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AD 913125

# Project Report

PA-229-9  
(RSP)

C. R. Berndtson  
R. H. French  
D. E. Nessman

Data Reduction Program Documentation  
ALC10

(Effective: April 1971)

17 May 1971

19685

Prepared for the Advanced Research Projects Agency,  
the Department of the Army, and the Department of the Air Force  
under Electronic Systems Division Contract F19628-70-C-0230 by

## Lincoln Laboratory

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Lexington, Massachusetts



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LINCOLN LABORATORY

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DATA REDUCTION PROGRAM DOCUMENTATION  
ALC10

(EFFECTIVE: APRIL 1971)

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PROJECT REPORT PA-229-9 (RSP)

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11 17 MAY 1971

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## FOREWORD

This is the ninth report in the Data Reduction Program Documentation series. It is dated according to the date of completion of the documentation. No implication is made that this program will not subsequently be modified, amended, or superseded; on the contrary, the history of radar data processing is one of continuous evolution of techniques, and it is unrealistic to assume that steady-state has been reached. The PA-229 series is being published for the convenience of interested parties, and Lincoln assumes no responsibility for the correctness of the information presented, nor for its currency.

The preparation of reports in this series is under the Editorship of Charles R. Berndtson of Lincoln, and of D. Nessman and R. French of Philco-Ford Corporation. Inquiries, suggestions, corrections, criticisms, and requests for additional copies should be directed to C. R. Berndtson.

The principal contributor to this report was G. L. Shapiro (Philco-Ford). Due to the intricate, evolutionary manner in which the programs came into being, the editors regret that it is in general impossible to give due credit to all -- mathematicians or radar analysts or programmers -- who contributed to the definition and writing of the programs.

  
Alan A. Grometsstein

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## COMMON SYMBOLS AND ABBREVIATIONS

(The units given for certain quantities are the units commonly used for those quantities, unless otherwise noted.)

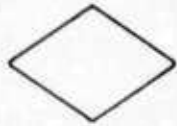
ADT	ALCOR Data Tape
ALCOR	ARPA-Lincoln C-band Observables Radar
ALTAIR	ARPA Long-Range Tracking and Instrumentation Radar
Alt	Altitude (km)
APS	Average Pulse Shape
ARS	ALTAIR Recording System
Avg	Average, Averaging
Az	Azimuth (deg)
c	Speed of Light
CADJ	Adjusted Calibration Constant (db)
C-band	ALCOR frequency, 5664 MHz (NB) and 5667 MHz (WB)
DBLT	Wide Band Pulse Doublet
EI	Elevation (deg)
EOF	End of File
GMT	Greenwich Mean Time
h	Hours
Hz	Hertz
IF	Intermediate Frequency
in	Inches
LC	Left Circular Polarization
lsb	Least Significant Bit
min	Minutes
NB	Narrow Band
NRTPOD	Non-real Time Precision Orbit Determination Program
POD	Project PRESS Operation and Data Summary Report
Phase	Presented in deg
PRF	Pulse Repetition Frequency (pps)
PRI	Pulse Repetition Interval (s)
pps	Pulses per second
pts	Points

R	Range (km)
$\dot{R}$	Range Rate (km/s)
rad	Radians
RC	Right Circular Polarization
RCS	Radar Cross Section (dbsm)
RF	Radio Frequency
s	Seconds
$SD_w$	Standard Deviation of Wake Velocity
SDBLT	Wide Band Slaved Pulse Doublet
S/N	Signal-to-noise Ratio
T	Time
TAL	Time After Launch (s)
UHF	ALTAIR Frequency; 415 MHz
V	Velocity
$V_d$	Doppler Velocity
$V_w$	Mean Wake Velocity
VHF	ALTAIR Frequency; 155.5 MHz
WB	Wide Band
WBS	Wide Band Slaved
WTR	Western Test Range
$\theta$	Total Off-axis Angle (deg)
$\lambda$	Wavelength
*	Denotes Multiplication

FLOW DIAGRAM SYMBOLS



PROCESS, ANNOTATION



DECISION



TERMINATOR



SUBROUTINE: where NAME is the entry  
call into the subroutine



CONNECTOR: where P specifies a page in the  
flow diagram, and L designates  
a statement number in the program  
listing or a reference point in the  
flow diagram



CONNECTOR: where X implies a continuation  
of the diagram to the next page



INPUT/OUTPUT OPERATION



MAGNETIC TAPE



PUNCHED CARD



DISK

ALC10

I. PURPOSE and UTILIZATION

A. Source of Data

ALCOR<sup>1</sup>

B. Data Input

ALCOR Data Tape (ADT)

C. Description

ALC10 is designed to obtain RCS data on hard body targets (NB and WB) and on multiple radar scattering centers (WB). It produces plots vs TAL and Alt of the peak RCS from a set of gates or of the RCS in a selected gate.

*RCS (radar cross section)*  
*narrowband and wideband*  
*wideband*  
*altitude*

D. Output

1. A listing of pertinent identification data.
2. Plots vs TAL and Alt of peak RCS or of RCS in a selected range gate.

*time after launch*

## II. DESCRIPTION

ALC10 computes average RCS as a function of range gate and time. The program averages in  $m^2$  and then converts to dbsm for printouts and plots.

The averaging interval (AVINT) is input in seconds, and must be either 0.01, 0.02, 0.04, 0.05, 0.08, or 0.1. Based on AVINT and the primary pulse PRF, the number of pulses averaged is shown in Table I.

Only single pulse RCS data are computed if the range offset (XINOFF) is not zero.

RCS is computed as follows:

$$\text{LC RCS} = \text{XATBL(N)} + 40 \log R + \text{XPPAGC} + \text{CONLC} - \text{POWER T}$$

$$\text{RC RCS} = \text{XATBL(M)} + 40 \log R + \text{XOPAGC} + \text{CONRC} - \text{POWER T}$$

where

XATBL(N) is obtained by indexing the LC calibration table with the LC amplitude values obtained in the ADT data record.<sup>1</sup>

XATBL(M) is obtained by indexing the RC calibration table with the RC amplitude values obtained in the ADT data record.<sup>1</sup>

XPPAGC is total LC attenuation (db)<sup>2</sup>

XOPAGC is total RC attenuation (db)<sup>2</sup>

CONLC and CONRC are calibration constants (db) obtained from Calibration Record Words 624 (NB LC), 625 (NB RC), 627 (WB LC), and 628 (WB RC)

POWER T (peak transmit power in dbw) for NB  
= PWRCN + PWRSN log XPKPWR

POWER T for WB  
= PWRSN + PWRSW log XPKPWR

where

PWRCN is Calibration Record Word 620

PWRSN is Calibration Record Word 621

PWRCW is Calibration Record Word 622

TABLE I  
AVERAGING PARAMETERS FOR ALC10

<u>PRF</u> <u>(pps)</u>	<u>Pulse</u> <u>Spacing</u> <u>(s/pulse)</u>	<u>No. of Pulses Averaged</u>					
		<u>0.01</u> <sup>#</sup>	<u>0.02</u> <sup>#</sup>	<u>0.04</u> <sup>#</sup>	<u>0.05</u> <sup>#</sup>	<u>0.08</u> <sup>#</sup>	<u>0.1</u> <sup>#</sup>
200	0.01 <sup>##</sup>	1	2	4	5	8	10
160	0.0125 <sup>##</sup>	(1) <sup>†</sup>	(1)	(1)	4	(1)	8
100	0.01	1	2	4	5	8	10
80	0.0125	(1)	(1)	(1)	4	(1)	8
50	0.02	(1)	1	2	2-3 <sup>††</sup>	4	5
40	0.025	(1)	(1)	(1)	2	(1)	4
25	0.04	(1)	(1)	1	(1)	2	2-3 <sup>††</sup>
20	0.05	(1)	(1)	(1)	1	(1)	2

<sup>#</sup> Averaging interval(s) (AVINT).

<sup>##</sup> When ALCOR transmits either 200 or 160 pps, the ADT tape (prior to April 71) has always contained every other pulse for a recorded PRF of 100 or 80 pps.

<sup>†</sup> If AVINT is not obtainable at the PRF without using fractional pulses, only one pulse is averaged (AVINT = 1/PRF).

<sup>††</sup> For this AVINT and PRF, 2 pulses and 3 pulses are averaged alternately.

PWRSW is Calibration Record Word 623

XPKPWR is ADT Record Byte 044

R, Az, and El are corrected as follows:

$$R = IRANGE + TRBIAS + TTCOR + RRCOR - RCORF$$

$$Az = IAZ + AZBIAS$$

$$El = IEL + ELBIAS - ECORF$$

where

IRANGE is uncorrected R

TRBIAS is range bias

TTCOR (transit time correction) =  $\dot{R}R/c$

RRCOR is range doppler coupling correction

RCORF is tropospheric refraction correction

IAZ is Az encoder angle

AZBIAS is Az bias (Calibration Record Word 602)

IEL is El encoder angle

ELBIAS is El bias (Calibration Record Word 603)

ECORF is tropospheric refraction correction

Alt is computed as follows:

$$Alt = (R^2 + R_e^2 + 2RR_e \sin El)^{\frac{1}{2}} - R_e$$

where

$$R_e = \text{radius of earth (6378.145 km)}$$

Before processing, the main program checks that ITBAND (tape) = IBAND (input). This determines that if WB data is requested, WB data exists on the tape requested.

### III. OPERATION

#### A. Input

Number of cases

Launch time (total GMT ms)

Range offset (m)

Waveform and polarization

Averaging interval (s)

Start and stop range gates for peak RCS search

First and last pulse nos. of processing intervals and initial PRF

No. of processing intervals

A sample input is shown in Appendix A.

#### CARD 1 (I2)

(Col.)

1-2 ICASEN No. of cases

#### CARD 2 (I10, F10.1, 5I5, F5.2, 1X, A4)

1-10	ILNCH	Launch time in total GMT ms
11-20	XINOFF <sup>#</sup>	Range offset (m) (0)
21-25	NCELL1 <sup>#</sup>	Initial gate for peak RCS plot (50)
26-30	NCELL2 <sup>#</sup>	Final gate for peak RCS plot (54)
31-35	NBAND	0 = NB; 1 = WB
36-40	IPOLAR	0 = LC; 1 = RC
41-45	NVAIS	No. of processing intervals
46-50	AVINT <sup>#</sup>	Averaging interval (s) (0.05)
52-55	TITL	Title for listing and plots

---

(U)<sup>#</sup> If left blank, program sets to indicated value.

CARD 3 (6I10)

(Col.)

1-10	NSTART	First pulse no. of initial processing interval
11-20	NSTOP	Last pulse no. of initial processing interval
21-30	INPRF	PRF at first pulse of initial processing interval
31-40	NSTART	First pulse no. of second processing interval
41-50	NSTOP	Last pulse no. of second processing interval
51-60	INPRF	PRF at first pulse of second processing interval

Repeat Card 3 as necessary.

Repeat Cards 2 and 3 for each case.

B. Output

LISTING

Selected input parameters  
No. of points to be plotted  
Processing interval (TAL)

PLOTS

RCS vs TAL and Alt

Sample outputs are given in Appendix B.

IV. PROGRAM LIMITATIONS

NVALS	$\leq 50$ processing intervals
XIVALS	Either 0.01, 0.02, 0.04, 0.05, 0.08, or 0.1 s
IPRS	either 200, 160, 100, 80, 50, 40, 25, or 20 pps (any other PRF will give single pulse averaging)
XINOFF	Must be on tape
No. of averaging intervals	$\leq 6000$

V. PROGRAMMING

A. L10ALC (see Appendices C and D.)

L10ALC is the control section of ALC10. L10ALC reads the input cards, calls READGS and UNPACK, and averages the data returned. L10ALC also calls the subroutines that plot and print the data.

B. HEDADT (see Appendix E.)

Subroutine HEDADT unpacks the ADT header record which contains bandwidth, reel no., WTR no., date of mission, and mission designator. The call statement is HEDADT [ ISIG<sup>#</sup>, INBUF(1), IEQM(1) ] .

INPUT

INBUF(1) First word in the ADT header record<sup>##</sup>

OUTPUT

IEQM(1) IZBAND (bandwidth: 1 = WB, 0 = NB)

IEQM(2) ITREEL (reel no.)

IEQM(3) ITWTR (WTR no.)

IEQM(4) IMTH

IEQM(5) IDAY (Date of test)

IEQM(6) IYR

IEQM(7-9) ITDESG (mission designator)

C. READGS<sup>†</sup> (see Appendix F.)

The first call to subroutine READGS opens the file and reads the ADT header record. The second call to READGS reads the ADT calibration record and stores the values in a buffer area. L10ALC extracts the individual calibration values it requires. Each subsequent call to READGS reads an ADT data record consisting of eight ALCOR pulses.

<sup>#</sup> Not used.

<sup>##</sup> INBUF (2) to INBUF (1803) contain the remaining words in the record.

<sup>†</sup> Same as READJS<sup>2</sup> except rewind procedure is included.

D. UNPACK<sup>2</sup>

Subroutine UNPACK unpacks the raw data from the ADT, and translates it into a format usable by the IBM 360/67 computer.

E. REFC (see Appendix G.)

The tropospheric refraction correction subroutine, REFC, is based on tropospheric refraction tables in PPP-36<sup>3</sup>. A modified version of this subroutine is now in use.

The call statement is REFC (E, R, DEE, DRR)

E      Uncorrected EI (must be between 0° and 90°)  
R      Uncorrected R (ft)  
DEE    EI tropospheric correction  
ERR    R tropospheric correction (ft)

The corrected values to be computed after exiting from the REFC routine are:

EI      = E - DEE  
R (ft) = R - DRR

F. CELPLT

Subroutine CELPLT plots the RCS vs TAL plots.

G. Plotting System Subroutines

They are REREAD, STOIDV, and PLTND.

### REFERENCES

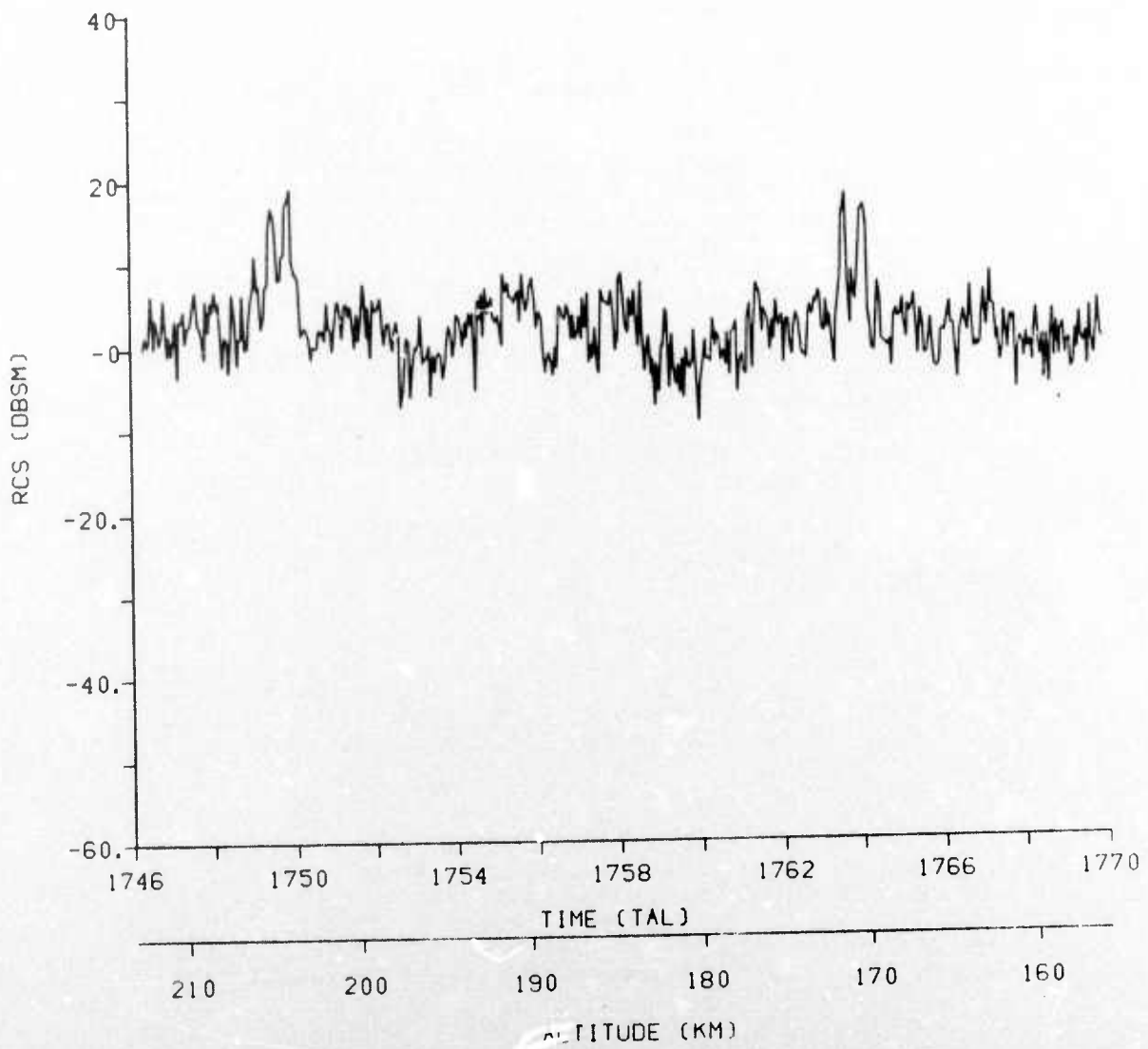
1. "ALCOR Data Users Manual", LM-86, Lincoln Laboratory, M.I.T. (17 June 1970), UNCLASSIFIED.
2. "Data Reduction Program Documentation, ALCOR Tape Read Package, (Effective: April 1974)", PA-229-7, Lincoln Laboratory, M.I.T. (26 April 1971), UNCLASSIFIED.
3. J.P. Penhune, "Refraction Corrections for the TRADEX Radar", PPP-36 Lincoln Laboratory, M.I.T. (21 April 1965), UNCLASSIFIED.



APPENDIX B  
ALC10 OUTPUTS

L60-ALCOR PJLAR = LC BAND = N3 REEL NO. = 2 TITLE = 1J05 DATE = 3/ 3/71  
 CELL BEGIN(SEARCH) = 50 KRCS(LC) = -88.100 IBAND = 0  
 CELL END(SEARCH) = 54 KRCS(RC) = -88.900 IPOLAR = 0 NVALS = 1  
 START STOP PRF START STOP PRF START STOP PRF  
 27191 29551 100  
 LIFT OFF TIME = 18900.972 AVERAGING INTERVAL (SECS) = 0.05 INPJT RANGE OFFSET (M) = 0.0  
 PLOT 473 POINTS FROM 1746.340 TO 1769.939 CASE NO 1 FROM CELL 50 TO CELL 54

1J05 NB LC FROM CELL 50 TO 54  
RANGE OFFSET (M) = 0.0



APPENDIX C  
L10ALC PROGRAM LISTING

```

DOUBLE PRECISION XLNCH,D1000
C
DIMENSION NSTART(50),NSTOP(50)
DIMENSION XLCSUM(170),XRCSUM(170),INPRF(50),
1 XATBL(128),XLCDB(170),XRCDB(170),ILCAMP(170),IRCAMP(170)
2,ILCPHA(170),IRCPHA(170)
DIMENSION IPRS(8),I01(8,2),I02(8,2),I04(8,2),I05(8,2),I08(8,2),
1 I10(8,2),IUSE(8,2),XIVALS(6)
DIMENSION XNBUF(1803),PIFA(16),OIFA(16),          XKRCS(5)
DIMENSION IEQM(9),ITDESG(3)
DOUBLE PRECISION TCOM
C
COMMON/ICOM/INPUF(1803),IAZ,IEL,INDEX,IPPRCS,IORS,IRANGE,IPKPWR,IR
IDOT,IALT,INDAZ,JNDAZ,INDEL,IRB54,IRB85,IOPRCS,I240B1,I240B2,I240B3
1,I241B1,I241B2,I241B3,XPPAGC,IBETA,NEWA,IBAND,NSW,RBIAS(B),ISVPRI,
1IHRS,IMIN,ISEC,IMSEC,ISTAT(21),TRBIAS,ISTAT1,ISTAT2,ISTAT3,ISTAT4,
1IALSW,ISTSW,NBWB,ISIGNO,I27812,JCON,NBEG,NEND,ITST,NUMPRI,XOPAGC,
1ITBAND,ITAPNG,IPRF,IPOLAR,ISSERR,PIFA,CIFA,PFSA,OFSA,PSSA,CSSA,
1PSSL,OSSL,ICODF,I273B5,I273B6,I273B7,I273B8,IMCVP,IMCVC,IOFFST,
1IDAT(682)
COMMON/PLOW/ALSAV(100),DBT ,DBB ,IRUN,KOUNT,NALT,NEWREQ,PLOTID(8
1),CSRV(6000),TCOM(6000),TPINCH,TSAV(100),DPINCH,ICASE
C
EQUIVALENCE (ILCAMP(1),IDAT(1)),(ILCPHA(1),IDAT(171)),(IRCAMP(1),
1IDAT(341)),(IRCPHA(1),IDAT(511))
EQUIVALENCE(XNBUF(1),INBUF(1))
EQUIVALENCE (IEQM(1),IZBAND),(IEQM(2),ITREEL),(IEQM(3),ITWTR),
2(IEQM(4),IMTH ),(IEQM(5),IDAY ),(IEQM(6),IYR),
3(IEQM(7),ITDESG(1))
C
DATA ZLC/'LC  '//,ZRC/'RC  '//,ZWB/'WB  '//,ZNB/'NB  '//,BLANK/'  ' /
DATA IPRS/200,160,100,80,50,40,25,20/
DATA XIVALS/.01,.02,.04,.05,.08,.10/
DATA I01/ 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1/
DATA I02/ 2, 1, 2, 1, 1, 1, 1, 1, 2, 1, 2, 1, 1, 1, 1, 1, 1/
DATA I04/ 4, 1, 4, 1, 2, 1, 1, 1, 4, 1, 4, 1, 2, 1, 1, 1, 1/
DATA I05/ 5, 4, 5, 4, 2, 2, 1, 1, 5, 4, 5, 4, 3, 2, 1, 1, 1/
DATA I08/ 8, 1, 8, 1, 4, 1, 2, 1, 8, 1, 8, 1, 4, 1, 2, 1, 1/
DATA I10/10, 8,10, 8, 5, 4, 2, 2,10, 8,10, 8, 5, 4, 3, 2/
DATA ER /6378.145/
DATA D1000/1000. DO/
C
IPOLAR = 0 LEFT CIRCULAR DATA REQUESTED
C
IPOLAR = 1 RIGHT CIRCULAR DATA REQUESTED
C
NBAND = 0 NARROW BAND DATA REQUESTED
C
NBAND = 1 WIDE BAND DATA REQUESTED
C
NEWA = 0 MISSION FLOWN BEFORE 15 CCT 70 (OLD ATTN.)
C
NEWA = 1 MISSION FLOWN AFTER 15 CCT 70 (NEW ATTN.)
C

```

```

CALL STOIOV('ALC1060',6,0)
CALL REREAD(99,530)
KOUNT=0
ICASE=0
READ(5,13)ICASFN
13 FORMAT(I2)
IF(ICASEN.LE.0)ICASEN=1
5 CONTINUE
IFRST1=0
IFRST2=0
IFRST3=0
IFRST4=0
IAV=0
JJ=0
ICASE=ICASE+1
IF(ICASE.GT.ICASEN)GO TO 127
READ(5,1)ILNCH,XINOFF,NCELL1,NCELL2,NBAND,IFDLAR,NVALS,AVINT,
ITITL,(NSTART(I),NSTOP(I)),INPRF(I),I=1,NVALS)
1 FORMAT(I10,F10.1,5I5,F5.2,1X,A4/(6I10))
C
IF(AVINT.LE.0.)AVINT=.05
IEOF=0
IERR=0
CALL READGS(INBUF,IEOF,IERR)
IF(ICASE.GT.1)GO TO 14
ISIG=1
CALL HEDADT (ISIG,INBUF(1),IEQM(1))
ITBAND=IZBAND
NEWA=0
IF(IYR.GT.70)GO TO 282
IF(IYR.LT.70)GO TO 283
IF(IMTH.GT.10)GO TO 282
IF(IMTH.LT.10)GO TO 283
IF(IDAY.LT.15)GO TO 283
282 NEWA=1
283 CONTINUE
14 IERR=0
CALL READGS(INBUF,IEOF,IERR)
IF(ICASE.GT.1)GO TO 12
C
C STORE THE DESIRED CALIBRATION VALUES
C
N=0
DO 20 K=256,383
N=N+1
20 XATBL(N)=XNBUF(K)
C
N=0
DO 22 K=512,527
N=N+1
22 PIFA(N)=XNBUF(K)
N=0
DO 53 K=528,543
N=N+1
53 OIFA(N)=XNBUF(K)
C
PFSB=XNBUF(592)

```

```

PSSA=XNBUF(593)
OFSA=XNBUF(594)
OSSA=XNBUF(595)
C
ABIAS=XNBUF(607)
EBIAS=XNBUF(603)
DEGCON=(180.*.0479369)/3141.59
AZBIAS=DEGCON*ABIAS
ELBIAS=JEGCON*FBIAS
C
N=0
DO 55 K=604,611
N=N+1
55 RBIAS(N)=XNBUF(K)
C
PWRCN=XNBUF(620)
PWRSN=XNBUF(621)
PWRCW=XNBUF(622)
PWRSW=XNBUF(623)
C
N=0
DO 57 K=624,628
N=N+1
57 XKRCS(N)=XNBUF(K)
C
PSSL=XNBUF(629)
USSL=XNBUF(630)
C
12 LGO=0
DO 8 K=1,6
IF((XIVALS(K)-AVINT).LE..005) LGO=K
8 CONTINUE
IF(LGO.NE.0) GO TO 9
WRITE(6,793) AVINT
793 FIDRMT('OILLEGAL AVERAGING INTERVAL',F12.3)
GO TO 127
C
9 GO TO (21,23,25,27,29,51),LGO
C
21 DO 31 N=1,2
DO 31 M=1,8
31 IUSE(M,N)=I01(M,N)
GO TO 42
C
23 DO 33 N=1,2
DO 33 M=1,8
33 IUSE(M,N)=I02(M,N)
GO TO 42
C
25 DO 35 N=1,2
DO 35 M=1,8
35 IUSE(M,N)=I04(M,N)
GO TO 42
C
27 DO 37 N=1,2
DO 37 M=1,8
37 IUSE(M,N)=I05(M,N)

```

```

      GO TO 42
C
29 DO 39 N=1,2
   DO 39 M=1,8
39 IUSE(M,N)=I08(M,N)
   GO TO 42
C
51 DO 41 N=1,2
   DO 41 M=1,8
41 IUSE(M,N)=I10(M,N)
   GO TO 42
C
42 CONTINUE
C
      JCCN=-1
      INDEX=0
      ITST=1
      IPULS=0
C
      DO 120 IJ=1,NVALS
      NBEG=NSTART(IJ)
C
      DO 7 K=1,170
      XLCSUM(K)=0.
7 XRCOSUM(K)=0.
      IPRF=INPRF(IJ)
      INTAV=1
      IF( ABS(XINOFF).GT.1)GO TO 81
      DO 85 N=1,8
      IF(IPRS(N).NE.IPRF)GO TO 85
      INTAV=IUSE(N,1)
85 CONTINUE
81 JX=1
      GO TO 3
      2 CONTINUE
      JX=JX+1
      INTAV=1
      IF( ABS(XINOFF).GT.1)GO TO 3
      DO 83 N=1,8
      IF(IPRS(N).NE.IPRF)GO TO 83
      INTAV=IUSE(N,JX)
      IF(JX.EQ.2)JX=0
83 CONTINUE
C
      3 JCCN=JCON+1
      IF(JCON.EQ.9.OR.JCON.EQ.0)GO TO 97
      INDEX=(JCON-1)*900
      GO TO 99
97 JCCN=1
      INDEX=0
98 IEOF=0
      IERR=0
      CALL READGS(INPUF,IEOF,IERR)
      IF(IEOF.NE.0)GO TO 127
      IF(IERR.EQ.1)GO TO 103
99 CALL UNPACK
      XOFFST=(FLOAT(IOFFST)/2048.)*14.969625

```

```

      JOFFST=XOFFST
      IF(ICODE.EQ.5)XOPAGC=XPPAGC
      IF(ICODE.EQ.7)XOPAGC=XPPAGC
101  IF(IFRST2.EQ.1)GO TO 92
      ZBAN=ZNB
      IF(ITBAND.EQ.1)ZBAN=ZWB
      ZPOL=ZLC
      IF(IPOLAR.EQ.1)ZPOL=ZRC
      IF(NCELL1.LE.0)NCELL1=50
      IF(NCELL2.LE.0)NCELL2=54

C
      PWRUS1=PWRCN
      IF(NBAND.EQ.1)PWRUS1=PWRCH
      PWRUS2=PWRSN
      IF(NBAND.EQ.1)PWRUS2=PWRSH
      CONLC=XKRCS(1)
      CCNRC=XKRCS(2)
      IF(NBAND.NE.1)GO TO 17
      CCNLC=XKRCS(4)
      CCNRC=XKRCS(5)
17  CCNTINUE
      IF(ICODE.EQ.5)CCNRC=CONLC
      IF(ICODE.EQ.7)CCNRC=CONLC
      WRITE(6,200)ZPOL,ZBAN,ITREEL,TITL,(IEQM(I),I=4,6)
200  FORMAT('1L60-ALCOR  POLAR = ',A2,4X,'BAND = ',A2,4X,'REEL NO. = '
1,15,'  TITLE = ',A4,'  DATE = ',I2,'/',I2,'/',I2)
      IF(ICASE.GT.1)GO TO 207
207  WRITE(6,208)NCELL1,CONLC,NBAND
208  FORMAT('OCELL BEGIN(SEARCH)= ',I3,5X
1'KRCS(LC) = ',F10.3,2X,'IBAND = ',I1,5X)
      WRITE(6,210) NCELL2,CCNRC,  IPOLAR,NVALS
210  FORMAT('OCELL END(SEARCH)) = ',I3,5X
1'KRCS(RC) = ',F10.3,2X,'IPOLAR = ',I1,5X,'NVALS = ',I2)
      WRITE(6,212)(NSTART(I),NSTOP(I),INPRF(I),I=1, NVALS)
212  FORMAT('O START  STOP  PRF',12X,'START  STOP  PRF',12X,'START
1STOP  PRF',12X,'START  STOP  PRF'/(4(2X,I5,2X,I5,2X,I3,10X)))
      XLNCH=DFLOAT(ILNCH)/D1000
      WRITE(6,214)XLNCH,AVINT,XINOFF
214  FORMAT('O  LIFT OFF TIME = ',F10.3,'  AVERAGING INTERVAL (SE
1CS) = ',F8.2,'  INPUT RANGE OFFSET (M) = ',F10.1)

C
      RRUSE=-.00943
      IF(ITBAND.EQ.1)RRUSE=-.000115
      IF(NBAND.NE.ITRAND)GO TO 695
      IFRST2=1
      92  CONTINUE

C
620  IF(NUMPRI.LT.NSTART(IJ))GO TO 3
      IF( ABS(XINOFF-XCFFST).GT.1.)GO TO 117
      ITST=1
627  IPULS=IPULS+1
      IF(IPULS.LT.INTAV)GO TO 10
      IPULS=0
      ITST=2

C
10  CONTINUE
      IF(IFRST4.EQ.1)GO TO 610

```

```

IPRCLD=IPRF
IFRST4=1
GO TO 611
610 IF(IPRF.EQ.IPRCLD)GO TO 611
WRITE(6,624)NUMPRI,IPRCLD,IPRF
624 FORMAT(/25X'CURRENT PRI = ',I8,', ' OLD PRF = ',I5,', ' CURRENT PRF =
1 ',I5/)
611 CCNTINUE
IF(ISSERR.NE.1)GO TO 617
WRITE(6,612)ISVPRI
612 FORMAT(' SLOW SWITCH BITS ARE BOTH = 0',5X,', ' CURRENT PRI = ',I10)
617 CONTINUE
ITOT=(3600*IHR*60*IMIN+ISEC)*1000+IMSEC
ITAL=ITOT-ILNCH
TAL=DFLOAT(ITAL)/D1000
TOTL=DFLOAT(ITOT)/D1000
RDOT=(IRDOT/(8192.0))*14.989625
RANGE=(FLOAT(IPRANGE)/2048000.)*14.989625+TRBIAS*.14989625
TTCCR=(RANGF/299776.)*(RDOT/1000.)
RANGE=RANGE+TTCCR
RRCOR=RRUSE*RDOT
RANGE=RANGF+RRCOR/1000.
EL=(IEL*2*3141.59266)/(2.0**17)
XEL=EL*.0572958
XFL=XEL+ELBIAS
CALL REFC(XEL,RANGE,ECORF,RCORF)
RNGF=RANGE-RCORF
ELVF=XEL-ECORF
RADEL=ELVF*.017453
ALT=SQRT(RNGF**2+ER*ER+2.*RNGF*ER*SIN(RADEL))-ER
RANGE=RNGF
XTRR=4C.*ALOG10(RANGE)
XPKPWR=IPKPWR
POWER=PWRUS1+PWRUS2*ALOG10(XPKPWR)
C
IF(IFRST1.EQ.1)GO TO 11
TALBEG=TAL
NPRBEG=NUMPRI
ALTBEG=ALT
IFRST1=1
11 CCNTINUE
C
IAV=IAV+1
IF(IPOLAR.EQ.1)GO TO 73
DO 79 K=NCELL1,NCELL2
N=ILCAMP(K)+1
XLCDB(K)=XATBL(N)+XTRR+XPPAGC+CONLC-POWER
XLCSUM(K)=XLCSUM(K)+10.**(XLCDB(K)/10.)
79 CCNTINUE
GO TO 74
73 DO 76 K=NCELL1,NCELL2
M=IRCAMP(K)+1
XRCDB(K)=XATBL(M)+XTRR+XCPAGC+CONRC-POWER
XRCSUM(K)=XRCSUM(K)+10.**(XRCDB(K)/10.)
76 CCNTINUE
C
74 GO TO (199,19),ITST

```

```

199 IF(NUMPRI.NE.NSTOP(IJ))GO TO 117
C
19 CCNTINUE
XDBPK=-1000.
IF(IPOLAR.EQ.1)GO TO 77
DO 72 K=NCELL1,NCELL2
XLCDB(K)=10.*ALOG10(XLCSUM(K) /FLOAT(IAV ))
IF(XLCDB(K).LT.XDBPK)GO TO 72
XDBPK=XLCDB(K)
IRGPK=K
72 CCNTINUE
GO TO 93
77 DO 78 K=NCELL1,NCELL2
XRCDB(K)=10.*ALOG10(XRCSUM(K) /FLOAT(IAV ))
IF(XRCDB(K).LT.XDBPK)GO TO 78
XDBPK=XRCDB(K)
IRGPK=K
78 CCNTINUE
93 JJ=JJ+1
IRUN=JJ
255 IF(IRUN.GT.1)GO TO 260
NALT=1
TSAV(NALT)=TAL
ALSAV(NALT)=ALT
GO TO 360
260 IALT1=IFIX(ALPREV/10.)
IALT2=IFIX(ALT/10.)
IF(IALT1.EQ.IALT2)GO TO 360
IF(ALT.GT.ALPREV)GO TO 280
ALTEST=IALT1*10
GO TO 300
280 ALTEST=IALT2*10
300 NALT=NALT+1
ALSAV(NALT)=ALTEST
FAC=(ALTEST-ALPREV)/(ALT-ALPREV)
TSAV(NALT)=TPREV+FAC*(TAL-TPREV)
360 ALPREV=ALT
TPREV=TAL
TCOM(JJ)=TALBEG
CSRV(JJ)=XDBPK
71 DO 82 K=1,170
XLCSUM(K)=0.
82 XRCSUM(K)=0.
C
IAV=0
IFRST4=0
IFRST1=0
IF(JJ.GE.6000)GO TO 121
118 IF(NUMPRI.LT.NSTOP(IJ))GO TO 2
117 IF(NUMPRI.LT.NSTOP(IJ))GO TO 3
119 IFRST3=0
IPULS=0
IAV=0
IFRST4=0
IFRST1=0
120 CCNTINUE
121 CCNTINUE

```

```
NALT=NALT+1
TSAV(NALT)=TAL
ALSAV(NALT)=ALT
NEWREQ=0
```

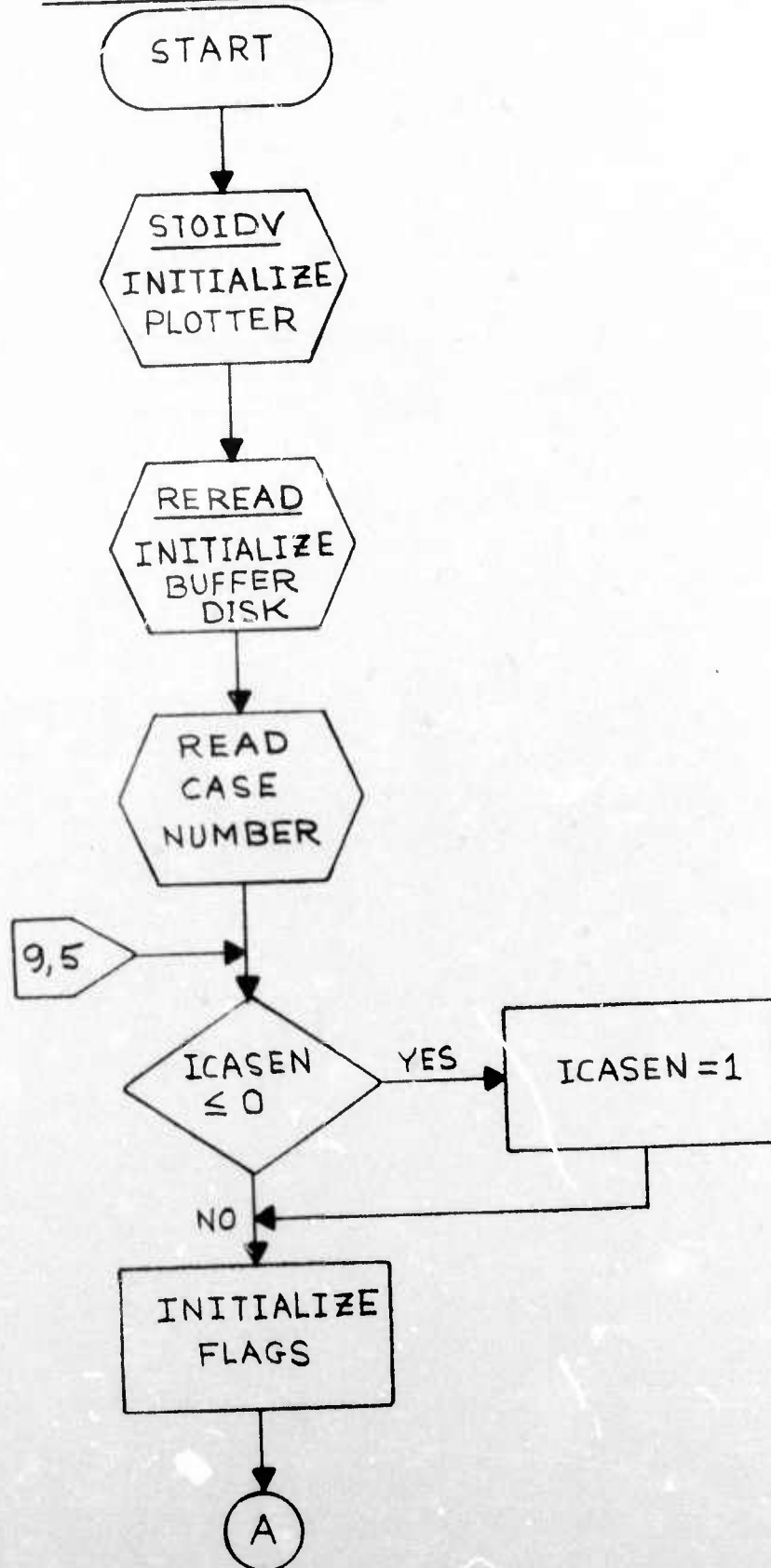
C

```
GO TO 125
103 WRITE(6,107)NUMPRI
107 FORMAT('OPARITY ERROR ON READ AFTER PRI = ',I10)
GO TO 99
680 WRITE(6,109)NUMPRI
109 FORMAT(' END OF FILE REACHED LAST NUMPRI VALUE = ',I10)
GO TO 125
695 WRITE(6,114)IBAND,ITBAND
114 FORMAT(' INPUT BAND= 'I10,' BAND ON TAPE = 'I10)
GO TO 127
125 PLOTID(1)=TITL
PLOTID(2)=BLANK
PLOTID(3)=ZBAN
PLOTID(4)=ZPCL
DO 126 K=5,8
126 PLOTID(K)=BLANK
```

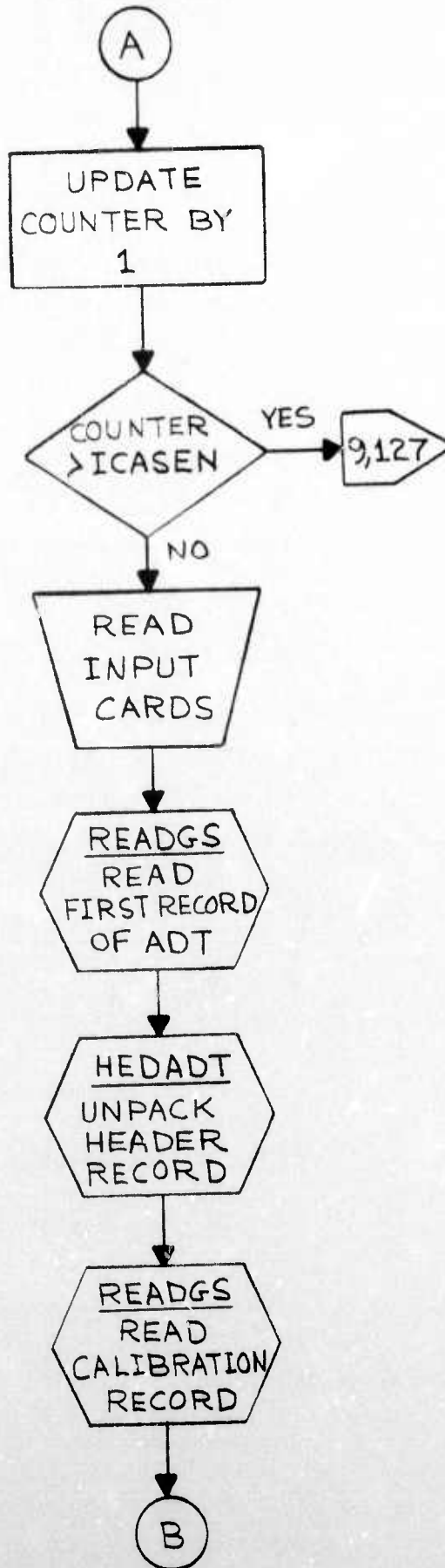
C

```
TMIN=TCOM(1)
TMAX=TCOM(IJ)
WRITE(6,66)IRUN,TMIN,TMAX,ICASE,NCELL1,NCELL2
66 FORMAT('J PLOT',I5,' POINTS FROM ',F15.3,' TO ',F15.3,
110X,'CASE NO',I5,' FROM CELL',I5,' TO CELL',I5)
640 CALL CELPLT(TCOM,CSRV,JJ,PLOTID,NCELL1,NCELL2,ALSAV,NALT,TSAV,
1XINOFF)
IEOF=2
CALL READGS(INPUF,IEOF,IERR)
GO TO 5
127 CALL PLTND
RETURN
END
```

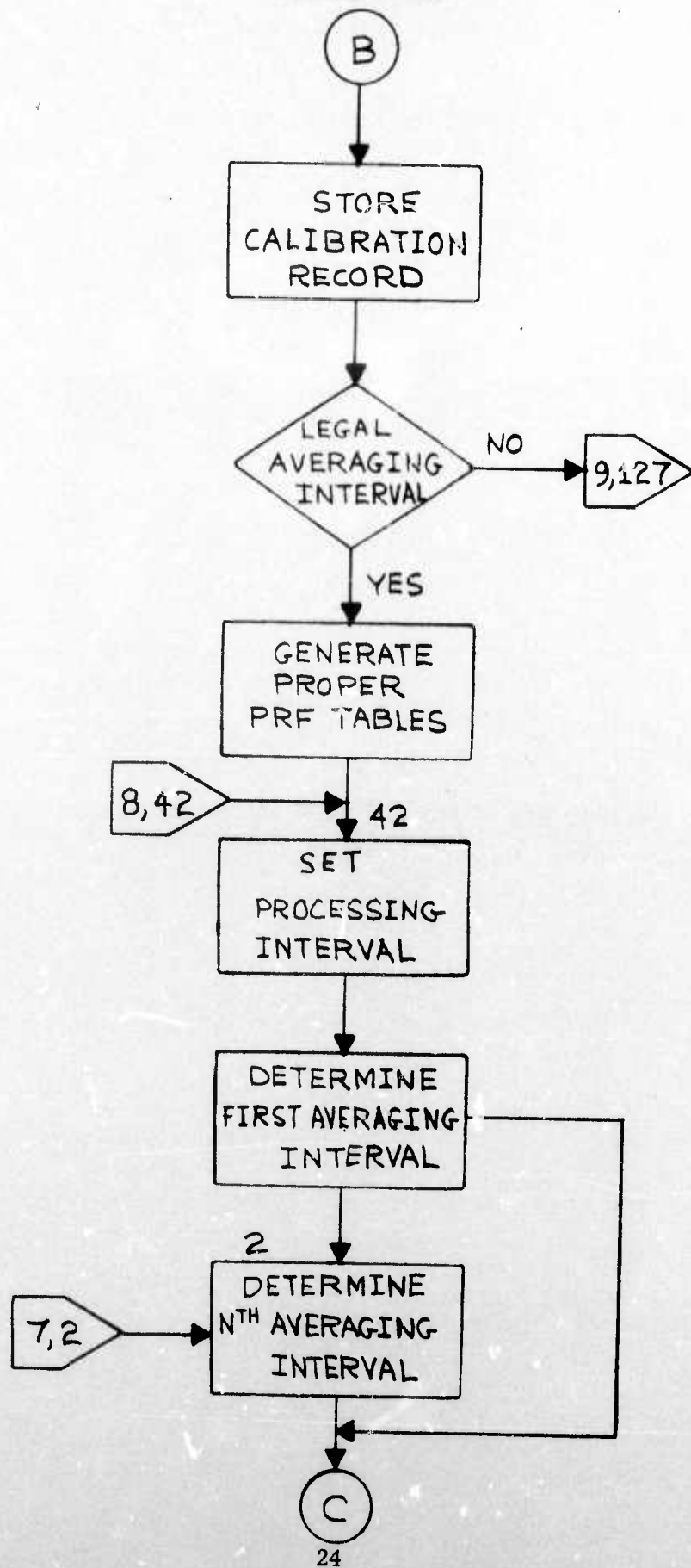
APPENDIX D  
L10ALC FLOW DIAGRAM



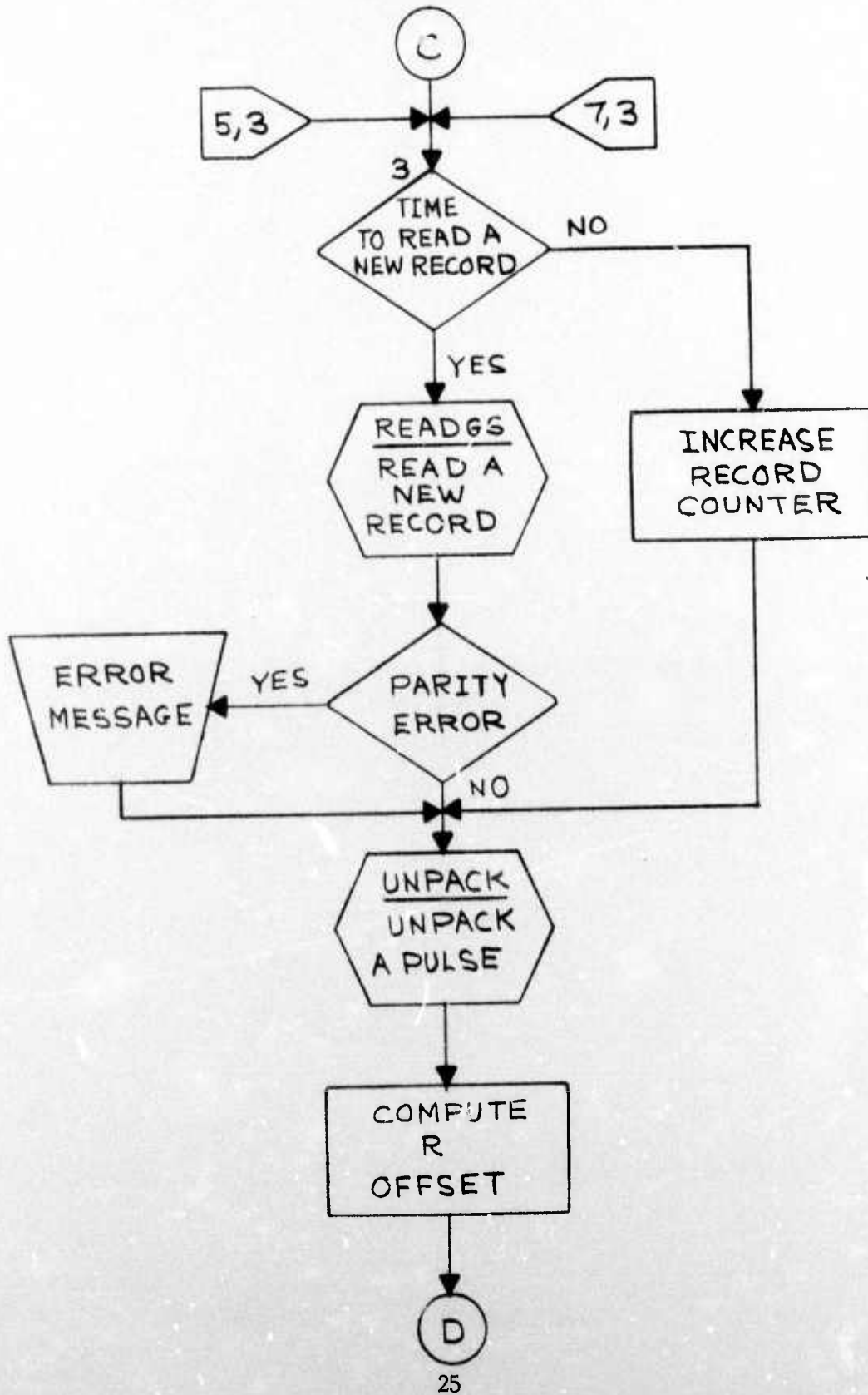
APPENDIX D-2



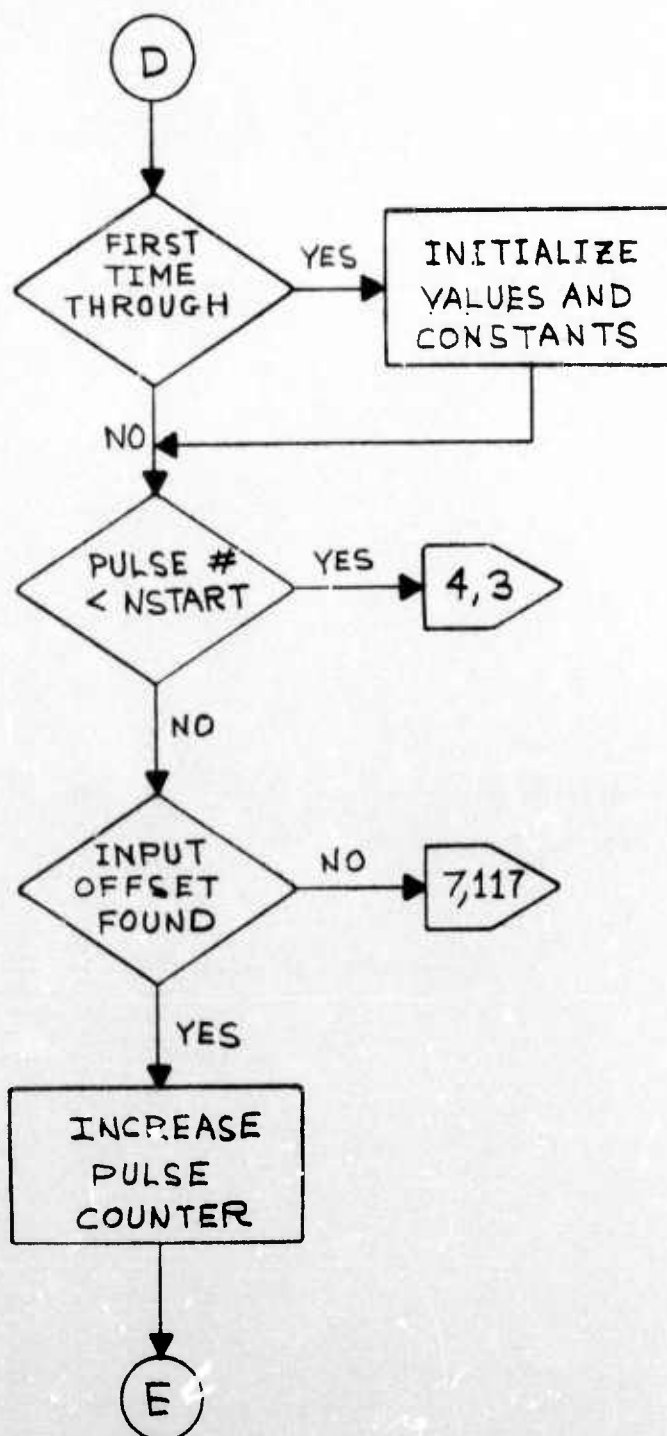
APPENDIX D-3



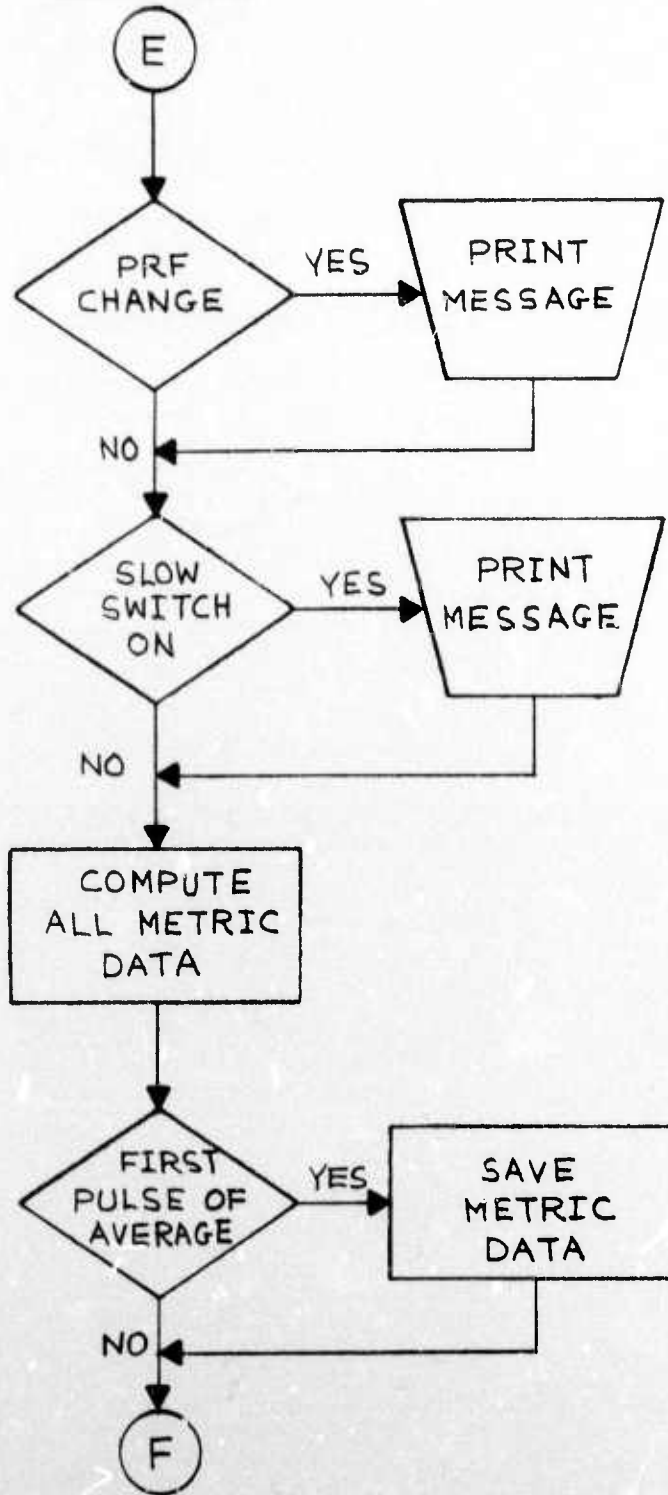
APPENDIX D-4



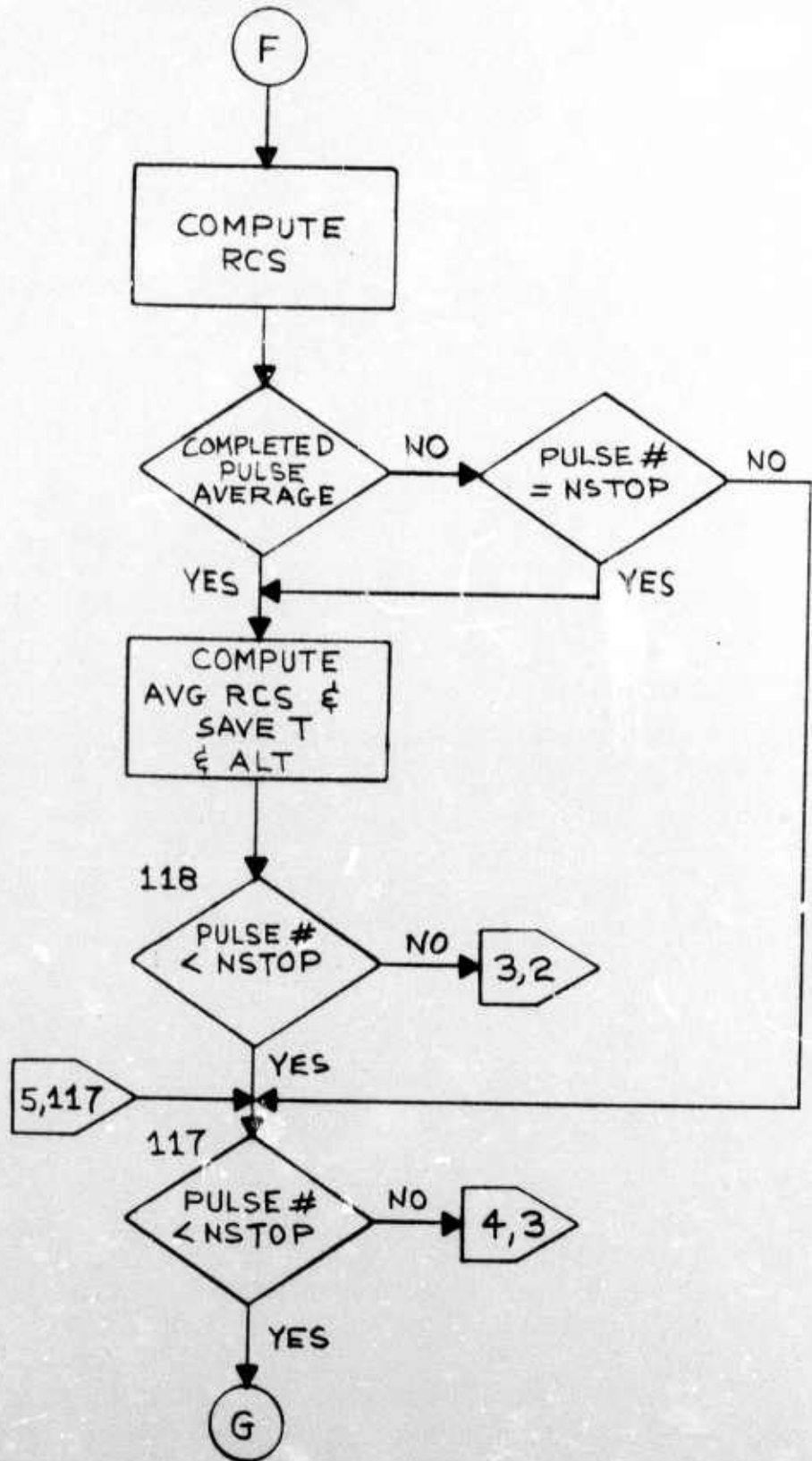
APPENDIX D-5



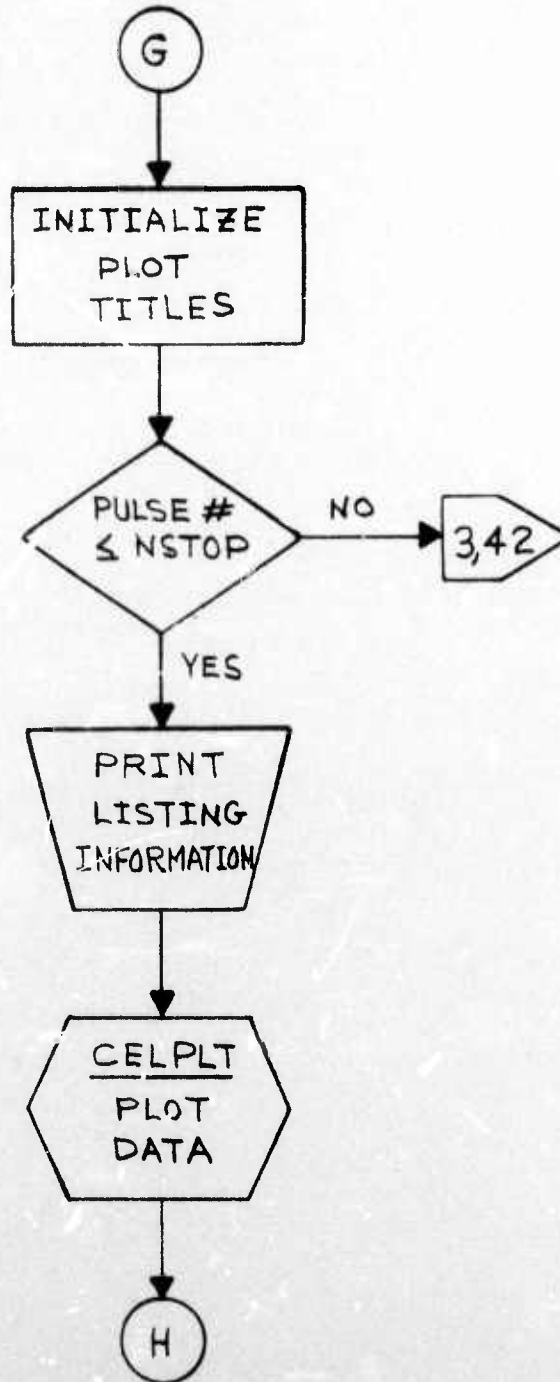
APPENDIX D-6



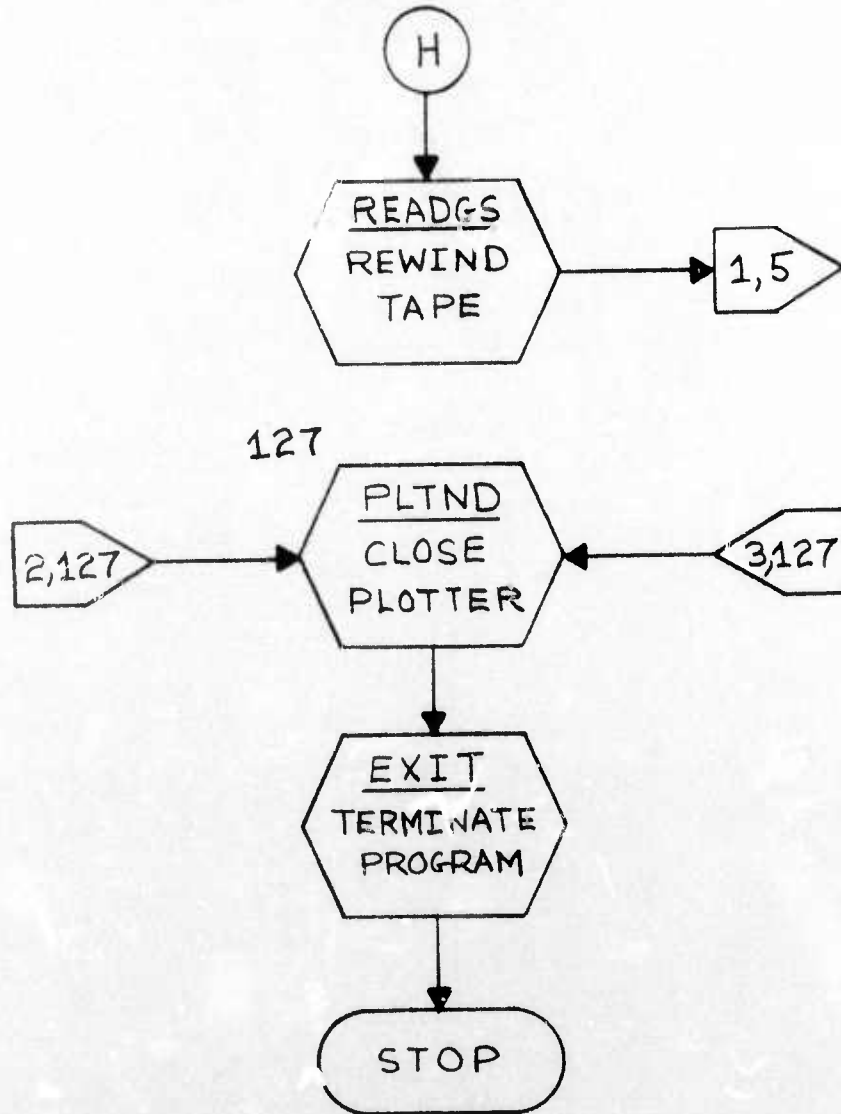
APPENDIX D-7



APPENDIX D-8



APPENDIX D-9



APPENDIX E  
SUBROUTINE HEDADT PROGRAM LISTING

```

*          CALL HEDADT (ISIG, INBUF, IEQU)
*          ISIG = 1      UNPACK THE 20 WORD ADT HEADER

          START
          ENTRY HEDADT
          SPACE
XISIG    EQU    4
XICAL   EQU    5
XIEQU   EQU    6
BASE    EQU    12
          SPACE
HEDADT  SAVE    (14,12),T,*
        BALR   12,0
        USING *,BASE
        ST    13,SAVEA+4
        LA   7,SAVFA
        ST    7,8(0-13)
        LR   13,7
          SPACE
        LM    XISIG,XIEQU,0(1)
          SPACE
        L    8,0(XICAL)
        ST   8,TEMP1
        ST   8,TEMP2
        SRL  8,31
        ST   8,0(XIEQU)      MBAND
        L    8,TEMP1
        SLL  8,1
        SRL  8,25
        ST   8,4(XIEQU)      MREEL
          SPACE
        L    8,4(XICAL)
        ST   8,TEMP1
        ST   8,TEMP2
        SRL  8,16
        ST   8,8(XIEQU)      MWTR
        L    8,TEMP1
        SLL  8,16
        SRL  8,24
        ST   8,12(XIEQU)     MMNTH
        L    8,TEMP2
        SLL  8,24
        SRL  8,24
        ST   8,16(XIEQU)     MDAY
          SPACE
        SR   8,8
        IC   8,8(XICAL)
        ST   8,20(XIEQU)     MYEAR
        MVC  24(9,XIEQU),9(XICAL)  MISSION DES.
          SPACE
RETURN   L    13,SAVEA+4
        RETURN (14,12),T
        CNOP 0,4
TEMP1   DC   F'0'
TEMP2   DC   F'0'
SAVEA   DC   18A(*)
        END

```

APPENDIX F  
SUBROUTINE READGS PROGRAM LISTING

```

-          CALL READGS(INBUF,IEOF,IERR)
          START
          ENTRY READGS
          SPACE
XZBUF    EQU    4
XEOF     EQU    5
XERR     EQU    6
BASE     EQU    12
          SPACE
READGS   SAVE   (14,12),T,*
          BALR  12,0
          USING *,BASE
          ST   13,SAVEA+4
          LA   7,SAVEA
          ST   7,8(0,13)
          LR   13,7
          SPACE
          LM   XZBUF,XERR,0(1)
          L    7,0(XFOF)
          C    7,TWO
          BE   S99
          SPACE
          L    7,IFRST1
          C    7,TWO
          BE   INIT2
          C    7,ZERO
          BNE  WHICHF
          SPACE
INIT2    OPEN   (INDCR,(INPUT))
          READ  RDB3,SF,INDCB,BUFF1,7212
          CHECK RDB3
          MVC  BUFNUM(4),ZERO
          MVC  IFRST1(4),CNE
          B    SK1
          SPACE
WHICHF   L      3,BUFNUM
          S      3,ONE
          BM    NEXTBUF2
          B     NEXTBUF1
          SPACE
NEXTBUF1 MVC   BUFNUM(4),ZERO
          CHECK RDB1
SK1      READ  RDB2,SF,INDCB,BUFF2,7212
          L      9,ABUFF1

```

```

      B      LOOPQ
      SPACE
NEXTBUF2 MVC  BUFNUM(4),ONE
      CHECK RDB2
      READ  RDB1,SF,INDCB,BUFF1,7212
      L      9,ABUFF2
      SPACE
LCCPG   LR    10,XZPUF
      SR    11,11
      SR    3,3
      LA    8,1803
LCCPZ   L      7,0(3,9)
      ST    7,0(11,10)
      BCT   8,INDUP
      B      CUTLP
INDUP   LA    3,4(3)
      LA    11,4(11)
      B      LCOPZ
CUTLP   B      RETURN
      SPACE
BADRD   L      2,ONE
      ST    2,0(XFRR)
      BR    14
      SPACE
ENDFILE L      2,ONE          STORE END OF FILE INDICATOR
      ST    2,0(XFCF)
S99     CLOSE (INDCB,REREAD),TYPE=T
      MVC   IFRST1(4),TWO
RETURN  L      13,SAVEA+4
      RETURN (14,12),T
      SPACE
INDCB   CNOP   0,8
      DCB   DSORG=PS,MACRF=(RC),DEV=TA,DEN=2,BUFNO=1,ECDAD=ENDFILE,C
          SYNAD=BADRD,BFTEK=S,DDNAME=FT11FC01
      SPACE
      CNOP
ZERO    DC     F'0'
CNE     DC     F'1'
TWC     DC     F'2'
IFRST1  DC     F'0'
BUFNUM  DC     F'0'
      SPACE
ABUFF1  DC     A(BUFF1)
ABUFF2  DC     A(BUFF2)
SAVEA   DC     18A(*)
      SPACE
BUFF1   DS     1803F
BUFF2   DS     1803F
      END

```

APPENDIX G  
SUBROUTINE REFC PROGRAM LISTING

```

SUBROUTINE REFC(E,R,OEE,ORR)                                VERSION 6/16/70
DIMENSION OE(16,8),DR(16,8),EO(16),RD(8)
DATA OE/0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,
10.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0313,
20.0303,0.0292,0.0287,0.0282,0.0272,0.0262,0.0253,0.0243,0.0223,
30.0214,0.0195,0.0171,0.0135,0.0075,0.0,0.0937,0.0848,0.0770,
40.0732,0.0694,0.0627,0.0571,0.0522,0.0480,0.0412,0.0385,0.0337,
50.0278,0.0205,0.0105,0.0,0.1850,0.1520,0.1250,0.1140,0.1050,
60.0904,0.0795,0.0708,0.0636,0.0523,0.0478,0.0405,0.0323,0.0229,
70.0114,0.0,0.5310,0.3070,0.2120,0.1830,0.1600,0.1280,0.1060,
80.0899,0.0780,0.0612,0.0550,0.0455,0.0354,0.0246,0.0120,0.0,
90.7550,0.3720,0.2400,0.2020,0.1750,0.1370,0.1120,0.0942,0.0811,
A0.0631,0.0566,0.0466,0.0361,0.0250,0.0122,0.0,0.9120,0.4110,
B0.2560,0.2140,0.1840,0.1420,0.1150,0.0967,0.0830,0.0643,0.0575,
C0.0472,0.0365,0.0252,0.0122,0.0,0.9700,0.4200,0.2600,0.2200,
D0.1900,0.1460,0.1170,0.0980,0.0840,0.0653,0.0584,0.0478,0.0369,
EO.0254,0.0123,0.0 /
DATA OR/0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,
1 0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,
2 19.4,18.5,17.6,16.8,16.1,14.8,14.2,13.2,12.0,10.4,8.6,
3 7.7,67.3,57.9,50.2,47.0,44.1,35.3,35.4,32.1,29.3,24.8,
4 22.9,19.7,16.3,12.7,9.4,8.1,132.0,98.5,77.4,69.7,63.2,
5 52.9,44.7,38.4,33.4,26.4,23.9,20.1,16.4,12.7,9.4,8.1,
6 340.0,167.0,103.0,86.1,73.4,56.7,46.2,38.9,33.6,26.4,24.0,
7 20.2,16.4,12.8,9.5,8.2,405.0,170.0,104.0,86.3,73.6,56.8,
8 46.3,38.9,37.7,26.5,24.1,20.3,16.5,12.8,9.5,8.2,421.0,
9 171.0,104.0,86.6,73.9,57.1,46.4,35.0,33.8,26.8,24.3,20.5,
A 16.6,13.0,9.8,8.4,446.0,172.0,105.0,87.4,74.0,58.0,46.6,
B 39.2,34.0,27.0,24.6,20.7,16.7,13.0,10.0,8.4/
DATA ED,RTDEG/0.01,2.0,4.0,5.0,6.0,8.0,10.0,12.0,14.0,18.,20.,
124.,30.,40.,60.,90.,57.29578/
DATA RD/0.01,10.,30.,60.,200.,400.,1000.,2000./
IF(R.LE.0.0)GO TO 300
RG=R/1.8520+00
OO :OO IEO=2,15
(=17-IEO
IF(E.GE.EO(I))GO TO 120
100 CCNTINUE
I=1
120 OO 200 JRO=2,8
J=10-JRO
IF(RG.GE.RD(J))GO TO 220
200 CCNTINUE
J=1
220 IF(J.EQ.8)GO TO 340
ZR=ALOG(RG/RD(J))/ALOG(RD(J+1)/RD(J))
IF(E.LE.0.0)GO TO 320
ZE=ALOG(E/EO(I))/ALOG(EO(I+1)/EO(I))
OE1=(DR(I+1,J)-DE(I,J))*(1.-ZR)+(DE(I,J+1)-OE(I,J))*ZR*ZE
OE2=(DE(I,J+1)-DE(I,J))*(1.-ZE)+(DE(I+1,J+1)-OE(I,J+1))*ZE*ZR
OEE=OE1+DE2+DE(I,J)
OR1=(DR(I+1,J)-OR(I,J))*(1.-ZR)+(OR(I,J+1)-OR(I,J))*ZR*ZE
OR2=(DR(I,J+1)-DR(I,J))*(1.-ZE)+(DR(I+1,J+1)-DR(I,J+1))*ZE*ZR
ORR=(OR1+OR2+OR(I,J))
GO TO 400
300 OEE=0.0
ORR=0.0
GO TO 400
320 OEE=OE(I,J)+(OE(I,J+1)-DE(I,J))*ZR
ORR=OR(I,J)+(DR(I,J+1)-DR(I,J))*ZR
GO TO 400
340 OELT=(E-EO(I))/(EO(I+1)-EO(I))
DEE=OELT*(DE(I+1,J)-DE(I,J))+OE(I,J)
ORR=OELT*(DR(I+1,J)-OR(I,J))+OR(I,J)
400 ORR=ORR*.30480-C3
RETURN
ENO

```