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HIGHWAY,
A TRANSPORTATION ROUTING MODEL:
PROGRAM DESCRIPTION AND REVISED USERS' MANUAL

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HIGHWAY, A TRANSPORTATION ROUTING MODEL: PROGRAM DESCRIPTION AND USERS' MANUAL

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ABSTRACT

A computerized transportation routing model has been developed at the Oak Ridge National Laboratory to be used for predicting likely routes for shipping radioactive materials. The HIGHWAY data base is a computerized road atlas containing descriptions of the entire Interstate System, the federal highway system, and most of the principal state roads. In addition to its prediction of the most likely commercial route, options incorporated in the HIGHWAY model can allow for maximum use of Interstate highways or routes that will bypass urbanized areas containing populations greater than 100,000 persons. The user may also interactively modify the data base to predict routes that bypass any particular state, city, town, or specific highway segment.

1. INTRODUCTION

1.1 DEVELOPMENT OF THE ROUTING MODEL

A routing model has been developed at the Oak Ridge National Laboratory (ORNL) in support of the Waste Transportation Studies sponsored by the U.S. Department of Energy (DOE) through the Transportation Technology Center (TTC) at Sandia National Laboratories and through the Transportation Operations and Traffic Management (TOTM) organization. Initially, a commercially available routing model and a highway data base (COMPU.MAP) were purchased from Logistics Systems, Inc., and the computer programs associated with COMPU.MAP were completely rewritten at ORNL. The new routing model, HIGHWAY, provides a flexible tool to be used in predicting highway routes for transporting radioactive materials. The proprietary COMPU.MAP highway data base was retained as part of the HIGHWAY model; however, it has been carefully checked for accuracy and substantially modified to include locations of specific interest to DOE and its contractors.

A number of program and data base enhancements have been made since the publication of the original HIGHWAY Users' Manual.[1] The internal structure of the program has been changed to include more-detailed prompting statements, which are designed to minimize the casual users' need to refer to the manual. The users' manual portion of this report contains a detailed description of all program commands of interest to non-ORNL users.

The data base has been enhanced by adding the locations of commercial nuclear power plants and more than 800 major commercial and military airports. The user needs to be aware that the data base is constantly being revised as new roads and locations are added to satisfy programmatic needs. It is conceivable that as the data base changes, a user will not be able to reproduce all of the examples in this report.

1.2 HIGHWAY DATA BASE

The HIGHWAY data base is essentially a computerized road atlas that currently contains more than 18,000 highway segments and 12,000 intersections and includes over 240,000 miles of highways in the continental United States. A complete description of the Interstate System and all U.S. highways except those that parallel a nearby Interstate highway is included in the data base. Most of the principal state highways and a number of local and county highways are also identified. Data included for each highway segment are: highway designation, distance between end points, estimated average driving speed, and whether a toll is charged.

1.3 NAMING CONVENTIONS EMPLOYED

The highway naming convention for the model uses the first letter of the highway name to identify the road as follows:

I = interstate highway (i.e., I40, I75);

U = U.S. highway (i.e., U66, U30);

S = state highway (i.e., S147, S1);

T = turnpikes that are not part of the Interstate System (i.e., TCIM);

C = county roads; and

L = local roads.

Toll roads are followed by a \$ sign (i.e., I35\$), and a # sign is used to indicate that a toll bridge is included in a highway segment.

All highway intersections are named. Any name that is not followed by a directional and/or an intersection modifier is located in the center of a city or town. Names of intersections that are located in the vicinity of a town will be followed by a directional modifier (e.g., N, S, W, NW) and generally will also include an intersection description (e.g., I35, U64).

Figure 1 illustrates the highway and intersection naming conventions used in the HIGHWAY program. This example shows a portion of the highway network in the vicinity of Stillwater, Oklahoma. Interstate 35 (I35) is the main north-south highway, and there is a junction with U.S. 64 (U64) located west of the town of Perry, Oklahoma. This intersection is labeled PERRY W I35, U64, showing the nearest town, Perry; direction of the intersection, west; and the intersection description of Interstate 35 and U.S. Highway 64. It should be noted that there are two junctions in the vicinity of Morrison, Oklahoma. The junction of the Cimarron Turnpike and U.S. 64 (MORRISON E TCIM, U64) is east of Morrison, and the junction of U.S. 177 and U.S. 64 is west of Morrison (MORRISON W U177, U64).

The Cimarron Turnpike is a toll road; therefore, it is identified by the symbol TCIM\$. The T indicates that it is a turnpike and the \$ that a toll is charged for its use. The other roads shown in Fig. 1 are toll-free.

1.4 GENERAL ROUTING CONSIDERATIONS

1.4.1 Setting the Routing Criteria

Several different types of routes may be calculated, and each type can be constrained to follow certain criteria. Routes are calculated by minimizing the total impedance between the origin and the destination. Basically, the impedance is defined as a function of distance and driving time along a particular segment, and the program

ORNL DWG 82-1001R

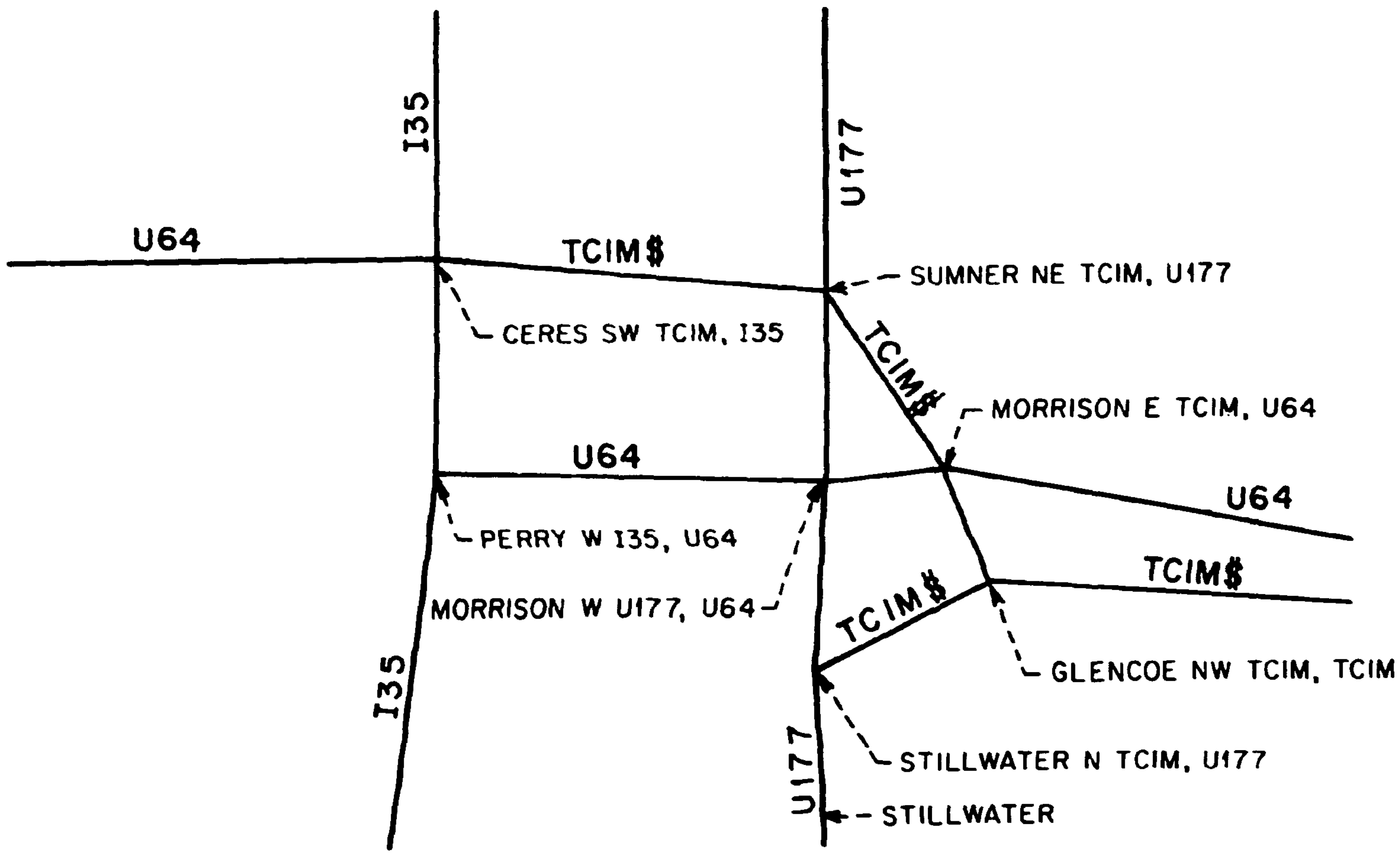

Fig. 1. Example showing highway and intersection naming conventions.

calculates the set of links between the origin and the destination that minimizes these factors:

$$L = \text{Min} \sum_i (\alpha D_i + \beta T_i), \qquad (1)$$

where

L = total impedance of a route;

α = distance modifier;

D_i = distance of segment i, miles;

β = time modifier; and

T_i = time required to travel along segment i, min.

By varying the values of the time and distance modifiers, different types of routes can be predicted. For example, if $\alpha = 1.00$ and $\beta = 0.0$, the shortest possible route will be calculated (give entire weight to distance). Setting $\alpha = 0.0$ and $\beta = 1.00$, the most rapid route will be estimated (give entire weight to time). A compromise between these extremes is the "commercial" route, where α and β are defined to be 0.3 and 0.7, respectively. This compromise is the criterion for verifying the HIGHWAY-predicted routes with actual trucking routes used for a number of DOE shipments. The user can select any combination of distance and time modifiers by simply defining the value of β. The distance modifier is then automatically set by Eq. (2):

$$\alpha = 1.0 - \beta, \qquad (2)$$

where $0 \leq \beta \leq 1$.

Theoretically, the criteria outlined above could produce different routes between any two points. However, in actual practice, two or occasionally all three of the criteria will produce identical routes. Figure 2 shows a set of routes generated between Morris, Illinois, and Richland, Washington, using the various routing criteria. In this example, the quickest and commerci 1 routes are identical, following Interstate 80 across Iowa, Nebraska, Wyoming, and Utah for a distance of 1946 miles and an estimated driving time of 40 h 22 min. The shortest route follows a more northerly path through Minnesota, North Dakota, and Montana, covering a distance of 1880 miles. While

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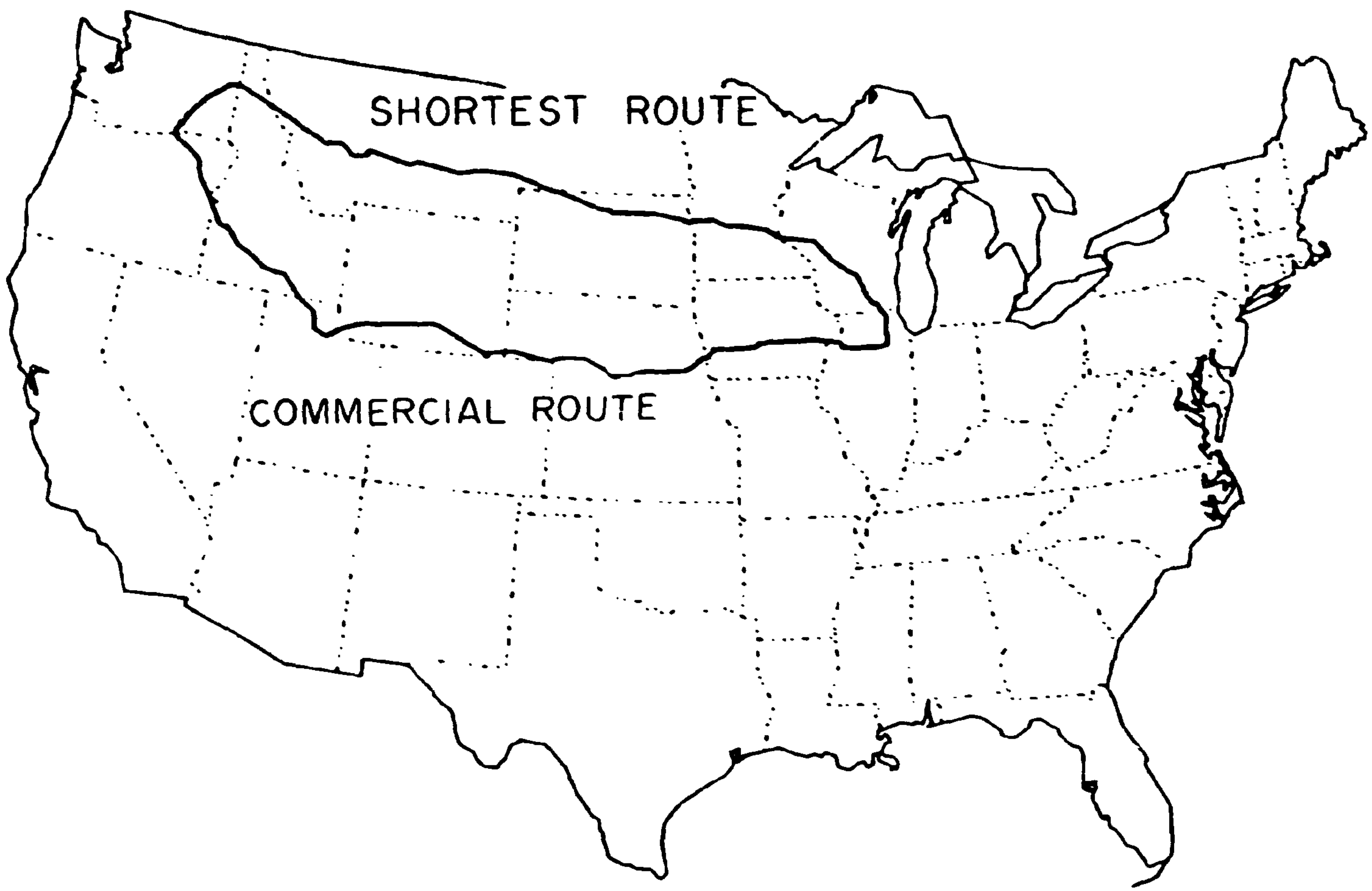

Fig. 2 Comparison of the commercial and the shortest routes between Morris, Illinois, and Richland, Washington.

the shortest route is 66 miles less than the commercial route, the estimated driving time is 44 h 53 min, or 4.50 h longer than the commercial route.

The "commercial" routing criterion, with its compromise between the shortest time and distance, closely approximates the routes that are most likely to be used commercially by various trucking companies.

1.4.2 Toll Bias

The use of toll roads and/or toll bridges can be controlled by the toll bias. Routes calculated with a large value for the toll bias will avoid all toll roads. On the other hand, setting the toll bias to zero does not place any special penalty on the use of toll roads; in such cases, toll roads and other highways are treated equally. The default or normal value of the toll bias is 1.15. This value will generally exclude the use of toll roads unless a significant advantage can be gained by using one.

1.4.3 Number of Drivers

The estimated time of travel is reported for each route. Normally, times are based on a two-driver team, where a given shipment is assumed to move for 4 h and then stop for a 0.5-h break. This cycle is repeated until the destination is reached.

The user also has the option of specifying a single driver; and in this case, the shipment is assumed to move for 5 h, stop for a 0.5-h break, and then move for an additional 5 h, after which an 8-h break is taken. This pattern is repeated until the destination is reached. The number of drivers does not change the estimated route, but it does affect the time required to make a particular shipment.

1.4.4 Routing Constraints

In addition to the route-type criteria already discussed, several additional constraints can be imposed during the calculations. An entire state can be bypassed, if necessary, to reflect local legislation or specific carrier operating rights. It is also possible to bypass a specific city or highway intersection. Specific highway segments may be avoided by simply blocking transport along that particular road. Routes preferentially following certain types of highways (e.g., the interstate System) can be developed. Any combination of the above constraints can be imposed at the same time.

A number of examples showing the effects of various routing constraints are presented in Figs. 3-9. These examples are based on a route between Waterloo, Iowa, and Dalhart, Texas. The expected route was calculated by using the commercial routing criterion discussed in Sect. 1.4.1 and is shown in Fig. 3. This route is 817 miles long, and the expected driving time for a two-driver team is 18.0 h. The route primarily follows U.S. and state highways between Waterloo and Des Moines, Iowa, and Interstate highways between Des Moines, Iowa, and Wichita, Kansas. West of Wichita, the route again follows along U.S. highways.

An example of bypassing an entire state is shown in Fig. 4. In this case, the route between Waterloo and Dalhart bypasses the state of Kansas. This route, which goes west from Des Moines through southern Nebraska and then south through eastern Colorado, is 933 miles long and has an expected driving time of 21.9 h. It is 33 miles shorter than a route through Missouri and Oklahoma which bypasses Kansas on the east and south.

An example of bypassing a specific city or town is shown in Fig. 5. In this case, the route between Waterloo and Dalhart was constrained to bypass Wichita. Between Waterloo and Emporia, it is identical to the commercial route (Fig. 3) but at this point the constrained route passes to the north and west of Wichita before rejoining the original route at Meade, Kansas. Bypassing Wichita is 5 miles shorter than the normal route; however, due to the use of more U.S. and state highways, the expected driving time is approximately 54 min longer.

The blocking of transportation through a specific city or town can be extended to include as many cities as needed. For the example shown in Fig. 6, the route was constrained to bypass all cities having populations greater than 100,000: Waterloo, Des Moines, Kansas City, and Wichita. Since we start in Waterloo, that city cannot be bypassed completely. Under these conditions, the program logic will find the

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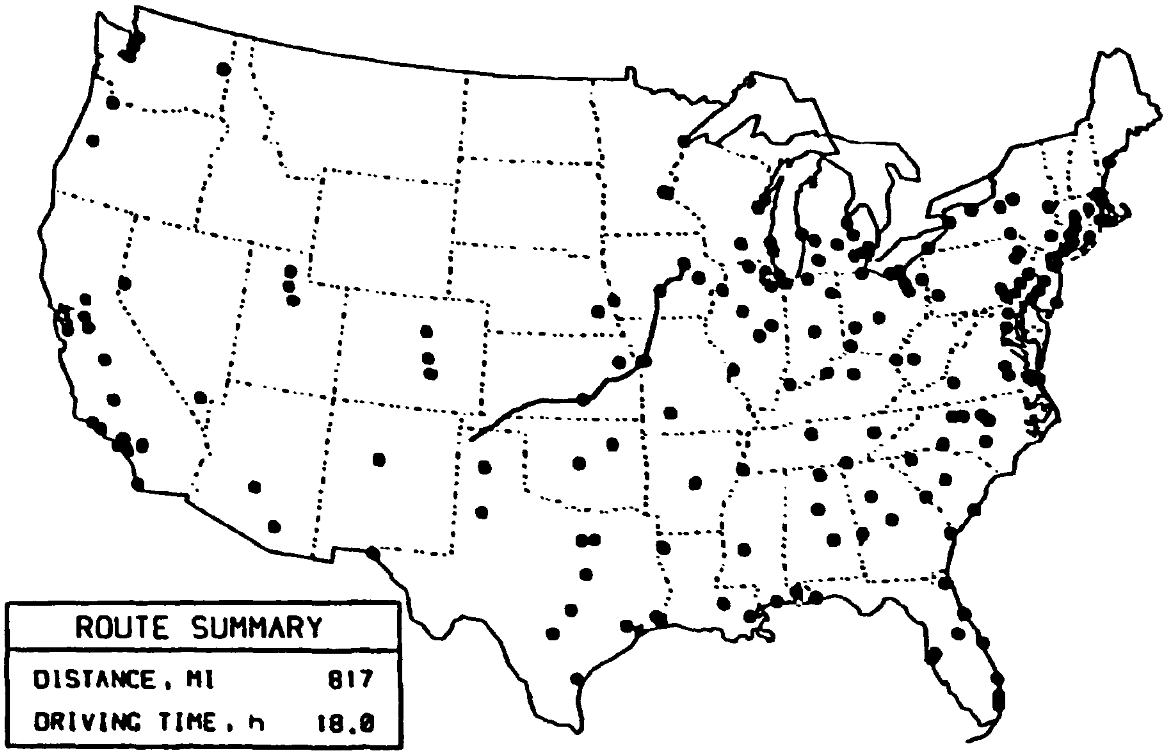

Fig. 3. Estimated commercial route between Waterloo, Iowa, and Dalhart, Texas.

ORNL DWG 83-778

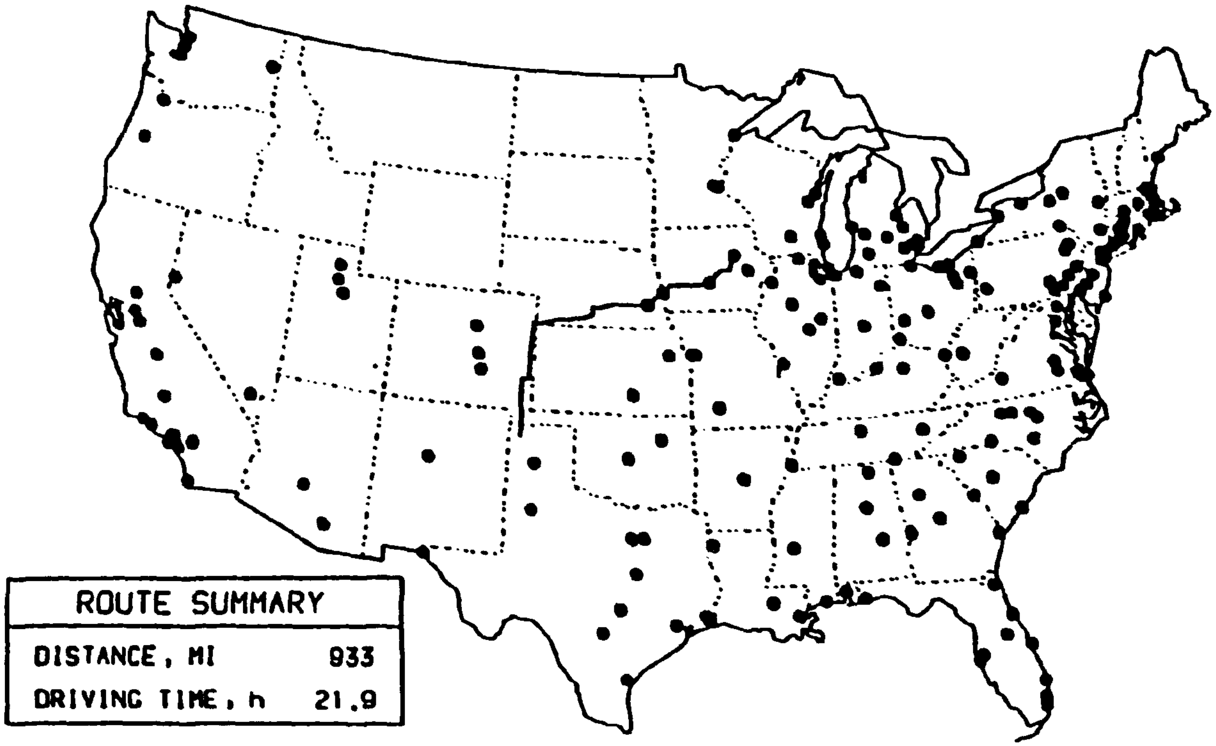

Fig. 4. Route between Waterloo, Iowa, and Dalhart, Texas, which bypasses Kansas.

ORNL DWG 83-779

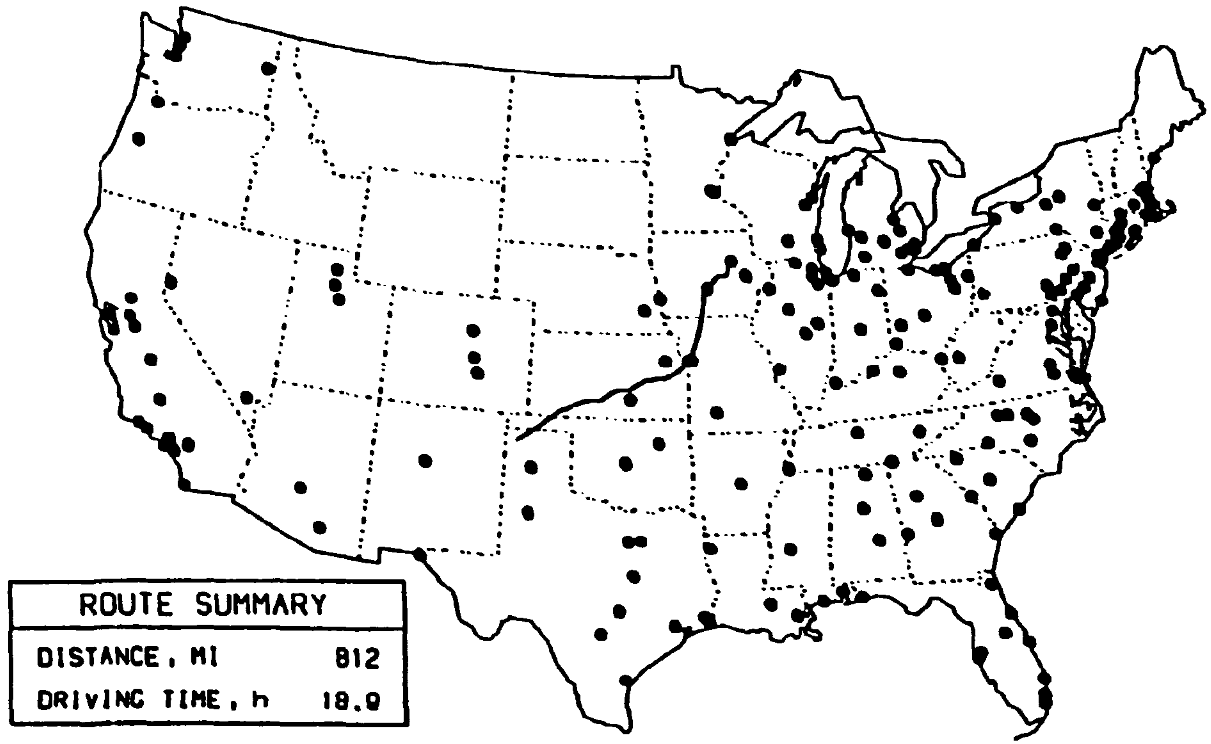

Fig. 5. Route between Waterloo, Iowa, and Dalhart, Texas, which bypasses Wichita, Kansas.

ORNL DWG 83-780

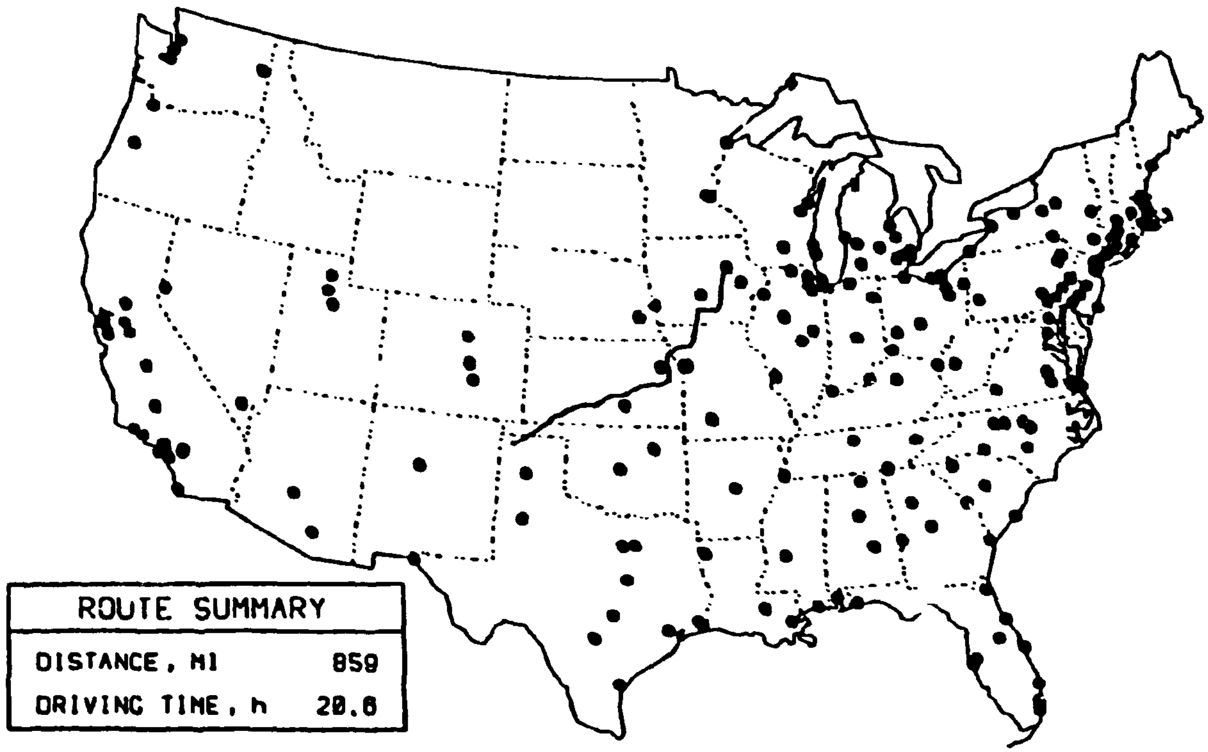

Fig. 6. Route between Waterloo, Iowa, and Dalhart, Texas, which bypasses all metropolitan areas with a population greater than 100,000.

ORNL DWG 83-781

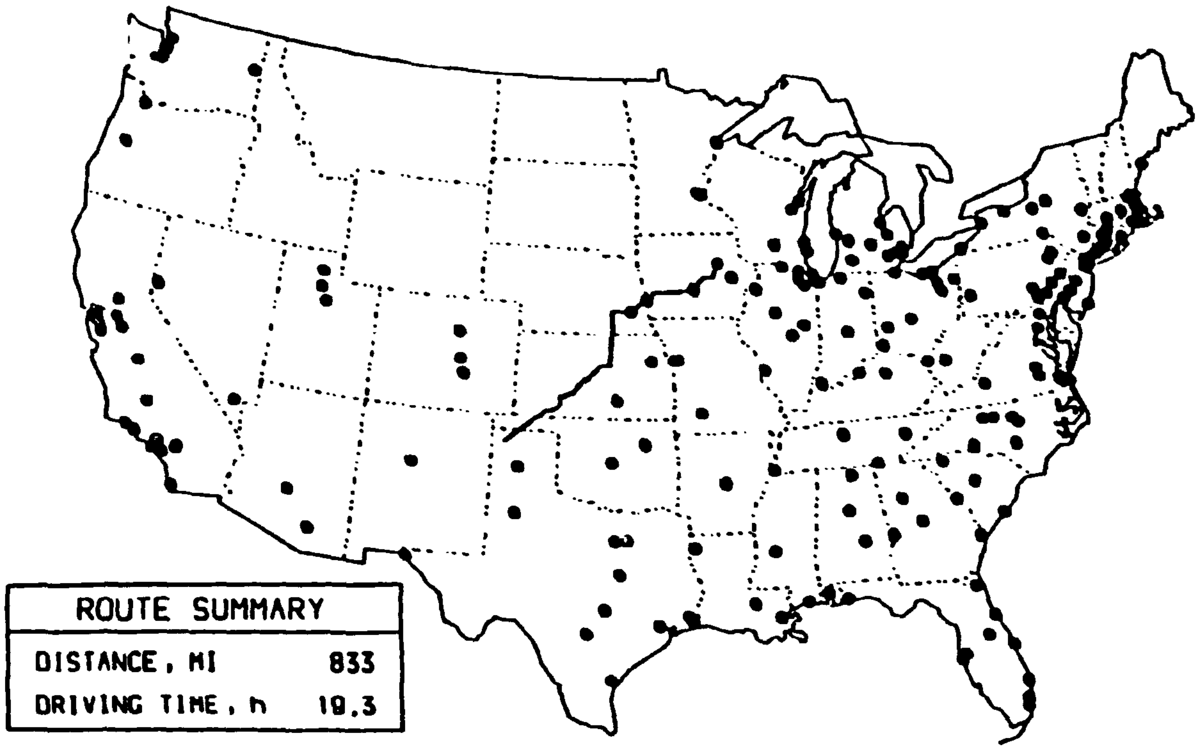

Fig. 7. Route between Waterloo, Iowa, and Dalhart, Texas, which avoids a particular section of highway (Interstate 35 between Des Moines, Iowa, and the Iowa-Missouri border).

ORNL DWG 83-782

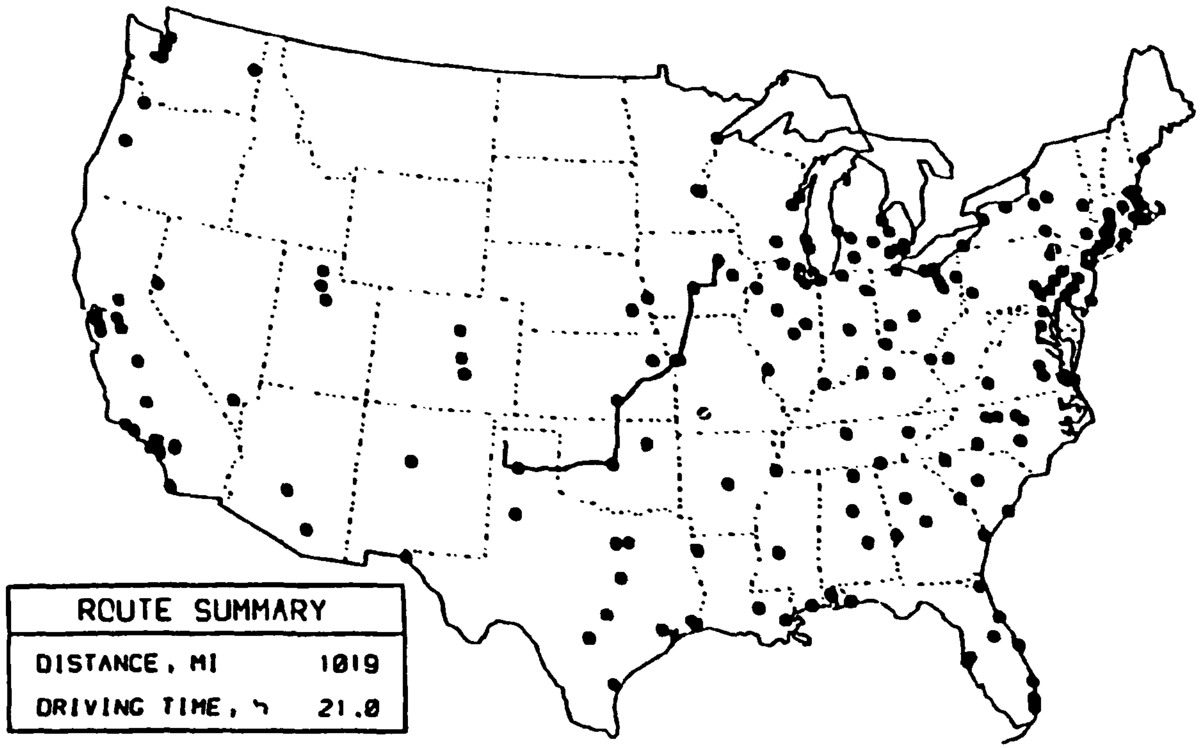

Fig. 8. Route between Waterloo, Iowa, and Dalhart, Texas, which maximizes the use of Interstate highways.

ORNL DWG 83-783

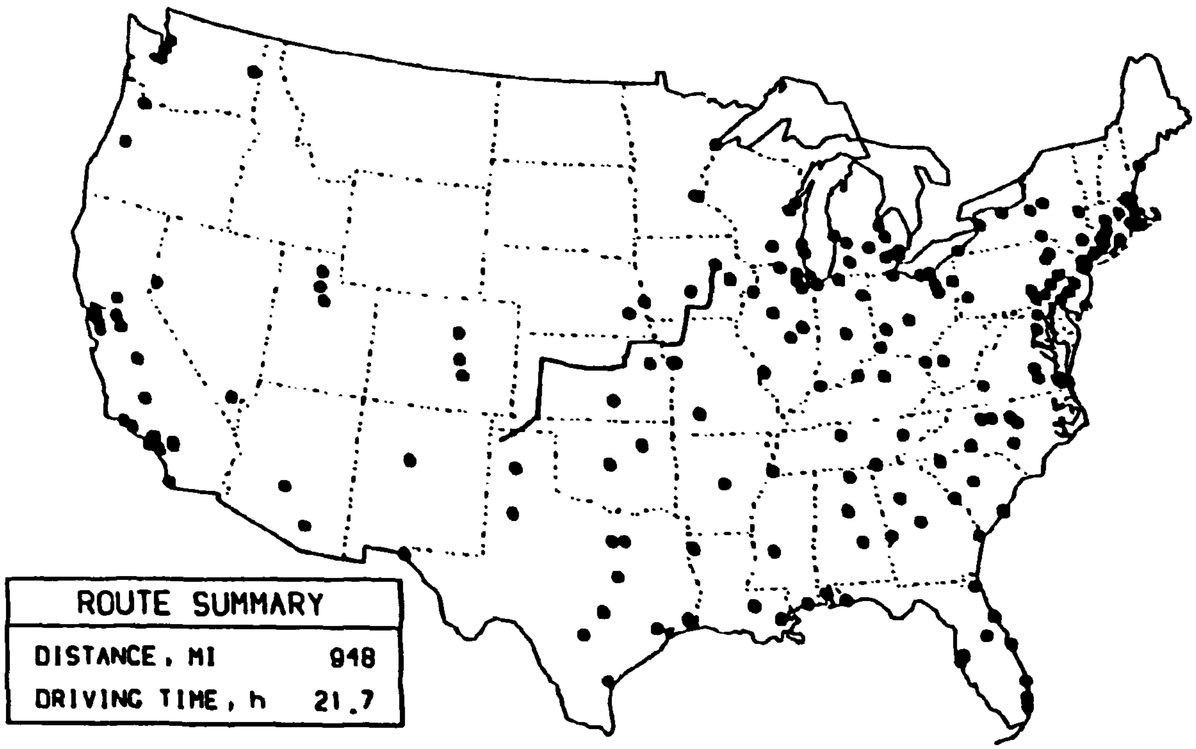

Fig. 9. Route between Waterloo, Iowa, and Dalhart, Texas, which maximizes Interstate travel while bypassing metropolitan areas with populations greater than 100,000.

shortest path out of Waterloo. As shown in Fig. 6, once we leave Waterloo, we pass east of Des Moines, between Kansas City and Topeka, Kansas, and north of Wichita. The total length of this route is 859 miles, and the expected driving time is 20.6 h.

In addition to blocking transport in cities, specific highway segments can also be bypassed. The route shown in Fig. 7 was constrained from using Interstate 35 between Des Moines and the Iowa-Missouri border. Under these conditions, we would head west from Des Moines along Interstate 80 through Council Bluffs, Iowa, to York, Nebraska.

Another possible constraint is the need to keep on a specific type of highway (e.g., the Interstate System). A route utilizing Interstate highways is shown in Fig. 8. Currently, there are no Interstate highways near Waterloo. Under these conditions, the program logic will find the shortest route to an Interstate highway (I80 south of Waterloo). Then the route follows I80, I35, and I40 through Kansas City, Wichita, Oklahoma City, Oklahoma, and Amarillo, Texas, before using noninterstate roads to Dalhart. This path covers 1019 miles and would require 21.0 h of driving time.

The constraints identified above can be combined in various ways. An example (shown in Fig. 9) combines the need to utilize Interstate highways, where possible, while bypassing cities with populations of more than 100,000. Since the Interstate highways connect major cities in the United States, it is impossible to find a route which completely satisfies both constraints. Bypassing the major cities is given the higher priority.

It is interesting to look at the effect of various constraints on the type of highways used in the various routes. The fraction of each route along Interstate, U.S., and state highways is shown in Table 1. As a result of the existing highway network between Waterloo and Dalhart, the Interstate System is normally utilized for slightly less than half the route. In general, placing constraints will reduce the ability to utilize the Interstate highways. The extreme case is the one that was required to bypass all major cities, where only 17% of the route was along Interstate highways. The example that was constrained to follow the Interstate highways did so for approximately 87% of the route between Waterloo and Dalhart. The only noninterstate portions were those in the vicinity of Waterloo and Dalhart. For this particular example, it should be noted that utilizing the Interstate highways added 202 miles to the driving distance.

Table 1. Highway usage for various routes

		Highway type (% of total distance)		
Route	Constraint	Interstate	U.S.	State
1	None	47.5	50.1	2.4
2	Bypass Kansas	36.3	61.5	2.1
3	Bypass Wichita	38.7	53.2	8.1
4	Bypass major cities	17.2	74.4	8.4
5	Bypass I35	32.2	65.4	2.4
6	Use Interstates	87.3	12.7	0.0
7	Use Interstates and bypass major cities	32.4	64.9	2.7

2. HIGHWAY PROGRAM USERS' MANUAL

This users' manual is designed to provide a complete description of the HIGHWAY routing model functions that can be performed with computer terminals outside the Oak Ridge area. Additional program functions which are designed to use the specialized graphics equipment at ORNL are not included.

The beginning user should completely master the procedures described for connecting with the computer and for executing the HIGHWAY program (the ROUTE and the STOP commands) before trying the other functions.

2.1 USING THE ORNL TIME-SHARING OPTION SYSTEM

The HIGHWAY transportation routing program is run as an interactive program on the Union Carbide Corporation, Nuclear Division's IBM 3033 time-sharing option (TSO) system, which is operated by Computer Sciences at the X-10 (ORNL) site. As with any time-sharing system, the speed of the calculations (and hence the computer's response) will be a function of the number of users connected to the machine at any given time. Interactive programs will present a series of questions on the terminal, and the answers supplied by the user will set up the conditions and provide the necessary data for calculating routes over the U.S. highway network.

The HIGHWAY model has been designed to minimize data input by the user. Any information typed by the user must be followed by a return (denoted as <CR>). This signals the computer that the typed statement should be processed. Since the TSO system does not have a type-ahead feature, the user must wait for the question to be asked before supplying data. If a mistake is made (e.g., hitting the wrong key), the error can be erased by backspacing, and the correct information must then be reentered from that point to the end of the statement. A control H will act as a backspace for terminals that do not have a backspace key. A control H is typed by holding the control key (usually located on the left side of the keyboard) down while typing the letter H. Each time the H key is pressed, one character will be erased.

In some instances, the spacing and punctuation of the input data are critical. This manual uses a <CR> to represent a return and an @ to represent a blank space. Generally, a free-format system is used for entering input data; that is, the user types the appropriate data under the question mark (?) with no special punctuation or spacing. For the few cases where data must be placed in a specific location, a guide (consisting of dashes) will be typed. The appropriate numbers should be placed beneath the dashes. Any blank spaces under dashes will be interpreted as zero; thus, it is advisable to place a number under each dash.

This manual will show all commands fully typed. The Appendix lists the acceptable abbreviations.

2.2 MAKING THE COMPUTER CONNECTION

To access the HIGHWAY routing program, the user must first set up a communication channel with the computer. In these instructions, it is assumed that the user will have a terminal similar to a Texas Instruments Silent 700. Other types of computer terminals can be used, provided the phone modem is Bell 212A-compatible. The terminal should be turned on with the speed switch set to high (300 baud), the duplex switch set to half duplex, and the on-line switch set to on-line.

The phone numbers for the TSO system are: (commercial) 615-574-7630 and (FTS) 624-7630. The phone will be answered with a whistle. As soon as the tone is heard, the phone should be inserted into the two rubber cups located at the back of the terminal. Note the direction of the cord, as shown by a picture on the terminal or a sign indicating which cup is connected with the cord side of the phone receiver. After a few seconds, the green light in the lower right corner of the keyboard will be illuminated, indicating that a connection has been established between the terminal and the computer.

Many different types of terminals can be used for running the HIGHWAY model. Users who wish to use terminals other than the Texas Instrument Silent 700 are requested to contact the authors for terminal setup parameters and the appropriate phone numbers to connect with the TSO system. The authors can be contacted on the following phone numbers:

	Commercial	FTS
D. S. Joy	615-576-2068	626-2068
P. E. Johnson	615-574-7450	624-7450

2.3 LOGGING-ON PROCEDURE

To activate the TSO system, the user must type: ARLOGON <CR>. The notation <CR> represents the return button, which is the large red key on the right side of the keyboard. The computer will then ask for the LOGON ID. Each qualified user is assigned a unique three-letter identifier to be used for this purpose. For the example shown in Fig. 10, the LOGON ID was DSJ. The second item requested is the password, which is either a six- or an eight-character word. The area where the password must be typed is blocked out in Fig. 10. A special password is assigned to each authorized user.

```
ARLOGON
ACF82003  ACF2, ENTER LOGON ID-
DSJ
ACF82004  ACF2, ENTER PASSWORD-
[redacted]
IKJ56455I DSJ LOGON IN PROGRESS AT 17:23:31 ON AUGUST 16, 1982
 WELCOME TO NYC TSO AT X-10
DSJ:  LINE(T 089 T1076) VOLUME(TSOLB2) TSO USERS(5)  X10B  05:23.34PM
READY
```

Fig. 10. Typical logging-on procedure.

The user assigned to each account is responsible for maintaining the account ID and password. This information should not be divulged to anyone not authorized to access the HIGHWAY model.

Once the LOGON ID and password have been properly entered, the computer will finally respond with the word READY. At this point, the computer is ready to proceed with the user's requests.

If either the LOGON ID or the password is not entered correctly, the user will be asked to repeat the procedure. A check should be made to ensure the accuracy of all information before proceeding. If three consecutive mistakes are made, the user will be disconnected from the computer. Six errors in a single day will deactivate the account, and 1 to 2 weeks will be required to reactivate the account. Obtaining a replacement for a lost password will take approximately two weeks.

2.4 EXECUTING THE HIGHWAY ROUTING PROGRAM

After the LOGON procedure has been completed, the word READY will be displayed on the terminal, and the user will activate the routing model by typing:

EX@HIGHWAY<CR>

(Please note that the symbol @ is used to signify a blank space.) The computer will respond with a question to determine which data files are to be used during this session:

DO YOU WANT TO USE THE DATA BASE THAT HAS THE HIGHWAYS IN ALL URBANIZED AREAS OVER 100,000 PEOPLE BLOCKED? (YES/NO)>

The question must be answered with a YES or NO. If the user wants to calculate routes that will bypass major metropolitan areas, the answer is YES<CR>. In most cases, bypassing major cities is not required; therefore, the appropriate answer is NO<CR>.

The computer will check to determine whether a personal work file has been established for the user. If such a file does not exist, one will automatically be created. If a new file must be copied, there will be a pause of ~1 min at this point.

Figures 11 and 12 demonstrate how the HIGHWAY model is executed. In Fig. 11, the question was answered with a NO<CR>. The most general data base was used, and all highways in the data base were available for route selection. Figure 12 represents a special case where calculated routes are not allowed to pass through major metropolitan areas (i.e., the question was answered with a YES<CR>). Note that a different master file was identified and a number of highway segments were deleted in this particular data file. These are the highway segments within the urbanized area of the cities with populations greater than 100,000 and, except for a few special cases, are not available for route selection when using this data base.

2.5 COMMANDS

After the initial question pertaining to the appropriate data files has been answered, the following statement will be displayed:

COMMAND TYPE HELP FOR A LIST OF COMMANDS

At this point, the program is ready to accept specific instructions defining the actions to be taken. Table 2 lists the valid responses to the COMMAND statement in the order in which they are discussed in this section.

Table 2. Valid commands

HELP
ROUTE
REROUTE
INST
RIS
REMOVE
RETYPE
ADVANCED
STOP

```
EX HIGHWAY
HIGHWAY 1.5 SUPERVISOR PROGRAM   04/05/83   12:51:20

DO YOU WANT TO USE THE DATA BASE THAT HAS THE HIGHWAYS IN ALL
URBANIZED AREAS OVER 100,000 PEOPLE BLOCKED? (YES/NO) >NO

FILES ARE BEING LOADED . . . . .

                     *    HIGHWAY 1.5  HIGHWAY ROUTING PROGRAM   *
                     *      OAK RIDGE NATIONAL LABORATORY        *


                                ___________________
                                  HIGHWAY   1.5
                                ___________________
                              ****   ****   ****   ****
                                 ****   ****   ****
                                    ****   ****
                                       ****
T.DSJ17999.INDEX.HGWPGMS                           - MASTER FILE


INITIALIZATION COMPLETE - ENTER "HELP" FOR A COMMAND LIST.
 **** COMMAND ****  TYPE HELP FOR A LIST OF COMMANDS
```

Fig. 11. Execution of HIGHWAY model using the standard highway data base.

```
EX HIGHWAY
HIGHWAY 1.5 SUPERVISOR PROGRAM   04/05/83   12:53:07

DO YOU WANT TO USE THE DATA BASE THAT HAS THE HIGHWAYS IN ALL
URBANIZED AREAS OVER 100,000 PEOPLE BLOCKED? (YES/NO) >YES

FILES ARE BEING LOADED . . . . .

                     *    HIGHWAY 1.5  HIGHWAY ROUTING PROGRAM   *
                     *      OAK RIDGE NATIONAL LABORATORY        *


                                ___________________
                                  HIGHWAY   1.5
                                ___________________
                              ****   ****   ****   ****
                                 ****   ****   ****
                                    ****   ****
                                       ****
T.DSJ17999.INDEX.BLKHGWS                           - MASTER FILE
   ***** FILE CONTAINS   7650 DELETIONS *****


INITIALIZATION COMPLETE - ENTER "HELP" FOR A COMMAND LIST.
 **** COMMAND ****  TYPE HELP FOR A LIST OF COMMANDS
```

Fig. 12. Executing HIGHWAY model to generate a route bypassing major metropolitan areas.

2.5.1 HELP

The HELP command will print a brief description of the COMMAND list. A copy of the output generated by the HELP command is shown in Fig. 13. The HELP command is a useful reminder of the proper instructions for a user who is familiar with the HIGHWAY model.

2.5.2 ROUTE

The ROUTE command, which generates a route from an origin to a destination, is the most frequently used command. Figure 14 illustrates a sample of the computer output generated during the ROUTE command and will be referred to repeatedly in this discussion. In order to completely define the parameters to be used during the routing calculations, a series of prompting statements will be displayed on the terminal during the execution of the ROUTE command. The first prompting statement is:

```
NOTE: A <CR> WILL RETURN YOU TO THE COMMAND STATEMENT
ENTER ORIGIN CITY/STATE (EXAMPLE ERIE/PA)
```

The user responds with the city and state of the origin or starting point of the route. City names may be spelled out completely or entered in an abbreviated form by deleting characters from the end. The city and state names are separated by a slash (/), and the standard two-letter post office abbreviations are used for states. Referring to the example in Fig. 14, the desired origin is Omaha, Nebraska, which was entered as

```
OMAH/NE <CR>
```

After the user has entered the appropriate city/state, a list of all cities in that state starting with the letters given will be displayed. In Fig. 14, nine highway intersections identified as Omaha were found. The user is asked to select a highway intersection in the origin city from this list when the following prompter is displayed:

```
SELECT ORIGIN CITY
?
```

For this example, the highway intersection of I680 and U6 located west of Omaha was selected, which corresponds to the ninth entry in the origin city

```
        HIGHWAY 1.5 COMMAND LIST
   THIS IS A BRIEF SUMMARY OF THE COMMAND SYNTAX FOR THE ROUTING PROGRAM.
"ROUTE"      CALCULATE A ROUTE BETWEEN THE SHIPMENT ORIGIN AND DESTINATION.
"REROUTE"    CALCULATE ANOTHER ROUTE FROM LAST ORIGIN DEFINED.
"INST"       GENERATE ROUTES FOLLOWING INTERSTATE HIGHWAYS.
"RIS"        FIND HIGHWAY NODE ASSIGNED TO RIS CODE.
"REMOVE"     REMOVE AN ENTIRE STATE FROM THE DATA BASE.
"RETYPE"     DISPLAY OUTPUT FOR THE LAST ROUTE GENERATED.
"ADVANCED"   TYPE A LISTING OF THE ADVANCED COMMANDS FOR SPECIALIZED
             APPLICATIONS.
"STOP"       TURN OFF THE PROGRAM.
       SEE THE HIGHWAY USERS MANUAL FOR FURTHER INFORMATION.
 *** COMMAND ***  TYPE HELP FOR A LIST OF COMMANDS
```

Fig. 13. Using the HELP command.

```
!HCO 3M

INITIALIZATION COMPLETE - ENTER "HELP" FOR A COMMAND LIST.
 **** COMMAND ****  TYPE HELP FOR A LIST OF COMMANDS
ROUTE

NOTE: A <CR> WILL RETURN YOU TO THE COMMAND STATEMENT

ENTER ORIGIN CITY/STATE  (EXAMPLE ERIE/PA)
OMAHA/NE
 1  OMAHA                       NE    2  OMAHA        N     I680 U73  NE
 3  OMAHA          NW   I680 U73  NE    4  OMAHA        S     I480 I80  NE
 5  OMAHA          S    I80  U73  NE    6  OMAHA        SW    I680 I80  NE
 7  OMAHA          SW   I80  U275 NE    8  OMAHA        W     I480 U6   NE
 9  OMAHA          W    I680 U6   NE

SELECT ORIGIN CITY
?
9

ENTER DESTINATION CITY/STATE  (EXAMPLE ELY/MN)
LAS V/NV
 1  LAS VEGAS                   NV    2  LAS VEGAS    NE    I15  U93  NV
 3  LAS VEGAS      NW   U95  S599 NV    4  LAS VEGAS    W     U95  S153 NV

SELECT DESTINATION CITY
?
1

DO YOU WANT TO CHANGE THE STANDARD ROUTING OPTIONS - WHICH ARE:
COMMERCIAL ROUTE, 15% TOLL BIAS,AND 2 DRIVERS? (Y/N)
N

DO YOU WANT TO SET THE DEPARTURE DATE AND TIME? (Y/N)
IF NOT, THE PROGRAM USES THE CURRENT DATE AND TIME.
N
<<ROUTING>>

FROM: OMAHA          W    I680 U6    NE     LEAVING :  2/ 7/83 AT 15:32
TO  : LAS VEGAS                      NV     ARRIVING:  2/ 8/83 AT 18:50

ROUTE TYPE: C WITH  2 DRIVER(S)                     TOTAL ROAD TIME: 27:19
  TIME BIAS:  0.70  MILE BIAS:  0.30  TOLL BIAS:  1.15   TOTAL MILES: 1289.0
STATE MILAGE:
 NV   82.0  AZ   29.0  UT   366.0  CO   465.0  NE  347.0
MILEAGE BY HIGHWAY TYPE:
    INTERSTATE: 1254.0   U.S.:    35.0  STATE:     0.0  TURNPIKE:     0.0
        COUNTY:     0.0  LOCAL:     0.0  OTHER:     0.0
CONTINUE WITH ROUTE LISTING? (Y/N)
Y

FROM: OMAHA          W    I680 U6    NE     LEAVING :  2/ 7/83 AT 15:32
TO  : LAS VEGAS                      NV     ARRIVING:  2/ 8/83 AT 18:50

  ROUTING THROUGH:
   0.0            OMAHA          W    I680 U6    NE        0.0   2/ 7/83 AT 15:32
   3.0  I680      OMAHA          SW   I680 I80   NE        3.0   2/ 7/83 AT 15:35
 342.0  I80       BIG SPRINGS    SW   I76  I80   NE      345.0   2/ 7/83 AT 22:10
 180.0  I76       COMMERCE CITY  W    I25  I76   CO      525.0   2/ 8/83 AT  2: 5
   3.0  I25       DENVER         N    I25  I70   CO      528.0   2/ 8/83 AT  2: 8
 463.0  I70       SALINA                         UT      991.0   2/ 8/83 AT 12: 7
  35.0  U89       SEVIER                         UT     1026.0   2/ 8/83 AT 12:53
  20.0  I70       COVE FORT      W    I15  I70   UT     1046.0   2/ 8/83 AT 13:25
 243.0  I15       LAS VEGAS                      NV     1289.0   2/ 8/83 AT 18:50


 **** COMMAND ****  TYPE HELP FOR A LIST OF COMMANDS
```

Fig. 14. Using the ROUTE command.

list. Hence a 9 is typed below the question mark. A number must be entered even if the origin city list contains only a single entry. If the origin city list does not contain the desired entry, the selection process can be restarted by typing a zero followed by a carriage return, <CR>, under the question mark. After an origin has been selected, the program will ask for the destination city and state.

ENTER DESTINATION CITY/STATE (EXAMPLE ELY/MN)

Following the example in Fig. 14, the desired destination was Las Vegas, Nevada, which was entered as LAS V/NV. Four highway intersections identified as Las Vegas are reported, and the first entry was selected by entering a 1 under the question mark of the following statement:

SELECT DESTINATION CITY
?

At this time, the end points of the route have been defined and the user will be asked for the routing criterion to be used. The following statement will be displayed on the terminal:

DO YOU WANT TO CHANGE THE STANDARD ROUTING OPTIONS - WHICH ARE COMMERCIAL ROUTE, 15% TOLL BIAS, AND 2 DRIVERS? (Y/N)

Here the user has some flexibility as to the information that is to be entered. Each of the parameters has a predefined default value, shown in the above statement, which will be used if this question is answered with a NO (N). Instructions for changing these parameters will be given at the end of this section.

The final prompting statement is:

DO YOU WANT TO SET THE DEPARTURE DATE AND TIME? (Y/N)
IF NOT, THE PROGRAM USES THE CURRENT DATE AND TIME

The computer output includes a listing of the date and time the shipment is expected to reach various points along the route. Frequently, the departure date and time are not important, and the user can simply answer this question with a NO (N) and the computer will use the current time and date. Since the computer is located in the Eastern Time Zone, all times listed will be Eastern times, which are expressed using a 24-h clock convention. Instructions for specifying the departure time and date are given at the end of this section.

In the example shown in Fig. 14, both of these statements were answered with a NO or N.

At this point a <<ROUTING>> statement will be displayed, signifying that all questions have been answered satisfactorily and that the routing calculations are being performed. The length of the delay before results are displayed on the terminal is a function of the number of users currently running programs on the TSO system and of the particular origin and destination selected.

When the calculations have been completed, a brief summary will be printed showing the origin, destination, departure and arrival times, the type of route, number of drivers, time bias, distance bias, toll bias, estimated driving time, and total distance. The mileage traveled in each state is also listed, along with the mileage traveled on the various highway types. A sample output is shown in Fig. 14.

After the brief summary, the terminal will display:

CONTINUE WITH ROUTE LISTING (Y/N)

If a more-detailed route description is needed, the user types: Y <CR>. However, if the data given are sufficient, the user types: N <CR>.

A sample of the detailed listing is also included in Fig. 14. The first line following the words: "ROUTING THROUGH" lists the origin and the departure date and time. Additional lines of information are printed each time the highway designation changes. For example, the second line of the output is interpreted as follows: The route follows I680 for 3 miles to the intersection of I680 and I80, which is located southwest of Omaha. The cumulative distance is 3 miles, and the expected time of arrival at this intersection is 15:35 (3:35 p.m.). The next line of the printout shows that the route then follows I80 for 342 miles to the junction of I76 and I80, which is located southwest of Big Springs, Nebraska. The cumulative distance at this point is 345 miles, and the shipment would be expected to arrive at 22:18, or 10:18 p.m. The final line lists the destination as Las Vegas, Nevada, and the total distance as 1289 miles.

When the route listing has been completed, the computer signifies that it is ready for the next command by typing:

COMMAND TYPE HELP FOR A LIST OF COMMANDS

2.5.2.1 Changing the Default Routing Parameters.

In some instances, the user needs to change the default routing parameters. There are two prompting questions in the route command which give the user this capability. The predefined default values are: commercial route (70% time bias and 30% distance bias), 15% toll bias, two drivers, and current time and date as the departure time and date.

The first prompting statement is:

DO YOU WANT TO CHANGE THE STANDARD ROUTING OPTIONS, WHICH ARE:
COMMERCIAL ROUTE, 15% TOLL BIAS, AND 2 DRIVERS? (Y/N)

If these values are suitable, the user simply enters an N for NO and proceeds to the next prompting question. If the user wishes to change any of these parameters, he must enter a Y for YES. The computer will respond with a series of five questions to determine which parameters are to be changed and to request the new data.

The first question is:

DO YOU WANT TO HAVE ONE DRIVER? (Y/N)

The user enters a Y to specify a single driver or an N to specify a two-driver team. The computer will then respond with:

DO YOU WANT TO CHANGE THE ROUTE TYPE? (Y,N)

A negative answer (N) indicates that the commercial route is desired and no further route type information will be requested. An affirmative answer (Y) will cause the computer to respond with the following statement to specify the desired route type:

ENTER THE ROUTE TYPE (S = SHORTEST, Q = QUICKEST, C = COMMERCIAL)

The user enters an S, Q, or C to define the appropriate type of route. The final prompts are:

DO YOU WANT TO CHANGE THE TOLL BIAS? (Y/N)

A negative answer will retain the default value of 15%. The value may be changed by answering the question affirmatively, at which point the computer will respond with:

ENTER THE TOLL BIAS (VALUE MUST BE BETWEEN 0 AND 99)
?

The appropriate toll bias is then entered under the question mark.

The next series of computer-generated statements pertains to the departure date and time. The computer will display the following:

```
DO YOU WANT TO SET THE DEPARTURE DATE AND TIME? (Y/N)
IF NOT, THE PROGRAM USES THE CURRENT DATE AND TIME
```

A negative answer to this question will define the departure date and time as the current date and time. If a specific departure date and/or time is needed, this question must be answered affirmatively. The computer will ask for the date by typing:

```
ENTER DEPARTURE DATE (MM/DD/YY) Example 10/26/82
ENTER A <CR> FOR THE CURRENT DATE
```

Entering a carriage return will signal the program to use the current date and ask for the time. A desired date may be specified by entering the month, day, and year, using two-digit numbers separated by slashes to identify the needed information. Two digits must be used for each entry. Referring to Fig. 15, the date of Feb. 7, 1983, was entered as 02/07/83. If this date were entered as 2/7/83, the computer would not interpret the information correctly.

The departure time is specified after the next prompt:

```
ENTER DEPARTURE TIME (HHMM) in 24 HOUR CLOCK TIME
ENTER A <CR> FOR THE CURRENT TIME
```

The time is entered as a four-digit number with no colon (:) between the hour and minutes. Please note that a 24-h clock convention is used. For times earlier than 1000 (10:00 a.m.) the leading zero must be included (e.g., 0630 = 6:30 a.m.).

The example shown in Fig. 15 illustrates how the parameters are changed. In this example, the following information was specified: one driver, shortest route, 50% toll bias, departure date to be Feb. 7, 1983, and departure time at 1830 (6:30 p.m.).

2.5.3 REROUTE

The REROUTE command is extremely useful for generating a series of routes from the same origin. The first route must be calculated using the ROUTE command; however, subsequent routes can be generated quickly with the REROUTE command since all of the data calculated for the previous route are retrained and reused in subsequent calculations. Because of the significant savings of computer resources by using calculations already performed, the user will notice an improvement in the response time.

```
DO YOU WANT TO CHANGE THE STANDARD ROUTING OPTIONS - WHICH ARE:
COMMERCIAL ROUTE, 15% TOLL BIAS,AND 2 DRIVERS? (Y/N)
Y

NOTE: ANY OF THE FOLLOWING CHANGES APPLY ONLY TO THIS ROUTE OR SUBSEQUENT
ROUTES GENERATED BY THE REROUTE COMMAND

DO YOU WANT TO HAVE ONE DRIVER? (Y/N)
Y

DO YOU WANT TO CHANGE THE ROUTE TYPE? (Y/N)
Y

ENTER THE ROUTE TYPE (S=SHORTEST, Q=QUICKEST, C=COMMERCIAL)
S

DO YOU WANT TO CHANGE THE TOLL BIAS? (Y/N)
Y

ENTER THE TOLL BIAS (VALUE MUST BE BETWEEN 0 AND 99)
?
50

DO YOU WANT TO SET THE DEPARTURE DATE AND TIME? (Y/N)
IF NOT, THE PROGRAM USES THE CURRENT DATE AND TIME.
Y
ENTER DEPARTURE DATE (MM/DD/YY) EXAMPLE 10/26/82
ENTER A <CR> FOR THE CURRENT DATE
02/07/83
ENTER DEPARTURE TIME (HHMM) IN 24 HOUR CLOCK TIME
ENTER A <CR> FOR THE CURRENT TIME
1830
<<ROUTING>>
```

Fig. 15. Changing the predefined routing parameters.

With the REROUTE command, it should be noted that parameters such as origin city/state, route type, toll bias, and number of drivers cannot be changed. The values of these parameters were established during the last use of the ROUTE command and apply to all subsequent routes generated by the REROUTE command.

One other aspect which extends the usefulness of the REROUTE command is the route symmetry. Since the path between any two points is not a function of the direction traveled, the origin and destination may be reversed with no loss of information. For example, if a number of routes are needed from several different origins to a common destination, the REROUTE command may be used if the actual destination is considered as the origin for routing purposes. Whenever possible, the REROUTE command should be used to save computer costs and the user's time.

The prompting statements (see Fig. 16) for execution of the REROUTE command are very similar to those for the ROUTE command. The first statement is:

ENTER DESTINATION CITY/STATE

The user types the appropriate city and state abbreviation, as discussed for the ROUTE command. The same rules apply. The next prompter is:

SELECT DESTINATION CITY
?

Again, a number associated with the appropriate city in the list must be entered under the question mark. The final prompting statement is:

DO YOU WANT TO SET THE DEPARTURE DATE AND TIME? (Y/N)
IF NOT, THE PROGRAM USES THE CURRENT DATE AND TIME.

The user simply types N for NO if the current time and date are desired. Actual dates and times can also be entered (see previous section).

Figure 16 shows a continuation of the example given in Fig. 14, in which a route between Omaha, Nebraska, and Las Vegas, Nevada, was calculated. For Fig. 16, a route between Omaha and Idaho Falls was generated using the REROUTE command, since the origin is the same as that used in the previous run. Note that specification of the origin city, route type, time bias, and other parameters is not requested. By definition, the REROUTE option assumes the values specified in the last execution of the ROUTE command (i.e., values defined in Fig. 14).

```
 **** COMMAND ****  TYPE HELP FOR A LIST OF COMMANDS
REROUTE


ENTER DESTINATION CITY/STATE  (EXAMPLE ELY/MN)
IDAH/ID
 1  IDAHO FALLS                      ID    2  IDAHO FALLS    NW   I15  X119 ID
 3  IDAHO FALLS    W    I15  X118 ID


SELECT DESTINATION CITY
?
1

DO YOU WANT TO SET THE DEPARTURE DATE AND TIME? (Y/N)
IF NOT, THE PROGRAM USES THE CURRENT DATE AND TIME.
N
<<ROUTING>>


FROM: OMAHA          W    I680 U6   NE     LEAVING :  2/ 9/83 AT 15:32
TO  : IDAHO FALLS                   ID     ARRIVING:  2/10/83 AT 12:50

ROUTE TYPE: C WITH  2 DRIVER(S)                       TOTAL ROAD TIME: 21:19
  TIME BIAS:  0.70  MILE BIAS:  0.30  TOLL BIAS:  1.15   TOTAL MILES: 1012.0
STATE MILAGE:
 ID   70.0  WY   494.0  NE   448.0
MILEAGE BY HIGHWAY TYPE:
    INTERSTATE:  754.0   U.S.:  258.0  STATE:     0.0  TURNPIKE:    0.0
        COUNTY:    0.0  LOCAL:    0.0  OTHER:     0.0
```

Fig. 16. Use of the REROUTE command.

2.5.4 INST

The INST command is used to calculate routes that preferentially follow Interstate highways. This command will instruct the program to double the calculated impedance for all noninterstate roads. To calculate routes following the Interstate System, the user types INST<CR> following the command statement. The computer will respond with a single question:

DO YOU WANT TO GENERATE ROUTES FAVORING INTERSTATE HIGHWAYS? (Y/N)

The user enters a Y for YES or an N for NO. It should be noted that the interstate routing criterion will remain in effect until a negative answer is entered after a subsequent use of the INST command or until a STOP command is issued. When a user first executes the HIGHWAY program, the interstate routing criterion is not in effect; thus, the program starts by assuming that the desired answer to this question is NO.

The user does not have control of the weighting function applied to the different highway types in the INST command. The INST command doubles the impedance for all noninterstate roads. If other weighting functions are desired, the reader is referred to the WE subcommand discussed under the OPTION command.

An example of using the INST command is shown in Fig. 17.

```
 *** COMMAND ***  TYPE HELP FOR A LIST OF COMMANDS
INST
DO YOU WANT TO GENERATE ROUTES FAVORING INTERSTATE HIGHWAYS? (Y/N)
Y

NOTE: THIS OPTION REMAINS ACTIVE UNTIL TURNED OFF VIA A NO ANSWER.
 *** COMMAND ***  TYPE HELP FOR A LIST OF COMMANDS
```

Fig. 17. Use of the INST command.

2.5.5 RIS

The RIS command is used to determine which node in the HIGHWAY data base is closest to the location of an organization having a Reporting Identification Symbol (RIS) code. In some instances, the origin or destination of a shipment is identified by an RIS code rather than a city and state. The appropriate location in the HIGHWAY data base has been identified for approximately 2500 RIS codes. To determine a location for a RIS code, the user must enter RIS after the command statement. The computer will respond as follows:

ENTER RIS CODE OR <CR> TO END

The appropriate three-letter RIS code is typed on the next line. The computer is programmed to read only three characters; consequently blanks should not be inserted before the RIS code.

If an organization is assigned this particular RIS code, its name and location will be printed. The second line shown will be the node in the HIGHWAY data base which should be used to make routes to or from that location.

In the example shown in Fig. 18, the RIS code XFT is assigned to the Dairyland PWR Corporation in Genoa, Wisconsin. The corresponding node for routing is the La Crosse BWR nuclear plant in Wisconsin. Two other RIS code inquiries are also included in Fig. 18. YSK is assigned to La Sierra College in Riverside, California, and the nearest node is located northeast of Riverside at the junction of Interstate 15E and state highway 60. Chapman College in Orange, California, has the RIS code ZDJ, and the Yorba Linda node at the junction of state highways 55 and 91 should be used.

If a particular RIS code is unassigned, the computer will respond with:

***XXX RIS NOT FOUND

After each search, the computer will ask for another RIS code. The user can return to the command statement simply by typing a carriage return (<CR>).

2.5.6 REMOVE

REMOVE is one of three commands that can be used interactively to alter the highway data bases. The other two commands, D NODE and D LINK, will be discussed in Sect. 2.5.8. The REMOVE command may be

```
 **** COMMAND ****  TYPE HELP FOR A LIST OF COMMANDS
RIS

ENTER RIS CODE OR <CR> TO END
XFT

RIS CODE - XFT   DAIRYLAND PWR CORP     GENOA                WI
USE NODE - LA CROSSE B-R  NP WI

ENTER RIS CODE OR <CR> TO END
YSK

RIS CODE - YSK   LA SIERRA COLLEGE      RIVERSIDE            CA
USE NODE - RIVERSIDE       NE CA I15E S60

ENTER RIS CODE OR <CR> TO END
ZDJ

RIS CODE - ZDJ   CHAPMAN COLLEGE        ORANGE               CA
USE NODE - YORBA LINDA     SW CA S55  S91

ENTER RIS CODE OR <CR> TO END
XXU

**** XXU RIS CODE NOT FOUND

ENTER RIS CODE OR <CR> TO END

 **** COMMAND ****  TYPE HELP FOR A LIST OF COMMANDS
```

Fig. 18. Use of the RIS command.

used to either delete an entire state from the data base or to reinsert a state which was previously deleted.

At the start of any session using the HIGHWAY model, all states are in the data base; that is, the removal status of each state is set to false. If a state is removed, the removal status is changed to true. The removal status for that state will remain true unless the state is reinserted with the REMOVE command or the calculations are terminated with a STOP command. When the model is executed at a later time, the data base again includes all states.

If a number of states are to be removed from the data base, the user must make sure that a route exists between the origin or destination. If none exists, the ROUTE command will not be executed, and an error message will appear on the terminal.

After the REMOVE command has been entered, the computer will respond with the primary prompt:

```
THIS COMMAND WILL DELETE A STATE FROM OR ADD A PREVIOUSLY DEFINED
STATE INTO THE DATA BASE
ENTER ONE OF THE FOLLOWING SUBCOMMANDS:
DEL - TO DELETE A STATE          RETURN - TO RETURN TO COMMAND LEVEL
ADD - TO ADD A STATE             LIST - TO LIST DELETED STATES
```

To remove a state from the data base, the user enters DEL. The computer will respond with:

```
ENTER ABBREVIATION OF STATE TO BE DELETED
__
```

The two-letter state abbreviation must be typed under the dashes. The program will then return to the basic prompt shown above and request another subcommand. To delete multiple states, the user will have to use the DEL command for each state to be deleted.

The addition of a previously deleted state to the data base is accomplished by typing ADD after the basic prompt, and the computer will display:

```
ENTER ABBREVIATION OF STATE TO BE ADDED
__
```

Again, the two-letter state abbreviation must be typed under the dashes.

The RETURN subcommand will return the user to the command statement.

Occasionally, the user wishes to ask the computer to display the states currently deleted from the data base. This can be done by entering the word LIST after the primary prompt. The computer wil)   nd with a list showing any deleted states.

An example of using the REMOVE command is shown in Fig. 19, where two states (Arizona and Utah) were deleted. The LIST command was used to list any deleted states, and the RETURN command was used to terminate the operation of the REMOVE command and display the command statement.

2.5.7 RETYPE

Occasionally, extra copies of a route listing are desired. The RETYPE command will automatically print another copy of the last route generated. This saves the user from recalling the ROUTE command and reentering the origin, destination, and routing parameters a second time.

The RETYPE command is particularly useful if a detailed output, which shows all the nodes and links used on a route, is needed for a route just calculated. The detailed output switch can be turned on (see OPTION command, Sect. 3) and the data displayed by using the RETYPE command.

To obtain another copy of the last route generated, type RETYPE<CR> after the computer prints the COMMAND request:

COMMAND TYPE HELP FOR A LIST OF COMMANDS

2.5.8 ADVANCED

A number of special commands, which are not generally needed by the casual user, are included as part of the HIGHWAY model. A list, shown in Fig. 20, of these commands can be generated by typing the word ADVANCED after the command statement is displayed. A description of some of the advanced commands is included in Sect. 3.

2.5.9 STOP

After all of the desired routing calculations have been completed, the execution of the HIGHWAY model is terminated by entering STOP <CR> following the COMMAND statement. The computer will respond with several lines of type as shown in Fig. 21.

The first message is related to input errors detected by the program. On rare occasions, the user may inadvertently enter a city name where the program is expecting a number. This is interpreted by

```
 **** COMMAND ****  TYPE HELP FOR A LIST OF COMMANDS
REMOVE
THIS COMMAND WILL DELETE A STATE FROM OR ADD BACK A PREVIOUSLY DELETED STATE
INTO THE DATA BASE
ENTER ONE OF THE FOLLOWING SUBCOMMANDS:
   DEL - TO DELETE A STATE              RETURN - TO RETURN TO COMMAND LEVEL
   ADD - TO ADD A STATE                 LIST - TO LIST DELETED STATES
DEL
ENTER ABBREVIATION OF THE STATE TO BE DELETED
--
AZ
AZ HAS BEEN DELETED FROM THE DATA BASE
ENTER ONE OF THE FOLLOWING SUBCOMMANDS:
   DEL - TO DELETE A STATE              RETURN - TO RETURN TO COMMAND LEVEL
   ADD - TO ADD A STATE                 LIST - TO LIST DELETED STATES
DEL
ENTER ABBREVIATION OF THE STATE TO BE DELETED
--
UT
UT HAS BEEN DELETED FROM THE DATA BASE
ENTER ONE OF THE FOLLOWING SUBCOMMANDS:
   DEL - TO DELETE A STATE              RETURN - TO RETURN TO COMMAND LEVEL
   ADD - TO ADD A STATE                 LIST - TO LIST DELETED STATES
LIST
THE FOLLOWING STATES ARE DELETED FROM THE DATA BASE:
         AZ
         UT
ENTER ONE OF THE FOLLOWING SUBCOMMANDS:
   DEL - TO DELETE A STATE              RETURN - TO RETURN TO COMMAND LEVEL
   ADD - TO ADD A STATE                 LIST - TO LIST DELETED STATES
RETURN
 **** COMMAND ****  TYPE HELP FOR A LIST OF COMMANDS
```

Fig. 19. Example of using the REMOVE command.

```
**** COMMAND ****  TYPE HELP FOR A LIST OF COMMANDS
ADVANCED


        HIGHWAY 1.5 ADVANCED COMMAND LIST

"D LINK"     DELETE LINKS FROM THE DATA BASE.
"D NODE"     DELETE NODES FROM THE DATA BASE.
"OPTIONS"    REDEFINE PARAMETERS USED TO CALCULATE ROUTES.
"OUTPUT"     DISPLAY OUTPUT FOR THE LAST ROUTE GENERATED ON EITHER THE
             TERMINAL OR IBM SYSTEM PRINTER.
"TRANS"      CHANGE INTERSTATE TRANSFER COSTS (NORMALLY 0).
"RESET"      RESET LINK FILE (UNDELETE LINKS AND NODES).
"FILES"      SHOW FILENAMES AND FILE STATUS.

        NOTE: REFER THE HIGHWAY USERS MANUAL FOR FURTHER INFORMATION
        ON THESE ADVANCED COMMANDS.  THEY ARE NOT AS USER FRIENDLY AS
        THE OTHER MORE FREQUENTLY USED COMMANDS.


**** COMMAND ****  TYPE HELP FOR A LIST OF COMMANDS
```

Fig. 20. Output generated by the ADVANCED command.

```
STOP

                    ________________
                     HIGHWAY    1.5
                    ________________
                   ****  ****  ****  ****
                      ****  ****  ****
                         ****  ****
                            ****

PLEASE DO NOT WORRY IF YOU GET SOME ERROR MESSAGES FOLLOWING THESE LINES.
THEY HAVE NOT AFFECTED THE ACCURACY OF THE ROUTE.

TO END YOUR SESSION ON THE COMPUTER PLEASE TYPE THE WORD --->  LOGOFF
AS ONE WORD AFTER THE COMPUTER HAS TYPED READY.
READY
```

Fig. 21. Use of the STOP command.

the computer as an error. The program has been designed to detect such an error and to repeat the question; however, the computer keeps a record of these errors and, after the STOP command, will print a message indicating the existence of one or more errors. These errors do not affect the results reported, and the message can be ignored.

A second message will be printed to show the user the proper command to disconnect the communications link with the computer.

After the messages have been typed, the computer will signal that it is ready for the next command by typing:

READY

2.6 LOGGING-OFF PROCEDURE

When work is completed, the user must type:

LOGOFF<CR>

to terminate the connection with the computer. After some hesitation, a few messages will be printed, showing that the user has completed the session; then, the following statements will appear:

SELECT A SYSTEM
TYPE RECON, TLOGON, I FOR INTERACT, OR HELP

The on-line switch on the terminal should then be turned to off-line, the phone should be disconnected from the terminal, and the terminal turned off.

Do not hang up without going through the proper LOGOFF sequence. If the connection is broken, the user will still be classified as an active user for ~30 min and will not be able to access his account with the normal LOGON procedure.

2.7 REESTABLISHING A COMMUNICATIONS LINK

Occasionally, the communications link with the computer will be disrupted during a session. Some of the factors that can cause such a disruption include: (1) a loss of power to the terminal, (2) the phone is hung up inadvertently, or (3) noise on the phone line causes the computer to break the link. If the green light under the on-line switch goes off, the communications link with the computer has been broken. The user will not be able to reestablish contact with the terminal via the normal method described in Sect. 2.3 for ~30 min; however, it is possible for him to call the computer and reconnect to his original account. After the phone has been placed in the rubber cups and the green on-line light has lit, the user must type:

ARLOGON<CR>

The computer will respond with:

AC82003 ACF2, ENTER LOGON ID-

The user should then type his three-letter identifier, followed by a blank space and the word RECONNECT, as shown here:

xxx@RECONNECT<CR>

where xxx represents the user identifier. The computer will then ask for the password, in the normal manner. At this point, the computer will respond in one of two ways. If the user has reconnected to his original account, the computer will respond with:

ATTENTION EXIT IN CONTROL--BYE
READY

and the user can reactivate the HIGHWAY program using the procedure described in Sect. 2.4. If the account has already been closed by the computer operator, the following message will appear:

IKJ56409I TSOLOGON RECONNECT REJECTED - USERID xxx NOT FOUND

In this instance, the user should repeat the normal LOGON procedure as described in Sect. 2.3.

3. ADVANCED ROUTING COMMANDS

The basic routing commands discussed in Sect. 2 allow the user to perform most of the routing operations needed for day-to-day operations. Occasionally, certain applications require a more in-depth routing analysis. The advanced routing commands discussed in this section allow the user to employ a greater degree of freedom in attacking his particular problem. The user should be familiar with the basic commands given in Sect. 2 before trying to use the commands discussed in this section.

3.1 OPTION

The OPTION command is used to set up all routing parameters and constraints. Eleven codes are defined to perform a number of operations. The most frequently used codes (DR, DE, OP, IN, and RE) will be discussed first. Of the remaining five codes, only WE will be included in this section. The other four are designed for specific applications at ORNL and will not be discussed in this report.

Any parameters changed by the OPTION command remain in effect until further changes are made or until the calculation session has ended (i.e., until the phone connection is broken). When the user first executes the HIGHWAY program, all parameters are set to their most frequently used values.

To use the OPTION features, the user simply types OPTION <CR> after the COMMAND statement. The computer will respond with:

ENTER OPTION CODE OR TYPE HELP FOR ASSISTANCE

A list and a brief discussion of the OPTION codes will be printed when the user types the word HELP as the option code. This list is shown in Fig. 22. The codes designed for special applications at ORNL are grouped under the SP code. A list of these codes is also included in Fig. 22.

3.1.1 OP Code

The OP code will print a list of the current values for the routing parameters. The default values that are assigned at the start of the calculations are shown in Fig. 23. These parameters can be changed by using the various OPTION codes.

The initial values shown in Fig. 23 indicate that the toll bias is set to 1.15 (see Sect. 1.4.2). The time and distance biases are set for the commercial, quickest, and shortest routing criteria, as discussed in Sect. 1.4.1. The remaining route type 0 (other) has no meaning and can be ignored. A two-driver team is assumed for calculating the driving time (see Sect. 1.4.3). The PRINT = F indicates that all output will be directed to the user's terminal rather than to the line printers at ORNL. DETAIL = F indicates that the normal output will be displayed rather than the detailed listings showing every link and node (see Sect. 3.1.3). The map prompt shows

Basic OPTION Codes

```
        OPTION CODES
DR CHANGE THE NUMBER OF DRIVERS
DE PRINT DETAILED ROUTE LISTINGS
OP SHOW CURRENT PARAMETER VALUES
IN GENERATE ROUTES FOLLOWING INTERSTATE HIGHWAYS
SP SPECIALIZED OPTIONS HELP LIST
RE RETURN TO THE COMMAND STATEMENT
```

Specialized OPTION codes

```
        ADDITIONAL OPTION CODES
RO ROUTE TYPE OPTIONS
PR PRINT ROUTES AT THE ORNL COMPUTING CENTER
MA PROMPT FOR MAP FILE
DL ALERT TO DELETED SOURCE OR SINK
WE ALLOW WEIGHTS FOR HIGHWAY TYPE IN ROUTING
ST OUTPUT STATE FILE FOR ROUTE
DI SET LINK DELETIONS 1 OR 2 WAY

NOTE: REFER TO SPECIALIZED TECHNIQUES SECTION OF USERS MANUAL FOR
      DETAILED INSTRUCTIONS.
```

Fig. 22. Option codes.

that a special data file that is used for preparing graphics at ORNL will not be created. The deletion warning switch is turned off. The various links are not weighted by class of highway (see Sect. 2.5.4 or Sect. 3.1.6). The last two lines have no meaning for non-ORNL users and may be ignored.

Whenever a user is not sure of the parameters in effect, the OP code provides a means for determining their current value.

```
            CURRENT DEFAULT VALUES FOR OPTIONS

TOLL BIAS FOR ALL ROUTES =        1.15
ROUTE       TIME      DIST
 TYPE       BIAS      BIAS
  C          0.70     0.30
  Q          1.00     0.0
  S          0.0      1.00
  O          0.50     0.50
NUMBER OF DRIVERS =  2
PRINT =F     DETAIL =F
MAP PROMPT =F
DELETION WARNING =F
WEIGHT LINKS BY FUNCTIONAL CLASS =F
OUTPUT STATE MILEAGE FILE FOR ROUTES =T
2-WAY LINK DELETIONS =T
```

Fig. 23. Default values for routing parameters.

3.1.2 DR Code

The number of drivers used to calculate travel time can be changed with this subcommand. Although the default value is two drivers (essentially around-the-clock driving), a single driver can be specified with this subcommand. Note that the number of drivers can be defined for a single route application, as previously described in Sect. 2.5.2.1; however, if a number of routes using a single driver are desired, this subcommand is very useful. The computer will respond with:

ENTER NUMBER OF DRIVERS

_

The user must respond with a 1 <CR> or a 2 <CR>, as shown in Fig. 24.

3.1.3 DE Code

The DE code will produce a detailed listing of the route. While such a listing is useful under certain instances, it will produce a lengthy output. An example of the standard and detailed listings for a route between Chattanooga and Memphis, Tennessee, is shown in Fig. 25. The normal listing consists of only 4 lines, while the detailed listing contains more than 30 lines. One can see that a cross-country route could easily cover many pages.

To generate detailed codes, the user types DE after the statement requesting the option code. The computer will respond with

DETAILED ROUTE LISTINGS (ALL LINKS AND NODES)? (Y/N)

The user responds with a Y for YES or N for NO. Once turned on, the detailed listing will remain in effect until turned off by a subsequent use of the DE code.

```
ENTER OPTION CODE OR TYPE HELP FOR ASSISTANCE
DR
ENTER NUMBER OF DRIVERS (1 OR 2)
-
1
```

Fig. 24. Use of the DR code.

3.1.4 IN Code

The IN code is used to calculate routes that preferentially follow Interstate highways. This code automatically sets the standard weighting function, which doubles the calculated impedance for all noninterstate roads. The effect of the IN code is identical to the INST command discussed in Sect. 2.5.4 and operates in the same manner.

3.1.5 RE Code

The RE code indicates that no additional changes are needed and returns the program to the COMMAND statement.

3.1.6 WE Code

This code is used to change the highway type modifiers, which control the type of road a route should follow. For example, if a route along Interstate highways is desired, the highway modifiers for all noninterstate highways would be set to a larger value. Initially, all highway type modifiers are given a value of 1.0. The first prompting question is:

ALLOW CLASS WEIGHTED ROUTING?

Standard Route Listing

0.0		CHATTANOOGA				TN	0.0	4/11/83 AT 12:46
129.0	I24	NASHVILLE	SE	I24	I40	TN	129.0	4/11/83 AT 15: 7
201.0	I40	MEMPHIS	E	I240	I40	TN	330.0	4/11/83 AT 19:17
12.0	I240	MEMPHIS				TN	342.0	4/11/83 AT 19:30

Detailed Route Listing

0.0		CHATTANOOGA				TN	0.0	4/11/83 AT 12:46
12.0	I24	WILDWOOD	NW	I24	I59	GA	12.0	4/11/83 AT 12:59
15.0	I24	KIMBAL	S	I24	U72	TN	27.0	4/11/83 AT 13:16
17.0	I24	MONTEAGLE				TN	44.0	4/11/83 AT 13:34
18.0	I24	ARNOLD ENG D C	NE	I24	X117	TN	62.0	4/11/83 AT 13:54
6.0	I24	MANCHESTER				TN	68.0	4/11/83 AT 14: 0
30.0	I24	MURFREESBORO	S	I24	U231	TN	98.0	4/11/83 AT 14:33
3.0	I24	MURFREESBORO	W	I24	S96	TN	101.0	4/11/83 AT 14:36
24.0	I24	NASHVILLE	SE	I24	TBPW	TN	125.0	4/11/83 AT 15: 2
2.0	I24	BERRY FIELD	W	I24	I40	TN	127.0	4/11/83 AT 15: 5
2.0	I24	NASHVILLE	SE	I24	I40	TN	129.0	4/11/83 AT 15: 7
1.0	I40	NASHVILLE	SE	I40	U31A	TN	130.0	4/11/83 AT 15: 9
0.0	I40	NASHVILLE	S	I40	I65	TN	130.0	4/11/83 AT 15: 9
1.0	I40	NASHVILLE	SW	I40	U431	TN	131.0	4/11/83 AT 15:10
1.0	I40	NASHVILLE	W	I265	I40	TN	132.0	4/11/83 AT 15:11
26.0	I40	FAIRVIEW	NW	I40	S96	TN	158.0	4/11/83 AT 15:40
10.0	I40	POMONA	SE	I40	S46	TN	168.0	4/11/83 AT 15:51
9.0	I40	PINEWOOD	N	I40	S48	TN	177.0	4/11/83 AT 16: 0
20.0	I40	LOBELVILLE	N	I40	S13	TN	197.0	4/11/83 AT 16:22
17.0	I40	MC ILLWAIN	SW	I40	U641	TN	214.0	4/11/83 AT 16:41
18.0	I40	CLARKSBURG	S	I40	S22	TN	232.0	4/11/83 AT 17: 0
21.0	I40	JACKSON	NE	I40	U70	TN	253.0	4/11/83 AT 17:53
5.0	I40	JACKSON	N	I40	U45	TN	258.0	4/11/83 AT 17:59
2.0	I40	JACKSON	N	I40	S5B	TN	260.0	4/11/83 AT 18: 1
1.0	I40	JACKSON	NW	I40	U412	TN	261.0	4/11/83 AT 18: 2
13.0	I40	LEIGHTON	NW	I40	U70	TN	274.0	4/11/83 AT 18:16
10.0	I40	BROWNSVILLE	S	I40	S76	TN	284.0	4/11/83 AT 18:27
38.0	I40	BARTLETT	E	I40	U64	TN	322.0	4/11/83 AT 19: 8
8.0	I40	MEMPHIS	E	I240	I40	TN	330.0	4/11/83 AT 19:17
4.0	I240	MEMPHIS	NE	I240	S14	TN	334.0	4/11/83 AT 19:22
5.0	I240	MEMPHIS	N	I240	I240	TN	339.0	4/11/83 AT 19:27
2.0	I240	MEMPHIS	N	I240	S14	TN	341.0	4/11/83 AT 19:29
1.0	I240	MEMPHIS				TN	342.0	4/11/83 AT 19:30

Fig. 25. Example of standard and detailed listings for a route between Chattanooga and Memphis, Tennessee.

The user will respond with a YES<CR> or NO<CR>. A NO response will automatically reset all highway type modifiers to 1.0, and no further action is taken. After a YES response, the following information will be typed:

```
                 HIGHWAY TYPE WEIGHTS
INTERSTATE: 1.00    U.S.: 2.00    STATE: 2.00  TURNPIKE: 2.00
    COUNTY: 2.00   LOCAL: 2.00    OTHER: 2.00
CHANGE WEIGHTS?
```

The highway type weights are a recommended set of values for the highway type modifiers used in estimating routes which preferentially follow interstate highways. The user is expected to respond with a YES<CR> or NO<CR>. A NO response will accept the predefined set of highway type modifiers, and no further action is required.

At this point, the WE code has performed the same function as the INST command and the IN code discussed previously. With the WE code, however, the user has the ability to define a different set of weighting functions by responding YES to the above question. The computer response will be:

```
          ENTER NEW VALUES FOR WEIGHTS — 0 TO RETAIN VALUE
 INT       US        ST       TRNPK      CO        LOCL      OTHER
---.--    ---.--    ---.--    ---.--    ---.--    ---.--    ---.--
```

The user must enter the desired values. Note that a decimal point is required and that the displayed pattern indicates where the numbers must be typed. In the example shown in Fig. 26, the predefined set of highway modifiers was changed. A value was not entered under the Interstate highway type (INT); this has the same effect as entering a zero and specifies that the value already defined (1.00) for Interstate highways will be used. A value of 20. was entered for all other highway types. (Note the spacing and inclusion of the decimal point.)

3.2 D NODE

The D NODE command will remove specific highway intersections or nodes from the data base. After a node has been deleted, all routes must bypass that particular node. The D NODE command effectively blocks any shipments through a particular town or city.

```
ENTER OPTION CODE OR TYPE HELP FOR ASSISTANCE
WE
ALLOW CLASS WEIGHTED ROUTING?
Y
                HIGHWAY TYPE WEIGHTS
    INTERSTATE:     1.00 U.S.:      2.00 STATE:      2.00 TURNPIKE:     2.00
        COUNTY:     2.00 LOCAL:     2.00 OTHER:      2.00
CHANGE WEIGHTS?
Y
ENTER NEW VALUES FOR WEIGHTS - 0 TO RETAIN VALUE
  INT      US       ST     TRNPK     CO      LOCL     OTHER
___.__  ___.__  ___.__  ___.__  ___.__  ___.__  ___.__
          20.0    20.0    20.0    20.0    20.0    20.0
ENTER OPTION CODE OR TYPE HELP FOR ASSISTANCE
```

Fig. 26. Use of the WE code.

Any deletions made by the D NODE command are permanent. This command actually alters the user's personal copy of the highway data base; however, deleted nodes can also be reinserted into the data base by this command. If a number of deletions have been made, it is usually easier to reset the data base, using the method described in the data file initialization section (Sect. 4) of this report.

A series of examples will be given in this discussion to demonstrate the execution of the D NODE option. Following the command statement, the user types:

D@NODE<CR>

(Note the blank space inserted between the D and the N.) The computer will respond with:

NODE DELETE/REPLACE ROUTINE

WILL YOU BE ENTERING DATA FROM THE TERMINAL?

The answer to this question must be YES<CR>. A brief set of instructions will be typed, and the user will be asked to identify a city and state:

ENTER CITY/ST OR <CR> TO END

The user gives the identification in the same way the origin and destination cities are specified (see ROUTE command, Sect. 2.5.2). In Fig. 27 (Example 1), the city of Washington, Indiana, is specified by typing WASH/IN<CR>. The computer then prints a list of all cities in Indiana starting with the letters WASH, and the user is asked to select the desired city or cities as follows:

SELECT ONE CITY, A RANGE, OR <CR> TO END

```
 **** COMMAND ****  TYPE HELP FOR A LIST OF COMMANDS
D NODE
NODE DELETE/REPLACE ROUTINE
WILL YOU BE ENTERING DATA FROM THE TERMINAL?
YES
ENTER CITY/ST FOR LIST. THEN CHOOSE INDIVIDUAL CITIES OR A RANGE.
DELETIONS ARE PERFORMED UNLESS A "+" IS ENTERED IN COLUMN 10.

ENTER CITY/ST OR <CR> TO END
WASH/IN
 1  WASHINGTON                         IN

SELECT ONE CITY, A RANGE, OR <CR> TO END
-- --    -
01

SELECT ONE CITY, A RANGE, OR <CR> TO END
-- --    -


ENTER CITY/ST OR <CR> TO END


    1 NODES DELETED          0 NODES REPLACED
 **** COMMAND ****  TYPE HELP FOR A LIST OF COMMANDS
```

Fig. 27. D NODE command (Example 1).

Since only a single Washington is found, an 01 is typed under the first two dashes. Note that a two-digit number must be typed under the dashes in this command. The computer continues to ask the user to select a city from the list until all the desired nodes have been deleted; the user terminates this action by typing <CR>.

The user will then be asked to specify another city/state. If no other cities are needed, a <CR> will end the D NODE operation and return the user to the COMMAND statement after typing a message showing the number of nodes deleted or replaced.

Example 2 (Fig. 28) shows how to delete a number of nodes rapidly. In this case, all four nodes in the vicinity of Des Moines, Iowa, are to be deleted. When the computer prompts the user to select a city or a range, the user should respond with:

01@04 <CR>

This signifies that all cities from No. 1 through No. 4 in the list are to be deleted.

The more-complicated Example 3 (Fig. 29) deletes a number of nodes (i.e., the first four and the seventh) in the vicinity of Omaha, Nebraska. The range feature was used to delete the first four nodes by typing 01@04<CR>, while the seventh node was deleted by typing 07<CR> after the user was again asked to select a city.

Figure 30 shows how one or more nodes can be reinserted into the data base. For this example, the four nodes near Des Moines, Iowa (which were deleted in Example 2), will be replaced. The procedure is identical to that used for deletion until the selection of a city is requested. To replace the four nodes, the user types:

01@04@@@@+<CR>

The plus sign at the end of the statement indicates the nodes are to be added rather than deleted. Note that the final message indicates four nodes have been replaced.

While the D NODE command is a powerful tool, the average user probably will not need to exercise this capability.

3.3 D LINK

The D LINK command is used to remove a specific highway segment or link from the data base. As with the D NODE command, deletions made with

```
 *** COMMAND ***  TYPE HELP FOR A LIST OF COMMANDS
D NODE
NODE DELETE/REPLACE ROUTINE
WILL YOU BE ENTERING DATA FROM THE TERMINAL?
YES
ENTER CITY/ST FOR LIST. THEN CHOOSE INDIVIDUAL CITIES OR A RANGE.
DELETIONS ARE PERFORMED UNLESS A "+" IS ENTERED IN COLUMN 10.

ENTER CITY/ST OR <CR> TO END
DES/IA
 1  DES MOINES                      IA    2  DES MOINES     N    I235 I35  IA
 3  DES MOINES    S     U65  S5     IA    4  DES MOINES     W    I235 I35  IA

SELECT ONE CITY, A RANGE, OR <CR> TO END
-- --   -
01 04

SELECT ONE CITY, A RANGE, OR <CR> TO END
-- --   -


ENTER CITY/ST OR <CR> TO END


    4 NODES DELETED          0 NODES REPLACED
 *** COMMAND ***  TYPE HELP FOR A LIST OF COMMANDS
```

Fig. 28. D NODE command (Example 2).

```
 *** COMMAND ***  TYPE HELP FOR A LIST OF COMMANDS
D NODE
NODE DELETE/REPLACE ROUTINE
WILL YOU BE ENTERING DATA FROM THE TERMINAL?
YES
ENTER CITY/ST FOR LIST. THEN CHOOSE INDIVIDUAL CITIES OR A RANGE.
DELETIONS ARE PERFORMED UNLESS A "+" IS ENTERED IN COLUMN 10.

ENTER CITY/ST OR <CR> TO END
OMAHA/NE
 1  OMAHA                      NE    2  OMAHA          N    I680 U73  NE
 3  OMAHA        NW   I680 U73 NE    4  OMAHA          S    I480 I80  NE
 5  OMAHA        S    I80  U73 NE    6  OMAHA          SW   I680 I80  NE
 7  OMAHA        SW   I80  U275 NE   8  OMAHA          W    I480 U6   NE
 9  OMAHA        W    I680 U6  NE

SELECT ONE CITY, A RANGE, OR <CR> TO END
-- --   -
01 04

SELECT ONE CITY, A RANGE, OR <CR> TO END
-- --   -
07

SELECT ONE CITY, A RANGE, OR <CR> TO END
-- --   -


ENTER CITY/ST OR <CR> TO END


    5 NODES DELETED           0 NODES REPLACED
 *** COMMAND ***  TYPE HELP FOR A LIST OF COMMANDS
```

Fig. 29. D NODE command (Example 3).

```
 *** COMMAND ***  TYPE HELP FOR A LIST OF COMMANDS

D NODE
NODE DELETE/REPLACE ROUTINE
WILL YOU BE ENTERING DATA FROM THE TERMINAL?
YES
ENTER CITY/ST FOR LIST. THEN CHOOSE INDIVIDUAL CITIES OR A RANGE.
DELETIONS ARE PERFORMED UNLESS A "+" IS ENTERED IN COLUMN 10.

ENTER CITY/ST OR <CR> TO END
DES/IA
 1  DES MOINES                 IA    2  DES MOINES     N    I235 I35  IA
 3  DES MOINES    S   U65  S5  IA    4  DES MOINES     W    I235 I35  IA

SELECT ONE CITY, A RANGE, OR <CR> TO END
-- --    -
01 04    +

SELECT ONE CITY, A RANGE, OR <CR> TO END
-- --    -


ENTER CITY/ST OR <CR> TO END


    0 NODES DELETED          4 NODES REPLACED
 *** COMMAND ***  TYPE HELP FOR A LIST OF COMMANDS
```

Fig. 30. D NODE command (Example 4).

the D LINK command are permanent, since the user's personal copy of the highway data base is altered. Deleted links can be manually reinserted; however, if a number of deletions have been made, the user should consider using the technique described in the data file initialization section (Sect. 4) for resetting the data base.

Examples of the D LINK command operation are shown in Figs. 31 and 32. Figure 31 shows how a particular link may be removed, and Fig. 32 illustrates reinsertion of a link using the D LINK command.

After the command statement, the user types D@LINK<CR>. (Note the blank space between the D and L.) The computer responds with:

LINK DELETION/INSERTION ROUTINE - DEFAULT MODE IS 2-WAY
WILL YOU BE ENTERING DATA FROM THE TERMINAL?

The answer to this question must be YES<CR>.

The computer types a short set of instructions and then requests the user to specify a city and state:

ENTER CITY/ST OR <CR> TO END

A city name is entered, using the same rules previously described in the ROUTE command section. A list of nodes is displayed, and the user is asked to select the desired intersection:

SELECT A CITY OR ENTER A <CR> TO END
?

A number is entered under the question mark.

All highway segments associated with the selected city will then be listed, labeled as the forward star for that city. In Fig. 31, four links are identified with Huron, South Dakota. At this point, a good road atlas should be consulted to visualize the physical layout of the highway network. The first link is State Highway 37, heading south to Woonsocket, South Dakota; the second is U.S. 14, heading west to Wolsey; the third is State Highway 37, heading north toward the Huron airport (HON); and the fourth is U.S. 14, heading east to Arlington.

The user will be asked to specify the links to be altered:

ENTER LINK #, A RANGE, OR <CR> TO END
-- -- M D

The specific link to be deleted is entered beneath the first set of dashes as a two-digit number. A range of links can be deleted by entering

```
 *** COMMAND ***  TYPE HELP FOR A LIST OF COMMANDS
D LINK

LINK DELETION/INSERTION ROUTINE - DEFAULT MODE IS 2-WAY
WILL YOU BE ENTERING DATA FROM THE TERMINAL?
YES

ENTER CITY/ST FOR NODE LIST. CHOOSE A NODE AND THE LINKS EMINATING
FROM THAT NODE WILL BE DISPLAYED. THEN CHOOSE LINKS FROM LIST.
DELETIONS ARE PERFORMED UNLESS A "+" IS ENTERED IN COLUMN 10.

ENTER CITY/ST OR <CR> TO END
HURON/SD
 1  HURON                         SD
SELECT A CITY OR ENTER A "0" TO END
?
1

   FORWARD STAR FOR HURON                               SD

 1  HGWYS:S37           46 MPH  22 MILES TO WOONSOCKET     E    S34  S37  SD
 2  HGWYS:U14           46 MPH  12 MILES TO WOLSEY         S    U14  U281 SD
 3  HGWYS:S37           28 MPH   1 MILES TO HON AIRPORT                   SD
 4  HGWYS:U14           46 MPH  55 MILES TO ARLINGTON                     SD

ENTER LINK#, A RANGE, OR <CR> TO END
         M D
-- --    - -
02

ENTER LINK#, A RANGE, OR <CR> TO END
         M D
-- --    - -
04

ENTER LINK#, A RANGE, OR <CR> TO END
         M D
-- --    - -


ENTER CITY/ST OR <CR> TO END


    4 LINKS DELETED          0 LINKS INSERTED
 *** COMMAND ***  TYPE HELP FOR A LIST OF COMMANDS
```

Fig. 31. Removing links from the data base using the D LINK command.

```
 **** COMMAND ****  TYPE HELP FOR A LIST OF COMMANDS
D LINK

LINK DELETION/INSERTION ROUTINE - DEFAULT MODE IS 2-WAY
WILL YOU BE ENTERING DATA FROM THE TERMINAL?
YES

ENTER CITY/ST OR <CR> TO END
HURON/SD
 1  HURON                              SD
SELECT A CITY OR ENTER A "0" TO END
?
1

   FORWARD STAR FOR HURON                                   SD

 1  HGWYS:S37            46 MPH  22 MILES TO WOONSOCKET      E    S34  S37  SD
 2  HGWYS:U14            46 MPH  12 MILES TO WOLSEY          S    U14  U281 SD
 3  HGWYS:S37            28 MPH   1 MILES TO HON AIRPORT                    SD
 4  HGWYS:U14            46 MPH  55 MILES TO ARLINGTON                      SD

ENTER LINK#, A RANGE, OR <CR> TO END
         M D
-- --    - -
02       +

ENTER LINK#, A RANGE, OR <CR> TO END
         M D
-- --    - -


ENTER CITY/ST OR <CR> TO END


    0 LINKS DELETED          2 LINKS INSERTED
 **** COMMAND ****  TYPE HELP FOR A LIST OF COMMANDS
```

Fig. 32. Removing a deleted link using the D LINK command.

the first and last links under the first two sets of dashes (see the section on D NODE command for an example using a range). The ENTER LINK # statement will be repeated until the user has completed all of the desired deletions. At this point, the user simply enters a <CR> to end this operation. The computer will then respond with:

ENTER CITY/ST OR <CR> TO END

Another city can be selected, or a <CR> will return the user to the COMMAND statement, if all desired deletions have been made. In the example shown in Fig. 31, links 2 and 4 were deleted in separate operations. Note that, although only two links were deleted, the report typed at the end of the D LINK action shows that four were deleted. From a mathematical standpoint, it is convenient to represent each segment by two unidirectional links. Traffic can flow along a highway in two directions; thus, to block flow along a particular highway segment, both of the unidirectional links must be deleted. For this reason, the number of deleted links reported will always be twice the number of highway segments the user has actually deleted.

An example of reinserting a deleted link is shown in Fig. 32. The responses for adding a link are identical to those described for deletion, with one exception. The computer responds with:

ENTER LINK #, A RANGE, OR <CR> TO END

__ __ M D

A plus sign (+) should then be entered under the M.

4. DATA FILE INITIALIZATION

When a number of highway segments and intersections have been deleted from the data base, the same links and nodes can be replaced with the D LINK and D NODE commands, but this is a time-consuming procedure.

The simplest way to reset the data base to its original condition is to delete the user's personal copy. A new copy of the original version will automatically be generated when the user next executes the HIGHWAY model.

To delete data bases, the computer must have just typed READY. There are two ways to obtain the READY statement: (1) after the user has logged on, the computer will signal it is available by typing READY; and (2) after the STOP command has been issued, the computer will signal READY. The user then types:

SHOW@DA('T.XXX17999.INDEX')@ALL@SCR<CR>

The xxx in this command must be replaced by the user's three-letter ID. An example illustrating deletion of the data bases is shown in Fig. 33; in this example, the user's ID is DSJ. Each of the data sets is then identified, and the user is asked if this set should be deleted by the displayed message OK?. The data sets are deleted by typing YES<CR>.

```
READY
SHOW DA('T.DSJ17999.INDEX') ALL SCR
** CATALOG RESIDES ON FIRST1
T.DSJ17999.INDEX.BLKHGWS
   VOLUME(FIRST1)-DEVICE(3330-1)-ADDRESS(40B)
   CREATED(4/12/83)-LAST USED(4/12/83)-LAST USER(DSJ)-USES(2)
   RECFM(F)-LRECL(13008)-BLKSIZE(13008)-DSORG(PS)-SECURITY(N)
   TRKS ALLOCATED(95)-TRKS FREE(3)-SPACE(BLK-1)-EXTENTS(1)
OK? YES
T.DSJ17999.INDEX.HGWPGMS
   VOLUME(FIRST1)-DEVICE(3330-1)-ADDRESS(40B)
   CREATED(4/11/83)-LAST USED(4/12/83)-LAST USER(DSJ)-USES(6)
   RECFM(F)-LRECL(13008)-BLKSIZE(13008)-DSORG(PS)-SECURITY(N)
   TRKS ALLOCATED(95)-TRKS FREE(3)-SPACE(BLK-1)-EXTENTS(1)
OK? YES
** 2 DATA SETS SCRATCHED-UNCATALOGING IN PROGRESS
READY
```

Fig. 33. Deletion of data sets.

5. REFERENCE

1. D. S. Joy, P. E. Johnson, and S. M. Gibson, HIGHWAY, A Transportation Routing Model: Program Description and Users' Manual, ORNL/TM-8419, December 1982.

6. APPENDIX: ACCEPTABLE ABBREVIATIONS FOR COMMANDS IN THE HIGHWAY MODEL

Command	Abbreviation
YES	Y
NO	N
ROUTE	ROUT
REROUTE	RERO
OPTION	OPTI
REMOVE	REMO
D@NODE	D@NO
D@LINK	D@LI

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