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TECHNOLOGY TRANSFER SYSTEM AUTOMATION IMPLEMENTATION

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16. Abstract

The Technology Transfer Unit of the Colorado Department of Highways maintains a technical library consisting of research and technical reports from varied sources. This report documents the implementation of an automated data base management program to file the reports as well as supporting information on each report such as distribution information and comments. Objectives, observations and an appendix with instructions to the system's operations as currently set up are included.

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BACKGROUND

The Research Branch of the Colorado Department of Highways maintains the Technology Transfer Library, located in the Technology Transfer (TT) Unit. The library includes approximately 4000 research and technical reports from many varied sources, including the Federal Highway Administration, the Transportation Research Board, other Federal and State transportation agencies, and in-house articles. The TRB series reports account for approximately half of this total; these are listed in TRB's List of Publications. The documents that come in from other agencies are recorded on a filing system designed by the TT staff.

This system has had three main components: a Rolodex card file, a computer card key word card file, and a summary sheet file. Figures 1, 2, and 3 show samples of these items. A newly received report has its appropriate information entered on these records. A separate keyword card is made for each of the keywords that might be applicable to the report subject matter. These keyword cards are filed according to the keyword. A report search on the present system would proceed as follows: If information on a particular subject is wanted, one would search through the computer card keyword file for the keyword(s) that most closely describe the desired subject. Reading across the card, the user would find the title and library location number of a report which has the given keyword associated with it. Given a known title, one would look it up in the Rolodex card file.

Figure 1.
A sample Rolodex card. Included are the title, date of publication, performing agency/ sponsoring agency, area (location in the library), and number of copies. The first three significant words in the title are printed across the top of the card. The first letters in these words become the alphabetical reference in the library location number. The keywords are printed on the back of the card. The cards are then filed alphabetically according to title.

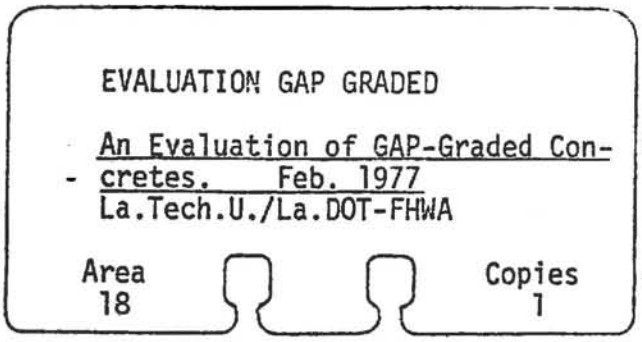

Figure 2: A keyword card includes the keyword, report title, and location number printed across the top of a computer card. The cards are filed alphabetically according to the keyword.

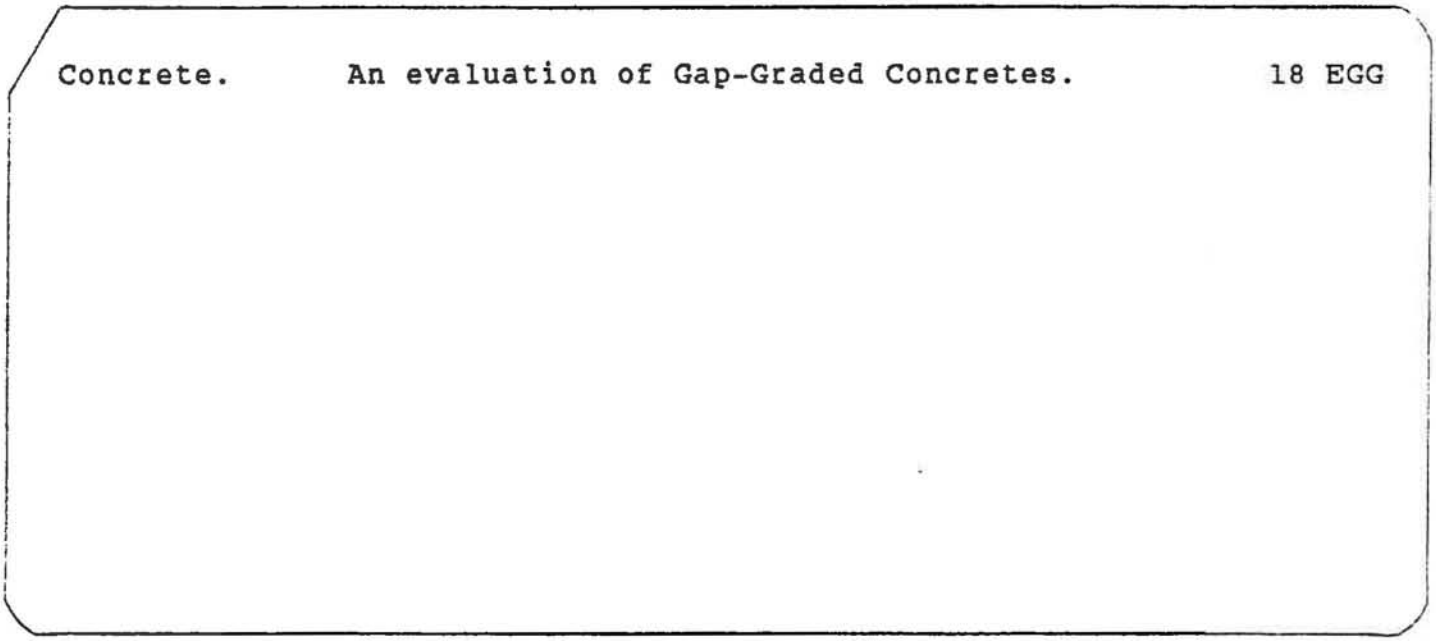

Figure 3a: The front of a sample summary sheet. "Useful Facts" are obtained from the abstract of the report.

DOCUMENT SUMMARY

TITLE and DATE: LEFT TURN TREATMENTS AT SIGNALIZED INTERSECTIONS WITHOUT TURNSLOTS

PERFORMING AGENCY: NEW JERSEY D.O.T.

SPONSORING AGENCY: FHWA

USEFUL FACTS:

Guidelines were developed for left turn provisions at signalized intersections with mixed traffic lanes. They consist of: 1) a general left turn provision guideline which determines, on the basis of delay, if a left turn provision should be considered for the intersection approach under study, and 2) a set of guidelines which determine the type of left turn provision to be used.

These guidelines were tested using the results of a series of before and after field studies conducted at intersections where a left turn provision was installed. The results of this testing, along with a procedure for proper application of the guidelines, are included.

Figure 3b: The back of the summary sheet. Summary distribution information as well as the area definitions are included here.

summarized by_____ date:_____ copies:_____

1 Design - Pavements
2 Administration - Economics
3 Traffic - Operations and Control
4 Materials and Construction - General Materials
5 Traffic - Illumination and Visibility
6 Maintenance - Snow & Ice Control
7 Transportation Planning - Traffic Planning
8 Transportation Planning - Urban Transportation
9 Materials and Construction -
10 Materials and Construction - Specifications, Procedures, and Practices
11 Administration - Law
12 Design - Bridges
13 Maintenance - Equipment
14 Maintenance - Maintenance of Way and Structures
15 Design - General Design
16 Design - Roadside Development
17 Traffic - Safety
18 Materials and Construction- Concrete Materials
19 Administration - Finance
20 Special Projects
21 Soils and Geology -
22 Design - Vehicle Barrier Systems
23 Soils Properties
24 Soils Mechanics and Foundations

Copies sent to:

Summaries sent to:

1) District 1
2) District 2
3) District 3
4) District 4
5) District 5
6) District 6
7) Staff Materials

It is obvious from Figures 1, 2, and 3 that there is much duplication of information, and as the total number or reports grows, a file search becomes more and more time consuming. In addition, the records, themselves take up more and more physical space as reports are added, and any tabulation of total reports, total summaries, reports requested, etc., requires lengthy manual counting.

OBJECTIVE

The goal for this project was to adapt the TT records to an automated data system to facilitate standard record keeping, file searches, retrieval, and quarterly tabulations of TT activities. Along the same line, TT also keeps a file on product evaluations performed by the Department. The record keeping procedure for this data, as well as for mailing lists for information dissemination, could be automated for the same reasons. The resulting system will ultimately be connected into terminals in other branches of the Colorado Department of Highways and outside agencies including public libraries, enabling any party to access files on the system.

WORKPLAN

The first task in this endeavor was to define the types of report record data to be entered and the desired access methods. There was both statistical and descriptive information in the old system. An example of this was the summary information on the back of the summary sheet; the total number of summaries, as well as to whom they were sent. One entry would consist of the report descriptors such as title, performing agency, location number, number of available copies, etc., as well as the summary distribution information and associated keywords.

The file program selected had to have the capability to count the entries and also to total the figures within each entry such as number of summaries sent and returned. Partial entry search was desired: this would enable the user to search the files when only part of a title or keyword was known, or when one was unsure of the proper descriptor. Lastly, the accession procedure should be as simple as possible to enable persons unfamiliar with Technology Transfer to use the system.

The next step was to conduct a literature search and review of current activity in this area. This was relatively simple as one of the results of the recently heightened interest in microcomputers has been a multitude of published articles describing data-base managers and their capabilities. The U.S. D.O.T. Publication "Microcomputers in Transportation: Selecting a Single User System" was a great help in the literature review as it included true performance and feature and price comparisons between various computers and software. Conversations with other Federal and state officials who had experience with database management, as well as with several private agencies, brought out valuable tips and pointers as to what features to look for and formatting procedures.

It was determined that the features of the IBM PC/XT personal computer system appropriately met the needs of the intended operation. Writing the specifications for the system was relatively straightforward as the Department was already planning to purchase several IBM PC/XTs. Added to the request were specifications for a software-controlled modem with selectable baud rate and a parallel port printer. The software requested included a text editor package, a communication software package to mimic the terminal, and a data base management system. In reflection, the specifications for the latter item should have been tighter as the "database management system" received was the PFS Series File Management software which failed to meet many of the needs for a data base management system.

Following the equipment installation, software testing began by putting together a sample data file with the PFS File Manager. It quickly became apparent that the program was not powerful enough for the intended needs. Most difficulties stemmed from the fact that the PFS Series can only treat one file at a time, hence the name "file manager". A "data base manager" is what was needed with capabilities to access and treat multiple files at a time.

After further investigation, an R:Base 4000 Data Base Manager was purchased. This more powerful program met the user's needs much more closely. Besides being more versatile in the types of computations and modifications allowed to and between files, R:Base allows modifications to the program itself. This allows the user to streamline many repetitive or exhaustive functions by placing numerous commands in a mini-program and then executing the mini-program as opposed to retyping the commands again and again. The program also gives the capability to create commands that require interactive responses, and to create comments and conditional (If/Then) commands. These features lend a great deal of flexibility to the program.

OBSERVATIONS

The main difficulty with implementing the system was the fact that a computer, in order to execute its functions properly, must have its data clearly and distinctly displayed and "explained" to it. There is no room for implication, as opposed to a manual system. The various computations required have to be meticulously diagrammed. This pointed out the differences between the File Manager and the Database Manager. Whereas the File Manager could carry out only one computation at a time (e.g. print out all reports in the file first, then count them), the Data Base Manager could count them, divide the count by the number of days in the previous month, count all reports by a specific performing agency, etc.,

all in one command. In a larger system such as the one TT uses, the flexibility to tie a large series of commands together was a major keystroke saver. The ability to create screen messages and interactive commands which require the user only to answer prompted questions also saved time and made the program easier to use for the users that were uninitiated with the program or computers in general. The File Manager program allowed very little in the way of customization; this would have necessitated writing an extensive set of instructions covering every manipulation that the computer would be required to perform to achieve a desired result.

After a major portion of the report data was entered, it became apparent that search speed would be a problem. Searches sometimes took 5-7 minutes to complete. Two factors were identified as contributory to the slow results. The first was the fact that the search parameters were inexact. In the current setup, the search command takes a word typed in by the user, such as "barrier", and tries to find that word somewhere within the title and keyword fields of each record. The program takes much longer to find a word within a line of text than to find a whole line of text. Since exact titles and keywords aren't known all the time, the search routine had to be left as is. Attention was therefore turned to the second factor, namely the size of the database. The computer had to go through the entire database to find a particular report. It was then decided to define a limited number of subject areas, create files for each and place each report in its appropriate subject file. In this way, a file search on a particular subject could be confined to the one or two files which were most likely to include the subject. The 12 categories are as follows:

1) Pavements;
2) Bridges;
3) Soils/Geology;
4) Maintenance;
5) Administration;
6) Traffic;
7) Environment;

8) Planning/Design;
9) Safety;
10) Hydrology/Hydraulics;
11) Construction;
12) Energy.

Most reports fit within one of these areas. The definitions for the categories are kept flexible to allow for unusual subjects, and if a report covers more than one subject, it can be filed in as many categories as applicable. Since each "sub-file" is much smaller than the master file, search time can be reduced considerably; in fact, five or six "sub-file" searches can be accomplished in the time it takes to search the entire file. The capability to search the entire file will, of course, be retained.

IMPLEMENTATION

The present system requires of the user little more than knowledge of what product is desired of the machine; i.e. a file search, a review of report information, or data entry. A set of instructions as currently used by the Technology Transfer Unit is included in Appendix A.

The system as currently set up meets the objectives set out for it. Report Information retrieval is relatively fast and the system is easy to use. The option is still open to refine the procedures and the program in the future if necessary, thanks to the flexibility of the software. This section will summarize the present format of the system and discuss applications to other agencies' needs.

A given report has a number of attributes such as title, report date, authors, etc., which distinguish it from others. These attributes (plus others, such as the date the report was received and the number of copies received) are all entered and filed together by the program to compose one report entry. Each attribute is entered in a certain area, called a "field" in R:Base parlance. These fields are given "attribute names" of 8 characters or less for the program's reference.

The complete list of descriptors, their corresponding attribute names, and their assigned field lengths are given as follows:

1) Report title (TITLE), 150 characters;
2) Date report is received/summarized (DATERCVD), 1 date value in day/month/year;

3) Performing agency (PERFORM), 55 characters;
4) Sponsoring agency (SPONSOR), 55 characters;
5) TT Library location number (LOC), 8 characters;
6) Report number (REPT#), 25 characters;
7) Number of copies received (COPIES), 2 numbers;
8) Keywords associated with the report (KEYWORD), 140 characters;
9) Number of summaries sent out (SUMSENT#), 2 numbers;
10) Number of summaries returned with responses (SUMRET#), 2 numbers;
11) Summaries returned with positive responses (SUMPOS#), 2 numbers;
12) Who the summaries were sent to (SUMTO), 60 characters;
13) Number of copies sent out without summaries (CPYSENT#), 2 numbers;
14) Who the copies were sent to (CYPTO), 50 characters;
15) Who the report has been loaned to (LOANTO), 5 characters;
16) Who is waiting to see the report (WAITING), 80 characters.

In the R:Base program, delimiters cannot be placed within fields for the purpose of counting; in other words, the program cannot count separate entries within data field such as SUMTO, which lists the recipients of summaries, so a separate field (in this case SUMSENT#) must be included to show how many summaries SUMTO represents. This procedure is a bit cumbersome; a provision for delimiters, such as commas or semicolons, to separate entries within data fields would be a welcome feature in a prospective data base. User-created screen messages and interactive commands were mentioned earlier in the report. Appendix B diagrams the command files created by TT and their uses in the system. These greatly streamline the most-used functions of the system by reducing long strings of commands to one or two-key actions. Other data base managers may or may not have similar program-modification capabilities; the TT unit highly recommends such features. Computer system requirements such as disk space, memory capacity, etc., are largely dictated by the software used. The IBM PC/XT used by the TT

Unit possesses 512K bytes of Random Access Memory (RAM); the R:Base program requires 256K for execution.

Additional possible future uses of the automation system include the storage and production of summary sheets similar to the one shown in figure 3 and complete listings of all mailing and distribution lists. At this time, however the summary sheet has been retained. It was originally planned to have the computer print out a similar summary sheet based on the data base information, but formatting and disk space problems preclude that use. Mailing and distribution lists, for much the same reasons, have not been automated as yet, though improvements in software may facilitate their inclusion in the future.

APPENDIX A

Instructions to R:Base 4000 Applications on the TT Computer (IBM PC/XT)

TO ENTER THE R:BASE PROGRAM:

The computer prompts up this screen upon start-up. Entering date and time is optional.

```
C>DATE
Current date is Tue  1-01-1980
Enter new date:

C>TIME
Current time is  8:18:16.60
Enter new time:

C>PATH/;C:DOS;C:/ASYNC;C:/RBASE;C:/PFS;C:/PROEDIT

C>REM ENTER CD 'your subdirectory'

C>REM IF YOU DO NOT HAVE A SUBDIRECTORY ENTER MD "your last name" BEFORE

C>REM THE CD COMMAND

C>
```

The TT computer's files are split up into subdirectories. Access to the R:Base program is accomplished by entering the R:Base specification after the C> prompt, as shown.

```
C>cd rbase
```

Insert the Rbase Disk #1 and enter RBASE.

```
C>rbase
```

The following screen is prompted.

```
Begin R:base 4000 Version 1.11 MSDOS Serial # #######
For the IBM PC, PC/XT and compatibles (Compaq, Columbia, Eagle, and others)
Copyright (C) 1983, 1984 by Microrim, Inc.

For assistance type "HELP", for Prompt mode type "PROMPT:
  Database exists
  Switching INPUT back to TERMINAL
```

TO CONDUCT A FILE SEARCH:

Enter PROMPT SEARCH after the R> prompt.

```
R>prompt search
```

When the following screen is prompted, press the "G" key.

```
E(dit), R(elation list), A(ttribute list), G(o), Q(uit):
PROMPTS
The SEARCH program will search the title and keyword fields of each record on file to find the
word you choose.
      Press G(o) to initiate the program.
```

Choose a word or phrase and enter it. The program will search the files to find any reports which have your chosen word(s) in either their title or keyword fields. The example below uses the word "DEER".

```
INPUT ABA.RPT
Enter the word you would like to search by:  DEER
```

The program will display the location and title of the reports that meet your specifications and ask you if you would like to do another search. Entering "Y" here, indicating "yes", will run the SEARCH program again.

```
INPUT ABA.RPT
Enter the word you would like to search by:  DEER
17 EHC  Effects of Highway Construction and Use on Big Game Populations 3/76
17 EHD  Evaluation of Highway Deer Kill Mitigation on SIE/LAS-395 9/76
17 HFD  Highway Fences as Vehicle-Deer Collision Deterrents.  6/76
20 EDM  Evaluation of Deer Mirrors for Reducing Deer-Vehicle Collisions 5/82
20 EHO  Effects of Highway Operation Practices and Facilities on Elk, Mule Deer, and Pronghorn
        Antelope 3/80
Would you like to search again (Y/N)?
```

NOTE: To print the information viewed on the screen on the printer press the shift key and the "PRT SC" key at the same time.

TO REVIEW AND/OR EDIT ALL INFORMATION ON A PARTICULAR REPORT:

Enter "PROMPT SUMMARY" to the R> prompt.

```
R>prompt summary
```

The program will search the file for all reports with the specified word and (optionally) location number. There may be more than one word with those parameters; it is best to be as specific as possible when specifying a report. After you read the screen, press the "G" key.

```
E(dit), R(elation list), A(ttribute list), G(o), Q(uit):
PROMPTS
```

```
The SUMMARY program will allow you to review and/or edit a particular record
on file.  You'll need to know all or part of the title and (optionally) the
location number of the report(s) you want.
        Press G(o) to initiate the program.
```

Enter one or more words that you know are in the title, and enter the location number if you know it. The example below looks for a report which has "DEER KILL" in its title and "17" in its location number.

```
INPUT AAA.RPT
Enter part or all of the title of the desired report(s):  DEER KILL
Enter part or all of the location number:  17
```

The report information is presented on the screen.

```
C(hange entry), A(dd entry), R(eset), S(kip), E(dit), D(elete), Q(uit):

TITLE   : Evaluation of Highway Deer Kill Mitigation on SIE/LAS-395
          9/76
                                                    DATERCVD:
PERFORM:  California Dept. of Transportation
SPONSOR:  FHWA
LOC     :  17 EHD                                 REPT#    :  CA-DOT-EN-4103-1-76
COPIES :  1                 KEYWORD :

                                                  SUMSENT#:
                                                  SUMPOS# :
SUMRET#
SUMTO  :
                                                  CPYSENT#:
CPYTO  :
                                                  LOANTO  :
WAITING:
```

Use the cursor control to locate cursor and type corrections. Insert and delete keys can also be used.

The options at the top of the screen work as follows: C(hange entry) will write any changes to the file and go to the next record which meets the criteria you entered. R(eset) will negate any changes and restore the record to its original state. S(kip) will skip to the next record that meets your criteria. D(elete) will erase the record from the file. Q(uit) will return you to the R> prompt with no action for the file. E(dit) will allow you to edit the file.

If the program cannot find any reports with your specifications, the following screen will prompt up:

```
                    0 row(s) were changed
                    0 row(s) were deleted
Would you like to review/edit again (Y/N)?
```

If you want to review or edit another report, push the "Y" key, and the SUMMARY program will start up again.

TO ENTER A REPORT:

The command PROMPT DATA will allow data entry.

```
R>prompt data

E(dit), R(elation list), A(ttribute list), G(o), Q(uit):
PROMPTS
```

Press G(o)

Press G to initiate the program.

The following screen prompts up. Use the cursor control to locate the cursor and make corrections. Use the return key to change entry fields. When entry is completed, press the ESC key. This will prompt the following screen:

```
Press [ESC] when done with this data
                          DOCUMENT DATA ENTRY FORM

Title (include data of publication in month/year):

Performing Agency:
Sponsoring Agency:
Location Number                                   Date Received:
Report Number:
Keywords:

# of Summaries Sent:        # of Summaries Returned:
                                        # of Positive Responses:
Summaries sent to:

# of Copies Received:       # of Copies sent W/O Summary:
                                        Copies W/O Summary to:

Report loaned to (include date sent):

Persons waiting for report (including date requested):
```

Pressing "A" will add the data and prompt a fresh entry screen. "R" will add the data and leave the data just added on the screen; this is useful if there is another report to be entered with similar information. "E" will allow you to edit the present screen. "Q" will return you to the R> prompt and erase anything on the screen - make sure there is not any valuable information on the screen when you press "Q"!

CUSTOMIZED SEARCHES

The "PROMPT SEARCH" command is set up to accommodate the type of file search most commonly done: that is, searching the title and keyword fields for a particular work, and getting a report title and location number as output. However, searches can be made on any of the reports' 16 parameters(or attributes, as called by R:Base). Similarly, any of these attributes can be output. Example: You want to search for a particular report number, and you want to see the title, report number, and performing agency. For this, you enter "PROMPT SELECT" and the following screen prompts up.

```
Press (ESC) when done with this data
SELECT
 SELECT is used to retrieve data from a relation. Specify the relation
as well as the attributes you want to see. To see all attributes, use
ALL for the attribute name. To sort the data, you can optionally
specify attributes for sorting. If you want to restrict the rows
selected, you can optionally specify the selection conditions with a
WHERE clause. To sum a column, add =S to the attribute name. To set
the width of a column, add =n to the attribute name, where n is a
number from 1 to 132.

PROMPTS
Name of relation          :
Attribute name(s) or All  :
Sorted by attribute(s)    :
Where (optional)          :
```

"NAME OF RELATION" is the name of the master report file. You simply type in "REPORTS".

```
PROMPTS
Name of relation          : REPORTS
Attribute name(s) of All  :
Sorted by attribute(s)    :
Where (optional)          :
```

"ATTRIBUTE NAME(S) OR ALL" refers to the attributes you want to be displayed. The following is the list for attribute abbreviations.

ATTRIBUTE	R: BASE ABBREVIATION
Title	TITLE
Area Location	LOC
Performing Agency	PERFORM
Sponsoring Agency	SPONSOR
Report Number	REPT#
Keyword	KEYWORD

In this block, simply type out the abbreviations for the attributes you want, with just a space between. For the "TITLE" attribute, include a "=25" after the word "TITLE" like this: TITLE =25. The reason for this is that the title is usually too long to fit horizontally across the screen without blocking out any other attribute you wanted to display. The "=25" tells the program to put the TITLE printout in a column 25 characters wide. You can do the same with any other attribute if you wish, with any given column width from 1 to 132 characters.

So, for the example, you want to see the title, report number, and performing agency. Just type in TITLE =25 REPT# PERFORM.

```
PROMPTS                    :REPORTS
Name of relation           :TITLE=25  REPT# PERFORM
Attribute name(s) or ALL   :
Sorted by attribute(s)     :
Where (optional)           :
```

"SORTED BY ATTRIBUTE(S)" means that if you type in an attribute here, the program will sort the search results in ascending order of the attribute you choose, e.g., from A to Z or from 1 on up, depending on whether the attribute is numerical or alphabetical. The example will sort by title.

```
PROMPTS
Name of relation           :REPORTS
Attribute name(s) or All   :TITLE=25 REPT# PERFORM
Sorted by attribute(s)     :TITLE
Where (optional)           :
```

"WHERE (OPTIONAL)" specifies what specification you want to search by. If you want an exact match between what you specify and the result, use this syntax: (attribute) EQ (words). In our example, type in REPT # EQ FHWA-TS-83-203. If you are looking for a work within the line of text, use this syntax: (attribute) CONTAINS (word). Example: REPT # CONTAINS FHWA for all reports with "FHWA" in their report numbers. When ready, press the ESC button and then press the "G" key.

```
PROMPTS
Name of relation          :REPORTS
Attribute name(s) or All:TITLE=25 REPT# PERFORM
Sorted by attribute(s)    :TITLE
Where (optional)          :REPT# EQ FHWA - TS-83-203
```

APPENDIX B

List of prompt and command files for the TT system.

SEARCH program-prompt file

```
SEARCH
INPUT SEARCH2.RPT
The SEARCH program will search the title and keyword fields of each record
within the subject file you choose or, if desired, the master file which
includes all the subject files.  The choices are listed below.
-------------------------------------------------------------------------------
                              SUBJECT FILES
1) Pavements   2) Bridges   3) Soils/Geology   4) Maintenance
5) Administration   6) Traffic   7) Environment   8) Planning
9) Safety   10) Hydrology   11) Construction   12) Energy
13) Master File (all of the above)
-------------------------------------------------------------------------------
                  Press G(o) to initiate the program.
ENDC
```

SEARCH program Command File

```
FILLIN V1 USING "Enter your choice of subject file (1-13):"
FILLIN V2 USING "Enter the word you would like to search by:"
SELECT LOC TITLE FROM .VI SORTED BY LOC WHERE TITLE CONTAINS ".V2" OR
KEYWORD CONTAINS ".V2"
FILLIN V3 USING "Would you like to search again Y/N?"
IF V3 EQ Y THEN
INPUT SEARCH2.RPT
ENDIF
QUIT
```

SUMMARY program-prompt file

```
EDIT ALL FROM REPORTS WHERE TITLE CONTAINS "@1" AND LOC
CONTAINS "@2"

The SUMMARY program will allow you to review and/or edit a particular
record on file.  You will need to know all or part of the title and
(optionally) the location number of the report(s) you want.
-------------------------------------------------------------------------------
Enter all or part of the title of the report:  @1
Enter all or part of the location number:  @2
ENDC
```

QUICK program-prompt file

```
EDIT ALL FROM REPORTS WHERE LOC EQ "@1"
```

The QUICK command allows you to quickly access a record in order to edit the report or summary information, given an EXACT location number. Be sure that the location number has at least two digits; for instance, type "02 RBS", not "2 RBS".

```
Enter location number here:  @1
ENDC
```