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DECUS NO.	8-617
TITLE	V. A. Pks.-1 and V. A. Pks.-2 REAL TIME G.C. DATA INTEGRATOR and G.C. DATA MANIPULATOR
AUTHOR	Dr.J. B. Pearce, Ball Brothers Research Corporation, Boulder, Colorado; Dr. S. P. Levine, Veterans Administration Hospital, Denver, Colorado; P. J. R. Boyle, University of Colorado, Denver, Colorado; J. L. Naylor, Veterans Administration Hospital, Denver, Colorado
DATE	February 10, 1972
Write-up Revised	December 10, 1973
SOURCE LANGUAGE	PAL-8

DECUS Program Library Write-up Decus #8-617

V.A. PKS.-1 (MARK I) - A NEAR-REAL TIME GAS CHROMATOGRAPH DATA SYSTEM

Abstract

GC separation and integration is accomplished by an assembly language program which makes extensive use of the floating point arithmetic interpreter. The real time portion of the program samples data from the GC detector once per second. This data is smoothed and differentiated using a weighted, odd integer smoothing routine. When the derivative exceeds an operator selected value, a "GC peak" is provisionally established. If the peak satisfies the selected minimum width criterion, the location and area of this event are either printed out immediately on the teletypewriter or stored in memory for further processing if there is evidence that the peak is incompletely resolved. When the GC data returns to within a selectable vicinity of the baseline, or five peaks is exceeded, the perpendicular drop method is used to resolve them and the results are printed out.

V.A. PKS.-2 (MARK I) - A NON-REAL TIME GAS CHROMATOGRAPH DATA MANIPULATOR

Abstract

Automatic data reduction is as important as peak area integration. Reduction of the data is accomplished using the same equipment in an off-line mode. This segment of the program accepts the paper tapes generated by the first segment, as well as additional information from the keyboard. This program also uses the floating point interpreter. The interpreter remains resident in core and only the driving segments of the program need be exchanged.

I. V.A. PKS.-1 (MARK I)

A. Introduction

This system is not a "turnkey" system. In other words, you will need a reasonable amount of software and hardware support in your laboratory in order to install and understand this system. Although these programs were designed to operate on a "classic" PDP/8, modifications can be obtained for use on PDP/8E or PDP/12 computers.

These programs are the result of a learning process on the part of the parties involved and therefore they are not very clearly organized. Although a second generation program was planned to resolve logical inadequacies and program structure problems, this plan was never acted upon. Despite these drawbacks, the programs are fully operational and represent the most powerful data aquisition, reduction, and manipulation routines available for GC in the price range of $3-7000. A description of this system (that should be read) is published in Analytical Chemistry, 45, 1560 (1973).

B. Operating Instructions

A reasonable amount of knowledge concerning DEC hardware and software is assumed in the following discussions:

1. Hardware

a. These programs are designed for use with a 4k. "classic" PDP/8 equipped with a type 189 A/D, either a KW08, or R401+ B104 + R302 + ten turn pot. + 100 MFD capacitor clock assembly, and a type 33 teletype (tty). DEC will advise you in the assembly of these components. Programs are available for use on the PDP/8E through DECUS.

b. The GC is connected to the computer using an inexpensive op-amp filter assembly such as that described in Appendix I. This filter can be used to either shift or invert the GC signal so that it is compatible with the A/D input. The use of this filter is desirable, but not vital. The software is designed to handle a GC output of 0 to +10V. that has been shifted to -10 to 0V. The signal is then converted to 0 to -10V. by software. (An approach that works but would have been corrected in a Mark II program).

c. Make sure that there are no ground loops and that the line voltage is stable. These are important points to check.

2. Software

Although the operation of the program is straightforward, the understanding of its application to complex GC patterns is not. This writeup should form the basis for such an understanding.

a. Load the floating point package (FPP), DEC #08-YQ2B-PB, using BIN loader, then load VAPKS-1.

b. 2000, Load Add., Start, samples GC baseline voltage to A/D. Before running any chromatograms, check the correspondence between your recorder pen position and your computer-sensed baseline. You must also know the A/D full scale vs. recorder full scale relationship at different GC attenuation settings; otherwise, you might inject a sample that the recorder can't see, but the computer can, or the reverse. Be sure that your recorder chart speed is high (2-6 cm/min) during the checkout procedure so that you can see the actual peak shapes and separations.

c. Bit 10 (numbering 0-11, left to right) sets baseline polarity. Depending on your input polarity bit 10 can be either up or down (after subroutine start) in order to display the A/D voltage in the Accumulator. Bit 11 up initiates a continuous tty. printout of A/D voltage x 5 (an arbitrary multiplier to make the number larger). Low baseline noise is essential. Push Stop when baseline and full scale characteristics are known.

d. Set clock rate to 1/sec (set automatically by program if KW08 clock present).

e. Set the filter slew rate so that it is approximately <0.1 of the expected peak width. This will filter out high frequency GC noise without peak shape distortion.

f. Simple samples should be used for the checkout procedure. All peaks should be completely out of the GC using an isothermal run within 5-15 minutes (for convenience). Start with two non-overlapping peaks of different areas. When you are sure that integration is correct, proceed to a sample containing two peaks of exactly equal (or known) areas that overlap by approximately 20-50%, then three overlapping equal area peaks, then three overlapping peaks of area ratios 1:10:1 to 1:20:1. All peaks should be >11 secs. wide for accurate integration.

g. The actual operating characteristics of the program are outlined in the Anal. Chem. article referred to, but further comments are included here: Location 25 contains N of 2N+1 odd integer smoothing routine. N may be set between 1 and 12_8

and should be between 1 and 3 for peaks 15-40 secs. wide. Larger numbers are used for wider peaks.

h. 1600, Load Add., Start, initiates program and asks questions that are outlined in the Anal. Chem. articles.

1. Mode 0 = Peak time and area values

   1 = Mode 0 + baseline slope values

   2 = Mode 0 + repetitive run

   3 = Mode 1 + repetitive run

   Modes 1 and 3 are most useful. Modes 2 and 3 are used in conjunction with a GC equipped with an autoinjector.

2. Delta T is the time elapsed between sample injection and the offscale solvent peak. This must be entered for modes 2 and 3 only.

3. The minimum solvent delay allowed is 27 seconds.

4. All questions (except Blend Slope) are answered in integers. Time is in seconds.

5. Figure 1 illustrates the meanings of the questions asked by the program.

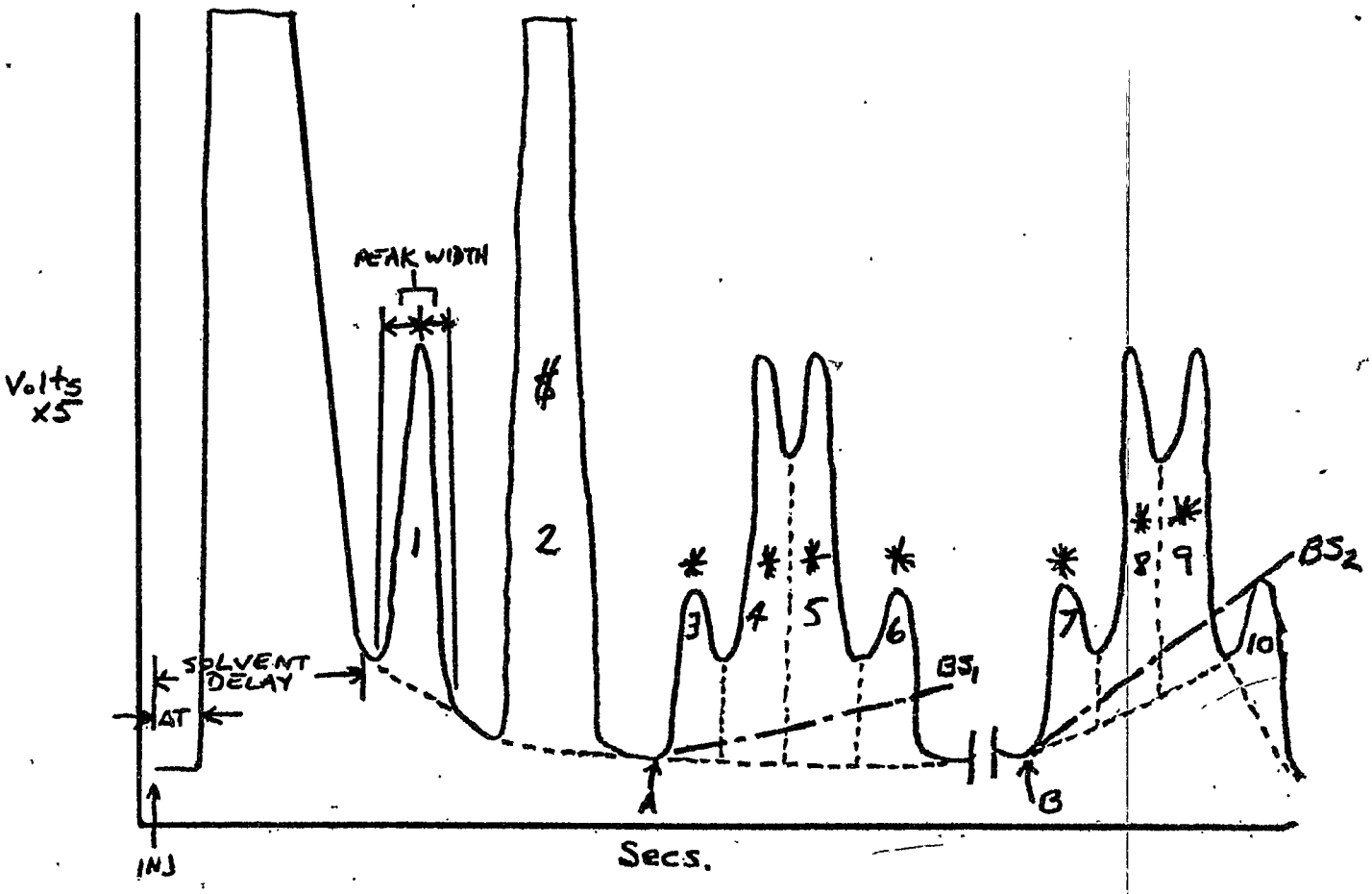

Figure 1. Example of integration of chromatogram. From left:

ΔT = Time from injection to solvent offscale. Used only for modes 2 and 3. Solvent Delay must be >26 seconds.

Peak Width tested twice for each peak.

A $ indicates an offscale peak; * indicates overlapped peaks

Blend Slope (BS) is in Volts x 5/secs. In envelope 3-6, the slope of the line from A to each valley is $>BS_1$ and the envelope is therefore integrated correctly. If Blend Slope (BS_2) had been used (envelope 7-10), the slope from B to the valley between peaks 9 and 10 is $<BS_2$, and the envelope is therefore integrated incorrectly as indicated.

i. During the checkout procedure, first run each sample in the mode just described and then rerun in either the diagnostic (D) or full-diagnostic (FD) mode. In these modes the voltage, derivative, and the peak sensing state, respectively, are printed out, in each of three columns, for each A/D sample (once per second). At the end of each peak, the peak time, area, and blend slope are typed. Mode D can be used by changing location 0275 from 7000 to 4756; for mode FD also change 1701 from 5675 to 7000. Replacing the original values will return you to the normal operating mode. Never run in FD mode for more than 1400-1800 seconds at one time. FD mode prints out values for the baseline, which D mode does not.

Sample checkout chromatograms and FD printouts are provided (Appendix II). Although the quality of the Xerox is poor and the comments may not be immediately self-explanatory, they will be useful for purposes of comparison with equivalent results that you obtain. Note particularly the size of the smoothed derivative values. The larger these are the more accurate the integration will be.

II. V.A. PKS.-2 (MARK II)

A. Introduction

This program accepts either the paper tape output generated by V.A. PKS.-1, or direct tty. input. Basically there are two sections to this program, with two options per section. In the first section, the options are "Peaks" or "RF". "Peaks" subroutine is used to edit the

V.A.PKS.-1 output as well as to set up a methylene unit time scale. "RF" subroutine is used to calculate and average GC detector response factors.

In the second section, the options are "Mode 0" or "Mode 1". In the "Mode 0" subroutine corrections for internal standard recovery as well as other desired factors are allowed. "Mode 1" is used when the response factors and recoveries of each component analyzed are known, and percent of total calculations are to be performed.

Peaks and Mode 0 subroutines are usually used together for general metabolic profile applications. The use of these subroutines is illustrated in outline form while the use of the RF and Mode 1 subroutines is illustrated by a copy of a letter sent to a system user.

B. Operating Instructions

1. Load V.A.PKS.-2 FPP need not be reloaded if V.A.PKS.-1 was previously in use. 200, Load Add., Start, initiates program. To all questions answer 0=No, 1=Yes. An "*↵ " restates a question (in Mode 0 or 1 subroutines only) and zeroes an erroneous reply. ↵ indicates "carriage return".

a. Subroutines "Peaks" and "Mode 0"

(An underlined work indicates users input; a "SP" indicates space bar):

Step (Computer printout in caps).

1. RF=0, or PEAKS=1 ? 1 "SP"
2. NEW DATA? 1 "SP" or 0 "SP"

This question is asked on any run after the first pass through the program. Answer 1 if new data to be loaded, 0 if data from last run to be reanalyzed.

3. READY

Load in data from paper tape simply by pushing tape "start" lever on tty. Data may also be entered directly using the tty keyboard. Only peak time (LOC) and area data will be accepted by this program (this is an automatic editing process; letters, *, $, and third columns of data will be ignored). If data is entered by keyboard enter only peak time "SP" area. Type "↵, line feed" after each entry, and 0↵ at the end of the data.

4. LIST? 1 "SP" or 0 "SP"

Lists data with peak number assigned.

5. DELETE (N)

Enter peak # "SP" to be deleted. This is useful if a peak area is grossly wrong and must be changed. Type 0↵ if none to be deleted. All other peak numbers are changed to take into account the deleted peak.

6. LIST? See step 4.

7. ADD AT NO (N,T,A)

Enter peak #"SP" time "SP" area ↵. This is used to correctly enter a previously deleted peak, or enter a peak that was missed for any reason. Enter 0↵ if no peaks are to be added or at end of additions. Peak numbers are automatically re-adjusted.

8. LIST? See step 4.

9. T SCALE (N,T,N,T)

This is useful to establish a methylene unit (for temperature programmed GC) time scale. Two peaks of known methylene unit values are used as reference points for the scale which is set up by linear interpolation and extrapolation. Enter peak # "SP" methylene unit of peak "SP" 2nd peak # "SP" methylene unit of 2 peak ↵. Enter 0 ↵ if no scale is needed.

10. MODE = 0, or 1

Enter 1.

11. CORR (N,A)

This step is used to normalize all peaks to 100% recovery of internal standard (IS): Normalized Peak Area = Peak Area X Area of IS for 100% Recovery / Actual Area of IS

First enter peak # (N) of IS peak, then "SP". A "?" will be printed which will allow the calculation of the area of the IS if there was 100% recovery. (See appendix III - A for an example of the actual calculation). Place an X between each number to be multiplied and a / between the numerator and the denominator. Do not use a "SP" except at the end of a calculation. An "= answer" with four digits each to the left and right of the decimal point will be printed out and normalized peak areas (AN) will be calculated and stored in memory for later use. Remember * ↵ reintiates the calculation.

12. SCALE (X,Y)

This allows the multiplication of the AN column separately by

factor X (to give the stored column AX) and by factor Y (AY). After the "?" perform the calculation of X, then of Y after the second "?", in the same way as in step 11. An example of AX = µg component per ml. physiological fluid, and AY = µg component per mg. creatinine, is given in Appendix III-B.

13. IND PK (N,Z)

In order to perform a specific correction on an individual peak, type peak # "SP" and perform the calculation after the "?". The factor calculated will be printed out and then multiplied by AN of the specified peak and stored. Push paper tape punch On button if permanent tape record desired. Type 0 ↵ if no corrections, or at end of corrections.

14. After 0 ↵ above, the result matrix will be printed. The heading is: N,T,CT,A,AN,AX,AY,AZ, where N = peak #, T = peak time (secs.), CT = corrected time (methylene units, step 9), A = area (volts X secs X 5), AN = normalized area (step 11), AX = AN X factor "X" (step 12), AY = AN X factor "Y" (step 12), AZ = AN X factor "Z" for each peak (if no factor Z; then AN printed; step 13).

b. Subroutines "RF" and "Mode 1".

This section is presented as an excerpt from a letter describing its use:

Enclosed is a copy of one of my serum bile acid runs and an explanation of the RF and MODE 0 sections of VAPKS-2.

I use an internal standard (peak 4) to correct for procedural losses and calculate response factors (RF) daily for all bile acids measured.

$$RF = \frac{\text{(Range x Attenuation*) (Sample volume-ml) (Peak area)}}{\text{(mg solute) (injection volume-µl)}}$$

The amount (mg) of solute in a biological sample is calculated similarly.

$$mg = \frac{\text{(Range x Attenuation*) (Sample volume-ml) (Peak area)}}{\text{(RF) (injection volume-µl)}}$$

The RF section of the program is entered by typing zero (0) on the tty. On the enclosed example A, peak #1, I entered the following: attenuation = 1, area = 3301, injection volume = 1.79 µl, mg solute/ml = 0.2425. This routine is exited by typing 0, RETURN. The mean is printed by tty. Its only value to me is as a general indication of GC sensitivity on any given day. The RF values are not stored in the computer and must be typed in by the operator in MODE 0.

I have included 2 examples of the RF section and only the B values were used in MODE 0. Due to severe spiking, the computer calculated areas (A) were not reliable and I calculated the peak areas with a planimeter (B). I included A to give you an example of how it normally works. The 436x4x1.71 in B is the planimeter area (sq.in.) times the appropriate factor to convert the area to computer area units (volts x secs. x 5).

To enter the data reduction section of the program, press CONT (on computer) and type 1. MODE 0 general information follows.

GIVE INJ DATA ? The number(s) following the ? can be of the form $AxBxCx\cdots/MxNxOx\cdots$ with no spaces between numbers or operations (x or /).** A space terminates the factor. In my example, I've entered range = 10, sample volume = 0.1 ml, value to convert data to µg = 1000, and injection volume = 1.79 µl.

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*When computer calculated areas are used, the attenuation is dropped, as it does not affect the computer area.

**I think + or - can also be used, but as I've never used them I'm not sure.

GIVE ALL RFS Enter the RF values calculated previously, following each values by a space or return.

PRINT*** If the peak number of any component is typed at this point, the tty will print the amount of the component and its RF value. I have to print the amount of internal standard (peak 4) present.

DELETE (N)*** I delete the internal standard peak at this point so it won't be present in the weight per cent calculations. If the specified peak is successfully deleted, the tty will type DONE. If not, the program is not able to locate the specified peak. Thus the operator has typed the wrong peak number, or the peaks are not numbered the way the operator thinks they are. To check the peak numbers, restart the program, type 0 after NEW DATA? and LIST.

GIVE MMF ? This factor is of the form $^{AxBxCx\cdots}/_{MxNxOx\cdots}$. I use it to correct to 100% recovery of the internal standard and to adjust the data to weight/ml of biological fluid.

The abbreviated headings for the matrix are:

N	peak number
T	retention time in sec.
CT	corrected retention time
A	area in whatever units you use
RF	response factor
MG	amount of component present in sample (mg or µg in my case)
MM	concentration of component (mg/ml or µg/ml in my case)
%T	% of total (weight %)

***Exit this routine by typing 0, space or 0, return.

RF=0, OR PEAKS=1? BA RF'S (7-10-73) (6-4-73)
0

A)

# 1	?1X3301/1.79X.2425	= 7604.6700
# 2	?1X3419/1.79X.2750	= 6945.6600
# 3	?1X3048/1.79X.2450	= 6950.1800
# 4	?1X3004/1.79X.2370	= 7081.0600
# 5	?1X2843/1.79X.2264	= 7015.3200
# 6	?0	

MEAN= 7119.380

RF=0 OR PEAKS=1? BA RF'S 7-10-73 (ALL FROM PLANIMETER)
0

B)

# 1	?436X4X1.71/1.79X.2425	= 6870.3300
# 2	?4X436X1.73/1.79X.2750	= 6129.2400
# 3	?4X436X1.49/1.79X.2450	= 5925.3500
# 4	?4X436X1.52/1.79X.2370	= 6248.6800
# 5	?4X436X1.46/1.79X.2264	= 6283.0400
# 6	?0	

MEAN= 6291.330

```
RF=0 OR PEAKS=1?
1

NEW DATA?1

READY

960 4

1490 4

1855 483

2082 484

2644 187

0

LIST?
1
        1       960        4.00
        2      1490        4.00
        3      1855      483.00
        4      2082      484.00
        5      2644      187.00


DELETE (N)
0

LIST?
0

ADD AT NO (N,T,A)
0

LIST?
0

T SCALE (N,T,N,T)
1  1060 5 2715

MODE=0 OR 1  0

GIVE INJ DATA  ?10X.1X1000/1.79  =  558.6590

GIVE ALL RFS

6870 6129 5925 6249 6283

PRINT : 4 MG=   43.269  RF=   6249.000
```

```
LIST?
1
        1       960         4.00
        2      1490         4.00
        3      1855       483.00
        4      2082       484.00
        5      2644       187.00


DELETE (N)
0

LIST?
0

ADD AT NO (N,T,A)
0

LIST?
0

T SCALE (N,T,N,T)
1 1060 5 2715

MODE=0, OR 1 0

GIVE INJ DATA   ?10X.1X1000/1.79   =   558.6590

GIVE ALL RFS

6870 6129 5925 6249 6283

PRINT : 4  MG=   43.269  RF=   6249.000
PRINT : 0

DELETE (N)
4 DONE

DELETE (N)
0
            amt. internal std. added
                  ↙          ↙ Vol. of serum used (in ml)
GIVE MMF   ?43.7/43.3X1   =   1.0092

N,T,CT,A,RF,MG,MM,%T

  1     960     1060.0000       4.0000     6870.0000      .3252       .3282     .0051
  2    1490     1580.8700       4.0000     6129.0000      .3646       .3679     .0058
  3    1855     1939.5800     483.0000     5925.0000    45.5413     45.9620     .7245
  4    2644     2715.0000     187.0000     6283.0000    16.6273     16.7809     .2645

FASTING SERUM #1.  F.M.   GC ON 7-10-73 STUDY 1
```

Appendix I:

SIMPLE INEXPENSIVE GAS CHROMATOGRAPH-COMPUTER NOISE FILTER

A simple inexpensive filter for the reduction of detector noise in gas chromatography (G.C.) has been applied to a coupled G.C.-computer system (1). A decrease in noise due to detector high frequency, high amplitude spiking, as well as that due to low amplitude baseline noise, was observed. No peak shape distortion or area change was observed for chromatographic peaks having a half-height width of >12 seconds (2). The G.C.-computer system consists of a Hewlett-Packard 7620 G.C. equipped with a flame ionization detector which is interfaced to a Digital Equipment Corp. PDP-8 computer by the circuit described here. In this installation the analog to digital converter (A/D) is not buffered or input protected thus necessitating the inclusion of these features in the device described. This circuit accepts an input voltage range of 0 to + 10v and delivers an output of 0 to -10v to the A/D converter. The time constant is variable from 0.1 sec to 5 sec making it able to pass peaks whose half width exceeds from 1 to 50 seconds respectively.

The device is constructed from three inexpensive operational amplifier integrated circuits (I.C.) (3). IC_1 forms a differential receiver which prevents losses due to the ground loop in the cabling to the G.C. IC_2 is a field effect transistor input operational amplifier and is needed to prevent adjustment of R_5 from affecting the circuit gain. The output at point A is that required if the A/D is suitably buffered and protected. If not, it is wise to buffer it with another IC having good short circuit protection, such as IC_3, clamp its output (D_1) and load it as close as possible to the A/D itself. Offset trim of the operational amplifiers

is not required since this is provided by trimming the G.C. output amplifier. The remaining errors are less than the 2mv resolution of the A/D converter.

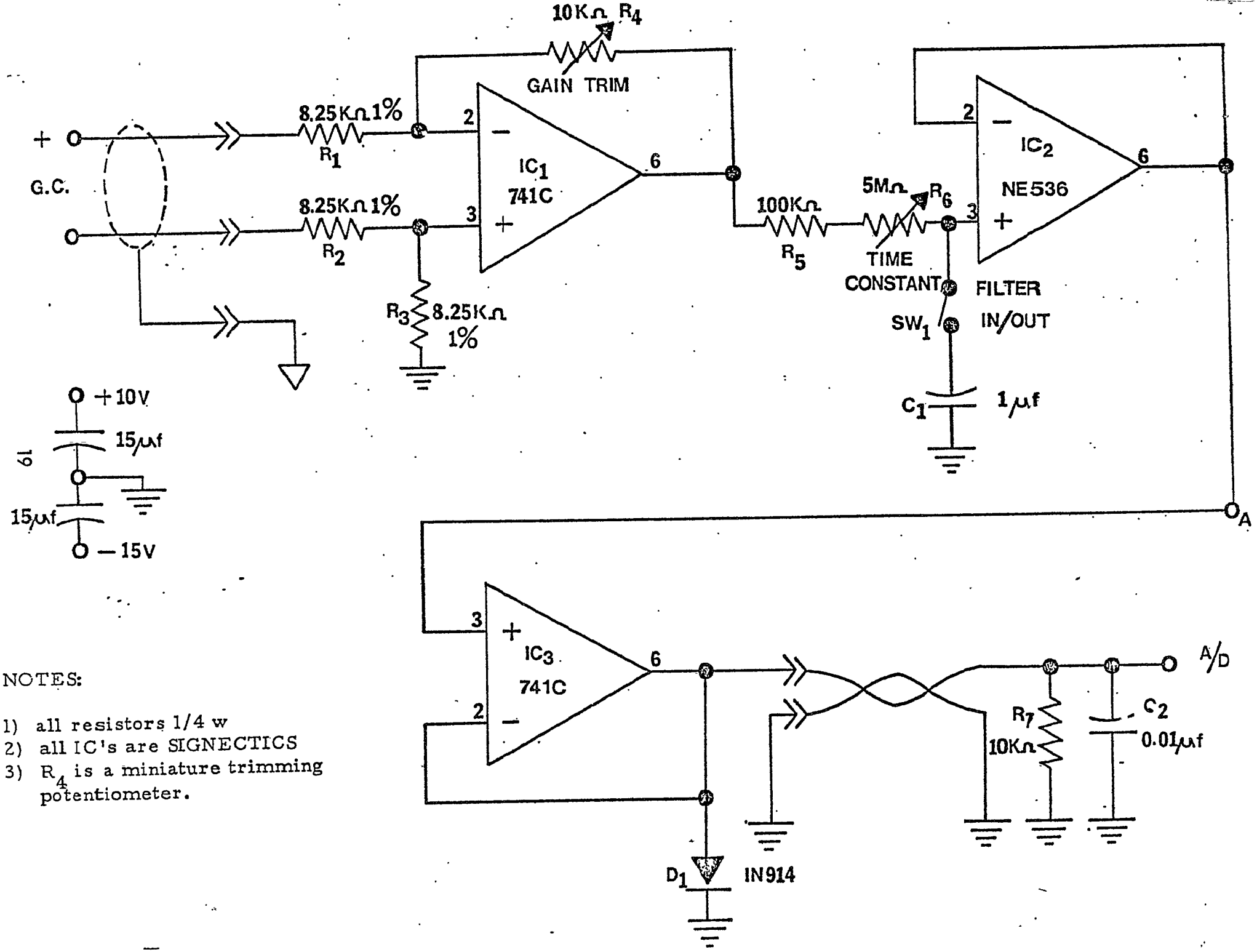
The power and signal connections to the computer are constructed of twisted pairs of wires terminating in the R_7 and C_2 load on a card in the computer. The remainder of the circuit is placed close to the computer, such that R_5 and SW_1 are within inches of IC_1 and IC_2. A shielded pair with the shield connected to equipment ground at one end only is then used for the long connection to the G.C.

The power supplies of the computer tend to be noisy but the rejection of the IC's is adequate so that all that is required is a 15μf capacitor from each power line to ground near the IC's.

Any ± 15v 50 ma power supply could be used and R_1 through R_4 can be selected to provide other gains.

S.P. Levine, J.G. Naylor and J.B. Pearce, gas chromatograph - mini computer system: design and application to biomedical problems. ANAL. CHEM., 45, 1560 (1973).

M. Dressler and M. Deml, Reduction of detector noise in gas chromatography by means of an R.C. filter, J. Chromatogr. 56, 23 (1971).



NOTES:

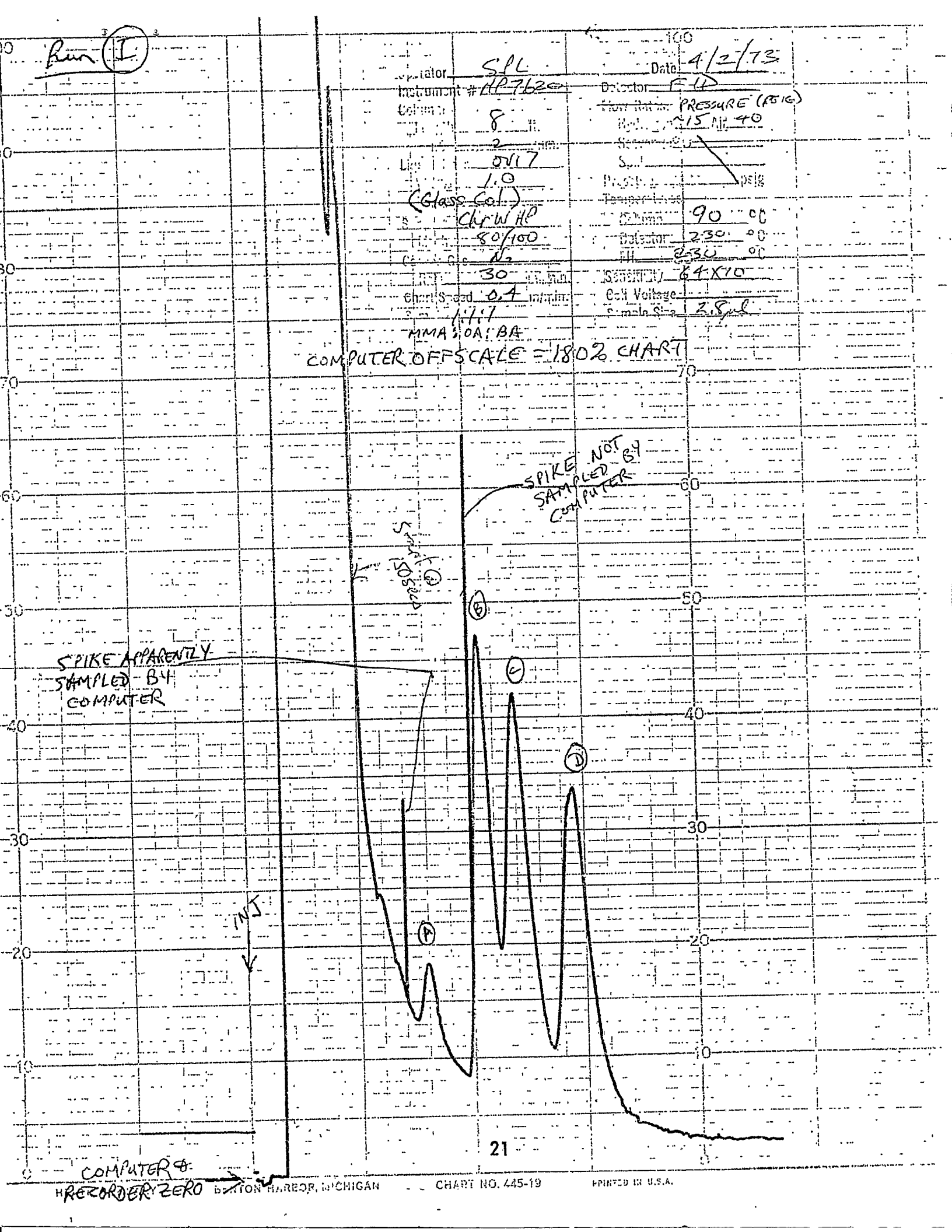
1) all resistors 1/4 w
2) all IC's are SIGNECTICS
3) R_4 is a miniature trimming potentiometer.

Appendix II

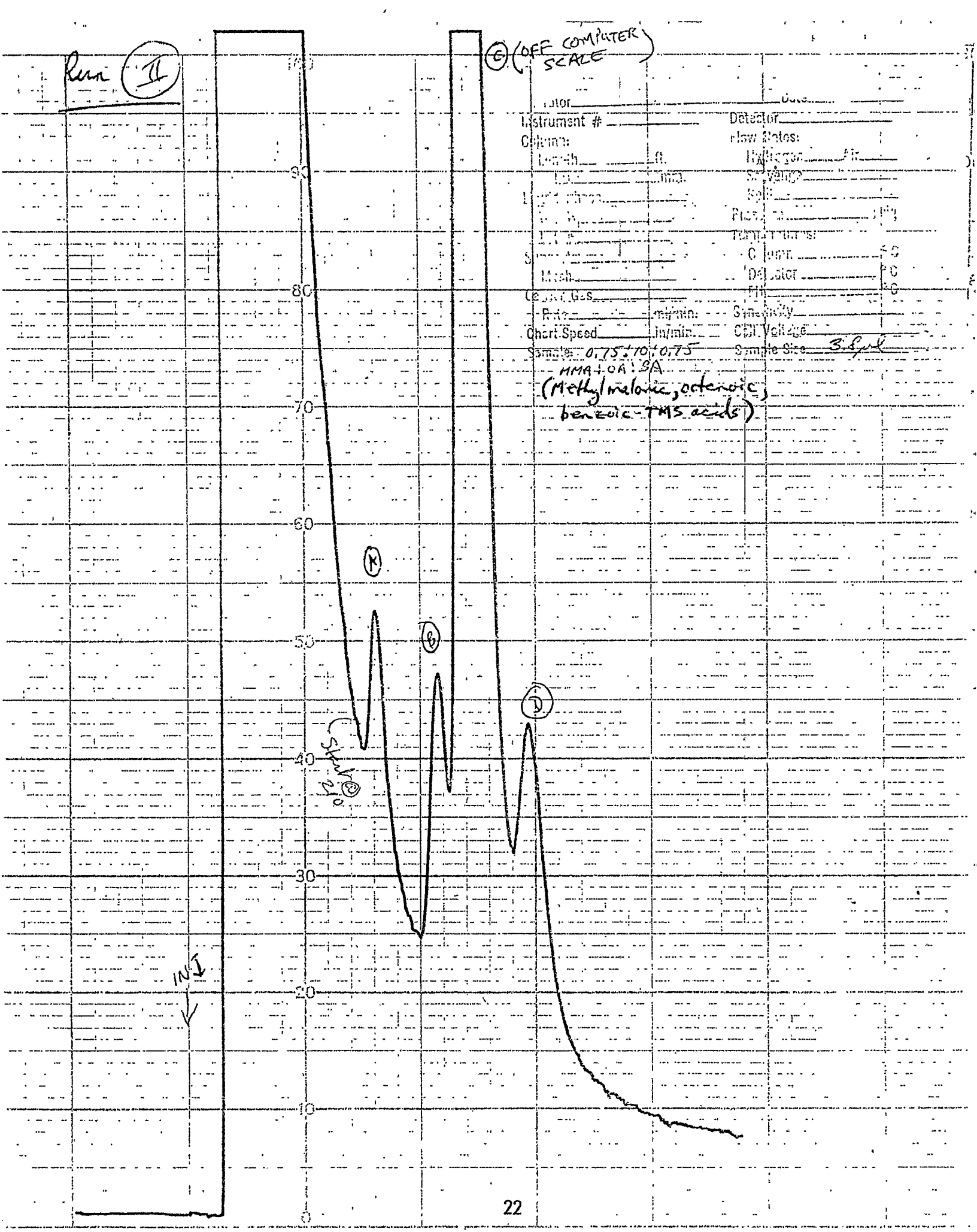
FULL-DIAGNOSTIC MODE PRINTOUT AND CHROMATOGRAMS

Change: First page, run I printout heading

from	to
AVG.	A/D Voltage Level x 5
ΔAVG./ΔT	Smoothed Derivative



BENTON HARBOR, MICHIGAN CHART NO. 445-19 PRINTED IN U.S.A.


Run II
(E) (OFF COMPUTER SCALE)
Instrument #
Detector
Column:
Length ft.
Flow Rates:
Hydrogen
Air
Nitrogen
Helium
Split
Pressure
Temperatures:
Column °C
Detector °C
Inlet °C
Carrier Gas
Ratio
Chart Speed in/min
Sensitivity
CDT Voltage
Sample: 0.75 : 10 : 0.75
Sample Size 3.5 µl
HMA + OA : SA
(Methylmalonic, octenoic, benzoic-TMS acids)
100
90
80
70
60
50
40
30
20
10
0
K
G
D
Shoulder
INJ

Run (I)

```
MODE?1
RUN LENGTH?1200
MIN DERIVATIVE?1
END DERIV?1
MIN WIDTH?3
BLEND SLOPE?.01
SOLVENT DELAY?150
```

N = 3 ∴ 2N+1 (length of avg) = 7 points
This was set at Loc. 0025 before the run.

MODE
3 = Baseline
2 = Upslope
1 = Top
4 = Downslope

LOC AVG	AREA ΔAVG/ΔT	MODE
1621-	205	3
1506-	206	3
1401-	202	3
1300-	193	3
1215-	181	3
1141-	165	3
1073-	148	3
1013-	131	3
959-	115	3
921-	100	3
889-	86	3
864-	74	3
840-	64	3
821-	56	3
802-	49	3
788-	43	3
773-	39	3
757-	36	3
743-	34	3
729-	33	3
717-	30	3
704-	28	3
691-	26	3
677-	23	3
669-	21	3
655-	19	3
653-	16	3
654-	15	3
640-	13	3
643-	12	3
639-	11	3
637-	11	3
633-	11	3
629-	12	3
625-	13	3
617-	15	3
610-	16	3
603-	13	3
592-	19	3
582-	19	3
575-	20	3

563-	20	3
55..-	21	3
543-	24	3
537-	20	3
525-	19	3
521-	15	3
515-	17	3
501-	16	3
493-	15	3
483-	15	3
473-	14	3
473-	14	3
470-	14	3
47.-	14	3
466-	14	3
463	31	3
454	25	2
447	18	2
441	12	2
433	6	2
424	1	2
419-	4	2
409-	9	1
1412-	14	4
392-	19	4
387-	24	4
384-	29	4
381-	34	4
377-	39	4
377-	43	4
369-	48	4
369-	52	4
360-	6	4
356-	5	4
356-	4	4
353-	2	4
353	0	4
240	8-	.063
352	2	3
353	5	2
356	8	2
360	11	2
365	14	2
372	16	2
378	18	2
389	20	2
402	21	2
419	21	2
429	20	2
445	19	2
458	17	2
461	14	2
468	11	2
477	7	2
481	2	2
481-	2	2

AREA

BASELINE SLOPE (PK, START TO END)

PEAK ~~START~~ TOP TIME

479-	0	1
473-	10	4
464-	14	4
456-	17	4
447-	19	4
435-	21	4
423-	23	4
411-	24	4
400-	24	4
383-	24	4
373-	23	4
367-	23	4
356-	22	4
349-	21	4
338-	20	4
331-	19	4
322-	18	4
317-	17	4
306-	16	4
301-	15	4
292-	14	4
283-	13	4
275-	12	4
261-	11	4
275-	10	4
272-	9	4
266-	9	4
263-	8	4
260-	8	4
259-	7	4
250-	7	4
255-	6	4
253-	6	4
249-	6	4
240-	6	4
245-	0	4
242-	6	4
241-	6	4
239-	5	4
235-	5	4
234-	5	4
232-	5	4
229-	4	4
228-	4	4
226-	2	4
223	0	4
233	40-	.0024
223	2	3
221	6	2
221	11	2
221	17	2
223	25	2
230	36	2
242	47	2
258	60	2
281	73	2
309	87	2
349	141	2

402	114	2
464	125	2
555	135	2
601	142	2
684	146	2
761	147	2
839	144	2
921	137	2
991	126	2
1056	113	2
1113	97	2
1160	80	2
1194	61	2
1216	41	2
1231	21	2
1224	2	2
1202-	15	2
1197-	30	1
1177-	44	4
1140-	56	4
1098-	66	4
1058-	74	4
1023-	79	4
985-	83	4
953-	86	4
915-	87	4
876-	87	4
829-	86	4
771-	83	4
745-	80	4
711-	77	4
671-	72	4
637-	66	4
611-	59	4
576-	51	4
558-	43	4
544-	33	4
527-	24	4
517-	14	4
511-	3	4
511	9	4
516	20	3
527	31	2
541	42	2
565	52	2
594	62	2
623	70	2
669	77	2
713	81	2
756	84	2
802	85	2
848	84	2
895	81	2
938	76	2
975	70	2
999	62	2

1032	52	2	
1050	41	2	
1069	34	2	
1085	19	2	
1094	9	2	
1099-	2	2	
1093-	12	1	
1073-	21	4	
1057-	29	4	
1027-	36	4	
1017-	43	4	
993-	49	4	
973-	54	4	
947-	58	4	
911-	60	4	
889-	62	4	
863-	63	4	
835-	64	4	
793-	64	4	
762-	64	4	
737-	63	4	
711-	61	4	
689-	60	4	
650-	58	4	
627-	56	4	
608-	53	4	
587-	51	4	
565-	49	4	
544-	47	4	
525-	46	4	
505-	44	4	
487-	42	4	
469-	40	4	
451-	39	4	
435-	37	4	
418-	35	4	
404-	34	4	
388-	32	4	
373-	30	4	
358-	28	4	
351-	26	4	
341-	24	4	
329-	22	4	
320-	20	4	
313-	18	4	
305-	16	4	
297-	14	4	
291-	11	4	
287-	8	4	
282-	5	4	
281	0	4	
347	308	.0685*	
352	327	.0065*	
278	2	3	
278	6	2	
281	11	2	
287	16	2	

PK. START TO END.

TO INTEGRATE PK. (B)-(D) AS ONE ENVELOPE, BLEND SLOPE SHOULD HAVE BEEN < 0006. IT WAS .01

PK. (B) START TO PK. (C) END.

295	21	2
305	26	2
317	32	2
333	39	2
350	45	2
369	50	2
391	56	2
418	60	2
448	64	2
486	68	2
525	71	2
561	72	2
597	73	2
633	72	2
663	70	2
689	67	2
729	62	2
762	57	2
793	51	2
819	46	2
837	39	2
845	33	2
861	26	2
866	18	2
864	11	2
874	3	2
881-	4	2
879-	10	1
873-	16	4
863-	22	4
848-	27	4
832-	33	4
810-	37	4
797-	42	4
775-	45	4
752-	48	4
729-	50	4
705-	51	4
677-	52	4
652-	52	4
633-	52	4
605-	52	4
580-	51	4
557-	49	4
541-	48	4
519-	46	4
500-	45	4
484-	43	4
466-	42	4
445-	40	4
426-	39	4
409-	38	4
394-	37	4
381-	35	4
363-	34	4
349-	32	4

335-	31	4
320-	29	4
305-	28	4
293-	26	4
285-	25	4
276-	23	4
268-	22	4
259-	20	4
253-	19	4
244-	18	4
235-	17	4
227-	16	4
223-	16	4
217-	15	4
209-	14	4
204-	13	4
198-	13	4
192-	12	4
189-	12	4
185-	11	4
178-	11	4
177-	10	4
170-	10	4
167-	9	4
162-	9	4
160-	9	4
157-	9	4
153-	9	4
148-	8	4
146-	7	4
144-	7	4
140-	6	4
138-	6	4
131-	5	4
128-	5	4
128-	4	4
131-	4	4
131-	4	4
128-	3	4
127-	3	4
125-	2	4
125-	2	4
125-	3	4
122-	3	4
121-	4	4
122-	4	4
121-	4	4
121-	4	4
121-	4	4
117-	4	4
111-	3	4
106-	3	4
106-	3	4
107-	3	4
107-	3	4

107-	2	4
109-	2	4
109-	2	4
107	0	4
495	274-	.017
106	6	3
105-	2	3
104-	2	3
104-	2	3

END DERIV. < -1
∴ PEAK END

MODE?4
RUN LENGTH?1200
MIN DERIVATIVE?1
PNL DERIV?1
MIN.WIDTH?3
BLEND SLOPE?.004
SOLVENT DELAY?210

Run II

LOC	AREA	
1323-	40	3
1312-	39	3
1274-	38	3
1245-	37	3
1242-	36	3
1221-	36	3
1213-	35	3
1197-	33	3
1178-	31	3
1171-	28	3
1163-	26	3
1153-	24	3
1133-	23	3
1122-	22	3
1117-	21	3
1113-	20	3
1107-	19	3
1099-	18	3
1088-	17	3
1087-	16	3
1074-	14	3
1065-	12	3
1050-	9	3
1049-	5	3
1050	0	3
1049	5	3
1045	12	2
1049	19	2
1056	26	2
1065	34	2
1085	41	2
1109	46	2
1135	50	2
1168	52	2
1205	52	2
1233	50	2
1270	45	2
1305	38	2
1331	29	2
1347	19	2
1353	8	2
1346-	4	2
1333-	15	1
1320-	27	4
1300-	38	4
1279-	48	4

1252-	56	4
1223-	61	4
1192-	65	4
1162-	67	4
1124-	68	4
1085-	68	4
1044-	67	4
1005-	65	4
976-	62	4
967-	59	4
946-	55	4
914-	51	4
895-	47	4
881-	43	4
864-	39	4
847-	36	4
825-	34	4
813-	32	4
807-	29	4
799-	27	4
778-	25	4
767-	23	4
765-	22	4
757-	21	4
747-	20	4
742-	20	4
729-	19	4
724-	18	4
720-	17	4
712-	16	4
691-	17	4
689-	16	4
683-	16	4
677-	15	4
672-	14	4
674-	13	4
669-	12	4
665-	11	4
640-	10	4
640-	10	4
640-	9	4
639-	8	4
638-	7	4
637-	6	4
633-	3	4
633	0	4
(A) 239	78-	.076
630	3	3
625	6	2
623	11	2
628	16	2
634	22	2
643	29	2
653	37	2

671	45	2
689	53	2
716	61	2
749	68	2
784	74	2
825	79	2
868	82	2
911	85	2
960	84	2
1001	82	2
1042	78	2
1085	71	2
1117	63	2
1149	54	2
1184	43	2
1201	32	2
1209	20	2
1213	8	2
1213-	3	2
1203-	14	1
1189-	23	4
1177-	32	4
1154-	39	4
1134-	43	4
1101-	45	4
1073-	45	4
1049-	43	4
1023-	38	4
997-	28	4
978-	15	4
962	5	4
953	29	3
948	61	2
957	100	2
977	146	2
1018	201	2
1093	263	2
1197	331	2
1331	406	2
1501	286	2
1733	171	2
1989	62	2
2308-	42	2
2681-	140	1
3063-	230	4
3504-	311	4
3980-	381	4
4095-	437	4
4095-	500	4
4095-	566	4
4095-	632	4
4095-	694	4
4095-	747	4
4095-	789	4
4095-	814	4
4095-	819	4
4095-	819	4

NOTE THAT AVG. & DVTNS. VALUES ARE OFFSET (BY ? AMT)

4095-	819	4
4095-	819	4
4095-	819	4
4095-	819	4
4095-	819	4
4095-	819	4
4095-	819	4
4095-	819	4
4095-	819	4
4095-	819	4
4095-	647	4
4095-	507	4
4095-	397	4
4095-	317	4
4095-	263	4
4095-	232	4
4095-	224	4
4095-	238	4
3890-	272	4
3637-	303	4
3417-	329	4
3103-	349	4
2981-	362	4
2818-	300	4
2666-	362	4
2511-	349	4
2371-	324	4
2229-	299	4
2093-	275	4
1984-	253	4
1889-	235	4
1797-	219	4
1700-	203	4
1621-	188	4
1552-	174	4
1485-	160	4
1421-	148	4
1362-	138	4
1305-	128	4
1241-	118	4
1194-	109	4
1145-	101	4
1101-	93	4
1069-	86	4
1039-	79	4
1009-	72	4
981-	65	4
957-	58	4
930-	52	4
909-	46	4
889-	41	4
868-	36	4
857-	31	4
840-	26	4
832-	20	4
829-	14	4

825-	7	4
825	6	4
810	5	3
817	11	2
827	16	2
839	21	2
852	25	2
868	29	2
885	33	2
903	36	2
921	38	2
945	39	2
965	39	2
985	38	2
992	37	2
1014	35	2
1037	32	2
1053	28	2
1071	24	2
1081	18	2
1087	13	2
1094	8	2
1099	3	2
1098-	3	2
1092-	9	1
1085-	14	4
1070-	18	4
1055-	23	4
1050-	27	4
1037-	31	4
1021-	34	4
1009-	38	4
995-	41	4
976-	43	4
957-	45	4
938-	46	4
911-	48	4
886-	48	4
861-	48	4
832-	48	4
804-	48	4
788-	47	4
773-	46	4
757-	44	4
740-	43	4
723-	41	4
704-	40	4
685-	39	4
669-	38	4
653-	37	4
634-	37	4
620-	35	4
605-	35	4
591-	33	4
573-	32	4
559-	31	4

546-	30	4
537-	29	4
524-	27	4
516-	26	4
499-	25	4
490-	24	4
484-	23	4
469-	22	4
463-	21	4
451-	20	4
445-	19	4
433-	18	4
429-	16	4
423-	15	4
419-	14	4
411-	13	4
404-	12	4
400-	11	4
399-	11	4
392-	10	4
388-	10	4
386-	10	4
383-	9	4
377-	9	4
377-	9	4
371-	9	4
367-	9	4
364-	9	4
360-	9	4
357-	9	4
355-	9	4
349-	9	4
346-	9	4
340-	8	4
333-	8	4
332-	7	4
330-	7	4
324-	6	4
322-	6	4
323-	5	4
320-	5	4
320-	5	4
320-	4	4
319-	4	4
319-	4	4
317-	4	4
313-	4	4
313-	4	4
305-	4	4
305-	5	4
303-	5	4
305-	4	4
302-	4	4
303-	4	4
299-	4	4
294-	4	4
295-	4	4

	296-	5	4
	293-	5	4
	293-	5	4
	290-	5	4
	288-	5	4
	287-	5	4
	282-	5	4
	275-	5	4
	274-	5	4
	277-	4	4
	276-	4	4
	272-	3	4
	264-	3	4
	271-	2	4
	271-	2	4
	271-	2	4
	272-	2	4
	269-	2	4
	271-	2	4
	271-	3	4
	269-	3	4
	266-	3	4
	263-	3	4
	259-	4	4
	260-	4	4
	261-	4	4
	259-	4	4
	255-	4	4
	256-	3	4
	257-	3	4
	253-	3	4
	249-	3	4
	244-	3	4
	245-	3	4
	249-	2	4
	249-	2	4
	253-	2	4
	245-	2	4
	249	0	4
(B)	315	159	.109*
(C)	339	240(C)	.019*
(D)	433	324(D)	.117*
	243	0	3
	245-	1	3

END DERIV. AT -1 DRAGS PK. TAIL OUT, END DERIV SHOULD HAVE BEEN -2 OR -3.

* INDICATES PK. ENVELOPE

SLOPE PK (B) START TO PK (C) END

SLOPE PK. (B) START TO PK (D) END

, INDICATES OFFSCALE

(-) PRINTED HERE FOR COLUMN TO LIGHT

Appendix III - V.A.PKS.-2 Calculations

Examples of calculations are presented

A. - Peak area normalization (AN)

The terms that are entered on the keyboard after the "?" are:

Peak area average of external standard (ES) x GC Range (ES) x Concentration of internal standard (IS) in sample if recovery was 100% x Injected volume of sample (S)/Injected volume (ES) x Range (S) x Concentration (ES).

Then type "SP" for the area of the internal standard peak at 100% recovery (AN). This correction will be applied automatically to all other peaks.

B. - Peak area scaling (AX,AY)

1. The "X" calculated is the scaling factor applied to AN of each peak to get the answer in, for example, micrograms component per milliliter of physiological fluid:

   1000 X concentration of internal standard in sample if recovery was 100% X volume of final sample in ml./answer from A above X volume of physiological fluid in ml. (Type "SP" for answer).

2. The "Y" calculated is the scaling factor applied to AN of each peak to get the answer in, for example, µg conponent per mg creatinine:

   Answer from B.1. above X volume physiological fluid in ml./mg. creatinine in sample (Type "SP" for answer).

3. Although only the "X" and "Y" scaling factors are printed for each of the above calculation, they are automatically applied to the AN value for each peak.
   Remember that an erroneous calculation can be reinitiated by typing * ↵ .

THE B. F. STOLINSKY RESEARCH LABORATORIES
DEPARTMENT OF PEDIATRICS
UNIVERSITY OF COLORADO MEDICAL CENTER
4200 EAST NINTH AVENUE
DENVER, COLORADO 80220

February 20, 1974

Digital Equipment Corp.
DECUS Librarian
Maynard, Massachusetts

Re: DECUS 08-617 Addendum

Dear Sir:

Enclosed is a copy of an addendum to DECUS #8-617. This version of VAPKS-1, to be called BFS-1, is for a PDP-8E with 4k. core, a DK8EA clock, a 10 bit AD8EA converter with a floating input bucked with a 5 volt precision signal, and a teletypewriter.

All operating instructions are identical to those for VAPKS-1.

Sincerely yours,

Steven P. Levine

Steven P. Levine, Ph.D.
V.A. Hospital/150A
1055 Clermont Street
Denver, Colorado 80220

SPL/dp
Encl: Listing

```
/MARK I 12/23/73 BFS                    PAL8  1/19/74   PAGE 1

                /MARK I 12/23/73 BFS
                XLIST
                CLEI=6131
                CLSK=6133
                ADCL=6530
                ADST=6532
                ADRB=6533
                ADSK=6534
                BEND=5377
                /PAGE ZERO J B PEARCE 8/7/72
                      *1
0001  5402              JMP I .+1          /INTERRUPT TRANSFER LOCATION
0002  1444              SERV               /SERVICE ROUTINE
0003  0000  TP1,       0                  /TEMPORARY LOCATIONS
0004  0000  PPB,       0
0005  1745  AD8EP,     AD8EA              /JFK A/D CONVERTER ROUTINE
                ADCV=JMS I AD8EP
                      *6
0006  7200  FPO,       7200
0007  5600  FPPI,      5600               /INTERPRETER
                FPT=JMS I FPPI
0010  4000  AX0,       4000               /AUTO INDEX REGISTERS
0011  0000  AX1,       0
0012  0000  AX2,       0
0013  0000  AX3,       0
0014  0000  AX4,       0                  /NOT USED
0015  0000  AX5,       0                  /USED BY FLOATING POINT PACKAGE
0016  2177  AX6,       LAST-1             /PUSH DOWN LIST OF BLENDS
0017  0000  AX7,       0
0020  0000  SOLVE,     0
0021  0000  SECS,      0
0022  0000              0
0023  7762  MCNT,      STRTV-BLEND-1
0024  0062  VECTA,     STRTV-1
0025  0003  ID,        3
0026  0003  LPV,       3
0027  0000  DDOT,      0
```

```
0030  0000  DIV,     ZBLOCK 3
0033  0000  SAC,     0
0034  0000  SLK,     0
0035  1504  GET,     GETVAL
0036  0000  TOLDB,   0
0037  0000  TOLW,    0
                     *40
0040  0000           ZBLOCK 4
0044  0000  FAE,     0
0045  0000  FAH,     0
0046  0000  FAL,     0
                     *63
0063  0000  STRTV,   0              /KEEP THESE TOGETHER
0064  0000  STRTL,   0
0065  0000  PEAKV,   0
0066  0000  PEAKL,   0
0067  0000           0
0070  0000  TAILV,   0
0071  0000  TAILL,   0
0072  0000  PKAR,    ZBLOCK 3
0075  0000  PSLP,    ZBLOCK 3
0100  0000  BLEND,   0              /KEEP THESE TOGETHER !
0101  0000  X,       0
            P3,
0102  0003  PV,      3
            P4,
0103  0004  PL,      4
            P5,
0104  0005  PLPO,    5
0105  0006  TV,      6
0106  0010  PAREA,   10
0107  0013  PSLPP,   13
0110  2321  BBEG,    DPE
0111  2177  PDS,     LAST-1
0112  0000  TOL2,    ZBLOCK 3
0115  0000  AREA,    ZBLOCK 3
0120  0000  CLKCON,  ZBLOCK 3
0123  0000  DVIN,    ZBLOCK 3
0126  7716  M50C,    -62
0127  7716  M50,     -62
0130  0000  FT1,     ZBLOCK 3
0133  0000  FT2,     ZBLOCK 3
0136  0000  FT3,     ZBLOCK 3
0141  0000  FT4,     ZBLOCK 3
0144  0000  FT5,     ZBLOCK 3
            TL,
0147  0007  SKON,    7              /81.92 SCALING CONSTANT
0150  2436           2436
0151  5606           5606
0152  0000  K,       0
            P2,
            SL,
0153  0002  TWO,     2
0154  2000           2000
0155  0000           0
```

```
                SV,
0156    0001    ONE,    1
0157    2000            2000
0160    0000            Ø
0161    2322    BBP,    DPE+1
0162    0000    PKNT,   Ø
0163    0000    TP2,    Ø
0164    0000    TP3,    Ø
0165    0000    TP4,    Ø
0166    0000    TOL3,   Ø
0167    1723    TYPE,   TTF
0170    0000    CLKK,   ZBLOCK 3
0173    2143    DOWNP,  DOWN
0174    0016    BLP,    16
0175    1444    SERVP,  SERV
                        PAGE
```

```
                /MARK I-2 BFS
0200  4777' GASCHR, JMS GETCON      /OBTAIN RUN PARAMETERS
0201  1110         TAD BBEG
0202  3010         DCA AX0
0203  1025         TAD ID           /CHECK ID FOR CORE
0204  1376         TAD (-14
0205  7750         SPA SNA CLA
0206  5211         JMP BYY
0207  1375         TAD (14
0210  3025         DCA ID
0211  1025 BYY,    TAD ID           /CALCULATE NORMALIZATION FACTOR
0212  7040         CMA
0213  3165         DCA TP4
0214  3003         DCA TP1
0215  2003         ISZ TP1
0216  1003         TAD TP1
0217  2165         ISZ TP4
0220  5215         JMP .-3
0221  7104         CLL RAL
0222  7104         CLL RAL
0223  4774'        JMS FLOAT
0224  4407         FPT
0225  6773'        FPUT KSCAL
0226  0000         FEXT
0227  1372         TAD (-5          /5 IS
0230  3165         DCA TP4          /MAXIMUM BLEND NUMBER
0231  1111         TAD PDS
0232  3016         DCA AX6          /DATA POINTER
0233  1371         TAD (-31         /-25(10)
0234  3003         DCA TP1
0235  4435 SUP,    JMS I GET        /CONVERT AND STORE
0236  2003         ISZ TP1
0237  5235         JMP .-2
0240  4770'        JMS TXT          /PUT HEADING ON OUTPUT
0241  0530         HEAD
0242  4767'        JMS CRLF
0243  4767'        JMS CRLF
0244  3115         DCA AREA         /INITIALIZE AREA
0245  3116         DCA AREA+1
0246  3117         DCA AREA+2
0247  1102         TAD P3
0250  3026         DCA LPV          /INITIALIZE DISPATCH VECTOR
0251  7001         IAC
0252  3152         DCA K            /INITIALIZE PEAK NUMBER
0253  4435 MAINL,  JMS I GET        /MAIN LOOP
0254  1766'        TAD DPM+1        /MIDDLE VALUE
0255  1103         TAD P4           /FOR 10 BIT CONVERTERS ONLY
0256  7440         SZA              /DID CONVERTER TOP OUT?
0257  5270         JMP MLOK         /NOPE: S'OK
0260  7346         LWM3             /ARE WE INTEGRATING?
0261  1026         TAD LPV
0262  7650         SNA CLA
0263  5267         JMP MLOK-1       /NOPE: JIST MOSYING ALONG
0264  7040         CMA              /YES: CHANGE IT TO FULL SCALE
0265  3766'        DCA DPM+1
```

```
0266  2100          ISZ BLEND       /MARK IT SATURATED
0267  1766'         TAD DPM+1
0270  4765' MLOK,   JMS FLOAU
0271  4407          FPT
0272  1115          FADD AREA
0273  6115          FPUT AREA
0274  0000          FEXT
0275  4764' BY,     JMS DSUB        /CALCULATE DERIVATIVE
0276  7000          NOP             /REPLACE WITH 'JMS I DIAGP' FOR TEST
0277  4573          JMS I DOWNP     /CHECK IF RESOLUTION NEEDED
0300  4763'         JMS SEARCH
0301  5306          JMP MLEND       /NOTHING EXCITING HAPPENED
0302  1100          TAD BLEND
0303  7710          SPA CLA         /BLEND?
0304  5312          JMP PUSD        /YEP
0305  4762' PNY,    JMS DECONV      /NOPE: HOW ABOUT BEFORE?
0306  2101  MLEND,  ISZ X           /UPDATE LOCATION COUNTER
0307  5253          JMP MAINL       /BACK WE GO
0310  4761'         JMS OOPS        /A LOOOONG ONE
0311  5253          JMP MAINL
0312  2165  PUSD,   ISZ TP4
0313  5317          JMP .+4         /PUSH ONTO LIST
0314  7240          CLA CMA         /FIX UP COUNTER
0315  3165          DCA TP4
0316  5305          JMP PNY         /FORCED FINISH
0317  1023          TAD MCNT        /DIMENSION OF VECTOR
0320  3163          DCA TP2
0321  1024          TAD VECTA       /ADDRESS OF PRESENT PEAK VECTOR
0322  3017          DCA AX7
0323  1417  PUSHL,  TAD I AX7       /PUSH
0324  3416          DCA I AX6       / DOWN
0325  2163          ISZ TP2         /  EVERYBODY
0326  5323          JMP PUSHL
0327  5306          JMP MLEND
0330  0000  UPCLO,   0
0331  2021          ISZ SECS        /UPDATE THE CLOCK ROUTINE
0332  7410          SKP
0333  2022          ISZ SECS+1
0334  7410          SKP
0335  4761'         JMS OOPS
0336  4407          FPT
0337  5120          FGET CLKCON
0340  2156          FSUB ONE
0341  6120          FPUT CLKCON
0342  0000          FEXT
0343  1045          TAD FAH
0344  7700          SMA CLA
0345  5730          JMP I UPCLO
0346  4762'         JMS DECONV      /CLEAN UP LOOSE ENDS
0347  1353          TAD RMODE       /AUTO RESTART?
0350  7650          SNA CLA
0351  5200          JMP GASCHR      /GO ASK THE QUESTIONS
0352  5760'         JMP RESTR       /YES: REINITIALIZE
0353  0000  RMODE,   0               /AUTO-RESTART MODE SWITCH
0354  0000  SOLVT,   ZBLOCK 3
```

```
0357  1675  DIAGP,  DIAG
0360  2131
0361  0401
0362  1233
0363  0600
0364  0431
0365  0506
0366  2305
0367  1732
0370  1137
0371  7747
0372  7773
0373  0502
0374  0517
0375  0014
0376  7764
0377  1000
                    PAGE
0400  0000  TS,     0
0401  0000  OOPS,   0
0402  7200          CLA
0403  4777'         JMS CRLF
0404  1376          TAD (-4
0405  3200          DCA TS
0406  1375          TAD ("E
0407  4567          JMS I TYPE
0410  7040          CMA
0411  1201          TAD OOPS
0412  7104          CLL RAL
0413  7006  L,      RTL
0414  7004          RAL
0415  3164          DCA TP3
0416  1164          TAD TP3
0417  0374          AND (7
0420  1373          TAD (260
0421  4567          JMS I TYPE
0422  7200          CLA
0423  1164          TAD TP3
0424  2200          ISZ TS
0425  5213          JMP L
0426  7200          CLA
0427  4777'         JMS CRLF
0430  5601          JMP I OOPS
0431  0000  DSUB,    0
0432  7200          CLA
0433  3130          DCA FT1
0434  3131          DCA FT1+1
0435  3132          DCA FT1+2
0436  1025          TAD ID
0437  7041          CIA
0440  3200          DCA TS
0441  1200          TAD TS
0442  1372          TAD (DPM
0443  3013          DCA AX3
0444  1025          TAD ID
```

```
0445  7001          IAC
0446  7104          CLL RAL
0447  7041          CIA
0450  7001          IAC
0451  3305          DCA MB12
0452  1413  INLP2,  TAD I AX3
0453  4306          JMS FLOAU
0454  4407          FPT
0455  6133          FPUT FT2
0456  0000          FEXT
0457  1200          TAD TS
0460  2200          ISZ TS
0461  7000          NOP
0462  7450          SNA
0463  5272          JMP ZBY
0464  4317          JMS FLOAT
0465  4407          FPT
0466  3133          FMUL FT2
0467  1130          FADD FT1
0470  6130          FPUT FT1
0471  0000          FEXT
0472  2305  ZBY,     ISZ MB12
0473  5252          JMP INLP2
0474  4407          FPT
0475  4302          FDIV KSCAL
0476  0000          FEXT
0477  4771          JMS FIX
0500  3027          DCA DDOT
0501  5631          JMP I DSUB
0502  0000  KSCAL,  ZBLOCK 3        /DERIVATIVE SCALE FACTOR (I D DEPENDE
0505  0000  MB12,   0
0506  0000  FLOAU,  0
0507  7110          CLL RAR         /UNSIGNED NUMBERS
0510  3045          DCA FAH
0511  1306          TAD FLOAU
0512  3317          DCA FLOAT
0513  7010          RAR
0514  3046          DCA FAL
0515  7001          IAC
0516  5322          JMP FLOAT+3
0517  0000  FLOAT,  0
0520  3045          DCA FAH
0521  3046          DCA FAL
0522  1370          TAD (13
0523  3044          DCA FAE
0524  4407          FPT
0525  7000          FNOR
0526  0000          FEXT
0527  5717          JMP I FLOAT
0530  4040  HEAD,    TEXT /     LOC     AREA/
0531  4040
0532  4014
0533  1703
0534  4040
0535  4040
```

```
0536  0122
0537  0501
0540  0000
0541  2225  RUNL,   TEXT /RUN LENGTH?/
0542  1640
0543  1405
0544  1607
0545  2410
0546  7700
0547  1511  TTOLDB, TEXT /MIN DERIVATIVE?/
0550  1640
0551  0405
0552  2211
0553  2601
0554  2411
0555  2605
0556  7700
0557  0214  TSLOPE, TEXT /BLEND SLOPE?/
0560  0516
0561  0440
0562  2314
0563  1720
0564  0577
0565  0000
0570  0013
0571  1200
0572  2304
0573  0260
0574  0007
0575  0305
0576  7774
0577  1732
```

```
                /MARK I-3 BFS
0600  0000  SEARCH, 0
0601  7200        CLA
0602  1026        TAD LPV
0603  1777'       TAD DISTA
0604  3210        DCA T           /CALCULATE DISPATCH ADDRESS
0605  1610        TAD I T
0606  3210        DCA T
0607  5610        JMP I T         /DISPATCH
0610  0000  T,     0               /TEMPORARY
0611  1036  NEG,    TAD TOLDB       /SLOPE MORE NEGATIVE
0612  1027        TAD DDOT        / THAN TOLERANCE?
0613  7700        SMA CLA
0614  5600        JMP I SEARCH    /NO
0615  1103        TAD P4
0616  3026        DCA LPV         /YES
0617  5600        JMP I SEARCH
0620  1027  PEAK,   TAD DDOT       /DERIVATIVE NEGATIVE?
0621  7700        SMA CLA
0622  5600        JMP I SEARCH    /NO
0623  1064        TAD STRTL       /WAS START FAR
0624  1037        TAD TOLW        / ENOUGH BACK?
0625  7041        CIA
0626  1101        TAD X
0627  7700        SMA CLA
0630  5234        JMP STRPK       /YES: STORE PEAK
0631  1102  XIT2,   TAD P3          /NO
0632  3026        DCA LPV         /LOOK FOR POSITIVE SLOPE NEXT
0633  5600        JMP I SEARCH
0634  1776' STRPK,  TAD DPM+1       /FOUND ONE!
0635  3065        DCA PEAKV       /SAVE THE INFO
0636  1021        TAD SECS
0637  3066        DCA PEAKL
0640  1022        TAD SECS+1
0641  3067        DCA PEAKL+1
0642  7001  XIT1,   IAC
0643  3026        DCA LPV         /LOOK FOR DOWN SLOPE NEXT
0644  5600        JMP I SEARCH
0645  1036  POS,    TAD TOLDB       /DERIVATIVE MORE POSITIVE
0646  7041        CIA             / THAN TOLERANCE?
0647  1027        TAD DDOT
0650  7710        SPA CLA
0651  5600        JMP I SEARCH    /NO
0652  3115        DCA AREA        /YES: START ANEW
0653  3116        DCA AREA+1
0654  3117        DCA AREA+2
0655  1004        TAD PPB         /ZERO COUNTER IF NEW
0656  7700        SMA CLA
0657  3101        DCA X
0660  3100        DCA BLEND       /START FRESH
0661  1776'       TAD DPM+1
0662  3063        DCA STRTV       /SAVE VALUE AND LOCATION
0663  1101        TAD X
0664  3064        DCA STRTL
0665  7326        LW2
```

```
0666  3026          DCA LPV          /FIND PEAK NEXT
0667  5600          JMP I SEARCH
0670  1027  TAIL,   TAD DDOT         /DERIVATIVE GREATER THAN
0671  1166          TAD TOL3         / TOLERANCE?
0672  7710          SPA CLA
0673  5600          JMP I SEARCH     /NO
0674  1064          TAD STRTL
0675  1037          TAD TOLW
0676  1037          TAD TOLW
0677  7041          CIA              /FAR ENOUGH FROM START?
0700  1101          TAD X
0701  7710          SPA CLA
0702  5242          JMP XIT1         /NO WAIT UNTIL IT BLOWS OVER
0703  1776'         TAD DPM+1        /YES
0704  3070          DCA TAILV        /SAVE LOCATON AND VALUE
0705  1101          TAD X
0706  3071          DCA TAILL
0707  1101          TAD X
0710  4775'         JMS FLOAU
0711  4407          FPT
0712  6030          FPUT DIV
0713  5115          FGET AREA
0714  6072          FPUT PKAR
0715  0000          FEXT
0716  1004          TAD PPB          /PREVIOUS PEAK
0717  7700          SMA CLA
0720  5323          JMP .+3
0721  1774'         TAD LAST         /VERY FIRST STARTING VALUE
0722  7410          SKP
0723  1063          TAD STRTV
0724  4775'         JMS FLOAU
0725  4407          FPT
0726  6130          FPUT FT1
0727  0000          FEXT
0730  1776'         TAD DPM+1        /AND DELTA BASELINE
0731  4775'         JMS FLOAU
0732  4407          FPT
0733  2130          FSUB FT1
0734  4030          FDIV DIV
0735  4147          FDIV SKON        /CALIBRATE IN VOLTS/SEC.
0736  6075          FPUT PSLP        /SAVE THE SLOPE
0737  2112          FSUB TOL2
0740  0000          FEXT
0741  1045          TAD FAH
0742  7710          SPA CLA
0743  5351          JMP IK
0744  7330          LW4K
0745  1100          TAD BLEND
0746  3100          DCA BLEND
0747  7040          CMA
0750  3004          DCA PPB
0751  2152  IK,     ISZ K
0752  7410          SKP
0753  4773'         JMS OOPS
0754  2200          ISZ SEARCH       /MARK END
```

```
0755  5231          JMP XIT2
0756  2317  TSOLV,  TEXT /SOLVENT DELAY?/
0757  1426
0760  0516
0761  2440
0762  0405
0763  1401
0764  3177
0765  0000
0773  0401
0774  2200
0775  0506
0776  2305
0777  1642
                    PAGE
```

```
                /MARK I-4 BFS
                /ROUTINE TO SET UP THE INITIAL VARIABLES J B PEARCE 8/7/72
1000  0000  GETCON, 0
1001  6002        IOF
1002  3056        DCA 56          /NO LINE FEED AFTER USER TYPES CR
1003  1147        TAD TL
1004  3062        DCA 62          /F FORMAT
1005  4777'       JMS NSTRT
1006  7040        CMA
1007  3056        DCA 56          /LINE FEED AFTER USER TYPES CR
1010  4776'       JMS CRLF
1011  4337  CK,   JMS TXT         /TYPE INITIAL MESSAGE
1012  0541        RUNL            /RUN LENGTH
1013  4407        FPT
1014  0003        INPUT
1015  6170        FPUT CLKK
1016  0000        FEXT
1017  1045        TAD FAH
1020  7750        SPA SNA CLA
1021  5211        JMP CK
1022  4337  DB,   JMS TXT
1023  0547        TTOLDB
1024  4407        FPT
1025  0003        INPUT
1026  0000        FEXT
1027  4775'       JMS FIX
1030  3036        DCA TOLDB       /DERIVATIVE TOLERANCE
1031  1045        TAD FAH
1032  7750        SPA SNA CLA
1033  5222        JMP DB
1034  4337  ES,   JMS TXT
1035  1550        EDRV
1036  4407        FPT
1037  0003        INPUT
1040  0000        FEXT
1041  4775'       JMS FIX
1042  3166        DCA TOL3        /ENDING DERIVATIVE VALUE
1043  1166        TAD TOL3
1044  7710        SPA CLA
1045  5234        JMP ES
1046  4337  LW,   JMS TXT
1047  1433        TTOLW
1050  4407        FPT
1051  0003        INPUT
1052  0000        FEXT
1053  4775'       JMS FIX
1054  3037        DCA TOLW        /WIDTH
1055  1045        TAD FAH
1056  7750        SPA SNA CLA
1057  5246        JMP LW
1060  4337  PE,   JMS TXT
1061  0557        TSLOPE
1062  4407        FPT
1063  0003        INPUT
1064  6112        FPUT TOL2       /BASELINE SLOPE TOLERANCE
```

```
1065  0000          FEXT
1066  1045          TAD FAH
1067  7750          SPA SNA CLA
1070  5260          JMP PE
1071  4337  LV,     JMS TXT
1072  0756          TSOLV           /SOLVENT DELAY
1073  4407          FPT
1074  0003          INPUT
1075  0000          FEXT
1076  4775'         JMS FIX
1077  1374          TAD (-31        /LESS 25(10) FOR THE INITIAL SETUP
1100  7550          SPA SNA
1101  5271          JMP LV
1102  7041          CIA
1103  3773'         DCA SOLVT
1104  3021  RESTRT, DCA SECS        /PEAK LOCATION COUNTER
1105  3022          DCA SECS+1
1106  1773'         TAD SOLVT       /SET UP DELAY
1107  3020          DCA SOLVE
1110  4407          FPT
1111  5170          FGET CLKK
1112  2772'         FSUB ADDON      /CORRECT FOR REPEATS
1113  6120          FPUT CLKCON     /AND RUN LENGTH
1114  0000          FEXT
1115  6032          KCC             /ZAP FLAG
1116  4776'         JMS CRLF
1117  1127          TAD M50         /SET UP 50 CYCLE
1120  3126          DCA M50C        / COUNTER
1121  6133          CLSK            /WAIT FOR TICK
1122  5321          JMP .-1
1123  2126          ISZ M50C        /ONE SECOND?
1124  5321          JMP .-3         /NO
1125  1127          TAD M50
1126  3126          DCA M50C        /RESET TIMER
1127  4771'         JMS UPCLO       /SOFTWARE CLOCK
1130  2020          ISZ SOLVE       /SOLVENT DELAY EXPIRED?
1131  5321          JMP .-10        /NO
1132  1370          TAD (TYP
1133  3167          DCA TYPE        /SET UP FOR INTERRUPT OPERATION
1134  6131          CLEI            /INITIALIZE DK8-EC CLOCK
1135  6001          ION
1136  5600          JMP I GETCON
1137  0000  TXT,     0
1140  7240          CLA CMA
1141  1737          TAD I TXT
1142  3017          DCA AX7         /POINTS TO TEXT
1143  2337          ISZ TXT
1144  1417  TXL,     TAD I AX7
1145  3003          DCA TP1
1146  1003          TAD TP1
1147  0367          AND (7700       /MASK OFF FIRST CHARACTER
1150  7450          SNA
1151  5737          JMP I TXT
1152  7112          RTR CLL
1153  7012          RTR
```

```
1154  7012          RTR             /SHIFT INTO POSITION
1155  4766'         JMS OTT         /DECODE AND TYPE
1156  1003          TAD TP1
1157  0365          AND (0077
1160  7450          SNA
1161  5737          JMP I TXT
1162  4766'         JMS OTT
1163  5344          JMP TXL
1165  0077
1166  1541
1167  7700
1170  1441
1171  0330
1172  2123
1173  0354
1174  7747
1175  1200
1176  1732
1177  2043

                    PAGE
1200  0000  FIX,     0               /COPIED FROM FLOATING POINT MANUAL
1201  1044          TAD FAE
1202  7540          SMA SZA
1203  5206          JMP .+3
1204  7200          CLA
1205  5600          JMP I FIX
1206  1377          TAD (-13
1207  7450          SNA
1210  5224          JMP DONE
1211  7500          SMA
1212  4776'         JMS OOPS
1213  3044          DCA FAE
1214  7100  GO,     CLL
1215  1045          TAD FAH
1216  7510          SPA             /AN ARITHMETIC SHIFT
1217  7020          CML
1220  7010          RAR
1221  3045          DCA FAH
1222  2044          ISZ FAE
1223  5214          JMP GO
1224  1045  DONE,   TAD FAH
1225  5600          JMP I FIX
```

```
                    /MARK I-5 BFS
1226  0000  INX,     0
1227  1165            TAD TP4
1230  3164            DCA TP3
1231  1564            TAD I TP3
1232  5626            JMP I INX       /SPECIAL PURPOSE INDEXING ROUTINE
1233  0000  DECONV,   0
1234  4775'           JMS SVCR        /TO FIX CORE PROBLEM
1235  1071            TAD TAILL       /VERY LAST LOCATION
1236  4774'           JMS FLOAU
1237  4407            FPT
1240  6133            FPUT FT2
1241  0000            FEXT            /TAILL
1242  1070            TAD TAILV
1243  4774'           JMS FLOAU
1244  4407            FPT
1245  2130            FSUB FT1
1246  4133            FDIV FT2
1247  6133            FPUT FT2        /SLOPE
1250  0000            FEXT
1251  1162            TAD PKNT
1252  7650            SNA CLA
1253  5773'           JMP DIRCT
1254  1111            TAD PDS
1255  3165  BACK,     DCA TP4
1256  1103            TAD PL          /DOUBLE PRECISION INTEGER
1257  4226            JMS INX
1260  3046            DCA FAL
1261  1104            TAD PLPO
1262  4226            JMS INX
1263  3045            DCA FAH
1264  1372            TAD (27
1265  3044            DCA FAE
1266  4407            FPT
1267  7000            FNOR
1270  2355            FSUB F13        /DERIVATIVE LAG
1271  1771'           FADD ADDON      /OFFSET TIME FOR REPEATED RUNS
1272  0004            OUTPUT          /PRINT PEAK LOCATION
1273  0000            FEXT
1274  1147            TAD TL
1275  4226            JMS INX
1276  4774'           JMS FLOAU
1277  4407            FPT
1300  6136            FPUT FT3        /TAIL LOCATION
1301  0000            FEXT
1302  1106            TAD PAREA
1303  1165            TAD TP4
1304  3353            DCA DTMP
1305  1153            TAD SL
1306  4226            JMS INX
1307  4774'           JMS FLOAU
1310  4407            FPT
1311  6141            FPUT FT4        /STARTING LOCATION
1312  1136            FADD FT3
1313  4153            FDIV TWO        /X-BAR
```

```
1314  3133          FMUL FT2        /SLOPE
1315  1130          FADD FT1        /Y-NAUGHT
1316  6144          FPUT FT5        /Y-BAR
1317  5136          FGET FT3        /TAIL LOCATION
1320  2141          FSUB FT4        /=DELTA X
1321  3144          FMUL FT5        /Y-BAR
1322  6144          FPUT FT5        /AREA OF TRAPEZOID
1323  5753          FGET I DTMP     /AREA
1324  2144          FSUB FT5        /TRAPEZOID
1325  4147          FDIV SKON
1326  0004          OUTPUT
1327  0000          FEXT
1330  1174          TAD BLP
1331  4226          JMS INX
1332  0370          AND (1777       /DID THIS ONE OVERFLOW?
1333  7640          SZA CLA
1334  1367          TAD ("S         /MARK IT
1335  4567          JMS I TYPE
1336  1354          TAD SLPSW       /SLOPE DIAGNOSTIC?
1337  7650          SNA CLA
1340  5766'         JMP POVER       /NO
1341  1107          TAD PSLPP
1342  1165          TAD TP4         /CALCULATE ADDRESS OF SLOPE
1343  3353          DCA DTMP
1344  4407          FPT
1345  5753          FGET I DTMP
1346  0000          FEXT
1347  1102          TAD P3
1350  4406          JMS I FPO
1351  5766'         JMP POVER
1352  5633  JMPT,   JMP I DECONV
1353  0000  DTMP,   0
1354  0000  SLPSW,  0
1355  0004  F13,    4
1356  3200          3200
1357  0000          0
1360  1365  JFK,    TAD (TTF
1361  3167          DCA TYPE
1362  5764'         JMP RESTRT
1364  1104
1365  1723
1366  1400
1367  0244
1370  1777
1371  2123
1372  0027
1373  1422
1374  0506
1375  1647
1376  0401
1377  7765
                    PAGE
1400  1004  POVER,  TAD PPB
1401  7710          SPA CLA         /BLENDED?
1402  1377          TAD ("*
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1403  4567          JMS I TYPE
1404  4776'         JMS CRLF
1405  1165          TAD TP4          /LAST ONE?
1406  7041          CIA
1407  1024          TAD VECTA
1410  7640          SZA CLA
1411  5224          JMP AGAIN        /NO
1412  1375          TAD (-5          /FINALLY!
1413  3165          DCA TP4          /SET UP FOR NEXT GO
1414  1111          TAD PDS
1415  3016          DCA AX6
1416  7332          LW2K
1417  3100          DCA BLEND
1420  3004          DCA PPE
1421  5774'         JMP JMPT
1422  1024' DIRCT,  TAD VECTA        /SET UP FOR MOST RECENT PEAK
1423  5773'         JMP BACK
1424  2162' AGAIN,  ISZ PKNT         /DONE WITH PDL?
1425  7410          SKP              /NO
1426  5222          JMP DIRCT        /YEAH
1427  1023          TAD MCNT         /BUMP POINTER
1430  7041          CIA
1431  1165          TAD TP4
1432  5773'         JMP BACK
1433  1511  TTOLW,  TEXT /MIN WIDTH?/
1434  1640
1435  2711
1436  0424
1437  1077
1440  0000
1441  0000  TYP,     0
1442  6046          TLS
1443  5243          JMP .
1444  6041  SERV,    TSF
1445  5252          JMP CLOCK
1446  6001          ION
1447  6042          TCF
1450  7200          CLA
1451  5641          JMP I TYP
1452  6133  CLOCK,  CLSK             /CLOCK?
1453  7410          SKP              /OOPS
1454  2126          ISZ M50C
1455  5302          JMP IEXI         /NOT YET
1456  3033          DCA SAC
1457  7010          RAR
1460  3034          DCA SLK
1461  1127          TAD M50          /RELOAD REGISTER
1462  3126          DCA M50C
1463  1010          TAD AX0          /STILL ROOM?
1464  7041          CIA
1465  1372          TAD (BEND
1466  7700          SMA CLA
1467  5273          JMP QVRT         /A OK
1470  7000          NOP              /NEEDS FIXING
      /             JMS OOPS
```

```
1471  1110          TAD BBEG        /START OVER
1472  3010          DCA AX0
1473  4405  QVRT,   ADCV
1474  3410          DCA I AX0       /STORE NEW VALUE IN QUEUE
1475  6131  RTRN,   CLEI
1476  7300          CLA CLL
1477  1034          TAD SLK
1500  7004          RAL
1501  1033          TAD SAC
1502  6001  IEXI,   ION
1503  5400          JMP I 0
1504  0000  GETVAL, 0
1505  6001          ION
1506  1010          TAD AX0         /ANYTHING ON LIST?
1507  7041          CIA
1510  1110          TAD BBEG
1511  7650          SNA CLA
1512  5305          JMP GETVAL+1    /NOT YET
1513  6002          IOF             /NO FAIR ADDING TO LIST WHILE MOVING
1514  1010          TAD AX0
1515  7041          CIA
1516  1110          TAD BBEG
1517  7450          SNA
1520  5305          JMP GETVAL+1
1521  1371          TAD (-31
1522  3356          DCA GKNT        /AHA: AT LEAST ONE
1523  1370          TAD (DPBASE
1524  3011          DCA AX1         /PUSH DOWN THE LIST
1525  1367          TAD (DPBASE+1
1526  3012          DCA AX2
1527  1412          TAD I AX2
1530  3411          DCA I AX1
1531  2356          ISZ GKNT
1532  5327          JMP .-3
1533  7040          CMA
1534  1010          TAD AX0         /BACK UP THE LIST POINTER
1535  6001          ION             /ONE INSTRUCTION DELAY
1536  3010          DCA AX0
1537  4766          JMS UPCLO       /UPDATE THE CLOCK
1540  5704          JMP I GETVAL
1541  0000  OTT,    0
1542  1365          TAD (-40        /SPECIAL CHX?
1543  7510          SPA
1544  1364          TAD (100        /NO
1545  1363          TAD (240
1546  4567          JMS I TYPE
1547  5741          JMP I OTT
1550  0516  EDRV,   TEXT /END DERIV?/
1551  0440
1552  0405
1553  2211
1554  2677
1555  0000
1556  0000  GKNT,   0
1563  0240
```

```
1564  0100
1565  7740
1566  0330
1567  2271
1570  2270
1571  7747
1572  5377
1573  1255
1574  1352
1575  7773
1576  1732
1577  0252

                PAGE
```

```
                /MARK I-6 BFS
1600  4202            JMS MFPP
1601  5777'           JMP GASCHR
1602  0000  MFPP,      0
1603  7300            CLA CLL
1604  4227            JMS CMODS
1605  6547            6547            /FPP FUNCTION TABLE
1606  7400            7400            /FPP INPUT ROUTINE
1607  6550            6550
1610  7200            7200            /OUTPUT
1611  7352            7352
1612  4567            JMS I TYPE      /TYPE ROUTINE MODS (1970) VERSION
1613  7353            7353
1614  7000            NOP
1615  7354            7354
1616  7000            NOP
1617  7333            7333            /NO PLUS SIGNS PLEASE
1620  0240            240
1621  7334            7334
1622  0015            15
1623  0167            TYPE
1624  1723            TTF
1625  0000            0
1626  5602            JMP I MFPP
1627  0000  CMODS,     0               /CORE MODIFICATION ROUTINE
1630  1627            TAD I CMODS
1631  2227            ISZ CMODS
1632  7450            SNA             /0 MARKS LIST END
1633  5627            JMP I CMODS
1634  3241            DCA CMODT
1635  1627            TAD I CMODS     /GET CONTENTS
1636  2227            ISZ CMODS
1637  3641            DCA I CMODT     /DO IT
1640  5230            JMP CMODS+1
1641  0000  CMODT,     0
1642  1642  DISTA,     .
1643  0611            NEG
1644  0620            PEAK
1645  0645            POS
1646  0670            TAIL
1647  0000  SVCR,      0
1650  1100            TAD BLEND       /ALREADY PRINTED?
1651  7004            RAL
1652  7710            SPA CLA
1653  5776'           JMP JMPT        /YES
1654  1104            TAD P5
1655  1165            TAD TP4
1656  7041            CIA
1657  3162            DCA PKNT
1660  1162            TAD PKNT        /IS THIS A BLEND?
1661  7650            SNA CLA
1662  1274            TAD DELT        /NO
1663  1111            TAD PDS         /SET UP FOR FIRST ONE
1664  3165            DCA TP4
1665  7001            IAC
```

```
1666  4775'          JMS INX          /GET STARTING VALUE
1667  4774'          JMS FLOAU
1670  4407           FPT
1671  6130           FPUT FT1         /Y(0)
1672  0000           FEXT
1673  5647           JMP I SVCR
1674  5663  DELT,     STRTV-LAST       /ADDRESS DIFFERENTIAL
1675  0000  DIAG,     0
1676  7346           LWM3
1677  1026           TAD LPV
1700  7650           SNA CLA
1701  5675           JMP I DIAG
1702  1773'          TAD DPM+1
1703  4774'          JMS FLOAU
1704  4407           FPT
1705  0004           OUTPUT
1706  0000           FEXT
1707  1027           TAD DDOT
1710  4772'          JMS FLOAT
1711  4407           FPT
1712  0004           OUTPUT
1713  0000           FEXT
1714  1026           TAD LPV
1715  4772'          JMS FLOAT
1716  4407           FPT
1717  0004           OUTPUT
1720  0000           FEXT
1721  4332           JMS CRLF
1722  5675           JMP I DIAG
1723  0000  TTF,     0
1724  6046           TLS
1725  7200           CLA
1726  6041           TSF
1727  5326           JMP .-1
1730  6042           TCF
1731  5723           JMP I TTF
1732  0000  CRLF,     0
1733  1371           TAD (215
1734  4567           JMS I TYPE
1735  1370           TAD (212
1736  4567           JMS I TYPE
1737  5732           JMP I CRLF
1740  0405  MADS,     TEXT /DELTA T?/
1741  1424
1742  0140
1743  2477
1744  0000
1745  0000  ADSEA,    0                /1972 SCH 7-117
1746  6530           ADCL             /ZAP MULTIPLEXOR
1747  6532           ADST             /START CONVERTER
1750  6534           ADSK             /WAIT
1751  5350           JMP .-1
1752  6533           ADRB             /READ CONVERTER
1753  1356           TAD K1000        /FIX ARITHMETIC
1754  7106           CLL RTL          /MULTIPLY BY 4
```

```
1755  5745          JMP I AD8EA
1756  1000  K1000,  1000
1770  0212
1771  0215
1772  0517
1773  2305
1774  0506
1775  1226
1776  1352
1777  0200
                    PAGE
2000  4777' LEITZ,  JMS MFPP
2001  1104          TAD P5
2002  3062          DCA 62          /5 SIG FIGS
2003  7604  LIGHT,  LAS
2004  7010          RAR             /SR(11) ON FOR TTY OUTPUT
2005  7620          SNL CLA
2006  5220          JMP QUIET       /LIGHTS ONLY
2007  4233          JMS CINVT       /INVERSION SUBROUTINE
2010  4776'         JMS FLOAU
2011  4407          FPT
2012  4147          FDIV SKON       /0 TO 50 VOLTS
2013  0000          FEXT
2014  1153          TAD P2
2015  4630          JMS I OUTP
2016  4775'         JMS CRLF
2017  5203          JMP LIGHT
2020  1102  QUIET,  TAD P3
2021  7041          CIA
2022  3232          DCA LQCNT       /20 TIMES PER SEC REFRESH RATE
2023  4233          JMS CINVT
2024  2000          ISZ 0
2025  5224          JMP .-1
2026  2232          ISZ LQCNT
2027  5224          JMP .-3
2030  7200  OUTP,   CLA             /ISN'T THAT CLEVER?
2031  5203          JMP LIGHT
2032  0000  LQCNT,  0
2033  0000  CINVT,  0
2034  7604          LAS
2035  0153          AND P2          /SR(10) UP MEANS INVERT
2036  7012          RTR
2037  4405          ADCV
2040  7430          SZL
2041  7040          CMA
2042  5633          JMP I CINVT
2043  0000  NSTRT,  0
2044  4774'         JMS CMODS       /START CLEAN
2045  2123          ADDON
2046  0000          0
2047  2124          ADDON+1
2050  0000          0
2051  2125          ADDON+2
2052  0000          0
2053  0167          TYPE
```

```
2054  1723          TTF
2055  0100          BLEND
2056  0000          0
2057  0004          PPB
2060  0000          0
2061  0000          0
2062  6032          KCC
2063  4775'         JMS CRLF
2064  4773'         JMS TXT
2065  2117          MMODE           /MODE MESSAGE
2066  6031          KSF
2067  5266          JMP .-1
2070  6036          KRB
2071  6046          TLS
2072  6041          TSF
2073  5272          JMP .-1
2074  0372          AND (3
2075  3322          DCA MODE
2076  7326          LW2
2077  0322          AND MODE        /REPEAT?
2100  3771'         DCA RMODE
2101  1771'         TAD RMODE
2102  7650          SNA CLA
2103  5313          JMP NOR         /NO
2104  4775'         JMS CRLF
2105  4773'         JMS TXT
2106  1740          MADS            /DELTA T MESSAGE
2107  4407          FPT
2110  0003          INPUT
2111  6326          FPUT TBIAS
2112  0000          FEXT
2113  7301  NOR,     CLA CLL IAC
2114  0322          AND MODE
2115  3770'         DCA SLPSW       /PRINT SLOPE SWITCH
2116  5643          JMP I NSTRT
2117  1517  MMODE,  TEXT /MODE?/
2120  0405
2121  7700
2122  0000  MODE,   0
2123  0000  ADDON,  ZBLOCK 3
2126  0000  TBIAS,  ZBLOCK 3
2131  4407  RESTR,  FPT
2132  5326          FGET TBIAS
2133  6323          FPUT ADDON
2134  0000          FEXT
2135  6002          IOF
2136  4405          ADCV
2137  1103          TAD P4
2140  7640          SZA CLA         /WAIT FOR SATURATION
2141  5336          JMP .-3
2142  5767'         JMP JFK
2143  0000  DOWN,   0
2144  1100          TAD BLEND       /BLENDED PEAK?
2145  7700          SMA CLA
2146  5743          JMP I DOWN
```

```
2147  1766'          TAD DPM+1       /PRESENT VALUE
2150  7110           CLL RAR         /GET RID OF SIGN PROBLEM
2151  3003           DCA TP1
2152  1765'          TAD LAST        /START OF FIRST PEAK
2153  7110           CLL RAR         /LIKEWISE
2154  7041           CIA
2155  1003           TAD TP1
2156  7700           SMA CLA         /HAS VALUE GONE BELOW?
2157  5743           JMP I DOWN
2160  7040           CMA
2161  1165           TAD TP4
2162  3165           DCA TP4         /BACK UP POINTER
2163  5764'          JMP PNY         /PRINT IT OUT
2164  0305
2165  2200
2166  2305
2167  1360
2170  1354
2171  0353
2172  0003
2173  1137
2174  1627
2175  1732
2176  0506
2177  1602
                PAGE
          LAST=.
          DPBASE=LAST-1+71
          DPM=DPBASE+14
          DPE=DPBASE+31
          $
```

ADCL	6530	ADCV	4405	ADDON	2123	ADRB	6533	ADSK	6534
ADST	6532	AD8EA	1745	AD8EP	0005	AGAIN	1424	AREA	0115
AX0	0010	AX1	0011	AX2	0012	AX3	0013	AX4	0014
AX5	0015	AX6	0016	AX7	0017	BACK	1255	BBEG	0110
BBP	0161	BEND	5377	BLEND	0100	BLP	0174	BY	0275
BYY	0211	CINVT	2033	CK	1011	CLEI	6131	CLKCON	0120
CLKK	0170	CLOCK	1452	CLSK	6133	CMODS	1627	CMODT	1641
CRLF	1732	DB	1022	DDOT	0027	DECONV	1233	DELT	1674
DIAG	1675	DIAGP	0357	DIRCT	1422	DISTA	1642	DIV	0030
DONE	1224	DOWN	2143	DOWNP	0173	DPBASE	2270	DPE	2321
DPM	2304	DSUB	0431	DTMP	1353	DVIN	0123	EDRV	1550
ES	1034	FAE	0044	FAH	0045	FAL	0046	FIX	1200
FLOAT	0517	FLOAU	0506	FPO	0006	FPPI	0007	FPT	4407
FT1	0130	FT2	0133	FT3	0136	FT4	0141	FT5	0144
F13	1355	GASCHR	0200	GET	0035	GETCON	1000	GETVAL	1504
GKNT	1556	GO	1214	HEAD	0530	ID	0025	IEXI	1502
IK	0751	INLP2	0452	INX	1226	JFK	1360	JMPT	1352
K	0152	KSCAL	0502	K1000	1756	L	0413	LAST	2200
LEITZ	2000	LIGHT	2003	LPV	0026	LQCNT	2032	LV	1071
LW	1046	MADS	1740	MAINL	0253	MB12	0505	MCNT	0023
MFPP	1602	MLEND	0306	MLOK	0270	MMODE	2117	MODE	2122
M50	0127	M50C	0126	NEG	0611	NOR	2113	NSTRT	2043
ONE	0156	OOPS	0401	OTT	1541	OUTP	2030	PAREA	0106
PDS	0111	PE	1060	PEAK	0620	PEAKL	0066	PEAKV	0065
PKAR	0072	PKNT	0162	PL	0103	PLPO	0104	PNY	0305
POS	0645	POVER	1400	PPB	0004	PSLP	0075	PSLPP	0107
PUSD	0312	PUSHL	0323	PV	0102	P2	0153	P3	0102
P4	0103	P5	0104	QUIET	2020	QVRT	1473	RESTR	2131
RESTRT	1104	RMODE	0353	RTRN	1475	RUNL	0541	SAC	0033
SEARCH	0600	SECS	0021	SERV	1444	SERVP	0175	SKON	0147
SL	0153	SLK	0034	SLPSW	1354	SOLVE	0020	SOLVT	0354
STRPK	0634	STRTL	0064	STRTV	0063	SUP	0235	SV	0156
SVCR	1647	T	0610	TAIL	0670	TAILL	0071	TAILV	0070
TBIAS	2126	TL	0147	TOLDB	0036	TOLW	0037	TOL2	0112
TOL3	0166	TP1	0003	TP2	0163	TP3	0164	TP4	0165
TS	0400	TSLOPE	0557	TSOLV	0756	TTF	1723	TTOLDB	0547
TTOLW	1433	TV	0105	TWO	0153	TXL	1144	TXT	1137
TYP	1441	TYPE	0167	UPCLO	0330	VECTA	0024	X	0101
XIT1	0642	XIT2	0631	ZBY	0472				