Paratransit Advanced Routing and Scheduling System Documentation: Routing and Scheduling Dial-A-Ride Subsystem

Howard K. Hung
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U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
National Engineering Laboratory
Center for Applied Mathematics
Gaithersburg, MD 20899

July 1985

Sponsored by
U.S. Department of Transportation
Urban Mass Transportation Administration
Office of Technical Assistance
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PARATRANSIT ADVANCED ROUTING AND SCHEDULING SYSTEM DOCUMENTATION: ROUTING AND SCHEDULING DIAL-A-RIDE SUBSYSTEM

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This research was conducted under the sponsorship of the Paratransit Integration Program (PTIP), Urban Mass Transportation Administration, U.S. Department of Transportation, by the Operations Research Division, Center for Applied Mathematics, National Engineering Laboratory, National Bureau of Standards. Mr. Edward G. Neigut was the UMTA program manager for the project. The Routing/Scheduling Dial-A-Ride (RSDAR) algorithm described in this report creates tour schedules from a file of trip requests made by dial-a-ride patrons. A trip request consists of the number of passengers (a patron and his party), a pickup location, a dropoff location and either a desired pickup or dropoff time. Tour schedules created by RSDAR contain a list of locations, times of vehicle stops, and the names of patrons boarding and alighting at each stop.

The RSDAR is a heuristic algorithm designed for operation in a batch mode. It can accommodate up to eight different characteristics for a patron, and up to 15 classes of priority. Conditions such as separate limits for the number of wheelchairs on a vehicle and economies of scale on patron dwell time are also included. The RSDAR is intended for use by dial-a-ride system operators in routing and scheduling their daily trip requests.

This report is designed as a technical reference for setting up and maintaining the RSDAR model. However, a preprocessor, CONENV, which constructs physical and policy environments, and contains trip request information; and a post processor, GREPOR, which generates hard copy of all necessary reports, are integral parts of the Advanced Routing and Scheduling System. Hence, a reader should read the reports describing CONENV and GREPOR, and the report on data structure before beginning to implement the system.
ABSTRACT

The Advanced Routing and Scheduling System (ARSS) is a software system designed to route and schedule patrons in a dial-a-ride environment. The system consists of three subsystems: CONENV, a preprocessor, constructs physical and policy environments; RSDAR routes and schedules patrons; and GREPOR generates hard copy of all necessary reports. This report only describes RSDAR.

The RSDAR is a heuristic algorithm. It assigns patrons to form subtours in time intervals; these subtours are then linked to become a tour.

Patrons are included in a subtour on the basis of best use of the remaining time of the base trip. Subtours are included in a tour on the basis of a measure of best productivity.

The model is written in FORTRAN and complies with the American National Standards Institute X3.9-1973 standard for that language.

Keywords: Dial-a-ride; heuristic algorithm; routing; scheduling
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1. INTRODUCTION

Many different types of paratransit systems have been in operation for over a decade. However, most of them have been manually routed and scheduled. The first major effort to develop a computer aided routing and scheduling approach for demand responsive transit was the CARS (Computer Aided Routing System) research project at the Massachusetts Institute of Technology from 1967 to 1971. Subsequently, a field demonstration was implemented in Haddonfield, New Jersey from 1972 to 1975. During most of the demonstration period, routing and scheduling of patrons were done manually; computer dispatching was used towards the end of the project. The computer control algorithm used in Haddonfield was that developed at MIT during the CARS project. A second field demonstration was implemented in Rochester, New York from 1975 to 1978. The computer control system used in Rochester was related to the system developed in the CARS project, although modifications were made to reflect the experience gained in Haddonfield. Immediate assignment of all patrons requesting service is a common feature of these two computer control systems. The assignment not only selects a vehicle, but also inserts the new pickup and dropoff stops in the tour of a vehicle.

A routing and scheduling algorithm for patrons with advance reservations was developed for the Urban Mass Transportation Administration at the University of Maryland. The algorithm was a mathematical programming approach, but embedded with heuristics.

When UMTA asked NBS to undertake the current project of developing a dispatching, scheduling, and routing algorithm and supporting operational software packages, it specified the following six basic guidelines to be observed:
(1) Products must be user oriented.

(2) Solution techniques must be simple.

(3) Products and documentation must be structured to facilitate the separation and use of individual, self-contained segments.

(4) Programs must be portable.

(5) Programs must be executable on low cost minicomputers.

(6) Software packages must be amenable to assembly and/or integration into systems at sites to suit the specific needs of those localities.

In consideration of the above mentioned six guidelines, NBS designed a software package with three stand-alone, but related, subsystems. The first of these subsystems, CONENV, constructs the physical environment and the policy environment; reads, transforms and augments trip request information; and creates required environmental reports. The physical environment includes vehicle characteristics such as initial location, final location, vehicle capabilities, capacities and dwell times; it defines geographic zones and zone-to-zone speeds. The policy environment includes service time intervals, policy-dictated breaks in service, definition of priority for both patron and vehicle accommodation capability, and definition of service quality requirements.

The trip request input is range-checked, transformed, and augmented by required environment information. The checking is extensive: in most cases, a non-legitimate entry is corrected to a default value and processing continues. When a default is impossible, the trip is omitted. Any abnormality generates a warning message.
Mandatory outputs are information (stored internally) necessary for the execution of subsequent subsystems and monitoring/error information (CRT and hard copy). There are also a number of independent and optional hard copy reports.

After reading file zc.rsd, output of the first subsystem, (i.e., CONENV), the second subsystem, RSDAR, performs the routing and scheduling of all trip requests. After routing and scheduling are completed, RSDAR writes results on file zr.gre. They are used as input to the third subsystem, GREPOR. The algorithm for the RSDAR subsystem is a collection of heuristics which will be described in detail later in this report.

The third subsystem, GREPOR, creates the necessary hard copy reports using as input the output from CONENV and RSDAR as well as the input file zs.gre. There are two types of report. The first is the driver trip list, designed specifically for the vehicle operator. The second, the dispatcher report, has considerably more information than the driver requires and is intended for the dispatcher/scheduler. Both report types are generalized to allow for user specified item selection, sorting, and paging.

Figure 1.1 depicts the relationship between the three subsystems with respect to input, output, and interfaces. This report is one of a sequence of reports, focusing on the RSDAR subsystem of the Advanced Routing and Scheduling System (ARSS).

The first report of the sequence, NBSIR 85-3174, Paratransit Advanced Routing and Scheduling System Documentation: Functional Program and Data Specifications, establishes the concepts upon which the software development was based. The overall tone of that report is general; it does not address program and data organization details such as
formats and specific computations. It describes the total paratransit environment and defines the functions, ranges and accuracy requirements.

The remaining reports of the series describe the software developed. In accordance with the aforementioned guidelines, each report is independent and self contained. There is redundancy among the reports since each is intended to be definitive with respect to a specific component or aspect of the system and only descriptive of the remainder.

The series of reports:

1 - NBSIR 85-3175 PARASSD:* USER/OPERATOR MANUAL
2 - NBSIR 85-3176 PARASSD: DATA SPECIFICATION
3 - NBSIR 85-3177 PARASSD: ENVIRONMENT CONSTRUCTION SUBSYSTEM
4 - NBSIR 85-3178 PARASSD: ROUTING AND SCHEDULING DIAL-A-RIDE SUBSYSTEM
5 - NBSIR 85-3179 PARASSD: GENERALIZED REPORTING SUBSYSTEM

*PARATRANSIT ADVANCED ROUTING AND SCHEDULING SYSTEM DOCUMENTATION.
Figure 1.1 Schematic View of ARSS
2. A HEURISTIC ROUTING/SCHEDULING DIAL-A-RIDE (RSDAR) ALGORITHM

A heuristic algorithm is presented here to solve the dial-a-ride routing and scheduling problem. The basic approach of the algorithm is to assign patrons to tours in such a way that productivity measures of subtours are maximized while all requirements for service quality constraints are satisfied.

2.1 BASIC CONCEPTS

The heuristic algorithm is based on a set of concepts specifically developed for routing and scheduling dial-a-ride patrons. A familiarity with these concepts, as introduced in the following subsections, is essential to the understanding of RSDAR.

2.1.1 Tour, Subtour, Trip and Base Trip

Some of the basic concepts used in RSDAR are those of tour, subtour, trip and base trip. A tour is defined as a collection of subtours assigned to a vehicle over a specified time interval, the elapsed time from the start to the end of a designated work shift for a vehicle. Each time interval in a tour during which the vehicle has at least one patron on board, (i.e., the vehicle is not empty) is a subtour.

A trip can be defined by its three major components: (1) a patron and his characteristics, (2) his origin and destination locations; and (3) his desired pickup time and/or delivery time.

A base trip is tied to the concept of a base patron. In a subtour, the first patron who boards the vehicle is the base patron and his trip is the base trip. All other patrons in the subtour must share some portion of the ride with the base patron. A patron who can not share some portion of a ride with the base patron can not be included in that subtour.
Tour and subtour are associated with the vehicle, while trip and base trip are associated with the patron.

2.1.2 Service Quality Constraints

The dial-a-ride operating authority establishes its service quality by imposing two independent requirements: (1) patron maximum on board time; and (2) pickup/delivery deviation allowance.

Patron maximum on board time limits the time that a patron may stay on board a vehicle, eliminating routings where ride times become excessive. Maximum on board time is the sum of an allowance for excessive ride time and the trip exclusive ride time (i.e., the minimum time for the vehicle to go from the patron's origin location to his destination location). The allowance for excessive ride time can be established by assigning a percentage of the trip exclusive ride, and superimposing a lower bound and an upper bound on the allowance, or it can simply be decreed as a fixed value.

The pickup/delivery deviation allowance time defines another service quality requirement. This allowance establishes the length of a time window within which the pickup or delivery must be made. The patron specified clock time becomes one end point of the time window as described in the next sections.

2.1.3 Pickup and Delivery Time Windows

Trip requests are classified either as pickup specified or as dropoff specified. If a trip request asks for a pickup time, the trip is considered as pickup specified. Likewise, if a trip request asks for a dropoff time, the trip is considered as dropoff specified. A trip request can be either pickup specified or dropoff specified, but not both.
Two time windows are created for each trip request: one pickup window and one dropoff window. The pickup window is the time interval between the earliest pickup time (EP) and the latest pickup time (LP). The dropoff window is the time interval between the earliest dropoff time (ED) and the latest dropoff time (LD). When a pickup specified trip request calls for a pickup after a certain time, the specified time becomes the earliest pickup time (EP), and the latest pickup time (LP) is the earliest pickup time plus the deviation allowance time. However, if a pickup-specified trip request calls for a pickup before a certain time, the specified time becomes the latest pickup time (LP), and the earliest pickup time is the latest pickup time minus the deviation allowance time. For a pickup-specified trip request, the earliest dropoff time (ED) is the earliest pickup time plus the trip exclusive ride time, and the latest dropoff time (LD) is the latest pickup time plus the maximum on board time.

For dropoff-specified trips, the process is reversed with the dropoff window established first. If a trip calls for a dropoff before a certain time, the specified time becomes the latest dropoff time (LD), and the earliest dropoff time (ED) is the latest dropoff time minus deviation allowance time. On the other hand, if a trip calls for a dropoff after a certain time, the specified time becomes the earliest dropoff time (ED) and the latest dropoff time (LD) is the earliest dropoff time plus the deviation allowance time. The windows for pickup-specified and dropoff-specified trips are illustrated in Figure 2.1.
### Pickup-Specified Trips

<table>
<thead>
<tr>
<th>EP</th>
<th>Pick Window</th>
<th>ED</th>
<th>Drop Window</th>
<th>LP</th>
<th>Allowance</th>
<th>LD</th>
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- **Exclusive Ride Time**
- **Maximum on Board Time**

### Dropoff Specified Trips

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<thead>
<tr>
<th>EP</th>
<th>Pick Window</th>
<th>LP</th>
<th>Allowance</th>
<th>LD</th>
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</table>

- **Exclusive Ride Time**
- **Maximum on Board Time**

**Figure 2.1 Time Windows for Pickup Specified and Dropoff-Specified Trips**

A trip's scheduled pickup and delivery times have to fall within the pickup and delivery windows, respectively. However, this does not guarantee that the trip is scheduled feasibly because the windows are so constructed that both pickup and delivery times may be within their respective windows, but the trip time can exceed the maximum on board time. Therefore, the RSDAR algorithm also checks the feasibility of maximum on board time.
2.1.4 Priority

In a dial-a-ride system, each trip is assigned a priority depending upon the patron's characteristics. RSDAR uses the trip priority as assigned in CONENV. Priority (i.e., the relationship with patron characteristics) is determined by the local dial-a-ride management system. The RSDAR algorithm is capable of handling up to fifteen priorities. According to the precedence rules within the assignment procedure, no patron can be assigned to a sub tour if a patron of higher priority is yet to be assigned. Thus the priorities are useful not only for ordering, but for stratification as well. The best sub tour is selected based on the trips of highest priority. The precedence rules provide a mechanism for implicit enumeration.

2.1.5 Productivity Measures

Productivity measures are used in the algorithm to help achieve the optimization objectives in a dial-a-ride system.

The productivity measures that are currently defined in the RSDAR are:

1. Number of patrons;
2. Number of trips;
3. Number of patrons per unit travel time;
4. Number of trips per unit travel time;
5. Patron exclusive ride times per unit travel time; and
6. Trip exclusive ride time per unit travel time.

All of these measures represent either work or work per unit time. Items (1) through (4) consider the unit of work to be patrons (or trips); all patrons
(trips) have equal value. Items (1) and (2) are integer counts; items (3) and (4) are utilization factors. Items (5) and (6) consider the unit of work to be the patron (trip) exclusive ride time; the value of a trip is proportional to its length.

2.1.6 Dwell Time

Dwell time is the time spent loading or unloading patrons to or from a vehicle. Number of patrons, characteristics of patrons, type of vehicle and whether it is loading or unloading, all affect vehicle dwell time at a stop.

A dwell time file is constructed for each type of vehicle. Each file has two major headings, pickup and drop-off dwell time. Under each major heading are three subheadings, namely, non-wheelchair (regular patrons), lift (those patrons who need a vehicle lift to get on board a vehicle), and wheelchair (patrons who use wheelchairs).

Empirical or estimated time values for each category are stored for each number of patrons up to the vehicle capacity. This format is used to accommodate observed non-linearities (e.g., n patrons can board/alight at a single stop in less time than is required for a single patron at each of n stops). In the routing and scheduling, numbers of each type of patron (whether they belong to a single trip or multiple trips) at a vehicle stop are first determined, then the dwell times are obtained for the various types. The largest time value is considered the dwell time of this stop. Thus, with mixed patron types, the largest dwell time is considered the total dwell time.

The pickup dwell time is included in a schedule before the scheduled pickup time; the drop-off dwell time enters a schedule after the scheduled drop-off time. If a number of trips in a subtour have the same stop location, the total
dwell time is consolidated into a single entry and is shown as the first scheduled pickup time or as the last scheduled drop-off time depending upon the type of stop.

![Diagram of dwell time]

**Figure 2.2** The Relative Position of Dwell Time to Scheduled Pickup Time and Dropoff Time

### 2.1.7 Vehicle Capacity

Vehicle capacity is defined in terms of combinations of patron types. For example, a vehicle may accommodate both wheelchair and non-wheelchair patrons with capacity defined as:

- with no wheelchairs, twelve non-wheelchair patrons;
- with one wheelchair, nine non-wheelchair patrons;
- with two wheelchairs, seven non-wheelchair patrons;
- with three wheelchairs, three non-wheelchair patrons;

and with four wheelchairs, no non-wheelchair patrons.

### 2.1.8 Mobility Code

A mobility code with four levels is built in the dial-a-ride system. The four levels are: (1) extended wheelchair; (2) wheelchair; (3) lift; and (4) regular or non-handicapped. Each patron has a single code; for multiple riders on a single trip, the code corresponding to the least mobile rider is used. An extended wheelchair patron is considered less mobile than a wheelchair patron;
a wheelchair patron, less mobile than a lift patron; and a lift patron, less mobile than a regular or non-handicapped one. Vehicles have multiple code classifications which indicate capability.

The RSDAR algorithm checks the compatibility of patron mobility code with the vehicle mobility classification code. If they are not compatible, then the patron can not be assigned to the vehicle.

2.2 HEURISTIC APPROACHES

To facilitate understanding of the heuristic algorithm, it is appropriate to describe some basic concepts of the algorithm before stating the procedures.

2.2.1 Time Interval

To generate a tour, the heuristic algorithm creates subtours in time intervals, terminating when all time intervals have been exhausted or no patrons can be assigned to the tour. The first task is to set in the starting and ending times of a given tour, and any scheduled breaks such as lunch, coffee breaks, etc. The algorithm then picks the first time interval, usually from tour starting time to the starting time of the first break. If no break is scheduled, this time interval ends with the ending time of the tour. The algorithm attempts to form a subtour in the interval. When a subtour is formed, there will be two intervals, one immediately preceding and one immediately succeeding the subtour. The algorithm attempts to create a subtour in the first interval. If no subtour can be formed in an interval, it is considered to have been examined and the algorithm moves to the next interval. A tour is completed after the last interval is examined.
2.2.2 Maximum Remaining Time

One measure used in RSDAR to decide which patron is to be included in a subtour is the remaining time of the base trip. The remaining time of the base trip is obtained, first by including the patron's trip in the subtour, then subtracting base trip travel time from the maximum on board time of the base trip. The underlying rationale is that the larger the remaining time of a base trip, the greater the opportunity to add new patrons to the subtour.

In a given time interval, a base trip (a subtour of two stops) is first tentatively chosen; the algorithm then expands this two-stop subtour by inserting more patrons. The process of expansion adds only one patron at a time, hence the subtour grows from two stops to four stops, then six, and so on. At any stage of expanding a subtour from \( n \) stops to \( n+2 \) stops, the algorithm examines all combinations of \( n+2 \) stops which do not affect the internal order of the \( n \) stops for patrons already assigned, selecting the one which allows the largest remaining time for the base patron, which in turn identifies the patron to be added in the subtour. The process of expansion will be repeated until no feasible trip can be added to the subtour. In short, the maximum remaining time of a base trip is the selection criterion for adding an additional patron to a subtour.

2.2.3 Productivity Measure

In a given time interval, subtours are formed based on a maximum remaining time criterion. There are as many subtours as the number of feasible patrons. However, only one subtour, among all possible subtours, can be selected in a time interval. The selection criterion for a subtour is the productivity measure.
In a time interval, the first subtour formed becomes the incumbent; any subsequently formed subtour with higher productivity will replace the incumbent. The process of selecting a subtour in a time interval terminates after all qualified patrons are examined.

Since each trip is assigned a priority and each priority is related to a productivity measure, comparisons of subtours are made by their productivity measures for the highest priority. If there is a tie, then the productivity measures for the next highest priority will be considered.

2.2.4 Base Trip Matrix

The most time-consuming part of the algorithm is the formation of subtours. For each subtour, a base trip is first selected, then the size of the subtour is increased by adding one patron at a time. Every unassigned (unscheduled) patron is examined for possible ride-sharing with the base trip patron, and the patron providing the maximum remaining time of the base trip is selected to be included in the sub tours. The process is repeated until no unassigned patrons can be added to the sub tours.

To avoid examining every unassigned patron repetitively, the algorithm uses the Base Trip Matrix, constructed in CONENV and updated in RSDAR as tours are constructed, which defines all pairwise ride sharing. In the Base Trip Matrix, each row represents a base patron and each column represents a patron. Elements of the Base Trip Matrix have values of one or zero. A one in an element means that the patron can share a ride with the base patron; a zero means that the patron can not share a ride with the base patron. The Base Trip Matrix effectively reduces the number of patrons to be examined for every base trip.
2.2.5 Compatibility Matrix

The Compatibility Matrix is of the same 0-1 form as the Base Trip Matrix, an element of "1" meaning that the row-column patrons can share a ride (be on the same vehicle at the same time); a "0", that they cannot share a ride. The Compatibility Matrix is a mechanism by which the mixing of classes of patrons can be avoided. Criteria for making this determination are site specific; they could include physical characteristics (elderly, mentally retarded, juvenile, etc.) and policy characteristics (priorities, sponsoring agencies, etc.). These are expected to be so different from one site to another that it is not appropriate to write a general procedure for this purpose.

In some instances, incompatibility can result not from patron characteristics, but from the times and geography of origins and destinations. For example, candidates A and B may each be potential sharing riders for base patron C but not be able to share with each other.

The Compatibility Matrix as constructed in the current version of CONENV uses only geographic considerations. However, RSDAR does not require any interpretation of the share/no share criteria. Therefore, the structure and procedure require no internal modification.

2.2.6 Potential Upper Bound

Another effort to reduce the number of subtours to be built is to set a bounding constraint in the algorithm, the productivity measure of the incumbent subtour. Initially, a potential upper bound is obtained for every patron from the Base Trip Matrix. These potential upper bounds are revised as patrons are assigned to tours. Since a subtour has a productivity measure for each priority, the appropriate productivity measure has to be used as a potential upper bound.
After an incumbent subtour is formed and its productivity measure obtained, new base patrons are examined to form new subtours. Before starting the process of constructing new subtours, the potential upper bounds of new base patrons are compared with the productivity measure of the incumbent subtour. If the potential upper bound of a base patron is smaller than the productivity measure of the incumbent subtour, this base patron is skipped for further investigation in the current time interval. The rationale is as follows: if the potential upper bound of the base patron is smaller than the productivity measure of the incumbent subtour, then this base patron can never form a subtour with a productivity measure higher than that of the incumbent subtour. Therefore, one can skip this base patron.

This procedure is an implicit, rather than total, enumeration. Subtour selection is based on the highest productivity measure of the highest priority. Subsequent insertion of lower priority tours is made in priority order.

2.2.7 Time and Locations of Tour Start, End, and Break

Every stop in a tour has two attributes, time and location. The time and location for stops of tour start, tour end, and tour break are input to RSDAR.

Every tour start time, tour end time and tour break time are entered as time windows. Stops that do not have pre-assigned time windows can simply be assigned a 24-hour time interval. It should be pointed out that the duration of a tour break is a necessary input to RSDAR. In terms of data storage, both a tour start-tour end pair and break start-break end pair are equivalent to dummy trips and appear in the patron list as such.
A location (the x,y coordinate) for each tour stop is generally required in RSDAR. However, in cases of tour start, end, and break, locations are not necessary. If the locations are not given, then the location of the stop succeeding the tour start stop in a tour is considered as the location for the tour start, and the location of the stop preceding the tour break or tour end will be considered as the location for the tour break or tour end.

The ability to have an unspecified location allows for a break in service scheduled with respect to time, but at any location. This is useful for coffee breaks, lunch periods, etc. It also allows for "artificial" tours; these correspond to a hired-by-ride shared-ride taxicab. Artificial tours are treated exactly as regular tours except that each may have only one subtour. This allows for short term (one subtour) utilization of a vehicle which can appear whenever and wherever needed and disappears after the assigned subtour is completed.

2.2.8 Shifting

Since a subtour is formed in a time interval, a larger time interval provides a better opportunity to build a larger subtour. Therefore, it is useful to shift the two ends of a time interval to make the interval as large as possible. In order to shift the two ends of an interval, it is necessary to shift all subtours preceding the interval to the earliest feasible time and all subtours following the interval to the latest feasible time. The algorithm implements the above idea by initially assigning all patrons in the subtour being formed to the latest feasible time. After the subtour is formed, the algorithm will examine the time interval preceding this subtour. If no subtour can be formed in the interval, then the algorithm will shift all scheduled times of the subtour from latest feasible time to earliest feasible time.
2.2.9 Call Back

It becomes necessary to call back a patron if his scheduled pickup time is not in his promised pickup time interval. A patron gets a promised pickup time interval when he calls in to make a trip request. However, this promised pickup time interval may not be the pickup time interval that RSDAR uses to schedule the patron. Due to the way that time windows are constructed, when a patron specifies a pickup time, his pickup time interval will coincide with the promised pickup time interval. However, if he specifies a dropoff time, his pickup time interval will not necessarily be the same as the promised pickup time interval. In this case, his scheduled time can be outside the promised time interval.

RSDAR has a subroutine CALBCK to check every patron if a call back is necessary. If so, affected patrons will be marked for call back and, in the report subsystem, a call back list will be generated.

2.3 FLOW CHART

The logical flow of the RSDAR algorithm is depicted in Figure 2.3.
Figure 2.3 Flow Diagram of the RSDAR Algorithm

Select a tour

Go to the first time interval

Can a subtour be formed?

Yes

Create a subtour

The new subtour becomes the incumbent

Is this subtour better than the incumbent?

Yes

Create a subtour

No

Can another subtour be formed?

Yes

The incumbent subtour becomes the subtour of the interval

Go to the time interval preceding the subtour

No

Is this the end?

Yes

End

No

Go to next time interval
3. FUNCTIONAL DESCRIPTION OF RSDAR

3.1 THE COMPUTER PROGRAM

The computer program for RSDAR consists of sixteen subroutines. Seven
form the main stream of the RSDAR algorithm, the other nine provide various
utility functions. A simple flowchart of RSDAR in terms of these seven
subroutines is depicted in Figure 3.1; descriptions of all subroutines in
RSDAR are provided in Appendix H. The complete listing of RSDAR can be found
in Appendix I. However, a more detailed description of the seven mainstream
subroutines can be found in the following sections.

3.1.1 Subroutine MAIN

Subroutine MAIN performs the following major functions: It declares
values of parameters which are sizes of various array dimensions; specifies
external units for input and output files; calls Subroutine READCV to read the
input file; calls Subroutine MNTOUR to perform routing and scheduling for all
trip requests; calls Subroutine CALBCK to check the need for calling patrons;
and, finally, calls Subroutine DUMPGR to write all output results on disk
files.

A PARAMETER statement is used in Subroutine MAIN to declare values of
eleven parameters which are used as "named constants" for array dimensions
throughout RSDAR. Detailed descriptions of these parameters can be found in
Section 3.3.

The specification of external units for input and output files is another
major function of Subroutine MAIN. The Advanced Routing and Scheduling System
has three subsystems, namely, the preprocessor, CONENV, the routing and
scheduling algorithm, RSDAR, and the report generator, GREPOR. Since RSDAR is
the second subsystem, it takes output of CONENV as its input, and its output is the input to GREPOR. Hence OPEN statements are used to bind file names with unit numbers of external devices.

The naming convention of files used in RSDAR subsystem is compatible with that in CONENV and GREPOR subsystems. All file names are of the form XX.XXX. The first letter is always z, the second letter indicates the subsystem that produces the file. Only three letters are involved: c means CONENV, g means GREPOR, and r means RSDAR. The three letters after the period denote the reading subsystem. For example, zr.gre means the file is produced by RSDAR and is to be read as input by GREPOR.

The input data to be read is in the file 'zc.rsd', and is assigned to external unit 11 with a status of 'old', meaning that the file should exist. The output file is 'zr.gre' and is assigned to external unit 21 with a status of 'new', meaning that the file cannot yet exist, but will be created.

After the input data are read, Subroutine MAIN calls Subroutine MNTOUR to initiate routing and scheduling of all trip requests, returning to Subroutine MAIN when the task of routing and scheduling is finished. At this time, Subroutine MAIN will call Subroutine CALBCK to identify those patrons whose scheduled times are not within their promised times. Patrons on this list must be telephoned to notify them of the change.

Finally, Subroutine MAIN will call Subroutine DUMPCC to write all RSDAR output on file 'zr.gre', so that the report generating subsystem will be able to process these data. Details of the output will be discussed in Section 3.4.
Figure 3.1 Flow Diagram of Subroutines of RSDAR
3.1.2 Subroutine MNTOUR

Subroutine MNTOUR is the center of activities, performing many tasks. It calculates initial upper bounds of productivity measures and determines the minimum size of time interval in which the algorithm will build subtours.

The subroutine searches the patron list and the tour list to see if there are any unassigned patrons or tours. If both are found, the subroutine will enter tour information, determine the time interval within which subtours will be built, initialize the priority sought to the highest, and select an unassigned patron with the highest estimated value of productivity measure for the sought priority as the base patron. It then calls Subroutine SBTOUR to build a subtour with the base patron. When Subroutine SBTOUR returns with a subtour, Subroutine MNTOUR will search for unassigned patrons whose upper bound of productivity measure is higher than the productivity measure of the current subtour and send them, one at a time, to Subroutine SBTOUR to build new subtours. The process terminates when the patron list is exhausted. If no subtour can be built with the base patron of the highest priority within a time interval, Subroutine MAIN then will advance the sought priority to the next highest priority and iterate until either a subtour is built in the time interval or the priority list is exhausted, indicating that no subtour can be built in the time interval.

A tour is completed when the last time interval in the tour has been examined.

Subroutine MNTOUR returns the control to Subroutine MAIN when either all patrons have been assigned to a tour or all available tours have been used.
3.1.3 Subroutine SBTOUR

The major functions of Subroutine SBTOUR are to set the stage to call Subroutine SBTGEN for expansion of the subtour for the given base patron, and to keep the best subtour that has been established.

3.1.4 Subroutine SBTGEN

Subroutine SBTGEN screens patrons for ridesharing with the base patrons; then it calls Subroutine TRCOMB to conduct further investigation. Patrons are added to the subtour one at a time.

3.1.5 Subroutine TRCOMB

Subroutine TRCOMB systematically inserts the two stops for the new patron into the existing order of stops of the subtour. It then calls Subroutine FESIBL to check the feasibility of the specific order of patron stops, and Subroutine RMTIME to calculate the remaining time of the base trip.

3.1.6 Subroutine FESIBL

Subroutine FESIBL checks whether the given order of patron stops of the subtour is feasible in terms of service quality criteria, such as time windows and maximum on-board time.

3.1.7 Subroutine RMTIME

Subroutine RMTIME calculates the remaining free time from the maximum on-board time of the base patron for the currently entered tentative stop sequence of the subtour, saving the stop sequence with the larger remaining time.

The complete listing of RSDAR can be found in Appendix I.
3.2 INPUT DATA REQUIREMENTS

The RSDAR Subsystem assumes the existence of many data files to be read as input. These data files are a subset of files generated by the CONENV subsystem.

The input data to be read by RSDAR are a set of variables and a set of arrays. The variables to be read in are PA03VX, PA03XX, PA07XX, PA10XX, PA08XX, PA08RX, IBX and IDX. These variables are defined below:

PA03VX: Number of Vehicle Entries in Candidate Trip List (one/tour + one/break).
PA03XX: Total Number of Entries in Candidate Trip List (Vehicles + Trips).
PA07XX: Number of Vehicle Types.
PA08RX: Number of Real Tours.
PA08XX: Number of Available Tours (Real + Artificial).
PA10XX: Number of Entries in Vehicle Capacity-Dwell List.
IBX: Local Index Variable for Base Trip Matrix.
IDX: Local Index Variable for Distance Matrix.

Nine arrays (namely, VTYPEL, VCADWE, TOURLI, CANDTP, BASETP, COMPAT, DISTOO, DISTOD, and PRIORL) are also read in as input. They are described in the following paragraphs.

The VTYPEL array contains, for each type of vehicle, mobility and priority types that the vehicle can accommodate, the maximum capacity for non-wheelchair patrons, characteristics of vehicle, and a pointer to array VCADWE.

The VCADWE array contains information on vehicle dwell time due to patrons boarding or debarking the vehicle. VCADWE has three patron
categories, non-wheelchair, lift, and wheelchair, and two types of dwell time, pick dwell and drop dwell for each. Dwell times are indexed by the number of non-wheelchair patrons.

The VCADWE array also provides the vehicle capacity for wheelchair patrons. All combined capacities of wheelchair patrons and non-wheelchair patrons can also be found there.

Dwell times of vehicle types are stored consecutively in VCADWE. For each type, a pointer in VTYPEL indicates the corresponding first row of dwell times.

The TOURLI array lists information on vehicles assigned to tours. For every available tour, this array stores the vehicle index, type, and patron priorities that the vehicle can handle.

The CANDTP array is the candidate trip list; it contains information on a trip required by a patron and stops required of the vehicle. For each trip request, the CANDTP uses sixteen words to store all relevant information.

The BASETP array is a matrix used to indicate permissible ride sharing of base trips. The BASETP rows represent base trips, columns of the matrix represent sharing trips, and elements of the matrix are either zero or one. If $a_{ij} = 1$, trip $j$ can share a ride with base trip $i$; if $a_{ij} = 0$, trip $j$ cannot share a ride with base trip $i$.

BASETP also presents the number of trips, by priority, that can share a ride with each base trip.

The COMPAT array is similar to the BASETP array: its elements, $b_{ij}$, indicate whether trip $i$ and trip $j$ can be assigned to the same subtour.

The DIST00 and DISTOD arrays contain distance (or equivalent travel time) matrices. The DIST00 array stores distances from origin to origin or
destination to destination. The origin-to-origin distances are stored in the upper right part of the matrix, and the destination-to-destination distances in the lower left part of the array. They are separated by the diagonal elements, which are all zero's.

The DISTOD array contains the distance matrix of origin to destination. A row of the matrix represents origin index, and a column of the matrix represents destination index.

Distances are actually stored in terms of travel time (to the nearest 1/8 of a minute) at a nominal speed. Since only ten bits of storage are allocated for this element, travel distance is limited to a maximum of 128 minutes at nominal speed. To save memory space, three distance elements are stored in one word in DISTOO and DISTOD.

The PRIORL array contains the assigned productivity code for each priority, a productivity measure calculated in subroutine PRDCTY. PRIORL also stores numbers of patrons in each priority.

3.3 PARAMETERS

The PARAMETER statement in Subroutine MAIN declares values of eleven parameters which are used as "named constants" for array dimensions throughout RSDAR.

Since RSDAR may be installed in different computer systems and may have to handle extremely diverse dial-a-ride situations, array dimensions in all subroutines are expected to be changed to satisfy the need. Using parameter declaration makes it easier to locate and change these values. Changes are limited to Subroutine MAIN; other subroutines need not be recompiled.
1. PARM01: It dimensions arrays BASETP and COMPAT.
   The minimum value should be \((PA03PX/31)+4)*PA03PX\), where PA03PX is the
   number of trip requests. All divisions performed in estimating values of
   parameters are rounded up to the next higher integer.
   The divisor is 31 because the first bit of a 32-bit word is a sign bit.
   In BASETP and COMPAT, information is stored in a single bit.

2. PARM02: It dimensions array BVEST1, and the minimum value should be
   \((PA03PX/31)+4\).

3. PARM03: It dimensions array CANDTP and the minimum value is set to be
   ICAX, the maximum number of entries for CANDTP. The entries for CANDTP
   are of three types: tour start, tour break, and patron trip. Each tour
   start, tour break, and patron trip needs an entry in CANDTP.

4. PARM04: It dimensions arrays DISTOD and DISTO00 and the minimum value is
   \((PA03XX)^2/3\).

5. PARM05: It dimensions arrays IBSBTR, ICSETR, ISE, and KSE. Since it is
   the maximum number of stops in a subtour, the value is estimated by an
   "educated guess."

6. PARM06: It dimensions array IVWHTR. Since it is the maximum number of
   stops in a tour, the value is estimated by an "educated guess."

7. PARM07: It dimensions array VTYPEL. The minimum value is the number of
   vehicle types.

8. PARM08: It dimensions array TOURLI. The minimum value is the number of
   tours.

9. PARM09: It dimensions array TSTOPL. The minimum value is 2*PA03XX.

10. PARM10: It dimensions array VCADWE. The minimum value is \(\sum_i (1+C_i)\) where
    \(C_i\) is the non-wheelchair capacity of vehicle type \(i\).

11. PARM11: It dimensions array PRD2D and the minimum value is PA03PX.
3.4 MODEL OUTPUT

The outputs of the RSDAR model are stored in three arrays: two of them, CANDTP and TOURLI appear in input and are augmented by RSDAR. The third file, TSTOPL, the tour stop list, is created in RSDAR.

The following items are associated with each patron in the CANDTP array as part of the output of RSDAR.

1. Scheduled* and expected pickup time;
2. Scheduled and expected dropoff time;
3. Tour assignment;
4. Pickup stop in the tour;
5. Dropoff stop in the tour;
6. Callback indicator; and
7. Locations for tour stops if necessary

Two items are to be added to every tour in the TOURLI array: the number of stops assigned to the tour, and the number of the row in TSTOPL where tour stops begin.

The TSTOPL array contains the tour stop list, storing the following items for every stop of each tour.

(1) Type of stop.
   (A) pickup
   (B) dropoff
   (C) break start
   (D) break end
   (E) tour start
   (F) tour end

* In RSDAR, scheduled and expected times have the same value. The expected time is included here to accommodate monitoring and ex post facto reporting functions.
Dwell time. During the vehicle dwell time (expressed in 1/8ths of a minute) at a stop, patrons board or disembark the vehicle.

Patron index. This is the candidate trip list, making accessible all information regarding the patron in CANDTP.

Number of non-wheelchair patrons on board for next leg.

Number of lift patrons on board for next leg.

Number of wheelchair patrons on board for next leg.

Travel time. The time, expressed in minutes, to travel from this stop to the next.

Slack time. This is the time the vehicle is idle, expressed in minutes.

Possible delay time. The difference between latest drop time and scheduled drop time shows the possible delay time for this stop without violating its time window.
4. OPERATIONAL CHARACTERISTICS OF RSDAR

4.1 COMPUTATIONAL RESULTS WITH RSDAR

A sample problem, collected from a one-day paratransit operation, was used for all test runs. There were 300 patron trip requests, 33 of which were for wheelchair patrons. The data file first listed all wheelchair trip requests, then the regular trip requests. Within each patron type, the data were chronologically ordered. The trip request data included patron's name, required pickup time, type of patron, number in the party, and locations (X,Y coordinates) of trip origin and destination. Appendix J lists the complete data file for 300 patron trip requests.

A set of external conditions influences the routing and scheduling of patrons. As set in CONENV, these are read as input to the RSDAR subsystem, including information on:

1. service quality criteria;
2. productivity measures for each priority;
3. patron characteristics;
4. dwell time;
5. vehicle characteristics;
6. number of tours available;
7. tour starting, break and ending times and locations; and
8. names of patron sponsoring agency.
Two series of test runs were made on the development system (see section 4.3 for description). Each series had seven runs, the first run started with 25 patrons, and the number of patrons increased by 25 for each succeeding run. The last run had 175 patrons. The two series of test runs differed in the productivity measure used in selecting subtours. The first series of test runs used number of patrons as the productivity measure for all patrons in the run. The second series used number of patrons as the productivity measure for wheelchair patrons and the ratio of number of patrons per unit time as the productivity measure for regular patrons. The details of run times, number of tours, and number of patrons assigned for the two series of test run are listed in Table 4.1 and Table 4.2 respectively; the numbers of stops in each for every test run is listed in Table 4.3 and Table 4.4. Wheelchair patrons were assigned a priority of 1; others were assigned a priority of 15.

From these runs, it was observed that the heuristic algorithm is very sensitive to input data. The run time appears to vary approximately cubically with respect to the number of patrons. That the run time varies with the productivity measure used can be seen in Table 4.1 and Table 4.3 for the two series of test runs.

To explore the effect of the number of priorities on the computer running time, eight test runs were carried out. Using 100 non-wheelchair patrons from the data base, each run was given a number of priorities, then these 100 patrons were uniformly distributed over the number of priorities. The test results are in Table 4.5.
Table 4.1 Results of #1 Test Series (Using Productivity Measure #1 for All Patrons)

<table>
<thead>
<tr>
<th>Number of Patrons</th>
<th>Run Time</th>
<th>Number of Tours</th>
<th>Number of Patrons Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>1:17</td>
<td>7</td>
<td>25</td>
</tr>
<tr>
<td>50</td>
<td>5:11</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>75</td>
<td>16:07</td>
<td>20</td>
<td>75</td>
</tr>
<tr>
<td>100</td>
<td>1:02:38</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>125</td>
<td>1:34:20</td>
<td>29</td>
<td>125</td>
</tr>
<tr>
<td>150</td>
<td>2:13:47</td>
<td>32</td>
<td>149</td>
</tr>
<tr>
<td>175</td>
<td>2:48:46</td>
<td>32</td>
<td>172</td>
</tr>
</tbody>
</table>

Table 4.2 Results of #2 Test Series (Using Productivity Measure #1 for Wheelchair Patrons and Productivity Measure #3 for Regular Patrons)

<table>
<thead>
<tr>
<th>Number of Patrons</th>
<th>Run Time</th>
<th>Number of Tours</th>
<th>Number of Patrons Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>1:12</td>
<td>7</td>
<td>25</td>
</tr>
<tr>
<td>50</td>
<td>6:25</td>
<td>11</td>
<td>50</td>
</tr>
<tr>
<td>75</td>
<td>29:46</td>
<td>22</td>
<td>75</td>
</tr>
<tr>
<td>100</td>
<td>1:28:26</td>
<td>27</td>
<td>100</td>
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<td>125</td>
<td>2:33:12</td>
<td>30</td>
<td>125</td>
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<tr>
<td>150</td>
<td>3:29:37</td>
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<td>146</td>
</tr>
<tr>
<td>175</td>
<td>5:03:12</td>
<td>32</td>
<td>170</td>
</tr>
</tbody>
</table>
Table 4.3 Tour Assignments of #1 Test Series

<table>
<thead>
<tr>
<th>Tour Number</th>
<th>Number of Patrons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
</tr>
<tr>
<td>1*</td>
<td>4</td>
</tr>
<tr>
<td>2*</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
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</tr>
<tr>
<td>31</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>

Number of Tours 7 10 20 25 29 32 32
Number of Patrons Assigned 25 50 75 100 125 149 172

*The first and second tours include a mandatory break stop.*
Table 4.4 Tour Assignments of #2 Test Series

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<th>Tour Number</th>
<th>Number of Patrons</th>
</tr>
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<tr>
<td>1*</td>
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<tr>
<td>2*</td>
<td>6</td>
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<tr>
<td>26</td>
<td>1</td>
</tr>
<tr>
<td>27</td>
<td>1</td>
</tr>
<tr>
<td>28</td>
<td>2</td>
</tr>
<tr>
<td>29</td>
<td>1</td>
</tr>
<tr>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>31</td>
<td>1</td>
</tr>
<tr>
<td>32</td>
<td>3</td>
</tr>
</tbody>
</table>

Number of Tours  
7  11  22  27  30  32  32

Number of Patrons Assigned  
25  50  75  100  125  146  170

*The first and second tours include a mandatory break stop.
<table>
<thead>
<tr>
<th>Number of Priorities</th>
<th>Run Time</th>
<th>Number of Tours</th>
<th>Number of Subtours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2:47:28</td>
<td>26</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>1:23:20</td>
<td>29</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>1:08:48</td>
<td>29</td>
<td>37</td>
</tr>
<tr>
<td>4</td>
<td>1:10:18</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>6</td>
<td>1:10:18</td>
<td>31</td>
<td>41</td>
</tr>
<tr>
<td>8</td>
<td>59:14</td>
<td>32</td>
<td>41</td>
</tr>
<tr>
<td>10</td>
<td>58:45</td>
<td>32</td>
<td>41</td>
</tr>
<tr>
<td>15</td>
<td>1:04:36</td>
<td>30</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>1:10:13</td>
<td>30</td>
<td>38</td>
</tr>
</tbody>
</table>

Table 4.5 Test Results of Different Number of Priorities

Test runs were also made by perturbing the length of the time interval for patron starting times. It was observed that both the computer run time and the number of tours decreased monotonically as the length of the time interval increased. For a set of 100 patrons, the starting times of all patrons were distributed uniformly within a time interval of 100 minutes, the RSDAR generated a schedule of 29 tours and the computer run time was about one hour and thirty six minutes. When the time interval was increased to 400 minutes, the schedule had only 14 tours and the run time was only about twenty minutes.

4.2 COMPUTER SYSTEM CONFIGURATION

All computer runs described in this report were executed on a WICAT System 150. The processor for the WICAT System 150 is the Motorola 68000 which runs at 8 MHz and executes approximately one million instructions per second. This processor has a 16-bit external data path, but internally it has

1Identification of commercial products is included only to adequately specify the test procedure. Identification does not imply recommendation or endorsement by the National Bureau of Standards.
32-bit registers and supports 32-bit operations. The computer system hardware configuration has a memory size of 512 KB of dynamic RAM, a 15 MB 5 1/4" Winchester disk drive, a 960KB 5 1/4" floppy disk drive, a cathode ray terminal, and a 132 character/line hard copy printer.

The operating system for the WICAT-150 is a WICAT version of UNIX. A FORTRAN 77 compiler is also a part of the system software.

4.3 COMPUTER HARDWARE AND SOFTWARE REQUIREMENTS

The minimum requirements for computer hardware to be able to run the RSDAR subsystem are specified as follows:

1. The Central Processing Unit (CPU) requires 32-bit internal registers to support 32-bit data operations. Lengths greater than 32-bits are acceptable.

2. The memory size requires at least 512 kilobytes.

3. The mass storage requires a Winchester disk drive of at least 15 megabyte capacity and at least one floppy disk drive for backup and file handling purposes.

4. A CRT (24 line by 80 character) which generates and displays the 96 character ASCII set.

5. A high-quality printer which has a line width of 132 characters and handles tractor feed pages.

The computer software requirement for RSDAR are a FORTRAN compiler which implements FORTRAN-77 and an operating system with file handling and editing capability.
Appendix A INTERNAL DATA FORMATS

This appendix defines all global data arrays used in RSDAR. The specifications are given in a series of tables. The tables appear in alphabetic order of variable name. Each specification includes:

1 - Array name (e.g., CANDTP)
2 - Dimensioning parameter (e.g., PARM03)
3 - Counts and subcounts as necessary (e.g., PA03VX, PA03RX, PA03XX)
4 - Definition (e.g., Deviation Both [i.e., patron and vehicle])
5 - Element length: bits or characters (e.g., 7 bits)
6 - Bit/word/field relations (e.g., bits 2-8, word 7, Deviation)
7 - Units (e.g., minutes)
8 - Range or discrete allowable values (e.g., 0-127)
9 - Coding or interpretation (e.g., not used)

The tables are numbered consecutively for all global arrays for the system (CONENV, RSDAR, and GREPOR). Only those tables (A.10 through A.39) for arrays in RSDAR appear in this appendix.

Examples given in the text are based on an entry from table A.12.
<table>
<thead>
<tr>
<th>Name</th>
<th>Word</th>
<th>1st Bit</th>
<th>Length</th>
<th>Units</th>
<th>Range</th>
<th>Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priority 1 Trips</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>-</td>
<td>0-127</td>
<td></td>
</tr>
<tr>
<td>Priority 2 Trips</td>
<td>9</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 3 Trips</td>
<td>17</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 4 Trips</td>
<td>25</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 5 Trips</td>
<td>2</td>
<td>7</td>
<td>-</td>
<td>-</td>
<td>0-127</td>
<td></td>
</tr>
<tr>
<td>Priority 6 Trips</td>
<td>9</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 7 Trips</td>
<td>17</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 8 Trips</td>
<td>25</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 9 Trips</td>
<td>3</td>
<td>7</td>
<td>-</td>
<td>-</td>
<td>0-127</td>
<td></td>
</tr>
<tr>
<td>Priority 10 Trips</td>
<td>9</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 11 Trips</td>
<td>17</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 12 Trips</td>
<td>25</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 13 Trips</td>
<td>4</td>
<td>7</td>
<td>-</td>
<td>-</td>
<td>0-127</td>
<td></td>
</tr>
<tr>
<td>Priority 14 Trips</td>
<td>9</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 15 Trips</td>
<td>17</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>All Trips</td>
<td>25</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
</tbody>
</table>

Incidence Bits

<table>
<thead>
<tr>
<th>Word</th>
<th>1st Bit</th>
<th>Length</th>
<th>Units</th>
<th>Range</th>
<th>Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>2-32</td>
<td>1</td>
<td>-</td>
<td>0-1</td>
<td></td>
</tr>
</tbody>
</table>

By bit for trips 1-31
0=not potential sharer
1=potential sharer

Words 6, 7, etc. are analogous to word 5 for trips 32-62, 63-93 etc., up to total number of patrons.

There are as many replications of the sequence as necessary for all patron base trips.
### Table A.11 - BVECT1: Base trip matrix row VECTor

<table>
<thead>
<tr>
<th>Name</th>
<th>Word</th>
<th>1st Bit</th>
<th>Length</th>
<th>Units</th>
<th>Range</th>
<th>Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priority 1 Trips</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>-</td>
<td>0-127</td>
<td></td>
</tr>
<tr>
<td>Priority 2 Trips</td>
<td>9</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 3 Trips</td>
<td>17</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 4 Trips</td>
<td>25</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 5 Trips</td>
<td>2</td>
<td>2</td>
<td>7</td>
<td>-</td>
<td>0-127</td>
<td></td>
</tr>
<tr>
<td>Priority 6 Trips</td>
<td>9</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 7 Trips</td>
<td>17</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 8 Trips</td>
<td>25</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 9 Trips</td>
<td>3</td>
<td>2</td>
<td>7</td>
<td>-</td>
<td>0-127</td>
<td></td>
</tr>
<tr>
<td>Priority 10 Trips</td>
<td>9</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 11 Trips</td>
<td>17</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 12 Trips</td>
<td>25</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 13 Trips</td>
<td>4</td>
<td>2</td>
<td>7</td>
<td>-</td>
<td>0-127</td>
<td></td>
</tr>
<tr>
<td>Priority 14 Trips</td>
<td>9</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Priority 15 Trips</td>
<td>17</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>All Trips</td>
<td>25</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Incidence Bits</td>
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<td>2-32</td>
<td>1</td>
<td>-</td>
<td>0-1</td>
<td></td>
</tr>
</tbody>
</table>

By bit for trips 1-31
0—not potential sharer
1+potential sharer

Words 6, 7, etc. are analogous to word 5 for trips 32-62, 63-93 etc, up to total number of patrons.
Table A.12 - CANDTP CANDidate TriPs
PARM03,PA03VX,PAO3RX,PAO3XX

<table>
<thead>
<tr>
<th>Name</th>
<th>P/V</th>
<th>Word</th>
<th>1st Bit</th>
<th>Length</th>
<th>Units</th>
<th>Range</th>
<th>Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop Type</td>
<td>Both</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>0-2</td>
<td>0+Patron</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1+Break</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2+End</td>
</tr>
<tr>
<td>Trip Type</td>
<td>Both</td>
<td>4</td>
<td>2</td>
<td>-</td>
<td>0-3</td>
<td></td>
<td>0+Vehicle</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1+Advanced</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2+Immediate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3+Deferred</td>
</tr>
<tr>
<td>Trip Status</td>
<td>Both</td>
<td>6</td>
<td>5</td>
<td>-</td>
<td>0-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assigned</td>
<td>-</td>
<td>6</td>
<td>1</td>
<td>-</td>
<td>0-1</td>
<td></td>
<td>1+Assigned</td>
</tr>
<tr>
<td>In Process</td>
<td>-</td>
<td>7</td>
<td>1</td>
<td>-</td>
<td>0-1</td>
<td></td>
<td>1+In process</td>
</tr>
<tr>
<td>Completed</td>
<td>-</td>
<td>8</td>
<td>1</td>
<td>-</td>
<td>0-1</td>
<td></td>
<td>1+Completed</td>
</tr>
<tr>
<td>Cancelled</td>
<td>-</td>
<td>9</td>
<td>1</td>
<td>-</td>
<td>0-1</td>
<td></td>
<td>1+Cancelled</td>
</tr>
<tr>
<td>No Show</td>
<td>-</td>
<td>10</td>
<td>1</td>
<td>-</td>
<td>0-1</td>
<td></td>
<td>1+No Show</td>
</tr>
<tr>
<td>Mobility Codes</td>
<td>Both</td>
<td>11</td>
<td>3</td>
<td>-</td>
<td>0-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extended WC</td>
<td>11</td>
<td>1</td>
<td></td>
<td>-</td>
<td>0-1</td>
<td></td>
<td>1+Extended WC</td>
</tr>
<tr>
<td>Wheelchair</td>
<td>12</td>
<td>1</td>
<td></td>
<td>-</td>
<td>0-1</td>
<td></td>
<td>1+Wheelchair</td>
</tr>
<tr>
<td>Lift</td>
<td>13</td>
<td>1</td>
<td></td>
<td>-</td>
<td>0-1</td>
<td></td>
<td>1+Lift</td>
</tr>
<tr>
<td>Patron Codes</td>
<td>Patron</td>
<td>14</td>
<td>3</td>
<td></td>
<td>0-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Call Back</td>
<td>14</td>
<td>1</td>
<td></td>
<td>0-1</td>
<td>1+Call Back</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pick/Drop ...</td>
<td>15</td>
<td>1</td>
<td></td>
<td>0-1</td>
<td>1+Drop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before/After</td>
<td>16</td>
<td>1</td>
<td></td>
<td>0-1</td>
<td>1+After</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pick Stop Index</td>
<td>Both</td>
<td>17</td>
<td>8</td>
<td>-</td>
<td>0-255</td>
<td></td>
<td>Within Tour</td>
</tr>
<tr>
<td>Drop Stop Index</td>
<td>25</td>
<td>8</td>
<td>-</td>
<td>0-255</td>
<td></td>
<td>Within Tour</td>
<td></td>
</tr>
<tr>
<td>Report Flag</td>
<td>Both</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>0-7</td>
<td>#0+Selected</td>
</tr>
<tr>
<td>Priority</td>
<td>Patron</td>
<td>5</td>
<td>4</td>
<td>-</td>
<td>1-15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table A.12 - CANDTP CANDidate TriPs (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>P/V</th>
<th>Word</th>
<th>1st Bit</th>
<th>Length</th>
<th>Units</th>
<th>Range</th>
<th>Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Type</td>
<td>Vehicle</td>
<td>5</td>
<td>4</td>
<td>-</td>
<td>1-15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Characteristics</td>
<td>Both</td>
<td>9</td>
<td>8</td>
<td>-</td>
<td>0-1</td>
<td></td>
<td>By Bit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1+Existence of Characteristic</td>
</tr>
<tr>
<td>Agency</td>
<td>Both</td>
<td>17</td>
<td>8</td>
<td>-</td>
<td>1-127</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle Index</td>
<td>Both</td>
<td>25</td>
<td>8</td>
<td>-</td>
<td>0-255</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tour</td>
<td>3</td>
<td>2</td>
<td>7</td>
<td>-</td>
<td>0-127</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exclusive Ride Time</td>
<td>Patron</td>
<td>9</td>
<td>12</td>
<td>1/8 min.</td>
<td>0-511</td>
<td>7/8</td>
<td></td>
</tr>
<tr>
<td>Break Duration</td>
<td>Vehicle</td>
<td>9</td>
<td>12</td>
<td>1/8 min.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max on Board Time</td>
<td>Patron</td>
<td>21</td>
<td>12</td>
<td>1/8 min.</td>
<td>0-511</td>
<td>7/8</td>
<td></td>
</tr>
<tr>
<td>Expected Pick Time</td>
<td>Both</td>
<td>4</td>
<td>2</td>
<td>15</td>
<td>1/8 min.</td>
<td>0-4095</td>
<td>7/8</td>
</tr>
<tr>
<td>Expected Drop Time</td>
<td>Both</td>
<td>17</td>
<td>16</td>
<td>1/8 min.</td>
<td>0-8191</td>
<td>7/8</td>
<td></td>
</tr>
<tr>
<td>Pick X</td>
<td>Both</td>
<td>5</td>
<td>2</td>
<td>15</td>
<td>1/8 min.</td>
<td>0-4095</td>
<td>7/8</td>
</tr>
<tr>
<td>Drop X</td>
<td>Both</td>
<td>17</td>
<td>16</td>
<td>1/8 min.</td>
<td>0-8191</td>
<td>7/8</td>
<td></td>
</tr>
<tr>
<td>Pick Y</td>
<td>Both</td>
<td>6</td>
<td>2</td>
<td>15</td>
<td>1/8 min.</td>
<td>0-4095</td>
<td>7/8</td>
</tr>
<tr>
<td>Drop Y</td>
<td>Both</td>
<td>17</td>
<td>16</td>
<td>1/8 min.</td>
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<tr>
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<td>0-31 7/8</td>
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<td>1/8 min.</td>
<td>0-31 7/8</td>
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Table A.13 - COMPAT COMPATibility matrix
PARMO1,PA01XX

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Words 6, 7, etc. are analogous to word 5 for trips 32-62, 63-93 etc, up to total number of patrons.

There are as many replications of the sequence as necessary for all patron base trips.
Table A.14 - DISTOD DISTance Origin-Destination
PARM04, PA04XX

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<td>7/8</td>
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<tr>
<td>Pick 1 to Drop 2</td>
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<td>10</td>
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DISTOD is a square matrix stored as a vector.

Table A.15 - DISTOO DISTance Origin-Origin
PARM04, PA04XX

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<td>10</td>
<td>1/8 min.</td>
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<td>7/8</td>
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<tr>
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<td>Pick 1 to Pick 3</td>
<td>23</td>
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</table>

DISTOO is a square matrix stored as a vector. The upper triangular portion has pick-to-pick times; the lower triangular portion, drop-to-drop times.
<table>
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<tr>
<th>Name</th>
<th>Word</th>
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<th>Length</th>
<th>Units</th>
<th>Range</th>
<th>Coding</th>
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<td>31</td>
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<td>31</td>
<td></td>
<td>1/8 min.</td>
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<tr>
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### Table A.25 - PRDBD PRODuctivity bounds PARM11

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There are as many replications of the sequence as necessary for all patrons.
Table A.26 - PRD COD PRoDuctivity CODE of priority 15,15

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Table A.28 - PRDIC Productivities of Current subtour 15,15

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<td>31</td>
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<td></td>
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<td>Productivity of priority #7 for current base patron</td>
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<td>31</td>
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Table A.29 - PRIORL PRIORity List
15,15

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Table A.30 - PRIOTR Priority TRuth table 15,15

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1 - indicates yes and 0 indicates no.
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<td>Agency</td>
<td>3</td>
<td>2</td>
<td>7</td>
<td>-</td>
<td>0-127</td>
<td></td>
</tr>
<tr>
<td>Characteristics Capability</td>
<td>9</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>0-1</td>
<td>By Bit: 1 + ability to accommodate indexed characteristic</td>
</tr>
</tbody>
</table>
### Table A.37 - TSTOPL Tour STOP List
**PARM09, PA09XX**

<table>
<thead>
<tr>
<th>Name</th>
<th>Word</th>
<th>1st Bit</th>
<th>Length</th>
<th>Units</th>
<th>Range</th>
<th>Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop Type</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>1-6</td>
<td>1+Pick, 2+Drop, 3+Start Break, 4+End Break, 5+End Tour, 6+Start Tour</td>
</tr>
<tr>
<td>Dwell Time</td>
<td>5</td>
<td>8</td>
<td>1/8 min</td>
<td>0-31</td>
<td>7/8</td>
<td></td>
</tr>
<tr>
<td>Candidate Index</td>
<td>13</td>
<td>16</td>
<td>-</td>
<td>1-215</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Report Flag</td>
<td>29</td>
<td>4</td>
<td>-</td>
<td>0-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On Board-Next Leg</td>
<td>2</td>
<td>2</td>
<td>7</td>
<td>-</td>
<td>0-127</td>
<td></td>
</tr>
<tr>
<td>NHC Riders</td>
<td></td>
<td>2</td>
<td>7</td>
<td>-</td>
<td>0-127</td>
<td></td>
</tr>
<tr>
<td>Lift Riders</td>
<td></td>
<td>9</td>
<td>8</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Wheelchair Riders</td>
<td></td>
<td>17</td>
<td>8</td>
<td>-</td>
<td>0-255</td>
<td></td>
</tr>
<tr>
<td>Times-Next Leg</td>
<td>3</td>
<td>2</td>
<td>7</td>
<td>minutes</td>
<td>0-127</td>
<td></td>
</tr>
<tr>
<td>Travel</td>
<td></td>
<td>9</td>
<td>12</td>
<td>minutes</td>
<td>0-4K</td>
<td></td>
</tr>
<tr>
<td>Slack</td>
<td></td>
<td>9</td>
<td>12</td>
<td>minutes</td>
<td>0-4k</td>
<td></td>
</tr>
<tr>
<td>Maximum Offset Time</td>
<td>21</td>
<td>12</td>
<td>minutes</td>
<td>0-4K</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Report Pointers</td>
<td>4</td>
<td>16</td>
<td>15</td>
<td>-</td>
<td>0-32K</td>
<td></td>
</tr>
<tr>
<td>Candidate Pointer</td>
<td></td>
<td>16</td>
<td>15</td>
<td>-</td>
<td>0-32K</td>
<td>0+Candidate, 1+Drop Stop, 2+Pick Stop</td>
</tr>
<tr>
<td>Report Item</td>
<td></td>
<td>31</td>
<td>2</td>
<td>-</td>
<td>0-2</td>
<td>2+Pick Stop</td>
</tr>
</tbody>
</table>
Table A.38 - VCADWE Vehicle Capacity and Dwell
PARM10, P10XX

<table>
<thead>
<tr>
<th>Name</th>
<th>Word</th>
<th>1st Bit</th>
<th>Length</th>
<th>Units</th>
<th>Range</th>
<th>Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WC Capacity</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>-</td>
<td>0-15</td>
<td>WC capacity with 0 NHC</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>--</td>
<td>Not Used</td>
</tr>
<tr>
<td>Record I (I=2, NHC Capacity+1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WC Capacity</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>-</td>
<td>0-15</td>
<td>With I-1 NHC</td>
</tr>
<tr>
<td>NHC Pick Dwell Time</td>
<td>9</td>
<td>8</td>
<td>1/8 min. 0-31 7/8</td>
<td>For I-1 riders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lift Pick Dwell Time</td>
<td>17</td>
<td>8</td>
<td>1/8 min. 0-31 7/8</td>
<td>For I-1 riders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WC Pick Dwell Time</td>
<td>25</td>
<td>8</td>
<td>1/8 min. 0-31 7/8</td>
<td>For I-1 riders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NHC Drop Dwell Time</td>
<td>2</td>
<td>9</td>
<td>8</td>
<td>1/8 min. 0-31 7/8</td>
<td>For I-1 riders</td>
<td></td>
</tr>
<tr>
<td>Lift Drop Dwell Time</td>
<td>17</td>
<td>8</td>
<td>1/8 min. 0-31 7/8</td>
<td>For I-1 riders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WC Drop Dwell Time</td>
<td>25</td>
<td>8</td>
<td>1/8 min. 0-31 7/8</td>
<td>For I-1 riders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Word</td>
<td>1st Bit</td>
<td>Length</td>
<td>Units</td>
<td>Range</td>
<td>Coding</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------</td>
<td>---------</td>
<td>--------</td>
<td>-------</td>
<td>-------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Vehicle Type</td>
<td>Index</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1-15</td>
<td></td>
</tr>
<tr>
<td>Mobility Code</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>0-7</td>
<td></td>
<td>First three characteristics</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>0-1</td>
<td></td>
<td>1+ 'X' capability</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>0-1</td>
<td></td>
<td>1+ 'W' capability</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>0-1</td>
<td></td>
<td>1+ 'L' capability</td>
</tr>
<tr>
<td>Non Handicapped Capacity</td>
<td>5</td>
<td>4</td>
<td>-</td>
<td>1-15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Characteristic Capability</td>
<td>9</td>
<td>8</td>
<td>-</td>
<td>0-1</td>
<td></td>
<td>By Bit 1+ capability indexed</td>
</tr>
<tr>
<td>VCADWE Pointer</td>
<td>17</td>
<td>16</td>
<td>-</td>
<td>0-64K</td>
<td></td>
<td>To 0th VCADWE for this vehicle type</td>
</tr>
</tbody>
</table>
Appendix B, within this series of reports, is reserved for input formats.

Since RSDAR uses no input, Appendix B is empty.
APPENDIX C · INTERFACE FORMATS

This appendix defines the use, content, and format of the files which are interfaces to RSDAR. Content is as extracted from a FORTRAN READ/WRITE statement. The format specification is as extracted from a FORMAT statement. To avoid confusion between the number 0 and the letter O representing an octal FORMAT, a lower case o will be used.
1. File zc.rsd

This file is created by CONENV for input to RSDAR. Its content is those global variables required for execution of RSDAR plus several variables used for setting read specifications. The content, format and example reference are as follows:

1 - Outer loop - none
   Content - PA01XX, PA02XX, PA03XX, PA04XX, PA05XX, PA06XX, PA07XX, PA08XX, PA09XX, PA10XX, PA11XX, PA12XX, PA13XX, PA14XX, PA15XX, PA16XX, PA17XX, PA18XX, PA03VX, PA08RX, IBX, IDX.
   IBX is the number of words/base trip
   IDX = PA04XX
   Format - (2006)

2 - Outer loop - none
   Content - (VTYPEL [I], I=1, PA07XX)
   Format - (8012)

3 - Outer loop - (I=1, PA10XX)
   Content - (I, VCADWE [I,J], J=1,2)
   Format - (I5, 2o12)

4 - Outer loop - (I=1, PA08XX)
   Content - (I, TOURLI [I,J], J=1,3)
   Format - (I5, 3o12)

5 - Outer loop - (I=1, PA03XX)
   Content - (I, CANDTP [I,J], J=1,16)
   Format - (I5, 8o12/5X, 8o12)

6 - Outer loop - (I=1, PA03XX-PA03VX)
   Content - (I, BASETP [I,J], J=1, IBX)
   (I, COMPAT [I,J], J=1, IBX)
   Format - (I5, 8o12/5X, 8o12) for each write

7 - Outer loop - (I=1, IDX)
   Content - (I, DIST00 [I], DIST0D [I])
   Format - (I5, 2o12)

8 - Outer loop - (I=1,15)
   Content - (I, PRIORL [I])
   Format - (I5, o12)
2. File zr.gre

This file is created by RSDAR for input to GREPOR. Its content is some global variables created by RSDAR and some from zc.rsd whose values have been modified by RSDAR. The content, format, and example reference are as follows:

1 - Outer loop - none  
   Content - PA09XX, PA08UX  
   Format - (2012)

2 - Outer loop - (I=1, PA03XX)  
   Content - (CANDTP [I,J], J=1,16)  
   Format - (8012)

3 - Outer loop - (I=1, PA09XX)  
   Content - (TSTOPL [I,J], J=1,4)  
   Format - (8012)

4 - Outer loop - (I=1, PA08UX)  
   Content - (TOURLI [I,J], J=1,3)  
   Format (8012)
APPENDIX D  OUTPUT FORMATS

Appendix D, within this set of reports, is reserved for output formats. Since RSDAR produces no output, this appendix is empty.
Appendix E, within this series of reports, is reserved for a sample input set. The sample input is never referenced in the RSDAR exposition; therefore this appendix is empty.
Appendix F, in this series of reports is reserved for listings of interface files produced by execution of CONENV and RSDAR with the sample input of Appendix E. Since the sample input is not referenced in the RSDAR exposition, this appendix is empty.
Appendix G, in this series of reports, is reserved for a sample output set.

There is no output from RSDAR; this appendix is empty.
APPENDIX E SUBROUTINE SPECIFICATIONS

This appendix provides a brief description of all subroutines in the model. For the MAIN program, a more detailed description by functional block is given in Chapter 3. The appendix is arranged in alphabetical order by subroutine name. Each subroutine is described on a single program summary sheet. This summary sheet includes: (a) the name of the subroutine; (b) the mnemonic of the subroutine; (c) the purpose of the subroutine; (d) the called routines; (e) the arguments used; (f) the calling routines; (g) input from file storage; (h) output to file storage. The information provided on these summary sheets in conjunction with the model flowchart shown in Chapter 3 should facilitate the programmer's task of effectively maintaining the model. The interactions among subroutines which are explicitly stated on the summary sheets should also assist the programmer in making any modifications to the source code dictated by user needs or peculiarities of the operating system.
<table>
<thead>
<tr>
<th>Subroutine</th>
<th>CALBCK - CALL Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>Mark those patron who need a call back because the scheduled pickup time is outside the promised time window.</td>
</tr>
<tr>
<td>Called by</td>
<td>MAIN</td>
</tr>
<tr>
<td>Arguments</td>
<td>CANDTP PA03VX PA03XX</td>
</tr>
<tr>
<td>Calls</td>
<td>FIELD</td>
</tr>
<tr>
<td>Subroutine</td>
<td>DUMPGR - DUMP to GREPOR</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Purpose</td>
<td>Write output of RSDAR on a disk file, zr.gre.</td>
</tr>
<tr>
<td>Called by</td>
<td>MAIN</td>
</tr>
<tr>
<td>Arguments</td>
<td>PA03XX PA08UX PA09XX CANDTP TOURLI TSTOPL PARM03 PARM08 PARM09</td>
</tr>
<tr>
<td>Calls</td>
<td>None</td>
</tr>
<tr>
<td>Output</td>
<td>zr.gre interface to GREPOR</td>
</tr>
</tbody>
</table>
Subroutine  DWELLT - DWELL Time
Purpose     Obtain appropriate dwell time from VCADWE array
Called by   TRCOMB
Arguments   VCADWE PARM10

I1: Number of non-wheelchair patrons to pickup
I2: Number of lift patrons to pickup
I3: Number of wheelchair patrons to pickup
I4: Number of non-wheelchair patrons to drop off
I5: Number of lift patrons to drop off
I6: Number of wheelchair patrons to drop off

J1: Starting row in VTYPEL

DWT: Dwell Time

Calls      FIELD
Subroutine     FESIBL - FEaSIBiLity check
Purpose         Check if the subtour is feasible
Called by      TRCOMB
Arguments   CANDTP,DISTOD,DIST00,PARM03,PA03XX,PARM04,PARM05,PARM06
             IK2:  Number of stops in subtour.
             IFLAG1: =1 : subtour is feasible.
                     =0 : subtour is not feasible.
             IFLAG5: =1 : subtour cut short due to end of interval
                     =0 : otherwise.
             IVWHTR:  Whole tour of a vehicle.
             KSE:  Storage area of subtour.
             IBGNP:  Patron at the beginning of time interval.
             IBGNS:  Stop at the beginning of time interval.
             IENDP:  Patron at the end of time interval.
             IENDS:  Stop at the end of time interval.
Calls          None
Subroutine FIELD - store or fetch FIELD

Purpose Pack or unpack bits information into or from a word.

Called by CALBCK DWELLT MNTOUR PREPRD RMTIME SBTGEN SBTOUR TFETCH TRCOMB

Arguments I: I=1 means unpacking
       I=2 means packing

J: Packed argument

K: Unpacked argument

Il: First bit position in packed argument

I2: Number of bits

Calls None
<table>
<thead>
<tr>
<th>Subroutine</th>
<th>MAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>Initialize the run. Call READCV to read input tile; MNTOUR to create tours, and DUMPGR to write output file.</td>
</tr>
<tr>
<td>Called by</td>
<td>None</td>
</tr>
<tr>
<td>Arguments</td>
<td>None</td>
</tr>
<tr>
<td>Calls</td>
<td>READCC MNTOUR CALBCK DUMPCC</td>
</tr>
<tr>
<td>Parameters</td>
<td>PARM01, PARM02, PARM03, PARM04, PARM05, PARM06, PARM07, PARM08, PARM09, PARM10, PARM11</td>
</tr>
</tbody>
</table>
Subroutine MNTOUR - Main Tour

Purpose
1. Calculate productivity upper bounds
2. Read in starting, ending, and break time of a tour, then call SBTOUR to generate subtours for the tour.
3. Repeat step 2 until either all patrons are assigned or all available tours are exhausted.

Called by MAIN

Arguments BASETP, CANDTP, COMPAT, DISTOD, DISTOO, PA03FX, PA03VX, PA03XX, PA08R, PRIORL, TOURLI, TSTOPL, VCADWE, VTYPEL

BVECT1: A row vector from BASETP
IBSBTR: Best subtour in existence
ICSBTR: Current subtour
IVWHTR: Whole tour of a vehicle
ISE: Working area of subtour
KSE: Storage area of subtour
PRIOTR: Priority truth table
PRDIB: Productivities of the best subtour
PRDIC: Productivities of the current subtour
PRDBD: Productivity bounds
PRIOSM: Priority sum
PRDCOD: Productivity code of priority

Calls FIELD PRDCTY SHIFT TFETCH SBTOUR
Subroutine PRDCTY - Productivity calculation

Purpose Calculate value of productivity

Called by PREPRD MNTOUR

Arguments

IPCODE: Productivity code

PATRN: Number of patrons

TRIP: Number of trips

PATRT: Sum of patron ride time

TRPRT: Sum of trip ride time

TIME: Total elapsed time of the subtour

PRDV: Productivity value

Calls None
Subroutine PREPRD - PREpare for PRoDuctivity
Purpose Prepare for calculating value of productivity
Called by SBTOUR
Arguments CANDTP,PRDCOD,PARM03,PARM05

IP: Priority
ICSBTR: Current subtour
PRDIC: Productivity of current subtour
ISCTP: Number of stops in th current subtour

Calls PRDCTY FIELD
Subroutine: READCV - READ ConenV interface

Purpose: Read input data from disk file

Called by: MAIN

Arguments:

- BASETP
- CANDTP
- COMPAT
- DISTOD
- DISTOO
- PRIORL
- TOURLI
- VCADWE
- VTIPEL
- PARM03
- PARM08
- PARM10

PA03PX: Number of all trip entries in CANDTP
PA03VX: Number of all vehicle entries in CANDTP
PA03XX: Number of all entries in CANDTP
PA08RX: Number of real tour entries in TOURLI
PA08XX: Number of all tour entries in TOURLI

Calls: None

Input: zc.rsd interface from CONENV
Subroutine RMTIME - ReMaining TIME

Purpose Calculate the remaining free time of base patron

Called by TRCOMB

Arguments CANDTP,IK2,ISE,KSE,PARM03,PARM05

IA: New patron to be inserted
JK: Number of stops in the subtour
IFLAG2: =1: A better subtour of IK2 stops is found,
      =0 otherwise
IC1: Base patron
IC2: Scratch
RTB: Remaining time of the best subtour
RTS: Remaining time of subtour
SHTB: Shortest travel time of the best subtour
SHTS: Shortest travel time of subtour

Calls FIELD
Subroutine SBTGEN - SubTour GENERator

Purpose Generate subtours

Called by SBTOUR

Arguments IFLAG2 IFLAG5 BVECT1 CANDTP COMPAT DISTOD DISTOO
ICSBTR ISE IVWHTR KSE VCADWE IBGNP IBGNS IC1 PA03XX ICSTP
IENDP IENDS PA03PX PA03VX PA08UX PARM03 PARM04 PARM05 PARM06
PARM10

JA: Base patron

IP1: Priority

JRDWT: VCADWE pointer

MCVC: Vehicle Mobility Code

NWCAP: Non-wheelchair capacity

Calls FIELD TRCOMB
Subroutine: SBTOUR - SubTour for base patron

Purpose: Obtain the best subtour for the given base patron

Called by: MNTOUR

Arguments:
- IFLAG5
- BVECT1
- CANDTP
- COMPAT
- DISTOD
- DISTOO
- IBSBTR
- ICsbtr
- ISE
- IWHTR
- KSE
- PRDCOD
- PRIOTR
- VCADWE
- PRDIB
- PRDIC
- IBGNP
- IBCNS
- PA03XX
- IENDP
- IENDS
- PA03PX
- PA03VX
- JRDWT
- MCVC
- PA08UX
- NWCAP
- PARM03
- PARM04
- PARM05
- PARM06
- PARM10

JA: Scratch
TALSB: Arrival time to subtour
IFLAG3: =1: a new subtour is made,
=0: otherwise
BIPR: Scratch
IPRIOP: Patron priority
IPRIOT: Tour priority
IBSTP: Number of stops in the best subtour.

Calls: FIELD SBTGEN PREPRD
<table>
<thead>
<tr>
<th>Subroutine</th>
<th>SHIFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>Shift a subtour to the earliest feasible time</td>
</tr>
<tr>
<td>Called by</td>
<td>MNTOUR</td>
</tr>
<tr>
<td>Arguments</td>
<td>CANDTP,IVWHTR,IBGNS,PARM03,PARM06</td>
</tr>
<tr>
<td>NSTPTR:</td>
<td>Number of stops in the tour.</td>
</tr>
<tr>
<td>Calls</td>
<td>None</td>
</tr>
</tbody>
</table>
Subroutine TFETCH - Time FETCH

Purpose Obtain travel time between two stops

Called by MNTOUR TRCOMB

Arguments I: Travel time
J: Candidate row
K: Candidate column
IV: DISTOD or DISTOO

Calls FIELD
Subroutine TRCOMB - Tour COMBination

Purpose Generate orders of patron stops to form a subtour

Called by SBTGEN

Arguments IFLAG2 IFLAG5 CANDTP DISTOD DISTOO ISE ICSBTR
IA: New patron to be inserted
JK: Number of stops in the subtour

Calls FIELD TFETCH DWELLT FESIBL RTIME
This appendix contains program listings of all subroutines used in RSDAR.
SUBROUTINE CALBCK (CANDTP, PA03VX, PA03XX, PARM03)
IMPLICIT INTEGER (B-Y)
DIMENSION CANDTP(PARM03, 1)
PSHIFT=24
PGAP=240
IVAX1=PA03VX+1
DO 200 11=IVAX1, PA03XX
CALL FIELD(1, CANDTP(11,1), 12, 15, 1)
IF (12.EQ.0) GO TO 200
PTL=CANDTP(11,12)-PSHIFT
PTE=PTL-PGAP
IF (CANDTP(11,11).GT.PTL) GO TO 100
IF (CANDTP(11,11).LT.PTE) GO TO 100
GO TO 200
100 CALL FIELD(2, CANDTP(11,1), 1, 14, 1)
200 CONTINUE
RETURN
END
SUBROUTINE DUMPGR(PA03XX, PA08UX, PA09XX, CANDTP, TOURL1,
1 (TSTOPL, PARM03, PARM08, PARM09)
IMPLICIT INTEGER (B-Y)
DIMENSION CANDTP(PARM03, 1), TOURL1(PARM08, 1), TSTOPL(PARM09, 1)
NAG=-1
WRITE(21,100) PA09XX, PA08UX
100 FORMAT(8012)
DO 150 I=1,PA03XX
WRITE(21,100) (CANDTP(I,J), J=1,16)
150 CONTINUE
WRITE(21,100) NAG, (CANDTP(I,J), J=2,16)
DO 250 I=1,PA09XX
WRITE(21,100) (TSTOPL(I,J), J=1,4)
250 CONTINUE
WRITE(21,100) NAG, (TSTOPL(I,J), J=2,4)
DO 350 I=1,PA08UX
WRITE(21,100) (TOURL1(I,J), J=1,3)
350 CONTINUE
WRITE(21,100) NAG, (TOURL1(I,J), J=2,3)
RETURN
END
SUBROUTINE DWELL1(I1, I2, I3, I4, I5, I6, Ji, DWT, VCADWE, PARM10)
IMPLICIT INTEGER (B-Y)
DIMENSION VCADWE(PARM10, 1)
C  I1: NUMBER OF NWC TO PICK
C  I2: NUMBER OF LIFT TO PICK
C  I3: NUMBER OF WC TO PICK
C  I4: NUMBER OF NWC TO DROP
C  I5: NUMBER OF LIST TO DROP
C  I6: NUMBER OF WC TO DROP
C  Ji: STARTING ROW (FROM VTYPEL)
C DWT: DWELL TIME
DWT = 0
TP1 = 0
TD1 = 0
IF (I3.EQ.0) GO TO 100
  J2 = J1 + I3
  CALL FIELD1, VCADWE(J2, 1), TP2, 25, 8
  IF (TP2.GT.TP1) TP1 = TP2
100 IF (I2.EQ.0) GO TO 200
  J2 = J1 + I2
  CALL FIELD1, VCADWE(J2, 1), TP2, 17, 8
  IF (TP2.GT.TP1) TP1 = TP2
200 IF (I1.EQ.0) GO TO 300
  J2 = J1 + I1
  CALL FIELD1, VCADWE(J2, 1), TP2, 9, 8
  IF (TP2.GT.TP1) TP1 = TP2
300 DWT = TP1
  IF (TP1.GT.0) RETURN
  IF (I6.EQ.0) GO TO 400
  J2 = J1 + I6
  CALL FIELD1, VCADWE(J2, 2), TD2, 25, 8
  IF (TD2.GT.TD1) TD1 = TD2
400 IF (I5.EQ.0) GO TO 500
  J2 = J1 + I5
  CALL FIELD1, VCADWE(J2, 2), TD2, 17, 8
  IF (TD2.GT.TD1) TD1 = TD2
500 IF (I4.EQ.0) GO TO 600
  J2 = J1 + I4
  CALL FIELD1, VCADWE(J2, 2), TD2, 9, 8
  IF (TD2.GT.TD1) TD1 = TD2
600 DWT = TD1
RETURN
END
SUBROUTINE FESIBL(1K2,IFLAG1,IFLAG5,
CANDTP,DISTOD,DISTOO,IVWHTR,KSE,
1 IBGNP,IBGNS,PA03XX,1ENDP,1ENDS,
3 PARM03,PARM04,PARM05,PARM06 )
IMPLICIT INTEGER (B-Y)
DIMENSION CANDTP(1,1),DISTOD(1,1),DISTOO(1)
DIMENSION IVWHTR(1,1),KSE(1,1)
C CHECK ROUTING IN KSE FOR FEASIBLE SCHEDULE
C IFLAG1=1:ROUTING IS FEASIBLE; =0:NOT FEASIBLE
IFLAG1=0
IFLAG5=0
DIFLA=0
DIFLB=0
DIFUA=0
DIFUB=0
PDWEL=0
DDWEL=0
C SEARCH FOR LARGEST DIFLB AND DIFUB
DO 100 11=1,1K2
J1=KSE(11,1)
J2=KSE(11,2)
X1=KSE(11,8)
IF (J2.NE.1) GO TO 20
X4=CANDTP(J1,10)
X5=CANDTP(J1,12)
IF (11.NE.1K2) GO TO 40
CALL TFETCH(TPD,PA03XX,J1,IBGNP,DISTOD)
PDWEL=KSE(11,7)
X6=IVWHTR(1,IBGNS,8)+IVWHTR(1,IBGNS,7)+TPD+PDWEL
IF (X6.GT.X4) X4=X6
GO TO 40
20 CONTINUE
X4=CANDTP(J1,13)
X5=CANDTP(J1,15)
IF (11.NE.1K2) GO TO 40
CALL TFETCH(TPD,PA03XX,1ENDP,J1,DISTOD)
DDWEL=KSE(11,7)
X6=IVWHTR(1,1ENDS,8)-IVWHTR(1,1ENDS,7)-TPD-DDWEL
IF (X6.LT.X5) X5=X6
40 CONTINUE
IF (X1.GE.X4) GO TO 60
DIFLA=X4-X1
IF (DIFLA.GT.0.AND.DIFUB.LT.0) RETURN
IF (DIFLA.GT.DIFLB) DIFLB=DIFLA
GO TO 100
60 IF (X1.LE.X5) GO TO 100
DIFUA=X5-X1
IF (DIFLB.GT.0.AND.DIFUA.LT.0) RETURN
IF (DIFUA.LT.DIFUB) DIFUB=DIFUA
100 CONTINUE
IF (DIFLB.EQ.0) GO TO 200
SHIFT TO THE RIGHT
DO 150 11=1,1K2
J1=KSE(11,1)
J2=KSE(11,2)
KSE(11,11)=KSE(11,8)+DIFLB
IF (J2.NE.1) GO TO 120
IF (KSE(I1,8).LT.CANDTP(J1,10)) RETURN
IF (KSE(I1,8).GT.CANDTP(J1,12)) RETURN
GO TO 140
120 CONTINUE
IF (KSE(I1,8).LT.CANDTP(J1,13)) RETURN
IF (KSE(I1,8).GT.CANDTP(J1,15)) RETURN
140 CONTINUE
IF (I1.NE.1K2) GO TO 150
IF (J2.EQ.1) GO TO 150
CALL TFETCH(TPD,PA03XX,IEPDP,J1,DISP0D)
X6=IIVWHTR(IENDS,8)-IIVWHTR(IENDS,7)-TPD-DDWEL
IF (KSE(I1,8).GT.X6) GO TO 400
150 CONTINUE
GO TO 300
200 IF (DIIFUB.EQ.0) GO TO 300
C SHIFT TO THE LEFT
DO 250 I1=1,1K2
J1=KSE(I1,1)
J2=KSE(I1,2)
KSE(I1,8)=KSE(I1,8)+DIIFUB
IF (J2.NE.1) GO TO 220
IF (KSE(I1,8).LT.CANDTP(J1,10)) RETURN
IF (KSE(I1,8).GT.CANDTP(J1,12)) RETURN
GO TO 240
220 CONTINUE
IF (KSE(I1,8).LT.CANDTP(J1,13)) RETURN
IF (KSE(I1,8).GT.CANDTP(J1,15)) RETURN
240 CONTINUE
IF (I1.NE.1) GO TO 250
IF (J2.EQ.2) GO TO 250
CALL TFETCH(TPD,PA03XX,J1,IEGNP,DISP0D)
X6=IIVWHTR(IBGNS,8)-IIVWHTR(IBGNS,7)-TPD+PDWEL
IF (KSE(I1,8).LT.X6) RETURN
250 CONTINUE
300 CONTINUE
C NOT TO EXCEED THE MAXIMUM ON BOARD TIME
DO 350 I1=1,1K2
TD=0
IF (KSE(I1,2).EQ.2) GO TO 350
J1=KSE(I1,1)
I2=I1+1
DO 340 I3=I2,1K2
IF (KSE(I3,1).EQ.J1.AND.KSE(I3,2).EQ.2) J3=I3
340 CONTINUE
TD=KSE(I3,8)-KSE(I1,8)
CALL FIELD1,CANDTP(J1,3),TMX08,21,12)
IF (TD.GT.TMX08) RETURN
350 CONTINUE
IFLAG1=1
RETURN
400 CONTINUE
C IFLAG5=1 : SUBTOUR CUT SHORT DUE TO END INTERVAL
C IFLAG5=0 : OTHERWISE
IFLAG5=1
RETURN
SUBROUTINE FIELD(I,J,K,I1,I2)

* DIMENSION NV(32)

* POWERS OF 2 TABLE

DATA NV /1,2,4,8,16,32,64,128,256,512,1024,2048,4096,8192,
* 16384,32768,65536,131072,262144,524288,1048576,2097152,
* 4194304,8388608,16777216,33554432,67108864,134217728,
* 268435456,536870912,1073741824,2147483648/

* I3=34-I1-I2

J1=J/NV(I3)
I4=I2+1
IF (I.EQ.2) GO TO 100

* UNPACKING

K=J1
IF (I4.GE.32) RETURN
J2=J1/NV(I4)
K=J1-J2*NV(I4)
RETURN

* PACKING

100 J2=0
J3=0
IF (J4.GE.32) GO TO 110
J3=NV(I4)
J2=J1/J3
110 J=J-J1*NV(I3)+(J2*J3+K)*NV(I3)
RETURN
END
PROGRAM RSDAR

MAXIMUM CAPACITY: PA03XX <= 249; PA03PX <= 217

CALCULATION OF ARRAY SIZES
(NOTE: ALL NUMBERS SHOULD BE ROUNDED TO NEXT HIGHER INTEGER)
PARM01: (PA03PX/31)+4) * PA03PX: BASETP, COMPAT
PARM02: PA03PX/31)*4: BVECT1
PARM03: PA03XX: CANDTP: MAX NUMBER OF ENTRIES FOR CANDTP
PARM04: (PA03XX**2)/3: DISTOD, DISTOO
PARM05: GUESS: IBSBTR, ICSBTR, ISE, KSE: MAX NUMBER OF STOPS IN A SUBTOUR
PARM06: GUESS: IVWHTR: MAX NUMBER OF STOPS IN A TOUR
PARM07: INFORMATION OR GUESS: VTYPEP
PARM08: INFORMATION OR GUESS: TOURL1: MAX NUMBER OF TOURS
PARM09: 2*PA03XX: TSTOPL
PARM10: INFORMATION OR GUESS: VCADWE
PARM11: PRDBD

IMPLICIT INTEGER (B-Y)
PARAMETER! (PARM01=2387, PARM02=11, PARM03=249, PARM04=20667,
1 PARM05=40, PARM06=80, PARM07=15, PARM08=50, PARM09=498,
2 PARM10=50, PARM11=217)
DIMENSION BASETP(PARM01), BVECT1(PARM02), CANDTP(PARM03, 16)
DIMENSION COMPAT(PARM01), DISTOD(PARM04), DISTOO(PARM04)
DIMENSION IBSBTR(PARM05, 12), ICSBTR(PARM05, 12), ISE(PARM05, 12)
DIMENSION IVWHTR(PARM06, 10), KSE(PARM05, 12), PRDCCD(15)
DIMENSION PRI0RL(15), PRI0TR(15), TOURL1(PARM08, 3)
DIMENSION TSTOPL(PARM09, 2), VCADWE(PARM10, 2), VTYPEP(PARM07)
DIMENSION PRDIBI(15), PRDICI(15), PRDBDI(PARM11, 15)
OPEN(11, FILE='zc.rsd', STATUS='OLD')
OPEN(21, FILE='zz.ge', STATUS='NEW')
CALL READCV(PA03XX, PA03PX, PA08XX, PA08RX, PA03VX, BASETP, CANDTP,
1 COMPAT, DISTOD, DISTOO, PRI0RL, TOURL1, VCADWE, VTYPEP,
2 PARM03, PARM08, PARM10)

CALL MNTOUR(BASETP, BVECT1, CANDTP, COMPAT, DISTOD, DISTOO,
1 IBSBTR, PA03XX, ICSBTR, PA03PX, ISE, PA08RX, PA03VX, IVWHTR,
2 KSE, PRDCCD, PRI0RL, PRI0TR, TOURL1, TSTOPL, VCADWE, VTYPEP,
3 PRDIB, PRDICI, PRDBDI, PA08UX, PA09XX,
4 PARM03, PARM04, PARM05, PARM06, PARM08,
5 PARM09, PARM10, PARM11)
CALL CALBCK(CANDTP, PA03VX, PA03XX, PARM03)
CALL DUMPGR(PA03XX, PA08UX, PA09XX, CANDTP, TOURL1,
1 TSTOPL, PARM03, PARM08, PARM09)
CLOSE(11)
CLOSE(21)
STOP
END
SUBROUTINE MNTOUR(BASETP, BVECT1, CANDTP, COMPAT, DISTOO, DIStO0, IBSBTR, PA03XX, ICSBTR, PA03PX, ISE, PA08RX, PA03VX, IVWHTR, KSE, PRDCCOD, PRIORL, PRIOTR, TOURL1, TSTOPL, VCADWE, VTYPEL, PRDIB, PRD1C, PRD6D, PA08UX, PA09XX, PARM03, PARM04, PARM05, PARM06, PARM08, PARM09, PARM10, PARM11)
IMPLICIT INTEGER(B-Y)
DIMENSION BASETP(1), BVECT1(1), CANDTP(PARM03, 1), COMPAT(1)
DIMENSION DISTOO(1), DIStO0(1), IBSBTR(PARM05, 1), ICSBTR(PARM05, 1)
DIMENSION ISE(PARM05, 1), IVWHTR(PARM06, 1), KSE(PARM05, 1), PRDCCOD(1)
DIMENSION PRIORL(1), PRIOTR(1), TOURL1(PARM08, 1), TSTOPL(PARM09, 1)
DIMENSION VCADWE(PARM10, 1), VTYPEL(1), PRDIB(1), PRD1C(1)
DIMENSION PRD6D(PARM11, 1), PRIOSM(15)
DO 130 J1=1, 15
CALL FIELD(1, PRIORL(1), PRIOSM(1), 1, 12)
CALL FIELD(1, PRIORL(1), PRIOSM(1), 29, 4)
CONTINUE
PA08UX=0
PA09XX=0
IVAX1=PA03VX+1
IVYP=0
** CALCULATE UPPER BOUNDS **
DO 170 J4=1, 15
IF (PRIOSM(J4).EQ.0) GO TO 160
DO 155 J5=IVAX1, PA03XX
I1=J5-PA03VX
I4=PA03PX/31
I5=PA03PX-31*I4
IF (15.NE.0) I4=14+1
I4=14+4
J1=J4/4
J2=J4-4**J1
IF (J2.EQ.0) J2=4
IF (J2.NE.4) J1=J1+1
J2=(J2-1)*8+1
J3=I4*(I1-1)+J1
CALL FIELD(1, BASETP(J3), TRIP, J2, 8)
IF (TRIP.EQ.0) GO TO 150
CALL FIELD(1, COMPAT(J3), PATRN, J2, 8)
CALL FIELD(1, CANDTP(J5, 3), TIME, 9, 12)
PATRT=PATRN*TIME
TRPRT=TRIP*TIME
CALL PRDCTY(PRDCCOD(J4), PATRN, TRIP, PATRT, TRPRT, TIME, PRDV)
PRD6D(11, J4)=PRDV
GO TO 155
150 PRD6D(11, J4)=0
155 CONTINUE
GO TO 170
160 DO 165 J3=1, PA03PX
PRD6D(J3, J4)=0
165 CONTINUE
170 CONTINUE
DO 190 I=1, IVAX1, PA03XX
CANDTP(I, 1)=0
190 CONTINUE
C ARE ALL PATRONS ASSIGNED?
200 CONTINUE
   DO 210 I1=1VAX1,PA03XX
   CALL FIELD(1,CANDTP(11,1),12,6,1)
   IF (12.EQ.0) GO TO 220
210 CONTINUE
RETURN
C **NEW TOUR**
220 CONTINUE
   GPSIZE=99000
   DO 240 I1=1VAX1,PA03XX
   CALL FIELD(1,CANDTP(11,1),12,6,1)
   IF (12.GT.0) GO TO 240
   CALL FIELD(1,CANDTP(11,3),12,9,12)
   IF (GPSIZE.GT.I2) GPSIZE=12
240 CONTINUE
   GPSIZE=GPSIZE+80
   DO 255 I1=1,PARM06
       IVWHTR(I1,9)=0
   255 CONTINUE
   ISUBTR=0
   NSTPTR=1
   IBGNS=1
   IVTYP=1
   PA08UX=PA08UX+1
   ITOUR=PA08UX
   IF (PA08UX.LE.PA08RX) GO TO 260
   ISUBTR=1
260 CONTINUE
C **PRIOTR(I): PRIORITY ACCEPTED BY CURRENT TOUR**
   DO 270 I1=1,15
      I2=I1+17
      CALL FIELD(1,TOURL(I1TOUR,1),PRIOTR(I1),I2,1)
   270 CONTINUE
C IVIDX: VEHICLE INDEX
C IVTYP: VEHICLE TYPE
C MCVC: MOBILITY CHARACTERSISTICS OF VEHICLE
C NWCAP: NON WHEEL CHAIR CAPACITY
   CALL FIELD(1,TOURL(I1TOUR,1),IVIDX,1,8)
   CALL FIELD(1,TOURL(I1TOUR,1),IVTYP,9,4)
   CALL FIELD(1,VTYP1(IVTYP),MCVC,1,4)
   CALL FIELD(1,VTYP1(IVTYP),NWCAP,5,4)
   IF (IVTYP.EQ.IVTYP) GO TO 290
C **STORE DWELL TIME IN KSE**
   CALL FIELD(1,VTYP1(IVTYP),ROWVCA,17,16)
   DO 275 I1=1,NWCAP
      I2=ROWVCA+I1
      DO 275 J1=1,3
         J2=J1*8+1
         CALL FIELD(1,VCADWE(I2,1),KSE(I1,J1),J2,8)
         J3=J1+3
         CALL FIELD(1,VCADWE(I2,2),KSE(I1,J3),J2,8)
   275 CONTINUE
C **CONSTRUCT DWELL TIME**
   DO 285 I1=1VAX1,PA03XX
      CALL FIELD(1,CANDTP(11,1),I2,6,1)
IF (12.EQ.1) GO TO 285
PT=0
DT=0
DO 280 13=1,3
  I4=4*13+1
  CALL FIELD(1,CANDTP(11,16),J1,14,4)
  IF (PT.LT.KSE(J1,13)) PT=KSE(J1,13)
  I5=13+3
  IF (DT.LT.KSE(J1,15)) DT=KSE(J1,15)
280 CONTINUE
  CALL FIELD(2,CANDTP(11,16),PT,17,8)
  CALL FIELD(2,CANDTP(11,16),DT,25,8)
285 CONTINUE
290 CONTINUE
C ENTER TOUR STARTING TIME
DO 300 11=1,PAO3VX
  CALL FIELD(1,CANDTP(11,1),12,1,3)
  IF (12.NE.2) GO TO 300
  CALL FIELD(1,CANDTP(11,1),12,6,1)
  IF (12.NE.0) GO TO 300
  CALL FIELD(1,CANDTP(11,2),12,25,8)
  IF (12.NE.IVIDX) GO TO 300
  SET TOUR STARTING POINT AND TIME
  CALL FIELD(2,CANDTP(11,1),1,6,1)
  IBGNP=11
  JLAST=11
  TLAST=CANDTP(I1,12)
  IVWHTR(1,1)=11
  IVWHTR(1,2)=6
  IVWHTR(1,8)=CANDTP(11,13)
  CALL FIELD(1,CANDTP(11,16),IVWHTR(1,7),17,8)
  IVWHTR(1,3)=0
  IVWHTR(1,4)=0
  IVWHTR(1,5)=0
  GO TO 310
300 CONTINUE
RETURN
310 CONTINUE
C ENTER TOUR BREAK TIME
DO 330 11=1,PAO3VX
  CALL FIELD(1,CANDTP(11,1),12,1,3)
  IF (12.NE.1) GO TO 330
  CALL FIELD(1,CANDTP(11,1),12,6,1)
  IF (12.NE.0) GO TO 330
  CALL FIELD(1,CANDTP(11,2),12,25,8)
  IF (12.NE.IVIDX) GO TO 330
  I4=NSTPTR+1
  I5=NSTPTR+2
  NSTPTR=15
  IVWHTR(14,1)=11
  IVWHTR(14,2)=3
  IVWHTR(15,1)=11
  IVWHTR(15,2)=4
  IVWHTR(14,3)=0
  IVWHTR(14,4)=0
IVWHTR(14,5) = 0
IVWHTR(15,3) = 0
IVWHTR(15,4) = 0
IVWHTR(15,5) = 0
CALL FIELD(2,CANDTP(11,1),1,6,1)
CALL FIELD(1,CANDTP(11,3),IVWHTR(14,6),9,12)
CALL FIELD(1,CANDTP(11,16),IVWHTR(14,7),17,8)
CALL FIELD(1,CANDTP(11,16),IVWHTR(15,7),25,8)
IVWHTR(14,8) = CANDTP(11,12)
IVWHTR(15,8) = CANDTP(11,15)

330 CONTINUE
NSTPTR = NSTPTR + 1
IVWHTR(NSTPTR, 1) = JLAST
IVWHTR(NSTPTR, 2) = 5
IVWHTR(NSTPTR, 3) = 0
IVWHTR(NSTPTR, 4) = 0
IVWHTR(NSTPTR, 5) = 0
IVWHTR(NSTPTR, 6) = 0
IVWHTR(NSTPTR, 7) = 0
IVWHTR(NSTPTR, 8) = TLAST

C ** NEW GAP ** NEW SUBTOUR

350 CONTINUE
IFLAG3 = 0
C SEARCH GAP FOR INSERTION
I1 = IVWHTR(IBGNS, 2)
IF (I1 .EQ. 1) GO TO 395
IF (I1 .EQ. 3) GO TO 360
IF (I1 .EQ. 4) GO TO 370
IF (I1 .EQ. 5) GO TO 700
IBGNP = IVWHTR(IBGNS, 1)
GO TO 380
C SHIFT TO THE LEFT

360 CONTINUE
CALL SHIFT(CANDTP, IVWHTR, IBGNS, NSTPTR, PARM03, PARM06)
IBGNS = IBGNS + 1
IBRK = 0
GO TO 350

370 CONTINUE
IBGNP = IVWHTR(IBGNS, 1)
IF (IBRK .EQ. 1) IBGNP = IBRKP
IBRKP = IBGNP
CALL FIELD(1, CANDTP(IBGNP, 5), DRPX, 17, 16)
IF (DRPX .NE. 0) GO TO 380
CALL FIELD(1, CANDTP(IBGNP, 6), DRPY, 17, 16)
IF (DRPY .NE. 0) GO TO 380
IENDS = IBGNS + 1
I2 = IBGNS - 2
I3 = IVWHTR(12, 1)
IENDP = IVWHTR(IENDS, 1)
CALL TFETCH(TPD, PA03XX, IENDP, 13, DISTCO)
IVWHTR(IBGNS, 6) = TPD
CANDTP(IBGNP, 5) = CANDTP(13, 5)
CANDTP(IBGNP, 6) = CANDTP(13, 6)
CALL FIELD(1, CANDTP(13, 5), ITEMP, 17, 16)
CALL FIELD(2, CANDTP(IBGNP, 5), ITEMP, 1, 16)
CALL FIELD(1, CANDTP(13, 6), ITEMP, 17, 16)
CALL FIELD(2,CANDTP(IBGNP,6),ITEMP,1,16)
IBRK=1
IBRKP=13
GO TO 390

365 CONTINUE
**TRAVEL TIME**
I1=IBGNS
I2=IBGNS+1
I4=IVWHTR(I1,1)
IF (IVWHTR(I1,2).EQ.4) I4=IBRKP
I3=IVWHTR(I2,1)
CALL TFETCH(TPD,PA03XX,13,14,DISTOD)
IVWHTR(I1,6)=TPD
GO TO 395

380 IENDS=IBGNS+1
IENDP=IVWHTR(IENDS,1)
CALL TFETCH(TPD,PA03XX,IENDP,IBGNP,DISTOD)
I1=IBGNS
I2=IBGNS+1

390 OPEN1=IVWHTR(IENDS,8)-IVWHTR(IBGNS,8)-TPD
1 -IVWHTR(IENDS,7)-IVWHTR(IBGNS,7)
IF (OPEN1.GE.GPSIZE) GO TO 400

395 IBGNS=IBGNS+1
IBRK=0
CALL SHIFT(CANDTP,IVWHTR,IBGNS,NSTPTR,PARM03,PARM06)
**IDLE TIME**
IVWHTR(I1,9)=IVWHTR(I2,8)-IVWHTR(I1,8)-IVWHTR(I1,7)
1 -IVWHTR(I2,7)-IVWHTR(I1,6)
GO TO 350

400 CONTINUE
TOUR PRIORITY SETTING
IPRIOT=0

410 IPRIOT=IPRIOT+1
IF (IPRIOT.GT.15) GO TO 365
IF (IPRIOT(IPRIOT).EQ.0) GO TO 410
IF (IPRIOSM(IPRIOT).EQ.0) GO TO 410
DO 420 I1=1,15
PRD1B(I1)=0
420 CONTINUE
BPBR=0
DO 430 J5=IVAX1,PA03XX
CALL FIELD(1,CANDTP(J5,1),J6,6,1)
IF (J6.NE.0) GO TO 430
CANDTP(J5,4)=0
430 CONTINUE
440 CONTINUE
JA=0
IFLAG3=0
IFLAG5=0
PRDMX=0
SEARCH FOR THE PATRON WITH THE HIGHEST UPBOUND
DO 450 I1=IVAX1,PA03XX
CALL FIELD(1,CANDTP(I1,1),I2,6,1)
IF (I2.NE.0) GO TO 450
IF (CANDTP(I1,4).LT.0) GO TO 450
I2=I1-PA03VX
PRDV=PRDBD(JA,PRDMX) PRDMX=PRDV
JA=11
450 CONTINUE
IF (PRDMX.LE.BIPR) GO TO 500
C
NNW08=0
NW08=0
C MCPA: MOBILITY CHARACTERISTICS OF PATRON
CALL FIELD(1,CANDTP(JA,1),MCPA,11,3)
IF (MCPA.GT.MVC) GO TO 460
CALL FIELD(1,CANDTP(JA,2),IPRIOPT,5,4)
C CHECK FOR COMPATIBLE TOUR PRIORITY
IF (PR10T(IPRIOPT).NE.1) GO TO 460
C CHECK TIME WINDOWS
CALL FIELD(1,CANDTP(JA,3),ICSBTR(1,6),9,12)
CALL FIELD(1,CANDTP(JA,16),ICSBTR(1,7),17,8)
IF (1VWHTR(I16GNS,2).EQ.4) IBGNP=IBRP
CALL TFETCH(1PA03XX,JA,IBGNP,DISTOD)
TAL8=I1VWHTR(I16GNS,8)+1PD+ICSBTR(1,7)+1VWHTR(I16GNS,7)
IF (TALS8.GT.CANDTP(JA,12)) GO TO 460
ICSBTR(1,8)=CANDTP(JA,12)
ICSBTR(2,8)=ICSBTR(1,8)+ICSBTR(I16GNS,6)
CALL TFETCH(1PA03XX,JA,16,ICSBTR(1,7),DISTOD)
T1=ICSBTR(2,8)+ICSBTR(2,6)+ICSBTR(1,7)+1VWHTR(I16GNS,7)
IF (T1.LE.1VWHTR(I16GNS,8)) GO TO 455
T2=T1-1VWHTR(I16GNS,8)
ICSBTR(2,8)=ICSBTR(2,8)-T2
ICSBTR(1,8)=ICSBTR(1,8)-T2
IF (ICSBTR(1,8).LT.CANDTP(JA,10)) GO TO 460
IF (ICSBTR(2,8).LT.CANDTP(JA,13)) GO TO 460
455 CONTINUE
C CHECK VEHICLE CAPACITY
CALL FIELD(1,VTYPE,1VTPY),JRDWT,17,16)
CALL FIELD(1,CANDTP(JA,16),NNWP,1,8)
CALL FIELD(1,CANDTP(JA,16),NLFP,9,4)
NA=NNW08+NNWP+NLFP
IF (NA.GT.NWCAP) GO TO 460
CALL FIELD(1,CANDTP(JA,16),NWCP,13,4)
NB=NNW08+NWCP
N1=JRDWT+NA
CALL FIELD(1,VCADW(N1,1),NWCCP,1,8)
IF (NB.LE.NWCCP) GO TO 470
CANDTP(JA,4)=PRDBD(JA-PA03VX,IPRIOPT)
GO TO 440
470 CONTINUE
I4=PA03PX/31
I5=PA03PX-31*I4
IF (I5.NE.0) I4=14+1
I4=I4+4
I6=JA-PA03VX
DO 490 I1=1,14
I2=I4+I6-1
BVECT(I1)=BASETP(I2)
CONTINUE
CALL SBTOUR(JA,TALSB,1PRIOP,IFLAG3,IFLAG5,BIPR,
 1 BVECT,CANDTP,COMPAT,DISTOD,DISTOC,IBSBTR,ICSBTR,ISE,
 2 IVWHTR,KSE,PRDCCD,PRIOTR,VCADWE,PRD1B,PRD1C,
 3 IBGNP,IBGNS,IBSTP,PA03XX,IIENDP,IIENDS,PA03PX,1PRIOT,PA03VX,JRDWT,
 4 MCVC,PA08UX,NWCAP,
 5 PARM03,PARM04,PARM05,PARM06,PARM10)
IFLAG3=1: A BETTER SUBTOUR IS FOUND
IFLAG3=0: OTHERWISE
SEE FES1BL FOR IFLAGS
IF (IFLAG5.EQ.1) GO TO 495
PRDBD(JA-PA03VX,1PRIOT)=B1PR
CONTINUE
IF (IFLAG3.EQ.1) IFLAG4=1
IFLAG4=1 IF IFLAG3=1
GO TO 440
IF (IFLAG4.EQ.0) GO TO 410
IFLAG3=0
IFLAG4=0
CONTINUE
**UPDATE BASETP AND COMPAT (SUM AND RIDE SHARES)
DO 620 11=1,1IBSTP
IF (IBSBTR(11,2).NE.1) GO TO 620
I2=IBSBTR(I1,1)
CALL FIELD(2,CANDTP(I2,1),1,6,1)
CANDTP(I2,4)=1
I2=I2-PA03VX
I3=I2/31
I4=I2-31*I3
IF (I4.EQ.0) I4=31
IF (I4.NE.31) I3=I3+1
I3=I3+4
I4=I4+1
J3=PA03PX/31
J4=PA03PX-31*J3
IF (J4.NE.0) J3=J3+1
J3=J3+4
IPR=IBSBTR(I1,12)
PRIOSM(IPR)=PRIOSM(IPR)-1
J6=IPR/4
J7=IPR-4*J6
IF (J7.EQ.0) J7=4
IF (J7.NE.4) J6=J6+1
J7=(J7-1)*8+1
DO 620 K1=1VAX1,PA03XX
K2=K1-PA03VX
K3=(K2-1)*J3+I3
CALL FIELD(1,BASETP(K3),L1,14,1)
IF (L1.EQ.0) GO TO 620
CALL FIELD(2,BASETP(K3),0,14,1)
K3=(K2-1)*J3+J6
CALL FIELD(1,BASETP(K3),L1,J7,8)
L1=L1-1
CALL FIELD(2,BASETP(K3),L1,J7,8)
CALL FIELD(1,COMPAT(K3),L1,J7,8)
L1=L1-IBSBTR(I1,9)-IBSBTR(I1,10)-IBSBTR(I1,11)
CALL FIELD(I2,COMPAT(K3),L1,J7,8)

620 CONTINUE
NSTPTR=NSTPTR+1BSTP
C SHIFTING POINTERS FOR PREVIOUSLY ASSIGNED STOPS
I1=1BGNS+1BSTP+1
DO 640 I2=NSTPTR,11,-1
I3=12-1BSTP
DO 640 I4=1,8
IVWHTR(I2,14)=IVWHTR(I3,14)
640 CONTINUE
C FILLING IN POINTERS FOR NEW STOPS
I1=1BGNS+1
I2=1BGNS+1BSTP
DO 660 I3=11,I2
I4=I3-1BGNS
DO 660 I5=1,8
IVWHTR(I3,15)=1BSBTR(I4,15)
660 CONTINUE
C ***IDLE TIME***
I1=1BGNS
I2=1BGNS+1
I4=IVWHTR(I1,1)
I3=IVWHTR(I2,1)
IF (IVWHTR(I2,2).EQ.5) GO TO 670
IF (IVWHTR(I1,2).EQ.4) I4=1BRKP
CALL TFETCH(TPD,PA03XX,13,14,DISTCD)
IVWHTR(I1,6)=TPD
IVWHTR(I1,9)=IVWHTR(I2,8)-IVWHTR(I1,8)-IVWHTR(I1,7)
1 +IVWHTR(I2,7)-IVWHTR(I1,6)
670 CONTINUE
IF (1SUBTR.EQ.0) GO TO 350
I1=NSTPTR-1
I2=NSTPTR
GO TO 710
700 CONTINUE
C ***SHIFT ENDING TIME TO THE LEFT***
I1=1BGNS-1
I2=1BGNS
710 CONTINUE
I3=IVWHTR(I2,1)
IVWHTR(I2,10)=CANDTP(I3,12)-IVWHTR(I2,8)
I4=IVWHTR(I1,1)
IF (IVWHTR(I1,2).EQ.4) I4=1BRKP
CALL TFETCH(TPD,PA03XX,13,14,DISTCD)
IVWHTR(I1,6)=TPD
IVWHTR(I1,8)=IVWHTR(I1,8)+IVWHTR(I1,6)+IVWHTR(I1,7)
1 +IVWHTR(I2,7)
IF (CANDTP(I13,10).GT.1VWHTR(12,8)) IVWHTR(12,8)=CANDTP(I3,10)
C ***IDLE TIME***
IVWHTR(I1,9)=IVWHTR(I2,8)-IVWHTR(I1,8)-IVWHTR(I1,7)
1 -IVWHTR(I1,6)-IVWHTR(I1,7)
C ***SHIFT STARTING TIME TO THE RIGHT***
I1=IVWHTR(1,1)
IVWHTR(1,10)=CANDTP(I11,15)-IVWHTR(1,8)
T1=IVWHTR(2,8)-IVWHTR(1,6)-IVWHTR(2,7)
IF (T1.LE.CANDTP(I11,12)) 1VWHTR(1,8)=T1
IF (T1.GT.CANDTP(11,15)) IVWHTR(1,8)=CANDTP(11,15)
IVWHTR(1,9)=IVWHTR(2,8)-IVWHTR(1,8)
1 -IVWHTR(1,6)-IVWHTR(2,7)
DO 740 I1=1,NSTPTR
I2=IVWHTR(I1,1)
TRIP STATUS
CALL FIELDI(2,CANDTP(12,1),1,6,1)
TOUR
CALL FIELDI(2,CANDTP(12,3),PA08UX,1,8)
I3=IVWHTR(I1,2)
IF (I3.EQ.2) GO TO 730
IF (I3.EQ.4) GO TO 730
IF (I3.EQ.6) GO TO 730
CALL FIELDI(2,CANDTP(12,1),I1,17,8)
CALL FIELDI(2,CANDTP(12,4),IVWHTR(I1,8),1,16)
CANDTP(12,11)=IVWHTR(I1,8)
IVWHTR(I1,10)=CANDTP(12,12)-CANDTP(12,11)
GO TO 740
730 CANDTP(12,14)=IVWHTR(I1,8)
IVWHTR(I1,10)=CANDTP(12,15)-CANDTP(12,14)
CALL FIELDI(2,CANDTP(12,1),I1,25,8)
CALL FIELDI(2,CANDTP(12,4),IVWHTR(I1,8),17,16)
740 CONTINUE
DO 750 I1=1,NSTPTR
I2=PA09XX+I1
CALL FIELDI(2,TSTOPL(12,1),IVWHTR(I1,2),1,4)
CALL FIELDI(2,TSTOPL(12,1),IVWHTR(I1,7),5,8)
CALL FIELDI(2,TSTOPL(12,1),IVWHTR(I1,1),13,16)
CALL FIELDI(2,TSTOPL(12,2),IVWHTR(I1,3),1,8)
CALL FIELDI(2,TSTOPL(12,2),IVWHTR(I1,4),9,8)
CALL FIELDI(2,TSTOPL(12,2),IVWHTR(I1,5),17,8)
I3=IVWHTR(I1,6)/8
CALL FIELDI(2,TSTOPL(12,3),I3,1,8)
I3=IVWHTR(I1,9)/8
CALL FIELDI(2,TSTOPL(12,3),I3,9,12)
I3=IVWHTR(I1,10)/8
CALL FIELDI(2,TSTOPL(12,3),I3,21,12)
750 CONTINUE
CALL FIELDI(2,TOURLI(PA08UX,2),NSTPTR,5,12)
I1=PA09XX+1
CALL FIELDI(2,TOURLI(PA08UX,2),I1,17,16)
WRITE(6,770)PA08UX,NSTPTR
770 FORMAT( 'TOUR #', I3, ' IS COMPLETED: ', 'STOPS')
PA09XX=PA09XX+NSTPTR
GO TO 200
END
SUBROUTINE PRDCTY(IPCODE, PATRN, TRIP, PATRT, TRPRT, TIME, PRDV)
IMPLICIT INTEGER (B-Y)
IF (IPCODE.EQ.1) GO TO 100
IF (IPCODE.EQ.2) GO TO 200
IF (IPCODE.EQ.3) GO TO 300
IF (IPCODE.EQ.4) GO TO 400
IF (IPCODE.EQ.5) GO TO 500
IF (IPCODE.EQ.6) GO TO 600
100 PRDV=PATRN
RETURN
200 PRDV=TRIP
RETURN
300 PRDV=(PATRN*3840)/TIME
RETURN
400 PRDV=(TRIP*3840)/TIME
RETURN
500 PRDV=(PATRT*480)/TIME
RETURN
600 PRDV=(TRPRT*480)/TIME
RETURN
END
SUBROUTINE PREPRD (IP, CANDTPI, ICSBTR, PRDCOD, PRDIC, ICSTP, PARM03, 1 PARM05)
IMPLICIT INTEGER (B-Y)
DIMENSION CANDTPI (PARM03, 1), ICSBTR (PARM05, 1), PRDCOD (1), PRDIC (1)
PRDCOD (IP):
1: NUMBER OF PATRONS WITH PRIORITY IP
2: NUMBER OF TRIPS WITH PRIORITY IP
3: PATRONS PER UNIT TIME
4: TRIPS PER UNIT TIME
5: (PATRN*ERT)/TIME
6: (TRIP*ERT)/TIME
PATRN=0
TRIP=0
PATRT=0
TRPRT=0
11=PRDCOD (IP)
IF (11.EQ.1) GO TO 100
IF (11.EQ.2) GO TO 200
IF (11.EQ.3) GO TO 300
IF (11.EQ.4) GO TO 400
IF (11.EQ.5) GO TO 500
IF (11.EQ.6) GO TO 600
100 CONTINUE
DO 150 12=1, ICSTP
IF (ICSBTR (12, 12).NE.1) GO TO 150
IF (ICSBTR (12, 2).NE.1) GO TO 150
PATRN=PATRN+ICSBTR (12, 9)+ICSBTR (12, 10)+ICSBTR (12, 11)
150 CONTINUE
CALL PRDCTY (11, PATRN, TRIP, PATRT, TRPRT, TIME, PRDIC (IP))
RETURN
200 CONTINUE
DO 250 12=1, ICSTP
IF (ICSBTR (12, 12).NE.1) GO TO 250
IF (ICSBTR (12, 2).NE.1) GO TO 250
TRIP=TRIP+1
250 CONTINUE
CALL PRDCTY (11, PATRN, TRIP, PATRT, TRPRT, TIME, PRDIC (IP))
RETURN
300 CONTINUE
DO 350 12=1, ICSTP
IF (ICSBTR (12, 12).NE.1) GO TO 350
IF (ICSBTR (12, 2).NE.1) GO TO 350
PATRN=PATRN+ICSBTR (12, 9)+ICSBTR (12, 10)+ICSBTR (12, 11)
350 CONTINUE
TIME=ICSBTR (ICSTP, 8)-ICSBTR (1, 8)
CALL PRDCTY (11, PATRN, TRIP, PATRT, TRPRT, TIME, PRDIC (IP))
RETURN
400 CONTINUE
DO 450 12=1, ICSTP
IF (ICSBTR (12, 12).NE.1) GO TO 450
IF (ICSBTR (12, 2).NE.1) GO TO 450
TRIP=TRIP+1
450 CONTINUE
TIME=ICSBTR (ICSTP, 8)-ICSBTR (1, 8)
CALL PRDCTY (11, PATRN, TRIP, PATRT, TRPRT, TIME, PRDIC (IP))
RETURN
500 CONTINUE
DO 550 12 = 1, ICSTP
IF (ICSBTR(12, 12), NE. 1) GO TO 550
IF (ICSBTR(12, 2), NE. 1) GO TO 550
I3 = ICSBTR(12, 9) + ICSBTR(12, 10) + ICSBTR(12, 11)
J1 = ICSBTR(12, 1)
CALL FIELD(1, CANDTP(J1, 3), 14, 9, 12)
PATRT = PATRT + I3*14
550 CONTINUE
TIME = ICSBTR(ICSTP, 8) - ICSBTR(1, 8)
CALL PRDCTY(11, PATRN, TRIP, PATRT, TRPRT, TIME, PRDIC(1P))
RETURN
600 DO 650 I2 = 1, ICSTP
IF (ICSBTR(I2, 12), NE. 1) GO TO 650
IF (ICSBTR(I2, 2), NE. 1) GO TO 650
J1 = ICSBTR(I2, 1)
CALL FIELD(1, CANDTP(J1, 3), 13, 9, 12)
TRPRT = TRPRT + 13
650 CONTINUE
TIME = ICSBTR(ICSTP, 8) - ICSBTR(1, 8)
CALL PRDCTY(11, PATRN, TRIP, PATRT, TRPRT, TIME, PRDIC(1P))
RETURN
END
SUBROUTINE READCV(PA03XX, PA03PX, PA08XX, PA08RX, PA03VX, BASETP,
  1 CANDTP, COMPAT, DISTOD, DISTOO, PRIORL, TOURL1,
  2 VCADWE, VTYPEL, PARM03, PARM08, PARM10)
IMPLICIT INTEGER (B-Y)
DIMENSION BASETP(1), CANDTP(PARM03, 1)
DIMENSION COMPAT(1), DISTOD(1), DISTOO(1)
DIMENSION PRIORL(1), TOURL1(PARM08, 1)
DIMENSION VCADWE(PARM10, 1), VTYPEL(1)
READ(11, 1001) 1, I, PA03XX, I, I, I, PA07XX, PA08XX, I, PA10XX,
  1 I, I, I, I, I, I, I, PA03VX, PA08RX, IBX, IDX
1001 FORMAT(2006)
  PA03PX = PA03XX - PA03VX
READ(11, 1071) (VTYPEL(I), I=1, PA07XX)
1071 FORMAT(8012)
DO 1080 I=1, PA010XX
READ(11, 1081) M1, (VCADWE(I, J), J=1, 2)
1080 CONTINUE
1081 FORMAT(15,8012/5X,8012)
DO 1110 I=1, PA008XX
READ(11, 1081) M1, (TOURL1(I, J), J=1, 3)
1110 CONTINUE
DO 1140 I=1, PA03XX
READ(11, 1081) M1, (CANDTP(I, J), J=1, 15)
1140 CONTINUE
I1=1
I2=1IBX
DO 1170 I=1, PA03PX
READ(11, 1081) M1, (BASETP(I, J), J=11, I2)
READ(11, 1081) M1, (COMPAT(I, J), J=11, I2)
I1=11+IBX
I2=12+IBX
1170 CONTINUE
DO 1200 I=1, IDX
READ(11, 1081) M1, DISTOO(I), DISTOD(I)
1200 CONTINUE
DO 1220 I=1, 15
READ(11, 1081) M1, PRIORL(I)
1220 CONTINUE
RETURN
END
SUBROUTINE RMTIME(I1A,IK2,JK,IFLAG2,
1 CANDTP,ISE,KSE,IC1,IC2,RTB,RTS,SHTB,SHTS,
2 PARM03,PARM05)
IMPLICIT INTEGER (B-Y)
DIMENSION CANDTP(PARM03,1),ISE(PARM05,1),KSE(PARM05,1)

C C IFLAG2=1: A BETTER SUBTOUR OF IK2 STOPS IS FOUND
C IFLAG2=0: OTHERWISE
DO 100 11=1,IK2
IF (KSE(11,1).EQ.IC1.AND.KSE(11,2).EQ.IC2) 12=11
IF (KSE(11,1).EQ.IC1.AND.KSE(11,2).EQ.IC2) 13=11
100 CONTINUE
CALL FIELD(1,CANDTP(IC1,3),TMXOB,21,12)
RTS=TMXOB-(KSE(I3,8)-KSE(I2,8))
SHTS=KSE(IK2,8)-KSE(1,8)
IF (RTB-RTS) 300,200,500
200 IF (SHTB.LE.SHTS) GO TO 500
300 RTB=RTS
SHTB=SHTS
IFLAG2=1
JK=IK2
IC2=IC2
DO 400 11=1,IK2
DO 400 12=1,12
ISE(11,12)=KSE(11,12)
400 CONTINUE
500 CONTINUE
RETURN
END
SUBROUTINE SBTENI(JA,IP1,IFLAG2,IFLAG5,
  1 BVECT1,CANDTP,COMPAT,DISTOD,DISTOO,ICSBTR,ISE,IVWHTR,
  2 KSE,VCADWE,
  3 IBGNP,IBGNS,IC1,PA03XX,ICSTP,ICENP,ICENDS,PA03PX,PA03VX,
  4 JRDWT,MCVC,PA08UX,NWCAP,
  5 PARM03,PARM04,PARM05,PARM06,PARM10)

IMPLICIT INTEGER(I-B-Y)

DIMENSION BVECT(1),CANDTP(PARM03,1),COMPAT(1)
DIMENSION DISTOD(1),DISTOO(1),ICSBTR(PARM05,1)
DIMENSION ISE(PARM05,1),IVWHTR(PARM06,1),KSE(PARM05,1)
DIMENSION VCADWE(PARM10,1)
DIMENSION BVECT2(20)

JK=0
IVAX1=PA03VX+1

200 IFLAG2=0
IC2=0
RTS=0
RTB=0
SHTS=99999
SHTB=99999

SEARCH A PATRON FOR RIDE SHARING
DO 290 JB=IVAX1,PA03XX
  IF (JB.EQ.JA) GO TO 290
  CALL FIELD(1,CANDTP(JB,1),I1,6,1)
  IF (I1.NE.0) GO TO 290
  CALL FIELD(1,CANDTP(JB,1),MCRA,11,3)
  IF (MCRA.GT.MCVC) GO TO 290
  CALL FIELD(1,CANDTP(JB,2),IP10P,5,4)
  IF (IP10P.NE.IP1) GO TO 290
C CAN THE PATRON SHARE RIDE WITH THE BASE TRIP?
  I1=JB-PA03VX
  J1=I1/31
  J2=I1-31*J1
  IF (J2.EQ.0) J2=31
  IF (J2.NE.31) J1=J1+1
  J1=J1+4
  J2=J2+1
  CALL FIELD(1,BVECT1(J1),I2,J2,1)
  IF (I2.EQ.0) GO TO 290
C **TRANSFER COMPATIBILITY MATRIX**
  I4=PA03PX/31
  I5=PA03PX-31*I4
  IF (I5.NE.0) I4=I4+1
  I5=I4+4
  I3=JB-PA03VX
  DO 240 I1=1,14
    I2=I5*(I3-1)+I1+4
  CALL FIELD(I1,COMPAT(I2))
  DO 240 CONTINUE
C **TEST FOR RIDE COMPATIBILITY**
  DO 280 I1=1,ICSTP
    IF (ICSBTR(I1,1).EQ.JA) GO TO 280
    IF (ICSBTR(I1,1).EQ.JB) GO TO 280
    IF (ICSBTR(I1,2).NE.1) GO TO 280
    I2=ICSBTR(I1,1)-PA03VX
    J1=I2/31
J2 = J2 - 31 * J1
IF (J2 .EQ. 0) J2 = 31
IF (J2 .NE. 31) J1 = J1 + 1
J2 = J2 + 1
CALL FIELD(1, BVECT2(J1), 13, J2, 1)
IF (13 .EQ. 0) GO TO 290

280 CONTINUE
CALL TRCOMB(JB, JK, IFLAG2, IFLAG5, 1 CANDTP, DISTOD, DISTOO, ISE, ICSBTR, IVWHTR, KSE, VCADWE, 2 IBGNP, IBGNS, IC1, IC2, PA03XX, ICSTP, IENDP, IENDS, JRDWT, 3 NWCAP, RTB, RTS, SHTB, SHTS, 4 PARM03, PARM04, PARM05, PARM06, PARM10)

290 CONTINUE
IF (IFLAG2 .EQ. 0) RETURN
ICSTP = JK
DO 400 I1 = 1, JK
DO 400 I2 = 1, 12
ICSBTR(I1, I2) = ISE(I1, I2)
400 CONTINUE
C REMOVE 1 FROM BVECT1
I1 = IC2 - PA03VX
J1 = I1 / 31
J2 = I1 - 31 * J1
IF (J2 .EQ. 0) J2 = 31
IF (J2 .NE. 31) J1 = J1 + 1
J1 = J1 + 4
J2 = J2 + 1
CALL FIELD(2, BVECT1(J1), 0, J2, 1)
C REMOVE 1 FROM PRIORITY SUM FROM BVECT1
J1 = IP1 / 4
J2 = IP1 - 4 * J1
IF (J2 .EQ. 0) J2 = 4
IF (J2 .NE. 4) J1 = J1 + 1
IF (J2 .EQ. 4) BVECT1(J1) = BVECT1(J1) - 1
IF (J2 .EQ. 3) BVECT1(J1) = BVECT1(J1) - 256
IF (J2 .EQ. 2) BVECT1(J1) = BVECT1(J1) - 65536
IF (J2 .EQ. 1) BVECT1(J1) = BVECT1(J1) - 16777216
GO TO 200
END
SUBROUTINE SBTOUR(JA, TALSB, IPRIOP, IFLAG3, IFLAG5, BIPR,
  1 BVECT1, CANDTP, COMPAT, DISTOD, DISTOO, IBSBTR, ICSBTR, ISE,
  2 IVWHTR, KSE, PRDCOD, PRIOTR, VCADWE, PRDIB, PRDIC,
  3 IBGNP, IBGNS, IBSTP, PA03XX, IENDP, IENDS, PA03PX, IPRIOT, PA03VX, JRDWT,
  4 MCVC, PA08UX, NWCAP,
  5 PARM03, PARM04, PARM05, PARM06, PARM10)
  IMPLICIT INTEGER (B-Y)
  DIMENSION BVECT1(11), CANDTP(PARM03, 1), COMPAT(1), DISTOD(1)
  DIMENSION DISTOO(1), IBSBTR(PARM05, 1), ICSBTR(PARM05, 1)
  DIMENSION ISE(PARM05, 1), IVWHTR(PARM06, 1), KSE(PARM05, 1)
  DIMENSION PRDCOD(1), PRIOTR(1), VCADWE(PARM10, 1)
  DIMENSION PARM03, PARM04, PARM05, PARM06, PARM10)
  ICSTP=2
  IC1=JA
  IP1=IPRIOT
  DO 80 11=1,15
  PRDICI(11)=0
  80 CONTINUE
  ICSBTR(1,1)=JA
  ICSBTR(1,2)=1
  CALL FIELD(I1,CANDTP(JA, 16), ICSBTR(1,9), 1, 8)
  CALL FIELD(I1,CANDTP(JA, 16), ICSBTR(1,10), 9, 4)
  CALL FIELD(I1,CANDTP(JA, 16), ICSBTR(1,11), 13, 4)
  ICSBTR(1,3)=ICSBTR(1,9)
  ICSBTR(1,4)=ICSBTR(1,10)
  ICSBTR(1,5)=ICSBTR(1,11)
  ICSBTR(1,12)=IPRIOT
  ICSBTR(2,1)=JA
  ICSBTR(2,2)=2
  CALL FIELD(I1,CANDTP(JA, 16), ICSBTR(2,7), 25, 8)
  ICSBTR(2,3)=0
  ICSBTR(2,4)=0
  ICSBTR(2,5)=0
  ICSBTR(2,9)=ICSBTR(1,9)
  ICSBTR(2,10)=ICSBTR(1,10)
  ICSBTR(2,11)=ICSBTR(1,11)
  ICSBTR(2,12)=ICSBTR(1,12)
  X1=CANDTP(JA, 13)-ICSBTR(1,6)
  IF (TALSB.GT.X1) X1=TALSB
  CALL FIELD(I1,CANDTP(JA, 13), EMXRT, 21, 12)
  X2=CANDTP(JA, 15)-EMXRT
  IF (TALSB.GT.X2) EMXRT=CANDTP(JA, 15)-TALSB
  100 CONTINUE
  CALL SUBTOUR GENERATOR
  CALL SBTGEN(JA, IP1, IFLAG2, IFLAG5,
  1 BVECT1, CANDTP, COMPAT, DISTOD, DISTOO, IBSBTR, ISE, IVWHTR,
  2 KSE, VCADWE,
  3 IBGNP, IBGNS, IC1, PA03XX, ICSTP, IENDP, IENDS, PA03PX, PA03VX,
  4 JRDWT, MCVC, PA08UX, NWCAP,
  5 PARM03, PARM04, PARM05, PARM06, PARM10)
  CALL PREPRDI(IP1, CANDTP, ICSBTR, PRDCOD, PRDIC, ICSTP, PARM03,
  1 PARM05)
  IF (PRDICI(11)-PRDIBI(IP1)) 600, 140, 200
  140 IF (IP1.NE.IPRIOT) GO TO 160
  150 IF (PRDIBI(IP1).EQ.0) RETURN
160 1P1=1P1+1
IF (1P1.GT.15) GO TO 600
IF (PRIOTR(1P1).NE.1) GO TO 160
GO TO 100
200 CONTINUE
DO 220 11=IPRIOT,1P1
PRDIB(I1)=PRDIC(I1)
220 CONTINUE
B1PR=PRDIC(IPRIOT)
IP1=IP1+1
IF (IP1.GT.15) GO TO 320
DO 300 1P2=1P1,15
IF (PRIOTR(1P2).NE.1) GO TO 300
J1=1P2/4
J2=1P2-4*J1
IF (J2.EQ.0) J2=4
IF (J2.NE.4) J1=J1+1
J2=(J2-1)*8+1
CALL FIELD(1,BVECT1(J1),11,J2,8)
IF (11.EQ.0) GO TO 300
CALL SBTGENI(JA,1P2,1FLAG2,1FLAG5,
1 BVECT1,CANDTP,COMPAT,DISTOD,DISTOO,ICSBTR,ISE,IVWHTR,
2 KSE,VCADWE,
3 IBGNP,IBGNS,IC1,PA03XX,ICSTP,1ENDP,1ENDS,PA03PX,PA03VX,
4 JRDWT,MCVC,PA08UX,NWCA,
5 PARM03,PARM04,PARM05,PARM06,PARM10)
CALL PREPRD(1P2,CANDTP,ICSBTR,PRDCOD,PRDIC,ICSTP,PARM03,
1 PARM05)
PRDIB(1P2)=PRDIC(1P2)
300 CONTINUE
C A SUBTOUR IS MADE
320 IBSTP=ICSTP
IFLAG3=1
DO 400 11=1,ICSTP
DO 400 12=1,12
IBSBTR(11,12)=1CSBTR(11,12)
400 CONTINUE
1ENDP=IVWHTR(1ENDS,1)
11=1CSBTR(1CSTP,1)
CALL TFETCH(TPD,PA03XX,1ENDP,11,DISTOD)
1CSBTR(1CSTP,6)=TPD
600 RETURN
END
SUBROUTINE SHIFT(CANDTP,IVWHTR,IBGNS,NSTPTR,PARM03,PARM06)
IMPLICIT INTEGER (B-Y)
DIMENSION CANDTP(PARM03,1),IVWHTR(PARM06,1)

SHIFT TO THE LEFT
IS THE SHIFTING POSSIBLE?
I1=IBGNS-1
I2=IBGNS
L1=1IVWHTR(11,8)+1IVWHTR(11,6)+1IVWHTR(11,7)+1IVWHTR(12,7)
DELT=1IVWHTR(12,8)-L1

DETERMINE SUBTOUR'S LENGTH
DO 350 I3=I2,NSTPTR
IF (1IVWHTR(I3,2).EQ.1) GO TO 350
IF (1IVWHTR(I3,2).EQ.3) GO TO 360
IF (1IVWHTR(I3,2).EQ.4) GO TO 400
IF (1IVWHTR(I3,2).EQ.5) GO TO 400
IF (1IVWHTR(I3,3).NE.0) GO TO 350
IF (1IVWHTR(I3,4).NE.0) GO TO 350
IF (1IVWHTR(I3,5).NE.0) GO TO 350
GO TO 400
350 CONTINUE
RETURN

360 I3=I3+1

400 CONTINUE
I4=I3-12
IF (DELT.LE.0) GO TO 600

SHIFT TO THE LEFT
DO 450 J1=12,13
J2=1IVWHTR(J1,1)
J3=1IVWHTR(J1,2)
IF (J3.EQ.2) GO TO 420
IF (J3.EQ.4) GO TO 420
IF (J3.EQ.6) GO TO 420
DELT=1IVWHTR(J1,8)-CANDTP(J2,10)
GO TO 430
420 DELT=1IVWHTR(J1,8)-CANDTP(J2,13)

430 CONTINUE
IF (DELT.GE.DELT) GO TO 450
DELT=DELT

450 CONTINUE
DO 500 J1=12,13
1IVWHTR(J1,8)=1IVWHTR(J1,8)-DELT
500 CONTINUE

600 IBGNS=IBGNS+14
RETURN
END
SUBROUTINE TFETCH (1,J,K,L,IV)
DIMENSION IV(1)
L1=(K-1)*J+L
L2=L1/3
L3=L1-3*L2
IF (L3.NE.0) L2=L2+1
IF (L3.EQ.0) L3=3
L3=10*L3-7
CALL FIELD (1,IV(L2),1,L3,10)
RETURN
END
SUBROUTINE TRCOMB(A, JK, IFLAG2, IFLAG5,
1 CANDTP, DISTO0, DISTO0, ISE, ICSTP, IVWHTR, KSE, VCADWE,
2 IBGNP, IBGNS, IC1, IC2, PA03XX, ICSTP, IENDP, IENDS, JRDWT,
3 NWCP, RTB, RTS, SHTB, SHTS,
4 PARM03, PARM04, PARM05, PARM06, PARM10)
IMPLICIT INTEGER (B-Y)
DIMENSION CANDTP(PARM03,1), DISTO0(1), DISTO0(1)
DIMENSION ISE(PARM05,1), ICSTP(PARM05,1), IVWHTR(PARM06,1)
DIMENSION KSE(PARM05,1), VCADWE(PARM10,1)

IK=ICSTP
IK1=IK+1
IK2=IK+2
DO 100 I1=1, IK
I2=ICSTP(I1,1)
I3=ICSTP(I1,2)
IF (I2.EQ.IC1.AND.I3.EQ.2) 1J=I1
100 CONTINUE
I1=2
I3=3
IM=IK2
PICK LIMIT
DO 500 J7=I1, IJ
DROP LIMIT
DO 400 J8=IL, IM
IF (J7.GE.J8) GO TO 400
KSE(IK1,1)=IA
KSE(IK1,2)=1
KSE(IK2,1)=IA
KSE(IK2,2)=2
CALL FIELD(1,CANDTP(IA,2),KPRI0,5,4)
CALL FIELD(1,CANDTP(IA,16),NNWP,1,8)
CALL FIELD(1,CANDTP(IA,16),NLFP,9,4)
CALL FIELD(1,CANDTP(IA,16),NWCP,13,4)
KSE(IK2,9)=NNWP
KSE(IK2,10)=NLFP
KSE(IK2,11)=NWCP
KSE(IK2,12)=KPRI0
KSE(IK1,12)=KPRI0
J3=1
DO 130 J4=1, IK
IF (J7.NE.J4) GO TO 110
IF (J7.EQ.IK1.AND.J8.EQ.IK2) GO TO 120
KSE(IJ3,1)=1A
KSE(IJ3,2)=1
KSE(IJ3,9)=NNWP
KSE(IJ3,10)=NLFP
KSE(IJ3,11)=NWCP
KSE(IJ3,12)=KPRI0
J3=J3+1
110 IF (J8.NE.J4+1) GO TO 120
KSE(IJ3,1)=1A
KSE(IJ3,2)=2
KSE(IJ3,9)=NNWP
KSE(IJ3,10)=NLFP
KSE(IJ3,11)=NWCP
KSE(IJ3,12)=KPRI0
J3=J3+1
130
J3=J3+1

120 KSE(J3,1)=ICSBTR(J4,1)
KSE(J3,2)=ICSBTR(J4,2)
KSE(J3,9)=ICSBTR(J4,9)
KSE(J3,10)=ICSBTR(J4,10)
KSE(J3,11)=ICSBTR(J4,11)
KSE(J3,12)=ICSBTR(J4,12)
J3=J3+1

130 CONTINUE

C
CALCULATE NUMBER OF PATRON ON BOARD
J2=0
DO 180 J1=1,1K2
IF (J1.NE.1) GO TO 150
KSE(J1,3)=KSE(J1,9)
KSE(J1,4)=KSE(J1,10)
KSE(J1,5)=KSE(J1,11)
GO TO 180
150 CONTINUE
J2=J2+1
J3=KSE(J1,2)
IF (J3.EQ.2) GO TO 170
KSE(J1,3)=KSE(J2,3)+KSE(J1,9)
KSE(J1,4)=KSE(J2,4)+KSE(J1,10)
K1=KSE(J1,3)+KSE(J1,4)
IF (K1.GT.NWCAP) GO TO 400
KSE(J1,5)=KSE(J2,5)+KSE(J1,11)
N1=JRDWT+K1
CALL FIELD(1,VCADWE(N1,1),NWCCP,1,8)
IF (KSE(J1,5).GT.NWCCP) GO TO 400
GO TO 180
170 KSE(J1,3)=KSE(J2,3)-KSE(J1,9)
KSE(J1,4)=KSE(J2,4)-KSE(J1,10)
KSE(J1,5)=KSE(J2,5)-KSE(J1,11)
180 CONTINUE

C
CALCULATE NEXT LEG TRAVEL TIME
J2=1
DO 270 J1=1,1K2
J2=J2+1
K1=KSE(J1,1)
K2=KSE(J1,2)
IF (J1.EQ.1K2) GO TO 200
K3=KSE(J2,1)
K4=KSE(J2,2)
GO TO 210
200 CONTINUE
K3=IENDP
K4=1
210 CONTINUE
IF (K2.EQ.K4) GO TO 230
IF (K2.EQ.2) GO TO 220
CALL TFETCH(KSE(J1,6),PA03XX,K1,K3,DISTOD)
GO TO 270
220 CALL TFETCH(KSE(J1,6),PA03XX,K3,K1,DISTOD)
GO TO 270
230 IF (K2.EQ.2) GO TO 240
IF (K1.GT.K3) GO TO 260
GO TO 250
240 IF (K1.LT.K3) GO TO 260
250 CALL TFETCH(KSE(J1,6),PA03XX,K1,K3,DISTOO)
GO TO 270
260 CALL TFETCH(KSE(J1,6),PA03XX,K3,K1,DISTOO)
270 CONTINUE
C CALCULATE DWELL TIME
J1=0
278 J1=J1+1
IF (J1.GT.IK2) GO TO 300
I9=KSE(J1,9)
I10=KSE(J1,10)
I11=KSE(J1,11)
IF (KSE(J1,2).EQ.2) GO TO 286
IF (KSE(J1,6).EQ.0) GO TO 280
I1=KSE(J1,1)
CALL FIELD(1,CANDTPI(11,16),KSE(J1,7),17,8)
GO TO 278
280 CONTINUE
J2=J1
282 J1=J1+1
IF (KSE(J1,2).EQ.2) GO TO 284
KSE(J1,7)=0
I9=I9+KSE(J1,9)
I10=I10+KSE(J1,10)
I11=I11+KSE(J1,11)
IF (KSE(J1,6).EQ.0) GO TO 282
284 CALL DWELT(I9,I10,I11,0,0,0,JRDWT,KSE(J2,7),VCADWE,PARM10)
GO TO 278
286 IF (KSE(J1,6).EQ.0) GO TO 290
287 I1=KSE(J1,1)
288 CALL FIELD(1,CANDTPI(11,16),KSE(J1,7),25,8)
GO TO 278
290 CONTINUE
IF (J1+1.GT.IK2) GO TO 287
J2=J1
292 J1=J1+1
IF (KSE(J1,2).EQ.1) GO TO 294
KSE(J2,7)=0
I9=I9+KSE(J1,9)
I10=I10+KSE(J1,10)
I11=I11+KSE(J1,11)
IF (KSE(J1,6).EQ.0) GO TO 292
294 CALL DWELT(0,0,0,0,19,I10,I11,JRDWT,KSE(J1,7),VCADWE,PARM10)
GO TO 278
300 CONTINUE
C ASSIGN THE SCHEDULED TIME
KSE(1,8)=ICSBTR(1,8)
DO 370 J1=2,IK2
IF (KSE(J1,2).EQ.2) GO TO 340
IF (KSE(J1-1,2).EQ.2) GO TO 330
KSE(J1,8)=KSE(J1-1,8)+KSE(J1-1,6)+KSE(J1,7)
GO TO 370
330 KSE(J1,8)=KSE(J1-1,8)+KSE(J1-1,6)+KSE(J1-1,7)
1+KSE(J1,7)
GO TO 370
CONTINUE
IF (KSE(J1-1,2).EQ.2) GO TO 350
KSE(J1,8)=KSE(J1-1,8)+KSE(J1-1,6)
GO TO 370
350 KSE(J1,8)=KSE(J1-1,8)+KSE(J1-1,6)+KSE(J1-1,7)
370 CONTINUE
CALL FESIBL(IK2,IFLAG1,IFLAG5,
1 CANDTP,DISTOD,DISTOO,IVWHT,KSE,
2 IBGNP,IBGNS,PA03XX,ENDP,ENDS,
3 PARM03,PARM04,PARM05,PARM06)
IF (IFLAG1.EQ.0) GO TO 400
CALL RMTIME(IA,IK2,JK,IFLAG2,
1 CANDTP,ISE,KSE,IC1,IC2,RTB,RTS,SHTB,SHTS,
2 PARM03,PARM05)
400 CONTINUE
500 CONTINUE
RETURN
END
APPENDIX J TEST DATA

This appendix contains data on trip information used in test runs. Trip information are real. The meaning of columns are stated below. Trip data are reproduced as exactly as they were received. The data format and the contents are not necessarily the same as used in the RSDAR.

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01. Summary date
Yr. | Mo. | Day
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1975 | 02 | 05

02. Summary prepared by (Name and Phone)
Howard K. Hung (301) 921-3855

03. Summary action
New Replacement Deletion
- | - | -

04. Software date
Yr. | Mo. | Day
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1975 | 02 | 05

05. Software title
Routing and Scheduling Dial-A-Ride (RSDAR)

06. Short title

07. Internal Software ID

08. Software type
- Automated Data System
- Computer Program Subroutine/Module

09. Processing mode
- Interactive
- Batch
- Combination

10. Computer Systems
- General
- Management/ Business
- Scientific/Engineering
- Process Control
- Bibliographic/Textual

11. Submitting organization and address
Center for Applied Mathematics
National Bureau of Standards
Gaithersburg, MD 20899

12. Technical contact(s) and phone
Howard K. Hung
William G. Hall
Robert E. Chapman
(301) 921-3855

13. Narrative
The RSDAR is a heuristic algorithm. It assigns patrons to form subtours in time
intervals, and subtours are linked to become a tour. Patrons are chosen to be
included in a subtour on the basis of the best remaining time of the base trip.
Subtours are selected to be included in a tour on the basis of the best productivity
measure.

14. Keywords
Dial-a-ride; heuristic algorithm; routing; scheduling

15. Computer manufacturer and model

16. Computer operating system
- UNIX

17. Programming language(s)
- FORTRAN 77

18. Number of source program statements
Appx 1400

19. Computer memory requirements
512K Bytes

20. Tape drives

21. Disk/Drum units
- 15 MB Winchester Disk Drive

22. Terminals

23. Other operational requirements

24. Software availability
Available Limited In-house only

25. Documentation availability
Available Inadequate In-house only

26. FOR SUBMITTING ORGANIZATION USE
The Advanced Routing and Scheduling System (ARSS) is a software system designed to route and schedule patrons in a dial-a-ride environment. The system consists of three subsystems: CONENV, a preprocessor which constructs physical and policy environments; RSDAR, which routes and schedules patrons; and GREPOR, which generates hard copy of all necessary reports. This report provides a description of RSDAR.

The RSDAR is a heuristic algorithm. It assigns patrons to form subtours in time intervals, and these subtours are linked to become a tour.

Patrons are chosen to be included in a subtour on the basis of the best remaining time of the base trip. Subtours are selected to be included in a tour on the basis of the best productivity measure.

The model is written in FORTRAN and complies with the American National Standards Institute X3.9-1978 standard for that language.