NOAA TM NWS DATAC-4

NOAA Technical Memorandum NWS DATAC-4

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service

A Mini-Computer System for Upper Air Observations

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Office of
Meteorological
Operations
Data
Acquisition
Division

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WBTM DATAC 3 Requirements Statements for Selected Data Acquisition Equipment. James Giraytys and Paul L. Hexter, July 1969. (PB-185 231)

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A MINI-COMPUTER SYSTEM FOR UPPER AIR OBSERVATIONS

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.501.7	Methods of computation of upper air data
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CONTENTS

A MINI-COMPUTER SYSTEM FOR UPPER AIR OBSERVATIONS

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ABSTRACT. The development, testing, and detailed operational use of a small computer system for semiautomatic on-station processing of upper air data is described. Adoption of this system by the National Weather Service will result in considerable savings in manpower and money. In addition, the system will produce significantly better quality upper air data.

INTRODUCTION

Between January and April 1969, the National Weather Service operationally tested the feasibility of using time-share computers for semiautomatic processing of rawinsonde data. The test used computer programs developed by Parry (Parry, 1969). This test proved that such a system was indeed workable and could be used to significant advantage at locations where time-share computers are readily available at reasonable cost. Subsequently, a report was prepared (National Weather Service, 1969) which, among other things, recommended development of a small on-station computer system that could be used in much the same way as a time-share computer. The on-station computer system would bring the savings of automation to isolated locations where personnel costs are especially high, and might prove better in many other ways, than the time-share concept.

This recommendation was adopted, and funds were provided to obtain a single prototype system that could be operationally tested. The test would: (1) confirm the technical feasibility of the concept, (2)prove the reliability of the system to reveal any necessary changes for operational units, and (3) obtain necessary data to meet federal requirements for quantity procurement of computers, (Bureau of the Budget, 1969).

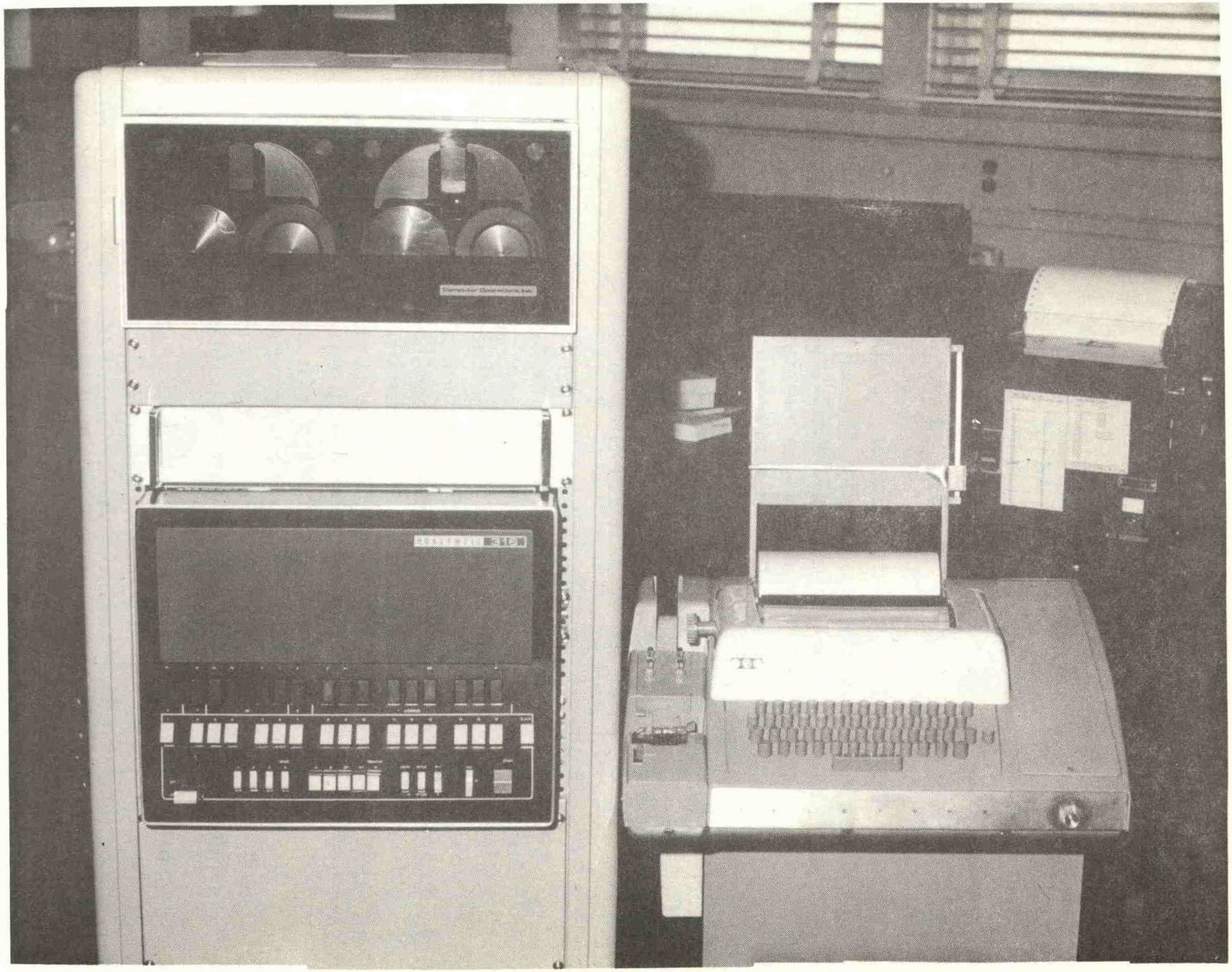

Figure 1. Upper Air Mini-Computer System

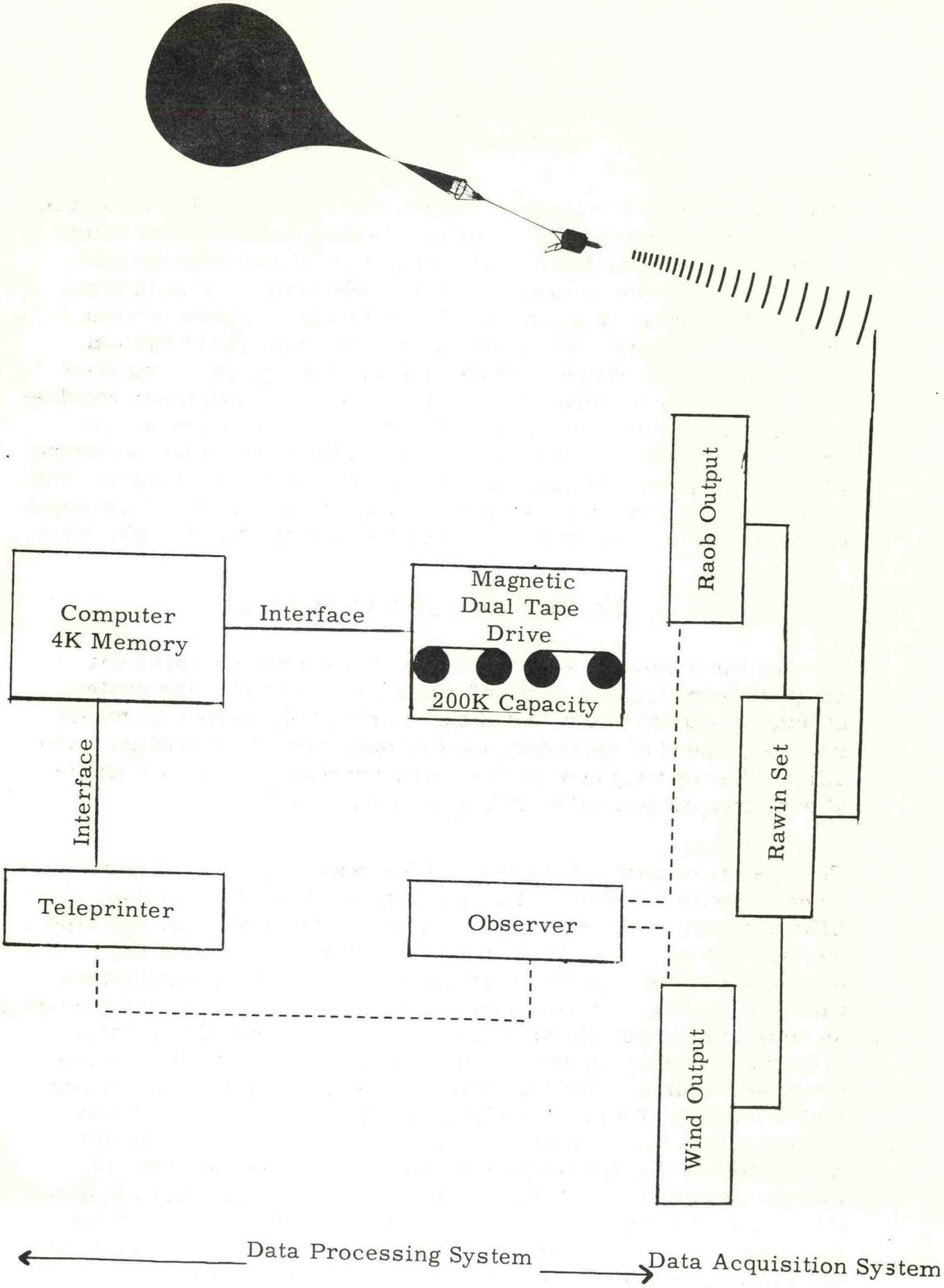

Figure 2. Automated on-station Upper Air System

PART I

1. CONCEPT OF OPERATION

At the time the mini-computer project was begun, in May 1969, use of time-share computers for rawinsonde data reduction was being expanded where possible to replace the manual reduction method. Therefore, in order to ensure a compatible system, a basic tenet used in developing programs for the on-station computer system was to closely follow the concept used in the time-share system. Although the time-share computer method does not fully automate rawinsonde observations, it does reduce the total manpower requirement from two men to one. In addition, with semiautomation no special equipment is required to interface the rawinsonde equipment with the computer; the upper air observer serves this function. This factor was considered mandatory since the analog output of the upper air equipment currently in use is not easily adaptable to digitization.

2. DESCRIPTION OF THE SYSTEM

In selecting a suitable small computer system for the upper-air program many factors were, of course, considered. The system ultimately chosen was selected based principally on four factors: low cost, speed of operation, ease of operation and expansion capability. The development contract was awarded to Computer Operations, Inc., of Beltsville, Md., at a cost of $20, 700.

The system consists of Honeywell H316 general purpose digital computer with 4, 096 word (4K) magnetic core memory, a dual LINC magnetic tape unit, a teletypewriter with tape punch and tape reader, and necessary interfaces (as shown in figs. 1 and 2). Software was developed by converting those programs used on the time-share computer to assembly language and segmenting the programs as necessary to permit running on a machine with a 4K memory. A special executive program was also developed to simplify operational procedures. The tape unit acts as an auxillary memory unit that is capable of rapid transfer (8, 000 bytes per second) of data and programs to and from core as required. The programs are segmented so that any single part does not exceed one coreload, thereby permitting rapid execution of programs many times greater than the core capacity of the computer. The total capacity of the dual tape drive is just over 400, 000 8-bit bytes divided equally into two 4-inch reels of 150-foot sandwich tape magnetic type.

The teletypewriter acts as the input-output device and may be used either in the key or tape mode. It may also be used in the local mode for cutting and reading paper tapes off line.

3. OBSERVER TRAINING REQUIREMENTS

The computer system was installed at the Sterling, Va., upper air unit on Oct. 8, 1970. On-the-job observer training was conducted by National Weather Service Headquarters personnel for 15 consecutive upper air observations. Subsequent to the training period the three observers involved in the project were able to handle one-man shifts. A fourth observer was only partially trained, since he was not available during the entire training period. Upon return to duty, his training was completed by the other observers. It should be noted that all the observers involved were people fully trained in manual reduction. This is considered mandatory because of the requirement for backup in the event of a computer outage, and of the need to ensure thorough understanding of the upper air observation.

The observers involved proved themselves very capable in adapting to the new system. A significantly longer training period should be expected especially at stations with large staffs. A training program including at least 10 observations for each observer is recommended. This suggestion is based on previous experience in conducting training at numerous stations using the time-share computer.

The training was broken into three different phases:

1. Approximately 2 hours of classroom work consisting of concept of operation, handling of equipment, and trouble shooting.
2. On-the-job-training and working up scheduled observations with instructor present to assist with problems.
3. Checking and reworking those observations containing errors.

To ensure a successful training program, the following items must be emphasized:

1. Extreme care in preparing input data files emphasizing garbage-in, garbage-out concept.

2. Typing input data so that it can be easily checked (columnizing).

3. Careful checking of output data for consistency and correct overlap.

It is mandatory that, during training, observers also physically perform all operations which they may be required to do in operating the computer. These include:

1. Checking the bootstrap
2. Replacing the entire bootstrap
3. Replacing a single word in the bootstrap
4. Changing program and data tapes
5. Cleaning the read/write heads on the tape unit
6. Changing fuses and cables
7. Power up and power down procedures
8. Shortcutting executive program

Since most of the above items are not normally required, except for item 7, the instructor will have to rely on simulation.

4. ECONOMICS OF A MINI-COMPUTER

The prototype computer system was procured at a cost of $20, 700. The price included the computer, magnetic tape unit with two spare tapes, teletypewriter, interfaces, software conversion, maintenance training (for three persons), and programming training (for two persons). Cost estimates for subsequent systems are subject to bids received. However, considering necessary changes recommended for operational models, a unit cost of $18, 000 in quantities of 5-10 appears to be a reasonable budgeting estimate.

Concerning maintenance support for this system, we have little concrete information on recurring costs of operation. No repairs of any kind were needed during the 3-month operational test. Maintenance was limited to that recommended in this report and the instruction manual supplied by the contractor, (Computer Operations Inc., 1970). Nevertheless, based on the mini-computer experience available in the NWS Engineering Division, we feel that the following is a reasonable estimate for operation of the system over a 6-year period.

Estimated Annual Recurring Cost Per Station (Alaska)

Total unit cost $18,000 amortized over 6 years	$3,000
.2 man-year, GS-10 Electronics Technician including training, tools, travel, etc.	4,800
Spare parts	800
	$8,600

Estimated Annual Recurring Savings Per Station (Alaska)

Overtime, travel, etc.	$10,200
Net recurring savings -	1,600

The above recurring savings estimate is very conservative and in practice will probably be higher, especially considering the likelihood of escalating personnel costs. These computers will initially be installed at isolated stations in the NWS Alaska and Pacific Regions. Many of the personnel manning these stations are inexperienced. This factor results in a relatively high rate of errors which will be significantly reduced by the computer. Experience has shown us that, as a minimum, chargeable errors are cut in half. In addition the overall data quality, which cannot necessarily be measured in terms of errors, is greatly improved. Although it is impractical to place a dollar value on this intangible benefit, it cannot be overlooked in considering acquisition of an upper air computer system.

This report considers only a portion of the upper air application. As stated earlier, the automation goal was to reduce manpower requirements and this goal was attained. However, it has become obvious that only a very small part of the mini-computer's capability is being tapped for this application (probably about one or two percent). Between observations the system is completely idle, and during observations it is working only a small portion of the time. Expansion capability is therefore tremendous. Realizing this, we have already begun work on further use of the system in the upper air observation (development of an output checking and coding program is underway). Other program areas will no doubt also share in use of these computers as they become available.

5. RECOMMENDED SYSTEM IMPROVEMENTS

The system performed exceptionally well in the 3 months of operational testing it underwent at Sterling, Va. No hardware failures were recorded during the total of 180 flights computed using the system. About the only problem encountered was loss of the bootstrap program on three occasions. In each of these cases, reloading was accomplished in 3 to 5 minutes by the observer on duty (this is considered a routine observer task).

Subsequently, after advising the contractor of this problem, it was discovered that we were not taking advantage of a power-interrupt feature of the machine. The problem was corrected using software and has not recurred. Although we were not aware of it at the time, it is interesting to note that this damage to the bootstrap occurred only if the machine were running at the time a power failure occurred. Such an occurrence is rare; this explains why the problem occurred only three times. However, as running time increases, it could have become a serious problem. Other minor software problems were discovered and corrected.

The prototype system was delivered as separate components and included mounting hardware but no rack. It was therefore necessary to operate the prototype as separate components on a table until a suitable mounting rack could be obtained. Operational units will require permanent mounting. It is therefore recommended that a compatible rack mount be included in the quantity procurement Request for Proposals.

Although it did not become apparent during the test, a known weak point in the system is the teletypewriter. This fact is borne out by our experience in using them in the time-share computer system. This piece of equipment has the lowest mean time between failure, and in many ways is the most difficult to repair. This fact is the basis for our recommendation that subsequent systems be supplied with a heavy duty teletypewriter. Although this suggestion probably cannot be justified on the basis of current equipment usage, it will permit necessary expansion as upper air program usage increases and as other programs begin using the system. It is therefore recommended that operational systems include a Model 35 teletypewriter or equivalent in lieu of the Model 33 machine supplied with the prototype system.

6. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

1. Use of a small mini-computer system of the type described in this report is feasible for upper air data reduction, from the technical point of view.

2. Use of such a system is very desirable because of both resulting manpower savings and improved data accuracy.

3. Use of these systems in the Alaska Region should result in minimum annual recurring savings of $1, 600 per station.

4. The upper air computer has a significant beneficial effect on the morale and attitude of observer personnel.

B. Recommendations

1. Begin immediate action to procure mini-computers for Alaska, using FEC funds appropriated in the FY-71 budget.

2. Look into possible ways of reprogramming funds to increase procurement to the point where all Alaska stations can be supplied with these systems.

3. Expand current computer programs to make maximum use of the mini-computer.

4. Investigate other uses of the mini-computer at those locations at which it will be installed.

5. Make necessary arrangements for the training of both operations and engineering personnel at the Alaska Region Headquarters prior to implementation of the mini-computers.

7. SUMMARY OF OBSERVER FUNCTIONS

1. Pre-flight checks, baseline check, release, and recorder record evaluation performed in the same manner as during a manual observation (entire operation performed by one man).

2. One man raob release.

3. Raw raob data transcribed from analog record to work sheet. Using this worksheet and data printer tapes, observer prepares teletypewriter tape of raw data in prescribed format (Parry, 1969). Flight may be broken at any point in order to meet transmission schedules. ←

4. Computer "powered up". (see section 2, under Part 2, Operational Procedures)
5. Raw data read into computer via teletypewriter. (see section 3)

6. Data file manually checked for correct format and consistency.

7. Necessary corrections, if any, made to data file. (see section 3, under Part 2, Operational Procedures)

8. Computation program executed. (see section 3, under Part 2, Operational Procedures)

9. Coded message prepared from output.

PART II

1. OPERATIONAL PROCEDURES [1]

As indicated above, the operational procedures for the minicomputer are similar (and in most cases identical) to those used in time-sharing. In lieu of making a telephone contact and going though the prescribed security procedures, the observer is required to act as computer operator. This task, although not complicated, does require careful attention to detail. Use of a checklist has been found to be very helpful. Under normal circumstances all operations are accomplished by the teletypewriter except for "power up" and "power down." This does not include items related to required routine maintenance.

1. Preparation of Input Data

Observer prepares paper input tape of raw upper air data in the same manner as for time-share computer observation (National Weather Service, 1970). Teletypewriter is placed in local mode with computer main power switch in on-position.

2. Power Up Procedure

When input data tape is ready, computer is powered up as follows:

(a) Computer main power switch to ON position. [2]
(b) Tension Magnetic tapes by pressing "load" control on tape unit (left button above each drive). [3]
(c) Teletypewriter switch to LINE position.
(d) Mode switch to single instruction (SI).
(e) Press MASTER CLEAR.
(f) Press P/Y register switch.
(g) Press bit 16 switch (indicator light should come on).
(h) Mode switch to RUN position.
(i) Press START switch--this will begin bootstrap sequence, which is used to start system.

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1) See references, (1) Computer Operations, Inc., "Instruction Manual--Upper Air Observational Data Computer System" (2) National Weather Service, "Use of the Time-Share Computer in the Processing of Rawinsonde Data".

2) Wait at least 15 seconds after turning main power off before switching it on again.

3) Tape marker must be to right of head.

3. Bootstrap Followup

(a) Bootstrap followup sequence starts. Teleprinter prints out "wait." Magnetic tapes are tested. This sequence requires about 60 seconds. If tapes do not check out, system will not sequence to next step and a diagnostic may or may not print out (see section 4).

(b) When bootstrap followup is completed, system prints "new or old data". System is now ready to work.

(c) Observer answers by typing either "new" or "old". If "new" is typed, any data on magnetic tape left over from a previous flight is erased. The system then steps to the executive program. If "old" is typed, system steps to executive program without erasing old data stored on magnetic tape. In other words, "new" indicates beginning of a new flight, while "old" indicates continuation of an old flight.

(d) Executive program types out "?". This means the system is waiting for a command. At this point, observer has five command options: Input, List, Check, Compute , and End[4]. Any other command will automatically return system to executive routine.

(1) Inp-- System will fetch input file from magnetic tape. If no data is on tape, blank file will be fetched and loaded into core. After system prints "ready", it will accept input data via paper tape or key. When input run is completed, observer types line feed, return, return. System will sort data file, make corrections, then log it on magnetic tape in ASCII code and automatically return to executive routine. Completion of this command is indicated by a "?".

---

[4] In giving the system a command, type only the command's first three letters.

(2) Lis-- System will retrieve data file in ASCII code from LINC tape and print it out. When printout is completed (indicated by "end of file") or aborted by using break key, (indicated by "break abort") system automatically returns to the executive routine. Completion of this routine is indicated by "?".

(3) Che-- This command first converts the data file from ASCII code to floating point format, (real numbers) then loads check program (two coreloads required) and automatically executes check program. One of four printouts is possible: (1) Flags with program completed, (2) No flags with program completed, (3) Flags with incomplete program execution and (4) A math diagnostic. Upon completion or abortion of printout, (possibilities 1-3) system automatically returns to executive routine. Completion of this routine is indicated by "?". See 8.1 in the case of a math diagnostic printout indicated by two letters, e.g. SA.

(4) Com-- This command first converts the data file from ASCII code to floating point format (real numbers) and executes the computation program (four coreloads). One of four printouts is possible: (1) Complete correct computation, (2) Incomplete or no computation, (3) Complete computation with errors, and (4) a math diagnostic. Upon completion or abortion of printout (possibilities 1-3), system automatically returns to executive program. Completion of this routine is indicated by "?". See section 8.1 in case of a math diagnostic printout indicated by two letters, e.g. SA.

(5) End-- This is the only command of the five possibilities which does not return the system to the executive program. The command is used normally upon completion of any part of a rawinsonde flight. The magnetic tape is rewound to its starting position and the printout "power down" appears when the rewind process is completed. At this point, the observer may either shut off the main power switch (first place the mode switch in the SI position) or leave the computer in the "idle" mode. In either case the teletypewriter should be turned off.

(a) Power Down-- The teletypewriter is turned off, the mode switch placed in the SI position, and the main computer power switch is then placed in the off position. Restart from this point is accomplished by returning to start and going through bootstrap, bootstrap followup, and the power up procedure. Data from the previous input is retained on tape. If this were a continuation of an observation, the input file could be updated by typing "old", thereby bypassing the erase data sequence. If this were a new flight, the command "new" would wipe out the stored data file.

(b) Idle-- The teletypewriter is turned to the off position. Power is not shut off in this mode. Restart is accomplished by depressing the computer start switch after turning teletypewriter to line position. Sequence is then picked up immediately after tape test. This is normally the system mode used between secessive parts of an observation.

X

The "end" command may also be used if the observer desires to completely erase the data file and start over (see fig. 3 for a flow chart of the system).

4. Power Failure and Its Effect on the System

At any point within the executive program loop, a power failure will result in a return to the "power up"step. However, since no power would have been available at the magnetic tape unit after a power failure, it is necessary to manually rewind the tape to the starting point (marked by a white dot on the tape, which should be positioned just to the right of the read/write head) prior to sequencing through the "power up" procedure. The system will then be ready to re-boot.

(a) If the power failure occurs during "input", data already recorded on magnetic tape will be safe. Data in core, although it is protected, should be reentered since it will be difficult to determine the exact point where power was lost.

(b) A power failure during list will be similar to a "list abort". The observer should repeat this command after going through the power up procedures.

(c) When a power failure occurs during the running of either the "check" or "compute" program, the program should be rerun after powering up.

(d) Power failure during "idle" returns the system to the power up step.

IMPORTANT-- In the event of a power failure, every effort should be made to turn the main computer power switch to the off position, immediately. This will preclude the possibility of damage to the computer in the event of a surge when power is returned. It will also ensure protection of the bootstrap program which is stored in the first seventeen positions of memory.

5. Rules for Preparing the Input Data File

A sample flight including a sample input file is shown in the appendix of this paper. Rules followed in preparing the input file are as follows:

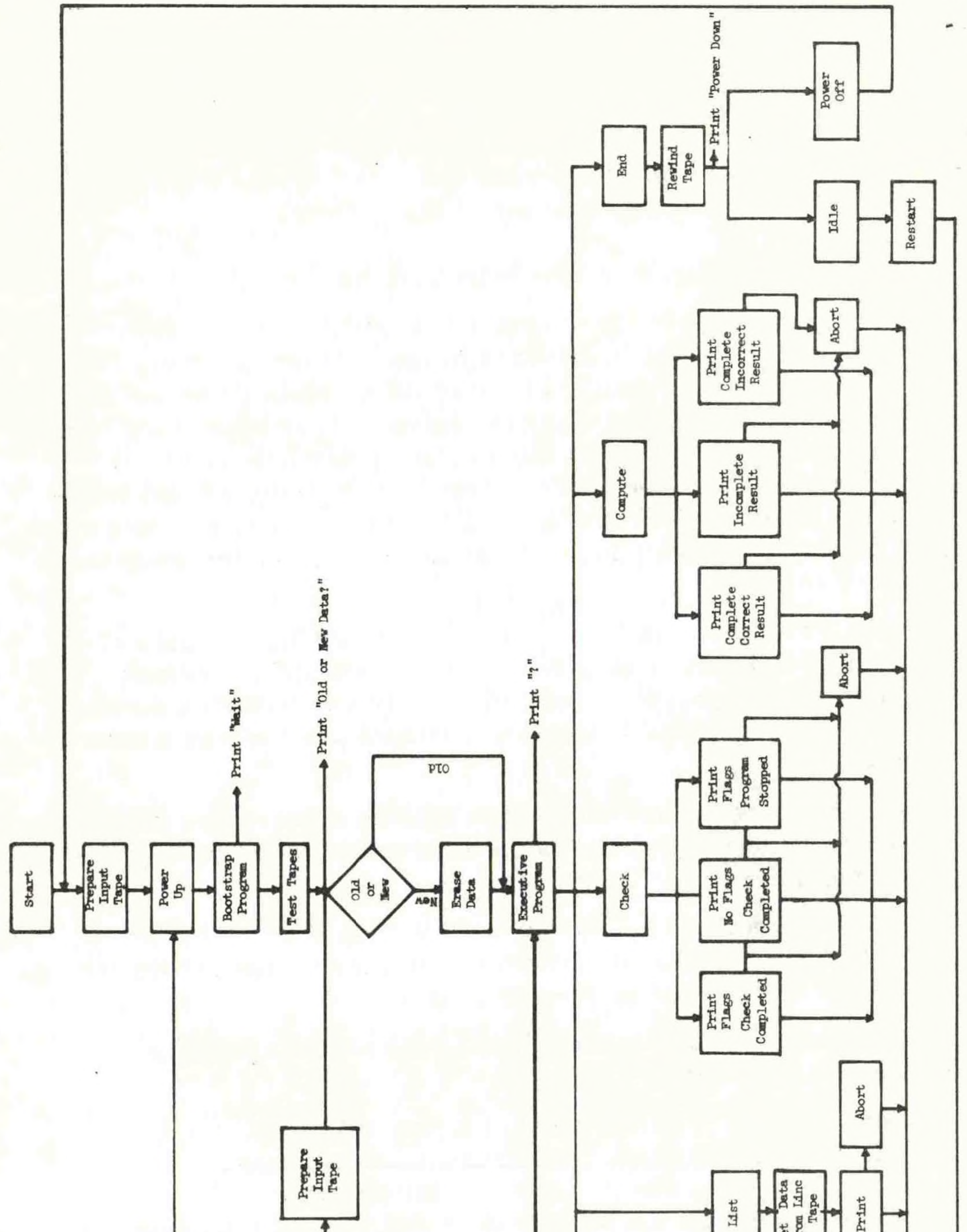

Figure 3. Flow Chart for Upper Air Mini-Computer System

Input File Format	-Follow exact format outlined on data sheet I and described in Chapter C10, Federal Meteorolgical Handbook No. 3.
Line Format	-Every line must start with a line number. Data is separated by one or more spaces. The computer will accept up to 100 characters per line but it is not good practice to type more than the teletypewriter can print in one line.
Line Numbers	-Line numbers up to 500 are accepted. Line numbers over 500 are automatically deleted.
Legal Acceptable Characters	-Zero thru nine, space, period, return, line feed and back arrow. All other characters are ignored.
Replacing a Line	-When two or more lines are assigned the same line number, only the last line typed will be accepted.
Deleting Characters	-One back arrow will delete the previous character, two will delete the previous two characters, etc.
Deleting a Line	-Typing a line number without data will delete any previous line with that number.
Entering Data	-Data may be entered either from tape or keyboard.
Saving Data	-After inputting or updating a data file, it may be "saved" by typing (on the keyboard) an extra carriage return.

2. ROUTINE PROBLEMS IN OPERATION OF THE SYSTEM

The observer may perform certain corrective actions should the system not operate properly. Difficulties can result from a data error made by the observer, an improper procedure, or a fault in the system.

1. Math Diagnostics

When attempting to run either the Che or Com program, a two-letter math diagnostic may be printed out and the program will be halted. This normally indicates a gross error in the input file which must be corrected before the computation can be run.

Corrective Action - since the system stopped during the running of a program it must be returned to the executive routine. This can be accomplished as follows:

(a) Press the "computer start" button. If the program begins to run it will probably print out either obviously incorrect answers (in the case of the Com program) or an error message (in the case of the Che program). In either case, the printout may be aborted and the system will automatically return to the executive routine. In this case correct the data file and proceed. In the event another two letter math diagnostic is printed, the program probably will not run. In this case go to step "b".

(b) This procedure is called the "executive program shortcut".

(1) Place mode switch to single instruction (SI)
(2) Press MASTER CLEAR
(3) Depress P/Y register button
(4) Press register button 12 (light should come on)
(5) Place mode switch to RUN position
(6) Press computer START button. A "?" should appear on teletypewriter. The data file may now be corrected.

(c) If procedure "b" does not work, or if the observer prefers, the main power may be shut off and the system may be run through "power up". Be sure to leave the power off at least 15 seconds. After the system returns to the executive routine, correct the data file and continue.

2. Magnetic tapes fail to move at all after power up procedure is completed.

Corrective Action -

(a) Try "power up" again
(b) Check protected bootstrap and correct if necessary
(c) Power down and check for blown fuse in tape unit, or disconnected cables.

3. "Wait" not printed as tape moves forward. Tape may or may not stop.

Corrective Action -

(a) Reset tape position and try again
(b) Check and correct protected bootstrap if necessary

4. Should the system not respond properly after several trys at "power up", try the following:

(a) Either exchange or try new program tapes
(b) Clean heads
(c) Check and correct protected bootstrap

REFERENCES

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Parry, H. Dean, "Semiautomatic Computation of Rawinsondes," Weather Bureau Technical Memorandum EDL 10, U.S. Weather Bureau, Silver Spring, Md., Oct. 1969, 48 pp.

APPENDIX A

SAMPLE COMPUTER REDUCED RAWINSONDE FLIGHT

```
WAIT

OLD OR NEW DATA?
NEW

? INP
READY
```

Sample - Input Data as Read into Computer by Observer (Part I)

```
0 5
80 999 0 10 10
90 71.1 26.7 73.0 5 94789
95 101069 1115 349 40 5.1 .1
250 9999 9999
1    0.0 1012.6 58.7 38.0   0.8 1000 58.3 21.2
3    1.7 967 57.7  9.2    2.7 936 62.2 73.8
5    4.4 887 61.2 80.8    5.8 850 59.7 79.2
7    8.0 795 57.3 71.9    9.3 755 55.2 47.9
9   10.6 732 54.1 59.0   11.8 700 52.6 46.9
11  12.0 695 52.3 69.0   14.8 631 50.1 64.7
13  15.7 611 49.1 44.4   18.7 550 47.0 81.3
15  21.4 500 43.2 82.1   24.2 452 40.0 74.5
17  25.4 433 38.7 14.8   26.6 414 37.1 19.3
19  27.4 400 36.1 54.3   28.6 381 34.4 71.5
21  32.0 332 28.6 69.3   34.6 300 24.1 85
23  38.2 250 17.9 85
101 21.05   41.4   19.94   59.0   24.63   64.9   27.76   68.6
105 29.76   72.5   30.82   75.7   32.32   77.0   32.88   75.1   33.72   74.5
110 34.64   75.4   36.20   73.9   37.52   71.3   38.57   70.4   39.54   66.6
115 41.12   62.3   41.78   58.8   43.44   55.9   44.51   53.5   .1 .1
120 .1 .1   .1 .1   .1 .1   .1 .1   .1 .1
125 53.72    9.1   55.12 356.6   56.46 343.1   56.80 328.7   55.14 315.0
130 51.62 302.9   48.12 293.6   44.62 285.3   41.32 279L←.0   38.48 274.1
135 35.74 270.3   33.72 267.3   31.80 264.5   29.92 263←2.3   27.85 260.6
WAIT

? LIS
```

Listing of Input Data as Sorted and Corrected by Computer (Part I)

```
0 5
1    0.0 1012.6 58.7 38.0   0.8 1000 58.3 21.2
3    1.7 967 57.7  9.2    2.7 936 62.2 73.8
5    4.4 887 61.2 80.8    5.8 850 59.7 79.2
7    8.0 795 57.3 71.9    9.3 755 55.2 47.9
9   10.6 732 54.1 59.0   11.8 700 52.6 46.9
11  12.0 695 52.3 69.0   14.8 631 50.1 64.7
13  15.7 611 49.1 44.4   18.7 550 47.0 81.3
15  21.4 500 43.2 82.1   24.2 452 40.0 74.5
17  25.4 433 38.7 14.8   26.6 414 37.1 19.3
19  27.4 400 36.1 54.3   28.6 381 34.4 71.5
21  32.0 332 28.6 69.3   34.6 300 24.1 85
23  38.2 250 17.9 85
80 999 0 10 10
90 71.1 26.7 73.0 5 94789
95 101069 1115 349 40 5.1 .1
```

Line 0 - Height of base level

Raw Raob Levels
Lines 1 - 23

Line 80 - Dummy line
Line 90 - Baseline check
Line 95 - Station identifiction data

Line 101 - 135 - Range/Angle Data

```
101 21.05   41.4   19.94  59.0   24.63  64.9   27.76  68.6
105 29.76   72.5   30.82  75.7   32.32  77.0   32.88  75.1   33.72  74.5
110 34.64   75.4   36.20  73.9   37.52  71.3   38.57  70.4   39.54  66.6
115 41.12   62.3   41.78  58.8   43.44  55.9   44.51  53.5   .1  .1
120 .1 .1   .1 .1   .1 .1   .1 .1   .1 .1
125 53.72    9.1   55.12 356.6   56.46 343.1   56.80 328.7   55.14 315.0
130 51.62 302.9   48.12 293.6   44.62 285.3   41.32 279.0   38.48 274.1
135 35.74 270.3   33.72 267.3   31.80 264.5   29.92 262.3   27.85 260.6
250 9999 9999
```

Line 250 - Dummy line

```
END OF FILE.
```

Printout after Executing Check Program on Input Data

```
? CHE

 WIND DATA FOR MINUTES    1 THRU  39 HAVE BEEN RECEIVED.
 CHECK AZ ANGLES     9.1  356.6 FOR MINUTES  25 AND   26
 CHECK USING EL ANGLE COMPLETED.
? COM
```

Output Printout (Part I)

```
 BB
  DATE      TIME   A.NO    F.EQ   STATION
 101069.   1115    349     0.1    94789.
```

Identification Data

```
   TIME    PRESS     M-MSL     TEMP    DP-DEP
    0.0  1012.6         5.      2.7      4.2
    0.8  1000.0       106.      2.1      2.7
    1.7   967.0       377.      1.1      0.9
    2.7   936.0       643.      8.7     11.7
    4.4   887.0      1086.      6.9     19.0
    5.8   850.0      1434.      4.4     15.6
    8.0   795.0      1975.      0.4     10.1
    9.3   755.0      2387.     -2.8      5.2
   10.6   732.0      2631.     -4.5      6.5
   11.8   700.0      2982.     -6.7      5.1
   12.0   695.0      3038.     -7.2      8.6
   14.8   631.0      3787.    -10.4      7.2
   15.7   611.0      4034.    -11.8      4.7
   18.7   550.0      4835.    -14.7     16.4
   21.4   500.0      5550.    -19.9     16.7
   24.2   452.0      6292.    -24.3      9.5
   25.4   433.0      6604.    -26.0      2.0
   26.6   414.0      6928.    -28.1      2.4
   27.4   400.0      7174.    -29.5      5.3
   28.6   381.0      7520.    -31.7      7.9
   32.0   332.0      8478.    -39.6      6.8
   34.6   300.0      9161.    -46.1   9999.0
   38.2   250.0     10348.    -55.9   9999.0
```

Significant and
Mandatory Raob
Data

MIN	M-AS	DIR	S-MPS	FT-MSL
0	0.	40	5.1	16.
1	161.	59	10.4	546.
2	452.	73	9.9	1498.
3	716.	87	5.4	2366.
4	977.	92	5.3	3221.
5	1230.	96	5.6	4053.
6	1478.	93	5.0	4867.
7	1724.	72	4.7	5673.
8	1970.	65	5.9	6479.
9	2287.	77	4.9	7519.
10	2513.	68	2.7	8263.
11	2743.	32	3.4	9016.
12	3033.	41	3.8	9967.
13	3300.	27	4.2	10845.
14	3568.	359	5.4	11722.
15	3837.	357	5.5	12604.
16	4109.	353	4.6	13498.
17	4376.	342	3.7	14375.
18	4643.	353	3.7	15251.
19	4910.	0	0.0	16124.
20	5174.	0	0.0	16992.
21	5439.	0	0.0	17860.
22	5704.	0	0.0	18729.
23	5969.	0	0.0	19599.
24	6234.	0	0.0	20469.
25	6495.	270	17.2	21326.
26	6761.	264	17.7	22198.
27	7046.	255	19.1	23133.
28	7342.	253	20.8	24104.
29	7628.	256	23.7	25041.
30	7909.	255	25.6	25965.
31	8191.	249	26.9	26889.
32	8473.	246	28.1	27813.
33	8736.	244	27.8	28676.
34	8998.	244	28.5	29539.
35	9288.	244	28.5	30489.
36	9618.	242	28.6	31570.
37	9947.	242	30.8	32651.

Minute Wind Data

P-MB	DIR	S-KTS
1000	50	16
850	95	10
700	40	7
500	0	0
400	255	39
300	245	55

Mandatory Level Wind Data

```
 H K-FT DIR     S-KTS
     1    65        20
     2    80        14
     3    90        10
     4    95        11
     6    70        10
     7    70        11
     8    70         7
     9    35         7
    12   360        11
    14   345         8
    16     0         0
    20     0         0
    25   255        46
    30   245        55
 EE
 BB
 MEAN WIND--SFC  TO  5000 FT    80    13
 MEAN WIND--5000 TO 10000 FT    60     9
```

Fixed Wind Levels

Mean Wind Data

```
 SIG. WINDS
 H K-FT  DIR     S-KTS
       1   60       20
       2   85       11
       4   95       11
       6   65       12
      12  360       11
      13  355       11
      21  270       33
      23  255       37
      33  240       60
 EE
? END

POWER DOWN

OLD OR NEW DATA?
OLD

? INP
```

Significant Wind
Levels

READY **Sample - Input Data as Read into Computer by Observer (Part II)**

```
0 9161
95 101069 1115 349 40 5.1 1456
1
3
5
7
9
11
13
15
17
19
21
22 34.6 300 24.1 85
24 38.7 243 17.2 85
25 40.1 230 17.9 85
25 40.1 230 17.8 85      41.2 220 19.1 85
2743←← 43.0 200 18.3 85     48.9 150 17.4 85
29 53.2 121 17.6 85      56.8 100 15.7 85
31 60.3 85  15.0 85      61.7 78  16.7 85
33 63.7 70  15.0 85      65.3 64  15.3 85
35 70.0 50  17.2 85      75.3 37  16.5  ←85
37 78.4 30  17.6 85      85.0 20  20.3 85
39 88.0 17  22.5 85
101
105
110
115
120
125
130
140 26.32 259.7  25.00 258.4  23.84 257.7  22.82 256.9  21.60 256.3
145 20.62 256.2  19.83 255.8  19.04 256.9←0  18.57 256.2  17.94 256.7
150 17.54 257.0  17.14.257.2  16.72 257.4  16.34 257.6  16.02 257.6
155 15.63 257.8 1← 15.44 258.5  15.16 259.0  15.05 259.6  14.92 260.1
160 14.92 260.3  14.64 260.4  14.64 260.7  14.64 260.8  14.63 261.0
165 14.64←5 261.1  14.63 261.4  14.72 261.8  14.82 262.0  14.96 262.4
170 15.09 262.4  15.24 262.3  15.42 262.3  15.57 262.5  15.80 262.8
175 16.03 263.1  16.11 263.4  16.24 263.3  16.68 263.4  16.82 263.6
180 17.14 263.7  17.52 263.6  17.72 263.7  17.94 263.9  18.26 264.3
185 18.52 264.5  19.02 264.7  19.34 264.7  19.67 264.8
WAIT
```

Line 0 - Height of base level
Line 95 - Station identification line

Deleted Raob Levels
Lines 1 - 21

New Raob Levels
Lines 22 - 39

Deleted Wind Data
Lines 101 - 130

New Wind Data
Lines 140 - 185

Listing of Input Data as Sorted and Corrected by Computer (Part II)

```
? LIS
0 9161
22 34•6 300 24•1 85
23 38•2 250 17•9 85
24 38•7 243 17•2 85
25 40•1 230 17•8 85    41•2 220 19•1 85
27 43•0 200 18•3 85    48•9 150 17•4 85
29 53•2 121 17•6 85    56•8 100 15•7 85
31 60•3 85  15•0 85    61•7 78  16•7 85
33 63•7 70  15•0 85    65•3 64  15•3 85
35 70•0 50  17•2 85    75•3 37  16•5 85
37 78•4 30  17•6 85    85•0 20  20•3 85
39 88•0 17  22•5 85
80 999 0 10 10
90 71•1 26•7 73•0 5 94789
95 101069 1115 349 40 5•1 1456
135 35•74 270•3  33•72 267•3  31•80 264•5  29•92 262•3  27•85 260•6
140 26•32 259•7  25•00 258•4  23•84 257•7  22•82 256•9  21•60 256•3
145 20•62 256•2  19•83 255•8  19•04 256•0  18•57 256•2  17•94 256•7
150 17•54 257•0  17•14 257•2  16•72 257•4  16•34 257•6  16•02 257•6
155 15•63 257•8  15•44 258•5  15•16 259•0  15•05 259•6  14•92 260•1
160 14•92 260•3  14•64 260•4  14•64 260•7  14•64 260•8  14•63 261•0
165 14•65 261•1  14•63 261•4  14•72 261•8  14•82 262•0  14•96 262•4
170 15•09 262•4  15•24 262•3  15•42 262•3  15•57 262•5  15•80 262•8
175 16•03 263•1  16•11 263•4  16•24 263•3  16•68 263•4  16•82 263•6
180 17•14 263•7  17•52 263•6  17•72 263•7  17•94 263•9  18•26 264•3
185 18•52 264•5  19•02 264•7  19•34 264•7  19•67 264•8
250 9999 9999

END OF FILE•
```

```
? CHE
```

Printout after Executing Check Program on Input Data (Part II)

```
 WIND DATA FOR MINUTES  35 THRU  88 HAVE BEEN RECEIVED•
 CHECK USING EL ANGLE COMPLETED•
? CKM

? COM
```

Output Printout

```
 BB
  DATE      TIME  A•NO   F•EQ   STATION
 101069•   1115    349 1456•0   94789•
```

> Identification Data

Significant and Mandatory Raob Data

TIME	PRESS	M-MSL	TEMP	DP-DEP
34.6	300.0	9161.	-46.1	9999.0
38.2	250.0	10347.	-55.9	9999.0
38.7	243.0	10528.	-57.1	9999.0
40.1	230.0	10876.	-56.1	9999.0
41.2	220.0	11160.	-53.9	9999.0
43.0	200.0	11771.	-55.2	9999.0
48.9	150.0	13601.	-56.8	9999.0
53.2	121.0	14963.	-56.4	9999.0
56.8	100.0	16164.	-59.8	9999.0
60.3	85.0	17177.	-61.1	9999.0
61.7	78.0	17715.	-58.0	9999.0
63.7	70.0	18392.	-61.1	9999.0
65.3	64.0	18949.	-60.5	9999.0
70.0	50.0	20499.	-57.1	9999.0
75.3	37.0	22399.	-58.3	9999.0
78.4	30.0	23724.	-56.4	9999.0
85.0	20.0	26325.	-51.9	9999.0
88.0	17.0	27387.	-48.5	9999.0

Minute Wind Data

MIN	M-AS	DIR	S-MPS	FT-MSL
36	9617.	242	28.7	31569.
37	9947.	242	30.8	32650.
38	10276.	245	34.7	33731.
39	10597.	248	34.4	34784.
40	10846.	247	31.7	35601.
41	11104.	247	33.1	36446.
42	11427.	248	34.6	37505.
43	11766.	248	38.5	38617.
44	12076.	252	40.7	39635.
45	12386.	253	38.5	40652.
46	12696.	255	38.8	41670.
47	13006.	259	36.1	42688.
48	13316.	263	36.0	43705.
49	13627.	264	36.6	44725.
50	13944.	262	33.7	45765.
51	14261.	262	35.3	46805.
52	14578.	261	35.9	47844.
53	14895.	261	37.7	48884.
54	15225.	265	36.4	49968.
55	15559.	267	36.6	51062.
56	15892.	272	34.4	52156.
57	16217.	277	31.2	53221.
58	16506.	276	27.4	54171.
59	16796.	273	28.2	55120.
60	17085.	271	27.5	56069.
61	17441.	268	25.8	57236.
62	17811.	268	26.9	58451.
63	18150.	270	21.4	59562.
64	18491.	271	21.2	60682.
65	18840.	276	19.7	61825.
66	19175.	279	17.3	62925.

```
 67   19505.      288     15.2    64007.
 68   19834.      289     11.6    65089.
 69   20164.      278      9.7    66171.
 70   20494.      274      8.1    67253.
 71   20852.      266      8.0    68429.
 72   21211.      282      6.5    69605.
 73   21569.      308      6.2    70781.
 74   21928.      304      9.2    71957.
 75   22286.      292      9.2    73134.
 76   22693.      298      5.8    74468.
 77   23121.      285      7.5    75871.
 78   23548.      306      2.5    77274.
 79   23956.       58      3.9    78611.
 80   24350.      334      1.8    79904.
 81   24744.       29      2.1    81197.
 82   25138.       14      3.6    82490.
 83   25532.      343      5.1    83782.
 84   25926.       35      7.4    85075.
 85   26320.       52      8.3    86368.
 86   26674.       65      8.1    87529.
 87   27028.       72     10.4    88690.
 88   27382.       74      6.1    89850.
```

Minute Wind Data

```
P-MB    DIR     S-KTS
 250    245       67
 200    250       75
 150    265       71
 100    275       62
  70    270       41
  50    275       16
  30    355        6
  20     50       16
```

Mandatory Level Wind Data

```
H K-FT  DIR     S-KTS
  35    250       65
  50    265       71
  70    290       12
```

Fixed Wind Level Data

```
EE
BB

SIG. WINDS
H K-FT   DIR      S-KTS
     40  250        79
     51  265        71
     54  275        53
     61  270        41
     64  290        30
     68  265        15
     71  310        12
     76  285        14
     86   50        16
     89   75        12
EE
? END

POWER DOWN
```

Significant Wind Level Data

㉜ all