AFS DETECTION LIMITS
Listing and explanation of a computer program
for the Baird Plasma/AFS and Apple II computer
to determine detection limits

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Abstract

AFS DETECTION LIMITS is a computer program written specifically for an Apple II PLUS computer with 48K of memory, one disk drive, and an Epson MX-80 printer. The computer is connected to a PLASMA/AFS Atomic Fluorescence Spectrometer manufactured by Baird Corporation. The program is menu driven and prompts the operator for all input. The program collects raw signal data from the PLASMA/AFS and then calculates, displays and prints the mean, standard deviation, and relative standard deviation of the signal data, and detection limit for each element determined in a standard solution. These statistics and detection limits are used to check instrument performance and to set up the operating conditions of the instrument. A data collection routine is also provided in the AFS DETECTION LIMITS program to collect and print data from the menu modes of the PLASMA/AFS instrument.

Introduction

The Atomic Fluorescence Spectrometer (PLASMA/AFS) manufactured by Baird Corporation is capable of determining from 1 to 12 elements simultaneously. The instrument has two modes of operation: (1) the menu mode allows for the calibration of each of the twelve channels of the instrument and the printout of results on an internal printer; and (2) the command mode provides raw signal data but has no provision for printing this raw data. The raw signal data are used to set up the instrument and calculate detection limits of elements in standard solutions. Detection limits are used to check for proper instrument performance and to determine the best instrumental parameters and plasma conditions to use. The detection limit is defined, in this report, as the concentration of an element that will produce a signal that is twice the standard deviation of ten repetitions of the signal produced by a blank.
The Baird PLASMA/AFS generates data rapidly but has no provision for printing raw data or calculating detection limits using the internal computer of the instrument. Because the raw signal data and detection limit information are used to set up the instrument, an external computer is useful, if not essential, for these data collections and calculations. By connecting an Apple II PLUS Computer to the external printer interface of the Baird PLASMA/AFS and using the program described in this report, detection limits and raw instrumental data can be collected and printed.

AFS DETECTION LIMITS is a computer program written specifically for an Apple II PLUS Computer with 48K of memory, one disk drive, and an Epson MX-80 printer. It is to be used to collect instrumental data from a Baird PLASMA/AFS and calculate detection limits of elements in standard solutions and has no other intended purpose. The program is menu driven and prompts the operator for all input. The program collects raw signal data from the Baird PLASMA/AFS, and then calculates, displays and prints the mean, standard deviation, relative standard deviation, and detection limit for each element in a standard solution. A data collection routine is also provided in the AFS DETECTION LIMITS program to collect and print data from the menu modes of the Baird PLASMA/AFS instrument. The user of this program must have a knowledge of the Baird PLASMA/AFS and its operation, however, little computer experience is necessary to use the program.

Program description

This program is written in Applesoft Basic Language for an Apple II PLUS computer system with 48K memory and one disk drive and an Epson MX-80 printer. The program is menu driven and prompts the operator for all input. All inputs use "Y" for yes, "N" for no, and "Return" for a default or no change. Other inputs are entered by pressing a numbered key, or if operator
input information is requested, by typing numbers or words followed by the "Return" key.

The program consists of three sections: input; data collection and reduction; and output.

The input section requires that the operator enter information in response to prompting menus, as they appear on the screen. The information entered is used in the data collection and reduction and output sections for labeling and heading information and for selecting data for manipulation using output routines provided. These "Header" conditions are stored on disk and are retrieved by the program; therefore, only minor changes are usually required in subsequent runs.

The data collection and reduction section of the program passes control of the computer to the Baird PLASMA/AFS instrument for data input. Data, for one to 12 elements, are transmitted from the test exerciser mode of the Baird PLASMA/AFS instrument to the Apple II computer. A maximum of 10 repetitions may be made on a maximum of 10 runs of a standard solution. Between data collection repetitions provision is made for the operator to abort the data collection and to reject data before they are used in the calculations performed by the program. The mean, standard deviation, relative standard deviation, and detection limit are calculated for each element in each standard solution run. The detection limit is calculated using the mean and standard deviation of the last blank run and the standards run by the formula:

\[ D = \frac{2VC}{S-B} \]

Where, \( D \) is the detection limit, \( V \) is the standard deviation of the blank signal, \( C \) is the concentration of the standard, \( S \) is the mean standard signal, and \( B \) is the mean blank signal. The blank values used in the calculations are always the last ones run. The data collection routine displays or prints data from the menu modes of the PLASMA/AFS instrument.
The output section provides for display and/or printout of the data collected and calculated. Printer commands for the Epson MX-80 printer are embedded in the program to provide a readable and useful printout. Options are provided to allow the operator to print as much or as little of the header information as is needed to indicate the conditions under which the data were collected.

Program execution

The following are the prompts that appear on the computer screen, shown as underlined characters. A brief description of each prompt is given with the possible responses. The numbers in parentheses are the program line numbers at which these prompts occur.

**HOW MANY ELEMENTS ARE YOU RUNNING?** (210)
A number from 0 to 12 is entered and the return key pressed. If 0 is entered, the program goes directly to the ending routine. If a number greater than 12 is entered, the prompt will return.

**SELECT PRINTER OPTION** (240)
0= NOTHING
1= EVERYTHING

**ENTER OPTION NUMBER**
Only 0 or 1 will be accepted. If 0 is entered, nothing is printed. If 1 is entered, all data requested in the next menu are printed. The next menu appears as soon as a 0 or 1 is entered.
SELECT DATA OPTION (320)
0= ALL DATA FULL HEADER
1= ALL DATA ELEMENT INFO.
2= ALL DATA NO HEADER
3= DETECTION LIMITS FULL HEADER
4= DETECTION LIMITS ELEMENT INFO.
5= DETECTION LIMITS NO HEADER
6= DATA FROM KEYBOARD FULL HEADER
7= DATA FROM KEYBOARD ELEMENT INFO.
8= DATA FROM KEYBOARD NO HEADER
9= PRINT FROM MENU MODE

ENTER OPTION NUMBER (440)

When 0, 3, or 6 (full header) is selected, all information contained in the header file will be displayed or printed next to the titles shown in the next menu (title, operator, day, month, year, time, power, carrier flow, coolant flow, pump speed, remarks, remarks, remarks, and remarks). Likewise, if 1, 4, or 7 (element information) is chosen, that is all that will be displayed or printed under the titles of Position, Element, Current, and PMT. Entry of 6, 7, or 8 allows the operator to input data manually. Selection 9 provides the use of the computer and printer as an external printer from the menu modes of the instrument.

TITLE
OPERATOR
DAY
MONTH
YEAR
TIME
POWER
CARRIER FLOW
COOLANT FLOW
PUMP SPEED
REMARKS
REMARKS
REMARKS
REMARKS
DO YOU WANT TO CHANGE ANYTHING? (1700)

If a header was selected in the previous menu, any information contained in the header disk file will be displayed on the screen with each of the above titles (title, operator, day, month, year, time, power, carrier flow, coolant flow, pump speed, remarks, remarks, remarks, and remarks). If any key except "Y" is pressed, all of the information is retained and used in subsequent printouts. If "Y" is pressed, the following prompt is displayed on the screen, and each of the above titles (title, operator, day, month, year, time, power, carrier flow, coolant flow, pump speed, remarks, remarks, remarks, and remarks) is displayed one at a time with its current contents in inverse video.

RETURN FOR NO CHANGE < / > TO DELETE (1860)

As the prompt indicates, pressing the return key retains the contents of that section of the header as displayed in inverse video. If a "/" key is entered, that section is deleted and nothing will be displayed or printed in that position of the header. Anything typed into the keyboard and followed by the return key replaces the contents of that section. After a response is made to the last remark, the header, with changes, is once again displayed and can be accepted or further changed.

POSITION ELEMENT CURRENT PMT

DO YOU WANT TO CHANGE ANYTHING? (1860)

The contents of the element information file will be displayed under each of the headings (position, element, current, pmt) for the number of elements being run. If any key except "Y" is pressed, all of the above information is retained and used in subsequent printouts.
If "Y" is entered, the following message is displayed, and each of the above titles (position, element, current, pmot) is displayed, one at a time, with its contents in inverse video.

RETURN FOR NO CHANGE <. /. TO DELETE (1860)

As the prompt indicates, pressing the return key retains the contents of that section of the header as displayed in inverse video. If a "/" key is entered, that section is deleted and nothing will be displayed or printed in that position of the header. Anything typed into the keyboard and followed by the return key replaces the contents of that section. After responding to the last PMT (photomultiplier tube voltage), the header, as changed, is once again displayed and can be accepted or altered. The positions of the elements can be entered in any order but they must be in the range of 1 to 12 and be the module positions in use by the AFS instrument. The program will not accept two positions with the same number or two elements with the same symbol.

HOW MANY REPETITIONS DO YOU WANT? (2130)
The number of repeats desired is entered. The range must be from 0 to 10 or an error message will be displayed and the question will be asked again. If 0 is entered, the program will go to the end of data input section and ask if more standards are to be run. If a number between 1 and 10 is entered, the program continues.

ENTER REMARK FOR THIS RUN (2160)
A remark of up to 255 characters can be entered for the run. The return key is pressed, if no remark is desired.

FOR RUN 

IS CONCENTRATION = FOR ALL ELEMENTS (2160)
The return key or "Y" is pressed if the standard to be run contains all of the elements at the same concentration. The prompt below (WHAT IS THE
CONCENTRATION IN G/ML?) appears. If the standard to be run contains the elements at different concentrations, then "N" is entered and the second prompt (ENTER CONCENTRATION IN G/ML FOR ELEMENT "") appears.

WHAT IS THE CONCENTRATION IN G/ML: (2170)

A concentration value that equals the standard is entered. If the solution is a blank, then 0 is entered.

ENTER CONCENTRATION IN G/ML FOR ELEMENT " " (2190)

This prompt will appear for each element being run and requires that a concentration be entered for each.

DO YOU HAVE ANY CHANGES? (2220)

If "Y" is entered, the program returns to the prompt, "HOW MANY REPETITIONS DO YOU WANT?", and all entries must be re-entered. If the return key is pressed, all entries are accepted and the program continues by going directly to accepting data from the instrument or keyboard. The instrument must be in the test exerciser mode with the external print command given. Control of the computer is taken away from the operator until data are transferred from the instrument to the computer. At that time the following message appears and "*" are slowly printed across the screen.

HIT CTRL C TO ABORT: RUN " " OF " " (2310)

The run and the data taken in the run can be canceled by pressing the CTRL and C keys simultaneously, while the "*" are being printed across the screen. The program then returns to the prompt, "HOW MANY REPETITIONS DO YOU WANT?", and the run can be restarted. If the data collection is not aborted, the data are collected for the number of repeats selected. The computer will beep and the following prompt will appear.
The computer will take some time making calculations before printing the newly calculated data on the screen. Then the following prompt will be displayed.

**DO YOU HAVE MORE STANDARDS TO RUN?** (2640)

If the return key is pressed, the program will ask for the number of repetitions for the next run and go through the same data collection routine. If "N" is entered, the data selected will be printed on the printer. If no printout was selected, the data will be printed on the screen. The following prompt will be displayed after the print.

**DO YOU WANT TO CONTINUE USING THE SAME ELEMENTS AND SAME DATA?** (3130)

If "Y" is entered, then the next prompt appears. If the return key is pressed, the second prompt appears.

**DO YOU WANT TO CHANGE PRINT INSTRUCTIONS?** (3140)

If "Y" is entered, then the program returns to the beginning, prompts for changes, except the number of elements which cannot be changed. If any other key is entered, the program returns to the prompt, "DO YOU HAVE MORE STANDARDS TO RUN?".

**DO YOU WANT TO RUN NEW DATA?** (3160)

If "Y" is entered, the program starts from the beginning. If any other key is entered, the next prompt appears.

**DO YOU WANT TO QUIT?** (3190)

If any key other than "Y" is pressed, the program returns to the ending prompts starting at "DO YOU WANT TO CONTINUE USING THE SAME ELEMENTS AND SAME DATA?". If "Y" is entered, the following prompt appears.

**ATOMIC FLUORESCENCE PROGRAM ENDED! ENTER RUN TO BEGIN AGAIN** (3200)
A Computer listing of the AFS DETECTION LIMITS program

100 REM THIS PROGRAM COLLECTS DATA FROM THE BAIRD ATOMIC
FLUORESCENCE ICP CALCULATES STATISTICS, AND DETECTION LIMITS.
110 REM PROVISION IS MADE TO USE THE COMPUTER AND PRINTER AS AN
EXTERNAL PRINTER
120 REM LAST UPDATED ON 11 JANUARY 1984
130 REM WRITTEN BY ALLEN MEIER AFTER A PROGRAM OF ROBERT BIGELOW
OF USGS DENVER, CO
140 REM **********************
150 REM **PRINTER MX-80 EPSON**
160 REM ********************
170 DIM Z$(12), B$(12), C$(12), D$(12,10), A$(100),
EL(12,10,10), RS(12,10), SQ(12,10), ST(12,10), SU(12,10), EL$(12),
LC$(12), PM$(12), MP$(12), D(12,10), ME(12,10), C(12,10),
RS$(12,10), ST%(12,10), ME%(12,10), ES$(12)
180 D$ = CHR$(4)
190 HOME
200 RESTORE
210 INPUT "HOW MANY ELEMENTS ARE YOU RUNNING?"; NE: IF NE = 0
GOTO 3190
220 DATA
230 FOR N = 1 TO NE: READ NE$: NEXT
240 HOME
250 ON ERR GOTO 240
260 PRINT : PRINT "0= NOTHING ",&
270 PRINT : PRINT "1= EVERYTHING ",&
280 PRINT : PRINT : INVERSE : PRINT "ENTER OPTION NUMBER"; NORMAL
290 GET A: POKE 216,0
300 A = A + 1
310 IF A > 3 GOTO 240
320 HOME : INVERSE : PRINT "SELECT DATA OPTION": NORMAL : PRINT
330 ON ERR GOTO 320
340 PRINT : PRINT "0= ALL DATA FULL HEADER"
350 PRINT : PRINT "1= ALL DATA ELEMENT INFO."
360 PRINT : PRINT "2= ALL DATA NO HEADER"
370 PRINT : PRINT "3= DETECTION LIMITS FULL HEADER"
380 PRINT : PRINT "4= DETECTION LIMITS ELEMENT INFO."
390 PRINT : PRINT "5= DETECTION LIMITS NO HEADER"
400 PRINT : PRINT "6= DATA FROM KEYBOARD FULL HEADER"
410 PRINT : PRINT "7= DATA FROM KEYBOARD ELEMENT INFO."
420 PRINT : PRINT "8= DATA FROM KEYBOARD NO HEADER"
430 PRINT : PRINT "9= PRINT FROM MENU MODE"
440 PRINT : PRINT : INVERSE : PRINT "ENTER OPTION NUMBER"; NORMAL
450 GET H: POKE 216,0
460 H = H + 1
470 IF H > 10 GOTO 240
490 ON ERR GOTO 530
500 PRINT D$: PRINT D$; "OPEN HEADFILE"
510 PRINT D$: "READ HEADFILE"
INPUT TIS, OPS, DAS, MOS, YRS, TS, POS, CAS, COS, RES, OXS, PUS, R1S, R2S, R3S, R4S
PRINT D$; "CLOSE HEADFILE"
POKE 216, 0
ONERR GOTO 610
PRINT D$; "OPEN"; NE$
PRINT D$; "READ"; NE$
INPUT NE
FOR I = 1 TO NE: INPUT ELSCI), MP$<I), LCSCI), PM$(I)
NEXT I: PRINT D$; "CLOSE"; NE$
POKE 216, 0
GOTO 1490
HOME: ON H GOTO 680, 1070, 680, 1070, 680, 1070, 1070, 3710
REM *******************
REM "HEADER INPUT"
REM *******************
PRINT "TITLE ";
INVERSE: PRINT TIS; NORMAL: INPUT XS$: IF XS$ < > "" THEN TIS$ = XS$: IF XS$ = "/" THEN TIS$ = ""
PRINT "OPERATOR ";
INVERSE: PRINT OPS: NORMAL: INPUT XS$: IF XS$ < > "" THEN OPS$ = XS$: IF XS$ = "/" THEN OPS$ = ""
PRINT "DAY ";
INVERSE: PRINT DAS: NORMAL: INPUT XS$: IF XS$ < > "" THEN DAS$ = XS$: IF XS$ = "/" THEN DAS$ = ""
PRINT "MONTH ";
INVERSE: PRINT MOS$: NORMAL: INPUT XS$: IF XS$ < > "" THEN MOS$ = XS$: IF XS$ = "/" THEN MOS$ = ""
PRINT "YEAR ";
INVERSE: PRINT YRS$: NORMAL: INPUT XS$: IF XS$ < > "" THEN YRS$ = XS$: IF XS$ = "/" THEN YRS$ = ""
PRINT "TIME ";
INVERSE: PRINT T$: NORMAL: INPUT XS$: IF XS$ < > "" THEN T$ = XS$: IF XS$ = "/" THEN T$ = ""
PRINT "POWER ";
INVERSE: PRINT POS$: NORMAL: INPUT XS$: IF XS$ < > "" THEN POS$ = XS$: IF XS$ = "/" THEN POS$ = ""
PRINT "CARRIER FLOW ";
INVERSE: PRINT CAS$: NORMAL: INPUT XS$: IF XS$ < > "" THEN CAS$ = XS$: IF XS$ = "/" THEN CAS$ = ""
PRINT "COOLANT FLOW ";
INVERSE: PRINT COS$: NORMAL: INPUT XS$: IF XS$ < > "" THEN COS$ = XS$: IF XS$ = "/" THEN COS$ = ""
PRINT "REDUCTANT FLOW ";
INVERSE: PRINT RES$: NORMAL: INPUT XS$: IF XS$ < > "" THEN RES$ = XS$: IF XS$ = "/" THEN RES$ = ""
PRINT "OXIDANT FLOW ";
INVERSE: PRINT OXS$: NORMAL: INPUT XS$: IF XS$ < > "" THEN OXS$ = XS$: IF XS$ = "/" THEN OXS$ = ""
PRINT "PUMP SPEED ";
INVERSE: PRINT PUS$: NORMAL: INPUT XS$: IF XS$ < > "" THEN PUS$ = XS$: IF XS$ = "/" THEN PUS$ = ""
PRINT "REMARKS ";
INPUT X$: IF X$ = "" THEN R1$ = ""

PRINT "REMARKS ";

INPUT X$: IF X$ = "" THEN R2$ = ""

PRINT "REMARKS ";

INPUT X$: IF X$ = "" THEN R3$ = ""

PRINT "REMARKS ";

INPUT X$: IF X$ = "" THEN R4$ = ""

REM *******************
REM *END HEADER INPUT*
REM ***********************
POKE 34,0: HOME : GOTO 1550

REM *ELEMENT INFOR INPUT*
IF NE = 0 THEN GOTO 1200
FOR I = 1 TO NE
    PRINT "MODULE POSITION ";
    PRINT MP$(I): NORMAL : INPUT X$: IF X$ = "" THEN MP$(I) = ""
    IF VAL (MP$(I)) > 12 THEN FLASH : GOTO 1090
    IF MP$(I) = MPS(X) THEN GOTO 1260
    IF EL$(I) = EL$(I) THEN GOTO 1260
    IF LC$(I) = "" THEN GOTO 1260
    IF PM$(I) = "" THEN GOTO 1260
FOR I = 1 TO NE
    FOR X = 1 TO NE
        IF I = X THEN GOTO 1260
    NEXT
    IF I = X THEN GOTO 1260
NEXT
FOR I = 1 TO 12
    FOR Z = 1 TO 12
NEXT
NEXT
FOR I = 1 TO 12
    IF MPS(X) = MPS(I) THEN GOTO 1750
NEXT
FOR I = 1 TO 12
    IF MPS(I) = MPS(X) THEN GOTO 1750
NEXT
FOR I = 1 TO 12
    IF MPS(I) = MPS(I) THEN GOTO 1750
NEXT
FOR I = 1 TO 12
    IF MPS(I) = MPS(I) THEN GOTO 1750
NEXT
FOR I = 1 TO 12
    IF MPS(I) = MPS(I) THEN GOTO 1750
NEXT
FOR I = 1 TO 12
    IF MPS(I) = MPS(I) THEN GOTO 1750
NEXT
MP$(X) = Z$(I)
1390 EL$(X) = B$(I)
1400 LC$(X) = C$(I)
1410 PM$(X) = E$(I)
1420 X = X + 1
1430 Z$(I) = ""
1440 NEXT
1450 POKE 34,0: HOME
1460 REM ***********************
1470 REM END ELEMENT INFO INPUT*
1480 REM ***********************
1490 HOME : ON H GOSUB 1550, 1750, 1550, 1750, 1550, 1750, 1750, 3710
1500 IF BB < > 1 GOTO 2120
1510 GOTO 1910
1520 REM ***********************
1530 REM *HEADER OUTPUT*
1540 REM ***********************
1550 IF TIS$ < > "" THEN PRINT "TITLE ";TIS$
1560 IF OP$ < > "" THEN PRINT "OPERATOR ";OP$
1570 IF (DAS < > "") AND (MOS < > "") AND (YRS < > "") THEN PRINT "DATE ";DAS$; "";MOS$; "";YRS$
1580 IF TS < > "" THEN PRINT " TIME ";TS$
1590 IF T$ = "" THEN PRINT
1600 IF POS$ < > "" THEN PRINT "POWER ";POS$
1610 IF CAS$ < > "" THEN PRINT "CARRIER FLOW ";CAS$
1620 IF COS$ < > "" THEN PRINT "COOLANT FLOW ";COS$
1630 IF RES$ < > "" THEN PRINT "REDUCTANT FLOW ";RES$
1640 IF OXS$ < > "" THEN PRINT "OXIDANT FLOW ";OXS$
1650 IF PUS$ < > "" THEN PRINT "PUMP SPEED ";PUS$
1660 IF R1S$ < > "" THEN PRINT "REMARKS ";R1S$
1670 IF R2S$ < > "" THEN PRINT "REMARKS ";R2S$
1680 IF R3S$ < > "" THEN PRINT "REMARKS ";R3S$
1690 IF R4S$ < > "" THEN PRINT "REMARKS ";R4S$
1700 INPUT "DO YOU WANT TO CHANGE ANYTHING?";BS$: IF BS$ = "Y" THEN BB = 1: INVERSE : PRINT "RETURN FOR NO CHANGE < / > TO DELETE": NORMAL : PRINT : POKE 34, PEEK (37): GOTO 640
1710 REM ***********************
1720 REM *HEADER OUT END*
1730 REM ***********************
1740 POKE 34,0: HOME
1750 PRINT "POSITION ELEMENT CURRENT PMT"
1760 REM ***********************
1770 REM **ELEMENT OUT**
1780 REM ***********************
1790 FOR I = 1 TO NE
1800 HTAB 4: PRINT MPS$(I);
1810 HTAB 13: PRINT EL$(I);
1820 HTAB 22: PRINT LC$(I);
1830 HTAB 30: PRINT PM$(I)
1840 NEXT
1850 P = FRE (O)
1860 INPUT "DO YOU WANT TO CHANGE ANYTHING?";BS$: IF BS$ = "Y" THEN BB = 1: INVERSE : PRINT "RETURN FOR NO CHANGE < / > TO DELETE": NORMAL : PRINT : POKE 34, PEEK (37): GOTO 1070
1870 RETURN
1880 REM *********************************************************
1890 REM **DISK HEADER FILES**
1900 REM *********************************************************
1920 PRINT DS: "OPEN HEADFILE"
1930 PRINT DS: "DELETE HEADFILE"
1940 PRINT DS: "OPEN HEADFILE"
1950 PRINT DS: "WRITE HEADFILE"
R1S: PRINT R2S: PRINT R3S: PRINT R4S
1970 PRINT DS: "CLOSE HEADFILE"
1980 IF BB < > 1 GOTO 2120
1990 PRINT DS: "OPEN"; NES
2000 PRINT DS: "DELETE"; NES
2010 PRINT DS: "OPEN"; NES
2020 PRINT DS: "WRITE"; NES
2030 PRINT NE
2040 FOR I = 1 TO NE: PRINT EL(I): PRINT MPS(I): PRINT LCS(I):
PRINT PM(I)
2050 NEXT
2060 PRINT DS: "CLOSE"; NES
2070 BB = 0
2080 REM *********************************************************
2090 REM **DISK HEADER END**
2100 REM **STAT. INITIALIZATION**
2110 REM *********************************************************
2120 RN = RT + 1: RT = RT + 1
2130 SPEED = 255: PRINT: PRINT: INPUT "HOW MANY REPETITIONS DO
YOU WANT? "; R(RN): IF R(RN) = 0 THEN RN = RT - 1: RT = RT - 1:
GOTO 2640
2140 IF R(RN) > 10 THEN INVERSE: PRINT "REPETITIONS MUST BE 10
OR LESS."; NORMAL: GOTO 2130
2150 PRINT: PRINT "ENTER REMARK FOR THIS RUN": INPUT R$(RN)
2160 PRINT: HTAB 14: PRINT "FOR RUN "; RN: PRINT "IS
CONCENTRATION = FOR ALL ELEMENTS?": GET BS
2170 PRINT: PRINT: PRINT: IF BS < > "N" THEN INPUT "WHAT IS
THE CONCENTRATION IN UG/ML?"; CC: FOR I = 1 TO NE:C(I,RN) = CC:
NEXT: GOTO 2220
2180 FOR I = 1 TO NE
2190 PRINT: PRINT "ENTER CONCENTRATION IN UG/ML FOR ELEMENT
"; EL(I);
2200 INPUT C(I,RN)
2210 NEXT
2220 PRINT: PRINT "DO YOU HAVE ANY CHANGES?": GET BS: IF BS = "Y"
GOTO 2130
2230 ON H GOTO 2240, 2240, 2240, 2240, 2240, 2240, 2240, 3260, 3260, 3260, 3710
2240 ONERR GOTO 2130
2250 FOR I = 1 TO R(RN)
2260 REM *********************************************************
2270 REM **INSTRUMENT INPUT**
2280 REM *********************************************************
2290 PRINT DS: PRINT DS; "IN#2": INPUT "": A$(I): PRINT DS; "IN#0":
IF A$(I) = "": THEN I = I - 1
2300 IF I = R(RN) THEN PRINT CHR$(7), CHR$(7): PRINT : INVERSE : PRINT "RUN ";I;" OF ";R(RN);" DONE ";"CHANGE STANDARDS!"": NORMAL : GOTO 2330
2310 PRINT "HIT CTRL C TO ABORT! ";"RUN ";I;" OF ";R(RN)
2320 FOR Z = 0 TO 79: SPEED = 10: PRINT "*";: NEXT: SPEED = 255
2330 IF LEN (A$(I)) < 10 * NE THEN A$(I) = " ": A$(I): GOTO 2330
2330 FOR N = 1 TO NE
2340 L = ((N - 1) * 10) + 1
2343 FOR J = L TO L + 9
2344 IF (MIDS (A$(I),J,1) = "-") THEN SIGN = - 1
2350 NEXT
2360 REM ******************************************
2370 REM **STATISTICS CALCULATION**
2380 REM ******************************************
2390 EL(N,RN,I) = VAL (MIDS (A$(I),L,10)) * SIGN
2400 SUM(N,RN) = SUM(N,RN) + EL(N,RN,I)
2401 SQ(N,RN) = SQ(N,RN) + EL(N,RN,I)^2
2402 NEXT
2403 NEXT
2404 P = FRE (O)
2405 POKE 216,0
2410 FOR N = 1 TO NE
2420 MEAN(N,RN) = SU(N,RN) / R(RN)
2430 IF R(RN) - 1 = 0 GOTO 2470
2440 IF ((SQ(N,RN) - ((SU(N,RN) ^ 2) / R(RN))) / (R(RN) - 1)) < 0 GOTO 2470
2450 STDV(N,RN) = SQR ((SQ(N,RN) - ((SU(N,RN) ^ 2) / R(RN))) / (R(RN) - 1))
2460 RSD(N,RN) = ST(N,RN) * 100 / ME(N,RN)
2470 PRINT "ELEMENT ";EL$(N):" RUN NUMBER= ";RN;" REPETITIONS= ";R(RN);" CONC.= "C(N,RN);" "RS$(RN)
2475 ST%(N,RN) = ST(N,RN)
2476 RS$(N,RN) = STR$(RS$(N,RN))
2480 IF ME(N,RN) > 32767 THEN PRINT "MEAN= ";ME(N,RN);" STD. DEV.= ";ST%(N,RN);" RSD%= "; LEFT$(RS$(N,RN),4): GOTO 2510
2490 ME%(N,RN) = ME(N,RN)
2500 PRINT "MEAN= ";ME%(N,RN);" STD.DEV.= ";ST%(N,RN);" RSD%= "; LEFT$(RS$(N,RN),4)
2510 NEXT
2520 IF RT < 2 THEN INVERSE : PRINT " NOT ENOUGH STANDARDS TO RUN DETECTION LIMITS!": NORMAL : GOTO 2640
2530 FOR RN = 1 TO RT
2540 FOR I = 1 TO NE
2550 C = C + C(I,RN)
2551 NEXT 2552 IF C = 0 THEN B = RN
2560 C = 0
2570 NEXT
2580 IF B = 0 THEN INVERSE : PRINT "NO BLANK HAS BEEN RUN!": NORMAL : GOTO 2640
2590 FOR RN = 1 TO RT
2591 FOR N = 1 TO NE
2592 IF C(N,RN) = 0 GOTO 2630
2600 IF ME(N,RN) - ME(N,B) = 0 THEN D(N,RN) = 0: GOTO 2630
2610 D(N,RN) = (2000 * C(N,RN) * ST(N,B)) / (ME(N,RN) - ME(N,B))
2620 D$(N,RN) = STRS (D(N,RN))
2630 NEXT : NEXT
2640 PRINT CHR$(7): PRINT "DO YOU HAVE MORE STANDARDS TO RUN?":
GET B$: IF B$ < > "N" GOTO 2120
2650 IF RT = 0 THEN INVERSE : PRINT "NO STANDARDS HAVE BEEN
RUN!!": NORMAL : GOTO 3130
2660 IF A = 1 GOTO 3130
2670 IF A = 2 THEN PRINT D$: PRINT D$;"PR#1"
2680 ON H GOSUB 3370,3370,2780,3370,3370,2900,3370,3370,2780,3710
2710 ON H GOSUB 2780,2780,2900,2900,2900,2900,2780,2900,2900,3710
2740 ON H GOTO 3090,3090,3090,2960,2960,2960,3090,3090,3090,3710
2750 REM ****************
2760 REM *DATA PRINT*
2770 REM ****************
2780 FOR N * 1 TO NE
2790 FOR RN = 1 TO RT
2800 PRINT CHRS (18);"ELEMENT "; EL$(N); CHRS (20);" RUN=";RN;" REPS=";R(RN);" CONC=";C(N,RN);" UG/ML";
2810 IF ME(N,RN) > 32767 THEN PRINT " MEAN=";ME(N,RN);" STD.DEV.=";ST%(N,RN);" RSD%="; LEFTS (RS$(N,RN),4); GOTO 2830
2820 PRINT " MEAN=";ME(N,RN);" STD.DEV.=";ST%(N,RN);" RSD%="; LEFTS (RS$(N,RN),4)
2830 IF RS(RN) < > "" THEN PRINT RS$(RN)
2840 IF C(N,RN) < > 0 THEN PRINT CHR$(14);"DET. LMT. "; LEFTS (D$(N,RN),6);" UG/L "; CHR$(20);
2850 PRINT CHR$(15);"RAW DATA ";
2860 FOR I = 1 TO R(RN): PRINT EL(N,RN,I);" ";
2870 NEXT
2880 PRINT : NEXT : PRINT : NEXT
2890 PRINT CHR$(18)
2900 RETURN
2910 REM ****************
2920 REM *END OF DATA PRINT*
2930 REM ****************
2940 REM *DETECTION LIMIT PRINT*
2950 REM ****************
2960 IF RT < 2 THEN INVERSE : PRINT " NOT ENOUGH STANDARDS TO
RUN DETECTION LIMITS!!": NORMAL : GOTO 3130
2970 FOR RN = 1 TO RT
2980 FOR I = 1 TO NE
2990 C = C + C(I,RN)
3000 NEXT
3010 IF C = 0 THEN B = RN
3020 IF B = 0 THEN INVERSE : PRINT "NO blank HAS BEEN RUN!!":
NORMAL : GOTO 3130
3030 FOR RN = 1 TO RT
3040 FOR N = 1 TO NE
3050 D(N,RN) = (2000 * C(N,RN) * ST(N,B)) / (ME(N,RN) - ME(N,B))
3060 D$(N,RN) = STRS (D(N,RN))
3070 IF C(N,RN) < > 0 THEN PRINT CHR$: (18); "DET. LMT. AT CONC.="; C(N,RN); " FOR "; CHRS (14); EL$(N); CHRS (20); " IS "; LEFT$(D$(N,RN), 6); " UG/L "; RS(RN)
3080 NEXT : NEXT
3090 PRINT D$; "PR#0"
3100 REM *********************
3110 REM *END DETECTION LIMITS*
3120 REM *********************
3130 PRINT : HTAB 8: PRINT "DO YOU WANT TO CONTINUE": PRINT "USING THE SAME ELEMENTS AND SAME DATA?": GET B$
3140 IF BS = "Y" THEN PRINT "DO YOU WANT TO CHANGE PRINT INSTRUCTIONS? ": GET X$: IF X$ = "Y" THEN GOTO 240
3150 IF BS = "Y" GOTO 2640
3160 PRINT : PRINT : PRINT "DO YOU WANT TO RUN NEW DATA?": GET B$: IF B$ < > "Y" GOTO 3190
3170 IF A < > 2 THEN PRINT : CLEAR : GOTO 170
3180 IF BS = "Y" THEN PRINT D$: "PR#1": PRINT CHR$: (12): PRINT D$: "PR#0": CLEAR : GOTO 170
3190 PRINT : PRINT : PRINT "DO YOU WANT TO QUIT?": GET B$: IF B$ < > "Y" THEN GOTO 3220
3200 IF A < > 2 THEN PRINT : HOME : PRINT D$: "PR#0": PRINT "ATOMIC FLUORESCENCE PROGRAM ENDED!": PRINT : PRINT " ENTER RUN TO BEGIN AGAIN": END
3210 IF BS = "Y" THEN PRINT D$: "PR#1": PRINT CHR$: (12): PRINT D$: "PR#0": PRINT "ATOMIC FLUORESCENCE PROGRAM ENDED!": PRINT : PRINT " ENTER RUN TO BEGIN AGAIN": END
3220 PRINT D$: "PR#1": PRINT : PRINT : PRINT : PRINT : PRINT D$: "PR#0": GOTO 3130
3230 REM *********************
3240 REM **KEYBOARD INPUT**
3250 FOR N = 1 TO NE
3260 FOR I = 1 TO R(RN)
3270 PRINT : PRINT "FOR ELEMENT "; EL$(N); " CONC. "; C(N,RN); " READING= ";
3280 NEXT : NEXT
3290 INPUT EL(N,RN,I)
3300 NEXT
3310 NEXT
3320 FOR N = 1 TO NE
3330 FOR I = 1 TO R(RN)
3340 GOTO 2400
3350 REM **END KEYBOARD IN**
3360 REM *********************
3370 REM *********************
3380 IF OP$ < > "" THEN PRINT "OPERATOR "; OP$;
3390 PRINT TAB(41); "POSITION ELEMENT CURRENT PMT"
3400 IF (DA$ < > "") OR (MO$ < > "") OR (YR$ < > "") THEN PRINT "DATE "; DA$; " ; MO$; " ; YR$;
3410 IF TS < > "" THEN PRINT " TIME "; TS;
3420 IF MP$(1) < > "" THEN PRINT TAB(45); MP$(1); TAB(14); EL$(1); TAB( 23); LC$(1); TAB( 31); PM$(1)

17
3030 IF POS < > "" THEN PRINT "POWER ";POS;: IF MPS(2) = "" THEN PRINT
3440 IF MPS(2) < > "" THEN PRINT TAB(45);MPS(2); TAB(14);ELS(2); TAB(23);LCS(2); TAB(31);PMS(2)
3450 IF CAS < > "" THEN PRINT "CARRIER FLOW ";CAS;: IF MPS(3) = "" THEN PRINT
3460 IF MPS(3) < > "" THEN PRINT TAB(45);MPS(3); TAB(14);ELS(3); TAB(23);LCS(3); TAB(31);PMS(3)
3470 IF COS < > "" THEN PRINT "COOLANT FLOW ";COS;: IF MPS(4) = "" THEN PRINT
3480 IF MPS(4) < > "" THEN PRINT TAB(45);MPS(4); TAB(14);ELS(4); TAB(23);LCS(4); TAB(31);PMS(4)
3490 IF MPS < > "" THEN PRINT "PUMP SPEED ";MPS;: IF MPS(5) = "" THEN PRINT
3500 IF MPS(5) < > "" THEN PRINT TAB(45);MPS(5); TAB(14);ELS(5); TAB(23);LCS(5); TAB(31);PMS(5)
3510 IF OXS < > "" THEN PRINT "OXIDANT FLOW ";OXS;: IF MPS(6) = "" THEN PRINT
3520 IF MPS(6) < > "" THEN PRINT TAB(45);MPS(6); TAB(14);ELS(6); TAB(23);LCS(6); TAB(31);PMS(6)
3530 IF MPS(7) = "" THEN PRINT
3540 IF MPS(7) < > "" THEN PRINT TAB(45);MPS(7); TAB(14);ELS(7); TAB(23);LCS(7); TAB(31);PMS(7)
3550 IF MPS(8) < > "" THEN PRINT TAB(45);MPS(8); TAB(14);ELS(8); TAB(23);LCS(8); TAB(31);PMS(8)
3560 IF MPS(9) < > "" THEN PRINT TAB(45);MPS(9); TAB(14);ELS(9); TAB(23);LCS(9); TAB(31);PMS(9)
3570 IF MPS(10) < > "" THEN PRINT TAB(45);MPS(10); TAB(14);ELS(10); TAB(23);LCS(10); TAB(31);PMS(10)
3580 IF MPS(11) < > "" THEN PRINT TAB(45);MPS(11); TAB(14);ELS(11); TAB(23);LCS(11); TAB(31);PMS(11)
3590 IF MPS(12) < > "" THEN PRINT TAB(45);MPS(12); TAB(14);ELS(12); TAB(23);LCS(12); TAB(31);PMS(12)
3600 IF R1$ < > "" THEN PRINT "REMARKS ";R1$
3610 IF R2$ < > "" THEN PRINT "REMARKS ";R2$
3620 IF R3$ < > "" THEN PRINT "REMARKS ";R3$
3630 IF R4$ < > "" THEN PRINT "REMARKS ";R4$
3640 PRINT : PRINT D$;"PR#0"
3650 RETURN
3660 REM ***********************
3670 REM END HEADER PRINT**
3680 REM ***********************
3690 REM MENU MODE PRINT
3700 REM ***********************
3710 HOME
3720 INVERSE : PRINT "SELECT EXTERNAL PRINTER IN MENU MODE";
PRINT : PRINT "HIT CONTROL RESET TO ESCAPE!"; NORMAL
3730 PRINT D$: PRINT D$;"IN#2"
3740 FOR I = 0 TO 71
3750 GET A$(I)
3760 NEXT 3770 FOR I = 72 TO 92
3780 INPUT A$(I)
3790 IF RIGHTS A$(I),6) = "CYCLES" GOTO 3810
3800 NEXT

3810 PRINT DS;"IN#0"
3820 PRINT DS: PRINT DS;"PR#1"
3830 FOR I = 0 TO 71
3840 PRINT AS(I);:
3850 NEXT : PRINT
3860 FOR I = 72 TO 92
3870 PRINT AS(I)
3880 IF RIGHT$(AS(I),6) = "CYCLES" GOTO 3900
3890 NEXT
3900 PRINT DS;"PR#0"
3910 GOTO 3720
3920 REM ***********************
3930 REM END OF MENU PRINT
3940 REM ***********************
PROGRAM OUTPUT SECTION

The following is an example of a printout produced using the option of all data full header.
DETECTION LIMITS PROGRAM EXAMPLE

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REMARKS THIS IS AN EXAMPLE OF A PRINTOUT!
REMARKS THE VALUES LISTED HERE ARE ONLY FOR EXAMPLE!

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