AFCRL-71-0115

ANALYSIS OF STRATOSPHERIC BALLOON PROGRAMS

M. PATRICIA HAGAN

THE TRUSTEES OF EMMANUEL COLLEGE
400 THE FENWAY
BOSTON, MASSACHUSETTS 02115

Contract No. F19628-68-C-0065
Project No. 6665
Task No. 666506
Unit No. 66650601

FINAL REPORT

Period Covered: 1 January 1968 through 31 December 1970

Date of Report
31 March 1971

Contract Monitor: George F. Nolan
Aerospace Instrumentation Laboratory

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Prepared
for

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS 01730

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ABSTRACT

The work under this contract has been computational and analytical services in support of operations analysis, applications research and post flight analysis of stratospheric scientific balloon programs conducted by the Air Force Cambridge Research Laboratories (AFCRL). Geophysical and flight data, furnished by the Government, were utilized for transcription, analysis, graphing, and mathematical computations. The work performed includes hand and machine plotting and the writing of several computer programs.

1. COMPUTER PROGRAMS AND COMPUTER RUNS

1.1 A printout of VHF Omnidirectional Range (VOR) data for approximately 60 stations using a program previously written at Emmanuel College was made. The program uses geographic and magnetic positions of receiving stations to calculate latitude and longitude crossings of any VOR signal received from a balloon. This work was accomplished in support of an in-house research effort to develop balloon locating systems that make use of existing navigational aids. The VOR network was utilized to provide position data.

1.2 Programs were written to reproduce and analyze a computer tape of Weather Bureau Aerological Network (WBAN) data for Kwajalein. Wind data for selected criteria were printed out using the computer program. These data provided meteorological input to feasibility studies for a Simulated Large Explosive Detonable Gas Experiment (SLEDGE) conducted for the Defense Atomic Support Agency (DASA) by AFCRL.

1.3 Several analyses were made using Rawinsonde tapes supplied by AFCRL. The tapes required much editing before analysis could be performed. Some of the analyzed data were plotted by an electronic plotter. This work provided a statistically valid wind data base to be used in balloon trajectory analyses for balloon programs conducted at the White Sands Missile Range. Feasibility studies and operational planning data were provided for Project 698AJ recovery tests, "Study of Atmospheric Aerosols" also under Project 698AJ, and the National Aeronautics and Space Administration (NASA) Cosmic Ray Ionization Spectrograph Program (CRISP).

1.4 Full printouts were made of data for balloon flights from the AFCRL launch sites at Chico, California and Holloman AFB, New Mexico after compilation and analysis. (See Section 4). This effort used a program previously written by Emmanuel College. Partial printouts of selected criteria were made for balloon reliability studies.

2. KEYPUNCHING

Various keypunching done included FORTRAN programs, meteorological information for Standard Atmospheric Tables, and balloon flight data.

3. ANALYSES AND PLOTTING

3.1 Wind data were extracted from microfilm and analyzed for an Advanced Research Projects Agency (ARPA) study.

3.2 Winter stratospheric winds at Chico and Holloman (7 years of data) were analyzed and plotted for use in flight operational planning.

3.3 Surface wind durations for world-wide geographic locations were analyzed.

3.4 Time-altitude, azimuth angle and elevation angle data were reduced and analyzed and trajectory plots made for in-house research studies on balloon station keeping concepts.

3.5 Wallops Island, Virginia, launch projections and trajectory dispersion patterns were computed in support of balloon operations conducted by AFCRL for the NASA and for VOR test flight planning.

3.6 Stratospheric wind statistics were computed for White Sands, Cape Kennedy and Point Mugu as input for general trajectory studies for Air Force high altitude balloon programs.

3.7 Vector analysis of 15-minute wind data for two balloon flights using azimuth angle and HDO were made for research studies of minimum wind field fine structure in the lower stratosphere.

3.8 Tracking analysis of two balloon flights consisted of checking and correcting, if necessary, VOR readings for station and position; determining approximate location of the balloon using triangulation; plotting position using VOR information; and comparing results with Federal Communications Commission (FCC) data. Radar data were also plotted. These data provided information on the accuracy of the VOR balloon navigational system.

3.9 Miscellaneous data for the Balloon Field Test Director Handbook were collected and prepared for compilation to assist the Field Test Director in carrying out balloon operations.

3.10 Balloon Behavior Study (See Section 6).

3.11 Wind Characteristics Study (See Section 5).

3.12 M-hour maximum computations were made from White Sands wind data for use in tethered balloon studies and operational planning.

3.13 Balloon gore length and crease distance for various types of balloons were computed for use in balloon design research.

3.14 Wind data at 10,000 feet for many parts of the world were used to plot m-hour maximum curves. These curves became part of a tethered balloon study for the Mid-Course Surveillance System (MSS) program.

4. INVENTORY LISTING OF FLIGHT DATA FOR POST FLIGHT ANALYSIS

4.1 Information was extracted from post flight summary forms.

4.2 Information was checked for consistency and accuracy with data in flight folders.

4.3 Data were punched on IBM cards for further processing using a program written at Emmanuel College.

4.4 Multiple copies of the full printout were made for balloon flights conducted at Holloman (1962-68) and Chico (1964-68).

4.5 Selected printouts were generated to analyze balloon performance.

5. WIND CHARACTERISTICS STUDY

5.1 Wind velocities were extracted from rocketsonde data (1959-67) for eight stations at three heights for all months. Data were interpolated and units converted. These data were used in long duration balloon trajectory studies at 110,000 ft, 120,000 ft, and 130,000 ft.

5.2 Statistical analysis of wind data for selected months were made for research studies of trajectory dispersion models.

5.3 Plotting of winds for several altitudes and locations at various times of the year was done on weather maps to determine optimum balloon flight scheduling.

5.4 Coefficients of variation for speed and direction were calculated for input into trajectory studies.

6. BALLOON BEHAVIOR STUDY - RESEARCH CONCERNING THE VERTICAL MOTION OF BALLOONS

6.1 Baracoder sheets were corrected and time-altitude data generated for 39 flights.

6.2 Standard Atmospheric Pressures for various altitudes were calculated from tables.

6.3 Temperatures were taken from WBAN charts.

6.4 Pressure vs temperature charts were plotted and corresponding temperatures from pre-flight radiosonde runs were determined.

6.5 All data were keypunched for analysis.

6.6 Three-point means for elapsed time, altitude, and temperature were calculated and plotted for smoothing purposes.

7. BALLOON FLIGHT SIMULATION PROGRAMS

General: There are four programs named respectively SIMBALL, BALLFLT, PARAFLIT, and MAGMED. All programs operate on input wind data tape (blocked CC-808 described below with blocked backup tape) to be mounted on tape 3.

Input parameters for all four programs are the same except as noted below under individual program description.

TOPALT, ISD, IED--(F10.0,2I4)

TOPALT--maximum altitude for simulation (feet); if negative indicates flight parameters are changing (see below).

ISD, IED--start date and end date for simulation (inclusive); first two digits are month, last two are day.

If TOPALT is negative, the following are expected:

New flight parameters (NAMELIST /ALTY/TIME,STOP).

New TITLE (13A6) for printed or graphic output.

Flight parameters:

TIME--Ascent rate (feet per minute) between (N-2) thousand feet and N-thousand feet goes into TIME(N/2000-1). Ascent rate is converted into time in minutes; alternatively, ascent rates less than 50 fpm are assumed to be time in minutes.

STOP--Float time (minutes) at N-thousand feet goes into STOP(N/2000-1).

Programs compute statistics and/or solve problems associated with balloon flights. Below are listed two of these with abbreviated description and idiosyncracies if any:

7.1 SIMBALL--Basic balloon flight simulator described above. Prepares CRT output with individual flights, statistical summaries, 50% and 90% probability ellipses.

Idiosyncracy: Calls PLOTID, use CRTPLT if needed.

7.2 MAGMED--Program to compute when balloon crosses point 86.4NM west of launch site.

Idiosyncracies: None.

Following are listings of these two aforementioned programs.

```
$ID    # 5079    CANTOR        SIMBALL              K-1
$SETUP 3         CC-808,NORING
$IBJOB
$IBFTC MAIN
        VR(A,B,C)=(A-B*C/FN)/(FN-1.0)
        VAR(A,B)=VR(A,B,B)
        DIMENSION CARD(80)
        DIMENSION EZ(2,217)
        DIMENSION TIME(99),STOP(99),ALT(99),VX(99),VY(99)
        NAMELIST /ALTY/TIME,STOP
        DIMENSION  TITLE(13),TTL(2)
        COMMON TITLE,TTL
        COMMON EX,EY,SUMX,SUMY,R,P,I,XA,X[illegible],ISD,IED,VARX,VARY,NFLITE,FN
        DIMENSION TTT(2,361)
        EQUIVALENCE(TTT(1,362),EZ)
        DATA TIME,STOP/1.0,2.0,3.0,4.0,95*1.0,99*0.0/
        RAD=57.2957795
        IDATE=1300
        CALL PLOTID(1.0)
        CALL REREAD
        TEST1=1.0E7-1.0
  1     READ(5,100)TOPALT,ISD,IED,IREW
        READ (99,1515)CARD
        WRITE(6,1516)CARD
 1515   FORMAT(  80A1)
 1516   FORMAT(1X,80A1)
        WRITE(99,114)ISD,IED
  114   FORMAT(I4,4H TO  I4)
        READ(99,115)TTL
  100   FORMAT(F10.0,2I4,I1)
        IF(ISD.LT.IDATE)REWIND 3
        IF(TOPALT.GT.0.0)GO TO 88
        IF(TOPALT.EQ.0.0)CALL ENDPLT
        READ(5,ALTY)
        READ(5,115)TITLE
  115   FORMAT(13A6)
        DO 928 I=1,99
        IF(TIME(I).GT.50.0)TIME(I)=2000.0/TIME(I)
  928   CONTINUE
        TOPALT=-TOPALT
        DO 929 I=1,99
        J=2000*(I+1)
  929   WRITE(6,930)J,TIME(I),STOP(I)
  930   FORMAT(I10,F10.3,F10.0)
        REWIND 3
  88    NFLITE=0
        SUMX=0.0
        SUMY=0.0
        SUMXX=0.0
        SUMYY=0.0
        SUMXY=0.0
        IF(IDATE.EQ.ISD)GO TO 3
  2     READ(3)SITE,IYR,IDATE,IHR,NALT,(ALT(I),VX(I),VY(I),I=1,NALT)
        IF(SITE.NE.TEST1)GO TO 996
        IDATE=1300
        GO TO 995
  996   IF(IDATE.LT.ISD)GO TO 2
        IF(IDATE.LE.IED)GO TO 3
  995   IF(NFLITE.GT.1)GO TO 4
        WRITE(6,101)ISD,IED
  101   FORMAT(21HONO FLIGHT BETWEEN   I6,5H AND  I6)
```

```
      GO TO 1
  3   IF(ALT(NALT).LT.TOPALT)GO TO 2
C     WRITE(6,102)IDATE,IYR,(ALT(I),VX(I),VY(I),I=1,NALT)
 102  FORMAT(1H12I6/(6F20.6))
      NFLITE=NFLITE+1
      NMAX=TOPALT
      IVEC=1
      T=0.0
      S=0.0
      I=6000
 666  J=I/2000-1
      IVEC=INTERP(NALT,ALT,I-1000,IVEC)
      FF=I-1000
      T=T+FVECT(TIME,ALT,VX,IVEC,FF,J)
      S=S+FVECT(TIME,ALT,VY,IVEC,FF,J)
 10   FF=I
      IVEC=INTERP(NALT,ALT,I,IVEC)
      S=S+FVECT(STOP,ALT,VY,IVEC,FF,J)
      T=T+FVECT(STOP,ALT,VX,IVEC,FF,J)
      I=I+2000
      IF(I.LE.NMAX)GO TO 666
      T=T/60.0
      S=S/60.0
      EZ(1,NFLITE)=T
      EZ(2,NFLITE)=S
      SUMX=SUMX+T
      SUMY=SUMY+S
      SUMXX=SUMXX+T*T
      SUMYY=SUMYY+S*S
      SUMXY=SUMXY+T*S
      GO TO 2
 4    CONTINUE
      FN=NFLITE
      VARX=VAR(SUMXX,SUMX)
      VARY=VAR(SUMYY,SUMY)
      R=VR(SUMXY,SUMX,SUMY)
      PSI=0.5*ATAN2(R+R,VARX-VARY)*RAD
      XA=SQRT((VARX+VARY)**2-4.0*(VARX*VARY-R*R))
      XB=0.5*(VARX+VARY-XA)
      XA=0.5*(VARX+VARY+XA)
      XA=SQRT(XA)
      XB=SQRT(XB)
      R=R/SQRT(VARX*VARY)
      SUMX=SUMX/FN
      SUMY=SUMY/FN
      EZ(1,NFLITE+1)=0.0
      EZ(2,NFLITE+1)=0.0
      EZ(1,NFLITE+2)=SUMX
      EZ(2,NFLITE+2)=SUMY
      CALL PLOTR(EZ,TTT)
      GO TO  1
      END
$IBFTC PPP
      SUBROUTINE PLOTR (EZ,T)
      DIMENSION EZ(2,217),T(2,361)
      DIMENSION  TITLE(13),TTL(2)
      COMMON TITLE,TTL
      COMMON EX,EY,SUMX,SUMY,R,PSI,XA,XB,ISD,IED,VARX,VARY,NFLITE,FN
      DIMENSION GARB(6)
      DIMENSION EL(2,361)
      DATA BL/1H /
```

```
      CALL ELLIPS(EL,XA,XB)
      CALL ROT(PSI,SUMX,SUMY,EL,T,2,12)
      WRITE(6,115)T
      WRITE(6,115)EZ
      WRITE(6,117)SUMX,SUMY,R,PSI,XA,XB
  117 FORMAT(//(1P12E10.2))
  115 FORMAT(//(12F10.3))
      N=2*(NFLITE+362)
      III=1
      CALL SCALE(T,8.0,N,1,20.0,XMIN,DX)
      WRITE(6,116)NFLITE,XMIN,DX
  116 FORMAT(1H0,I5,2F20.6)
      WRITE(6,116)III
      DO 1  I=1,13
      IF(TITLE(I).NE.BL)N=6*I
    1 CONTINUE
      N=-N
      CALL FRAME(0.5,2.25)
      CALL AXIS(0.0,TITLE,N,6.0,0.0,XMIN,DX,20.0)
      III=III+1
      WRITE(6,116)III
      CALL AXIS(0.0,TTL,12,8.0,90.0,XMIN,DX,20.0)
      III=III+1
      WRITE(6,116)III
      CALL LINE(EZ,EZ(2,1),NFLITE,2,-1,4,XMIN,DX,XMIN,DX)
      III=III+1
      WRITE(6,116)III
      CALL LINE(EZ(1,NFLITE+1),EZ(2,NFLITE+1),2,2,0,0,XMIN,DX,XMIN,DX)
      III=III+1
      WRITE(6,116)III
      CALL LINE(T         ,T(2,1),361,2,0,0,XMIN,DX,XMIN,DX)
      III=III+1
      WRITE(6,116)III
      CALL LINE(T,T(2,1)          ,2,360,0,0,XMIN,DX,XMIN,DX)
      III=III+1
      WRITE(6,116)III
      CALL LINE(T(1,91),T(2,91),2,360,0,0,XMIN,DX,XMIN,DX)
      III=III+1
      WRITE(6,116)III
      CALL ROT(PSI,SUMX,SUMY,EL,T,1,18)
      III=III+1
      WRITE(6,116)III
      CALL LINE(T         ,T(2,1),361,2,0,0,XMIN,DX,XMIN,DX)
      III=III+1
      WRITE(6,116)III
      VARX=SQRT(VARX)
      VARY=SQRT(VARY)
      X=-XMIN/DX
      CALL PLOT(X,0,3)
      III=III+1
      WRITE(6,116)III
      CALL PLOT(X,8.0,2)
      III=III+1
      WRITE(6,116)III
      CALL PLOT(0,X,3)
      III=III+1
      WRITE(6,116)III
      CALL PLOT(8.0,X,2)
      III=III+1
      WRITE(6,116)III
      WRITE(99,127)
```

```
 127    FORMAT(80X)
        WRITE(99,101)SUMX,SUMY
        READ(99,102)GARB
 101    FORMAT(6HXBAR =  F7.2,2X,6HYBAR =  F7.2)
 102    FORMAT(6A6)
        CALL PLOT(0,-1.0,-3)
        III=III+1
        WRITE(6,116)III
        CALL SYMBOL(0.0,0.125,GARB,0,34)
        WRITE(99,103)VARX,VARY
 103    FORMAT(9HSIGMA-X =  F7.2,2X,9HSIGMA-Y =  F7.2)
        CALL PLOT(0,-0.25,-3)
        III=III+1
        WRITE(6,116)III
        READ(99,102)GARB
        CALL SYMBOL(0.0,0.125,GARB,0,34)
        WRITE(99,104)XA,XB
 104    FORMAT(9HSIGMA-A =   F7.2,2X,9HSIGMA-B =   F7.2)
        CALL PLOT(0,-0.25,-3)
        III=III+1
        WRITE(6,116)III
        READ(99,102)GARB
        CALL SYMBOL(0.0,0.125,GARB,0,34)
        CALL PLOT(0,-0.25,-3)
        III=III+1
        WRITE(6,116)III
        WRITE(99,105)R,PSI,NFLITE
 105    FORMAT(3HR = F7.4,2X,5HPSI =  F5.1,2X,3HN =  I4,6H          )
        READ(99,102)GARB
        CALL SYMBOL(0.0,0.125,GARB,0,34)
        RETURN
        END
$IBFTC ELL
        SUBROUTINE ELLIPS(E,A,B)
        DIMENSION E(2,361)
        RAD=3.14159265358 9/180.0
        DO 1  I=1,361
        X=FLOAT(I-1)*RAD
        E(1,I)=A*COS(X)
 1      E(2,I)=B*SIN(X)
        RETURN
        END
$IBFTC RT
        SUBROUTINE ROT(THET,XO,YO,EL,T,S)
        DIMENSION EL(2,361),T(2,361)
        DIMENSION XMAT(2,2),X(2)
        RAD=3.14159265358 9/180.0
        TT=THET*RAD
        TT=-TT
        XMAT(1,1)=COS(TT)
        XMAT(1,2)=SIN(TT)
        XMAT(2,1)=-XMAT(1,2)
        XMAT(2,2)=XMAT(1,1)
        X(1)=XO
        X(2)=YO
        DO 1  J=1,361
        DO 1  I=1,2
        T(I,J)=X(I)
        DO 2  K=1,2
 2      T(I,J)=T(I,J)+S*XMAT(I,K)*EL(K,J)
 1      CONTINUE
```

```
       RETURN
       END
$IBFTC FV
       FUNCTION FVECT(T,A,X,I,P,K)
       DIMENSION T(9),A(9),X(9)
       TEMP=(X(I+1)-X(I))/(A(I+1)-A(I))*(P-A(I))+X(I)
       FVECT=TEMP*T(K)
       RETURN
       END
$IBFTC INTRP
       FUNCTION INTERP(N,A,I,J)
       DIMENSION A(99)
       IF(J.GT.N)J=N
       IF(J.LT.1)J=1
 2     K=A(J)
       IF(K.EQ.I)GO TO 1
       IF(K.GT.I)GO TO 3
       KK=A(J+1)
       IF(KK.GE.I)GO TO 1
       J=J+1
       GO TO 2
 3     IF(J.EQ.1)GO TO 1
       J=J-1
       GO TO 2
 1     INTERP=J
       RETURN
       END
$DATA
 10000.0   07010715
 $ALTY  TIME=99*800.0,  STOP=99* 0.0  $
  TO 10 K FT AT 800 FPM.  SCALES ARE NM
 10000.0   07160731
 10000.0   08010815
 10000.0   08160831
```

```
$ID    * 5079    CANTOR        MAGMED              K-1
$SETUP 3         CC-808,NORING
$IBJOB
$IBFTC MAIN
        VR(A,B,C)=(A-B*C/FN)/(FN-1.0)
        VAR(A,B)=VR(A,B,B)
        DIMENSION CARD(80)
        DIMENSION EZ(2,217)
        DIMENSION TIME(99),STOP(99),ALT(99),VX(99),VY(99)
        NAMELIST /ALTY/TIME,STOP
        DIMENSION  TITLE(13),TTL(2)
        COMMON TITLE,TTL
        COMMON EX,EY,SUMX,SUMY,R,PSI,XA,XB,ISD,IED,VARX,VARY,NFLITE,FN
        DIMENSION TTT(2,361)
        EQUIVALENCE(TTT(1,362),EZ)
        DATA TIME,STOP/1.0,2.0,3.0,4.0,95*0.0,99*0.0/
        RAD=57.2957795
        DATA IXX,IBL,XMAX/1HX,1H ,-5184.0/
        IDATE=1300
        CALL REREAD
        TEST1=1.0E7-1.0
 1      READ(5,100)TOPALT,ISD,IED,IREW
 100    FORMAT(F10.0,2I4,I1)
        IF(ISD.LT.IDATE)REWIND 3
        IF(TOPALT.GT.0.0)GO TO 88
        READ(5,ALTY)
        READ(5,115)TITLE
 115    FORMAT(13A6)
        WRITE(6,1515)
        TMM=0.0
        DO 928 I=1,99
        IF(TIME(I).GT.50.0)TIME(I)=2000.0/TIME(I)
        TMM=TMM+TIME(I)
 928    CONTINUE
        TOPALT=-TOPALT
        DO 929 I=1,99
        J=2000*(I+1)
 929    WRITE(6,930)J,TIME(I),STOP(I)
 930    FORMAT(I10,F10.3,F10.0)
        WRITE(6,1515)TITLE
 1515   FORMAT(1H1,13A6/20HODATE     TIME      Y        )
        REWIND 3
 88     NFLITE=0
        IF(IDATE.EQ.ISD)GO TO 3
 2      READ(3)SITE,IYR,IDATE,IHR,NALT,(ALT(I),VX(I),VY(I),I=1,NALT)
        IF(SITE.NE.TEST1)GO TO 996
        IDATE=1300
        GO TO 995
 996    IF(IDATE.LT.ISD)GO TO 2
        IF(IDATE.LE.IED)GO TO 3
 995    IF(NFLITE.GT.1)GO TO 4
        WRITE(6,101)ISD,IED
 101    FORMAT(21HONO FLIGHT BETWEEN   I6,5H AND  I6)
        GO TO 1
 3      IF(ALT(NALT).LT.TOPALT)GO TO 2
C       WRITE(6,102)IDATE,IYR,(ALT(I),VX(I),VY(I),I=1,NALT)
 102    FORMAT(1H1216/(6F20.6))
        NFLITE=NFLITE+1
        NMAX=TOPALT
        IVEC=1
        T=0.0
```

```
      S=0.0
      I=6000
  666 J=I/2000-1
      IVEC=INTERP(NALT,ALT,I-1000,IVEC)
      FF=I-1000
      T=T+FVECT(TIME,ALT,VX,IVEC,FF,J)
      S=S+FVECT(TIME,ALT,VY,IVEC,FF,J)
      IOUT=IBL
      IF(T.GT.XMAX)GO TO 667
      IOUT=IXX
      GO TO 668
  667 CONTINUE
      I=I+2000
      IF(I.LE.NMAX)GO TO 666
      FF=TOPALT
      I=NMAX
      IVEC=INTERP(NALT,ALT,I,IVEC)
      X=FUNC(STOP,ALT,VX,IVEC,FF,J)
      STOP(J)=(XMAX-T)/X
      TMI=TMM+STOP(J)
      Y=S+FVECT(STOP,ALT,VY,IVEC,FF,J)
      Y=Y/60.0
      IF(X.GE.0.0)Y=TEST1
  668 CONTINUE
      IVEC=IVEC+1
      WRITE(6,114)IDATE,IYR,TMI,IOUT,Y
  114 FORMAT(   I5,I2,F7.1,A1,F7.1,5X,I8,2I3,1P7E13.3)
      STOP(J)=0.0
      GO TO 2
  4   CONTINUE
      GO TO  1
      END
$IBFTC FV
      FUNCTION FVECT(T,A,X,I,P,K)
      DIMENSION T(9),A(9),X(9)
      TEMP=(X(I+1)-X(I))/(A(I+1)-A(I))*(P-A(I))+X(I)
      FVECT=TEMP*T(K)
      RETURN
      END
$IBFTC INTTT
      FUNCTION FUNC(T,A,X,I,P,K)
      DIMENSION T(9),A(9),X(9)
      TEMP=(X(I+1)-X(I))/(A(I+1)-A(I))*(P-A(I))+X(I)
      FUNC=TEMP
      RETURN
      END
$IBFTC INTRP
      FUNCTION INTERP(N,A,I,J)
      DIMENSION A(99)
      IF(J.GT.N)J=N
      IF(J.LT.1)J=1
  2   K=A(J)
      IF(K.EQ.I)GO TO 1
      IF(K.GT.I)GO TO 3
      KK=A(J+1)
      IF(KK.GE.I)GO TO 1
      J=J+1
      GO TO 2
  3   IF(J.EQ.1)GO TO 1
      J=J-1
      GO TO 2
```

```
 1      INTERP=J
        RETURN
        END
$DATA
 110000.0 07010831
 $ALTY TIME=0.0,53*800.0 $
 800 FPM TO 110000 FT. PROFILE A
 110000.0 07010831
 $ALTY TIME=0.0,23*800.0,30*600.0$
 800 FPM TO 50 K-FT. 600 FPM TO 110 K-FT.    PROFILE B
```

PROJECTS SUPPORTED UNDER THIS CONTRACT

1. Air Force
   - 6665
   - 8292
   - 698AJ (Recovery)
   - 698AJ (AOMP)
2. DASA - SLEDGE
3. NASA
   - Goddard - BAPE
   - MSC - CRISP
   - Langley - Viking
4. ARPA - 1366

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13. ABSTRACT

The work under this contract has been computational and analytical services in support of operations analysis, applications research and post flight analysis of stratospheric scientific balloon programs conducted by the Air Force Cambridge Research Laboratories (AFCRL). Geophysical and flight data, furnished by the Government, were utilized for transcription, analysis, graphing, and mathematical computations. The work performed includes hand and machine plotting and the writing of several computer programs.

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Balloon trajectories						
Balloon post-flight analysis						

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