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PROGRAM DOCUMENTATION FOR THE HEAD SWITCHING SOFTWARE PACKAGE.(U)

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PROGRAM DOCUMENTATION FOR THE HEAD SWITCHING SOFTWARE PACKAGE

J. J. MILLER, JR.

INTERNATIONAL BUSINESS MACHINES CORPORATION
FEDERAL SYSTEMS DIVISION
OWEGO, NEW YORK 13827

JUNE 1977

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AEROSPACE MEDICAL RESEARCH LABORATORY
AEROSPACE MEDICAL DIVISION
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AMRL-TR-77-41

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FOR THE COMMANDER

CHARLES BATES, JR.
Chief
Human Engineering Division
Aerospace Medical Research Laboratory

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The Head Switching Software Package is a system of programs which provide the capability to study item selection and switch activation by an operator's head line of sight. Data is gathered on the speed and accuracy of accomplishing discrete pointing tasks with the helmet mounted sight and stored on magnetic tape for subsequent data analysis.

The programs were written for an IBM System/370, Model 155 computer running under the standard MFT version of the Operating System. Assembler language

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was used in coding the executive program and Fortran was used for the subroutine programs. The IBM System/370 Operating System Graphic Subroutine Package (GSP) for Fortran IV was utilized for the graphic software support.

PREFACE

These programs were developed for the Human Engineering Division, Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio 45433. The work was performed by the International Business Machines Corporation, Owego, New York 13827, under Contract Number F 33615-75-C-5152. Mr. Stephen D. Kay of the Systems Research Branch was the contract monitor for the Aerospace Medical Research Laboratory. The work was performed in support of Project 7184, "Human Engineering for Air Force Systems", Task 718414, "System Research for Advanced Design."

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SECTION I

INTRODUCTION

The Head Switching Software Package provides a capability to study item selection and switch activation by an operator's head line of sight. The primary research objective is to identify the human engineering considerations of helmet mounted sight application to item selection and switch activation. The purpose of this application is to expand existing data on head aiming utility, by systematically investigating the speed and accuracy of accomplishing discrete pointing tasks with the helmet mounted sight.

Section II of this document summarizes the hardware configuration for which the Head Switching Software Package was written.

Section III contains a detailed description of the logic flow of the system of programs.

Section IV describes and illustrates the data output record formats which are generated for data reduction and analysis.

Section V describes and illustrates the card decks required for using the Head Switching Software Package.

Section VI contains the flow diagrams for program logic and detailed flowcharts.

Appendix A consists of a user guide which includes user operating instructions and general information.

Appendicies B thru G contain representations of the graphic displays generated by the Head Switching Software Package.

Appendix H contains an example of the printer output generated during the experiment.

SECTION II

HARDWARE CONFIGURATION

The Head Switching Software Package was written for an IBM System/370 Computer running under Operating System/370 (OS/370). The following list comprises the hardware required in the system configuration:

- IBM System/370 Computer, Model 155
- Problem Program Core Requirements - 110K
- ITEL 7830 Storage Control Unit
- Two ITEL 7330 Disk Storage Drives
- IBM 3215 Console-Printer Keyboard
- IBM 2501 Card Reader
- IBM 1403 Printer
- IBM 2840 Display Control Unit
- IBM 2250 Display Unit
- IBM 1827 Data Control Unit (DCU)
- STC 3800 Tape Control Unit
- STC 3450 Tape Unit

SECTION III

PROGRAM DESCRIPTION

The Head Switching Software Package consists of an Assembler Language executive program and fourteen Fortran subroutine programs designed to perform the following functions:

- o user selection of the test environment criteria.
- o drive a galvomirror projection system for calibration of experiment hardware.
- o graphics monitoring of real-time subject performance.
- o data gathering of subject performance statistics.
- o rerun of subject task failures.
- o statistical analysis of task performance.
- o graphics summary of test environment criteria, hardware calibration results, and scoring of task performance.
- o summary printout of criteria, performance, calibrations, and results.
- o save of all pertinent data to conventional tape.

Upon execution of the Head Switching Software Package, the executive program (HSWITCH) gains control and initializes the common data area used to communicate information to and from the Fortran subroutines. A CALL is then made to the subroutine INITAL to generate the Cell Initialization Data Display (Appendix B). This display presents a data entry menu to the user, from which he must select the following items:

- o Subject Number - used to distinguish data gathered on different subjects' performance by subsequent data reduction.
- o Controller Type - used to identify which controller, joystick (JOY) or helmet mounted sight (HMS), was used for the cell by subsequent data reduction.

- Button Size - used to set up the tolerance diameter to be allowed on the targets presented to the subject. Figure 1 illustrates the tolerances used based on button size selection by the user.

- Minimum Reaction Time - used to establish the minimum time, in milliseconds, allowed the subject, in determining if a pass was successful.

- Start Point Tolerance - used to establish the minimum distance, in degrees, allowed the subject from dead center of the start point, in determining if the reticle is positioned properly.

- Rest Period - used to provide a user controlled time in seconds, between subject passes, for rest.

- Task Time - used to establish the total maximum time, in seconds, allowed the subject to accomplish the tasks within a pass.

The user selects the desired items via light-pen action from the data entry menu. When an item is light-penned (tagged) by the user, it is displayed in the box above the menu list and below the criteria headings. If a menu item is selected erroneously, the user need only reselect an item to replace the previous displayed selection. When all criteria selection has been completed, the user must tag the * preceding the phrase CELL DATA ENTRY COMPLETE. If the user has failed to select all criteria, the light-pen action on the * will have no effect. Once all criteria has been selected and the * tagged, INITAL will return processing control to HSWITCH.

The executive program will process the user requested rest period and task time, initialize for analog input and output, and CALL the CALFAC subroutine. CALFAC will perform initialization of zero point and deflection point data areas and return control to HSWITCH. The executive program then CALLs the ADJCAL subroutine.

ADJCAL will generate the ADJUSTMENTS AND CALIBRATIONS DISPLAY (Appendix C). This display provides the user the capability to make galvonometer adjustments manually and to calibrate the experiment screen (Figure 2) based on subject aiming ability on selected calibration points. The display is divided into two functional areas, GALVONOMETER ADJUSTMENTS and SUBJECT/CONTROLLER CALIBRATIONS. To activate a functional area, the user must tag the * preceding the phrase of the desired function. Once a

BUTTON SIZES

	1	2	3
Tolerance in diameter degrees	.75	1.50	3.00
Tolerance in diameter inches	1.50	3.00	6.00

FIGURE 1. BUTTON SIZE TOLERANCES

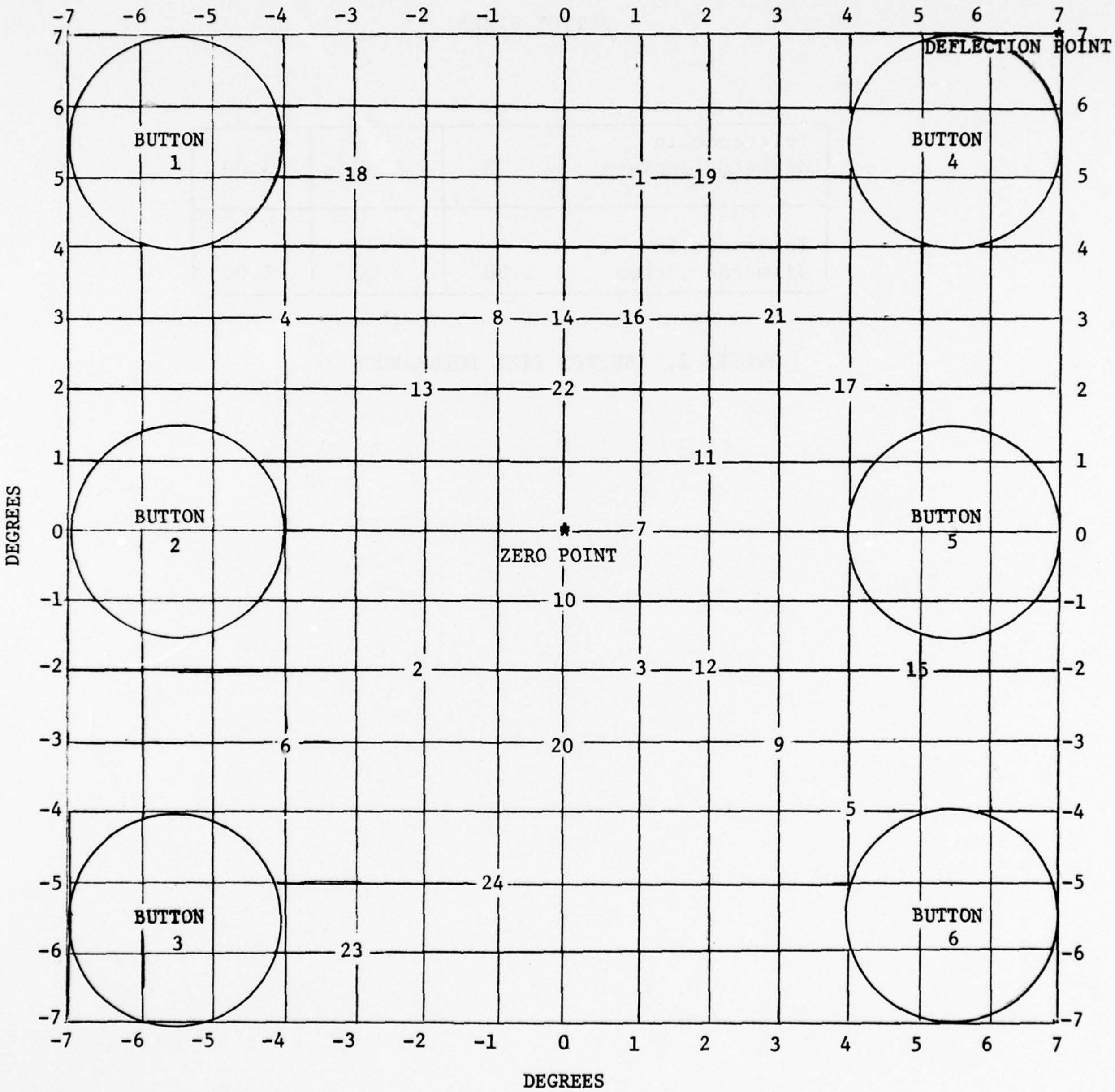


FIGURE 2. EXPERIMENT SCREEN DESIGN

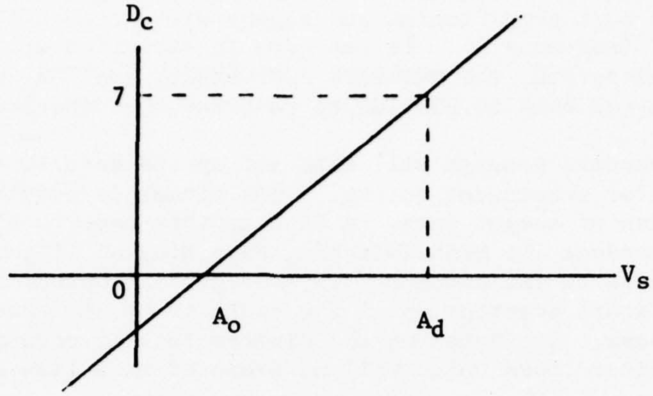
functional area has been tagged, an arrow (-->) will be generated to the left of the asterisk to inform the user that the request has been recognized. The GALVONOMETER ADJUSTMENTS functional area is designed to provide the user a mechanism for manual alignment of the galvomirror projection system laser beams. The user must tag the * preceding either the TARGET ZERO POINT GENERATION or TARGET DEFLECTION POINT GENERATION phrase to generate the respective point on the experiment screen (Figure 2). When the user requests either option, ADJCAL will generate an arrow to the left of the * tagged to inform the user the request has been recognized and return control to HSWITCH for output of the analog voltage required to produce the user request. HSWITCH then CALLs ADJCAL again for processing of the next user light-pen action. Once a requested point is generated, it will remain active until the user requests generation of the other point. The user has the flexibility to alternately generate the zero point and deflection point until he is satisfied with the manual equipment adjustments. As each succeeding user request is made, the arrow is moved to identify the current request. When the user has finished the equipment adjustments, the * preceding the phrase ADJUSTMENTS COMPLETED must be tagged to exit the functional area. At this time all arrows within the functional area will be removed, allowing the user selection again of a functional area.

The SUBJECT/CONTROLLER CALIBRATIONS functional area provides the capabilities for ZERO POINT GENERATION and DEFLECTION POINT GENERATION to verify equipment adjustments and mathematical calibration of the subject/controller. The same program logic is used to generate requested points and to produce the arrows for user notification of requests. Once a zero point or deflection point is generated, the user must instruct the subject to position the reticle, of the controller being used, on the generated point and remain there. The user must now tag the * preceding either the phrase INITIATE ZERO POINT SAMPLING or INITIATE DEFLECTION POINT SAMPLING respective to the point currently being active. When sampling has been requested, ADJCAL will sound the alarm on the 2250 to notify the user and the subject that sampling has begun. Control is returned to HSWITCH to CALL the subroutine CALFAC for initialization of the data area used for data summation. HSWITCH then reads 600 samples of analog voltage generated by the subject/controller. When sampling has been completed (approximately 8 seconds) ADJCAL is CALLed to sound the alarm on the 2250 and remove the arrows, to notify the user and subject that sampling has been completed. The user may repeat the sampling process as many times as necessary until satisfied with the subject's performance. When satisfied, the functional area can be exited by tagging the * preceding the phrase CALIBRATIONS COMPLETED. The user must now tag the * preceding the phrase ADJUSTMENTS AND CALIBRATIONS COMPLETED to remove the display and return control to HSWITCH.

The executive program then CALLs CALFAC to average the sampled data, compute x- and y-axis gain and position, convert voltages to experiment screen degrees, compute start point tolerance and button tolerance. Figure 3 illustrates the math logic used in the calculations. After the calculations have been completed, CALFAC returns control to HSWITCH which CALLs the PRECAL subroutine.

The PRECAL subroutine will generate the PRELIMINARY CALIBRATION RESULTS DISPLAY. This display provides the user with the data averaged from subject/controller calibrations on the zero point and deflection point. It also provides the calibration factors for x-axis and y-axis gain and position. The primary function of the display is to supply the user information pertaining to the status of the hardware. The 0.000 and 7.000 degree values are the theoretical measurements for zero point and deflection point calibration. After the user has inspected the display data he must tag the * to the left of the desired item at the bottom of the display. Tagging the left * selects the desired function. The user must also tag the * to the right of the selected function to execute the function. The TERMINATE HEAD SWITCHING PROGRAM function will end the job on the S/370 computer. The TERMINATE CELL & RESTART PROGRAM function will reinitialize the Head Switching Software Package and regenerate the CELL INITIALIZATION DATA DISPLAY (Appendix B). If the calibration results are not satisfactory, the RECALIBRATE SUBJECT/CONTROLLER function will allow the user to repeat the equipment adjustments and calibrations by returning program control to the ADJUSTMENTS AND CALIBRATIONS DISPLAY (Appendix C). If the user decides the calibration was successful, the CALIBRATION RESULTS SATISFACTORY function will remove the display and transfer control to HSWITCH.

The executive program will then CALL the BUTTON subroutine to generate the BUTTON GENERATION DISPLAY (Appendix E). This display will produce a graphic representation of the experiment screen (Figure 2), showing position of the six buttons (subject targets) and location of the zero and deflection points. The purpose of the display is to provide the user a mechanism for verifying the positioning of the buttons and permit manual realignment if necessary. The user can generate a button by tagging the number of the button desired. BUTTON will replace the tagged number with an asterisk to notify the user that the request has been recognized and return control to HSWITCH. The executive program will output the analog voltages for the requested button and CALL BUTTON for processing of the next user request. As successive requests are made by the user, the previous request is deactivated and the user informed by replacing the * with the original number of the button on the display. When the user has completed button generation, he must select one of the three options at the bottom of the display by tagging the * to the left of the desired option. After a selection has been made, the * to the right of the option must be tagged to activate the function. The TERMINATE HEAD SWITCHING PROGRAM function will end the job on the S/370



$$D_c = \left(\frac{7}{A_d - A_o}\right) V_s + \left(\frac{-7A_o}{A_d - A_o}\right)$$

(GAIN) (POSITION)

After x-axis and y-axis gain and position have been calculated from the sampled data, the following math is used to convert voltages to computer degrees, compute screen degrees/inch.

DSXZ = (XGAIN * VSXZ) + XPOSITION DSYZ = (YGAIN * VSYZ) + YPOSITION
DSXD = (XGAIN * VSXD) + XPOSITION DSYD = (YGAIN * VSYD) + YPOSITION

DEFINITIONS:

D_c = Degrees Computer
V_s = Volts Subject
A_o = Average Subject Zero Point Volts
A_d = Average Subject Deflection Point Volts

DSXZ = Degrees Subject x-Axis Zero Point
DSXD = Degrees Subject x-Axis Deflection Point
DSYZ = Degrees Subject y-Axis Zero Point
DSYD = Degrees Subject y-Axis Deflect Point

VSXZ = Volts Subject x-Axis Zero Point
VSXD = Volts Subject x-Axis Deflection Point
VSYZ = Volts Subject y-Axis Zero Point
VSYD = Volts Subject y-Axis Deflection Point

SQRT = Square Root

FIGURE 3. CALIBRATION MATH LOGIC

computer. The TERMINATE CELL & RESTART PROGRAM function will reinitialize the Head Switching Program and regenerate the CELL INITIALIZATION DATA DISPLAY (Appendix B). If the user is satisfied with the results of button generation, the GENERATE PERFORMANCE MONITOR function will transfer control back to HSWITCH to continue the experiment.

The executive program will then set up the data ID number (YYDDDHHMM) for subsequent output. This number is provided for user identification of output data. A CALL is then made to the DIAGRAM subroutine to produce the Head Switching Pass Diagram (Figure 4) and output the diagram to the printer. This diagram is output to provide the user a functional description of the tasks to be performed by the subject during one pass. The boxes on the diagram totally composed of asterisks identify subject tasks which will be measured on a time basis.

An internal subroutine in the executive program (Random) is used to generate a random Pass *Combination* Table (Figure 5). This table was supplied by the user to establish a known base for pass performance measurements. A total of 24 pass combinations were provided with an equal balance of buttons presented, start times, stimulus distances and quadrant location of start points. The start points are illustrated for the 24 pass combinations on the equipment screen design in Figure 2. The purpose of the internal subroutine Random is to generate a random table of the numbers 1 thru 24. This random table is used as the sequence for presenting the pass combinations. The time-of-day (TOD) clock, a 64-bit binary counter in the S/370, was used to generate the random table. Bits 47-51 were used for a seed value. The S/370 updates bit 51 of the clock every microsecond. Each time a seed value is obtained the random table is updated, providing the value is not already present, until the table is complete. Upon return from Random, the executive program sets up the pass combination data in the order to be presented, initializes control words, and CALLs the RTPMIF subroutine.

The RTPMIF subroutine will generate the REAL-TIME PERFORMANCE MONITOR DISPLAY (Appendix F). This display provides real-time subject pass performance data and user control of the experiment. The pass numbers and the randomly generated pass combinations are the only information items initially displayed to the user. The pass combinations are displayed to provide the user the ability to use the Pass Combination Table (Figure 5) and the Experiment Screen Design (Figure 2) to gain information on the pass criteria before it is presented to the subject. After the user has explained the tasks to be accomplished to the subject, the * preceeding the phrase INITIATE PASS DATA PRESENTATION must be tagged to select the function. To activate the function and return control to HSWITCH, the user must tag the * to the right of the selected function. RTPMIF then returns control to HSWITCH.

The executive program will CALL the subroutine PASSDA to output the initial pass data header to the printer. Figure 6 illustrates the header

HEAD SWITCHING PASS DIAGRAM

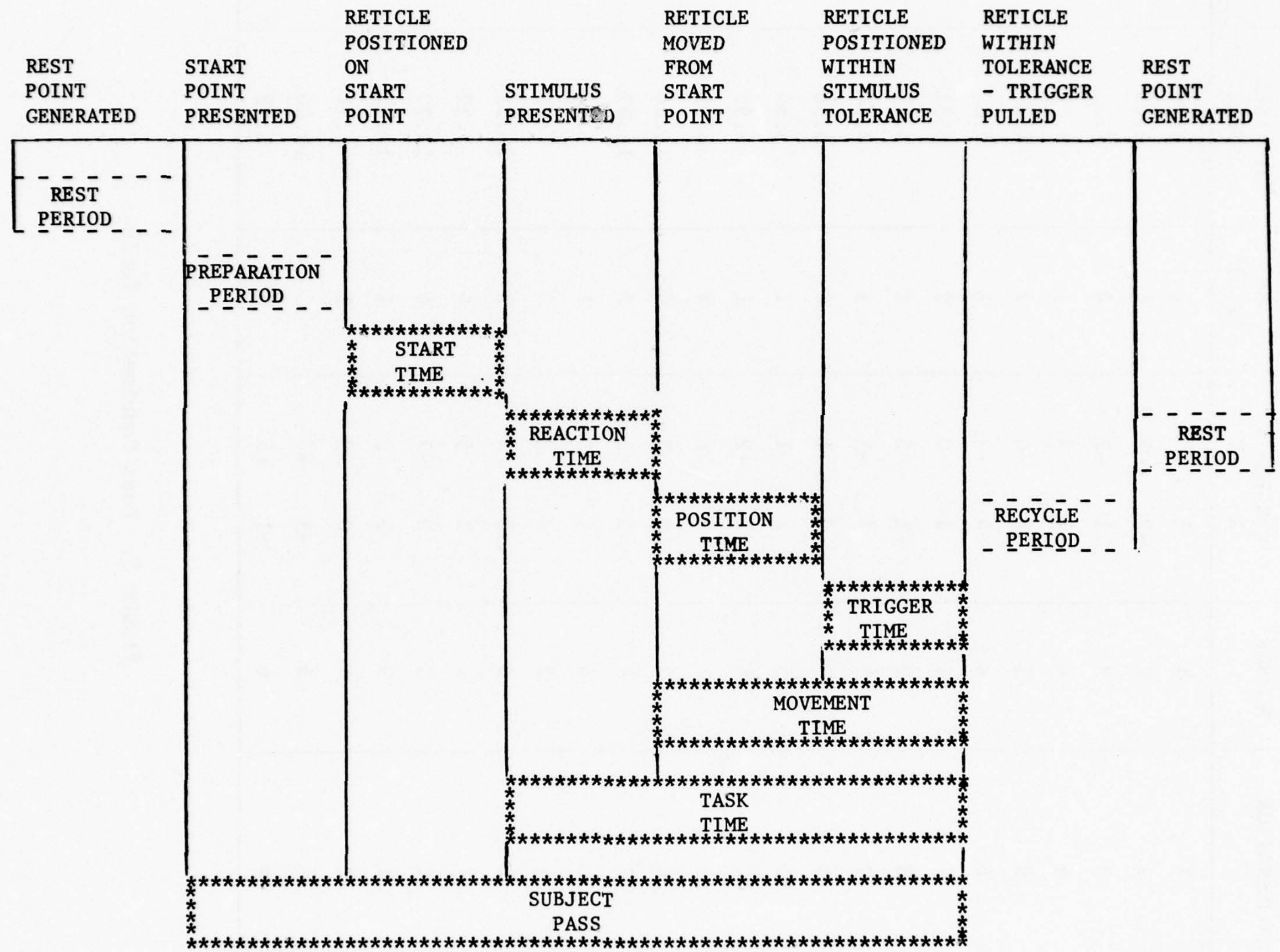


FIGURE 4. HEAD SWITCHING PASS DIAGRAM

PASS COMBINATION	BUTTON NUMBER	START POINT (DEGREES) X	Y	START TIME (SEC)	STIMULUS DISTANCE (DEGREES)	QUADRANT
1	1	1	5	3	6.52	1
2	2	-2	-2	2	4.03	3
3	3	1	-2	4	7.38	4
4	4	-4	3	1	9.82	2
5	5	4	-4	2	4.27	4
6	6	-4	-3	3	9.82	3
7	1	1	0	2	8.51	4
8	2	-1	3	2	5.41	2
9	3	3	-3	3	3.54	4
10	4	0	-1	2	5.50	3
11	5	2	1	1	3.64	1
12	6	2	-2	1	4.95	4
13	1	-2	2	4	4.95	2
14	2	0	3	4	6.26	2
15	3	5	-2	2	11.07	4
16	4	1	3	1	5.15	1
17	5	4	2	3	2.50	1
18	6	-3	5	3	13.51	2
19	1	2	5	4	7.52	1
20	2	0	-3	4	10.27	3
21	3	3	3	1	12.02	1
22	4	0	2	1	6.52	2
23	5	-3	-6	3	10.40	3
24	6	-1	-5	4	6.52	3

FIGURE 5. Pass Combination Table

HEAD SWITCHING PASS DATA

INITIAL ATTEMPT

SUBJECT/CELL INFORMATION

DATA ID NUMBER -	770221339	REACTION MINIMUM -	100 MILSECS
SUBJECT NUMBER -	01	START TOLERANCE -	0.50 DEGREES
BUTTON SIZE -	2	REST PERIOD -	03 SECONDS
CONTROLLER TYPE -	JOY	TASK TIME LIMIT -	20 SECONDS

	PREDEFINED PASS CRITERIA					PASS PERFORMANCE MEASUREMENTS							
PASS NUMBER	PASS COMBI-NATION	BUTTON NUMBER	START POINT (DEGREES) X Y	START TIME (SEC)	STIMULUS DISTANCE (DEGREES)	REACTION TIME (MSEC)	POSITION TIME (MSEC)	TRIGGER TIME (MSEC)	MOVEMENT TIME (MSEC)	TASK TIME (MSEC)	MISS HITS	OFF CENTER DISTANCE (DEGREES)	GOOD PASS

FIGURE 6. INITIAL PASS DATA HEADER

with example Subject/Cell Information. The user requested criteria from the CELL INITIALIZATION DATA DISPLAY (Appendix B) and the Data ID Number generated from the TOD Clock are output as Subject/Cell Information and the column headings for the Predefined Pass Criteria and Pass Performance Measurements are output. After the header is output, PASSDA will return control to HSWITCH to output header information to tape (SECTION IV). After tape output has been completed, the executive program performs initialization of control information prior to initiating the subject pass.

A subject pass is initiated by analog output of the voltages required to generate the subject start point (Figure 5) for the previously determined pass combination. An analog read of the voltages is then executed and the subroutine LOCATE CALLed. This subroutine will use the analog input voltages to determine the location, on the equipment screen (Figure 2), of the reticle positioned by the subject. The algorithm used to determine subject reticle location is illustrated in Figure 7. Once the subject reticle location has been determined, an algorithm (Figure 8) is used to determine if the subject reticle is within the start point tolerance. LOCATE will return a tolerance determination code to HSWITCH. If the subject has not positioned the reticle within the start point tolerance, another analog read is executed and the location and tolerance algorithms are repeated. Once the subject reticle is determined to be within tolerance, the executive program will execute a STIMER WAIT for the user supplied start time (Figure 5). After the start time wait period has elapsed, LOCATE is CALLed to verify the subject is still positioned on the start point. If the subject is not positioned on the start point the entire start point program logic is repeated. Once the subject has positioned the reticle on the start point for the required start time, the TOD Clock is stored in memory to establish the subject's starting reaction time.

The button number (Figures 2 and 5) is then presented to the subject by executing an analog write of the voltages required to generate the button number. Analog reads of subject reticle position and subroutine CALLs to LOCATE are then repetitively executed until the subject reticle is positioned outside the start point tolerance. The TOD Clock is then stored in memory to establish the subject's ending reaction time and starting position time. An analog read and CALL to LOCATE is executed repeatedly until the subject has positioned the reticle within the predetermined tolerance for the button being presented. When this task has been accomplished, the TOD Clock is stored in memory to establish the subject's ending position time and starting trigger time.

The subject's task is to pull the trigger on the joystick, regardless of whether the HMS or joystick is the controller, while the reticle is positioned within the predetermined button tolerance. Repetitive analog reads and CALLs to LOCATE are executed until it is recognized that

Convert 1827 analog subject input units to volts.

```
XSUB = (XS * (-5.0) / 32768.0)
YSUB = (YS * (-5.0) / 32768.0)
```

Convert 1827 start point computer units to degrees.

```
XSTD = (XC * 10.0 / 32768.0)
YSTD = (YC * 10.0 / 32768.0)
```

Apply gain and position factors (Figure 3) to subject voltages to obtain subject degrees.

```
XDEG = (XGAIN * XSUB) + XPOSITION
YDEG = (YGAIN * YSUB) + YPOSITION
```

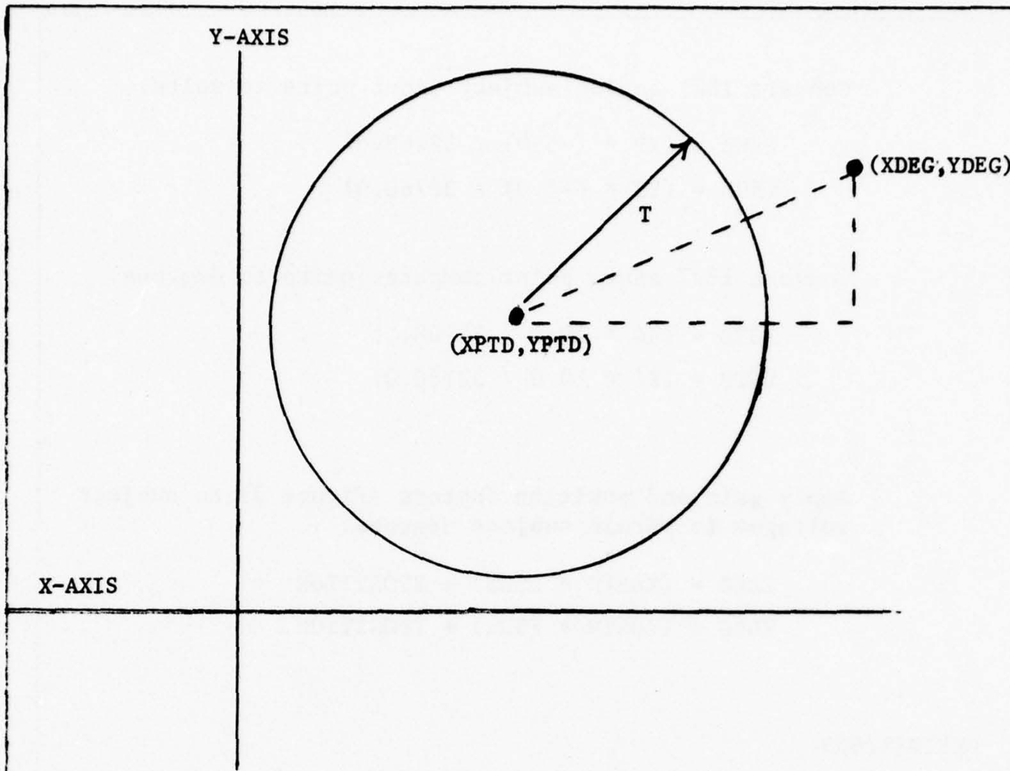
DEFINITIONS:

XS = X-Axis Input Subject Units
YS = Y-Axis Input Subject Units
XSUB = X-Axis Subject Volts
YSUB = Y-Axis Subject Volts

XC = X-Axis Computer Units
YC = Y-Axis Computer Units
XSTD = X-Axis Start Point Degrees
YSTD = Y-Axis Start Point Degrees

XDEG = X-Axis Subject Degrees
YDEG = Y-Axis Subject Degrees

FIGURE 7. SUBJECT LOCATION ALGORITHM



Compute subject distance from generated point.

DIST = SQRT((XPTD - XDEG)**2 + (YPTD - YDEG)**2

Determine if subject within predefined tolerance.

IF DIST $>$ T then subject is not within tolerance.

IF DIST $\leq$ T then subject is within tolerance.

DEFINITIONS:

XPTD = X-Axis Generated Point in Degrees
YPTD = Y-Axis Generated Point in Degrees

XDEG = X-Axis Subject Location in Degrees
YDEG = Y-Axis Subject Location in Degrees

SQRT = Square Root

T = Tolerance (previously defined by applying the BIAS (Figure 3) to the user requested tolerance)

FIGURE 8. TOLERANCE DETERMINATION ALGORITHM

the trigger has been pulled. LOCATE is then CALLed to check if the subject was within the tolerance of the button when the trigger was pulled. If the subject was not within tolerance, it is scored as a miss hit and the executive program repeats the logic looking for a new trigger pull within tolerance. When the subject has completed the task, the TOD Clock is stored in memory to establish the ending trigger time. The presented stimulus is then moved to the zero point to notify the subject that the pass has been completed.

The executive program then sets up a common area in memory containing the predefined pass criteria data and the TOD Clock values previously saved. The subroutine CALPPM is then CALLed to calculate the pass performance measurements for reaction time, position time, trigger time, movement time, task time, and off-center distance. Upon return, the executive program sets this data along with the miss hits data in a common data area in memory. A check is then made to see if the user selected reaction time minimum or task time limit was exceeded. If either limit was exceeded, the good pass status is scored as "NO." If both criteria were met, the good pass status is scored as "YES." The subroutines RTPMUP and PASSDA are then called successively. The RTPMUP subroutine will update the REAL-TIME PERFORMANCE MONITOR DISPLAY (Appendix F) with the information pertaining to the performance of the pass just completed. The PASSDA subroutine will output the same information, as well as the off-center distance and predefined pass criteria data, to the printer. The cell pass data are then saved on tape and the subroutine RTPMIF called to check for user requests. This check provides the user the opportunity to TERMINATE CELL & RESTART PROGRAM or TERMINATE HEAD SWITCHING PROGRAM after each of the twenty-four subject passes, based on his analysis of how the experiment is progressing. If the user has not elected to terminate the experiment, a STIMER WAIT is issued for the previously defined rest period. Once the rest period time has elapsed, the criteria for the next pass combination is set up and the program logic repeated beginning with presentation of the start point.

When all twenty-four passes have been completed by the subject, the executive program removes the arrows from INITIATE PASS DATA PRESENTATION and checks the status of each pass. If any pass status is found to be scored "NO", the subroutine RTPMUP is called to blank the pass performance data associated with that pass. The subroutine RTPMIF is then called to process user requests. The user should take this time to explain to the subject that any unsuccessful passes will be rerun. The user must tag the * to the left and right of the phrase INITIATE PASS DATA PRESENTATION to start the rerun of previously unsuccessful passes. RTPMIF will then update the display to read *FINAL* ATTEMPT and return control to HSWITCH. The executive program then CALLs PASSDA to output the final pass data header, similar to the initial pass data header (Figure 6), to the printer. Header information is also output to tape by the executive program. The same program logic is used to rerun the final attempts by the subject to successfully complete the pass tasks, display updates, calculate pass performance, score passes, and output data. When the final attempt has been completed the subroutine RTPMIF is CALLed to replace the phrase INITIATE PASS DATA PRESENTATION with RECALIBRATE SUBJECT/CONTROLLER. The user can review the displayed pass performance information. After analyzing the subject's performance, the user must select and activate either the recalibration function or one of the termination functions. If the user has decided to continue the experiment and activated the RECALIBRATE SUBJECT/CONTROLLER function, the executive program CALLs the subroutine ADJCAL.

The ADJUSTMENTS AND CALIBRATIONS DISPLAY (Appendix C) is regenerated to provide the user the capability to recheck equipment alignment and recalibrate the subject/controller. The same program logic used earlier in the experiment for adjustments and calibrations is repeated. The user can verify hardware alignment and calibrations and analyze the effect of any hardware discrepancies, from the start to the end of the experiment, on the data collected. When the ADJUSTMENTS AND CALIBRATIONS FUNCTIONS COMPLETED function has been selected and activated, control is returned to HSWITCH. The executive program CALLs the subroutine CALFAC to perform the final calibration calculations. Upon return from CALFAC, the executive program will CALL the subroutine SUMCAL to perform cell calculations.

SUMCAL will use the performance data from successful passes to calculate the percentage of passes with miss hits, total number of misses, mean hit error, mean reaction time, mean trigger time, mean movement time, and mean task time. When cell calculations have been completed and control returned to HSWITCH, the subroutine SUMPRI is CALLed to output the Head Switching Summary (Appendix H) to the printer. Upon return the executive program will output summary data (SECTION IV) to tape and CALL the SUMDIS subroutine.

SUMDIS will generate the CELL SUMMARY DISPLAY (Appendix G). The purpose of the display is to provide the user with pertinent experiment information and results for analysis prior to data reduction. The user is provided with four categories of information; subject/cell information, subject/controller calibrations, calibration factors, and cell calculations. The subject/cell information section contains the user selected criteria from the CELL INITIALIZATION DATA DISPLAY (Appendix B) and the generated data ID number. The subject/controller calibrations section contains the data previously presented on the PRELIMINARY CALIBRATIONS RESULTS DISPLAY (Appendix D) and the final recalibration data. The calibration factor section contains the resultant computations from the Calibration Math Logic (Figure 3). The cell calibrations section contains the statistical analysis data from pass performance calculations. After the user has reviewed the cell summary data, one of the termination functions must be selected and activated. The TERMINATE HEAD SWITCHING PROGRAM function will end the job on the S/370 computer. The TERMINATE CELL & RESTART PROGRAM function will cause the executive program to re-initialize and generate the CELL INITIALIZATION DATA DISPLAY (Appendix B).

SECTION IV

INPUT/OUTPUT FORMAT

This section describes the analog input/output channel definition and the formats used to save data on magnetic tape for subsequent data reduction.

The tables illustrated in Figure 9, Analog Input/Output, provide the user with the information necessary for hardware attachments and software interpretation of data transfer.

Output data is recorded on magnetic tape during the experiment. Three types of data records are output; Header Record (Figure 10), Pass Data Record (Figure 11), and the Cell Summary Record (Figure 12). Each output record contains a variable length control word, in the first two bytes, describing the length of the record in bytes and a Record Type Key (Figure 13) describing the output record type.

The Header Record (Figure 10) contains the software generated data ID number and data, selected by the user, from the data entry menu on the Cell Initialization Data Display (Appendix B). The Controller Type Key (Figure 13) describes which controller was used by the subjects. This record is output when the user has selected and activated the INITIATE PASS DATA PRESENTATION function on the Real Time Performance Monitor Display (Appendix F).

The Pass Data Record (Figure 11) contains the data pertaining to subject performance of the tasks for an individual pass within a cell, the pass combination (Figure 5), and Pass Type and Pass Status Keys (Figure 13). The keys provide the user information pertaining to which attempt the data was gathered on and the qualification of the data based on predefined criterion. This record is output after subject completion of each pass.

The Cell Summary Record (Figure 12) contains start and final calibration data, calibration factors, and statistical analysis of subject cell performance. This record is output after final calibrations and prior to generation of the Cell Summary Display (Appendix G).

ANALOG OUTPUT

DAC NUMBER	DECIMAL ADDRESS	DESCRIPTION
1	00 01	Unused X-Axis or Azimuth
2	02 03	Y-Axis or Elevation Unused

ANALOG INPUT

GROUP NUMBER	POINT NUMBER	DESCRIPTION
0	3 4 5 6	X-Axis or Azimuth (Reticle) Y-Axis or Elevation (Reticle) Trigger State Unused

VOLTAGES

TRANSFER TYPE	MINIMUM VOLTAGE	MAXIMUM VOLTAGE
INPUT	-5	+5
OUTPUT	-7	+7

FIGURE 9. ANALOG INPUT/OUTPUT

DECIMAL RELATIVE OFFSET	LENGTH IN BYTES	CONTENTS	TYPE OF DATA	UNITS
0	2	Variable Length Control Word	INTEGER	BYTES
2	2	Zeroes	-------	-------
4	4	Record Type Key	INTEGER	-------
8	12	Data ID Number (b̸b̸b̸yydddhhmm - y=year, d=day, h=hour, m=minutes)	LITERAL	-------
20	4	Subject Number	INTEGER	-------
24	4	Controller Type Key	INTEGER	--------
28	4	Button Size	INTEGER	--------
32	4	Minimum Reaction Time	INTEGER	MILLISECONDS
36	4	Start Point Tolerance	REAL	DEGREES
40	4	Rest Period	INTEGER	SECONDS
44	4	Task Time	INTEGER	SECONDS
48	12	Spare Area	INTEGER	-1

FIGURE 10. HEADER RECORD

DECIMAL RELATIVE OFFSET	LENGTH IN BYTES	CONTENTS	TYPE OF DATA	UNITS
0	2	Variable Length Control Word	INTEGER	BYTES
2	2	Zeroes	-------	-------
4	4	Record Type Key	INTEGER	-------
8	4	Pass Type Key	INTEGER	-------
12	4	Pass Number	INTEGER	-------
16	4	Pass Combination	INTEGER	-------
20	4	Reaction Time	INTEGER	MILLISECONDS
24	4	Position Time	INTEGER	MILLISECONDS
28	4	Trigger Time	INTEGER	MILLISECONDS
32	4	Movement Time	INTEGER	MILLISECONDS
36	4	Task Time	INTEGER	MILLISECONDS
40	4	Miss Hits	INTEGER	-------
44	4	Off-Center Distance	REAL	DEGREES
48	4	Pass Status Key	INTEGER	-------
52	8	Spare Area	INTEGER	-1

FIGURE 11. PASS DATA RECORD

DECIMAL RELATIVE OFFSET	LENGTH IN BYTES	CONTENTS	TYPE OF DATA	UNITS
0	2	Variable Length Control Word	INTEGER	BYTES
2	2	Zeroes	-------	-------
4	4	Record Type Key	INTEGER	-------
8	4	X-Axis Zero Point (Start)	REAL	DEGREES
12	4	Y-Axis Zero Point (Start)	REAL	DEGREES
16	4	X-Axis Deflection Point (Start)	REAL	DEGREES
20	4	Y-Axis Deflection Point (Start)	REAL	DEGREES
24	4	X-Axis Zero Point (Final)	REAL	DEGREES
28	4	Y-Axis Zero Point (Final)	REAL	DEGREES
32	4	X-Axis Deflection Point (Final)	REAL	DEGREES
36	4	Y-Axis Deflection Point (Final)	REAL	DEGREES
40	4	X-Axis Gain	REAL	DEGREES/VOLT
44	4	X-Axis Position	REAL	DEGREES
48	4	Y-Axis Gain	REAL	DEGREES/VOLT
52	4	Y-Axis Position	REAL	DEGREES
56	4	Passes With Miss Hits	REAL	PERCENT
60	4	Total Number of Miss Hits	INTEGER	-------
64	4	Mean Hit Error	REAL	DEGREES
68	4	Mean Reaction Time	INTEGER	MILLISECONDS

FIGURE 12. CELL SUMMARY RECORD
(continued)

DECIMAL RELATIVE OFFSET	LENGTH IN BYTES	CONTENTS	TYPE OF DATA	UNITS
72	4	Mean Position Time	INTEGER	MILLISECONDS
76	4	Mean Trigger Time	INTEGER	MILLISECONDS
80	4	Mean Movement Time	INTEGER	MILLISECONDS
84	4	Mean Task Time	INTEGER	MILLISECONDS
88	4	Number of Passes Used for Statistics	INTEGER	------------
92	28	Spare Area	INTEGER	-1

FIGURE 12. CELL SUMMARY RECORD
(concluded)

RECORD TYPE KEY

VALUE	DEFINITION
1	Header Record
2	Pass Data Record
3	Cell Summary Record

CONTROLLER TYPE KEY

VALUE	DEFINITION
1	HMS (Helmet Mounted Sight)
2	JOY (Joystick)

PASS TYPE KEY

VALUE	DEFINITION
1	Initial Pass Data
2	Final Pass Data

PASS STATUS KEY

VALUE	DEFINITION
1	Bad Pass
2	Good Pass

FIGURE 13. OUTPUT DATA KEYS

SECTION V

PROGRAM DECKS

The source program card decks and program object decks for the Head Switching Software Package are available at the Systems Research Branch, Human Engineering Division of the Aerospace Medical Research Laboratory. A printed listing of the source code is also available in card image and assembled format.

These programs are stored on a magnetic tape, AMRL serial number 000409. File 24 contains the program object decks, with Job Control Language (JCL), for link-editing the Head Switching Software Package. File 25 contains the source code, with JCL, for assembling the Head Switching Software Package programs. Both files are in card image format; fixed length 80 byte records.

To simplify the operating procedures for execution of the Head Switching Software Package, the programs are link-edited into a private library on disk. Figures 14 and 15 illustrate the link-edit decks required to link-edit the Head Switching Software Package programs from object decks or the private library respectively. Figure 16 illustrates the JCL comprising the execution deck required for execution of the Head Switching Software Package.

```
//LINKEDIT  JOB   MILLER,MSGLEVEL=1
//LNKHEAD  EXEC   PGM=IEWL,PARM=(XREF,LIST)
//SYSLIB      DD  DSNAME=SYS1.HESSFORT,DISP=OLD
//            DD  DSN=SYSL.LINKLIB,DISP=OLD
//SYSPRINT    DD  SYSOUT=A
//SYSUT1      DD  UNIT=3330,SPACE=(2048,(50,20))
//SYSLMOD     DD  DSN=SYS1.HESSLINK(HEADS),DISP=OLD
//SYSLIN      DD  *
(OBJECT DECKS)

/*
```

FIGURE 14. LINK-EDIT DECK FOR OBJECT DECK INPUT

```
//LINKHEAD JOB MILLER,MSGLEVEL= 1

// EXEC LINK

//LKED.SYSLMOD DD DSN=SYSL.HESSLINK(HEADS),DISP=SHR

//LKED.MY DD DSN=IBM.JOES,DISP=SHR

//LKED.SYSIN DD *

 INCLUDE MY(HSWITCH)
 INCLUDE SYSLIB(IHCGSPO3)
 INCLUDE MY(INITAL)
 INCLUDE MY(ADJCAL)
 INCLUDE MY(DIAGRM)
 INCLUDE MY(TRPMIF)
 INCLUDE MY(PASSDA)
 INCLUDE MY(SUMPRI)
 INCLUDE MY(SUMDIS)
 INCLUDE MY(RTPMUP)
 INCLUDE MY(CALFAC)
 INCLUDE MY(CALPPM)
 INCLUDE MY(LOCATE)
 INCLUDE MY(BUTTON)
 INCLUDE MY(PRECAL)
 INCLUDE MY(SUMCAL)
/*
```

FIGURE 15. LINK-EDIT DECK FOR PRIVATE LIBRARY INPUT

```
//HEADS JOB MILLER,MSGLEVEL=1

//STP1 EXEC PGM=HEADS

//STEPLIB DD DSN=SYS1.HESSLINK,DISP=SHR

//FT06F001 DD SYSOUT=A

//FT10F001 DD UNIT=1E1

//ANAIN DD UNIT=002

//ANAOUT DD UNIT=005

//TAPEOUT DD DSN=HDATA,VOL=SER=000000,LABEL=(,SL),DISP=NEW,UNIT=181

/*
```

FIGURE 16. EXECUTION DECK

SECTION VI

FLOW DIAGRAMS

The logic diagram and program flowchart for the Head Switching Software Package are illustrated in Figures 17 and 18 respectively.

These machine-produced charts were generated by AUTODOC-V, a S/360 program. The conventions used on these flow charts are described in "AUTODOC-V on AUTOMATIC DOCUMENTATION AND SYMBOLIC FLOW CHARTING PROGRAM", 360D-001.1.014, available at the Systems Research Branch, Human Engineering Division of AMRL.

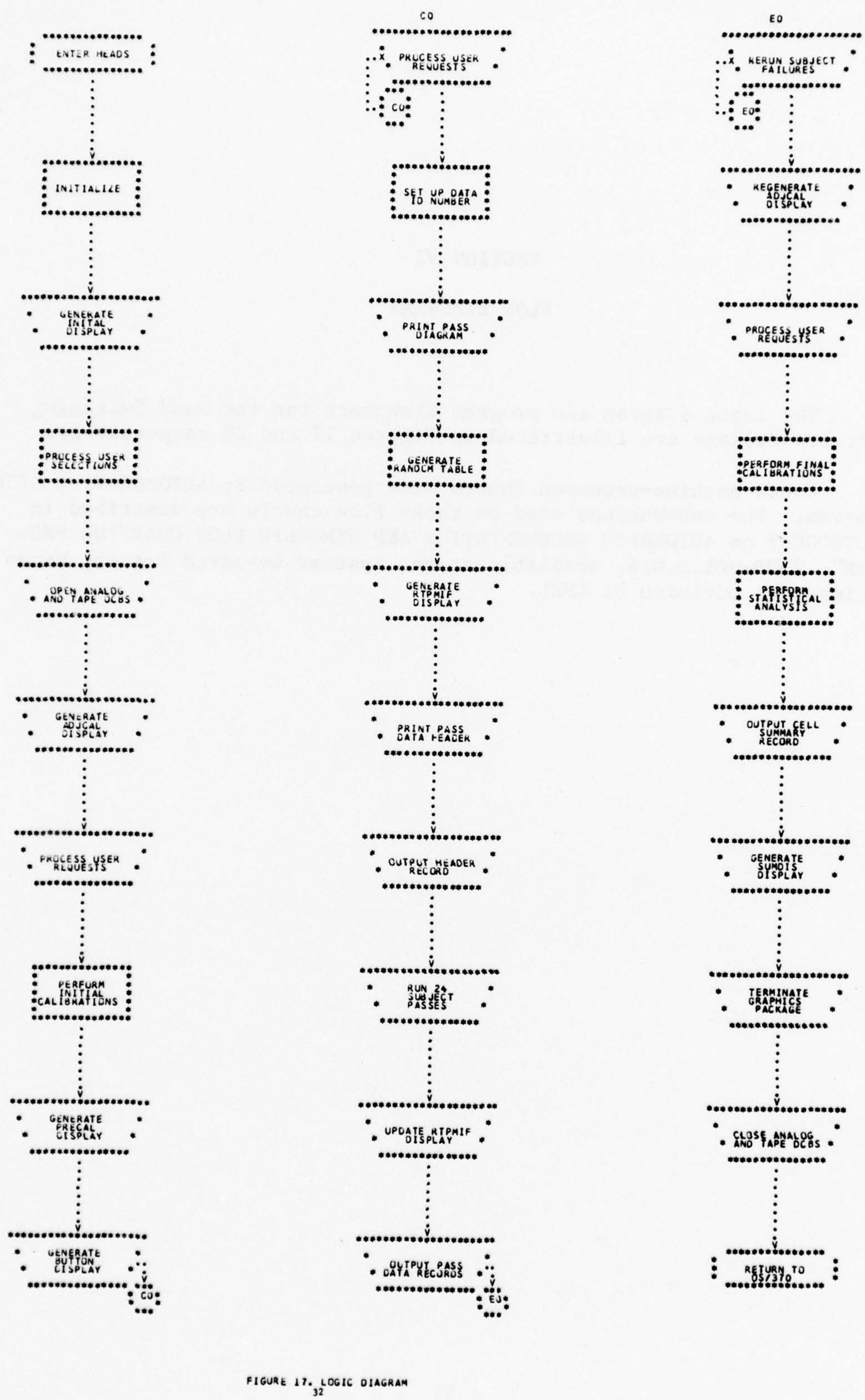


FIGURE 17. LOGIC DIAGRAM

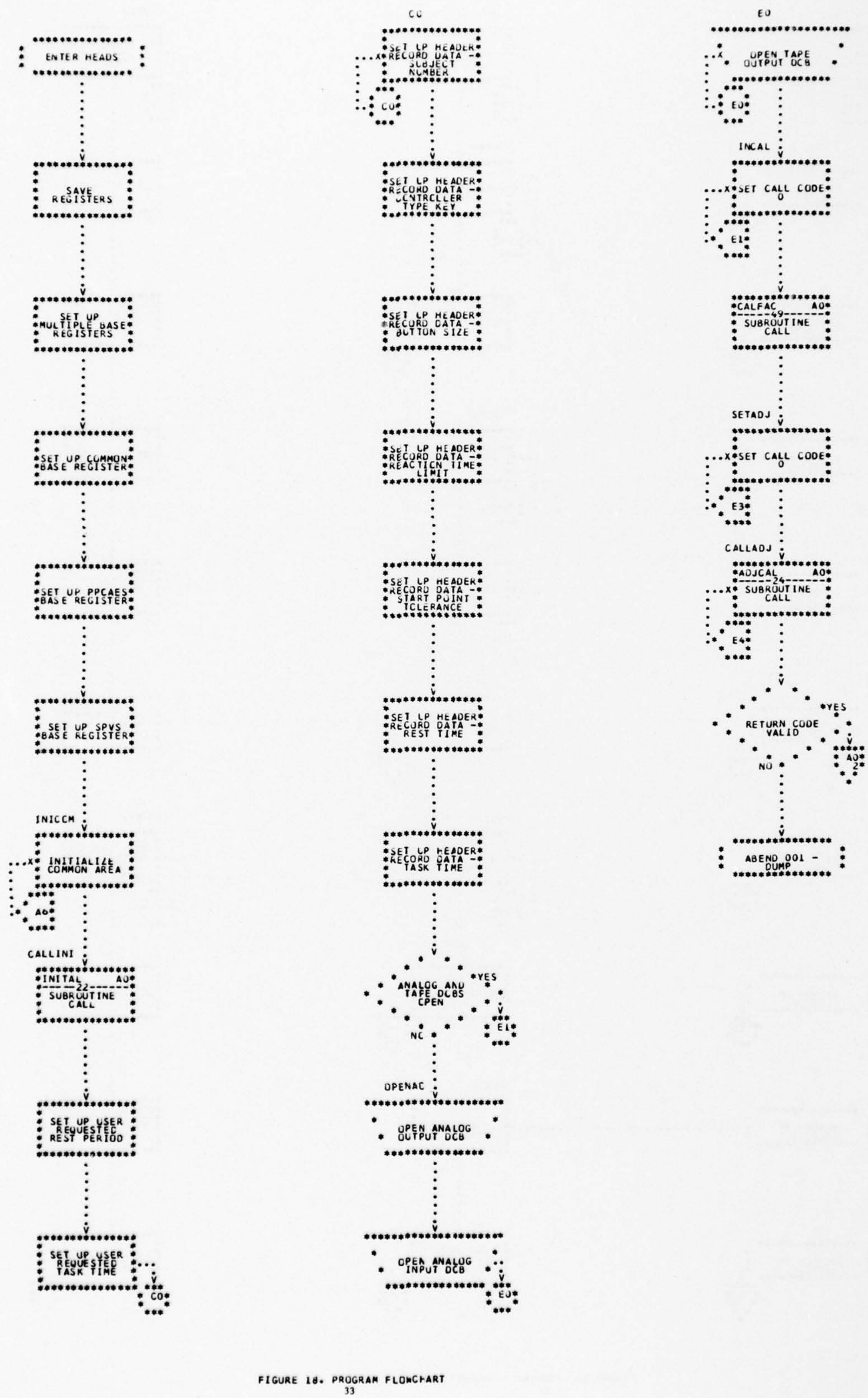
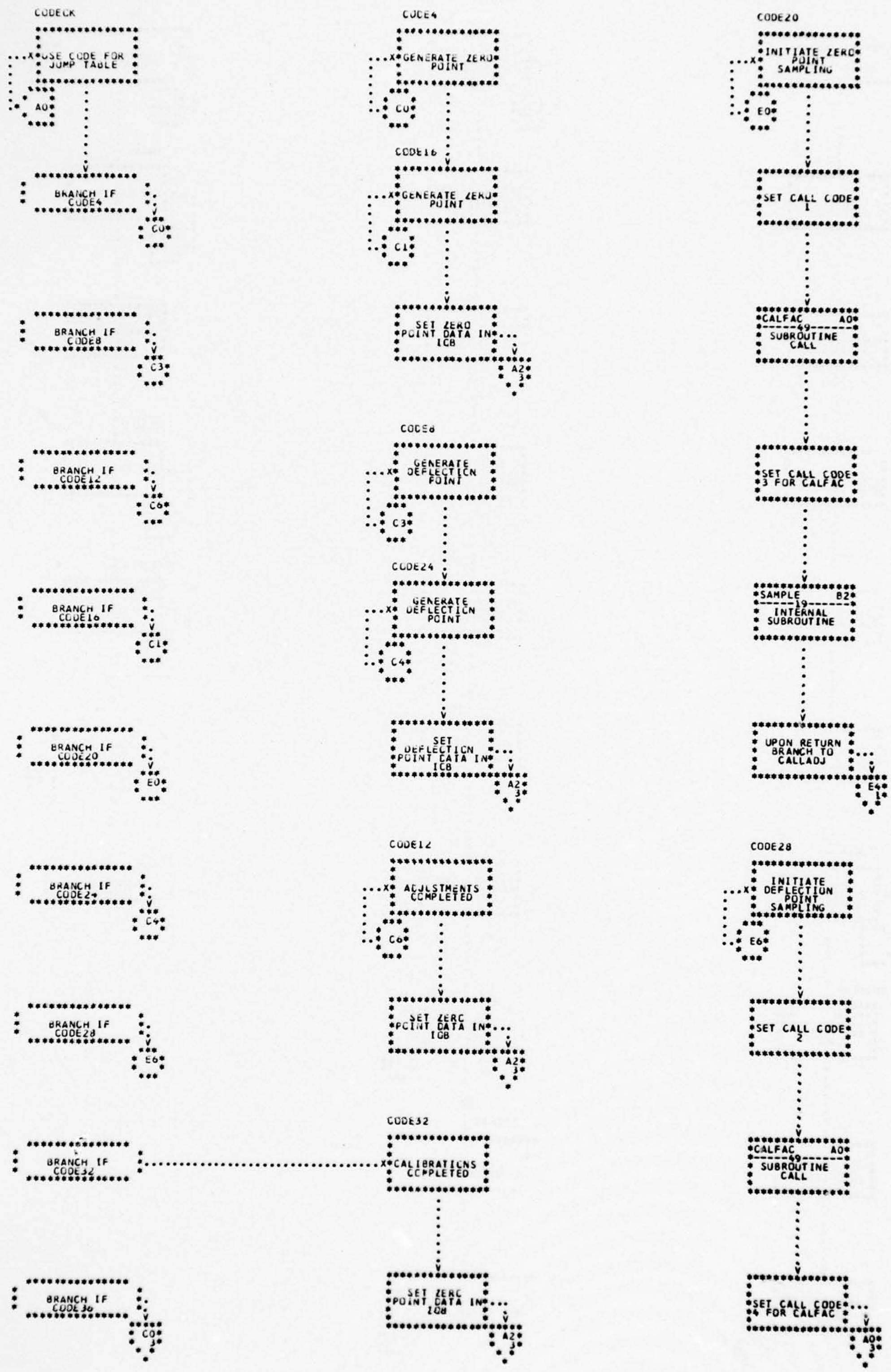


FIGURE 18. PROGRAM FLOWCHART



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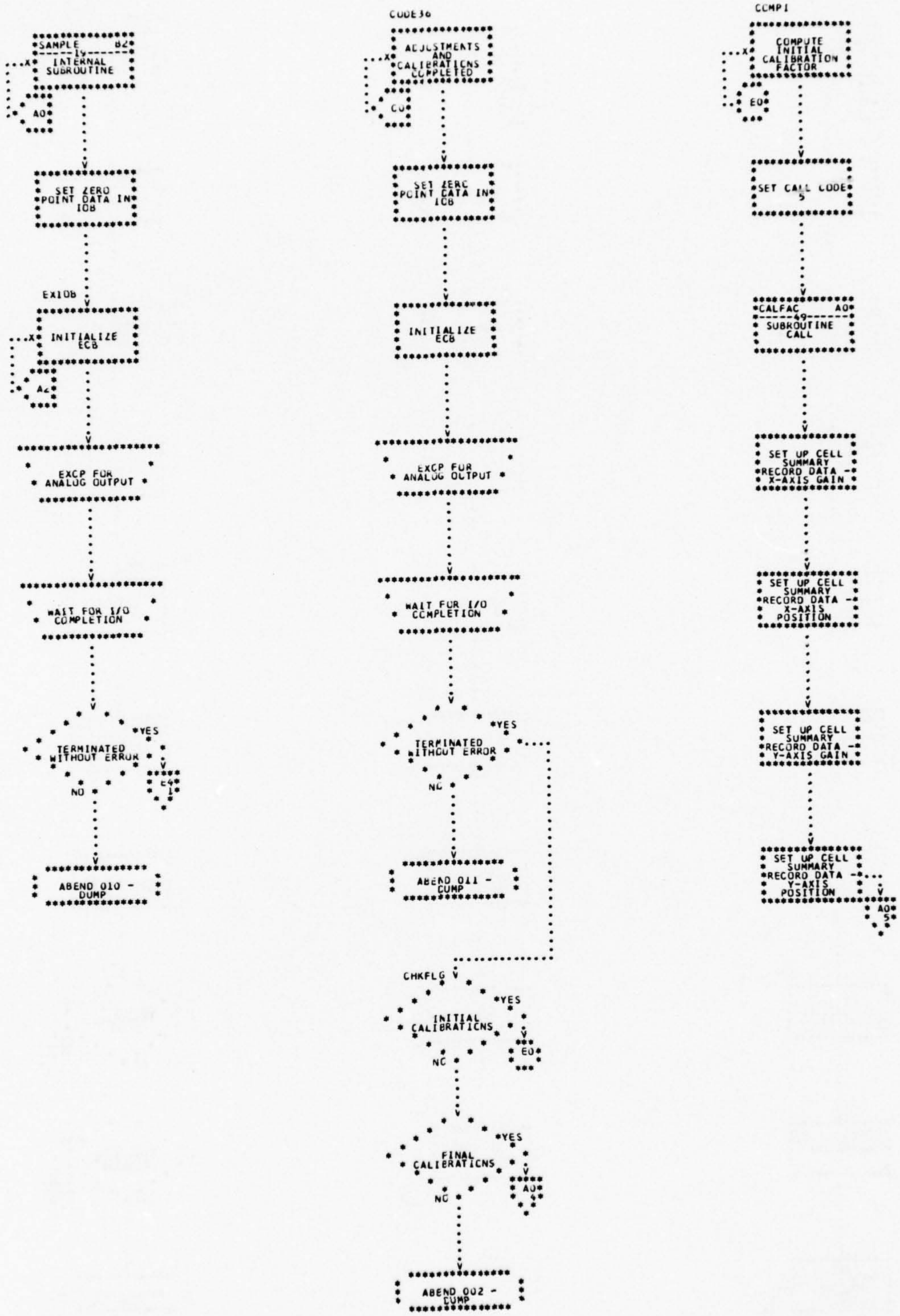
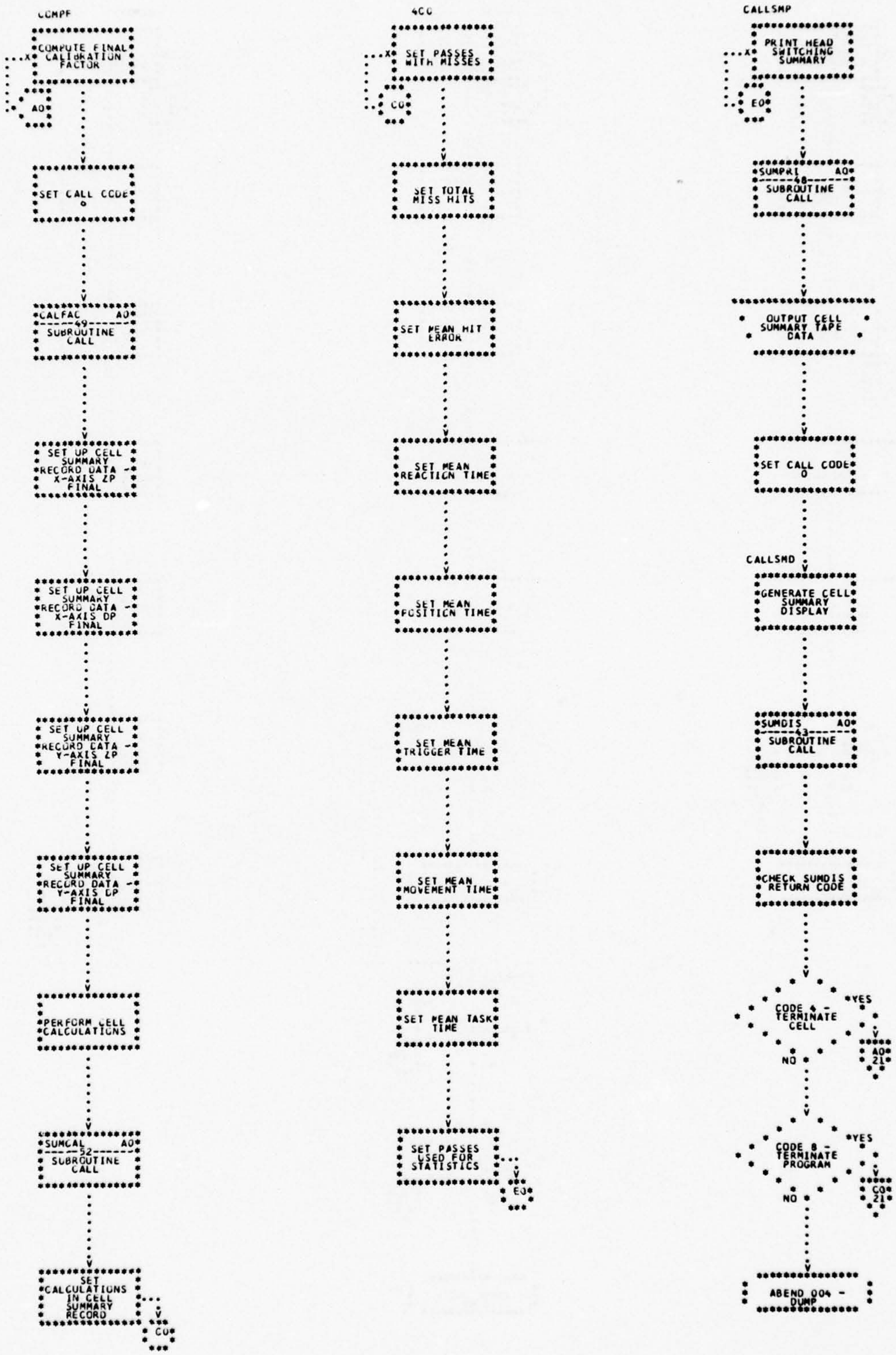


FIGURE 18. PROGRAM FLOWCHART



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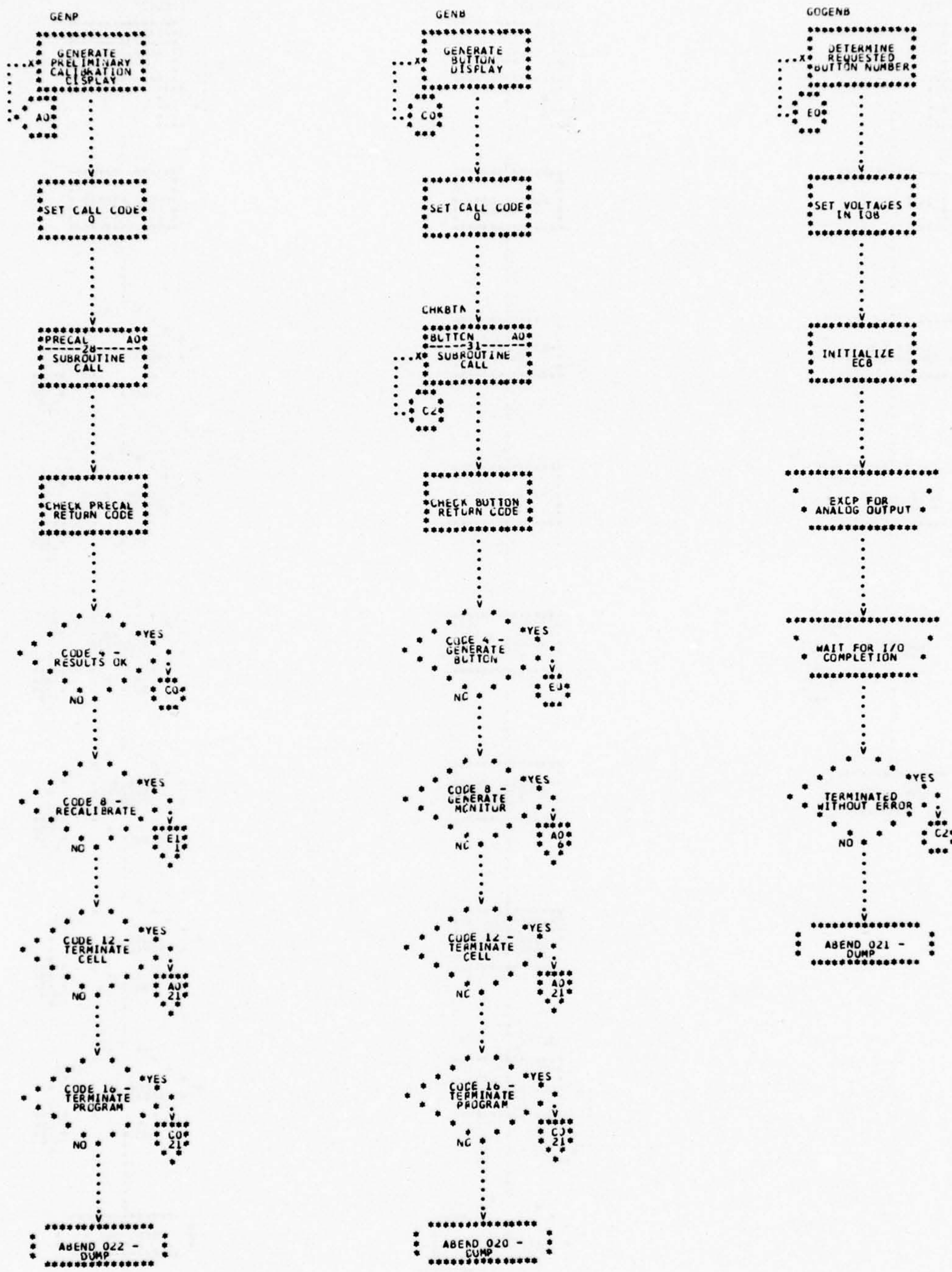

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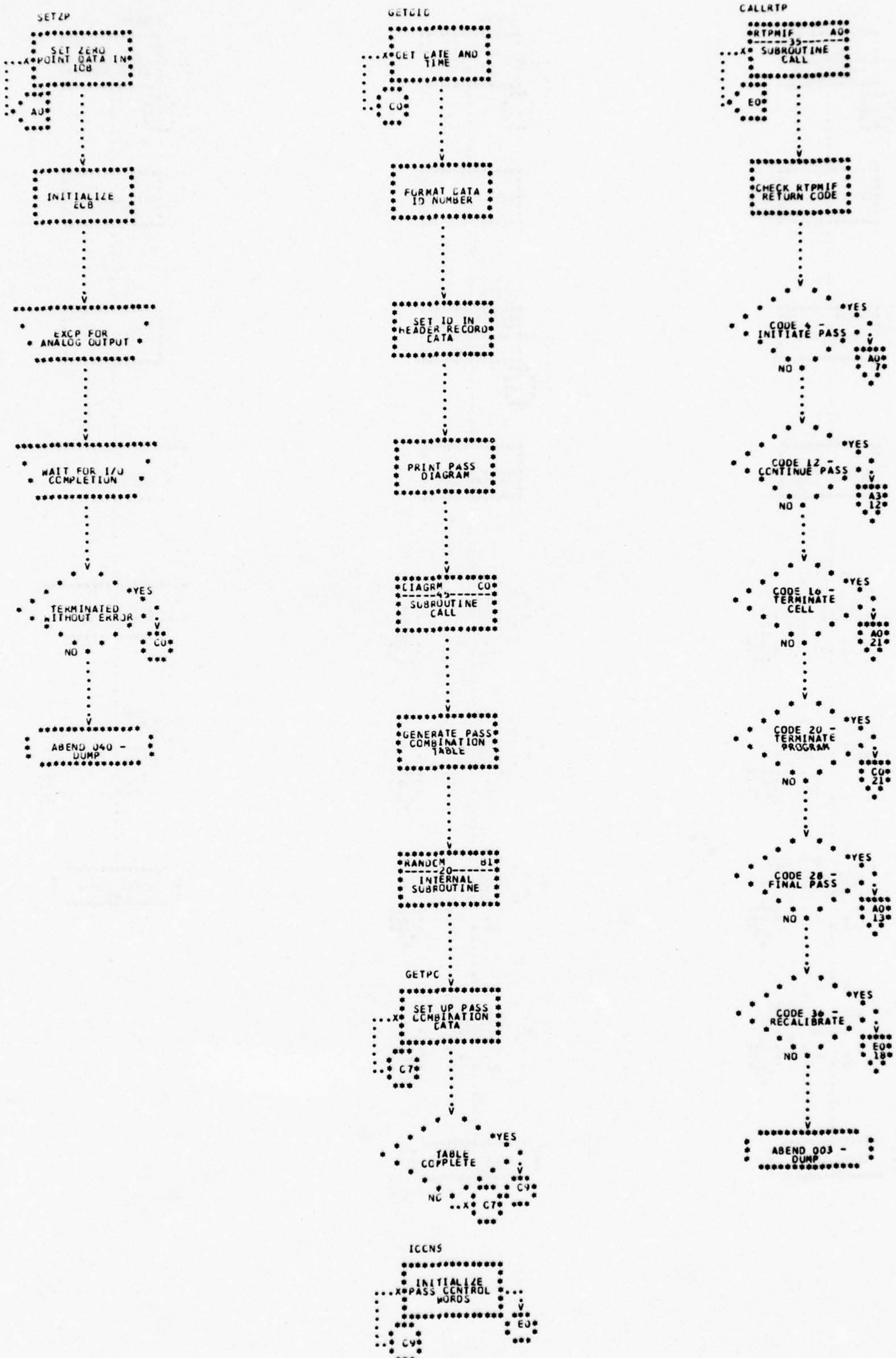

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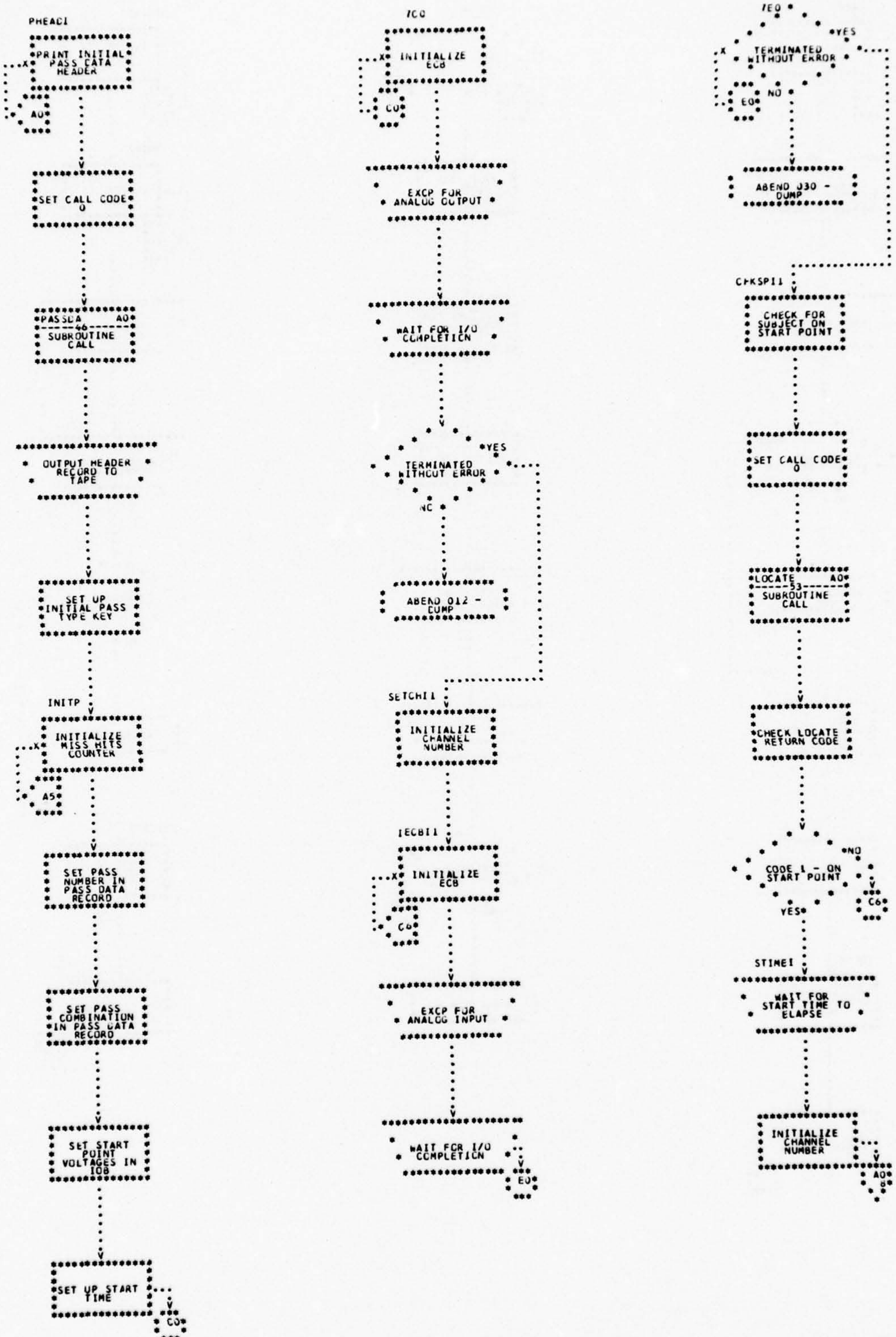
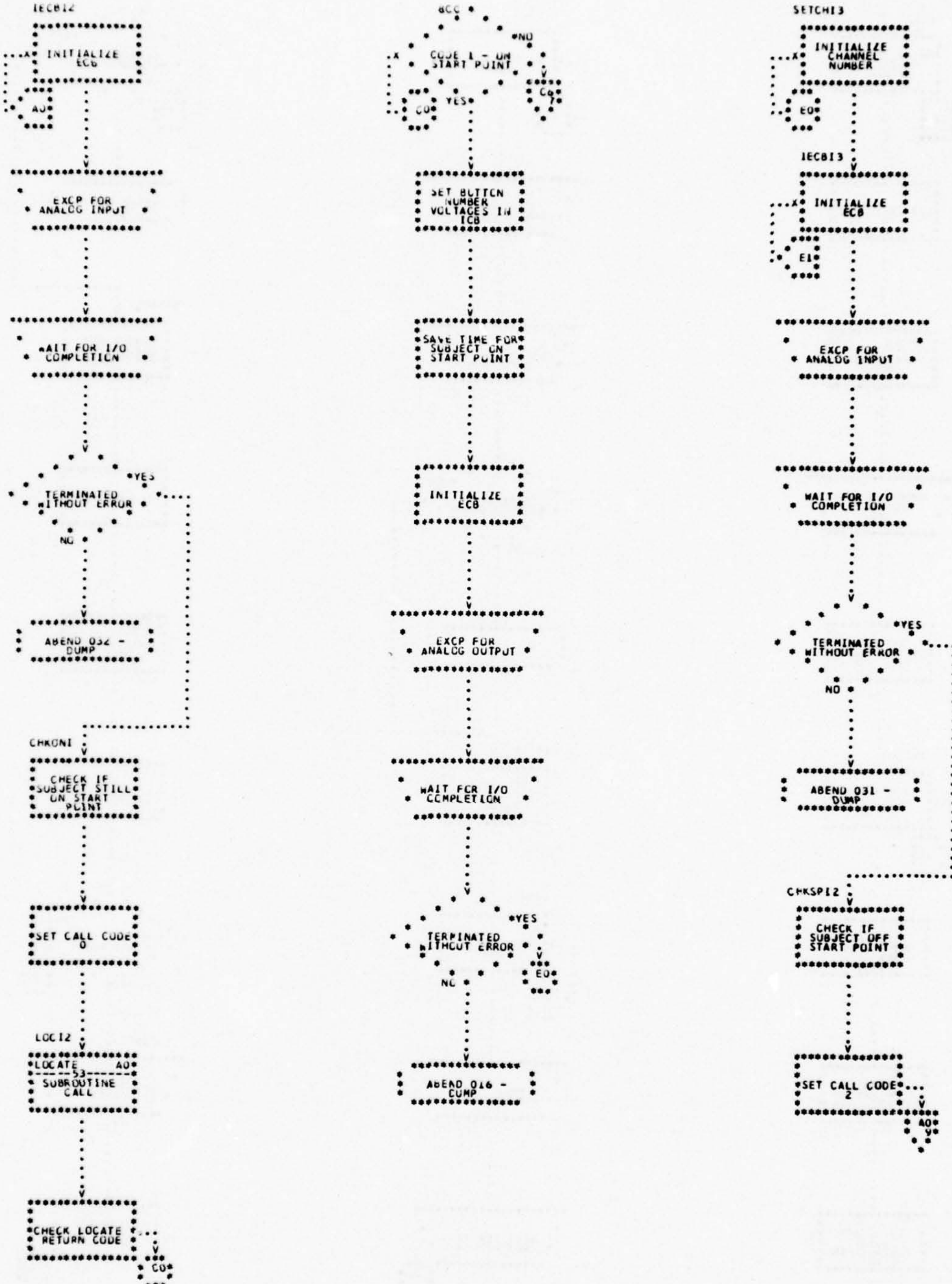


FIGURE 18. PROGRAM FLOWCHART



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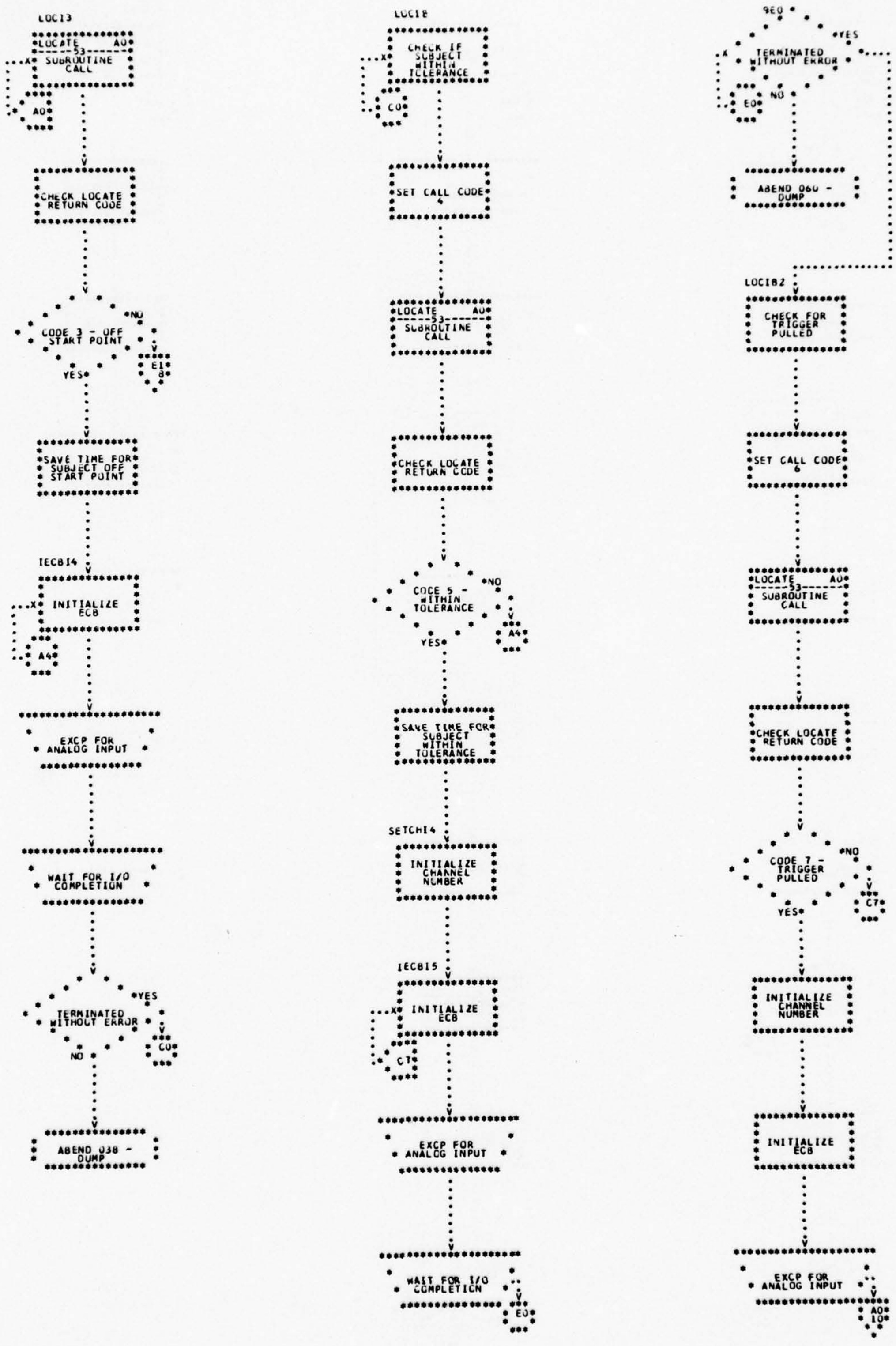
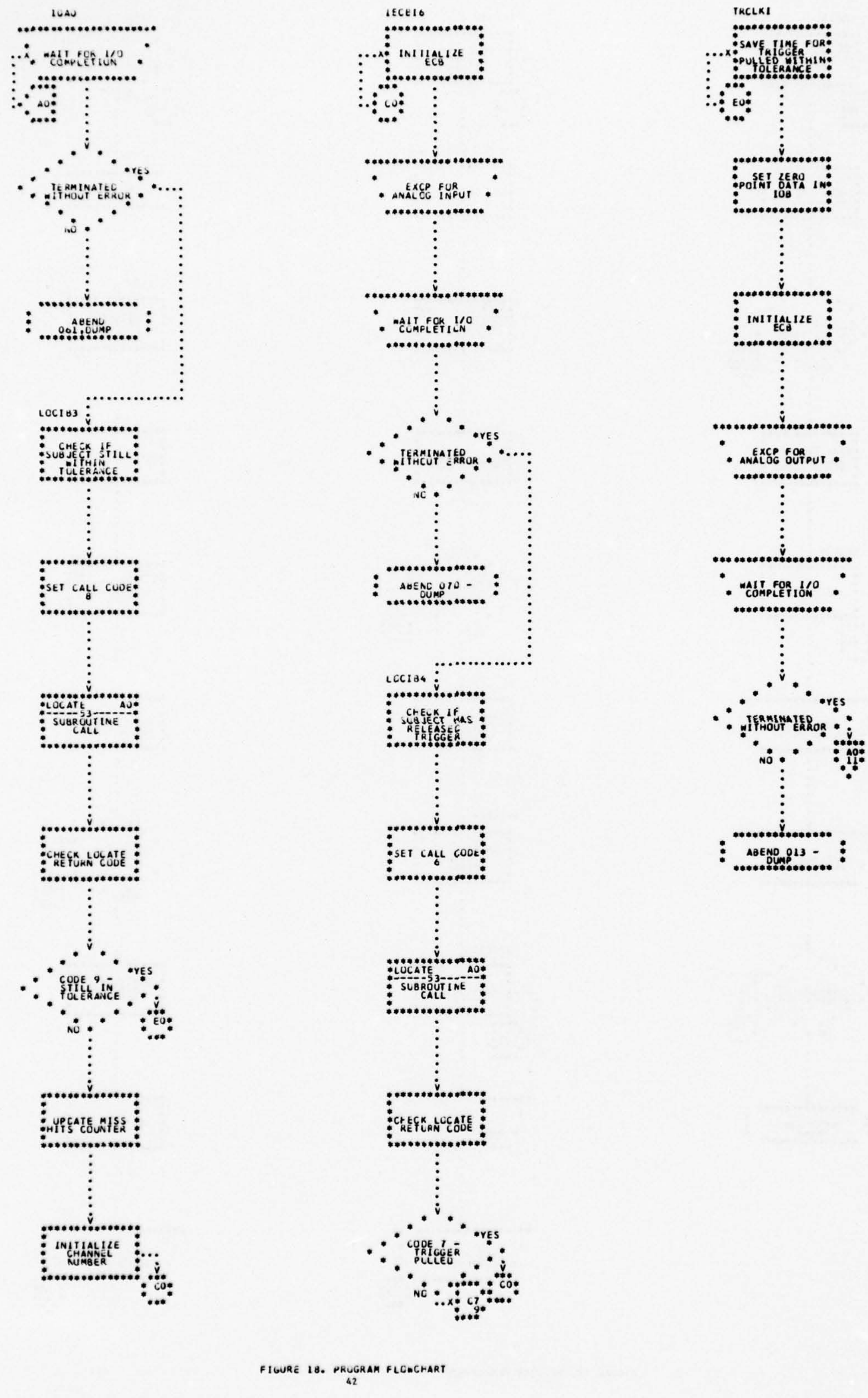


FIGURE 18. PROGRAM FLOWCHART



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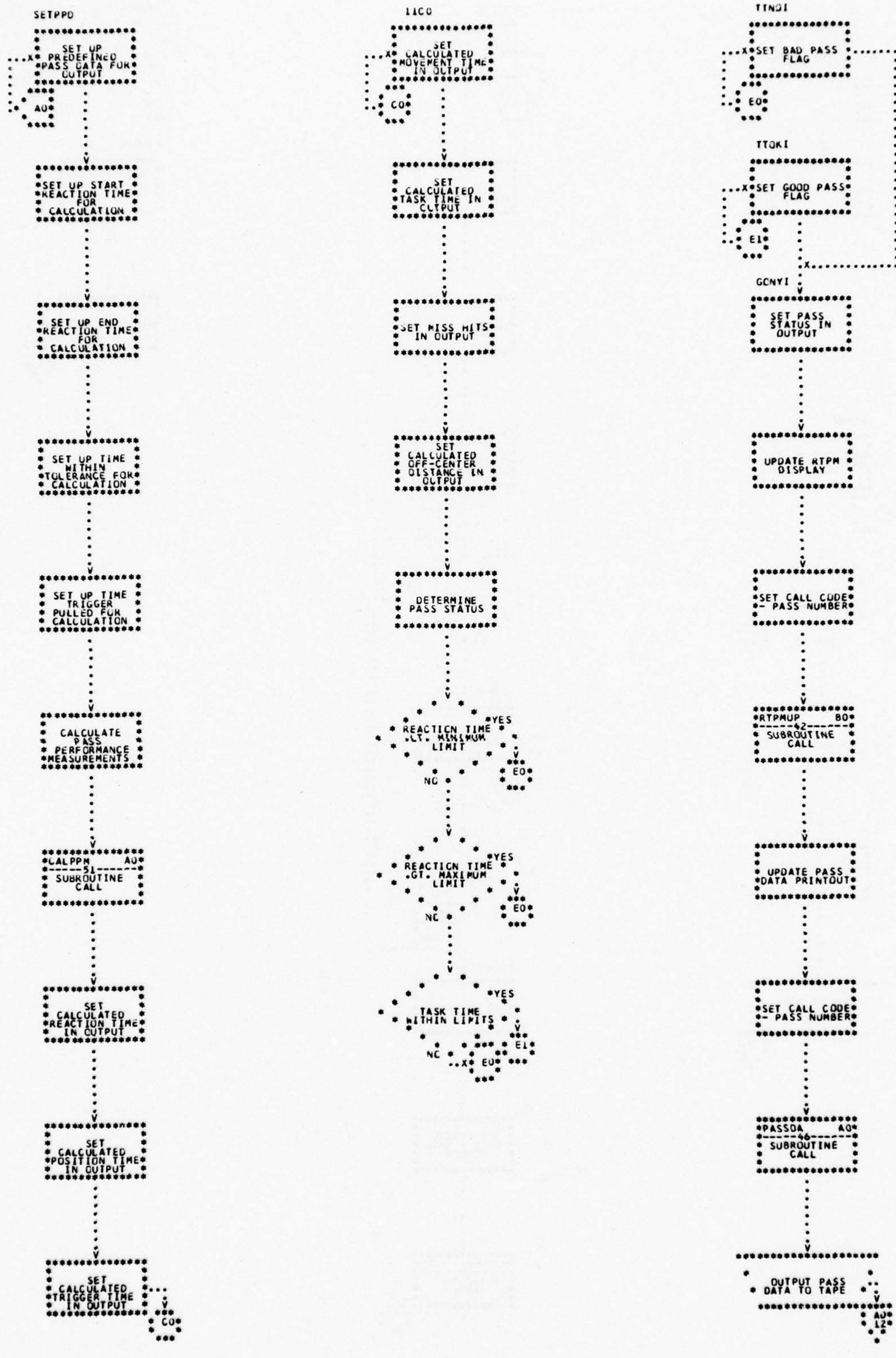

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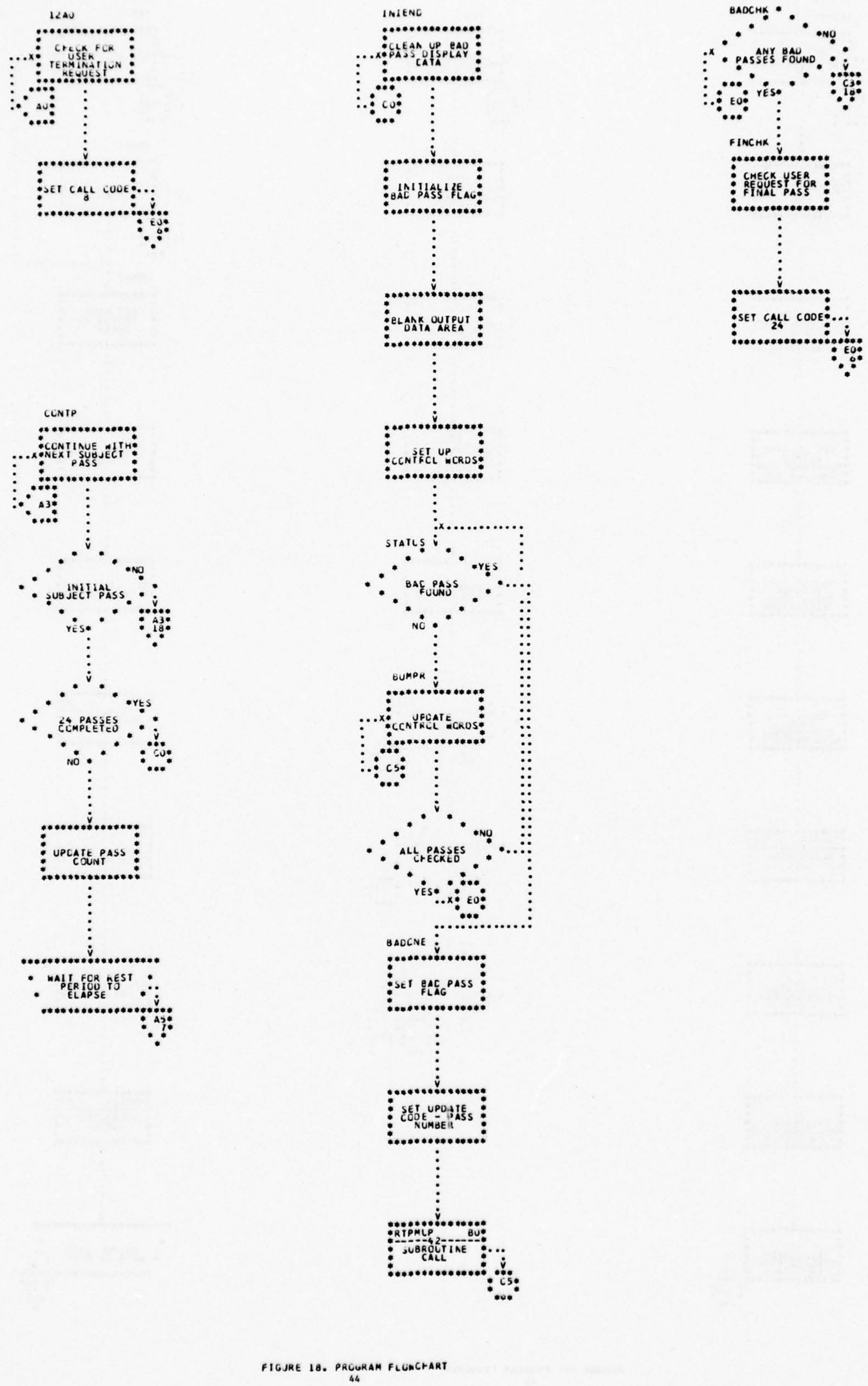

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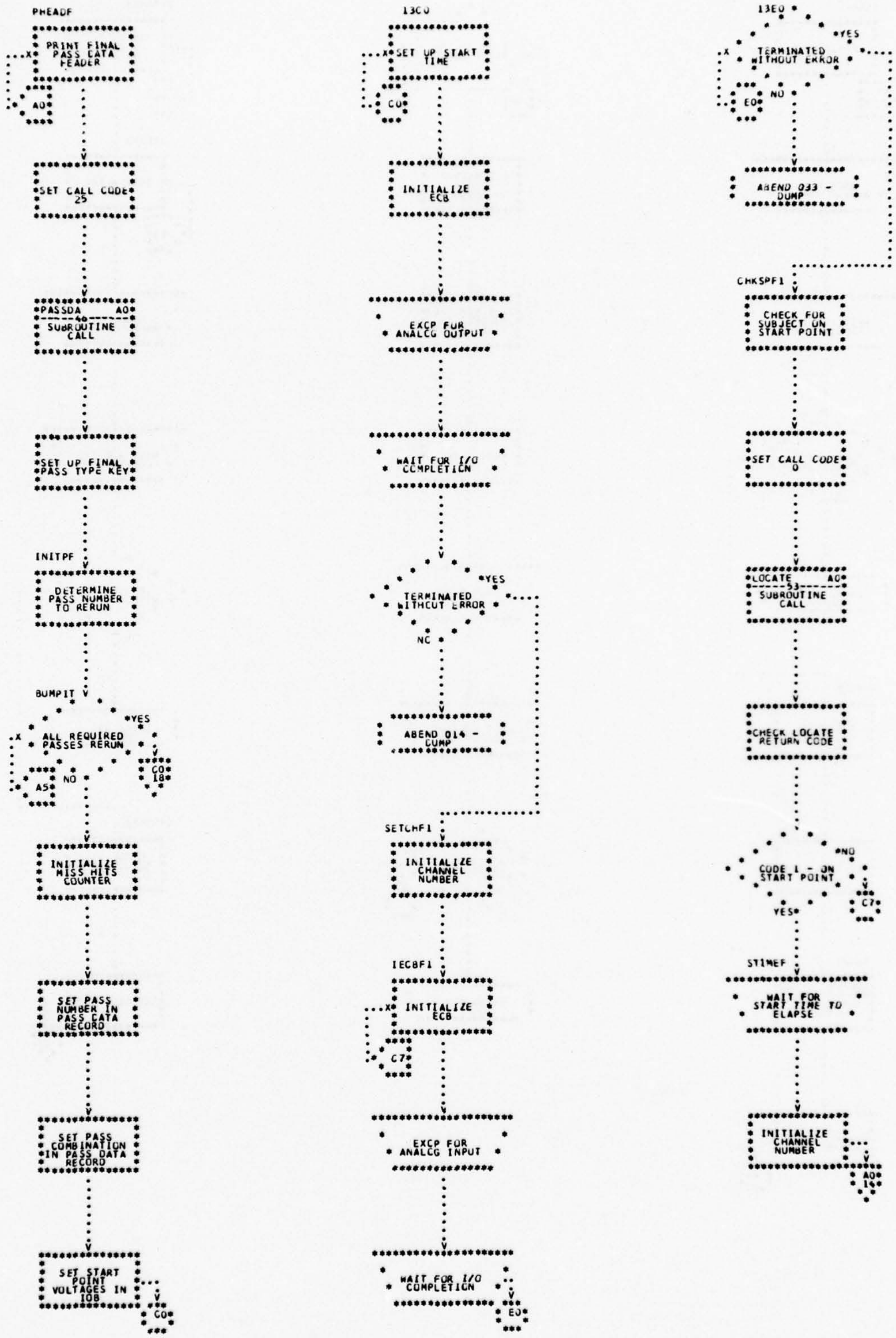

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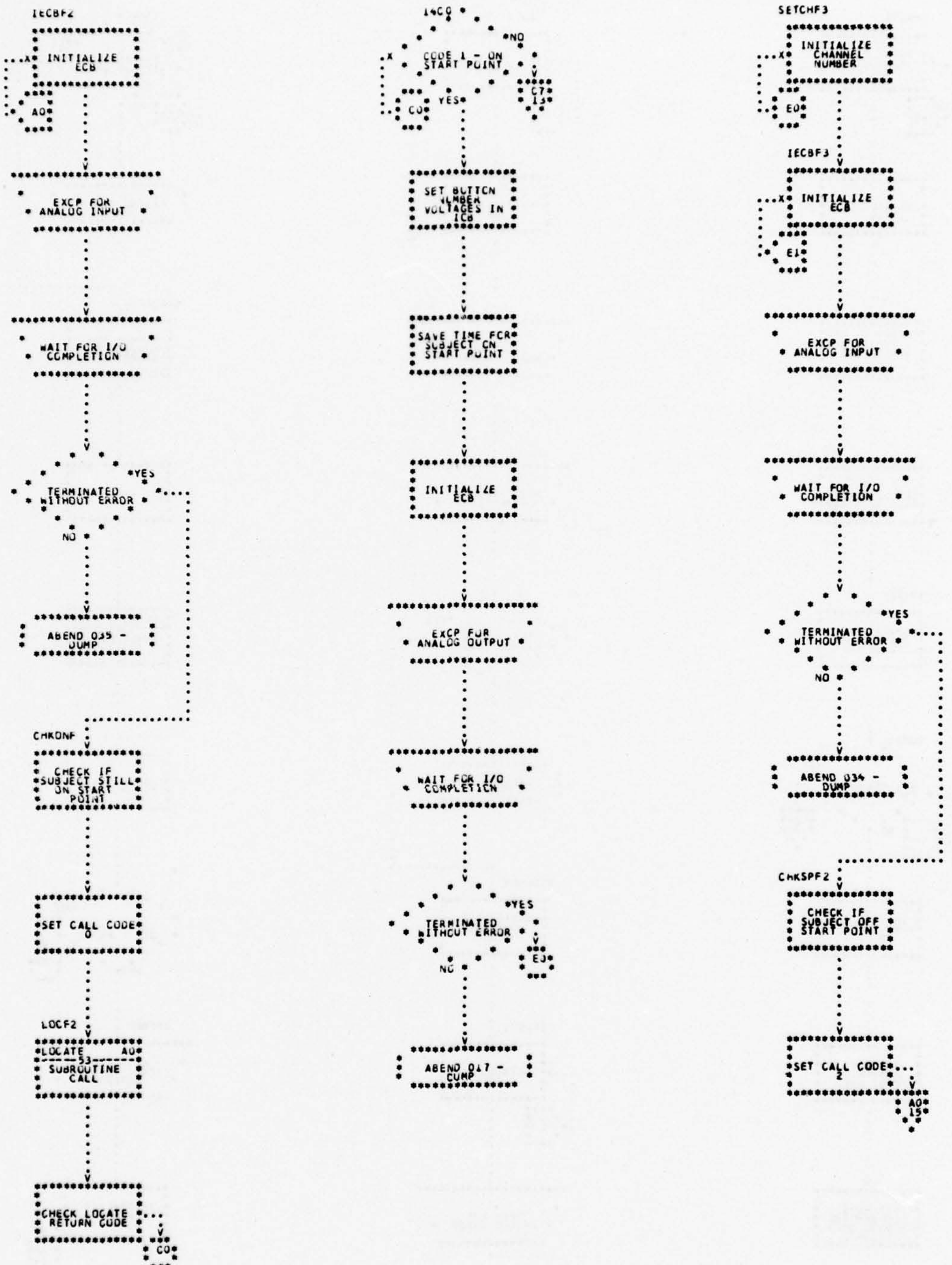

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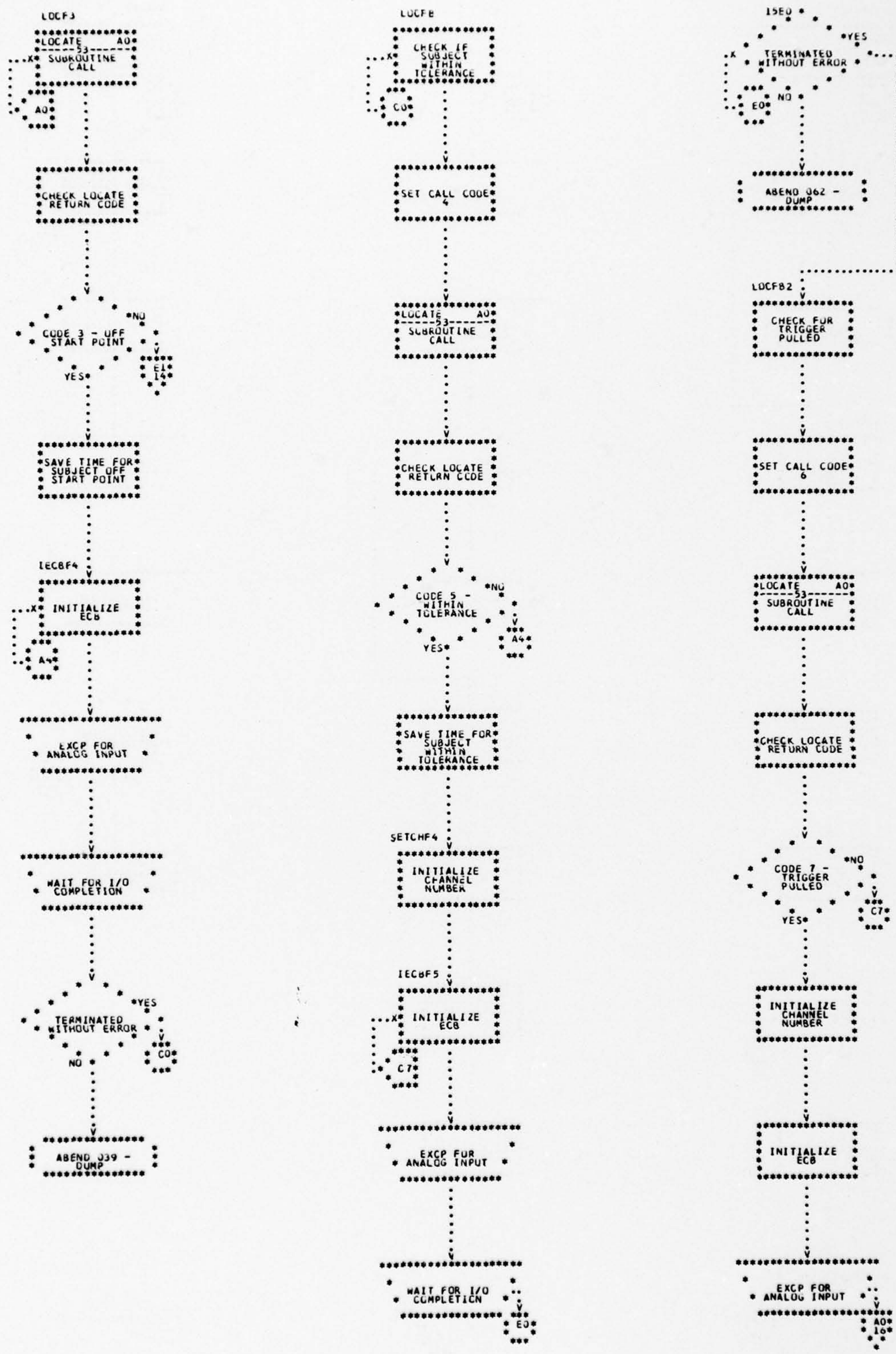

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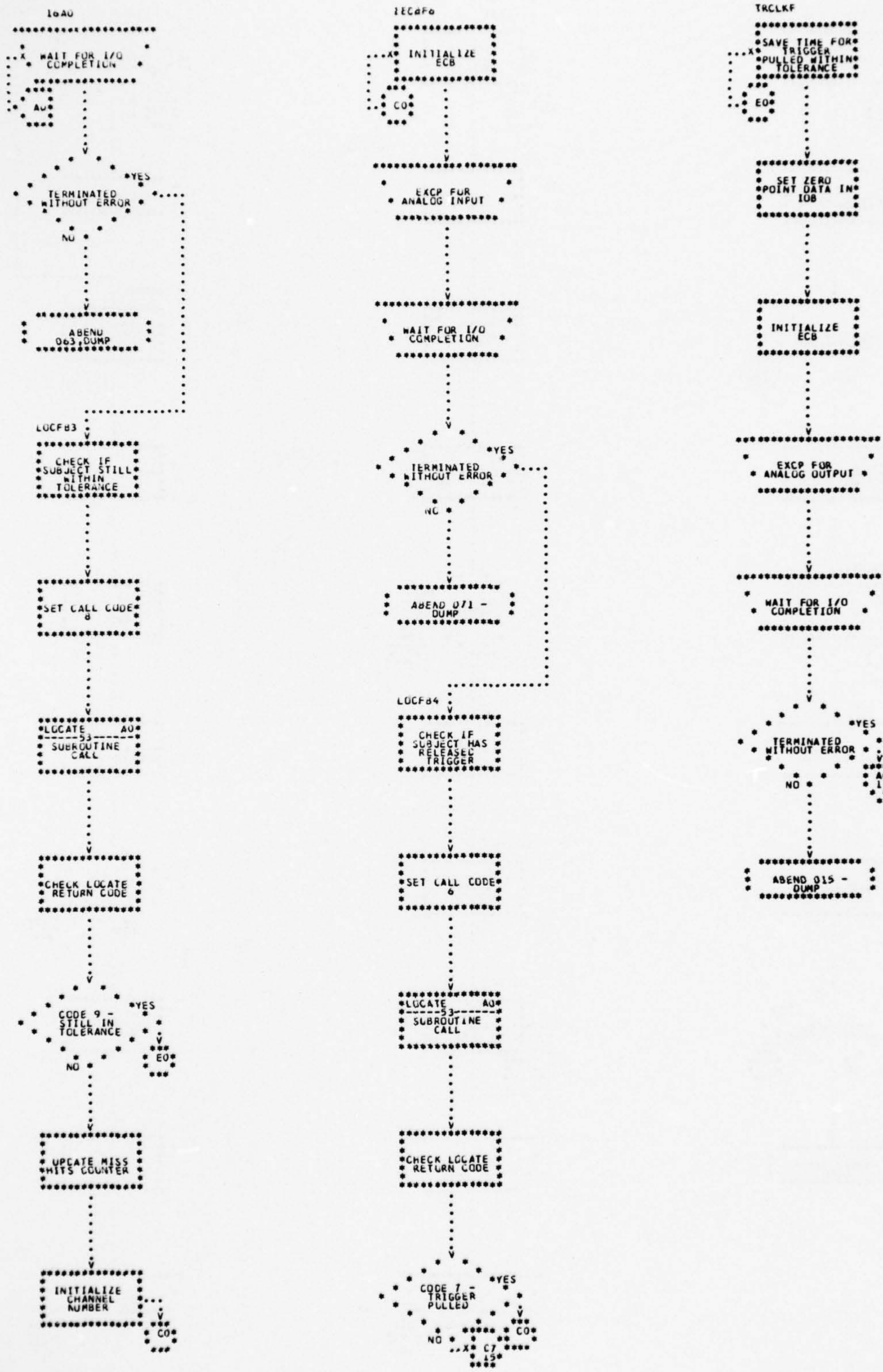

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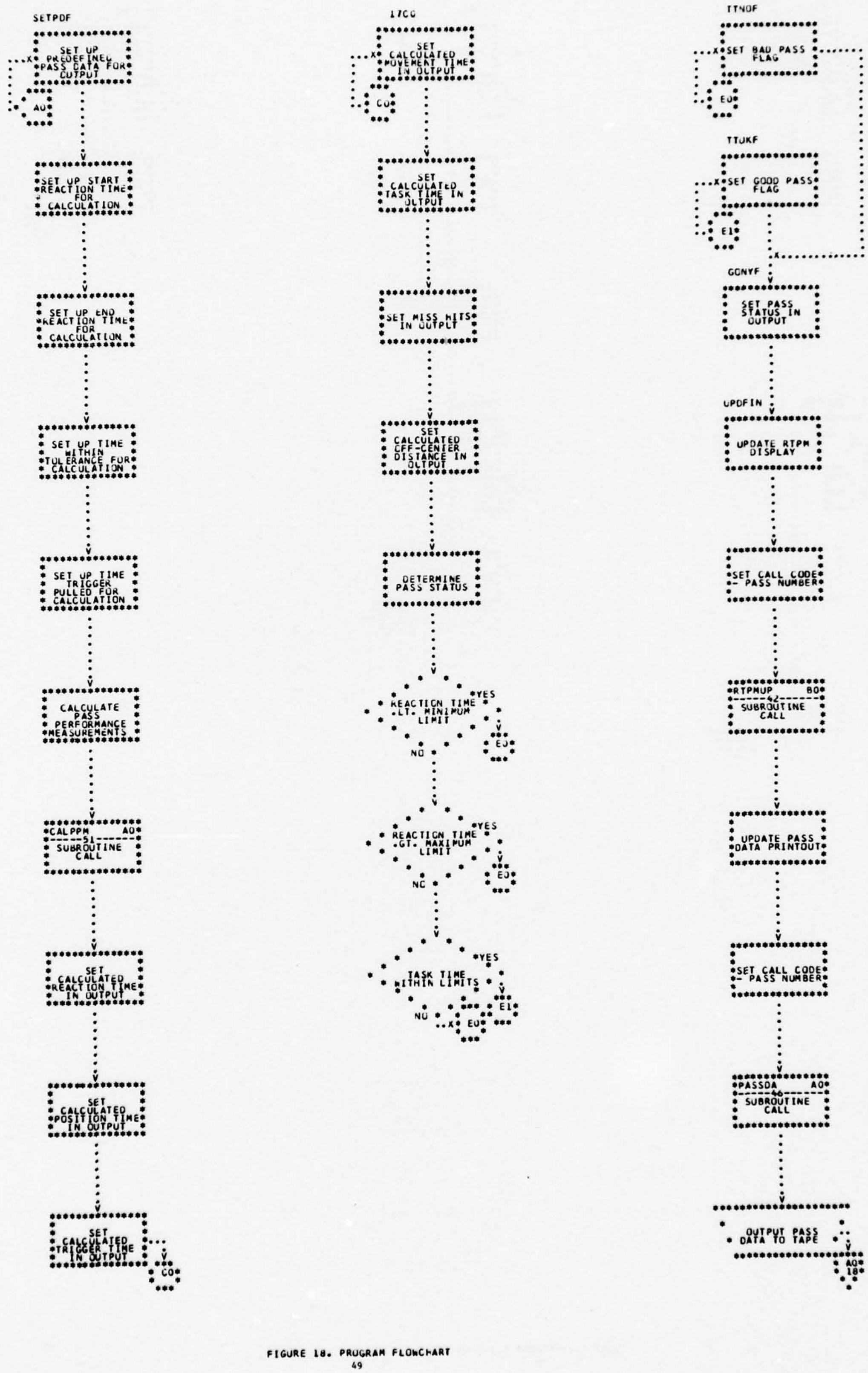

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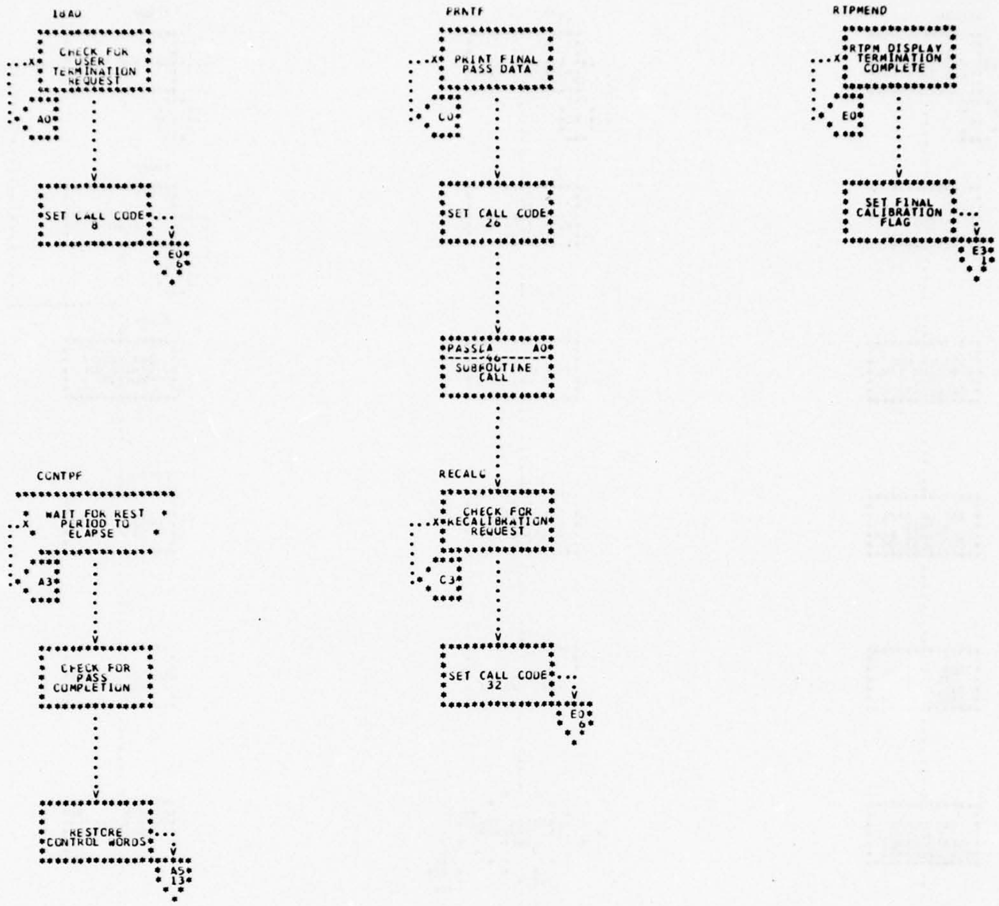

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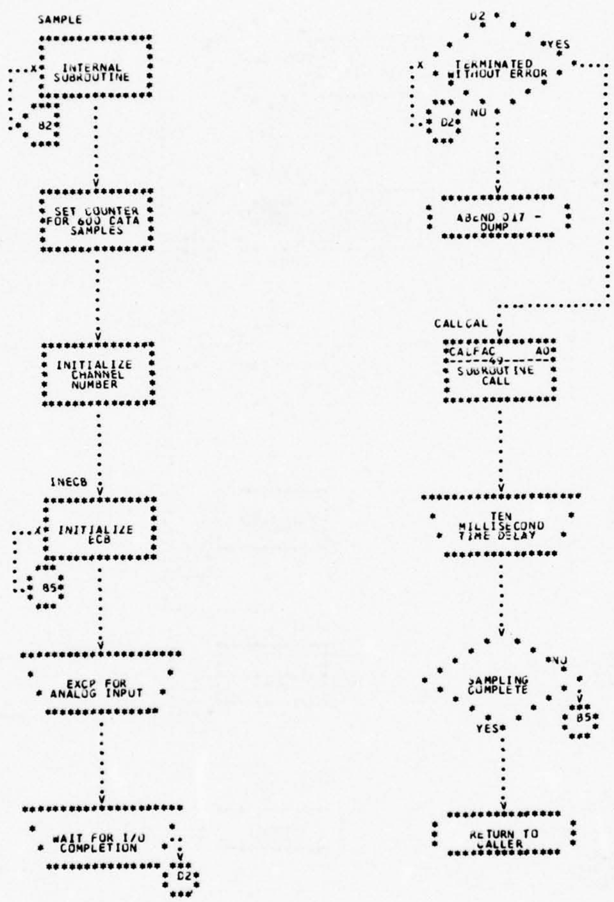

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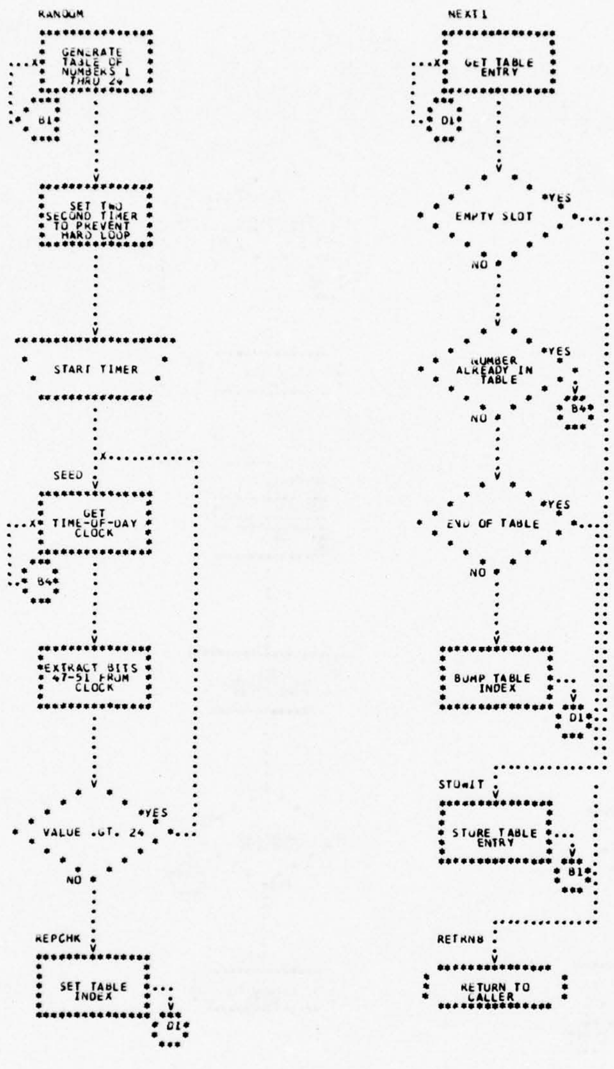

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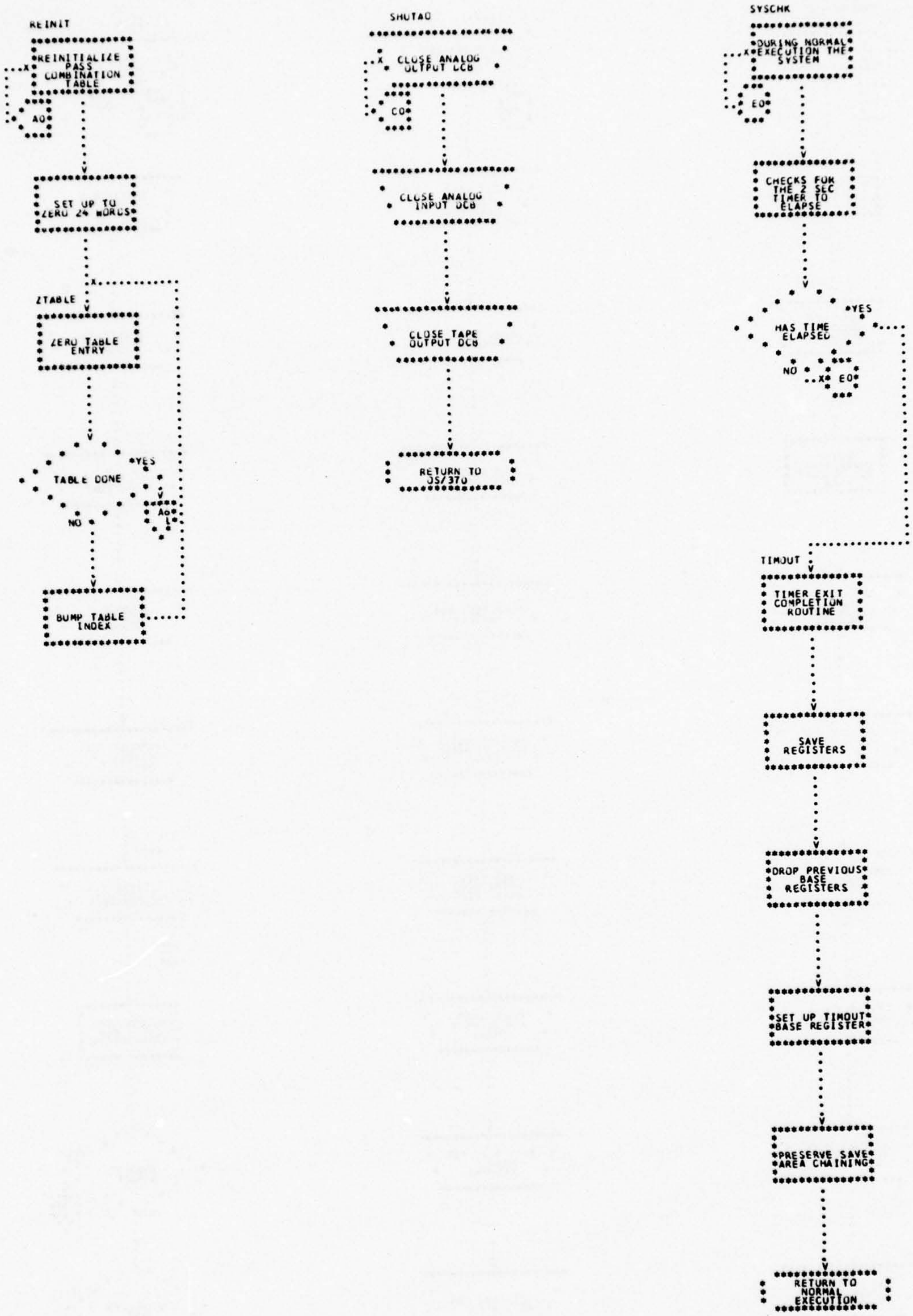

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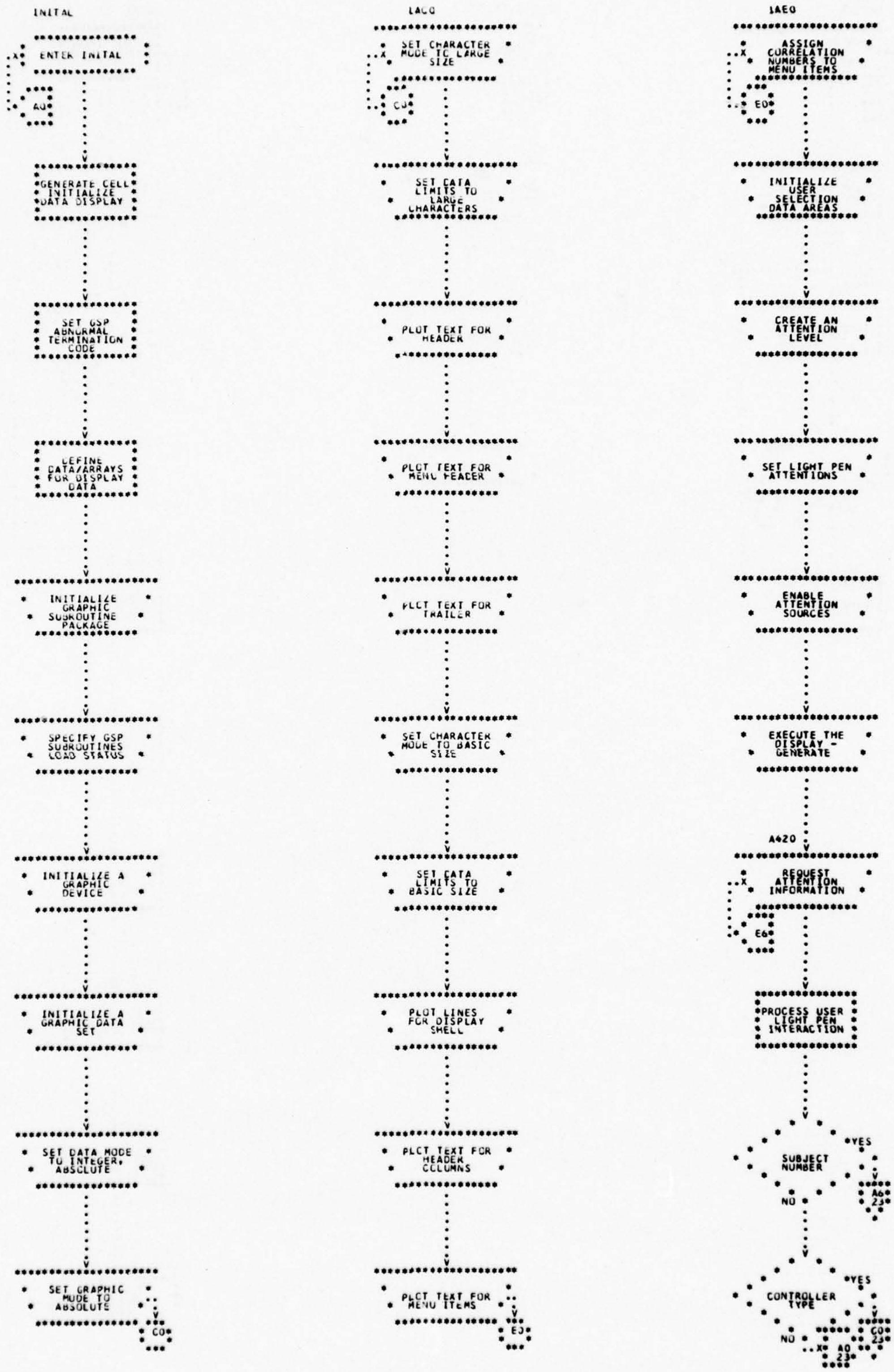

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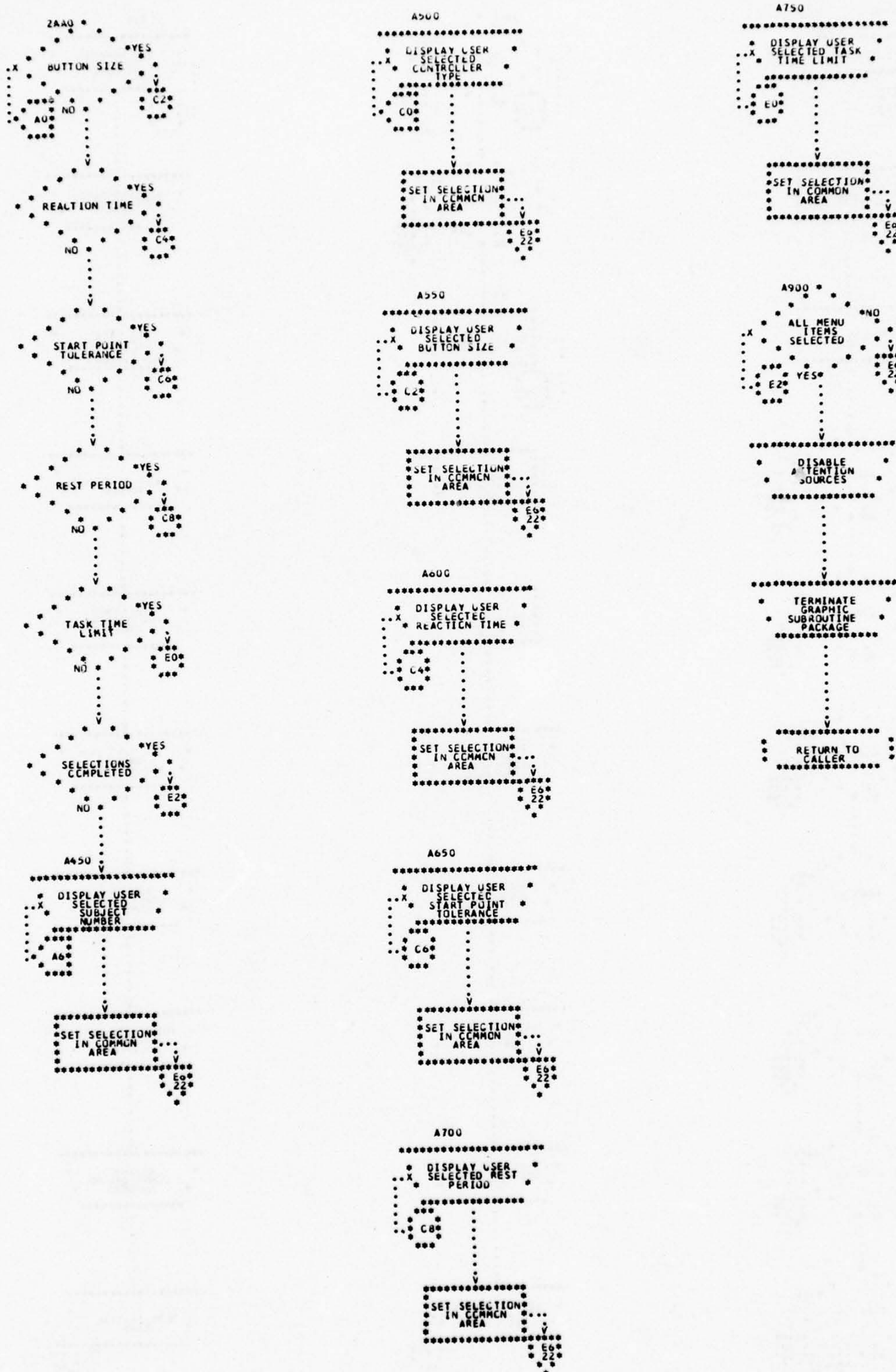

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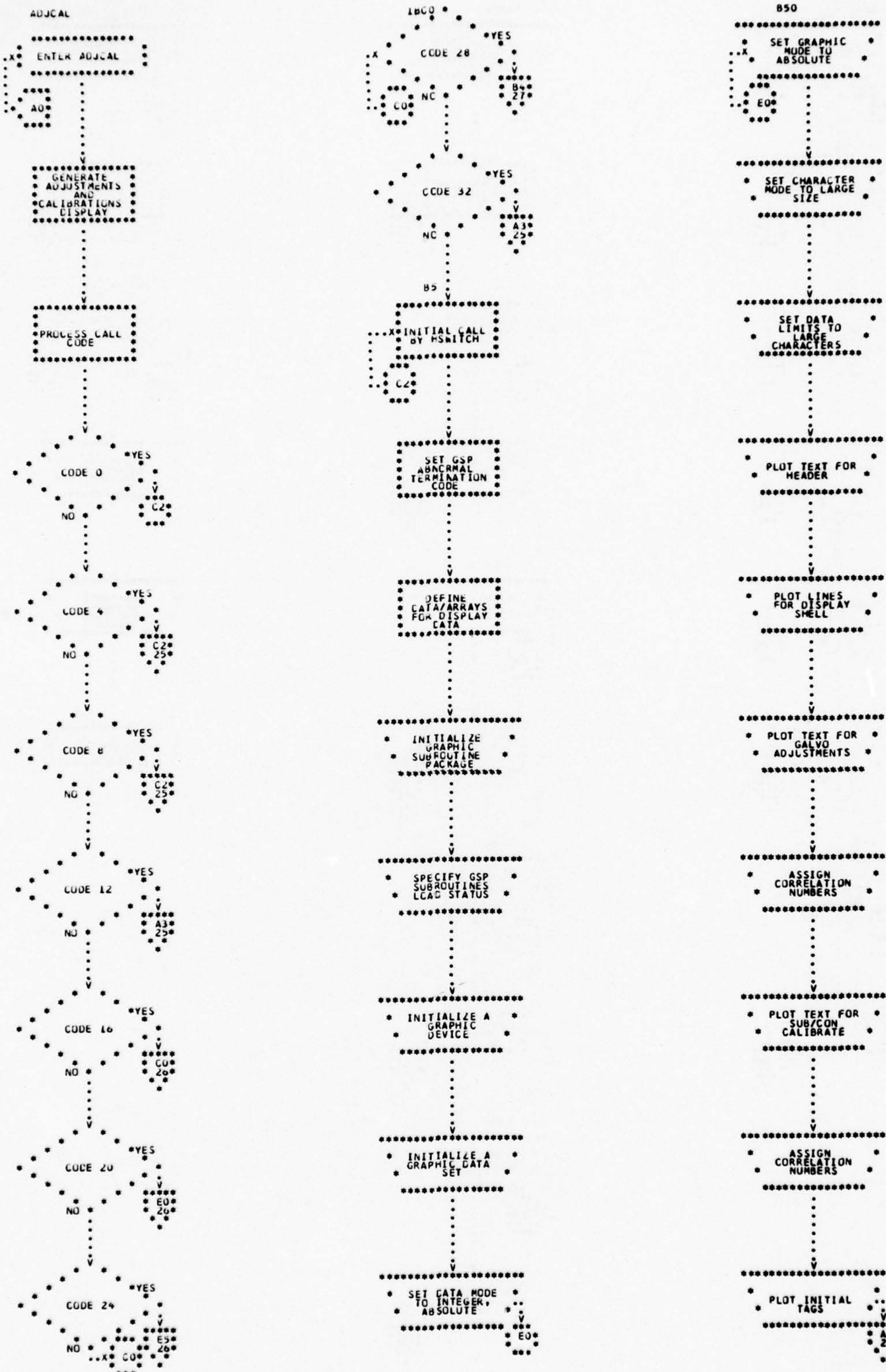

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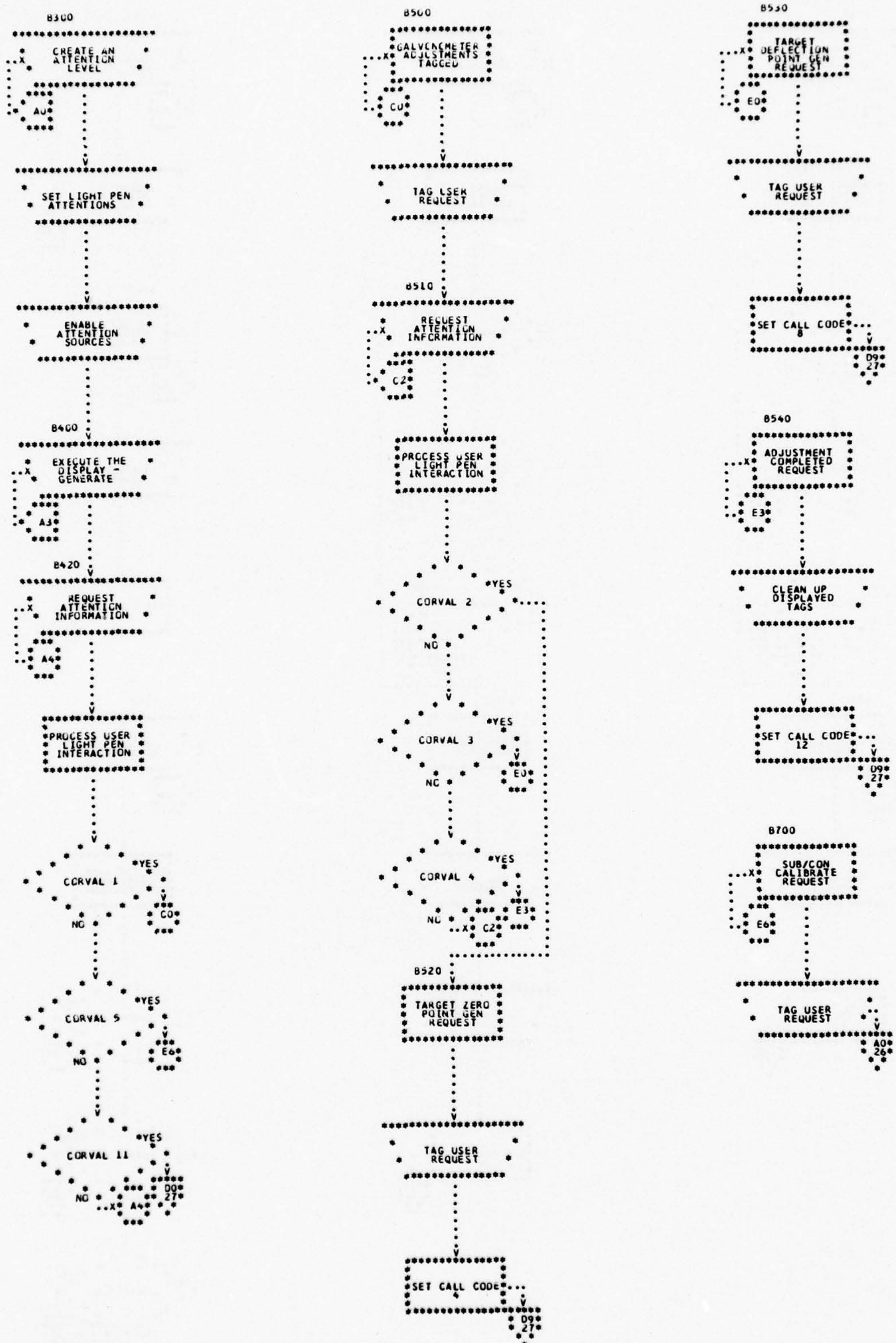

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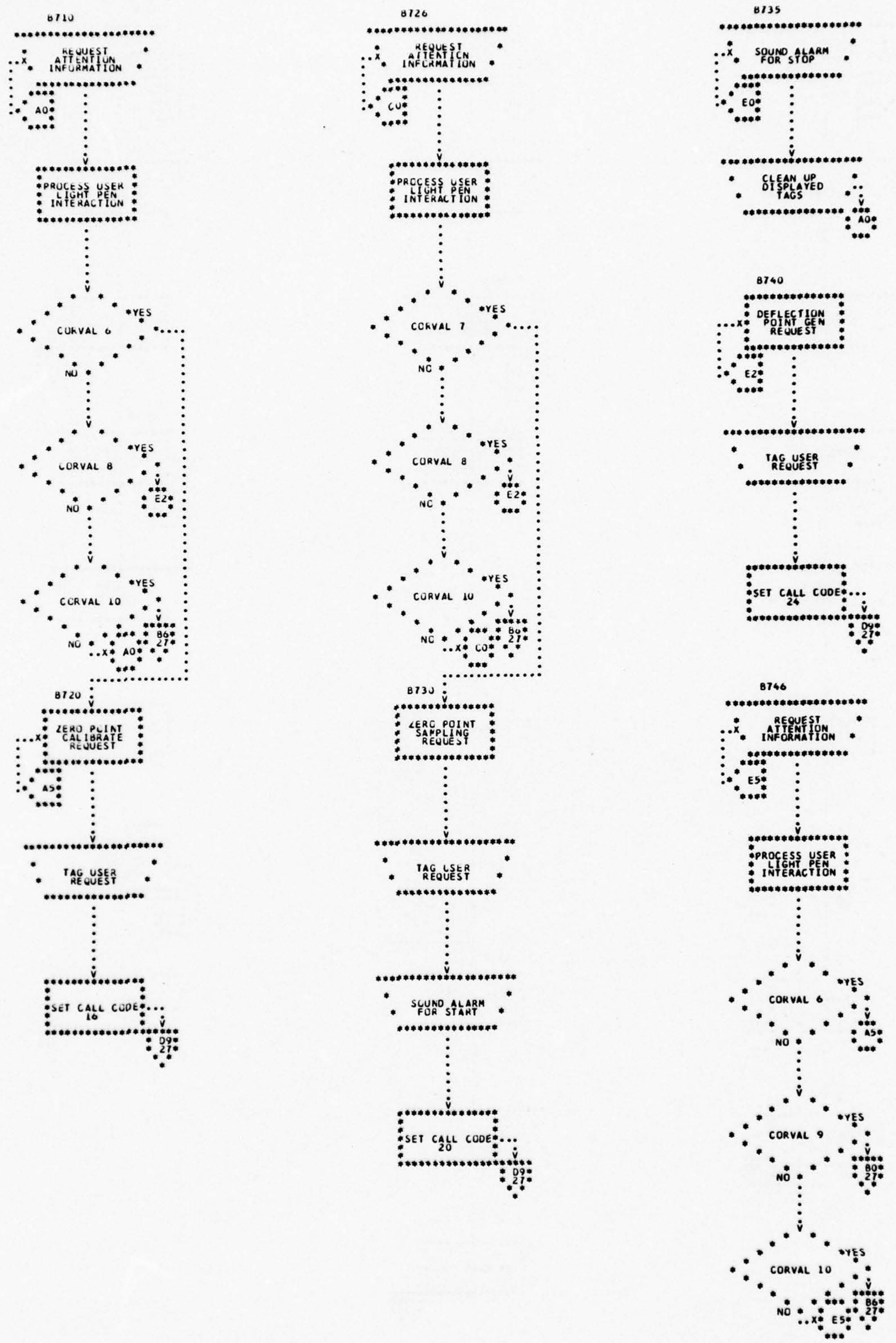


FIGURE 18. PROGRAM FLOWCHART

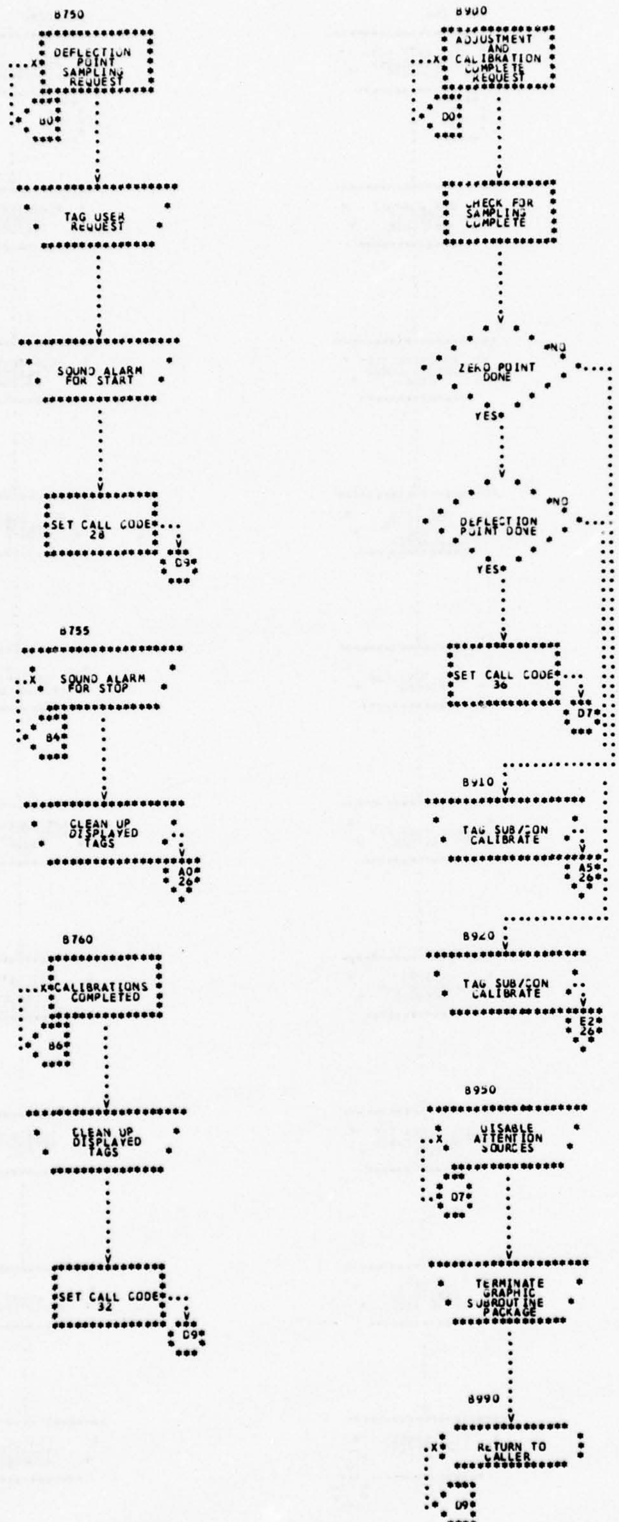


FIGURE 18. PROGRAM FLOWCHART

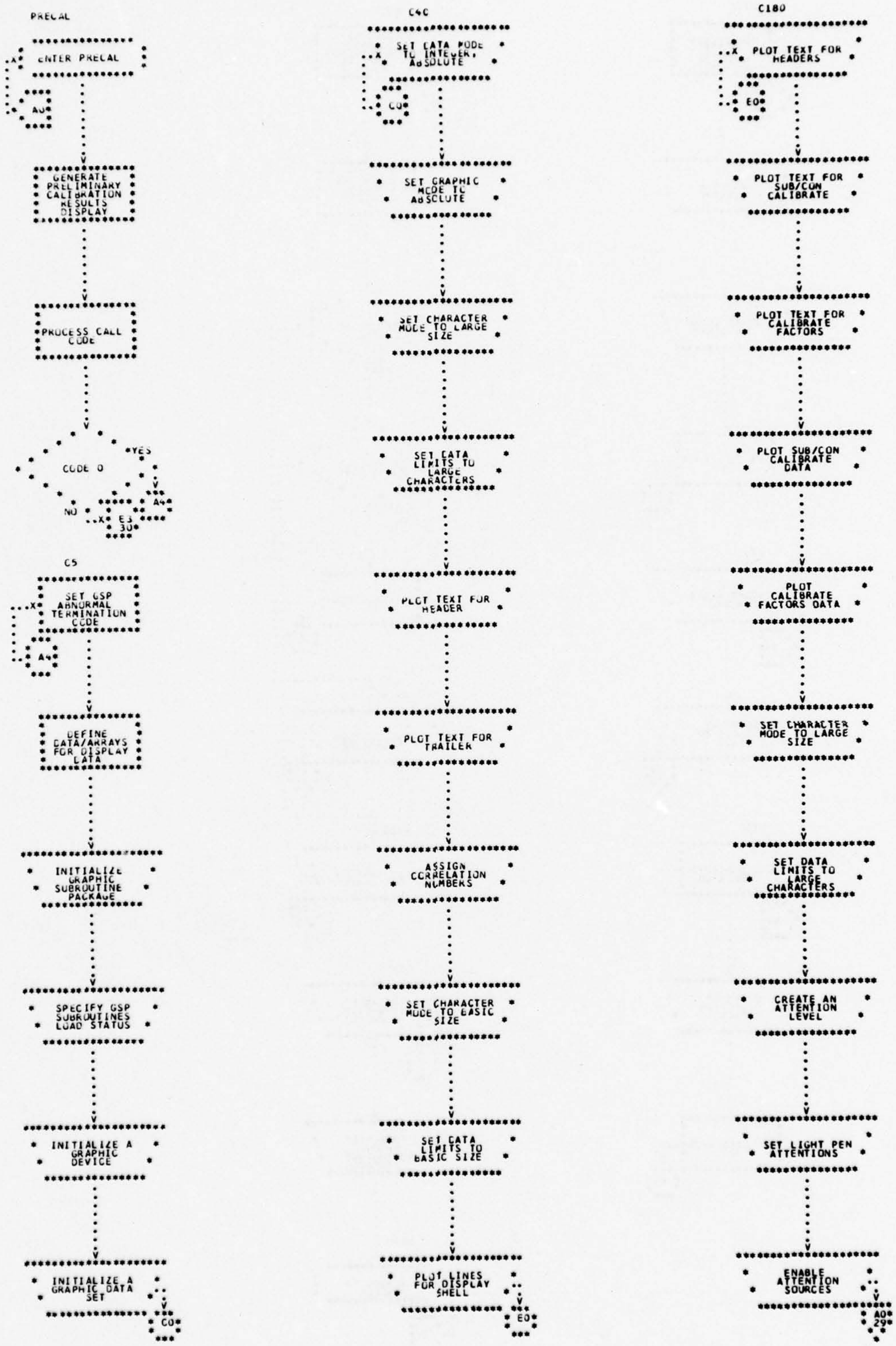


FIGURE 18. PROGRAM FLOWCHART

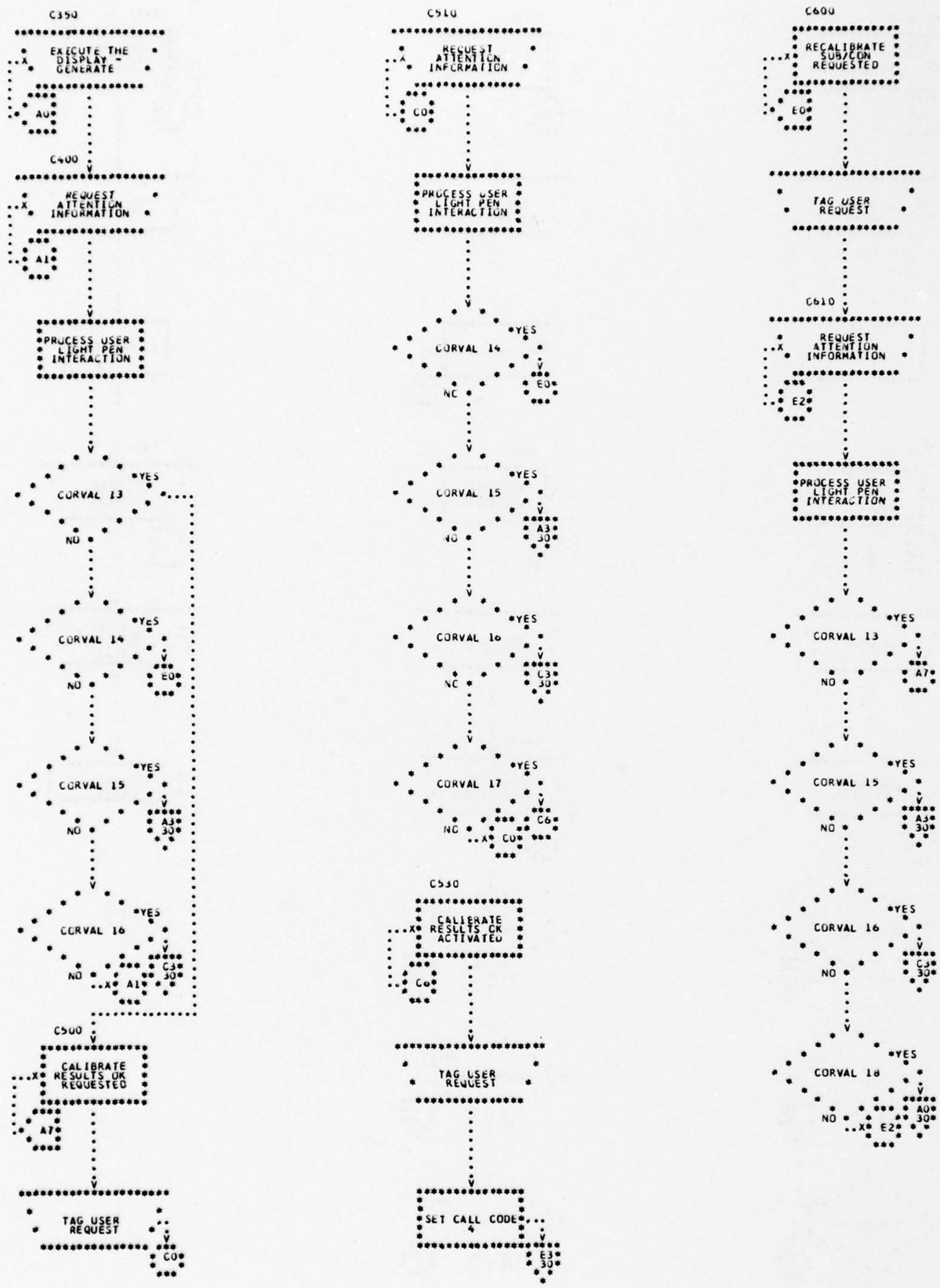


FIGURE 18. PROGRAM FLOWCHART

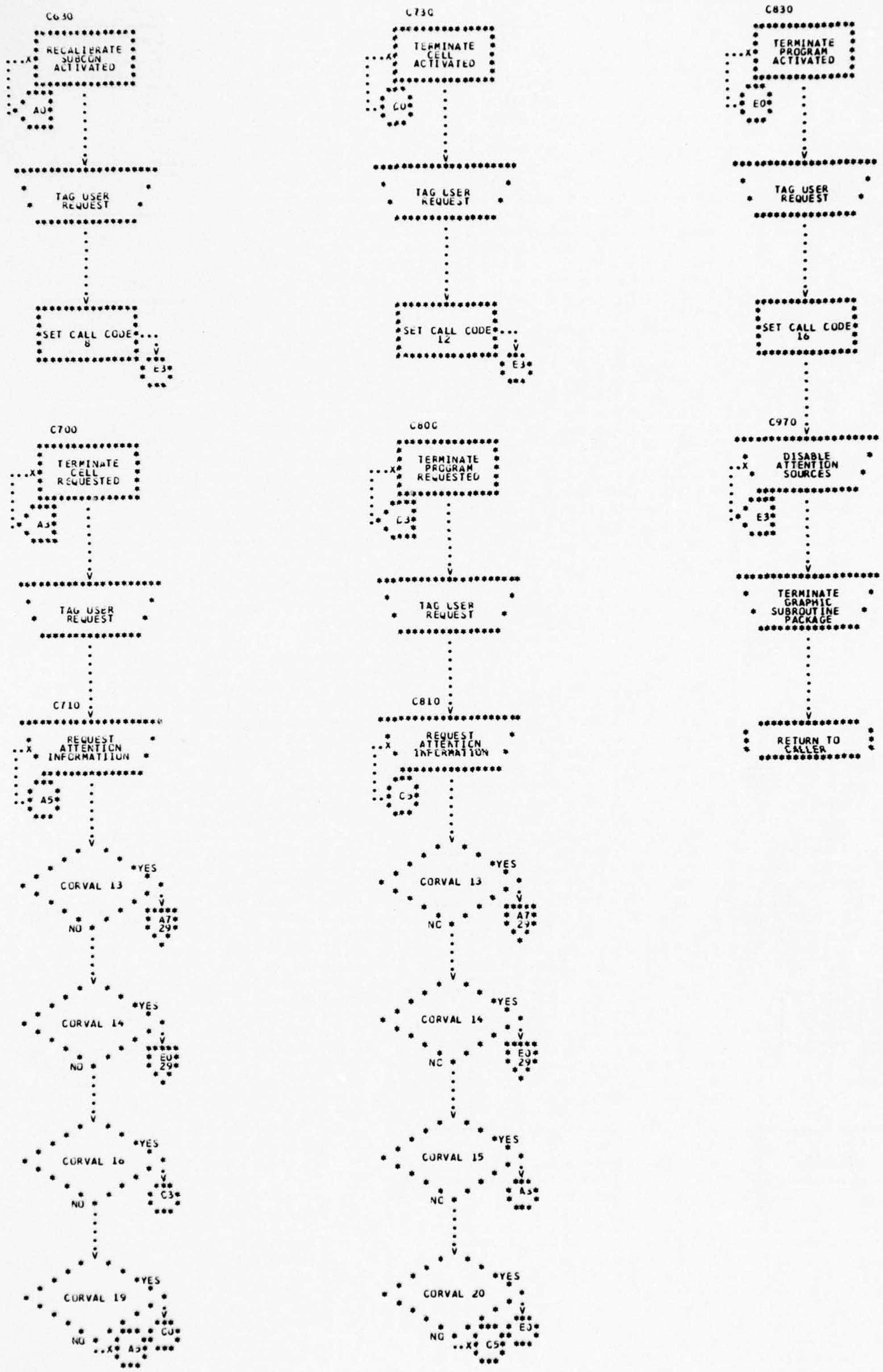
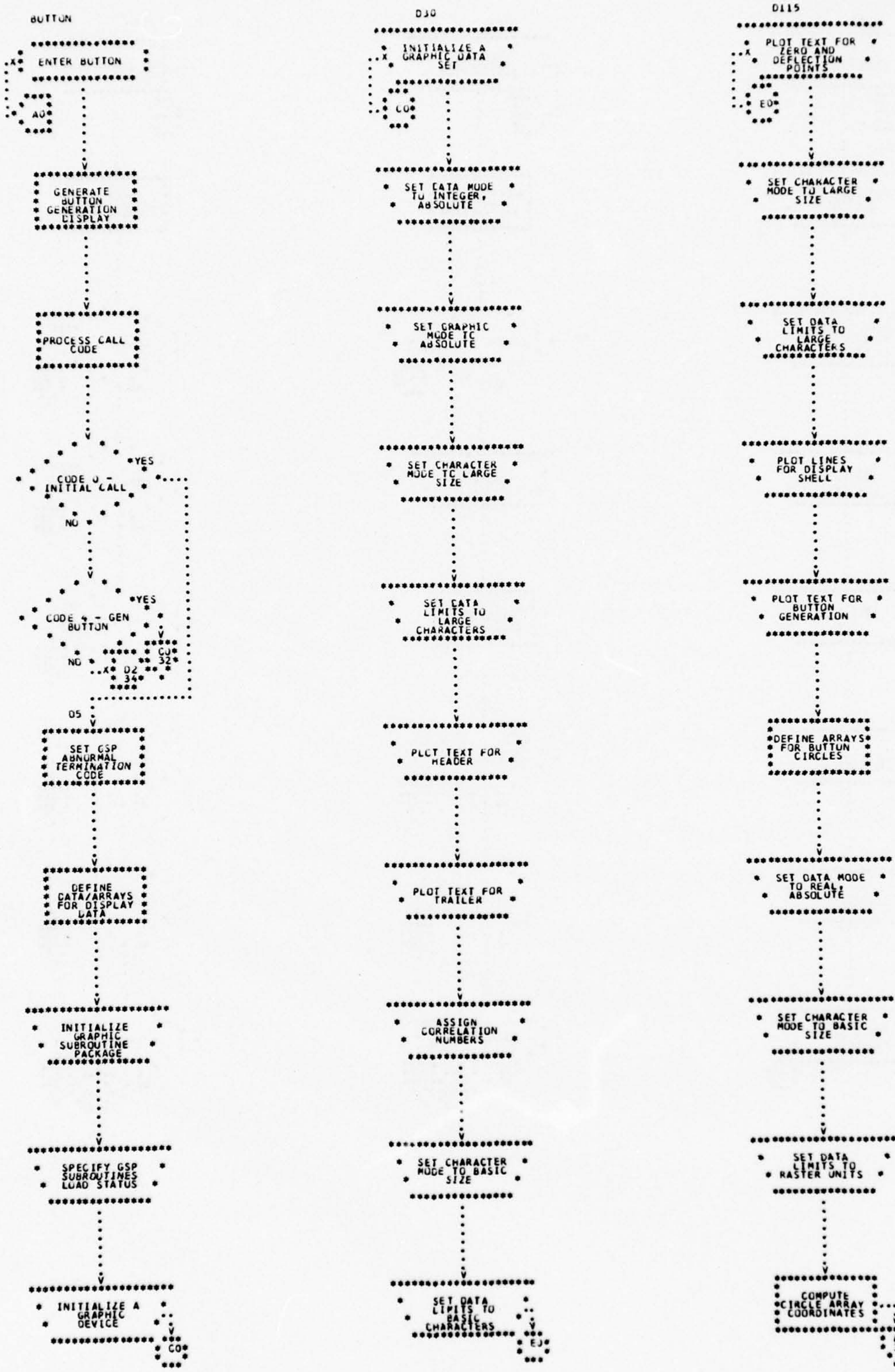


FIGURE 18. PROGRAM FLOWCHART



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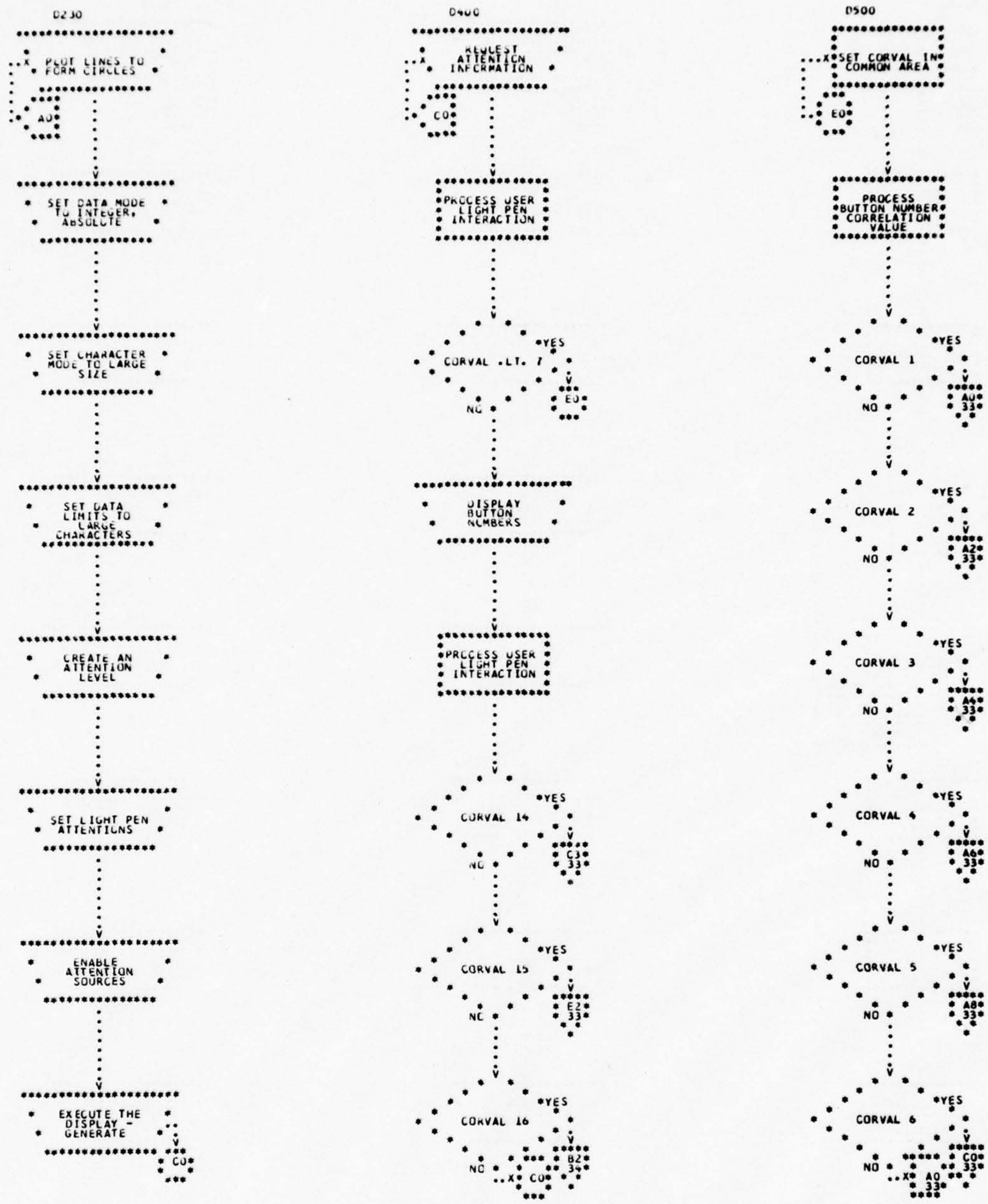
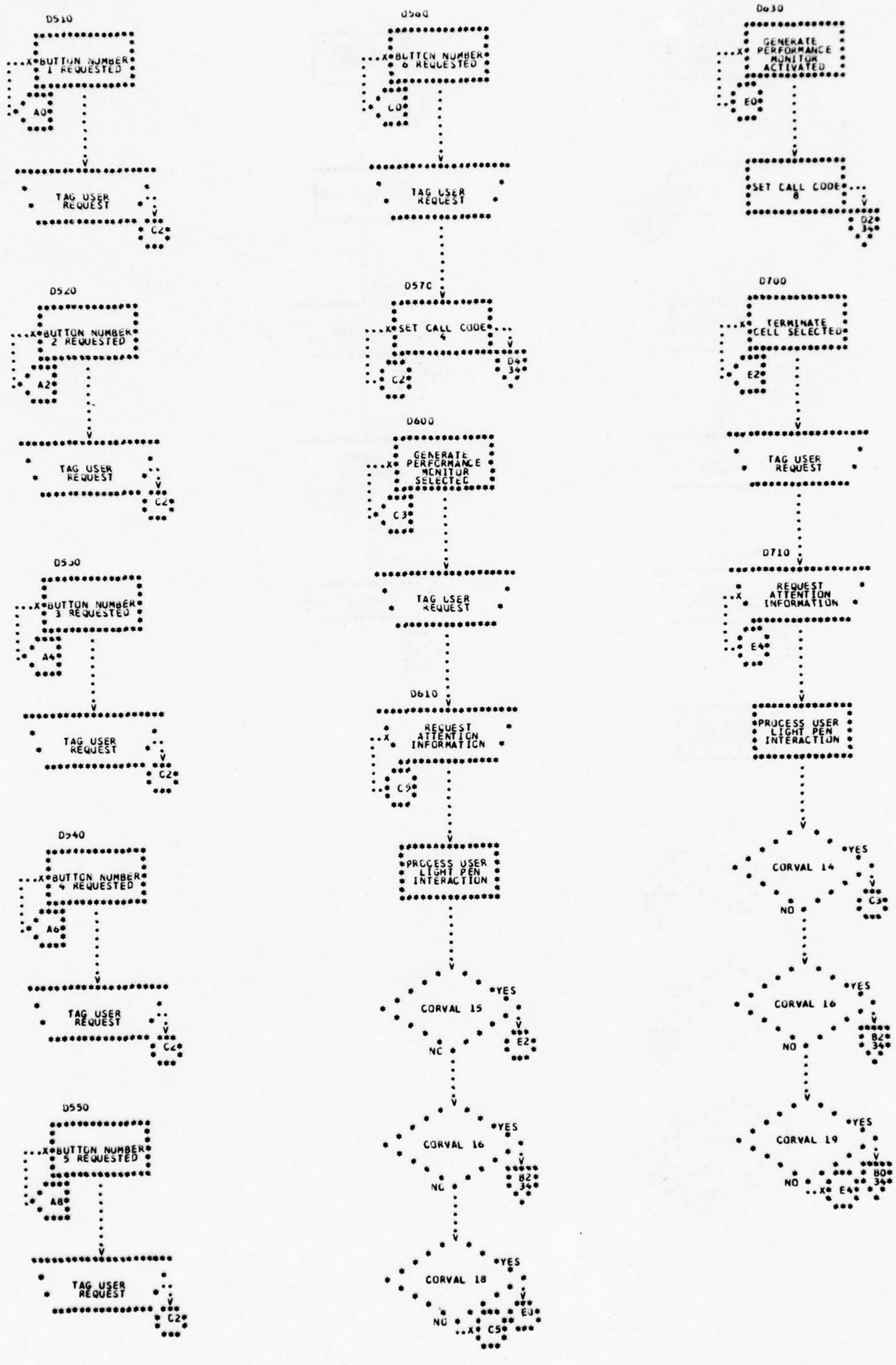


FIGURE 18. PROGRAM FLOWCHART



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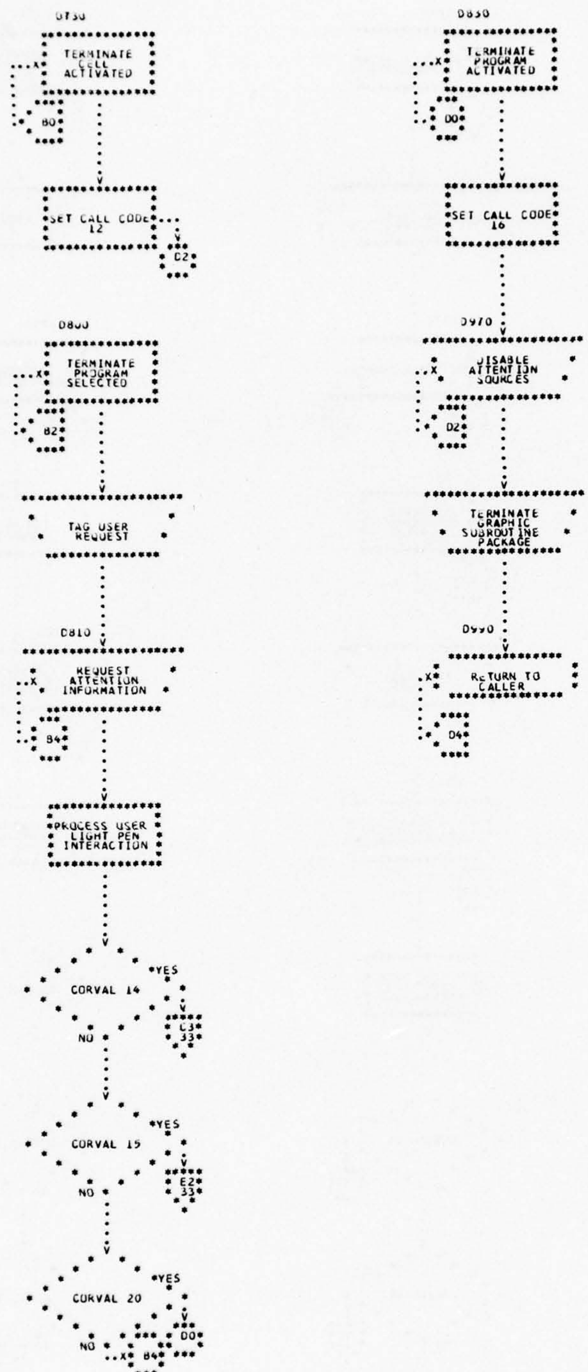

FIGURE 18. PROGRAM FLOWCHART

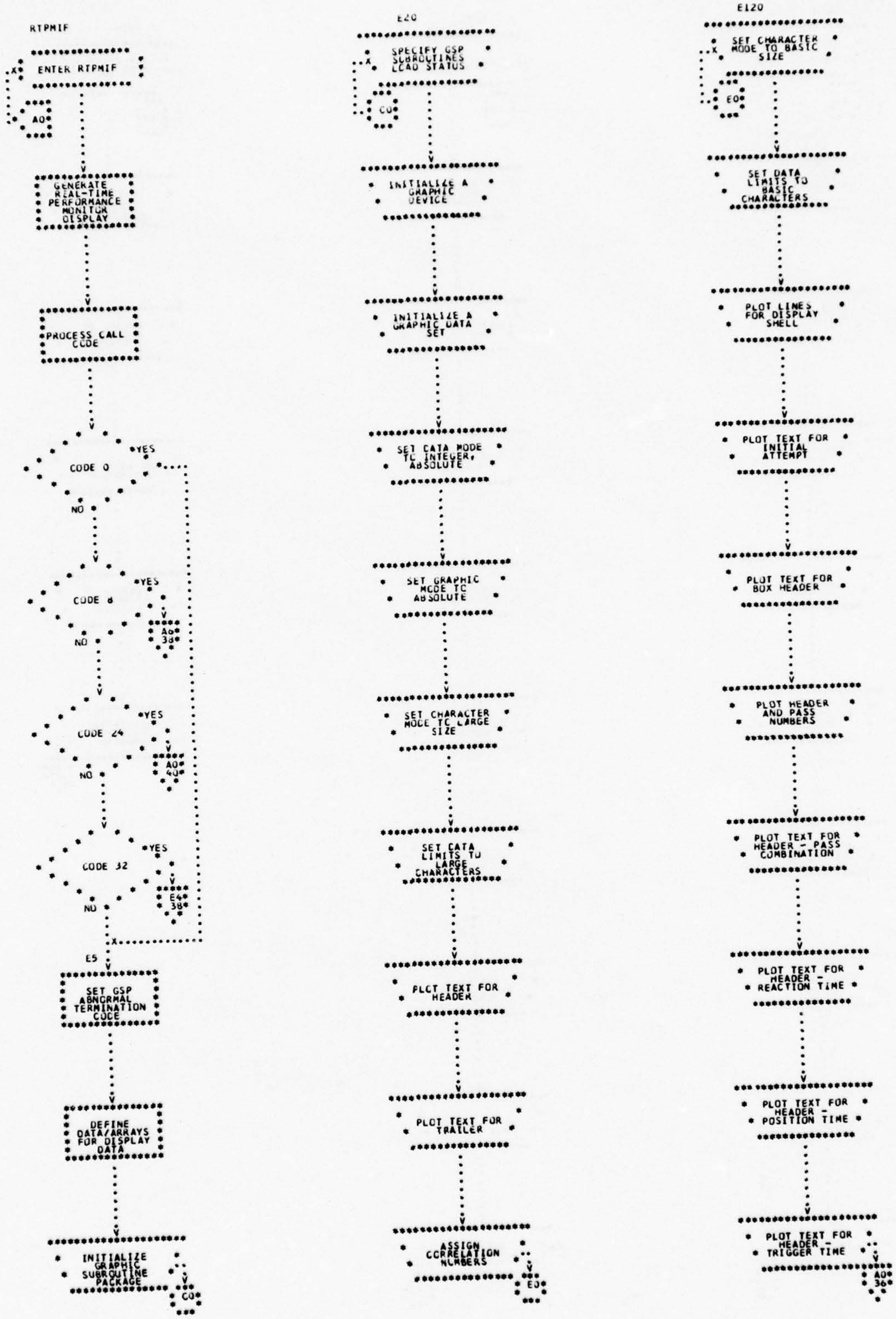

FIGURE 18. PROGRAM FLOWCHART

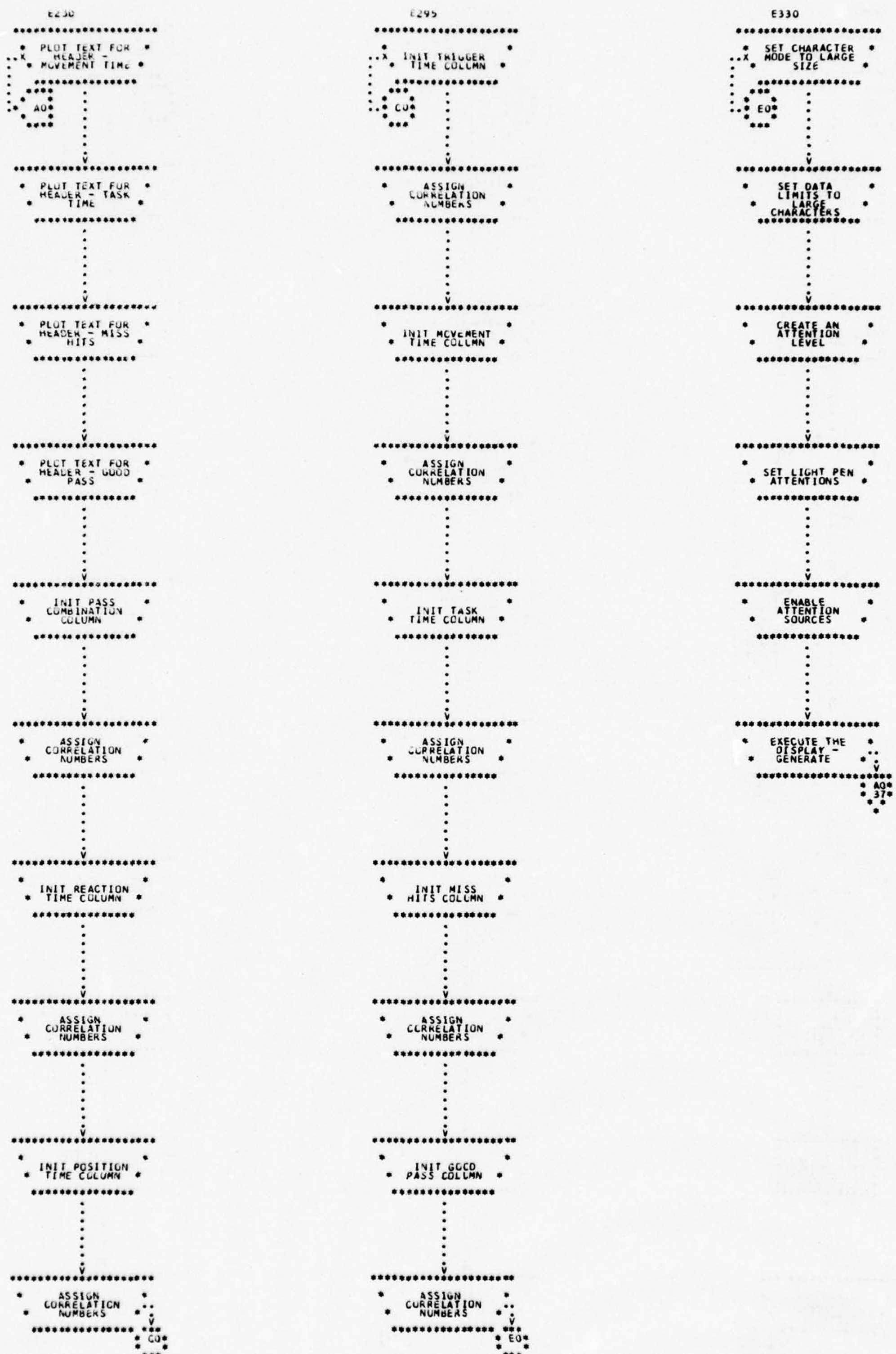

FIGURE 18. PROGRAM FLOWCHART

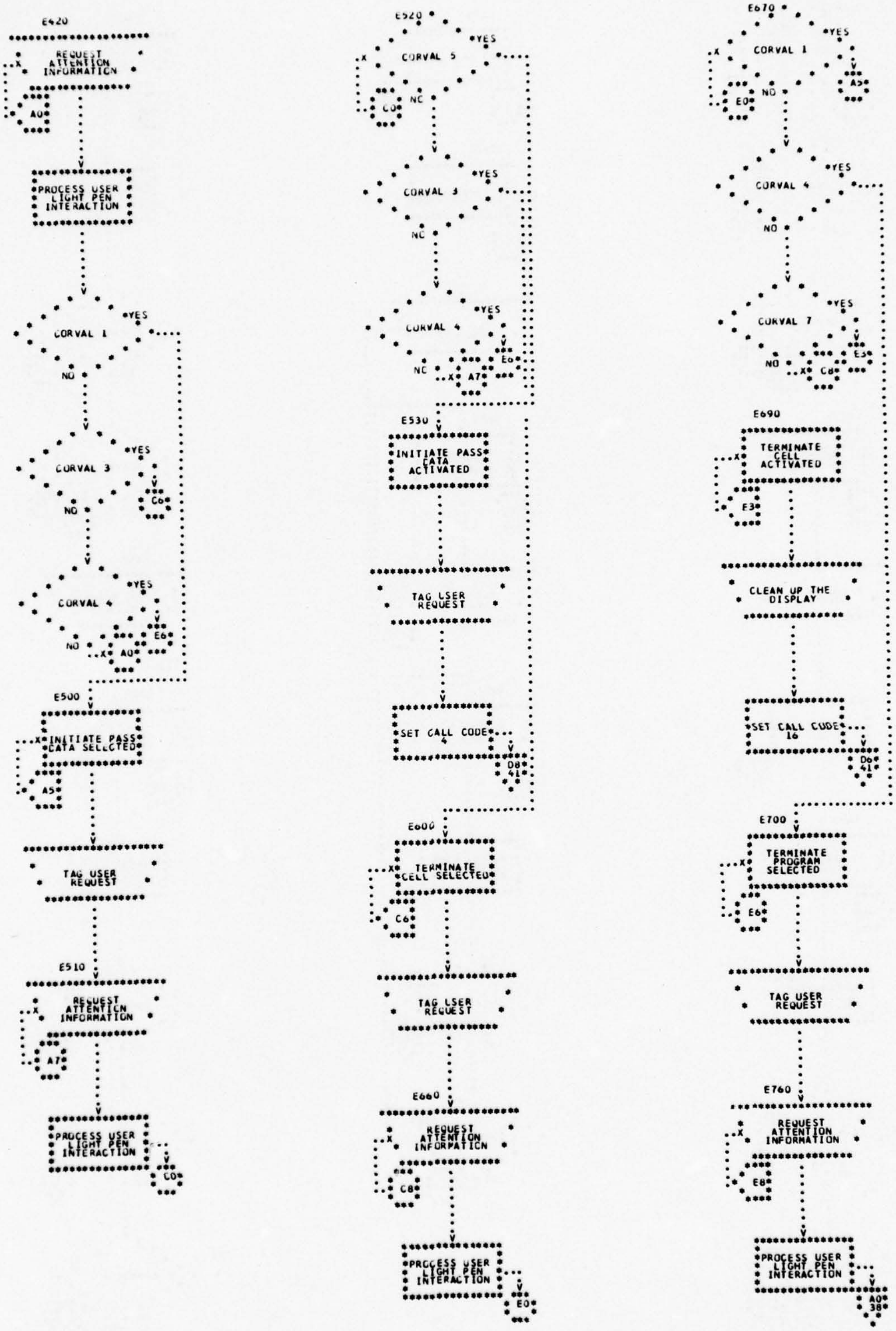

FIGURE 18. PROGRAM FLOWCHART

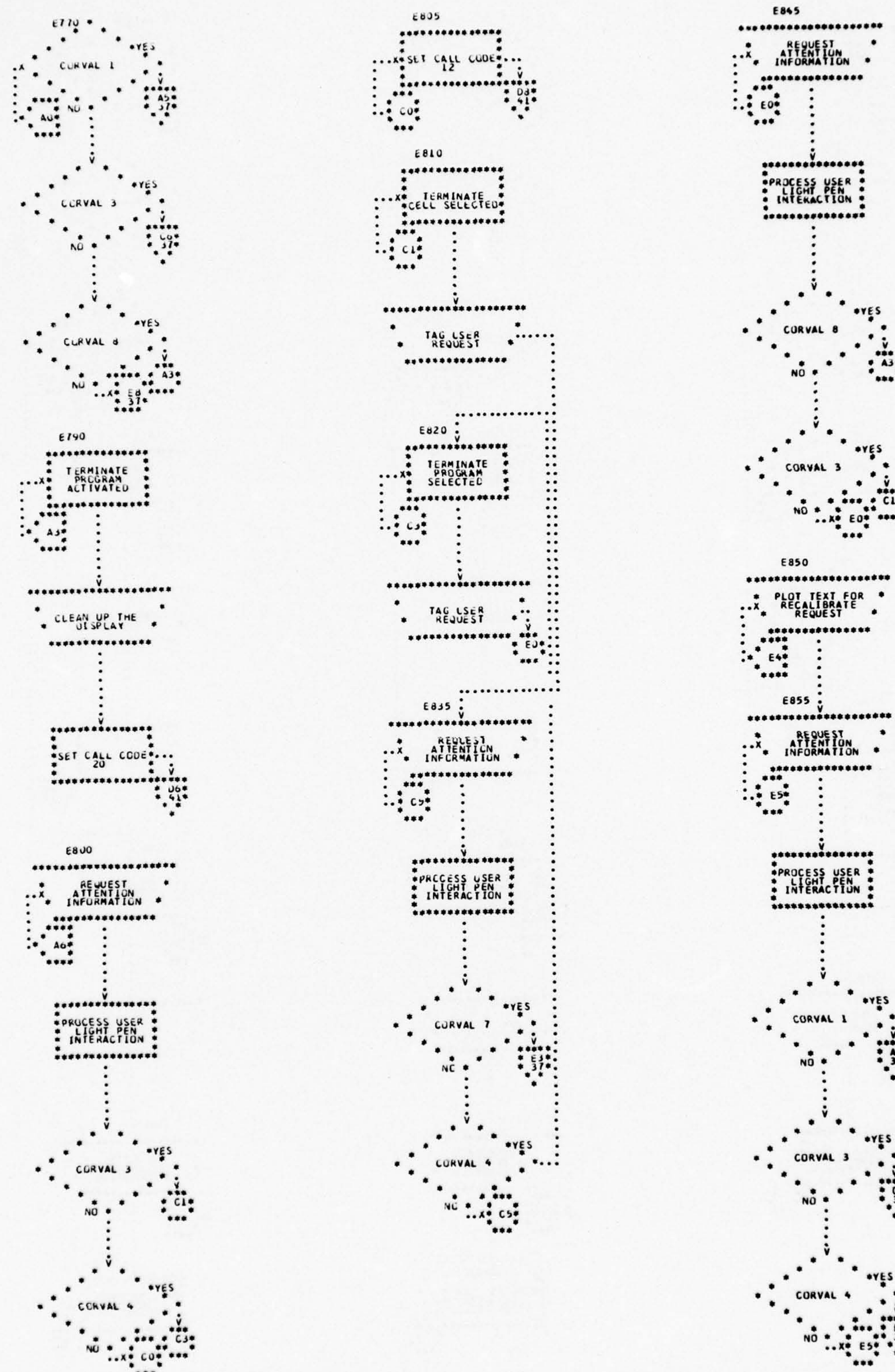

FIGURE 18. PROGRAM FLOWCHART

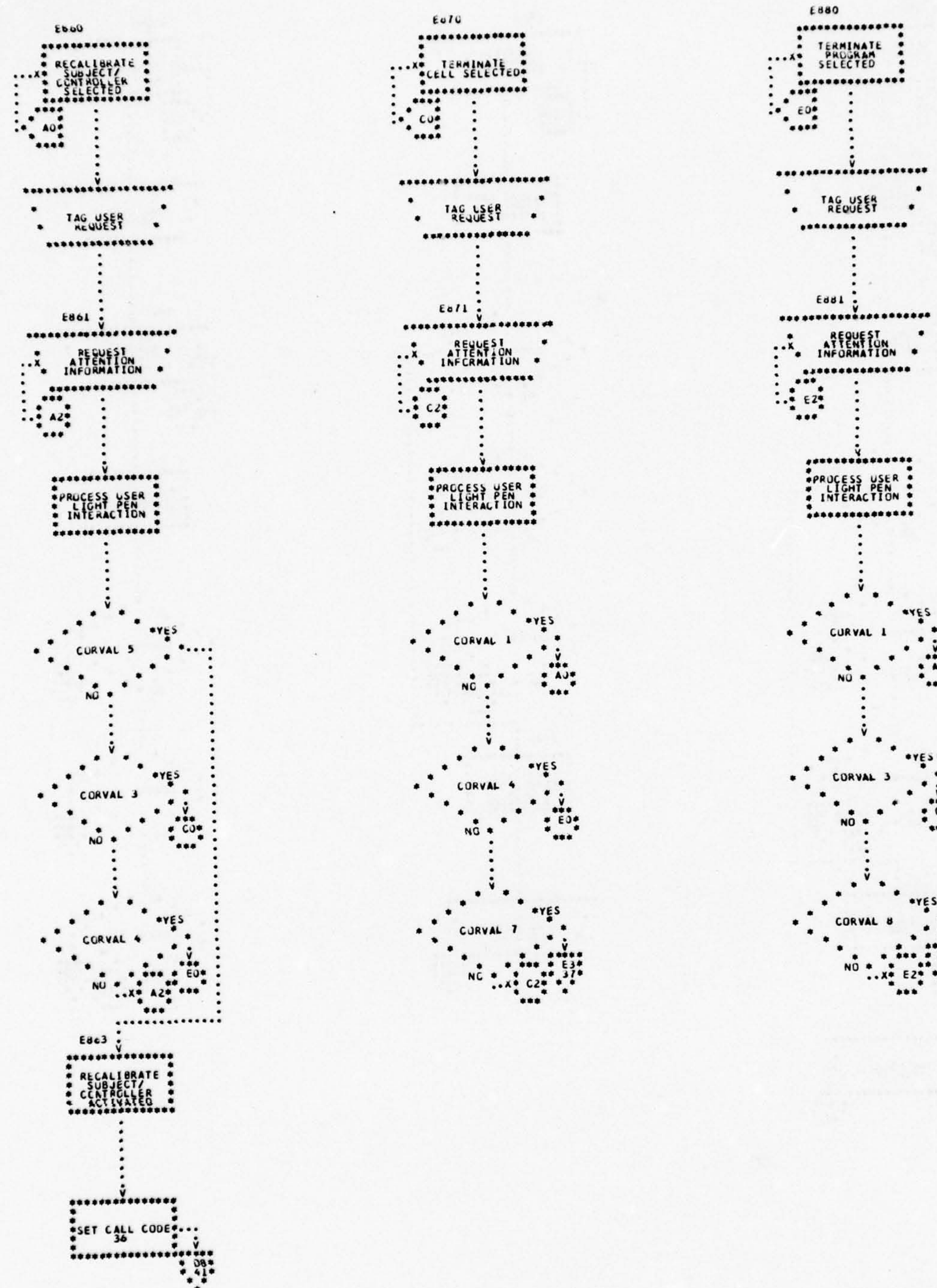

FIGURE 18. PROGRAM FLOWCHART

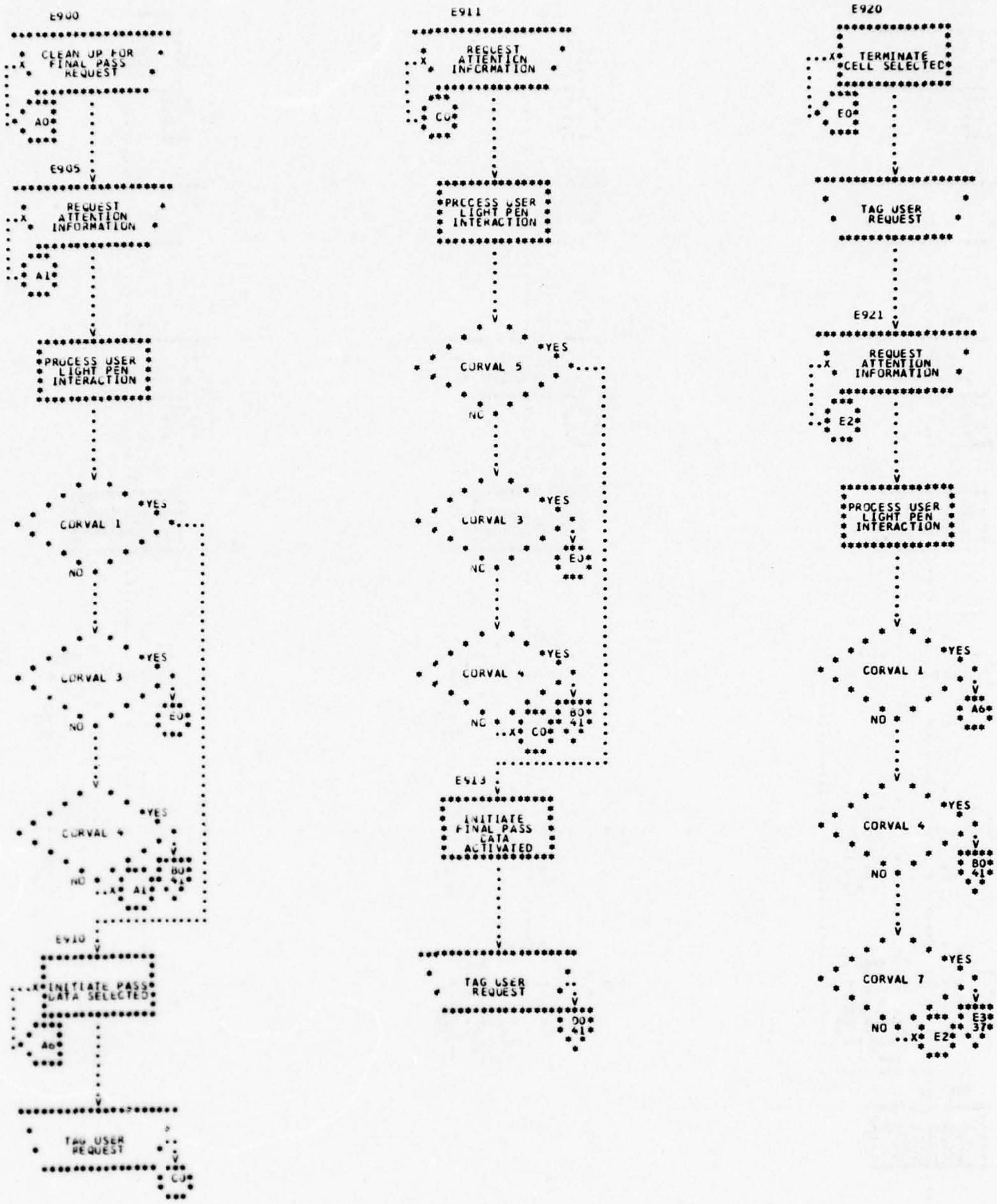

FIGURE 18. PROGRAM FLOWCHART

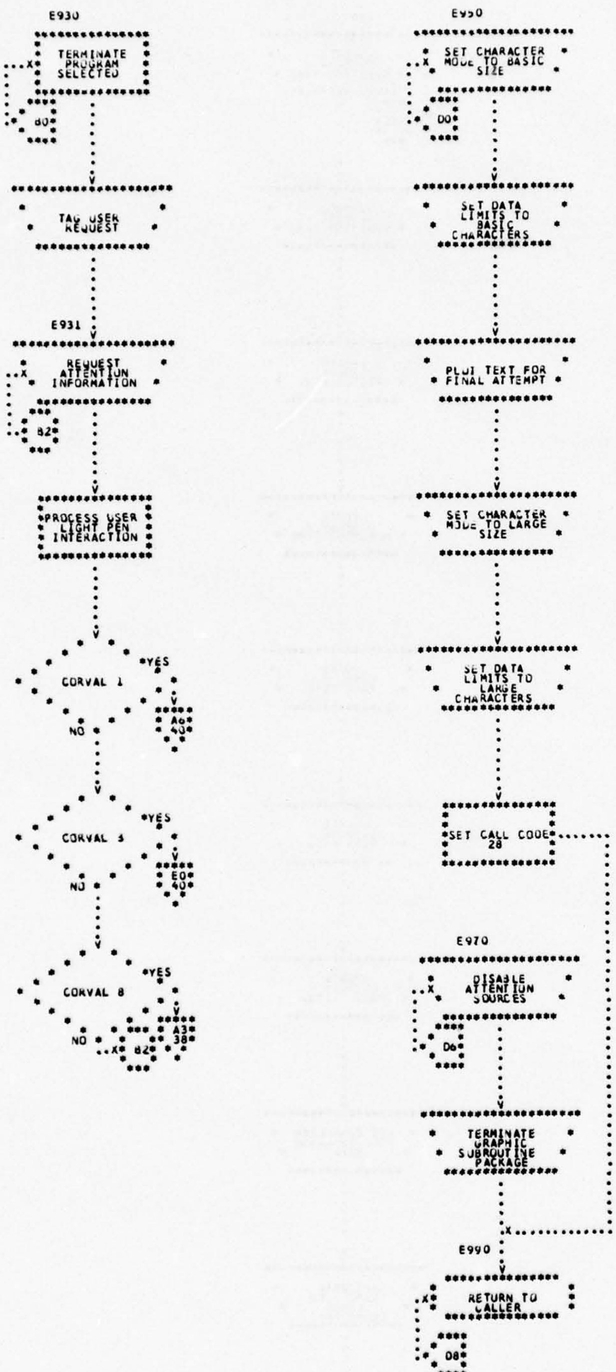

FIGURE 18. PROGRAM FLOWCHART

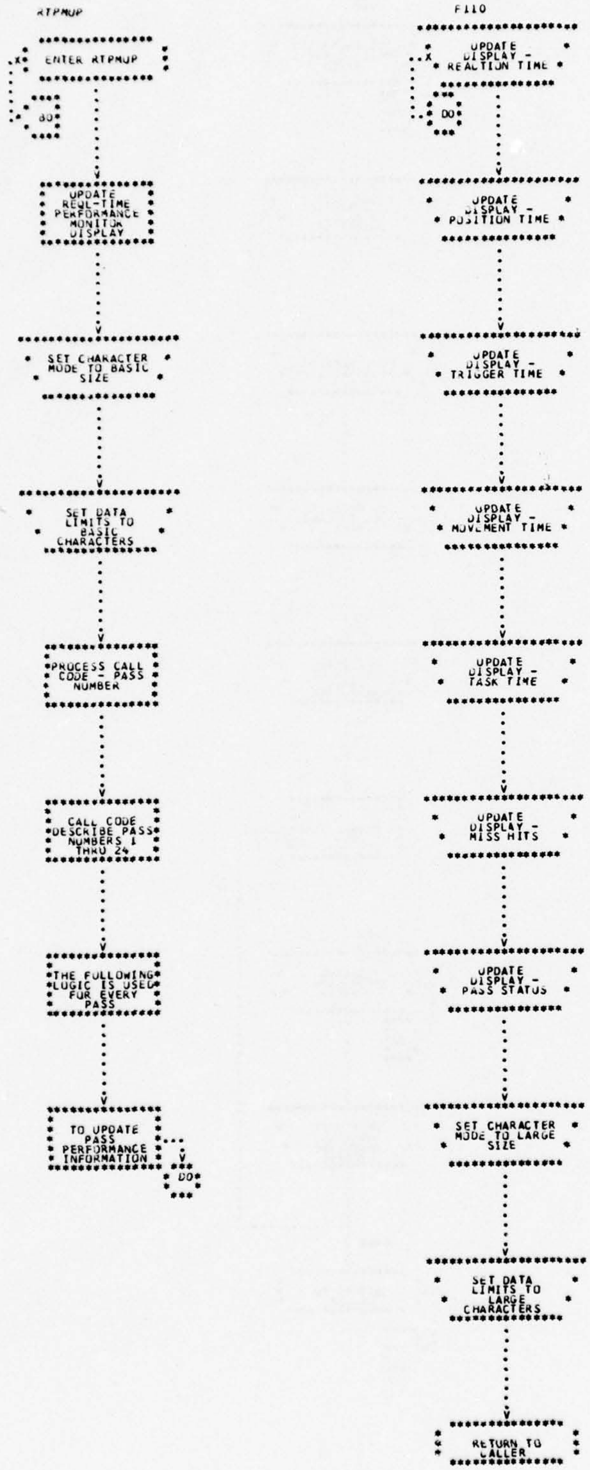

FIGURE 18. PROGRAM FLOWCHART

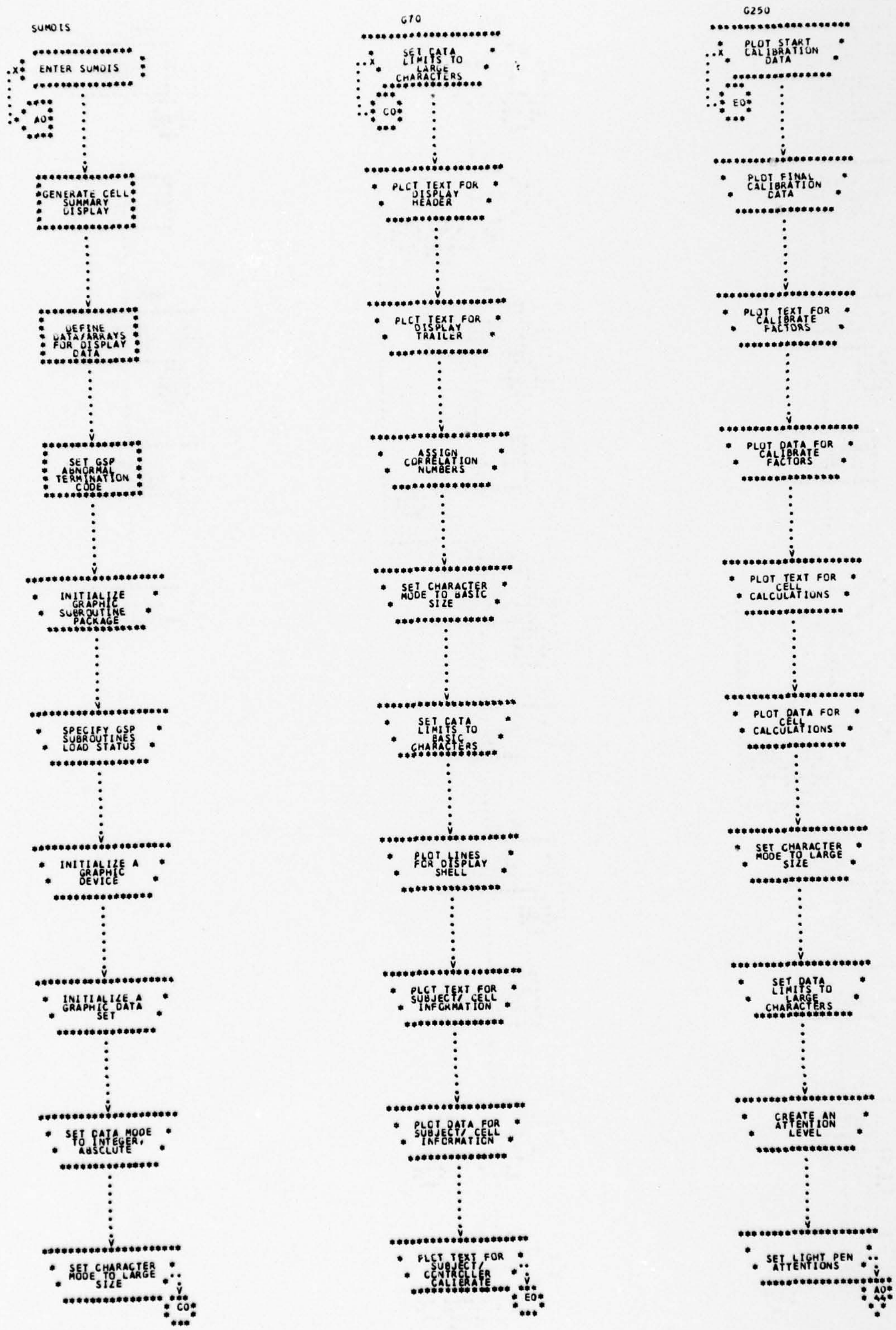

FIGURE 18. PROGRAM FLOWCHART

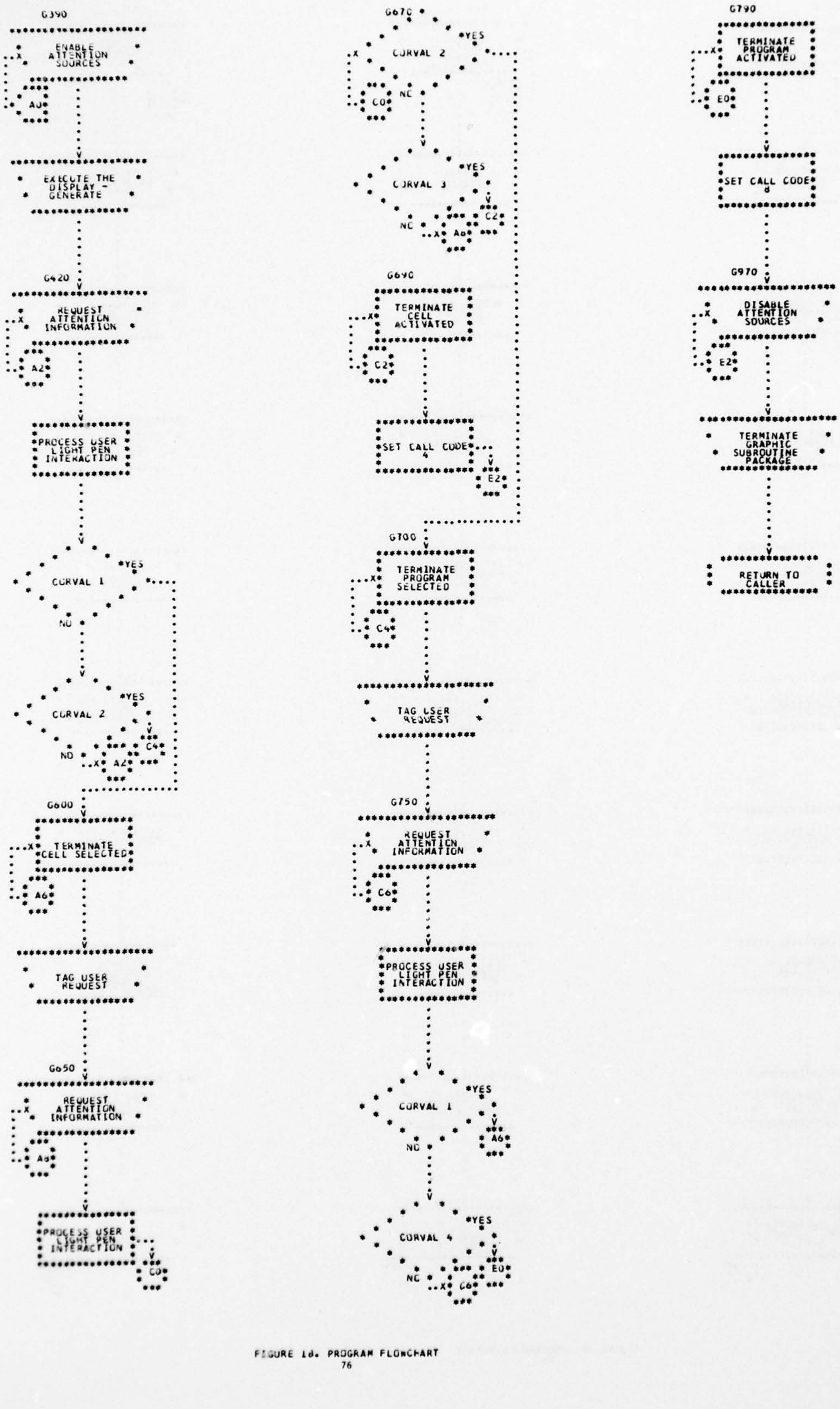

FIGURE 18. PROGRAM FLOWCHART

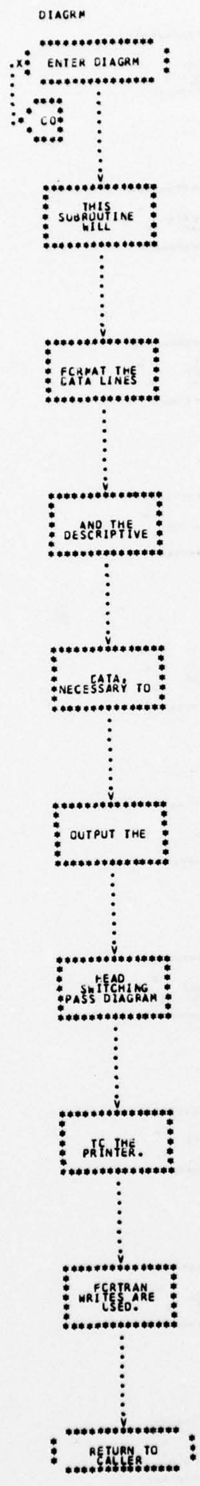

FIGURE 18. PROGRAM FLOWCHART

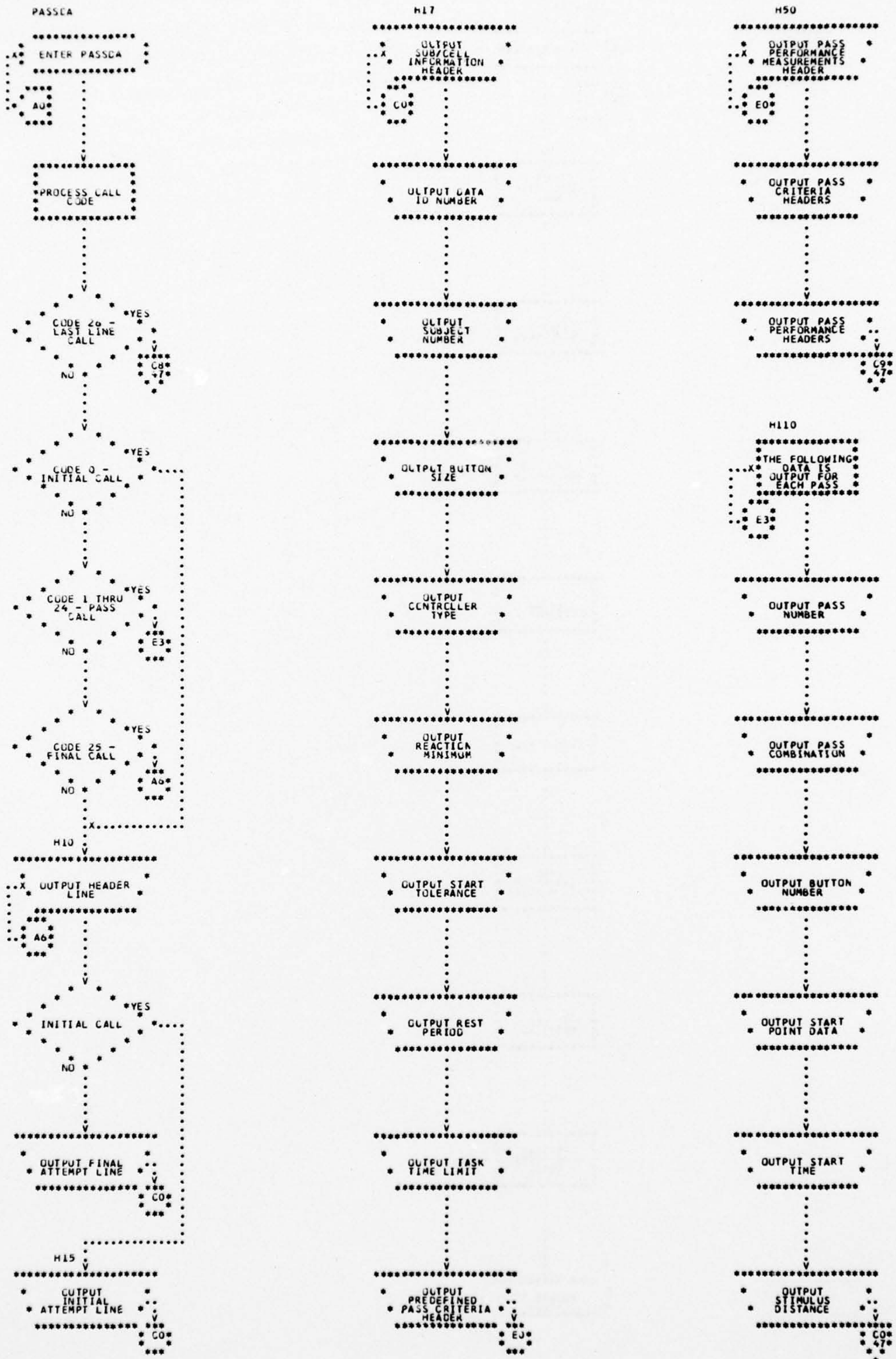

FIGURE 18. PROGRAM FLOWCHART

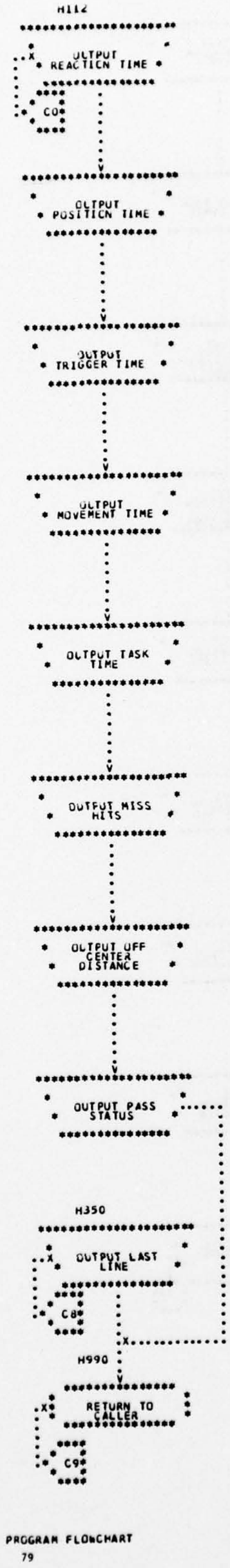

FIGURE 18. PROGRAM FLOWCHART

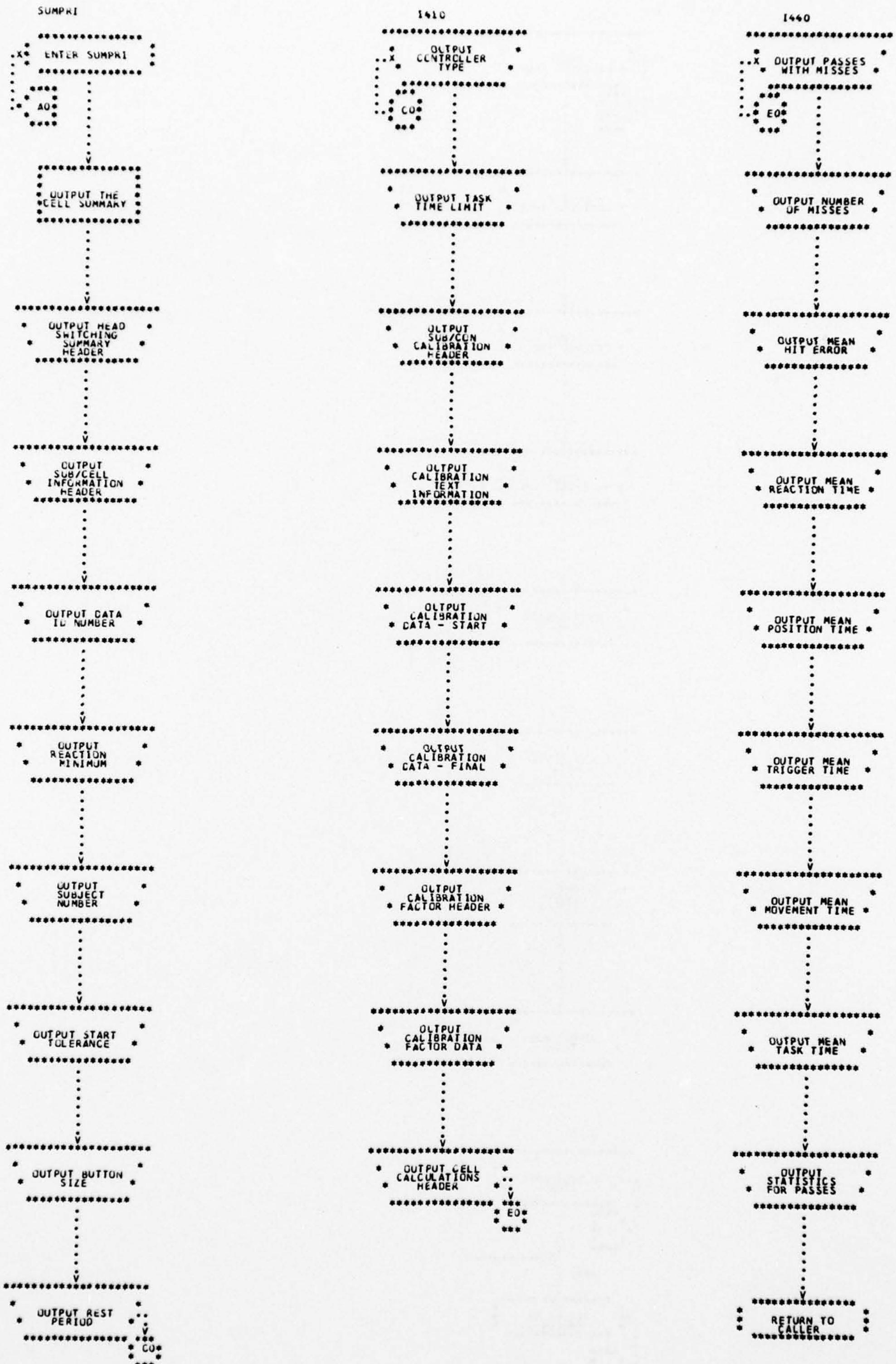

FIGURE 18. PROGRAM FLOWCHART

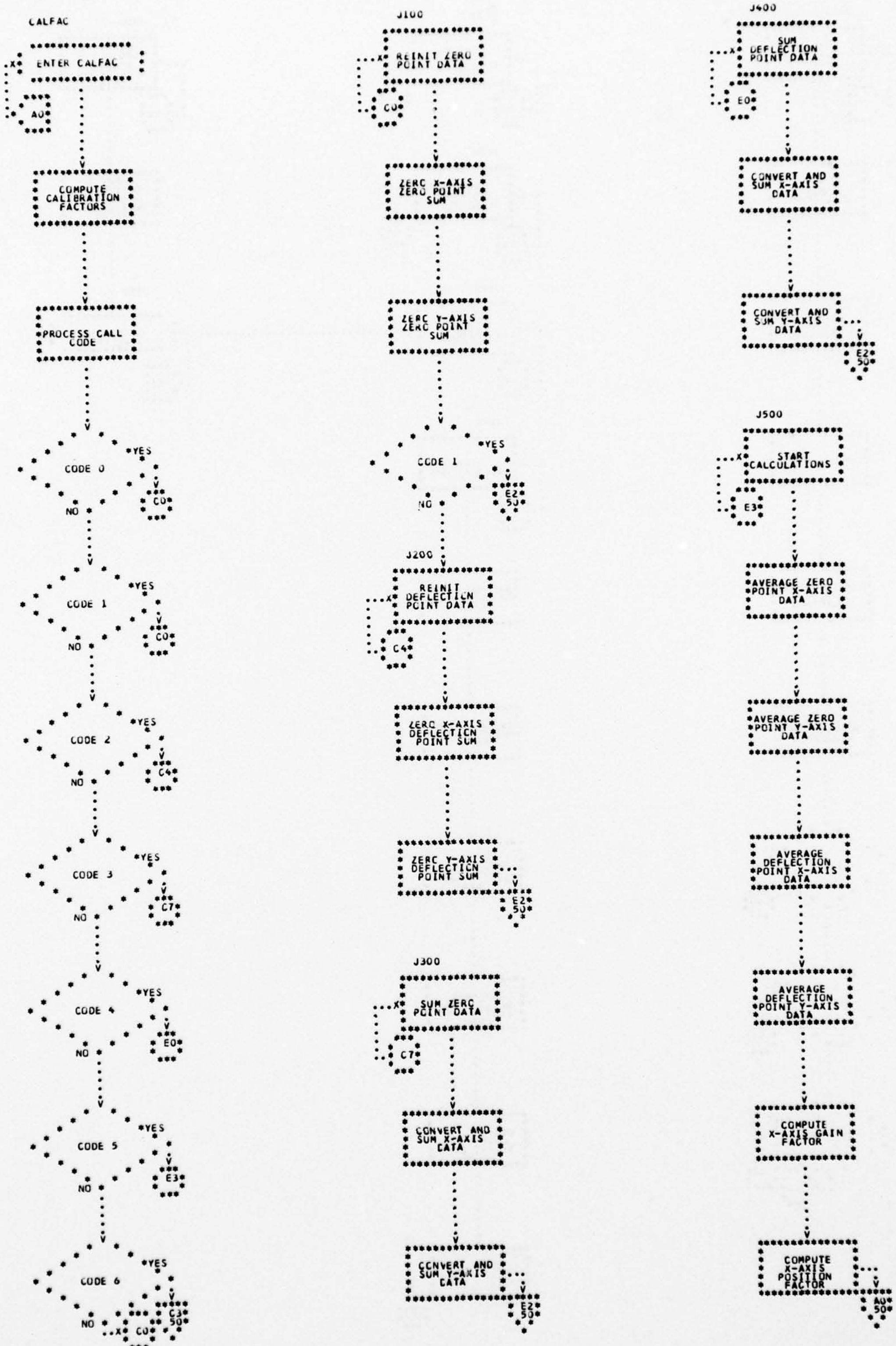

FIGURE 18. PROGRAM FLOWCHART

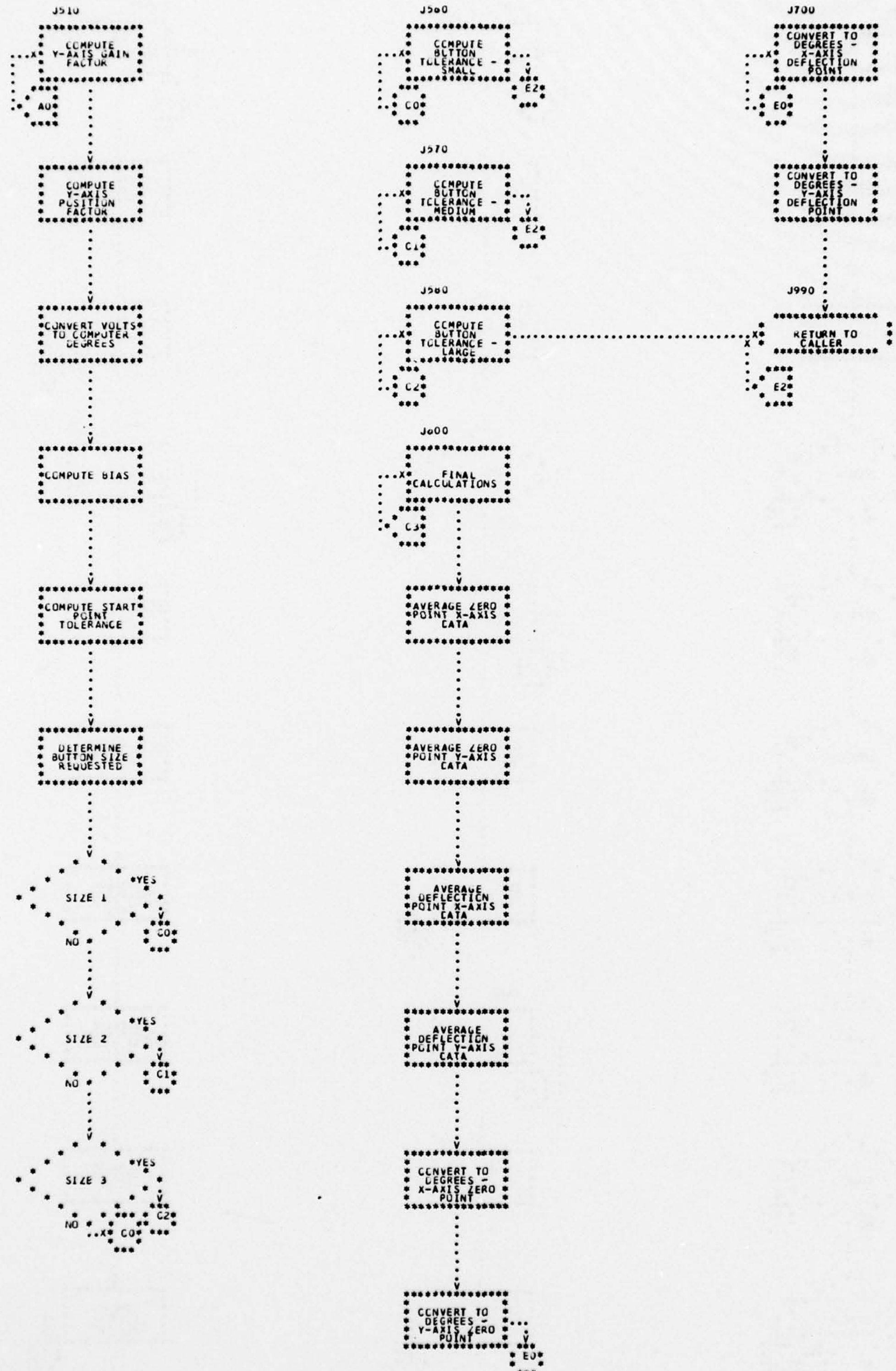

FIGURE 18. PROGRAM FLOWCHART

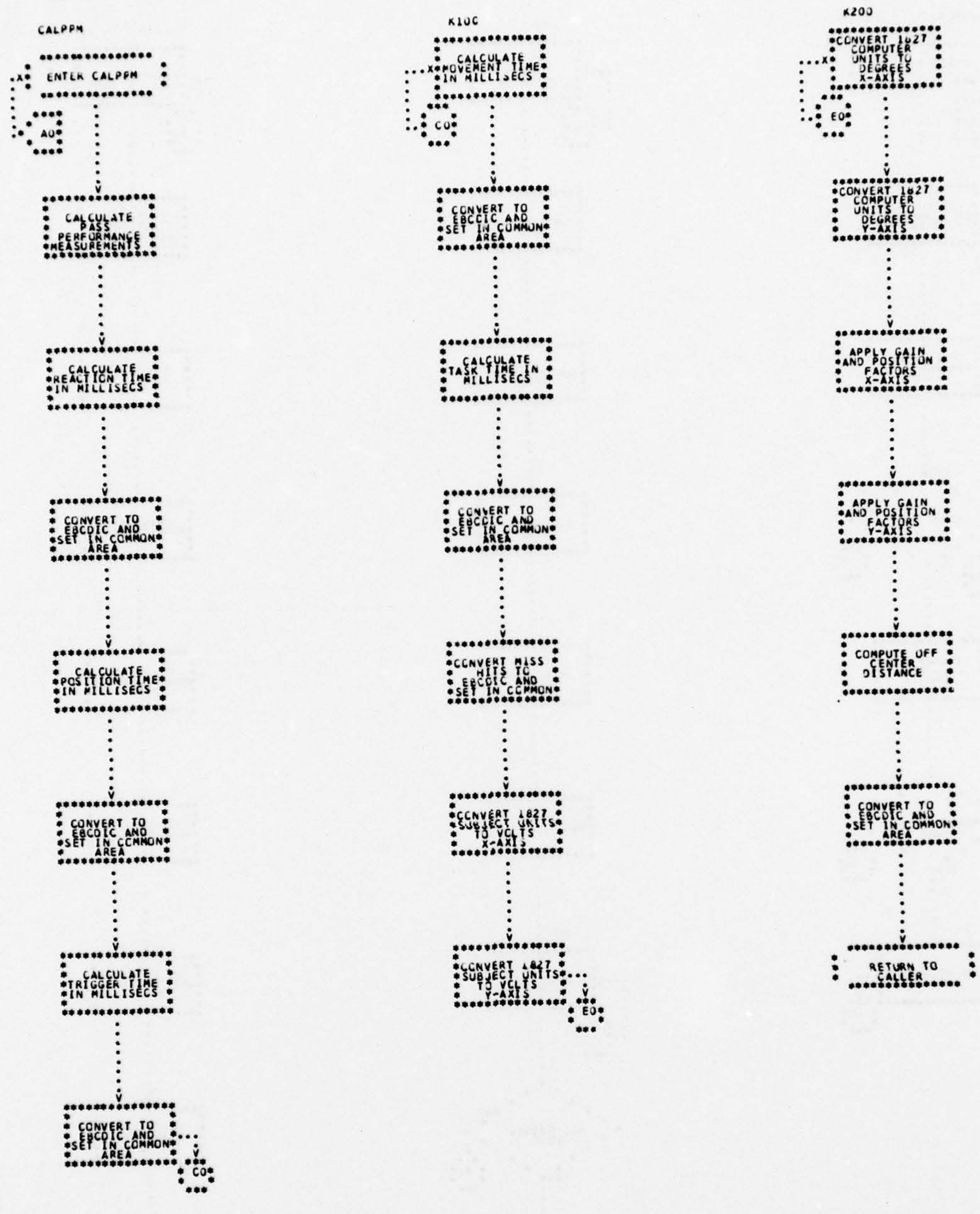

FIGURE 18. PROGRAM FLOWCHART

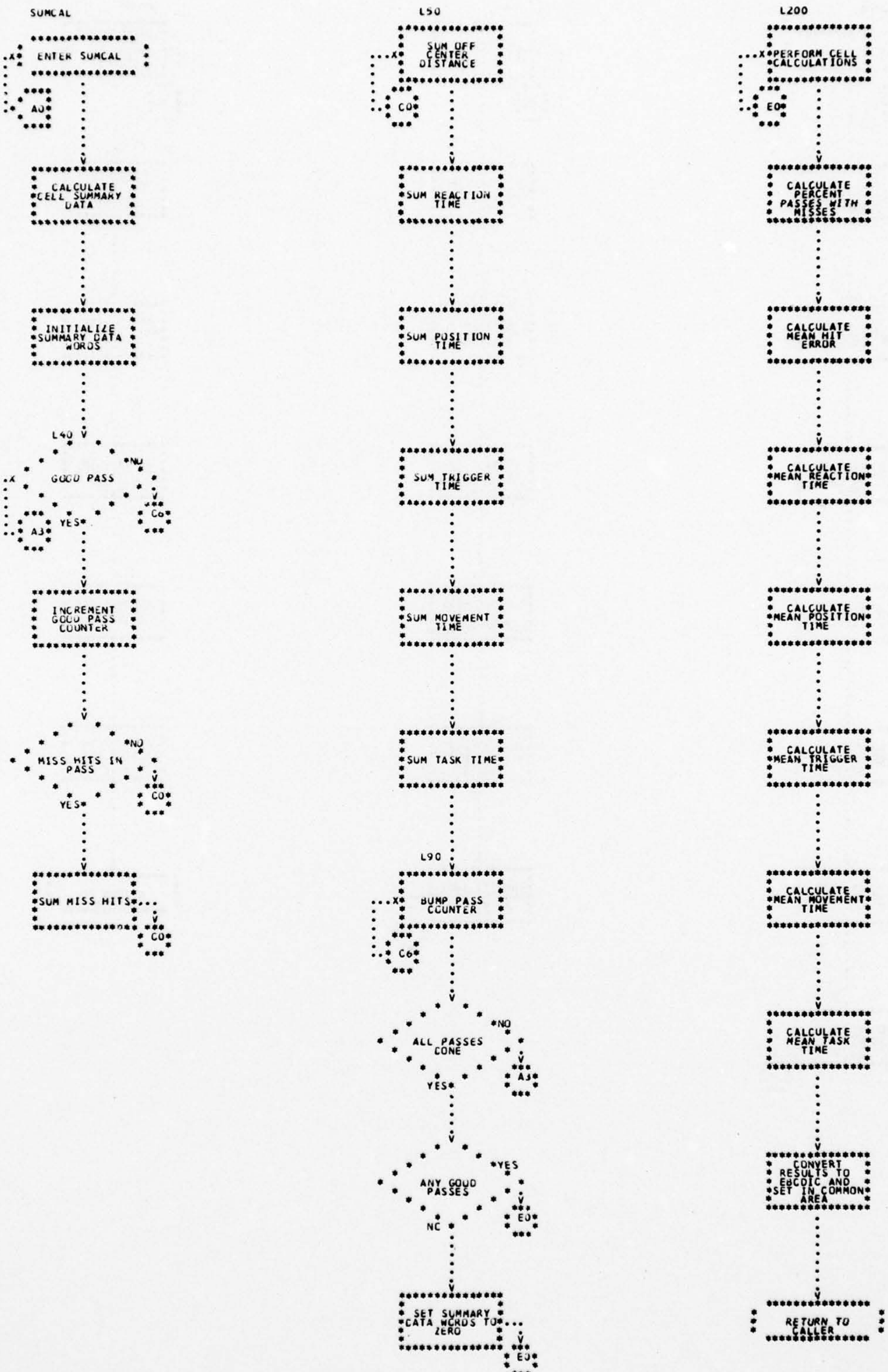

FIGURE 18. PROGRAM FLOWCHART

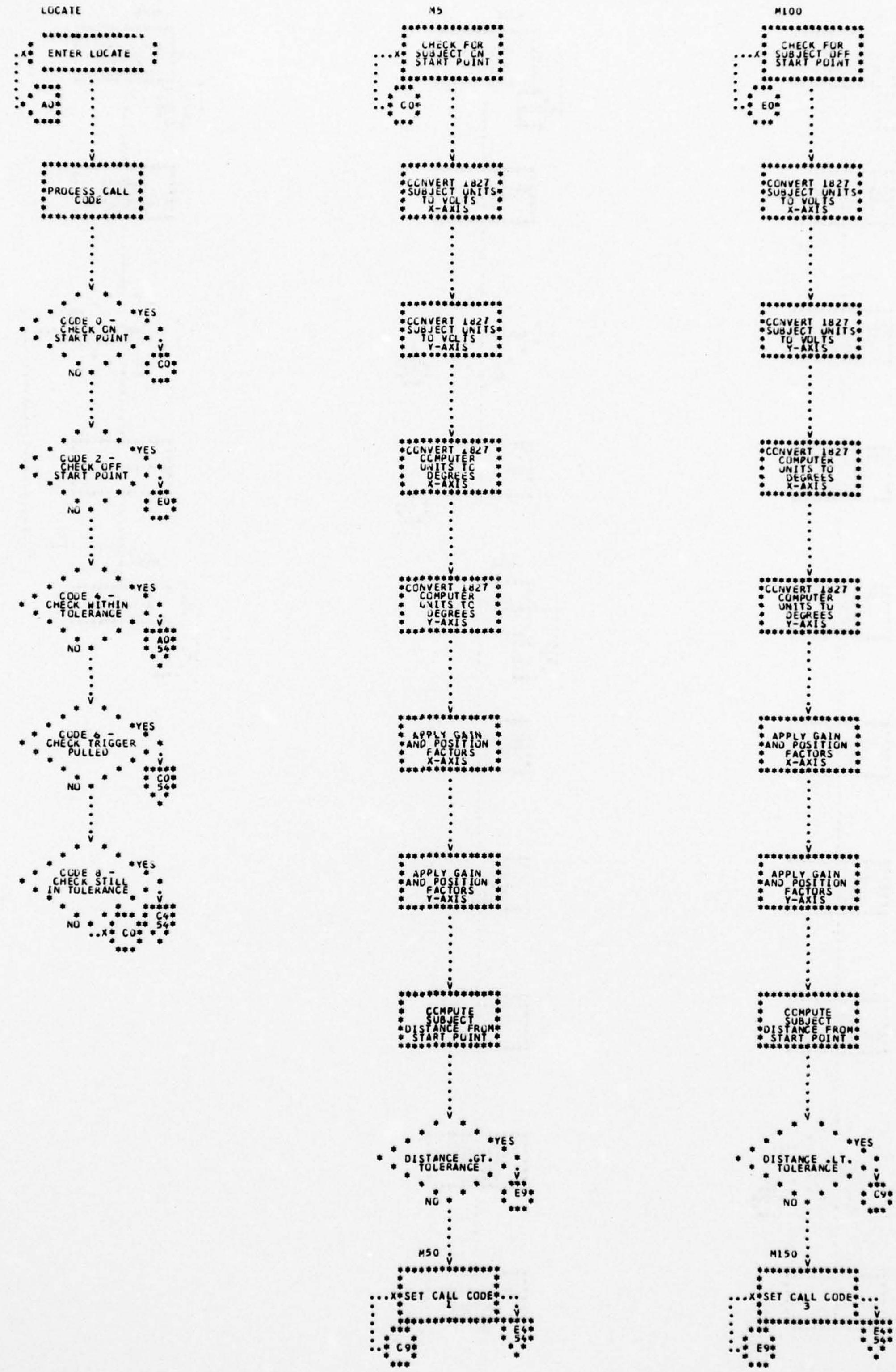

FIGURE 18. PROGRAM FLOWCHART

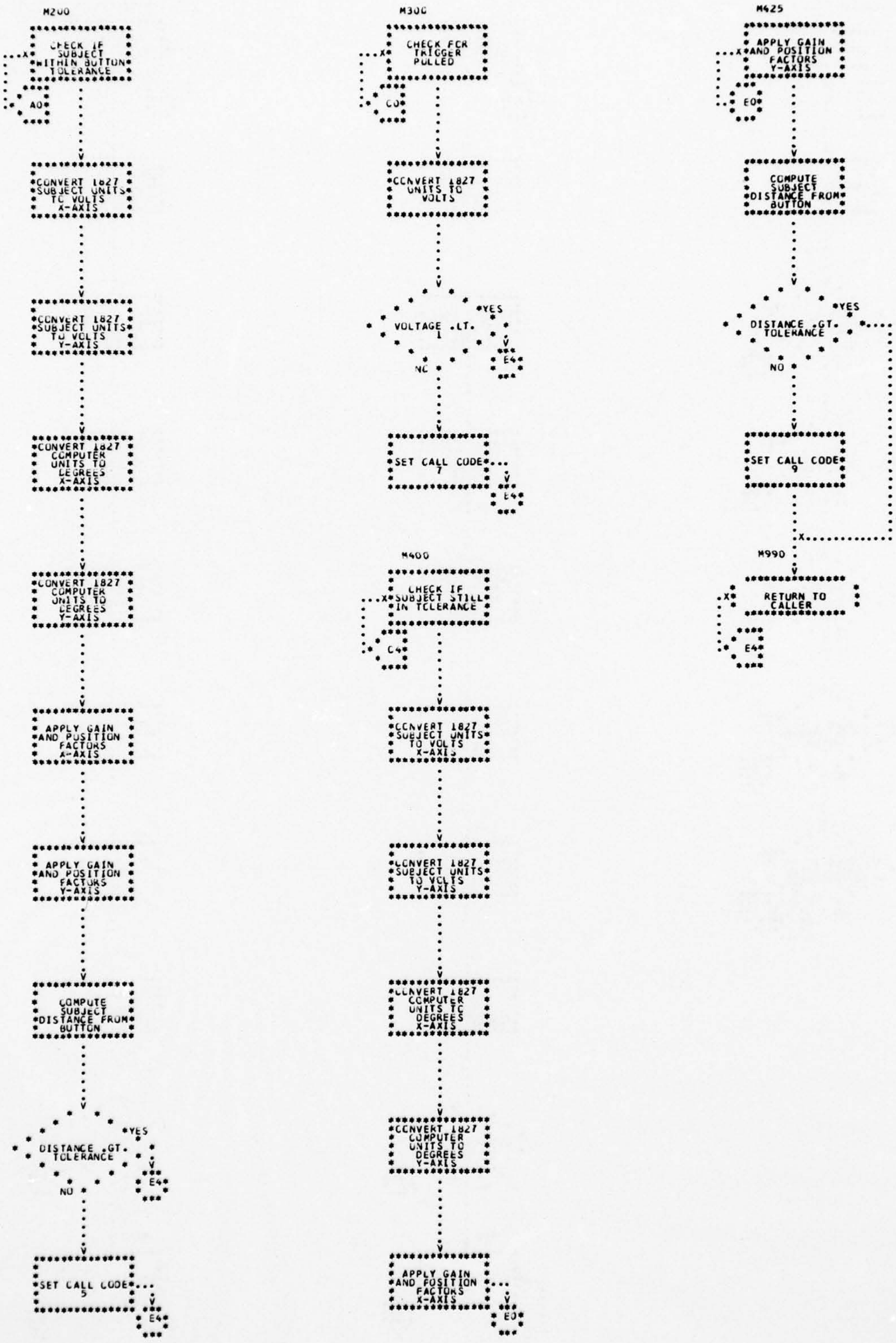

FIGURE 18. PROGRAM FLOWCHART

APPENDIX A

USER GUIDE

The following information is presented to enable the user community to maximize efficient use of the Head Switching Software Package:

1. Operating Instructions

2. General Information

1. Operating Instructions

The following steps should be taken for executing the Head Switching Software Package.

A. Enable the 2840 Display Control Unit.

B. "POWER ON" the 2250 Display Unit specified by the //FT10F001 DD card in the execution deck (Figure 16).

C. Ensure the correct user boards are in the 1827 Data Control Unit.

D. Ensure the 1443 printer is on line.

E. Enable the 3800 Tape Control Unit.

F. "POWER ON" the 3450 Tape Unit specified by the //TAPEOUT DD card in the execution deck (Figure 16).

G. Place the Head Switching Software Package execution deck (Figure 16) in the card reader and depress the "START" button.

H. Mount disk packs as requested by the operating system on the console-printer keyboard.

I. Mount the output tape as requested by the operating system on the console-printer keyboard.

J. Once program execution begins, the Cell Initialization Data Display (Appendix B) will be generated on the 2250 Display Unit.

K. User control of the experiment is now via light pen action, on the 2250 Display Unit, as detailed in SECTION III.

L. After execution has been terminated by the user, remove the execution deck from the card reader, the output listing from the printer, the save tape from the tape unit, and the write ring from the save tape.

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PROGRAM DOCUMENTATION FOR THE HEAD SWITCHING SOFTWARE PACKAGE.(U)

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2. General Information

The following items will provide the user with general information pertinent to successful program utilization:

A. The partition in the S/370 to be used should provide a minimum of 230K of core for the Head Switching Software Package.

B. The necessary steps should be taken to prevent other users from simultaneous execution of other jobs in the S/370. All experiment control is via a graphics package and subject response is time based. Any CPU time given to a simultaneous user will perturb the experiment and the statistical data to be gathered.

C. The ADJUSTMENTS AND CALIBRATIONS DISPLAY (Appendix C) requires the user to complete the subject/controller data sampling because it is necessary for experiment success. If the * preceding the phrase ADJUSTMENTS AND CALIBRATIONS COMPLETED is inadvertently tagged, the software will display arrows on the necessary items to be completed by the user.

D. The information provided on the PRELIMINARY CALIBRATION RESULTS DISPLAY (Appendix D) shows the theoretical zero point and deflection point. It is the user's responsibility to interpret the data and decide whether to continue or recalibrate.

E. The ZERO POINT and DEFLECTION POINT shown on the BUTTON DISPLAY (Appendix E) are provided solely for frame reference and are not light-pen active.

F. The subject should be instructed prior to initiating the pass data presentation, to attempt to position the reticle on the start point and on the presented stimulus before pulling the trigger, regardless of the allowed tolerances. The purpose of the start point and button tolerances is to compensate for subject inability to position the reticle exactly on either point.

G. The subject should be informed that once a pass has been completed, the presented stimulus will be reset to the zero point on the experiment screen (Figure 2) for a rest period. The rest period is intended to prevent subject fatigue from influencing the statistics to be gathered.

H. At the start of a subject pass, the location of the subject's reticle is reverified to be within start point tolerance after the start time has elapsed. This is done to prevent an erroneous position time if the subject attempts to second-guess the stimulus to be presented and leaves the start point.

I. During a subject pass, any trigger pulls prior to initial positioning of the reticle within button tolerance will be ignored. If the subject pulls the trigger before a position within tolerance has been achieved and continues depressing the trigger, the subject must release and pull the trigger again to successfully complete the task. This logic prevents an erroneous trigger time of 2 - 3 milliseconds.

J. If the user decides to terminate the presentation of pass data, he must tag either * preceding the phrases beginning with TERMINATE, on the REAL-TIME PERFORMANCE MONITOR DISPLAY (Appendix F). The user will not be notified of the acceptance of the request until the subject pass in progress has been completed. The check for user requests is done between subject passes to permit the greatest accuracy possible during the timing measurements of subject activity.

K. The Head Switching Software Package has been designed to be serially reusable and reëntrant. The user is cautioned to make minimum use of this capability because of core limitations. Due to the large graphics package and primarily the inability to reinitialize system overhead functions, the system will eventually ABEND with a system code 80A. To prevent the possibility of a system ABEND, the user is advised to select and activate the TERMINATE HEAD SWITCHING PROGRAM function on the CELL SUMMARY DISPLAY (Appendix G) upon each completion of subject cell performance and reload the job on the S/370 computer.

L. All system failures of I/O requests will either be recognized by the system or the Head Switching Software Package. In both cases the user will be informed by a coded ABEND on the console-printer keyboard. System codes are detailed in the IBM manuals in the computer center. User codes should be resolved by referring to the program listing for HSWITCH in the delivered documentation.

M. The Trigger State (Figure 9) is defined by the software as pulled, whenever the input voltage exceeds + 1 volt. All voltages less than + 1 will be defined as not pulled.

N. If an abnormal termination occurs during the experiment, the user should note the point of the occurrence for input to personnel responsible for data reduction.

O. A maximum of 48 Pass Data Records (Figure 11) can be recorded. Personnel responsible for data reduction, should be aware that this number is affected by subject performance and user termination requests. The minimum number of records recorded is 2, a Header Record (Figure 10) and a Pass Data Record.

P. The statistics output in the Cell Summary Record (Figure 12) are for good passes only as defined by the Pass Status Key (Figure 13) in the Pass Data Record (Figure 11).

Q. The DISP parameter on the TAPEOUT DD card in the Execution Deck (Figure 16) should be NEW for the first run only. To add data from subsequent runs the parameter must be changed to MOD. Therefore the first run should be terminated by user selection and activation of the TERMINATE HEAD SWITCHING PROGRAM function on the Cell Summary Display (Appendix G).

APPENDIX B

CELL INITIALIZATION DATA DISPLAY

HEAD SWITCHING PROGRAM

CELL INITIALIZATION DATA

Subject Number	Controller Type	Button Size	Minimum Reaction Time (MSEC)	Start Point Tolerance (DEG)	Rest Period (SEC)	Task Time (SEC)
01 34 67	HMS	1	60	0.50	03	05
02 35 68	JOY	2	70	0.75	04	10
03 36 69		3	80	1.00	05	15
04 37 70			90	1.25	06	20
05 38 71			100		07	25
06 29 72			110		08	30
07 40 73			120		09	35
08 41 74			130		10	40
09 42 75					11	45
10 43 76					12	50
11 44 77					13	55
12 45 78					14	60
13 46 79					15	65
14 47 80					16	70
15 48 81					17	75
16 49 82					18	80
17 50 83					19	85
18 51 84					20	90
19 52 85						
20 53 81						
21 54 87						
22 55 88						
23 56 89						
24 57 90						
25 58 91						
26 59 92						
27 60 93						
28 61 94						
29 62 95						
30 63 96						
31 64 97						
32 65 98						
33 66 99						

* CELL DATA ENTRY COMPLETE

APPENDIX C

ADJUSTMENTS AND CALIBRATIONS DISPLAY

HEAD SWITCHING PROGRAM

ADJUSTMENTS AND CALIBRATIONS

* GALVONOMETER ADJUSTMENTS

    * TARGET ZERO POINT GENERATION
    * TARGET DEFLECTION POINT GENERATION

    * ADJUSTMENTS COMPLETED

* SUBJECT/CONTROLLER CALIBRATIONS

    * ZERO POINT GENERATION
        * INITIATE ZERO POINT SAMPLING

    * DEFLECTION POINT GENERATION
        * INITIATE DEFLECTION POINT SAMPLING

    * CALIBRATIONS COMPLETED

* ADJUSTMENTS AND CALIBRATIONS COMPLETED

APPENDIX D

PRELIMINARY CALIBRATION RESULTS DISPLAY

PRELIMINARY CALIBRATION RESULTS

SUBJECT/CONTROLLER CALIBRATIONS

	ZERO POINT				DEFLECTION POINT			
UNITS	(VOLTS)		(DEGREES)		(VOLTS)		(DEGREES)	
AXIS	X	Y	X	Y	X	Y	X	Y
START			0.000	0.000			7.000	7.000

CALIBRATION FACTOR

X-AXIS		Y-AXIS	
GAIN (DEGREES/VOLT)	POSITION (DEGREES)	GAIN (DEGREES/VOLT)	POSITION (DEGREES)

* CALIBRATION RESULTS SATISFACTORY *

* RECALIBRATE SUBJECT/CONTROLLER *

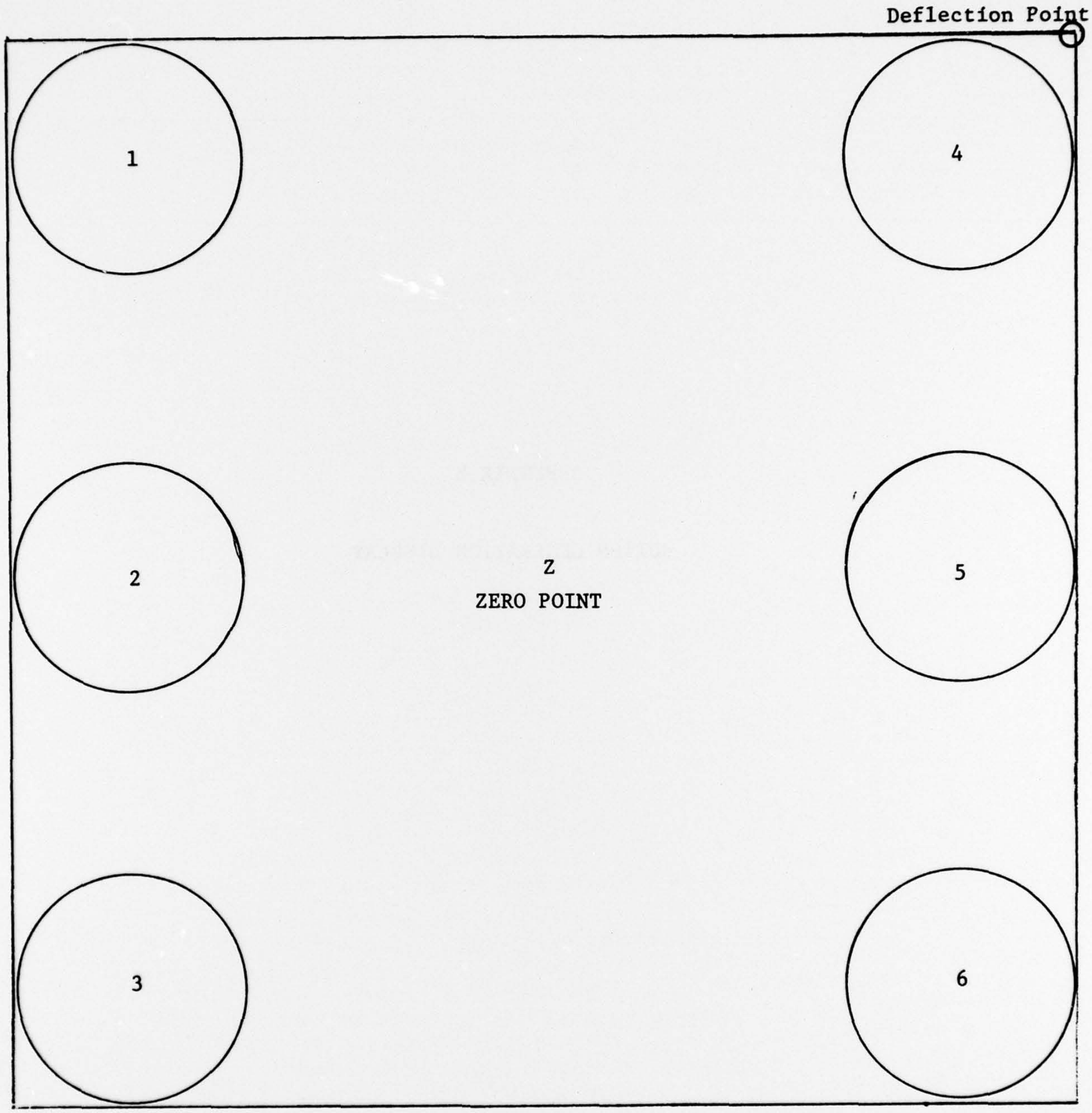
* TERMINATE CELL & RESTART PROGRAM *

* TERMINATE HEAD SWITCHING PROGRAM *

APPENDIX E

BUTTON GENERATION DISPLAY

BUTTON GENERATION



* GENERATE PERFORMANCE MONITOR *

* TERMINATE CELL & RESTART PROGRAM *

* TERMINATE HEAD SWITCHING PROGRAM *

APPENDIX F

REAL-TIME PERFORMANCE MONITOR DISPLAY

HEAD SWITCHING PROGRAM

REAL-TIME PERFORMANCE MONITOR

INITIAL ATTEMPT

PASS PERFORMANCE INFORMATION

PASS NUMBER	PASS COMBINATION	REACT TIME (MSEC)	POSITION TIME (MSEC)	TRIGGER TIME (MSEC)	MOVE TIME (MSEC)	TASK TIME (MSEC)	MISS HITS	GOOD PASS
1	5							
2	24							
3	1							
4	17							
5	11							
6	21							
7	6							
8	12							
9	2							
10	18							
11	10							
12	22							
13	9							
14	13							
15	3							
16	19							
17	15							
18	8							
19	23							
20	14							
21	22							
22	4							
23	20							
24	7							

* INITIATE PASS DATA PRESENTATION *

* TERMINATE CELL & RESTART PROGRAM *

* TERMINATE HEAD SWITCHING PROGRAM *

APPENDIX G

CELL SUMMARY DISPLAY

HEAD SWITCHING PROGRAM
CELL SUMMARY

SUBJECT/CELL INFORMATION

DATA ID NUMBER -	761821339	REACTION MINIMUM -	100 MILSECS
SUBJECT NUMBER -	01	START TOLERANCE -	0.50 DEGREES
BUTTON SIZE -	2	REST PERIOD -	03 SECONDS
CONTROLLER TYPE -	JOY	TASK TIME LIMIT -	20 SECONDS

SUBJECT/CONTROLLER CALIBRATIONS

	ZERO POINT				DEFLECTION POINT			
UNITS	(VOLTS)		(DEGREES)		(VOLTS)		(DEGREES)	
AXIS	X	Y	X	Y	X	Y	X	Y
START	0.248	0.070	0.000	0.000	3.680	3.233	7.000	7.000
FINAL	0.256	0.055	0.018	-0.033	3.671	3.358	6.982	7.275

CALIBRATION FACTOR

X-AXIS		Y-AXIS	
GAIN (DEGREES/VOLT)	POSITION (DEGREES)	GAIN (DEGREES/VOLT)	POSITION (DEGREES)
2.039	-0.505	2.313	-0.155

CELL CALCULATIONS

PASSES WITH MISSES	--	0.042	PERCENT
NUMBER OF MISSES	--	1	ERRORS
MEAN HIT ERROR	--	0.241	DEGREES
MEAN REACTION TIME	--	306	MILLISECONDS
MEAN POSITION TIME	--	906	MILLISECONDS
MEAN TRIGGER TIME	--	1097	MILLISECONDS
MEAN MOVEMENT TIME	--	2003	MILLISECONDS
MEAN TASK TIME	--	2309	MILLISECONDS
STATISTICS FOR	--	24	PASSES

* TERMINATE CELL & RESTART PROGRAM *

* TERMINATE HEAD SWITCHING PROGRAM *

APPENDIX H

PRINTER OUTPUT EXAMPLE

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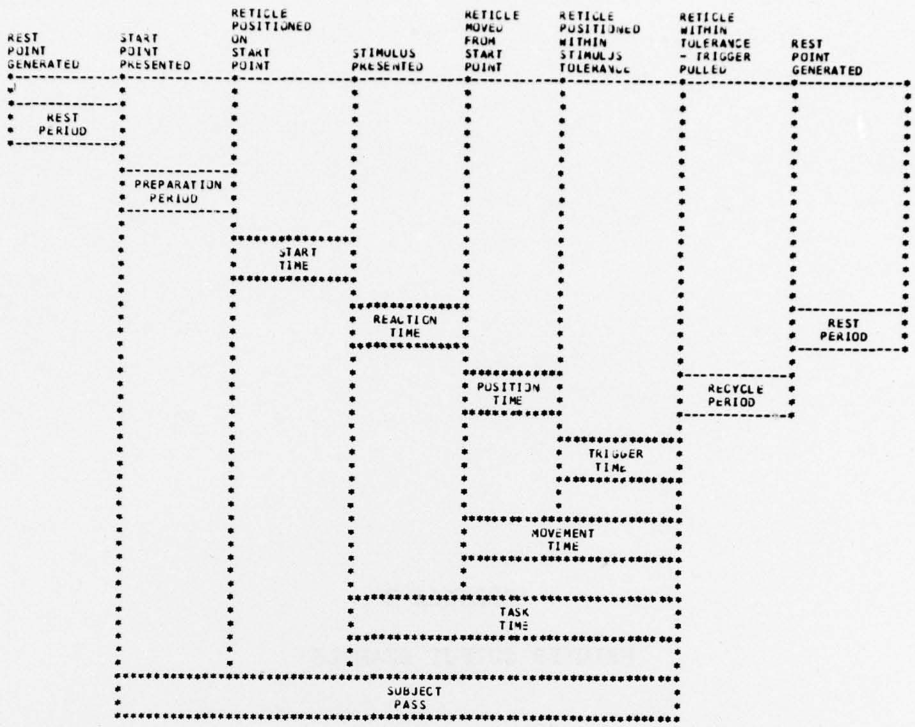
HEAD SWITCHING PASS DIAGRAM



HEAD SWITCHING PASS DATA

INITIAL ATTEMPT

SUBJECT/CELL INFORMATION

DATA ID NUMBER	770601003	REACTION MINIMUM	60 MILSECS
SUBJECT NUMBER	02	START TOLERANCE	1.25 DEGREES
BUTTON SIZE	3	REST PERIOD	03 SECONDS
CONTROLLER TYPE	JOY	TASK TIME LIMIT	60 SECONDS

PREDEFINED PASS CRITERIA							PASS PERFORMANCE MEASUREMENTS							
PASS NUMBER	PASS COMBI-NATION	BUTTON NUMBER	START POINT (DEGREES) X	START POINT (DEGREES) Y	START TIME (SEC)	STIMULUS DISTANCE (DEGREES)	REACTION TIME (MSEC)	POSITION TIME (MSEC)	TRIGGER TIME (MSEC)	MOVEMENT TIME (MSEC)	TASK TIME (MSEC)	MISS HITS	OFF CENTER DISTANCE (DEGREES)	GOOD PASS
1	10	4	0	-1	2	8.51	530	355	675	1030	1560	0	0.213	YES
2	8	2	-1	3	2	5.41	466	253	351	604	1070	0	0.146	YES
3	15	3	5	-2	2	11.07	420	227	523	750	1170	0	0.736	YES
4	5	5	4	-4	2	4.27	139	891	4325	5216	5355	1	0.163	YES
5	4	4	-4	3	1	9.82	329	5868	9835	15703	16032	2	0.228	YES
6	3	3	1	-2	4	7.38	410	412	743	1155	1565	0	0.774	YES
7	7	1	1	0	2	8.51	504	345	783	1128	1632	0	0.276	YES
8	18	6	-3	5	3	13.51	300	826	371	1197	1497	0	0.457	YES
9	19	1	2	5	4	7.52	300	971	491	1462	1762	0	0.343	YES
10	9	3	3	-3	3	8.86	351	167	223	390	741	0	0.489	YES
11	1	1	1	5	3	6.52	354	379	326	705	1059	0	0.318	YES
12	24	6	-1	-5	4	6.52	27	1986	845	2831	2858	0	0.879	NO
13	11	5	2	1	1	3.64	361	122	742	864	1225	0	0.122	YES
14	23	5	-3	-6	3	10.40	2	823	1090	1913	1915	0	0.228	NO
15	16	4	1	3	1	5.15	420	201	908	1109	1529	0	0.129	YES
16	14	2	0	3	4	6.26	3657	34443	461	34904	38561	0	0.099	YES
17	12	6	2	-2	1	4.95	560	67937	1537	69474	70034	0	0.645	NO
18	22	4	0	2	1	6.52	412	799	673	1472	1884	0	0.125	YES
19	6	6	-4	-3	3	9.82	17	1637	1244	2881	2898	0	0.507	NO
20	13	1	-2	2	4	4.95	500	383	1064	1447	1947	0	0.458	YES
21	17	5	4	2	3	2.50	376	39	742	781	1157	0	0.121	YES
22	2	2	-2	-2	2	4.03	421	75	616	591	1112	0	0.480	YES
23	21	3	3	3	1	12.02	1956	313	308	621	2577	0	0.695	YES
24	20	2	0	-3	4	6.26	281	188	450	638	919	0	0.039	YES

HEAD SWITCHING PASS DATA

FINAL ATTEMPT

SUBJECT/CELL INFORMATION

DATA ID NUMBER -	770601003	REACTION MINIMUM -	60 MILSECS
SUBJECT NUMBER -	02	START TOLERANCE -	1.25 DEGREES
BUTTON SIZE -	3	REST PERIOD -	03 SECONDS
CONTROLLER TYPE -	JOY	TASK TIME LIMIT -	60 SECONDS

PREDEFINED PASS CRITERIA							PASS PERFORMANCE MEASUREMENTS								
PASS NUMBER	PASS COMBI-NATION	BUTTON NUMBER	START POINT (DEGREES) X	START POINT (DEGREES) Y	START TIME (SEC)	STIMULUS DISTANCE (DEGREES)	REACTION TIME (MSEC)	POSITION TIME (MSEC)	TRIGGER TIME (MSEC)	MOVEMENT TIME (MSEC)	TASK TIME (MSEC)	MISS HITS	OFF CENTER DISTANCE (DEGREES)	GOOD PASS
12	24	6	-1	-5	4	6.52	1181	402	1096	1498	2679	0	0.982	YES
14	23	5	-3	-6	3	10.40	326	333	586	919	1245	0	0.430	YES
17	12	6	2	-2	1	4.95	375	397	1432	1829	2204	0	0.907	YES
19	6	6	-4	-3	3	9.82	317	334	1054	1388	1705	0	0.319	YES

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HEAD SWITCHING SUMMARY

SUBJECT/CELL INFORMATION

DATA ID NUMBER -	770601003	REACTION MINIMUM -	60 MILSECS
SUBJECT NUMBER -	02	START TOLERANCE -	1.25 DEGREES
BUTTON SIZE -	3	REST PERIOD -	03 SECONDS
CONTROLLER TYPE -	JOY	TASK TIME LIMIT -	60 SECONDS

SUBJECT/CONTROLLER CALIBRATIONS

	ZERO POINT				DEFLECTION POINT			
UNITS	(VOLTS)		(DEGREES)		(VOLTS)		(DEGREES)	
AXIS	X	Y	X	Y	X	Y	X	Y
START	0.070	0.022	0.000	0.000	1.974	1.998	7.000	7.000
FINAL	0.103	0.032	0.123	0.036	1.983	1.999	7.034	7.005

CALIBRATION FACTOR

X-AXIS		Y-AXIS	
GAIN (DEGREES/VOLT)	POSITION (DEGREES)	GAIN (DEGREES/VOLT)	POSITION (DEGREES)
3.677	-0.257	3.543	-0.078

CELL CALCULATIONS

PASSES WITH MISSES	--	8.333 PERCENT
NUMBER OF MISSES	--	3 ERRORS
MEAN HIT ERROR	--	0.377 DEGREES
MEAN REACTION TIME	--	611 MILLISECONDS
MEAN POSITION TIME	--	2030 MILLISECONDS
MEAN TRIGGER TIME	--	1199 MILLISECONDS
MEAN MOVEMENT TIME	--	3229 MILLISECONDS
MEAN TASK TIME	--	3841 MILLISECONDS
STATISTICS FOR	--	24 PASSES

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