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D-REGION BLUNT PROBE DATA ANALYSIS USING HYBRID COMPUTER TECHNIQUES

by
William John Burkhard

June 28, 1973

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13 ABSTRACT

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A presentation of the theory of blunt probe operation is included with emphasis on the equations necessary to perform the analysis. This is followed by a discussion of computer program development. Included in this discussion is a comparison of computer and hand reduction results for the blunt probe launched on 31 January 1972. The comparison showed that it was both feasible and desirable to use the computer for data reduction.

The results of computer data reduction performed on flight data acquired from five blunt probes are presented in the fourth chapter. Four of these probes were launched at Wallops Island, Virginia, and the fifth from White Sands Missile Range, New Mexico.

The computer programs were developed in a manner that would insure ease of operation and flexibility. Operation of the programs is not complicated. Appendix A is the operations manual which provides the user with a means of becoming familiar with computerized data reduction techniques.

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CHAPTER I

INTRODUCTION

1.1 Historical Background

In 1964, a program was initiated in which the primary objective was to develop a subsonic probe which would measure the characteristics of the D-region of the Ionosphere (L.C. Hale, 1969). Early probes were launched using the standard ARCAS meteorological rockets. At about 80Km the probe separated from the rocket and fell, in the inverted position, suspended from a parachute. Accuracy of measurements required the probe to remain subsonic throughout the entire range of data acquisition, 40 to 80Km.

The theory of parachute born blunt probes indicated that the probes collected charge according to a simple mobility mechanism (D.P. Hoult, 1965 and A.S. Sonin, 1967). Because of the simplicity of the theory involved the blunt probe collected data which were independent of the angle of attack, with current proportional to probe potential. Since those early years the blunt probe has gone through several design modifications. Figure 1 shows the present blunt probe used for data acquisition. The collector surface is the small inner disc at the top of the probe, and it in turn is surrounded by the guard ring.

While the blunt probe was undergoing improvements in design the theory of operation was continually being studied. The theory of the blunt probe was originally

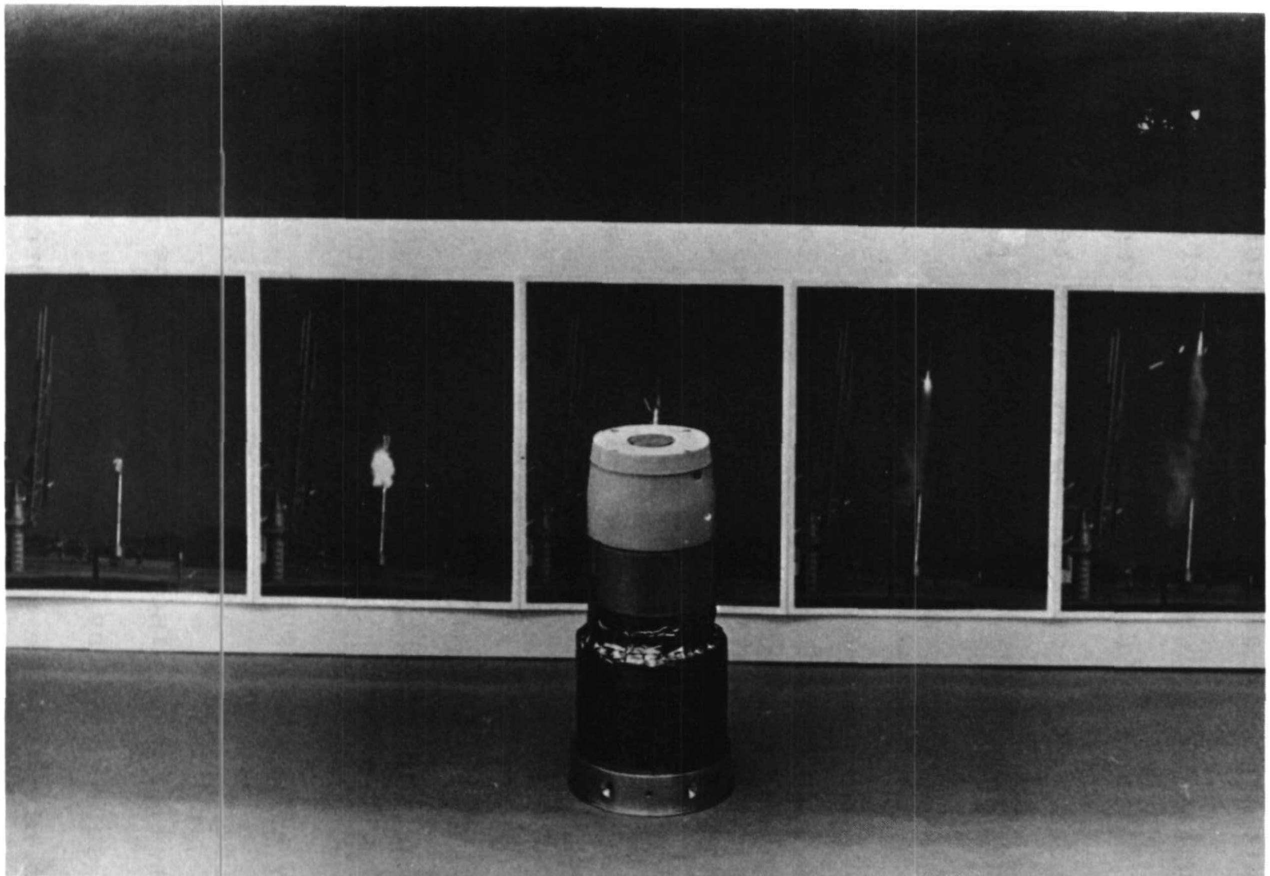

Figure 1: Blunt Probe Used for Data Acquisition

developed by D.P. Hoult in 1965. In 1968, L.C. Hale et al., gave a summary of the theory associated with the probe and in more recent years the application of probe theory was performed by J.D. Mitchell, 1973.

1.2 Previously Related Work

Development of the theory of operation was only the beginning of the efforts to gain an understanding of the D-region. The theory was only a tool which had to be applied to the data acquired during the flight of a probe. Each of the investigators mentioned in the previous section were faced with the task of data reduction. In order to obtain results from the probe flight, the data had to be hand scaled several times, averaged, and tabulated. This process took approximately two weeks to complete, and then the tabulated data were used in the appropriate equations for determining positive ion and negative conductivities. The final phase of data reduction consisted of searching numerous tables and applying the same formulae innumerable times. After approximately four weeks of intensive calculations the end product of positive ion, negative ion and electron densities was obtained.

1.3 Specific Statement of the Problem

Although there have been continual improvements in the blunt probe and its associated theory, the method of data reduction has remained somewhat stagnant. The methods used have proven to be both time consuming and laborious. They are time consuming from the standpoint of taking three to four weeks to reduce data from a rocket launch, and laborious because of the repetitive nature of the analysis. There is a certain amount of error introduced because of these two factors. Errors introduced in the scaling phase of the analysis arise because no two people scale the data in the exact same way. These errors, coupled with those introduced in the repetitive applications of the formulae reduce the accuracy of conductivities, ion densities and electron densities. These effects could be decreased considerably if the amount of human interaction with the data could be reduced. One obvious way to achieve this reduction of human involvement is through the use of computer aided data reduction.

The purpose of this work is to examine the feasibility of computer aided data analysis and to develop such a system. To achieve these objectives a series of computer programs are developed. These programs i) digitize blunt probe data, ii) analyze flight slopes, iii) calculate positive and negative conductivities, and iv) calculate positive ion, negative ion and electron densities. Before these programs could be developed a decision was made on the type of computer facility to be used.

There were two possible choices of computer systems available for this study: the digital computer or hybrid computer facilities of The Pennsylvania State University.

Hybrid computer analysis has a definite advantage over the purely digital computer approach. The analog portion of the hybrid system allows direct input of the data stored on quarter inch magnetic tape, and also facilitates implementation of signal sampling procedures and filtering techniques. In effect, the analog computer takes the place of the strip chart recording and provides the necessary interface between raw data and the digital computer phase of data reduction. The digital computer then applies the known mathematical relationships to the information received from the analog computer.

Using a hybrid system for reduction of data obtained from a rocket born probe has definite advantages over the present hand reduction system; i) appreciably reduces the time between data acquisition and results; ii) frees personnel from mathematical computations which can be better performed by a computer; and iii) provides a greater accuracy in results.

CHAPTER II

BLUNT PROBE THEORY

2.1 Introduction

The theory of operation of the blunt probe can be described by the voltage applied to the collector surface. This applied voltage varies between -10 and +10 volts, Figure 2(a). By using either a calibration or flight plug two modes of operation can be observed as the voltage varies through its range. One of these modes of operation is the calibration mode, Figure 2(b). The second is the flight mode, Figure 2(c), which is an example of data obtained at one point in the flight of a probe. Data obtained from either of these two modes of operation represents the current of the collector surface (I_c) as a function of time. The ratio of current obtained in the flight mode to that obtained in the calibration mode is directly proportional to conductivity.

Presently there is some consideration being given to the possibility of reducing the probe sweep voltage to a lower range of -5 to +5 volts. The nature of the data reduction process insures that such a change would have little effect on the theory of blunt probe operation if it were accounted for in the calculation of the probe E-field.

The theoretical analysis of data acquired by the blunt probe was designed to obtain knowledge about the chemical composition of the D-region of the Ionosphere. In order to

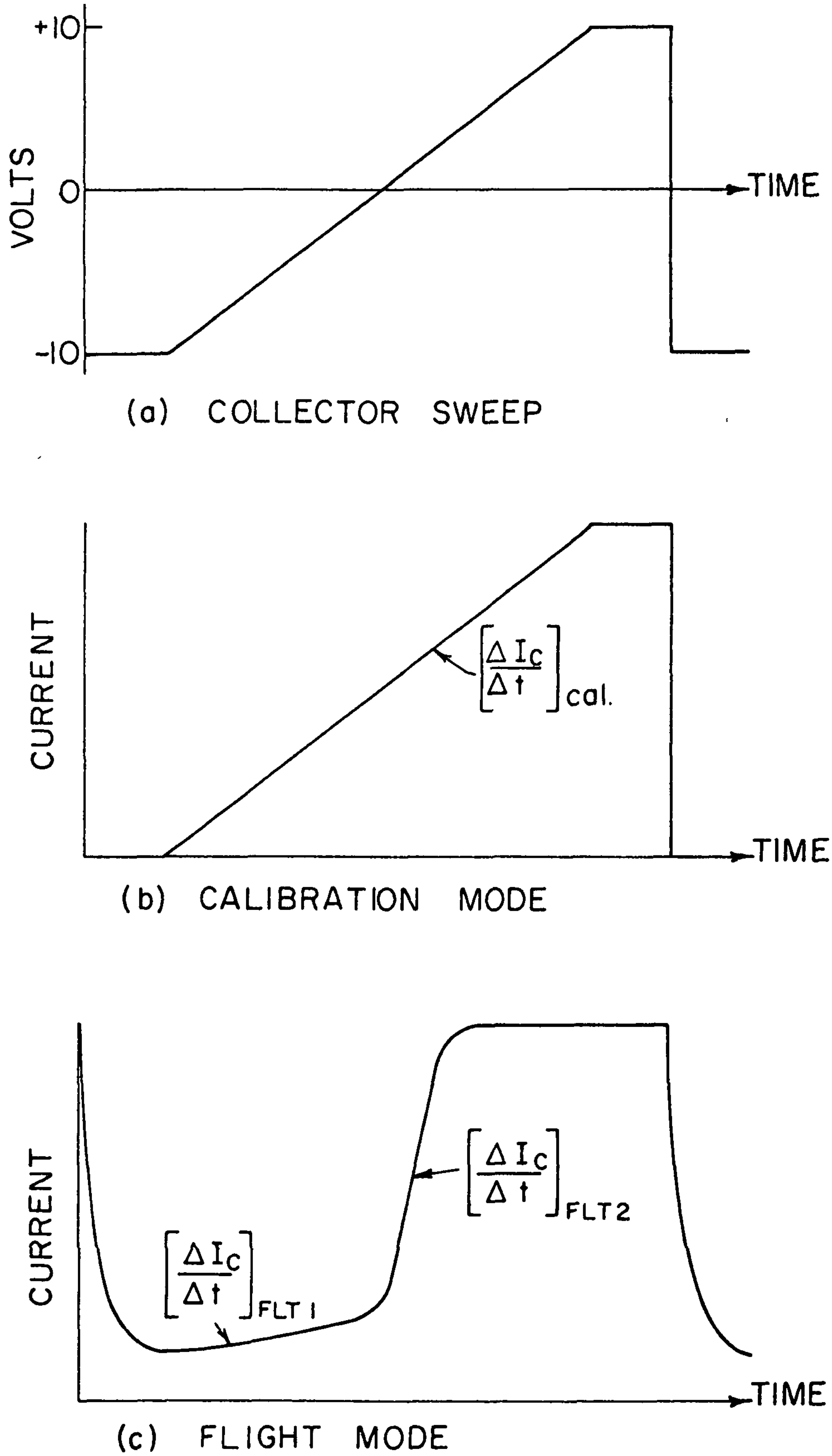

Figure 2: Blunt Probe Sweep Characteristics

gain this knowledge it is necessary to extract positive ion and negative conductivities and densities from the data. Blunt probe theory dictates that the conductivities be obtained from the recorded flight data. Once the conductivities have been calculated they are used to determine ion and electron densities.

2.2 Conductivity Calculations

By making use of the slopes in Figure 2(b) and 2(c), both positive ion and negative conductivities can be calculated. The positive conductivities are claculated by use of the formula:

$$\sigma^{+} = \frac{1}{2\,R_{CAL}} \; \frac{R}{r^2} \left[\frac{\Delta I_c}{\Delta t}\right]_{FLT1} \left[\frac{\Delta I_c}{\Delta t}\right]^{-1}_{CAL} \tag{1}$$

The formula for calculating negative conductivities is:

$$\sigma^{-} = \frac{1}{2\,R_{CAL}} \; \frac{R}{r^2} \left[\frac{\Delta I_c}{\Delta t}\right]_{FLT2} \left[\frac{\Delta I_c}{\Delta t}\right]^{-1}_{CAL} \tag{2}$$

In the above formulae R and r are the guard ring and collector radii, respectively. R_{CAL} is the value of the calibration resistance. The subscripts FLT1 and FLT2 refer to the time in the flight that the data slopes were taken (see Figure 2(c)).

During design modifications of the blunt probe the two radii mentioned above have undergone changes. Throughout most of these changes in design the R/r^2 ratio has remained nearly constant, (approximately 2.0 per cm). At the present time there is some thought given to miniaturizing the blunt probe for use with a Super LOKI Dart rocket as opposed to the currently used ARCAS and Super ARCAS rockets. This change would not affect the method of data reduction. However, if the ratio is changed the new values of collector and guard ring radii can be typed into the computer before conductivity calculations are performed.

Initially the purpose of this work was to examine the feasibility of using the Hybrid Computer Facility of The Pennsylvania State University to calculate positive ion and negative conductivities. The basis for this decision was that this phase of the data reduction had been the most time consuming and tedious portion of the entire data reduction process. However, after examining the remainder of the data analysis computations it was decided that, with certain assumptions, the computer could provide the accurate results needed for total data reduction. The assumptions made were that in the altitude range of 35 to 80Km temperature and pressure variations could be described by the data of 1 September 1965 (CIRA, 1965). These assumptions were shown to be valid when J.P. Cipriano and J.D. Mitchell, 1972, compared the results of two separate data reductions of a probe flight. One of these data reductions used the data from CIRA, 1965, and the other used actual temperature and pressure data obtained from a meteorological datasonde, which was launched on the same day as the blunt probe.

These assumptions were made primarily for convenience in generating a table of constant values of temperature and pressure in the altitude range of interest. This table permits elimination of one step in the data reduction process and any errors interjected by these assumptions are considered negligible. If there is ever a need for greater accuracy there would be no difficulty in generating a new table. This could be done by using the computer and data acquired from a meteorological datasonde.

It is now possible to discuss the methods used to calculate positive ion, electron, and negative ion densities. The method used for determining positive ion densities is fairly straightforward and will be presented next.

2.3 Calculations of Positive Ion Densities, N^+

Calculations of positive ion densities are greatly simplified if it is assumed that mobilities of different ion species are comparable in value. This assumption allows the ion mobilities to be represented by an effective small ion reduced mobility model (A. Dalgarno, 1962). The equation used for determining positive ion densities is:

$$N^+ = \frac{\sigma^+}{e\,u_+} = \frac{\sigma^+}{e\,u_{0+}} \quad \frac{T_0}{T}\,\frac{P}{P_0} \tag{3}$$

There are several constants in this equation: i) the positive ion mobility u_+ and the reduced positive ion mobility u_{0+}, which was assumed to be 1.8 $cm^2/v.s.$ (R.K. Cole and E.T. Pierce, 1965), ii) the standard atmospheric temperature and pressure at sea level, T_0 and P_0

respectively, and iii) the charge of an electron, e. Values for T and P are found in the table which are stored on disc and DEC tape. These tables were generated using model atmosphere data from CIRA, 1965. The positive ion conductivity is obtained from Equation (1) of the previous section.

Positive ion densities and electron mobility are two major variables required to determine the electron density. Because of the complexity of calculating electron densities their analysis will be divided into two parts: 1) electron mobility calculations, and 2) electron density calculations.

2.4 Electron Mobility, u_e

Electron mobility varies over the altitude range of interest and is found to be dependent on the ratio of electric field to atmospheric pressure (E/P), E.S. McDaniel, 1964. The equation used for calculation of electron mobility is:

$$u_e = \frac{v_d}{E} = \frac{1}{E}\left[\alpha \frac{E}{P} + \beta\right] \tag{4}$$

in which v_d is the electron drift velocity and is proportional to alpha and beta. Both alpha and beta are dependent upon the particular value of the E/P ratio at the point of interest. Table I is a tabulation of the values calculated for alpha and beta for given values of the electric field to pressure ratio, J.D. Mitchell, 1972. Once the values for these two variables are calculated the electron mobility can be calculated by using both the

Table I: Parameters for Electron Mobility Calculations

E/P (v./cm.-mm.Hg)	α (cm.^{2}-mm.Hg/v.s.)	β (cm./s.)
0.2	1.23×10^{6}	3.2×10^{5}
0.4	9.50×10^{5}	4.0×10^{5}
0.6	8.00×10^{5}	4.8×10^{5}
0.3	6.00×10^{5}	6.0×10^{5}
1.0	5.63×10^{5}	6.4×10^{5}
1.2	4.91×10^{5}	7.2×10^{5}
1.4	4.36×10^{5}	7.6×10^{5}
1.6	4.36×10^{5}	7.6×10^{5}
1.8	4.36×10^{5}	7.6×10^{5}
2.0	4.36×10^{5}	7.6×10^{5}
4.0	4.14×10^{5}	9.0×10^{5}
6.0	4.00×10^{5}	1.0×10^{6}
8.0	3.95×10^{5}	1.0×10^{6}
10.0	3.82×10^{5}	1.1×10^{6}
12.0	3.77×10^{5}	1.2×10^{6}
14.0	3.63×10^{5}	1.4×10^{6}
16.0	3.59×10^{5}	1.5×10^{6}
18.0	3.50×10^{5}	1.6×10^{6}
20.0	3.50×10^{5}	1.6×10^{6}

pressure at a given altitude and the electric field, which is determined from the blunt probe data.

The method used to determine the electron drift velocity introduces uncertainties in later calculations of electron densities. Because of these uncertainties greater confidence is placed in electron densities considered relative to each other than in their absolute values (J.P. Cipriano, 1972).

2.4.1 Calculation of Electric Field, E

The electric field referred to in Equation (4) is the field produced by the blunt probe as the probe potential varies from 0 to +10 volts. More precisely, it is the field produced at the point of measurement of the slope corresponding to the negative conductivity (see Figure 2(c), $[\Delta I_c/\Delta t]_{FLT2}$). The electric field is directly proportional to the voltage applied (V_p) to the collector disc at the time of the slope measurement and is determined from the formula

$$E = \frac{2}{\pi}\frac{V_p}{R} \tag{5}$$

where R is again the radius of the guard ring.

At this point in the data reduction the values of positive and negative conductivites, positive ion densities, and electron mobility are known. It is now possible to discuss the method of determining the electron densities.

2.5 Calculation of Electron Density, N_e

In the previous section it was shown that the electron mobility is a function of the E/P ratio. Since there are some uncertainties in the exact values of the electric field and pressure there will be a slight error introduced into the calculated values of electron mobility. This error will also be reflected in the calculations of electron densities. However, the data analysis techniques are such that the primary concern is not the absolute values of electron densities. The essential interest is the relative values obtained. Considering the consistent manner of data reduction and the interest in relative electron densities leads to the conclusion that the errors introduced can be neglected (J.D. Mitchell and L.C. Hale, 1972). The electron densities can be determined from an equation relating the density to negative conductivity.

Negative conductivity is proportional to the sum of the negative ion and electron densities, N^- and N_e, respectively. The equation for negative conductivities is:

$$\sigma^- = N^- e\, u_- + N_e\, e\, u_e \qquad (6)$$

where e is the charge of an electron, u_- is the negative ion mobility, and u_e is the electron mobility previously discussed. Application of the principle of conservation of charge yields

$$N^- = N^+ - N_e \qquad (7)$$

and substitution of Equation (7) into Equation (6) gives

$$\sigma^- = (N^+ - N_e)\, e\, u_- + N_e\, e\, u_e \tag{8}$$

Because $u_e >> u_-$, Equation (8) can be written as

$$\sigma^- \cong N^+\, e\, u_- + N_e\, e\, u_e \tag{9}$$

and solving for the electron density results in the equation

$$N_e \cong \frac{\sigma^- - N^+\, e\, u_-}{e\, u_e} \tag{10}$$

The only term which remains to be defined in this equation is the negative ion mobility.

This mobility can be determined from the following relationship:

$$u_- = u_{0-}\, \frac{T_0\; P}{T\; P_0} \tag{11}$$

where u_{0-} is the reduced ion mobility, which is assumed to be 2.3 cm^2/v.s. (R.K. Cole and E.T. Pierce, 1965). All the meteorological data in this equation are obtained in the manner discussed in Section 2.3 (Calculations of Positive Ion Density, N^+).

At this point the only remaining unknown in the data analysis procedure is the value of the negative ion density. The negative ion density can be determined by using the principle of conservation of charge, which was introduced in the previous section (Equation (7)). Substitution of the calculated electron and positive ion densities into this equation yields the negative ion densities.

CHAPTER III

COMPUTER PROGRAM DEVELOPMENT

3.1 Introduction

Before a definite computer programming approach could be decided upon it was necessary to determine the type and amount of machine and program operator interaction. There were two possible ways in which the data could be analyzed: (1) total machine analysis, through complex mathematical and signal analysis procedures, or (2) standard hand data analysis procedures which could be modified for implementation of computerized data reduction methods. The second method is the most advantageous approach because it allows observation and human interpretation of data (L.C. Hale and J.D. Mitchell, 1972). This method of analysis can be implemented by making complete use of the hybrid computer facility.

The equipment available at the computer facility consists of i) Digital Equipment Corporation's (DEC) PDP-10 with 80K of core and two 5 megaword disc units, ii) a DEC type TU-20 magnetic tape unit, iii) a DEC type 340 digital display scope, and iv) an Electronics Associates Incorporated (EAI) model 680 Analog computer. In order to make efficient use of the computer facility the data analysis was divided into three phases: (1) digitization of data, (2) conductivity analysis, and (3) positive ion, negative ion, and electron density calculations.

3.2 Digitization of Data

The data obtained from the flight of a blunt probe is recorded on standard quarter-inch magnetic tape. In order to perform the data analysis, the information stored on this tape must be digitized and transferred to magnetic tape which is compatible with DEC's magnetic tape unit. This requires that there exist some type of interface between the two tape recording units. The analog computer was chosen as the interface.

Because of the nature of the data recorded from a blunt probe flight, the analog computer interface had to perform two functions: (1) convert the raw data to an analog signal, and (2) convert the analog signal to a digital signal. The first function could be obtained by developing an analog data tachometer.

3.2.1 The Analog Computer Data Tachometer

The information stored on quarter-inch magnetic tape consists of variable pulse rate data. As the blunt probe sweeps through its range the information recorded takes the form of pulses. In order to convert this pulse data to the desired analog signal the analog computer data tachometer must consist of a pulse shaper, an integrator, and a signal filtering system. The pulse shaper chosen was a monostable with a two millisecond pulse width. The filter network consisted of a sharp cutoff low pass filter (A.S. Jackson, 1960). Figure 3 is the schematic diagram of the analog computer data tachometer.

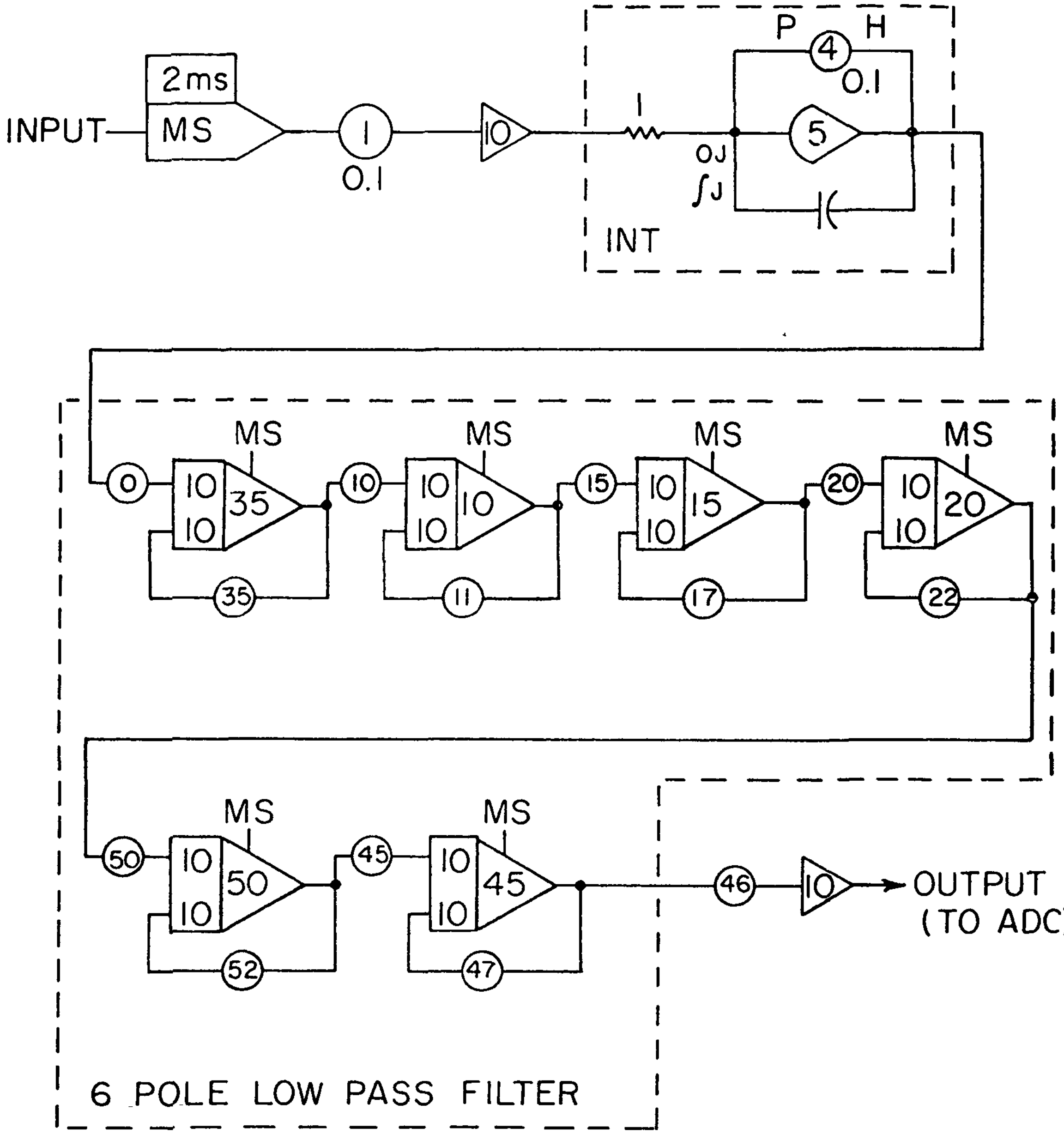

Figure 3: Analog Computer Data Tachometer Schematic

In order to understand the operation of the analog computer data tachometer, it is helpful to consider what takes place when a series of noisy data pulses are applied to the input. These data pulses trigger the two millisecond monostable, which in turn produces a series of clean, well-defined pulses. Following the monostable is an integrator with a potentiometer connected from the output of the integrator to its OJ (OPERATE summing junction) and $\int$ J (INTEGRATE summing junction) terminals. The purpose of the potentiometer is to provide a discharge path for the integrator's capacitor, which enables the integrator output to return to zero before the next series of pulses arrive at the input. After the integration process the data takes the form of an analog signal. This new signal must now be applied to a filter to remove unwanted noise. Prior to the digitization the data must undergo an amplification and inversion. This is the purpose of the potentiometer and amplifier at the output of the low pass filter network.

The performance of the analog computer data tachometer had to be evaluated before it could be used in the digitization phase of data reduction. This evaluation consisted of optimizing the analog computer data tachometer and then comparing its output to the output of an existing data tachometer, which had been used in the past.

3.2.2 Optimization and Evaluation of the Analog Computer Data Tachometer

Optimization consisted of adjusting the integrator decay time constant (potentiometer #4, Figure 3) and varying the cutoff frequency of the filter network. Observation of the output signal from the data tachometer revealed that the tachometer performed best when the integrator decay time constant was 50μsec. and the filter network had a cutoff frequency of 600 Hz. These criteria were satisfied when potentiometer #4 was set to 0.1, all potentiometers associated with the filter network were adjusted to 0.3768, and the integrators in the filter network were operating in the millisecond mode (MS)(refer to Figure 3). Upon completion of this optimization phase it was necessary to evaluate the performance of the analog computer data tachometer.

The evaluation consisted of simultaneous observations of calibration and flight data processed by the analog computer data tachometer and the standard data tachometer previously used. Tests involving the calibration data revealed that the slopes reproduced by the analog computer data tachometer were approximately 15% lower than the slopes reproduced by the standard data tachometer. This reduction in slopes caused no great concern because the mathematics involved in conductivity calculations utilize the ratio of flight slope to calibration slope, Equations (1) and (2), Section 2.2. A 15 percent reduction in both calibration and flight slopes therefore would not alter the resultant conductivities. However, analysis of the flight data revealed more than a simple 15 percent reduction in slope. The analysis disclosed that the analog computer data tachometer could not respond accurately enough to the fast rise times of data obtained early in the flight. It can be seen, Figure 4, that the data reproduced by the analog computer data tachometer (lower trace) was not an accurate representation of the actual flight data reproduced by the standard data tachometer (upper waveform). Efforts were made to correct this problem by increasing the filter network cutoff frequency. This approach was not successful because noise became a limiting factor as the cutoff frequency was increased. The only conclusion which could explain the observed effects was that the capacitors involved in the integration and filtering process limited the rate at which the analog computer data tachometer could process data. Because of this inaccuracy the idea of an analog computer data tachometer was abandoned and a system was developed to make use of the standard data tachometer.

3.2.3 Data Digitization System

This new system of removing data from tape and converting it to a usable form was similar to that used in the past (J.D. Mitchell, 1973, J.P. Cipriano, 1973); however, there was one difference. In the method previously used the output of the data tachometer was connected to a strip chart recorder. In the new system the output is connected to the

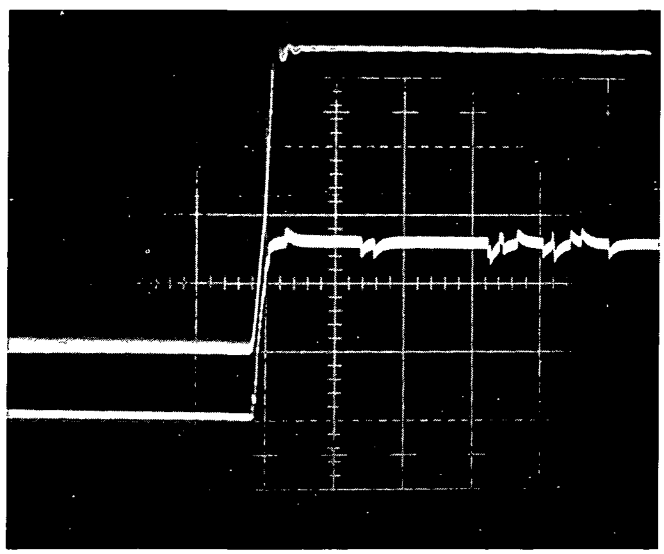

Figure 4: Analog Computer and Standard Data Tachometer Outputs

analog computer, which acts as the interface in the digitization process. Digitization takes place by using the digital computer to control i) the analog computer's mode of operation, ii) the rate at which the analog to digital conversion of data takes place, and iii) the initialization and termination of the digitizing process.

In the hybrid computer system the digital computer's control over the variables was obtained by writing a program, DIGPGM.F4 (see Appendix B). This computer program provided the operator with the ability to control the data digitization process and allowed the data to be catalogued before storing it on magnetic tape. Operator control consists of answering questions about the setup of the analog computer and providing information about the type of data to be digitized, i.e., calibration or flight data. After this preliminary information has been processed the data sampling rate must be set. Then the data digitization process is started and its status is continually monitored. These two steps were performed by incorporating commands from HFOS (Hybrid Fortran Operating System, 1972) in the program. The digitized data is placed into an array which is periodically transferred to magnetic tape by MTIO (Magnetic Tape Input/Output, 1972). Figure 5(a) is a block diagram of the digitization system and Figure 5(b) shows the patching of the analog computer.

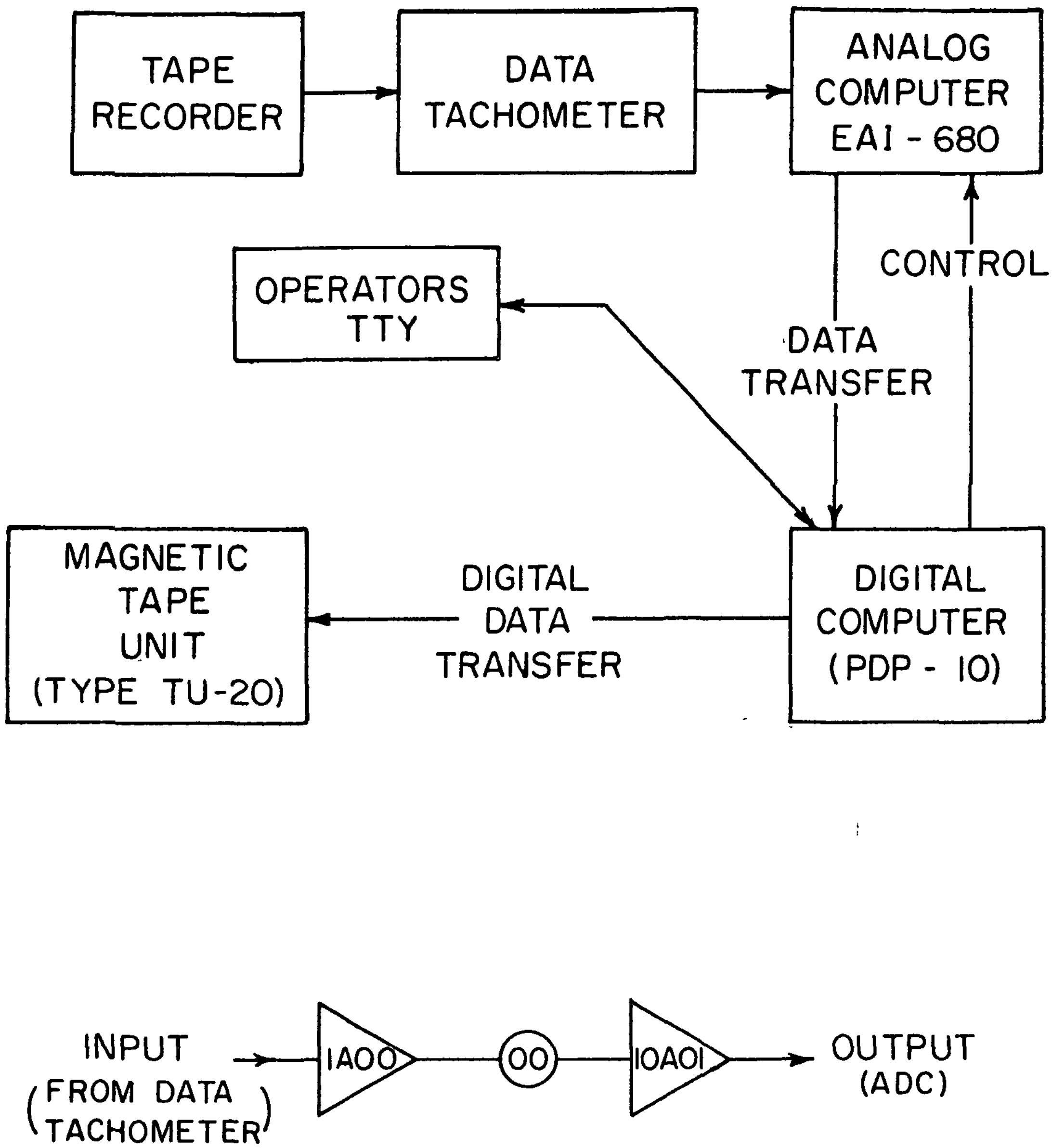

Figure 5: Digitization System

After the data has been catalogued, digitized, and stored on magnetic tape the task of conductivity analysis can commence.

3.3 Conductivity Analysis

To be able to appreciate the use of the hybrid computer facility in conductivity analysis one must consider the work involved in the standard hand reduction method. In this method the data recorded on quarter-inch magnetic tape were played through the standard data tachometer and a Sanborn Model 320 strip chart recorder. One disadvantage of this system is the need for a minimum of three rolls of strip chart recordings per flight. The first roll is a high speed record required to reduce the steep negative conductivity slopes in the first third of the flight. A second roll, at a slower speed, enables calculation of positive and negative conductivity slopes which occur during the middle portion of the flight. And the third roll, obtained by increasing the recording sensitivity of the Sanborn recorder, enables analysis of slopes late in the flight. Other disadvantages of this system are: i) the errors made when drawing slope lines on chart recordings are reflected in the values obtained for conductivities, ii) the repetitive application of the formulae to tabulated slopes is not only time consuming but also tedious. However, this standard method of data reduction does have one major advantage: one has the ability to easily extract meaningful results from data which has some noise present. The object of the computer program was to make use of this positive trait while minimizing errors and eliminating the disadvantages of the classical data reduction methods.

To incorporate the ability of a human to discriminate between meaningful data and noise into the program requires the capability to observe the data. This requirement can be fulfilled by proper programming techniques and the use of DEC's 340 digital display scope. Implementation of the display scope not only allows observation of data but it also eliminates the need for strip chart recordings, allows manipulation and analysis of data, and reduces errors in the scaling of data slopes. Manipulation of data includes the ability to i) amplify the observed signal to facilitate scaling of slopes which have small gradients, ii) perform time base expansions of slopes which have steep gradients, and iii) calculate the slopes of the signal.

3.3.1 Conductivity Computer Program

After becoming familiar with data acquisition and hand reduction methods the task of developing computer analysis methods began in May 1972. At that time the hybrid computer facility had 48K of core and did not have a disc. Consequently, the analysis program had to be stored on a DEC tape and operated from the DEC tape system. This type of system was slow and limited the size of the analysis program. While the program was in the developmental stages it became apparent that its size was approaching the maximum usable core limitations imposed during timesharing hours. To avoid this problem the program was divided into subprograms called Chain Links (Digital Equipment Corporation, 1970). One subprogram was designated as the main program (LINK MAIN, see Appendix B).

The purpose of the main program is to control and keep track of the data reduction process. It consists primarily of questions which ask the operator what phase of the analysis he wishes to perform. All of the questions specify two possible responses. An incorrect response simply causes the program to type the question again. Upon recognition of an answer the main program either types out the next question or calls into core the chain link which performs the requested phase of the data reduction process. After the new chain link completes its operations, control is transferred back to the main link. The processing continues in this manner until the resultant conductivities with their corresponding altitudes are obtained. In July 1972, the analysis program was completed and the results obtained from it were ready for evaluation. However, the evaluation of the program was delayed because the hybrid computer facility was shut down for the installation of the first 5 megaword disc pack.

When the disc system became operable it was obvious that it was faster and more efficient than the DEC tape system. For this reason the evaluation of the analysis program was delayed while the chain links were revised for disc operation. The modifications to the programs included installing the option of running the program from either system. This option insured that the data reduction process could be performed even if the disc system became inoperable. Before discussing the results of program evaluation the name and purpose of each individual chain link should be mentioned.

DATAN (Appendix B) was the name given to the data analysis program. It consists of six chain links: (1) MAIN, previously discussed, (2) CALC, calibration slope analysis, (3) CALD, evaluation of flight slopes, (4) CONC, conductivity calculations, (5) MTAH, matches times-in-flight and altitudes, and (6) SIGP, automatically plots altitude vs. conductivity curves on the digital display scope. Links CALC and CALD require manipulation of the magnetic tape unit to bring the digitized data into core. This was achieved by using the Magnetic Tape Input/Output routine (MTIO). Once the data were in core the program automatically scaled it before storing the data in an array for display purposes. The array had to be constructed in a manner that was consistent with specifications outlined in the display routine package (DISUBS). Several other arrays were constructed and displayed on the scope. These arrays included a grid, decision section, and display of time-in-flight information.

Figure 6 shows a typical cycle of calibration data with the operator-scaled slope. The slope was obtained by first placing the Lite-pen on the words TAKE SLOPE. This caused all other decision sections, except the ACCEPT region, to be ignored until a second ACCEPT was detected by the Lite-pen. The Lite-pen was then moved around until the asterisk was on the beginning portion of the calibration slope. After that, the Lite-pen was moved to the ACCEPT region. When the Lite-pen detected the light from this region, the X and Y coordinates of the asterisk were stored in core, and the asterisk was returned to the READY position. The next step was to select the second point on the calibration slope. Upon detection of light the asterisk was moved to the curve and a line was drawn between the first point chosen and the new location of the asterisk. The asterisk was moved until the line matched the slope of the calibration data. When this match was obtained the Lite-pen was placed over the ACCEPT region a second time. The new X and Y coordinates of the asterisk were used in conjunction with the first set to determine the slope of the data. This slope, along with others, was stored in an array until all the calibration data were analyzed. When the analysis of slopes was completed, the Lite-pen was placed over the END region of the display scope. The program then proceeded to calculate the average calibration slope and store all the slopes and this average value on the disc or a DEC tape. Analysis of flight

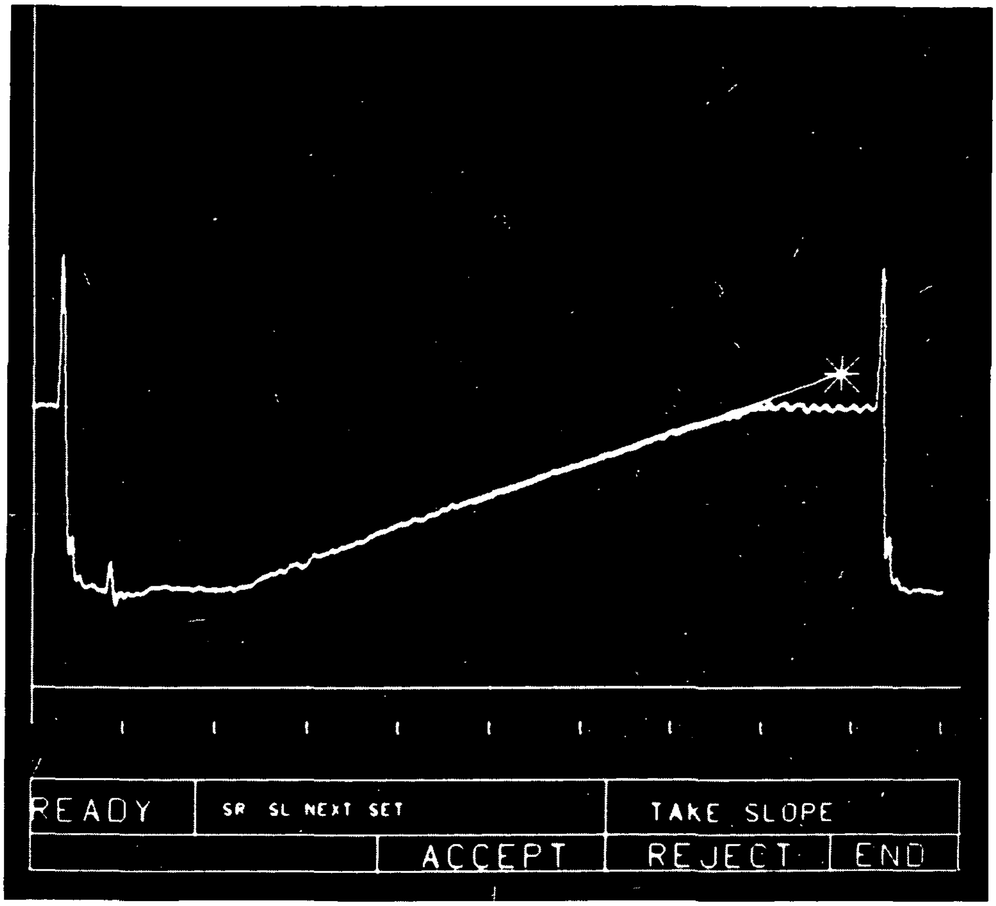

Figure 6: Scaled Calibration Data

data proceeds in much the same manner; however, there are more options available when scaling the data.

Link CALD provides the ability to expand the magnitude or time base of the data. When the slope of the data is small it can be expanded by a factor of four. The flight data is displayed with a ten second time base. If the rise time of the data is less than two seconds the operator has the option of calling for a two second expansion. Both of these options increase the accuracy of data reduction and enable complete analysis without the need to process the data more than once. Figure 7 shows a typical cycle of flight data. The data were displayed and scaled when it was i) multiplied by a factor of four, Figure 8, and ii) expanded under a two second display, Figure 9. Slope analysis was performed the same way the calibration data were reduced; however, when the slopes were expanded they were multiplied by an appropriate scale factor. After the analysis was completed the slopes used in calculating positive ion conductivities and their times-in-flight were stored on disc or a DEC tape. The slopes used to calculate negative ion conductivities were stored with their corresponding times-in-flight and data required to calculate the E-field of the blunt probe. Once all the information was stored, the results were printed on the line printer. The next step in the analysis was to calculate the conductivities.

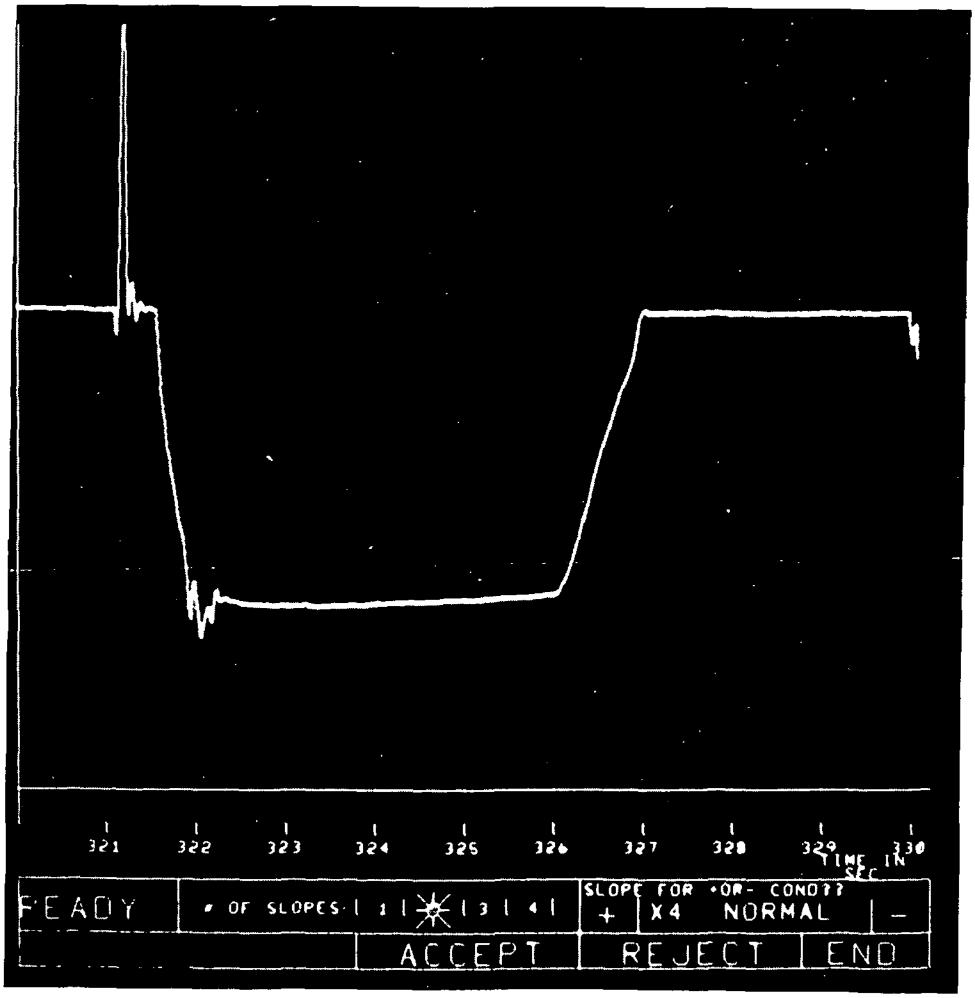

Figure 7: Normal Cycle of Flight Data

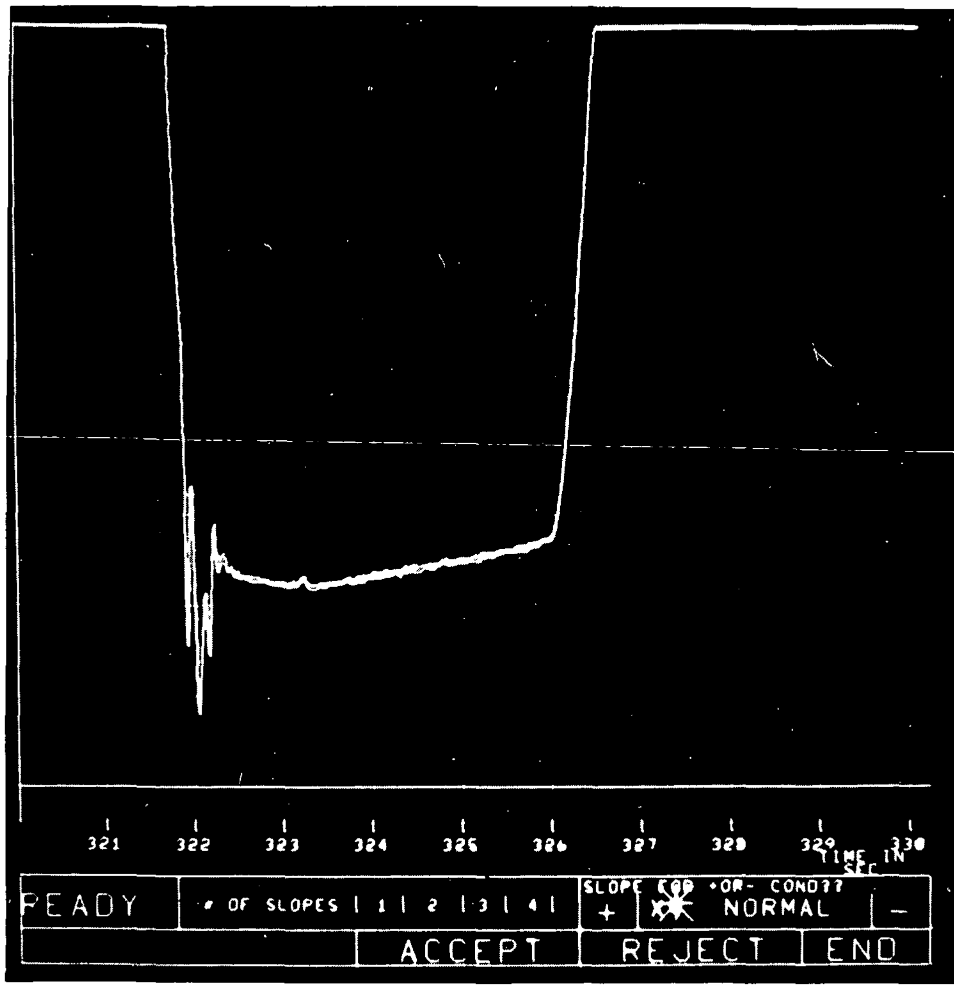

Figure 8: Flight Data Multiplied by Four

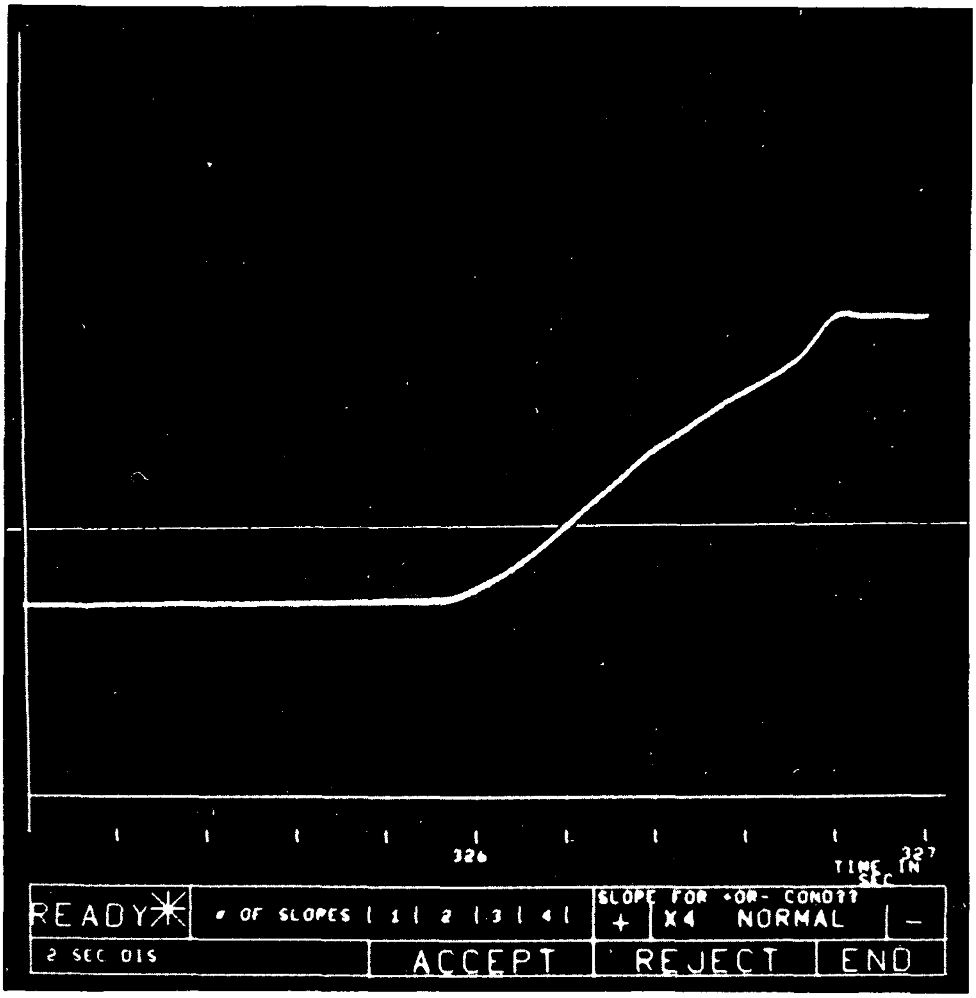

Figure 9: Two Second Expansion of a Portion of Flight Data

Conductivity calculations were performed by link CONC. This link uses the average calibration slope and the slopes obtained from the analysis of flight data to determine conductivities. These are proportional to the flight slope divided by the average calibration slope, Equations (1) and (2) in Chapter II. After the conductivities are calculated, the data is stored and then printed on the line printer. Once this phase is completed the times-in-flight must be matched to their corresponding altitudes.

There were two possible methods of translating time-in-flight information to altitudes. One method was to extract this information from a radar plot. The second procedure was to read the data from a computer printout. Both these sources of information can be obtained from the launch facility. Use of this data in conjunction with link MTAH permits the transformation of time-in-flight data to corresponding altitudes. Upon completion of the matching process the computer program provides the option of automatically plotting altitude vs. conductivity data.

The plotting process was performed by link SIGP. This link generated semi-log scales for these displays: (1) a plot of positive conductivities, Figure 10, (2) a plot of negative conductivities, Figure 11, and (3) a combination plot of both positive and negative conductivities, Figure 12. Each plot remained on the display scope until a Lite-pen detection was received. The third Lite-pen

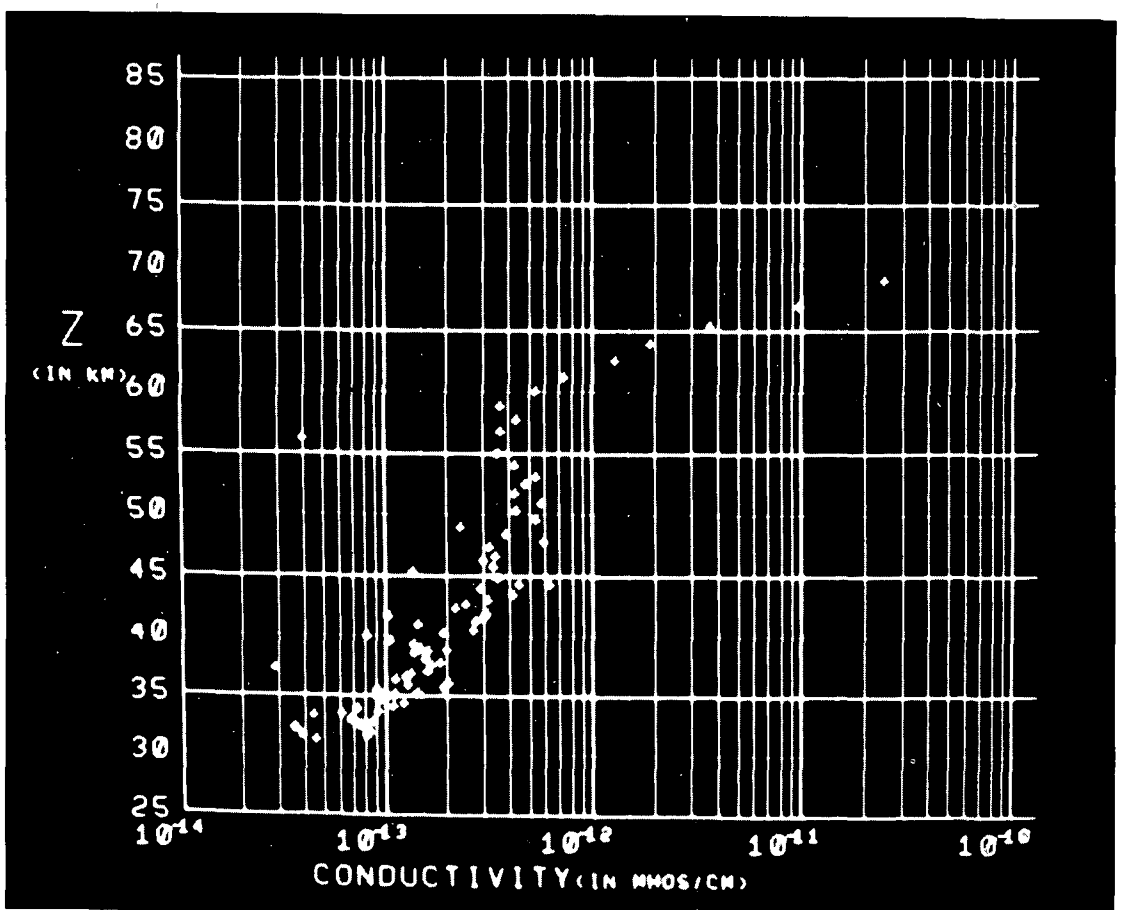

Figure 10: Computer Calculated Positive Conductivities for 31 Jan 1972

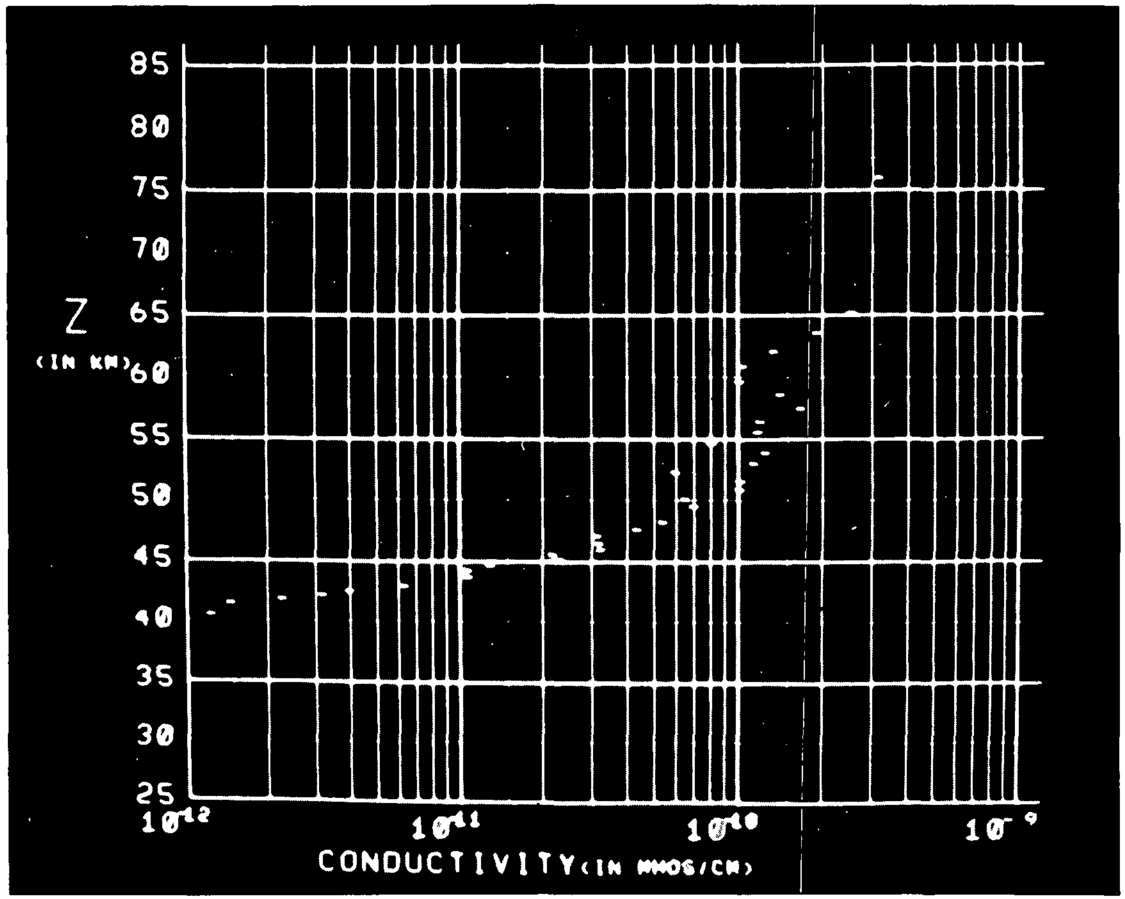

Figure 11: Computer Calculated Negative Conductivities for 31 Jan 1972

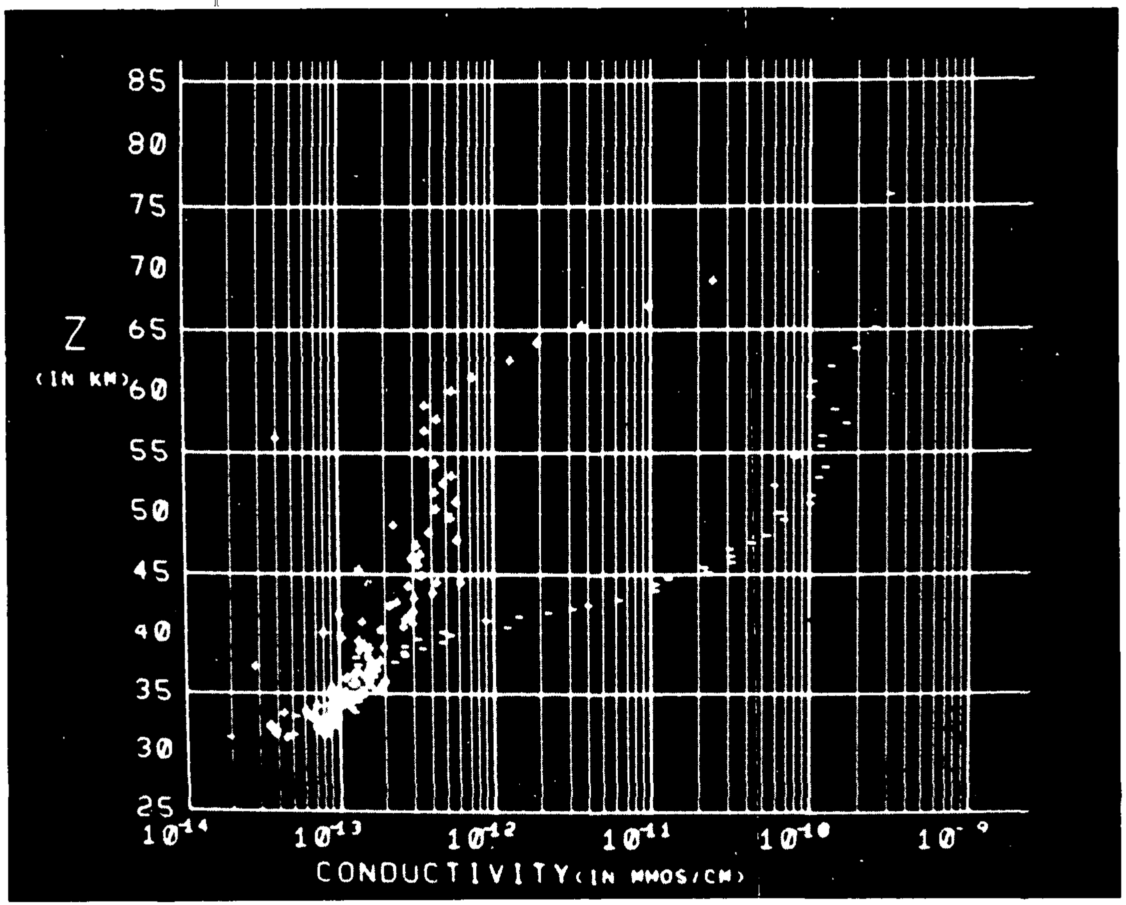

Figure 12: Combined Positive and Negative Conductivity Plot for 31 Jan 1972

detection terminated the program and concluded the conductivity analysis.

3.3.2 Evaluation and Correction of Conductivity Program

The changes from one large program to chain links and from operation off of the DEC tape system alone to either the disc or DEC tape system were successfully completed. In September 1972, the program was ready to be evaluated. Preliminary tests were encouraging. Except for errors in the times four expansion, everything appeared to be working. The expansion process did not display the data accurately when there was a slight bend in the data. An example of this problem can be seen by referring to Figure 13. Consider Figure 13(a) as an example of the data to be expanded. Figure 13(b) shows the expected expansion of the data, while Figure 13(c) depicts the observed results. An analysis of the problem revealed that the error was due to a peculiarity in the subroutine LINE of the display program package. The display scope is divided into 1024 raster units in the X and Y directions. (1 raster unit = .0095 inch) Whenever the ΔX or ΔY between two digitized points was less than one raster unit the subroutine would round off the delta to zero. Since ΔX was always one raster unit this error occurred whenever ΔY was less than one raster unit. This error was cumulative but somewhat compensated for by ΔY's which were one raster unit or greater. The overall effect was to de-emphasize slight

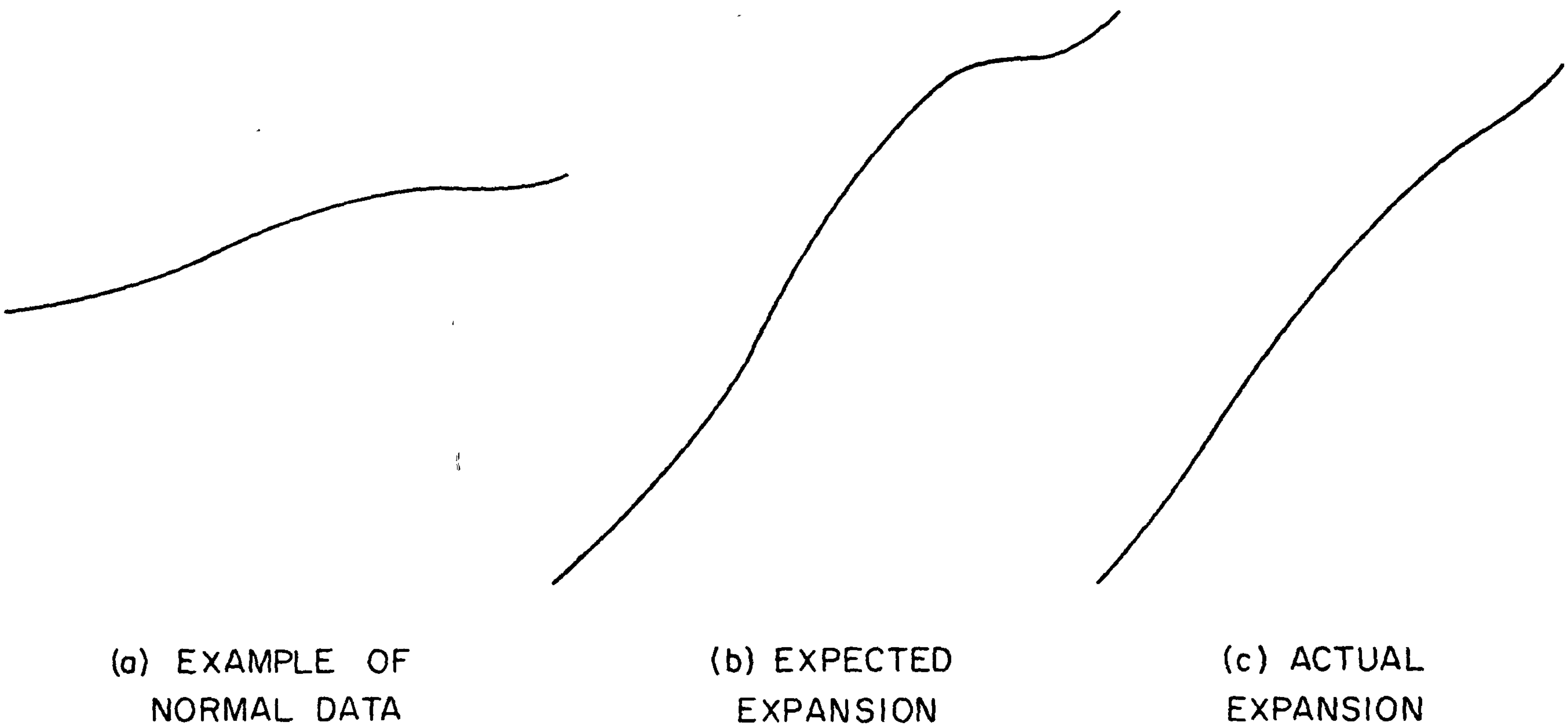

Figure 13: Observed Error in Times Four Expansion

curvatures in the data. The problem was corrected by using another display package subroutine, POINT. A statement was added before each call to LINE. This statement checked to see if a ΔY was less than one raster unit. If this situation occurred the program would perform a call to POINT before the call to LINE. The effects of this were to eliminate round-off error and display a point prior to generating a line on the display scope. All the chain links which were involved with analysis of data on the display scope were modified to insure that no errors due to ΔY's less than one raster unit would effect the display of data. Upon completion of the modifications, tests revealed that there were no longer any difficulties in expanding data by a factor of four.

The first conductivity analysis of flight data was performed on data obtained from the rocket launch of 31 January 1972. A comparison of the conductivities obtained by computerized data reduction methods with those obtained by hand reduction methods revealed a factor of two error. This error implied that the ratio of flight slope to average calibration slope obtained by the computer reduction was less than the hand reduced ratio. Tests showed that this was not the case; in fact, the ratios obtained from the computer were larger than the hand reduced ratios. Further analysis revealed an error in a formula in the link which calculates conductivities (CONC).

The formula was corrected and the data for 31 January 1972 was again reduced.

Resultant conductivities obtained from both the hand and computerized data reduction methods were plotted for comparison, Figure 14. The curves show that both reduction methods yield approximately the same results. Computerized results are more accurate than the hand reduction results because i) the display scope scaling of slopes is more accurate and consistent than hand scaling of strip chart recordings, ii) computer reduction techniques require that the data be scaled only once whereas the hand reduction technique requires analysis of at least three separate strip chart recordings, the latter increases the probability of scaling errors, and iii) the computer automatically performs all calculations, so another possible source of errors in the hand reduction method is eliminated.

The consistent nature of computerized slope scaling was observed when the previously mentioned ratio test was performed. Table II lists the values obtained for the ratio of flight slope to average calibration slope and their corresponding conductivities. The tabulation includes computer and hand reduced results for two independently performed tests on the same flight data. One conclusion that can be obtained from this table is that the differences between conductivities of the two data reduction methods are primarily attributable to inaccuracies in the hand reduction of slopes.

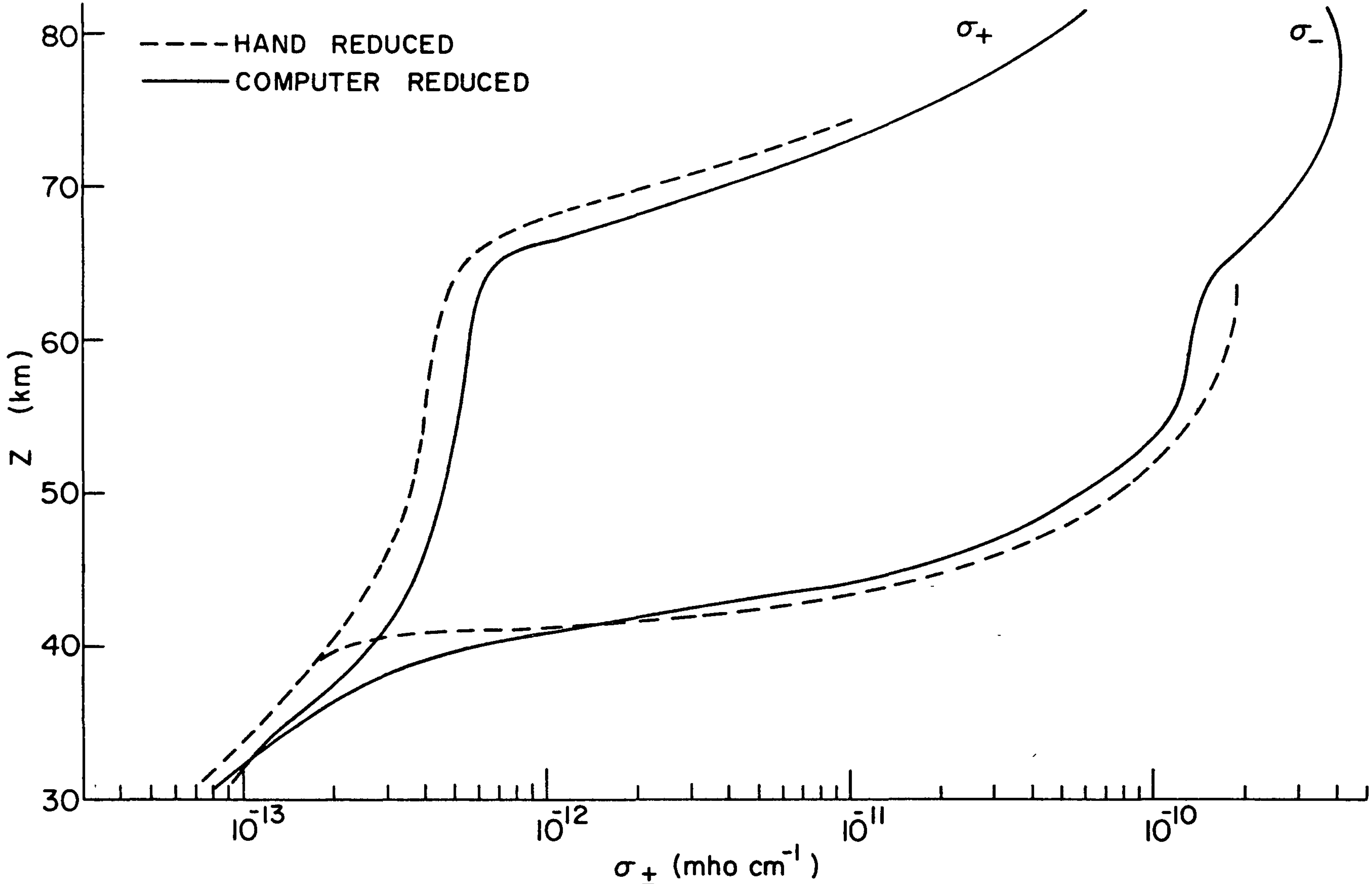

Figure 14: Smoothed Conductivity Curves for 31 Jan 1972

Table II: Ratio Test Results

Computer Reduction I		Computer Reduction II		Hand Reduction I		Hand Reduction II	
Ratio	Conductivity ($MHOS/cm^3$)	Ratio	Conductivity ($MHOS/cm^3$)	Ratio	Conductivity ($MHOS/cm^3$)	Ratio	Conductivity ($MHOS/cm^3$)
105.39	$1.32x10^{-10}$	104.00	$1.30x10^{-10}$	85.0	$1.06x10^{-10}$	90.97	$1.14x10^{-10}$
96.79	$1.21x10^{-10}$	96.02	$1.20x10^{-10}$	96.8	$1.21x10^{-10}$	85.90	$1.07x10^{-10}$
322.46	$4.03x10^{-10}$	320.85	$4.01x10^{-10}$	217.9	$2.72x10^{-10}$	289.96	$3.62x10^{-10}$
108.69	$1.36x10^{-10}$	107.21	$1.34x10^{-10}$	89.5	$1.11x10^{-10}$	92.79	$1.16x10^{-10}$
109.91	$1.37x10^{-10}$	110.46	$1.38x10^{-10}$	100.5	$1.26x10^{-10}$	100.84	$1.26x10^{-10}$
241.84	$3.02x10^{-10}$	242.53	$3.03x10^{-10}$	233.0	$2.91x10^{-10}$	257.74	$3.22x10^{-10}$
38.39	$0.48x10^{-10}$	37.80	$0.47x10^{-10}$	32.1	$0.40x10^{-10}$	32.43	$0.41x10^{-10}$

After determining that the computerized data reduction methods were feasible and accurate it was decided that computer calculation of densities should be attempted.

3.4 Density Analysis

The theory and equations associated with the calculation of ion and electron densities were presented in Chapter II, Sections 3 through 6. Before calculations could begin, two interpolation programs had to be written. The first program ATP (Appendix B) was developed to interpolate altitude, temperature, and pressure data of 1 September 1965. This information was obtained from CIRA '65 tables. This program included the capability of generating two data files: (1) ZTP.DAT, and (2) WIZTP.DAT. These files contained some of the information required to calculate densities from data obtained at White Sands Missile Range, N.M., and NASA's Wallops Island, Va., station, respectively. The reason for using the data from CIRA '65 tables was that constant data files proved to be accurate enough for the data reduction calculations (Chapter II, Section 2.1). If greater accuracy should ever be required ATP could be run again using meteorological data obtained from a datasonde launched on the same day as the blunt probe. The second program ALPBAT (Appendix B) interpolated the data in Table I, Chapter II. Its purpose was to determine the values of alpha and beta, in Equation 4, for 0.01 incremental changes in the E/P ratio.

Once this information was obtained the program generated the data file ALBA.DAT. This file, along with the files generated by ATP, were stored on the disc for use in the program which calculated densities (DENSIT, Appendix B).

3.4.1 Density Analysis Program

Because of the dependency of electron densities on the positive ion densities (Equation (10), Chapter II) DENSIT was divided into two parts: (1) positive ion density calculations, and (2) electron and negative ion density calculations. The calculation of positive ion densities is simple and fairly straightforward, Chapter II, Section 2.3. Equation (3) was used to calculate these densities where the values of T (temperature) and P (pressure) were obtained from one of the files generated by ATP. The values of T and P correspond to the temperature and pressure at the altitude at which a positive ion conductivity measurement was made. Calculation of electron densities is considerably more complicated than positive ion density calculations.

It was necessary to calculate the values of the reduced ion mobility (μ-) and electron mobility (μ_e) before the electron densities could be determined. The reduced ion mobility was calculated by using Equation (11), Chapter II, Section 2.5, and the appropriate file generated by ATP. Calculations of the electron mobility were performed by implementation of Equation (4), Chapter II, Section 2.4.

The program first determined the E/P ratio and then used this ratio to obtain the appropriate values of alpha and beta from the file ALBA.DAT. These variables were then used in Equation (4) to determine μ_e. The only unknown remaining in Equation (10) was the value of the positive ion density at the point at which the negative conductivity was measured. This variable was obtained by interpolation of the positive ion densities which were previously calculated. Once all the variables were known the program proceeded to calculate the electron densities. The negative ion densities were then calculated using Equation (7). The results of positive ion, negative ion, and electron density calculations were stored on a storage device (disc or DEC tape) and then printed on the line printer. This printout concluded the data reduction process and an analysis of the validity of the densities was all that remained to be performed.

3.4.2 Evaluation of Density Analysis

The positive ion densities obtained from the computer reduction of the data from 31 January 1972 were in good agreement with those obtained by hand reduction techniques. Figure 15 is the plot of both the hand and the computer reduced positive ion densities. The differences between these plots can again be attributed primarily to the increased accuracy of computerized data reduction methods (Section 3.3.2).

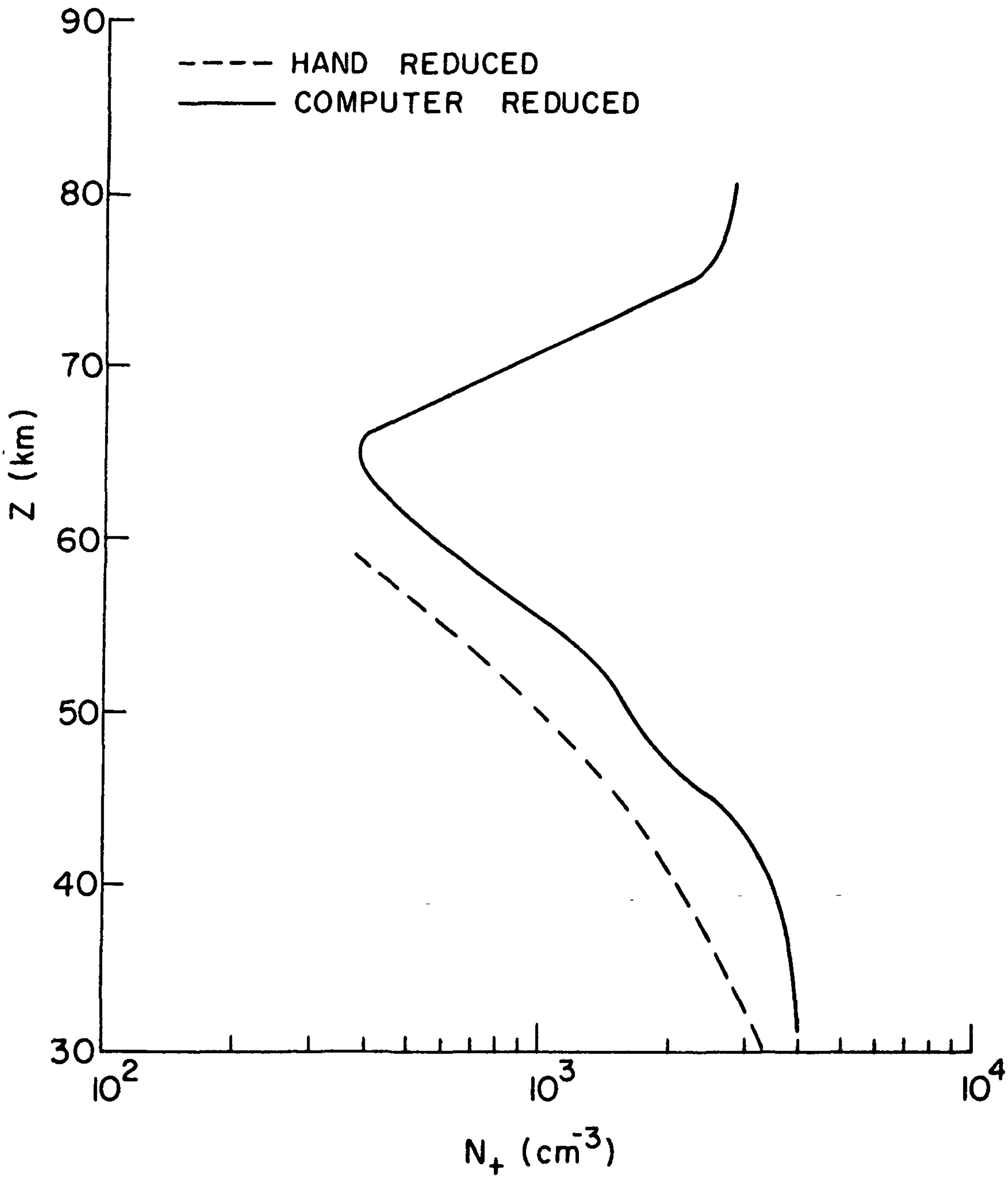

Figure 15: Smoothed Positive Ion Density Curves for 31 Jan 1972

A plot of hand and computer reduced electron densities (Figure 16) also revealed a discrepancy in the observed results. The electron densities calculated by the computer were found to be larger than those obtained from hand reduction. A portion of the difference can again be attributed to the greater slope scaling accuracy of the computer. However, there are two other factors which influence the differing values obtained for electron densities. One factor is that hand reduction processes ignore the term involving positive ion densities in Equation (10). The second factor is that the hand reduction process uses a graph to determine the electron mobilities. This graph contains a curve which is an average plot of the electron mobilities obtained from data acquired from five rocket launches in 1971 (J.D. Mitchell, 1973); whereas, the computer calculates the electron mobilities for each set of data.

Once it was determined that all the computer programs were yielding accurate results the task of data reduction began.

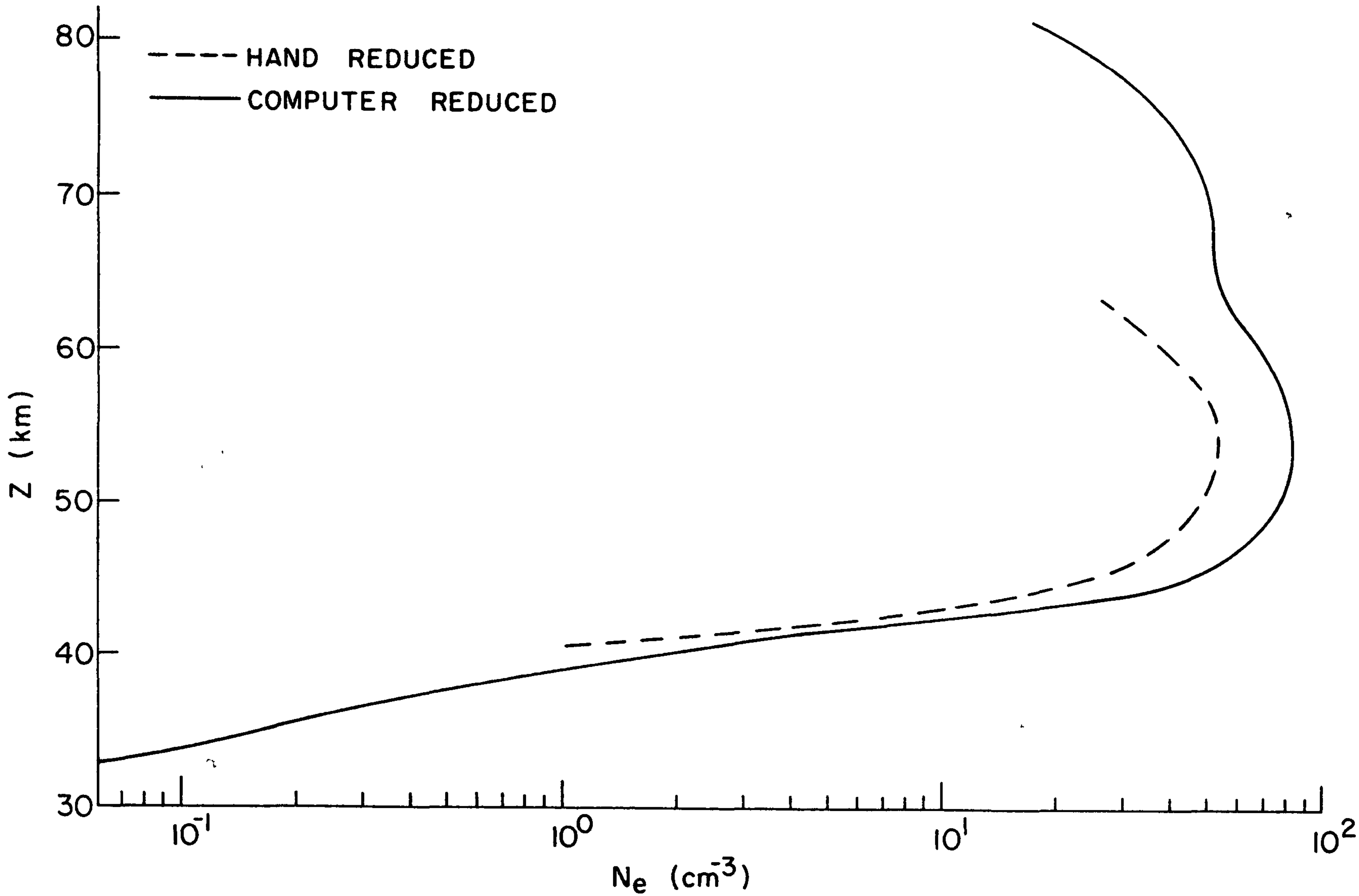

Figure 16: Smoothed Electron Density Curves for 31 Jan 1972

CHAPTER IV

COMPUTER REDUCTION OF DATA

4.1 Introduction

The reduction of data is divided into three phases: (1) digitization of data, (2) conductivity analysis, and (3) density analysis. Appendix A is the operation manual which includes a detailed description of how to perform each phase of data reduction. It is not necessary to perform all three of the phases at one time.

Because of the length of phase two it was subdivided into five operations: (1) calibration slope analysis, (2) flight slope analysis, (3) conductivity calculations, (4) matching of times-in-flight to altitudes, and (5) altitude vs. conductivity plotting. DATAN, which is the conductivity analysis program, was designed to provide the user with the option of performing one, several, or all of the five operations at once. If one of the first two options is chosen the results obtained at the time of interruption of the data reduction are stored for future use. When the user decides to return and complete phase two, DATAN asks a series of questions to determine what operations must be completed. After ascertaining which operation to perform next the data processing continues.

Computer analysis was performed on data acquired from the flight of five blunt probes. These probes were launched during the period of 6 January 1972 to 2 February 1973. Table III lists the date, launch site, and statistics of each flight.

4.2 Positive and Negative Conductivity Analysis

The results of the conductivity analysis performed by DATAN are presented in a series of figures which consist of altitude vs. conductivity plots. There are three figures for each flight. The first figure of the series is a plot of positive conductivities. This is followed by a figure which depicts the negative conductivities. The final figure is a combined plot of both positive and negative conductivities. Each series of figures deals with the data for a particular probe flight: i) Figures 17 to 19, 06 January 1972, ii) Figures 10 to 12 (Chapter III), 31 January 1972, iii) Figures 20 to 22, 05 December 1972, iv) Figures 23 to 25, 16 January 1973, and v) Figures 26 to 28, 02 February 1973. These series of figures are followed by Figure 29 which consists of smoothed curves of positive and negative conductivities for all five probe flights.

The rocket launched on 16 January 1973 reached an altitude of 94.2 Km. This was the highest altitude ever attained by a Super ARCAS. It was believed that for the first time meaningful data could be obtained above 80 Km. DATAN was run a second time for this particular flight, in an attempt to extract the data at these higher altitudes.

Table III: Parameters for Blunt Probe Launchings

Date of Launch	Launch Site	Local Time (Hours)	Apogee (Km)
06 Jan 72	WI	1337	66.6
31 Jan 72	WI	1307	82.1
05 Dec 72	WI	1314	83.6
16 Jan 73	WI	1304	94.2
02 Feb 73	WSMR	1315	66.0

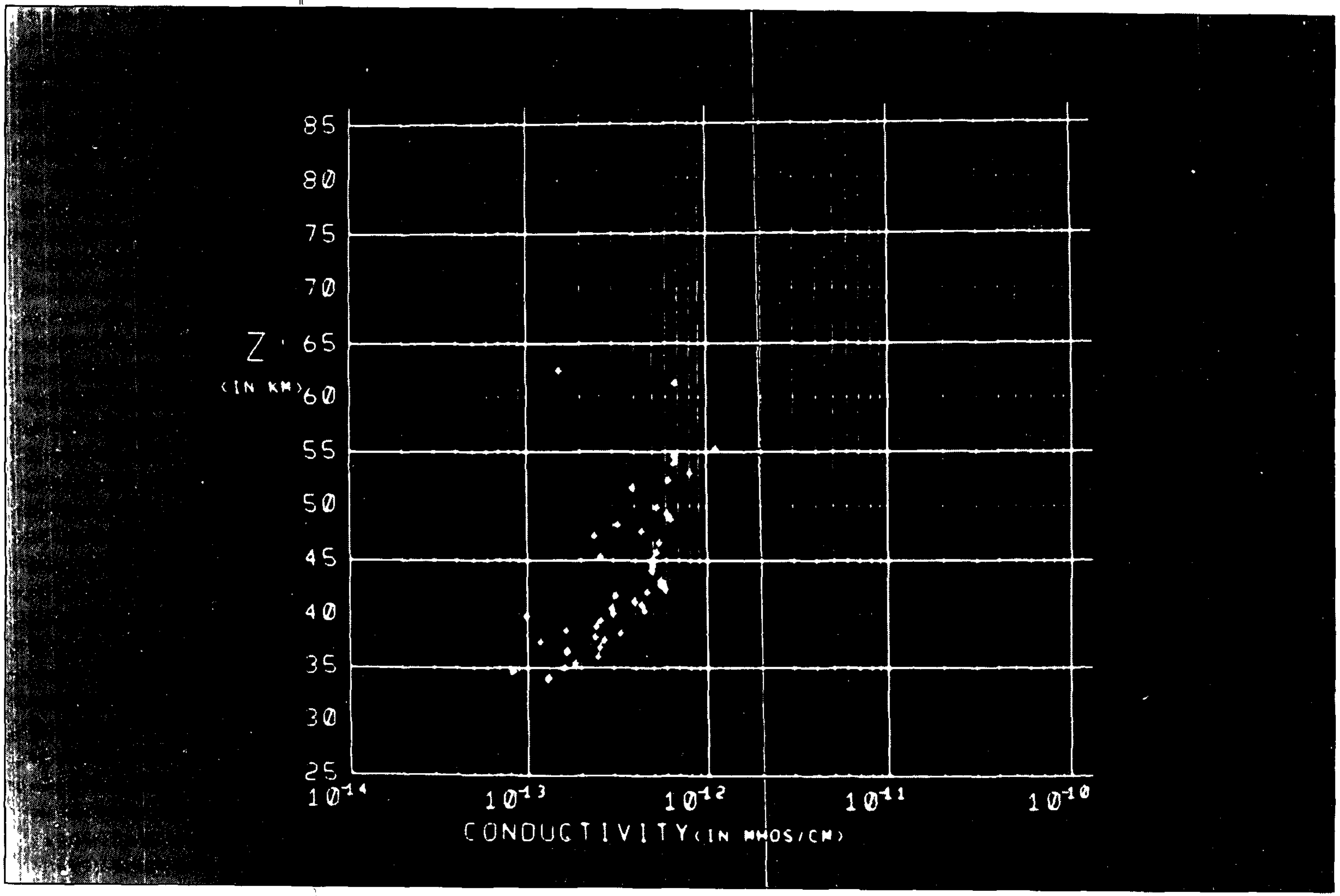

Figure 17: Computer Calculated Positive Conductivities for 06 Jan 1972

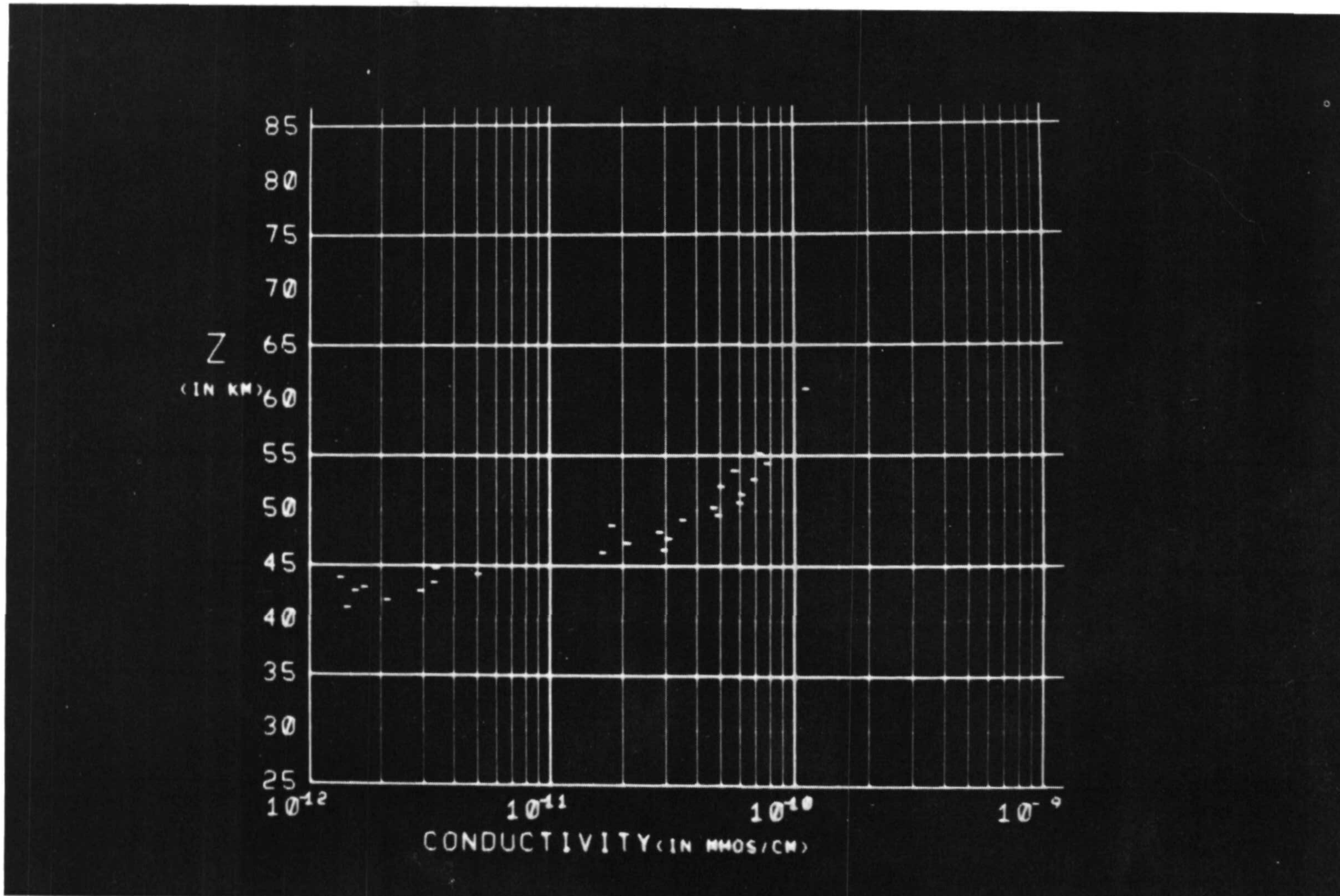

Figure 18: Computer Calculated Negative Conductivities for 06 Jan 1972

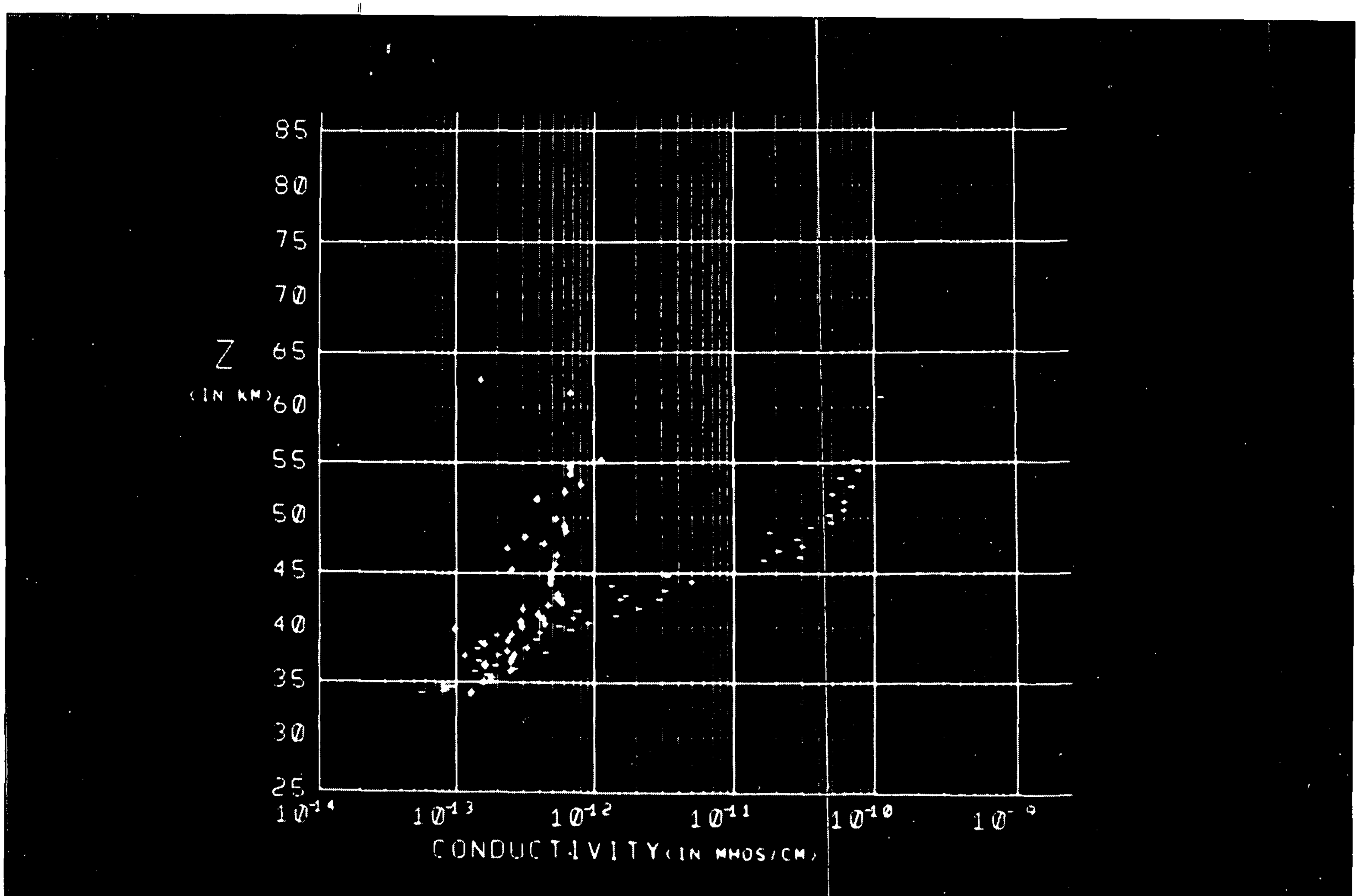

Figure 19: Combined Positive and Negative Conductivity for 06 Jan 1972

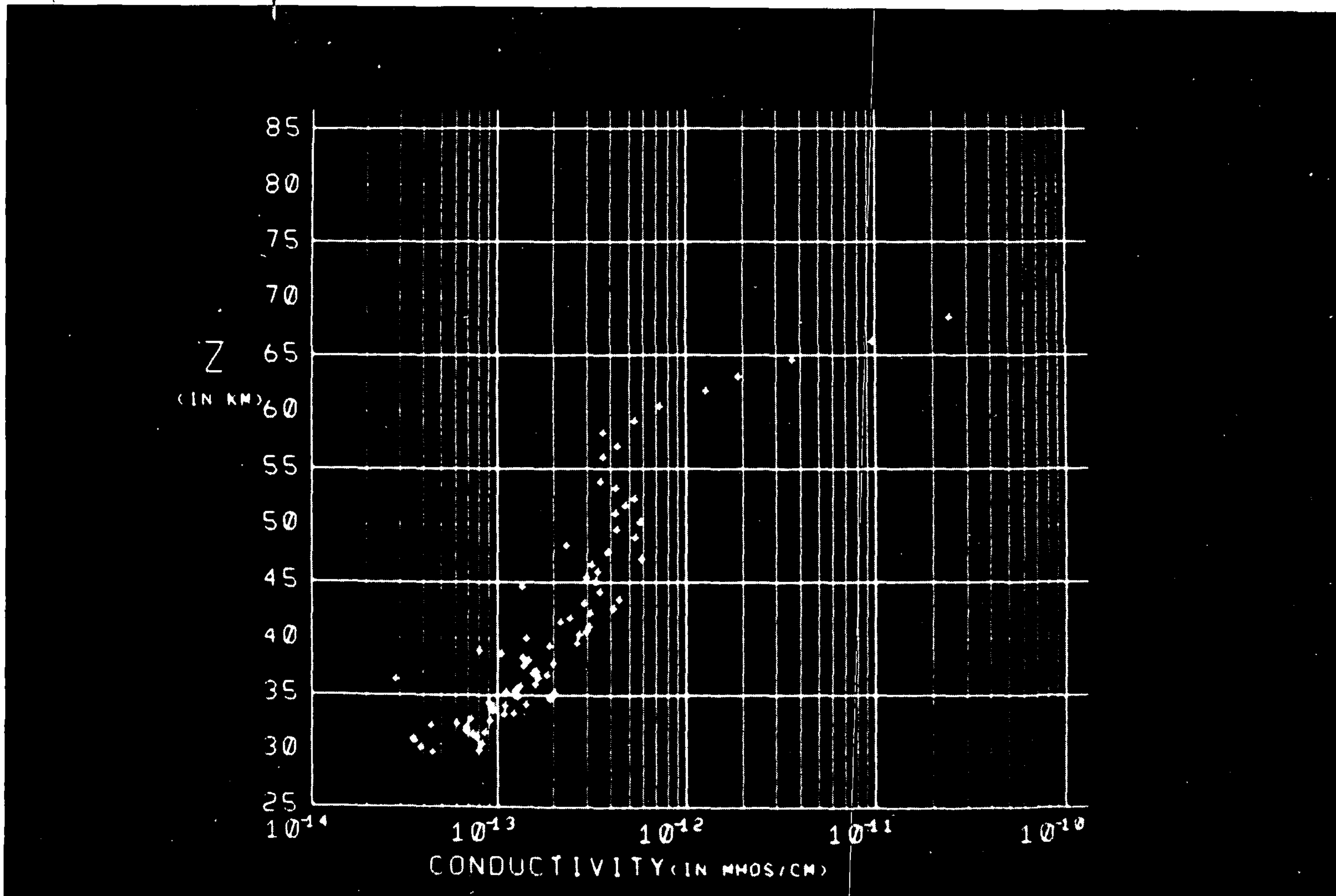

Figure 20: Computer Calculated Positive Conductivities for 05 Dec 1972

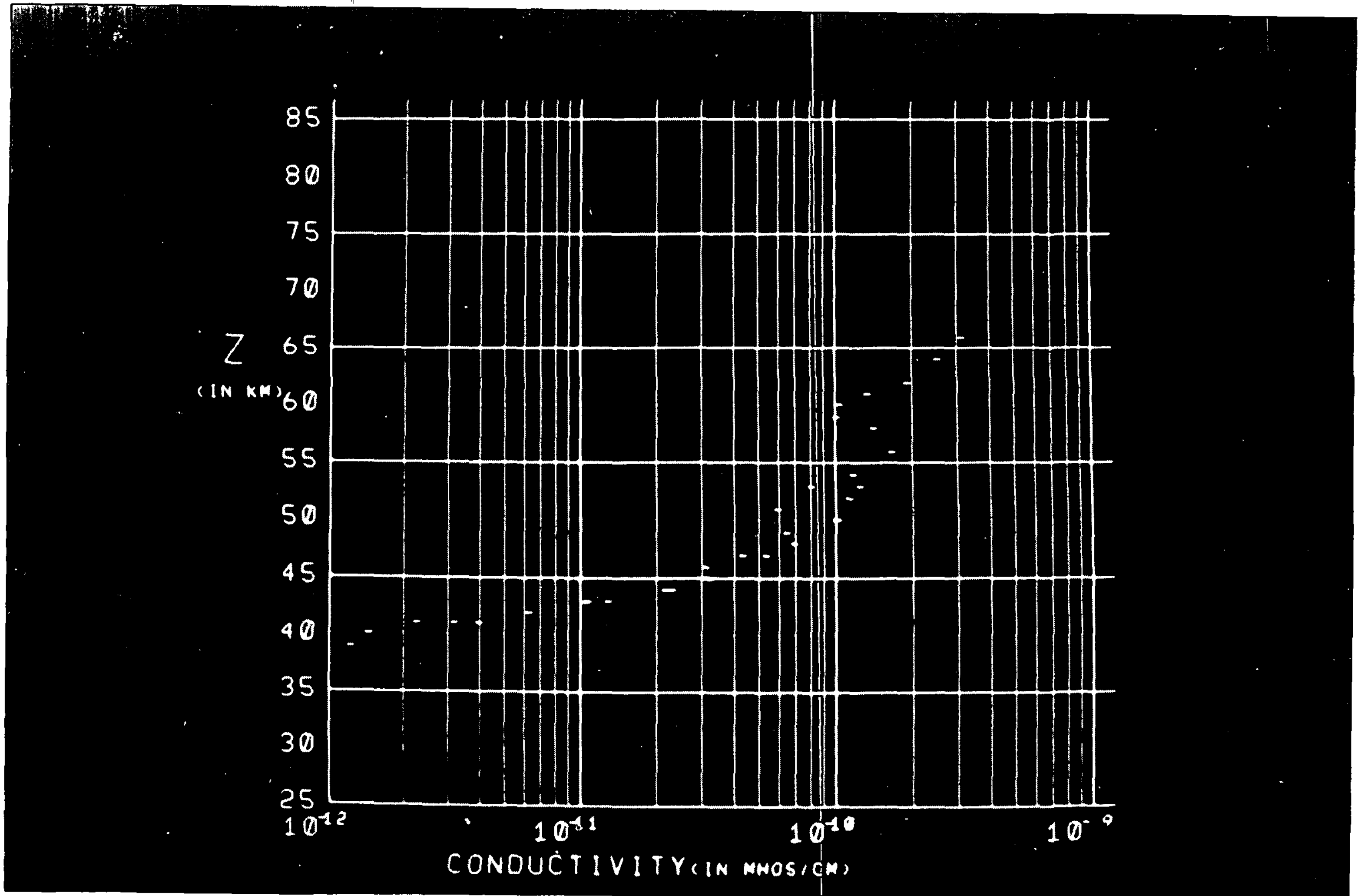

Figure 21: Computer Calculated Negative Conductivities for 05 Dec 1972

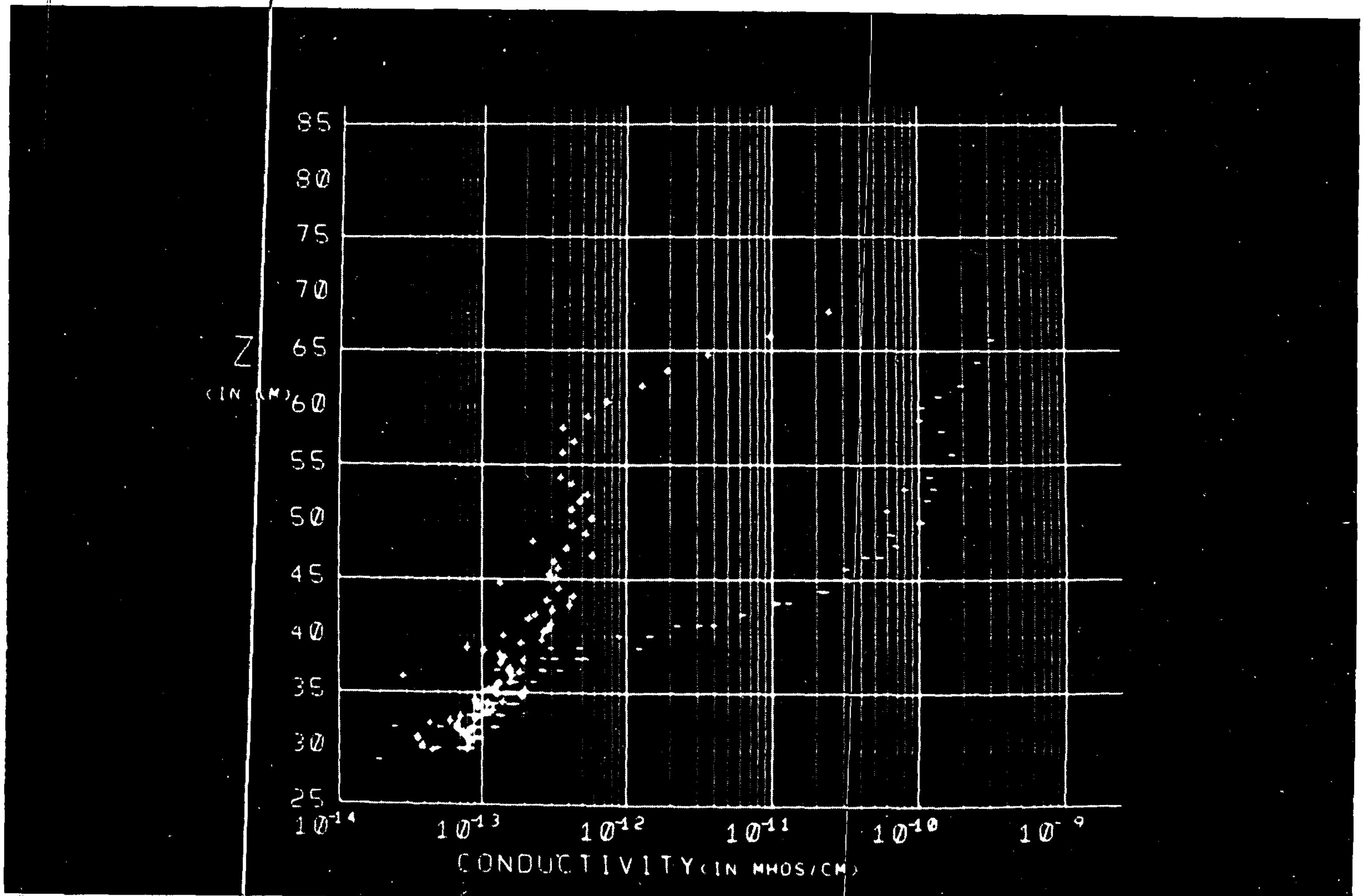

Figure 22: Combined Positive and Negative Conductivity Plot for 05 Dec 1972

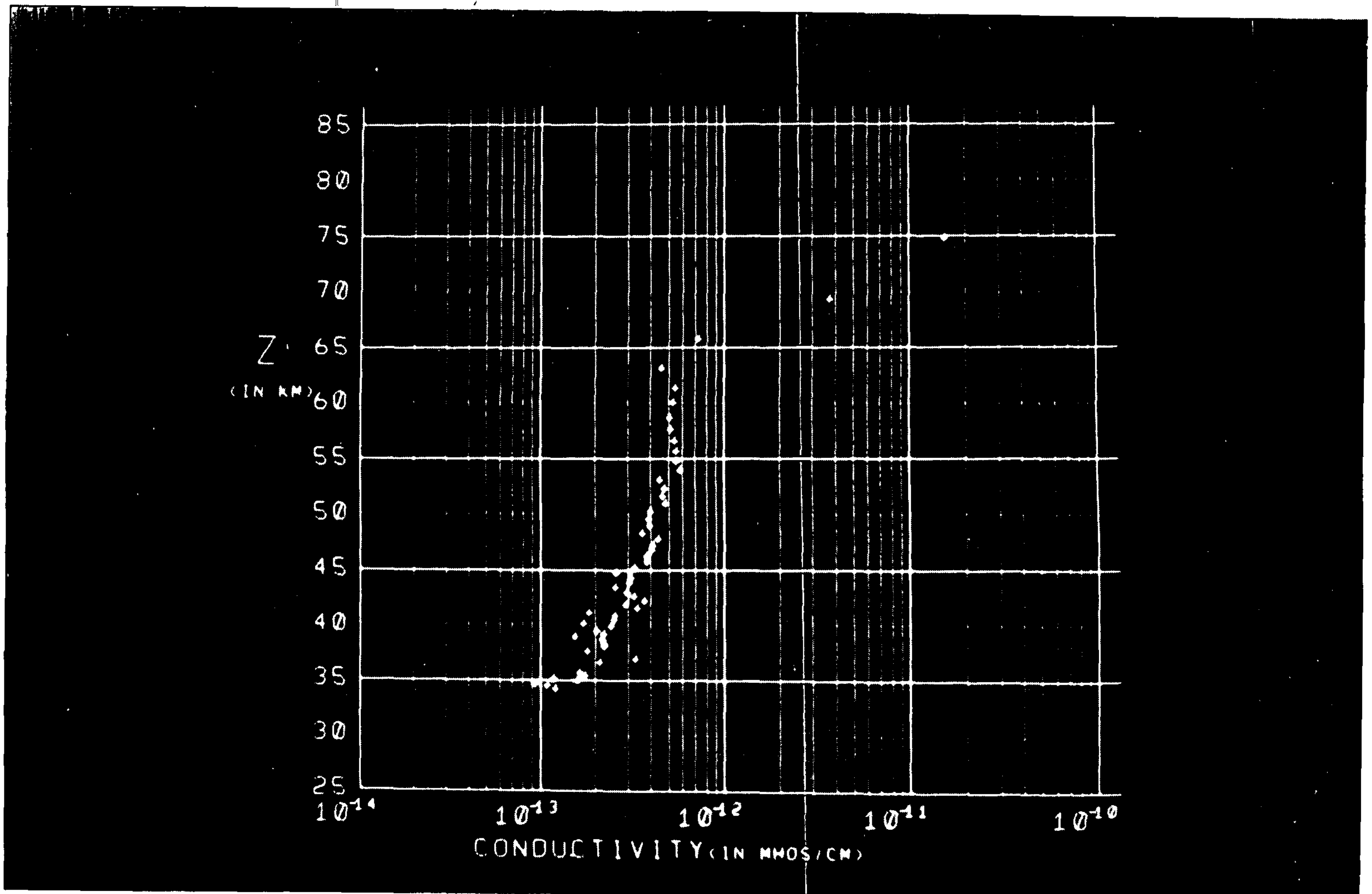

Figure 23: Computer Calculated Positive Conductivities for 16 Jan 1973

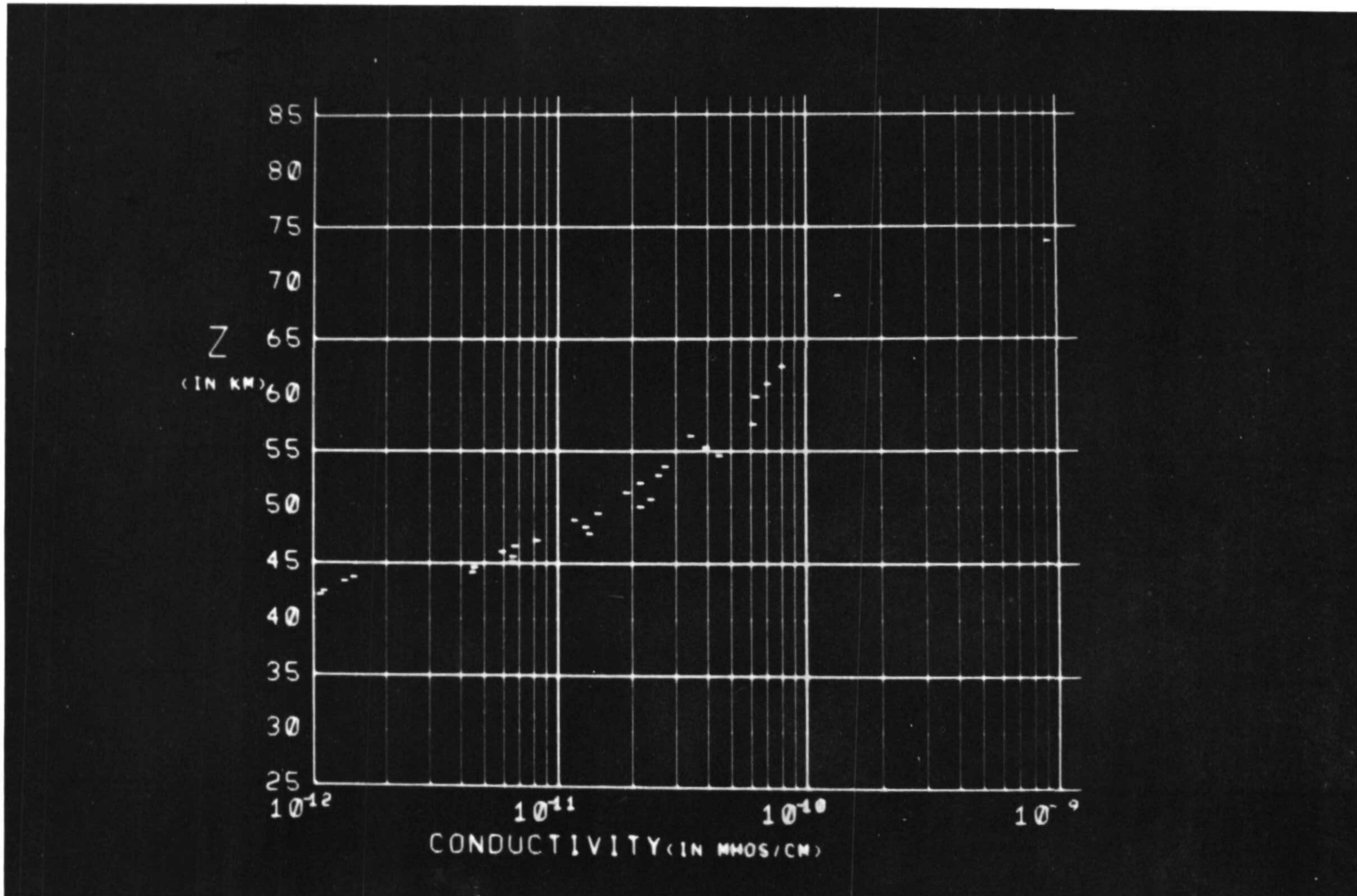

Figure 24: Computer Calculated Negative Conductivities for 16 Jan 1973

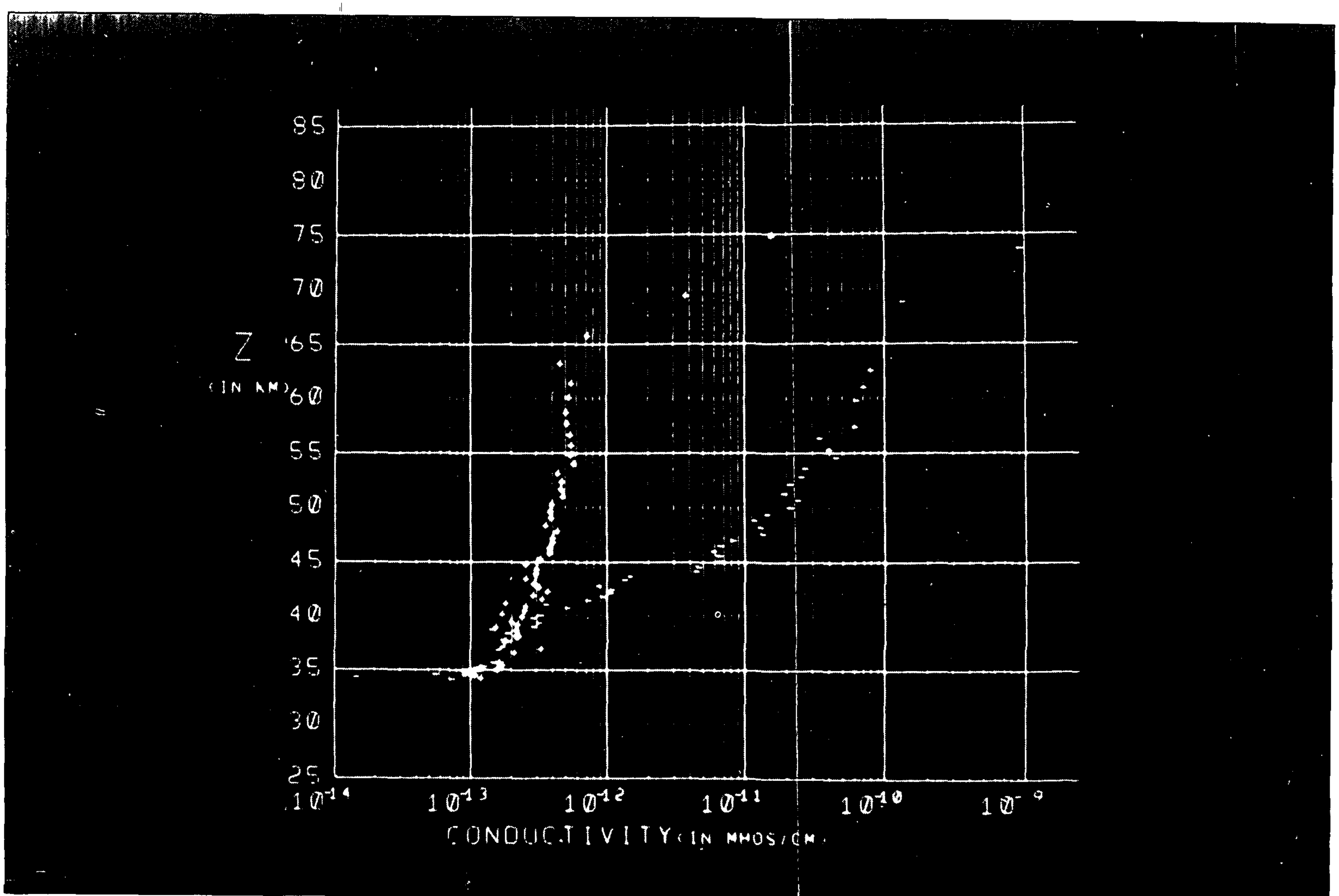

Figure 25: Combined Positive and Negative Conductivity Plot for 16 Jan 1973

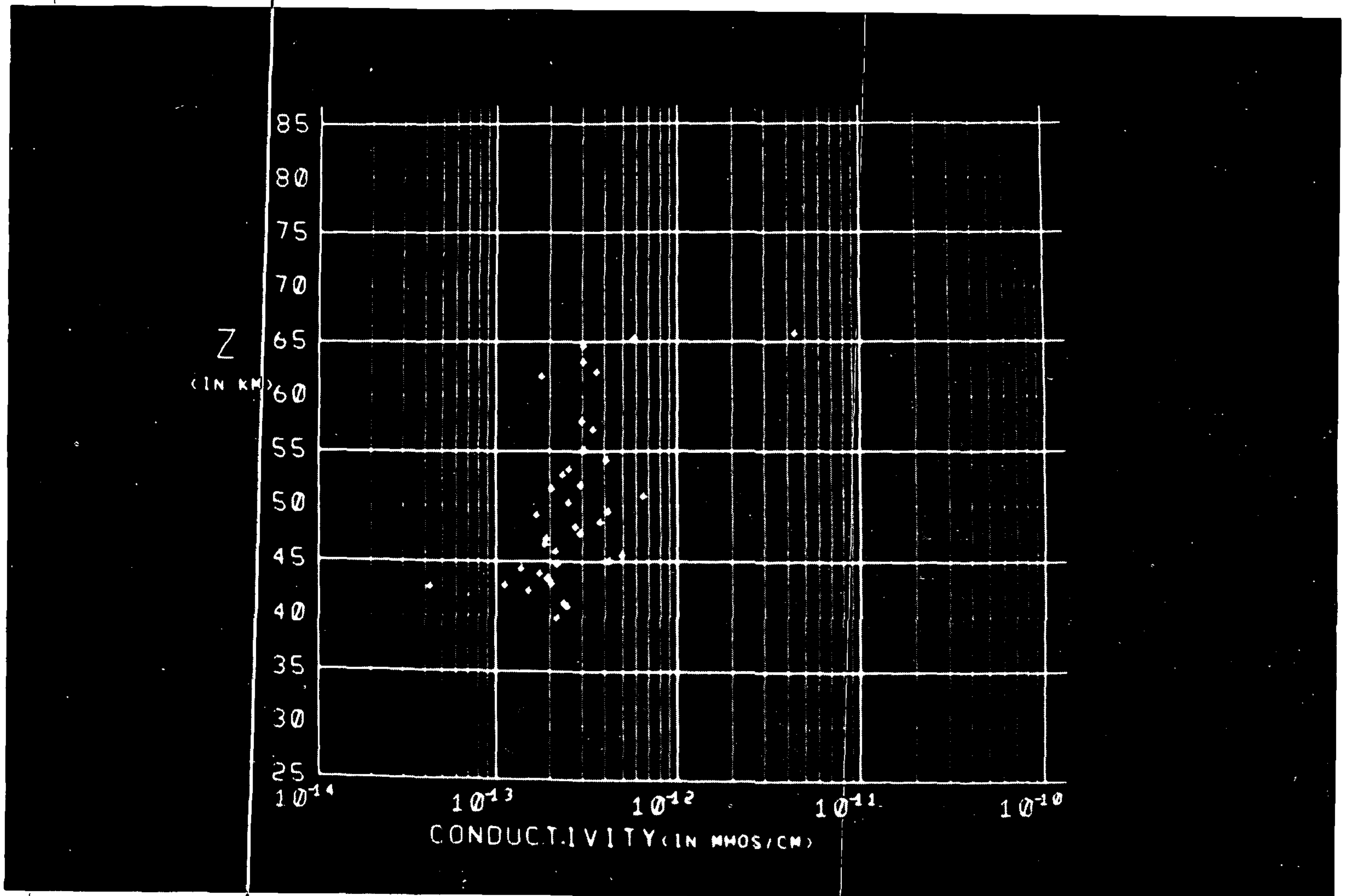

Figure 26: Computer Calculated Positive Conductivities for 02 Feb 1973

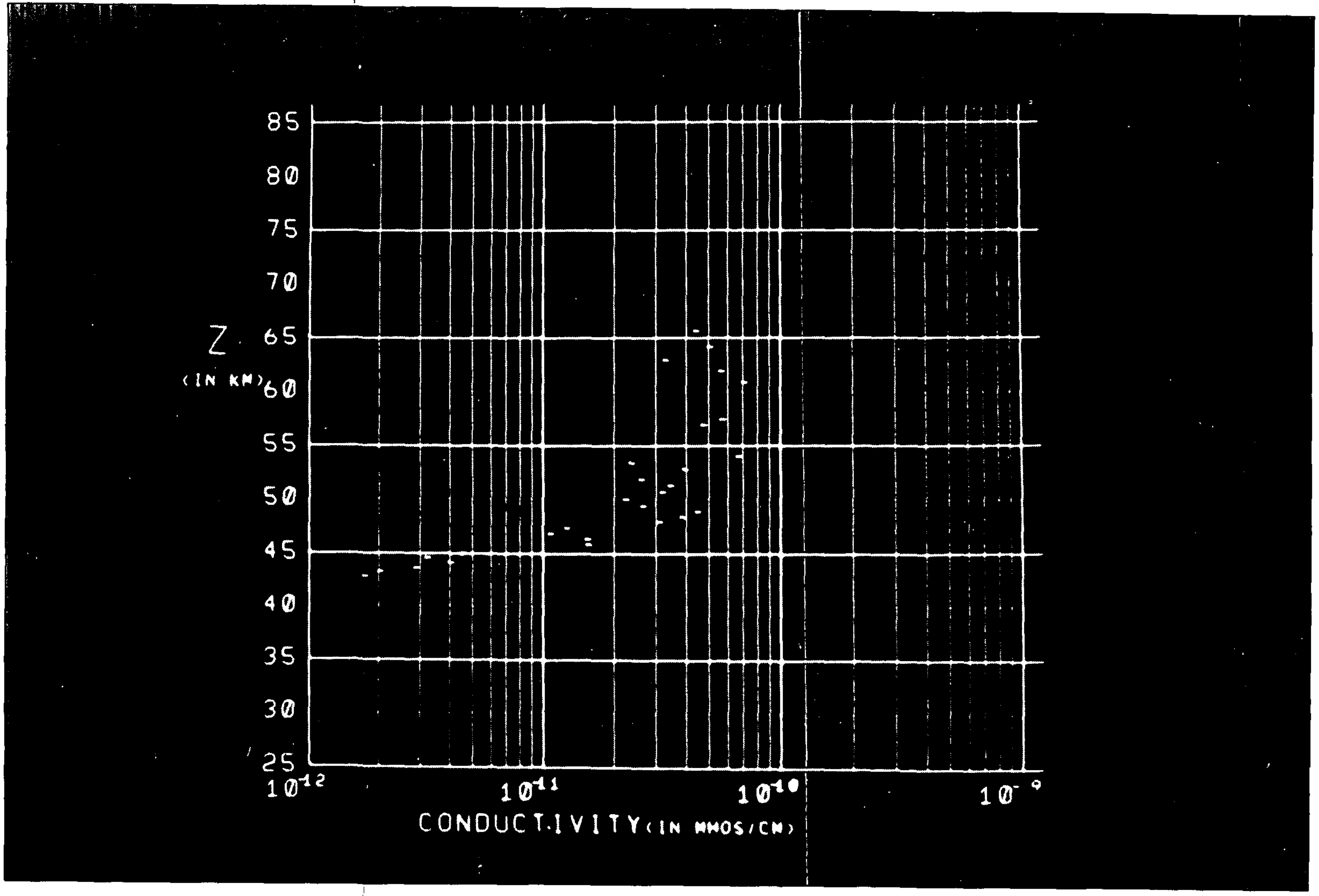

Figure 27: Computer Calculated Negative Conductivities for 02 Feb 1973

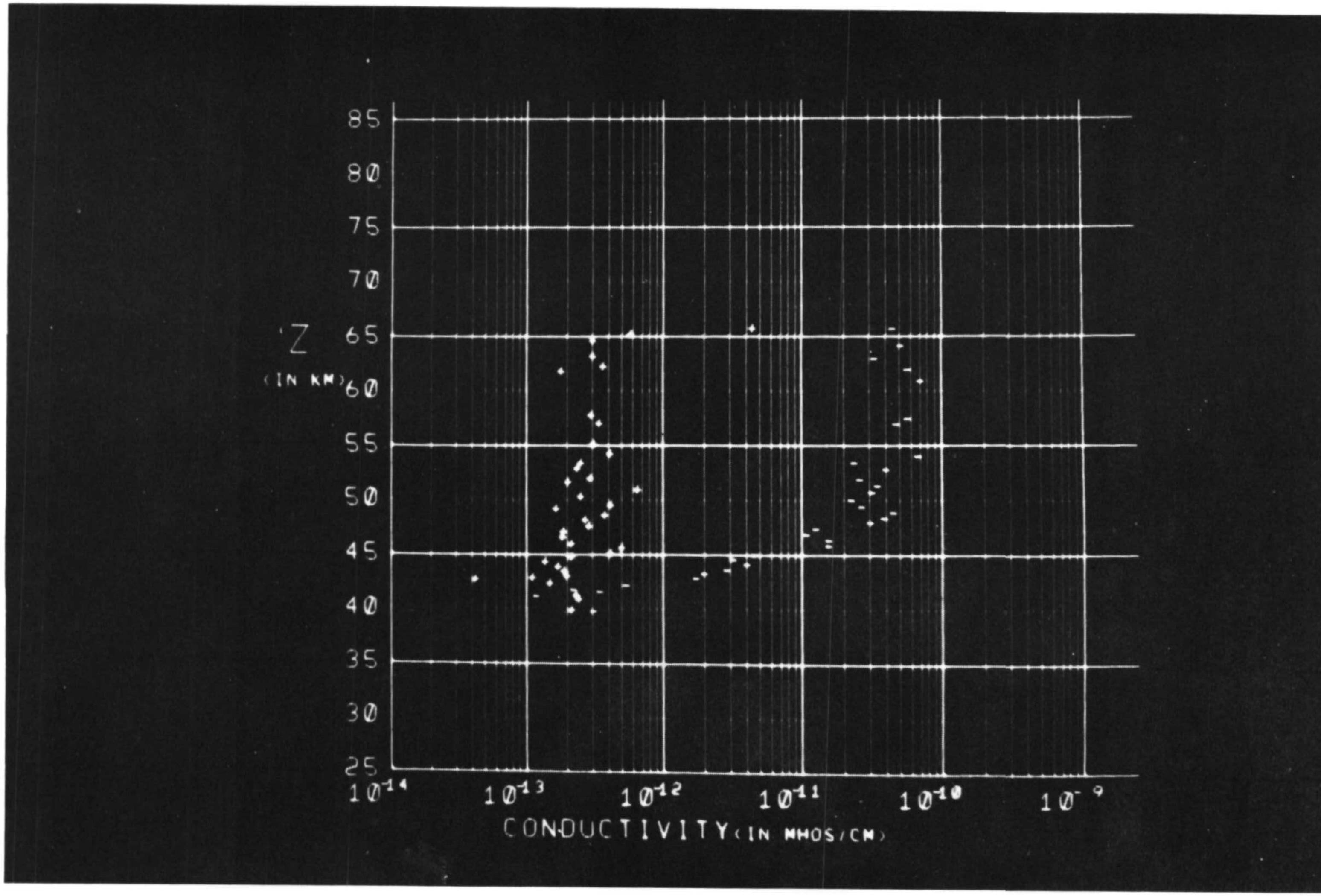

Figure 28: Combined Positive and Negative Conductivity Plot for 02 Feb 1973

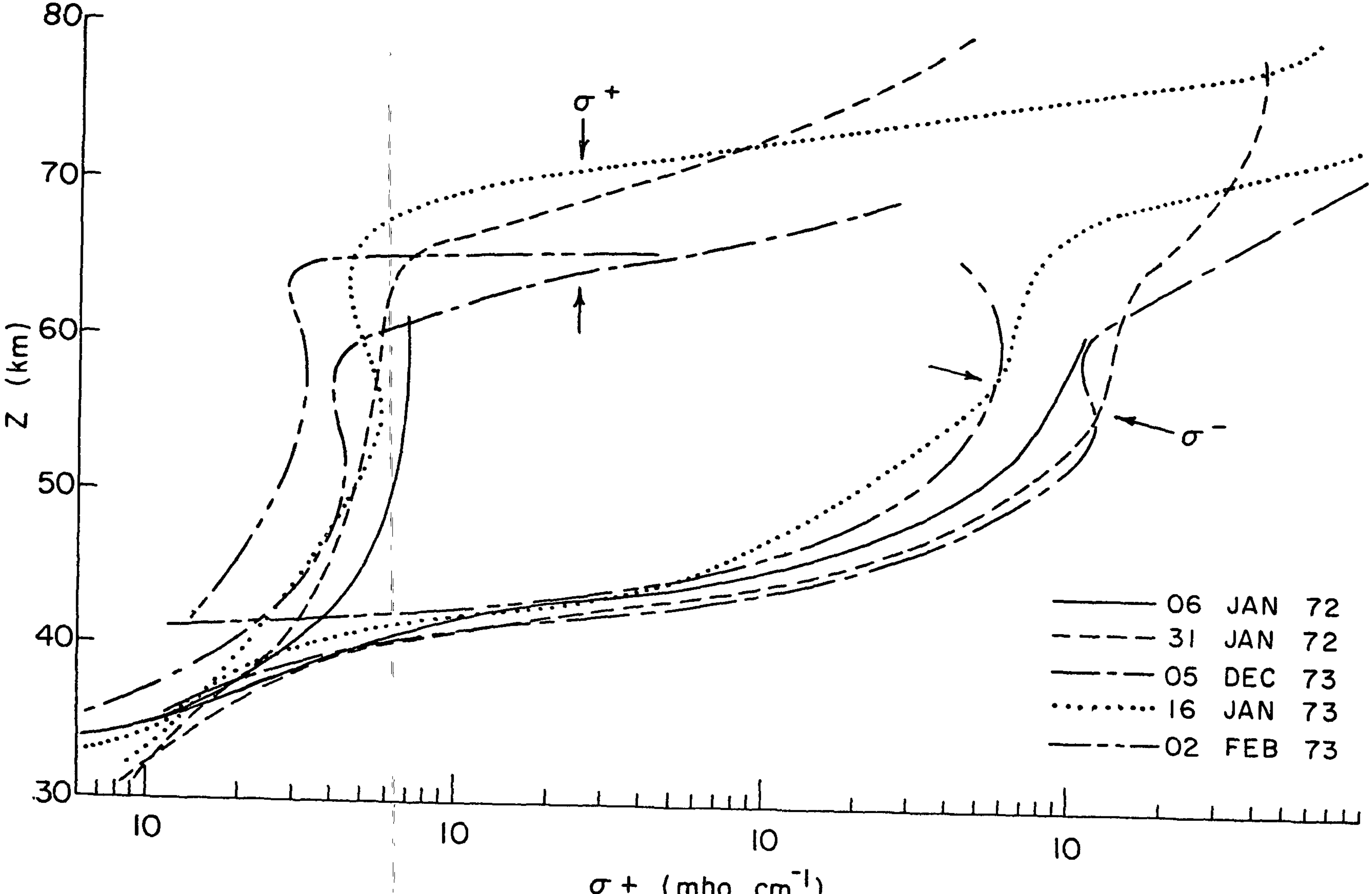

Figure 29: Smoothed Conductivity Curves

The resultant smoothed altitude vs. conductivity curves are shown in Figure 30. These curves indicate that the conductivities tend to decrease above 80 Km. This trend caused some concern so an investigation was initiated to determine if the results were accurate.

The investigation revealed that data acquired above 80 Km were not accurate. This conclusion was based on the following factors: i) photo-emission from the collector surface affects measurements when the probe face is exposed to the sun as the payload swings from side to size, ii) the rate at which the probe is initially falling can introduce errors, and iii) the probe was originally designed to measure conductivities in the altitude range of approximately 40 to 80 Km; above 80 Km system saturation introduces errors. Although all three factors affect the data the third is probably the most significant. The reason for stressing the third factor is that a two second expansion of flight data revealed a probe sweep time less than 50 ms. The expansion made it possible to accurately scale these slopes. This accuracy made it possible to conclude that the observed conductivities were attributable to frequency response limitations of i) the electrometer used in the blunt probe, and ii) the data tachometer used in the digitization phase of data reduction.

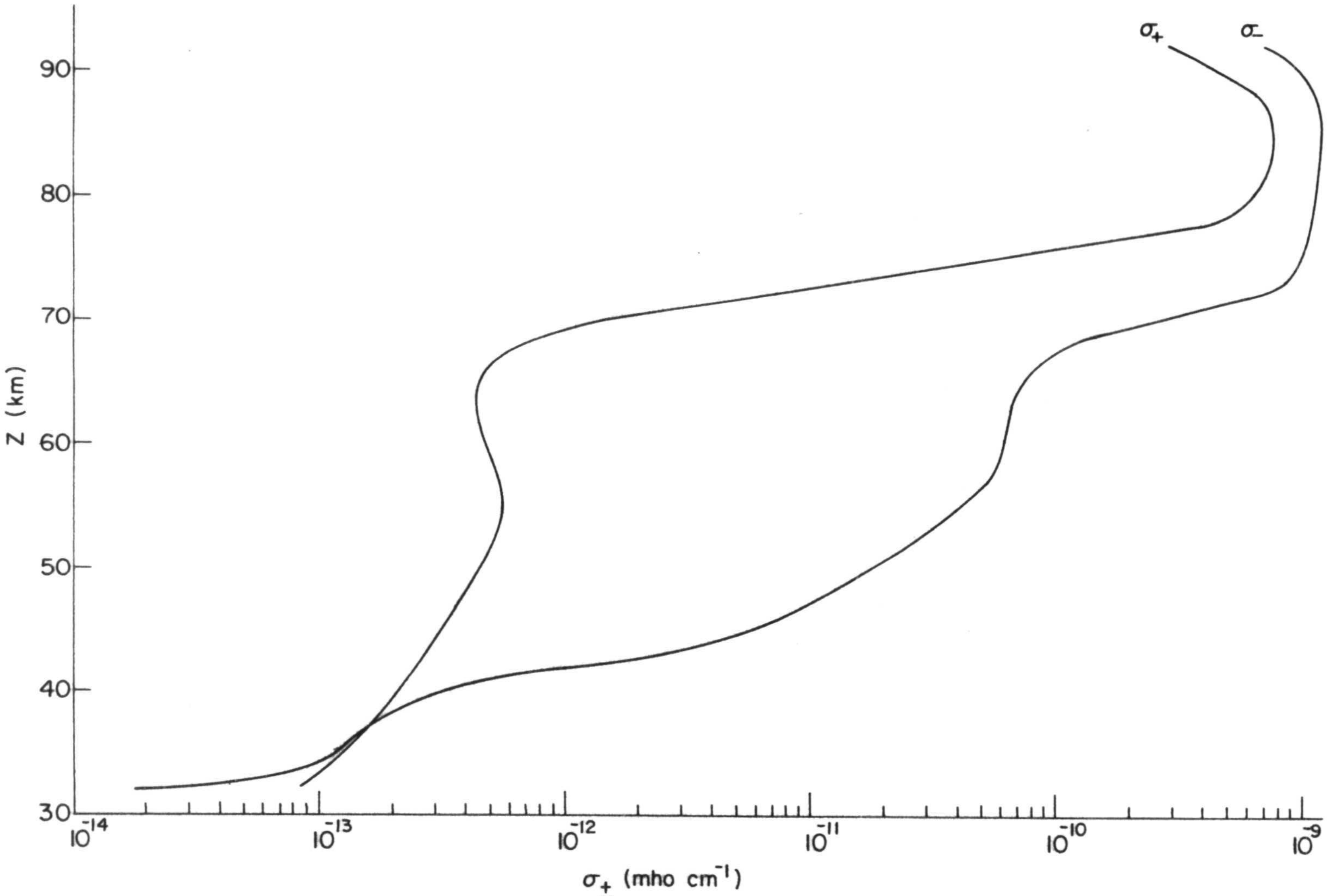

Figure 30: Smoothed Conductivity Curves for 16 Jan 1973

4.3 Density Analysis

The conductivities obtained in the previous section were used to determine the positive ion, negative ion, and electron densities. These densities were calculated by using the density analysis program (DENSIT). Figure 31 is a plot of the smoothed positive ion densities and Figure 32 shows the smoothed electron densities. A comparison of these two figures reveals that $N_+ >> N_e$ between 30 and 80 Km. When this observation is combined with the requirement of charge neutrality (Equation (7), Chapter II) the negative ion densities can be found by the relationship

$$N_- \cong N_+ \tag{12}$$

Thus Figure 31 also represents the negative ion densities.

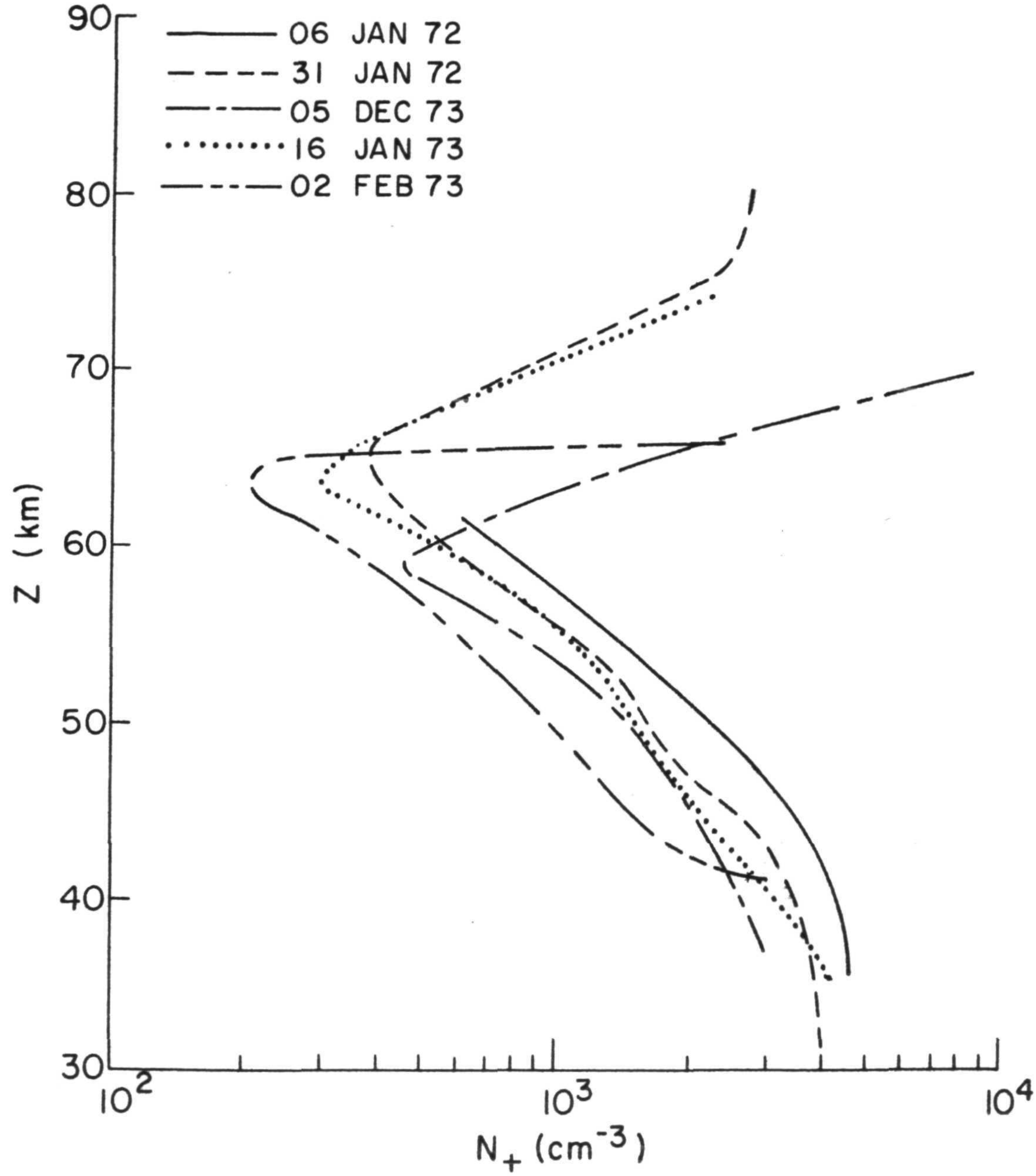

Figure 31: Smoothed Positive Ion Density Curves

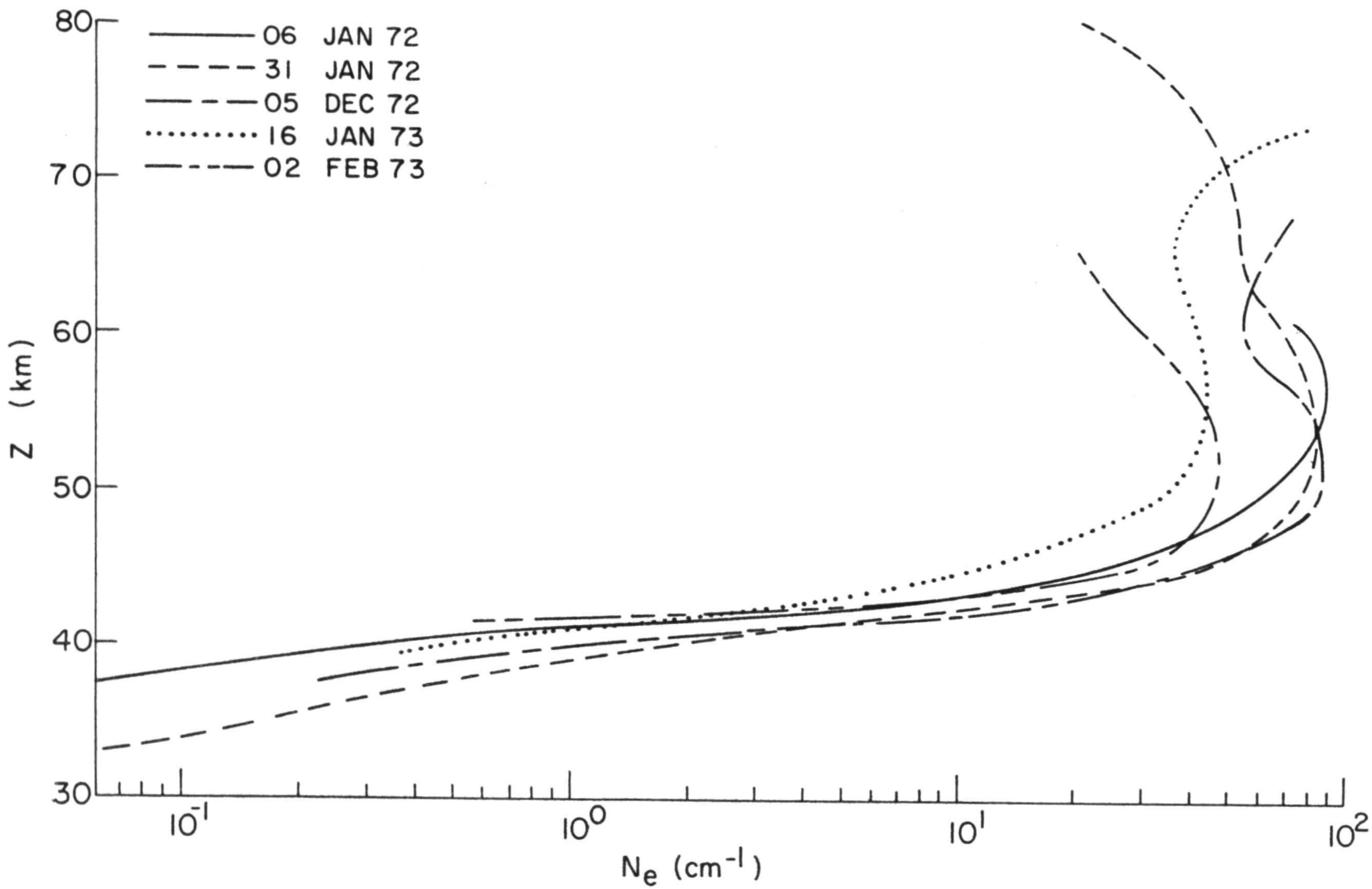

Figure 32: Smoothed Electron Density Curves

CHAPTER V

CONCLUSION

5.1 Summary of Results

A bank of computer programs was developed which i) digitized data, ii) performed conductivity analysis, and iii) calculated ion and electron densities. These programs were used to analyze the data obtained from the blunt probe launched on 31 January 1972. The results of this analysis were compared with those obtained from hand reduction procedures (Chapter III). This comparison showed that computerized data analysis was not only feasible but also desirable. It was feasible from the standpoint of yielding conductivities approximately equal to those obtained from hand reduction procedures. The desirability is exemplified by the increase in accuracy, which is attributable to i) greater consistency in scaling slopes, ii) the use of equations instead of approximate curves to obtain several variables, iii) increased accuracy in performing calculations through the elimination of possible human error, and iv) the elimination of the tedious nature of hand reduction methods. Another desirable feature of computer analysis is the significant reduction in the time required to perform the data reduction. The typical amount of time required to perform the hand reduction of data was three to four weeks. Computerized analysis has made it possible to reduce this time to four to six hours.

An important byproduct of the new data reduction system was the revelation of possible frequency response limitations of the blunt probe and the data tachometer. The blunt probe was found to be too sensitive above 80 Km and not sensitive enough below 35 Km. These sensitivity problems are believed to be attributable to the electrometer used in the blunt probe. Frequency response limitations of the data tachometer also influence the reproduction of data acquired above 80 Km.

5.2 Suggestions for Further Research

Even though the new computerized analysis system has considerably improved the data reduction process, there is the possibility for further improvement. The time required for reduction would be decreased by eliminating the need for human interaction in the processing of data; also, increased accuracy would probably be obtained through the implementation of statistical analysis of data. This type of analysis would allow the reduction of extremely noisy data tapes.

Plotting of data could be extended to include the display of ion and electron densities. The plotting routines could then be expanded to include a subroutine which would determine and plot a curve which would best fit the calculated conductivities and densities.

Current data acquisition equipment should be improved to insure accurate measurements of conductivities above 80 Km and below 35 Km. To achieve this, the probe would have to be desensitized for measurements above 80 Km and made more sensitive for measurements below 35 Km.

Presently there are three standard data tachometers which can be used in data reduction. The characteristics of the data tachometers differ; therefore, the resultant analog signals vary slightly. To insure consistency and greater accuracy the possibility of an analog computer data tachometer should be studied further.

REFERENCES

Cipriano, J. P., Relations among low ionosphere parameters and high frequency radio wave absorption, M.S. Thesis in Meteorology, The Pennsylvania State University, 1973.

Cipriano, J. P. and J. D. Mitchell, Private Communication, 1972.

CIRA 1965, COSPAR International Reference Atmosphere, North-Holland Publishing Company, Amsterdam, 1965.

Cole, R. K. and E. T. Pierce, J. Geophys. Res., 70, 2735, 1965.

Dalgarno, A., Atomic and Molecular Processes, edited by D. R. Bates, Academic Press, New York, 643, 1962.

DEC PDP-10 Timesharing Handbook, Digital Equipment Corp., Maynard, Mass., 1970.

DISUBS, Hybrid Computer Laboratory, The Pennsylvania State University, 1970.

Hale, L. C., Space Res. VII Vol. I, edited by R. L. Smith-Rose, North-Holland Publishing Company, Amsterdam, 1967.

Hale, L. C., D. P. Hoult and D. C. Baker, Space Res. VIII, edited by A. P. Mitra, L. G. Jacchic and W. S. Newman, North-Holland Publishing Company, Amsterdam, 320, 1968.

Hale, L. C. and J. D. Mitchell, Private Communication, 1972.

Hybrid Fortran Operating System, Hybrid Computer Laboratory, The Pennsylvania State University, 1972.

Hoult, D. P., J. Geophys. Res., 70, 3183, 1965.

Jackson, A. S., Analog Computation, McGraw-Hill Book Company, Inc., New York, 1960.

McDaniel, E. S., Collision Phenomena in Ionized Gases, John Wiley & Sons, New York, 1964.

Mitchell, J. D. and L. C. Hale, paper presented at COSPAR, Madrid, May 1972, in press, Space Res. XIII, North-Holland Publishing Company, Amsterdam.

Mitchell, J. D., Private Communication, 1972.

Mitchell, J. D., Ph.D. Thesis in Electrical Engineering, The Pennsylvania State University, 1973.

MTIO, Hybrid Computer Laboratory, The Pennsylvania State University, 1972.

Sonin, A. A., J. Geophys. Res., 72, 4547, 1967.

APPENDIX A

OPERATION INSTRUCTION MANUAL

A.1 Introduction

This manual was designed to familiarize the user with the digitization and analysis programs, DIGPGM and DATAN, respectively. Since its purpose does not include a detailed description of the hybrid computer facility it is recommended that the user take the Hybrid Computer Short Course. This course is offered in the fall, winter, and spring terms. Its purpose is to acquaint the user with the hybrid computer facility and its capabilities. The course includes descriptions of the EAI 680 Analog computer and the DEC PDP-10 digital computer. Before discussing the use of the programs some introductory information as to how the manual is written is necessary.

Words, characters, or statements which are underlined are typed onto the teletype (TTY) when the computer is in the monitor mode; e.g., PASSWORD, ., and NO EXECUTION ERRORS DETECTED. When the user types two control C's (CTRL C) the program is interrupted and control is transferred back to the monitor mode. The control C appears on the user TTY as C. Questions asked by the program are preceded by several blanks so as not to confuse them with monitor responses.

The manual is divided into three sections: (1) digitization, (2) conductivity analysis, and (3) density analysis.

A.2 Digitization

Before any of the programs can be operated the user must sign up for time on the sheets outside the hybrid computer office. The user must sign up the equipment needed under the project programmer number (PPN). This number is the same for all programs (1001,422). The equipment required for digitization is i) the analog computer, ii) the magnetic tape unit (Mag Tape), and iii) one TTY. When signing up for the analog computer, the user is required to supply the amount of core needed (7+5) and the words LOCK IN CORE. This informs the hybrid computer laboratory operator that on this particular day there will be a hybrid job which must lock into core. Upon arriving at the computer facility tell the operator that there is going to be a job locked in core. This insures the user that the core will be available for the digitization of data. The digitizing process is automatically terminated if the computer types a Hybrid Fortran Operating System (HFOS) error. If this happens, depress the control button (CTRL) and then two C's. This returns the user to the monitor mode. The digitizing process must be restarted from the beginning. If this error occurs twice inform the operator that something is interrupting the digitizing process. Other user programs which require line-printer listings or heavy disc usage can sometimes be the cause of HFOS errors.

A.2.1 Logging Onto the System

The logging-on procedure enables the user to address the computer from the monitor mode. The first step is to turn the TTY switch to LINE. A typical log-on procedure is initiated in the following manner:

```
.LOG 1001,422
JOB 3 PSU HCL 504H37   II   TTY7
PASSWORD:  LCH    (the LCH will not be printed)
2019    20-MAY-73    SUN

.
```

The user is now logged onto the system and is in the monitor mode. Before running any program it is advisable to assign the devices to be used to the job. The purpose of this is to insure that no one else can address a piece of equipment and interrupt the processing of data. Equipment can be assigned to a job in the following way:

```
.AS MTA0:          (causes the magnetic tape unit
                     to be assigned to a job)
MTA0 ASSIGNED
.AS HYB            (assigns the analog computer
                     to a job)
HYB ASSIGNED
```

Once the user has logged onto the system and assigned the necessary devices, the analog patch panel must be wired.

A.2.2 Patching and Setup of the Analog Computer

Figure A.1 shows a typical digitizing system wired on the analog computer. The schematic diagram of this

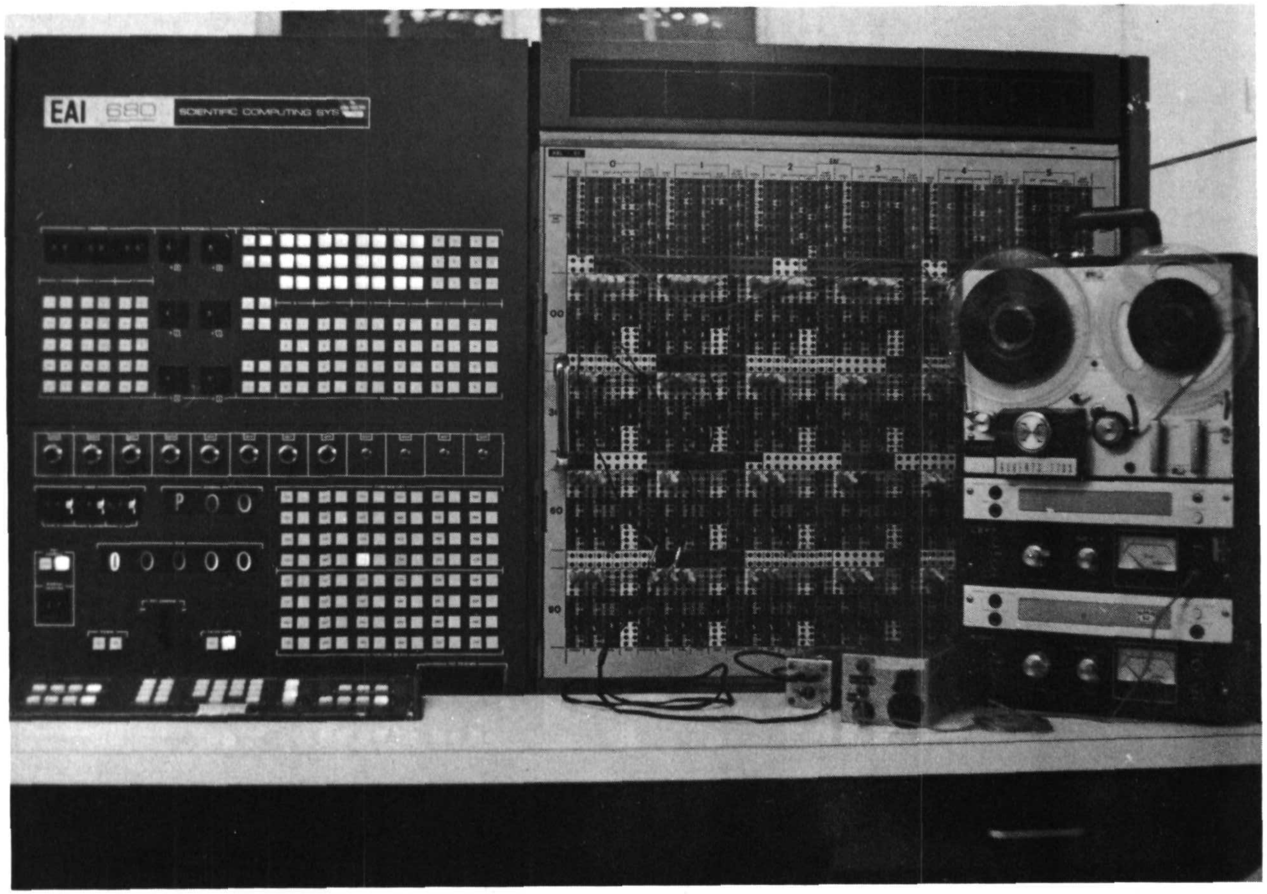

Figure A.1: EAI 680 Analog Computer

digitizing system appears in Figure A.2. The pushbuttons shown in Figure A.2 are located to the left of the patch panel. The output terminals are located at the top of the patch panel in the logic section. Both the normal and inverted pushbutton outputs are available; however, the normal outputs are the only ones used.

Wiring of the analog portion of the patch panel is slightly more complicated. The best way to become familiar with this wiring is to sit down at the analog computer or refer to the EAI 680 instruction manual which can be signed out from the hybrid computer laboratory office. Wiring of the analog computer proceeds as follows: (1) connect a 25 volt power supply to the data tachometer, (2) wire the output of the tape recorder to the data tachometer, (3) connect the output of the data tachometer to the input of a summing amplifier with a gain of one (the output of this amplifier is normally connected to the Hi side of the potentiometer associated with the amplifer), (4) connect the P terminal of the potentiometer to the input of another summing amplifier with a gain of ten (the low side of the potentiometer is normally connected to ground and is not available on the panel), (5) wire the output of the second amplifier to an ADC (analog to digital converter) and to one of the plotter outputs, (6) ground the ADC's on either side of the one used, and (7) connect the plotter output on the oscilloscope cart to the oscilloscope input. After these steps are

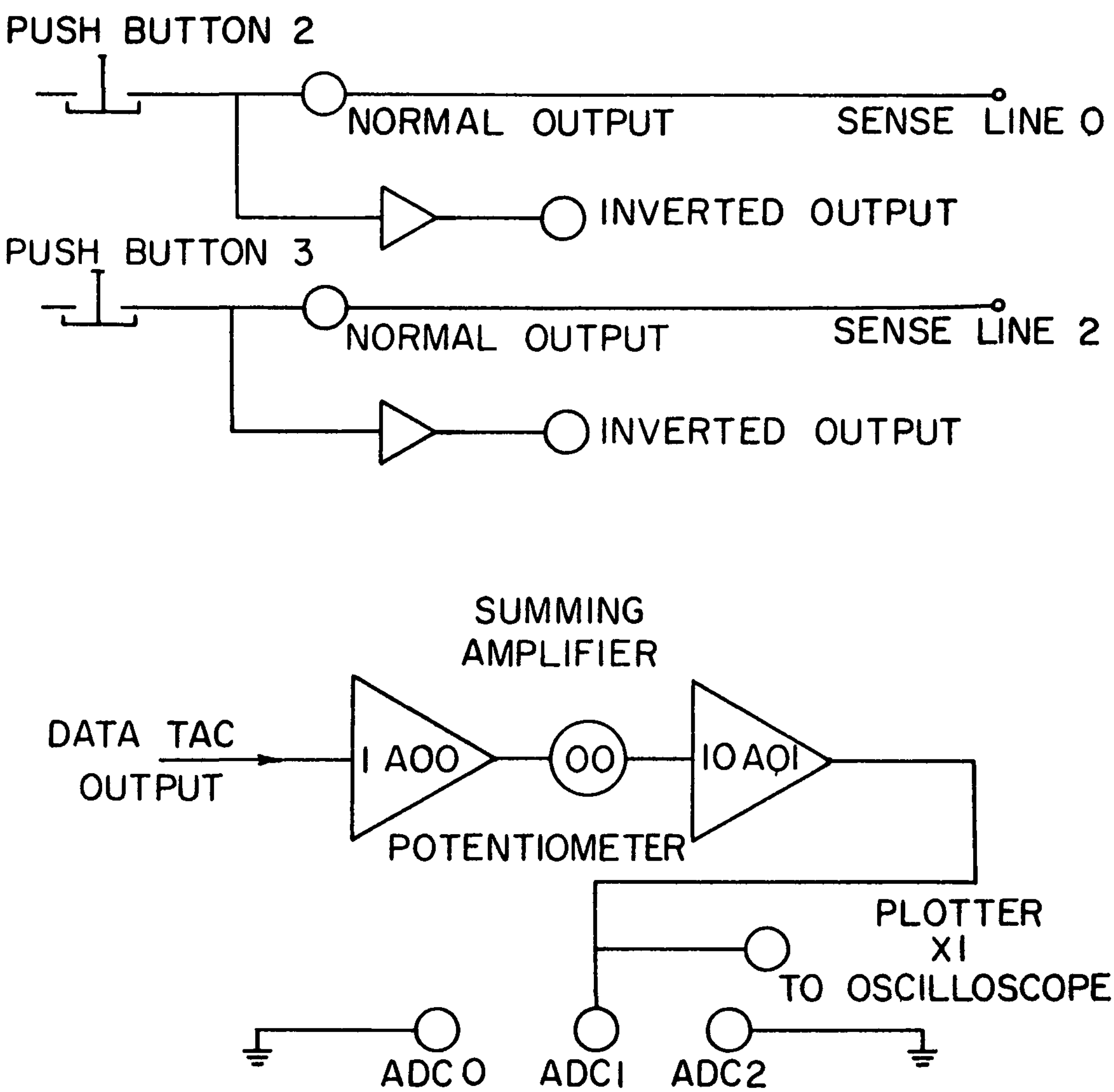

Figure A.2: Analog Computer Wiring Diagram

performed the user is ready to set oscilloscope controls and the potentiometer value.

The oscilloscope adjustments involve the setting of the volts/division and time base controls, 1 v/div (calibrated) and 200 msec (uncalibrated, turn the calibrate knob completely clockwise). Once this is completed the user can now set the mode controls on the keyboard of the analog computer. The keyboard is divided into three sections: (1) digital mode control (left side of the keyboard), (2) device address (center), and (3) analog mode control (right side of the keyboard). On the digital mode control section, depress the 10^6 and S (stop) buttons. On the analog mode control section, depress the N (normal), SEC (seconds), PS (potentiometer set), and H (hold) buttons. The final step before digitization can begin is to adjust the potentiometer in Figure A.2. In order to set this potentiometer the following steps must be performed: (1) make sure the PS button is depressed in the analog mode control section of the keyboard, (2) depress P (potentiometer) button in the device address section of the keyboard, (3) depress the numbered buttons, located in the device address section, which correspond to the number of the potentiometer used, (4) push the GO button in this section, (5) select the potentiometer setting by depressing four numbered buttons, and (6) depress the GO button once again. The value to which the potentiometer is adjusted to appears on the digital readout meter above the keyboard.

If a red light appears on the meter after the GO button is depressed the second time, the potentiometer was not set correctly. Should this occur depress the CL (clear) button and adjust the potentiometer to a value which differs from the fourth digit previously used. For an initial setting of the potentiometer follow the above sequence and use .5000 as the value. When the potentiometer is set depress the PC (potentiometer coefficient) and OP (operate) buttons in the analog mode control section of the keyboard. The next step is to advance the tape recorder to the point at which the probe separates from the rocket. At this point the launch noise diminishes greatly and the probe sweep has its steepest gradient. Play the tape and observe the data on the oscilloscope. The vertical deflection should be approximately four divisions. A deflection greater than four divisions will cause the data to be cut off when it is displayed on the display scope. If there is a drop out of data as the probe sweeps through its range increase the volume of the tape recorder slightly. Rewind the tape to the point of separation of the probe and observe the sweep again. If it is appreciably less than four divisions the value of the potentiometer must be increased. Reset the potentiometer to a larger value by performing the steps previously mentioned. Once the potentiometer is adjusted it should not be reset until another flight is analyzed. Both calibration and flight data for a given probe flight <u>must</u> be digitized with the same potentiometer setting.

A.2.3 Digitization of Data

To digitize both calibration and flight data the digitizing computer program must be run twice. The digitized data is stored on the mag tape, one storage file being used for each type of data.

DIGPGM is the name of the program which digitizes blunt probe data. Before running the program make sure the start and stop pushbuttons are not lit. If either of the buttons are lit depress the button to its right. To operate this program type the following words:

.RUN DIGPGM

The program proceeds to ask the user questions about the data to be digitized and it requests information about the setup of the analog computer. Keep a record of the magnetic tape on which the data has been stored and what file number it has been given (see Table A.I). After the calibration data has been processed the program asks if data digitization is completed. A response of "Y" causes the program to be terminated. If another file is to be digitized reset the pushbuttons before typing the letter "N." Figure A.3 shows a typical series of events which occur when DIGPGM is being run. If the user does not desire to analyze the data at this time the magnetic tape should be removed from the drive and placed in its storage location. After this is done the user must log off the system by typing the following:

.K/F

Table A.1: Mag Tape Storage Data for Rocket Launchings

Mag Tape	File Num.	Date	Statistics Type Day	Type Data	Launch Site
DD-04	3	31 Jan 72	L	Calibration	Wallops
	4	31 Jan 72	L	Flight	Wallops
	5	05 Dec 72	L	Calibration	Wallops
	6	05 Dec 72	L	Flight	Wallops
DD-05	1	16 Jan 73	Hi	Calibration	Wallops
	2	16 Jan 73	Hi	Flight	Wallops
	3	06 Jan 72	Unknown	Calibration	Wallops
	4	06 Jan 72	Unknown	Flight	Wallops
	5	22 Jan 71	Unknown	Calibration	WSMR
	6	22 Jan 71	Unknown	Flight	WSMR
DD-07	1	02 Feb 73	Unknown	Calibration	WSMR
	2	02 Feb 73	Unknown	Flight	WSMR

```
.LOG 1ØØ1,422
JOB 3 PSU HCL 5Ø4H37 II TTY7
PASSWORD:
2Ø19     2Ø-MAY-73          SUN

.AS MTAØ:
MTAØ ASSIGNED

.AS HYB
HYB ASSIGNED

.RUN DIGPGM


  TYPE DATE OF LAUNCH AS MM-DD-YY   Ø1-16-73

  TYPE "CAL" FOR CALIBRATION DATA
  OR "FLT" FOR FLIGHT DATA    CAL

  TYPE THE CHARACTERISTICS OF THE LAUNCH DAY.
  EITHER L, H1, H2   H1

  TYPE ANY COMMENTS OR NOTES SUCH AS NOISY, BALLOON, MAX
  ALTITUDE, UP TO 1Ø CHARACTERS IN LENGTH   94.5KM

  TYPE # FOR START SENSE LINE & # FOR STOP SENSE LINE.
  TYPE ##,##    ØØ,Ø1

  # OF ADC BEING USED= 1

  FILE STORAGE # ON MAG TAPE= 1

  TO START, SET THE START SENSE LINE HIGH & START RECORDER.
  TO STOP SET THE STOP SENSE LINE HIGH & STOP RECORDER.

  ARE YOU THROUGH DIGITIZING DATA? Y OR N    Y


CPU TIME:  14.92 ELAPSED TIME:  1:43.55
NO EXECUTION ERRORS DETECTED

EXIT

.K/F
JOB 3, USER [1ØØ1,422] LOGGED OFF TTY7   2Ø21  2Ø-MAY-73
SAVED ALL 4Ø FILES (695. DISK BLOCKS)
RUNTIME Ø MIN, 15.87 SEC
```

Figure A.3: Example Run of DIGPGM

If the data is to be analyzed immediately after digitization the user must first deassign the analog computer and assign the display scope:

.DEA HYB

.AS DIS

DIS ASSIGNED

.

A.3 Conductivity Analysis

Positive and negative conductivity analysis is performed by the data analysis program, DATAN. A description of this program was presented in Chapter III. The program was designed to allow the user to halt the data reduction process after any phase of the analysis and then re-enter at a later date. This option was incorporated to provide flexibility and continuity in the analysis of data. To operate the analysis program type the following:

.RUN DATAN

The program starts by asking if the operator desires a program description. If the operator is using the program for the first time the response to this question should be "Y." This response causes the program to list all the questions asked and describes the action of the program upon recognition of an answer. If the operator types an invalid answer the program asks the question again. The listing was designed to enable the operator to analyze the data with a minimum of difficulty; therefore, this manual only presents information on scaling of calibration and flight data.

When the program is requested to perform the analysis of calibration data link CALC (see Chapter III) is placed into core. Before the analysis of data begins the program asks two questions: (1) what mag tape file is to be analyzed, and (2) what is the sweep voltage of the probe. At present the value used for sweep voltage is 22.0 volts. The operator is also instructed to estimate the sweep time of the voltage ramp. To enable the operator to estimate this time the display scope has one second interval marks displayed (see Figure 6, Chapter III). Upon the completion of the scaling of slopes the operator is requested to type in the estimated sweep time. Scaling of calibration slopes is performed in the following manner: (1) use the Lite-pen to initiate any operation, (2) observe the data and determine if there are any scaleable slopes (if not, select the REJECT region), (3) decide if the data should be shifted left (SL) or right (SR), (4) place the Lite-pen over the TAKE SLOPE region, (5) move the Lite-pen to the beginning portion of the data slope, which will move the asterisk to the curve, (6) once the asterisk is on the curve select the ACCEPT region with the Lite-pen (once the first point has been accepted the asterisk automatically returns to the READY position), (7) select the second point on the data curve (the computer automatically joins the two points with a line), (8) match the line to the slope of the curve,

(9) move the Lite-pen to the ACCEPT region, (10) when the asterisk is again in the READY position decide if another slope can be obtained by shifting the data (if there are no more scaleable slopes on a given display, move the Lite-pen to NEXT SET; however, if there is more than one scaleable slope for a given display, repeat steps 3 through 10), (11) after all the calibration slopes have been analyzed make certain the line printer is available for use, and (12) place the Lite-pen over the END region. The END causes the program to store the data on a storage device. When the data has been stored the results are printed on the line printer. Scaling of flight slopes is performed by using link CALD (see Chapter III). It proceeds in much the same manner as the analysis of calibration data; however, there are different options. These options include the times four expansion and the two second display.

When the flight slope analysis commences, the scope displays a ten second time base. Figure 7 in Chapter III shows the display of a typical cycle of flight data. Advance through the data by holding the Lite-pen over the REJECT region. Continue this process until scaleable data appears on the display scope, approximately 150 to 170 seconds into the flight. From this point on the data analysis proceeds as follows: (1) select the number of slopes to be scaled, (2) place the Lite-pen over the "+" (for positive conductivity slope) or "-" (for negative conductivity slope), (3) if necessary, choose a times four expansion (option available for positive and negative conductivity slope analysis) or a two second display about a point (option available for negative conductivity slope analysis only), (4) perform steps 5 through 9 of the calibration slope analysis, (5) if in step 1 a number greater than one was selected, perform steps 2 through 4 again. After the chosen number of slopes have been analyzed the program automatically displays the next ten seconds of data. If a given display of data contains unscaleable slopes simply place the Lite-pen over the REJECT region and the next ten seconds of data will be displayed. The expansion by a factor of four is initiated after selecting a + or - by performing the following steps: (1) place the Lite-pen on the vertical axis at the right of the display scope (this causes the asterisk to be moved to the line), (2) move the Lite-pen over the X4 (if the data is not displayed correctly move the Lite-pen to NORMAL), (3) place the Lite-pen over the axis again (if the data was off the bottom of the screen move the asterisk up the line; if it was off the top of the display move the asterisk down the line), (4) repeat step 2 and scale the data. To obtain a two second display perform the subsequent steps after selecting a - on the scope: (1) move the Lite-pen over the time below the point on the curve about which the expansion is desired, (2) place the Lite-pen on the 2 of 2 SEC DIS, (3) if the display must be altered move the Lite-pen to NORMAL, repeat steps 1 and 2, and (4) scale the data.

After the data has been completely analyzed make certain the line printer is ready for use and then place the Lite-pen over the END region. This concludes the analysis of slopes and the conductivities can be calculated.

The conductivities are calculated by link CONC (see Chapter III). Before the calculations are performed CONC asks if the user desires to change the probe radii. In most cases this will not be necessary. However, if the ratio discussed in Chapter II, Section 2 is other than 2.0 the new values of probe radii must be entered at this point. After the conductivities are printed on the line printer the times-in-flight can be matched to their corresponding altitudes.

This matching process is performed by link MTAH (see Chapter III). When the matching process has been completed the user has the option of obtaining an automatic plot of altitude vs. conductivity data or terminating the program. Calculation of ion and electron densities is the final phase of data analysis.

A.4 Density Analysis

The analysis of densities is performed by running the program named DENSIT (refer to Chapter III, Section 4). To run this program type

.RUN DENSIT

When the program starts it requests that the operator type in the launch facility: WSMR (White Sands Missile Range) or WI (Wallops Island). From this point on the program is entirely automatic. The positive ion densities are calculated first and the results are i) stored on a storage device, and ii) printed on the line printer. After this phase is completed the negative ion and electron densities are calculated, stored, and printed. At this point a complete reduction of data has been performed. Prior to logging off the system the data should be catalogued and stored on a DEC tape.

A.5 Storage of Data

When the analysis is completed the results are stored either on the disc or a DEC tape under the following names: (1) CAL.DAT, calibration data, (2) AVCAS.DAT, average calibration slope, (3) VOST.DAT, probe sweep voltage divided by sweep time, (4) POS.DAT, positive conductivity slopes, (5) NEG.DAT, negative conductivity slopes, (6) PSI.DAT, positive conductivities, (7) NSI.DAT, negative conductivities, (8) PDEN.DAT, positive densities, and (9) NENI.DAT, electron and negative ion densities. If these data files are not coded and stored for future reference the data from a probe flight will be destroyed when the next set of data is analyzed. For this reason a coding scheme has been devised.

Twelve DEC tapes have been set aside for the storage of coded data. They are located in the Hybrid Computer Laboratory in row B of the DEC tape storage cabinet, tapes B-03 through B-15. Mount one of these tapes on a DEC tape drive and Write Enable the tape. Code and transfer the data from the storage device to the DEC tape in the following manner:

```
.AS DTAN:
DTAN ASSIGNED
.R PIP
*DTAN:MMDDYY.CAL/B ← DEV:CAL.DAT
*DTAN:MMDDYY.VST/B ← DEV:VOST.DAT
*DTAN:MMDDYY.AVC/B ← DEV:AVCAS.DAT
*DTAN:MMDDYY.POS/B ← DEV:POS.DAT
*DTAN:MMDDYY.NEG/B ← DEV:NEG.DAT
*DTAN:MMDDYY.PSI/B ← DEV.PSI.DAT
*DTAN:MMDDYY.NSI/B ← DEV:NSI.DAT
*DTAN:MMDDYY.PDN/B ← DEV:PDEN.DAT
*DTAN:MMDDYY.NDN/B ← DEV:NENI.DAT
*↑C
.
```

In the above example i) the N in DTAN indicates the number of the DEC tape drive to which the data is to be transferred, ii) the MMDDYY is the month, day, year code of the day on which the rocket was launched, and iii) DEV: is the device from which the data is to be obtained, either DSK: (for disc) or DTA# (the DEC tape drive). After the coding has been completed type the following statement:

```
*DIR DTAN:
```

This statement generates a listing of the information stored on the DEC tape. Place this listing in the cannister containing the DEC tape. The listing serves as a catalog of the information stored on a particular DEC tape. When this is completed the user can log off the system by typing K/F.

APPENDIX B

COMPUTER PROGRAMS

```
.C     ************************************************************
C
C              MAINPGM: PROGRAM TO DIGITIZE BLUNT PROBE DATA.
C
C     ************************************************************

         EXTERNAL ICRAC
         INTEGER DATA(1000), OLD, SIZE, DONE
         LOGICAL TRSL, STOP
         DATA DIV/1000.0/
         DIMENSION FILID(10),TDMP(100)
C
C     INITIALIZATION & SETUP OF ANALOG COMPUTER
C
1        CALL HINIT
         CALL RSL
         IERCT=0
         IND=1
C
C     REQUEST FOR INFORMATION AS TO DATE OF LAUNCH, TYPE
C     OF DATA, CHARACTERISTICS OF LAUNCH DAY, AND ANY
C     COMMENTS UP TO 10 CHARACTERS IN LENGTH.
C
         TYPE 300
300      FORMAT('   TYPE DATE OF LAUNCH AS MM-DD-YY    ',$)
         ACCEPT 310, FILID(2), FILID(3)
310      FORMAT(2A5)
         TYPE 320
320      FORMAT('   TYPE "CAL" FOR CALIBRATION DATA',/,'   OR
         1 "FLT" FOR FLIGHT DATA     ',$)
         ACCEPT 310, FILID(4), FILID(5)
         TYPE 330
330      FORMAT('   TYPE THE CHARACTERISTICS OF THE LAUNCH DAY.',/
         1,'   EITHER L, H1, H2    ',$)
         ACCEPT 310, FILID(6), FILID(7)
         TYPE 340
340      FORMAT('   TYPE ANY COMMENTS OR NOTES SUCH AS NOISY,
         1 BALLOON, MAX ALTITUDE,',/,'   UP TO 10 CHARACTERS IN
         2 LENGTH     ',$)
         ACCEPT 310, FILID(8), FILID(9)
C
C     ZEROING OF THE DATA ARRAY, AND QUESTIONS CONSERING
C     ANALOG CONTROL LINES AND FILE SYORAGE INFORMATION.
C
         DO 5 IB=1,100
5        TDMP(IB)=0.0
10       FORMAT(A3)
15       TYPE 20
20       FORMAT('   TYPE # FOR START SENSE LINE & # FOR STOP SENSE LINE
         1.',/,'   TYPE ##,##    ',$)
```

```
.C    ************************************************************
C
C               MAINPGM: PROGRAM TO DIGITIZE BLUNT PROBE DATA.
C
C    ************************************************************

        EXTERNAL ICRAC
        INTEGER DATA(1000), OLD, SIZE, DONE
        LOGICAL TRSL, STOP
        DATA DIV/1000.0/
        DIMENSION FILID(10),TDMP(100)
C
C    INITIALIZATION & SETUP OF ANALOG COMPUTER
C
1       CALL HINIT
        CALL RSL
        IERCT=0
        IND=1
C
C    REQUEST FOR INFORMATION AS TO DATE OF LAUNCH, TYPE
C    OF DATA, CHARACTERISTICS OF LAUNCH DAY, AND ANY
C    COMMENTS UP TO 10 CHARACTERS IN LENGTH.
C
        TYPE 300
300     FORMAT('   TYPE DATE OF LAUNCH AS MM-DD-YY    ',$)
        ACCEPT 310, FILID(2), FILID(3)
310     FORMAT(2A5)
        TYPE 320
320     FORMAT('   TYPE "CAL" FOR CALIBRATION DATA',/,'   OR
        1 "FLT" FOR FLIGHT DATA     ',$)
        ACCEPT 310, FILID(4), FILID(5)
        TYPE 330
330     FORMAT('   TYPE THE CHARACTERISTICS OF THE LAUNCH DAY.',/
        1,'   EITHER L, H1, H2    ',$)
        ACCEPT 310, FILID(6), FILID(7)
        TYPE 340
340     FORMAT('   TYPE ANY COMMENTS OR NOTES SUCH AS NOISY,
        1 BALLOON, MAX ALTITUDE,',/,'   UP TO 10 CHARACTERS IN
        2 LENGTH     ',$)
        ACCEPT 310, FILID(8), FILID(9)
C
C    ZEROING OF THE DATA ARRAY, AND QUESTIONS CONSERING
C    ANALOG CONTROL LINES AND FILE SYORAGE INFORMATION.
C
        DO 5 IB=1,100
5       TDMP(IB)=0.0
10      FORMAT(A3)
15      TYPE 20
20      FORMAT('   TYPE # FOR START SENSE LINE & # FOR STOP SENSE LINE
        1.',/,'   TYPE ##,##    ',$)
```

```
      ACCEPT 30, LSTAR, LSTOP
      IF(LSTAR.GT.7.OR.LSTOP.GT.7.OR.LSTAR.LT.0.OR.LSTOP.
     1LT.0) GO TO 15
30    FORMAT(2I)
27    TYPE 28
28    FORMAT('   # OF ADC BEING USED= ',$)
      ACCEPT 30, IADC
      IF(IADC.LT.0.OR.IADC.GT.7) GO TO 27
      TYPE 35
35    FORMAT('   FILE STORAGE # ON MAG TAPE= ',$)
      ACCEPT 30, IFIN
C
C   INITIALIZATION OF MAG TAPE TO ACCEPT DATA
C
      CALL MTINIT(IFIN,1)
      FILID(1)=IFIN
      CALL SETDEC
      CALL MTWRIT(FILID,10,IERR)
      IF(IERR.EQ.0) GO TO 25
      TYPE 26,IERR
26    FORMAT('  ***MTIO ERROR= ',I2,' PROCESSING
     1 CONTINUED***',///)
      CALL MTSKIP(-1,0)
      CALL MTSKIP(1,0)
      IERCT=IERCT+1
      IF(IERCT.GT.5) GO TO 74
25    IERCT=0
C
C   SETTING OF ANALOG COMPUTER MODES AND PRINT OUT
C   OF STARTING AND STOPPING INSTRUCTIONS.
C
      CALL STCO('NSEC')
      CALL SAMO('OP')
      CALL SLMO('RUN')
      TYPE 40
40    FORMAT('   TO START, SET THE START
     1 SENSE LINE HIGH & START RECORDER.',/,'
     2   TO STOP SET THE STOP SENSE LINE HIGH & STOP
     3 RECORDER.',/)
C
C   SET UP DATA ACQUISITION TIMER, & CHECK FOR ERROR
C   IN SETUP. THE CALL TO "INTCNT" TELL THE COMPUTER THE
C   NUMBER OF INTERRUPTS TO PERFORM, A ZERO IMPLIES
C   CONTINIOUS PROCESSING.
C
      CALL DTM(2000,IERR,ICRAC,IADC,1000,DATA)
      IF(IERR.GT.0) TYPE 45, IERR
45    FORMAT('   DTM ERR= ',I2,' **** PGM TERMINATED ****',////)
      IF(IERR.GT.0) GO TO 100
      CALL INTCNT(0)
```

```
C
C   TEST TO SEE IF SAMPLING SHOULD BEGIN.
C
 50      IF(TRSL(LSTAR)) GO TO 60
         GO TO 50
C
C   START INTERRUPT
C
 60      CALL STINT
         SIZE=1000
         FREE=SIZE
         OLD=0
C
C   TEST TO SEE IF SAMPLING IS OVER
C
 65      STOP=TRSL(LSTOP)
         CALL DTMSTA(STOP,ISTAT,FREE,DONE)
C
C   TEST TO SEE HOW MUCH DATA HAS BEEN PROCESSED.
C
         IF(DONE-OLD) 66,67,68
 66      IF(OLD-SIZE) 69,70,70
C
C   PROCESS DATA AND STORE IT IN ARRAY "TDMP",
C   THEN DUMP ARRAY "TDMP" ON TO MAG TAPE.
C
 69      DO 71 I=OLD+1,SIZE
         TDMP(IND)=FLOAT(DATA(I))/DIV
         IF(IND.EQ.100) CALL MTWRIT(TDMP,100,IERR)
         IF(IND.EQ.100.AND.IERR.NE.0) ISTAT=-1
         IF(IND.LT.100) GO TO 210
C
C   ZERO ARRAY "TDMP".
C
         DO 200 IB=1,100
200      TDMP(IB)=0.0
         IND=1
         GO TO 71
210      IND=IND+1
 71      IF(ISTAT) GO TO 67
 70      OLD=0
C
C   PROCESS DATA AND STORE IT IN ARRAY "TDMP",
C   THEN DUMP ARRAY "TDMP" ON TO MAG TAPE.
C
 68      DO 72 I=OLD+1,DONE
         TDMP(IND)=FLOAT(DATA(I))/DIV
         IF(IND.EQ.100) CALL MTWRIT(TDMP,100,IERR)
         IF(IND.EQ.100.AND.IERR.NE.0) ISTAT=-1
         IF(IND.LT.100) GO TO 220
```

```
C
C   ZERO ARRAY "TDMP".
C
      DO 230 IB=1,100
230   TDMP(IB)=0.0
      IND=1
      GO TO 72
220   IND=IND+1
 72   IF(ISTAT) GO TO 67
      FREE=DONE
      OLD=DONE
 67   IF(.NOT.ISTAT) GO TO 65
C
C   CHECK THE STATIUS OF THE DATA ACQUISITION TIMER
C   AND REPORT ANY ERRORS.
C
      CALL DTMSTA(.TRUE.,ISTAT,FREE,DONE)
 74   IF(IERR.GT.0) TYPE 73, IERR
 73   FORMAT('   **** ERROR IN PROCESSING: MTIO OUTPUT
     1 ERR= ',I2,' ****',/,' ',4X,'CONTROL TRANSFERRED
     2 TO START OF PGM.',///)
      IF(IERR.GT.0) GO TO 1
C
C   ENDS OUTPUT ON MAG TAPE.
C
      CALL MTWRIT(TDMP,100,IERR)
      IF(IERR.NE.0) TYPE 79,IERR
 79   FORMAT(' ***MTIO ERROR ',I1,' ON FINAL OUTPUT***',/,'
     1THE VERY LAST DISPLAY MAY BE IN ERROR,NORMAL
     2 TERMINATION IN EFFECT',//////)
C
C   CLOSE THE MAG TAPE FILE AND TYPE THE FINAL
C   QUESTION.
C
      CALL MTCLOS
80    TYPE 90
90    FORMAT('   ARE YOU THROUGH  DIGITIZING DATA? Y OR N
     1 ',$)
      ACCEPT 10, ANS
      IF(ANS.EQ.'N') GO TO 1
      IF(ANS.NE.'Y') GO TO 80
100   STOP
      END
```

```
C    ******************************************************
C
C                      BLKDA: BLOCK DATA
C
C    ********************************************************

         BLOCK DATA
C
C    COMMON STATEMENT FOR DISPLAY SCOPE.
C
         COMMON LP,ISHOW,XMAX,XMIN,YMAX,YMIN,INTENS,ISCALE
C
C    COMMON AREA FOR DATA AND VARIABLES TRANSFERRED
C    FROM ONE CHAIN LINK TO ANOTHER.
C
C    DISPLAY ARRAYS:
C      ADVAL(3000): DATA ARRAY
C      GRID(1000):  GRID SETUP FOR DISPLAY
C      DEC(100):    USED FOR "CAL" AND "DATA" OPTIONS IN
C                   LINK "MAIN" AND "2 SEC DIS" IN LINK "CALD.
C      XA(5) & YA(5): SEPERATION LINES BETWEEN DISPLAY
C                       LITERALS.
C      STAR(20) & SEC(10) MOBILE STAR
C      ILINE(100):  NEEDED TO DRAW A LINE BETWEEN POINTS ON
C                   CURVE.
C      TIME(250):   TEN SECOND TIME SCALE.
C
C    OTHER MOST SIGNIFICANT VARIABLES:
C      AVCASL:      AVERAGE CALIBRATION SLOPE (LINKS CALC &
C                   CONC).
C      SLOPE(150,2):CALIBRATION SLOPE ARRAY IN LINK "CALC",
C                   POSITIVE AND NEGATIVE SLOPE ARRAY IN
C                   LINK "CALD".
C      TIF(150,3):  TIME IN FLIGHT ARRAY USED IN LINKS
C                   "CALD" AND "MTAH".
C      SIGPOS(150): POSITIVE CONDUCTIVITY ARRAY USED IN
C                   LINKS "CONC", "MTAH", AND "SIGP".
C      SIGNEG(150): NEGATIVE CONDUCTIVITY ARRAY USED IN
C                   LINKS "CONC", "MTAH", ANS "SIGP".
C      TIMEIF(150,2):  TIME IN FLIGHT ARRAY USED IN LINK "CONC".
C      FILID(10):   ARRAY WHICH CONTAINS INFORMATION
C                   PERTAINING TO THE FLIGHT.
C      FVAL(1005):  ARRAY CONTAINING DIGITIZED FLIGHT DATA
C                   READ IN FROM MAG TAPE, USED IN LINK "CALD".
C      CVAL(1600):  ARRAY CONTAINING DIGITIZED CALIBRATION
C                   DATA READ IN FROM MAG TAPE, USED IN
C                   LINK "CALC".
C      ALT(150,2):  ARRAY FOR STORAGE OF ALTITUDES, USED IN
C                   LINKS "MTAH" AND "SIGP".
C      IDSK:        IDSK=1 INDICATES DISK OPERATION, OTHER
```

```
C                   VALUES OF IDSK INDICATE DEC TAPE
C                   OPERATION.
C
      COMMON /A/ ADVAL(3000), GRID(1000), DEC(100) /B/ XA(5), YA(4)
      1 /C/ AVCASL /D/ STAR(20), SEC(10) /E/ SLOPE(150,2)
      2 /F/ X(4), Y(4) /G/ ISKIP /H/ TIF(150,3)
      3 /I/ TIME(250) /J/ ASK(4), R(6), B(2)/K/ SIGPOS(150),
      4 SIGNEG(150) /L/ TIMEIF(150,2) /M/ IND, IFLAG,
      5 IEOF, KIN, INDF, NFLG /N/ IPSI, INSI
      6 /P/ ILINE(100), RB(5) /Q/ ALT(150,2)
      7 /R/ ASK1(2) /S/ FVAL(1005) /T/ CVAL(1600)
      8 /U/ I, J /DA/IDSK, NUM /DB/ NUM2, LB /DC/ FILID(10),
      9 TDMP(100)

C
C   SETTING OF CONSTANTS.
C
      DATA  XA/0.0,380.0,630.0,880.0,1023.0/,
      1 YA/0.0,180.0,630.0,1023.0/, XMAX/1023.0/, XMIN/0.0/,
      2 YMAX/1023.0/, YMIN/0.0/, B/695.0,958.0/,
      3 RB/380.0,433.0,500.0,548.0,600.0/, LB/10/, NUM/100/,
      4 IDSK/1/, NUM2/100/

      END
```

```
C     ****************************************************************
C          DATAN: ASKS IF DSK OR DEC TAPE IS BEING USED,
C                    AND IF HELP IS NEEDED TO RUN PGM.
C     ****************************************************************
           COMMON /DA/ IDSK
C
C     QUESTION TYPED TO DETERMINE IF A DESCRIPTION
C     OF THE PROGRAM IS DESIRED. IF NOT CONTROL IS
C     TRANSFERRED TO STATEMENT 60.
C
30         TYPE 40
40         FORMAT('   DO YOU DESIRE A PROGRAM DESCRIPTION?
           1  Y OR N    ',$)
           ACCEPT 50, ANS
50         FORMAT(A2)
           IF(ANS.EQ.'N') GO TO 60
           IF(ANS.NE.'Y') GO TO 30
C
C             TYPE OUT EXPLANATION OF ENTIRE PROGRAM
C
           PRINT 100
100        FORMAT('1', ' THIS PRINT OUT IS AN EXPLANATION OF
           1 ALL QUESTIONS WHICH THE PROGRAM WILL ASK. IT IS AIMED AT
           2 GIVING THE USER',/,' ', 'A STEP BY STEP DESCRIPTI
           3ON OF HOW THE PROGRAM OPERATES.',////,' **********
           4********* YOU ARE NOW IN THE STARTING PROGRAM, IIS NAME IS
           5 DATAN ***********************',//,
           6' DATAN IS TO BE USED FOR DATA ANALYSIS ONLY AFETER
           7 DATA HAS BEEN DIGITIZED AND STORED',/,' ON MAG TAPE.
           8FOR A DESCRIPTION OF THE DIGITIZING PROGRAM (DIGPGM) SEE
           9 THE APPROPRIATE',/,' SIDE REPORT.',////,' ',10X,'EXPLA
           1NATION OF THE QUESTIONS TO BE ASKED BY THE PROGRAM',//,
           2' THE NEXT QUESTION TO BE ASKED PERTAINS TO THE SYSTEM
           3 YOU ARE OPERATING UNDER.',/,' ',10X,'IF THE DISK
           4 SYSTEM IS INOPERABLE YOU ARE OBVIOUSLY RUNNING OFF THE
           5 DEC TAPE SYSTEM, SO TYPE IN',/,' ',10X,'THE NUMBER OF
           6THE DEC TAPE DRIVE THE MAIN TAPE IS ON. THIS NUMBER
           7MUST BE IN THE RANGE OF 1 THRU 8.',/,' ',10X,'IF YOU
           8ARE PERATING ON THE DISK SYSTEM TYPE THE NUMBER
           9 10.',///)
           PRINT 200
200        FORMAT('  THE PROGRAM HAS BEEN CONSTRUCTED TO CHECK FOR
           1ANY WRONG RESPONSES. UPON DETECTION OF AN',/,'  INCORR
           2ECT RESPONSE THE PROGRAM WILL ASK THE SAME QUESTION OVER
           3.',///,'  AFTER ANSWERING THE INITIAL QUESTION THE PROG
           4RAM BEGINS BY ASKING A SERIES OF QUESTIONS PERTAINING
```

```
     5 TO THE STATUS',/,'  OF THE DATA REDUCTION. FROM
     6 THIS POINT ALL QUESTIONS WILL BE NUMBERED IN THIS
     7 DESCRIPTION.',//)
       PRINT 250
250    FORMAT('- BECAUSE OF THE TREMENDOUS SIZE OF THE PROGRAM
     1 IT HAS BEEN BROKEN DOWN INTO SEVEN SEPARATE',/,' PRO
     2GRAMS CALLED CHAIN LINKS. AT THE CORRECT POINTS IN THE
     3 DATA REDUCTION CONTROL IS AUTOMATICALLY TRANSFERRED
     4 TO THE',/,' APPROPRIATE CHAIN LINK. FOUR OF THE CHAIN
     5 LINKS PRINT OUT THEIR FUNCTION AND YOU HAVE THE OPTION
     6 OF CONTINUEING THE',/,' PROCESSING OR EXITING. BEFORE LISTING
     7 THE QUESTIONS HERE IS A BRIEF DESCRIPTION OF THE',/,'
     8 NAMES AND PURPOSE OF SOME OF THE CHAIN LINKS:',/,'-',15X
     9,'MAIN: QUESTIONING PROGRAM WHICH DETERMINES STATIUS
     1 OF DATA REDUCTION AND',/,' ',20X,'LINKS TO THE
     2 APPROPRIATE CHAIN LINK TO BE USED.',/,'  ALL OTHER LINKS
     3 CHAIN BACK TO "MAIN" AFTER PERFORMING THEIR OPERATIONS.',
     4/,' ',15X,'CALC: CALIBRATION SLOPE CALCULATIONS',/,' ',15X,
     5'CALD: FLIGHT SLOPE CALCULATIONS',/,' ',15X,'CONC: COND
     6UCTIVITY CALCULATIONS',/,' ',15X,'MTAH: MATCH TIMES AND
     7 ALTITUDES',/,' ',15X,'SIGP: ALTITUDE VS. CONDUCTIVITY
     8 PLOTS',//)
C
C   EXPLANATION OF QUERTIONS ASKED IN LINK MAIN.
C
       PRINT 300
300    FORMAT('1 QUESTION #1:',/,' ',15X,'IF YOU HAVE CONDUCTIV
     1ITIES CALCULATED AND STORED, DO YOU DESIRE TO',/,' ',15X,
     2'MATCH TIME IN FLIGHT WITH ALTITUDE?',/,' ',20X,'POSS
     3IBLE RESPONSES: "Y"...YES OR "N"...NO.',/,' ',15X
     4,'A RESPONSE OF "Y" CAUSES CONTROL TO BE TRANSFERRED
     5 TO THE CHAIN LINK "MTAH", IF AND ONLY IF',/,' ',15X,'OPER
     6ATION IS OFF THE DISK SYSTEM. IF OPERATION IS OFF DEC TAPE
     7 SYSTEM THE PROGRAM REQUESTS',/,' ',15X,'THE NUMBER OF
     8 THE DEC TAPE DRIVE WHICH CONTAINS PREVIOUSLY REDUCED DATA
     9. A RESPONSE OF "N" CAUSES',/.' ',15X,'QUESTION #2 TO
     1 BE TYPED.',//,'  QUESTION #2:',/,' ',15X,'IF YOU ALREADY
     2 HAVE CONDUCTIVITIES MATCHED WITH CORRESPONDING ALTITUDES
     3,',/,' ',15X,'DO YOU DESIRE TO PLOT ALTITUDE VS. CONDUCTI
     4VITY CURVES?',/,' ',20X,'POSSIBLE RESPONSES: "Y"...YES OR
     5 "N"...NO.',/,' ',15X,'A RESPONSE OF "Y" CAUSES CONTROL
     6 TO BE TRANSFERRED TO THE CHAIN LINK "SIGP", IF AND ONLY',
     7/,' ',15X,'IF OPERATION IS OFF THE DISK SYSTEM. IF OPERA
     8TION IS OFF THE DEC TAPE SYSTEM THE PROGRAM REQUESTS')
       PRINT 350
350    FORMAT(' ',15X,'THE NUMBER OF THE DEC TAPE DRIVE WHICH CONT
     1AINS PREVIOUSLY REDUCED DATA. A RESPONSE OF "N"',/,' ',15X
     2,'CAUSES QUESTION #3 TO BE TYPED.',//)
       PRINT 400
400    FORMAT('  QUESTION #3:',/,' ',15X,'IF YOU HAVE SLOPES
```

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      1 CALCULATED AND STORED DO YOU DESIRE TO CALCULATE THE
      2 CONDUCTIVITIES',/,' ',15X,'OR DO YOU DESIRE TO REDUCE
      3 NEW DATA?',/,' ',20X,'POSSIBLE RESPONSES: "O"...OLD OR "N"
      4...NEW.',/,' ',15X,'A RESPONSE OF "O" CAUSEC CONTROL
      5 TO BE TRANSFERRED TO THE CHAIN LINK "CONC".',/,
      6' ',15X,'THIS TRANSFERR OF CONTROL TAKES PLACE ON BOTH DEC
      7 TAPE AND DISK SYSTEMS OF OPERATION. A RESPONSE OF "N"
      8',/,' ',15X,'RESULTS IN TYPE OUT OF QUESTION #4.',//,
      9'  QUESTION #4:',/,' ',15X,'DO YOU KNOW IF THE FILE YOU
      1 DESIRE TO ANALYZE CONTAINS CALIBRATION OR FLIGHT
      2 DATA?',/,' ',20X,'POSSIBLE RESPONSES: "Y"...YES OR "N"
      3...NO.',/,' ',15X,'A RESPONSE OF "Y" CAUSES QUESTION #6
      4 TO BE TYPED. AND A RESPONSE OF "N" CAUSES QUESTION #5
      5 TO BE TYPED.',//)
      PRINT 500
500   FORMAT('  QUESTION #5:',/,' ',15X,'TYPE THE NUMBER OF THE
      1 MAG TAPE FILE OF THE DATA WHICH IS TO BE OBSERVED.',/
      2,' ',20X,'POSSIBLE RESPONSES: ANY MAGNETIC TAPE FILE
      3 NUMBER.',/,' ',15X,'THE PROGRAM WILL DISPLAY THE DATA
      4 CONTAINED IN THE APPROPRIATE MAG TAPE FILE AND AWAIT
      5 A LITE PEN',/,' ',15X,'DETECTION IN THE "CAL"
      6 (CALIBRATION DATA) OR "DATA" (FLIGHT DATA) REGIONS.
      7 CONTROL IS THEN TRANSFERRED',/,' ',15X,'TO THE APP
      8ROPRIATE CHAIN LINK.',//,'  QUESTION #6:',/,' ',15X,
      9'IF THE FILE YOU WISH TO ANALYZE IS A CALIBRATION FILE
      1 TYPE CAL; IF IT IS A FLIGHT DATA FILE TYPE FLT.'
      2,/,' ',20X,'POSSIBLE RESPONSES: CAL OR FLT.',/,' ',15X,
      3'A RESPONSE OF CAL CAUSES CONTROL TO BE TRANSFERRED TO
      4 CHAIN LINK "CALC", AND A RESPONSE OF FLT CAUSES',/,
      6' ',15X,'CONTROL TO BE TRANSFERRED TO CHAIN LINK "CALD".'
      7,//)
      PRINT 600
600   FORMAT('- AFTER COMPLETION OF ANALYSIS OF CALIBRATION
      1 OR FLIGHT SLOPES THE FOLLOWING QUESTIONS',/,' ARE
      2 ASKED.',/,'1','  QUESTION #7:',/,' ',15X,'AT THIS
      3 POINT DO YOU WISH TO COMPUTE CONDUCTIVITIES?',/,' ',
      420X,'POSSIBLE RESPONSES: "Y"...YES OR "N"...NO.',/,
      5' ',15X,'IF THE RESPONSE IS "Y" CONTROL IS TRANSFERRED
      6 TO CHAIN LINK "CONC". IF THE RESPONSE IS',/,' ',15X,'
      7"N" QUESTION #10 IS ASKED.',/,'- AFTER CONDUCTIV
      8ITIES HAVE BEEN CALCULATED IN "CONC" CONTROL IS TRANSF
      9ERRED BACK TO CHAIN LINK "MAIN", AND',/,' QUESTION
      1 #8 IS TYPED.',/,'- QUESTION #8:',/,' ',15X,'SAME AS
      2 QUESTION #1 BUT WITH A DIFFERENT RESPONSE TO AN',/,' ',
      315X,'ANSWER OF "N".',/,' ',20X,'A RESPONSE OF "N" CAUSES
      4 QUESTION #10 TO BE TYPED.',/,'- AFTER TIMES HAVE
      5 BEEN MATCHED TO ALTITUDES, IN CHAIN LINK "MTAH", CONT
      6ROL IS TRANSFERRED BACK TO CHAIN',/,' LINK "MAIN" AND
      7 QUESTION #9 IS ASKED.',//)
      PRINT 700
```

```
700     FORMAT('- QUESTION #9:',/,' ',15X,'DO YOU DESIRE TO
        1 PLOT ALTITUDE VS. CONDUCTIVITY CURVES?',/,' ',20X,
        2'POSSIBLE RESPONSES: "Y"...YES OR "N"...NO.',/,' ',
        315X,'A RESPONSE OF "Y" CAUSES TRANSFERR OF CONTROL TO
        4 CHAIN LINK "SIGP", AND A RESPONSE OF "N"',/,' ',15X,'
        5CAUSES QUESTION #10 TO BE ASKED.',/,' QUESTION #10:',
        6/,' ',15X,'ARE YOU FINISHED WITH THE PROGRAM?',/,' ',
        720X,'POSSIBLE RESPONSES: "Y"...YES OR "N"...NO.',/,' '
        8,15X,'A RESPONSE OF "Y" CAUSES TERMINATION OF THE
        9 PROGRAM BUT A RESPONSE OF "N" TRANSFERRS CONTROL',/,
        1' ',15X,'TO THE START OF THE PROGRAM AND THE QUESTION
        2ING SEQUENCE AGAIN BEGINS WITH QUESTION #1',//)
        PRINT 800
800     FORMAT('  THE ONLY OTHER INFORMATION WHICH THE OPERATOR
        1 MUST PROVIDE IS THE NUMBER OF THE MAG TAPE FILE WHICH',/,
        2'  CONTAINS THE DATA TO BE ANALYZED; OR, THE NUMBER
        3 OF A DEC TAPE DRIVE ON WHICH DATA IS TO BE STORED OR
        4 READ IF',/,'  OPERATION IS OFF THE DEC TAPE SYSTEM.
        5',/,'-',5X,'**********************
        6************* END DISCREPTION SECTION *************
        7*********************',/,'-',
        815X,'YOU ARE NOW READY TO BEGIN DATA
        9 PROCESSING.  :::::::::: GOOD LUCK!!!! ::::::::::',//,
        1'1',/,'1',/,'1',/,'1')
C
C   REQUEST FOR INFORMATION AS TO WHETHER THE
C   PROGRAM WILL BE OPERATING OFF THE DISK OR DEC
C   TAPE. IF OPERATION IS OFF DEC TAPE ADD 8
C   TO THE DEC TAPE NUMBER AND THEN CHAIN TO LINK
C   "MAIN". OTHERWISE "IDSK" WILL EQUAL ONE FOR
C   DISK OPERATION AND THE PROGRAM WILL AUTOMATICALLY
C   CHAIN TO "MAIN".
C
60      IBAD=0
        TYPE 10
10      FORMAT('   IF YOU ARE RUNNING OFF OF DEC TAPE TYPE
        1 THE # OF THE DTA',/,'   OTHERWISE TYPE 10    ',$)
        ACCEPT 20, IDOT
20      FORMAT(I)
        IF(IDOT.LT.1.OR.IDOT.GT.8) IBAD=1
        IF(IBAD.EQ.1.AND.IDOT.NE.10) GO TO 60
        IF (IDOT.EQ.10) GO TO 70
        IDSK=IDOT+8
70      CALL CHAIN(0,IDSK,'MAIN')
        END
```

```
C     ***************************************************************
C          MAIN: USE OF DISPLAY SCOPE TO CALCULATE
C                        CONDUCTIVITIES
C     ***************************************************************
           COMMON LP, ISHOW, XMAX, XMIN, YMAX, YMIN, INTENS, ISCALE
           COMMON /A/ ADVAL(3000), GRID(1000), DEC(100) /B/ XA(5), YA(4)
           1 /C/ AVCASL /G/ ISKIP /N/ IPSI, INSI /DA/ IDSK, NUM
           2/DC/ FILID(10),TEMP(100) /S/ FVAL(1005)
C
C     COMPUTED GO TO REQUIRED TO DETERMINE WHERE CONTROL
C     SHOULD BE TRANSFERRED AFTER OTHER LINKS CHAIN
C     BACK TO LINK "MAIN".
C
           GO TO (165, 150, 156, 119, 124, 112, 115), NUM
6          IPLT=0
C
C     QUESTIONING SECTION TO DETERMINE ANY PRIOR STATIUS
C     OF THE REDUCTION.
C
           TYPE 7
7          FORMAT('   IF YOU HAVE CONDUCTIVITIES CALCULATED
           1 & STORED,'/,'   DO YOU DESIRE TO MATCH
           2 TIME IN FLIGHT WITH ALTITUDE? Y OR N   ',$)
           ACCEPT 10, MTA
           IF(MTA.EQ.'Y') GO TO 157
           IF(MTA.NE.'N') GO TO 6
8          TYPE 9
9          FORMAT('   IF YOU ALREADY HAVE CONDUCTIVITIES MATCHED
           1 WITH CORRESPONDING',/,'   ALTITUDES, DO YOU DESIRE
           2 TO PLOT ALTITUDE VS. CONDUCTIVITY',/,'   CURVES
           3 Y OR N?   ',$)
           ACCEPT 10, PLT
           IF(PLT.EQ.'Y') IPLT=1
           IF(IPLT.EQ.1) GO TO 157
           IF(PLT.NE.'N') GO TO 8
2          TYPE  5
5          FORMAT('   IF YOU HAVE SLOPES CALCULATED AND
           1 STORED,',/,'   DO YOU DESIRE TO
           2 CALCULATE THE CONDUCTIVITIES',/,'   OR DO YOU
           3 DESIRE TO REDUCE NEW DATA??',/,'
           4TYPE "O" FOR OLD..."N" FOR NEW.    ',$)
           ACCEPT 10, ITY
           IF(ITY.EQ.'O') GO TO 155
           IF(ITY.NE.'N') GO TO 2
10         FORMAT(A3)
30         FORMAT(3I)
```

```
1       LP=1
        ISCALE=0
        YI=200.0
C
C   INITIALIZATION OF GRID ARRAY; THIS SETS UP
C   THE GRID FOR THE DISPLAY.
C
        CALL INTAB(GRID,1000)
        INTENS=5
        ISHOW=1
C
C   GENERATION OF HORIZONTAL LINES OF GRID
C
        CALL POINT(GRID,0.0,160.0)
        CALL VECONT(GRID,0.0,160.0,1023.0,160.0)
        ADV=0.0
        DO 140 I=1,9
        CALL POINT(GRID,0.0,ADV+200.0)
        CALL VECONT(GRID,0.0,ADV+200.0,1023.0,ADV+200.0)
140     ADV=ADV+100.0
C
C   GENERATION OF VERTICLE LINES FOR GRID
C
        ADV=0.0
        DO 180 I=1,11
        CALL POINT(GRID,ADV,160.0)
        CALL VECONT(GRID,ADV,160.0,ADV,1023.0)
180     ADV=ADV+100.0
C
C   GENERATION OF BASE LINE IN GRID
C
        INTENS=7
        ISHOW=1
        CALL POINT(GRID, 0.0, 0.0)
        CALL VECONT(GRID, 0.0, 0.0, 1023.0, 0.0)
        CALL POINT(GRID, 0.0, 40.0)
        CALL VECONT(GRID, 0.0, 40.0, 1023.0, 40.0)
        CALL POINT(GRID,0.0,99.9)
        CALL VECONT(GRID,0.0,99.9,1023.0,99.9)
C
C   TICK MARK TO SHOW 1 SEC INTERVALS.
C
        TIMK=100.0
        DO 185 I=1,10
        CALL POINT(GRID,TIMK,150.0)
        CALL LINE(GRID,TIMK,150.0,TIMK,165.0)
185     TIMK=TIMK+100.0
C
C   GENERATION OF SEPERATION LINES BETWEEN
C   LITERALS ON DISPLAY SCOPE
```

```
C
      DO 190 J=1,5
      CALL POINT(GRID, XA(J), 0.0)
190   CALL LINE(GRID, XA(J), 0.0, XA(J), 40.0)
      DO 195 J=1,4
      CALL POINT(GRID, YA(J), 40.0)
195   CALL LINE(GRID, YA(J), 40.0, YA(J), 99.9)
C
C   GENERATION OF LITERALS FOR DISPLAY SCOPE
C
      CALL INTAB(DEC,100)
      CALL POINT(DEC,180.0,0.0)
      CALL LINE(DEC,180.0,0.0,180.0,40.0)
      CALL CHRGEN(DEC, 'CAL.', 20.0, 5.0, 4, 0)
      CALL CHRGEN(DEC, 'DATA', 230.0, 5.0, 4, 0)
      CALL CHRGEN(GRID, 'ACCEPT', 430.0, 5.0, 4, 0)
      CALL CHRGEN(GRID, 'REJECT', 680.0, 5.0, 4, 0)
      CALL CHRGEN(GRID, 'END',910.0,5.0,4, 0)
      CALL CHRGEN(GRID,'READY',2.0,55.0,4,0)
C
C   GENERATION OF VERTICAL & HORIZONTAL
C   ZERO LINES
C
      CALL POINT(GRID, 0.0,160.0)
      CALL VECONT(GRID,0.0,160.0,0.0,1023.0)
      CALL POINT(GRID,0.0, 200.0)
      CALL VECONT(GRID,0.0,200.0,1023.0,200.0)
C
C   DISPLAY OF ARRAY GRID
C
      CALL DISPLY(2,GRID, DEC)
C
C   DO YOU KNOW WHAT TYPE OF DATA IS IN THE FILE
C   YOU WANT TO ANALIZE? IF YES GO TO 121
C
85    TYPE 86
86    FORMAT('   DO YOU KNOW IF THE FILE YOU DESIRE TO
     1 ANALIZE CONTAINS',/,'   CALIBRATION OR FLIGHT DATA?
     2  Y OR N?   ',$)
      ACCEPT 10, ANS
      IF(ANS.EQ.'Y') GO TO 121
      IF(ANS.NE.'N') GO TO 85
C
C   INPUT OF FILE # FOR THE INPUT OF DATA FROM THE
C   MAG TAPE & INITIALIZATION OF MAG TAPE & ARRAY ADVAL
C
      IERCT=0
      TYPE 82
82    FORMAT('   TYPE THE # OF THE MAG TAPE FILE OF THE DATA
     1 WHICH IS',/,'   TO BE OBSERVED    ', $)
```

```
      ACCEPT 30, IFIN
C
C   INITIALIZATION OF MAG TAPE FOR INPUT AND INPUT OF
C   ARRAY CONTAINING FILE IDENTIFICATION INFORMATION.
C   IDENTIFICATION INFORMATION IS PLACED INTO ARRAY
C   "FILID". "FILID(1)" CONTAINS THE NUMBER
C   OF THE MAG TAPE FILE. THIS NUMBER IS COMPAIRED TO
C   "IFIN" TO SEE IF THE CORRECT FILE HAS BEEN READ.
C   IF AN ERROR OCCURS AN ERROR MESSAGE IS TYPED.
C   THE PROGRAM TRYES SIX TIMES TO READ IN THE FILE.
C   IF THE PROGRAM IS NOT ABLE TO READ IN THE FILE,
C   PROCESSING IS TERMINATED.
C
      CALL MTINIT(IFIN,1)
      CALL SETDEC
81    CALL MTREAD(FILID,12,IERR)
      IF(IERR.EQ.0) GO TO 87
      TYPE 200, IERR
200   FORMAT(' <---MTIO ERROR ',I1,' IGNORED PROCESSING
     1CONTINUED --->',///)
      IERCT=IERCT+1
      IF(IERCT.LE.5) CALL MTSKIP(-1,0)
      IF(IERCT.LE.5) CALL MTSKIP(1,0)
      IF(IERCT.LE.5) GO TO 81
205   TYPE 210
210   FORMAT('  ERROR WILL NOT CORRECT, PROCESSING STOPPED.',////)
      GO TO 150
C
C   TEST TO SEE IF "FILID(1)" CORRESPONDS TO "IFIN",
C   IF IT DOES PROCESSING IS CONTINUED THROUGH THE
C   PROGRAM. IF THEY ARE NOT EQUAL CORRECTIVE STEPS
C   ARE TAKEN TO FIND THE DESIRED MAG TAPE FILE.
C
87    IFF=FILID(1)
      IF(IFF-IFIN) 1000,1010,1020
1000  IERCT=IERCT+1
      IF(IERCT.LE.5) TYPE 200,IERR
      IF(IERCT.GE.5) GO TO 205
      INF=IFIN-IFF
      CALL MTSKIP(INF,0)
      GO TO 81
1020  IERCT=IERCT+1
      IF(IERCT.LE.5) TYPE 200, IERR
      IF(IERCT.GT.5) GO TO 205
      INF=IFIN-IFF-1
      CALL MTSKIP(INF,0)
      CALL MTSKIP(1,0)
      GO TO 81
C
C   TYPE OUT OF FILE IDENTIFICATION INFORMATION
```

```
C   AFTER THE CORRECT FILE HAS BEEN FOUND.
C
1010     TYPE 1100, FILID(2), FILID(3), FILID(4), FILID(5),
         1 FILID(6), FILID(7), FILID(8), FILID(9)
1100     FORMAT('   DATE OF LAUNCH:   ',2A5,/,'   TYPE OF DATA:
         1   ',2A5,/,'   TYPE OF DAY:   ',2A5,/,'   COMMENTS:   ',2A5,
         2 ////////)
         IERCT=0
         CALL INTAB(ADVAL,3000)
C
C   READ IN LOOP CONSISTING OF 1000 POINTS FOR DISPLAY
C   OF ARRAY ADVAL WHICH CONTAINS DATA FROM A FILE
C   O MAG TAPE, IN ORDER TO DETERMINE IF THE FILE
C   CONTAINS CALIBRATION OR FLIGHT DATA.
C
C
C   GET DATA FROM THE MAG TAPE
C
         DO 90 K=1,50
         IERCT=0
490      CALL MTREAD(TDMP,100,IERR)
         IF(IERR.EQ.2) GO TO 100
         IF(IERR.NE.0) GO TO 500
         IF(K.EQ.1) INDX=1
         DO 88 L=0,100,5
         LN=L
         IF(L.EQ.0) LN=1
         FVAL(INDX)=TDMP(LN)
88       INDX=INDX+1
         GO TO 90
500      TYPE 200, IERR
         IERCT=IERCT+1
         IF(IERCT.LE.5) CALL MTSKIP(0,-1)
         IF(IERCT.LE.5) GO TO 490
         TYPE 210
         GO TO 160
90       CONTINUE
C
C   MULTIPLY DATA IN BY 150.0 & ADD 200.0 TO SHIFT ZERO
C   AXIS UP TO LEVEL 200.0 ON THE DISPLAY SCOPE
C
         XI=0.0
         YI=FVAL(1)*150.0+200.0
         IF(YI.LT.1023.0) GO TO 510
         YI=1020.0
         TYPE 91
C
C   SETUP OF DISPLAY DATA ARRAY "ADVAL". IF ANY VALUES
C   ARE OVER MAXIMUM VALUE FOR DISPLAY THOSE VALUES
C   ARE TRUNCATED TO FIT THE DISPLAY, AND A MESSAGE
```

```
C   IS TYPED OUT.
C
510     CALL POINT(ADVAL,XI,YI)
        DO 515 K=2,1000
        XE=K
        YE=FVAL(K)*150.0+200.0
        IF(YE.LT.1023.0) GO TO 89
        TYPE 91
91      FORMAT('   <--- ERROR: VALUE TO BE DISPLAYED IS OUT OF
        1 THE RANGE OF DISPLAY --->',/,'   THE VALUE HAS BEEN
        2 TRUNCATED TO FIT THE DISPLAY',//)
        YE= 1020.0
89      IF(YE-YI.LT.0.999) CALL POINT(ADVAL,XI,YI)
        CALL LINE(ADVAL, XI, YI, XE, YE)
        XI=XE
515     YI=YE
C
C   DISPLAY OF DATA & GRID ARRAYS
C   & ZERO THE ISKIP FLAG
C
100     CALL DISPLY(3, GRID, ADVAL, DEC)
        IF(IERR.EQ.2) TYPE 105
105     FORMAT(' ***END OF MAG TAPE FILE***',///)
        ISKIP=0
C
C   ENABLING OF LITE PEN FOR DECISION MAKING PROCESS
C
110     CALL LITEPN(IDET, XDET, YDET)
        IF (IDET.EQ.0) GO TO 110
        IF((XDET.GT.680.0).AND.(XDET.LT.800.0).AND.(
        1YDET.LE.40.0)) GO TO 120
        IF((XDET.GT.920.0).AND.(YDET.LE.40.0)) GO TO 150
C
C   IF CAL DETECTED FROM DISPLAY SCOPE, CHAIN
C   TO LINK CALC (CALIBRATION COMPUTATION)
C
        IF((XDET.LE.0).OR.(XDET.GE.180).OR.(YDET.GE.40))
        1 GO TO 112
        NUM=6
        CALL CHAIN(0, IDSK, 'CALC ')
C
C   IF DAT DETECTED FROM DISPLAY SCOPE, CHAIN
C   TO LINK CALD (CALCULATIONS ON FLIGHT DATA)
C
112     IF((XDET.LE.180).OR.(XDET.GE.380).OR.(YDET.GE.40))
        1 GO TO 115
        NUM=7
        CALL CHAIN(0,IDSK,'CALD ')
C
C   FLAG ISKIP TRANSFERS CONTROL TO 125 IF THE FLAG
```

```
C   IS SET BY LINK "CALC" OR LINK "CALD".
C
115      IF(ISKIP.EQ.1) GO TO 125
         GO TO 110
120      CALL DISPLY(0)
         GO TO 1010
C
C   ZERO THE DISPLAY
C
160      CALL DISPLY(0)
C
C   IF THERE HAS BEEN AN ERROR WHICH WILL NOT CORRECT
C   THERE IS A PAUSE AND ONE CAN EITHER CONTINUE
C   OR EXIT THE PROGRAM.
C
         IF(IERCT.GT.5) PAUSE 'WHAT DO YOU WANT TO DO?'
         GO TO 125
C
C   OPERATOR PROVIDES TYPE OF FILE TO BE ANALIZED
C   AND THE CORRECT SUBROUTINE IS CALLED.
C
121      ISKIP=0
         TYPE 122
122      FORMAT('   IF THE FILE YOU WISH TO ANALIZE IS A
         1 CALIBRATION FILE TYPE CAL',/,'   IF IT IS A FLIGHT
         2 DATA FILE TYPE FLT    ',$)
         ACCEPT 10, TYPF
         IF (TYPF.NE.'CAL') GO TO 123
         NUM=4
C
C   CHAIN TO LINK "CALC" IF ANSWER TO ABOVE QUESTION
C   IS "CAL".
C
         CALL CHAIN(0,IDSK,'CALC')
119      IF(ISKIP.EQ.1) GO TO 125
123      IF(TYPF.NE.'FLT') GO TO 124
         NUM=5
C
C   CHAIN TO LINK "CALD" IF ANSWER TO ABOVE QUESTION
C   IS "FLT".
C
         CALL CHAIN(0,IDSK,'CALD')
124      IF(ISKIP.NE.1) GO TO 121
C
C   DECISION TO COMPUTE CONDUCTIVITIES
C
125      TYPE 126
126      FORMAT('  AT THIS POINT DO YOU WISH TO COMPUTE
         1 CONDUCTIVITIES? Y OR N    ', $)
         ACCEPT 10, COND
```

```
      IF(COND.EQ.'N') GO TO 150
      IF(COND.NE.'Y') GO TO 125
C
C   LINK TO CONC(CONDUCTIVITY CALCULATION)
C
155   NUM=3
      CALL CHAIN(0,IDSK,'CONC')
C
C   TYPE QUESTION AS TO WHETHER OPERATIOR WANTS
C   TO MATCH TIMES TO CORRESPONDING ALTITUDES.
C
156   TYPE 7
      ACCEPT 10, MTA
      IF(MTA.EQ.'N') GO TO 150
      IF(MTA.NE.'Y') GO TO 156
157   IF(IDSK.EQ.1) GO TO 2000
C
C   GO TO 2000 IF OPERATING UNDER THE DISK, OTHERWISE
C   TYPE THE FOLLOWING STATEMENT.
C
      TYPE 158
158   FORMAT('   TYPE # OF DTA ON WHICH POSITIVE CONDUCTIVITY
     1 IS STORED &',/,'   # OF DTA ON WHICH NEGATIVE CONDUC
     2TIVITY IS STORED.',//,'   POSITIVE=  ',$)
      ACCEPT 30, IPSI
      TYPE 159
159   FORMAT('   NEGATIVE=  ',$)
      ACCEPT 30, INSI
      GO TO 2010
2000  IPSI=IDSK
      INSI=IDSK
2010  IF(IPLT.EQ.1) GO TO 175
      NUM=1
C
C   CHAIN TO LINK "MTAH" TO MATCH TIMES TO ALTITUDES.
C
      CALL CHAIN(0,IDSK,'MTAH')
C
C   QUESTION TO ASCERTAIN WHETHER OPERATOR DESIRES
C   TO PLOT CONDUCTIVITIES ON THE DISPLAY.
C
165   TYPE 170
170   FORMAT('   DO YOU DESIRE TO PLOT ALTITUDE VS
     1 CONDUCTIVITY CURVES? Y OR N.   ',$)
      ACCEPT 10, ANS
      IF(ANS.EQ.'N') GO TO 150
      IF(ANS.NE.'Y') GO TO 165
175   NUM=2
C
C   CHAIN TO LINK "SIGP" TO PLOT ALTITUDE VS.
```

```
C   CONDUCTIVITY.
C
        CALL CHAIN(0,IDSK,'SIGP ')
C
C   TYPE OUT THE FINAL QUESTION TO BE ASKED IN THE
C   PROGRAM.
C
150     TYPE 130
130     FORMAT(' ARE YOU FINISHED WITH THE PROGRAM? Y OR N. ',$)
        ACCEPT 10, ANS
        IF (ANS.EQ.'N') GO TO 6
        IF(ANS.NE.'Y') GO TO 150
        END
```

```
C     ***********************************************************
C          LINK CALC: DETERMINES THE SLOPES OF
C                         CALIBRATION DATA
C     ***********************************************************
          COMMON LP, ISHOW, XMAX, XMIN, YMAX, YMIN, INTENS, ISCALE
          COMMON /A/ ADVAL(3000), GRID(1000) /C/ AVCASL /D/ STAR(20),
          1 SEC(10) /E/ SLOPE(150,2) /F/ X(4), Y(4) /P/ ILINE(100),
          2 RB(5) /G/ ISKIP /H/ TIF(150,3) /I/ TIME(250) /M/
          3 IND, IFLAG, IEOF, KIN, INDF, NFLG /T/ CVAL(1600)
          4 /DA/ IDSK /DC/ FILID(10),TDMP(100)
C
C     STATEMENT REQUIRING OPERATOR ACTION UPON
C     ENTERING SUBROUTINE.
C
          PAUSE 'CALIBRATION SLOPE CALCULATIONS'
          AVCASL=0.0
C
C     ADDITION OF THE LITERALS 'SR','SL',& 'TAKE SLOPE' WHERE
C     SR IS SHIFT@RIGHT & SL IS SHIFT LEFT.
C
          CALL CHRGEN(GRID,'SR',210.0,62.0,2,0)
          CALL CHRGEN(GRID,'SL',260.0,62.0,2,0)
          CALL CHRGEN(GRID,'TAKE SLOPE',680.0,55.0,3,0)
C
C     REQUESTS THE # OF THE CALIBRATION FILE BEING
C     ANALIZED & INITIALIZES MAG TAPE FOR INPUT
C
          IERCT=0
          NFLG=1
C
C     REQUEST FOR INPUT OF MAG TAPE FILE NUMBER OF THE
C     CALIBRATION FILE TO BE ANALIZED.
C
1         TYPE 2
2         FORMAT(' TYPE THE MAG TAPE FILE # OF THE CAL FILE YOU
          1 ARE ANALIZING.   ',$)
          ACCEPT 3, IFILE
3         FORMAT(I)
          TYPE 5000
5000      FORMAT('  WHILE TAKING CAL SLOPES ESTIMATE THE TIME
          1 REQUIRED',/,'   FOR SLOPE TO SWEEP FROM MINIMUM
          2TO MAXIMUM. AT THIS TIME TYPE IN SWEEP VOLTAGE.',$)
          ACCEPT 5100, SWVOL
5100      FORMAT(F10.5)
C
C     INITCALIZATION OF MAG TAPE, SETTING DEC MODE &
```

```
C   READ IN OF FILE IDENTIFICATION INFORMATION.
C   IF THERE IS AN ERROR IN READING IN THE IDENTIFICATION
C   FILE A MESSAGE IS TYPED & THE PROGRAM WILL ATTEMPT
C   TO TRY AGAIN.  IF THE ERROR DOES NOT CORRECT BY THE
C   SIXTH ATTEMPT THE PROGRAM WILL TRANSFER CONTROL TO
C   LINK 'MAIN'.
C
        CALL MTINIT(IFILE,1)
        CALL SETDEC
8       CALL MTREAD(FILID,10,IERR)
        IF(IERR.EQ.0) GO TO 7
        TYPE 11,IERR
11      FORMAT(' <--- MTIO ERROR ',I1,'  IGNORED PROCESSING
        1 CONTINUED --->',///)
        IERCT=IERCT+1
        IF(IERCT.LE.5) CALL MTSKIP(-1,0)
        IF(IERCT.LE.5) CALL MTSKIP(1,0)
        IF(IERCT.LE.5) GO TO 8
6       TYPE 9
9       FORMAT('   ERROR WILL NOT CORRECT, PROCESSING STOPPED.',////)
        GO TO 300
C
C   SECTION TO DETERMINE IF CORRECT FILE HAS BEEN
C   LOCATED.  'FILID(1)' CONTAINS THE # OF
C   THE DESIRED FILE.  IF THESE TWO NUMBERS ARE EQUAL
C   THE PROGRAM BEGINS DATA ANALYSIS, OTHERWISE,
C   CORRECTIVE ACTION TO FIND THE CORRECT FILE IS
C   TAKEN.  THIS IS DONE BY EITHER ADVANCING 'IFF-IFILE'
C   FILES OR BACKSPACING 'IFILE-IFF-1' FILES AND READING
C   THE NEW FILE LOCATED.
C
7       IFF=FILID(1)
        IF(IFF-IFILE)500,510,520
500     IERCT=IERCT+1
        IF(IERCT.LE.5) TYPE 11,IERR
        IF(IERCT.GT.5) GO TO 6
        INF=IFILE-IFF
        CALL MTSKIP(INF,0)
        GO TO 8
520     IERCT=IERCT+1
        IF(IERCT.LE.5) TYPE 11,IERR
        IF(IERCT.GT.5) GO TO 6
        INF=IFILE-IFF-1
        CALL MTSKIP(INF,0)
        CALL MTSKIP(1,0)
        GO TO 8
C
C   TYPE OUT OF FILE IDENTIFICATION INFORMATION
C
510     TYPE 515, FILID(2), FILID(3), FILID(4), FILID(5),
```

```
      1 FILID(6),FILID(7),FILID(8),FILID(9)
515     FORMAT('  DATE OF LAUNCH:  ',2A5,/,'   TYPE OF DATA  ',
      12A5,/,'   TYPE OF DAY:  ',2A5,/,'   COMMENTS:  ',2A5,
      2////////)
        IERCT=0
        IFLAG=0
        IND=1
        INDF=0
        IEOF=0
4       N=0
C
C   DO LOOP TO READ IN 1600 DATA POINTS INTO ARRAY 'CVAL'.
C
        DO 20 L=1,80
        IERCT=0
C
C   READ IN OF ONE BLOCK OF DATA FROM MAG TAPE.
C   FOLLOWING 'MTREAD' THERE IS AN ERROR DETEDTION SECTION.
C
 400    CALL MTREAD(TDMP,100,IERR)
        IF(IERR.EQ.2) TYPE 405
405     FORMAT(' *** END OF MAG TAPE FILE ***',//)
        IF(IERR.EQ.2) GO TO 40
        IF(IERR.NE.0) GO TO 410
        IF(L.EQ.1) INDX=1
        DO 5 K=0,100,5
        KN=K
        IF(K.EQ.0) GO TO 5
C
C   ADDITION OF SCALING FACTORS TO EACH ELEMENT OF THE
C   BLOCK OF DATA READ IN FROM MAG TAPE & THEN EACH OF
C   THESE ELEMENTS BECOME ONE ELEMENT OF ARRAY 'CVAL'.
C   FOLLOWING THIS EACH ELEMENT IS TESTED TO INSURE IT DOES
C   NOT EXCEED DISPLAY SCOPE RANGE.  IF A VALUE
C   EXCEEDS THE RANGE IT IS TRUNCATED TO FIT THE DISPLAY
C   & A MESSAGE IS TYPED PRIOR TO ACTUAL DISPLAY OF DATA
C
        CVAL(INDX)=TDMP(KN)*150.0+200.0
        IF(CVAL(INDX).LE.1023.0) GO TO 5111
        IF(N.NE.0) GO TO 10
        TYPE 31
        N=1
10      CVAL(INDX)=1020.0
5111    INDX=INDX+1
5       CONTINUE
        GO TO 20
C
C   SHOULD AN ERROR OCCUR DURING READ IN OF A BLOCK OF
C   DATA.  CONTROL IS TRANSFERRED HERE TO ATTEMPT TO CLEAR
```

```
C   THE ERROR
C
410     TYPE 11,IERR
        IERCT=IERCT+1
        IF(IERCT.LE.5) CALL MTSKIP(0,-1)
        IF(IERCT.LE.5) GO TO 400
        TYPE 9
        GO TO 75
31      FORMAT('   <--- ERROR: VALUE TO BE DISPLAYED IS OUT OF
        1 THE RANGE OF DISPLAY --->',/,'   THE VALUE HAS BEEN
        2TRUNCATED TO FIT THE DISPLAY',//)
20      CONTINUE
C
C   TEST TO SEE IF 'CVAL' CONTAINS 1600 ELEMENTS IN ORDER
C   TO CENTER THE DISPLAY OF DATA CONTAINED IN ARRAY 'CVAL'.
C
40      L=INDX-1
        IF(L.EQ.1600) GO TO 25
        INDF=(L-1000)/2
        IF(INDF) 21,22,23
21      INDF=1
        I=L
        GO TO 26
22      INDF=1
        I=1000
        GO TO 26
23      I=L-INDF
        GO TO 26
25      INDF=300
        I=L-300
C
C   INITIALIZATION AND SET UP OF DATA DISPLAY ARRAY 'ADVAL'.
C
26      CALL INTAB(ADVAL,3000)
        XI=0.0
        YI=CVAL(INDF)
        CALL POINT(ADVAL,XI,YI)
        DO 30 K=INDF+1,I
        XE=XI+1.0
        YE=CVAL(K)
        IF(YE-YI.LT.0.999) CALL POINT(ADVAL,XI,YI)
        CALL LINE(ADVAL,XI,YI,XE,YE)
        XI=XE
30      YI=YE
C
C   CALL TO SUBROUTINE 'SLOPCA' TO ANALIZE
C   CALIBRATION DATA.
C
        CALL SLOPCA
        IF (IEOF.EQ.1) GO TO 75
```

```
      GO TO 4
C
C   OPTION TO CONTINUE PROCESSING IF A MINOR ERROR
C   OCCURS OR EXIT IF A MAJOR ERROR OCCURS.
C
 75   IF(IERCT.GT.5) PAUSE 'WHAT DO YOU WANT TO DO?'
C
C   TRANSFER OF CONTROL TO STATEMENT 1000 IF THE PROGRAM
C   IS OPERATING OFF THE DISK SYSTEM; OTHERWISE, THE PROGRAM
C   REQUESTS DATA STORAGE INFORMATION.
C
      TYPE 5200
5200  FORMAT('  TYPE IN ESTIMATED TIME FOR PROBE TO SWEEP
     1 FROM',/,'   FROM MINIMUM TO MAXIMUM.    ',$)
      ACCEPT 130, ST
      VDS= SWVOL/ST
      IF(IDSK.EQ.1) GO TO 1000
      TYPE 76
 76   FORMAT('  TYPE THE # OF THE DTA YOU WISH THE DATA TO BE'
     1,/,'   STORED.    ',$)
      ACCEPT 3, IDTA
      IDTA=IDTA+8
      GO TO 1010
C
C   INITIALIZE STORAGE DEVICE TO ACCEPT CALIBRATION SLOPE DATA
C
1000  IDTA=IDSK
C
C   OUTPUT OF CALIBRATION SLOPES & AVERAGE CALIBRATION
C   SLOPE TO STORAGE DEVICE.
C
1010  CALL OFILE(IDTA,'VOST')
      WRITE(IDTA,130) VDS
      CALL RELEAS(IDTA)
      CALL OFILE(IDTA,'CAL')
      DO 90 I=1,IND-1
90    WRITE(IDTA,130) SLOPE(I,1)
      CALL RELEAS(IDTA)
      DO 85 I=1,IND-1
85    AVCASL= AVCASL+SLOPE(I,1)
      AVCASL=AVCASL/(IND-1)
C
C   INITIALIZE STORAGE DEVICE TO ACCEPT AVERAGE OF CAL SLOPES
C
      CALL OFILE(IDTA,'AVCAS')
      WRITE(IDTA, 130) AVCASL
      CALL RELEAS(IDTA)
      IF(IDTA.EQ.IDSK) GO TO 1020
      IDTA=IDTA-8
C
```

```
C    PRINT OUT OF HEADINGS AND FILE IDENTIFICATION
C    INFORMATION
C
         PRINT 78
78       FORMAT('1 THE CALIBRATION DATA HAS BEEN
         1 STORED ON DTA',1X,' UNDER THE NAME CAL.DAT.')
         PRINT 79, IDTA
79       FORMAT('+',44X,I1)
         PRINT 1015, FILID(2), FILID(3), FILID(6),FILID(7),
         1FILID(8), FILID(9)
1015     FORMAT('-',20X,'DATE OF LAUNCH:   ',2A5,5X,'TYPE OF DAY:
         1   ',2A5,5X,'COMMENTS:   ',2A5)
         GO TO 1040
1020     PRINT 1030, FILID(2), FILID(3), FILID(6), FILID(7),
         1FILID(8), FILID(9)
1030     FORMAT('1 THE CALIBRATION DATA HAS BEEN STORED ON THE
         1DSK UNDER THE NAME CAL.DAT.',/,'-',20X,'DATE OF THE
         2 LAUNCH   ',2A5,5X,'TYPE OF DAY:   ',2A5,5X,'COMMENTS:
         3,2A5)
C
C    PRINT THE VALUES OF THE CALIBRATION SLOPES
C
1040     PRINT 80
80       FORMAT('-      THE VALUES OF THE SLOPES OF THE CALIBRATE
         1 CURVES FOLLOWS:',/)
         DO 91 I=1,IND-1
91       PRINT 95, I, SLOPE(I,1)
95       FORMAT('*  SLOPE (',I3, ')=   ', F10.5)
130      FORMAT(F10.5)
C
C    PRINT THE AVERAGE CALIBRATION SLOPES
C
         PRINT 120, AVCASL
120      FORMAT(',  THE AVERAGE CAL SLOPE=   ', F10.5)
300      ISKIP=1
         IF(IDTA.EQ.IDSK) GO TO 1050
         IDTA=IDTA+8
1050     CALL RELEAS(3)
         CALL DISPLY(0)
C
C    LINK BACK TO 'MAIN' UPON COMPLETION OF THE ANALYSIS
C    OF CALIBRATION DATA.
C
         CALL CHAIN(0,IDSK,'MAIN')
         END


C    ************************************************************
```

```
C
C         SUBROUTINE SLOPCA: CALCULATION OF SLOPES OF
C                         CALIBRATION FLIGHT DATA.
C
C    ************************************************************
          SUBROUTINE SLOPCA
          COMMON LP, ISHOW, XMAX, XMIN, YMAX, YMIN, INTENS, ISCALE
          COMMON /A/ ADVAL(3200), GRID(1020) /C/ AVCASL /D/ STAR(20),
          1 SEC(10) /E/ SLOPE(150,2) /F/ X(4), Y(4) /P/ ILINE(100),
          2 RB(5) /G/ ISKIP /M/ IND, IFLAG, IEOF, KIN, INDF, NFLG
          3 /T/ CVAL(1600)
C
C    SET UP LITERAL SHOWN FOR DISPLAY ON SCOPE, TO ALLOW
C    USER TO ANALIZE CALIBRATE SLOPES.
C
          ISTAT=0
          JMP=0
          IF(NFLG.GT.1) GO TO 5
          NFLG=NFLG+1
          CALL CHRGEN(GRID,'NEXT SET',300.0,62.0,2,0)
C
C    INITIALIZATION OF ARRY STAR & SEC. THEN CONSTRUCT
C    MOVEABLE STAR.
C
5         CALL INTAB(STAR,20)
          CALL INTAB(SEC, 10)
          ISHOW=0
          CALL POINT(SEC,155.0,75.0)
          CALL LINE(STAR,20.0,20.0,0.0,20.0)
          ISHOW=1
          CALL LINE(STAR,0.0,20.0,40.0,20.0)
          ISHOW=0
          CALL LINE(STAR,40.0,20.0,40.0,0.0)
          ISHOW=1
          CALL LINE(STAR,40.0,0.0,0.0,40.0)
          ISHOW=0
          CALL LINE(STAR,0.0,40.0,20.0,40.0)
          ISHOW=1
          CALL LINE(STAR,20.0,40.0,20.0,0.0)
          ISHOW=0
          CALL LINE(STAR,20.0,0.0,0.0,0.0)
          ISHOW=1
          CALL LINE(STAR,0.0,0.0,40.0,40.0)
C
C    MPOINT MOBILIZES THE STAR, THEN ALL ARRAYS ARE
C    DISPLAYED, THEN CALL LITEPN TO ACTIVATE THE LITE PEN.
C
          CALL MPOINT(SEC, 155.0,75.0)
          CALL DISPLY(4, SEC, STAR, GRID, ADVAL)
```

```
10      CALL LITEPN(NSLOPE, XS, YS)
        IF(NSLOPE.EQ.0) GO TO 10
C
C   DECISION SECTION:
C                            REJECT????
C
        IF((XS.GT.680.0).AND.(XS.LT.800.0).AND.(YS.LE.40.0))
       1 GO TO 50
C
C                            END????
C
        IF((XS.GT.920.0).AND.(XS.LT.1023.0).AND.(YS.LE.40.0))
       1 GO TO 60
C
C                       NEXT SET????
C
        IF((XS.GT.300.0).AND.(XS.LT.380.0).AND.(YS.GT.62.0).AND.
       1(YS.LT.76.0)) GO TO 50
        IF(INDF.EQ.1) GO TO 19
C
C                        SHIFT RIGHT???
C
        IF((JMP.EQ.1).AND.(ISTAT.EQ.1)) GO TO 12
        IF((XS.LT.210.0).OR.(XS.GT.230.0).OR.(YS.LT.62.0).OR.
       1(YS.GT.76.0)) GO TO 12
        IF(ISTAT.NE.2) GO TO 11
        IL=INDF
        IM=INDF+1000
        ISTAT=0
        GO TO 1000
11      IL=1
        IM=1000
        JMP=1
        ISTAT=1
        GO TO 1000
C
C                        SHIFT LEFT???
C
12      IF((XS.LT.260.0).OR.(XS.GT.280.0).OR.(YS.LT.62.0).OR.
       1(YS.GT.76.0)) GO TO 19
        IF(ISTAT.EQ.2) GO TO 10
        IF(ISTAT.EQ.0) GO TO 13
        IL=INDF
        IM=INDF+1000
        ISTAT=0
        JMP=0
        GO TO 1000
13      IL=2*INDF
        IM=IL+1000
        ISTAT=2
```

```
1000    XI=0.0
        CALL DISPLY(0)
C
C   INITIALIZATION OF DATA DISPLAY ARRAY 'ADVAL' AND
C   BUILD UP OF SAME TO DISPLAY DATA AFTER A SHIFT LEFT
C   OR SHIFT RIGHT.
C
        CALL INTAB(ADVAL,3000)
        YI=CVAL(IL)
        CALL POINT(ADVAL,XI,YI)
        DO 1010 K=IL+1,IM-1
        XE=XI+1.0
        YE=CVAL(K)
        IF(YE-YI.LT.0.999) CALL POINT(ADVAL,XI,YI)
        CALL LINE(ADVAL,XI,YI,XE,YE)
        XI=XE
1010    YI=YE
C
C   DISPLAY OF ALL ARRAYS TO SHOW SHIFTED SECTION
C   OF DATA ARRAY.
C
        CALL DISPLY(4,SEC,STAR,GRID,ADVAL)
        GO TO 10
C
C   CALCULATION  OF SLOPES
C
19      IF((XS.LT.680.0).OR.(XS.GT.830.0).OR.(YS.LT.55.0).OR.
        1(YS.GT.76.0)) GO TO 10
        ISAV=1
C
C   ACTIVATE LITEPEN TO ACCEPT FIRST POINT IN CALCULATING
C   SLOPES.
C   IF POINT RECEIVED INDICATES "ACCEPT" GO TO 30
C   OTHERWISE MOVE THE STAR. AND INITIALIZE
C   ARRAY ILINE.
C
21      CALL LITEPN(IACC,X2,Y2)
        IF(IACC.EQ.0) GO TO 21
        IF((X2.GT.380.0).AND.(X2.LT.630.0).AND.(Y2.LE.40.0)) GO TO 30
        CALL MPOINT(SEC, X2, Y2)
        CALL DISPLY(4, SEC, STAR, GRID, ADVAL)
        CALL INTAB(ILINE,100)
C
C   X & Y COORDINATES OF DESIRED POINT ON CURVE
C
        X(ISAV)=X2
        Y(ISAV)=Y2
        CALL POINT(ILINE, X(1), Y(1))
        IF(ISAV.LT.2) GO TO 21
C
```

```
C   CHECK TO SEE IF THERE WAS AN ERROR IN SELECTING
C   THE SECOND POINT ON THE CURVE. IF THERE WAS
C   DISPLAY THE ERROR MESSAGE SHOWN, CONNECT THE
C   TWO POINTS SELECTED WITH A LINE, AND DISPLAY
C   ALL ARRAYS. IF NO ERROR JUST CONNECT THE
C   POINTS WITH A LINE & DISPLAY ALL ARRAYS.
C
        CALL LINE(ILINE, X(1), Y(1), X(2), Y(2))
        IF((Y(1).LT.Y(2)).AND.(X(1).LT.X(2))) GO TO 25
C
C   SETUP & DISPLAY OF ERROR MESSAGE IF A NEGATIVE
C   SLOPE IS DETECTED.
C
        CALL CHRGEN(ILINE,'<-- ERROR NEG. SLOPE -->',210.0,82.0,2,0)
        CALL DISPLY(0)
        DO 26 IB=1,4
        CALL DISPLY(1,ILINE)
        CALL WAIT(250)
26      CALL DISPLY(0)
25      CALL DISPLY(5,SEC,STAR,GRID,ADVAL,ILINE)
        GO TO 21
C
C   WAIT 1500 MSEC, CLEAR LITE PEN VALUES, & MOVE STAR
C   TO READY POSITION. INCREASE ISAV BY 1, & IF ISAV<
C   OR =2 GO TO 50, TO ACCEPT SECOND COORDINATES OF DATA
C   IF ISAV>2 CALCULATE SLOPES.
C
30      CALL WAIT(1500)
        CALL LITEPN(ICLE, X4, Y4)
        CALL MPOINT(SEC, 155.0, 75.0)
        ISAV=ISAV+1
        IF(ISAV.LE.2) GO TO 21
        SLOPE(IND,1)= (Y(2)-Y(1))/(X(2)-X(1))
        IND= IND+1
        GO TO 10
50      IFLAG=0
        GO TO 70
C
C   UPON COMPLETION OF CALIBRATION DATA ANALYSIS FLAG 'IEOF' IS
C   SET TO ONE WHEN 'END' IS DETECTED BY DISPLAY.
C
60      IEOF=1
70      CALL DISPLY(0)
        RETURN
        END
```

```
C    ************************************************************
C         CALD: DETERMINES THE SLOPES OF
C                 THE FLIGHT DATA
C    ************************************************************
        COMMON LP, ISHOW,XMAX, XMIN, YMAX, YMIN, INTENS, ISCALE
        COMMON /A/ ADVAL(3000), GRID(1000),DEC(100)
        4 /D/ STAR(20), SEC(10) /DC/ FILID(10), TDMP(100)
        1 /E/ SLOPE(150,2) /F/ X(4), Y(4) /G/ ISKIP /H/ TIF(150,3)
        2 /I/ TIME(250) /J/ ASK(4), R(6), B(2) /M/ IND, IFLAG,
        3 IEOF, KIN,INDF, NFLG /S/ FVAL(1005) /DA/ IDSK
C
C        SET UP THE LITERAL SHOWN TO DETERMINE THE TYPE
C        (POS. OR NEG. COND.) OF SLOPE TO BE CALCULATED.
C
C
C    STATEMENT REQUIREING OPERATOR ACTION UPON
C    ENTERING SUBROUTINE.
C
        PAUSE 'FLIGHT SLOPE CALCULATIONS'
        CALL DISPLY(1,GRID)
        NFLG=1
C
C        SET UP THE LITERAL SHOWN TO DETERMINE THE TYPE
C        (POS. OR NEG. COND.) OF SLOPE TO BE CALCULATED.
C
        CALL CHRGEN(GRID,'SLOPE FOR +OR- COND??',635.0,82.0,2,0)
        CALL CHRGEN(GRID,'+',650.0,44.0,5,0)
        CALL CHRGEN(GRID,'-',978.0,44.0,5,0)
C
C    ADDITION OF LITERAL TO ARRAY 'GRID' TO ALLOW MAGNIFICATION
C    BY A FACTOR OF 4 & RETURN TO NORMAL DISPLAY.  FOLLOWING
C    THAT THERE IS INSERTION OF LITERAL SEPARATORS.
C
        CALL CHRGEN(GRID,'X4  NORMAL',710.0,55.0,3,0)
        DO 2 J=1,2
        CALL POINT(GRID,B(J),40.0)
2       CALL LINE(GRID,B(J),40.0,B(J),80.0)
C
C    INITIALIZATION & SET UP OF ARRAY 'TIME' FOR A TEN
C    SECOND TIME BASE.
C
        CALL INTAB(TIME, 250)
        XCOOR=65.0
        DO 1 I=1,10
        ENCODE(4,5,ASK),I
5       FORMAT(I4)
```

```
      ASK(2)=0.0
      CALL CHRGEN(TIME,ASK,XCOOR,130.0,2,0)
1     XCOOR=XCOOR+100.0
      CALL CHRGEN(GRID,'TIME IN',900.0,115.0,2,0)
      CALL CHRGEN(GRID,'  SEC   ',900.0,100.0,2,0)
C
C   ACCEPTS THE MAG TAPE FILE # OF THE FLIGHT DATA
C   BEING ANALIZED, & INITIALIZES MAG TAPE FOR INPUT.
C
      IERCT=0
      TYPE 20
20    FORMAT('  TYPE THE # OF THE MAG TAPE FILE #, WHICH CONTAINS
     1 THE',/,'     FLIGHT DATA YOU ARE ANALYIZING. ',$)
      ACCEPT 25, IFILE
25    FORMAT(I)
      CALL MTINIT(IFILE,1)
      CALL SETDEC
C
C   READ IN OF FILE IDENTIFICATION INFORMATION.
C   IF THERE IS AN ERROR IN READING IN THE INFORMATION
C   A MESSAGE IS TYPED & THE PROGRAM WILL ATTEMPT
C   TO READ IT AGAIN.  SHOULD THE ERROR NOT CORRECT BY
C   THE SIXTH ATTEMPT THE PROGRAM WILL TRANSFER
C   CONTROL TO LINK 'MAIN'.
C
19    CALL MTREAD(FILID,10,IERR)
      IF(IERR.LE.0) GO TO 24
      TYPE 21,IERR
21    FORMAT(' <---MTIO ERROR ',I1,' IGNORED PROCESSING
     1 CONTINUED --->',///)
      IERCT=IERCT+1
      IF(IERCT.LE.5) CALL MTSKIP(-1,0)
      IF(IERCT.LE.5) CALL MTSKIP(1,0)
      IF(IERCT.LE.5) GO TO 19
4     TYPE 22
22    FORMAT('   ERROR WILL NOT CORRECT, PROCESSING STOPPED.',////)
      GO TO 290
C
C   SECTION TO DETERMINE IF CORRECT FILE HAS BEEN
C   LOCATED.  'FILID(1)' CONTAINS THE # OF THE MAG TAPE
C   FILE THAT HAS BEEN FOUND, WHILE 'IFILE' IS THE # OF
C   THE DESIRED FILE.  IF THESE TWO NUMBERS ARE EQUAL
C   THE PROGRAM BEGINS DATA ANALYSIS; OTHERWISE,
C   CORRECTIVE ACTION TO FIND THE CORRECT FILE IS
C   TAKEN.  THIS IS DONE BY EITHER ADVANCING 'IFF-IFILE'
C   FILES OR BACKSPACING 'IFILE-IFF-1' FILES AND READING
C   THE NEW FILE LOCATED.
C
24    IFF=FILID(1)
      IF(IFF-IFILE) 1001,1010,1020
```

```
1001    IERCT=IERCT+1
        IF(IERCT.LE.5) TYPE 21,IERR
        IF(IERCT.GT.5) GO TO 4
        INF=IFILE-IFF
        CALL MTSKIP(INF,0)
        GO TO 19
1020    IERCT=IERCT+1
        IF(IERCT.LE.5) TYPE 21,IERR
        IF(IERCT.GT.5) GO TO 4
        INF=IFIN-IFF-1
        CALL MTSKIP(INF,0)
        CALL MTSKIP(1,0)
        GO TO 19
C
C   TYPE OUT OF FILE IDENTIFICATION INFORMATION
C
1010    TYPE 1030,FILID(2),FILID(3),FILID(4),FILID(5),
        1 FILID(6),FILID(7),FILID(8),FILID(9)
1030    FORMAT('   DATE OF LAUNCH:   ',2A5,/,'   TYPE OF DATA:   ',2A5,/,
        1'   TYPE OF DAY:   ',2A5,/,'   COMMENTS:   ',2A5,////////)
        IERCT=0
        IFLAG=0
        IND=1
        INDF=1
        IEOF=0
        KIN=1
        MIN=10
C
C   INITIALIZATION OF ARRAY DEC TO FACILITATE
C   THE 2 SEC DISPLAY OPTION USED WHEN ANALYZING
C   NEGATIVE CONDUCTIVITY SLOPE.  IT OCCURS TWICE
C   BECAUSE AFTER THE FIRST DISPLAY OF DATA THE
C   PROGRAM NEVER PASSES THE FIRST POINT.
C
        CALL INTAB(DEC,100)
        CALL CHRGEN(DEC,'2 SEC DIS',20.0,15.0,2,0)
        GO TO 27
26      CALL INTAB(DEC,100)
        CALL CHRGEN(DEC,'2 SEC DIS',20.0,15.0,2,0)
C
C   UP DATING OF TIME BASE DATA ON
C   SUCESSIVE DISPLAYS BY INITIALIZING AND
C   CHANGING ARRAY 'TIME'.
C
        CALL INTAB(TIME, 250)
        XCOOR=65.0
        KIN=KIN+10
        MIN=MIN+10
        DO 16 I=KIN,MIN
        ENCODE(4,15,ASK),I
```

```
15      FORMAT(I4)
        ASK(2)=0.0
        CALL CHRGEN(TIME,ASK,XCOOR,130.0,2,0)
16      XCOOR=XCOOR+100.0
27      CALL DISPLY(3,GRID, TIME,DEC)
        IDISER=0
        INDX=1
C
C   DO LOOP TO TRANSFER DATA FROM MAG TAPE
C   TO ARRAY 'FVAL' TO FACILITATE ANALYSIS.
C
        DO 40 L=1,50
        IERCT=0
C
C   READ IN OF ONE BLOCK OF DATA FROM MAG TAPE.
C   FOLLOWING 'MTREAD' THERE IS AN ERROR DETECTION SECTION
C
500     CALL MTREAD(TDMP,100,IERR)
        IF(IERR.EQ.2) IEOF=1
        IF(IEOF.EQ.1) GO TO 140
        IF(IERR.EQ.0) GO TO 530
        TYPE 21,IERR
        IERCT=IERCT+1
        IF(IERCT.LE.5) GO TO 500
        TYPE 22
        GO TO 200
C
C   ADDITION  OF SCALING FACTORS TO EACH ELEMENT OF THE
C   BLOCK OF DATA READ IN FROM MAG TAPE & THEN EACH OF
C   THESE ELEMENTS BECOME ONE ELEMENT OF ARRAY 'FVAL'.
C   FOLLOWING THIS EACH ELEMENT IS TESTED TO INSURE IT DOES
C   NOT EXCEED DISPLAY SCOPE RANGE.  IF A VALUE
C   EXCEEDS THE RANGE IT IS TRUNCATED TO FIT THE DISPLAY
C   & A MESSAGE IS TYPED PUIOR TO ACTUAL DISPLAY OF DATA.
C
530     DO 40 I=0,100,5
        IX=I
        IF(I.EQ.0) IX=1
        FVAL(INDX)=TDMP(IX)*150.0+200.0
        INDX=INDX+1
        IF(FVAL(INDX-1).LE.1023.0) GO TO 40
        FVAL(INDX-1)=1023.0
        IDISER=IDISER+1
40      CONTINUE
C
C   INITILIZATION AND SET UP OF DATA DISPLAY ARRAY 'ADVAL'.
C
140     CALL INTAB(ADVAL,3000)
        XI=0.0
        YI=FVAL(1)
```

```
      CALL POINT(ADVAL,XI,YI)
      DO 1000 L=2,1000
      XE=XI+1.0
      YE=FVAL(L)
      IF(YE-YI.LT.0.999) CALL POINT(ADVAL,XI,YI)
      CALL LINE(ADVAL,XI,YI,XE,YE)
      XI=XE
1000  YI=YE
C
C   IF ANY DISPLAY VALUES HAVE BEEN TRUNCATED TO FIT THE DISPLAY
C   TYPE THE FOLLOWING ERROR MESSAGE.
C
      IF(IDISER.NE.0) TYPE 29,IDISER
29    FORMAT('   <--- ERROR: VALUES TO BE DISPLAYED ARE OUT OF
     1 THE RANGE OF DISPLAY --->',/,' ',7X,I4,' VALUES HAVE BEEN
     2 TRUNCATED TO FIT THE DISPLAY',//)
C
C   CALL TO SUBROUTINE 'SLOPCA' TO ANALIZE FLIGHT DATA
C
      CALL SLOPCA
      IF(IEOF.EQ.1) GO TO 200
      GO TO 26
C
C   OPTION TO CONTINUE PROCESSING IF A MINOR ERROR
C   OCCURS OR  EXIT IF A MAJOR ERROR OCCURS.
C
200   IF(IERCT.GT.5) PAUSE 'WHAT DO YOU WANT TO DO?'
C
C   TRANSFER OF CONTROL TO STATEMENT 2000 IF THE
C  PROGRAM IS OPERATING OFF THE DISK; OTHERWISE,
C   THE PROGRAM REQUESTS DATA STORAGE INFORMATION.
C
      IF(IDSK.EQ.1) GO TO 2000
      TYPE 204
204   FORMAT('  TYPE THE # OF THE DTA YOU WANT THE DATA TO BE
     1 WRITTEN.  ',$)
      ACCEPT 25, IDTA
      IDTA=IDTA+8
2000  IF(IDSK.EQ.1) IDTA=IDSK
C
C   INITIALIZATION OF OUTPUT STORAGE DEVICE TO ACCEPT
C   POSITIVE SLOPES FOR CONDUCTIVITY CALCULATIONS
C
      CALL OFILE(IDTA,'POS')
      J=1
      N=IND-1
C
C   DO LOOP TO WRITE FIRST POSITIVE SLOPE DATA
C   THEN NEGATIVE SLOPE DATA ONTO THE STORAGE CEVICE
C
```

```
215     DO 220 I=1,N
        IF(J.EQ.1) WRITE(IDTA,230) SLOPE(I,J), TIF(I,J)
220     IF(J.EQ.2) WRITE(IDTA,230) SLOPE(I,J), TIF(I,J), TIF(I,3)
230     FORMAT(F10.5)
        CALL RELEAS(IDTA)
        J=J+1
        IF(J.GT.2) GO TO 270
C
C    INITIALIZATION OF OUTPUT STORAGE DEVICE TO
C    ACCEPT NEGATIVE SLOPES FOR CONDUCTIVITY
C    CALCULATIONS.
C
        CALL OFILE(IDTA,'NEG')
        N=INDF-1
        GO TO 215
270     N=IND-1
        IF(IDSK.NE.1) IDTA=IDTA-8
        J=1
        IF(IDSK.EQ.1) GO TO 2010
C
C    PRINT OUT OF HEADING & FILE INFORMATION
C    DATA FOR POSITIVE SLOPES
C
        PRINT 206
206     FORMAT('1 THE FLIGHT DATA HAS BEEN WRITTEN ON DTA',1X,
        1' UNDER THE NAMES POS.DAT (FOR POS. COND.) &
        2 NEG.DAT (FOR NEG. COND.)')
        PRINT 207, IDTA
207     FORMAT('+',40X,I1)
        PRINT 208,FILID(2),FILID(3),FILID(6),FILID(7),
        1FILID(8),FILID(9)

208     FORMAT('-',20X,'DATE OF LAUNCH:   ',2A5,5X,'TYPE OF DAY:'
        1,2A5,5X,'COMMENTS:   ',2A5)
C
C    PRINT THE VALUES OF THE FLIGHT SLOPES
C
2010    PRINT 2020
2020    FORMAT(' THE FLIGHT DATA HAS BEEN WRITTEN ON THE DSK
        1 UNDER THE NAMES POS.DAT (FOR POS. COND.) & NEG.DAT (FOR
        2 NEG. COND.)')
        PRINT 208,FILID(2),FILID(3),FILID(6),FILID(7),
        1 FILID(8),FILID(9)
2030    PRINT 210
210     FORMAT('-       THE VALUES OF THE SLOPES OF THE FLIGHT
        1 CURVES FOLLOWS:',/)
280     IF(J.EQ.2) PRINT 245
        IF(J.GE.2) GO TO 249
C
C    PRINT OUT OF HEADING & FILE INFORMATION
```

```
C   DATA FOR NEGATIVE SLOPES.
C
         PRINT 240
240      FORMAT('  FLIGHT SLOPES USED TO CALCULATE POSITIVE
         1 CONDUCTIVITIES FOLLOW: ',//,'+',3X,'SLOPE',13X,
         2'TIME IN FLIGHT',//,'+',25X,'IN SEC',//)
245      FORMAT('-  FLIGHT SLOPES USED TO CALCULATE NEGATIVE
         1 CONDUCTIVITIES FOLLOW: ',//,'+',3X,'SLOPE',13X,
         2'TIME IN FLIGHT',//,'+',25X,'IN SEC',//)
C
C   ACTUAL PRINT OUT OF SLOPE EITHER POSITIVE
C   OR NEGATIVE
C
249      DO 250 I=1,N
250      PRINT 260, SLOPE(I,J), TIF(I,J)
260      FORMAT(' ',F10.5,12X,F10.5)
         J=J+1
         IF(J.GT.2) GO TO 290
         N=INDF-1
         GO TO 280
290      ISKIP=1
         IF(IDSK.NE.1) IDTA=IDTA+8
         CALL DISPLY(0)
         CALL RELEAS(3)
C
C   CHAIN BACK TO LINK 'MAIN'.
C
         CALL CHAIN(0,IDSK,'MAIN')
         END


C   ***********************************************************
C
C         SUBROUTINE SLOPCA: CALCULATION OF SLOPES OF
C                            FLIGHT DATA.
C
C   ************************************************************
         SUBROUTINE SLOPCA
         COMMON LP, ISHOW, XMAX, XMIN, YMAX, YMIN, INTENS, ISCALE
         COMMON /A/ ADVAL(3000), GRID(1000)
         4,DEC(100) /D/ STAR(20), SEC(10) /J/ ASK(4)
         1 /E/ SLOPE(150,2) /F/ X(4), Y(4) /H/ TIF(150,3)
         2 /I/ TIME(250) /M/ IND, IFLAG, IEOF, KIN, INDF, NFLG
         3 /P/ ILINE(100), RB(5) /S/ FVAL(1005) /DC/ FILID(10),
         4 TDMP(100)
C
C   SET UP LITERAL SHOWN FOR DISPLAY ON SCOPE, TO ALLOW
C   USER TO CHOOSE THE # OF CALIBRATE SLOPES TO BE
C   ANALIZED IN ONE GIVEN DISPLAY
C
```

```
      ITS=0
      IEXPN=0
      IF(NFLG.GT.1) GO TO 5
      NFLG=NFLG+1
      CALL CHRGEN(GRID,'# OF SLOPES   1   2   3   4   ',
     1 210.0, 62.0, 2, 0)
C
C   DO LOOP TO INSERT VERTICAL SEPARATION LINES BETWEEN
C   EACH # ABOVE, TO DEFINE SELECTION AREA FOR EACH #.
C
      DO 100 I=1,5
      CALL POINT(GRID, RB(I), 60.0)
100   CALL LINE(GRID, RB(I), 60.0, RB(I), 80.0)
C
C   INITIALIZATION OF ARRY STAR & SEC. THEN CONSTRUCT
C   MOVEABLE STAR.
C
5     CALL INTAB(STAR,20)
      CALL INTAB(SEC, 10)
      ISHOW=0
      CALL POINT(SEC,155.0,75.0)
      CALL LINE(STAR,20.0,20.0,0.0,20.0)
      ISHOW=1
      CALL LINE(STAR,0.0,20.0,40.0,20.0)
      ISHOW=0
      CALL LINE(STAR,40.0,20.0,40.0,0.0)
      ISHOW=1
      CALL LINE(STAR,40.0,0.0,0.0,40.0)
      ISHOW=0
      CALL LINE(STAR,0.0,40.0,20.0,40.0)
      ISHOW=1
      CALL LINE(STAR,20.0,40.0,20.0,0.0)
      ISHOW=0
      CALL LINE(STAR,20.0,0.0,0.0,0.0)
      ISHOW=1
      CALL LINE(STAR,0.0,0.0,40.0,40.0)
C
C   MPOINT MOBILIZES THE STAR, THEN ALL ARRAYS ARE
C   DISPLAYED, THEN CALL LITEPN TO ACTIVATE THE LITE PEN.
C
      CALL MPOINT(SEC, 155.0,75.0)
      CALL DISPLY(5,SEC,STAR,GRID,ADVAL,TIME)
10    CALL LITEPN(NSLOPE, XS, YS)
      IF(NSLOPE.EQ.0) GO TO 10
C
C   DECISION SECTION:
C                            REJECT????
C
      IF((XS.GT.680.0).AND.(XS.LT.800.0).AND.(YS.LE.40.0))
     1 GO TO 50
```

```
C
C                          END????
C
      IF((XS.GT.920.0).AND.(XS.LT.1023.0).AND.(YS.LE.40.0))
     1 GO TO 60
C
C   WHAT IS THE # OF SLOPES TO BE
C   CALCULATED????
C
      IF((XS.GT.380.0).AND.(XS.LT.433.0).AND.(YS.GT.60.0).
     1AND.(YS.LT.80.0)) NUMSL=1
      IF((XS.GT.433.0).AND.(XS.LT.500.0).AND.(YS.GT.60.0).
     1AND.(YS.LT.80.0)) NUMSL=2
      IF((XS.GT.500.0).AND.(XS.LT.548.0).AND.(YS.GT.60.0).
     1AND.(YS.LT.80.0)) NUMSL=3
      IF((XS.GT.548.0).AND.(XS.LT.600.0).AND.(YS.GT.60.0).
     1AND.(YS.LT.80.0)) NUMSL=4
      IF((XS.GT.665.0).OR.(XS.LT.380.0).OR.(YS.LT.60.0).
     1OR.(YS.GT.80.0)) GO TO 10
C
C   CALCULATION LOOP FOR THE # OF SLOPES TO BE CALCULATED
C
      DO 40 I=1,NUMSL
      ISAV=1
      NFST=0
C
C   ACTIVATE LITEPEN TO ACCEPT FIRST POINT IN CALCULATING
C   SLOPES.
C
20    CALL LITEPN(IACC,X2,Y2)
      IF(IACC.EQ.0) GO TO 20
      CALL MPOINT(SEC,X2,Y2)
      IF(ISAV.NE.1) GO TO 21
C
C   SLOPE FOR POSITIVE CONDUCTIVITY???
C
      IF((Y2.LT.40.0).OR.(Y2.GT.80.0).OR.(X2.LT.650.0)
     1.OR.(X2.GT.675.0)) GO TO 3000
      ITYSL=1
      GO TO 3010
C
C   SLOPE FOR NEGATIVE SLOPE???
C
C   IF LITE PEN DETECTION DOES NOT FALL
C   WITHIN ABOVE TWO SECTIONS THEN 'GO TO 20'
C   AND WAIT FOR ONE OF THE TWO RESPONSES.
C
3000  IF((Y2.LT.40.0).OR.(Y2.GT.80.0).OR.(X2.LT.978.0)
     1.OR.(X2.GT.1003.0)) GO TO 20
      ITYSL=2
```

```
3010    CALL WAIT(1000)
        CALL LITEPN(ICLE,X4,Y4)
C
C   MOVE STAR TO READY POSITION & TEST FLAGS
C   'ITYSL' AND 'ITS'.
C
15      CALL MPOINT(SEC,155.0,75.0)
        IF(ITYSL.EQ.1.AND.ITS.EQ.1) GO TO 2000
C
C   CALL TO 'LITEPN' TO ALLOW MOVING OF STAR
C   ANYWHERE ABOVE 200 RASTER UNITS ON THE
C   DISPLAY SCREEN, CHECK OTHER FLAGS, MOVE
C   STAR TO DETECTED POINT, & PLACE X & Y
C   COORDINATES DETECTED INTO 'X(ISAV)' & 'Y(ISAV)'.
C   AT NO TIME WILL 'ISAV' BE ANY OTHER VALUE THAN
C   ONE.
C
21      CALL LITEPN(IACC,X2,Y2)
        IF(IACC.EQ.0) GO TO 21
        IF((Y2.LE.200.0).OR.(ISAV.GT.1).OR.(NFST.EQ.1)) GO TO 200
        CALL MPOINT(SEC,X2,Y2)
        X(ISAV)=X2
        Y(ISAV)=Y2
        YLOC=Y2+400.0
        GO TO 21
200     IF(ITS.EQ.1) GO TO 23
        IF(ISAV.GT.1) GO TO 23
        IF(IEXPN.EQ.1) GO TO 22
C
C   TESTS TO SEE IF OPERATOR DESIRES TO MAGNIFY
C   DATA BY A FACTOR OF 4.  IF NOT 'GO TO 22'.
C
        IF((Y2.LT.55.0).OR.(Y2.GE.76.0).OR.(X2.LE.710.0)
        1.OR.(X2.GT.740.0)) GO TO 22
        CALL DISPLY(0)
        IEXPN=1
        ICHKS=1
        YLOC2=YLOC
C
C   PERFORM MULTIPLICATION ON FLIGHT DATA STORED
C   IN ARRAY 'FVAL', THE INITIALIZE DISPLAY ARRAY
C   'ADVAL' & TRANSFER DATA FROM 'FVAL' TO
C   'ADVAL'
C
        DO 1000 L=1,1001
1000    FVAL(L)=(FVAL(L)-650.0)*4.0+YLOC2
        CALL INTAB(ADVAL,3000)
        XI=0.0
        YI=FVAL(1)
        IF(YI.LT.150.0) YI=150.0
```

```
      IF(YI.GT.1020.0) YI=1020.0
      CALL POINT(ADVAL,XI,YI)
      DO 1010 L=2,1000
      XE=XI+1.0
      YE=FVAL(L)
      IF(YE.LT.150.0) YE=150.0
      IF(YE.GT.1020.0) YE=1020.0
      IF(YE-YI.LT.0.999) CALL POINT(ADVAL,XI,YI)
      CALL LINE(ADVAL,XI,YI,XE,YE)
      XI=XE
1010  YI=YE
      GO TO 24
22    IF(IEXPN.NE.1) G TO 23
C
C   TEST TO SEE IF MAGNIFIED DISPLAY SHOULD RETURN TO NORMAL.
C
      IF((Y2.LT.55.0).OR.(Y2.GE.76.0).OR.(X2.LT.755.0)
      1.OR.(X2.GT.845.0)) GO TO 23
      CALL DISPLY(0)
      X2=155.0
      Y2=75.0
      ICHKS=0
C
C   REDUCES EXPANDED VALUES TO NORMAL SIZE
C   THEN INITIALIZE DATA DISPLAY 'ADVAL' &
C   TRANSFER DATA FROM ARRAY 'FVAL' TO ARRAY
C   'ADVAL'.
C
      DO 1020 L=1,1001
1020  FVAL(L)=(FVAL(L)-YLOC2)/4.0+650.0
      CALL INTAB(ADVAL,3000)
      XI=0.0
      YI=FVAL(1)
      CALL POINT(ADVAL,XI,YI)
      DO 1030 L=2,1000
      XE=XI+1.0
      YE=FVAL(L)
      IF(YE-YI.LT.0.999) CALL POINT(ADVAL,XI,YI)
      CALL LINE(ADVAL,XI,YI,XE,YE)
      XI=XE
1030  YI=YE
      IEXPN=0
      GO TO 24
C
C   TEST FLAGS TO SEE WHICH ARRAYS ARE TO
C   BE DISPLAYED.
C
23    CALL DISPLY(5,SEC,STAR,GRID,ADVAL,TIME)
      IF((ITYSL.DQ.2).AND.(ITS.EQ.0).AND.(IEXPN.EQ.0))
      1 CALL DISPLY(6,SEC,STAR,GRID,ADVAL
```

```
     2,TIME,DEC)
     IF((ITYSL.EQ.2.AND.ITS.EQ.1).AND.(IEXPN.EQ.0))
     1 CALL DISPLY(5,SEC,STAR,GRID,ADVAL
     2,DEC)
C
C   TEST TO SEE IF 'ACCEPT' GAS BEEN DETECTED;
C   IF SO, 'GO TO 30'.  OTHERWISE TEST TO SEE
C   IF 'ITYSL' EQUALS TWO & A TWO SECOND
C   DISPLAY ('2 SEC DIS') HAS BEEN DETECTED.
C   IF NEITHER OF THE ABOVE TWO OCCUR, TEST
C   TO SEE IF 'NORMAL' HAS BEEN DETECTED TO
C   RETURN FROM A TWO SECOND DISPLAY.
C
     IF((X2.GT.380.0).AND.(X2.LT.630.0).AND.(Y2.LE.40.0)) GO TO 30
     IF((ITYSL.EQ.2).AND.(X2.GT.15.0).AND.(X2.LT.110.0).AND.
     1(Y2.GT.15.0).AND.(Y2.LT.30.0)) GO TO 2000
     IF((ITYSL.EQ.2).AND.(X2.GT.755.0).AND.(X2.LT.845.0).AND.
     1(Y2.GT.55.0).AND.(Y2.LT.76.0).AND.(ITS.EQ.1)) GO TO 2000
C
C   MOVE STAR TO DETECTED POINT & TEST TO
C   SEE WHICH ARRAYS SHOULD BE DISPLAYED.
C
24   CALL MPOINT(SEC, X2, Y2)
     CALL DISPLY(5,SEC,STAR,GRID,ADVAL,TIME)
     IF((ITYSL.EQ.2).AND.(ITS.EQ.0).AND.(IEXPN.EQ.0))
     1 CALL DISPLY(6,SEC,STAR,GRID,ADVAL
     2,TIME,DEC)
     IF((ITYSL.EQ.2).AND.(ITS.EQ.1).AND.(IEXPN.EQ.0))
     1 CALL DISPLY(5,SEC,STAR,GRID,ADVAL
     2,DEC)
     CALL INTAB(ILINE,100)
C
C   X & Y COORDINATES OF DESIRED POINT ON CURVE
C
     X(ISAV)=X2
     Y(ISAV)=Y2
     CALL POINT(ILINE, X(1), Y(1))
     IF(ICHKS.EQ.1) NFST=1
     IF(ICHKS.EQ.0) NFST=0
     IF(ISAV.LT.2) GO TO 21
C
C   CHECK TO SEE IF THERE WAS AN ERROR IN SELECTING
C   THE SECOND POINT ON THE CURVE. IF THERE WAS
C   DISPLAY THE ERROR MESSAGE SHOWN, CONNECT THE
C   TWO POINTS SELECTED WITH A LINE, AND DISPLAY
C   ALL ARRAYS. IF NO ERROR JUST CONNECT THE
C   POINTS WITH A LINE & DISPLAY ALL ARRAYS.
C
     CALL LINE(ILINE, X(1), Y(1), X(2), Y(2))
     IF((Y(1).LT.Y(2)).AND.(X(1).LT.X(2))) GO TO 25
```

```
      CALL CHRGEN(ILINE,'<-- ERROR NEG. SLOPE -->',210.0,82.0,2,0)
      CALL DISPLY(0)
      DO 26 IB=1,4
      CALL DISPLY(1,ILINE)
      CALL WAIT(250)
26    CALL DISPLY(0)
C
C   TEST TO SEE WHICH ARRAYS SHOULD BE
C   DISPLAYED.
C
25    CALL DISPLY(6,SEC,STAR,GRID,ADVAL,TIME,ILINE)
      IF((ITYSL.DQ.2).AND.(ITS.EQ.0).AND.(IEXPN.EQ.0))
      1 CALL DISPLY(7,SEC,STAR,GRID,
      2ADVAL,TIME,ILINE,DEC)
      IF((ITYSL.EQ.2).AND.(ITS.EQ.1).AND.(IEXPN.EQ.0))
      1 CALL DISPLY(6,SEC,STAR,GRID,
      2ADVAL,ILINE,DEC)
      GO TO 21
C
C        WAIT 1500 MSEC, CLEAR LITE PEN VALUES, & MOVE STAR
C        TO READY POSITION. INCREASE ISAV BY 1, & IF ISAV<
C        OR=2 GO TO 50, TO ACCEPT SECOND COORDINATES OF DATA
C        IF ISAV>2 CALCULATE SLOPES.
C
30    CALL WAIT(1500)
      CALL LITEPN(ICLE, X4, Y4)
      CALL MPOINT(SEC, 155.0, 75.0)
      ISAV=ISAV+1
      IF(ISAV.LE.2) GO TO 21
      IF(ITYSL.EQ.2) GO TO 35
      TIF(IND,1)=(KIN-1)+X(1)*0.01
C
C   SLOPE CALCULATIONS TO COMPENSATE FOR
C   FACTOR OF FOUR EXPANSION IN POSITIVE
C   SLOPE CALCULATIONS
C
      SLOPE(IND,1)=(Y(2)-Y(1))/(X(2)-X(1))
      IF(IEXPN.EQ.1) SLOPE(IND,1)=SLOPE(IND,1)/4.0
      GO TO 39
35    IF(ITS.EQ.1) GO TO 36
      TIF(INDF,2)=(KIN-1)+X(1)*0.01
      TIF(INDF,3)=(((KIN-1)+X(2)*0.01)-TIF(INDF,2))/2.0
      SLOPE(INDF,2)=(Y(2)-Y(1))/(X(2)-X(1))
C
C   TEST TO COMPENSATE FOR FACTOR OF FOUR
C   EXPANSION IN NEGATIVE SLOPE CALCULATIONS
C
      IF(IEXPN.EQ.1) SLOPE(INDF,2)=SLOPE(INDF,2)/4.0
      GO TO 37
C
```

```
C    STATEMENTS TO COMPENSATE FOR TWO SECONS
C    TIME EXPANSION IN NEGATIVE SLOPE CALCULATIONS.
C
36        TIF(INDF,2)=ITMVA+X(1)*0.002
          TIF(INDF,3)=((ITMVA+X(2)*0.002)-TIF(INDF,2))/2.0
          SLOPE(INDF,2)=((Y(2)-Y(1))/(X(2)-X(1)))*5.0
37        INDF=INDF+1
          GO TO 40
39        IND= IND+1
40        CONTINUE
50        IFLAG=0
          GO TO 70
60        IEOF=1
70        CALL DISPLY(0)
          GO TO 80
C
C    SECTION TO CHANGE TIME SCALE FACTOR FOR
C    A TWO SECOND DISPLAY.  'ITS' EQUAL ONE IMPLIES
C    THAT THERE ALREADY HAS BEEN A TIME SCALE
C    EXPANSION & DISPLAY IS TO RETURN TO NORMAL.
C
2000   CALL DISPLY(0)
          IF(ITS.EQ.1) GO TO 2130
          ITS=1
          ISAV=1
2005      ITMVA=KIN-1
          ST=0.0
          EN=100.0
C
C    DO LOOP TO DETERMINE ABOUT WHICH
C    TIME EXPANSION IS TO OCCUR.
C
          DO 2010 IN=1,10
          IF(X(1).GE.ST.AND.X(1).LE.EN) GO TO 2030
          ST=ST+100.0
2010      EN=EN+100.0
          TYPE 2020
2020      FORMAT(' ***ERROR REGION NOT FOUND***',/,' ',10X,'
         1TRYING AGAIN',//)
          GO TO 2005
2030      ITMVA=ITMVA+IN
C
C    STATEMENTS TO DETERMINE HOW MANY RECORDS
C    THE MAG TAPE SHOULD BACKSPACE,
C    BACKSPACE THE MAG TAPE, AND SET UP
C    NEW EXPANDED TIME SCALE FOR DESPLAY
C    IN ARRAY 'DEC'.
C
          LRU=ST
          IBKSP=(1000-LRU)/20+1
```

```
      IRET=IBKSP-10
      CALL MTSKIP(3,-IBKSP)
      XCOOR=460.0
      DO 2040 IN=0,1
      ITMVA=ITMVA+IN
      ENCODE(4,2035,ASK),ITMVA
2035  FORMAT(I4)
      ASK(2)=0.0
      CALL CHRGEN(DEC,ASK,XCOOR,130.0,2,0)
2040  XCOOR=XCOOR+500.0
      ITMVA=ITMVA-2
      LNTH=10
      INST=1
C
C   INITIALIZE DATA DISPLAY ARRAY 'ADVAL' AND
C   READ IN THE REQUIRED NUMBER ('LNTH') OF
C   RECORDS FOR DISPLAY.
C
2045  CALL INTAB(ADVAL,3000)
      INDX=1
      DO 2090 NR=1,LNTH
      IDISER=0
      IERCT=0
2050  CALL MTREAD(TDMP,100,IERR)
C
C   TEST FOR MAG TAPE INPUT ERROR AND IF AN
C   ERROR OCCURS TAKE THE APPROPRIATE
C   BRANCH.
C
      IF(IERR.EQ.2) IEOF=1
      IF(IEOF.EQ.1) GO TO 2110
      IF(IERR.EQ.0) GO TO 2080
C
C   TYPE OUT ERROR MESSAGES IF AN ERROR
C   OCCURS.
C
      TYPE 2060,IERR
2060  FORMAT(' ***MTIO ERROR',I1,' PROCESSING CONTINUED***',//)
      IERCT=IERCT+1
      IF(IERCT.LE.5) GO TO 2050
      TYPE 2070
2070  FORMAT(' ',8X,'ERROR WILL NOT CORRECT PROCESSING ENDED',///)
      IEOF=1
      GO TO 70
C
C   DO LOOP TO PERFORM PROPER OPERATIONS ON
C   DATA READ IN FROM MAG TAPE AND PUT THE RESULTS
C   ONTO DATA ARRTY 'FVAL'.  THEN TEST
C   DATA TO SEE IF ANY POINTS EXCEED DISPLAY
C   SCOPE RANGE; IF SO, THEN TRUNCATE THE VALUE
```

```
C   TO FIT THE DISPLAY & PRINT OUT ERROR MESSAGES.
C
2080     DO 2090 LI=0,100,INST
         IF(LI.EQ.0.AND.INST.EQ.1) GO TO 2090
         LB=LI
         IF(LI.EQ.0) LB=1
         FVAL(INDX)= TDMP(LB)*150.0+200.0
         INDX=INDX+1
         IF(FVAL(INDX-1).LE.1023.0) GO TO 2090
         FVAL(INDX-1)=1020.0
         IDISER=IDISER+1
2090     CONTINUE
         IF(IDISER.EQ.0) GO TO 2110
         TYPE 2100,IDISER
2100     FORMAT(' <---ERROR: VALUES TO BE DISPLAYED ARE OUT OF
         1 THE RANGE OF DESPLAY--->',/,' ',7X,I4,'VALUES
         2 HAVE BEEN TRUNCATED TO FIT THE DISPLAY.',//////)
C
C   TRANSFER OF DATA FROM ARRAY 'FVAL' TO
C   DISPLAY ARRAY 'ADVAL'.
C
2110     XI=0.0
         YI=FVAL(1)
         CALL POINT(ADVAL,XI,YI)
         DO 2120 NI=2,1000
         XE=XI+1.0
         YE=FVAL(NI)
         IF(YE-YI.LT.0.999) CALL POINT(ADVAL,XI,YI)
         CALL LINE(ADVAL,XI,YI,XE,YE)
         XI=XE
2120     YI=YE
C
C   DISPLAY OF APPROPRIATE ARRAYS & RESET
C   ARRAY DEC WHEN NORMAL IS DETECTED.
C
         CALL DISPLY(5,SEC,STAR,GRID,DEC,ADVAL)
         IF(ITS.EQ.0) CALL DISPLY(5,SEC,STAR,GRID,ADVAL,TIME)
         GO TO 15
2130     ITS=0
         CALL INTAB(DEC,100)
         CALL CHRGEN(DEC,'2 SEC DIS',20.0,15.0,2,0)
C
C   DETERMINE HOW MANY RECORDS MUST BE
C   BACKSPACED TO BRING BACK ORIGINAL TEN
C   SECOND DISPLAY.
C
         IBKSP=LRU/20+9
         CALL MTSKIP(0,-IBKSP)
         LNTH=50
         INST=5
```

```
      GO TO 2045
C
C   IF FINAL SLOPE IN DISPLAY HAS
C   BEEN TAKEN & THERE IS A TWO SECOND
C   DISPLAY IN EFFECT, BACKSPACE THE MAG TAPE
C   'IRET' RECORDS TO BEGINING OF ORIGINAL TEN
C   SECOND DISPLAY.  THIS IS NECESSARY TO INSURE
C   NO LOSS IN DATA.  THEN RETURN TO CALLING
C   PROGRAM.
C
80    IF(ITS.EQ.1) CALL MTSKIP(0,IRET)
      RETURN
      END
```

```
C    ***************************************************************
C        CONC: DETERMINES BOTH THE POSITIVE
C              AND NEGATIVE CONDUCTIVITIES
C    ***************************************************************
         COMMON /C/ AVCASL /K/ SIGPOS(150), SIGNEG(150)
         1 /L/ TIMEIF(150,2) /DA/ IDSK
C
C    STATEMENT REQUIRING OPERATOR ACTION UPON
C    ENTERING SUBROUTINE.
C
         PAUSE 'CALCULATION OF CONDUCTIVITIES'
C
C    IF THE PROGRAM IS OPERATED OFF OF THE DISK
C    SYSTEM CONTROL IS TRANSFERRED TO STATEMENT
C    NUMBER 200; OTHERWISE, TYPE OUT THE FOLLOWING
C    QUESTION PERTAINING TO STORAGE OF DATA ON
C    DEC TAPE.
C
         IF(IDSK.EQ.1) GO TO 200
6        TYPE 1
1        FORMAT('   TYPE # OF DTA ON WHICH CAL SLOPES ARE
         1 STORED   ',$)
         ACCEPT 2, IANS
2        FORMAT(I2)
C
C    INITIALIZE DEC TAPE INDICATED FOR READ IN OF
C    THE AVERAGE OF THE CALIBRATION SLOPES.
C
         IF(IANS.GT.7) GO TO 6
         IDTA=IANS+8
         GO TO 210
200      IDTA=IDSK
C
C    INITIALIZATION OF STORAGE DEVICE FOR INPUT OF
C    AVERAGE CALIBRATION SLOPE AND INPUT OF SAME.
C
210      CALL IFILE(IDTA,'AVCAS')
         READ(IDTA, 3) AVCASL
3        FORMAT(F10.5)
         CALL RELEAS(IDTA)
C
C    INITIALIZE N, J, & CALRES(CALIBRATION RESISTANCE),
C    DETERMINE SMALL R & LARGE R (PROBE DIMESIONS),
C    & THE RATIO OF LARGE R TO SMALL R MULTIPLIED BY .5
C
         N=1
         J=1
```

```
      CALRES= 0.2E+12
211   TYPE 212
212   FORMAT('   DO YOU DESIRE TO CHANGE THE PROBE
      1 RADII? Y OR N    ',$)
      ACCEPT 213, ANS
213   FORMAT(A3)
      IF(ANS.EQ.'N') GO TO 214
      IF(ANS.NE.'Y') GO TO 211
      TYPE 215
215   FORMAT('   TYPE THE COLLECTOR RADIUS IN CM,
      1 EX. 2.5    ',$)
      ACCEPT 216, SMALR
216   FORMAT(F10.5)
      TYPE 217
217   FORMAT('   TYPE THE GUARD RING RADIUS IN CM,
      1 EX. 4.6    ',$)
      ACCEPT 216, LARGR
      GO TO 221
214   SMALR=(17.0/32.0)*2.54
      LARGR=(23.0/16.0)*2.54
221   SMALR=SMALR**2
      RATIO=LARGR/SMALR
C
C   CALCULATE THE FACTOR TO BE MULTIPLIED BY THE
C   FLIGHT SLOPE.
C
      CONST=(RATIO/(2*CALRES))/AVCASL
      IF(IDSK.EQ.1) GO TO 220
5     TYPE 10
10    FORMAT(' TYPE THE # OF THE DTA ON WHICH THE FLIGHT DATA HAS
      1 BEEN RECORDED.  ', $)
      ACCEPT 20, IDTA
20    FORMAT(I)
      IDTA=IDTA+8
      GO TO 230
220   IDTA=IDSK
C
C   INITIALIZE STORAGE DEVICE FOR INPUT OF DATA.
C
230   CALL IFILE(IDTA,'POS')
30    READ(IDTA, 40, END=50) SLOPE, TIFL
40    FORMAT(F10.5)
C
C   CALCULATE POSITIVE CONDUCTIVITY, INCREMENT N,
C   THEN GO TO 30 TO CONTINUE THE PROCESSING
C   OF DATA.
C
      SIGPOS(N)=CONST*SLOPE
      TIMEIF(N,1)=TIFL
      N=N+1
```

```
      GO TO 30
50    CALL RELEAS(IDTA)
C
C   STORE POSITIVE CONDUCTIVITIES ON THE STORAGE DEVICE UNDER
C   THE NAME PSI.DAT & THEN PRINT OUT THE POSITIVE
C   CONDUCTIVITY.
C
      CALL OFILE(IDTA,'PSI')
      DO 60 I=1,N-1
60    WRITE(IDTA,65) SIGPOS(I), TIMEIF(I,1)
65    FORMAT(E10.5,F10.5)
      CALL RELEAS(IDTA)
C
C   IF OPERATION IS OFF DISK "GO TO 240" TO PRINT
C   HEADINGS AND POSITIVE CONDUCTIVITIES; OTHERWISE,
C   PRINT THE FOLLOWING HEADING AND THEN THE POSITITE
C   CONDUCTIVITIES.
C
      IF(IDSK.EQ.1) GO TO 240
      ISTDTA=IDTA-8
      PRINT 70, ISTDTA
70    FORMAT('1 THE POSITIVE CONDUCTIVITIES HAVE BEEN STORED
     1 ON DTA',1X,' UNDER THE NAME PSI.DAT',/,'+',52X,I1,////,
     2'  THE POSITIVE CONDUCTIVITIES FOLLOW:',///,'+',
     3'CONDUVTIVITY',4X,'TIME IN FLIGHT',//,'+',2X,'(IN MHOS/CM)',
     48X,'(IN SEC)',//)
      GO TO 260
240   PRINT 250
250   FORMAT('1 THE POSITIVE CONDUCTIVITIES HAVE BEEN STORED
     1 ON THE DSK UNDER THE NAME PSI.DAT',/,'-',10X,
     2' THE POSITIVE CONDUCTIVITIES FOLLOW:',///,'+',
     3'CONDUCTIVITY',4X,'TIME IN FLIGHT',//,'+',2X,'(IN MHOS
     4/CM)',8X,'(IN SEC)',//)
260   DO 80 I=1,N-1
80    PRINT 90, SIGPOS(I), TIMEIF(I,1)
90    FORMAT(' ',1X,E10.5,7X,F10.5)
C
C   INITIALIZE STORAGE DEVICE TO READ IN NEGATIVE
C   SLOPES TO CALCULATE NEG. CONDUCTIVITIES, INCREMENT J, THEN
C   GO TO 100 TO CONTINUE THE PROCESSING OF DATA.
C
      CALL IFILE(IDTA,'VOST')
      READ(IDTA,40) VDS
      CALL RELEAS(IDTA)
      CALL IFILE(IDTA,'NEG')
100   READ(IDTA,40,END=110) SLOPE, TIFL, TE
      SIGNEG(J)=CONST*SLOPE
      TIMEIF(J,1)=TIFL
      TIMEIF(J,2)=(VDS*TE*2.0)/(3.1414*LARGR)
      J=J+1
```

```
      GO TO 100
C
C   STORE NEG. COND. ON THE STORAGE DEVICE UNDER THE NAME
C   NSI.DAT & THEN PRINT OUT THE NEG. COND.
C
110   CALL RELEAS(IDTA)
      CALL OFILE(IDTA,'NSI')
      DO 120 I=1,J-1
120   WRITE(IDTA,125) SIGNEG(I), TIMEIF(I,1), TIMEIF(I,2)
125   FORMAT(E10.5,F10.5,F10.5)

      CALL RELEAS(IDTA)
C
C   IF OPERATION IS OFF THE DISK SYSTEM "GO TO 265",
C   PRINT APPROPRIATE HEADING AND THEN NEGATIVE
C   CONDUCTIVITIES. OTHERWISE, PRINT THE FOLLOWING
C   HEADING AND THEN THE NEGATIVE CONDUCTIVITIES.
C
      IF(IDSK.EQ.1) GO TO 265
      PRINT 130, ISTDTA
130   FORMAT('1 THE NEGATIVE CONDUCTIVITIES HAVE BEEN STORED
     1 ON DTA',1X,' UNDER THE NAME NSI.DAT',/,'-',10X,
     2'  THE NEGATIVE CONDUCTIVITIES FOLLOW:',///,'+',
     3'CONDUCTIVITY',4X,'TIME IN FLIGHT',4X,'E FIELD',//
     4,'+',2X,'(IN MHOS/CM)',8X,'(IN SEC)',6X,'(IN V/CM)',//)
      GO TO 280
265   PRINT 270
270   FORMAT('1 THE NEGATIVE CONDUCTIVITIES HAVE BEEN STORED
     1 ON THE DSK UNDER THE NAME NSI.DAT',/,'-',10X,
     2' THE NEGATIVE CONDUCTIVITIES FOLLOW:',///,'+',
     3'CONDUCTIVITY',4X,'TIME IN FLIGHT',4X,'E FIELD',//
     4,'+',2X,'(IN MHOS/CM)',8X,'(IN SEC)',6X,'(IN V/CM)',//)
280   DO 140 I=1,J-1
140   PRINT 145, SIGNEG(I), TIMEIF(I,1), TIMEIF(I,2)
145   FORMAT(' ',1X,E10.5,7X,F10.5,6X,F10.5)
      CALL RELEAS(3)
C
C   CHAIN TO LINK "MAIN".
C
      CALL CHAIN(0,IDSK,'MAIN')
      END
```

```
C     ******************************************************
C
C           MTAH: MATCH TIME & ALTITUDE
C
C     ******************************************************
          COMMON /H/ TIF(150,3) /K/ SIGPOS(150), SIGNEG(150)
         1 /N/ IPSI, INSI /Q/ ALT(150,2) /DA/ IDSK
C
C     STATEMENT REQUIRING OPERATION ACTION UPON
C     ENTERING THIS LINK.
C
          PAUSE 'MATCH TIMES TO ALTITUDES'
C
C     IF OPERATION IS OFF THE DISK SYSTEM
C     "GO TO 5" TO INITIALIZE THE STORAGE DEVICE
C     FOR INPUT OF CONDUCTIVITIES; OTHERWISE,
C     PERFORM TWO ADDITIONS BEFORE INITIALIZATION
C     OF STORAGE DETICE FOR INPUT OF DATA.
C
          IF(IDSK.EQ.1) GO TO 5
          IPSI=IPSI+8
          INSI=INSI+8
5         CALL IFILE(IPSI,'PSI')
          I=1
C
C     INPUT POSITIVE CONDUCTIVITIES AND STORE THEM
C     IN ARRAY "SIGPOS".
C
10        READ(IPSI,20,END=30) SIGPOS(I), TIF(I,1)
          I=I+1
          GO TO 10
20        FORMAT(E10.5,F10.5)
30        CALL RELEAS(IPSI)
C
C     INITIALIZATION OF STORAGE DEVICE FOR INPUT
C     OF NEGATIVE CONDUCTIVITIES, READ THE
C     CONDUCTIVITIES AND STORE THEM IN ARRAY
C     "SIGNEG".
C
          CALL IFILE(INSI,'NSI')
          J=1
40        READ(INSI,21,END=50) SIGNEG(J), TIF(J,2), TIF(J,3)
21        FORMAT(D10.5,F10.5,F10.5)
          J=J+1
          GO TO 40
```

```
50      CALL RELEAS(INSI)
C
C   TYPE OUT INSTRUCTIONS AND HEADING FOR
C   INPUT OF ALTITUDES.
C
        TYPE 60
60      FORMAT('   AFTER COMPUTER PRINTS OUT CONDUCTIVITY &
        1 TIME, TYPE IN CORRESPONDING',/,'   ALTITUDE
        2. EXAMPLE...65.5 MEANS 65.5KM.',///,'   CONDUCTIVITY'
        3,4X,'TIME (IN SEC)',4X,'ALTITUDE=????',//)
C
C   TYPE POSITIVE CONDUCTIVITIES ALONG WITH
C   CORRESPONDING TIMES AND WAIT FOR INPUT
C   OF ALTITUDES.
C
        DO 80 L=1,I-1
        TYPE 70, SIGPOS(L), TIF(L,1)
70      FORMAT(' ',4X,E10.5,7X,F10.5,6X,$)
        ACCEPT 90, HEI
80      ALT(L,1)=HEI
90      FORMAT(F10.5)
C
C   TYPE NEGATIVE CONDUCTIVITIES ALONG WITH
C   CORRESPONDING TIMES AND WAIT FOR
C   INPUT OF ALTITUDES.
C
        DO 100 L=1,J-1
        TYPE 70, SIGNEG(L), TIF(L,2)
        ACCEPT 90, HEI
100     ALT(L,2)= HEI
C
C   TYPE QUESTION CONCERNING THE NEED FOR
C   ANY CORRECTIONS.
C
110     TYPE 120
120     FORMAT('   ARE THERE ANY CORRECTIONS. Y OR N    ',$)
        ACCEPT 130, ANS
130     FORMAT(A2)
        IF(ANS.EQ.'N') GO TO 190
        IF(ANS.NE.'Y') GO TO 110
        IF(J.GT.I) K=J
        IF(J.GT.I) GO TO 135
        K=I
C
C   REQUESTS INPUT OF INCORRECT ALTITUDE
C   THEN SEARCH DATA ARRAYS FOR THE
C   INCORRECT ALTITUDE.
C
135     TYPE 140
140     FORMAT('   INCORRECT ALTITUDE=  ',$)
```

```
      ACCEPT 90, ALTIN
      DO 150 L=1,K-1
      IF(ALTIN.GT.ALT(L,1)-0.1.AND.ALTIN.LT.ALT(L,1)+0.1) GO TO 170
150   IF(ALTIN.GT.ALT(L,2)-0.1.AND.ALTIN.LT.ALT(L,2)+0.1) GO TO 180
      TYPE 160
160   FORMAT('   <--- ERROR: INCORRECT ALTITUDE NOT FOUND
     1--->',////)
      GO TO 110
C
C   SECTION TO TYPE OUT CONDUCTIVITIES (POS. OR
C   NEG.) AND THE TIME CORRESPONDING TO THE
C   INCORRECT ALTITUDE, THEN WAIT FOR THE
C   INPUT OF THE CORRECT VALUE.
C
170   TYPE 185
      TYPE 70, SIGPOS(L), TIF(L,1)
      ACCEPT 90, HEI
      ALT(L,1)=HEI
      GO TO 110
180   TYPE 185
185   FORMAT('   CONDUCTIVITY',4X,'TIME (IN SEC)',
     14X,'CORRECT ALTITUDE=????',//)
      TYPE 70, SIGNEG(L), TIF(L,2)
      ACCEPT 90, HEI
      ALT(L,2)= HEI
      GO TO 110
C
C   OUTPUT OF CONDUCTIVITIES, TIMES, AND ALTITUDES
C   TO THE STORAGE DEVICE. FIRST POSITIVE THEN
C   NEGATIVE.
C
190   CALL OFILE(IPSI, 'PSI')
      DO 200 L=1,I-1
200   WRITE(IPSI,210) SIGPOS(L), TIF(L,1), ALT(L,1)
210   FORMAT(E10.5,F10.5,F10.5)
      CALL RELEAS(IPSI)
      CALL OFILE(INSI, 'NSI')
      DO 220 L=1,J-1
220   WRITE(INSI,211) SIGNEG(L), TIF(L,2), TIF(L,3), ALT(L,2)
211   FORMAT(E10.5,F10.5,F10.5,F10.5)
      CALL RELEAS(INSI)
C
C   PRINT OUT OF THE HEADING PERTAINING TO THE
C   POSITIVE CONDUCTIVITIES AND THEN PRINT OUT
C   THE CONDUCTIVITIES.
C
      PRINT 230
230   FORMAT('1','POSITIVE CONDUCTIVITES WITH CORRESPONDING
     1 ALTITUDES',//,' ',5X,'CONDUCTIVITY',20X,'ALTITUDE',//,
     2'+',5X,'(IN MHOS/CM)',20X,'(IN KM)',//)
```

```
      DO 240 L=1,I-1
240   PRINT 250, SIGPOS(L), ALT(L,1)
250   FORMAT(' ',6X,E10.5,20X,F10.5)
C
C   PRINT OUT OF THE HEADING PERTAINING TO THE
C   NEGATIVE CONDUCTIVITIES AND THEN PRINT OUT
C   THE CONDUCTIVITIES.
C
      PRINT 260
260   FORMAT('-','NEGATIVE CONDUCTIVITIES WITH CORRESPONDING
     1 ALTITUDES AND ASSOCIATED E FIELD',//,' ',5X
     2,'CONDUCTIVITY',20X,'ALTITUDE',//,'+',5X,'(IN MHOS/CM)',
     320X,'(IN KM)',21X,'(IN V/CM)',//)
      DO 270 L=1,J-1
270   PRINT 275, SIGNEG(L), ALT(L,2), TIF(L,3)
275   FORMAT(' ',6X,E10.5,20X,F10.5,18X,F10.5)
      IF(IDSK.EQ.1) GO TO 280
      INSI=INSI-8
      IPSI=IPSI-8
C
C   CHAIN BACK TO LINK "MAIN".
C
280   CALL CHAIN(0,IDSK,'MAIN')
      END
```

```
C    ******************************************************
C
C            SIGP: PLOT ALTITUDE VS.
C                  CONDUCTIVITY
C
C    ********************************************************

      COMMON LP,ISHOW,XMAX,XMIN,YMAX,YMIN,INTENS,ISCALE
      COMMON /A/ ADVAL(3200), GRID(1200) /D/ STAR(20), SEC(10)
      1 /H/ TIF(150,3) /K/ SIGPOS(150), SIGNEG(150)
      2 /Q/ ALT(150,2) /R/ ASKI(2)
      3 /DA/ IDSK /DB/ NUM2, LB /N/ IPSI,INSI /U/ I, J
C
C   STATEMENT REQUIRING OPERATIR ACTION UPON
C   ENTERING THIS LINK.
C
      PAUSE 'ALTITUDE VS CONDUCTIVITY PLOT'
      I=1
      J=1
C
C   READ IN CONDUCTIVITIES & CORRESPONDING
C   ALTITUDES. IF OPERATION IS OFF THE DISK
C   "GO TO 105"; OTHERWISE, PERFORM TWO
C   ADDITIONS SHOWN.
C
C
      IF(IDSK.EQ.1) GO TO 105
      IPSI=IPSI+8
      INSI=INSI+8
C
C   INITIALIZE STORAGE DEVICE FOR INPUT OF
C   POSITIVE CONDUCTIVITY FILE AND INPUT
C   THE INFORMATION INTO THE TWO ARRAYS
C   SHOWN.
C
105   CALL IFILE(IPSI,'PSI')
110   READ(IPSI,120,END=130) SIGPOS(I),TIF(I,1),ALT(I,1)
120   FORMAT(E10.5,2F10.5)
      I=I+1
      GO TO 110
130   CALL RELEAS(IPSI)
C
C   INITIALIZATION OF STORAGE DEVICE FOR INPUT
C   OF NEGATIVE CONDUCTITITY FILE AND INPUT THE
C   INFORMATION INTO THE TWO ARRAYS SHOWN.
C
      CALL IFILE(INSI,'NSI')
140   READ(INSI,145,END=150) SIGNEG(J), TIF(J,2), TIF(J,3), ALT(J,2)
145   FORMAT(E10.5,3F10.5)
      J=J+1
```

```
      GO TO 140
150   CALL RELEAS(INSI)
      EXP1=10.0**-14
      EXP2=10.0**-9
      EXP3=10.0**-10
      EXP4=10.0**-12
C
C         INITIALIZE ARRAY GRID
C
1     LP=1
      ISCALE=0
      CALL INTAB(GRID,1000)
      INTENS=7
      ISHOW=1
      ADV=300.0
C
C         GENERATION OF HORIZ. LINES FOR 10 INCREMENTS
C         IN ALTITUDE
C
      DO 20 N=1,7
      CALL POINT(GRID,215.0,ADV)
      CALL VECONT(GRID,215.0,ADV,1023.0,ADV)
20    ADV=ADV+117.0
      INTENS=5
C
C   INSERTION OF INTERMEDIATE HORIZ. LINES
C   DENOTING 5KM INCREMENTS IN ALTITUDE
C
      ADV=358.5
      DO 50 N=1,6
      CALL POINT(GRID,215.0,ADV)
      CALL VECONT(GRID,215.0,ADV,1023.0,ADV)
50    ADV=ADV+117.0
      INTENS=7
C
C   GENERATION OF ALTITUDE SCALE FACTORS
C
      YCOOR=293.0
      N=25
      DO 100 L=1,13
      ENCODE(2,60,ASK1), N
      ASK1(2)=0.0
      CALL CHRGEN(GRID,ASK1,165.0,YCOOR,3,0)
      YCOOR=YCOOR+58.5
100   N=N+5
C
C   GENERATION OF LABLES.
C
      CALL CHRGEN(GRID,'Z',100.0,750.0,5,0)
      CALL CHRGEN(GRID,'(IN KM)',70.0,715.0,2,0)
```

```
      CALL CHRGEN(GRID,'CONDUCTIVITY',340.0,230.0,3,0)
      CALL CHRGEN(GRID,'(IN MHOS/CM)',590.0,230.0,2,0)
      CALL CHRGEN(GRID,'NEXT PHASE',10.0,50.0,2,0)
C
C   DECISION SECTION
C
      IF(NUM2.NE.100) GO TO 970
      INI=5
      NI=14
      ADVI=196.3
      GO TO 990
970   IF(NUM2.NE.1) GO TO 980
      INI=4
      NI=12
      ADVI=262.0
      GO TO 990
980   INI=6
      NI=14
      ADVI=150.0
C
C   SECTION TO PLOT POSITIVE OR NEGATIVE CONDUCTIVITIES
C   OR BOTH.
C
C   SET UP LOG SCALE: MAJOR VERTICLE LINES
C
990   ADV=215.0
      DO 1000 N=1,INI
      CALL POINT(GRID,ADV,300.0)
      CALL VECONT(GRID,ADV,300.0,ADV,1023.0)
1000  ADV=ADV+ADVI
C
C   GENERATION OF MINOR VERTICLE LINES
C
      INTENS=6
      AL=2.0
      ADV=215.0+ALOG10(AL)*ADVI
1005  DO 1010 N=1,INI-1
      CALL POINT(GRID,ADV,330.0)
      CALL VECONT(GRID,ADV,300.0,ADV,1023.0)
1010  ADV=ADV+ADVI
      AL=AL+1.0
      ADV=215.0+ALOG10(AL)*ADVI
      IF(AL.LE.9.0) GO TO 1005
      INTENS=5
      ADV=215.0+ALOG10(1.5)*ADVI
      IF(AL.LE.10.0) GO TO 1005
C
C   GENERATION OF CONDUCTIVITY SCALE FACTORS
C
      INTENS=7
```

```
      XCOOR=168.0
      ENCODE(2,60,ASK1), LB
60    FORMAT(I2)
      ASK1(2)=0.0
      DO 1020 N=1,INI
      CALL CHRGEN(GRID,ASK1,XCOOR,265.0,3,0)
1020  XCOOR=XCOOR+ADVI
      XCOOR=203.0
      DO 1030 N=1,INI
      CALL CHRGEN(GRID,'-',XCOOR,277.0,2,0)
1030  XCOOR=XCOOR+ADVI
      XCOOR=210.0
      DO 1040 L=1,INI
      ENCODE(2,60,ASK1), NI
      ASK1(2)=0.0
      CALL CHRGEN(GRID,ASK1,XCOOR,277.0,2,0)
      XCOOR=XCOOR+ADVI
1040  NI=NI-1
      INTENS=7
C
C   INITIALIZATION OF DATA DISPLAY ARRAY "ADVAL".
C
      CALL INTAB(ADVAL,3000)
      GO TO (1200,1300), NUM2
      NUM2=1
C
C   LOCATING REGION, ON DISPLAY, IN WHICH A
C   GIVEN POSITIVE CONDUCTIVITY SHOULD BE
C   PLACED. UPON FINDING THE REGION "GO TO 1050".
C   IF CONDUCTIVITY DOES NOT FALL IN ANY REGION
C   TO BE DISPLAYED "TYPE 60" AND CONTINUE.
C
      DO 1080 L=1,I-1
      IF(SIGPOS(L).GT.EXP1.AND.SIGPOS(L).LT.EXP3) GO TO 1050
      TYPE 160, SIGPOS(L), ALT(L,1)
      GO TO 1080
1050  XSTART=215.0
      IEXP=-13
C
C   SECTION TO PERFORM NECESSARY OPERATIONS ON
C   CONDUCTIVITIES IN ORDER TO PLOT DATA AND
C   CONSTRUCT DATA ARRAY "ADVAL".
C
      DO 1060 K=1,4
      IF(SIGPOS(L).LT.10.0**IEXP) GO TO 1070
      XSTART=XSTART+196.3
1060  IEXP=IEXP+1
1070  XC=ALOG10((SIGPOS(L)*10.0**-IEXP)*10.0)*196.3+XSTART-4.0
      YC=294.0+(ALT(L,1)-25.0)*11.7
      CALL CHRGEN(ADVAL,'+',XC,YC,2,0)
```

```
1080    CONTINUE
C
C    DISPLAY DATA AND WAIT FOR A "NEXT PHASE"
C    DETECTION. UPON A LITE PEN DETECTION
C    "GO TO 1" AND PREPARE FOR PLOT
C    OF NEGATIVE CONDUCTIVITIES.
C
        CALL DISPLY(2,GRID,ADVAL)
1090    CALL LITEPN(IACC,X5,Y5)
        IF(IACC.EQ.0) GO TO 1090
        CALL WAIT(500)
        CALL LITEPN(ICLE,X4,Y4)
        GO TO 1
1200    NUM2=2
C
C    LOCATING REGION, ON DISPLAY, IN WHICH A
C    GIVEN NEGATIVE CONDUCTIVITY SHOULD BE
C    PLACED. UPON FINDING THE REGION "GO TO 1210".
C    IF CONDUCTIVITY DOES NOT FALL IN ANY REGION
C    TO BE DISPLAYED "TYPE 60" AND CONTINUE.
C
        DO 1240 L=1,J-1
        IF(SIGNEG(L).GT.EXP4.AND.SIGNEG(L).LT.EXP2) GO TO 1210
        TYPE 160, SIGNEG(L), ALT(L,2)
        GO TO 1240
1210    XSTART=215.0
        IEXP=-11
C
C    SECTION TO PERFORM NECESSARY OPERATIONS ON
C    CONDUCTIVITIES IN ORDER TO PLOT DATA AND
C    CONSTRUCT DATA ARRAY "ADVAL".
C
        DO 1220 K=1,3
        IF(SIGNEG(L).LT.10.0**IEXP) GO TO 1230
        XSTART=XSTART+262.0
1220    IEXP=IEXP+1
1230    XC=ALOG10((SIGNEG(L)*10.0**-IEXP)*10.0)*262.0+XSTART-4.0
        YC=294.0+(ALT(L,2)-25.0)*11.7
        CALL CHRGEN(ADVAL,'-',XC,YC,2,0)
1240    CONTINUE
C
C    DISPLAY DATA AND WAIT FOR A "NEXT PHASE"
C    DETECTION. UPON A LITE PEN DETECTION
C    "GO TO 1" AND PREPARE FOR PLOT
C    OF BOTH POSITIVE AND NEGATIVE CONDUCTIVITIES.
C
        CALL DISPLY(2,GRID,ADVAL)
1250    CALL LITEPN(IACC,X5,Y5)
        IF(IACC.EQ.0) GO TO 1250
        CALL WAIT(500)
```

```
      CALL LITEPN(ICLE,X4,Y4)
      GO TO 1
C
C   SECTION TO PLOT BOTH POSITIVE AND NEGATIVE
C   CONDUCTIVITIES TOGETHER.
C
C
C   PLOT ROUTINE FOR POSITIVE CONDUCTIVITY.
C
C
C   LOCATING REGION, ON DISPLAY, IN WHICH A
C   GIVEN POSITIVE CONDUCTIVITY SHOULD BE
C   PLACED. UPON FINDING THE REGION "GO TO 170".
C   IF CONDUCTIVITY DOES NOT FALL IN ANY REGION
C   TO BE DISPLAYED "TYPE 60" AND CONTINUE.
C
1300  DO 200 L=1,I-1
      IF(SIGPOS(L).GT.EXP1.AND.SIGPOS(L).LT.EXP2) GO TO 170
      TYPE 160, SIGPOS(L), ALT(L,1)
160   FORMAT(' ','<--- ERROR: VALUE IS OUT OF DISPLAY
     1 SCOPE RANGE --->',//,' ',5X,'COND=  ',E10.5,5X,
     2'ALTITUDE=  ',F10.5,//,'   VALUE WAS IGNORED,
     3 PROCESSING BEING CONTINUED',///)
      GO TO 200
170   XSTART=215.0
      IEXP=-13
C
C   SECTION TO PERFORM NECESSARY OPERATIONS ON
C   CONDUCTIVITIES IN ORDER TO PLOT DATA AND
C   CONSTRUCT DATA ARRAY "ADVAL".
C
      DO 180 N=1,5
      IF(SIGPOS(L).LT.10.0**IEXP) GO TO 190
      XSTART=XSTART+150.0
180   IEXP=IEXP+1
190   XC=ALOG10((SIGPOS(L)*10.0**-IEXP)*10.0)*150.0+XSTART-4.0
      YC=294.0+(ALT(L,1)-25.0)*11.7
      CALL CHRGEN(ADVAL,'+',XC,YC,2,0)
200   CONTINUE
C
C   PLOT ROUTINE FOR NEGATIVE CONDUCTIVITIES.
C
C
C   LOCATING REGION, ON DISPLAY, IN WHICH A
C   GIVEN POSITIVE CONDUCTIVITY SHOULD BE
C   PLACED. UPON FINDING THE REGION "GO TO 230".
C   IF CONDUCTIVITY DOES NOT FALL IN ANY REGION
C   TO BE DISPLAYED "TYPE 60" AND CONTINUE.
C
      DO 260 L=1,J-1
```

```
      IF(SIGNEG(L).GT.EXP1.AND.SIGNEG(L).LT.EXP2) GO TO 230
      TYPE 160, SIGNEG(L), ALT(L,2)
      GO TO 260
230   XSTART=215.0
      IEXP=-13
C
C   SECTION TO PERFORM NECESSARY OPERATIONS ON
C   CONDUCTIVITIES IN ORDER TO PLOT DATA AND
C   CONSTRUCT DATA ARRAY "ADVAL".
C
      DO 240 N=1,5
      IF(SIGNEG(L).LT.10.0**IEXP) GO TO 250
      XSTART=XSTART+150.0
240   IEXP=IEXP+1
250   XC=ALOG10((SIGNEG(L)*10.0**-IEXP)*10.0)*150.0+XSTART-4.0
      YC=294.0+(ALT(L,2)-25.0)*11.7
      CALL CHRGEN(ADVAL,'-',XC,YC,2,0)
260   CONTINUE
C
C   DISPLAY OF DATA ARRAY "ADVAL" AND WAIT
C   FOR "NEXT PHASE" DETECTION. UPON A LITE
C   PEN DETECTION TERMINATE THE PROGRAM.
C
      CALL DISPLY(2,GRID,ADVAL)
267   CALL LITEPN(IACC,X5,Y5)
      IF(IACC.EQ.0) GO TO 267
      IF(X5.GT.10.0.AND.X5.LT.110.0.AND.Y5.GT.50.0.AND.
     1Y5.LT.65.0) GO TO 264
      GO TO 267
264   CALL WAIT(500)
      CALL LITEPN(ICLE,X4,Y4)
C
C   TYPE OUT TERMINATION STATEMENT AND
C   END THE PROGRAM.
C
      TYPE 280
280   FORMAT('   PROGRAM COMPLETED & TERMINATED.',/////)
      END
```

```
C *******************************************************
C
C        PROGRAM TO CALCULATE DENSITIES
C
C *******************************************************
        DIMENSION ALTMP(651,3), COND(150,8), DEN(150,8), EOPAB(2000,3)

        J=1
        I=1
C
C    TYPE OUT OF QUESTION REQUESTING THE
C    NAME OF THE LAUNCH FACILITY. FOLLOWING
C    THAT ARE THE STATEMENTS WHICH DETERMINE
C    WHAT DATA FILE SHOULD BE READ, THIS
C    DEPENDS ON THE RESPONCE TO THE QUESTION
C    ASKED.
C
1       TYPE 2
2       FORMAT('  LAUNCH SITE, WSMR OR WI...',$)
        ACCEPT 3, WHR
3       FORMAT(A4)
        IF(WHR.EQ.'WI') GO TO 4
        IF(WHR.NE.'WSMR') GO TO 1
        CALL IFILE(1,'ZTP')
        GO TO 5
4       CALL IFILE(1,'WIZTP')
5       READ(1,10,END=20) ALTMP(I,1), ALTMP(I,2), ALTMP(I,3)
10      FORMAT(2F10.5,E10.5)
        I=I+1
        GO TO 5
20      CALL RELEAS(1)
C
C    INPUT OF FILE CONTAINING
C    POSITIVE CONDUCTIVITY VALUES.
C
        CALL IFILE(1,'PSI')
25      READ(1,30,END=40) COND(J,1), TIF, COND(J,2)
30      FORMAT(E10.5,2F10.5)
        J=J+1
        GO TO 25
40      CALL RELEAS(1)
        I=I-1
        J=J-1
        CONST=293.0*10.0**13/(1.8*1.01*1.6)
        K=1
C
C   DO LOOP WHICH (1) MATCHES ALTITUDES
C   OF CALCULATED CONDUCTIVITIES TO ALTITUDES IN
C   TABLE WHICH CONTAINS TEMPERATURE
C   & PRESSURE DATA, AND(2) CALCULATES THE POSITIVE
```

```
C   ION DENSITY.
C
45      DO 50 N=1,I
        IF((COND(K,2).LT.ALTMP(N,1)-.01).OR.(COND(K,2).GT.
        1ALTMP(N,1)+.01)) GO TO 50
        DEN(K,1)=COND(K,1)*CONST*(ALTMP(N,3)/ALTMP(N,2))
        DEN(K,2)= COND(K,2)
        GO TO 55
50      CONTINUE
55      K=K+1
        IF(K.LE.J) GO TO 45
C
C   OUTPUT POSITIVE ION DENSITY TO DISK UNDER THE
C   FILE NAME PDEN.DAT AND THEN PRINT OUT DENSITIES
C
        CALL OFILE(1,'PDEN')
        DO 60 K=1,J
60      WRITE(1,70) DEN(K,1), DEN(K,2)
70      FORMAT(E10.5,F10.5)
        CALL RELEAS(1)
        PRINT 80
80      FORMAT('1',5X,'THE POSITIVE DENSITIES FOLLOW:',///,
        1' ',5X,'DENSITY',20X,'ALTITUDE',//,'+',2X,'(+ ION/CM
        2**3)',18X,'(IN KM)',//)
        DO 90 K=1,J
90      PRINT 100, DEN(K,1), DEN(K,2)
100     FORMAT(' ',2X,E10.5,20X,F10.5)
        K=1
C
C   INPUT OF FILE CONTAINING NEGATIVE
C   CONDUCTIVITIES.
C
        CALL IFILE(1,'NSI')
110     READ(1,120,END=130) COND(K,3), TIF, COND(K,5), COND(K,4)
120     FORMAT(E10.5,3F10.5)
        K=K+1
        GO TO 110
130     K=K-1
        L=1
C
C   LOOP TO CALCULATE E/P
C
136     DO 140 N=1,I
        IF((COND(L,4).LT.ALTMP(N,1)-.01).OR.(COND(L,4).GT.
        1ALTMP(N,1)+0.01)) GO TO 140
        COND(L,6)=(COND(L,5)*1.01*10.0**4)/(ALTMP(N,3)*7.6)
        L=L+1
        IF(L.LE.K) GO TO 136
        IF(L.GT.K) GO TO 150
140     CONTINUE
```

```
C
C   INPUT OF FILE CONTAINING VALUES OF
C   ALPHA & BETA FOR GIVEN VALUES OF EIP.
C
150      CALL IFILE(1,'ALBA')
         IEOP=1
160      READ(1,170,END=180) EOPAB(IEOP,1), EOPAB(IEOP,2), EOPAB(IEOP,3)
170      FORMAT(F10.5,2E12.5)
         IEOP=IEOP+1
         GO TO 160
C
C   SECTION TO DETERMINE UE
C
180      CALL RELEAS(1)
         IEOP=IEOP-1
         LA=1
185      DO 190 IA=1,IEOP
         IF((COND(LA,6).LT.EOPAB(IA,1)-0.005).OR.(COND(LA,6).GT.
         1EOPAB(IA,1)+0.005)) GO TO 187
         DEN(LA,3)=(1/COND(LA,5))*((EOPAB(IA,2)*EOPAB(IA,1))+EOPAB(IA,3))
         LA=LA+1
         IF(LA.GT.K) GO TO 200
         GO TO 185
187      IF(IA.LT.IEOP) GO TO 190
         TYPE 186, COND(LA,6)
186      FORMAT('  <---ERROR: THE E/P
         1 RATIO OF ',F10.5,' WAS OUT',/,
         2'  OF THE RANGE OF THE TABLES
         3--->',///////)
         LA=LA+1
         IF(LA.GT.K) GO TO 200
         GO TO 185
190      CONTINUE
C
C   CALCULATIONS OF U-
C
200      LA=1
210      DO 220 IA=1,I
         IF((COND(LA,4).LT.ALTMP(IA,1)-0.01).OR.(COND(LA,4).GT.
         1ALTMP(IA,1)+0.01)) GO TO 220
         DEN(LA,4)=(2.3*1.01*10.0**6*ALTMP(IA,2))/(293.0*ALTMP(IA,3))
         LA=LA+1
         IF(LA.GT.K) GO TO 230
         GO TO 210
220      CONTINUE
230      LA=1
         INC=J-1
231      ALTINC=0.0
         DO 280 IA=1,INC
         IF(COND(LA,4).LT.DEN(IA+1,2)) GO TO 250
```

```
      INCALT=(DEN(IA,2)*10.0-DEN(IA+1,2)*10.0)+2
      DO 240 IB=1,INCALT
      CHK=DEN(IA,2)-ALTINC
      IF(COND(LA,4).LT.CHK-0.04.OR.COND(LA,4).GT.
     1CHK+0.04) GO TO 235
      FACTOR=(DEN(IA+1,1)-DEN(IA,1))/FLOAT(INCALT)
      FACTOR=DEN(IA,1)+FACTOR*FLOAT(IB)
C
C   ELECTRON DENSITY CALCULATION
C
      DEN(LA,5)=(1.0/DEN(LA,3))*((COND(LA,3)*10.0**19/1.6)
     1-FACTOR*DEN(LA,4))
C
C   CALCULATION OF NEG ION DENSITY
C
      DEN(LA,6)=FACTOR-DEN(LA,5)
      LA=LA+1
      IF(LA.GT.K) GO TO 290
      GO TO 231
235   ALTINC=ALTINC+0.1
240   CONTINUE
C
C   TYPE OUT OF ERROR MESSAGE WHEN A VALUE
C   WAS NOT ACCURATELY CONVERTABLE TO A
C   DENSITY.
C
      TYPE 245
245   FORMAT('-  <---ERROR IN PROCESSING, PROGRAM CONTINUING.--->',//)
      ALTINC=0.0
      GO TO 255
250   IF(IA.LT.INC) GO TO 280
255   TYPE 260, COND(LA,3), COND(LA,4)
260   FORMAT(' THE NEGATIVE CONDUCTIVITY OF ',E10.5,' AT AN
     1 ALTITUDE OF',/,' ',F10.5,' WAS NOT ACCURATELY CONVERTABLE TO A
     2 DENSITY;',/,' THEREFORE, IT WAS IGNORED.'//////////)
      DEN(LA,5)=0.0
      DEN(LA,6)= 0.0
      LA=LA+1
      IF(LA.GT.K) GO TO 290
      GO TO 231
280   CONTINUE
C
C   OUTPUT OF DATA TO DISK UNDER THE
C   FILE NAMED NENI.DAT.
C
290   CALL OFILE(1,'NENI')
      DO 300 LA=1,K
300   WRITE(1,310) DEN(LA,3), DEN(LA,4), DEN(LA,5), DEN(LA,6)
     1, COND(LA,4)
310   FORMAT(4E10.4,F10.5)
```

```
      CALL RELEAS(1)
C
C   PRINT OUT HEADING SHOWN BELOW & CORRESPONDING
C   DATA.
C
      PRINT 320
320   FORMAT('1 MOBILITIES AND NEGATIVE ION DENSITIES FOLLOW
      1:',//,' ',2X,'ELECTRON MOBILITIES',5X,'NEG ION MOBILITIES',
      25X,'ELEC DEN',10X,'- ION DEN',10X,'ALTITUDE',//,'+',
      34X,'(IN CM**2/VS)',10X,'(IN CM**2/VS)',6X,'(ELEC/CM**3)',
      47X,'(ION/CM**3)',10X,'(IN KM)',//)
      DO 330 LA=1,K
330   PRINT 340, DEN(LA,3), DEN(LA,4), DEN(LA,5),DEN(LA,6),
      1 COND(LA,4)
340   FORMAT(' ',6X,E10.5,14X,E10.5,7X,E10.4,11X,E10.4,8X,F10.5)
      STOP
      END
```

```
C ***************************************************
C
C          PROGRAM TO LINEARLY INTERPOLATE TEMPERATURE
C          AND PRESSURE DATA FROM CIRA 1965.
C
C ***************************************************
        DIMENSION ALTMP(651,3), FIND(2,3)
        M=1
        L=50
        K=0
        TYPE 2
2       FORMAT(' FOR WSMR USE LATITUDE OF 30N & FOR
        1 WI USE 40N',/,' TYPE WSMR OR WI   ',$)
        ACCEPT 3,WHR
3       FORMAT(A4)
        I=1
5       TYPE 10
10      FORMAT('  ALTITUDE=  ',$)
        ACCEPT 30, ALT
30      FORMAT(F10.5)
        TYPE 20
20      FORMAT('  TEMPERATURE (IN DEG K)=  ',$)
        ACCEPT 30, TEMP
        TYPE 35
35      FORMAT('  PRESSURE (AS 0.000E+00, IN DYNES/CM**2)=  ',$)
        ACCEPT 40, PRES
40      FORMAT(E10.5)
        FIND(I,1)= ALT
        FIND(I,2)= TEMP
        FIND(I,3)= PRES
        IF(I.GE.2) GO TO 50
        I=I+1
        GO TO 5
50      ALTMP(M,1)= FIND(I-1,1)
        ALTMP(M,2)= FIND(I-1,2)
        ALTMP(M,3)= FIND(I-1,3)
        ALTINC= (FIND(I,1)-FIND(I-1,1))/50.0
        TMPINC= (FIND(I,2)-FIND(I-1,2))/50.0
        PREINC= (FIND(I,3)-FIND(I-1,3))/50.0
        DO 60 N=M,L
        ALTMP(N+1,1)= ALTMP(N,1)+ALTINC
        ALTMP(N+1,2)= ALTMP(N,2)+TMPINC
        ALTMP(N+1,3)= ALTMP(N,3)+PREINC
        IF(ALTMP(N,1).GT.80.0) ALTMP(N+1,2)=199.0
                IF(ALTMP(N,1).GT.80.0.AND.WHR.EQ.'WI ')
        1 ALTMP(N+1,2)=194.0
60      IF(ALTMP(N,1).GT.80.0) ALTMP(N+1,3)=.11400E+0
        12*EXP(-((ALTMP(N,1)-80.0)/5.59))
        IF(ALTMP(N,1).GT.80.0.AND.WHR.EQ.'WI ')
        1 ALTMP(N+1,3)=.11300E+02*EXP(-((ALTMP(N,1)-80.0)/5.59))
```

```
      FIND(1,1)=FIND(2,1)
      FIND(1,2)=FIND(2,2)
      FIND(1,3)=FIND(2,3)
      M=M+50
      L=L+50
      IF(M.LE.650) GO TO 5
      IF(WHR.EQ.'WI') GO TO 85
      CALL OFILE(1,'ZTP')
65    DO 70 I=1,651
70    WRITE(1,80) ALTMP(I,1), ALTMP(I,2), ALTMP(I,3)
80    FORMAT(2F10.5,E10.5)
      CALL RELEAS(1)
      GO TO 89
85    CALL OFILE(1,'WIZTP')
      GO TO 65
89    PRINT 90
90    FORMAT('1','ALTITUDE',10X,'TEMPERATURE',10X,'PRESSURE',
     1//,'+',1X,'(IN KM)',11X,'(IN DEG K)',6X,'
     2(IN DYNES/CM**2)',///)
      DO 100 I=1,651
100   PRINT 110, ALTMP(I,1), ALTMP(I,2), ALTMP(I,3)
110   FORMAT(' ',F10.5,8X,F10.5,8X,E10.5)
      STOP
      END
```

```
C    ******************************************************
C
C       PROGRAM TO DETERMINE ALPHA AND BETA FOR KNOWN
C         VALUES OF E/P.
C
C    *********************************************************
        DIMENSION EOPAB(2000,3)
        M=2
        N=5
        I=1
C
C     STATEMENTS REQUESTING INPUT OF DATA
C     FROM TABLES.
C
5       TYPE 10
10      FORMAT(' E/P=  ',$)
        ACCEPT 15, EOPAB(I,1)
15      FORMAT(F10.5)
        TYPE 20
20      FORMAT(' ALPHA (IN THE FORM .00000E+00)=  ',$)
        ACCEPT 30, EOPAB(I,2)
30      FORMAT(E10.5)
        TYPE 40
40      FORMAT(' BETA (IN THE FORM.00000E+00)=  ',$)
        ACCEPT 30, EOPAB(I,3)
        IF(I.GE.2) GO TO 45
        I=I+1
        GO TO 5
C
C     DETERMINATION OF INCREMENTAL VALUES.
C
45      CEOP=(EOPAB(I,1)-EOPAB(I-1,1))/0.01
        AINC=(EOPAB(I,2)-EOPAB(I-1,2))/CEOP
        BINC=(EOPAB(I,3)-EOPAB(I-1,3))/CEOP
C
C     DO LOOP TO INTERPOLATE VALUES AND INSERT
C     THEM IN THE ARRAY EOPAB.
C
        DO 50 K=M,N
        EOPAB(K,1)=EOPAB(K-1,1)+0.01
        EOPAB(K,2)=EOPAB(K-1,2)+AINC
50      EOPAB(K,3)=EOPAB(K-1,3)+BINC
        I=N+1
        M=N+1
        IF(N.EQ.5.OR.N.EQ.10.OR.N.EQ.15) N=N+5
        IF(M.EQ.16) GO TO 5
        IF(N.GT.15.AND.N.LE.200) N=N+20
        IF(N.GT.200) N=N+200
        IF(M.EQ.201) N=N-20
        IF(N.GT.2000) GO TO 60
```

```
      GO TO 5
C
C     OUTPUT OF DATA INTO FILE NAMED ALBA.DAT.
C
60    CALL OFILE(1,'ALBA')
      DO 65 L=1,2000
65    WRITE(1,67) EOPAB(L,1), EOPAB(L,2), EOPAB(L,3)
67    FORMAT(F10.5,2X,E10.5,2X,E10.5)
      CALL RELEAS(1)
C
C     PRINT OUT OF CALCULATED VALUES.
C
      PRINT 70
70    FORMAT('1  TABLE TO FIND ALPHA & BETA WHEN E/P IS
     1 KNOWN:',/,'-',6X,'E/P',20X,'ALPHA',20X,'BETA',//,
     2'+','(IN V/CM-MMHG)',9X,'(IN CM**2-MMHG/VS)',10X,
     3'(IN CM/S)',//)
      DO 80 L=1,2000
80    PRINT 90, EOPAB(L,1), EOPAB(L,2), EOPAB(L,3)
90    FORMAT(' ',3X,F10.5,14X,E10.5,15X,E10.5)
      STOP
      END
```