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Mathematics and Computers

MASTER

AUTOMATED QUANTOMETER DATA
HANDLING SYSTEM

G. L. Bowers
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UNION CARBIDE CORPORATION
NUCLEAR DIVISION
OAK RIDGE Y-12 PLANT

operated for the ATOMIC ENERGY COMMISSION under U. S. GOVERNMENT Contract W-7405 eng 26

UNION
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OAK RIDGE Y-12 PLANT
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Nuclear Division

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ABSTRACT

Analysis by spectrographic methods requires that large volumes of data be recorded and processed; and, prior to element analysis, a time-consuming system calibration procedure must be completed. To automate the data acquisition, data analysis, and calibration procedures, a small digital computer has been interfaced to a direct-reading spectrograph (Quantometer). Development of this system has essentially eliminated several hours of menial paper work which were required to prepare the Quantometer for each day's work, thereby making the instrument useful for production analysis.

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SUMMARY

Quantitative analysis of materials by spectrographic methods is readily adaptable to a computerized system. Two methods of analysis have been utilized at the Oak Ridge Y-12 Plant^(a): aluminum spark and uranium carrier distillation. A small computer has been interfaced to a Quantometer,^(b) and computer programs written for the aluminum and uranium analyses.

Light given off by decomposing a material with a high-intensity burn is diffracted into definite wavelengths. By measuring the intensity of these wavelengths which are characteristic of specific elements, the elemental concentration of a material is determined.

Sample and standard materials are burned for each analysis. From standard voltage values, calibration curves are calculated for the aluminum spark method. Referencing the sample voltage to the calibration curve determines the concentration of a given element. The standard material for the uranium carrier analysis consists of blank and reference standards. Predetermined calibration curves are stored in the computer for each element analyzed. The average value of the blank standard voltages is subtracted from the reference standard and sample data to eliminate the background effect. The average value of the reference standard voltages is used to normalize the sample data after the background effect has been subtracted. The resulting voltage value referenced to the appropriate calibration curve determines the element concentration. Computerization of the Quantometer system resulted in: (1) a decrease in the time required for analysis, (2) elimination of a manual calibration of the system, and (3) providing an output format.

(a) Operated by the Union Carbide Corporation's Nuclear Division for the US Atomic Energy Commission.

(b) Manufactured by Applied Research Laboratories, Glendale, California.

INTRODUCTION

A Quantometer system was purchased some three years ago with the expectation that it would provide high-quantity, fast, production-line testing. As delivered, the instrument requires that output data be taken by a strip-chart recorder and that element concentration values be read from a strip chart and recorded on a report form. Another requirement was the need to apply a tedious calibration procedure prior to each analysis. Attenuators had to be set for each element. As a rule, calibration of the system required more time than did the actual analysis.

In an effort to upgrade the facility, a small digital computer was added to the system. The computer's function is primarily to digitize the output signals from the Quantometer, store the resulting values for processing at the end of the run, and automatically analyze the data obtained. In this manner, the principal time-consuming manual labor problems concerned with instrument calibration and data analysis are eliminated. Concentration values are outputted to both laboratory and customer formats.

AUTOMATED DATA HANDLING SYSTEM

SYSTEM OPERATION

A diagram of the laboratory Quantometer (direct-reading spectrograph) with computer is presented in Figure 1; detailed engineering drawings are contained in Appendix A. An automatic sample injecting device, capable of handling 40 specimens, loads a sample of the material into the arcing chamber where it is burned. Light from the arc is passed through a lens, reflected by a mirror through a primary slit, and focused on a diffracting grating. The light, as reflected from the grating, is broken into different wavelengths or spectra. The wavelength of light passing through the secondary or exit slit will be characteristic of one particular element. Each spectral line is focused on a photomultiplier tube (PMT) which, in turn, develops a capacitor voltage (V_C , shown in Figure 1) proportional to the intensity of the light. With the completion of a burn, each capacitor should contain a voltage proportional to the concentration of the impurity element within the base material. Since V_C is not directly proportional to the elemental concentration, a calibration curve is required.

COMPUTER HARDWARE

The Quantometer hardware was designed to operate in an interrupt mode. When an external device needs servicing, an interrupt is generated and a flag is set. The computer program in progress is interrupted until the external device has been serviced. A block diagram of the computer interface is given in Figure 2.

The address logic samples the state of the 17 relays in the Quantometer that are closed to indicate which of the possible 60 (5×12) elements are present at the output. By inspection of the relay closures guided by the Quantometer tape, the proper storage location within the element voltage table, seen in Figure 3 can be found. This address is stored for proper placement of the analog-to-digital converter (ADC) output reading. Radio frequency (RF) line filters are provided in the lines to the computer to help isolate the noise generated in the Quantometer by the relay closures.

Element voltages are read through a 12-bit successive approximation ADC. The output data are strobed into the computer through the accumulator by using the proper input/output transfer (IOT) pulse. The ADC is reset and conversion is started by an IOT. When conversion is complete, the ADC sets a flag to indicate to the computer that data are ready to be strobed. Since the voltage from the Quantometer can be as high as 30 volts, and the ADC input circuit could be damaged above 15 volts, an ADC input protect circuit is necessary to limit the input to 11 volts for analysis purposes, the data are in error if the voltage exceeds 10 volts. When this condition exists, the Quantometer output amplifier becomes saturated and requires approximately three or four seconds to recover. Therefore, for this case the computer steps to the next capacitor and pauses for five seconds before reading another V_C value.

Figure 1. QUANTOMETER AND COMPUTER COMPONENTS.

Figure 2. COMPUTER INTERFACE.

0000	Ag	1000		2000	Ga	3000	Mg	4000	P	5000		6000	Ta	7000	
100	Al	1100	Ca	2100	Ge	3100	Mn	4100	Pb	5100		6100		7100	Zn
0200	As	1200	Cd	2200	Hf	3200	Mo	4200	Pd	5200	Sb	6200	Th	7200	Zr
300	Au	1300	Co	2300	Hg	3300	Na	4300		5300	Sc	6300	Ti		
0400	B	1400	Cr	2400	In	3400	Nb	4400		5400		6400	Tl	7400	
500	Ba	1500	Cs	2500		3500	Ni	4500	Rb	5500	Si	6500	U		
0600	Be	1600	Cu	2600	K	3600		4600		5600	Sn	6600	V	7600	
700	Bi	1700	Fe	2700	Li	3700		4700		5700	Sr	6700	W		

Figure 3. ELEMENT VOLTAGE STORAGE.

A Soroban card reader is supplied with the system to input identification data on each sample. Punched cards contain information needed to identify the data being taken as standard or sample data. Since all material is burned in duplicate, only one card needs to be read per two burns. The computer stores the number of total burns and only reads a card after an odd-numbered burn. On deciding that a card needs to be read, the computer issues a "start" command to the reader, and a signal is given to read one card. The card reader issues "ready to read" commands for each of the 80 columns on the card. When this signal is received by the computer, a check is made to determine if this particular column should be read. If so, the data are entered into the computer, decoded into a usable format, and stored for future use. Information from each card will be stored in blocks consisting of six 12-bit words. Each decimal digit is stored as a 4-bit binary coded decimal (BCD) number. A sample IBM data card is shown in Figure 4.

Due to noise generated by the Quantometer during a burn sequence and other devices in the same area using RF energy sources, a power failure detection and restart option was installed on the computer. This feature permits a complete power loss to the computer prior to the burn cycle, and then returns the computer to its former state when power is returned. After installation of this option, RF noise ceased to be a problem. Computer power is shut off approximately 500 milliseconds (via a time delay relay) before a burn starts. Upon termination of a burn, computer power is restored. Approximately three seconds (another time delay relay) after the power comes on, the Quantometer signals the computer to start the card reader.

The control panel contains push buttons to stop or start the computer, read a card, and erase the last sequence. The erase function is used to correct a series of tests if the read-delay tape malfunctions or some other failure invalidates the last set of data.

Figure 4. SAMPLE IBM CARD.

ANALYSIS METHODS

Aluminum Spark Method

Computer programs have been written for two methods of analysis on the Quantometer: aluminum spark and uranium carrier distillation. Operation of the Quantometer and computer hardware is identical for both methods.

The aluminum spark process involves burning both standard and sample material. After all measurements for a given run have been made and stored, the standard data are extracted and used for calculating a calibration curve for each element. If the equation of the least-squares straight line fitted to a group of "n" points is assumed to be $y = mx + b$ (where m is the slope and b the intercept on the y axis), then m and b can be computed from the simultaneous solution of the equations:

$$m \sum x + nb = \sum y$$

$$m \sum x^2 + b \sum x = \sum xy$$

where y is expressed in volts and x is the element concentration. The solution for m and b is:

$$m = \frac{n \sum xy - \sum x \sum y}{n \sum x^2 - (\sum x)^2}, \text{ and}$$

$$b = \frac{\Sigma x^2 \Sigma y - \Sigma x \Sigma xy}{n \Sigma x^2 - (\Sigma x)^2}$$

Known concentrations for the elements of each standard are stored, and calibration straight lines for each element are calculated statistically from the standard data. Concentration of each element for a loaded sample is determined by comparison with the element's calibration curve. When all element curves are known, element concentration values are calculated from the calibration curve, thus:

$$\text{Element Concentration} = x = \frac{y - b}{m}, \text{ where } y \text{ is the element sample voltage.}$$

Two-element concentrations are calculated resulting from the duplicate burn of a sample. These values are averaged and checked against a predetermined maximum and minimum. Concentration data are outputted in a format consisting of two-element concentration values corresponding to the duplicate burn of the sample and an average concentration value. This output form is retained by the laboratory. A second output format containing the average concentration value only is provided for the customer. A sample output is given in Figure 5. A detailed explanation of the aluminum spark computer software is given in Appendix B and a listing is given in Appendix C.

Uranium Carrier Distillation Method

The uranium carrier distillation process requires second-order calibration equations. Curves were calculated for each element, and corresponding values stored. For the uranium analysis, blank and reference standards are burned with the samples. After all material has been burned, a blank standard average and a reference standard

402845	6061	1394	1111	% AS RECVD
CR	.1361		.2205	.2033
CU	.1880		.2166	.2023
FE	.2653		.3865	.3259
MG	.7197		.7729	.7463
MN	.0519		.0671	.0595
NI	.0004		.0011	< .0120
PB	.0094		.0111	.0102
SI	.4375		.4850	.4612
SN	.0023		.0012	< .0090
TI	.0231		.0465	.0348
ZN	.0078		.0363	.0221

402845	6061	1394	1111	% AS RECVD
CR	.2033			
CU	.2023			
FE	.3259			
MG	.7463			
MN	.0595			
NI	< .0120			
PB	.0102			
SI	.4612			
SN	< .0090			
TI	.0348			
ZN	.0221			

Figure 5. ALUMINUM ANALYSIS OUTPUT.

average are calculated for each element analyzed. In order to eliminate background effects, blank averages are subtracted from each reference average and sample voltage. Element concentration is then calculated by the following equation:

$$\text{Element Concentration} = B \left(\frac{V_c - \text{Blank Average}}{\text{Reference Average} - \text{Blank Average}} \right) + C \left(\frac{V_c - \text{Blank Average}}{\text{Reference Average} - \text{Blank Average}} \right)^2$$

where B and C are the predetermined constants from the calibration curves. As in the aluminum method, two-element concentrations are calculated and the average value is checked against the maximum and minimum values. A sample output is given in Figure 6. Appendix D contains a detailed explanation of the uranium carrier computer software; a listing is given in Appendix E.

113225	6061	1682	0331			
CARRIER	DIST	MICRO-G/G (PPM)	METAL BASIS			
AL	.000 .000 <1.00	CU 115 104 109	P+	404 380 392		
AS	60.6 50.9 55.8	FE 647 622 634	PB	45.9 42.8 44.4		
AU	10.2 9.51 9.88	GA 6.67 5.48 6.07	PD	44.6 39.5 >10.0		
B+	6.33 6.70 6.51	GE 4.53 4.13 4.33	SB	11.5 9.72 >10.0		
BA	10.6 10.6 10.6	LI 15.5 15.8 15.7	SI	497 418 457		
BE	.527 .534 .530	MG 349 317 333	SN	38.1 32.9 35.5		
BI	8.95 8.77 8.86	MN 164 161 163	SR	55.9 61.2 58.5		
CA	381 344 362	MO 7.61 6.19 <10.0	TI	17.4 16.5 17.0		
CD	10.9 9.85 10.4	NA 45.8 56.5 51.2	V+	34.8 37.3 36.0		
CO	63.4 58.9 61.2	NB 19.2 16.2 17.7	W+	686 639 663		
CR	219 210 214	NI 99.7 82.8 91.3	ZN	50.7 49.3 50.0		
U+	1.34 .269 <XXX					

113225	6061	1682	0331			
CARRIER	DIST	MICRO-G/G (PPM)	METAL BASIS			
AL	<1.00	CU 109	P+	392		
AS	55.8	FE 634	PB	44.4		
AU	9.88	GA 6.07	PD	>10.0		
B+	6.51	GE 4.33	SB	>10.0		
BA	10.6	LI 15.7	SI	457		
BE	.530	MG 333	SN	35.5		
BI	8.86	MN 163	SR	58.5		
CA	362	MO <10.0	TI	17.0		
CD	10.4	NA 51.2	V+	36.0		
CO	61.2	NB 17.7	W+	663		
CR	214	NI 91.3	ZN	50.0		

Figure 6. URANIUM ANALYSIS OUTPUT.

ACKNOWLEDGEMENTS

The authors wish to thank R. T. Goodpasture of the Y-12 Plant Laboratory Department for his major role in providing the problem definition and the project requirements, and for his efforts in operating the equipment during the shakedown stage of interfacing the computer to the Quantometer. Appreciation is also expressed to G. R. Boser and A. E. Stephens for their technical guidance and supervision during the study.

APPENDIX A

Figure A-1. QUANTOMETER LOGIC DIAGRAM.

Figure A-2. QUANTOMETER MISCELLANEOUS LOGIC.

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APPENDIX B

ALUMINUM SPARK COMPUTER PROGRAM DESCRIPTION AND FLOW CHARTS

Introduction

This software package is for the aluminum spark method of analysis on the Quantometer system. The program consists of hardware service routines and a data processing routine for calculating element concentrations. Calibration curves are calculated by means of a least-squares straight-line fit of standard data, and the slope and intercept values are stored for each element. After all calibration curves have been calculated, sample data are referenced to the calibration curves to determine the element concentration. Concentration values are outputted in two formats—one for the laboratory and one for the customer.

Operation

Steps in the operation of the instrument are as follows:

1. Place the RIM loader in memory, starting at Location 7757, by means of the switch registers.
2. Read in the binary loader using the RIM loader.
3. Load the aluminum spark program binary tape, using the binary loader. Set the switch register to 77778 and depress the "load address" key. Next, set the switch register to 37778 and depress the "start" key. At the conclusion of the read in, the accumulator should be zero; if not, return to Step 1.
4. Start the program by setting the switch register to 4000g and depress the "load address" and "start" keys. The program should then be in the interrupt mode.
5. Assuming the sample material was loaded, it is time to depress the "fire" button on the Quantometer.
6. Just prior to the burn, power will be removed from the computer, card reader, interface, and teletype. At the conclusion of the burn, power will be restored to these instruments. The power-down process is necessary to prevent burn noise from affecting the computer operations.
7. After a five-second delay following power up, the card reader should read one card and continue to read one card following every odd-numbered burn thereafter.

8. At the completion of the read-card sequence, the computer initiates the stepping of the read-relay tape. Individual element voltages are read by the analog-to-digital converter (ADC) and stored within the computer.
9. After reading all elements specified by the read relay tape, the program enters the interrupt loop. This sequence is repeated until all sample material has been burned. Then the program should be halted, the switch register set to 0600g, and the "load address" and "start" keys depressed.
10. The element concentrations for all the samples will then be outputted by way of the teletype. The laboratory format is typed first followed by the customer format for each sample.

A list of the memory locations for the aluminum spark computer software is given in Table B-1 followed by a description of the various subsections.

Table B-1
MEMORY ALLOCATION FOR ALLUMINUM SPARK COMPUTER SOFTWARE

Locations	Function
0000-0177	Variable Storage
0200-0377	Element Location and Read ADC
0400-0577	Read Card Routine
0600-0777	Standard Type Identification
1000-1177	Element Identification from Element Present Code
1200-1377	Determination of Major Address for Element
1400-1577	Least-Squares Fit Calculations
1600-1777	Maximum and Minimum Concentration Check
2000-2177	Card Information Type Out
2200-2377	Element Concentration Output Routine
2400-2577	Element Concentration Calculation
2600-2777	Customer Output Routine
3000-3126	Known Element Concentration Storage
3200-3434	Card Information Storage
3435-3577	ADC, Read Relay, Prevent Routines, Output Routine
3600-3777	ENDCRD, POWOFF, SKIP, and CLEARC Routines
4000-4177	Initialization and Interrupt Loop
4200-4377	ADC Overflow and Erase Feature
4400-4577	Element Voltage Type Out and Delay
4600-4631	Voltage Conversion
5000-5300	Table Storage

Subsection Description

Title - Element Location and Read ADC

Location - 0200-0377

Purpose - To determine the element storage location as defined by the read-relay tape, read ADC, and store the voltage value in the element location determined.

Description - The routine is entered from the interrupt service routine. The read-relay tape contains subgroups of 5 and 12 relays, giving a total possible combination of 60 states. Upper memory is divided into five major sections which are further divided into 12 minor sections each. The decoding sequence gives the correct element address for data storage. After determining the proper address, the element voltage is strobed into the accumulator (AC) from the ADC and then placed in core memory at the decoded address.

IOT's Used - 6334 (Start ADC), 6312 (Read ADC), 6302 (Clear), 6324 (Start).

Routines Called - Name	Location
DELAY	4465
GOFER	3435
STBADC	3451
OVERFL	4242
OUTVLT	4400
PRINT	0026
PREP	0020
AMRCI	4450

Title - Read Card Routine

Location - 0400-0577

Purpose - To read and store information from standard and sample cards.

Description - This program is entered from the interrupt service routine. Cards are read on every odd-numbered burn. Standard and compute cards are coded in the first column. A "%" symbol represents a standard card, and a "@" symbol indicates a compute card. The first column is checked for either symbol, and the appropriate routine is entered for each. No symbol in the first column indicates a sample data card. Four-number groups totaling 18 digits are read for each sample card. Storing the data in BCD requires 6 twelve-bit words per card; therefore, six words are used for each card read. A table starting in Location *3200 is used for card data storage.

There are 11 different standards with each standard card coded A through G. The proper code is typed in the second column. As the standard card is read, Column 2 is stored in the first word of six in the card data table.

IOT's Used - 6324 (START), 6321 (PICCRD), 6322 (STBDAT), 6302 (CLEAR)

<u>Routines Called</u> - Name	<u>Location</u>
AMRCI	4450
ENDCRD	3701
COMPUT	0600

Title - Standard Type Identification

Location - 0600-0777

Purpose - To determine the code (A-G) stored for each standard card read; and, as the code is determined, form a table indicating the presence of a particular element.

Description - As standard cards are read, a table is constructed containing the address location for each in the card data table. The contents of each address in this standard table is decoded as being A-G. Of the seven different standards, each contains a varying number of the 11 (possible) elements. For a standard containing 11 elements, the code would be 37778 or a 1 bit for each element present. A third table is formed containing the octal position of the standard voltage values in the upper memory.

Example - For a standard card read on the third burn (data contained on second card), its particular code (A-G) would be stored in Location *3206g. Card data table starts in Location 3200g with six words for each card. As the voltage values are stored in the upper memory, the third burn would correspond to the number 28 for each element location. If *3200 is subtracted from 3206 and the resulting number divided by 3, the voltage location is 28.

A1	*0000	(upper memory)
	0001	
	0002	(standard voltage value location)

This type of procedure allows sample and standard materials to be burned in any order.

IOT's Used - None

<u>Routines Called</u>	<u>Name</u>	<u>Location</u>
	STOP	0134
	FLTIT	4200
	FIXIT	4211
	SCANN	1000
	CRLF	0151

Title - Element Identification from Element Present Code

Location - 1000-1777

Purpose - To determine the presence of a particular element from the element present code. This is the routine from which the calibration curves are calculated.

Description - Calibration curves are calculated in a sequential manner with regard to elements. Each standard is scanned for one particular element. Calibration curves are calculated from a least-squares fit of the standard data.

This routine begins with chromium (Cr) and calculates a calibration curve for Cr storing the intercept and slope values (b, m). After 11 such calibration curves have been calculated, the program proceeds to determine the element concentration.

IOT's Used - 6211 (CDF2), 6201 (CDF1)

<u>Routines Called</u> - <u>Name</u>	<u>Location</u>
CHKCNT	1305
STOP	0134
ADDVLT	1200
FOXIT	4504
CALATE	1443
DUMPIT	4262
DATA	2000

Title - Determination of Major Address for Element

Location - 1200-1377

Purpose - To determine the major address for the particular element curve being calculated.

Description - The major element address corresponding to the element curve being calculated must be determined. This address added to the octal position of the standard voltage value (as determined in the Example, Page 20) gives the correct address from which the specific voltage value can be pulled from the upper memory. The position of the C2K "and" bit determines the correct major address. The ADDVLT and CHKCNT routines are both subroutines of Page *1000.

IOT's Used - None

<u>Routines Called</u> - Name	<u>Location</u>
CALATE	1443
DUMPIT	4262
SCANN	1000
DATA	2000

Title - Least-Squares Fit Calculations

Location - 1400-1577

Purpose - To form the product terms for the least-squares fit and make the least-squares fit calculations.

Description - The least-squares fit calculations are:

$$m = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2}, \text{ and}$$

$$b = \frac{\sum x^2 \sum y - \sum x \sum xy}{n\sum x^2 - (\sum x)^2},$$

where:

x represents the known concentration,

y the standard voltage, and

n the number of points.

The product terms are formed with "n" being equal to the number of times a specific element is found in all standards burned. After all contributions are made to the product terms, the intercept (b) and slope (m) values are calculated and stored consecutively in the order calculated. The two routines PRDCT and CALATE serve as subroutines.

IOT's Used - None

<u>Routines Called</u> - <u>Name</u>	<u>Location</u>
FIXVLT	4600
FLTIT	4200

Title - Maximum and Minimum Concentration Check

Location - 1600-1777

Purpose - To establish the maximum and minimum concentration values for a particular element and determine if the calculated concentration average is within the fixed magnitude spectrum.

Description - Concentration values of all standards for a particular element are stored in one location. Maximum and minimum values will be contained in this table in random order. This table must be scanned and the maximum and minimum values located. After the average concentration value is calculated, the magnitude is compared to the upper and lower limits. If the magnitude exceeds the limits, a < or > sign is typed followed by the proper limit value. FMAMCV and CHKCON are subroutines.

IOT's Used - None

Routines Called - Name	Location
FLTIT	4200
PRINT	0026

Title - Card Information Type Out

Location - 2000-2177

Purpose - To type the sample card identification data at the top of the laboratory and customer output forms.

Description - After all calibration curves have been calculated, the program enters the element concentration calculation and concentration output routines. The card data table is scanned for sample data. As previously described, the sample data block will contain 18 BCD digits. This information is reproduced at the heading of the output form.

IOT's Used - None

<u>Routines Called</u> - <u>Name</u>	<u>Location</u>
CRLF	0151
SKIP	3532
GOFOT	4652
PRINT	0026
STOP	0134

Title - Element Concentration Output Routine

Location - 2200-2377

Purpose - To output the concentration values.

Description - When a sample data block is located in the sample card data table, the starting address is stored. Minus 3200 added to this address divided by three gives the location for sample voltages in the upper memory. For a given sample, element concentration values are calculated in sequence Cr - Zn. The element abbreviation is typed followed by concentration values for Burns 1 and 2. The average concentration value is calculated and maximum/minimum checks are made. The actual calculations and output are performed by Subroutines JMS to form this page. This output sequence generates the laboratory format.

IOT's Used - None

<u>Routines Called</u> - <u>Name</u>	<u>Location</u>
CRLF	0151
FLTIT	4200
FIXIT	4211
OPDATA	2400
NPO	3523
SAVE	3500
FMAMCV	1600
PRINT	0026
BUNCH	0720

Title - Element Concentration Calculation

Location - 2400-2577

Purpose - To calculate concentration values.

Description - This routine is a subroutine called from *2200 for calculating the element concentration values. The equation:

$$x = \frac{y - b}{m} \text{ (where } y \text{ is the sample voltage)}$$

determines the concentration value.

IOT's Used - 6211 (CDF2), 6201 (CDF1)

<u>Routines Called</u> - <u>Name</u>	<u>Location</u>
FIXVLT	4600

Title - Customer Output Routine

Location - 2600-2777

Purpose - To generate the customer output format.

Description - This routine is called after the completion of the element concentration output routine (*2200). Sample identification data are retyped at the heading of the form. The element abbreviation followed by the average value is typed in sequence Cr - Zn.

IOT's Used - None

<u>Routines Called</u> - <u>Name</u>	<u>Location</u>
CRLF	0151
PRINT	0026
SKIP13	3600
FMAMCV	1600
YAR	3127

Title - Known Element Concentration Storage

Location - 3000-3126

Purpose - For concentration storage.

Description - This page contains the known element concentrations of each standard, grouped by individual elements.

Title - Card Information Storage

Location - 3200-3434

Purpose - For storage of card information data.

Description - These pages are used for storage of the card information data. Six words are allocated for each card read. Sample data cards consist of 18 digits stored in BCD form. Standard cards have one character (A-G) stored in the first word with the five remaining words vacant. The address of the last block used for storage is recorded and called SAOLB (starting address of last block).

Title - ADC, Read Relay, Prevent Routine, and Output Routine

Location - 3435-3577

Purpose - Subroutines for ADC, read relay, and output routine.

Description - The group of five relays associated with the read-relay tape are decoded first by the *0200 routine. As a result of contact bounce it is possible to issue the ADD5SB IOT during a period of no contact, resulting in a program shut down. The GOFER routine insures contact closure for the ADD5SB IOT. The ADC has a tendency to "hang" following a start of the ADC IOT (STADC). This condition is avoided by a restart of the ADC by the STBADC routine. The SAVE routine is the output routine for concentration values by means of the floating point package.

IOT's Used - 6304 (ADD5SB), 6334 (STADC), 6312 (RDADC)

<u>Routines Called</u> - <u>Name</u>	<u>Location</u>
DELAY	4465
SKIP3	3624
CHKCON	1653
CRLF	0151
PRINT	0026

Title - ENDCRD, POWOFF, SKIP, and CLEARC Routines

Location - 3600-3777

Purpose - Subroutines as listed in the title.

Description - Three skip or teletype space routines are contained within this page. Space routines of length 3, 13, and 15 are provided. The CLEARC subroutine clears the table storage area from Locations 5000g through 5350g.

In addition, upper 4K memory is cleared from 0g - 7200g. The ENDCRD routine has a small delay then terminates the run mode of the card reader. The POWOFF routine enables the computer to be shut down and then restarted with no effect on the program operation.

IOT's Used - 6211 (CDF2), 6201 (CDF1), 6324 (START), 6302 (CLEAR)

<u>Routines Called</u> - Name	<u>Location</u>
PRINT	0026
PREP	0020
ABCD	0140

Title - Initialization and Interrupt Loop

Location - 4000-4177

Purpose - To initialize proper registers and provide a no-action sequence for the program operation.

Description - Initialization is performed in Locations *4001g - *4030g. Locations 4031g - 4055g contain the interrupt loop routine. In an idle state, the program will run in this NOP loop. When an interrupt occurs, the program goes to Location *0000g and then jumps to PRGINT Location *4056g. Here the interrupt is identified as being a power down, read card, read-relay tape, or erase interrupt. If the interrupt is not identified, the program halts. When the interrupt is identified, the proper service routine is entered.

IOT's Used - 6102 (SPC), 6301 (RECORD), 6331 (RDCRD), 6332 (ERASE)

<u>Routines Called - Name</u>	<u>Location</u>
CLEARC	3636
POWOFF	3723
READAD	0200
RDDCRD	0400
ERASED	4303

Title - ADC Overflow and Erase FeatureLocation - 4200-4377Purpose - To provide an ADC overflow delay and erase capability.

Description - Two routines, FLTIT and FIXIT, are contained within this page and provide a means for converting octal numbers to floating and fixed forms. After each ADC value is strobed into the AC, a check is made to determine if this value is 77778, indicating a greater than 10-volt input to the ADC. A greater than 10-volt reading results in a saturated condition for the Quantometer amplifier. This saturated condition begins to decay after the read-relay tape has been stepped. After the step, a five-second delay is initiated, allowing the Quantometer output to return to normal. The erase feature provides the capability of erasing the last burn data. This arrangement includes card information data and element voltage entries.

IOT's Used - 6032 (CLEAR), 6324 (START)

<u>Routines Called</u> - <u>Name</u>	<u>Location</u>
CRLF	0151
PREP	0020
DELAY	4465
ENUF	4712

Title - Element Voltage Type Out and Delay

Location - 4400-4577

Purpose - To type out the ADC voltage values as read by the ADC.

Description - After the ADC read sequence is complete, the voltage is outputted. This step gives a listing of all voltage values stored in the upper memory. The AMRCI and DELAY routines are variable time-delay routines.

IOT's Used - 6324 (START), 6302 (CLEAR), 6211 (CDF2), 6201 (CDF1)

<u>Routines Called</u>	<u>Name</u>	<u>Location</u>
	FLTIT	4200
	CRLF	0151
	PREP	0020
	PRDUCT	1400

Title - Voltage Conversion

Location - 4600-4631

Purpose - To convert octal ADC values to decimal 0 - 10 values.

Description - The FIXVLT routine is identical to the first part of the OUTVLT routine. ADC octal values are converted to decimal values. Several times during the operation of the program the decimal ADC value is required without the type out sequence.

Title - Table Storage

Location - 5000-5300

Purpose - This portion of memory is designated for table storage.

APPENDIX C

ALUMINUM SPARK SOFTWARE LISTING

ALUMINUM

MAY, 8 70

PAGE ZERO

```

CDF2=6211
CDF1=6201
SPL=6102
RECORD=6301
CLEAR=6302
ADD5SB=6304
OVRFL0=6311
RDADC=6312
AD12SB=6314
PICCRD=6321
STBDAT=6322
START=6324
RDCRD=6331
ERASE=6332
STADC=6334
FNOR=7000
FADD=1000
FSUB=2000
FMPY=3000
FDIV=4000
FGET=5000
FPU=6000
FEXT=0000
FIXTAB
*0000
0000 0000 PI, 0
0001 5777 JMP PRGINT
0002 0000 LINC, 0
0003 0000 AC, 0
*0005
0005 7400 7400
0006 7200 7200
0007 5600 5600
*0010
0010 0000 AOS, 0
0011 0000 SC, 0
0012 0000 AN, 0
0013 0000 CON, 0
0014 0000 VOLT, 0
0015 0000 SLOPEM, 0
0016 0000 INTCPB, 0
0017 0000 GRAVY, 0
0020 7300 PREP, CLA CLL
0021 1002 TAD LINC
0022 7004 RAL
0023 1003 TAD AC

```

```

0024 6001      ION
0025 5400      JMP I 0
0026 0000 PRINT, 0
0027 6046      TLS
0030 6041      TSF
0031 5030      JMP .-1
0032 6042      TCF
0033 7300      CLA CLL
0034 5426      JMP I PRINT
0035 5050      AUTO15, 5050
0036 0302      C302, 0302      /B ASCII CODE
          *0063

0063 0303      C303, 0303      / C
0064 0305      C305, 0305      /E
0065 0306      C306, 0306      /F
0066 0307      C307, 0307      /G
0067 0311      C311, 0311      /I
0070 0315      C315, 0315      /M
0071 0316      C316, 0316      /N
0072 0320      C320, 0320      /P
0073 0323      C323, 0323      /S
0074 0324      C324, 0324      /T
0075 0325      C325, 0325      /U
0076 0332      C332, 0332      /Z
0077 0322      C322,0322      /R
0100 0215      C215, 0215      /CR
0101 0212      C212, 0212      /LF
0102 0331      B331, 0331      /Y
0103 0261      C261, 0261      /1
0104 0262      C262, 0262      /2
0105 1400      CRLOC, 1400
0106 1600      CULOC, 1600
0107 1700      FELOC, 1700
0110 3200      MGLOC, 3200
0111 3300      MNLOC, 3300
0112 4000      NILOC, 4000
0113 4300      PBLOC, 4300
0114 4700      SILOC, 4700
0115 5000      SNLOC, 5000
0116 5400      TILOC, 5400
0117 4200      ZNLOC, 4200
0120 0000      STDCNT, 0
0121 0000      PASSNO, 0
0122 0000      GORF, 0
0123 0000      CONADD, 0
0124 0000      ADD, 0
0125 0000      ADDLOC, 0
0126 0000      VOLTLO, 0
0127 0000      CONCEN, 0
0130 0000      VOLTGE, 0
0131 0000      ELENUM, 0
0132 0000      CHARLE, 0
0133 0000      MINENO, 0
0134 0000      SAOLB, 0
0135 0000      KEEPAD, 0
0136 0000      REALAD, 0
0137 0000      STOP, 0
0140 7402      HLT
0141 0000      CRDCNT, 0
0142 0000      REG, 0

```



```

0143 1002 ABCD, TAD LINC
0144 7104 CLL RAL
0145 1003 TAD AC
0146 6001 ION
0147 2153 ISZ BURNO
0150 7000 NOP
0151 5552 JMP I PC
0152 0000 PC, 0
0153 0000 BURNO, 0
0154 0000 CRLF, 0
0155 6032 KCC
0156 6046 TLS
0157 7300 CLA CLL
0160 1176 TAD (215)
0161 4026 JMS PRINT
0162 1175 TAD (212)
0163 4026 JMS PRINT
0164 5554 JMP I CRLF

*0200
0200 0000 READAD, 0000
0201 7300 AGAIN, CLA CLL
0202 4777 JMS DELAY
0203 2263 ISZ TIM /(-2)
0204 5213 JMP .+7
0205 6314 AD12SB
0206 3271 DCA B
0207 1264 TAD MIN2
0210 3263 DCA TIM
0211 1271 TAD B
0212 5214 JMP CHECK
0213 4776 JMS GOFER
0214 4231 CHECK, JMS DECOD
0215 4231 JMS DECOD
0216 4231 JMS DECOD
0217 4231 JMS DECOD
0220 4231 JMS DECOD
0221 4231 JMS DECOD
0222 4231 JMS DECOD
0223 4231 JMS DECOD
0224 4231 JMS DECOD
0225 4231 JMS DECOD
0226 4231 JMS DECOD
0227 4231 JMS DECOD
0230 4326 JMS OFF
0231 0000 DECOD, 0000
0232 7010 RAR
0233 7430 SZL
0234 5237 JMP DECODE
0235 2272 ISZ RAG
0236 5631 JMP I DECOD
0237 7440 DECODE, SZA
0240 5326 JMP OFF
0241 2272 ISZ RAG
0242 5243 Y, JMP DECO5
0243 1265 DECO5, TAD X1
0244 3242 DCA Y
0245 1267 TAD CONST5
0246 1272 TAD RAG
0247 3273 DCA F
0250 3272 DCA RAG

```

0251	5673		JMP I F	
0252	1266	DECO12,	TAD X2	
0253	3242		DCA Y	
0254	1270		TAD CONS12	
0255	1272		TAD RAG	
0256	3273		DCA F	
0257	3272		DCA RAG	
0260	1264		TAD MIN2	
0261	3263		DCA TIM	
0262	5673		JMP I F	
0263	7776	TIM,	7776	
0264	7776	MIN2,	7776	
0265	5252	X1,	5252	
0266	5243	X2,	5243	
0267	0276	CONST5,	0276	
0270	0305	CONS12,	0305	
0271	0000	B,	0000	/TEMP. STORAGE UTILITY REGISTER
0272	0000	RAG,	0	
0273	0000	F,	0000	
0274	1400	C1400,	1400	
0275	0100	C100,	0100	
0276	0000	TEMPST,	0000	
0277	1274		TAD C1400	
0300	1274		TAD C1400	
0301	1274		TAD C1400	
0302	1274		TAD C1400	
0303	7000		NOP	
0304	3276		DCA TEMPST	
0305	5201		JMP AGAIN	
0306	1275		TAD C100	
0307	1275		TAD C100	
0310	1275		TAD C100	
0311	1275		TAD C100	
0312	1275		TAD C100	
0313	1275		TAD C100	
0314	1275		TAD C100	
0315	1275		TAD C100	
0316	1275		TAD C100	
0317	1275		TAD C100	
0320	1275		TAD C100	
0321	7000		NOP	
0322	1276		TAD TEMPST	
0323	1153		TAD BURNO	/THE ADDRESS IN WHICH DAT.
0324	3365		DCA ADDRES	/IS TO BE DEPOSITED,
0325	5336		JMP LOKADC	
0326	0000	OFF,	0	
0327	6302		CLEAR	
0330	6046		TLS	
0331	7300		CLA CLL	
0332	1375		TAD (207)	
0333	4026		JMS PRINT	
0334	7402		HLT	
0335	5020		JMP PREP	
0336	7300	LOKADC,	CLA CLL	
0337	4774		JMS STBADC	
0340	3364		DCA HOPP	
0341	7001		IAC / SD	
0342	1364		TAD HOPP	
0343	7650		SNA CLA / ADC = 7777 ?	
0344	4773		JMS OVERFL	/ YES

```

0345 1364      TAD HOPP          / NO
0346 4772      JMS OUTVLT        / TYPE OUT VOLTAGE
0347 6211      CDF2
0350 3765      DCA I ADDRES
0351 6201      CDF1
0352 6302      CLEAR
0353 7300      CLA CLL
0354 1371      TAD (10)
0355 6324      START
0356 7300      CLA CLL
0357 1370      TAD (5050)
0360 3035      DCA AUTO15
0361 1370      TAD (5050)
0362 3015      DCA 0015
0363 5020      JMP PREP
0364 0000      HOPP, 0
0365 0000      ADDRES, 0
                  / READ CARD ROUTINE
                  /ROW ZERO ON CARD GOES IN BIT ZERO IN AC

0370 5050
0371 0010
0372 4400
0373 4242
0374 3451
0375 0207
0376 3435
0377 4465

*0400
0400 0000      RDDCRD, 0000
0401 7300      CLA CLL
0402 3353      DCA COLCNT
0403 3346      DCA TEMP1
0404 3344      DCA NUMBER
0405 2141      ISZ CRDCNT
0406 1141      TAD CRDCNT
0407 7010      RAR
0410 7420      SNL          /EVEN OR ODD NUMBERED BUM
0411 4777      JMS AMRCI      / EVEN IGNORE DELAY STEP TAPE
0412 7300      CLA CLL
0413 1376      TAD (2)
0414 6324      START
0415 7200      CLA
0416 6321      PICCRD
0417 5216      JMP -1
0420 7300      DATSTB, CLA CLL
0421 6322      STBDAT
0422 5220      JMP -2
0423 7000      NOP
0424 6302      CLEAR
0425 6322      STBDAT
0426 3345      DCA TEMX
0427 2353      ISZ COLCNT
0430 1353      TAD COLCNT
0431 1375      TAD (-1)
0432 7450      SNA          /IS THIS THE FIRST COL.
0433 5317      JMP COMCHK      /YES CHECK FOR COMPUTER B.S.
0434 1374      TAD (-7)
0435 7510      SPA          /2 < OR < TO COLCNT < OR = 7?
0436 5262      JMP GOODNO      /YES
0437 1373      TAD (-13)      / NO

```

```

0440 7510 SPA /8< OR = COLCNT < OR = 18?
0441 5220 JMP DATSTB /YES
0442 1372 TAD (-4) / NO
0443 7510 SPA /19 < OR = COLCNT < OR = 22
0444 5262 JMP GOODNO /YES
0445 1371 TAD (-24) / NO
0446 7510 SPA / 23 < OR = COLCNT < OR = 42
0447 5220 JMP DATSTB /YES
0450 1372 TAD (-4) / NO
0451 7510 SPA / 43 < OR = COLCNT < OR = 46
0452 5262 JMP GOODNO
0453 1370 TAD (-10) / NO
0454 7510 SPA / 47 < OR = COLCNT < OR = 58
0455 5220 JMP DATSTB /YES
0456 1372 TAD (-4) / NO
0457 7510 SPA /55 < OR = COLCNT < OR = 58
0460 5262 JMP GOODNO /YES
0461 5767 JMP ENDCRD / NO
0462 7300 GOODNO, CLA CLL
0463 1345 TAD TEMX
0464 7500 A, SMA
0465 5314 JMP ROTATE
0466 7300 CLA CLL
0467 1344 TAD NUMBER
0470 1346 TAD TEMP1
0471 2347 ISZ M3
0472 7410 SKP
0473 5301 JMP .+6
0474 7006 RTL
0475 7006 RTL
0476 3346 DCA TEMP1
0477 3344 DCA NUMBER
0500 5220 JMP DATSTB
0501 3525 DCA I ADDLOC
0502 1125 TAD ADDLOC
0503 7001 IAC
0504 3125 DCA ADDLOC
0505 1350 TAD MIN3
0506 3347 DCA M3
0507 3346 DCA TEMP1
0510 3344 DCA NUMBER
0511 2352 ISZ M6
0512 5220 JMP DATSTB
0513 5767 JMP ENDCRD
0514 7004 ROTATE, RAL
0515 2344 ISZ NUMBER
0516 5264 JMP A
0517 7100 COMCHK, CLL
0520 1345 TAD TEMX
0521 7450 SNA
0522 5220 JMP DATSTB
0523 7700 SMA CLA /COMPTT OR STANDARD?
0524 5766 JMP COMPUT / COMPUTE CARD
0525 3344 DCA NUMBER /STANDARD CARD
0526 1125 TAD ADDLOC
0527 3410 DCA I 10
0530 2120 ISZ STDCNT
0531 7300 CLA CLL
0532 6322 STBDAT
0533 5331 JMP .-2 / READ NEXT COLUMN

```

```

0534 7000      NOP
0535 6302      CLEAR
0536 6322      STBDAT
0537 3525      DCA I ADDLOC      /STORE INDE IDENT. FOR STD.
0540 1125      TAD ADDLOC
0541 1365      TAD (6)
0542 3125      DCA ADDLOC
0543 5767      JMP ENDCRD
0544 0000      NUMBER, 0000
0545 0000      TEMX, 0
0546 0000      TEMP1, 0000
0547 7775      M3, 7775
0550 7775      MIN3, 7775
0551 7772      MIN6, 7772
0552 7772      M6, 7772
0553 0000      COLCNT, 0
                   / PRECOMPUTE

0565 0006
0566 0600
0567 3701
0570 7770
0571 7754
0572 7774
0573 7765
0574 7771
0575 7777
0576 0002
0577 4450

*0600
0600 7300      COMPUT, CLA CLL
0601 1125      TAD ADDLOC
0602 3134      DCA SAOLB
0603 3331      DCA NUMADD
0604 1377      TAD (5177)
0605 3010      DCA Z 10
0606 1376      TAD (5227)
0607 3011      DCA Z 11
0610 1375      TAD (5257)
0611 3012      DCA Z 12
0612 1410      BEGIN, TAD I 10      / GET FIRST STD. ADDRESS
0613 3332      DCA TEMP
0614 1732      TAD I TEMP      /GET CODE
0615 0374      AND (2000)
0616 7650      SNA CLA /CODE=A?
0617 5223      JMP .+4 /NO
0620 1347      TAD C3777      /YES
0621 3411      DCA I 11
0622 4276      JMS FIXADD
0623 1732      TAD I TEMP
0624 0350      AND CIK
0625 7650      SNA CLA /CDD B?
0626 5232      JMP .+4 /NO
0627 1346      TAD C3553      /YES
0630 3411      DCA I 11
0631 4276      JMS FIXADD
0632 1732      TAD I TEMP
0633 0345      AND C400
0634 7650      SNA CLA /CODE C?
0635 5241      JMP .+4 /NO
0636 1344      TAD C3610      /YES

```

```

0637 3411 DCA I 11
0640 4276 JMS FIXADD
0641 1732 TAD I TEMP
0642 0343 AND C200
0643 7650 SNA CLA /CODE D?
0644 5250 JMP .+4 / NO
0645 1342 TAD C3601
0646 3411 DCA I 11
0647 4276 JMS FIXADD
0650 1732 TAD I TEMP
0651 0373 AND (0100)
0652 7650 SNA CLA /CODE E?
0653 5257 JMP .+4 /NO
0654 1341 TAD C0024 /YES
0655 3411 DCA I 11
0656 4276 JMS FIXADD
0657 1732 TAD I TEMP
0660 0340 AND C40
0661 7650 SNA CLA /CODE F?
0662 5266 JMP .+4 /NO
0663 1337 TAD C3753 /YES
0664 3411 DCA I 11
0665 4276 JMS FIXADD
0666 1732 TAD I TEMP
0667 0351 AND C20
0670 7650 SNA CLA /CODE G?
0671 5275 JMP .+4 /NO
0672 1336 TAD C7753 /YES
0673 3411 DCA I 11
0674 4276 JMS FIXADD
0675 4137 JMS STOP
0676 0000 FIXADD, 0
0677 1332 TAD TEMP
0700 1372 TAD (-3200)
0701 4771 JMS FLTIT
0702 4407 JMS I Z 7
0703 4333 FDIV SIX
0704 3352 FMPY TWO
0705 0000 FEXT
0706 4770 JMS FIXIT
0707 3412 DCA I 12
0710 2331 ISZ NUMADD
0711 7200 CLA
0712 1120 TAD STDCNT
0713 7041 CIA
0714 1331 TAD NUMADD
0715 7640 SZA CLA /NUMADD=STDCNT?
0716 5212 JMP BEGIN /NO
0717 5767 JMP SCANN
0720 0000 BUNCH, 0
0721 7300 CLA CLL
0722 1366 TAD (-34)
0723 3330 DCA CNT
0724 4154 DO, JMS CRLF
0725 2330 ISZ CNT
0726 5324 JMP DO
0727 5720 JMP I BUNCH
0730 0000 CNT, 0
0731 0000 NUMADD, 0000
0732 0000 TEMP, 0000

```

```

p733 0003 SIX, 0003
0734 3000 3000
0735 0000 0000
0736 7753 C7753, 7753
0737 3753 C3753, 3753
0740 0040 C40, 0040
0741 0024 C0024, 0024
0742 3601 C3601, 3601
0743 0200 C200, 0200
0744 3610 C3610, 3610
0745 0400 C400, 0400
0746 3553 C3553, 3553
0747 3777 C3777, 3777
0750 1000 CIK, 1000
0751 0020 C20, 0020
0752 0002 TWO, 0002
0753 2000 2000
0754 0000 0000
/ STORE STANDARD DATA

0766 7744
0767 1000
0770 4211
0771 4200
0772 4600
0773 0100
0774 2000
0775 5257
0776 5227
0777 5177

*1000
1000 7300 SCANN, CLA CLL
1001 1344 TAD C5227
1002 3011 DCA Z 11
1003 1345 TAD C5257
1004 3012 DCA Z 12
1005 1346 TAD C5317
1006 3013 DCA Z 13
1007 1347 TAD C5347
1010 3014 DCA Z 14
1011 1120 SART, TAD STDCNT
1012 7041 CIA
1013 3362 DCA FROG
1014 1362 TAD FROG
1015 3122 DCA GORF
1016 1411 TART, TAD I 11 /GET CODE
1017 3350 DCA STOR
1020 2121 ISZ PASSNO
1021 1350 TAD STOR
1022 0351 AND C2K
1023 7650 SNA CLA /CR PRESENT
1024 5777 JMP CHKCNT /NO
1025 1350 TAD STOR /YES
1026 1352 TAD M3777
1027 7640 SZA CLA /STANDARD A
1030 5232 JMP .+2 /NO
1031 5270 JMP OUT /YES
1032 1350 TAD STOR
1033 1353 TAD M3553
1034 7640 SZA CLA /STANDARD B
1035 5237 JMP .12 /NO

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1036	5271	JMP OUT+1	/YES
1037	1350	TAD STOR	
1040	1354	TAD M3610	
1041	7640	SZA CLA /STANDARD C	
1042	5244	JMP .+2 /NO	
1043	5272	JMP OUT+2	/YES
1044	1350	TAD STOR	
1045	1355	TAD M3601	
1046	7640	SZA CLA /STANDARD D	
1047	5251	JMP .+2 /NO	
1050	5273	JMP OUT+3	/YES
1051	1350	TAD STOR	
1052	1356	TAD M0024	
1053	7640	SZA CLA /STANDARD E	
1054	5256	JMP .+2 /NO	
1055	5274	JMP OUT+4	/YES
1056	1350	TAD STOR	
1057	1357	TAD M3753	
1060	7640	SZA CLA /STANDARD F	
1061	5263	JMP .+2 /NO	
1062	5275	JMP OUT+5	/YES
1063	1350	TAD STOR	
1064	1360	TAD M7753	
1065	7640	SZA CLA /STANDARD G	
1066	4137	JMS STOP	/NO
1067	5276	JMP OUT+6	/YES
1070	1361	OUT, TAD CM1 /STD. A	
1071	1361	TAD CM1 /STD. B	
1072	1361	TAD CM1 /STD. C	
1073	1361	TAD CM1 /STD. D	
1074	1361	TAD CM1 /STD. E	
1075	1361	TAD CM1 /STD. F	
1076	1123	TAD CONADD	
1077	3124	DCA ADD	
1100	1524	TAD I ADD	
1101	3127	DCA CONCEN	
1102	1127	TAD CONCEN	
1103	3413	DCA I 13	/TABLE STORE CON.
1104	1412	TAD I 12	
1105	3126	DCA VOLTLO	
1106	4776	JMS ADDVLT	
1107	6211	CDF2	
1110	1526	TAD I VOLTLO	
1111	6201	CDF1	
1112	3130	DCA VOLTGE	
1113	1130	TAD VOLTGE	
1114	3414	DCA I 14	/TABLE STORE VOLT.
1115	4775	JMS FOXIT	
1116	2362	ISZ FROG	/X ELEMENT BEEN CHECKED
1117	5216	JMP TART	
1120	4774	JMS CALATE	
1121	4773	JMS DUMPII	
1122	1351	TAD C2K	
1123	7010	RAR	
1124	3351	DCA C2K	
1125	1123	TAD CONADD	
1126	1372	TAD (10)	
1127	3123	DCA CONADD	
1130	1123	TAD CONADD	
1131	3124	DCA ADD	


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1132 1351      TAD C2K
1133 7640      SZA CLA /LOOKED AT ALL ELEMENTS
1134 5200      JMP SCANN      /NO
1135 1371      TAD (2000)      / YES
1136 3351      DCA C2K
1137 1370      TAD (3006)
1140 3124      DCA ADD
1141 1124      TAD ADD
1142 3123      DCA CONADD
1143 5771      JMP DATA
1144 5227 C5227, 5227
1145 5257 C5257, 5257
1146 5317 C5317, 5317
1147 5347 C5347, 5347
1150 0000 STOR, 0
1151 2000 C2K, 2000
1152 4001 M3777, 4001
1153 4225 M3553, 4225
1154 4170 M3610, 4170
1155 4177 M3601, 4177

1156 7754 M0024, 7754
1157 4025 M3753, 4025
1160 0025 M7753, 0025
1161 7777 CM1, 7777
1162 0000 FROG, 0000
1170 3006
1171 2000
1172 0010
1173 4262
1174 1443
1175 4504
1176 1200
1177 1305

      *1200
1200 0000 ADDVLT, Q
1201 1777      TAD C2K /2K THRU 1
1202 0340      AND CON2K
1203 7650      SNA CLA /CR?
1204 5211      JMP .+5 /NO
1205 1105      TAD CRLQC      /YES
1206 1126 REPEAT, TAD VOLTLO
1207 3126      DCA VOLTLO
1210 5600      JMP I ADDVLT
1211 1777      TAD C2K
1212 0341      AND CONIK
1213 7650      SNA CLA /CU?
1214 5217      JMP .+3 /NO
1215 1106      TAD CULQC      /YES
1216 5206      JMP REPEAT
1217 1777      TAD C2K
1220 0342      AND CON400
1221 7650      SNA CLA /FE?
1222 5225      JMP .+3 /NO
1223 1107      TAD FELOC      /YES
1224 5206      JMP REPEAT
1225 1777      TAD C2K
1226 0343      AND CON200
1227 7650      SNA CLA /MG?
1230 5233      JMP .+3 /NO

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1231	1110	TAD MGLOC	/YES
1232	5206	JMP REPEAT	
1233	1777	TAD C2K	
1234	0344	AND CON100	
1235	7650	SNA CLA /MN?	
1236	5241	JMP .+3 /NO	
1237	1111	TAD MNLOC	/YES
1240	5206	JMP REPEAT	
1241	1777	TAD C2K	
1242	0345	AND CON40	
1243	7650	SNA CLA /NI?	
1244	5247	JMP .+3 /NO	
1245	1112	TAD NILOC	/YES
1246	5206	JMP REPEAT	
1247	1777	TAD C2K	
1250	0346	AND CON20	
1251	7650	SNA CLA /PB?	
1252	5255	JMP .+3 /NO	
1253	1113	TAD PBLOC	/YES
1254	5206	JMP REPEAT	
1255	1777	TAD C2K	
1256	0347	AND CON10	
1257	7650	SNA CLA /SI?	
1260	5263	JMP .+3 /NO	
1261	1114	TAD SILOC	/YES
1262	5206	JMP REPEAT	
1263	1777	TAD C2K	
1264	0350	AND CON4	
1265	7650	SNA CLA /SN?	
1266	5271	JMP .+3 /NO	
1267	1115	TAD SNLOC	/YES
1270	5206	JMP REPEAT	
1271	1777	TAD C2K	
1272	0351	AND CON2	
1273	7650	SNA CLA /TI?	
1274	5277	JMP .+3 /NO	
1275	1116	TAD TILOC	/YES
1276	5206	JMP REPEAT	
1277	1777	TAD C2K	
1300	0352	AND CON1	
1301	7650	SNA CLA /ZN?	
1302	4137	JMS STOP	/NO
1303	1117	TAD ZNLOC	/YES
1304	5206	JMP REPEAT	/X=CR.....ZN
1305	7300	CHKCNT, CLA CLL	
1306	2776	ISZ FROG	/ X ELEMENT BEEN CHECKED FOR ALL S
1307	5334	JMP LOWER	/ NO
1310	4775	JMS CALATE	
1311	4774	JMS DUMPIT	/ YES
1312	1777	TAD C2K	
1313	7010	RAR	
1314	3777	DCA C2K	
1315	1123	TAD CONADD	
1316	1347	TAD CON10	
1317	3123	DCA CONADD	
1320	1123	TAD CONADD	
1321	3124	DCA ADD	
1322	1777	TAD C2K	
1323	7640	SZA CLA /LOOKED AT ALL ELEMENTS	
1324	5773	JMP SCANN	

1325	1372	TAD (2000)	/ YES
1326	3777	DCA C2K	
1327	1371	TAD (3006)	
1330	3124	DCA ADD	
1331	1124	TAD ADD	
1332	3123	DCA CONADD	
1333	5772	JMP DATA	
1334	7300	LOWER, CLA CLL	
1335	1412	TAD I 12	
1336	3126	DCA VOLTLO	
1337	5770	JMP TART	
1340	2000	CON2K, 2000	
1341	1000	CONIK, 1000	
1342	0400	CON400, 0400	
1343	0200	CON200, 0200	
1344	0100	CON100, 0100	
1345	0040	CON40, 0040	
1346	0020	CON20, 0020	
1347	0010	CON10, 0010	
1350	0004	CON4, 0004	
1351	0002	CON2, 0002	
1352	0001	CON1, 0001	
1370	1016		
1371	3006		
1372	2000		
1373	1000		
1374	4262		
1375	1443		
1376	1162		
1377	1151		
		*1400	
1400	0000	PRDUCT, 0	
1401	7300	CLA CLL	
1402	2131	ISZ ELENUM	
1403	1131	TAD ELENUM	
1404	7041	CIA	
1405	1377	TAD (-1)	
1406	3133	DCA MINEND	
1407	1130	TAD VOLTGE	
1410	4776	JMS FIXVLT	
1411	4407	JMS I Z 7	
1412	6320	FPUT SINGLY	
1413	1323	FADD SUMY	
1414	6323	FPUT SUMY	
1415	0000	FEXT	
1416	7300	CLA CLL	
1417	1127	TAD CONCEN	
1420	4775	JMS FLTIT	
1421	4407	JMS I Z 7	
1422	6326	FPUT SINGLX	
1423	3361	FMPY C0001	
1424	1331	FADD SUMX	
1425	6331	FPUT SUMX	
1426	5326	FGET SINGLX	
1427	3326	FMPY SINGLX	
1430	3364	FMPY C0002	
1431	1334	FADD XSQURD	
1432	6334	FPUT XSQURD	
1433	5326	FGET SINGLX	
1434	3320	FMPY SINGLY	

1435	3361	FMPY C0001
1436	1337	FADD SUMXY
1437	6337	FPUT SUMXY
1440	0000	FEXT
1441	7300	CLA CLL
1442	5600	JMP I PRDUCT
1443	0000	CALATE, 0
1444	1131	TAD ELENUM
1445	4775	JMS FLTIT
1446	4407	JMS I Z 7
1447	6342	FPUT NNORM
1450	3334	FMPY XSQURD
1451	6345	FPUT PRODCI
1452	5331	FGET SUMX
1453	3331	FMPY SUMX
1454	6350	FPUT SUMX2
1455	5345	FGET PRODCI
1456	2350	FSUB SUMX2
1457	6353	FPUT DENOMR
1460	5331	FGET SUMX
1461	3323	FMPY SUMY
1462	6356	FPUT PROSXY
1463	5342	FGET NNORM
1464	3337	FMPY SUMXY
1465	2356	FSUB PROSXY
1466	4353	FDIV DENOMR
1467	6415	FPUT I SLOPEM
1470	5331	FGET SUMX
1471	3337	FMPY SUMXY
1472	6345	FPUT PRODCI
1473	5334	FGET XSQURD
1474	3323	FMPY SUMY
1475	2345	FSUB PRODCI
1476	4353	FDIV DENOMR
1477	6416	FPUT I INTCPB
1500	0000	FEXT
1501	7300	CLA CLL
1502	1015	TAD SLOPEM
1503	1374	TAD (3)
1504	3015	DCA SLOPEM
1505	1016	TAD INTCPB
1506	1374	TAD (3)
1507	3016	DCA INTCPB
1510	5643	JMP I CALATE
1511	7777	M1, 7777
		*1520
1520	0000	SINGLY, 0
1521	0000	0
1522	0000	0
1523	0000	SUMY, 0
1524	0000	0
1525	0000	0
1526	0000	SINGLY, 0
1527	0000	0
1530	0000	0
1531	0000	SUMX, 0
1532	0000	0
1533	0000	0
1534	0000	XSQURD, 0
1535	0000	0

1536	0000		0
1537	0000	SUMXY,	0
1540	0000		0
1541	0000		0
1542	0000	NNORM,	0
1543	0000		0
1544	0000		0
1545	0000	PRODCT,	0
1546	0000		0
1547	0000		0
1550	0000	SUMX2,	0
1551	0000		0
1552	0000		0
1553	0000	DENOMR,	0
1554	0000		0
1555	0000		0
1556	0000	PROSXY,	0
1557	0000		0
1560	0000		0
1561	7767	C0001,	7767
1562	2030		2030
1563	4470		4470
1564	7755	C0002,	7755
1565	2061		2061
1566	5737		5737
1574	0003		
1575	4200		
1576	4600		
1577	7777		
		*1600	
1600	0000	FMAMCV,	0
1601	1757		TAD I AOMC
1602	4777		JMS FLIT
1603	4407		JMS I Z 7
1604	3341		FMPI C001
1605	6344		FMPI MCV
1606	0000		FEXT
1607	7300		CLA CLL
1610	1357		TAD AOMC
1611	1376		TAD (10)
1612	3357		DCA AOMC
1613	1352		TAD M5
1614	3353		DCA MIN5
1615	1360		TAD AOMAXC
1616	3354		DCA KEEP
1617	1754		TAD I KEEP
1620	3355		DCA LARGE
1621	1354	DOAGN,	TAD KEEP
1622	7001		IAC
1623	3354		DCA KEEP
1624	1754		TAD I KEEP
1625	3356		DCA GOGL
1626	1356		TAD GOGL
1627	7041		CIA
1630	1355		TAD LARGE
1631	7700		SMA CIA / LARGER VALUE
1632	5235		JMP .+3 / NO
1633	1356		TAD GOGL
1634	3355		DCA LARGE
1635	2353		ISZ MIN5 / THROUGH ?

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1636 5221      JMP DOAGN
1637 7300      CLA CLL
1640 1360      TAD AQMAXC
1641 1376      TAD (10)
1642 3360      DCA AQMAXC
1643 1355      TAD LARGE
1644 4777      JMS FLTIT
1645 4407      JMS I Z 7
1646 3341      FMPY C001
1647 6347      FPUT MAXCV
1650 0000      FEXT
1651 7300      CLA CLL
1652 5600      JMP I FMAMCV
1653 0000      CHKCON, 0
1654 7300      CLA CLL
1655 1775      TAD FLAG1
1656 7640      SZA CLA / ADC > 10 VOLTS ?
1657 4312      JMS GTC
1660 1774      TAD FLAG2
1661 7640      SZA CLA / ADC > 10 VOLTS ?
1662 4312      JMS GTC
1663 4407      FAKE, JMS I Z 7
1664 5347      FGET MAXCV
1665 2773      FSUB YAVG
1666 0000      FEXT
1667 7300      CLA CLL
1670 1045      TAD 45
1671 7710      SPA CLA / CONCENTRATION LESS THAN MAXIMUM CON VALU
1672 4312      JMS GTC
1673 4407      JMS I Z 7
1674 5773      FGET YAVG
1675 2344      FSUB MCV
1676 0000      FEXT
1677 7300      CLA CLL
1700 1045      TAD 45
1701 7710      SPA CLA / CON > MINIMUM CON. VALUE
1702 4327      JMS LTC
1703 4407      JMS I Z 7
1704 5773      FGET YAVG
1705 0000      FEXT
1706 7300      CLA CLL
1707 1372      TAD (4)
1710 4406      JMS I Z 6
1711 5653      JMP I CHKCON
1712 0000      GTC, 0
1713 7300      CLA CLL
1714 1371      TAD (276)
1715 4026      JMS PRINT
1716 1370      TAD (240)
1717 4026      JMS PRINT
1720 4407      JMS I Z 7
1721 5347      FGET MAXCV
1722 0000      FEXT
1723 7300      SNEAK, CLA CLL
1724 1372      TAD (4)
1725 4406      JMS I Z 6
1726 5653      JMP I CHKCON
1727 0000      LTC, 0
1730 7300      CLA CLL
1731 1367      TAD (274)

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1732 4026      JMS PRINT
1733 1370      TAD (240)
1734 4026      JMS PRINT
1735 4407      JMS I Z 7
1736 5344      FGET MCV
1737 0000      FEXT
1740 5323      JMP SNEAK
1741 7767      COO1, 7767
1742 2030      2030
1743 4470      4470
1744 0000      MCV, 0
1745 0000      0
1746 0000      0
1547 0000      MAXCV, 0
1750 0000      0
1751 0000      0
1752 7773      M5, 7773
1753 0000      MIN5, 0
1754 0000      KEEP, 0
1755 0000      LARGE, 0
1756 0000      GOGL, 0
1757 0000      AQMC, 0
1760 0000      AQMAXC, 0
                                /DATA OUTPUT ROUTINE

1767 0274
1770 0240
1771 0276
1772 0004
1773 2555
1774 2561
1775 2560
1776 0010
1777 4200

*2000
2000 6032      DATA, KCC
2001 6046      TLS
2002 4154      JMS CRLF
2003 1364      TAD AOFB
2004 7001      IAC
2005 3365      DCA AOXBPO
2006 1765      GO, TAD I AOXBPO
2007 7650      SNA CLA / SAMPLE CARD ?
2010 5350      JMP MORCRD /NO, STANDARD
2011 1365      TAD AOXBPO
2012 7041      CIA
2013 7040      CMA
2014 7041      CIA
2015 1134      TAD SAOLB
2016 7650      SNA CLA /HAS ALL DATA BEEN OUTPUTED?
2017 4137      JMS STOP /YES
2020 1365      TAD AOXBPO /NN
2021 7041      CIA
2022 7040      CMA
2023 3136      DCA REALAD
2024 1365      TAD AOXBPO
2025 1377      TAD (K)
2026 3365      DCA AOXBPO
2027 1136      TAD REALAD
2030 3132      DCA CHARLE
2031 1376      TAD (5/70)

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2032	3316	DCA WAT	
2033	7300	CLA CLL	
2034	1536	TAD I REALAD	/AC=FIRST WORD
2035	4317	JMS CODE1	
2036	4333	JMS CODE2	
2037	7300	CLA CLL	
2040	1136	TAD REALAD	
2041	7001	IAC	
2042	3136	DCA REALAD	
2043	1536	TAD I REALAD	
2044	4317	JMS CODE1	/FIRST 6 DIGIT WORK WORD
2045	4333	JMS CODE2	
2046	4775	JMS SKIP	
2047	1136	TAD REALAD	
2050	7001	IAC	
2051	3136	DCA REALAD	
2052	1536	TAD I REALAD	
2053	4317	JMS CODE1	/FIRST 3 DIGITS OF WORD 2
2054	4333	JMS CODE2	
2055	1136	TAD REALAD	
2056	7001	IAC	
2057	3136	DCA REALAD	
2060	1536	TAD I REALAD	
2061	4317	JMS CODE1	
2062	4775	JMS SKIP	
2063	1536	TAD I REALAD	
2064	3366	DCA TEMZ	
2065	4333	JMS CODE2	
2066	1136	TAD REALAD	
2067	7001	IAC	
2070	3136	DCA REALAD	
2071	1536	TAD I REALAD	
2072	4317	JMS CODE1	
2073	1366	TAD TEMZ	
2074	0374	AND (0360)	
2075	7012	RTR	
2076	7012	RTR	
2077	1373	TAD (260)	
2100	4026	JMS PRINT	
2101	4775	JMS SKIP	
2102	1366	TAD TEMZ	
2103	0372	AND (0017)	
2104	1373	TAD (260)	
2105	4026	JMS PRINT	
2106	1136	TAD REALAD	
2107	7001	IAC	
2110	3136	DCA REALAD	
2111	1536	TAD I REALAD	
2112	4317	JMS CODE1	
2113	4333	JMS CODE2	
2114	4771	JMS GOFOT	
2115	4154	JMS CRLF	
2116	5770	JMP LOCDAT	
2117	0000	0	
2120	3366	DCA TEMZ	
2121	1366	TAD TEMZ	
2122	0367	AND (7400)	
2123	7012	RTR	
2124	7012	RTR	
2125	7012	RTR	


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2126 7012 RTR
2127 1373 TAD (260)
2130 4026 JMS PRINT
2131 5717 JMP I CODE1
2132 0000 0
2133 0000 CODE2, 0
2134 1366 TAD TEMZ
2135 0374 AND (036Q)
2136 7012 RTR
2137 7012 RTR
2140 1373 TAD (260)
2141 4026 JMS PRINT
2142 7300 CLA CLL
2143 1366 TAD TEMZ
2144 0372 AND (0017)
2145 1373 TAD (260)
2146 4026 JMS PRINT
2147 5733 JMP I CODE2/SAOLB=STARTING ADDRESS OF LAST BLOCK.
2150 1365 MORCRD, TAD AOXBPO
2151 7041 CIA
2152 7040 CMA
2153 7041 CIA
2154 1134 TAD SAOLB
2155 7650 SNA CLA /HAS ALL DATA BEEN OUTPUTED?
2156 4137 JMS STOP /YES
2157 1365 TAD AOXBPO /NO
2160 1377 TAD (6)
2161 3365 DCA AOXBPO
2162 5206 JMP GO
2163 2610 MOLE, 2610
2164 3200 AOFB, 3200
2165 0000 AOXBPO, 0
2266 0000 TEMZ, 0
      /ELEMENT LOCATION

2167 7400
2170 2200
2171 4652
2172 0017
2173 0260
2174 0360
2175 3532
2176 5770
2177 0006

*2200
2200 7300 LOCDAT, CLA CLL
2201 4154 JMS CRLF
2202 1377 TAD (-3200)
2203 1132 TAD CHARLE /REAL ADD. OF FIRST WORD IN BLOCK
2204 3353 DCA GOOD
2205 1353 TAD GOOD
2206 4776 JMS FLTIT
2207 4407 JMS I Z 7
2210 4354 FDIV SEX
2211 0000 FEXT
2212 4775 JMS FIXIT
2213 3135 DCA KEEPAD /REAL ADD. - AOFB DIV. BY SIX
2214 1374 TAD (5050)
2215 3015 DCA 15
2216 1373 TAD (5120)
2217 3016 DCA 16 /INTCPB A.I. REG

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2220	1372	TAD (3000)
2221	3771	DCA AOMC
2222	1370	TAD (3001)
2223	3767	DCA AOMAXC
2224	4766	JMS FMAMCV
2225	1105	TAD CRLOC
2226	4765	JMS OPDATA
2227	4764	JMS NPO
2230	4763	JMS SAVE
2231	4766	JMS FMAMCV
2232	1106	TAD CULOC
2233	4765	JMS OPDATA
2234	1063	TAD C303
2235	4026	JMS PRINT
2236	1075	TAD C325
2237	4026	JMS PRINT
2240	4763	JMS SAVE
2241	4766	JMS FMAMCV
2242	1107	TAD FELOC
2243	4765	JMS OPDATA
2244	1065	TAD C306
2245	4026	JMS PRINT
2246	1064	TAD C305
2247	4026	JMS PRINT
2250	4763	JMS SAVE
2251	4766	JMS FMAMCV
2252	1110	TAD MGLOC
2253	4765	JMS OPDATA
2254	1070	TAD C315
2255	4026	JMS PRINT
2256	1066	TAD C307
2257	4026	JMS PRINT
2260	4763	JMS SAVE
2261	4766	JMS FMAMCV
2262	1111	TAD MNLOC
2263	4765	JMS OPDATA
2264	1070	TAD C315
2265	4026	JMS PRINT
2266	1071	TAD C316
2267	4026	JMS PRINT
2270	4763	JMS SAVE
2271	4766	JMS FMAMCV
2272	1112	TAD NILOC
2273	4765	JMS OPDATA
2274	1071	TAD C316
2275	4026	JMS PRINT
2276	1067	TAD C311
2277	4026	JMS PRINT
2300	4763	JMS SAVE
2301	4766	JMS FMAMCV
2302	1113	TAD PBLOC
2303	4765	JMS OPDATA
2304	1072	TAD C320
2305	4026	JMS PRINT
2306	1036	TAD C302
2307	4026	JMS PRINT
2310	4763	JMS SAVE
2311	4766	JMS FMAMCV
2312	1114	TAD SILOC
2313	4765	JMS OPDATA

2314	1073		TAD C323
2315	4026		JMS PRINT
2316	1067		TAD C311
2317	4026		JMS PRINT
2320	4763		JMS SAVE
2321	4766		JMS FMAMCV
2322	1115		TAD SNLOC
2323	4765		JMS OPDATA
2324	1073		TAD C323
2325	4026		JMS PRINT
2326	1071		TAD C316
2327	4026		JMS PRINT
2330	4763		JMS SAVE
2331	4766		JMS FMAMCV
2332	1116		TAD TILOC
2333	4765		JMS OPDATA
2334	1074		TAD C324
2335	4026		JMS PRINT
2336	1067		TAD C311
2337	4026		JMS PRINT
2340	4763		JMS SAVE
2341	4766		JMS FMAMCV
2342	1117		TAD ZNLOC
2343	4765		JMS OPDATA
2344	1076		TAD C332
2345	4026		JMS PRINT
2346	1071		TAD C316
2347	4026		JMS PRINT
2350	4763		JMS SAVE
2351	4762		JMS BUNCH
2352	5761		JMP SECND
2353	0000	GOOD,	0
2354	0002	SEX,	0002
2355	3000		3000
2356	0000		0000
2361	2600		
2362	0720		
2363	3500		
2364	3523		
2365	2400		
2366	1600		
2367	1760		
2370	3001		
2371	1757		
2372	3000		
2373	5120		
2374	5050		
2375	4211		
2376	4200		
2377	4600		
		*2400	
2000	0000	OPDATA,	0
2401	1135		TAD KEEPAD
2402	3334		DCA GPMB
2403	3360		DCA FLAG1
2404	3361		DCA FLAG2
2405	1035		TAD AUTO15
2406	3015		DCA 15
2407	4407		JMS I Z 7
2410	5416		FGET I INICPD

2411	6335		FPUT FISH
2412	5415		FGET I SLOPEM
2413	6340		FPUT M
2414	0000		FEXT
2415	7300		CLA CLL
2416	1015		TAD SLOPEM
2417	1377		TAD (3)
2420	3035		DCA AUTO15
2421	1016		TAD INTCPB
2422	1377		TAD (3)
2423	3016		DCA INTCPB
2424	6211		CDF2
2425	1734		TAD I GPMB
2426	6201		CDF1
2427	3343		DCA STORE
2430	1343		TAD STORE
2431	7650		SNA CLA / VOLTAGE ZERO ?
2432	5244		JMP ZERO / YES
2433	1343		TAD STORE / NO
2434	4776		JMS FIXVLT
2435	4407		JMS I Z 7
2436	2335		FSUB FISH
2237	4340		FDIV M
2440	6344		FPUT OCTLX1
2441	0000		FEXT
2442	7300		CLA CLL
2443	5252		JMP HOG
2444	7300	ZERO,	CLA CLL
2445	3344		DCA OCTLX1
2446	3345		DCA OCTLX1+1
2447	3346		DCA OCTLX1+2
2450	1375		TAD (7000)
2451	3360		DCA FLAG1
2452	1334	HOG,	TAD GPMB
2453	7001		IAC
2454	3334		DCA GPMB
2455	6211		CDF2
2456	1734		TAD I GPMB
2457	6201		CDF1
2460	3343		DCA STORE
2461	1343		TAD STORE
2462	7650		SNA CLA / VOLTAGE ZERO ?
2463	5275		JMP HAT / YES
2464	1343		TAD STORE / NO
2465	4776		JMS FIXVLT
2466	4407		JMS I Z 7
2467	2335		FSUB FISH
2670	4340		FDIV M
2471	6347		FPUT OCTLX2
2472	0000		FEXT
2473	7300		CLA CLL
2474	5302		JMP FINDAV
2475	3347	HAT,	DCA OCTLX2
2476	3350		DCA OCTLX2+1
2477	3351		DCA OCTLX2+2
2500	1375		TAD (7000)
2501	3361		DCA FLAG2
2502	7300	FINDAV,	CLA CLL
2503	1360		TAD FLAG1
2504	7640		SZA CLA / Y1 = 0 ?

```

2505 5325      JMP AVGZRO      / YES
2506 1361      TAD FLAG2
2507 7640      SZA CLA / Y2 = 0 ?
2510 5325      JMP AVGZRO      / YES
2511 4407      JMS I Z 7      / NO , BOTH HAVE VALUE
2512 5344      FGET OCTLX1
2513 1347      FADD OCTLX2
2514 4352      FDIY UG2
2515 6355      FPUT YAVG
2516 6417      FPUT I GRAVY
2517 0000      FEXT
2520 7300      HEY,      CLA CLL
2521 1017      TAD GRAVY
2522 1377      TAD (3)
2523 3017      DCA GRAVY
2524 5600      JMP I OPDATA
2525 4407      AVGZRO, JMS I Z 7
2526 5362      FGET ZERO1
2527 6355      FPUT YAVG
2530 6417      FPUT I GRAVY
2531 0000      FEXT
2532 7300      CLA CLL
2533 5320      JMP HEY
2334 0000      GPMB,      0
2535 0000      FLSH,      0
2536 0000      0
2537 0000      0
2540 0000      M,        0
2541 0000      0
2542 0000      0
2543 0000      STORE,    0
2544 0000      OCTLX1,   0
2545 0000      0
2546 0000      0
2547 0000      OCTLX2,   0
2550 0000      0
2551 0000      0
2552 0002      UG2,      0002
2553 2000      2000
2554 0000      0000
2555 0000      YAVG,     0
2556 0000      0
2557 0000      0
2560 0000      FLAG1,    0
2661 0000      FLAG2,    0
2562 0000      ZERO1,    0
2563 0000      0
2564 0000      0

2575 7000
2576 4600
2577 0003      *2600
2600 7300      SECND,      CLA CLL
2601 1377      TAD (5000)
2602 3017      DCA GRAVY
2603 1376      TAD (5763)
2604 3775      DCA WAT /CHANGE JMS LOCDAT TO JMP HOLE
2605 1132      TAD CHARLE
2606 3136      DCA REALAD

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2607	5774		JMP SPUD	
2610	7300	HOLE.	CLA CLL	
2611	4154		JMS CRLF	
2612	1063		TAD C303	/C
2613	4026		JMS PRINT	
2614	1077		TAD C322	/R
2615	4026		JMS PRINT	
2616	4773		JMS SKIP13	
2617	7300		CLA CLL	
2620	1372		TAD (3000)	
2621	3771		DCA AOMC	
2622	1174		TAD(3001)	
2623	3770		DCA AOMAXC	
2624	4767		JMS FMAMCV	
2625	4766		JMS YAR	
2626	1063		TAD C303	/C
2627	4026		JMS PRINT	
2630	1075		TAD C325	/U
2631	4026		JMS PRINT	
2632	4773		JMS SKIP13	
2633	4767		JMS FMAMCV	
2634	4766		JMS YAR	
2635	1065		TAD C306	/F
2636	4026		JMS PRINT	
2637	1064		TAD C305	/E
2640	4026		JMS PRINT	
2641	4773		JMS SKIP13	
2642	4767		JMS FMAMCV	
2643	4766		JMS YAR	
2644	1070		TAD C315	/M
2645	4026		JMS PRINT	
2646	1066		TAD C307	/G
2647	4026		JMS PRINT	
2650	4773		JMS SKIP13	
2651	4767		JMS FMAMCV	
2652	4766		JMS YAR	
2653	1070		TAD C315	/M
2654	4026		JMS PRINT	
2655	1071		TAD C316	/N
2656	4026		JMS PRINT	
2657	4773		JMS SKIP13	
2660	4767		JMS FMAMCV	
2661	4766		JMS YAR	
2662	1071		TAD C316	/N
2663	4026		JMS PRINT	
2664	1067		TAD C311	/I
2665	4026		JMS PRINT	
2666	4773		JMS SKIP13	
2667	4767		JMS FMAMCV	
2670	4766		JMS YAR	
2671	1072		TAD C320	/P
2672	4026		JMS PRINT	
2673	1036		TAD C302	/B
2674	4026		JMS PRINT	
2675	4773		JMS SKIP13	
2676	4767		JMS FMAMCV	
2677	4766		JMS YAR	
2700	1073		TAD C323	/S
2701	4026		JMS PRINT	
2702	1067		TAD C311	/I

4026	JMS PRINT	
4773	JMS SKIP13	
4767	JMS FMAMCV	
4766	JMS YAR	
1073	TAD C323	/S
4026	JMS PRINT	
1071	TAD C316	/N
4026	JMS PRINT	
4773	JMS SKIP13	
4767	JMS FMAMCV	
4766	JMS YAR	
1074	TAD C324	/T
4026	JMS PRINT	
1067	TAD C311	/I
4026	JMS PRINT	
4773	JMS SKIP13	
4767	JMS FMAMCV	
4766	JMS YAR	
1076	TAD C332	/Z
4026	JMS PRINT	
1071	TAD C316	/N
4026	JMS PRINT	
4773	JMS SKIP13	
4767	JMS FMAMCV	
4766	JMS YAR	
1377	TAD (5000)	
3017	DCA GRAVY	

1365	TAD (5050)	
3035	DCA AUTO15	
4764	JMS MUNH	
5763	JMP GO	
	/CONCENTRATIONS	

2006
4702
5050
3127
1600
1760
1757
3000
3600
2034
2116
5763
5000

*3000		
0013	CRA,	0013
0226	CRB,	0226
0036	CRC,	0036
0036	CRD,	0036
0000	CRE,	0
0430	CRF,	0430
0360	CRG,	0360

*3010		
0013	CUA,	0013
0454	CUB,	0454
0144	CUC,	0144
0144	CUD,	0144
0000	CUE,	0
0264	CUF,	0264

3016	0442	CUG,	0442
		*3020	
3020	0144	FEA,	0144
3021	1356	FEB,	1356
3222	0454	FEC,	0454
3023	0454	FED,	0454
3024	0000	FEE,	0
3025	1212	FEF,	1212
3026	0512	FEG,	0512
		*3030	
3030	0006	MGA,	0006
3031	0000	MGB,	0
3032	1604	MGC,	1604
3033	1775	MGD,	1775
3034	0000	MGE,	0
3035	1604	MGF,	1604
3036	1700	MGG,	1700
		*3040	
3040	0004	MNA,	0004
3041	0240	MNB,	0240
3042	0000	MNC,	0
3043	0000	MND,	0
3044	0000	MNE,	0
3045	0056	MNF,	0056
3046	0062	MNG,	0062
		*3050	
3050	0014	NIA,	0014
3051	0015	NIB,	0015
3052	0000	NIC,	0
3053	0000	NID,	0
3054	0000	NIE,	0
3055	0021	NIF,	0021
3056	0066	NIG,	0066
		*3060	
3060	0012	PBA,	0012
3061	0000	PBB,	0
3062	0000	PBC,	0
3063	0000	PBD,	0
3064	0264	PBE,	0264
3065	0000	PBF,	0
3066	0000	PBG,	0
		*3070	
3070	0144	SIA,	0144
3071	1130	SIB,	1130
3072	1320	SIC,	1320
3073	0000	SID,	0
3074	0000	SIE,	0
3075	1104	SIF,	1104
3076	1104	SIG,	1104
		*3100	
3100	0011	SNA1,	0011
3101	0000	SNB,	0
3102	0000	SNC,	0
3103	0000	SND,	0
3104	0035	SNE,	0035
3105	0000	SNF,	0
3106	0000	SNB,	0
		*3110	
3110	0014	TIA,	0014

3111	0144	TIB,	0144
3112	0000	TIC,	0
3113	0000	TID,	0
3114	0000	TIE,	0
3115	0033	TIF,	0033
3116	0140	TIG,	0140
		*3120	
3120	0012	ZNA,	0012
3121	0120	ZNB,	0120
3122	0000	ZNC,	0
3123	0036	ZND,	0036
3124	0000	ZNE,	0
3125	0226	ZNF,	0226
3126	0120	ZNG,	0120
3127	0000	YAR,	0
3130	7300		CLA CLL
3131	1377		TAD (3151)
3132	3776		DCA CHKCON
3133	4407		JMS I Z 7
3134	5417		FGET I GRAVY
3135	6775		FPUT YAVG
3136	0000		FLXT
3137	7300		CLA CLL
3140	1017		TAD GRAVY
3141	1374		TAD (3)
3142	3017		DCA GRAVY
3143	1044		TAD 44
3144	1045		TAD 45
3145	1046		TAD 46
3146	7650		SNA CLA
3147	4773		JMS GTC
3150	5772		JMP FAKE
3151	7300		CLA CLL
3152	4154		JMS CRLF
3153	5727		JMP I YAR

3172	1663		
3173	1712		
3174	0003		
3175	2555		
3176	1653		
3177	3151		
		*3435	
3435	0000	GOFER,	0
3436	7300		CLA CLL
3437	1377		TAD (7700)
3440	3271		DCA GATOR
3441	7300	ARF,	CLA CLL
3442	6304		ADD5SB
3443	7440		SZA
3444	5635		JMP I GOFER
3445	4260		JMS WAITT
3446	2271		ISZ GATOR
3447	5241		JMP ARF
3450	7402		HLT
3451	0000	STBADC,	0
3452	7300	APPLE,	CLA CLL
3453	6334		STADC

3454	4776		JMS DELAY
3455	6312		RDADC
3456	5252		JMP APPLE
3457	5651		JMP I STBADC
3460	0000	WAITT,	0
3461	7300		CLA CLL
3462	2272		ISZ GOLF
3463	5262		JMP .-1
3464	2273		ISZ TATER
3465	5262		JMP .-3
3466	7240		CLA CMA
3467	3273		DCA TATER
3770	5660		JMP I WAITT
3471	0000	GATOR,	0
3472	0000	GOLF,	0
3473	0000	TATER,	0
		*3500	
3100	0000	SAVE,	0
3501	4775		JMS SKIP3
3502	4407		JMS I Z 7
3503	5774		FGET OCTLX1
3504	0000		FEXT
3505	7300		CLA CLL
3506	1373		TAD (4)
3507	4406		JMS I Z 6
3510	4775		JMS SKIP3
3511	4407		JMS I Z 7
3512	5772		FGET OCTLX2
3513	0000		FEXT
3514	7300		CLA CLL
3515	1373		TAD (4)
3516	4406		JMS I Z 6
3517	4775		JMS SKIP3
3520	4771		JMS CHKCON
3521	4154		JMS CRLF
3522	5700		JMP I SAVE
3523	0000	NPO,	0
3524	7300		CLA CLL
3525	1370		TAD (303)
3526	4026		JMS PRINT
3527	1367		TAD (322)
3530	4026		JMS PRINT
3531	5723		JMP I NPO
3532	0000	SKIP,	0
3533	7300		CLA CLL
3534	1366		TAD (240)
3535	4026		JMS PRINT
3536	1366		TAD (240)
3537	4026		JMS PRINT
3540	1366		TAD (240)
3541	4026		JMS PRINT
3542	1366		TAD (240)
3543	4026		JMS PRINT
3544	1366		TAD (240)
3545	4026		JMS PRINT
3546	5732		JMP I SKIP
			/MISS. ROUTINES
3566	0240		
3567	0322		

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3570 0303
3571 1653
3572 2547
3573 0004
3574 2544
3575 3624
3576 4465
3577 7700
      *3600
3600 0000  SKIP13, 0
3601 7300      CLA CLL
3602 1377      TAD (-15)
3603 3337      DCA MIN15
3604 1376      TAD (240)
3605 4026      JMS PRINT
3606 2337      ISZ MIN15      /13 SPACES?
3607 5204      JMP .-3 /NO
3610 7300      CLA CLL
3611 5600      JMP I SKIP13
3612 0000  SKIP15, 0
3613 7300      CLA CLL
3614 1375      TAD (-17)
3615 3340      DCA MIN17
3616 1376      TAD (240)
3617 4026      JMS PRINT
3620 2340      ISZ MIN17      /15 SPACES?
3621 5216      JMP .-3 /NN
3622 7300      CLA CLL /YES
3623 5612      JMP I SKIP15
3624 0000  SKIP3, 0
3625 7300      CLA CLL
3626 1374      TAD (-7)
3627 3341      DCA MIN7
3630 1376      TAD (240)
3631 4026      JMS PRINT
3632 2341      ISZ MIN7
3633 5230      JMP .-3 /NO
3634 7300      CLA CLL /YES
3635 5624      JMP I SKIP3
3636 0000  CLEARC, 0
3637 7300      CLA CLL
3640 1373      TAD (-350)
3641 3342      DCA ODD
3642 1372      TAD (5000)
3643 3343      DCA LOC
3644 3743  GORG,  DCA I LOC
3645 1343      TAD LOC
3646 7001      IAC
3647 3343      DCA LOC
3650 2342      ISZ ODD /FINISHED?
3651 5244      JMP GORG      /NO
3652 1371      TAD (-7200)    / YES
3653 3344      DCA BIG
3654 1345      TAD CO
3655 3346      DCA COL
3656 6211  UPPER, CDF?
3657 3746      DCA I COL
3660 6201      CDF1
3661 1346      TAD COL
3662 7001      IAC

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3663	3346		DCA COL
3664	2344		ISZ BIG /FINISHED?
3665	5256		JMP UPPER /NO
3666	1370		TAD (7545)
3667	3342		DCA ODD
3670	1367		TAD (3200)
3671	3343		DCA LOC
3672	3743	DOIT,	DCA I LOC
3673	1343		TAD LOC
3674	7001		IAC
3675	3343		DCA LOC
3676	2342		ISZ ODD
3677	5272		JMP DOIT
3700	5636		JMP I CLEARC
3701	7300	ENDCRD,	CLA CLL
3702	2336		ISZ UU
3703	5302		JMP .-1
3704	2335		ISZ YY
3705	5302		JMP .-3
3706	1366		TAD (7776)
3707	3335		DCA YY
3710	7201		CLA IAC
3711	6324		START
3712	7300		CLA CLL
3713	3765		DCA COLCNT
3714	1364		TAD (-6)
3715	3763		DCA M6
3716	6302		CLEAR
3717	7300		CLA CLL
3720	1362		TAD (10)
3721	6324		START
3722	5020		JMP PREP
3723	0000	POWOFF,	0
3724	3003		DCA AC
3725	7010		RAR
3726	3002		DCA LINC
3727	1000		TAD Z 0
3730	3152		DCA PC
3731	1334		TAD RESTRT
3732	3000		DCA Z 0
3733	7402		HLT
3734	5143	RESTRT,	JMP ABCD
3735	7766	YY,	7766
3736	0000	UU,	0
3737	0000	MIN15,	0
3740	0000	MIN17,	0
3741	0000	MIN7,	0
3742	0000	ODD,	0
3743	0000	LOC,	0
3744	0000	BIG,	0
3745	0000	CO,	0
3746	0000	COL,	0
3762	0010		
3763	0552		
3764	7772		
3765	0553		
3766	7776		
3767	3200		
3770	7545		
3771	0600		

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3772 5000
3773 7430
3774 7771
3775 7761
3776 0240
3777 7763

*4000
4000 7300 FRED, CLA CLL
4001 3141 DCA CRDCNT
4002 3142 DCA REG
4003 3153 DCA BURNQ
4004 3121 DCA PASSNO
4005 1377 TAD (3006) / CARD INFORMATION
4006 3124 DCA ADD
4007 1124 TAD ADD
4010 3123 DCA CONADD
4011 1376 TAD (5050)
4012 3015 DCA 15
4013 1375 TAD (5120)
4014 3016 DCA 16
4015 1374 TAD (5000)
4016 3017 DCA GRAVY
4017 4773 JMS CLEARC
4020 1372 TAD (3200)
4021 3125 DCA ADDLOC
4022 1371 TAD (7777)
4023 3153 DCA BURNQ
4024 1370 TAD (5177)
4025 3010 DCA 10
4026 3120 DCA STDCNT
4027 1376 TAD (5050)
4030 3035 DCA AUTO15
4031 7300 CNTNUE, CLA CLL
4032 6001 ION
4033 7200 CLA
4034 7000 NOP
4035 7000 NOP
4036 7000 NOP
4037 7000 NOP
4040 7000 NOP
4041 7000 NOP
4042 7000 NOP
4043 7000 NOP
4044 7000 NOP
4045 7000 NOP
4046 7000 NOP
4047 7000 NOP
4050 7000 NOP
4051 7000 NOP
4052 7000 NOP
4053 7000 NOP
4054 7000 NOP
4055 5233 JMP CNTNUE+2
4056 3003 PRGINT, DCA AC
4057 7004 RAL
4060 3002 DCA LINC
4061 6102 SPL / POWER LOW FLAG
4062 7410 SKP / NOT SET
4063 4767 JMS POWOFF
4064 6301 RECORD /SKIP IF NO! RECORD DATA

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4065	4766	JMS READAD	/ RECORD DATA ROUTINE
4066	6331	RDCRD	/SKIP IF NOT READ CARD
4067	4765	JMS RDDCRD	/ READ CARD
4070	6332	ERASE	/SKIP IF NOT ERASE ROUTINE
4071	4764	JMS ERASED	
4072	6031	KSF	
4073	7402	HLT	
4074	6032	KCC	
4075	6001	ION	
4076	5400	JMP I 0	
4077	0000	LOT,	0
4100	1363	TAD (-3)	
4101	1015	TAD SLOPEM	
4102	3015	DCA SLOPEM	
4103	1363	TAD (-3)	
4104	1016	TAD INTCPB	
4105	3016	DCA INTCPB	
4106	4407	JMS I Z 7	
4107	5415	FGET I SLOPEM	
4110	6325	FPUT SM	
4111	5416	FGET I INTCPB	
4112	6330	FPUT IN	
4113	0000	FEXT	
4114	5677	JMP I LOT	
4115	0000	CARP,	0
4116	1362	TAD (2)	
4117	1015	TAD SLOPEM	
4120	3015	DCA SLOPEM	
4121	1362	TAD (2)	
4122	1016	TAD INTCPB	
4123	3016	DCA INTCPB	
4124	5715	JMP I CARP	
4125	0000	SM,	0
4126	0000		0
4127	0000		0
4130	0000	IN,	0
4131	0000		0
4132	0000		0
4133	0000	CON75,	0000
4134	3000		3000
4135	0000		000
4136	0001	CON125,	0001
4137	2400		2400
4140	0000		0000
4162	0002		
4163	7775		
4164	4303		
4165	0400		
4166	0200		
4167	3723		
4170	5177		
4171	7777		
4172	3200		
4173	3636		
4174	5000		
4175	5120		
4176	5050		
4177	3006		
		*4200	
4200	0000	FLITIT,	0

4201	3045		DCA 45
4202	3046		DCA 46
4203	1377		TAD (13)
4204	3044		DCA 44
4205	4407		JMS I Z 7
4206	7000		FNOR
4207	0000		FEXT
4210	5600		JMP I FLTIT
4211	0000	FIXIT,	0
4212	7200		CLA
4213	1044		TAD 44
4214	7540		SZA SMA
4215	5220		JMP .+3
4216	7200		CLA
4217	5237		JMP DONE+1
4220	1376		TAD (-13)
4221	7450		SNA
4222	5236		JMP DONE
4223	7500		SMA
4224	5240		JMP ERROR
4225	3044		DCA 44
4226	7100	GOBER,	0
4227	1045		TAD 45
4230	7510		SPA
4231	7020		CML
4232	7010		RAR
4233	3045		DCA 45
4234	2044		ISZ 44
4235	5226		JMP GOBER
4236	1045	DONE,	TAD 45
4237	5611		JMP I FIXIT
4240	7402	ERROR,	HLT
4241	5240		JMP .-1
4242	0000	OVERFL,	0
4243	6302		CLEAR
4244	4154		JMS CRLF
4245	1375		TAD (10)
4246	6324		START
4247	7300		CLA CLL
4250	2257		ISZ AAA
4251	5250		JMP .-1
4252	2260		ISZ RRR
4253	5250		JMP .-3
4254	1261		TAD DDD
4255	3260		DCA BBB
4256	5020		JMP PREP
4257	0000	AAA,	0
4260	7400	BBB,	7400
4261	7400	DDD,	7400
4262	0000	DUMPIT,	0
4263	7300		CLA CLL
4264	1374		TAD (-41)
4265	3302		DCA JJ
4266	1373		TAD (1520)
4267	3301		DCA KK
4270	3701	BAT,	DCA I KK
4271	1301		TAD KK
4272	7001		IAC
4273	3301		DCA KK
4274	2302		ISZ JJ

4275	5270		JMP BAT
4276	7300		CLA CLL
4277	3131		DCA ELENUM
4300	5662		JMP I DUMPIT
4301	0000	KK,	0
4302	0000	JJ,	0
4303	0000	ERASED,	0
4304	4772		JMS DELAY
4305	4771		JMS ENUF
4306	4346		JMS ZCD
4307	4346		JMS ZCD
4310	4346		JMS ZCD
4311	4346		JMS ZCD
4312	4346		JMS ZCD
4313	4346		JMS ZCD
4314	1153		TAD BURNO
4315	7010		RAR
4316	7630		SZL CLA
4317	5331		JMP BURN2
4320	1153		TAD BURNO
4321	1370		TAD (-1)
4322	3153		DCA BURNO
4323	1141		TAD CRDCNT
4324	1370		TAD (-1)
4325	3141		DCA CRDCNT
4326	1367		TAD (-2)
4327	3766		DCA TIM
4330	5341		JMP STUPID
4331	1153	BURN2,	TAD BURNO
4332	1367		TAD (-2)
4333	3153		DCA BURNO
4334	1141		TAD CRDCNT
4335	1367		TAD (-2)
4336	3141		DCA CRDCNT
4337	1367		TAD (-2)
4340	3766		DCA TIM
4341	6302	STUPID,	CLEAR
4342	7300		CLA CLL
4343	7000		NOP
4344	7000		NOP
4345	5020		JMP PREP
4346	0000	ZCD,	0
4347	1125		TAD ADDLOC
4350	1370		TAD (-1)
4351	3125		DCA ADDLOC
4352	3525		DCA 1 ADDLOC
4353	5746		JMP I ZCD
4366	0263		
4367	7776		
4370	7777		
4371	4712		
4372	4465		
4373	1520		
4374	7737		
4375	0010		
4376	7765		
4377	0013		
		*4400	
4400	0000	OUTVLT,	0
4401	3326		DCA JUG

4402	3327		DCA LIT
4403	3330		DCA LIT+1
4404	3331		DCA LIT+2
4405	7300		CLA CLL
4406	1326		TAD JUG
4407	7010		RAR
4410	3332		DCA BORE
4411	7420		SNL
4412	5221		JMP CONT
4413	7300		CLA CLL
4414	4407		JMS I Z 7
4415	5333		FGET ENO
4416	6327		FPUT LIT
4417	0000		FEXT
4420	7300		CLA CLL
4421	1332	CONT,	TAD BORE
4422	4777		JMS FLTIT
4423	4407		JMS I Z 7
4424	1327		FADD LIT
4425	3336		FMPY T22
4426	3341		FMPY BIT
4427	0000		FEXT
4430	7300		CLA CLL
4431	6032		KCC
4432	6046		TLS
4433	7300		CLA CLL
4434	1376		TAD (20)
4435	6324		START
4436	7300		CLA CLL
4437	1375		TAD (4)
4440	4406		JMS I Z 6
4441	4154		JMS CRLF
4442	7300		CLA CLL
4443	1374		TAD (10)
4444	6324		SIARI
4445	7300		CLA CLL
4446	1326		TAD JUG
4447	5600		JMP I OUTVLT
4450	0000	AMRCI,	0 / AVOID MUT READ CARD INTERRUPTS
4451	7300		CLA CLL
4452	2344		ISZ V
4453	5252		JMP .-1
4454	2345		ISZ W
4455	5252		JMP .-3
4456	1346		TAD X
4457	3345		DCA W
4460	6302		CLEAR
4461	7300		CLA CLL
4462	1374		TAD (10)
4463	6324		START
4464	5020		JMP PREP
4465	0000	DELAY,	0 / DELAY READING ADD LOCATION FROM TAPE
4466	7300		CLA CLL
4467	1376		TAD (20)
4470	6324		START
4471	7300		CLA CLL
4472	2301		ISZ FFF
4473	5272		JMP .-1
4474	2302		ISZ G
4475	5272		JMP .-3

4476	1303		TAD H
4477	3302		DCA G
4500	5665		JMP I DELAY
4501	0000	FFF.	0
4502	7760	G.	7760
4503	7760	H.	7760
4504	0000	FOXIT.	0
4505	7300		CLA CLL
4506	1130		TAD VOLTGE
4507	7640		SZA CLA / VOLTAGE > 10 VOLTS
4510	4773		JMS PRDUCT
4511	1126		TAD VOLTLO
4512	1372		TAD (1)
4513	3126		DCA VOLTLO
4514	6211		CDF2
4515	1526		TAD I VOLTLO
4516	6201		CDF1
4517	3130		DCA VOLTGE
4520	1130		TAD VOLTGE
4521	3414		DCA I 14
4522	1130		TAD VOLTGE
4523	7640		SZA CLA / VOLTAGE > 10 VOLTS
4524	4773		JMS PRDUCT
4525	5704		JMP I FOXIT
4526	0000	JUG.	0
4527	0000	LIT.	0
4530	0000		0
4531	0000		0
4532	0000	BORE.	0
4533	0001	ENO.	0001
4534	2000		2000
4535	0000		0000
4536	0002	T22.	0002
4537	2000		2000
4540	0000		0000
4541	7770	BIT.	7770
4542	2400		2400
4543	0000		0000
4544	0000	V.	0
4545	7760	W.	7760
4546	7760	X.	7760
4572	0001		
4573	1400		
4574	0010		
4575	0004		
4576	0020		
4577	4200		
		*4600	
4600	0000	FIXVLT.	0
4601	3237		DCA RR
4602	3234		DCA SS
4603	3235		DCA SS+1
4604	3236		DCA SS+2
4605	7300		CLA CLL
4606	1237		TAD RR
4607	7010		RAR
4610	3240		DCA APES
4611	7420		SNL
4612	5221		JMP BOO

4613	7300		CLA CLL
4614	4407		JMS I Z 7
4615	5241		FGET ONEE
4616	6234		FPUT SS
4617	0000		FEXT
4620	7300		CLA CLL
4621	1240	BOO,	TAD APES
4622	4777		JMS FLTIT
4623	4407		JMS I Z 7
4624	1234		FADD SS
4625	3244		FMPY HAD
4626	3247		FMPY GG
4627	0000		FEXT
4630	7300		CLA CLL
4631	5600		JMP I FIXVLT
4632	0000	HMSG,	0
4633	0000	GOOSE,	0
4634	0000	SS,	0
4635	0000		0
4636	0000		0
4637	0000	RR,	0
4640	0000	APES,	0
4641	0001	ONEE,	0001
4642	2000		2000
4643	0000		0000
4644	0002	HAD,	0002
4645	2000		2000
4646	0000		0000
4647	7770	GG,	7770
4650	2400		2400
4651	0000		0000
4652	0000	GOFOT,	0
4653	7300		CLA CLL
4654	4776		JMS SKIP
4655	1375		TAD (245)
4656	4026		JMS PRINT
4657	1374		TAD (240)
4660	4026		JMS PRINT
4661	1373		TAD (301)
4662	4026		JMS PRINT
4663	1073		TAD C323
4664	4026		JMS PRINT
4665	1374		TAD (240)
4666	4026		JMS PRINT
4667	1077		TAD C322
4670	4026		JMS PRINT
4671	1064		TAD C305
4672	4026		JMS PRINT
4673	1063		TAD C303
4674	4026		JMS PRINT
4675	1372		TAD (326)
4676	4076		JMS PRINT
4677	1371		TAD (304)
4700	4026		JMS PRINT
4701	5652		JMP I GOFOT
4702	0000	MUNH,	0
4703	7300		CLA CLL
4704	1370		TAD (7766)
4705	3237		DCA HMSG
4706	4154		JMS CRLF

4707	2232	ISZ HMSG
4710	5306	JMP .-2
4511	5702	JMP I MUNH
4712	0000	ENUF, 0
4713	7300	CLA CLL
4714	1125	TAD ADDLOC
4715	1367	TAD (-5)
4716	3233	DCA GOOSE
4717	1233	TAD GOOSE
4720	7001	IAC
4721	3335	DCA HELP
4722	1633	TAD I GOOSE
4723	1735	TAD I HELP
4724	7640	SZA CLA
4725	5712	JMP I ENUF
4726	1120	TAD STDCNT
4727	1366	TAD (-1)
4730	3120	DCA STDCNT
4731	1365	TAD (10)
4732	1366	TAD (-1)
4733	3010	DCA 10
4734	5712	JMP I ENUF
4735	0000	HELP, 0
4765	0010	
4766	7777	
4767	7773	
4770	7766	
4771	0304	
4772	0326	
4773	0301	
4774	0240	
4775	0245	
4776	3532	
4777	4200	
0174	3001	
0175	0212	
0176	0215	
0177	4056	
A	0464	
AAA	4257	
ABCD	0140	
AC	0003	
ADD	0121	
ADDLOC	0122	
ADDRES	0365	
ADDVLT	1200	
ADD5SB	6304	
AD12SB	6314	
AGAIN	0201	
AMRCI	4450	
AN	0012	
AOFB	2164	
AOMAXC	1760	
AOMC	1757	
AOS	0010	
AOXBPO	2165	
APPLE	3445	
ARF	3434	
AUT015	0035	
AVGZRO	2525	

B	0271
BBB	4260
BEGIN	0612
BIG	3744
BIT	4541
BORE	4532
BUNCH	0720
BURNO	0150
BURN2	4331
B331	0077
CALATE	1443
CARP	4115
CDF1	6201
CDF2	6211
CHARLE	0127
CHECK	0214
CHKCNT	1307
CHKCON	1653
CIK	0752
CLEAR	6302
CLEARC	3636
CM1	1162
CNT	0730
CNTNUE	4031
CO	3745
CODE1	2117
CODE2	2133
COL	3746
COLCNT	0552
COMCHK	0517
COMPUT	0600
CON	0013
CONADD	0120
CONCEN	0124
CONIK	1344
CONST5	0267
CONS12	0270
CONT	4421
CON1	1355
CON10	1352
CON100	1347
CON125	4136
CON2	1354
CON2K	1343
CON20	1351
CON200	1346
CON4	1353
CON40	1350
CON400	1345
CON75	4133
CRA	3000
CRB	3001
CRC	3002
CRD	3003
CRDCNT	0136
CRE	3004
CRF	3005
CRG	3006
CRLF	0151
CRLCC	0102

CTWOK	1163
CUA	3010
CUB	3011
CUC	3012
CUD	3013
CUE	3014
CUF	3015
CUG	3016
CULOC	0103
C0001	1561
C0002	1564
C001	1741
C0024	0741
C10	1144
C100	0275
C1400	0274
C2K	0751
C20	0753
C200	0744
C212	0076
C215	0075
C261	0100
C262	0101
C3006	1164
C302	0036
C303	0037
C305	0040
C306	0041
C307	0063
C311	0064
C315	0065
C316	0066
C320	0067
C322	0074
C323	0070
C324	0071
C325	0072
C332	0073
C3553	0747
C3601	0743
C3610	0745
C3753	0737
C3777	0750
C40	0740
C400	0746
C5227	1145
C5257	1146
C5317	1147
C5347	1150
C7753	0736
DATA	2000
DATSTB	0420
DDD	4261
DECOD	0231
DECODE	0237
DECO12	0252
DECO5	0243
DELAY	4465
DENOMR	1553
DO	0724

DOAGN	1621
DOIT	3672
DONE	4236
DUMPIT	4262
ELENUM	0126
ENDCRD	3701
ENO	4533
ENUF	4712
ERASE	6332
ERASED	4303
ERROR	4240
F	0273
FADD	1000
FAKE	1663
FDIV	4000
FEA	3020
FEB	3021
FEC	3022
FED	3023
FEE	3024
FEF	3025
FEG	3026
FELOC	0104
FEXT	0000
FGET	5000
FINDAV	2502
FIXADD	0676
FIXIT	4211
FIXVLT	4600
FLAG1	2560
FLAG2	2561
FLTIT	4200
FMAMCV	1600
FMPY	3000
FNOR	7000
FOXIT	4504
FPUT	6000
FRED	4000
FROG	1165
FSUB	2000
G	4502
GATOR	3464
GETC2K	1360
GG	4647
GO	2006
GOFER	3430
GOFOT	4652
GUGL	1756
GOLF	3465
GOOD	2353
GOODNO	0462
GOOSE	4633
GORF	0117
GPMB	2534
GRAVY	0017
OTC	1712
H	4503
HAD	4644
HELP	4735
HEY	2520

HMSG	4632
HOG	2452
HOLE	2163
HOPP	0364
IN	4130
INTCPB	0016
JJ	4302
JUG	4526
KEEP	1754
KEEPA	0132
KK	4301
LARGE	1755
LINE	0002
LIT	4527
LOC	3743
LOCDA	2200
LOKAD	0336
LOPIT	3444
LOT	4077
LOWER	1336
LTC	1727
M	2540
MAXCV	1747
MCV	1744
MGA	3030
MGB	3031
MGC	3032
MGD	3033
MGE	3034
MGF	3035
MGG	3036
MGL	0105
MINEN	0130
MIN15	3737
MIN17	3740
MIN2	0264
MIN3	0547
MIN5	1753
MIN6	0550
MIN7	3741
MNA	3040
MNB	3041
MNC	3042
MND	3043
MNE	3044
MNF	3045
MNG	3046
MNLOC	0106
MORCR	2150
MUNH	4702
M0024	1157
M1	1511
M13	0555
M24	0556
M3553	1154
M3601	1156
M3610	1155
M3753	1160
M3777	1153
M4	0553

M5	1752
M6	0551
M7	0554
M7753	1161
NIA	3050
NIB	3051
NIC	3052
NID	3053
NIE	3054
NIF	3055
NIG	3056
NILOC	0107
NNORM	1542
NPO	3523
NUMADD	0731
NUMBER	0544
OCTLX1	2544
OCTLX2	2547
ODD	3742
OFF	0326
ONEE	4641
OPDATA	2400
OUT	1070
OUTVLT	4400
OVERFL	4242
OVRFLO	6311
PASSNO	0116
PRA	3060
PBB	3061
PBC	3062
PBD	3063
PBE	3064
PBF	3065
PBG	3066
PBLOC	0110
PC	0147
PI	0000
PICCRD	6321
POWOFF	3723
PRDUCT	1400
PREP	0020
PRGINT	4056
PRINT	0026
PRODCI	1545
PROSXY	1556
RAG	0272
RDADC	6312
RDCRD	6331
RDDCRD	0400
READAD	0200
REALAD	0133
RECORD	6301
REG	0137
REPEAT	1210
RESTRT	3734
ROTATE	0514
RR	4637
SAOLB	0131
SARKI	1011

SAVE	3500
SC	0011
SCANN	1000
SECND	2600
SEX	2354
SIA	3070
SIB	3071
SIC	3072
SID	3073
SIE	3074
SIF	3075
SIG	3076
SILOC	0111
SINGLX	1526
SINGLY	1520
SIX	0733
SKIP	3532
SKIP13	3600
SKIP15	3612
SKIP3	3624
SLOPEM	0015
SM	4125
SNA1	3100
SNB	3101
SNC	3102
SND	3103
SNE	3104
SNEAK	1723
SNF	3105
SNG	3106
SNLOC	0112
SPL	6102
SPUD	2034
SS	4634
STADC	6334
START	6324
STBDAT	6322
STDCNT	0115
STOP	0134
STOR	1151
STORE	2543
STUPID	4341
SUMX	1531
SUMXY	1537
SUMX2	1550
SUMY	1523
TART	1016
TATER	3466
TEMP	0732
TEMPST	0276
TEMP1	0546
TEMX	0545
TEMZ	2166
TIA	3110
TIB	3111
TIC	3112
TID	3113
TIE	3114
TIF	3115

TIG	3116
TILOC	0113
TIM	0263
TWO	0754
T22	4536
UPPER	3656
UU	3736
V	4544
VOLT	0014
VOLTGE	0125
VOLTLO	0123
W	4545
WAITT	3453
WAT	2116
X	4546
XSQURD	1534
X1	0265
X2	0266
Y	0242
YAR	3127
YAVG	2555
YY	3735
ZCD	4346
ZERO	2444
ZER01	2562
ZJA	3120
ZNB	3121
ZNC	3122
ZND	3123
ZNE	3124
ZNF	3125
ZNG	3126
ZNLOC	0114

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APPENDIX D

URANIUM CARRIER DISTILLATION COMPUTER PROGRAM DESCRIPTION AND FLOW CHARTS

Introduction

This software package is for the uranium carrier distillation process of analysis on the Quantometer system. From second-order calibration curves determined prior to material burn, concentration of the element impurities in a uranium sample can be determined. Concentration values are outputted in two formats—a laboratory form and a customer form.

Operation

Steps in the operation of the instrument are as follows:

1. Place the RIM loader in memory, starting at Location 77578, by means of the switch registers.
2. Read in the binary loader, using the RIM loader.
3. Load the uranium carrier program binary tape by using the binary loader. Set the switch register to 77778 and depress the "load address" key, then set the switch register to 37778 and depress the "start" key. At the conclusion of the read in, the accumulator should be zero; if not, return to Step 1.
4. Start the program by setting the switch register to 40008 and depress the "load" and "address" and "start" keys. The program should then be in the interrupt mode.
5. Assuming the sample material is loaded, the operator is then ready to depress the "fire" button on the Quantometer.
6. Just prior to the burn, power will be removed from the computer, card reader, interface, and teletype. At the conclusion of the burn, power will be restored to these instruments. This power-down process is necessary to prevent burn noise from affecting the computer operations.
7. After a five-second delay following power up, the card reader should read one card and should read one card following every odd-numbered burn thereafter.
8. At the completion of the read card sequence, the computer initiates the stepping of the read-relay tape. Individual element voltages are read by the analog-to-digital converter (ADC) and stored within the computer.
9. After reading all elements specified by the read-relay tape, the program enters the interrupt loop. This burn sequence is repeated until all sample material has been burned. With the completion of the burn sequence, the program should be halted.
10. At this point the operator has a choice. By setting the switch register to 06008 and depressing the "load address" and "start" keys, all standard blank voltage values will be outputted by the teletype. When the type out is completed, OPT

will be typed. If the operator desires to delete any voltage value from the voltages listed, a "y" (yes) key on the teletype keyboard should be typed. The decimal value of the starting address for the element of interest should then be typed, followed by a carriage return. The decimal value of the voltage location in the element row should be typed followed by a carriage return. After the proper address values have been inputted, the specified voltage value is deleted. OPT will then be typed. If more deletions are necessary, the same sequence should be followed. When no deletions are necessary, an "n" (no) should be typed. Standard reference voltage values will then be listed. Voltage values can be deleted in the manner outlined. When an "n" is typed in reply to a standard reference OPT, the COMPUT routine is entered.

11. If the operator does not desire a blank-reference type out, the switch registers should be set to 12018—load address and start. The element concentration values are outputted by way of the teletype. The laboratory format is typed followed by the customer format. Both formats are typed in succession for each sample analysis.

A list of the memory locations for the uranium carrier computer software is given in Table D-1 followed by a description of the various subsections.

Table D-1

MEMORY ALLOCATION FOR URANIUM CARRIER COMPUTER SOFTWARE

Locations	Function
0000-0177	Variable Storage, Print, CRLF Routines
0200-0377	Element Location and Read ADC
0400-0577	Read Card Routine
0600-0777	Blank and Reference Voltage Type Out
1000-1177	BLK and REF Delete Option
1200-1377	Compute Sequence
1400-1577	Card Data Type Out
1600-1777	Average Blank and Average Reference Calculations
2000-2177	Calculate Concentration Values
2200-2377	Maximum/Minimum Concentration Check
2400-2701	Table Storage
2702-2777	Determination of Concentration Magnitude
3000-3177	Vacant
3200-3577	Card Data Storage
3600-3777	Miscellaneous Routines and Erased
4000-4177	Initialization and Interrupt Loop
4200-4377	Magnitude Scale, Fix, Floating, and Type Out Routines
4400-4577	Magnitude Scale Output and ADC Routine
4600-4777	Storage
5000-5313	B and C Calibration Curve Values

Subsection Description

Title - Element Location and Read ADC

Location - 0200-0377

Purpose - To determine the element storage location as defined by the read-relay tape, read the ADC, and store the voltage value in the element location determined.

Description - The routine is entered from the interrupt service routine. The read-relay tape contains subgroups of 5 and 12 relays, giving a total possible combination of 60 states. Upper memory is divided into five major sections which are further divided into 12 minor sections each. The decoding sequence gives the correct element address for data storage. After determining the proper address, the element voltage is strobed into the accumulator (AC) from the ADC and then placed in the core memory at the decoded address.

IOT's Used - 6334 (STADC), 6312 (RDADC), 6302 (CLEAR), 6324 (START)

<u>Routines Called - Name</u>	<u>Location</u>
DELAY	4306
HOBO	3600
LOK.ADC	4476
PRINT	0066
PREP	0115

Title - Read Card Routine

Location - 0400-0577

Purpose - To read and store information from standard and sample cards.

Description - This routine is entered from the interrupt service routine. Cards are read on every odd-numbered burn. Standard cards are coded in the first column by a "%" symbol. The first column is checked for the "%" symbol and the appropriate routine entered. No symbol in the first column indicates a sample data card. Four-number groups totaling 18 digits are read for each sample card. Storing the data in BCD requires 6 twelve-bit words per card; therefore, six words are used for each card read. A table starting in Location *3200 is used for card data storage.

IOT's Used - 6324 (START), 6321 (PICCRD), 6322 (STBDAT), 6302 (CLEAR)

<u>Routines Called - Name</u>	<u>Location</u>
ENDCRD	3645
COMPUT	1200
WOSTOP	1066

Title - Blank and Reference Voltage Type Out

Location - 0600-0777

Purpose - To provide a visual check of the blank and reference voltage values.

Description - Standard-blank and standard-reference-voltage values are outputted at the conclusion of the entire burn sequence. Steps for voltage deletion are described in Step 10 of the operation procedure.

IOT's Used - 6211 (CDF2), 6201 (CDF1)

<u>Routines Called - Name</u>	<u>Location</u>
SPACE	0106
PRINT	0066
CRLF	0075
OPTNI	1000
CALATE	1111
OUTVLT	4400

Title - BLK and REF Delete OptionLocation - 1000-1177

Purpose - OPTNI is a subroutine of Page 0600g. The address of the voltage to be deleted is calculated by this routine and then deleted.

Description - The decimal value of the starting address of the element voltage to be deleted is entered first. This information provides the correct major address for upper memory. The voltage position in the element row indicates the order of the standard burn. From this information a specific upper memory location is determined.

MORCRD, WOSTOP, and CALATE routines are included in this page. MORCRD is a part of Page 1400g, WOSTOP is a delay and initiate read-relay tape subroutine of Page 0200g, and CALATE is a subroutine used in various parts of the program to calculate an upper memory address from a card data table address.

IOT's Used - 6211 (CDF2), 6201 (CDF1), 6324 (START), 6302 (CLEAR)

<u>Routines Called</u> - Name	<u>Location</u>
FIXIT	4254
CRLF	0075
PRINT	0066
SPACE	0106
STOP	0135
PREP	0115
FLOIT	4243

Title - Compute Sequence

Location - 1200-1377

Purpose - A complete data analysis is directed from this page.

Description - A sequence of subroutines construct the output format, calculate concentration values, check maximum/minimum limits, and output the final results. For one sample, 33 elements are analyzed. The concentration values are calculated for one element and outputted; meaning the subroutine sequence will be used 33 times for one sample analysis.

IOT's Used - None

<u>Routines Called</u> - <u>Name</u>	<u>Location</u>
DATOP	1400
ETOUT	0720
AVGBLK	1600
AVGREF	1657
CONCAL	2000
CONCHK	2200
CRLF	0075

Title - Card Data Type Out

Location - 1400-1577

Purpose - To type the sample card identification data at the beginning of the laboratory and customer output forms.

Description - This subroutine is called at the beginning of every output form. Requisition number, material type code, procedure code, and plate sheet numbers constitute the identification data for each sample. These numbers are stored in BCD form. The DATOP routine converts the BCD digits to ASCII code for output by the teletype.

IOT's Used - None

<u>Routines Called - Name</u>	<u>Location</u>
CRLF	4075
MORCRD	1052
STOP	0135
SKIP	4462
PRINT	0066
GOFOT	4326

Title - Average Blank and Average Reference Calculations

Location - 1600-1777

Purpose - To calculate the blank and reference averages for each element.

Description - AVGBLK and AVGREF routines are two of the sequence subroutines referred to in the COMPUT program. The average blank value is subtracted from the average reference value and the sample voltage value to eliminate background effects. Blank and reference standards are burned in sequence. The standard voltages are located by using the standard address table entries. Reference values are found, and the average calculated using the same method as used for blank averages.

IOT's Used - 6211 (CDF2), 6201 (CDF1)

<u>Routines Called - Name</u>	<u>Location</u>
CALATE	1111
FIXVLT	4200
FLOIT	4243

Title - Calculate Concentration Values

Location - 2000-2177

Purpose - To determine an unknown element concentration value from a corresponding sample voltage using a calibration curve.

Description - The concentration of uranium impurities is determined by the following equation:

Element Concentration = $\left(\frac{V_{\text{sample}} - V_{\text{blkavg}}}{V_{\text{ref}} - V_{\text{blkavg}}} \right) B + \left(\frac{V_{\text{sample}} - V_{\text{blkavg}}}{V_{\text{ref}} - V_{\text{blkavg}}} \right)^2 C,$

where:

V_{sample} represents the sample voltage,

V_{blkavg} the average standard blank voltage, and

V_{ref} the average standard reference voltage.

B and C are calibration curve constants.

Two concentration values are calculated corresponding to the duplicate burn of the sample material. These values are then averaged.

IOT's Used - 6211 (CDF2), 6201 (CDF1)

Routines Called - Name	Location
FLOIT	4243
FIXIT	4200
SPACE	4106
OPTSZ	2702

Title - Maximum/Minimum Concentration Check

Location - 2200-2377

Purpose - To check yavg concentration value against upper and lower limits.

Description - Maximum/minimum concentration values for each element are stored in a table beginning in Location *2600g. When an average value is calculated, the corresponding maximum/minimum values are checked to determine if the yavg is within the upper and lower limits. For a yavg value greater than the maximum concentration, a > symbol is typed followed by the maximum value. For a less-than condition, a < symbol is typed followed by the minimum value.

IOT's Used - None

Routines Called - Name	Location
FLOIT	4243
SPACE	0106
OPTSZ	2702
CRLF	0075
PRINT	0066

Title - Table Storage

Location - 2400-2701

Purpose - For storage.

Description - Locations 2400g - 2441g contain element abbreviation codes. The last two digits (six bits) of the ASCII code for numbers are stored for each letter. An "A" would be stored as 01. As the codes are removed, 300 is added to each value. Locations 2442g - 2503g contain the major address of each element storage area in upper memory. Minimum and maximum concentration values are stored in Locations 2600g through 2701g.

Title - Determination of Concentration Magnitude

Location - 2702-2777

Purpose - To determine the relative magnitude of concentration values prior to type out.

Description - OPTSZ is a subroutine called from every point where data are being outputted. The floating point package 2 does not type a decimal point for numbers that contain the same amount of digits as the value placed in Location 0062g. If the magnitude is greater than 10010, a space is typed for the vacant decimal point. This arrangement permits the output to be perfectly aligned by column.

IOT's Used - None

<u>Routines Called</u> - <u>Name</u>	<u>Location</u>
SPACE	0106

Title - Card Data Storage

Location - 3200-3577

Purpose - For storage.

Description - Information from standard and sample cards is stored in Locations 3200-3577. Each card occupies six words. Eighteen BCD digits are stored for each sample card. Standard card blocks will be vacant.

Title - Miscellaneous Routines and Erased

Location - 3600-3777

Purpose - For general purpose programs.

Description - The HOB0 routine is equivalent to the GOFER routine described in the aluminum spark program. The OVERFL, ENDCRD, and ERASED routines are identical for both the uranium and aluminum programs. Description and flow diagrams are given in the aluminum program definition.

Title - Initialization and Interrupt Loop

Location - 4000-4177

Purpose - To initialize proper registers and provide a no-action sequence for program operation.

Description - Initialization is performed in Locations 4001g - 4046g. Locations 4047g - 4075g contain the interrupt loop routine. In an idle state, the program runs in this NOP loop. When an interrupt occurs, the program goes to Location 0000g and then jumps to INTIOS Location *4076. The cause is identified as being a power down, read card, read-relay tape, or erase interrupt. When the cause is identified, the proper service routine is entered.

IOT's Used - 6102 (SPL), 6301 (RECORD), 6331 (RDCRD), 6332 (ERASE), 6324 (START)

<u>Routines Called</u> - <u>Name</u>	<u>Location</u>
READAD	0200
REDCRD	0400
ERASED	3671
ABCD	5123

Title - Magnitude Scale, Fix, Float, and Type Out Routines

Location - 4200-4377

Purpose - To scale ADC output, convert octal values to fixed and floating forms, and identify type out.

Description - The FIXVLT routine converts the octal ADC output to 0-10 decimal representation. The FLOIT and FIXIT routines perform floating point fix and floating operations on octal values. DELAY is identical to the DELAY for the aluminum program. The GOFOT routine types (CARRIER DIST MICRO-G/G (PPM) Metal Basis).

Title - Magnitude Scale Output and ADC Routine

Location - 4400-4577

Purpose - To magnitude scale the ADC reading, output the value, and read the ADC.

Description - OUTVLT is identical to FIXVLT except for the added output function. The LOKADC routine is described in the aluminum program description.

Title - Storage

Location - 4600-4777

Purpose - For floating point constant storage.

Description - WAIT routine is a variable time delay. GOFOT2 is a constant type out routine. STUPID and ZCD are called from ERASED program.

Title - B and C Calibration Curve Values

Location - 5000-5313

Purpose - For constant storage.

Description - Floating point values B and C from the second-order calibration curves are stored in pairs for each element.

APPENDIX E

URANIUM CARRIER DISTILLATION SOFTWARE LISTING

PYRO

MAY 4, 1970

/ PAGE ZERO

CDF2=6211
 CDF1=6201
 SPL=6102
 RECORD=6301
 CLEAR=6302
 ADD5SB=6304
 OVRFLD=6311
 RDADC=6312
 AD12SB=6314
 FNOR=7000
 FADD=1000
 FSUB=2000
 FMPY=3000
 FDIV=4000
 FGET=5000
 FPUT=6000
 FEXT=0000
 PICCRD=6321
 STBDAT=6322
 START=6324
 RDCRD=6331
 ERASE=6332
 STADC=6334
 *0000

0000	0000	PI,	0
0001	5777		JMP INTIOS
0002	0000	LINC,	0
0003	0000	AC,	0
0004	0000	MAD,	0
		*0005	
0005	7400		7400
0006	7200		7200
0007	5600		5600
0010	0000	AUT010,	0
0011	0000	AUT011,	0
0012	0000	AUT012,	0
0013	0000	AUT013,	0
0014	0000	AUT014,	0
0015	0000	AUT015,	0
0016	0000	AUT016,	0
0017	0000	AUT017,	0
		*0020	
0020	0000	BLKAVG,	0
0021	0000		0
0022	0000		0
0023	0000	REFAVG,	0
0024	0000		0
0025	0000		0
0026	0000	CONC1,	0
0027	0000		0
0030	0000		0
0031	0000	CONC2,	0
0032	0000		0
0033	0000		0
0034	0000	YAVG	0

0035	0000		0	
0036	0000		0	
		*0063		
0063	7775	COUNT3,	7775	
0064	0000	AOXBPO,	0	
0065	0000	CHARLE,	0	
0066	0000	PRINT,	0	
0067	6046		TLS	
0070	6041		TSF	
0071	5070		JMP .-1	
0072	6042		TCF	
0073	7300		CLA CLL	
0074	5466		JMP I PRINT	
0075	0000	CRLF,	0	
0076	6032		KCC	
0077	6046		TLS	
0100	7300		CLA CLL	
0101	1176		TAD (215)	
0102	4066		JMS PRINT	
0103	1175		TAD (212)	
0104	4066		JMS PRINT	
0105	5475		JMP I CRLF	
0106	0000	SPACE,	0	
0107	6032		KCC	
0110	6046		TLS	
0111	7300		CLA CLL	
0112	1174		TAD (240)	
0113	4066		JMS PRINT	
0114	5506		JMP I SPACE	
0115	7300	PREP,	CLA CLL	
0116	1002		TAD LINC	
0117	7004		RAL	
0120	1003		TAD AC	
0121	6001		ION	
0122	5400		JMP I 0	
0123	1002	ABCD,	TAD LINC	
0124	7104		CLL RAL	
0125	1003		TAD AC	
0126	6001		ION	
0127	2133		ISZ BURNO	
0130	7000		NOP	
0131	5532		JMP I PC	
0132	0000	PC,	0	
0133	0000	BURNO,	0	
0134	0000	KEEP,	0	
0135	0000	STOP,	0	
0136	7402		HLT	
0137	0000	ADDLOC,	0	
0140	0000	STDCNT,	0	
0141	0000	CRDCNT,	0	
0142	7737	CNT41,	7737	
0143	0000	ADCVLT,	0	
0144	0000		0	
0145	0000		0	
0146	7400	COWS, 7400		
0147	0000	ADDRES, 0		
*200	/READ TAPE			
0200	7300	READAD,	CLA CLL	
0201	4777		JMS DELAY	/DISABLE TAPE AND DELAY
0202	7300	AGAIN,	CLA CLL	

0203	2261		ISZ TIM	/5 OR 12 RELAY SET
0204	5776		JMP HOB0	
0205	6314		AD12SB	
0206	3266		DCA GOBLE	
0207	1375		TAD (7776)	
0210	3261		DCA TIM	
0211	1266		TAD GOBLE	
0212	4227	CHECK,	JMS DECOD	
0213	4227		JMS DECOD	
0214	4227		JMS DECOD	
0215	4227		JMS DECOD	
0216	4227		JMS DECOD	
0217	4227		JMS DECOD	
0220	4227		JMS DECOD	
0221	4227		JMS DECOD	
0222	4227		JMS DECOD	
0223	4227		JMS DECOD	
0224	4227		JMS DECOD	
0225	4227		JMS DECOD	
0226	4321		JMS OFF	
0227	0000	DECOD,	0	
0230	7010		RAR	
0231	7430		SZL	
0232	5235		JMP DECODE	
0233	2267		ISZ RAG	
0234	5627		JMP I DECOD	
0235	7440	DECODE,	SZA	
0236	4321		JMS OFF	
0237	2267		ISZ RAG	
0240	5241	Y,	JMP DECOD5	
0241	1262	DECOD5,	TAD X1	
0242	3240		DCA Y	
0243	1264		TAD CONST5	
0244	1267		TAD RAG	
0245	3270		DCA F	
0246	3267		DCA RAG	
0247	5670		JMP I F	
0250	1263	DECOD12,	TAD X2	
0251	3240		DCA Y	
0252	1265		TAD CONS12	
0253	1267		TAD RAG	
0254	3270		DCA F	
0255	3267		DCA RAG	
0256	1375		TAD (7776)	
0257	3261		DCA TIM	
0260	5670		JMP I F	
0261	7776	TIM,	7776	
0262	5250	X1,	5250	
0263	5241	X2,		5241
0264	0271	CONST5,	271	
0265	0300	CONS12,	300	
0266	0000	GOBLE,	0	
0267	0000	RAG,	0	
0270	0000	F,	0	
0271	0000	TEMPST,	0	
0272	1374		TAD (1400)	/DECODE 5 BITS
0273	1374		TAD (1400)	
0274	1374		TAD (1400)	
0275	1374		TAD (1400)	
0276	7000		NOP	/DO NOT REMOVE

0277	3271		DCA TEMPST
0300	5202		JMP AGAIN
0301	1373		TAD (100)
0302	1373		TAD (100)
0303	1373		TAD (100)
0304	1373		TAD (100)
0305	1373		TAD (100)
0306	1373		TAD (100)
0307	1373		TAD (100)
0310	1373		TAD (100)
0311	1373		TAD (100)
0312	1373		TAD (100)
0313	1373		TAD (100)
0314	7000		NOP
0315	1271		TAD TEMPST
0316	1133		TAD BURNO
0317	3147		DCA ADDRES
0320	5772		JMP LOKADC
0321	0000	OFF,	0
0322	6032		KCC
0323	6046		TLS
0324	7300		CLA CLL
0325	1371		TAD (207)
0326	4066		JMS PRINT
0327	7402		HLT
0330	6302		CLEAR
0331	5115		JMP PREP
0332	0000	UMP,	0
0333	7760	SUR,	7760
0334	7760	AMP,	7760
0371	0207		
0372	4476		
0373	0100		
0374	1400		
0375	7776		
0376	3600		
0377	4306		
*400			
			/READ CARD ROUTINE
			/ROW ZERO=BIT ZERO IN AC
0400	7300	REDCRD,	CLA CLL
0401	7300		CLA CLL
0402	3341		DCA COLCNT
0403	3340		DCA TEMP1
0404	3336		DCA NUMBER
0405	2141		ISZ CRDCNT
0406	1141		TAD CRDCNT
0407	7010		RAR
0410	7420		SNL
0411	4777		JMS WOSTOP
0412	7300		CLA CLL /ODD READ
0413	1376		TAD (2)
0414	6324		START
0415	7300		CLA CLL
0416	6321		PICCRD
0417	5216		JMP .-1
0420	7300	DATSTB,	CLA CLL
0421	6322		STBDAT
0422	5220		JMP .-2
0423	7000		NOP

0424	6302		CLEAR
0425	6322		STBDAT
0426	3337		DCA TEMP
0427	2341		ISZ COLCNT
0430	1341		TAD COLCNT
0431	1375		TAD (-1)
0432	7450		SNA /FIRST COL
0433	5317		JMP COMCHK /YES CHECK FOR COMP OR B.R
0434	1374		TAD (-7)
0435	7510		SPA /2<OR=COLCNT<OR=7?
0436	5262		JMP GOODNO /YES
0437	1373		TAD (-13) /NO
0440	7510		SPA /8<OR=COLCNT <OR=18?
0441	5220		JMP DATSTB /YES
0442	1372		TAD (-4) /NO
0443	7510		SPA /19<OR=COLCNT<OR=22
0444	5262		JMP GOODNO /YES
0445	1371		TAD (-24) /NO
0446	7510		SPA /23 <OR=8LENT<OR=42
0447	5220		JMP DATSTB /YES
0450	1372		TAD (-4) / NO
0451	7510		SPA /43<OR=CONCNT<OR=46
0452	5262		JMP GOODNO /YES
0453	1370		TAD (-10) /NO
0454	7510		SPA /47<OR=COLCNT<OR=54
0455	5220		JMP DATSTB /YES
0456	1372		TAD (-4) /NO
0457	7510		SPA /55<OR=COLCNT<OR=58
0460	5262		JMP GOODNO /YES
0461	5767		JMP ENDCRD
0462	7300	GOODNO,	CLA CLL
0463	1337		TAD TEMP
0464	7500	A,	SMA
0465	5314		JMP ROTATC
0466	7300		CLA CLL
0467	1336		TAD NUMBER
0470	1340		TAD TEMP1
0471	2344		ISZ M3
0472	7410		SKP
0473	5301		JMP .+6
0474	7006		RTL
0475	7006		RTL
0476	3340		DCA TEMP1
0477	3336		DCA NUMBER
0500	5220		JMP DATSTB
0501	3537		DCA I ADDLOC
0502	1137		TAD ADDLOC
0503	7001		IAC
0504	3137		DCA ADDLOC
0505	1343		TAD MIN3
0506	3344		DCA M3
0507	3340		DCA TEMP1
0510	3336		DCA NUMBER
0511	2342		ISZ M6
0512	5220		JMP DATSTB
0513	5767		JMP ENDCRD
0514	7004	ROTATC,	RAL
0515	2336		ISZ NUMBER
0516	5264		JMP A
0517	7100	COMCHK,	CLI

0520	1337		TAD TEMP	
0521	7450		SNA	
0522	5220		JMP DATSTB	
0523	7700		SMA CLA /COMPUT OR BLK	
0524	5766		JMP COMPUT	/COMPUT CARD
0525	3336		DCA NUMBER	/STANDARD CARD
0526	1137		TAD ADDLOC	
0527	3410		DCA I 10	/ADDRESS TABLE FOR BLKS
0530	2140		ISZ STDCNT	
0531	7300		CLA CLL	
0532	1137		TAD ADDLOC	
0533	1365		TAD (6)	
0534	3137		DCA ADDLOC	
0535	5767		JMP ENDCRD	
0536	0000	NUMBER,	0	
0537	0000	TEMP,	0	
0540	0000	TEMP1,	0	
0541	0000	COLCNT,	0	
0542	7772	M6,	7772	
0543	7775	MIN3,	7775	
0544	7775	M3,	7775	
0565	0006			
0566	1200			
0567	3645			
0570	7770			
0571	7754			
0572	7774			
0573	7765			
0574	7771			
0575	7777			
0576	0002			
0577	1066			
*600				
			/OUTPUT BLANK VOLTAGES & REF. VOLTS	
0600	7300	BEGIN,	CLA CLL	
0601	3351		DCA COUN	
0602	3346		DCA TNUOC	
0603	1377		TAD (2377)	
0604	3011		DCA AUTO11	
0605	1376		TAD (2441)	
0606	3012		DCA AUTO12	
0607	4106		JMS SPACE	
0610	1375		TAD (302)	
0611	4066		JMS PRINT	
0612	1374		TAD (314)	
0613	4066		JMS PRINT	
0614	1373		TAD (313)	
0615	4066		JMS PRINT	
0616	4075		JMS CRLF	
0617	4320	GOTIT,	JMS ETOUT	
0620	1412		TAD I AUTO12	
0621	3344		DCA MAGAD	
0622	4271		JMS IMA	
0623	2351		ISZ COUN	
0624	7300		CLA CLL	
0625	1345		TAD M41	
0626	1351		TAD COUN	
0627	7640		SZA CLA	/OUTPUTTED ACC BLK VOLTAGE
0630	5217		JMP GOTIT	/NO
Q631	3772		DCA ONE	

0632	4771	JMS OPTN1	YYES, OUTPUT REF VOLTAGES
0633	4075	JMS CRLF	
0634	4075	JMS CRLF	
0635	4075	JMS CRLF	
0636	4106	JMS SPACE	
0637	1370	TAD (322)	
0640	4066	JMS PRINT	
0641	1367	TAD (305)	
0642	4066	JMS PRINT	
0643	1366	TAD (306)	
0644	4066	JMS PRINT	
0645	4075	JMS CRLF	
0646	1377	TAD (2377)	
0647	3011	DCA AUTO11	
0650	1376	TAD (2441)	
0651	3012	DCA AUTO12	
0652	4320	JMS ETOUT	
0653	1412	TAD I AUTO12	
0654	1365	TAD (1)	
0655	3344	DCA MAGAD	
0656	4271	JMS IMA	
0657	2346	IS7 TMIHC	
0660	7300	CLA CLL	
0661	1345	TAD M41	
0662	1346	TAD TNUOC	
0663	7640	SZA CLA	/OUTPUTD ALL REF VOLTAGES.
0664	5252	JMP GARF	/NO
0665	7201	CLA IAC	/YES
0666	3772	DCA ONE	
0667	4771	JMS OPTN1	
0670	4764	JMS COMPUT	
0671	0000	Q000	
0672	1363	TAD (2507)	
0673	3010	DCA AUTO10	
0674	1140	TAD STDCNT	
0675	7041	CIA	
0676	3347	DCA CRCK	
0677	1410	TAD I AUTO10	
0700	4762	JMS CALATE	
0701	1344	TAD MAGAD	
0702	3134	DCA KEEP	
0703	6211	CDF2	
0704	1534	TAD I KEEP	
0705	6201	CDF1	
0706	4761	JMS OUTVLT	
0707	4106	JMS SPACE	
0710	4106	JMS SPACE	
0711	4106	JMS SPACE	
0712	2347	ISZ CRCK	/ALL VOLTAGES OUTPUTED
0713	5277	JMP FINK	/NO
0714	4075	JMS CRLF	/YES
0715	1363	TAD (2507)	
0716	3010	DCA AUTO10	
0717	5671	JMP I IMA	
0720	0000	0	
0721	6032	KCC	
0722	6046	TLS	
0723	1411	TAD I AUTO11	
0724	3350	DCA STOR	
0725	7100	CLL	

0726	1350		TAD STOR
0727	0360		AND (7700)
0730	7012		RTR
0731	7012		RTR
0732	7012		RTR
0733	1357		TAD (300)
0734	4066		JMS PRINT
0735	1350		TAD STOR
0736	0356		AND (0077)
0737	1357		TAD (300)
0740	4066		JMS PRINT
0741	4106		JMS SPACE
0742	7300		CLA CLL
0743	5720		JMP I ETOUT
0744	0000	MAGAD,	0
0745	7737	M41,	7737
0746	0000	TNUOC,	0
0747	0000	CRCK,	0
0750	0000	STOR,	0
0751	0000	COUN,	0
0752	0000	DIODE,	0
0756	0077		
0757	0300		
0760	7700		
0761	4400		
0762	1111		
0763	2507		
0764	1200		
0765	0001		
0766	0306		
0767	0305		
0770	0322		
0771	1000		
0772	1131		
0773	0313		
0774	0314		
0775	0302		
0776	2441		
0777	2377		

*1000

/OPTION FOR BLK. IF CORRECTION NEEDED TYPE YES

/NOTE: 1. INPUT ELEMENT ADDRESS IN DECIMAL

/ 2. INPUT POSITION IN PARTICULAR ELEMENT ROW

1000	0000	OPTN1,	0000	
1001	7300		CLA CLL	
1002	4240	SANTA,	JMS OPTION	
1003	4405		JMS I Z 5	/TYPE Y OR N
1004	7300		CLA CLL	
1005	1057		TAD 57	
1006	1377		TAD (-331)	
1007	7640		SZA CLA	/DELETION NEEDED?
1010	5600		JMP I OPTN1	/NO
1011	4405		JMS I Z 5	/YES, INPUT FIRST ELEMENT ADD
1012	4407		JMS I Z 7	
1013	6334		FPUT MEMB	
1014	4776		FDIV TWO	
1015	0000		FEXT	
1016	4775		JMS FIXIT	
1017	7004		RAL	
1020	3330		DCA MUMP	

			/TYPE POSITION IN	ROW
1021	4405	JMS I Z 5		
1022	4775	JMS FIXIT		
1023	3333	DCA SNOW		
1024	1333	TAD SNOW		
1025	1374	TAD (2506)		
1026	3010	DCA AUTO10		
1027	1410	TAD I AUTO10		
1030	4311	JMS CALATE		
1031	1330	TAD MUMP		
1032	1331	TAD ONE		
1033	3332	DCA DELADD		
1034	6211	CDF2		
1035	3732	DCA I DELADD		
1036	6201	CDF1		
1037	5202	JMP SANTA		
1040	0000	OPTION, 0		
1041	4075	JMS CRLF		
1042	1373	TAD (317)		
1043	4066	JMS PRINT	/O	
1044	1372	TAD (320)		
1045	4066	JMS PRINT	/P	
1046	1371	TAD (324)		
1047	4066	JMS PRINT	/T	
1050	4106	JMS SPACE		
1051	5640	JMP I OPTION		
1052	7300	MORCRD, CLA CLL		
1053	1064	TAD AOXBPO		
1054	7041	CIA		
1055	7040	CMA		
1056	7041	CIA		
1057	1337	TAD SAOLB		
1060	7650	SNA CLA	/HAS ALL DATA BEEN OUTPUTTED?	
1061	4135	JMS STOP	/YES	
1062	1064	TAD AOXBPO	/NO	
1063	1370	TAD (6)		
1064	3064	DCA AOXBPO		
1065	5767	JMP DATOP+1		
1066	0000	WOSTOP, 0		
1067	7300	CLA CLL		
1070	1366	TAD (20)		
1071	6324	START		
1072	7300	CLA CLL		
1073	2306	ISZ VV		
1074	5273	JMP .-1		
1075	2307	ISZ WW		
1076	5273	JMP .-3		
1077	1310	TAD X		
1100	3307	DCA WW		
1101	1365	TAD (10)		
1102	6324	START		
1103	6302	CLEAR		
1104	7300	CLA CLL		
1105	5115	JMP PREP		
1106	0000	VV, 0		
1107	7700	WW, 7700		
1110	7700	X, 7700		
1111	0000	CALATE, 0		
1112	3340	DCA TEMPX		
1113	1340	TAD TEMPX		
1114	1364	TAD (-3200)		

```

1115 4763 JMS FLOIT
1116 4407 JMS I Z 7
1117 4325 FDIV THRE
1120 0000 FEXT
1121 4775 JMS FIXIT
1122 3134 DCA KEEP
1123 1134 TAD KEEP
1124 5711 JMP I CALATE
1125 0002 THRE, 0002
1126 3000 3000
1127 0000 0000
1130 0000 MUMP, 0
1131 0000 ONE, 0
1132 0000 DELADD, 0
1133 0000 SNOW, 0
1134 0000 MEMB, 0
1135 0000 0
1136 0000 0
1137 0000 SAOLB, 0
1140 0000 TEMPX, 0

```

/START CALCULATION OF

/ELEMENT CONCENTRATION

```

1163 4243
1164 4600
1165 0010
1166 0020
1167 1401
1170 0006
1171 0324
1172 0320
1173 0317
1174 2506
1175 4254
1176 2135
1177 7447

```

*1200

COMPUT,

0

```

1200 0000 CLA CLL
1201 7300 TAD (2507)
1202 1377 DCA AUTO10
1203 3010 TAD (2377)
1204 1376 DCA AUTO11
1205 3011 TAD (2441)
1206 1375 DCA AUTO12
1207 3012 TAD (2577)
1210 1374 DCA 14
1211 3014 TAD (5000)
1212 1373 DCA 13
1213 3013 TAD (7775)
1214 1372 DCA 63
1215 3063 TAD ADDLOC
1216 1137 DCA SAOLB
1217 3771 TAD (3201)
1220 1370 DCA AOXBPO
1221 3064 JMS DATOP
1222 4767 BOFUS, JMS ETOUT
1223 4766 HAVAT, JMS AVGBLK
1224 4765 JMS AVGREF
1225 4764 JMS CONCAL
1226 4763 JMS CONCHK
1227 4762

```

/BLANK ADDRESS TABLE

/ELEMENT ABBREVIATION

/MAJOR ADDRESS

/ADDRESS OF FIRST DATA BLO

/TYPE SAMPLE CARD DATA

/TYPE ELEMENT ABBREVIATION

/FIND BLANK AVERAGE

/FIND REFERENCE AVERAGE

/FIND Y1&Y2 CONC. AND (Y1+

/MIN.CONC.<YAVG.<MAX. CONC

1230	7300	CLA CLL	
1231	2142	ISZ CNT41	/ALL ELEMENT CONCENTRATION
1232	5223	JMP HAVAT	/NO
1233	1372	TAD (7775)	
1234	3063	DCA 63	
1235	4075	JMS CRLF	/YES OUTPUT YAVGS ONLY
1236	4075	JMS CRLF	
1237	4075	JMS CRLF	
1240	4075	JMS CRLF	
1241	7300	CLA CLL	
1242	1065	TAD CHARLE	
1243	7001	IAC	
1244	3064	DCA A0XBPO	
1245	4767	JMS DATOP	
1246	7300	CLA CLL	
1247	1361	TAD (2331)	
1250	3016	DCA 16	
1251	1377	TAD (2507)	
1252	3010	DCA AUTO10	
1253	1376	TAD (2377)	
1254	3011	DCA AUTO11	
1255	1375	TAD (2441)	
1256	3012	DCA AUTO12	
1257	1373	TAD (5000)	
1260	3013	DCA AUTO13	
1261	1374	TAD (2577)	
1262	3014	DCA AUTO14	
1263	1360	TAD (5600)	
1264	3757	DCA RACKM	
1265	1356	TAD (7737)	
1266	3142	DCA CNT41	
1267	4766	JMS ETOUT	
1270	4765	JMS AVGBLK	
1271	4764	JMS AVGREF	
1272	4763	JMS CONCAL	
1273	4762	JMS CONCHK	
1274	7300	CLA CLL	
1275	2142	ISZ CNT41	/ALL ELEMENT AVERAGES OUTP
1276	5267	JMP HARK	/NO
1277	1355	TAD (7736)	/ YES
1300	3142	DCA CNT41	
1301	1354	TAD (4762)	/ REPLACE RACKM
1302	3757	DCA RACKM	
1303	1377	TAD (2507)	
1304	3010	DCA AUTO10	
1305	1376	TAD (2377)	
1306	3011	DCA AUTO11	
1307	1375	TAD (2441)	
1310	3012	DCA AUTO12	
1311	1373	TAD (5000)	
1312	3013	DCA AUTO13	
1313	1374	TAD (2577)	
1314	3014	DCA AUTO14	
1315	1361	TAD (2331)	
1316	3016	DCA 16	
1317	1372	TAD (7775)	
1320	3063	DCA 63	
1321	4075	JMS CRLF	
1322	4075	JMS CRLF	
1323	4075	JMS CRLF	

HARK.

1324 5222
 1354 4762
 1355 7736
 1356 7737
 1357 2117
 1360 5600
 1361 2331
 1362 2200
 1363 2000
 1364 1657
 1365 1600
 1366 0720
 1367 1400
 1370 3201
 1371 1137
 1372 7775
 1373 5000
 1374 2577
 1375 2441
 1376 2377
 1377 2507

JMP BOFUS

*1400

1400 0000 DATOP,
 1401 4075
 1402 7300
 1403 6032
 1404 6046
 1405 1464
 1406 3352
 1407 1064
 1410 7001
 1411 3353
 1412 1753
 1413 1352
 1414 7650
 1415 5777
 1416 1064
 1417 7041
 1420 7040
 1421 7041
 1422 1776
 1423 7650
 1424 4135
 1425 1064
 1426 7041
 1427 7040
 1430 3354
 1431 1064
 1432 1375
 1433 3064
 1434 1354
 1435 3065
 1436 7300 SPUD,
 1437 1754
 1440 4322
 1441 4335
 1442 7300
 1443 1354
 1444 7001

/TYPE CARD INFORMATION DATA

0
 JMS CRLF
 CLA CLL
 KCC
 TLS
 TAD I AOXBP0
 DCA CAMEL
 TAD AOXBP0
 IAC
 DCA AOXBP2
 TAD I AOXBP2
 TAD CAMEL
 SNA CLA /SAMPLE CARD?
 JMP MORCRD /NO BLANK CARD
 TAD AOXBP0 /YES, SAMPLE DATA
 CIA
 CMA
 CIA
 TAD SAOLB
 SNA CLA /HAS ALL DATA BEEN OUTPU
 JMS STOP /YES
 TAD AOXBP0 /NO
 CIA
 CMA
 DCA REALAD
 TAD AOXBP0
 TAD (6)
 DCA AOXBP0
 TAD REALAD
 DCA CHARLE
 CLA CLL
 TAD I REALAD / AC = FIRST WORD
 JMS CODE1
 JMS CODE2
 CLA CLL
 TAD REALAD
 IAC

1445	3354	DCA REALAD	
1446	1754	TAD I REALAD	
1447	4322	JMS CODE1	/FIRST 6 DIGIT WORD
1450	4335	JMS CODE2	
1451	4774	JMS SKIP	
1452	1354	TAD REALAD	
1453	7001	IAC	
1454	3354	DCA REALAD	
1455	1754	TAD I REALAD	
1456	4322	JMS CODE1	/FIRST 3 DIGITS OF WORD 2
1457	4335	JMS CODE2	
1460	1354	TAD REALAD	
1461	7001	IAC	
1462	3354	DCA REALAD	
1463	1754	TAD I REALAD	
1464	4322	JMS CODE1	
1465	4774	JMS SKIP	
1466	1754	TAD I REALAD	
1467	3355	DCA HOG	
1470	4335	JMS CODE2	
1471	1354	TAD REALAD	
1472	7001	IAC	
1473	3354	DCA REALAD	
1474	1754	TAD I REALAD	
1475	4322	JMS CODE1	
1476	1355	TAD HOG	
1477	0373	AND (0360)	
1500	7012	RTR	
1501	7012	RTR	
1502	1372	TAD (260)	
1503	4066	JMS PRINT	
1504	4774	JMS SKIP	
1505	1355	TAD HOG	
1506	0371	AND (0017)	
1507	1372	TAD (260)	
1510	4066	JMS PRINT	
1511	1354	TAD REALAD	
1512	7001	IAC	
1513	3354	DCA REALAD	
1514	1754	TAD I REALAD	
1515	4322	JMS CODE1	
1516	4335	JMS CODE2	
1517	4770	JMS GOFOT	
1520	4075	JMS CRLF	
1521	5600	JMP I DATOP	
1522	0000	0	CODE1,
1523	3355	DCA HOG	
1524	1355	TAD HOG	
1525	0367	AND (7400)	
1526	7012	RTR	
1527	7012	RTR	
1530	7012	RTR	
1531	7012	RTR	
1532	1372	TAD (260)	
1533	4066	JMS PRINT	
1534	5722	JMP I CODE1	
1535	0000	0	CODE2,
1536	1355	TAD HOG	
1537	0373	AND (0360)	
1540	7012	RTR	

1541 7012
 1542 1372
 1543 4066
 1544 7300
 1545 1355
 1546 0371
 1547 1372
 1550 4066
 1551 5735
 1552 0000
 1553 0000
 1554 0000
 1555 0000
 1567 7400
 1570 4326
 1571 0017
 1572 0260
 1573 0360
 1574 4462
 1575 0006
 1576 1137
 1577 1052

*1600

1600 0000 AVGBLK,
 1601 7300
 1602 3337
 1603 3350
 1604 4407
 1605 5326
 1606 6334
 1607 6345
 1610 0000
 1611 1140
 1612 7041
 1613 3331
 1614 1412
 1615 3004
 1616 1377
 1617 3010
 1620 1410 MORE,
 1621 4776
 1622 1004
 1623 3332
 1624 6211
 1625 1732
 1626 6201
 1627 3333
 1630 1333
 1631 7650
 1632 5243
 1633 1333
 1634 4775
 1635 4407
 1636 1334
 1637 6334
 1640 0000
 1641 2337
 1642 7300

RTR
 TAD (260)
 JMS PRINT
 CLA CLL
 TAD HOG
 AND (0017)
 TAD (260)
 JMS PRINT
 JMP I CODE2
 0
 0
 0
 0

/FIND BLANK AND REFERENCE
 /AVERAGES

0
 CLA CLL
 DCA BLKCNT
 DCA REFCNT
 JMS I Z 7
 FGET HCKIT
 FPUT TOTAL
 FPUT OTAL
 FEXT
 TAD STDCNT
 CIA
 DCA FROG
 TAD I AUTO12
 DCA MAD /STORE MAJOR ADD.
 TAD (2507)
 DCA AUTO10
 TAD I AUTO10
 JMS CALATE
 TAD MAD
 DCA GOTCHA
 CDF2
 TAD I GOTCHA
 CDF1
 DCA KEEPIT /STORE BLK VOLTAGE VALUE
 TAD KEEPIT
 SNA CLA /BLK VOLTAGE =0
 JMP COUNT /YES
 TAD KEEPIT /NO
 JMS FIXVLT
 JMS I Z 7
 FADD TOTAL /SUM OF BLK VOLTAGES
 FPUT TOTAL
 FEXT
 ISZ BLKCNT /COUNT NO. OF BLK VOLTAGES
 CLA CLL

1643	2331	COUNT,	ISZ FROG	/HAVE ALL BLK VOLTAGES BEE
1644	5220		JMP MORE	/NO
1645	7300		CLA CLL	/YES
1646	1337		TAD BLKCNT	
1647	4774		JMS FLOIT	
1650	4407		JMS I Z 7	
1651	6340		FPUT SUMBLK	
1652	5334		FGET TOTAL	
1653	4340		FDIV SUMBLK	
1654	6020		FPUT BLKAVG	
1655	0000		FEXT	
1656	5600		JMP I AVGBLK	
1657	0000	AVGREF,	0	
1660	7300		CLA CLL	
1661	1140		TAD STDCNT	
1662	7041		CIA	
1663	3343		DCA GORF	
1664	1377		TAD (2507)	
1665	3010		DCA AUTO10	
1666	1410	DOIT,	TAD I AUTO10	
1667	4776		JMS CALATE	
1670	1004		TAD MAD	
1671	1373		TAD (1)	
1672	3332		DCA GOTCHA	
1673	6211		CDF2	
1674	1732		TAD I GOTCHA	
1675	6201		CDF1	
1676	3344		DCA PEEK	/STORE REF. VOLTAGE VALUE
1677	1344		TAD PEEK	
1700	7650		SNA CLA	/REF VOLTAGE=0?
1701	5312		JMP ONH	/YES
1702	1344		TAD PEEK	/NO
1703	4775		JMS FIXVLT	
1704	4407		JMS I Z 7	
1705	1345		FADD OTAL	/SUM REF VOLTAGES
1706	6345		FPUT OTAL	
1707	0000		FEXT	
1710	2350		ISZ REFCNT	/COUNT NUMBER OF REF VOLTA
1711	7300		CLA CLL	
1712	2343	ONH,	ISZ GORF	
1713	5266		JMP DOIT	
1714	1350		TAD REFCNT	
1715	4774		JMS FLOIT	
1716	4407		JMS I Z 7	
1717	6351		FPUT SUMREF	
1720	5345		FGET OTAL	
1721	4351		FDIV SUMREF	
1722	2020		FSUB BLKAVG	
1723	6023		FPUT REFAVG	
1724	0000		FEXT	
1725	5657		JMP I AVGREF	
1726	0000	HOCKIT, 0		
1727	0000	0		
1730	0000	0		
1731	0000	FROG,	0	
1732	0000	GOTCHA,	0	
1733	0000	KEEPIT,	0	
1734	0000	TOTAL,	0	
1735	0000		0	
1736	0000		0	

```

1737 0000 BLKCNT,      0
1740 0000 SUMBLK,     0
1741 0000             0
1742 0000             0
1743 0000 GORF,       0
1744 0000 PEEK,       0
1745 0000 OTAL,       0
1746 0000             0
1747 0000             0
1750 0000 REFCNT,     0
1751 0000 SUMREF,     0
1752 0000             0
1753 0000             0
1773 0001
1774 4243
1775 4200
1776 1111
1777 2507
*2000

```

/CALCULATE CONCENTRATION VALUES

```

2000 0000 CONCAL,     0
2001 7300 CLA CLL
2002 1377 TAD (3200)   /ADDRESS OF FIRST BLOCK#A0
2003 7041 CIA
2004 1065 TAD CHARLE
2005 3330 DCA GOOD     / (ADD OF FIRST SAMPLE BLOC
2006 1330 TAD GOOD
2007 4776 JMS FLOIT
2010 4407 JMS I Z 7
2011 4331 FDIV THREE
2012 0000 FEXT
2013 4775 JMS FIXIT
2014 3774 DCA JUST
2015 1774 TAD JUST
2016 1004 TAD MAD
2017 3334 DCA KEEPAD   / (AOF SB-AOFB) / 3
2020 6211 CDF2
2021 1734 TAD I KEEPAD
2022 6201 CDF1
2023 4773 JMS FIXVLT
2024 4407 JMS I Z 7
2025 2020 FSUB BLKAVG
2026 6772 FPUT ADCMBV
2027 5413 FGET I AUTO13 / GET B CONSTANT
2030 6771 FPUT BCON
2031 3772 FMPY ADCMBV
2032 4023 FDIV REFAVG
2033 6770 FPUT K
2034 0000 FEXT
2035 7300 CLA CLL
2036 1367 TAD (3)
2037 1013 TAD AUTO13
2040 3013 DCA AUTO13
2041 4407 JMS I Z 7
2042 5413 FGET I AUTO13 / GET C CONSTANT
2043 6766 FPUT CCON
2044 5772 FGET ADCMBV
2045 4023 FDIV REFAVG
2046 6765 FPUT VREF0   / VREF0 = SDCMBV/VREF CORR
2047 3765 FMPY VREF0

```

2050	3766		FMPY CCON	
2051	6764		FPUT BKVS	/ BKVS = C(VREF0)(VREF0)
2052	1770		FADD K	
2053	6026		FPUT CONC1	
2054	0000		FEXT	
2055	7300		CLA CLL	
2056	1334		TAD KEEPAD	
2057	7001		IAC	
2060	3334		DCA KEEPAD	
2061	6211		CDF2	
2062	1734		TAD I KEEPAD	
2063	6201		CDF1	
2064	4773		JMS FIXVLT	
2065	4407		JMS I Z 7	
2066	6143		FPUT ADCVLT	
2067	2020		FSUB BLKAVG	
2070	6772		FPUT ADCMBV	
2071	3771		FMPY BCQN	
2072	4023		FDIV REFAVG	
2073	6770		FPUT K	
2074	5772		FGET ADCMBV	
2075	4023		FDIV REFAVG	
2076	6765		FPUT VREF0	
2077	3765		FMPY VREF0	
2100	3766		FMPY CCON	
2101	6764		FPUT BKVS	
2102	1770		FADD K	
2103	6031		FPUT CONC2	
2104	1026		FADD CONC1	
2105	4335		FDIV TWO	
2106	6034		FPUT YAVG	
2107	5026		FGET CONC1	
2110	6763		FPUT STUD	
2111	0000		FEXT	
2112	7300		CLA CLL	
2113	7300		CLA CLL	
2114	1367		TAD (3)	
2115	1013		TAD AUTO13	
2116	3013		DCA AUTO13	
2117	4762	RACKM,	JMS OPTSZ	
2120	4106		JMS SPACE	
2121	4407		JMS I Z 7	
2122	5031		FGET CONC2	
2123	6763		FPUT STUD	
2124	0000		FEXT	
2125	4762		JMS OPTSZ	
2126	4106		JMS SPACE	
2127	5600		JMP I CONCAL	
2130	0000	GOOD,	0	
2131	0002	THREF,	0002	
2132	3000		3000	
2133	0000		0000	
2134	0000	KEEPAD,	0	
2135	0002	TWO,	0002	
2136	2000		2000	
2137	0000		0000	
2162	2702			
2163	2756			
2164	4625			
2165	4614			

2166 4630
 2167 0003
 2170 4617
 2171 4622
 2172 4611
 2173 4200
 2174 4633
 2175 4254
 2176 4243
 2177 3200
 *2200

/CHECK CALCULATED CONCENTRATION
 /VALUE FOR UPPER AND LOWER LIMITS

2200	0000	CONCHK,	Q	
2201	7300		CLA CLL	
2202	1414		TAD I AUTO14	/GET MINIMUM VALUE
2203	3321		DCA TROUT	
2204	7201		CLA IAC	/SET AC=1
2205	1321		TAD TROUT	
2206	7650		SNA CLA	/VALUE=7777?
2207	5311		JMP GOFER	/YES
2210	1321		TAD TROUT	/NO
2211	4777		JMS FLOIT	
2212	4407	FAKE,	JMS I Z 7	
2213	6322		FPUT MIN	/MINIMUM CONCENTRATION VAL
2214	5034		FGET YAVG	
2215	2322		FSUB MIN	
2216	0000		FEXT	
2217	7300		CLA CLL	
2220	1045		TAD 45	
2221	7710		SPA CLA	/CONCENTRATION >MINIMUM CO
2222	4264		JMS LTC	/NO
2223	1414		TAD I AUTO14	/YES
2224	3325		DCA BASS	
2225	1325		TAD BASS	
2226	4777		JMS FLOIT	
2227	4407		JMS I Z 7	
2230	6326		FPUT MAX	
2231	2034		FSUB YAVG	
2232	0000		FEXT	
2233	7300		CLA CLL	
2234	1045		TAD 45	
2235	7710		SPA CLA	/CONCENTRATION <MAXIMUM CO
2236	4277		JMS GTC	/NO
2237	4407		JMS I Z 7	/YES
2240	5034		FGET YAVG	
2241	6776		FPUT STUD	
2242	0000		FEXT	
2243	4106		JMS SPACE	
2244	4775		JMS OPTSZ	
2245	7300	CHK3,	CLA CLL	
2246	2063		ISZ COUNT3	
2247	5255		JMP PACE	
2250	4075		JMS CRLF	
2251	4075		JMS CRLF	
2252	1374		TAD (7775)	
2253	3063		DCA COUNT3	
2254	5600		JMP I CONCHK	
2255	4106	PACE,	JMS SPACE	
2256	4106		JMS SPACE	

2257	4106		JMS SPACE	
2260	4106		JMS SPACE	
2261	4106		JMS SPACE	
2262	4106		JMS SPACE	
2263	5600		JMP I CONCHK	
2264	0000	LTC.	0	
2265	4407		JMS I Z 7	
2266	5322		FGET MIN	
2267	6776		FPUT STUD	
2270	0000		FEXT	
2271	7300		CLA CLL	
2272	1373		TAD (274)	
2273	4066		JMS PRINT	/ <
2274	4775		JMS OPTSZ	/ OUTPUT MINIMUM VALUE
2275	1414		TAD I 14	
2276	5245		JMP CHK3	
2277	0000	GTC.	0	
2300	4407		JMS I Z 7	
2301	5326		FGET MAX	
2302	6776		FPUT STUD	
2303	0000		FEXT	
2304	7300		CLA CLL	
2305	1372		TAD (276)	
2306	4066		JMS PRINT	/ >
2307	4775		JMS OPTSZ	/ OUTPUT MAX VALUE
2310	5245		JMP CHK3	
2311	4407	GOFER.	JMS I Z 7	
2312	5416		FGET I AUTO16	
2313	0000		FEXT	
2314	7300		CLA CLL	
2315	1016		TAD AUTO16	
2316	1371		TAD (3)	
2317	3016		DCA AUTO16	
2320	5212		JMP FAKE	
2321	0000	TROUT;	0	
2322	0000	MIN.	0	
2323	0000		0	
2324	0000		0	
2325	0000	BASS.	0	
2326	0000	MAX.	0	
2327	0000		0	
2330	0000		0	
2331	7775	NOAUTO.	7775	
2332	3146		3146	
2333	3147		3147	
2334	7776		7776	/ 0.2
2335	3146		3146	
2336	3147		3147	
2337	7772		7772	/ 0.01
2340	2436		2436	
2341	5603		5603	
2342	7775		7775	/ 0.1
2343	3146		3146	
2344	3147		3147	
2371	0003			
2372	0276			
2373	0274			
2374	7775			
2375	2702			
2376	2756			

2377 4243

*2400

/ELEMENT ABV TABLE

2400	0114	AL,	0114
2401	0325	CU,	0325
2402	2037	P,	2037
2403	0123	AS,	0123
2404	0605	FE,	0605
2405	2002	PB,	2002
2406	0125	AU,	0125
2407	0701	GA,	0701
2410	2004	PD,	2004
2411	0237	B,	0237
2412	0705	GE,	0705
2413	2302	SB,	2302
2414	0201	BA,	0201
2415	1411	LI,	1411
2416	2311	SI,	2311
2417	0205	BE,	0205
2420	1507	MG,	1507
2421	2316	SN,	2316
2422	0211	BI,	0211
2423	1516	MN,	1516
2424	2322	SR,	2322
2425	0301	CA,	0301
2426	1517	MO,	1517
2427	2411	TI,	2411
2430	0304	CD,	0304
2431	1601	NA,	1601
2432	2637	V,	2637
2433	0317	CO,	0317
2434	1602	NB,	1602
2435	2737	W,	2737
2436	0322	CR,	0322
2437	1611	NI,	1611
2440	3216	ZN,	3216
2441	2537	U,	2537

*2442 / MAJOR ADDRESS OF ELEMENTS

2442	0200	200
2443	1600	1600
2444	4100	4100
2445	0300	300
2446	1700	1700
2447	4300	4300
2450	0400	400
2451	2000	2000
2452	4400	4400
2453	0500	500
2454	2100	2100
2455	4600	4600
2456	0600	600
2457	3100	3100
2460	4700	4700
2461	0700	700
2462	3200	3200
2463	3400	3400
2464	1000	1000
2465	3300	3300
2466	5100	5100
2467	1100	1100

2470	3500	3500
2471	5400	5400
2472	1200	1200
2473	3600	3600
2474	5700	5700
2475	1300	1300
2476	3700	3700
2477	6000	6000
2500	1400	1400
2501	4000	4000
2502	6100	6100
2503	5600	5600
*2600	/MINIMUM AND MAXIMUM CONCENTRATION VALUES	
2600	0001 AL1,	0001
2601	0620 AL2,	0620
2602	0001 CU1,	0001
2603	0310 CU2,	0310
2604	0144 P1,	0144
2605	1747 P2,	1747
2606	0012 AS1,	0012
2607	0144 AS2,	0144
2610	0012 FE1,	0012
2611	1747 FE2,	1747
2612	0001 PB1,	0001
2613	0144 PB2,	0144
2614	0001 AU1,	0001
2615	0012 AU2,	0012
2616	0001 GA1,	0001
2617	0012 GA2,	0012
2620	0001 PD1,	0001
2621	0012 PD2,	0012
2622	7777 B1,	7777
2623	0144 B2,	0144
2624	0001 GE1,	0001
2625	0012 GE2,	0012
2626	0002 SB1,	0002
2627	0012 SB2,	0012
2630	0002 BA1,	0002
2631	0144 BA2,	0144
2632	7777 LT1,	7777
2633	0144 LT2,	0144
2634	0012 SI1,	0012
2635	1747 SI2,	1747
2636	7777 BE1,	7777
2637	0012 BE2,	0012
2640	0002 MG1,	0002
2641	1747 MG2,	1747
2642	0001 SN1,	0001
2643	0144 SN2,	0144
2644	0001 BI1,	0001
2645	0012 BI2,	0012
2646	0001 MN1,	0001
2647	1747 MN2,	1747
2650	0024 SR1,	0024
2651	0144 SR2,	0144
2652	0012 CA1,	0012
2653	1747 CA2,	1747
2654	0012 MO1,	0012
2655	0144 MO2,	0144
2656	0004 TI1,	0004

2657	0144	TI2,	0144
2660	7777	CD1,	7777
2661	0144	CD2,	0144
2662	0001	NA1,	0001
2663	0144	NA2,	0144
2664	0001	V1,	0001
2665	0144	V2,	0144
2666	0001	C01,	0001
2667	1747	C02,	1747
2670	0012	NB1,	0012
2671	0144	NB2,	0144
2672	0144	W1,	0144
2673	1747	W2,	1747
2674	0002	CR1,	0002
2675	0620	CR2,	0620
2676	0001	NI1,	0001
2677	1747	NI2,	1747
2700	0012	ZN1,	0012
2701	0144	ZN2,	0144
2702	0000	OPTSZ,	0
2703	7300		CLA CLL
2704	6032		KCC
2705	6046		TLS
2706	7300		CLA CLL
2707	1045		TAD 45
2710	7710		SPA CLA / NUMBER NEGATIVE ?
2711	5342		JMP IVE / YES
2712	1377		TAD (3) / NO
2713	3062		DCA 62
2714	4407		JMS I Z 7
2715	5356		FGET STUD
2716	2361		FSUB HNDONE
2717	0000		FEXT
2720	7300		CLA CLL
2721	1045		TAD 45
2722	7710		SPA CLA / > 100 ?
2723	5333		JMP BEEN
2724	4407		JMS I Z 7
2725	5356		FGET STUD
2726	0000		FEXT
2727	1377		TAD (3)
2730	4406		JMS I Z 6
2731	4106		JMS SPACE
2732	5702		JMP I OPTSZ
2733	4407	BEEN,	JMS I Z 7
2734	5356		FGET STUD
2735	0000		FEXT
2736	7300		CLA CLL
2737	1377		TAD (3)
2740	4406		JMS I Z 6
2741	5702		JMP I OPTSZ
2742	1376	IVE,	TAD (2)
2743	3062		DCA 62
2744	4407		JMS I Z 7
2745	5356		FGET STUD
2746	0000		FEXT
2747	7300		CLA CLL
2750	1376		TAD (2)
2751	4406		JMS I Z 6
2752	7300		CLA CLL

/ OUTPUT NEGATIVE

2753	1377		TAD (3)
2754	3062		DCA 62
2755	5702		JMP I OPTSZ
2756	0000	STUD,	0
2757	0000		0
2760	0000		0
2761	0007	HNDONE,	0007
2762	3100		3100
2763	0000		0000
2776	0002		
2777	0003		
*3600			
/MISC. ROUTINES AND ERASED			
3600	7300	HOB0,	CLA CLL
3601	7300		CLA CLL
3602	1377		TAD (7700)
3603	3225		DCA GATOR
3604	7300	ARF,	CLA CLL
3605	6304		ADD5SB
3606	7440		SZA
3607	5776		JMP CHECK
3610	4214		JMS WHAT
3611	2225		ISZ GATOR
3612	5204		JMP ARF
3613	7402		HLT
3314	0000	WHAT,	0
3615	7300		CLA CLL
3616	2226		ISZ GOLF
3617	5216		JMP .-1
3620	2227		ISZ TATER
3621	5216		JMP .-3
3622	7240		CLA CMA
3623	3227		DCA TATER
3624	5614		JMP I WHAT
3625	0000	GATOR,	0
3626	0000	GOLF,	0
3627	7777	TATER,	7777
3630	0000	OVERFL,	0
3631	6302		CLEAR
3632	7300		CLA CLL
3633	1375		TAD (10)
3634	6324		START
3635	7300		CLA CLL
3636	2350		ISZ BOX
3637	5236		JMP .-1
3640	2146		ISZ COWS
3641	5236		JMP .-3
3642	1374		TAD (7400)
3643	3146		DCA COWS
3644	5115		JMP PREP
3645	7300	ENDCRD,	CLA CLL
3646	2267		ISZ ALFE
3647	5246		JMP .-1
3650	2270		ISZ GOB
3651	5246		JMP .-3
3652	1373		TAD (7760)
3653	3270		DCA GOB
3654	7201		CLA IAC
3655	6324		START
3656	7300		CL

3657	3772		DCA COLCNT	
3660	1371		TAD (-6)	
3661	3770		DCA M6	
3662	6302		CLEAR	
3663	7300		CLA CLL	
3664	1375		TAD (10)	
3665	6324		START	
3666	5115		JMP PREP	
3667	0000	ALFE,	0	
3670	7760	GOB,	7760	
3671	7300	ERASED,	CLA CLL	
3672	4767		JMS DELAY	
3673	7300		CLA CLL	
3674	1137		TAD ADDLOC	/UPPER MEMORY ADDRESS
3675	1366		TAD (-5)	
3676	3351		DCA GOOSE	
3677	1351		TAD GOOSE	
3700	7001		IAC	
3701	3352		DCA HELP	
3702	1751		TAD I GOOSE	
3703	1752		TAD I HELP	
3704	7640		SZA CLA	/LAST CARD READ SAMPLE OR
3705	5314		JMP MOHOLE	/SAMPLE CARD
3706	1140		TAD STDCNT	/BLK CARD
3707	1365		TAD (-1)	
3710	3140		DCA STDCNT	
3711	1010		TAD 10	
3712	1365		TAD (-1)	
3713	3010		DCA 10	
3714	4764	MOHOLE,	JMS ZCD	
3715	4764		JMS ZCD	
3716	4764		JMS ZCD	
3717	4764		JMS ZCD	
3720	4764		JMS ZCD	
3721	4764		JMS ZCD	
3722	1133		TAD BURNO	
3723	7010		RAR	
3724	7630		SZL CLA	
3725	5337		JMP BURN2	
3726	1133		TAD BURNO	
3727	1365		TAD (-1)	
3730	3133		DCA BURNO	
3731	1141		TAD CRDCNT	
3732	1365		TAD (-1)	
3733	3141		DCA CRDCNT	
3734	1363		TAD (-2)	
3735	3762		DCA TIM	
3736	5761		JMP STUPID	
3737	1133	BURN2,	TAD BURNO	
3740	1363		TAD (-2)	
3741	3133		DCA BURNO	
3742	1141		TAD CRDCNT	
3743	1363		TAD (-2)	
3744	3141		DCA CRDCNT	
3745	1363		TAD (-2)	
3746	3762		DCA TIM	
3747	5761		JMP STUPID	
3750	0000	BOX,	0	
3751	0000	GOOSE,	0	
3752	0000	HELP,	0	

3761 4636
 3762 0261
 3763 7776
 3764 4643
 3765 7777
 3766 7773
 3767 4306
 3770 0542
 3771 7772
 3772 0541
 3773 7760
 3774 7400
 3775 0010
 3776 0212
 3777 7700

*4200			
4200	0000	FIXVLT,	0
4201	3235		DCA A1
4202	3232		DCA D
4203	3233		DCA D+1
4204	3234		DCA D+2
4205	7300		CLA CLL
4206	1235		TAD A1
4207	7010		RAR
4210	3236		DCA DAMIT
4211	7420		SNL
4212	5221		JMP CONT
4213	7300		CLA CLL
4214	4407		JMS I Z 7
4215	5777		FGET ONE
4216	6232		FPUT D
4217	0000		FEXT
4220	7300		CLA CLL
4221	1236	CONT,	TAD DAMIT
4222	4243		JMS FLOIT
4223	4407		JMS I Z 7
4224	1232		FADD D
4225	3637		FMPY I XTWO
4226	3240		FMPY GOGLE
4227	0000		FEXT
4230	7300		CLA CLL
4231	5600		JMP I FIXVLT
4232	0000	D,	0
4233	0000		0
4234	0000		0
4235	0000	A1,	0
4236	0000	DAMIT,	0
4237	2135	XTWO,	TWO
4240	7770	GOGLE,	7770
4241	2400		2400
4242	0000		0000
4243	0000	FLOIT,	0
4244	3045		DCA 45
4245	3046		DCA 46
4246	1303		TAD C13
4247	3044		DCA 44
4250	4407		JMS I Z 7
4251	7000		FNOR
4252	0000		FEXT

4253	5643		JMP I FLOIT	
4254	0000	FIXIT,	O	
4255	7200		CLA	
4256	1044		TAD 44	
4257	7540		SZA SMA	
4260	5263		JMP .+3	
4261	7200		CLA	
4262	5302		JMP DONE+1	
4263	1325		TAD MC13	
4264	7450		SNA	
4265	5301		JMP DONE	
4266	7500		SMA	
4267	5304		JMP ERROR	
4270	3044		DCA 44	
4271	7100	GO,	CLL	
4272	1045		TAD 45	
4273	7510		SPA	
4274	7020		CML	
4275	7010		RAR	
4276	3045		DCA 45	
4277	2044		ISZ 44	
4300	5271		JMP GO	
4301	1045	DONE,	TAD 45	
4302	5654		JMP I FIXIT	
4303	0013	C13,	0013	
4304	7402	ERROR,	HLT	/STOP IF NUMBER IS TOO
4305	5304		JMP .-1	/LARGE TO FIX.
4306	0000	DELAY,	O	
4307	7300		CLA CLL	
4310	1376		TAD (20)	
4311	6324		START	/DISABLE
4312	7300		CLA CLL	
4313	2322		ISZ FRA	
4314	5313		JMP .-1	
4315	2323		ISZ SLOW	
4316	5313		JMP .-3	
4317	1324		TAD GETCHA	
4320	3323		DCA SLOW	
4321	5706		JMP I DELAY	
4322	0000	FRA,	O	
4323	7720	SLOW,	7720	
4224	7720	GETCHA,	7720	
4325	7765	MC13,	7765	
4326	0000	GOFOT,	O	
4327	7300		CLA CLL	
4330	7300		CLA CLL	
4331	4075		JMS CRLF	
4332	1375		TAD (303)	/C
4333	4066		JMS PRINT	
4334	1374		TAD (301)	/ A
4335	4066		JMS PRINT	
4336	1373		TAD (322)	/ R
4337	4066		JMS PRINT	
4340	1373		TAD (322)	/ R
4341	4066		JMS PRINT	
4342	1372		TAD (311)	/ I
4343	4066		JMS PRINT	
4344	1371		TAD (305)	/ E
4345	4066		JMS PRINT	
4346	1373		TAD (322)	/ R

4347	4066		JMS PRINT	
4350	4106		JMS SPACE	
4351	1370		TAD (304)	/ D
4352	4066		JMS PRINT	
4353	1372		TAD (311)	/ I
4354	4066		JMS PRINT	
4355	4767		JMS GOFOT2	
4356	5726		JMP I GOFOT	
4357	5726		JMP I GOFOT	
4367	4651			
4370	0304			
4371	0305			
4372	0311			
4373	0322			
4374	0301			
4375	0303			
4376	0020			
4377	1131			
*4400				
4400	0000	OUTVLT,	0	
4401	3244		DCA SPECK	
4402	3245		DCA Q	
4403	3246		DCA Q+1	
4404	3247		DCA Q+2	
4405	7300		CLA CLL	
4406	1244		TAD SPECK	
4407	7010		RAR	
4410	3250		DCA TORE	
4411	7420		SNL	
4412	5221		JMP PETER	
4413	7300		CLA CLL	
4414	4407		JMS I Z 7	
4415	5251		FGET ONE1	
4416	6245		FPUT Q	
4417	0000		FEXT	
4420	7300		CLA CLL	
4421	1250	PETER,	TAD TORE	
4422	4777		JMS FLOIT	
4423	4407		JMS I Z 7	
4424	1245		FADD Q	
4425	3254		FMPY TWO2	
4426	3257		FMPY SQRL	
4427	0000		FEXT	
4430	7300		CLA CLL	
4431	6032		KCC	
4432	6046		TLS	
4433	7300		CLA CLL	
4434	1376		TAD (20)	
4435	6324		START	
4436	7300		CLA CLL	
4437	1375		TAD (3)	
4440	4406		JMS I Z 6	
4441	7300		CLA CLL	
4442	1244		TAD SPECK	
4443	5600		JMP I OUTVLT	
4444	0000	SPECK,	0	
4445	0000	Q,	Q	
4446	0000		0	
4447	0000		0	
4450	0000	TORE,	0	

4451	0001	ONE1,	0001
4452	2000		2000
4453	0000		0000
4454	0002	TWO2,	0002
4455	2000		2000
4456	0000		0000
4457	7770	SQRL,	7770
4460	2400		2400
4461	0000		0000
4462	0000	SKIP,	0
4463	1374		TAD (240)
4464	4066		JMS PRINT
4465	1374		TAD (240)
4466	4066		JMS PRINT
4467	1374		TAD (240)
4470	4066		JMS PRINT
4471	1374		TAD (240)
4472	4066		JMS PRINT
4473	1374		TAD (240)
4474	4066		JMS PRINT
4475	5662		JMP I SKIP
4476	7300	LOKADC,	CLA CLL
4477	4317		JMS STBADC
4500	3340		DCA HOPP
4501	7001		IAC
4502	1340		TAD HOPP
4503	7650		SNA CLA
4504	4773		JMS OVERFL
4505	1340		TAD HOPP
4506	6211		CDF2
4507	3547		DCA I ADDRES
4510	6201		CDF1
4511	6302		CLEAR
4512	7300		CLA CLL
4513	1372		TAD (10)
4514	6324		START
4515	7300		CLA CLL
4516	5115		JMP PREP
4517	0000	STBADC,	0
4520	7300	APPLE,	CLA CLL
4521	6334		STADC
4522	4326		JMS WAITT
4523	6312		RDADC
4524	5320		JMP APPLE
4525	5717		JMP I STBADC
4526	0000	WAITT,	0
4527	7300		CLA CLL
4530	2341		ISZ TT
4531	5330		JMP .-1
4532	2342		ISZ RR
4533	5330		JMP .-3
4534	7300		CLA CLL
4535	1343		TAD TRAF
4536	3342		DCA RR
4537	5726		JMP I WAITT
4540	0000	HOPP,	0
4541	0000	TT,	0
4542	7776	RR,	7776
4543	7776	TRAF,	7776
4572	0010		

4573 3630
 4574 0240
 4575 0003
 4576 0020
 4577 4243

*4000

/PROGRAM START (URANIUM CARRIER)

4000	7300	WHOOPEE,	CLA CLL
4001	4330		JMS DUMP
4002	1377		TAD (7777)
4003	3133		DCA BURNO
4004	1376		TAD (2507)
4005	3010		DCA AUTO10
4006	1375		TAD (2377)
4007	3011		DCA AUTO11
4010	1374		TAD (2441)
4011	3012		DCA AUTO12
4012	1373		TAD (5000)
4013	3013		DCA AUTO13
4014	1372		TAD (2577)
4015	3014		DCA AUTO14
4016	3141		DCA CRDCNT
4017	3140		DCA STDCNT
4020	3771		DCA COUN
4021	3770		DCA BLKCNT
4022	3767		DCA REFCNT
4023	1366		TAD (7736)
4024	3142		DCA CNT41
4025	1365		TAD (20)
4026	6324		START
4027	7300		CLA CLL
4030	1364		TAD (3200)
4031	3137		DCA 137
4032	1363		TAD (7401)
4033	3345		DCA BIG
4034	1364		TAD (3200)
4035	3346		DCA COL
4036	3746	PUT,	DCA I COL
4037	1346		TAD COL
4040	7001		IAC
4041	3346		DCA COL
4042	2345		ISZ BIG
4043	5236		JMP PUT
4044	7300		CLA CLL
4045	1362		TAD (3)
4046	3062		DCA 62
4047	7300	CNTNUE,	CLA CLL
4050	6001		ION
4051	7200		CLA
4052	7000		NOP
4053	7000		NOP
4054	7000		NOP
4055	7000		NOP
4056	7000		NOP
4057	7000		NOP
4060	7000		NOP
4061	7000		NOP
4062	7000		NOP
4063	7000		NOP
4064	7000		NOP

4065	7000		NOP
4066	7000		NOP
4067	7000		NOP
4070	7000		NOP
4071	7000		NOP
4072	7000		NOP
4073	7000		NOP
4074	7000		NOP
4075	5247		JMP CNTNUE +2
4076	3003	INTIOS,	DCA AC
4077	7004		RAL
4100	3002		DCA LINC
4101	6102		SPL /POWER LOW FLAG?
4102	7410		SKP /NO
4103	5317		JMP POWOFF /YES
4104	6301		RECORD /SKIP IF NOT RECORD DATA
4105	5761		JMP READAD /RECORD DATA ROUTINE
4106	6331		RDCRD /SKIP IF NOT READ CARD
4107	5760		JMP REDCRD /READ CARD
4110	6332		ERASE /SKIP IF NOT ERASE ROUTINE
4111	5757		JMP ERASED /ERASE
4112	6031		KSF
4113	7402		HLT
4114	6032		KCC
4115	6001		ION
4116	5400		JMP I 0
4117	3003	POWOFF,	DCA AC /POWER FAIL OPTION
4120	7010		RAR
4121	3002		DCA LINC
4122	1000		TAD Z 0
4123	3132		DCA PC
4124	1327		TAD RESTRT
4125	3000		DCA Z 0
4126	7402		HLT
4127	5123	RESTRT,	JMP ABCD
4130	0000	DUMP,	0 /CLEARS UPPER MEMORY
4131	1361		TAD (-7600)
4132	3345		DCA BIG
4133	3346		DCA COL
4134	6211	UPPER,	CDF2
4135	3746		DCA I COL
4136	6201		CDF1
4137	1346		TAD COL
4140	7001		IAC
4141	3346		DCA COL
4142	2345		ISZ BIG
4143	5334		JMP UPPER
4144	5730		JMP I DUMP
4145	0000	BIG,	0
4146	0000	COL,	0
4157	3671		
4160	0400		
4161	0200		
4162	0003		
4163	7401		
4164	3200		
4165	0020		
4166	7736		
4167	1750		


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4170 1737
4171 0751
4172 2577
4173 5000
4174 2441
4175 2377
4176 2507
4177 7777
*4600
4600 0000 WAIT, 0
4601 7300 CLA CLL
4602 2777 ISZ UMP
4603 5202 JMP .-1
4604 2776 ISZ SUR
4605 5202 JMP .-3
4606 1775 TAD AMP
4607 3776 DCA SUR
4610 5600 JMP I WAIT
4611 0000 ADCMBV, 0
4612 0000 0
4613 0000 0
4614 0000 VREF0, 0
4615 0000 0
4616 0000 0
4617 0000 K, 0
4620 0000 0
4621 0000 0
4622 0000 BCON, 0
4623 0000 0
4624 0000 0
4625 0000 BKVS, 0
4626 0000 0
4627 0000 0
4630 0000 CCON, 0
4631 0000 0
4632 0000 0
4633 0000 JUST, 0
4634 0000 0
4635 0000 0
4636 6302 STUPID, CLEAR
4637 7300 CLA CLL
4640 7000 NOP
4641 7000 NOP
4642 5115 JMP PREP
4643 0000 ZCD, 0
4644 1137 TAD ADDLOC
4645 1374 TAD (-1)
4646 3137 DCA ADDLOC
4447 3537 DCA I ADDLOC
4650 5643 JMP I ZCD
4651 0000 GOFOT2, 0
4652 1373 TAD (4664)
4653 3017 DCA 17
4654 1417 TAD I 17
4655 7510 SPA
4656 5651 JMP I GOFOT2
4657 4066 JMS PRINT
4660 7300 CLA CLL
4661 5254 JMP .-5
*4665

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4665	0323	323
4666	0324	324
4667	0240	240
4670	0240	240
4671	0240	240
4672	0240	240
4673	0315	315
4674	0311	311
4675	0303	303
4676	0322	322
4677	0317	317
4700	0255	255
4701	0307	307
4702	0257	257
4703	0307	307
4704	0240	240
4705	0250	250
4706	0320	320
4707	0320	320
4710	0315	315
4711	0251	251
4712	0240	240
4713	0240	240
4714	0315	315
4715	0305	305
4716	0324	324
4717	0301	301
4720	0314	314
4721	0240	240
4722	0302	302
4723	0301	301
4724	0323	323
4725	0311	311
4726	0323	323
4727	0212	212
4730	0215	215
4731	4000	4000
4773	4664	
4774	7777	
4775	0334	
4776	0333	
4777	0332	

*5000

/ CONSTANTS FROM CALIBRATION CURVES

5000	0000	ALB,	0000
5001	0000		0000
5002	0000		0000
5003	0000	ALC,	0000
5004	0000		0000
5005	0000		0000
5006	0007	CUB,	0007
5007	2667		2667
5010	6561		6561
5011	0000	CUC,	0000
5012	0000		0000
5013	0000		0000
5014	0011	PBB,	0011
5015	2607		2607
5016	1463		1463
5017	0000	PBC,	0000

5020	0000		0000
5021	0000		0000
5022	0006	ASB,	0006
5023	2332		2332
5024	4366		4366
5025	0000	ASC,	0000
5026	0000		0000
5027	0000		0000
5030	0011	FEB,	0011
5031	2126		2126
5032	6315		6315
5033	0011	FEC,	0011
5034	2217		2217
5035	1463		1463
5036	0006	PBBB,	0006
5037	2532		2532
5040	4366		4366
5041	0000	PBBC,	0000
5042	0000		0000
5043	0000		0000
5044	0004	AUB,	0004
5045	2440		2440
5046	0000		0000
5047	0000	AUC,	0000
5050	0000		0000
5051	0000		0000
5052	0003	GAB,	0003
5053	2674		2674
5054	5301		5301
5055	0000	GAC,	0000
5056	0000		0000
5057	0000		0000
5060	0006	PDB,	0006
5061	2247		2247
5062	5342		5342
5063	0000	PDC,	0000
5064	0000		0000
5065	0000		0000
5066	0003	BBB,	0003
5067	2507		2507
5070	7372		7372
5071	0000	BBC,	0000
5072	3364		3364
5073	4200		4200
5074	0003	GEB,	0003
5075	2051		2051
5076	7676		7676
5077	0000	GEC,	0000
5100	0000		0000
5101	0000		0000
5102	0004	SBB,	0004
5103	2057		2057
5104	3716		3716
5105	0000	SBC,	0000
5106	0000		0000
5107	0000		0000
5110	0004	BAB,	0004
5111	2517		2517
5112	2702		2702
5113	0000	BAC,	0000

5114	0000		0000
5115	0000		0000
5116	0004	LIB,	0004
5117	2650		2650
5120	7534		7534
5121	0002	LIC,	0002
5122	2421		2421
5123	3207		3207
5124	0010	SIB,	0010
5125	2765		2765
5126	4632		4632
5127	0010	SIC,	0010
5130	3106		3106
5131	3146		3146
5132	7777	BEB,	7777
5133	2625		2625
5134	7236		7236
5135	7776	BEC,	7776
5136	3560		3560
5137	5075		5075
5140	0011	MGB,	0011
5141	2111		2111
5142	1463		1463
5143	0006	MGC,	0006
5144	2041		2041
5145	7270		7270
5146	0006	SNB,	0006
5147	2554		2554
5150	3656		3656
5151	0000	SNC,	0000
5152	0000		0000
5153	0000		0000
5154	0003	BIB,	0003
5155	2217		2217
5156	0652		0652
5157	0000	BIC,	0000
5160	0000		0000
5161	0000		0000
5162	0010	MNB,	0010
5163	2215		2215
5164	4632		4632
5165	0000	MNC,	0000
5166	0000		0000
5167	0000		0000
5170	0006	SRB,	0006
5171	2545		2545
5172	3412		3412
5173	0000	SRC,	0000
5174	0000		0000
5175	0000		0000
5176	0007	CAB,	0007
5177	3530		3530
		*5200	
5200	0000		0000
5201	0010	CAC,	0010
5202	3271		3271
5203	4632		4632
5204	0002	MOB,	0002
5205	2000		2000
5206	0000		0000

5207	0002	MOC,	0002
5210	3000		3000
5211	0000		0000
5212	0005	PIB,	0005
5213	2135		2135
5214	3412		3412
5215	0000	PIC,	0000
5216	0000		0000
5217	0000		0000
5220	0002	CDB,	0002
5221	3045		3045
5222	3004		3004
5223	0003	CDC,	0003
5224	2104		2104
5225	2642		2642
5226	0006	NAB,	0006
5227	2234		2234
5230	6315		6315
5231	0000	NAC,	0000
5232	0000		0000
5233	0000		0000
5234	0006	VB,	0006
5235	2100		2100
5236	0000		0000
5237	0002	VC,	0002
5240	2770		2770
5241	6517		6517
5242	0006	COB,	0006
5243	2352		2352
5244	1727		1727
5245	0003	COC,	0003
5246	3566		3566
5247	0102		0102
5250	0004	NBB,	0004
5251	3524		3524
5252	3657		3657
5253	0000	NBC,	0000
5254	0000		0000
5255	0000		0000
5256	0012	WB,	0012
5257	2134		2134
5260	1463		1463
5261	0000	WC,	0000
5262	0000		0000
5263	0000		0000
5264	0010	CRB,	0010
5265	2465		2465
5266	4632		4632
5267	0006	CRC,	0006
5270	2122		2122
5271	1727		1727
5272	0007	NIB,	0007
5273	2210		2210
5274	1217		1217
5275	0005	NIC,	0005
5276	2675		2675
5277	3412		3412
5300	0006	ZNB,	0006
5301	2413		2413
5302	1463		1463

5303	0000	ZNC,	0000
5304	0000		0000
5305	0000		0000
5306	0001	UB,	0001
5307	2000		2000
5310	0000		0000
5311	0000	UC,	0000
5312	0000		0000
5313	0000		0000
0174	0240		
0175	0212		
0176	0215		
0177	4076		
A	0464		
ABCD	0123		
AC	0003		
ADCMBV	4611		
ADCVLT	0143		
ADDLOC	0137		
ADDRES	0147		
ADD5SB	6304		
AD12SB	6314		
AGAIN	0202		
AL	2400		
ALB	5000		
ALC	5003		
ALFE	3667		
AL1	2600		
AL2	2601		
AMP	0334		
AOXBPO	0064		
AOXBP2	1553		
APPLE	4520		
ARF	3604		
AS	2403		
ASB	5022		
ASC	5025		
AS1	2606		
AS2	2607		
AU	2406		
AUB	5044		
AUC	5047		
AUT010	0010		
AUT011	0011		
AUT012	0012		
AUT013	0013		
AUT014	0014		
AUT015	0015		
AUT016	0016		
AUT017	0017		
AU1	2614		
AU2	2615		
AVGBLK	1600		
AVGREF	1657		
A1	4235		
B	2411		
BA	2414		
BAB	5110		
BCC	5113		
BASS	2325		

BA1	2630
BA2	2631
BBB	5066
BBC	5071
BCON	4622
BE	2417
BEB	5132
BCC	5135
BEEN	2733
BEGIN	0600
BE1	2636
BE2	2637
BI	2422
BIB	5154
BIC	5157
BIG	4145
BI1	2644
BI2	2645
BKVS	4625
BLKAVG	0020
BLKCNT	1737
BQFUS	1222
BOX	3750
BURNO	0133
DURN2	3737
B1	2622
B2	2623
CA	2425
CAB	5176
CAC	5201
CALATE	1111
CAMEL	1552
CA1	2652
CA2	2653
CCUN	4630
CD	2430
CDB	5220
CDC	5223
CDF1	6201
CDF2	6211
CD1	2660
CD2	2661
CHARLE	0065
CHECK	0212
CHK3	2245
CLEAR	6302
CNTNUE	4047
CNT41	0142
CO	2433
COB	5242
COC	5245
CODE1	1522
CODE2	1535
COL	4146
COLCNT	0541
COMCHK	0517
COMPUT	1200
CONCAL	2000
CONCHK	2200
CONC1	0026

CONC2	0031
CONST5	0264
CONS12	0265
CONT	4221
COUN	0751
COUNT	1643
COUNT3	0063
COWS	0146
CO1	2666
CO2	2667
CR	2436
CRB	5264
CRC	5267
CRCK	0747
CRDCNT	0141
CRLF	0075
CR1	2674
CR2	2675
CU	2401
CUB	5006
CUC	5011
CU1	2602
CU2	2603
C13	4303
D	4232
DAMIT	4236
DATOP	1400
DATSTB	0420
DECODE	0227
DECODE	0235
DEC012	0250
DEC05	0241
DELADD	1132
DELAY	4306
DIODE	0752
DOIT	1666
DONE	4301
DUMP	4130
ENDCRD	3645
ERASE	6332
ERASED	3671
ERROR	4304
ETOUT	0720
F	0270
FADD	1000
FAKE	2212
FDIV	4000
FE	2404
FEB	5030
FGC	5033
FEXT	0000
FE1	2610
FE2	2611
FGET	5000
FINK	0677
FIXIT	4254
FIXVLT	4200
FLOIT	4243
FMPY	3000
FNOR	7000

FPUT	6000
FRA	4322
FROG	1731
FSUB	2000
GA	2407
GCB	5052
GAC	5055
GARF	0652
GATOR	3625
GA1	2616
GA2	2617
GE	2412
GEB	5074
GGC	5077
GETCHA	4324
GE1	2624
GE2	2625
GO	4271
GOB	3670
GOBLE	0266
GOFER	2311
GOFOT	4026
GOFOT2	4651
GOGLE	4240
GOLF	3626
GOOD	2130
GOODNO	0462
GOOSE	3751
GORF	1743
GOTCHA	1732
GOTIT	0617
GTC	2277
HARK	1267
HAVAT	1223
HELP	3752
HNDONE	2761
HOB0	3600
HOCKIT	1726
HOG	1555
HOPP	4540
IMA	0671
INTIOS	4076
IVE	2742
JUST	4633
K	4617
KEEP	0134
KEEPA	2134
KEEPIT	1733
LI	2415
LHB	5116
LIC	5121
INC	0002
LOKADC	4476
LTC	2264
LT1	2632
LT2	2633
MAD	0004
MAGAD	0744
MAX	2326
MC13	4325

MEMB	1134
MG	2420
MGB	5140
MGC	5143
MG1	2640
MG2	2641
MIN	2322
MIN3	0543
MN	2423
MNB	5162
MNC	5165
MN1	2646
MN2	2647
MO	2426
MOB	5204
MOC	5207
MOHOLE	3714
MORCRD	1052
MORE	1620
MO1	2654
MO2	2655
MUMP	1130
M3	0544
M41	0745
M6	0542
NA	2431
NAB	5226
NAC	5231
NA1	2662
NA2	2663
NB	2434
NBB	5250
NBC	5253
NB1	2670
NB2	2671
NI	2437
NIB	5272
NIC	5275
NI1	2676
NI2	2677
NOAUTO	2331
NUMBER	0536
OFF	0321
ONE	1131
ONE1	4451
ONH	1712
OPTION	1040
OPTN1	1000
OPTSZ	2702
OTAL	1745
OUTVLT	4400
OVERFL	3630
OVRFLO	6311
P	2402
PACE	2255
PB	2405
PBB	5014
PBBB	5036
PBBC	5041
PBC	5017
PC	0132

PD	2410
PDB	5060
PDC	5063
PD1	2620
PD2	2621
PEEK	1744
PETER	4421
PI	0000
PIB	5212
PIC	5215
PICCRD	6321
POW0FF	4117
PREP	0115
PRINT	0066
PUT	4036
P1	2604
P2	2605
Q	4445
RACKM	2117
RAG	0267
RDADC	6312
RDCRD	6331
READAD	0200
REALAD	1554
RECORD	6301
REDCRD	0400
REFAVG	0023
REFCNT	1750
RESTRI	4127
ROTATC	0514
RR	4542
SANTA	1002
SAOLB	1137
SB	2413
SBB	5102
SBC	5105
SB1	2626
SB2	2627
SI	2416
SCB	5124
SIC	5127
SI1	2634
SI2	2635
SKIP	4462
SLOW	4323
SN	2421
SNB	5146
SNC	5151
SNOW	1133
SN1	2642
SJ2	2643
SPACE	0106
SPECK	4444
SPL	6102
SPUD	1436
OQRL	4457
SR	2424
SRB	5170
SRC	5173
SR1	2650

SR2	2651
STADC	6334
START	6324
STBADC	4517
STBDAT	6322
STDCNT	0140
SVOP	0135
STOR	0750
STUD	2756
STUPID	4636
SUMBLK	1740
SUMREF	1751
SUR	0333
TATER	3627
TEMP	0537
TEMPST	0271
TEMPX	1140
TEMP1	0540
THRE	1125
THREE	2131
TI	2427
TIM	0261
TY1	2656
TI2	2657
TNUOC	0746
TORE	4450
TOTAL	1734
TRAF	4543
TROUT	2321
TI	4541
TWO	2135
TWO2	4454
U	2441
UB	5306
UC	5311
UMP	0332
UPPER	4134
V	2432
VB	5234
VC	5237
VREFO	4614
VV	1106
V1	2664
V2	2665
W	2435
WAIT	4600
WAITT	4526
WB	5256
WC	5261
WHAT	3614
WHOPEE	4000
WOSTOP	1066
WW	1107
W1	2672
W2	2673
X	1110
X.TWO	4237
X1	0262
X2	0263
Y	0240

YAVG	0034
ZCD	4643
ZN	2440
ZNB	5300
ZNC	5303
ZN1	2700
ZN2	2701