(12)

A METEOROLOGICAL ROCKET DATA REDUCTION PROGRAM WITH
AUTOMATED TEMPERATURE PROCESSING

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The reduction of meteorological rocketsonde data at White Sands Missile Range, New Mexico, typically was done with a mixture of manual and computer techniques. The effort described by this report presents the conversion of the manual process to automated techniques, reviews the mathematical formulation of the data reduction process, and flowcharts and lists the complete data reduction program. Comparisons between manually reduced and computerized rocketsonde temperature data are presented.

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1

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

v

LIST OF FIGURES

LIST OF TABLES

Computer Reduction of Meteorological Rocketsonde Data

INTRODUCTION

This final report provides complete documentation of software, and hardware that was developed to permit same day processing of meteorological rocketsonde data at White Sands Missile Range.

Software listings of all programs that comprise the present METROC program are included along with detailed flow charts for those programs that were specially developed to handle the digitized met data. Hardware documentation includes schematics of all electrical components, overall diagrams of interconnection wiring and the microprocessor computer program listing.

As an indication of accuracy, graphical plots of significant level temperature profiles as determined by manual methods and the computer method is included.

Since the report that covered the original data reduction program* is no longer available, this report will include some of the material from that report.

Meteorological rocket sounding systems (metrockets) have been developed to obtain upper air observations in the lowest 100 km of the atmosphere, especially that portion inaccessible to routine balloon observations, i.e., above 30 km. Some of these systems that are routinely used include a payload which consists of an atmospheric sensor, a radio transmitter for telemetering the measurements to ground tracking, receiving and recording equipment, and a radar-reflective retardation device. The atmospheric sensor normally provides temperature measurements. A radar

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*A General-Purpose Meteorological Rocket Data Reduction Program by Mary Ann Seagraves, ECOM 5 2, August 1972

track of the payload is used to compute wind data and altitude information to correlate with the temperature measurements. Another type of metrocket payload contains only a radar target, i.e., chaff or inflatable sphere, to provide wind measurements. Other types of payloads collect specialized data for various research and development programs.

The purpose of the computer program METROC is to produce routine wind and thermodynamic data from the raw data collected from metrocket firings at White Sands Missile Range (WSMR), New Mexico, Utah Launch Complex (ULC), Green River, Utah, and other sites.

The program is written to be used on the UNIVAC 1108 computer at WSMR. It is designed so that the complete reduction of the data from each firing may be accomplished with one pass through the computer. This increases efficiency in operation by eliminating delays between the various steps of the data processing. With this approach, however, the data may not be monitored during intermediate phases of the reduction process.

The data input to METROC may be both winds and temperatures, winds only, or temperatures only. A digital tape of the radar track and telemetry is used for the computation of wind and temperature data when available. Manually reduced wind and temperature data may be input using punch cards.

The output listings are in metric units and may contain any, or all, of the following:

1. Individual wind data points

2. Summarized data for significant temperature levels, even kilometer levels, 5000 ft levels and mandatory levels

3. Listing of Meteorological Rocket Network (MRN) formatted data

4. Ozonesonde parameters

5. Wind data in English units

The summarized data listings may include layer winds averaged over 2 kilometers, corrected temperatures, pressure data computed using hydrostatic equations and a base-level point from a conjunctive raob, atmospheric density and speed of sound.

Output data cards are punched in the MRN reporting format for all runs which include wind data. Additional output cards are punched when the English units output option is selected.

An effort has been made to conform to the IRIG standards for met-rocket data reduction [1] where possible throughout the data reduction process. Smithsonian Meteorological Tables [2] was used as a source for formulae and constants.

I. MATHEMATICAL DEVELOPMENT

A. WIND COMPUTATIONS - RADAR DATA TAPE INPUT

The subroutine READTP obtains the raw data from the input tape and converts it to standard units and sampling rates. The range is converted to meters, the azimuth and elevation to radians, and the sampling rate to 10 samples per second. The sample time is referenced to time of launch. The raw data is filtered using a technique described by Avara and Miers [3]. A 117-point symmetrical filter is applied to data so that 5 consecutive samples of smoothed data are available.

Then, for each of these 5 points, the following computations are made:

Altitude corrected for earth's curvature Z_c

$$Z_c = \frac{R^2 \cos^2 E}{1.2742458 \times 10^7 + R \sin E + Z_A} \tag{1}$$

-3-

where R = range

E = elevation angle

Z_A = station altitude.

Elevation angle corrected for earth's curvature E_c

$$E_c = \frac{E + Z_A \cos E}{1.40167038 \times 10^7 \sin E.} \qquad (2)$$

East-west position, X

$$X = R \cos E_c \sin A \qquad (3)$$

where A = azimuth.

North-south position, Y

$$Y = R \cos E_c \cos A. \qquad (4)$$

The accelerations are then used to correct the velocities for sensor motion by a technique developed by Eddy [1]. If v is the uncorrected component velocity, then v, the corrected component velocity, is

$$v = v - \frac{a \cdot v_z}{a_z + g} \qquad (5)$$

where a = component acceleration

v_z = vertical velocity

a_z = vertical acceleration

g = gravitational acceleration.

A check is made to determine if apogee has been reached. When 12 consecutive points have been encountered for which the altitudes are decreasing, it is assumed that apogee has been reached and payload expulsion has occurred.

After apogee has been found, additional checks are made to determine whether the data is valid. If the computed vertical velocity

is positive, the data sample is rejected as invalid. Other checks may be made, but there is an option to by-pass these. (See sixth option on options data card). They are

1. The vertical velocity must be greater than -250 m/s.

2. The change in total velocity from the previous point does not exceed 30%.

The list of questionable data points is generated that consists of those samples for which

1. The change in wind direction exceeds 30° when the speed is greater than 20m/s, or

2. There is a 100% change in windspeed when the windspeed is greater than 5 m/s.

If a sample is found to be invalid, the message "DATA EXCEEDS LIMITS AT TIME XXX" is printed and that sample is not used in computing layer winds.

When a sample is valid (or questionable), it is printed and stored for use in computing layer wind data. The sample output rate is one per second.

B. WIND COMPUTATIONS - CARD INPUT

The wind data samples input on punch cards are printed and stored for subsequent use as they are read. A message is printed following each point for which the time or altitude is not sequential or for which the data exceeds certain limits. The limits for valid data are 0° to 360° for wind direction, 0 to 200 m/s for windspeed, and 0 to 250 m/s for fall velocity.

C. COMPUTATION OF LAYER WIND DATA

The altitudes of the points for which layer winds are to

be computed are first determined in the main program. The sub-routine WNDAVG is called to compute the layer wind data.

An interval over which averages are to be computed is deter-mined for each layer wind data point. Then each of the individual data points is read, and the component wind velocities are accu-mulated for each interval. After all the individual data points have been considered, average component winds and fall velocities are calculated, along with the time for each layer. The vector wind is determined from the component wind. Any layer which con-tains fewer than n points is bad-flagged, n being 6 when the wind data is computed from a radar tape and n=1 when the wind data is input on cards.

D. BASE-LEVEL POINT

A base-level point is a data point obtained from a conjunc-tive rawinsonde observation that was taken close in time and space to the rocketsonde observation. The data provided is at-mospheric pressure and temperature at a specified altitude. By using this and rocket temperatures, thermodynamic data is computed with the hydrostatic equations. To be valid, the temperatures measured by the rawisonde and rocketsonde should agree within 2.5° at the base-level point. The program will reject all base-level points that do not have this agreement, unless a special option is selected.

Any run which contains temperature data may contain zero to 5 base-level points. If more than one base-level point is input, the one which is closest to 25 kilometers and which meets the tempera-ture agreement criterion is used in the thermodynamic computations.

Thermodynamic computations are not made if no base-level point is input or if none meets the temperature agreement criterion and the option overriding this criterion is not selected. These computations are not done if there is no valid base-level point available which is within 2 kilometers of the lowest temperature data point.

If the override option is selected and none of the input base-level points meets the temperature agreement criterion, that point which has the best temperature agreement is used.

The base-level point which is ьo be used in thermodynamic computations is stored, and the rocket temperature in degrees Kelvin and the geopotential altitude are found:

$$T_k = T + 273.16 \qquad (6)$$

where T_k = temperature °K

T = temperature °C

and

$$Z_p = \frac{g \times R_e \times Z}{9.8 \ (R_e + Z)} \qquad (7)$$

where Z_p = geopotential altitude

g = gravitational acceleration

R_e = local radius of earth

Z = geometric altitude.

E. TEMPERATURE AND THERMODYNAMIC DATA

At each step in the program where temperature and thermodynamic data are to be processed, the altitudes of the points to be output are determined first. The altitudes for the significant levels are interpolated from the individual wind data points;

when wind data is not being processed, the altitudes are read from
the input data cards. Significant levels are not processed for
those points at which the altitudes are not available from the
wind data.

Constant-altitude layers, i.e., even kilometers, 0.5 kilo-
meters, 500 feet, or 1000 feet, are determined by considering the
highest and lowest available data, either wind data or signifi-
cant temperature levels. A table of constant-altitude layers is
produced for points within this span.

A table of standard constant pressures is contained within
the program. It is determined which of these pressures fall with-
in the span of available data, and then altitudes are exponential-
ly interpolated for the constant pressure (mandatory) levels from
the altitude-vs.-pressure data for the significant levels.

When wind data processing is to be included, the layer winds
and fall velocity are computed after determining the layer altitudes.

Next, except for significant levels, temperatures for each layer
are linearly interpolated. Subroutine THERMO is then called to do
the thermodynamic computations.

First, the absolute temperatures are computed as in Equation
(6).

Then, if a temperature correction is to be computed, a
correction is derived based on a method developed by Krumins
and Lyons and is the IRIG temperature correction [4]:

$$\Delta T(k) = T(k) - A(z) \times (Vz(k))^2 + \frac{B(z) \times (T(k+1) - T(k-1)}{t(k+1) - t(k-1)}$$

$$-C(z) + D(z) \times T(k)^4 \qquad (8)$$

where $\Delta T(k)$ = temperature correction for kth point

$T(k)$ = absolute temperature at kth point

$t(k)$ = time of kth point

$V_z(k)$ = fall velocity at kth point

and $A(z)$, $B(z)$, $C(z)$ and $D(z)$ are coefficients which vary with sensor type and altitude and $C(z)$ is also a function of time of day (night or day).

NOTE: When wind data is not processed in a run, fall velocity data is not available. Thus, no provision has been made to compute temperature corrections. However, temperature corrections which have been manually computed may be input on data cards and used in the final computations.

The temperature correction is added to the uncorrected temperatures, and the geopotential altitude is computed for each point as in Equation (7).

Atmospheric pressure is computed next, except when processing constant-press levels. Any time there is a layer of missing temperature data greater than 3 kilometers, pressure and related computations are not continued beyond that point. Pressure is computed both upward and downward from the base-level point:

$$P(k) = P(k-1) \times \exp \frac{Z_p(k-1) \quad Z_p(k)}{14.63725 \times (T(k) - T(k-1))} \tag{9}$$

where $P(k)$ = pressure (mb)

$Z_p(k)$ = geopotential altitude (m)

$T(k)$ = corrected absolute temperature

k-1 is the previous point when k>1, and k-1 is the base-level point when k=1.

-9-

Density is computed:

$$D = P \times 348.38/T \qquad (10)$$

$$D_1 = D \times 1.9403806 \times 10^{-6} \qquad (11)$$

where D = density (gm/cu m)

P = pressure (mb)

T = corrected absolute temperature

D_1 = density (slugs/cu ft).

Speed of sound is calculated:

$$S = 20.0544 \times \sqrt{T} \qquad (12)$$

where S = speed of sound (m/s)

T = absolute temperature

II. SYSTEM FORMULATION

In order to process high altitude meteorological data from a rocket born datasonde, the radar positional data and the significant level temperature data from the datasonde must be combined into a single profile.

The system described in this report provides a means of combining both the radar data and telemetry data into a common data bank for final processing by the UNIVAC 1108 computer into a meteorological profile.

A. OUTLINE OF TOTAL SYSTEM

The total system consists of 1)-a microprocessor system that will digitize the temperature telemetry, form the appropriate message format with this data, and transmit this data to the control record facility - this combines the temperature data but not significant level data with the radar data; 2)-software or that will process the digitized telemetry data to form a significant level

temperature profile that is consistant with the levels selected by hand. (4)

Once the data is in significant level form, the final existing computer program (ROCKET) will generate the final met profile.

B. MICROPROCESSOR SYSTEM

The microprocessor chosen was the INTEL 8080 configured as an SBC 80 single board computer. [5] This provides the user with 1024 bytes of RAM, 1024 bytes of ROM or EPROM, two 8255 parallel I/0, ports, one 8251 USART serial I/0 port, EIA RS 232 logical level converters, card cage and power supply. This particular system was selected because it has the necessary hardware to do the job and was available.

C. ADDITIONAL SYSTEM REQUIREMENTS

In order to provide additional future capabilities, provisions were made to read and incorporate into the message, time data from an IRIG B time code reader, and data from four event-marker flip-flops.

These hardware items together with the analog-to-digital converter, and tri-state multiplexing chips were mounted on a general purpose prototype board. This board was inserted in the card cage to form the total system. A block diagram of this system is shown in figure 1.

D. MESSAGE FORMAT

The message format for transmission to the Central Record Facility (CRF) is composed of two 120 bit messages. The only restrictions in these messages is that the first 15 bits are fixed by the sync and station identification numbers. The message format that was used is shown in table 1. In looking at table 1 it should be noted that the time, seconds, is contained in two seperate bit
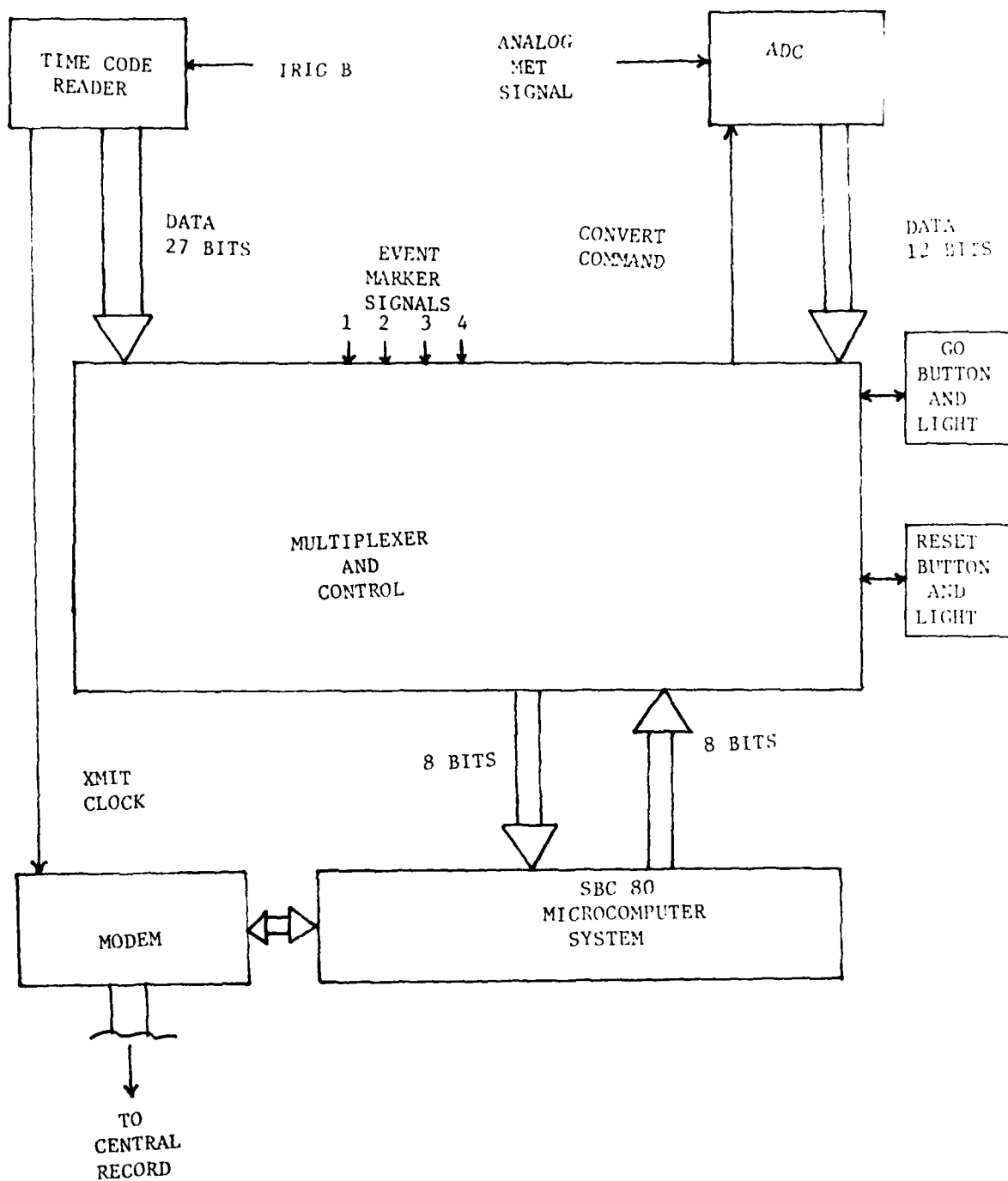
Figure 1. System block diagram.

DATA-WORD 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Message 1	1	0	1	0	1	1	1	1	0	0	0	0	0	1	1	0								
			SYNC BITS								STATION ID													
Message 2	0	1	0	1	0	1	1	1	0	0	0	1	0	1	0									
			SYNC BITS								STATION ID													

DATA-WORD 2

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Message 1			2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0					2^{16}	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}		
						TIME–MILLISECONDS													TIME–SECONDS					
Message 2																								

DATA-WORD 3

	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
Message 1						2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	SIGN	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4
									TIME–SECONDS										MET DATA x10/2^{11} VOLTS					
Message 2																								

DATA-WORD 4

	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
Message 1	2^3	2^2	2^1	2^0	#1	#2	#3	#4																
							EVENT MARKERS																	
Message 2																								

DATA-WORD 5

	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Message 1																								
Message 2																								

-13-

blocks. This problem occurred because the original time code
reader, for which the system was designed, had time broken down
into BCD 10 h,   hours, 10 min, min, 10 s,   and sec. When
the modems were installed, a new time code reader was also installed
that had time in binary seconds and milliseconds as indicated.
The new data was brought into the system by changing only the wiring
to the connector. The time data, met data, and event-marker data is
combined properly by the software program that generates the signifi-
cant level data.

E.   8080 SOFTWARE

Figure 2 is a flow-chart of the software program that performs
the data collection, message formation and transmission. The last
block in figure 2 was necessary because the data when received by
the CRF is complimented and the 1st bit received is treated as the
most significant bit of the message. In contrast, the modem interface
(USART) sends the least significant bit first. The software program
for the ROM control corresponding to figure 2 is shown in table 2.

III. MICROPROCESSOR SYSTEM HARDWARE DIAGRAMS

The system is composed of six subsystems. 1) - SBC 80 micro-
processors, 2) - Interface card, 3) - IRIG B time code reader-gen-
erator, 4) - Modem, 5) - Card cage, 6) - Power Supply.

Items 1, 3, 4, 5 and 6 are standard commercial units and will
not be described in detail.

A.   INTERCONNECTION

Figure 3 illustrates the various connection cables that are
used to interconnect the various subsystems. The only connection
not indicated is the backplane connection - this is made when the
two cards are inserted into the card cage.

-14-
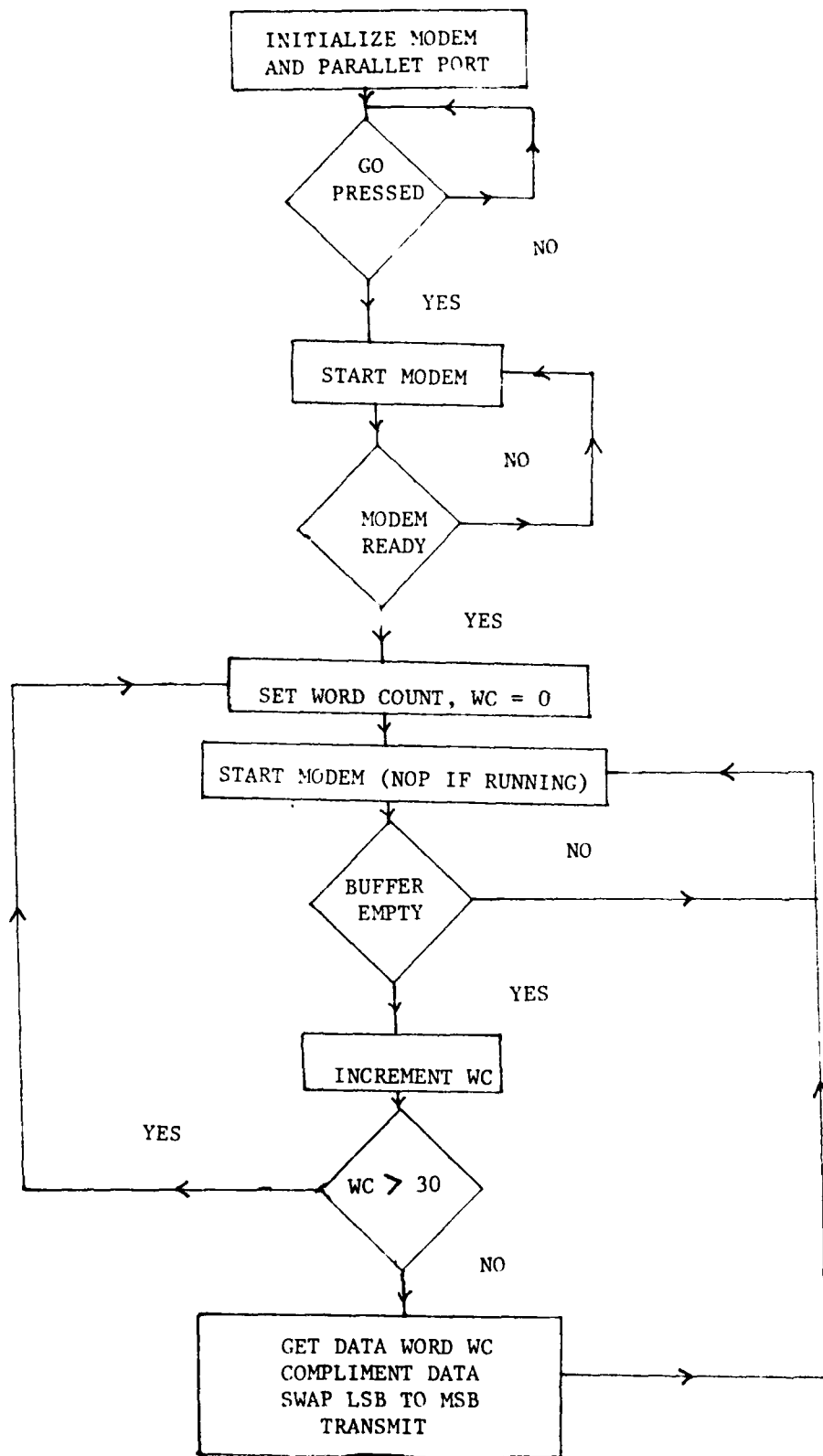
Figure 2. Flow chart for 8080 software.

-15-

```
0000                       1000 WORD      EQU 3C00H     AVAIL RAM LOCATION
0000                       1010 *
0000                       1020 *
0000                       1030           ORG 0000
0000                       1040 ***********************
0000 F3                    1050 RSET      DI            DISABLE INTERRUPTS
0001 3E 0C                 1060 MODE      MVI A,014Q    SET IN SYNC MODE
0003 D3 ED                 1070           OUT 355Q
0005 3E 75                 1080 SYNC      MVI A,165Q    SET IN SYNC 1 WORD
0007 D3 ED                 1090           OUT 355Q
0009 3E 24                 1100           MVI A,044Q    SET IN SYNC 2 WORD
000B D3 ED                 1110           OUT 355Q
000D 3E 12                 1120 HUSH      MVI A,022Q    SET IN COMMAND WORD
000F D3 ED                 1130           OUT 355Q         TO QUIET MODEM
0011 3E 82                 1140 NOGO      MVI A,202Q    SET IN CONTROL WORD
0013 D3 E7                 1150           OUT 347Q         FOR CONTROL PORT
0015 3E 3F                 1160           MVI A,077Q    CHECK FOR GO BUTTON
0017 D3 E4                 1170           OUT 344Q
0019 DB E5                 1180           IN  345Q
001B E6 01                 1190           ANI 001Q
001D CA 11 00              1200           JZ  NOGO      IF NOT, JUMP BACK
0020 3E 23                 1210 GO        MVI A,043Q    START MODEM
0022 D3 ED                 1220           OUT 355Q
0024 DB ED                 1230           IN  355Q      IS MODEM READY?
0026 E6 80                 1240           ANI 200Q
0028 CA 20 00              1250           JZ  GO        IF NOT, ASK AGAIN
002B 21 00 3C              1260 CLRW      LXI H,WORD    INITIALIZE WORD COUNTER
002E 36 00                 1270           MVI M,000
0030 00                    1280 NEWW      NOP           (THIS REGION OF CODE HAS
0031 00                    1290           NOP           (HAS BEEN DELETED IN THE
0032 00                    1300           NOP           (ACTUAL ROM IMPLEMENTATION)
0033 00                    1310           NOP
0034 DB ED                 1320           IN  355Q      TRANSMITTER BUFFER
0036 E6 01                 1330           ANI 001          EMPTY?  IF NOT,
0038 CA 30 00              1340           JZ  NEWW          ASK UNTIL IT IS
003B 21 00 3C              1350           LXI H,WORD
003E 34                    1360           INR M         INCREMENT WORD COUNT
003F 3E 82                 1370           MVI A,202Q
0041 D3 E7                 1380           OUT 347Q      REINITIALIZE PARALLEL PORT
0043 7E                    1390           MOV A,M
0044 FE 01                 1400 WRD1      CPI 001Q      WORD1 (SYNC 1)
0046 C2 4E 00              1410           JNZ WRD2
0049 3E AF                 1420 SYN1      MVI A,257Q
004B C3 C8 00              1430           JMP XMIT
004E FE 02                 1440 WRD2      CPI 002Q      WORD2 (SYNC 2 = ID)
0050 C2 58 00              1450           JNZ WRD3
0053 3E 34                 1460 ID        MVI A,064Q
0055 C3 C8 00              1470           JMP XMIT
0058 FE 03                 1480 WRD3      CPI 003Q      WORD3 (ZERO)
005A C2 61 00              1490           JNZ WRD4
005D AF                    1500 ZERO      XRA A
005E C3 C8 00              1510           JMP XMIT
0061 FE 04                 1520 WRD4      CPI 004Q      WORD4 (HD,TD)
0063 C2 6B 00              1530           JNZ WRD5
0066 3E 38                 1540           MVI A,070Q
0068 C3 C4 00              1550           JMP DOIT
```

TABLE 2 (cont)

```
006B FE 05        1560 WRD5    CPI 005Q        WORD5 (UD,TH)
006D C2 75 00      1570         JNZ WRD6
0070 3E 39         1580         MVI A,071Q
0072 C3 C4 00      1590         JMP DOIT
0075 FE 06         1600 WRD6    CPI 006Q        WORD6 (UH,TM)
0077 C2 7F 00      1610         JNZ WRD7
007A 3E 3A         1620         MVI A,072Q
007C C3 C4 00      1630         JMP DOIT
007F FE 07         1640 WRD7    CPI 007Q        WORD7 (UM,TS)
0081 C2 89 00      1650         JNZ WRD8
0084 3E 3B         1660         MVI A,073Q
0086 C3 C4 00      1670         JMP DOIT
0089 FE 08         1680 WRD8    CPI 010Q        WORD8 (US,DS)
008B C2 93 00      1690         JNZ WRD9
008E 3E 3C         1700         MVI A,074Q
0090 C3 C4 00      1710         JMP DOIT
0093 FE 09         1720 WRD9    CPI 011Q        WORD9 (DIGITIZER)
0095 C2 9D 00      1730         JNZ WD10
0098 3E 3D         1740         MVI A,075Q
009A C3 C4 00      1750         JMP DOIT
009D FE 0A         1760 WD10    CPI 012Q        WORD10 (DIGITIZER,
009F C2 A7 00      1770         JNZ WD11           CONTACTS)
00A2 3E 3E         1780         MVI A,076Q
00A4 C3 C4 00      1790         JMP DOIT
00A7 FE 10         1800 WD11    CPI 020Q
00A9 DA 5D 00      1810         JC  ZERO        WORDS11-15 (=ZERO)
00AC C2 B4 00      1820 WD16    JNZ WD17
00AF 3E 57         1830         MVI A,127Q      WORD16 (SYNC 3)
00B1 C3 C8 00      1840         JMP XMIT
00B4 FE 11         1850 WD17    CPI 021Q        WORD17 (SYNC 4=ID)
00B6 C2 BC 00      1860         JNZ WD18
00B9 C3 53 00      1870         JMP ID
00BC FE 1F         1880 WD18    CPI 037Q        WORDS18-30 (=ZERO)
00BE DA 5D 00      1890         JC  ZERO
00C1 C3 2B 00      1900         JMP CLRW        RESET WORD COUNT
00C4 D3 E4         1910 DOIT    OUT 344Q        OUTPUT DATA TO BE READ
00C6 DB E5         1920         IN  345Q        INPUT ACCESSED DATA
00C8 2F            1930 XMIT    CMA             COMPLEMENT THE DATA
00C9 47            1940         MOV     B,A     SAVE IT OFF TO SIDE
00CA 16 08         1950         MVI     D,8     ESTABLISH BYTE COUNTER
00CC AF            1960         XRA     A       CLEAR A REGISTER
00CD 4F            1970         MOV     C,A     CLEAR C REGISTER
00CE 78            1980 SWAP    MOV     A,B     SWAP MSB'S TO LSB'S
00CF 67            1990         MOV     H,A     (APPARENT ERROR IN HAND CODE)
00D0 17            2000         RAL             PUT MSB IN THE CARRY AND
00D1 47            2010         MOV     B,A     RESTORE THE REMAINDER
00D2 79            2020         MOV     A,C     FORM NEW WORD FROM OLD C
00D3 1F            2030         RAR             BY SHIFTING CARRY INTO THE
00D4 4F            2040         MOV     C,A     WORD BEING FORMED
00D5 15            2050         DCR     D       DECREMENT THE COUNT
00D6 C2 CE 00      2060         JNZ     SWAP    DONE YET? NO-CONTINUE
00D9 79            2070         MOV     A,C     RESTORE THE WORD
00DA D3 EC         2080         OUT     354Q    OUTPUT REV WORD TO MODEM
00DC C3 30 00      2090         JMP     NEWW    AND GET ANOTHER NEW WORD
00DF               2100 ***********************
```

TABLE 2   (cont)

```
PROGRAM IS 223 BYTES LONG (1) WITH 0 ERRORS DETECTED.
', SYMBOL LISTING (Y=YES,N=NO)?
CLRW=002B DOIT=00C4 GO=0020 HUSH=000D ID=0053 MODE=0001 NEWW=0030
NOGO=0011 PSW=0006 RSET=0000 SP=000( SWAP=00CE SYN1=0049 SYNC=0005
WD10=009D WD11=00A7 WD16=00AC WD17=00B4 WD18=00BC WORD=3C00 WRD1=0044
WRD2=004E WRD3=0058 WRD4=0061 WRD5=006B WRD6=0075 WRD7=007F WRD8=0089
WRD9=0093 XMIT=00C8 ZERO=005D
*
```
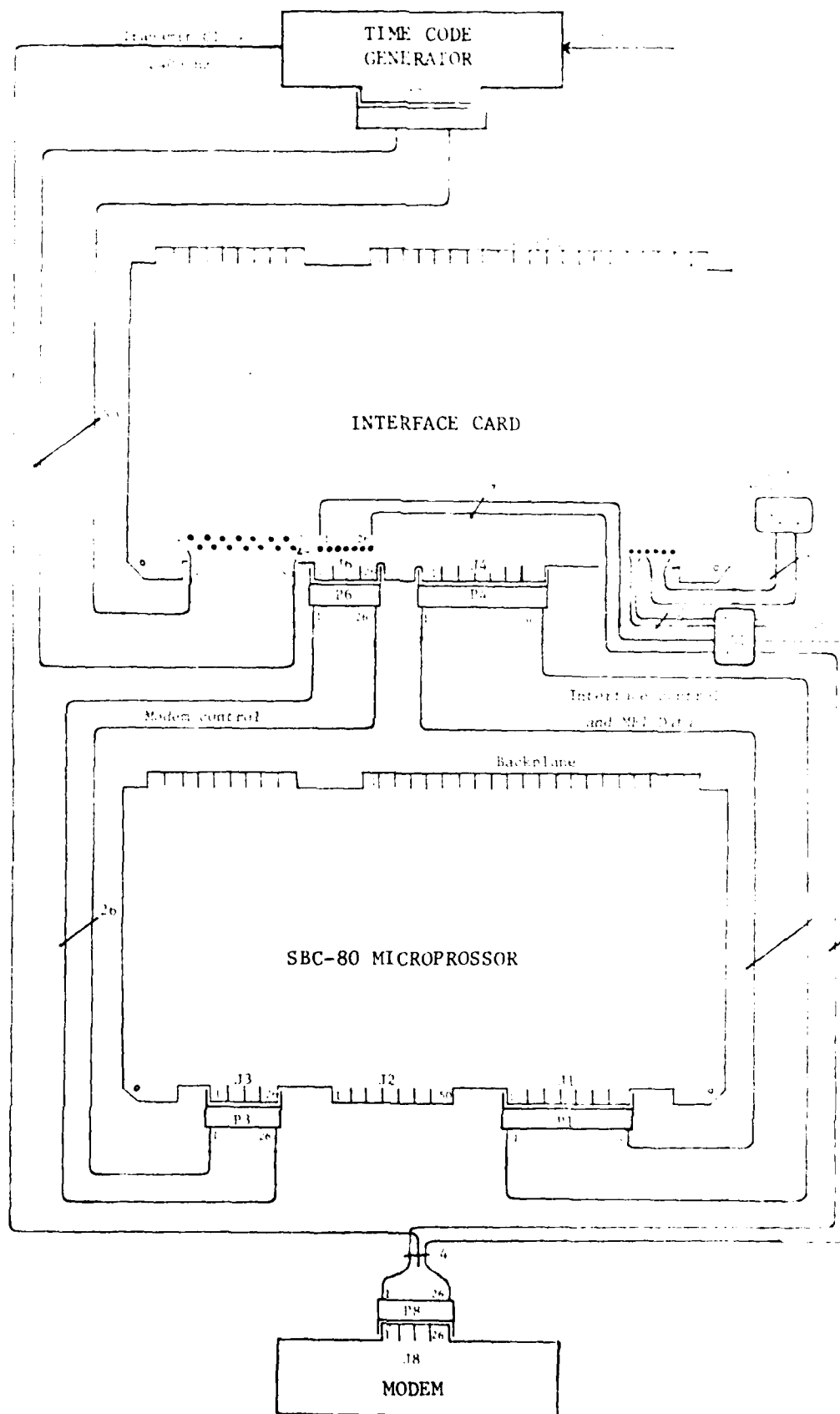
Figure 3. Microcomputer subsystem connections.

Table 3 shows the pin connections and signal identification for all connectors. TB refers to Terminal Block.

B.   INTERFACE CARD

Figure 4 shows the component locations on the interface card. Each integrated circuit (IC) is indicated by a number (1 thru 17) and IC type (SN 74367, etc.).

Figure 5 illustrates the event marker logic, Go and Reset logic and the B0 thru B3 data flow from the Analog to Digital Converter (A/D). The 8 bit word composed of B3, B2, B1, B0 and event marker bits 1 thru 4 are gated into the microprocessor when pin 9, IC 15 is active. The numbers inside the gates indicate the IC number. The event marker outputs are set by a +5 volt pulse.

Figures 6 thru 8 show the various bits that compose the words brought into the microcomputer. Figure 9 illustrates the A/D pin connections and the multiplexer circuit for selecting the various words.

An ADC (Analog-to-Digital Converter) manufactured by Burr-Brown Research Corporation was used to digitize the met data. The met data signal was available from an on-site frequency to voltage converter.

IV.   SOFTWARE

A.   ORIGINAL METHODS

In order to process high altitude meteorological data from a rocket born datasonde, the positional data from the tracking radar and the significant level temperature data from the datasonde must be combined into a single profile.

E
TABLE 3. PIN NUMBER CONNECTIONS FOR PLUGS.

TIME CODE GENERATOR CONNECTIONS

J7	P7	Cable no.	Board pin no.
2^9 msec	1	18	17
2^8	k	17	18
2^7	j	41	42
2^6	h	40	39
2^5	f	16	15
2^4	e	15	16
2^3	d	39	40
2^2	c	38	37
2^1	b	14	13
2^0	a	13	14
2^{16} sec	C	12	11
2^{15}	F	11	12
2^{14}	H	35	36
2^{13}	J	34	33
2^{12}	L	10	9
2^{11}	M	9	10
2^{10}	N	28	27
2^9	P	4	3
2^8	R	3	4
2^7	S	27	28
2^6	T	26	25
2^5	U	2	1
2^4	V	1	2
2^3	W	49	50
2^2	X	46	45
2^1	Y	37	38
2^0	Z	36	35
	K	32	31
	A	8	7
	A	7	8
Gnd	K	31	32
	K	30	29
	A	6	5
	A	5	6

MODEM AND ADC CONNECTIONS

Signal	J3-P3-pin-board board pin no.		
ADC Input	--		
ADC Ground	--		
TXC Output			
DSR			
TxD			
CTS			
DTR			
RTS			
Gnd			
TxC Input	--		

INTERFACE DATA AND CONTROL CONNECTIONS

Signal	J-P	
Port 2, in		
B7		
B6		
B5		
B4		
B0,B8		
B1,B9		
B2,B10		
B3,B11		
Port 1, out		
$G2_B$		
$G2_A$		
B		
A		
C		
G1		

INTERFACE BACKPLANE CONNECTIONS

Signal	Pin no.
RESET	24
RESET	26
GO	28
GO Pilot	30
RESET Pilot	32
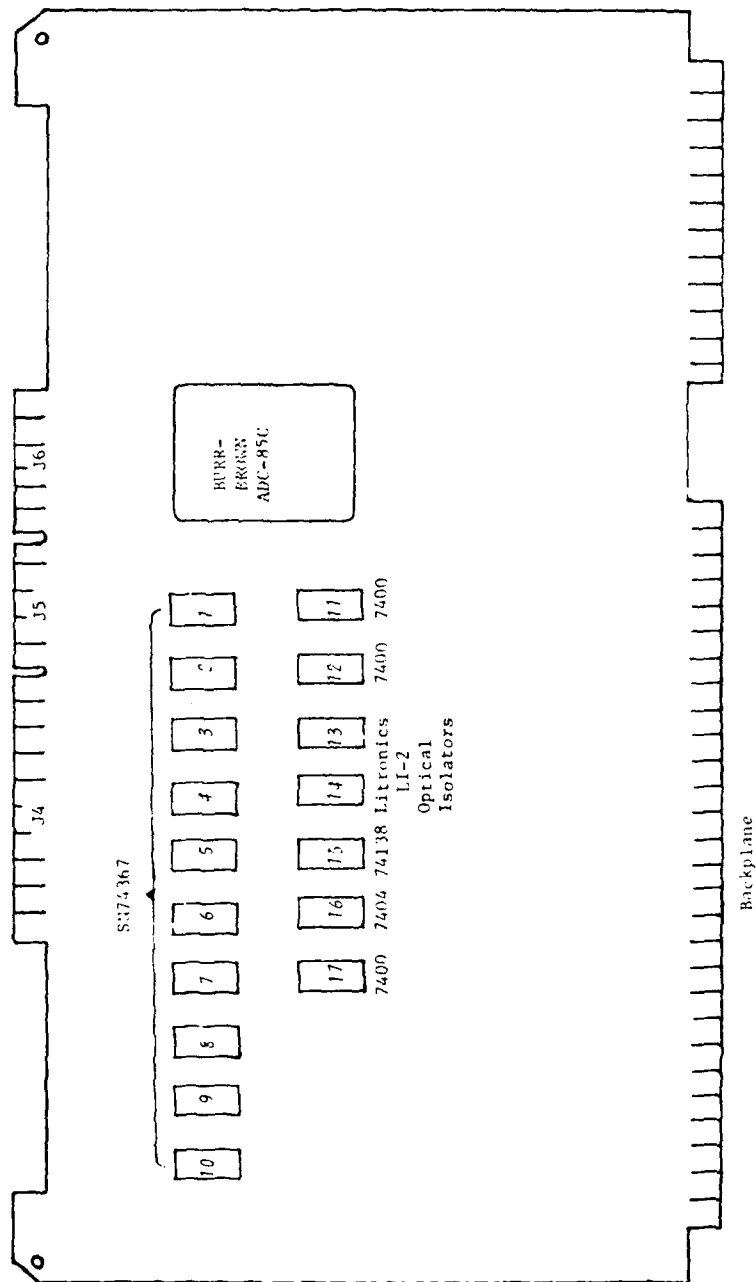
Figure 4.   Component location on interface card.

-22-
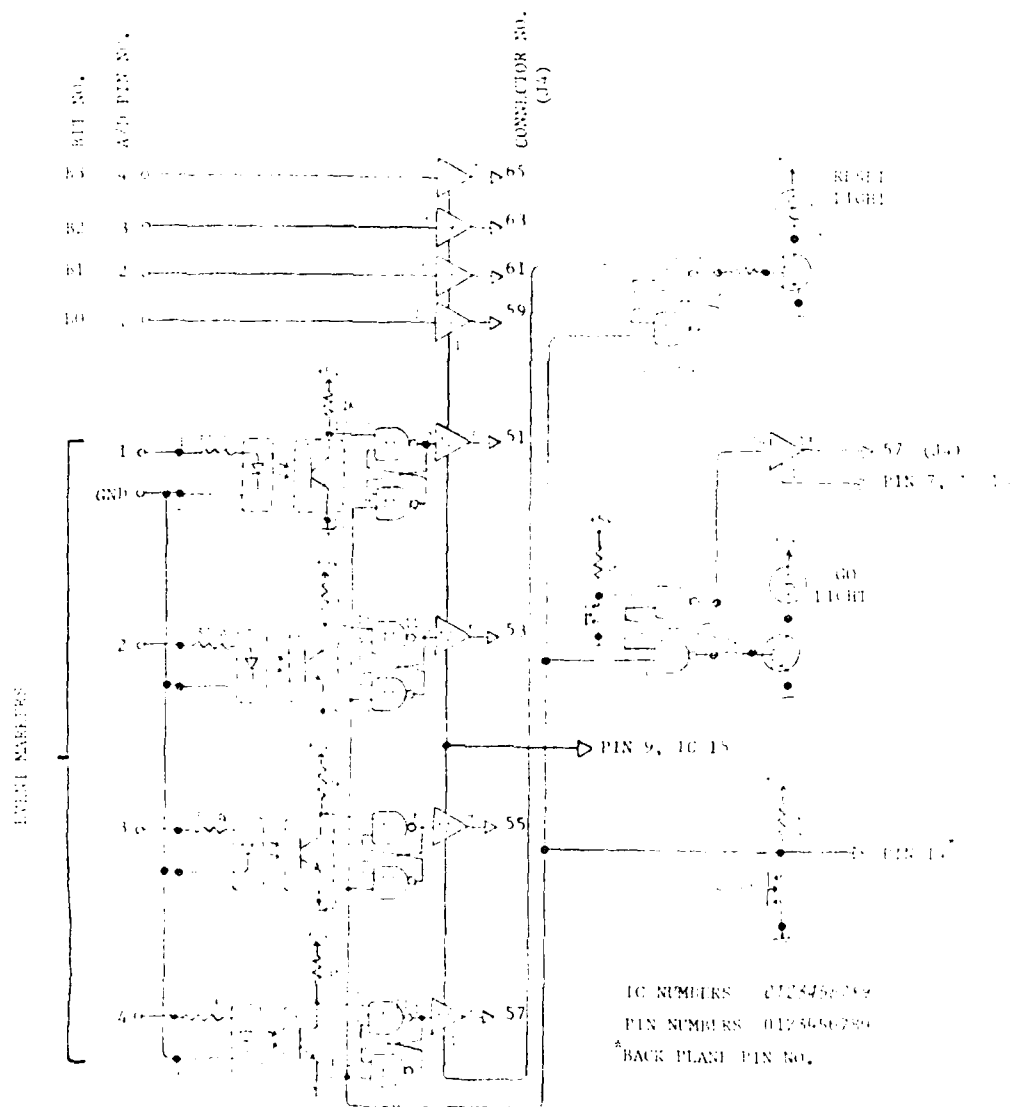
Figure 5. Event Markers, Go, Reset Diagram.

Data transfer diagram. Upper section labels (read vertically): 2^n SECONDS, CONNECTOR NO. (P7), CABLE NO., BOARD NO., PIN NO., IC NO., PIN NO., CONNECTOR NO. (J5)

2^n SECONDS	CONNECTOR NO. (P7)	CABLE NO.	BOARD NO.	PIN NO.	IC NO.	PIN NO.	CONNECTOR NO. (J5)
2^7	S	27	28	2	6	3	65
2^6	T	26	25	4	6	5	63
2^5	U	2	1	6	6	7	61
2^4	V	1	2	10	6	9	59
2^3	W	49	50	2	7	3	51
2^2	X	46	45	4	7	5	53
2^1	Y	37	38	6	7	7	55
2^0	Z	36	35	10	7	9	57

1 → PIN 11, IC 15

Lower section labels: BIT NO., A/D PIN NO.

BIT NO.	A/D PIN NO.	PIN NO.	IC NO.	PIN NO.	CONNECTOR NO.
B11	12	2	8	3	65
B10	11	4	8	5	63
B9	10	6	8	7	61
B8	9	10	8	9	59
B7	8	12	7	11	51
B6	7	14	7	13	53
B5	6	12	8	11	55
B4	5	14	8	13	57

15 → PIN 10, IC 15

Figure 6.   Data transfer diagram (A/D (B11 to B4) and 2^7 to 2^0 seconds.

-24-

SECONDS   CONNECTOR NO. (P7)   CABLE NO.   BOARD NO.   PIN NO.   IC NO.   PIN NO.   CONNECTOR NO. (14)

2^{14} H   35   36   2   4   3   65

2^{13} J   34   33   4   4   5   63

2^{12} L   10   9   6   4   7   61

2^{11} M   9   10   10   4   9   59

1

GROUND

K   32   31   12   2   11   53

A   8   7   14   2   13   55

15

A   7   8   12   3   11   57

15

PIN 13, IC 15

GROUND

K   31   32   2   5   3   65

K   30   29   4   5   5   63

A   6   5   6   5   7   61

A   5   6   10   5   9   59

1

SECS.

2^{10} N   28   27   12   4   11   53

2^{9} P   4   3   14   4   13   55

15

2^{8} R   3   4   12   5   11   57

15

PIN 12, IC 15
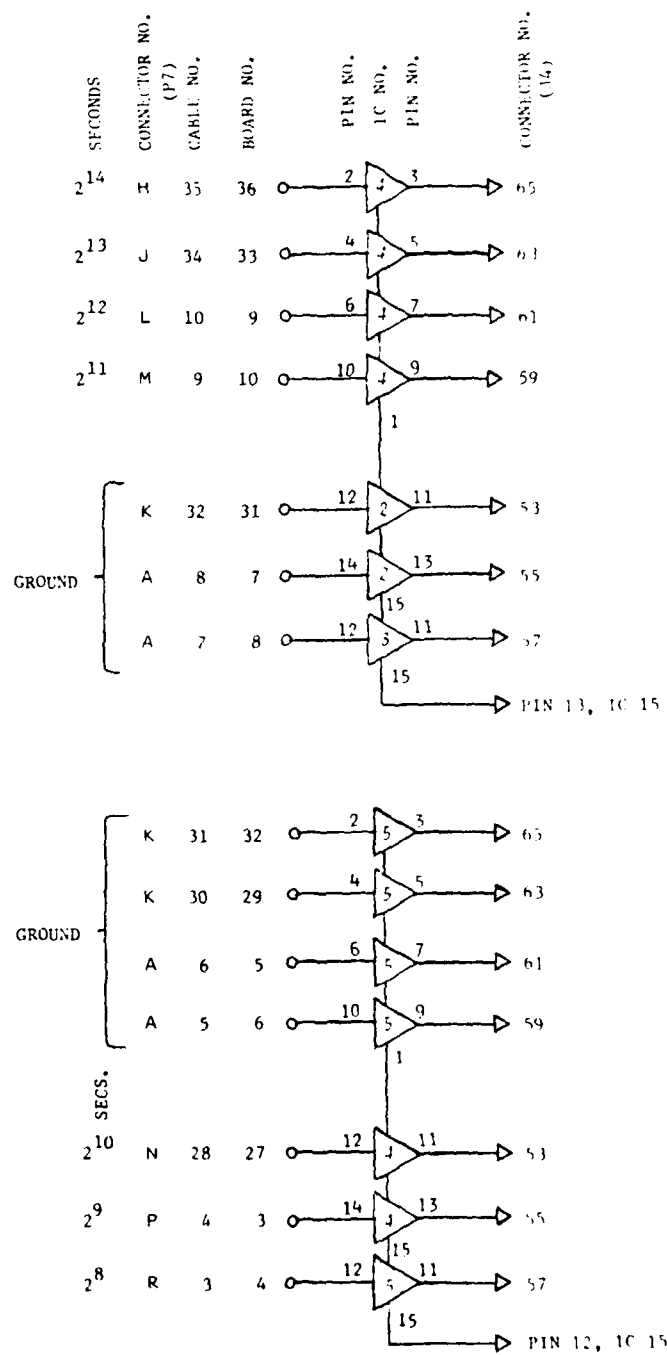
Figure 7. Data transfer diagram 2^{14} to 2^{8} seconds.

-25-

MILLI-SECONDS	CONNECTOR NO. (P7)	CABLE NO.	BOARD NO.	PIN NO.	IC NO.	PIN NO.	CONNECTOR NO. (J4)
2^9	ℓ	18	17	12	1	11	61
2^8	k	17	18	14	1	13	59
						15	
2^7	j	41	42	2	1	3	51
2^6	h	40	39	4	1	5	53
2^5	f	16	15	6	1	7	55
2^4	e	15	16	10	1	9	57
						1	PIN 15, IC 15

2^3	d	39	40	2	2	3	65
2^2	c	38	37	4	2		63
2^1	b	14	13	6	2	7	61
2^0	a	13	14	10	2	9	59
						1	
SECS. 2^{16}	C	12	11	4	3	5	55
SECS. 2^{15}	F	11	12	6	3	7	57
						1	PIN 14, IC 15

Figure 8. Data transfer diagram 2^{16} to 2^{15} seconds and 2^9 to 2^0 milliseconds.

-26-
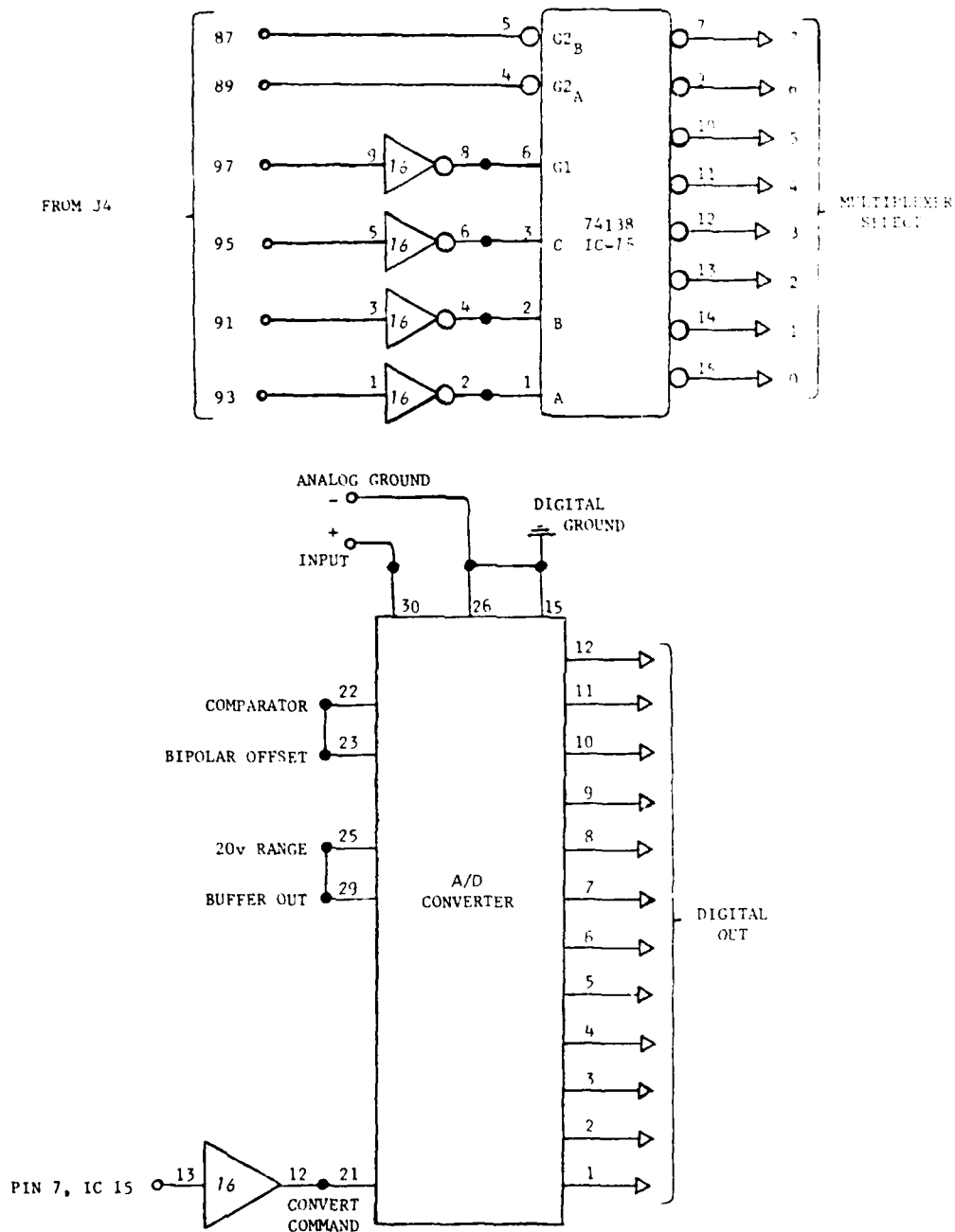
Figure 9. Diagram for word select and A/D connections.

-27-

Originally the telemetry data was processed by hand to form
significant level temperature data. This data is a table of time
after launch, and corresponding temperatures, which were punched on
cards for the later, combining with the radar positional data.

The radar positional data of azimuth, elevation, and slant range
of the datasonde are transmitted via a syncronous modem to a central
record facility (CRF) and recorded on a unilog magnetic tape. Later
the ROCKET program calculates a wind profile from the radar data
and combines the temperature data with it from the significant tem-
perature cards - to produce the final met profile.

B.   REAL-TIME METHOD

The real-time system records simultaneously the digitized met
data from the microprocessor system and the positional radar
data on unilog magnetic tape.
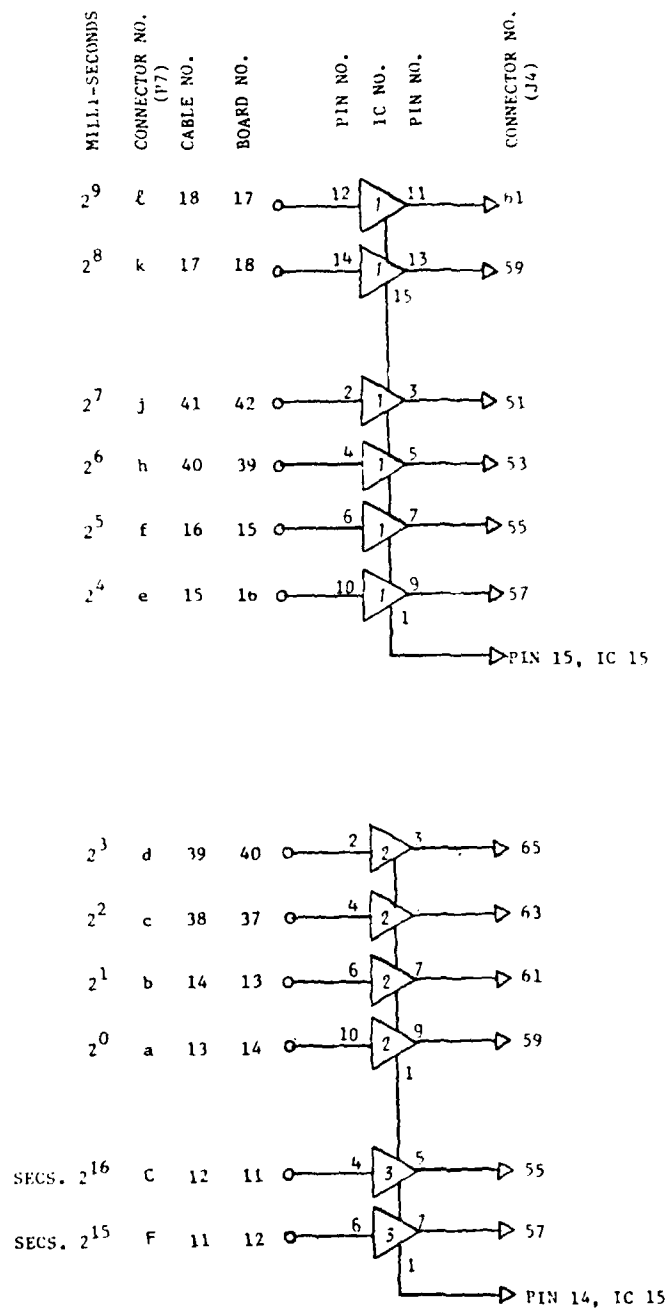
When the unilog tape has been transferred to the 1108 system
B computer system, the modified ROCKET program then processes both
sets of data to form significant level temperature data, radar
wind data, and ultimately a final met profile.

V.   DESCRIPTION OF NEW SOFTWARE

In order to process the telemetry data to get significant
level temperature data, 6 new programs were developed. A brief
description of these programs and corresponding flow charts follow:

Subroutine SIGLEV I1SIG, TIME, VALUE, REFT)

As the telemetry is read from the UNILOG tape by RTDATA, SIGLEV
is called to build an array of reference ordinates and significant
temperature ordinates, which have passed through the filter, along with

their corresponding times. These ar° passed to the subroutine by the arguments TIME and VALUE. The significant temperature ordinates are selected by a call to subroutine SIGPT.

When the entire tape is read, the significant temperature ordinates are converted into ordinate-to-reference ratios. Once an ordinate-to-reference ratio is interpolated, subroutine LOKTEM converts the ratio to an actual temperature.

Finally, after the conversion of the data to a temperature array, the significant levels of this array are found within a tolerance of 2°C by subroutine SIGPT. The final significant temperatures are then printed along with their corresponding flight times, ratios, and ordinate values.

The other two calling arguments do the following: IISIG flags the subroutine for initialization and final runs, and REFT is the distinguishing level for testing whether VALUE is a reference or a temperature ordinate.

Subroutine LOKTEM (ICAL, CRATIO)

The subroutine LOKTEM has two functions which are distinguished by the argument ICAL.

The first is performed when RTDATA calls LOKTEM to read temperature calibration data from cards and to set up an interpolation scheme for temperature calculation. Once this is done, a check of the interpolation scheme is made. If the calculated values differ from the calibration values by more than 1°C the baseline calibration is rejected and a message written. The calibration ratios, values, and test are all printed on the output as well.

-29-

The second function is to perform normal temperature calculations. A temperature ordinate to reference ordinate ratio (CRATIO) is passed to the subroutine by SIGLEV as it builds the arrays. From this ratio the subroutine interpolates a temperature value from the array of stored calibration values and returns it via CRATIO.

Subroutine RTDATA

RTDATA is a general purpose tape-read routine used when processing data from a UNILOG tape. Subroutine READTP and TAPE1 use RTDATA to read FPS-16 radar data, as well as MET data for processing temperatures from telemetry. When RTDATA is called, the data in all active subchannels for one time is stored in the CCMMON area FPS. Since the data is recorded on the tape in blocks of 20 samples per record, a new record is read once every 20 times the subroutine is called.

If temperature telemetry is being processed, RTDATA initially calls LOKTEM to perform the baseline temperature calibration. During subsequent calls, the data is filtered by calling subroutine FILTER and the calculation of temperatures is overseen by calls to SIGLEV. When an EOF indication is read, the final call to SIGLEV is made to finish the calculations and print the significant temperature levels.

When no temperature telemetry is processed from the tape, radar data is read as needed until an EOF occurs.

Subroutine SIGPT

This subroutine determines which temperature out of a string are significant - namely those points which when connected by straight lines forms a temperature profile that is within a given tolerance of the true profile.

-30-

Each temperature ordinate is taken as it comes and an array of significant temperatures is formed. After processing the ordinate values, the significant points are converted to degrees and passed through the subroutine a second time with the tolerance set at two degrees.

Subroutine FILTER

This subroutine creates a filtered-ordinate sum of six values. This is done by first selecting every eighth point, and then comparing each point to adjacent points for correlation. When an ordinate value survives the filter, it is added to the previous sum until a string of six is completed. The sum is passed to the calling program and a flag is set to indicate that a filtered ordinate value is available.

Subroutine ROCOB1

The subroutine ROCOB1 is called by the main program to perform the task of formulating and printing the ROCOB message. ROCOB1 is sent the complete array of 1-KM level wind and thermodynamic data in the COMMON area ROCOB.

VI. DESCRIPTION OF REMAINING SUBROUTINES

Subroutine MRN (NOM, ID, IW IC)

The subroutine MRN arranges the wind and thermodynamic data found in the COMMON areas WIND and TMP into the Meteorological Rocket Network reporting format [4], prints it, and punches it on data cards. Since leading zeros are to be preserved in this format, all interger fields are broken into fields of one digit so that zeros will appear when printed and punched via Fortran statements.

The variable NOM is the number of points to be processed. The variable ID equals 30 when processing significant or kilometer levels, 40 for constant-pressure levels. The variable IW is an indicator of wind input type, while IC indicates uncorrected or corrected winds.

The COMMON area MRN is used to store the data as it is broken into single-digit fields. The COMMON area SIGN is made up of alphanumeric fields containing a plus sign, a minus sign, a blank, and a nine.

Subroutine OZONE (N1, N2)

The subroutine OZONE computes and prints special thermodynamic parameters which are of significance in reference to metrockets with ozonesonde payloads. These parameters are $d (\ln (T))/dZ$ and $d(\ln(P))/dZ$, where T is temperature, P is pressure, and Z is altitude.

The data used in the computations is found in the COMMON areas WIND and TMP. The variables N1 and N2 are the indices of the first and last points to be used.

Subroutine QUESS

The subroutine QUESS prints the time and altitude of as many as 100 wind data samples of questionable validity. A point is considered questionable if either there is a direction shift of at least 30° when the windspeed is greater than 20 m/s, or there is a 100 percent change in speed with a windspeed greater than 5 m/s.

The times and altitudes of the questionable points are stored by the main program in the COMMON area QQ, along with the number of questionable points.

-32-

Subroutine TPREAD (10F, IND, NEND)

The subroutine TPREAD is used to obtain raw data from digital tape and convert the times, units, and sampling rates to standard values. For each sample, the data is stored in the COMMON area TRAE. Time of the sample, TM, is in seconds referenced to lift-off time. Range, RG, is in meters while azimuth, AZ, and elevation, EL, are in radians. The standard sampling rate is 10 samples per second. An end of file indicator is found in the parameter 10F. The variable IND specifies the type of data tape being processed. NEND contains the number of reels of input tape.

When the input radar data is contained on a DR format tape, the time and sampling rate are not altered. The range is converted from yards to meters, and the azimuth and elevation are converted from mils to radians.

If the input data is on a UNILOG tape, the sampling rate is reduced from 20 samples per second to 10 samples per second by averaging each 2 consecutive points. The time is referenced to the time of launch by subtracting the lift-off time, found in the COMMON area LIFTTM, which also contains input subchannel numbers and radar numbers. The range is converted from yards to meters, and the angles are converted to radians. If two radars are to be processed in one run, the data for the second radar is converted and written on Fortran logical unit 3, while the data for the first radar is being reduced. This data is used directly, without further conversion, when processing the second radar.

The data is read from the UNILOG tape by the subroutine RTDATA and is stored in the common area FPS. The common area EOFF contains an end of file indicator.

-33-

Subroutine THERMO (TIEP, ALTIT, TIET N1, N2, NOM, IN, NCOR, GG, RE)

The subroutine THERMO computes corrected temperature, pressure, density and speed of sound for the data points found in the COMMON area WIND and stores them in the COMMON area TMP. The uncorrected temperature corresponding to each point in the array ARR is stored in the array ARC in the COMMON area TMP.

First, the temperature correction is computed by using Equation (8). The geopotential altitude is computed thus:

$$Z_p = \frac{g \times R_e \times Z}{9.8 \times (Re + Z)}$$

where Z_p = geopotential altitude

g = acceleration due to gravity

R_e = radius of the earth

Z = geometric altitude.

Except when processing constant-pressure-level data, the next step is to compute corresponding pressure. For the kth point,

$$P(k) = P(k-1) \times exp\ [Z_p(k-1)-Z_p(k)/(14.63725 \times (T(k)+T(k-1)))]$$

where P = pressure (mb)

Z_p = geopotential altitude (m)

T = temperature (°K)

and k-1 is the previous point computed if k>1, the raob base-level point is k=1.

Then density is computed:

$$D = P \times 348.38/T$$

where D = density (gm/cu m)

P = pressure (mb)

T = temperature (°K).

-34-

Also,

$$D_1 = D \times 1.9403806 \times 10^{-6}$$

where D_1 = density (slugs/cu ft).

Speed of sound is calculated:

$$S = 20.0544 \times \sqrt{T}$$

where S = speed of sound (m/s)

T = temperature (°K).

All missing data is bad-flagged.

The variables TIEP, ALTIT, and TIET are the RAOB base-level pressure, geopotential altitude and rocket absolute temperature. The variables N1 and N2 are the indices of the first and last points for which there is temperature data, while NOM is the number of points in the array ARR. The variable IN indicates the type of data levels. The temperature correction to be used is specified by the variable NCOR. GG is the local acceleration due to gravity and RE is the local radius of the earth.

Subroutine WNDAVG (DIV, NOM, KK, JL)

The subroutine WNDAVG computes averaged wind data for an interval of size DIV. The wind data samples which are to be used in averaging were written on Fortran logical unit 13 as they were computed by the main program. As the individual samples are read, sums of the x, y, and z component velocities are computed. After all the data has been read, component velocities are computed. Vector wind and wind shear are then calculated from the component velocities. The time is obtained by interpolation. Any layer for which fewer than N points were found is bad-flagged, where N is 6 when the wind is computed from radar input

tape, and N equals 1 when the wind is input on data cards.

All computed data is stored in the array ARR in the COMMON
area WIND. The variable NOM is the number of points for which
wind averages are to be computed. The variable KK indicates
whether the altitudes to be used are in meters or feet. The
variable JL is used to indicate the wind data input type, i.e.,
cards or digital tape.

VII. GLOSSARY OF MNEMONICS

Main Program

A	wind direction in radians
AA	constant used in computing constant-pressure altitudes
AB	constant used in interpolating
ACC (3,10)	array used in storing acceleration prior to use of 10-point filter
ALT (200)	array containing altitudes
ALTIT	geopotential altitude of base-level point
ALTITD	geometric altitude of base-level point
APO (12)	array of altitudes used in searching for apogee
ARC (7,200)	array used to store thermodynamic data
elt 1	temperature °C
2	temperature °K
3	temperature correction
4	pressure mb)
5	density (gm/m3)
6	density (slug/cu ft)
7	speed of sound (m/s)
ARR (10,200)	array used to store layer wind data
elt 1	time (sec)
2	altitude (meters)
3	altitude (feet)
4	N-S wind component
5	E-W wind component
6	windspeed
7	wind direction
8	fall velocity
9	wind shear
10	time (min sec)
ATE	layer thickness used in computing altitude array
AZ	azimuth
BLANK	5-character field of blanks
BLANN	1-character field containing a blank

-36-

C	constant equal to .0174533
CONF	factor used to convert input altitudes to feet
CONM	factor used to convert input altitudes to meters
CON1	1.94254 converts m/s to knots
CONZ	-1.68895 converts knots to ft/sec
DEN	constant equal to change in time
DY	day of month
EL	elevation
FLAG (200)	array used to indicate missing temperature data
GG	acceleration due to gravity
IDD	data card type indicator
IND	indicates type of data being processed
	= -1 when processing one radar from UNILOG tape
	= 0 when processing 1st of 2 radars (UNILOG tape)
	= 1 when processing 2nd of 2 radars (UNILOG tape)
	= 2 when processing DR format tape
INK	indicator = 0 except when missing data layer greater than 5 km
IOF	end of file indicator
IOP (11)	input options
elt 1	wind input type
2	temperature input type
3	temperature correction type
4	English units output option
5	ozone parameters output option
6	constraints on wind data option
7	corrected winds input indicator
8	use base-level-point option
9	continue temperature data indicator
10	continue thermodynamic data option
11	suppress printing 1/sec wind data option
IRAD (2)	radar number
IRDAR	radar being processed
ISC (2)	input subchannel
ITE	layer thickness used in computing altitude array
K	temperature correction type indicator
KEX	number of questionable data points
KK	index used in searching for apogee
KLM	= 0 until printing wind shear data
KYM	= 0 until first wind data card has been checked
LAST	altitude of last point in array
LFIRST	altitude of first point in array
LL	index used in Eddy correction
MINUS	1-character field containing a minus sign

MK (11)	array containing data to be output in MRN format
elt 1	altitude
2	wind direction
3	windspeed
4	N-S wind component
5	E-W wind component
6	fall velocity
7	temperature
8	temperature correction
9	power of 10 multiplied to obtain pressure
10	power of 10 multiplied to obtain density
11	speed of sound
MON	month (integer)
MONTH (24)	array containing names of months
MSIG	number of base-level points input
MUN (2)	two digits representing month
MI (5)	five digits representing altitude
M2 (3)	three digits representing wind direction
M3 (3)	three digits representing windspeed
M4 (3)	three digits representing N-S wind component
M5 (3)	three digits representing E-W wind component
M6 (3)	three digits representing fall velocity
M7 (3)	three digits representing temperature
M8 (2)	two digits representing temperature correction
M11 (3)	three digits representing speed of sound
NEND	number of reels of input tape
NINE	1-character field containing a nine
NMP	number of significant temperature points input
NOM	number of levels in array
NOMM	number of levels in array
NOMP	number of levels in array
NOMI	number of levels in array
NZ	number of consecutive bad wind data points
NI	index of first level with temperature data
N2	index of last level with temperature data
PLUS	1-character field containing a plus sign
QUS (2,100)	array containing time and altitude of questionable wind data points
RAW (4,121)	raw radar data array
elt 1	time
2	range
3	azimuth
4	elevation
RDNUM	round number
RE	radius of the earth
RG	range
ROCKT (3)	type of rocket
SALT	station altitude

SHEAR	wind shear
SIG (4,200)	array containing data for significant levels
elt 1	corrected temperature °K
2	uncorrected temperature °C
3	pressure
4	altitude
SITE (3)	launch site
SLAT	station latitude
SLAT2	SLAT multiplied by 2
SLAT4	SLAT multiplied by 4
SLONG	station longitude
SMOT (10,5)	array containing smoothed radar data
elt 1	time
2	range
3	azimuth
4	elevation
5	X
6	Y
7	Z
8	X velocity
9	Y velocity
10	Z velocity
SM4	1-character field containing sign of N-S wind component
SM5	1-character field containing sign of E-W wind component
SS (5,6)	array containing input base-level points
elt 1	altitude
2	pressure
3	raob temperature
4	rocket temperature
5	temporary storage
STAT	station number
SZ (11)	array containing altitudes of constant-pressure levels
TEMP (200)	array containing temperatures
TFF	first time read from radar input tape
TIE	base-level rocket temperature °C
TIEP	base-level pressure
TIER	base-level raob temperature
TIET	base-level rocket temperature °K
TIME (200)	array containing times
TIMEL	time of launch (GMT)
TIMEZ	lift-off time (sec)
TIMM	time in minutes and seconds
TM	time of raw data point
TP (4,200)	array containing input temperature data
elt 1	time
2	temperature
3	altitude
4	temperature correction
TPCOR (200)	array containing temperature corrections
TT	time of wind data point

TT1	time of previous point
VD	wind direction
VD1	wind direction of previous point
VS	windspeed
VS1	windspeed of previous point
VT	total velocity
VT1	total velocity of previous point
VT2	VT1 multiplied by 1.3
VT3	VT1 multiplied by .7
VX	corrected E-W wind component
VX1	E-W wind component of previous point
VY	corrected N-S wind component
VY1	N-S wind component of previous point
VZ	vertical velocity
VZP (200)	array containing fall velocity
WGT (59)	weighting factors used in the 117-point raw data filter
WSSITE (3)	alpha field containing SMR, WSMR, NM
WSSTAT	station number for WSMR
WW (10)	weighting factors used in the 10-point filter used to smooth accelerations
XAC	smoothed X acceleration
YAC	smoothed Y acceleration
YR	year
ZAC	smoothed Z acceleration
ZF	altitude in feet
ZFIRST	altitude of first valid wind data point
ZLAST	altitude of last valid wind data point
ZZ	altitude (meters) corrected for earth's curvature
ZZ1	altitude of previous point

MRN

B	temporary storage
F9	pressure divided by power of 10
F10	density divided by power of 10
SM10	sign of exponent of 10 used with density
SM7	sign of temperature
SM8	sign of temperature correction
SM9	sign of exponent of 10 used with pressure

WINDAVE

CON	factor to convert altitude to meters
DIV	averaging interval ize
JL	= 0 if wind input is radar tape
KK	equal 2 if altitude to be used are in meters, 3 for feet
KJ	equal 0 until first point has been processed
NOM	number of averaged points

NZ	number of consecutive bad wind data points
TPREV	time of previous point
TT	time
VD	wind direction
VS	windspeed
VX	E-W wind component
VY	N-S wind component
VZ	fall velocity
ZPREV	altitude of previous point
ZZ (2)	array containing data point altitude
elt 1	meters
2	feet

RTDATA

BUFFA (3241)	input data buffer
IA (32)	array containing azimuth data by subchannel
ID (32)	array containing rate of change of range (R dot) data by subchannel
IE (32)	array containing elevation data by subchannel
IEOF	end of file indicator
IFIRST	equals 0 until initialization is complete
IMTDAT	array used when reading met data
INBUF (3241)	input data buffer
IREAD	end of data block indicator
ITQ (32)	array containing tracking mode data by subchannel
ITYPE	data type indicator
KK (6)	status array used by tape read routine
KNT	number of points of data processed in data block
T	time of data point
T1	time of met data point

TPREAD

AZM (32)	array containing azimuth data by subchannel
A1	azimuth value used in 2-point average
A2	azimuth value used in 2-point average
ELV (32)	array containing elevation data by subchannel
ENDFI1	end of file indicator
E1	elevation value used in 2-point average
E2	elevation value used in 2-point average
ID (32)	array containing radar identification by subchannel
IPAR	parity error indicator
IRDT (32)	array containing rate of change of range (R dot) by subchannel
ITQ (32)	array containing radar tracking mode by subchannel
J1	index for data for first radar processed
J2	index for data for second radar processed

RAN (32)	array containing range data by subchannel
R1	range value used in 2-point average
R2	range value used in 2-point average
TALT	time of data point
T1	time value used in 2-point average

THERMO

JJ	index of element in array ARC which corresponds to jth element in ALT array
KKK	index of first element for which pressures are computed

D	interpolated value of DZ
DZ (46,3)	array containing coefficients used in Thermo correction
RATIO	constant used in interpolation
Z (46)	array containing altitudes corresponding to coefficients AZ, BZ, CZ, and DZ

OZONE

O1	$d(\ln P)/dz$
O2	$d(\ln T)/dz$
ZX	change in altitude from following point
ZY	change in altitude from previous point

VIII. TEMPERATURE REDUCTION COMPARISON

Since this report describes a system that will perform automated processing of the temperature data from a rocketsonde, an indication of the accuracy of such processing will now be made.

Because the temperature data from the automated system merely replaces the manual data with no further changes in the computer processing of the rocketsonde, only comparisons of temperatures from both systems need be made.

As an indication of accuracy between the two systems, three separate rocket flights were processed by the automated system and the temperature data compared with manual data in graphical plots. These results are shown in Figures 10, 11 and 12.

-42-

TIME AFTER LAUNCH (SECONDS)

MANUAL REDUCTION

ATMOSPHERIC DEGREES CELCIUS

- 4 -

MANUAL REDUCTION

TIME AFTER LAUNCH (SECONDS)

TEMPERATURE DEGREES CELSIUS

-44-

TIME AFTER LAUNCH (SECONDS)

TEMPERATURE DEGREES CELCIUS

MANUAL REDUCTION

-45-
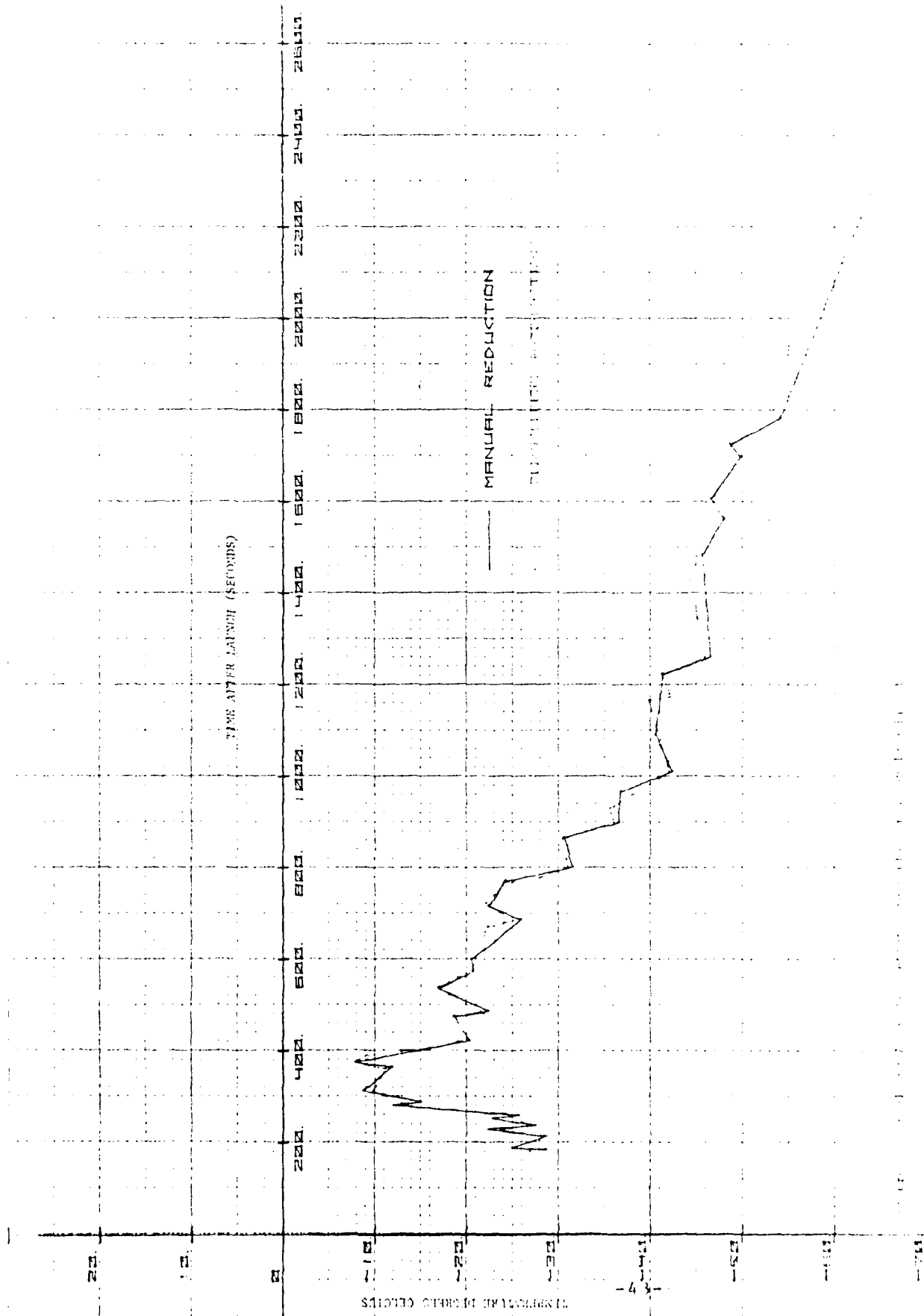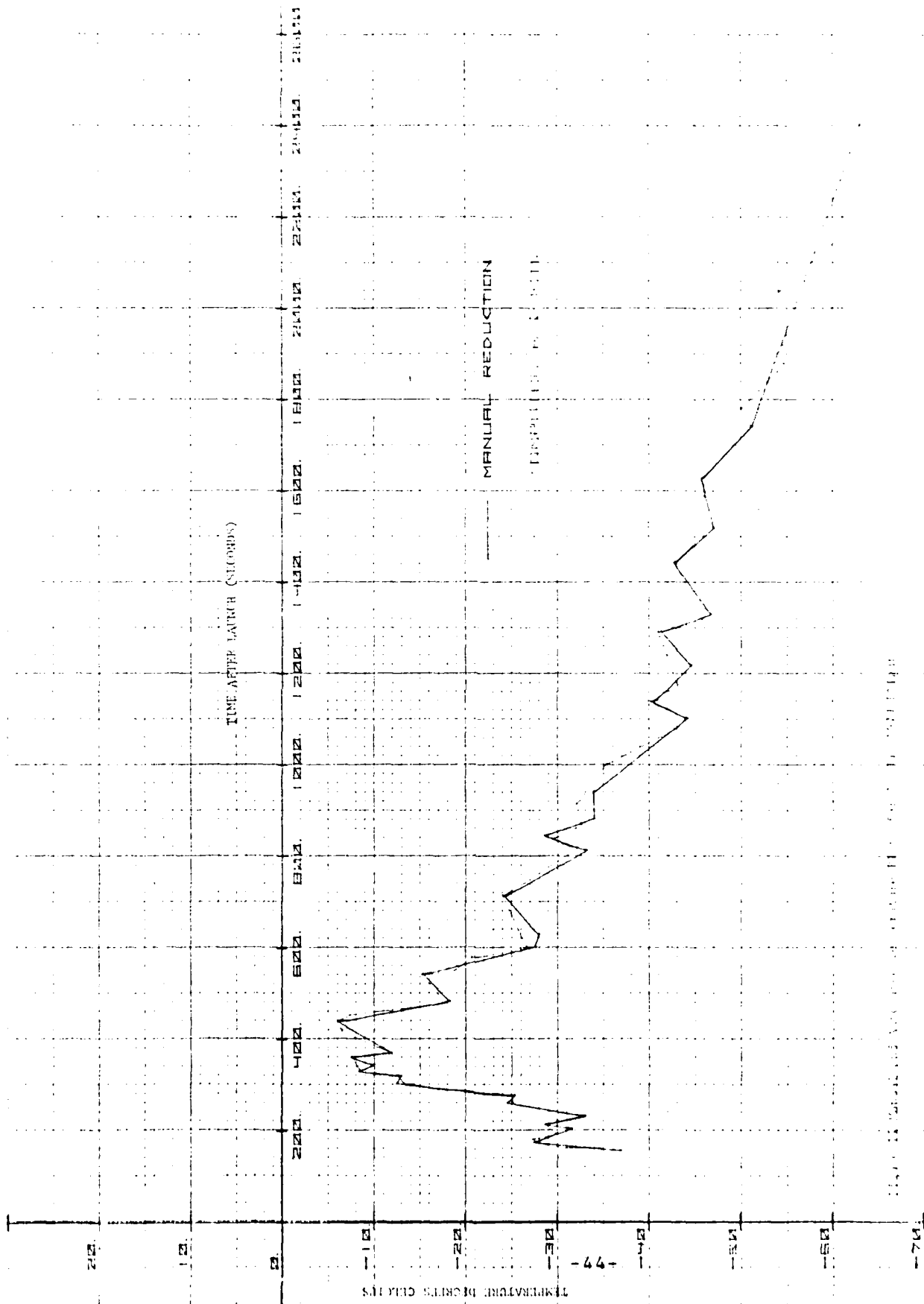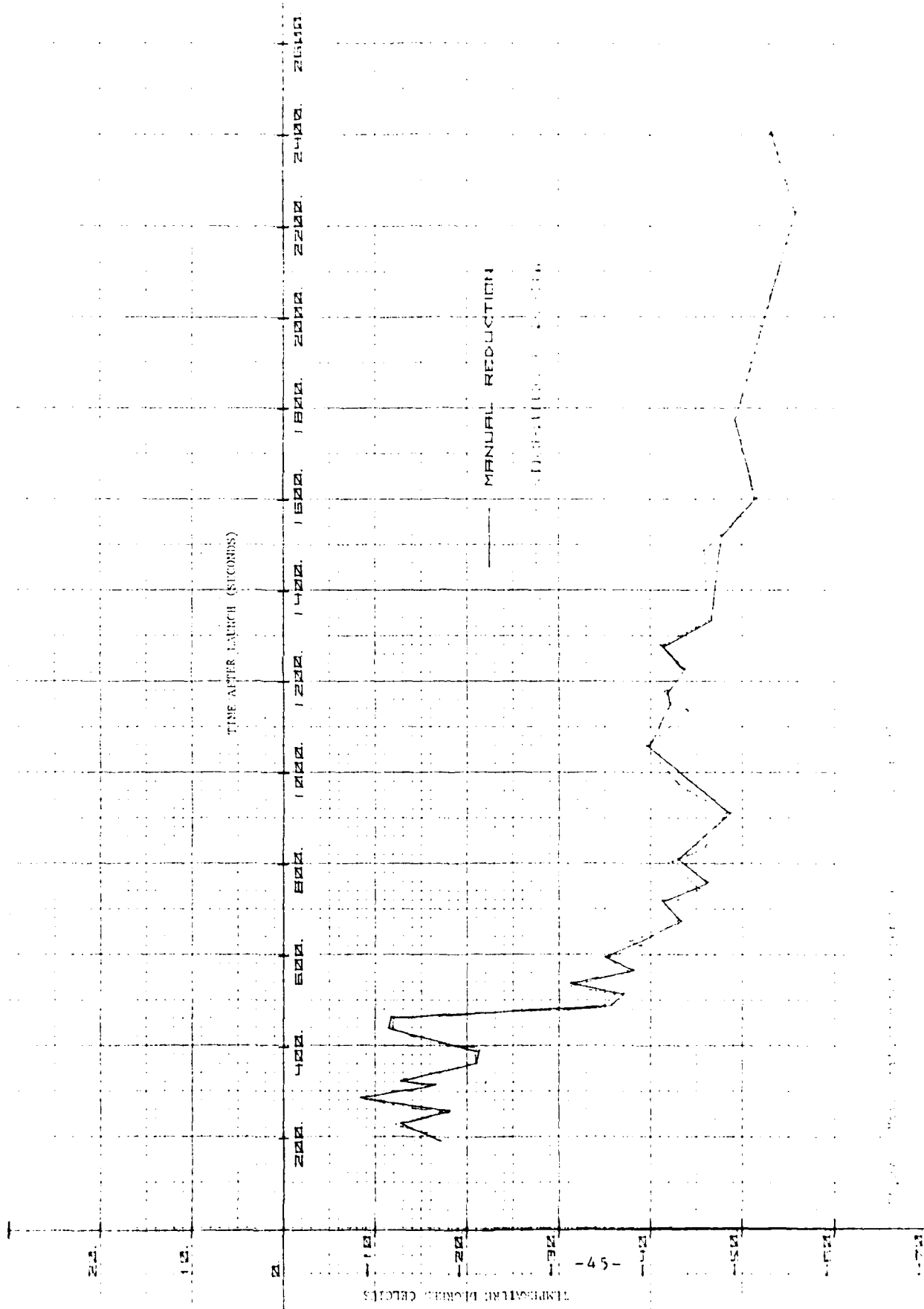
In comparing the two plots in each figure, there is good agreement in some areas and not so good agreement in other areas. Since the criterion specified by the IRIG data reduction requires that the straight line segments be only within 2° of the actual curve--there curve--there is some room for difference. For example in Figure is some room for difference. For example in figure 10, the point at 2150 s and -58° yields a difference of 3.5. If the actual (strip chart) temperature were -59.75°, then the differences (manual and computer verses actual) would both be 1.75°, well with the 2nd degree tolerance.

In a further analysis for comparison, the actual raw data plots (Q5 recording) were compared with both the manual and automated output of points where the differences were large. In all cases except one, both data were within the 2° limit. The one exception was the manual reduction, which was in error due to the incorrect reading of the raw data chart.

These comparisons indicate that the automated reduction method is as good or better than the manual technique.

IX. DESCRIPTION OF DATA CARDS FOR PROGRAM

A. IDENTIFICATION CARD

The identification card is included in all runs and contains general information about the type of round and the launch location.

Col No	Format	
01-18	3A6	Rocket Type (Super Loki, etc.)
19-22	A4	Round number for the type of rocket fired during the year from that site
23-24	A2	Last two digits of year
25-26	21	Two-digit number representing month
27-28	A2	Two-digit number for day of month
29-32	A4	GMT time of launch rounded to nearest minute (leave remaining fields blank if launch site is SMR, WSMR
33-50	3A6	Name of launch site, e.g., Green River, Utah

51-55	A5	MRN station number (e.g., 72477 for Green River)
56-64	F9.4	Station latitude (e.g., 38.933 for Green River)
65-73	F9.4	Station longitude (e.g., 110.083 for Green River)
74-78	F7.2	Station altitude meters MSL (e.g., 1305 for Green River)

B. OPTIONS CARD

The options card is included in all runs and is used for selecting the options for each run.

Col No Format

1	I1 IOP(1)	Wind input type = (0 or blank) - no wind input, temperatures only = 1 UNILOG radar tape used to compute winds = 2 DR format radar tape used to compute winds = 3 winds input on cards
3	I1 IOP(2)	Temperature input type = (0 or blank) - no temperature input - winds only (no temp sense) = 1 time vs. temp input on cards (used only with winds) = 2 altitude (km) vs. temp input on cards (no wind input) = 3 altitude (ft) vs. temp input on cards (no wind input) = 4 no temperature input (sensor failure) = 5 temperature vs. time from digitized telemetry
5	I1 IOP(3)	Temperature correction type = (0 or blank) - no temp correction used = 1 Arcasonde temp correction used = 2 Loki Datasonde temp correction used (for runs with wind and temperature, for temperature-only runs, no temperature correction is computed but one may be included on the temperature data cards). = 3 Krumins' correction
7	I1 IOP(4)	English units option = (0 or blank) - no additional output ≠ (0 or blank) - additional listing and output cards containing data in English units for 1000 ft levels
9	I1 IOP(5)	Ozonesonde parameters option = (0 or blank) - no additional output ≠ (0 or blank) - data computed for .5 km and 1 kft instead of standard 1 km and 5 kft, ozonesonde parameters computed for all levels

11	I1	Ignore wind data constraints option
		= (0 or blank) - standard
	IOP(6)	≠ (0 or blank) - constraints on fall velocity and point-to-point wind variation ignored
13	I1	Corrected winds used on card input
		= (0 or blank) - assumes input wind data is uncorrected
		≠ (0 or blank) - assumes input wind data is corrected
	IOP(7)	(This option is used only when winds are input on cards. The only difference in output is the columns in which the wind is put in the MRN formatted output).
15	I1	Ignore base-level criterion option
		= (0 or blank) - if no input base-level point has agreement of 2.5° between raob and rocket temperatures, no thermodynamic data is computed. If more than one point
	IOP(8)	meets the criterion, the one closest to 25 km is selected.
		≠ (0 or blank) - if one or more points meet the above criterion, the one closest to 25 km is selected.
17	I1	Continue temperature data option
		≠ (0 or blank) - if a layer of missing tem-
	IOP(9)	perature data is greater than 5 km - temperatures are considered missing for remainder of flight.
		≠ (0 or blank) - temperature computations are continued regardless of existence of missing data
19	I1	Continue thermodynamic data option
		= (0 or blank) - if a layer of missing temperature data is greater than 3 km,
	IOP(10)	pressure, density, etc. are not computed for remainder of flight
		≠ (0 or blank) - thermodynamic computations are continued regardless of existence of missing data.
21	I1	Suppress printing 1/sec wind data
		= (0 or blank) - standard
	IOP(11)	≠ (0 or blank) - 1/sec wind data points are not printed. The summarized output remains unchanged.

C. DIGITAL RADAR TAPE PARAMETERS

This card is included only when winds are to be computed from radar data input on a digital tape (i.e., UNILOG tape or DR formatted tape).

Col No. Format

1-3	I3	Radar number
5-6	I2	Radar subchannel (leave blank for DR tape)
8-10	3	Radar number for 2nd Radar (leave blank for DR tape or for processing only one radar)
12-13	I2	Radar subchannel for 2nd radar
15-23	F9.3	Lift-off time in seconds (leave blank for DR tape)
25	I1	Number of reels of input tape

D. TEMPERATURE CALIBRATION DATA

These cards are included only when temperature input option and temperature vs. time from digitized telemetry, is selected. The data for these cards is taken from the calibration chart data.

1. Cards 1, 2, and 3
   Col 1 thru 70 7F10.4 format - the 21 values located in the 2nd column of the calibration sheet that shows the instrument number and thermister number for the datasonde. See Table 4.

2. Card 4
   Col 1 thru 50 5F10.3 format - the 5 values located in the last row of the sheet used for cards 1, 2 and 3 above. See Table 4.

3. Card 5
   Col 1 thru 30 3F10.3 format - the 3 values of temperature corresponding to the ratios of 0.3, 0.5, and 0.7, respectively, from the ratio vs. temperature data.

4. Card 6
   Col 1 thru 10 F10.1 format - this value is taken from the Q-5 plot and represents the ordinate corresponding to reference during the T-2 minute prelaunch plot. This value is not necessary for temperature calculations but does provide a cross reference value to the Q-5 recording.

E. WIND DATA CARDS

These cards are used to input manually reduced winds and are omitted if a radar tape is used or for a temperatures-only run. There is no program limitation on the number of wind data cards which may be included in any run.

Col No Format

1	I1	= 1 card id for wind cards
2-10	F9.6	Time from lift-off (min. sec.)
11-22	F10.2	Altitude km MSL
21-30	F10.0	Wind direction - degrees from north
31-40	F10.0	Windspeed - meters/sec

F. BASE-LEVEL POINT CARDS

These cards are used to input a base-level pressure and corresponding altitude from which thermodynamic data (pressure, density) is computed using hydrostatic equations and rocket temperatures. Zero to 5 base level points are input with each run with temperatures and the best one is selected as described for the 8th option on the option card. If no base-level point is input or if all are rejected because of temperature disagreement, then pressures and densities are not computed.

Col No Format

1	I1	= 2 card id for base-level point
2-10	F9.2	= Geometric altitude - km MSL (ft MSL are used if temperature altitudes are input in ft)
11-20	F10.3	Raob pressure - millibars
21-30	F10.3	Raob temperature - °C

G. TEMPERATURE DATA CARDS

These cards are used to input temperature on all runs that include temperatures when the temperature vs time - telemetry option has not been selected. As many as 200 temperature data cards may be included in any run.

Col No Format

1	I1	= 4 card id for temperature cards
2-10	F9.2	Time from lift-off (min. sec.)
11-20	F10.3	Temperature - °C

(Rest of card is blank except for temperatures-only runs)

21-30	F10.3	Geometric altitude - km or ft MSL - (see 2nd option on options card)
31-40	F10.3	Temperature correction - °C

-50-

X. EXAMPLES

A. TEMPERATURE VS. TIME FROM DIGITIZED TELEMETRY

An example of how the program can be run from a terminal will now be given.

The Table 4 below shows most of the calibration data that is needed for computing temperature versus time from telemetry ($IOP(2) = 5$).

The data within the rectangle (Column 2) of Table 4 is input on 4I thru 6I, and the data within the rectangle (last row) of Table 4 is input on 7I. See next page.

The remainder of the data is as described in Section VI.

INSTRUMENT NO   21540   THERMISTOR NO   77-10-19212

21	5			
1.0	0.9915	5572.0	5620.0	
5.0	0.9577	5572.0	5818.0	
10.0	0.9190	5572.0	6063.0	
20.0	0.8509	5572.0	6548.0	
30.0	0.7935	5572.0	7022.0	
40.0	0.7440	5572.0	7489.0	
50.0	0.7006	5572.0	7953.0	
60.0	0.6623	5572.0	8413.0	
70.0	0.6299	5572.0	8846.0	
80.0	0.6000	5572.0	9286.0	
90.0	0.5736	5571.0	9713.0	
100.0	0.5506	5571.0	10118.0	
150.0	0.4594	5571.0	12126.0	
200.0	0.3986	5571.0	13976.0	
300.0	0.3222	5571.0	17291.0	
400.0	0.2766	5571.0	20139.0	
600.0	0.2234	5571.0	24938.0	
800.0	0.1941	5571.0	28708.0	
1000.0	0.1757	5572.0	31722.0	
1500.0	0.1498	5572.0	37191.0	
2000.0	0.1359	5572.0	40986.0	
-65.0	-50.0	-25.0	0.0	35.0
1333.000	479.600	109.400	31.000	7.107

TABLE 4   THERMISTOR AND INSTRUMENT CALIBRATION DATA

NOTE ALL LINES THAT HAVE > IN THEM

ARE TERMINATED WITH A RETURN ON TERMINAL

>@USE A.,8300*DATAFL.

READY

>@ED,I A.

CASE UPPER ASSUMED

ED 16R1W1 - (DAY - TIME)

INPUT

1I:>

EDIT

0:>TAB /   This establishes the tab character

0:>SET 19

0:>

INPUT

1I:>LOKI PARACHUTE/00137901221900

2I:>

EDIT

1:>SET 3,5,7,17,19,21

1:>

INPUT

2I:>1/5/2/1/1/1

3I:>

EDIT

```
2:>SET 5,8,15,25

2:>

INPUT

31:>113/1/396/68400.0/1

41:>

EDIT

3:>SET 11,21,31,41,51,61

3:>

INPUT

41:>.9915/.9577/.9190/.8509/.7935/.7440/.7006

51:>.6623/.6299/.6000/.5736/.5506/.4594/.3986

61:>.3222/.2766/.2234/.1941/.1757/.1498/.1359

71:>1333./479.6/109.4/31./7.107

81:>-44.5/-27.6/-10.

91:>90.2

101:>2 20.939/50./-55.6

111:>2 24.021/30./-49.2

121:>2 26.953/20./-46.9

131:>2  31.577/10./-37.8

141:>

EDIT

13:>LNP!
```

```
 1:LOKI PARACHUTE  00587901221900

 2:1 5 2 1        1 1

 3:113 1  396  68400.0    1

 4:.9915       .9577    .9190     .8509    .7935    .7440    .7006

 5:.6623       .6299    .6000     .5736    .5506    .4594    .3986

 6:.3222       .2766    .2234     .1941    .1757    .1498    .1359

 7:1333.       479.6    109.4     31.0     7.107

 8:-44.5       -27.6    -10.

 9:90.2

10:2 20.939  50.      -55.6

11:2 24.021  30.      -49.2

12:2 26.953  20.      -46.9

13:2 31.577  10.      -37.8
```

TABLE 5 Card Images for ROCKET Program

```
0:>EXIT

LINES:   13 FIELDATA

(ANY ERRORS MADE ABOVE CAN BE CORRECTED BY USING THE OTHER EDIT COMMANDS)

>@USE B.,8300*ROCKET.

READY

>@ASG,TZ 2.,U,ACB788 (Assign unilog tape)

>@ASG,ZA PUNCHFL.

>@ASG,ZA PRINTFL.
```

```
>@BRKP.  PUNCH$/PUNCHFL

>@BRKPT  PRINT$/PRINTFL

>@HDG    (NAME NUMBER FOR OUTPUT)

>@XQT    B.METROC

>@ADD    A.

         (There will be a wait period here until a > is printed)

>@BRKPT  PUNCH$

>@BRKPT  PRINT$
```

The results of the output PRINTFL can be sent to any of the high speed printers by use of the SYM control statement or the user can examine the output with the ED processor. For this example the results of the computations up to where the wind data is printed is shown on the next pages.

OPTIONS SELECTED

WIND INPUT-UNILOG TAPE

TEMPERATURE VS TIME-TELEMETRY

HENRY (IRIG) CORRECTION FOR LOKI DATASONDE TEMPERATURES USED

CONTINUE THERMODYNAMIC COMPUTATIONS EVEN IF LAYER OF TEMP DATA MISSING

IS GREATER THAN 3KM

SUPPRESS PRINTING 1/SEC WIND DATA

LOKI PARACHUTE NUMBER 0013 LAUNCHED 22 JAN. 79, 1900 from SMR, WSMR, NM

STATION LATITUDE 32.467 LONGITUDE 106.417 ALTITUDE 1215.910 METERS

RADAR 113

GEOMETRIC ALTITUDES

LOKI CALIBRATION TAPE DATA

Ratios

.9915

.9577

.9190

.8509

.7935

.7440

.7006

.6623

.6299

.6000

.5736

.5506

.4594

.3986

.3222

.2766

.2234

.1941

.1757

.1498

.1359

CALIBRATION VALUES

1333.0000   479.6000 109.4000 31.0000   7.1070

CALIBRATION CHECK

RATIO	COMP	CHART	DIFF
.3	-44.7	-44.5	-.1
.5	-27.4	-27.6	-.2
.7	-10.0	-10.0	.0

DATA FOUND IN SUBCHANNELS

   1

   9

  19

FIRST TIME ENCOUNTERED ON RADAR TAPE   .065 SEC

LOKI PARACHUTE NUMBER 0013 LAUNCHED 22 JAN 79, 1900 FROM SMR, WSMR, NM
STATION LATITUDE 32.467 LONGITUDE 106.417 ALTITUDE 1215.910 METERS
RADAR 113
GEOMETRIC ALTITUDES

SIGNIFICANT LEVEL TEMPERATURES

SEC	TIME MIN:SEC	TEMP	RATIO	ORDINATE
123	2:03	31.71	.9299	83.7
127	2:07	33.99	.9355	84.2
156	2:36	.32	.7905	71.0
166	2:46	-1.21	.7786	70.0
175	2:55	-8.79	.7122	64.0
185	3:05	-8.16	.7184	64.6
195	3:15	-14.30	.6554	58.9
213	3:33	-15.76	.6392	57.4
232	3:52	-12.32	.6761	60.7
259	4:19	-17.37	.6210	55.7

279	4:39	-11.08	.6891	61.9
293	4:53	-9.30	.7072	63.6
315	5:15	-15.94	.6373	57.3
330	5:30	-13.20	.6669	60.0
367	6:07	-21.10	.5769	51.9
401	6:41	-20.86	.5802	52.2
414	6:54	-15.86	.6387	57.5
443	7:23	-12.04	.6795	61.2
465	7:45	-12.14	.6787	61.1
475	7:55	-17.46	.6202	55.8
484	8:04	-31.76	.4466	40.2
489	8:09	-34.62	.4111	37.0
516	8:36	-36.23	.3920	35.3
535	8:55	-31.42	.4500	40.5
567	9:27	-37.68	.3767	33.9
596	9:56	-35.36	.4024	36.3
623	10:23	-39.13	.3606	32.5
632	10:32	-37.77	.3753	33.9
674	11:14	-43.11	.3166	28.6
707	11:47	-41.43	.3345	30.2
744	12:24	-45.44	.2930	26.4
804	13:24	-42.51	.3224	29.1
836	13:56	-46.05	.2873	25.9
911	15:11	-48.35	.2662	24.1
974	16:14	-43.31	.3142	28.4
1058	17:38	-39.67	.3542	32.0
1135	18:55	-44.24	.3056	27.7
1176	19:36	-41.62	.3325	30.1
1227	20:27	-43.62	.3117	28.2
1278	21:18	-41.27	.3369	30.5
1333	22:13	-46.45	.2836	25.7
1485	24:45	-45.95	.2882	26.1
1600	26:40	-51.81	.2376	21.5
1783	29:43	-49.20	.2595	23.5
2223	37:03	-55.99	.2059	18.6
2403	40.03	-53.46	.2234	20.3

B.   TEMPERATURE VS. TIME FROM CARDS

On page 60 is a listing of a file called 8300*LOKI.CONTROL.

This file contains information for:

   1)   Control of operations - Lines 1-8 and Lines 44-45
   2)   Data for IDENTIFICATION CARD (page 46) - Line 9
   3)   Data for OPTIONS CARD (page 47) - Line 10
   4)   Data for DIGITAL RADAR TAPE PARAMETERS (page 48) Line - 11
   5)   Data for BASE-LEVEL Point Cards (page 50) - Lines 12-15
   6)   Data for TEMPERATURE DATA CARDS (page 50) - Lines 16-43

Prior to execution of the control file, a phone call to the tape

library (678-3173) requesting that tape E206 be taken to system D

should be made. The execution is made by typing (the '·' is the system

promter)

         ·(·ADD 8300*LOKI.CONTROL

When the system responds with '>', the file PRINT. can be examined

with the ED processor or SYMmed to a printer.

Below is an explanation of the listing shown on the pages

indicated:

Page   LISTING

61   Options selected
62   One per second wind (would continue until end of flight)
63   Thermodynamic data for input temperatures
64   Thermodynamic data for kilometer levels
65   ROCOB message
66   Plot of Wind (x,y) and Temp vs. Altitude
67   MRN 30 cards
68   MRN 30 cards (continued)
69   Thermodynamic data for 5000 feet levels
70   Thermodynamic data for mandatory levels
71   MRN 40 cards

```
 1        @ASG,CP  PRINT.
 2        @BRKPT PRINTS/PRINT
 3        @ASG,CP  PUNCH.
 4        @BRKPT PUNCHS/PUNCH
 5        @ENABLE  B300*ROCKET.
 6        @ASG,A   B300*ROCKET.
 7        @ASG,TF  2,U,E2U6
 8        @XQT B300*ROCKET.METROC
 9        LOKI PARACHUTE    00426109251630
10        1  1  3
11        114 OZ       59400.151 1
12        221.641           44.6      -57.8
13        222.860           36.9      -55.9
14        224.089           26.5      -52.7
15        225.299           25.3      -52.2
16        4  2.35          -26.2
17        4  3.01          -15.7
18        4  3.35          -14.7
19        4  3.46          -17.3
20        4  4.25          -08.1
21        4  4.46          -09.5
22        4  5.06          -07.1
23        4  5.48          -10.6
24        4  6.09          -04.9
25        4  7.34          -13.8
26        4  7.52          -10.2
27        4  8.33          -09.3
28        4  9.59          -21.5
29        4 10.37          -26.8
30        4 11.30          -32.6
31        4 13.17          -32.3
32        4 15.24          -36.4
33        4 16.37          -36.5
34        4 18.08          -42.2
35        4 21.36          -49.3
36        4 22.59          -48.4
37        4 27.55          -52.2
38        4 30.32          -52.9
39        4 32.37          -55.9
40        4 35.07          -56.0
41        4 36.02          -58.0
42        4 36.53          -57.4
43        4 38.52          -56.8
44        @BRKPT PRINTS
45        @BRKPT PUNCHS
```

OPTIONS SELECTED

WIND INPUT-UNILOG TAPE

TEMPERATURE VS TIME-CARD

KROMIN CORRECTION (DAY) USED FOR ROCKET TEMPERATURES

DATA FOUND IN SUBCHANNELS--
  2
  9
  12

FIRST TIME ENCOUNTERED ON RADAR TAPE   .000 SEC

-61-

LOKI PARACHUTE   NUMBER 0042 LAUNCHED 25 SEP 81 1630 FROM SMR, ASWR, N M
STATION LATITUDE   32.467 LONGITUDE   106.417 ALTITUDE   1215.906 METERS   RADAR 114
GEOMETRIC ALTITUDES

TIME	ALTITUDE (MSL)		WIND VELOCITY (M/SEC)			DIRECTION	FALL VELOCITY	WIND SHEAR	TIME
(SEC)	(METERS)	(FEET)	-N+S	-E+W	TOTAL	(DEGREES)	(M/SEC)	(MPS/M)	(MIN-SEC)
129.2	66535.	224852.	-80.5	58.8	99.7	323.84	-69.	-.130	2.09
130.2	66403.	224616.	-88.8	63.0	108.9	324.67	-75.	-.075	2.10
131.2	66365.	224360.	-83.0	62.5	103.9	323.02	-81.	-.178	2.11
132.2	66302.	224087.	-80.7	60.3	89.9	317.86	-86.	-.154	2.12
133.2	66214.	224798.	-53.2	57.1	79.5	312.01	-90.	-.078	2.13
134.2	66121.	223493.	-46.0	59.7	75.3	307.62	-96.	-.071	2.14
135.2	66022.	223170.	-38.2	64.0	74.5	300.80	-101.	-.076	2.15
136.2	65920.	224634.	-31.0	60.8	66.3	297.02	-114.	-.068	2.16
137.2	65814.	224486.	-24.5	57.8	62.8	292.94	-118.	-.047	2.17
138.2	65705.	222120.	-19.9	53.8	59.0	289.69	-111.	-.036	2.18
139.2	65592.	221760.	-16.3	57.6	59.9	285.83	-113.	-.060	2.19
140.2	65478.	221384.	-11.7	62.7	63.8	280.61	-116.	-.046	2.20
141.2	65360.	220999.	-6.8	64.4	64.9	275.89	-119.	-.047	2.21
142.2	65240.	220602.	-4.4	62.0	62.2	274.07	-123.	-.006	2.22
143.2	65115.	220195.	-4.1	62.8	62.9	273.74	-125.	-.017	2.23
144.2	64990.	219782.	-6.1	63.7	64.0	275.45	-126.	-.012	2.24
145.2	64863.	219368.	-6.6	62.3	62.6	276.06	-126.	-.045	2.25
146.2	64736.	218952.	-5.6	59.3	59.5	275.39	-128.	-.034	2.26
147.2	64608.	218529.	-4.8	55.0	55.2	275.00	-130.	-.010	2.27
148.2	64477.	218101.	-5.2	53.8	54.0	275.52	-131.	-.019	2.28
149.2	64346.	217689.	-3.9	51.7	51.8	274.28	-132.	-.091	2.29
150.2	64213.	217235.	-2.4	46.4	46.5	272.97	-132.	-.050	2.30
151.2	64081.	216800.	-1.1	39.9	39.9	271.61	-133.	-.032	2.31
152.2	65948.	216363.	-1.1	35.6	35.6	271.77	-133.	-.011	2.32
153.2	65814.	215925.	-.6	34.2	34.2	271.05	-134.	-.030	2.33
154.2	65680.	215486.	.9	37.9	37.9	268.58	-134.	-.011	2.34
155.2	65546.	215046.	.8	36.4	36.4	268.78	-134.	-.022	2.35
156.2	65413.	214609.	.5	33.5	33.5	269.10	-133.	-.013	2.36
157.2	65280.	214174.	.1	35.1	35.1	268.24	-133.	-.043	2.37
158.2	65148.	213739.	1.7	40.7	40.7	267.34	-133.	-.041	2.38
159.2	65015.	213305.	1.9	43.2	43.2	269.02	-132.	-.030	2.39
160.2	64884.	212874.	-.9	39.6	39.6	271.23	-131.	-.060	2.40
161.2	64754.	212446.	-1.7	31.9	31.9	273.00	-130.	-.054	2.41
162.2	64623.	212019.	-3.5	25.0	25.3	277.98	-130.	-.038	2.42
163.2	64493.	211592.	-7.8	22.6	23.8	289.14	-129.	-.030	2.43
164.2	64365.	211171.	-10.1	25.7	27.6	291.53	-128.	-.030	2.44
165.2	64238.	210754.	-8.4	29.3	30.4	286.10	-127.	-.019	2.45
166.2	64111.	210339.	-6.0	28.7	29.3	281.69	-127.	-.040	2.46

LOKI PARACHUTE   NUMBER GG42 LAUNCHED 25 SEP 81 1630 FROM SMR, WSMR, N M
STATION LATITUDE   32.467 LONGITUDE   106.417 ALTITUDE 1215.906 METERS   RADAR 114
GEOMETRIC ALTITUDES
WIND DATA AVERAGED OVER 2 KM LAYER

THERMODYNAMIC DATA FOR SIGNIFICANT LEVELS

BASE LEVEL PRESSURE 25.30 MB, ROCKET TEMPERATURE=52.42 RAOB TEMPERATURE=52.42
GEOMETRIC ALTITUDE 25299. METERS GEOPOTENTIAL 25187. METERS

| TIME | ALTITUDE (MSL) | | WIND VELOCITY (M/SEC) | | | WIND DIRECTION | FALL VELOCITY | WIND SHEAR | TEMPERATURE | | CORR. | PRESSURE | DENSITY | | SPEED OF SOUND |
(SEC)	(KM)	(FEET)	-N+S	-E+W	TOTAL	(DEGREES)	(M/SEC)	(MPS/M)	(CENTI)	(KEL)		(MB)	(GRAMS/ CU.M.)	(SLUGS/ CU.FT.)	(M/SEC)
155.0	65.57	215119.	-1.0	39.0	39.0	271.4	-132.	.006	-39.4	233.8	-13.2	.103	.154	.2979-06	306.61
181.0	62.32	204466.	-9.4	22.7	24.5	292.0	-114.	.007	-24.9	248.2	-9.2	.162	.227	.4403-06	315.96
215.0	58.84	193031.	2.4	2.3	3.3	223.4	-91.	.008	-21.2	251.9	-6.5	.258	.357	.6920-06	318.32
226.0	57.87	189859.	-.7	8.9	8.9	274.7	-86.	.006	-22.6	250.5	-5.3	.293	.408	.7917-06	317.42
265.0	54.81	179834.	16.3	.8	16.3	182.7	-71.	.009	-11.7	261.4	-3.6	.438	.584	.1132-05	324.24
286.0	53.40	175186.	3.5	-.3	3.6	175.7	-65.	.002	-12.8	260.3	-3.3	.525	.703	.1365-05	323.57
306.0	52.14	171071.	1.5	1.4	2.1	223.8	-60.	.003	-10.1	263.1	-3.0	.617	.817	.1586-05	325.27
348.0	49.85	163540.	-2.8	-3.4	4.4	51.2	-51.	.003	-12.0	260.2	-2.3	.829	1.110	.2153-05	323.52
369.0	48.83	160188.	6.4	-2.2	2.3	103.1	-47.	.003	-7.0	266.2	-2.1	.944	1.236	.2394-05	327.19
454.0	45.22	148356.	6.4	-11.3	13.0	119.6	-39.	.001	-15.5	257.7	-1.7	1.501	2.029	.3937-05	321.93
472.0	44.54	146138.	5.5	-11.0	12.3	116.4	-37.	.005	-11.6	261.6	-1.4	1.638	2.182	.4234-05	324.35
513.0	43.13	141495.	-.9	-10.1	10.1	85.1	-32.	.001	-10.7	262.5	-1.4	1.965	2.608	.5061-05	324.90
599.0	40.60	133211.	-2.0	-9.6	9.6	79.6	-27.	.004	-22.8	250.4	-1.3	2.739	3.810	.7393-05	317.34
637.0	39.63	130022.	-5.5	-8.6	10.8	60.2	-25.	.001	-28.0	245.2	-1.2	3.126	4.442	.8618-05	314.02
690.0	38.19	125950.	-5.9	-8.6	10.5	55.6	-22.	.002	-33.6	239.5	-1.0	3.715	5.403	.1048-04	310.39
797.0	36.19	118736.	-8.0	-4.4	9.2	28.9	-19.	.006	-33.2	240.0	-.9	5.063	7.349	.1426-04	310.68
924.0	34.01	111569.	4.0	-6.3	7.5	122.8	-16.	.004	-37.2	236.0	-.8	6.902	10.189	.1977-04	308.08
997.0	32.88	107884.	4.2	-10.9	11.7	111.3	-14.	.005	-37.2	235.9	-.7	8.107	11.970	.2343-04	308.04
1088.0	31.67	103893.	-1.3	-13.7	13.8	84.5	-13.	.002	-42.9	230.3	-.7	9.670	14.631	.2839-04	304.31
1296.0	29.19	95778.	-1.6	-9.5	9.6	84.7	-11.	.001	-49.9	223.2	-.6	13.985	21.824	.4245-04	299.64
1379.0	28.35	93018.	-1.6	-10.0	10.1	80.9	-10.	.002	-49.0	224.2	-.6	15.882	24.681	.4789-04	300.27
1675.0	25.08	84245.	-.9	-5.8	5.9	81.5	-8.	.001	-52.7	220.4	-.5	23.865	37.716	.7318-04	297.75
1722.5	25.30	83002.	-1.3	-5.5	5.7	77.1	-8.	.002	-52.9	220.2	-.5	25.296	40.016	.7765-04	297.61
1932.0	24.68	80319.	-1.3	-3.9	4.1	71.5	-7.	.003	-53.4	219.8	-.5	28.692	45.486	.8826-04	295.29
1957.0	23.60	77438.	-1.3	-3.9	4.0	104.0	-7.	.000	-56.4	216.8	-.5	32.882	52.850	.1025-03	295.25
2107.0	22.64	74279.	1.3	-4.2	4.4	106.7	-6.	.003	-56.5	216.7	-.5	38.226	61.467	.1193-03	295.18
2162.0	22.31	73208.	-.3	-4.0	4.0	94.5	-6.	.004	-58.5	214.7	-.5	40.244	65.316	.1267-03	293.82
2213.0	22.00	72195.	-.9	-3.5	3.6	75.0	-6.	.003	-57.9	215.3	-.5	42.249	68.374	.1327-03	293.24
2332.0	21.34	69932.	-1.3	-1.2	1.7	43.8	-6.	.000	-57.3	215.9	-.5	47.090	75.997	.1475-03	294.65

LOKI PARACHUTE   NUMBER 0042 LAUNCHED 25 SEP 81 1630 FROM SMK, AS'R, N M
STATION LATITUDE   32.46/ LONGITUDE   106.417 ALTITUDE 1215.906 METERS RADAR 114
GEOMETRIC ALTITUDES
WIND DATA AVERAGED OVER 2 KM LAYER

THERMODYNAMIC DATA FOR KILOMETER LEVELS
BASE LEVEL PRESSURE 25.30 MB, ROCKET TEMPERATURE=52.42 RAOB TEMPERATURE=52.20
GEOMETRIC ALTITUDE 25299. METERS GEOPOTENTIAL 25187. METERS

TIME	ALTITUDE		WIND VELOCITY			WIND DIRECTION	FALL VELOCITY	WIND SHEAR	TEMPERATURE			PRESSURE	DENSITY		SPEED OF
(SEC)	(KM)	(FEET)	-E-W	-N-S	TOTAL	(DEGREES)	(M/SEC)	(MPS/M)	(CENT)	(REL)	CORR.	(MB)	(GRAMS/ CU-M)	(SLUGS/ CU-FT)	SOUND (M/SEC)
159.3	65.00	213255.	-2.3	-9.5	33.4	273.9	-131.	.008	-36.5	236.6	-12.2	.112	.164	.3192-08	308.48
167.0	64.00	209973.	-9.1	30.1	31.6	287.4	-125.	.001	-31.8	241.4	-10.6	.129	.185	.3594-08	311.59
175.2	63.00	206693.	-9.8	29.6	31.0	287.1	-119.	.011	-27.5	245.7	-9.6	.147	.209	.4057-08	314.34
183.8	62.00	203412.	-8.1	18.4	20.8	298.1	-112.	.002	-24.6	248.5	-9.0	.169	.237	.4593-08	316.15
193.0	61.00	200131.	-8.1	16.7	18.5	295.9	-106.	.012	-23.7	249.5	-8.4	.193	.279	.5413-08	316.76
202.8	60.00	196850.	4.5	15.1	15.7	254.2	-99.	.012	-22.4	250.8	-7.4	.221	.307	.5953-08	317.57
213.2	59.00	193570.	3.4	3.1	4.6	222.1	-92.	.006	-21.6	251.6	-6.8	.252	.349	.6781-08	318.08
224.5	58.00	190289.	-1.0	7.6	7.6	277.3	-86.	.008	-21.7	250.4	-5.8	.288	.401	.7785-08	317.36
236.4	57.00	187008.	4.2	13.4	14.0	252.5	-82.	.008	-19.3	253.9	-4.8	.329	.452	.8771-08	319.56
249.0	56.00	183727.	12.3	12.7	17.7	225.8	-77.	.009	-15.6	257.5	-4.0	.376	.508	.9860-08	321.82
262.4	55.00	180448.	10.7	4.4	17.5	194.9	-72.	.011	-12.8	260.7	-3.8	.428	.571	.1119-05	323.80
276.6	54.00	177165.	7.9	-2.4	8.2	163.3	-67.	.007	-12.5	260.7	-3.6	.486	.650	.1261-05	323.78
292.2	53.00	173885.	1.7	.4	1.7	193.7	-63.	.001	-11.9	261.3	-3.1	.553	.737	.1431-05	324.16
308.4	52.00	170604.	2.3	.8	2.4	200.4	-59.	.002	-10.2	262.9	-2.9	.629	.833	.1616-05	325.18
325.9	51.00	167323.	-1.4	-1.1	1.8	171.6	-55.	.001	-11.6	261.5	-2.8	.715	.952	.1847-05	324.23
344.0	50.00	164042.	-1.2	-3.0	3.2	67.5	-52.	.001	-12.7	260.5	-2.3	.813	1.087	.2107-05	323.68
365.3	49.00	160761.	-.8	-2.6	2.7	73.9	-47.	.005	-7.8	265.3	-1.9	.924	1.213	.2353-05	326.67
387.2	48.00	157480.	3.7	-1.4	3.9	158.7	-44.	.004	-9.0	264.2	-2.0	1.049	1.383	.2684-05	325.96
410.4	47.00	154199.	7.8	-1.8	7.8	179.6	-42.	.009	-10.0	261.8	-2.0	1.192	1.586	.3078-05	324.49
434.4	46.00	150919.	9.1	-8.8	12.6	136.0	-41.	.004	-13.7	259.5	-1.8	1.356	1.821	.3533-05	323.06
459.8	45.00	147638.	5.7	-11.2	12.5	116.8	-38.	.002	-14.1	257.0	-1.5	1.544	2.077	.4030-05	322.75
487.1	44.00	144357.	3.8	-9.5	10.2	111.9	-35.	.005	-11.2	262.0	-1.3	1.757	2.337	.4534-05	324.59
517.1	43.00	141076.	-.8	-10.7	10.7	85.6	-32.	.001	-11.3	261.9	-1.4	1.998	2.684	.5198-05	324.53
549.8	42.00	137795.	-2.0	-13.7	13.9	81.8	-30.	.003	-16.1	257.0	-1.4	2.275	3.084	.5984-05	321.53
584.4	41.00	134514.	-1.5	-14.4	14.4	83.7	-28.	.005	-20.9	252.3	-1.3	2.597	3.587	.6959-05	318.34
622.3	40.00	131234.	-4.2	-10.5	11.3	67.9	-25.	.003	-26.0	247.2	-1.2	2.973	4.190	.8131-05	315.28
663.2	39.00	127953.	-6.2	-8.9	10.8	54.8	-24.	.001	-30.9	242.3	-1.1	3.412	4.906	.9517-05	312.17
707.6	38.00	124672.	-5.0	-8.2	10.0	54.7	-22.	.002	-33.5	239.6	-1.0	3.925	5.706	.1107-04	310.44
755.4	37.00	121391.	-7.1	-6.4	9.8	70.7	-20.	.003	-33.3	239.9	-.9	4.518	6.562	.1273-04	310.59
807.1	36.00	118110.	-7.5	-3.8	8.2	27.6	-18.	.006	-35.5	237.7	-.8	5.201	7.561	.1467-04	310.46
863.6	35.00	114829.	-1.7	-3.1	3.5	60.4	-17.	.007	-35.4	237.6	-.8	5.991	8.777	.1703-04	309.26
924.1	34.00	111549.	4.5	-6.3	7.5	122.8	-16.	.004	-37.2	235.9	-.8	6.909	10.199	.1979-04	308.08
988.8	33.00	108268.	4.5	-10.5	11.5	113.1	-14.	.005	-37.2	235.9	-.7	7.973	11.772	.2284-04	308.04
1061.0	32.00	104987.	-1.3	-12.9	12.9	86.7	-13.	.004	-41.3	231.8	-.7	9.212	13.845	.2686-07	305.34
1141.9	31.00	101706.	-4.0	-12.7	13.3	72.7	-12.	.003	-44.8	228.4	-.7	12.670	16.278	.3158-04	303.06
1223.3	30.00	98425.	-2.5	-10.3	10.6	76.4	-12.	.002	-47.6	225.5	-.6	12.385	19.131	.3712-04	301.17
1315.1	29.00	95166.	-1.7	-9.9	9.9	87.1	-10.	.002	-49.7	243.5	-.6	14.399	22.446	.4356-04	299.79
1415.0	28.00	91904.	-1.7	-8.9	9.0	79.4	-10.	.002	-49.5	243.7	-.6	16.752	26.090	.5062-04	299.94
1519.4	27.00	88583.	-1.6	-6.5	6.7	76.4	-9.	.001	-56.9	224.3	-.5	19.498	30.559	.5930-04	298.00
1635.8	26.00	85302.	-1.7	-6.2	6.2	82.1	-8.	.002	-52.3	224.0	-.5	22.717	35.829	.6952-04	298.06
1761.5	25.00	82021.	-1.7	-5.2	5.4	75.0	-8.	.002	-53.1	220.1	-.5	26.440	41.937	.8137-04	297.09
1897.7	24.00	78740.	.2	-3.4	3.5	93.0	-7.	.001	-55.1	218.1	-.5	30.920	49.388	.9563-04	296.17
2048.5	23.00	75459.	1.1	-1.1	1.3	105.2	-6.	.002	-56.5	216.7	-.5	36.137	58.098	.1147-03	295.42
2213.8	22.00	72178.	-.9	-3.5	3.6	75.0	-6.	.003	-57.9	215.3	-.5	42.279	66.425	.1328-03	294.23
2398.6	21.00	68898.	-1.1	-.5	1.2	23.8	-6.	.000							

LOKI PARACHUTE   NUMBER 0142 LAUNCHED 25 SEP 81 1630 FROM SMR, WSMR, N M
STATION LATITUDE   32.467 LONGITUDE   106.467 ALTITUDE   1215.906 METERS   RADAR T14
GEOMETRIC ALTITUDES

ROCOB MESSAGE

21999	02001	99999	22558	07004	91644
23556	11004	91581	24555	09003	91494
25253	08005	91419	26552	08006	91358
27251	08007	91306	28549	08009	91261
29559	09010	91224	30548	08011	91171
31545	07015	91165	32541	09013	91138
33237	11011	91118	34537	12007	91102
35535	06005	92878	36538	03008	92756
37533	04010	92656	38534	05010	92571
39531	05011	92491	40526	07011	92419
41521	08014	92359	42516	08014	92308
43511	09011	92266	44511	11010	92234
45514	12013	92208	46514	14013	92162
47511	18008	92159	48509	16004	92138
49508	07003	92121	50513	07003	92109
51512	19002	93952	52510	20002	93833
53512	19002	93737	54512	16008	93650
55512	19017	93571	56516	23018	93508
57519	25014	93452	58523	28008	93401
59522	26005	93349	60522	25016	93307
61524	30019	93270	62525	30021	93237
63527	30042	93209	64532	29032	93185
65557	27033	93164			

X AND Y WIND(M/SEC) AND TEMPERATURE(DEG C) VS. ALTITUDE(KM)

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MRN FORMATTED DATA CARDS LOKI PARACHUTE      0042 25 SEP 81 1630 K-114
 STA  DATE TIME ALT DIR SP            NS  EW FV TMP COR  PRES   DEN  S/S
72269810925163006557271039           -001 039132-039-131,030-11.535-1307          30
72269810925163006500274033           -002 033131-037-121,117-11.645-1308          30
72269810925163006400287032           -009 030125-032-111,285-11.855-1312          30
72269810925163006300287031           -009 030119-027-101,474-12.091-1314          30
72269810925163006232292024           -009 023114-025-091,617-12.269-1316          30
72269810925163006200298021           -010 018112-025-091,688-12.367-1316          30
72269810925163006100296019           -008 017106-024-081,931-12.697-1317          30
72269810925163006000254016            004 015079-022-072,205-13.068-1316          30
72269810925163005900222005            003 003092-022-072,524-13.495-1318          30
72269810925163005884223003            002 002091-021-072,579-13.566-1318          30
72269810925163005800277008           -001 008086-023-062,884-14.012-1317          30
72269810925163005787275009           -001 009086-023-052,934-14.080-1317          30
72269810925163005700252014            004 013082-019-053,294-14.520-1320          30
72269810925163005600226018            012 013077-016-043,756-15.082-1322          30
72269810925163005500194017            017 004072-012-044,276-15.714-1324          30
72269810925163005481183016            016 001071-012-044,379-15.836-1324          30
72269810925163005400163008            008-002067-012-049,863-16.500-1324          30
72269810925163005340176004            004 000065-013-035,255-17.033-1324          30
72269810925163005300193002            002 000063-012-035,531-17.374-1324          30
72269810925163005219224002            001 001060-010-036,173-18.174-1325          30
72269810925163005200200002            002 001059-010-036,287-18.330-1325          30
72269810925163005100142002            001-001055-012-037,146-19.519-1324          30
72269810925163005000067003           -001-003052-013-028,128-11.087+0324          30
72269810925163004985051004           -003-003051-013-028,289-11.110+0324          30
72269810925163004900074003           -001-003047-008-029,237-11.213+0327          30
72269810925163004883103002            001-002047-007-029,444-11.236+0327          30
72269810925163004800159004            004-001044-009-021,049+01.383+0326          30
72269810925163004700180008            008 000042-011-021,192+01.586+0324          30
72269810925163004600136013            009-009091-014-021,356+01.821+0323          30
72269810925163004522120013            006-011039-015-021,501+02.029+0322          30
72269810925163004500117013            006-011038-014-021,544+02.077+0323          30
72269810925163004454116012            005-011037-012-011,635+02.182+0324          30
72269810925163004400112010            004-010035-011-011,757+02.337+0325          30
72269810925163004313085010           -001-010032-011-011,965+02.608+0325          30
72269810925163004300086011           -001-011032-011-011,998+02.658+0325          30
72269810925163004200082014           -002-014030-016-012,275+03.084+0322          30
72269810925163004100084014           -002-014028-021-012,597+03.587+0319          30
72269810925163004060080011           -002-011027-023-012,739+03.810+0317          30
72269810925163004000068011           -004-010025-026-012,973+04.190+0315          30
72269810925163003963060011           -006-010025-028-013,126+04.442+0314          30
72269810925163003900055011           -006-009024-031-013,412+04.906+0312          30
72269810925163003839056010           -006-009022-034-013,715+05.403+0310          30
72269810925163003800055010           -006-008022-034-013,925+05.706+0310          30
72269810925163003700041010           -007-006020-033-014,516+06.562+0311          30
72269810925163003619029009           -008-004019-033-015,063+07.349+0311          30
72269810925163003600028008           -007-004018-034-015,201+07.561+0310          30
72269810925163003500060004           -002-003017-035-015,991+08.777+0309          30
72269810925163003401123007            004-006016-037-016,902+01.019+1308          30
72269810925163003400123007            004-006016-037-016,904+01.020+1308          30
72269810925163003300113011            005-011015-037-017,973+01.17[illegible] 13[illegible]8          30
72269810925163003248111012            004-011014-037-018,107+01.197+13[illegible]8          30
72269810925163003200089013            000-013013-[illegible]-019,212+01.364+1305          30
72269810925163003167084014           -001-014013-043-019,67[illegible]+01.463+1304          30
72269810925163003100073013           -004-013012-045-011,067+11.526+1303          30
7226981092516[illegible]0075011           -002-010012-048-011,23[illegible]+11.713+13[illegible]1          30
```

LOKI PARACHUTE   NUMBER UC42 LAUNCHED 25 SEP 81 1630 FROM SMK, WS-K, N M
STATION LATITUDE   32.40/ LONGITUDE 106.417 ALTITUDE 1215.906 METERS RADAR 114
GEOMETRIC ALTITUDES
*NO DATA AVERAGED OVER 2 KM LAYER

THERMODYNAMIC DATA FOR 5000 FEET LEVELS
BASE LEVEL PRESSURE 25.30 MB, ROCKET TEMPERATURE-52.42 RAOB TEMPERATURE-52.20
GEOMETRIC ALTITUDE 25299. METERS GEOPOTENTIAL 25187. METERS

TIME	ALTITUDE		WIND VELOCITY			WIND DIRECTION	FALL VELOCITY	WIND SHEAR	TEMPERATURE		PRESSURE CORR.	DENSITY		SPEED OF SOUND
(SEC)	(KM)	(FEET)	N-S	E-W	TOTAL	(DEGREES)	(M/SEC)	(MPS/M)	(CENT)	(REL)	(MB)	(GRAMS/ CU-M)	(SLUGS/ CU-FT)	(M/SEC)
155.3	65.53	215000.	-1.0	39.0	39.0	271.4	-132.	.006	-39.1	234.0	.104	.154	.2990-06	306.78
167.0	64.01	210000.	-9.2	30.1	31.4	287.0	-126.	.003	-31.8	241.3	.128	.185	.3594-06	311.53
179.6	62.78	205000.	-8.9	24.9	26.4	289.6	-115.	.006	-25.5	247.7	.158	.222	.4314-06	315.60
193.4	60.76	200000.	-7.3	16.6	18.2	293.7	-105.	.011	-23.5	249.6	.194	.271	.5255-06	314.86
208.6	59.44	195000.	5.1	6.2	8.0	230.8	-95.	.004	-22.0	251.2	.238	.330	.6405-06	317.82
225.5	57.91	190000.	-.7	8.9	8.9	274.7	-86.	.007	-22.8	250.4	.292	.406	.7876-06	317.35
244.0	56.39	185000.	8.2	13.8	16.0	239.2	-79.	.009	-17.0	256.1	.357	.486	.9422-06	320.95
204.3	54.86	180000.	16.5	1.9	16.6	186.7	-71.	.009	-12.0	261.1	.435	.580	.1126-05	324.06
256.9	53.34	175000.	3.2	-.2	3.2	176.5	-65.	.000	-12.7	260.4	.529	.708	.1374-05	323.63
311.6	51.82	170000.	3.3	-.5	3.3	188.6	-59.	.002	-10.5	262.7	.644	.854	.1657-05	325.03
339.2	50.29	165000.	.4	-1.7	1.7	102.2	-53.	.000	-10.5	260.0	.783	1.046	.2024-05	323.89
370.2	48.77	160000.	.5	-2.2	2.3	103.1	-47.	.004	-7.0	266.1	.951	1.245	.2415-05	327.15
404.8	47.24	155000.	6.4	-.5	6.2	175.8	-43.	.007	-10.8	262.4	1.154	1.533	.2974-05	324.84
441.3	45.72	150000.	8.3	-10.9	13.7	127.4	-40.	.002	-14.2	258.9	1.405	1.891	.3669-05	322.89
481.6	44.20	145000.	5.1	-10.2	11.4	116.8	-36.	.005	-11.4	261.8	1.712	2.278	.4420-05	324.46
527.7	42.67	140000.	-2.5	-12.4	12.7	77.4	-31.	.002	-12.9	260.3	2.084	2.788	.5411-05	323.56
579.1	41.15	135000.	-1.5	-15.1	15.2	84.2	-28.	.004	-20.2	253.0	2.545	3.505	.6800-05	318.98
637.3	39.62	130000.	-5.5	-9.6	11.1	60.4	-25.	.001	-28.0	245.2	3.128	4.445	.8625-05	314.01
707.1	38.10	125000.	-5.7	-8.5	10.2	56.4	-22.	.003	-33.6	239.6	3.867	5.623	.1091-04	310.42
777.1	36.58	120000.	-8.5	-5.6	10.2	33.5	-19.	.005	-35.2	239.0	4.792	6.959	.1350-04	310.64
860.7	35.05	115000.	-2.0	-2.9	3.5	55.4	-17.	.006	-35.2	237.9	5.944	8.704	.1689-04	309.33
953.7	33.53	110000.	5.5	-7.8	9.5	125.4	-15.	.005	-37.2	236.0	7.387	10.905	.2118-04	308.06
1061.3	32.00	105000.	-.3	12.9	12.9	88.7	-13.	.002	-41.3	231.8	9.206	13.833	.2684-04	305.35
1183.7	30.48	100000.	-3.5	-11.1	11.6	72.5	-12.	.002	-46.5	226.8	11.525	17.695	.3934-04	302.08
1319.4	28.96	95000.	-.5	-10.0	10.1	87.4	-10.	.002	-49.6	223.5	14.489	22.584	.4382-04	299.82
1473.1	27.43	90000.	-1.7	-7.4	7.6	77.5	-9.	.001	-50.3	222.9	18.256	28.533	.5537-04	299.40
1645.7	25.91	85000.	-1.2	6.1	6.1	81.1	-8.	.002	-52.4	220.8	23.037	36.354	.7055-04	297.97
1795.2	24.38	80000.	-1.1	-3.7	3.8	72.7	-7.	.002	-53.7	219.4	29.127	46.245	.8973-04	297.06
2071.2	22.86	75000.	1.3	-4.1	4.3	107.1	-6.	.002	-56.5	216.7	36.912	59.347	.1152-03	295.20
2326.2	21.34	70000.	-1.3	-1.3	1.9	45.2	-6.	.000	-57.3	215.8	46.874	75.657	.1468-03	294.63

LOKI PARACHUTE   NUMBER U042 LAUNCHED 25 SEP 81 1630 FROM SMR, WSMR, N M
STATION LATITUDE   32.467 LONGITUDE   106.417 ALTITUDE 1215.906 METERS RADAR T14
GEOMETRIC ALTITUDES
WIND DATA AVERAGED OVER 2 KM LAYER

THERMODYNAMIC DATA FOR MANDATORY (CONSTANT PRESSURE) LEVELS

BASE LEVEL PRESSURE 25.30 MB, ROCKET TEMPERATURE-52.42 RAOB TEMPERATURE-52.20
GEOMETRIC ALTITUDE 25299. METERS GEOPOTENTIAL 25187. METERS

TIME	ALTITUDE		WIND VELOCITY (M/SEC)			WIND DIRECTION	FALL VELOCITY	WIND SHEAR	TEMPERATURE (DEGREES)			PRESSURE	DENSITY		SPEED OF SOUND	GEOPOT.
(SEC)	(KM)	(FEET)	N-S	E-W	TOTAL	(DEGREES)	(M/SEC)	(MPS/M)	(CENT)	(KEL)	CORR.	(MB)	(GRAMS/CU.M.)	(SLUGS/CU.FT.)	(M/SEC)	ALT.(KM)
195.6	60.73	199261.	-4.8	17.6	18.3	285.1	-103.	.003	-23.6	249.6	-8.3	.200	.279	.5417-06	316.82	60.13
228.0	57.70	189309.	.1	10.8	10.8	269.3	-85.	.007	-22.2	251.0	-5.4	.300	.416	.8079-06	317.73	57.16
255.6	55.50	182103.	15.9	10.0	18.8	212.1	-74.	.009	-14.1	259.0	-3.9	.400	.538	.1044-05	322.77	55.00
280.0	53.78	176455.	5.9	-1.8	6.2	162.9	-66.	.002	-12.6	260.6	-3.5	.500	.668	.1297-05	323.73	53.31
323.0	51.16	167860.	1.7	-1.4	2.2	139.7	-55.	.000	-11.2	262.0	-2.6	.700	.931	.1806-05	324.59	50.73
378.6	48.38	158739.	2.5	-2.1	3.2	140.3	-45.	.002	-8.0	265.2	-2.0	1.000	1.314	.2549-05	326.57	47.99
517.2	43.00	141062.	-1.6	-10.6	10.7	81.6	-32.	.001	-11.3	261.9	-1.4	2.000	2.661	.5163-05	324.53	42.65
625.0	39.93	131013.	-1.2	-10.5	11.3	67.9	-25.	.002	-26.3	246.8	-1.2	3.000	4.234	.8215-05	315.08	39.66
792.4	36.28	119026.	-8.3	-4.8	9.6	30.0	-19.	.005	-33.2	240.0	-.9	5.000	7.259	.1409-04	310.66	36.06
930.0	33.91	111248.	4.1	-6.5	7.7	122.2	-16.	.004	-37.2	236.0	-.8	7.000	10.334	.2005-04	308.07	33.71
1105.8	31.44	103159.	-2.4	-13.8	14.0	80.0	-13.	.002	-43.5	229.6	-.7	10.000	15.171	.2944-04	303.90	31.27
1537.5	26.84	88053.	-1.2	-6.3	6.4	79.1	-9.	.001	-51.1	222.1	-.5	20.000	31.377	.6088-04	298.84	26.71
1872.0	24.19	79377.	-.5	-3.4	3.5	81.6	-7.	.000	-54.4	218.8	-.5	30.000	47.773	.9270-04	296.62	24.09

MRN FORMATTED DATA CARDS LUKI PARACHUTE   0042 25 SEP 81 1630 R-114
STA DATE TIME ALT DIR SP   NS EW FV TMP COR PRES DEN S/S
/22269810925163006013485018 -005 018 -024-082.000-12.792-1317 40
722698109251630005716269011   000 011 -022-053.000-14.164-1318 40
722698109251630055002012019   016 010 -014-044.000-15.380-1323 40
722698109251630053311163006   006-002 -013-035.000-16.685-1324 40
722698109251630050731140002   002-001 -011-037.000-19.309-1325 40
722698109251630047991400003   002-002 -008-021.000-01.314+0327 40
722698109251630042690820011   002-011 -011-012.000+02.661+0325 40
722698109251630039660680011 -004-010 -026-013.000+04.234+0315 40
722698109251630036060300010 -008-005 -033-015.000+07.259+0311 40
722698109251630033711220008   004-006 -037-017.000+01.033-1308 40
722698109251630031270800014 -002-014 -044-011.000+11.517+1304 40
722698109251630026710790006 -001-006 -051-012.000+13.138+1299 40
722698109251630024090820003 -001-003 -054-013.000+14.777+1297 40

●BRKPT PRINTS

XI. TAPE UNIT ASSIGNMENTS

INPUT TAPES

1. UNILOG Tape - radar data recorded on a digital tape using a real-time log routine on the UNIVAC 1108. The UNILOG Tape is assigned to Fortran logical unit 2 and is read by the system subroutine FLDTAP.

Each physical record contains data for a one-second interval and begins with the first message after the whole second. The data rate is 20 messages per second. The record length is variable.

Each physical record contains a control word and 20 logical records. The control word should be ignored. Each logical record contains a word count and a time word, which are followed by five words of information for each active input. The maximum number of inputs is 32. Therefore, the maximum size of a physical record is 3241 words (1 + (20* (2 + (32*5)))). If no inputs are active, each logical record will contain only a word count (equal to one) and a time word. The minimum size of a physical record is, therefore, 41 words (1 + (20*(2))).

The time word is floating-point range time in milliseconds. The five data words for each input contain information from the standard serial data format. The IOMUX input subchannel number appears in the second sixth-word (second most significant character) in the second data word of each five-word input data block. This number has a value from zero to 31. An example of a physical record containing radar data is on the following page.

-72-

UNILOG TAPE FORMAT

	35										0
CONTROL WORD											

WORD COUNT		(ELEVEN)					11
TIME WORD		FLOATING POINT MILLISECONDS					

	35 33	32 30	29 24	23 16	15 9	8 5	0
DATA WORD 1	Run #	TGT #	C C	SYNC	ID	000	T M
		29 24	23				0
DATA WORD 2		S/C #*		RANGE			LSB
			23				0
DATA WORD 3			MSB	AZIMUTH			
			23				0
DATA WORD 4			MSB	ELEVATION			LOGICAL RECORD
			23				0
DATA WORD 5				RANGE RATE			LSB

	35 33	32 30	29 24	23 16	15 9	8 5	0	PHYSICAL RECORD
DATA WORD 1	RUN #	TGT #	C C	SYNC	ID	000	T M	
		29 24	23				0	
DATA WORD 2		S/C #*		RANGE			LSB	
			23				0	
DATA WORD 3			MSB	AZIMUTH				
			23				0	
DATA WORD 4			MSB	ELEVATION				
			23				0	
DATA WORD 5				RANGE RATE			LSB	

19 more logical records

TGT # = Target Number

CC = Confidence Counter

ID = Site Identification

TM = Tracking Mode

* Subchannel Numbers will be in ascending order (0 - 31).

-73-

The range is in yards and the azimuth and elevation are in units equivalent to 4.7937×10^{-5} radians.

2.   DR format tape - radar data recorded on a digital tape generated by processing the radar field tape   DR formatted tapes are assigned to Fortran logical unit 1. These tapes are BCD and contain information used by METRØC in the following format.

Character No	Format	
11-19	F9.3	Time (seconds from lift-off time)
51-59	F9.1	Slant range from radar (yards)
61-69	F9.2	Azimuth from radar (mils)
71-79	F9.2	Elevation from radar (mils)

3.   The program METRØC may be written on a tape which is used in each run (see section on control cards).

Intermediate tapes Note: On the UNIVAC 1108, intermediate data may be written on magnetic drum rather than magnetic tape.

1.   When a UNILØG tape is being processed and it contains data from two radars, the data from both radars may be reduced in a single run. In this case, when the data from the first radar is being processed, information from the second radar is being written on Fortran unit 3 in an unformatted mode.

Word	
1	Time (seconds from lift-off-time)
2	Slant range from radar (meters)
3	Azimuth from radar (radians)
4	Elevation from radar (radians)

2.   In any run with wind data to be processed, the individual
wind samples are recorded on Fortran logical unit 13 for use in
obtaining averaged layer wind data. If the wind data is input on
cards, the input data points are recorded. When the input is digital
tape, data is computed and stored at one sample per second. These
records are written in an unformatted mode.

Word

1   Time (seconds from lift-off time)

2   Altitude (meters)

3   Altitude (feet)

4   N-S wind component (meters/sec)

5   E-W wind component (meters/sec)

6   Wind speed (meters/sec)

7   Wind direction (degrees)

8   Fall velocity (meters/sec)

9   Number of points since last good point which were rejected
     as bad data.

     Output tapes At present there are no output tapes being generated
by METRØC.

OUTPUT LISTINGS

The output listings are in metric units, with additional listings
in English units available as an option. The data consists of:

   1.   Wind Data

        A.   Individual wind samples

             1.   One sample/second with digital tape input

             2.   Input points with punch card input

B. Averaged wind data for even kilometer levels averaged
    over 2 kilometer layers.(When temperatures are included,
    the averaged winds are listed combined with the thermo-
    dynamic data.)

II. Thermodynamic Data

A. Type of data

1. Wind averaged over 2 kilometer layers

2. Temperatures

3. Pressure computed using hydrostatic equations,
    rocket temperatures, and base-level point from
    conjunctive raob

4. Computed density

5. Computed speed of sound

B. Types of levels for thermodynamic data

1. Significant temperature levels

2. Even kilometer or .5 kilometer levels

3. 5000 foot or 1000 foot levels

4. Mandatory (constant-pressure) levels

C. Types of listings output

1. Standard data summary

2. MRN formatted data

3. Ozonesonde parameters (optional)

4. English units data (optional)

Initialization
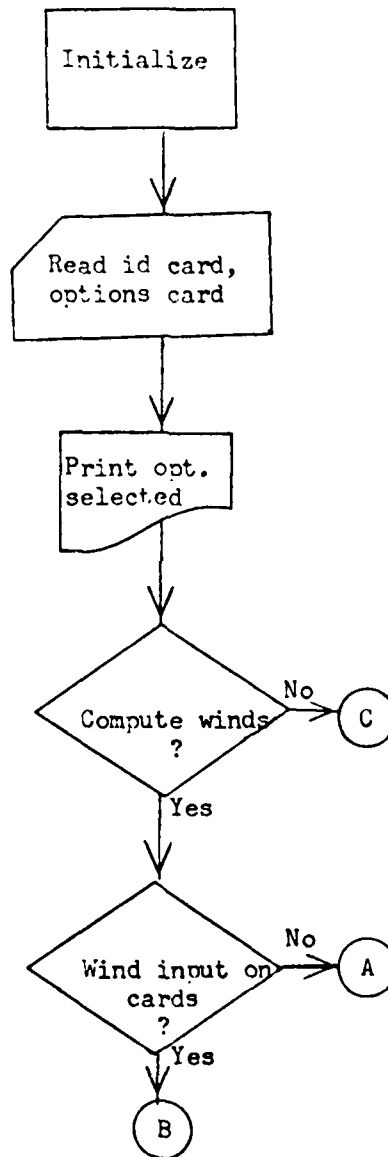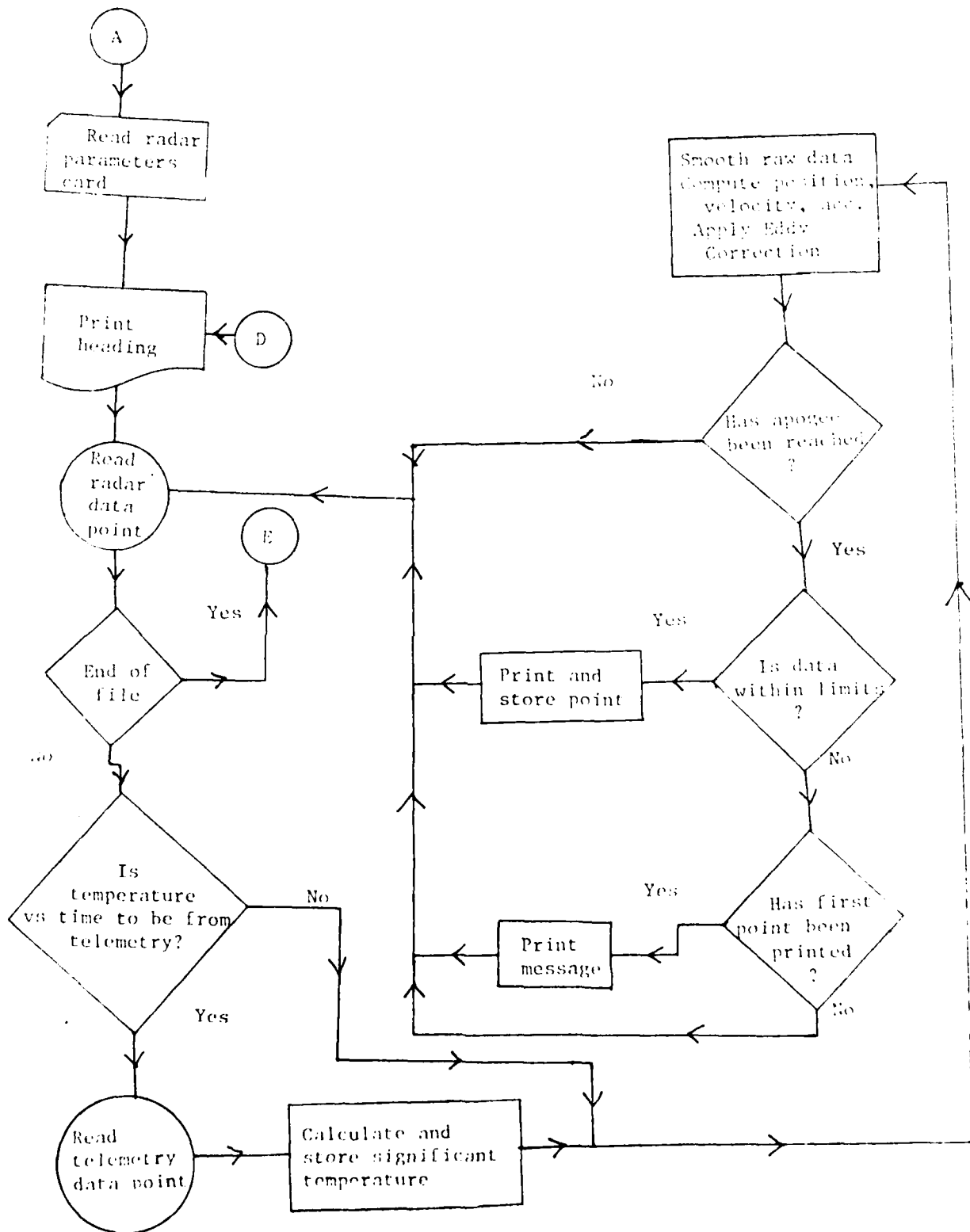
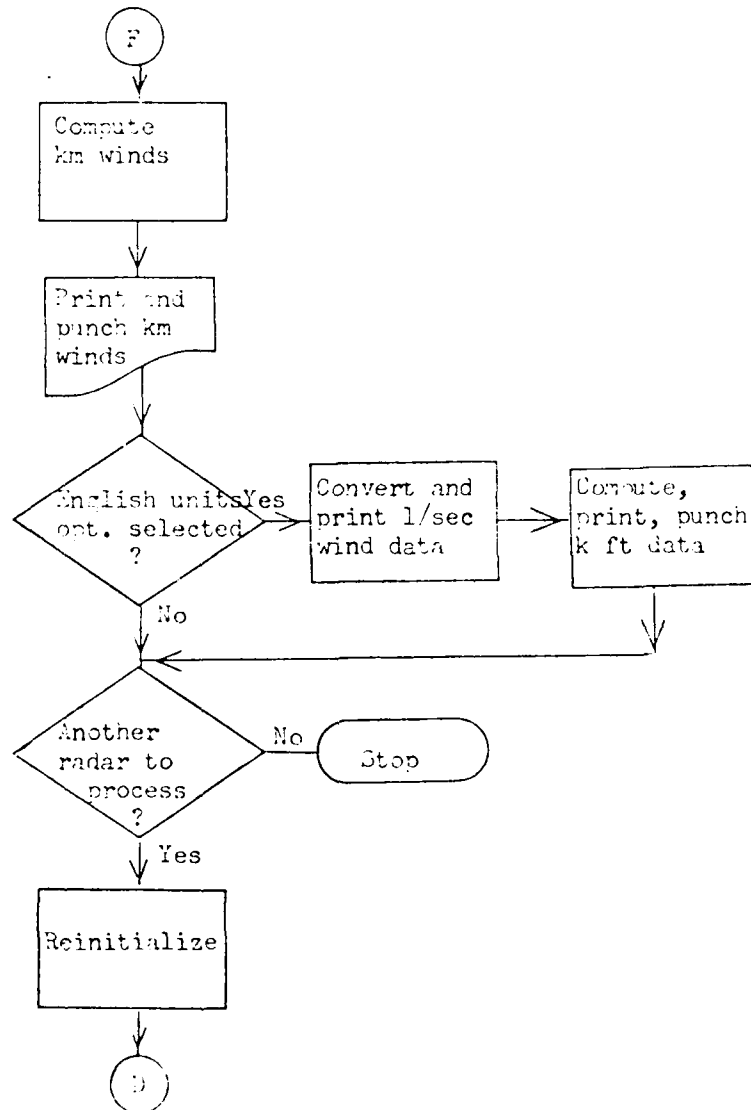Wind Data Card Processing
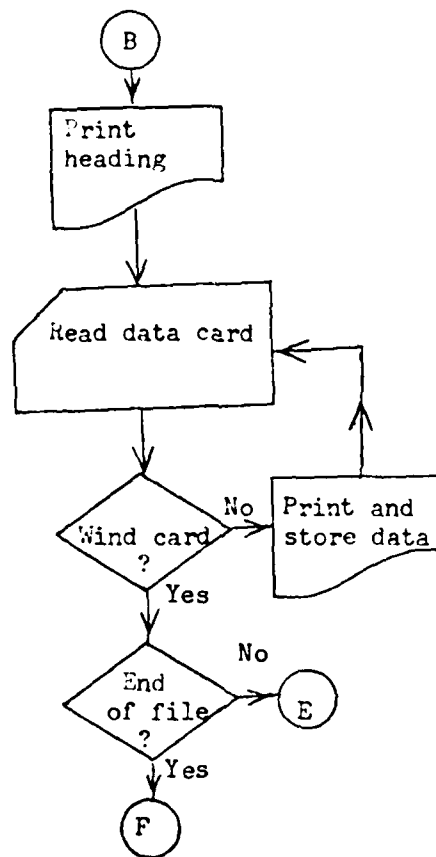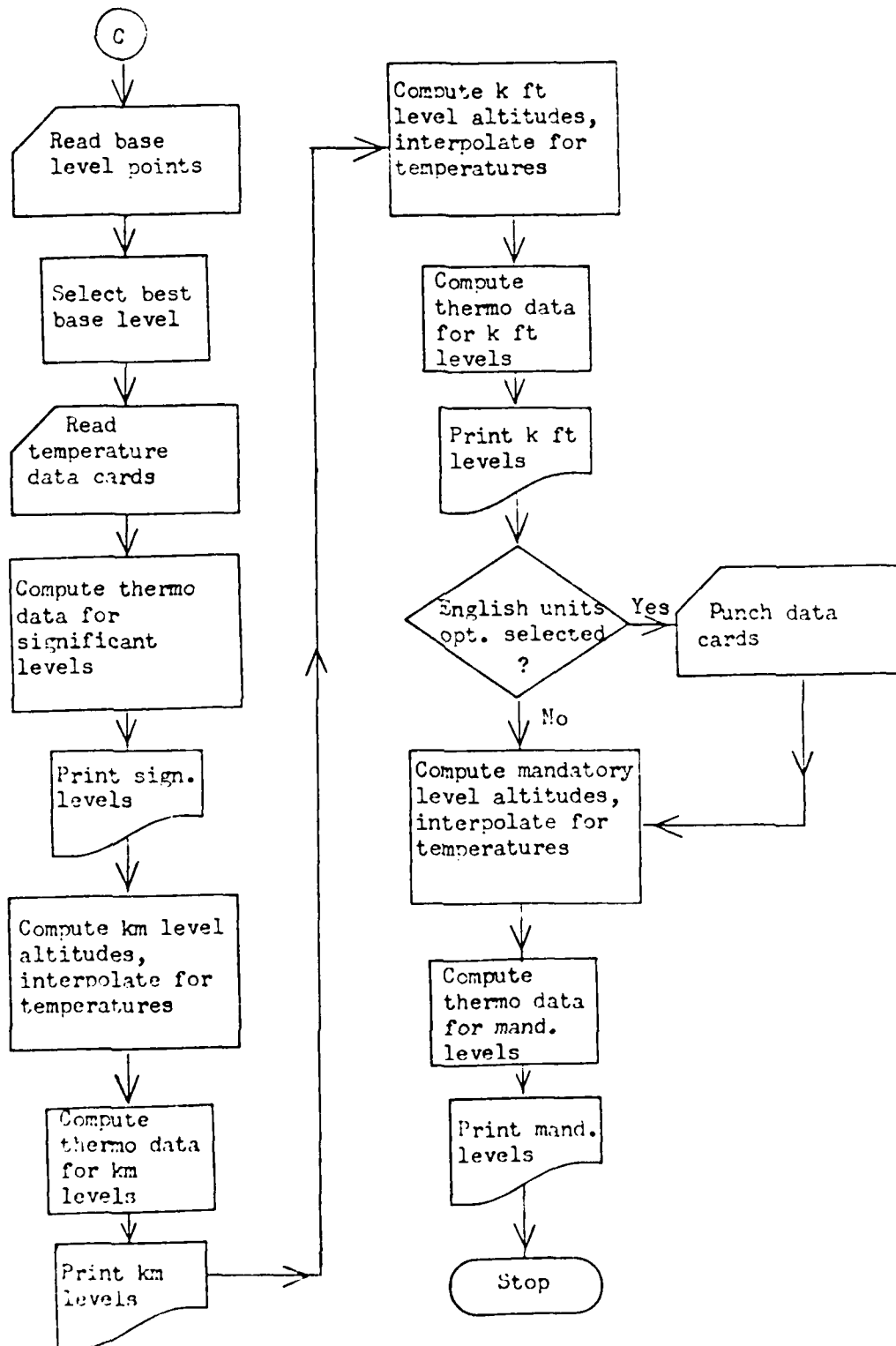
Temperature with Wind Processing (cont.)
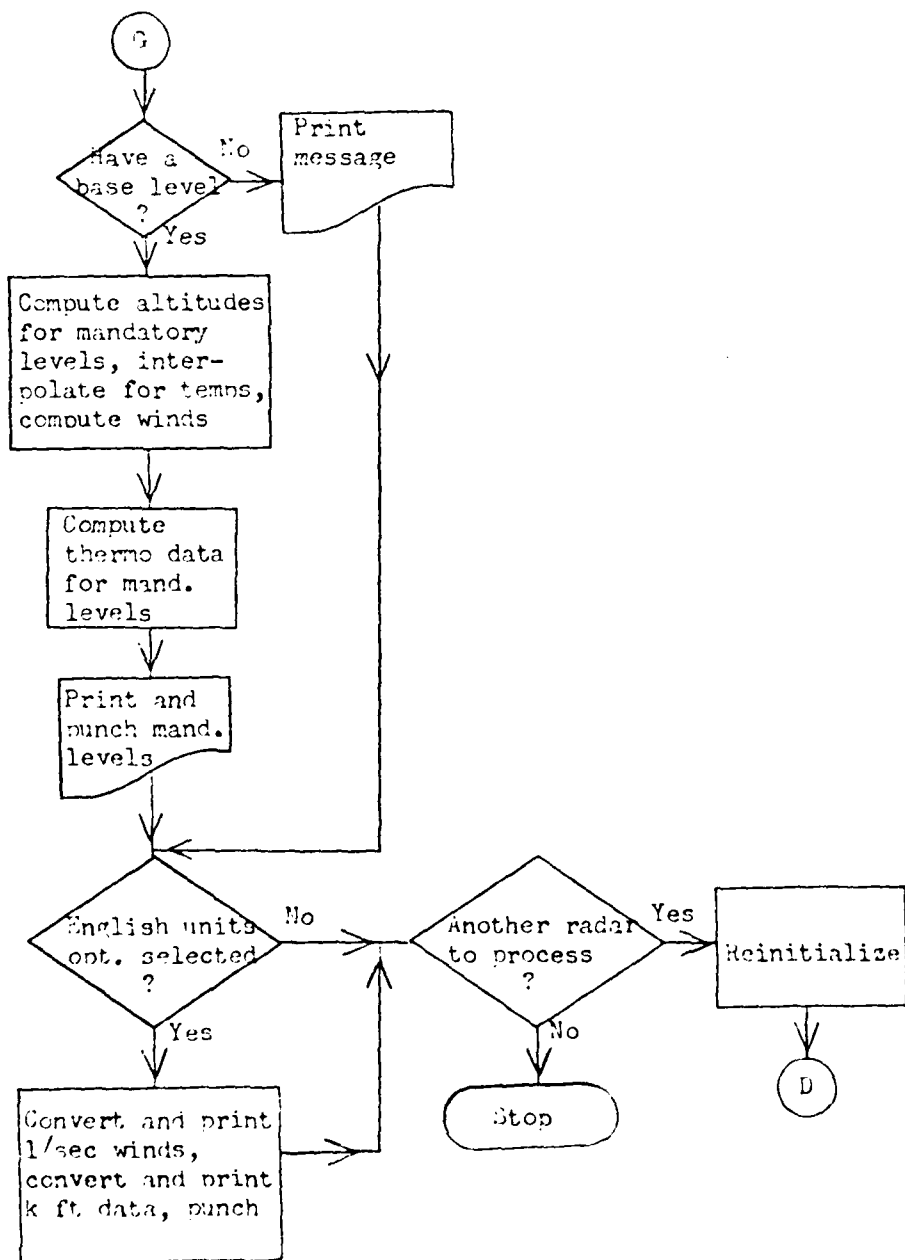
Kilometer Winds Processing

XIII FLOWCHARTS OF MODIFIED OR NEW PROGRAMS

START

EOF?

YES

REWIND TAPE

NO

IS BUFFER FULL?

YES

A
2.2

NO

FIRST CALL?

NO

B
2.2

YES

IS TEMPERATURE VS TIME TO BE FROM TELEMETRY?

NO

YES

INITIALIZE MET FILTER VIA CALL FILTER

WRITE PAGE HEADING

PERFORM TEMPERATURE CALIBRATION AND TEST VIA CALL LOKTEM

INITIALIZE FLAGS

C
2.2