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THE REMOTE WORKING LEVEL MONITOR

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

by

Argonne National Laboratory

with the

U. S. Energy Research and Development Administration

Argonne, Illinois

FINAL REPORT

on

The Remote Working Level Monitor

Contract No. HO 252053

Design and Construction of a Remote Working Level Meter

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THE REMOTE WORKING LEVEL MONITOR

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Sponsoring Organization

Office of the Assistant Director
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Abstract

The Remote Working Level Monitor (RWLM) is an instrument used to remotely monitor the Rn-daughter concentrations and the Working Level (WL). It is an ac powered, microprocessor based instrument which multiplexes two independent detector units to a single central processor unit (CPU). The CPU controls the actuation of the detector units and processes and outputs the data received from these remote detector units. The remote detector units are fully automated and require no manual operation once they are set up. They detect and separate the alpha emitters of RaA and RaC' as well as detecting the beta emitters of RaB and RaC. The resultant pulses from these detected radioisotopes are transmitted to the CPU for processing. The programmed microprocessor performs the mathematical manipulations necessary to output accurate Rn-daughter concentrations and the WL. A special subroutine within the program enables the RWLM to run and output a calibration procedure on command. The data resulting from this request can then be processed in a separate program on most computers capable of BASIC programming. The calibration program results in the derivation of coefficients and beta efficiencies which provides calibrated coefficients and beta efficiencies.

Key Words
Remote Working Level Monitor (RWLM)
Working Level (WL)
Rn-daughter Concentrations

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UNCLASSIFIED

FOREWORD

This report was prepared by Argonne National Laboratory, Electronics Division, 9700 S. Cass Avenue, Argonne, Illinois 60439 under Contract Number HO 252053. The contract was initiated under the Metal and Nonmetal Health and Safety Research Program. It was administered under the technical direction of DMRC with Mr. Robert Droullard acting as the Technical Project Officer. Mr. David Askin was the contract administrator for the Bureau of Mines.

This report is a summary of the work recently completed as part of this contract during the period April 1975 to June 1977. This report was submitted by the authors on June 1977.

Subject Inventions

The design of the filter-advance mechanism was recently submitted to the Chicago Patent Group of the Energy Research and Development Administration for a patent review. The Chicago Patent Group of ERDA will contact the Bureau of Mines regarding the disposition of this patent application in accordance with the contract.

TABLE OF CONTENTS

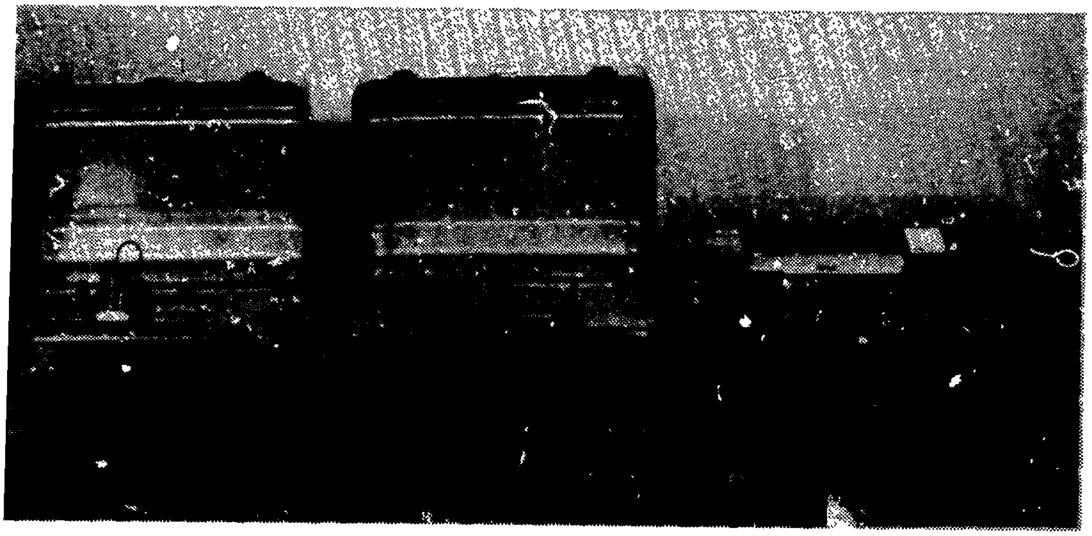

Figure 1 RWLM System

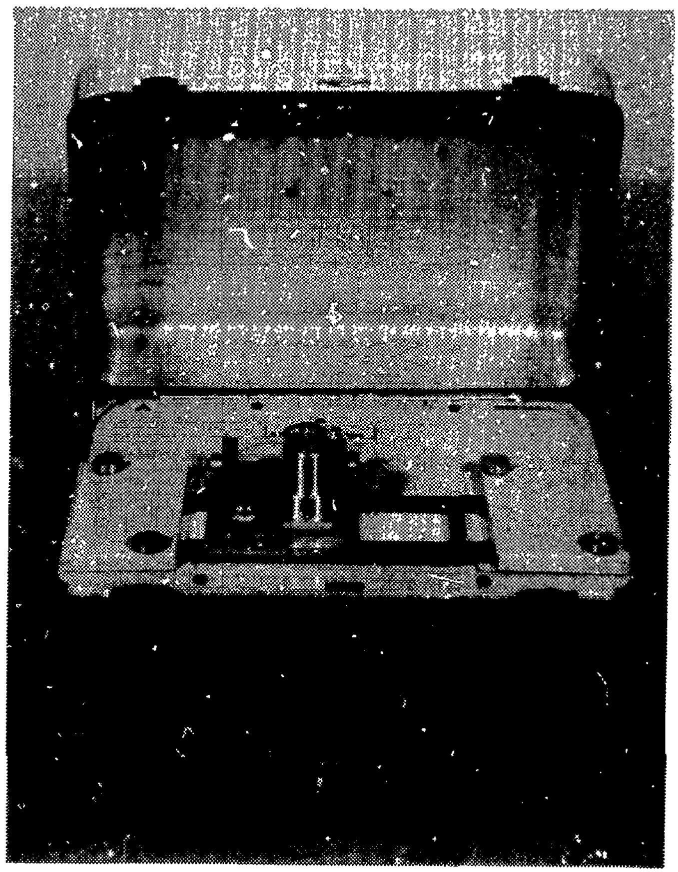

Figure 2 RWLM Detector Unit #1 - Covers in place

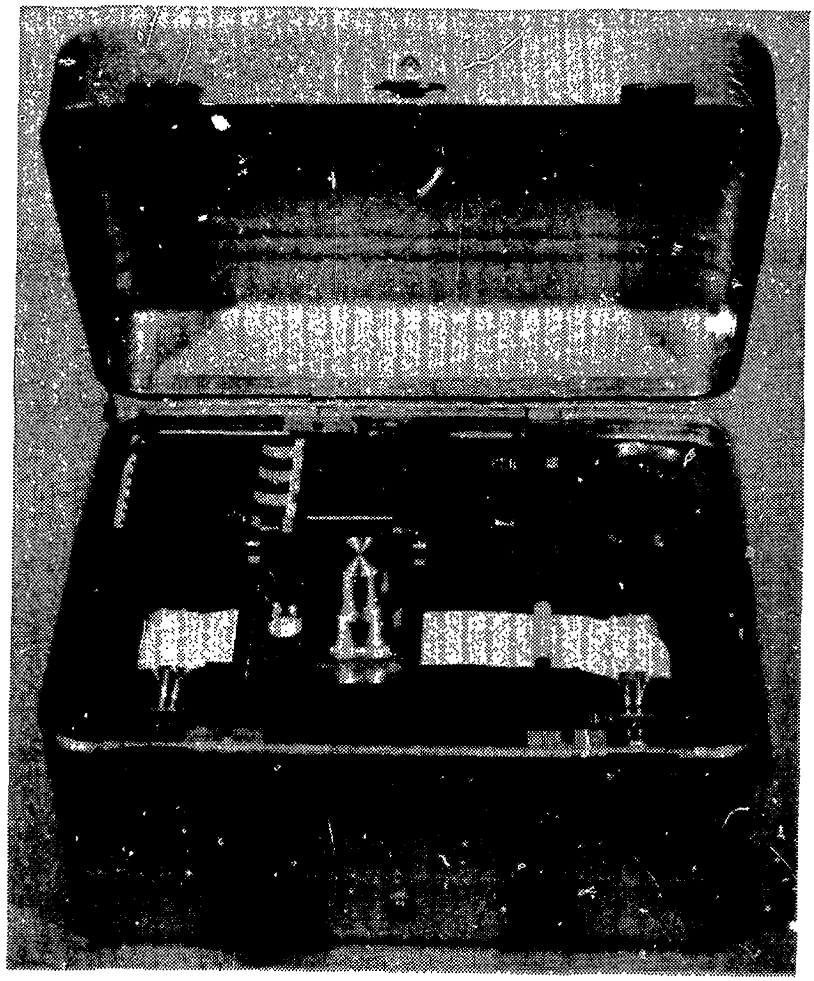

Figure 3 RWLM Detector Unit #2 - Covers removed

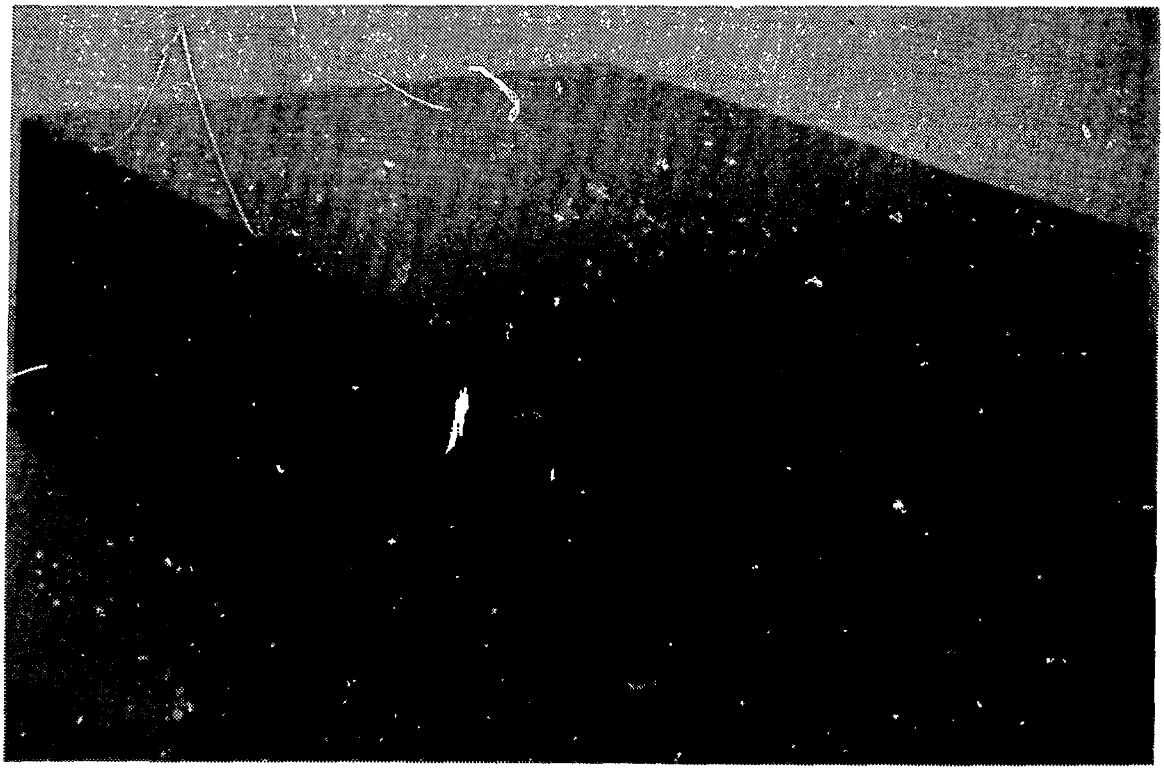

Figure 4 Central Processing Unit (CPU)

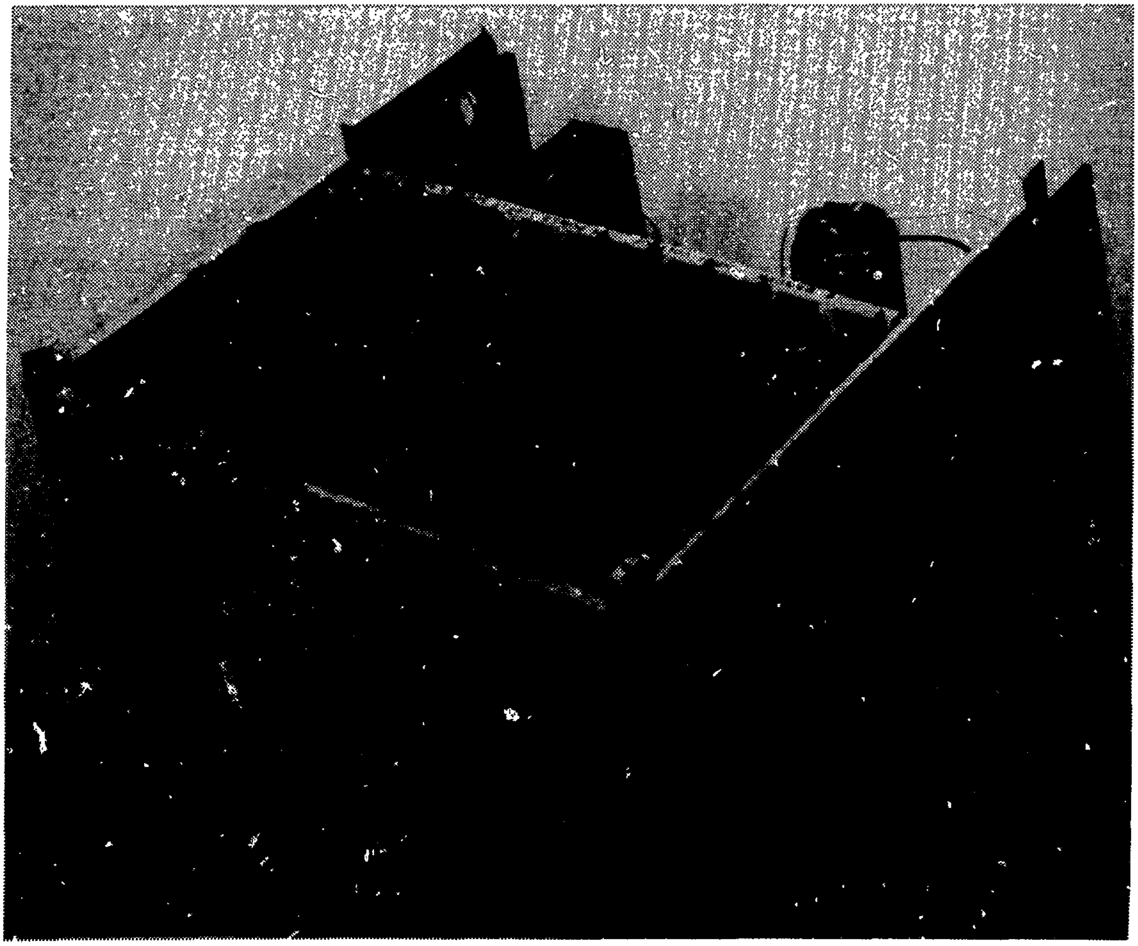

Figure 5 Exposed View of Central Processing Unit (CPU)

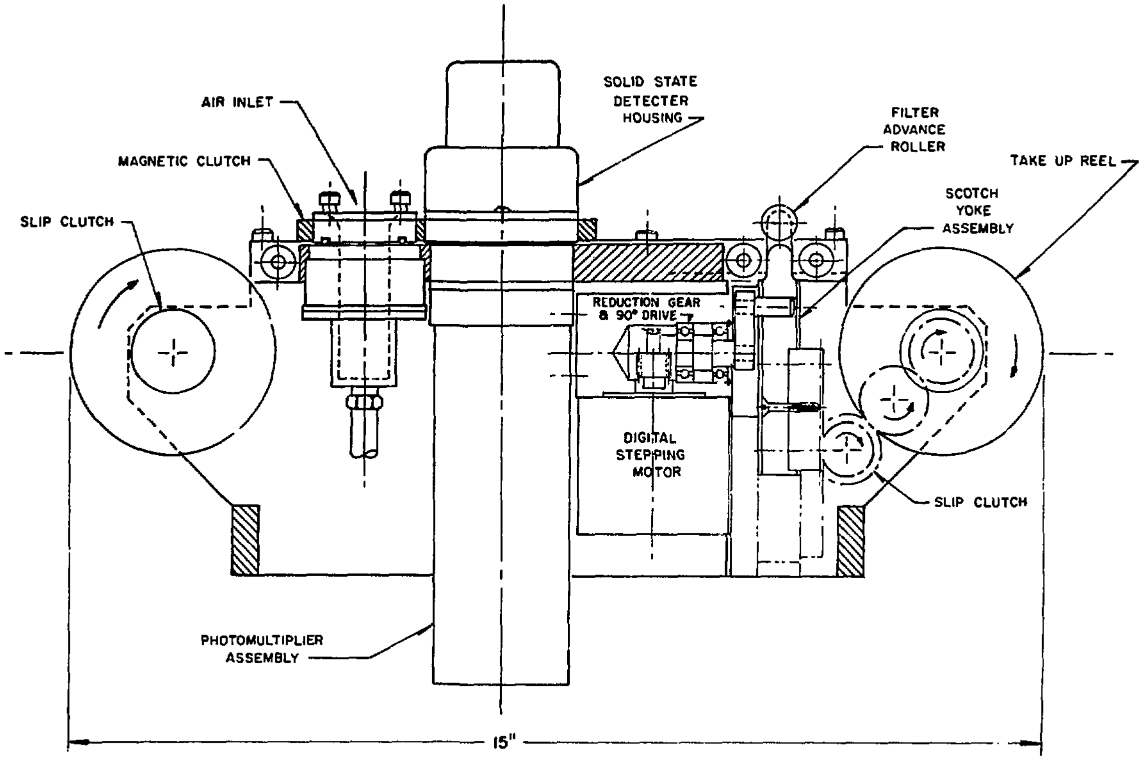

Figure 6 Schematic of Filter Transport Mechanism

1.0 *INTRODUCTION*

The exact methods commonly used to determine Working Level (WL) measure the total alpha activity on a filter membrane during three preselected time periods. Due to the half-lives of the isotopes involved (TRaB = 26.8 min. TRaC = 19.7 min.), these methods require 35 minutes to complete. Methods of measuring WL using the total alpha counts, where the counting time is less than about one RaB half-life after the end of sampling, are unsatisfactory because of statistical problems. In addition, these methods are almost blind to RaB (Pb^{214}) as a consequence of its relatively long half-life and the fact that RaB is a beta emitter. The solution to this dilemma is to measure RaB directly through its beta activity. Since RaB's daughter RaC (Bi^{214}) is also a beta emitter, the two beta spectra have to be separated to obtain RaB. How this is accomplished is described in subsequent sections describing the theory of the Remote Working Level Monitor/Instant Working Level Meter (RWLM/IWLM) and its calibration.

It is important to note that the IWLM, described in the Bureau of Mines Final Report prepared under contract No. HO 122106, and the RWLM described here use the same method to obtain the measurement of the radon-daughter concentrations and the WL. The IWLM is a portable battery-operated instrument which automatically performs the sequence of operations required after initiation of the start button. Its output is displayed visually and must be manually recorded. The RWLM is a multichannel (two channel in this case) totally automatic instrument designed to measure working levels and individual Rn-daughter concentrations and record the data. The RWLM is capable of taking up to 200 samples at operator-selected time intervals. The capability to perform these automatic operations is obtained through the use of a microprocessor as the instrument controller. The microprocessor enables he RWLM to keep real time, provide timing logic for the electronic sequencing necessary for proper operation, perform the necessary mathematical operations, communicate with the outside world through the data terminal, and perform its three different modes of operation. The microprocessor, in addition to performing the circuit logic through the use of software, also provides an automatic operational check of four mechanical functions and a functional check on remote power. It checks for proper operation of the filter positioning, adequate filter supply, release of the solenoid-operated air seal brake and monitors the pump speed within preselected limits. It any one of these parameters are beyond limits or not operational, the computer is flagged, resulting in a vectored interrupt which provides the specific error message to be printed on the data terminal and stops the measurement sequence. A Texas Instrument's Silent 700 data terminal is used for data recording and instrument control.

The instrument is thoroughly described in section 2. Its theory of operation and calibration are described in sections 2 and 4. Test results are tabulated in section 5, and section 6 contains the operating procedures for its three modes of operation. The drawings and computer programs are contained in Appendices A, B, and C.

2.0 THEORY

After taking a background count for two minutes, the RWLM collects an air sample for two minutes onto a filter membrane, moves the filter membrane to a counting station and then counts this air sample for two minutes starting 13 sec after the end of the sampling period. The instrument has three counting channels, the lower-energy alpha channel, the upper-energy alpha channel, and a beta sensitive channel. The RaA counts observed are accumulated in the lower-energy alpha channel; the RaC' counts are stored in the upper-energy alpha channel while the total beta counts from RaB and RaC are recorded in the beta channel. The counts in these three channels are functions of N_A, N_B, N_C, the unknown concentrations of RaA, RaB, and RaC in the ambient air (units are atoms/liter). The following relationships hold:

$$TA = 0.558814\, E_1 V N_A$$

$$B + C = (0.038498E_2 + 0.001793E_3)VN_A + (0.097712E_2 + 0.007473_3)VN_B + 0.130234E_3VN_C$$

$$TC' = (0.001793N_A + 0.007473N_B + 0.130234N_C)E_1V \qquad (1)$$

where:

TA = alpha counts from RaA accumulated during the 2-min counting period starting 13 sec after the end of sampling.

B + C = beta counts from RaB and RaC in beta channel accumulated during the same time interval as above.

TC' = alpha counts from RaC' (same period of accumulation as above).

V = flowrate (liters/min).

E_1 = detection efficiency for RaA and RaC'.

E_2 = detection efficiency for RaB.

E_3 = detection efficiency for RaC.

N_A = RaA concentration in units of atoms/liter.

N_B = RaB concentration in units of atoms/liter.

N_C = RaC concentration in units of atoms/liter.

The numerical coefficients in (1) follow from the laws of radioactive-series decay. The half-lives used are:

Nuclide	Half-life
RaA(^{218}Po)	3.05 min
RaB(^{214}Pb)	26.8 min
RaC(^{214}Bi)	19.7 min

To show the principle of calculation of these numerical coefficients, a sample calculation is given below:

EXAMPLE: Calculate the numerical coefficient for the first of (1).

This coefficient is the product of three factors:

1) Buildup factor = $1 - \exp(-\lambda_A t_B)$

t_B = buildup time = 2 min.

2) Delay factor = $\exp(-\lambda_A D)$

D = Delay before start of the counting interval

= 13 sec or 13/60 min.

3) Decay factor = $\left[1 - \exp(-\lambda_A t_D)\right] / \lambda_A$

t_D = decay time = 2 min.

λ_A = RaA decay constant = 0.2272614.

Multiplying all these factors one obtains:

$$\left[1 - \exp\,(^{-}\lambda_A t_B)\right] \exp\,(^{-}\lambda_A D) \left[1 - \exp\,(^{-}\lambda_A t_D)\right] / \lambda_A = 0.558814.$$

The derivations of the analogous coefficients for the other equations are more complex but easily obtainable by the computer programs given in Appendix C. If all the efficiencies and the flowrate are known, (1) contains only numerical coefficients and the unknowns N_A, N_B, and N_C. Inverting (1) results in another set of equations which give a N_A, N_B, and N_C for every observed set of TA, (B+C), and TC'. The WL can be calculated easily from the resulting N_A, N_B, and N_C.

The RWLM method does not make any assumptions about the equilibrium conditions between the Rn daughters, but does assume that the airborne concentrations N_A, N_B, and N_C remain constant during the sampling period of two minutes. A detailed description of how the efficiencies are obtained and how (1) is inverted is given in section 4.0 and in the computer programs in Appendix C.

3.0 DESCRIPTIONS

The Remote Working Level Monitor (RWLM) consists of two independent detector assemblies, a central processing unit and a data terminal. (See Figs. 1 through 6.)

3.1 The Detector Assembly

Each detector assembly (see Figs. 2 and 3) is housed in a portable aluminum instrument case. This high-density package contains:

1. The mechanical drive mechanisms for the filter-transport assembly.
2. The air pump and its motor-tachometer assembly.
3. The necessary power supplies for the mechanical and electronic subassemblies.
4. The alpha- and beta-detector assemblies.
5. The electronic preamplifiers, discriminators, and single-channel analyzer.
6. The electronic control package.

3.1.1 The mechanical filter-transport assembly (see Fig. 6) advances the filter membrane 2.000 ± 0.005 inches each transport cycle. The sequence of mechanical operation is as follows:

1. The filter paper is advanced two cycles to provide a clean surface for background measurements.
2. The pump draws a sample.
3. The filter paper is advanced again to move the filtered sample to the detectors for counting.

Six inches of filter membrane* are used per measurement. Each sensor has a sufficient filter supply to allow up to 200 samples, either one sample per hour for eight days or any other programmed frequency limited by a total of 200 samples and a 14 min or greater sampling period.

This operation is motor driven, and computer controlled. As shown in Fig. 6, a 5V, bifilar-wound stepping motor** provides 200 steps per revolution. a 5:1-90° drive and reduction gear couples the motor to a "Scotch Yoke" drive assembly. One revolution of this drive assembly will provide one filter-advance cycle and requires 1000 pulses from the stepping motor per cycle.

The filter advance cycle is implemented as follows: The power to the magnetic clutch is turned off, releasing the clutch which is under mechanical spring pressure. Upon activation of pulses to the digital motor, the filter advance roller moves down due to the mechanical conversion of angular to linear motion of the scotch yoke mechanism. This advances the paper from the storage reel. At the 500th pulse the filter advance roller is at its bottom dead center position, which completes the filter advance. At this time, the computer energizes the magnetic clutch,

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*GELMAN ACROPOR AN-800

**Superior Electronics SLO-SYN Model M061-FC02.

braking the filter membrane and preventing further motion of the filter. Due to the action of the slip clutch and the one-way bearing on the take-up reel and its drive, the filter paper is taken up during the last 500 pulses of the motor operation. The four-phase drive signal to the stepping motor is generated by a digital motor-translator circuit explained in section 3.1.6.3.

3.1.2 <u>The Air-Pump and Motor-Tachometer Drive</u>

A GAST rotary-vane vacuum pump, Model 1033, is coupled with a universal self-aligning coupler to a printed circuit motor-tachometer combination, Model U9M4T. The pump-motor system is servo-regulated using tachometer feedback for a constant-speed operation. It is activated under computer control. The interface circuit is described in section 3.1.6.3. The pump speed is adjusted to provide a flowrate of 12 liters per min. The computer-controlled solenoid-operated magnetic clutch assures a tight air seal of the filter against the inlet air port.

3.1.3 <u>Regulated DC Power Supplies</u>

The following regulated DC power supplies are included within each portable detector assembly:

1. An ELEXON Model OLV30-15 (15V @ 3.3 amp) regulated power supply provides power for the air pump motor.

2. An Analog Devices Model PS 933 (±24V @ 50 mA) regulated power supply and a ±12V @ 50 mA regulated supply (drawing EL-C-7171) provide power for the alpha detector and preamp.
3. A Semiconductor Circuits, Model MP 1.5. 750/2.15.100 (±15V @ 100 mA plus +5V @ 750 mA) regulated power supply provides power for the linear circuits and the digital logic.
4. A Semiconductor Circuits, Model DPS 1.5.1500 (+5V @ 1.5 A) regulated power supply provides power for the solenoid.
5. A 5V @ 3 A regulated supply (see drawing EL-C-7171, sheet 7, Appendix B) provides power for the stepping motor.

The AC line power is supplied to the detector assemblies via a power cable from the central processing unit and is independently fused within the detector assembly. Each detector assembly also contains its own power "ON/OFF" switch.

3.1.4 Radiation Detectors

The alpha detector is a silicon-surface barrier detector.* The face of the detector is protected with double-aluminized Mylar (25 gauge). The detector is sensitive to both the 6.00 MeV RaA and the 7.68 MeV RaC' alpha particles.

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*Ortec #CA-29-300-100.

The beta detector is a NE 102 Scintillator optically coupled to a 10-stage, low-noise, high-gain photomultiplier (EMI 9633B). The gamma-background sensitivity has been reduced by a factor of 50 over that of the original MIT IWLM by the provision of an integral lead shield for the beta detector and the use of a thin scintillator (0.003 in).

3.1.5 Detector Preamplifier and Single-Channel Analyzer

The alpha channel utilizes a Canberra preamplifier Model 1406, whose output is further amplified by a dual integrated-circuit amplifier having a gain of 100. This combination nets a charge gain of 20 V/pico-coulomb for the alpha channel. The output of this charge-sensitive amplifier is delivered to a single-channel analyzer which separates the 6.00 MeV RaA energy peaks from the 7.68 MeV RaC' energy peaks. (See Appendix C, drawing EL-C-7171, sheet 12.) These separated energy pulses are routed via line drivers to the appropriate accumulators in the central processing unit (CPU).

The beta channel's preamplifier is contained within the photomultiplier tube, voltage divider and preamplifier housing. The charge gain of this amplifier is fixed at .05 V/pico-coulomb. A regulated high-voltage converter (Venus K30) is used to supply a well regulated voltage to the dynode bias divider to insure the gain stability of the photomultiplier .

A voltage of approximately 1250V was found to be a satisfactory value for the PM tube. At this value the optimum signal-to-noise ratio is obtained. The output pulses from the PM tubes' charge-sensitive amplifier are routed to a low-level discriminator which prevents the counting of noise pulses. The signals that satisfy the discriminator requirements are shaped, routed to a line driver and then to the beta-channel accumulator in the CPU.

3.1.6 The Electronic Control Package

This package contains four printed circuit cards which perform the following functions:

Card 1: Line drivers and opto-isolated line receivers (see drawing EL-C-7171, sheet 10 of Appendix B).

Card 2: Tachometer output window comparator, high-voltage regulator, solenoid driver and the pump-motor speed control (see drawing EL-C-7171, sheet 11 of Appendix B).

Card 3: Slo-Syn motor translator control (see drawing EL-C-7171, sheet 4 of Appendix B).

Card 4: Source check logic control and paper position and paper empty comparators (see drawing EL-C-7171, sheet 9 of Appendix B).

3.1.6.1 Line Drivers and Opto-Isolated Line Receivers

The two detector assemblies and the central processing unit are separated by up to 500 ft of shielded cable. To drive digital pulses, with minimum distortion over this distance, requires line drivers and line receivers. The line drivers are designed to drive a 50 ohm line which is terminated in the characteristic impedance of the cable. Opto-isolators are used to terminate the line, as well as to provide electrical isolation between the three units. This further reduces noise-induced signals and electrically isolates the computer from the detection heads. Signals from the CPU are terminated within the particular detector assembly and the return signal is returned to the CPU ground via the remaining wire of the twisted pair. Signals from the detector assembly are terminated within the CPU and the ground is returned in a similar fashion to the detector assembly.

3.1.6.2 Tachometer Output Window Comparator, High-Voltage Regulator, Solenoid Driver and Pump-Motor Speed Control Circuit

Since the pump speed is approximately proportional to the flowrate, the subject of course to wear the efficiency, pump speed is regulated using a tachometer. (See Appendix B, sheet 6, tachometer vs flowrate graph.) The tachometer voltage is sensed and electrically compared to an upper and lower limit. If the tachometer voltage does not fall within this preselected window, it is sensed as an error by the comparator. The comparator output is monitored by the CPU and an off normal signal causes the error message "FLOWRATE OUT-OF-RANGE" to be types on the terminal. If this occurs, the measurement cycle is aborted and the CPU returns to command loop.

A buffered reference signal is fed to the low-voltage input of a high-voltage DC to DC converter (see drawing EL-C-7171, sheet 11). A temperature compensated zener reference feeds a potentiometer which provides a variable reference for a closed-loop feed-back-buffer amplifer. This amplifier supplies the regulated voltage and current necessary for the regulated high-voltage converter.

This regulated high voltage is used by the beta channel's high-voltage photomultiplier bias string. Regulating this voltage provides a measure of stability in the gain of the photomultiplier.

The solenoid driver provides the necessary current to activate the solenoid-driven clutch.

The circuit itself is basically a current-controlled switch. A provision for a solenoid status check signal is fed back to the computer which checks for this signal at the appropriate times If this flag signal is present when checked, the message "SOLENOID NOT RELEASED" is printed on the terminal and the measurement operation is aborted.

A closed-loop servo-controlled motor-drive circuit is provided to regulate the angular velocity of the pump motor, keeping the pump at a constant regulated speed. Pump activation is computer controlled.

3.1.6.3 Slo-Syn Motor Translator Control

A four phase, 5V, one Amp, step sequence (full-step mode) is required to drive the stepping motor. This four-bit driver code is generated by the translator control card. This circuit operates as follows: A hexi-decimal divider is either counted up or down depending on the motor-rotation direction desired. The binary output of this divider provides a four-bit address to a programmable read-only memory which has the proper motor code stored. The memory outputs provide the current drivers with the proper input code sequence. The chip-enable input of the PROM provides an On/Off switch for these drivers. The motor direction is controlled by either an up or down count, the motor stepping speed is controlled by the pulse-repetition rate to the counter, and power is provided by the PROM chip-enable input. This motor can be driven to a maximum speed of 330 steps/sec of a 3 sec paper-advance cycle.

3.1.6.4 Source Check Paper Position and Paper Empty Logic

In the source-check mode of operation, the discriminator setting for the RaC' energy must be lowered in order to detect the Am^{241} source used in the source check. To accomplish this, a linear switch is automatically actuated by the CPU to provide a lower voltage to the upper-level channel when a C' source check operation is selected. The upper-level discriminator is usually set at approximately 1.3 volts to detect the 7.6 MeV RaC' energy. When a source check mode is entered, this voltage is automatically set to approximately 0.4V.

The paper position and paper empty comparators provide logic signals to the CPU which enable the CPU to check these parameters. To accomplish this, each comparator receives a signal from a light-sensitive detector (Skan-a-matic). These detectors provide their own infrared light source and are able to detect reflected IR energy and provide a current output proportional to the magnitude of IR-reflected light received. The current output is fed through a high-impedance resistor which provides a signal voltage to the comparators where it is compared to a common reference voltage. As long as the light is not reflected, the current switch is turned off. However, when this light source is detected, due to reflection, the current switch is turned on until the paper is exhausted. When the filter feed reel is empty, the light source projects against a black surface causing no reflection. The paper-position detector looks for a white scribe mark etched on one end of the scotch yoke cam drive assembly which appears within the view of the detector only when the filter advance roller is at top dead center.

3.2 Central Processing Unit (CPU)

The RWLM central processing unit consists of a chassis with an integral power unit containing the following:

1) an IMSAI MPU-A-8080 processor board
2) an IMSAI RAM 4-1 random access memory board with 1K of memory.
3) a Cromemco 8K read only memory board
4) a Processor Technology 2KRO -2K read only memory board
5) a Processor Technology 3P+S - serial I/O board
6) a vectored interrupt board
7) a head control and line driver board
8) a line receiver board
9) an accumulator board
10) a front panel substitute board
11) a system bus board
12) a system power supply

The CPU is housed in an IMSAI corporation main frame modified to meet the needs of the RWLM. The modification consists of the addition of system I/O cable connectors and system power connectors.

3.2.1 IMSAI MPU-A Theory of Operation

The IMSAI MPU-A board is structured around the Intel 8080A microprocessor chip, and much of the MPU-A board is wired to support the 8080A device. The MPU-A board provides interfacing between the 8080A chip and the data and address busses, clock and synchronization signals, and the voltage regulation necessary for the 8080A and other chips.

The address lines from the 8080A drive the address bus on the back plane through 8T97 tri-state buffer drivers. These drivers may be disabled through the ADDRESS DISABLE line on pin 22 of the back plane. Intel 8216 bi-directional bus drivers connect the 8080's bi-directional data bus to the back plane's dual uni-directional DATA IN and DATA OUT busses. The direction of data transmission is determined by the DIRECTION ENABLE line. The DIRECTION ENABLE line is in turn controlled by the front panel and the processor status signals DATA BUS IN and HALF ACKNOWLEDGE. The 8216 can be disabled by the DATA OUT DISABLE line on pin 23 of the back plane.

The 8080A's bi-directional data bus is also connected to the data bus socket and the 8212 status byte latch. The data bus socket is used to connect a front panel (not included) to the bi-directional bus, while the 8312 latch transfers the status byte to the back plane via 8T97 drivers. These drivers are disabled by the STATUS DISABLE line on pin 18 of the back plane. The 8212 is latched up by the STATUS STROBE signal of the 8224 clock chip to store the status information for each instruction cycle.

One K pullup resistors to +5 volts are connected to all the bi-directional bus lines to ensure that during the time the bus is not driven, the 8080A reads all 1's.

The 8824 clock ship and crystal oscillator, provide the two-phase non-overlapping 2 megacycle system clock for the 8080A. These clocks are also driven onto the back plane through 8T97 tri-state buffered drivers.

The CLOCK line on the back plane is driven from the TTL Phase II clock line through a delay so that the phase relation of the clock signal to the Phase II and Phase I back plane signals is nearly identical to that produced by the MITS Altair 8800 system. Six sections of a 7404 are used for this delay to provide greater simplicity and higher reliability than a one shot. The 8224 chip also provides the power-on reset function through use of a 4.7K resistor and 33 uF capacitor connected to the reset input of the 8224. The power-on reset is applied to the 8080A and is applied to the POWER ON CLEAR line, pin 99 on the back plane.

The two BACK PLANE READY signals are ANDed and connected to the 8224 for synchronization with the Phase II clock before being connected to the 8080A chip. The INTERRUPT line is connected directly to the 8080A, while the HOLD REQUEST line is synchronized with the Phase II clock and then connected to the 8080A.

The six processor status signals (SYNC WRITE, STROBE DATA BIT IN, READ STROBE, INTERRUPT ENABLED, HOLD ACKNOWLEDGE, and WAIT ACKNOWLEDGE) are all driven onto the back plant through 8T97 tri-state buffered drivers. These drivers may be disabled by the CONTROL DISABLE line, pin 19 on the back plane.

The +% volts is regulated from the +8 volts by a 7805 integrated circuit regulator, while the -5 volts is regulated by a 5-volt zener and a 470 ohm resistor from the 16-volt bus. The +12 volts is regulated by a 12-volt zener and connected to the +16-volt line by two 82 ohm 1/2 watt resistors in parallel. All voltages are filtered with .33 microfarad tantalum and disc ceramic capacitors.

3.2.2 IMSAI RAM 4-1 Theory of Operation

The RAM-4 board has space for 4K bytes of memory which consist of 32 chips of Intel 8111 or 2111 type random access memory organized 456 words x 4 bits wide in each chip. In the RWLM system only 1K bytes are implemented.

These RAM devices are arranged on the board in a 2 x N ($1 \leq N \leq 16$) array, with the top row A containing bits 0,1 2,3 of all the data and Row B containing bits 4,5,6, and 7 of all the data. Read/write and address control is provided by a support network of Gates (C8, C9, C13) and a decoder (C10). Bi-directional tri-state bus drivers (C15, C16) are used to receive and transmit data to and from the IMSAI 8080 System bus.

To begin the Read or Write Cycles, the board must be enabled. As shown in the schematic, the board enable is produced by an 8-input NAND (741LS30 in position C13). Four of the NAND inputs are the jumper selected board address bits (A12, A13, A14, A15 or complements), and the remaining two are the inverted status bits SINP and SOUT. When the board is properly addressed, the NAND output is driven low. The 8205 1-of-8 decoder is then enabled, addressing a particular memory chip pair uniquely determined by the states of A8, A9, A10 and A11.

The 8T97 bus driver (C14) is also driven by the NAND (C13). Also enabled at this time are the 8216 (C15, C16) tri-state bi-directional bus drivers.

The direction of data flow is determined by the 7402 in position C8, which when low selects a data path going from the IMSAI 8080 data bus to the RAM-4 board's data bus. This is made low by either the memory write line from the control panel or the complement of the memory read status signal from the processor. Thus for normal operation, with the machine running, the status signal memory read determines whether these data bus drivers are driving to the IMSAI 8080 data-out bus. When the machine is stopped and the front panel is being used, the direction of data transmission is selected by the memory write pulse from the front panel. When writing from the front panel, a delay is necessary before turning off the data on the memory chips (so that there is time for the memory chips to write on the trailing edge of the write strobe before the data disappears) and this delay is provided by the disc capacitor to ground connected at the output of the inverter at C9 pin 8. In addition to selecting the direction of data flow through the bi-directional data bus drivers, the direction control signal is also inverted and applied to the output disable pin on the 8111's so that during writing the 8111 is receiving data on its bi-directional data pins and not attempting to drive. The write strobe is applied to the 8111's through a 4 section data out DIP switch which enables the programmer to turn off the write pulse for each K for debugging purposes. When the machine is running normally, the write comes from the processor write strobe line (pin 77 on the back plane) and when the front panel is being used, the write strobe line comes from the front panel on the memory write line (pin 60 on the back plane). Two other sections of the 7402 are used to take either one of these write strobes and buffer them to drive the memory chips.

3.2.3 Cromenco 8K Bytesaver Read Only Memory

This board is a read only memory board plug compatible with the standard S-100 microcomputer bus. It has the capacity to hold eight 2708 type UV erasable read only memories.

The board also contains provisions for programming the 2708 type memories; however, the RWLM does not support the software required to perform this function. In the RWLM seven of the eight sockets are used. This broad is addressed at Zero and Stores the main RWLM program.

3.2.4 Processor Technology 2KRO 2K Read Only Memory

This board is a read only memory, socket compatible with the standard S-100 microcomputer bus. It has the capacity to hold eight 1702A type UV erasable read only memories. Each 1702A is capable of holding 256 bytes of program. In the RWLM this board holds the floating point mathematics package and the floating point-PLM transfer routines.

3.2.5 Processor Technology 3P+S Input Output Module

This board is designed to provide the interface between the microcomputer system and the terminal device. In the RWLM this board is wired to implement the standard RS-232C signals required by the TI Silent 700.

The board contains a serial I/O port which links the terminal to the system and a parallel port which is designed to provide I/O status information to the processor. It also contains two parallel I/O ports that are not used by the RWLM.

3.2.6 Vectored Interrupt Board

The vectored interrupt board provides the processor with an eight level priority interrupt capability and a controlled interval clock that can be used to interrupt the processor on a regular basis. In the RWLM a one second interrupt is used to provide the timing information. The program control of the vector interrupt board is performed via output port OFBH. The output of the address select gate (74L30) is ANDed with processor signals PWR and SOUT. These signals are used to latch the lower four bits of data into the 8214 priority interrupt chip. When 8214 is enabled and one of its priority request lines is low, the 8314 INT line is used to strobe an 8212 IC. This causes the 8212's INT flip-flop to be set and requests an interrupt from the processor. When the processor acknowledges the interrupt with an INTA, the 8212 outputs are enabled and this puts the interrupt request address on bits 3, 4, and 5 of the DATA IN bus. The remaining bits of DATA IN are held high. The byte thus formed on the DATA IN lines is a restart instruction with bits 3, 4, and 5 directing the processor to one of eight restart locations.

The clock circuit consists of a set of frequency dividers which count the phase 2 clock pulses. In the RWLM, the one second intervals are selected. The clock interrupt flip-flop is reset by ANDing the RST 7 instruction with the INTA signal. Details of operation on the 8212 and the 8214 can be found in the Intel Data Book.

3.2.7 Head Control on Select Board

The Head control board consists of an I/O address decoder, an 8212 used as an output port latch, and two sets of line drivers. When a command is to be sent to the remote heads an OUT 7 instruction is placed on the bus. This is decoded by the 8205 whose output, along with PWR and SOUT cause the 8212 to latch the output instruction. The output lines of 8212 are then used to select the head and to hold the required information. Bit 0 selects the head to be addressed via a set of 7408 AND gates. When Bit 0 is equal to 0, head one is selected and when Bit 0 is equal to one, head two is selected. Bits 2 and 3 are not used. Bit 4 delivers pulses to the digital motor, Bit 5 turns on the digital motor, Bit 6 activates the solenoid and Bit 7 activates the pump.

3.2.8 Line Receiver Board

The line receiver board consists of a set of opto-isolator line receivers which detect the signals sent by each remote head. Head selection is performed by 72LS158 multiplexers which select either head one or head two using the head select bit from the output port on the Head control board.

This data is placed on the processors data bus whenever an IN 7 instruction is performed. Address decoding is performed on the Head Control Board and signals are bussed to the 8212 on the line receiver board.

3.2.9 The Accumulator Board

In order to count the pulses in each of the detection channels (RaA, Ra(B+C) and RaC'). A seven-decade accumulator has been implemented for each channel. The accumulator section consists of a MC 14518 decade prescaler which holds the least significant decade with a Mostek MK 50395N six decade up/down counter with latch and comparator.

The accumulator board is controlled as output port seven by an 8212 latch. The data is read out of the accumulators onto the data bus by a set of 8212 latches used as input ports, four, five and six. Output port 4's output commands are:

1) $\overline{\text{STOREL}}$ - This strobes the output 8212 and causes Them to hold the data being impressed on their input lines.

2) $\overline{\text{SET}}$ - This resets the multiplexed output of the MK50395N to the most significant digit.

3) SCAN - This strobes the MK50395N output selector to output the next digit.

4) $\overline{\text{CLEAR}}$ - Resets all counters.

5) COUNT ENABLE - opens the count gates and allows the accumulators to collect data.

6) STORES - Enables latch in MK50395N.

The MK50395N is a N-MOS device and requires a VCC of +12 volts; therefore, open collector 7406 devices are used to interface with the output port and the RCA 3081. Seven transistor common emitter IC devices are used to interface with the input port.

3.2.10 Front Panel Replacement Card

In the normal S-100 system, a front panel is used which generates a MWRITE signal. When no front panel is installed, a way of generating this signal must be provided. A single 7400 NAND gate is used to implement the function.

$\text{MWRITE} = \text{PWR} \cdot \overline{\text{SOUT}}$

3.2.11 System Bus

The S100 system bus structure consists of 100 lines. These are arranged 50 on each side of the plug-in board, with pins 1 through 50 on the component side and pins 51 through 100 on the back side.

As the board is viewed right-side up (components up, 100 pin connector towards you) pin #1 is on the left end on the top and pin 51 is on the back side directly opposite pin #1.

Conventions:

SYMBOLS: "P" prefix indicates a processor command or control signal
"S" prefix indicates a processor status signal

LOADING: All inputs to a card should be loaded with a maximum of 1 TTL low power load

LEVELS: All bus signals except the power supply are TTL. All Data and Address lines are positive TRUE (ground = 0 bit)

BUS DEFINITION

Front Side

No.	SYMBOL	NAME	FUNCTION
1	+8V	+8 volts	Unregulated input to 5 V regulators
2	+16V	+16 volts	Positive unregulated voltage
3	XRDY	External Ready	Used by Front Panel: Pulling this line low will cause the processor to enter a WAIT state and allows the status of the normal Ready Line (PRDY) to be examined.

BUS DEFINITION

Front Side

No.	SYMBOL	NAME	FUNCTION
4	V10	Vectored Interrupt Line #0	
5	V11	Vectored Interrupt Line #1	
6	V12	Vectored Interrupt Line #2	
7	V13	Vectored Interrupt Line #3	
8	V14	Vectored Interrupt Line #4	
9	V15	Vectored Interrupt Line #5	
10	V16	Vectored Interrupt Line #6	
11	V17	Vectored Interrupt Line #7	
12	HS	Head Select Bit	
13		SINP·PDBIN for Head Output Port	
14-16	UNUSED		
17		HEAD ADDRESS SELECT	$\overline{\text{I/O SEL}}$
18	$\overline{\text{STATUS DSBL}}$	STATUS DISABLE	Allows the buffers for the 8 status lines to be tristated

BUS DEFINITION

Front Side

No.	SYMBOL	NAME	FUNCTION
19	$\overline{\text{CC DSB}}$	COMMAND CONTROL DISABLE	Allows the buffers for the 6 output c command/ control lines to be tri-stated
20	UNPROT	UNPROTECT	Reserved for input to the memory protect flip-flop on a given memory board
21	SS	SINGLE STEP	Used by Front Panel to disable input buffer while panel drives bidirectional data bus
22	$\overline{\text{ADDR DSBL}}$	ADDRESS DISABLE	Allows the buffers for the 16 address lines to be tri-stated
23	$\overline{\text{DO DSBL}}$	DATA OUT DISABLE	Allows the bidirectional data bus drivers for the 8 data lines to be tri-stated for both input and output data buses
24	Ø2	Phase 2 Clock	
25	Ø1	Phase 1 Clock	
26	PHLDA	Hold Acknowledge	Processor control output signal which appears in response to the HOLD signal;

BUS DEFINITION

Front Side

No.	SYMBOL	NAME	FUNCTION
26(continued)			indicates that the data and address bus will go to the high impedance state on the 8080. Note: ADDR DSBL and DO DSBL must be driven to the tri-state the system bus
27	PWAIT	WAIT	Processor control output signal which acknowleges that the processor is in a WAIT state
28	PINTE	INTERRUPT ENABLE	Processor control output signal indicating interrupts are enabled: may be set or reset by EI and DI instruction and inhibits interrupts from being accepted by the CPU if it is reset
29	A5	Address Line #5	
30	A4	Address Line #4	
31	A3	Address Line #3	
32	A15	Address Line #15	
33	A12	Address Line #12	

BUS DEFINITION

Front Side

No.	SYMBOL	NAME	FUNCTION
34	A9	Address Line #9	
35	DO	Data Out Line #1	
36	DOO	Data Out Line #0	
37	A10	Address Line #10	
38	D04	Data Out Line #4	
39	D05	Data Out Line #5	
40	D06	Data Out Line #6	
41	D12	Data In Line #2	
42	D13	Data In Line #3	
43	D17	Data In Line #7	
44	SM1	M1	Status output signal that indicates that the processor in in the fetch cycle for the first byte of an instruction
45	SOUT	OUT	Status output signal which indicates that the address bus contains the address of an output device and the data bus will contain the output data when $\overline{PWR}$ is active

BUS DEFINITION

Front Side

No.	SYMBOL	NAME	FUNCTION
46	SNIP	INP	Status output signal which indicates that the address bus contains the address of an input device and the input data should be placed on the data bus when PDBIN is active
47	SMEMR	MEMR	Status output signal which indicates that the data bus will be used for memory read data
48	SHLTA	HLTA	Status output signal which acknowledges a HALT instruction
49	$\overline{\text{CLOCK}}$	CLOCK	2 MHz clock signal
50	GND	GROUND	

Back Side

No.	SYMBOL	NAME	FUNCTION
51	-8V	+8 volts	Unregulated input to 5V regulators
52	-16V	-16 volts	Negative unregulated voltage

BUS DEFINITION

Back Side

No.	SYMBOL	NAME	FUNCTION
53	$\overline{\text{SSW DSB}}$	SENSE SWITCH DISABLE	Disables the data input buffers so the input from the sense switches may be strobed onto the bidirectional data bus
54	$\overline{\text{EXT CLR}}$	EXTERNAL CLEAR	Clear signal for I/O devices (front panel switch closure to ground)
55	CGND	CHASSIS GROUND	
56-57	UNUSED		
68	MWRT	MEMORY WRITE	From the Front Panel replacement card indicates that the current data on the Data Out Bus is to be written into the memory location currently on the address bus
69	$\overline{\text{PS}}$	PROTECT STATUS	Reserved to indicate the status of the memory protect flip-flop on the memory board currently addressed
70	PROT	PROTECT	Reserved for input to the memory protect flip-flop on the memory board currently addressed

BUS DEFINITION

Back Side

No.	SYMBOL	NAME	FUNCTION
71	RUN	RUN	Indicates that the RUN/ STOP flip-flop is set to run on the front panel
72	PRDY	READY	Processor command/control input that controls the run state of the processor; if the line is pulled low the processor will enter a wait state until the line is released
73	$\overline{\text{PINT}}$	INTERRUPT REQUEST	The processor recognizes an interrupt request on this line at the end of the current instruction or while halted. If the processor is in the HOLD state or the Interrupt Enable flip-flop is reset, it will not honor the request
74	$\overline{\text{PHOLD}}$	HOLD	Processor command input signal which requests the processor to enter the HOLD state; allows an external device to gain control of address and data buses as soon as the processor

BUS DEFINITION

Back Side

No.	SYMBOL	NAME	FUNCTION
74(continued)			has completed its use of these buses for the current machine cycle
75	$\overline{\text{PRESET}}$	RESET	Processor command input; while activated the content of the program counter is cleared and the instruction register is set to 0
76	PSYNC	SYNC	Processor control output provides a signal to indicate the beginning of each machine cycle
77	$\overline{\text{PWR}}$	WRITE	Processor control output used for memory write or I/O output control; data on the data bus is stable while the $\overline{\text{PWR}}$ is active
78	PDBIN	DATA BUS IN	Processor control output signal indicates to external circuits that the data bus is in the input mode
79	A0	Address Line #0	
80	A1	Address Line #1	

BUS DEFINITION

Back Side

No.	SYMBOL	NAME	FUNCTION
81	A2	Address Line #2	
82	A6	Address Line #6	
83	A7	Address Line #7	
84	A8	Address Line #8	
85	A13	Address Line #13	
86	A14	Address Line #14	
87	A11	Address Line #11	
88	DO2	Data Out Line #2	
89	DO3	Data Out Line #3	
90	DO7	Data Out Line #7	
91	DI4	Data In Line #4	
92	DI5	Data In Line #5	
93	DI6	Data In Line #6	
94	DI7	Data In Line #1	
95	DI0	Data In Line #0	
96	SINTA	INTA	Status output signal to acknowledge signal for INTERRUPT request
97	SWO	WO	Status output signal indicates that the operation in the current machine cycle will be a WRITE memory or output function

BUS DEFINITION

Back Side

No.	SYMBOL	NAME	FUNCTION
98	SSTACK	STACK	Status output signal indicates that the address bus holds the pushdown stack address from the Stack Pointer
99	$\overline{POC}$	Power-On Clear	
100	GND	GROUND	

3.2.12 CPU Power Supply - Functional Description

The power supply is designed to be used in the CPU with boards that have on-board regulators. It provides +10 volts and ±18 volts at no load and approximately +7 and ±15.8 volts at full load.

The rectifiers and 115 volt power switching and fusing functions are contained on a small power supply PC board. Large computer-grade filter capacitors are used to provide minimum ripple. A custom-wound transformer is used to provide the maximum amount of power in the available space to match the exact requirements of the 8080 system. One hundred fifteen volt output terminals are available on the board, switched both fused for such functions as the ventilating fan and auxiliary power outlets on the back panel. A position is provided on the rectifier board for a power switch, for use when the front panel is not installed in the system.

The secondary windings of the power transformer are all connected in series to provide a winding with a center tap and one tap on each side of the center tap midway up the secondary out of which three separate full wave center tap rectifier circuits provide the three required voltages.

Two heavy duty rectifiers are connected to the mid points of the winding and provide +10 volts at the output. A full wave bridge for both plus and negative voltages is connected to the end points of the secondary winding to provide +18 and -18 volts.

Large computer grade electrolytic capacitors are used to filter the rectifier output before applying the voltages to the 8080 back plane.

Since the 7805 regulators used on the 8080 system boards require 7 volts minimum to regulate at 5 volts, a maximum power supply voltage drop of 3 volts is permissible between the no load voltage of 10 volts and the minimum permissible full load voltage of 7 volts.

Many components contribute significantly to the full load power supply voltage drop due to the heavy currents involved. Among these are the resistance of the transformer winding, the resistance of the hook-up wire used in assembling the power supply, the voltage drop accross the diode, the voltage drop between cycles from the discharge of the filter capacitor, and contact resistance in any of the joints. A similar situation is true for the ±18 volt supplies; however, because of the lower currents involved, this design situation is less stringent.

Additionally, three series diodes were put in both the +18 and -18 volt power supply leads to hold the no load voltage down to an acceptable value for a number of boards which use a simple resistor and zener diode to regulate for +12 volts.

3.3 Control Program

3.3.1 Program Description

The control program for the RWLM is written in the PL/M Language (Programming Language/Microcomputers). This language is block structured and somewhat self-documenting. The complete program listing is contained in Appendix C. Most procedures are explained by the comments in the listing.

3.3.2 The Language

A PL/M program is a sequence of "declarations" and "executable statements."

The declarations allow the programmer to control allocation of storage, define simple textual substitutions (macros), and define procedures. PL/M is a "block structured" language: procedures may contain further declarations which control storage allocation and define other procedures.

The procedure definition facility of PL/M allows modular programming: a program can be divided into sections (e.g., Teletype input, conversion from binary to decimal forms, and printing putput messages). Each of these sections is written as a PL/M procedure.

PL/M handles two kinds of data. Its two basic "data types" are BYTE and ADDRESS. A BYTE variable or constant is one that can be represented as an 8-bit quantity; an ADDRESS variable or constant is a 16-bit or double-byte quantity.

The programmer can DECLARE variable names to represent BYTE or ADDRESS values. One can also declare vectors (or array) of the type of BYTE or ADDRESS.

In general, executable statements specify the computational processes that are to take place. To achieve this, arithmetic, logical (Boolean), and comparison (relational) operators are defined for variables and constants of both types (BYTE and ADDRESS). These operators and operands are combined to form EXPRESSIONS which resemble those of elementary algebra. For example, the PL/M expression

```
X * (Y - 3)/R
```

represents this calculation: the value of X multiplied by the quantity Y-3, divided by the value of R. Expressions are a major component of PL/M statements. A simple statement which computes a result and stores it in a memory location defined by a variable name. The assignment

```
Q = X * (Y - 3)/R
```

first causes the computation to the right of the equal sign, as described above. The result of this computation is then saved in a memory location labeled by the variable name "Q."

Other statements in PL/M perform conditional tests and branching, loop control, and procedure invocation with parameter passing. The flow of program execution is specified by means of control structures that take advantage of the block-structured nature of the language. Input and output statements read and write 8-bit values from and to the 8080 microprocessor's input and output ports. Procedures can be defined which use these basic input and output statements to perform more complicated I/O operations.

3.3.3 Calibration Coefficients

The Rn-daughter and WL coefficients which were calculated during the calibration runs are stored in the READ ONLY memory of the RWLM in matrix form and are accessed by the CAL procedure on page 9 of the listing. Each constant is allocated 16 bytes of memory starting at location 110 H. The format of the data is as follows:

ADDRESS (HEX)			
110-11F	WL	COEF. #1	HEAD #1
120-12F	WL	COEF. #2	
130-13F	WL	COEF. #3	
140-14F	RaA	COEF. #1	
150-15F	RaA	COEF. #2	
160-16F	RaA	COEF. #3	
170-17F	RaB	COEF. #1	
180-18F	RaB	COEF. #2	
190-19F	RaB	COEF. #3	
1A0-1AF	RaC	COEF. #1	
1B0-1BF	RaC	COEF. #2	
1C0-1CF	RaC	COEF. #3	

1D0-1DF	WL	COEF. #1	HEAD #2
1E0-1EF	WL	COEF. #2	
1F0-1FF	WL	COEF. #3	
200-20F	RaA	COEF. #1	
210-21F	RaA	COEF. #2	
220-22F	RaA	COEF. #3	
230-23F	RaB	COEF. #1	
240-24F	RaB	COEF. #2	
250-75F	RaB	COEF. #3	
260-26F	RaC	COEF. #1	
270-27F	RaC	COEF. #2	
280-28F	RaC	COEF. #3	

Note from the listing that the last character in each data string is a 24H. The math pack interprets this character as the end of a number.

The arrangement of data in this structure allows the routines that calculate the WL and Rn-daughter levels to be tightly coded and it also allows using the same routines to do the calculation for each head with only the change of an indexing variable.

For example, in the CAL procedure the fixed point numbers in the above matrix must be converted to four-byte floating point numbers to be used in the calculations. The code to perform this conversion is as follows:

```
DO I=0 to 11;
CALL INSTR(.CONSTR + (I*16) + (192 * SELDET),
.FCON + (I*4)0;
END;
```

The INSTR routine is passed to the address of the number it is to convert to floating point as the first parameter:

CONSTR + (I*16) + (192*SELDET)

when I = 0 and SELDET = 0 (HEAD #1).

The first number converted starts at location 110H, i.e., the first WL coefficient for Head #1. If SELDET = 1 as it would if Head #2 were selected, the first number converted would at location 100H, i.e., 110H+0+(192D x 1) = 1DOH

The INSTR routine then stores the converted number at location pointed by .FCON + (I*4). This, of course, forms a second matrix holding the floating point values of the constant data starting at the address of FCON (21BFH).

The altitude correction factor, the data counts and the background counts are also converted to floating point and stored by the CAL PROCEDURE.

The calculations are then performed on the data and constants as shown in the listing. The output data is stored in a vector called WL for use by the PRINTREPORT Procedure.

3.4 Floating Point Math Pack

The floating point system consists of a set of subroutines designed to perform arithmetic operations on numeric quantities represented in memory.

The software constituting the floating point system is divided into two sections.

Section 1 contains all the arithmetic routines, while section 2 contains routines which are used to convert data between a binary floating point format and a decimal format suitable for entry or display on input/output equipment.

3.4.1 Floating Point Routines

The 8080 binary floating point system consists of a set of subroutines designed to perform operations on numeric quantities represented in a specific notation. Subroutines are provided to perform a variety of arithmetic and related operations.

The subroutines are designed to be stored and executed in READ-ONLY-MEMORY (ROM) and require 64 bytes of RAM. Scratchpad memory is initialized by a utility subroutine which must be executed before other subroutines are executed for the first time (INT routine called by PL/M).

In general, the subroutines have the following characteristics. Subroutines requiring one operand take it from an internal floating point accumulator. Subroutines requiring two operands take one from the accumulator and the other from the memory location indicated by the contents of the H and L registers upon entry. The numeric result of each operation is stored in the accumulator and is returned to the called in the A,B,C, and D registers.

Upon exit from the arithmetic subroutines, the properties of the result are indicated by the settings of the control bits.

Carry Bit = 1	The result exceeds the capacity of the accumulator. The other control bits, the contents of the hardware registers, and the contents of the accumulators are meaningless. This situation is also indicated by a non-zero quantity being stored in a flag word.
Carry Bit = 0	The result is in range. The zero and sign bits are properly set, and the A,B,C, and D registers contain a representation of the value in the accumulator.
Zero Bit = 1	The result of the operation is zero or a quantity too small to be represented.
Zero Bit = 0	The result is non-zero.
Sign Bit = 0	The result is non-zero.
Sign Bit = 1	The result is negative.
Sign Bit = 0	The result is positive.

Data are represented in a notation which records eight bits of exponent. One bit of sign, and 24 bits of fraction. The largest magnitude that can be represented is approximately $3.6 * 10^{38}$. The smallest non-zero magnitude is approximately $2.7 * 10^{-39}$. The resolution of the notation is approximately $6.2 * 10^{-8}$, i.e., better than seven-decimal digit precision.

Data values are represented in four consecutive memory words which must be in the same bank of memory. The interpretation of these words is shown below.

Word 1 — If non-zero, this word contains the exponent plus a bias of 200 octal. The exponent indicates the power of 2 by which the fraction is multiplied to obtain the represented value. If this word is zero the represented value is zero and words 2, 3, and 4 are meaningless.

Word 2, Bit 7 — This bit indicates the sign of the value: 0 if positive, 1 if negative.

Word 2, Bits 6-0 — These bits plus as sssumed 1 in the bit 7 are the most significant bits of the fraction. The fraction is stored in absolute form (unsigned) with the radix point positioned to the left of bit 7. The value of the fraction is thus less than 1.0 and equal to or greater than 0.5.

Word 3 — This word contains the second most significant eight bits of the fraction.

Word 4 — This word contains the least significant eight bits of the fraction.

Examples of Data Notation (Octal Notation).

Value	Word 1	Word 2	Word 3	Word 4
0.0	000	xxx	xxx	xxx x = don't care
+1.0	201	000	000	000
-1.0	201	200	000	000
+0.1	175	114	314	314
-100.1	207	310	063	063

3.4.2 Floating Point Accumulator

The floating point accumulator consists of 5 scratchpad words containing, respectively, the accumulator exponent, the accumulator sign, and three words of accumulator fraction. The exponent is recorded with a bias of 200 octal. An exponent word of zero indicates that the value in the accumulator is zero and the remaining words of the accumulator are meaningless. The sign word holds 000 if the accumulator is negative, 200 octal if positive. The fraction is recorded as a normalized positive value with the radix point to the left of the most significant bit of the first fraction word.

3.5 Format Conversion Package

The format conversion package of the 8080 binary floating point system contains subroutines for the conversion of data between the floating point system notation and two other formats. The non-floating, point formats are four-word fixed-point format and variable-length character-string format.

The format conversion package is contained in 512 consecutive words of memory (2 banks of ROM) and requires for its execution that the arithmetic and utility packages be available in memory. The combination of this format conversion package and the arithmetic and utility packages uses the first 64 words of a bank of RAM as scratchpad memory.

The fixed point format data processes by this package consist of 32-bit binary numbers occupying four words. (Two's complement notation is used to represent negative values.) The position of the binary point relative to the bits representing the value is denoted by a binary scaling factor. The binary scaling factor is not normally recorded in the computer; but, when a format conversion subroutine is called, the binary scaling factor must be specified (in the E register). A binary scaling factor of zero indicates the binary point is immediately to the left of the most significant of the 32 bits representing the value. A binary scaling factor of 32 indicates the binary point is immediately to the right of the least significant bit. The permissible range of the binary scaling factor is -128 (200 octal) to +127 (177 octal).

The character string format data processed by this package consist of binary representations of characters occupying consecutive words of memory. A character string may not cross a memory-bank boundary. The characters which may be included in a character string, and the corresponding octal representations are listed below.

Decimal Digits	00B-011B BCD digits*
Space	360B
+	373B
-	375B
.	376
Exponential sign	025B

*(These octal representations can be converted to the corresponding ASCII characters by adding 060B to each.)

The out subroutine generates character strings in two formats. Each consists of 13 characters. The format used in a specific case is dependent upon the magnitude of the value represented.

Zero and magnitudes between .10000000 and 9999999. are represented by a space or minus sign, seven decimal digits and an appropriately positioned decimal point, and four spaces.

Magnitudes outside the above range are represented by a space or minus sign, a value between 1.000000 and 9.999999, an exponential sign, and a signed two-digit power of ten.

The input subroutine converts character strings in either of the above formats, or a modified version of them. The leading sign character may be included or omitted. Up to 37 digits may be used to indicate the value, with or without an ' ‿uded decimal point. If a power-of-ten multiplier is indicated it may be signed or unsigned and may contain one or two digits. An input character string is terminated by the first character which departs from the specified format.

3.6 Interface Between PL/M and Assembly Language Floating Point Math Pack Routines

There are two sets of routines that interface the PL/M and the assembly language routines. One set of these interfaces appears on page 8 of the PL/M control program listing in Appendix C. The assembly language part of the routine is labeled Math Pack Transfer Routine and is also found in Appendix C.

The PL/M procedures are called by elements in the control program. In turn, they transfer control to the assembly language transfer control to the assembly language transfer routines. These routines move parameters passed by PL/M and make these parameters correspond with the requirements of the Math Pack.

4.0 CALIBRATION

It is evident from (1) in section 2.0 that the numerical values for N_A, N_B, and N_C depend on V, E_1, E_2, E_3, and the corrected counts TA, TC' see (5) and the measured counts (B + C). Therefore, to calibrate the RWLM, V, E_1, E_2, and E_3 (the flowrate and the efficiencies of RaA, RaB, and RaC) have to be determined, and one has to ensure that the counts used to calculate N_A, N_B, and N_C are TA, (B + C), and TC' as defined in section 2.0.

4.1 Measurement of Flowrate V

The flowrate, V (liters/min), can easily be measured with a Wet Test Meter (Precision Scientific Co.). The numerical value of V (in liters/min) for the particular detector measured is used in the calibration procedure (see Fig. 8).

4.2 Determinations of E_1, E_2, and E_3

The alpha efficiency of the RWLM detectors, E_1, was determined by comparison with a calibrated hemispherical proportional counter. The proportional counter was calibrated with an NBS ^{241}Am source. An air sample from a plastic drum containing uranium ore was taken. About 40 minutes after the ending of the sampling period the circular portion of the filter strip containing the filtered Rn daughters was cut out. This circular disc was then counted with the proportional counter and with the RWLM. The counting period was always 30 seconds. About 10 measurements with each counter were taken. These results were averaged and E_1 was calculated according to the formula:

$$E_1 = (C_{RWLM}/C_{PC})E_{PC}$$

where:

C_{RWLM} = average number of alpha counts observed with RWLM

C_{PC} = average number of alpha counts observed with the proportional counter.

E_{PC} = known alpha efficiency of the proportional counter.

The measurements with the two counters should be interlaced. The first measurement with the RWLM, for example, should be followed by the first measurement with the proportional counter, and so on. Counting in this interlaced fashion avoids bias due to decay. The counts from the RWLM detection system can be recorded with an external scaler.

Once E_1 is know, E_2 and E_3 can be determined by the following procedure: Knowledge of E_1 allows a complete analysis of any air sample by a method using total alpha counts. This method allows calculation of N_A, N_B, and N_C for this particular air sample. N_A, N_B, and N_C can then be used to calculate the beta disintegrations from RaB and RaC. By comparing the calculated beta disintegrations with the observed total beta counts, the values for E_2 and E_3 are obtained. The necessary calculations are all performed by the "RWLM CALIBRATION PROGRAM" (see Fig. 8).

To calculate the beta efficiencies E_2 and E_3, the Rn-daughter concentrations (atoms/liter) N_A, N_B, and N_C must first be determined from the alpha counts during several counting periods using the following equations:

$$N_A = 0.962617*A_5/E_1*V$$

$$N_B = (-0.919056*A_5 - 11.17412*C_5 + 2.764731*C_3)/E_1*V \quad (2)$$

$$N_C = (0.054135*A_5 + 4.305161*C_5 - 0.264945*C_3)/E_1*V$$

where: *

A_5 = RaA counts observed during 5 min starting 13 sec after the end of the 2-min sampling time.

C_5 = RaC' counts observed during the same time interval as above.

C_3 = RaC' counts observed during 30 min, starting at the same time as above.

The numerical coefficients in (2) are again derived from the laws of radioactive-series decay. This derivation is straightforward but lengthy and will therefore be omitted.

With N_A, N_B, and N_C known, E_2 and E_3 can be determined from the following equations:

$$Q_1 = (0.131911*N_A + 0.235122*N_B)*V*E_2 + (0.010901*N_A + 0.029629*N_B + 0.309182*N_C*V*E_3 \quad (3)$$

$$Q_2 = (0.984198*N_A + 1.046109*N_B)*V*E_2 + (0.389388*N_A + 0.481449*N_B + 1.24961*N_C)*V*E_3$$

where

Q_1 = total beta counts observed during 5 min starting 13 sec after the end of the 2-min sampling time.

Q_2 = total beta counts observed during 30 min same time as above.

---

*The overlap corrections must be incorporated into the alpha counts (A_5, C_5 and C_3). See (5).

With the beta efficiencies E_2 and E_3 so determined, (1) can be inverted and properly scaled. When properly scaled this yields a set of equations which gives the Rn-daughter concentrations in pCi/liter. The WL can also be expressed as a linear combination of A, (B + C), and C'. These counts are net counts, i.e., the background has been subtracted. The equations are of the following form:

$$
\begin{aligned}
\text{WL} &= C_1(A) + C_2(B + C) + C_3(C') \\
\text{RaA(pCi/liter)} &= C_4(A) + C_5(B + C) + C_6(C') \\
\text{RaB(pCi/liter)} &= C_7(A) + C_8(B + C) + C_9(C') \\
\text{RaC(pCi/liter)} &= C_{10}(A) + C_{11}(B + C) + C_{12}(C')
\end{aligned}
\qquad (4)
$$

C_1 through C_{12} are the derived weighting coefficients which are atored in the memory of the RWLM. It is clear from this description of the calibration that N_A, N_B, and N_C are treated as independent unknowns (i.e., no a priori relationship between these quantities other than radioactive series decay is assumed). The RWLM determines, therefore, the Rn-daughter concentrations and WL without any assumptions about the Rn-daughter equilibrium. Since all weighting coefficients are strictly proportional to the inverse of the flowrate, or 1/V, a flowrate correction can be made by including a multiplication factor in (4). This implies that a recalibration of the RWLM is unnecessary if it is operated at different altitudes, or any condition which may result in a flowrate different from that used in the calibration, such as a loss of pump efficiency due to wear.

4.3 Discriminator Adjustments

V, E_1, E_2, and E_3 have been determined so far. We will now discuss the adjustments necessary to ensure that the other input parameters VO (overlap), A, (B + C) and C' are properly determined.

VO = fraction of RaC' counts appearing in the RaA channel during the corresponding counting period.

A = total alpha counts in RaA channel during 2 min counting period starting 13 sec after the end of sampling.

(B+C) = total beta counts from RaB and RaC (same period of accumulation as above).

C = total alpha counts in RaC' channel (same as above).

CKUS = total alpha counts from 39 to 41 min used to calculate WLKUS, the Kusnetz WL (with time base starting 13 sec after the end of sampling).

First, the lower alpha discriminator level has to be set above the noise level. This is done easily by gradually increasing the reference voltage level until no background counts due to noise are observed. This adjustment has to be done in an area with negligible airborne radioactivity. In a similar manner the beta channel must be adjusted. A certain number of counts due to ambient gamma radiation will always appear since the beta detector is sensitive to gamma rays. The RWLM channel accumulator registers approximately 250 counts/min for 1 mr/hr of gamma radiation from a ^{226}Ra source. The next step is the adjustment of the upper alpha discriminator level. For this adjustment,

a multi-channel analyzer (MCA) is needed. The multichannel-analyzer displys shows clearly the separation between the RaA and the RaC' alpha peaks. Integrating the combined spectrum between the analyzer's baseline and the channel with the minimum number of counts between the two alpha peaks gives A, the number of counts in the lower alpha channel. Integrating from this channel to the descent of the RaC' spectrum gives C', the number of counts in the upper alpha channel. The upper level alpha discriminator must then be adjusted to obtain agreement between A and C' by comparing the integrated counts under each peak on the MCA with the A and C' counts observed in the alpha channels of the RWLM. This data is collected simultaneously from the same air sample. This agreement can be achieved by gradually adjusting the upper alpha discriminator level in the RWLM and comparing the different sets of A counts and C' counts. An initial minimum setting of the RWLM's upper alpha discriminator can be achieved with a ^{241}Am standard. This initial setting should be slightly higher than the pulses from the 5.5 MeV ^{241}alpha's. After the upper alpha discriminator has been properly set, the RWLM will record the quantities A and C' properly. The A counts and C' counts are, however, not yet suitable for the necessary calculations. The A and C' have to be corrected for the degradation of the RaC' spectrum.
VO (overlap) is the fraction of the RaC' counts that is detected by the lower alpha channel when a sample is made with the counting delayed 45 min to assure complete decay of RaA. It is algebraically defined by:

VO = (RaC' counts in RaA channel)/(RaC' counts in C channel).

With VO known, all TA and TC counts can be determined from:

$$TA = A - ((VO) \cdot C') \qquad (5)$$

$$TC' = (1 + VO) \cdot C'$$

These relationships (5) are used in the "RWLM CALIBRATION PROGRAM."

4.4 Calibration Program (see Fig. 8)

The calibration program automates the solution of the equations for radioactive-series decay, as applied to the RWLM, and calculates the required efficiencies and coefficients. This program is available in both the FORTRAN and BASIC languages. The program performs the following functions:

1) It calculates the Rn-daughter concentrations by three different methods and the WL by four different methods from the same air sample.

   The four different methods are:

   a) The alpha-spectroscopic method

   b) The total-alpha method

   c) The Kusnetz method

   d) The IWLM/RWLM method

2) It calculates the RaB and RaC efficiencies using the Rn-daughter concentrations calculated by the total-alpha method, and the beta counts at two different periods of time.

3) It calculates the 12 coefficients needed for the IWLM/RWLM method. See (4).

4) It calculates the Rn-daughter concentrations from 9 of these calculated coefficients, in units of atoms/liter, for

comparison to the other two methods, and also in units of pCi/liter which is the unit used by the RWLM.

5) It calculates the WL from the Rn-daughter concentrations, and with the use of the three remaining coefficients it also determines the WL directly from the measured counts.

In order to understand the program, it will be necessary to refer to the calibration program and to the "Table of Definitions of Symbols in the calibration program" (see Appendix C and Fig. 8). The program has two branches, one which calculates beta efficiencies from the input data, and another which uses the mean value of the beta efficiencies to derive the final weighted coefficients (see Figs. 9 and 10). In both branches the Rn-daughter concentrations are calculated by using the alpha-spectroscopic method (line 140) and the total-alpha method (line 150).

Lines 50 through 52 are the coefficients for these two equations. Lines 100 through 120 are statements that adapt the input data for these methods. Line 170 calculates the WL with the alpha-spectroscopic method. Line 180 uses the total-alpha method for the same calculation. Line 190 calculates the WL by the Kusnetz method. These three WL calculations are available for comparison with the IWLM/RWLM method to be explained later.

As shown in Fig. 9, the first question asked by the computer is "Calculate or Input E_B, E_C" (E_1, E_2). When the operator types a "C", the program is routed into Branch 1 (lines 2000 to 2100) which uses the inverted equations calculate the beta efficiencies for RaB and RaC (E_2 and E_3, respectively) by using the observed beta counts (Q_1 and Q_2) and the Rn-daughter concentrations previously determined by the total-alpha method. If an "I" is entered (see Fig. 10), the input branch is selected and the beta efficiencies are entered as data (line 210).

Statements 3000 to 3210 perform a matrix inversion and give the final weighting coefficients C_1 through C_{12} for (4) after conversion to the proper units.

The Rn-daughter concentrations are calculated in units of atoms/liter by the statements for FO(1), FO(2), and FO(3) and are printed out to allow comparison with the values calculated by the alpha methods. FO(1), FO(2), and FO(3) are then converted to units of pCi/liter (line 260) and printed. The WL is calculated from the Rn-daughter concentrations which were derived using the IWLM/RWLM method (line 270) and directly using the coefficients of the IWLM/RWLM method (line 280). Note that these two different equations give exactly the same results. See Fig. 9, "WL from IWLM (direct and from Rn daughters)."

4.5 Calibration Procedure

The calibration procedure consists of the following steps: first, 10 sets of data are automatically collected; second, the RWLM calibration program is used to calculate the beta efficiencies; third, the RWLM calibration program is used to calculate the coefficients for the RWLM using the mean value of the calculated beta efficiencies; and, fourth, these new coefficients

```
+G
TODAY IS 00/00/00  THE TIME IS 00:00
DATE CORRECT (Y/N)?N
ENTER YEAR-77 ENTER MONTH-03 ENTER DAY -21 ENTER HOUR-11 ENTER MINUTE--45

TODAY IS 03/21/77  THE TIME IS 11:45
DO YOU WANT  DETECTOR  1 RUN(Y/N)?Y
DO YOU WANT  DETECTOR  2 RUN(Y/N)?Y

ENTER TIME INTERVAL BETWEEN SAMPLES HOURS-00 MIN-20
ENTER TIME TO START HOUR-12  MIN-00
INPUT TIME TO STOP
ENTER YEAR-77 ENTER MONTH-03 ENTER DAY -22 ENTER HOUR-00 ENTER MINUTE-00
```

Figure 7 Data Terminal Dialog between Operator and System

```
1 REM        RWLM CALIBRATIØN PRØGRAM
2 REM     ARGONNE NATIØNAL LABØRATØRY ELECTRONICS DIVISION
20 PRINT "RWLMCAL.BAS   V02.1": GOSUB 4000
30 FØR I=0 TØ 8
35 READ C(I),CO(I)
40 NEXT I
50 DATA .926838,1.918637,0,-3.196779,0,2.506266
51 DATA -.879403,1.701921,-11.12606,-18.620953,2.752840,16.756924
52 DATA .049957,-3.6592397,4.232080,12.896776,-.251541,-10.308247
100 S5=A5+C5:S3=A3+C3:S2=A2+C2
110 T1=A5-V0*C5:T2=(1+V0)*C5:T3=(1+V0)*C3:T4=A-V0*C
120 T5=(1+V0)*C
130 FØR Q=0 TO 6 STEP 3
140 F1(Q/3)=(C(Q)*T1+C(Q+1)*T2+C(Q+2)*T3)/(E1*V)
150 F2(Q/3)=(CO(Q)*S5+CO(Q+1)*S3+CO(Q+2)*S2)/(E1*V)
160 NEXT Q
170 W1=(13.68*F1(0)+7.68*(F1(1)+F1(2)))/130000
180 W2=(13.68*F2(0)+7.68*(F2(1)+F2(2)))/130000
190 W3=K1/(E1*2*V*150)
200 IF S0=1 THEN GØSUB 2000:GØTO 250
210 INPUT "EB,EC PLEASE";E2,E3
250 GØSUB 3000
260 P1=.227261*F0(1)/2.22:P2=.025864*F0(2)/2.22:P3=.035185*F0(3)/2.22
270 P4=(13.68*F0(1)+7.68*(F0(2)+F0(3)))/130000
280 F9=W(1)*A+W(2)*B3+W(3)*C
299 PRINT:PRINT:PRINT:PRINT
300 PRINT "                R W L M   C A L I B R A T I Ø N ":PRINT
301 PRINT:PRINT:PRINT A$:PRINT D$,P$
302 PRINT:PRINT "FNA=";F1(0),,"FNB=";F1(1),,"FNC=";F1(2):PRINT
305 PRINT:PRINT "FNA2=";F2(0),,"FNB2=";F2(1),"FNC2="F2(2)
307 PRINT:PRINT"WL1=";W1,"WLKUS=";W3,"EB=";E2,"EC="E3
310 PRINT:PRINT"WL2=";W2
312 PRINT:PRINT"RN-DAUGHTER CØEFFICIENTS FØR IWL-MEMØRY"
320 FØR I=1 TØ 3: FØR J=1 TØ 3
330 PRINTP(I,J),:NEXTJ:PRINT:NEXT I
335 PRINT:PRINT"RN-DAUGHTER (RWLM) IN ATØMS"
336 PRINT F0(1),F0(2),F0(3)
340 PRINT:PRINT"RN-DAUGHTER (RWLM) IN PCI/L"
345 PRINT P1,P2,P3
350 PRINT:PRINT:PRINT"WL FROM IWLM (DIRECT AND FROM RN-DAUGHTERS)"
355 PRINT P4,F9
360 PRINT:PRINT:PRINT"WL CØEFFICIENTS FOR IWLM-MEMORY"
370 PRINT W(1),W(2),W(3)
490 PRINT:PRINT:PRINT:PRINT:PRINT
500 PRINT"NØRMAL STOP AT LINE 500":STOP
2000 X1=(.127907*F2(0)+.236138*F2(1))*V
2010 X2=(.385895*F2(0)+.478116*F2(1)+1.256959*F2(2))*V
2020 X3=(.981722*F2(0)+1.050628*F2(1))*V
2030 X4=(.010200*F2(0)+.028418*F2(1)+.311*F2(2))*V
2040 Q9=X1*X2-X3*X4
2050 Y1=(.385895*F2(0)+.478116*F2(1)+1.256959*F2(2))*V*Q1
2060 Y2=(.0102*F2(0)+.028418*F2(1)+.311*F2(2))*V*Q2
2070 Q8=Y1-Y2:E2=Q8/Q9
2080 Z1=(.127907*F2(0)+.236138*F2(1))*V*Q2
2090 Z2=(.981722*F2(0)+1.050628*F2(1))*V*Q1
2100 E3=(Z1-Z2)/Q9
2110 RETURN
3000 A1(1)=.580386*E1*V:A2(1)=.035204*E2*V+.001584*E3*V
3010 A2(2)=.098134*E2*V+.006941*E3*V:A2(3)=.131*E3*V:A3(1)=.001584*E1*V.
```

Figure 8 RWLM Calibration Program

```
3020 A3(2)=.006941*E1*V:A3(3)=.131*E1*V
3030 B4=A1(1)*(A2(2)*A3(3)-A3(2)*A2(3))
3040 C1(1)=(A2(2)*A3(3)-A2(3)*A3(2))/B4
3050 C2(1)=(A2(3)*A3(1)-A2(1)*A3(3))/B4
3060 C2(2)=(A1(1)*A3(3))/B4
3065 C2(3)=-(A1(1)*A2(3))/B4
3070 C3(1)=(A2(1)*A3(2)-A2(2)*A3(1))/B4
3080 C3(2)=-(A1(1)*A3(2))/B4
3090 C3(3)=(A1(1)*A2(2))/B4
3100 P(1,1)=C1(1)*.22726/2.22
3105 P(1,2)=0
3110 P(1,3)=-P(1,1)*V0:F0(1)=C1(1)*T4
3120 F0(2)=C2(1)*T4+C2(2)*B3+C2(3)*T5
3130 P(2,1)=C2(1)*.025864/2.22:P(2,2)=C2(2)*.025864/2.22
3140 P(2,3)=(C2(3)*(1+V0)-C2(1)*V0)*.025864/2.22
3150 F0(3)=C3(1)*T4+C3(2)*B3+C3(3)*T5
3160 P(3,1)=C3(1)*.035185/2.22:P(3,2)=C3(2)*.035185/2.22
3170 P(3,3)=(C3(3)*(1+V0)-C3(1)*V0)*.035185/2.22
3180 W(1)=(13.68*C1(1)+7.68*(C2(1)+C3(1)))/130000
3190 W(2)=7.68*(C2(2)+C3(2))/130000
3200 W(3)=(7.68*(1+V0)*(C2(3)+C3(3)))/130000-V0*W(1)
3210 RETURN
4000 INPUT "CALCULATE OR INPUT EB,EC (C/I)"; B$
4001 A$="DATE                PLACE"
4010 IF NOT(B$="I" OR B$="C") THEN 4000
4020 IF B$="I" THEN  S0=0
4021 IF B$="C" THEN S0=1
4030 INPUT "DATE,PLACE" ; D$,P$
4040 INPUT "FLOWRATE (LITERS/MIN)";V
4050 INPUT "EFFICIENCY OF ALPHA DETECTOR"; E1
4055 INPUT "OVLAP"; V0
4057 INPUT "TOTAL BETA COUNTS FROM RAB AND RAC DURING 5 MINUTES";O1
4060 INPUT "TOTAL BETA COUNTS FROM RAB AND RAC DURING 30 MINUTES";O2
4070 INPUT "TOTAL ALPHA COUNTS IN RAA CHANNEL DURING 30 MINUTES";A3
4080 INPUT "TOTAL ALPHA COUNTS IN RAA CHANNEL DURING 35 MINUTES";A2
4090 INPUT "TOTAL ALPHA COUNTS IN RAC' CHANNEL DURING 35 MINUTES";C2
4100 INPUT "TOTAL ALPHA COUNTS IN RAA CHANNEL DURING 5 MINUTES";A5
4110 INPUT "TOTAL ALPHA COUNTS IN RAC' CHANNEL DURING 5 MINUTES";C5
4120 INPUT "TOTAL ALPHA COUNTS IN RAC' CHANNEL DURING 30 MINUTES"; C3
4130 INPUT "TOTAL ALPHA COUNTS IN RAA CHANNEL DURING 2 MINUTES";A
4140 INPUT "TOTAL BETA COUNTS FROM RAB AND RAC DURING 2 MINUTES"; B3
4150 INPUT "TOTAL ALPHA COUNTS IN RAC' CHANNEL DURING 2 MINUTES";C
4160 INPUT "TOTAL ALPHA COUNTS FROM 39-41 MINUTES";K1
4999 RETURN
5000 END
OK
```

Figure 8. (Continued)

positioned decimal point, and four spaces.


```
RWLMCAL.BAS   V02.1
CALCULATE ØR INPUT EB,EC (C/I)? C
DATE,PLACE? 8/4/76,      QUIRK 1
FLØWRATE (LITERS/MIN)? 11.2
EFFICIENCY ØF ALPHA DETECTØR? .20
OVLAP? .18
TØTAL BETA CØUNTS FRØM RAB AND RAC DURING 5 MINUTES? 56416.5
TØTAL BETA CØUNTS FRØM RAB AND RAC DURING 30 MINUTES? 294583
TØTAL ALPHA CØUNTS IN RAA CHANNEL DURING 30 MINUTES? 25419
TØTAL ALPHA CØUNTS IN RAA CHANNEL DURING 35 MINUTES? 27405.5
TØTAL ALPHA CØUNTS IN RAC' CHANNEL DURING 35 MINUTES? 107085
TØTAL ALPHA CØUNTS IN RAA CHANNEL DURING 5 MINUTES? 10151.5
TØTAL ALPHA CØUNTS IN RAC' CHANNEL DURING 5 MINUTES? 16980
TØTAL ALPHA CØUNTS IN RAC' CHANNEL DURING 30 MINUTES? 94182
TØTAL ALPHA CØUNTS IN RAA CHANNEL DURING 2 MINUTES? 5157
TØTAL BETA CØUNTS FRØM RAB AND RAC DURING 2 MINUTES? 22898
TØTAL ALPHA CØUNTS IN RAC' CHANNEL DURING 2 MINUTES? 6993
TØTAL ALPHA CØUNTS FRØM 39-41 MINUTES? 2685


               R W L M   C A L I B R A T I Ø N


DATE            PLACE
8/4/76          QUIRK 1

FNA= 2935.72                FNB= 34272.6                FNC= 25533.5


FNA2= 3029.67                              FNB2= 32477.7
FNC2= 25368.5

WL1= 3.84209  WLKUS= 3.99554               EB= .191372   EC= .395248

WL2= 3.73619

RN-DAUGHTER CØEFFICIENTS FØR IWL-MEMØRY
 .0787421        0              -.0141736
-3.30609E-03    .0553894        -.128571
 9.08931E-05   -3.99245E-03     .0730273

RN-DAUGHTER (RWLM) IN ATØMS
 2998.51         30227.2         26482.9

RN-DAUGHTER (RWLM) IN PCI/L
 306.957         352.161         419.73


WL FRØM IWLM (DIRECT AND FRØM RN-DAUGHTERS)
 3.66579         3.66579


WL CØFFICIENTS FØR IWLM-MEMØRY
 6.45171E-05    2.65986E-04   -3.94318E-04



NØRMAL STØP AT LINE 500

BREAK IN 500
ØK
```

Figure 9 RWLM Calibration Program - Readout with calculate (C) beta efficiency branch

```
RWLMCAL.BAS    V02.1
CALCULATE ØR INPUT EB,EC (C/I)? I
DATE,PLACE? 8/4/76,          QUIRK 1
FLØWRATE (LITERS/MIN)? 11.2
EFFICIENCY ØF ALPHA DETECTØR? .20
OVLAP? .18
TØTAL BETA CØUNTS FRØM RAB AND RAC DURING 5 MINUTES? 56416.5
TØTAL BETA CØUNTS FRØM RAB AND RAC DURING 30 MINUTES? 294583
TØTAL ALPHA CØUNTS IN RAA CHANNEL DURING 30 MINUTES? 25419
TØTAL ALPHA CØUNTS IN RAA CHANNEL DURING 35 MINUTES? 27405.5
TØTAL ALPHA CØUNTS IN RAC' CHANNEL DURING 35 MINUTES? 107085
TØTAL ALPHA CØUNTS IN RAA CHANNEL DURING 5 MINUTES? 10151.5
TØTAL ALPHA CØUNTS IN RAC' CHANNEL DURING 5 MINUTES? 16980
TØTAL ALPHA CØUNTS IN RAC' CHANNEL DURING 30 MINUTES? 94182
TØTAL ALPHA CØUNTS IN RAA CHANNEL DURING 2 MINUTES? 5157
TØTAL BETA CØUNTS FRØM RAB AND RAC DURING 2 MINUTES? 22898
TØTAL ALPHA CØUNTS IN RAC' CHANNEL DURING 2 MINUTES? 6993
TØTAL ALPHA CØUNTS FRØM 39-41 MINUTES? 2685
EB,EC PLEASE? .205, .3865


           R W L M   C A L I B R A T I Ø N


DATE           PLACE
8/4/76         QUIRK 1

FNA= 2935.72              FNB= 34272.6              FNC= 25533.5


FNA2= 3029.67                          FNB2= 32477.7
FNC2= 25368.5

WL1= 3.84209  WLKUS= 3.99554           EB= .205      EC= .3865

WL2= 3.73619

RN-DAUGHTER CØEFFICIENTS FØR IWL-MEMØRY
 .0787421      0             -.0141736
-3.30609E-03   .0517072      -.117316
 9.08931E-05  -3.72704E-03    .072216

RN-DAUGHTER (RWLM) IN ATØMS
 2998.51       29746.1        26508.4

RN-DAUGHTER (RWLM) IN PCI/L
 306.957       346.555        420.134


WL FRØM IWLM (DIRECT AND FRØM RN-DAUGHTERS)
 3.63888       3.63888


WL CØFFICIENTS FØR IWLM-MEMØRY
 6.45171E-05   2.48304E-04  -3.40269E-04



NØRMAL STØP AT LINE 500

BREAK IN 500
ØK
```

Figure 10 RWLM Calibration Program - Readout with input (I) beta efficiency branch

*** R W L M ***
DETECTØR 1

TØDAY IS 08/04/76 THE TIME IS 16:45
ALTITUDE CØRRECTIØN FACTØR = 1

WØRKING LEVEL	3.66579	
RADIUM A	306.957	PC/L
RADIUM B	352.161	PC/L
RADIUM C	419.73	PC/L

	SAMPLE CØUNTS	BACKGRØUND CØUNTS	NET CØUNTS
RADIUM A	5184	27	5157.0
RADIUM (B+C)	23569	671	22898.0
RADIUM C'	7015	22	6993.0

05 MINUTE CØUNT

	SAMPLE CØUNTS	BACKGRØUND CØUNTS	NET CØUNTS
RADIUM A	10219	27	10151.5
RADIUM (B+C)	58094	671	56416.5
RADIUM C'	17035	22	16980.0

30 MINUTE CØUNT

	SAMPLE CØUNTS	BACKGRØUND CØUNTS	NET CØUNTS
RADIUM A	25824	27	25419.0
RADIUM (B+C)	304648	671	294583.0
RADIUM C'	94512	22	94182.0

35 MINUTE CØUNT

	SAMPLE CØUNTS	BACKGRØUND CØUNTS	NET CØUNTS
RADIUM A	27878	27	27405.5
RADIUM (B+C)	344188	671	332445.5
RADIUM C'	107470	22	107085.0

39-41 MINUTE CØUNT

	SAMPLE CØUNTS	BACKGRØUND CØUNTS	NET CØUNTS
RADIUM A	762	27	735.0
RADIUM (B+C)	13850	671	13179.0
RADIUM C'	4657	22	4635.0

Figure 11 Sample Calibration Data Readout

are loaded into the RWLM memory. This procedure assumes that the alpha efficiency, the flowrate, and the RaC' overlap were previously determined. The first step is initiated by entering a "C" command via the keyboard. The RWLM then proceeds automatically to complete 10 successive calibration sampling runs (see Fig. 11).

When the calibration mode is selected by typing a "C" command, the following events occur:

1) a normal sampling run is taken, but the accumulators are not reset at the end of the 2-min counting time.*
2) the total count for 5 min is recorded.
3) the total count for 30 min is recorded.
4) the total count for 35 min is recorded.
5) the accumulators are reset and the total count from 39 to 41 min is recorded.

This procedure is automatically repeated a total of 10 times for each head in order to obtain a statistically sufficient number of runs. It is possible to acquire the data for a complete calibration run in approximately 14 hours. A calibration run can be completed overnight. Unlike the earlier IWLM which had no microprocessor, the RWLM does not require an operator to be present to record the data. A sample calibration run is shown in Fig. 11.

On completion of the data collection, the RWLM calibration program is run, using the collected data to calculate beta efficiencies E_1

---

*The zero time-base is selected as 13 sec after the end of the sampling period.

and E_2. The beta efficiencies calculated by the program are averaged to obtain the mean beta efficiencies.

The program is then rerun in the input branch (see Fig. 10) to calculate the final coefficients C_1 through C_{12} for the RWLM equations.

These calculated coefficients C_1 through C_{12} are then programmed into the RWLM PROM memory and the calibration is complete. Note that since the RWLM has two detection heads, two individual calibrations are required for the total system.

5.0 TEST RESULTS

The measurements of WL and Rn-daughter concentrations taken with the RWLM in the Twilight Mine on November 16-18, 1976, are tabulated in Table 5.1. The agreement of the WL, N_A, N_B, and N_C values obtained during the calibration runs is very good. WL is compared with three different and independent methods of measurement. One sample is used to obtain data for all the different methods of measurement. The WL's as measured by the total-alpha method, alpha-spectroscopic method, and the RWLM method show consistently good agreement. Occasionally the WL as measured by Kusnetz method reads a higher value than the other three methods; however, the WL using the Kusnetz method is in good agreement with the other three methods in more than 80% of the measurements. The Rn-daughter concentrations as measured by the RWLM show an absence of bias which can be seen easily by inspection of the tabulated data in Table 5.1.

TABLE 5.1

Data Calculated from Calibration Runs
in Twilight Mine

		WL	RaA	RaB	RaC	Method
			(in units of atoms/liter)			
11/16/76	Det 1					
	Run #1	1.640	2187	15496	8365	alpha spectroscopic
	Time: 1353	1.610	2112	14799	8687	total alpha
		1.686				Kusnetz
		1.645	2163	15330	8664	RWLM
	Det 1					
	Run #2	1.607	2216	15110	8137	alpha spectroscopic
	Time: 1439	1.566	2116	14168	8569	total alpha
		1.623				Kusnetz
		1.547	2215	13993	8243	RWLM
	Det 1					
	Run #3	1.569	2153	14595	8130	alpha spectroscopic
	Time: 1525	1.607	2327	15615	7441	total alpha
		1.669				Kusnetz
		1.606	2128	15402	7998	RWLM
	Det 1					
	Run #4	1.574	2095	15159	7752	alpha spectroscopic
	Time: 1630	1.540	2012	14364	8111	total alpha
		2.139				Kusnetz
		1.584	2125	15395	7638	RWLM
	Det 1					
	Run #5	1.500	2147	13824	7740	alpha spectroscopic
	Time: 1716	1.461	1938	12721	8554	total alpha
		1.635				Kusnetz
		1.461	2125	12944	7996	RWLM
	Det 1					
	Run #6	1.481	2157	13351	7881	alpha spectroscopic
	Time: 1801	1.509	2189	13938	7713	total alpha
		2.075				Kusnetz
		1.527	2163	13940	8057	RWLM
	Det 1					
	Run #7	1.482	2025	14200	7276	alpha spectroscopic
	Time: 1847	1.419	1722	12489	8469	total alpha
		1.512				Kusnetz
		1.475	1971	14215	7235	RWLM
	Det 1					
	Run #8	1.481	2064	13759	7642	alpha spectroscopic
	Time: 1933	1.487	1999	13747	7862	total alpha
		1.591				Kusnetz
		1.487	2090	13915	7540	RWLM
	Det 1					
	Run #9	1.442	2052	13396	7361	alpha spectroscopic
	Time: 2019	1.461	2070	13774	7262	total alpha
		1.523				Kusnetz
		1.482	2070	14125	7270	RWLM

Date	Sample	WL	RaA	RaB	RaC	Method
11/16/76	Det 1					
	Run #10	1.470	2037	13760	7488	alpha spectroscopic
	Time: 2105	1.472	1998	13731	7624	total alpha
		1.593				Kusnetz
		1.460	2051	13471	7597	RWLM
	Det 1					
	Run #11	1.437	2026	13280	7434	alpha spectroscopic
	Time: 2150	1.454	1999	13553	7498	total alpha
		1.537				Kusnetz
		1.474	2040	13916	7404	RWLM
	Det 1					
	Run #12	1.459	2075	13380	7628	alpha spectroscopic
	Time: 2236	1.459	1971	13190	8002	total alpha
		1.598				Kusnetz
		1.510	2101	14447	7379	RWLM
	Det 1					
	Run #13	1.427	2118	13266	7120	alpha spectroscopic
	Time: 2322	1.428	2040	13137	7396	total alpha
		1.484				Kusnetz
		1.463	2121	13854	7130	RWLM
11/17/76	Det 2					
	Run #1	1.761	2762	16266	8628	alpha spectroscopic
	Time: 0008	1.752	2743	16056	8710	total alpha
		2.322				Kusnetz
		1.759	2752	16587	8288	RWLM
	Det 2					
	Run #2	1.810	2800	17298	8359	alpha spectroscopic
	Time: 0053	1.761	2515	15874	9462	total alpha
		1.832				Kusnetz
		1.801	2801	17053	8436	RWLM
	Det 2					
	Run #3	1.793	2805	16725	8633	alpha spectroscopic
	Time: 0139	1.800	2768	16786	8751	total alpha
		1.878				Kusnetz
		1.827	2804	17378	8552	RWLM
	Det 2					
	Run #4	1.790	2881	16404	8764	alpha spectroscopic
	Time: 0225	1.813	2867	16812	8772	total alpha
		1.813				Kusnetz
		1.776	2849	16779	8810	RWLM
	Det 2					
	Run #5	1.788	2827	15973	9250	alpha spectroscopic
	Time: 0311	1.838	2933	17104	8781	total alpha
		1.890				Kusnetz
		1.864	2831	17246	9263	RWLM
	Det 2					
	Run #6	1.852	2903	17142	9042	alpha spectroscopic
	Time: 0356	1.875	2902	17565	9005	total alpha
		2.574				Kusnetz
		1.841	2897	16721	[illegible]278	RWLM

		WL	RaA	RaB	RaC	Method
11/17/76	Det 2					
	Run #7	1.858	2903	16689	9593	alpha spectroscopic
	Time: 0442	1.884	2905	17181	9537	total alpha
		1.932				Kusnetz
		1.886	2950	16745	9922	RWLM
	Det 2					
	Run #8	1.844	2858	17030	9097	alpha spectroscopic
	Time: 0528	1.877	2911	17744	8849	total alpha
		2.017				Kusnetz
		1.886	2852	18003	8843	RWLM
	Det 2					
	Run #9	1.888	3053	16553	9967	alpha spectroscopic
	Time: 0614	1.957	3187	18084	9365	total alpha
		2.062				Kusnetz
		1.953	3032	17769	9886	RWLM
	Det 2					
	Run #10	1.916	2894	17874	9409	alpha spectroscopic
	Time: 0700	1.880	2674	16793	10259	total alpha
		1.994				Kusnetz
		1.913	2875	17450	9818	RWLM

Data Calculated from Calibration Runs
in Twilight Mine

		WL	RaA	RaB	RaC	Method
			(in units of atoms/liter)			
11/17/76	Det 1					
	Run #1	0.333	640	3055	1438	alpha spectroscopic
	Time: 1529	0.311	562	2510	1756	total alpha
		0.342				Kusnetz
		0.329	657	2882	1514	RWLM
	Det 1					
	Run #2	0.330	650	3027	1402	alpha spectroscopic
	Time: 1615	0.323	648	2895	1422	total alpha
		0.325				Kusnetz
		0.318	669	2752	1447	RWLM
	Det 1					
	Run #3	0.306	596	2766	1348	alpha spectroscopic
	Time: 1701	0.299	587	2633	1388	total alpha
		0.312				Kusnetz
		0.296	611	2519	1405	RWLM
	Det 1					
	Run #4	0.293	554	2772	1201	alpha spectroscopic
	Time: 1746	0.265	466	2083	1567	total alpha
		0.374				Kusnetz
		0.281	527	2629	1188	RWLM
	Det 1					
	Run #5	0.290	532	2727	1237	alpha spectroscopic
	Time: 1832	0.279	512	2483	1327	total alpha
		0.289				Kusnetz
		0.279	513	2499	1310	RWLM
	Det 1					
	Run #6	0.267	513	2265	1343	alpha spectroscopic
	Time: 1918	0.276	557	2509	1173	total alpha
		0.278				Kusnetz
		0.257	505	2036	1406	RWLM
	Det 1					
	Run #7	0.253	492	2257	1147	alpha spectroscopic
	Time: 2004	0.250	469	2163	1235	total alpha
		0.267				Kusnetz
		0.252	500	2250	1123	RWLM
	Det 1					
	Run # 8	0.255	475	2456	1017	alpha spectroscopic
	Time: 2050	0.245	441	2211	1155	total alpha
		0.244				Kusnetz
		0.256	477	2545	933	RWLM
	Det 1					
	Run #9	0.222	469	1894	1021	alpha spectroscopic
	Time: 2135	0.221	464	1864	1042	total alpha
		0.228				Kusnetz
		0.207	464	1597	1074	RWLM

the calculated beta efficiencies, and, fourth, these new coefficients

Date	Detector / Run	WL	RaA	RaB	RaC	Method
11/17/76	Det 1					
	Run #10	0.213	431	1889	942	alpha spectroscopic
	Time: 2221	0.205	405	1697	1047	total alpha
		0.223				Kusnetz
		0.230	427	2192	944	RWLM
	Det 2					
	Run #1	1.90	2871	17707	9268	alpha spectroscopic
	Time: 2301	1.90	2882	17821	9218	total alpha
		2.00				Kusnetz
		1.83	2891	16511	9299	RWLM
	Det 2					
	Run #2	1.85	2847	16555	9690	alpha spectroscopic
	Time: 2353	1.82	2772	15806	10018	total alpha
		1.91				Kusnetz
		1.85	2873	16402	9765	RWLM
11/18/76	Det 2					
	Run #3	1.864	2937	16752	9569	alpha spectroscopic
	Time: 0038	1.867	2952	16838	9509	total alpha
		2.017				Kusnetz
		1.869	2919	17028	9406	RWLM
	Det 2					
	Run #4	1.893	2848	17795	9167	alpha spectroscopic
	Time: 0124	1.865	2664	16959	9872	total alpha
		1.993				Kusnetz
		1.811	2857	16199	9367	RWLM
	Det 2					
	Run #5	1.836	2822	16839	9204	alpha spectroscopic
	Time: 0210	1.822	2803	16544	9297	total alpha
		1.913				Kusnetz
		1.835	2823	16695	9339	RWLM
	Det 2					
	Run #6	1.961	2975	18096	9797	alpha spectroscopic
	Time: 0256	1.902	2722	16549	10805	total alpha
		2.603				Kusnetz
		1.921	2963	17350	9890	RWLM
	Det 2					
	Run #7	2.007	2998	18929	9707	alpha spectroscopic
	Time: 0341	1.975	2863	18075	10249	total alpha
		2.089				Kusnetz
		2.006	2943	19097	9618	RWLM
	Det 2					
	Run #8	1.983	3022	18304	9874	alpha spectroscopic
	Time: 0427	1.980	3000	18213	9956	total alpha
		2.670				Kusnetz
		1.879	3011	16436	10012	RWLM
	Det 2					
	Run #9	1.973	2950	18687	9461	alpha spectroscopic
	Time: 0513	1.877	2596	16240	10897	total alpha
		2.048				Kusnetz
		1.929	2986	17934	9391	RWLM
	Det 2					
	Run #10	1.985	2976	18546	9750	alpha spectroscopic
	Time: 0559	1.972	2934	18234	9923	total alpha
		2.123				Kusnetz
		1.946	2937	17748	9955	RWLM

6.0 OPERATING INSTRUCTIONS

6.1 Normal Operation

6.1.1 Load the filter-paper transport mechanism. This is accomplished by removing the alpha-detector hold-down screw and swinging the detector assembly up. The feed and takeup reel covers can then be removed and the reels freed from the instrument by pulling the release plunger for each reel. Note that the reels are identical. The filter paper is then loaded onto the feed reel in such a manner that it is pulled from the top of the reel as it feeds to the sampling port (see Fig. 6). The paper is then placed in the guide slots, under the paper-advance bar, and attached to the takeup reel with a small piece of tape. The takeup reel is then advanced manually several revolutions to assume proper action. If the paper advance bar is not in the highest position, type a "J" on the terminal.

6.1.2 Assure that both the signal cable and the power cable are properly connected to the detector assemblies, and that these cables are also connected to the appropriate channel connector on the CPU.

6.1.3 Apply power to the central processing unit and the TI Silent 700 terminal.

6.1.4 Assure that the AC power in ON in the remote unit by observing the red lamp above the name plate.

6.1.5 If the lamp does not come on the power is applied, the internal switch is in the "off" position. Remove the cover plate and place the switch in the "on" position.

6.1.6 Place the control switch on the terminal to the "ON-LINE" position and press the restart button. The terminal should respond with:

REMOTE WORKING LEVEL MONITOR VERSION 11.0

TODAY IS XX/XX/XX THE TIME IS XX:XX

6.1.7 When first energized, the contents of the data memory locations are unspecified; to reset the system type:

R

The system will respond:

REMOTE WORKING LEVEL MONITOR VERSION 11.0

TODAY IS 00/00/00 THE TIME IS 00:00

6.1.8 To set the date and time, type

D

The system will respond:

ENTER YEAR-XX ENTER MONTH-XX ENTER DAY-XX

ENTER HOUR-XX ENTER MINUTE-XX

The operator must always enter a two-digit number, i.e., January is 01, etc. If a mistake is made in entry, continue typing or press the restart button and re-enter the "D": command. When all data has been entered, the system will respond:

TODAY IS XX/XX/XX THE TIME IS XX:XX

Note that the time function assumes a 24-hour clock. When in the command loop (indicated by an asterisk on the terminal), an "F" can be types to check the date and time.

6.1.9 If an altitude-correction factor other than 1.0 is desired, the operator can now type an "A". The system will respond:

SELECT HEAD 1 OR 2 -

The operator then types 1 or 2.

The system responds:

ENTER ALTITUDE CORRECTION FACTOR=

The operator then types in an appropriate number such as 1.053 or 0.9562. The sequence repeats to allow the operator to set the correction factor on the remaining head and then returns to the command loop.

6.1.10 The system is now ready for normal operation. To enter this mode the operator types a "G".

The system responds:

TODAY IS XX/XX/XX THE TIME IS XX:XX DATE CORRECT (Y/N)?

If date is correct, type "Y"; if not, type "N" and system will enter correction routine. When date is correct, system responds: DO YOU WANT DETECTOR 1 RUN (Y/N)? and waits for operator response.

After response the system types -

DO YOU WANT DETECTOR 2 RUN (Y/N)?

The system responds: (Operator response is indicated as Y or N)

ENTER TIME INTERVAL BETWEEN SAMPLES HOURS-XX MINS-XX

(Time interval must be greater than 14 minutes.)

ENTER TIME TO START HOUR-XX

MIN-XX

INPUT TIME TO STOP

ENTER YEAR-XX ENTER MONTH-XX ENTER DAY-XX

ENTER HOUR-XX ENTER MIN-XX

The system now enters the sampling loop and remains in it until:

a) tie time interval is complete.

b) an error is detected.

c) the reset button on the terminal is depressed.

Fig. 7 shows a complete dialogue between an operator and the system.

6.2 Source Check Mode

6.2.1 In order to provide a first-order check of the system functions, a source check mode has been provided. To use this mode the alpha-detector hold-down screw must be removed and the source holder inserted between the detectors. When it is properly inserted, it cannot be removed without slightly lifting the alpha detector holder assembly.

6.2.2 When the source holder is in place in the desired head or heads, type "S" to enter the Source Check Mode. The system will respond with:

SELECT HEAD 1 OR 2 - 1

SELECT MODE A - B - C - A

The system now proceeds to accumulate a two-minute count in the detector RaA channel. At the end of the counting time it will print a report. All normal calculations will be performed with the count data in the unselected channels set to 0.

This mode allows the operator to assure that the system is operating normally as the calculations for all source check modes should be consistent within statistical variances from day to day.

6.3 Calibration Mode

The calibration mode which has been described in section 4.0 is entered by typing a "C".

7.0 REFERENCES

An Instant Working Level Meter with Automatic Individual Radon Daughter Readout for Uranium Mines,
P. G. Groer, D. J. Keefe, W. P. McDowell, and R. F. Selman, Proc. 3rd Int. Congress of the International Radiation Protection Association, Part II: 950-956, 1973 (September). National Technical Information Service

Rapid Determination of Radon Daughter Concentrations and Working Level with the Instant Working Level Meter
P. G. Groer, D. J. Keefe, W. P. McDowell, and R. F. Selman, Int. Symp. on Radiation Protection in Mining and Milling of Uranium and Thorium, Bordeaux, France, 1974 (September).

A Portable Alpha Counter for Uranium Mines with Preset, Updated Readout,
D. J. Keefe, W. P. McDowell, and P. G. Groer, Int. Symp. on Radiation Protection in Mining and Milling of Uranium and Thorium, Bordeaux, France, 1974 (September).

Interfacing Calculator Chips to Nuclear-Counting Systems,
W. P. McDowell, E. J. Keefe, and P. G. Groer, IEEE Trans. Nucl. Sci., Vol. NS22, 467-472, 1975 (February).

APPENDIX A

This appendix contains the drawings of all mechanical parts. Copies of these drawings can be obtained from the reproducible master.

TABLE OF CONTENTS
FILTER TRANSPORT ASSEMBLY
MODEL 1A

Part #	Drawing #	Part Name and Description
	G0230-0003-PL-00	Parts List
	G0230-0003-DE-00	Assembly Drawing
1	G0230-0004-DC-00	Top Guide Plate
2	G0240-0005-DC-00	Right Side Plate
3	G0230-0006-DC-00	Left Side Plate
4	G0230-0007-DC-00	Actuating Plate Housing
5	G0230-0008-DC-00	Actuating Plate
6	G0230-0009-DC-00	Spool
7	G0230-0010-DC-00	Gear Housing
8	G0230-0011-DB-00	Gear Housing Shaft
9	G0230-0012-DB-00	Actuating Plate Cam
10	G0230-0013-DB-00	Actuating Plate Drive Rack
11	G0230-0014-DB-00	Actuating Plate Retaining Bar
12	G0230-0015-DB-00	Spool Plunger Spring.
13	G0230-0016-DB-00	Plunger Knob
14	G0230-0017-DB-00	Spool Retaining Plunger
15	G0230-0018-DB-00	Retaining Plunger Housing
16	G0230-0019-DB-00	Spacer Washer
17	G0230-0020-DB-00	Spool Shaft
18	G0230-0021-DB-00	Spool Bearing Housing
19	G0230-0022-DB-00	Spacer
20	G0230-0023-DB-00	Idler Gear Shaft
21	G0230-0024-DB-00	Drive Gear Bearing Housing
22	G0230-0025-DB-00	Drive Gear Shaft
23	G0230-0026-DB-00	Lower Tie Bar
24	G0230-0027-DB-00	Roller
25	G0230-0028-DB-00	Roller Shaft
26	G0230-0029-DB-00	Actuating Plate Roller Shaft
27	G0230-0030-DB-00	Hinge Pin
28	G0230-0031-DB-00	Mounting Plate Hinge Piece
29	G0230-0032-DB-00	Mounting Plate Hinge Bracket
30	G0230-0033-DB-00	Mounting Plate
31	G0230-0034-DB-00	Pressure Plate
32	G0230-0035-DB-00	Pressure Plate Guide Screw
33	G0230-0036-DB-00	Pressure Plate Support Spring
34	G0230-0037-DB-00	Stand off
35	G0230-0038-DB-00	Stand Off Shield
36	G0230-0039-DB-00	Stand Off Shield Insert
37	G0230-0040-DB-00	Shielding Cover
38	G0230-0041-DB-00	Cover Upper Shield Slug
39	G0230-0042-DB-00	Cover Lower Shield Disc
40	G0230-0043-DB-00	Tube Holder
41	G0230-0044-DB-00	Tube Holder Insert
42	G0230-0045-DB-00	Tube

Part #	Drawing #	Part Name and Description
43	G0230-0046-DB-00	Tube End Cap
44	G0230-0047-DB-00	Spacer Ring
45	G0230-0048-DB-00	Coil Bobbin
46	G0230-0049-DB-00	Supply Spool Shaft
47	G0230-0050-DB-00	Friction Washer
48	G0230-0051-DB-00	Tape Tension Adjustment Spring
49	G0230-0052-DB-00	Source Holder
50	G0230-0053-DB-00	Coil Shield Washer
51	G0230-0054-DB-00	Led Proximity Sensor Collet
52	G0230-0055-DB-00	Retaining Cap
53	G0230-0056-DB-00	Led Proximity sensor collet Housing
54	G0230-0057-DB-00	Counter Shield
55	G0230-0058-DB-00	Skanner Spacer
56	G0230-0059-DB-00	Worm 32P. 4th'Ds, 438PD

*APPENDIX B

TABLE OF CONTENTS
ANL - ELECTRONICS DIVISION
DRAWING # EL-C-7171

REMOTE WORKING LEVEL MONITOR (RWLM)

*This appendix contains the electronic circuit diagrams.
Copies of these diagrams can be obtained from the reproducible master.

APPENDIX C

This appendix contains the computer programs used in the development and calibration of the RWLM.

1. RWLM Floating Point Math Pack - Arithmetic and Utility Routines
2. RWLM Floating Point Math Pack - Format Conversion Routines
3. Math Pack Transfer Routine
4. Remote Working Level Monitor Control Program
5. RWLM Calibration Program
6. Table of Definitions of Symbols in the Calibration Program
7. Rn-daughter and Working Level Coefficient Program

```
00000006 SYSIN          LINE  ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE    1
00000007 SYSIN            1   3200                              ORG     3200H
00000008 SYSIN            2   3200  00 32               ARTHB           EQU         32H ;   BANK NUMBER OF ARITH PKG
00000009 SYSIN            3   3200  32 00               ARITH           EQU         $
00000010 SYSIN            4   3200  22 00               SCR     EQU     2200H
00000011 SYSIN            5   3200  00 22               SCRB            EQU         22H ;      BANK NUMBER OF SCRATCH
00000012 SYSIN            6                             ;       8080 BINARY FLOATING POINT SYSTEM
00000013 SYSIN            7                             ;       PROGRAMMER CAL OHME
00000014 SYSIN            8                             ;       DATE 26 DECEMBER 1973
00000015 SYSIN            9                             ;       ARITH IS THE BEGINNING ADDRESS OF THE
00000016 SYSIN           10                             ;       ARITHMETIC AND UTILITY PACKAGE OF THE FLOATING
00000017 SYSIN           11                             ;       POINT SYSTEM.
00000018 SYSIN           12                             ;       SCR IS THE BEGINNING ADDRESS OF THE
00000019 SYSIN           13                             ;       RAM USED AS SCRATCPAD FOR THE SYSTEM.
00000020 SYSIN           14                             ;       THE RAM MULTIPLY AND DIVIDE SUBROUTINES
00000021 SYSIN           15                             ;       ARE MOVED FROM ROM TO RAM BY SUBROUTINE
00000022 SYSIN           16                             ;       INIT AND ARE EXECUTED IN RAM ONLY.
00000023 SYSIN           17                             ;       RAM MULTIPLY SUBROUTINE.
00000024 SYSIN           18   3200  22 00               MULX4           EQU         $-ARITH+SCR
00000025 SYSIN           19   3200  C6 00                       ADI     0 ;          ADD OPERAND 3RD FRACTION
00000026 SYSIN           20   3202  00 01               MULP3           EQU         $-1-ARITH
00000027 SYSIN           21   3202  5F                          MOV     E,A ;        4TH PARTIAL PRODUCT
00000028 SYSIN           22   3203  7A                          MOV     A,D ;        3RD PARTIAL PRODUCT
00000029 SYSIN           23   3204  CE 00                       ACI     0 ;          ADD OPERAND 2ND FRACTION
00000030 SYSIN           24   3206  00 05               MULP2           EQU         $-1-ARITH
00000031 SYSIN           25   3206  57                          MOV     D,A ;        3RD PARTIAL PRODUCT
00000032 SYSIN           26   3207  79                          MOV     A,C ;        2ND PARTIAL PRODUCT
00000033 SYSIN           27   3208  CE 00                       ACI     0 ;          ADD OPERAND 1ST FRACTION
00000034 SYSIN           28   320A  00 09               MULP1           EQU         $-1-ARITH
00000035 SYSIN           29   320A  C3 73 34                    JMP     MULX5 ; TO ROM CODE
00000036 SYSIN           30                             ;       RAM DIVIDE SUBROUTINE.
00000037 SYSIN           31   320D  22 0D               DIVX5           EQU         $-ARITH+SCR
00000038 SYSIN           32   320D  D6 00                       SUI     0 ;          SUB DIVISOR 4TH FRACTION
00000039 SYSIN           33   320F  00 0E               OP4S            EQU         $-1-ARITH
00000040 SYSIN           34   320F  7D                          MOV     A,L ;        REMAINDER 3RD FRACTION
00000041 SYSIN           35   3210  DE 00                       SBI     0 ;          SUB DIVISOR 3RD FRACTION
00000042 SYSIN           36   3212  00 11               OP3S            EQU         $-1-ARITH
00000043 SYSIN           37   3212  6F                          MOV     L,A ;        REMAINDER 3RD FRACTION
00000044 SYSIN           38   3213  7C                          MOV     A,H ;        REMAINDER 2ND FRACTION
00000045 SYSIN           39   3214  DE 00                       SBI     0 ;          SUB DIVISOR 2ND FRACTION
00000046 SYSIN           40   3216  00 15               OP2S            EQU         $-1-ARITH
00000047 SYSIN           41   3216  67                          MOV     H,A ;        REMAINDER 2ND FRACTION
00000048 SYSIN           42   3217  7B                          MOV     A,E ;        REMAINDER 1ST FRACTION
00000049 SYSIN           43   3218  DE 00                       SBI     0 ;          SUB DIVISOR 1ST FRACTION
00000050 SYSIN           44   321A  00 19               OP1S            EQU         $-1-ARITH
00000051 SYSIN           45   321A  5F                          MOV     E,A ;        REMAINDER 1ST FRACTION
00000052 SYSIN           46   321B  3E 00                       MVI     A,0 ;        REMAINDER 4TH FRACTION
00000053 SYSIN           47   321D  00 1C               OP4A            EQU         $-1-ARITH
00000054 SYSIN           48   321D  C9                          RET       ;          RETURN TO ROM
00000055 SYSIN           49   321E  22 1E               DIVX6           EQU         $-ARITH+SCR
00000056 SYSIN           50   321E  C6 00                       ADI     0 ;          ADD DIVISOR 3RD FRACTION
00000057 SYSIN           51   3220  00 1F               OP3A            EQU         $-1-ARITH
00000058 SYSIN           52   3220  6F                          MOV     L,A ;        REMAINDER 3RD FRACTION
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00000061 SYSIN      LINE  ADDR   B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE    2
00000062 SYSIN        53  3221   7C                          MOV     A,H ;        REMAINDER 2ND FRACTION
00000063 SYSIN        54  3222   CE 00                       ACI     0 ;          ADD DIVISOR 2ND FRACTION
00000064 SYSIN        55  3224   00 23                   OP2A        EQU       $-1-ARITH
00000065 SYSIN        56  3224   67                          MOV     H,A ;        REMAINDER 2ND FRACTION
00000066 SYSIN        57  3225   7B                          MOV     A,E ;        REMAINDER 1ST FRACTION
00000067 SYSIN        58  3226   CE 00                       ACI     0 ;          ADD DIVISOR 1ST FRACTION
00000068 SYSIN        59  3228   00 27                   OP1A        EQU       $-1-ARITH
00000069 SYSIN        60  3228   5F                          MOV     E,A ;        REMAINDER 1ST FRACTION
00000070 SYSIN        61  3229   3E 00                       MVI     A,0 ;        REMAINDER 4TH FRACTION
00000071 SYSIN        62  322B   00 2A                   OP4X        EQU       $-1-ARITH
00000072 SYSIN        63  322B   C3 DF 34                    JMP     DIVX2 ; TO ROM CODE
00000073 SYSIN        64                                 ;       RAM LOCATIONS USED BY THE BINARY
00000074 SYSIN        65                                 ;       FLOATING POINT SYSTEM.
00000075 SYSIN        66  322E   00 2E                   OVER        EQU       $-ARITH
00000076 SYSIN        67  322E   00                          DB      0 ;          INITIALLY CLEAR
00000077 SYSIN        68  322F   00 2F                   PREX        EQU       OVER+1 ; PREVIOUS EXPONENT
00000078 SYSIN        69  322F   00 30                   ACCE        EQU       PREX+1 ; ACCUMULATOR EXPONENT
00000079 SYSIN        70  322F   00 31                   ACCS        EQU       ACCE+1 ; ACCUMULATOR SIGN
00000080 SYSIN        71  322F   00 32                   ACC1        EQU       ACCS+1 ; ACCUMULATOR 1ST FRACTION
00000081 SYSIN        72  322F   00 33                   ACC2        EQU       ACC1+1 ; ACCUMULATOR 2ND FRACTION
00000082 SYSIN        73  322F   00 34                   ACC3        EQU       ACC2+1 ; ACCUMULATOR 3RD FRACTION
00000083 SYSIN        74  322F   00 35                   SF      EQU     ACC3+1 ; SUBTRACTION FLAG
00000084 SYSIN        75                                 ;       INIT SUBROUTINE ENTRY POINT
00000085 SYSIN        76  322F   2E 2F                   INIT:       MVI       L,PREX ;  TO ADDR LAST WD TO MOVE
00000086 SYSIN        77  3231   26 32                   INIT1:      MVI       H,ARTHB ; TO ADDRESS ROM COPY
00000087 SYSIN        78  3233   5E                          MOV     E,M ;        CURRENT WORD OF ROM COPY
00000088 SYSIN        79  3234   26 22                       MVI     H,SCRB ;     TO ADDRESS RAM COPY
00000089 SYSIN        80  3236   73                          MOV     M,E ;        WRITE CURRENT WD TO RAM
00000090 SYSIN        81  3237   2D                          DCR     L ;          DECREMENT WORD ADDRESS
00000091 SYSIN        82  3238   F2 31 32                    JP      INIT1 ; IF MORE TO MOVE
00000092 SYSIN        83  323B   C9                          RET     ;            RETURN TO CALLER
00000093 SYSIN        84                                 ;       STR SUBROUTINE ENTRY POINT.
00000094 SYSIN        85  323C   73                      STR0:       MOV       M,E ;        STORE ZEROETH WORD
00000095 SYSIN        86  323D   2C                          INR     L ;          TO ADDRESS FIRST WORD
00000096 SYSIN        87  323E   77                      STR:  MOV   M,A ;        STORE FIRST WORD
00000097 SYSIN        88  323F   2C                      STR1:       INR       L ;  TO ADDRESS SECOND WORD
00000098 SYSIN        89  3240   70                          MOV     M,B ;        STORE SECOND WORD
00000099 SYSIN        90  3241   2C                          INR     L ;          TO ADDRESS THIRD WORD
00000100 SYSIN        91  3242   71                          MOV     M,C ;        STORE THIRD WORD
00000101 SYSIN        92  3243   2C                          INR     L ;          TO ADDRESS FOURTH WORD
00000102 SYSIN        93  3244   72                          MOV     M,D ;        STORE FOURTH WORD
00000103 SYSIN        94  3245   C9                          RET     ;            RETURN TO CALLER
00000104 SYSIN        95                                 ;       FLOATING POINT ZRO SUBROUTINE ENT. PNT.
00000105 SYSIN        96  3246   26 22                   ZRO:  MVI   H,SCRB ;     TO ADDRESS SCRATCH BANK
00000106 SYSIN        97  3248   2E 30                   ZRO1:       MVI       L,ACCE    ;  TO ADDR ACCUM EXPON
00000107 SYSIN        98  324A   AF                          XRA     A ;          ZERO
00000108 SYSIN        99  324B   77                          MOV     M,A ;        CLEAR ACCUMULATOR EXPONENT
00000109 SYSIN       100  324C   C9                          RET     ;            RETURN TO CALLER
00000110 SYSIN       101                                 ;       FLOATING POINT CHS SUBROUTINE ENT. PNT.
00000111 SYSIN       102  324D   3E 80                   CHS:  MVI   A,200Q ;     MASK FOR SIGN BIT
00000112 SYSIN       103  324F   0E                          DB      016Q ;       LBI INST TO SKIP NEXT WD
00000113 SYSIN       104                                 ;       FLOATING POINT ABS SUBROUTINE ENT. PNT.
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00000116 SYSIN          LINE  ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE    3
00000117 SYSIN           105  3250  AF                  ABS:  XRA    A ;          ZERO
00000118 SYSIN           106  3251  26 22                     MVI    H,SCRB ;     TO ADDRESS SCRATCH BANK
00000119 SYSIN           107  3253  2E 31                     MVI    L,ACCS ;     TO ADDRESS ACCUM SIGN
00000120 SYSIN           108  3255  A6                        ANA    M            ;    COMPLEMENT OF SIGN
00000121 SYSIN           109  3256  EE 80                     XRI    200Q ;       COMPLEMENT THE SIGN BIT
00000122 SYSIN           110  3258  77                        MOV    M,A ;        ACCUMULATOR SIGN
00000123 SYSIN           111                            ;     FLOATING POINT TEST ENTRY POINT.
00000124 SYSIN           112  3259  26 22               TST:  MVI    H,SCRB ;     TO ADDRESS SCRATCH BANK
00000125 SYSIN           113  325B  2E 30               TST1:        MVI         L,ACCE ;   TO ADDR ACCUM EXPONENT
00000126 SYSIN           114  325D  7E                        MOV    A,M ;        ACCUMULATOR EXPONENT
00000127 SYSIN           115  325E  A7                        ANA    A            ;    SET CONTROL BITS
00000128 SYSIN           116  325F  CA 46 32                  JZ     ZRO ;        IF ACCUMULATOR IS ZERO
00000129 SYSIN           117  3262  5F                        MOV    E,A ;        ACCUMULATOR EXPONENT
00000130 SYSIN           118  3263  2C                        INR    L ;          TO ADDR ACCUMULATOR SIGN
00000131 SYSIN           119  3264  7E                        MOV    A,M ;        ACCUMULATOR SIGN
00000132 SYSIN           120  3265  2C                        INR    L ;          TO ADDR ACCUM 1ST FRCTN
00000133 SYSIN           121  3266  AE                        XRA    M ;          ACCUM SIGN AND 1ST FRCTN
00000134 SYSIN           122  3267  2C                        INR    L ;          TO ADDR ACCUM 2ND FRCTN
00000135 SYSIN           123  3268  4E                        MOV    C,M ;        ACCUMULATOR 2ND FRACTION
00000136 SYSIN           124  3269  2C                        INR    L ;          TO ADDR ACCUM 3RD FRCTN
00000137 SYSIN           125  326A  56                        MOV    D,M ;        ACCUMULATOR 3RD FRCTN
00000138 SYSIN           126  326B  C3 7A 33                  JMP    ADD12 ;      TO SET EXIT CONDITIONS
00000139 SYSIN           127                            ;     FLOATING POINT LOAD ENTRY POINT.
00000140 SYSIN           128  326E  7E                  LOD:  MOV    A,M ;        OPERAND EXPONENT
00000141 SYSIN           129  326F  A7                        ANA    A            ;    SET CONTROL BITS
00000142 SYSIN           130  3270  CA 46 32                  JZ     ZRO ;        IF OPERAND IS ZERO
00000143 SYSIN           131  3273  5F                        MOV    E,A ;        OPERAND EXPONENT
00000144 SYSIN           132  3274  2C                        INR    L ;          TO ADDR OP SIGN AND 1ST
00000145 SYSIN           133  3275  7E                        MOV    A,M ;        OPERAND SIGN AND 1ST FRCTN
00000146 SYSIN           134  3276  2C                        INR    L ;          TO ADDRESS OPERAND 2ND FRACTION
00000147 SYSIN           135  3277  4E                        MOV    C,M ;        OPERAND 2ND FRACTION
00000148 SYSIN           136  3278  2C                        INR    L ;          TO ADDRESS OPERAND 3RD FRACTION
00000149 SYSIN           137  3279  56                        MOV    D,M ;        OPERAND 3RD FRACTION
00000150 SYSIN           138                            ;     STORE THE OPERAND IN THE ACCUMULATOR.
00000151 SYSIN           139  327A  6F                        MOV    L,A ;        OPERAND SIGN AND 1ST FRCTN
00000152 SYSIN           140  327B  F6 80               LOD1:        ORI         200Q ;    ACCUMULATOR 1ST FRACTI
00000153 SYSIN           141  327D  47                        MOV    B,A ;        ACCUMULATOR 1ST FRACTION
00000154 SYSIN           142  327E  AD                        XRA    L ;          ACCUMULATOR SIGN
00000155 SYSIN           143  327F  26 22                     MVI    H,SCRB ;     TO ADDRESS SCRATCH BANK
00000156 SYSIN           144  3281  2E 30                     MVI    L,ACCE ;     TO ADDR ACCUM EXPONENT
00000157 SYSIN           145  3283  CD 3C 32                  CALL   SIRO ;       SET THE ACCUMULATOR
00000158 SYSIN           146  3286  A8                        XRA    B ;          ACCUM SIGN AND 1ST FRCTN
00000159 SYSIN           147                            ;     SET CONTROL BITS AND EXIT
00000160 SYSIN           148  3287  47                        MOV    B,A ;        ACCUM SIGN AND 1ST FRACTION
00000161 SYSIN           149  3288  F6 01                     ORI    1 ;          SET SIGN BIT FOR EXIT
00000162 SYSIN           150  328A  7B                        MOV    A,E ;        ACCUMULATOR EXPONENT
00000163 SYSIN           151  328B  C9                        RET    ;            RETURN TO CALLER
00000164 SYSIN           152                            ;     FLOATING POINT MUL SUBROUTINE ENT. PNT.
00000165 SYSIN           153  328C  7E                  MUL:  MOV    A,M ;        OPERAND EXPONENT
00000166 SYSIN           154  328D  A7                        ANA    A            ;    SET CONTROL BITS
00000167 SYSIN           155  328E  C4 95 33                  CNZ    MDEX ;       READ OPERAND IF NOT ZERO
00000168 SYSIN           156  3291  CA 46 32                  JZ     ZRO    ;        IF ZERO OR UNDERFLOW
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00000171 SYSIN    LINE  ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE    4
00000172 SYSIN     157  3294  DA CA 32                    JC      OVERF ; IF OVERFLOW
00000173 SYSIN     158  3297  CD 4D 34                    CALL    MULX ;       CALL FIXED MULT SUBRTN
00000174 SYSIN     159                            ;       NORMALIZE IF NECESSARY.
00000175 SYSIN     160  329A  78                          MOV     A,B ;        1ST PRODUCT
00000176 SYSIN     161  329B  A7                          ANA     A            ;   SET CONTROL BITS
00000177 SYSIN     162  329C  FA A9 32                    JM      RNDA ;       IF NO NORMALIZATION REQUIRED
00000178 SYSIN     163  329F  2E 3C                       MVI     L,ACCE    ;    TO ADDR ACCUM EXPONENT
00000179 SYSIN     164  32A1  7E                          MOV     A,M ;        ACCUMULATOR EXPONENT
00000180 SYSIN     165  32A2  DE 01                       SBI     1 ;          DECREMENT ACCUMULATOR EXPONENT
00000181 SYSIN     166  32A4  77                          MOV     M,A ;        ACCUMULATOR EXPONENT
00000182 SYSIN     167  32A5  C8                          RZ       ;           RETURN TO CALLER IF UNDERFLOW
00000183 SYSIN     168  32A6  CD BC 33                    CALL    LSH ;        CALL LEFT SHIFT SUBROUTINE
00000184 SYSIN     169                            ;       ROUND IF NECESSARY.
00000185 SYSIN     170  32A9  CD 30 34            RNDA:           CALL        ROND ;     CALL ROUNDING SUBROUTI
00000186 SYSIN     171  32AC  DA CA 32                    JC      OVERF ; IF OVERFLOW
00000187 SYSIN     172  32AF  47                          MOV     B,A ;        ACCUM SIGN AND 1ST FRACTION
00000188 SYSIN     173  32B0  F6 01                       ORI     1 ;          SET SIGN BIT
00000189 SYSIN     174  32B2  7B                          MOV     A,E ;        ACCUMULATOR EXPONENT
00000190 SYSIN     175  32B3  C9                          RET      ;           RETURN TO CALLER
00000191 SYSIN     176                            ;       FLOATING POINT DIV SUBROUTINE ENT. PNT.
00000192 SYSIN     177  32B4  AF                  DIV:    XRA     A ;          ZERO
00000193 SYSIN     178  32B5  96                          SUB     M ;          COMPLEMENT OF DIVISOR EXPONENT
00000194 SYSIN     179  32B6  FE 01                       CPI     1 ;          SET CARRY IF DIVISION BY ZERO
00000195 SYSIN     180  32B8  D4 95 33                    CNC     MDEX ;       READ OPERAND IF NOT ZERO
00000196 SYSIN     181  32BB  DA CA 32                    JC      OVERF ;      IF OVERFLOW OR DIVISION BY ZERO
00000197 SYSIN     182  32BE  CA 48 32                    JZ      ZRO1 ;       IF UNDERFLOW OR ZERO
00000198 SYSIN     183  32C1  4F                          MOV     C,A ;        DIVISOR 1ST FRACTION
00000199 SYSIN     184  32C2  CD 90 34                    CALL    DIVX ;       CALL FIXED DIV SUBRTN
00000200 SYSIN     185  32C5  26 22                       MVI     H,SCRB ;     TO ADDRESS SCRATCH BANK
00000201 SYSIN     186  32C7  DA A9 32                    JC      RNDA ;       IF NO OVERFLOW
00000202 SYSIN     187                            ;       SET OVERFLOW FLAG.
00000203 SYSIN     188  32CA  26 22               OVERF:          MVI         H,SCRB ;   TO ADDRESS SCRATCH BAN
00000204 SYSIN     189  32CC  2E 2E                       MVI     L,OVER ;     TO ADDR OVERFLOW FLAG
00000205 SYSIN     190  32CE  3E FF                       MVI     A,377Q ;     OVERFLOW FLAG
00000206 SYSIN     191  32D0  77                          MOV     M,A ;        OVERFLOW FLAG
00000207 SYSIN     192  32D1  07                          RLC      ;           SET CARRY BIT FOR EXIT
00000208 SYSIN     193  32D2  C9                          RET      ;           RETURN TO CALLER
00000209 SYSIN     194  32D3  00                          DB      0 ;          CHECK SUM WORD
00000210 SYSIN     195                            ;       FLOATING POINT SUB SUBROUTINE ENT. PNT.
00000211 SYSIN     196  32D4  3E 80               SB:     MVI     A,200Q ;     MASK TO CHANGE OP SIGN
00000212 SYSIN     197  32D6  0E                          DB      016Q ;       LBI INST TO SKIP NEXT WD
00000213 SYSIN     198                            ;       FLOATING POINT ADD SUBROUTINE ENT. PNT.
00000214 SYSIN     199  32D7  AF                  AD:     XRA     A ;          ZERO
00000215 SYSIN     200                            ;       LOAD THE OPERAND.
00000216 SYSIN     201  32D8  5E                          MOV     E,M ;        OPERAND EXPONENT
00000217 SYSIN     202  32D9  2C                          INR     L ;          TO ADDR OP SIGN, 1ST FRCTN
00000218 SYSIN     203  32DA  AE                          XRA     M ;          OPERAND SIGN AND 1ST FRCTN
00000219 SYSIN     204  32DB  47                          MOV     B,A ;        OPERAND SIGN AND 1ST FRCTN
00000220 SYSIN     205  32DC  2C                          INR     L ;          TO ADDR OPERAND 2ND
00000221 SYSIN     206  32DD  4E                          MOV     C,M ;        OPERAND 2ND FRACTION
00000222 SYSIN     207  32DE  2C                          INR     L ;          TO ADDR OPERAND 3RD FRCTN
00000223 SYSIN     208  32DF  56                          MOV     D,M ;        OPERAND 3RD FRACTION
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00000226 SYSIN          LINE  ADDR  B1 B2 B3 B4 ERROR    SOURCE  INTEL 8080 ASSEMBLER  PAGE    5
00000227 SYSIN           209                              ;      SAVE INITIAL EXPONENT.
00000228 SYSIN           210  32E3  26 22                        MVI    H,SCRB ;     TO ADDRESS SCRATCH BANK
00000229 SYSIN           211  32E2  2E 30                        MVI    L,ACCE ;     TO ADDR ACCUM EXPONENT
00000230 SYSIN           212  32E4  7E                           MOV    A,M ;        ACCUMULATOR EXPONENT
00000231 SYSIN           213  32E5  2D                           DCR    L ;          TO ADDR INITIAL EXPONENT
00000232 SYSIN           214  32E6  77                           MOV    M,A ;        INITIAL EXPONENT
00000233 SYSIN           215                              ;      CHECK FOR ZERO OPERAND.
00000234 SYSIN           216  32E7  7B                           MOV    A,E ;        OPERAND EXPONENT
00000235 SYSIN           217  32E8  A7                           ANA    A            ;     SET CONTROL BITS
00000236 SYSIN           218  32E9  CA 5B 32                     JZ     TST1 ;       IF OPERAND IS ZERO
00000237 SYSIN           219                              ;      GENERATE SUBTRACTION FLAG, RESTORE
00000238 SYSIN           220                              ;      SUPPRESSED FRACTION BIT.
00000239 SYSIN           221  32EC  68                           MOV    L,B ;        OPERAND SIGN AND 1ST FRCTN
00000240 SYSIN           222  32ED  78                           MOV    A,B ;        OPERAND SIGN AND 1ST FRACTION
00000241 SYSIN           223  32EE  F6 80                        ORI    200Q ;       OPERAND 1ST FRACTION
00000242 SYSIN           224  32F0  47                           MOV    B,A ;        OPERAND 1ST FRACTION
00000243 SYSIN           225  32F1  AD                           XRA    L ;          OPERAND SIGN
00000244 SYSIN           226  32F2  2E 31                        MVI    L,ACCS ;     TO ADDRESS ACCUMULATOR SIGN
00000245 SYSIN           227  32F4  AE                           XRA    M ;          SUBTRACTION FLAG
00000246 SYSIN           228  32F5  2E 35                        MVI    L,SF ;       TO ADDRESS SUBTRACTION FLAG
00000247 SYSIN           229  32F7  77                           MOV    M,A ;        SUBTRACTION FLAG
00000248 SYSIN           230                              ;      DETERMINE RELATIVE MAGNITUDES OF
00000249 SYSIN           231                              ;      OPERAND AND ACCUMULATOR.
00000250 SYSIN           232  32F8  2E 30                        MVI    L,ACCE ;     TO ADDRESS ACCUMULATOR EXPONENT
00000251 SYSIN           233  32FA  7E                           MOV    A,M ;        ACCUMULATOR EXPONENT
00000252 SYSIN           234  32FB  A7                           ANA    A            ;     SET CONTROL BITS
00000253 SYSIN           235  32FC  CA 86 33                     JZ     ADD17 ; IF ACCUMULATOR IS ZERO
00000254 SYSIN           236  32FF  93                           SUB    E ;          DIFFERENCE IN EXPONENTS
00000255 SYSIN           237  3300  DA 0E 33                     JC     ADD2 ;       IF ACCUM SMALLER THAN OP
00000256 SYSIN           238                              ;      CHECK FOR INSIGNIFICANT OPERAND.
00000257 SYSIN           239  3303  FA 5B 32                     JM     TST1 ;       IF THE OPERAND IS INSIGNIFICANT
00000258 SYSIN           240  3306  FE 19                        CPI    031Q ;       COMPARE SHIFT COUNT TO 25
00000259 SYSIN           241  3308  DA 2D 33                     JC     ADD3 ;       JOIN EXCH PATH IF OP SIGNIF
00000260 SYSIN           242  330B  C3 5B 32                     JMP    TST1 ;       OPERAND IS INSIGNIFICANT
00000261 SYSIN           243                              ;      CHECK FOR INSIGNIFICANT ACCUMULATOR
00000262 SYSIN           244  330E  F2 86 33              ADD2:         JP           ADD17 ;     IF ACCUM IS INSIGNIFIC
00000263 SYSIN           245  3311  FE E7                        CPI    347Q ;       COMPARE SHIFT COUNT TO MINUS 25
00000264 SYSIN           246  3313  DA 86 33                     JC     ADD17 ;      IF ACCUM IS INSIGNIFICANT
00000265 SYSIN           247  3316  73                           MOV    M,E ;        OPERAND EXPONENT
00000266 SYSIN           248  3317  5F                           MOV    E,A ;        SHIFT COUNT
00000267 SYSIN           249  3318  2E 35                        MVI    L,SF ;       TO ADDRESS THE SUBTRACTION FLAG
00000268 SYSIN           250  331A  7E                           MOV    A,M ;        SUBTRACTION FLAG
00000269 SYSIN           251  331B  2E 31                        MVI    L,ACCS ;     TO ADDRESS THE ACCUMULATOR SIGN
00000270 SYSIN           252  331D  AE                           XRA    M ;          OPERAND SIGN
00000271 SYSIN           253  331E  77                           MOV    M,A ;        ACCUMULATOR SIGN
00000272 SYSIN           254  331F  AF                           XRA    A ;          ZERO
00000273 SYSIN           255  3320  93                           SUB    E ;          COMPLEMENT SHIFT COUNT
00000274 SYSIN           256                              ;      EXCHANGE ACCUMULATOR AND OPERAND.
00000275 SYSIN           257  3321  2C                           INR    L ;          TO ADDR ACCUM 1ST FRACTION
00000276 SYSIN           258  3322  5E                           MOV    E,M ;        ACCUMULATOR 1ST FRACTION
00000277 SYSIN           259  3323  70                           MOV    M,B ;        OPERAND 1ST FRACTION
00000278 SYSIN           260  3324  43                           MOV    B,E ;        ACCUMULATOR 1ST FRACTION
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00000281 SYSIN    LINE  ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE   6
00000282 SYSIN    261   3325  2C                          INR    L ;           TO ADDR ACCUM 2ND FRACTION
00000283 SYSIN    262   3326  5E                          MOV    E,M ;         ACCUMULATOR 2ND FRACTION
00000284 SYSIN    263   3327  71                          MOV    M,C ;         OPERAND 2ND FRACTION
00000285 SYSIN    264   3328  4B                          MOV    C,E ;         ACCUMULATOR 2ND FRACTION
00000286 SYSIN    265   3329  2C                          INR    L ;           TO ADDR ACCUM 3RD FRACTION
00000287 SYSIN    266   332A  5E                          MOV    E,M ;         ACCUMULATOR 3RD FRACTION
00000288 SYSIN    267   332B  72                          MOV    M,D ;         OPERAND 3RD FRACTION
00000289 SYSIN    268   332C  53                          MOV    D,E ;         ACCUMULATOR 3RD FRACTION
00000290 SYSIN    269                             ;       POSITION THE OPERAND.
00000291 SYSIN    270   332D  CD C9 33            ADD3:          CALL          RSH ;      POSITION THE OPERAND
00000292 SYSIN    271   3330  2E 35                       MVI    L,SF ;        TO ADDRESS SUBTRACTION FLAG
00000293 SYSIN    272   3332  7E                          MOV    A,M ;         SUBTRACTION FLAG
00000294 SYSIN    273   3333  A7                          ANA    A             ;    SET CONTROL BITS
00000295 SYSIN    274   3334  2E 34                       MVI    L,ACC3 ;      TO ADDR ACCUM 3RD FRCTN
00000296 SYSIN    275   3336  FA 5D 33                    JM     ADD9 ;        IF SUBTRACTION REQUIRED
00000297 SYSIN    276                             ;       ADD ADDEND TO AUGEND.
00000298 SYSIN    277   3339  7E                          MOV    A,M ;         AUGEND 3RD FRACTION
00000299 SYSIN    278   333A  82                          ADD    D ;           ADDEND 3RD FRACTION
00000300 SYSIN    279   333B  57                          MOV    D,A ;         SUM 3RD FRACTION
00000301 SYSIN    280   333C  2D                          DCR    L ;           TO ADDRESS AUGEND 2ND FRACTION
00000302 SYSIN    281   333D  7E                          MOV    A,M ;         AUGEND 2ND FRACTION
00000303 SYSIN    282   333E  89                          ADC    C ;           ADDEND 2ND FRACTION
00000304 SYSIN    283   333F  4F                          MOV    C,A ;         SUM 2ND FRACTION
00000305 SYSIN    284   3340  2D                          DCR    L ;           TO ADDRESS AUGEND 1ST FRACTION
00000306 SYSIN    285   3341  7E                          MOV    A,M ;         AUGEND 1ST FRACTION
00000307 SYSIN    286   3342  88                          ADC    B ;           ADDEND 1ST FRACTION
00000308 SYSIN    287   3343  47                          MOV    B,A ;         SUM 1ST FRACTION
00000309 SYSIN    288   3344  D2 74 33                    JNC    ADD11 ;       IF NO CARRY FROM 1ST FRCTN
00000310 SYSIN    289                             ;       RIGHT SHIFT SUM TO NORMALIZED POSITION.
00000311 SYSIN    290   3347  1F                          RAR    ;             RIGHT SHIFT SUM 1ST FRACTION
00000312 SYSIN    291   3348  47                          MOV    B,A ;         SUM 1ST FRACTION
00000313 SYSIN    292   3349  79                          MOV    A,C ;         SUM 2ND FRACTION
00000314 SYSIN    293   334A  1F                          RAR    ;             RIGHT SHIFT SUM 2ND FRACTION
00000315 SYSIN    294   334B  4F                          MOV    C,A ;         SUM 2ND FRACTION
00000316 SYSIN    295   334C  7A                          MOV    A,D ;         SUM 3RD FRACTION
00000317 SYSIN    296   334D  1F                          RAR    ;             RIGHT SHIFT SUM 3RD FRACTION
00000318 SYSIN    297   334E  57                          MOV    D,A ;         SUM 3RD FRACTION
00000319 SYSIN    298   334F  1F                          RAR    ;             4TH FRCTN = LOW BIT OF 3RD
00000320 SYSIN    299   3350  5F                          MOV    E,A ;         SUM 4TH FRACTION
00000321 SYSIN    300   3351  2E 30                       MVI    L,ACCE ;      TO ADDRESS ACCUMULATOR EXPONENT
00000322 SYSIN    301   3353  7E                          MOV    A,M ;         ACCUMULATOR EXPONENT
00000323 SYSIN    302   3354  C6 01                       ADI    1 ;           INCREMENT ACCUMULATOR EXPONENT
00000324 SYSIN    303   3356  DA CA 32                    JC     OVERF ;       IF OVERFLOW
00000325 SYSIN    304   3359  77                          MOV    M,A ;         ACCUMULATOR EXPONENT
00000326 SYSIN    305   335A  C3 74 33                    JMP    ADD11 ;       TO ROUND FRACTION
00000327 SYSIN    306                             ;       SUBTRACT SUBTRAHEND FROM MINUEND.
00000328 SYSIN    307   335D  AF                  ADD9:          XRA           A ;   MINUEND 4TH FRCTN IS ZERO
00000329 SYSIN    308   335E  93                          SUB    E ;           SUBTRAHEND 4TH FRACTION
00000330 SYSIN    309   335F  5F                          MOV    E,A ;         DIFFERENCE 4TH FRACTION
00000331 SYSIN    310   3360  7E                          MOV    A,M ;         MINUEND 3RD FRACTION
00000332 SYSIN    311   3361  9A                          SBB    D ;           SUBTRAHEND 3RD FRACTION
00000333 SYSIN    312   3362  57                          MOV    D,A ;         DIFFERENCE 3RD FRACTION
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ADDR   B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE   7
3363   2D                          DCR    L ;          TO ADDRESS MINUEND 2ND FRACTION
3364   7E                          MOV    A,M ;        MINUEND 2ND FRACTION
3365   99                          SBB    C ;          SUBTRAHEND 2ND FRACTION
3366   4F                          MOV    C,A ;        DIFFERENCE 2ND FRACTION
3367   2D                          DCR    L ;          TO ADDRESS MINUEND 1ST FRACTION
3368   7E                          MOV    A,M ;        MINUEND 1ST FRACTION
3369   98                          SBB    B ;          SUBTRAHEND 1ST FRACTION
336A   47                          MOV    B,A ;        DIFFERENCE 1ST FRACTION
336B   DC EF 33            ADD10:         CC          COMP ;     COMPLEMENT IF NEGATIVE
336E   F4 02 34                    CP     NORM ;       NORMALIZE IF NECESSARY
3371   F2 48 32                    JP     ZRO1 ;       IF UNDERFLOW OR ZERO
3374   CD 30 34            ADD11:         CALL        ROND ;     CALL ROUNDING SUBROUTI
3377   DA CA 32                    JC     OVERF ;      IF OVERFLOW
337A   47                  ADD12:         MOV         B,A ;      ACCUM SIGN AND 1ST FRC
337B   2E 2F                       MVI    L,PREX ;     TO ADDRESS PREV EXPONENT
337D   7B                          MOV    A,E ;        ACCUMULATOR EXPONENT
337E   96                          SUB    M ;          DIFFERENCE IN EXPONENTS
337F   6F                          MOV    L,A ;        DIFFERENCE IN EXPONENTS
3380   78                          MOV    A,B ;        ACCUM SIGN AND 1ST FRCTN
3381   F6 01                       ORI    1 ;          SET SIGN BIT FOR EXIT
3383   7B                          MOV    A,E ;        ACCUMULATOR EXPONENT
3384   5D                          MOV    E,L ;        SIGNIFICANCE INDEX
3385   C9                          RET     ;           RETURN TO CALLER
                           ;       LOAD THE ACCUMULATOR WITH THE OPERAND.
3386   2E 35               ADD17:         MVI         L,SF ;     TO ADDR SUBTRACTION FL
3388   7E                          MOV    A,M ;        SUBTRACTION FLAG
3389   2E 31                       MVI    L,ACCS ;     TO ADDR ACCUMULATOR SIGN
338B   AE                          XRA    M ;          OPERAND SIGN
338C   2D                          DCR    L ;          TO ADDR ACCUM EXPONENT
338D   CD 3C 32                    CALL   STR0 ;       SET THE ACCUMULATOR
3390   A8                          XRA    B ;          ACCUM SIGN AND 1ST FRCTN
3391   C3 7A 33                    JMP    ADD12 ;      JOIN EXIT CODE
3394   00                          DB     0 ;          CHECK SUM WORD
                           ;       SUBROUTINE TO READ THE OPERAND AND
                           ;       CHECK THE ACCUMULATOR EXPONENT.
3395   47                  MDEX:          MOV         B,A ;      EXPONENT MODIFIER
3396   2C                          INR    L ;          TO ADDR OF SIGN, 1ST FRCTN
3397   4E                          MOV    C,M ;        OPERAND SIGN AND 1ST FRACTION
3398   2C                          INR    L ;          TO ADDRESS OPERAND 2ND FRACTION
3399   56                          MOV    D,M ;        OPERAND 2ND FRACTION
339A   2C                          INR    L ;          TO ADDRESS OPERAND 3RD FRACTION
339B   5E                          MOV    E,M ;        OPERAND 3RD FRACTION
339C   26 22                       MVI    H,SCRB ;     TO ADDRESS SCRATCH BANK
339E   2E 30                       MVI    L,ACCE ;     TO ADDRESS ACCUMULATOR EXPONENT
33A0   7E                          MOV    A,M ;        ACCUMULATOR EXPONENT
33A1   A7                          ANA    A            ;    SET CONTROL BITS
33A2   C8                          RZ      ;           RETURN IF ACCUM IS ZERO
33A3   80                          ADD    B ;          RESULT EXPONENT PLUS BIAS
33A4   47                          MOV    B,A ;        RESULT EXPONENT PLUS BIAS
33A5   1F                          RAR     ;           CARRY TO SIGN
33A6   A8                          XRA    B ;          CARRY AND SIGN MUST DIFFER
33A7   78                          MOV    A,B ;        RESULT EXPONENT PLUS BIAS
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                                                                 JC     OVUN ;     IF OVERFLOW OR UNDERFLOW
00000394 SYSIN        367  33AD  90                              SUB    B ;        REMOVE EXCESS EXP BIAS
00000395 SYSIN        368  33AE  C8                              RZ       :        RETURN IF UNDERFLOW
00000396 SYSIN        369  33AF  77                              MOV    M,A :      RESULT EXPONENT
00000397 SYSIN        370  33B0  2C                              INR    L :        TO ADDRESS ACCUMULATOR SIGN
00000398 SYSIN        371  33B1  7E                              MOV    A,M ;      ACCUMULATOR SIGN
00000399 SYSIN        372  33B2  A9                              XRA    C ;        RESULT SIGN IN SIGN BIT
00000400 SYSIN        373  33B3  A0                              ANA    B          ;    RESULT SIGN
00000401 SYSIN        374  33B4  77                              MOV    M,A ;      RESULT SIGN
00000402 SYSIN        375  33B5  79                              MOV    A,C ;      OPERAND SIGN AND 1ST FRCTN
00000403 SYSIN        376  33B6  B0                              ORA    B ;        OPERAND 1ST FRACTION
00000404 SYSIN        377  33B7  C9                              RET      :        RETURN TO CALLER
00000405 SYSIN        378  33B8  07                       OVUN:         RLC        ;    SET CARRY BIT IF OVERFLOW
00000406 SYSIN        379  33B9  D8                              RC       :        RETURN IF OVERFLOW
00000407 SYSIN        380  33BA  AF                              XRA    A ;        ZERO
00000408 SYSIN        381  33BB  C9                              RET      :        RETURN IF UNDERFLOW
00000409 SYSIN        382                                 ;      SUBROUTINE TO LEFT SHIFT THE B, C,
00000410 SYSIN        383                                 ;      D, AND E REGISTERS ONE BIT.
00000411 SYSIN        384  33BC  7B                       LSH:   MOV    A,E :      ORIGINAL CONTENTS OF E
00000412 SYSIN        385  33BD  17                              RAL      ;        LEFT SHIFT E
00000413 SYSIN        386  33BE  5F                              MOV    E,A :      RESTORE CONTENTS OF E REGISTER
00000414 SYSIN        387  33BF  7A                       LSH1:         MOV        A,D ;     ORIGINAL CONTENTS OF D
00000415 SYSIN        388  33C0  17                              RAL      :        LEFT SHIFT D
00000416 SYSIN        389  33C1  57                              MOV    D,A ;      RESTORE CONTENTS OF D REGISTER
00000417 SYSIN        390  33C2  79                              MOV    A,C ;      ORIGINAL CONTENTS OF C REGISTER
00000418 SYSIN        391  33C3  17                              RAL      ;        LEFT SHIFT C
00000419 SYSIN        392  33C4  4F                              MOV    C,A ;      RESTORE CONTENTS OF C REGISTER
00000420 SYSIN        393  33C5  78                              MOV    A,B ;      ORIGINAL CONTENTS OF B REGISTER
00000421 SYSIN        394  33C6  8F                              ADC    A ;        LEFT SHIFT B
00000422 SYSIN        395  33C7  47                              MOV    B,A ;      RESTORE CONTENTS OF B REGISTER
00000423 SYSIN        396  33C8  C9                              RET      :        RETURN TO CALLER
00000424 SYSIN        397                                 ;      RIGHT SHIFT THE B, C, D AND E REGISTERS
00000425 SYSIN        398                                 ;      BY THE SHIFT COUNT IN THE A REGISTER
00000426 SYSIN        399                                 ;      SHIFT OPERAND TO REGISTER INDICATED BY
00000427 SYSIN        400                                 ;      SHIFT COUNT
00000428 SYSIN        401  33C9  1E 00                    RSH:   MVI    E,0 ;      OPERAND 4TH FRCTN IS ZERO
00000429 SYSIN        402  33CB  2E 08                    RSH0:         MVI        L,010Q ;  EACH REG IS 8 BITS OF
00000430 SYSIN        403  33CD  BD                       RSH1:         CMP        L ;  COMPARE SHIFT COUNT TO 8
00000431 SYSIN        404  33CE  FA DA 33                        JM     RSH2 ;     IF REQ SHIFT LESS THAN 8
00000432 SYSIN        405  33D1  5A                              MOV    E,D ;      OPERAND 4TH FRACTION
00000433 SYSIN        406  33D2  51                              MOV    D,C ;      OPERAND 3RD FRACTION
00000434 SYSIN        407  33D3  48                              MOV    C,B ;      OPERAND 2ND FRACTION
00000435 SYSIN        408  33D4  06 00                           MVI    B,0 ;      OPERAND 1ST FRACTION IS ZERO
00000436 SYSIN        409  33D6  95                              SUB    L ;        REDUCE SHIFT COUNT BY 1 REG
00000437 SYSIN        410  33D7  C2 CD 33                        JNZ    RSH1 ;     IF MORE SHIFTS REQUIRED
00000438 SYSIN        411                                 ;      SHIFT OPERAND RIGHT BY -SHIFT COUNT-
00000439 SYSIN        412                                 ;      BITS.
00000440 SYSIN        413  33DA  A7                       RSH2:         ANA        A     :    SET CONTROL BITS
00000441 SYSIN        414  33DB  C8                              RZ       ;        RETURN IF SHIFT COMPLETE
00000442 SYSIN        415  33DC  6F                              MOV    L,A ;      SHIFT COUNT
00000443 SYSIN        416  33DD  A7                       RSH3:         ANA        A     ;    CLEAR CARRY BIT
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00000446 SYSIN        LINE  ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE    9
00000447 SYSIN         417  33DE  78                              MOV    A,B ;      OPERAND 1ST FRACTION
00000448 SYSIN         418  33DF  1F                              RAR      ;        RIGHT SHIFT OP 1ST FRCTN
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00000446 SYSIN          LINE  ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE    9
00000447 SYSIN           417  33DE  78                         MOV    A,B ;        OPERAND 1ST FRACTION
00000448 SYSIN           418  33DF  1F                         RAR     ;           RIGHT SHIFT OF 1ST FRCTN
00000449 SYSIN           419  33E0  47                         MOV    B,A ;        OPERAND 1ST FRACTION
00000450 SYSIN           420  33E1  79                         MOV    A,C ;        OPERAND 2ND FRACTION
00000451 SYSIN           421  33E2  1F                         RAR     ;           RIGHT SHIFT OF 2ND FRCTN
00000452 SYSIN           422  33E3  4F                         MOV    C,A ;        OPERAND 2ND FRACTION
00000453 SYSIN           423  33E4  7A                         MOV    A,D ;        OPERAND 3RD FRACTION
00000454 SYSIN           424  33E5  1F                         RAR     ;           RIGHT SHIFT OF 3RD FRCTN
00000455 SYSIN           425  33E6  57                         MOV    D,A ;        OPERAND 3RD FRACTION
00000456 SYSIN           426  33E7  7B                         MOV    A,E ;        OPERAND 4TH FRACTION
00000457 SYSIN           427  33E8  1F                         RAR     ;           RIGHT SHIFT OF 4TH FRCTN
00000458 SYSIN           428  33E9  5F                         MOV    E,A ;        OPERAND 4TH FRACTION
00000459 SYSIN           429  33EA  2D                         DCR    L ;          DECREMENT SHIFT COUNT
00000460 SYSIN           430  33EB  C2 DD 33                   JNZ    RSH3 ;       IF MORE SHIFTS REQUIRED
00000461 SYSIN           431  33EE  C9                         RET     ;           RETURN TO CALLER
00000462 SYSIN           432                            ;      COMPLEMENT THE B, C, D, AND E REGISTERS.
00000463 SYSIN           433  33EF  2D                  COMP:         DCR        L ;   TO ADDR ACCUM SIGN
00000464 SYSIN           434  33F0  7E                         MOV    A,M ;        ACCUMULATOR SIGN
00000465 SYSIN           435  33F1  EE 80                      XRI    200Q ;       CHANGE SIGN
00000466 SYSIN           436  33F3  77                         MOV    M,A ;        ACCUMULATOR SIGN
00000467 SYSIN           437  33F4  AF                  COMP1:        XRA        A ;   ZERO
00000468 SYSIN           438  33F5  6F                         MOV    L,A ;        ZERO
00000469 SYSIN           439  33F6  93                         SUB    E ;          COMPLEMENT 4TH FRCTN
00000470 SYSIN           440  33F7  5F                         MOV    E,A ;        4TH FRACTION
00000471 SYSIN           441  33F8  7D                         MOV    A,L ;        ZERO
00000472 SYSIN           442  33F9  9A                         SBB    D ;          COMPLEMENT 3RD FRCTN
00000473 SYSIN           443  33FA  57                         MOV    D,A ;        3RD FRACTION
00000474 SYSIN           444  33FB  7D                         MOV    A,L ;        ZERO
00000475 SYSIN           445  33FC  99                         SBB    C ;          COMPLEMENT 2ND FRCTN
00000476 SYSIN           446  33FD  4F                         MOV    C,A ;        2ND FRACTION
00000477 SYSIN           447  33FE  7D                         MOV    A,L ;        ZERO
00000478 SYSIN           448  33FF  98                         SBB    B ;          COMPLEMENT 1ST FRCTN
00000479 SYSIN           449  3400  47                         MOV    B,A ;        1ST FRACTION
00000480 SYSIN           450  3401  C9                         RET     ;           RETURN TO CALLER
00000481 SYSIN           451                            ;      NORMALIZE THE REGISTERS.
00000482 SYSIN           452  3402  2E 20               NORM:         MVI        L,040Q ;   MAX NORMALIZING SHIFT
00000483 SYSIN           453  3404  78                  NORM1:        MOV        A,B ;      1ST FRACTION
00000484 SYSIN           454  3405  A7                         ANA    A            ;    SET CONTROL BITS
00000485 SYSIN           455  3406  C2 22 34                   JNZ    NORM3 ;      IF 1ST FRACTION NONZERO
00000486 SYSIN           456  3409  41                         MOV    B,C ;        1ST FRACTION
00000487 SYSIN           457  340A  4A                         MOV    C,D ;        2ND FRACTION
00000488 SYSIN           458  340B  53                         MOV    D,E ;        3RD FRACTION
00000489 SYSIN           459  340C  5F                         MOV    E,A ;        ZERO 4TH FRACTION
00000490 SYSIN           460  340D  7D                         MOV    A,L ;        NORMALIZING SHIFT COUNT
00000491 SYSIN           461  340E  D6 08                      SUI    010Q ;       REDUCE SHIFT COUNT
00000492 SYSIN           462  3410  6F                         MOV    L,A ;        NORMALIZING SHIFT COUNT
00000493 SYSIN           463  3411  C2 04 34                   JNZ    NORM1 ;      IF FRACTION NONZERO
00000494 SYSIN           464  3414  C9                         RET     ;           IF FRACTION IS ZERO
00000495 SYSIN           465  3415  2D                  NORM2:        DCR        L ;   DECREMENT SHIFT COUNT
00000496 SYSIN           466  3416  7B                         MOV    A,E ;        ORIGINAL CONTENTS OF E
00000497 SYSIN           467  3417  17                         RAL     ;           LEFT SHIFT E
00000498 SYSIN           468  3418  5F                         MOV    E,A ;        RESTORE CONTENTS OF E REGISTER
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ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE  10
3419  7A                          MOV    A,D ;        ORIGINAL CONTENTS OF D REGISTER
341A  17                          RAL     ;           LEFT SHIFT D
341B  57                          MOV    D,A ;        RESTORE CONTENTS OF D REGISTER
341C  79                          MOV    A,C ;        ORIGINAL CONTENTS OF C REGISTER
341D  17                          RAL     ;           LEFT SHIFT C
341E  4F                          MOV    C,A ;        RESTORE CONTENTS OF C REGISTER
341F  78                          MOV    A,B ;        ORIGINAL CONTENTS OF B REGISTER
3420  8F                          ADC    A ;          LEFT SHIFT B
3421  47                          MOV    B,A ;        RESTORE CONTENTS OF B REGISTER
3422  F2 15 34                NORM3:       JP        NORM2 ;    IF NOT NORMALIZED
3425  7D                          MOV    A,L ;        NORMALIZING SHIFT COUNT
3426  D6 20                       SUI    040Q ;       REMOVE BIAS
3428  2E 30                       MVI    L,ACCE ;     TO ADDR ACCUM EXPONENT
342A  86                          ADD    M ;          ADJUST ACCUM EXPONENT
342B  77                          MOV    M,A ;        NEW ACCUM EXPONENT
342C  C8                          RZ      ;           RETURN IF ZERO EXP
342D  1F                          RAR     ;           BORROW BIT TO SIGN
342E  A7                          ANA    A            ;    SET SIGN TO IND. UNDERFLOW
342F  C9                          RET     ;           RETURN TO CALLER
                              ;   SUBROUTINE TO ROUND THE B, C, D REGISTERS.
3430  2E 30                   ROND:        MVI       L,ACCE ;   TO ADDR ACCUM EXPONENT
3432  7B                          MOV    A,E ;        4TH FRACTION
3433  A7                          ANA    A            ;    SET CONTROL BITS
3434  5E                          MOV    E,M ;        ACCUMULATOR EXPONENT
3435  FC 3F 34                    CM     RNDR ;       CALL 2ND LEVEL ROUNDER
3438  D8                          RC      ;           IF OVERFLOW
3439  78                          MOV    A,B ;        1ST FRACTION
343A  2C                          INR    L ;          TO ADDR ACCUM SIGN
343B  AE                          XRA    M ;          ACCUM SIGN AND 1ST FRCTN
343C  C3 3F 32                    JMP    STR1 ;       RETURN THRU STORE SUBR.
                              ;   SECOND LEVEL ROUNDING SUBROUTINE.
343F  14                      RNDR:        INR       D ;   ROUND 3RD FRACTION
3440  C0                          RNZ     ;           RETURN IF NO CARRY
3441  0C                          INR    C ;          CARRY TO 2ND FRACTION
3442  C0                          RNZ     ;           RETURN IF NO CARRY
3443  04                          INR    B ;          CARRY TO 1ST FRACTION
3444  C0                          RNZ     ;           RETURN IF NO CARRY
3445  7B                          MOV    A,E ;        ACCUMULATOR EXPONENT
3446  C6 01                       ADI    1 ;          INCREMENT ACCUM EXPONENT
3448  5F                          MOV    E,A ;        NEW ACCUM EXPONENT
3449  06 80                       MVI    B,200Q ;     NEW 1ST FRACTION
344B  77                          MOV    M,A ;        NEW ACCUM EXPONENT
344C  C9                          RET                 RETURN TO ROND SUBROUTINE
                              ;   FIXED POINT MULTIPLY SUBROUTINE.
344D  2E 09                   MULX:        MVI       L,MULP1 ;  TO ADDR 1ST MULTIPLICA
344F  77                          MOV    M,A ;        1ST MULTIPLICAND
3450  2E 05                       MVI    L,MULP2 ;    TO ADDR 2ND MULTIPLICAND
3452  72                          MOV    M,D ;        2ND MULTIPLICAND
3453  2E 01                       MVI    L,MULP3 ;    TO ADDR 3RD MULTIPLICAND
3455  73                          MOV    M,E ;        3RD MULTIPLICAND
3456  AF                          XRA    A ;          CLEAR 6TH PRODUCT
3457  5F                          MOV    E,A ;        CLEAR 5TH PRODUCT
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LINE  ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE   11
      3458  57                          MOV    D,A ;      CLEAR 4TH PRODUCT
                                ;       MULTIPLY BY EACH ACCUMULATOR
                                ;       FRACTION IN TURN.
      3459  2E 34                       MVI    L,ACC3 ;   TO ADDRESS 3RD FRCTN
      345B  CD 68 34                    CALL   MULX2 ;    MULTIPLY BY ACCUM 3RD FRCTN
      345E  2E 33                       MVI    L,ACC2 ;   TO ADDRESS 2ND FRCTN
      3460  CD 65 34                    CALL   MULX1 ;    MULTIPLY BY ACCUM 2ND FRCTN
      3463  2E 32                       MVI    L,ACC1 ;   TO ADDRESS 1ST FRCTN
                                ;       MULTIPLY BY ONE ACCUMULATOR WORD.
      3465  7A                  MULX1:         MOV        A,D ;     5TH PARTIAL PRODUCT
      3466  59                          MOV    E,C ;      4TH PARTIAL PRODUCT
      3467  50                          MOV    D,B ;      3RD PARTIAL PRODUCT
      3468  46                  MULX2:         MOV        B,M ; MULTIPLIER
      3469  6F                          MOV    L,A ;      5TH PARTIAL PRODUCT
      346A  AF                          XRA    A ;        ZERO
      346B  4F                          MOV    C,A ;      2ND PARTIAL PRODUCT
      346C  90                          SUB    B ;        SET CARRY BIT FOR EXIT FLAG
      346D  DA 79 34                    JC     MULX3 ;    IF MULTIPLIER IS NOT ZERO
      3470  4A                          MOV    C,D ;      2ND PARTIAL PRODUCT
      3471  53                          MOV    D,E ;      3RD PARTIAL PRODUCT
      3472  C9                          RET    ;          MULT BY ZERO COMPLETE
                                ;       COMPLETE ADDITION OF MULTIPLICAND.
      3473  4F                  MULX5:         MOV        C,A ;     2ND PARTIAL PRODUCT
      3474  D2 79 34                    JNC    MULX3 ;    IF NO CARRY TO 1ST PRODUCT
      3477  04                          INR    B ;        ADD CARRY TO 1ST PRODUCT
      3478  A7                          ANA    A          ;    CLEAR CARRY BIT
                                ;       LOOP FOR EACH BIT OF MULTIPLIER WORD.
      3479  7D                  MULX3:         MOV        A,L ;     5TH PART PRODUCT, EXIT
      347A  8F                          ADC    A ;        SHIFT EXIT FLAG OUT IF DONE
      347B  C8                          RZ     ;          EXIT IF MULTIPLICATION DONE
      347C  6F                          MOV    L,A ;      5TH PART PRODUCT, EXIT FLAG
      347D  7B                          MOV    A,E ;      4TH PARTIAL PRODUCT
      347E  17                          RAL    ;          SHIFT 4TH PARTIAL PRODUCT
      347F  5F                          MOV    E,A ;      4TH PARTIAL PRODUCT
      3480  7A                          MOV    A,D ;      3RD PARTIAL PRODUCT
      3481  17                          RAL    ;          SHIFT 3RD PARTIAL PRODUCT
      3482  57                          MOV    D,A ;      3RD PARTIAL PRODUCT
      3483  79                          MOV    A,C ;      2ND PARTIAL PRODUCT
      3484  17                          RAL    ;          SHIFT 2ND PARTIAL PRODUCT
      3485  4F                          MOV    C,A ;      2ND PARTIAL PRODUCT
      3486  78                          MOV    A,B ;      1ST PART PROD AND MULTIPLIER
      3487  17                          RAL    ;          SHIFT 1ST PROD AND MULTIPLIER
      3488  47                          MOV    B,A ;      1ST PART PROD AND MULTIPLIER
      3489  D2 79 34                    JNC    MULX3 ;    IF NO ADDITION REQUIRED
                                ;       ADD THE MULTIPLICAND TO THE PRODUCT
                                ;       IF THE MULTIPLIER BIT IS ONE.
      348C  7B                          MOV    A,E ;      4TH PARTIAL PRODUCT
      348D  C3 00 22                    JMP    MULX4 ;    TO RAM CODE
                                ;       FIXED POINT DIVIDE SUBROUTINE.
                                ;       SUBTRACT DIVISOR FROM ACCUMULATOR TO
                                ;       OBTAIN 1ST REMAINDER.
      3490  2E 34               DIVX:          MVI        L,ACC3 ;   TO ADDRESS ACCUM 3RD F
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00000611 SYSIN          LINE  ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE   12
00000612 SYSIN           573  3492  7E                          MOV   A,M ;       ACCUMULATOR 3RD FRACTION
00000613 SYSIN           574  3493  93                          SUB   E ;         DIVISOR 3RD FRACTION
00000614 SYSIN           575  3494  77                          MOV   M,A ;       REMAINDER 3RD FRACTION
00000615 SYSIN           576  3495  2D                          DCR   L ;         TO ADDRESS ACCUM 2ND FRCTN
00000616 SYSIN           577  3496  7E                          MOV   A,M ;       ACCUMULATOR 2ND FRACTION
00000617 SYSIN           578  3497  9A                          SBB   D ;         DIVISOR 2ND FRACTION
00000618 SYSIN           579  3498  77                          MOV   M,A ;       REMAINDER 2ND FRACTION
00000619 SYSIN           580  3499  2D                          DCR   L ;         TO ADDRESS ACCUM 1ST FRCTN
00000620 SYSIN           581  349A  7E                          MOV   A,M ;       ACCUMULATOR 1ST FRACTION
00000621 SYSIN           582  349B  99                          SBB   C ;         DIVISOR 1ST FRACTION
00000622 SYSIN           583  349C  77                          MOV   M,A ;       REMAINDER 1ST FRACTION
00000623 SYSIN           584                            ;       HALVE THE DIVISOR AND STORE FOR
00000624 SYSIN           585                            ;       ADDITION OR SUBTRACTION.
00000625 SYSIN           586  349D  79                          MOV   A,C ;       DIVISOR 1ST FRACTION
00000626 SYSIN           587  349E  17                          RAL     ;         SET CARRY BIT
00000627 SYSIN           588  349F  79                          MOV   A,C ;       DIVISOR 1ST FRACTION
00000628 SYSIN           589  34A0  1F                          RAR     ;         HALF OF DIVISOR 1ST FRCTN
00000629 SYSIN           590                            ;       + 200B TO CORRECT QUOTIENT
00000630 SYSIN           591  34A1  2E 19                       MVI   L,OP1S ;    TO ADDRESS 1ST SUBTRACT DIVISOR
00000631 SYSIN           592  34A3  77                          MOV   M,A ;       1ST SUBTRACT DIVISOR
00000632 SYSIN           593  34A4  2E 27                       MVI   L,OP1A ;    TO ADDRESS 1ST ADD DIVISOR
00000633 SYSIN           594  34A6  77                          MOV   M,A ;       1ST ADD DIVISOR
00000634 SYSIN           595  34A7  7A                          MOV   A,D ;       DIVISOR 2ND FRACTION
00000635 SYSIN           596  34A8  1F                          RAR     ;         HALF OF DIVISOR 2ND FRACTION
00000636 SYSIN           597  34A9  2E 15                       MVI   L,OP2S ;    TO ADDRESS 2ND SUBTRACT DIVISOR
00000637 SYSIN           598  34AB  77                          MOV   M,A ;       2ND SUBTRACT DIVISOR
00000638 SYSIN           599  34AC  2E 23                       MVI   L,OP2A ;    TO ADDRESS 2ND ADD DIVISOR
00000639 SYSIN           600  34AE  77                          MOV   M,A ;       2ND ADD DIVISOR
00000640 SYSIN           601  34AF  7B                          MOV   A,E ;       DIVISOR 3RD FRACTION
00000641 SYSIN           602  34B0  1F                          RAR     ;         HALF OF DIVISOR 3RD FRACTION
00000642 SYSIN           603  34B1  2E 11                       MVI   L,OP3S ;    TO ADDRESS 3RD SUBTRACT DIVISOR
00000643 SYSIN           604  34B3  77                          MOV   M,A ;       3RD SUBTRACT DIVISOR
00000644 SYSIN           605  34B4  2E 1F                       MVI   L,OP3A ;    TO ADDRESS 3RD ADD DIVISOR
00000645 SYSIN           606  34B6  77                          MOV   M,A ;       3RD ADD DIVISOR
00000646 SYSIN           607  34B7  06 00                       MVI   B,0 ;       INIT QUOTIENT 1ST FRCTN
00000647 SYSIN           608  34B9  78                          MOV   A,B ;       DIVISOR FOURTH FRACTION IS ZERO
00000648 SYSIN           609  34BA  1F                          RAR     ;         LOW BIT OF DIVISOR 3RD FRACTION
00000649 SYSIN           610  34BB  2E 0E                       MVI   L,OP4S ;    TO ADDRESS 4TH SUBTRACT DIVISOR
00000650 SYSIN           611  34BD  77                          MOV   M,A ;       4TH SUBTRACT DIVISOR
00000651 SYSIN           612  34BE  2E 1C                       MVI   L,OP4A ;    TO ADDRESS 4TH ADD DIVISOR
00000652 SYSIN           613  34C0  77                          MOV   M,A ;       4TH ADD DIVISOR
00000653 SYSIN           614  34C1  2E 2A                       MVI   L,OP4X ;    TO ADDRESS 4TH ADD DIVISOR
00000654 SYSIN           615  34C3  77                          MOV   M,A ;       4TH ADD DIVISOR
00000655 SYSIN           616                            ;       LOAD 1ST REMAINDER, CHECK SIGN.
00000656 SYSIN           617  34C4  2E 32                       MVI   L,ACC1 ;    TO ADDR REMAINDER 1ST FRCTN
00000657 SYSIN           618  34C6  7E                          MOV   A,M ;       REMAINDER 1ST FRACTION
00000658 SYSIN           619  34C7  2C                          INR   L ;         TO ADDR REMAINDER 2ND FRCTN
00000659 SYSIN           620  34C8  56                          MOV   D,M ;       REMAINDER 2ND FRACTION
00000660 SYSIN           621  34C9  2C                          INR   L ;         TO ADDR REMAINDER 3RD FRCTN
00000661 SYSIN           622  34CA  5E                          MOV   E,M ;       REMAINDER 3RD FRACTION
00000662 SYSIN           623  34CB  A7                          ANA   A           ;   SET CONTROL BITS
00000663 SYSIN           624  34CC  FA F6 34                    JM    DIVX4 ;     IF REMAINDER IS NEGATIVE
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```
LINE  ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE   13
 625                            ;       ADJUST EXPONENT,POSITION REMAINDER
 626                            ;       AND INITIALIZE THE QUOTIENT.
 627  34CF  2E 30                       MVI    L,ACCE ;   TO ADDRESS ACCUMULATOR EXPONENT
 628  34D1  4E                          MOV    C,M ;      QUOTIENT EXPONENT
 629  34D2  0C                          INR    C ;        INCREMENT QUOTIENT EXPONENT
 630  34D3  C8                          RZ      ;         RETURN IF OVERFLOW
 631  34D4  71                          MOV    M,C ;      QUOTIENT EXPONENT
 632  34D5  6B                          MOV    L,E ;      REMAINDER 3RD FRACTION
 633  34D6  62                          MOV    H,D ;      REMAINDER 2ND FRACTION
 634  34D7  5F                          MOV    E,A ;      REMAINDER 1ST FRACTION
 635  34D8  16 01                       MVI    D,1 ;      INITIALIZE QUOT 3RD FRCTN
 636  34DA  48                          MOV    C,B ;      INITIALIZE QUOT 2ND FRCTN
 637                            ;       SUBTRACT THE DIVISOR FROM THE REMAINDER
 638                            ;       IF IT IS POSITIVE
 639  34DB  AF                  DIVX1:         XRA        A ;   REMAINDER 4TH FRCTN IS ZERO
 640  34DC  CD 0D 22                    CALL   DIVX5 ;    CALL RAM SECTION
 641  34DF  07                  DIVX2:         RLC         ;    SHFT REM 4TH FRCTN TO CY
 642                            ;       SHIFT THE REMAINDER LEFT ONE BIT.
 643  34E0  78                          MOV    A,B ;      QUOTIENT 1ST FRACTION
 644  34E1  17                          RAL     ;         MS BIT OF QUOTIENT TO CY
 645  34E2  D8                          RC      ;         IF DIVISION COMPLETE
 646  34E3  1F                          RAR     ;         REMAINDER 4TH FRCTN TO CY
 647  34E4  7D                          MOV    A,L ;      REMAINDER 3RD FRACTION
 648  34E5  17                          RAL     ;         LEFT SHIFT REM 3RD FRCTN
 649  34E6  6F                          MOV    L,A ;      REMAINDER 3RD FRACTION
 650  34E7  7C                          MOV    A,H ;      REMAINDER 2ND FRACTION
 651  34E8  17                          RAL     ;         LEFT SHIFT REM 2ND FRCTN
 652  34E9  67                          MOV    H,A ;      REMAINDER 2ND FRACTION
 653  34EA  CD BC 33                    CALL   LSH ;      CALL LEFT SHIFT SUBROUTINE
 654                            ;       BRANCH IF SUBTRACTION IS REQUIRED
 655  34ED  7A                          MOV    A,D ;      QUOTIENT 3RD FRACTION
 656  34EE  0F                          RRC     ;         REM SIGN INDIC TO CARRY BIT
 657  34EF  DA DB 34                    JC     DIVX1 ;    TO SUB DIVISOR IF REM POS
 658                            ;       ADD THE DIVISOR IF THE REMAINDER
 659                            ;       IS NEGATIVE.
 660  34F2  7D                  DIVX3:         MOV        A,L ;      REMAINDER 3RD FRACTION
 661  34F3  C3 1E 22                    JMP    DIVX6 ;    TO RAM CODE
 662                            ;       POSITION THE REMAINDER AND INITIALIZE
 663                            ;       THE QUOTIENT.
 664  34F6  6B                  DIVX4:         MOV        L,E ;      REMAINDER 3RD FRACTION
 665  34F7  62                          MOV    H,D ;      REMAINDER 2ND FRACTION
 666  34F8  5F                          MOV    E,A ;      REMAINDER 1ST FRACTION
 667  34F9  50                          MOV    D,B ;      INITIALIZE QUOT 3RD FRCTN
 668  34FA  48                          MOV    C,B ;      INITIALIZE QUOT 2ND FRCTN
 669  34FB  C3 F2 34                    JMP    DIVX3 ;    ADD DIVISOR IF REM IS NEG
 670  34FE  00                          DB     0 ;        CHECKSUM WORD
 671  34FF                              END
TOTAL ASSEMBLER ERRORS =     0
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00000006 SYSIN      LINE  ADDR   B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE    1
00000007 SYSIN         1  3500                                ORG      3500H
00000008 SYSIN         2  3500   22 00               SCR     EQU      2200H
00000009 SYSIN         3  3500   00 22               SCRB             EQU          22H  ;      BANK NUMBER OF SCRATC
00000010 SYSIN         4  3500   32 00               ARITH            EQU          3200H ;    BASE ADDRESS OF ARITHM
00000011 SYSIN         5                             ;       8080 BINARY FLOATING POINT SYSTEM
00000012 SYSIN         6                             ;       FORMAT CONVERSION PACKAGE
00000013 SYSIN         7                             ;       PROGRAMMER CAL OHME
00000014 SYSIN         8                             ;       DATE 26 DECEMBER 1973
00000015 SYSIN         9                             ;       ARITH IS THE BEGINNING ADDRESS OF THE
00000016 SYSIN        10                             ;       ARITHMETIC AND UTILITY PACKAGE OF THE FLOATING
00000017 SYSIN        11                             ;       POINT SYSTEM.
00000018 SYSIN        12                             ;       SCR IS THE BEGINNING ADDRESS OF THE
00000019 SYSIN        13                             ;       RAM USED AS SCRATCPAD FOR THE SYSTEM.
00000020 SYSIN        14                             ;       RAM LOCATIONS USED BY THE BINARY
00000021 SYSIN        15                             ;       FLOATING POINT SYSTEM.
00000022 SYSIN        16  3500   00 2E               OVER             EQU          56Q ;       OVERFLOW FLAG
00000023 SYSIN        17  3500   00 30               ACCE             EQU          60Q ;       ACCUMULATOR EXPONENT
00000024 SYSIN        18  3500   00 31               ACCS             EQU          ACCE+1 ;    ACCUMULATOR SIGN
00000025 SYSIN        19  3500   00 32               ACC1             EQU          ACCS+1 ;    ACCUMULATOR 1ST FRACTI
00000026 SYSIN        20  3500   00 33               ACC2             EQU          ACC1+1 ;    ACCUMULATOR 2ND FRACTI
00000027 SYSIN        21  3500   00 34               ACC3             EQU          ACC2+1 ;    ACCUMULATOR 3RD FRACTI
00000028 SYSIN        22  3500   00 35               SF      EQU      ACC3+1 ;      SUBTRACTION FLAG
00000029 SYSIN        23  3500   00 36               ADRL             EQU          SF+1 ;      CHARACTER STRING WORD
00000030 SYSIN        24  3500   00 37               ADRH             EQU          ADRL+1 ;    CHARACTER STRYNG BANK
00000031 SYSIN        25  3500   00 38               TMP1             EQU          ADRH+1 ;    TEMPORARY STORAGE
00000032 SYSIN        26  3500   00 39               TMP2             EQU          TMP1+1 ;    TEMPORARY STORAGE
00000033 SYSIN        27  3500   00 3A               TMP3             EQU          TMP2+1 ;    TEMPORARY STORAGE
00000034 SYSIN        28  3500   00 3B               VALE             EQU          TMP3+1 ;    VALUE EXPONENT
00000035 SYSIN        29  3500   00 3C               VAL1             EQU          VALE+1 ;    VALUE 1ST FRACTION
00000036 SYSIN        30  3500   00 3D               VAL2             EQU          VAL1+1 ;    VALUE 2ND FRACTION
00000037 SYSIN        31  3500   00 3E               VAL3             EQU          VAL2+1 ;    VALUE 3RD FRACTION
00000038 SYSIN        32  3500   00 3F               TMP4             EQU          VAL3+1 ;    TEMPORARY STORAGE
00000039 SYSIN        33                             ;       ADDRESSES IN THE ARITHMETIC AND UTILITY
00000040 SYSIN        34                             ;       PACKAGE REFERENCED BY THE FORMAT CONVERSION
00000041 SYSIN        35                             ;       PACKAGE.
00000042 SYSIN        36  3500   32 3E               STR     EQU      ARITH+76Q
00000043 SYSIN        37  3500   32 46               ZRO     EQU      ARITH+106Q
00000044 SYSIN        38  3500   32 50               ABS     EQU      ARITH+120Q
00000045 SYSIN        39  3500   32 59               TST     EQU      ARITH+131Q
00000046 SYSIN        40  3500   32 6E               LOD     EQU      ARITH+156Q
00000047 SYSIN        41  3500   32 8C               MUL     EQU      ARITH+214Q
00000048 SYSIN        42  3500   32 B4               DIV     EQU      ARITH+264Q
00000049 SYSIN        43  3500   32 D7               AD      EQU      ARITH+327Q
00000050 SYSIN        44  3500   33 6B               ADD10            EQU          ARITH+553Q
00000051 SYSIN        45  3500   33 BC               LSH     EQU      ARITH+674Q
00000052 SYSIN        46  3500   33 C9               RSH     EQU      ARITH+711Q
00000053 SYSIN        47  3500   33 EF               COMP             EQU          ARITH+757Q
00000054 SYSIN        48                             ;       SUBROUTINE TO CONVERT FROM FIXED
00000055 SYSIN        49                             ;       POINT TO FLOATING POINT FORMAT.
00000056 SYSIN        50  3500   6B                  FLT:    MOV      L,E ;         INPUT EXPONENT
00000057 SYSIN        51  3501   5A                          MOV      E,D ;         4TH INPUT FRACTION
00000058 SYSIN        52  3502   51                          MOV      D,C ;         3RD INPUT FRACTION
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LINE ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE    2
  53 3503  48                         MOV    C,B ;         2ND INPUT FRACTION
  54 3504  47                         MOV    B,A ;         1ST INPUT FRACTION
  55 3505  7D                         MOV    A,L ;         INPUT EXPONENT
  56 3506  EE 80                      XRI    200Q ;        APPLY EXPONENT BIAS
  57 3508  26 22                      MVI    H,SCRB ;      TO ADDRESS SCRATCH BANK
  58 350A  2E 30                      MVI    L,ACCE ;      TO ADDR ACCUM EXPONENT
  59 350C  77                         MOV    M,A ;         ACCUMULATOR EXPONENT
  60 350D  2C                         INR    L ;           TO ADDRESS ACCUM SIGN
  61 350E  36 80                      MVI    M,200Q ;      SET ACCUM SIGN POSITIVE
  62 3510  2C                         INR    L ;           TO ADDR ACCUM 1ST FRCTN
  63 3511  78                         MOV    A,B ;         1ST INPUT FRACTION
  64 3512  A7                         ANA    A             ;    SET SIGN BIT
  65 3513  17                         RAL     ;            INPUT SIGN TO CARRY
  66 3514  C3 6B 33                   JMP    ADD10 ;       COMPLETE CONVERSION
  67                          ;       SUBROUTINE TO CONVERT FROM FLOATING
  68                          ;       POINT TO FIXED POINT FORMAT.
  69 3517  26 22              FIX:    MVI    H,SCRB ;      TO ADDRESS SCRATCH BANK
  70 3519  2E 30                      MVI    L,ACCE ;      TO ADDR ACCUM EXPONENT
  71 351B  7E                         MOV    A,M ;         ACCUMULATOR EXPONENT
  72 351C  A7                         ANA    A             ;    SET CONTROL BITS
  73 351D  CA 45 35                   JZ     FIX1 ;        IF ACCUMULATOR IS ZERO
  74 3520  7B                         MOV    A,E ;         INPUT EXPONENT
  75 3521  C6 7F                      ADI    177Q ;        APPLY BIAS - 1
  76 3523  96                         SUB    M ;           SHIFT COUNT - 1
  77 3524  D8                         RC      ;            RETURN IF ACCUM TOO LARGE
  78 3525  FE 1F                      CPI    037Q ;        COMPARE TO LARGE SHIFT
  79 3527  D2 45 35                   JNC    FIX1 ;        IF ACCUMULATOR TOO SMALL
  80 352A  C6 01                      ADI    1 ;           SHIFT COUNT
  81 352C  2E 32                      MVI    L,ACC1 ;      TO ADDR ACCUM 1ST FRCTN
  82 352E  46                         MOV    B,M ;         ACCUMULATOR 1ST FRACTION
  83 352F  2C                         INR    L ;           TO ADDR ACCUM 2ND FRCTN
  84 3530  4E                         MOV    C,M ;         ACCUMULATOR 2ND FRCTN
  85 3531  2C                         INR    L ;           TO ADDR ACCUM 3RD FRCTN
  86 3532  56                         MOV    D,M ;         ACCUMULATOR 3RD FRCTN
  87 3533  CD C9 33                   CALL   RSH ;         POSITION THE FRACTION
  88 3536  2E 31                      MVI    L,ACCS ;      TO ADDR ACCUM SIGN
  89 3538  7E                         MOV    A,M ;         ACCUMULATOR SIGN
  90 3539  A7                         ANA    A             ;    SET CONTROL BITS
  91 353A  F4 EF 33                   CP     COMP ;        COMPLEMENT FRCTN IF NEG
  92 353D  3E 01                      MVI    A,1 ;         NON-ZERO
  93 353F  B0                         ORA    B ;           SET CONTROL BITS FOR EXIT
  94 3540  78                         MOV    A,B ;         1ST RESULT
  95 3541  41                         MOV    B,C ;         2ND RESULT
  96 3542  4A                         MOV    C,D ;         3RD RESULT
  97 3543  53                         MOV    D,E ;         4TH RESULT
  98 3544  C9                         RET     ;            RETURN TO CALLER
  99 3545  AF                 FIX1:          XRA         A ;  ZERO
 100 3546  47                         MOV    B,A ;         ZERO
 101 3547  4F                         MOV    C,A ;         ZERO
 102 3548  57                         MOV    D,A ;         ZERO
 103 3549  C9                         RET     ;            RETURN TO CALLER
 104 354A  00                         DB     0 ;           CHECKSUM WORD
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LINE  ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE    3
 105                            ;       INP SUBROUTINE ENTRY POINT.
 106                            ;       INITIALIZE TEMPORARY STORAGE.
 107  354B  5E                  INP:    MOV     E,M ;         FIRST CHARACTER OF STRING
 108  354C  CD D5 36                    CALL    SVAD ;        SET CHAR ADDR, PNT FLG, EXP
 109  354F  2C                          INR     L ;           TO ADDRESS VALUE SIGN
 110  3550  36 80                       MVI     M,200Q ;      SET VALUE SIGN POSITIVE
 111  3552  2E 30                       MVI     L,ACCE ;      TO ADDR ACCUM EXPONENT
 112  3554  72                          MOV     M,D ;         SET ACCUM TO ZERO
 113  3555  7B                          MOV     A,E ;         FIRST CHARACTER
 114  3556  FE F0                       CPI     360Q ;        COMPARE TO SPACE
 115  3558  CA 68 35                    JZ      INP1 ;        IF SPACE CHARACTER
 116  355B  FE FB                       CPI     373Q ;        COMPARE CHAR TO PLUS
 117  355D  CA 68 35                    JZ      INP1 ;        IF PLUS SIGN
 118  3560  FE FD                       CPI     375Q ;        COMPARE TO MINUS
 119  3562  C2 6E 35                    JNZ     INP2 ;        IF NOT MINUS SIGN
 120  3565  2E 3A                       MVI     L,TMP3 ;      TO ADDR VALUE SIGN
 121  3567  72                          MOV     M,D ;         SET VALUE SIGN NEGATIVE
 122                            ;       ANALYZE NEXT CHARACTER IN STRING.
 123  3568  CD E2 36            INP1:           CALL        CHAD ;  CALL CHAR ADDR SBRTN
 124  356B  7E                          MOV     A,M ;         NEXT CHARACTER
 125  356C  26 22                       MVI     H,SCRB ;      TO ADDRESS SCRATCH BANK
 126  356E  06 00               INP2:           MVI         B,0 ;      DIGIT 2ND WD OR DEC EX
 127  3570  FE FE                       CPI     376Q ;        COMPARE TO DECIMAL POINT
 128  3572  CA AB 35                    JZ      INP3 ;        IF DECIMAL POINT
 129  3575  FE 15                       CPI     025Q ;        COMPARE TO EXPONENT SIGN
 130  3577  CA B5 35                    JZ      INP4 ;        IF EXPONENT SIGN
 131  357A  FE 0A                       CPI     12Q ;         SET CARRY IF CHAR IS DIGIT
 132  357C  D2 E6 35                    JNC     INP8 ;        IF CHAR IS NOT A DIGIT
 133  357F  2E 3F                       MVI     L,TMP4 ;      TO ADDR CURRENT DIGIT
 134  3581  77                          MOV     M,A ;         SAVE CURRENT DIGIT
 135  3582  21 ED 36                    LXI     H,FTEN ;      TO ADDR FLOATING TEN
 136  3585  CD 8C 32                    CALL    MUL ;         MULTIPLY BY TEN
 137  3588  2E 3B                       MVI     L,VALE ;      TO ADDR VALUE
 138  358A  CD 3E 32                    CALL    STR ;         STORE OLD VALUE TIMES TEN
 139  358D  2C                          INR     L ;           TO ADDR CURRENT DIGIT
 140  358E  7E                          MOV     A,M ;         CURRENT DIGIT
 141  358F  06 00                       MVI     B,0 ;         CLEAR 2ND WORD OF DIGIT
 142  3591  48                          MOV     C,B ;         CLEAR 3RD WORD OF DIGIT
 143  3592  50                          MOV     D,B ;         CLEAR 4TH WORD OF DIGIT
 144  3593  1E 08                       MVI     E,010Q ;      INDICATE DIGIT IS IN REG A
 145  3595  CD 00 35                    CALL    FLT ;         CONVERT DIGIT TO FLOATING PNT
 146  3598  2E 3B                       MVI     L,VALE ;      TO ADDR VALUE
 147  359A  CD D7 32                    CALL    AD  ;         ADD OLD VALUE TIMES TEN
 148  359D  2E 39                       MVI     L,TMP2 ;      TO ADDR DEC PNT FLAG
 149  359F  7E                          MOV     A,M ;         DECIMAL POINT FLAG
 150  35A0  A7                          ANA     A             ;    SET CONTROL BITS
 151  35A1  CA 68 35                    JZ      INP1 ;        IF NO DEC PNT ENCOUNTERED
 152  35A4  2D                          DCR     L ;           TO ADDR INPUT EXPONENT
 153  35A5  46                          MOV     B,M ;         INPUT EXPONENT
 154  35A6  05                          DCR     B ;           DECREMENT INPUT EXPONENNT
 155  35A7  70                          MOV     M,B ;         UPDATE INPUT EXPONENT
 156  35A8  C3 68 35                    JMP     INP1 ;        TO GET NEXT CHARACTER
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00000171 SYSIN     LINE  ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE    4
00000172 SYSIN      157  35AB  2E 39               INP3:       MVI       L,TMP2 ;   TO ADDR DEC PNT FLAG
00000173 SYSIN      158  35AD  AE                          XRA   M ;        ZERO IF FLAG SET
00000174 SYSIN      159  35AE  77                          MOV   M,A ;      SET DEC PNT FLAG
00000175 SYSIN      160  35AF  C2 68 35                    JNZ   INP1 ;     IF FLAG NOT ALREAY SET
00000176 SYSIN      161  35B2  C3 E6 35                    JMP   INP8 ;     IF 2ND DEC PNT
00000177 SYSIN      162                                ;   PROCESS DECIMAL EXPONENT.
00000178 SYSIN      163  35B5  CD E2 36            INP4:       CALL      CHAD ;  CALL CHAR ADDR SBRTN
00000179 SYSIN      164  35B8  7E                          MOV   A,M ;      NEXT CHARACTER OF STRING
00000180 SYSIN      165  35B9  47                          MOV   B,A ;      CURRENT CHARACTER
00000181 SYSIN      166  35BA  D6 FD                       SUI   375Q ;     COMPARE TO MINUS CHAR
00000182 SYSIN      167  35BC  5F                          MOV   E,A ;      CHAR - MINUS SIGN
00000183 SYSIN      168  35BD  CA C6 35                    JZ    INP5 ;     IF MINUS SIGN
00000184 SYSIN      169  35C0  C6 02                       ADI   2 ;        COMPARE TO PLUS CHAR
00000185 SYSIN      170  35C2  78                          MOV   A,B ;      CURRENT CHARACTER
00000186 SYSIN      171  35C3  C2 C8 35                    JNZ   INP6 ;     IF NOT PLUS SIGN
00000187 SYSIN      172  35C6  2C                  INP5:       INR       L ;  TO ADDRESS NEXT CHAR
00000188 SYSIN      173  35C7  7E                          MOV   A,M ;      NEXT CHARACTER OF STRING
00000189 SYSIN      174  35C8  06 00               INP6:       MVI       B,0 ;       POSSIBLE DEC EXPONENT
00000190 SYSIN      175  35CA  FE 0A                       CPI   12Q ;      SET CARRY IF CHAR IS DIGIT
00000191 SYSIN      176  35CC  D2 E6 35                    JNC   INP8 ;     IF CHAR IS NOT A DIGIT
00000192 SYSIN      177  35CF  47                          MOV   B,A ;      DEC EXP EQUAL DIGIT
00000193 SYSIN      178  35D0  2C                          INR   L ;        TO ADDRESS NEXT CHAR
00000194 SYSIN      179  35D1  7E                          MOV   A,M ;      NEXT CHARACTER OF STRING
00000195 SYSIN      180  35D2  FE 0A                       CPI   12Q ;      SET CARRY IF CHAR IS DIGIT
00000196 SYSIN      181  35D4  D2 DF 35                    JNC   INP7 ;     IF CHAR IS NOT A DIGIT
00000197 SYSIN      182                                ;   FORM COMPLETE DECIMAL EXPONENT.
00000198 SYSIN      183  35D7  4F                          MOV   C,A ;      LS DIGIT OF DEC EXP
00000199 SYSIN      184  35D8  78                          MOV   A,B ;      MS DIGIT OF DEC EXP
00000200 SYSIN      185  35D9  87                          ADD   A ;        2 * MS DIGIT
00000201 SYSIN      186  35DA  87                          ADD   A ;        4 * MS DIGIT
00000202 SYSIN      187  35DB  80                          ADD   B ;        5 * MS DIGIT
00000203 SYSIN      188  35DC  87                          ADD   A ;        10 * MS DIGIT
00000204 SYSIN      189  35DD  81                          ADD   C ;        10 * MS + LS DIGIT
00000205 SYSIN      190  35DE  47                          MOV   B,A ;      DECIMAL EXPONENT
00000206 SYSIN      191  35DF  7B                  INP7:       MOV       A,E ;       SIGN OF DEC EXPONENT
00000207 SYSIN      192  35E0  A7                          ANA   A          ;   SET CONTROL BITS
00000208 SYSIN      193  35E1  C2 E6 35                    JNZ   INP8 ;     IF SIGN PLUS
00000209 SYSIN      194  35E4  90                          SUB   B ;        COMPLEMENT DEC EXP
00000210 SYSIN      195  35E5  47                          MOV   B,A ;      DECIMAL EXPONENT
00000211 SYSIN      196  35E6  26 22               INP8:       MVI       H,SCRB ;  TO ADDRESS SCRATCH BANK
00000212 SYSIN      197  35E8  2E 3A                       MVI   L,TMP3 ;   TO ADDRESS INPUT SIGN
00000213 SYSIN      198  35EA  4E                          MOV   C,M ;      INPUT SIGN
00000214 SYSIN      199  35EB  2E 31                       MVI   L,ACCS ;   TO ADDRESS ACCUM SIGN
00000215 SYSIN      200  35ED  71                          MOV   M,C ;      ACCUMULATOR SIGN
00000216 SYSIN      201  35EE  78                          MOV   A,B ;      DECIMAL EXPONENT
00000217 SYSIN      202                                ;   CONVERT DECIMAL EXPONENT TO BINARY.
00000218 SYSIN      203  35EF  2E 38               INP9:       MVI       L,TMP1 ;  TO ADDRESS DEC EXPONENT
00000219 SYSIN      204  35F1  86                          ADD   M ;        ADJUST DECIMAL EXPONENT
00000220 SYSIN      205  35F2  CA 59 32                    JZ    TST ;      IN DEC EXP IS ZERO
00000221 SYSIN      206  35F5  77                          MOV   M,A ;      CURRENT DECIMAL EXPONENT
00000222 SYSIN      207  35F6  21 ED 36                    LXI   H,FTEN ;   TO ADDR FLOATING TEN
00000223 SYSIN      208  35F9  F2 04 36                    JP    INP10 ;    IF MULTIPLY REQUIRED
```

RFLM FLOATING POINT MATH PACK-FORMAT CONVERSION ROUTINES

```
00000226 SYSIN     LINE  ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE    5
00000227 SYSIN      209  35FC  CD B4 32                      CALL    DIV ;        DIVIDE BY TEN
00000228 SYSIN      210  35FF  3E 01                         MVI     A,1 ;        TO INCREMENT DEC EXP
00000229 SYSIN      211  3601  C3 EF 35                      JMP     INP9 ;       TO TEST FOR COMPLETION
00000230 SYSIN      212  3604  CD 8C 32                INP10:        CALL        MUL ;      MULTIPLY BY TEN
00000231 SYSIN      213  3607  D8                            RC       ;           RETURN IF OVERFLOW
00000232 SYSIN      214  3608  3E FF                         MVI     A,377Q ;     TO DECREMENT DEC EXP
00000233 SYSIN      215  360A  C3 EF 35                      JMP     INP9 ;       TO TEST FOR COMPLETION
00000234 SYSIN      216                                ;     OUT SUBROUTINE ENTRY POINT.
00000235 SYSIN      217                                ;     SAVE CHARACTER ADDRESS AND ACCUMULATOR.
00000236 SYSIN      218  360D  2D                      OU:   DCR     L ;          DECREMENT CHARACTER ADDRESS
00000237 SYSIN      219  360E  CD D5 36                      CALL    SVAD ;       SET CHAR ADDR, DIG CNT, DEC EXP
00000238 SYSIN      220  3611  CD 59 32                      CALL    TST ;        LOAD ACCUM TO REGISTERS
00000239 SYSIN      221  3614  2E 3B                         MVI     L,VALE ;     TO ADDR ACCUM SAVE AREA
00000240 SYSIN      222  3616  CD 3E 32                      CALL    STR ;        CALL REG STR SUBROUTINE
00000241 SYSIN      223                                ;     OUTPUT SIGN CHARACTER.
00000242 SYSIN      224  3619  CD E2 36                      CALL    CHAD ;       CALL CHAR ADDR SBRTN
00000243 SYSIN      225  361C  36 F0                         MVI     M,360Q ;     STORE SPACE CHARACTER
00000244 SYSIN      226  361E  A7                            ANA     A            ;    SET CONTROL BITS
00000245 SYSIN      227  361F  CA 3B 36                      JZ      OUT3 ;       IF ACCUMULATOR IS ZERO
00000246 SYSIN      228  3622  5F                            MOV     E,A ;        ACCUMULATOR EXPONENT
00000247 SYSIN      229  3623  78                            MOV     A,B ;        ACCUM SIGN AND 1ST FRCTN
00000248 SYSIN      230  3624  A7                            ANA     A            ;    SET CONTROL BITS
00000249 SYSIN      231  3625  7B                            MOV     A,E ;        ACCUMULATOR EXPONENT
00000250 SYSIN      232  3626  F2 2B 36                      JP      OUT1 ;       IF ACCUM IS POSITIVE
00000251 SYSIN      233  3629  36 FD                         MVI     M,375Q ;     CHANGE SIGN TO MINUS
00000252 SYSIN      234                                ;     SCALE ACCUMULATOR TO .1 - 1. RANGE.
00000253 SYSIN      235  362B  FE 7E                   OUT1:         CPI        176Q ;      COMPARE TO SMALL EXPON
00000254 SYSIN      236  362D  21 ED 36                OUT2:         LXI        H,FTEN ;    TO ADDR FLOATING TEN
00000255 SYSIN      237  3630  DA 45 36                      JC      OUT4 ;       IF EXPONENT TOO SMALL
00000256 SYSIN      238  3633  FE 81                         CPI     201Q ;       COMPARE TO LARGE EXP
00000257 SYSIN      239  3635  DA 50 36                      JC      OUT5 ;       IF EXP SMALL ENOUGH
00000258 SYSIN      240  3638  CD B4 32                      CALL    DIV ;        DIVIDE BY TEN
00000259 SYSIN      241  363B  26 22                   OUT3:         MVI        H,SCRB ;    TO ADDRESS SCRATCH BAN
00000260 SYSIN      242  363D  2E 39                         MVI     L,TMP2 ;     TO ADDR DECIMAL EXPONENT
00000261 SYSIN      243  363F  5E                            MOV     E,M ;        DECIMAL EXPONENT
00000262 SYSIN      244  3640  1C                            INR     E ;          INCREMENT DECIMAL EXPONENT
00000263 SYSIN      245  3641  73                            MOV     M,E ;        DECIMAL EXPONENT
00000264 SYSIN      246  3642  C3 2D 36                      JMP     OUT2 ;       TO TEST FOR SCALING COMPLETE
00000265 SYSIN      247  3645  CD 8C 32                OUT4:         CALL       MUL ;       MULTIPLY BY TEN
00000266 SYSIN      248  3648  2E 39                         MVI     L,TMP2 ;     TO ADDR DECIMAL EXPONENT
00000267 SYSIN      249  364A  5E                            MOV     E,M ;        DECIMAL EXPONENT
00000268 SYSIN      250  364B  1D                            DCR     E ;          DECREMENT DECIMAL EXPONENT
00000269 SYSIN      251  364C  73                            MOV     M,E ;        DECIMAL EXPONENT
00000270 SYSIN      252  364D  C3 2B 36                      JMP     OUT1 ;       TO TEST FOR SCALING COMPLETE
00000271 SYSIN      253                                ;     ROUND THE VALUE BY ADDING ,00000005.
00000272 SYSIN      254  3650  CD 50 32                OUT5:         CALL       ABS ;       SET ACCUM POSITIVE
00000273 SYSIN      255  3653  21 F1 36                      LXI     H,RNDO ;     TO ADDRESS ROUNDER
00000274 SYSIN      256  3656  CD D7 32                      CALL    AD  ;        ADD THE ROUNDER
00000275 SYSIN      257  3659  FE 81                         CPI     201Q ;       CHECK FOR OVERFLOW
00000276 SYSIN      258  365B  D2 2D 36                      JNC     OUT2 ;       IF EXP TOO LARGE
00000277 SYSIN      259                                ;     SET DIGIT COUNTS.
00000278 SYSIN      260  365E  2E 39                         MVI     L,TMP2 ;     TO ADDR DECIMAL EXPONENT
```

```
00000281 SYSIN        LINE  ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE    6
00000282 SYSIN         261  3660  7E                          MOV    A,M ;        DECIMAL EXPONENT
00000283 SYSIN         262  3661  5F                          MOV    E,A ;        DIGITS BEFORE DEC POINT
00000284 SYSIN         263  3662  FE 08                       CPI    010Q ;       COMPARE TO LARGE EXP
00000285 SYSIN         264  3664  DA 69 36                    JC     OUT6 ;       IF EXPONENT IN RANGE
00000286 SYSIN         265  3667  1E 01                       MVI    E,1 ;        DIGITS BEFORE DEC POINT
00000287 SYSIN         266  3669  93                  OUT6:          SUB         E ;   ADJUST DEC EXPONENT
00000288 SYSIN         267  366A  77                          MOV    M,A ;        DECIMAL EXPONENT
00000289 SYSIN         268  366B  3E 07                       MVI    A,7 ;        TOTAL NUMBER OF DIGITS
00000290 SYSIN         269  366D  93                          SUB    E ;          DIGITS AFTER DECIMAL PNT
00000291 SYSIN         270  366E  2C                          INR    L ;          TO ADDR 2ND DIGIT CNT
00000292 SYSIN         271  366F  77                          MOV    M,A ;        DIGITS AFTER DECIMAL POINT
00000293 SYSIN         272  3670  1D                          DCR    E ;          DECREMENT DIGIT COUNT
00000294 SYSIN         273  3671  7B                          MOV    A,E ;        DIGITS BEFORE DEC PNT
00000295 SYSIN         274                            ;       OUTPUT SIGNIFICANT DIGITS.
00000296 SYSIN         275  3672  2E 38               OUT7:          MVI         L,TMP1 ;   TO ADDR DIGIT COUNT
00000297 SYSIN         276  3674  86                          ADD    M ;          ADJUST DIGIT COUNT
00000298 SYSIN         277  3675  77                          MOV    M,A ;        NEW DIGIT COUNT
00000299 SYSIN         278  3676  FA 93 36                    JM     OUT8 ;       IF COUNT RUN OUT
00000300 SYSIN         279  3679  21 ED 36                    LXI    H,FTEN ;     TO ADDR FLOATING TEN
00000301 SYSIN         280  367C  CD 8C 32                    CALL   MUL ;        MULTIPLY BY TEN
00000302 SYSIN         281  367F  1E 08                       MVI    E,10Q ;      TO PLACE DIGIT IN REG A
00000303 SYSIN         282  3681  CD 17 35                    CALL   FIX ;        CONVERT TO FIXED FORMAT
00000304 SYSIN         283  3684  CD E2 36                    CALL   CHAD ;       CALL CHAR ADDR SBRTN
00000305 SYSIN         284  3687  77                          MOV    M,A ;        OUTPUT DECIMAL DIGIT
00000306 SYSIN         285  3688  AF                          XRA    A ;          CLEAR CURRENT DIGIT
00000307 SYSIN         286  3689  1E 08                       MVI    E,010Q ;     BINARY SCALING FACTOR
00000308 SYSIN         287  368B  CD 00 35                    CALL   FLT ;        RESTORE VALUE MINUS DIGIT
00000309 SYSIN         288  368E  3E FF                       MVI    A,377Q ;     TO ADJUST DIGIT CNT
00000310 SYSIN         289  3690  C3 72 36                    JMP    OUT7 ;       LOOP FOR NEXT DIGIT
00000311 SYSIN         290  3693  2E 3A               OUT8:          MVI         L,TMP3 ;   TO ADDR 2ND DIGIT CNT
00000312 SYSIN         291  3695  7E                          MOV    A,M ;        DIGITS AFTER DECIMAL PNT
00000313 SYSIN         292  3696  36 FF                       MVI    M,377Q ;     SET 2ND COUNT NEG
00000314 SYSIN         293  3698  A7                          ANA    A            ;    SET CONTROL BITS
00000315 SYSIN         294  3699  FA A6 36                    JM     OUT9 ;       IF 2ND COUNT RAN OUT
00000316 SYSIN         295  369C  CD E2 36                    CALL   CHAD ;       CALL CHAR ADDR SBRTN
00000317 SYSIN         296  369F  36 FE                       MVI    M,376Q ;     STORE DECIMAL POINT
00000318 SYSIN         297  36A1  26 22                       MVI    H,SCRB ;     TO ADDRESS SCRATCH BANK
00000319 SYSIN         298  36A3  C3 72 36                    JMP    OUT7 ;       LOOP FOR NEXT DIGIT
00000320 SYSIN         299  36A6  2D                  OUT9:          DCR         L ;   TO ADDR DECIMAL EXP
00000321 SYSIN         300  36A7  A6                          ANA    M            ;    DECIMAL EXPONENT
00000322 SYSIN         301  36A8  CA CD 36                    JZ     OUT13 ;      IF DECIMAL EXPONENT IS ZERO
00000323 SYSIN         302                            ;       OUTPUT DECIMAL EXPONENT.
00000324 SYSIN         303  36AB  06 FB                       MVI    B,373Q ;     PLUS CHARACTER
00000325 SYSIN         304  36AD  F2 B5 36                    JP     OUT10 ;      IF EXPONENT IS POSITIVE
00000326 SYSIN         305  36B0  06 FD                       MVI    B,375Q ;     CHANGE SIGN TO MINUS
00000327 SYSIN         306  36B2  4F                          MOV    C,A ;        NEGATIVE EXPONENT
00000328 SYSIN         307  36B3  AF                          XRA    A ;          ZERO
00000329 SYSIN         308  36B4  91                          SUB    C ;          COMPLEMENT EXPONENT
00000330 SYSIN         309  36B5  0E FF               OUT10:         MVI         C,377Q ;   EMBRYO TENS DIGIT
00000331 SYSIN         310  36B7  57                  OUT11:         MOV         D,A ;      UNITS DIGIT
00000332 SYSIN         311  36B8  0C                          INR    C ;          INCREMENT TENS DIGIT
00000333 SYSIN         312  36B9  D6 0A                       SUI    012Q ;       REDUCE REMAINDER
```

RWLM FLOATING POINT MATH PACK-FORMAT CONVERSION ROUTINES

```
00000336 SYSIN      LINE  ADDR  B1 B2 B3 B4 ERROR   SOURCE  INTEL 8080 ASSEMBLER  PAGE   7
00000337 SYSIN       313  36BB  D2 B7 36                     JNC     OUT11 ;      IF MORE TENS
00000338 SYSIN       314  36BE  3E 15                        MVI     A,025Q ;     EXPONENT SIGN
00000339 SYSIN       315  36C0  CD E2 36                OUT12:       CALL        CHAD ;     CALL CHAR ADDR SBRTN
00000340 SYSIN       316  36C3  CD 3E 32                     CALL    STR ;        STORE LAST 4 CHARACTERS
00000341 SYSIN       317  36C6  26 22                        MVI     H,SCRB ;     TO ADDRESS SCRATCH BANK
00000342 SYSIN       318  36C8  2E 3B                        MVI     L,VALE ;     TO ADDRESS ACCUM SAVE AREA
00000343 SYSIN       319  36CA  C3 6E 32                     JMP     LOD ;        RESTORE ACCUM AND EXIT
00000344 SYSIN       320                                ;    OUTPUT 4 SPACES IF EXPONENT IS ZERO.
00000345 SYSIN       321  36CD  3E F0                   OUT13:       MVI         A,360Q ;   SPACE CHARACTER
00000346 SYSIN       322  36CF  47                           MOV     B,A ;        SPACE CHARACTER
00000347 SYSIN       323  36D0  4F                           MOV     C,A ;        SPACE CHARACTER
00000348 SYSIN       324  36D1  57                           MOV     D,A ;        SPACE CHARACTER
00000349 SYSIN       325  36D2  C3 C0 36                     JMP     OUT12 ;      TO STORE CHARACTERS
00000350 SYSIN       326                                ;    SUBROUTINE TO SAVE CHARACTER STRING ADDR.
00000351 SYSIN       327  36D5  7D                      SVAD:        MOV         A,L ;      CHARACTER STRING WORD
00000352 SYSIN       328  36D6  44                           MOV     B,H ;        CHARACTER STRING BANK
00000353 SYSIN       329  36D7  0E 00                        MVI     C,0 ;        INPUT EXP OR DIGIT CNT
00000354 SYSIN       330  36D9  51                           MOV     D,C ;        DEC PNT FLAG OR DEC EXP
00000355 SYSIN       331  36DA  26 22                        MVI     H,SCRB ;     TO ADDRESS SCRATCH BANK
00000356 SYSIN       332  36DC  2E 36                        MVI     L,ADRL ;     TO ADDR CHAR STRING WORD
00000357 SYSIN       333  36DE  CD 3E 32                     CALL    STR ;        STORE A, B, C, AND D
00000358 SYSIN       334  36E1  C9                           RET      ;           RETURN TO CALLER
00000359 SYSIN       335                                ;    SUBROUTINE TO OBTAIN NEXT CHARACTER ADDR.
00000360 SYSIN       336  36E2  26 22                   CHAD:        MVI         H,SCRB ;   TO ADDRESS SCRATCH BAN
00000361 SYSIN       337  36E4  2E 36                        MVI     L,ADRL ; TO ADDR CHAR STRING WORD
00000362 SYSIN       338  36E6  5E                           MOV     E,M ;        CHARACTER STRING WORD
00000363 SYSIN       339  36E7  1C                           INR     E ;          TO ADDR NEXT CHARACTER
00000364 SYSIN       340  36E8  73                           MOV     M,E ;        UPDATE CHAR STRING WORD
00000365 SYSIN       341  36E9  2C                           INR     L ;          TO ADDR CHAR STRING BANK
00000366 SYSIN       342  36EA  66                           MOV     H,M ;        CHARACTER STRING BANK
00000367 SYSIN       343  36EB  6B                           MOV     L,E ;        CHARACTER STRING WORD
00000368 SYSIN       344  36EC  C9                           RET      ;           RETURN TO CALLER
00000369 SYSIN       345  36ED  84 20 00 00             FTEN:        DB          204Q,040Q,0,0 ; FLOATING TEN
00000370 SYSIN       346  36F1  68 56 BF AD             RND0:        DB          150Q,126Q,277Q,255Q ; .00000005
00000371 SYSIN       347  36F5  00                           DB      0 ;          CHECKSUM WORD
00000375 SYSIN       348  36F6                               END
00000375 SYSIN        TOTAL ASSEMBLER ERRORS =    0
```

```
                        ;MATH PACK TRANS ROUTINE
                        ; MOVES B TO H AND C TO L THEN JUMPS TO
                        ; MATH PACK
                        ;
                        ;
                        ;                          RTW     3/9/76
                        ;
                        ;
0000 32 59              TST     EQU     3259H
0000 32 3E              STR     EQU     323EH
0000 32 6E              LOD     EQU     326EH
0000 32 D7              ADD0    EQU     32D7H
0000 32 D4              SUB0    EQU     32D4H
0000 32 8C              MUL     EQU     328CH
0000 32 B4              DIV     EQU     32B4H
0000 35 4B              INP     EQU     354BH
0000 36 0D              OUTPUT  EQU     360DH
                        ;
                        ;
31D5                            ORG     31D5H
                        ;
                        ;SET SO BUTS UP TO MATH PACK
                        ;
31D5 60                 STRT:   MOV     H,B
31D6 69                         MOV     L,C
31D7 E5                         PUSH    H
31D8 CD 59 32                   CALL    TST
31DB E1                         POP     H
31DC C3 3E 32                   JMP     STR
31DF 60                 LODT:   MOV     H,B
31E0 69                         MOV     L,C
31E1 C3 6E 32                   JMP     LOD
31E4 60                 ADDT:   MOV     H,B
31E5 69                         MOV     L,C
31E6 C3 D7 32                   JMP     ADD0
31E9 60                 SUBT:   MOV     H,B
31EA 69                         MOV     L,C
31EB C3 D4 32                   JMP     SUB0
31EE 60                 MULT:   MOV     H,B
31EF 69                         MOV     L,C
31F0 C3 8C 32                   JMP     MUL
31F3 60                 DIVT:   MOV     H,B
31F4 69                         MOV     L,C
31F5 C3 B4 32                   JMP     DIV
31F8 60                 INPT:   MOV     H,B
31F9 69                         MOV     L,C
31FA C3 4B 35                   JMP     INP
31FD 60                 OUTT:   MOV     H,B
31FE 69                         MOV     L,C
31FF C3 0D 36                   JMP     OUTPUT
3202 00                         END

TOTAL ASSEMBLER ERRORS =   0
```

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SYMBOL TABLE (600 MAX. 27 USED)

1	A	0007	ADD0	32D7	ADDT	31E4	B	0000	C	0
6	D	0002	DIV	32B4	DIVT	31F3	E	0003	H	0
11	INP	354B	INPT	31F8	L	0005	LOD	326E	LODT	3
16	M	0006	MUL	328C	MULT	31EE	OUTPUT	360D	OUTT	3
21	PSW	0006	SP	0006	STR	323E	STRT	31D5	SUB0	3.
26	SUBT	31E9	TST	3259						

```
        /* RWLM PROGRAM */
    /* BY W.P. MCDOWELL  AND D.J.KEEFE  AND R.T.WITEK*/
    /*FOR BOM CONTRACT # HO 252053         */
    /*ARGONNE NATIONAL LABORATORY*/
     /* NOVEMBER 8,1976*/
     /*COPYRIGHT 1976*/
       /*V11*/
 /*THIS PROGRAM REQUIRES THE USE OF THE INTEL PLM COMPILER TO
   GENERATE 8080 CODE-USE THE FOLLOWING COMPILER SWITCH SETTINGS
   $*=9215(SETS STACK POINTER TO 23FFH FOR 1K RAM,$V=32-RAM=2000H,
   $H=256 ORG FOR PROPER MATHPACK OPERATION,$F,$G,$B=6,$O=7 */
       /* DATA DECLARATIONS*/
DECLARE LIT LITERALLY 'LITERALLY';
DECLARE SP16 LIT '0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,24H';
DECLARE MASK DATA(1,2,4,8,16,32,64,128,255,0);
/* 255 AND 0 IN ABOVE MASK ARE DUMMIES INSERTED TO PREVENT
 CONSTANT DATA WHICH FOLLOWS FROM OVERLAPING A MEMORY PAGE
 THE MATH-PACK REQUIRES THAT REG H NOT CHANGE IN THE
 ADDRESS OF A VARIABLE          */
DECLARE CONSTR DATA(SP16,SP16,SP16,SP16,SP16,SP16,SP16,
SP16,SP16,SP16,SP16,SP16,SP16,SP16,SP16,
SP16,SP16,SP16,SP16,SP16,SP16,SP16,SP16,SP16);
DECLARE TRUE LITERALLY '1111$1111B';
DECLARE FALSE LITERALLY '0';
DECLARE QM LITERALLY '3FH';
DECLARE OUT BYTE;
DECLARE BIT$07(8) BYTE; DECLARE BIT$04(8) BYTE;
DECLARE (NET1,NET2,NET3)(13) BYTE;
DECLARE (B0,B1,B2,D0,D1,D2) (8)  BYTE;
DECLARE LF LITERALLY '0AH', CR LITERALLY '0DH',BELL LITERALLY '7';
DECLARE (FAILTST,SELDET)BYTE;
DECLARE DETSEL(2) BYTE;
DECLARE ( TIMERMINS,TIMERHRS,TIT) BYTE;
DECLARE (TIMERSECS) ADDRESS;
DECLARE (TIM,TIH,SMIN,SHRS) BYTE;
DECLARE  HEAD(2) BYTE;
DECLARE (SAMPLE$HOURS,SAMPLE$MINS )  BYTE;
DECLARE ( DETHRS,DETMINS) (3) BYTE;
DECLARE  RWLM$HEAD LITERALLY '7';
DECLARE (YRS,MONS,DAYS,HRS ,MINS,SECS) BYTE ;
DECLARE (I,N,M,TT) BYTE;
DECLARE (TSTPWR,TSTSOL)BYTE;
DECLARE (TSTART,TSTOP) ADDRESS;
DECLARE TTYSTT LITERALLY '0',TTYBUF LITERALLY '1';
DECLARE DATEOK DATA ('DATE CORRECT (Y/N)',QM);
DECLARE WISH DATA('DO YOU WANT ');
DECLARE WISH2 DATA(' RUN(Y/N)',QM);
DECLARE STOPTIME DATA ('INPUT TIME TO STOP');
DECLARE TQH DATA ('ENTER TIME INTERVAL BETWEEN SAMPLES HOURS-');
DECLARE TQM DATA (' MIN-');
DECLARE SHORT DATA(CR,LF,'TIME TOO SHORT MUST BE >14 MINS',CR,LF);
DECLARE STM DATA('ENTER TIME TO START HOUR-');
DECLARE STMM DATA ('  MIN-');
DECLARE ALT$COR$FACTOR(13) BYTE;
DECLARE WL(52) BYTE;
DECLARE (YS,MNS,DS,HS,MS) BYTE;
DECLARE (CAL$TEST,CAL$TEST1,CALTEST2,CAL$TIME)  BYTE;
DECLARE (ALTFACTOR1,ALTFACTOR2) (13) BYTE;
```

```
      /*PROCEDURES*/
 TYPEOUT: PROCEDURE(CHAR); /* TYPE A CHARACTER */
  DECLARE (CHAR,I) BYTE;
   DO WHILE((INPUT(TTYSTT) AND 80H)=FALSE); END; /* WAIT FOR TTY */
   OUTPUT(TTYBUF)=CHAR;/* PRINT THE CHAR*/
   IF CHAR=CR THEN /* WAIT ON CR FOR S700*/
        DO I=0 TO 8; CALL TIME(250); END;/*200 MSEC WAIT*/
  END TYPEOUT;/*THATS ALL*/

  TYPEIN:  PROCEDURE BYTE ;/* INPUT A CHAR FROM TTY */
    DO WHILE((INPUT(TTYSTT) AND 1)=FALSE);END;/*WAIT FOR DATA*/
     RETURN INPUT(TTYBUF);/*GET THE CHAR*/
   END TYPEIN;

TYINOUT:PROCEDURE; /*ECHOS A CHAR TO TTY */
    N=TYPEIN AND 7FH;
    CALL TYPEOUT(N);
    END TYINOUT;

  ECHO:PROCEDURE  BYTE;
  CALL TYINOUT;RETURN(N);
  END ECHO;

DECLARE CNT BYTE;

  INP$LINE:PROCEDURE(P);
  DECLARE P ADDRESS,(T,C BASED P)BYTE;
  CNT=0;
  DO WHILE((T:=ECHO)<>CR);
  C(CNT)=T;CNT=CNT+1; END;
 C(CNT)='$'-'0';
  CALL TYPEOUT(LF);
  END INP$LINE;

  CRLF: PROCEDURE; /* OUTPUTS A CR-LF TO THE TTY*/
   CALL TYPEOUT(0DH);
   CALL TYPEOUT(0AH);
  END CRLF;

  PRINTPROMPT:PROCEDURE; /*PRINTS PROMPT CHAR*/
   CALL CRLF;
   CALL TYPEOUT('*');
  END PRINTPROMPT;

 PACKBCD: PROCEDURE; /*PRODUCES A PACKED BCD BYTE*/
   CALL TYINOUT;
   M=N-'0';
       CALL TYINOUT;
   M=SHL(M,4)+(N-'0');
   END PACKBCD;
```

```
 PRINTSTRING:PROCEDURE(NAME, LENGTH); /* TYPES A DATA STRING*/
   DECLARE NAME ADDRESS,(LENGTH,I,CHAR BASED NAME) BYTE;
   DO I=0 TO LENGTH-1;
   CALL TYPEOUT(CHAR(I));
    END;
 END PRINTSTRING;

  PRINTBCD: PROCEDURE(B) ; /*PRINT BCD CHAR PAIR*/
   DECLARE B BYTE;
   CALL TYPEOUT(SHR(B,4)+'0');
   CALL TYPEOUT((B AND 0FH)+'0');
  END PRINTBCD;

  ERROR:   PROCEDURE;
   /*  ERROR RESTART PROCEDURE RESTARTS PROGRAM
       AFTER ANY ERROR*/
  DECLARE ERRMSG DATA (CR,LF,BELL,BELL,
     '**  E R R O R  **',BELL,BELL,CR,LF,LF);
        CALL PRINTSTRING(.ERRMSG,LENGTH(ERRMSG));
        GOTO START;
     END ERROR;

DELAY$1MS: PROCEDURE;  /*1 MS DELAY */
     DISABLE;
     CALL TIME(10);
     ENABLE;
  END DELAY$1MS;

DELAY$5MS:PROCEDURE;  /*5 MS.DELAY*/
     DISABLE;
    CALL TIME(48);
    ENABLE;
    END DELAY$5MS;

  TYPEDATE: PROCEDURE; /*OUTPUTS CLOCK DATA*/
   DECLARE DATE  DATA(CR,LF,'TODAY IS ');
   DECLARE TIME DATA('  THE TIME IS ');
   CALL PRINTSTRING(.DATE,LENGTH(DATE));
   CALL PRINTBCD(MONS);
   CALL TYPEOUT('/');
   CALL PRINTBCD(DAYS);
   CALL TYPEOUT('/');
   CALL PRINTBCD(YRS);
   CALL PRINTSTRING(.TIME,LENGTH(TIME));
   CALL PRINTBCD(HRS);
   CALL TYPEOUT(':');
   CALL PRINTBCD(MINS);
   CALL CRLF;
  END TYPEDATE;
```

```
/* SET DATE AND TIME FROM KEYBOARD*/
   DECLARE SETYEAR DATA(CR,LF,'ENTER YEAR-');
   DECLARE SETMON DATA(' ENTER MONTH-');
   DECLARE SETDAY  DATA(' ENTER DAY -');
   DECLARE SETHR   DATA(' ENTER HOUR-');
   DECLARE SETMIN  DATA(' ENTER MINUTE-');
   CHANGEDATE: PROCEDURE;
  DISABLE;
 CALL PRINTSTRING(.SETYEAR,LENGTH(SETYEAR));
  CALL PACKBCD;
   YRS=M;
CALL PRINTSTRING(.SETMON,LENGTH(SETMON));
  CALL PACKBCD;
   MONS=M;
 CALL PRINTSTRING(.SETDAY,LENGTH(SETDAY));
    CALL PACKBCD;
   DAYS=M;
CALL PRINTSTRING(.SETHR,LENGTH(SETHR));
  CALL PACKBCD;
   HRS=M;
CALL PRINTSTRING(.SETMIN,LENGTH(SETMIN));
  CALL PACKBCD;
   MINS=M;
  CALL CRLF;
       SECS=0;
        OUTPUT(OFBH)=0;
   ENABLE;
   CALL TYPEDATE;
END CHANGEDATE;

     RESTART: PROCEDURE INTERRUPT 0;
      /* STARTUP AND RESTART PROCEDURE INT 0*/
       GO TO START;/* ALL YOU DO ON INT 0 IS GO TO START*/
       END RESTART;
```

```
      TIMEKEEPER: PROCEDURE INTERRUPT 7;
/*MACHINE IS INTERRUPTED ONCE PER SEC TO UPDATE CLOCK*/
/* DAYMAX IS A VECTOR FOR LENGTH OF MONTH */
  DECLARE DAYMAX DATA(0,31H,28H,31H,30H,31H,30H,31H,31H,30H,
   0,0,0,0,0,0,31H,30H,31H);
   TIMERSECS=TIMERSECS+1;
SECS=SECS OR SECS;/*RESETS CARRY BIT TO ACCOUNT FOR COMPILER BUG*/
  IF(SECS := DEC(SECS+1))=60H THEN    /*INCR SECONDS*/
  DO;
    SECS=0;
     SECS=SECS OR SECS;  /*SEE ABOVE*/
      TIMERMINS=DEC( TIMERMINS+1);  /*EXTERNAL TIMER*/
          IF TIMERMINS=60H THEN
  DO;TIMERMINS=0;SECS=SECS OR SECS;TIMERHRS=DEC(TIMER$HRS+1);END;
      MINS=MINS OR MINS;  /*SEE ABOVE*/
    IF (MINS:=DEC(MINS+1))=60H THEN   /*INCR MINS*/
    DO;
       MINS=0;
      HRS=HRS OR HRS;  /*SEE ABOVE*/
       IF(HRS:=DEC(HRS+1))=24H THEN   /*INCR HRS*/
       DO;
       HRS=0;
/*NOW INCR DAYS AND THEN CHECK FOR LENGTH OF MONTH */
      DAYS=DAYS OR DAYS;  /*SEE ABOVE*/
        IF (DAYS:=DEC(DAYS+1)) > DAYMAX(MONS)
    THEN DO;
          DAYS=1;
          DAYS=DAYS OR DAYS;
           IF(MONS:=DEC(MONS+1))=13H THEN
            DO; YRS=DEC(YRS+1);
            MONS=1;
            END;
          END;
         END;
        END;
    END;
   OUTPUT(0FBH)=0;
  END TIMEKEEPER;
```

```
   DETMSG: PROCEDURE; /*PRINTS DET NUMBER*/
   DECLARE COMMSG DATA(' DETECTOR  ');
    CALL PRINTSTRING(.COMMSG,LENGTH(COMMSG));
      CALL TYPEOUT(SELDET + '1');
    END DETMSG;

   /* CHAN 7 OUTPUT PROCEDURE  */
   /* OUTPUT 7 CONTROLS THE RWLM HEAD*/
   /* BIT 0 HEAD SELECT-0=HEAD 1,1=HEAD 2 */
    /*BIT 1                   */
  /*BIT 2                   */
  /*BIY 3 MOTOR PULSES      */
  /*BIT 4 MOTOR POWER       */
  /*BIT 5 SOLENOID POWER    */
  /*BIT 6 PUMP ON           */
  /*BIT 7 SOURCE CHECK                    */
   DET$HEAD$OUT:   PROCEDURE;
   DECLARE I BYTE;
      OUT=FALSE;
      DO I=0 TO 7;
      CUT=OUT OR (BIT$07(I) AND MASK(I));
      END;
   OUTPUT(7)=OUT;
   END DET$HEAD$OUT;

     /* CHAN 4 OUTPUT  PROCEDURE */
 /* OUTPUT 4 CONTROLS THE DATA ACCUMULATORS  */
  /* BIT 0  STORE(NOT)              */
  /* BIT 1 SET(NOT)                 */
  /* BIT 2 SCAN                     */
  /* BIT 3 CLEAR(NOT)               */
  /* BIT 4 COUNT ENABLE             */
  /* BIT 5                          */
  /* BIT 6                          */
  /* BIT 7                          */
     CHN$4$OUT:  PROCEDURE;
     DECLARE I BYTE;
          OUT=FALSE;
          DO I=0 TO 7;
          OUT=OUT OR (BIT$04(I) AND MASK(I));
          END;
     OUTPUT(4)=OUT;
     END CHN$4$OUT;

    RELEASE$SOLENOID: PROCEDURE;
    DECLARE SOLMSG DATA(' SOLENOID NOT RELEASED');
       FAILTST=FALSE;
          BIT$07(5)=FALSE;
          CALL DET$HEAD$OUT;
          IF (INPUT(RWLM$HEAD) AND MASK(5))=FALSE THEN
            DO;
            CALL DETMSG;
            CALL PRINTSTRING(.SOLMSG,LENGTH(SOLMSG));
            FAILTST=TRUE; CALL ERROR;
            END;
    END RELEASE$SOLENOID;
```

```
/*PAPADV MOVES FILTER 1 CYCLE,CHECKS 0 POS AND FILTER QUANT*/
 PAPADV:PROCEDURE;
      DECLARE PULSES ADDRESS;
      DECLARE FINISH LABEL;
      DECLARE NOPAPER DATA( ' FILTER SUPPLY EXHAUSTED',CR,LF);
      DECLARE EXTRA$ADVANCE DATA(' FILTER ADVANCE ERROR',CR,LF);
       FAILTST=FALSE;
       BIT$07(4)=MASK(4);
       CALL RELEASE$SOLENOID;
       IF FAILTST=0 THEN
          DO PULSES = 0 TO 1150;
          /*TURN ON SOLENOID WHEN STARTING PAPER TAKE UP*/
          IF PULSES > 500 THEN BIT$07(5)=TRUE;
          /*START FORMING MOTOR PULSE*/
          BIT$07(3)=FALSE;
          CALL DET$HEAD$OUT;
          CALL DELAY$1MS;
          BIT$07(3)=MASK(3);
          CALL DET$HEAD$OUT;
          CALL DELAY$5MS;
IF ((INPUT(RWLM$HEAD) AND MASK(7))=MASK(7) AND PULSES>100 ) THEN
             DO;
             IF(INPUT(RWLM$HEAD) AND MASK(4))= 0 THEN
                DO; CALL DETMSG;
                CALL PRINTSTRING(.NOPAPER,LENGTH(NOPAPER));
                FAILTST=TRUE;/* SET ERROR FLAG */
                END;
             GO TO FINISH;/*GO HOME NICELY*/
             END;
          END;
          /*IF HERE THERE HAS BEEN AN ERROR*/
       CALL DETMSG;
       CALL PRINTSTRING(.EXTRA$ADVANCE,LENGTH(EXTRA$ADVANCE));
       FAILTST=TRUE;
FINISH:BIT$07(4)=FALSE;/*TURN OFF POWER */
       BIT$07(5)=FALSE;/*AND THE SOLENOID*/
        CALL DET$HEAD$OUT;/*DO IT NOW*/
          IF FAILTST=TRUE THEN CALL ERROR;/*ERROR IF BADNESS SET*/
       END  PAPADV;/*ELSE GO BACK TO WERE YOU CAME FROM*/
```

```
/* THIS SECTION INTERFACES PLM TO THE MATH PACK*/
DECLARE ADDT LIT '31E2H';
DECLARE SUBT LIT '31E7H';
DECLARE INITT LIT '322FH';
DECLARE MULT LIT '31ECH';
DECLARE DIVT LIT '31F1H';
DECLARE INPT LIT '31F6H';
DECLARE OUTT LIT '31FBH';
DECLARE STRT LIT '31D3H';
DECLARE LODT LIT '31DDH';
INIT:   PROCEDURE ;
GOTO INITT;
END INIT;
ADD:    PROCEDURE(LOC);
        DECLARE LOC ADDRESS;
        GOTO ADDT;
END ADD;
SUB:    PROCEDURE(LOC);
        DECLARE LOC ADDRESS;
        GOTO SUBT;
        END SUB;
MUL:    PROCEDURE(LOC);
        DECLARE LOC ADDRESS;
        GO TO MULT;
        END MUL;
DIV:    PROCEDURE(LOC);
        DECLARE LOC ADDRESS;
        GOTO DIVT;
END DIV;
LOD:    PROCEDURE(LOC);
        DECLARE LOC ADDRESS;
        GO TO LODT;
END LOD;
STR:    PROCEDURE(LOC);
        DECLARE LOC ADDRESS;
        GOTO STRT;
END STR;
INP:    PROCEDURE(LOC);
        DECLARE LOC ADDRESS;
        GOTO INPT;
END INP;
OUTPT:  PROCEDURE(LOC);
         DECLARE LOC ADDRESS;
         GO TO OUTT;
END OUTPT;
  INSTR: PROCEDURE(A1,A2);
    DECLARE (A1,A2) ADDRESS;
    CALL INP(A1); CALL STR(A2);
  END INSTR;
/* THIS END THE MATH PACK -PLM INTERFACE*/
```

```
     DECLARE TEMP(48) BYTE;
     DECLARE  (ASUB,FSUB,TSUB) ADDRESS;
   DECLARE ALTCONF(4) BYTE;
     DECLARE  FT(12) BYTE,FB(24) BYTE, FCON(48) BYTE;

 NET$COUNT:PROCEDURE; /*SUBTRACTS BACKGROUND FROM SAMPLE*/
     DO I=0 TO 2;
     ASUB=.FB+I*4;FSUB=ASUB+12;TSUB=.FT+I*4;
     CALL LOD(FSUB);CALL SUB(ASUB);CALL STR(TSUB);
       CALL OUTPT(.NET1+I*13);
     END;
  END NET$COUNT;

CAL:   PROCEDURE; /* PERFORMES CALCULATIONS*/
     DECLARE (I,I1) BYTE;
     CALL INIT;
/* CONVERT CONSTANT VALUES TO FLOATING POINT AND STORE*/
     DO I=0 TO 11;
     CALL INSTR(.CONSTR+(I*16)+(192*SELDET),.FCON+(I*4));
     END;
/* CONVERT ALTITUDE CORRECTION FACTOR TO FP AND STORE*/
        /* DETERMINE WHICH HEAD IS SELECTED*/
       IF SELDET=0 THEN
        DO I=0 TO 13;ALT$COR$FACTOR(I)=ALTFACTOR1(I);END;
     ELSE
        DO I=0 TO 13;ALT$COR$FACTOR(I)=ALTFACTOR2(I);END;
     CALL INSTR(.ALT$COR$FACTOR,.ALTCONF);
/*CONVERT BACKGROUND AND SAMPLE COUNTS TO FP AND STORE*/
     DO I=0 TO 5;
     CALL INSTR(.B0+I*8,.FB+I*4);
     END;
/* SUBTRACT BACKGROUND FROM SAMPLE AND STORE*/
   CALL NET$COUNT;
  /* PERFORM MULTIPLICATIONS AND STORE RESULTS IN TEMP*/
     DO I1=0 TO 3 ;
        DO I=0 TO 8 BY 4;
        CALL LOD(.FT+I);
        CALL MUL(.FCON+I+(I1*12));
        CALL STR(.TEMP+I+(I1*12));
        END;
     CALL LOD(.TEMP+(I1*12));
        DO I=4 TO 8 BY 4;
/* PERFORM ADDITIONS*/
        CALL ADD(.TEMP+I+(I1*12));
        END;
/* MULTIPLY BY ALTITUDE CORRECTION FACTOR*/
     CALL MUL(.ALTCONF);
/*STORE RESULTS*/
     CALL OUTPT(.WL+(I1*13));
     END;
 END CAL;
```

```
/*THIS SECTION PRINTS THE REPORT ON THE TERMINAL*/
DECLARE WLM DATA ('WORKING LEVEL           RADIUM',
' A                RADIUM B                RADIUM C',
'                ');
DECLARE L DATA('      PC/L PC/L PC/L');
DECLARE HEAD1 DATA (CR,LF,LF,'                               '
,'      *** R W L M ***',CR,LF,'                               ');
DECLARE CL DATA('RADIUM A        RADIUM (B+C)     RADIUM C''  ');
DECLARE CH DATA('                        SAMPLE COUNTS',
'          BACKGROUND COUNTS     NET COUNTS',CR,LF);
 DECLARE ALTMSG DATA(CR,LF,'ENTER ALTITUDE CORRECTION FACTOR= ');

PRINT$REPORT:  PROCEDURE;
DECLARE I BYTE;
   /*CONVERT COUNT DATA FROM BCD TO ASCII*/
DO I=0 TO 47 ; B0(I)=B0(I)+'0'; END;
DO I=0 TO 38;NET1(I)=NET1(I)+'0';END;
    /*CHECK IF CALIBRATION REPORT*/
   IF CAL$TEST2=TRUE THEN GOTO CAL$PRINT;
     DO I=0 TO 51; WL(I)=WL(I)+'0';END;
   CALL PRINTSTRING(.HEAD1,LENGTH(HEAD1));
     CALL DETMSG;
   CALL CRLF;
CALL TYPEDATE;
CALL PRINTSTRING(.ALTMSG+8,27);
 DO I=0 TO CNT-1; N=ALT$COR$FACTOR(I)+30H;CALL TYPEOUT(N);END;
CALL CRLF;CALL CRLF;
   DO I=0 TO 3;
   CALL PRINTSTRING(.WLM+I*24,24);
   CALL PRINTSTRING(.WL+I*13,13);
   CALL PRINTSTRING(.L+I*5,5);
   CALL CRLF;
   END;
   CALL CRLF;CALL CRLF;CALL CRLF;
    /*PRINT CALIBRATION REPORT*/
  CAL$PRINT:;
   CALL PRINTSTRING(.CH,LENGTH(CH));
   DO I=0 TO 2;
   CALL PRINTSTRING(.CL+I*16,16);
   CALL PRINTSTRING(.B0+I*8+24,7);
   CALL PRINTSTRING(.HEAD1+3,16);
   CALL PRINTSTRING(.B0+I*8,7);
   CALL PRINTSTRING(.HEAD1+3,16);
    CALL PRINTSTRING(.NET1+I*13,13);
   CALL CRLF;
   END;
   CALL CRLF;CALL CRLF;
      /* RETURN DATA TO ORIGINAL CONDITION*/
  /* RECONVERT TO BCD*/
DO I=0 TO 47; B0(I)=B0(I)-'0';END;
DO I=0 TO 38;NET1(I)=NET1(I)-'0';END;
DO I=0 TO 51;WL(I)=WL(I)-'0';END;
   END PRINTREPORT;
```

```
     COUNT: PROCEDURE;
     /*  TURN COUNTERS ON AT TSTART AND OFF
         AT TSTOP , CLEAR BEFORE COUNT */
  IF CAL$TEST1=TRUE THEN GO TO CAL$LOOP;
          BIT$O4(3)=FALSE; BIT$O4(4)=FALSE;CALL CHN$4$OUT;
          BIT$O4(3)=MASK(3);BIT$O4(4)=MASK(4);
          DO WHILE (TIMER$SECS<TSTART); END;
          CALL CHN$4$OUT;
     /* FOR CALIBRATION ONLY */
  CAL$LOOP:;
          BIT$O4(4)=FALSE;
 DECLARE TS ADDRESS;
STARTTIM:  DISABLE;
    TS= TIMER$SECS;   ENABLE;
  IF TSTOP>TS THEN GOTO STARTTIM;
          CALL CHN$4$OUT;
     END COUNT;
```

```
     READ$ACCUM: PROCEDURE(A,B,C);
     DECLARE I BYTE;
/* READ ACCUM PROCEDURE
WILL READ DATA FROM SELECTED HEAD AND RETURN DATA */
DECLARE (A,B,C) ADDRESS, (R1 BASED A,R2 BASED B, R3 BASED C) BYTE;
          /* LATCH LSD*/
     BIT$04(0)=MASK(0);CALL CHN$4$OUT;
     BIT$04(0)=FALSE; CALL CHN$4$OUT;
          /*INPUT LSD AND RIGHT JUSTIFY */
     R1(6)=SHR(INPUT(4),4);
     R2(6)=SHR(INPUT(5),4);
     R3(6)=SHR(INPUT(6),4);
          /* SET THE COUNTER DISPLAY COUNTER*/
     BIT$04(1)=MASK(1); CALL CHN$4$OUT;
     BIT$04(1)=FALSE;   CALL CHN$4$OUT;
          /* THIS LOOP READS THE SIX DIGITS FROM THE COUNTERS*/
        DO I=0 TO 5;
          /*LATCH THE DIGIT */
        BIT$04(0)=MASK(0) ;CALL CHN$4$OUT;
        BIT$04(0)=FALSE ;CALL CHN$4$OUT;
          /*INPUT DIGIT AND STRIP OFF LSD*/
        R1(I)=NOT(INPUT(4)) AND 15;
        R2(I)=NOT(INPUT(5)) AND 15;
        R3(I)=NOT(INPUT(6)) AND 15;
          /*STROBE THE SCAN INPUT HAS TO BE SLOW FOR THE CMOS*/
        BIT$04(2)=MASK(2);CALL CHN$4$OUT;
     CALL DELAY$1MS;
        BIT$04(2)=FALSE; CALL CHN$4$OUT;
     CALL DELAY$1MS;
     END;
          /* PUT $-0 ON THE END OF EACH NUMBER FOR THE MATH PACK*/
     R1(7)='$'-'0';R2(7)='$'-'0';R3(7)='$'-'0';
     END READ$ACCUM;

   DECLARE FLO$MSG DATA(' FLOW RATE OUT OF RANGE ');
   FLOW$CHECK: PROCEDURE;
       IF (INPUT(RWLM$HEAD) AND MASK(3))=0 THEN
       DO;
         CALL DET$HEAD$OUT;    /*STOP PUMP*/
         CALL DETMSG;
         CALL PRINTSTRING(.FLO$MSG,LENGTH(FLO$MSG));
         CALL ERROR;
       END;
   END FLOW$CHECK;
```



```
  TEST$AC$POWER:  PROCEDURE;
   DECLARE PWRMSG DATA(' POWER FAIL',CR,LF);
     FAILTST=FALSE;
     IF (INPUT(RWLM$HEAD) AND MASK(6)) =0 THEN
      DO;
```

```
TEST$AC$POWER:  PROCEDURE;
 DECLARE PWRMSG DATA(' POWER FAIL',CR,LF);
   FAILTST=FALSE;
   IF (INPUT(RWLM$HEAD) AND MASK(6)) =0 THEN
    DO;
   CALL DETMSG;
  CALL PRINTSTRING(.PWRMSG,LENGTH(PWRMSG));   /* POWER FAILURE*/
  FAILTST = TRUE;
    END;
   END TEST$AC$POWER ;

   SAMPLE:  PROCEDURE;
   /* SAMPLE PROCEDURE  TAKES SAMPLE FROM HEAD
       HEAD SCHOULD BE SELECTED BEFORE CALL*/
  /* MAKE SURE THE POWER IS ON SO THAT THINGS WILL RUN*/
 CALL TEST$AC$POWER;IF FAILTST THEN CALL ERROR;
   /* TOP OUT THE PAPER BEFORE YOU START TO WORK*/
   /* CHECK FOR ZERO POSITION*/
IF (INPUT(RWLM$HEAD) AND MASK(7)) = FALSE THEN CALL PAPADV;
   CALL PAPADV; CALL PAPADV;
   /* CLEAR OUT PAPER */
   TIMER$SECS=0;/* SET REAL TIME TO ZERO*/
        /* TAKE BACKGROUND COUNT FROM 1 SEC TO 121 SEC*/
   TSTART=1;TSTOP=121;CALL COUNT;
        /* READ IN BACKGROOUND COUNT*/
   CALL READ$ACCUM(.B0,.B1,.B2);
        /* SET TO START PUMP IN OUTPUT VECTOR*/
   BIT$07(5)=TRUE;BIT$07(6)=TRUE;
          /* WAIT TILL TIME TO START PUMP*/
   DO WHILE (TIMER$SECS<122);END;
        /* START PUMP*/
   CALL DET$HEAD$OUT;BIT$07(6)=FALSE;
       /*TEST FLOW RATE AT 200 SEC*/
    DO WHILE (TIMER$SECS<200);  END;
    CALL FLOW$CHECK;
        /* LET PUMP RUN FOR 2 MIN*/
   DO WHILE (TIMER$SECS<242); END;
        /* STOP PUMP*/
   CALL DET$HEAD$OUT;
        /* MOVE SAMPLE UNDER HEAD*/
   CALL PAPADV;
        /*SET UP TO COUNT SAMPLE*/
   TSTART=256;TSTOP=376;CALL COUNT;
        /*READ DATA FOR SAMPLE*/
   CALL READ$ACCUM(.D0,.D1,.D2);
  /*WHEN CALIBRATING JUMP BACK TO CALIBRATE PROCEDURE*/
   IF CAL$TEST=TRUE THEN GOTO FINISH;
        /* DO MATH AND PRINT IT OUT*/
    CALL CAL; CALL PRINT$REPORT;
        /* GO ON HOME NOW ALL IS DONE*/
 FINISH:;
    END SAMPLE;
```

```
CYCLE:     PROCEDURE;
   CAL$TEST=FALSE;  /*NORMAL RUN*/
      /* WAIT TILL TIME TO START*/
     DO WHILE (SMIN<>MINS OR SHRS<>HRS);END;
     /*ONCE IN INTERRUPT ONLY WAY OUT */
   TT=FALSE;
     DO WHILE NOT(TT);/*MAKE A STATMENT AFTER TEST*/
     /* CLEAR MIN AND HRS TIMER*/
     TIMER$MINS=0; TIMER$HRS=0;
     /*HEAD 0 SELECT*/
     IF HEAD(0)   THEN
          DO;
          BIT$07(0)=FALSE;SELDET=0;CALL DET$HEAD$OUT;CALL SAMPLE;
     DO WHILE (TIMER$MINS<07H);END;
          END;
     IF HEAD(1)  THEN
          DO;
          BIT$07(0)=TRUE;SELDET=1;CALL DET$HEAD$OUT;CALL SAMPLE;
          END;
     DO WHILE NOT(TIMER$MINS=TIM AND TIMER$HRS=TIH);END;
 TT=(YRS>=YS AND MONS>=MNS AND DAYS>=DS AND HRS>=HS AND MINS>=MS);
    END;
      END CYCLE; /* THATS ALL THERE IS*/
```

```
  MAIN:     PROCEDURE;/* THE ONE THAT STARTS IT OFF*/
    CALL TYPEDATE;CALL PRINTSTRING(.DATEOK,LENGTH(DATEOK));
         /*IF DATE OK THEN JUST TURN ON CLOCK ELSE CHANGE DATE*/
    /*PRINT DATE AND SEE IF IT IS OK*/
    CALL TYINOUT;IF N='N' THEN CALL CHANGEDATE;
         ELSE DO;OUTPUT(0FBH)=0;ENABLE;CALL CRLF;END;
         DO SELDET=0 TO 1; /*ASK FOR EACH HEAD*/
         CALL PRINTSTRING(.WISH,LENGTH(WISH));CALL DETMSG;
         CALL PRINTSTRING(.WISH2,LENGTH(WISH2)); CALL TYINOUT;
         IF N='Y' THEN HEAD(SELDET)=TRUE;
             ELSE HEAD(SELDET)=FALSE;
         CALL CRLF;
         END;
       TIT=TRUE; DO WHILE (TIT=TRUE);
         CALL CRLF; CALL PRINTSTRING(.TQH,LENGTH(TQH));
         CALL PACKBCD;TIH=M;
          CALL PRINTSTRING(.TQM,LENGTH(TQM));
         CALL PACKBCD; TIM=M;
CALL CRLF; IF((TIH<1 AND TIM<14H) OR TIM>59H ) THEN
     TIT=TRUE;
              ELSE TIT=FALSE;
            IF TIT THEN CALL PRINTSTRING(.SHORT,LENGTH(SHORT));
       END;
         CALL PRINTSTRING(.STM,LENGTH(STM));CALL PACKBCD;
       SHRS=M;CALL PRINTSTRING(.STMM,LENGTH(STMM));CALL PACKBCD;
          SMIN=M;
         CALL CRLF;
    CALL PRINTSTRING(.STOPTIME,LENGTH(STOPTIME));
     CALL PRINTSTRING(.SETYEAR,LENGTH(SETYEAR));
     CALL PACKBCD; YS=M;
     CALL PRINTSTRING(.SETMON,LENGTH(SETMON));
     CALL PACKBCD; MNS=M;
     CALL PRINTSTRING (.SETDAY,LENGTH(SETDAY))·
     CALL PACKBCD; DS=M;
     CALL PRINTSTRING(.SETHR,LENGTH(SETHR));
     CALL PACKBCD; HS=M;
     CALL PRINTSTRING(.SETMIN,LENGTH(SETMIN));
     CALL PACKBCD; MS=M;
     CALL CRLF;
    CALL CYCLE;
  END MAIN;


DECLARE LST DATA(CR,LF,'ILLEGAL CHAR PLEASE REENTER',
  CR,LF);
```

```
 DECLARE SELECT$HEAD DATA(CR,LF,'SELECT HEAD 1 OR 2-');
  SEL$HEAD:PROCEDURE; /* SETS UP HEAD BITS FROM INPUT DATA*/
CALL PRINTSTRING(.SELECT$HEAD,LENGTH(SELECT$HEAD));
CALL TYINOUT;CALL CRLF;
N=N-'0';IF N=0 THEN GOTO EXIT;IF N>2 THEN GOTO EXIT;
   IF N=1 THEN DO;
   SELDET=0;BIT$07(0)=FALSE;   END;
  ELSE DO;
      SELDET=1;BIT$07(0)=TRUE;END;
 GOTO FINISH;
 DECLARE NPOSS DATA(CR,LF,'NOT POSSIBLE');
 EXIT:CALL PRINTSTRING(.NPOSS,LENGTH(NPOSS));
GOTO LOOP;
 FINISH:;
 END SEL$HEAD;

RSTART$ACCUM:PROCEDURE; /*RESTARTS ACCUM AFTER READ */
          BIT$04(3)=MASK(3);BIT$04(4)=MASK(4);
          CALL CHN$4$OUT;
  END RSTART$ACCUM;

 /*THIS PROCEDURE PRINTS THE CALIBRATION DATA*/
PRINT$CALDATA:PROCEDURE;
DECLARE CAL$HEAD DATA(' MINUTE COUNT',CR,LF,LF);
CALL PRINTSTRING(.HEAD1+3,20);CALL PRINTBCD(CAL$TIME);
 CALL PRINTSTRING(.CAL$HEAD,LENGTH(CAL$HEAD));
 CALL PRINT$REPORT;
END PRINTCALDATA;

/*THIS PROCEDURE ADJUSTS THE 2 MIN BACKGROUND FOR
  THE CALIBRATION RUN REQUIREMENTS                */
NET$BKG:PROCEDURE;
 CALL CAL;
 DECLARE MLP1 DATA(2,0FEH,5,0,0,24H);
 DECLARE MLP2 DATA(1,5,0FEH,0,0,24H);
 DECLARE MLP3 DATA(1,7,0FEH,5,0,24H);
  DECLARE MLP4 DATA(1,0FEH,0,0,0,24H);
  DO I=0 TO 2;
CALL INP(.MLP1+M*6);CALL MUL(.FB+I*4);CALL STR(.FB+I*4);
  END;
CALL NET$COUNT;
  END NET$BKG;

CAL$SUB:PROCEDURE; /*SUBROUTINE FOR CALIBRATE PROCEDURE*/
CALL CCUNT; CALL READ$ACCUM(.D0,.D1,.D2); CALL RSTART$ACCUM;
  /* CALCULATE AND PRINT*/
  CALL NET$BKG;  CALL PRINT$CALDATA;
 END CAL$SUB;
```

REMOTE WORKING LEVEL MONITOR CONTROL PROGRAM

```
     CALIBRATE:    PROCEDURE;  /*CONTROLS CALIBRATION CYCLE*/
  DECLARE(N1,N2) BYTE;
  DO N1=1 TO 2;
   IF N1 =1 THEN DO;  SELDET=0; BIT$07(0)=FALSE;  END;
   ELSE DO; SELDET=1; BIT$07(0)=TRUE;END;
    DO N2=0 TO 9;
  OUTPUT(0FBH)=0;ENABLE; /*BE SURE CLOCK IS RUNNING*/
 CAL$TEST=TRUE;
 CALL SAMPLE;  /*TAKE A NORMAL RUN*/
 CALL RSTART$ACCUM;
          /* DO MATH AND PRINT IT OUT*/
     CALL CAL; CALL PRINT$REPORT;
  CAL$TEST1=TRUE;CAL$TEST2=TRUE;
  /* SET UP TO GET 5MIN DATA*/
  CAL$TIME=05H;
TSTOP=556; M=0; CALL CAL$SUB;
 /*SET UP TO GET 30 MIN DATA */
   CAL$TIME=30H;
 TSTOP=2056; M=1; CALL CAL$SUB;
  /*SET UP FOR 35 MIN DATA*/
  CAL$TIME=35H;
  TSTOP=2356; M=2; CALL CALSUB;
/*   SET UP TO DO KUSNETZ METHOD*/
 M=3;
   CAL$TIME=39H;
CAL$TEST1=FALSE;
  CAL$TEST = FALSE; TSTART=2596;TSTOP=2716;
CALL CAL$SUB;
  CAL$TEST2=FALSE;
IF INPUT(TTYBUF)AND 7FH=1BH THEN GOTO FINISH;
  END; /*END OF INNER LOOP-10 CAL RUNS*/
  END; /*END OF OUTER LOOP -BOTH HEADS*/
FINISH:; /*ESCAPE ROUTE*/
 END CALIBRATE;
```

```
  SOURCE$CHECK:   PROCEDURE; /*ALLOWS CALIBRATION WITH SOURCES */
DECLARE SCHK DATA('SOURCE CHECK MODE  ');
DECLARE SEL$SOURCE DATA(CR,LF,'SELECT MODE  A-B-C -');
DECLARE I BYTE;
  START:CALL SEL$HEAD;CALL DET$HEAD$OUT;
  CALL TEST$AC$POWER;
   IF FAILTST=TRUE THEN GOTO LOOP;
  CALL PRINTSTRING(.SEL$SOURCE,LENGTH(SEL$SOURCE));
CALL TYINOUT;CALL CRLF;
    /* CHECK ALLOWABLE VALUES OF INPUT*/
IF N<'A' THEN GOTO EXIT;IF N>'C' THEN GOTO EXIT;
   /*CHECK MODE AND SET UP OUTPUT PORTS*/
  IF N='C' THEN BIT$07(7)=TRUE;
  ELSE BIT$07(7)=FALSE;CALL DET$HEAD$OUT;
   /*TAKE A TWO MINUTE COUNT*/
  OUTPUT(0FBH)=0;ENABLE; /*BE SURE CLOCK IS RUNNING*/
  TIMER$SECS=0;TSTART=1;TSTOP=121;CALL COUNT;/*GET DATA*/
   /* READ COUNT AND STORE*/
    CALL READ$ACCUM(.D0,.D1,.D2);
    /*ZERO UNSELECTED DATA AREAS*/
   DO CASE N-'A';
      DO;   /* CASE 0,N=A,ZERO (B+C) AND C'*/
        DO I=0 TO 6;
            D1(I)=0;D2(I)=0;END;
      END;
       DO;  /* CASE 1,N=B,  ZERO A AND C'*/
        DO I=0 TO 6;
            D0(I)=0;D2(I)=0;END;
         END;
      DO; /*CASE 2,N=C, ZERO A AND (B+C)*/
        DO I=0 TO 6;
          D0(I)=0;D1(I)=0;END;
        END;
     END; /*END CASE*/
  /* ZERO BACKGROUND DATA AREA*/
  DO I=0 TO 23;B0(I)=0;END;
B0(7)=24H;B1(7)=24H;B2(7)=24H; /*PLACE $ FOR MATH PACK DELIMITER*/
    /* PERFORM MATH AND PRINT IT OUT*/
CALL PRINTSTRING(.HEAD1+3,20);
CALL PRINTSTRING(.SCHK,LENGTH(SCHK));
CALL PRINTSTRING(.N,1);
   CALL CAL;CALL PRINT$REPORT;
    GO TO START;
EXIT:;
DECLARE PRNTEND DATA(CR,LF,'END ');
CALL PRINTSTRING(.PRNTEND,LENGTH(PRNTEND));
CALL PRINTSTRING(.SCHK,LENGTH(SCHK));CALL CRLF;
    END SOURCE$CHECK;
```

```
   ALT$FACTOR:PROCEDURE;
      DO M=1 TO 2     ;
      CALL SEL$HEAD;
   CALL PRINTSTRING(.ALTMSG,LENGTH(ALTMSG));
   CALL IMP$LINE(.ALT$COR$FACTOR);
   DO I=0 TO CNT;ALT$COR$FACTOR(I)=ALT$COR$FACTOR(I)-30H;END;
   ALT$COR$FACTOR(13)=24H;
         IF SELDET=0 THEN
      DO I=0 TO 13;ALTFACTOR1(I)=ALT$COR$FACTOR(I);    END;
      ELSE
      DO I=0 TO 13;ALTFACTOR2(I)=ALT$COR$FACTOR(I);     END;
      END;
   END ALT$FACTOR;

         /* MAIN */
/*  THE MAIN PROGRAM LOOP  CALLS THE REQUIRED PROCEDURES*/
DECLARE SIGNON DATA('REMOTE WORKING LEVEL MONITOR VERSION',
  '   11  04-26-77',CR,LF);
RESET:
   OUTPUT(RWLM$HEAD)=FALSE; /*RESET HEAD*/
DO I=0 TO 5 ;YRS(I)=0;END; /*RESET DATE AND TIME TO 0*/
   CAL$TEST=FALSE; /*BE SURE NOT IN CAL MODE*/
    CAL$TEST1=FALSE;CAL$TEST2=FALSE;
  /*RESET ALTITUDE CORECTION FACTOR TO 1.0*/
  DO I=0 TO 12;ALTFACTOR1(I)=0;ALTFACTOR2(I)=0;END;
  ALTFACTOR1(0)=1;ALTFACTOR1(1)=24H;
  ALTFACTOR2(0)=1;ALTFACTOR2(1)=24H;
CNT=1; SELDET=0;
START: CALL CRLF;
 CALL PRINTSTRING(.SIGNON, LENGTH(SIGNON));
 CALL TYPEDATE;
DO I=0 TO 7;BIT$07(I)=0;BIT$04(I)=0; END; /*CLEAR CONTROL VECTOR*/
LOOP: CALL PRINTPROMPT;   /* INPUT CHAR FROM TTY,ECHO,BRANCH*/
        OUTPUT(0FBH)=0;  ENABLE;
        CALL TYINOUT;
         /*PROCESS TYPED COMMAND INTO NUMBER AND EXECUTE*/
      IF (N:=(N-40H)) > 19
       THEN GOTO MESSAGE;
```

```
      /* THIS SECTION SELECTS THE BRANCH SELECTED BY THE KBRD*/
      DO CASE N;
        GOTO MESSAGE;  /* CASE 0 */
        CALL ALT$FACTOR; /*CHAR A*/
        GOTO MESSAGE;  /* CHAR=B */
        CALL CALIBRATE; /*CHAR C*/
        CALL CHANGEDATE;   /*CHAR = D*/
        CALL CAL;  /* CHAR = E*/
        CALL TYPEDATE;    /* CHAR = F*/
        CALL MAIN;    /*CHAR = G */
         CALL SEL$HEAD;      /*CHAR H*/
        GOTO MESSAGE;    /* CHAR = I*/
        CALL PAPADV;    /*CHAR = J*/
        GOTO MESSAGE;  /* CHAR=K */
        GOTO MESSAGE;  /* CHAR=L */
        GO TO 3800H;/*CHAR =M,RETURN TO MONITOR*/
        GOTO MESSAGE;  /* CHAR=N */
        GOTO MESSAGE;  /* CHAR=O */
       CALL PRINT$REPORT;  /* CHAR =P*/
DO;
 CALL READ$ACCUM(.B0,.B1,.B2);CALL READACCUM(.D0,.D1,.D2);
END;   /*CHAR Q*/
        GOTO RESET;    /* CHAR =R */
        CALL SOURCE$CHECK; /*CHAR=S*/
      END;
     GOTO LOOP;
MESSAGE:    CALL PRINTSTRING(.LST,LENGTH(LST));
GOTO LOOP;
      EOF;
```

PIM TO ASSEMBLY LANGUAGE CROSS INDEX

00000005 SYSIN	1=0103H	19=0106H	20=0110H	26=0290H	51=02A3H	52=02AFH
00000006 SYSIN	53=02B9H	54=02CBH	55=02F5H	56=02FAH	61=031DH	62=0336H
00000007 SYSIN	63=033CH	76=0340H	77=0342H	78=0349H	79=034FH	80=0352H
00000008 SYSIN	81=0372H	82=0373H	84=0375H	85=037CH	86=037FH	89=0382H
00000009 SYSIN	90=0384H	91=038CH	92=038DH	94=0390H	95=0395H	99=039BH
00000010 SYSIN	101=039FH	102=03ABH	103=03C1H	104=03CFH	105=03D5H	106=03D6H
00000011 SYSIN	110=03DBH	111=03E0H	112=03E1H	115=03F4H	116=03F9H	117=03FAH
00000012 SYSIN	120=03EDH	121=03F3H	122=03F5H	123=03F8H	124=0406H	125=0400H
00000013 SYSIN	130=0412H	131=0415H	132=0420H	133=042CH	134=0433H	135=0434H
00000014 SYSIN	138=0438H	139=0441H	140=0447H	141=0453H	142=0454H	146=0457H
00000015 SYSIN	147=0471H	148=0479H	149=047FH	154=048CH	155=049DH	156=04EFH
00000016 SYSIN	157=048FH	160=0490H	161=049DH	162=049FH	163=049FH	166=04A2H
00000017 SYSIN	167=04ADH	168=04BBH	169=04C3H	170=04CAH	171=04CFH	172=04D6H
00000018 SYSIN	173=04DBH	174=04E2H	175=04FAH	176=04F1H	177=04F6H	178=04FDH
00000019 SYSIN	179=0500H	180=0501H	183=050FH	184=051FH	185=0527H	186=0533H
00000020 SYSIN	187=0541H	191=0542H	192=054AH	193=054DH	194=0551H	195=0559H
00000021 SYSIN	196=055CH	197=056CH	198=056BH	199=056BH	200=056FH	201=0577H
00000022 SYSIN	202=057AH	203=057EH	204=0586H	205=0580H	206=058DH	207=0590H
00000023 SYSIN	208=0595H	209=0598H	210=0599H	211=059CH	212=059DH	217=05A1H
00000024 SYSIN	213=05A7H	228=05ABH	229=05C1H	231=05C6H	233=05C8H	234=05CDH
00000025 SYSIN	235=05D5H	236=05D8H	237=05DAH	238=05DCH	239=05E3H	240=05E6H
00000026 SYSIN	241=05F7H	242=05FBH	243=0603H	244=0606H	245=0608H	246=060BH
00000027 SYSIN	247=0613H	248=0616H	250=061BH	251=061BH	252=0621H	253=062FH
00000028 SYSIN	254=0634H	255=0636H	256=063FH	257=0647H	258=064BH	259=064DH
00000029 SYSIN	264=064EH	265=0654H	267=0657H	268=0662H	269=066AH	270=0674H
00000030 SYSIN	271=0675H	285=067AH	286=0687H	287=069EH	288=06A5H	299=06AAH
00000031 SYSIN	290=06ABH	305=06B0H	306=06BEH	307=06D7H	308=06DFH	309=06E5H
00000032 SYSIN	310=06E6H	312=06E9H	313=06FFH	314=0704H	315=070BH	316=070FH
00000033 SYSIN	317=071DH	318=0720H	319=0723H	320=072BH	321=0733H	322=0734H
00000034 SYSIN	329=0737H	330=0751H	331=0768H	332=076DH	333=077CH	334=0781H
00000035 SYSIN	335=0787H	336=07A1H	337=07B6H	338=07BEH	339=07C3H	340=07C6H
00000036 SYSIN	341=07D4H	342=07D9H	343=07DCH	344=0805H	345=0809H	346=0817H
00000037 SYSIN	347=081DH	348=0825H	349=082AH	350=082DH	352=0836H	353=083BH
00000038 SYSIN	354=083EH	355=0846H	356=084BH	357=0853H	358=085CH	359=0860H
00000039 SYSIN	360=086BH	361=0869H	374=086CH	375=086DH	377=0873H	378=0876H
00000040 SYSIN	379=0877H	381=087DH	382=0880H	383=0881H	385=0887H	386=088AH
00000041 SYSIN	387=088BH	389=0891H	390=0894H	391=0895H	393=089BH	394=089EH
00000042 SYSIN	395=089FH	397=08A5H	398=08A8H	399=08A9H	401=08AFH	402=08B2H
00000043 SYSIN	403=08B3H	405=08B9H	406=08BCH	407=08BDH	409=08C7H	410=08CFH
00000044 SYSIN	411=08D8H	412=08D9H	420=08DFH	421=08F7H	422=0953H	423=0970H
00000045 SYSIN	424=0994H	425=099BH	426=099CH	429=099FH	431=09A4H	432=09ADH
00000046 SYSIN	433=0A08H	434=0A0FH	435=0A15H	436=0A18H	437=0A41H	438=0A44H
00000047 SYSIN	439=0A6DH	440=0A76H	442=0A7BH	443=0A84H	444=0ACFH	445=0AD6H
00000048 SYSIN	447=0AD9H	453=0ADEH	454=0AE7H	455=0B0CH	456=0B0FH	457=0B3DH
00000049 SYSIN	458=0B6EH	459=0B6EH	460=0B92H	461=0BADH	462=0BB0H	463=0BD8H
00000050 SYSIN	464=0BDBH	465=0BDEH	466=0BE1H	467=0BF4H	468=0C05H	469=0C0CH
00000051 SYSIN	470=0C0DH	473=0C6DH	474=0C81H	476=0CD1H	477=0CFCH	479=0D45H
00000052 SYSIN	481=0D69H	486=0D6EH	487=0D95H	488=0DB8H	489=0DC9H	490=0DF1H
00000053 SYSIN	491=0DF9H	492=0DFCH	493=0DFFH	494=0E02H	495=0E11H	496=0E3AH
00000054 SYSIN	497=0E40H	498=0E4EH	499=0E6BH	500=0E83H	501=0EA8H	502=0EABH
00000055 SYSIN	503=0EB2H	504=0EBBH	505=0EC3H	506=0EC7H	507=0ED0H	508=0EEAH
00000056 SYSIN	509=0F16H	510=0F25H	511=0F4BH	512=0F5AH	513=0F80H	514=0F83H
00000057 SYSIN	515=0F8AH	516=0F90H	517=0F95H	518=0FBCH	519=0FE5H	520=100FH
00000058 SYSIN	521=100FH	527=1015H	528=101BH	529=102DH	530=104FH	531=1060H
00000059 SYSIN	532=1063H	533=106BH	534=106CH	536=106DH	537=1079H	538=108CH
00000060 SYSIN	539=108DH	541=1097H	547=109FH	548=10A2H	549=10A9H	550=10B1H
00000061 SYSIN	551=10BCH	552=10D1H	553=10E6H	554=10E8H	555=10E7H	556=10FFH
00000062 SYSIN	557=1104H	558=110DH	559=1115H	560=1118H	561=111FH	562=112AH

562=112AH

PLM TO ASSEMBLY LANGUAGE CROSS INDEX

```
00000063 SYSIN          563=112FH  564=1140H  565=1151H  566=1152H  567=1167H  568=116AH
00000064 SYSIN          569=1175H  570=1178H  571=117FH  572=1187H  573=11A5H  574=11A7H
00000065 SYSIN          576=11BFH  579=11C1H  580=11CDH  581=11D0H  582=11D3H  583=11D6H
00000066 SYSIN          584=11DEH  585=11E1H  586=11F2H  590=11F5H  591=11F2H  592=11F7H
00000067 SYSIN          593=1205H  594=1208H  595=120BH  596=1213H  597=1218H  598=1219H
00000068 SYSIN          607=121CH  608=1227H  609=1224H  610=1238H  611=123BH  614=1242H
00000069 SYSIN          615=1252H  616=1255H  617=1264H  618=126CH  619=1275H  620=1276H
00000070 SYSIN          621=1285H  622=1288H  623=129FH  624=12BFH  625=129EH  626=12A1H
00000071 SYSIN          627=12ADH  628=12B0H  629=12B3H  631=12B6H  633=12BDH  634=12C6H
00000072 SYSIN          635=12C9H  636=12D8H  637=12DEH  638=12E4H  639=12E1H  640=12F7H
00000073 SYSIN          642=12E8H  650=12EDH  651=1306H  653=130AH  654=1313H  655=1317H
00000074 SYSIN          657=131AH  658=1321H  659=1325H  660=132EH  661=1338H  662=133CH
00000075 SYSIN          663=1340H  664=1345H  665=134FH  666=1356H  667=1369H  668=13A2H
00000076 SYSIN          669=13A9H  670=13AAH  673=13ADH  674=13B5H  676=13B8H  677=13C4H
00000077 SYSIN          678=13CEH  679=13DCH  680=13E7H  681=13F2H  682=1404H  683=1411H
00000078 SYSIN          684=1415H  685=141CH  686=1429H  687=1434H  688=1437H  689=1443H
00000079 SYSIN          690=1446H  691=1466H  692=146AH  693=1471H  694=1482H  695=1485H
00000080 SYSIN          696=1490H  697=149FH  698=14A3H  699=14A6H  700=14AFH  701=14B6H
00000081 SYSIN          702=14B9H  703=14C6H  704=14C9H  705=14D6H  706=14D9H  707=14E6H
00000082 SYSIN          708=14E9H  709=14F6H  710=14F9H  711=1501H  712=1504H  713=1505H
00000083 SYSIN          714=1524H  717=1539H  719=1541H  720=1544H  721=1547H  722=155CH
00000084 SYSIN          723=1559H  724=155EH  725=1566H  726=1569H  727=1571H  728=1574H
00000085 SYSIN          729=1582H  730=158AH  731=1590H  732=1591H  736=1599H  737=15B3H
00000086 SYSIN          738=15B8H  739=15B9H  741=15BCH  742=15CCH  743=15D1H  744=15E9H
00000087 SYSIN          745=15ECH  746=15EDH  747=15F0H  748=15F3H  749=15F9H  750=15FFH
00000088 SYSIN          751=1605H  752=160BH  753=1619H  754=1679H  755=1680H  756=1683H
00000089 SYSIN          757=1684H  759=1687H  760=169CH  761=169FH  762=16A2H  763=16A3H
00000090 SYSIN          768=16A8H  769=16B1H  770=16BFH  771=16C8H  772=16D9H  774=16DCH
00000091 SYSIN          775=16DDH  776=16E1H  777=16E4H  778=16E7H  779=16EAH  780=16EDH
00000092 SYSIN          781=16F1H  782=16F4H  783=16F7H  784=1706H  786=170AH  787=1719H
00000093 SYSIN          790=171DH  791=172CH  793=1731H  794=1736H  795=173AH  796=1745H
00000094 SYSIN          797=174EH  799=1752H  800=1764H  801=1767H  802=176CH  803=176DH
00000095 SYSIN          807=1770H  808=1783H  809=1799H  811=179CH  812=179FH  813=17A2H
00000096 SYSIN          814=17B1H  815=17B9H  816=17BCH  817=17BFH  819=17C5H  819=17D1H
00000097 SYSIN          820=17CEH  821=17DBH  822=17EAH  823=17EDH  824=17EEH  825=1805H
00000098 SYSIN          826=1808H  827=1817H  828=181DH  829=1823H  830=1828H  831=1831H
00000099 SYSIN          832=184DH  833=1850H  834=1855H  835=185FH  836=187AH  837=187DH
00000100 SYSIN          838=1882H  839=188BH  840=18A7H  841=18AAH  842=18BAH  843=18BFH
00000101 SYSIN          844=18D8H  845=18F2H  847=18F3H  848=1902H  849=190AH  850=1912H
00000102 SYSIN          851=1918H  852=191BH  853=191EH  854=1924H  855=192CH  856=1937H
00000103 SYSIN          857=1938H  859=193DH  860=1946H  861=1949H  862=1951H  863=1957H
00000104 SYSIN          864=1983H  865=198AH  866=1991H  867=19BCH  868=19BFH  869=19E7H
00000105 SYSIN          870=19EEH  871=19EFH  876=1A24H  879=1A27H  880=1A44H  881=1A49H
00000106 SYSIN          882=1A4CH  884=1A4FH  885=1A79H  886=1A80H  887=1A88H  888=1A8FH
00000107 SYSIN          889=1A93H  890=1A96H  891=1A9FH  892=1AA1H  893=1AC9H  894=1ACCH
00000108 SYSIN          895=1ACFH  896=1AD3H  897=1ADAH  898=1AE4H  901=1AE1H  903=1AE9H
00000109 SYSIN          904=1AECH  905=1AEFH  906=1AF5H  907=1AF8H  909=1AFFH  909=1B04H
00000110 SYSIN          910=1B0AH  911=1B10H  912=1B16H  913=1B1CH  914=1B1FH  915=1B25H
00000111 SYSIN          916=1B28H  917=1B2BH  918=1B31H  919=1B34H  920=1B37H  921=1B3AH
00000112 SYSIN          922=1B5EH  923=1B61H  924=1B64H  925=1B67H  926=1B9CH  927=1B9FH
00000113 SYSIN          928=1BA7H  929=1BAAH
00000114 SYSIN        STACK SIZE = 36 BYTES
```

VARIABLE LOCATION IN RAM

```
00000117 SYSIN          MEMORY..........................2200H
00000118 SYSIN          MASK............................0106H
00000119 SYSIN          CONSTR..........................0110H
00000120 SYSIN          CNT.............................2049H
00000121 SYSIN          BIT07...........................204AH
00000122 SYSIN          BIT04...........................2052H
00000123 SYSIN          NET1............................205AH
00000124 SYSIN          NET2............................2067H
00000125 SYSIN          NET3............................2074H
00000126 SYSIN          B0..............................2081H
00000127 SYSIN          B1..............................2089H
00000128 SYSIN          B2..............................2091H
00000129 SYSIN          D0..............................2099H
00000130 SYSIN          D1..............................20A1H
00000131 SYSIN          D2..............................20A9H
00000132 SYSIN          FAILTST.........................20B1H
00000133 SYSIN          SELRET..........................20B2H
00000134 SYSIN          DETSEL..........................20B3H
00000135 SYSIN          TIMERMINS.......................20B5H
00000136 SYSIN          TIMERHRS........................20B6H
00000137 SYSIN          TIT.............................20B7H
00000138 SYSIN          TIMERSECS.......................20B9H
00000139 SYSIN          TIM.............................20BAH
00000140 SYSIN          TIH.............................20BBH
00000141 SYSIN          SMIN............................20BCH
00000142 SYSIN          SHRS............................20BDH
00000143 SYSIN          HEAD............................20BFH
00000144 SYSIN          SAMPLEHOURS.....................20C0H
00000145 SYSIN          SAMPLEMINS......................20C1H
00000146 SYSIN          DETHRS..........................20C2H
00000147 SYSIN          DETMINS.........................20C5H
00000148 SYSIN          YRS.............................20C8H
00000149 SYSIN          MONS............................20C9H
00000150 SYSIN          DAYS............................20CAH
00000151 SYSIN          HRS.............................20CBH
00000152 SYSIN          MINS............................20CCH
00000153 SYSIN          SECS............................20CDH
00000154 SYSIN          I...............................20CEH
00000155 SYSIN          N...............................20CFH
00000156 SYSIN          M...............................20D0H
00000157 SYSIN          TT..............................20D1H
00000158 SYSIN          TSTPWR..........................20D2H
00000159 SYSIN          TSTSOL..........................20D3H
00000160 SYSIN          TSTART..........................20D4H
00000161 SYSIN          TSTOP...........................20D6H
00000162 SYSIN          DATEOK..........................0290H
00000163 SYSIN          WISH............................02A3H
00000164 SYSIN          WISH2...........................02AFH
00000165 SYSIN          STOPTIME........................02B9H
00000166 SYSIN          TOH.............................02CBH
00000167 SYSIN          TOM.............................02F5H
00000168 SYSIN          SHORT...........................02FAH
00000169 SYSIN          STM.............................031DH
00000170 SYSIN          STMX............................0336H
00000171 SYSIN          ALTCORFACTOR....................20D9H
00000172 SYSIN          VL..............................20E6H
00000173 SYSIN          YS..............................211AH
00000174 SYSIN          MNS.............................211BH
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.............................211FH

VARIABLE LOCATION IN RAM

```
00000175 SYSIN      DS.............................211CH
00000176 SYSIN      HS.............................211DH
00000177 SYSIN      MS.............................211EH
00000178 SYSIN      CALTEST........................211FH
00000179 SYSIN      CALTEST1.......................2120H
00000180 SYSIN      CALTEST2.......................2121H
00000181 SYSIN      CALTIME........................2122H
00000182 SYSIN      AITFACTOR1.....................2123H
00000183 SYSIN      AITFACTOR2.....................2130H
00000184 SYSIN      TYPEOUT........................033CH
00000185 SYSIN      CHAR...........................213DH
00000186 SYSIN      I..............................213EH
00000187 SYSIN      TYPEIN.........................0373H
00000188 SYSIN      TYINOUT........................037FH
00000189 SYSIN      ECHO...........................038DH
00000190 SYSIN      CNT............................213FH
00000191 SYSIN      IMPLINE........................0395H
00000192 SYSIN      P..............................2140H
00000193 SYSIN      T..............................2143H
00000194 SYSIN      CRLF...........................03D6H
00000195 SYSIN      PRINTPROMPT....................03E1H
00000196 SYSIN      PACKBCD........................03FAH
00000197 SYSIN      PRINTSTRING....................0409H
00000198 SYSIN      NAME...........................2144H
00000199 SYSIN      LENGTH.........................2147H
00000200 SYSIN      I..............................2148H
00000201 SYSIN      PRINTBCD.......................0434H
00000202 SYSIN      B..............................2149H
00000203 SYSIN      ERROR..........................0454H
00000204 SYSIN      ERRMSG.........................0457H
00000205 SYSIN      START..........................1A93H
00000206 SYSIN      DELAY1MS.......................047FH
00000207 SYSIN      DELAY5MS.......................048FH
00000208 SYSIN      TYPEDATE.......................049FH
00000209 SYSIN      DATE...........................04A2H
00000210 SYSIN      TIME...........................04ADH
00000211 SYSIN      SETYEAR........................0501H
00000212 SYSIN      SETMON.........................050EH
00000213 SYSIN      SETDAY.........................051BH
00000214 SYSIN      SETHR..........................0527H
00000215 SYSIN      SETMIN.........................0533H
00000216 SYSIN      CHANGEDATE.....................0541H
00000217 SYSIN      RESTART........................059DH
00000218 SYSIN      TIMEKEEPER.....................05A7H
00000219 SYSIN      DAYMAX.........................05AFH
00000220 SYSIN      DETMSG.........................0654H
00000221 SYSIN      COMMSG.........................0657H
00000222 SYSIN      DETHEADOUT.....................0675H
00000223 SYSIN      T..............................214AH
00000224 SYSIN      CHN4OUT........................06ABH
00000225 SYSIN      I..............................214BH
00000226 SYSIN      RELEASESOLENOID................06E6H
00000227 SYSIN      SOLMSG.........................06E9H
00000228 SYSIN      PAPADV.........................0734H
00000229 SYSIN      PULSES.........................214CH
00000230 SYSIN      FINISH.........................084BH
00000231 SYSIN      NOPAPER........................0737H
00000232 SYSIN      EXTRAADVANCE...................0751H
```

```
00000230 SYSIN                    FINISH.........................[illegible]
00000231 SYSIN                    NOPAPER........................0737H
00000232 SYSIN                    EXTRAADVANCE...................0751H
```

VARIABLE LOCATION IN RAM

```
00000233 SYSIN            INIT...........................0869H
00000234 SYSIN            ADD............................086DH
00000235 SYSIN            LOC............................214FH
00000236 SYSIN            SUB............................0877H
00000237 SYSIN            LOC............................2150H
00000238 SYSIN            MUL............................0881H
00000239 SYSIN            LOC............................2152H
00000240 SYSIN            DIV............................088BH
00000241 SYSIN            LOC............................2154H
00000242 SYSIN            LOD............................0895H
00000243 SYSIN            LOC............................2156H
00000244 SYSIN            STR............................089FH
00000245 SYSIN            LOC............................2158H
00000246 SYSIN            INP............................08A9H
00000247 SYSIN            LOC............................215AH
00000248 SYSIN            OUTPT..........................08B3H
00000249 SYSIN            LOC............................215CH
00000250 SYSIN            INSTR..........................08BDH
00000251 SYSIN            A1.............................215EH
00000252 SYSIN            A2.............................2160H
00000253 SYSIN            TEMP...........................2162H
00000254 SYSIN            ASUB...........................2192H
00000255 SYSIN            FSUB...........................2194H
00000256 SYSIN            TSUB...........................2196H
00000257 SYSIN            ALTCONF........................2199H
00000258 SYSIN            FT.............................219DH
00000259 SYSIN            FB.............................21A9H
00000260 SYSIN            FCON...........................21C1H
00000261 SYSIN            NETCOUNT.......................08D9H
00000262 SYSIN            CAL............................099CH
00000263 SYSIN            I..............................21F1H
00000264 SYSIN            I1.............................21F2H
00000265 SYSIN            TIM............................0C0DH
00000266 SYSIN            L..............................0C6DH
00000267 SYSIN            HEAD1..........................0C81H
00000268 SYSIN            CL.............................0CD1H
00000269 SYSIN            CH.............................0CFCH
00000270 SYSIN            ALTMSG.........................0D45H
00000271 SYSIN            PRINTREPORT....................0D69H
00000272 SYSIN            I..............................21F3H
00000273 SYSIN            CALPRINT.......................0FBBH
00000274 SYSIN            COUNT..........................100FH
00000275 SYSIN            CALLOOP........................1063H
00000276 SYSIN            TS.............................21F4H
00000277 SYSIN            STARTTIM.......................106CH
00000278 SYSIN            READACCUM......................108DH
00000279 SYSIN            A..............................21F6H
00000280 SYSIN            B..............................21F8H
00000281 SYSIN            C..............................21FAH
00000282 SYSIN            I..............................21FCH
00000283 SYSIN            FLOWMSG........................11A7H
00000284 SYSIN            FLOWCHECK......................11BFH
00000285 SYSIN            TESTACPOWER....................11F2H
00000286 SYSIN            PWRMSG.........................11F5H
00000287 SYSIN            SAMPLE.........................1219H
00000288 SYSIN            FINISH.........................12E7H
00000289 SYSIN            CYCLE..........................12F8H
00000290 SYSIN            MAIN...........................13AAH
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                                        VARIABLE LOCATION IN RAM

00000291 SYSIN                          LST..............................1505H
00000292 SYSIN                          SELECTHEAD.......................1524H
00000293 SYSIN                          SELHEAD..........................1539H
00000294 SYSIN                          EXIT.............................1582H
00000295 SYSIN                          FINISH...........................1590H
00000296 SYSIN                          NPOSS............................1574H
00000297 SYSIN                          LOOP.............................1AC9H
00000298 SYSIN                          ESTARTACCUM......................1591H
00000299 SYSIN                          PRINTCALDATA.....................1599H
00000300 SYSIN                          CALHEAD..........................15BCH
00000301 SYSIN                          NETBKG...........................15EDH
00000302 SYSIN                          MLP1.............................15F3H
00000303 SYSIN                          MLP2.............................15F9H
00000304 SYSIN                          MLP3.............................15FFH
00000305 SYSIN                          MLP4.............................1605H
00000306 SYSIN                          CALSUB...........................1684H
00000307 SYSIN                          CALIBRATE........................16A3H
00000308 SYSIN                          N1...............................21FDH
00000309 SYSIN                          N2...............................21FEH
00000310 SYSIN                          FINISH...........................176CH
00000311 SYSIN                          SOURCECHECK......................176DH
00000312 SYSIN                          SCHK.............................1770H
00000313 SYSIN                          SELSOURCE........................1783H
00000314 SYSIN                          I................................21FFH
00000315 SYSIN                          START............................1799H
00000316 SYSIN                          EXIT.............................191BH
00000317 SYSIN                          PRNTEND..........................191EH
00000318 SYSIN                          ALTFACTOR........................1938H
00000319 SYSIN                          SIGNON...........................19FFH
00000320 SYSIN                          RESET............................1A24H
00000321 SYSIN                          MESSAGE..........................1B9FH

                                        PIM COMPILER ASSEMBLY LANGUAGE OUTPUT

00000324 SYSIN                          0000H JMP    9DH    05H
00000325 SYSIN                          0038H JMP    A7H    05H
00000326 SYSIN                          0100H LXI SP FFH    23H    JMP    24H    1AH
00000327 SYSIN                          0106H 01H 02H 04H 08H 10H 20H 40H 80H FFH 00H
00000329 SYSIN                          0110H 00H 00H 00H 00H 00H 00H 00H 00H 00H 00H ...
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00000324 SYSIN       0000H JMP    9DH    05H
00000325 SYSIN       0038H JMP    A7H    05H
00000326 SYSIN       0100H LXI SP FFH    23H    JMP    24H    1AH
00000327 SYSIN       0106H 01H 02H 04H 08H 10H 20H 40H 80H FFH 00H
00000329 SYSIN       0110H 00H 00H 00H 00H 00H 00H 00H 00H 00H 00H 00H 00H 00H 00H 01H 24H
00000330 SYSIN       0290H 44H 41H 54H 45H 20H 43H 4FH 52H 52H 45H 43H 54H 20H 28H 59H 2FH
00000331 SYSIN       02A0H 4EH 29H 3FH
00000332 SYSIN       02A3H 44H 4FH 20H 59H 4FH 55H 20H 57H 41H 4EH 54H 20H
00000333 SYSIN       02AFH 20H 52H 55H 4EH 28H 59H 2FH 4EH 29H 3FH
00000334 SYSIN       02B9H 49H 4EH 50H 55H 54H 20H 54H 49H 4DH 45H 20H 54H 4FH 20H 53H 54H
00000335 SYSIN       02C9H 4FH 50H
00000336 SYSIN       02CBH 45H 4EH 54H 45H 52H 20H 54H 49H 4DH 45H 20H 49H 4EH 54H 45H 52H
00000337 SYSIN       02DBH 56H 41H 4CH 20H 42H 45H 54H 57H 45H 45H 4EH 20H 53H 41H 4DH 50H
00000338 SYSIN       02EBH 4CH 45H 53H 20H 48H 4FH 55H 52H 53H 20H
00000339 SYSIN       02F5H 20H 4DH 49H 4EH 2DH
00000340 SYSIN       02FAH 0DH 0AH 54H 49H 4DH 45H 20H 54H 4FH 4FH 20H 53H 48H 4FH 52H 54H
00000341 SYSIN       030AH 20H 4DH 55H 53H 54H 20H 42H 45H 20H 3EH 31H 34H 20H 4DH 49H 4EH
00000342 SYSIN       031AH 53H 0DH 0AH
00000343 SYSIN       031DH 45H 4EH 54H 45H 52H 20H 54H 49H 4DH 45H 20H 54H 4FH 20H 53H 54H
00000344 SYSIN       032DH 41H 52H 54H 20H 48H 4FH 55H 52H 2DH
00000345 SYSIN       0336H 20H 20H 4DH 49H 4EH 2DH
00000346 SYSIN       033CH LXI H  3DH    21H    MOV MC IN     00H    ANA I  80H    SUB I
00000347 SYSIN       0345H 00H    JZ     40H    03H    LXI H  3DH    21H    MOV AM OUT
00000348 SYSIN       034EH 01H    MOV AM SUB I  0DH    JNZ    72H    03H    INR I  MOV MI
00000349 SYSIN       0357H 00H    MOV AI 08H    LXI H  3EH    21H    SUB M  JC     72H
00000350 SYSIN       0360H 03H    MOV AI FAH    MOV BI 0CH    MOV CB DCR C  JNZ    66H
00000351 SYSIN       0369H 03H    DCR A  JNZ    65H    03H    INR M  JNZ    58H    03H
00000352 SYSIN       0372H RET    IN     00H    ANA I  01H    SUB I  00H    JZ     73H
00000353 SYSIN       037BH 03H    IN     01H    RET    CALL   73H    03H    ANA I  7FH
00000354 SYSIN       0384H LXI H  CFH    20H    MOV MA MOV CM CALL   3CH    03H    RET
00000355 SYSIN       038DH CALL   7FH    03H    LXI H  CFH    20H    MOV AM RET    LXI H
00000356 SYSIN       0396H 40H    21H    MOV MC INX H  MOV MB MOV LI 3FH    MOV MI 00H
00000357 SYSIN       039FH CALL   8DH    03H    INR H  MOV LI 43H    MOV MA SUB I  0DH
00000358 SYSIN       03A8H JZ     C1H    03H    MOV LI 3FH    MOV CM MOV BI 00H    LHLD
00000359 SYSIN       03B1H 40H    21H    DAD B  XCHG   LXI H  43H    21H    MOV CM MOV AC
00000360 SYSIN       03BAH STAX D MOV LI 3FH    INR M  JMP    9EH    03H    MOV LI 3FH
00000361 SYSIN       03C3H MOV CM MOV BI 00H    LHLD   40H    21H    DAD B  XCHG   MOV AI
00000362 SYSIN       03CCH 24H    SUB I  30H    STAX D MOV CI 0AH    CALL   3CH    03H
00000363 SYSIN       03D5H RET    MOV CI 0DH    CALL   3CH    03H    MOV CI 0AH    CALL
00000364 SYSIN       03DEH 3CH    03H    RET    CALL   D6H    03H    MOV CI 2AH    CALL
00000365 SYSIN       03E7H 3CH    03H    RET    CALL   7FH    03H    LXI H  CFH    20H
00000366 SYSIN       03F0H MOV AM SUB I  30H    INR L  MOV MA CALL   7FH    03H    LXI H
00000367 SYSIN       03F9H D0H    20H    MOV AM ADD A  ADD A  ADD A  ADD A  DCR L  MOV CA
00000368 SYSIN       0402H MOV AM SUB I  30H    ADD C  INR L  MOV MA RET    LXI H  44H
00000369 SYSIN       040BH 21H    MOV MC INX H  MOV MB MOV LI 47H    MOV ME INR L  MOV MI
00000370 SYSIN       0414H 00H    LXI H  47H    21H    MOV CM DCR C  MOV AC INR L  SUB M
00000371 SYSIN       041DH JC     33H    04H    MOV CM MOV BI 00H    LHLD   44H    21H
00000372 SYSIN       0426H DAD B  MOV AM MOV CA CALL   3CH    03H    LXI H  48H    21H
00000373 SYSIN       042FH INR M  JNZ    15H    04H    RET    LXI H  49H    21H    MOV MC
00000374 SYSIN       0438H MOV CI 04H    MOV AM ORA A  RAR    DCR C  JNZ    3BH    04H
00000375 SYSIN       0441H ADD I  30H    MOV CA CALL   3CH    03H    LXI H  49H    21H
00000376 SYSIN       044AH MOV AM ANA I  0FH    ADD I  30H    MOV CA CALL   3CH    03H
00000377 SYSIN       0453H RET    JMP    71H    04H
00000378 SYSIN       0457H 0DH 0AH 07H 07H 2AH 2AH 20H 20H 45H 20H 52H 20H 52H 20H 4FH 20H
00000379 SYSIN       0467H 52H 20H 20H 2AH 2AH 07H 07H 0DH 0AH 01H
00000380 SYSIN       0471H LXI B  57H    04H    MOV EI 1AH    CALL   09H    04H    LXI SP
00000381 SYSIN       047AH FFH    23H    JMP    93H    1AH    DI     MOV AI 0AH    MOV BI
00000382 SYSIN       0483H 0CH    MOV CB DCR C  JNZ    85H    04H    DCR A  JNZ    84H
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00000381 SYSIN                 047AH FFH    23H    JMP    93H    1AH    DI     MOV AI CAH    MOV BI
00000382 SYSIN                 0483H 0CH    MOV CB DCR C  JNZ    85H    C4H    DCR A  JNZ    84H
```

PLM COMPILER ASSEMBLY LANGUAGE OUTPUT

```
00000383 SYSIN                 048CH 04H    EI     RET    DI     MOV AI 30H    MOV BI 0CH    MOV CB
00000384 SYSIN                 0495H DCR C  JNZ    95H    04H    DCR A  JNZ    94H    04H    EI
00000385 SYSIN                 049EH RET    JMP    BBH    04H
00000386 SYSIN                 04A2H 0DH 0AH 54H 4FH 44H 41H 59H 20H 49H 53H 20H
00000387 SYSIN                 04ADH 20H 20H 54H 48H 45H 20H 54H 49H 4DH 45H 20H 49H 53H 20H
00000388 SYSIN                 04BBH LXI B  A2H    04H    MOV EI 0BH    CALL   09H    04H    DCR H
00000389 SYSIN                 04C4H MOV LI C9H    MOV CM CALL   34H    04H    MOV CI 2FH    CALL
00000390 SYSIN                 04CDH 3CH    03H    LXI H  CAH    20H    MOV CM CALL   34H    04H
00000391 SYSIN                 04D6H MOV CI 2FH    CALL   3CH    03H    LXI H  C8H    20H    MOV CM
00000392 SYSIN                 04DFH CALL   34H    04H    LXI B  ADH    04H    MOV EI 0EH    CALL
00000393 SYSIN                 04E8H 09H    04H    DCR H  MOV LI CBH    MOV CM CALL   34H    04H
00000394 SYSIN                 04F1H MOV CI 3AH    CALL   3CH    03H    LXI H  CCH    20H    MOV CM
00000395 SYSIN                 04FAH CALL   34H    04H    CALL   D6H    03H    RET
00000396 SYSIN                 0501H 0DH 0AH 45H 4EH 54H 45H 52H 20H 59H 45H 41H 52H 2DH
00000397 SYSIN                 050EH 20H 45H 4EH 54H 45H 52H 20H 4DH 4FH 4EH 54H 48H 2DH
00000398 SYSIN                 051BH 20H 45H 4EH 54H 45H 52H 20H 44H 41H 59H 20H 2DH
00000399 SYSIN                 0527H 20H 45H 4EH 54H 45H 52H 20H 48H 4FH 55H 52H 2DH
00000400 SYSIN                 0533H 20H 45H 4EH 54H 45H 52H 20H 4DH 49H 4EH 55H 54H 45H 2DH
00000401 SYSIN                 0541H DI     LXI B  01H    05H    MOV EI 0DH    CALL   09H    04H
00000402 SYSIN                 054AH CALL   EAH    03H    MOV CM MOV LI C8H    MOV MC LXI B  0EH
00000403 SYSIN                 0553H 05H    MOV EI 0DH    CALL   09H    04H    CALL   EAH    03H
00000404 SYSIN                 055CH MOV CM MOV LI C9H    MOV MC LXI B  1BH    05H    MOV EI 0CH
00000405 SYSIN                 0565H CALL   09H    04H    CALL   EAH    03H    MOV CM MOV LI CAH
00000406 SYSIN                 056EH MOV MC LXI B  27H    05H    MOV EI 0CH    CALL   09H    04H
00000407 SYSIN                 0577H CALL   EAH    03H    MOV CM MOV LI CBH    MOV MC LXI B  33H
00000408 SYSIN                 0580H 05H    MOV EI 0EH    CALL   09H    04H    CALL   EAH    03H
00000409 SYSIN                 0589H MOV CM MOV LI CCH    MOV MC CALL   D6H    03H    LXI H  CDH
00000410 SYSIN                 0592H 20H    MOV MI 00H    XRA A  OUT    FBH    EI     CALL   9FH
00000411 SYSIN                 059BH 04H    RET    PUSH H PUSH D PUSH B PUSH A LXI SP FFH    23H
00000412 SYSIN                 05A4H JMP    93H    1AH    PUSH H PUSH D PUSH B PUSH A JMP    C1H
00000413 SYSIN                 05ADH 05H
00000414 SYSIN                 05AEH 00H 31H 28H 31H 30H 31H 30H 31H 31H 30H 00H 00H 00H 00H 00H 00H
00000415 SYSIN                 05BEH 31H 30H 31H
00000416 SYSIN                 05C1H LHLD   B8H    20H    INX H  SHLD   B8H    20H    LXI H  CDH
00000417 SYSIN                 05CAH 20H    MOV AM ORA M  MOV MA MOV CM INR C  MOV AC DAA    MOV MA
00000418 SYSIN                 05D3H SUB I  60H    JNZ    4BH    06H    MOV MI 00H    MOV AM ORA M
00000419 SYSIN                 05DCH MOV MA MOV LI B5H    MOV CM INR C  MOV AC DAA    MOV MA SUB I
00000420 SYSIN                 05E5H 60H    JNZ    F7H    05H    MOV MI C0H    MOV LI CDH    MOV AM
00000421 SYSIN                 05EEH ORA M  MOV MA MOV LI B6H    MOV CM INR C  MOV AC DAA    MOV MA
00000422 SYSIN                 05F7H MOV LI CCH    MOV AM ORA M  MOV MA MOV CM INR C  MOV AC DAA
00000423 SYSIN                 0600H MOV MA SUB I  60H    JNZ    4BH    06H    MOV MI 00H    DCR L
00000424 SYSIN                 0609H MOV AM ORA M  MOV MA MOV CM INR C  MOV AC DAA    MOV MA SUB I
00000425 SYSIN                 0612H 24H    JNZ    4BH    06H    MOV MI 00H    DCR L  MOV AM ORA M
00000426 SYSIN                 061BH MOV MA MOV CM INR C  MOV AC DAA    MOV MA DCR L  MOV EM MOV DI
00000427 SYSIN                 0624H 00H    LXI H  AEH    05H    DAD D  MOV CA MOV AM SUB C  JNC
00000428 SYSIN                 062DH 4BH    06H    LXI H  CAH    20H    MOV MI 01H    MOV AM ORA M
00000429 SYSIN                 0636H MOV MA DCR L  MOV CM INR C  MOV AC DAA    MOV MA SUB I  13H
00000430 SYSIN                 063FH JNZ    4BH    06H    DCR L  MOV CM INR C  MOV AC DAA    MOV MA
00000431 SYSIN                 0648H INR L  MOV MI 01H    XRA A  OUT    FBH    POP A  POP B  POP D
00000432 SYSIN                 0651H POP H  EI     RET    JMP    62H    06H
00000433 SYSIN                 0657H 20H 44H 45H 54H 45H 43H 54H 4FH 52H 20H 20H
00000434 SYSIN                 0662H LXI B  57H    06H    MOV EI 0BH    CALL   09H    04H    DCR H
00000435 SYSIN                 066BH MOV LI B2H    MOV AM ADD I  31H    MOV CA CALL   3CH    03H
00000436 SYSIN                 0674H RET    LXI H  49H    20H    MOV MI 00H    INR H  INR L  MOV MI
00000437 SYSIN                 067DH 00H    MOV AI 07H    LXI H  4AH    21H    SUB M  JC     A5H
00000438 SYSIN                 0686H 06H    MOV CM MOV BI 00H    DCR H  DAD B  MOV AM LXI H  4AH
00000439 SYSIN                 068FH 21H    MOV EM MOV DI 00H    LXI H  06H    01H    DAD D  MOV CA
00000440 SYSIN                 0698H MOV AM ANA C  LXI H  49H    20H    ORA M  MOV MA INR H  INR L
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PIM COMPILER ASSEMBLY LANGUAGE OUTPUT

```
00000441 SYSIN      06A1H INR M  JNZ     7EH     06H     DCR H  DCR L  MOV AM OUT     07H
00000442 SYSIN      06AAH RET    LXI H   49H     20H     MOV MI 00H    INR H  MOV LI 4BH
00000443 SYSIN      06B3H MOV MI 00H     MOV AI 07H      LXI H  4BH    21H    SUB M  JC
00000444 SYSIN      06BCH DFH    06H     MOV CM MOV BI  00H     DCR H  MOV LI 52H     DAD B
00000445 SYSIN      06C5H MOV AM LXI H   4BH     21H     MOV EM MOV DI 00H    LXI H  06H
00000446 SYSIN      06CEH 01H    DAD D   MOV CA MOV AM  ANA C  LXI H  49H    20H    ORA M
00000447 SYSIN      06D7H MOV MA INR H   MOV LI 4BH     INR M  JNZ    B5H    06H    DCR H
00000448 SYSIN      06E0H MOV LI 49H     MOV AM OUT     04H    RET    JMP    FFH    06H
00000449 SYSIN      06E9H 20H 53H 4FH 4CH 45H 4EH 4FH 49H 44H 20H 4FH 4FH 54H 20H 52H 45H
00000450 SYSIN      06F9H 4CH 45H 41H 53H 45H 44H
00000451 SYSIN      06FFH LXI H  B1H     20H     MOV MI 00H     LXI B  05H    00H    MOV LI
00000452 SYSIN      0708H 4AH    DAD B   MOV MI 00H     CALL   75H    06H    IN     07H
00000453 SYSIN      0711H LXI D  05H     00H     LXI H  06H    01H    DAD D  MOV CA MOV AM
00000454 SYSIN      071AH ANA C  SUB I   00H     JNZ    33H    07H    CALL   54H    06H
00000455 SYSIN      0723H LXI B  E9H     06H     MOV EI 16H    CALL   09H    04H    DCR H
00000456 SYSIN      072CH MOV LI B1H     MOV MI FFH     CALL   54H    04H    RET    JMP
00000457 SYSIN      0735H 68H    07H
00000458 SYSIN      0737H 20H 46H 49H 4CH 54H 45H 52H 20H 53H 55H 50H 50H 4CH 59H 20H 45H
00000459 SYSIN      0747H 58H 48H 41H 55H 53H 54H 45H 44H 0DH 0AH
00000460 SYSIN      0751H 20H 46H 49H 4CH 54H 45H 52H 20H 41H 44H 56H 41H 4EH 43H 45H 20H
00000461 SYSIN      0761H 45H 52H 52H 4FH 52H 0DH 0AH
00000462 SYSIN      0768H LXI H  B1H     20H     MOV MI 00H     LXI B  04H    00H    MOV LI
00000463 SYSIN      0771H 4AH    DAD B   PUSH H LXI B   04H    00H    LXI H  06H    01H
00000464 SYSIN      077AH DAD B  MOV AM  POP H  MOV MA  CALL   F6H    06H    LXI H  B1H
00000465 SYSIN      0783H 20H    MOV AM  SUB I  00H     JNZ    3BH    08H    INR H  MOV LI
00000466 SYSIN      078CH 4CH    MOV MI  00H     INX H  MOV MI 00H    MOV AI 7EH    MOV BI
00000467 SYSIN      0795H 04H    LXI H   4CH     21H     SUB M  INR L  MOV CA MOV AB SBC M
00000468 SYSIN      079EH JC     3BH     08H     MOV AI F4H     MOV BI 01H    DCR L  SUB M
00000469 SYSIN      07A7H INR L  MOV CA  MOV AB SBC M   JNC    B7H    07H    LXI B  05H
00000470 SYSIN      07B0H 00H    DCR H   MOV LI 4AH     DAD B  MOV MI FFH    LXI B  03H
00000471 SYSIN      07B9H 00H    LXI H   4AH     20H     DAD B  MOV MI 00H    CALL   75H
00000472 SYSIN      07C2H 06H    CALL    7FH     04H     LXI B  03H    00H    INR L  DAD B
00000473 SYSIN      07CBH PUSH H LXI B   03H     00H     LXI H  06H    01H    DAD B  MOV AM
00000474 SYSIN      07D4H POP H  MOV MA  CALL    75H     06H    CALL   8FH    04H    IN
00000475 SYSIN      07DDH 07H    LXI D   07H     00H     LXI H  06H    01H    DAD D  MOV CA
00000476 SYSIN      07E6H MOV AM ANA C   MOV EA PUSH D  LXI B  07H    00H    LXI H  06H
00000477 SYSIN      07EFH 01H    DAD B   MOV AM POP D   SUB E  SUB I  01H    SBC A  MOV CA
00000478 SYSIN      07F8H MOV AI 64H     LXI H  4CH     21H    SUB M  INR L  MOV BA MOV AI
00000479 SYSIN      0801H 00H    SBC M   SBC A  ANA C   RRC    JNC    20H    08H    IN
00000480 SYSIN      080AH 07H    LXI D   04H     00H     LXI H  06H    01H    DAD D  MOV CA
00000481 SYSIN      0813H MOV AM ANA C   SUB I  00H     JNZ    2AH    08H    CALL   54H
00000482 SYSIN      081CH 06H    LXI B   37H     07H     MOV EI 1AH    CALL   09H    04H
00000483 SYSIN      0825H DCR H  MOV LI  B1H     MOV MI FFH     JMP    49H    08H    DCR L
00000484 SYSIN      082EH MOV CM INR L   MOV BM LXI H   01H    00H    DAD B  SHLD   4CH
00000485 SYSIN      0837H 21H    JMP     92H     07H     CALL   54H    06H    LXI B  51H
00000486 SYSIN      0840H 07H    MOV EI  17H     CALL    09H    04H    DCR H  MOV LI B1H
00000487 SYSIN      0849H MOV MI FFH     LXI B  04H     00H    LXI H  4AH    20H    DAD B
00000488 SYSIN      0852H MOV MI 00H     LXI B  05H     00H    LXI H  4AH    20H    DAD B
00000489 SYSIN      085BH MOV MI 00H     CALL   75H     06H    MOV LI B1H    MOV AM SUB I
00000490 SYSIN      0864H FFH    CZ      54H     04H     RET    JMP    27H    32H    RET
00000491 SYSIN      086DH LXI H  4EH     21H     MOV MC INX H  MOV MB JMP    E2H    31H
00000492 SYSIN      0876H RET    LXI H   50H     21H     MOV MC INX H  MOV MB JMP    E7H
00000493 SYSIN      087FH 31H    RET     LXI H  52H     21H    MOV MC INX H  MOV MB JMP
00000494 SYSIN      0888H ECH    31H     RET     LXI H  54H    21H    MOV MC INX H  MOV MB
00000495 SYSIN      0891H JMP    F1H     31H     RET     LXI H  56H    21H    MOV MC INX H
00000496 SYSIN      089AH MOV MB JMP     DDH     31H     RET    LXI H  59H    21H    MOV MC
00000497 SYSIN      08A3H INX H  MOV MB  JMP     D3H     31H    RET    LXI H  5AH    21H
00000498 SYSIN      08ACH MOV MC INX H   MOV MB JMP     F6H    31H    RET    LXI H  5CH
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PIM COMPILER ASSEMBLY LANGUAGE OUTPUT

```
00000499 SYSIN      08B5H 21H    MOV MC INX H  MOV MB JMP     FBH    31H    RET    LXI H
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00000499 SYSIN          08B5H 21H    MOV MC INX H  MOV MB JMP    FBH    31H    RET    LXI H
00000500 SYSIN          08BEH 5EH    21H    MOV MC INX H  MOV MB INR L  MOV ME INX H  MOV MD
00000501 SYSIN          08C7H MOV LI 5EH    MOV CM INR L  MOV BM CALL   A9H    08H    LXI H
00000502 SYSIN          08D0H 60H    21H    MOV CM INR L  MOV BM CALL   9FH    08H    RET
00000503 SYSIN          08D9H LXI H  CEH    20H    MOV MI 00H    MOV AI 02H    LXI H  CEH
00000504 SYSIN          08E2H 20H    SUB M  JC     9BH    09H    LXI B  A9H    21H    MOV LI
00000505 SYSIN          08EBH 46H    MOV MC INR L  MOV MB MOV EI 04H    MOV DI 0CH    LXI H
00000506 SYSIN          08F4H CEH    20H    MOV CM MOV BI 00H    JMP    1FH    09H    MOV AC
00000507 SYSIN          08FDH SUB E  MOV AB SBC D  JP     08H    09H    MOV HB MOV LC XCHG
00000508 SYSIN          0906H MOV BH MOV CL LXI H  00H    00H    XCHG   MOV AB ORA C  RZ
00000509 SYSIN          090FH XCHG   MOV AB RAR    MOV BA MOV AC RAR    MOV CA JNC    1AH
00000510 SYSIN          0918H 09H    DAD D  XCHG   DAD H  JMP    0CH    09H    CALL   FCH
00000511 SYSIN          0921H 08H    LXI H  46H    20H    MOV CM INR L  MOV BM XCHG   DAD B
00000512 SYSIN          092AH SHLD   92H    21H    LXI B  0CH    00H    DAD B  SHLD   94H
00000513 SYSIN          0933H 21H    LXI B  9DH    21H    LXI H  44H    20H    MOV MC INR L
00000514 SYSIN          093CH MOV MB MOV EI 04H    MOV DI 00H    LXI H  CFH    20H    MOV CM
00000515 SYSIN          0945H MOV BI 00H    CALL   FCH    08H    LXI H  44H    20H    MOV CM
00000516 SYSIN          094EH INR L  MOV BM XCHG   DAD B  SHLD   96H    21H    LXI H  94H
00000517 SYSIN          0957H 21H    MOV CM INR L  MOV BM CALL   95H    08H    LXI H  92H
00000518 SYSIN          0960H 21H    MOV CM INR L  MOV BM CALL   77H    08H    LXI H  96H
00000519 SYSIN          0969H 21H    MOV CM INR L  MOV BM CALL   9FH    08H    LXI B  5AH
00000520 SYSIN          0972H 20H    LXI H  42H    20H    MOV MC INR L  MOV MB MOV EI 0DH
00000521 SYSIN          097BH MOV DI 0CH    LXI H  CFH    20H    MOV CM MOV BI 00H    CALL
00000522 SYSIN          0984H FCH    08H    LXI H  42H    20H    MOV CM INR L  MOV BM XCHG
00000523 SYSIN          098DH DAD B  XCHG   MOV CE MOV BD CALL   B3H    08H    LXI H  CFH
00000524 SYSIN          0996H 20H    INR M  JNZ    DEH    08H    RET    CALL   69H    08H
00000525 SYSIN          099FH LXI H  F1H    21H    MOV MI 00H    MOV AI 08H    LXI H  F1H
00000526 SYSIN          09A8H 21H    SUB M  JC     0FH    0AH    MOV BI 10H    MOV DI 0CH
00000527 SYSIN          09B1H LXI H  F1H    21H    MOV CM MOV BI 00H    CALL   FCH    08H
00000528 SYSIN          09BAH LXI B  10H    01H    XCHG   DAD B  XCHG   LXI H  40H    20H
00000529 SYSIN          09C3H MOV ME INR L  MOV MD LXI H  B2H    20H    MOV EM MOV DI 00H
00000530 SYSIN          09CCH MOV CI C0H    MOV BI 00H    CALL   FCH    08H    LXI H  40H
00000531 SYSIN          09D5H 20H    MOV CM INR L  MOV BM XCHG   DAD B  XCHG   LXI B  C1H
00000532 SYSIN          09DEH 21H    LXI H  3CH    20H    MOV MC INR L  MOV MB INR L  MOV ME
00000533 SYSIN          09E7H INR L  MOV MD MOV EI 04H    MOV DI 00H    LXI H  F1H    21H
00000534 SYSIN          09F0H MOV CM MOV BI 00H    CALL   FCH    08H    LXI H  3CH    20H
00000535 SYSIN          09F9H MOV CM INR L  MOV BM XCHG   DAD B  XCHG   LXI H  3FH    20H
00000536 SYSIN          0A02H MOV CM INR L  MOV BM CALL   BDH    08H    LXI H  F1H    21H
00000537 SYSIN          0A0BH INR M  JNZ    A4H    09H    DCR H  MOV LI B2H    MOV AM SUB I
00000538 SYSIN          0A14H 00H    JNZ    44H    0AH    INR H  MOV LI F1H    MOV MI 00H
00000539 SYSIN          0A1DH MOV AI 0DH    LXI H  F1H    21H    SUB M  JC     6DH    0AH
00000540 SYSIN          0A26H MOV CM MOV BI 00H    DCR H  MOV LI D9H    DAD B  PUSH H LXI H
00000541 SYSIN          0A2FH F1H    21H    MOV CM MOV BI 00H    MOV LI 23H    DAD B  MOV AM
00000542 SYSIN          0A38H POP H  MOV MA LXI H  F1H    21H    INR M  JNZ    1DH    0AH
00000543 SYSIN          0A41H JMP    6DH    0AH    INR H  MOV LI F1H    MOV MI 00H    MOV AI
00000544 SYSIN          0A4AH 0DH    LXI H  F1H    21H    SUB M  JC     6DH    0AH    MOV CM
00000545 SYSIN          0A53H MOV BI 00H    DCR H  MOV LI D9H    DAD B  PUSH H LXI H  F1H
00000546 SYSIN          0A5CH 21H    MOV CM MOV BI 00H    MOV LI 30H    DAD B  MOV AM POP H
00000547 SYSIN          0A65H MOV MA LXI H  F1H    21H    INR M  JNZ    49H    0AH    LXI B
00000548 SYSIN          0A6EH D9H    20H    LXI D  99H    21H    CALL   BDH    08H    LXI H
00000549 SYSIN          0A77H F1H    21H    MOV MI 00H    MOV AI 05H    LXI H  F1H    21H
00000550 SYSIN          0A80H SUB M  JC     D6H    0AH    LXI B  81H    20H    DCR H  MOV LI
00000551 SYSIN          0A89H 3AH    MOV MC INR L  MOV MB MOV EI 08H    MOV DI 00H    LXI H
00000552 SYSIN          0A92H F1H    21H    MOV CM MOV BI 00H    CALL   FCH    08H    LXI H
00000553 SYSIN          0A9BH 3AH    20H    MOV CM INR L  MOV BM XCHG   DAD B  XCHG   LXI B
00000554 SYSIN          0AA4H A9H    21H    LXI H  36H    20H    MOV MC INR L  MOV MB INR L
00000555 SYSIN          0AADH MOV ME INR L  MOV MD MOV EI 04H    MOV DI 00H    LXI H  F1H
00000556 SYSIN          0AB6H 21H    MOV CM MOV BI 00H    CALL   FCH    08H    LXI H  36H
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PLM COMPILER ASSEMBLY LANGUAGE OUTPUT

PIM COMPILER ASSEMBLY LANGUAGE OUTPUT

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00000557 SYSIN     0ABFH 20H    MOV CM INR L  MOV BM XCHG   DAD B  XCHG   LXI H  38H
00000558 SYSIN     0AC8H 20H    MOV CM INR L  MOV BM CALL   BDH    08H    LXI H  F1H
00000559 SYSIN     0AD1H 21H    INR M  JNZ    7BH    0AH    CALL   D9H    08H    INR H
00000560 SYSIN     0ADAH MOV LI F2H    MOV MI 00H    MOV AI 03H    LXI H  F2H    21H
00000561 SYSIN     0AE3H SUB M  JC     0CH    0CH    DCR L  MOV MI 00H    MOV AI 08H
00000562 SYSIN     0AECH LXI H  F1H    21H    SUB M  JC     6EH    0BH    JMP    00H
00000563 SYSIN     0AF5H 0BH    LXI H  F1H    21H    MOV AM ADD I  04H    MOV MA JMP
00000564 SYSIN     0AFEH EAH    0AH    LXI B  9DH    21H    MOV BM MOV DI 00H    MOV LC
00000565 SYSIN     0B07H MOV HB DAD D  XCHG   MOV CE MOV BD CALL   95H    08H    LXI B
00000566 SYSIN     0B10H C1H    21H    LXI H  F1H    21H    MOV EM MOV DI 00H    MOV LC
00000567 SYSIN     0B19H MOV HB DAD D  XCHG   LXI H  34H    20H    MOV ME INR L  MOV MD
00000568 SYSIN     0B22H MOV EI 0CH    MOV DI 00H    LXI H  F2H    21H    MOV CM MOV BI
00000569 SYSIN     0B2BH 00H    CALL   FCH    08H    LXI H  34H    20H    MOV CM INR L
00000570 SYSIN     0B34H MOV BM XCHG   DAD B  XCHG   MOV CE MOV BD CALL   81H    08H
00000571 SYSIN     0B3DH LXI B  62H    21H    LXI H  F1H    21H    MOV EM MOV DI 00H
00000572 SYSIN     0B46H MOV LC MOV HB DAD D  XCHG   LXI H  32H    20H    MOV ME INR L
00000573 SYSIN     0B4FH MOV MD MOV EI 0CH    MOV DI 00H    LXI H  F2H    21H    MOV CM
00000574 SYSIN     0B58H MOV BI 00H    CALL   FCH    08H    LXI H  32H    20H    MOV CM
00000575 SYSIN     0B61H INR L  MOV BM XCHG   DAD B  XCHG   MOV CE MOV BD CALL   9FH
00000576 SYSIN     0B6AH 08H    JMP    F6H    0AH    LXI B  62H    21H    DCR H  MOV LI
00000577 SYSIN     0B73H 30H    MOV MC INR L  MOV MB MOV EI 0CH    MOV DI 00H    LXI H
00000578 SYSIN     0B7CH F2H    21H    MOV CM MOV BI 00H    CALL   FCH    08H    LXI H
00000579 SYSIN     0B85H 30H    20H    MOV CM INR L  MOV BM XCHG   DAD B  XCHG   MOV CE
00000580 SYSIN     0B8EH MOV BD CALL   95H    08H    LXI H  F1H    21H    MOV MI 04H
00000581 SYSIN     0B97H MOV AI 08H    LXI H  F1H    21H    SUB M  JC     DBH    0BH
00000582 SYSIN     0BA0H JMP    ADH    0BH    LXI H  F1H    21H    MOV AM ADD I  04H
00000583 SYSIN     0BA9H MOV MA JMP    97H    0BH    LXI B  62H    21H    MOV EM MOV DI
00000584 SYSIN     0BB2H 00H    MOV LC MOV HB DAD D  XCHG   LXI H  2EH    20H    MOV ME
00000585 SYSIN     0BBBH INR L  MOV MD MOV EI 0CH    MOV DI 00H    LXI H  F2H    21H
00000586 SYSIN     0BC4H MOV CM MOV BI 00H    CALL   FCH    08H    LXI H  2EH    20H
00000587 SYSIN     0BCDH MOV CM INR L  MOV BM XCHG   DAD B  XCHG   MOV CE MOV BD CALL
00000588 SYSIN     0BD6H 6DH    08H    JMP    A3H    0BH    LXI B  99H    21H    CALL
00000589 SYSIN     0BDFH 81H    08H    LXI B  E6H    20H    LXI H  2CH    20H    MOV MC
00000590 SYSIN     0BE8H INR L  MOV MB MOV EI 0DH    MOV DI 00H    LXI H  F2H    21H
00000591 SYSIN     0BF1H MOV CM MOV BI 00H    CALL   FCH    08H    LXI H  2CH    20H
00000592 SYSIN     0BFAH MOV CM INR L  MOV BM XCHG   DAD B  XCHG   MOV CE MOV BD CALL
00000593 SYSIN     0C03H B3H    08H    LXI H  F2H    21H    INR M  JNZ    DEH    0AH
00000594 SYSIN     0C0CH RET
00000595 SYSIN     0C0DH 57H 4FH 52H 4BH 49H 4EH 47H 20H 4CH 45H 56H 45H 4CH 20H 20H 20H
00000596 SYSIN     0C1DH 20H 20H 20H 20H 20H 20H 20H 20H 52H 41H 44H 49H 55H 4DH 20H 41H
00000597 SYSIN     0C2DH 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H
00000598 SYSIN     0C3DH 52H 41H 44H 49H 55H 4DH 20H 42H 20H 20H 20H 20H 20H 20H 20H 20H
00000599 SYSIN     0C4DH 20H 20H 20H 20H 20H 20H 20H 20H 52H 41H 44H 49H 55H 4DH 20H 43H
00000600 SYSIN     0C5DH 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H
00000601 SYSIN     0C6DH 20H 20H 20H 20H 20H 20H 50H 43H 2FH 4CH 20H 50H 43H 2FH 4CH 20H
00000602 SYSIN     0C7DH 50H 43H 2FH 4CH
00000603 SYSIN     0C81H 0DH 0AH 0AH 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H
00000604 SYSIN     0C91H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H
00000605 SYSIN     0CA1H 2AH 2AH 2AH 20H 52H 20H 57H 20H 4CH 20H 4DH 20H 2AH 2AH 2AH 0DH
00000606 SYSIN     0CB1H 0AH 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H
00000607 SYSIN     0CC1H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H
00000608 SYSIN     0CD1H 52H 41H 44H 49H 55H 4DH 20H 41H 20H 20H 20H 20H 20H 20H 20H 20H
00000609 SYSIN     0CE1H 52H 41H 44H 49H 55H 4DH 20H 28H 42H 29H 43H 29H 20H 20H 20H 20H
00000610 SYSIN     0CF1H 52H 41H 44H 49H 55H 4DH 20H 43H 27H 20H 20H
00000611 SYSIN     0CFCH 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H 20H
00000612 SYSIN     0D0CH 53H 41H 4DH 50H 4CH 45H 20H 43H 4FH 55H 4EH 54H 53H 20H 20H 20H
00000613 SYSIN     0D1CH 20H 20H 20H 20H 20H 20H 20H 42H 41H 43H 4BH 47H 52H 4FH 55H 4EH
00000614 SYSIN     0D2CH 44H 20H 43H 4FH 55H 4EH 54H 53H 20H 20H 20H 20H 20H 4EH 45H 54H
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PIM COMPILER ASSEMBLY LANGUAGE OUTPUT

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00000615 SYSIN     0D3CH 20H 43H 4FH 55H 4EH 54H 53H 0DH 0AH
00000616 SYSIN     0D45H
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PIM COMPILER ASSEMBLY LANGUAGE OUTPUT

```
00000615 SYSIN      0D3CH 20H 43H 4FH 55H 4EH 54H 53H 0DH 0AH
00000616 SYSIN      0D45H 0DH 0AH 45H 4EH 54H 45H 52H 20H 41H 4CH 54H 49H 54H 55H 44H 45H
00000617 SYSIN      0D55H 20H 43H 4FH 52H 52H 45H 43H 54H 49H 4FH 4EH 20H 46H 41H 43H 54H
00000618 SYSIN      0D65H 4FH 52H 3DH 20H
00000619 SYSIN      0D69H LXI H  F3H    21H    MOV MI 00H    MOV AI 2FH    LXI H  F3H
00000620 SYSIN      0D72H 21H    SUB M  JC     95H    0DH    MOV CM MOV BI 00H    DCR H
00000621 SYSIN      0D7BH MOV LI 81H    DAD B  PUSH H LXI H  F3H    21H    MOV CM MOV BI
00000622 SYSIN      0D84H 00H    DCR H  MOV LI 81H    DAD B  MOV AM ADD I  30H    POP H
00000623 SYSIN      0D8DH MOV MA LXI H  F3H    21H    INR M  JNZ    6EH    0DH    MOV MI
00000624 SYSIN      0D96H 00H    MOV AI 26H    LXI H  F3H    21H    SUB M  JC     BFH
00000625 SYSIN      0D9FH 0DH    MOV CM MOV BI 00H    DCR H  MOV LI 5AH    DAD B  PUSH H
00000626 SYSIN      0DA8H LXI H  F3H    21H    MOV CM MOV BI 00H    DCR H  MOV LI 5AH
00000627 SYSIN      0DB1H DAD B  MOV AM ADD I  30H    POP H  MOV MA LXI H  F3H    21H
00000628 SYSIN      0DBAH INR M  JNZ    97H    0DH    MOV LI 21H    MOV AM SUB I  FFH
00000629 SYSIN      0DC3H JZ     BBH    0EH    MOV LI F3H    MOV MI 00H    MOV AI 33H
00000630 SYSIN      0DCCH LXI H  F3H    21H    SUB M  JC     F1H    0DH    MOV CM MOV BI
00000631 SYSIN      0DD5H 00H    DCR H  MOV LI E6H    DAD B  PUSH H LXI H  F3H    21H
00000632 SYSIN      0DDEH MOV CM MOV BI 00H    DCR H  MOV LI F6H    DAD B  MOV AM ADD I
00000633 SYSIN      0DE7H 30H    POP H  MOV MA LXI H  F3H    21H    INR M  JNZ    CAH
00000634 SYSIN      0DF0H 0DH    LXI B  81H    0CH    MOV EI 50H    CALL   09H    04H
00000635 SYSIN      0DF9H CALL   54H    06H    CALL   D6H    03H    CALL   9FH    04H
00000636 SYSIN      0E02H LXI B  08H    00H    LXI H  45H    0DH    DAD B  XCHG   MOV CE
00000637 SYSIN      0E0BH MOV BD MOV EI 1BH    CALL   09H    04H    MOV LI F3H    MOV MI
00000638 SYSIN      0E14H 00H    LXI H  3FH    21H    MOV CM DCR C  MOV AC MOV LI F3H
00000639 SYSIN      0E1DH SUB M  JC     3AH    0EH    MOV CM MOV BI 00H    DCR H  MOV LI
00000640 SYSIN      0E26H D9H    DAD B  MOV AM ADD I  30H    LXI H  CFH    20H    MOV MA
00000641 SYSIN      0E2FH MOV CM CALL   3CH    03H    LXI H  F3H    21H    INR M  JNZ
00000642 SYSIN      0E38H 15H    0EH    CALL   D6H    03H    CALL   D6H    03H    LXI H
00000643 SYSIN      0E41H F3H    21H    MOV MI 00H    MOV AI 03H    LXI H  F3H    21H
00000644 SYSIN      0E4AH SUB M  JC     B2H    0EH    MOV EI 18H    MOV DI C0H    LXI H
00000645 SYSIN      0E53H F3H    21H    MOV CM MOV BI 00H    CALL   FCH    08H    LXI B
00000646 SYSIN      0E5CH 0DH    0CH    XCHG   DAD B  XCHG   MOV CE MOV BD MOV EI 18H
00000647 SYSIN      0E65H CALL   09H    04H    LXI B  F6H    20H    DCR B  MOV LI 2AH
00000648 SYSIN      0E6EH MOV MC INR L  MOV MB MOV EI 0DH    MOV DI 00H    LXI H  F3H
00000649 SYSIN      0E77H 21H    MOV CM MOV BI 00H    CALL   FCH    08H    LXI H  2AH
00000650 SYSIN      0E80H 20H    MOV CM INR L  MOV BM XCHG   DAD B  XCHG   MOV CE MOV BD
00000651 SYSIN      0E89H MOV EI 0DH    CALL   09H    04H    MOV EI C5H    MOV DI 00H
00000652 SYSIN      0E92H LXI H  F3H    21H    MOV CM MOV BI 00H    CALL   FCH    08H
00000653 SYSIN      0E9BH LXI B  6DH    0CH    XCHG   DAD B  XCHG   MOV CE MOV BD MOV EI
00000654 SYSIN      0EA4H 05H    CALL   09H    04H    CALL   D6H    03H    LXI H  F3H
00000655 SYSIN      0EADH 21H    INR M  JNZ    45H    0EH    CALL   D6H    03H    CALL
00000656 SYSIN      0EB6H D6H    03H    CALL   D6H    03H    LXI B  FCH    0CH    MOV EI
00000657 SYSIN      0EBFH 49H    CALL   09H    04H    MOV LI F3H    MOV MI 00H    MOV AI
00000658 SYSIN      0EC8H 02H    LXI H  F3H    21H    SUB M  JC     8AH    0FH    MOV EI
00000659 SYSIN      0ED1H 10H    MOV DI 00H    LXI H  F3H    21H    MOV CM MOV BI 00H
00000660 SYSIN      0EDAH CALL   FCH    08H    LXI B  D1H    0CH    XCHG   DAD B  XCHG
00000661 SYSIN      0EE3H MOV CE MOV BD MOV EI 10H    CALL   09H    04H    LXI B  81H
00000662 SYSIN      0EECH 20H    DCR H  MOV LI 28H    MOV MC INR L  MOV MB MOV EI 08H
00000663 SYSIN      0EF5H MOV DI 00H    LXI H  F3H    21H    MOV CM MOV BI 00H    CALL
00000664 SYSIN      0EFEH FCH    08H    LXI H  28H    20H    MOV CM INR L  MOV BM XCHG
00000665 SYSIN      0F07H DAD B  XCHG   LXI B  18H    00H    XCHG   DAD B  XCHG   MOV CE
00000666 SYSIN      0F10H MOV BD MOV EI 07H    CALL   09H    04H    LXI B  03H    00H
00000667 SYSIN      0F19H LXI H  81H    0CH    DAD B  XCHG   MOV CE MOV BD MOV EI 10H
00000668 SYSIN      0F22H CALL   09H    04H    LXI B  81H    20H    DCR B  MOV LI 26H
00000669 SYSIN      0F2BH MOV MC INR L  MOV MB MOV EI 08H    MOV DI 00H    LXI H  F3H
00000670 SYSIN      0F34H 21H    MOV CM MOV BI 00H    CALL   FCH    08H    LXI H  26H
00000671 SYSIN      0F3DH 20H    MOV CM INR L  MOV BM XCHG   DAD B  XCHG   MOV CE MOV BD
00000672 SYSIN      0F46H MOV EI 07H    CALL   09H    04H    LXI B  03H    00H    LXI H
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PLM COMPILER ASSEMBLY LANGUAGE OUTPUT

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00000673 SYSIN    0F4FH 81H    0CH    DAD B  XCHG   MOV CE MOV BD MOV EI 10H    CALL
00000674 SYSIN    0F58H 09H    04H    LXI B  5AH    20H    DCR H  MOV LI 24H    MOV MC
00000675 SYSIN    0F61H INR L  MOV MB MOV EI 0DH    MOV DI 00H    LXI H  F3H    21H
00000676 SYSIN    0F6AH MOV CM MOV BI 00H    CALL   FCH    08H    LXI H  24H    20H
00000677 SYSIN    0F73H MOV CM INR L  MOV BM XCHG   DAD B  XCHG   MOV CE MOV BD MOV EI
00000678 SYSIN    0F7CH 0DH    CALL   09H    04H    CALL   D6H    03H    LXI H  F3H
00000679 SYSIN    0F85H 21H    INR M  JNZ    C7H    0EH    CALL   D6H    03H    CALL
00000680 SYSIN    0F8EH D6H    03H    LXI H  F3H    21H    MOV MI 00H    MOV AI 2FH
00000681 SYSIN    0F97H LXI H  F3H    21H    SUB M  JC     BCH    0FH    MOV CM MOV BI
00000682 SYSIN    0FA0H 00H    DCR H  MOV LI 81H    DAD B  PUSH H LXI H  F3H    21H
00000683 SYSIN    0FA9H MOV CM MOV BI 00H    DCR H  MOV LI 81H    DAD B  MOV AM SUB I
00000684 SYSIN    0FB2H 30H    POP H  MOV MA LXI H  F3H    21H    INR M  JNZ    95H
00000685 SYSIN    0FBBH 0FH    MOV MI 00H    MOV AI 26H    LXI H  F3H    21H    SUB M
00000686 SYSIN    0FC4H JC     E5H    0FH    MOV CM MOV BI 00H    DCR H  MOV LI 5AH
00000687 SYSIN    0FCDH DAD B  PUSH H LXI H  F3H    21H    MOV CM MOV BI 00H    DCR H
00000688 SYSIN    0FD6H MOV LI 5AH    DAD B  MOV AM SUB I  30H    POP H  MOV MA LXI H
00000689 SYSIN    0FDFH F3H    21H    INR M  JNZ    BEH    0FH    MOV MI 00H    MOV AI
00000690 SYSIN    0FE8H 33H    LXI H  F3H    21H    SUB M  JC     0FH    10H    MOV CM
00000691 SYSIN    0FF1H MOV BI 00H    DCR H  MOV LI E6H    DAD B  PUSH H LXI H  F3H
00000692 SYSIN    0FFAH 21H    MOV CM MOV BI 00H    DCR H  MOV LI E6H    DAD B  MOV AM
00000693 SYSIN    1003H SUB I  30H    POP H  MOV MA LXI H  F3H    21H    INR M  JNZ
00000694 SYSIN    100CH E7H    0FH    RET    LXI H  20H    21H    MOV AM SUB I  FFH
00000695 SYSIN    1015H JZ     63H    10H    LXI B  03H    00H    DCR H  MOV LI 52H
00000696 SYSIN    101EH DAD B  MOV MI 00H    LXI B  04H    00H    LXI H  52H    20H
00000697 SYSIN    1027H DAD B  MOV MI 00H    CALL   ABH    06H    LXI B  03H    00H
00000698 SYSIN    1030H MOV LI 52H    DAD B  PUSH H LXI B  03H    00H    LXI H  06H
00000699 SYSIN    1039H 01H    DAD B  MOV AM POP H  MOV MA LXI B  04H    00H    LXI H
00000700 SYSIN    1042H 52H    20H    DAD B  PUSH H LXI B  04H    00H    LXI H  06H
00000701 SYSIN    104BH 01H    DAD B  MOV AM POP H  MOV MA LXI H  B8H    20H    MOV AM
00000702 SYSIN    1054H INR L  MOV BM MOV LI D4H    SUB M  INR L  MOV CA MOV AB SBC M
00000703 SYSIN    105DH JC     50H    10H    CALL   ABH    06H    LXI B  04H    00H
00000704 SYSIN    1066H LXI H  52H    20H    DAD B  MOV MI 00H    DI     LXI H  B8H
00000705 SYSIN    106FH 20H    MOV CM INR L  MOV BM INR H  MOV LI D4H    MOV MC INX H
00000706 SYSIN    1078H MOV MB EI     DCR L  MOV AM INR L  MOV BM DCR H  MOV LI D6H
00000707 SYSIN    1081H SUB M  INR L  MOV CA MOV AB SBC M  JC     6CH    10H    CALL
00000708 SYSIN    108AH ABH    06H    RET    LXI H  F8H    21H    MOV MC INX H  MOV MB
00000709 SYSIN    1093H INR L  MOV ME INX H  MOV MD LXI H  06H    01H    MOV CM LXI H
00000710 SYSIN    109CH 52H    20H    MOV MC CALL   ABH    06H    MOV LI 52H    MOV MI
00000711 SYSIN    10A5H 00H    CALL   ABH    06H    LXI B  06H    00H    LHLD   F6H
00000712 SYSIN    10AEH 21H    DAD B  XCHG   IN     04H    PUSH D MOV EI 04H    ORA A
00000713 SYSIN    10B7H RAR    DCR E  JNZ    B6H    10H    POP H  MOV MA LXI B  06H
00000714 SYSIN    10C0H 00H    LHLD   F8H    21H    DAD B  XCHG   IN     05H    PUSH D
00000715 SYSIN    10C9H MOV EI 04H    ORA A  RAR    DCR E  JNZ    CBH    10H    POP H
00000716 SYSIN    10D2H MOV MA LXI B  06H    00H    LHLD   FAH    21H    DAD B  XCHG
00000717 SYSIN    10DBH IN     06H    PUSH D MOV EI 04H    ORA A  RAR    DCR E  JNZ
00000718 SYSIN    10E4H E0H    10H    POP H  MOV MA LXI H  52H    20H    INX H  PUSH H
00000719 SYSIN    10EDH LXI H  06H    01H    INX H  MOV AM POP H  MOV MA CALL   ABH
00000720 SYSIN    10F6H 06H    MOV LI 52H    INX H  MOV MI 00H    CALL   ABH    06H
00000721 SYSIN    10FFH INR H  MOV LI FCH    MOV MI 00H    MOV AI 05H    LXI H  FCH
00000722 SYSIN    1108H 21H    SUB M  JC     7FH    11H    LXI H  05H    01H    MOV CM
00000723 SYSIN    1111H LXI H  52H    20H    MOV MC CALL   ABH    06H    MOV LI 52H
00000724 SYSIN    111AH MOV MI 00H    CALL   ABH    06H    INR H  MOV LI FCH    MOV CM
00000725 SYSIN    1123H MOV BI 00H    LHLD   F6H    21H    DAD B  XCHG   IN     04H
00000726 SYSIN    112CH CMA    ANA I  0FH    STAX D LXI H  FCH    21H    MOV CM MOV BI
00000727 SYSIN    1135H 00H    LHLD   F8H    21H    DAD B  XCHG   IN     05H    CMA
00000728 SYSIN    113EH ANA I  0FH    STAX D LXI H  FCH    21H    MOV CM MOV BI 00H
00000729 SYSIN    1147H LHLD   FAH    21H    DAD B  XCHG   IN     06H    CMA    ANA I
00000730 SYSIN    1150H 0FH    STAX D LXI B  02H    00H    LXI H  52H    20H    DAD B
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00000730 SYSIN                 1150H 0FH     STAX D LXI B  02H    00H    LXI H  52H    20H    DAD B
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PLM COMPILER ASSEMBLY LANGUAGE OUTPUT

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00000731 SYSIN        1159H PUSH H LXI B  02H    00H    LXI H  06H    01H    DAD B  MOV AM
00000732 SYSIN        1162H POP H  MOV MA CALL   ABH    06H    CALL   7EH    04H    LXI B
00000733 SYSIN        116BH 02H    00H    MOV LI 52H    DAD B  MOV MI 00H    CALL   ABH
00000734 SYSIN        1174H 06H    CALL   7FH    04H    INR H  MOV LI FCH    INR M  JNZ
00000735 SYSIN        117DH 04H    11H    LXI B  07H    00H    LHLD   F6H    21H    DAD B
00000736 SYSIN        1186H XCHG   MOV AI 24H    SUB I  30H    STAX D LXI B  07H    00H
00000737 SYSIN        118FH LHLD   F8H    21H    DAD B  XCHG   MOV AI 24H    SUB I  30H
00000738 SYSIN        1198H STAX D LXI B  07H    00H    LHLD   FAH    21H    DAD B  XCHG
00000739 SYSIN        11A1H MOV AI 24H    SUB I  30H    STAX D RET
00000740 SYSIN        11A7H 20H 46H 4CH 4FH 57H 20H 52H 41H 54H 45H 20H 4FH 55H 54H 20H 4FH
00000741 SYSIN        11B7H 46H 20H 52H 41H 4EH 47H 45H 20H
00000742 SYSIN        11BFH IN     07H    LXI D  03H    00H    LXI H  06H    01H    DAD D
00000743 SYSIN        11C8H MOV CA MOV AM ANA C  SUB I  00H    JNZ    E1H    11H    CALL
00000744 SYSIN        11D1H 75H    06H    CALL   54H    06H    LXI B  A7H    11H    MOV EI
00000745 SYSIN        11DAH 18H    CALL   09H    04H    CALL   54H    04H    RET    JMP
00000746 SYSIN        11E3H F2H    11H
00000747 SYSIN        11E5H 20H 50H 4FH 57H 45H 52H 20H 46H 41H 49H 4CH 0DH 0AH
00000748 SYSIN        11F2H LXI H  B1H    20H    MOV MI 00H    IN     07H    LXI D  06H
00000749 SYSIN        11FBH 00H    LXI H  06H    01H    DAD D  MOV CA MOV AM ANA C  SUB I
00000750 SYSIN        1204H 00H    JNZ    18H    12H    CALL   54H    06H    LXI B  F5H
00000751 SYSIN        120DH 11H    MOV EI 0DH    CALL   09H    04H    DCR H  MOV LI B1H
00000752 SYSIN        1216H MOV MI FFH    RET    CALL   E2H    11H    LXI H  B1H    20H
00000753 SYSIN        121FH MOV AM RRC    CC     54H    04H    IN     07H    LXI D  07H
00000754 SYSIN        1228H 00H    LXI H  06H    01H    DAD D  MOV CA MOV AM ANA C  SUB I
00000755 SYSIN        1231H 00H    CZ     34H    07H    CALL   34H    07H    CALL   34H
00000756 SYSIN        123AH 07H    MOV LI B8H    MOV MI 00H    INX H  MOV MI 00H    MOV LI
00000757 SYSIN        1243H D4H    MOV MI 01H    INX H  MOV MI 00H    INR L  MOV MI 79H
00000758 SYSIN        124CH INX H  MOV MI 00H    CALL   0FH    10H    LXI B  81H    20H
00000759 SYSIN        1255H INR H  MOV LI F6H    MOV MC INX H  MOV MB LXI B  89H    20H
00000760 SYSIN        125EH LXI D  91H    20H    CALL   8DH    10H    LXI B  05H    00H
00000761 SYSIN        1267H LXI H  4AH    20H    DAD B  MOV MI FFH    LXI B  06H    00H
00000762 SYSIN        1270H LXI H  4AH    20H    DAD B  MOV MI FFH    LXI H  B8H    20H
00000763 SYSIN        1279H MOV AM INR L  MOV BM SUB I  7AH    MOV CA MOV AB SBC I  00H
00000764 SYSIN        1282H JC     76H    12H    CALL   75H    06H    LXI B  06H    00H
00000765 SYSIN        128BH INR L  DAD B  MOV MI 00H    LXI H  B8H    20H    MOV AM INR L
00000766 SYSIN        1294H MOV BM SUB I  C8H    MOV CA MOV AB SBC I  00H    JC     8FH
00000767 SYSIN        129DH 12H    CALL   BFH    11H    LXI H  B8H    20H    MOV AM INR L
00000768 SYSIN        12A6H MOV BM SUB I  F2H    MOV CA MOV AB SBC I  00H    JC     A1H
00000769 SYSIN        12AFH 12H    CALL   75H    06H    CALL   34H    07H    MOV LI D4H
00000770 SYSIN        12B8H MOV MI 00H    INX H  MOV MI 01H    INR L  MOV MI 78H    INX H
00000771 SYSIN        12C1H MOV MI 01H    CALL   0FH    10H    LXI B  99H    20H    INR H
00000772 SYSIN        12CAH MOV LI F6H    MOV MC INX H  MOV MB LXI B  A1H    20H    LXI D
00000773 SYSIN        12D3H A9H    20H    CALL   8DH    10H    LXI H  1FH    21H    MOV AM
00000774 SYSIN        12DCH SUB I  FFH    JZ     E7H    12H    CALL   9CH    09H    CALL
00000775 SYSIN        12E5H 69H    0DH    RET    LXI H  1FH    21H    MOV MI 00H    LXI H
00000776 SYSIN        12EEH BCH    20H    MOV AM MOV LI CCH    SUB M  ADD I  FFH    SBC A
00000777 SYSIN        12F7H MOV LI BDH    MOV CA MOV AM MOV LI CBH    SUB M  ADD I  FFH
00000778 SYSIN        1300H SBC A  ORA C  RRC    JC     EDH    12H    MOV LI D1H    MOV MI
00000779 SYSIN        1309H 00H    LXI H  D1H    20H    MOV AM CMA    RRC    JNC    A9H
00000780 SYSIN        1312H 13H    MOV LI B5H    MOV MI 00H    INR L  MOV MI 00H    MOV LI
00000781 SYSIN        131BH BEH    MOV AM RRC    JNC    38H    13H    MOV LI 4AH    MOV MI
00000782 SYSIN        1324H 00H    MOV LI B2H    MOV MI 00H    CALL   75H    06H    CALL
00000783 SYSIN        132DH 19H    12H    LXI H  B5H    20H    MOV AM SUB I  07H    JC
00000784 SYSI.        1336H 2FH    13H    MOV LI BEH    INX H  MOV AM RRC    JNC    4FH
00000785 SYSIN        133FH 13H    LXI H  4AH    20H    MOV MI FFH    MOV LI B2H    MOV MI
00000786 SYSIN        1348H 01H    CALL   75H    06H    CALL   19H    12H    LXI H  B5H
00000787 SYSIN        1351H 20H    MOV AM MOV LI BAH    SUB M  SUB I  01H    SBC A  MOV LI
00000788 SYSIN        135AH B6H    MOV CA MOV AM MOV LI BBH    SUB M  SUB I  01H    SBC A
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PIM COMPILER ASSEMBLY LANGUAGE OUTPUT

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00000789 SYSIN        1363H ANA C   CMA     RRC     JC      4FH     13H     MOV LI C8H      MOV AM
00000790 SYSIN        136CH INR H   MOV LI  1AH     SUB M   SBC A   CMA     DCR H   MOV LI C9H
00000791 SYSIN        1375H MOV CA  MOV AM  INR H   MOV LI  1BH     SUB M   SBC A   CMA     ANA C
00000792 SYSIN        137EH DCR H   MOV LI  CAH     MOV EA  MOV AM  INR H   MOV LI  1CH     SUB M
00000793 SYSIN        1387H SBC A   CMA     ANA E   DCR H   MOV LI  CBH     MOV CA  MOV AM  INR H
00000794 SYSIN        1390H MOV LI  1DH     SUB M   SBC A   CMA     ANA C   DCR H   MOV LI  CCH
00000795 SYSIN        1399H MOV EA  MOV AM  INR H   MOV LI  1EH     SUB M   SBC A   CMA     ANA E
00000796 SYSIN        13A2H DCR H   MOV LI  D1H     MOV MA  JMP     0AH     13H     RET     CALI
00000797 SYSIN        13ABH 9FH     04H     LXI B   90H     02H     MOV EI  13H     CALL    09H
00000798 SYSIN        13B4H 04H     CALL    7FH     03H     LXI H   CFH     20H     MOV AM  SUB I
00000799 SYSIN        13BDH 4EH     JNZ     C7H     13H     CALL    41H     05H     JMP     CFH
00000800 SYSIN        13C6H 13H     XRA A   OUT     FBH     EI      CALL    D6H     03H     LXI H
00000801 SYSIN        13CFH B2H     20H     MOV MI  00H     MOV AI  01H     LXI H   B2H     20H
00000802 SYSIN        13D8H SUB M   JC      1CH     14H     LXI B   A3H     02H     MOV EI  0CH
00000803 SYSIN        13E1H CALL    09H     04H     CALL    54H     06H     LXI B   AFH     02H
00000804 SYSIN        13EAH MOV EI  0AH     CALL    09H     04H     CALL    7FH     03H     LXI H
00000805 SYSIN        13F3H CFH     20H     MOV AM  SUB I   59H     JNZ     09H     14H     MOV LI
00000806 SYSIN        13FCH B2H     MOV CM  MOV BI  00H     MOV LI  BEH     DAD B   MOV MI  FFH
00000807 SYSIN        1405H JMP     12H     14H     MOV LI  B2H     MOV CM  MOV BI  00H     MOV LI
00000808 SYSIN        140EH BEH     DAD B   MOV MI  00H     CALL    D6H     03H     LXI H   B2H
00000809 SYSIN        1417H 20H     INR M   JNZ     D3H     13H     MOV LI  B7H     MOV MI  FFH
00000810 SYSIN        1420H LXI H   B7H     20H     MOV AM  SUB I   FFH     JNZ     85H     14H
00000811 SYSIN        1429H CALL    D6H     03H     LXI B   CBH     02H     MOV EI  2AH     CALI
00000812 SYSIN        1432H 09H     04H     CALL    EAH     03H     MOV CM  MOV LI  BBH     MOV MC
00000813 SYSIN        143BH LXI B   F5H     02H     MOV EI  05H     CALL    09H     04H     CALI
00000814 SYSIN        1444H EAH     03H     MOV CM  MOV LI  BAH     MOV MC  CALL    D6H     03H
00000815 SYSIN        144DH LXI H   BBH     20H     MOV AM  CMP I   01H     MOV AI  FFH     JC
00000816 SYSIN        1456H 59H     14H     XRA A   DCR L   MOV CA  MOV AM  SUB I   14H     SBC A
00000817 SYSIN        145FH ANA C   MOV EA  MOV AI  59H     SUB M   SBC A   ORA E   RRC     JNC
00000818 SYSIN        1468H 71H     14H     MOV LI  B7H     MOV MI  FFH     JMP     75H     14H
00000819 SYSIN        1471H MOV LI  B7H     MOV MI  00H     MOV AM  RRC     JNC     20H     14H
00000820 SYSIN        147AH LXI B   FAH     02H     MOV EI  23H     CALL    09H     04H     JMP
00000821 SYSIN        1483H 20H     14H     LXI B   1DH     03H     MOV EI  19H     CALL    09H
00000822 SYSIN        148CH 04H     CALL    EAH     03H     MOV CM  MOV LI  BDH     MOV MC  LXI B
00000823 SYSIN        1495H 36H     03H     MOV EI  06H     CALL    09H     04H     CALL    EAH
00000824 SYSIN        149EH 03H     MOV CM  MOV LI  BCH     MOV MC  CALL    D6H     03H     LXI B
00000825 SYSIN        14A7H B9H     02H     MOV EI  12H     CALL    09H     04H     LXI B   C1H
00000826 SYSIN        14B0H 05H     MOV EI  0DH     CALL    09H     04H     CALL    EAH     03H
00000827 SYSIN        14B9H MOV CM  INR H   MOV LI  1AH     MOV MC  LXI B   CEH     05H     MOV EI
00000828 SYSIN        14C2H 0DH     CALL    09H     04H     CALL    EAH     03H     MOV CM  INR H
00000829 SYSIN        14CBH MOV LI  1BH     MOV MC  LXI B   1BH     05H     MOV EI  0CH     CALL
00000830 SYSIN        14D4H 09H     04H     CALL    EAH     03H     MOV CM  INR H   MOV LI  1CH
00000831 SYSIN        14DDH MOV MC  LXI B   27H     05H     MOV EI  0CH     CALL    09H     04H
00000832 SYSIN        14E6H CALL    EAH     03H     MOV CM  INR H   MOV LI  1DH     MOV MC  LXI B
00000833 SYSIN        14EFH 33H     05H     MOV EI  0EH     CALL    09H     04H     CALL    EAH
00000834 SYSIN        14F8H 03H     MOV CM  INR H   MOV LI  1EH     MOV MC  CALL    D6H     03H
00000835 SYSIN        1501H CALL    E8H     12H     RET
00000836 SYSIN        1505H 0DH 0AH 49H 4CH 4CH 45H 47H 41H 4CH 20H 43H 48H 41H 52H 20H 50H
00000837 SYSIN        1515H 4CH 45H 41H 53H 45H 20H 52H 45H 45H 4EH 54H 45H 52H 0DH 0AH
00000838 SYSIN        1524H 0DH 0AH 53H 45H 4CH 45H 43H 54H 20H 48H 45H 41H 44H 20H 31H 20H
00000839 SYSIN        1534H 4FH 52H 20H 32H 2DH
00000840 SYSIN        1539H LXI B   24H     15H     MOV EI  15H     CALL    09H     04H     CALI
00000841 SYSIN        1542H 7FH     03H     CALL    D6H     03H     LXI H   CFH     20H     MOV AM
00000842 SYSIN        154BH SUB I   30H     MOV MA  SUB I   00H     JZ      82H     15H     MOV AI
00000843 SYSIN        1554H 02H     SUB M   JC      82H     15H     MOV CM  DCR C   JNZ     69H
00000844 SYSIN        155DH 15H     MOV LI  B2H     MOV MI  00H     MOV LI  4AH     MOV MI  00H
00000845 SYSIN        1566H JMP     71H     15H     MOV LI  B2H     MOV MI  01H     MOV LI  4AH
00000846 SYSIN        156FH MOV MI  FFH     JMP     90H     15H
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PIM COMPILER ASSEMBLY LANGUAGE OUTPUT

PLM COMPILER ASSEMBLY LANGUAGE OUTPUT

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00000847 SYSIN      1574H 0DH 0AH 4EH 4FH 54H 20H 50H 4FH 53H 53H 49H 42H 4CH 45H
00000848 SYSIN      1582H LXI B  74H    15H     MOV EI 0EH     CALL   09H    04H    LXI SP
00000849 SYSIN      158BH FFH    23H    JMP     C9H    1AH     RET    LXI B  03H    C0H
00000850 SYSIN      1594H LXI H  52H    20H     DAD B  PUSH H  LXI B  03H    00H    LXI H
00000851 SYSIN      159DH 06H    01H    DAD B   MOV AM POP H   MOV MA LXI B  04H    C0H
00000852 SYSIN      15A6H LXI H  52H    20H     DAD B  PUSH H  LXI B  04H    00H    LXI H
00000853 SYSIN      15AFH 06H    01H    DAD B   MOV AM POP H   MOV MA CALL   A8H    06H
00000854 SYSIN      15B8H RET    JMP    CCH     15H
00000855 SYSIN      15BCH 20H 4DH 49H 4EH 55H 54H 45H 20H 43H 4FH 55H 4EH 54H 0DH 0AH 0AH
00000856 SYSIN      15CCH LXI B  03H    00H     LXI H  81H     0CH    DAD B  XCHG   MOV CE
00000857 SYSIN      15D5H MOV BD MOV EI 14H     CALL   09H     04H    MOV LI 22H    MOV CM
00000858 SYSIN      15DEH CALL   34H    04H     LXI B  BCH     15H    MOV EI 10H    CALL
00000859 SYSIN      15E7H 09H    04H    CALL    69H    CDH     RET    CALL   9CH    09H
00000860 SYSIN      15F0H JMP    0BH    16H
00000861 SYSIN      15F3H 02H FEH 05H 00H 00H 24H
00000862 SYSIN      15F9H 01H 05H FEH 00H 00H 24H
00000863 SYSIN      15FFH 01H 07H FEH 05H 00H 24H
00000864 SYSIN      1605H 01H FEH 00H 00H 00H 24H
00000865 SYSIN      160BH DCR H  MOV LI CEH     MOV MI 00H     MOV AI 02H    LXI H  CEH
00000866 SYSIN      1614H 20H    SUB M  JC      80H    16H     MOV BI 06H    MOV DI 00H
00000867 SYSIN      161DH LXI H  D0H    20H     MOV CM MOV BI 00H     CALL   FCH    08H
00000868 SYSIN      1626H LXI B  F3H    15H     XCHG   DAD B   XCHG   MOV CE MOV BD CALL
00000869 SYSIN      162FH A9H    08H    LXI B   A9H    21H     LXI H  22H    20H    MOV MC
00000870 SYSIN      1638H INR L  MOV MB MOV EI  04H    MOV DI  00H    LXI H  CEH    20H
00000871 SYSIN      1641H MOV CM MOV BI 00H     CALL   FCH     08H    LXI H  22H    20H
00000872 SYSIN      164AH MOV CM INR L  MOV BM  XCHG   DAD B   XCHG   MOV CE MOV BD CALL
00000873 SYSIN      1653H 81H    08H    LXI B   A9H    21H     LXI H  20H    20H    MOV MC
00000874 SYSIN      165CH INR L  MOV MB MOV EI  04H    MOV DI  00H    LXI H  CEH    20H
00000875 SYSIN      1665H MOV CM MOV BI 00H     CALL   FCH     08H    LXI H  20H    20H
00000876 SYSIN      166EH MOV CM INR L  MOV BM  XCHG   DAD B   XCHG   MOV CE MOV BD CALL
00000877 SYSIN      1677H 9FH    08H    LXI H   CEH    20H     INR M  JNZ    10H    16H
00000878 SYSIN      1680H CALL   D9H    08H     RET    CALL    0FH    10H    LXI B  99H
00000879 SYSIN      1689H 20H    INR H  MOV LI  F6H    MOV MC  INX H  MOV MB LXI B  A1H
00000880 SYSIN      1692H 20H    LXI D  A9H     20H    CALL    8DH    10H    CALL   91H
00000881 SYSIN      169BH 15H    CALL   EDH     15H    CALL    B9H    15H    RET    LXI H
00000882 SYSIN      16A4H FDH    21H    MOV MI  01H    MOV AI  02H    LXI H  FDH    21H
00000883 SYSIN      16ADH SUB M  JC     6CH     17H    MOV CM  DCR C  JNZ    C2H    16H
00000884 SYSIN      16B6H DCR H  MOV LI B2H     MOV MI 00H     MOV LI 4AH    MOV MI 00H
00000885 SYSIN      16BFH JMP    CBH    16H     DCR H  MOV LI  B2H    MOV MI 01H    MOV LI
00000886 SYSIN      16C8H 4AH    MOV MI FFH     INR H  MOV LI  FFH    MOV MI 00H    MOV AI
00000887 SYSIN      16D1H 09H    LXI H  FEH     21H    SUB M   JC     67H    17H    XRA A
00000888 SYSIN      16DAH OUT    FBH    EI      MOV LI 1FH     MOV MI FFH    CALL   19H
00000889 SYSIN      16E3H 12H    CALL   91H     15H    CALL    9CH    09H    CALL   69H
00000890 SYSIN      16ECH 0DH    MOV LI 20H     MOV MI FFH     INR L  MOV MI FFH    INR L
00000891 SYSIN      16F5H MOV MI 05H    DCR H   MOV LI D6H     MOV MI 2CH    INX H  MOV MI
00000892 SYSIN      16FEH 02H    MOV LI D0H     MOV MI 00H     CALL   84H    16H    MOV LI
00000893 SYSIN      1707H 22H    MOV MI 30H     DCR H  MOV LI  D6H    MOV MI 08H    INX H
00000894 SYSIN      1710H MOV MI 08H    MOV LI  D0H    MOV MI  01H    CALL   84H    16H
00000895 SYSIN      1719H MOV LI 22H    MOV MI  35H    DCR H   MOV LI D6H    MOV MI 34H
00000896 SYSIN      1722H INX H  MOV MI 09H     MOV LI D0H     MOV MI 02H    CALL   84H
00000897 SYSIN      172BH 16H    DCR H  MOV LI  D0H    MOV MI  03H    INR H  MOV LI 22H
00000898 SYSIN      1734H MOV MI 39H    MOV LI  20H    MOV MI  00H    DCR L  MOV MI 00H
00000899 SYSIN      173DH DCR H  MOV LI D4H     MOV MI 24H     INX H  MOV MI 0AH    INR L
00000900 SYSIN      1746H MOV MI 9CH    INX H   MOV MI 0AH     CALL   84H    16H    MOV LI
00000901 SYSIN      174FH 21H    MOV MI 00H     IN     01H     MOV CA MOV AI 7FH    SUB I
00000902 SYSIN      1758H 1BH    SUB I  01H     SBC A  ANA C   RRC    JC     6CH    17H
00000903 SYSIN      1761H MOV LI FEH    INR M   JNZ    D0H     16H    DCR L  INR M  JNZ
00000904 SYSIN      176AH A8H    16H    RET     JMP    99H     17H
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00000905 SYSIN     1770H 53H 4FH 55H 52H 43H 45H 20H 43H 48H 45H 43H 4BH 20H 4DH 4FH 44H
00000906 SYSIN     1780H 45H 20H 20H
00000907 SYSIN     1783H 0DH 0AH 53H 45H 4CH 45H 43H 54H 20H 4DH 4FH 44H 45H 20H 20H 41H
00000908 SYSIN     1793H 2DH 42H 2DH 43H 20H 2DH
00000909 SYSIN     1799H CALL   39H    15H    CALL   75H    06H    CALL   F2H    11H
00000910 SYSIN     17A2H LXI H  B1H    20H    MOV AM SUB I  FFH    JNZ    B1H    17H
00000911 SYSIN     17ABH LXI SP FFH    23H    JMP    C9H    1AH    LXI B  83H    17H
00000912 SYSIN     17B4H MOV EI 16H    CALL   09H    04H    CALL   7FH    03H    CALL
00000913 SYSIN     17BDH D6H    03H    LXI H  CFH    20H    MOV AM SUB I  41H    JC
00000914 SYSIN     17C6H 1BH    19H    MOV AI 43H    SUB M  JC     18H    19H    MOV AM
00000915 SYSIN     17CFH SUB I  43H    JNZ    DFH    17H    LXI B  07H    00H    MOV LI
00000916 SYSIN     17D8H 4AH    DAD B  MOV MI FFH    JMP    F7H    17H    LXI B  07H
00000917 SYSIN     17E1H 00H    MOV LI 4AH    DAD B  MOV MI 00H    CALL   75H    06H
00000918 SYSIN     17EAH XRA A  OUT    FBH    EI     MOV LI 88H    MOV MI 00H    INX H
00000919 SYSIN     17F3H MOV MI 00H    MOV LI D4H    MOV MI 01H    INX H  MOV MI 0CH
00000920 SYSIN     17FCH INR L  MOV MI 79H    INX H  MOV MI 00H    CALL   0FH    10H
00000921 SYSIN     1805H LXI B  99H    20H    INR H  MOV LI F6H    MOV MC INX H  MOV MB
00000922 SYSIN     180EH LXI B  A1H    20H    LXI D  A9H    20H    CALL   8DH    10H
00000923 SYSIN     1817H LXI H  CFH    20H    MOV AM SUB I  41H    MOV LA MOV MI 00H
00000924 SYSIN     182CH J..   AAH    18H    LXI H  FFH    21H    MOV MI 00H    MOV AI
00000925 SYSIN     1829H 06H    LXI H  FFH    21H    SUB M  JC     BAH    18H    MOV CM
00000926 SYSIN     1832H MOV BI 00H    DCR H  MOV LI A1H    DAD B  MOV MI 00H    LXI H
00000927 SYSIN     183BH FFH    21H    MOV CM MOV BI 00H    DCR H  MOV LI A9H    DAD B
00000928 SYSIN     1844H MOV MI 00H    LXI H  FFH    21H    INR M  JNZ    28H    18H
00000929 SYSIN     184DH JMP    BAH    18H    LXI H  FFH    21H    MOV MI 00H    MOV AI
00000930 SYSIN     1856H 06H    LXI H  FFH    21H    SUB M  JC     BAH    18H    MOV CM
00000931 SYSIN     185FH MOV BI 00H    DCR H  MOV LI 99H    DAD B  MOV MI 00H    LXI H
00000932 SYSIN     1868H FFH    21H    MOV CM MOV BI 00H    DCR H  MOV LI A9H    DAD B
00000933 SYSIN     1871H MOV MI 00H    LXI H  FFH    21H    INR M  JNZ    55H    18H
00000934 SYSIN     187AH JMP    BAH    18H    LXI H  FFH    21H    MOV MI 00H    MOV AI
00000935 SYSIN     1883H 06H    LXI H  FFH    21H    SUB M  JC     BAH    18H    MOV CM
00000936 SYSIN     188CH MOV BI 00H    DCR H  MOV LI 99H    DAD B  MOV MI 00H    LXI H
00000937 SYSIN     1895H FFH    21H    MOV CM MOV BI 00H    DCR H  MOV LI A1H    DAD B
00000938 SYSIN     189EH MOV MI 00H    LXI H  FFH    21H    INR M  JNZ    82H    18H
00000939 SYSIN     18A7H JMP    BAH    18H    DAD H  LXI B  B4H    18H    DAD B  MOV EM
00000940 SYSIN     18B0H INX H  MOV DM XCHG   PCHL
00000941 SYSIN     18B4H 23H 18H 50H 18H 7DH 18H
00000942 SYSIN     18BAH LXI H  FFH    21H    MOV MI 00H    MOV AI 17H    LXI H  FFH
00000943 SYSIN     18C3H 21H    SUB M  JC     D8H    18H    MOV CM MOV BI 00H    DCR H
00000944 SYSIN     18CCH MOV LI 81H    DAD B  MOV MI 00H    LXI H  FFH    21H    INR M
00000945 SYSIN     18D5H JNZ    BFH    18H    LXI B  07H    00H    DCR H  MOV LI 81H
00000946 SYSIN     18DEH DAD B  MOV MI 24H    LXI B  07H    00H    LXI H  89H    20H
00000947 SYSIN     18E7H DAD B  MOV MI 24H    LXI B  07H    00H    LXI H  91H    20H
00000948 SYSIN     18F0H DAD B  MOV MI 24H    LXI B  03H    00H    LXI H  81H    0CH
00000949 SYSIN     18F9H DAD B  XCHG   MOV CE MOV ED MOV EI 14H    CALL   09H    04H
00000950 SYSIN     1902H LXI B  70H    17H    MOV EI 13H    CALL   09H    04H    LXI B
00000951 SYSIN     190BH CFH    20H    MOV EI 01H    CALL   09H    04H    CALL   9CH
00000952 SYSIN     1914H 09H    CALL   69H    0DH    JMP    99H    17H    JMP    24H
00000953 SYSIN     191DH 19H
00000954 SYSIN     191EH 0DH 0AH 45H 4EH 44H 20H
00000955 SYSIN     1924H LXI B  1EH    19H    MOV EI 06H    CALL   09H    04H    LXI B
00000956 SYSIN     192DH 70H    17H    MOV EI 13H    CALL   09H    04H    CALL   D6H
00000957 SYSIN     1936H 03H    RET    LXI H  D0H    20H    MOV MI 01H    MOV AI 02H
00000958 SYSIN     193FH LXI H  D0H    20H    SUB M  JC     FEH    19H    CALL   39H
00000959 SYSIN     1948H 15H    LXI B  45H    0DH    MOV EI 24H    CALL   09H    04H
00000960 SYSIN     1951H LXI B  D9H    20H    CALL   95H    03H    LXI H  CEH    20H
00000961 SYSIN     195AH MOV MI 00H    LXI H  3FH    21H    MOV AM DCR H  MOV LI CEH
00000962 SYSIN     1963H SUB M  JC     83H    19H    MOV CM MOV BI 00H    MOV LI D9H
```


00000963 SYSIN

PLM COMPILER ASSEMBLY LANGUAGE OUTPUT

```
00000963 SYSIN     196CH DAD B  PUSH H LXI H  CEH     20H     MOV CM MOV BI 00H    MOV LI
00000964 SYSIN     1975H D9H    DAD B  MOV AM SUB I  30H     POP H  MOV 'A LXI H  CEH
00000965 SYSIN     197EH 20H    INR M  JNZ    5CH     19H     LXI B  0DH    00H    MOV LI
00000966 SYSIN     1987H D9H    DAD B  MOV MI 24H     LXI H   B2H    20H    MOV AM SUB I
00000967 SYSIN     1990H 00H    JNZ    BFH    19H     MOV LI  CEH    MOV MI 0CH    MOV AI
00000968 SYSIN     1999H 0DH    LXI H  CEH    20H     SUB M   JC     E7H    19H    MOV CM
00000969 SYSIN     19A2H MOV BI 00H    INR H  MOV LI  23H     DAD B  PUSH H LXI H  CEH
00000970 SYSIN     19ABH 20H    MOV CM MOV BI 00H     MOV LI  D9H    DAD B  MOV AM POP H
00000971 SYSIN     19B4H MOV MA LXI H  CEH    20H     INR M   JNZ    98H    19H    JMP
00000972 SYSIN     19BDH E7H    19H    MOV LI CEH     MOV MI  00H    MOV AI 0DH    LXI H
00000973 SYSIN     19C6H CEH    20H    SUB M  JC      E7H     19H    MOV CM MOV BI 00H
00000974 SYSIN     19CFH INR H  MOV LI 30H    DAD B   PUSH H  LXI H  CEH    20H    MOV CM
00000975 SYSIN     19D8H MOV BI 00H    MOV LI D9H     DAD B   MOV AM POP H  MOV MA LXI H
00000976 SYSIN     19E1H CEH    20H    INR M  JNZ     C3H     19H    LXI H  DCH    20H
00000977 SYSIN     19EAH INR M  JNZ    3DH    19H     RET
00000978 SYSIN     19EFH 52H 45H 4DH 4FH 54H 45H 20H 57H 4FH 52H 4BH 49H 4EH 47H 20H 4CH
00000979 SYSIN     19FFH 45H 56H 45H 4CH 20H 4DH 4FH 4EH 49H 54H 4FH 52H 20H 56H 45H 52H
00000980 SYSIN     1A0FH 53H 49H 4FH 4EH 20H 20H 20H 31H 31H 20H 20H 30H 34H 2DH 32H 36H
00000981 SYSIN     1A1FH 2DH 37H 37H 0DH 0AH
00000982 SYSIN     1A24H XRA A  OUT    07H    LXI H   CEH     20H    MOV MI 00H    MOV AI
00000983 SYSIN     1A2DH 05H    LXI H  CEH    20H     SUB M   JC     44H    1AH    MOV CM
00000984 SYSIN     1A36H MOV BI 00H    MOV LI C8H     DAD B   MOV MI 00H    LXI H  CEH
00000985 SYSIN     1A3FH 20H    INR M  JNZ    2CH     1AH     INR H  MOV LI 1FH    MOV MI
00000986 SYSIN     1A48H 00H    INR L  MOV MI 00H     INR L   MOV MI 00H    DCR H  MOV LI
00000987 SYSIN     1A51H CEH    MOV MI 00H    MOV AI  0CH     LXI H  CEH    20H    SUB M
00000988 SYSIN     1A5AH JC     79H    1AH    MOV CM  MOV BI  00H    INR H  MOV LI 23H
00000989 SYSIN     1A63H DAD B  MOV MI 00H    LXI H   CEH     20H    MOV CM MOV BI 00H
00000990 SYSIN     1A6CH INR H  MOV LI 30H    DAD B   MOV MI  00H    LXI H  CEH    20H
00000991 SYSIN     1A75H INR M  JNZ    54H    1AH     INR H   MOV LI 23H    MOV MI 01H
00000992 SYSIN     1A7EH INX H  MOV MI 24H    LXI H   30H     21H    MOV MI 01H    INX H
00000993 SYSIN     1A87H MOV MI 24H    LXI H  3FH     21H     MOV MI 01H    DCR H  MOV LI
00000994 SYSIN     1A90H B2H    MOV MI 00H    CALL    D6H     03H    LXI B  EFH    19H
00000995 SYSIN     1A99H MOV EI 35H    CALL   09H     04H     CALL   9FH    04H    LXI H
00000996 SYSIN     1AA2H CEH    20H    MOV MI 00H     MOV AI  07H    LXI H  CEH    20H
00000997 SYSIN     1AABH SUB M  JC     C9H    1AH     MOV CM  MOV BI 00H    MOV LI 4AH
00000998 SYSIN     1AB4H DAD B  MOV MI 00H    LXI H   CEH     20H    MOV CM MOV BI 00H
00000999 SYSIN     1ABDH MOV LI 52H    DAD B  MOV MI  00H     LXI H  CEH    20H    INR M
00001000 SYSIN     1AC6H JNZ    A6H    1AH    CALL    E1H     03H    X   A  OUT    FBH
00001001 SYSIN     1ACFH EI     CALL   7FH    03H     LXI H   CEH    20H    MOV AM SUB I
00001002 SYSIN     1AD8H 40H    MOV MA MOV CA MOV AI  13H     SUB C  JC     9FH    1BH
00001003 SYSIN     1AE1H LHLD   CEH    20H    MOV BI  00H     JMP    6AH    1BH    JMP
00001004 SYSIN     1AEAH 9FH    1BH    CALL   38H     19H     JMP    9CH    1BH    JMP
00001005 SYSIN     1AF3H 9FH    1BH    CALL   A3H     16H     JMP    9CH    1BH    CALL
00001006 SYSIN     1AFCH 41H    05H    JMP    9CH     1BH     CALL   9CH    09H    JMP
00001007 SYSIN     1B05H 9CH    1BH    CALL   9FH     04H     JMP    9CH    1BH    CALL
00001008 SYSIN     1B0EH AAH    13H    JMP    9CH     1BH     CALL   39H    15H    JMP
00001009 SYSIN     1B17H 9CH    1BH    JMP    9FH     1BH     CALL   34H    07H    JMP
00001010 SYSIN     1B20H 9CH    1BH    JMP    9FH     1BH     JMP    9FH    1BH    JMP
00001011 SYSIN     1B29H 00H    38H    JMP    9CH     1BH     JMP    9FH    1BH    JMP
00001012 SYSIN     1B32H 9FH    1BH    CALL   69H     0DH     JMP    9CH    1BH    LXI B
00001013 SYSIN     1B3BH 81H    20H    LXI H  F6H     21H     MOV MC INX H  MOV MB LXI B
00001014 SYSIN     1B44H 89H    20H    LXI D  91H     20H     CALL   8DH    10H    LXI B
00001015 SYSIN     1B4DH 99H    20H    LXI H  F6H     21H     MOV MC INX H  MOV MB LXI B
00001016 SYSIN     1B56H A1H    20H    LXI D  A9H     20H     CALL   8DH    10H    JMP
00001017 SYSIN     1B5FH 9CH    1BH    JMP    24H     1AH     CALL   6DH    17H    JMP
00001018 SYSIN     1B68H 9CH    1BH    DAD H  LXI B   74H     1BH    DAD B  MOV EM INX H
00001019 SYSIN     1B71H MOV DM XCHG   PCHL
00001020 SYSIN     1B74H E9H 1AH ECH 1AH F2H 1AH F5H 1AH FBH 1AH 01H 1BH 07H 1BH 0DH 1BH
```

PIM COMPILER ASSEMBLY LANGUAGE OUTPUT

```
00001021 SYSIN          1B84H 13H 1BH 19H 1BH 1CH 1BH 22H 1BH 25H 1BH 28H 1BH 2EH 1BH 31H 1BH
00001022 SYSIN          1B94H 34H 1BH 3AH 1BH 61H 1BH 64H 1BH
00001023 SYSIN          1B9CH JMP    C9H    1AH    LXI B  05H    15H    MOV EI 1FH    CALI
00001024 SYSIN          1BA5H 09H    04H    JMP    C9H    1AH    EI     HLT
00001025 SYSIN          NO PROGRAM ERRORS
```

```
1 REM       RWLM CALIBRATIØN PRØGRAM
2 REM     ARGØNNE NATIØNAL LABØRATØRY ELECTRØNICS DIVISIØN
20 PRINT "RWLMCAL.BAS   V02.1": GØSUB 4000
30 FØR I=0 TØ 8
35 READ C(I),CO(I)
40 NEXT I
50 DATA .926838,1.918637,0,-3.196779,0,2.506266
51 DATA -.879403,1.701921,-11.12606,-18.620853,2.752840,16.756924
52 DATA .049957,-3.6592397,4.232080,12.896776,-.251541,-10.308247
100 S5=A5+C5:S3=A3+C3:S2=A2+C2
110 T1=A5-VO*C5:T2=(1+VO)*C5:T3=(1+VO)*C3:T4=A-VO*C
120 T5=(1+VO)*C
130 FØR Q=0 TØ 6 STEP 3
140 F1(Q/3)=(C(Q)*T1+C(Q+1)*T2+C(Q+2)*T3)/(E1*V)
150 F2(Q/3)=(CO(Q)*S5+CO(Q+1)*S3+CO(Q+2)*S2)/(E1*V)
160 NEXT Q
170 W1=(13.68*F1(0)+7.68*(F1(1)+F1(2)))/130000
180 W2=(13.68*F2(0)+7.68*(F2(1)+F2(2)))/130000
190 W3=K1/(E1*2*V*150)
200 IF S0=1 THEN GØSUB 2000:GØTØ 250
210 INPUT "EB,EC PLEASE";E2,E3
250 GØSUB 3000
260 P1=.227261*FO(1)/2.22:P2=.025864*FO(2)/2.22:P3=.035185*FO(3)/2.22
270 P4=(13.68*FO(1)+7.68*(FO(2)+FO(3)))/130000
280 F9=W(1)*A+W(2)*B3+W(3)*C
299 PRINT:PRINT:PRINT:PRINT
300 PRINT "              R W L M   C A L I B R A T I Ø N ":PRINT
301 PRINT:PRINT:PRINT A$:PRINT D$,P$
302 PRINT:PRINT "FNA=";F1(0),,"FNB=";F1(1),,"FNC=";F1(2):PRINT
305 PRINT:PRINT "FNA2=";F2(0),,"FNB2=";F2(1),"FNC2="F2(2)
307 PRINT:PRINT"WL1=";W1,"WLKUS=";W3,"EB=";E2,"EC="E3
310 PRINT:PRINT"WL2=";W2
312 PRINT:PRINT"RN-DAUGHTER CØEFFICIENTS FØR IWL-MEMØRY"
320 FØR I=1 TØ 3: FØR J=1 TØ 3
330 PRINTP(I,J),:NEXTJ:PRINT:NEXT I
335 PRINT:PRINT"RN-DAUGHTER (RWLM) IN ATØMS"
336 PRINT FO(1),FO(2),FO(3)
340 PRINT:PRINT"RN-DAUGHTER (RWLM) IN PCI/L"
345 PRINT P1,P2,P3
350 PRINT:PRINT:PRINT"WL FRØM IWLM (DIRECT AND FRØM RN-DAUGHTERS)"
355 PRINT P4,F9
360 PRINT:PRINT:PRINT"WL CØFFICIENTS FØR IWLM-MEMØRY"
370 PRINT W(1),W(2),W(3)
490 PRINT:PRINT:PRINT:PRINT:PRINT
500 PRINT"NØRMAL STØP AT LINE 500":STØP
2000 X1=(.127907*F2(0)+.236138*F2(1))*V
2010 X2=(.385895+F2(0)+.478116*F2(1)+1.256959*F2(2))*V
2020 X3=(.981722*F2(0)+1.050628*F2(1))*V
2030 X4=(.010200*F2(0)+.028418*F2(1)+.311*F2(2))*V
2040 Q9=X1*X2-X3*X4
2050 Y1=(.385895*F2(0)+.478116*F2(1)+1.256959*F2(2))*V*Q1
2060 Y2=(.0102*F2(0)+.028418*F2(1)+.311*F2(2))*V*Q2
2070 Q8=Y1-Y2:E2=Q8/Q9
2080 Z1=(.127907*F2(0)+.236138*F2(1))*V*Q2
2090 Z2=(.981722*F2(0)+1.050628*F2(1))*V*Q1
2100 E3=(Z1-Z2)/Q9
2110 RETURN
3000 A1(1)=.580386*E1*V:A2(1)=.036204*E2*V+.001584*E3*V
3010 A2(2)=.098134*E2*V+.006941*E3*V:A2(3)=.131*E3*V:A3(1)=.001584*E1*V
```

```
3020 A3(
3030 B4=
3040 C1(
3050 C2(
3060 C2(
3065 C2(
3070 C3(
3080 C3(
3090 C3(
3100 P(1
3105 P(1
3110 P(1
3120 FO(
3130 P(2
3140 P(2
3150 FO(
3160 P(3
3170 P(3
3180 W(1
3190 W(2
3200 W(3
3210 RETU
4000 INPU
4001 A$="
4010 IF N
4020 IF E
4021 IF E
4030 INPU
4040 INPU
4050 INPU
4055 INPU
4057 INPU
4060 INPU
4070 INPU
4080 INPU
4090 INPU
4100 INPU
4110 INPU
4120 INPU
4130 INPU
4140 INPU
4150 INPU
4160 INPU
4999 RETU
5000 END
ØK
```

```
3020 A3(2)=.006941*E1*V:A3(3)=.131*E1*V
3030 B4=A1(1)*(A2(2)*A3(3)-A3(2)*A2(3))
3040 C1(1)=(A2(2)*A3(3)-A2(3)*A3(2))/B4
3050 C2(1)=(A2(3)*A3(1)-A2(1)*A3(3))/B4
3060 C2(2)=(A1(1)*A3(3))/B4
3065 C2(3)=-(A1(1)*A2(3))/B4
3070 C3(1)=(A2(1)*A3(2)-A2(2)*A3(1))/B4
3080 C3(2)=-(A1(1)*A3(2))/B4
3090 C3(3)=(A1(1)*A2(2))/B4
3100 P(1,1)=C1(1)*.227261/2.22
3105 P(1,2)=0
3110 P(1,3)=-P(1,1)*VO:FO(1)=C1(1)*T4
3120 FO(2)=C2(1)*T4+C2(2)*B3+C2(3)*T5
3130 P(2,1)=C2(1)*.025864/2.22:P(2,2)=C2(2)*.025864/2.22
3140 P(2,3)=(C2(3)*(1+VO)-C2(1)*VO)*.025864/2.22
3150 FO(3)=C3(1)*T4+C3(2)*B3+C3(3)*T5
3160 P(3,1)=C3(1)*.035185/2.22:P(3,2)=C3(2)*.035185/2.22
3170 P(3,3)=(C3(3)*(1+VO)-C3(1)*VO)*.035185/2.22
3180 W(1)=(13.68*C1(1)+7.68*(C2(1)+C3(1)))/130000
3190 W(2)=7.68*(C2(2)+C3(2))/130000
3200 W(3)=(7.68*(1+VO)*(C2(3)+C3(3)))/130000-VO*W(1)
3210 RETURN
4000 INPUT "CALCULATE ØR INPUT EB,EC (C/I)"; B$
4001 A$="DATE            PLACE"
4010 IF NØT(B$="I" ØR B$="C") THEN 4000
4020 IF B$="I" THEN  SO=0
4021 IF B$="C" THEN SO=1
4030 INPUT "DATE,PLACE" ; D$,P$
4040 INPUT "FLØWRATE (LITERS/MIN)";V
4050 INPUT "EFFICIENCY ØF ALPHA DETECTØR"; E1
4055 INPUT "OVLAP"; VO
4057 INPUT "TØTAL BETA CØUNTS FRØM RAB AND RAC DURING 5 MINUTES";Q1
4060 INPUT "TØTAL BETA CØUNTS FRØM RAB AND RAC DURING 30 MINUTES";Q2
4070 INPUT "TØTAL ALPHA CØUNTS IN RAA CHANNEL DURING 30 MINUTES";A3
4080 INPUT "TØTAL ALPHA CØUNTS IN RAA CHANNEL DURING 35 MINUTES";A2
4090 INPUT "TØTAL ALPHA CØUNTS IN RAC' CHANNEL DURING 35 MINUTES";C2
4100 INPUT "TØTAL ALPHA CØUNTS IN RAA CHANNEL DURING 5 MINUTES";A5
4110 INPUT "TØTAL ALPHA CØUNTS IN RAC' CHANNEL DURING 5 MINUTES";C5
4120 INPUT "TØTAL ALPHA CØUNTS IN RAC' CHANNEL DURING 30 MINUTES"; C3
4130 INPUT "TØTAL ALPHA CØUNTS IN RAA CHANNEL DURING 2 MINUTES";A
4140 INPUT "TØTAL BETA CØUNTS FRØM RAB AND RAC DURING 2 MINUTES"; B3
4150 INPUT "TØTAL ALPHA CØUNTS IN RAC' CHANNEL DURING 2 MINUTES";C
4160 INPUT "TØTAL ALPHA CØUNTS FRØM 39-41 MINUTES";K1
4999 RETURN
5000 END
ØK
```

TABLE OF DEFINITIONS OF SYMBOLS IN CALIBRATION PROGRAM

A. Constants and Data Inputs

- V = Flowrate (liters/min)
- V0 = Overlap of RaC' counts
- A = RaA counts (2 min)
- A5 = RaA counts (5 min)
- A3 = RaA counts (30 min)
- A2 = RaA counts (35 min)
- B3 = Ra(B+C) counts (2 min)
- Q1 = Ra(B+C) counts (5 min)
- Q2 = Ra(B+C) counts (30 min)
- C = RaC' count (2 min)
- C5 = RaC' count (5 min)
- C3 = RaC' count (30 min)
- C2 = RaC' count (35 min)
- E1 = Alpha efficiency (EA)
- K1 = 2-min Kusnetz count from (39 to 41 min)

B. Calculated Variables

- E2 = RaB beta efficiency
- E3 = RaC beta efficiency
- F1(0) = FNA atoms/liter of RaA *
- F1(1) = FNB atoms/liter of RaB *
- F1(2) = FNC atoms/liter of RaC *

- F2(0) = FNA2 atoms/liter of RaA **
- F2(1) = FNB2 atoms/liter of RaB **
- F2(2) = FNC2 atoms/liter of RaC **

- W1 = WL_1 (WL calculated from Rn-daughters derived by spectroscopic method)
- W2 = WL_2 (WL calculated from Rn-daughters derived by total-alpha method)
- W3 = WLKUS (WL calculated by the Kusnetz method)

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*Calculated by alpha-spectroscopic method.
**Calculated by total-alpha method.

P(1,1), P(1,2) P(1,3) P(2,1), P(2,2) P(2,3) P(3,1), P(3,2) P(3,3)	=	Rn-daughter coefficients for RWLM memory RaA, RaB, RaC coefficients
F0(1), F0(2), F0(3)	=	Rn-daughters (A, B, C) in atoms/liter calculated from previous coefficient
P1, P2, P3	=	Rn-daughters (A, B, C) in pCi/liter calculated from previous coefficient
F9	=	WL calculated directly from derived WL coefficients
P4	=	WL calculated from the Rn-daughters, F0's
W(1), W(2), W(3)	=	WL coefficients for RWLM memory

```
C       RWLMCN.FTN
C
C               PROGRAM TO CAL PHYSICAL CONSTANTS FOR RWLM
C
C
C               R.T.WITEK/M.K.MCGEE
C                                               4-FEB-77
C
        DOUBLE PRECISION AS(3),DELAY,TD,T,TD2(4),ANSWER(4,3,3),B(9)
        DOUBLE PRECISION D0(9),DA,DB,DC,DH,DJ,DG,DF,DE
        DOUBLE PRECISION FLAM(3),A0(3),C(3),AI(3),CS(3),A(3),AL(3),D(9)
        TYPE 50
        ACCEPT  2,T,TD2(1)
        A0(1) = 0.0
        A0(2) = 0.0
        A0(3) = 0.0
        FLAM(1) = 0.2272614
        FLAM(2) = 0.0258637
        FLAM(3) = 0.0351851
        NUM=3
        N=1
        TD2(2)=5
        TD2(3)=30
        TD2(4)=35
        DO 70 II=1,4
        DO 70 JJ=1,3
        DO 90 I=1,3
 90     C(I)=0.0
        C(JJ)=1.0
        TD=TD2(II)
        CALL BTMNEQ(NUM,FLAM,A0,C,T,AS,AI)
        DO 100 I=1,3
 100    CS(I) = 0.0
        DELAY = 13.0/60.0
        CALL BTMNEQ(NUM,FLAM,AS,CS,DELAY,AL,AI)
        CALL BTMNEQ(3,FLAM,AL,CS,TD,A,AI)
        DO 70 I=1,3
        ANSWER(II,JJ,I)=AI(I)
 70     CONTINUE
        DO 6 II = 1,4
        TYPE 200,TD2(II)
        DO 6 JJ = 1,3
6       TYPE 7,(ANSWER(II,JJ,I),I=1,3)
        K=0
        DO 10 JJ=1,3
        K=K+1
        B(K)=ANSWER(2,JJ,1)
 10     CONTINUE
        DO 11 II=2,3
        DO 11 JJ=1,3
        K=K+1
        B(K)=ANSWER(II,JJ,3)
 11     CONTINUE
C       SPECTROSCOPIC DETERM & INVERTED MAT
        TYPE 300,N
        TYPE 8,(B(K),K=1,9)
        D(1)=B(5)*B(9)-B(6)*B(8)
        D(2)=B(3)*B(8)-B(2)*B(9)
        D(3)=B(2)*B(6)-B(3)*B(5)
        D(4)=B(6)*B(7)-B(4)*B(9)
        D(5)=B(1)*B(9)-B(3)*B(7)
        D(6)=B(3)*B(4)-B(1)*B(6)
        D(7)=B(4)*B(8)-B(5)*B(7)
        D(8)=B(2)*B(7)-B(1)*B(8)
        D(9)=B(1)*B(5)-B(2)*B(4)
        DA=B(1)*((B(5)*B(9))-(B(8)*B(6)))
        DB=B(4)*((B(2)*B(9))-(B(8)*B(3)))
        DC=B(7)*((B(2)*B(6))-(B(5)*B(3)))
```

```
      DE=DA-DB+DC
      DO 17 K=1,9
      D(K)=D(K)/DE
17    CONTINUE
      TYPE 400
      TYPE 8,(D(K),K=1,9)
      N=N+1
      K=0
      III=1
      DO 13 II=2,4
      DO 13 JJ=1,3
      K=K+1
      IF (K.EQ.1) GO TO 55
      IF (K.EQ.4) GO TO 55
      IF (K.EQ.7) GO TO 55
      B(K)=ANSWER(II,JJ,3)
13    CONTINUE
C     TOTAL ALPHA DETERM & INVERTED MAT
      TYPE 300,N
      DO 14 K=1,9
      L=K-1
      TYPE 5,L,B(K)
14    CONTINUE
      D0(1)=B(5)*B(9)-B(6)*B(8)
      D0(2)=B(3)*B(8)-B(2)*B(9)
      D0(3)=B(2)*B(6)-B(3)*B(5)
      D0(4)=B(6)*B(7)-B(4)*B(9)
      D0(5)=B(1)*B(9)-B(3)*B(7)
      D0(6)=B(3)*B(4)-B(1)*B(6)
      D0(7)=B(4)*B(8)-B(5)*B(7)
      D0(8)=B(2)*B(7)-B(1)*B(8)
      D0(9)=B(1)*B(5)-B(2)*B(4)
      DF=B(1)*((B(5)*B(9))-(B(8)*B(6)))
      DG=B(4)*((B(2)*B(9))-(B(8)*B(3)))
      DH=B(7)*((B(2)*B(6))-(B(5)*B(3)))
      DJ=DF-DG+DH
      DO 18 K=1,9
      D0(K)=D0(K)/DJ
18    CONTINUE
      TYPE 700
      TYPE 8,(D0(K),K=1,9)
      TYPE 500
      TYPE 7,(ANSWER(1,1,I),I=1,3)
      TYPE 7,(ANSWER(1,2,2),ANSWER(1,2,3),ANSWER(1,3,3))
      TYPE 7,(ANSWER(1,JJ,3),JJ=1,3)
      K=0
      K=K+1
      TYPE 600
      TYPE 4,K,(ANSWER(2,JJ,2),JJ=1,2)
      K=K+1
      TYPE 3,K,(ANSWER(3,JJ,3),JJ=1,3)
      K=K+1
      TYPE 4,K,(ANSWER(3,JJ,2),JJ=1,2)
      K=K+1
      TYPE 3,K,(ANSWER(2,JJ,3),JJ=1,3)
      K=0
      DO 20 II=3,2,-1
      K=K+1
      TYPE 15,K,(ANSWER(II,JJ,3),JJ=1,3)
20    CONTINUE
      K=0
      DO 30 II=2,3
      K=K+1
      TYPE 16,K,(ANSWER(II,JJ,2),JJ=1,2)
30    CONTINUE
      GO TO 60
4     FORMAT(1X,'X',I1,'= ',E16.10,', ',E16.10)
3     FORMAT(1X,'X',I1,'= ',2(E16.10,', '),E16.10)
```

```
 15     FORMAT(1X,'Y',I1,'= ',2(E16.10,', '),E16.10)
 16     FORMAT(1X,'Z',I1,'= ',E16.10,', ',E16.10)
 5      FORMAT(1X,'A0(',I1,')=',1X,E16.10)
  50    FORMAT(1X,' INPUT VARIABLES ')
 200    FORMAT(//1X,F4.0,' MINUTE COUNTING TIME VALUES'/)
 300    FORMAT(//1X,'INVERSE MATRIX DATA FOR F',I1,' CONVERSION'/)
 8      FORMAT(1X,(3(E20.10,2X)))
 400    FORMAT(//1X,'SPECTROSCOPIC INVERTED MATRIX'/)
 700    FORMAT(//1X,'TOTAL ALPHA INVERTED MATRIX'/)
 500    FORMAT(//1X,'DAUGHTEP COEFFICIENTS***2 MINUTE COUNTING TIME '/)
 600    FORMAT(//1X,'BETA COEFFICIENTS***5&30 MINUTE COUNTING TIME '/)
 2      FORMAT(2F10.2)
 7      FORMAT(1X,3(E16.10,2X))
 55     III=III+1
        B(K)=(ANSWER(II,JJ,3))+(ANSWER(III,1,1))
        GO TO 13
 60     CALL PETER2(ANSWER,D0,D)
        END
C
C
C
C       IWLMAL.FORT     THIS WAS A SEP PROG THAT IS MERGED
C
        SUBROUTINE PETER2(ANSWER,D0,D)
C
        DOUBLE PRECISION ANSWER(4,3,3),D0(9),D(9)
        DOUBLE PRECISION P(3,3),FM(3),WL(3)
 100    TYPE    10
  10    FORMAT(' INPUT PLEASE...')
        ACCEPT 1, SWITCH
        IF (SWITCH .EQ. 2.0) GOTO 900
 1      FORMAT(F3.1)
        ACCEPT 11,V,EA,OVLAP,BC5,BC30,A30,A35,C35
        TYPE 200,V,EA,OVLAP,BC5,BC30,A30,A35,C35
 200    FORMAT(1X,F5.2,1X,F5.3,1X,F4.2,1X,5(F8.1,1X))
 11     FORMAT(8F20.5)
 12     TYPE 13
 13     FORMAT(' COUNTS PLEASE...')
        ACCEPT 14, A5,C5,C30,A,BC,C,CKUS
 14     FORMAT(7F15.5)
        TYPE    210,A5,C5,C30,A,BC,C,CKUS
 210    FORMAT(1X,7(F10 2,1X))
        S5=A5+C5
        S30=A30+C30
        S35=C35+A35
        TA5 = A5 - OVLAP*C5
        TC5 = (1. + OVLAP)*C5
        TC30 = (1. + OVLAP)*C30
        TA = A-OVLAP*C
        TC = (1 + OVLAP) * C
        FNA = (D(1)*TA5)/(EA*V)
        FNA2 = (D0(1)*S5+D0(2)*S30+D0(3)*S35)/(EA*V)
        FNB = (D(4)*TA5+D(5)*TC5+D(6)*TC30)/(EA*V)
        FNB2 = (D0(4)*S5+D0(5)*S30+D0(6)*S35)/(EA*V)
        FNC = (D(7)*TA5+D(8)*TC5+D(9)*TC30)/(EA*V)
        FNC2 = (D0(7)*S5+D0(8)*S30+D0(9)*S35)/(EA*V)
        WL1 = (13.68*FNA+7.68*(FNB+FNC))/130000.
        WL2 = (13.68*FNA2+7.68*(FNB2+FNC2))/130000.
        WLKUS = CKUS/(EA*2.*V*150.)
        IF(SWITCH.EQ.1.0) GO TO 99
        CALL BETEFF(V,FNA2,FNB2,FNC2,BC5,BC30,EB,EC,ANSWER)
        GO TO 88
 99     TYPE 3
 3      FORMAT(' EB,EC PLEASE.....')
        ACCEPT 2, EB,EC
 2      FORMAT(2F10.5)
 88     CALL MATINV(EA,EB,EC,V,OVLAP,TA,TC,BC,P,FM,WL,ANSWER)
        PA = .227261 * FM(1)/2.22
```

```
      PB = .025864 * FM(2)/2.22
      PC = .035185 * FM(3)/2.22
      PWL = (13.68*FM(1) +7.68*(FM(2)+FM(3)))/130000.
      FIWL = WL(1)*A + WL(2) * BC + WL(3) * C
      TYPE 15, FNA,FNB,FNC
      TYPE 22, FNA2,FNB2,FNC2
22    FORMAT(' FNA2=',F8.1,' FNB2=',F8.1,' FNC2=',F8.1)
15    FORMAT(' FNA=',F8.1,' FNB=',F8.1,' FNC=',F8.1)
      TYPE 16, WL1,WLKUS,EB,EC
16    FORMAT(' WL1=',F10.6,'WLKUS=',F10.6,' EB=',F8.4,' EC=',F8.4)
      TYPE 21, WL2
21    FORMAT(' WL2=',F5.2)
      TYPE 71
71    FORMAT(' RN-DAUGHTER COEFFICIENTS FOR IWLM-MEMORY')
      TYPE 17,((P(I,K),K=1,3),I=1,3)
17    FORMAT(3(1X,F9.6,2X))
      TYPE 72
72    FORMAT(' RN-DAUGHTERS(IWLM) IN ATOMS AND PCI/LITER')
      TYPE 18, (FM(I),I=1,3),PA,PB,PC
18    FORMAT(1X,3(D15.9,2X),3(F7.3,2X))
      TYPE 73
73    FORMAT(' WL FROM IWLM(DIRECT AND FROM RN-DAUGHTERS)')
      TYPE 19,PWL,FIWL
19    FORMAT(1X,2(F5.2,2X))
      TYPE 74
74    FORMAT(' WL COEFFICENTS FOR IWLM-MEMORY')
      TYPE 20,(WL(I),I=1,3)
20    FORMAT(1X,3(D20.10,2X))
      GO TO 100
900   RETURN
      END
C

C
C
C
C     MATRINV.FORT
C
C
C
      SUBROUTINE MATINV(EA,EB,EC,V,OVLAP,TA,TC,BC,P,FM,WL,A)
      DOUBLE PRECISION A(4,3,3),P(3,3),FM(3),WL(3)
      A11=A(1,1,1)*EA*V
      A12=.0
      A13=.0
      A21=A(1,1,2)*EB*V+A(1,1,3)*EC*V
      A22=A(1,2,2)*EB*V+A(1,2,3)*EC*V
      A23=A(1,3,3)*EC*V
      A31=A(1,1,3)*EA*V
      A32=A(1,2,3)*EA*V
      A33=A(1,3,3)*EA*V
      BD=A11*(A22*A33-A32*A23)
      C11=(A22*A33-A23*A32)/BD
      C21=(A23*A31-A21*A33)/BD
      C22=(A11*A33)/BD
      C23=-(A11*A23)/BD
      C31=(A21*A32-A22*A31)/BD
      C32=-(A11*A32)/BD
      C33=(A11*A22)/BD
      P(1,1)=C11*.227261/2.22
      P(1,2)=.0
      P(1,3)=-P(1,1)*OVLAP
      FM(1)=C11*TA
      FM(2)=C21*TA+C22*BC+C23*TC
      P(2,1)=C21*.025864/2.22
      P(2,2)=C22*.025864/2.22
      P(2,3)=(C23*(1.+OVLAP)-C21*OVLAP)*.025864/2.22
      FM(3)=C31*TA+C32*BC+C33*TC
```

```
      P(3,1)=C31*.035185/2.22
      P(3,2)=C32*.035185/2.22
      P(3,3)=(C33*(1+OVLAP)-C31*OVLAP)*.035185/2.22
      WL(1)=(13.68*C11+7.68*(C21+C31))/130000.
      WL(2)=7.68*(C22+C32)/130000.
      WL(3)=(7.68*(1.+OVLAP)*(C23+C33))/130000.-OVLAP*WL(1)
      RETURN
      END
C
C
C
C
C
C
C     BETEFF SUB
C
C
C
      SUBROUTINE BETEFF(V,FNA,FNB,FNC,BC5,BC30,EB,EC,A)
      DOUBLE PRECISION A(4,3,3)
      X1=(A(2,1,2)*FNA+A(2,2,2)*FNB)*V
      X2=(A(3,1,3)*FNA+A(3,2,3)*FNB+A(3,3,3)*FNC)*V
      X3=(A(3,1,2)*FNA+A(3,2,2)*FNB)*V
      X4=(A(2,1,3)*FNA+A(2,2,3)*FNB+A(2,3,3)*FNC)*V
      DET = X1*X2-X3*X4
      Y1 = (A(3,1,3)*FNA+A(3,2,3)*FNB+A(3,3,3)*FNC)*V*BC5
      Y2=(A(2,1,3)*FNA+A(2,2,3)*FNB+A(2,3,3)*FNC)*V*BC30
      DETB=Y1-Y2
      EB=DETB/DET
      Z1=(A(2,1,2)*FNA+A(2,2,2)*FNB)*V*BC30
      Z2=(A(3,1,2)*FNA+A(3,2,2)*FNB)*V*BC5
      DETC=Z1-Z2
      EC=DETC/DET
      RETURN
      END
C
C
C
C
C
C
C     BTMNEQ SUBROUTINE
C
C
C
C
      SUBROUTINE BTMNEQ (NUM,FLAM,A0,C,T,A,AI)
      DOUBLE PRECISION FLAM(3),A0(3),C(3),A(3),AI(3),T
      DOUBLE PRECISION ANK
      DO 1 I=1,NUM
      AI(I) = 0.0
      A(I) = 0.0
 1    CONTINUE
      DO 40 N1 = 1,NUM
      DO 30 K = N1,NUM
      DO 20 N = N1,K
      ANK = A0(N1)*FLAM(N)/FLAM(N1)-C(N1)
      DO 10 I = N1,K
      IF (I-N) 9,10,9
 9    ANK = ANK*FLAM(I)/(FLAM(I) -FLAM(N))
 10   CONTINUE
      AI(K) = AI(K) + ANK*(1.0 - DEXP(-FLAM(N)*T))/FLAM(N)
 20   A(K) = A(K) + ANK*DEXP(-FLAM(N)*T)
      AI(K) = AI(K) + C(N1) * T
 30   A(K) = A(K) + C(N1)
 40   CONTINUE
      RETURN
      END
```