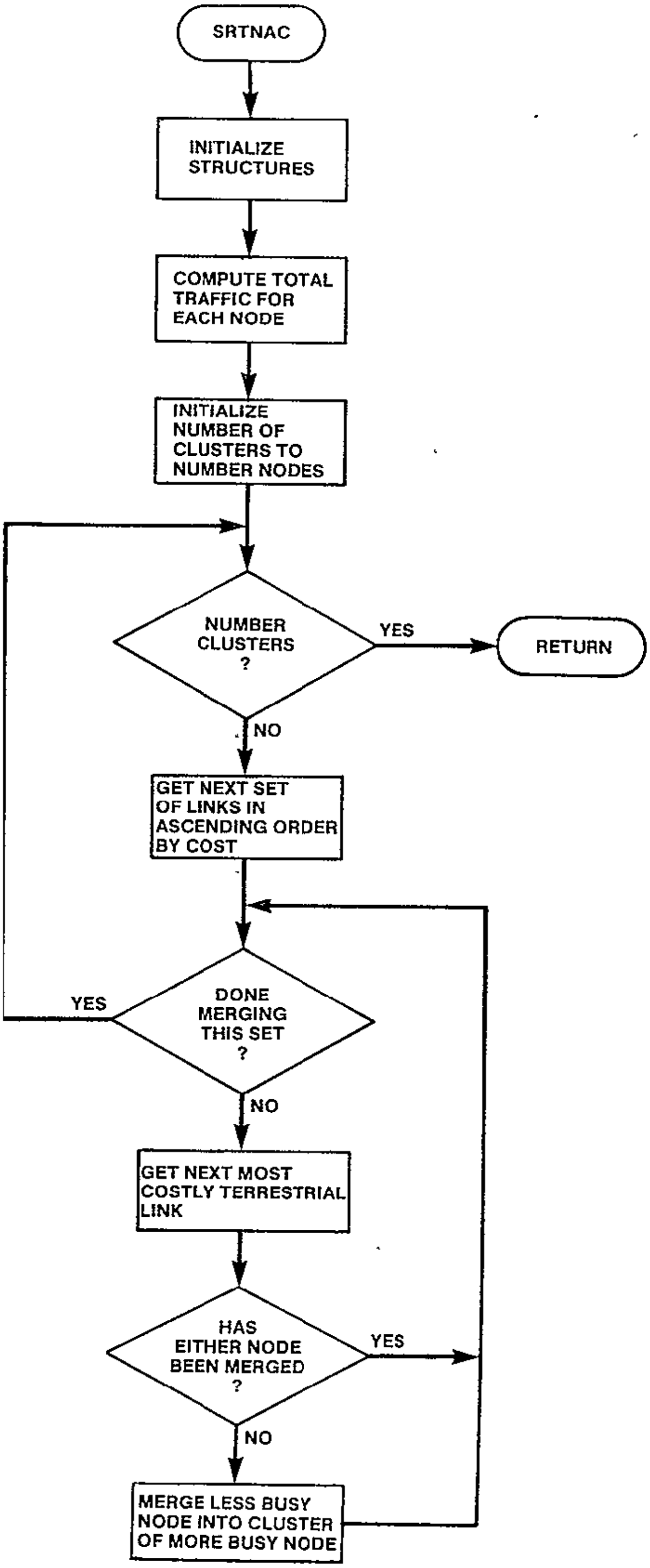

SRTNAC
INITIALIZE STRUCTURES
COMPUTE TOTAL TRAFFIC FOR EACH NODE
INITIALIZE NUMBER OF CLUSTERS TO NUMBER NODES
NUMBER CLUSTERS ?
YES
RETURN
NO
GET NEXT SET OF LINKS IN ASCENDING ORDER BY COST
YES
DONE MERGING THIS SET ?
NO
GET NEXT MOST COSTLY TERRESTRIAL LINK
HAS EITHER NODE BEEN MERGED ?
YES
NO
MERGE LESS BUSY NODE INTO CLUSTER OF MORE BUSY NODE

Figure 3-8. SRTNAC Logic Flow

3.2.4 PRTITN Module

SUBROUTINE PRTITN

PURPOSE

PARTITION NETWORK AROUND NAC CITIES

INPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NACLOC	/SBSMXD/	U
NACNMB	/SBSMXD/	U
NNODES	/SBSMXD/	U
NODPTR	/SBSMXD/	S
MINCPC	/CSTOUT/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

MINCST	I*4	MINIMUM TERRESTRIAL COSE REQUIRED TO GET FROM CURRENT NODE TO A NAC LOCATION
MINPTR	I*4	NUMBER OF NAC THAT IS CHEAPEST FOR NODE TO GET TO
NAC	I*4	NUMBER OF CURRENT NAC UNDER CONSIDERATION
NODE	I*4	NUMBER OF CURRENT NODE UNDER CONSIDERATION
NACPTR	I*4	NODE PRINTER OF CURRENT NAC
MAXINT	I*4	MAXIMUM I*4 VALUE
I	I*4	LOOP INDEX

SUBPROGRAMS CALLED

ISNAC

ERRORS

FATAL

NONE

NONFATAL

NONE

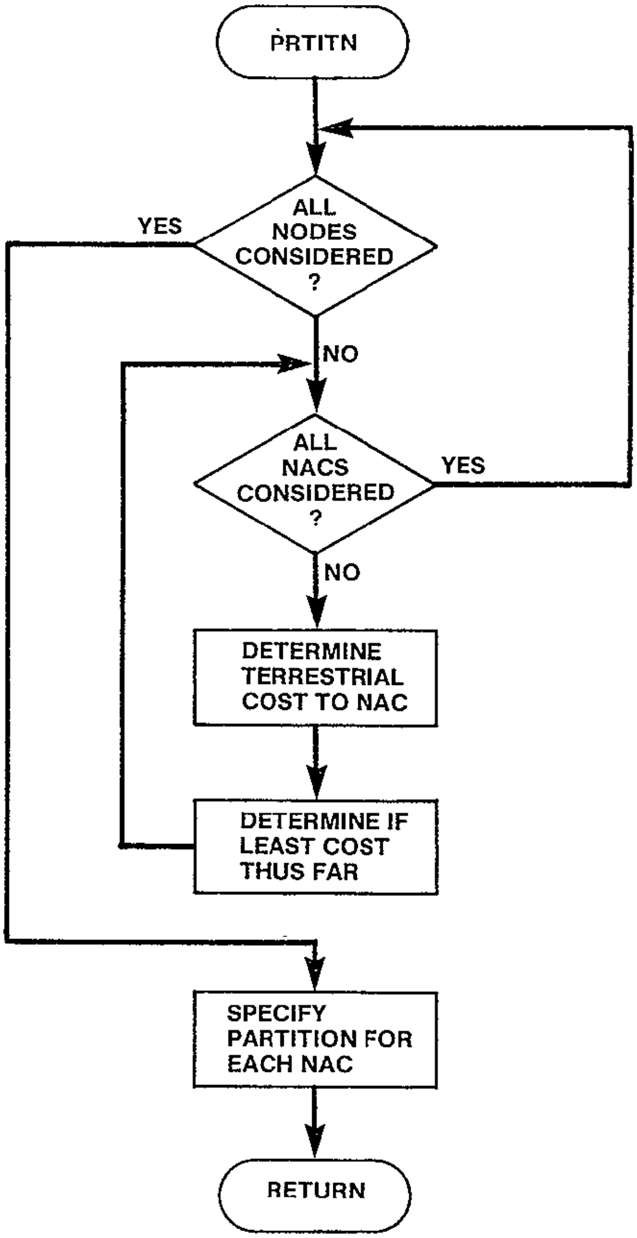

PRTITN
ALL NODES CONSIDERED ?
YES
NO
ALL NACS CONSIDERED ?
YES
NO
DETERMINE TERRESTRIAL COST TO NAC
DETERMINE IF LEAST COST THUS FAR
SPECIFY PARTITION FOR EACH NAC
RETURN

Figure 3-9. PRTITN Logic Flow

3.2.5 SBSC Module

SUBROUTINE SBSC

PURPOSE

COMPUTE COST PER CIRCUIT FOR EACH NAC LOCATION

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NACNMB	/SBSMXD/	U
NODPTR	/SBSMXD/	U
NNODES	/RUN/	U
TRAFIC	/TRFC/	U
SATNVC	/SBSMX2/	S
SATCST	/SBSMX2/	S
SVC	/CSTOUT/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

SBS	I*4	TARIFF NUMBER OF SBS TARIFF /2/ CONSTANT
PART1	I*4	NUMBER OF FROM PARTITION
NVC	I*4	NUMBER OF VOICE CIRCUIT USING NAC
FROM	I*4	FROM NODE
TO	I*4	TO NODE
PRTFRM	I*4	PARTITION TO WHICH FROM NODE BELONGS
PRTTO	I*4	PARTITION TO WHICH TO NODE BELONGS
BIGNUM	R*4	CONSTANT /16.0**62/LARGE REAL NUMBER TO REPRESENT INFINITE COST

SUBPROGRAMS CALLED

SBCOST

ERRORS

FATAL

NONE

NONFATAL

NONE

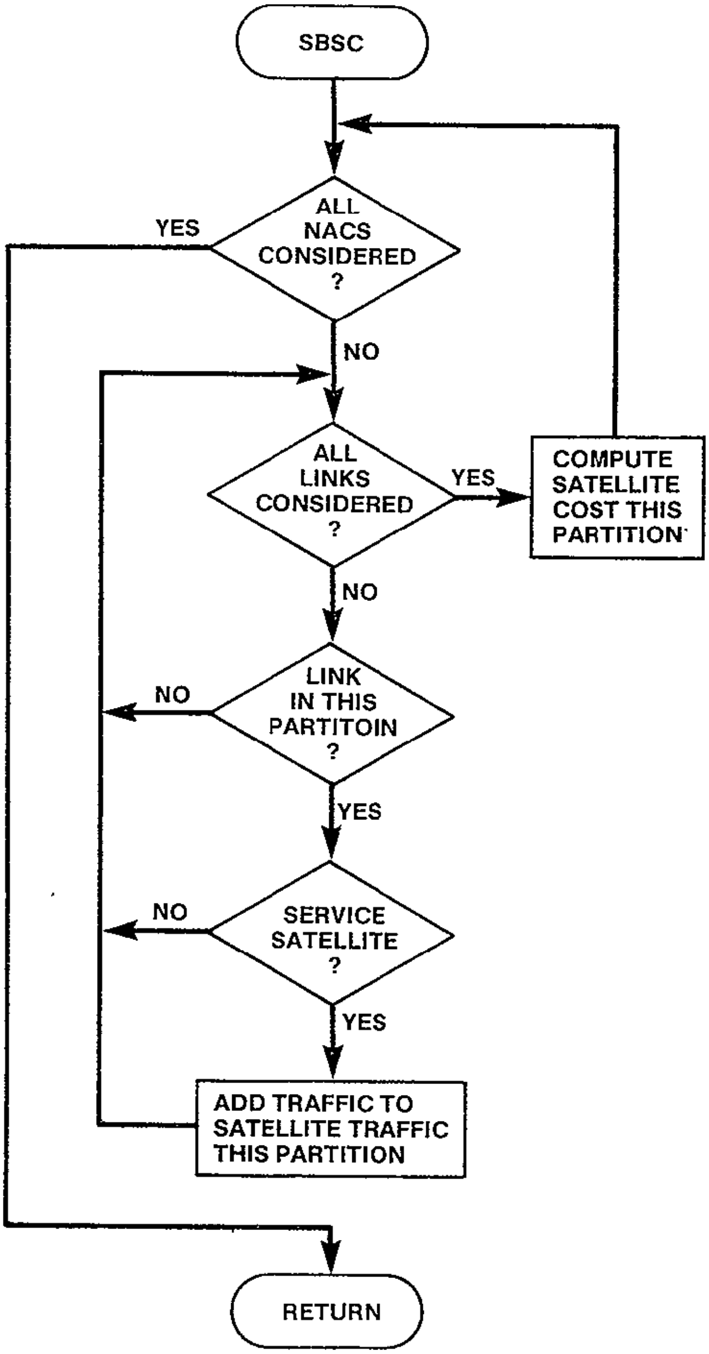


Figure 3-10. SBSC Logic Flow

3.2.6 DECIDE Module

SUBROUTINE DECIDE

PURPOSE

ALLOW EACH LINK TO MAKE TERRESTRIAL VS SATELLITE DECISION

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NACNMB	/SBSMXD/	U
NNODES	/RUN/	U
NODPTR	/SBSMXD/	U
NACLOC	/SBSMXD/	U
MINCPC	/CSTOUT/	U
SVC	/CSTOUT/	U
SATCST	/SBSMX2/	U
SYSTBL	/SBSMX2/	S
DEBUG	/LUN/	U

LOCAL VARIABLES

I	I*4	LOOP INDEX
FROM	I*4	PARTITION OF FROM NODE
PART1	I*4	PARTITION OF FROM NODE
NOD1	I*4	NODE WHICH HAS NAC IN FROM PARTITION
TAIL1	R*4	COST OF TAIL TO NAC
NOD2	I*4	NODE WHICH HAS NAC IN TO PARTITION
TO	I*4	TO NODE
PART2	I*4	PARTITION OF TO NODE
FULL	R*4	MINIMUM TERRESTRIAL COST OF LINK
TAIL2	R*4	MINIMUM COST OF TRAIL FROM TO NAC
CRSOVR	R*4	CROSSOVER COST FOR THIS LINK
TRSTRL	I*4	CONSTANT /1/ TERRESTRIAL SERVICE
CHANGE	I*4	INDICATES OF NAC LOCATION MADE A CHANGE THIS ITERATION
BIGNUM	R*4	CONSTANT /16.0**62) LARGE REAL TO REPRESENT INFINITE COST

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

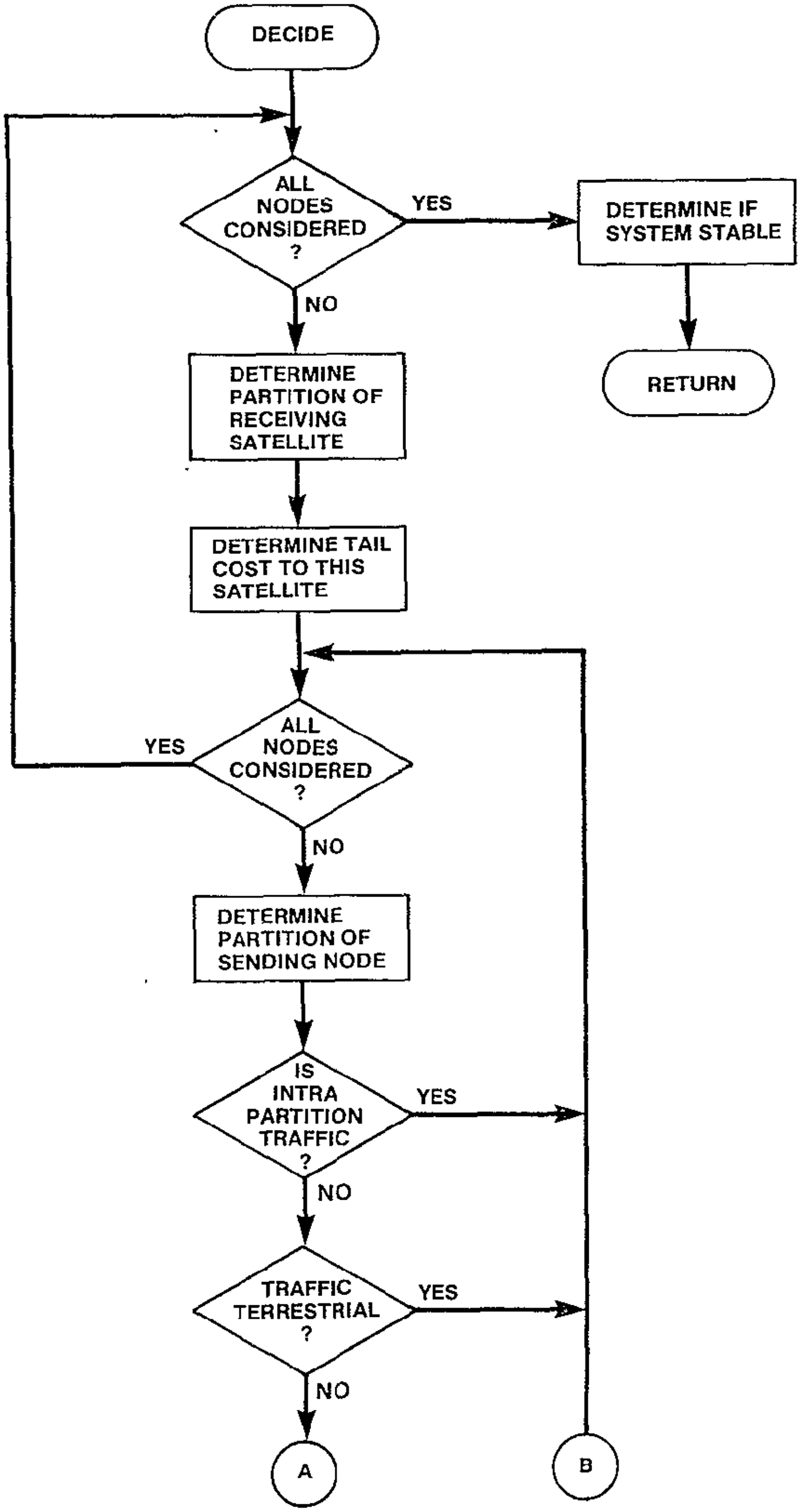

DECIDE
ALL NODES CONSIDERED ?
YES
NO
DETERMINE IF SYSTEM STABLE
RETURN
DETERMINE PARTITION OF RECEIVING SATELLITE
DETERMINE TAIL COST TO THIS SATELLITE
YES
ALL NODES CONSIDERED ?
NO
DETERMINE PARTITION OF SENDING NODE
IS INTRA PARTITION TRAFFIC ?
YES
NO
TRAFFIC TERRESTRIAL ?
YES
NO
A
B

Figure 3-11. DECIDE Logic Flow (Sheet 1 of 2)

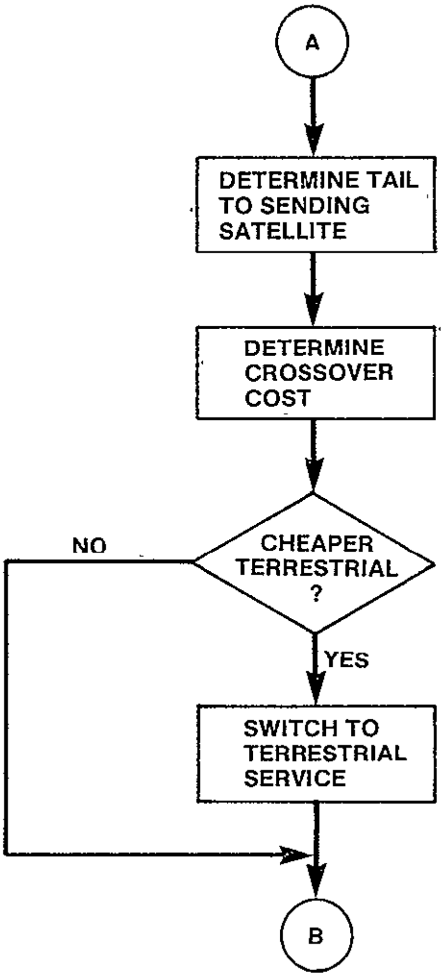

A
DETERMINE TAIL TO SENDING SATELLITE
DETERMINE CROSSOVER COST
CHEAPER TERRESTRIAL ?
NO
YES
SWITCH TO TERRESTRIAL SERVICE
B

Figure 3-11. DECIDE Logic Flow (Sheet 2 of 2)

3.2.7 TOTCST Module

SUBROUTINE TOTCST(SYSCST)

PURPOSE

COMPUTE TOTAL SYSTEM COST

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

SYSCST	R*8	TOTAL SYSTEM COST

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NNODES	/RUN/	U
NETOTL	/CSTOUT/	S
SATOTL	/SATMXD/	S
SVC	/CSTOUT/	U
NODPTR	/SBSMXD/	U
NACLOC	/SBSMXD/	U
TRRCST	/CSTMXD/	S
TRRMLG	/CSTMXD/	S
TRRCKT	/CSTMXD/	S
MINCPC	/CSTMXD/	U
STLMLG	/CSTMXD/	S
STLCKT	/CSTMXD/	S
STLCST	/CSTMXD/	S
SATNVC	/SBSMX2/	U
SATCST	/SBSMX2/	U
NACNMB	/SBSMXD/	U
TRAFIC	/TRFC/	U
STABLE	/SBSMX2/	S
DEBUG	/LUN/	U

LOCAL VARIABLES

FROM	I*4	NUMBER OF FROM NODE FOR TERRESTRIAL SERVICE
TO	I*4	NUMBER OF TO NODE FOR TERRESTRIAL SERVICE
TRSTRL	I*4	CONSTANT /1/ TERRESTRIAL TARIFF
PART1	I*4	NUMBER OF FROM PARTITION
NAC1	I*4	NODE WHICH IS NAC LOCATION IN FROM PARTITION
PART2	I*4	NUMBER OF TO PARTITION
NAC2	I*4	NODE WHICH IS NAC LOCATION IN TO PARTITION
NACFRM	I*4	NODE WHICH IS NAC LOCATION IN FROM PARTITION
NACTO	I*4	NODE WHICH IS NAC LOCATION IN TO PARTITION
I	I*4	LOOP INDEX
TRAFC	I*4	NUMBER OF VOICE CIRCUITS BETWEEN TWO NODES
NETFT	I*4	NUMBER OF VOICE CIRCUITS - FROM TO
MINET	R*4	MINIMUM COST PER CIRCUIT - FROM TO
PROD	R*4	TOTAL CIRCUIT COST

SUBPROGRAMS CALLED

TRSTOT
MILES
MTPY

```
ERRORS
     FATAL
       NONE
     NONFATAL
       NONE
```

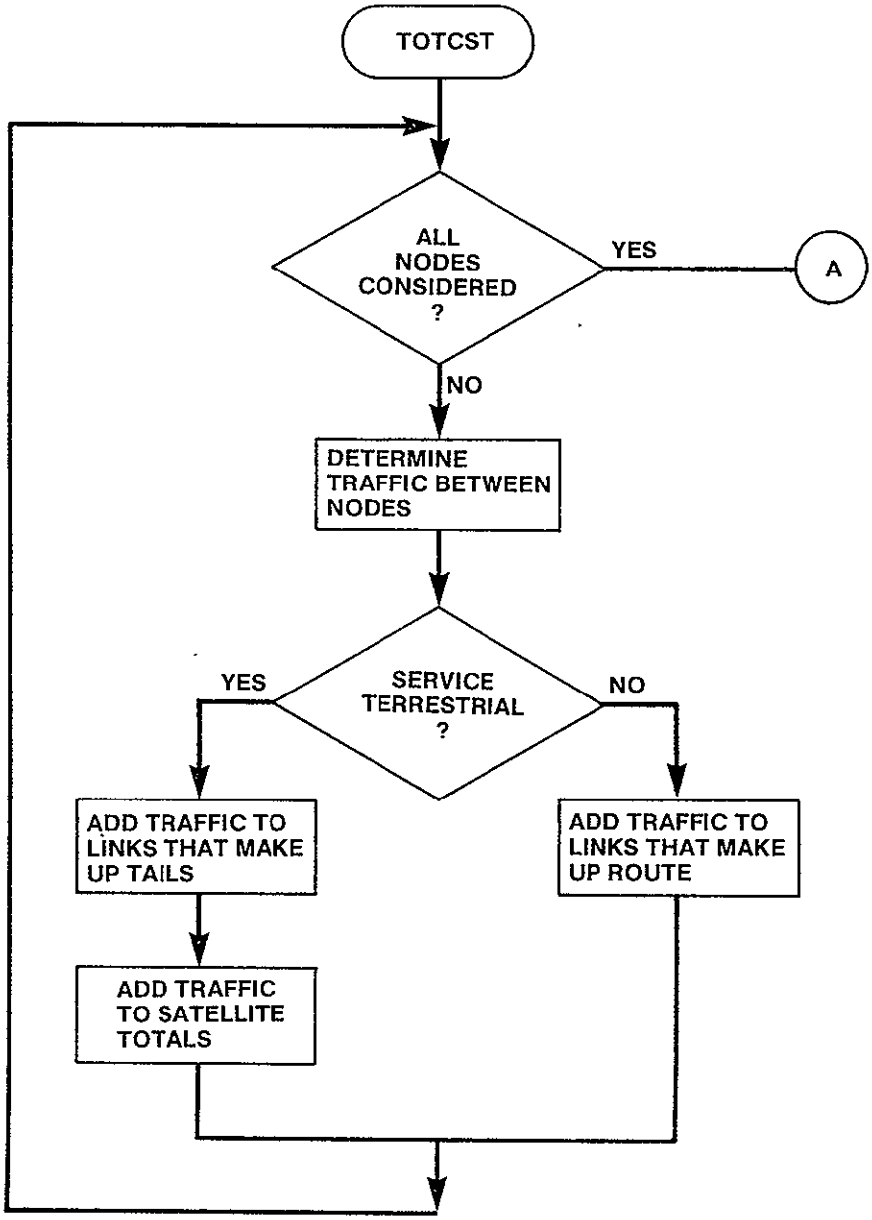

TOTCST
ALL NODES CONSIDERED ?
YES
A
NO
DETERMINE TRAFFIC BETWEEN NODES
SERVICE TERRESTRIAL ?
YES
NO
ADD TRAFFIC TO LINKS THAT MAKE UP TAILS
ADD TRAFFIC TO LINKS THAT MAKE UP ROUTE
ADD TRAFFIC TO SATELLITE TOTALS

Figure 3-12. TOTCST Logic Flow (Sheet 1 of 2)

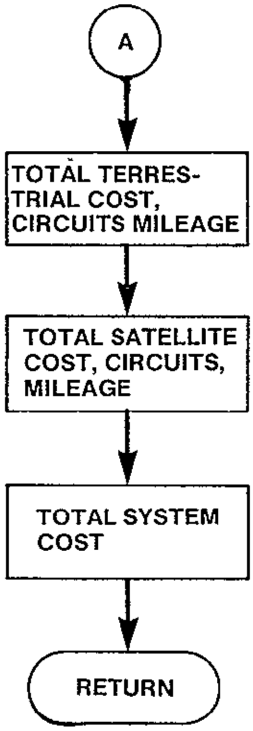

A
TOTAL TERRESTRIAL COST, CIRCUITS MILEAGE
TOTAL SATELLITE COST, CIRCUITS, MILEAGE
TOTAL SYSTEM COST
RETURN

Figure 3-12. TOTCST Logic Flow (Sheet 2 of 2)

3.2.8 TRSTOT Module

SUBROUTINE TRSTOT (FROM,TO,TRAFC)

PURPOSE

ADD SPECIFIED TRAFFIC TO LINKS THAT MAKE UP THE LEAST COST NETWORK BETWEEN SPECIFIED NODES

INPUT ARGUMENTS

FROM	I*4	NUMBER OF FROM NODE
TO	I*4	NUMBER OF TO NODE
TRAFC	I*4	NUMBER OF VOICE CIRCUITS TO ADD TO EACH LINK OF PATH BETWEEN FROM AND TO

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

OROUTE	/CSTOUT/	U
NETOTL	/CSTOUT/	S
DEBUG	/LUN/	U

LOCAL VARIABLES

CURFRM	I*4	CURRENT FROM NODE ALONG LEAST COST ROUTE
CURTO	I*4	CURRENT TO NODE ALONG LEAST COST ROUTE

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

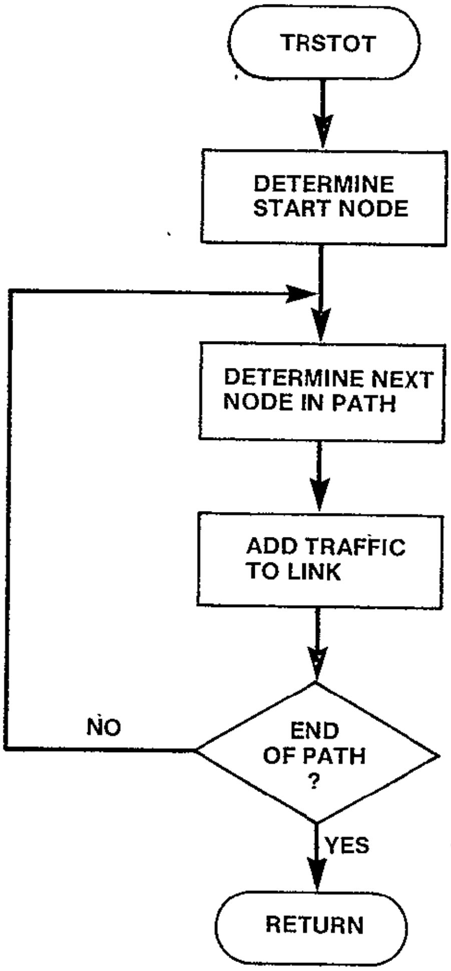


Figure 3-13. TRSTOT Logic Flow

3.2.9 ALDONE Module

```
SUBROUTINE ALDONE (FINISH,BSTSOL)
```

PURPOSE

DETERMINE IF OPTIMAL SOLUTION HAS BEEN FOUND

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

FINISH	L	INDICATES IF NAC SELECTION IS FINISHED - OPTIMAL SOLUTION HAS BEEN FOUND
BSTSOL	I*4	NUMBER OF NACS IN OPTIMAL SOLUTION

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

TOTSAT	/SBSMX2/	U
NACNMB	/SBSMXD/	S
NNODES	/RUN/	U
STABLE	/SBSMX2/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

BSTCST	R*4	SYSTEM COST OF OPTIMAL SOLUTION
I	I*4	LOOP INDEX
FINFAC	R*4	FACTOR BY WHICH CURRENT SOLUTION MUST EXCEED BEST SOLUTION TO TERMINATE NAC PLACEMENT

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

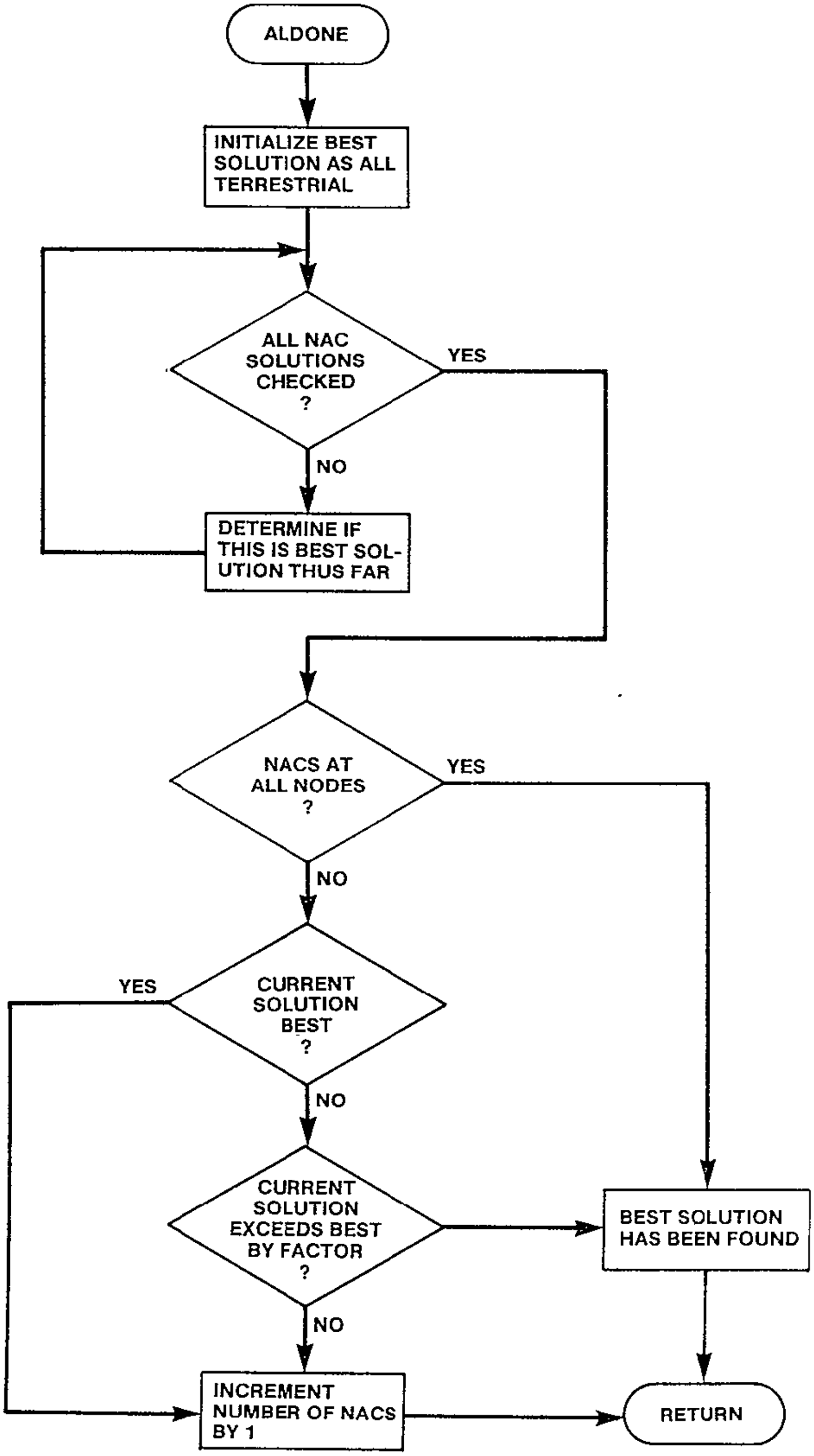

ALDONE
INITIALIZE BEST SOLUTION AS ALL TERRESTRIAL
ALL NAC SOLUTIONS CHECKED ?
YES
NO
DETERMINE IF THIS IS BEST SOLUTION THUS FAR
NACS AT ALL NODES ?
YES
NO
CURRENT SOLUTION BEST ?
YES
NO
CURRENT SOLUTION EXCEEDS BEST BY FACTOR ?
NO
BEST SOLUTION HAS BEEN FOUND
INCREMENT NUMBER OF NACS BY 1
RETURN

Figure 3-14. ALDONE Logic Flow

3.2.10 ISNAC Module

LOGICAL FUNCTION ISNAC(NODE)

PURPOSE

DETERMINE IF SPECIFIED NODE IS ALREADY IN LIST OF NETWORK NAC LOCATIONS

INPUT ARGUMENTS

NODE	I*4	INTEGER POSITION OF NODE WITHIN NETWORK

OUTPUT ARGUMENTS

ISNAC	L	FUNCTION VALUE OF .TRUE. IF NODE IS IN LIST OF NETWORK LINKS, .FALSE. OTHERWISE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NACLOC	/SBSMXD/	U
NACNMB	/SBSMXD/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

FOUND	L	INDICATES IF NODE FOUND IN NACLOC LIST
I	I*4	LOOP INDEX

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

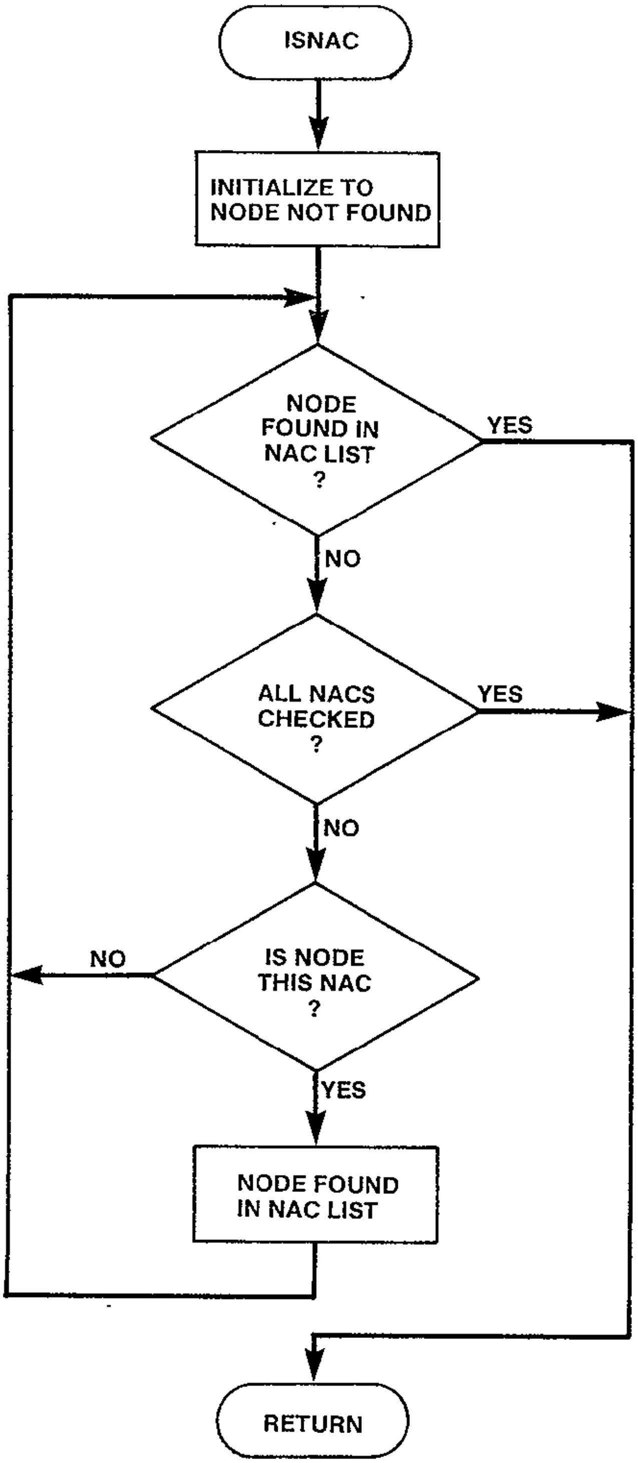


Figure 3-15. ISNAC Logic Flow

3.2.11 SORTR Module

SUBROUTINE SORTR (CODE, ORDER, NEL)

PURPOSE

SORTS THE NEL ITEMS IN CODE ARRAY IN ASCENDING ORDER

INPUT ARGUMENTS

CODE	R*4	REAL ARRAY TO BE SORTED
NEL	I*4	NUMBER OF ELEMENTS TO BE SORTED

OUTPUT ARGUMENTS

ORDER	I*2	POSITION OF ITEMS IN CODE ARRAY IN ASCENDING ORDER. IT IS ASSUMED THAT ORDER HAS BEEN INITIALIZED BY CALLING ROUTINE

DATA STRUCTURES

NONE

LOCAL VARIABLES

INDX1	I*4	POINTER TO FIRST OF TWO ITEMS IN CODE TO BE COMPARED
INDX2	I*4	POINTER TO SECOND OF TWO ITEMS IN CODE TO BE COMPARED
IEND	I*4	NUMBER OF COMPARISONS
SORTED	L	INDICATES IF LIST FULLY SORTED
I	I*4	LOOP INDEX
POS	I*2	POSITIONS OF CODE
HI	I*2	TEMPORARY LOCATION FOR ORDER VALUE TO BE SHIFTED
H2	I*2	TEMPORARY LOCATION FOR ORDER VALUE TO BE SHIFTED

SUBPROGRAMS CALLED

NONE

ERRORS

NONE

3.2.12 INDX Module

INDX Module

SUBROUTINE INDX (ORDR, FROM, TO)

PURPOSE

DETERMINE THE FROM AND TO COORDINATES OF A POSITION WHICH CORRESPONDS TO A SLOT IN THE UPPER RIGHT TRIANGLE OF A SQUARE MATRIX

INPUT ARGUMENTS

ORDR	I*4	POSITION IN ONE DIMENSIONAL ARRAY WHICH REPRESENTS UPPER RIGHT TRIANGLE OF A SQUARE MATRIX WHERE ELEMENTS ARE ARRANGED IN ORDER BY COLUMN

OUTPUT ARGUMENTS

FROM	I*4	ROW IN SQUARE MATRIX ASSOCIATED WITH ORDR
TO	I*4	COLUMN IS SQUARE MATRIX ASSOCIATED WITH ORDR

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

DEBUG	/LUN/	U

LOCAL VARIABLES

COL	I*4	COLUMN NUMBER
ENDCOL	I*4	POINTER TO END OF COLUMN
DISP	I*4	DISPLACEMENT BETWEEN ORDR AND END OF COLUMN

SUBPROGRAMS CALLED

NONE

ERRORS

NONE

3.3 INPUT DESCRIPTION

All user specified input necessary for execution of the CNDC Model is controlled through the INPUT module. During any input session, the user may specify problem data sets for one or more runs. The input session may be operated in batch mode. The batch processing input modules are described in section 3.9.

The INPUT module consists of three submodules:

1 NETCON - network construction
2 TARCON - tariff construction
3 EXCON - execution control

A brief description of each submodule is contained in the following paragraphs.

NTECON

This submodule allows the user to specify the network to be analyzed by the CNDC Model. During a network construction session, the user may create a network file to identify the nodes of the network. Nodes may be selected from a prestored list of SMSA cities or specified as any city that the user wishes to include in the network. The user may create several network files. The program will organize these files and maintain a directory of current network files. The user is also provided the capability to list the directory and the contents of any file in the directory. He is also provided the capability to delete any existing network files. In this case the program will automatically remove the file name from the network directory making it available for a new definition. The NETCON submodule is described in detail in section 3.4.

TARCON

This submodule allows the user to specify tariffs to be used as input to the CNDC model. During a tariff construction session, the user may create up to twelve different tariff files. These files are stored and can be specified as input to any particular run during program execution. TARCON provides the user with the capability to manage the tariff files. The program organizes existing tariff files in a directory. Options are available to create, delete, and list tariff files. The tariff directory may also be listed to examine which files are currently stored. The creation of a tariff file includes the use of any one of the three tariffs (AT&T, Western Union, or SBS) as a starting point. The user defined tariff follows the same structure and connectivity philosophy of the modeled tariff. TARCON is described in section 3.5.

EXCON

This submodule allows the user to specify input parameters which define the problem being solved and control the execution of the program. The user may specify multiple problem sets for batching program runs. For each run the user specifies the network file to use, the tariffs to be considered, and the output reports desired. The EXCON submodule is described in this section.

A hierarchy chart of the INPUT module is in Figure 3-16.

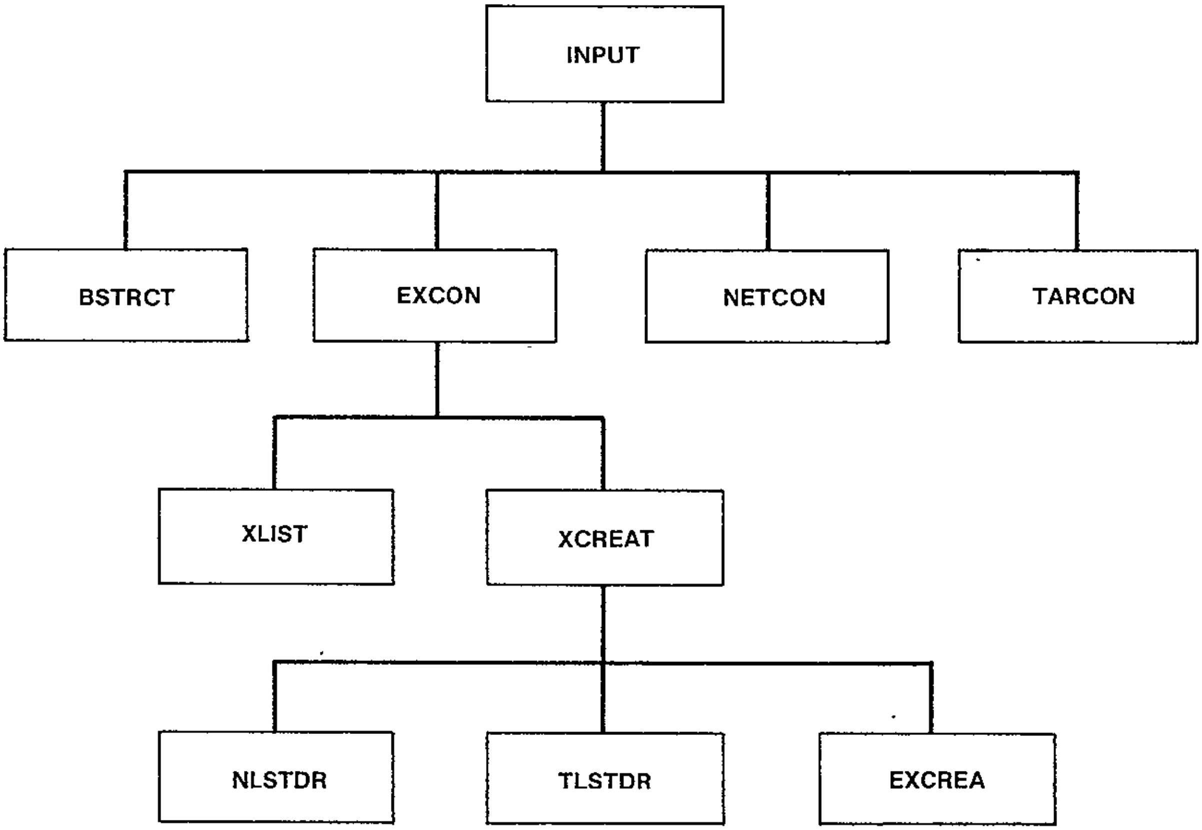


Figure 3-16. INPUT Hierarchy Chart

3.3.1 INPUT Module

SUBROUTINE INPUT (CONT)

PURPOSE

QUERY USER AND BUILD EXECUTION FILE OR TARIFF OR NETWORK FILES SPECIFIED

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

CONT	LOGICAL	FLAG WHICH INDICATES THAT EXECUTION CONTROL FILE HAS BEEN CREATED AND USER WISHES TO RUN MODEL

DATA STRUCTURE

(U - USED, S - DEFINED, R - READ)

NONE

LOCAL VARIABLES

IOPT	I*4	MENU OPTION SELECTED
IANS	I*4	RESPONSE OF YES OR NO
YES	I*4	CONSTANT /'Y'/ ANSWER OF YES
NO	I*4	CONSTANT /'N'/ ANSWER OF NO

SUBPROGRAMS CALLED

BSTRCT
NETCON
TARCON
EXCON

ERRORS

FATAL

NONE

NONFATAL

NONE

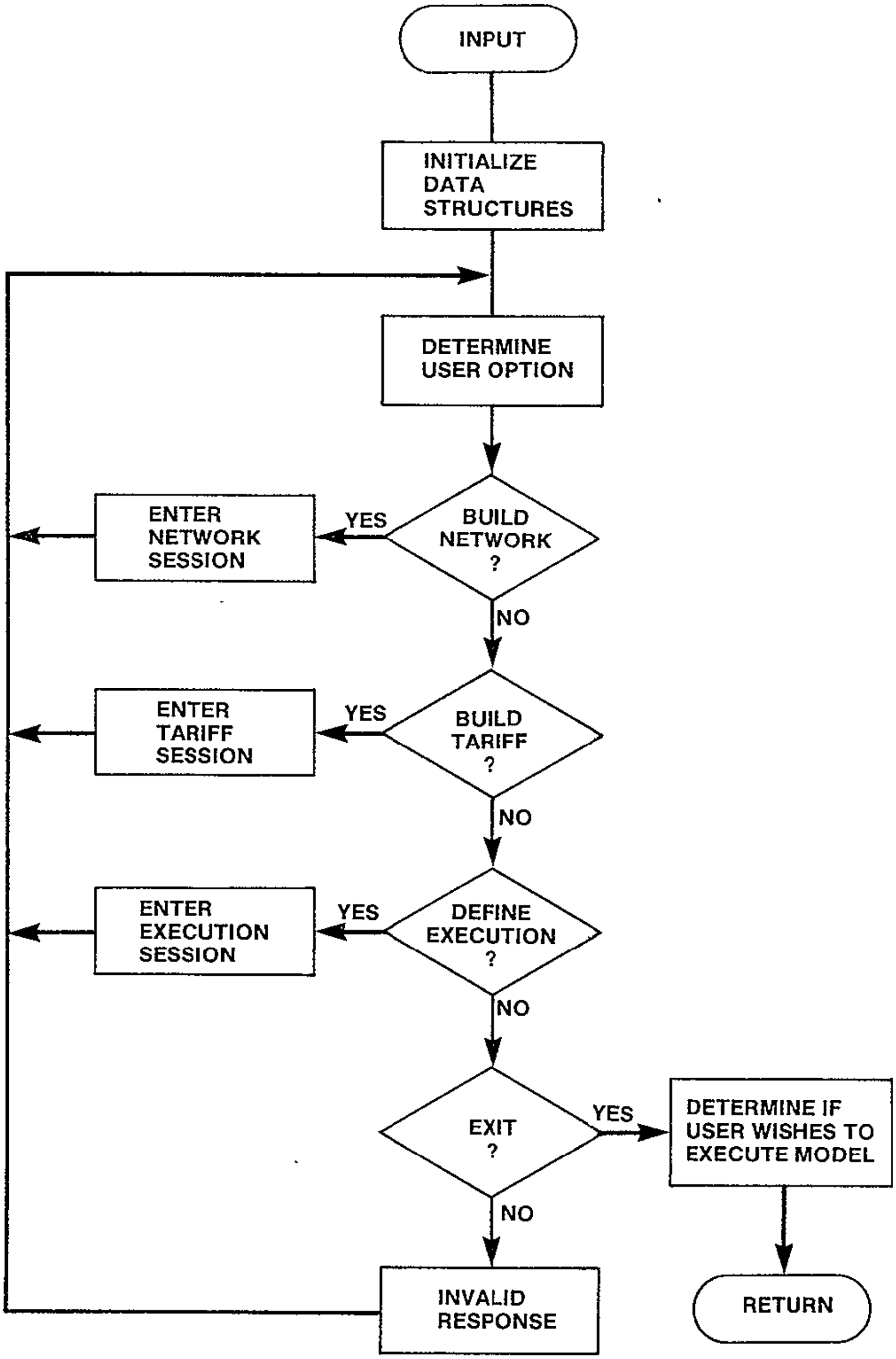


Figure 3-17. INPUT Logic Flow

3.3.2 BSTRCT Module

SUBROUTINE BSTRCT

PURPOSE

BUILE DATA STRUCTURES REQUIRED BY INPUT

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

TRFNDS	/LUN/	U
NPRNDS	/PRSNDS/	S
PRNDS	/PRSNDS/	S
TRFATT	/LUN/	U
HPATT	/HEADRS/	U
HNOD	/HEADRS/	U
NCATA	/INPATT/	S
PRCATA	/INPATT/	S
NLEVL	/ATT/	U
NTLEVL	/INPATT/	S
TATMIL	/INPATT/	S
TRFSBS	/LUN/	U
HPSBS	/HEADERS/	U
NAC	/INPSBS/	S
SCU	/INPSBS/	S
FTU	/INPSBS/	S
CAUMIN	/INPSBS/	S
NSBTAB	/INPSBS/	S
NTAB	/SBS/	U
TSBCAM	/INPSBS/	S
KPBLK	/PRSNDS/	S
KDIR	/PRSNDS/	S
KRNODE	/PRSNDS/	S
MPBLK	/INPATT/	S
MDIR	/INPATT/	S
DRCATA	/INPATT/	S
HPWU	/HEADRS/	U
TRFWU	/LUN/	U
LSTACC	/PRSWU/	S
NACC	/PRSWU/	S
NWUTRI	/WU/	U
WUPRS	/WU/	S
MXPRN	/ARRYS/	U
MXCTA	/ARRYS/	U
MXACC	/ARRYS/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

B1,B2,B3	R*4	BASE RATES FOR THREE SCHEDULES OF TERRESTRIAL TARIFF
END	I*4	INDEX OF LAST ITEM TO READ IN RECORD
HC	I*4	HORIZONTAL COORDINATE
HEADER(2)	R*8	FILE HEADER TO IDENTIFY FILE CONTENTS
I	I*4	LOOP INDEX
INDX	I*4	INDEX OF ARRAY ITEM TO PUT IN DIRECTORY
I1,I2,I3	R*4	INCREMENT CHANGES FOR THREE SCHEDULES OF TERRESTRIAL TARIFF
J	I*4	LOOP INDEX
NPREC	I*4	NUMBER OF ITEMS FOR RECORD
NREC	I*4	NUMBER OF RECORDS
START	I*4	INDEX OF FIRST ITEM TO READ IN RECORD
VC	I*4	VERTICAL COORDINATES
CODL	I*4	LEFT CODE SPECIFIED IN WU PRESTORED TARIFF
CODR	I*4	RIGHT CODE SPECIFIED IN WU PRESTORED TARIFF
CTG	I*4	RATE TYPE FOR PAIR SPECIFIED IN PRESTORED WU TARIFF
FOUND	I*4	FLAG WHICH INDICATES WHICH OF ACCESS PAIR IS FOUND IN LIST OF ACCESS CITIES 0 NEITHER FOUND 1 ONLY CODL FOUND 2 ONLY CODR FOUND 3 BOTH FOUND
LPTR	I*4	NUMBER OF ACCESS CITY IN LSTACC LIST
RPTR	I*4	NUMBER OF RIGHT ACCESS CITY IN LSTACC LIST
PTR	I*4	NUMBER OF PAIR IN WUPRS

SUBPROGRAMS CALLED

PTRPRS
TRFSKP

ERRORS

FATAL

2010	HEADER FROM TRAFFIC NODES NOT AS EXPECTED
2020	HEADER FROM PRESTORED TERRESTRIAL TARIFF NOT AS EXPECTED
2030	ATT TARIFF LEVELS EXCEEDS ARRAY SIZE IN MODEL
2040	HEADER FROM PRESTORED SBS TARIFF NOT AS EXPECTED
2050	SBS TARIFF LEVELS EXCEEDS ARRAY SIZE IN MODEL
2060	HEADER FROM PRESTORED WU TARIFF NOT AS EXPECTED
2070	NUMBER OF ITEMS REQUIRED FOR PRSNDS ARRAY EXCEEDS NUMBER ALLOWED
2080	NUMBER OF ITEMS REQUIRED FOR PRCATA ARRAY EXCEEDS NUMBER ALLOWED
2090	NUMBER OF ITEMS REQUIRED FOR LSTACC ARRAY EXCEEDS NUMBER ALLOWED

NONFATAL

NONE

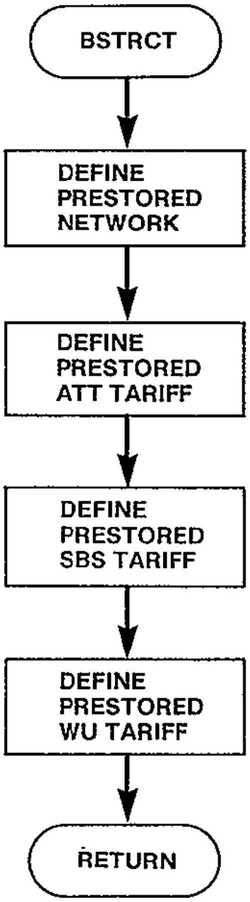

BSTRCT
DEFINE PRESTORED NETWORK
DEFINE PRESTORED ATT TARIFF
DEFINE PRESTORED SBS TARIFF
DEFINE PRESTORED WU TARIFF
RETURN

Figure 3-18. BSTRCT Logic Flow

3.3.3 EXCON Module

```
   SUBROUTINE EXCON(CONT)

PURPOSE
     MAINTAIN EXECUTION CONTROL FILE

INPUT ARGUMENTS
     NONE

OUTPUT ARGUMENTS
     CONT          LOGICAL      INDICATES THAT AN EXECUTION CONTROL FILE
                                WAS SUCCESSFULLY CREATED

DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
     DEBUG          /LUN/    U

LOCAL VARIABLES
     IOPT       I*4             MENU OPTION

SUBPROGRAMS CALLED
     XLIST
     XCREAT
     DIRGEN

ERRORS
     FATAL
       NONE
     NONFATAL
       NONE
```

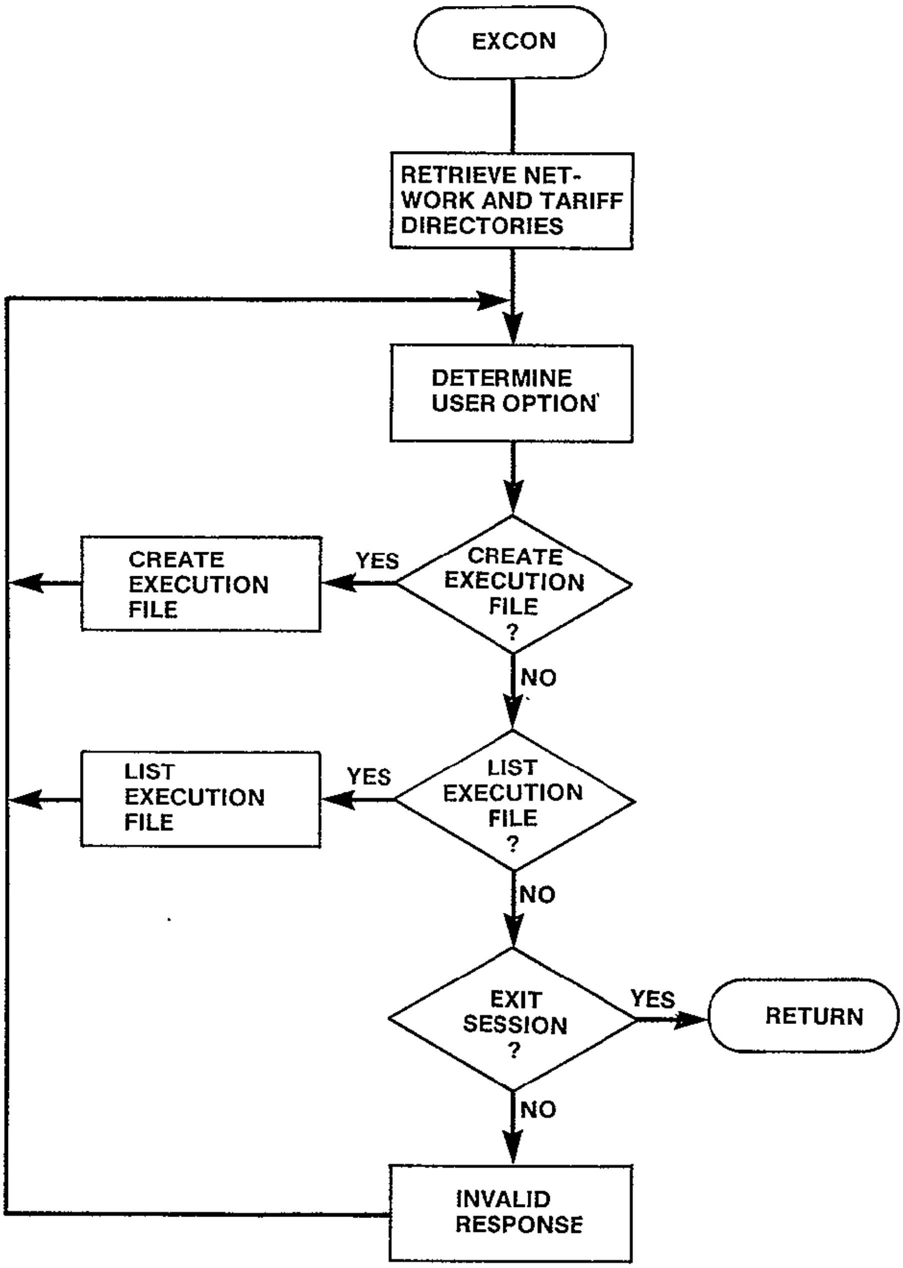


Figure 3-19. EXCON Logic Flow

3.3.4 XCREAT Module

```
   SUBROUTINE XCREAT(CONT)

PURPOSE
     QUERY THE USER AND BUILD FROM THE RESPONSES THE EXECUTION FILE

INPUT ARGUMENTS
     NONE

OUTPUT ARGUMENTS
     CONT          LOGICAL       INDICATES THAT AN EXECUTION CONTROL FILE
                                 WAS SUCCESSFULLY CREATED

DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
     RUNID         /INPEXC/      S
     MAXRST        /INPEXC/      U
     NRSTRT        /INPEXC/      S
     OPTN          /INPEXC/      S
     NETFIL        /INPEXC/      S
     NTRF          /INPEXC/      S
     FILNAM        /INPEXC/      S
     MAXTRF        /INPEXC/      U
     NOUT          /INPEXC/      U
     OUTCNT        /INPEXC/      S
     TFILES        /TARFIL/      U
     TARDEF        /TARFIL/      U
     NTFIL         /TARFIL/      U
     DEBUG         /LUN/         U
     LEVEL         /INPEXC/      S

LOCAL VARIABLES
     NULL          R*8           RESPONSE OF <CR> TO REQUEST
     TEMP          R*4           NUMERIC RESPONSE TO QUERY REQUIRING
                                 DECIMAL
     N             I*4           POINTER TO NEXT SLOT AVAILABLE IN ARRAY
                                 CONTAINING TARIFF NAMES
     I             I*4           INDEX TO LOOP WHICH ACCUMULATES DATA FOR
                                 NRSTRT PROBLEMS
     M             I*4           NUMBER OF TARIFFS SPECIFIED FOR CURRENT
                                 PROBLEM
     J             I*4           LOOP INDEX FOR NUMBER OF TARIFFS FOR
                                 CURRENT PROBLEM
     K,L           I*4           LOOP INDEX
     NTAB          I*4           OUTPUT OPTION SUPRESSED
     INDEX         I*4           POINTER TO TARIFF NAME FOUND IN TARIFF
                                 DIRECTORY - IF 999 THEN NOT IN DIRECTORY
     IFIL          I*4           LOOP INDEX USED IN SEARCH OF TARIFF
                                 DIRECTORY
     NETWRK        I*4           CONSTANT - NETWORK DIRECTORY
     DEFIND        I*4           CONSTANT - FILE IS DEFINED
     START         I*4           BEGINNING OF LIST OF TARIFFS SPECIFIED
                                 FOR CURRENT PROBLEM WITHIN FILNAM
```

END	I*4	END OF LIST OF TARIFFS SPECIFIED FOR CURRENT PROBLEM
IOPT	I*4	OPTION FOR CURRENT PROBLEM
ITAR	I*4	TARIFF TYPE
ERROR	LOGICAL	TARIFF FILE SPECIFIED IS ALREADY IN LIST FOR THIS PROBLEM
PRSTAR	R*8	CONSTANT - TARIFF NAMES OF PRESTORED TARIFFS
NO	I*4	CONSTANT - RESPONSE OF 'N' FOR NO
IYES	I*4	CONSTANT - RESPONSE OF 'Y' FOR YES
IANS	I*4	RESPONSE OF YES OR NO
IT	I*4	CONSTANT /'T'/ RETURN TO INPUT MENU
IR	I*4	CONSTANT /'R'/ REENTER
MAXINT	R*4	MAXIMUM INTEGER

SUBPROGRAMS CALLED
FILDEF
NLSTDR
TLSTDR
EXCREA

ERRORS
FATAL
NONE
NONFATAL
NONE

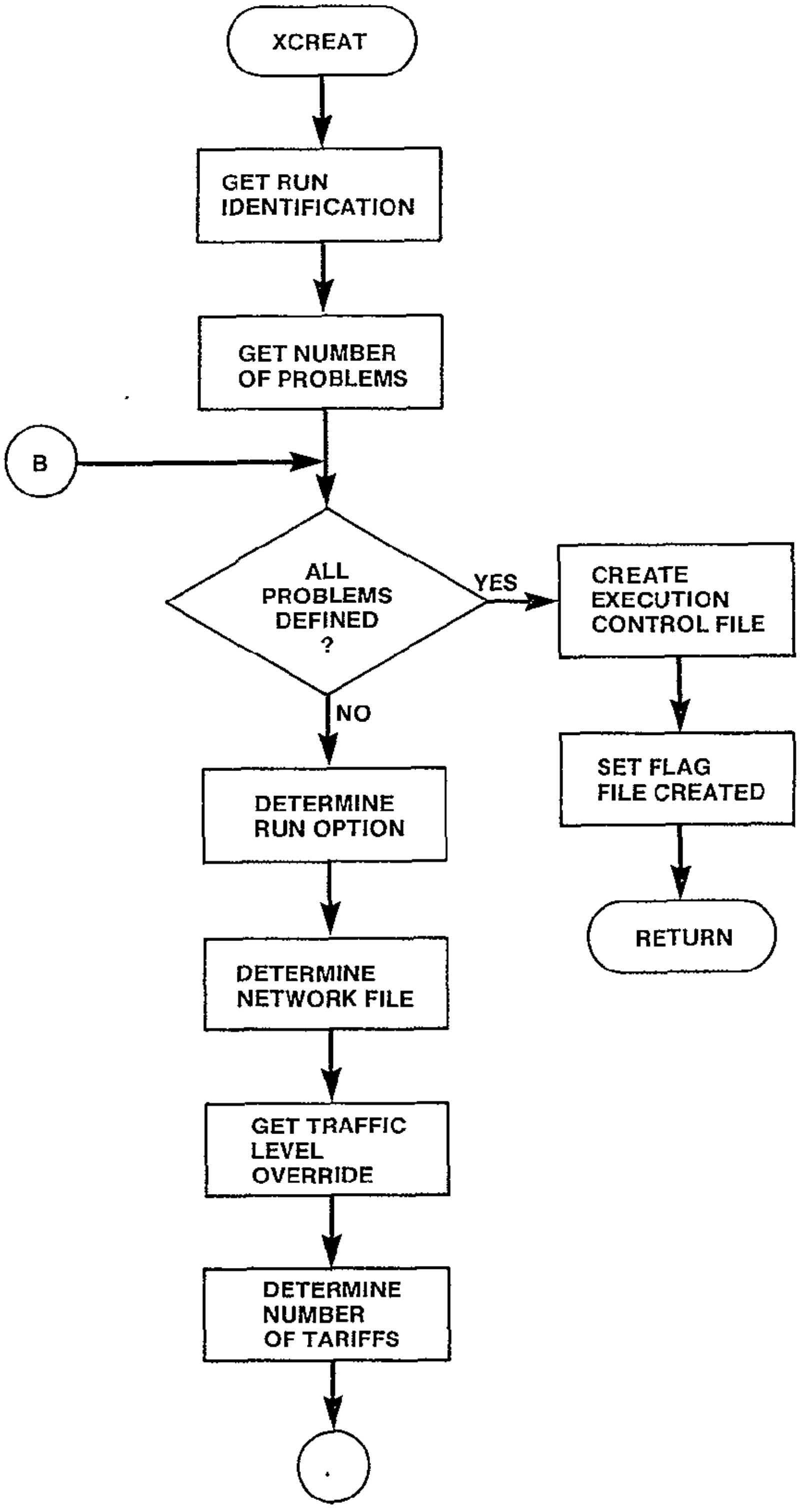


Figure 3-20. XCREAT Logic Flow (Sheet 1 of 2)

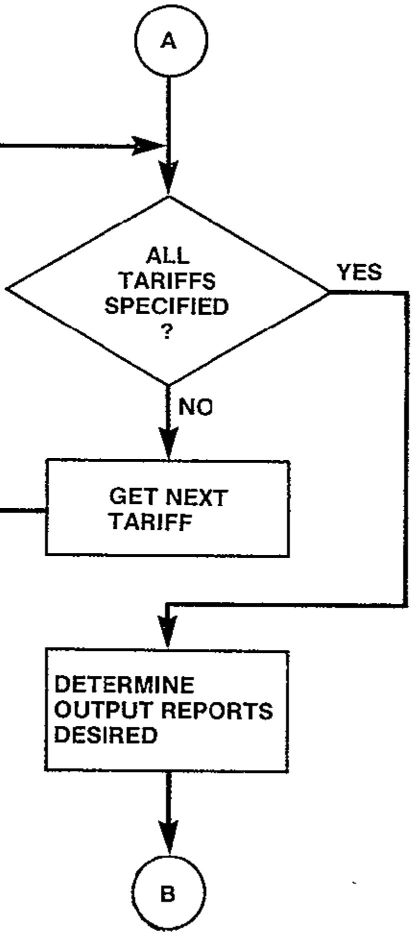


Figure 3-20. XCREAT Logic Flow (Sheet 2 of 2)

3.3.5 EXCREA Module

```
     SUBROUTINE EXCREA

  PURPOSE
       CREATE THE EXECUTION CONTROL FILE

  INPUT ARGUMENTS
       NONE

  OUTPUT ARGUMENTS
       NONE

  DATA STRUCTURES
       (U - USED, S - DEFINED, R - READ)
       HEXEC          /HEADRS/      U
       NETFIL         /INPEXC/      U
       FILNAM         /INPEXC/      U
       RUNID          /INPEXC/      U
       NRSTRT         /INPEXC/      U
       NOUT           /INPEXC/      U
       OPTN           /INPEXC/      U
       NTRF           /INPEXC/      U
       OUTCNT         /INPEXC/      U
       EXCUTE         /LUN/         U
       DEBUG          /LUN/         U
       LEVEL          /INPEXC/      U

  LOCAL VARIABLES
       BEGIN          I*4        INDEX OF FIRST TARIFF FILE TO
                                 BE READ FROM FILNAM FOR CURRENT
                                 PROBLEM
       END            I*4        INDEX OF LAST TARIFF FILE TO BE READ
                                 FROM FILNAM FOR CURRENT PROBLEM
       I,J            I*4        LOOP INDICES
       ASTRX          R*8        CONSTANT '********' TO SEPARATE
                                 PROBLEM DEFINITIONS ON EXCUTE
       ITOT           I*4        NUMBER OF TARIFF FILES IN ENTIRE RUN

  SUBPROGRAMS CALLED
       NONE

  ERRORS
       FATAL
         NONE
       NONFATAL
         NONE
```

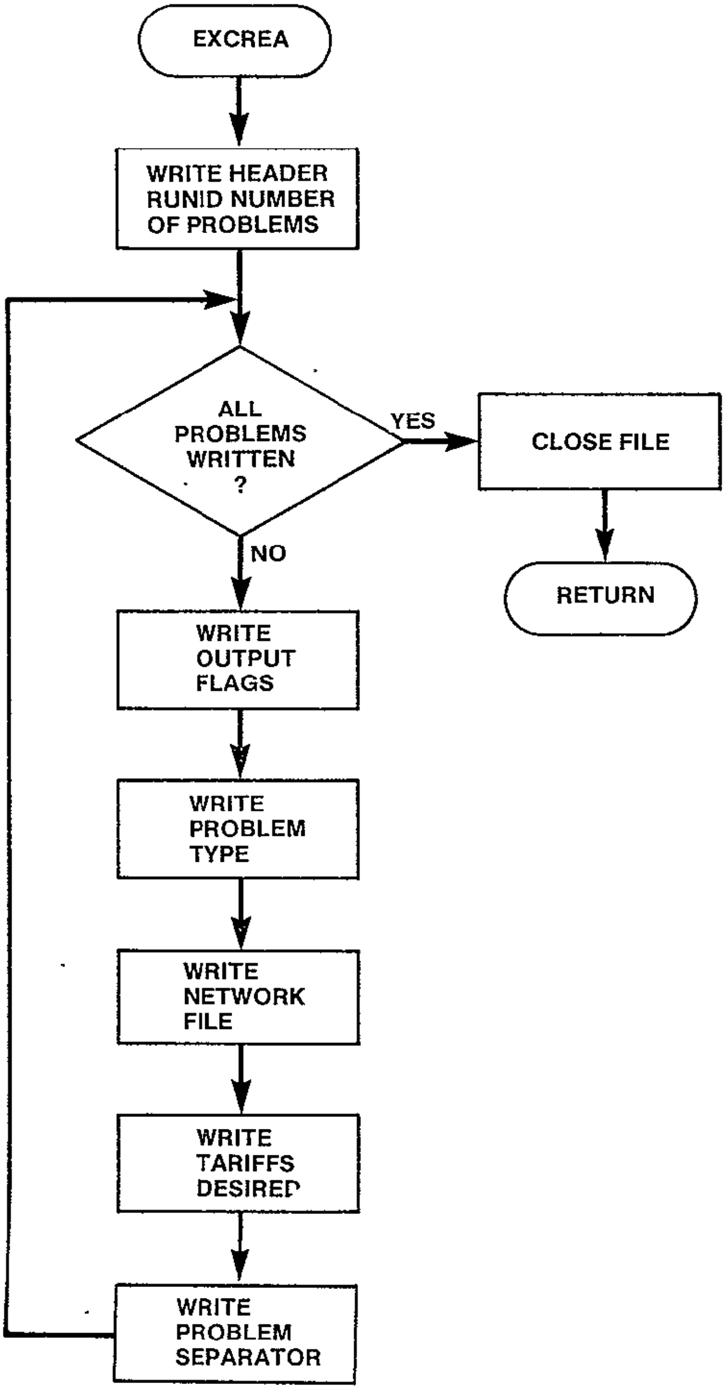


Figure 3-21. EXCREA Logic Flow

3.3.6 XLIST Module

SUBROUTINE XLIST

PURPOSE

LIST CURRENT EXECUTION CONTROL FILE

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

EXCUTE	/LUN/	U
HEXEC	/HEADRS/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

HEADERS	R*8	FILE HEADER
ID	R*8	RUN ID
NPROB	I*4	NUMBER OF RESTARTS
I,K	I*4	LOOP INDICES
FLG(5)	I*4	OUTPUT FLAGS
IDX	I*4	WHICH OUTPUT OPTION
OPT(2)	I*4	CONSTANT OUTPUT OPTIONS
OUTTYP(5)	R*5	CONSTANT OUTPUT TYPE
OPTN	I*4	RUN TYPE
DESCP(5)	C*16	CONSTANT RUN TYPES
FILNAM	R*8	FILENAME
NFIL	I*4	NUMBER OF TARIFFS IN CURRENT PROBLEM
ASTRX	R*8	WORD OF ****** SEPARATING PROBLEM SETS
IANS	I*4	ANSWER OF <CR>

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

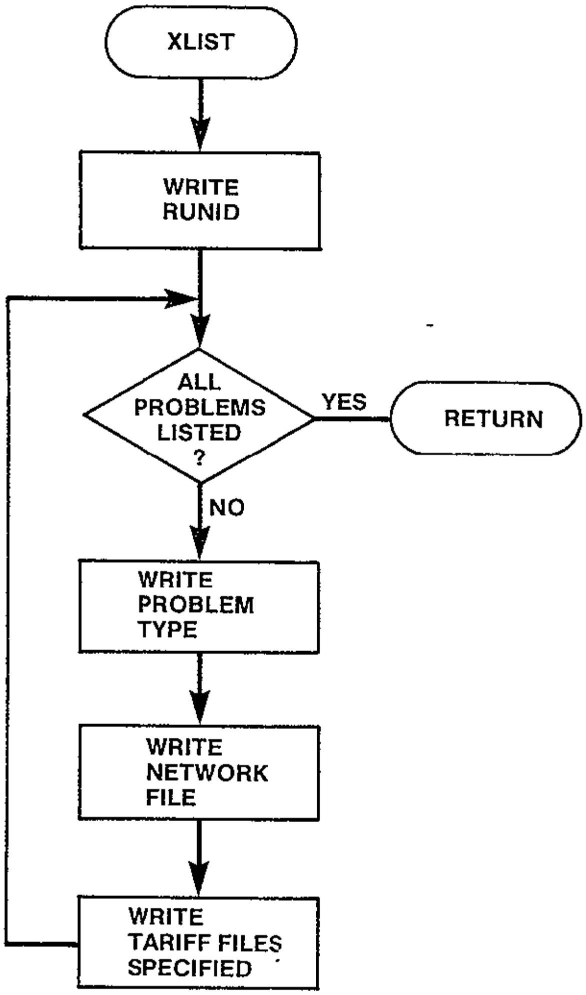


Figure 3-22. XLIST Logic Flow

3.4 NETCON Description

The NETCON submodule allows the user to specify a network to be analyzed by the CNDC model. It is called by INPUT when the user selects the network construction option. This submodule also provides the user with the capability to manage a set of network files for use in multiple program runs. The user is provided the options of adding files to the set, deleting files from the set, and reviewing the contents of the stored files in the set. Upon entry into this submodule, a menu of options is displayed and the program accepts the users choice from the following options:

1 Create a network file

2 Delete a network file

3 List a network file or directory

4 Exit from network session

The user may remain in NETCON as long as he likes. After returning from the control of the create, delete, or list options, the initial NETCON menu is redisplayed and any option may again be selected. The exit option must be selected in order to get out of NETCON and pass control back to the INPUT module. Figure 3-23 contains the hierarchy chart of the modules that make up NETCON.

When the user is creating a network he may specify the prestored nodes desired in his network in one of four ways.

1 ALL

2 ALL EXCEPT

3 ONLY

4 PERCENT

The method chosen should be that method that requires the least amount of input. The ALL option creates a network with all of the prestored nodes. The ALL EXCEPT option creates a network with all the prestored nodes except those specified by the user. When using the ONLY option, only those prestored nodes specified will be included. The PERCENT option will build a network from those nodes busiest to least busy that make up the specified percent of the traffic. Once the prestored nodes have been specified in one of the above manners, the user may specify up to 350 addtional, non-prestored nodes.

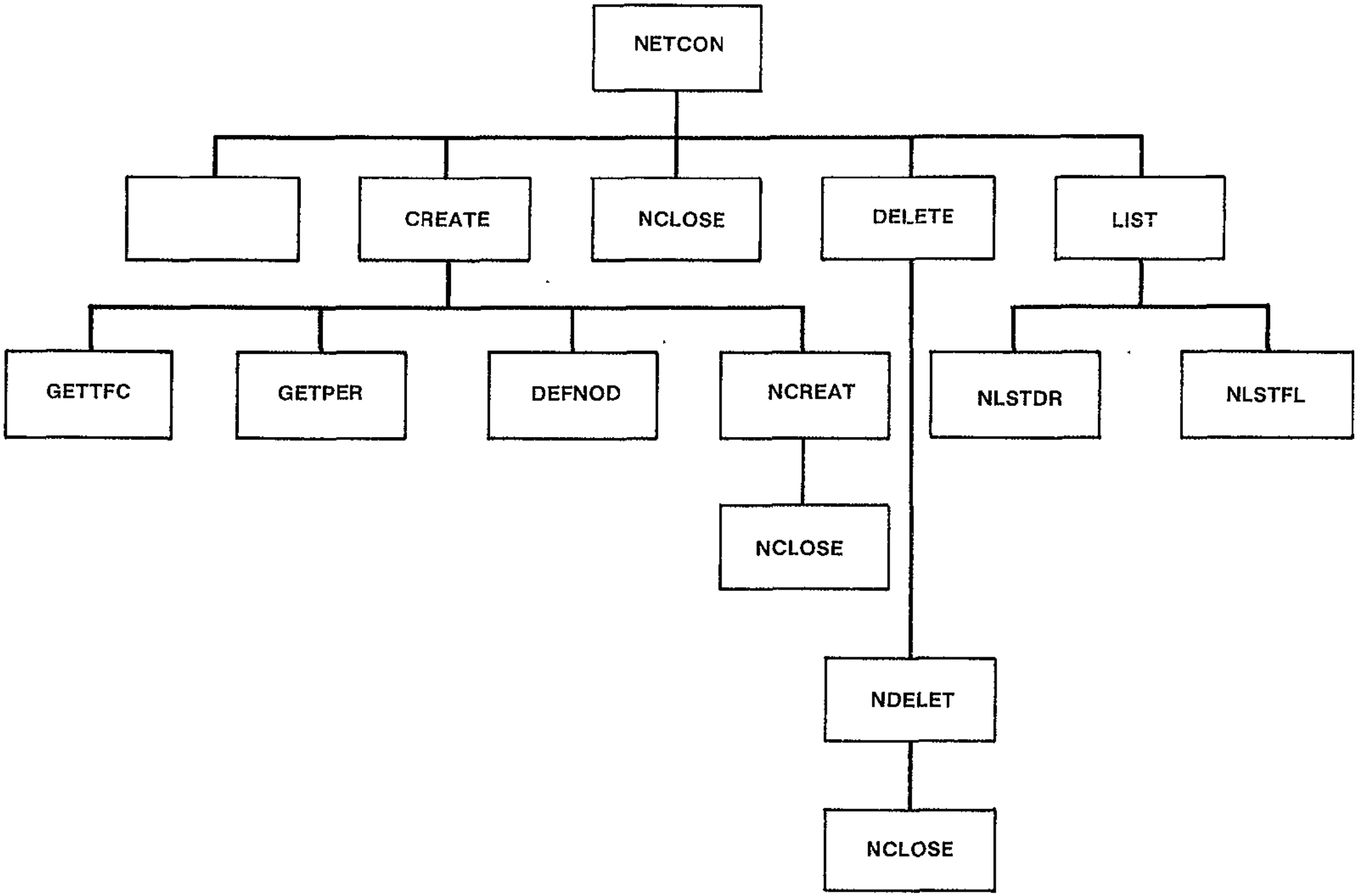


Figure 3-23. NETCON Hierarchy Chart

3.4.1 NETCON Module

```
   SUBROUTINE NETCON

PURPOSE
     MAINTAIN NETWORK FILES FOR USER

INPUT ARGUMENTS
     NONE

OUTPUT ARGUMENTS
     NONE

DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
       NONE

LOCAL VARIABLES
     IOPT          I*4          MENU OPTION SELECTED

SUBPROGRAMS CALLED
     NINIT
     CREATE
     DELETE
     LIST
     NCLOSE

ERRORS
     FATAL
       NONE
     NONFATAL
       NONE
```

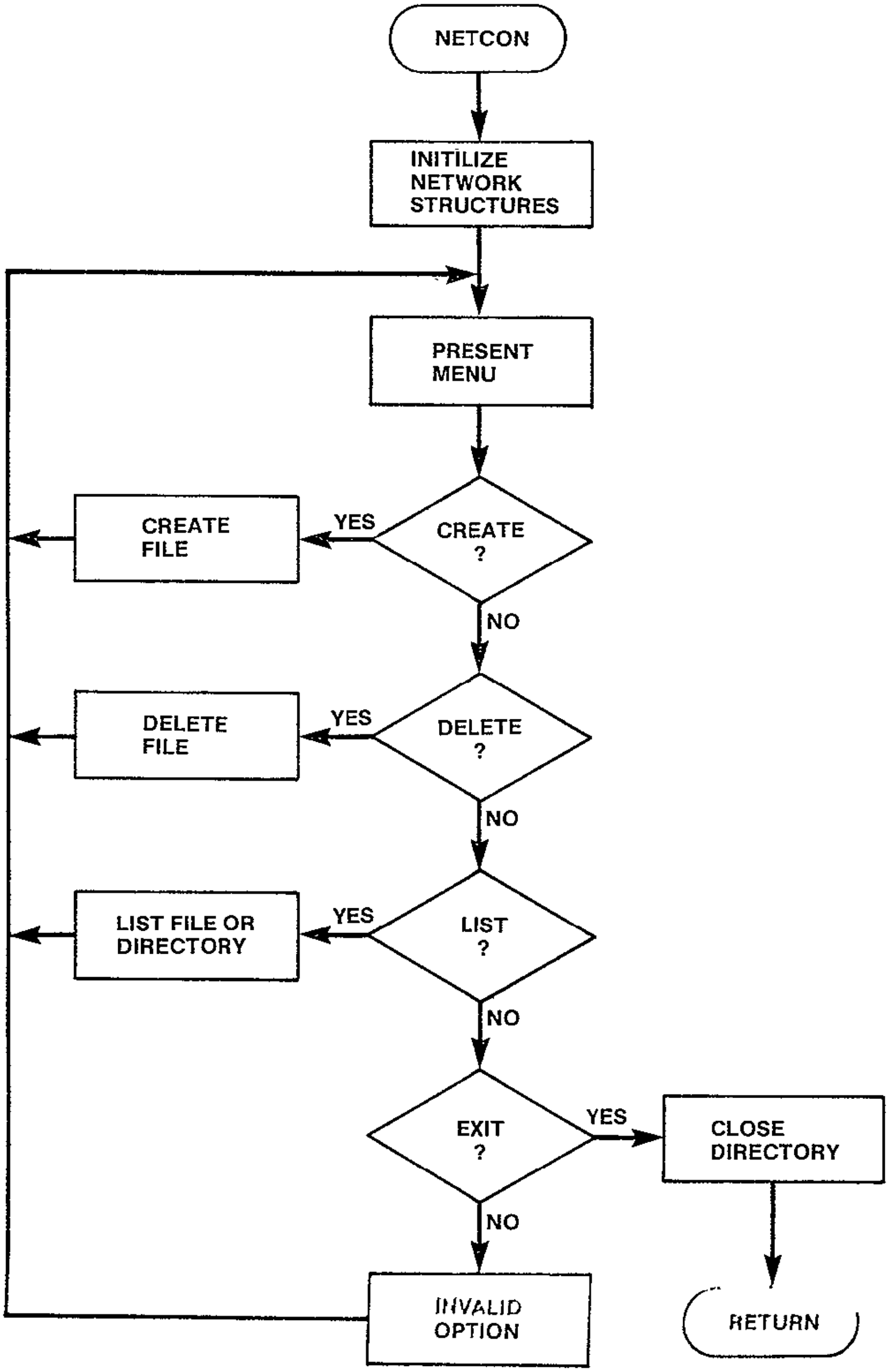


Figure 3-24. NETCON Logic Flow

3.4.2 NINIT Module

SUBROUTINE NINIT

PURPOSE

PERFORM INITIALIZATION FOR THE INPUT PROGRAMS NETWORK CONSTRUCTION OPTION

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NFILES	/NETFIL/	S
NNFIL	/NETFIL/	S
NETDEF	/NETFIL/	U
DEBUG	/LUN/	U
NETDIR	/LUN/	U
HNET	/HEADRS/	U

LOCAL VARIABLES

HEADER(S)	R*8	FILE HEADER
MAXNET	I*4	CONSTANT /20/ MAXIMUM NUMBER OF NETWORK FILES EXPECTED IN NETWORK
I	I*4	LOOP INDEX

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

3010	FILE HEADER OF NETWORK DIRECTORY NOT AS EXPECTED
3020	NUMBER OF FILES IN DIRECTORY EXCEEDS THE CAPACITY OF THE ARRAYS IN /NETFIL/

NONFATAL

NONE

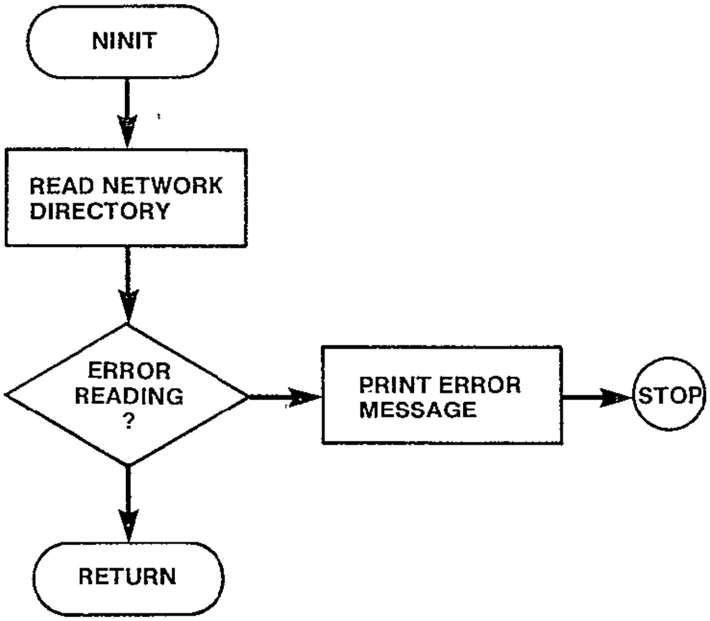


Figure 3-25. NINIT Logic Flow

3.4.3 CREATE Module

```
      SUBROUTINE CREATE

   PURPOSE
        QUERY USER ABOUT ENTRIES TO MAKE IN A USER
        DEFINED NETWORK DEFINITION FILE

   INPUT ARGUMENTS
        NONE

   OUTPUT ARGUMENTS
        NONE

   DATA STRUCTURES
        (U - USED, S - DEFINED, R - READ)
        CROPT     /INPNET/      S
        NNDS      /INPNOD/      S
        CODE      /INPNOD/      S
        NPRNDS    /PRSNDS/      U
        TOTNDS    /INPNET/      S
        PERCNT    /INPNET/      S
        LVLTRF    /INPNET/      S
        VC        /INPNET/      S
        HC        /INPNET/      S
        MAXUSR    /INPNET/      U
        NTRFC     /INPNET/      S
        CODEL     /INPNOD/      S
        CODER     /INPNOD/      S
        VCIRTS    /INPNET/      S
        TRAFIC    /TRFC/        U
        DEBUG     /LUN/         U
        MAXNDS    /INPNOD/      U

   LOCAL VARIABLES
        FILNAM    R*8           NAME OF NETWORK FILE TO BE CREATED
        IANS      I*4           RESPONSE OF USER AFTER HE HAS ENTERED
                                INVALID RESPONSE TO REQUESTED DATA
        IT        I*4           CONSTANT  /T/  RETURN TO INPUT MENU
        IR        I*4           CONSTANT  /R/  REENTER
        NO        I*4           CONSTANT  /N/  NO
        IYES      I*4           CONSTANT  /Y/  YES
        VERIFY    L             IF USER WANTS RESPONSES ECHOED BACK WITH
                                OPPORTUNITY TO REJECT
        ITEMP     I*4           TEMPORARY LOCATION OF INTEGER RESPONSES
        NULL      I*4           CONSTANT  <CR>
        FOUND     L             INDICATES IF CODE JUST ENTERED HAS
                                ALREADY BEEN ENTERED
        I         I*4           LOOP INDEX
        TEMP      R*4           TEMPORARY LOCATION OF REAL RESPONSE
        BIGNUM    R*4           CONSTANT  LARGE NUMBER
        NADD      I*4           NUMBER OF ADDITIONAL CITIES ADDED
```

BEGIN	I*4	START LOCATION WITHIN CODE FOR ADDITIONAL CITIES
IVC	I*4	VERTICAL COORDINATE
IHC	I*4	HORIZONTAL COORDINATE
NFROM	I*4	WHEN REQUESTING INDIVIDUAL TRAFFIC VOLUMES THE FROM CODE
NTO	I*4	WHEN REQUESTING INDIVIDUAL TRAFFIC VOLUMES THE TO CODE
NTFC	I*4	NUMBER OF VOICE CIRCUITS FORM NFROM TO NTO
TRFOPT	L	INDICATES IF LISTING OF TRAFFIC TABLE DESIRED
MAXINT	R*4	MAXIMUM INTEGER*4
FILSTT	I*4	FILE STATUS 1 INVALID NAME 2 UNAVAILABLE 3 IN USE
IFRM	I*4	NUMBER OF FROM NODE
ITO	I*4	NUMBER OF TO NODE
CVC	I*4	NUMBER OF VOICE CIRCUITS BETWEEN IFRM, ITO IN TRAFIC TABLE
TVC	I*4	TOTAL ADDITIONAL TRAFFIC SPECIFIED BETWEEN IFRM AND ITO
IEND	I*4	END OF LOOP
SKIP	L	IF TRUE - DONT ENTER ADDITIONAL TRAFFIC JUST SPECIFIED

SUBPROGRAMS CALLED

FILDEF
SMSA
GETPER
DEFNOD
USRNET
RVTFC
NCREAT
GETTFC
MNMPTR

ERRORS

FATAL
NONE
NONFATAL
NONE

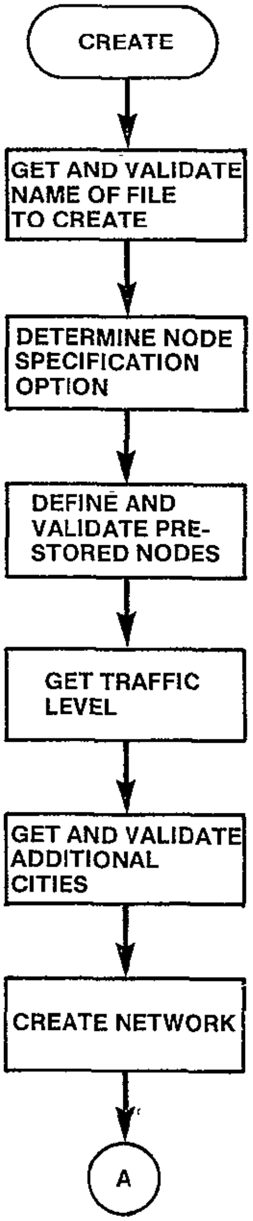

CREATE
GET AND VALIDATE NAME OF FILE TO CREATE
DETERMINE NODE SPECIFICATION OPTION
DEFINE AND VALIDATE PRE-STORED NODES
GET TRAFFIC LEVEL
GET AND VALIDATE ADDITIONAL CITIES
CREATE NETWORK
A

Figure 3-26. CREATE Logic Flow (Sheet 1 of 2)

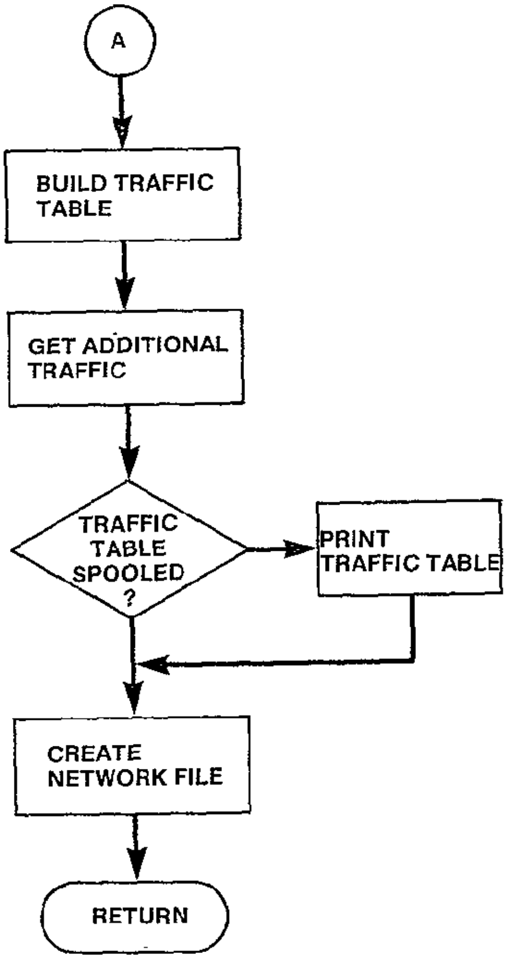


Figure 3-26. CREATE Logic Flow (Sheet 2 of 2)

3.4.4 GETTFC Module

SUBROUTINE GETTFC

PURPOSE

BUILD THE TRAFFIC TABLE FOR THE USER DEFINED NETWORK INCLUDING ONLY THAT TRAFFIC FROM THE PRESTORED TRAFFIC TABLE

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

TOTNDS	/INPNET/	U
LVLTRF	/INPNET/	U
TRFTBL	/LUN/	U
TRAFIC	/TRFC/	S
HTFC	/HEADRS/	U
NPRNDS	/PRSNDS/	U
RTCNTR	/RNODES/	S
PRNDS	/PRSNDS/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

HEADER(2)	R*8	HEADER OF THE PRESTORED TRAFFIC TABLE
NEL	I*4	NUMBER OF ELEMENTS PER COLUMN IN TRAFFIC TABLE
FACT	I*4	NORMALIZATION FACTOR
LSTCOL	I*4	LAST COLUMN OF PRESTORED TRAFFIC TABLE READ
CURCOL	I*4	COLUMN WITHIN TRAFFIC TABLE BEING DEFINED
I,J	I*4	LOOP INDICES
NSKIP	I*4	NUMBER OF COLUMNS IN PRESTORED TRAFFIC TABLE TO SKIP TO GET TO NEXT RECORD TO READ
TRF(350)	I*4	NEXT RECORD FROM TRFTBL CONTAINING VALUES OF CURRENT COLUMN FROM TRAFFIC TABLE
M	I*4	NEXT USER DEFINED NODE IN COLUMN
N	I*4	NEXT ITEM IN RECORD
VCCNV	R*4	CONVERSION FACTOR TO COMPUTE NUMBER OF CIRCUITS FOR EACH NODE PAIR
WHO	I*2	TABLE WHICH IDENTIFIES EACH NODE WITHIN THE USER NETWORK WHICH IS IN THE PRE-STORED NETWORK BY THE RELATIVE POSITION OF THAT NODE WITHIN THE PRESTORED NETWORK
CURROW	I*4	CURRENT ROW WITHIN TRAFFIC TABLE

SUBPROGRAMS CALLED

    TRFSKP
    WRTTRF

ERRORS

    FATAL
      3030   FILE HEADER OR PRESTORED TRAFFIC TABLE NOT AS EXPECTED
    NONFATAL
      NONE

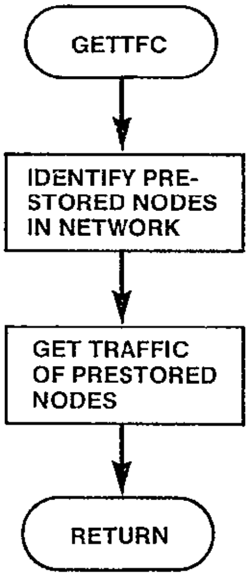

GETTFC
IDENTIFY PRE-STORED NODES IN NETWORK
GET TRAFFIC OF PRESTORED NODES
RETURN

Figure 3-27. GETTFC Logic Flow

3.4.5 GETPER Module

SUBROUTINE GETPER

PURPOSE

BUILD CODE ARRAY OF NODES FROM TRFVOL UP TO PERCNT SPECIFIED

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

PERCNT	/INPNET/	U
TRFVOL	/LUN/	U
HVOL	/HEADRS/	U
CODE	/INPNOD/	S
NNDS	/INPNOD/	S
TOTNDS	/INPNET/	S
DEBUG	/LUN/	U

LOCAL VARIABLES

FOUND	LOGICAL	INDICATES IF PERCENT FOUND IN INPUT TABLE
HEADER(2)	R*8	HEADER RECORD READ FROM FILE
NXTNOD	I*4	NODE READ FROM TRFVOL
ORDR	I*4	POSITION OF NXTNOD IN PRESTORED NETWORK
PRCTG	R*8	CUMULATIVE PERCENTAGE OF NETWORK UP TO NXTNOD
NENTRY	I*4	NUMBER OF ENTRIES IN TRFVOL TABLE
PCNT	R*8	PERCNT NORMALIZED
I	I*4	LOOP INDEX

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

3040	FILE HEADER OF TRFVOL NOT AS EXPECTED
3050	PERCNT NOT FOUND IN THE TABLE IN TRFVOL

NONFATAL

NONE

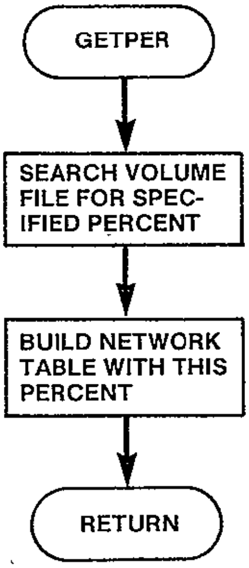

GETPER
SEARCH VOLUME FILE FOR SPECIFIED PERCENT
BUILD NETWORK TABLE WITH THIS PERCENT
RETURN

Figure 3-28. GETPER Logic Flow

3.4.6 DEFNOD Module

SUBROUTINE DEFNOD

PURPOSE

BUILD USER DEFINED NETWORK IN RTCNTR ARRAY AND BUILD NETWORK DIRECTORY

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

TOTNDS	/INPNET/	U
NNDS	/INPNOD/	U
CODE	/INPNOD/	U
CROPT	/INPNET/	U
NPRNDS	/PRSNDS/	U
PRNDS	/PRSNDS/	U
RTCNTR	/RNODES/	S
V	/RNODES/	S
H	/RNODES/	S
VC	/INPNET/	U
HC	/INPNET/	U
NPBLK	/RNODES/	S
NDIR	/RNODES/	S
DRNODE	/RNODES/	S
NNODES	/RUN/	S
LVLTRF	/INPNET/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

IPRS	I*4	POINTER TO WITHIN PRNDS ARRAY
IUSR	I*4	POINTER TO WITHIN ORDR ARRAY
IRTC	I*4	POINTER TO WITHIN RTCNTR ARRAY
PTRUSR	I*4	POINTER TO WITHIN CODE, VC, HC ARRAYS
ORDER (600)	I*4	POSITION OF EACH ELEMENT WITHIN CODE ARRAY SORTED
ONLY	I*4	CONSTANT /3/ OPTION OF ONLY
PRCNT	I*4	CONSTANT /4/ OPTION OF PERCENT
OMIT	I*4	CONSTANT /2/ OPTION OF ALL EXCEPT
I	I*4	LOOP INDEX
INDX	I*4	WHEN CREATING RTCNTR DIRECTORY NUMBER OF RTCNTR ITEM TO GO INTO NEXT POSITION IN DIRECTORY

SUBPROGRAMS CALLED

SORT1

```
ERRORS
     FATAL
       3060        TOTNDS VALUE NOT EQUAL TO NUMBER OF ITEMS IN RTCNTR
                   ARRAY
     NONFATAL
       NONE
```

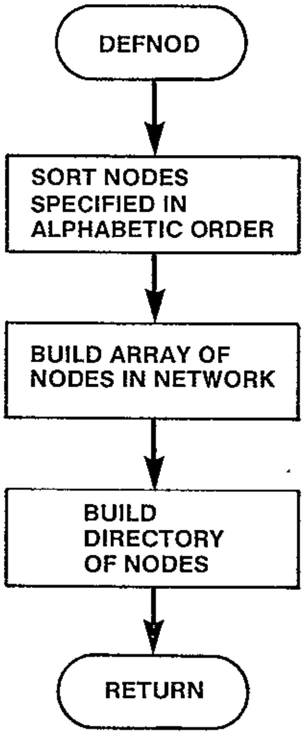

DEFNOD
SORT NODES SPECIFIED IN ALPHABETIC ORDER
BUILD ARRAY OF NODES IN NETWORK
BUILD DIRECTORY OF NODES
RETURN

Figure 3-29. DEFNOD Logic Flow

3.4.7 NCREAT Module

SUBROUTINE NCREAT (FILNAM, TRFOPT)

PURPOSE

CREATE A NEW NETWORK DEFINITION IN SPECIFIED FILE

INPUT ARGUMENTS

FILNAM	R*8	NAME OF NETWORK FILE TO CREATE
TRFOPT	L	PRINT TRAFFIC TABLE OF .TRUE.

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NNFIL	/NETFIL/	U
NFILES	/NETFIL/	U
NETDEF	/NETFIL/	S
LUNNET	/LUN/	U
TRFNDS	/LUN/	U
UNET	/HEADRS/	U
RTCNTR	/RNODES/	U
V	/RNODES/	U
H	/RNODES/	U
LVLTRF	/INPNET/	U
CODEL	/INPNOD/	U
CODER	/INPNOD/	U
TRAFIC	/TRFC/	S
VCIRTS	/LUN/	U
TOTNDS	/INPNET/	U
NTRFC	/INPNET/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

I	I*4	LOOP INDEX
FOUND	L	FILNAM FOUND IN DIRECTORY
UNIT	I*4	LOGICAL UNIT OF NETWORK FILE TO BE CREATED
EMPTY	I*4	CONSTANT /0/ FILE UNDEFINED
PCODE	I*4	CODE OF RATE CENTER READ FROM TRFNDS
PV	I*4	VERTICAL COORDINATE OF RATE CENTER READ FROM TRFNDS
PH	I*4	HORIZONTAL COORDINATE OF CENTER READ FROM TRFNDS
ORDR(600)	I*4	ORDER OF SORTED CODE ARRAY
FROM	I*4	FROM NODE WHEN SPECIFYING TRAFFIC
TO	I*4	TO NODE WHEN SPECIFYING TRAFFIC
SPOOL	I*4	LOGICAL UNIT NUMBER TO SPOOL TRAFFIC TABLE FOR THIS USER DEFINED NETWORK
NEXT	I*4	NEXT ENTRY OF TRAFFIC LEVELS IN ALPHABETIC ORDER

NETNUM	I*4	NUMBER OF NETWORK FILE
C1,C2,C3	I*2	CHARACTERS THAT MAKE UP NETWORK FILE NUMBER

SUBPROGRAMS CALLED

TRFSKP
SORT2
MNMPTR
WRTTRF
NCLOSE
INTCHR

ERRORS

FATAL

3070 FILE SPECIFIED FOR NETWORK FILE ALREADY DEFINED
3080 FILE SPECIFIED FOR NETWORK FILE NOT IN DIRECTORY

NONFATAL

NONE

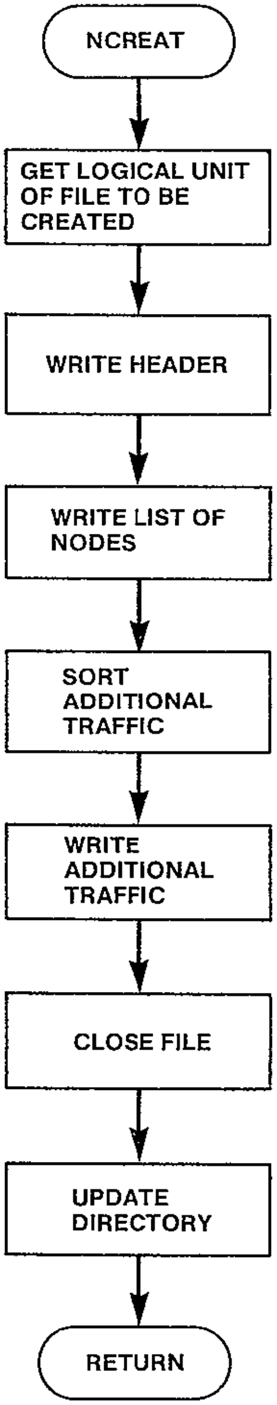


Figure 3-30. NCREAT Logic Flow

3.4.8 DELETE Module

```
        SUBROUTINE DELETE

     PURPOSE
          DELETE A NETWORK FILE

     INPUT ARGUMENTS
          NONE

     OUTPUT ARGUMENTS
          NONE

     DATA STRUCTURES
          (U - USED, S - DEFINED, R - READ)
          DEBUG          /LUN/      U

     LOCAL VARIABLES
          FILNAM         R*8        NAME OF FILE TO DELETE
          IANS           I*4        USER RESPONSE
          IYES           I*4        CONSTANT /'Y'/
          NO             I*4        CONSTANT /'N'/
          USED           I*4        CONSTANT  /3/ FILE IN USE

     SUBPROGRAMS CALLED
          FILDEF
          NDELET

     ERRORS
          FATAL
            NONE
          NONFATAL
            NONE
```

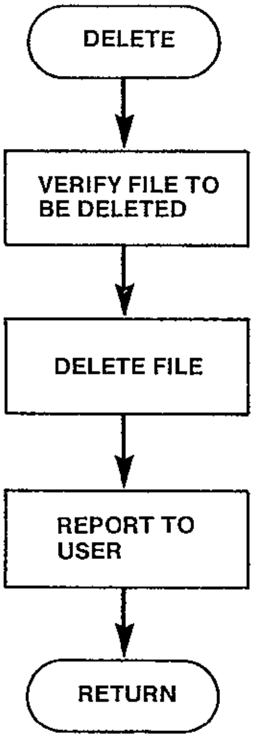


Figure 3-31. DELETE Logic Flow

3.4.9 NDELET Module

```
          SUBROUTINE NDELET(FILNAM)

      PURPOSE
          DELETE THE NETWORK FILE SPECIFIED

      INPUT ARGUMENTS
          FILNAM            R*8          NAME OF NETWORK FILE TO BE DELETED

      OUTPUT ARGUMENTS
          NONE

      DATA STRUCTURES
          (U - USED, S - DEFINED, R - READ)
          NNFIL     /NETFIL/             U
          NFILES    /NETFIL/             U
          NETDEF    /NETFIL/             U
          DEBUG     /LUN/                U

      LOCAL VARIABLES
          I                 I*4          LOOP INDEX
          FOUND             L            INDICATES IF FILNAM FOUND IN DIRECTORY

      SUBPROGRAMS CALLED
          NCLOSE

      ERRORS
          FATAL
            3090        FILE NAME TO DELETE NOT IN DIRECTORY
          NONFATAL
            3510        FILE NAME TO DELETE HAS ALREADY BEEN DELETED
```

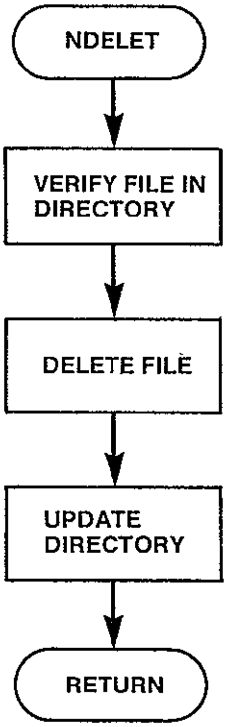


Figure 3-32. NDELET Logic Flow

3.4.10 LIST Module

```
   SUBROUTINE LIST

PURPOSE
     LIST A NETWORK FILE OR THE NETWORK DIRECTORY ON SYSOUT

INPUT ARGUMENTS
     NONE

OUTPUT ARGUMENTS
     NONE

DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
     DEBUG          /LUN/      U

LOCAL VARIABLES
     FILNAM         R*8        NAME OF NETWORK FILE TO LIST
     NULL           R*8        CONSTANT /'     '/ INDICATES <CR>
                               RESPONSE
     USED           I*4        CONSTANT  /3/  FILE DEFINED

SUBPROGRAMS CALLED
     NLSTDR
     NLSTFL
     FILDEF

ERRORS
     FATAL
       NONE
     NONFATAL
       NONE
```

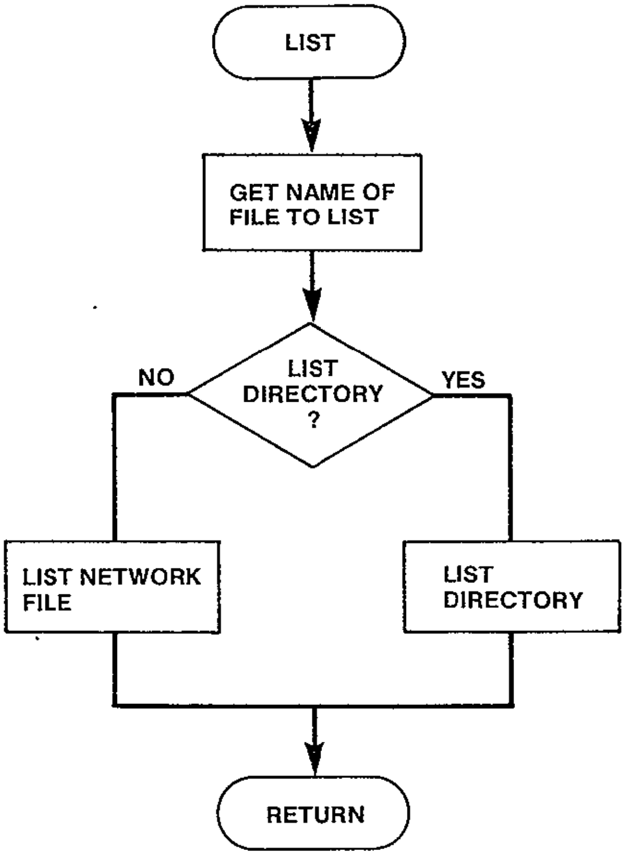


Figure 3-33. LIST Logic Flow

3.4.11 NLSTDR Module

SUBROUTINE NLSTDR

PURPOSE
LIST THE NETWORK DIRECTORY

INPUT ARGUMENTS
NONE

OUTPUT ARGUMENTS
NONE

DATA STRUCTURES
(U - USED, S - DEFINED, R - READ)

NNFIL	/NETFIL/	U
NETDEF	/NETFIL/	U
NFILES	/NETFIL/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

I	I*8	LOOP INDEX
STDES	R*8	ALPHA DESCRIPTION OF FILE STATUS
USED	R*8	CONSTANT - CHARACTER STRING 'UNUSED'
IANS	I*4	ANSWER OF <CR>

SUBPROGRAMS CALLED
NONE

ERRORS
FATAL
NONE
NONFATAL
NONE

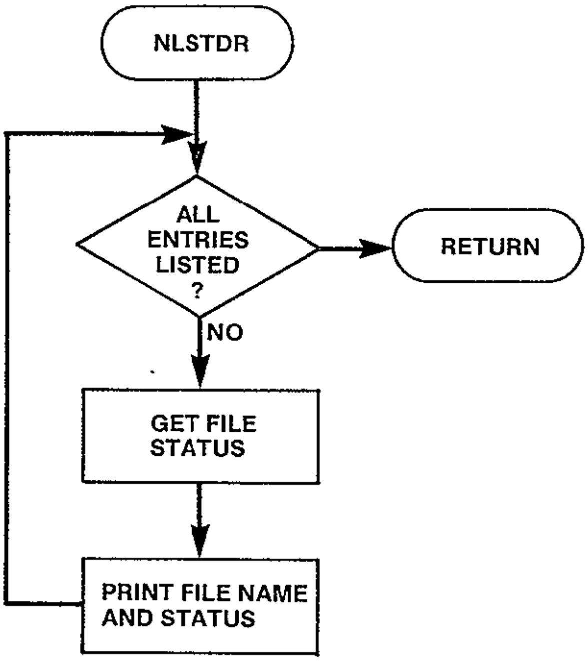


Figure 3-34. NLSTDR Logic Flow

3.4.12 NLSTFL Module

SUBROUTINE NLSTFL (FILNAM)

PURPOSE

LIST THE CONTENTS OF THE NETWORK FILE SPECIFIED

INPUT ARGUMENTS

FILNAM	R*8	FILE TO BE LISTED

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NNFIL	/NETFIL/	U
NFILES	/NETFIL/	U
NETDEF	/NETFIL/	U
LUNNET	/LUN/	U
UNET	/HEADRS/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

HEADER(2)	R*8	HEADER RECORD OF FILE
FOUND	LOGICAL	FILNAM FOUND IN DIRECTORY
CNODES	I*4	NUMBER OF NODES SPECIFIED IN THIS NETWORK
CODE	I*4	UNIQUE FOUR CHARACTER CODE FOR EACH NODE IN THE NETWORK
CODEL	I*4	FOUR CHARACTER CODE OF NODE WHERE TRAFFIC ORIGINATES
CODER	I*4	FOUR CHARACTER CODE OF NODE WHERE TRAFFIC TERMINATES
HC	I*4	HORIZONTAL COORDINATE OF NODE
I,J	I*4	LOOP INDICES
NTRFC	I*4	NUMBER OF TRAFFIC TABLE ADDITIONS SPECIFIED IN FILE
TRFLVL	I*4	TRAFFIC LEVEL
UNIT	I*4	LOGICAL UNIT NUMBER OF NETWORK FILE
VC	I*4	VERTICAL COORDINATE OF NODE
VCIRTS	I*4	AMOUNT OF TRAFFIC FROM CODEL TO CODER
EMPTY	I*4	CONSTANT /0/ FILE UNDEFINED
LSPCRN	I*4	CONSTANT /20/ LINES TO PRINT PER SCREEN
IANS	I*4	RESPONSE OF <CR> TO CONTINUE PRINTING FILE

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

3100	FILE SPECIFIED TO BE PRINTED NOT IN DIRECTORY
3110	HEADER RECORD OF FILE NOT AS EXPECTED

NONFATAL

3520	FILE SPECIFIED TO BE PRINTED NOT DEFINED

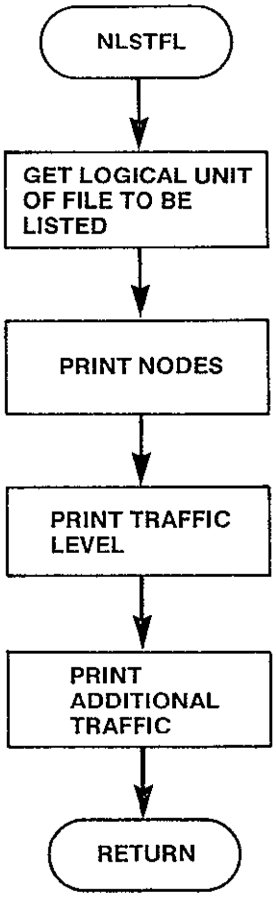


Figure 3-35. NLSTFL Logic Flow

3.4.13 NCLOSE Module

SUBROUTINE NCLOSE

PURPOSE
REPLACE NETWORK DIRECTORY WHEN CONTENTS OF DIRECTORY HAS CHANGED

INPUT ARGUMENTS
NONE

OUTPUT ARGUMENTS
NONE

DATA STRUCTURES
(U - USED, S - DEFINED, R - READ)

NNFIL	/NETFIL/	U
NFILES	/NETFIL/	U
NETDEF	/NETFIL/	U
HNET	/HEADRS/	U
NETDIR	/LUN/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

I	I*4	LOOP INDEX

SUBPROGRAMS CALLED
NONE

ERRORS
FATAL
NONE
NONFATAL
NONE

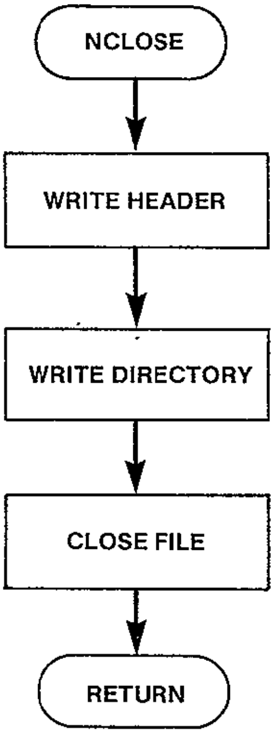


Figure 3-36. NCLOSE Logic Flow

3.5 TARCON DESCRIPTION

The TARCON submodule allows the user to maintain a set of tariff files which can be specified as input to the program. This module is called directly from INPUT. TARCON organized existing tariff files into a directory - all user defined tariff files. This module does not provide the user access to the prestored AT&T, WU, or SBS tariff files. It does, however, provide the capability for the user to make alterations to those prestored tariff files and store the resulting structures as a user defined tariff. The user can manage his defined tariffs by creating new files, deleting old files, and listing the contents of any file and/or the directory itself. The user may specify files contained in the directory as input during the EXCON session.

Upon entry into TARCON, a menu of options will be displayed and the user will be asked to select one of:

1. Create a tariff file

2. Delete a tariff file

3. List a tariff file or the directory

4. Exit TARCON session

The hierarchy chart of the modules that make up TARCON is contained in Figure 3-37.

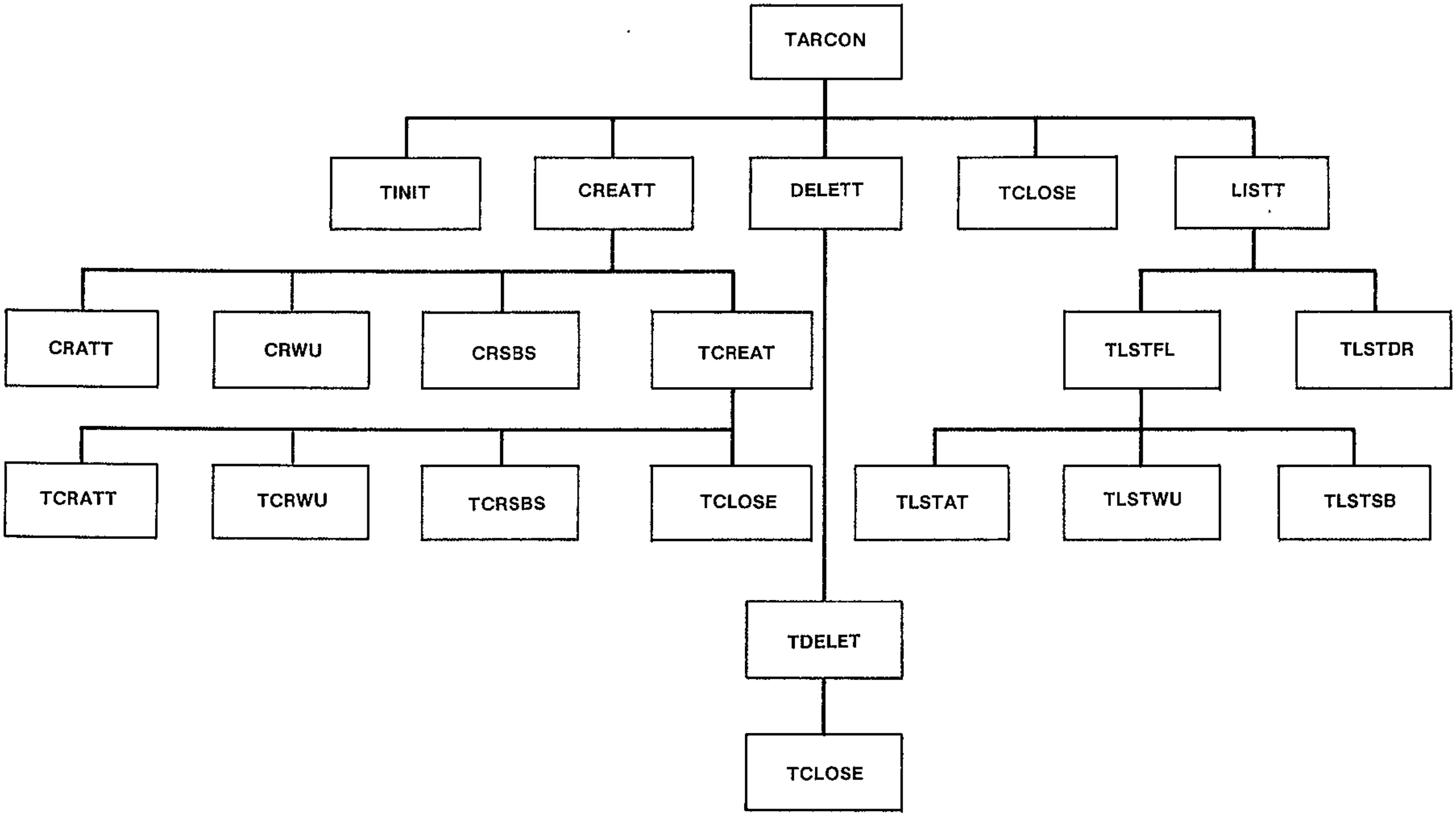


Figure 3-37. TARCON Hierarchy Chart

3.5.1 TARCON Module

```
     SUBROUTINE TARCON

  PURPOSE
       MAINTAIN TARIFF FILES FOR USER

  INPUT ARGUMENTS
       NONE

  OUTPUT ARGUMENTS
       NONE

  DATA STRUCTURES
       (U - USED, S - DEFINED, R - READ)
       DEBUG          /LUN/       U `

  LOCAL VARIABLES
       IOPT           I*4         MENU OPTION SELECTED

  SUBPROGRAMS CALLED
       TINIT
       CREATT
       DELETT
       LISIT
       TCLOSE

  ERRORS
       FATAL
         NONE
       NONFATAL
         NONE
```

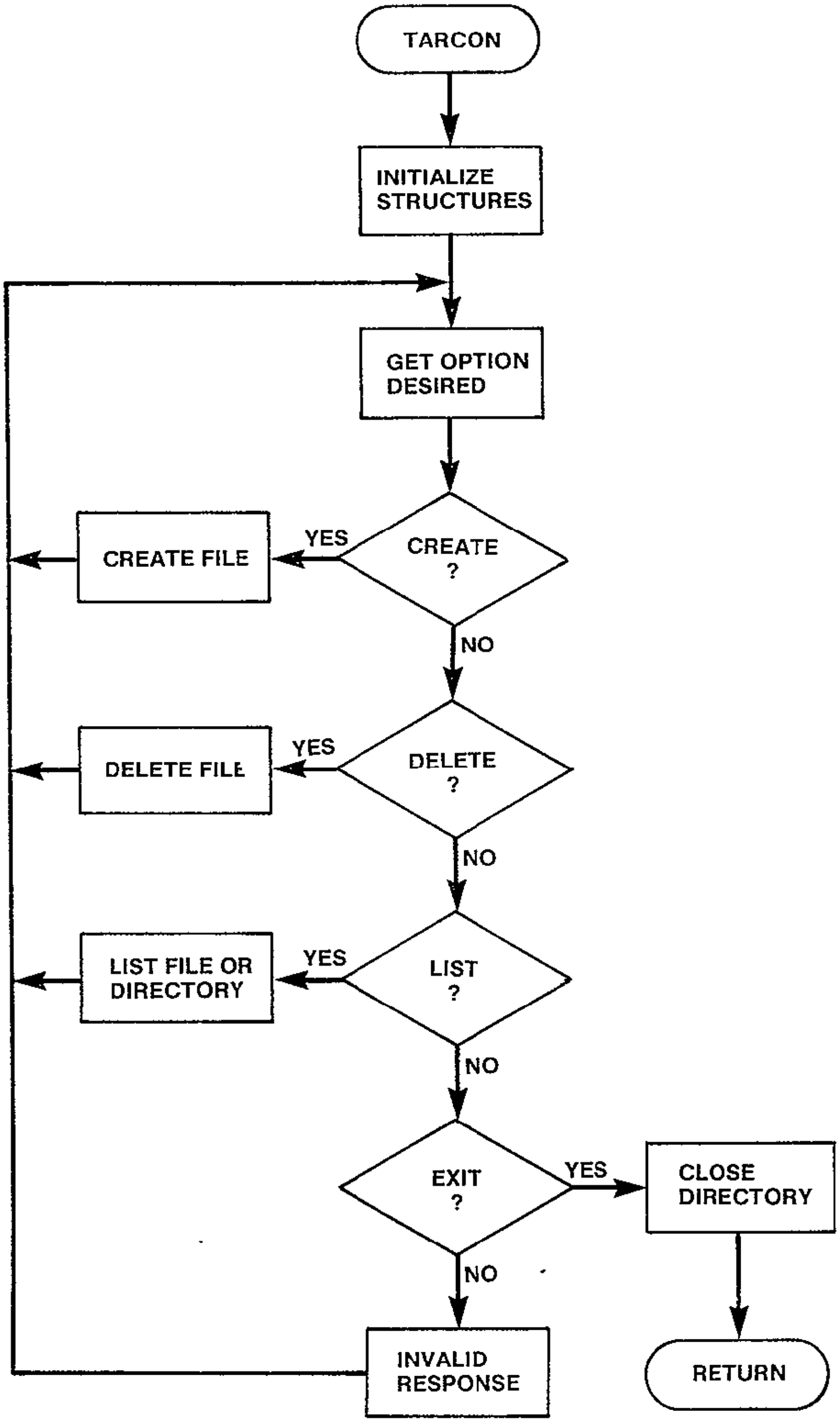


Figure 3-38. TARCON Logic Flow

3.5.2 TINIT Module

SUBROUTINE TINIT

PURPOSE

PERFORM INITIALIZATION FOR THE INPUT PROGRAMS TARIFF CONSTRUCTION OPTION

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

TFILES	/TARFIL/	S
NTFIL	/TARFIL/	S
TARDEF	/TARFIL/	S
TRFDIR	/LUN/	U
HTAR	/HEADRS/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

HEADER(2)	R*8	FILE HEADER
MAXTAR	I*4	CONSTANT /13/ MAXIMUM NUMBER OF TARIFF FILES EXPECTED IN DIRECTORY
I	I*4	LOOP INDEX

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

4010	FILE HEADER OF TARIFF DIRECTORY NOT AS EXPECTED
4020	NUMBER OF FILES IN DIRECTORY EXCEEDS THE CAPACITY OF THE ARRAYS IN /TARFIL/

NONFATAL

NONE

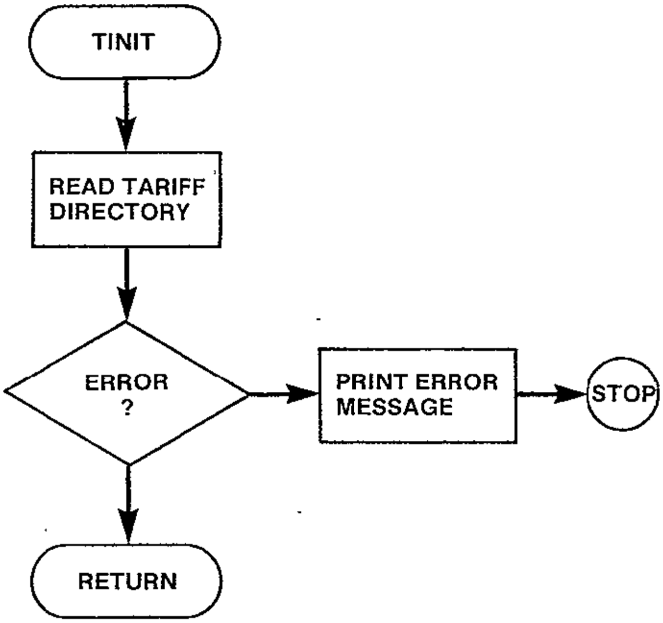


Figure 3-39. TINIT Logic Flow

3.5.3 CREATT Module

SUBROUTINE CREATT

PURPOSE
CREATE A TARIFF FILE ACCORDING TO USER SPECIFICATIONS

INPUT ARGUMENTS
NONE

OUTPUT ARGUMENTS
NONE

DATA STRUCTURES
(U - USED, S - DEFINED, R - READ)

DEBUG	/LUN/	U

LOCAL VARIABLES

FILNAM	R*8	NAME OF FILE TO CREATE
IANSE	I*4	USER RESPONSE
IR	I*4	CONSTANT /'R'/ USER OPTION TO REENTER
IT	I*4	CONSTANT /'T'/ USER OPTION TO TERMINATE
TYPE	I*4	TYPE OF TARIFF TO CREATE (1-ATT, 2-WU, 3-SBS)
FILSTT	I*4	FILE STATUS 1 INVALID NAME 2 AVAILABLE 3 IN USE

SUBPROGRAMS CALLED
CRATT
CRSBS
FILDEF
TCREAT

ERRORS
FATAL
NONE
NONFATAL
NONE

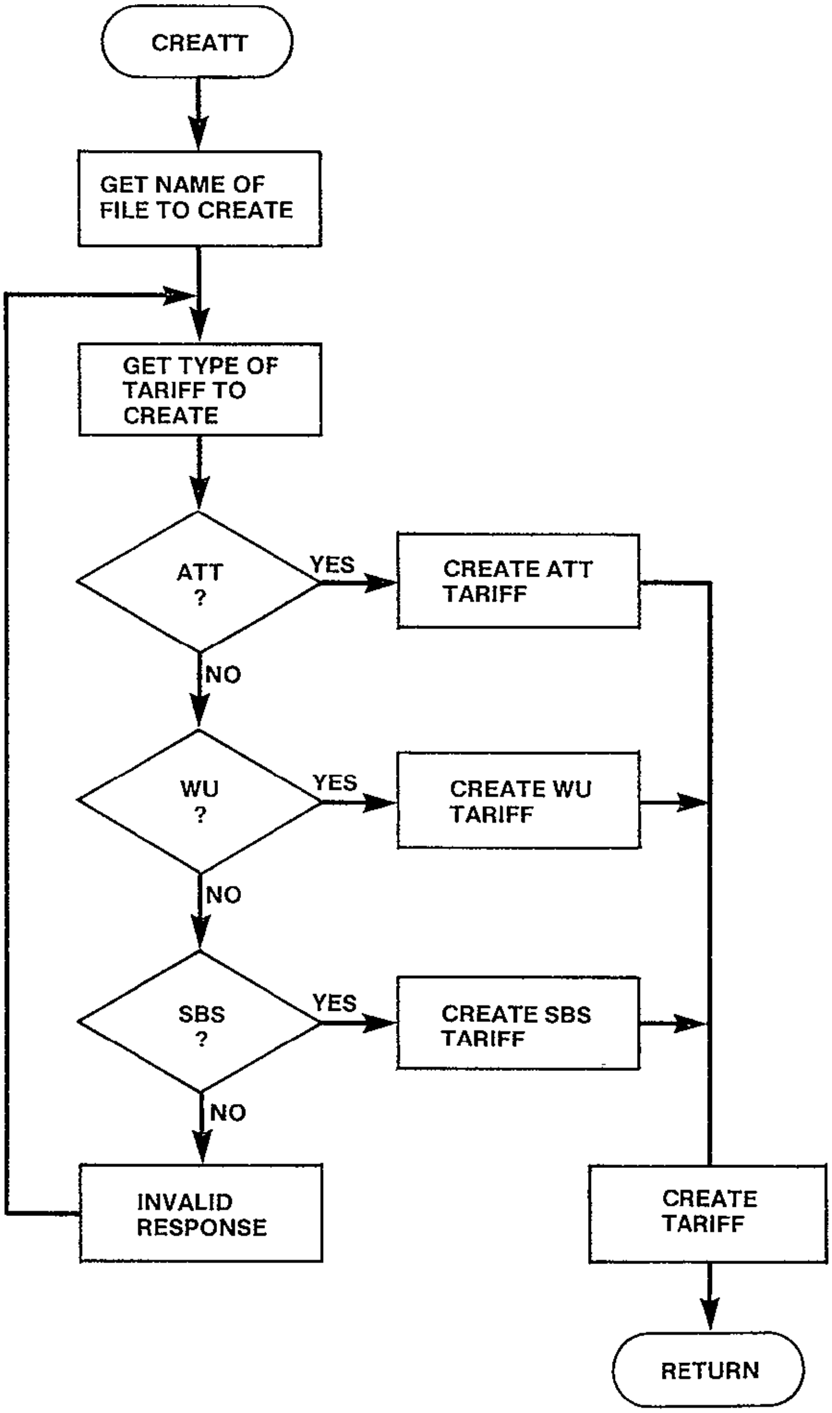


Figure 3-40. CREATT Logic Flow

3.5.4 CRATT Module

SUBROUTINE CRATT(*)

PURPOSE
CREATE A TARIFF BASED ON THE AT&T PHILOSOPHY

INPUT ARGUMENTS
NONE

OUTPUT ARGUMENTS
NONE

DATA STRUCTURES
(U - USED, S - DEFINED, R - READ)

NNDS	/INPNOD/	S
CODE	/INPNOD/	S
ADJ	/INPATT/	S
INCSC	/INPATT/	S
TATMIL	/INPATT/	U
DEBUG	/LUN/	U
NTLEVL	/INPATT/	U

LOCAL VARIABLES

ITEMP,JTEMP	I*4	BUFFERS FOR USER INPUTS
IANS	I*4	USER RESPONSE Y OR N
IR	I*4	CONSTANT /'R'/ USER RESPONSE TO REENTER
IT	I*4	CONSTANT /'T'/ USER RESPONSE TO TERMINATE
J	I*4	LOOP INDEX
MINUS	I*4	CONSTANT /'-'/ INDICATES DELETION
N	I*4	FINAL LOOP INDEX
NPLUS	I*4	CONSTANT /'+'/ INDICATES INSERTION
NULL	I*4	CONSTANT /' '/ INDICATES <CR> RESPONSE
INLIST	L	CODE ENTERED IS PRESTORED CATA
INCLUD	L	USER REQUEST TO ADD CODE AS CATA
EXCLUD	L	USER REQUEST TO EXCLUDE CODE FROM CATA
FOUND	L	CODE ALREADY IN ADJUSTMENT LIST
I	I*4	LOOP INDEX

SUBPROGRAMS CALLED
ATTLST

ERRORS
FATAL
NONE
NONFATAL
NONE

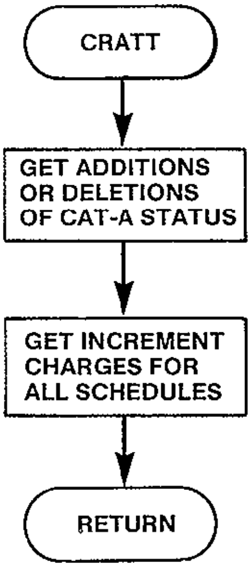

CRATT
GET ADDITIONS OR DELETIONS OF CAT-A STATUS
GET INCREMENT CHARGES FOR ALL SCHEDULES
RETURN

Figure 3-41. CRATT Logic Flow

3.5.5 CRWU Module

SUBROUTINE CRWU(*)

PURPOSE

CREATE A TARIFF BASED ON THE WU PHILOSOPHY

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NADJ	/INPWU/	S
CODEL	/INPNOD/	S
CODER	/INPNOD/	S
CAT	/INPWU/	S
CHGLH	/INPWU/	S
CHGMH	/INPWU/	S
CHGSH	/INPWU/	S
DEBUG	/LUN/	U

LOCAL VARIABLES

ITEMP,JTEMP,KTEMP	I*4	BUFFER FOR USER INPUTS
IANS	I*4	USER RESPONSE Y OR N
IR	I*4	CONSTANT /'R'/ USER CHOICE TO REENTER
IT	I*4	CONSTANT /'T'/ USER CHOICE TO TERMINATE
NULL	I*4	CONSTANT /' '/ INDICATES <CR> RESPONSE
FOUND	L	DUPLICATE ENTRY
I	T*4	LOOP INDEX
PAIR	I*4	NODES SPECIFIED ARE A SATELLITE ACCESS CITY PAIR IN PRESTORED TARIFF
ADD	L	PAIR SPECIFIED SHOULD BE ADDED TO LIST OF ACCESS CITY PAIRS
DELETE	L	PAIR SPECIFIED SHOULD BE DELETED FROM LIST OF ACCESS CITY PAIRS

SUBPROGRAMS CALLED

WUPAIR

ERRORS

FATAL

NONE

NONFATAL

NONE

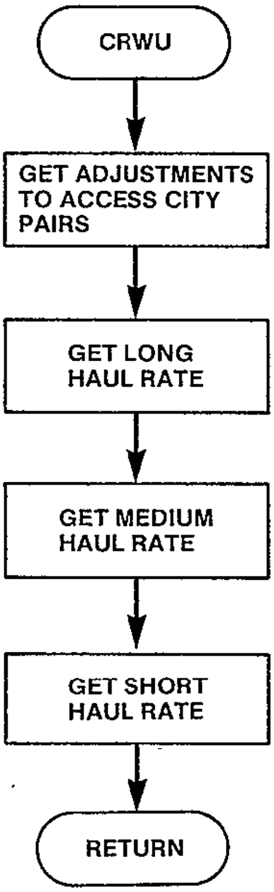


Figure 3-42. CRWU Logic Flow

3.5.6 CRSBS Module

SUBROUTINE CRSBS

PURPOSE

CREATE A TARIFF BASED ON THE SBS PHILOSOPHY

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NAC	/INPSBS/	S
SCU	/INPSBS/	S
FTU	/INPSBS/	S
CAUMIN	/INPSBS/	S
INCSB	/INPSBS/	S
NSBTAB	/INPSBS/	U
TSBCAM	/INPSBS/	U
NACNMB	/SBSMXD/	S
NACLOC	/SBSMXD/	S
DEBUG	/LUN/	U

LOCAL VARIABLES

I	I*4	LOOP INDEX
N	I*4	ONE LESS THAN THE NUMBER OF ITEMS IN THE CAU RATE TABLE
YES	I*4	CONSTANT /'Y'/ RESPONSE OF YES
NO	I*4	CONSTANT /'N'/ RESPONSE OF NO
IANS	I*4	RESPONSE TO YES/NO QUESTION
LOC	I*4	NAC LOCATION AS SPECIFIED BY USER
NULL	I*4	CONSTANT /' '/ RESPONSE OF <CR>
FOUND	L	INDICATES IF NAC LOCATION ENTERED IS DUPLICATE ENTRY
FINISH	L	INDICATES THAT USER COMPLETED ENTERING NAC LOCATIONS

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

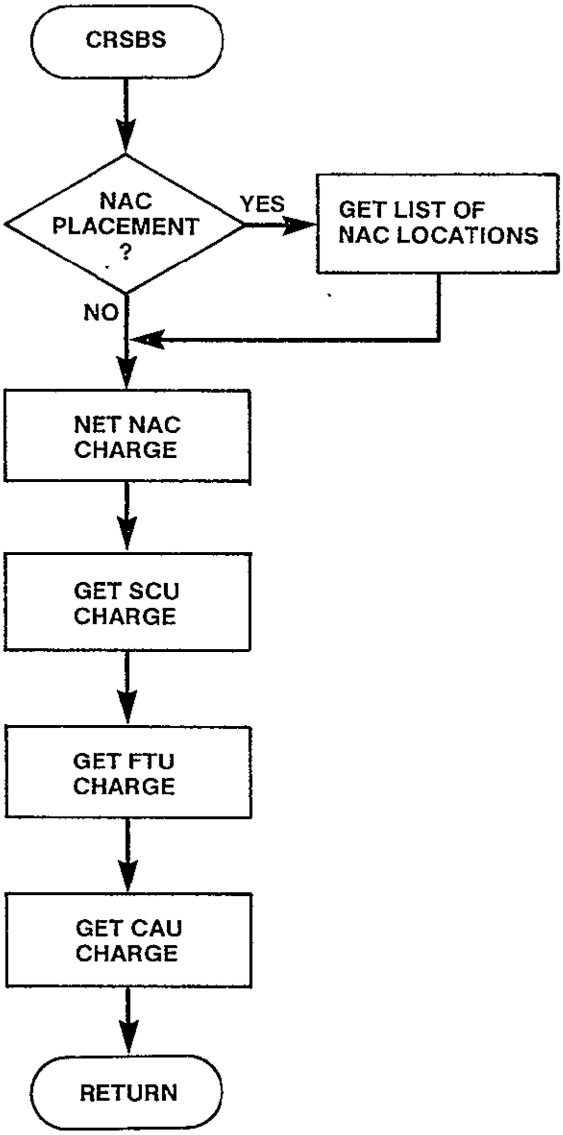


Figure 3-43. CRSBS Logic Flow

3.5.7 TCREAT Module

SUBROUTINE TCREAT(FILNAM,TYPE)

PUROSE

CREATE NEW TARIFF DEFINITION IN SPECIFIED FILE

INPUT ARGUMENTS

FILNAM	R*8	NAME OF FILE TO CONTAIN NEW TARIFF
TYPE	I*4	TYPE OF FILE TO CREATE 1 ATT 2 WU 3 SBS

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NTFIL	/TARFIL/	U
TFILES	/TARFIL/	U
TARDEF	/TARFIL/	S
LUNTRF	/LUN/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

FOUND	L	FILENAM FOUND IN LIST
LSTPTR	I*4	POSITION OF FILENAM IN LIST
UNIT	I*4	LOGICAL UNIT NUMBER OF FILE CREATED
I	I*4	LOOP INDEX
EMPTY	I*4	CONSTANT /0/ FILE UNDEFINED

SUBPROGRAMS CALLED

TCRATT

TCRWU

TCRSBS

TCLOSE

ERRORS

FATAL

4030	FILE NAME NOT IN DIRECTORY
4040	FILE SPECIFIED ALREADY CREATED
4050	FILE TYPE INVALID

NONFATAL

NONE

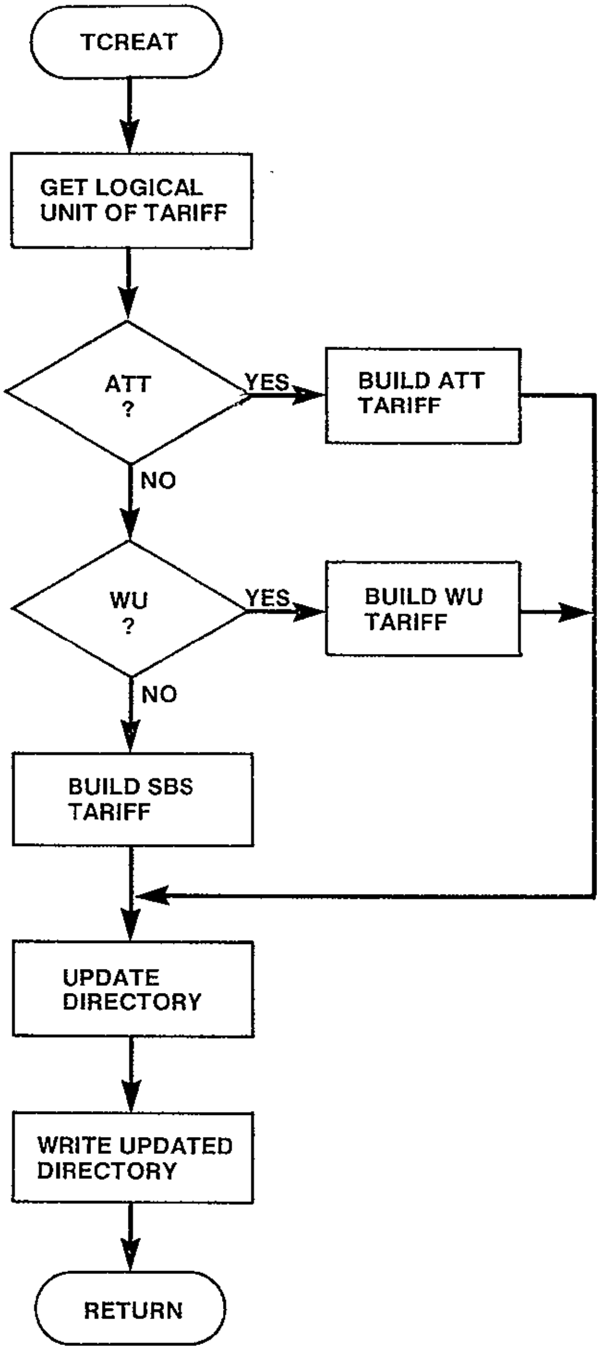


Figure 3-44. TCREAT Logic Flow

3.5.8 TCRATT Module

SUBROUTINE TCRATT(FILNAM,UNIT)

PURPOSE

CREATE ATT TARIFF DEFINITION AT SPECIFIED FILE

INPUT ARGUMENTS

FILNAM	R*8	NAME OF ATT TARIFF FILE TO BE CREATED
UNIT	I*4	LOGICAL UNIT NUMBER OF FILE TO BE CREATED

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

UTAR	/HEADRS/	U
NNDS	/INPNOD/	U
ADJ	/INPATT/	U
CODE	/INPNOD/	U
NTLEVL	/INPATT/	U
TATMIL	/INPATT/	U
INCSC	/INPATT/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

BASE1	R*4	BASE COST FOR SCHEDULE 1
BASE2	R*4	BASE COST FOR SCHEDULE 2
BASE3	R*4	BASE COST FOR SCHEDULE 3
I	I*4	LOOP INDEX
ORDR(600)	I*4	INDEX TO RATE CENTER CODES IN CODE IN ALPHABETIC ORDER
PRVMLG	I*4	PREVIOUS MILEAGE BREAKPOINT USED IN COMPUTATION OF BASE COSTS
PTR	I*4	INDEX OF NEXT CODE TO BE PRINTED

SUBPROGRAMS CALLED

SORT1

ERRORS

FATAL

NONE

NONFATAL

NONE

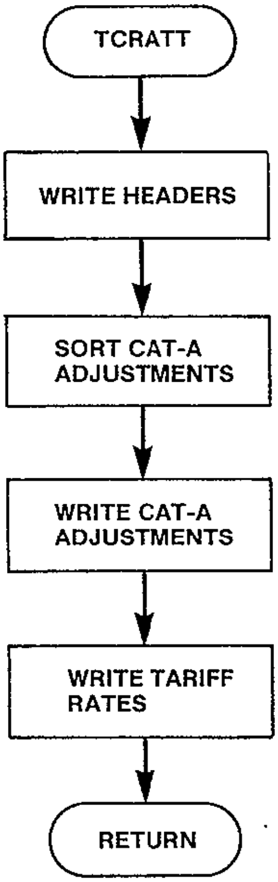


Figure 3-45. TCRATT Logic Flow

3.5.9 TCRWU Module

SUBROUTINE TCRWU(FILNAM,UNIT)

PURPOSE

CREATE WU TARIFF DEFINITION IN SPECIFIED FILE

INPUT ARGUMENTS

FILNAM	R*8	NAME OF WU FILE TO BE CREATED
UNIT	I*4	LOGICAL UNIT NUMBER OF WU FILE BEING CREATED

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

UTAR	/HEADRS/	U
NADJ	/INPWU/	U
CODEL	/INPNOD/	U
CODER	/INPNOD/	U
CAT	/INPWU/	U
CHGLH	/INPWU/	U
CHGMH	/INPWU/	U
CHGSH	/INPWU/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

ORDR(600)	I*4	ORDER OF CODEL AND CODER ARRAYS IN ALPHABETIC ORDER BY CODEL AND THEN BY CODER WITHIN CODEL
PTR	I*4	POINTER TO WITHIN CODEL, CODER, AND CAT OF NEXT ACCESS CITY PAIR IN ALPHABETIC ORDER
I	I*4	NEXT ACCESS CITY PAIR IN ALPHABETIC ORDER LOOP INDEX

SUBPROGRAMS CALLED

SORT2

ERRORS

FATAL

NONE

NONFATAL

NONE

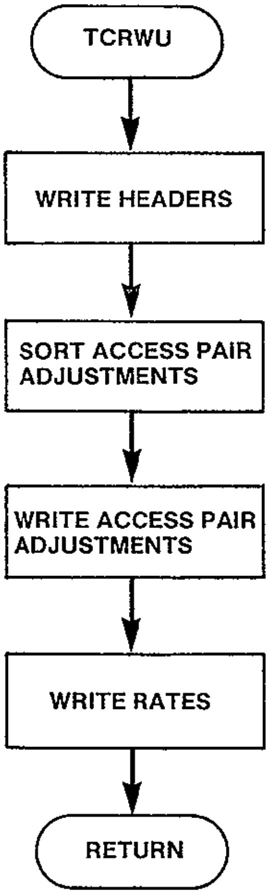


Figure 3-46. TCRWU Logic Flow

3.5.10 TCRSBS Module

SUBROUTINE TCRSBS (FILNAM,UNIT)

PURPOSE

CREATE WU TARIFF DEFINITION IN SPECIFIED FILE

INPUT ARGUMENTS

FILNAM	R*8	NAME OF WU TARIFF TO CREATE
UNIT	I*4	LOGICAL UNIT NUMBER OF THE FILE TO BE CREATED

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

UTAR	/HEADRS/	U
NAC	/INPSBS/	U
SCU	/INPSBS/	U
FTU	/INPSBS/	U
CAUMIN	/INPSBS/	U
NSBTAB	/INPSBS/	U
TSBCAM	/INPSBS/	U
INCSB	/INPSBS/	U
NACNMB	/SBSMXD/	U
NACLOC	/SBSMXD/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

ORDR(600)	I*4	POSITION OF EACH NAC LOCATION IN ALPHABETIC ORDER
PTR	I*4	POSITION WITHIN NACLOC OF NEXT NAC
I,J	I*4	LOOP INDICES
RECORD(16)	I*4	NEXT SET OF NAC LOCATIONS TO WRITE TO FILE
NREC	I*4	NUMBER OF RECORDS OF NAC LOCATIONS TO WRITE TO FILE
BEGIN	I*4	INDEX TO FIRST NAC IN THIS RECORD
END	I*4	INDEX TO LAST NAC IN THIS RECORD
NEXT	I*4	CURRENT ELEMENT IN RECORD BEING FILLED
BASE	R*4	BASE CAU CHARGE
PRVCNT	I*4	PREVIOUS CAU BREAKPOINT

SUBPROGRAMS CALLED

SORT1

ERRORS

FATAL

NONE

NONFATAL

NONE

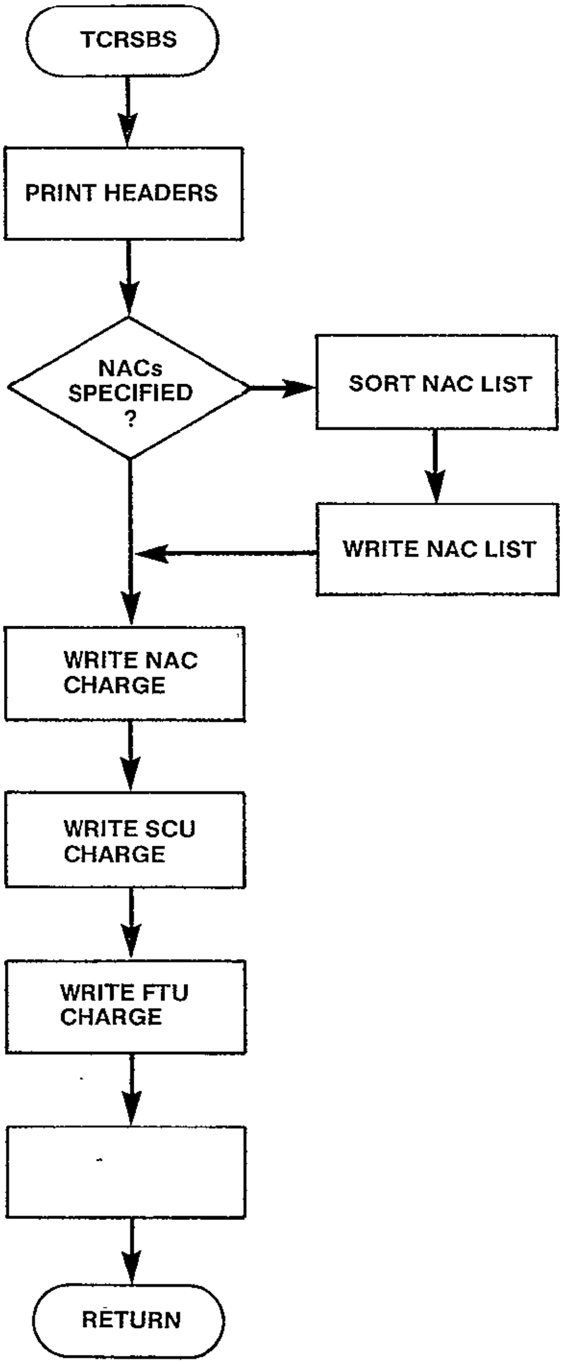


Figure 3-47. TCRSBS Logic Flow

3.5.11 DELETT Module

SUBROUTINE DELETT

PURPOSE
DELETE A TARIFF FILE

INPUT ARGUMENTS
NONE

OUTPUT ARGUMENTS
NONE

DATA STRUCTURES
(U - USED, S - DEFINED, R - READ)

DEBUG	/LUN/	U

LOCAL VARIABLES

FILNAM	R*8	NAME OF FILE TO DELETE
IANS	I*4	USER RESPONSE Y OR N
IYES	I*4	CONSTANT /'Y'/
NO	I*4	CONSTANT /'N'/

SUBPROGRAMS CALLED
TDELET
FILDEF

ERRORS
FATAL
NONE
NONFATAL
NONE

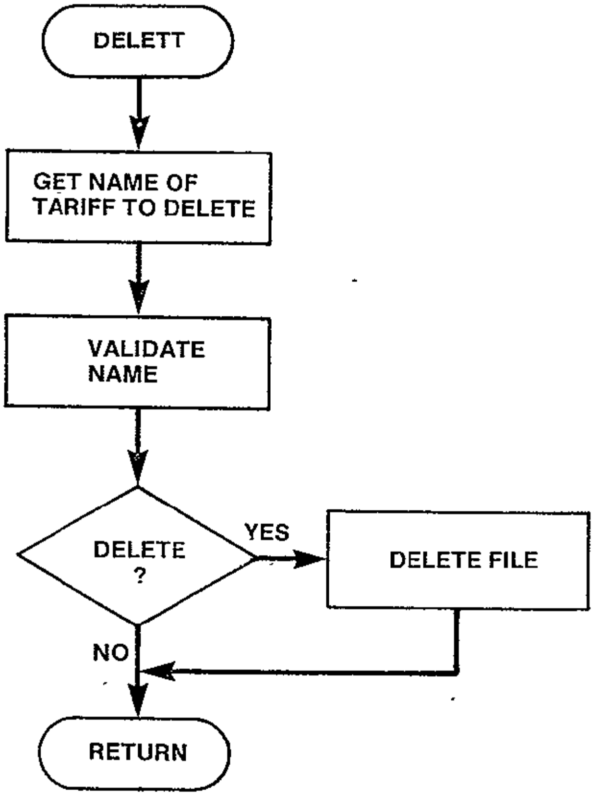


Figure 3-48. DELETT Logic Flow

3.5.12 TDELET Module

```
    SUBROUTINE TDELET(FILNAM)

 PURPOSE
      DELETE THE TARIFF FILE SPECIFIED

 INPUT ARGUMENTS
      FILNAM         R*8        NAME OF NETWORK FILE TO BE DELETED

 OUTPUT ARGUMENTS
      NONE

 DATA STRUCTURES
      (U - USED, S - DEFINED, R - READ)
      NTFIL        /TARFIL/     U
      TFILES       /TARFIL/     U
      TARDEF       /TARFIL/     U
      DEBUG        /LUN/        U

 LOCAL VARIABLES
      I              I*4        LOOP INDEX
      FOUND          L          INDICATES IF FILNAM FOUND IN DIRECTORY

 SUBPROGRAMS CALLED
      TCLOSE

 ERRORS
      FATAL
        4060       FILE NAME TO DELETE NOT IN DIRECTORY
      NONFATAL
        4510       FILE NAME TO DELETE HAS ALREADY BEEN DELETED
```

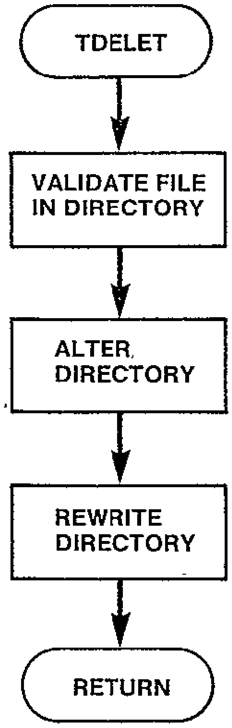


Figure 3-49. TDELET Logic Flow

3.5.13 LISTT Module

```
   SUBROUTINE LISTT

PURPOSE
     LIST OF NETWORK FILE OR THE NETWORK DIRECTORY ON SYSOUT

INPUT ARGUMENTS
     NONE

OUTPUT ARGUMENTS
     NONE

DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
     DEBUG          /LUN/       U

LOCAL VARIABLES
     FILNAM         R*8         NAME OF FILE TO LIST
     NULL           R*8         CONSTANT /'    '/ INDICATES <CR> RESPONSE

SUBPROGRAMS CALLED
     TLSTDR
     TLSTFL
     FILDEF

ERRORS
     FATAL
       NONE
     NONFATAL
       NONE
```

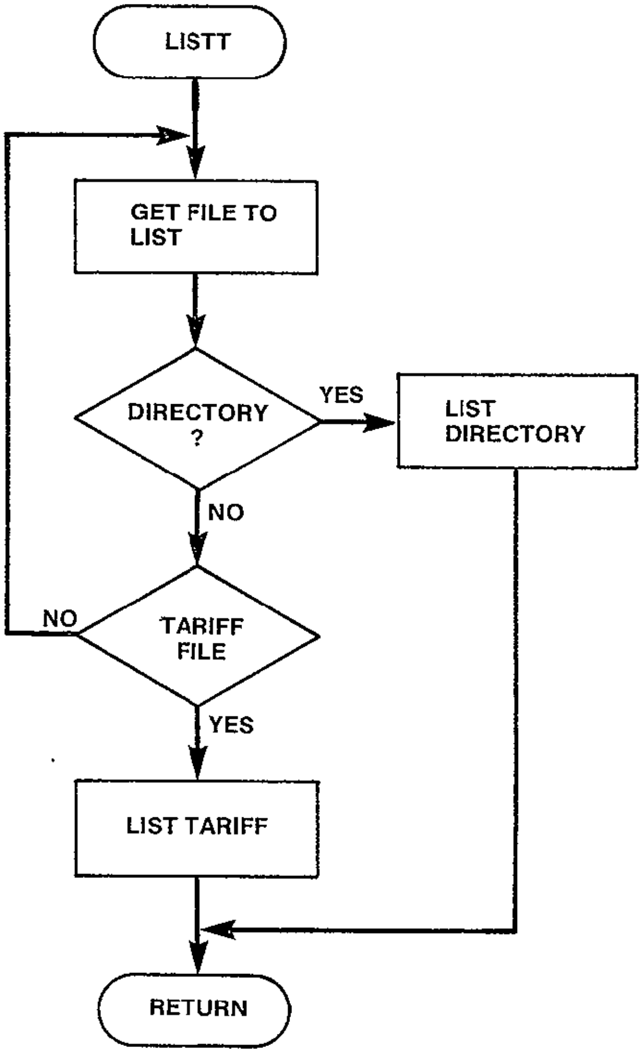


Figure 3-50. LISTT Logic Flow

3.5.14 TLSTDR Module

```
   SUBROUTINE TLSTDR

PURPOSE
     LIST THE TARIFF DIRECTORY

INPUT ARGUMENTS
     NONE

OUTPUT ARGUMENTS
     NONE

DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
     NTFIL          /TARFIL/   U
     TARDEF         /TARFIL/   U
     TFILES         /TARFIL/   U
     DEBUG          /LUN/      U

LOCAL VARIABLES
     I              I*8        LOOP INDEX
     J              I*4        FILE STATUS
     STDES          R*8        ALPHA DESCRIPTION OF FILE STATUS
     AVAIL          R*8        CONSTANT - CHARACTER STRING 'UNUSED'
     TYPE(3)        R*8        CONSTANT - TARIFF TYPE
     IANS           I*4        ANSWER OF <CR>

SUBPROGRAMS CALLED
     NONE

ERRORS
     FATAL
       NONE
     NONFATAL
       NONE
```

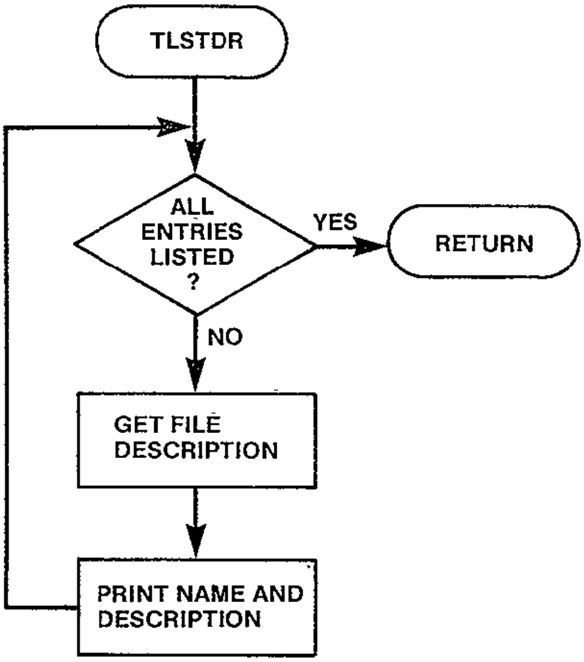


Figure 3-51. TLSTDR Logic Flow

3.5.15 TLSTFL Module

SUBROUTINE TLSTFL(FILNAM)

PURPOSE

LIST TARIFF FILE SPECIFIED

INPUT ARGUMENTS

FILNAME	R*8	NAME OF FILE TO BE LISTED

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NTFIL	/TARFIL/	U
TFILES	/TARFIL/	U
TARDEF	/TARFIL/	U
LUNTRF	/LUN/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

FOUND	L	FILE NAME IN LIST
LSTPTR	I*4	POSITION OF FILE NAME IN LIST
UNIT	I*4	LOGICAL UNIT NUMBER OF FILE TO BE LISTED
I	I*4	LOOP INDEX
EMPTY	I*4	CONSTANT /0/ FILE UNDEFINED
TYPE	I*4	TYPE OF FILE TO BE LISTED

SUBPROGRAMS CALLED

TLSTAT
TLSTWU
TLSTSB

ERRORS

FATAL

4070	FILE NAME NOT IN DIRECTORY
4080	FILE EMPTY
4090	FILE TYPE INVALID

NONFATAL

NONE

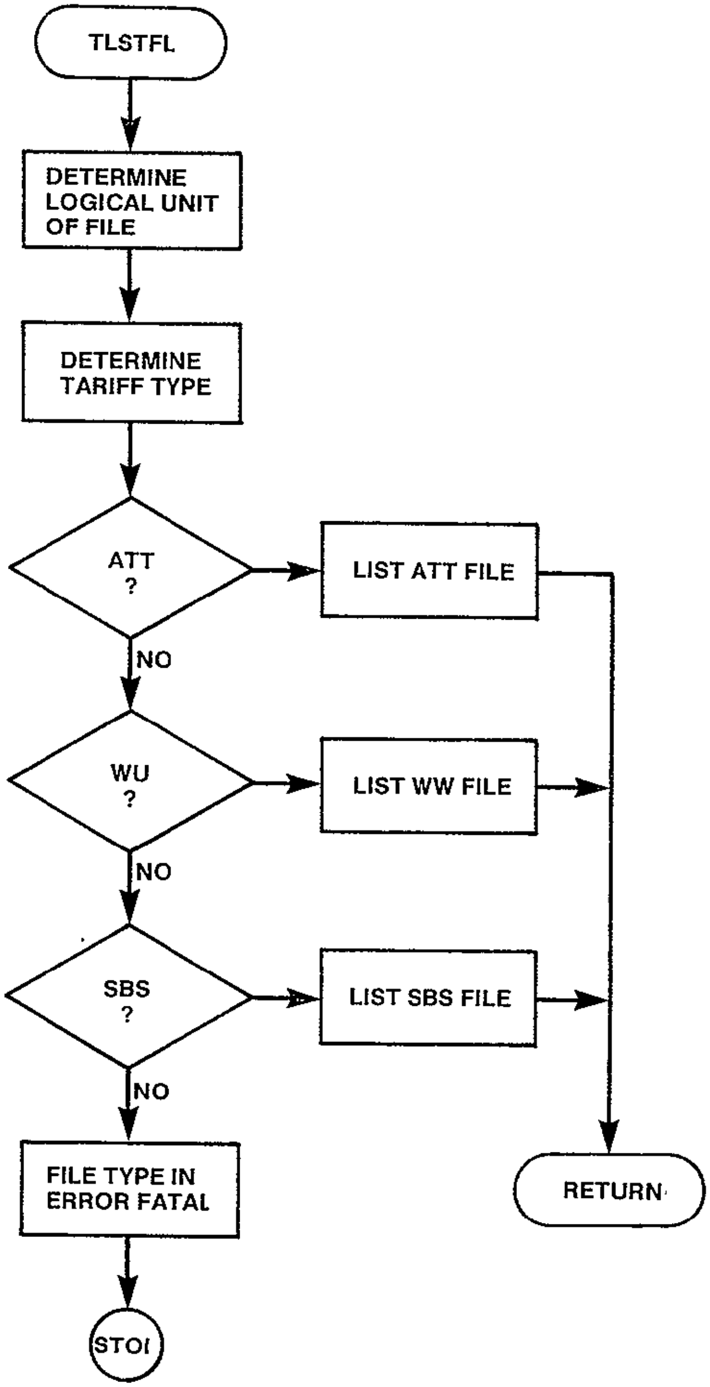


Figure 3-52. TLSTFL Logic Flow

3.5.16 TLSTAT Module

```
   SUBROUTINE TLSTAT(FILNAM,UNIT)

 PURPOSE
     LIST FILE WHICH DESCRIBES ATT TARIFF

 INPUT ARGUMENTS
     FILNAM         R*8         ATT FILE TO BE LISTED
     UNIT           I*4         LOGICAL UNIT NUMBER OF FILE TO BE LISTED

 OUTPUT ARGUMENTS
     NONE

 DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
     UTAR          /HEADRS/     U
     DEBUG         /LUN/        U

 LOCAL VARIABLES
     LPSCRN         I*4         CONSTANT  /20/  LINES PER SCREEN
     TYPADJ         I*4         ADJUSTMENT TYPE
                                1  LISTED
                                2  UNLISTED
     DESADJ(2)      R*8         CONSTANT  /'LISTED ', 'UNLISTED'/
                                DESCRIPTION OF ADJUSTMENT
     IANS           I*4         SIGNAL TO CONTINUE PRINT
     INC(3)         R*4         INCREMENT FOR EACH SCHEDULE
     BAS(3)         R*4         BASE CHARGE FOR EACH SCHEDULE
     MLG            I*4         MILEAGE INCREMENT
     CODE           I*4         CODE FOR CATA ADJUSTMENT
     ADJ            I*4         NATURE OF ADJUSTMENT
     NADJ           I*4         NUMBER OF ADJUSTMENTS SPECIFIED
     NLVL           I*4         NUMBER OF MILEAGE BREAKPOINTS
     HEADER(2)      R*8         HEDER RECORD OF TARIFF FILE
     I,J            I*4         LOOP INDICES
     LABL(2)        R*8         LABEL FOR RATE SCHEDULE
     DUMY           I*4         STAND IN FOR MLG IN LAST RECORD OF ATT
                                TARIFF

 SUBPROGRAMS CALLED
     NONE

 ERRORS
     FATAL
       4100         FILE HEADER NOT AS EXPECTED
     NONFATAL
       NONE
```

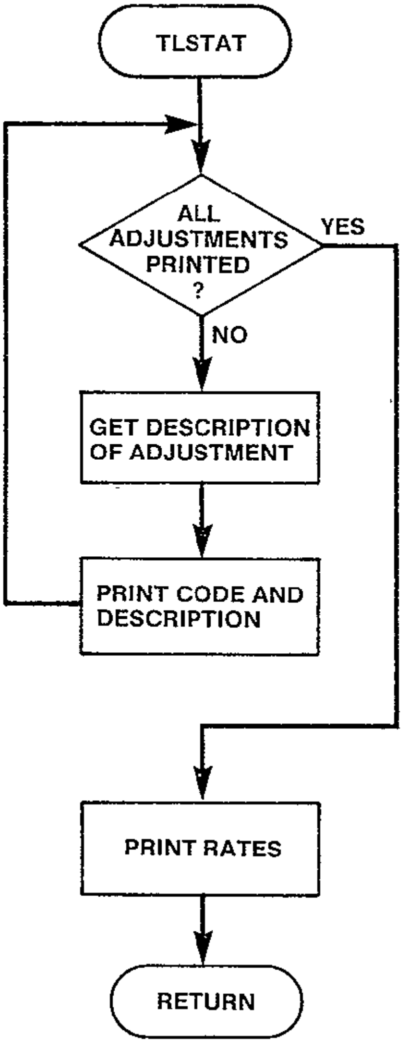

TLSTAT
ALL ADJUSTMENTS PRINTED ?
YES
NO
GET DESCRIPTION OF ADJUSTMENT
PRINT CODE AND DESCRIPTION
PRINT RATES
RETURN

Figure 3-53. TLSTAT Logic Flow

3.5.17 TLSTWU Module

```
SUBROUTINE TLSTWU(FILNAM,UNIT)
```

PURPOSE

LIST FILE WHICH DESCRIBES WU TARIFF

INPUT ARGUMENTS

FILNAM	R*8	NAME OF FILE TO BE LISTED
UNIT	I*4	LOGICAL UNIT NUMBER OF FILE TO BE LISTED

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

UTAR	/HEADRS/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

LPSCRN	I*4	LINES TO PRINT PER SCREEN
TYPADJ	I*4	TYPE OF ADJUSTMENT 1 EXCLUDE 2 LONG 3 MEDIUM 4 SHORT
DESADJ	R*8	DESCRIPTION OF ADJUSTMENT TYPE
HEADER(2)	R*8	HEADER RECORD
NREC	I*4	NUMBER OF RECORDS WHICH CONTAIN ADJUSTMENTS TO SATELLITE ACCESS CITY STATUS
I,J	I*4	LOOP INDICES
CL	I*4	LEFT MOST CODE OF PAIR
CR	I*4	RIGHT MOST CODE OF PAIR
CTG	I*4	RATE TYPE OF PAIR
IANS	I*4	ANSWER OF <CR>
RATE	R*4	WU RATE

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

4110	HEADER READ FROM WU TARIFF NOT AS EXPECTED

NONFATAL

NONE

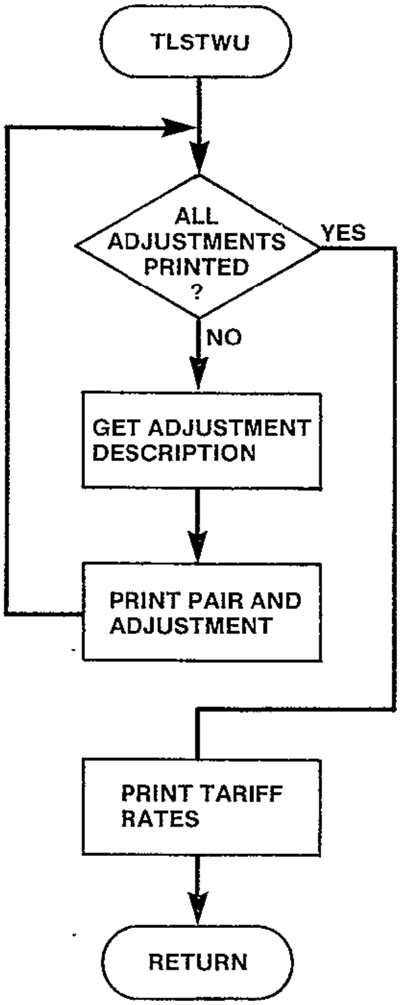

TLSTWU
ALL ADJUSTMENTS PRINTED ?
YES
NO
GET ADJUSTMENT DESCRIPTION
PRINT PAIR AND ADJUSTMENT
PRINT TARIFF RATES
RETURN

Figure 3-54. TLSTWU Logic Flow

3.5.18 TLSTSB Module

SUBROUTINE TLSTSB(FILNAM,UNIT)

PURPOSE

LIST FILE WHICH DESCRIBES SBS TARIFF.

INPUT ARGUMENTS

FILNAM	R*8	NAME OF SBS TARIFF TO BE PRINTED
UNIT	I*4	LOGICAL UNIT NUMBER FILE TO BE PRINTED

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

UTAR	/HEADRS/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

HEADER(2)	R*8	HEADER RECORD READ
LPSCRN	I*4	CONSTANT /20/ LINES PER SCREEN
NREC	I*4	NUMBER OF RECORDS CONTAINING NAC SPECIFICATIONS
NENTRY	I*4	NUMBER OF NAC LOCATIONS SPECIFIED
RECORD(16)	I*4	NEXT RECORD OF NAC LOCATIONS READ FROM TARIFF
END	I*4	NUMBER OF ITEMS IN NEXT RECORD
IANS	I*4	RESPONSE OF <CR>
BKP	I*4	NEXT CAU BREAKPOINT
NTAB	I*4	NUMBER OF ITEMS IN CAU RATE TABLE
BASE	R*4	BASE RATE FOR CAU
INC	R*4	INCREMENT CHARGE FOR CAU
LABL(2)	R*8	LABEL FOR CAU TABLE
DUMY	I*4	STAND FOR BKP ON FINAL RECORD OF CAU TABLE
IEND	I*4	NUMBER OF TARIFF LEVELS TO PRINT WITH LABL(1)
I,J,K	I*4	LOOP INDICES
NAC	R*4	NAC CHARGE
SCU	R*4	FTU CHARGE
CAUMIN	R*4	MIN CAU CHARGE

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

4120 FILE HEADER READ FROM WU TARIFF NOT AS EXPECTED

NONFATAL

NONE

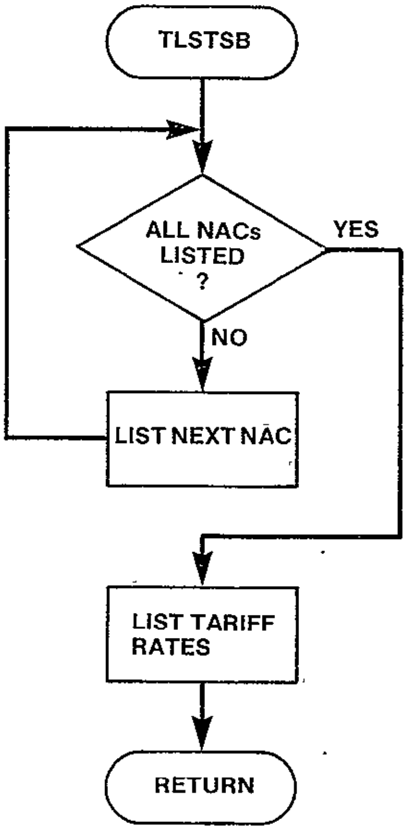


Figure 3-55. TLSTSB Logic Flow

3.5.19 TCLOSE Module

SUBROUTINE TCLOSE

PURPOSE

REPLACE TARIFF DIRECTORY WHEN CONTENTS OF DIRECTORY HAS CHANGED

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NTFIL	/TARFIL/	U
TFILES	/TARFIL/	U
TARDEF	/TARFIL/	U
HTAR	/HEADRS/	U
TRFDIR	/LUN/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

I	I*4	LOOP INDEX

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

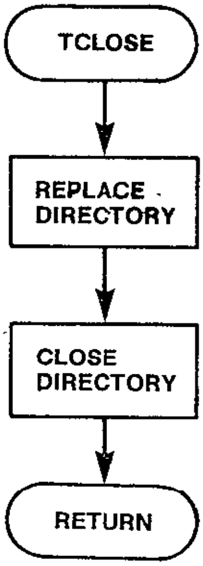


Figure 3-56. TCLOSE Logic Flow

3.6 INIT DESCRIPTION

The INIT module reads in turn the specifications for each problem from the Execution Control File. From these specifications it builds the data structures (network definition, traffic table, and tariffs) required for the specific CNDC problem, validating the input as it builds. If no error is encountered, INIT returns to the executive module, CNDC, and from there the appropriate optimization modules are initiated. If an error is encountered in the building of the data structures, INIT discontinues with the current problem description, locates within the Execution Control File the next problem description, and again attempts to build the required data structures, again validating the input in the process. INIT returns to CNDC whenever it has successfully constructed the data for a problem or when it has reached the end of the Execution Control File and the run is to terminate.

There are thirteen submodules which make up INIT. Figure 3-57 shows the hierarchical relationship of the thirteen submodules.

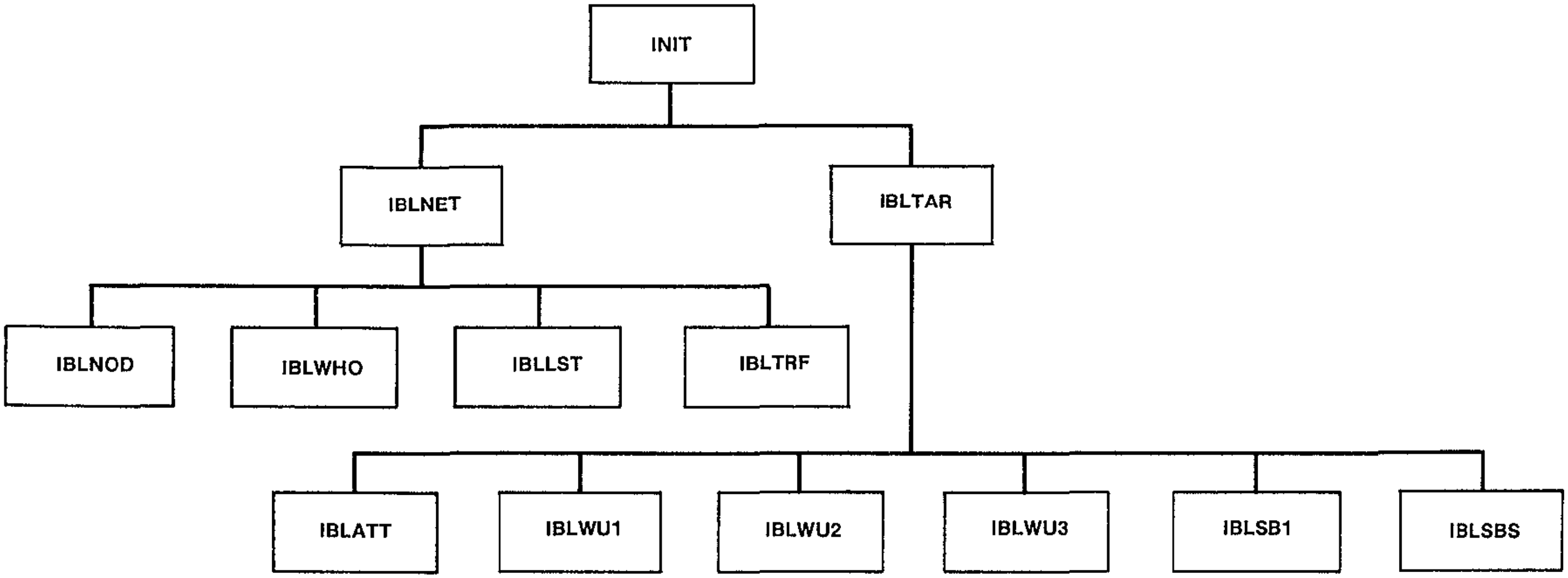


Figure 3-57. INIT Hierarchy Chart

3.6.1 INIT Module

SUBROUTINE INIT(CONT)

PURPOSE

READ THE RUN PARAMETERS FROM THE EXECUTION CONTROL FILE AND THE TARIFF AND NETWORK FILES SPECIFIED TO BUILD THE DATA STRUCTURES REQUIRED FOR A CNDC RUN

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

CONT	LOGICAL	FLAG WHICH COMMUNICATES TO THE EXECUTIVE IF IT SHOULD CONTINUE OR TERMINATE THE PROGRAM .TRUE. CONTINUE WITH THE RUN .FALSE. TERMINATE THE RUN

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

EXCUTE	/LUN/	U
FILNET	/RUN/	R
HEXEC	/HEADRS/	U
MAXTRF	/INPEXC/	U
NCASE	/RUN/	S
NOUT	/INPEXC/	U
NRSTRT	/INPEXC/	R
NTARIF	/RUN/	R
OPTION	/RUN/	R
OUTFLG(6)	/RUN/	R
RUNID	/INPEXC/	R
TF(13)	/RUN/	R
LUNOUT	/LUN/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

ERROR	LOGICAL	INDICATES IF NON FATAL ERROR ENCOUNTERED WHILE BUILDING DATA STRUCTURES FOR THIS PROBLEM
HEADER(2)	R*8	FILE HEADER READ FROM EXECUTE
WORD	I*4	FIRST WORD IN NEXT RECORD
ASTRX	I*4	CONSTANT '****'

SUBPROGRAMS CALLED

DIRGEN
DEFPRE
INBLNET
IBLTAR

```
ERRORS
     FATAL
       1010        EXECUTION CONTROL FILE HEADER NOT AS EXPECTED
     NONFATAL
       1510        ERROR ENCOUNTERED IN BUILDING TARIFF INPUT FOR
                   SPECIFIED PROBLEM
       1520        NUMBER OF TARIFFS SPECIFIED IN EXECUTION CONTROL
                   FILE OUT OF RANGE
       1530        ERROR ENCOUNTERED IN BUILDING NETWORK FOR SPECIFIED
                   PROBLEM
       1540        ERROR ENCOUNTERED IN BUILDING DATA STRUCTURES FOR
                   SPECIFIED CASE
       1550        ERROR ENCOUNTERED IN INPUT FOR SPECIFIED CASE
                   PROCEEDING TO NEXT CASE
```

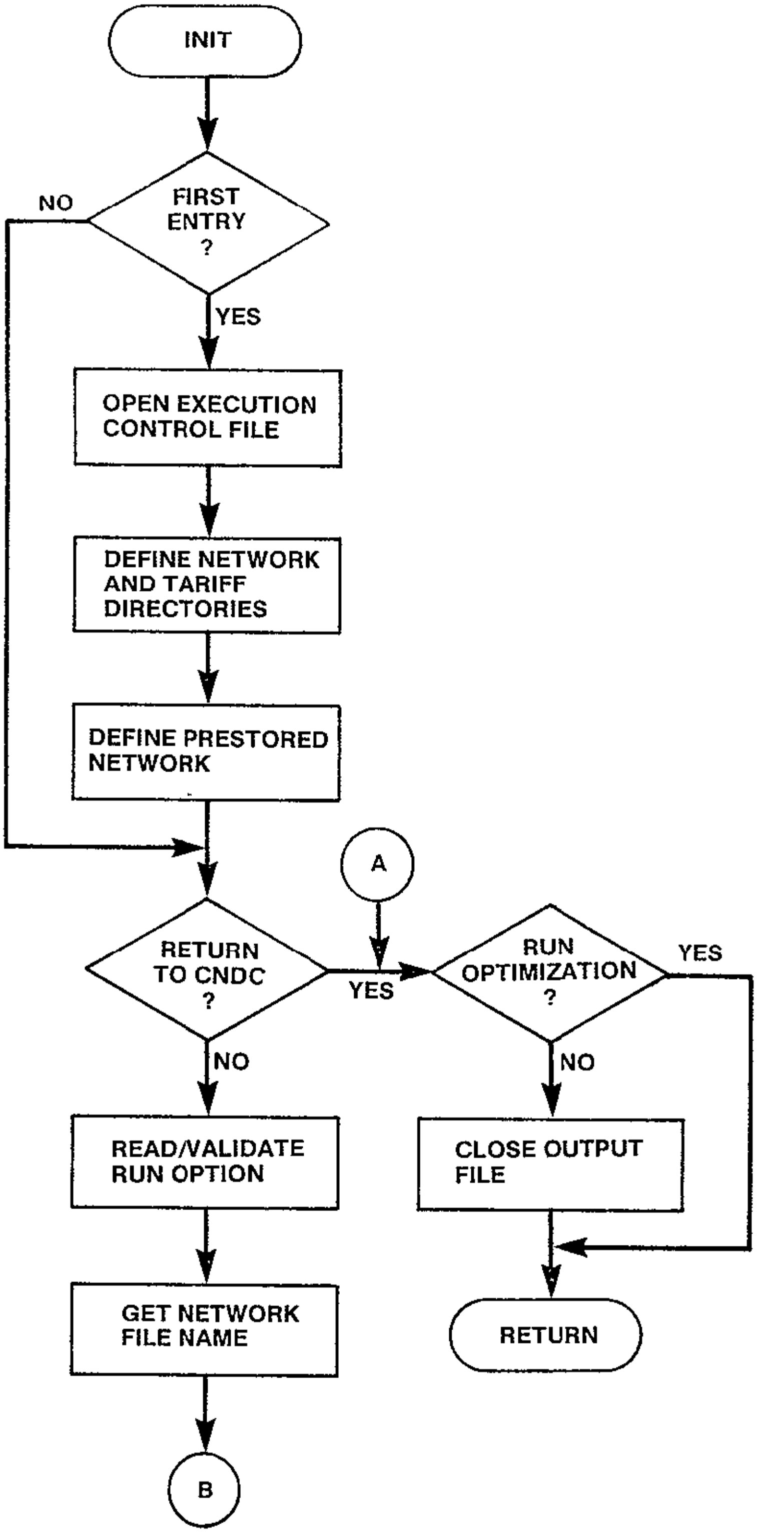


Figure 3-58. INIT Logic Flow (Sheet 1 of 2)

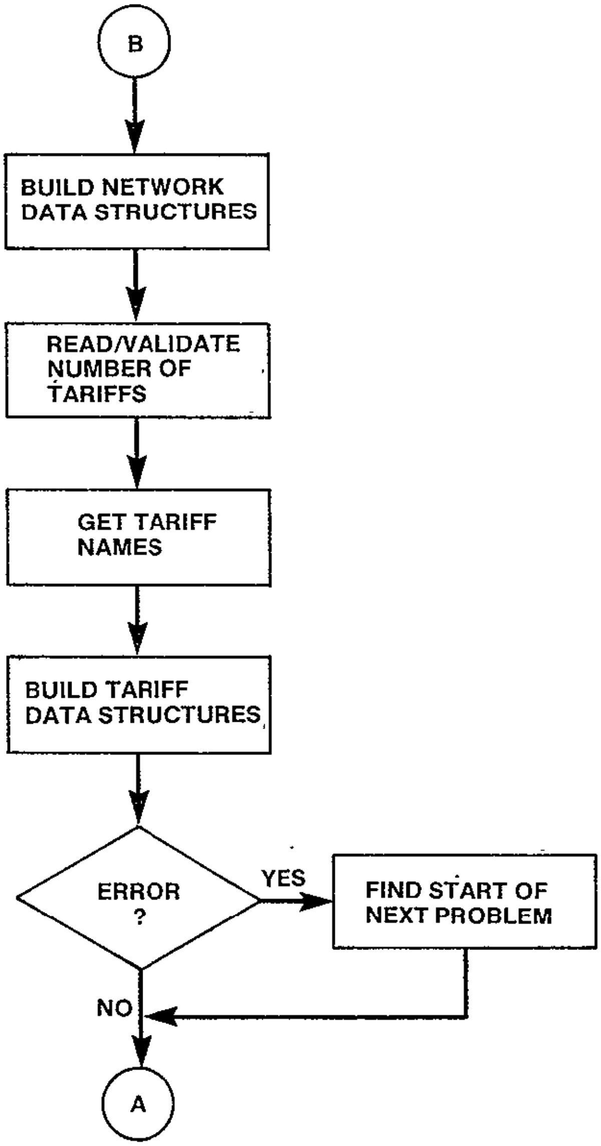

B
BUILD NETWORK DATA STRUCTURES
READ/VALIDATE NUMBER OF TARIFFS
GET TARIFF NAMES
BUILD TARIFF DATA STRUCTURES
ERROR ?
YES
FIND START OF NEXT PROBLEM
NO
A

Figure 3-58. INIT Logic Flow (Sheet 2 of 2)

3.6.2 IBLNET Module

```
        SUBROUTINE IBLNET(ERROR)

     PURPOSE
         READ THE NETWORK DESCRIPTION FILE AND BUILD THE NETWORK DATA
         STRUCTURES AND TRAFFIC TABLE DEFINED THEREIN

     INPUT ARGUMENTS
         NONE

     OUTPUT ARGUMENTS
         ERROR          LOGICAL    FLAG WHICH INDICATED IF AN ERROR WAS
                                   ENCOUNTERED WHILE VALIDATING INPUT

     DATA STRUCTURES
         (U - USED, S - DEFINED, R - READ)
         FILNET         /RUN/      U
         LUNNET         /LUN/      U
         NETDEF         /NETFIL/   U
         NFILES(20)     /NETFIL/   U
         NNFIL          /NETFIL/   U
         TRFLVL         /RUN/      R
         UNET           /HEADRS/   U
         OPTION         /RUN/      U
         DEBUG          /LUN/      U

     LOCAL VARIABLES
         EMPTY          I*4        CONSTANT  /0/  FILE NOT DEFINED
         FOUND          LOGICAL    NETWORK FILE NAME FOUND IN NETWORK
                                   DIRECTORY
         HEADER(2)      R*8        FILE HEADER
         I              I*4        LOOP INDEX
         SBONLY         I*4        CONSTANT  /3/  SBS TARIFF
         UNIT           I*4        LOGICAL UNIT NUMBER OF NETWORK FILE
         WHO(600)       I*2        IDENTIFIES FOR EACH NODE IN THE USER
                                   BY DEFINING THIS NUMBER OF THIS NODE IN
                                   THE PRESTORED NETWORK
         WUONLY         I*4        CONSTANT  /2/  WU TARIFF
         TEMP           I*4        TRAFFIC LEVEL READ FROM NETWORK FILE

     SUBPROGRAMS CALLED
         IBLNOD
         IBLWHO
         IBLLST
         IBLTRF

     ERRORS
         FATAL
           1030       FILE HEADER OF USER DEFINED NETWORK NOT AS EXPECTED
         NONFATAL
           1560       NETWORK FILE REQUESTED IS NOT DEFINED
           1570       NETWORK FILE REQUESTED NOT IN DIRECTORY
```

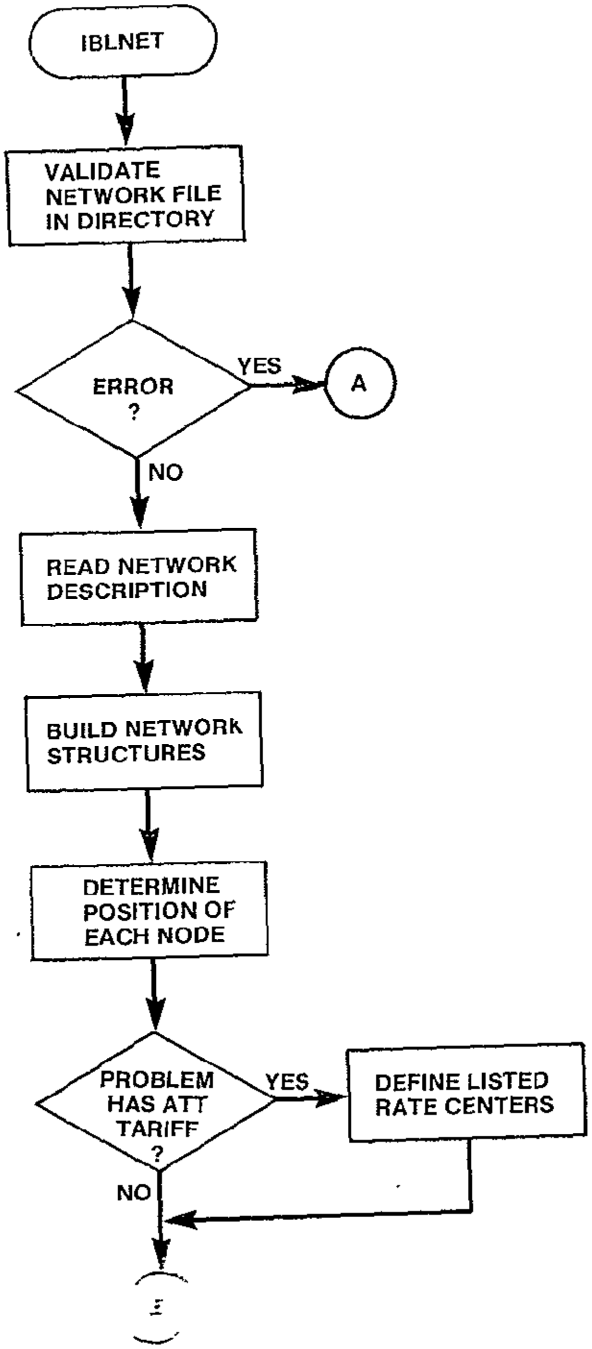


Figure 3-59. IBLNET Logic Flow (Sheet 1 of 2)

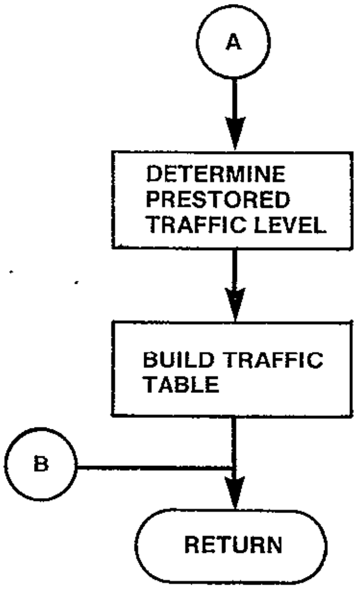


Figure 3-59. IBLNET Logic Flow (Sheet 2 of 2)

3.6.3 IBLNOD Module

SUBROUTINE IBLNOD(UNIT)

PURPOSE

READ THE SPECIFIED NETWORK FILE AND BUILD THE NETWORK AND THE DIRECTORY TO THE NETWORK

INPUT ARGUMENTS

UNIT	I*4	LOGICAL UNIT NUMBER OF NETWORK FILE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

DRNODE	/RNODES/	D
H(600)	/RNODES/	D
NDIR	/RNODES/	D
NNODES	/RUN/	D
NPBLK	/RNODES/	D
RTCNTR	/RNODES/	D
V(600)	/RNODES/	D
DEBUG	/LUN/	U

LOCAL VARIABLES

I	I*4	LOOP INDEX
INDX	I*4	POINTER TO NEXT ELEMENT IN RATE CENTER ARRAY TO BE PUT INTO DIRECTORY

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

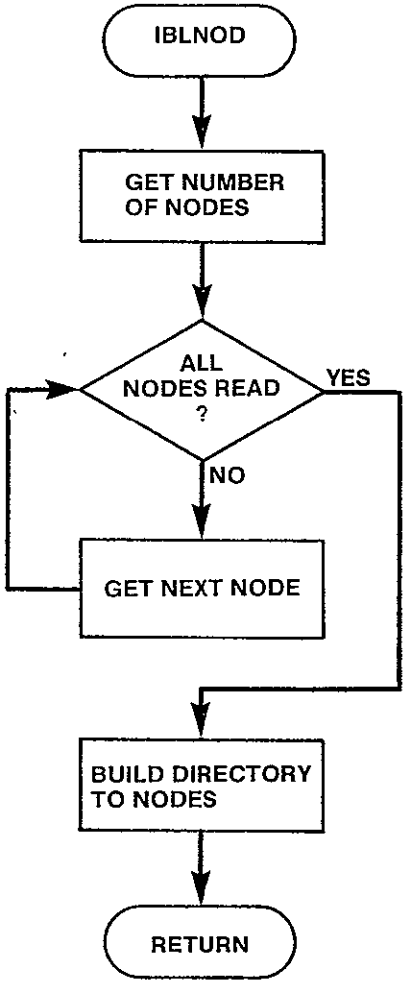


Figure 3-60. IBLNOD Logic Flow

3.6.4 IBLWHO Module

```
  SUBROUTINE IBLWHO(WHO)

PURPOSE
     BUILD A TEMPORARY TABLE, WHO, REQUIRED TO BUILD THE EXECUTION
     TRAFFIC TABLE FROM THE PRESTORED TRAFFIC TABLE

INPUT ARGUMENTS
     NONE

OUTPUT ARGUMENTS
     WHO            I*2       TABLE WHICH IDENTIFIES EACH NODE WITHIN
                              THE USER NETWORK WHICH IS IN THE PRESTORED
                              NETWORK BY THE RELATIVE POSITION OF THAT
                              NODE WITHIN THE PRESTORED NETWORK.  THIS
                              ARRAY IS REQUIRED BY THE SUBPROGRAM WHICH
                              BUILDS THE TRAFFIC TABLE TO PULL OUT THE
                              CORRECT TRAFFIC LEVELS FROM THE PRESTORED
                              TABLE

DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
     NNODES         /RUN/       U
     NPRNDS         /PRSNDS/    U
     RTCNTR         /RNODES/    U
     PRNDS          /PRSNDS/    U
     DEBUG          /LUN/       U

LOCAL VARIABLES
     I              I*4         INDEX TO NEXT PRESTORED NODE
     J              I*4         INDEX TO NEXT INPUT NODE

SUBPROGRAMS CALLED
     NONE

ERRORS
     FATAL
       NONE
     NONFATAL
       NONE
```

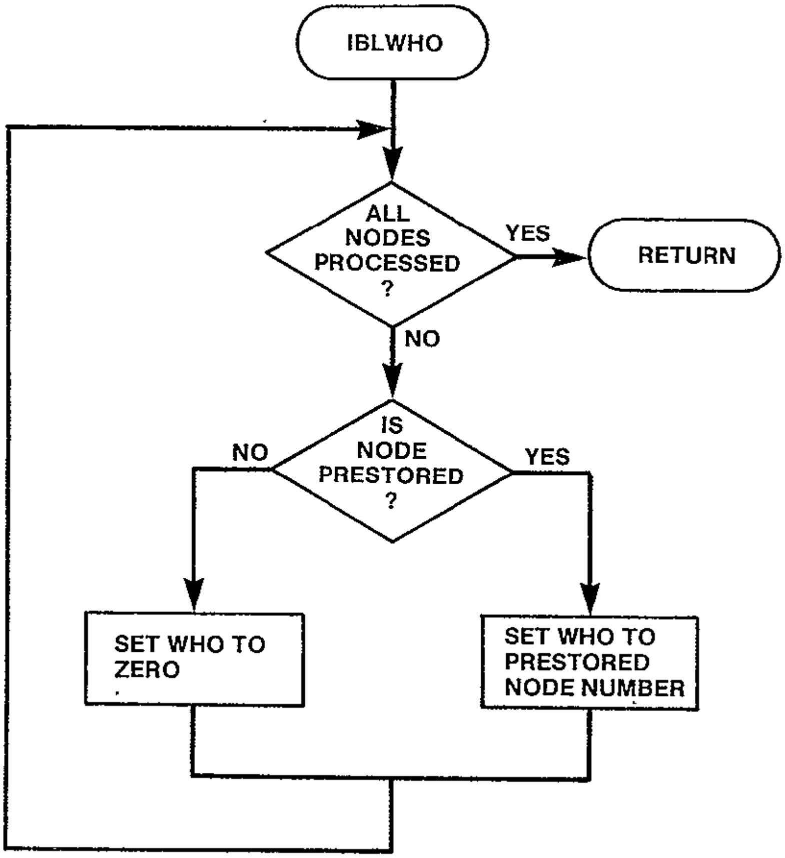


Figure 3-61. IBLWHO Logic Flow

3.6.5 IBLLST Module

SUBROUTINE IBLLST(ERROR)

PURPOSE

BUILD THE DATA STRUCTURE LSTED WHICH IDENTIFIES ALL OF THE NODES WHICH ARE ATT CATEGORY A RATE CENTERS. THIS STRUCTURE IS REQUIRED ONLY IF THE RUN INVOLVES A TERRESTRIAL TARIFF

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

ERROR	LOGICAL	ERROR DETECTED WHILE VALIDATING INPUT

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

HPATT	/HEADRS/	U
LSTED	/ATT/	S
NCATA	/INPATT/	S
NNODES	/RUN/	U
PRCATA	/INPATT/	S
RTCNTR	/RNODES/	U
TRFATT	/LUN/	U
NLEVL	/ATT/	U
NPLEVL	/ATT/	S
TATMLG	/ATT/	S
DEBUG	/LUN/	U

LOCAL VARIABLES

END	I*4	POSITION IN ARRAY OF LAST CATA RATE CENTER READ FROM CURRENT RECORD OF PRESTORED ATT TARIFF
J	I*4	LOOP INDEX
I	I*4	INDEX TO NEXT RATE CENTER IN NETWORK
K	I*4	INDEX TO NEXT PRESTORED CATA RATE CENTER
HEADER(2)	R*8	HEADER RECORD READ FROM FILE TRFATT
NLEFT	I*4	NUMBER CATA RATE CENTERS LEFT TO BE READ
NPREC	I*4	NUMBER OF CATA RATE CENTERS PER RECORD
NREC	I*4	NUMBER OF RECORDS CONTAINING CATA RATE CENTERS IN FILE TRFATT
DUM1-DUM6	R*4	DUMMY VARIABLES TO READ ATT TARIFF STRUCTURE
START	I*4	POSITION IN ARRAY OF FIRST CATA RATE CENTER READ FROM CURRENT RECORD OF PRE-STORED ATT TARIFF

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

1020 FILE HEADER OF PRESTORED ATT TARIFF FILE NOT AS EXPECTED

NONFATAL

1640 NUMBER OF BREAKPOINTS SPECIFIED IN ATT TARIFF EXCEEDS ARRAY CAPACITY IN MODEL

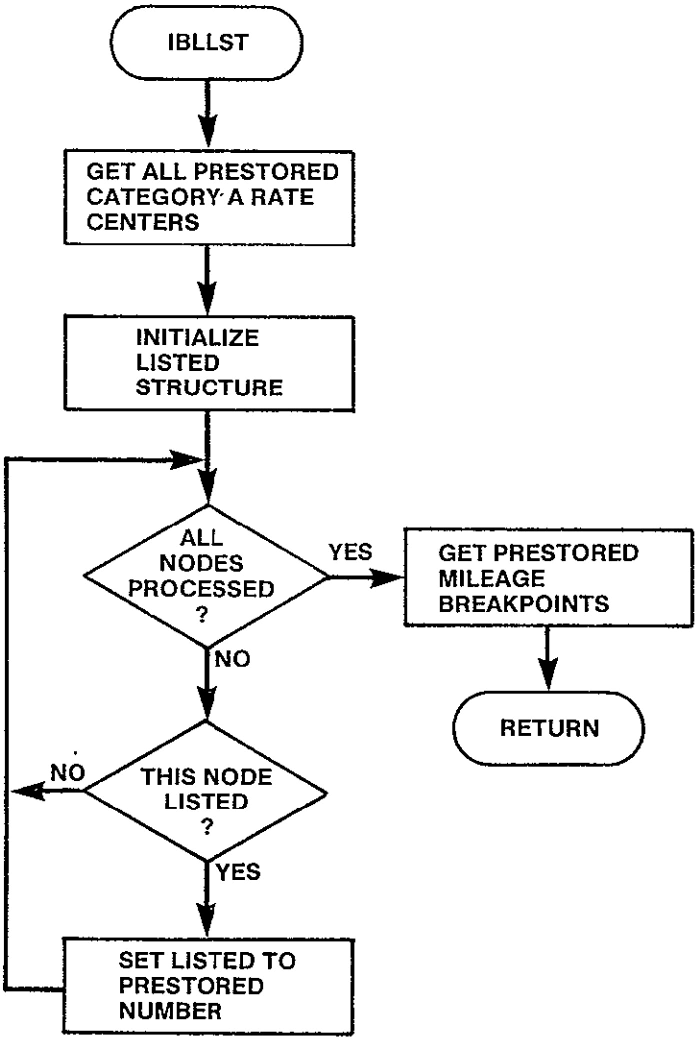

IBLLST
GET ALL PRESTORED CATEGORY A RATE CENTERS
INITIALIZE LISTED STRUCTURE
ALL NODES PROCESSED ?
YES
GET PRESTORED MILEAGE BREAKPOINTS
RETURN
NO
NO
THIS NODE LISTED ?
YES
SET LISTED TO PRESTORED NUMBER

Figure 3-62. IBLLST Logic Flow

3.6.6 IBLTRF Module

SUBROUTINE IBLTRF(WHO,UNIT)

PURPOSE

BUILD THE TRAFFIC TABLE FROM THE PRESTORED TRAFFIC TABLE AND THE ADDITIONAL TRAFFIC DEFINED IN THE NETWORK FILE

INPUT ARGUMENTS

WHO	I*2	ARRAY IDENTIFYING POSITION WITHIN PRESTORED NETWORK OF EVERY NODE IN THE USER NETWORK WHICH IS FROM THE PRESTORED SET
UNIT	I*4	LOGICAL UNIT NUMBER OF USER NETWORK DEFINITION FILE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NNODES	/RUN/	U
TRFLVL	/RUN/	U
TRFTBL	/LUN/	U
TRAFIC	/TRFC/	S
HTFC	/HEADRS/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

HEADER(2)	R*8	HEADER OF THE PRESTORED TRAFFIC TABLE
NEL	I*4	NUMBER OF ELEMENTS PER ROW IN TRAFFIC TABLE
FACT	I*4	NORMALIZATION FACTOR
LSTCOL	I*4	LAST COLUMN OF PRESTORED TRAFFIC TABLE READ
CURROW	I*4	ROW WITHIN TRAFFIC TABLE BEING DEFINED
I,J,K	I*4	LOOP INDICES
NSKIP	I*4	NUMBER OF ROWS IN PRESTORED TRAFFIC TABLE TO SKIP TO GET TO NEXT RECORD TO READ
TRF(350)	I*4	NEXT RECORD FROM TRFTBL CONTAINING CURRENT COLUMN FROM TRAFFIC TABLE
M	I*4	NEXT USER DEFINED MODE IN ROW
N	I*4	NEXT ITEM IN RECORD
CURCOL	I*4	CURRENT COLUMN BEING DEFINED
VCCNV	R*4	CONVERSION FACTOR TO COMPUTE NUMBER OF VOICE CURCUITS OR EACH NODE PAIR
NTRFC	I*4	NUMBER OF SETS OF ADDITIONAL TRAFFIC SPECIFIED
ROWNAM	I*4	ROW NAME
COLNAM	I*4	COLUMN NAME OF ADDITIONAL TRAFFIC
VC	I*4	NUMBER OF ADDITIONAL VOICE CIRCUITS BETWEEN ROWNAM AND COLNAM
ROWPTR	I*4	ROW POSITION OF ROWNAM IN USER NETWORK

COLPTR	I*4	COLUMN POSITION OF COLNAM IN USER NETWORK

SUBPROGRAMS CALLED
- MNMPTR
- TRFSKP
- WRTTRF

ERRORS

FATAL

1040	FILE HEADER OF PRESTORED TRAFFIC TABLE NOT AS EXPECTED

NONFATAL

1650	ADDITIONAL TRAFFIC SPECIFIED FOR A NODE NOT IN THE USER DEFINED NETWORK

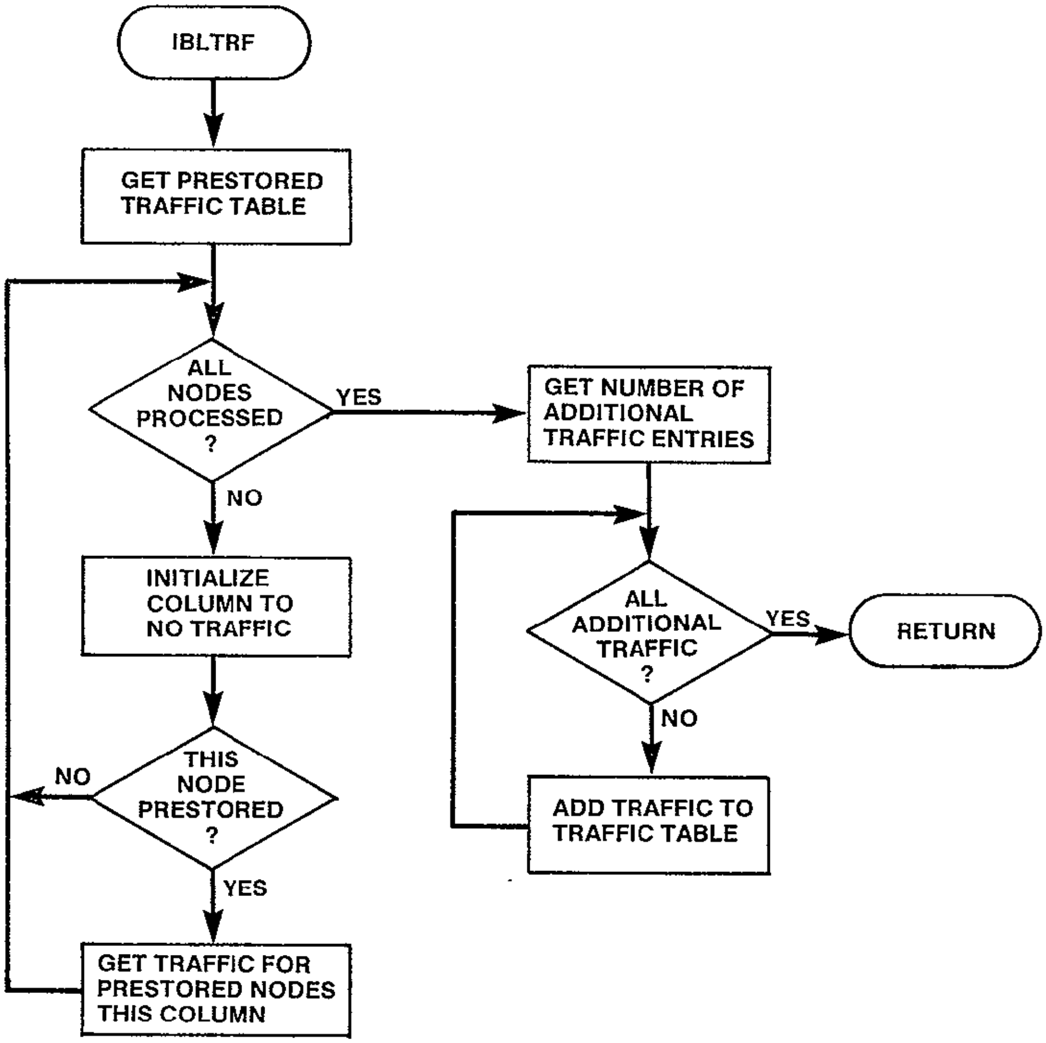

IBLTRF
GET PRESTORED TRAFFIC TABLE
ALL NODES PROCESSED ?
YES
GET NUMBER OF ADDITIONAL TRAFFIC ENTRIES
NO
INITIALIZE COLUMN TO NO TRAFFIC
ALL ADDITIONAL TRAFFIC ?
YES
RETURN
NO
THIS NODE PRESTORED ?
NO
ADD TRAFFIC TO TRAFFIC TABLE
YES
GET TRAFFIC FOR PRESTORED NODES THIS COLUMN

Figure 3-63. IBLTRF Logic Flow

3.6.7 IBLTAR Module

```
      SUBROUTINE IBLTAR(ERROR)

   PURPOSE
        READ THE TARIFF FILES SPECIFIED IN THE EXECUTION CONTROL
        FILE AND BUILD THE TARIFF DATA STRUCTURES

   INPUT ARGUMENTS
        NONE

   OUTPUT ARGUMENTS
        ERROR         LOGICAL       FLAG WHICH INDICATES IF AN ERROR
                                    WAS ENCOUNTERED WHILE BUILDING THE
                                    TARIFF DATA STRUCTURES

   DATA STRUCTURES
        (U - USED, S - DEFINED, R - READ)
        LUNTRF          /LUN/       U
        NTARIF          /RUN/       U
        NTFIL           /TARFIL/    U
        OPTION          /RUN/       U
        TARDEF(13)      /TARFIL/    U
        TF(13)          /RUN/       U
        TFILES(13)      /TARFIL/    U
        TRFATT          /LUN/       U
        TRFSBS          /LUN/       U
        TRFWU           /LUN/       U
        TTYP(13)        /RUN/       D
        DEBUG           /LUN/       U

   LOCAL VARIABLES
        I             I*4           LOOP INDEX
        UNDFND        I*4           CONSTANT  /0/  FILE UNDEFINED
        ATONLY        I*4           CONSTANT  /1/  ATT TARIFF
        SBONLY        I*4           CONSTANT  /3/  SBS TARIFF
        WUONLY        I*4           CONSTANT  /2/  WU TARIFF
        WUMXED        I*4           CONSTANT  /4/  WU MIXED RUN
        SBMXED        I*4           CONSTANT  /5/  SBS MIXED RUN
        NAVAIL        I*4           NEXT POSITION IN ATT STRUCTURES FOR NEXT
                                    ATT TARIFF DATA
        UNIT          I*4           LOGICAL UNIT NUMBER OF TARIFF FILE
        STATUS        I*4           TYPE OF TARIFF DEFINED
                                    1  ATT
                                    2  WU
                                    3  SBS
        SAVTAR(13)    I*4           SAVES NAMES OF TARIFFS THIS RUN
        PRSTRD        LOGICAL       INDICATES IF TARIFF DEFINITION FILE IS
                                    THE PRESTORED TARIFF
        FOUND         LOGICAL       INDICATES IF FILE NAME FOUND IN DIRECTORY
        TARNAM(3)     R*8           CONSTANT-NAMES OF PRESTORED TARIFF FILES
        K,J           I*4           LOOP INDEX
```

SUBPROGRAMS CALLED

IBLWU1
IBLWU2
ISLWU3
IBLATT
IBLSB1
IBLSBS

ERRORS

FATAL

NONE

NONFATAL

1580	REQUESTED FILE NOT DEFINED
1590	STATUS OF FILE OUT OR RANGE
1600	MISMATCH BETWEEN RUN TYPE AND TARIFF FILE TYPE
1610	MORE THAN 2 TARIFF FILES SPECIFIED FOR MIXED RUN
1620	TARIFF OPTION OUT OF RANGE
1630	FOR MIXED MODE THERE SHOULD BE TWO TARIFFS DEFINED - ONE SHOULD DEFINE AN ATT TARIFF AND THE OTHER EITHER WU OR SBS

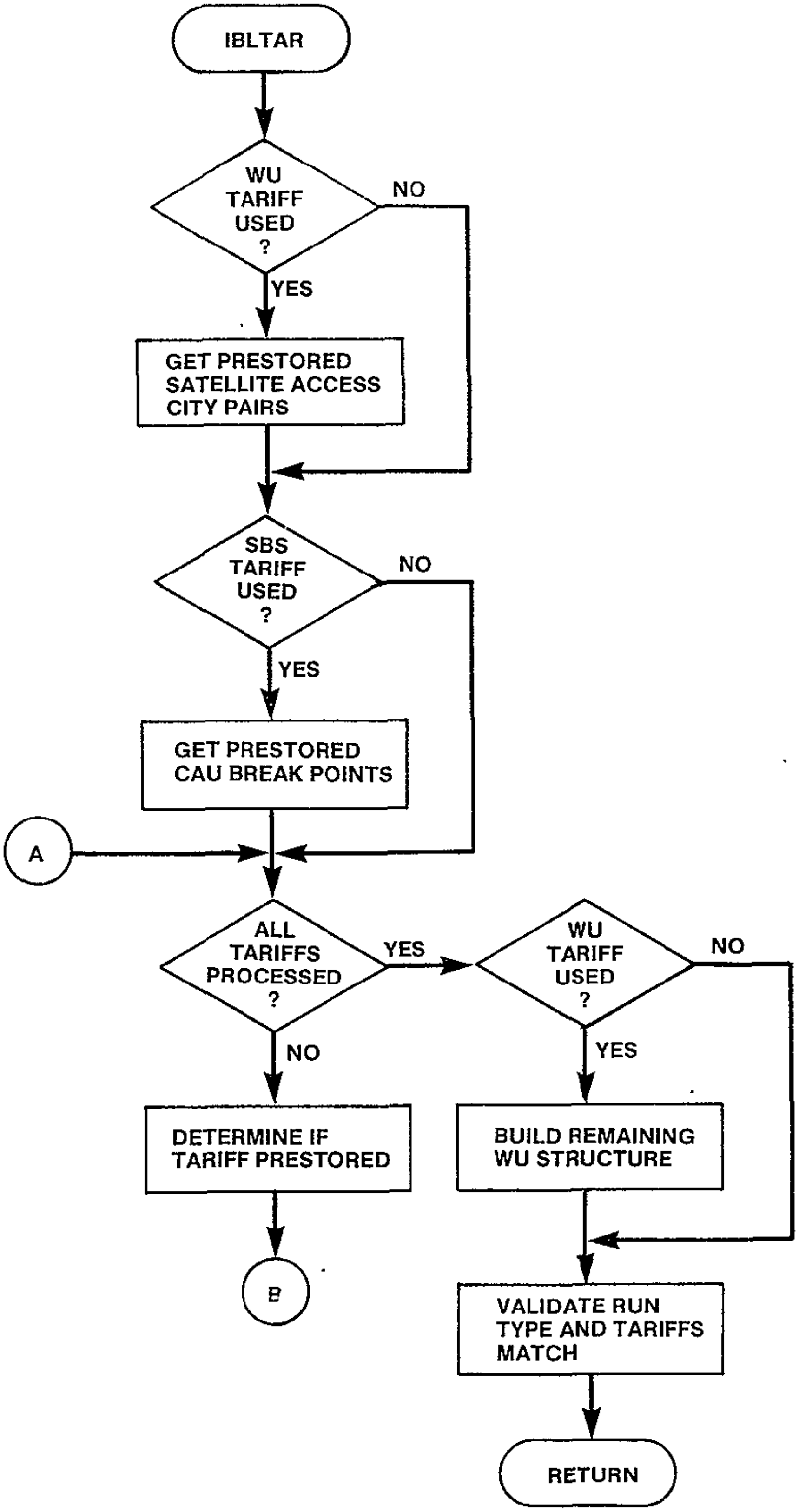

IBLTAR
WU TARIFF USED ?
NO
YES
GET PRESTORED SATELLITE ACCESS CITY PAIRS
SBS TARIFF USED ?
NO
YES
GET PRESTORED CAU BREAK POINTS
A
ALL TARIFFS PROCESSED ?
YES
NO
WU TARIFF USED ?
NO
YES
DETERMINE IF TARIFF PRESTORED
BUILD REMAINING WU STRUCTURE
B
VALIDATE RUN TYPE AND TARIFFS MATCH
RETURN

Figure 3-64. IBLTAR Logic Flow (Sheet 1 of 2)

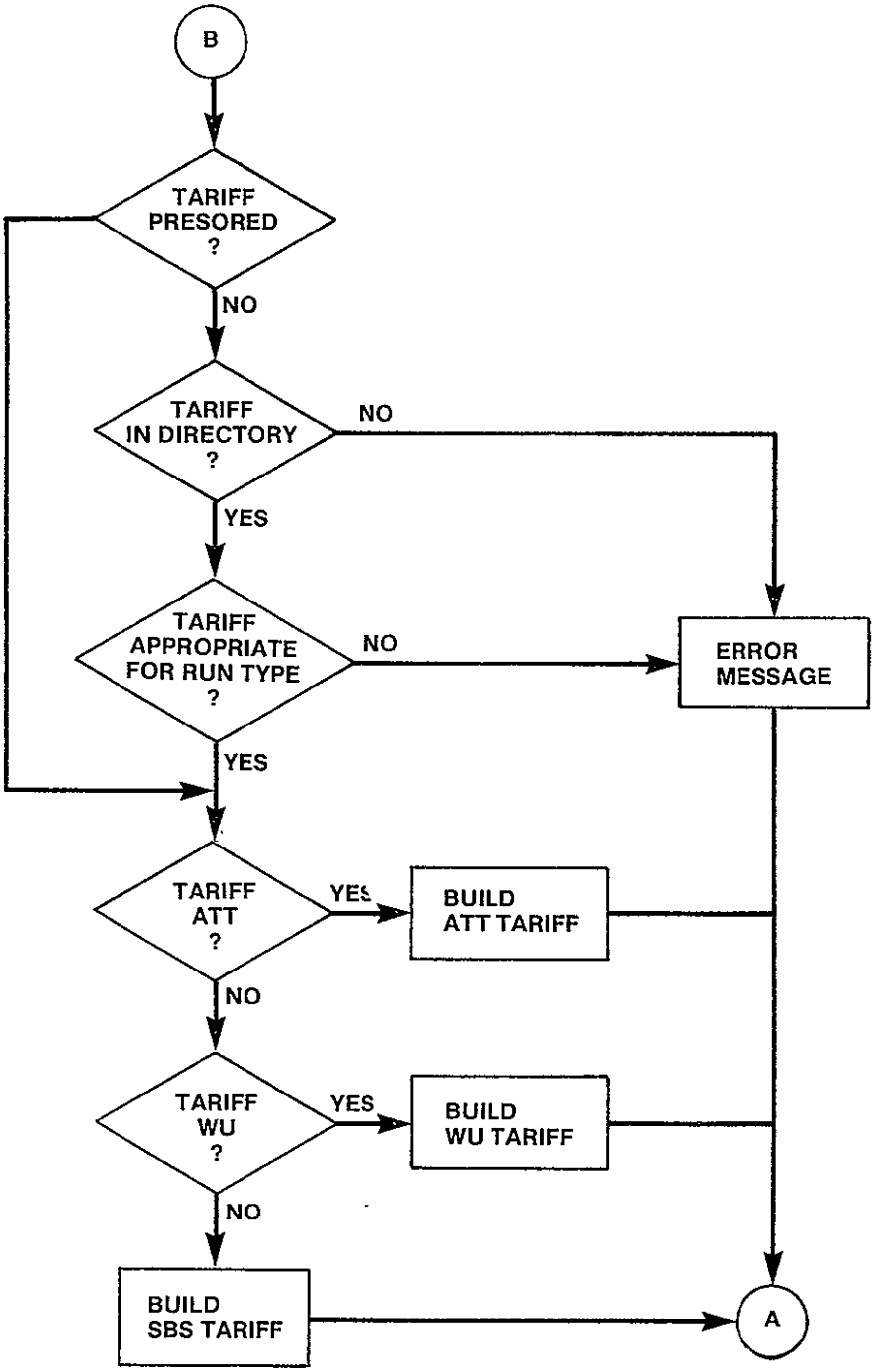


Figure 3-64. IBLTAR Logic Flow (Sheet 2 of 2)

3.6.8 IBLATT Module

```
SUBROUTINE IBLATT(PRSTRD,UNIT,FILE,K,NAVAIL,ERROR)
```

PURPOSE

READ ATT TARIFF SPECIFIED, EITHER THE PRESTORED TARIFF OR A NASA DEFINED ATT TYPE TARIFF, AND BUILD THE TERRESTRIAL TARIFF DATA STRUCTURES

INPUT ARGUMENTS

PRSTRD	L	INDICATOR OF TYPE OF ATT TARIFF BEING DEFINED .TRUE. PRESTORED ATT TARIFF .FALSE. NASA DEFINED ATT TYPE TARIFF
UNIT	I*4	LOGICAL UNIT NUMBER OF TARIFF FILE
FILE	R*8	NAME OF FILE CONTAINING TARIFF DEFINITION
K	I*4	NUMBER WITHIN CURRENT PROBLEM OF TARIFF BEING DEFINED
NAVAIL	I*4	NEXT AVAILABLE POSITION WITHIN THE ALSTD DATA STRUCTURE WHICH DEFINE NASA ALTERATIONS TO CATEGORY A RATE CENTER DEFINITION

OUTPUT ARGUMENTS

NAVAIL	I*4	NEXT AVAILABLE POSITION IN ALSTD DATA STRUCTURE
ERROR	L	ERROR DETECTED VALIDATING INPUT

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

ALSTD	/ATT/	S
NINLST	/ATT/	S
TATBAS	/ATT/	S
TATINC	/ATT/	S
TATMLG	/ATT/	U
TPTR	/ATT/	S
NPLEVL	/ATT/	U
HPATT	/HEADRS/	U
UTAR	/HEADRS/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

HEADER(2)	R*8	FILE HEADER
NADJ	I*4	NUMBER OF CATA ADJUSTMENTS IN USER DEFINED TARIFF
NREC	I*4	NUMBER OF RECORDS CONTAINING CATA SPECIFICATIONS IN PRESTORED TARIFF
NCATA	I*4	NUMBER OF CATA CENTERS IN PRESTORED TARIFF
CODE	I*4	CODE OF RATE CENTER SPECIFIED IN TARIFF ADJUSTMENTS

ADJ	I*4	NATURE OF ADJUSTMENT +1 CATA -1 NOT CATA
PTR	I*4	NUMBER OF RATE CENTER IN CURRENT NETWORK
I	I*4	LOOP INDEX
NTLEVL	I*4	NUMBER OF MILEAGE BREAKPOINTS SPECIFIED IN TARIFF FILE
MLG	I*4	MILEAGE BREAKPOINTS ON THIS FILE
ISTART	I*4	START OF ALSTD ARRAY TO PRINT FOR DEBUG
IEND	I*4	END OF ALSTD ARRAY TO PRINT FOR DEBUG

SUBPROGRAMS CALLED

MNMPTR
TRFSKP

ERRORS

FATAL

1050	HEADER RECORD OF TARIFF FILE NOT AS EXPECTED
1060	HEADER RECORD OF PRESTORD ATT FILE NOT AS EXPECTED

NONFATAL

1660	NUMBER OF MILEAGE BREAKPOINTS SPECIFIED IN TARIFF FILE NOT AS EXPECTED
1670	MILEAGE BREAKPOINTS SPECIFIED IN TARIFF FILE NOT AS EXPECTED

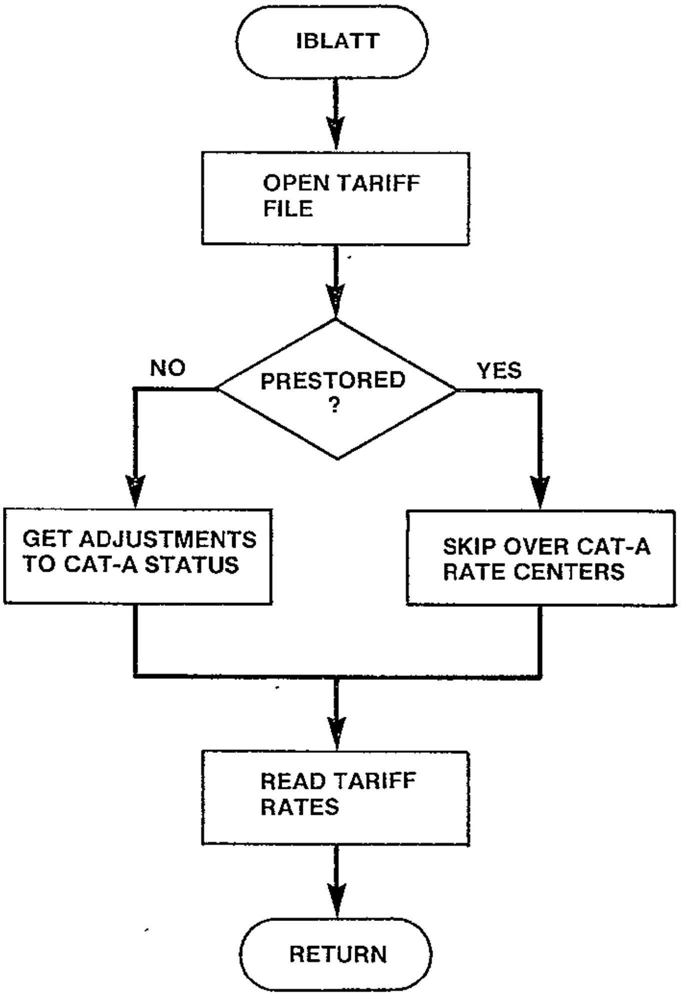


Figure 3-65. IBLATT Logic Flow

3.6.9 IBLWU1 Module

```
      SUBROUTINE IBLWU1

    PURPOSE
        IDENTIFY ALL OF THE NODES IN THE USER DEFINED NETWORK FOR
        THIS RUN WHICH ARE SATELLITE ACCESS CITIES AS DEFINED IN
        THE PRESTORED WU TARIFF

    INPUT ARGUMENTS
        NONE

    OUTPUT ARGUMENTS
        NONE

    DATA STRUCTURES
        (U - USED, S - DEFINED, R - READ)
        SA            /WU/        S
        NNODES        /RUN/       U
        HPWU          /HEADRS/    U
        TRFWU         /LUN/       U
        WUPRS         /WU/        S
        NWUTRI        /WU/        U
        NTARIF        /RUN/       U
        DEBUG         /LUN/       U

    LOCAL VARIABLES
        HEADER(2)     R*8         HEADER RECORD READ FROM TRFWU
        I,J           I*4         LOOP INDEX
        NPAIRS        I*4         NUMBER OF SATELLITE ACCESS CITY PAIRS IN
                                  PRESTORED TARIFF
        CODEL         I*4         LEFT MOST CODE SPECIFIED IN TARIFF
        CODER         I*4         RIGHT MOSE CODE SPECIFIED IN TARIFF
        CAT           I*4         TARIFF RATE
        PCODEL        I*4         PREVIOUS LEFT MOST CODE READ
        DUMY          I*4         CONSTANT TO INITIALIZE PCODEL
        LPTR          I*4         POSITION OF CODEL IN USER DEFINED NETWORK
                                  IF LPTR=0, CODEL NOT IN NETWORK
        RPTR          I*4         POSITION OF CODER IN USER DEFINED NETWORK
                                  IF RPTR=0, CODER NOT IN NETWORK

    SUBPROGRAMS CALLED
        MNMPTR

    ERRORS
        FATAL
          1070      HEADER RECORD READ FROM WU PRESTORED TARIFF NOT AS
                    EXPECTED
        NONFATAL
          NONE
```

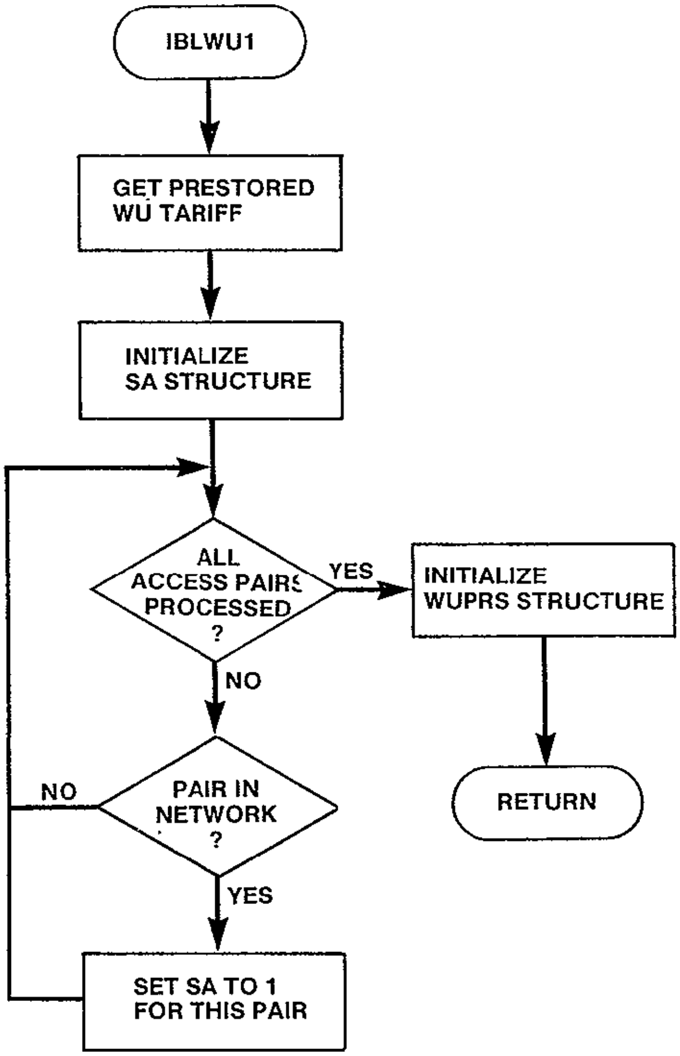


Figure 3-66. IBLWU1 Logic Flow

3.6.10 IBLWU2 Module

```
SUBROUTINE IBLWU2(PRSTRD,UNIT,FILE,K,SAVTAR)
```

PURPOSE

IDENTIFY ALL OF THE NODES IN THE USER DEFINED NETWORK FOR THIS PROBLEM WHICH ARE SATELLITE ACCESS CITY AS IDENTIFIED IN THE USER DEFINED WU TARIFFS

INPUT ARGUMENTS

PRSTRD	L	INDICATES IF THE CURRENT WU TARIFF IS PRESTORED .TRUE. PRESTORED TARIFF .FALSE. USER DEFINED
UNIT	I*4	LOGICAL UNIT NUMBER OF CURRENT WU TARIFF
FILE	I*4	NAME OF FILE DEFINING CURRENT WU TARIFF
K	I*4	NUMBER OF CURRENT TARIFF

OUTPUT ARGUMENTS

SAVTAR(13)	I*4	LUN FOR EACH WU TARIFF DEFINED FOR THIS PROBLEM

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

UTAR	/HEADR/	U
SA	/WU/	S
DEBUG	/LUN/	U

LOCAL VARIABLES

HEADER(2)	R*8	FILE HEADER READ FROM CURRENT TARIFF
NADJ	I*4	NUMBER OF ADJUSTMENTS TO TARIFF
PCODEL	I*4	PREVIOUS LEFT CODE IN TARIFF
DUMY	I*4	CONSTANT FOR INITIALIZING PCODEL
CODEL	I*4	LEFT CODE READ FROM CURRENT TARIFF
I	I*4	LOOP INDEX
CODER	I*4	RIGHT CODE SPECIFIED IN CURRENT TARIFF
LPTR	I*4	NUMBER OF CODEL IN USER DEFINED NETWORK
RPTR	I*4	NUMBER OF CODER IN USER DEFINED NETWORK
CAT	I*4	RATE TYPE OF SATELLITE CITY PAIR

SUBPROGRAMS CALLED

MNMPTR

ERRORS

FATAL

1080	FILE HEADER READ FROM USER DEFINED WU TARIFF NOT AS EXPECTED

NONFATAL

NONE

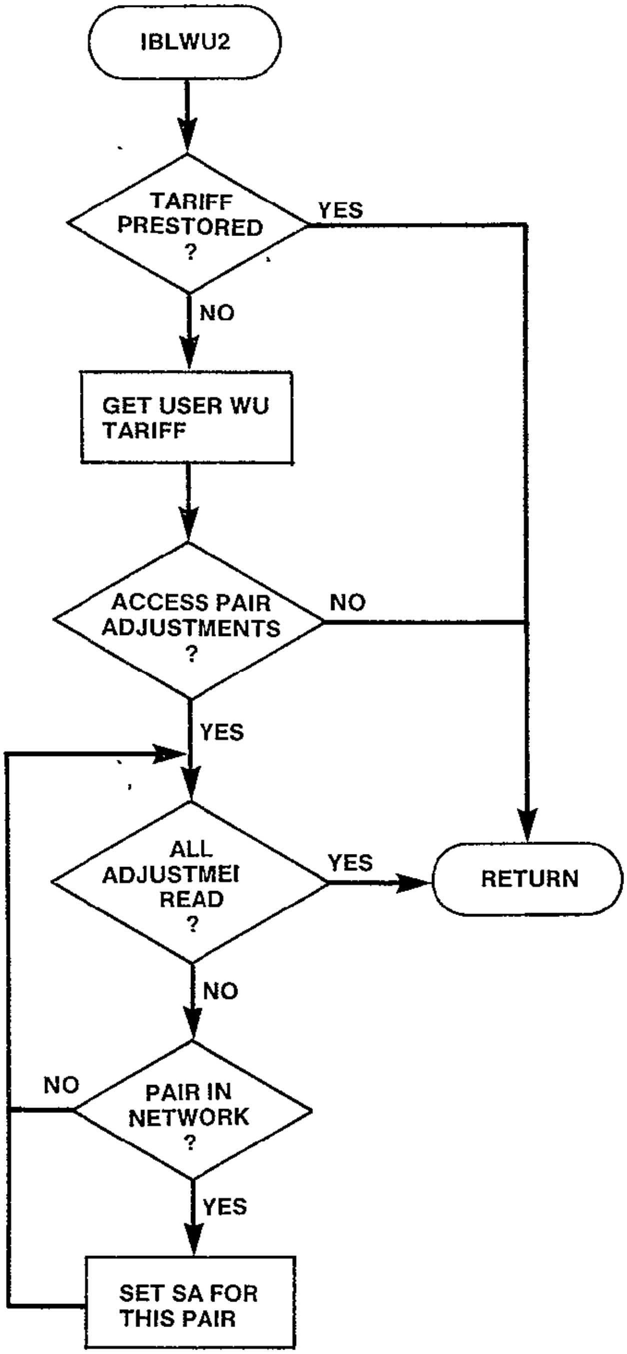


Figure 3-67. IBLWU2 Logic Flow

3.6.11 IBLWU3 Module

```
      SUBROUTINE IBLWU3(SAVTAR,ERROR)

   PURPOSE
        DETERMINE THE NUMBER OF SATELLITE ACCESS CITIES IN THIS
        PROBLEM AND BUILD REMAINING WU TARIFF DATA STRUCTURES

   INPUT ARGUMENTS
        SAVTAR(13)     I*4        ARRAY OF LOGICAL UNIT NUMBERS FOR WU
                                  TARIFF

   OUTPUT ARGUMENTS
        ERROR          LOGICAL    INDICATES IF ERROR ENCOUNTERED WHILE
                                  VALIDATING WU TARIFF INPUT

   DATA STRUCTURES
        (U - USED, S - DEFINED, R - READ)
        NNODES         /RUN/      U
        NTARIF         /RUN/      U
        OPTION         /RUN/      U
        TRFWU          /LUN/      U
        NSATAX         /WU/       S
        SA             /WU/       S
        SATACC         /WU/       S
        TWU            /WU/       S
        WUPRS          /WU/       S
        DEBUG          /LUN/      U
        HPWU           /HEADRS/   U
        WURTCT         /WU/       S
        MAXSAC         /WU/       U
        UTAR           /LUN/      U
        TF             /RUN/      U
        NWUCAT         /WU/       U

   LOCAL VARIABLES
        BEGIN          I*4        FIRST TARIFF TO CONSIDER
        END            I*4        LAST TARIFF TO CONSIDER
        HEADER(2)      R*8        HEADER RECORD FROM WU TARIFF
        PCODEL         I*4        PREVIOUS LEFT CODE READ FROM TARIFF
        CODEL          I*4        LEFT CODE IN TARIFF CITY PAIR
        CODER          I*4        RIGHT CODE IN TARIFF CITY PAIR
        DUMY           I*4        CONSTANT TO INITIALIZE PCODEL
        NPAIRS         I*4        NUMBER OF ACCESS CITY PAIRS SPECIFIED IN
                                  TARIFF
        CAT            I*4        TARIFF CATEGORY
        I,J,K          I*4        LOOP INDICES
        LPTR           I*4        POSITION OF CODEL IN USER DEFINED NETWORK
        RPTR           I*4        POSITION OF CODER IN USER DEFINED NETWORK
        PTR            I*4        POSITION WUPRS OF CITY PAIR LPTR, RPTR
        FOUND          L          INDICATES ONE OF WU TARIFFS IS THE PRE-
                                  STORED TARIFF
```

UNIT	I*4	LOGICAL UNIT NUMBER OF THE TARIFF UNDER CONSIDERATION
JEND	I*4	NUMBER OF ROWS TO CONSIDER
KBEG	I*4	BEGINNING TO NEXT ROW IN UPPER RIGHT TRIANGLE OF SQUARE MATRIX
LPTR2	I*4	POSITION OF CODEL IN SATELLITE ACCESS CITIES
RPTR2	I*4	POSITION OF CODER IN SATELLITE ACCESS CITIES
FIRST	I*4	INDEX TO PRINT ARRAY IN DEBUG PRINT
SEC	I*4	INDEX TO PRINT ARRAY IN DEBUG PRINT
LAST	I*4	INDEX TO PRINT ARRAY IN DEBUG PRINT
FINL	I*4	INDEX TO PRINT ARRAY IN DEBUG PRINT
NEXT	I*4	INDEX TO PRINT ARRAY IN DEBUG PRINT

SUBPROGRAMS CALLED

MNMPTR
PTRPRS

ERRORS

FATAL

1090 FILE HEADER OF PRESTORED WU TARIFF NOT AS EXPECTED

1100 FILE HEADER OF USER DEFINED W5 TARIFF NOT AS EXPECTED

NONFATAL

1680 NUMBER OF SATELLITE ACCESS CITIES FOR THIS PROBLEM EXCEEDS ARRAY CAPACITY OF THE MODEL

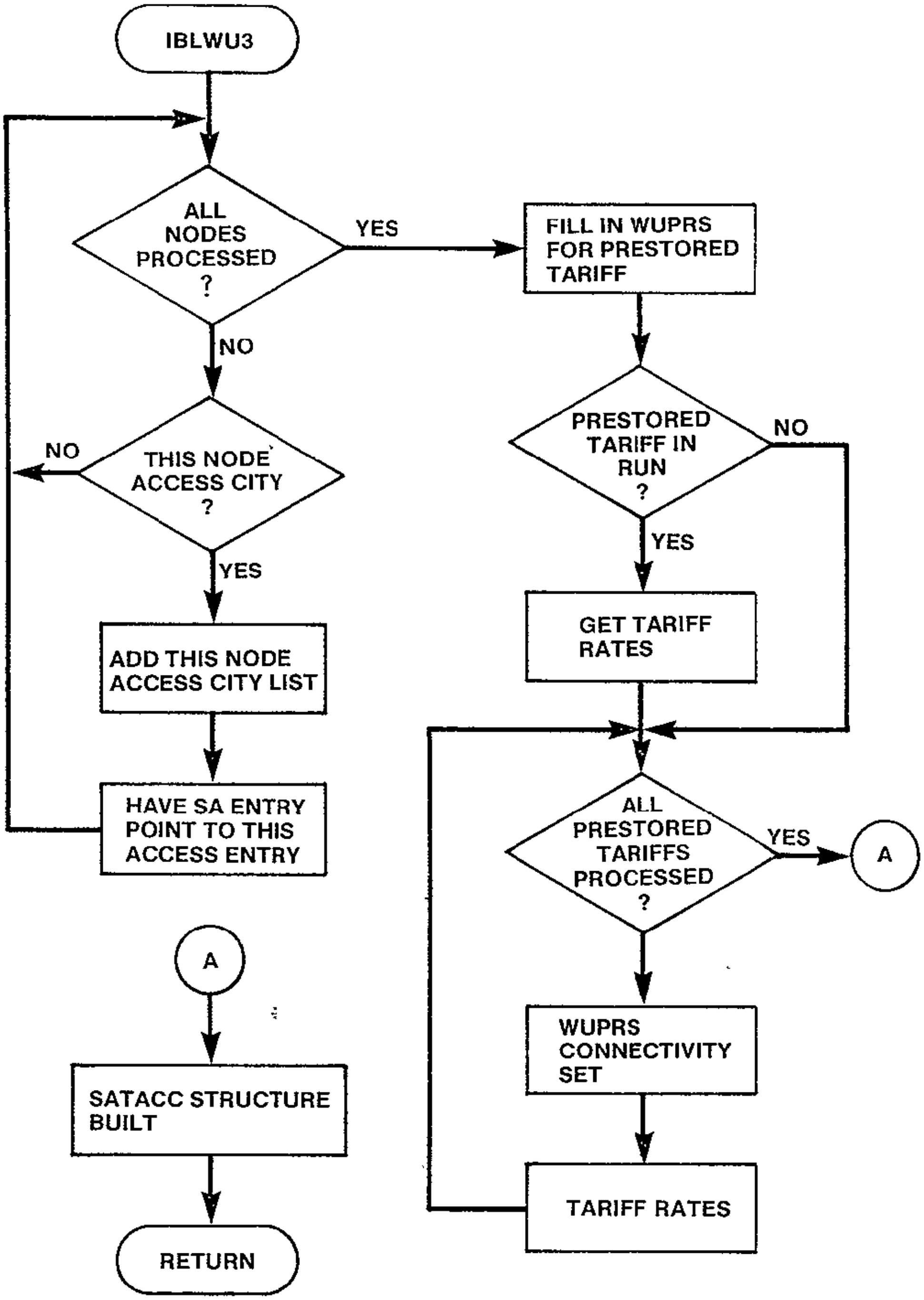

IBLWU3
ALL NODES PROCESSED ?
YES
NO
FILL IN WUPRS FOR PRESTORED TARIFF
THIS NODE ACCESS CITY ?
NO
YES
PRESTORED TARIFF IN RUN ?
NO
YES
ADD THIS NODE ACCESS CITY LIST
GET TARIFF RATES
HAVE SA ENTRY POINT TO THIS ACCESS ENTRY
ALL PRESTORED TARIFFS PROCESSED ?
YES
A
A
WUPRS CONNECTIVITY SET
SATACC STRUCTURE BUILT
TARIFF RATES
RETURN

Figure 3-68 IBLWU3 Logic Flow

3.6.12 IBLSB1 Module

SUBROUTINE IBLSB1(ERROR)

PURPOSE

DETERMINE PRESTORED NUMBER OF CAU PER NAC BREAKPOINTS

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

ERROR	L	INDICATES IF ERROR DETECTED DURING INPUT

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

TRFSBS	/LUN/	U
HPSBS	/HEADRS/	U
TSBBKP	/SBS/	S
NPTAB	/SBS/	S
NTAB	/SBS/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

HEADER(2)	R*8	HEADER READ FROM PRESTORED SBS TARIFF
DUM1-DUM2	R*4	DUMMY VARIABLES READ FROM SBS TARIFF
I	I*4	LOOP INDEX

SUBPROGRAMS CALLED

TRFSKP

ERRORS

FATAL

1110	FILE HEADER READ FROM PRESTORED SBS TARIFF NOT AS EXPECTED

NONFATAL

1690	NUMBER OF ENTRIES IN CAU COST TABLE GREATER THAN CAPACITY OF ARRAYS IN MODEL

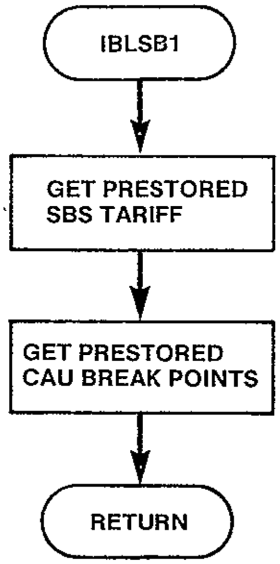


Figure 3-69. IBLSB1 Logic Flow

3.6.13 IBLSBS Module

SUBROUTINE IBLSBS(PRSTRD,UNIT,FILE,K,ERROR)

PURPOSE

READ THE PRESTORED OR NASA DEFINED SBS TARIFF SPECIFIED AND BUILD SBS TARIFF DATA STRUCTURES

INPUT ARGUMENTS

PRSTRD	L	LOGICAL FLAG WHICH INDICATES IF THE PRESTORED SBS OR NASA DEFINED SBS FILE IS TO BE READ .TRUE. PRESTORED SBS TARIFF .FALSE. NASA DEFINED SBS TARIFF
UNIT	I*4	LOGICAL UNIT NUMBER OF TARIFF TO BE READ
FILE	R*8	FILE NAME OF TARIFF
K	I*4	NUMBER OF CURRENT TARIFF IN THIS PROBLEM

OUTPUT ARGUMENTS

ERROR	L	INDICATES IF ERROR DETECTED WHILE VALIDATING TARIFF INPUT

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

TSBBKP	/SBS/	U
TSBCAB	/SBS/	S
TSBCAI	/SBS/	S
TSBCMN	/SBS/	S
TSBFTU	/SBS/	S
TSBNAC	/SBS/	S
TSBSCU	/SBS/	S
NPTAB	/SBS/	U
HPSBS	/HEADRS/	U
UTAR	/HEADRS/	U
NACNMB	/SBSMXD/	S
NACLOC	/SBSMXD/	S
SBMX	/SBSMXD/	S
OPTION	/RUN/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

NTABL	I*4	NUMBER OF BREAKPOINTS IN INPUT SBS TABLE
BKP	I*4	BREAKPOINT READ FROM INPUT SBS TABLE
HEADER(2)	R*8	HEADER READ FROM SBS TARIFF FILE
NREC	I*4	NUMBER OF RECORDS CONTAINING NAC LOCATIONS
NENTRY	I*4	NUMBER OF NAC SITES SPECIFIED
NPREC	I*4	NUMBER OF NAC SPECIFICATIONS PER RECORD
NLEFT	I*4	NUMBER OF NAC SPECIFICATIONS LEFT TO READ
I,J	I*4	LOOP INDICES
END	I*4	NUMBER OF NACS SPECIFIED ON CURRENT RECORD

NXTNAC(16)	I*4	ONE RECORDS WORTH OF NACS

SUBPROGRAMS CALLED
USRNET

ERRORS
FATAL
1120 FILE HEADER OF SBS TARIFF NOT AS EXPECTED
1130 FILE HEADER OF PRESTORED SBS TARIFF NOT AS EXPECTED
NONFATAL
1700 NUMBER OF BREAKPOINTS IN SBS TABLE NOT AS EXPECTED
1710 BREAKPOINT VALUES IN SBS TABLE NOT AS IN PRESTORED TARIFF

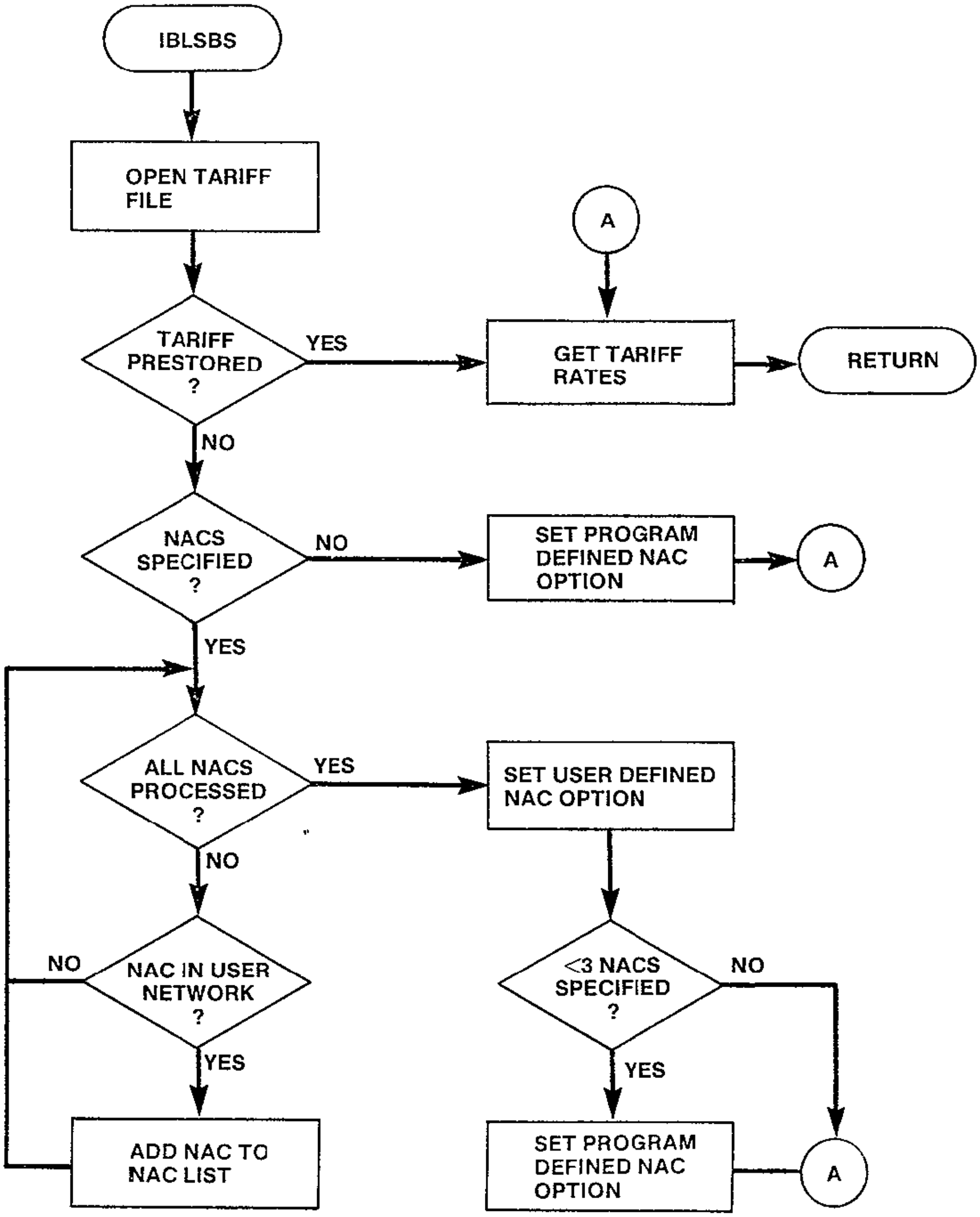


Figure 3-70. IBLSBS Logic Flow

3.7 OUTPUT DESCRIPTION

The CNDC model provides six categories of output: (1) user inputs to a problem, (2) city pair output - exclusive of other network traffic, (3) city pair output for least cost network, (4) network totals, (5) tariff totals, and (6) traffic table. The user selects which output is desired for each problem set at the time the execution control file is built. These six categories of output are contained in six tables which will be described below.

Table 1 - Input

This table presents the runid, current problem number, run type (terrestrial, Western Union, SBS, mixed Western Union, and mixed SBS), the name of the network file, number of tariffs and name of each tariff file. Each node in the network is identified by its four character code and name. The traffic level of the prestored traffic table is specified in voice circuits. Finally, each tariff included in the run is fully described.

Table 2 - City Pair Output - Exclusive of Other Network Traffic

The least-cost route and the transmission medium that is necessary to satisfy the traffic requirement for each unique pair of traffic nodes, exclusive of other network traffic, is listed in tabular form. For each unique city pair, a description of the least-cost route is followed by a table summarizing information about each link in the route.

Each unique pair of traffic nodes and the nodes in the corresponding least-cost route are identified by using the alphabetic codenames assigned to the cities. An ordered list of the codenames of the nodes in the least-cost route is followed by the total circuit mileage on the route. The link summary is a table containing one line of output for each link in the least-cost route.

There are seven items included in each link summary. The alphabetic codenames of the service nodes defining the link are indicated for each link. The airline mileage is calculated from the vertical and horizontal coordinates of the associated service nodes using the standard mileage formula. The traffic volume (in voice circuits) on each line is calculated by summing all traffic internal to the least-cost route that traverses the link. A facility size is determined to meet the requirements of this traffic volume. The cost per circuit that was determined to be a minimum for the link considering all tariffs in the run is included. The total cost of circuits for the link is the product of the traffic volume in voice circuits and the cost of a single circuit. The tariff used to determine the cost per circuit for the link is identified by its character description.

Entries in the line summary are added until all the lines in the least-cost route have been summarized. The same information is then output for the next unique city pair. Least-cost routes are described for all pairs of cities in the network.

Table 3 - City Pair Output for Least-Cost Network

For every city pair, considering traffic in the entire network, the least-cost route and medium that is necessary to satisfy the traffic requirements of the network is included in the CNDC output. If the satellite-only option was chosen any non-satellite access cities among the network nodes are indicated by a list of their alphabetic codenames. Non-satellite access cities do not appear further in the least-cost network output.

Each city pair and the nodes in the corresponding least-cost route are identified using alphabetic codenames. For each pair of cities, an enumeration of the nodes in the least-cost route is followed by a tabular line summary.

There are five items included in each link summary. The alphabetic codenames of the service nodes defining the link are identified for each link. The network traffic volume on each link represents the total number of voice circuits on the link. This number is the sum of the traffic volumes between all pairs of cities where the least-cost route between the cities traverses the link in question. The facility size required to accommodate the total link volume is included in the link summary. The cost per circuit that was determined to be a minimum for the link considering all tariffs in the run is listed. The tariff used to provide service for the link is specified by its character description (TRFWU, TRF003, etc).

Entries in the link summary are added until all the links in the least-cost route have been summarized. The same information is then output for the next unique city pair. Least-cost routes and the medium necessary to satisfy the traffic requirements of the network are described for all pairs of cities in the network.

Table 4 - Output Network Totals by Service

Overall totals for the entire least-cost network by service (satellite and terrestrial) are included in the CNDC output. The total terrestrial circuit mileage, the total satellite circuit mileage, and the combined total circuit mileage are printed. The total number of terrestrial voice circuits, the total number of satellite voice circuits, and the combined total number of voice circuits are printed. The total cost of all the terrestrial circuits, the total cost of all the satellite circuits, and the combined total cost of circuits are printed.

Table 5 - Output Network Totals by Tariff

For every tariff evaluated in the CNDC Model, a summary of its utilization in the least-cost routing network is included in the model output. Each tariff is identified by its character description. The total circuit mileage associated with each tariff in the least-cost routing network is printed. The total traffic volume associated with each tariff is expressed as a number of voice circuits and as a percentage of the total number of voice circuits in the least-cost routing network. The total cost associated with each tariff is expressed as a cost and as a percentage of the total cost of the least-cost routing network.

Table 6 - Traffic Table

Directional traffic from each node in the network to every other node (expressed in voice circuits) is presented in the traffic table.

A hierarchy chart of the output module can be seen in figure 3-71.

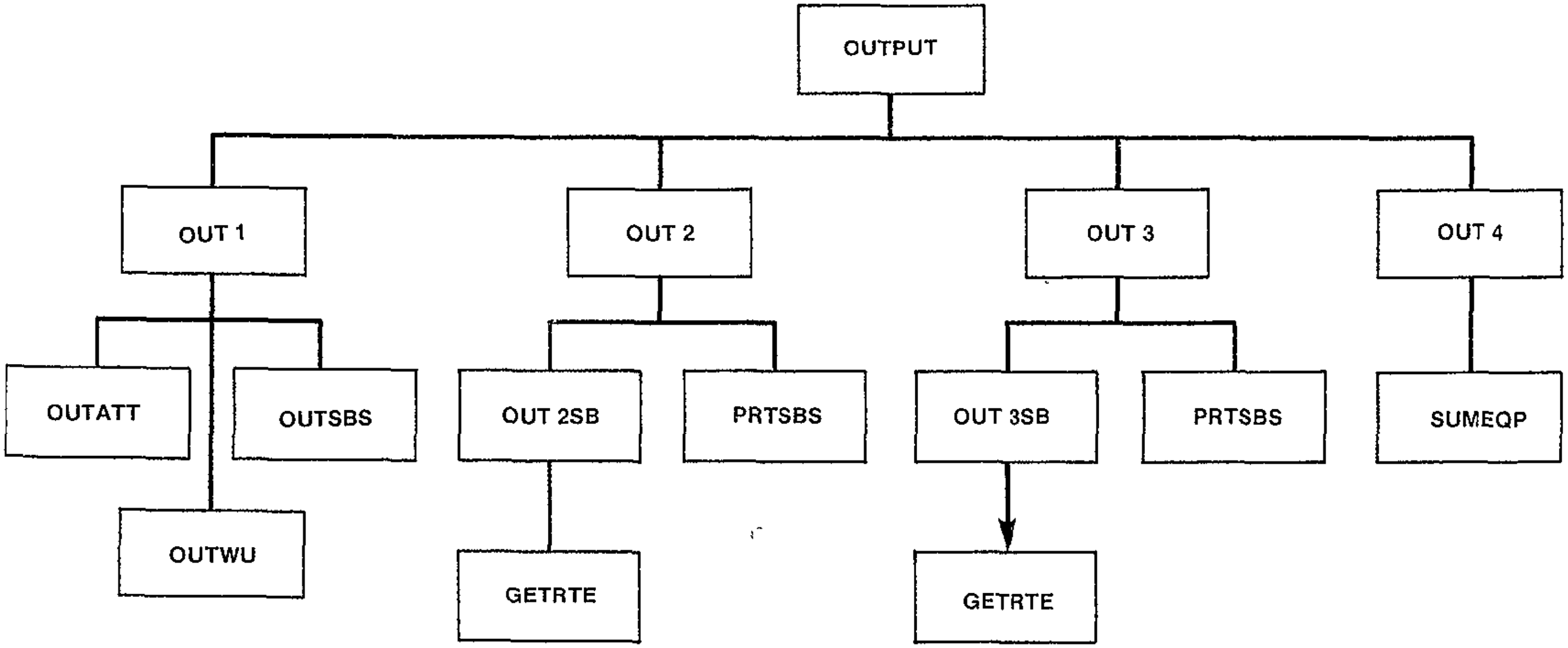


Figure 3-71. OUTPUT Hierarchy Chart

3.7.1 Output Module

SUBROUTINE OUTPUT

PURPOSE
PREPARE AND WRITE ALL MODEL OUTPUTS

INPUT ARGUMENTS
NONE

OUTPUT ARGUMENTS
NONE

DATA STRUCTURES
(U - USED, S - DEFINED, R - READ)

OUTFLG	/RUN/	U
LUNOUT	/LUN/	U
RUNID	/INPEXC/	U
NCASE	/RUN/	U
OPTION	/RUN/	U
TRAFIC	/TRFC/	U
RTCNTR	/RNODES/	U
NNODES	/RUN/	U
NTARIF	/RUN/	U

LOCAL VARIABLES

HEADER	L	HEADER TO LIST ON NON ACCESS CITIES
TOTAL	I*4	TOTAL CIRCUITS AMONG NON ACCESS CITIES
COL	I*4	COLUMN WITHIN TRAFFIC TABLE
ENDCOL	I*4	LAST ITEM IN COLUMN TO SEARCH
ROW	I*4	ROW WITHIN TRAFFIC TABLE
VFS	I*4	TRAFFIC BETWEEN NON ACCESS CITY PAIR
NODA	I*4	ALPHABETIC DESCRIPTION OF ACCESS CITY
NODB	I*4	ALPHABETIC DESCRIPTION OF ACCESS CITY
FND	L	INDICATES IF NODE PAIR IS ACCESS CITY PAIR FOR ANY WU TARIFF
K	I*4	NEXT TARIFF

SUBPROGRAMS CALLED
OUT1
OUT2
OUT3
OUT4
WRTTRF
CATEG

ERRORS
NONE

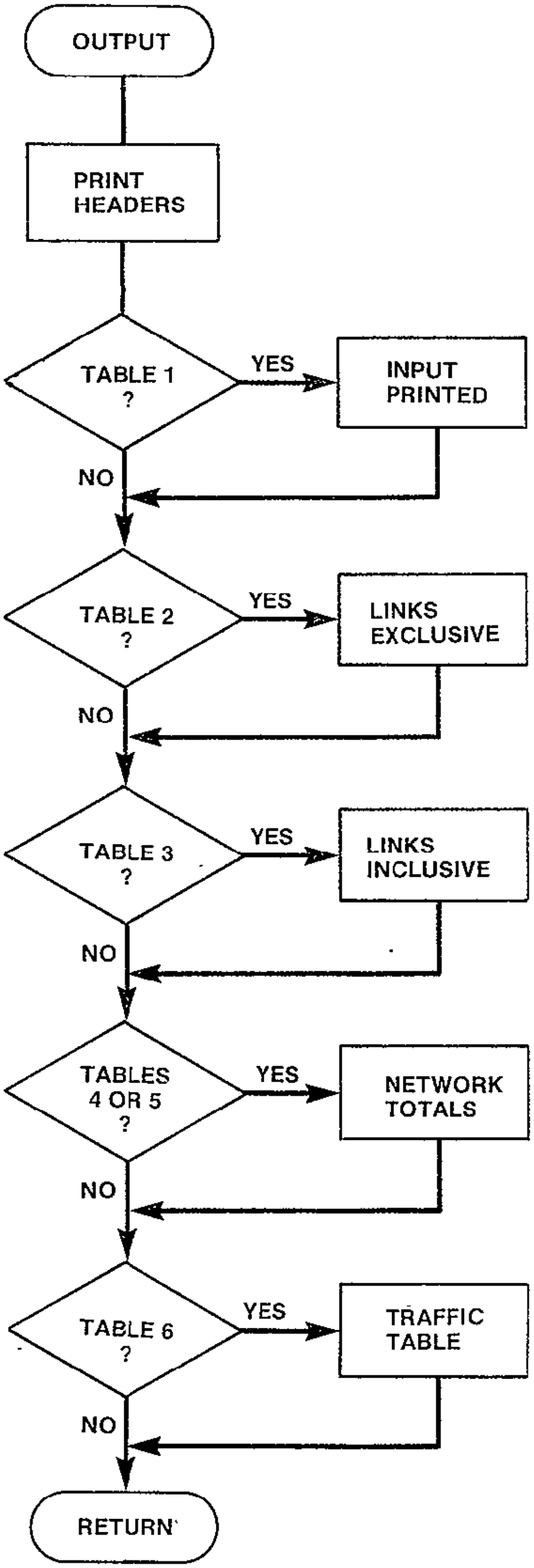


Figure 3-72. OUTPUT Logic Flow

3.7.2 OUT1 Module

SUBROUTINE OUT1

PURPOSE

PRINT INPUT AS OUTPUT

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NCASE	/RUN/	U
LUNOUT	/LUN/	U
RUNID	/INPEXC/	U
NNODES	/RUN/	U
RTCNTR	/RNODES/	U
TRFLVL	/RUN/	U
NTARIF	/RUN/	U
TTYP	/RUN/	U
TF	/RUN/	U
DEBUG	/LUN/	U
TRFNDS	/LUN/	U
FILNET	/RUN/	U

LOCAL VARIABLES

DESCR(5)	R*8	CONSTANT - LABEL OF PROBLEM TYPE
TYPE	I*4	TARIFF TYPE
I,J	I*4	LOOP INDICES
DUMY	I*4	DUMMY VALUE READ FROM TRAFFIC NODES
USERDEF(9)	I*4	CONSTANT /'USER DEFINED'/
RTC	I*4	RATE CENTER READ FROM TRFNDS
VT	I*4	VERTICAL COORDINATE
HT	I*4	HORIZONTAL COORDINATE
CITY(9)	I*4	CITY DESCRIPTION OF RATE CENTER

SUBPROGRAMS CALLED

OUTATT
OUTWU
OUTSBS
SMSA

ERRORS

FATAL

NONE

NONFATAL

6000	TARIFF IN PROBLEM HAS INVALID TYPE

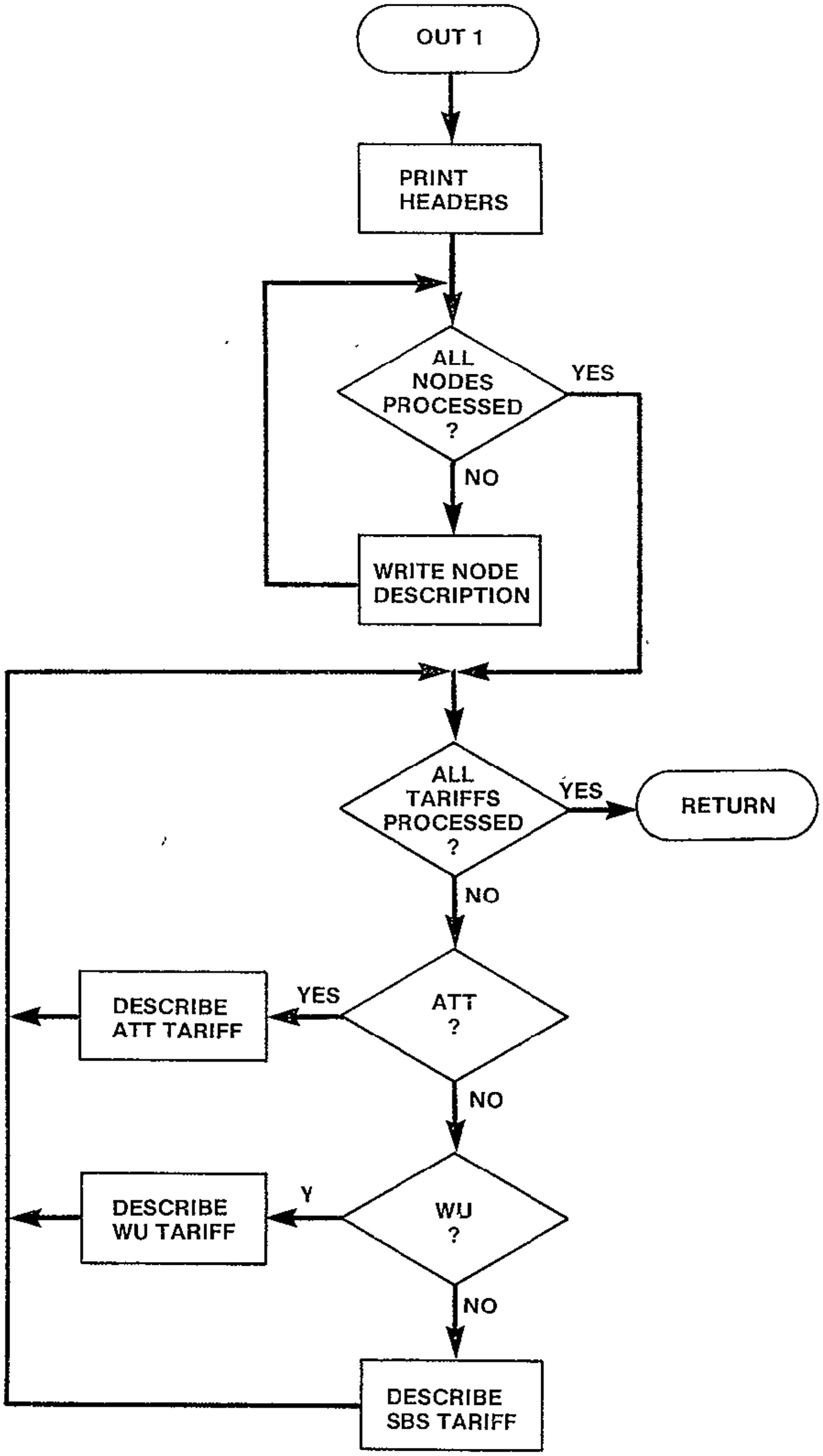


Figure 3-73. OUT.1 Logic Flow

3.7 3 OUTATT Module

SUBROUTINE OUTATT(TARNAM,TARNUM)

PURPOSE

PRINT DESCRIPTION OF ATT TARIFF IN OUTPUT FILE

INPUT ARGUMENTS

TARNAM	R*8	NAME OF TARIFF FILE BEING DESCRIBED
TARNUM	I*4	NUMBER OF THIS TARIFF IN PROBLEM

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

. (U - USED, S - DEFINED, R - READ)

LUNOUT	/LUN/	U
NPLEVL	/ATT/	U
TATMLG	/ATT/	U
TATBAS	/ATT/	U
TATINC	/ATT/	U
NNODES	/RUN/	U
RTCNTR	/RNODES/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

PRSTRD	R*8	CONSTANT /'TRFATT'/
CTGA(10)	I*4	RECORD OF CATA RATE CENTERS TO PRINT TO FILE
NCTG	I*4	NUMBER OF RECORDS OF CATA RATE CENTERS TO PRINT
UNLSTD	I*4	CONSTANT /1/ UNLISTED RATE CENTER
I,J	I*4	LOOP INDICES
IEND	I*4	LAST TARIFF LEVEL TO DESCRIBE IN LOOP
NEXT	I*4	START MILEAGE FOR TARIFF LEVEL
LAST	I*4	END MILEAGE FOR TARIFF LEVEL
NREC	I*4	NUMBER OF RECORDS OF CATA RATE CENTERS TO PRINT

SUBPROGRAMS CALLED

LISTED

ERRORS

FATAL

NONE

NONFATAL

NONE

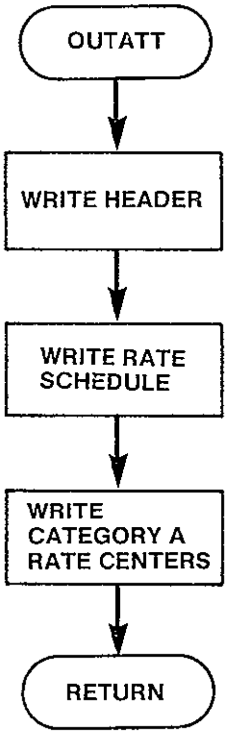


Figure 3-74. OUTATT Logic Flow

3.7.4 OUTWU Module

SUBROUTINE OUTWU(TARNAM,TARNUM)

PURPOSE

PRINT DESCRIPTION OF WU TARIFF IN OUTPUT FILE

INPUT ARGUMENTS

TARNUM	R*8	NUMBER OF TARIFF FILE BEING DESCRIBED
TARNUM	I*4	NUMBER OF THIS TARIFF IN PROBLEM

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

LUNOUT	/LUN/	U
NNODES	/RUN/	U
RTCNTR	/RNODES/	U
TWU	/WU/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

PRSTRD	R*8	CONSTANT NAME OF PRESTORED TARIFF
NCTG	I*4	NUMBER OF SATELLITE ACCESS CITY PAIRS
I,J	I*4	LOOP INDICES
CTG	I*4	RATE CATEGORY
END	I*4	LAST RATE CENTER TO CONSIDER FOR LEFT NODE OF SATELLITE ACCESS PAIR POSSIBILITY
BEGIN	I*4	FIRST RATE CENTER TO CONSIDER FOR RIGHT NODE OF SATELLITE ACCESS RATE POSSIBILITY
DESCP	C*16	DESCRIPTION OF RATE CATEGORY

SUBPROGRAMS CALLED

CATEG

ERRORS

FATAL

NONE

NONFATAL

NONE

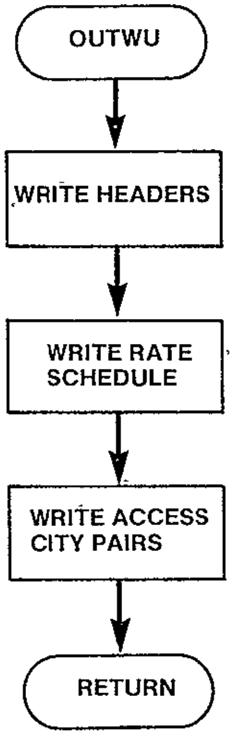


Figure 3-75. OUTWU Logic Flow

3.7.5 OUTSBS Module

SUBROUTINE OUTSBS(TARNAM,TARNUM)

PURPOSE
PRINT DESCRIPTION OF SBS TARIFF IN OUTPUT FILE

INPUT ARGUMENTS

TARNAM	R*8	NAME OF TARIFF FILE BEING DESCRIBED
TARNUM	I*4	NUMBER OF THIS TARIFF IN PROBLEM

OUTPUT ARGUMENTS
NONE

DATA STRUCTURES
(U - USED, S - DEFINED, R - READ)

LUNOUT	/LUN/	U
SBMX	/SBSMXD/	U
NACNMB	/SBSMXD/	U
NACLOC	/SBSMXD/	U
TSBNAC	/SBS/	U
TSBSCU	/SBS/	U
TSBFTU	/SBS/	U
TSBCMN	/SBS/	U
NPTAB	/SBS/	U
TSBBKP	/SBS/	U
TSBCAB	/SBS/	U
TSBCAI	/SBS/	U
DEBUG	/LUN/	U
OPTION	/RUN/	U
RTCNTR	/RNODES/	U

LOCAL VARIABLES

PRSTRD	R*8	CONSTANT /'TRFSBS'/ NAME OF PRESTORED SBS TARIFF
NREC	I*4	NUMBER OF RECORDS TO CONTAIN NAC LOCATIONS
BEGIN	I*4	INDEX TO FIRST ENTRY OF NACLOC ARRAY TO BE PRINTED ON NEXT OUTPUT RECORD
END	I*4	INDEX TO LAST ENTRY OF NACLOC ARRAY TO BE PRINTED ON NEXT OUTPUT RECORD
I,J	I*4	LOOP INDICES
NL	I*4	NUMBER OF NEXT NAC
REC(10)	I*4	ONE LINES WORTH OF NAC NAMES
NITM	I*4	NUMBER OF ITEMS TO PUT IN PRINT LINE

SUBPROGRAMS CALLED
NONE

ERRORS
FATAL
NONE
NONFATAL
NONE

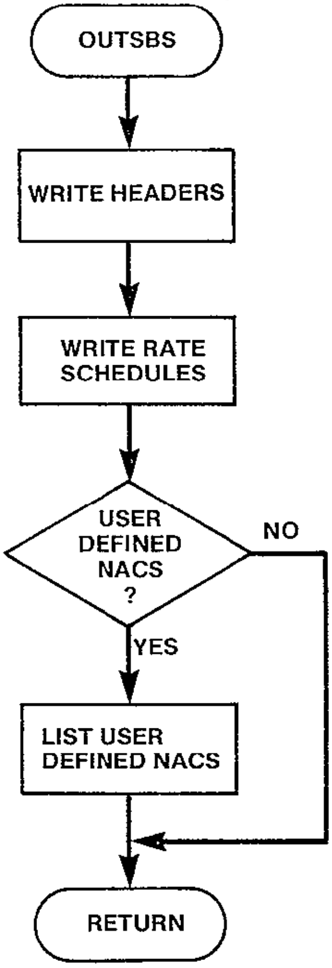


Figure 3-76. OUTSBS Logic Flow

3.7.6 OUT2 Module

SUBROUTINE OUT2

PURPOSE

PREPARE AND WRITE TABLE 2. LEAST-COST ROUTES (EXCLUSIVE OF OTHER NETWORK TRAFFIC)

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

RTCNTR	/RNODES/	U
MINCPC	/CSTOUT/	U
NNODES	/RUN/	U
OROUTE	/CSTOUT/	U
SVC	/CSTOUT/	U
TF	/RUN/	U
TRAFIC	/TRFC/	U
OPTION	/RUN/	U
LUNOUT	/LUN/	U
SATNVC	/SBSMX2/	U

LOCAL VARIABLES

DASH	I*4	CONSTANT /'-'/
I	I*4	LOOP INDEX - FROM CITIES –
IEND	I*4	END LOOP
I2END	I*4	END LOOP
TINT	I*4	LOOP INDEX - LINKS
ISTART	I*4	START LOOP
ITEMP	I*4	NODE NUMBER - USED IN TRACING ROUTE
IRT	I*4	FROM NODE - USED IN SUMMING ROUTE TRAFFIC ON LINKS
IPRT	I*4	USED FOR PRINTING CITY MNEMONICS
J	I*4	LOOP INDEX - TO CITIES
JINT	I*4	LOOP INDEX - FOR SUMMING ROUTE TRAFFIC ON LINKS
JRT	I*4	TO NODE - USED IN SUMMING ROUTE TRAFFIC ON LINKS
JPRT	I*4	USED FOR PRINTING CITY MNEMONICS
K	I*4	LOOP INDEX - LINKS
KFROM	I*4	ORIGINATING NODE OF A LINK
KFPRT	I*4	USED TO PRINT FROM CITY MNEMONICS
KPRT	I*4	USED FOR PRINTING CITY MNEMONICS
KTPRT	I*4	USED TO PRINT TO CITY MNEMONICS
KTO	I*4	TERMINATING NODE OF A LINK
LNKMLS	I*4	TOTAL CIRCUIT MILEAGE ON A ROUTE
LNKTOT	I*4	ARRAY CONTAINING TOTAL ROUTE TRAFFIC ON LINKS

MAXLNK	I*4	CONSTANT /20/ MAXIMUM LINKS ON A ROUTE
MPRT	I*4	USED TO PRINT MILEAGE ON A LINK
NB	I*4	NUMBER OF BASE GROUPS IN FACILITY
TRFC	I*4	NUMBER OF VOICE CIRCUITS BETWEEN NODAL PAIR
RMIN	R*4	DOLLAR PART OF MULTIPLIER
RTMP	R*4	DOLLAR PART OF RESULT
IMIN	I*4	CENTS PART OF MULTIPLIER
ITMP	I*4	CENTS PART OF RESULT
CA1-CA3	I*2	CHARACTER REPRESENTATION OF IMIN
CB1-CB3	I*2	CHARACTER REPRESENTATION OF ITMP
NJ	I*4	NUMBER OF JUMBO GROUPS IN FACILITY
NLINKS	I*4	NUMBER OF LINKS IN A ROUTE
NM	I*4	NUMBER OF MASTER GROUPS IN FACILITY
NS	I*4	NUMBER OF SUPER GROUPS IN FACILITY
ROUTE	I*2	ARRAY CONTAINING NODE NUMBERS IN LEAST-COST ROUTE
SAT	C*16	CONSTANT / 'SATELLITE' /
SERVCE	C*16	VARIABLE SET EQUAL TO SAT OR TERR
TEMP	R*4	COST OF CIRCUITS ON ROUTE
TERR	C*16	CONSTANT / 'TERRESTRIAL' /
TPRT	R*4	USED TO PRINT TARIFF USED ON
RNAME	I*4	NAME OF EACH LINK IN PATH
STLTE	I*4	CONSTANT /2/ SATELLITE SERVICE EACH LINK
SRV	I*4	SERVICE TYPE 1 TERRESTRIAL 2 SATELLITE
VC	I*2	NUMBER OF VOICE CIRCUITS FROM NAC
SCHED	I*4	TERRESTRIAL TARIFF SCHEDULE USED
NVC	I*4	NUMBER OF VOICE CIRCUITS
PTSB	L	.TRUE. IF DESCRIPTION OF SBS CHARGES TO BE PRINTED
ITR	I*4	TARIFF NUMBER

SUBPROGRAMS CALLED

FACSIZ
MILES
OUT2SB
PRTSBS
LISTED
MTPY
MTPLY
INTCHR

ERRORS

FATAL
NONE

NONFATAL
NONE

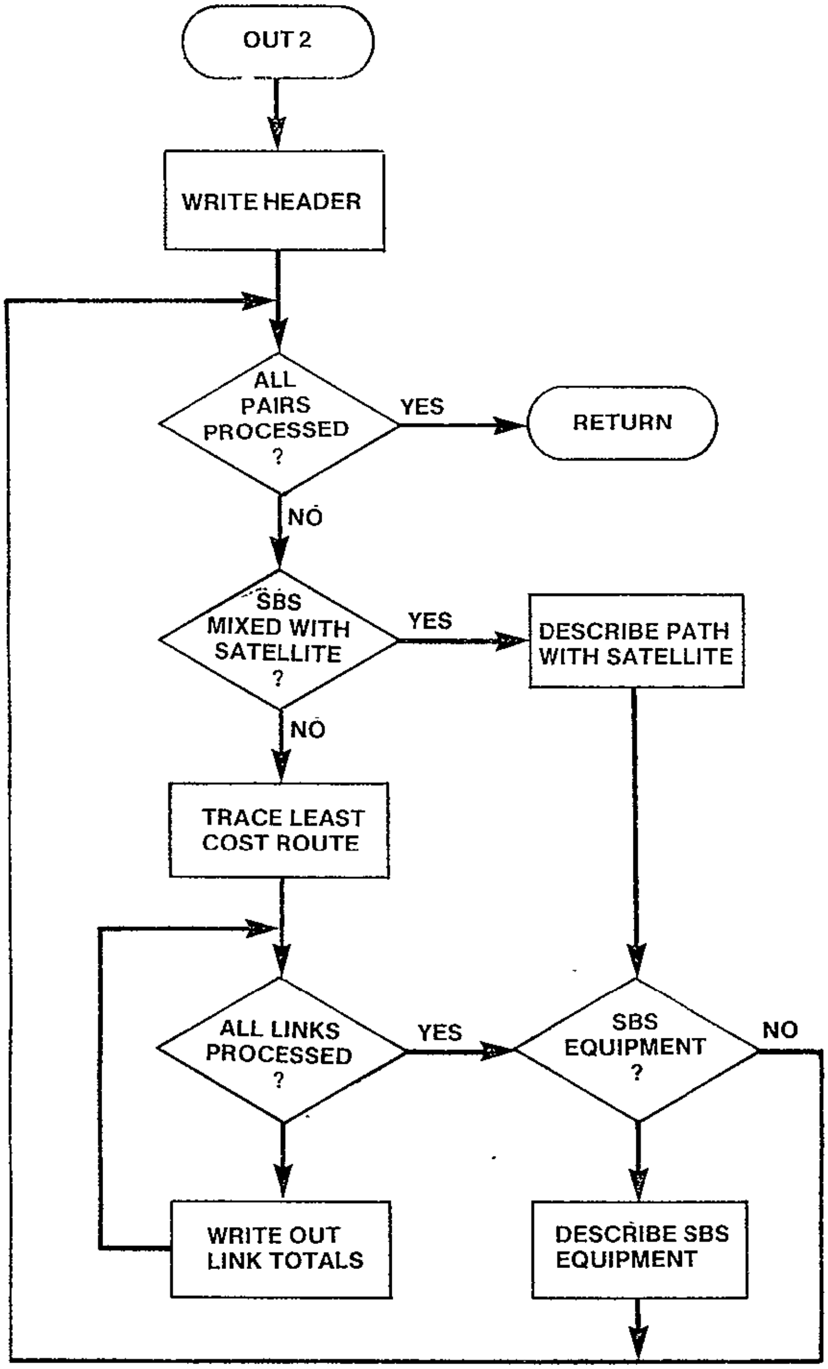


Figure 3-77. OUT2 Logic Flow

3.7.7 OUT2SB Module

SUBROUTINE OUT2SB(I,IPRT,J,JPRT,VC)

PURPOSE

PREPARE AND WRITE TABLE 2 LEAST COST ROUTES (EXCLUSIVE OR OTHER NETWORK TRAFFIC) FOR PATH WHICH INCLUDES SBS SATELLITE

INPUT ARGUMENTS

I	I*4	FROM CITY
J	I*4	TO CITY
IPRT	I*4	CITY MNEMONIC OF FROM CITY
JPRT	I*4	CITY MNEMONIC OF TO CITY

OUTPUT ARGUMENTS

VC	I*4	NUMBER OF VOICE CIRCUITS FROM THIS PARTITION

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NODPTR	/SBSMXD/	U
NACLOC	/SBSMXD/	U
RTCNTR	/RNODES/	U
TRAFIC	/TRFC/	U
MINCPC	/CSTOUT/	U
TF	/RUN/	U
SATCST	/SBSMX2/	U
OROUTE	/CSTOUT/	U
LUNOUT	/LUN/	U
DEBUG	/LUN/	U
SATNVC	/SBSMX2/	U

LOCAL VARIABLES

DASH	I*4	CONSTANT /'-'/
LNKMLS	I*4	TOTAL CIRCUIT MILEAGE ON A ROUTE
K, II, JJ	I*4	LOOP INDICES
MAXLNK	I*4	CONSTANT /20/ MAX LINKS ON A ROUTE
ROUTE(20)	I*2	ARRAY CONTAINING NODE NUMBERS IN LEAST COST ROUTE
LNKTOT(20)	I*4	ARRAY CONTAINING TOTAL ROUTE TRAFFIC ON LINKS
RNAME(20)	I*4	NAME OF EACH NODE IN PATH
BLANK	I*4	CONSTANT /' '/
NLINKS	I*4	NUMBER OF LINKS IN PATH BETWEEN TWO NODES
CURFRM	I*4	FROM NODE OF CURRENT LINK
SATFRM	I*4	THE FROM SATELLITE IN THIS PATH
PART	I*4	PARTITION OF SENDING SATELLITE
SATTO	I*4	THE RECEIVING SATELLITE
CURTO	I*4	TO NODE OF CURRENT LINK
IRT	I*4	FROM NODE
JRT	I*4	TO NODE
NLA	I*4	NUMBER OF LINKS UNDER CONSIDERATION IN I, J PATH

NLB	I*4	NUMBER OF LINKS IN RTB PATH
RTB(20)	I*4	LINKS THAT MAKE UP PATH BETWEEN ANY TWO NODES IN PATH I, J
SAME	L	TWO PATHS - SUBSET OF ROUTE AND RTB - ARE THE SAME
TEMP	R*4	COST OF CIRCUITS ON ROUTE
CPC	R*4	COST PER CIRCUIT
KFROM	I*4	ORIGINATING NODE OF A LINK
TRFC	I*4	NUMBER VOICE CIRCUITS BETWEEN NODAL PAIR
ITEMP	I*4	SUM OF CENTS PORTION OF COST
RMIN	R*4	DOLLAR PORTION OF MULTIPLIER
IMIN	I*4	CENTS PORTION OF MULTIPLIER
RTMP	R*4	DOLLAR PORTION OF RESULT
ITMP	I*4	CENTS PORTION OF RESULT
CA1-CA3	I*2	CHARACTER REPRESENTATION OF IMIN
CB1-CB3	I*2	CHARACTER REPRESENTATION OF ITMP
KTO	I*4	TERMINATING NODE OF A LINK
NJ	I*4	NUMBER OF JUMBO GROUPS
NM	I*4	NUMBER OF MASTER GROUPS
NS	I*4	NUMBER OF SUPER GROUPS
NB	I*4	NUMBER OF BASE GROUPS
SERVCE	C*16	TYPE OF SERVICE - SATELLITE OR TERRESTRIAL
TERR	C*16	CONSTANT /'TERRESTRIAL'/
SAT	C*16	CONSTANT /'SATELLITE'/
TPRT	R*8	NAME OF TARIFF
KFPRT	I*4	4 CHARACTER CODE OF FROM NODE
KTPRT	I*4	4 CHARACTER CODE OF TO NODE
MPRT	I*4	LINK MILEAGE
IBEG	I*4	FIRST ITEM OF ARRAY TO BE REFERENCED
IEND	I*4	LAST ITEM OF ARRAY TO BE REFERENCED
ILAST	I*4	LAST ITEM OF ARRAY TO BE REFERENCED
SRV	I*4	SERVICE TYPE 1 TERRESTRIAL 2 SATELLITE
SCHED	I*4	TERRESTRIAL SCHEDULE

SUBPROGRAMS CALLED

MILES
GETRTE
FACSIZ
LISTED
MTPY
MTPLY
INTCHR

ERRORS

FATAL
NONE
NONFATAL
NONE

NLB	I*4	NUMBER OF LINKS IN RTB PATH
RTB(20)	I*4	LINKS THAT MAKE UP PATH BETWEEN ANY TWO NODES IN PATH I, J
SAME	L	TWO PATHS - SUBSET OF ROUTE AND RTB - ARE THE SAME
TEMP	R*4	COST OF CIRCUITS ON ROUTE
CPC	R*4	COST PER CIRCUIT
KFROM	I*4	ORIGINATING NODE OF A LINK
TRFC	I*4	NUMBER VOICE CIRCUITS BETWEEN NODAL PAIR
ITEMP	I*4	SUM OF CENTS PORTION OF COST
RMIN	R*4	DOLLAR PORTION OF MULTIPLIER
IMIN	I*4	CENTS PORTION OF MULTIPLIER
RTMP	R*4	DOLLAR PORTION OF RESULT
ITMP	I*4	CENTS PORTION OF RESULT
CA1-CA3	I*2	CHARACTER REPRESENTATION OF IMIN
CB1-CB3	I*2	CHARACTER REPRESENTATION OF ITMP
KTO	I*4	TERMINATING NODE OF A LINK
NJ	I*4	NUMBER OF JUMBO GROUPS
NM	I*4	NUMBER OF MASTER GROUPS
NS	I*4	NUMBER OF SUPER GROUPS
NB	I*4	NUMBER OF BASE GROUPS
SERVCE	C*16	TYPE OF SERVICE - SATELLITE OR TERRESTRIAL
TERR	C*16	CONSTANT /'TERRESTRIAL'/
SAT	C*16	CONSTANT /'SATELLITE'/
TPRT	R*8	NAME OF TARIFF
KFPRT	I*4	4 CHARACTER CODE OF FROM NODE
KTPRT	I*4	4 CHARACTER CODE OF TO NODE
MPRT	I*4	LINK MILEAGE
IBEG	I*4	FIRST ITEM OF ARRAY TO BE REFERENCED
IEND	I*4	LAST ITEM OF ARRAY TO BE REFERENCED
ILAST	I*4	LAST ITEM OF ARRAY TO BE REFERENCED
SRV	I*4	SERVICE TYPE 1 TERRESTRIAL 2 SATELLITE
SCHED	I*4	TERRESTRIAL SCHEDULE

SUBPROGRAMS CALLED
MILES
GETRTE
FACSIZ
LISTED
MTPY
MTPLY
INTCHR

ERRORS
FATAL
NONE
NONFATAL
NONE

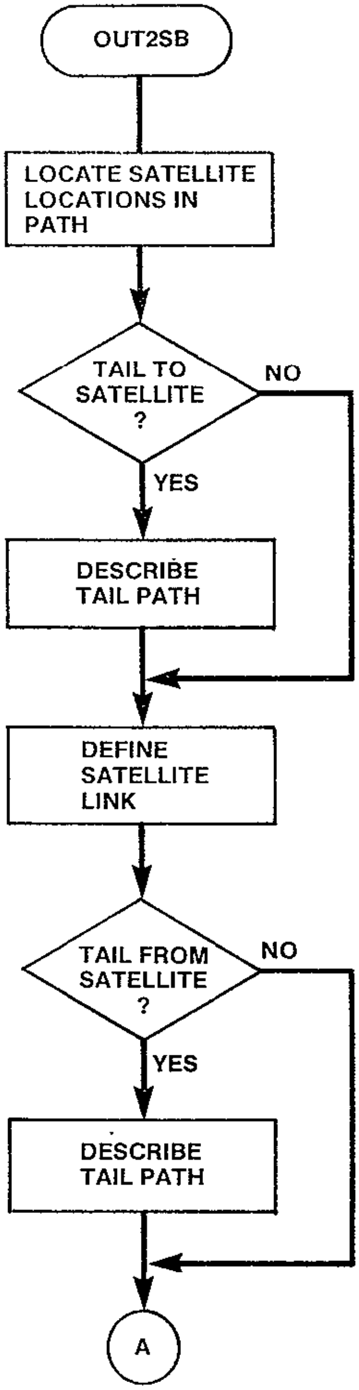


Figure 3-78. OUT2SB Logic Flow (Sheet 1 of 2)

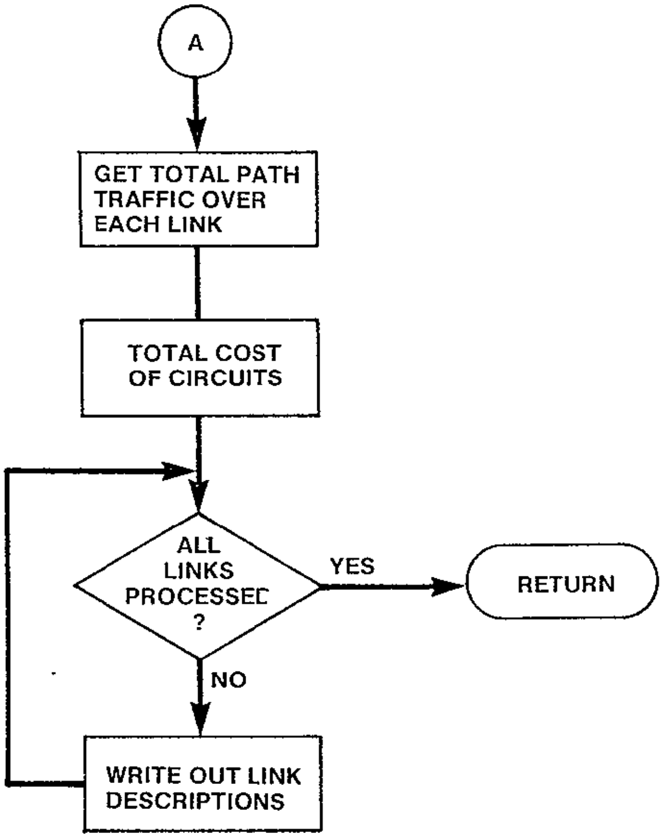

A
GET TOTAL PATH TRAFFIC OVER EACH LINK
TOTAL COST OF CIRCUITS
ALL LINKS PROCESSEC ?
YES
RETURN
NO
WRITE OUT LINK DESCRIPTIONS

Figure 3-78. OUT2SB Logic Flow (Sheet 2 of 2)

3.7.8 PRTSBS Module

```
SUBROUTINE PRTSBS(VC,TARIFF,LUN)
```

PURPOSE

COMPUTE EQUIPMENT COST FOR SBS TARIFF SPECIFIED

INPUT ARGUMENTS

VC	I*4	NUMBER OF VOICE CIRCUITS
TARIFF	I*4	NUMBER OF TARIFF IN QUESTION
LUN	I*4	LOGICAL UNIT NUMBER WHERE EQUIPMENT COSTS TO BE PRINTED

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

CPNA	/SBS/	U
VCPFTU	/SBS/	U
NSCUPN	/SBS/	U
NPTAB	/SBS/	U
TSBBKP	/SBS/	U
TSBCAB	/SBS/	U
TSBCAI	/SBS/	U
TSBCMN	/SBS/	U
TSBNAC	/SBS/	U
TSBFTU	/SBS/	U
TSBSCU	/SBS/	U
DEBUG	/LUN/	U
NTARIF	/RUN/	U

LOCAL VARIABLES

COST	I*4	TOTAL COST
IEND	I*4	MAXIMUM NUMBER OF ITERATIONS TO ASSIGN NVC TO CONFIGURATION OF 1 NAC AND UP TO NSCUPN SCUS
CPN	I*4	MAXIMUM CAUS PER NAC (SCU)
I,J	I*4	LOOP INDICES
NCAU	I*4	NUMBER OF CAUS AT NODE
NFTU	I*4	NUMBER OF NACS AT NODE
NNAC	I*4	NUMBER OF NACS REQUIRED NNAC(1) NUMBER OF NACS NNAC(2)-NNAC(4) NUMBER OF SCUS
PREV	I*4	LOWER BOUND OF NUMBER OF CAUS/NAC FOR BREAKPOINT IN RATE TABLES
TMPCMN	R*8	MINIMUM CAU COST
MXPNAC	I*4	MAXIMUM NUMBER OF CAU PER NAC/SCU CONFIGURATION
NLEFT	I*4	NCAU LEFT WHEN ASSIGN CAU TO TOTAL NAC/SCU CONFIGURATION
N	I*4	NUMBER OF NAC AND SCU REQUIRED FOR NLEFT

IC1	I*4	TARIFF LEVEL FOR NGRP GROUPS OF CAUS
IC2	I*4	TARIFF LEVEL FOR NLEFT CAUS
DIFF1	I*4	EXCESS CAUS FOR NGRP GROUPS
DIFF2	I*4	EXCESS CAUS FOR NLEFT CAUS
PRV1	I*4	PREVIOUS COUNT FOR NGRP GROUPS
PRV2	I*4	PREVIOUS COUNT FOR NLEFT CAUS
NGRP	I*4	NUMBER OF NACS AT NODE
SUBCST	R*4	COST OF TARIFF ITEM
NSCU	I*4	NUMBER OF SCUS

SUBPROGRAMS CALLED
    MTPY

ERRORS
    FATAL
      6010   INPUT ARGUMENTS OUT OF RANGE
    NONFATAL
      NONE

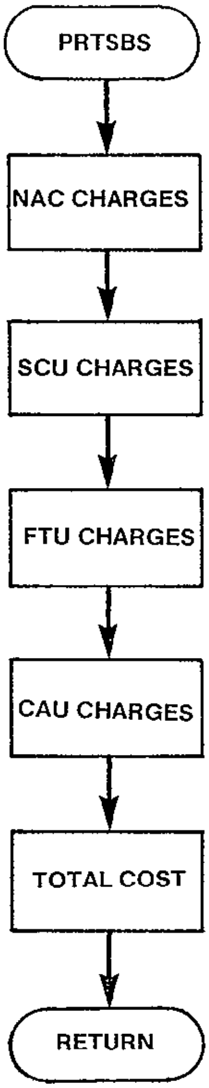


Figure 3-79. PRTSBS Logic Flow

3.7.9 GETRTE Module

SUBROUTINE GETRTE(FROM,TO,RTE,NL)

PURPOSE

DESCRIBE THE ROUTE BETWEEN TWO NODES IN TERMS OF ALL NODES INCLUDED IN THE ROUTE

INPUT ARGUMENTS

FROM	I*4	FROM NODE
TO	I*4	TO NODE

OUTPUT ARGUMENTS

RTE(20)	I*4	LIST OF NODES BETWEEN FROM AND TO INCLUDING FROM AND TO
NL	I*4	NUMBER OF LINKS IN PATH BETWEEN FROM AND TO

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

SVC	/CSTOUT/	U
OROUTE	/CSTOUT/	U
NODPTR	/SBSMXD/	U
NACLOC	/SBSMXD/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

SATLTE	I*4	CONSTANT /2/ SATELLITE SERVICE
CURFRM	I*4	CURRENT FROM NODE IN ROUTE
SATFRM	I*4	TRANSMITTING NAC
SATTO	I*4	RECEIVING NAC
PART	I*4	PARTITION THAT NODE BELONGS TO
CURTO	I*4	CURRENT TO NODE IN ROUTE
IEND	I*4	LAST ITEM OF ARRAY TO BE PRINTED

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

ORIGINAL PAGE IS
OF POOR QUALITY

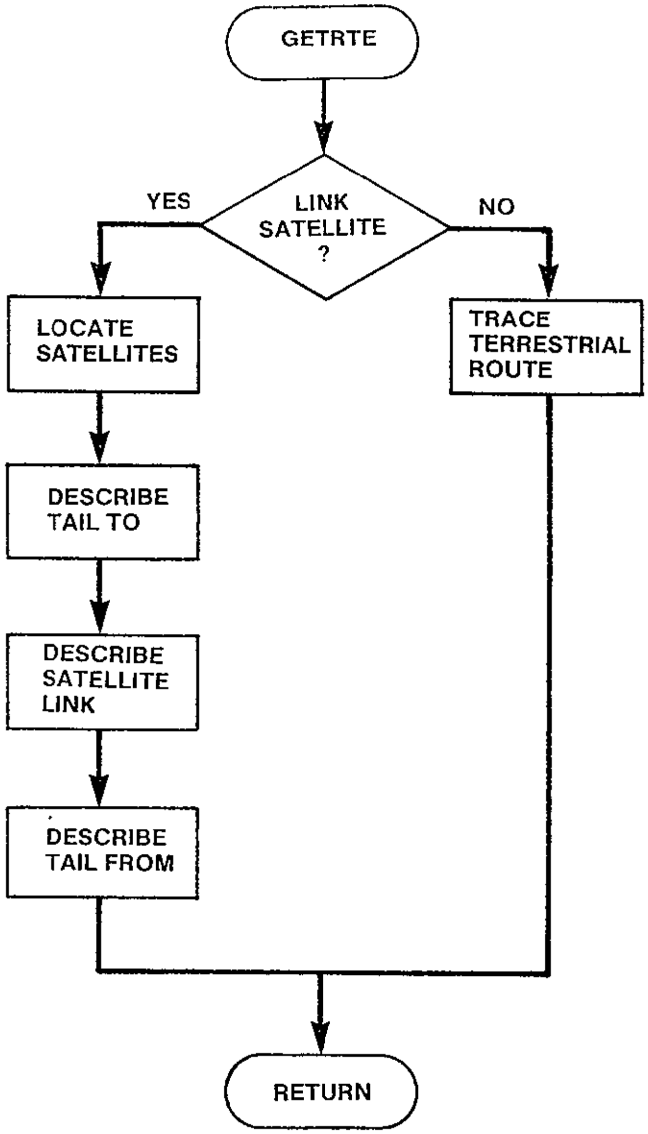


Figure 3-80. GETRTE Logic Flow

3.7.10 OUT3 Module

SUBROUTINE OUT3

PURPOSE

PREPARE AND WRITE TABLE 3. LEAST-COST NETWORK

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

RTCNTR	/RNODES/	U
NACNMB	/SBSMXD/	U
NACLOC	/SBSMXD/	U
MINCPC	/CSTOUT/	U
NETOTL	/CSTOUT/	U
NNODES	/RUN/	U
OPTION	/CSTOUT/	U
SA	/WU/	U
SVC	/CSTOUT/	U
TF	/RUN/	U
TRAFIC	/TRFC/	U
QNAC	/SBSEQP/	U
QSCU	/SBSEQP/	U
QFTU	/SBSEQP/	U
QCAU	/SBSEQP/	U
LUNOUT	/LUN/	U
OUTFLG	/RUN/	U
SATNVC	/SBSMX2/	U

LOCAL VARIABLES

DASH	I*4	CONSTANT /'-'/
I	I*4	LOOP INDEX - FROM CITIES
IPRT	I*4	USED TO PRINT FROM CITY MNEMONICS
ISTEMP	I*4	TAKES VALUES FROM SVC ARRAY - USED TO
ITEMP	I*4	NODE NUMBER - USED IN TRACING ROUTES
J	I*4	LOOP INDEX - TO CITIES
JPRT	I*4	USED TO PRINT TO CITY MNEMONICS
JTEMP	I*4	NODE NUMBER - USED IN SUMMING LIINK TRAFFIC TOTALS
K	I*4	LINK INDEX - USED IN PRINTING NON-SATELLITE ACCESS CITIES
KPRT	I*4	USED TO PRINT MNEMONICS ON NON-SATELLITE ACCESS CITIES
NB	I*4	NUMBER OF BASE GROUPS IN FACILITY
NJ	I*4	NUMBER OF JUMBO GROUPS IN FACILITY
NM	I*4	NUMBER OF IMASTER GROUPS IN FACILITY
NS	I*4	NUMBER OF SUPER GROUPS IN FACILITY

SAT	C*16	CONSTANT / 'SATELLITE' /
SERVCE	C*16	VARIABLE SET EQUAL TO SAT OR TERR
STEMP	R*8	USED TO PRINT NAME OF TARIFF USED
TEMP	R*4	TOTAL COST OF CIRCUITS FOR PRINTING
TERR	C*16	CONSTANT / 'TERRESTRIAL' /
RNAME(20)	I*4	NAME OF NODES IN LEAST COST PATH
STLTE	I*4	CONSTANT /2/ SATELLITE
VC	I*4	NUMBER OF SBS VOICE CIRCUITS IN SBS MIXED
NVC	I*4	NUMBER OF SBS VOICE CIRCUITS
KK	I*4	LOOP INDEX
PTSB	L	.TRUE. IF DESCRIPTION OF SBS CHARGES TO BE PRINTED, OTHERWISE .FALSE.
ITR	I*4	TARIFF NUMBER
SRV	I*4	SERVICE TYPE 1 TERRESTRIAL 2 SATELLITE
SKIP	L	LINK SUMMARY NOT PRINTED BECAUSE EITHER OR BOTH NODES NOT ACCESS CITY IN WU ONLY RUN
RMIN	R*4	DOLLAR PART OF MULTIPLIER
RTMP	R*4	DOLLAR PART OF MULTIPLICAND
IMIN	I*4	CENTS PART OF MULTIPLIER
ITMP	I*4	CENTS PART OF MULTIPLICAND
CA1,CA2,CA3	I*2	CHARACTERS ASSOCIATED WITH INTEGER VALUES
CB1,CB2,CB3	I*2	CHARACTERS ASSOCIATED WITH INTEGER VALUES

SUBPROGRAMS CALLED

FACSIZ
MTPLY
PRTSBS
LISTED
OUT3SB

ERRORS

NONE

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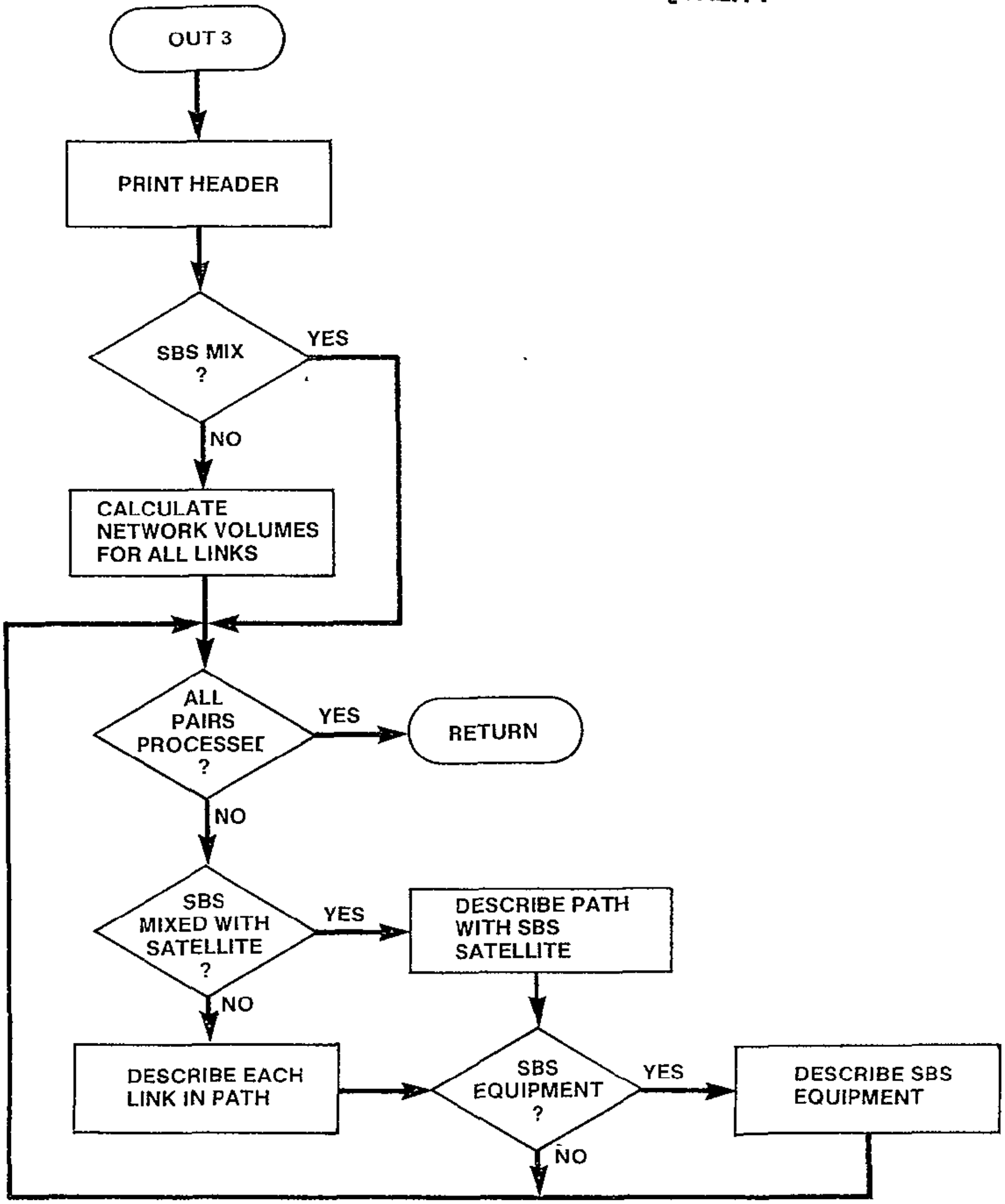


OUT 3
PRINT HEADER
SBS MIX ?
YES
NO
CALCULATE NETWORK VOLUMES FOR ALL LINKS
ALL PAIRS PROCESSEI ?
YES
RETURN
NO
SBS MIXED WITH SATELLITE ?
YES
DESCRIBE PATH WITH SBS SATELLITE
NO
DESCRIBE EACH LINK IN PATH
SBS EQUIPMENT ?
YES
DESCRIBE SBS EQUIPMENT
NO

Figure 3-81. OUT3 Logic Flow

3.7.11 OUT3SB Module

SUBROUTINE OUT3SB(FROM,FRMPRT,TO,TOPRT,VC)

PURPOSE

PREPARE AND WRITE TABLE 3 LEAST COST NETWORK (INCLUSIVE OF OTHER NETWORK TRAFFIC) FOR LINKS WHICH INCLUDE SBS SATELLITE

INPUT ARGUMENTS

FROM	I*4	FROM NODE
FRMPRT	I*4	CITY MNEMONIC OF FROM NODE
TO	I*4	TO NODE
TOPRT	I*4	CITY MNEMONIC OF TO NODE

OUTPUT ARGUMENTS

VC	I*4	NUMBER OF VOICE CIRCUITS FROM NAC LOCATION

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

RTCNTR	/RNODES/	U
LUNOUT	/LUN/	U
NETOTL	/CSTOUT/	U
MINCPC	/CSTOUT/	U
TF	/RUN/	U
NODPTR	/SBSMXD/	U
SATCST	/SBSMX2/	U
SATOTL	/SATMXD/	U
DEBUG	/LUN/	U
SATNVC	/SBSMX2/	U

LOCAL VARIABLES

DASH	I*4	CONSTANT /'-'/
RTE(20)	I*4	NODE NUMBERS OF EACH NODE IN PATH BETWEEN FROM AND TO
NL	I*4	NUMBER OF LINKS IN PATH BETWEEN FROM AND TO
RNAME(20)	I*4	NAME OF EACH LINK IN PATH
I	I*4	LOOP INDEX
IPRT	I*4	AS PROCEED ALONG PATH FROM NODE OF CURRENT LINK
CURTO	I*4	AS PROCEED ALONG PATH, TO NODE OF CURRENT LINK
NVC	I*4	NUMBER OF VOICE CIRCUITS ON LINK
NJ	I*4	NUMBER OF JUMBO GROUPS
NM	I*4	NUMBER OF MASTER GROUPS
NS	I*4	NUMBER OF SUPER GROUPS
NB	I*4	NUMBER OF BASE GROUPS
SERVCE	C*16	TYPE OF SERVICE ON LINK - SATELLITE OR TERRESTRIAL
CVC	R*4	COST PER VOICE CIRCUIT
CURFRM	I*4	AS PROCEED ALONG PATH, FROM NODE OF CURRENT LINK

PTARIF	R*8	NAME OF TARIFF
SAT	C*16	CONSTANT /'SATELLITE'/
TERR	C*16	CONSTANT /'TERRESTRIAL'/
PART	I*4	PARTITION WHERE NAC IS LOCATED
PRTFRM	I*4	NAME OF FROM NODE OF CURRENT LINK
PRTTO	I*4	NAME OF TO NODE OF CURRENT LINK
IEND	I*4	LAST ITEM OF ARRAY TO BE PRINTED
SCHED	I*4	TERRESTRIAL TARIFF SCHEDULED
SRV	I*4	SERVICE TYPE 1 TERRESTRIAL 2 SATELLITE
RMIN	R*4	DOLLAR PORTION OF MULTIPLIER
IMIN	I*4	CENTS PORTION OF MULTIPLIER
RTMP	R*4	DOLLAR PORTION OF RESULT
ITMP	I*4	CENTS PORTION OF MULTIPLIER
CA1-CA3	I*4	CHARACTER REPRESENTATION OF IMIN
CB1-CB3	I*2	CHARACTER REPRESENTATIONOF ITMP

SUBPROGRAMS CALLED

FACSIZ
GETRTE
LISTED
MTPY
MTPLY
INTCHR

ERRORS

FATAL

NONE

NONFATAL

NONE

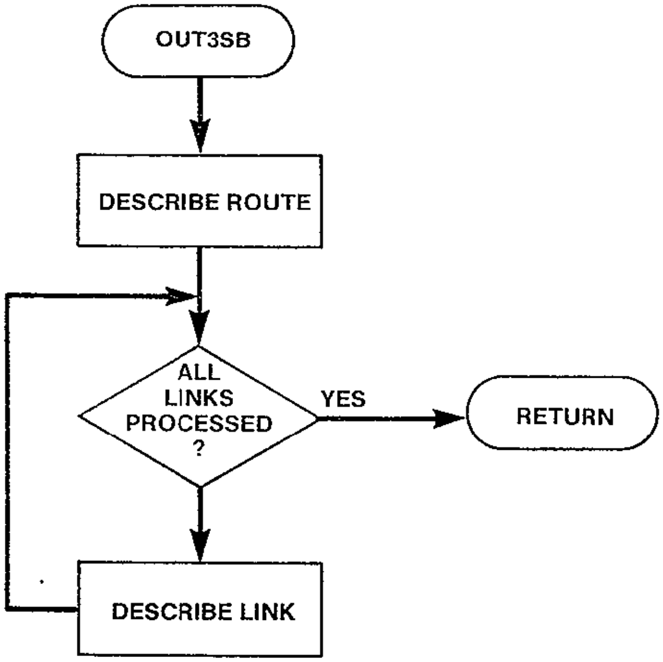


Figure 3-82. OUT3SB Logic Flow

3.7.12 OUT4 Module

SUBROUTINE OUT4

PURPOSE

PREPARE AND WRITE TABLE 4. OUTPUT NETWORK TOTALS AND
TABLE 5. TARIFF SUMMARY

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S- DEFINED, R - READ)

OUTFLG	/RUN/	U
MINCPC	/CSTOUT/	U
NETOTL	/CSTOUT/	U
NNODES	/RUN/	U
NTARIF	/RUN/	U
OPTION	/RUN/	U
SVC	/CSTOUT/	U
TF	/RUN/	U
TRRMLG	/CSTMXD/	U
TRRCST	/CSTMXD/	U
TRRCKT	/CSTMXD/	U
STLMLG	/CSTMXD/	U
STLCST	/CSTMXD/	U
STLCKT	/CSTMXD/	U
LUNOUT	/LUN/	U
QNAC	/SBSEQP/	U
QSCU	/SBSEQP/	U
QFTU	/SBSEQP/	U
QCAU	/SBSEQP/	U
SBMX	/SBSMXD/	U
TOTSAT	/SBSMX2/	U
NACNMB	/SBSMXD/	U
STABLE	/SBSMX2/	U
NACLOC	/SBSMXD/	U
RTCNTR	/RNODES/	U
SATNVC	/SBSMX2/	U

LOCAL VARIABLES

I	I*4	LOOP INDEX
USRDEF	I*4	CONSTANT /1/ USER DEFINE NAC LOCATION
NITER	I*4	NUMBER OF ITERATIONS OF SBSMXD ALGORITHM TO FIND OPTIMAL NUMBER OF NAC LOCATIONS
NLOC	I*4	NUMBER OF NAC LOCATIONS
ISAT	I*4	USED TO PRINT SATELLITE NETWORK TOTALS
ITERR	I*4	USED TO PRINT TERRESTRIAL NETWORK TOTALS
J	I*4	LOOP INDEX
PCKT	R*4	PERCENT OF CIRCUITS FOR EACH TARIFF

PCOST	R**4	PERCENT OF COST FOR EACH TARIFF
SAT	C*16	CONSTANT / 'SATELLITE' /
SERVCE	C*16	VARIABLE SET EQUAL TO SAT OR TERR
T	I*2	TAKES VALUES OF EACH TARIFF SUCCESSIVELY TO CALCULATE TARIFF TOTALS
TCKTS	I*4	ARRAY CONTAINING TOTAL CIRCUITS FOR EACH TARIFF
TCOSTS	R*4	ARRAY CONTAINING TOTAL COSTS FOR EACH TARIFF
TERR	C*16	CONSTANT / ' TERRESTRIAL' /
TMILES	I*4	ARRAY CONTAINING TOTAL MILEAGE FOR EACH TARIFF
TOTCKT	I*4	TOTAL NETWORK CIRCUITS
TOTCST	R*4	TOTAL NETWORK COST
TOTMIL	I*4	TOTAL NETWORK MILEAGE
TERCST	R*4	TERRESTRIAL COST
CSTSAT	R*4	SATELLITE COST
NREC	I*4	NUMBER OF RECORDS OF NAC LOCATIONS TO PRINT
END	I*4	LAST NAC IN CURRENT PRINT RECORD
BEGIN	I*4	FIRST NAC IN CURRENT PRINT RECORD
NL	I*4	NAC NUMBER
NITM	I*4	NUMBER OF ITEMS IN PRINT LINE
REC(10)	I*4	PRINT LINE
BIGNUM	R*4	16.0**62
N	I*4	NUMBER OF SPECIFIED NACS WHICH ACTUALLY HAVE SATELLITE TRAFFIC

SUBPROGRAMS CALLED

MILES
SUMEQP
MTPY

ERRORS

FATAL
NONE
NONFATAL
NONE

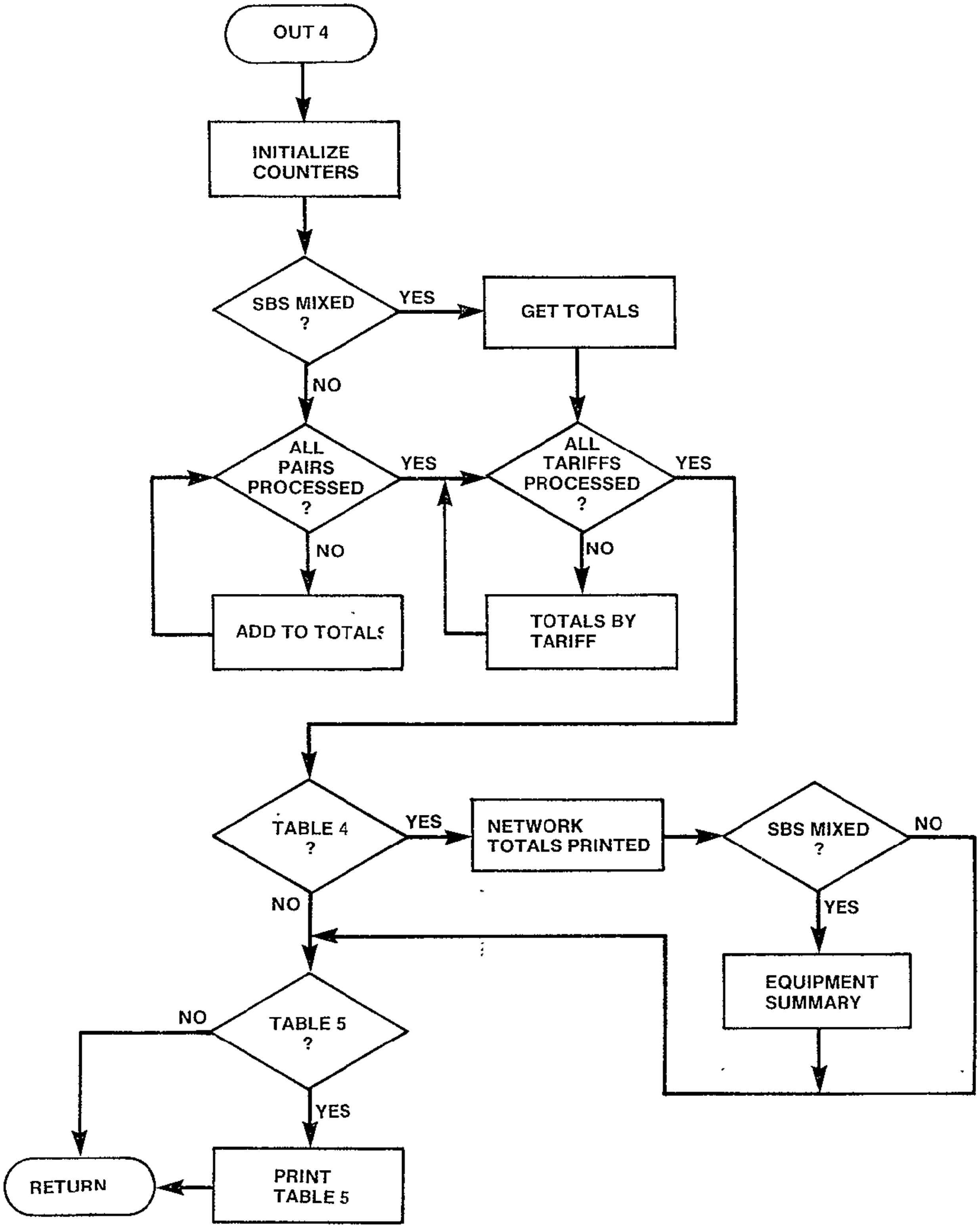


Figure 3-83. OUT-4 Logic Flow

3.7.13 SUMEQP Module

SUBROUTINE SUMEQP

PURPOSE

SUMMARY OF EARTH STATION EQUIPMENT FOR SBS MIXED MODE

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NACNMB	/SBSMXD/	U
QNAC	/SBSEQP/	S
QSCU	/SBSEQP/	S
QFTU	/SBSEQP/	S
QCAU	/SBSEQP/	S
SATNVC	/SBSMX2/	U
VCPFTU	/SBS/	U
NSCUPN	/SBS/	U
CPNA	/SBS/	U
OPTION	/RUN/	U
NNODES	/RUN/	U

LOCAL VARIABLES

I	I*4	LOOP INDEX
NVC	I*4	NUMBER OF ORIGINATING VOICE CIRCUITS
NCAU	I*4	NUMBER CAUs REQUIRED
NFTU	I*4	NUMBER FTUs REQUIRED
MXPNAC	I*4	MAXIMUM CAUs AT NAC/SCU CONFIGURATION
NGRP	I*4	NUMBER OF MAXIMUM NAC/SCU CONFIGURATIONS
NLEFT	I*4	NUMBER OF CAUs NOT IN MAX CONFIGURATION
NADTNL	I*4	NUMBER OF ADDITIONAL NAC, SCUs REQUIRED
NNAC	I*4	NUMBER OF NACs REQUIRED
NSCU	I*4	NUMBER OF SCUs REQUIRED
NMBNAC	I*4	NUMBER OF NAC LOCATIONS

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

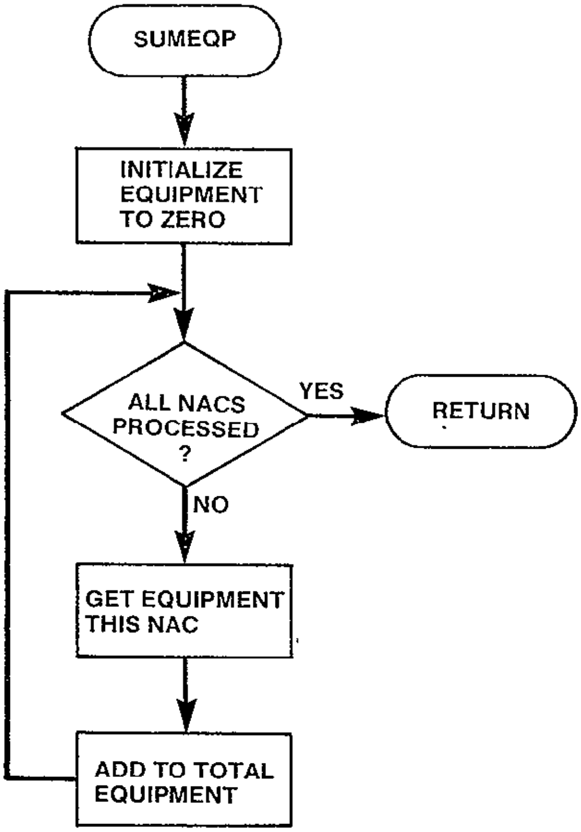


Figure 3-84. SUMEQP Logic Flow

3.8 UTILITY FUNCTIONS

CNDC contains 28 general purpose modules which are utilized by many other modules in the model. Because they cannot be easily grouped with a single portion of the model, they are grouped together as utility functions. For the most part the functions they perform are single, simple functions on a set of input arguments.

They all follow the same format. When the utility function is invoked, its input arguments are validated. If an error is detected, the value of the input argument is out of range, an error message is printed and the model is terminated.

Since, for the most part, the logic within these modules is relatively simple, logic flow figures have not been included.

3.8.1 ACC Module

```
   LOGICAL FUNCTION ACC(NODE,ITARIF)

PURPOSE
     LOGICAL FUNCTION WHICH DETERMINES IF RATE CENTER AT NODE IS A
     SATELLITE ACCESS CITY FOR TARIFF SPECIFIED

INPUT ARGUMENTS
     NODE          I*4          NODE NUMBER OF A RATE CENTER
     ITARIF        I*4          TARIFF IN QUESTION

OUTPUT ARGUMENTS
     ACC           L            LOGICAL FUNCTION VALUE
                                . TRUE.   RATE CENTER AT NODE IS A
                                          SATELLITE ACCESS CITY FOR
                                          SPECIFIED TARIFF
                                . FALSE.  RATE CENTER AT NODE IS NOT
                                          A SATELLITE ACCESS CITY FOR
                                          TARIFF SPECIFIED

DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
     NNODES        /RUN/        U
     NTARIF        /RUN/        U
     SA            /WU/         U
     SATACC        /WU/         U
     DEBUG         /LUN/        U

LOCAL VARIABLES
     IACC          I*4          POINTER TO POSITION WITHIN WU STRUCTURES
                                OF THIS INDICATES IF NODE SATELLITE
                                ACCESS CITY FOR THIS TARIFF
                                NODE IF IT IS A SATELLITE ACCESS CITY FOR
                                ANY TARIFF
     TACC          L            FUNCTION VALUE

SUBPROGRAMS CALLED
     NONE

ERRORS
     FATAL
       5000        INPUT ARGUMENTS OUT OF RANGE
     NONFATAL
       NONE
```

3.8.2 ATCOST Module

REAL FUNCTION ATCOST(MILAGE,ITARIF,ISCHED)

PURPOSE

DETERMINE COST PER CIRCUIT OF TERRESTRIAL SERVICE FOR TARIFF AND SCHEDULE SPECIFIED AT GIVEN MILEAGE

INPUT ARGUMENTS

MILAGE	I*4	DISTANCE OVER WHICH COST TO BE DETERMINED
ITARIF	I*4	TARIFF FOR WHICH COST TO BE DETERMINED
ISCHED	I*4	SCHEDULE FOR WHICH COST TO BE DETERMINED

OUTPUT ARGUMENTS

ATCOST	R	COST PER CIRCUIT FOR TARIFF USING SCHEDULE AT MILEAGE SPECIFIED

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NTARIF	/RUN/	U
NSCHED	/ATT/	U
NPLEVL	/ATT/	U
NPLEVL	/ATT/	U
TATBAS	/ATT/	U
TATINC	/ATT/	U
TATMLG	/ATT/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

I	I*4	LOOP INDEX
MLPREV	I*4	MILEAGE AT PREVIOUS BREAKPOINT
DLTMLG	R	DIFFERENCE BETWEEN PREVIOUS BREAKPOINT MILEAGE AND MILEAGE RATE DESIRED FOR
COST	R	TARIFF COST

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

5010	INPUT ARGUMENTS OUT OF RANGE

NONFATAL

NONE

3.8.3 ATTLST Module

LOGICAL FUNCTION ATTLST(MNEM)

PURPOSE

DETERMINE IF A RATE CENTER SPECIFIED BY ITS FOUR CHARACTER CODE IS ONE OF THE PRESTORED ATT CATEGORY A RATE CENTERS

INPUT ARGUMENTS

MNEM	I*4	CODE OF RATE CENTER IN QUESTION

OUTPUT ARGUMENTS

ATTLST	L	.TRUE.	MNEM IS A PRESTORED CATEGORY A RATE CENTER
		.FALSE.	MNEM IS NOT A PRESTORED CATEGORY A RATE CENTER

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

DRCATA	/INPATT/	U
MDIR	/INPATT/	U
MPBLK	/INPATT/	U
NCATA	/INPATT/	U
PRCATA	/INPATT/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

FOUND	L	MNEM FOUND IN DIRECTORY OF CATA LIST
PTR	I*4	POINTER TO ITEMS IN DIRECTORY OR CATA LIST BEING REFERENCED
END	I*4	END OF PORTION OF CATA LIST TO BE SEARCHED
START	I*4	BEGINNING OF PORTION OF CATA LIST TO BE SEARCHED

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

3.8.4 CATEG Module

```
   INTEGER FUNCTION CATEG(NODE1,NODE2,ITARIF)

PURPOSE
     DETERMINES THE SATELLITE ACCESS CATEGORY BETWEEN NODE1 AND
     NODE2 FOR THE TARIFF SPECIFIED

INPUT ARGUMENTS
     NODE1          I*4        FIRST NODE OF THE PAIR
     NODE2          I*4        SECOND NODE OF THE PAIR
     ITARIF         I*4        TARIFF IN QUESTION

OUTPUT ARGUMENTS
     CAT            I*4        SATELLITE ACCESS CATEGORY BETWEEN NODE1
                               AND NODE2 FOR TARIFF SPECIFIED
                               0  NON ACCESS
                               1  LONG HAUL
                               2  MEDIUM HAUL
                               3  SHORT HAUL

DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
     NNODES       /RUN/        U
     NSATAX       /WU/         U
     NTARIF       /RUN/        U
     SA           /WU/         U
     WUPRS        /WU/         U
     DEBUG        /LUN/        U

LOCAL VARIABLES
     WUA          I*4          POINTER TO NODE IN WU STRUCTURES IF NODE
                               1 IS SATELLITE ACCESS CITY FOR ANY TARIFF
     WUB          I*4          POINTER TO NODE IN WU STRUCTURE IF NODE
                               2 IS SATELLITE ACCESS CITY FOR ANY TARIFF
     PTR          I*4          POSITION OF PAIR WITHIN WUPRS ARRAY
     CAT          I*4          RATE CATEGORY OF PAIR

SUBPROGRAMS CALLED
     PTRPRS

ERRORS
     FATAL
       5020       INPUT ARGUMENTS OUT OF RANGE
     NONFATAL
       NONE
```

3.8.5 DEFPRE Module

SUBROUTINE DEFPRE

PURPOSE
DEFINE PRESTORED NETWORK

INPUT ARGUMENTS
NONE

OUTPUT ARGUMENTS
NONE

DATA STRUCTURES
(U - USED, S - DEFINED, R - READ)

HNOD	/HEADRS/	U
NPRNDS	/PRSNDS/	S
PRNDS	/PRSNDS/	S
TRFNDS	/LUN/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

HEADER(2)	R*8	FILE HEADER
HT	I*4	HORIZONTAL COORDINATE
I	I*4	LOOP INDEX
VT	I*4	VERTICAL COORDINATE

SUBPROGRAMS CALLED
NONE

ERRORS
FATAL

5090	FILE HEADER OF PRESTORED NETWORK FILE NOT AS EXPECTED

NONFATAL
NONE

3.8.6 DIRGEN Module

SUBROUTINE DIRGEN

PURPOSE

GET LIST OF FILENAMES IN NETWORK AND TARIFF DIRECTORIES

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFNED, R - READ)

HNET(2)	/HEADRS/	U
HTAR(2)	/HEADRS/	U
NETDEF(20)	/NETFIL/	R
NETDIR	/LUN/	U
NFILES(20)	/NETFIL/	R
NNFIL	/NETFIL/	R
NTFIL	/TARFIL/	R
TARDEF(13)	/LUN/	U
TFILES(13)	/TARFIL/	R
DEBUG	/LUN/	U

LOCAL VARIABLES

HEADER(2)	R*8	FILE HEADER READ
I	I*4	LOOP INDEX

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

5100 FILE HEADER READ FROM TARIFF DIRECTORY NOT AS EXPECTED

5110 FILE HEADER READ FROM THE NETWORK DIRECTORY NOT AS EXPECTED

NONFATAL

NONE

3.8.7 FACSIZ Module

```
SUBROUTINE FACSIZ(VFS,NJUMBO,NMSTER,NSUPER,NBASE)
```

PURPOSE

DETERMINES FACILITY SIZE GIVEN THE NUMBER OF VOICE CIRCUITS

INPUT ARGUMENTS

VFS	I*4	NUMBER OF VOICE CIRCUITS

OUTPUT ARGUMENTS

NJUMBO	I*4	NUMBER OF JUMBO GROUPS
NMSTER	I*4	NUMBER OF MASTER GROUPS
NSUPER	I*4	NUMBER OF SUPER GROUPS
NBASE	I*4	NUMBER OF BASE GROUPS

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

DEBUG	/LUN/	U

LOCAL VARIABLES

NLEFT	I*4	NUMBER OF VOICE CIRCUITS REMAINING TO BE ATTRIBUTED TO A GROUP

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

5120	NUMBER OF INPUT VOICE CIRCUITS OUT OF RANGE

NONFATAL

NONE

3.8.8 FILDEF Module

INTEGER FUNCTION FILDEF(DIR,INFIL)

PURPOSE

INTEGER FUNCTION WHICH DETERMINES IF FILENAME SPECIFIED IS IN CURRENT DIRECTORY (NETWORK OR TARIFF)

INPUT ARGUMENTS

DIR	I*4	DIRECTORY TO BE SEARCHED 1 NETWORK DIRECTORY 2 TARIFF DIRECTORY
INFIL	I*4	FILE NAME TO BE SEARCHED FOR IN DIRECTORY

OUTPUT ARGUMENTS

FILDEF	I*4	INTEGER INDICATOR OF STATUS OF FILNAM 1 FILE NAME INVALID 2 VALID NAME BUT FILE UNDEFINED 3 VALID NAME AND FILE IS DEFINED

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NNFIL	/NETFIL/	U
NFILES	/NETFIL/	U
NETDEF	/NETFIL/	U
NTFIL	/TARFIL/	U
TFILES	/TARFIL/	U
TARDEF	/TARFIL/	U
DEBUG	/LUN/	

LOCAL VARIABLES

FOUND	LOGICAL	INDICATES IF NAME FOUND IN DIRECTORY
I	I*4	LOOP INDEX
IVAL	I*4	STATUS OF FILE IF IN DIRECTORY

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL	DIRECTORY REQUESTED IS NOT VALID
5150	
NONFATAL	
NONE	

3.8.9 INTCHR Module

SUBROUTINE INTCHR(INVAL,C1,C2,C3)

PURPOSE

CONVERT RIGHT MOST THREE DIGITS OF THE INPUT INTEGER VALUE TO CHARACTER REPRESENTATION.

INPUT ARGUMENTS

INVAL	I*4	INPUT INTEGER

OUTPUT ARGUMENTS

C1	I*2	CHARACTER REPRESENTATION OF DIGIT IN HUNDREDS POSITION
C2	I*2	CHARACTER REPRESENTATION OF DIGIT IN TENS POSITION
C3	I*2	CHARACTER REPRESENTATION OF DIGIT IN ONES POSITION

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

DEBUG	/LUN/	U

LOCAL VARIABLES

ITRNK	I*4	INTEGER VALUE OF RIGHT MOST THREE DIGITS OF INPUT VALUE
I1	I*4	INTEGER VALUE OF DIGIT IN HUNDREDS POSITION
I2	I*4	INTEGER VALUE OF DIGIT IN TENS POSITION
I3	I*4	INTEGER VALUE OF DIGIT IN ONES POSITION

SUBPROGRAMS CALLED

NONE

ERRORS

NONE

3.8.10 LISTED Module

```
INTEGER FUNCTION LISTED(NODE,ITARIF)
```

PURPOSE

DETERMINES IF THE NODE SPECIFIED IN A CATEGORY A FOR TARIFF SPECIFIED

INPUT ARGUMENTS

NODE	I*4	INTEGER NUMBER OF NODE OF THE RATE CENTER IN QUESTION
ITARIF	I*4	INTEGER NUMBER OF THE TARIFF IN QUESTION

OUTPUT ARGUMENTS

LISTED	I	INDICATOR OF CATEGORY OF INPUT NODE 1 CATEGORY B UNLISTED 0 CATEGORY A LISTED

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

ALSTD	/ATT/	U
LSTED	/ATT/	U
NINLST	/ATT/	U
NNODES	/RUN/	U
NTARIF	/RUN/	U
TPTR	/ATT/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

IATT	I*4	CATA STATUS OF THIS NODE IN PRESTORED TARIFF
PTR	I*4	WHERE DESCRIPTION OF THIS TARIFF STARTS
NUMB	I*4	NUMBER OF ITEMS IN LIST THAT DESCRIBES THIS TARIFF
END	I*4	NUMBER OF LAST ITEM IN LIST THAT DESCRIBES THIS TARIFF

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

5030	INPUT ARGUMENTS OUT OF RANGE

NONFATAL

NONE

3.8.11 MILES Module

```
   INTEGER FUNCTION MILES(NODE1,NODE2)

PURPOSE
     CALCULATES THE AIRLINE MILEAGE BETWEEN NODE1 AND NODE2 USING
     METHOD DESCRIBED IN SECTION 3.2 OF FCC TARIFF NUMBER 264

INPUT ARGUMENTS
     NODE1          I*4        INTEGER NUMBER OF FIRST NODE
     NODE2          I*4        INTEGER NUMBER OF SECOND NODE

OUTPUT ARGUMENTS
     MILES          I*4        AIRLINE MILEAGE BETWEEN NODE1 AND NODE2

DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
     H            /RNODES/     U
     V            /RNODES/     U
     NNODES       /RUN/        U
     DEBUG        /LUN/        U

LOCAL VARIABLES
     IRL            I*4        INTEGER DISTANCE BETWEEN TWO NODES
     RL             R*4        REAL DISTANCE BETWEEN TWO NODES

SUBPROGRAMS CALLED
     NONE

ERRORS
     FATAL
       5040       INPUT ARGUMENTS OUT OF RANGE
     NONFATAL
       NONE
```

3.8.12 MNMPTR Module

INTEGER FUNCTION MNMPTR(MNEM)

PURPOSE

INTEGER FUNCTION WHICH FINDS NODE NUMBER WITHIN USER DEFINED NETWORK OF THE NODE WITH CODE MNEM

INPUT ARGUMENTS

MNEM	I*4	FOUR CHARACTER CODE OF RATE CENTER IN QUESTION

OUTPUT ARGUMENTS

MNMPTR	I*4	INTEGER NODE NUMBER OF RATE CENTER WITH CODE MNEM. MNMPTR MUST BE IN THE RANGE 0 TO NNODES. IF MNMPTR=0, THEN MNEM IS NOT A VALID CODE IN THE CURRENT RUN

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NNODES	/RUN/	U
RTCTR	/RNODES/	U
NDIR	/RNODES/	U
NPBLK.	/RNODES/	U
DRNODE	/RNODES/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

PTR	I*4	RATE CENTER IN DIRECTORY OR RATE CENTER LIST UNDER CONSIDERATION
START	I*4	START POSITION OF SEARCH IN LIST
END	I*4	END POSITION OF SEARCH IN LIST
FOUND	I*4	.TRUE. IF MNEM FOUND IN LIST OF DIRECTORY

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

3.8.13 MTPLY Module

```
SUBROUTINE MTPLY(A1,A2,M1,M2,R1,R2)
```

PURPOSE

MULTIPLY REAL COST ROUNDED TO TWO DECIMAL PLACES BY INTEGER QUANTITY

INPUT ARGUMENTS

A1	R*4	COST
A2	I*4	QUANTITY

OUTPUT ARGUMENTS

M1	R*4	DOLLAR PORTION OF A1
M2	I*4	CENTS PORTION OF A1
R1	R*4	DOLLOR PORTION OF RESULTS OF M1*A2
R2	I*4	CENTS PORTION OF RESULT OF M2*A2

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

DEBUG	/LUN/	U

LOCAL VARIABLES

P	R*4	CENTS PORTION OF M1 TO THREE DECIMAL PLACES PLUS 5 ADDED IN FOR ROUNDING

SUBPROGRAMS CALLED

NONE

ERRORS

NONE

3.8.14 MTPY Module

REAL FUNCTION MTPY(ARG1,ARG2)

PURPOSE

MULTIPLY REAL COST ROUNDED TO TWO DECIMAL PLACES BY INTEGER QUANTITY

INPUT ARGUMENTS

ARG1	R*4	COST
ARG2	I*4	QUANTITY

OUTPUT ARGUMENTS

MTPY	R*4	ROUNDED RESULT OF MULTIPLICATION

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

DEBUG	/LUN/	U

LOCAL VARIABLES

RARG2	R*4	INTEGER ARGUMENT EXPRESSED AS REAL
PART1	R*4	WHOLE NUMBER PART OF REAL ARGUMENT
PART2	R*4	DECIMAL PORTION OF REAL ARGUMENT
FULL	R*4	PRODUCT OF ARG1 ROUNDED TO 2 DECIMAL PLACES AND ARG2
AARG	R*4	ABSOLUTE VALUE OF REAL ARGUMENT

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

3.8.15 PTRPRS Module

INTEGER FUNCTION PTRPRS(NODE1,NODE2,NUM)

PURPOSE

GETS CORRECT POINTER FOR EACH NODE PAIR SPECIFIED BY NODE1 AND NODE2 INTO A ONE DIMENSIONAL ARRAY WHICH REPRESENTS THE TRIANGLE ABOVE THE DIAGONAL FROM THE UPPER LEFT TO THE LOWER RIGHT CORNERS OF A NUM*NUM MATRIX

INPUT ARGUMENTS

NODE1	I*4	INTEGER NUMBER OF THE FIRST NODE MUST BE IN THE RANGE OF 1 AND NUM
NODE2	I*4	INTEGER NUMBER OF THE SECOND NODE MUST BE IN THE RANGE OF 1 AND NUM
NUM	I*4	NUMBER OF NODES IN THE MATRIX

OUTPUT ARGUMENTS

PTRPRS	I*4	INTEGER POINTER DESIRED

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

DEBUG	/LUN/	U

LOCAL VARIABLES

FIRST	I*4	INPUT NODE WHICH IS THE SMALLEST
SECOND	I*4	DISTANCE INTO FINAL ROW OF POINTER
PUKA	I*4	DESIRED POSITION IN ONE DIMENSIONAL ARRAY
IEND	I*4	NUMBER OF INTERATIONS REQUIRED TO DETERMINE DESIRED POSITION
I	I*4	LOOP INDEX

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

5050	ARGUMENTS OUT OF RANGE

NONFATAL

NONE

3.8.16 ROWTOT Module

```
   INTEGER FUNCTION ROWTOT(NODE)

PURPOSE
     SUM SPECIFIED ROW OF TRAFFIC TABLE

INPUT ARGUMENTS
     NODE           I*4        ROW TO BE SUMMED

OUTPUT ARGUMENTS
     ROWTOT         I*4        SUM OF ROW NODE OF TRAFFIC TABLE

DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
     NNODES         /RUN/      U
     TRAFIC         /TRFC/     U
     DEBUG          /LUN/      U

LOCAL VARIABLES
     TOTAL          I*4        SUM OF ROW
     I              I*4        LOOP INDEX

SUBPROGRAMS CALLED
     NONE

ERRORS
     FATAL
       5060      INPUT ARGUMENT OUT OF RANGE
     NONFATAL
       NONE
```

3.8.17 RUTFCT Module

INTEGER FUNCTION RVTFC(FROM,TO)

PURPOSE

REVIEW TRAFFIC BETWEEN ANY PAIR OF NODES IN USER DEFINED NETWORK

INPUT ARGUMENTS

FROM	I*4	CODE OF FROM NODE
TO	I*4	CODE OF TO NODE

OUTPUT ARGUMENTS

RVTFC	I*4	NUMBER OF VOICE CIRCUITS BETWEEN FROM AND TO

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

TRAFIC	/TRFC/	U
DEBUG	/LUN/	U
NNODES	/RUN/	U

LOCAL VARIABLES

IFROM	I*4	POINTER TO FROM NODE IN NETWORK
ITO	I*4	POINTER TO TO NODE IN NETWORK
NVC	I*4	NUMBER OF VOICE CIRCUITS

SUBPROGRAMS CALLED

MNMPTR

ERRORS

FATAL

5130	NODES SPECIFIED DONT EXIST IN USER DEFINED NETWORK

NONFATAL

NONE

3.8.18 SBCOST Module

```
         REAL FUNCTION SBCOST(VC,TARIFF)

      PURPOSE
           DETERMINE THE COST PER CIRCUIT FOR SBS TARIFF SPECIFIED

      INPUT ARGUMENTS
           VC              I*4         NUMBER OF VOICE CIRCUITS
           TARIFF          I*4         NUMBER OF TARIFF IN QUESTION

      OUTPUT ARGUMENTS
           SBCOST          R           COST PER CIRCUIT FOR SBS TARIFF SPECIFIED

      DATA STRUCTURES
           (U - USED, S - DEFINED, R - READ)
           CPNA            /SBS/       U
           VCPFTU          /SBS/       U
           NSCUPN          /SBS/       U
           MAXGRP          /SBS/       U
           NPTAB           /SBS/       U
           TSBBKP          /SBS/       U
           TSBCAB          /SBS/       U
           TSBCAI          /SBS/       U
           TSBCMN          /SBS/       U
           TSBNAC          /SBS/       U
           TSBFTU          /SBS/       U
           TSBSCU          /SBS/       U
           DEBUG           /LUN/       U
           NTARIF          /RUN/       U

      LOCAL VARIABLES
           COST            R*4         TOTAL COST
           IEND            I*4         MAXIMUM NUMBER OF ITERATIONS TO ASSIGN
                                       NVC TO CONFIGURATION OF 1 NAC AND UP TO
                                       NSCUPN SCUS
           CPN             I*4         MAXIMUM OF CAUS PER NAC (SCU)
           CSTCAU          R*4         COST FOR CAUS
           I,J             I*4         LOOP INDICES
           NCAU            I*4         NUMBER OF CAUS AT NODE
           NFTU            I*4         NUMBER OF FTUS REQUIRED
           NGRP            I*4         NUMBER OF NACS AT NODE
           NNAC            I*4         NUMBER OF NACS REQUIRED
                                       NNAC(1)   NUMBER OF NACS
                                       NNAC(2)-NNAC(4) NUMBER OF SCUS
           PREV            I*4         LOWER BOUND OF NUMBER OF CAUS/NAC FOR
                                       BREAKPOINT IN RATE TABLES
           TCAU            R*4         CAU COST AT ONE NAC/SCU CONFIGURATION
           TMPCMN          R*8         MINIMUM CAU COST
           MXPNAC          I*4         MAXIMUM NUMBER OF CAU PER NAC/SCU
                                       CONFIGURATION
```

NLEFT	I*4	NCAU LEFT WHEN ASSIGN CAU TO TOTAL NAC/SCU CONFIGURATION
N	I*4	NUMBER OF NAC AND SCU REQUIRED FOR NLEFT

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

5070 INPUT ARGUMENTS OUT OF RANGE

NONFATAL

NONE

3.8.19 SMSA Module

LOGICAL FUNCTION SMSA(MNEM)

PURPOSE

LOGICAL FUNCTION WHICH DETERMINES IF NODE MNEM IS WITHIN THE PRESTORED NETWORK

INPUT ARGUMENTS

MNEM	I*4	FOUR CHARACTER CODE OF RATE CENTER IN QUESTION

OUTPUT ARGUMENTS

SMSA	LOGICAL	.TRUE.	MNEM IS A PRESTORED NODE
		.FALSE.	MNEM IS NOT A PRESTORED NODE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NPRNDS	/PRSNDS/	U
PRNDS	/PRSNDS/	U
KDIR	/PRSNDS/	U
KPBLK	/PRSNDS/	U
KRNODE	/PRSNDS/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

PTR	I*4	RATE CENTER IN DIRECTORY OR RATE CENTER LIST UNDER CONSIDERATION
START	I*4	START POSITION OF SEARCH IN LIST
END	I*4	END POSITION OF SEARCH IN LIST
FOUND	L	.TRUE. IF MNEM FOUND IN LIST OR DIRECTORY

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

3.8.20 SORT1 Module

SUBROUTINE SORT1(CODE,ORDER,NEL)

PURPOSE

SORTS THE NEL ELEMENTS IN CODE ARRAY IN ASCENDING ORDER

INPUT ARGUMENTS

CODE	I*4	INTEGER ARRAY TO BE RTED
NEL	I*4	NUMBER OF ELEMENTS TO BE SORTED

OUTPUT ARGUMENTS

ORDER	I*4	POSITION OF ITEMS IN CODE IN ASCENDING ORDER; IT IS ASSUMED THAT ORDER HAS BEEN INITIALIZED BY CALLING ROUTINE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NONE

LOCAL VARIABLES

INDX1	I*4	POINTER TO FIRST OF TWO ITEMS IN CODE TO BE COMPARED
INDX2	I*4	POINTER TO SECOND OF TWO ITEMS IN CODE TO BE COMPARED
IEND	I*4	NUMBER OF COMPARISONS
SORTED	L	INDICATES IF LIST FULLY SORTED
I	I*4	LOOP INDEX

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

3.8.21 SORTID Module

SUBROUTINE SORTID(CODE,ORDER,NEL)

PURPOSE

SORT THE NEL ELEMENTS IN CODE IN DESCENDING ORDER

INPUT ARGUMENTS

NEL	I*4	NUMBER OF ELEMENTS TO BE SORTED
CODE	I*4	ARRAY OF ELEMENTS TO BE SORTED

OUTPUT ARGUMENTS

ORDER	I*4	POINTER TO ITEMS IN CODE ARRAY IN SORTED ORDER

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NONE

LOCAL VARIABLES

INDX1	I*4	POINTER TO FIRST OF TWO ITEMS IN CODE TO BE COMPARED
INDX2	I*4	POINTER TO SECOND OF TWO ITEMS IN CODE TO BE COMPARED
IEND	I*4	NUMBER OF COMPARISONS
SORTED	L	INDICATES IF LIST FULLY SORTED
I	I*4	LOOP INDEX

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

3.8.22 SORT2 Module

```
SUBROUTINE SORT2(CODEL,CODER,ORDER,NEL)
```

PURPOSE

SORTS THE NEL ITEMS IN CODEL AND CODER IN ASCENDING ORDER BY CODEL AND THEN BY CODER WITHIN CODEL

INPUT ARGUMENTS

NEL	I*4	NUMBER OF ITEMS IN ARRAYS TO BE SORTED
CODEL	I*4	ARRAY TO BE SORTED
CODER	I*4	ARRAY TO BE SORTED WITHIN CODEL

OUTPUT ARGUMENTS

ORDER	I*4	ARRAY OF POINTER TO CODEL, CODER PAIR IN ASCENDING ORDER

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NONE

LOCAL VARIABLES

INDX1	I*4	POINTER TO FIRST OF TWO ITEMS IN CODE TO BE COMPARED
INDX2	I*4	POINTER TO SECOND OF TWO ITEMS IN CODE TO BE COMPARED
IEND	I*4	NUMBER OF COMPARISONS
SORTED	L	INDICATES IF LIST FULLY SORTED
I	I*4	LOOP INDEX

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

3.8.23 TARTYP Module

INTEGER FUNCTION TARTYP(TARIFF)

PURPOSE

DETERMINES THE TYPE OF THE TARIFF (ATT, WU, SBS) GIVEN THE TARIFF NUMBER

INPUT ARGUMENTS

TARIFF	I*4	NUMBER OF TARIFF

OUTPUT ARGUMENTS

TARTYP	I*4	TARIFF TYPE 1 ATT 2 WU 3 SBS

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NTARIF	/RUN/	U
OPTION	/RUN/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

TYPE	I*4	TARIFF TYPE

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

5080	INPUT ARGUMENT OUT OF RANGE

NONFATAL

NONE

3.8.24 TRFSKP Module

```
   SUBROUTINE TRFSKP(NREC,UNIT)

PURPOSE
    READ THE SPECIFIED NUMBER OF RECORDS FROM THE SPECIFIED
    LOGICAL UNIT NUMBER

INPUT ARGUMENTS
    NREC            I*4        NUMBER OF RECORDS TO READ
    UNIT            I*4        LOGICAL UNIT NUMBER OF FILE TO BE READ

OUTPUT ARGUMENTS
    NONE

DATA STRUCTURES
    DEBUG           /LUN/      U

LOCAL VARIABLES
    I               I*4        LOOP INDEX
    WORD            I*4        FIRST WORD ON RECORD

ERROR
    NONE
```

3.8.25 USRNET Module

LOGICAL FUNCTION USRNET(MNEM)

PURPOSE

DETERMINE IF A RATE CENTER SPECIFIED BY ITS 4 CHARACTER CODE IS ONE OF THE NODES IN THE CURRENTLY DEFINED NETWORK

INPUT ARGUMENTS

MNEM	I*4	4 CHARACTER CODE OF NODE

OUTPUT ARGUMENTS

USRNET	LOGICAL	.TRUE.	MNEM IS IN THE USER DEFINED NETWORK
		.FALSE.	MNEM IS NOT IN THE NETWORK

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

DEBUG	/LUN/	U

LOCAL VARIABLES

NET	LOGICAL	.TRUE.	MNEM IS IN THE USER DEFINED NETWORK
		.FALSE.	MNEM IS NOT IN THE USER DEFINED NETWORK
PTR	I*4	POINTER TO MNEM IN THE NETWORK	

SUBPROGRAMS CALLED

MNMPTR

ERRORS

FATAL

NONE

NONFATAL

NONE

3.8.26 WRTTRF Module

SUBROUTINE WRTTRF(UNIT)

PURPOSE

PRINT INTO FILE SPECIFIED BY UNIT, CURRENT TRAFFIC TABLE

INPUT ARGUMENTS

UNIT	I*4	LOGICAL UNIT NUMBER OF FILE TO CONTAIN LISTING OF TRAFFIC TABLE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NNODES	/RUN/	U
RTCNTR	/RNODES/	U
TRAFIC	/TRFC/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

I,J,K	I*4	LOOP INDICES
NBK	I*4	NUMBER OF BLOCKS OF TRAFFIC TABLE VALUES TO BE PRINTED
HEADER(5)	I*4	HEADER LINE OF TO RATE CENTERS IN THIS BLOCK
TFC(5)	I*4	TRAFFIC VALUES FOR CURRENT PRINT LINE
BEG	I*4	INDEX OF FIRST TO RATE CENTER IN THIS BLOCK
LAST	I*4	INDEX OF LAST TO RATE CENTER IN THIS BLOCK
LAST	I*4	LAST ELEMENT IN HEADER OR TFC TO BE FILLED FOR THIS BLOCK
NPLIN	I*4	CONSTANT NUMBER OF VALUES PER PRINT LINE

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

3.8.27 WUCOST Module

REAL FUNCTION WUCOST(CAT,TARIFF)

PURPOSE

DETERMINES THE WU COST PER CIRCUIT GIVEN THE RATE CATEGORY OF THE CITY PAIR AND THE DESIRED TARIFF

INPUT ARGUMENTS

CAT	I*4	RATE CATEGORY OF THE CITY PAIR 1 LONG HAUL 2 MEDIUM HAUL 3 SHORT HAUL
TARIFF	I*4	NUMBER OF THE TARIFF

OUTPUT ARGUMENTS

WUCOST	R	COST PER CIRCUIT GIVEN THE RATE CATEGORY OF THE CITY PAIR AND THE DESIRED TARIFF

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

TWU	/WU/	U
NTARIF	/RUN/	U
NWUCAT	/WU/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

COST	R	WU COST PER CIRCUIT

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

5140	INPUT ARGUMENTS OUT OF RANGE

NONFATAL

NONE

3.8.28 WUPAIR Module

INTEGER FUNCTION WUPAIR(MNEM1,MNEM2)

PURPOSE

DETERMINE IF RATE CENTERS SPECIFIED ARE AN ACCESS CITY PAIR

INPUT ARGUMENTS

MNEM1	I*4	FOUR CHARACTER CODE OF RATE CENTER
MNEM2	I*4	FOUR CHARACTER CODE OF SECOND RATE CENTER

OUTPUT ARGUMENTS

WUPAIR	LOGICAL	FUNCTION VALUE OF .TRUE. IF PAIR SPECIFIED IS SATELLITE ACCESS CITY PAIR IN PRESTORED WU TARIFF

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NACC	/PRSWU/	U
LSTACC	/PRSWU/	U
WUPRS	/WU/	U
DEBUG	/LUN/	U

LOCAL VARIABLES

RPTR	I*4	POINTER OF MNEM1 IN LSTACC IF IT IS THERE
LPTR	I*4	PINTER OF MNEM2 IN LSTACC IF IT IS THERE
PAIR	I*4	RATE CATEGORY OF PAIR IF THEY ARE A SATELLITE ACCESS CITY PAIR, ELSE 0
I	I*4	LOOP INDEX
PTR	I*4	POINTER OF MNEM1,MNEM2 RATE CATEGORY IN WUPRS IF THEY ARE IN ACCESS CITY PAIR

SUBPROGRAMS CALLED

PTRPRS

ERRORS

FATAL

NONE

NONFATAL

NONE

3.9 BATCH DESCRIPTION

As described earlier, the CNDC model has two phases: one in which the user may define networks and tariffs to model and the second in which the optimization of a selected network over specified tariffs takes place. The input phase is conducted through an interaction between the user and the model, which guides the user through network and/or tariff building by offering choices, posing questions, and evaluating responses. The model may also be run in a batch rather than an interactive environment. To provide this capability, several of the model modules which communicate with the user, asking questions and evaluating responses, were modified to have them simply read the input from a file or card deck.

The user may execute the model in batch mode or may create network and/or tariff files. Several of the services provided by the input function of the interactive version, however, are not available in the batch version. The user may not delete or list files, but may only create files. The batch version will read and evaluate the input and create the specified tariff and/or network files if there are no errors. If there are errors, however, descriptive error messages are printed and the desired files are not created. The user must simply correct the input using the error messages and resubmit the job.

Figure 3-85 contains a hierarchy chart of the modules which perform the batch function. The modules specified in broken boxes are those from the main model, described previously. Below is a list of the batch modules described in this section. Next to each is the name of its interactive counterpart.

BATCH MODULE	INTERACTIVE COUNTERPART
CNDCB	CNDC
INPUTB	INPUT, NETCON, TARCON, EXCON
NETB	CREATE
TARB	CREATT
CRATTB	TCRATT

BATCH MODULE	INTERACTIVE COUNTERPART
CRWUB	TCRWU
CRSBSB	TCRSBS
EXCONB	XCREAT

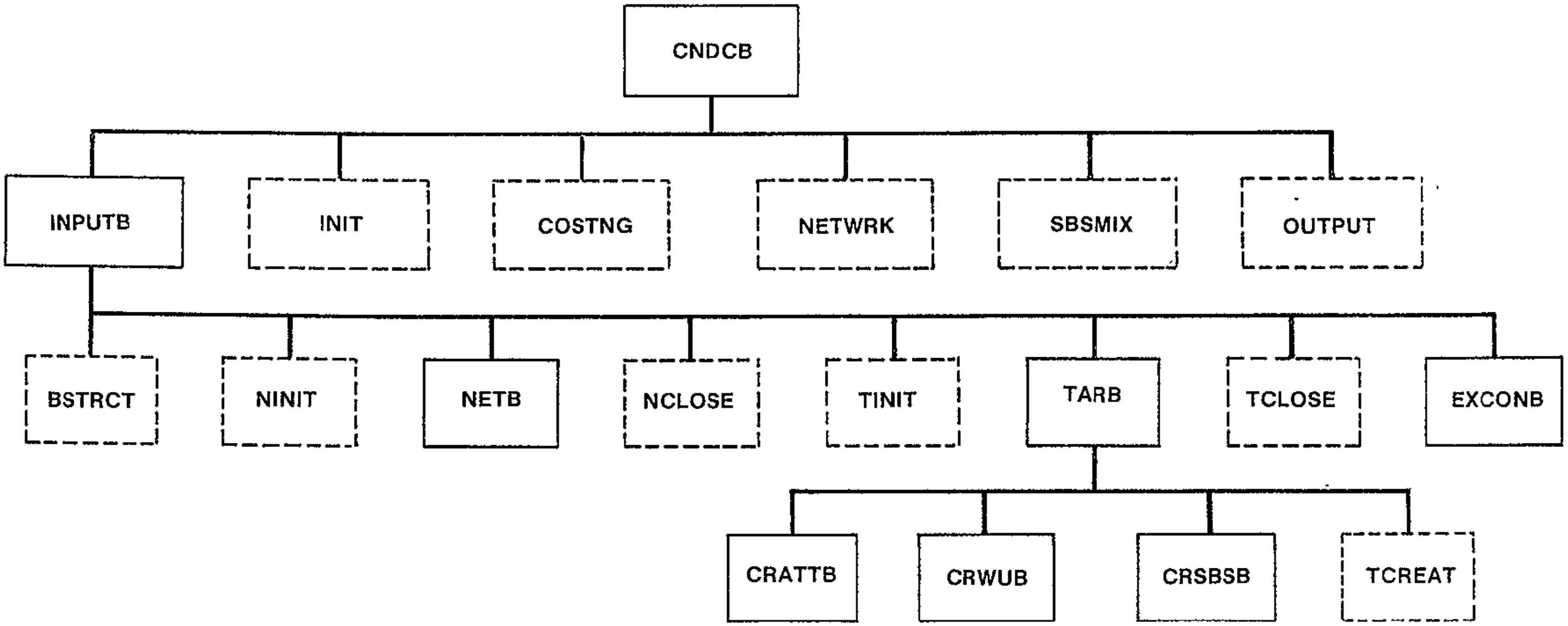


Figure 3-85. BATCH Hierarchy Chart

3.9.1 CNDCB Module

PURPOSE

DIRECT OVERALL PROCESSING OF BATCH VERSION OF CNDC MODEL

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NCASE	/RUN/	S

LOCAL VARIABLES

FLAG	LOGICAL	INDICATES WHETHER TO CONTINUE PROCESSING OR TERMINATE .TRUE. CONTINUE .FALSE. TERMINATE

SUBPROGRAMS CALLED

INPUTB
INIT
COSTNG
NETWRK
OUTPUT
SBSMIX

ERRORS

FATAL

NONE

NONFATAL

NONE

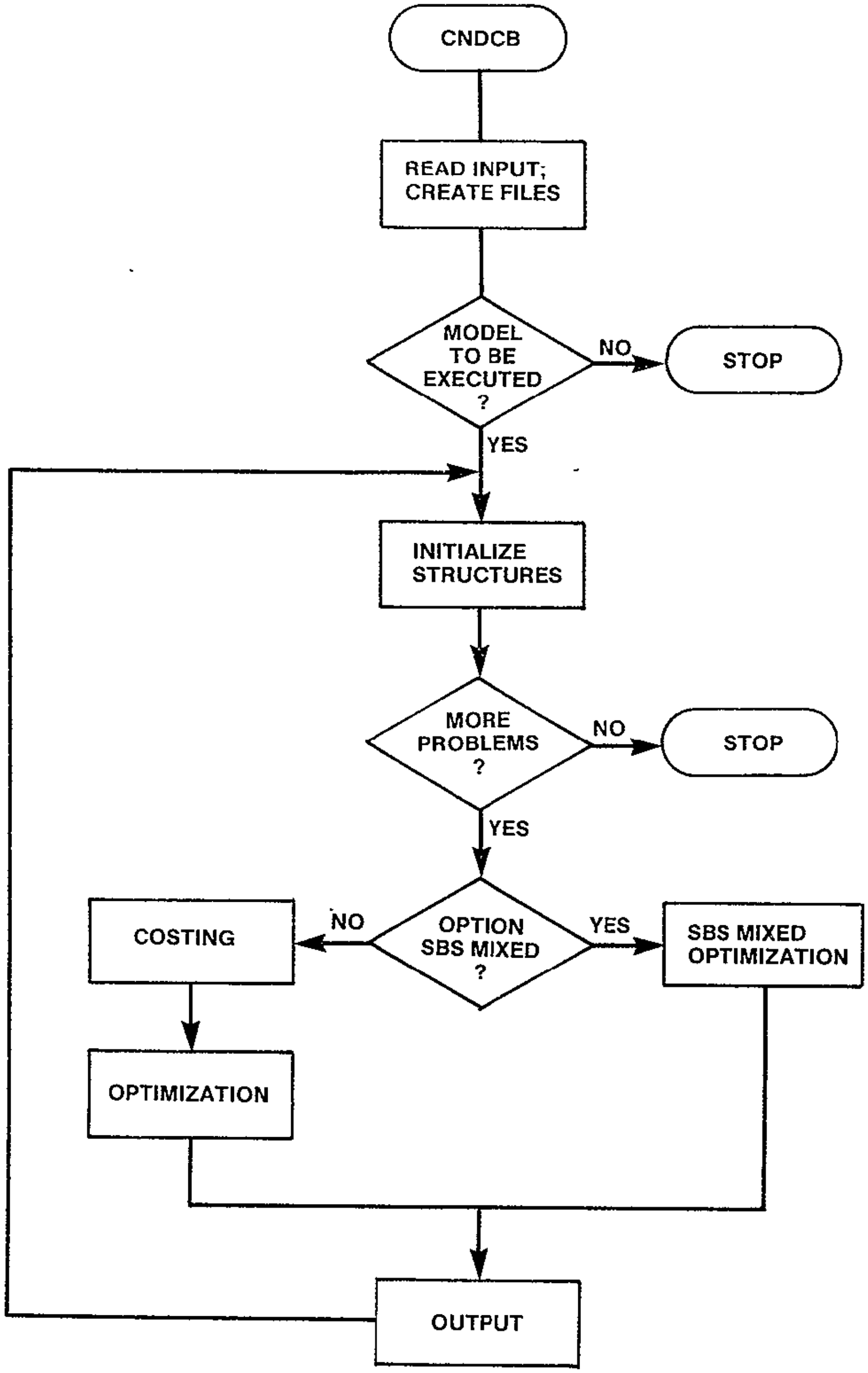


Figure 3-86. CNDCB Logic Flow

3.9.2 INPUTB Module

```
    SUBROUTINE INPUTB(FLAG)

 PURPOSE
     READ BATCH INPUTS AND CREATE NETWORK, TARIFF, AND EXECUTION CONTROL
     FILES

 INPUT ARGUMENTS
     NONE

 OUTPUT ARGUMENTS
     FLAG           LOGICAL    INDICATES WHETHER TO CONTINUE PROCESSING
                               OR TERMINATE
                               .TRUE.   CONTINUE
                               .FALSE.  TERMINATE

 DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
     DEBUG          /LUN/      U
     LUNOUT         /LUN/      U

 LOCAL VARIABLES
     IOPT           I*4        OPTION CODE DEFINING TYPE OF INPUT
                               SECTION
                               1 - CREATE NETWORK FILE
                               2 - CREATE TARIFF FILE
                               3 - CREATE EX CON FILE
                               4 - EXECUTE MODEL
                               5 - TERMINATE MODEL

 SUBPROGRAMS CALLED
     BSTRCT
     NINIT
     NETB
     NCLOSE
     TINIT
     TARB
     TCLOSE
     EXCONB

 ERRORS
     FATAL
       B1000  INVALID OPTION CODE
     NONFATAL
       NONE
```

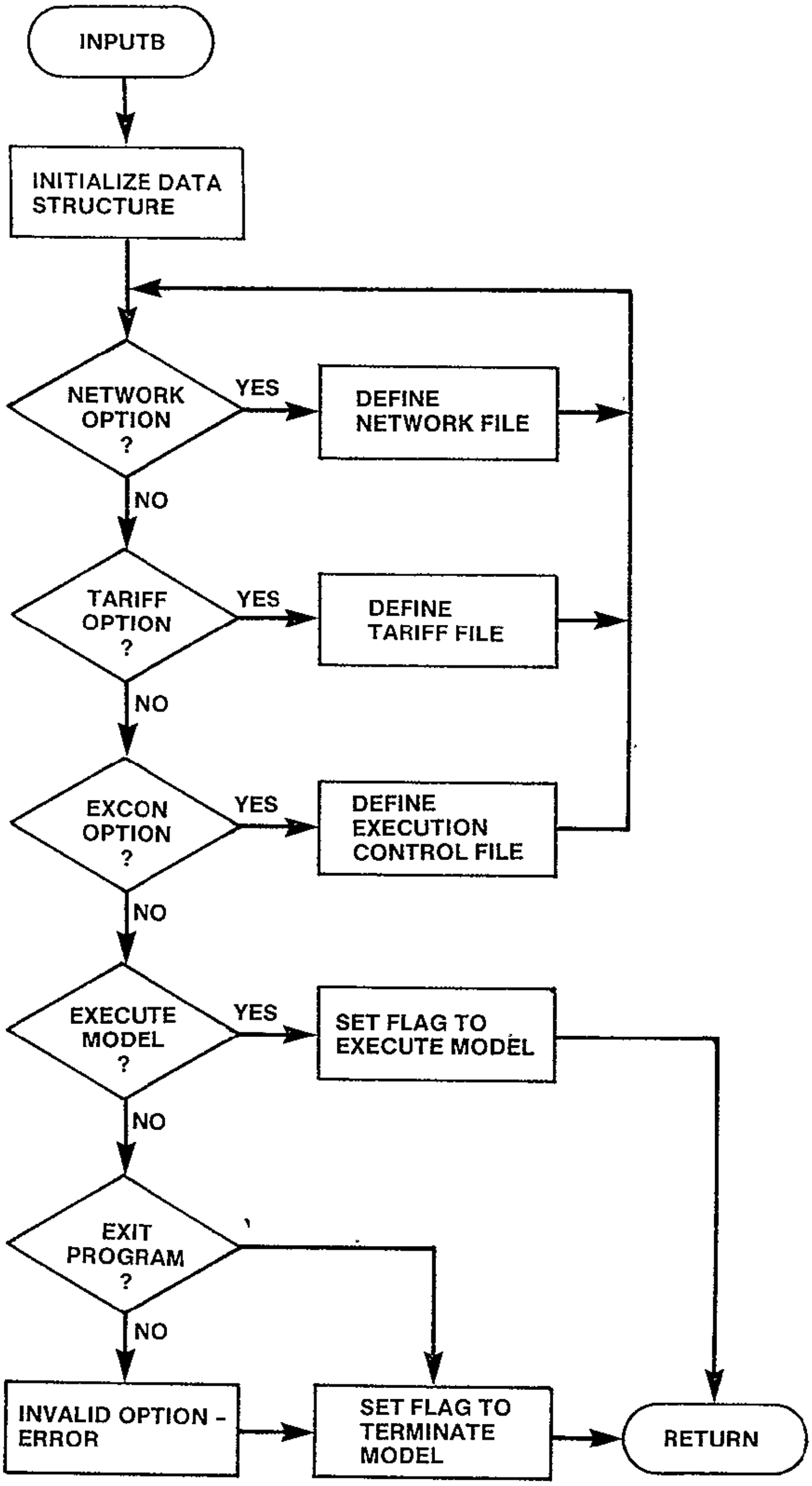


Figure 3-87. INPUTB Logic Flow

3.9.3 NETB Module

SUBROUTINE NETB

PURPOSE

READ NECESSARY INPUTS AND CREATE A NETWORK FILE

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

CROPT	/INPNET/	S
NNDS	/INPNOD/	S
CODE	/INPNOD/	S
NPRNDS	/PRSNDS/	U
TOTNDS	/INPNET/	S
PERCNT	/INPNET/	S
LVLTRF	/INPNET/	S
VC	/INPNET/	S
HC	/INPNET/	S
MAXUSR	/INPNET/	U
NTRFC	/INPNET/	S
CODEL	/INPNOD/	S
CODER	/INPNOD/	S
VCIRTS	/INPNET/	S
DEBUG	/LUN/	U
MAXNDS	/INPNOD/	U
LUNOUT	/LUN/	U

LOCAL VARIABLES

ERROR	L	INDICATES WHETHER A FATAL ERROR HAS BEEN FOUND: .TRUE. THERE IS A FATAL ERROR .FALSE. NO FATAL ERROR
FILNAM	R*8	NAME OF NETWORK FILE TO BE CREATED
IANS	I*4	0 OR 1 TO HAVE TRAFFIC TABLE SPOOLED
ITEMP	I*4	TEMPORARY LOCATION OF INTEGER RESPONSES
NULL	I*4	CONSTANT <CR>
I	I*4	LOOP INDEX
TEMP	R*4	TEMPORARY LOCATION OF REAL RESPONSE
NADD	I*4	NUMBER OF ADDITIONAL CITIES ADDED
BEGIN	I*4	START LOCATION WITHIN CODE FOR ADDITIONAL CITIES
IVC	I*4	VERTICAL COORDINATE
IHC	I*4	HORIZONTAL COORDINATE
NFROM	I*4	WHEN REQUESTING INDIVIDUAL TRAFFIC VOLUMES THE FROM CODE
NTO	I*4	WHEN REQUESTING INDIVIDUAL TRAFFIC VOLUMES THE TO CODE

TRFOPT	L	INDICATES IF LISTING OF TRAFFIC TABLE IS DESIRED
MAXINT	R*4	CONSTANT/2147483647./LARGEST I*4 VALUE
FILSTT	I*4	FILE STATUS 1 INVALID NAME 2 UNAVAILABLE 3 IN USE

SUBPROGRAMS CALLED

DEFNOD
FILDEF
GETPER
GETTFC
NCREAT
SMSA
USRNET

ERRORS

FATAL

B2010	INVALID NETWORK FILENAME
B2020	NETWORK FILE ALREADY DEFINED
B2030	INVALID NETWORK OPTION
B2040	INVALID PRESTORED CITY CODE
B2050	EXCEEDED # OF PRESTORED NODES
B2060	INVALID PERCENT OF SELECTING PRESTORE NODES
B2070	INVALID TRAFFIC LEVEL
B2080	MAXIMUM ADDITIONAL CITIES EXCEEDED
B2090	INVALID ADDITIONAL TRAFFIC VOLUME
B2100	ADDITIONAL TFC ENTRY CITY NOT IN NETWORK
B2110	TRAFFIC TABLE SPOOL OPTION NOT 0 OR 1
B2120	INVALID ADDITIONAL CITY COORDINATE

NONFATAL

B2500	PRESTORED NODE DUPLICATION?
B2510	ADDITIONAL CITY A PRESTORED NODE
B2520	ADDITIONAL CITY DUPLICATION
B2530	ADDITIONAL TFC PAIR DUPLICATION

FOR LOGIC FLOW, SEE FIGURE 3-26 - CREATE LOGIC FLOW.

3.9.4 TARB Module

```
   SUBROUTINE TARB

PURPOSE
     READ NECESSARY INPUTS AND CREATE A TARIFF FILE

INPUT ARGUMENTS
     NONE

OUTPUT ARGUMENTS
     NONE

DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
     DEBUG          /LUN/      U
     LUNOUT         /LUN/      U

LOCAL VARIABLES
     ERROR          LOGICAL    INDICATES WHETHER A FATAL ERROR HAS
                               BEEN FOUND:  .TRUE.   FATAL ERROR
                                            .FALSE.  NO FATAL ERROR
     FILNAM         R*8        NAME OF TARIFF FILE TO CREATE
     FILSTT         I*4        FILE STATUS
                               1 - INVALID NAME
                               2 - AVAILABLE
                               3 - IN USE
     TYPE           I*4        TYPE OF TARIFF TO CREATE
                               1 - ATT; 2 - WU; 3 - SBS

SUBPROGRAMS CALLED
     CRATTB
     CRWUB
     CRSBSB
     FILDEF
     TCREAT

ERRORS
     FATAL
       B3000  INVALID TARIFF FILENAME
       B3010  TARIFF FILE ALREADY DEFINED
       B3020  INVALID TARIFF FILE TYPE
     NONFATAL
       NONE

FOR LOGIC FLOW, SEE FIGURE 3-40.
```

3.9.5 CRATTB Module

SUBROUTINE CRATTB(ERROR,FILNAM)

PURPOSE

READ INPUTS TO CREATE A TARIFF BASED ON THE AT&T PHILOSOPHY

INPUT ARGUMENTS

ERROR	LOGICAL	INDICATES WHETHER A FATAL ERROR HAS BEEN FOUND: .TRUE. - FATAL .FALSE. - NO FATAL ERROR
FILNAM	REAL*8	NAME OF TARIFF FILE TO BE CREATED

OUTPUT ARGUMENTS

ERROR	LOGICAL	INDICATES WHETHER A FATAL ERROR HAS BEEN FOUND: .TRUE. - FATAL ERROR .FALSE. - NO FATAL ERROR

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

ADJ	/INPATT/	S
CODE	/INPNOD/	S
INCSC	/INPATT/	S
NNDS	/INPNOD/	S
NTLEVL	/INPATT/	U
DEBUG	/LUN/	U
LUNOUT	/LUN/	U

LOCAL VARIABLES

ITEMP,JTEMP	I*4	BUFFERS FOR USER INPUTS
MINUS	I*4	CONSTANT /'-'/ INDICATES DELETION
NPLUS	I*4	CONSTANT /'+'/ INDICATES INSERTION
INLIST	LOGICAL	CITY CODE ENTERED IN LISTED CITY
INCLUD	LOGICAL	USER WANTS TO ADD LISTED CITY
EXCLUD	LOGICAL	USER WANTS TO DELETE LIDTED CITY
I,J	I*4	LOOP INDEXES
NULL	I*4	CONSTANT /' '/ INDICATES BLANK CARD

SUBPROGRAMS CALLED

ATTLST

ERRORS

FATAL

B3100	INVALID LISTED CITY ADDITION/DELETION
B3110	LISTED CITY ADDITION/DELETION DUPLICATION

NONFATAL

B3500	CITY TO BE ADDED ALREADY A LISTED CITY
B3510	CITY TO BE DELETED NOT A LISTED CITY

FOR LOGIC FLOW SEE FIGURE 3-45.

3.9.6 CRWUB Module

```
   SUBROUTINE CRWUB(ERROR,FILNAM)

PURPOSE
     READ INPUTS TO CREATE A TARIFF BASED ON THE WU PHILOSOPHY

INPUT ARGUMENTS
     ERROR          LOGICAL    INDICATES WHETHER A FATAL ERROR IS
                               FOUND:  .TRUE.  - FATAL ERROR
                                       .FALSE. - NO FATAL ERROR
     FILNAM         REAL*8     NAME OF TARIFF FILE TO BE CREATED

OUTPUT ARGUMENTS
     ERROR          LOGICAL    INDICATES WHETHER A FATAL ERROR IS
                               FOUND:  .TRUE.  - FATAL ERROR
                                       .FALSE. - NO FATAL ERROR

DATA STRUCTURES
     (U - USED, S - DEFINED, R - READ)
     CAT          /INPWU/      S
     CHGLH        /INPWU/      S
     CHGMH        /INPWU/      S
     CHGSH        /INPWU/      S
     CODEL        /INPNOD/     S
     CODER        /INPNOD/     S
     NADJ         /INPWU/      S
     DEBUG        /LUN/        U
     LUNOUT       /LUN/        U

LOCAL VARIABLES
     ITEMP          I*4        BUFFERS
     JTEMP          I*4        FOR USER
     KTEMP          I*4        INPUTS
     NULL           I*4        CONSTANT /'     '/INDICATES BLANK CARD
     ADD            LOGICAL    PAIR SPECIFIED TO BE ACCESS CITIES
     DELETE         LOGICAL    PAIR SPECIFIED TO BE DELETED AS ACCESS
                               CITIES
     PAIR           I*4        INDICATES WHETHER NODES SPECIFIED ARE AN
                               ACCESS PAIR IN PRESTORED TARIFF
                               .TRUE.  - NODES ARE ACCESS PAIR
                               .FALSE. - NODES ARE NOT IN ACCESS PAIR
     I              I*4        LOOP INDEX

SUBPROGRAMS CALLED
     WUPAIR

ERRORS
     FATAL
       NONE
     NONFATAL
       B3600  ACCESS PAIR CATEGORY CHANGE ERRONEOUS
       B3610  ACCESS PAIR TO BE DELETED NOT IN LIST
```

B3620 CATEGORY OUT OF RANGE
B3630 ACCESS PAIR DUPLICATION

FOR LOGIC FLOW SEE FIGURE 3-46.

3.9.7 CRSBSB Module

SUBROUTINE CRSBSB(ERROR,FILNAM)

PURPOSE

READ INPUTS TO CREATE A TARIFF BASED ON THE SBS PHILOSOPHY

INPUT ARGUMENTS

ERROR	LOGICAL	INDICATES IF THERE IS A FATAL ERROR .TRUE. - FATAL ERROR .FALSE. - NO FATAL ERROR
FILNAM	REAL*8	NAME OF TARIFF FILE TO BE CREATED

OUTPUT ARGUMENTS

ERROR	LOGICAL	INDICATES IF THERE IS A FATAL ERROR .TRUE. - FATAL ERROR .FALSE. - NO FATAL ERROR

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

NAC	/INPSBS/	S
SCU	/INPSBS/	S
FTU	/INPSBS/	S
CAUMIN	/INPSBS/	S
INCSB	/INPSBS/	S
NSBTAB	/INPSBS/	U
NACNMB	/SBSMXD/	S
NACLOC	/SBSMXD/	S
DEBUG	/LUN/	U
LUNOUT	/LUN/	U

LOCAL VARIABLES

I	I*4	LOOP INDEX
LOC	I*4	NAC LOCATION AS SPECIFIED BY USER
NULL	I*4	CONSTANT /' '/ RESPONSE OF <CR>

SUBPROGRAMS CALLED

NONE

ERRORS

FATAL

NONE

NONFATAL

NONE

FOR LOGIC FLOW, SEE FIGURE 3-47.

3.9.8 EXCONB Module

SUBROUTINE EXCONB .

PURPOSE

READ INPUTS AND BUILD THE EXECUTION CONTROL FILE

INPUT ARGUMENTS

NONE

OUTPUT ARGUMENTS

NONE

DATA STRUCTURES

(U - USED, S - DEFINED, R - READ)

RUNID	/INPEXC/	S
MAXRST	/INPEXC/	U
NRSTRT	/INPEXC/	S
OPTN	/INPEXC/	S
NETFIL	/INPEXC/	S
NTRF	/INPEXC/	S
FILNAM	/INPEXC/	S
MAXTRF	/INPEXC/	U
NOUT	/INPEXC/	U
OUTCNT	/INPEXC/	S
TFILES	/TARFIL/	U
TARDEF	/TARFIL/	U
NTFIL	/TARFIL/	U
LEVEL	/INPEXC/	S
DEBUG	/LUN/	U
LUNOUT	/LUN/	U

LOCAL VARIABLES

NULL	R*8	CONSTANT /' '/ INDICATES BLANK CARD
TEMP	R*4	REAL BUFFER
N	I*4	POINTER TO NEXT SLOT AVAILABLE IN ARRAY CONTAINING TARIFF NAMES
I	I*4	INDEX TO LOOP THAT ACCUMULATES DATA FOR NRSTRT PROBLEMS
M	I*4	NUMBER OF TARIFFS SPECIFIED FOR CURRENT PROBLEM
K	I*4	USED IN CHECKING FOR DUPLICATE TARIFF FILES WITHIN A RUN
L	I*4	USED IN DETERMINING OUTPUT TABLES TO SUPPRESS
NTAB	I*4	NUMBER OF OUTPUT TABLE TO BE SUPPRESSED
INDEX	I*4	POINTER TO TARIFF NAME FOUND IN DIRECTORY - 999 IF NOT FOUND
IFIL	I*4	CONSTANT - NETWORK DIRECTORY
DEFIND	I*4	CONSTANT - FILE IS DEFINED
START	I*4	BEG OF LIST OF TARIFFS SPECIFIED FOR CURRENT PROBLEM WITHIN FILNAM

END	I*4	END OF LIST OF TARIFFS SPECIFIED FOR CURRENT PROBLEM
IOPT	I*4	OPTION FOR CURRENT PROBLEM
ITAR	I*4	TARIFF TYPE
PRSTAR	R*8	CONSTANT TARIFF NAMES OF PRESTORED TARIFFS
ERROR	LOGICAL	INDICATES A FATAL ERROR HAS BEEN FOUND
FDUP	LOGICAL	TARIFF FILE DUPLICATED WITHIN A RUN
J	I*4	LOOP INDEX

SUBPROGRAMS CALLED

FILDEF
DIRGEN
EXCREA

ERRORS

FATAL

B4000	NEGATIVE NUMBER OF RESTARTS SPECIFIED
B4010	INVALID OPTION
B4020	UNDEFINED NETWORK FILE
B4030	UNDEFINED TARIFF FILE (MIXED RUN)
B4040	TARIFF NOT ATT-TYPE
B4050	INVALID FILE TYPE
B4060	NON-POSITIVE # OF TARIFF FILES SPECIFIED
B4070	NO VALID TARIFF FILES SPECIFIED

NONFATAL

B4500	MAXIMUM RESTARTS EXCEEDED - WILL RUN MAX
B4510	MAXIMUM TARIFFS EXCEEDED - WILL RUN MAX
B4520	TARIFF FILE DUPLICATION
B4530	UNDEFINED TARIFF FILE (NON-MIXED RUN)
B4540	INVALID FILE TYPE (NON-MIXED RUN)
B4550	INVALID OUTPUT TABLE NUMBER

FOR LOGIC FLOW SEE FIGURE 3-20.

4.0 DATA STRUCTURES

The data structures required by the CNDC model are read from the data base files or built during the execution of the model. These data structures are contained in arrays and variables and maintained in common blocks. Following is a dictionary of these structures. Following each structure name and size, is the name of the common block where it is maintained, its data type, and definition.

* ADJ (600) /INPATT/ I*4

indicates if associated code is an ATT category A addition or deletion
-1 category B
+1 category A

* ALTSD (200) /ATT/ I*4

array of alterations to ATT rate center listed/unlisted classification for each tariff in the current run. This array is used only for runs involving terrestrial tariffs. The values in this array represent the number of the rate center of concern. If the value is negative, then for this tariff, the rate center is unlisted. If the value is positive, then for this tariff the rate center is listed. The alterations for each tariff are grouped together in this array. Within each tariff grouping, the rate center numbers are arranged in ascending order by absolute value of the rate center number. One extracts the desired data from this array by using two other arrays - TPTR (NTARIF) and NINLST (NTARIF).

* CAT (600) /INPWU/ I*4

tariff category of satellite access city pair
0 not satellite access city pair
1 long haul
2 medium haul
3 short haul

* CAUMIN /INPSBS/ R*4

minimum CAU charge per NAC

* CHGLH /INPWU/ R*4

long haul channel charge

* CHGMH /INPWU/ R*4

medium haul channel charge

* CHGSH /INPWU/ R*4

short haul channel charge

* CODE (600) /INPNOD/ I*4

unique four character code of each node

* CODEL (600) /INPNOD/ I*4

unique four character code of originator of traffic

* CODER (600) /INPNOD/ I*4

unique four character code of receiver of traffic

* CODER (600) /INPNOD/ I*4

unique four character code of receiver of traffic

* COST (600,600) /CSTOUT/ R*4

for each link in network, the cost per circuit that is the minimum over all tariffs that service that link

* CPNA /SBS/ I*4

maximum number of CAUs per SCU

* CROPT /INPNET/ I*4

network creation option
1 all prestored nodes
2 all prestored nodes except those specified
3 only those prestored nodes specified
4 all prestored nodes which make up specified percent of traffic

* DEBUG /LUN/ I*4

logical unit number of file DEBUG.OUT which contains debug print

* DRCATA (20) /INPATT/ I*4

directory of the prestored category A rate center array PRCATA

* DRNODE (25) /RNODES/ I*4

directory to the RTCNTR array of network nodes. Use of this directory will shorten the search time required to find an element in RTCNTR.

* EXCUTE /LUN/ I*4

logical unit number of the execution control file

* FILNAM (130) /INPEXC/ R*8

tariff files to be used for all problem sets in an execution

* FILNET /RUN/ R*8

network file used for current optimization problem

* FLNM (20) /CURFIL/ R*8

names of user defined network files

* FTU /INPSBS/ R*4

charge per full time transmission unit

* H (600) /RNODES/ I*4

horizontal coordinates of rate centers in current network

* HC (600) /INPNET/ I*4

horizontal coordinate of each node specified

* HEXEC (2) /HEADRS/ R*8

header of execution control file

* HNATT /HEADRS/ R*8

header of user defined ATT tariff file

* HNET /HEADRS/ R*8

header of network directory file

* HNOD (2) /HEADRS/ R*8

header of file of prestored nodes

* HNSBS /HEADRS/ R*8

header of user defined SBS tariff

* HNWU /HEADRS/ R*8

header of user defined Western Union tariff

* HPATT (2) /HEADRS/ R*8

header of prestored ATT tariff

* HPSBS (2) /HEADRS/ R*8

header of prestored SBS tariff

* HPWU (2) /HEADRS/ R*8

header of prestored Western Union tariff

* HTAR (2) /HEADRS/ R*8

header of tariff directory

* HTFC (2) /HEADRS/ R*8

header of traffic table

* HVOL (2) /HEADRS/ R*8

header of prestored file of nodes arranged by traffic volume

* INCSB (3) /INPSBS/ R*4

input SBS CAU increment charges

* INCSC (9,3) /INPATT/ R*4

increment charge at each mileage breakpoint for each terrestrial schedule

* KDIR /PRSNDS/ I*4

number of entries in directory KRNODE to PRNDS array

* KPBLK /PRSNDS/ I*4

number of PRNDS items per block of items referenced by directory KRNODE

* KRNODE (20) /PRSNDS/ I*4

directory to PRNDS array of prestored nodes

* LSTACC (65) /PRSWU/ I*4

list of satellite access cities in prestored Western Union tariff

* LSTED (600) /ATT/ I*4

if the rate center referenced is an ATT category A rate center, LSTED contains 1, otherwise it contains a 0

* MAXUSR /INPNET/ I*4

maximum number of user specified nodes

* LUNNET /LUN/ I*4

start logical unit number for prestored network files

* LUNOUT /LUN/ I*4

logical unit number of file to contain optimization output

* LUNSPL /LUN/ I*4

start logical unit number of files to contain traffic table using of network file being defined

* LUNTRF /LUN/ I*4

start logical unit number of prestored tariff files

* LVLTRF /INPNET/ I*4

level of traffic for prestored nodes as number of voice circuits

* MAXACC /PRSWU/ I*4

maximum slots in array LSTACC which contains prestored WU access cities

* MAXGRP /SBS/ I*4

no longer used in SBS

* MAXNDS /INPNOD/ I*4

maximum number of nodes in network

* MAXRST /INPEXC/ I*4

maximum number of problem sets in execution control file

* MAXSAC /WU/ I*4

maximum slots for satellite access cities for any optimization run using Western Union tariffs

* MAXTRF /INPEXC/ I*4

maximum number of user defined tariffs

* MDIR /INPATT/ I*4

number of entries in the directory to the prestored category A rate centers

* MINCPC (600,600) /CSTOUT/ R*4

for all ordered pairs of nodes, the cost per circuit to connect the nodes using the least case route

* MPBLK /INPATT/ I*4

number of prestored category A rate centers per block of items referenced by directory

* MXACC /ARRYS/ I*4

maximum number of prestored satellite access cities in Western Union tariff

* MXCTA /ARRYS/ I*4

maximum number of category A rate centes in prestored ATT tariff

* MXPRN /ARRYS/ I*4

maximum number of prestored nodes

* NAC /INPSBS/ R*4

SBS charge per network access center

* NACC /PRSWU/ I*4

number of prestored network access centers in Western Union tariff

* NACLOC (600) /SBSMXD/ I*4

NACLOC (1) to NACLOC (N) gives the number of the N nodes in the current network which will be NAC location in an SBS mixed problem

* NACNMB /SBSMXD/ I*4

number of NAC locations in the current network in an SBS mixed problem

* NADJ /INPWU/ I*4

number of satellite access only pair additions and deletions specified in user defined Western Union tariff

* NALT /ATT/ I*4

maximum number of alterations to ATT category A status

* NCASE /RUN/ I*4

current optimization problem being run from the set of problems specified in the execution control file

* NCATA /INPATT/ I*4

number of category A rate centers

* NDIR /RNODES/ I*4

number of entries in the directory, DRNODE, to the RTCNTR array

* NETDEF (20) /NETFIL/ I*4

status of the files in the user defined network directory

* NETDIR /LUN/ I*4

logical unit number of directory to user defined networks

* NETFIL (10) /INPEXC/ R*8

network file to be used for each problem set of execution control file

* NETOTL (600,600) /CSTOUT/ I*4

for each link in the least cost network, the total network traffic traversing the link

* NFIL /CURFIL/ I*4

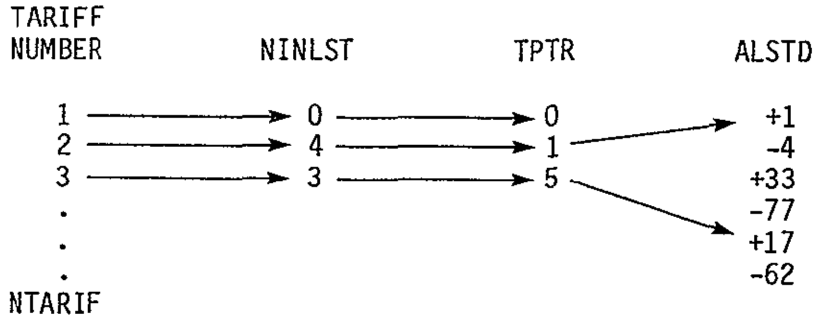
number of files listed in directory of interest

* NFILES (20) /NETFIL/ R*8

names of the files in the user defined network directory

* NINLST (13) /ATT/ I*4

array of number of alterations to ATT listed/unlisted status made by each tariff. Below is an example of how the three arrays ALSTD, TPTR, and NINLST work together:



In this example, terrestrial tariff 2 makes changes to the All listed/unlisted status of 4 rate centers. These changes are listed in the ALSTD starting at position 1. For tariff 2, rate center 1 will now be listed, rate center 4 unlisted, etc. Tariff 1 makes no changes.

* NLEVL /ATT/ I*4

maximum number of mileage breakpoints in model arrays involving ATT tariff rates

* NNDS /INPNOD/ I*4

number of nodes specified in network being created. Also, in creation of ATT tariff, the number of adjustments to category A status of a rate center

* NNFIL /NETFIL/ I*4

number of files in network directory

* NNODES /RUN/ I*4

number of nodes in current network

* NODPTR (600) /SBSMXD/ I*4

for each node in the network of an SBS mixed problem, the node which contains the SBS facilities that this node must use. If NODPTR (I) is negative than node I is an SBS facility.

* NOUT /INPEXC/ I*4

number of output tables generated within model

* NPBLK /RNODES/ I*4

number of RTCNTR items per block of items referenced by the directory DRNODE

* NPLEVL /ATT/ I*4

number of mileage breakpoint in ATT tariff being used

* NPRNDS /PRSNDS/ I*4

number of prestored nodes

* NPTAB /SBS/ I*4

number of CAU rate table entries in SBS tariff

* NRSTRT /INPEXC/ I*4

number of problems defined in current execution control file

* NSBTAB /INPSBS/ I*4

number of CAU per NAC breakpoints entries in tables describing the monthly charge per CAU

* NSCHED /ATT/ I*4

number of terrestrial schedules

* NSCUPN /SBS/ I*4

maximum number of SCUs per NAC

* NTARIF /RUN/ I*4

number of tariffs being considered in current problem

* NTFIL /TARFIL/ I*4

number of files in prestored tariff directory

* NSATAX /WU/ I*4

number of Western Union satellite access cities this problem

* NTLEVL /INPATT/ I*4

number of mileage breakpoints in terrestrial rate table

* NTRF (10) /INPEXC/ I*4

number of tariffs specified for each problem set in execution control file

* NTRFC /INPNET/ I*4

number of specifications of traffic levels between a pair of nodes

* NWUCAT /WU/ I*4

number of Western Union rate categories

* NWUTRI /WU/ I*4

number of values in table of satellite access city pair rates

NSATAX*(NSATAX -1)/2

Since for Western Union, the rate from A to B is the same as the rate from B to A, it is not necessary to put this information in a NSATAX*NSATAX array. All that is required is the triangle of values above the diagnol from the upper left to the lower right corner. The array WUPRS contains this upper triangle of data for each Western Union tariff in a problem. The integer function PTRPRS gets the pointer to the location in WUPRS for a specified pair.

* OPTION /RUN/ I*4

type of run

1	terrestrial only
2	WU only
3	SBS only
4	Mixed WU
5	Mixed SBS

* OPTN (10) /INPEXC/ I*4

type of problem for each problem set within the execution control file

1	terrestrial only
2	WU only
3	SBS only
4	mixed WU
5	mixed SBS

* OROUTE (600,600) /CSTOUT/ I*2

for each ordered pair of nodes in network the optimum successor node along the least cost path between the nodes

* OUTCNT (6,10) /INPEXC/ I*4

output control flags indicating which output tables are desired for each problem set in the execution control file

* OUTFLG (6) /RUN/ I*4

output desired for current problem

* PERCNT /INPNET/ I*4

when creating a network using the percent option, the percent desired

```
*    PRCATA (400)               /INPATT/                  I*4

     sorted list of the codes of the category A rate centers as defined in the
     ATT terrestrial tariff

*    PRNDS (350)                /PRSNDS/                  I*4

     array of nodes in prestored network

*    QCAU                       /SBSEQP/                  QCAU

     number of CAUs in SBS solution

*    QFTU                       /SBSEQP/                  I*4

     number of FTUs in SBS solution

*    QNAC                       /SBSEQP/                  I*4

     number NACs in SBS solution

*    QSCU                       /SBSEQP/                  I*4

     number of SCUs in SBS solution

*    RTCNTR (600)               /RNODES/                  I*4

     sorted list of the four character codes of the rate centers in the
     current network

*    RUNID                      /INPEXC/                  R*8

     character run identification of execution control file

*    SA (600)                   /WU/                      I*2

     if the rate center I is a satelliite access city for any tariff in a
     problem, SA(I) is the pointer to the data about this satellite access
     city.  If I is not an access city, SA(I) = 0.

*    SATACC (65,13)             /WU/                      I*2

*    SATACC (I,J) = 1 if satellite access city I is an access city for tariff
     J

*    SATCST (600)               /SBSMX2/                  R*4

*    SATCST (I) contains the cost per voice circuit for SBS satellite service
     from NAC location I
```

* SATNVC (600) /SBSMX2/ I*4

SATNVC (I) is the number of voice circuits using satellite from NAC location I .

* SATOTL (600,600) /SATMXD/ I*4

for each SBS satellite link in the least cost network, the total satellite traffic traversing the link

* SBMX /SBSMXD/ I*4

NAC placement option for this SBS mixed problem. If SBXM = 1, the user wishes to place NACs at the nodes specified in the user defined SBS tariff. Otherwise the model will determine the optimal placement of NACs.

* SCU /INPSBS/ R*4

charge per supplemental capacity unit in SBS tariff

* STABLE (600) /SBSMX2/ I*2

STABLE (I) specifies how many nodes actually contain SBS facilities for the proposed configuration of I NAC locations

* STATUS (20) /CURFIL/ I*4

status of each listed in the network directory

0	available
1	in use

* SYSTBL SBSMX2 L

indicates when in the optimization of a SBS mixed problem a proposed NAC placement configuration has stabilized and no more nodes are switching from satellite to terrestrial for cost reasons

* STLCKT /CSTMXD/ I*4

number of satellite circuits in optimal SBS mixed network

* STLCST /CSTMXD/ R*4

total satellite cost in optimal SBS mixed network

* STLMLG /CSTMXD/ I*4

number of miles of satellite circuits in optimal SBS mixed network

*   SVC (600,600)   /CSTOUT/   I*2

for all links in the network, the tariff that yields the minimum cost per circuit

*   TARDEF (13)   /TARFIL/   I*4

type of tariff defined in each of the user defined tariffs

0	available for definition
1	ATT tariff
2	WU tariff
3	SBS tariff

*   TATBAS (9,3,13)   /ATT/   R*4

base charge for each mileage breakpoint in terrestrial tariff for each of three schedules and each of the tariffs to be used in a problem

*   TATINC (9,3,13)   /ATT/   R*4

incremental charge for each mileage breakpoint in terrestrial tariff for each of three schedules and each of terrestrial tariffs to be used in current problem

*   TATMIL (9)   /INPATT/   I*4

mileage breakpoints in the terrestrial rate table. TATMIL (9) = MAXINT to take care of all mileages above the maximum mileage listed in the table TATMIL (8). The increment charge corresponding to TATMIL (9) is therefore the charge per mile for any distance greater than TATMIL (8). In the same way, as an example, the increment associated with TATMIL (4) is the rate per mile for any distance in excess of TATMIL (3) and less than or equal to TATMIL (4) used when creating an ATT tariff.

*   TATMLG (9)   /ATT/   I*4

mileage breakpoints in terrestrial tariffs being used in current runs. (See TATMIL for further description.)

*   TF (13)   /RUN/   R*8

names of tariffs being compared in current problem

*   TFILES (13)   /TARFIL/   R*8

names of user defined tariff in tariff directory

*   TOTNDS   /INPNET/   I*4

total nodes in network being defined

* TOTSAT (600) /SBSMX2/ R*4

TOTSAT (I) contains the total system cost for a proposed configuration of I NAC locations

* TPTR (13) /ATT/ I*4

array of pointers to position within ALSTD array where this tariff's alterations to listed/unlisted designations begin. A value of 0 indicates that there are no alterations to ATT listed/unlisted status for this tariff.

* TRAFIC (600,600) /TRFC/ I*4

traffic level in voice circuits from each node to every other node in the network of the current problem

* TRFATT /LUN/ I*4

logical unit number of prestored ATT terrestrial tariff

* TRFDIR /LUN/ I*4

logical unit number of directory to NASA defined tariffs

* TRFLVL /RUN/ I*4

total traffic level of prestored nodes as number of voice circuits

* TRFNDS /LUN/ I*4

logical unit number of file of prestored traffic nodes

* TRFSBS /LUN/ I*4

logical unit number of prestored SBS tariff

* TRFTBL /LUN/ I*4

logical unit number of prestored traffic table

* TRFVOL /LUN/ I*4

logical unit number of prestored file of nodes arranged from busiest to least busy

* TRFWU /LUN/ I*4

logical unit number of prestored Western Union tariff

* TRRCKT /CSTMXD/ 1*4

in optimal SBS mixed network, the number of terrestrial circuits

* TRRCST /CSTMXD/ R*4

in optimal SBS mixed network, the total terrestrial cost

* TRRMLG /CSTMXD/ I*4

in optimal SBS mixed network, the number of miles of terrestrial circuits

* TSBBKP (3) /SBS/ I*4

CAU/NAC breakpoints in table of CAU rates for SBS tariffs in current problem

* TSBCAB (3,13) /SBS/ R*4

base cost for each CAU/NAC breakpoint for each tariff in current SBS problem

* TSBCAI (3,13) /SBS/ R*4

incremental cost for each CAU/NAC breakpoint for each tariff in current SBS problem

* TSBCAM (3) /INPSBS/ I*4

CAU per NAC breakpoints used in description of monthly charge for CAUs. TSBCAM (3) - MAXINT. The logic for operating in this table is the same as for TATMIL described above.

* TSBCMN (13) /SBS/ R*4

minimum CAU charge per NAC for each SBS tariff in current problem

* TSBFTU (13) /SBS/ R*4

FTU charge for each SBS tariff in current problem

* TSBNAC (13) /SBS/ R*4

NAC charge for each SBS tariff in current problem

* TSBSCU (13) /SBS/ R*4

SCU rate for each SBS tariff in current problem

* TTYP (13) /RUN/ I*4

tariff type of each tariff in current problem

1 ATT
2 WU
3 SBS

* TWU (3,13) /WU/ R*4

Western Union channel charge for each tariff is current problem at each category

* UNET /HEADRS/ R*8

header of user defined network file

* UTAR /HEADRS/ R*8

header of user defined tariff file

* V (600) /RNODES/ I*4

vertical coordinates of rate centers in current problem

* VC (600) /INPNET/ I*4

vertical coordinates of each node specified when building a network

* VCIRTS (600) /INPNET/ I*4

number of addition traffic from CODEL to CODER when building a new network

* VCPFTU /SBS/ I*4

number of voice circuits per FTU for SBS tariffs

* WUPRS (2080, 13) /WU/ I*2

array of connections and rate categories for each Western Union tariff in current problem
0 no connection between this city pair
1 long haul
2 medium haul
3 short haul

see NWUTRI for further description

* WURTCT (65) /WU/ I*2

pointer to node in RTCNTR array of each satellite access city in current problem

5.0 CNDC PROGRAM DATA BASE

5.1 INTRODUCTION

Within the CNDC Model the Data Base Management System refers to the collection of files, prestored and user defined, on which is stored network and tariff descriptions; the program required to build and maintain the prestored data files; and the subprograms within the CNDC Model which retrieve data from and put data into the data base files. This section describes the files which make up the data base.

The modules within the CNDC program belong to one or two systems. One set of modules performs the data base management function and the other performs the optimization function. Figure 5-1 illustrates how these two systems interact with the data base. Those modules which perform the data base management function create and maintain the data base files and retrieve from these files that data which is required to perform the optimization function.

The files which make up the data base are of two kinds: the prestored files and the user defined files. The prestored files are created and maintained by a separate program, PRSTRD. Currently, Sonalysts has the responsibility to maintain the integrity of these files. The model does not provide the user with direct access to any of these prestored files. The prestored data base is described in section 5.2.

The files within the user defined data base can be referenced, created, deleted, listed by the user in any INPUT session (see sections 3.3 - 3.5). These files contain the descriptions of user defined networks, user defined tariffs, and an execution file. The user defined data base is described in section 5.3.

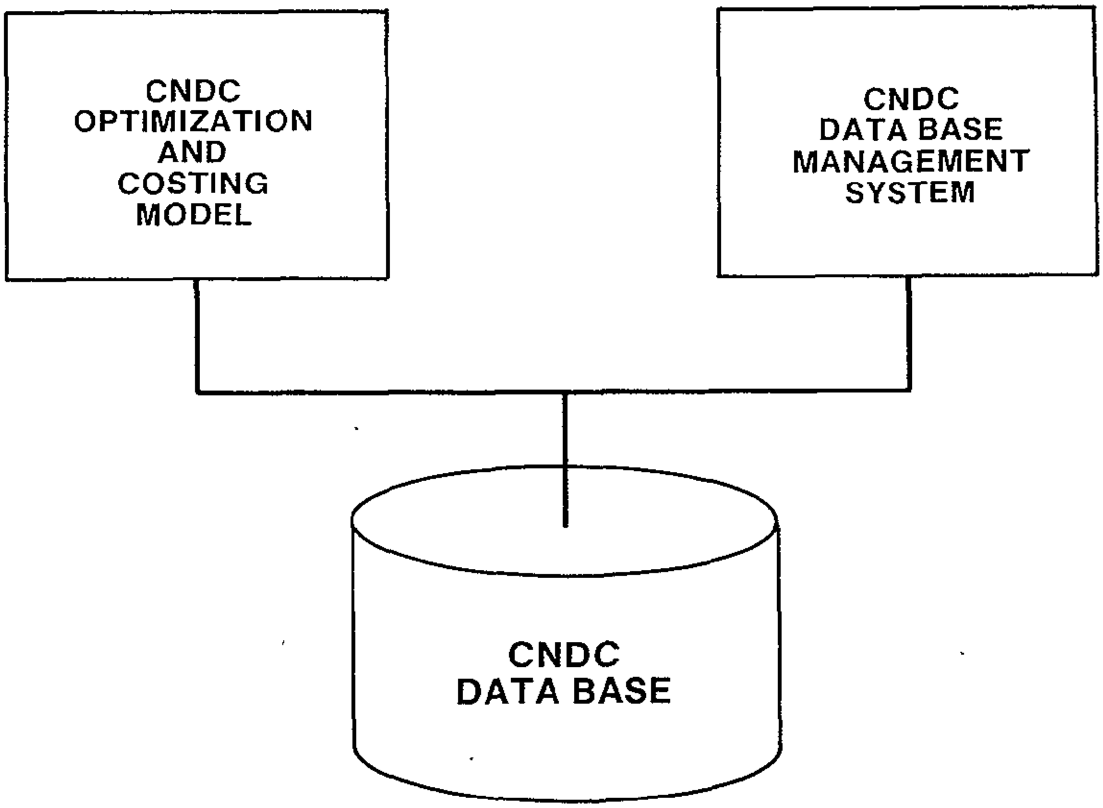


Figure 5-1. Communications Network Design and Costing Model

5.2 PRESTORED DATA BASE

The files which contain the prestored data are created and maintained by Sonalysts personnel only. These files define the set of prestored nodes (SMSA - Standard Metropolitan Statistical Areas), the traffic between every pair of nodes in the prestored set, the ATT, Western Union, and SBS tariffs, and the directories to the user defined network and tariff files. The eight files which form the prestored data base are described in the following sections.

5.2.1 Network

The prestored traffic table is to contain up to 350 unique traffic nodes, each node designated by a unique four letter alphabetic code name. The list of traffic nodes provided to Sonalysts contained 316 nodes. The file TRFNDF, known internally to CNDC as TRFNDS, contains the four letter code, vertical and horizontal coordinates, and SMSA descriptor of each of these 316 nodes. The 316 node description records are arranged alphabetically by the four character code. These 316 records are preceded by two additional records. The first identifies the file as the file of prestored traffic nodes. The second indicates the number of nodes defined. The file format follows. The data type of each field is in parentheses following the field name.

```
                 TRAFFIC NODES ƀƀƀ  (A16)
                 NREC (I3)
   NREC        ( CODE (A4) VCOORD (I5) HCOORD (I5) SMSA (A36)
OCCURRENCES    )    .
               )    .
               (    .
```

where

NREC   number of nodes in the file of prestored traffic nodes

CODE   unique four character code of the node

VCOOD   vertical coordinate of the node

HCOOD   horizontal coordinate of the node

This file has been created and will, if required, be updated by Sonalysts personnel. It will not be available to the user through the INPUT function for edit or deletion.

5.2.2 Traffic Table

The directional traffic between any pair of nodes in the prestored set is represented as a percentage of the total traffic between all prestored traffic nodes. This directional traffic is described by an ordered pair of nodes, the first node identifying the origin of the traffic and the second node the termination. The file TOUT, known internally to CNDC as TRFTBL, contains the traffic values. Although it may contain up to 350 X 350 traffic values, it currently contains the 316 X 316 array of traffic values for the 316 nodes identified in the traffic nodes file. The file contains 316 records with 350 values in each record. Each value is written in I10 format. To get the percent represented by each value, it is necessary to multiply each value by 10^{-10}. The 316 records of traffic values is preceded by two additional records. The first identifies this file as the file of prestored traffic levels. The second indicates the number of traffic nodes and the power to which ten must be raised (currently -10) to yield the factor by which each value must be raised to get percent traffic level. The file format follows:

```
                TRAFFIC TABLE       (A16)
                NNODES  (I3), POWER  (I3)
   NNODES     ( TLEVL1  (I10)......  TLEVL350  (I10)
OCCURRENCES  <      ...
              (     ...
```

where

NNODES number of nodes in prestored network

POWER power to which 10 must be raised to yield the factor by which each value in the table must be multiplied to yield a normalized matrix

TLEVL traffic level

5.2.3 Traffic by Volume

It was desirable to be able to specify a network by all those prestored nodes which constituted a given percentage of the total traffic. To make this possible, a file was created which lists the prestored nodes from busiest to least busy. With each node specification is the cumulative percentage which represents that portion of the total traffic contained in a network with all nodes up to a given node. The format of the file VLST, known internally to CNDC as TRFVOL, follows:

```
                TRAFFIC VOLUMES        (A16)
                NNODES  (I3)
   NNODES     ( CODE  (A4)  POS  (I4)  PCNT  (F11.7)
OCCURRENCES   <     ...
              (     ...
```

where

NNODES   number of nodes in prestored network

CODE   unique for character code of each prestored node

POS   position of node in prestored network file

PCNT   cumulative percent of traffic represented by all nodes up to and including specified node

5.2.4 ATT Tariff

The prestored ATT tariff contains a list of the category A rate centers and the rates for series 2000/series 3000 channels between any two cities for the three schedules: schedule 1: both cities are category A rate centers; schedule 2: only one of the pair of cities is a category A rate center; and schedule 3: neither of the pair of cities is a category A rate center. Each of the category A rate centers is identifid by its unique four character code. Each of the three tariff schedules is defined by a table of rates which are a function of mileage. The table is organized by mileage breakpoints. Associated with each breakpoint are a base charge plus an increment charge for every mile in excess of the mileage breakpoint. The file TRFATT contains the data required to define the ATT tariff structure. The first record, the header record, indicates that this file describes the prestored ATT tariff. The second record indicates the number of records required to list the category A rate centers and rate schedule. The file format follows:

```
                ATT TARIFF      (A16)
                NREC  (I3)  NCATA  (I3)
    NREC       { CODE1  (A5) .... CODE16  (A5)
OCCURRENCES    {     .............
               {

                NMLG  (I3)
   `NMLG       { MLG  (I10)  BASE1  (F8.2)  INC1  (F6.2)  BASE2  (F8.2)
OCCURRENCES    {             INC2  (F6.2)  BASE3  (F8.2)  INC3  (F6.2)
               {     .....
```

where

NREC	number of records following which contain the list of ATT category A rate centers
NCATA	number of category A rate centers in list
CODE	unique four character code for each category A rate center in the file
NMLG	number of mileage breakpoints in ATT rate table
BASE1	base charge for each mileage breakpoint for schedule 1
BASE2	base charge for each mileage breakpoint for schdeule 2
BASE3	base charge for each mileage breakpoint for schedule 3
INC1	increment charge for each mileage breakpoint for schedule 1
INC2	increment charge for each mileage breakpoint for schedule 2
INC3	increment charge for each mileage breakpoint for schedule 3

This file will, if required, be modified by Sonalysts personnel only. It is not available to the user through the INPUT function for edit or deletion.

5.2.5 WU Tariff

The prestored Western Union Tariff contains a list of the satellite access city pairs along with the tariff category (1: long haul, 2: medium haul, 3: short haul) associated with each pair. This list will be followed by the channel charge for each of the three categories. The satellite access city pairs are specified as a pair of four character codes arranged alphabetically by the left most member and then within the left member alphabetically by the right most member. The file TRFWU contains the above data in the following format:

```
                WU TARIFF      (A16)
                NPAIRS  (I3)
   NPAIRS     { CODEL  (A5)  CODER  (A5)  CAT  (I2)
OCCURRENCES   {     .....
              {
                CHGLH  (F8.2)
                CHGMH  (F8.2)
                CHGSH  (F8.2)
```

where

NPAIRS number of satellite access city pairs

CODEL unique four character code of member of satellite access city pair

CODER unique four character code of member of satellite access city pair

CAT tariff category of access city pair
1 long haul
2 medium haul
3 short haul

CHGLH long haul channel charge

CHGMH medium haul channel charge

CHGSH short haul channel charge

This file will be modified, if required, by Sonalysts personnel only. It will not be available to the user through the INPUT function for edit or deletion.

5.2.6 SBS Tariff

The prestored SBS tariff contains the SBS monthly rates for network access centers (NAC), supplemental capacity units (SCU), CNS-A full time transmission units (FTU), channel access units (CAU), and minimum CAU charge per NAC. The CAU charges are a function of the number of CAUs at each NAC. Associated with each CAU count breakpoint is a base charge plus an incremental charge per CAU.

The file TRFSBS contains the above data in the following format:

```
                SBS TARIFF      (A16)
                NAC  (F8.0)
                SCU  (F8.0)
                FTU  (F8.0)
                CAUMIN  (F8.0)
                NTAB  (I3)
    NTAB     {  NCAU  (I10)  BASE  (F8.0)  INC  (F4.0)
OCCURRENCES  {     ...
```

where

NAC	charge per network access center
SCU	charge per supplemental capacity unit
FTU	charge per full time transmission unit
CAUMIN	minimum CAU charge per NAC
NTAB	number of values in CAU rate table
NCAU	number of CAU/NAC up to which the accompanying base and increment charges apply
BASE	base charge for specified number of CAUs
INC	incremental charge for each CAU over a specified number

This file will be modified, if required by Sonalysts personnel only. It is not available to the user through the INPUT function for edit or deletion.

5.2.7 User Defined Tariff Directory

The CNDC Model, through the INPUT module, allows for the definition of NASA tariffs based on the prestored tariffs, terrestrial and satellite. In addition, the user may store up to 13 of the NASA defined tariffs so they may be used as previously stored data in future computer runs. These 13 NASA defined tariffs will be stored in files named TAR001-TAR013.

The INPUT module must be able to keep track of what NASA tariffs have been defined and what files they are located in. To this end, the file TRFDIR contains a directory of the current set of NASA defined tariffs. The file format follows:

```
               TARIFF DIRECTORY      (A16)
               NFIL  (I3)
    NFIL     ( FILENAME  (A6)  TYPE  (I3)
OCCURRENCES  {     ....
             (
```

where

NFIL   number of NASA defined tariff files in list below

FILENAME   name of file containing or available for a NASA defined tariff

TYPE   tariff type
0   file available for definition
1   ATT type tariff
2   WU type tariff
3   SBS type tariff

Currently, NFIL has the value of 13 and FILENAME can have the values TAR001 to TAR013. TYPE indicates if the associated file is currently in use or available for use. If this file is currently in use, TYPE also indicates the type of tariff it defines.

5.2.8 User Defined Network Directory

The CNDC Model, through the INPUT module, allows for the definition of networks. In addition, the user may store up to 20 of these network definitions so they may be used in future computer runs. These 20 network definitions are stored in files named NET001-NET020.

The INPUT module must be able to keep track of what networks have been defined and files they are located in. To this end, the file NETDIR contains a directory of the current set of network definitions. The file format follows:

```
                NETWORK DIRECTORY      (A16)
                NFIL  (I3)
               ( FILENAME  (A6)  STATUS  (I3)
    NFIL      <      ...
OCCURRENCES    (
```

where

NFIL — number of network definition file names in list below

FILENAME — name of file which contains or may contain a network definition

STATUS — status of network
0 available for definition
1 currently defined

Currently, NFIL has the value of 20 and FILENAME may have values NET001 to NET020.

5.3 USER DEFINED DATA BASE

The user has the capability, using the INPUT module, to define tariffs and network. These user defined network and tariff files constitute the user defined data base. These files are built by the user through an interactive process with the model. The user must also specify his program execution runstream. This execution control file, also built interactively through INPUT, is a final file maintained a part of the user defined data base.

5.3.1 User Defined Networks

The user supplied input to CNDC includes the NASA defined tariffs and a network configuration. The user must specify which, if any, of the prestored traffic nodes he wants to include in the run. In addition, he must define the total traffic for the stored nodes, expressed as voice circuits. The user also may include in his network, traffic not specified in the prestored traffic table. He does this by defining additional nodes to be included in his network and indicating traffic between these additional nodes and other nodes in the network. In addition the user may specify additional traffic for prestored nodal pairs. The traffic he specifies must be expressed as number of voice circuits. Each additional node must be specified by its unique four character code and must be accompanied by its vertical and horizontal coordinates. The user will define this network through the INPUT module and create a file named NETOn where n can assume a value between 01 and 20. The format of the network definition files follows:

```
                NETWORK  NETn       (A16)
                NNODES   (I3)
  NNODES       (CODE  (A4)  VCOORD  (I5)  HCOORD  (I5)
OCCURRENCES    {    .
               {    .
               (    .

                TRFLVL  (I11)
                NTRFC  (I3)
  NTRFC        (CODEL  (A4)  CODER  (A5)  VCIRTS  (I11)
OCCURRENCES    {    .
               {    .
               (    .
```

where

NNODES	number of nodes in network
CODE	unique 4 character code for each node in the network
VCOORD	vertical coordinate of each node in the network
HCOORD	horizontal coordinate of each node in the network
TRFLVL	traffic level of prestored set expressed in voice circuits
NTRFC	number of traffic table additions to follow
CODEL	four character code of node where traffic originates
CODER	four character code of node where traffic terminates
VCIRTS	amount of additional traffic fromm CODEL to CODER in voice circuits

These files can be created, deleted, or listed by the user through the INPUT module.

5.3.2 User Defined Tariffs

A NASA defined tariff can be defined based on the existing prestored licensed common carrier and specialized common carrier tariffs, both terrestrial and satellite. (Currently, these prestored tariffs are ATT, WU, and SBS). The model permits the storing in the data base of up to thirteen of these NASA defined tariffs. Following is a description of the structure of the data files which contain these tariffs.

5.3.2.1 NASA Defined ATT Tariff

A NASA terrestrial tariff can be defined using the ATT terrestrial tariff as a point of departure. The user may redefine which cities are to be considered category A and may alter any of the mileage increment charges of the three schedules.

In specifying the category A cities, the user may add new cities to the category A list (defining each new city by its unique 4 character code) and may declare that a city that is category A for ATT will not be category A for this tariff.

The user may not alter the ATT channel charge mileage breakpoints. He may, however, alter the increment charges associated with each breakpoint.

The user will define this tariff using the input program and create a file named TARn where n can assume the values 001 to 013 as selected by the user. As the user specifies category A city additions and deletion, INPUT will arrange the city codes specified in alphabetic order with a -1 following deletions and a +1 following additions.

After the user has altered the increment charges, INPUT will recalculate the base charges to be consistent with these new increment charges. The file format follows:

```
                     TARIFF  NETn       (A16)
                     NADJ  (I3)
    NADJ           ( CODE  (A4)  ADJ  (I3)
OCCURRENCES        {     ...
                   (     ..:

                     NMLG       (I3)
    NMLG           ( MLG  (I10)  BAS1  (F8.2)  INC1  (F6.2)  BAS2  (F8.2)  INC2
OCCURRENCES        {             (F6.2)  BAS3  (F8.2)  INC3  (F6.2)
                   (
```

where

NADJ — number of records following which describe adjustments to category A status of a rate center

CODE — unique four character code of rate center which is being added to or deleted from the list of category A rate centers

ADJ — code which indicates if this rate center is being added to or deleted from list of category A rate centers
 1 additions
-1 deletions

NMLG — number of mileage breakpoints

BAS1, BAS2, BAS3 — base charge for each mileage breakpoint for schedules one, two, and three respectively

INC1, INC2, INC3 — increment charge for each mileage breakpoint for the three schedules

MLG — mileage breakpoint

5.3.2.2 NASA Defined Western Union Tariff

A NASA satellite tariff can be defined using the Western Union satellite tariff a a point of departure. The user may define satellite access city pair additions and deletions and may alter the channel charge for any of the three charge categories.

In specifying a new access city pair, the user may create a new satellite access city and may also link up two existing access cities which are not currently linked. When specifying a new linkage, the user may also define the tariff category associated with this pair (1: long haul, 2: medium haul, and 3: short haul). As stated above, the user may also delete from his set of access city pairs a link that exists in the Western Union tariff. He may also keep the link but change its rate.

The user will define this tariff using the input program and define a file name TARn where n can assume the values 001 to 013. As the user defines access city pair additions and deletions by specifying the four character code of the two cities, INPUT will arrange the two cities in alphabetic order by code. Following the code pair will be a 0 to indicate deletion of a link or a 1, 2, or 3 to indicate rate category of a desired linkage. Once all city pair additions and deletion have been specified, INPUT will arrange them within the file in alphabetic order by the left most code and then, within the left code, alphabetically by the right most code. The file format follows:

```
                TARIFF  TARn       (A16)
                NADJ  (I3)
   NADJ       { CODEL  (A5)  CODER  (A5)  CAT  (I2)
OCCURRENCES   {   .
              {   .
              {   .

                CHGLH  (F8.2)
                CHGMH  (F8.2)
                CHGSH  (F8.2)
```

where

NADJ — number of records following which describe adjustments to list of satellite access city pairs

CODEL — unique four character code of member of satellite access city pair

CODER — unique four character code of member of satellite access city pair

CAT — tariff category of access city pair
0 deletion as access city pair
1 long haul
2 medium haul
3 short haul

CHGLH — long haul channel charge

CHGMH — medium haul channel charge

CHGSH — short haul channel charge

5.3.2.3 NASA Defined SBS Tariff

A NASA satellite tariff can be defined using the SBS satellite tariff as a point of departure. The user may change any of the rates specified in the tariff. When altering the CAU change, the user may not alter the CAU count breakpoint. He may however alter the increment charge.

The user will define this tariff using the INPUT module and create a file named TARn where n can assume the values 001 to 013 as selected by the user. After the user has finished altering the CAU increment rates, INPUT will adjust the associated base rates. The user may specify NAC locations for the SBS mixed problem. The file format follows:

```
                TARIFF  NETn      (A16)
                NREC  (I3)  NENTRY  (I3)
    NREC      ( LOC1  (A5)...LOCn  (A5)
OCCURRENCES   )     .
              <     .
              )     .
              (     .
                NAC  (F8.0)
                SCU  (F8.0)
                FTU  (F8.0)
                CAUMIN  (F8.0)
                NTAB  (I3)
              ( NCAU  (I10)  BASE  (F8.0)  INC  (F4.0)
    NTAB      )     .
OCCURRENCES   <     .
              )     .
              (     .
```

where

NREC	number of records following that contain the NAC locations
NENTRY	number of NACs specified
LOC1... LOCn	four character code of rate center to contain NAC
NAC	charge per Network Access Center
SCU	charge per Supplemental Capacity Unit
FTU	charge per Full Time Transmission Unit
CAUMIN	minimum CAU charge per NAC
NTAB	number of entries in following CAU rate table
NCAU	number of CAU/NAC up to which the accompanying base and increment rate apply
BASE	base charge for specified number of CAUs
INC	increment charge for each CAU over a specified number

5.3.3 Execution Control File

The user must specify his optimization execution runstream using the INPUT modules EXCON option. At this time he will specify the runid, type of run (terrestrial only, Western Union Only, SBS only, mixed terrestrial - Western Union, or mixed SBS), name of the user defined network, any alteration to the traffic level specified in the network, the number of tariffs to be compared, the names of the tariffs (user defined and/or prestored), and the output tables desired.

In addition the user may desire to piggyback several of these problem definitions in one runstream. EXCON creates an execution control file, EXCUTE, to contain this description. The file format follows:

```
                               EXECUTION FILE      (A16)
                               RUNID                (A8)
                 /             NPROB        (I3)
                 |             OUT1  (I2)  OUT2  (I2)  OUT3  (I2)  OUT4  (I2)
                 |                         OUT5  (I2)  OUT6  (I2)
                 |             NETFIL  (A6)
                 |             LEVEL   (I11)
    NPROB        |             NFIL    (I3)
OCCURRENCES     <       NFIL  /TARFIL  (A6)
                 |OCCURRENCES|    .
                 |           <    .
                 |           |    .
                 |           \  ****
                 \
```

where

RUNID   alphanumeric descriptor of this run

NPROB   number of problems defined

OUT1... flag indicating if the associated output table is desired
OUT6   0   suppress
         1   include

NETFIL   name of user defined network definition

LEVEL   traffic level to override that specified
         If LEVEL = 0, the level specified in NETFIL will be used

NFIL   number of tariffs to be compared

TARFIL	tariff to use
****	terminate each problem definition

Appendix A - Module Cross Reference

This section contains a cross reference listing of the modules that make up the CNDC Model. The modules are listed in alphabetic order. By each module name are two lists: the first of other modules called by this module and the second of all modules which call this module.

Module	Calls	Called By
ACC	none	none
ALDONE	none	SBSMIX
ATCOST	none	COSTNG DEFTER
ATTLST	none	CRATT CRATTB
BSTRCT	PTRPRS TRFSKP	INPUT INPUTB
CATEG	PTRPRS	COSTNG OUTWU
CNDC	COSTNG INIT INPUT NETWRK OUTPUT SBSMIX	none
CNDCB	COSTNG INIT INPUTB NETWRK OUTPUT SBSMIX	none
COSTNG	ATCOST CATEG LISTED MILES ROWTOT SBCOST WUCOST	CNDC CNDCB

Module	Calls	Called By
CRATT	ATTLST	CREATT
CRATTB	ATTLST	TARB
CREATE	DEFNOD FILDEF GETPER GETTFC MNMPTR NCREAT RVTFC SMSA USRNET	NETCON
CREATT	CRATT CRSBS CRWU FILDEF TCREAT	TARCON
CRSBS	none	CREATT
CRSBSB	none	TARB
CRWU	WUPAIR	CREATT
CRWUB	WUPAIR	TARB
DECIDE	none	SBSMIX
DEFNOD	SORT1	NCREAT CREATE NETB
DEFPRE	none	INIT
DEFTER	ATCOST LISTED MILES MTPY NETWRK TRSTOT	SBSMIX
DELETE	FILDEF NDELET	NETCON
DELETT	FILDEF TDELET	TARCON
DIRGEN	none	EXCON INIT

Module	Calls	Called By
EXCON	DIRGEN XCREAT XLIST	INPUT
EXCONB	EXCREA FILDEF	INPUTB
EXCREA	none	XCREAT EXCONB
FACSIZ	none	OUT3 OUT2 OUT2SB OUT3SB
FILDEF	none	CREATE CREATT DELETE DELETT LIST LISTT XCREAT EXCONB NETB TARB
GETPER	none	CREATE NETB
GETRTE	none	OUT2SB OUT3SB
GETTFC	TRFSKP WRTTRF	CREATE NETB
IBLATT	MNMPTR TRFSKP	IBLTAR
IBLLST	none	IBLNET
IBLNET	IBLLST IBLNOD IBLTRF IBLWHO	INIT
IBLNOD	none	IBLNET
IBLSBS	USRNET	IBLTAR

Module	Calls	Called By
IBLSB1	TRFSKP	IBLTAR
IBLTAR	IBLATT IBLSBS IBLSB1 IBLWU1 IBLWU2 IBLWU3	INIT
IBLTRF	MNMPTR TRFSKP WRTTRF	IBLNET
IBLWHO	none	IBLNET
IBLWU1	MNMPTR	IBLTAR
IBLWU2	MNMPTR	IBLTAR
IBLWU3	MNMPTR PTRPRS	IBLTAR
INDX	none	SRTNAC
INIT	DEFPRE DIRGEN IBLNET IBLTAR	CNDC CNDCB
INPUT	BSTRCT EXCON NETCON TARCON	CNDC
INPUTB	BSTRCT EXCONB NCLOSE NETB NINIT TARB TCLOSE TINIT	CNDCB
INTCHR	none	NCREAT OUT2 OUT2SB OUT3 OUT3SB
ISNAC	none	PRTITN

Module	Calls	Called By
LIST	FILDEF NLSTDR NLSTFL	NETCON
LISTED	none	COSTNG OUTATT OUT2 DEFTER OUT2SB OUT3 OUT3SB
LISTT	FILDEF TLSTDR TLSTFL	TARCON
MILES	none	COSTNG OUT2 OUT4 DEFTER OUT2SB TOTCST
MNMPTR	none	IBLATT IBLTRF IBLWU1 IBLWU2 IBLWU3 SMSA CREATE NCREAT RVTFC USRNET SBSMIX
MTPLY	none	OUT2 OUT2SB OUT3 OUT3SB
MTPY	none	OUT2 OUT4 DEFTER OUT2SB OUT3 OUT3SB PRTSBS TOTCST

Module	Calls	Called By
NCLOSE	none	NETCON NCREAT NDELET INPUTB
NCREAT	INTCHR MNMPTR NCLOSE TRFSKP WRTTRF	CREATE NETB
NDELET	NCLOSE	DELETE
NETB	DEFNOD FILDEF GETPER GETTFC NCREAT NLSTDR NLSTFL SMSA USRNET	INPUTB
NETCON	CREATE DELETE LIST NCLOSE NINIT	INPUT
NETWRK	none	CNDC DEFTER CNDCB
NINIT	none	NETCON INPUTB
NLSTDR	none	LIST XCREAT NETB
NLSTFL	none	LIST NETB
OUTATT	LISTED	OUT1
OUTPUT	OUT1 OUT2 OUT3 OUT4 WRTTRF	CNDC CNDCB

Module	Calls	Called By
OUTSBS	none	OUT1
OUTWU	CATEG	OUT1
OUT1	OUTATT OUTSBS OUTWU SMSA	OUTPUT
OUT2	FACSIZ INTCHR LISTED MILES MTPLY MTPY OUT2SB PRTSBS	OUTPUT
OUT2SB	MILES GETRTE FACSIZ MTPY MTPLY INTCHR	OUT2
OUT3	FACSIZ INTCHR LISTED MTPLY MTPY OUT2SB PRTSBS	OUTPUT
OUT3SB	FACSIZ GETRTE INTCHR LISTED MTPLY MTPY	OUT3
OUT4	MILES MTPY SUMEQP	OUTPUT
PRTITN	ISNAC	SBSMIX
PRTSBS	MTPY	OUT2 OUT3

Module	Calls	Called By
PTRPRS	none	IBLWU3 PTRPRS TRFSKP CATEG OUT2 WUPAIR
ROWTOT	none	COSTNG
RVTFC	MNMPTR	CREATE
SBCOST	none	COSTNG SBSC
SBSC	SBCOST	SBSMIX
SBSMIX	ALDONE DECIDE DEFTER MNMPTR PRTIIN SBSC SRTNAC TOTCST	CNDC CNDCB
SMSA	none	CREATE OUT1 NETB
SORTR	none	SRTNAC
SORT1	none	NCREAT TCRATT DEFNOD TCRSBS
SORTID	none	
SORT2	none	NCREAT TCREWU
SRTNAC	SORTR INDX	SBSMIX
SUMEQP	none	OUT4
TARB	CRATTB CRSBSB CRWUB FILDEF TCREAT	INPUTB

Module	Calls	Called By
TARCON	CREATT DELETT LISTT TCLOSE TINIT	INPUT
TARTYP	none	OUT1
TCLOSE	none	TARCON TCREAT TDELET INPUTB
TCRATT	SORT1	TCREAT
TCREAT	TCLOSE TCRATT TCRSBS TCRWU	CREATT TARB
TCRSBS	SORT1	TCREAT
TCREWU	SORT2	TCREAT
TDELET	TCLOSE	DELETT
TINIT	none	TARCON INPUTB
TLSTAT	none	TLSTFL
TLSTDR	none	LISTT XCREAT
TLSTFL	TLSTAT TLSTSB TLSTWU	LISTT
TLSTSB	none	TLSTFL
TLSTWU	none	TLSTFL
TOTCST	MILES MTPY TRSTOT	SBSMIX
TRFSKP	none	IBLATT IBLTRF IBLSB1 NCREAT GETTFC

Module	Calls	Called By
TRSTOT	none	TOTCST DEFTER
USRNET	MNMPTR	CREATE IBLSBS NETB
WRTTRF	none	IBLTRF NCREAT OUTPUT GETTFC
WUCOST	none	COSTNG
WUPAIR	PTRPRS	CRWU CRWUB
XCREAT	EXCREA FILDEF NLSTDR TLSTDR	EXCON
XLIST	none	EXCON

Appendix B - Error Numbers and Messages

Following is a list of all the error messages within the model. The fatal errors cause model execution to be terminated. Fatal errors may indicate that files within the data base have errors within them. They may also indicate that code within the model has been altered incompletely. Fatal errors require the intervention of a programmer and will not under normal conditions occur.

Nonfatal errors occur during initialization of a problem during optimization. They indicate that specifications within a problem are invalid, perhaps because the user is accessing a user defined file which is no longer valid because of tariff changes. Again, these errors should not occur under normal conditions.

FATAL ERRORS

Number	Module	Message
1010	INIT	Execution Control file header not as expected
1020	IBLLST	file header of prestored ATT tariff file not as expected
1030	IBLNET	file header of user defined network not as expected
1040	IBLTRF	file header of prestored traffic table not as expected
1050	IBLATT	header record of tariff file not as expected
1060	IBLATT	header of prestored ATT file not as expected
1070	IBLWU1	header record of prestored WU tariff not as expected
1080	IBLWU2	file header of user defined WU tariff not as expected
1090	IBLWU3	file header of prestored WU tariff not as expected

Number	Module	Message
1100	IBLWU3	file header of user defined WU tariff not as expected
1110	IBLSB1	file header of prestored SBS tariff not as expected
1120	IBLSBS	file header of user defined SBS tariff not as expected
1130	IBLSBS	file header of prestored SBS tariff not as expected
2010	BSTRCT	header from traffic nodes not as expected
2020	BSTRCT	header from prestored ATT tariff not as expected
2030	BSTRCT	ATT tariff levels exceeds array size in model
2040	BSTRCT	header from prestored SBS tariff not as expected
2050	BSTRCT	SBS tariff levels exceeds array size in model
2060	BSTRCT	header from prestored WU tariff not as expected
2070	BSTRCT	number of items in prestored network array exceeds number allowed
2080	BSTRCT	number of items in prestored category A list exceeds number allowed
2090	BSTRCT	number of items required for WU access cities exceeds number allowed
3010	NINIT	file header of network directory not as expected
3020	NINIT	number of files in directories exceeds the capacity of arrays
3030	GETTFC	file header of prestored traffic table not as expected
3040	GETPER	file header of TRFVOL file not as expected
3050	GETPER	desired percent not found in table
3060	DEFNOD	number of user defined nodes not number put into array
3070	NCREAT	file specified for network file already defined

Number	Module	Message
3080	NCREAT	file specified for network file not in directory
3090	NDELET	file name to delete not in directory
3100	NLSTFL	file specified to be printed not in directory
3110	NLSTFL	header record of file not as expected
4010	TINIT	file header of tariff directory not as expected
4020	TINIT	number of files in directory exceeds the capacity of array in model
4030	TCREAT	file name to create not in directory
4040	TCREAT	file specified already created
4050	TCREAT	file type to be created invalid
4060	TDELET	file to be deleted not in directory
4070	TLSTFL	file to list not in directory
4080	TLSTFL	file to be listed empty
4090	TLSTFL	file type of tariff to be listed is invalid
4100	TLSTAT	file header of ATT tariff invalid
4110	TLSTWU	file header of WU tariff invalid
4120	TLSTSB	file header of SBS tariff invalid
5000	ACC	input arguments out of range
5010	ATCOST	input arguments out of range
5020	CATEG	input arguments out of range
5030	LISTED	input arguments out of range
5040	MILES	input arguments out of range
5050	PTRPRS	input arguments out of range
5060	ROWTOT	input arguments out of range
5070	SBCOST	input arguments out of range
5080	TARTYP	input arguments out of range

Number	Module	Message
5090	DEFPRE	file header of prestored network file not as expected
5100	DIRGEN	file header from tariff directory not as expected
5110	DIRGEN	file header from network directory not as expected
5120	FACSIZ	number of input voice circuits out of range
5130	RVTFC	nodes specified don't exist in user defined network
5140	WUCOST	input arguments out of range
5150	FILDEF	directory requested is invalid
B1000	INPUTB	invalid option code
B2010	NETB	invalid network file name
B2020	NETB	network file already defined
B2030	NETB	invalid network option
B2040	NETB	invalid prestored city code
B2050	NETB	exceeded number of prestored nodes
B2060	NETB	invalid percent for selecting prestored nodes
B2070	NETB	invalid traffic level
B2080	NETB	maximum additional cities exceeded
B2090	NETB	invalid additional traffic volume
22100	NETB	additional traffic entry city not in network
B2110	NETB	traffic table spool option invalid
B2120	NETB	invalid additional city coordinate
B3000	TARB	invalid tariff filename
B3010	TARB	tariff file already defined
B3020	TARB	invalid tariff file type
B3100	CRATTB	invalid listed city addition/deletion

Number	Module	Message
B3110	CRATTB	listed city addition/deletion duplication
B4000	EXCONB	negative number of restarts specified
B4010	EXCONB	invalid option
B4020	EXCONB	undefined network file
B4030	EXCONB	undefined tariff file
B4040	EXCONB	tariff not ATT-type
B4050	EXCONB	invalid file type
B4060	EXCONB	negative number of tariff files specified
B4070	EXCONB	no valid tariff files specified

NONFATAL

Number	Module	Message
1510	INIT	error encountered in building tariff input for specified problem
1520	INIT	number of tariffs specified in execution control file out of range
1530	INIT	error encountered in building data structures for specified case - run option out of range
1540	INIT	error encountered in building data structures for specified case - run option out of range
1550	INIT	error encountered in input for specified case - proceeding to next case
1560	IBLNET	network file requested is not in directory
1570	IBLNET	network file requested is not defined
1580	IBLTAR	requested file not defined
1590	IBLTAR	status of file out of range
1600	IBLTAR	mismatch between run type and tariff file type
1610	IBLTAR	more than two tariff files specified for mixed run
1620	IBLTAR	tariff option out of range
1630	IBLTAR	for mixed mode there should be two tariffs defined - one for as ATT tariff, the other a satellite tariff
1640	IBLLST	number of breakpoint specified in ATT tariff exceeds array capacity in model
1650	IBLTRF	additional traffic specified for a node not in the user defined network
1660	IBLATT	number of mileage breakpoints specified in tariff file not as expected
1670	IBLATT	mileage breakpoint specified in tariff file not as expected
1680	IBLWU3	number of satellite access for the problem exceeds array capacity for this model

Number	Module	Message
1690	IBLSB1	number of entries in CAU cost table greater than capacity of arrays in model
1700	IBLSBS	number of breakpoints in SBS table not as expected
1710	IBLSBS	breakpoint values in SBS table not as in prestored tariff
3510	NDELET	file name to delete has already been deleted
3520	NLSTFL	file specified to be printed not defined
4510	TDELET	file name to delete has already been deleted
6000	OUT1	tariff in problem has invalid type
B2500	NETB	prestored node duplication
B2510	NETB	additional city a prestored node
B2520	NETB	additional city duplication
B2530	NETB	additional traffic pair duplication
B3500	CRATTB	city to be added already listed
B3510	CRATTB	city to be deleted not a listed city
B3600	CRWUB	access pair category change erroneous
B3610	CRWUB	access pair to be deleted not in list
B3620	CRWUB	category out of range
B3630	CRWUB	access pair duplication
B4500	EXCONB	maximum problems exceeded
B4510	EXCONB	maximum tariffs exceeded
B4520	EXCONB	tariff file duplication
B4530	EXCONB	undefined tariff file
B4540	EXCONB	invalid file type
B4550	EXCONB	invalid output table number

Appendix C - Prestored ATT Tariff

This appendix defines the American Telephone and Telegraph Company tariff as defined in F.C.C. No. 260 (effective March 3, 1982). This tariff is referred to as the prestored ATT tariff in the CNDC model.

Per airline mile, per month

(a) Schedule I (applies between a pair of Category "A" rate centers)

Mileage	Charge
1	$ 73.56
2-14	$ 73.56 + $2.59 for each mile over 1 mile
15	$ 109.82
16-24	$ 109.82 + $2.16 for each mile over 15 miles
25	$ 131.42
26-39	$ 131.42 + $1.62 for each mile over 25 miles
40	$ 155.72
41-59	$ 155.72 + $1.62 for each mile over 40 miles
60	$ 188.12
61-79	$ 188.12 + $1.62 for each mile over 60 miles
80	$ 220.52
81-89	$ 220.52 + $1.62 for each mile over 80 miles
100	$ 252.92
101-999	$ 252.92 + $ .94 for each mile over 100 miles
1000	$1,098.92
Over 1000	$1,098.92 + $ .58 for each mile over 1000 miles

(b) Schedule II (applies between a pair of rate centers where one rate center is in Category "A" and the other rate center of the same pair of rate centers is in Category "B").

Mileage	Charge
1	$ 75.00
2-14	$ 75.00 + $4.77 for each mile over 1 mile
15	$ 141.78
16-24	$ 141.78 + $4.47 for each mile over 15 miles
25	$ 186.48
26-39	$ 186.48 + $2.89 for each mile over 25 miles
40	$ 229.83
41-59	$ 229.83 + $1.95 for each mile over 40 miles
60	$ 268.83
61-79	$ 268.83 + $1.95 for each mile over 60 miles
80	$ 307.83
81-89	$ 307.83 + $1.95 for each mile over 80 miles
100	$ 346.83
101-999	$ 346.83 + $ .94 for each mile over 100 miles
1000	$1,192.83
Over 1000	$1,192.83 + $ .58 for each mile over 1000 miles

(c) Schedule III (applies between a pair of Category "B" rate centers).

Mileage	Charge
1	$ 76.43
2-14	$ 76.43 + $6.35 for each mile over 1 mile
15	$ 165.33
16-24	$ 165.33 + $5.48 for each mile over 15 miles
25	$ 220.13
26-39	$ 220.13 + $4.03 for each mile over 25 miles
40	$ 280.58
41-59	$ 280.58 + $3.03 for each mile over 40 miles
60	$ 341.18
61-79	$ 341.18 + $2.31 for each mile over 60 miles
80	$ 387.38
81-89	$ 387.38 + $1.95 for each mile over 80 miles
100	$ 426.38
101-999	$ 426.38 + $ .97 for each mile over 100 miles
1000	$1,299.38
Over 1000	$1,299.38 + $ .58 for each mile over 1000 miles

Following is a directory of those rate centers classified as "Category A", that is, those rate centers to which schedule I and II rates apply within the American Telephone and Telegraph Company as defined in F.C.C. No. 260 (effective July 16, 1983). Next to each rate center is the four character code used to describe it in the CNDC model. In those cases where the rate center is an SMSA, that is, it is in the prestored network, the four character code is the SMSA code used. When the rate center has a city name in parenthesis next to it, the rate center and its paired city are considered as one SMSA in the prestored network and will be viewed as one in the ATT tariff modules.

RATE CENTER	CODE
Alabama	
Anniston	ANAL
Birmingham	BIAL
Decatur	DEAL
Huntsville	HUAL
Mobile	MOAL
Montgomery	MNAL
Troy	TRAL
Arizona	
Flagstaff	FLAR
Phoenix	PHAZ
Prescott	PRAR
Tucson	TUAZ
Yuma	YUAR
Arkansas	
Fayetteville	FAAR
Forrest City	FOAR
Hot Springs	HOAR
Jonesboro	JOAR
Little Rock	LIAR
Pine Bluff	PIAR
Searcy	SEAR
California	
Anaheim	ANCA
Bakersfield	BACA
Chico	CHCA
Eureka	EUCA
Fresno	FRCA
Garoena	GACA
Hayward	HACA
Long Beach (Los Angeles)	LOCA
Los Angeles	LOCA
Oakland (San Francisco)	SFCA
Redwood City	RDCA
Sacramento	SACA
Salinas	SLCA
San Bernardina (Riverside)	RICA
San Diego	SNCA
San Francisco	SFCA
San Jose	SJCA
San Luis Obispo	SUCA
Santa Monica	STCA
Santa Rosa	SRCA
Stockton	SOCA
Sunnyvale	SYCA
Ukiah	UKCA
Van Nuys	VNCA

RATE CENTER	CODE
Colorado	
Colorado Springs	COCO
Denver	DECO
Fort Collins	FOCO
Fort Morgan	FRCO
Glenwood Springs	GLCO
Grand Junction	GACO
Greeley	CRCO
Montrose	MOCO
Pueblo	PUCO
Connecticut	
Bethany	BECT
Bloomfield	BLCT
Bridgeport	BRCT
Brookfield	BOCT
East Hartford	EACT
Groton	GRCT
Hamden	HMCT
Hartford	HACT
New Haven	NWCT
New London	NLCT
North Haven	NOCT
Orange	ORCT
Stamford	STCT
Stratford	SACT
West Hartford	WECT
West Haven	WSCT
Wethersfield	WTCT
Delaware	
Wilmington	WIDE
Destrict of Columbia	WADC
Florida	
Chipley	CHFL
Clearwater	CLFL
Cocoa (Melbourne)	MEFL
Crestview	CRFL
Daytona Beach	DAFL
Fort Lauderdale	FOFL
Fort Meyers	FRFL
Fort Pierce	FPFL
Fort Walton Beach	FTFL
Gainesville	GAFL
Jacksonville	JAFL
Key West	KEFL
Lake City	LKFL
Miami	MIFL

RATE CENTER	CODE
Florida (Continued)	
Ocala	OCFL
Orlando	ORFL
Panama City	PAFL
Pensacola	PEFL
St. Petersburg (Tampa)	TMFL
Sarasota	SAFL
Tallahassee	TAFL
Tampa	TMFL
West Palm Beach	WEFL
Winter Garden	WIFL
Winter Haven (Lakeland)	LAFL
Georgia	
Albany	ALGA
Atlanta	ATGA
Augusta	AUGA
Brunswick	BRGA
Columbus	COGA
Conyers	CNGA
Dublin	DUGA
Fitzgerald	FIGA
Macon	MAGA
Rome	ROGA
Savannah	SAGA
Thomasville	THGA
Waycross	WAGA
Idaho	
Boise	BOID
Pocatello	POID
Twin Falls	TWID
Illinois	
Centralia	CEIL
Champaign-Urbana	CHIL
Chicago	CIIL
Collinsville	COIL
De Kalb	DKIL
Hinsdale	HIIL
Joliet	JOIL
Marion	MAIL
Mattoon	MTIL
Newark	NEIL
Northbrook	NOIL
Peoria	PEIL
Rockford	ROIL
Rock Island (Davenport)	DAIA
Springfield	SPIL
Woodstock	WOIL

RATE CENTER	CODE
Indiana	
Bloomington	BLIN
Evansville	EVIN
Fort Wayne	FOIN
Indianapolis	ININ
Muncie	MUIN
New Albany	NEIN
South Bend	SOIN
Terre Haute	TEIN
Iowa	
Boone	BOIA
Burlington	BUIA
Cedar Rapids	CEIA
Davenport	DAIA
Dubuque	DUIA
Iowa City	IOIW
Sioux City	SINE
Waterloo	WAIA
Kansas	
Dodge City	DOKS
Hutchinson	HUKS
Kansas City	KAMO
Manhattan	MAKS
Salina	SAKS
Topeka	TOKS
Wichita	WIKS
Kentucky	
Danville	DAKY
Frankfort	FRKY
Loutsville	LOKY
Madisonville	MAKY
Paducah	PAKY
Winchester	WIKY
Louisiana	
Alexandria	ALLA
Baton Rouge	BALA
Lafayette	LALA
Lake Charles	LKLA
Monroe	MOLA
New Orleans	NELA
Shreveport	SHLA
Maine	
Augusta	AUME
Lewiston	LEME
Portland	POME

RATE CENTER	CODE
Maryland	
Baltimore	BAMD
Washington	WADC
Massachusetts	
Boston	BOMA
Brockton	BRMA
Cambridge	CAMA
Fall River	FAMA
Framingham	FRMA
Lawrence	LAMA
Springfield	SPCT
Worchester	WOMA
Michigan	
Detroit	DEMI
Flint	FLMI
Grand Rapids	GRMI
Houghton	HOMI
Iron Mountain	IRMI
Jackson	JAMI
Kalamazoo	KAMI
Lansing	LAMI
Petoskey	PEMI
Plymouth	PLMI
Pontiac	POMI
Saginaw	SAMI
Sault Ste. Marie	SUMI
Traverse City	TRMI
Minnesota	
Duluth	DUMN
Minneapolis	MIMN
St. Cloud	STMN
St. Paul (Minneapolis)	MIMN
Virginia	VIMN
Wadena	WAMN
Willmar	WIMN
Mississippi	
Biloxi	BIMS
Columbus	COMS
Greenville	GRMS
Greenwood	GEMS
Gulfport (Biloxi)	BIMS
Hattiesburg	HAMS
Jackson	JAMS
Laurel	LAMS
McComb	MCMS
Meridian	MEMS
Tupelo	TUMS

RATE CENTER	CODE
Missouri	
Cape Giradeau	
Joplin	JOMO
Kansas City	KAMO
St. Joseph	STMO
St. Louis	SLMO
Sikeston	SIMO
Springfield	SPMO
Montana	
Billings	BIMT
Glendive	GLMT
Helena	HEMT
Missoula	MIMT
Nebraska	
Grand Island	GRNE
Omaha	OMNE
Sidney	SDNE
Nevada	
Carson City	CANV
Las Vegas	LANV
Reno	RENV
New Hampshire	
Concord	CONH
Dover (Portsmouth)	POHN
Manchester	MANH
Nashua	NANH
New Jersey	
Atlantic City	ATNJ
Camden	CANJ
Hackensack	HANJ
Morristown	MONJ
Newark	NENJ
New Brunswick	NENJ
Trenton	TRNJ
New Mexico	
Albuquerque	ALNM
Las Cruces	LANM
Roswell	RONM
Santa Fe	SANM
New York	
Albany	ALNY
Binghamton	BINY
Buffalo	BUNY

RATE CENTER	CODE
New York (Continued)	
Huntington	HUNY
Nassua	NANY
New York City	NENY
Potsdam	PTNY
Poughkeepsie	PONY
Rochester	RONY
Syracuse	SYNY
Troy (Albany)	ALNY
Westchester	WENY
North Carolina	
Asheville	ASNC
Charlotte	CHNC
Fayetteville	FANC
Gastonia (Charlotte)	CHNC
Greensboro	GRNC
Greenville	GENC
Laurinburg	LANC
New Bern	NENC
Raleigh	RANC
Rocky Mount	RONC
Wilmington	WINC
Winston-Salem (Greensboro)	GRNC
North Dakota	
Bismark	BIND
Casselton	CAND
Dickinson	DIND
Fargo	FAND
Grand Forks	GRND
Ohio	
Akron	AKOH
Canton	CAOH
Cincinnati	CIOH
Cleveland	CLOH
Columbus	COOH
Dayton	DAOH
Findley	FIOH
Mansfield	MAOH
Toledo	TOOH
Youngstown	YOOH
Oklahoma	
Enid	ENOK
Lawton	LAOK
Muskogee	MUOK
Oklahoma City	OKOK
Tulsa	TUOK

RATE CENTER	CODE
Oregon	
Medford	MEOR
Pendleton	PEOR
Portland	POOR
Pennsylvania	
Allentown	ALPA
Altoona	ATPA
Harrisburg	HAPA
Philadelphia	PHPA
Pittsburg	PIPA
Pottsville	POPA
Reading	REPA
Scranton	SCPA
State College	STPD
Williamsport	WIPA
Rhode Island	
Providence	PRRI
South Carolina	
Charleston	CHSC
Columbia	COSC
Florence	FOSC
Greenville	GRSC
Orangeburg	ORSC
Spartanburg (Greenville)	GRSC
South Dakota	
Aberdeen	ABSD
Huron	HUSD
Sioux Falls	SISD
Tennessee	
Chattanooga	CHTN
Clarksville	CLTN
Jackson	JATN
Johnson City	JOTN
Kingsport (Johnson City)	JOTN
Knoxville	KNTN
Memphis	METN
Morristown	MOTN
Nashville	NATN
Texas	
Abilene	ABTX
Amarillo	AMTX
Austin	AUTX
Beaumont	BETX
Corpus Christi	COTX
Dallas	DATX

RATE CENTER	CODE
Texas (Continued)	
El Paso	ELTX
Fort Worth (Dallas)	DATX
Freeport	FRTX
Harlingen (Brownsville)	BRTX
Houston	HOTX
Laredo	LATX
Longview	LOTX
Lubbock	LUTX
Midland	MITX
San Angelo	SATX
San Antonio	SNTX
Sweetwater	SWTX
Waco	WATX
Utah	
Logan	LOUT
Ogden (Salt Lake City)	SAUT
Provo	PRUT
Salt Lake City	SAUT
Vermont	
Burlington	BUVT
White River Junction	WHVT
Virginia	
Blacksburg	BLVA
Leesburg	LEVA
Lynchburg	LYVA
Newport News	NEVA
Norfolk	NOVA
Petersburg	PEVA
Richmond	RIVA
Roanoke	ROVA
Washington	WADC
Washington	
Billingham	BEWA
Kennewick (Richland)	RIWA
North Bend	NOWA
Seattle	SEWA
Spokane	SPWA
Yakima	YAWA
West Virginia	
Beckley	BEWV
Charleston	CHWV
Clarksburg	CLWV
Fairmont	FAWV
Huntington	HUWV
Morgantown	MOWV

RATE CENTER	CODE
West Virginia (Continued)	
Parkensburg	PAWV
Wheeling	WHWV
Wisconsin	
Appleton	APWI
Dodgeville	DOWI
Eau Claire	EAWI
Green Bay	GRWI
La Crosse	LAWI
Madison	MAWI
Milwaukee	MIWI
Racine	RAWI
Stevens Port	STWI
Wyoming	
Casper	CAWY
Cheyanne	CHWY

Appendix D - Prestored WU Tariff

This appendix defines the Western Union Telegraph Company tariff as defined in F.C.C. No. 261 (effective May 11, 1982). This tariff is referred to as the prestored WU tariff in the CNDC model.

Channel Charges (per month per channel)

Category I	Long Haul	$925.00
Category II	Medium Haul	$695.00
Category III	Short Haul	$580.00

The monthly charge per channel specified above as for the routes listed below. By each route pair is the four character code by which the pair is known in the CNDC model. These codes are the SMSA codes of the associated rate center.

Category I - LONG HAUL

Los Angeles - Atlanta	LOCA - ATGA
Los Angeles - Baltimore	LOCA - BAMD
Los Angeles - Boston	LOCA - BOMA
Los Angeles - Buffalo	LOCA - BUNY
Los Angeles - Cincinnati	LOCA - CIOH
Los Angeles - Cleveland	LOCA - CLOH
Los Angeles - Columbus	LOCA - COOH
Los Angeles - Dayton	LOCA - DOAH
Los Angeles - Detroit	LOCA - DEMI
Los Angeles - New York	LOCA - NENY
Los Angeles - Philadelphia	LOCA - PHPA
Los Angeles - Pittsburg	LOCA - PIPA
Los Angeles - Washington	LOCA - WADC
Los Angeles - Wilmington	LOCA - WIDE
San Francisco - Atlanta	SFAC - ATGA
San Francisco - Baltimore	SFCA - BAMD
San Francisco - Boston	SFCA - BOMA
San Francisco - Buffalo	SFCA - BUNY
San Francisco - Cincinnati	SFCA - CIOH
San Francisco - Cleveland	SFCA - CLOH
San Francisco - Columbus	SFCA - COOH

San Francisco - Dayton	SFCA - DAOH
San Francisco - Detroit	SFCA - DEMI
San Francisco - New York	SFCA - NENY
San Francisco - Philadelphia	SFCA - PHPA
San Francisco - Pittsburgh	SFCA - PIPA
San Francisco - Washington	SFCA - WADC
San Francisco - Wilmington	SFCA - WIDE
Seattle - Boston	SEWA - BOMA
Seattle - Cleveland	SEWA - CLOH
Seattle - Detroit	SEWA - DEMI
Seattle - New York	SEWA - NENY
Seattle - Philadelphia	SEWA - PHPA
Seattle - Pittsburg	SEWA - PIPA
Seattle - Washington	SEWA - WADC

Category II - Medium Haul

Dallas/Ft Worth - Baltimore	DATX - BAMD
Dallas/Ft Worth - Boston	DATX - BOMA
Dallas/Ft Worth - Buffalo	DATX - BUNY
Dallas/Ft Worth - Los Angeles	DATX - LOCA
Dallas/Ft Worth - New York	DATX - NENY
Dallas/Ft Worth - Philadelphia	DATX - PHPA
Dallas/Ft Worth - San Francisco	DATX - SFCA
Dallas/Ft Worth - Washington	DATX - WADC
Houston - Baltimore	HOTX - BAMD
Houston - Boston	HOTX - BOMA
Houston - Cleveland	HOTX - CLOH
Houston - Columbus	HOTX - COOH
Houston - Dayton	HOTX - DAOH
Houston - Detroit	HOTX - DEMI
Houston - Los Angeles	HOTX - LOCA
Houston - New York	HOTX - NENY
Houston - Philadelphia	HOTX - PHPA
Houston - Pittsburgh	HOTX - PIPA
Houston - San Francisco	HOTX - SFCA
Houston - Washington	HOTX - WADC
Houston - Wilmington	HOTX - WIDE
Kansas City - Boston	KAMO - BOMA
Kansas City - Los Angeles	KAMO - LOCA
Kansas City - New York	KAMO - NENY
Kansas City - San Francisco	KAMO - SFCA
Los Angeles - Chicago	LOCA - CIIL
* Los Angeles - Bridgeton, MO	LOCA - SLMO
Los Angeles - Indianapolis	LOCA - ININ
Los Angeles - Milwaukee	LOCA - MIWI
Los Angeles - Minneapolis	LOCA - MIMN
Los Angeles - St Louis	LOCA - SLMO
Minneapolis - Boston	MIMN - BOMA
San Francisco - Chicago	SFCA - CIIL
San Francisco - Indianapolis	SFCA - ININ
San Francisco - Milwaukee	SFCA - MIWI

* Bridgeton, MO will be viewed as St. Louis, MO.

Category II - (Continued)

San Francisco - Minneapolis	SFCA - MIMN
San Francisco - St Louis	SFCA - SLMO
Seattle - Chicago	SEWA - CIIL
Seattle - Dallas/Ft Worth	SEWA - DATX
Seattle - Kansas City	SEWA - KAMO
Seattle - Milwaukee	SEWA - MIWI
Seattle - Minneapolis	SEWA - MIMN
Seattle - St Louis	SEWA - SLMO

Category III - Short Haul

Atlanta - Baltimore	ATGA - BAMD
Atlanta - Boston	ATGA - BOMA
Atlanta - Chicago	ATGA - CIIL
Atlanta - Cleveland	ATGA - CLOH
Atlanta - Dallas/Ft Worth	ATGA - DATX
Atlanta - Detroit	ATGA - DEMI
Atlanta - Houston	ATGA - HOTX
Atlanta - Indianapolis	ATGA - ININ
Atlanta - Kansas City	ATGA - KAMO
Atlanta - Milwaukee	ATGA - MIWI
Atlanta - Minneapolis	ATGA - MIMN
Atlanta - Philadelphia	ATGA - PHPA
Atlanta - New York	ATGA - NENY
Atlanta - Washington	ATGA - WADC
Atlanta - Wilmington	ATGA - WIDE
Boston - Chicago	BOMA - CIIL
Boston - Cincinnati	BOMA - CIOH
Boston - Columbus	BOMA - COOH
Boston - Dayton	BOMA - DAOH
Boston - Indianapolis	BOMA - ININ
Boston - Milwaukee	BOMA - MIWI
Boston - St Louis	BOMA - SLMO
Chicago - Baltimore	CIIL - BAMD
Chicago - Dallas/Ft Worth	CIIL - DATX
Chicago - Houston	CIIL - HOTX
Chicago - New York	CIIL - NENY
Chicago - Philadelphia	CIIL - PHPA
Chicago - Washington	CIIL - WADC
Chicago - Wilmington	CIIL - WIDE
Dallas/Ft Worth - Cincinnati	DATX - CIOH
Dallas/Ft Worth - Cleveland	DATX - CLOH
Dallas/Ft Worth - Columbus	DATX - COOH
Dallas/Ft Worth - Dayton	DATX - DAOH
Dallas/Ft Worth - Detroit	DATX - DEMI
Dallas/Ft Worth - Indianapolis	DATX - ININ
Dallas/Ft Worth - Milwaukee	DATX - MIWI
Dallas/Ft Worth - Minneapolis	DATX - MIMN
Dallas/Ft Worth - Pittsburgh	DATX - PIPA
Dallas/Ft Worth - St Louis	DATX - SLMO

Category III - (Continued)

Houston - Cincinnati	HOTX - CIOH
Houston - Indianapolis	HOTX - ININ
Houston - Milwaukee	HOTX - MIWI
Houston - Minneapolis	HOTX - MIMN
Houston - St Louis	HOTX - SLMO
Milwaukee - Baltimore	MIWI - BAMD
Milwaukee - New York	MIWI - NENY
Milwaukee - Philadelphia	MIWI - PHPA
Milwaukee - Washington	MIWI - WADC
New York - Columbus	NENY - COOH
New York - Dayton	NENY - DAOH
New York - Indianapolis	NENY - ININ
New York - Minneapolis	NENY - MINM
Philadelphia - Indianapolis	PHPA - ININ
Philadelphia - Kansas City	PHPA - KAMO
St Louis - Baltimore	SLMO - BAMD
St Louis - New York	SLMO - NENY
St Louis - Washington	SLMO - WADC
St Louis - Wilmington	SLMO - WIDE
Seattle - Los Angeles	SEWA - LOCA
Seattle - San Francisco	SEWA - SFCA
Washington - Indianapolis	WADC - ININ
Washington - Minneapolis	WADC - MIMN

Appendix E - Prestored SBS Tariff

This appendix defines the Satellite Business Systems tariff as set forth in F.C.C. No. 2 (effective date October 1, 1983). This tariff is referred to as the prestored SBS tariff in the CNDC model. All charges specified are monthly recurring charges.

Network Access Center (each)	NAC	$17,850.00
NAC Supplemental Capacity Units (each)	SCU	$ 5,700.00
Full Time Transmission Units	FTU	$ 2,550.00
Minimum CAU Charges		$17,850.00
Connection Arrangement Units (monthly at each NAC)	CAU	

NUMBER OF CAUs AT EACH NAC	MONTHLY RECURRING CHARGE
1 CAU - 150 CAUs	$95 per CAU
151 CAUs - 300 CAUs	$14,250.00 plus $90.00 per CAU in excess of 150
More than 300 CAUs	$27,750.00 plus $65.00 per CAU in excess of 300

Appendix F - Prestored Network

This appendix contains the 316 SMSAs that make up the prestored network of the CNDC model. Each SMSA is defined by the four character code by which it is known to the model, the vertical and horizontal coordinates, and the SMSA descriptor.

ABTX	8698	4513	ABILENE TX
AKOH	5637	2472	AKRON OH
ALGA	7649	1817	ALBANY GA
ALLA	8409	3168	ALEXANDRIA LA
ALNM	8549	5887	ALBUQUERQUE NM
ALNY	4639	1629	ALBANY-SCHENECTADY-TROY NY
ALPA	5166	1585	ALLENTOWN-BETHLEHEM-EASTON PA-NJ
AMTX	8266	5076	AMARILLO TX
ANAL	7406	2304	ANNISTON AL
ANCA	9250	7810	ANAHEIM-SANTA ANA-GARDEN GROVE CA
ANIN	6173	2958	ANDERSON IN
ANMI	5602	2908	ANN ARBOR MI
ANSC	6961	1894	ANDERSON SC
APWI	5589	3776	APPLETON-OSHKOSH WI
ASNC	6749	2001	ASHEVILLE NC
ATGA	7260	2083	ATLANTA GA
ATGE	7130	1948	ATHENS GE
ATNJ	5284	1284	ATLANTIC CITY NJ
ATPA	5460	1972	ALTOONA PA
AUGA	7089	1674	AUGUSTA GA-SC
AUTX	9005	3996	AUSTIN TX
BACA	8947	8060	BAKERSFIELD CA
BALA	8476	2874	BATON ROUGE LA
BAMD	5510	1575	BALTIMORE MD
BAME	3777	1322	BANGOR ME
BAMI	5713	3124	BATTLE CREEK MI
BEMI	5850	3281	BENTON HARBOR MI
BETX	8777	3344	BEAUMONT-PORT ARTHUR-ORANGE TX
BEWA	6087	8933	BELLINGHAM WA
BIAL	7518	2446	BIRMINGHAM AL
BICT	4730	1394	BRISTOL CT
BIMS	8296	2481	BILOXI-GULFPORT MS
BIMT	6391	6790	BILLINGS MT
BIND	5840	5736	BISMARK ND
BINY	4943	1837	BINGHAMTON NY-PA
BLIL	6358	3483	BLOOMINGTON-NORMAL IL
BLIN	6417	2984	BLOOMINGTON IN
BOID	7096	7869	BOISE CITY ID
BOMA	4422	1249	BOSTON MA
BRCT	4841	1360	BRIDGEPORT CT
BRFL	8270	1116	BRANDENTON FL

BRMA	4465	1205	BROCKTON MA
BRTX	9820	3663	BROWNVILLE-HARLINGEN-SAN BENI TX
BRWA	6349	8940	BREMERTON WA
BUNC	6364	1588	BURLINGTON NC
BUNY	5075	2326	BUFFALO NY
BUVT	4270	1808	BURLINGTON VT
BYMI	5368	3085	BAY CITY MI
BYTX	8827	3788	BRYAN-COLLEGE STATION TX
CAOH	5676	2419	CANTON OH
CAWY	6918	6297	CASPER WY
CEIA	6261	4021	CEDAR RAPIDS IA
CHCA	8057	8668	CHICO CA
CHIL	6371	3336	CHAMPAIGN-URBANA-RANTOUL IL
CHNC	6657	1698	CHARLOTTE-GASTONIA NC
CHSC	7021	1281	CHARLESTON-NORTH CHARLESTON SC
CHTN	7098	2366	CHATTANOOGA TN-GA
CHVA	5919	1683	CHARLOTTESVILLE VA
CHWV	6152	2174	CHARLESTON WV
CIIL	5986	3426	CHICAGO IL
CIOH	6263	2679	CINCINNATI OH-KY
CLOH	5574	2543	CLEVELAND OH
CLTN	6988	2837	CLARKSVILLE-HOPKINSVILLE TN-KY
COCO	7679	5813	COLORADO SPRINGS CO
COGA	7556	2045	COLUMBUS GA-AL
COMO	6901	3841	COLUMBIA MO
COOH	5972	2555	COLUMBUS OH
COSC	6901	1589	COLUMBIA SC
COTX	9475	3739	CORPUS CHRISTI TX
CUMD	5650	1916	CUMBERLAND MD-WV
DACT	4829	1423	DANBURY CT
DAFL	7791	1032	DAYTONA BEACH FL
DAIA	6273	3817	DAVENPORT-ROCK ISLAND-MOLINE IA-IL
DAOH	6113	2705	DAYTON OH
DATX	8436	4034	DALLAS-FORT WORTH TX
DAVA	6270	1640	DANVILLE VA
DECO	7501	5899	DENVER-BOULDER CO
DEIA	6471	4275	DES MOINES IA
DEIL	6478	3413	DECATUR IL
DEMI	5536	2828	DETROIT MI
DUIA	6088	3925	DUBUQUE IA
DUMN	5352	4530	DULUTH-SUPERIOR MN-WI
EAWI	5698	4261	EAU CLAIRE WI
ELIN	5895	3168	ELKHART IN
ELNY	5029	1953	ELMIRA NY
ELTX	9231	5655	EL PASO TX
ENOK	7783	4505	ENID OK
ERPA	5321	2397	ERIE PA
EUOR	7128	8954	EUGENE-SPRINGFIELD OR
EVIN	6729	3019	EVANSVILLE IN-KY
FAAR	7600	3872	FAYETTEVILLE-SPRINGDALE AR
FAMA	4543	1170	FALL RIVER MA-RI

FANC	6501	1385	FAYETTEVILLE NC
FAND	5615	5182	FARGO-MOORHEAD ND-MN
FIMA	4459	1374	FITCHBURG-LEOMINSTER MA
FLAL	7344	2715	FLORENCE AL
FLMI	5461	2993	FLINT MI
FOAR	7752	3855	FORT SMITH AR-OK
FOCO	7331	5965	FORT COLLINS CO
FOFL	8282	557	FORT LAUDERDALE-HOLLYWOOD FL
FOIN	5942	2982	FORT WAYNE IN
FOSC	6744	1417	FORENCE SC
FRCA	8669	8239	FRESNO CA
FRFL	8359	904	FORT MYERS FL
FTFL	8097	2097	FORT WALTON BEACH FL
GAAL	7355	2368	GADSDEN AL
GAFL	7838	1310	GAINESVILLE FL
GAIN	6017	3354	GARY-HAMMOND-EAST CHICAGO IN
GATX	8985	3397	GALVESTON-TEXAS CITY TX
GLNY	4515	1704	GLENS FALLS NY
GRCO	7345	5895	GREELEY CO
GRMI	5628	3261	GRAND RAPIDS MI
GRMT	6120	7281	GREAT FALLS MT
GRNC	6400	1638	GREENSBORO-WINSTON-SALEM-HIGH NC
GRND	5418	5297	GRAND FORKS ND-MN
GRSC	6250	1226	GREENVILLE-SPARTANBURG SC
GRWI	5512	3747	GREEN BAY WI
HACT	4687	1373	HARTFORD CT
HAMD	5555	1772	HAGERSTOWN MD
HAOH	6210	2718	HAMILTON-MIDDLETOWN OH
HAPA	5363	1733	HARRISBURG PA
HINC	6611	1833	HICKORY NC
HOTX	8938	3536	HOUSTON TX
HAUL	7267	2535	HUNTSVILLE AL
HUWV	6212	2299	HUNTONGTON-ASHLAND WV-KY
ININ	6272	2992	INDIANAPOLIS IN
IOIW	6313	3972	IOWA CITY IW
JAFL	7649	1276	JACKSONVILLE FL
JAMI	5663	3009	JACKSON MI
JAMS	8035	2880	JACKSON MS
JANC	6412	1131	JACKSONVILLE NC
JAWI	5970	3688	JANESVILLE-BELIOT WI
JENJ	5006	1409	JERSEY CITY NJ
JOMO	7421	4015	JOPLIN MO
JOPA	5542	2021	JOHNSTOWN PA
JOTN	6595	2050	JOHNSON CITY-KINGSPORT-BRISTOL TN-VA
KAIL	6149	3381	KANKAKEE IL
KAMI	5749	3177	KALAMAZOO-PORTAGE MI
KAMO	7027	4203	KANSAS CITY MO-KS
KEWI	5865	3526	KENOSHA WI
KITX	8832	4063	KILLEEN-TEMPLE TX
KNTN	6801	2251	KNOXVILLE TN
KOIN	6135	3063	KOKOMO IN
LAFL	8084	1034	LAKELAND-WINTER HAVEN FL

LAIN	6206	3167	LAFAYETTE-WEST LAFAYETTE IN
LAKS	7098	4294	LAWRENCE KS
LALA	8587	2996	LAFAYETTE LA
LAMA	4373	1311	LAWRENCE-HAVERHILL MA-NH
LAMI	5584	3081	LANSING-EAST LANSING MI
LANM	9132	5742	LAS CRUCES NM
LANV	8665	7411	LAS VEGAS NV
LOAK	8178	4451	LAWTON OK
LAPA	5348	1626	LANCASTER PA
LATX	9681	4099	LAREDO TX
LAWI	5874	4133	LA CROSSE WI
LEKY	6459	2562	LEXINGTON-FAYETTE KY
LEME	4042	1391	LEWISTON-AUBURN ME
LIAR	7721	3451	LITTLE ROCK-NORTH LITTLE ROCK AR
LINE	6832	4674	LINCOLN NE
LIOH	5921	2799	LIMA OH
LKLA	8679	3202	LAKE CHARLES LA
LOCA	9213	7878	LOS ANGELES-LONG BEACH CA
LOKY	6529	2772	LOUISVILLE KY-IN
LOMA	4399	1320	LOWELL MA-NH
LONJ	5073	1348	LONG BRANCH-ASBURY PARK NJ
LOOH	5623	2608	LORAIN-ELYRIA OH
LOTX	8348	3660	LONGVIEW TX
LUTX	8598	4962	LUBBOCK TX
LYVA	6093	1703	LYNCHBURG VA
MAGA	7364	1865	MACON GA
MANH	4354	1388	MANCHESTER NH
MAOH	5783	2575	MANSFIELD OH
MAWI	5887	3796	MADISON WI
MCTX	9856	3764	MCALLEN-PHARR-EDINBURG TX
MECT	4740	1358	MERIDEN CT
MEFL	7925	903	MELBOURNE-TITUSVILLE-COCOA FL
MEOR	7503	8892	MEDFORD OR
METN	7471	3125	MEMPHIS TN-AR
MIFL	8351	527	MIAMI FL
MIMN	5781	4525	MINNEAPOLIS-ST PAUL MN-WI
MITX	8934	4888	MIDLAND TX
MIWI	5788	3589	MILWAUKEE WI
MNAL	7692	2247	MONTGOMERY AL
MOAL	8167	2367	MOBILE AL
MOCA	8499	8473	MODESTO CA
MOLA	8148	3218	MONROE LA
MUIN	6130	2925	MUNCIE IN
MUMI	5622	3370	MUSKEGON-NORTON SHORES-MUSKEGO MI
NANH	4394	1356	NASHUA-NH
NANY	4961	1355	NASSUA-SUFFOLK NY
NATN	7010	2710	NASHVILLE-DAVIDSON TN
NECT	4715	1373	NEW BRITAIN CT
NELA	8483	2638	NEW ORLEANS LA
NEMA	4532	1131	NEW BEDFORD MA
NENJ	5085	1434	NEW BRUNSWICK-PERTH AMBOY-SAYR NJ

NENY	4997	1406	NEW YORK NY-NJ
NEOH	5904	2480	NEWARK OH
NEVA	5908	1260	NEWPORT NEWS-HAMPTON VA
NLCT	4700	1242	NEW LONDON-NORWICH CT-RI
NOCT	4877	1379	NORWALK CT
NOPA	5068	1719	NORTHEAST PENNSYLVANIA PA
NOVA	5918	1223	NORFOLK-VIRGINIA BEACH-PORTSMO VA-NC
NWCT	4792	1342	NEW HAVEN-WEST HAVEN CT
NWNJ	5015	1430	NEWARK NJ
NWNY	4915	1556	NEWBRGH-MIDDLETOWN NY
OCFL	7909	1227	OCALA FL
ODTX	8982	4930	ODESSA TX
OKOK	7947	4373	OKLAHOMA CITY OK
OLWA	6469	8971	OLYMPIA WA
OMNE	6687	4595	OMAHA NE-IA
ORFL	7954	1031	ORLANDO FL
OWKY	6731	2928	OWENSBORO KY
OXCA	9205	8050	OXNARD-SIMI VALLEY-VENTURA CA
PAFL	8057	1914	PANAMA CITY FL
PAMS	8273	2419	PASCAGOULA-MOSS POINT PATERSON MS
PANJ	4984	1452	PATERSON-CLIFTON-PASSAIC NJ
PAWV	5976	2268	PARKERSBURG-MARIETTA WV-OH
PEFL	8147	2200	PENSACOLA FL
PEIL	6362	3592	PEORIA IL
PEVA	5961	1429	PETERSBURG-COLONIAL HEIGHTS-HO VA
PHAZ	9135	6748	PHOENIX AZ
PHPA	5251	1458	PHILADELPHIA PA-NJ
PIAR	7803	3358	PINE BLUFF AR
PIMA	4626	1539	PITTSFIELD MA
PIPA	5621	2185	PITTSBURGH PA
POME	4121	1334	PORTLAND ME
PONH	3760	1431	PORTMOUTH-DOVER-ROCHESTER NH-ME
PONY	4821	1526	POUGHKEEPSIE NY
POOR	6799	8914	PORTLAND OR-WA
PRRI	4550	1219	PROVIDENCE-WARWICK-PAWTUCKET RI-MA
PRUT	7680	7006	PROV-OREM UT
PUCO	7787	5742	PUEBLO CO
RANC	6344	1436	RALEIGH-DURHAM NC
RAWI	5837	3535	RACINE WI
RECA	7880	8778	REDDING CA
RENV	8064	8323	RENO NV
REPA	5258	1612	READING PA
RICA	9172	7710	RIVERSIDE-SAN BERNARDINO-ONTAR CA
RIVA	5906	1472	RICHMOND VA
RIWA	6583	8415	RICHLAND-KENNEWICK WA
ROIL	6022	3675	ROCKFORD IL
ROMN	5916	4326	ROCHESTER MN
RONY	4913	2195	ROCHESTER NY
ROSC	6730	1692	ROCK HILL SC
ROVA	6196	1801	ROANOKE VA
SACA	8304	8580	SACRAMENTO CA

SAFL	8295	1094	SARASOTA FL
SAGA	7266	1379	SAVANNAH GA
SAMI	5404	3074	SAGINAW MI
SANC	6601	1679	SALISBURY-CONCORD NC
SAOR	6929	8958	SALEM OR
SATX	8944	4563	SAN ANGELO TX
SAUT	7576	7065	SALT LAKE CITY-OGDEN UT
SCCA	8664	8633	SANTA CRUZ CA
SEWA	6336	8896	SEATTLE-EVERETT WA
SFCA	8492	8719	SAN FRANCISCO-OAKLAND CA
SHLA	8272	3495	SHREVEPORT LA
SHPA	5520	2348	SHARON PA
SHTX	8253	4072	SHERMAN-DENISON TX
SHWI	5633	3629	SHEBOYGAN WI
SINE	6468	4768	SIOUX CITY NE-IA
SISD	6279	4900	SIOUX FALLS SD
SJCA	8583	8619	SAN JOSE CA
SLCA	8722	8560	SALINAS-SEASIDE-MONTERY CA
SLMO	6807	3482	ST LOUIS MO-IL
SNCA	9468	7629	SAN DIEGO CA
SNTX	9225	4062	SAN ANTONIO TX
SOCA	8435	8530	STOCKTON CA
SOIN	5918	3206	SOUTH BEND IN
SPCT	4620	1408	SPRINGFIELD-CHICOPEE-HOLYOKE CT-MA
SPIL	6539	3513	SPRINGFIELD IL
SPMO	7310	3836	SPRINGFIELD MO
SPOH	6049	2666	SPRINGFIELD OH
SPWA	6247	8180	SPOKANE WA
SRCA	8354	8787	SANTA ROSA CA
STCA	9171	8150	SANTA BARBARA-SANTA MARIA-LOMP CA
STCT	4897	1388	STAMFORD CT
STMN	5721	4705	ST CLOUD MN
STMO	6913	4301	ST JOSEPH MO
STOH	5689	2262	STEUBENVILLE-WEIRTON OH-WV
STPA	5360	1933	STATE COLLEGE PA
SYNY	4798	1990	SYRACUSE NY
TAFL	7877	1716	TALLAHASSEE FL
TAWA	6415	8906	TACOMA WA
TEIN	6428	3145	TERRE HAUTE IN
TETX	8111	3626	TEXARKANA TX-AR
TMFL	8173	1147	TAMPA-ST PETERSBURG FL
TOKS	7110	4369	TOPEKA KS
TOOH	5704	2820	TOLEDO OH-MI
TRNJ	5164	1440	TRENTON NJ
TUAL	7643	2535	TUSCALOOSA AL
TUAZ	9345	6485	TUCSON AZ
TUOK	7707	4173	TULSA OK
TYTX	8417	3744	TYLER TX
UTNY	4701	1878	UTICA-ROME NY
VACA	8422	8699	VALLEJO-FAIRFIELD-NAPA CA
VICA	8746	8139	VISALIA-TULARE-PORTERVILLE CA

VINJ	5320	1380	VINELAND-MILLVILLE-BRIDGETON NJ
VITX	9245	3748	VICTORIA TX
WACT	4761	1391	WATERBURY CT
WADC	5622	1583	WASHINGTON DC-MD
WAIA	6208	4167	WATERLOO-CEDAR FALLS IA
WATX	8706	3993	WACO TX
WAWI	5542	4014	WAUSAU WI
WEFL	8166	607	WEST PALM BEACH-BOCA RATON FL
WHWV	5755	2241	WHEELING WV-OH
WIDE	5326	1485	WILMINGTON DE-NJ
WIKS	7489	4520	WICHITA KS
WINC	6559	1143	WILMINGTON NC
WIPA	5200	1873	WILLIAMSPORT PA
WITX	8326	4413	WICHITA FALLS TX
WOMA	4513	1330	WORCESTER MA
YAWA	6533	8607	YAKIMA WA
YOOH	5557	2353	YOUNGSTOWN-WARREN OH
YOPA	5402	1674	YORK PA
YUCA	8181	8624	YUBA CITY CA

Appendix G - Network Optimization Literature Review - NASA Contract NAS3-23348

In preparation for designing the specifications for the optimization modules of the NASA LeRC least-cost network program, a study has been made of existing research on shortest path methods. This report summarizes Sonalysts review of network literature, proposes two algorithms to be implemented in the costing model, and explains the criteria that were used in their selection.

The basic algorithms underlying virtually all of the existing computer codes are very similar; two approaches were described by Dantzig [1] and Dijkstra [2] in 1959. Both of these methods are variations of the primal simplex method (see [7]). The implementation of the basic algorithm on a computer, however, can take many forms, and affects the efficiency of the algorithm tremendously. Over a decade, from 1968 to 1977, execution times to solve a problem using the same general algorithm, computer, and compiler became as much as 50 times faster [5,7]. This improvement is due to progress in the field of 'computer implementation technology' and the discovery of highly efficient ways to store and access the network data. The efficiency of a code also depends on the characteristics of the network with certain methods gaining an advantage for specific types of problems.

The NASA costing model requires the implementation of two distinct optimization algorithms, described in paragraphs 3.4.2 and 3.4.3 of the contract. We shall refer to these two requirements as problem 1 and problem 2, respectively.

Problem 1 involves finding the least-cost route from a given origin (or root) node to all other nodes in the network. (The same algorithm will be executed for each node as origin to obtain least-cost routes between each pair of nodes in the network). This problem has received considerable attention in the literature, and many different implementations have been documented, coded, and tested. Problem 2 requires the determination of the shortest paths between all pairs of nodes simultaneously. In contrast to problem 1, this problem appears to have been solved definitively and has, therefore, received far less attention. A simple though efficient algorithm has been coded and published, and it does not appear likely that it will be improved upon. We shall discuss the variety of solutions of these two problems, propose two algorithms to be used in the costing model, and discuss the characteristics of the network that have influenced the specific choices.

The following table lists some of the factors that affect algorithm performance and our assumptions about their value in the NASA network. These assumptions have been considered throughout the literature search.

	Factor	Value in NASA Network
1.	Size of network	Up to 600 nodes; up to 359,400 arcs
2.	Range of arc lengths	Unknown; expect it to be high
3.	Density of network	Totally dense
4.	Topology of network	Completely unstructured
5.	Existence of negative arc lengths	No negative costs
6.	Computer language (some implementation techniques exploit capabilities of assembly - language programming that are difficult or inefficient to duplicate in a higher level language.)	TSS/370 FORTRAN IV
7.	Importance of storage requirements vs speed	Neither particularly critical
8.	Capacities of links	Unlimited

Several articles have been written over the past twenty years that attempted to summarize and/or compare the shortest path algorithms of which the authors were aware at the time. These overviews have been very useful in comparing the techniques available and in locating additional material as well as original sources [3, 4, 5, 6, 7]. The earlier survey we studied was by Pollack and Wiebenson in 1959 [3]. Their article gives descriptions of several methods and discusses the advantages and disadvantages of each. The authors discuss methods they attribute to Minty and, later, Ford and Fulkerson, Dantzig, and Moore among others.

A paper by Dreyfus in 1968 [4] claims the Dijkstra algorithm "outperformed all competitors." More interestingly, section 2 (pp. 401-403) discusses our problem 2 and concludes that two algorithms, both requiring N*(N-1)*(N-2) additions and comparisons, "are easily proved, and programmed, and culminate a steady progression of successive improvements...(and hence) ... there is good reason to believe that they are definitive." The amount of computation required by these methods was also considered by Hu [9] to compare favorably to that of other methods. One of these methods was coded as Algorithm 97 in the Communications of the ACM [12] and will be embellished as necessary to implement it as a submodule within the optimization module of the NASA costing model.

In 1973 a comparative study was published by Gilsinn and Witzgall [5] that summarized available methods, measured their comparative efficiency, and focused attention on the importance of implementation technology. They concluded that a code developed by Dial [13], based on an algorithm of Moore [14], and published as algorithm 360 in the Communications of the ACM, was the fastest available.

In 1979, a comparative analysis by Dial and others included results measuring the speed of the above mentioned method (referred to as S1) as well as several others. For the class of networks we are studying -- in particular, a dense network with a wide range of non-negative arc lengths -- Dial's improvement to his own code (referred to as S2) appears to be the best. It is interesting to note that the advantage of S2 over S1 appears to increase with the density of the network. Several attempts were made by the authors to improve on the code, and execution times increased in each case. The conclusion was that the overhead added in attempting to avoid unnecessary processing was greater than the attendant savings. We propose to base the submodule of the optimization module that deals with problem 1 on a code of Dial, et al.

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(4) Dreyfus, S. E., "An Appraisal of Some Shortest-Path Algorithms," Operations Research, Vol. 17, 1969, pp. 395-412.

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(6) Golden, B., "Shortest-Path Algorithms: A Comparison", Operations Research, Vol. 24, No. 6, 1976, pp. 1164-1168.

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(9) Hu, T. C., "A Decomposition Algorithm for Shortest Paths in a Network", Operations Research, Vol. 16, 1968, pp. 91-102.

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(11) Ford, L. R. and D. R. Fulkerson, "Maximum Flow through a Network", Canadian J. Math., Vol. 8, 1956, pp. 399-404.

(12) Floyd, R. W. "Algorithm 97, Shortest Path", Communications of the ACM, Vol. 5, 1962, p. 345.

(13) Dial, R., "Algorithm 360, Shortest Path Forest with Topological Ordering", Communications of the ACM, Vol. 12 1969, pp. 632-633.

(14) Moore, E. F., "The Shortest Path Through a Maze", International Symposium on the Theory of Switching Proceedings, Harvard U. Press, Cambridge, Mass., 1957, pp. 285-292.

(15) Minieka, E., Optimization Algorithms for Networks and Graphs, Marcel Dekker, Inc., New York, N.Y., 1978.

Appendix H - Procedures for Model Execution

Procedures have been created to simplify the running of the model, cleaning up after the run, and getting output printed. These procedures are invoked simply by naming the procedures. A listing of these predefined procedures is contained below.

BATRUN - execute the batch version of the model.

```
PROCDEF BATRUN
UNLOAD CNDCB
UNLOAD BLKDTA
RELEASE FT
ERASE RUNLIB
ERASE TSTLIB
ERASE TRFTBL
ERASE TRFNDS
ERASE TRFVOL
RMDS TOUT,TRFTBL
RMDS TRFNDF,TRFNDS
RMDS VLST,TRFVOL
RELEASE $$$
RELEASE RMDS
GETLIBT CNCLIB,RUNLIB
GETLIBT BATLIB,TSTLIB
CDD BATDEF
LOAD BLKDTA
CNDCB
```

CNCRUN - execute the interactive version of the model

```
PROCDEF CNCRUN
UNLOAD CNDC
UNLOAD BLKDTA
```

```
RELEASE FT
ERASE RUNLIB
ERASE TRFTBL
ERASE TRFNDS
ERASE TRFVOL
RMDS TOUT,TRFTBL
RMDS TRFNDF,TRFNDS
RMDS VLST,TRFVOL
RELEASE $$$
RELEASE RMDS
GETLIBT CNCLIB,RUNLIB
CDD CNCDEF
LOAD BLKDTA
CNDC
```

DBGRUN - execute the debug interactive version of the model

```
PROCDEF DBGRUN
UNLOAD CNDC
UNLOD BLKDTA
RELEASE FT
ERASE RUNLIB
ERASE TRFTBL
ERASE TRFNDS
ERASE TRFVOL
RMDS TOUT,TRFTBL
RMDS TRFNDF,TRFNDS
RMDS VLST,TRFVOL
RELEASE $$$
RELEASE RMDS
GETLIBT DBGLIB,RUNLIB
CDD DBGDEF
LOAD BLKDTA
CNDC
```

FINISH - cleanup after executing the interactive or debug interactive version of the model

```
PROCDEF FINISH
UNLOAD CNDC
UNLOAD BLKDTA
RELEASE FT
ERASE RUNLIB
ERASE SSSLIB
ERASE TSTLIB
ERASE TRFTBL
ERASE TRFNDS
ERASE TRFVOL
```

LISTOUT pname - rename the CNDC output file and send it to the printer for hard copy output

pname is the name selected by the user for remaning the output file

```
PROCDEF LISTOUT
PARAM PNAME
FINISH
ERASE PNAME
DDEF PNAME,VS,PNAME,RET=T
CDS CNDCOUT,PNAME
ERASE CNDCOUT
PRINT PNAME,ERASE=Y
```

GETLIBP libnam - copy library specified by libname into permanent storage

```
PROCDEF GETLIBP
PARAM LIBNAM
RMDS LIBNAM
RELEASE $$$
DDEF LIBNAM,VP,LIBNAM,OPTION=JOBLIB
```

GETLIBT libnam - copy library specified by libnam into temporary storage

```
PROCDEF GETLIBT
PARAM PNAME,TNAME
RMDS PNAME,TNAME
RELEASE $$$
RELEASE RMDS
DDEF TNAME,VP,TNAME,OPTION=JOBLIB,RET=T
```

Appendix I - Output Samples

The CNDC Model provides six categories of output:

1) user inputs to run

2) city pair output - exclusive of other network traffic

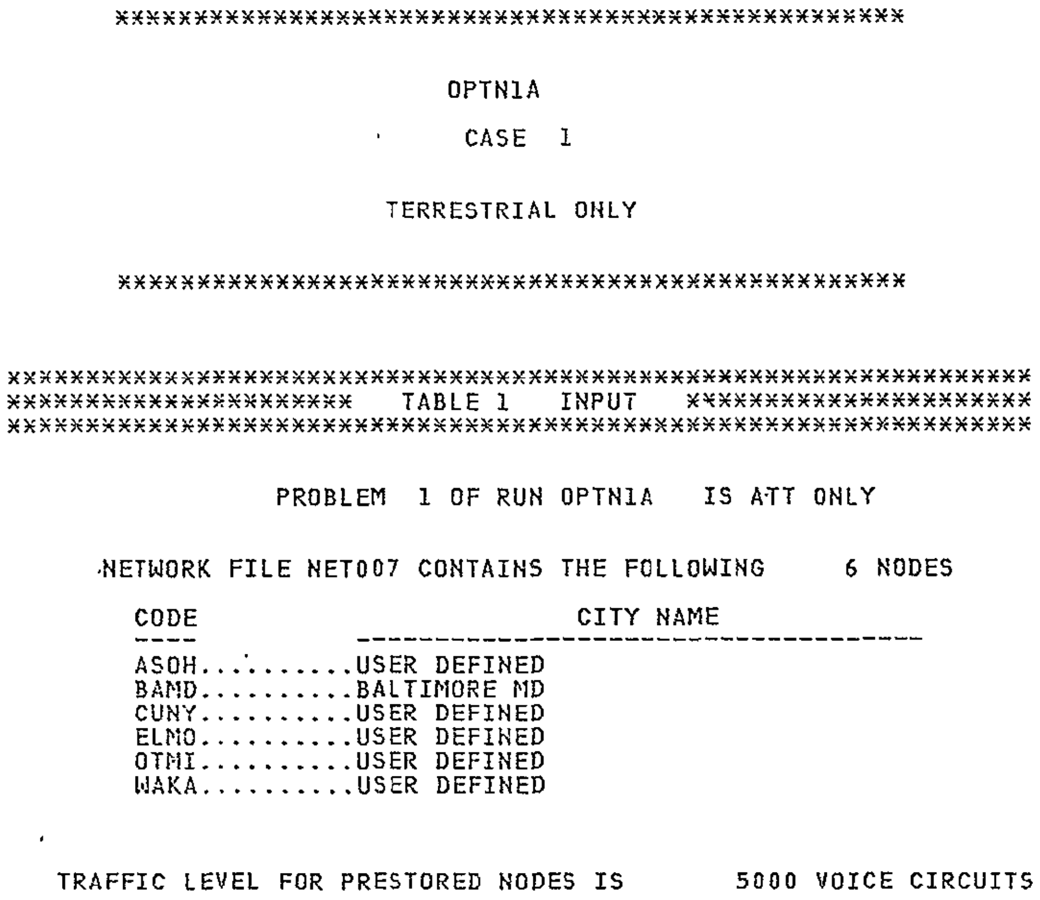
3) city pair output for least cost network

4) network totals

5) tariff totals

6) traffic table

The user selects which of these outputs are desired for each problem set. Figures I-1 through I-10 contain samples of all tables provided in the output.

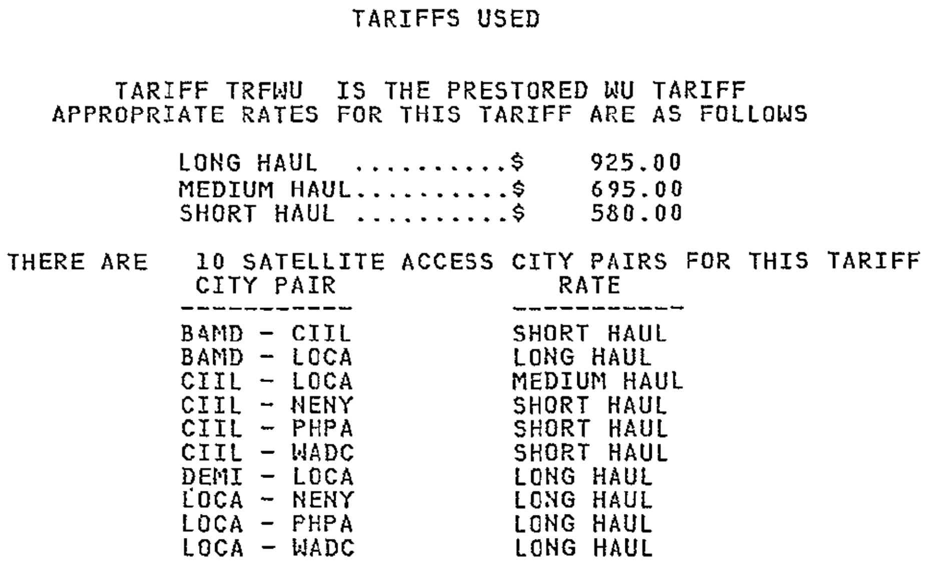


```
           ************************************************

                                OPTN1A

                                 CASE  1

                            TERRESTRIAL ONLY

           ************************************************


  ***************************************************************
  *********************    TABLE 1    INPUT    *********************
  ***************************************************************

                PROBLEM  1 OF RUN OPTN1A   IS ATT ONLY

       NETWORK FILE NET007 CONTAINS THE FOLLOWING     6 NODES

         CODE                         CITY NAME
         ----          -----------------------------------
         ASOH..........USER DEFINED
         BAMD..........BALTIMORE MD
         CUNY..........USER DEFINED
         ELMO..........USER DEFINED
         OTMI..........USER DEFINED
         WAKA..........USER DEFINED


     TRAFFIC LEVEL FOR PRESTORED NODES IS       5000 VOICE CIRCUITS
```

Figure I-1. Network Description

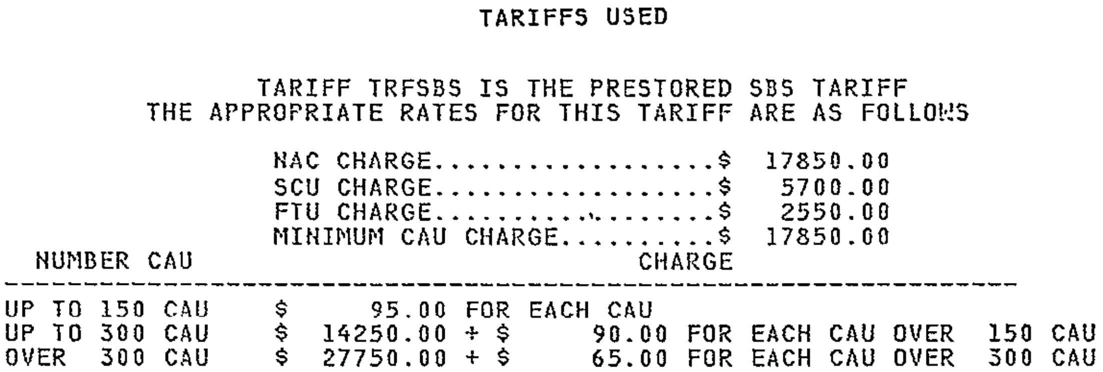
```
                         TARIFFS USED

              TARIFF TRFATT IS PRESTORED ATT TARIFF

SCHEDULE  1
 MILEAGE                           CHARGE
---------   ------------------------------------------------


        1   $   73.56
   2-  14   $   73.56  +  $2.59 FOR EACH MILE OVER    1 MILES
       15   $  109.82
  16-  24   $  109.82  +  $2.16 FOR EACH MILE OVER   15 MILES
       25   $  131.42
  26-  39   $  131.42  +  $1.62 FOR EACH MILE OVER   25 MILES
       40   $  155.72
  41-  59   $  155.72  +  $1.62 FOR EACH MILE OVER   40 MILES
       60   $  188.12
  61-  79   $  188.12  +  $1.62 FOR EACH MILE OVER   60 MILES
       80   $  220.52
  81-  99   $  220.52  +  $1.62 FOR EACH MILE OVER   80 MILES
      100   $  252.92
 101- 999   $  252.92  +  $0.94 FOR EACH MILE OVER  100 MILES
     1000   $ 1098.92
OVER 1000   $ 1098.92  +  $0.58 FOR EACH MILE OVER 1000 MILES

SCHEDULE  2
 MILEAGE                           CHARGE
---------   ------------------------------------------------
        1   $   75.00
   2-  14   $   75.00  +  $4.77 FOR EACH MILE OVER    1 MILES
       15   $  141.78
  16-  24   $  141.78  +  $4.47 FOR EACH MILE OVER   15 MILES
       25   $  186.48
  26-  39   $  186.48  +  $2.89 FOR EACH MILE OVER   25 MILES
       40   $  229.83
  41-  59   $  229.83  +  $1.95 FOR EACH MILE OVER   40 MILES
       60   $  268.83
  61-  79   $  268.83  +  $1.95 FOR EACH MILE OVER   60 MILES
       80   $  307.83
  81-  99   $  307.83  +  $1.95 FOR EACH MILE OVER   80 MILES
      100   $  346.83
 101- 999   $  346.83  +  $0.94 FOR EACH MILE OVER  100 MILES
     1000   $ 1192.83
OVER 1000   $ 1192.83  +  $0.58 FOR EACH MILE OVER 1000 MILES

SCHEDULE  3
 MILEAGE                           CHARGE
---------   ------------------------------------------------
        1   $   76.43
   2-  14   $   76.43  +  $6.35 FOR EACH MILE OVER    1 MILES
       15   $  165.33
  16-  24   $  165.33  +  $5.48 FOR EACH MILE OVER   15 MILES
       25   $  220.13
  26-  39   $  220.13  +  $4.03 FOR EACH MILE OVER   25 MILES
       40   $  280.58
  41-  59   $  280.58  +  $3.03 FOR EACH MILE OVER   40 MILES
       60   $  341.18
  61-  79   $  341.18  +  $2.31 FOR EACH MILE OVER   60 MILES
       80   $  387.38
  81-  99   $  387.38  +  $1.95 FOR EACH MILE OVER   80 MILES
      100   $  426.38
 101- 999   $  426.38  +  $0.97 FOR EACH MILE OVER  100 MILES
     1000   $ 1299.38
OVER 1000   $ 1299.38  +  $0.58 FOR EACH MILE OVER 1000 MILES

    TARIFF FILE      A CONTAINS THE FOLLOWING    1 CATEGORY A RATE CENTERS
BAMD
```

Figure I-2. ATT Tariff Description



```
                  TARIFFS USED

     TARIFF TRFWU  IS THE PRESTORED WU TARIFF
 APPROPRIATE RATES FOR THIS TARIFF ARE AS FOLLOWS

         LONG HAUL  ..........$    925.00
         MEDIUM HAUL..........$    695.00
         SHORT HAUL ..........$    580.00

THERE ARE   10 SATELLITE ACCESS CITY PAIRS FOR THIS TARIFF
          CITY PAIR               RATE
         -----------           ----------
         BAMD - CIIL           SHORT HAUL
         BAMD - LOCA           LONG HAUL
         CIIL - LOCA           MEDIUM HAUL
         CIIL - NENY           SHORT HAUL
         CIIL - PHPA           SHORT HAUL
         CIIL - WADC           SHORT HAUL
         DEMI - LOCA           LONG HAUL
         LOCA - NENY           LONG HAUL
         LOCA - PHPA           LONG HAUL
         LOCA - WADC           LONG HAUL
```

Figure I-3. WU Tariff Description



```
                            TARIFFS USED

                TARIFF TRFSBS IS THE PRESTORED SBS TARIFF
         THE APPROPRIATE RATES FOR THIS TARIFF ARE AS FOLLOWS

                 NAC CHARGE..................$  17850.00
                 SCU CHARGE..................$   5700.00
                 FTU CHARGE..................$   2550.00
                 MINIMUM CAU CHARGE..........$  17850.00
  NUMBER CAU                            CHARGE
----------------------------------------------------------------
UP TO 150 CAU    $      95.00 FOR EACH CAU
UP TO 300 CAU    $  14250.00 + $      90.00 FOR EACH CAU OVER  150 CAU
OVER  300 CAU    $  27750.00 + $      65.00 FOR EACH CAU OVER  300 CAU
```

Figure I-4. SBS Tariff Description

```
                          ******************************************************************
                          ****************   TABLE 2.  LEAST-COST ROUTES   ****************
TABLE 2                   ******************************************************************

-------------
 CIIL - BAMD
-------------

THE LEAST-COST ROUTE FROM CIIL TO BAMD IS

         CIIL-BAMD

THE TOTAL CIRCUIT MILEAGE FROM CIIL TO BAMD IS        604 MILES.

THE TOTAL COST OF CIRCUITS FROM CIIL TO BAMD IS $     284017.51

                                                LINK SUMMARY
                                                ---- -------

             |             |             |            FACILITY SIZE               |             |                  |         |                |
             |   TOTAL     |   TRAFFIC   |----------------------------------------|  COST PER   |    TOTAL COST    |         |                |
     LINK    |  AIRLINE    |  VOLUME ON  |  JUMBO  | MASTER  | SUPER  |   BASE    |  CIRCUIT    |   OF CIRCUITS    | TARIFF  |    SERVICE     |
             |  MILEAGE    | LINK (VC'S) | GROUPS  | GROUPS  | GROUPS |  GROUPS   |  (DOLLARS)  |    (DOLLARS)     |         |                |
-----------------------------------------------------------------------------------------------------------------------------------------------
             |             |             |         |         |        |           |             |                  |         |                |
   CIIL-BAMD |         604 |        1253 |       0 |       2 |      0 |         5 |$     226.67 | $      284017.51 | TRFSBS  |   SATELLITE    |
             |             |             |         |         |        |           |             |                  |         |                |


                        COST PER VOICE CIRCUIT BASED ON      10979 VOICE  CIRCUITS AT ORIGINATING NAC LOCATION

                      SATELLITE COST PER CIRCUIT BASED ON FOLLOWING CHARGES IN ORIGINATING CITY

                        NACS..........   10 @ COST      $  17850.00 EACH..........$       178500.00
                        SCUS..........   20 @ COST      $   5700.00 EACH..........$       114000.00
                        FTUS..........  549 @ COST      $   2550.00 EACH..........$      1399950.00
               9 GROUPS CAUS .......... 1116 @ BASE COST $  27750.00 PLUS
                                    INCREMENT $      65.00 EACH OVER  300..........$       727110.00
                        CAUS ..........  935 @ BASE COST $  27750.00 PLUS
                                    INCREMENT $      65.00 EACH OVER  300..........$        69025.00
                        -----------------------------------------------------------------------------
                        TOTAL EARTH STATION CHARGES............................$      2488585.00
```

Figure I-5. SBS Least Cost Route

TABLE 2

NANY - CIIL

THE LEAST-COST ROUTE FROM NANY TO CIIL IS

NANY-NENY-CIIL

THE TOTAL CIRCUIT MILEAGE FROM NANY TO CIIL IS 731 MILES.

THE TOTAL COST OF CIRCUITS FROM NANY TO CIIL IS $ 4519728.38

LINK SUMMARY

LINK	TOTAL AIRLINE MILEAGE	TRAFFIC VOLUME ON LINK (VC'S)	FACILITY SIZE				COST PER CIRCUIT (DOLLARS)	TOTAL COST OF CIRCUITS (DOLLARS)	TARIFF	SERVICE
			JUMBO GROUPS	MASTER GROUPS	SUPER GROUPS	BASE GROUPS				
NANY-NENY	20	21949	6	0	5	5	$ 120.62	$ 2647488.38	TRFATT-1	TERRESTRIAL
NENY-CIIL	711	3228	0	5	3	4	$ 580.00	$ 1872240.00	TRFWU	SATELLITE

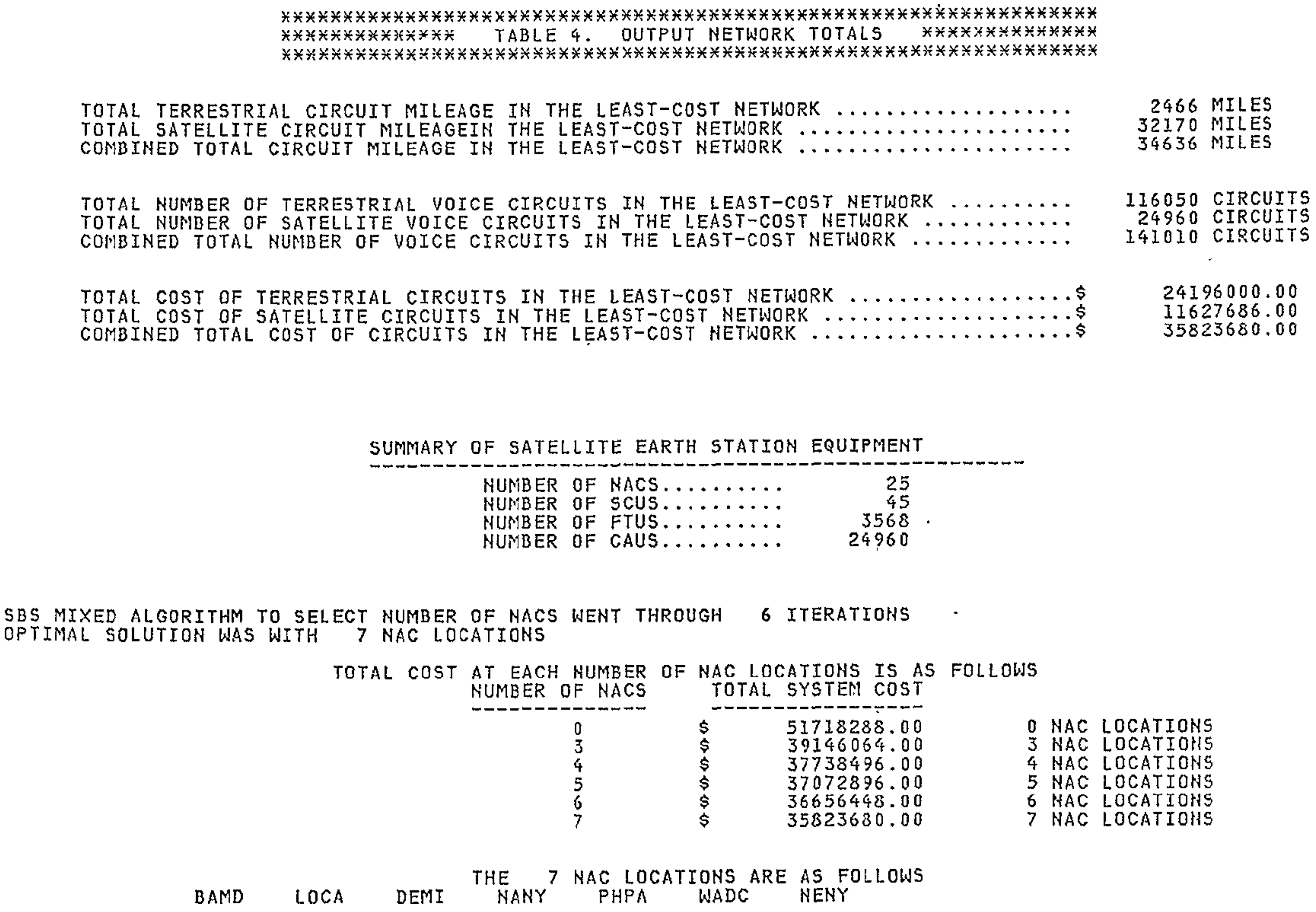
LINK SUMMARY

LINK	TOTAL AIRLINE MILEAGE	TRAFFIC VOLUME ON LINK (VC'S)	FACILITY SIZE				COST PER CIRCUIT (DOLLARS)	TOTAL COST OF CIRCUITS (DOLLARS)	TARIFF	SERVICE
			JUMBO GROUPS	MASTER GROUPS	SUPER GROUPS	BASE GROUPS				
NANY-NENY	20	1114	0	1	8	3	$ 120.62	$ 134370.68	TRFATT-1	TERRESTRIAL
NENY-CIIL	711	1114	0	1	8	3	$ 580.00	$ 646120.00	TRFWU	SATELLITE

Figure I-6. Least Cost Route

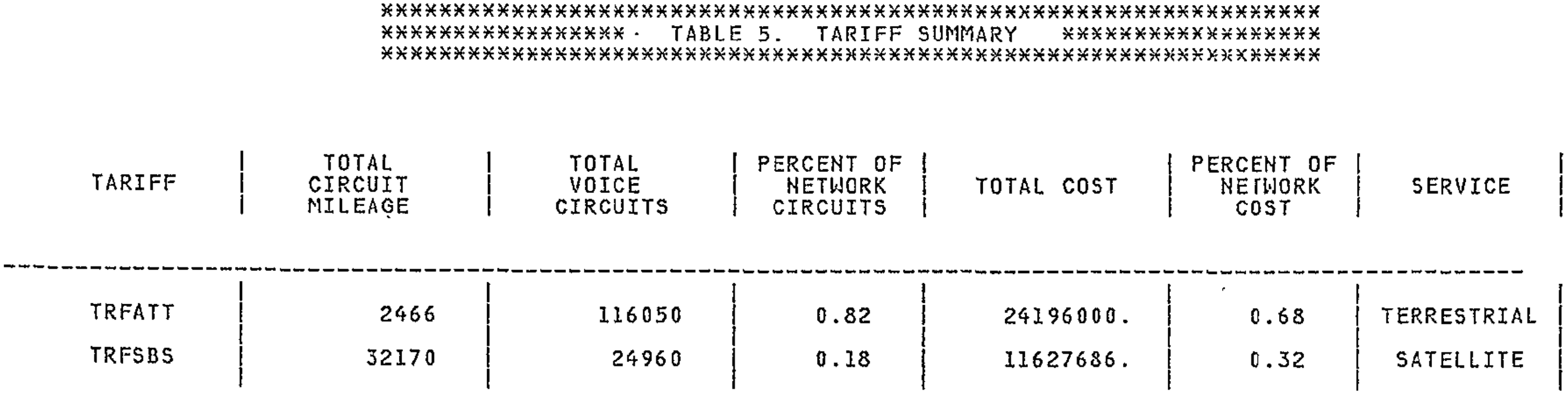
```
TABLE 3

--------------
 NANY - CIIL
--------------

THE LEAST-COST ROUTE FROM NANY TO CIIL IS

        NANY-NENY-CIIL

                                                  LINK SUMMARY
                                                  ---- -------

                |TOTAL NETWORK |               FACILITY SIZE             |             |                  |          |             |
      LINK      |TRAFFIC VOLUME|---------------------------------------- |  COST PER   |    TOTAL COST    |  TARIFF  |   SERVICE   |
                |ON LINK (VC'S)| JUMBO  | MASTER | SUPER  |  BASE  |  CIRCUIT    |   OF CIRCUITS    |          |             |
                |              | GROUPS | GROUPS | GROUPS | GROUPS |  (DOLLARS)  |    (DOLLARS)     |          |             |
--------------------------------------------------------------------------------------------------------------------------------
   NANY-NENY    |      22674   |     6  |     1  |     7  |     5  | $   120.62  | $   2734937.88   | TRFATT-1 | TERRESTRIAL |
   NENY-CIIL    |       3228   |     0  |     5  |     3  |     4  | $   580.00  | $   1872240.00   |  TRFWU   |  SATELLITE  |
```

Figure I-7. Least Cost Network



```
                  ***************************************************************
                  *************   TABLE 4.  OUTPUT NETWORK TOTALS   *************
                  ***************************************************************

TOTAL TERRESTRIAL CIRCUIT MILEAGE IN THE LEAST-COST NETWORK ..................      2466 MILES
TOTAL SATELLITE CIRCUIT MILEAGEIN THE LEAST-COST NETWORK .....................     32170 MILES
COMBINED TOTAL CIRCUIT MILEAGE IN THE LEAST-COST NETWORK .....................     34636 MILES

TOTAL NUMBER OF TERRESTRIAL VOICE CIRCUITS IN THE LEAST-COST NETWORK ..........   116050 CIRCUITS
TOTAL NUMBER OF SATELLITE VOICE CIRCUITS IN THE LEAST-COST NETWORK ............    24960 CIRCUITS
COMBINED TOTAL NUMBER OF VOICE CIRCUITS IN THE LEAST-COST NETWORK .............   141010 CIRCUITS

TOTAL COST OF TERRESTRIAL CIRCUITS IN THE LEAST-COST NETWORK ..................$      24196000.00
TOTAL COST OF SATELLITE CIRCUITS IN THE LEAST-COST NETWORK ....................$      11627686.00
COMBINED TOTAL COST OF CIRCUITS IN THE LEAST-COST NETWORK .....................$      35823680.00


                       SUMMARY OF SATELLITE EARTH STATION EQUIPMENT
                       ---------------------------------------------
                                NUMBER OF NACS..........        25
                                NUMBER OF SCUS..........        45
                                NUMBER OF FTUS..........      3568
                                NUMBER OF CAUS..........     24960


SBS MIXED ALGORITHM TO SELECT NUMBER OF NACS WENT THROUGH   6 ITERATIONS
OPTIMAL SOLUTION WAS WITH   7 NAC LOCATIONS

                   TOTAL COST AT EACH NUMBER OF NAC LOCATIONS IS AS FOLLOWS
                         NUMBER OF NACS     TOTAL SYSTEM COST
                         --------------     -----------------
                                0        $      51718288.00        0 NAC LOCATIONS
                                3        $      39146064.00        3 NAC LOCATIONS
                                4        $      37738496.00        4 NAC LOCATIONS
                                5        $      37072896.00        5 NAC LOCATIONS
                                6        $      36656448.00        6 NAC LOCATIONS
                                7        $      35823680.00        7 NAC LOCATIONS


                         THE   7 NAC LOCATIONS ARE AS FOLLOWS
        BAMD    LOCA    DEMI    NANY    PHPA    WADC    NENY
```

Figure I-8. Output Network Totals



```
******************************************************************
*****************·  TABLE 5.  TARIFF SUMMARY   *****************
******************************************************************


  TARIFF   |    TOTAL    |    TOTAL    | PERCENT OF |             | PERCENT OF |              |
           |   CIRCUIT   |    VOICE    |  NETWORK   | TOTAL COST  |  NETWORK   |   SERVICE    |
           |   MILEAGE   |  CIRCUITS   |  CIRCUITS  |             |    COST    |              |
-----------------------------------------------------------------------------------------------
           |             |             |            |             |            |              |
  TRFATT   |        2466 |      116050 |       0.82 |   24196000. |       0.68 | TERRESTRIAL  |
           |             |             |            |             |            |              |
  TRFSBS   |       32170 |       24960 |       0.18 |   11627686. |       0.32 |  SATELLITE   |
           |             |             |            |             |            |              |
```

Figure I-9. Tariff Summary

```
*****************************************************************
******************   TABLE 6   TRAFFIC TABLE   ******************
*****************************************************************
```

```
                                    TRAFFIC TABLE

             BAMD           DEMI           LOCA           NANY           NENY           PHPA           WADC
----------------------------------------------------------------------------------------------------------------
BAMD            0           1230            751           1813           4594           3618           6204
DEMI         1230              0            897           1067           2386           1353           1342
LOCA          751            897              0            725           1142            800            787
NANY         1813           1067            725              0          20835           3475           1774
NENY         4594           2386           1142          20835              0           8380           4201
PHPA         3618           1353            800           3475           8380              0           3131
WADC         6204           1342            787           1774           4201           3131              0
```

Figure I-10. Traffic Table

Appendix J - Common Blocks

The data structures used within the model (defined in section 4) are contained in common blocks. Below is a listing of the common blocks used within the CNDC model.

ARRYS

```
 COMMON /ARRYS/ MXPRN,MXCTA,MXACC
 INTEGER*4      MXPRN,MXCTA,MXACC
```

ATT

```
 COMMON /ATT/ TATBAS,TATINC,NALT,NLEVL,NSCHED,TATMLG,ALSTD,-
1             NPLEVL,LSTED,NINLST,TPTR
 REAL         TATBAS(9,3,13),TATINC(9,3,13)
 INTEGER*4    NALT,NLEVL,NSCHED,TATMLG(9),ALSTD(200),LSTED(600),-
1             NINLST(13),TPTR(13),NPLEVL
```

CSTMXD

```
 COMMON /CSTMXD/ TRRCST,STLCST,TRRMLG,TRRCKT,STLMLG,-
1             STLCKT
 REAL*4       TRRCST,STLCST
 INTEGER*4    TRRMLG,TRRCKT,STLMLG,STLCKT
```

CSTOUT

```
 COMMON /CSTOUT/ COST,MINCPC,NETOTL,OROUTE,SVC
 INTEGER*4       NETOTL(600,600)
 INTEGER*2       OROUTE(600,600),SVC(600,600)
 REAL            COST(600,600),MINCPC(600,600)
```

CURFIL

```
 COMMON /CURFIL/ FLNM,STATUS,NFIL
 INTEGER*4       NFIL,STATUS(20)
 REAL*8          FLNM(20)
```

HEADRS

```
 COMMON /HEADRS/ HNET,HTAR,HNOD,HTFC,HPATT,-
1                HNATT,HPWU,HNWU,HPSBS,HNSBS,-
2                HEXEC,UNET,UTAR,HVOL
 REAL*8          HNET(2),HTAR(2),HNOD(2),HTFC(2),-
1                HPATT(2),HNATT,HPWU(2),HNWU,HPSBS(2),-
2                HNSBS,HEXEC(2),UNET,UTAR,HVOL(2)
```

INPATT

```
 COMMON /INPATT/ NTLEVL,TATMIL,INCSC,ADJ,-
1                PRCATA,DRCATA,MDIR,MPBLK,NCATA
 INTEGER*4 NTLEVL,TATMIL(9),ADJ(600)
 REAL      INCSC(9,3)
 INTEGER*4 PRCATA(400),DRCATA(20),MDIR,MPBLK,NCATA
```

INPEXC

```
 COMMON /INPEXC/ NETFIL,FILNAM,MAXTRF,MAXRST,RUNID,-
1                NRSTRT,NOUT,OPTN,NTRF,OUTCNT,LEVEL
 REAL*8      NETFIL(10),FILNAM(130),RUNID
 INTEGER*4   MAXTRF,MAXRST,NRSTRT,NOUT,-
1            OPTN(10),NTRF(10),OUTCNT(6,10),LEVEL(10)
```

INPNET

```
 COMMON /INPNET/ CROPT,LVLTRF,NTRFC,MAXUSR,-
1                TOTNDS,PERCNT,VC,HC,VCIRTS
 INTEGER*4       CROPT,LVLTRF,NTRFC,MAXUSR,TOTNDS,-
1                PERCNT,VC(600),HC(600),VCIRTS(600)
```

INPNOD

```
 COMMON /INPNOD/ NNDS,MAXNDS,CODE,CODEL,CODER
 INTEGER*4       NNDS,MAXNDS,CODE(600),CODEL(600),-
1                CODER(600)
```

INPSBS

```
 COMMON /INPSBS/ NSBTAB,NAC,SCU,FTU,CAUMIN,TSBCAM,-
1                INCSB
 INTEGER*4 NSBTAB,TSBCAM(3)
 REAL      NAC,SCU,FTU,CAUMIN,INCSB(3)
```

INPWU

```
 COMMON /INPWU/ NADJ,CHGLH,CHGMH,CHGSH,CAT
 INTEGER*4      NADJ,CAT(600)
 REAL           CHGLH,CHGMH,CHGSH
```

LUN

```
 COMMON /LUN/ NETDIR,TRFATT,TRFDIR,TRFNDS,TRFSBS,-
1             TRFTBL,TRFWU,EXCUTE,LUNNET,LUNTRF,DEBUG,-
2             TRFVOL,LUNSPL,LUNOUT
 INTEGER      NETDIR,TRFATT,TRFDIR,TRFNDS,TRFSBS,-
1             TRFTBL,TRFWU,EXCUTE,LUNNET,LUNTRF,-
2             DEBUG,TRFVOL,LUNSPL,LUNOUT
```

NETFIL

```
 COMMON /NETFIL/ NFILES,NNFIL,NETDEF
 INTEGER*4 NNFIL,NETDEF(20)
 REAL*8 NFILES(20)
```

PRSNDS

```
 COMMON /PRSNDS/ NPRNDS,KDIR,KPBLK,KRNODE,PRNDS
 INTEGER*4       NPRNDS,KDIR,KPBLK,KRNODE(20),PRNDS(350)
```

PRSWU

```
 COMMON /PRSWU/ NACC,MAXACC,LSTACC
 INTEGER*4      NACC,MAXACC,LSTACC(65)
```

RNODES

```
 COMMON /RNODES/ NDIR,NPBLK,DRNODE,RTCNTR,V,H
 INTEGER*4       NDIR,NPBLK,DRNODE(25),RTCNTR(600),V(600),-
1                H(600)
```

RUN

```
 COMMON /RUN/ TF,FILNET,NTARIF,OPTION,NCASE,TRFLVL,OUTFLG,-
1             NNODES,TTYP
 REAL*8       TF(13),FILNET
 INTEGER*4    NNODES,NTARIF,OPTION,NCASE,TRFLVL,OUTFLG(6),-
1             TTYP(13)
```

SATMXD

```
 COMMON /SATMXD/ SATOTL
 INTEGER*4       SATOTL(600,600)
```

SBS

```
 COMMON /SBS/ TSBCAI,TSBCAB,TSBCMN,TSBSCU,TSBFTU,TSBNAC,CPNA
1             MAXGRP,NSCUPN,NTAB,TSBBKP,VCPFTU,NPTAB
 REAL         TSBCAI(3,13),TSBCMN(13),TSBSCU(13),-
1             TSBCAB(3,13),TSBFTU(13),TSBNAC(13)
 INTEGER*4    CPNA,MAXGRP,NSCUPN,NTAB,TSBBKP(3),-
1             VCPFTU,NPTAB
```

SBSEQP

```
 COMMON /SBSEQP/ QNAC,QSCU,QFTU,QCAU
 INTEGER*4       QNAC,QSCU,QFTU,QCAU
```

SBSMXD

```
 COMMON /SBSMXD/ SBMX,NACNMB,NACLOC,NODPTR
 INTEGER*4       SBMX,NACNMB,NACLOC(600),NODPTR(600)
```

SBSMX2

```
 COMMON /SBSMX2/ SATCST,TOTSAT,SATNVC,STABLE,SYSTBL
 REAL*4          SATCST(600),TOTSAT(600)
 INTEGER*4       SATNVC(600)
 INTEGER*2         STABLE(600)
 LOGICAL           SYSTBL
```

TARFIL

```
 COMMON /TARFIL/ TFILES,NTFIL,TARDEF
 INTEGER*4 NTFIL,TARDEF(13)
 REAL*8 TFILES(13)
```

TRFC

```
 COMMON /TRFC/ TRAFIC
 INTEGER*4     TRAFIC(600,600)
```

WU

```
 COMMON /WU/ TWU,NWUTRI,NWUCAT,MAXSAC,NSATAX,-
1            SA,WUPRS,SATACC,WURTCT
 INTEGER*2   SA(600),-
1            WUPRS(2080,13),SATACC(65,13),WURTCT(65)
 REAL        TWU(3,13)
 INTEGER*4   NWUTRI,NWUCAT,MAXSAC,NSATAX
```

Several of the common block variables are constant for the current version of the model, as, for example, the maximum number of prestored nodes. These constants are initialized in the Block Data Subprogram. Below is a listing of this program.

```
     BLOCK DATA
*LOAD INPEXC,CNDC.COMMON
*LOAD INPNOD,CNDC.COMMON
*LOAD INPNET,CNDC.COMMON
*LOAD LUN,CNDC.COMMON
*LOAD HEADRS,CNDC.COMMON
*LOAD ATT,CNDC.COMMON
*LOAD SBS,CNDC.COMMON
*LOAD RUN,CNDC.COMMON
*LOAD WU,CNDC.COMMON
*LOAD PRSWU,CNDC.COMMON
*LOAD ARRYS,CNDC.COMMON
C
C    ARRYS
C
       DATA MXPRN/350/, MXCTA/400/, MXACC/65/
C
C    INPEXC
C
       DATA MXTRF/13/,MAXRST/10/, NOUT/6/
C
C    INPNOD
C
       DATA MAXNDS/600/
C
C    INPNET
C
       DATA MAXUSR/250/
C
C    LOGICAL UNIT NUMBERS
C
       DATA NETDIR/1/, TRFATT/2/, TRFDIR/3/, TRFNDS/4/, TRFSBS/5/,-
     1      TRFTBL/6/, TRFWU/7/, EXECUTE/8/, LUNNET/30/, LUNTRF/50/,-
     1      DEBUG/91/, TRFVOL/12/, LUNSPL/70/, LUNOUT/99/
```

```
C
C    FILE HEADERS
C
       DATA HNET/'NETWRK D','IRECTORY'/
       DATA HTAR/'TARIFF D','IRECTORY'/
       DATA HNOD/'TRAFFIC ','NODES   '/
       DATA HTFC/'TRAFFIC ','TABLE   '/
       DATA HPATT/'ATT TARI','FF      '/
       DATA HNATT/'ATT-NASA'/
       DATA HPWU/'WU TARIF','F       '/
       DATA HNWU/'WU-NASA '/
       DATA HPSBS/'SBS TARI','FF      '/
       DATA HNSBS/'SBS-NASA'/
       DATA HEXEC/'EXECUTIO','N FILE  '/
       DATA UNET/'NETWORK '/
       DATA HVOL/'TRAFFIC ','VOLUMES '/
C
C    ATT
C
       DATA NALT/200/, NLEVL/9/, NSCHED/3/
C
C    SBS
C
       DATA MAXGRP/100/, NSCUPN/2/, VCPFTU/20/, NTAB/3/, CPNA/372/
C
C    WU
C
       DATA NWUCAT/3/, NWUTRI/2080/,  MAXSAC/65/
C
C    RUN
C
       DATA NCASE/0/
C
C    PRSWU
C
       DATA MAXACC/65/
C
     END
```

Appendix K - Directory of Files

There are many files which make up the CNDC model - source code, object code libraries, user defined data base files, prestored data base files, and command files. Below is a listing of these files and a brief description.

Source Code of Model:

SOURCE.BINPUT
SOURCE.TNTWRK
SOURCE.BCNDC
SOURCE.BOUTPUT
SOURCE.BATCH
SOURCE.BINIT
SOURCE.FSBSMXD
SOURCE.BTARCON
SOURCE.BLKDTA
SOURCE.BUTLTY
SOURCE.BNETCON
SOURCE.PBLKDTA
SOURCE.BTARIFF
SOURCE.BDRCTRY

Back up of Model Source Code

BACKUP.BCNDC
BACKUP.BINPUT
BACKUP.BNETCON
BACKUP.BTARCON
BACKUP.BOUTPUT
BACKUP.TNTWRK
BACKUP.BINIT
BACKUP.BDRCTRY
BACKUP.BTARIFF
BACKUP.BUTLTY
BACKUP.BATCH
BACKUP.FSBSMXD
BACKUP.CNCBAT

Debug version of the model:

A version of the model with debug statements is maintained to enable one to quickly locate problems if and when they develop.

DEBUG.BCNDC
DEBUG.BINPUT
DEBUG.BNETCON
DEBUG.BTARCON
DEBUG.BINIT
DEBUG.BUTLTY
DEBUG.FSBSMXD
DEBUG.BOUTPUT
DEBUG.BATCH

Libraries of object code:

CNCLIB - object code of source version

PRSLIB - object code of program which creates and maintains the prestored data base

DBGLIB - object code of debug version

BATLIB - library of modules required to run the model in batch mode

DBTLIB - debug version of BATLIB

Common Blocks Required by Source Code

CNDC.COMMON
PRSTRD.COMMON

Command Files Which Assemble Files Required to Execute Specific Version of the Model:

CNCDEF
DBGDEF
BATDEF

Files that Make Up Prestored Data Base

TRFATT	ATT tariff
TRFWU	WU tariff
TRFSBS	SBS tariff
NETDIR	directory to user defined networks
TRFDIR	directory to user defined tariffs
TOUT	traffic table
TRFNDF	prestored network
VLST	prestored network ordered by volume, most busy to least busy
NLST	annotated listing of prestored network
TLST	annotated listing of prestored traffic table

PTRFC	traffic table from which prestored traffic table constructed
PNODES	SMSA file from which prestored network constructed

Files that Make Up User Defined Data Base

User Defined Networks

NET001
.
.
.
.
.
NET020

User Defined Tariffs

TAR001
.
.
.
.
TAR013

Execution Control File

EXCUTE

Procedures described in Appendix H are found in USERLIB(SYSPRO).

Addendum

1.0 SBS Tariff Change

Change one to the manual reflects a change to the Satellite Business Systems tariff as set forth in F.C.C. No. 2, effective May 1, 1983. This tariff is described below. All charges specified are monthly recurring charges.

Network Access Center (each)	NAC	$17,850.00
NAC Supplemental Capacity Units (each)	SCU	$ 5,700.00
Full Time Transmission Units	FTU	$ 2,550.00
Minimum CAU Charges		$17,850.00
Connection Arrangement Units (monthly at each NAC)	CAU	

NUMBER OF CAUs AT EACH NAC	MONTHLY RECURRING CHARGE
1 CAU - 150 CAUs	$100 per CAU
151 CAUs - 300 CAUs	$15,000.00 plus $95.00 per CAU in excess of 150
More than 300 CAUs	$29,250.00 plus $70.00 per CAU in excess of 300