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"AS-BUILT" DESIGN SPECIFICATION
FOR
BOUNDARY DETECTION AND REGISTRATION PROGRAM (BDARP1)

Job Order 71-593

(TIRFs 76-0046 & 77-0059)

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For

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National Aeronautics and Space Administration
LYNDON B. JOHNSON SPACE CENTER
Houston, Texas

April 1978

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Appendix

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APPENDIX

1. SCOPE

This document describes the detailed design characteristics of the Boundary Detection and Registration Program (BDARP1), as built for the Bendix 100 Interactive Drafting System. The BDARP1 is an unsophisticated version of the final software system, yet it provides the user with the basic capabilities of obtaining classified data boundary plots, editing, and registration of the final boundary plot to a user-selected base.

2. APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein:

- Technical Memorandum Software Specifications for Automated Thematic Plotting of Classified Digital Data, LEC-8289
- Technical Memorandum Project Development Plan for the Bendix Interactive Drafting System Modification, LEC-8968
- Design Specification for Automated Thematic Plotting of Classified Digital Data, LEC-9506
- Technical Memorandum Acceptance Test Plan for Boundary Detection and Registration Program (BDARP1), LEC-10672
- TIRF 76-0046
- TIRF 77-0059
- Design Specification for Modification of Boundary Detection and Registration Program (BDARP1) for 9-track Data Input, January 1978, LEC-11879.
- Acceptance Test Specification for Modification of Boundary Detection and Registration Program (BDARP1) for 9-Track Tape Data Input, March 1978, LEC-12038.

3. SYSTEM DESCRIPTION

The Boundary Detection and Registration Program (BDARP1) was designed and implemented as an addition to the basic Bendix 100 Drafting Program. The BDARP1 consists of three overlays:

USER09 - the classified tape initialization module

T9 - the tape read and data storage routine

TM - the boundary detection and registration algorithm

To begin processing, USER09 accepts the user's options and reads the header record from a 7 or 9 track, 800 BPI, Universal formatted classified tape directly or indirectly obtained from the GE Interactive Multispectral Image Analyst System (Image 10(the Earth Resources Interactive Processing System (ERIPS) or the UNIVAC 1100 Software.

USER09 then calls overlay T9, which reads the required number of data records from the magnetic tape. The data are processed, packed and written on a temporary disk file, TDATA. Corner reference ticks are placed on the drawing file.

Overlay T9 calls the third and last overlay - TM. Overlay TM reads the data stored in TDATA, one line at a time, and performs the boundary detection and registration algorithm. The resultant boundary information is written into a standard format drawing file, and control is then returned to the basic Bendix 100 Drafting Program. Editing and write tape functions are now available to prepare the boundary data for plotting.

BDARP1 is designed to process one class at a time. For the case of multiple classes, BDARP1 has to run as many times as the number of classes. Each execution of BDARP1 under the Drafting Program is initialized by selecting USER OPTION:9 on the menu.

When processing is completed, BDARP1 informs the user by sounding the tone on the display device (Tektronix) and illuminating the red indicator light on the digitizer cursor.

Note that the editing and tape write functions are currently available under Bendix System 100 and can be used as long as the drawing file format used to store the boundary strings by the boundary detection routine is identical to the one employed by the Bendix System 100 software. Since no additional software is required for the editing and write tape routines, these two are not included in the software description. However, as a result, it imposes a restriction on the file format to be used to store the boundary strings.

3.1 HARDWARE DESCRIPTION

Bendix System 100 configuration.

3.2 SOFTWARE DESCRIPTION

In this section each of the three overlays which form an integral part of BDARP1 is further broken down into subroutines. Brief functional descriptions of each subroutine as well as inter-subroutine relationships are discussed.

Overlay USER09 is the initialization module for BDARP1, and consists of the following routines:

DRVF9- the driver routine for this overlay

INPBD - the subroutine which interacts with the operator to accomplish input of the control parameters

REAHD - subroutine which reads the header record on the classified input tape

INITN - subroutine which error checks header record data and positions the tape for reading the image data

CON79 - subroutine which converts unformatted 7-track input data to byte data

CONWD - subroutine which converts unformatted 9-track input data to byte data

The second overlay, T9, which performs input of classified data, consists of the following routines:

RDLIN9 - reads the classified data rape and packs the data into a temporary disk file, TDATA

ISET - sets the appropriate bits in 16 bit words to indicate which pixels belong to the class being examined. These words are the packed data which RDLIN packs into TDATA

CON79 - same as CON79 in overlay USER09

CONWD - same as CONWD in overlay USER09

FRAME - subroutine which inserts corner ticks in the drawing file

LINIT - subroutine which performs 8-parameter transformation to the data and sends it to the System 100 drawing file

The third and final overlay in BDARP1 is designated TM. This overlay is the boundary detection algorithm, which examines the packed data in TDATA, creates boundary strings to represent the boundaries of the specified data class, and writes these boundary strings into a drawing file formatted for the Bendix system. The routines which comprise overlay TM are:

BDT9 - This is the main routine for TM and the principal routine for the boundary detection algorithm.

READAT - This subroutine reads bit images of line data from the temporary disk file, TDATA.

IGET - This subroutine unpacks the bit data read into READAT for the boundary detection algorithm.

FILL - This routine redefines appropriate pixels as "classified" to facilitate connectivity as defined by the user input parameter Epsilon.

FINDAR - Subroutine which finds the appropriate boundary string to which a boundary line segment belongs.

CONECT; CONALL; JOIN - Subroutines which link appropriate boundary strings.

CLSTST - Subroutine which periodically checks the status of boundary strings for completeness, and processes the complete ones.

AREA1 - Subroutine which computes the area in pixel units of each classified group.

LINIT   Subroutine which performs 8-parameter transformation to the data and sends it to the System 100 drawing file.

ENDTST - Subroutine which handles segmentation of large plot string arrays.

3.2.1 SOFTWARE COMPONENT NO. 1 (DRVF9)

3.2.1.1 Linkage

Subroutine DRVF9 calls user subroutines INPBD and INITN, and calls the system subroutine FRNOV.

3.2.1.2 Interface

DRVF9 is linked with the common block ICONS (see Appendix A) which houses all the basic control parameters for BDARP1.

3.2.1.3 Input

None

3.2.1.4 Output

An error message is output including an error code whenever the system subroutine FRNOV fails.

3.2.1.5 Storage Requirements

Subroutine DRVF9 requires 184 words in core.

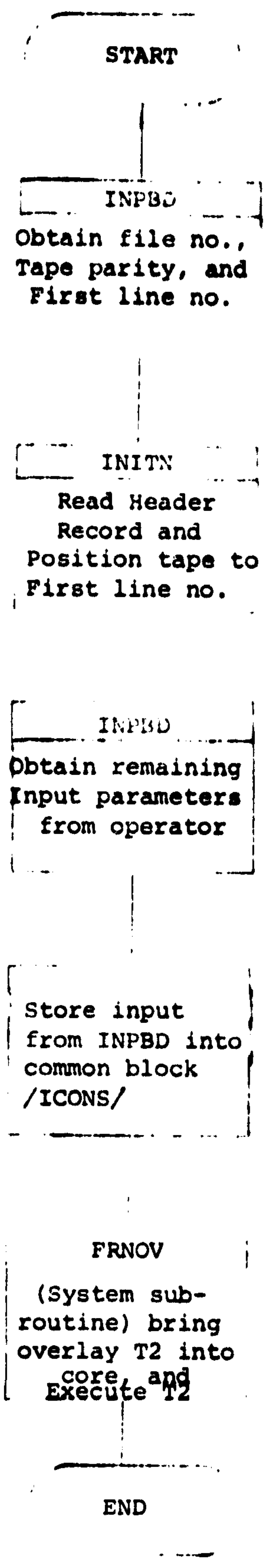
3.2.1.6 Description

DRVF9 is the driver for the initial overlay USER09, and calls overlay T9 into core after USER09 has been executed.

3.2.1.7 Flowchart

3.2.1.8 Listing

(DRVF9)


START
INPBD
Obtain file no., Tape parity, and First line no.
INITN
Read Header Record and Position tape to First line no.
INPBD
Obtain remaining Input parameters from operator
Store input from INPBD into common block /ICONS/
FRNOV
(System sub- routine) bring overlay T2 into core, and Execute T2
END

```
         COMMON /ICONS/ ID(14), OPTNS(17), ISET
         DIMENSION  IG0(5), IDENT(20), IALPH(5)
         IALPH(1)=" T9"
         IALPH(2)=", 1"
         CALL INPBD(1)
         CALL INITN
         CALL INPBD(2)
         IALPH(3)=0
         IER=0
         CALL FRNOV(IALPH, IER)
         PAUSE DIDNT USE FRNOV SUCCESSFULLY
         WRITE(10,1001) IER
  1001   FORMAT(10X,"IER =",I4)
C        PAUSE OVERLAY ERROR-NO RETURN TO SYSTEM 101
         END

READY
```

3.2.2 SOFTWARE COMPONENT NO. 2 (INPBD)

3.2.2.1 Linkage

Subroutine INPBD is called by DRVF9.

3.2.2.2 Interface

The basic common block ICONS (see Appendix A) which houses [illegible] the necessary control parameters is created by subroutine [illegible].

3.2.2.3 Input

All the basic information which BDARP1 needs for execution is requested and received by INPBD via the teletype or display screen and keyboard. The operator is queried for the following:

1. Tape file no.
2. Parity (0 or 1)
3. 7 or 9 Track
4. First line no.
5. Last line no.
6. First pixel no.
7. Last pixel no.
8. Channel no.
9. Class value
10. Epsilon value
11. Kappa value
12. Eight coefficients for registration (optional)

3.2.2.4 Output

The above control parameter queries are displayed on the screen.

3.2.2.5 Storage Requirements

Subroutine INPBD requires 615 words in core.

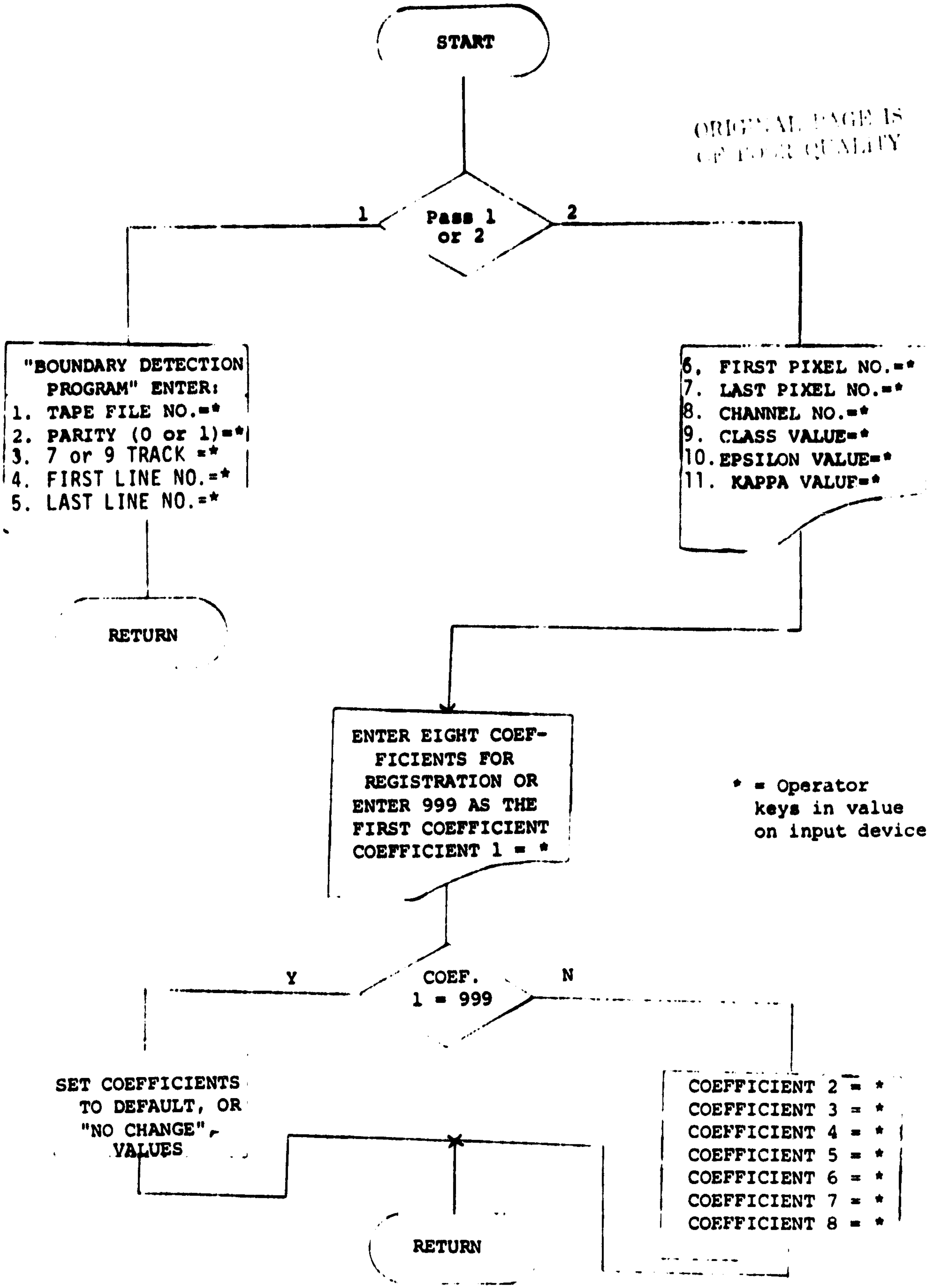
3.2.2.6 Description

Subroutine INPBD interacts with the operator to bring in the basic control parameters for BDARP1 execution, and defines them as components of the vector OPTNS (see Appendix A) which is part of the common block ICONS.

3.2.2.7 Flowchart

3.2.2.8 Listing

(INPBD)


START
Pass 1
or 2
1
2
"BOUNDARY DETECTION
PROGRAM" ENTER:
1. TAPE FILE NO.=*
2. PARITY (0 or 1)=*
3. 7 or 9 TRACK =*
4. FIRST LINE NO.=*
5. LAST LINE NO.=*
RETURN
6. FIRST PIXEL NO.=*
7. LAST PIXEL NO.=*
8. CHANNEL NO.=*
9. CLASS VALUE=*
10. EPSILON VALUE=*
11. KAPPA VALUE=*
ENTER EIGHT COEF-
FICIENTS FOR
REGISTRATION OR
ENTER 999 AS THE
FIRST COEFFICIENT
COEFFICIENT 1 = *
* = Operator
keys in value
on input device
COEF.
1 = 999
Y
N
SET COEFFICIENTS
TO DEFAULT, OR
"NO CHANGE",
VALUES
COEFFICIENT 2 = *
COEFFICIENT 3 = *
COEFFICIENT 4 = *
COEFFICIENT 5 = *
COEFFICIENT 6 = *
COEFFICIENT 7 = *
COEFFICIENT 8 = *
RETURN

```
                                            READY
      SUBROUTINE INPBD (LL)
      COMMON /ICONS/ ID(14),OPTNS(17),ISET
      IF(LL NE 1) GO TO 101

      WRITE(10,1)
    1 FORMAT(10X,"*****      BOUNDARY DETECTION PROGRAM      *****",
     /28X,"VERSION 1",///)
      WRITE(10,2)
    2 FORMAT(20X,"ENTER",//,23X,"1  TAPE FILE NO   =")
      READ (11) OPTNS(2)
      WRITE(10,21)
   21 FORMAT(23X,"2  PARITY(0 OR 1) =")
      READ (11) OPTNS(3)
      WRITE(10,23)
   23 FORMAT(23X,"3  7 OR 9 TRACK   =")
      READ (11) OPTNS(17)
      WRITE(10,22)
   22 FORMAT(23X,"4  FIRST LINE NO. =")
      READ (11) OPTNS(1)
      RETURN
  101 CONTINUE
      WRITE(10,3)
    3 FORMAT(23X,"5  LAST LINE NO.  =")
      READ (11) OPTNS(2)
      WRITE(10,4)
    4 FORMAT(23X,"6  FIRST PIXEL NO =")
      READ (11) OPTNS(3)
      WRITE(10,5)
    5 FORMAT(23X,"7  LAST PIXEL NO  =")
      READ (11) OPTNS(4)
      WRITE(10,6)
    6 FORMAT(23X,"8  CHANNEL NO.    =")
      READ (11) OPTNS(5)
      WRITE(10,7)
    7 FORMAT(23X,"9  CLASS VALUE     =")
      READ (11) OPTNS(6)
      WRITE(10,8)
    8 FORMAT(22X,"10  EPSILON VALUE  =")
      READ (11) OPTNS(7)
      WRITE(10,9)
    9 FORMAT(22X,"11  KAPPA  VALUE   =")
      READ(11) OPTNS(8)
      WRITE(10,10)
   10 FORMAT(   ,10X,"ENTER EIGHT COEFFICIENTS FOR REGISTRATION",
     ,10X,"OR", ,10X,"ENTER 999 AS THE FIRST COEFFICIENT")
      DO 100 I=1,8
      WRITE(10,11) I
   11 FORMAT(15X,"COEFFICIENT ",I1," =")
      J=I+8
      READ (11) OPTNS(J)
      NOP=OPTNS(J)
      IF(NOP-999) 100,120,100
  100 CONTINUE
      GO TO 130
  120 DO 200 N=10,16
  200 OPTNS(N) = 0.0
      OPTNS(9) = 1.0
      OPTNS(15) = 1.0
  130 CALL FENOT("1")
      RETURN
      END

READY
```

3.2.3 SOFTWARE COMPONENT NO. 3 (REAHD)

3.2.3.1 Linkage

Subroutine REAHD9 is called in overlay USER09 by subroutine INITN, and calls subroutines CON79, CONWD and RDTAPE (a system subroutine which affects magnetic tape reading).

3.2.3.2 Interface

The control information from the header record, and the information needed to read the header record, is transmitted through the common block ICONS.

3.2.3.3 Input

The subroutine reads the header record on the data tape.

3.2.3.4 Output

Error messages may be displayed to the operator if subroutine REAHD encounters ambiguities in the header information.

3.2.3.5 Storage Requirements

Subroutine REAHD requires 809 words in core.

3.2.3.6 Description

The main purpose of subroutine REAHD is to read the header record from the designated file on the data tape. A conversion using CON79 or CONWD is required to obtain descriptive values. These elements are tested and, if valid, are stored in the vector ID in the common block ICONS. If adequate information to process the data is not available, a message to that effect alerts the operator and the run is terminated. Under certain conditions, however, when only one or two parameters are in error, the subroutine will supply "standard" values for the one or two in error, and execution of BDARP1 will be attempted. An appropriate warning will be communicated to the operator under this condition.

3.2.3.7 **Flowchart**

3.2.3.8 **Listing**

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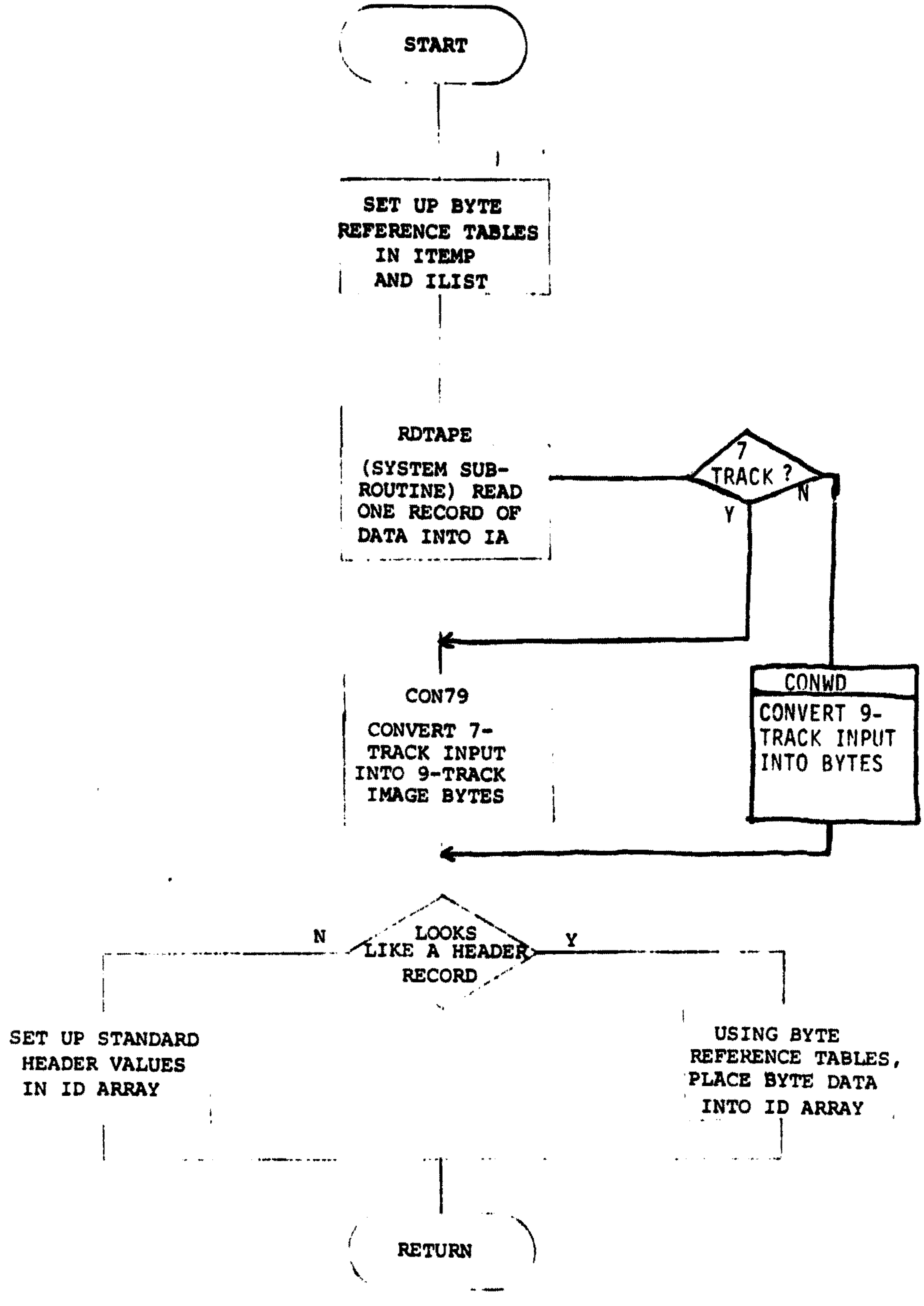
(REAHD)


START
SET UP BYTE REFERENCE TABLES IN ITEMP AND ILIST
RDTAPE
(SYSTEM SUB-ROUTINE) READ ONE RECORD OF DATA INTO IA
7 TRACK ?
Y
N
CON79
CONVERT 7-TRACK INPUT INTO 9-TRACK IMAGE BYTES
CONWD
CONVERT 9-TRACK INPUT INTO BYTES
N
LOOKS LIKE A HEADER RECORD
Y
SET UP STANDARD HEADER VALUES IN ID ARRAY
USING BYTE REFERENCE TABLES, PLACE BYTE DATA INTO ID ARRAY
RETURN

```
33
                                               READY
      SUBROUTINE REAHD (NOHD)
      COMMON /ITEMP/ LIST(17), IBYTE(17), IHD
      COMMON /ICONS/ ID(14), OPTNS(17), IFLAG
      DIMENSION IA(4080), IN(2), IB(3)
      DATA IHD /0/
      DATA LIST /5,7,11,11,2,3,1,4,4,8,12,12,9,10,10,6,6/
      DATA IBYTE /90,91,92,93,102,103,104,105,106,107,108,109,1778,
      1785,1786,1787,1788/
      IF (IHD) 160, 20, 160
   20 NIT = 0
      IF (OPTNS(17).GT.8.) NIT=1
      N = 4080
      IPAR = OPTNS(3)
      CALL ROTAPE(NIT, IA, N,IPAR, KSHR, JCON)
      IF (NIT.EQ.0) GO TO 25
      NZ=IA(1)
      CALL CONWD(NZ,IB)
      GO TO 29
   25 IN(1) = IA(1)
      IN(2) = IA(2)
      CALL CON79 (IN, IB)
   29 IF (IB(1)) 70, 30, 70
   30 IF (IB(2) - 1) 70, 35, 70
   35 WRITE (10,535) IB(2)
  535 FORMAT (1X, "  SINCE FIRST WORD = ", I3,", THIS RECORD APPEARS TO
      BE DATA INSTEAD HEADER.  WILL TRY TO USE STANDARD VALUES.")
C***  NOHD = 1 FOR I-100, 2 FOR LARSYS AND 3 FOR 1100.
      IF (NOHD - 2) 40, 50, 60
   40 ID(1) = 1
      ID(2) = 0
      ID(3) = 0
      ID(4) = 70
      ID(5) = 3
```

```
LIST LINES - 33
                                                  READY
         ID(6) = 500
         ID(7) = 8
         ID(8) = 0
         ID(9) = 1
         ID(10) = 3
         ID(11) = 1
         ID (12) = 1
         GO TO 160
   50    GO TO 40
C***   USE I-100 UNTIL VALUES FOR LARSYS AVAILABLE
   60    GO TO 40
C ***    INSERT UNIVAC CONSTANTS WHEN AVAILABLE
   70    IF (NIT EQ 0) GO TO 79
         I=44
         K=88
         L=1
   71    I=I+1
         IF (I-56) 73,72,73
   72    I=889
         K=1776
   73    NZ=IH(I)
         CALL CONWD(NZ,IN)
         DO 78 N=1,2
         K=K+1
         IF (K - IBYTE(L)) 78,77,105
   77    IBYTE(L)=IN(N)
         L=L+1
   78    CONTINUE
         IF (L - 18) 71,110,110
   79    I = 57
         K = 87
         L = 1
   80    I = I + 2
```

```
                                                      READY
         IF (I - 75)  90,  85, 90
   85    I = 1185
         K = 1776
   90    IN(1) = IA(I)
         IN(2) = IA(I + 1)
         CALL CON79 (IN, IB)
         IHD = IA(I + 1)
C        WRITE (10,930)  IN,IB, IA(I), IHD, I, K, L
C  ***   PUT VALUES FROM TAPE INTO BYTE
         DO  100  N = 1,3
         K = K + 1
         IF (K - IBYTE(L))  100, 95, 105
   95    IBYTE(L) = IB(N)
         L = L +1
  100    CONTINUE
         IF (I - 1191)  80, 110, 110
  105    WRITE (10,605)  K, IBYTE(L)
  605    FORMAT (1X,"  HOW CAN K = ", I3,"  WHICH IS LARGER THAN", I4)
C  ***   TEST FOR TWO-BYTE WORDS AND STORE IN ID
  110    L = 1
  120    IF (L - 16)  130, 130, 160
  130    N = LIST(L)
         K = L + 1
         IF (LIST(L) - LIST(K))  140, 150, 140
  140    ID(N) = IBYTE(L)
         L = L + 1
         GO TO 120
  150    IWD = IBYTE(L) * 400K + IBYTE(K)
         ID(N) = IWD
         L = L + 2
         GO TO 120
  160    IHD = 1
C        WRITE (10,650)  ID
```

```
C 650  FORMAT (1X, 10X,"HEADER VALUES FROM TAPE."//2(7I6//))
C ***  IHD FLAG SHOWS HEADER RECORD HAS BEEN READ.
       RETURN
       END

READY
```

3.2.4 SOFTWARE COMPONENT NO. 4 (INITN)

3.2.4.1 Linkage

Subroutine INITN is called by the driver subroutine DRVF9 in overlay USER09, and in turn calls user subroutines REAHD, CONWD, and CON79 and system subroutines RDTAPE and SPACE.

3.2.4.2 Interface

The common block ICONS transmits control information to INITN.

3.2.4.3 Input

See 3.2.4.2.

3.2.4.4 Output

None

3.2.4.5 Storage Requirements

Subroutine INITN requires 443 words in core.

3.2.4.6 Description

Subroutine INITN begins by positioning the input tape to the requested file and reading the header record via subroutine REAHD. Additional error checks are performed on the header data, then the input tape is positioned to the record containing the first data line requested by the user.

3.2.4.7 Flowchart

3.2.4.8 Listing

(INITN)

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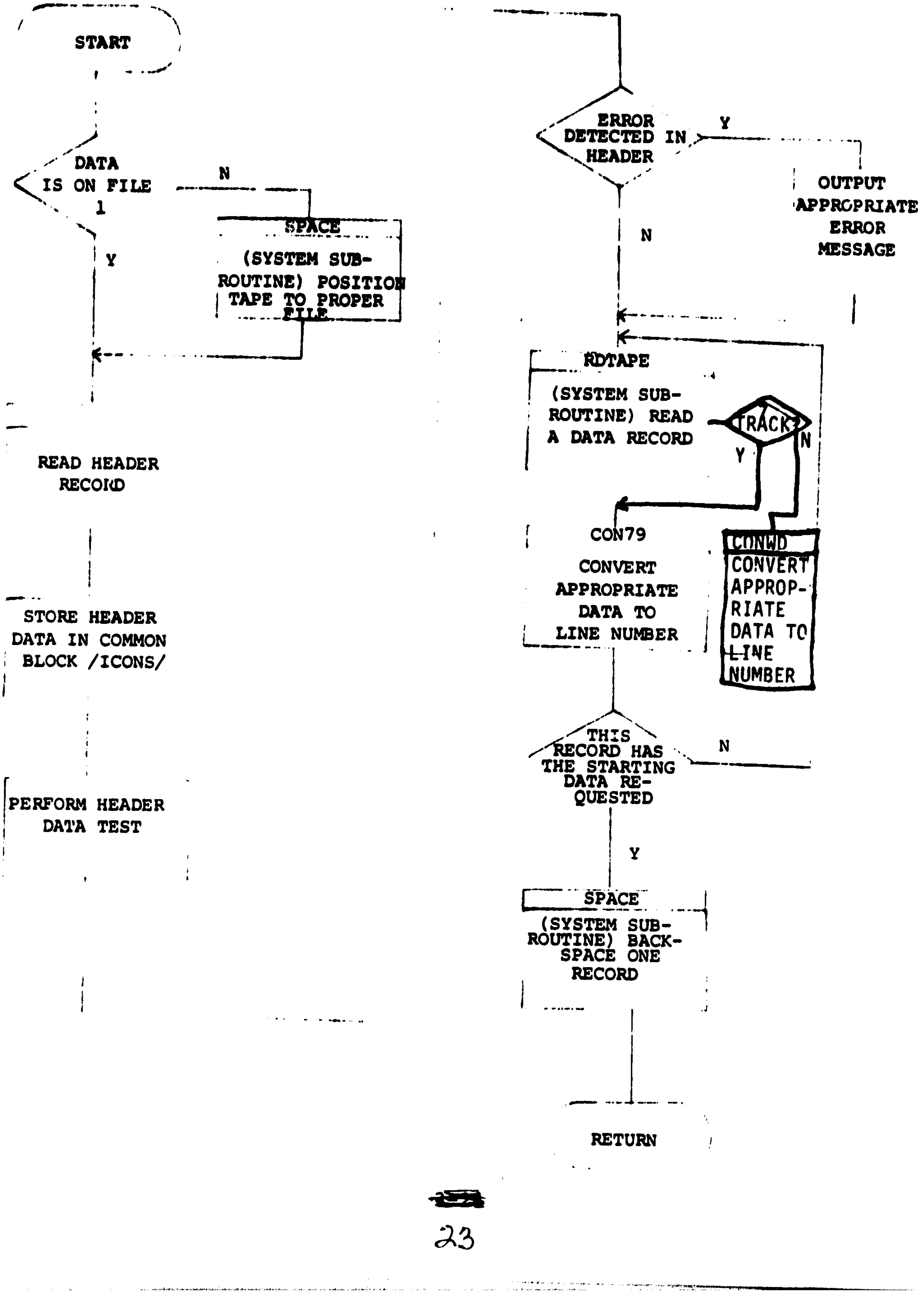


START
DATA IS ON FILE 1
N
Y
SPACE
(SYSTEM SUB-ROUTINE) POSITION TAPE TO PROPER FILE
READ HEADER RECORD
STORE HEADER DATA IN COMMON BLOCK /ICONS/
PERFORM HEADER DATA TEST
ERROR DETECTED IN HEADER
Y
OUTPUT APPROPRIATE ERROR MESSAGE
N
RDTAPE
(SYSTEM SUB-ROUTINE) READ A DATA RECORD
TRACK?
Y
N
CON79
CONVERT APPROPRIATE DATA TO LINE NUMBER
CONWD
CONVERT APPROP-RIATE DATA TO ~~LINE~~ LINE NUMBER
THIS RECORD HAS THE STARTING DATA RE-QUESTED
N
Y
SPACE
(SYSTEM SUB-ROUTINE) BACK-SPACE ONE RECORD
RETURN

```
                                          READY
      SUBROUTINE INITN
      COMMON /ICONS/ ID(14), OPTNS(17), IFLG1
      DIMENSION  IA(4080), IN(2), IB(3)
      ISYS=1
      IFLG1=0
      NRT = 0
      NIT = 0
      IF (OPTNS(17).GT.8.) NIT=1
      IFLSK = OPTNS(2)
      IFLG1 = 1
      N = IFLSK - 1
      IF (N)  50,50,40
   40 N = N - 1
      CALL SPACE (NIT, IFLG1, NRT, ISTAT)
      IF (N)  50,50,40
   50 CALL REAHD (ISYS)
      IANS = 1
C*** HEADER DATA TEST BY MINTER.
C*** ONE CHANNEL MUST NOT BE LARGER THAN ONE RECORD.
      IF (ID(3) - 1)  80,80,75
   75 WRITE (10,575)  ID(3)
C*** OR SUM ERRORS USING IERR = IERR + 2
  575 FORMAT (1X," FLAG3 = ", I4,".  INDICATES CHANNEL LARGER THAN "
      "RECORD.")
      ID(3) = 1
C*** START OF VIDEO DATA SHOULD BE GREATER THAN ZERO.
   80 IF (ID(1))  85,85,90
   85 ID(1) = 1
C*** NUMBER OF DATA SETS PER RECORD IS GREATER THAN ZERO.
   90 IF (ID(9))  95,95,100
   95 ID(9) = 1
C*** EXPECT 8 BITS FROM ORIGINAL DATA IN BYTES.
  100 IF (ID(7) - 8)  105,110,105
```

```
C*** AGAIN FOR ERROR SUM  IERR = IERR + 4
  105  WRITE (10,600)  ID(7)
  600  FORMAT (1X,"  NO OF BITS = ", I5)
       ID(7) = 8
C*** POSITION TAPE TO START OF REQUESTED DATA.
  110  ITEM = OPTNS(1)
C      WRITE (10,610) NIT, ISTAT
C 610  FORMAT (1X,"  READ DATA RECORD NEXT.  PARITY =", I5, "  STAT=",I6)
       ISTAT = 8192
       N = 4080
  120  CALL RDTAPE (NIT, IA, N, NIT, KSHRT, ISTAT)
       IF (NIT.EQ.0) GO TO 121
       NZ=IA(36)
       CALL CONWD(NZ,IB)
       IB(3)=IB(2)
       GO TO 125
  121  IN(1) = IA(47)
       IN(2) = IA(48)
       CALL CON79 (IN, IB)
  125  IF (IB(3) - ITEM)  120,140,130
  130  WRITE (10,630)  IFLSK, IB(3)
  630  FORMAT (1X,"  ON FILE ", I4,"  FIRST LINE IS", I5)
  140  MNUS = -1
       CALL SPACE (NIT, NRT, MNUS, ISTAT)

       RETURN
       END

READY
```

3.2.5 SOFTWARE COMPONENT NO. 5 (CON79)

3.2.5.1 Linkage

Subroutine CON79 is called by subroutines INITN and REAHD in overlay USER09 and by RDLIN9 in overlay T9.

3.2.5.2 Interface

Interface is accomplished by one input argument and one output argument.

3.2.5.3 Input

The input argument IA is a two-word array read from 7-track tape.

3.2.5.4 Output

The argument IB is a 3-word output array, one byte/word, right justified.

3.2.5.5 Storage Requirements

Subroutine CON79 requires 64 words in core.

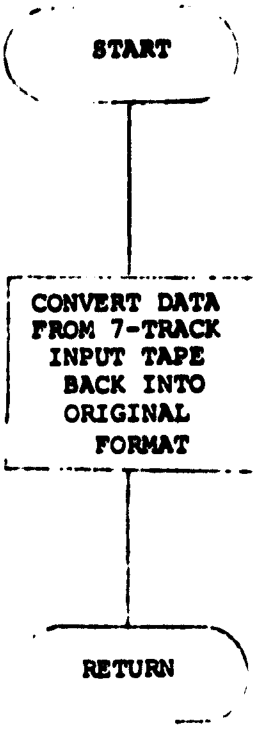
3.2.5.6 Description

Subroutine CON79 is designed to convert 7-track unformatted input data to formatted information in the form it originally appeared in a 9-track tape format. It is specifically designed to restore the data to its form as it appears on a Universally formatted classified tape.

3.2.5.7 Flowchart

3.2.5.8 Listing

(CON79)


START
CONVERT DATA FROM 7-TRACK INPUT TAPE BACK INTO ORIGINAL FORMAT
RETURN

ORIGINAL PAGE IS
OF POOR QUALITY

```
LIST LINES - 33
                                                READY
          TITLE CON79
  .      PROGRAM ID-SUBROUTINE CON79
         PROGRAMMER-PAUL LIN(LEC 626-45 SOFTWARE
  .                  DEVELOPMENT SECTION)
  .      DATE-SEPT  3,1976
         FUNCTION-CONVERT 2 WORDS READ FROM 7 TRACK TAPE
                   TO 3 WORDS(1 BYTE/WORD, RIGHT JUSTIFIED)
  .
         EXAMPLE:
            FROM WORD 1:00WWWWWW 00VVVVVV
                 WORD 2:00ZZZZZZ 00YYYYYY
  .         TO   WORD 1:00000000 WWWWWWVV
                 WORD 2:00000000 VVVVZZZZ
                 WORD 3:00000000 ZZYYYYYY
         SOURCE=<CON79.A>
         OBJECT=<CON79.R>

  .      CALLING SEQUENCE
           CALL CON79(IA,IB)
             WHERE IA IS A 2-WORD INPUT ARRAY READ FROM 7 TRACK TAPE
             IB IS A 3-WORD OUTPUT ARRAY, 1 BYTE/WORD, RIGHT JUSTIFIED

  .
          ENT CON79
          EXTD  CPYL,.FRET
          NREL
  .

          2
CON79     JSR @.CPYL
          STA 3,SAVE
          LDA 0,FTSTR,3
          LDA 2,FTSTR+1,3
```

```
LIST LINES - 65

        MOV 0,3
;
        PROCESS 1ST OUTPUT BYTE
;
        LDA 0.0.3
        LDA 1.MASK1
        AND 1.0
        LDA 1.SHFT4
CON01   MOVZR 0,0
        INC 1.1,SZR
        JMP CON01
        STA 0.TEMP

        LDA 0.0,3
        LDA 1.MASKR
        AND 1.0
        LDA 1,SHFT6
CON02   MOVZR 0,0
        INC 1,1,SZR
        JMP CON02

        LDA 1.TEMP
        ADD 1,0
        STA 0.0.2
;
        PROCESS 2ND OUTPUT BYTE
;
        LDA 0.0,3
        LDA 1,MASK2
        AND 1.0
        LDA 1,SHFT4
CON03   MOVZL 0,0
        INC 1,1,SZR
```

```
        JMP CON03
        STA 0.TEMP
;
        LDA 0,1,3
        LDA 1,MASKR
        AND 1,0
        MOVS 0,0
        MOVZR 0,0
        MOVZR 0,0
;
        LDA 1,TEMP
        ADD 1.0
        STA 0.1,2
;
;       PROCESS 3RD OUTPUT BYTE
;
        LDA 0,1,3
        LDA 1,MASKL
        AND 1.0
        STA 0,TEMP
        LDA 0,1,3
        LDA 1,MASK3
        AND 1,0
        MOVZR 0,0
        MOVZR 0.0
;
        LDA 1,TEMP
        ADD 1,0
        STA 0,2,2
;
        LDA 3,SAVE
        JSR @.FRET

READY
```

```
LIST LINES - 65

.
MASK1   000060   ;GET BITS 10,11
MASK2   000017   ;GET BITS 12-15
MASK3   001400   ;GET BITS 6,7
MASKL   000377   ;GET BITS 8-15
MASKR   177400   ;GET BITS 0-7
SHFT4   -4
SHFT6   -6
SAVE     0
TEMP    0
         END

READY
```

3.2.6 SOFTWARE COMPONENT NO.6 (CONWD)

3.2.6.1 Linkage

Subroutine CONWD is called by subroutine INITN and REAHD in USER09 and by RDLIN9 in overlay T9.

3.2.6.2 Interface

Interface is accomplished by one input argument and one output argument.

3.2.6.3 Input

The input argument IA is one word read from 9-track tape.

3.2.6.4 Output

The argument IB is a two-word output array, one byte/word, right justified.

3.2.6.5 Storage Requirements

Subroutine CONWD requires 19 words in core.

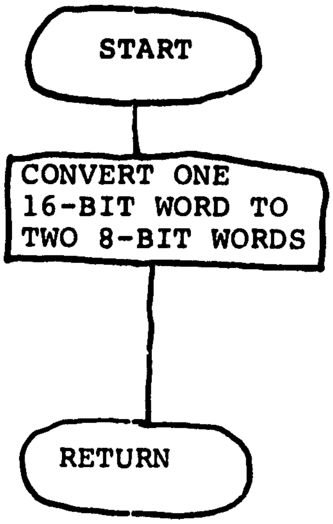
3.2.6.6 Description

Subroutine CONWD is designed to convert one 16 bit word to two 8 bit words, right justified.

3.2.6.7 Flowchart

3.2.6.8 Listing

(CONWD)



```
LIST LINES - 33

          TITLE CONWD
          ENT CONWD
          EXTD  CPYL,.FRET
          NREL
          1                ; 1 ARGUMENT INPUT
 CONWD   JSR@ .CPYL
         STA 3,SAVE        ; SAVE ACC3
         LDA 0,FTSTR,3 ; GET ARGUMENT ADDRESS
         LDA 2,FTSTR+1,3
         MOV 0,3

         LDA 0,0,3
         LDA 1,MASK
         AND 1,0
         STA 0,1,2

         LDA 0,0,3
         MOVS 0,0          ; SWAP THE TWO BYTES
         LDA 1,MASK
         AND 1,0
         STA 0,0,2

         LDA 3,SAVE
         JSR@ .FRET


         MASK  000377   ; GET BITS 8-15
         SAVE  0
          END

[illegible]
```

3.2.7 COMPONENT NO. 7 (RDLIN9)

3.2.7.1 Linkage

Subroutine RDLIN9 is the driver (main) routine in overlay T9. RDLIN9 calls the user subroutines ISET, CON79, and FRAME, as well as various system subroutines which read the input tape and create the temporary data file TDATA. After execution, RDLIN calls in overlay TM.

3.2.7.2 Interface

Subroutine RDLIN9 communicates with its associate subroutine via the common parameter block ICONS.

3.2.7.3 Input

Subroutine RDLIN9 accepts input from the Universally formatted input data tape.

3.2.7.4 Output

RDLIN9 creates a temporary data file TDATA on the system disk.

3.2.7.5 Storage Requirements

Subroutine RDLIN9 requires 1115 words in core.

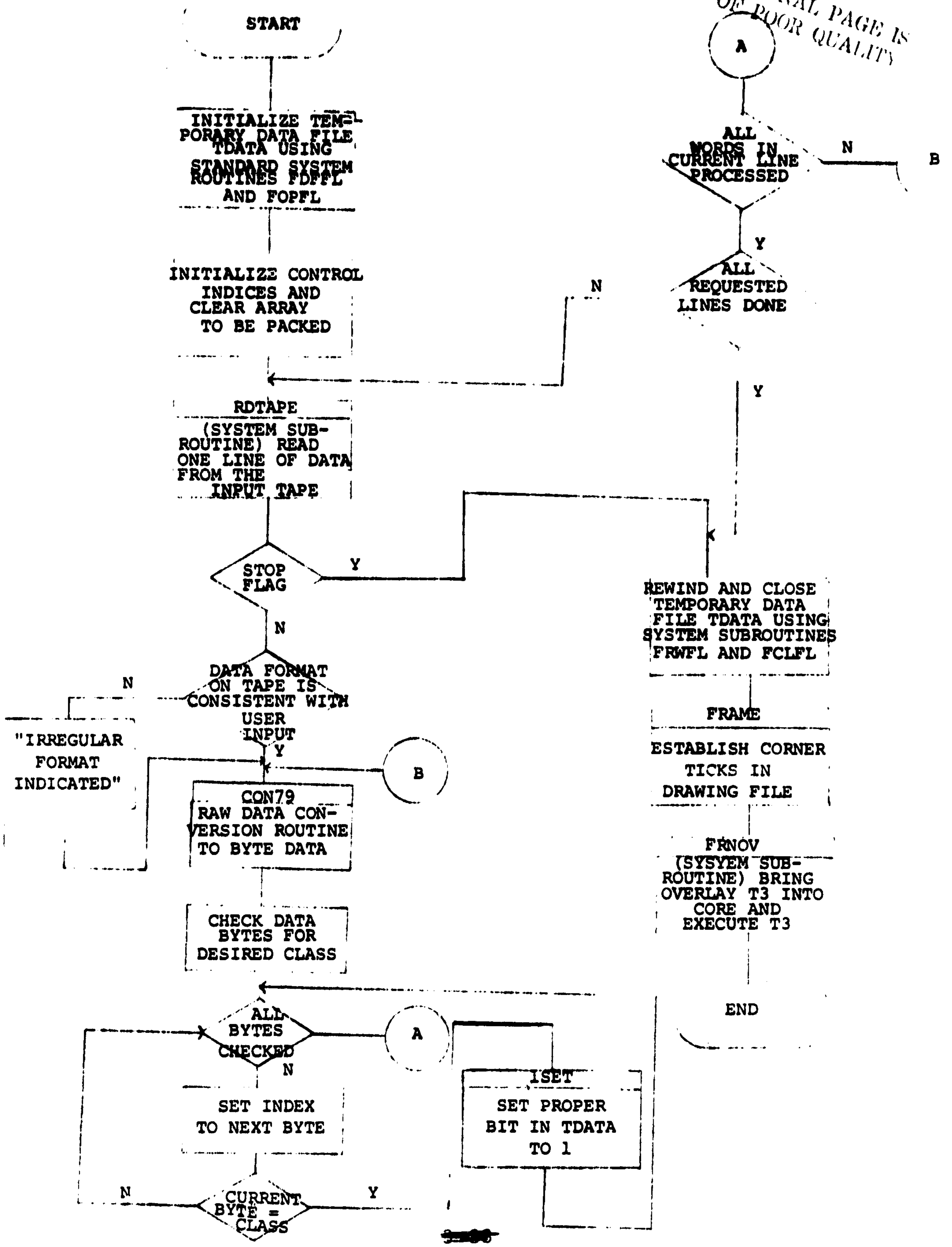
3.2.7.6 Description

Subroutine RDLIN9 reads the classified data tape, packs the classified data 16 pixels per word, and stores these data on a temporary disk file, TDATA.

3.2.7.7 Flowchart

3.2.7.8 Listing

(RDLIN9)


START
INITIALIZE TEMPORARY DATA FILE TDATA USING STANDARD SYSTEM ROUTINES FDFFL AND FOPFL
INITIALIZE CONTROL INDICES AND CLEAR ARRAY TO BE PACKED
RDTAPE
(SYSTEM SUBROUTINE) READ ONE LINE OF DATA FROM THE INPUT TAPE
STOP FLAG
Y
N
DATA FORMAT ON TAPE IS CONSISTENT WITH USER INPUT
N
Y
"IRREGULAR FORMAT INDICATED"
B
CON79
RAW DATA CONVERSION ROUTINE TO BYTE DATA
CHECK DATA BYTES FOR DESIRED CLASS
ALL BYTES CHECKED
A
N
SET INDEX TO NEXT BYTE
N
CURRENT BYTE = CLASS
Y
ISET
SET PROPER BIT IN TDATA TO 1
A
ALL WORDS IN CURRENT LINE PROCESSED
N
B
Y
ALL REQUESTED LINES DONE
N
Y
REWIND AND CLOSE TEMPORARY DATA FILE TDATA USING SYSTEM SUBROUTINES FRWFL AND FCLFL
FRAME
ESTABLISH CORNER TICKS IN DRAWING FILE
FRNOV
(SYSYEM SUBROUTINE) BRING OVERLAY T3 INTO CORE AND EXECUTE T3
END

```
                                            READY
         DIMENSION  IN (2   IB(3), IS(50), IA(4080)
         COMMON /ICONS/ ID 14), OPTNS(17), IFLG1
         COMMON /IBETA/  NAME (3)
         COMMON /ISTAR/ LNCNT, IEND, I
         DATA LNCNT, IEND  0,0/
         NAME (1) = "TM"
         NAME (2) = "/1"
         NAME (3) = 0
         IER = 0
         CALL FOFFL ("TDATA", IER)
         CALL FOPFL ("TDATA", 1, 1, IER)
    50   KT = 1
         NIT = 0
         JJ=3
         JK=2
         IF (OPTNS(17) LT.8.) GO TO 55
         NIT=1
         JJ=2
         JK=1
    55   IPAR = ID(14)
         LINRC = 0
         ISTAT = 0
         NWDS = 0
         DO  60  K = 1, 50
         IS(K) = 0
    60   CONTINUE
         IF (IEND -1)  70, 390, 390
    70   ICLS = OPTNS(6)
         N = 4080
    80   CALL RDTAPE (NIT, IA, N, IPAR, NSHR, ISTAT)
 C       WRITE (10,610)  (IA(IT), IT = 1,100)
 C  610  FORMAT (1X, 50I8)
         NUL = OPTNS (4) - OPTNS (3) + 1
```

```
                                                  READY
      IF (NOL)  90, 90, 100
  90  NOL = ID (6)
      GO TO 115
 100  IF (NOL - ID(6))  115,115,110
 110  WRITE (10,615)  NOL, ID (6)
 615  FORMAT (1X,"  WANT",I5,"  PIXELS PER LINE?  WILL TPY",I5)
      NOL = ID(6)
      OPTNS (4) = 0
 115  IF (ISTAT - 4)  160, 140, 120
 120  IEND = IEND + 1
      IF (IEND - 1)  140, 125, 390
 125  WRITE (10, 620)  ISTAT, LNCNT
 620  FORMAT (1X,"  STATUS WORD =",I3,"  TOTAL LINES DONE IS",I5)
 140  WRITE (10, 620)  ISTAT, LNCNT
 160  IF (ID(8) -1)  170, 400, 400
 170  IADD = MOD (IFLG1,10)
      IF (IADD - 5)  200, 200, 180
 180  IFLG1 = 5 - IADD
      IOD = 0
      GO TO 220
 200  IOD = ID(4)
 220  ISTAT = OPTNS(3)
      L = OPTNS(5)
      IP = ID(6) * (L - 1) + IOD + ISTAT
      L = 0
 240  IADD = 2 * (IP + (ID(6) * ID(5)) * LINRC)
      IF (NIT EQ 0) GO TO 245
      IDA=IADD/2
      IDA=IDA+3
      IOD=MOD(IDA,2)
      I=IDA/2
 242  CALL CONWD(IA(I),IB)
      GO TO 285
```

```
                                               READY
   245   IOD = MOD (IADD, 2)
         ISTAT = 3 - IOD
         IOD = MOD (ISTAT, 2)
         IADD = IADD/3
         I = IADD + 1
         IF (IOD - 2)  260, 250, 260
   250   I = I - 1
   260   IF (I -  4079)  270, 270, 350
   270   IF (ID(8) - 1)  280, 410,410
   280   IN(1) = IA(I)
         IN(2) = IA(I + 1)
         CALL CON79 (IN, IB)
   285   N = IOD + 1
C         PAUSE IN A PRINT LOOP
C         WRITE (10,780)  N, IN, IADD, I
C  780    FORMAT (1X, 40I6)
         DO 340  J = N, JJ
         NWDS = NWDS + 1
         L = L + 1
         IF (L - 16)  300,300,290
   290   L = 1
         KT = KT + 1
C  300  PAUSE OUTPUT ICLS, J, IB(J), I, IA(I)
C       WRITE(10,777)ICLS, J, IB(J), I, IA(I)
C  777  FORMAT(5I10)
   300   IF (ICLS - IB(J))  340, 320, 340
   320   CALL ISET (IS(KT), L)
   340   CONTINUE
         IOD = 0
         I = I + JK
         IF (NWDS - NOL)  345,345, 360
   345   IF (I-4079) 346,346,350
   346   IF (ID(8)-1)347,410,410
```

```
                                                  READY
 347   IF (NIT) 280,280,342
 350   IFLG1 = MOD (IFLG1, 10)
       IF (IFLG1 - 5)  360, 360, 355
 355   IFLG1 = 5 - IFLG1
 360   LNCNT = LNCNT + 1
       LINRC = LINRC + 1
       ID (13) = KT
       IBYT = 2 * KT
       CALL FWTFL (1,IS,IBYT,IER)
C      WRITE (10,864)  IBYT, IS
C 864  FORMAT (1X,"  NO OF BYTES=", I5,//,(1X, 8OI8))
       IF (LINRC - ID(9))  362, 365, 365
 362   IT = 1
       GO TO 240
 365   ISTAT = OPTNS (2) - OPTNS(1) + 1.05
       IF (LNCNT - ISTAT)  380, 370, 370
 370   IEND = 1
 380   IF (LNCNT- 400)  50, 390, 390
 390   CONTINUE
       CALL FRWFL (1, IER)
       CALL FCLFL (1, IER)
       CALL FCNOT ("<7>")
       IF (IER)  385, 395, 385
 385   WRITE (10,885)  IER
 885   FORMAT (1X,"   ERROR SET AT", I5,"  FROM WRITE, REWIND OR CLOSE")
       STOP
 395  XSC=0.1
      YSC=0.1
      NLINES=OPTNS(2) - OPTNS(1) + 1.1
      NPX   =OPTNS(4) - OPTNS(3) + 1.1
      XMAX=NPX
      YMAX=NLINES
      CALL FRAME(XMAX,YMAX,XSC,YSC)
      CALL FRNOU (NAME, IER)
      PAUSE FRNOU IN READLINE FAILED
  400 IEND = 1
      WRITE (10,900) ID(8)
  900 FORMAT (1X," IRREGULAR FORMAT INDICATED BY", I4)
      READ (11) I
      IF (I) 370, 370, 410
  410 ID(8) = -1
      IEND = 0
      GO TO 170
      END

READY
```

3.2.8 SOFTWARE COMPONENT NO. 8 (ISET)

3.2.8.1 Linkage

Subroutine ISET is called by RDLIN9 in overlay T9.

3.2.8.2 Interface

RDLIN9 communicates with subroutine ISET via two calling arguments.

3.2.8.3 Input

The argument IS(KL) is the KLth word in vector IS.
The argument L is the bit number in IS(KL) which needs to be set to 1.

3.2.8.4 Output

The argument IS(KL) is returned with the Lth bit set to 1.

3.2.8.5 Storage Requirements

Subroutine ISET requires 26 words in core.

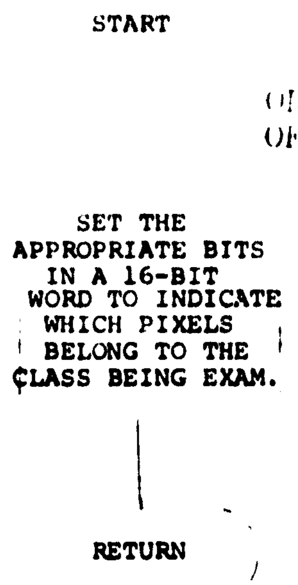
3.2.8.6 Description

Subroutine ISET sets the appropriate bit in a 16-bit word to indicate a pixel belonging to the class being examined. These words are the packed data which RDLIN packs into the temporary data disk file TDATA.

3.2.8.7 Flowchart

3.2.8.8 Listing

ISET



START

SET THE APPROPRIATE BITS IN A 16-BIT WORD TO INDICATE WHICH PIXELS BELONG TO THE CLASS BEING EXAM.

RETURN

```
LIST LINES - 60                                         READY

              TITL      ISET
              ENT      ISET
              ENTD        CPYL, FRET
              NREL

ISET           JSR       @ CPYL
              STA      3,SAUE
              LDA      0,@FTSTR,3
              STA      0,UALU
              NEG      0,1
              ADD      0,1
              MOUOR    1,1
              LDA      0,@FTSTR+1,3
              STA      0,@FTSTR+1,3
              STA      0,CONS
LOOP          LDA      0,CONS
              DSZ      CONS
              JMP      RITS
              LDA      0,UALU
              ADD      0,1
              STA      1,UALU
              JMP      END
RITS          MOUR     1,1
              JMP      LOOP
END           LDA      1,UALU
              STA      1,@FTSTR,3
              LDA      3,SAUE
              JSR      @ FRET
SAUE          0
CONS          0
UALU          0
               END
```

3.2.9 SOFTWARE COMPONENT NO. 9 (FRAME)

3.2.9.1 Linkage

Subroutine FRAME is called by RDLIN9, and calls subroutine LINIT.

3.2.9.2 Interface

FRAME receives format and scaling information through four input parameters.

3.2.9.3 Input

Four calling arguments are input to subroutine FRAME reflecting format and scaling constraints.

3.2.9.4 Output

None

3.2.9.5 Storage Requirements

Subroutine FRAME requires 347 words in core.

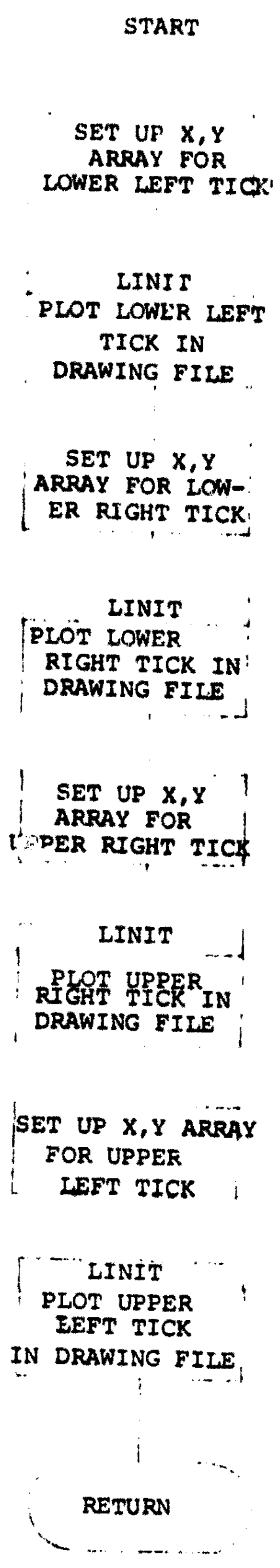
3.2.9.6 Description

Subroutine FRAME computes the output frame size, generates four corner ticks for the plot file, and calls subroutine LINIT to write these ticks in the plot file.

3.2.9.7 Flowchart

3.2.9.8 Listing

(FRAME)


START
SET UP X,Y ARRAY FOR LOWER LEFT TICK
LINIT
PLOT LOWER LEFT TICK IN DRAWING FILE
SET UP X,Y ARRAY FOR LOWER RIGHT TICK
LINIT
PLOT LOWER RIGHT TICK IN DRAWING FILE
SET UP X,Y ARRAY FOR UPPER RIGHT TICK
LINIT
PLOT UPPER RIGHT TICK IN DRAWING FILE
SET UP X,Y ARRAY FOR UPPER LEFT TICK
LINIT
PLOT UPPER LEFT TICK IN DRAWING FILE
RETURN

```
                                                READY
      SUBROUTINE FRAME(XMAX,YMAX,XSC,YSC)
      DIMENSION X(3),Y(3)
      ARM=0.5
      X(1)=0.0
      Y(1)=ARM *YSC
      X(2)=0.0
      Y(2)=0.0
      X(3)=ARM * XSC
      Y(3)=0.0
      CALL LINIT(X,Y,3,0)
      X(1)=(XMAX-ARM) * XSC
      Y(1)=0.0
      X(2)=XMAX * XSC
      Y(2)=0.0
      X(3)=X(2)
      Y(3)=ARM * YSC
      CALL LINIT(X,Y,3,0)
      X(1)=XMAX * XSC
      X(2)=X(1)
      Y(1)=(YMAX-ARM) * YSC
      Y(2)=YMAX * YSC
      X(3)=(XMAX-ARM) * XSC
      Y(3)=Y(2)
      CALL LINIT(X,Y,3,0)
      X(1)=ARM * XSC
      Y(1)=YMAX * YSC
      Y(2)=Y(1)
      X(2)=0.0
      X(3)=0.0
      Y(3)=(YMAX-ARM) * YSC
      CALL LINIT(X,Y,3,0)
      RETURN
      END
```

3.2.10 SOFTWARE COMPONENT NO. 10 (LINIT)

3.2.10.1 Linkage

In overlay T9 subroutine LINIT is called by subroutine FRAME. In overlay TM subroutine LINIT is called by BDT9, ENDTST, CONALL, CLSTST, CONECT, and FINDAR.

3.2.10.2 Interface

Subroutine LINIT receives control information through the user common block ICONS, and through the System 100 common blocks BLK and MENU1.

3.2.10.3 Input

LINIT receives x,y plot arrays through its calling arguments.

3.2.10.4 Output

Subroutine LINIT transfers registered boundary plot string arrays to a System 100 drawing file.

3.2.10.5 Storage Requirements

Subroutine LINIT requires 313 words in core.

3.2.10.6 Description

LINIT accepts as input plot string arrays. Data registration is accomplished at this point by transforming the x,y coordinates of the plot arrays using either the eight coefficients input by the user or the default (no change) coefficients. The standard expression for the data transformation is:

$$X_t = (A_1X_0 + A_2Y_0 + A_3)/(1 + A_4Y_0 + A_5Y_0)$$

$$Y_t = (A_6X_0 + A_7Y_0 = A_8)/(1 + A_4X_0 + A_5Y_0)$$

where

A_1-A_9 are the eight coefficients

X_0, Y_0 = Initial or observed coordinates

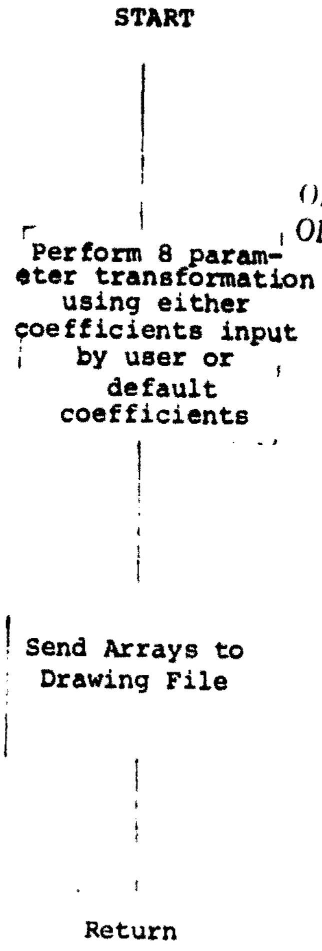
X_t, Y_t = Transformed coordinates

After transformation, these registered plot string arrays are transferred to a standard System 100 drawing file.

3.2.10.7 <u>Flowchart</u>

3.2.10.8 <u>Listing</u>

(LINIT)


START
Perform 8 parameter transformation using either coefficients input by user or default coefficients
Send Arrays to Drawing File
Return

```
                                                   END
      SUBROUTINE LINIT(ARX,ARY,N,ITYREADY
      DIMENSION ARX(50),ARY(50)
      COMMON  /ICONS/  IZ(4),O(17),IFLG1
      COMMON  /BLK/ X(30),Y(30),A(10),K(30),KP,ID(80)
      COMMON  /MENU1/ KODE,MRFLG,SFACT,LNMOD,LNWID
      EQUIVALENCE (X(1),X1),(Y(1),Y1),(K(11),K11),(K(12),K12)
      EQUIVALENCE (K(14),K14),(K(15),K15),(A(1),A1),(A(2),A2)
C          DESIGNATE FILE NUMBER
      K4=1
      IF(ITYP.EQ.99) GO TO 20
      DO 1 I=1,N
      RX = ARX(I)
      RY = ARY(I)
      D = 1 + O(12) * RX + O(13) * RY
      ARX(I) = ( O(9)*RX + O(10)*RY + O(11) ) / D
    1 ARY(I) = (O(14)*RX + O(15)*RY + O(16) ) / D
C          PEN UP COMMAND
      X1=ARX(1)
      Y1=ARY(1)
      K11=1
      CALL RWCON(K4,2)
C          PEN DOWN COMMAND
      K11=6
      DO 10 I=2,N
      X1=ARX(I)
      Y1=ARY(I)
      CALL RWCON(K4,2)
   10 CONTINUE
      GO TO 90
   20 K11=31
C          WRITE END-OF-FILE COMMAND
      CALL RWCON(K4,2)
   90 RETURN
```

3.2.11 SOFTWARE COMPONENT NO. 11 (BDT9)

3.2.11.1 Linkage

Subroutine BDT9 is the principal routine in overlay TM, and calls the following user subroutines: FINDAR, FILL, READAT, CONALL, ENDTST, CLSTST, and LINIT9. In addition, subroutine BDT9 utilizes the following system subroutines for drawing file manipulation: FOPFL, FCLFL, FDLFL, and FCNOT.

3.2.11.2 Interface

Subroutine BDT9 receives control information through the common block ICONS. BDT9 communicates with its associate subroutines via the common blocks Z,ZZ, and MAXFIL.

3.2.11.3 Input

Pixel data is brought in, line by line, from the disk file TDATA by subroutine READAT and placed in common block ZZ for processing in BDT9.

3.2.11.4 Output

While overlay TM is operating, BDT9 outputs a status message on the display device after each ten lines of requested data has been processed. In addition, BDT3 actuates the audible tone on the output device after processing is complete.

3.2.11.5 Storage Requirements

Subroutine BDT9 requires 9224 words in core.

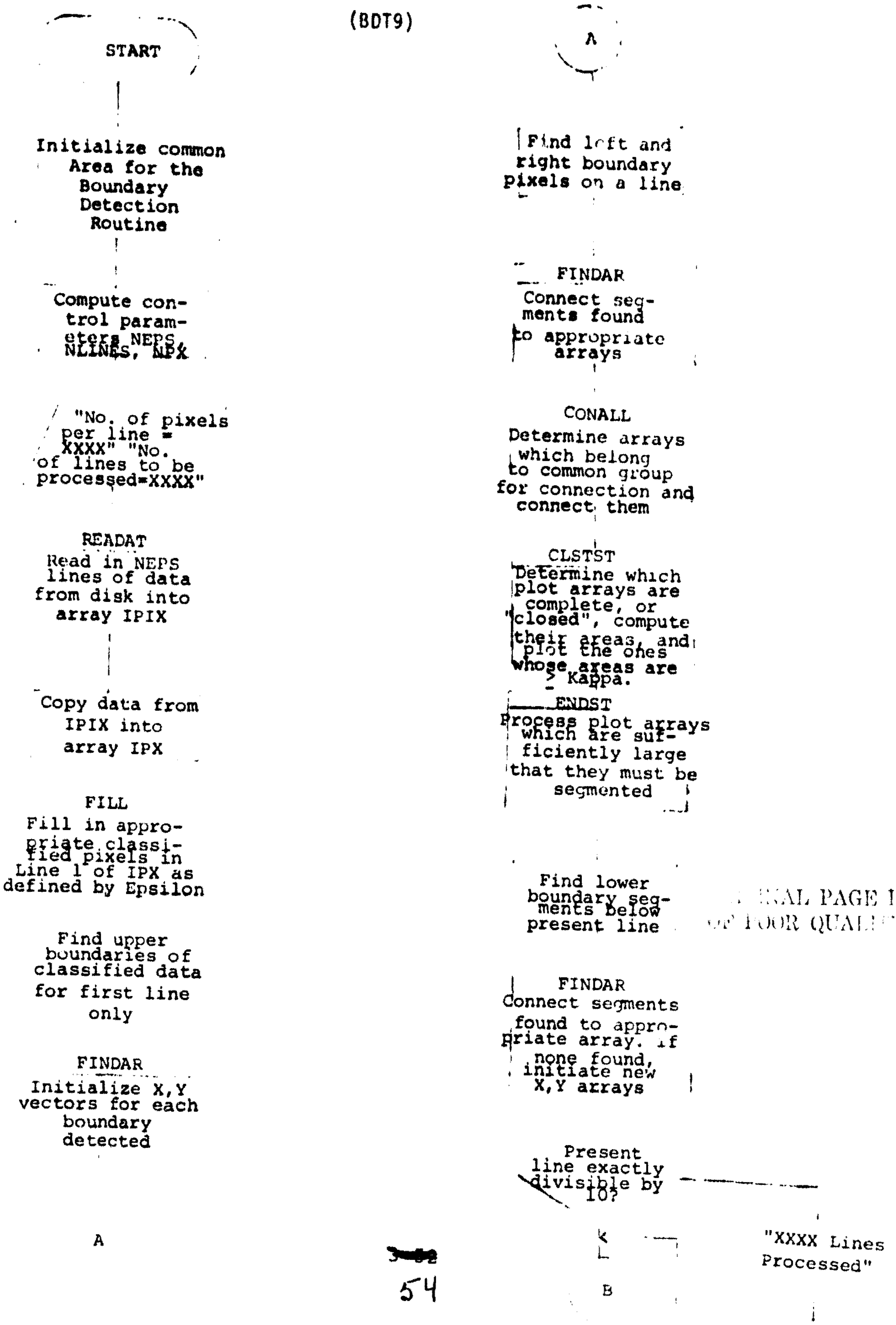
3.2.11.6 Description

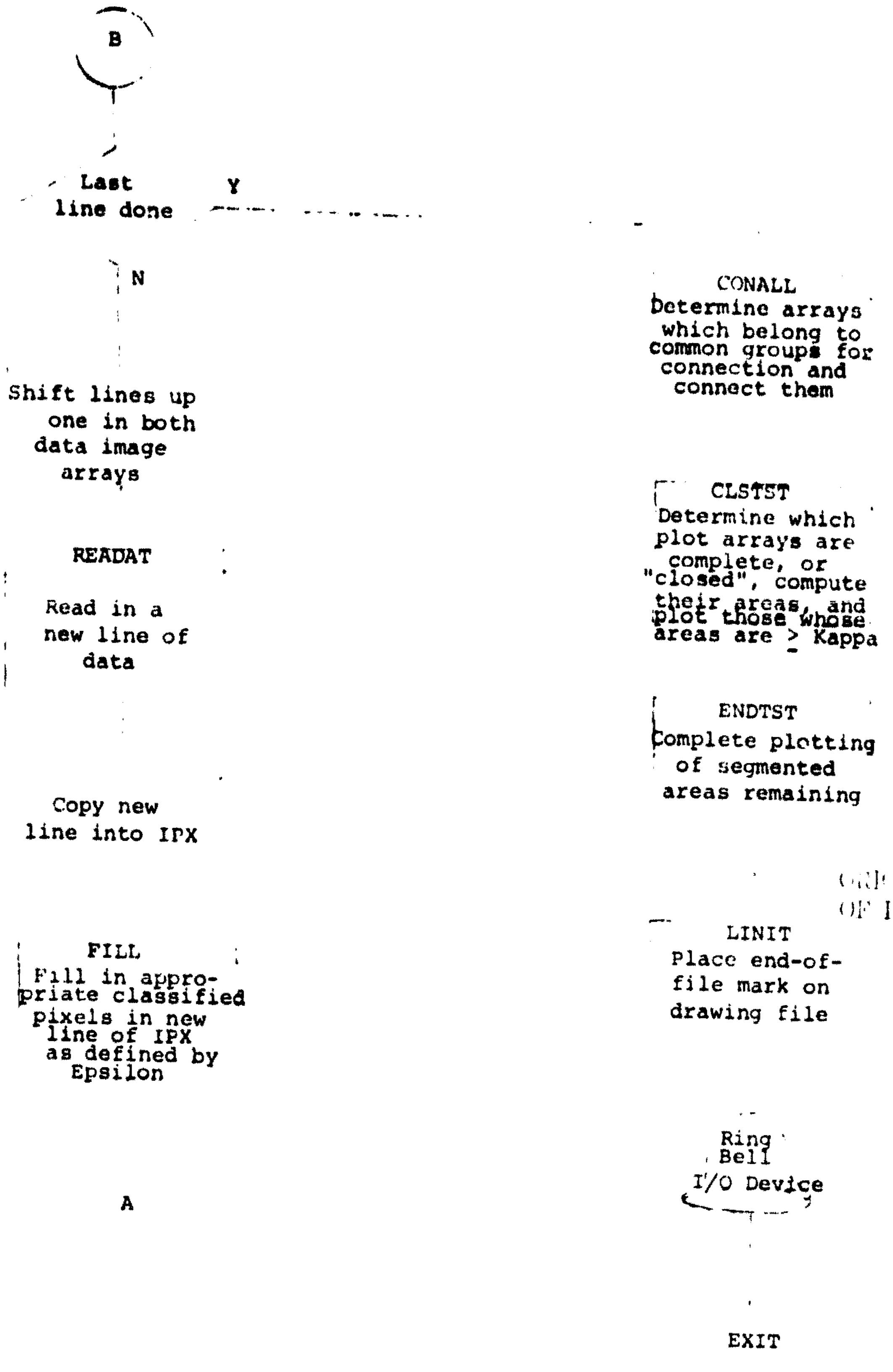
BDT9 is the routine which identifies, from the input pixel information, boundaries of a classified area or areas within a classified image. It processes the input data one line at a time, identifying border pixels, and building plot string arrays which describe the limits of the classified areas. These plot strings are introduced into a standard system 100 drawing file through subroutine LINIT, which also accomplishes data transformation as specified by eight user-input coefficients, for registration onto any desired base. Ultimately, this drawing file is output on a magnetic tape which is used as input to the Gerber plotter, which creates the final registered boundary plot.

3.2.11.7 Flowchart

3.2.11.8 Listing

(BDT9)


START
Initialize common Area for the Boundary Detection Routine
Compute control parameters NEPS, NLINES, NPX
"No. of pixels per line = XXXX" "No. of lines to be processed=XXXX"
READAT
Read in NEPS lines of data from disk into array IPIX
Copy data from IPIX into array IPX
FILL
Fill in appropriate classified pixels in Line 1 of IPX as defined by Epsilon
Find upper boundaries of classified data for first line only
FINDAR
Initialize X,Y vectors for each boundary detected
A
A
Find left and right boundary pixels on a line
FINDAR
Connect segments found to appropriate arrays
CONALL
Determine arrays which belong to common group for connection and connect them
CLSTST
Determine which plot arrays are complete, or "closed", compute their areas, and plot the ones whose areas are ≥ Kappa.
ENDST
Process plot arrays which are sufficiently large that they must be segmented
Find lower boundary segments below present line
FINDAR
Connect segments found to appropriate array. If none found, initiate new X,Y arrays
Present line exactly divisible by 10?
"XXXX Lines Processed"
B


B
Last line done
Y
N
Shift lines up one in both data image arrays
READAT
Read in a new line of data
Copy new line into IPX
FILL
Fill in appropriate classified pixels in new line of IPX as defined by Epsilon
A
CONALL
Determine arrays which belong to common groups for connection and connect them
CLSTST
Determine which plot arrays are complete, or "closed", compute their areas, and plot those whose areas are ≥ Kappa
ENDTST
Complete plotting of segmented areas remaining
LINIT
Place end-of-file mark on drawing file
Ring Bell I/O Device
EXIT

```
LIST LINES - 33
                                                       FEND
      COMMON /MAXFIL/ MX
      COMMON /2/ NGRUP,ARRAYX(50,50),ARRAYY(50,50),ISIZE(50),ASIZE(50),
     1ARX(50),ARY(50),LINE,YMAX,XSC,YSC,KAPPA
      COMMON /22/ IPIX(4,256),IPX(4,256),NPX,EPS
      COMMON /ICONS/ ID(14),OPTNS(17),IFLG1
      DIMENSION IA2(256)
      INTEGER ARRAYX,ARRAYY
      MAXGRP=50
      MXA = 0
      EPS=OPTNS(7)
      KAPPA=OPTNS(8)+0.1
      IBYTE=2*ID(13)
      XSC=0.1
      YSC=0.1
      K=1
      NEPS=EPS + 1.0
      NLINES=OPTNS(2) - OPTNS(1) +  1.1
      NPX   =OPTNS(4) - OPTNS(3) +  1.1
      WRITE (10,3)NPX,NLINES
      XMAX=NPX
      YMAX=NLINES
      CALL FRAME(XMAX,YMAX,XSC,YSC)
      NELEM=0
      IF(NEPS.GT.4) WRITE(10,2) EPS
    2 FORMAT(' EPSILON VALUE OF',F7.3,' EXCEEDS PRESENT PROGRAM CONSTRAI
     1NTS.')
    3 FORMAT(" NO. OF PIXELS PER LINE =",I4,//,
     1" NO. OF LINES TO BE PROCESSED =",I4,//)
      CALL FOPFL("TDATA",2,0,IE)
      IF(IE.EQ.0) GO TO 5
      WRITE(10,599) IE
  599 FORMAT(1X," IE=",I4)
      PAUSE ERROR IN OPENING TDATA IN BDT3
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
                                                READY
      GO TO 990
    5 CONTINUE
      DO 7  I=1,NEPS
      CALL READAT(IAZ,IBYTE)
      DO 4 JZ=1,NPX
    4 IPIX(I,JZ)=IAZ(JZ)
    7 CONTINUE
      DO 8 I=1,NEPS
      DO 8  J=1,NPX
    8 IPX(I,J)=IPIX(I,J)
      LREAD=NEPS
      CALL FILL
      N=0
      NGRUP=0
      IFL=0
      DO 10 IA=1,MAXGRP
      HSIZE(IA)=0
   10 ISIZE(IA)=0
C    FIND UPPER BOUNDARIES ABOVE FIRST LINE ONLY
      DO 100 IA=1,NPX
       IF(IPX(1,IA)) 100,100,20
   20 AX=IA-1
      AY=0
      BX=IA
      BY=0
      CALL FINDAR(AX,AY,BX,BY,0)
  100 CONTINUE
      LINE=0
C    FIND LEFT AND RIGHT BOUNDARY PIXELS ON A LINE
C    STORE LINE SEGMENTS IN APPROPRIATE ARRAYS
  110 LINE=LINE+1
      IT1=1
  115 N1=IT1
```

```
                                READY
      DO 200 IA=N1,NPX
      IF(IPX(1,IA)) 200,200,120
  120 AX=IA-1
      AY=LINE-1
      BX=IA-1
      BY=LINE
      CALL FINDAR(AX,AY,BX,BY,0)
      DO 150 IB=IA,NPX
      IF(IB EQ NPX) GO TO 125
      IF(IPX(1,IB)) 130,130,150
  125 IF(IPX(1,IB)) 130,130,126
  126 AX=IB
      AY=LINE-1
      BX=IB
      BY=LINE
      GO TO 135
  130 AX=IB-1
      AY=LINE-1
      BX=IB-1
      BY=LINE
  135 CALL FINDAR(AX,AY,BX,BY,0)
      IF(IB EQ NPX) GO TO 210
      IT1=IB
      GO TO 115
  150 CONTINUE
  200 CONTINUE
  210 CONTINUE
    TEST FOR ARRAYS NOT CONTAINING ARRAYY(1,MAX)=LINE
      IF(MOD(LINE,KZ) NE 0) GO TO 290
      NNN=0
  220 IPROB=0
      DO 223 IG=1,NGRUP
      IG1=ISIZE(IG)
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
                                      READY
   223 CONTINUE
       CALL CONALL(IPROB)
       CALL CLSTST
       IF(IPROB.EQ.1) GO TO 220
       CALL ENDTST
   290 CONTINUE
C    FIND LOWER BOUNDARIES BELOW A LINE
       ISKP=0
       DO 300 IA=1,NPX
       IF(ISKP) 291,291,401
   291 IF(IPX(1,IA).EQ.IPX(2,IA)) GO TO 300
       IF(IA.EQ.NPX) GO TO 299
       IPX1=IPX(1,IA)
       IPX2=IPX(2,IA)
       IPX3=IPX(1,IA+1)
       IPX4=IPX(2,IA+1)
       IF(IPX2.EQ.IPX4) GO TO 299
       IF(IPX1.EQ.IPX3)GO TO 299
       IF((IA-1).EQ.NPX) GO TO 402
       IPX5=IPX(1,IA+2)
       IPX6=IPX(2,IA+2)
       IF(IPX6.EQ.IPX4) GO TO 402
       IF(IPX3.EQ.IPX5) GO TO 402
       IF(IPX1.EQ.1.AND.EPS.GE.1.414) GO TO 410
       IF(IPX1.EQ.0.AND.EPS.LT.1.414) GO TO 410
       AX=IA
       AY=LINE
       BX=IA-1
       BY=LINE
       CALL FINDAP(AX,AY,BX,BY,2)
       AX=IA+1
       AY=LINE
       BX=IA+2
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
                                        READY
      BY=LINE
      CALL FINDAR(AX,AY,BX,BY,2)
      AX=IA
      AY=LINE
      BX=IA+1
      BY=LINE
      CALL FINDAR(AX,AY,BX,BY,4)
      ISKP=2
      GO TO 300
  402 IF(IPX1.EQ.1.AND.EPS.LT.1.414) GO TO 415
      IF(IPX1.EQ.0.AND.EPS.GE.1.414) GO TO 415
  410 AX=IA
      AY=LINE
      BX=IA+1
      BY=LINE
      CALL FINDAR(AX,AY,BX,BY,2)
      AX=IA-1
      AY=LINE
      BX=IA
      BY=LINE
      CALL FINDAR(AX,AY,BX,BY,2)
      ISKP=1
      GO TO 300
  415 AX=IA
      AY=LINE
      BX=IA-1
      BY=LINE
      CALL FINDAR(AX,AY,BX,BY,2)
      AX=IA
      AY=LINE
      BX=IA+1
      BY=LINE
      CALL FINDAR(AX,AY,BX,BY,3)
```

```
                                    READY
      ISKP=1
      GO TO 300
  299 AX=IA-1
      AY=LINE
      BX=IA
      BY=LINE
      CALL FINDAR(AX,AY,BX,BY,1)
      GO TO 300
  401 ISKP=ISKP-1
  300 CONTINUE
      IF(MXA LT 20) GO TO 308
      WRITE(10,307)
  307 FORMAT(1X," THIS CLASS TOO DENSE TO PROCESS A SECTOR THIS LARGE"
     /,2X,"RETRY PROGRAM USING A SMALLER SPAN OF PIXELS/LINE")
      GO TO 990
  308 CONTINUE
      IF(MOD(LINE,10).NE.0) GO TO 305
      WRITE(10,306) LINE
  306 FORMAT(1X,I4," LINES PROCESSED")
  305 CONTINUE
      IF(LINE.GE.NLINES) GO TO 999
C    SHIFT LINES UP ONE IN BOTH ARRAYS
      NEP=NEPS-1
      DO 310 I=1,NEP
      DO 310 J=1,NPX
      IPIX(I,J)=IPIX(I+1,J)
       IPX(I,J)= IPX(I+1,J)
  310 CONTINUE
C    READ IN NEW LINE
      IF(LREAD.GE.NLINES) GO TO 500
      LREAD=LREAD+1
      CALL READAT(IAZ,IBYTE)
      DO 320 JZ=1,NPX
  320 IPIX(NEPS,JZ)=IAZ(JZ)
      GO TO 600
  500 DO 501 J=1,NPX
  501 IPIX(NEPS,J)=0
  600 CONTINUE
      DO 700 J=1,NPX
  700 IPX(NEPS,J)=IPIX(NEPS,J)
CALL FILL WILL BE INSERTED HERE
      CALL FILL
      GO TO 110
  999 NNN=1
 1000 IPROB=0
      CALL CONALL(IPROB)
      CALL CLSTST
      CALL ENDTST
      DO 800 J=1,NGRUP
      IZ=ISIZE(J)
      IF(IZ) 800,800,750
  750 IF(IPROB.EQ.1) GO TO 1000
      GO TO 801
  800 CONTINUE
  801 CONTINUE
      CALL LINIT(ARX,ARY,I1,99)
  990 CONTINUE
      CALL FCLFL(2,IE)
      CALL FDLFL("TDATA",IE)
      CALL FCNOT("<7>")
      CALL OVRLY(1,IER)       ;RETURN TO PROG1 OF SYSTEM 101
      PAUSE OVRLY ERROR-NO RETURN TO SYSTEM 101
      END

READY
```

3.2.12 SOFTWARE COMPONENT NO. 12 (READAT)

3.2.12.1 Linkage

Subroutine READAT is called by subroutine BDT3, and calls subroutine IGET.

3.2.12.2 Interface

READAT transmits pixel information through the following two calling arguments:

IA - vector containing one line of classified pixel indicators, unpacked to one pixel per word.

IBYTE - number of bytes/line to be read from the temporary data file TDATA.

3.2.12.3 Input

Subroutine READAT reads in bit images of line data from the data disk file, TDATA.

3.2.12.4 Output

An error message may be displayed if a disk read error is encountered.

3.2.12.5 Storage Requirements

Subroutine READAT requires 125 words in core.

3.2.12.6 Description

Subroutine READAT reads in one line of packed pixel data from TDATA, unpacks the data into array IA using subroutine IGET, and transfers this line of data to subroutine BDT3.

3.2.12.7 Flowchart

3.2.]2.8 Listing

```
      SUBROUTINE READAT(IA,IBYTE)
      DIMENSION IRAY(16),IA(256)
      IWDS = IBYTE / 2
      CALL FROFL(2,IRAY,IBYTE,IBYTR,IE)
      IF(IE.EQ.0) GO TO 12
      PAUSE  DISK READ ERROR IN SUBROUTINE READAT
   12 CONTINUE
      IPT=0
       DO 50 I=1,IWDS
       DO 40 J=1,16
       L=J
       IT=IRAY(I)
       CALL IGET(IT,L)
       IPT=IPT + 1
       IA(IPT)=IT
   40 CONTINUE
   50 CONTINUE
      RETURN
      END

READY
```

3.2.13 SOFTWARE COMPONENT NO. 13 (IGET)

3.2.13.1 Linkage

Subroutine IGET is called exclusively by subroutine READAT.

3.2.13.2 Interface

Communication with READAT is accomplished through two calling arguments.

3.2.13.3 Input

Subroutine READAT requests the status of the Lth bit of word I from subroutine IGET.

3.2.13.4 Output

Subroutine IGET outputs the status of the Lth bit for READAT.

3.2.13.5 Storage Requirements

Subroutine IGET unpacks the bit data read from the disk data file TDATA into subroutine READAT.

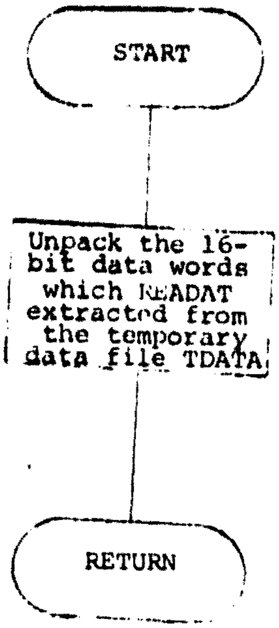
3.2.13.6 Description

Subroutine IGET unpacks the bit data read from the disk data file TDATA into subroutine READAT.

3.2.13.7 Flowchart

3.2.13.8 Listing

(IGET)


START
Unpack the 16-bit data words which READAT extracted from the temporary data file TDATA
RETURN

```
                                        READY
         TITL    IGET
         ENT     IGET
         EXTD    .CPYL,.FRET
        .NREL
        2
IGET    JSR     @.CPYL
        STA     3,RETN
        LDA     0,@FTSTR+1,3
        STA     0,CONS
        NEG     0,1
        ADD     0,1
        MOVOR   1,1
POOL    DSZ     CONS
        JMP     STIR
        JMP     MSK
STIR    MOVR    1,1
        JMP     POOL
MSK     LDA     0,@FTSTR,3
        STA     1,@FTSTR+1,3
        AND     0,1,SZR
        JMP     DOUT
        LDA     1,ZERO
        STA     1,@FTSTR,3
        JMP     BACK
DOUT    LDA     1,ONE1
        STA     1,@FTSTR,3
BACK    LDA     3,RETN
        JSR     @.FRET
RETN    0
CONS    0
ZERO    0
ONE1    1
         END
```

3.2.14 SOFTWARE COMPONENT NO. 14 (FILL)

3.2.14.1 Linkage

Subroutine FILL is called exclusively by subroutine BDT9.

3.2.14.2 Interface

Communication of data between subroutines FILL and BDT9 is accomplished through the common block ZZ.

3.2.14.3 Input

The data block IPIX enters subroutine FILL via ZZ.

3.2.14.4 Output

The data block IPX exits subroutine FILL via ZZ.

3.2.14.5 Storage Requirements

Subroutine FILL requires 584 words of core.

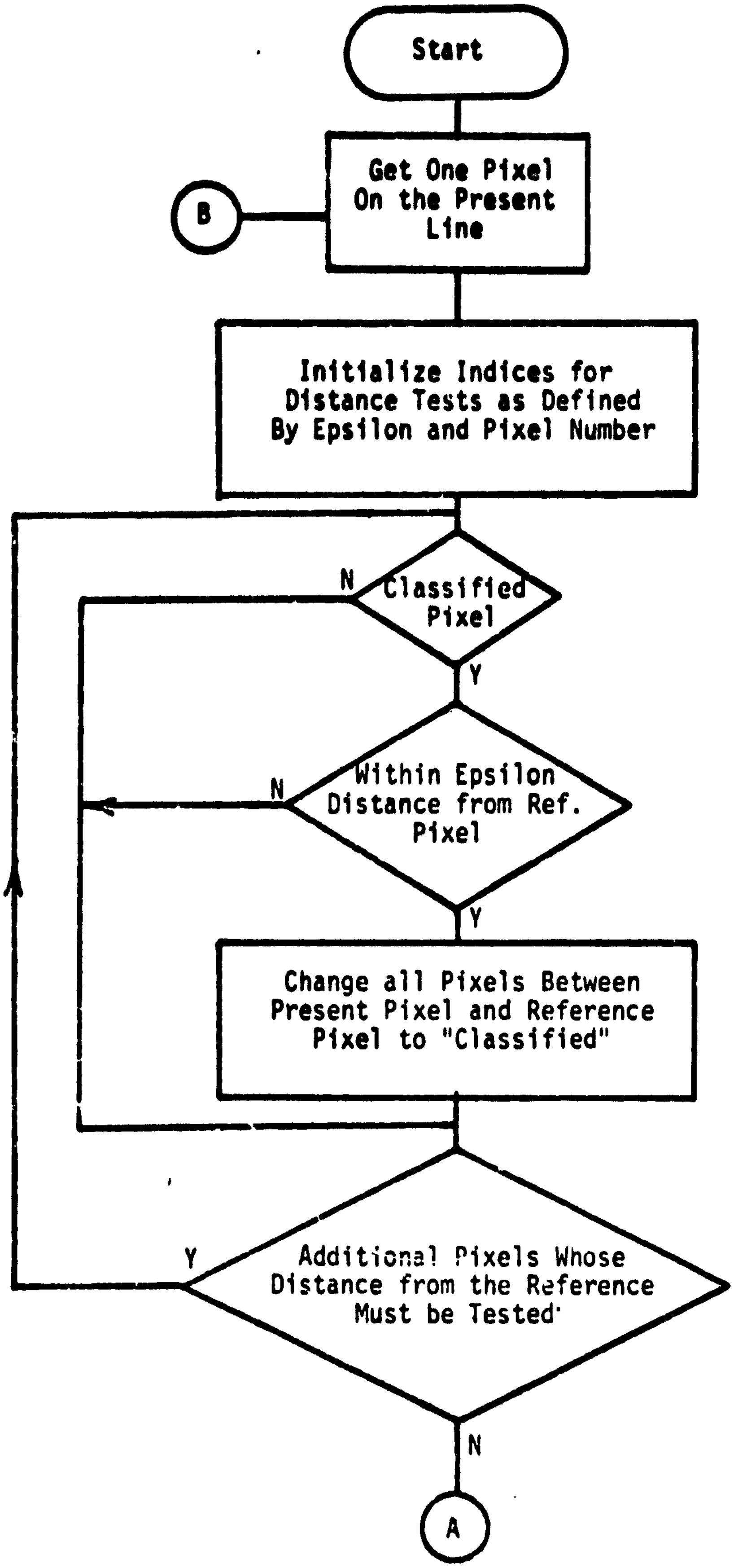
3.2.14.6 Description

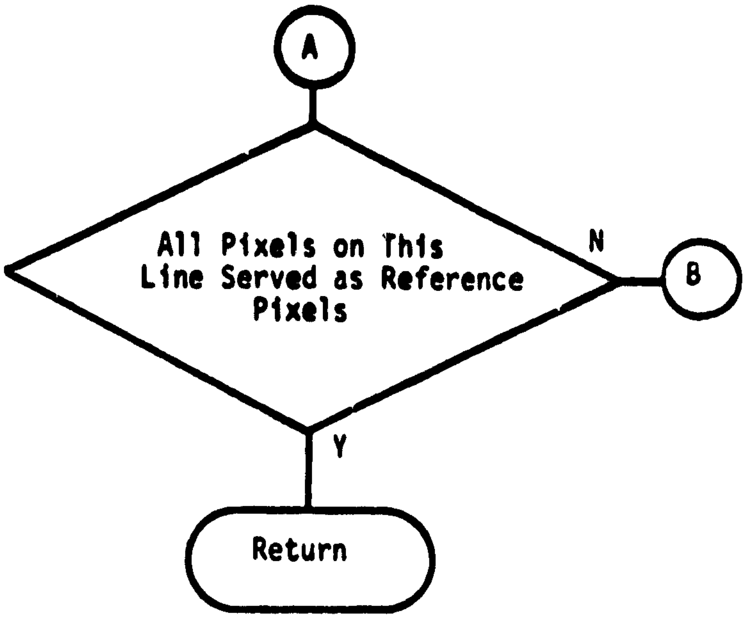
Subroutine FILL redefines appropriate pixels as classified to facilitate connectivity of "close" groups. The user defines the criteria for "closeness" via the input parameter Epsilon.

3.2.14.7 Flowchart

3.2.14.8 Listing

(FILL)


Start
Get One Pixel On the Present Line
B
Initialize Indices for Distance Tests as Defined By Epsilon and Pixel Number
N
Classified Pixel
Y
N
Within Epsilon Distance from Ref. Pixel
Y
Change all Pixels Between Present Pixel and Reference Pixel to "Classified"
Y
Additional Pixels Whose Distance from the Reference Must be Tested
N
A


A
All Pixels on This Line Served as Reference Pixels
N
B
Y
Return

```
                                                READY
      SUBROUTINE FILL
      COMMON /ZZ/ IPIX(4,256),IPX(4,256),NPX,EPS
      N=EPS
      L=1
       DO 100 IP=1,NPX
      IF(IPIX(1,IP).EQ.0) GO TO 100
      LFP=IP-N
      IF(LFP.LT.1) LFP=1
      IRP=IP+N
      IF(IRP.GT.NPX) IRP=NPX
      IBR=L+N
       DO 20 J=L,IBR
       DO 10 I=LFF,IRP
      IF(J.EQ.L.AND.I.LE.IP) GO TO 10
      IF(IPIX(J,I)) 10,10,11
   11 JPIX=(I-IP)**2 + (J-L)**2
      PIXDST=SQRT(FLOAT(JPIX))
      IF(PIXDST.GT.EPS) GO TO 10
      IF(IABS(I-IP).EQ.IABS(J-L)) GO TO 18
      IF(I-IP) 12,14,13
   12 IPLUS=I+1
      DO 15 II=IPLUS,IP
   15 IPX(J,II)=1
      GO TO 14
   13 IMIN=I-1
      DO 16 II =IP,IMIN
   16 IPX(J,II)=1
   14 IF((J-L).LE.1) GO TO 10
      LPLUS=L+1
      DO 17 JJ=LPLUS,J
   17 IPX(JJ,IP)=1
      GO TO 10
   18 IF(I-IP) 19,14,21
```

```
                                                    RETURN
                                                    END
 19 IPLU=I+1
    IPM=IP-1                                 READY
    IF((IPM-IPLU).LT.0) GO TO 10
    JJ=J
    DO 30 II=IPLU,IPM
    JJ=J-1
 30 IPX(JJ,II)=1
    GO TO 10
 21 IPPL=IP+1
    IM=I-1
    IF((IM-IPPL).LT.0) GO TO 10
    JJ=L
    DO 40 II=IPPL,IM
    JJ=JJ+1
 40 IPX(JJ,II)=1
 10 CONTINUE
 20 CONTINUE
100 CONTINUE
    IF(N.LT.2) GO TO 300
    NPXX=NPX-N
    DO 200 IP=1,NPXX
    IF(IPIX(2.IP).EQ.0) GO TO 200
    IRB=IP+N
    IPP=IP+2
    DO 220 I=IPP,IRB
    IF(IPIX(2,I).EQ.0) GO TO 220
    IP1=IP+1
    IR1=I-1
    DO 240 J=IP1,IR1
240 IPX(2,J)=1
220 CONTINUE
200 CONTINUE
300 CONTINUE
```

3.2.15 SOFTWARE COMPONENT NO. 15 (FINDAR)

3.2.15.1 Linkage

Subroutine FINDAR is called by subroutine BDT9, and calls subroutines CONECT, AREA1, and LINIT9.

3.2.15.2 Interface

Subroutine FINDAR receives control information via common blocks Z and MAXFIL (see Appendix A), and via five calling arguments.

3.2.15.3 Input

None

3.2.15.4 Output

None

3.2.15.5 Storage Requirements

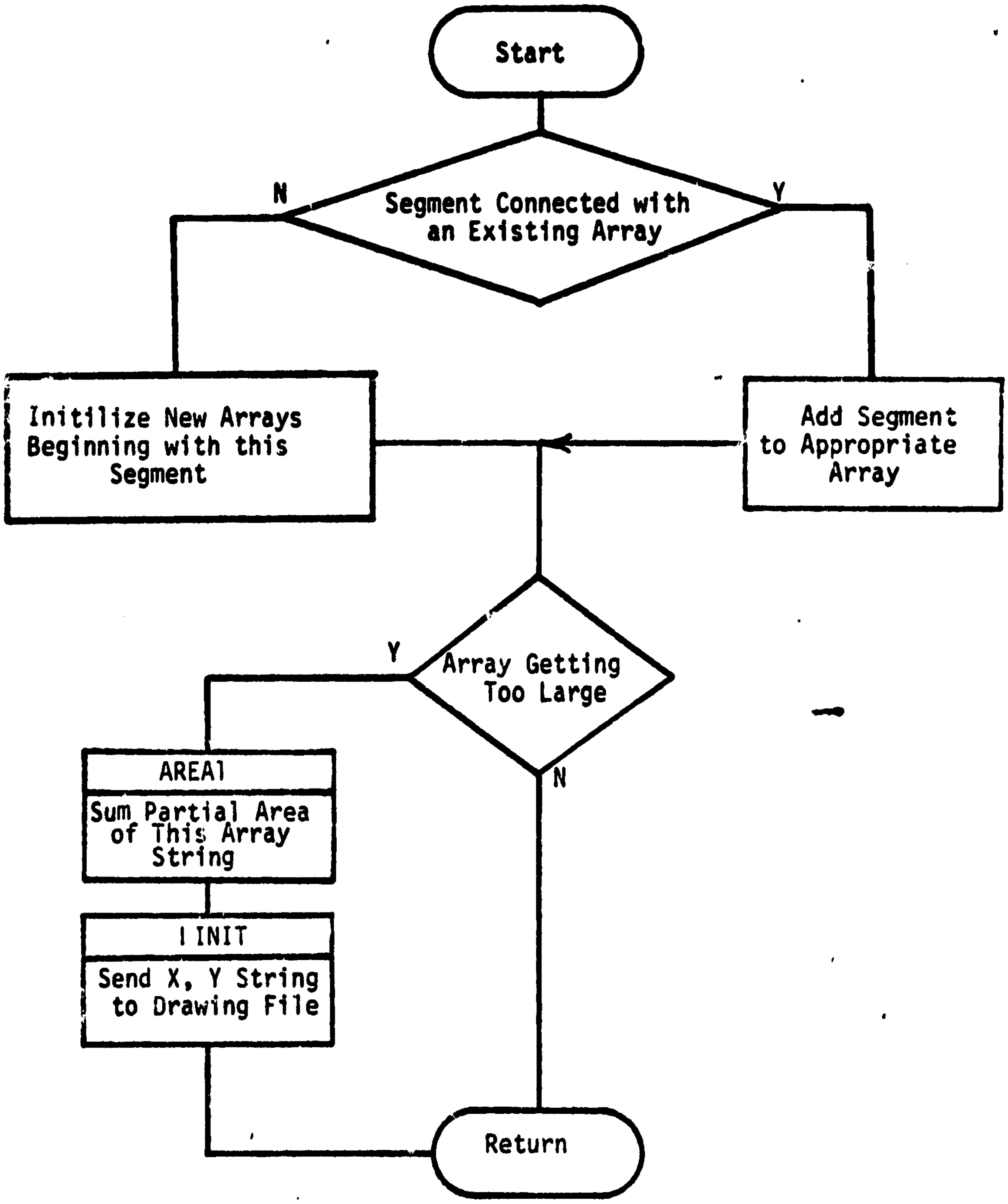
Subroutine FINDAR requires 693 words in core.

3.2.15.6 Description

Subroutine FINDAR accepts as input a boundary line segment, finds the plot string array, if any, to which the segment connects, and adds it. If no such array exists, new arrays are formed initializing on this segment.

3.2.15.7 Flowchart

3.2.15.8 Listing


Start
Segment Connected with an Existing Array
N
Y
Initilize New Arrays Beginning with this Segment
Add Segment to Appropriate Array
Array Getting Too Large
Y
N
AREA1
Sum Partial Area of This Array String
I INIT
Send X, Y String to Drawing File
Return

```
                                                 READY
      SUBROUTINE FINDAR(XA,YA,XB,YB,ITYPE)
      COMMON /MAXFIL/ MXA
      COMMON /2/ NGRUP,ARRAYX(50,50),ARRAYY(50,50),ISIZE(50),ASIZE(50
     .ARX(50),ARY(50),LINE,YMAX,XSC,YSC,KAPPA
      INTEGER ARRAYX,ARRAYY
      MAXGRP=50
      IPASS=0
      IF(ITYPE-2) 9,9,210
    9 IF(NGRUP) 200,200,10
   10 DO 100 IA=1,NGRUP
      I1=ISIZE(IA)
      IF(I1-1) 100,100,11
   11 DIF1=XA-ARRAYX(IA,I1)
      IF(ABS(DIF1).GT.0.01) GO TO 100
      DIF2=YA-ARRAYY(IA,I1)
      IF(ABS(DIF2).GT.0.01) GO TO 100
      IHOLD=IA
      IF(I1-1) 45,45,12
   12 I1M=I1-1
      XO=ARRAYX(IA,I1M)
      YO=ARRAYY(IA,I1M)
      IF(ABS(XO-XA).GT.0.01) GO TO 25
      IF(ABS(XA-XB).GT.0.01) GO TO 25
      GO TO 46
   25 IF(ABS(YO-YA).GT.0.01) GO TO 45
      IF(ABS(YA-YB).GT.0.01) GO TO 45
      GO TO 46
   45 ISIZE(IA)=ISIZE(IA) + 1
      I1=ISIZE(IA)
   46 ARRAYX(IA,I1)=XB
      ARRAYY(IA,I1)=YB
      IF(ITYPE-1) 902,902,900
  100 CONTINUE
```

```
                                        READY
      IF(IPASS) 101,101,200
  101 IPASS=1
      IF(ITYPE-1) 110,110,200
  110 TEMP=XB
      XB=XA
      XA=TEMP
      TEMP=YB
      YB=YA
      YA=TEMP
      GO TO 10
  200 IF(IPASS) 210,210,201
  201 TEMP=XA
      XA=XB
      XB=TEMP
      TEMP=YA
      YA=YB
      YB=TEMP
  210 DO 300 IA=1,MAXGRP
      IF(ISIZE(IA)) 220,220,300
  220 ARRAYX(IA,1)=XA
      ARRAYY(IA,1)=YA
      ARRAYX(IA,2)=XB
      ARRAYY(IA,2)=YB
      ISIZE(IA)=2
      IF(IA.GT.NGRUP) NGRUP=IA
      IHOLD=IA
      GO TO 900
  300 CONTINUE
      MXA = MXA + 1
      WRITE(10,5) LINE
    5 FORMAT(20X,'ALL ARRAYS FILLED AT LINE',I4)
      GO TO 990
  900 IF(ITYPE-3) 901,901,990
  901 CALL CONECT(IHOLD)
  902 DO 989 IA=1,NGRUP
      NU=ISIZE(IA)
      IF(NU.LT.49) GO TO 989
      DO 920 JK=1,NU
      ARX(JK)=ARRAYX(IA,JK) * XSC
  920 ARY(JK)=(YMAX-ARRAYY(IA,JK)) *YSC
      CALL AREA1(IA,AREA)
      CALL LINIT(ARX,ARY,NU,0)
      ASIZE(IA)=ASIZE(IA)+AREA
      ARRAYX(IA,1)=ARRAYX(IA,NU)
      ARRAYY(IA,1)=ARRAYY(IA,NU)
      ISIZE(IA)=1
  989 CONTINUE
  990 CONTINUE
      RETURN
      END

READY
```

3.2. 16 SOFTWARE COMPONENT NO. 16 (CONECT)

3.2.16 .1 Linkage

Subroutine CONECT is called by subroutine FINDAR, and calls subroutines LINIT, AREA1, and JOIN.

3.2.16 .2 Interface

Subroutine CONECT receives control information through common block Z (see Appendix A).

3.2.16 .3 Input

None

3.2.16 .4 Output

None

3.2.16 .5 Storage Requirements

Subroutine CONECT requires 435 words in core.

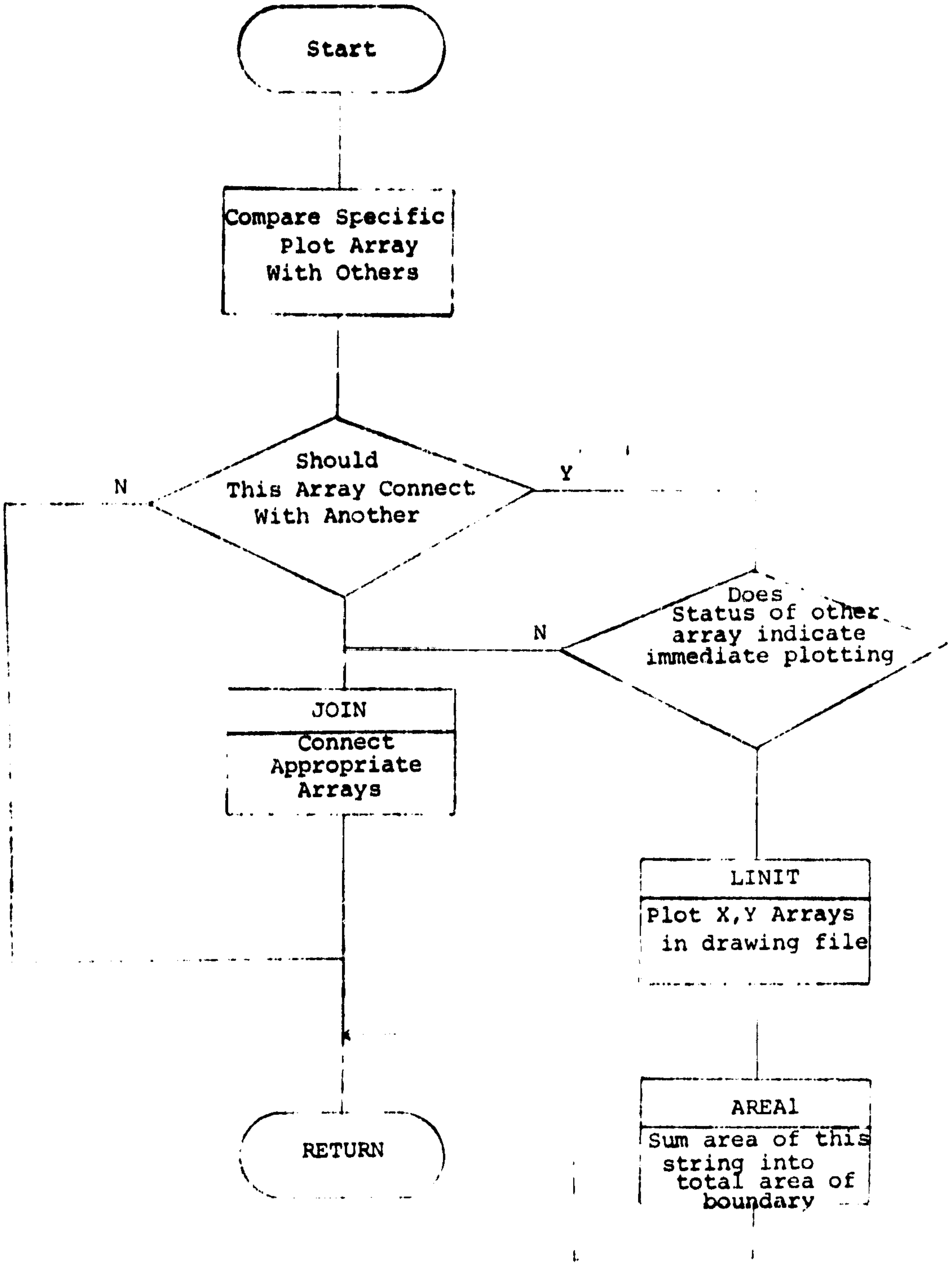
3.2.16.6 Description

Subroutine CONECT accepts as input a particular plot string array and forces immediate connection with the appropriate other plot string array.

3.2.16.7 Flowchart

3.2.16.8 Listing

(CONECT)



Start
Compare Specific Plot Array With Others
Should This Array Connect With Another
N
Y
Does Status of other array indicate immediate plotting
N
JOIN
Connect Appropriate Arrays
LINIT
Plot X,Y Arrays in drawing file
AREA1
Sum area of this string into total area of boundary
RETURN

```
                                                  READY
      SUBROUTINE CONECT(IH)
      COMMON /Z/ NGRUP,ARRAYX(50,50),ARRAYY(50,50),ISIZE(50),ASIZE(50
     .ARX(50),ARY(50),LINE,YMAX,XSC,YSC,KAPPA
      INTEGER ARRAYX,ARRAYY
      IB=ISIZE(IH)
      XA=ARRAYX(IH,IB)
      YA=ARRAYY(IH,IB)
      IF(NGRUP) 909,909,10
   10 DO 100 I=1,NGRUP
      IF(I.EQ.IH) GO TO 100
      I1=ISIZE(I)
      IF(I1.LT.1) GO TO 100
      DIF1=XA-ARRAYX(I,I1)
      IF(ABS(DIF1).GT.0.01) GO TO 100
      DIF2=YA-ARRAYY(I,I1)
      IF(ABS(DIF2).GT.0.01) GO TO 100
      IH2=I
      GO TO 102
  100 CONTINUE
      GO TO 909
  102 IB2=ISIZE(IH2)
      IF(IB2-1) 909,200,900
  200 J=IB+1
      DO 300 I=1,IB
      J=J-1
      ARX(I)=ARRAYX(IH,J)
  300 ARY(I)=ARRAYY(IH,J)
      DO 400 I=1,IB
      ARRAYX(IH,I)=ARX(I)
  400 ARRAYY(IH,I)=ARY(I)
      DO 500 I=1,IB
      ARX(I)=ARRAYX(IH,I) * XSC
  500 ARY(I)=(YMAX-ARRAYY(IH,I)) * YSC
```

```
      CALL LINIT(ARX,ARY,IB,0)
      CALL AREA1(IH,AREA)
      ASIZE(IH2)=ASIZE(IH2) + AREA
      ARRAYX(IH2,1)=ARRAYX(IH,IB)
      ARRAYY(IH2,1)=ARRAYY(IH,IB)
      ISIZE(IH)=0
      GO TO 909
  900 CALL JOIN(IH,IB,IH2,IB2,3)
  909 RETURN
      END

*EOR
```

3.2.17 SOFTWARE COMPONENT NO. 17 (CONALL)

3.2.17 .1 Linkage

Subroutine CONALL is called by subroutine BDT9, and calls subroutines JOIN, AREA1, and LINIT.

3.2.17.2 Interface

Subroutine CONALL receives control information through common block Z (see Appendix 1) and one calling argument.

3.2.17.3 Input

None

3.2.17.4 Output

None

3.2.17.5 Storage Requirements

Subroutine CONALL requires 513 words in core.

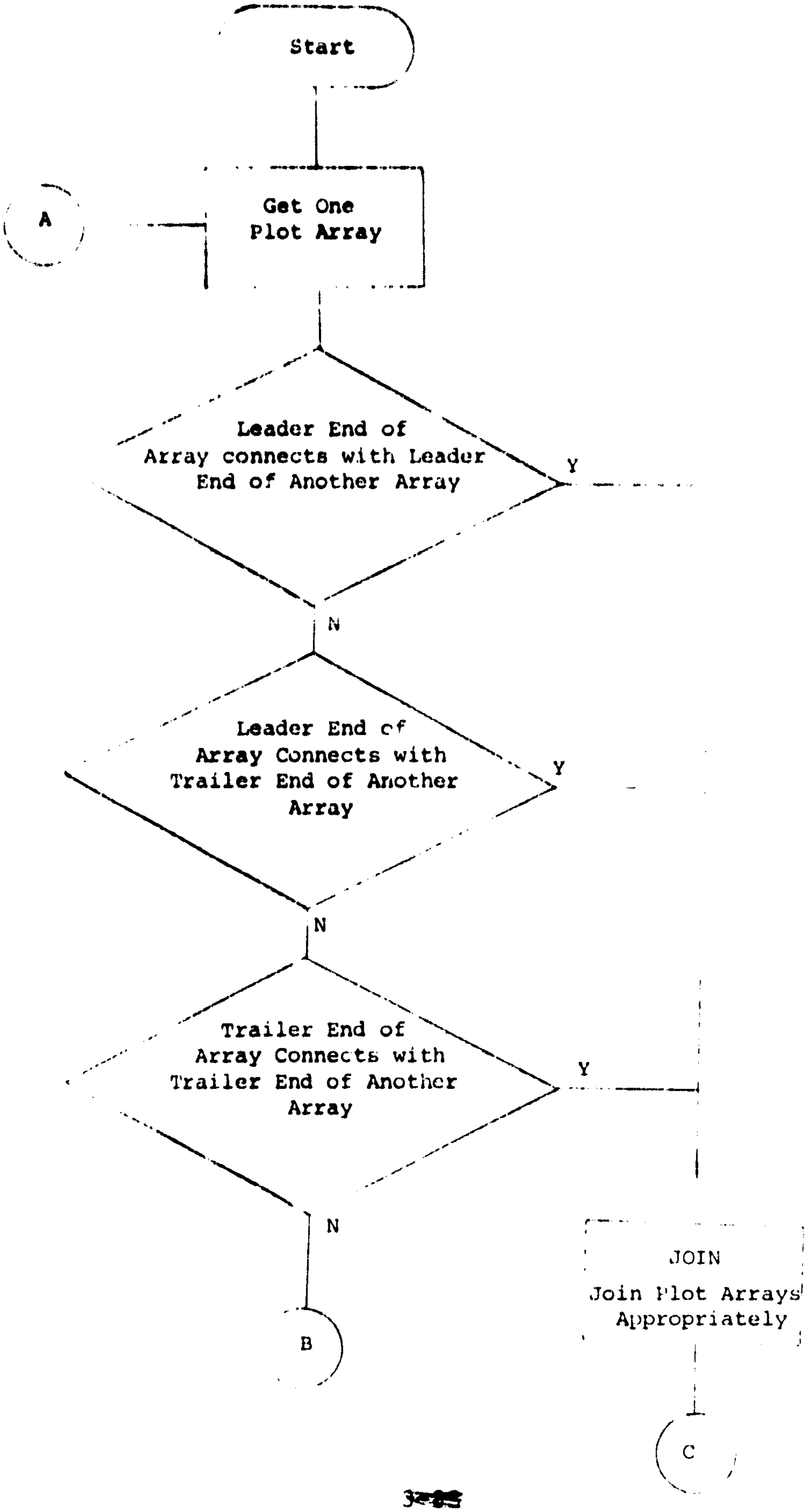
3.2.17.6 Description

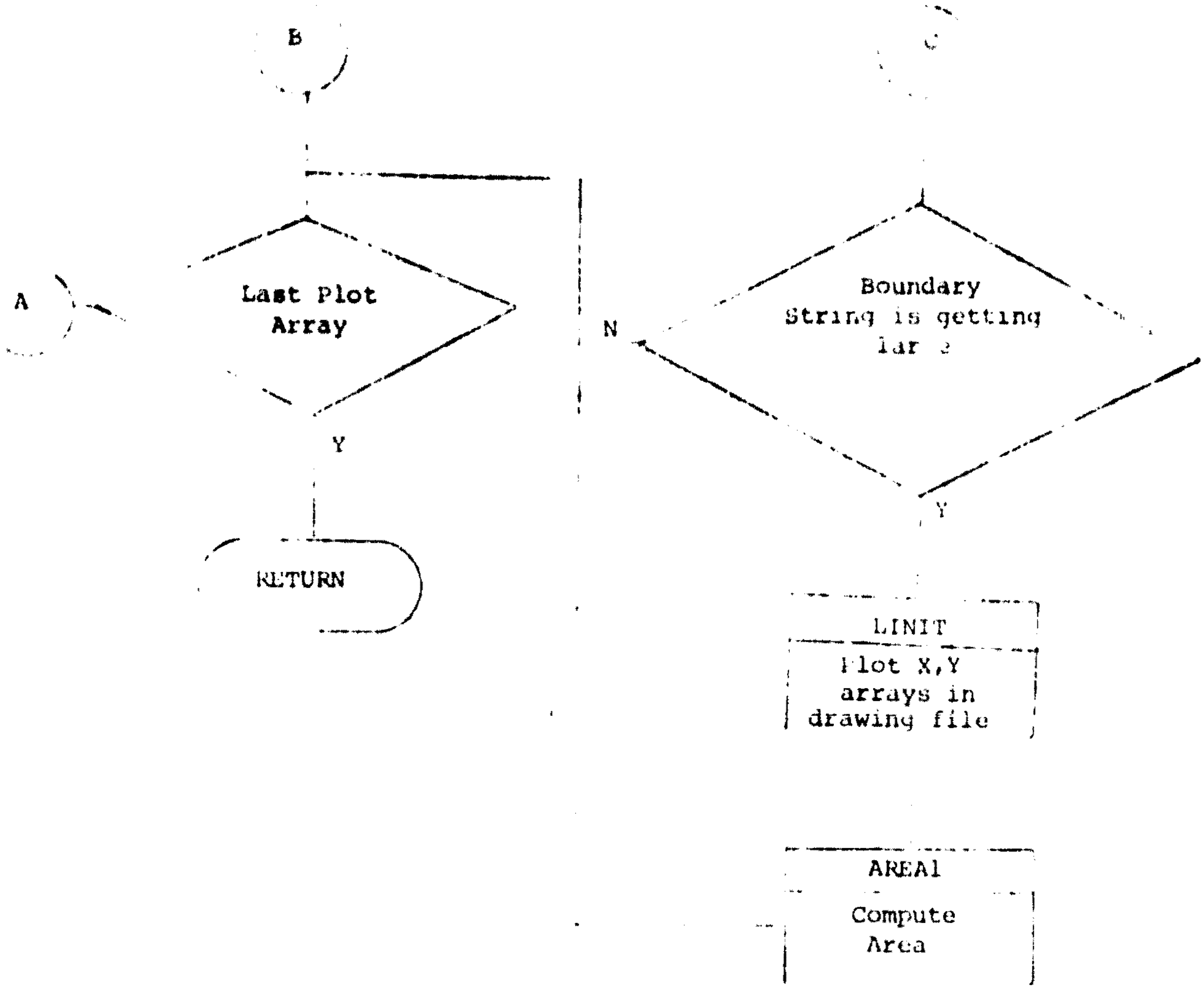
Subroutine CONALL determines which plot string arrays should be linked or connected, and how they should be joined (ordering).

3.2.17.7 Flowchart

3.2.17.8 Listing

(CONALL)


Start
A
Get One Plot Array
Leader End of Array connects with Leader End of Another Array
Y
N
Leader End of Array Connects with Trailer End of Another Array
Y
N
Trailer End of Array Connects with Trailer End of Another Array
Y
N
B
JOIN
Join Plot Arrays Appropriately
C


B
C
A
Last Plot Array
Y
RETURN
N
Boundary String is getting lar e
Y
LINIT
Plot X,Y arrays in drawing file
AREA1
Compute Area

```
                         READY
   SUBROUTINE CONALL(IPROB)
   COMMON /Z/ NGRUP,ARRAYX(50,50),ARRAYY(50,50),ISIZE(50),ASIZE(50)
  .ARX(50),ARY(50),LINE,YMAX,XSC,YSC,KAPPA
   INTEGER ARRAYX,ARRAYY
   DO 200 J=1,NGRUP
   IS=ISIZE(J)
   IF(IS-1) 200,200,10
10 DO 100 I=1,NGRUP
   IF(I.EQ.J) GO TO 100
   IS2=ISIZE(I)
   IF(IS2-1) 100,100,20
20 IND=1
   XA=ARRAYX(J,1)
   YA=ARRAYY(J,1)
   XB=ARRAYX(I,1)
   YB=ARRAYY(I,1)
22 DIF1=XA-XB
   IF(ABS(DIF1).GT.0.01) GO TO 25
   DIF2=YA-YB
   IF(ABS(DIF2).GT.0.01) GO TO 25
   IPROB=1
   JA=J
   ISA=IS
   IA=I
   IS2A=IS2
   CALL JOIN(JA,ISA,IA,IS2A,IND)
   IS=ISIZE(JA)
   J=JA
   IF(IS.LT.24) GO TO 24
   DO 23 IJ=1,IS
   ARX(IJ)=ARRAYX(J,IJ) * XSC
23 ARY(IJ)=(YMAX-ARRAYY(J,IJ)) * YSC
   CALL LINIT(ARX,ARY,IS,0)
```

```
      CALL AREA1(J,AREA)
      ASIZE(J)=ASIZE(J) + AREA
      IF (ARRAYY(J,1).LT.LINE) GO TO 235
      ASIZE(IA)=0.
      ARRAYX(IA,1)=ARRAYX(J,1)
      ARRAYY(IA,1)=ARRAYY(J,1)
      ISIZE(IA)=1
  235 ISIZE(J)=1
      ARRAYX(J,1)=ARRAYX(J,IS)
      ARRAYY(J,1)=ARRAYY(J,IS)
   24 GO TO 200
   25 IND=IND+1
      GO TO (20,30,40,50,100),IND
   30 XB=ARRAYX(I,IS2)
      YB=ARRAYY(I,IS2)
      GO TO 22
   40 XA=ARRAYX(J,IS)
      YA=ARRAYY(J,IS)
      GO TO 22
   50 XB=ARRAYX(I,1)
      YB=ARRAYY(I,1)
      GO TO 22
  100 CONTINUE
  200 CONTINUE
      RETURN
      END

READY
```

3.2.18 SOFTWARE COMPONENT NO. 18 (JOIN)

3.2.18.1 Linkage

Subroutine JOIN is called by subroutines CONECT and CONALL.

3.2.18.2 Interface

Subroutine JOIN receives control information through common block Z (see Appendix A).

3.2.18.3 Input

None

3.2.18.4 Output

None

3.2.18.5 Storage Requirements

Subroutine JOIN requires 358 words in core.

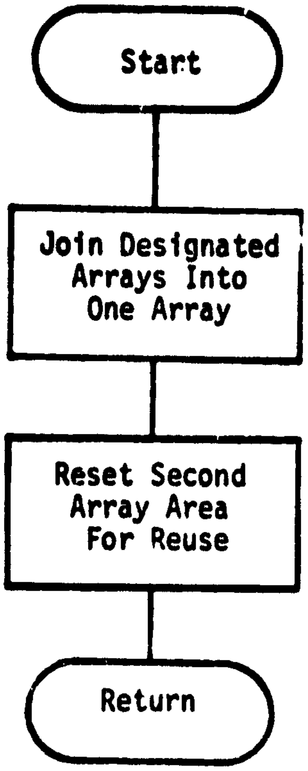
3.2.18.6 Description

Subroutine JOIN connects plot string arrays as determined by subroutines CONALL and CONECT. Arrays which are no longer needed, i.e., whose coordinates have been linked to another array, are flagged for reuse.

3.2.18.7 Flowchart

3.2.18.8 Listing

(JOIN)


Start
Join Designated Arrays Into One Array
Reset Second Array Area For Reuse
Return

```
                                        READY
      SUBROUTINE JOIN(J,IS,I,IS2,IND)
      DIMENSION ATX(50),ATY(50)
      COMMON /Z/ NGRUP,ARRAYX(50,50),ARRAYY(50,50),ISIZE(50),ASIZE(5
     .,ARX(50),ARY(50),LINE,YMAX,XSC,YSC,KAPPA
      INTEGER ARRAYX,ARRAYY
      IF(IND NE.2) GO TO 1
      IT=J
      J=I
      I=IT
      IT=IS
      IS=IS2
      IS2=IT
    1 GO TO (10,30,20,30),IND
   10 ISM=IS+1
      DO 12 II=1,IS
      ISM=ISM-1
      ATX(ISM)=ARRAYX(J,II)
   12 ATY(ISM)=ARRAYY(J,II)
      DO 14 II=1,IS
      ARRAYX(J,II)=ATX(II)
   14 ARRAYY(J,II)=ATY(II)
      GO TO 30
   20 ISM=IS2+1
      DO 22 II=1,IS2
      ISM=ISM-1
      ATX(ISM)=ARRAYX(I,II)
   22 ATY(ISM)=ARRAYY(I,II)
      DO 24 II=1,IS2
      ARRAYX(I,II)=ATX(II)
   24 ARRAYY(I,II)=ATY(II)
   30 IJ=0
      NEWE=IS+IS2-1
      DO 50 II=IS,NEWE
      IJ=IJ+1
      ARRAYX(J,II)=ARRAYX(I,IJ)
   50 ARRAYY(J.II)=ARRAYY(I,IJ)
      ISIZE(J)=NEWE
      ISIZE(I)=0
      RETURN
      END

READY
```

3.2.19 SOFTWARE COMPONENT NO. 19 (CLSTST)

3.2.19.1 Linkage

Subroutine CLSTST is called by subroutine BDT3, and calls subroutines AREA1 and LINIT.

3.2.19.2 Interface

Control information and data are communicated to subroutine CLSTST via common block Z (see Appendix A).

3.2.19.3 Input

None

3.2.19.4 Output

None

3.2.19.5 Storage Requirements

Subroutine CLSTST requires 324 words in core.

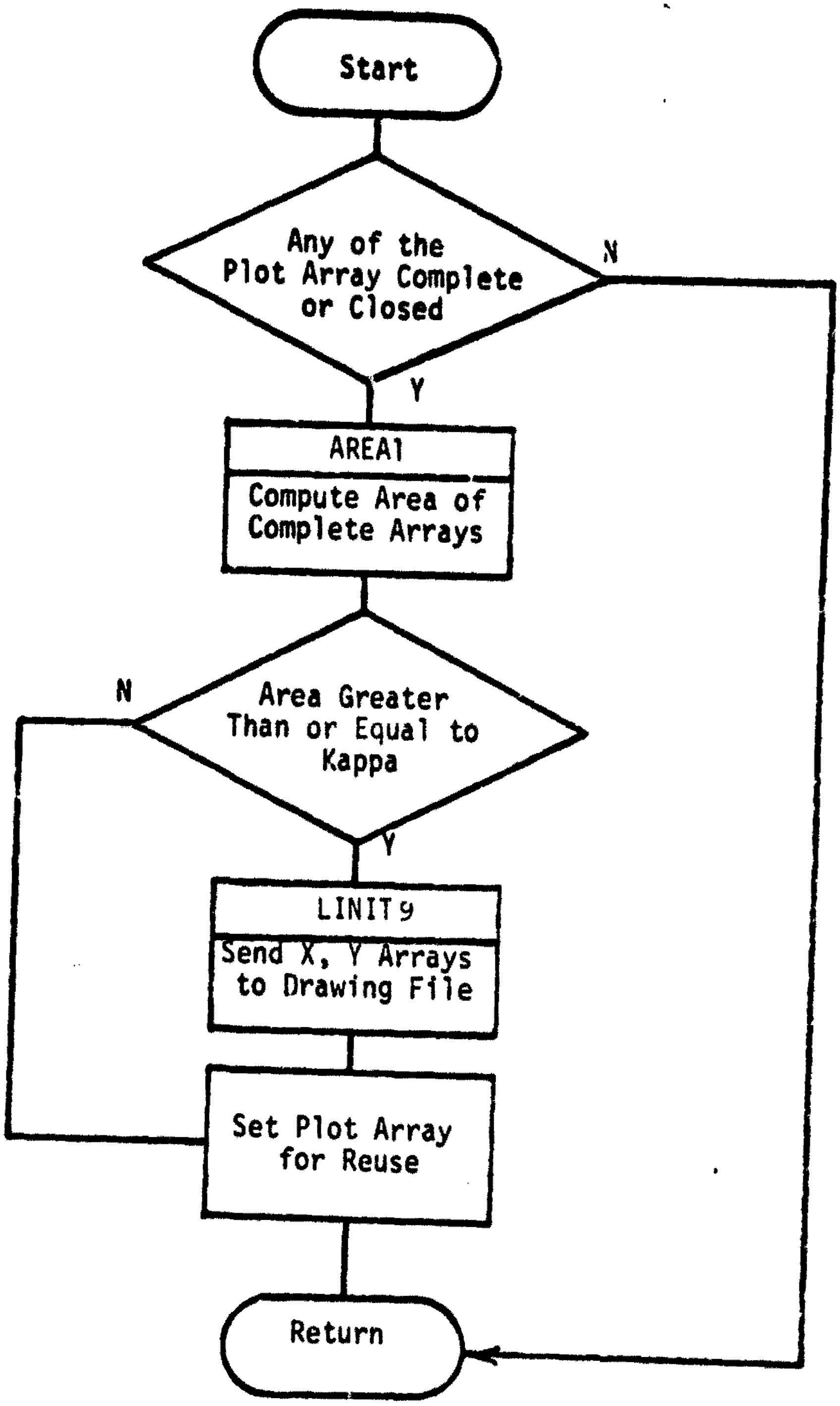
3.2.19.6 Description

Subroutine CLSTST accepts as input plot string arrays and determines whether these strings are complete, or "closed". Arrays which are complete are sent to subroutine AREA1 for area computation, and upon returning, are plotted if the area is ≥ Kappa, a user-supplied constant.

3.2.19.7 Flowchart

3.2.19.8 Listing

(CLSTST)


Start
Any of the Plot Array Complete or Closed
N
Y
AREA1
Compute Area of Complete Arrays
Area Greater Than or Equal to Kappa
N
Y
LINIT9
Send X, Y Arrays to Drawing File
Set Plot Array for Reuse
Return

```
      SUBROUTINE CLSTST
      COMMON /Z/ NGRUP,ARRAYX(50,50),ARRAYY(50,50),ISIZE(50),ASIZE(50)
     ,ARX(50),ARY(50),LINE,YMAX,XSC,YSC,KAPPA
      INTEGER ARRAYX,ARRAYY
      IF(NGRUP) 999,999,10
   10 DO 100 I=1,NGRUP
      A1=ASIZE(I)
      IF(ABS(A1).GT.0.1) GO TO 100
      I1=ISIZE(I)
      IF(I1.LT.2) GO TO 100
      DIF1=ARRAYX(I,1)-ARRAYX(I,I1)
      IF(ABS(DIF1).GT.0.01) GO TO 100
      DIF2=ARRAYY(I,1)-ARRAYY(I,I1)
      IF(ABS(DIF2).GT.0.01) GO TO 100
      CALL AREA1(I,AREA)
      IF(ABS(AREA).LT.KAPPA) GO TO 90
      DO 50 JK=1,I1
      ARX(JK)=ARRAYX(I,JK) * XSC
   50 ARY(JK)=(YMAX-ARRAYY(I,JK)) * YSC
      CALL LINIT(ARX,ARY,I1,0)
      ASIZE(I)=ASIZE(I) + AREA
      LX=ARRAYX(I,1)
      LY=ARRAYY(I,1)
C     WRITE(10,60)LY,LX,ASIZE(I)
C  60 FORMAT(' AREA(',I3,' X ',I3,')=',F8.2)
      ASIZE(I)=0
   90 ISIZE(I)=0
  100 CONTINUE
  999 RETURN
      END

READY
```

3.2.20 SOFTWARE COMPONENT NO. 20 (AREA1)

3.2.20.1 Linkage

Subroutine AREA1 is called by subroutines CONECT, CONALL, FINDAR, CLSTST, and ENDTST.

3.2.20.2 Interface

Control information and data information are communicated by means of common block Z (see Appendix A).

3.2.20.3 Input

A plot string index is input to AREA1 via a calling argument.

3.2.20.4 Output

An area value is output via a calling argument.

3.2.20.5 Storage Requirements

Subroutine AREA1 requires 122 words in core.

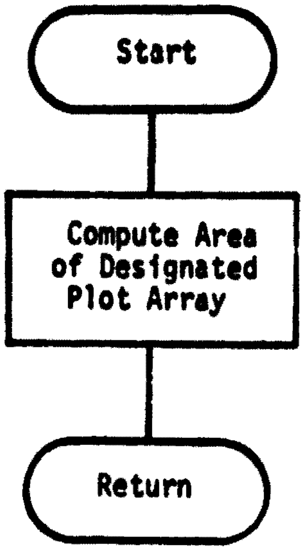
3.2.20.6 Description

Subroutine AREA1 accepts as input a plot string array, either partial or complete. AREA1 computes the area or partial area in pixel units that this array represents.

3.2.20.7 Flowchart

3.2.20.8 Listing

(AREA1)



```
      SUBROUTINE AREA1(I,AREA)
      COMMON /2/ NGRUP,ARRAYX(50,50),ARRAYY(50,50),ISIZE(50),ASIZE(50)
     ,ARX(50),ARY(50),LINE,YMAX,XSC,YSC,KAPPA
      INTEGER ARRAYX,ARRAYY
COMPUTE AREA USING ARRAYX(I,ALL),ARRAYY(I,ALL)
      I1=ISIZE(I)
      AREA=0
      DO 100 J=2,I1
      DX=ARRAYX(I,J)-ARRAYX(I,J-1)
      AREA=AREA + DX* ARRAYY(I,J)
  100 CONTINUE
      RETURN
      END

READY
```

3.2.21 SOFTWARE COMPONENT NO. 21 (ENDTST)

3.2.21.1 Linkage

Subroutine ENDTST is called by subroutine BDT9, and calls subroutines AREA1 and LINIT.

3.2.21.2 Interface

Subroutine ENDTST receives control information through common block Z (see Appendix A).

3.2.21.3 Input

None

3.2.21.4 Output

None

3.2.21.5 Storage Requirements

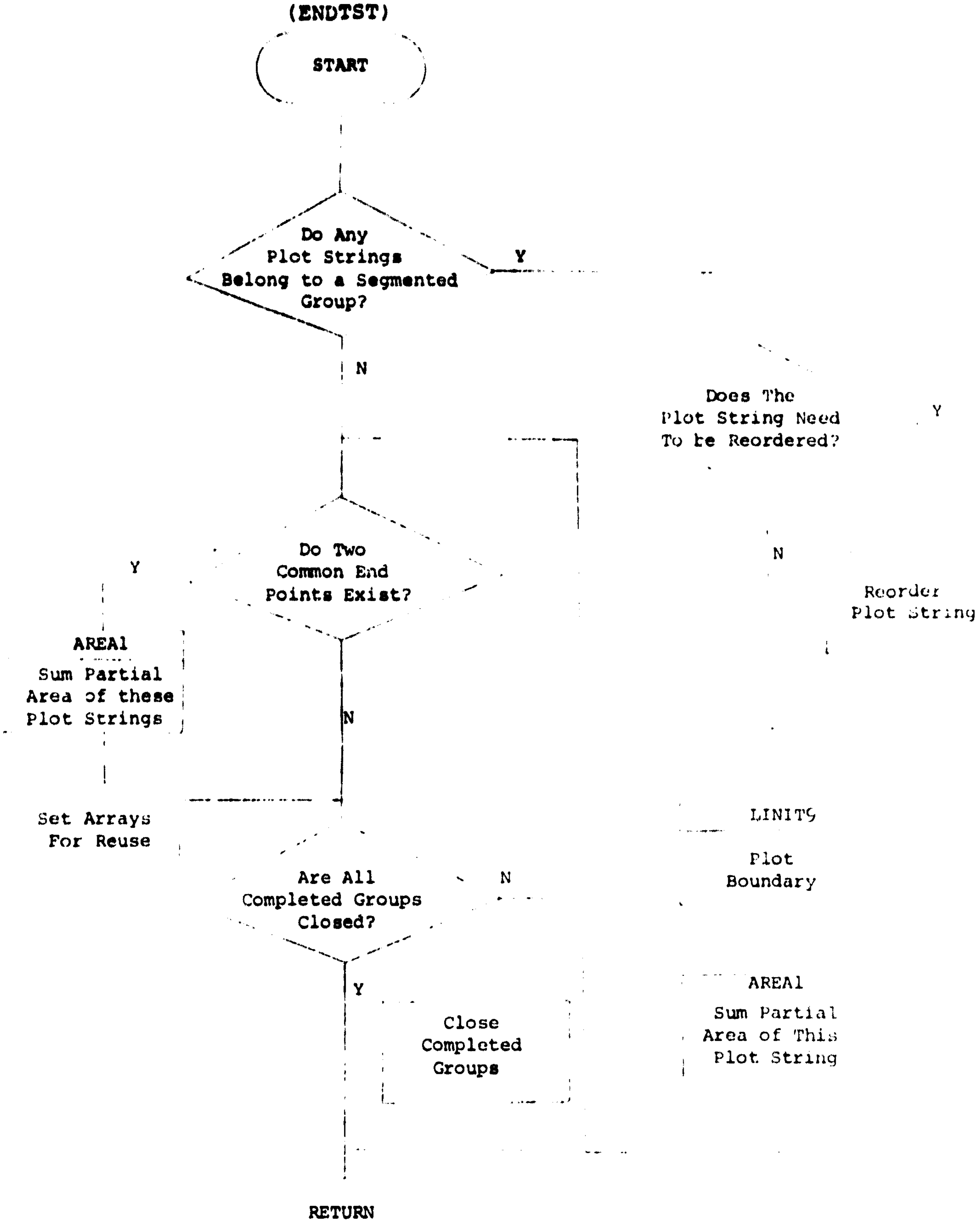
Subroutine ENDTST requires 723 words in core.

3.2.21.6 Description

Subroutine ENDTST handles, by segmentation, plotting and summation of area measurement for large plot strings which cannot be stored contiguously.

3.2.21.7 Flowchart

3.2.21.8 Listing


(ENDTST)
START
Do Any Plot Strings Belong to a Segmented Group?
Y
N
Does The Plot String Need To be Reordered?
Y
N
Reorder Plot String
Do Two Common End Points Exist?
Y
N
AREA1
Sum Partial Area of these Plot Strings
Set Arrays For Reuse
LINITS
Plot Boundary
Are All Completed Groups Closed?
N
Y
AREA1
Sum Partial Area of This Plot String
Close Completed Groups
RETURN

```
                                                READY
      SUBROUTINE ENDTST
      DIMENSION LRX(50),LRY(50)
      COMMON /Z/ NGRUP,ARRAYX(50,50),ARRAYY(50,50),ISIZE(50),ASIZE(50
     ,ARX(50),ARY(50),LINE,YMAX,XSC,YSC,KAPPA
      INTEGER ARRAYX,ARRAYY
      IF(NGRUP) 99,99,1
    1 DO 10 I=1,NGRUP
      I1=ISIZE(I)
      IF(I1-1) 10,2,10
    2 DO 9 J=1,NGRUP
      I2=ISIZE(J)
      IF(I2-1) 9,9,3
    3 N=1
      AX1=ARRAYX(I,1)
      AY1=ARRAYY(I,1)
    4 AX2=ARRAYX(J,N)
      AY2=ARRAYY(J,N)
      IF(ABS(AX1-AX2).GT.0.01) GO TO 5
      IF(ABS(AY1-AY2).GT.0.01) GO TO 5
      IF(N-1) 8,8,7
    5 IF(N-I2) 6,9,6
    6 N=I2
      GO TO 4
    7 L=I2+1
      DO 71 LL=1,I2
      L=L-1
      LRX(LL)=ARRAYX(J,L)
   71 LRY(LL)=ARRAYY(J,L)
      DO 72 LL=1,I2
      ARRAYX(J,LL)=LRX(LL)
   72 ARRAYY(J,LL)=LRY(LL)
    8 DO 88 L=1,I2
      ARX(L)=ARRAYX(J,L) * XSC
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
                                                  READY
   88 ARY(L)=(YMAX-ARRAYY(J,L)) * YSC
      CALL LINIT(ARX,ARY,I2,0)
      CALL AREA1(J,AREA)
      ASIZE(I)=ASIZE(I) + AREA
      ISIZE(I)=1
      ARRAYX(I,1)=ARRAYX(J,I2)
      ARRAYY(I,1)=ARRAYY(J,I2)
      ISIZE(J)=0
      ASIZE(J)=0.
      GO TO 10
    9 CONTINUE
   10 CONTINUE
      DO 20 I=1,NGRUP
      I1=ISIZE(I)
      IF(I1-1) 20,11,20
   11 DO 19 J=1,NGRUP
      IF(I-J) 12,19,12
   12 I2=ISIZE(J)
      IF(I2-1) 19,13,19
   13 AX1=ARRAYX(I,1)
      AY1=ARRAYY(I,1)
      AX2=ARRAYX(J,1)
      AY2=ARRAYY(J,1)
      IF(ABS(AX1-AX2).GT.0.01) GO TO 19
      IF(ABS(AY1-AY2).GT.0.01) GO TO 19
      LX=AX1
      LY=AY1
      AREA=ASIZE(I)-ASIZE(J)
C     WRITE(10,14)LY,LX,AREA
C  14 FORMAT("   AREA(",I3," , ",I3," )=",F8.2)
      ASIZE(I)=0.
      ASIZE(J)=0.
      ISIZE(I)=0
      ISIZE(J)=0
   19 CONTINUE
   20 CONTINUE
      DO 30 J=1,NGRUP
      J1=ISIZE(J)
      IF(J1-1)30,25,30
   25 LX=ARRAYX(J,1)
      LY=ARRAYY(J,1)
      IF(LY.GE.LINE) GO TO 30
      ASIZE(J)=0.
      ISIZE(J)=0
   30 CONTINUE
   99 RETURN
      END

READY
```

4. OPERATION

The users of this software system are researchers and analysts who need a method of comparing classification results to ground truth and an accurate means of production display of classification results. The input to this software system is a 7-or 9-track, 800 BPI universally formatted classification data tape directly or indirectly obtained from the GE Interactive Multispectral Image Analyst System (IMAGE 100), the Earth Resources Interactive Processing System (ERIPS), and the UNIVAC 1100 Software (EOD-LARSYS).

4.1 USER DOCUMENTATION

There is no formal user's document required in this phase implementation; the function of such a document is satisfied by the Technical Memorandum entitled "Software Specifications for Automated Thematic Plotting of Classified Digital Data", April 1976 (LEC 8289).

4.2 OPERATION DOCUMENTATION

N/A

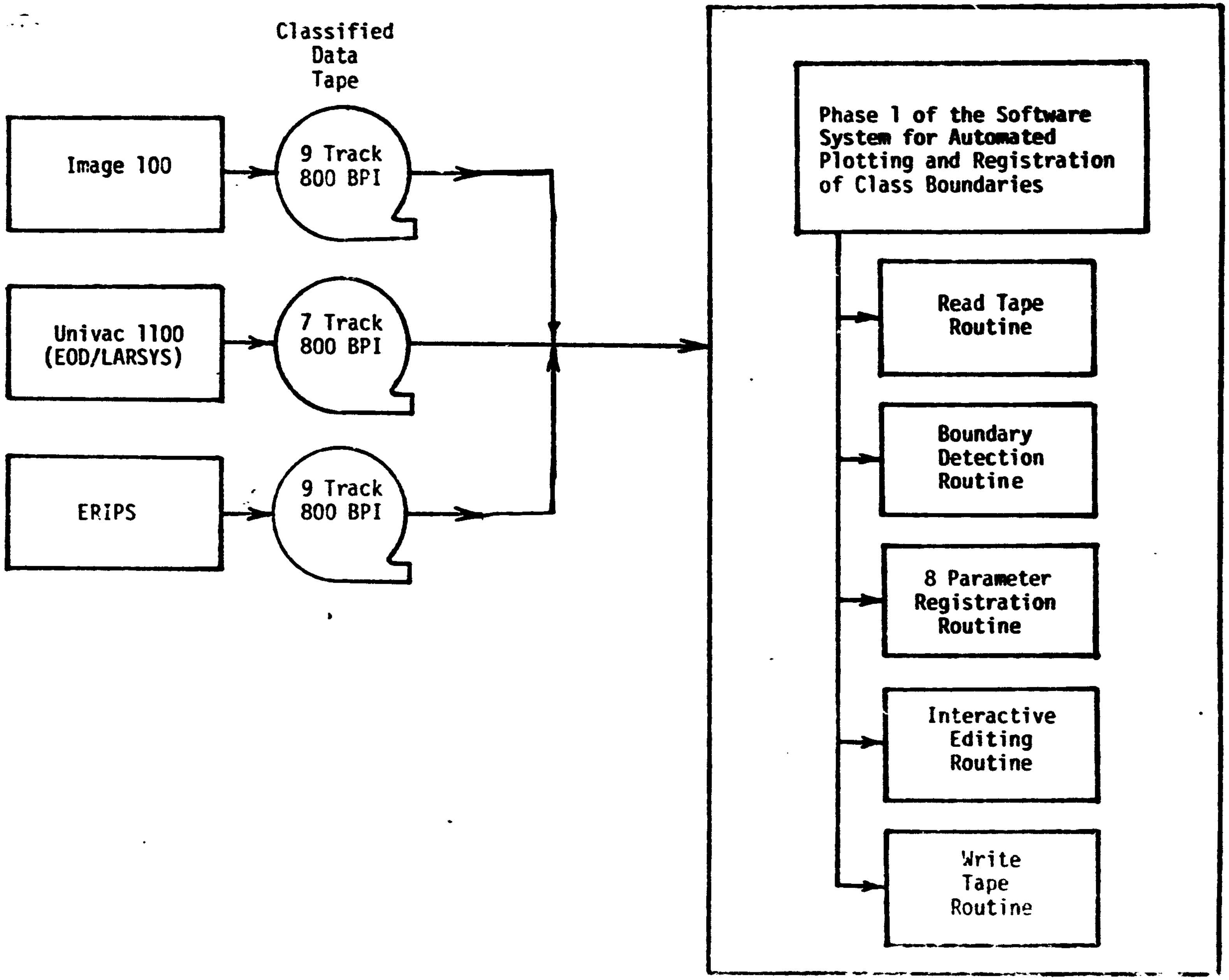

Classified
Data
Tape
Image 100
9 Track
800 BPI
Univac 1100
(EOD/LARSYS)
7 Track
800 BPI
ERIPS
9 Track
800 BPI
Phase 1 of the Software System for Automated Plotting and Registration of Class Boundaries
Read Tape Routine
Boundary Detection Routine
8 Parameter Registration Routine
Interactive Editing Routine
Write Tape Routine

Figure 1: Functional Diagram of Phase 1 Implementation of the Software System

STARTING OCTAL NUMBER	CORE MAP (32K)	
0	Page 0 and Constants	
440	1. Bendix System 100 labeled common 2. External references for Bendix System 100 in-core routines and plotter routines	
3330	Fortran initialization routine - 1st routine executed by each overlay	
4007	Fortran run-time linkage	
4200	Fortran libraries	
13651	Part 1 of Bendix System 100 subroutines	
14234	Menu	
16644	Part 2 of Bendix System 100 subroutines	
30641	User's overlay	} $13{,}919_{10}$
64000	Run time stack for main program	
70704	1. Monitor 2. System loader 3. Paper tape loader 4. Key-in loader	

Figure 2: Bendix System 100 Core Utilization Map

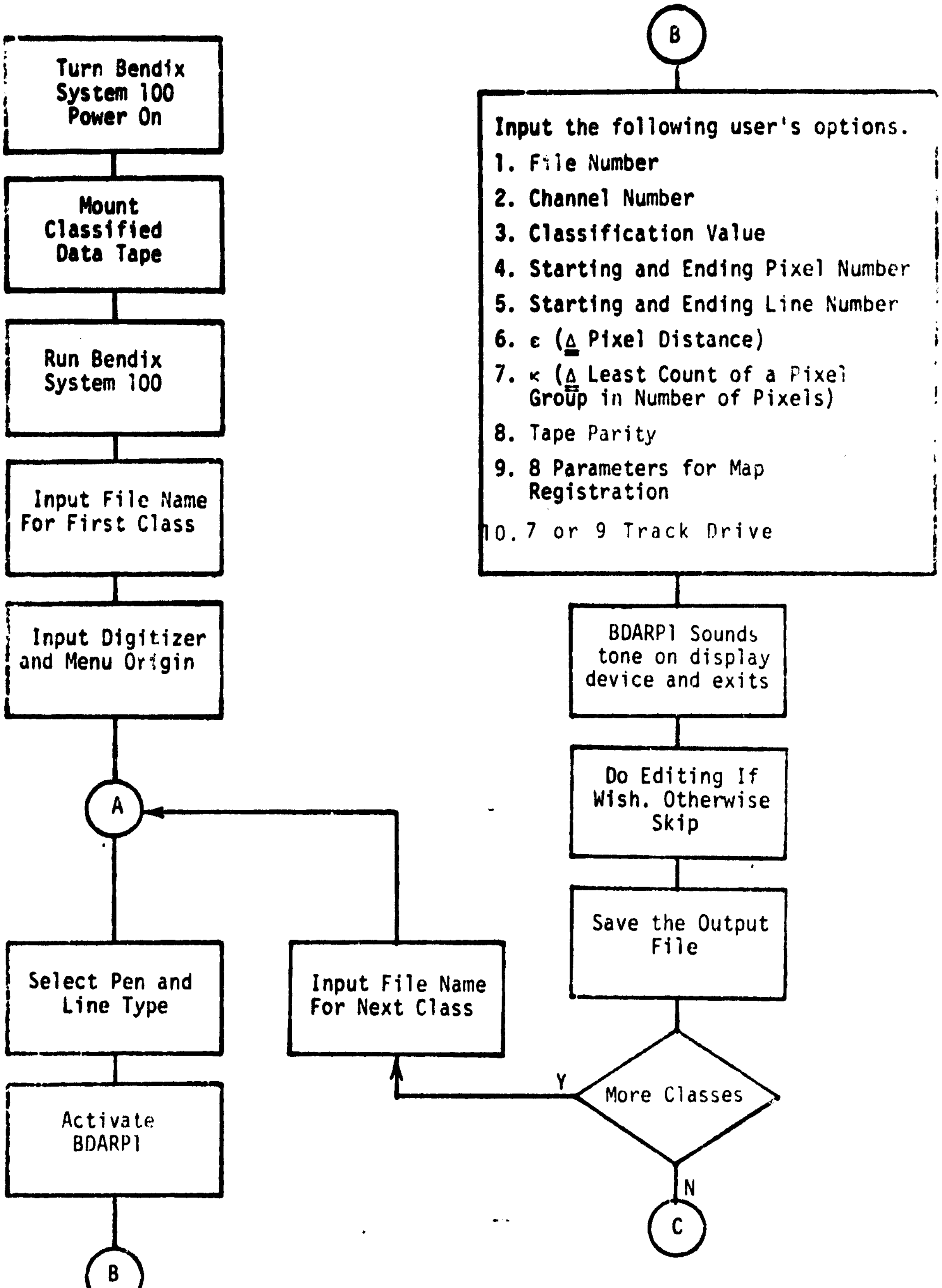

Turn Bendix System 100 Power On
Mount Classified Data Tape
Run Bendix System 100
Input File Name For First Class
Input Digitizer and Menu Origin
A
Select Pen and Line Type
Activate BDARP1
B
Input File Name For Next Class
B
Input the following user's options.
1. File Number
2. Channel Number
3. Classification Value
4. Starting and Ending Pixel Number
5. Starting and Ending Line Number
6. ε (≜ Pixel Distance)
7. κ (≜ Least Count of a Pixel Group in Number of Pixels)
8. Tape Parity
9. 8 Parameters for Map Registration
10. 7 or 9 Track Drive
BDARP1 Sounds tone on display device and exits
Do Editing If Wish. Otherwise Skip
Save the Output File
More Classes
Y
N
C

Figure 3: User's Procedure

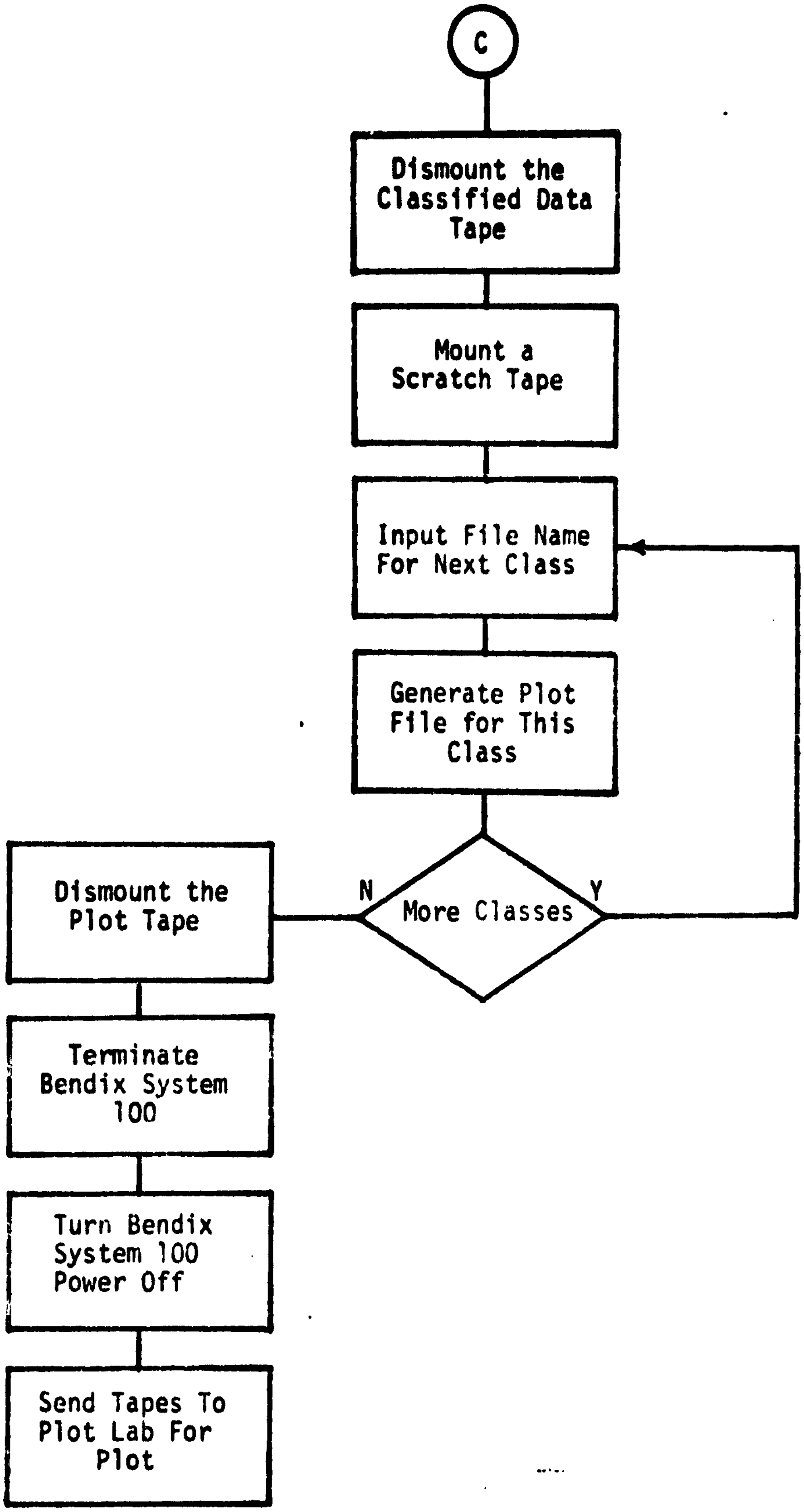

C
Dismount the Classified Data Tape
Mount a Scratch Tape
Input File Name For Next Class
Generate Plot File for This Class
More Classes
N
Y
Dismount the Plot Tape
Terminate Bendix System 100
Turn Bendix System 100 Power Off
Send Tapes To Plot Lab For Plot

Figure 3: User's Procedure (continued)

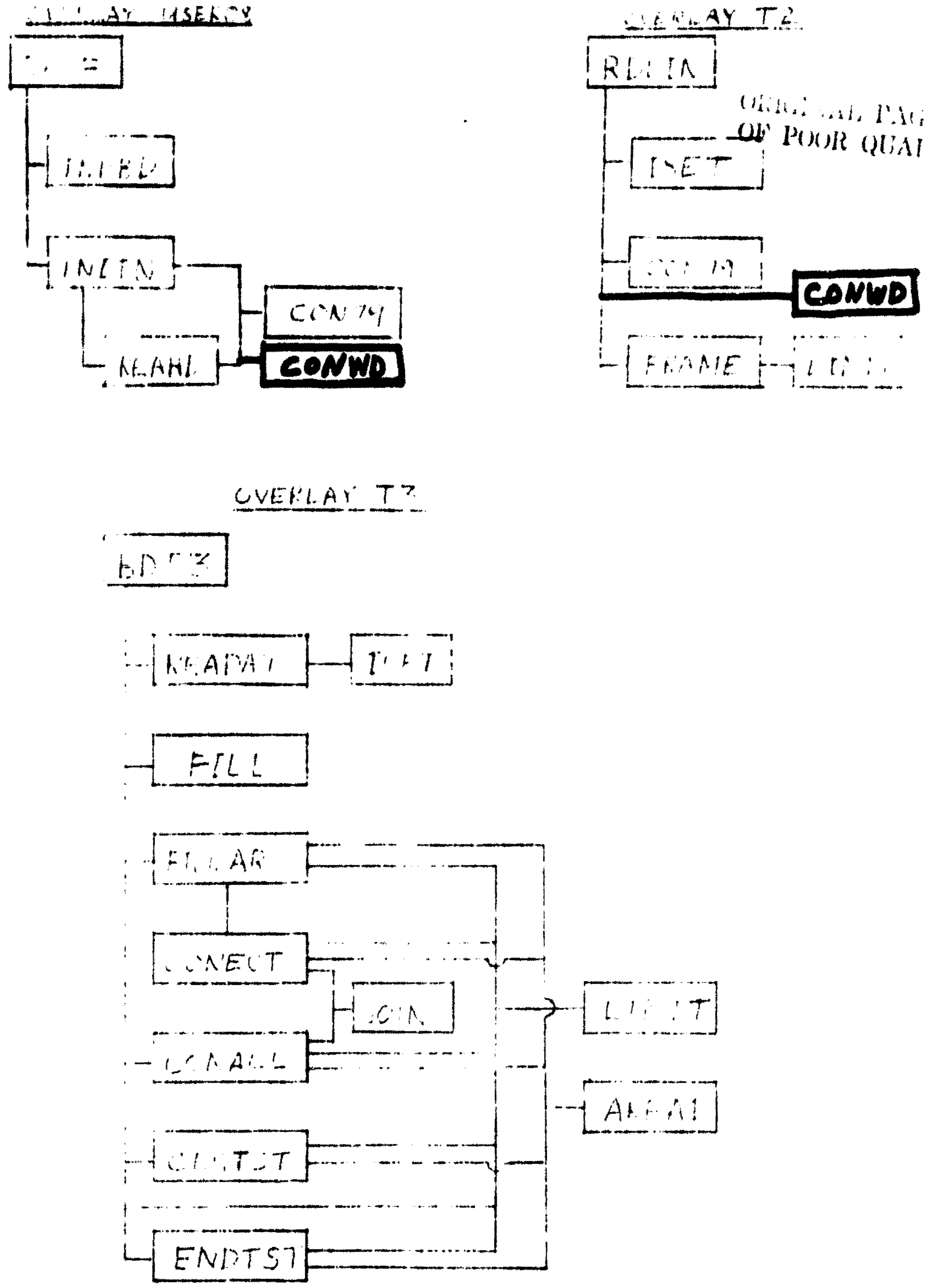


FIGURE 4. The Functional Block Diagram
[illegible]

APPENDIX A

BDARP1 COMMON TABLE

BDARF1 COMMON TABLE

No.	Title	Common Block	Initial Value	Initialized by	Referenced by	Modified by
1.	Header Record constants	ICONS	INPUT	REA[illegible] 9	[illegible] [illegible] 9	REAHD INITN
2.	Tape File Number	ICONS	INPUT	INPBD	[illegible]	--
3.	Tape Parity	ICONS	INPUT	INPBD	[illegible]	--
4.	7 or 9 Track	ICONS	INPUT			
5.	Channel No.	ICONS	INPUT	INPBD	REAHD, INITN	--
6.	Class Value	ICONS	INPUT	INPBD	RDLIN9	--
7.	Starting/Ending Line	ICONS	INPUT	INPBD	RDLIN9, BDT9	--
8.	Starting/Ending Pixel	ICONS	INPUT	INPBD	RDLIN9, BDT9	--
9.	Epsilon Value	ICONS, ZZ	INPUT	INPBD	BDT9, FILL	--
10.	Kappa Value	ICONS, Z	INPUT	INPBD	CLSTST	--
11.	8 Registration coefficients	ICONS	INPUT	INPBD	LINIT	--
12.	Index on FINDAR failures due to all plot arrays being filled	MAXFIL	0	BDT9	BDT9, FINDAR	FINDAR
13.	No. of plot arrays in use	Z	0	BDT9	FINDAR	FINDAR
14.	X and Y arrays of current boundary plot strings	Z	0	FINDAR	*	*

BDARP1 COMMON TABLE (cont)

No.	Title	Common Block	Initial Value	Initialized by	Referenced by	Modified by
15.	Vector describing length of each boundary string	Z	0	FINDAR	*	*
16.	Vector describing area of each boundary string	Z	0	FINDAR	*	*,AREA1
17.	X and Y array of plot string in drawing file format	Z	0	*	*	*
18.	Present line number	Z	1	BDT9	BDT9,FILL	BDT9
19.	Pixel scaling factors, X&Y	Z	0.1,0.1	BDT9	*	--
20.	Block of "pixel" data, unchanged	ZZ	INPUT	BDT9	BDT9,FILL	--
21.	Block of "pixel" data after fill	ZZ	COMPUTED	FILL	BDT9,FILL	FILL
22.	No. of pixels/line	ZZ	COMPUTED	BDT9	BDT9,FILL	--

* denotes most of the following: BDT3, ENDTST, CLSTST, CONECT, CONALL, JOIN, and FINDAR.