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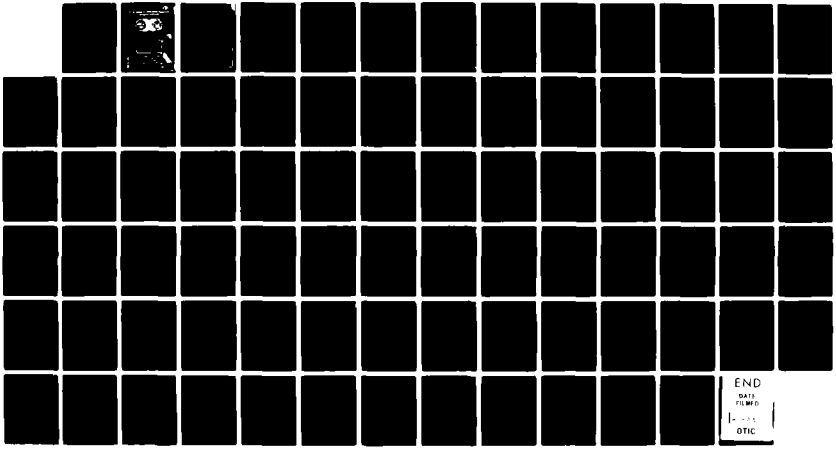

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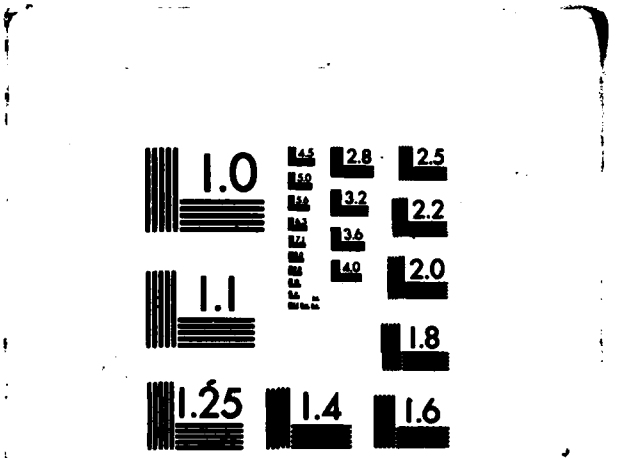
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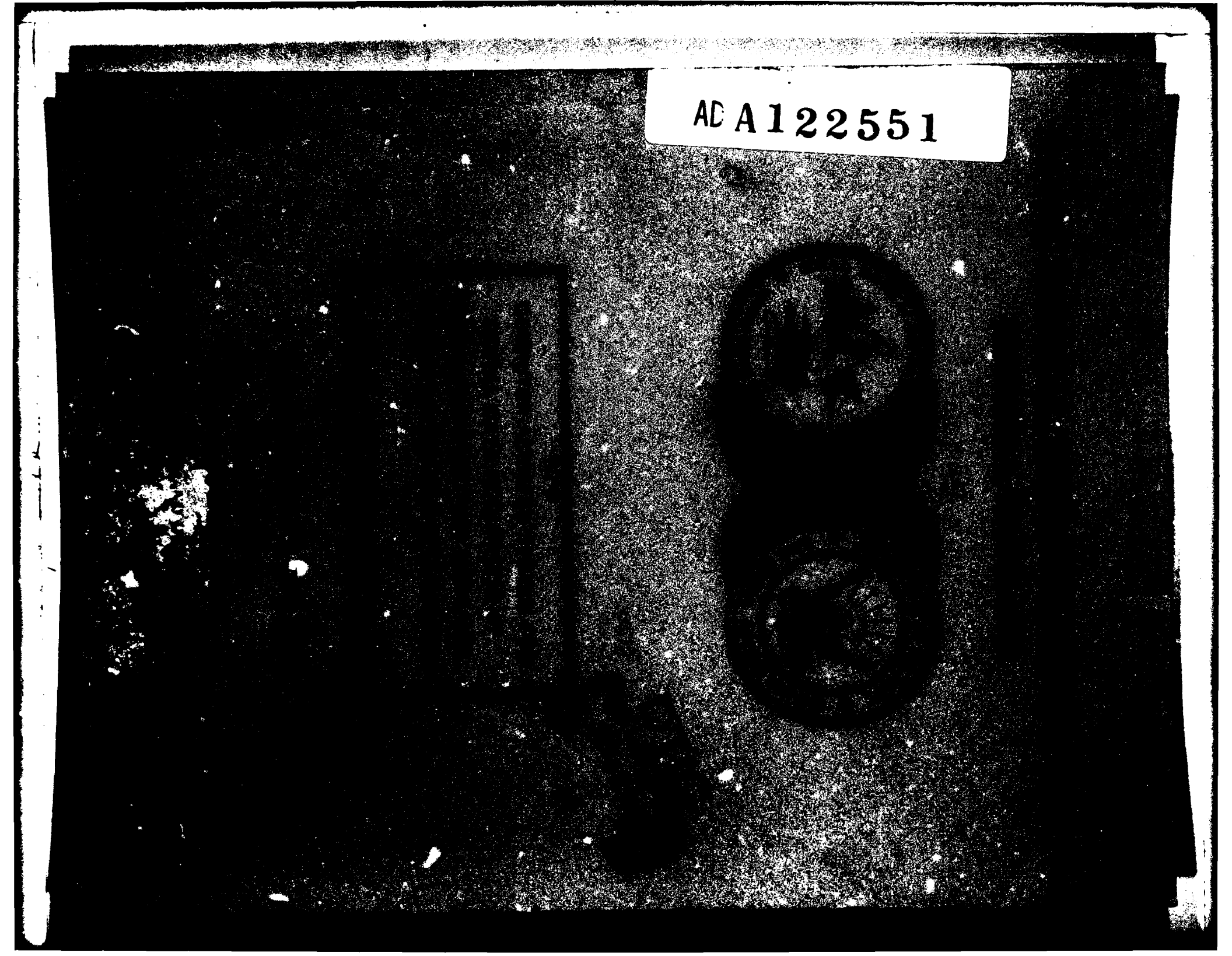

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Computerized methods for collection and transfer of data from pulmonary function tests and for analysis of isovolume resistance data are described. Detailed user instructions are provided for the programs, which are written for a desktop computer.

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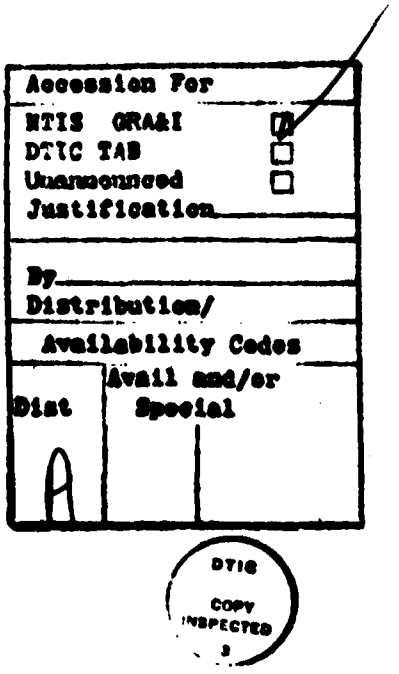


I. Introduction

The computer programs described in this report were developed to improve the speed and accuracy with which pulmonary function measurements can be made. Two main systems are discussed. The first makes use of a digital storage oscilloscope to acquire the output signals of transducers on a body plethysmograph. These signals are used to obtain pressure-volume curves, flow-volume loops, and FRC determinations. Multiple measurements can be made with the oscilloscope only if data previously acquired are transferred to a permanent storage medium. This function is performed by a desktop computer which uses the program "NDATA," (programs are described in section II) to record the data onto magnetic tape. Later, when sufficient information has been collected, the data are transferred to a computer system which has the large memory capacity, high computational speed, and sophisticated peripheral devices needed to properly perform the analysis. The program "PDPtfr" directs this second data transmission. An experiment in which flow-volume loops were recorded and subsequently analyzed using this system has been reported previously (1). Details also are given for two additional programs: "Nictfr" and "ERASE." The former allows data previously recorded to be displayed again on the Nicolet oscilloscope; the latter completely erases program or data tapes whose contents are no longer needed and thus permits them to be reused.

The second system measures isovolume resistance. This determination cannot be made using the digital oscilloscope since three signals (pressure, volume, and flow) must be recorded simultaneously. The traces, which are put on a three-channel strip chart recorder, are analyzed using the desktop computer, its digitizer, and program "ISOR" (described in section III). The computer-assisted system for handling isovolume resistance data greatly increases the speed and accuracy with which this measurement can be made when

compared to the standard method of measuring distances on the chart paper with a ruler and calculating values by hand.

In the following sections of this report are given detailed user instructions for all the programs required for digital data acquisition and transfer, and for analysis of isovolume resistance data. Program listings, variable assignment lists, and required equipment are given in the appendices. The programs for the desktop computer are written in HPL, a language developed by Hewlett-Packard for its 9825 series computers. The remaining software is written in FORTRAN IV for Digital Equipment Corporation PDP-11/34 and PDP-11/70 computers using the RSX-11M operating system.

II. Data Acquisition and Transfer

A. Program "NDATA"

1. Introduction

The program "NDATA" is used to transfer data stored in a Nicolet digital oscilloscope (model 2090) to the magnetic tape cassette of the desktop computer. The transfer is effected using an IEEE-488 interface bus between the two instruments. The program is written for a Hewlett-Packard 9825 computer with an external printer, a real-time clock, and the appropriate ROM's (see Appendix 1). Each cassette can store up to 32 data transfers from the Nicolet.

The system is designed to acquire and store data with as little operator interaction as possible. The interaction that is required is accomplished by the use of step-by-step prompts on the LED alphanumeric display of the computer. User instructions, which follow, describe in detail how to run the program. A flow chart is show in Fig. 1. Complete program and variable assignment lists are provided in Appendix 1.

When the program is run, "YES" is assigned to special function key f_0; "NO" is assigned to key f_6. Before any data can be recorded the cassette first must be "marked" into files. It is advisable to use the tape marking portion of program "NDATA" to prepare a number of tapes before an experiment instead of waiting until the last minute. Up to 32 data transfers from the Nicolet can be stored on a single cassette; however, once some data is stored on a tape and then the program subsequently is stopped or the tape is removed, no further data can be transferred to that particular tape. This feature is designed to prevent loss of data by recording new data over old.

Before it is recorded on tape, each data transfer has attached to it a descriptive header, a portion of which is common to all files on a given tape and a segment which is unique to each transfer. The following items are

"NDATA"

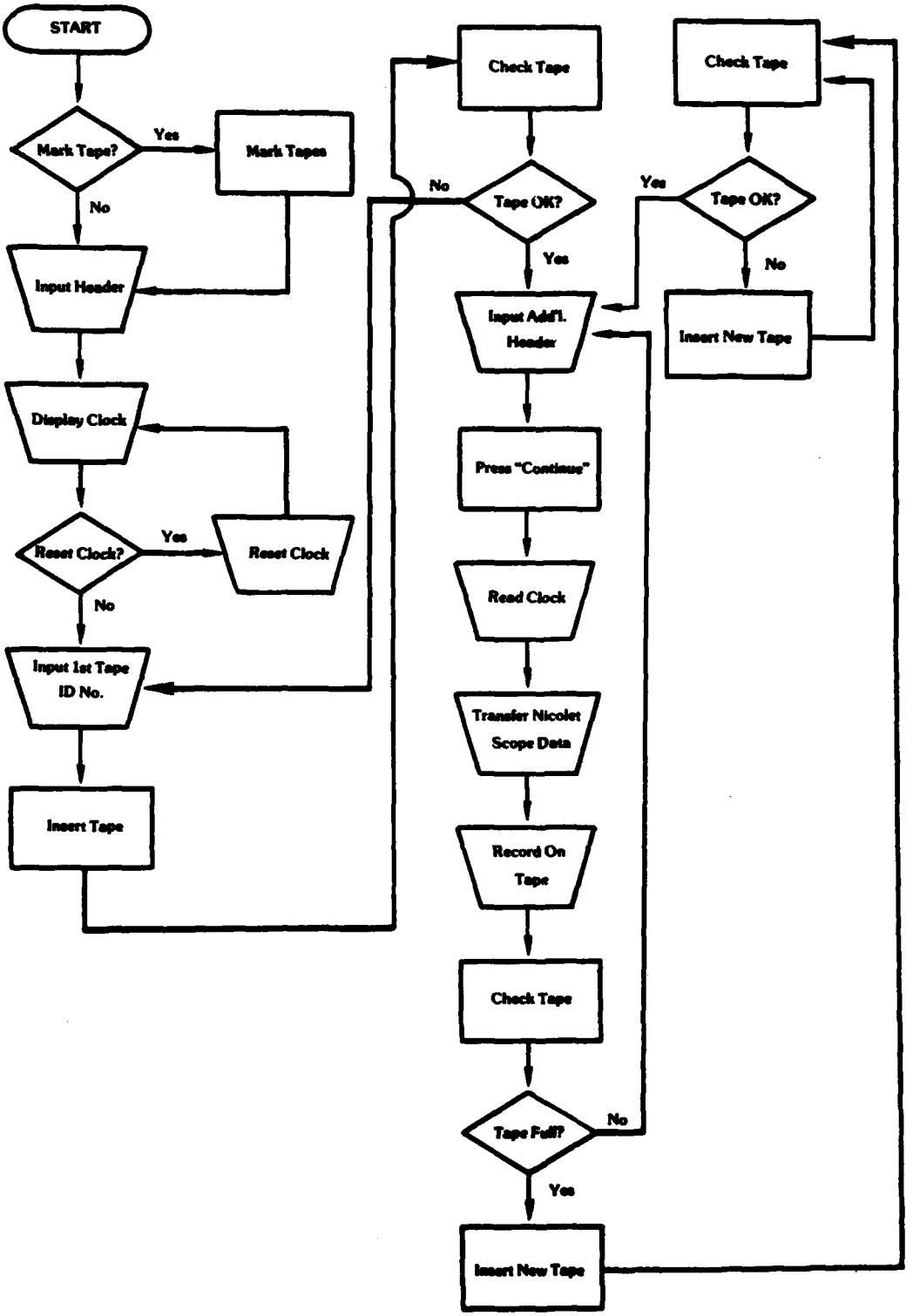


Fig. 1. Flow chart for program "NDATA"

requested by the program and make up the fixed part of the header: subject identification number, subject age, code number for subject sex, code number for subject race, subject height, subject weight, barometric pressure, room temperature, and a comment line of up to 47 characters. The unique portion of the header is entered just before each transfer of data from the Nicolet. This section consists of an experimental type number (1 digit), a four-character (alphanumeric) record type code, and an event time. The first two items are chosen by the user to identify the experiment; the event time defaults to a value of "ØØ-1" until a specific time is entered. This value can be the time at which some treatment or procedure important to the experiment occurs. Additionally, the time (month:day:hour:min:sec format) at which a transfer occurs is read from the computer clock and recorded as part of the header.

2. User Instructions

1. Insert: Tape cassette with program recorded

2. Press: ERASE
   Type : a
   Press: EXECUTE

3. Press: LOAD
   Type : 1
   Press: EXECUTE

4. Wait for end of line mark (⊢) to be displayed.

5. Press: RUN

6. When "REMOVE PROGRAM CASSETTE" is displayed;
   a. Remove tape
   b. Press: CONTINUE

7. When "Do you want to mark tapes?" is displayed;
   a. If no,
      1) Press "NO" (key f_6)
      2) Go to step 10
   b. If yes,
      1) Press "YES" (key f_0)
      2) Go to step 8

8. When "Number of tapes to be marked?" is displayed;
   a. Type: number of tapes
   b. Press: CONTINUE

9. When "INSERT TAPE CASSETTE" is displayed;
   a. Insert blank unmarked tape
   b. Press: CONTINUE
   c. If "Tape is not blank--use new tape" is displayed;
      1) Remove current tape
      2) Replace with blank unmarked tape
      3) Press: CONTINUE
   d. If "INSERT TAPE CASSETTE" is displayed again, either tape is not properly seated in tape drive or no tape is present;
      1) Properly insert tape
      2) Press: CONTINUE
   e. If "CASSETTE IS WRITE PROTECTED" is displayed;
      1) Remove cassette
      2) Slide tab on cassette to "RECORD" position
      3) Re-insert cassette
      4) Press: CONTINUE
   f. If "SYSTEM MALFUNCTION**GET HELP!" is displayed;
      1) Error number (ern) and error line (erl) are printed on built-in printer
      2) A serious software or hardware problem exists and must be corrected
      3) Once problem is solved, start over at step 1

g. If "MARKING CASSETTE" is displayed;
   1) Tape is being properly marked
   2) Program will return to step 9 until the number of tapes specified in step 8 are marked
   3) When last cassette is marked, program will proceed to step 10

10. When "3-digit Subject number = ?" is displayed;
    a. Type: number wanted (maximum of three digits allowed)
    b. Press: CONTINUE

11. When "2-digit Subject age = ?" is displayed;
    a. Type: age (maximum of two digits)
    b. Press: CONTINUE

12. When "Sex code (1=M, 2=F) = ?" is displayed;
    a. Type: number wanted
    b. Press: CONTINUE

13. When "1-digit race code = ?" is displayed;
    a. Type: number wanted (maximum of one digit)
    b. Press: CONTINUE

14. When "2-digit Ht. in inches = ?" is displayed;
    a. Type: number wanted for height
    b. Press: CONTINUE

15. When "3-digit Wt. in pounds = ?" is displayed;
    a. Type: number wanted for weight
    b. Press: CONTINUE

16. When "Enter Barometric Pressure (mm Hg)" is displayed;
    a. Type: number for pressure in mm of mercury
    b. Press: CONTINUE

17. When "2-digit Room Temperature = ?" is displayed;
    a. Type: number for temperature (Either ^{o}C or ^{o}F can be used since this number is not used for any computations)
    b. Press: CONTINUE

18. When "Enter heading line" is displayed;
    a. Type: up to 47 characters
    b. Press: CONTINUE

19. When "Do you want to change heading?" is displayed;
    a. If yes,
       1) Press: YES
       2) Go to step 10
    b. If no,
       1) Press: NO
       2) Go to step 20

20. When "Clock reads: <time>" is displayed;
    a. Time is displayed as month:day:hour:min:sec
    b. Press: CONTINUE

21. When "Do you want to reset clock?" is displayed;
    a. If yes,
        1) Press: YES
        2) Go to step 22
    b. If no,
        1) Press: NO
        2) Go to step 23

22. "Enter time as two-digit number" is displayed for three seconds:
    a. When "Month?" is displayed;
        1) Type: 2-digit month number
        2) Press: CONTINUE
    b. When "Day?" is displayed;
        1) Type: 2-digit day number
        2) Press: CONTINUE
    c. When "Hour?" is displayed;
        1) Type: 2-digit hour using 24 hour clock
        2) Press: CONTINUE
    d. When "Minute?" is displayed;
        1) Type: 2-digit minute
        2) Press: CONTINUE
    e. When "Second?" is displayed;
        1) Type: 2-digit second
        2) Press: CONTINUE
    f. As clock is internally reset, "Resetting Clock (Be patient!)" is displayed. This process may take two minutes.
    g. "CLOCK NOW READS: <time>" is displayed;
    Press: CONTINUE
    h. When "DO YOU WANT TO RESET CLOCK?" is displayed;
        1) If yes,
            a) Press: YES
            b) Go to step 22
        2) If no,
            a) Press: NO
            b) Go to step 23

23. When "ID number of first data tape = ?" is displayed;
    a. Type: number to be assigned to first tape (N)
    b. Press: CONTINUE

24. When "INSERT MARKED TAPE # <N>" is displayed;
    a. Insert tape on which data is to be recorded (Note: tape must be previously marked but cannot have any data recorded on it).
    b. Press: CONTINUE
    c. If "Tape not marked--use marked tape" is displayed;
        1) Remove tape
        2) Insert a tape which has been marked

3) Press: CONTINUE
4) Go to step 23

d. If "Tape not blank--use new tape" is displayed;
1) Remove tape
2) Insert a tape on which no data has been previously recorded
3) Press: CONTINUE
4) Go to step 23

e. If "SYSTEM MALFUNCTION**GET HELP!" is displayed;
1) A serious hardware or software problem exists which must be corrected
2) Program can be started without re-entering header by the following procedure:
a) Type: cont 37
b) Press: EXECUTE

25. When "1-digit experimental type # = ?" is displayed;
a. Type: number to identify type of experiment for which this data has been recorded
b. Press: CONTINUE

26. When "4-character record type code = ?" is displayed;
a. Type: 4 characters to identify the type of respiratory maneuver for which this data was taken
b. Press: CONTINUE

27. When "Do you have event time yet?" is displayed;
a. If yes,
1) Press: YES
2) When "4-digit event time = ?" is displayed;
a) Type: time wanted in 24-hour clock notation
b) Press: CONTINUE
3) Go to step 28
b. If no,
1) Press: NO
2) Go to step 28

28. When "Do you want to change data?" is displayed;
a. If yes,
1) Press: YES
2) Go to step 25
b. If no,
1) Press: NO
2) Go to step 29

29. When "Hit CONTINUE to read data" is displayed;
a. Wait until data wanted is stored in Nicolet oscilloscope
b. Press: CONTINUE
c. During transfer, "Data is being recorded" is displayed
d. If fewer than 32 data transfers have been recorded on the current tape, go to step 25
e. If 32 data transfers have been recorded, tape is full; go to step 30

30. ["REWINDING TAPE CASSETTE" is displayed.]

31. When tape has been removed;
    a. N is incremented by 1
    b. Go to step 24

32. To stop program at any time;
    a. Press: STOP
    b. Press: REWIND
    c. When tape stops rewinding, remove it
    d. Program is finished

B. Program "PDPtfr"

1. Introduction

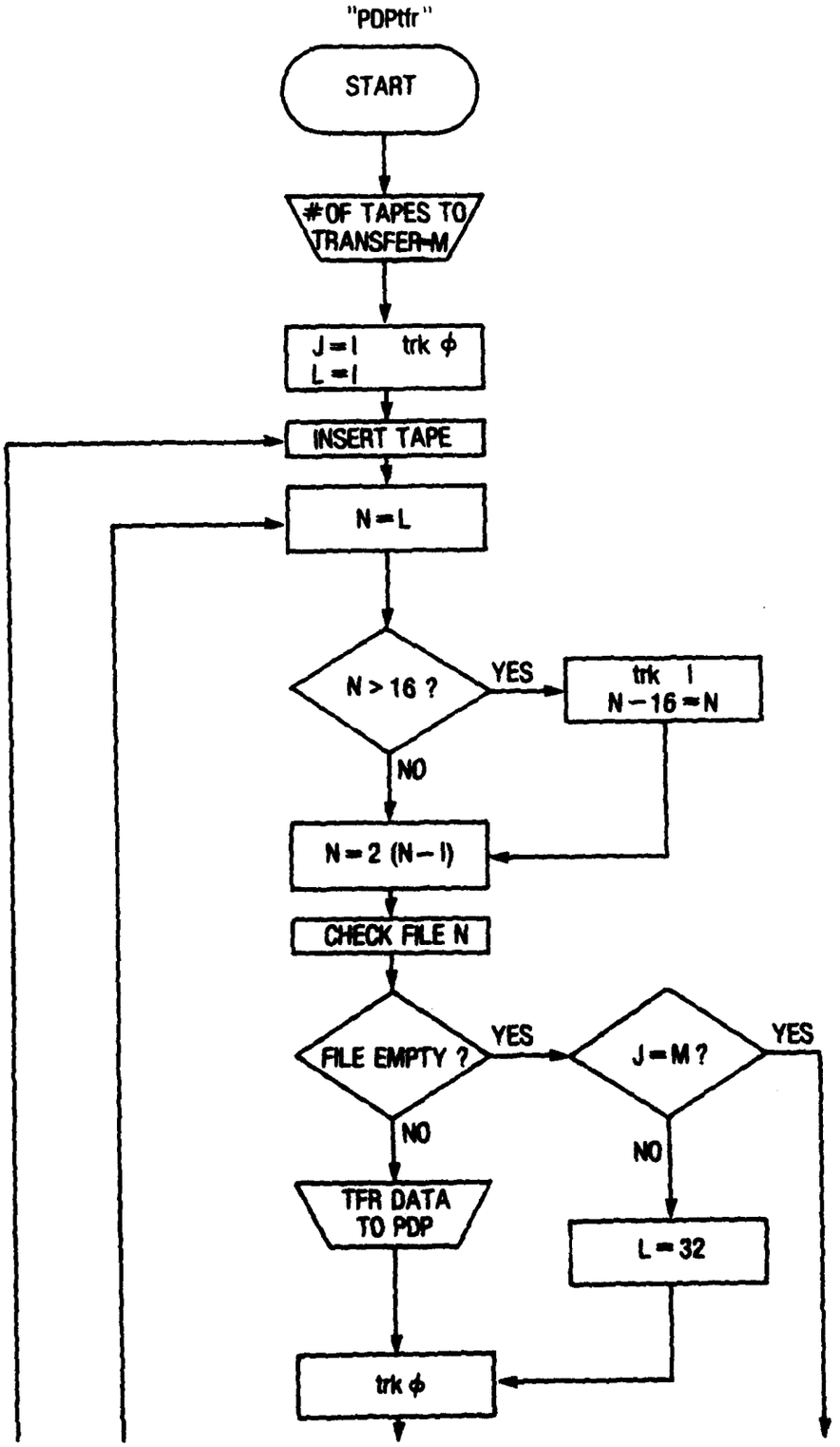
The limited memory size and computational speed of the HP 9825 desktop computer make it unsuitable for analysis of the large volume of data which rapidly can be accumulated with program "MDATA." Various analysis routines have been successfully developed for the PDP-11 series computers available at this facility (1). Thus, once the HP 9825 system has performed its job as a portable data acquisition device it must be able to transfer the data stored on its tape cassettes to the larger computer. The software to accomplish this task consists of program "PDPtfr" for the HP 9825 and program "LFSRECIB" for the PDP-11/34 computer. User instructions are given in the next section. Program listings appear in Appendix 2.

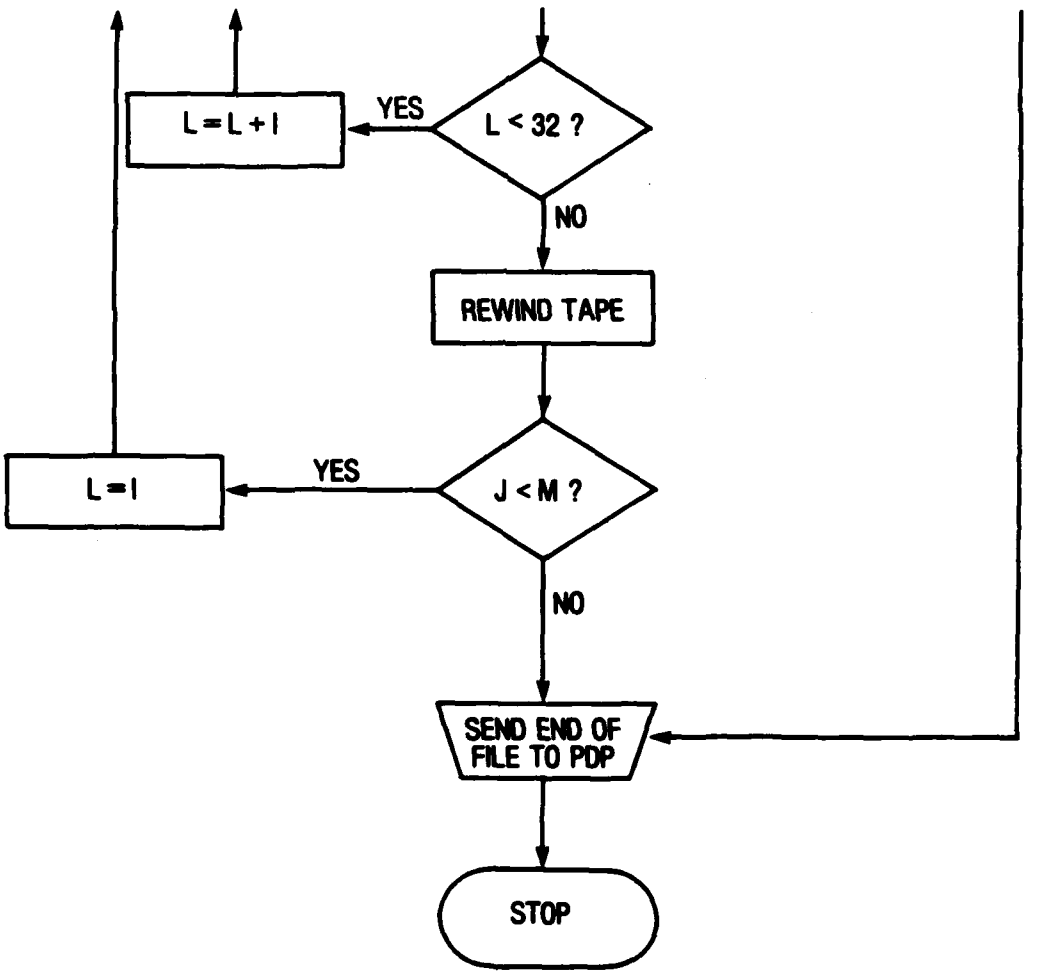
The PDP-11/34 must be equipped with a General Instruments GPIB-11 interface. This hardware is connected to the HP-IB interface of the HP-9825 which enables the two computers to communicate using the hand-shake conventions of the IEEE-488 standard. The program listed in Appendix 2 for the PDP requires the RSX-11M operating system with the addition of the GPIB driver supplied by General Instruments.

Once the data transfer has started, it is automatic and only requires the operator to remove and insert data tapes when the appropriate prompts are displayed on the HP 9825. Since the data from a single experiment may fill several tapes, the user must enter the number of tapes that are to be stored in a single data file in the PDP computer. The tapes themselves need not be completely full for the transfer to proceed properly. Each file stored on the larger system is organized into groups of three records. All three are written onto the PDP disk in unformatted binary form just as they are received. The first record contains parameters describing the data and is identical to the

header detailed in Appendix 1. Similarly, the second record contains the time at which the data was acquired and has the format of the time variable explained in Appendix 1. The third record contains the actual data as originally transmitted by the Nicolet oscilloscope. It should be noted that the binary data are byte-reversed relative to the standard PDP-11/34 word and must be inverted before any analysis programs can be run. Once all the data tapes that constitute one file have been transcribed to the disk of the PDP-11/34, both programs end. To transfer another file, the programs must be started over.

Fig. 2. Flow chart for program "PDPtfr"




L=L+1
YES
L < 32 ?
NO
REWIND TAPE
L=1
YES
J < M ?
NO
SEND END OF FILE TO PDP
STOP

2. User Instructions

1. Insert program tape
   Press: LOAD
   Type: 2
   Press: EXECUTE

2. When end of line (⊢) mark is displayed,
   Press: RUN

3. When "Remove Program Tape" is displayed;
   a. Remove tape
   b. Press: CONTINUE

4. When "Start PDP computer program" is displayed;
   a. Start program
   b. Press: CONTINUE

5. When "Press CONTINUE to start transfer" is displayed,
   Press: CONTINUE

6. When "Enter # of cassettes to be read" is displayed;
   a. Type: number of cassettes whose data are to be stored in a single data file on the PDP computer.
   b. Press: CONTINUE

7. When "ID number of first cassette = ?" is displayed;
   a. Type: number (This is used for operator prompts only)
   b. Press: CONTINUE

8. When "INSERT TAPE # <N>" is displayed;
   a. Insert tape with ID # N
   b. Press: CONTINUE

9. "File being transferred = # <n>" is displayed (The number n is incremented as all the files on the tape are automatically transferred.)

10. "REWINDING TAPE" is displayed after last file on a tape has been transferred.

11. Have the number of tapes specified in step 6 been transferred?
    a. If no,
       1) N is incremented by 1
       2) Go to step 8
    b. If yes,
       1) End-of-file character is sent to PDP computer
       2) "DATA TRANSFER COMPLETED" is displayed

3. User Instructions for PDP Program to be Used with "PDPtfr"

It is assumed that the operator has properly logged onto the PDP computer and that the transfer program, named "LFSRECIB," is accessible to him.

1. On the PDP computer terminal;
   Type: RUN LFSRECIB
   Press: RETURN

2. When "DATA FILE NAME [NAME.EXT]:" is displayed;
   a. Type: name wanted for PDP data file
   b. Press: RETURN

3. [PDP program is now ready for transfer to start.]

4. When data transfer is completed, "STOP-TTnn" is displayed, where nn is the number of the terminal being used.

C. Program "Nictfr" User Instructions

This program, called "Nictfr," allows the user to transmit data which has been stored on a cassette back to the Nicolet oscilloscope for display. Appendix 3 contains the program listing.

1. Insert: Tape cassette with program

2. Press: ERASE
   Type: a
   Press: EXECUTE

3. Press: LOAD
   Type: 3
   Press: EXECUTE

4. Wait for end of line mark (⊢) to be displayed.

5. Press: REWIND
   Remove: program tape
   Insert: data tape
   Press: RUN

6. When "Enter number of data dump wanted" is displayed;
   a. Type: number (between 1 and 32, inclusive)
   b. Press: CONTINUE

7. Data is displayed on Nicolet screen.
   Header is printed on external printer.
   Go to step 6 for another transfer.
   (Press: STOP to end program)

D. Program "ERASE" User Instructions

Program "ERASE" can be used to erase completely any data or program tape whose contents are no longer wanted. The only equipment needed is a Hewlett-Packard 9825 computer. Appendix 4 contains the program listing.

1. Insert: tape cassette with program

2. Press: ERASE
   Type: a
   Press: EXECUTE

3. Press: LOAD
   Type: 4
   Press: EXECUTE

4. Wait for end of line mark (⊢) to be displayed.

5. Press: RUN

6. When "Remove Program Tape" is displayed;
   a. Remove tape
   b. Press: CONTINUE

7. When "Insert tape to be erased" is displayed;
   a. Slide tab on tape cassette to "RECORD" position.
   b. Insert: tape
   c. Press: CONTINUE
   d. If "***TAPE IS BEING ERASED**" is displayed;
      1) Program is functioning
      2) When tape is erased, go to step 7
   e. If "ERROR OCCURRED" is displayed;
      1) rom and ern values are printed
      2) Problem must be corrected
      3) Start over with step 5

III. Isovolume Resistance

A. Program "ISOR"

1. Introduction

Program "ISOR" computes the value of isovolume resistance from volume, pressure, and flow data obtained for individual breaths during quiet breathing. Signals from the three types of transducers are recorded concurrently on a three-channel recorder so that each trace has the same time base. Two points of equal volume are selected on the volume trace for a single breath. The two pressure and flow values corresponding in time to these volumes are taken from the appropriate curves, as depicted in Fig. 3. The isovolume resistance is computed from the expression: $R_{ISO} = \frac{F_1 - F_2}{P_1 - P_2}$.

The program is written for a Hewlett-Packard 9825 desktop computer with an external printer, a digitizer, and the appropriate ROM's (read-only-memory modules). A flow chart is given in Fig. 4; a program listing, variable allocations, and required equipment list are provided in Appendix 5.

When the program is run, "ISOR" automatically assigns "YES" to special function key f_0 and "NO" to key f_6. These keys should be used as responses to the appropriate operator prompts that are displayed on the internal LED display of the computer. Before any analyzed results can be stored on a cassette, the tape must be "marked" into files with the marking routine of this program. Up to 400 groups of data (with a maximum of 10 breaths in each group) can be stored on each of the two tracks of a single cassette. The same tape can be used repeatedly for different analysis sessions. Unlike "NDATA," program "ISOR" finds the first available empty file on which to record data even if the tape has been removed from the computer or the program has been stopped and subsequently restarted.

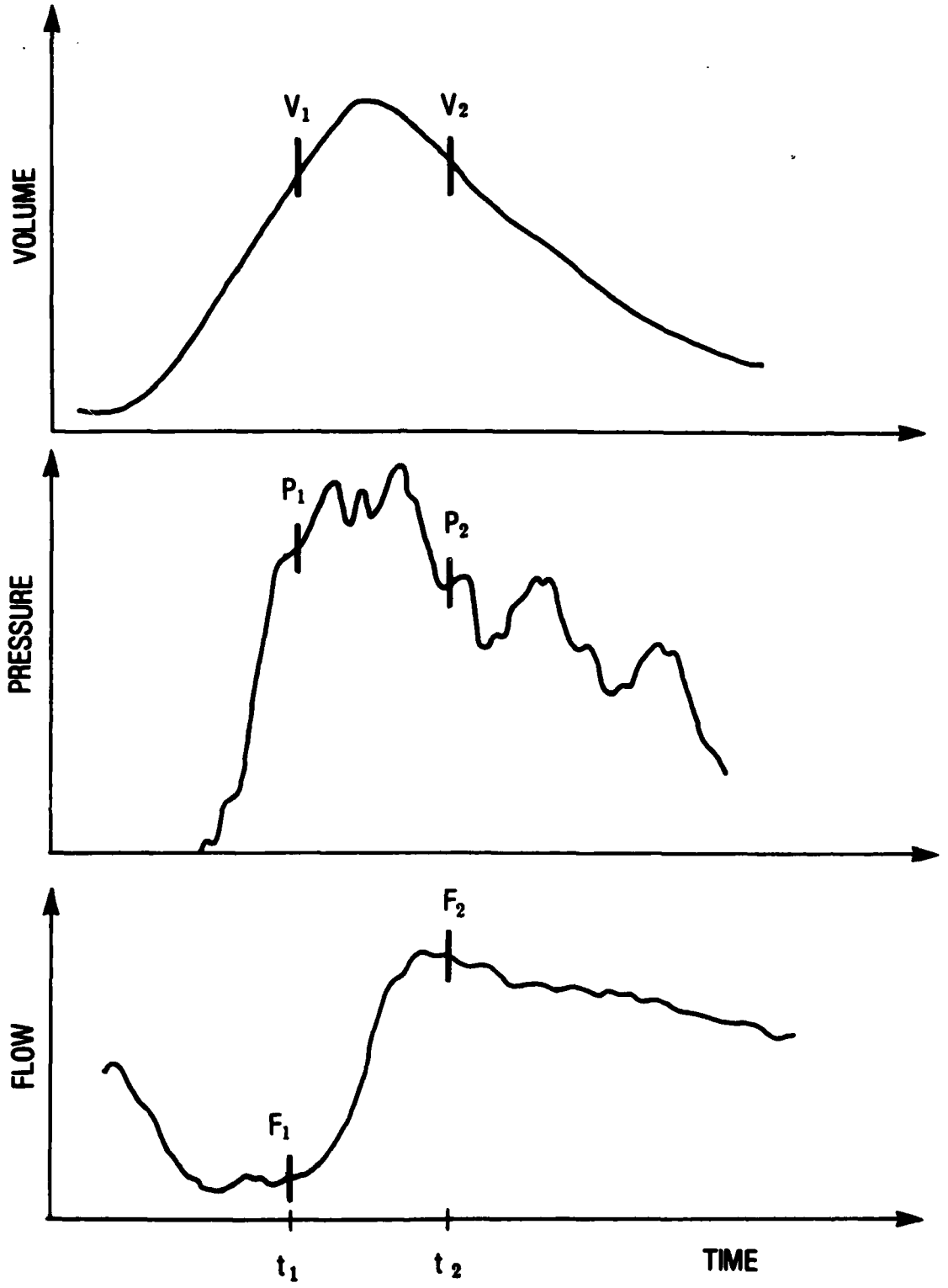
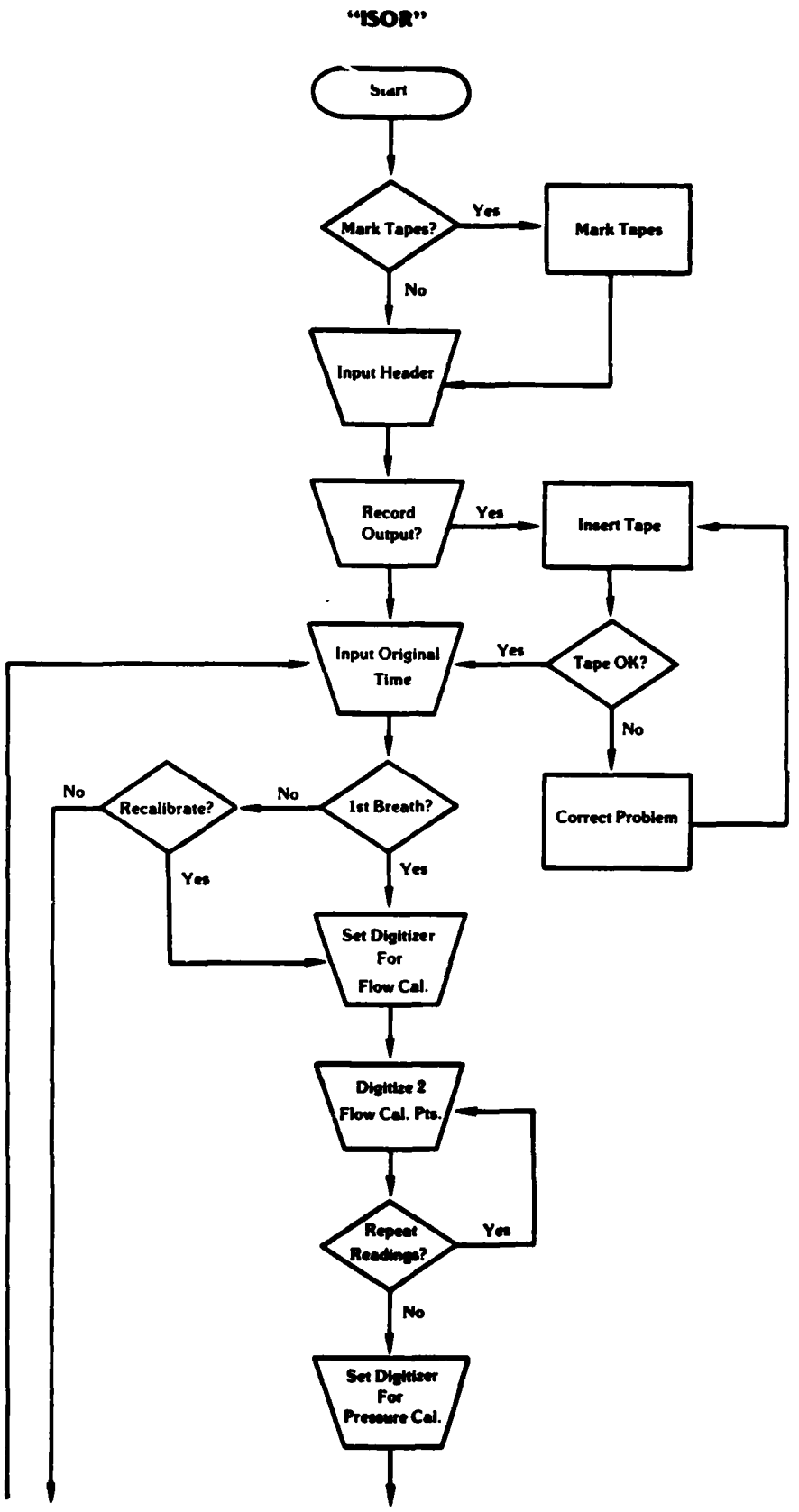
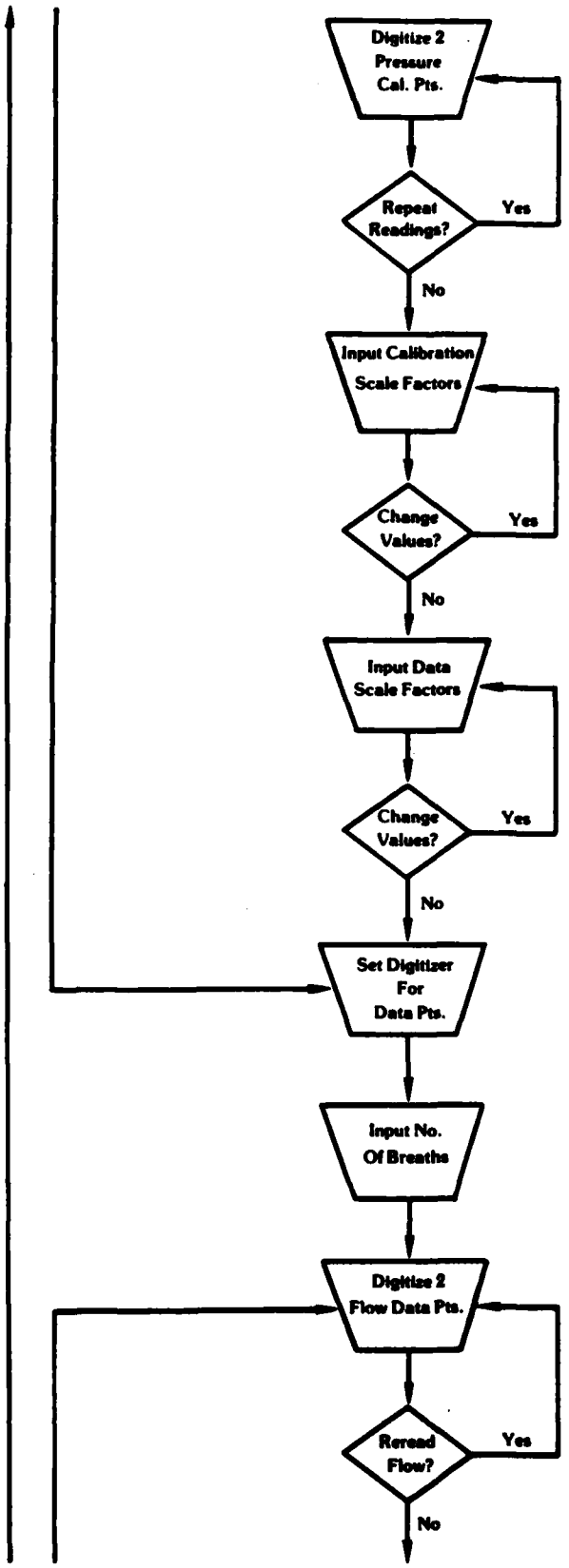
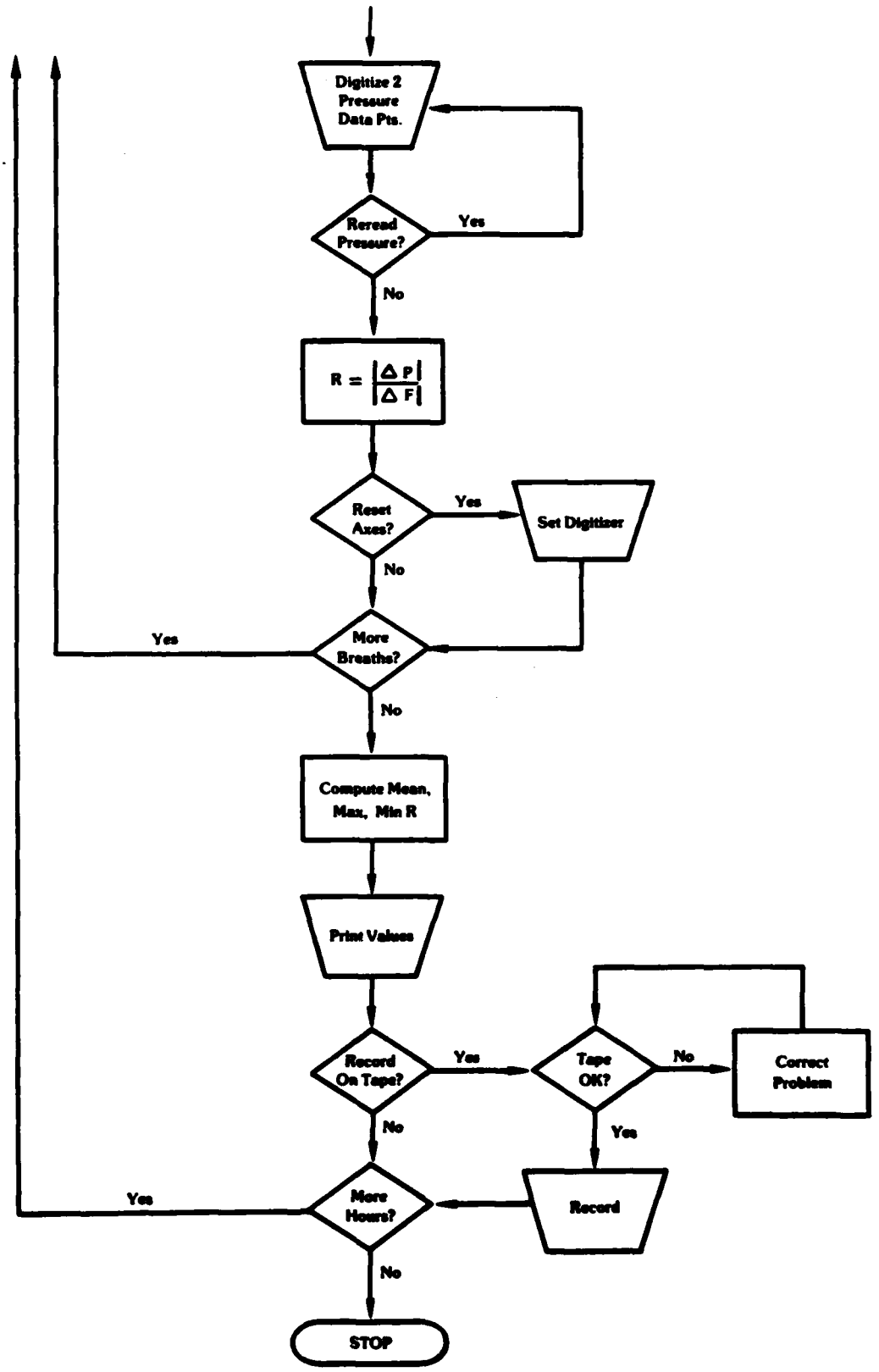


Fig. 3. Typical transducer signals for isovolume resistance measurement. V_1 and V_2 are points of equal volume which occur at times t_1 and t_2, respectively. P_1 is the value of transpulmonary pressure at time t_1 and F_1 the corresponding flow. Similarly, P_2 and F_2 represent the pressure and flow measurements at time t_2.

Fig. 4. Flow chart for program "ISOR"




Digitize 2 Pressure Cal. Pts.
Repeat Readings?
Yes
No
Input Calibration Scale Factors
Change Values?
Yes
No
Input Data Scale Factors
Change Values?
Yes
No
Set Digitizer For Data Pts.
Input No. Of Breaths
Digitize 2 Flow Data Pts.
Reread Flow?
Yes
No


Digitize 2 Pressure Data Pts.
Reread Pressure?
Yes
No
R = |ΔP| / |ΔF|
Reset Axes?
Yes
Set Digitizer
No
More Breaths?
Yes
No
Compute Mean, Max, Min R
Print Values
Record On Tape?
Yes
Tape OK?
No
Correct Problem
No
Yes
More Hours?
Yes
Record
No
STOP

The analyzed data is organized as follows: A maximum of 10 separate breaths may be analyzed for a given single period of data collection; the isovolume resistances calculated for these breaths are printed and also stored on tape as a group. Before being recorded, the data for a one-hour group have appended to them a header which is identical in format to that previously described for "NDATA" (See Appendix 1). The individual terms are also similar, with the following exceptions:

a. The experimental type digit is called the C/E code (control/experiment) in the printout.

b. The four-character record type code is automatically chosen to be "ISOR."

c. The event time section of the header is not used; it is filled with four blank spaces.

d. The actual time at which the data was originally recorded must be manually entered for each hour group.

Each file recorded has the format: 80-character header; 14-character date and time; hour number (data collection period number); 4-digit time in 24-hour clock notation; 10 values of isovolume resistance corresponding to each of the 10 breaths analyzed. If fewer than 10 breaths are measured, the unused variables are assigned the value zero.

The HP 9864A digitizer is easy to use, but a few precautionary comments are in order. This device consists of a flat bed, to which the chart paper must be firmly taped, and a cursor with cross-hairs to electronically select the point of interest on the tracing. Although the cursor has four buttons, only two need concern the user of this program. The "0" is pressed to denote the origin of an axes pair; "S" is used for all other points. The red

sample light on the digitizer cursor indicates when the origin has been properly set. Once the origin is set, the cursor may be moved anywhere on the digitizer bed, but it must not be lifted from the surface until the origin is to be reset. If the cursor is moved improperly, the digitizer beeps and the sample light goes out to indicate the origin has been lost. The origin must be re-established before any further entries can be made. Note that the exact positioning of the origin is not critical since all computations are performed by taking the difference between various points. The origin merely provides a point of reference for the digitizer; however, to facilitate the determination of the X-axis direction, it should be placed on one of the horizontal (i.e., time axis) lines of the chart paper. Since the paper most likely is not perfectly aligned on the digitizer bed, the program must measure the angle of rotation between the axes of the chart record and the internal, fixed coordinate system of the digitizer. Each time the origin is set, "ISOR" determines this angle by instructing the operator to read five points along the X-axis. The actual values of these points are immaterial and they need not be equally spaced. The requirements are:

a. The points should span a significant distance on the chart record to make possible on accurate determination of the angle.

b. The line chosen for these five points must parallel the time axis of the chart record and must contain the point chosen as the origin.

c. The origin itself must not be used as one of these five points or an error will occur that aborts the program.

In order to calculate a scale factor, two flow and two pressure calibration signals must be recorded. When the program instructs the user to

read the flow calibration levels, it assumes the first point corresponds to a condition of zero flow and the second to a level that spans the range of interest. The pressure signals are treated similarly.

Once the calibration is completed, the calibration chart record is removed, the data tracing is placed on the digitizer, and the origin and axes are again fixed. Data from several breaths can now be read. It is not necessary to reset the origin unless the chart paper is moved or replaced or the cursor is lifted off the digitizer surface.

The only remaining information required by the program to calculate isovolume resistance are the full-scale and scale-multiplier settings of the chart recorder amplifiers. The program prompts the operator for these values in a way that permits the pressure and flow channels to have different settings and allows these settings to be varied between calibration and data runs.

2. User Instructions

1. Insert: Tape cassette with program
   a. Press: ERASE
   b. Type: a
   c. Press: EXECUTE

2. Press: LOAD
   Type: 5
   Press: EXECUTE

3. Wait for end of line mark (⊢) to be displayed

4. Press: RUN

5. When "Remove Program Tape" is displayed;
   a. Remove tape
   b. Press: CONTINUE

6. When "Do you want to mark tapes?" is displayed;
   a. If yes,
      1) Press: YES (key f_0)
      2) Go to step 6.c.
   b. If no,
      1) Press: No (key f_6)
      2) Go to step 7
   c. When "Number of tapes to be marked?" is displayed;
      1) Type: number
      2) Press: CONTINUE
   d. When "INSERT TAPE CASSETTE" is displayed;
      1) Insert: blank tape
      2) Press: CONTINUE
   e. If "Tape is not blank--use new tape" is displayed;
      1) Remove tape
      2) Insert: new blank tape
      3) Press: CONTINUE
      4) Go to step 6.e.
   f. Go to "HELP"
      1) If a problem was found by "HELP" go to step 6.d.
      2) If no problem was found by "HELP" go to step 6.g.
   g. When "MARKING CASSETTE" is displayed, tape is being marked.
   h. Programs returns to step 6.d. until the number of tapes specified in 6.c. are marked. When all are marked it proceeds to step 7.

7. When "TURN ON DIGITIZER!!!" is displayed;
   a. Turn on digitizer
   b. Press: CONTINUE

8. When "Results to be recorded on tape?" is displayed;
   a. If yes,
      1) Press: YES (key f_0)
      2) Go to step 9

b. If no,
   1) Press: NO
   2) Go to step 10

9. When "Track to be recorded?" is displayed;
   a. Type: Ø or 1 to choose tape track to be used
   b. Press: CONTINUE

10. When "3-digit subject number = ?" is displayed;
   a. Type: number
   b. Press: CONTINUE

11. When "2-digit subject age = ?" is displayed;
   a. Type: number
   b. Press : CONTINUE

12. When "Sex Code (1=M, 2=F) = ?" is displayed;
   a. Type: number (single digit)
   b. Press: CONTINUE

13. When "1-digit race code = ?" is displayed;
   a. Type: number
   b. Press: CONTINUE

14. When "2-digit Ht. in inches = ?" is displayed;
   a. Type: number for height
   b. Press: CONTINUE

15. When "3-digit Wt. in pounds = ?" is displayed;
   a. Type: number for weight
   b. Press: CONTINUE

16. When "1-digit experimental type = ?" is displayed;
   a. Type: number
   b. Press: CONTINUE

17. When "Enter Barometric pressure (mm Hg)" is displayed;
   a. Type: number for pressure in millimeters of mercury
   b. Press: CONTINUE

18. When "2-digit room temperature is displayed;
   a. Type: number (may be in ^{o}C or ^{o}F)
   b. Press: CONTINUE

19. When "Enter heading line" is displayed;
   a. Type: alphanumeric header (47 characters maximum)
   b. Press: CONTINUE

20. When "Do you want to change heading?" is displayed;
   a. If yes,
      1) Press: YES
      2) Go to step 10

b. If no,
    1) Press: NO
    2) Go to step 21

21. When "How many hours of data?" is displayed;
    a. Type: number (10 breaths can be analyzed for each hour group)
    b. Press: CONTINUE

22. When "Number of first hour of data = ?" is displayed;
    a. Type: number
    b. Press: CONTINUE

23. Is data to be put on tape?
    a. If you answered NO in step 8, go to step 24.
    b. If you answered YES in step 8,
        1) Go to "HELP"; return to next line.
        2) If "HELP" found a problem go to step 23.b.
        3) If "HELP" found no problem go to step 24.

24. When "ENTER TIME AS 2-DIGIT NUMBER" is displayed;
    a. Wait three seconds, enter time of original data as requested in the following lines:
    b. When "Month?" is displayed;
        1) Type: 2-digit month number of original data
        2) Press: CONTINUE
    c. When "Day?" is displayed;
        1) Type: 2-digit day
        2) Press: CONTINUE
    d. When "Hour?" is displayed;
        1) Type: 2-digit hour (24-hour clock notation)
        2) Press: CONTINUE
    e. When "Minute?" is displayed;
        1) Type: 2-digit minute
        2) Press: CONTINUE
    f. When "Second?" is displayed;
        1) Type: 2-digit second
        2) Press: CONTINUE
    g. When "Time entered: <time>" is displayed;
        Press: CONTINUE to proceed
    h. When "Re-enter time?" is displayed;
        1) If yes,
            a) Press: YES
            b) Go to step 24
        2) If no,
            a) Press: NO
            b) Go to step 25

25. If "Do you want to RECALIBRATE?" is displayed;
    a. If yes,
        1) Press: YES
        2) Go to step 26
    b. If no,
        1) Press: NO
        2) Go to step 41

26. When "Set origin for Flow cal." is displayed;
    a. Set digitizer origin using cursor
    b. Press: CONTINUE
    c. Go to "DIGSET," then proceed to step 27

27. When "Hit CONT to read 2 Flow cal. pts." is displayed;
    a. Press: CONTINUE
    b. Go to "DATA" to read first point (must be a 0 flow signal); return to next line
    c. Go to "DATA" to read second point (must be a non-zero flow); return to next line
    d. When "Reread Flow cal. points?" is displayed;
        1) If yes,
            a) Press: YES
            b) Go to step 27
        2) If no,
            a) Press: NO
            b) Go to step 28

28. When "Hit CONT to read 2 P cal. pts." is displayed;
    a. Press: CONTINUE
    b. Go to "DATA" to read first point (must be zero pressure); return to next line
    c. Go to "DATA" to read second point (must be non-zero pressure); return to next line
    d. When "Reread Pressure cal. points?" is displayed;
        1) If yes,
            a) Press: YES
            b) Go to step 28
        2) If no,
            a) Press: NO
            b) Go to step 29

29. When "Calibration Flow (liters/sec) = ?" is displayed;
    a. Type: number
    b. Press: CONTINUE
    c. Value is printed

30. When "Volts Full Scale (Cal. Flow) = ?" is displayed;
    a. Type: number that represents chart recorder full scale (in volts) when flow calibration signals were recorded
    b. Press: CONTINUE

31. When "Scale Multiplier (Cal. Flow) = ?" is displayed;
    a. Type: number that represents scale multiplier on chart recorder when flow calibration signals were recorded
    b. Press: CONTINUE
    c. Values for volts full scale and scale multiplier are printed

32. When "Calibration pressure (cm H_2O) = ?" is displayed;
    a. Type: number
    b. Press: CONTINUE
    c. Value is printed

33. When "Volts Full Scale (Cal. Press) = ?" is displayed;
    a. Type: number that represents chart recorder full scale (in volts) when pressure calibration signals were recorded
    b. Press: CONTINUE

34. When "Scale Multiplier (Cal. Press) = ?" is displayed;
    a. Type: number that represents scale multiplier on chart recorder when flow calibration signals were recorded
    b. Press: CONTINUE
    c. Values for volts full scale and scale multiplier are printed

35. When "Change Calibration values?" is displayed;
    a. If yes,
        1) Press: YES
        2) Go to step 29
    b. If no,
        1) Press: NO
        2) Go to step 36

36. When "Volts Full Scale (Data Flow) = ?" is displayed;
    a. Type: number that represents chart recorder full scale (in volts) when the flow data points that are to be digitized were originally recorded
    b. Press: CONTINUE

37. When "Scale Multiplier (Data Flow) = ?" is displayed;
    a. Type: number that represents scale multiplier on chart recorder when flow data that are to be digitized were originally recorded
    b. Press: CONTINUE
    c. Full-scale and multiplier values are printed

38. When "Volts Full Scale (Data Press) = ?" is displayed;
    a. Type: number that represents chart recorder scale multiplier setting when pressure data points that are to be digitized were recorded
    b. Press: CONTINUE

39. When "Scale Multiplier (Data Press) = ?" is displayed;
    a. Type: number that represents chart recorder scale multiplier setting when pressure data points that are to be digitized were recorded
    b. Press: CONTINUE
    c. Full-scale and multiplier values are printed

40. When "Change data scale values?" is displayed;
    a. If yes,
        1) Press: YES
        2) Go to step 36
    b. If no,
        1) Press: NO
        2) Go to step 41

41. When "Set origin for Data axes" is displayed;
    a. Set digitizer origin using cursor
    b. Press: CONTINUE
    c. Go to "DIGSET," return to step 42

42. When "Number of breaths this hour = ?" is displayed;
    a. Type: number of individual breaths for this hour that are to be analyzed (maximum of 10 allowed)
    b. Press: CONTINUE

43. When "Hit CONT*Read 2 Flow pts. B-<n>" is displayed (note: <n> represents the number of the breath which currently is being digitized);
    a. Press: CONTINUE
    b. When "Read Flow point F1" is displayed;
        1) Go to "DATA"
        2) Return to next line
    c. When "Read Flow point F2" is displayed;
        1) Go to "DATA
        2) Return to step 44

44. When "Reread 2 Flow data points?" is displayed;
    a. If yes,
        1) Press: YES
        2) Go to step 43
    b. If no,
        1) Press: NO
        2) Go to step 45

45. When "Hit CONT*Read 2 Pres. pts. B-<n>" is displayed;
    a. Press: CONTINUE when ready to digitize pressure data points
    b. When "Read Pressure data point P1" is displayed;
        1) Go to "DATA"
        2) Go to next line
    c. When "Read Pressure data point P2" is displayed;
        1) Go to "DATA"
        2) Go to step 46

46. When "Reread 2 Pressure data points?" is displayed;
    a. If yes,
        1) Press: YES
        2) Go to step 45
    b. If no,
        1) Press: NO
        2) Go to step 47

47. When "Do you want to reset axes?" is displayed;
    a. If tracing for next breath is on another chart paper or if the current paper must be moved to accommodate the next tracing,
        1) Press: YES
        2) When "Set origin for axes," is displayed;
            a) Press: CONTINUE
            b) Go to "DIGSET"
            c) Go to step 48
    b. If tracing for next breath is already positioned on digitizer so that

nothing needs to be changed,
1) Press: NO
2) Go to step 48

48. Have the number of breaths entered in step 42 been analyzed for this hour?
a. If no, go to step 43
b. If yes, go to step 49

49. Data for each breath of this hour as well as mean, maximum, and variation of isovolume resistance are printed.
a. If data is not to be recorded (you answered NO in step 8), go to step 55.
b. If data is to be recorded (you answered YES in step 8), go to step 50.

50. If "DATA IS BEING RECORDED" is displayed;
a. The data just printed is stored on tape
b. Go to step 52

51. If the program detects an error in trying to record data;
a. Go to "HELP"
b. Go to step 50

52. If "Tape is full--remove it" is <u>not</u> displayed, go to step 55

53. If "Tape is full--remove it" is displayed you have two options:
a. If the current tape still has one track which has not been used, you may do the following:
1) Leave tape in the computer
2) Type: n → D, where n, either Ø or 1, is the number of the unused but properly marked track
3) Press: EXECUTE
4) Press: CONTINUE
5) Go to step 54
b. If you change the tape;
1) Insert: new properly marked but blank tape
2) Press: CONTINUE
3) Go to step 54

54. "INSERT MARKED TAPE" is displayed as a reminder that you must have performed step 53.a. or 53.b. by this time. If not, then you now must insert a new tape.
a. Press: CONTINUE
b. If "Tape full--replace" is displayed, the new track or new tape has been filled previously;
1) Remove: tape
2) Press: CONTINUE
3) Go to step 54.b.
c. If "TAPE NOT MARKED-USE MARKED TAPE" is displayed;
1) Remove: tape
2) Press: CONTINUE
3) Go to step 54.b.
d. Go to "HELP"; go to next line
e. Return from "HELP"
1) If a problem was found by "HELP" go to step 54.b.
2) If no problem was found by "HELP" go to step 55.

55. Have the number of hour groups entered in step 21 been analyzed?
    a. If no, go to step 24
    b. If yes, go to step 56

56. If data was recorded on tape "REWINDING TAPE CASSETTE" is displayed.

57. When "TURN OFF DIGITIZER!!" is displayed do so.

58. When "End of Data Reduction" is displayed;
    1) Program has finished
    2) Turn equipment off
    3) Remove data tape

"HELP":

a. If "INSERT TAPE CASSETTE" is displayed the tape is not properly inserted.
   1) Correctly insert tape
   2) Press: CONTINUE
   3 Return to main program
b. If "CASSETTE IS WRITE PROTECTED" is displayed;
   1) Remove: cassette
   2) Slide tab on cassette to "RECORD" position
   3) Insert tape into computer
   4) Press: CONTINUE
   5) Return to main program
c. If "SYSTEM MALFUNCTION**GET HELP" is displayed, there is a serious hardware or software problem which must be remedied. The ROM identifying character, ern, and erl are printed on the internal computer printer.

"DIGSET":

a. When "Read point on X axis" is displayed;
   1) Slide digitizer cursor to a point along chart paper X-axis
   2) Press: "S" button on cursor
   3) When data point is properly read, computer will beep once.
   4) *Go back to step a.1. until 5 points are read.*
b. When "Do you want to reread points?" is displayed;
   1) If yes,
      a) Press: "YES"
      b) Go to step a.
   2) If no,
      a) Press: "NO"
      b) Return to main program

"DATA":

a. Slide digitizer cursor to point to be read.
b. Press: button "S" on cursor to read point.
c. Computer will beep when point is properly recorded.
d. Return to main program.

3. User Instructions for PDP Program to be used with "ISOtfr"

It is assumed that the operator has properly logged onto the PDP computer and that the transfer program, named "LFSRC2IB" is accessible to him.

1. On the PDP computer terminal
   Type: RUN LFSRC2IB
   Press: RETURN

2. When "DATA FILE NAME [NAME.EXT]:" is displayed,
   a. Type: name wanted for PDP data file
   b. Press: RETURN

3. [PDP program is now ready for transfer to start.]

4. When data transfer is completed, "STOP-TTnn" is displayed where nn is the number of the terminal being used.

B. Program "ISOtfr"

1. Introduction

Program "ISOR" computes the isovolume resistance for individual breaths and records these results on a tape cassette. Thus it is not necessary to transfer the raw data to the PDP computer for analysis. However, for the purpose of making statistical comparisons of isovolume resistance between subjects and/or experimental conditions, the analyzed values are best transcribed to files on the PDP disk. The programs that effect this transfer are "ISOtfr" for the HP 9825 and "LFSRC2IB" for the PDP-11/34. The hardware requirements are the same as described for "PDPtfr."

Each data file from the tape is stored as three records on the PDP disk. The first two consist of the descriptive and time headers, respectively, as previously described for "ISOR." The third file holds the actual data: 12 numbers with format F10.5. The first number is the hour number, the second the time in 24-hour clock notation, and the remaining 10 are the calculated isovolume resistances (liters/sec-cm H_2O). All the data on a given track of the tape cassette are stored on one file in the PDP computer.

Detailed user instructions follow in the next section; program listings are given in Appendix 6.

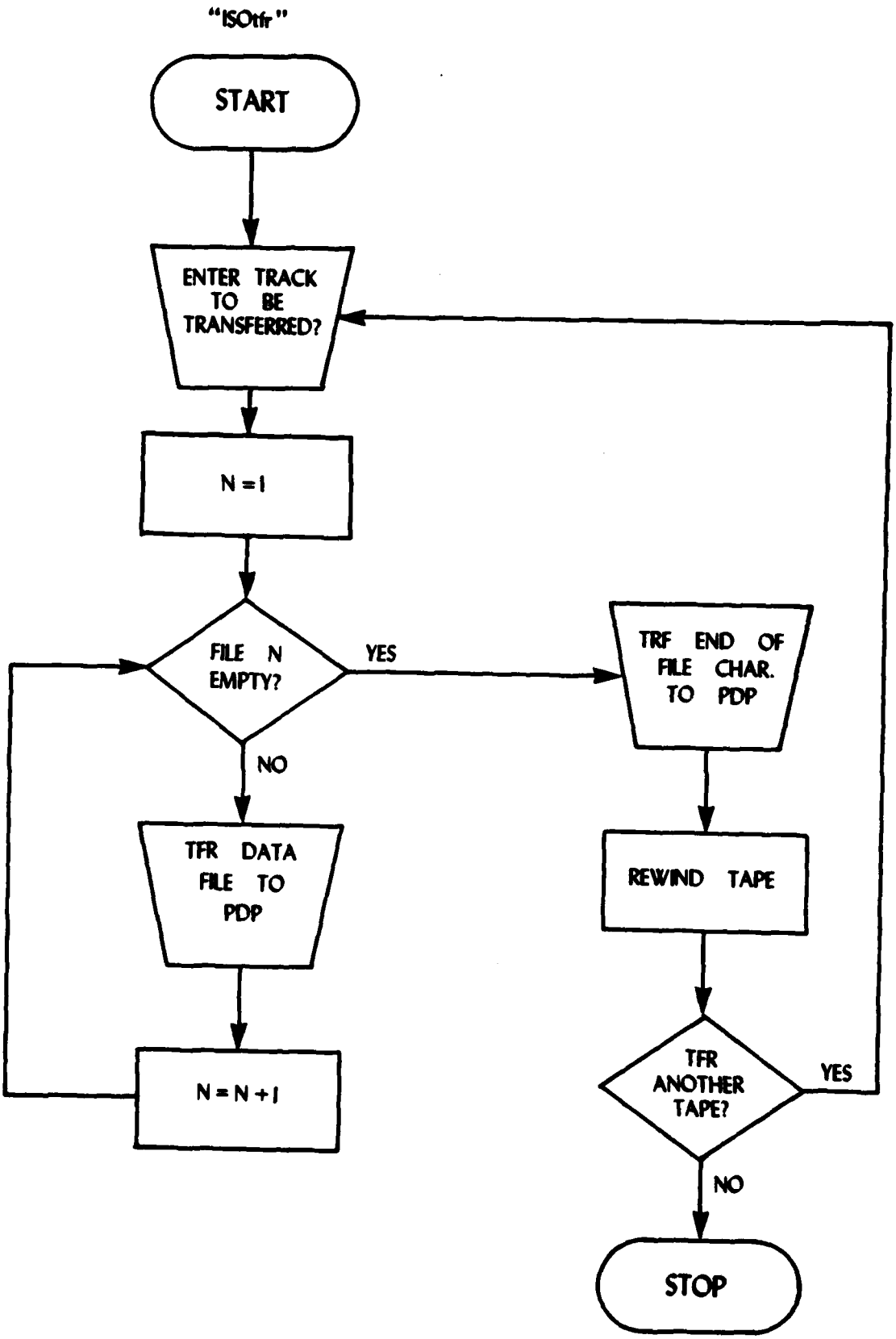


Fig. 5. Flow chart for program "ISOtfr"

2. User Instructions

1. Insert program tape
   Press: LOAD
   Type: 7
   Press: EXECUTE

2. When end of line mark (↵) is displayed
   Press: RUN

3. ["REWINDING TAPE" is displayed.]

4. When "Remove Program Tape" is displayed;
   a. Remove tape
   b. Press: CONTINUE

5. When "Insert Data Tape" is displayed;
   a. Insert: tape containing data files produced by "ISOR"
   b. Press: CONTINUE

6. When "Track to be transferred?" is displayed;
   a. Type: either Ø or 1 to specify which track on the tape is to be transferred
   b. Press: CONTINUE

7. When "Start PDP computer program" is displayed;
   a. Start program
   b. Press: CONTINUE

8. When "Press CONTINUE to start transfer" is displayed
   Press: CONTINUE

9. ["DATA IS BEING TRANSFERRED" is displayed until an empty file is encountered on the tape, then the end-of-file character is sent to the PDP computer.]

10. ["REWINDING TAPE" is displayed.]

11. When "DATA TRANSFER IS FINISHED" is displayed
    Press: CONTINUE

12. When "Another data transfer?" is displayed;
    a. If yes,
       1) Press: YES (key f_0)
       2) Go to step 5
    b. If no,
       1) Press: NO (key f_6)
       2) Program ends

C. Program "ISORED"

1. Introduction

Program "ISORED" reads data tapes containing isovolume resistance values calculated and recorded by program "ISOR." These values are then printed on an external printer. A program listing is given in Appendix 7.

The format of the printout is as follows:

Tape Track # Tape File#
Header
Time and Date of Original Data
Hour # Time of Data
10 Values of Isovolume Resistance (1 for each breath analyzed)

2. User Instructions

1. Insert: tape cassette containing program

2. Press: ERASE
   Type: a
   Press: EXECUTE

3. Press: LOAD
   Type: 6
   Press: CONTINUE

4. Wait for end of line mark (⊢) to be displayed

5. Press: RUN

6. When "Remove program tape" is displayed;
   a. Remove tape
   b. Press: CONTINUE

7. When "Insert data tape" is displayed;
   a. Insert: data tape
   b. Press: CONTINUE

8. When "Tape track (Ø or 1) wanted = ?" is displayed;
   a. Type: number
   b. Press: CONTINUE

9. When "File number to be read = ?" is displayed;
   a. Type: file number (between 1 and 400)
   b. Press: CONTINUE

10. [Data is printed.]

11. Go to step 9 (To end program, Press: STOP)

References

1. Catron, P.W.; Layton, R.P.; Krupa, T.A. A computerized method for acquisition and analysis of flow-volume loops. Bethesda, Md: Naval Medical Research Institute; [1981]; No. 81-13, Available from: Naval Medical Research Institute, Hyperbaric Medicine, Bethesda, Md.

APPENDIX 1a

"NDATA"

Equipment List

1. Nicolet oscilloscope (model 2090)

2. Hewlett-Packard (HP) 9825B Computer
   or
   HP 9825A Computer with the following ROM's:
   a. general I/O
   b. extended I/O
   c. advanced programming
   d. string variable

3. IEEE-488 (HP-IB) interface bus (HP 98034A)

4. Printer for HP 9825, such as HP 9866 (Note: program assumes select code of printer is 6; if not, all "wrt" commands must be changed to reflect actual select code.)

5. Real-Time Clock (HP 98035A)

"NDATA"

Program Listing

```
0: "This program is called NDATA.  It will mark tape cassettes and store":
1: "up to 32 transfers of data from the Nicolet digital oscilloscope on ":
2: "a single tape.  Raw data is stored just as sent from the Nicolet.":
3: "Version:  24 March 1982 ** RPL  ":
4:
5: list #6,0,3
6: wrt 0
7: dim A$[80],B$[14],X$[8208],C$[14],D$[1],E$[3]
8: buf "data",X$,3
9: ldk 0
10: 0→Q
11: cll 'TAPE'
12: dsp "REMOVE PROGRAM CASSETTE";stp
13: ent "Do you want to mark tapes?",r1
14: if r1=1;cll 'START'
15: ent "3-digit Subject number=?",E$
16: len(E$)→G
17: if G=3;E$→A$[1,3]
18: if G=2;"0"→A$[1,1];E$[1,2]→A$[2,3]
19: if G=1;"00"→A$[1,2];E$[1,1]→A$[3,3]
20: ent "2-digit Subject age= ?",A$[4,5]
21: ent "Sex code (1=M,2=F)= ?",A$[6,6]
22: ent "1-digit race code= ?",A$[7,7]
23: "0"→A$[8,8]
24: ent "2-digit Ht. in inches= ?",A$[9,10]
25: ent "3-digit Wt. in pounds=?",A$[11,13]
26: " "→A$[14,22];" "→A$[23,23]
27: ent "Enter Barometric Pressure (mmHg)",A$[24,28]
28: " "→A$[29];ent "2-digit room Temperature= ?",A$[30,31]
29: " "→A$[32]
30: fmt ;ent "Enter heading line",A$[33,80];wrt 6,A$
31: ent "Do you want to change heading?",r1
32: gto 15;if r1=0;gto +1
```

```
33: wrt 9,"R";red 9,B$
34: fmt ,"Clock reads: ",c14
35: wrt 0,B$;stp
36: ent "Do you want to reset clock?",r1
37: if r1=1;cll 'CLOCK'
38: cll 'DATA'
39: stp
40:
41: "CLOCK":
42: fmt ;dsp "Enter time as two digit number";wait 3000
43: " "→C$[1,14]
44: ent "Month?",C$[1,2]
45: ent "Day?",C$[4,5]
46: ent "Hour?",C$[7,8]
47: ent "Minute?",C$[10,11]
48: ent "Second?",C$[13,14]
49: wrt 9,"S",C$;dsp "Resetting Clock (Be patient!)"
50: wrt 9,"R";red 9,B$
51: fmt ,"CLOCK NOW READS: ",c14
52: wrt 0,B$;stp
53: ent "RESET CLOCK AGAIN ?",r1
54: if r1=1;gto 42
55: ret
56:
57: "START":
58: ent "Number of tapes to be marked?",N
59: fmt ,c24,f3.0
60: for I=1 to N
61: "err":on err "HELP";if L=1;0→L;gto +4
62: wrt 0,"INSERT TAPE CASSETTE # ",I;stp
63: trk 0;rew;fdf 0;idf A,A;gto +2;if A#0;gto +1
64: dsp "Tape is not blank--use new tape";stp ;gto -1
65: wrt 0,"MARKING CASSETTE #",I
66: rew;trk 0
67: cll 'MARK'
68: next I
```

```
 69: ret
 70:
 71: "MARK":
 72: for J=1 to 16
 73: mrk 1,112;mrk 1,8216
 74: next J
 75: rew;trk 1
 76: for J=1 to 16
 77: mrk 1,112;mrk 1,8216
 78: next J
 79: rew;trk 0
 80: ret
 81:
 82: "DATA":
 83: ent " ID number of first data tape=?",K;K-1→K
 84: 1→Q;K+1→K;1→Z;trk 0
 85: fmt ,c21,f3.0
 86: wrt 0,"INSERT MARKED TAPE # ",K;stp
 87: on err "NEXT"
 88: rew;trk 0;fdf 0;idf A,A;gto +2;if A#0;gto +1
 89: dsp "Tape not blank--use new tape";stp ;gto 83
 90: gto +5
 91: "NEXT":
 92: gto +2;if rom=0 and ern=65;gto +1
 93: dsp "Tape not marked--use marked tape";stp ;gto 83
 94: dsp "SYSTEM MALFUNCTION--GET HELP!";stp
 95: for J=1 to 2
 96: for I=1 to 16
 97: "HERE":on err "HELP";if G=1;0→G;if J=1;rew;trk 0
 98: if G=1;0→G;if J=2;dsp "SYSTEM MALFUNCTION**GET HELP!";stp
 99: (I-1)*2→F
100: ent "1-digit experimental type #= ?",A$[14,14]
101: ent "4-character record type code= ?",A$[15,18]
102: if r15=5;gto +4
103: ent "Do you have event time yet?",r1
104: if r1#1;"00-1"→A$[19,22];gto +2
```

```
105: if r1=1;5→r15;ent "4-digit event time= ?",A$[19,22]
106: ent "Do you want to cnange data?",r1
107: if r1=1;gto 100
108: fmt ,c28,f3.0
109: wrt 0,"Hit CONTINUE to read data #",Z;stp
110: dsp "Data is being recorded"
111: wrt 9,"R";red 9,3$
112: fmt 7,"Data tape # ",f3.0,10x,"Data dump # ",f2.0,/
113: wrt 6.7,K,Z
114: fmt 8;wrt 6.8,A$[1,80];wrt 6.8,B$;wrt 6.8;wrt 6.8
115: buf "data"
116: cll 'SCOPE'
117: F+1→P;rcf F,A$,B$
118: rcf P,X$
119: Z+1→Z
120: next I
121: dsp "REWINDING TAPE";rew;trk 1
122: next J
123: cll 'TAPE'
124: gto 84
125: ret
126: "SCOPE":
127: clr 7;wrt 715,"D2";clr 7
128: tfr 714,"data",8192
129: clr 7
130: ret
131:
132: "TAPE":
133: dsp "REWINDING TAPE CASSETTE";rew
134: rds(1)→H
135: if bit(5,H)=1;gto -1
136: ret
137:
138: "HELP":beep;wait 50;beep;wait 50;beep
139: gto +2;if rom=0 and ern=41;gto +1
140: dsp "INSERT TAPE CASSETTE";stp ;gto +6
```

```
141: gto +2;if rom=0 and ern=42;gto +1
142: dsp "CASSETTE IS WRITE PROTECTED";stp ;gto +4
143: gto +2;if rom=0 and ern=65;gto +1
144: 1→L;gto +2
145: char(rom)→D$;prt D$,ern,erl;dsp "SYSTEM MALFUNCTION**GET HELP!";stp
146: 1→G;gto "err";if Q=1;gto "HERE"
147: end
```

APPENDIX 1c

"NDATA"

Variable Assignments

A	used
F	tape file # in which header is recorded
G	used
H	used
I, J	used as counters
K	ID # of tape
L	used as error flag
N	# of tapes to be marked
P	tape file # in which data is recorded
Q	used
Z	# of data transfer
A$	header
B$	computer clock time
C$	computer clock reset time
D$	character identifying ROM in which error has occurred
E$	used
X$	used for data buffer
r1	yes/no indicator
r15	used

"NDATA"

Details of Header and Time String Variables

The header is stored in the string variable A$, dimensioned as A$[80].

A$[1,3]	3-digit subject number (right-adjusted)
A$[4,5]	2-digit subject age
A$[6,6]	1-digit sex code
A$[7,7]	1-digit race code
A$[8,8]	Ø (used as spacer)
A$[9,10]	2-digit height (inches)
A$[11,13]	3-digit weight (pounds)
A$[14,14]	1-digit experimental type code
A$[15,18]	4-character record type code
A$[19,22]	4-digit event time (default value is "ØØ-1")
A$[23,23]	"space"
A$[24,28]	barometric pressure (mm Hg)
A$[29,29]	"space"
A$[30,31]	2-digit room temperature
A$[32,32]	"space"
A$[33,80]	free comment section

The value of the real-time clock is stored in string variable B$, dimensioned as B$[14].

B$[1,2]	month
B$[3,3]	"space"
B$[4,5]	day
B$[6,6]	"space"
B$[7,8]	hour
B$[9,9]	"space"
B$[10,11]	minute
B$[12,12]	"space"
B$[13,14]	second

"PDPtfr"

Program Listing

```
 0: "This program is called PDPtfr;  it reads a Nicolet oscilloscope data":
 1: "transfer from the tape cassette and sends the data to the PDP computer":
 2: "It will automatically send the data from all tapes for an experiment":
 3: "on a given subject and store these data in a single data file on the":
 4: "PDP computer.  This program is designed to run using the General ":
 5: "Instruments GPIB interface bus on the PDP computer.":
 6: "Version : 29 March 1982  **  RPL  ":
 7:
 8: ldk 0
 9: rew
10: dsp "Remove Program Tape";stp
11: trk 0
12: dim A$[80],B$[14],X$[8208]
13: buf "data",X$,3
14: fmt 1,c80,z
15: fmt 2,c14,z
16: dsp "Start PDP computer program";stp
17: dsp "Press CONTINUE to start transfer";stp
18: cli 7
19: pct 700
20: ent "Enter # of cassettes to be read",M
21: ent " ID number of first cassette = ?",R
22: for J=1 to M
23: R-1+J→K
24: fmt ,c15,f3.0
25: wrt 0,"INSERT TAPE # ",K;stp
26: fmt
27: for L=1 to 32
28: cll 'SEND'
29: next L
30: dsp "REWINDING TAPE";rew
31: rds(1)→H;if bit(5,H)=1;gto +0
32: next J
```

```
33: gto "EXIT"
34:
35: "SEND":
36: L→N
37: if N>16;trk 1;N-16→N
38: (N-1)*2→N
39: fdf N;idf V,V
40: if V=0;if J=M;gto "EXIT"
41: if V=0;if J#M;32→L;gto 51
42: ldf N,A$,B$;dsp L
43: N+1→P;ldf P,X$
44: rds(7)→A;if bit(5,A)=0;gto +0
45: wrt 731.1,A$[1,80]
46: rds(7)→A;if bit(5,A)=0;gto +0
47: wrt 731.2,B$
48: rds(7)→A;if bit(5,A)=0;gto +0
49: tfr "data",731,8192
50: trk 0
51: ret
52:
53: "EXIT":
54: for I=1 to 80
55: " "→A$[I,I]
56: next I
57: "STOP"→A$[1,4]
58: rds(7)→A;if bit(5,A)=0;gto +0
59: wrt 731.1,A$
60: rew
61: dsp "DATA TRANSFER COMPLETED";stp
62: end
```

PDP PROGRAM "LFSRECIB"

```
C
C       S.PRINCE        19-FEB-82       ACI
C
C       TRANSFERS DATA FROM DR. CATRONS EXPERIMENT FROM THE HP-9825
C       TO THE 11/34 BY WAY OF THE GPIB-11 BUSS. THE HEADERS AND
C       THE ACTUAL DATA ARE TRANSFERED TO A FILE. NO CONVERSIONS
C       ARE DONE.
C
C       NOTE: THE TRANSFER OF NICOLET DATA CONTAINS VALUES THAT ARE
C       BYTE REVERSED RELATIVE TO THE PDP-11 WORD. IN ORDER TO DO
C       ANYTHING WORTH WHILE WITH THIS DATA IT WILL BE NECESSARY TO
C       SWAP THE BYTES IN EACH WORD.
C
        LOGICAL*1 LBYTE(8192),DOLLAR
        EQUIVALENCE (LBYTE(1),FIN)
        DATA STOP/'STOP'/,IREAD/1/,ID2/'D2'/
C
        IDATSZ=8192             ! SIZE OF 3RD TRANSFER
C
C-- GET FILE NAME
C
        TYPE 5
5       FORMAT(' DATA FILE NAME [NAME.EXT] : ',$)
        READ(5,7)(LBYTE(I),I=1,40)
7       FORMAT(40A1)
        CALL ASSIGN(2,LBYTE)
        CALL FDBSET(2,'NEW')
C
C-- READ FIRST HEADER LINE (80 CHARS)
C
10      J=IBUP(IREAD,3,LBYTE,80)
        IF(J.EQ.-4)GOTO 10              ! TIMEOUT, REPEAT READ
        IF(J.LT.0)GOTO 100
        IF(FIN.EQ.STOP)STOP
C
C-- OUTPUT LINE TO TERMINAL AND FILE
C
        WRITE(5,20)(LBYTE(I),I=1,80)
20      FORMAT(1H ,80A1)
        WRITE(2)(LBYTE(I),I=1,80)
C
C-- READ SECOND HEADER LINE (14 CHARS)
C
30      J=IBUP(IREAD,3,LBYTE,14)
        IF(J.EQ.-4)GOTO 30              ! TIMEOUT, REPEAT READ
        IF(J.LT.0)GOTO 100
        WRITE(5,40)(LBYTE(I),I=1,14)
40      FORMAT(1H ,14A1)
        WRITE(2)(LBYTE(I),I=1,14)       ! TO OUTPUT FILE
C
C-- READ DATA BUFFER ('IDATSZ' BYTES)
C
50      J=IBUP(IREAD,3,LBYTE,IDATSZ)
        IF(J.EQ.-4)GOTO 50              ! TIMEOUT, REPEAT READ
```

```
        IF(J.LT.0)GOTO 100
        TYPE 60
60      FORMAT(' DATA BUFFER RECEIVED!')
        WRITE(2)(LBYTE(I),I=1,IDATSZ)          ! DATA BUFFER TO OUTPUT FILE
        GOTO 10
C
C-- WRITE OUT ERROR MESSAGE
C
100     WRITE(5,110)J
110     FORMAT(' J= ',I5)
        STOP 'ERROR'
        END
```

APPENDIX 3a

"Nictfr"

Equipment List

1. Nicolet oscilloscope (Model 2090)

2. HP 9825 B desktop computer
   or
   HP 9825 A computer with following ROM's:
   a. general I/O
   b. extended I/O
   c. advanced programming
   d. string variable

3. IEEE-488 (HP-IB) interface bus for HP 9825 (HP 98034A)

4. Printer for HP 9825, such as HP 9866
   (Note: program assumes select code of printer is 6; if not, line 8 must be changed to reflect actual select code)

"Nictfr"

Program Listing

```
 0: "This program is called Nictfr; it reads Nicolet oscilloscope data ":
 1: "transfer from the tape cassette and sends":
 2: "the data back to the Nicolet for display":
 3: "Version : 28 January 1982 ** RPL  ":
 4:
 5: dim A$[80],B$[14],X$[8208]
 6: buf "data",X$,3
 7: ent "Enter number of data dump wanted",N
 8: trk 0;if N>16;trk 1;N-16→N
 9: (N-1)*2→N
10: ldf N,A$,B$;wrt 6;wrt 6,A$;wrt 6,B$
11: N+1→P;ldf P,X$
12: wrt 715,"D2";clr 7
13: tfr "data",714,8192
14: clr 7;trk 0;gto 7
15: end
```

"ERASE" PROGRAM LISTING

```
0: "This program is called ERASE;  it will completely erase both ":
1: "tracks 0 and 1 of a tape cassette":
2: "Version:  28 January 1982 ** RPL  ":
3:
4: rew
5: dsp "Remove Program Tape";stp
6: beep;dsp "Insert tape to be erased";stp
7: dsp "*** TAPE IS BEING ERASED ***"
8: on err "error"
9: trk 0;rew;ert 0
10: trk 1;ert 0
11: gto -5
12: "error":
13: rew;gto +4;if rom=0 and ern=43;gto +1
14: rds(1)→H
15: if bit(5,H)=1;gto -1
16: gto 6
17: prt rom,ern;dsp "ERROR OCCURRED"
18: end
```

APPENDIX 5a

"ISOR"

Equipment List

1. HP 9825B desktop computer
   or
   HP 9285A desktop computer with following ROM's:
   a. general I/O
   b. extended I/O
   c. advanced programming
   d. string variable

2. HP 9864A digitizer

3. Printer for HP 9825, such as HP 9866.
   (Note: program assumes printer select code is 6; if not, line 12 must be changed to reflect actual select code.)

"ISOR"

Program Listing

```
0: "This program is called ISOR;  it is used for lung function experiments":
1: "It uses the Digitizer to read data points from chart recorder traces":
2: "and calculates ISOVOLUME RESISTANCE ":
3: "Version: 28 January 1982 ** RPL  ":
4:
5: ldk 0;cll 'REW'
6: dsp "Remove Program Tape";stp
7: dim A$[80],B$[14],A,S,I[10]
8: dim F[12],E$[3]
9: dim Q[3],P[15],C[8],D[15]
10: dim X[10],Y[10],B[9],F$[10]
11:
12: "Select code of printer=":6→r12
13:
14: list #r12,1,4
15: cfg 5
16: ent "Do you want to mark tapes?",r1
17: if r1;0→r1;cll 'MARK'
18: dsp "TURN ON DIGITIZER !!!";stp
19: ent "Results to be recorded on tape?",r1;if r1=0;sfg 5
20: 0→C;if r1=1;1→C;ent "Track to be recorded?",D
21: "number of files recorded on each track":400→r20
22: cll 'HEADER'
23: ent "How many hours of data?",H
24: ent "Number of first hour of data=?",O
25: if flg5=0;cll 'CHECK'
26: for J=1 to H
27: "ISOR"→A$[15,18]
28: cll 'CLOCK'
29: if J=1;gto +3
30: ent "Do you want to RECALIBRATE?",r1
31: if r1=0;gto 62
32: dsp "Set origin for Flow cal.";stp
```

```
33: cll 'DIGSET'
34: dsp "Hit CONT to read 2 Flow cal. pts";stp
35: for M=1 to 2
36: cll 'DATA'
37: next M
38: ent "Reread Flow cal. points?",r1
39: if r1=1;gto 34
40: dsp "Set origin for P cal. axes";stp
41: cll 'DIGSET'
42: dsp "Hit CONT to read 2 P cal. pts.";stp
43: for M=3 to 4
44: cll 'DATA'
45: next M
46: ent "Reread Pressure cal. points?",r1
47: if r1=1;gto 42
48: cll 'CAL'
49: ent "Volts Full Scale (Data Flow)= ?",C[5]
50: ent "Scale Multiplier (Data Flow)= ?",C[6]
51: r12+.1→P
52: fmt 1,"Flow Data**Full Scale= ",f4.2," V",3x,"Multiplier= ",f3.0
53: wrt P,C[5],C[6]
54: P[6]*C[5]*C[6]/(C[1]*C[2])→P[6]
55: ent "Volts Full Scale (Data Press.)= ?",C[7]
56: ent "Scale Multiplier (Data Press.)= ?",C[8]
57: fmt 1,"Pressure Data**Full Scale= ",f4.2," V",3x,"Multiplier= ",f3.0
58: wrt P,C[7],C[8]
59: P[5]*C[7]*C[8]/(C[3]*C[4])→P[5]
60: ent "Change data scale values?",r1
61: if r1=1;gto 49
62: dsp "Set origin for Data axes";stp
63: cll 'DIGSET'
64: val(B$[7,11])→S
65: ent "Number of breatns this nour=?",B
66: for L=1 to B
67: fmt ,"Hit CONT*Read 2 Flow pts. B-",f2.0;wrt 0,L;stp
68: for M=1 to 2
```

```
 69: fmt ,"Read Flow point F",f1.0
 70: wrt 0,M
 71: cll 'DATA'
 72: next M
 73: ent "Reread 2 Flow data points?",r1
 74: if r1=1;gto 67
 75: fmt ,"Hit CONT*Read 2 Pres pts. B-",f2.0;wrt 0,L;stp
 76: for M=3 to 4
 77: M-2→E;fmt ,"Read Pressure data point P",f1.0
 78: wrt 0,E
 79: cll 'DATA'
 80: next M
 81: ent "Reread 2 Pressure data points?",r1
 82: if r1=1;gto 76
 83: cll 'CALC'
 84: if L=B;gto +3
 85: 0→r1;ent "Do you want to reset axes?",r1
 86: if r1=1;dsp "Set Origin for axes";stp ;cll 'DIGSET'
 87: next L
 88: G/B→O[J];0→G
 89: J+O-1→A
 90: cll 'PRINT1'
 91: N+1→N
 92: cll 'RECORD'
 93: next J
 94: cll 'REW';trk 0
 95: dsp "TURN OFF DIGITIZER !!";stp
 96: dsp "End of Data Reduction"
 97: stp
 98:
 99: "DIGSET":
100: 0→T
101: for I=1 to 5
102: fmt ;fxd 2
103: dsp "Read point on X axis";red 4,X,Y;beep
104: "calc. angle of paper to digitizer axis":atn(Y/X)→B[I]
```

```
105: T+B[I]→T
106: next I
107: ent "Do you want to reread points",r1
108: if r1=1;gto 100
109: T/5→T
110: ret
111:
112: "DATA":
113: fmt ;fxd 2
114: red 4,X,Y
115: Y*cos(T)-X*sin(T)→Y[M]
116: X*cos(T)+Y*sin(T)→X[M]
117: beep
118: ret
119:
120: "CALC":
121: for M=1 to 2
122: Y[M]→P[M];Y[M+2]→P[M]
123: next M
124: abs((P[1]-P[2])*P[5]/((P[1]-P[2])*P[6]))→I[L]
125: G+I[L]→G
126: ret
127:
128: "PRINT1":
129: if r12=706;wtb 706,27,40,65
130: wrt r12,"Date of this data:",B$
131: fmt 5,3/,3x,"HOUR",3x,"TIME",3x,"NUMBER",3x,"C/E CODE",3x,z
132: r12+.5→P;wrt P
133: fmt 6,"R-Isovol. (cm H2O/L/S)",2/
134: r12+.6→P;wrt P
135: I[1]→Q[1]→Q[2]
136: for I=1 to 3
137: fmt 7,3x,f2.0,4x,f5.0,5x,f2.0,x,c8,7x,f5.2,7x,f5.2,/
138: r12+.7→P;wrt P,A,S,I,A$[15,18],I[I]
139: if I[I]>Q[1];I[I]→Q[1]
140: if I[I]<Q[2];I[I]→Q[2]
```

```
141: next I
142: r12+.1→P
143: fmt 1,/,"The largest R-Isovolume= ",f5.2;wrt P,Q[1]
144: fmt 1,/,"The smallest R-Isovolume = ",f5.2;wrt P,Q[2]
145: (Q[1]-Q[2])/Q[2]*100→Q[3]
146: fmt 1,/,"Variation in R-Isovolume = ",f7.2," %";wrt P,Q[3]
147: fmt 1,/,"Mean R-Isovolume = ",f5.2;wrt P,D[J]
148: ret
149:
150: "CAL":
151: ent "Calibration Flow (liters/sec)= ?",F
152: fmt 1,"Calibration Flow Value= ",f5.2," Liters/sec";r12+.1→P;wrt P,F
153: 1/abs((Y[1]-Y[2])/F)→F[5]
154: ent "Volts Full Scale (Cal. Flow)= ?",C[1]
155: ent "Scale Multiplier (Cal. Flow)= ?",C[2]
156: r12+.1→P;fmt 1,"Flow cal.**Full Scale= ",f4.2," V",3x,"Multiplier= ",f3.0
157: wrt P,C[1],C[2]
158: ent "Calibration pressure (cm H2O)= ?",W
159: fmt 1,"Pressure Calibration Value= ",f5.2," cm H2O";wrt P,W
160: ent "Volts Full Scale (Cal. Press)= ?",C[3]
161: ent "Scale Multiplier (Cal. Press)= ?",C[4]
162: fmt 1,"Pressure cal.**Full Scale= ",f4.2," V",3x,"Multiplier= ",f3.0
163: wrt P,C[3],C[4]
164: abs(W/(Y[3]-Y[4]))→P[5]
165: ent "Change Calibration values?",r1;if r1=1;gto 151
166: ret
167:
168: "RECORD":
169: trk D;if C=0;ret
170: "HERE":on err "HELP"
171: dsp "DATA IS BEING RECORDED"
172: rcf N,A$,B$,A,S,I[*]
173: dsp
174: gto +3;if N=r20;cll 'REW';0→N;gto +1
175: dsp "Tape is full--remove it";stp
176: cll 'CHECK';gto +1
```

```
177: ret
178:
179: "REW":
180: dsp "REWINDING TAPE CASSETTE";rew
181: rds(1)→K
182: if bit(5,K);gto -1
183: ret
184:
185: "HEADER":
186: ent "3-digit Subject number=?",E$
187: len(E$)→I
188: if I=3;E$→A$[1,3]
189: if I=2;"0"→A$[1,1];E$[1,2]→A$[2,3]
190: if I=1;"00"→A$[1,2];E$[1,1]→A$[3,3]
191: ent "2-digit Subject age=?",A$[4,5]
192: ent "Sex code(1=M, 2=F)=?",A$[6,6]
193: ent "1 digit race code=?",A$[7,7]
194: "0"→A$[8,8]
195: ent "2-digit Ht. in inches=?",A$[9,10]
196: ent "3-digit Wt. in pounds=?",A$[11,13]
197: ent "1-digit experimental type=?",A$[14,14]
198: " "→A$[15,23]
199: ent "Enter Barometric pressure (mmHg)",A$[24,28]
200: " "→A$[29,29];ent "2-digit room temperature=?",A$[30,31]
201: " "→A$[32]
202: fmt ;ent "Enter heading line",A$[33,80];wrt 6,A$;wrt 6
203: ent "Do you want to change heading?",r1
204: gto 186;if r1=0;gto +1
205: ret
206:
207: "CLOCK":
208: dsp "ENTER TIME AS 2-DIGIT NUMBER";wait 3000
209: " "→B$[1,14]
210: ent "Month?",B$[1,2]
211: ent "Day?",B$[4,5]
212: ent "Hour?",B$[7,8]
```

```
213: ent "Minute?",B$[10,11]
214: ent "Second?",B$[13,14]
215: fmt ,"Time entered: ",c14
216: wrt 0,B$;stp
217: B$[7,8]→A$[19,20];B$[10,11]→A$[21,22]
218: ent "Re-enter time?",r1
219: if r1=1;gto -10
220: ret
221:
222: "CHECK":
223: dsp "INSERT MARKED TAPE";stp
224: on err "NEXT"
225: trk 0;rew;1→N
226: fdf N;idf Q,Q,Q;if Q#0;N+1→N;gto +1;if N#r20;gto +0
227: gto +5;if N=r20;dsp "Tape full--replace";rew;stp ;gto 224
228: "NEXT":
229: gto +2;if rom=0 and ern=65;gto +1
230: dsp "TAPE NOT MARKED--USE MARKED TAPE";stp ;gto 224
231: 2→Z;gto "HELP"
232: ret
233:
234: "HELP":
235: gto +2;if rom=0 and ern=41;gto +1
236: dsp "INSERT TAPE CASSETTE";stp ;gto +6
237: gto +2;if rom=0 and ern=42;gto +1
238: dsp "CASSETTE IS WRITE PROTECTED";stp ;gto +4
239: gto +2;if rom=0 and ern=65;gto +1
240: 1→L;gto +2
241: char(rom)→F$;prt F$,ern,erl;dsp "SYSTEM MALFUNCTION**GET HELP!";stp
242: if Z=0;gto "HERE"
243: if Z=1;gto "err"
244: if Z=2;0→A;gto 223
245:
246: "MARK":
247: 1→Z
248: ent "Number of tapes to be marked?",R
```

```
249: fmt ,c24,f3.0
250: for I=1 to R
251: "err":on err "HELP";if L=1;0→L;gto +4
252: wrt 0,"INSERT TAPE CASSETTE # ",I;stp
253: trk 0;rew;fdf 0;idf A,A;gto +2;if A#0;gto +1
254: dsp "Tape is not blank--use new tape";stp ;gto -1
255: wrt 0,"MARKING CASSETTE # ",I
256: rew;trk 0
257: cll 'MARK2'
258: next I
259: 0→Z
260: ret
261:
262: "MARK2":
263: mrk 1,10;mrk 400,250
264: rew;trk 1
265: mrk 1,10;mrk 400,250
266: rew;trk 0
267: ret
```

APPENDIX 5c

"ISOR"

Varible Assignments

A	hour number
B	# of breaths for a given hour
C	flag for recording data on tape
D	track of tape on which data is recorded
E	used
F	calibration flow value
G	used
H	# of hours of data
I	used as counter
J	used as counter
K	used
L	used as counter
M	used as counter
N	used as counter
O	# of first hour of data
P	used
Q	used
R	# of tapes to be marked
S	time of data
T	used
W	calibration pressure value
Y	used
Z	used as flag
B[*]	used
C[*]:	used for calibration information
	C[1] recorder volts full scale, calibration flow
	C[2] recorder scale multiplier, calibration flow
	C[3] recorder volts full scale, calibration pressure
	C[4] recorder scale multiplier, calibration pressure
	C[5] recorder volts full scale, data flow
	C[6] recorder scale multiplier, data flow
	C[7] recorder volts full scale, data pressure
	C[8] recorder scale multiplier, data pressure
D[*]	D[I] is average isovolume resistance for data of hour # I
F[*]:	flow data
	F[1] digitizer value for data flow point F1
	F[2] digitizer value for data flow point F2
	F[6] scale factor for flow
I[*]	I[L] is isovolume resistance for breath #L
P[*]:	pressure data
	P[1] digitizer value for data pressure point P1
	P[2] digitizer value for data pressure point P2
	P[5] scale factor for pressure

Q[*]:	resistance values
	Q[1] max. isovolume resistance
	Q[2] min. isovolume resistance
	Q[3] variation in isovolume resistance
X[*]	used
Y[*]	used
A$	header string
B$	clock time string
E$	used
F$	used
r1	yes/no indicator
r12	printer select code

"ISOtfr"

Program Listing

```
0: "This program is called ISOtfr;  it transfers data from isovolume":
1: "resistance data tapes, created by program ISOR, and stores the data":
2: "in data files on the PDP computer.  This program is designed to be ":
3: "used with the General Instruments GPIB interface bus on the PDP ":
4: "computer.":
5: "Version:  23 February 1982 ** RPL  ":
6:
7: dim A$[80],B$[14],I[10]
8: ldk 0
9: cll 'REWIND'
10: dsp "Remove Program Tape";stp
11:
12: "START":
13: dsp "Insert Data Tape";stp
14: ent "Track to be transferred=?",T
15: fmt 1,c80,z;fmt 2,c14,z;fmt 3,f10.5,z
16: fmt 4,12f10.5,z
17: dsp "Start PDP computer program";stp
18: dsp "Press CONTINUE to start transfer";stp
19: cli 7
20: pct 700
21: 0→N
22: trk T
23:
24: "N":
25: N+1→N
26: dsp "DATA IS BEING TRANSFERRED"
27: fdf N;idf V,V;if V=0;gto "EXIT"
28: ldf N,A$,B$,A,S,I[*]
29: rds(7)→Q;if bit(5,Q)=0;gto +0
30: wrt 731.1,A$[1,80]
31: rds(7)→Q;if bit(5,Q)=0;gto +0
32: wrt 731.2,B$[1,14]
```

```
33: rds(7)→Q;if bit(5,Q)=0;gto +0
34: wrt 731.4,A,S,I[1],I[2],I[3],I[4],I[5],I[6],I[7],I[8],I[9],I[10]
35: gto "N"
36:
37: "REWIND":
38: dsp "REWINDING TAPE";rew
39: rds(1)→K
40: if bit(5,K);gto -1
41: ret
42:
43: "EXIT":
44: for I=1 to 80
45: " "→A$[I,I]
46: next I
47: "STOP"→A$[1,4]
48: rds(7)→Q;if bit(5,Q)=0;gto +0
49: wrt 731.1,A$
50: trk 0
51: cll 'REWIND'
52: dsp "DATA TRANSFER FINISHED";stp
53: ent "Another data transfer?",r1
54: if r1;gto "START"
55: end
```

PDP PROGRAM "LFSRC2IB"

```
C
C       S.PRINCE        19-FEB-82       ACI
C
C       TRANSFERS DATA FROM DR. CATRONS EXPERIMENT FROM THE HP-9825
C       TO THE 11/34 BY WAY OF THE GPIB-11 BUSS. THE HEADERS AND
C       THE ACTUAL DATA ARE TRANSFERED TO A FILE. NO CONVERSIONS
C       ARE DONE.
C
C       NOTE: THE TRANSFER OF NICOLET DATA CONTAINS VALUES THAT ARE
C       BYTE REVERSED RELATIVE TO THE PDP-11 WORD. IN ORDER TO DO
C       ANYTHING WORTH WHILE WITH THIS DATA IT WILL BE NECESSARY TO
C       SWAP THE BYTES IN EACH WORD.
C
        LOGICAL*1 LBYTE(8192),DOLLAR
        EQUIVALENCE (LBYTE(1),FIN)
        DATA STOP/'STOP'/,IREAD/1/,ID2/'D2'/
C
        IDATSZ=120              ! SIZE OF 3RD TRANSFER
C
C-- GET FILE NAME
C
        TYPE 5
5       FORMAT(' DATA FILE NAME [NAME.EXT] : ',$)
        READ(5,7)(LBYTE(I),I=1,40)
7       FORMAT(40A1)
        CALL ASSIGN(2,LBYTE)
        CALL FDBSET(2,'NEW')
C
C-- READ FIRST HEADER LINE (80 CHARS)
C
10      J=IBUP(IREAD,3,LBYTE,80)
        IF(J.EQ.-4)GOTO 10              ! TIMEOUT, REPEAT READ
        IF(J.LT.0)GOTO 100
        IF(FIN.EQ.STOP)STOP
C
C-- OUTPUT LINE TO TERMINAL AND FILE
C
        WRITE(5,20)(LBYTE(I),I=1,80)
20      FORMAT(1H ,80A1)
        WRITE(2)(LBYTE(I),I=1,80)
C
C-- READ SECOND HEADER LINE (14 CHARS)
C
30      J=IBUP(IREAD,3,LBYTE,14)
        IF(J.EQ.-4)GOTO 30              ! TIMEOUT, REPEAT READ
        IF(J.LT.0)GOTO 100
        WRITE(5,40)(LBYTE(I),I=1,14)
40      FORMAT(1H ,14A1)
        WRITE(2)(LBYTE(I),I=1,14)       ! TO OUTPUT FILE
C
C-- READ DATA BUFFER ('IDATSZ' BYTES)
C
50      J=IBUP(IREAD,3,LBYTE,IDATSZ)
        IF(J.EQ.-4)GOTO 50              ! TIMEOUT, REPEAT READ
```

```
        IF(J.LT.0)GOTO 100
        TYPE 60
60      FORMAT(' DATA BUFFER RECEIVED!')
        WRITE(2)(LBYTE(I),I=1,IDATS%)          ! DATA BUFFER TO OUTPUT FILE
        GOTO 10
C
C-- WRITE OUT ERROR MESSAGE
C
100     WRITE(5,110)J
110     FORMAT(' J= ',I5)
        STOP 'ERROR'
        END
```

APPENDIX 7a

"ISORED"

Equipment List

1. HP 9825 B desktop computer
   or
   HP 9825 A computer with following ROM's:
   a. general I/O
   b. extended I/O
   c. advanced programming
   d. string variable

2. Printer for HP 9825, such as HP 9866.
   (Note: program assumes printer select code is 6; if not, all "wrt" statements must be modified to reflect actual select code.)

"ISORED"

Program Listing

```
0: "This program is called ISORED;  it reads data files from the isovolume":
1: "resistance data tapes created by program ISOR and prints the contents":
2: "of each file selected by the operator":
3: "Version:  28 January 1982  ** RPL  ":
4:
5: rew
6: dsp "Remove Program Tape";stp
7: dsp "Insert Data Tape ";stp
8: dim A$[80],B$[14],A,S,I[10]
9: ent "Tape track (0 or 1) wanted=?",F
10: ent "File number to be read=?",N
11: trk F
12: ldf N,A$,B$,A,S,I[*]
13: fmt 1,"Track # ",f1.0,5x,"File # ",f3.0
14: wrt 6.1,F,N
15: fmt 1,c80;wrt 6.1,A$
16: fmt 1,c14;wrt 6.1,B$
17: fmt 1,f3.0,10x,f4.0;wrt 6.1,A,S
18: fmt 1,f5.2,2x,z
19: for I=1 to 10
20: wrt 6.1,I[I]
21: next I
22: fmt 1,2/;wrt 6.1
23: gto 10
24: end
```

APPENDIX 8

Identification of Files of Program Tape

Tape File #	File Size	Program Name
0	100	(special function keys)
1	5000	"NDATA"
2	2000	"PDPtfr"
3	1000	"Nictfr"
4	1000	"ERASE"
5	8000	"ISOR"
6	1000	"ISORED"
7	2000	"ISOtfr"

END

DATE
FILMED

DTIC