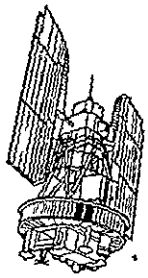
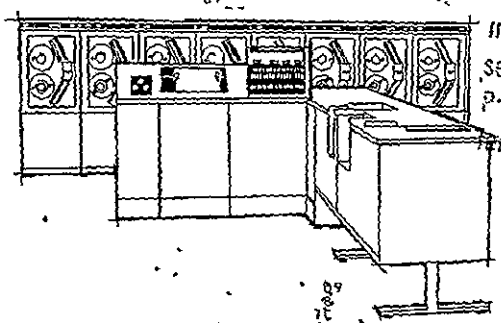
NASA CR-147874 JSC-11377

DETECTION AND MAPPING PACKAGE

(E77-10101)





VOLUME 2a: SOFTWARE USER MANUAL (part 1)

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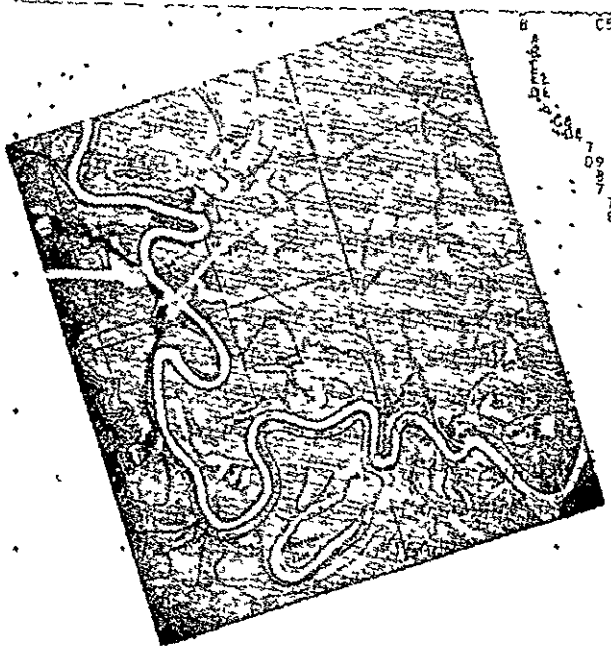

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Lyndon B Johnson Space Center
Houston Texas 77058

JSC - 11377

DETECTION AND MAPPING PACKAGE

VOLUME 2a: SOFTWARE USER MANUAL (part 1)

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16 Abstract
The DAM package is an integrated set of manual procedures, computer programs, and graphic devices designed for efficient production of precisely registered and formatted maps from digital Landsat multispectral scanner (MSS) data. The software can be readily implemented on any Univac 1100 series computer with standard peripheral equipment. This version of the software includes pre-defined spectral limits for use in classifying and mapping surface water.

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PREFACE

Multispectral scanners onboard NASA unmanned Landsat satellites provide an ideal source of current data for earth resources applications. The Detection And Mapping (DAM) package was originally developed at the Johnson Space Center for rapid conversion of the Landsat digital data into hydrographic maps matching standard topographic quadrangle series. Recent improvements in both the manual procedures and computer programs within the DAM package make it easier to use, faster, and more general purpose.

Documentation and software for the DAM package are available to all public and private agencies, in accordance with the NASA policy of encouraging maximum use of remote sensing technology.

Published documentation, of which this is volume 2a, is comprised of the following volumes·

Volume 1: General Procedure

Volume 2· Software User Manual (in two parts)

Volume 3: Control Network Establishment

These volumes supersede the previous documentation published in 1973. Software releases prior to version 7602 cannot be used with the current documentation.

CONTENTS

VOLUME 2a

Section Page

VOLUME 2b

ACRONYMS

CCT	computer-compatible tape
DAM	Detection And Mapping package
GMT	Greenwich mean time
JSC	Lyndon B. Johnson Space Center
MSS	Multispectral scanner
Pixel	picture element
RMS	root mean square
USGS	United States Geological Survey
UTM	Universal Transverse Mercator

1. INTRODUCTION

The Detection and Mapping (DAM) package is an integrated set of computer programs, manual procedures, and graphic devices designed for efficient production of maps from digital Landsat MSS data. This volume describes the computer programs and how to operate them. See volume 1 for the function of these programs in the overall operation of the DAM package.

1.1 LANDSAT MSS DIGITAL DATA

A Landsat scene covers an area of the Earth's surface 100 x 100 nautical miles. Each scene is composed of approximately 7,500,000 digital picture elements (pixels). The scanner coordinates defining the location of a pixel are scan line number and sample number. Scan lines are numbered from 1 to 2340, starting at the top of each scene. Samples are numbered from 1 to 3240 (approximately), starting at the left of each scene.

A Landsat scene is divided into four 25-mile wide strips (numbered 1 to 4 from the left). The data for all four strips of the scene are recorded on either 1, 2, or 4 reels of computer tape, depending on the file structure and recording density.

The DAM package accepts the original Landsat tape format. Users, therefore, are not required to re-format the data prior to processing.

1.2 COMPUTER SYSTEM REQUIREMENTS

The computer programs in the DAM package are designed for use on any UNIVAC 1100 series computer system with the following minimum characteristics.

- EXEC-8 operating system
- 20,000 words of user core storage
- 2,000,000 words of user mass storage
- 1 tape drive (2 if tapes are to be duplicated)
- 1 card reader
- 1 line printer
- 1 remote terminal (optional)
- 1 pen plotter (optional)

The software is highly modular and contains provisions for easily specifying local hardware and system software characteristics at implementation time. Conversion to other computer systems is possible, but would involve significant reprogramming.

1.3 COMPUTER PROGAMS

The DAM package software is currently organized in 9 main programs. Program names and functions are as follows:

PROGRAM	FUNCTION
ERTS-DUP	Duplicate Landsat MSS data tape
ERTSIDC	Identify scene on Landsat tape
PICTAB	Display and tabulate raw Landsat data
CONTROL	Adjust and diagram control network
CLASSIFY	Transform raw Landsat data
PRTDENS	Display transformed Landsat data
PRTCLASS	Produce line-printer maps
PLTCLASS	Produce pen-plotter maps
STATUS	Monitor computer runs and programs

1.4 PROGRAMMING LANGUAGE

The DAM package contains approximately 200 subroutines. Over 90 percent of the subroutines are written in UNIVAC FORTRAN V, and the remainder in assembler and EXEC-8 control language.

1.5 USER LANGUAGE

Familiarity with programming languages is not required. Users communicate with the computer system by means of a few English-like commands and exec commands.

Exec commands generally request facilities from the executive, prior to executing a program. They also release facilities after termination of a program. Those exec commands required for each program are explained in the section on that program.

Commands communicate with a currently executing program. They are used to direct program operations and specify the nature of the output desired. The commands to be used with each program are also explained in the section on that program.

1.6 COMPUTER RUN PROCEDURES

The basic unit for work accounting under the UNIVAC EXEC-8 operating system is the run. Before any programs can be executed, a run must first be initiated, and after the last program has terminated; the run must be terminated. The following four cards are always required to initiate a DAM package run (lowercase letters indicate user-supplied information):

```
@RUN accounting-information
@USE DAM.,name-of-program-file
@ASG,A DAM.
@ADD DAM.SETUP
```

The RUN card supplies accounting information, as explained below. The USE card identifies the external name currently used by the operating system for the DAM package program file (consult local installation standards for this name). The ASG card insures that the program file is available on mass storage. The SETUP card prepares the programs for execution.

The following card is always required to terminate a computer run:

```
@FIN
```

Batch runs are initiated by card input at the main computer site (or at a remote batch terminal). Demand runs are initiated by keyboard input at an interactive remote terminal.

1.6.1 BATCH PROCEDURE

The procedure for utilizing the DAM package in batch mode is listed below.

(1) Prepare punch card deck for desired program(s) as follows (lowercase letters indicate user-supplied information):

```
@RUN,priority/NR runid,acct,project,minutes,pages
@USE DAM.,name-of-program-file
@ASG,A DAM.
@ADD DAM.SETUP
(runstream for program-1)
(runstream for program-2)
. . .
(runstream for program-N
@FIN
```

(2) Submit deck, required Landsat tape(s), and appropriate local form(s). The runid is a unique six-character identifier for each run. If not unique, error termination may result.

Two commonly used characters (@ and:) are absent from most keypunches. Their multi-punch representations are as follows:

@ is multi-punch 87
: is multi-punch 85

1.6.2 DEMAND PROCEDURE

The exact techniques for connecting a terminal to the computer and logging in are dependent on the operating system, terminal, and communications equipment. Once logged in, follow the procedure below, always remembering to end each line with a carriage return. (Lowercase letters indicate information supplied by user.)

To initiate a demand run, enter:

```
@RUN runid,acct,project
@USE DAM.,name-of-program-file
@ASG,A DAM.
@ADD DAM.SETUP
```

At this point, key in the required exec commands and commands for the program(s) desired. Remember, every line must end with a carriage return.

At the completion of the demand run enter:

```
@FIN
```

Then follow the local standards for logging off.

2. (RESERVED FOR FUTURE USE)

3. ERTS-DUP PROGRAM

ERTS-DUP copies an original Landsat MSS tape onto a reel of blank computer tape. If unrecoverable tape errors occur, it rewinds both tapes and tries a second time. Once a successful copy is made, ERTS-DUP identifies the Landsat scene and terminates the computer run. For this reason, no other program may follow ERTS-DUP in the same computer run.

3.1 PREREQUISITES

ERTS-DUP must be used within a separate computer run (normally batch - - see 1.6). For information on tape staging and management, consult local installation standards.

3.2 EXEC COMMANDS

The following exec commands are normally used with ERTS-DUP (lower case letters indicate user-supplied information):

@ASG,BOTH tape-file.,U9,reel-number
This exec command reserves an available 9 track tape drive (800 BPI) and requests that the specified reel be mounted. Reel numbers are limited to 6 characters chosen from the letters A - Z and the numbers 0-9.

@ADD DAM.ERTS-DUP
This form of the @ADD exec command uses a series of system processors and programs to copy and verify the Landsat tape.

@FREE,S tape-file
This exec command requests that the tape be dismounted, but that the tape drive be retained.

3.3 COMMANDS

There are no commands for ERTS-DUP.

3.4 RUNSTREAM

ERTS-DUP must not be used in the same computer run with any other program. The complete runstream for ERTS-DUP is:

```
@RUN,user-specifications
@USE DAM.,name-of-program-file
@ASG,A DAM
@ADD DAM.SETUP
@ASG,BOTH INN.,U9,original-reel
@ASG,BOTH OUT.,U9,original-reel
@ADD DAM.ERTS-DUP
@FREE,S OLDOUT.
@ASG,BOTH INN.,U9,original reel
@MSG SWAPPING TAPES
@FREE,S OLDINN.
@ASG,BOTH OUT.,U9,blank-reel
@ADD DAM.ERTS-DUP
@FIN
```

4. ERTSIDC PROGRAM

ERTSIDC prints scene identification information for Landsat MSS data recorded on computer-compatible tape. This is useful if tape labels are defaced or missing.

4.1 PREREQUISITES

ERTSIDC must be executed within a computer run, either batch or demand (See 1.6). For information on tape staging and management, consult local installation standards.

4.2 EXEC COMMANDS

The following exec commands are normally employed in executing ERTSIDC (lowercase letters indicate user-supplied information):

@ASG,BOTH 3.,U9,reel-number
This exec command reserves an available 9 track tape drive (800 BPI) and requests that the specified reel containing Landsat data be mounted. Reel numbers are limited to 6 characters chosen from the letters A-Z and the numbers 0-9.

@REWIND 3.
This exec command insures that the tape reel containing Landsat data is positioned at the load point.

@XQT ERTSIDC
This exec command initiates execution of the ERTSIDC program.

@FREE 3.

This exec command is the opposite of the @ASG exec command. This command requests that the Landsat tape be dismounted and the tape drive released for use by other computer runs.

4.3 COMMANDS

There are no commands for ERTSIDC.

4.4 RUNSTREAM

The partial runstream required for ERTSIDC is:

```
. . .
@ASG,BOTH 3.,U9,reel-number
@REWIND 3.
@XQT  ERTSIDC
@FREE  3.
. . .
```

4.5 SAMPLE RUN

The following portions of a demand terminal run illustrate typical execution of ERTSIDC to identify a Landsat MSS data tape. The computer displays a prompt character (>) before each statement keyed in by the user.

```
>@ASG,BOTH 3 ,U9,X06516
>@REWIND 3
FURPUP 0026-06/11-10 09
```

The above exec commands assign the Landsat tape and position it at the load point. Once this is complete, initiate execution of the ERTSIDC program.

```
>@XQT ERTSIDC
MAP27 1 RL71-3 06/11/76 10 13 56 (0,)
END MAP
DATA IGNORED - IN CONTROL MODE
@EOF IGNORED - IN CONTROL MODE
 MBL8A /MBL8A     DAM ERTSIDC(7605)          06/11/76   10 14
 ERTS-1       MSS
 SCENE    1092-16305

 CCT           3 OF 4
 LINES         1 TO 2340 OF 2340
 SAMPLES  1621 TO 2430 OF 3240
 DATE         23 OCT 72
 CENTER       30 2167     96.7500
 NADIP        30 2000     96 6667
 SUN EL       41
 SUN AZ      146
 HDG-YAW     189
 ALT         912
 PITCH.       +0 04
 ROLL         -0 52
 MODE/COR    047 (OCTAL)
```

ERTSIDC prints the above scene and strip identification information from the Landsat MSS tape and then exits.

```
 ***PLEASE @FREE OR @REWIND ERTS TAPE***

 NORMAL TERMINATION       06/11/76   10 14      0 FATAL ERRORS
```

Now @FREE the tape unless it will be needed by subsequent programs in the same computer run.

```
>@FREE 3
READY
```

5. (RESERVED FOR FUTURE USE)

6. PICTAB PROGRAM

PICTAB reads raw Landsat MSS data from a computer-compatible tape and produces displays and tabulations on a line-printer or a computer terminal. In these displays, each MSS pixel is represented by one character position on the output device. The symbol displayed in that character position represents the radiance value recorded for that pixel in a given channel. Scan line numbers are shown along the left edge of each display and sample numbers at the top edge (also at the bottom edge for large displays).

Any number of displays, in any order, may be generated from one tape within a single program execution. However, in order to improve response time and minimize tape wear, displays should be generated in the same order that the data is stored on tape -- in order of increasing line numbers.

6.1 PREREQUISITES

PICTAB must be executed within a computer run, either batch or demand (see 1.6). Approximate scanner coordinates for displaying features of interest may be estimated by using a set of ERTS-1 MSS Scales (see volume 3). These scales may be used for both Landsat-1 and Landsat-2. For information on tape staging and management, consult local installation standards.

6.2 EXEC COMMANDS

The following exec commands are normally used in executing PICTAB (lowercase letters indicate user-supplied information):

@ASG,BOTH 3.,U9,reel-number
This exec command reserves an available 9 track tape drive (800 BPI) and requests that the specified reel containing Landsat data be mounted. Reel numbers are limited to 6 characters chosen from the letters A-Z and the numbers 0-9.

@REWIND 3.
This exec command insures that the tape is positioned at the load point.

@XQT PICTAB
This exec command initiates execution of the PICTAB program.

@FREE 3.
This exec command is the opposite of the @ASG exec command. This command requests that the Landsat tape be dismounted and the tape drive released for use by other computer runs.

6.3 COMMANDS

The following commands are normally used to provide specifications for the PICTAB program and direct its operations (lowercase letters indicate user-supplied information).

ORIGIN,SCAN,line,sample

This command specifies the origin (typically center) scan line and sample of the area to be processed by PICTAB.

WINDOW,PRINT,line,column,line,column
This command defines the boundary, relative to the origin, of a rectangular area to be processed. The first coordinate pair specifies the minimum print line and column relative to the origin, and the second coordinate pair specifies the maximum print line and column relative to the origin.

SPACING,line-increment,sample-increment
This command specifies the MSS scan line and sample increments to be used for processing the subsequent window.

DISPLAY
This command specifies that data for the current window be displayed by PICTAB. In the event a window does not exist for the DISPLAY command, the program will proceed without error to the next command.

EXIT
This command terminates the PICTAB program.

6.4 RUNSTREAM

PICTAB normally occurs in a separate batch computer run from other programs. In this run, PICTAB is usually executed once for each strip to be processed. The partial runstream required for PICTAB is.

```
. . .
@ASG,BOTH 3.,U9,reel-number
@REWIND 3.
@XQT PICTAB
ORIGIN,SCAN,line,sample                          } repeat for
WINDOW,PRINT,line,column,line,column             } each display
SPACING,line-increment,sample-increment          }
DISPLAY                                          }
EXIT
@FREE 3.
. . .
```

6.5 SAMPLE RUN

The following portions of a demand terminal run illustrate typical use of the PICTAB program to produce displays from raw Landsat MSS data on tape. The computer provides a prompt character (>) before each statement keyed in by the user.

```
>@ASG,BOTH 3 ,U9,X06616
READY
 >@REWIND 3
FUPPUR 0026-06/11-10.09
```

The above exec commands assign the Landsat tape and position it at the load point. Once this is complete, initiate execution of the PICTAB program.

```
>@XQT PICTAB
 MEL8A /MBL8A     DAM PICTAB(7605)          06/11/76   10 15
```

```
 +++WARNING   NOMINAL REGISTRATION BASED ON ESTIMATED SCENE CENTER
 ERTS-1       MSS
SCENE     1092-16305
CCT          3 OF 4
LINES        1 TO 2340 OF 2340
SAMPLES   1621 TO 2430 OF 3240
DATE        23 OCT 72
CENTER      30 2167     96 7500
NADIR       30 2000     96 6667
SUN EL      41
SUN AZ     146
HDG-YAW    189
ALT        912
PITCH       +0 04
ROLL        -0 52
MODE/COR   047 (OCTAL)
```

PICTAB identifies the Landsat MSS scene and strip, and then supplies default specifications for several commands. The default commands for batch runs are different from those for demand terminal runs, and are installation-dependent.

```
    **CURRENT DEFAULT COMMANDS

ON,CONFIRM
SYMBOLS,     0,000,    9,009
SYMBOLS,     A,010,    J,019
SYMBOLS,     K,020,    T,039
SYMBOLS,     U,040,    Z,127
WINDOW, PRINT,'
     -9 LINE,   -25 COLUMN,
      9 LINE,    25 COLUMN
```

The default WINDOW in this demand terminal run specifies a rectangular area centered on the ORIGIN, and 18 print lines by 50 print columns in size. (The default WINDOW in a batch run is much larger at most computer installations.)

```
SPACING, 3 LINES, 2 SAMPLES
```

The default SPACING in this demand run specifies every third scan line and every second sample. This allows the small print WINDOW at a terminal to cover a larger area of MSS data, but at a reduced resolution. (The default SPACING in a batch run normally specifies every line and every sample.)

```
CHANNEL, 4 (BAND 7)

TICK,  SCAN, 2400 LINES, 3300 SAMPLES PRIMARY,
       SCAN,   10 LINES,   10 SAMPLES SECONDARY

RADIANCE,   0 MINIMUM,  14 MAXIMUM

ZONE, ** (UTM CENTRAL MERIDIAN ****** DEG)


MBL8A /MBL8A     DAM PICTAB(7605)          06/11/76   10 15

   *+USER COMMANDS
```

To specify the location of the window, use the ORIGIN command.

```
>ORIGIN,865,1870
  ****WARNING   BAD COORDINATE SYSTEM --
      865
```

PICTAB has detected a problem with the user input -- the key word SCAN, specifying the coordinate system, was omitted. The user then re-enters the ORIGIN command with the correct specifications.

```
>ORIGIN,SCAN,865,1870
 ORIGIN, SCAN,  865 LINE, 1370 SAMPLE
 ORIGIN, DEGREES,  30 45489 LATITUDE,  95 09579 LONGITUDE
```

PICTAB confirms the user input and estimates the geographic coordinates of the origin. This estimate is based on the approximate scene center recorded on the Landsat tape (unless CONTROL was executed before PICTAB). The user now requests a DISPLAY of the current WINDOW.

```
>DISPLAY
   *++NOTE   PREVIOUS WARNINGS -- NO WINDOW GENERATED
    *+TRY AGAIN'
```

PICTAB notes that warnings have occurred. If all problems have been corrected, enter DISPLAY again.

```
>DISPLAY
  WINDOW NUMBER 001
```

```
E-1092-16305-3 23OCT72 3240SAMPLES SUNEL+41 PITCH+0 04 ROLL-0 52
CHAN= 4  RAD 000-014='0'-'E'  SPA=3X2  ORIGIN= 865,1870
     11111111111111111111111111111111111111111111111111
     88888888888888888888888888888888888888889999999999
     22222333334444455555666667777788888999990000011111
     02468024680246802468024680246802468024680246802468
0837    D                             E    E   E
0840                                      BE D
0843                                        DC E
0846                                          D  E   D
0849                       7                E   E     D
0852     E   E          EC7588C                  D
0855                            A31114      E       E
0858                             601119    EE  E       E
0861   7D        95          2100129
0864 4332211111112CE  4 2012111112 D5
0867 B122111111101110111110112111E 102
0870     6  83D21111111111110111   111C
0873 D         6589111111100012129211112224411247
0876                  11111121110112131111111111112
0879                   010010101111111100111110111101
0882                  800011111111101111011011101111012
0885                   10001011111111101110001110111111
0888  C                11011111101101111111111111110111
0891    D25010B6    8  70000101111111010110110001110010
```

At the top of this display are listed the channel, the range of radiance values displayed (000 - 014), and the range of symbols used to display them ('0' - 'E'). This means that a radiance of 000 is displayed by the symbol '0', 001 by '1', . . . 009 by '9', 010 by 'A', 011 by B, etc.

Note that one in every three lines is displayed and one in every two samples. This SPACING is useful to locate a feature when its coordinates are known only approximately. Once a feature has been located in this manner, the ORIGIN can be refined and a new display generated with line and sample SPACING of 1.

```
>ORIGIN,SCAN,865,1860
 ORIGIN, SCAN,   865 LINE, 1860 SAMPLE
 ORIGIN, DEGREES,   30 45584 LATITUDE,   95 10174 LONGITUDE

>SPACING,1,1
 SPACING, 1 LINES, 1 SAMPLES


>DISPLAY
  WINDOW NUMBER 002
  E-1092-16305-3 23OCT72 3240SAMPLES SUNEL+41 PITCH+0 04 ROLL-0 52
   CHAN= 4  PAD 000-014='0'-'E'  SPA=1X1  ORIGIN= 865,1860
      1111111111111111111111111111111111111111111111111111111
      8888888888888888888888888888888888888888888888888888888
      3312344444444445555555555666666666777777777789888
      5678901234567890123456789012345678901234567890123456789012345
 0856 E                                        91101111129
 0857                                          C3111121115
 0858                                          E61011111129
 0859             E                            DA21111212224
 0860      +     758  +       EE +           C93121121122228
 0861 E         9559             D            B2110010011229
 0862 D  BACE  A36D              B6B          611110012101SE
 0863 32222237C75E              B31598ED6321121111213B  EE
 0864 110111112230 E     A4A A2101122111111111112B  D25
 0865 2111221122222222222129  7112212112222122330  C113C
 0866 2222112222111222122215AD702213522121222128   21223
 0867 0111111001110100111111111111001210211011113E  5110120
 0868 1111110110110111011011011101101111111112A   9101107
 0869 2112312211111111112111011111111111112113D    E212123
 0870 438DB201111111111111110111111101111115     E101112
 0871      E62121222211122122112111112221122126     712111
 0872      D8122235222112112211212122211212137    8112111
 0873      D6458BC92111110111111110101011211125992111101l
 0874       EE     B655321110001111011110111101291 70111010
```

If a larger display is required, the WINDOW may be enlarged.

```
>WINDOW,PRINT,-120,-60,+120,+60
 WINDOW, PRINT,
   -120 LINE,   -60 COLUMN,
    120 LINE,    60 COLUMN
```

This example specifies a WINDOW centered at the current ORIGIN, and 240 print lines by 120 print columns in size.

```
>DISPLAY
  WINDOW NUMBER 003
  E-1092-16305-3 23OCT72 3240SAMPLES SUNEL+41 PITCH+0 04 ROLL-0 52
   CHAN= 4  PAD 000-014='0'-'E'  SPA=1X1  ORIGIN= 865,1860
```

This time PICTAB does not generate a display at the terminal because the window is too large. Instead, the display is automatically stored internally for subsequent printing at an onsite line printer. Once all desired displays have been generated, we EXIT.

```
>EXIT
```

PICTAB verifies the integrity of the Landsat tape and then allows the user to request hard copies of all displays generated (the user response is YES or NO).

```
    **PROGRAM TERMINATION
    VERIFYING EOF ON ERTS TAPE

    **PLEASE @FREE DP @REWIND ERTS TAPE

 DO YOU WANT DISPLAYS FROM THIS SESSION PRINTED ONSITE?
 >YES
    3 DISPLAYS PRINTED

  NORMAL TERMINATION      06/11/76   10 27     0 FATAL ERRORS
```

A YES response results in all 3 of the displays being printed onsite. The user now releases the Landsat tape and tape drive.

```
>@FREE 3
READY
```

7. CONTROL PROGRAM

CONTROL adjusts a scene-wide network of 6 or more points, for which both scanner coordinates and earth coordinates are known, to determine the exact relationship between these two coordinate systems. This program also estimates errors in individual control points and produces diagrams of the control network. Registration parameters generated by CONTROL are automatically stored on disk for use by subsequent programs in the same computer run.

7.1 PREREQUISITES

CONTROL must be executed within a computer run, either demand or batch (see 1.6). For information on selection and measurement of control points see volume 3. A control network consists of.

- scene identification information
- attitude information
- control point coordinates
- check point coordinates (not included in adjustment but errors are estimated)

The control network may be input to CONTROL from one or more of the following sources:

- punch cards (batch run only)
- terminal keyboard (demand run only)
- disk file (either batch or demand)

Network validation normally is an iterative process between human and computer in which the computer program locates errors and the human operator progressively corrects them until a satisfactory adjustment is achieved.

If a terminal is available, this process should preferably be carried out from the terminal in demand mode. In this case it is convenient to store and update the network as a symbolic element within a disk file, rather than keying it in repeatedly for each execution of CONTROL. Use of the @ED exec command to store and update a control network on disk is illustrated in 7.5.

7.2 EXEC COMMANDS

The following exec commands are normally used in executing CONTROL (lowercase letters indicate user-supplied information):

@ASG,A disk-file-name.
This exec command assigns an existing disk file to this run. This is only required if the control network is already stored (or is to be stored) in a symbolic element within this file. The file remains assigned until freed.

@ED,CPU disk-file-name.scene-number
This exec command calls the text editor, (a system processor) to either store a new network or update and old network in the disk file. This is required only if input to CONTROL will be from disk.

@XQT CONTROL
This exec command initiates execution of the CONTROL program.

@ADD disk-file-name.scene-number
This exec command causes input to be taken from the control network stored on disk, instead of from the terminal or card reader. At the end of the network, input is again taken from the terminal or card-reader.

@FREE disk-file-name.
This exec command is the opposite of the @ASG exec command. It releases a previously assigned disk file so that it may be used by other computer runs.

7.3 COMMANDS

The following commands are normally used to provide specifications for the CONTROL program and direct its operations (lowercase letters indicate user-supplied information):

SCENE,scene-number,samples-per-scene
This command specifies the scene number and the number of MSS samples per scene. Both of these must agree with the corresponding items as displayed for this scene by the PICTAB program.

ATTITUDE,pitch,roll
Pitch and roll must agree in value with the corresponding items as displayed by PICTAB. Both must be signed (even if positive).

```
POINT,point-number,
     SCAN,line,sample,
          DEGREES,latitude,longitude,description
```

The POINT command specifies the coordinates of a control or check point according to the following rules:

- the entire command must be on one card
- "POINT," may be omitted
- control point numbers are positive
- check point numbers are negative
- point numbers are limited to 3 digits
- line and sample must be integers
- "DEGREES" may be shortened to "DEG"
- description may be omitted

ADJUST
This command directs CONTROL to adjust the network.

DIAGRAM
This command directs CONTROL to produce a diagram of the network.

EXIT
This command terminates the CONTROL program.

7.4 RUNSTREAM

The partial runstream required for CONTROL is:

```
. . .
@XQT CONTROL
SCENE,scene-number,sample-per-scene
ATTITUDE,pitch,roll
POINT,point-number,SCAN,line,sample,DEGREES,
     latitude,longitude
. . .
ADJUST
DIAGRAM
EXIT
. . .
```

7.5 SAMPLE RUN

The following portions of a demand terminal run illustrate typical use of the CONTROL program to adjust and diagram a network. Note that the @ED processor is used to store the network on disk and to update it. The computer displays a prompt character (>) before each statement keyed in by the user.

```
>@ASG,A SCHLOSSER
READY
```

The above exec command assigns an existing disk file to this run. To enter the control network into a symbolic element within this disk file, key in the @ED exec command, followed by the file name and scene number.

```
>@ED,CPU SCHLOSSER 1092-16305
CASE UPPER ASSUMED
ELEMENT 1092-16305 NOT IN SPECIFIED FILE
INPUT MODE ASSUMED
ED 14 01-04/23-12 20-(,0)
INPUT
```

The computer responds that a symbolic element with this name does not exist in the file. It then sets up a new element with this name. Each time the computer requests input, key in one more statement of the control network.

```
1I >*CONTROL NET FOR ERTS SCENE 1092-16305 (23 OCT 72)
2I >SCENE,1092-16305,3240
3I >ATTITUDE,+0 04,-0 52
4I >1, SCAN,2243,516, DEG,29 4956,97 624,  COST SPILLWAY
5I >5, SCAN,1315,502, DEG,30 1506,97 4534,  BASTROP RIVER BEND
6I >6, SCAN,646,947, DEG,32 5819,97 059,  ALCOA LAKE LARGE LAKE
7I >7, SCAN,1441,896, DEG,30 0263,97 2457,  SMITHVILLE RIVER BEND
8I >8, SCAN,480,1345, DEG,30 6625,96 7892,  MILANO SMALL LAKE
9I >9, SCAN,1163,1509, DEG,37 1644,96 8276,  LEDBETTER SMALL POND
```

```
10I >10, SCAN,1447,1464, DEG,29 9684,96 9102,  LA GRANGE W RIVER
11I >11, SCAN,1603,1710, DEG,29 8355,96 7956,  AMMANSVILLE RIVER
12I >14, SCAN,1094,2052, DEG,30 1617,96 4921,  BRENHAM SMALL LAKE
13I >16, SCAN,44,2724, DEG,30 8374,95 8827,  BEDIAS-LAKE DONNA V
14I >19, SCAN,1851,2567, DEG,29 5795,96 342,  EAGLE LAKE EAGLE LA
```

Once the last line of the network has been keyed in, respond to the next computer request for input with a carriage return.

```
15I >
EDIT
```

This causes a mode change, from input to edit. After any errors have been corrected, enter EXIT.

```
14 >EXIT
LINES 14 FIELDATA
```

The control network is now stored on disk and we are ready to execute CONTROL.

```
>@XQT CONTROL



 ESL8X /ESL8X      DAM CONTROL(7602)          04/23/76   12 22

    **CURRENT DEFAULT COMMANDS.

 ON,CONFIRM


 ESL8X /ESL8X      DAM CONTROL(7602)          04/23/76   12 22

    **USER COMMANDS
```

At this point CONTROL requests user input. Employ the @ADD exec command to specify that input be taken from the symbolic element just created.

```
>@ADD SCHLOSSER 1092-16305
   (001)    *CONTROL NET FOR ERTS SCENE 1092-16305 (23 OCT 72)
 SCENE, 1092-16305, 3240 SAMPLES/SCENE
 ATTITUDE, +0 04 PITCH, -0 52 ROLL
 POINT,    1,    SCAN, 2243 00,  516 00,   DEG,  29 49560,  97 62400
 POINT,    5,    SCAN, 1315 00,  502 00,   DEG,  30 15060,  97 45340
 POINT,    6,    SCAN,  646 00,  947 00,   DEG,  32 58190,  97 05900
 POINT,    7,    SCAN, 1441 00,  896 00,   DEG,  30 02630,  97 24570
 POINT,    8,    SCAN,  480 00, 1345 00,   DEG,  30 66250,  96 78920
 POINT,    9,    SCAN, 1163 00, 1509 00,   DEG,  37 16440,  96 82760
 POINT,   10,    SCAN, 1447 00, 1464 00,   DEG,  29 96840,  96 91020
 POINT,   11,    SCAN, 1603 00, 1710 00,   DEG,  29 83550,  96 79560
 POINT,   14,    SCAN, 1094 00, 2052 00,   DEG,  30 16170,  96 49210
 POINT,   16,    SCAN,   44 00, 2724 00,   DEG,  30 83740,  95 88270
 POINT,   19,    SCAN, 1851 00, 2567 00,   DEG,  29 57950,  96 34200
```

CONTROL checks all input and formats it for easy reference. When the program requests additional input, enter ADJUST.

```
>ADJUST
```

```
 ESL8X /ESL8X     DAM CONTROL(7602)        04/23/76   12 22

 SCENE 1092-16305
                        LINE    SAMPLE   LATITUDE  LONGITUDE
 SCENE CENTER       1170 50  1620 50   30 94671   96 76198
 CONTROL CENTROID   1211 55  1475 64   30 95228   96 85673
 CENTER-CENTROID     -41 05   144 86    - 00557    - 09475   (  9 1 KM
 PROJECTION CENTRAL MERIDIAN                      96 76000

 CONTROL COVERAGE      55 5 PERCENT

 NOMINAL ALTITUDE     912 0 KM
 COMPUTED ALTITUDE   1119 4 KM
```

```
 RESIDUAL ERRORS IN CONTROL POINT ADJUSTMENT·
 POINT     LINE  SAMPLE   LATITUDE  LONGITUDE  METERS   POINT
     1  -450 64 -152 46    - 59038    - 00442  65422        1
     5  -794 82 -267 77   -1 04076    - 00561 115340        5
     6   583 71  191 84      76240    - 00176  84508        6
     7  -664 46 -223 80    - 87010    - 00275  96421        7
     8  -920 35 -310 09   -1 20511      00178 133558        8
     9  4708 79 1597 86    6.16710      00055 683787        9
    10  -541 28 -183 57    - 70929    - 00054  78597       10
    11  -431 35 -146 70    - 56542    - 00002  62652       11
    14  -544 94 -184 83    - 71407      00250  79130       14
    16  -786 52 -265 30   -1 02983      01127 114149       16
    19  -158 13  -55 19    -.20782      00010  23026       19

 RMS CTL1539 08  521 71    2 01566      00425 223474    11 CTL PTS

 *****FATAL ERROR   RMS ERROR TOO LARGE
```

Note the results of this adjustment. Both the individual errors for each point and the Root-Mean-Square (RMS) error for the total network are unacceptable. This is typical of an initial adjustment. Point number 9 has the largest error, and should be changed from a control point to a check point. To do this, first EXIT from CONTROL, then call the @ED processor to update the symbolic element containing the network.

```
>EXIT

  ABORT TERMINATION      04/23/76   12 25     1 FATAL ERRORS



>@ED,CPU SCHLOSSER 1092-16305
CASE UPPER ASSUMED
ED 14 01-04/23-12 26-(0,1)
EDIT
```

Assuming that the character string "9," occurs in the network only once (as a control point number) then the following input will LOCATE the information on point 9.

```
0 >LOCATE 9,
6, SCAN,646,947, DEG,32 5819,97 059,  ALCOA LAKE LARGE LAKE
```

Apparently, the first occurrence of "9," is in the latitude for point number 6. To insure finding point 9, we LOCATE the first occurrence of "9, SCAN".

```
6 >LOCATE 9, SCAN
9, SCAN,1163,1509, DEG,37 1644,96 8276,  LEDBETTER SMALL POND
```

Change the point number from "9" to "-9" (a negative point number indicates a check point), and EXIT.

```
9 >CHANGE /9/-9/
-9, SCAN,1163,1509, DEG,37 1644,96 8276,  LEDBETTER SMALL POND
9 >EXIT
LINES.14 FIELDATA
```

Now execute CONTROL again.

```
>@XQT CONTROL


 ESL8X /ESL8X     DAM CONTROL(7602)        04/23/76   12 27

    **CURRENT DEFAULT COMMANDS

 ON,CONFIRM


 ESL8X /ESL8X     DAM CONTROL(7602)        04/23/76   12 27

    **USER COMMANDS
```

Then, @ADD the revised network.

```
>@ADD SCHLOSSER 1092-16305
   (001)    *CONTROL NET FOR ERTS SCENE 1092-16305 (23 OCT 72)
 SCENE, 1092-16305, 3240 SAMPLES/SCENE
 ATTITUDE, +0 04 PITCH, -0 52 ROLL
 POINT,    1,    SCAN, 2243 00,  516 00,    DEG,  29 49560,  97 62400
 POINT,    5,    SCAN, 1315 00,  502 00,    DEG,  30 15060,  97 45340
 POINT,    6,    SCAN,  646 00,  947 00,    DEG,  32 58190,  97 05900
 POINT,    7,    SCAN, 1441 00,  896 00,    DEG,  30 02630,  97 24570
 POINT,    8,    SCAN,  480 00, 1345 00,    DEG,  30 66250,  96 78920
 POINT,   -9,    SCAN, 1163 00, 1509 00,    DEG,  37 16440,  96 82760
 POINT,   10,    SCAN, 1447 00, 1464 00,    DEG,  29 96840,  96 91020
 POINT,   11,    SCAN, 1603 00, 1710 00,    DEG,  29 83550,  96 79560
 POINT,   14,    SCAN, 1094 00, 2052 00,    DEG,  30 16170,  96 49210
 POINT,   16,    SCAN,   44 00, 2724 00,    DEG,  30 83740,  95 88270
 POINT,   19,    SCAN, 1851 00, 2567 00,    DEG,  29 57950,  96 34200
```

And once more enter ADJUST.

```
>ADJUST

 ESL8X /ESL8X     DAM CONTROL(7602)        04/23/76   12 27

 SCENE 1092-16305

                      LINE    SAMPLE    LATITUDE  LONGITUDE
 SCENE CENTER      1170 50   1620 50    30 32320   96 76239
 CONTROL CENTROID  1216 40   1472 30    30 33071   96 85948
 CENTER-CENTROID    -45 90    148 20     - 00750    - 09709    (  9 4 KM)
 PROJECTION CENTRAL MERIDIAN                       96 76000

 CONTROL COVERAGE      55 5 PERCENT

 NOMINAL ALTITUDE     912 0 KM
 COMPUTED ALTITUDE   1140 7 KM
```

```
RESIDUAL ERRORS IN CONTROL POINT ADJUSTMENT
POINT     LINE  SAMPLE   LATITUDE  LONGITUDE  METERS   POINT
    1   -56 11  -18 58    - 06953    - 00028   7704        1
    5  -363 44 -121 39    - 45073    - 00174  49949        5
    6  1138 37  380 06    1 41149    - 00013 156446        6
    7  -227 14  -75 40    - 28154    - 00021  31197        7
    8  -431 81 -144 31    - 53554      00152  59349        8
   -9  5467 50 1855 32    6 78890      00056 752693  CHK   -9
   10   -88 29  -29 85    - 10965    - 00003  12150       10
   11    22 27    7 22      02753    - 00020   3051       11
   14   -61 30  -20 71    - 07612      00031   8435.      14
   16  -241 97  -80 51    - 29992      00390  33242       16
   19   309 42  103 47     .38385    - 00271  42530       19

RMS CTL 428 43  143 04      53125      00168  58879    10 CTL PTS

RMS CHK5467 50 1855 32    6 78890      00056 752693     1 CHK PTS

*****FATAL ERROR   RMS ERROR TOO LARGE
```

The results of this adjustment are somewhat better, but still far from acceptable. Point number 6 has the largest error of the remaining control points. Again EXIT, update the network, and re-execute CONTROL. The results of this adjustment are as follows:

```
ESL8X /ESL8X     DAM CONTROL(7602)        04/23/76   12 31

SCENE 1092-16305

                      LINE   SAMPLE   LATITUDE  LONGITUDE
SCENE CENTER      1170 50  1620 50   30 14928   96 76295
CONTPOL CENTROID  1279 78  1530 67   30 08070   96 83788
CENTER-CENTROID   -109 28    89 83      06858    - 07492   ( 10 5 KM
PROJECTION CENTPAL MERIDIAN                     96 76000

CONTROL COVERAGE     55 5 PERCENT

NOMINAL ALTITUDE    912 0 KM
COMPUTED ALTITUDE   921 9 KM
```

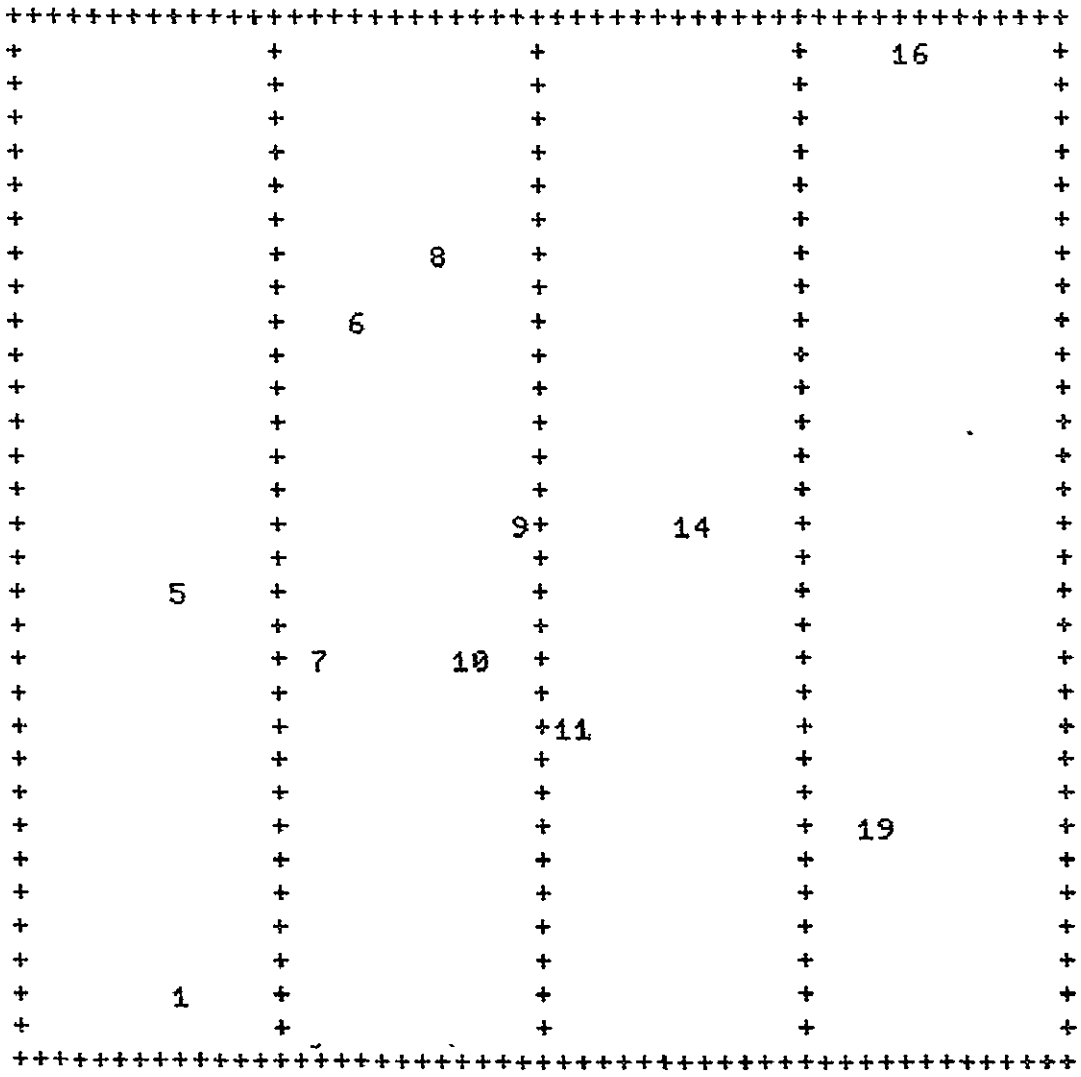
```
RESIDUAL ERRORS IN CONTROL POINT ADJUSTMENT
POINT      LINE   SAMPLE    LATITUDE  LONGITUDE   METERS    POINT
    1         1 46      64     00109      00010      121        1
    5         - 89      - 34     - 00066     - 00003      73        5
   -6      2715 08   906 46     1 99934     - 00024  221592  CHK   -6
    7           06      46       00009       00026      26        7
    8           30      - 05       00021     - 00009      24        8
   -9      9504 33  3203 06     6 99929       00001  776006  CHK   -9
   10         - 81      - 64     - 00063     - 00022      73       10
   11         - 38      - 34     - 00030     - 00012      35       11
   14         - 57      - 44     - 00045     - 00014      51       14
   16           81        54       00062       00015      71       16
   19           01        17       00002       00009      10       19

RMS CTL       .73        44       00055       00015      63      9 CTL PTS

RMS CHK6989 42  2353 85     5 14720       00017  570652      2 CHK PTS
```

The RMS error for the 9 control points in this network is only 63 meters. Further inspection of the residual errors for check points 6 and 9 suggests that blunders of exactly 2 degrees and 7 degrees, respectively, have been made in recording their latitudes. If a check of the coordinate measurements confirms this, these points should be corrected, changed back to control points, and the network adjusted again. Once a satisfactory adjustment is obtained, enter DIAGRAM.

```
>DIAGRAM
```

ESL8X /ESL8X DAM CONTROL(7602) 04/23/76 12 31

SCENE 1092-16305 -- ALL POINTS



(HUNDREDS DIGIT OMITTED)

This diagram shows the location of all control and check points within the Landsat scene. It should be evaluated visually to determine if the control points are well-distributed throughout the scene.

To terminate the program, enter EXIT.

```
>EXIT

 NORMAL TERMINATION      04/23/76   12 35     0 FATAL ERRORS
```

The disk file containing this network should be freed, unless it will be used again within this run. The final network is now available for use to control map generation in subsequent computer runs.

```
>@FREE SCHLOSSER
READY
```

8. CLASSIFY PROGRAM

This program uses a spectral filter to transform raw Landsat MSS data into orthogonal form. The results of this transformation are stored in a density file on disk for use, in the same run, by PRTDENS, PRTCLASS, or PLTCLASS. All or part of a Landsat scene may be processed. If the area specified lies in more than one strip, then CLASSIFY must be executed once for each of the strips.

8.1 PREREQUISITIES

CLASSIFY must be executed within a computer run (normally batch -- see 1.6). Prior to executing CLASSIFY, there are several tasks that must first be accomplished:

- CONTROL must be executed in order to adjust a network of control points for the Landsat MSS scene to be processed (see volume 3 of this series for a comprehensive discussion of control network establishment. The parameters from this adjustment are required by CLASSIFY in order to process the raw data.
- Tapes covering the area to be processed must be provided. The tape(s) must be for the same scene as the control network. For information on tape staging and management, consult local installation standards.

8.2 EXEC COMMANDS

The following exec commands are normally used in executing CLASSIFY (lowercase letters indicate user-supplied information).

@ASG,BOTH 3.,U9,reel-number
This exec commands reserves an available 9 track tape drive (800 BPI) and requests that the specified reel containing Landsat data be mounted. Reel numbers are limited to 6 characters chosen from the letters A-Z and the numbers 0-9.

@REWIND
This exec commands insures that the tape reel containing Landsat data is positioned at the load point.

@XQT CLASSIFY
This exec command initiates execution of the CLASSIFY program.

@ADD name-of-symbolic-element
This exec command causes input to be taken from a symbolic element in a disk file, instead of from the terminal or card reader. At the end of the element, input is again taken from the terminal or card reader. This exec command is normally used to input spectral limits to CLASSIFY.

@FREE 3.
This exec command is the opposite of the @ASG exec command. This command requests that the Landsat tape be dismounted and the tape drive released for use by other runs.

8.3 COMMANDS

The following commands are normally used to provide specifications for the CLASSIFY program and direct its operations (lowercase letters indicate user-supplied information):

ORIGIN,SCAN,line,sample
This command specifies the origin (typically minimum sample) of the area to be processed by CLASSIFY.

WINDOW,SCAN,line,sample
This command specifies the size (in lines and samples) of a rectangular area to be processed by CLASSIFY.

DETECT
This command initiates the processing of data for the previously specified window. CLASSIFY reads the Landsat tape, detects all pixels which match the spectral limits, and stores the results on disk.

EXIT
This command terminates the CLASSIFY program.

8.4 RUNSTREAM

CLASSIFY is executed in the same computer run (normally batch) with several other programs. The partial runstream required for CLASSIFY is:

```
. . .
(runstream for CONTROL)
@ASG,BOTH 3.,U9,reel-number
@REWIND 3.
@XQT CLASSIFY
@ADD element-containing-spectral-limits
ORIGIN,SCAN,line,sample
WINDOW,SCAN,line,sample
DETECT
EXIT
@FREE
(runstream for PRTDENS, PRTCLASS or PLTCLASS)
. . .
```

8.5 SAMPLE RUN

CLASSIFY always appears in a run with several other programs. See 10.5 for a sample run illustrating its use with PRTCLASS.

9. PRTDENS PROGRAM

PRTDENS produces line-printer displays from density file(s) created by the CLASSIFY program. PRTDENS is normally used only for debugging and instructional purposes.

9.1 PREREQUISITES

PRTDENS must be executed within a computer run, either batch or demand (See 1.6). CLASSIFY must be executed in the same run, prior to PRTDENS, in order to generate the density file(s). Tape input is required for CLASSIFY, but not for PRTDENS.

9.2 EXEC COMMANDS

The following exec command is normally used to execute PRTDENS:

@XQT PRTDENS
This exec command initiates execution of the PRTDENS PROGRAM.

9.3 COMMANDS

The following commands are normally used to provide specifications for the PRTDENS program and direct its operations (lowercase letters indicate user-supplied information).

ORIGIN,SCAN,line,sample
This command specifies the origin (typically center) scan line and sample of the area to be displayed.

WINDOW,PRINT,line,column,line,column
This command defines the boundary, relative to the origin, of the rectangular area to be displayed. The first coordinate pair specifies the minimum print line and column relative to the origin, and the second coordinate pair specifies the maximum print line and column relative to the origin.

DISPLAY
This command specifies that data from the density file for the current window is to be displayed.

EXIT
This command terminates the PRTDENS program.

9.4 RUNSTREAM

PRTDENS is executed in the same computer run with several other programs. The partial runstream required for PRTDENS is:

```
. . .
(runstream for CONTROL)
(runstream for CLASSIFY -- repeat once for each strip)
@XQT PRTDENS
ORIGIN,SCAN,line,sample
WINDOW,PRINT,line,column,line, column      } repeat for each display
DISPLAY
EXIT
. . .
```

10. PRTCLASS PROGRAM

PRTCLASS generates any number of custom formatted and scaled maps on a line printer. The maps for a Landsat MSS scene are printed using data from the density file(s) produced by the CLASSIFY program. PRTCLASS assigns each pixel to a print position on the classification map. The number of Landsat pixels assigned to each print position will vary with the scale of the map. At 1.24,000, each character position on the map represents approximately one Landsat pixel.

10.1 PREREQUISITES

PRTCLASS must be executed in a computer run (normally batch -- see 1.6). CLASSIFY must be executed in the same run, prior to PRTCLASS, in order to generate the density file(s). Tape input is required for CLASSIFY, but not for PRTCLASS.

10.2 EXEC COMMANDS

@XQT PRTCLASS
This exec command initiates execution of the PRTCLASS program.

10.3 COMMANDS

ORIGIN,DEGREES,latitude,longitude
This command specifies the origin in degrees (typically minimum latitude and minimum longitude) of the area PRTCLASS is to map.

WINDOW,MINUTES,latitude,longitude
This command specifies the size (in minutes of latitude and longitude) of a rectangular area to be mapped by PRTCLASS.

HEADING,1,heading-text
This command specifies the text to be printed on line 1 of the map heading. The text is limited to 72 characters and may not contain commas.

SCALE,1/denominator-of-representative-fraction
This command specifies the scale at which subsequent windows are to be mapped. The minimum denominator is 20000 and the maximum is 260000 (commas may not be embedded in the denominator).

TICK,MINUTES,latitude,longitude,MINUTES,latitude,longitude
This command specifies the intervals for printing the primary ticks (*) and the secondary ticks (+) within subsequent windows. The primary intervals in minutes are given first, followed by the secondary intervals in minutes.

MAP
This command generates a single map covering the current window.

MAP,maximum-number-of-sub-windows
This variation of the MAP command divides the current window into the specified number of sub-windows (based on the current primary tick interval) and generates a separate map for each sub-window.

EXIT

This command terminates the PRTCLASS program.

10.4 RUNSTREAM

PRTCLASS is executed in the same computer run with several other programs. The partial runstream required for PRTCLASS is:

```
. . .
(runstream for CONTROL)
(runstream for CLASSIFY) -- repeat once for each strip
@XQT PRTCLASS
SCALE,1/denominator-of-representative-fraction
TICK,MINUTES,latitude,longitude,MINUTES,latitude,
   longitude
ORIGIN,DEGREES,latitude,longitude
WINDOW,MINUTES,latitude,longitude
HEADING,1,heading-text
MAP
EXIT
. . .
```

} repeat for each area to be mapped

10.5 SAMPLE RUN

PRTCLASS always appears in a computer run (normally batch) with several other programs. The following portions of a demand terminal run illustrate combined use of the CONTROL, CLASSIFY, and PRTCLASS programs to produce registered maps from Landsat MSS data. The computer displays a prompt character (>) before each statement keyed in by the user.

First, assign the disk file containing the validated control network for the scene to be processed.

```
>@ASG,A BROWN
READY
```

Now, execute the CONTROL program.

```
>@XQT CONTROL


 MBL8X /MBL8X      DAM CONTROL(7602)          05/05/76    09 39
    **CURRENT DEFAULT COMMANDS

 ON,CONFIRM


 MBL8X /MBL8X      DAM CONTROL(7602)          05/05/76    09 39
    **USER COMMANDS
```

Here, CONTROL requests user input. Use the @ADD exec command to specify that input be taken from the symbolic element containing the previously validated control network.

```
>@ADD BROWN 1092-16305
   (001)    *CONTROL NET FOR ERTS SCENE 1092-16305 (23 OCT 72)
SCENE, 1092-16305, 3240 SAMPLES/SCENE
ATTITUDE, +0 04 PITCH, -0 52 ROLL
   (004)    *LATITUDE SHOULD BE 30 5819 FOR PT -6 AND 30 1644 FOR PT
POINT,   1,   SCAN, 2243 00,  516 00,   DEG,  29 49560,  97 62400
POINT,   5,   SCAN, 1315 00,  502 00,   DEG,  30 15060,  97 45340
POINT,  -6,   SCAN,  646 00,  947 00,   DEG,  32 58190,  97 05900
POINT,   7,   SCAN, 1441 00,  896 00,   DEG,  30 02630,  97 24570
POINT,   8,   SCAN,  480 00, 1345 00,   DEG,  30 66250,  96 78920
POINT,  -9,   SCAN, 1163 00, 1509 00,   DEG,  37 16440,  96 82760
POINT,  10,   SCAN, 1447 00, 1464 00,   DEG,  29 96840,  96 91020
POINT,  11,   SCAN, 1603 00, 1710 00,   DEG,  29 83550,  96 79560
POINT,  14,   SCAN, 1094 00, 2052 00,   DEG,  30 16170,  96 49210
POINT,  16,   SCAN, 44 00,   2724 00,   DEG,  30 8374,   95 88270
POINT,  19,   SCAN, 1851 00, 2567 00,   DEG,  29 5795,   96 3420
>ADJUST
```

When the program requests additional input, enter ADJUST.

```
MBL8X /MBL8X     DAM CONTROL(7602)        05/05/76   09 39

SCENE 1092-16305
                        LINE    SAMPLE    LATITUDE  LONGITUDE
SCENE CENTER         1170 50   1620 50    30 14928    96 76295
CONTROL CENTROID     1279 78   1530 67    30 08070    96 83788
CENTER-CENTROID      -109 28     89 83       06858     - 07492    ( 10 5 KM)
PROJECTION CENTRAL MERIDIAN                           96 76000
CONTROL COVERAGE       55 5 PERCENT
NOMINAL ALTITUDE      912 0 KM
COMPUTED ALTITUDE     921 9 KM

RESIDUAL ERRORS IN CONTROL POINT ADJUSTMENT
POINT      LINE   SAMPLE    LATITUDE  LONGITUDE  METERS    POINT
    1      1 46       64       00109      00010     121        1
    5      - 89     - 34     - 00066    - 00003      73        5
   -6   2715 08   906 46     1 99934    - 00024  221592  CHK  -6
    7        06       46       00009      00026      26        7
    8        30     - 05       00021    - 00009      24        8
   -9   9504 33  3203 06     6 99929      00001  776006  CHK  -9
   10      - 81     - 64     - 00063    - 00022      73       10
   11      - 38     - 34     - 00030    - 00012      35       11
   14      - 57     - 44     - 00045    - 00014      51       14
   16        81       54       00062      00015      71       16
   19        01       17       00002      00009      10       19
RMS CTL      73       44       00055      00015      63     9 CTL PTS
RMS CHK6989 42  2353 85     5 14720      00017  570652     2 CHK PTS
```

CONTROL also stores the registration parameters from this adjustment on disk for use by subsequent programs in the same run. To terminate the program, enter EXIT.

```
>EXIT

 NORMAL TERMINATION      05/05/76   09.42     0 FATAL ERRORS
```

The control network is no longer needed by this computer run. To avoid conflicts with other runs, free the file containing this network.

```
>@FREE BROWN
READY
```

Now assign the reel of tape containing Landsat MSS data to be processed.

```
>@ASG,BOTH 3 ,U9,X04745
READY
>@REWIND 3
FURPUR 0026-05/05-09 43
```

Once this tape is positioned at the load point, execute CLASSIFY.

```
>@X,OT CLASSIFY
```

```
MBL8X /MBL8X     DAM CLASSIFY(7602)       05/05/76   09 55
E-1092-16305 2/4
  ***NOTE   EXACT REGISTRATION BASED ON CONTROL NETWORK
ERTS-1       MSS
SCENE    1092-16305
CCT            2 OF 4
LINES          1 TO 2340 OF 2340
SAMPLES    811 TO 1620 OF 3240
DATE          23 OCT 72
CENTER        30 1493     96 7630
NADIR            0000        0000
SUN EL        41
SUN AZ       146
HDG-YAW      189
ALT          922
PITCH         +0 04
ROLL          -0 52
MODE/COR     047 (OCTAL)
```

CLASSIFY identifies the Landsat MSS scene and strip and verifies that the registration parameters from CONTROL match this scene. The program then supplies default specifications for several commands. ' (The user may override any that he wishes.)

```
    **CURRENT DEFAULT COMMANDS·

 ON,CONFIRM

 COPIES,  1

 WINDOW, SCAN,
     -80 LINE,   -400 SAMPLE,
      80 LINE,    400 SAMPLE


 MBL8X /MBL8X      DAM CLASSIFY(7602)        05/05/76   09 55
    **USER COMMANDS
```

At this point, @ADD the symbolic element containing spectral limits to be used in classification.

```
>@ADD DAM WATER-LIM
 NAME, WATER (CH4/CH1)
   (002) ·  *ORIGINAL 2-CHANNEL SPECTRAL LIMITS MODIFIED
```

The following ORIGIN and WINDOW commands specify that the area to be processed is 1200 lines by 1000 samples, beginning at line 700, and sample 1500. (Part of the data for this area are recorded on the currently assigned tape, and part on the tape to be assigned next.)

```
>ORIGIN,SCAN,700,1500
 ORIGIN, SCAN,  700 LINE, 1500 SAMPLE
 ORIGIN, DEGREES,  30 49248 LATITUDE,  96 74086 LONGITUDE

>WINDOW,SCAN,1200,1000
 WINDOW, SCAN,
    1200 LINE,  1000 SAMPLE
```

Enter the DETECT command. CLASSIFY now reads Landsat data for the specified area from tape, detects all pixels which match the spectral limits, and stores the results in a density file. (This file is dynamically assigned by the program.)

```
>DETECT
 (@ASG,CP *DAMDEN-2 ,F/1/POS/4   CLS DENSITY)
   LINE 0700
   LINE 0750
   LINE 0800
   LINE 0850
   LINE 0900
   LINE 0950
   LINE 1000
   LINE 1050
   LINE 1100
   LINE 1150
   LINE 1200
   LINE 1250
   LINE 1300
   LINE 1350
   LINE 1400
   LINE 1450
   LINE 1500
   LINE 1550
   LINE 1600
   LINE 1650
   LINE 1700
   LINE 1750
   LINE 1800
   LINE 1850
   LINE 1900
```

Every 50 lines CLASSIFY prints out the scan line number. Once detection is completed, enter EXIT. Before terminating, the program verifies the integrity of the Landsat tape and then catalogs the density file.

```
>EXIT
    **PROGRAM TERMINATION
    VERIFYING EOF ON ERTS TAPE

    **PLEASE @FREE OR @REWIND ERTS TAPE

-(@FREE          22       )

 (@ASG,AX *DAMDEN-2       )


; NORMAL TERMINATION      05/05/76   10 06     0 FATAL ERRORS
```

MSS data for the remainder of the area to be processed are on another tape. First, @FREE,S the current tape (the S option retains the tape drive). Then assign the next tape.

```
>@FREE,S 3
READY
>@ASG,BOTH 3 ,U9,X06616
READY
>@REWIND 3
FURPUR 0026-05/05-11 25
```

Now execute CLASSIFY again with the new tape.

```
>@XQT CLASSIFY
```

```
MBL8X /MBL8X      DAM CLASSIFY(7602)        05/05/76   11.31
E-1092-16305 3/4
  +**NOTE   EXACT REGISTRATION BASED ON CONTROL NETWORK

ERTS-1      MSS

SCENE.    1092-16305
CCT           3 OF 4
LINES         1 TO 2340 OF 2340
SAMPLES    1621 TO 2430 OF 3240
DATE.        23 OCT 72
CENTER       30 1493     96 7630
NADIR             0000        0000
SUN EL.      41
SUN AZ.     146
HDG-YAW     189
ALT.        922
MODE/COR    047 (OCTAL)



   **CURRENT DEFAULT COMMANDS


ON,CONFIRM

COPIES,  1

WINDOW, SCAN,
     -80 LINE,   -400 SAMPLE,
      80 LINE,    400 SAMPLE
```

At this point, do not enter any user commands. Instead enter the @EOF exec command. CLASSIFY will then recall the user commands from the last execution.

```
MBL8X /MBL8X      DAM CLASSIFY(7602)        05/05/76   11 31

   **USER COMMANDS


/@EOF
   +**NOTE   NO PARAMETER INPUT -- PREVIOUS PARAMETERS RECALLED
  (***)    *PARAMETERS FROM DAM CLASSIFY(7602)    05/05/76   09.5
```

```
 NAME, WATER (CH4/CH1)

   (002)    *ORIGINAL 2-CHANNEL SPECTRAL LIMITS MODIFIED FOR


 ORIGIN, SCAN,   700 LINE,  1500 SAMPLE
 ORIGIN, DEGREES,   30 49248 LATITUDE,   96 74086 LONGITUDE

 WINDOW, SCAN,
    1200 LINE,   1000 SAMPLE

 (@ASG,CP *DAMDEN-3 ,F/1/POS/4    CLS DENSITY)

   LINE 0700
   LINE 0750
   LINE 0800
   LINE 0850
   LINE 0900
   LINE 0950
   LINE 1000
   LINE 1050
   LINE 1100
   LINE 1150
   LINE 1200
   LINE 1250
   LINE 1300
   LINE 1350
   LINE 1400
   LINE 1450
   LINE 1500
   LINE 1550
   LINE 1600
   LINE 1650
   LINE 1700
   LINE 1750
   LINE 1800
   LINE 1850
   LINE 1900

    **PROGRAM TERMINATION
    VERIFYING EOF ON ERTS TAPE
    **PLEASE @FREE OR @REWIND ERTS TAPE

 (@FREE           23        )

 (@ASG,AX *DAMDEN-3         )


 NORMAL TERMINATION       05/05/76    11 46      0 FATAL ERRORS
```

CLASSIFY has used data from the second tape to generate another density file for the remainder of the area, verified the tape, cataloged the density file, and terminated. Since no more tapes are to be processed (in this example), the user must free the tape and release the tape drive.

```
>@FREE 3
READY
```

Next execute PRTCLASS (or PLTCLASS) to generate a series of maps, using data in the density files produced by CLASSIFY.

```
>@XQT PRTCLASS


MBL8X /MBL8X     DAM PRTCLASS(7602)        05/05/76   11 48

(@ASG,AX *DAMDEN-1.        )
  ***NOTE   DENSITY FILE NOT CATALOGED

(@ASG,AX *DAMDEN-2         )
(@ASG,AX *DAMDEN-3         )
(@ASG,AX *DAMDEN-4         )
  ***NOTE   DENSITY FILE NOT CATALOGED
```

PRTCLASS verifies that all density files assigned to this run are for the same scene, have the same registration parameters, and have the same spectral limits. It then prints the following summary:

```
ERTS SCENE   1092-16305
DATE   23 OCT 72
SUN ELEV   41 DEGREES
SUN AZIMUTH   146 DEGREES
```

```
CCT STRIPS              1       2       3       4
DATE CLASSIFIED·          050576 050576
MINIMUM LINE            0     698     698       0
MAXIMUM LINE·           0    1902    1902       0
MINIMUM SAMPLE          0    1498    1621       0
MAXIMUM SAMPLE·         0    1620    2430       0
MATERIAL CLASSIFIED     WATER (CH4/CH1)
```

The program now supplies default specifications for several commands. The default commands for batch runs are different from those for demand terminal runs, and are installation dependent.

```
   **CURRENT DEFAULT COMMANDS

ON,CONFIRM
COPIES,  1

SYMBOLS,      ,000,     ,000
SYMBOLS,     1,001,    9,009
SYMBOLS,     A,010,    R,099
SYMBOLS,     S,100,    Y,169
SYMBOLS,     Z,170,    Z,255

DENSITY, 10 MINIMUM, 19 MAXIMUM,·

SCALE, 1/24000

WINDOW, DEGREES,
       1250 LAT,      .1250 LON

TICK,  MINUTES,    7 500 LAT,    7 500 LON PRIMARY,
       MINUTES,    2 500 LAT,    2 500 LON SECONDARY

ZONE, ** (UTM CENTRAL MERIDIAN ****** DEG)
```

The default SCALE, WINDOW, and TICK intervals shown above are suitable for generating a standard USGS 7.5 minute quadrangle map, and need not be changed. To specify the quadrangle location, enter its ORIGIN (in North America, its southeast corner).

```
MBL8X /MBL2X      DAM PRTCLASS(7602)        05/05/76   11 48

    **USER COMMANDS

>ORIGIN,DEG,30 15,96 30
 ORIGIN, DEGREES,  30 25000 LATITUDE,  96 50000 LONGITUDE
 ORIGIN, DEGREES,  30 15 00 LATITUDE,  96 30 00 LONGITUDE
 ORIGIN, SCAN,  977 LINE, 1999 SAMPLE
```

Next specify the map HEADING and enter the MAP command.

```
>HEADING,1,SOMERVILLE--7 5' QUAD
 HEADING, 1. SOMERVILLE--7 5' QUAD

>MAP
```

Since the number of sub-windows was not given on the map command, PRTCLASS generates a single map covering the entire window, and confirms this at the terminal. (The map will be printed at an onsite line printer after program termination.)

```
 MAP,   0 SUB-WINDOWS
      WINDOW #  1 (ORIGIN   30 2500 LAT,  96 5000 LON)
```

The following example illustrates how to generate several sub-window maps covering different parts of a window.

```
>WINDOW,MINUTES,15,15
 WINDOW, DEGREES,
       .2500 LAT,      .2500 LON

>HEADING,1,7 5' QUADS--SOMERVILLE VICINITY
 HEADING, 1, 7 5' QUADS--SOMERVILLE VICINITY

>MAP,4
```

PRTCLASS breaks the new 15 minute window into four 7.5 minute sub-windows (based on the 7.5 minute primary tick interval), and generates a separate map for each sub-window.

```
 MAP,    4 SUB-WINDOWS
      WINDOW #  2 (ORIGIN   30 2500 LAT,   96 5000 LON)
      WINDOW #  3 (ORIGIN   30 2500 LAT,   96 6250 LON)
      WINDOW #  4 (ORIGIN   30 3750 LAT,   96 5000 LON)
      WINDOW #  5 (ORIGIN   30 3750 LAT,   96 6250 LON)
```

To generate a single small-scale map covering the area of these four quadrangles, change the SCALE and HEADING.

```
>SCALE,1/100000
 SCALE, 1/100000

>HEADING,1,SOMERVILLE VICINITY
 HEADING, 1, SOMERVILLE VICINITY

>MAP
 MAP,    0 SUB-WINDOWS
      WINDOW #  6 (ORIGIN   30 2500 LAT,   96 5000 LON)
```

To terminate the program, enter EXIT.

```
>EXIT
    **PROGRAM TERMINATION
 DO YOU WANT DENSITY FILES SAVED?
```

Unless YES is entered, PRTCLASS destroys the density files on termination to conserve mass storage and prevent conflicts with future runs. The density files should not be saved unless needed by a subsequent program in this run.

```
>NO

 NORMAL TERMINATION      05/05/76   11.59     0 FATAL ERRORS
```

11. PLTCLASS PROGRAM

PLTCLASS generates any number of custom formatted and scaled maps on a pen plotter. The maps for a Landsat MSS scene are plotted using data from the density file(s) produced by program CLASSIFY. PLTCLASS assigns each pixel to a plot position on the classification map.

11.1 PREREQUISITES

PLTCLASS must be executed in a computer run (normally batch -- see 1.6). CLASSIFY must be executed in the same run prior to PLTCLASS, in order to generate the density file(s). Tape input is required for CLASSIFY, but not for PLTCLASS.

11.2 EXEC COMMANDS

@XQT PLTCLASS
This exec command initiates execution of the PLTCLASS program.

11.3 COMMANDS

ORIGIN,DEGREES,latitude,longitude
This command specifies the origin in degrees (typically minimum latitude and minimum longitude) of the area PLTCLASS is to map.

WINDOW,MINUTES,latitude,longitude
This command specifies the size (in minutes of latitude and longitude) of a rectangular area to be mapped by PLTCLASS.

HEADING,1,heading-text
This command specifies the text to be printed on line 1 of the map heading. The text is limited to 72 characters and may not contain commas.

SCALE,1/denominator-of-representative-fraction
This command specifies the scale at which subsequent windows are to be mapped. The minimum denominator is 20000 and the maximum is 260000 (commas may not be embedded in the denominator).

TICK,MINUTES,latitude,longitude,MINUTES,latitude,longitude
This command specifies the intervals for plotting the primary ticks and the secondary ticks within subsequent windows. The primary intervals in minutes are given first, followed by the secondary intervals in minutes.

MAP
This command generates a single map covering the current window.

MAP,maximum-number-of-sub-windows
This variation of the MAP command divides the current window into the specified number of sub-windows (based on the current primary tick interval) and generates a separate map for each sub-window.

EXIT
This command terminates the PLTCLASS program.

11.4 RUNSTREAM

PLTCLASS is executed in the same computer run with several other programs. The partial runstream required for PLTCLASS is:

```
. . .
(runstream for CONTROL)
(runstream for CLASSIFY -- repeat once for each strip)
@XQT PLTCLASS
SCALE,1/denominator-of-representative-fraction
TICK,MINUTES,latitude,longitude,MINUTES,latitude,
   longitude
ORIGIN,DEGREES,latitude,longitude
WINDOW,MINUTES,latitude,longitude
HEADING,1,heading-text
MAP
EXIT
. . .
```

} repeat for each area to be mapped

12. (RESERVED FOR FUTURE USE)

13. STATUS PROGRAM

The STATUS program allows a user to monitor the execution of programs in other demand or batch runs. This program is particularly useful for a demand user to inquire about the status of previously submitted batch runs.

13.1 PREREQUISITES

STATUS must be executed in a computer run (normally demand -- see 1.6).

13.2 EXEC COMMANDS

The following exec commands are the only ones required for the STATUS program.

@XQT STATUS
This exec command initiates execution of the STATUS program.

@EOF
This exec command terminates the STATUS program. At least one runid (see below) must be entered before terminating the program.

13.3 COMMANDS

Command input to the STATUS program is normally either a runid or an index:

runid
A runid begins with a letter and may contain no more than 6 characters. STATUS responds to this command by printing a short summary (including index number) for all recent runs with the specified runid.

index
An index is composed entirely of numeric characters. STATUS responds to this command by printing summary information on every program execution within the indexed run.

13.4 RUNSTREAM

The partial runstream required for STATUS is:

```
. . .
@XQT STATUS
runid      repeat as desired
index
. . .
@EOF
. . .
```

13.5 SAMPLE RUN

The following portion of a demand terminal run illustrates use of the STATUS program. The computer displays a prompt character (>) before each statement keyed in by the user.

```
>@XQT STATUS
```

Once the @XQT STATUS exec command is entered, a list of current default commands is printed, followed by a request for user input.

```
MBL8A /MBL8A      DAM STATUS(7605)          06/11/76   10 06

   **CURRENT DEFAULT COMMANDS

ON,CONFIRM
MBL8A /MBL8A      DAM STATUS(7605)          06/11/76   10 06

   **USER COMMANDS

ENTER RUNID
```

Now enter a string of characters corresponding to the runid of a computer run for which summary status information is desired. In this example, information is requested for all runs having SRT17 in the first five characters of the runid, regardless of the sixth character (slash matches with any character).

```
>SRT17/
```

The program responds by printing a status summary for the most recent runs with runid matching that specified above.

```
INDEX  RUNID   MODE     DATE      TIME   QUALIFIER      ACCOUNT

  548  SRT17   DEMAND   06/08/76  08 02  TF5-N86750
  512  SRT17A  BATCH    06/05/76  02 08  TF5-L71312
  496  SRT17   DEMAND   06/03/76  08 06  TF5-N86750
```

The STATUS program now requests either another runid or an index. In this example, the index 512 (for batch run SRT17A, dated 06/05/76) is entered.

```
ENTER RUNID OR INDEX
>512

(00512)  SRT17A/SRT17A  *TF5-L71312
-------------------------
DAM CONTROL(7605)          06/05/76   02 09
 NORMAL TERMINATION        06/05/76   02 09      0 FATAL ERRORS
-------------------------
QUALIFIER CHANGED TO TF5-L713127A
-------------------------
DAM CLASSIFY(7605)         06/05/76   02 11
 **NOTE   EXACT REGISTRATION BASED ON CONTROL NETWORK
 NORMAL TERMINATION        06/05/76   02 21
-------------------------
DAM CLASSIFY(7605)         06/05/76   02 21
 **NOTE   NO PARAMETER INPUT -- PREVIOUS PARAMETERS RECALLED
 NORMAL TERMINATION        06/05/76   02 33      0 FATAL ERRORS
-------------------------
DAM CLASSIFY(7605)         06/05/76   02 36
 **NOTE   NO PARAMETER INPUT -- PREVIOUS PARAMETERS RECALLED
 NORMAL TERMINATION        06/05/76   02 42      0 FATAL ERRORS
-------------------------
DAM CLASSIFY(7605)         06/05/76   02 46
 **NOTE   NO PARAMETER INPUT -- PREVIOUS PARAMETERS RECALLED
 NORMAL TERMINATION        06/05/76   02 52      0 FATAL ERRORS
-------------------------
DAM PRTCLASS(7605)         06/05/76   02 52
 NORMAL TERMINATION        06/05/76   03 23      0 FATAL ERRORS
-------------------------
```

The STATUS program has printed out a more detailed summary of the run identified by index 512. This summary gives, for each program executed in the run, the starting time and termination time and whether or not the program terminated normally or in error. Once the summary is completed, STATUS will once again request a runid or index.

In this example, no additional information is desired and execution of STATUS is terminated by entering the exec command @EOF.

```
ENTER RUNID OR INDEX
@EOF


NORMAL TERMINATION      06/11/76   10 09      0 FATAL ERRORS
```

14. (RESERVED FOR FUTURE USE)

15. ADDITIONAL CAPABILITIES

Preceding sections have summarized the basic procedures for executing programs within the DAM package. This section explains several additional capabilities. For complete software user specifications, see Appendices A through G.

15.1 EXEC COMMANDS

The following optional exec commands may be used with programs in the DAM package (lowercase letters indicate user-supplied information):

@EOF

If this exec command immediately follows the @XQT exec command, then all commands from the previous program execution are recalled and used by the currently executing program. This is useful if the same processing is to be repeated with several different Landsat data tapes.

@XQT,E program-name

This variation of the @XQT exec command initiates execution of the named program if and only if the previous program execution terminated in error, otherwise the program is not executed. This is useful in a batch run when processing a Landsat tape which may have parity errors. The following portion of a runstream illustrates the use of this capability:

```
@XQT PICTAB
commands
EXIT
@REWIND 3.
@XQT,E PICTAB   } repeat as desired
@EOF
```

@LOCATE 3.,strip-number
This exec command searches a Landsat multi-file data tape and locates that file containing data for the specified strip. This exec command is used instead of @REWIND, when processing a Landsat multi-file tape.

15.2 COMMANDS

All commands may be abbreviated to no fewer than the first three characters.

Normally each card contains a single command. However, several related commands may appear on the same card, provided they are always separated by a triple comma (,,,).