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IM41-1085-00
SOFTWARE INSTRUCTION MANUAL
ND4410 X-RAY ANALYSIS OVERLAY PROGRAM

A

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SECTION I
INTRODUCTION

1-1. PROGRAM SUMMARY

1-2. The ND4410 X-Ray Analysis Overlay Program (41-1085) is written for use with the ND4410 Single Parameter Data Acquisition and Display System. The program is an overlay for the ND4410 Basic Physics Analyzer Program (41-1060) used in conjunction with the ND4410 Data Manipulation Overlay Program (41-1061). It enables performance of two general X-Ray functions: (1) setting and manipulation of the data contained in up to 32 user-specified areas, and (2) display of the principal K- and L-lines for any specified element. Each of these functions is performed by inter-active use of the teletype keyboard, the pushbuttons on the ND4410 Function Control Module and the oscilloscope display.

1-3. PROGRAM AREA

1-4. The program occupies memory core locations $\emptyset,42\emptyset\emptyset_8$ through $\emptyset,7666_8$.

1-5. STARTING ADDRESS

1-6. All routines are called through the command mode of the ND4410 Basic Physics Analyzer Program (41-1060) via teletype entered mnemonics or the pushbuttons on the ND4410 Function Control Module.

1-7. EQUIPMENT CONFIGURATION

1-8. MINIMUM EQUIPMENT

1-9. The minimum equipment required for proper operation of this program is:

    a. An ADC.
    b. The ND4410 Function Control Unit.
    c. A 33ASR Teletype.

      d. A display oscilloscope.

      e. The 8K, ND812 Computer.

1-10. The program will operate with either an 8K, 12K or 16K ND812 memory configuration, providing maximum storage configuration of 2K, 4K or 6K (24 bits), respectively.

SECTION II
PROGRAM DESCRIPTION

(TO BE SUPPLIED)

SECTION III
OPERATIONAL PROCEDURE

3-1. INITIALIZATION PROCEDURE

3-2. The following is a step-by-step procedure for loading and initializing the ND4410 X-Ray Analysis Overlay Program (41-1085):

    a. Depress the STOP key at the ND812 Computer.

    b. Place the START/STOP/FREE switch at the teletype in the FREE position.

    c. Load the ND4410 Basic Physics Analyzer Program (41-1060) Tape into the teletype reader with the leader (8-level punches) over the read head.

    d. Set the START/STOP/FREE switch to START.

    e. Simultaneously depress the LOAD AR and NEXT WORD keys at the ND812 Computer. The teletype will step through the leader and read the program into the ND812 memory. Upon completion of read-in, the reader will automatically stop. When the reader stops, check the J register for zero. If non-zero, reload.

NOTE

Refer to the ND812 Binary Paper Tape and Cassette Loader Program (41-0005) for loading procedures using a high speed paper tape reader or magnetic tape cassette. To avoid destruction of the loader program when 41-1085 is read in, 41-0005 should be loaded into field 1.

    f. Repeat steps a through e to read-in the ND4410 Data Manipulation Overlay Program (41-1061).

    g. Repeat steps a through e to read-in the ND4410 X-Ray Analysis Overlay Program (41-1085).

    h. Set the SWITCH REGISTER switches at starting address $(\emptyset, \emptyset 2 \emptyset \emptyset_8)$ and depress the LOAD AR key.

i. Depress the START key at the ND812 Computer. The program will cause the teletype to perform a carriage return and line feed, print ND4410, perform another carriage return and line feed, print PLOTTER? and then wait for entry of a Y or N to indicate whether or not an X-Y plotter is to be used.

j. If an X-Y plotter is not used, type N. When N is typed, the program causes the teletype to perform a carriage return and line feed and type an asterisk (*).

k. If an X-Y plotter is to be used, type Y. When Y is typed, the program will cause the teletype to print YES and supply a (∅, ∅) calibration voltage to the X-Y plotter.

l. Adjust the plotter zero controls to place the pen at the desired (∅, ∅) point.

m. Depress the SPACE bar at the teletype. This supplies a full scale X-Y calibration voltage to the X-Y plotter.

n. Adjust the plotter Vernier controls to place the pen at the desired full scale X-Y point.

o. Depress the SPACE bar at the teletype again. This returns the calibration voltage to the (∅, ∅) point. Re-adjust the plotter zero controls to place the pen at the desired (∅, ∅) point.

p. Depress the SPACE bar at the teletype again. This returns the calibration voltage to the full scale X-Y point. Re-adjust the plotter Vernier controls to place the pen at the desired full scale X-Y point.

q. Repeat steps o and p as often as necessary to attain satisfactory calibration. When satisfactory calibration is obtained, depress the RETURN key at the teletype. When the RETURN key is depressed, the program causes the teletype to perform a carriage return and line feed and type an asterisk (*).

r. When an asterisk (*) is typed either after step j or q, depress the GROUPS pushbutton and then call up the desired routine from the monitor mode by depressing the appropriate pushbutton at the ND4410 Function Control Module or by typing the appropriate single letter mnemonic at the teletype keyboard.

SECTION IV
OPERATOR OR USER CONTROL

4-1. GENERAL INFORMATION

4-2. The commands of the ND4410 X-Ray Analysis Overlay Program (41-1085) are executed by entering the appropriate single letter mnemonic at the teletype or by depressing the appropriate pushbutton at the ND4410 Function Control Module after the program causes an asterisk (*) to be typed, signifying the command mode. In the following description, the portion of the command to be typed at the teletype keyboard is underlined. All other information is provided by the program.

4-3. SET INTERVALS COMMAND

4-4. The Set Intervals command is the basic command for setting and altering the list of internally stored intervals. Up to 32 intervals can be specified in the list. Any one or all the specified intervals can be altered. It is possible to add on intervals or to modify one or more intervals without re-entering the entire list. Each interval may be set independently of the others. The intervals may overlap and they do not have to be in ascending order. The only requirement is that the starting point be less than or equal to the stopping point. The following operation is an example of the entries made the first time a list of intervals is specified. In this example, five intervals will be specified starting with interval one. Interval four will use the left and right markers as its starting and stopping points, respectively. Intervals one, two, three and five will use the digital values specified as their starting and stopping points.

```
* I SET INTERVAL NO.:  A
  INTERVAL START STOP
        1:23(SPACE) :43(SPACE)
        2:648(SPACE):708(SPACE)
        3:94(SPACE) :162(SPACE)
        4:M          :M
        5:376(SPACE):476(SPACE)
        6:@
```

4-5.   The following operation is an example of changing the last interval previously specified and adding one additional interval. In this example assume that interval number five was the last interval previously specified and interval number six is to be added.

```
* I SET INTERVAL NO.:  5 (SPACE)
      5:300(SPACE):500(SPACE)
      6:M            :M
      7:@
```

4-6.   The following operation is an example of changing two consecutive intervals which were previously specified without changing any other intervals. In this example, assume that six intervals were previously specified and intervals four and five are to be changed.

```
* I SET INTERVAL NO.:  4 (SPACE)
      4:M            :M
      5:357(SPACE):505(RETURN PUSHBUTTON)
```

4-7.   The Set Intervals Command is specified by typing I after an asterisk (*) is typed. When I is typed, the routine causes the teletype to print SET INTERVAL NO.: and then waits for entry of an A to specify all intervals, or a number (from 1 to 32) to specify a particular previously specified interval for modification. When A is typed, the routine causes the teletype to perform a carriage return and line feed, print the column headings: INTERVAL, START and STOP, perform another carriage return and line feed, type 1: and then waits for entry of the starting point of interval number one (1). When a number of a previously defined interval is typed, it must be terminated by depressing the SPACE bar at the teletype. When the SPACE bar is depressed, the routine causes the teletype to perform a carriage return and line feed, type the number of the interval specified and a colon (:), and then waits for entry of the starting point of the specified interval. When an interval number is typed in place of the letter A, printing of the column headings is suppressed.

4-8.   After the interval number is typed, the starting point of the interval is entered. The starting point of the interval can be any digital channel number from 1 to the current group width, or M to specify the left marker channel of the current group. Entry of a digital channel number for the starting point must be terminated by depressing the SPACE bar at the teletype. When entry of the starting channel number is terminated by depressing the SPACE bar or when an M is typed to specify the left marker channel, the routine causes the teletype to print a colon (:) and then waits for entry of the stopping point of the interval. The stopping point can be any digital channel number equal to or greater than the starting channel number but less than or equal to the current group width, or M to specify the right marker channel of the current group. Entry of a digital channel number for the stopping point must be terminated by depressing the SPACE bar at the teletype. When entry of a stopping channel is terminated by depressing the SPACE bar or when an M is typed to specify the right marker channel, the routine causes the teletype to perform a carriage return and line feed, type the next consecutive interval number and a colon (:), and then waits for entry of the starting and stopping points for

the next consecutive interval number. The requirements for entry of the starting and stopping points for each succeeding interval are the same as the first. After entry of the stopping point for each succeeding interval is terminated, the routine causes the teletype to type the next consecutive interval number. The list can be terminated at any time by typing the character "@" in place of the starting point of an interval. When the character "@" is typed, the routine stores the interval entries made thus far and causes the teletype to perform a carriage return and line feed and then type an asterisk (*) signifying return to the command mode.

4-9. When the starting and stopping points of an interval are modified and the interval is not the last interval in the list, entry of the stopping point is terminated by depressing the RETURN pushbutton at the ND4410 Function Control Module in place of the SPACE bar at the teletype. This ensures that the end point of the interval list is not disturbed and all previously specified intervals, other than those being modified, will remain unaltered.

NOTE

The RETURN pushbutton can be depressed at any time during the Set Intervals Command without disturbing the end point of the interval list.

4-10. ENERGY CALIBRATE COMMAND

4-11. The Energy Calibrate Command permits entering the channel number of two known peaks and then the known energy in eV of the two known peaks. The routine then calculates the energy per channel (A) and the energy intercept (B). The following is an example of the entries made for the Energy Calibrate Command. In this example, assume a current group width of 1024 channels and the two known energy peaks of 320 eV and 6620 eV at channel locations 33 and 678, respectively.

```
* ENERGY CALIBRATE
  PCH1:  33(SPACE) E1:  320(SPACE)
  PCH2:  678(SPACE) E2:  6620(SPACE)
  A=       9EV/CH
  B=-      2EV
*
```

4-12. The Energy Calibrate Command is specified by typing E after an asterisk (*) is typed. When E is typed, the routine causes the teletype to print ENERGY CALIBRATE, perform a carriage return and line feed, and print PCH1: and then waits for entry of the channel number of the first known peak. The channel number entered can be any channel number from 1 to the current group width. Entry of the channel number must be terminated by depressing the SPACE bar at the teletype. When the SPACE bar is depressed, the routine causes the teletype to print E1: and then waits for entry of the energy of the first known peak. The energy value entered for E1 should be selected such that (E2 - E1)*

(Current group width) does not exceed 8,388,607. This will ensure that an overflow will not occur when the peak channel energy is calculated. If the energy values exceed these limitations, they should be scaled up accordingly. Entry of the energy must be terminated by depressing the SPACE bar at the teletype. When the SPACE bar is depressed, the routine causes the teletype to perform a carriage return and line feed and print PCH2: and then waits for entry of the channel number of the second known peak. The requirements for entry of the second peak channel are the same as the first. When the SPACE bar is depressed to terminate entry of the second peak channel, the routine causes the teletype to print E2: and then waits for entry of the energy of the second known peak. The requirements for entry of the second peak energy are the same as the first. When the SPACE bar is depressed to terminate entry of the second peak energy, the routine causes the teletype to perform a carriage return and line feed; print A=, the energy per channel and EV/CH; perform a carriage return and line feed, print B=, the energy intercept and EV; and perform a carriage return and line feed and type an asterisk (*), signifying return to the command mode.

4-13. PRINT REPORT COMMAND

4-14. The Print Report Command provides a printout of the information pertaining to a specified interval or all specified intervals in the list. Information included in the list is: the interval number, the starting and stopping channel numbers of the interval, the background counts in the interval, the net counts in the interval and the energy in eV for the peak channel in the interval. The number of counts in the background is determined by taking the area under a straight line drawn between the gross values in the end channel of each interval. The net count is determined by subtracting the background counts from the total counts in the interval. The energy of the peak channel in the interval is based upon the previously entered energy calibration obtained using the Energy Calibrate Command. The following operation is an example of the entries made and the printout for all intervals in the list. In this example assume the list contains six previously specified intervals and the Energy Calibrate Command was previously performed.

```
* PRINT INTERVAL NO.:  A
  INTERVAL    START    STOP    BKGND    NET     PEAK
         1       23      43     3423    1386      271
         2      684     708     7076    1813     6434
         3       94     162     6417     276     1297
         4      184     252     7245    1154     1951
         5      357     505     4768    2201     3563
         6      591     739     2086   12781     6434
```

4-15. The following operation is an example of the entries made and the printout for a previously specified interval number. In this example assume the specified interval is interval number four and the Energy Calibrate Command was previously performed.

* <u>P</u>RINT INTERVAL NO.: <u>4</u> (SPACE)

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4   184   252   1245   1145   1951

</div>

4-16.   The Print Report Command is specified by typing a P after an asterisk (*) is typed. When P is typed, the routine causes the teletype to print PRINT INTERVAL NO.: and then waits for entry of an A to specify all previously specified intervals or a number (from 1 to 32) to specify a particular previously defined interval for printout. When A is typed, the routine causes the teletype to perform a carriage return and line feed and print the column headings: INTERVAL, START, STOP, BKGND, NET and PEAK, and then performs the background, net counts and peak energy calculations and prints the interval number, starting channel, stopping channel, background counts, net counts, and peak channel energy for each previously specified interval in the list. When a particular interval number is specified for printout, it must be terminated by depressing the SPACE bar at the teletype. When the SPACE bar is depressed, the routine performs the background, net counts and peak energy calculations and prints the interval number, starting channel, the stopping channel, the background counts, net counts and peak channel energy for the specified interval. When a particular interval number is typed in place of the letter A, printing of the column heading is suppressed and the values are printed in a single line. Upon completion of printing the values for the last interval in the list (or a specific interval number), the routine causes the teletype to perform a carriage return and line feed and type an asterisk (*), signifying return to the command mode.

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NOTE

</div>

The Print Report Command can be terminated at any time by depressing the RETURN pushbutton at the ND4410 Function Control Module.

4-17.   MARKER PRINT REPORT COMMAND

4-18.   The Marker Print Report Command provides a printout of the same information as the Print Report Command for the interval defined by the current markers. This command has no effect on the interval list. The following operation is an example of the entries made and the printout for the interval between the current markers. In this example, assume the left marker is at channel 591 and the right marker is at channel 739.

* <u>M</u>

<div align="center">

∅   591   739   3427   18348   6542

</div>

*

4-19.   The Marker Print Report Command is specified by typing M after an asterisk (*) is typed. When M is typed, the routine causes the teletype to perform a carriage return and line feed, and then performs the background, net counts and peak energy calculation for the interval defined by the current markers and causes the teletype to print a zero for the interval number, the left marker channel, the right marker channel, the background

<div align="center">

4-5

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counts, the net counts and the peak channel energy in eV. Upon completion of printout of the peak channel energy, the routine causes the teletype to perform a carriage return and line feed and type an asterisk (*), signifying return to the command mode.

4-20. X-RAY STATUS DISPLAY COMMAND

4-21. The sequence of parameters displayed by depressing the STATUS pushbutton (41-1060) is modified by this program to include display of the following X-Ray parameters: current left and right marker channels and the net counts, background counts and the peak channel energy in eV of the last interval for which these values were calculated. The left and right marker channels do not necessarily pertain to the same interval as the background counts, net counts and peak channel energy. However, the intervals can be made the same by performing the Display Interval Command or by depressing the SPARE pushbutton on the ND4410 Function Control Module. The values displayed for the left and right marker channels are altered whenever the left and right markers are moved using the MARK POS and MARK SPAN pushbuttons. The values displayed for the background counts, net counts and peak channel energy are altered by the Print Report Command, Marker Print Report Command and the Auto Analyze Command (41-1061). The following is an example of X-Ray Status Parameters as they appear on the display. In this example, the left marker is at channel 591, the right marker is at channel 739, the background counts equals 3427, the net count is 18348 and the peak channel energy is 6542 eV.

> 591-739
> 3427/18348
> 6542

4-22. The status display of the Preset and Remaining Acquisition Time parameters (41-1060) is also modified by this program to include display of the total counts between the current markers and the count rate. During data acquisition, the display of the total count and count rate values is updated at one second intervals. The following is an example of these parameters as they appear on the display. In this example, the preset acquisition time is 1000 centiseconds, the remaining acquisition time is 731 centiseconds, the total counts between the markers as of the last update is 32582, and the count rate as of the last update is 1489.

> 1000/-731
> 32582/1489

4-23. DISPLAY INTERVAL COMMAND

4-24. The Display Interval Command permits display of starting and stopping channel, the background counts, net counts and peak channel energy for any specified interval. The starting and stopping channels are determined by resetting the left and right marker to the starting and stopping points of the specified interval and then updating the X-Ray Status display. This command is useful for visually checking the isolation of peaks or

other features in the various intervals stored by the system. The following is an example of the entries made for the Display interval command. In this example interval number three (3) is selected for display.

* DISPLAY INTERVAL NO.: 3 (SPACE)
*

4-25.   The Display Interval Command is specified by typing a D after an asterisk (*) is typed. When D is typed, the routine causes the teletype to print DISPLAY GROUP NO.: and then waits for entry of an interval number. Any previously assigned interval number from 1 to 32 may be specified. Entry of the interval number must be terminated by depressing the SPACE bar at the teletype. When the SPACE bar is depressed after entry of an interval number, the routine resets the left and right markers to the starting and stopping points of the specified interval, calculates the background counts, net counts and peak channel energy and updates the X-Ray Status Display (refer to paragraph 4-20). After the X-Ray Status Display has been updated, the routine causes the teletype to perform a carriage return and line feed and type an asterisk (*), signifying return to the command mode.

NOTE

The Energy Calibrate Command should be performed prior to the Display Interval Command in order to obtain a meaningful peak channel energy.

4-26.   SPARE PUSHBUTTON COMMAND

4-27.   Depressing the SPARE pushbutton updates the X-Ray Status Display of the Print Report so that interval of the Print Report corresponds to the current markers. Refer to the X-Ray Status Display Command (paragraph 4-20).

4-28.   PRESET COUNTS COMMAND

4-29.   The Preset Counts Command permits entering a preset maximum number of counts from 1 to 8,388,607 for determining analysis time. After analysis has been initiated by depressing the ACQUIRE pushbutton, it will automatically terminate when the total number of counts between the left and right markers of the current group as of the last status update exceeds the preset maximum number of counts. Entering Ø suppresses the preset count restriction, permitting analysis to continue until either manually terminated by depressing the ACQUIRE pushbutton or automatically terminated upon completion of the current preset analysis time. The following is an example of an entry for the Preset Counts Command. In this example, 100,000 is entered as the preset maximum number of counts. After analysis has been initiated by depressing the ACQUIRE pushbutton, it will automatically terminate when the total counts between the current markers exceed 100,000 counts.

* Q MAXIMUM COUNTS: 100000 (SPACE)
* ‾

4-30.   The Preset Counts Command is specified by typing a Q after an asterisk (*) is
typed. When Q is typed, the routine causes the teletype to print MAXIMUM COUNTS:
and then waits for entry of the preset maximum number of counts. The preset number can
be any number from 1 to 8,388,607. Entering ∅ suppresses the preset count restriction
on analysis. Entry of the preset count must be terminated by depressing the SPACE bar
at the teletype. When the SPACE bar is depressed, the routine causes the teletype to
perform a carriage return and line feed and type an asterisk (*), signifying return to the
Command mode.

4-31. ACQUIRE PUSHBUTTON COMMAND

4-32.   The ACQUIRE Pushbutton Command (41-1060) is modified by this program to
calculate the total counts between the current markers and the count rate, and then update
the X-Ray Status Display with the calculated values at one second intervals. The
display update occurs only during data acquisition. When not in acquire, the values
resulting from the last calculation that occurred during acquire are displayed.

4-33. DISPLAY K/L LINES COMMAND

4-34.   The Display K/L Lines Command permits display of a marker at the channel
locations of the principal K or L lines for a specified atomic number from 1 to 100.
The command also alters the X-Ray Status to display the specified atomic number and
the principal K "beta" and K "alpha" values in eV or principal L "beta", L "gamma"
and L "alpha" values in eV. If any of the K or L values is zero, it indicates that the
system has no value for that particular parameter. The following is an example of the
entries required and the X-Ray Status Display for the principal K lines. In this example,
the atomic number is 27, the K "beta" is 7649 eV and the K "alpha" is 6925 eV. The
zero indicates no other K values are available.

Entry	X-Ray Status Display
* T ATOMIC NO.: 27 K	7649 - ∅ - 27
	6925

4-35.   The following is an example of the entries required and the X-Ray Status Display
for the principal L lines. In this example, the atomic number is 27, the L "beta" is
790 eV and the L "alpha" is 775 eV. No L "gamma" is present.

Entry	X-Ray Status Display
* T ATOMIC NO.: 27 L	790 - ∅ - 27
	775

4-36. The Display K/L Lines Command is specified by typing T after an asterisk (*) is typed. When T is typed, the routine causes the teletype to print ATOMIC NO.: and then waits for entry of an atomic number. The atomic number can be any number from 1 to 100 (Refer to Appendix A for a table of atomic numbers). Entry of the atomic number must be followed by typing either a K to specify the K lines or an L to specify the L lines. When K is typed, the routine displays markers at the principle K lines and alters the X-Ray Status to display the principle K "beta" and K "alpha" in eV. When L is typed, the routine displays markers at the principal L lines and alters the X-Ray Status to display the principle L "beta", L "gamma" and L "alpha" in eV. If any of the K or L values displayed is zero, it indicates that the system has no values for that particular parameter. Display of the principal K or L lines is terminated by depressing the RETURN pushbutton at the ND4410 Function Control Unit. When the RETURN pushbutton is depressed, the markers and the X-Ray Status Display are restored to the value they were at prior to performing the Display K/L lines command and the program is returned to the command mode as signified by the teletype performing a carriage return and line feed and typing an asterisk (*).

4-37. AUTO ANALYZE COMMAND

4-38. The auto analyze sequence of the Auto Analyze Command (41-1061) is modified by this program to replace the totalize and print operations with printout of print report for each of the pre-assigned intervals in the list. The following is an example of the information printed by the Auto Analyze Command (41-1061) modified for X-Ray printout. In this example the auto analyze sequence is performed two times with an acquire time of 1000 centiseconds, and six intervals are assigned to the list.

NOTE

Analysis time during auto analyze can be controlled either on a preset clock time basis as selected by the Clock Set Command (41-1060) or on a preset maximum number of counts basis as selected by the Preset Counts Command (41-1086). However, when the Clock Set Command (41-1060) is used to control analysis time, the entry for the Preset Counts Command (41-1086) should be zero ($\emptyset$), or vice versa.

* <u>AUTO ANALYZE:</u> <u>2</u> <u>(SPACE)</u> TIMES

*

INTERVAL	START	STOP	BKGND	NET	PEAK
1	23	43	3339	1422	281
2	648	708	7259	1715	6610
3	94	162	6417	230	1414
4	184	252	8073	383	1931
5	357	505	5960	829	3719
6	591	739	2086	12637	6610

*

INTERVAL	START	STOP	BKGND	NET	PEAK
1	23	43	3507	1318	281
2	648	708	7198	1863	6542
3	94	162	6417	319	1355
4	184	252	6831	1474	2048
5	357	505	6109	903	3934
6	591	739	1490	13307	6542

*

SECTION V
ERROR DIAGNOSTICS

5-1. ERROR INDICATION

5-2.   Execution of an illegal operation will result in an error message being typed at
the teletype. Table 5-1 lists the error messages and their causes.

Table 5-1. Error Indication

Error Message	Cause
59XXXXX	Depressing an unassigned teletype key to call up a command or enter a command argument.
52XXXXX	Entering an atomic number other than 1 to 100 in the Atomic Number Command.

NOTE

The least significant digits indicated by X's in Table 5-1 for the
ERROR message may change depending upon what illegal operation
was performed. However, the two most significant digits will be the
same for the same type of error.

SECTION VI
COMMAND SUMMARY

6-1.   The following summarizes the commands described in Section IV.

   1. I SET INTERVALS COMMAND. Permits assigning a list of up to 32 intervals
       of interest in the current display group. The command also permits adding
       or modifying one or more intervals without re-entering the entire list. Each
       interval is assigned by entering the starting and stopping channel of the desired
       area of interest. The starting channel can be any channel from 1 to the
       current group width or M for the left marker channel. The stopping channel
       can be any channel equal to or greater than the starting channel but less
       than or equal to the current group width or M for the right marker channel.

   2. ENERGY CALIBRATE COMMAND. Permits energy calibration based upon
       entry of the known energy in eV for two peak channels. The routine calculates
       and prints the energy per channel and the energy intercept. These values are
       used to determine the peak channel energy for the print report.

   3. PRINT REPORT COMMAND. Provides teletype printout of the print report
       for any specified interval number or all intervals in the previously assigned
       interval list. The print report lists the interval number, starting channel,
       stopping channel, background counts, net counts and peak channel energy for
       the specified interval or all intervals in the interval list.

   4. MARKER PRINT REPORT COMMAND. Provides teletype printout and display
       of the print report for the interval between the left and right markers of the
       current display group. The print report lists the current left and right marker
       channels, the background counts, net counts and peak channel energy for the
       interval defined by current markers.

   5. X-RAY STATUS COMMAND. Modifies the status display sequence (41-1060)
       to include display of the print report. The print report lists the interval number,
       the current left and right marker channel numbers, the background counts,
       net counts and peak channel energy in eV for the last interval for which
       these values were calculated. Note, that the current markers may not be
       set at the limits of interval to which the values correspond. However, they

can be set to correspond by depressing the SPARE pushbutton or by performing the Display Interval Command. The Status display of the preset and remaining acquisition time (41-1060) is also modified to include display of the total counts between the current markers and the count rate. During data acquisition these values are updated at one second intervals.

6. DISPLAY INTERVAL COMMAND. Sets the left and right markers to the limits of any specified interval number and displays the print report for that interval. The print report lists the interval number, the starting point (left marker channel), the stopping point (right marker channel), background counts, net counts and peak channel energy for the specified interval number.

7. SPARE PUSHBUTTON. Sets the interval of X-Ray Status Display to correspond to the current markers.

8. Q PRESET COUNTS COMMAND. Permits entry of a preset maximum number of counts from 1 to 8,388,607 for control of analysis time. Entering $\emptyset$ suppresses the preset count restriction on analysis.

9. ACQUIRE PUSHBUTTON. Modifies acquire operation (41-1060) to calculate the total counts between the current markers and the count rate and then updates the status display at one second intervals.

10. T DISPLAY K/L LINES COMMAND. Sets the markers at the principle K or L lines and alters the X-Ray Status to display the K "beta" and K "alpha" values in eV or the L "beta", L "gamma" and L "alpha" values in eV for a specified atomic number. Refer to Appendix A for a listing of atomic numbers.

11. AUTO ANALYZE COMMAND. Modifies the auto analyze sequence (41-1061) to replace the totalize and print operations with the teletype printout of the print report for each interval assigned to the interval list.

SECTION VII
FLOW CHARTS

(TO BE SUPPLIED)

SECTION VIII
PROGRAM LISTING

8-1. A listing of the ND4410 X-Ray Analysis Overlay Program (41-1085) as produced by Pass 3 of the ND812 BASC-12 General Assembler Program (41-0001) is provided on the following pages.

/ND41-1085-00
/X-RAY FUNCTIONS   SA=N.A.
/OVERLAY FOR 4410(1060,1061)- VERSION A

/RM/DB
/9(36) 8/14/72
/LOADER MUST BE IN FIELD 1

/SYMBOLS DEFINED IN 41-1060-00(EDIT 52)

```
                AQEXIT      = 2061
                AQOFF       = 2025
                CHARX       = 2320
                CLOCK1      = 2100
                CNTR        = 2230
                DECODE      = 0227
                DUBINT      = 2441
                ECHOF       = 2106
                ERROR       = UNUSED = 2120
                FCHAR       = 0245
                GROUPW      = 1664
                GROUPZ      = 0156
                GSC         = 1640
                HORD        = 2506
                II1         = 1656
                INEC        = 2140
                IN2         = 1642
                IN2000      = 1644
                IRTRN       = 2105
                LDF         = 2252
                LDLIST      = 0632
                LORD        = 2505
                LOREAD      = 0264
                MGCCP       = 1515
                MGCC        = 1525
                MGCLP       = 1513
                MGCL        = 1266
                MGCRP       = 1514
                MGCR        = 1270
                OLYEXT      = 2074
                RETRN       = 0362
                STATX       = 1041
                TABLE       = 2336
                TAB1        = 2304
                TIME        = 2076
                TTY         = 0003
                UNPACK      = 2403
```

/SYMBOLS DEFINED IN 41-1061-00(EDIT 23)

```
        AQR         =  3061

/INTEGER PACKAGE DEFINITIONS

        IEXT         =  0000         /EXIT
        IOUT         =  3400         /OUTPUT
        ISUB         =  4000         /SUBTRACTION
        IADD         =  4400         /ADDITION
        ILOD         =  5000         /LOAD
        ISTR         =  5400         /STORE
        INEG         =  6000         /NEGATE INTEGER AC
        IDIV         =  6400         /DIVISION
        IMUL         =  7000         /MULTIPLICATION
        INOP         =  7400         /NO OPERATION
        IM  =  DUBINT         /INTEGER PACKAGE ENTRY
```

```
[FIELD 0

              *IN2000
0 1644  4000                4000        /DATA STARTS AT 0000 IN FIELD 1
0 1645  0000                0000

              *AQOFF-0004              /MODIFICATION TO CLOCK SERVICE
0 2021  1442                SKIP

              *AQOFF-0002              /MOD TO CLOCK SERVICE
0 2023  0600                TWJMP
0 2024  5173                CDTR

              *OLYEXT                  /LINK INTO ACQ ON/OFF
0 2074  5117                SRCT

              *TAB1+0005
0 2311  0111                0111        /SET INTERVALS
0 2312  0115                0115        /PRINT REPORT FOR CURRENT MARKERS
0 2313  0120                0120        /PRINT REPORT FOR SPECIFIED PAIR
0 2314  0105                0105        /ENERGY CALIBRATION
0 2315  0104                0104        /DISPLAY SPECIFIED PAIR
0 2316  0124                0124        /DISPLAY K- OR L-LINES

              *CHARX+0006
0 2326  4247                SLIM
0 2327  4664                PRCM
0 2330  4740                MPRR
0 2331  5011                ECOF
0 2332  5131                DLMP
0 2333  5350                DENR

              *CHARX+0015
0 2335  5103                PSCN               /CHECK FOR PRESET COUNTS

              *TABLE+0014
0 2352  5324                RMDP        /RESTORE ORIGINAL MARKERS ON "RETURN"

              *TABLE+0017              /SPECIAL X-RAY PUSHBUTTON
0 2355  5000                MSTD

              *LDF+0003
0 2255  5545                XCLK-1      /REVISE CLOCK STATUS DISPLAY
0 2256  5533                XSTS-1      /ADD X-RAY STATUS DISPLAY

              *AQR
0 3061  0640                TWJPS       /LINK INTO AUTO-ACQUIRE
0 3062  4366                PRPT

/E1747
```

```
                    *4047
0 4047   1400             IDLE      /MODIFY MEMORY SIZE CALCULATION
                                    /TO ACCOMODATE SMALLER DATA AREA

                    *4000
                    LMTB      *.        /BEGINNING OF LIMIT PAIR BUFFER

                    *LMTB+0200 /NUMBER OF WORDS=MAX. NO. OF PAIRS*4
                                    /MINIMUM NO. OF WORDS=0164 TO ACCOMODATE
                                    /41=1060 INITIALIZATION
                    LMTE      *.

/GET LEGAL PAIR NUMBER AND INITIATE POINTERS TO
/MARKER BUFFER
/ENTER WITH "LLMA" SET TO POINT TO LAST WORD+1 OF
/LAST PAIR ENTERED
/IF CALL+1 CONTAINS AN <IDLE>, ROUTINE WILL NOT ALLOW
/SPECIFICATION OF LAST ENTERED PAIR NUMBER+1
/IF IT CONTAINS <SET O>, IT WILL ALLOW SPECIFICATION
/OF LAST ENTERED PAIR+1
/RETURN WITH "LMPR"=SPECIFIED PAIR IF "ALL" WERE
/SPECIFIED AND "LMPP" POINTED TO APPROPRAITE
/WORD IN LIMIT PAIR BUFFER
/RETURN TO CALL+2 IF PAIR NO. IS SPECIFIED
/RETURN TO CALL+3 IF "A" IS ENTERED SPECIFYING ALL PAIRS

0 4200   0000    IPSP,    0
0 4201   7047             XCT    X25      /<JPS UNPACK>
0 4202   5667             GLMP
0 4203   7062             XCT    X21      /<JPS INEC>GET LIMIT PAIR NO.
0 4204   4355    LMPRI,   LMPR
0 4205   0500    X05,     TWLDJ
0 4206   2320             CHARX
0 4207   2431             SMJ    C101     /A?
0 4210   6032             JMP    IPSP1    /YES- SET UP FOR MODIFICATION STARTING
0 4211   5305             LDJ@   LMPRI    /NO
0 4212   2301             SUBL   01       /SUBTRACT "1" FROM SPECIFIED PAIR NO.
0 4213   1142             SFTZ   02 J     /MULTIPLY PAIR NUMBER BY 4
0 4214   1502             SIP    J        /FORM POINTER TO SPECIFIED PAIR
0 4215   6624             JPS@   ERRORI   /PAIR NUMBER TOO LARGE
0 4216   1450             CLR    O        /NEW POINTER MUST BE BETWEEN BEGINNING
0 4217   0440             TWADJ           /OF TABLE AND LAST SPECIFICATION
0 4220   4354    BLMTI,   BLMT
0 4221   1455             SIZ    CLR O
0 4222   6617             JPS@   ERRORI   /PAST END OF FIELD
0 4223   0400             TWSBJ           /GREATER THAN LAST SPECIFICATION?
0 4224   4357    LLMAI,   LLMA
0 4225   1501             SNZ    J        /LAST PAIR ENTERED+1 SPECIFIED?
0 4226   7326             XCT@   IPSP     /YES- EXECUTE CALL+1 TO SEE IF ITS AN ER
0 4227   1451             SNZ    CLR O    /NO- LEGAL PAIR NO.?
```

```
0  4230   6611            JPS@ ERRORI      /YES
0  4231   4705            ADJ@ LLMAI       /NO- RESTORE J
0  4232   5472   IPSP2,   STJ  LMPP
0  4233   1510            CLR  J
0  4234   0540            TWSTJ
0  4235   4356            LMPR+1
0  4236   3536            ISZ  IPSP        /RETURN TO CALL+2 OR 3
0  4237   6337   [RETURN IPSP

0  4240   0101   C101,    0101
0  4241   2120   ERRORI,  ERROR

0  4242   3542   IPSP1,   ISZ  IPSP
0  4243   1514            CLR  INC J
0  4244   5740            STJ@ LMPRI
0  4245   5325            LDJ@ BLMTI
0  4246   6114            JMP  IPSP2

/SET LIMITS LIST VIA KEYBOARD

0  4247   0000   SLIM,    0
0  4250   7057   X25,     XCT  X07         /<JPS UNPACK>
0  4251   5567            LIMS
0  4252   6552            JPS  IPSP        /GET LEGAL PAIR NO.
0  4253   1470            SET  0           /MAY SPECIFY LAST PAIR NO. ENTERED+1
0  4254   6005            JMP  SLIM3
0  4255   7052            XCT  X07         /<JPS UNPACK>
0  4256   5575            HDNG
0  4257   7050            XCT  X07         /<JPS UNPACK>
0  4260   5627            CRLF
0  4261   7046   SLIM3,   XCT  X07         /<JPS UNPACK>
0  4262   5627            CRLF
0  4263   0340            TWISZ            /<ISZ ECHOF>SET FLAG FOR PRINT ONLY
0  4264   2106            ECHOF
0  4265   7035   X21,     XCT  X06         /<JPS INEC>PRINT PAIR NO.
0  4266   4355            LMPR
0  4267   5071            LDJ  MGCLI       /INITIALIZE MARKER BUFFER POINTER
0  4270   5471            STJ  MKBP
0  4271   6430            JPS  GLIM        /GET LOWER LIMIT
0  4272   7165   X23,     XCT  X05         /<LDJ CHARX>
0  4273   2425            SMJ  C100        /@?
0  4274   6020            JMP  SLIM1       /YES- LAST PAIR IN LIST
0  4275   7004            XCT  X08         /<JPS IM>SAVE IN "ITMP"
0  4276   5464            ISTR ITMP
0  4277   0000            IEXT
0  4300   6421            JPS  GLIM        /GET UPPER LIMIT
0  4301   0640   X08,     TWJPS            /<JPS IM>NO-CHECK UPPER LIMIT AGAINST
0  4302   2441            IM               /LOWER LIMIT
0  4303   4057            ISUB ITMP
0  4304   0000            IEXT             /RETURNS WITH JK=IAC
```

```
0 4305   1602            SIP   K        /UPPER LIMIT <OR= LOWER LIMIT?
0 4306   6745            JPS@  ERRORI   /YES
0 4307   3446            ISZ   LMPR     /NO- INCREMENT PAIR NUMBER
0 4310   5014            LDJ   LMPP     /INCREMENT PAIR POINTER BY 2
0 4311   2406            SMJ   ELMT     /END OF TABLE?
0 4312   6002            JMP   SLIM1    /YES
0 4313   6132            JMP   SLIM3    /NO

0 4314   5010   SLIM1,   LDJ   LMPP     /SAVE POINTER TO LAST PAIR+1
0 4315   5442            STJ   LLMA
0 4316   6347   [RETURN SLIM

0 4317   4200   ELMT,    LMTE
0 4320   0100   C100,    0100

0 4321   0000   GLIM,    0
0 4322   0640   X06,     TWJPS
0 4323   2140            INEC
0 4324   0000   LMPP,    0
0 4325   0340            TWISZ            /FILL FIELD OUT WITH SPACES
0 4326   2230   CNTRI,   CNTR

         GLIM4           *.

0 4327   7047   X07,     XCT   X02      /<JPS UNPACK>PRINT ONE SPACE
0 4330   5566            SPCS
0 4331   3303            DSZ@  CNTRI    /LAST SPACE?
0 4332   6103            JMP   GLIM4    /NO
0 4333   7141            XCT   X23      /<LDJ CHARX>YES
0 4334   2430            SMJ   C115     /TERMINATING CHARACTER=M?
0 4335   6010            JMP   GLIM1    /YES- USE MARKER VALUE POINTED TO BY "M
0 4336   2516            SMJ   C100     /TERMINATOR?
0 4337   6316   [RETURN GLIM            /YES- SKIP PAIR POINTER INCREMENTATION
0 4340   3514            ISZ   LMPP     /NO- VALUE ENTERED
0 4341   3420            ISZ   MKBP     /INCREMENT BUFFER POINTERS
0 4342   3516   GLIM2,   ISZ   LMPP
0 4343   3416            ISZ   MKBP
0 4344   6323   [RETURN GLIM

0 4345   5214   GLIM1,   LDJ@  MKBP
0 4346   5722            STJ@  LMPP
0 4347   3412            ISZ   MKBP
0 4350   3524            ISZ   LMPP
0 4351   5210            LDJ@  MKBP
0 4352   5726            STJ@  LMPP
0 4353   6111            JMP   GLIM2

0 4354   4000   BLMT,    LMTB     /POINTER TO BEGINNING OF LIMIT
                                  /PAIR TABLE
```

```
0 4355   0001   LMPR,   0001       /LIMIT PAIR NO.
0 4356   0000           0000       /HIGH ORDER MUST BE=0
0 4357   4000   LLMA,   LMTB       /ADDRESS+1 OF LAST LIMIT PAIR
                                   /"LLMA" IS RESET UPON SPECIAL
                                   /CHARACTER TERMINATION IN "SLIM"
                                   /OF LIMIT SET COMMAND
0 4360   1266   MGCLI,  MGCL
0 4361   0000   MKBP,   0          /MOVING POINTER TO MARKER BUFFER
0 4362   0000   ITMP,   0          /TEMPORARY DOUBLE PRECISION INTEGER STORAGE
0 4363   0000           0
0 4364   0115   C115,   0115
0 4365   0140   C140,   0140

/E3679
```

/PRINT AUTO-ANALYZER REPORT

```
0 4366    0000    PRPT,       0
0 4367    0500            TWLDJ                   /FORM <TWLDJ> POINTER TO BEGINNING
0 4370    0157            GROUPZ+1                /WORD OF ACQUISITION GROUP
0 4371    4504            ADJ   C140              /"GROUPZ" CONTAINS A <TWISZ FY>
0 4372    5425            STJ   SPNT+1            /INSTRUCTION
0 4373    0500            TWLDJ
0 4374    0156            GROUPZ
0 4375    5421            STJ   SPNT
0 4376    0640    X02,    TWJPS                   /PRINT HEADING
0 4377    2403            UNPACK
0 4400    5575            HDNG
0 4401    7103            XCT   X02               /<JPS UNPACK>
0 4402    5613            SHDG
0 4403    1514            CLR   INC J             /SET LIMIT PAIR NUMBER=1
0 4404    5527            STJ   LMPR
0 4405    1510            CLR   J
0 4406    5530            STJ   LMPR+1
0 4407    5130            LDJ   LLMA
0 4410    0540            TWSTJ
0 4411    4655            LAPR
0 4412    5136            LDJ   BLMT              /INITIATE POINTER TO LIMIT PAIR
0 4413    6414            JPS   POPR
0 4414    6326    [RETURN PRPT

0 4415    1642    IN2I,   IN2
0 4416    0000    SPNT,   0           /DOUBLE PRECISION <TWLDJ> POINTER TO
0 4417    0000            0           /STARTING ADDRESS OF ACQUISITION GROUP
```

/PRINT DOUBLE PRECISION INTEGER POINTED TO
/BY "LMTP" AND ADVANCE "LMTP" TO NEXT DOUBLE
/PRECISION INTEGER

```
0 4420    0000    PLNO,   0
0 4421    7015            XCT   X01               /<ISZ ECHOF>SET FLAG FOR PRINT ONLY
0 4422    7016            XCT   X03               /<JPS INEC>
0 4423    0000    LMTP,   0
0 4424    3501            ISZ   LMTP              /ADVANCE POINTER TO NEXT VALUE
0 4425    3502            ISZ   LMTP
0 4426    6306    [RETURN PLNO
```

/ENTER WITH J=POINTER TO FIRST PAIR TO BE LISTED
/AND "LAPR" INITIALIZED WITH POINTER TO END OF PAIR
/BUFFER TO BE LISTED+1; "LMPR" SET TO NUMBER OF FIRST
/PAIR TO BE LISTED; AND "SPNT" INITIALIZED TO ADDRESS
/OF BEGINNING OF GROUP

```
0 4427    0000    POPR,   0
0 4430    5505            STJ   LMTP
```

```
0  4431   0500   POPR1,   TWLDJ              /LAST PAIR ENTERED+1?
0  4432   4423            LMTP
0  4433   0240            TWSMJ
0  4434   4655            LAPR
0  4435   6306   [RETURN  POPR               /YES
0  4436   0340   X01,     TWISZ              /PRINT LIMIT PAIR NO.
0  4437   2106            ECHOF
0  4440   0640   X03,     TWJPS
0  4441   2140            INEC
0  4442   4355            LMPR
0  4443   6523            JPS   PLNO          /PRINT INTERVAL START CHANNEL
0  4444   6524            JPS   PLNO          /PRINT INTERVAL STOP CHANNEL
0  4445   5122            LDJ   LMTP          /RESTORE "LMTP"
0  4446   2304            SUBL  04
0  4447   5524            STJ   LMTP
0  4450   6420            JPS   CALC          /PERFORM CALCULATIONS FOR ONE PAIR
0  4451   7113            XCT   X01           /<ISZ ECHOF>"INEC" PRINT ONLY
0  4452   7112            XCT   X03           /<JPS INEC>PRINT BACKGROUND
0  4453   4661            BGND
0  4454   7116            XCT   X01           /<ISZ ECHOF>PRINT ONLY
0  4455   7115            XCT   X03           /<JPS INEC>PRINT NET COUNTS
0  4456   4653            NTOT
0  4457   7121            XCT   X01           /<ISZ ECHOF>
0  4460   7120            XCT   X03           /<JPS INEC>PRINT PEAK ENERGY
0  4461   4656            PADD
0  4462   0640            TWJPS
0  4463   2403            UNPACK
0  4464   5627            CRLF
0  4465   0340            TWISZ              /ADVANCE LIMIT PAIR NUMBER
0  4466   4355            LMPR
0  4467   6136            JMP   POPR1         /NO
```

/E1680

```
/CALCULATE REPORT VALUES
/ENTER WITH "LMTP" POINTING TO TWO DOUBLE PRECISION
/INTEGER CHANNELS
/EXIT WITH "SUML,SUMH"=GROSS COUNTS UNDER PEAK IN
/SPECIFIED INTERVAL; "HPTL,HPTH"=ADDRESS OF HIGHEST
/CHANNEL CONTAINING THE HIGHEST POINT
/IN SPECIFIED INTERVAL; AND "PADD"= ENERGY OF HIGHEST
/POINT AS CALCULATED FROM CALIBRATION COEFFICIENTS "A" AND "B"

0 4470  0000  CALC,      0
0 4471  0640  X04,       TWJPS          /CONVERT STARTING CHANNEL INTO
0 4472  2441             IM             /ADDRESS POINTER
0 4473  5350             ILOD@ LMTP     /GET STARTING LIMIT
0 4474  5447             ISTR FPNT      /SAVE STARTING LIMIT
0 4475  7360             IMUL@ IN2I
0 4476  4361             ISUB@ IN2I
0 4477  4561             IADD SPNT
0 4500  0000             IEXT           /RETURNS WITH JK=IAC
0 4501  5446             STJ  DATP+1    /TRANSFER POINTER FROM IAC TO "DATP"
0 4502  0540             TWSTJ          /INITIALIZE HIGHEST POINT ADDRESS
0 4503  4657             PADD+1
0 4504  1374             EXJK
0 4505  5441             STJ  DATP
0 4506  0540             TWSTJ
0 4507  4656             PADD
0 4510  3565             ISZ  LMTP      /INCREMENT LIMIT BUFFER POINTER
0 4511  3566             ISZ  LMTP
0 4512  7121             XCT  X04       /<JPS IM>AND CALCULATE CHANNEL COUNTER
0 4513  5370             ILOD@ LMTP     /GET STOPPING LIMIT
0 4514  4027             ISUB FPNT      /SUBTRACT STARTING LIMIT
0 4515  0000             IEXT           /RETURNS WITH JK=IAC=NO. OF CHANNELS
0 4516  3573             ISZ  LMTP      /INCREMENT LIMIT BUFFER POINTER
0 4517 <3574             ISZ  LMTP
0 4520  1504             INC  J         /(STOP-START)+1
0 4521  5424             STJ  DCNT      /SET INTERVAL COUNTER
0 4522  0540             TWSTJ          /SAVE INTERVAL WIDTH
0 4523  4651             IWID
0 4524  7022             XCT  DATP      /<TWLDJ FX "DATP+1">
0 4525  5416             STJ  FPNT      /SAVE VALUE OF FIRST POINT OF INTERVAL
0 4526  7034             XCT  X22       /<STJ SUML>AND INITIALIZE TOTAL
0 4527  5646             STJ@ HPTLI     /AND INITIALIZE HIGHEST POINT
0 4530  3417             ISZ  DATP+1    /CHANNEL CANNOT CROSS MEMORY FIELDS
0 4531  7015             XCT  DATP      /<LDJ FX "DATP+1">
0 4532  5412             STJ  FPNT+1
0 4533  7035             XCT  X24       /<STJ SUMH>
0 4534  7050             XCT  X13       /<STJ HPTH>
0 4535  3412             ISZ  DATP+1    /LAST CHANNEL IN FIELD?
0 4536  1442             SKIP           /NO
0 4537  3407             ISZ  DATP      /YES- INCREMENT MEMORY FIELD
0 4540  3005  PRPT4,     DSZ  DCNT      /LAST CHANNEL?
```

```
0 4541   6005          JMP  POPR2        /NO
0 4542   6052          JMP  PRPT3        /YES

0 4543   0000   FPNT,  0             /COUNTS IN FIRST CHANNEL IN INTERVAL
0 4544   0000          0             /USED ALSO FOR TEMPORARY STORAGE
0 4545   0000   DCNT,  0             /INTERVAL COUNTER

               POPR2          *.
0 4546   0504   DATP,  TWLDJ F0
0 4547   0000          0
0 4550   1204          LKFJ              /LOW ORDER TO K
0 4551   3502          ISZ  DATP+1
0 4552   7104          XCT  DATP         /<LDJ FX "DATP+1">HIGH ORDER IN J
0 4553   1301          LRSFJK
0 4554   3505          ISZ  DATP+1
0 4555   1442          SKIP
0 4556   3510          ISZ  DATP
0 4557   1374          EXJK
0 4560   1450          CLR  0            /ADD TO "SUM"
0 4561   4602          ADJ@ SUMLI
0 4562   0540   X22,   TWSTJ
0 4563   4645   SUMLI, SUML
0 4564   1455          SIZ  CLR 0
0 4565   1604          INC  K
0 4566   1374          EXJK
0 4567   4602          ADJ@ SUMHI
0 4570   0540   X24,   TWSTJ
0 4571   4646   SUMHI, SUMH
0 4572   1302          LJKFRS            /HIGHEST POINT?- RESTORE JK
0 4573   1450          CLR  0            /(J=HIGH ORDER,K= LOW)
0 4574   0410          TWSBK
0 4575   4647   HPTLI, HPTL
0 4576   1455          SIZ  CLR 0
0 4577   2301          SUBL 01
0 4600   4050          SBJ  HPTH
0 4601   1455          SIZ  CLR 0        /POSITIVE RESULT?
0 4602   6142          JMP  PRPT4        /NO- DO NEXT POINT
0 4603   1302          LJKFRS            /YES- REPLACE OLD VALUE WITH NEW
0 4604   5444   X13,   STJ  HPTH
0 4605   0550          TWSTK
0 4606   4647          HPTL
0 4607   5140          LDJ  DATP+1       /AND UPDATE ADDRESS
0 4610   5446          STJ  PADD
0 4611   5143          LDJ  DATP
0 4612   5445          STJ  PADD+1
0 4613   6153          JMP  PRPT4        /DO NEXT POINT

0 4614   1302   PRPT3, LJKFRS            /RESTORE JK
0 4615   0550          TWSTK             /AND STORE IN IAC
0 4616   2505          LORD
```

```
0  4617  0540          TWSTJ
0  4620  2506          HORD
0  4621  0640   X28,   TWJPS              /CALCULATE BACKGROUND
0  4622  2441          IM
0  4623  4560          IADD FPNT
0  4624  6637          IDIV@ IN2I1
0  4625  7024          IMUL IWID
0  4626  5433          ISTR BGND          /STORE BACKGROUND
0  4627  5016          ILOD SUML          /GET GROSS COUNTS
0  4630  4031          ISUB BGND          /AND CALCULATE NFT
0  4631  5422          ISTR NTOT          /STORE NET COUNTS
0  4632  5024          ILOD PADD          /CONVERT ADDRESS OF HIGHEST
0  4633  4225          ISUB@ SPNTI        /POINT TO CHANNEL NUMBER
0  4634  6627          IDIV@ IN2I1
0  4635  5421          ISTR PADD
0  4636  0000          IEXT
0  4637  0640          TWJPS              /CONVERT CHANNEL NUMBER TO ENERGY
0  4640  4723          PECA
0  4641  4656          PADD
0  4642  0620
0  4643  4470   [RETURN CALC

0  4644  1656   II1I,   II1     /POINTER TO DOUBLE PRECISION CONSTANT IN 41-106
0  4645  0000   SUML,   0       /GROSS TOTAL UNDER PEAK
0  4646  0000   SUMH,   0
0  4647  0000   HPTL,   0       /VALUE OF HIGHEST POINT ON INTERVAL
0  4650  0000   HPTH,   0
0  4651  0000   IWID,   0       /WIDTH OF INTERVAL
0  4652  0000           0000    /HIGH ORDER MUST BE=0
0  4653  0000   NTOT,   0       /NET TOTAL UNDER PEAK(GROSS-BACKGROUND)
0  4654  0000           0
0  4655  4000   LAPR,   LMTB    /MOVING POINTER TO LAST PAIR TO BE PRINTED
0  4656  0000   PADD,   0       /ADDRESS OF HIGHEST POINT IN INTERVAL
0  4657  0000           0       /CONVERTED TO ENERGY BEFORE PRINTING
0  4660  4416   SPNTI,  SPNT
0  4661  0000   BGND,   0       /BACKGROUND COUNTS IN INTERVAL
0  4662  0000           0

/E3123
```

```
0 4663  1642  IN2I1,  IN2
```

/PRINT REPORT FOR CURRENT MARKERS ONLY

```
0 4664  0000  PRCM,   0
0 4665  0640  X26,    TWJPS
0 4666  2403          UNPACK
0 4667  5627          CRLF
0 4670  6417          JPS   SSTC        /INITIALIZE "SPNT"
0 4671  1510          CLR   J           /SET PAIR NUMBER≠0 TO INDICATE
0 4672  0540          TWSTJ             /MARKERS
0 4673  4355          LMPR
0 4674  0500  X27,    TWLDJ
0 4675  4360          MGCLI
0 4676  2204          ADDL  04          /INITIALIZE END POINTER TO
0 4677  0540          TWSTJ             /END OF CURRENT MARKERS BUFFER
0 4700  4655          LAPR              /AS USED IN 41+1060
0 4701  2304          SUBL  04          /RESTORE J
0 4702  0640  X20,    TWJPS             /PERFORM CALCULATIONS AND PRINT REPORT
0 4703  4427          POPR
0 4704  6320          [RETURN PRCM
```

```
0 4705  1640  GSCI,   GSC
0 4706  0504  CTWLD,  TWLDJ FO
```

/INITIALIZE "SPNT" WITH STARTING ADDRESS OF BEGINNING
/OF CURRENTLY DISPLAYED GROUP

```
0 4707  0000  SSTC,   0
0 4710  7167  X29,    XCT   X28        /<JPS IM>
0 4711  5304          ILOD@ GSCI
0 4712  7327          IMUL@ IN2I1
0 4713  0000          IEXT
0 4714  0450          TWADK
0 4715  4706          CTWLD
0 4716  0550          TWSTK
0 4717  4417          SPNT+1
0 4720  0540          TWSTJ
0 4721  4416          SPNT
0 4722  6313          [RETURN SSTC
```

/CALCULATE ENERGY FROM CALIBRATION COEFFICIENTS: "BN,BD" AND "ACON"
/WHICH ARE SET UP BY "ECOF."
/REPLACES CHANNEL NO. (DOUBLE PRECISION INTEGER) POINTED
/TO BY CALL+1 WITH ENERGY
/RETURNS TO CALL+2

```
0 4723  0000  PECA,   0
0 4724  5301          LDJ@ PECA
0 4725  3502          ISZ  PECA
```

```
0 4726  5411          STJ   PNTR1
0 4727  7117          XCT   X29        /<JPS IM>
0 4730  5207          ILOD* PNTR1
0 4731  7037          IMUL  BN
0 4732  6440          IDIV  BD
0 4733  4433          IADD  ACON
0 4734  5603          ISTR* PNTR1
0 4735  0000          IEXT
0 4736  6313   [RETURN PECA

0 4737  0000   PNTR1,  0
```

/MANUAL PRINT REPORT

```
0 4740  0000   MPRR,   0
0 4741  7154          XCT   X26        /<JPS UNPACK>
0 4742  5572          PRMM
0 4743  6534          JPS   SSTC       /INITIALIZE "SPNT"
0 4744  0640          TWJPS            /GET LIMIT PAIR NO.
0 4745  4200          IPSP
0 4746  1400          IDLE             /LAST PAIR ENTERED IS LARGEST LEGAL PAI
0 4747  6025          JMP   MPRR1
0 4750  7163          XCT   X26        /<JPS UNPACK>
0 4751  5575          HDNG
0 4752  7165   X32,    XCT   X26        /<JPS UNPACK>
0 4753  5613          SHDG
0 4754  0500          TWLDJ
0 4755  4357          LLMA
0 4756  0540   MPRR2,  TWSTJ
0 4757  4655          LAPR
0 4760  7106          XCT   X32        /<JPS UNPACK>
0 4761  5627          CRLF
0 4762  0500          TWLDJ
0 4763  4324          LMPP
0 4764  7162          XCT   X20        /<JPS POPR>
0 4765  6325   [RETURN MPRR

0 4766  0000   ACON,   0          /CALIBRATION CONSTANT
0 4767  0000          0
0 4770  0000   BN,     0          /CALIBRATION COEFFICIENT NUMERATOR
0 4771  0000          0
0 4772  0000   BD,     0          /CALIBRATION COEFFICIENT DENOMINATOR
0 4773  0000          0

0 4774  0500   MPRR1,  TWLDJ
0 4775  4324          LMPP
0 4776  2204          ADDL  04
0 4777  6121          JMP   MPRR2
```

/UPDATE STATUS DISPLAY OF PEAK PARAMETERS BETWEEN

/CURRENT MARKERS

```
0 5000   0000   MSTD,    0
0 5001   6572            JPS    SSTC
0 5002   0500   X12,     TWLDJ
0 5003   4360            MGCLI
0 5004   0540            TWSTJ
0 5005   4423            LMTP
0 5006   0640            TWJPS
0 5007   4470            CALC
0 5010   6310   [RETURN MSTD
```

/CALCULATE ENERGY CALIBRATION COEFFICIENTS

```
0 5011   0000   ECOF,    0
0 5012   7140            XCT    X32          /<JPS UNPACK>
0 5013   5630            ENCF
0 5014   0640   X31,     TWJPS               /GET "X1"
0 5015   2140            INEC
0 5016   5073            X1
0 5017   7145            XCT    X32          /<JPS UNPACK>
0 5020   5643            EM1
0 5021   7105            XCT    X31          /<JPS INEC>GET "Y1"
0 5022   5077            Y1
0 5023   7151            XCT    X32          /<JPS UNPACK>
0 5024   5647            PM1
0 5025   7111            XCT    X31          /<JPS INEC>GET "X2"
0 5026   5075            X2
0 5027   7155            XCT    X32          /<JPS UNPACK>
0 5030   5652            EM2
0 5031   7115            XCT    X31          /<JPS INEC>GET "Y2"
0 5032   5101            Y2
0 5033   7161   X11,     XCT    X32          /<JPS UNPACK>
0 5034   5656            OUT1
0 5035   0640   X09,     TWJPS
0 5036   2441            IM
0 5037   5036            ILOD   X2           /CALCULATE DENOMINATOR OF CALIBRA-
0 5040   4033            ISUB   X1           /TION COEFFICIENT
0 5041   5547            ISTR   BD
0 5042   5037            ILOD   Y2           /CALCULATE NUMERATOR OF CALIBRA-
0 5043   4034            ISUB   Y1           /TION COEFFICIENT
0 5044   5554            ISTR   BN
0 5045   6553            IDIV   BD           /PRINT CALIBRATION COEFFICIENT(SLOPE)
0 5046   3400            IOUT                /(A IN ENERGY=A*CHANNEL+B)
0 5047   0000            IEXT
0 5050   7115            XCT    X11          /<JPS UNPACK>
0 5051   0003            TTY
0 5052   7115            XCT    X09          /<JPS IM>
0 5053   5163            ILOD   BN
0 5054   7017            IMUL   X1
```

```
0  5055   6563            IDIV  BD
0  5056   6000            INEG              /CALCULATE CALIBRATION CONSTANT
0  5057   4420            IADD  Y1
0  5060   5572            ISTR  ACON
0  5061   0000            IEXT
0  5062   7127            XCT   X11         /<JPS UNPACK>
0  5063   5660            OUT2
0  5064   0340            TWISZ
0  5065   2106            ECHOF
0  5066   7152            XCT   X31         /<JPS INEC>
0  5067   2505            LORD
0  5070   7135            XCT   X11         /<JPS UNPACK>
0  5071   5665            OUT3
0  5072   6361   [RETURN  ECOF

0  5073   0000   X1,      0                /FIRST CHANNEL VALUE
0  5074   0000            0
0  5075   0000   X2,      0                /SECOND CHANNEL VALUE
0  5076   0000            0
0  5077   0000   Y1,      0                /FIRST ENERGY VALUE(TO CORRESPOND TO
0  5100   0000            0                /CHANNEL VALUE "X1")
0  5101   0000   Y2,      0                /SECOND CHANNEL VALUE(TO CORRESPOND TO
0  5102   0000            0                /CHANNEL VALUE "X2")

/E2707
```

/CHECK FOR PRESET COUNTS

```
0 5103   0000   PSCN,    0
0 5104   0500            TWLDJ           /LAST CHAR
0 5105   2320            CHARX
0 5106   2410            SMJ   P121      /Q ?
0 5107   1442            SKIP
0 5110   7030            XCT   X33       /NO -ERROR
0 5111   7156            XCT   X11       /<JPS UNPACK>
0 5112   5707            SPCM
0 5113  <7177            XCT   X31       /<JPS INEC>
0 5114   5317            PSCL
0 5115   6312           [RETURN PSCN

0 5116   0121   P121,   121
```

/INITIATE "RCNT"(MODIFICATION OF "ACQUIRE" COMMAND)

```
0 5117   5050   SRCT,    LDJ   C144
0 5120   5446            STJ   RCNT
0 5121   0500            TWLDJ           /SAVE CURRENT MARKER LOCATIONS
0 5122   1266   MGCLI1,  MGCL
0 5123   5437            STJ   LMKR
0 5124   0500            TWLDJ
0 5125   1270   MGCRI,   MGCR
0 5126   5435            STJ   RMKR
0 5127   0600            TWJMP
0 5130   2062            AQEXIT+1
```

/DISPLAY LIMIT PAIR (SET MARKERS= LIMIT PAIR)

```
0 5131   0000   DLMP,    0
0 5132  <7177            XCT   X11       /<JPS UNPACK>
0 5133   5675            DMES
0 5134   0640            TWJPS           /GET PAIR NO.
0 5135   4200            IPSP
0 5136   1400            IDLE            /DO NOT ALLOW LAST PAIR+1
0 5137   6003            JMP   DLMP1
0 5140   0640   X33,     TWJPS           /"ALL" SPECIFICATION NOT ALLOWED
0 5141   2120            ERROR

0 5142   5120   DLMP1,   LDJ MGCLI1      /SET UP POINTER TO BEGINNING
0 5143   5407            STJ   PNTR2     /OF MARKER BUFFER
0 5144   1510            CLR   J
0 5145   2204            ADDL  04
0 5146   5417            STJ   CNTR2
0 5147   0520   DLMP2,   TWLDJ@
0 5150   4324   LMPPI,   LMPP
0 5151   0540            TWSTJ
0 5152   0000   PNTR2,   0
```

```
0 5153  3501            ISZ   PNTR2
0 5154  3704            ISZ⏀ LMPPI
0 5155  3010            DSZ   CNTR2
0 5156  6107            JMP   DLMP2
0 5157  0640            TWJPS           /UPDATE STATUS FOR NEW MARKER VALUES
0 5160  5000            MSTD
0 5161  6330    [RETURN DLMP
```

/RATE CALCULATION -PART OF BACKGROUND DISPLAY DURING ACQ

```
0 5162   0000   LMKR,    0              /MARKER LOC AT START OF ACQ
0 5163   0000   RMKR,    0
0 5164   0000   CNTR1,   0
0 5165   0000   CNTR2,   0
0 5166   0000   RCNT,    0              /CLOCK COUNTER FOR RATE DETERMINATION
0 5167   0144   C144,    0144
0 5170   0140   CX140,   140
0 5171   0362   RTRNI,   RETRN
0 5172   2025   AQOFFI,  AQOFF
```

/CALCULATE RATE OF ACQUISITION FOR 1-SECOND INTERVALS
/(MODIFICATION OF CLOCK SERVICE)

```
0 5173   0340   CDTR,    TWISZ          /INCREMENT CLOCK COUNTER
0 5174   2100            CLOCK1
0 5175   6012            JMP  CDTR2
0 5176   0340            TWISZ
0 5177   2101            CLOCK1+1
0 5200   6007            JMP  CDTR2
0 5201   0500            TWLDJ          /CLOCK EXPIRED -DID USER SET A TIME?
0 5202   2076            TIME
0 5203   0510            TWLDK
0 5204   2077            TIME+1
0 5205   1705            SIZ  JK
0 5206   6314            JMP# AQOFFI     /YES- CLOCK EXPIRED- STOP ACQUISITION
0 5207   3121   CDTR2,   DSZ  RCNT       /NO SET TIME- 10 SECONDS ELAPSED?
0 5210   6317   X14,     JMP# RTRNI      /NO
0 5211   5122            LDJ  C144       /YES- RE-INITIALIZE COUNTER
0 5212   5524            STJ  RCNT
0 5213   5131            LDJ  LMKR       /SET-UP POINTERS
0 5214   1610            CLR  K
0 5215   2301            SUBL 01
0 5216   1341            SFTZ 01 JK
0 5217   0440            TWADJ
0 5220   0156            GROUPZ
0 5221   5422            STJ  RPNT+1
0 5222   1374            EXJK
0 5223   0440            TWADJ
0 5224   0157            GROUPZ+1
0 5225   4535            ADJ  CX140
0 5226   5414            STJ  RPNT
0 5227   5144            LDJ  RMKR       /CALCULATE POINT COUNTER
0 5230   4146            SBJ  LMKR
0 5231   2201            ADDL 01
0 5232   5546            STJ  CNTR1
0 5233   5060            LDJ  TSML       /SAVE LAST TOTAL
0 5234   5461            STJ  OSML
0 5235   5057            LDJ  TSMH
```

```
0  5236   5460         STJ    OSMH
0  5237   1510         CLR    J
0  5240   5453         STJ    TSML          /CLEAR SUM
0  5241   5453         STJ    TSMH
                CDTR1        ..
0  5242   0505   RPNT,  TWLDJ  F1
0  5243   0000         0
0  5244   1450         CLR    O
0  5245   4446         ADJ    TSML
0  5246   5445         STJ    TSML
0  5247   3504         ISZ    RPNT+1
0  5250   7106         XCT    RPNT          /<LDJ FX "RPNT+1">
0  5251   1455         SIZ    CLR O
0  5252   1504         INC    J
0  5253   4441         ADJ    TSMH
0  5254   5440         STJ    TSMH
0  5255   3512         ISZ    RPNT+1
0  5256   1442         SKIP
0  5257   3515         ISZ    RPNT
0  5260  <3174         DSZ    CNTR1         /LAST POINT IN INTERVAL?
0  5261   6117         JMP    CDTR1         /NO
0  5262   1450         CLR    O             /CALCULATE DIFFERENCE BETWEEN
0  5263   5030         LDJ    TSML          /LAST AND LATEST TOTALS WHICH IS
0  5264   4031         SBJ    OSML          /*RATE PER SECOND
0  5265   5430         STJ    OSML
0  5266   5026         LDJ    TSMH
0  5267   1455         SIZ    CLR O
0  5270   2301         SUBL   01
0  5271   4025         SBJ    OSMH
0  5272   5424         STJ    OSMH
0  5273   5024         LDJ    PSCL          /PRESET COUNT ?
0  5274   0510         TWLDK
0  5275   5320         PSCH
0  5276   1705         SIZ    JK
0  5277   6002         JMP    CDTR4         /YES
0  5300   7170         XCT    X14           /<JMP RETRN>

0  5301   4012   CDTR4,  SBJ    TSML          /PRESET COUNT EXCEEDED ?
0  5302   1374         EXJK
0  5303   1455         SIZ    CLR O
0  5304   2301         SUBL   01
0  5305   4007         SBJ    TSMH
0  5306   1455         SIZ    CLR O
0  5307   6203         JMP@   AQOFI         /YES
0  5310   0600         TWJMP                /NO
0  5311   0362         RETRN

0  5312   2025   AQOFI,  AQOFF
0  5313   0000   TSML,   0                  /TOTAL BETWEEN MARKERS
0  5314   0000   TSMH,   0
```

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```
0  5315   0000   OSML,    0
0  5316   0000   OSMH,    0
0  5317   0000   PSCL,    0                  /PRESET COUNTS
0  5320   0000   PSCH,    0
0  5321   5533   XSTSI,   XSTS-1
0  5322   5555   XATNI,   XATN-1
0  5323   0145   CX145,   0145

0  5324   0000   RMDP,    0                  /RESTORE NORMAL MARKER DISPLAY
0  5325   5104            LDJ  XSTSI         /RESTORE X-RAY STATUS DISPLAY
0  5326   5625            STJ@ LDF4I
0  5327   5626            STJ@ STATXI
0  5330   0500            TWLDJ
0  5331   4360            MGCLI
0  5332   5661            STJ@ MGCLPI
0  5333   0500            TWLDJ
0  5334   5125            MGCRI
0  5335   5661            STJ@ MGCRPI
0  5336   5004            LDJ  MGCCI
0  5337   5662            STJ@ MGCCPI
0  5340   0600            TWJMP
0  5341   0230            DECODE+1
```

/E2763

```
0  5342   1525   MGCCI,   MGCC
0  5343   0113   C113,    0113
0  5344   0114   C114,    0114
0  5345   2120   ERRI1,   ERROR
0  5346   0000   ATNO,    0
0  5347   0000            0
```

/DISPLAY PRINCIPAL ENERGY MARKERS

```
0  5350   0000   DENR,    0
0  5351   5127            LDJ   XATNI        /RESET X-RAY STATUS DISPLAY
0  5352   0540            TWSTJ              /FOR ATOMIC NUMBER
0  5353   2256   LDF4I,   LDF+4
0  5354   0540            TWSTJ
0  5355   1041   STATXI,  STATX
0  5356   0640            TWJPS
0  5357   2403            UNPACK
0  5360   5701            ATNM
0  5361   0640            TWJPS              /GET ATOMIC NO.
0  5362   2140            INEC
0  5363   5346            ATNO
0  5364   5116            LDJ   ATNO
0  5365   1501            SNZ   J            /ZERO?
0  5366   6721            JPS@  ERRI1        /YES
0  5367   1450            CLR   0            /NO- GREATER THAN 100(10) ?
0  5370   4145            SBJ   CX145
0  5371   1451            SNZ   CLR 0
0  5372   6725            JPS@  ERRI1        /YES
0  5373   4550            ADJ   CX145        /NO RESTORE J
0  5374   5472            STJ   CNTR3
0  5375   0500   DENR5,   TWLDJ              /INPUT TERMINATED WITH "K" OR "L"?
0  5376   2320            CHARX
0  5377   2534            SMJ   C113
0  5400  >6076            JMP   DENR6        /YES- "K"
0  5401   2535            SMJ   C114
0  5402   6004            JMP   DENR7        /YES- "L"
0  5403   0640            TWJPS              /NO- WAIT FOR CHARACTER FROM KEYBOARD
0  5404   0245            FCHAR
0  5405   6110            JMP   DENR5        /GO CHECK IT
0  5406   5066   DENR7,   LDJ   BLTB
0  5407   6414            JPS   GMKR
0  5410   0003            0003
0  5411   5064   DENR4,   LDJ   MKR1I        /REDIRECT MARKER DISPLAY
0  5412   0540            TWSTJ
0  5413   1513   MGCLPI,  MGCLP
0  5414   2202            ADDL  02
0  5415   0540            TWSTJ
0  5416   1514   MGCRPI,  MGCRP
0  5417   2202            ADDL  02
0  5420   0540            TWSTJ
```

```
0 5421  1515  MGCCPI, MGCCP
0 5422  6352    [RETURN DENR


/GET MARKERS LOCATIONS FROM TABLE
/ENTER WITH POINTER TO BEGINNING OF TABLE IN "J" AND
/NUMBER OF MARKER LOCATIONS TO BE RETREIVED IN CALL+1
/RETURN TO CALL+2

0 5423  0000  GMKR,   0
0 5424  5464          STJ   ETLP
0 5425  5050          LDJ   MKR1I         /SET UP POINTER TO MARKER DISPLAY
0 5426  5437          STJ   PNTR9         /BUFFER
0 5427  5062          LDJ   ENR1I         /AND ENERGY BUFFER
0 5430  5434          STJ   PNTR8
0 5431  5306          LDJ@  GMKR          /SET UP MARKER COUNTER
0 5432  5455          STJ   CNTR4
0 5433  3510          ISZ   GMKR
0 5434  3032  GMKR1,  DSZ   CNTR3
0 5435  6032          JMP   GMKR2
0 5436  5252  GMKR9,  LDJ@  ETLP          /TRANSFER TO DISPLAY AREA
0 5437  3451          ISZ   ETLP
0 5440  5455          STJ   ITMP1
0 5441  5247          LDJ@  ETLP
0 5442  3446          ISZ   ETLP
0 5443  5453          STJ   ITMP1+1
0 5444  0640          TWJPS               /CALCULATE CHANNEL
0 5445  2441          IM
0 5446  5047          ILOD  ITMP1
0 5447  5615          ISTR@ PNTR8
0 5450  4242          ISUB@ ACONI
0 5451  7243          IMUL@ BDI
0 5452  6641          IDIV@ BNI
0 5453  5612          ISTR@ PNTR9
0 5454  0000          IEXT
0 5455  3410          ISZ   PNTR9
0 5456  3407          ISZ   PNTR9
0 5457  3405          ISZ   PNTR8
0 5460  3404          ISZ   PNTR8
0 5461  3026          DSZ   CNTR4         /LAST ONE?
0 5462  6124          JMP   GMKR9         /NO
0 5463  6340    [RETURN GMKR              /YES

0 5464  0000  PNTR8,  0
0 5465  0000  PNTR9,  0
0 5466  0000  CNTR3,  0

0 5467  5021  GMKR2,  LDJ   ETLP          /ADVANCE TABLE POINTER
0 5470  4417          ADJ   CNTR4
0 5471  4416          ADJ   CNTR4
```

```
0 5472   5416          STJ   ETLP
0 5473   6137          JMP   GMKR1

0 5474   6537   BLTB,  LTBB
0 5475   5520   MKR1I, MKR1

0 5476   5021   DENR6, LDJ   BKTB
0 5477   6554          JPS   GMKR      /GET TWO MARKERS
0 5500   0002          0002
0 5501   1510          CLR   J         /CLEAR THIRD MARKER
0 5502   5422          STJ   MKR3
0 5503   5422          STJ   MKR3+1
0 5504   5426          STJ   ENR1+4
0 5505   5426          STJ   ENR1+5
0 5506  ◄6175          JMP   DENR4

0 5507   0000   CNTR4, 0
0 5510   0000   ETLP,  0
0 5511   5526   ENR1I, ENR1
0 5512   4766   ACONI, ACON
0 5513   4770   BNI,   BN
0 5514   4772   BDI,   BD
0 5515   0000   ITMP1, 0
0 5516   0000          0
0 5517   5717   BKTB,  KTBB

0 5520   0000   MKR1,  0         /THESE THREE DOUBLE PRECISION INTEGERS
0 5521   0000          0         /MUST BE STORED SEQUENTIALLY
0 5522   0000   MKR2,  0
0 5523   0000          0
0 5524   0000   MKR3,  0
0 5525   0000          0

0 5526   0000   ENR1,  0
0 5527   0000          0
0 5530   0000          0
0 5531   0000          0
0 5532   0000          0
0 5533   0000          0
```

/E1984

/STATUS DISPLAY LISTS

/ITEMS ARE DISPLAYED FROM RIGHT TO LEFT
/BETWEEN CRLF'S

```
0 5534   1271   XSTS,   MGCR+1   /RIGHT MARKER
0 5535   0075           0075     /DASH
0 5536   1267           MGCL+1   /LEFT MARKER
0 5537   0057           0057     /CRLF
0 5540   4662           BGND+1   /TOTAL BACKGROUND
0 5541   0077           0077     /SLASH
0 5542   4654           NTOT+1   /NET TOTAL ON MARKER INTERVAL
0 5543   0057           0057     /CRLF
0 5544   4657           PADD+1   /PEAK ENERGY
0 5545   7760           7760     /TERMINATOR

0 5546   2101   XCLK,   CLOCK1+1          /TIME REMAINING
0 5547   0077           0077     /SLASH
0 5550   2077           TIME+1   /SET TIME
0 5551   0057           0057     /CRLF
0 5552   5316           OSMH     /COUNTS/SECOND
0 5553   0077           0077     /SLASH
0 5554   5314           TSMH     /TOTAL COUNTS
0 5555   7760           7760     /TERMINATOR

0 5556   5347   XATN,   ATNO+1   /ATOMIC NUMBER
0 5557   0075           0075     /DASH
0 5560   5533           ENR1+5   /FIRST ENERGY
0 5561   0075           0075     /DASH
0 5562   5531           ENR1+3   /SECOND ENERGY
0 5563   0057           0057     /CRLF
0 5564   5527           ENR1+1   /THIRD ENERGY
0 5565   7760           7760     /TERMINATOR
```

/MESSAGE STRINGS

```
0 5566   0075   SPCS,   0075

0 5567   0063   LIMS,   0063     / SET
0 5570   4564           4564
0 5571   0075           0075

0 5572   6251   PRMM,   6251     /RINT
0 5573   5664           5664
0 5574   0075           0075

0 5575   7777   HDNG,   7777
0 5576   5156           5156     /INTERVAL    START    STOP
0 5577   6445           6445
0 5600   6266           6266
```

```
0  5601   4154            4154
0  5602   0000            0000
0  5603   0063            0063
0  5604   6441            6441
0  5605   6264            6264
0  5606   0000            0000
0  5607   0000            0000
0  5610   6364            6364
0  5611   5760            5760
0  5612   7575            7575

0  5613   0000   SHDG,    0000    /    BKGND       NET     PEAK
0  5614   0042            0042
0  5615   5347            5347
0  5616   5644            5644
0  5617   0000            0000
0  5620   0000            0000
0  5621   0056            0056
0  5622   4564            4564
0  5623   0000            0000
0  5624   0000            0000
0  5625   6045            6045
0  5626   4153            4153
0  5627   7775   CRLF,    7775

0  5630   5645   ENCF,    5645    /NERGY CALIBRATE,CRLF
0  5631   6247            6247    /PCH1
0  5632   7100            7100
0  5633   4341            4341
0  5634   5451            5451
0  5635   4262            4262
0  5636   4164            4164
0  5637   4577            4577
0  5640   6043            6043
0  5641   5021            5021
0  5642   7575            7575

0  5643   0000   EM1,     0000    /    E1
0  5644   0000            0000
0  5645   4521            4521
0  5646   7575            7575

0  5647   7760   PM1,     7760    /CRLF,PCH2
0  5650   4350            4350
0  5651   2275            2275

0  5652   0000   EM2,     0000    /    E2
0  5653   0000            0000
0  5654   4522            4522
0  5655   7575            7575
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0  5657    3575             3575

0  5660    0045    OUT2,    0045    / EV/CH,CRLF
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0  5662    4350             4350
0  5663    7742             7742
0  5664    3575             3575

0  5665    0045    OUT3,    0045    / EV
0  5666    6675             6675

0  5667    5156    GLMP,    5156    /INTERVAL NO.
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0  5671    6266             6266
0  5672    4154             4154
0  5673    0056             0056
0  5674    5775             5775

0  5675    5163    DMES,    5163    /IS
0  5676    6054             6054    /PL
0  5677    4171             4171    /AY
0  5700    0075             0075    / ■

0  5701    0041    ATNM,    0041    / A
0  5702    6457             6457    /TO
0  5703    5551             5551    /MI
0  5704    4300             4300    /C
0  5705    5657             5657    /NO
0  5706    1675             1675    /.■

0  5707    0055    SPCM,    0055    /MAXIMUM COUNTS
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0  5712    6555             6555
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/E1454

/K-LINE TABLE

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0	5730	0000		0000	/	3	54
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0	5742	0000		0000	/	5	0
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0	5762	0000		0000	/	9	0
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0	5764	0000		0000	/10		849
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0	5766	0000		0000	/10		0
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0	5770	0000		0000	/11		1041
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0  6050  0001      0001    /23     4949
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0  6052  0001      0001    /23     5427
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0	6064	0001	0001	/26	6400
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0	6067	5415	5415	/27	6925
0	6070	0001	0001	/27	6925
0	6071	6741	6741	/27	7649
0	6072	0001	0001	/27	7649
0	6073	6460	6460	/28	7472
0	6074	0001	0001	/28	7472
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0	6076	0002	0002	/28	8265
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0	6102	0002	0002	/29	8907
0	6103	0667	0667	/30	8631
0	6104	0002	0002	/30	8631
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0	6106	0002	0002	/30	9572
0	6107	2033	2033	/31	9243
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0	6116	0002	0002	/32	10984
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0	6123	5712	5712	/34	11210
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0	6130	0002	0002	/35	11907
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0	6132	0003	0003	/35	13296
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0	6134	0003	0003	/36	12630
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0	6136	0003	0003	/36	14120
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0	6140	0003	0003	/37	13375

0	6141	5173	5173	/37	14971
0	6142	0003	0003	/37	14971
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0	6144	0003	0003	/38	14142
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0	6162	0004	0004	/41	18621
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0	6236	0007	0007	/52	30993
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0	6242	0007	0007	/53	32292
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0	6442	0026	0026	/85	92319
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0	6570	0000		0000	/	5
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0	6716	0000	0000	/19
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0	7024	0000	0000	/31	1096
0	7025	2142	2142	/31	1122
0	7026	0000	0000	/31	1122
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0	7030	0000	0000	/31	1120
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0	7034	0000	0000	/32	1216
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0	7036	0000	0000	/32	1210
0	7037	2402	2402	/33	1282
0	7040	0000	0000	/33	1282
0	7041	2445	2445	/33	1317
0	7042	0000	0000	/33	1317
0	7043	0000	0000	/33	1310
0	7044	0000	0000	/33	1310
0	7045	2543	2543	/34	1379
0	7046	0000	0000	/34	1379
0	7047	2613	2613	/34	1419
0	7050	0000	0000	/34	1419
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0	7062	0000	0000	/36	1587
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0	7064	0000	0000	/36	1638
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0	7066	0000	0000	/36	1630
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0	7101	0000	0000	/38	1870
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0	7124	0000	0000	/41	2462
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0	7126	0000	0000	/42	2293
0	7127	4533	4533	/42	2395
0	7130	0000	0000	/42	2395
0	7131	5077	5077	/42	2623
0	7132	0000	0000	/42	2623
0	7133	4570	4570	/43	2424
0	7134	0000	0000	/43	2424
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0	7143	5173	5173	/44	2683
0	7144	0000	0000	/44	2683
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0 7167   6677          6677    /47    3519
0 7170   0000          0000    /47    3519
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0 7175   7204          7204    /48    3716
0 7176   0000          0000    /48    3716
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0 7200   0000          0000    /49    3287
0 7201   6637          6637    /49    3487
0 7202   0000          0000    /49    3487
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0 7205   6564          6564    /50    3444
0 7206   0000          0000    /50    3444
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0 7220   0001          0001    /51    4347
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0 7236	0001	0001	/54	4111
0 7237	0506	0506	/54	4422
0 7240	0001	0001	/54	4422
0 7241	1654	1654	/54	5036
0 7242	0001	0001	/54	5036
0 7243	0276	0276	/55	4286
0 7244	0001	0001	/55	4286
0 7245	1014	1014	/55	4620
0 7246	0001	0001	/55	4620
0 7247	2240	2240	/55	5280
0 7250	0001	0001	/55	5280
0 7251	0563	0563	/56	4467
0 7252	0001	0001	/56	4467
0 7253	1334	1334	/56	4828
0 7254	0001	0001	/56	4828
0 7255	2633	2633	/56	5531
0 7256	0001	0001	/56	5531
0 7257	1053	1053	/57	4651
0 7260	0001	0001	/57	4651
0 7261	1663	1663	/57	5043
0 7262	0001	0001	/57	5043
0 7263	3235	3235	/57	5789
0 7264	0001	0001	/57	5789
0 7265	1350	1350	/58	4840
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0 7267	2216	2216	/58	5262
0 7270	0001	0001	/58	5262
0 7271	3644	3644	/58	6052
0 7272	0001	0001	/58	6052
0 7273	1652	1652	/59	5034
0 7274	0001	0001	/59	5034
0 7275	2561	2561	/59	5489
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0  7565    1246        1246    /90    12966
0  7566    0003        0003    /90    12966
0  7567    7510        7510    /90    16200
0  7570    0003        0003    /90    16200
0  7571    5041        5041    /90    18977
0  7572    0004        0004    /90    18977
0  7573    1753        1753    /91    13291
0  7574    0003        0003    /91    13291
0  7575    0474        0474    /91    16700
0  7576    0004        0004    /91    16700
0  7577    6147        6147    /91    19559
0  7600    0004        0004    /91    19559
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0	7601	2455	2455	/92	13613
0	7602	0003	0003	/92	13613
0	7603	1502	1502	/92	17218
0	7604	0004	0004	/92	17218
0	7605	7303	7303	/92	20163
0	7606	0004	0004	/92	20163
0	7607	3171	3171	/93	13945
0	7610	0003	0003	/93	13945
0	7611	2514	2514	/93	17740
0	7612	0004	0004	/93	17740
0	7613	0446	0446	/93	20774
0	7614	0005	0005	/93	20774
0	7615	3707	3707	/94	14279
0	7616	0003	0003	/94	14279
0	7617	3546	3546	/94	18278
0	7620	0004	0004	/94	18278
0	7621	1631	1631	/94	21401
0	7622	0005	0005	/94	21401
0	7623	4432	4432	/95	14618
0	7624	0003	0003	/95	14618
0	7625	4615	4615	/95	18829
0	7626	0004	0004	/95	18829
0	7627	3032	3032	/95	22042
0	7630	0005	0005	/95	22042
0	7631	5161	5161	/96	14961
0	7632	0003	0003	/96	14961
0	7633	5701	5701	/96	19393
0	7634	0004	0004	/96	19393
0	7635	4253	4253	/96	22699
0	7636	0005	0005	/96	22699
0	7637	5715	5715	/97	15309
0	7640	0003	0003	/97	15309
0	7641	7003	7003	/97	19971
0	7642	0004	0004	/97	19971
0	7643	5512	5512	/97	23370
0	7644	0005	0005	/97	23370
0	7645	6455	6455	/98	15661
0	7646	0003	0003	/98	15661
0	7647	0122	0122	/98	20562
0	7650	0005	0005	/98	20562
0	7651	6770	6770	/98	24056
0	7652	0005	0005	/98	24056
0	7653	7222	7222	/99	16018
0	7654	0003	0003	/99	16018
0	7655	1256	1256	/99	21166
0	7656	0005	0005	/99	21166
0	7657	0266	0266	/99	24758
0	7660	0006	0006	/99	24758
0	7661	7773	7773	/100	16379
0	7662	0003	0003	/100	16379

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0 7663  2431           2431    /100  21785
0 7664  0005           0005    /100  21785
0 7665  1603           1603    /100  25475
0 7666  0006           0006    /100  25475

/E1873
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SE 3034
ACON      =  4766
ACONI     =  5512
AQEXIT    =  2061
AQOFF     =  2025
AQOFFI    =  5172
AQOFI     =  5312
AQR       =  3061
ATNM      =  5701
ATNO      =  5346
BD        =  4772
BDI       =  5514
BGND      =  4661
BKTB      =  5517
BLMT      =  4354
BLMTI     =  4220
BLTB      =  5474
BN        =  4770
BNI       =  5513
C100      =  4320
C101      =  4240
C113      =  5343
C114      =  5344
C115      =  4364
C140      =  4365
C144      =  5167
CALC      =  4470
CDTR      =  5173
CDTR1     =  5242
CDTR2     =  5207
CDTR4     =  5301
CHARX     =  2320
CLOCK1    =  2100
CNTR      =  2230
CNTR1     =  5164
CNTR2     =  5165
CNTR3     =  5466
CNTR4     =  5507
CNTRI     =  4326
CRLF      =  5627
CTWLD     =  4706
CX140     =  5170
CX145     =  5323
DATP      =  4546
DCNT      =  4545
DECODE    =  0227
DENR      =  5350
DENR4     =  5411
DENR5     =  5375
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DENR6    = 5476
DENR7    = 5406
DLMP     = 5131
DLMP1    = 5142
DLMP2    = 5147
DMES     = 5675
DUBINT   = 2441
ECHOF    = 2106
ECOF     = 5011
ELMT     = 4317
EM1      = 5643
EM2      = 5652
ENCF     = 5630
ENR1     = 5526
ENR1I    = 5511
ERRI1    = 5345
ERROR    = UNUSED
ERRORI   = 4241
ETLP     = 5510
FCHAR    = 0245
FPNT     = 4543
GLIM     = 4321
GLIM1    = 4345
GLIM2    = 4342
GLIM4    = 4327
GLMP     = 5667
GMKR     = 5423
GMKR1    = 5434
GMKR2    = 5467
GMKR9    = 5436
GROUPW   = 1664
GROUPZ   = 0156
GSC      = 1640
GSCI     = 4705
HDNG     = 5575
HORD     = 2506
HPTH     = 4650
HPTL     = 4647
HPTLI    = 4575
IADD     = 4400
IDIV     = 6400
IEXT     = 0000
II1      = 1656
II1I     = 4644
ILOD     = 5000
IM       = 2441
IMUL     = 7000
IN2      = 1642
IN2000   = 1644
IN2I     = 4415
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IN2I1    ▪ 4663
INEC     ▪ 2140
INEG     ▪ 6000
INOP     ▪ 7400
IOUT     ▪ 3400
IPSP     ▪ 4200
IPSP1    ▪ 4242
IPSP2    ▪ 4232
IRTRN    ▪ 2105
ISTR     ▪ 5400
ISUB     ▪ 4000
ITMP     ▪ 4362
ITMP1    ▪ 5515
IWID     ▪ 4651
KTBB     ▪ 5717
LAPR     ▪ 4655
LDF      ▪ 2252
LDF4I    ▪ 5353
LDLIST   ▪ 0632
LIMS     ▪ 5567
LLMA     ▪ 4357
LLMAI    ▪ 4224
LMKR     ▪ 5162
LMPP     ▪ 4324
LMPPI    ▪ 5150
LMPR     ▪ 4355
LMPRI    ▪ 4204
LMTB     ▪ 4000
LMTE     ▪ 4200
LMTP     ▪ 4423
LORD     ▪ 2505
LOREAD   ▪ 0264
LTBB     ▪ 6537
MGCC     ▪ 1525
MGCCI    ▪ 5342
MGCCP    ▪ 1515
MGCCPI   ▪ 5421
MGCL     ▪ 1266
MGCLI    ▪ 4360
MGCLI1   ▪ 5122
MGCLP    ▪ 1513
MGCLPI   ▪ 5413
MGCR     ▪ 1270
MGCRI    ▪ 5125
MGCRP    ▪ 1514
MGCRPI   ▪ 5416
MKBP     ▪ 4361
MKR1     ▪ 5520
MKR1I    ▪ 5475
MKR2     ▪ 5522
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MKR3    = 5524
MPRR    = 4740
MPRR1   = 4774
MPRR2   = 4756
MSTD    = 5000
NTOT    = 4653
OLYEXT  = 2074
OSMH    = 5316
OSML    = 5315
OUT1    = 5656
OUT2    = 5660
OUT3    = 5665
P121    = 5116
PADD    = 4656
PECA    = 4723
PLNO    = 4420
PM1     = 5647
PNTR1   = 4737
PNTR2   = 5152
PNTR8   = 5464
PNTR9   = 5465
POPR    = 4427
POPR1   = 4431
POPR2   = 4546
PRCM    = 4664
PRMM    = 5572
PRPT    = 4366
PRPT3   = 4614
PRPT4   = 4540
PSCH    = 5320
PSCL    = 5317
PSCN    = 5103
RCNT    = 5166
RETRN   = 0362
RMDP    = 5324
RMKR    = 5163
RPNT    = 5242
RTRNI   = 5171
SHDG    = 5613
SLIM    = 4247
SLIM1   = 4314
SLIM3   = 4261
SPCM    = 5707
SPCS    = 5566
SPNT    = 4416
SPNTI   = 4660
SRCT    = 5117
SSTC    = 4707
STATX   = 1041
STATXI  = 5355
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SUMH      ■ 4646
SUMHI     ■ 4571
SUML      ■ 4645
SUMLI     ■ 4563
TAB1      ■ 2304
TABLE     ■ 2336
TIME      ■ 2076
TSMH      ■ 5314
TSML      ■ 5313
TTY       ■ 0003
UNPACK    ■ 2403
UNUSED    ■ 2120
X01       ■ 4436
X02       ■ 4376
X03       ■ 4440
X04       ■ 4471
X05       ■ 4205
X06       ■ 4322
X07       ■ 4327
X08       ■ 4301
X09       ■ 5035
X1        ■ 5073
X11       ■ 5033
X12       ■ 5002
X13       ■ 4604
X14       ■ 5210
X2        ■ 5075
X20       ■ 4702
X21       ■ 4265
X22       ■ 4562
X23       ■ 4272
X24       ■ 4570
X25       ■ 4250
X26       ■ 4665
X27       ■ 4674
X28       ■ 4621
X29       ■ 4710
X31       ■ 5014
X32       ■ 4752
X33       ■ 5140
XATN      ■ 5556
XATNI     ■ 5322
XCLK      ■ 5546
XSTS      ■ 5534
XSTSI     ■ 5321
Y1        ■ 5077
Y2        ■ 5101
ER 0000
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APPENDIX A
PRINCIPAL K AND L LINES BY ATOMIC NUMBER

Atomic Number	Element	Energy (eV)				
		K "alpha"	K "beta"	L "alpha"	L "beta"	L "gamma"
1	H	0	0	0	0	0
2	He	0	0	0	0	0
3	Li	54	0	0	0	0
4	Be	109	0	0	0	0
5	B	184	0	0	0	0
6	C	279	0	0	0	0
7	N	393	0	0	0	0
8	O	524	0	0	0	0
9	F	675	0	0	0	0
10	Ne	849	0	0	0	0
11	Na	1041	0	0	0	0
12	Mg	1255	0	0	0	0
13	Al	1487	0	0	0	0
14	Si	1739	1838	0	0	0
15	P	2014	2142	0	0	0
16	S	2307	2468	0	0	0
17	Cl	2622	2817	0	0	0
18	Ar	2957	3191	0	0	0
19	K	3312	3589	0	0	0
20	Ca	3690	4012	341	344	340
21	Sc	4088	4459	395	399	390
22	Ti	4508	4931	452	458	450
23	V	4949	5427	510	519	510
24	Cr	5411	5947	571	581	580
25	Mn	5895	6492	636	647	640
26	Fe	6400	7059	704	717	710
27	Co	6925	7649	775	790	790
28	Ni	7472	8265	849	866	860
29	Cu	8041	8907	928	948	940
30	Zn	8631	9572	1009	1032	1030

Atomic Number	Element	Energy (eV)				
		K "alpha"	K "beta"	L "alpha"	L "beta"	L "gamma"
31	Ga	9243	10263	1096	1122	1120
32	Ge	9876	10984	1186	1216	1210
33	As	10532	11729	1282	1317	1310
34	Se	11210	12501	1379	1419	1410
35	Br	11907	13296	1480	1526	1520
36	Kr	12630	14120	1587	1638	1630
37	Rb	13375	14971	1694	1752	1750
38	Sr	14142	15849	1806	1872	1870
39	Y	14933	16754	1922	2124	2120
40	Zr	15746	17666	2042	2124	2302
41	Nb	16584	18621	2166	2257	2462
42	Mo	17443	19607	2293	2395	2623
43	Tc	18327	20585	2424	2538	2792
44	Ru	19235	21655	2558	2683	2964
45	Rh	20167	22721	2696	2834	3144
46	Pd	21123	23816	2838	2990	3328
47	Ag	22104	24942	2984	3151	5519
48	Cd	23109	26093	3133	3316	3716
49	In	24139	27274	3287	3487	3920
50	Sn	25270	28483	3444	3662	4131
51	Sb	26357	29723	3605	3843	4347
52	Te	27471	30993	3769	4029	4570
53	I	28610	32292	3937	4220	4800
54	Xe	29802	33644	4111	4422	5036
55	Cs	30970	34984	4286	4620	5280
56	Ba	32191	36376	4467	4828	5531
57	La	33440	37799	4651	5043	5789
58	Ce	34717	39255	4840	5262	6052
59	Pr	36023	40746	5034	5489	6322
60	Nd	37359	42269	5230	5722	6602
61	Pm	38649	43945	5431	5956	6891
62	Sm	40124	45400	5636	6206	7180
63	Eu	41529	47027	5846	6456	7478
64	Gd	42983	48718	6059	6714	7788
65	Tb	44470	50391	6275	6979	8104
66	Dy	45985	52178	6495	7249	8418
67	Ho	47528	53934	6720	7528	8748
68	Er	49099	55690	6948	7810	9089
69	Tm	50730	57576	7181	8103	9424
70	Yb	52360	59352	7414	8401	9779
71	Lu	54063	61282	7654	8708	10142
72	Hf	55757	63209	7898	9021	10514
73	Ta	57524	65210	8145	9341	10892

Atomic Number	Element	Energy (eV)				
		K "alpha"	K "beta"	L "alpha"	L "beta"	L "gamma"
74	W	59310	67233	8396	9670	11283
75	Re	61131	69298	8651	10008	11684
76	Os	62991	71404	8910	10354	12094
77	Ir	64886	73549	9173	10706	12509
78	Pt	66820	75736	9441	11069	12939
79	Au	68794	77968	9711	11439	13379
80	Hg	70821	80258	9987	11823	13828
81	Ti	72860	82558	10266	12210	14288
82	Pb	74957	84922	10549	12611	14762
83	Bi	77097	87335	10836	13021	15244
84	Po	79296	89809	11128	13441	15740
85	At	81525	92319	11424	13873	16248
86	Rn	83800	94877	11724	14316	16768
87	Fr	86119	97483	12029	14770	17301
88	Ra	88485	100136	12338	15223	17845
89	Ac	90894	102846	12650	15712	18045
90	Th	93334	105592	12966	16200	18977
91	Pa	95851	108408	13291	16700	19559
92	U	98428	111289	13613	17218	20163
93	Np	101005	114181	13945	17740	20774
94	Pu	103653	117146	14279	18278	21401
95	Am	106351	120163	14618	18829	22042
96	Cm	109098	123235	14961	19393	22699
97	Bk	111896	126362	15309	19971	23370
98	Cf	114745	129544	15661	20562	24056
99	Es	117646	132781	16018	21166	24758
100	Fm	120598	136075	16379	21785	25475