University of Wisconsin-Extension

GEOLOGICAL AND NATURAL HISTORY SURVEY
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DATALOGGER PROGRAMMING FOR AUTOMATED WEATHER STATIONS: PROGRAM 1072 FOR THE CAMPBELL SCIENTIFIC CR-10 DATALOGGER

by

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Open-File Report 87-5
20 p.

1987

Program: 1072a -- August 16, 1987
CR10 Automated Weather Station Program
For the Univ. Of Wisconsin Network

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Signatures: *BA 01:40886 pgm, 02:14826 prom
For this pgm and prom, instruction 19 gives 5572

Program features:

1. Sensor multipliers and offsets are manually loaded in input locations, rather than embedded in program instructions. This allows the identical program to be used at several stations, and for sensors or calibration values to change without having to modify the datalogger program.
2. Logging does not begin until FLAG 1 is set HIGH. This enables parameter values to be loaded before logging begins, and also enables logging to be suspended when sensors are serviced or disconnected, to prevent bad data from being logged. FLAG 2 is separately used to control logging of precipitation values, to enable calibration of the rain gage without getting bogus rain in the data.
3. Record "499" is provided as a marker/parameter dump record to indicate when logging begins or is suspended. Similar use as the *D scan in CR-21. This record includes the "signature" value for the datalogger program to identify the program version in the output data.
4. To avoid loss of accumulated intermediate data for the current hour and day when the program is changed or datalogger is reset, FLAG 6 is provided to cause immediate output of all hourly and daily output records.
5. Negative pyranometer and quantum readings are set to zero.
6. Dew point temperature is derived from temperature and relative humidity.
7. Five-minute precipitation values are output, with coincident five-minute average wind speed.
8. Output Storage Area 2 is used for storage of continuous five-minute average "current weather" output records for real-time retrieval.
9. All records are identified by 1) record number, 2) station ID number, 3) 5-digit year-day date YYDDD, and 4) time HHMM. Subroutine 9 is used to output these values at the beginning of all output. Time value of 2400 is used at midnight, not 0000, although time-of-maximums/minimums can come out as 0000, which should be changed to 2400.
10. Wind speed is measured every 5 seconds to enable an hourly and daily "peak wind" value to be logged, following NWS specification for ASOS.

Direction is also read every 5 seconds and a one-minute resultant direction is calculated to provide a more stable wind direction measurement than a 60-second interval reading would give.

Input locations requiring manually loaded constants:

1 :	StnNum	47nn	Station number (47 for WISC.)
2 :	StnLat	degr nrth	Station latitude (not used)
3 :	StnLon	degr west	Station longitude (not used)
4 :	StnElv	m	Station elevation (not used)
5 :	kSol	W/m^2/mV	Multiplier for pyranometer
6 :	kPAR	Multiplier	for Quantum sensor
7 :	kPcpn	mm/count	Multiplier for raingage
8 :	kWind	m/s/count	Multiplier for anemom (0.798
9 :	OSWind	m/s	Offset for anemometer (0.447
10 :	OSDir	degrees	Offset to add to direction
11 :	OSTair	C	Tair thermistor offset
12 :	OSTS05	C	TS05 thermistor offset
13 :	OSTS10	C	TS10 thermistor offset
14 :	OSTS50	C	TS50 thermistor offset
15 :	OSTS1M	C	TS1M thermistor offset

Flag Usage: (set by *6AD then press digit to toggle)
- 1 : ENABLE TALLY. Set high to begin processing data
- 2 : ENABLE PRECIP. Set high to enable precip count
- 3 : ENABLE CURRENT CONDITIONS output to area 2
- 4 :
- 5 :
- 6 : FORCE HOURLY & DAILY OUTPUT (before pgm change)
- 7 : TEMPORARY FLAG used internally for output control
- 8 : INTERNAL TOGGLE. High when 1 goes hi, lo when 1
- 9 : INTERMEDIATE PROCESSING FLAG (system)
- 0 : OUTPUT FLAG (system)

Input Channel Usage: (wire color, sensor, variable)

1/1H:	red LiCor...ObSol	7/4H: red	107...ObTS1m
2/1L:	red Quantum.ObPAR	8/4L:	
3/2H:	red 207.....ObTair	9/5H:	
4/2L:	red 107.....ObTS05	10/5L:	
5/3H:	red 107.....ObTS10	11/6H: white	207...ObRHum
6/3L:	red 107.....ObTS50	12/6L: red	024...ObDir

Excitation Channel Usage:
- E1 : black 207 & 107
- E2 :
- E3 : black 024

Control Port Usage:
NONE.

Pulse Input Channel Usage: (5-second, table *1)
- P1 : clear 014 AvWind5s (switch closure, freq)
- P2 : red rngage ToPcpn5s (switch closure, total)

Output Array Definitions:
----- AREA 1 -----
- 401 : 5-Minute Precipitation Record (with wind)
- 403 : Primary Hourly Summary

```
  411 : Primary 24-Hour Summary (midnight)
  412 : Secondary 24-Hour Summary (soil temps)
  499 : Dump of FLAG1 and first 20 locations/parameters
  ----- AREA 2 -----
  451 : Current Readings every 5 minutes if FLAG 3 set


*     1        Table 1 Programs
  01: 5.0      Sec. Execution Interval P

 Read and process wind obs ----------------------------

01:  P3        Pulse                 5-second average for peak wind is
  01: 1        Rep                   NWS design spec for ASOP stations
  02: 1        Pulse Input Chan
  03: 22       Switch Closure -- frequency, Hz
  04: 33       Loc [:ObWind5s ]
  05: 1        Mult
  06: 0        Offset

02:  P89       If X<=>F    IF wind not calm...
  01: 33       X Loc ObWind5s
  02: 3        >=
  03: 0.001    F
  04: 30       Then Do

03:  P36       Z=X*Y Multiply by anemometer factor kWind (LOC 8)
  01: 33       X Loc ObWind5s
  02: 8        Y Loc kWind
  03: 33       Z Loc [:ObWind5s ]

04:  P33       Z=X+Y Add anemometer offset OSWind (LOC 9)
  01: 33       X Loc ObWind5s
  02: 9        Y Loc OSWind
  03: 33       Z Loc [:ObWind5s ]

05:  P4        Excite,Delay,Volt(SE) READ WINDVANE into ObDir
  01: 1        Rep
  02: 11       2.5 mV fast Range
  03: 12       IN Chan
  04: 3        Excite all reps w/EXchan 3
  05: 0        Delay (units .01sec)
  06: 2        mv Excitation 2 mV excit. to get 1 mV output range
  07: 32       Loc [:ObDir     ]
  08: 360      Mult 1 mV = 360 DEGREES
  09: 0        Offset

06:  P33       Z=X+Y Add Direction offset OSDir (LOC 10)
  01: 32       X Loc ObDir
  02: 10       Y Loc OSDir
  03: 32       Z Loc [:ObDir     ]

07:  P94       Else

08:  P30       Z=F Direction = 000 if calm
  01: 0        F
  02: 0        Exponent of 10
  03: 32       Z Loc [:ObDir     ]
```

```
09:  P95       End          END
-------------------------------------------------------

 Read and process rain gage obs (only because required
 to read all count channels in same pgm table)

10:  P3        Pulse        READ ToPcpn5s  { get precip count }
  01: 1        Rep
  02: 2        Pulse Input Chan
  03: 2        Switch Closure (total)
  04: 34       Loc [:ToPcpn5s ] { 5-second precip input count }
  05: 1.0      Mult
  06: 0.0      Offset

11:  P36       Z=X*Y Multiply count by gage factor kPcpn (LOC 7)
  01: 34       X Loc ToPcpn5s
  02: 7        Y Loc kPcpn
  03: 34       Z Loc [:ToPcpn5s ]

12:  P92       If time is
  01: 0        minutes into a
  02: 1        minute interval
  03: 10       Set high Flag 0 (output)

13:  P80       Set Active Storage Area
  01: 3        Input Storage Area
  02: 35       Array ID or location ToPcpn1m
-------------------------------------------------------
 MAKE ONE-MINUTE VALUES FOR USE IN PROGRAM TABLE *2
-------------------------------------------------------

14:  P72       Totalize LOC 35 : ToPcpn1m : 1-min total precip
  01: 1        Rep
  02: 34       Loc ToPcpn5s

15:  P73       Maximize LOC 36 : PkWind1m : 1-min peak 5-sec wind spd
  01: 1        Rep
  02: 0        Value only
  03: 33       Loc ObWind5s

16:  P76       Wind Vector LOC 37 : AvWind1m : 1-min avg Wind Speed
  01: 1        Rep          LOC 38 : RsDir1m : 1-min Result. Direction
  02: 20       WS, Dir (Polar Sensor)
  03: 33       Wind Speed/East Loc ObWind5s
  04: 32       Wind Direction/North Loc ObDir

17:  P         End Table 1
=======================================================


*      2       Table 2 Programs
  01: 60.0     Sec. Execution Interval

 First create year-day date value YYDDD ---------------

01:  P86       Do
  01: 10       Set high Flag 0 (output)
```

```
02:  P80          Set Active Storage Area
  01: 3           Input Storage Area
  02: 41          Array ID or location

03:  P77          Real Time
  01: 1220        Year,Day,Hour-Minute with 2400 option

04:  P86          Do
  01: 20          Set low Flag 0 (output)

05:  P46          Z=X MOD F
  01: 41          X Loc Year
  02: 100         F
  03: 40          Z Loc [:YYDDD     ]

06:  P37          Z=X*F
  01: 40          X Loc YYDDD
  02: 1000        F
  03: 40          Z Loc [:YYDDD     ]

07:  P33          Z=X+Y
  01: 40          X Loc YYDDD
  02: 42          Y Loc DDD
  03: 40          Z Loc [:YYDDD     ]
-------------------------------------------------------

 If FLAG 2 is LOW, set Precip to 0.  This is to enable
 gage calibration without disconnecting gage wire.

08:  P91          If Flag/Port FLAG 2 is 'ENABLE PRECIP'
  01: 22          Do if flag 2 is low
  02: 30          Then Do

09:  P30          Z=F Zero ToPcpnlm if FLAG 2 is low, for calibration
  01: 0.0         F
  02: 0           Exponent of 10
  03: 35          Z Loc [:ToPcpnlm  ]

10:  P95          End
-------------------------------------------------------

 Read battery, pyranometer and quantum sensors

11:  P10          Battery Voltage   Read BATTERY VOLTAGE into ObBatt
  01: 20          Loc [:ObBatt    ]

12:  P1           Volt (SE)         Read PYRANOMETER and QUANTUM sensors
  01: 2           Reps
  02: 2           15mv slow Range
  03: 1           IN Chan
  04: 21          Loc [:ObSol     ]
  05: 1.0         Mult
  06: 0.0         Offset
```

```
13:  P36       Z=X*Y Multiply by calibration factor kSol (LOC 5)
  01: 21       X Loc ObSol
  02: 5        Y Loc kSol
  03: 21       Z Loc [:ObSol     ]

14:  P89       If X<=>F           IF ObSol < 0.0 THEN DO
  01: 21       X Loc ObSol
  02: 4        <
  03: 0.0      F
  04: 30       Then Do

15:  P30       Z=F                    { set negative value to 0.0 }
  01: 0.0      F
  02: 00       Exponent of 10
  03: 21       Z Loc [:ObSol     ]

16:  P95       End                 END

17:  P36       Z=X*Y  Multiply by calibration factor kPAR (LOC 6)
  01: 22       X Loc ObPAR
  02: 6        Y Loc kPAR
  03: 22       Z Loc [:ObPAR     ]

18:  P89       If X<=>F           IF ObPAR < 0.0 THEN DO
  01: 22       X Loc ObPAR
  02: 4        <
  03: 0.0      F
  04: 30       Then Do

19:  P30       Z=F                    { set negative value to 0.0 }
  01: 0.0      F
  02: 00       Exponent of 10
  03: 22       Z Loc [:ObPAR     ]

20:  P95       End                 END
```

Read air and soil temperatures and add offsets

```
21:  P11       Temp 107 Probe Read Tair, TS05, TS10, TS50, TS1M
  01: 5        Reps
  02: 3        IN Chan
  03: 1        Excite all reps w/EXchan 1 (same as for 207 RH below)
  04: 23       Loc [:ObTair    ]
  05: 1.0      Mult CELSIUS
  06: 0.0      Offset

22:  P33       Z=X+Y Add sensor offset OSTair (LOC 11)
  01: 23       X Loc ObTair
  02: 11       Y Loc OSTair
  03: 23       Z Loc [:ObTair    ]

23:  P33       Z=X+Y Add sensor offset OSTS05 (LOC 12)
  01: 24       X Loc ObTS05
  02: 12       Y Loc OSTS05
  03: 24       Z Loc [:ObTS05    ]
```

```
24:  P33       Z=X+Y Add sensor offset OSTS10 (LOC 13)
  01: 25       X Loc ObTS10
  02: 13       Y Loc OSTS10
  03: 25       Z Loc [:ObTS10    ]

25:  P33       Z=X+Y Add sensor offset OSTS50 (LOC 14)
  01: 26       X Loc ObTS50
  02: 14       Y Loc OSTS50
  03: 26       Z Loc [:ObTS50    ]

26:  P33       Z=X+Y Add sensor offset OSTS1M (LOC 15)
  01: 27       X Loc ObTS1M
  02: 15       Y Loc OSTS1M
  03: 27       Z Loc [:ObTS1M    ]
-------------------------------------------------------

 Read relative humidity and derive vapor pressure and
 dew point temperature

27:  P12       RH 207 Probe       Read RELATIVE HUMIDITY into RelHum
  01: 1        Rep
  02: 11       IN Chan
  03: 1        Excite all reps w/EXchan 1 (same as for temp on 207)
  04: 23       Temperature Loc ObTair
  05: 31       Loc [:ObRHum    ]
  06: 1.0      Mult                PERCENT
  07: 0.0      Offset

28:  P56       Saturation Vapor Pressure SatVapor := fn(Tair)
  01: 23       Temperature Loc ObTair
  02: 46       Loc [:ObVSat    ]

29:  P31       Z=X                 Vapor := SatVapor
  01: 46       X Loc ObVSat
  02: 47       Z Loc [:ObVPre    ]

30:  P31       Z=X                 ObTdew := ObTair (100% RH)
  01: 23       X Loc ObTair
  02: 49       Z Loc [:AvTDew    ]

31:  P89       If X<=>F            IF RelHum < 100.0 THEN DO
  01: 31       X Loc ObRHum           { only multiply by RH if RH
  02: 4        <                        less than 100, otherwise
  03: 100.0    F                        leave Vapor = SatVapor }
  04: 30       Then Do

32:  P36       Z=X*Y                  Vapor := SatVapor * RelHum
  01: 47       X Loc ObVPre
  02: 31       Y Loc ObRHum
  03: 47       Z Loc [:ObVPre    ]

33:  P37       Z=X*F                  Vapor := Vapor / 100
  01: 47       X Loc ObVPre
  02: 0.01     F
  03: 47       Z Loc [:ObVPre    ]
```

```
34:  P37       Z=X*F Tdew(ObVPre) = 242.35*Ln(ObVPre/.61078) /
  01: 47       X Loc ObVPre         (17.590 - Ln(ObVPre/.61078))
  02: 1.6375   F { = 1 / 0.61078 }
  03: 19       Z Loc [:Templ     ] ObVPre / 0.61078

35:  P40       Z=LN(X)
  01: 19       X Loc Templ
  02: 19       Z Loc [:Templ     ] Ln (ObVPre / 0.61078)

36:  P30       Z=F
  01: 17.590   F
  02: 0        Exponent of 10
  03: 49       Z Loc [:AvTDew    ] 17.590

37:  P35       Z=X-Y
  01: 49       X Loc AvTDew
  02: 19       Y Loc Templ
  03: 49       Z Loc [:AvTDew    ] 17.590 - Ln (ObVPre / 0.61078)

38:  P38       Z=X/Y
  01: 19       X Loc Templ
  02: 49       Y Loc AvTDew
  03: 49       Z Loc [:AvTDew    ] Ln() / (17.590 - Ln())

39:  P37       Z=X*F
  01: 49       X Loc AvTDew
  02: 242.35   F
  03: 49       Z Loc [:AvTDew    ] 242.35 * Ln() / (17.590 - Ln())

40:  P95       End                END

41:  P35       Z=X-Y               VaporDef := SatVapor - Vapor
  01: 46       X Loc ObVSat
  02: 47       Y Loc ObVPre
  03: 48       Z Loc [:ObVDef    ]
-------------------------------------------------------------

 Create 5-minute averages for "current weather"

42:  P92       If time is
  01: 0        minutes into a
  02: 5        minute interval
  03: 10       Set high Flag 0 (output)

43:  P80       Set Active Storage Area
  01: 3        Input Storage Area
  02: 51       Array ID or location LOC 51 : CToPcpn
-------------------------------------------------------------
 MAKE FIVE MINUTE "CURRENT" VALUES IN LOCATIONS 51..58
-------------------------------------------------------------

44:  P72       Totalize LOC 51 : CToPcpn : 5-min total precip
  01: 1        Rep
  02: 35       Loc ToPcpnlm
```

```
45:  P71       Average LOC 52 : CvSol : 5-min avg global rad
  01: 1        Rep
  02: 21       Loc ObSol

46:  P71       Average LOC 53 : CAvTair : 5-min avg Air Temp
  01: 1        Rep
  02: 23       Loc ObTair

47:  P71       Average LOC 54 : CAvTdew : 5-min avg Dew Point Temp
  01: 1        Rep
  02: 49       Loc AvTDew

48:  P71       Average LOC 55 : CAvRHum : 5-min avg Relative Humidity
  01: 1        Rep
  02: 31       Loc ObRHum

49:  P73       Maximize LOC 56 : CPkWind : 5-min Peak 5-sec Wind Spd
  01: 1        Rep
  02: 0        Value only
  03: 36       Loc PkWind1m

50:  P76       Wind Vector LOC 57 : CAvWind : 5-min avg Wind Speed
  01: 1        Rep          LOC 58 : CRsDir : 5-min Wind Direction
  02: 20       WS, Dir (Polar Sensor)
  03: 37       Wind Speed/East Loc AvWind1m
  04: 38       Wind Direction/North Loc RsDir1m
-------------------------------------------------------

51:  P92       If time is          IF TIME is 5 minute interval
  01: 0        minutes into a
  02: 5        minute interval
  03: 30       Then Do

52:  P89       If X<=>F              AND IF CToPcpn >= 0.005 THEN DO
  01: 51       X Loc CToPcPn
  02: 3        >=
  03: 0.005    F
  04: 10       Set high Flag 0 (output)

53:  P80       Set Active Storage Area
  01: 1        Final Storage Area 1
  02: 401      Array ID or location
-------------------------------------------------------
  FIVE MINUTE PRECIPITATION DATA --- TABLE 401, AREA 1
-------------------------------------------------------

54:  P86       Do
  01: 9        Call Subroutine 9

55:  P70       Sample 05 : CToPcpn : 5 minute rainfall in mm
  01: 1        Rep
  02: 51       Loc CToPcPn

56:  P70       Sample 06 : CAvWind : 5 minute avg Wind Speed in m/s
  01: 1        Rep
  02: 57       Loc CAvWind
```

```
57:  P95       End ---- FIVE-MINUTE PRECIP EVENT
-------------------------------------------------------
```

If FLAG 1 is low, disable intermediate processing via FLAG 9. This is to allow servicing and disconnection of sensors without generating bad data values (as long as interruption is brief--a few minutes).

```
58:  P91       If Flag/Port                  IF FLAG 1 LOW
  01: 21       Do if flag 1 is low
  02: 30       Then Do

59:  P86       Do
  01: 19       Set high Flag 9                   Disable Processing

60:  P91       If Flag/Port                      IF FLAG 8 HIGH
  01: 18       Do if flag 8 is high
  02: 30       Then Do

61:  P86       Do
  01: 8        Call Subroutine 8

62:  P86       Do
  01: 28       Set low Flag 8

63:  P95       End                                   END

64:  P94       Else                          ELSE (FLAG 1 HIGH)

65:  P91       If Flag/Port                      IF FLAG 8 LOW
  01: 28       Do if flag 8 is low
  02: 30       Then Do

66:  P86       Do
  01: 8        Call Subroutine 8

67:  P86       Do
  01: 18       Set high Flag 8

68:  P95       End                                   END

69:  P95       End                             END
-------------------------------------------------------
```

If FLAG 6 is HIGH, call subroutine 8 to output a "499" marker/parameter-dump record, then force immediate hourly and 24-hour output records via FLAG 7. This is provided to enable accumulated hourly and daily statistics (such as max and min values) to be output before a datalogger program change, which would otherwise reset all output statistics and cause the loss of the intermediate hourly and daily stats. Note: these premature hourly and daily output records will have the current time when they are output, rather than even hour or 2400 time.

```
70:  P91        If Flag/Port
  01: 16        Do if flag 6 is high
  02: 8         Call Subroutine 8
-------------------------------------------------------

 FLAG 7 is used internally to control output FLAG 0
 It is set HIGH on the hour, OR when FLAG 6 is high

71:  P86        Do
  01: 27        Set low Flag 7

72:  P92        If time is
  01: 0         minutes into a
  02: 60        minute interval
  03: 17        Set high Flag 7

73:  P91        If Flag/Port
  01: 16        Do if flag 6 is high
  02: 17        Set high Flag 7

74:  P91        If Flag/Port
  01: 17        Do if flag 7 is high
  02: 10        Set high Flag 0 (output)

75:  P80        Set Active Storage Area
  01: 1         Final Storage Area 1
  02: 403       Array ID or location
-------------------------------------------------------
  PRIMARY HOURLY SUMMARY DATA --- TABLE 403, AREA 1
-------------------------------------------------------

76:  P86        Do
  01: 9         Call Subroutine 9 ( begin output record )

77:  P72        Totalize 05 : HToPcpn : TOTAL PRECIPITATION, mm
  01: 1         Rep
  02: 35        Loc ToPcpnlm

78:  P71        Average 06 : HAvSol : HOURLY AVG GLOBAL RADIATION W/m2
  01: 1         Rep
  02: 21        Loc ObSol

79:  P71        Average 07 : HAvTair : HOURLY AVG Air Temp
  01: 1         Rep
  02: 23        Loc ObTair

80:  P71        Average 08 : HAvRHum : HRLY AVG RELATIVE HUMIDITY, PCT
  01: 1         Rep
  02: 31        Loc ObRHum

81:  P71        Average    09 : HAvTS05 : HRLY AVG SOIL TEMP C, 5 cm
  01: 3         Reps       10 : HAvTS10 : HRLY AVG SOIL TEMP C, 10 cm
  02: 24        Loc ObTS05 11 : HAvTS50 : HRLY AVG SOIL TEMP C, 50 cm
```

Table 2

```
82:  P73        Maximize 12 : HPkWind : PEAK FIVE-SECOND WIND SPD m/s
  01: 1         Rep
  02: 0         Value only
  03: 36        Loc PkWind1m

83:  P76        Wind Vector 13-16 : HAvWind, HRsWind, HRsDir, HDvDir
  01: 1         Rep
  02: 0         Polar Sensor (speed and direc)
  03: 37        Wind Speed/East Loc AvWind1m
  04: 38        Wind Direction/North Loc RsDir1m

84:  P71        Average   17 : HAvPAR : HOURLY AVG PAR uE/m^2/hr
  01: 1         Rep
  02: 22        Loc ObPAR

85:  P73        Maximize 18 : HMxWnd1 : MAXIMUM 1-MINUTE WIND SPEED
  01: 1         Rep
  02: 0         Value only
  03: 37        Loc AvWind1m

86:  P71        Average 19 : HAvTDew : HOURLY AVG Dew Point Temp
  01: 1         Rep
  02: 49        Loc AvTDew
-------------------------------------------------------

 Use FLAG 7 again to control daily output
 FLAG 7 is set HIGH if time is 2400, OR FLAG 6 is HIGH

87:  P86        Do
  01: 27        Set low Flag 7

88:  P92        If time is
  01: 0         minutes into a
  02: 1440      minute interval
  03: 17        Set high Flag 7

89:  P91        If Flag/Port
  01: 16        Do if flag 6 is high
  02: 17        Set high Flag 7

90:  P91        If Flag/Port
  01: 17        Do if flag 7 is high
  02: 10        Set high Flag 0 (output)

91:  P80        Set Active Storage Area
  01: 1         Final Storage Area 1
  02: 411       Array ID or location
-------------------------------------------------------
     PRIMARY 24-HOUR SUMMARY --- TABLE 411, AREA 1
-------------------------------------------------------

92:  P86        Do
  01: 9         Call Subroutine 9 (begin output record)
```

```
93:  P74       Minimize 05 : DMnBatt : 24-HOUR MINIMUM BATTERY, V
  01: 1        Rep
  02: 0        Value only
  03: 20       Loc ObBatt

94:  P72       Totalize 06 : DToPcpn : TOTAL PRECIPITATION, mm
  01: 1        Rep
  02: 35       Loc ToPcpnlm

95:  P71       Average 07 : DAvSol : 24-HOUR AVG GLOBAL RADIATION, W/
  01: 1        Rep
  02: 21       Loc ObSol

96:  P71       Average 08 : DAvTair : 24-Hour avg AIR TEMP C
  01: 1        Rep
  02: 23       Loc ObTair

97:  P73       Maximize 09 : DMxTair : MAXIMUM AIR TEMP C
  01: 1        Rep      10 : DTxTair : TIME OF MAX
  02: 10       Value with Hr-Min
  03: 23       Loc ObTair

98:  P74       Minimize 11 : DMnTair : MINIMUM AIR TEMP C
  01: 1        Rep      12 : DTnTair : TIME OF MIN
  02: 10       Value with Hr-Min
  03: 23       Loc ObTair

99:  P71       Average 13 : DAvRHum : AVERAGE RELATIVE HUMIDITY, pct
  01: 1        Rep
  02: 31       Loc ObRHum

100: P73       Maximize 14 : DMxRHum : MAXIMUM REL. HUMIDITY
  01: 1        Rep      15 : DTxRHum : TIME OF MAX
  02: 10       Value with Hr-Min
  03: 31       Loc ObRHum

101: P74       Minimize 16 : DMnRHum : MINIMUM REL. HUMIDITY
  01: 1        Rep      17 : DTnRHum : TIME OF MIN
  02: 10       Value with Hr-Min
  03: 31       Loc ObRHum

102: P71       Average 18 : DAvVPre : VAPOR PRESSURE, kPa
  01: 2        Reps    19 : DAvVDef : VAPOR PRESS. DEFICIT, kPa
  02: 47       Loc ObVPre

103: P73       Maximize 20 : DPkWind : MAXIMUM 5-SECOND WIND
  01: 1        Rep      21 : DTkWind : TIME OF PEAK
  02: 10       Value with Hr-Min
  03: 36       Loc PkWindlm
```

Table 2

```
104: P76        Wind Vector 22 : DAvWind : Avg Wind m/s
                            23 : DRsWind : Resultant m/s
                            24 : DRsDir : Res. Direction
                            25 : DDvDir : Deviation Dir.
  01: 1         Rep
  02: 0         Polar Sensor (speed and direc)
  03: 37        Wind Speed/East Loc AvWind1m
  04: 38        Wind Direction/North Loc RsDir1m

105: P71        Average 26 : DAvPAR :DAILY AVG PAR
  01: 1         Rep
  02: 22        Loc ObPAR

106: P73        Maximize 27 : DMxWnd1 : MAXIMUM 1-MINUTE WIND SPEED,
  01: 1         Rep      28 : DTxWnd1 : TIME OF MAX
  02: 10        Value with Hr-Min
  03: 37        Loc AvWind1m

107: P79        Sample on Max or Min 29 : DMxDir1 : DIRECTION OF MAX
  01: 1         Rep
  02: 38        Loc RsDir1m

108: P71        Average 30 : DAvTDew : DAILY AVG DEW POINT TEMP
  01: 1         Rep
  02: 49        Loc AvTDew

109: P73        Maximize 31 : DMxTDew : MAX DEW POINT
  01: 1         Rep      32 : DTxTDew : TIME OF MAX
  02: 10        Value with Hr-Min
  03: 49        Loc AvTDew

110: P74        Minimize 33 : DMnTDew : MIN DEW POINT
  01: 1         Rep      34 : DTnTDew : TIME OF MIN
  02: 10        Value with Hr-Min
  03: 49        Loc AvTDew
-------------------------------------------------------

111: P86        Do
  01: 27        Set low Flag 7

112: P92        If time is
  01: 0         minutes into a
  02: 1440      minute interval
  03: 17        Set high Flag 7

113: P91        If Flag/Port
  01: 16        Do if flag 6 is high
  02: 17        Set high Flag 7

114: P91        If Flag/Port
  01: 17        Do if flag 7 is high
  02: 10        Set high Flag 0 (output)
```

```
115: P80        Set Active Storage Area
  01: 1         Final Storage Area 1
  02: 412       Array ID or location
-------------------------------------------------------
   24-HOUR SOIL TEMPERATURE DATA  -- TABLE 412, AREA 1
-------------------------------------------------------

116: P86        Do
  01: 9         Call Subroutine 9 (begin output record)

117: P71        Average 05 : DAvTS05 : AVERAGE SOIL TEMP, 5 cm, bare
  01: 1         Rep
  02: 24        Loc ObTS05

118: P73        Maximize 06 : DMxTS05 : MAX SOIL TEMP, 5 cm, bare
  01: 1         Rep      07 : DTxTS05 : TIME OF MAX
  02: 10        Value with Hr-Min
  03: 24        Loc ObTS05

119: P74        Minimize 08 : DMnTS05 : MIN SOIL TEMP, 5 cm, bare
  01: 1         Rep      09 : DTnTS05 : TIME OF MIN
  02: 10        Value with Hr-Min
  03: 24        Loc ObTS05

120: P71        Average 10 : DAvTS10 : AVERAGE SOIL TEMP, 10 cm, bare
  01: 1         Rep
  02: 25        Loc ObTS10

121: P73        Maximize 11 : DMxTS10 : MAX SOIL TEMP, 10 cm, bare
  01: 1         Rep      12 : DTxTS10 : TIME OF MAX
  02: 10        Value with Hr-Min
  03: 25        Loc ObTS10

122: P74        Minimize 13 : DMnTS10 : MIN SOIL TEMP, 10 cm, bare
  01: 1         Rep      14 : DTnTS10 : TIME OF MIN
  02: 10        Value with Hr-Min
  03: 25        Loc ObTS10

123: P71        Average 15 : DAvTS50 : AVERAGE SOIL TEMP, 50 cm, bare
  01: 1         Rep
  02: 26        Loc ObTS50

124: P73        Maximize 16 : DMxTS50 : MAX SOIL TEMP, 50 cm, bare
  01: 1         Rep      17 : DTxTS50 : TIME OF MAX
  02: 10        Value with Hr-Min
  03: 26        Loc ObTS50

125: P74        Minimize 18 : DMnTS50 : MIN SOIL TEMP, 50 cm,
  01: 1         Rep      19 : DTnTS50 : TIME OF MIN
  02: 10        Value with Hr-Min
  03: 26        Loc ObTS50
```

```
126: P71        Average 20 : DAvTS1M : AVERAGE SOIL TEMP, 1 meter, bar
  01: 1         Rep
  02: 27        Loc ObTS1M
-------------------------------------------------------

 Use STORAGE AREA 2 to store 5-minute "current weather"
 values for real-time weather data retrieval.  FLAG 3
 enables this output.

127: P91        If Flag/Port
  01: 13        Do if flag 3 is high
  02: 30        Then Do

128: P92        If time is
  01: 0         minutes into a
  02: 5         minute interval
  03: 10        Set high Flag 0 (output)

129: P80        Set Active Storage Area
  01: 2         Final Storage Area 2
  02: 451       Array ID or location
-------------------------------------------------------
  5 MINUTE CURRENT CONDITIONS --- TABLE 451, AREA 2
-------------------------------------------------------

130: P86        Do
  01: 9         Call Subroutine 9 (begin output record)

131: P70        Sample
  01: 8         Reps
  02: 51        Loc CToPcPn 05 : CToPcpn
                            06 : CAvSol
                            07 : CAvTair
                            08 : CAvTdew
                            09 : CAvRHum
                            10 : CPkWind
                            11 : CAvWind
                            12 : CRsDir

132: P95        End of CURRENT CONDITIONS OUTPUT
-------------------------------------------------------

133: P86        Do
  01: 26        Set low Flag 6 RESET FLAG 6 (forces hrly/dly output)

134: P          End Table 2
=======================================================


*     3         Table 3 Subroutines

01:  P85        Beginning of Subroutine
  01: 8         Subroutine Number

02:  P86        Do
  01: 10        Set high Flag 0 (output)
```

```
03:  P80        Set Active Storage Area
  01: 1         Final Storage Area 1
  02: 499       Array ID or location
-------------------------------------------------------
    DUMP OF PARAMETER VALUES --- TABLE 499, AREA 1
    Output when FLAG 1 toggled to begin or suspend
    output processing.  Documents parameters in output.
-------------------------------------------------------

04:  P86        Do
  01: 9         Call Subroutine 9 (begin output record)

05:  P91        If Flag/Port Get 0/1 value of FLAG 1 for output
  01: 11        Do if flag 1 is high
  02: 30        Then Do

06:  P30        Z=F
  01: 1         F
  02: 0         Exponent of 10
  03: 19        Z Loc [:Templ     ]

07:  P94        Else

08:  P30        Z=F
  01: 0         F
  02: 0         Exponent of 10
  03: 19        Z Loc [:Templ     ]

09:  P95        End

10:  P70        Sample 05 : FLAG1 : 1 if processing on, 0 if off
  01: 1         Reps
  02: 19        Loc Templ

11:  P19        Signature of ROM and user program in LOC 19
  01: 19        Loc [:Templ     ]

12:  P70        Sample 06..25 : StnNum to ObBatt
  01: 20        Reps
  02: 1         Loc StnNum

13:  P95        End

14:  P85        Subroutine =======  SUBROUTINE 9  ==============
  01: 9         Label#  Output STATION ID, DAY, and HOUR/MIN
                        for all output tables.  This is
                        called after setting output flag
                        and table ID (instruction 80)

15:  P70        Sample              02 : STATION ID   eg: 4772.0
  01: 1         Rep
  02: 1         Loc StnNum

16:  P78        Resolution Allow 5-digit date value to be output
  01: 1         High Resolution
```

```
17:  P70       Sample              03 : DATE           YYDDD
  01: 1        Reps
  02: 40       Loc YYDDD

18:  P78       Resolution Return to normal 4-digit output
  01: 0        Low Resolution

19:  P70       Sample              04 : TIME           HHMM
  01: 1        Reps
  02: 43       Loc HHMM

20:  P95       End

21:  P         End Table 3
```

```
*      A       Mode 10 Memory Allocation
  01: 70       Input Locations
  02: 200      Intermediate Locations
  03: 200      Final Storage Area 2


*      C       Mode 12 Security
  01: 0000     LOCK 1
  02: 0000     LOCK 2
  03: 0000     LOCK 3
```

Input Location Assignments (with comments):

(Key: T=Table Number E=Entry Number L=Location Number)

```
 T: E: L:
2:34:19:  Z Loc [:Templ    ] ObVPre / 0.61078
2:35:19:  Z Loc [:Templ    ] Ln (ObVPre / 0.61078)
3: 6:19:  Z Loc [:Templ    ]
3: 8:19:  Z Loc [:Templ    ]
3:11:19:  Loc [:Templ    ]
2:11:20:  Loc [:ObBatt   ]
2:12:21:  Loc [:ObSol    ]
2:13:21:  Z Loc [:ObSol    ]
2:15:21:  Z Loc [:ObSol    ]
2:17:22:  Z Loc [:ObPAR    ]
2:19:22:  Z Loc [:ObPAR    ]
2:21:23:  Loc [:ObTair   ]
2:22:23:  Z Loc [:ObTair   ]
2:23:24:  Z Loc [:ObTS05   ]
2:24:25:  Z Loc [:ObTS10   ]
2:25:26:  Z Loc [:ObTS50   ]
2:26:27:  Z Loc [:ObTS1M   ]
2:27:31:  Loc [:ObRHum   ]
1: 5:32:  Loc [:ObDir    ]
1: 6:32:  Z Loc [:ObDir    ]
1: 8:32:  Z Loc [:ObDir    ]
1: 1:33:  Loc [:ObWind5s ]
1: 3:33:  Z Loc [:ObWind5s ]
1: 4:33:  Z Loc [:ObWind5s ]
1:10:34:  Loc [:ToPcpn5s ] { 5-second precip input count }
1:11:34:  Z Loc [:ToPcpn5s ]
2: 9:35:  Z Loc [:ToPcpn1m ]
2: 5:40:  Z Loc [:YYDDD    ]
2: 6:40:  Z Loc [:YYDDD    ]
2: 7:40:  Z Loc [:YYDDD    ]
2:28:46:  Loc [:ObVSat   ]
2:29:47:  Z Loc [:ObVPre   ]
2:32:47:  Z Loc [:ObVPre   ]
2:33:47:  Z Loc [:ObVPre   ]
2:41:48:  Z Loc [:ObVDef   ]
2:30:49:  Z Loc [:AvTDew   ]
2:36:49:  Z Loc [:AvTDew   ] 17.590
2:37:49:  Z Loc [:AvTDew   ] 17.590 - Ln (ObVPre / 0.61078)
2:38:49:  Z Loc [:AvTDew   ] Ln() / (17.590 - Ln())
2:39:49:  Z Loc [:AvTDew   ] 242.35 * Ln() / (17.590 - Ln())
```

First 99 Input Location Labels:

1:	StnNum	51:	CToPcPn
2:	StnLat	52:	CAvSol
3:	StnLon	53:	CAvTair
4:	StnElv	54:	CAvTdew
5:	kSol	55:	CAvRHum
6:	kPAR	56:	CPkWind
7:	kPcpn	57:	CAvWind
8:	kWind	58:	CRsDir
9:	OSWind	59:	
10:	OSDir	60:	
11:	OSTair	61:	
12:	OSTS05	62:	
13:	OSTS10	63:	
14:	OSTS50	64:	
15:	OSTS1M	65:	
16:		66:	
17:		67:	
18:		68:	
19:	Templ	69:	
20:	ObBatt	70:	
21:	ObSol	71:	
22:	ObPAR	72:	
23:	ObTair	73:	
24:	ObTS05	74:	
25:	ObTS10	75:	
26:	ObTS50	76:	
27:	ObTS1M	77:	
28:		78:	
29:		79:	
30:		80:	
31:	ObRHum	81:	
32:	ObDir	82:	
33:	ObWind5s	83:	
34:	ToPcpn5s	84:	
35:	ToPcpn1m	85:	
36:	PkWind1m	86:	
37:	AvWind1m	87:	
38:	RsDir1m	88:	
39:		89:	
40:	YYDDD	90:	
41:	Year	91:	
42:	DDD	92:	
43:	HHMM	93:	
44:		94:	
45:		95:	
46:	ObVSat	96:	
47:	ObVPre	97:	
48:	ObVDef	98:	
49:	AvTDew	99:	
50:			