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SEP 76 E C WETZLER, L H ZITMAN DOT-FA75WA-3553
UNCLASSIFIED APL/JHU-FP8-E-024-3 FAA-RD-77-12-3 NL

1 OF 2
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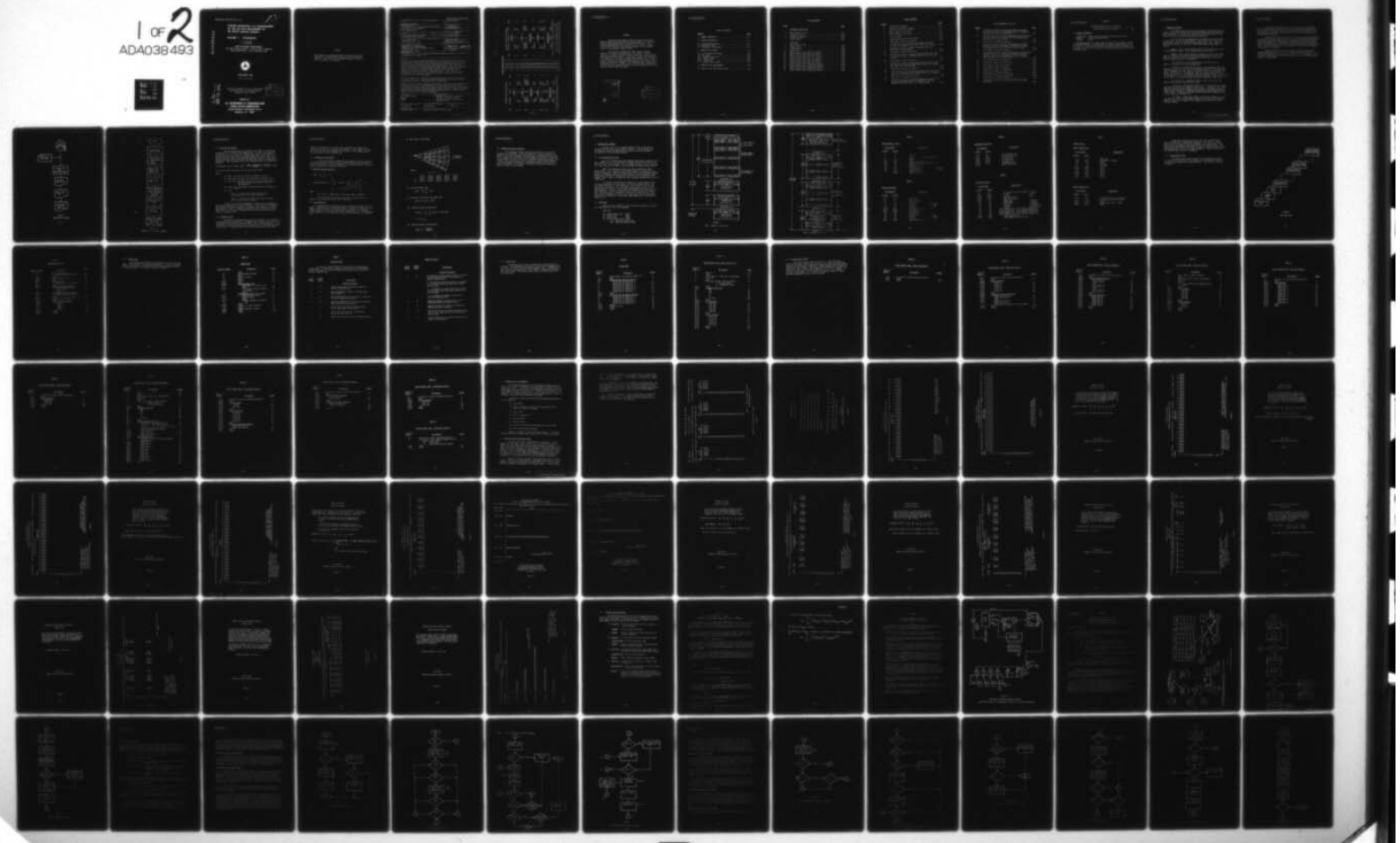

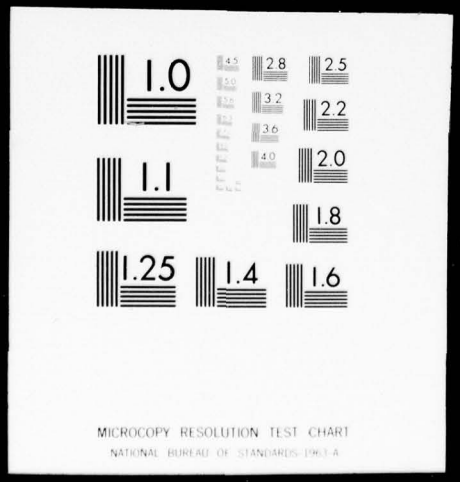

Report No. FAA-RD-77-12, III

12 NW

SYSTEM DEFINITION AND INVESTIGATION OF THE ON SITE PROCESSING OF EN ROUTE SENSOR SIGNALS

VOLUME 3 APPENDICES

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THE JOHNS HOPKINS UNIVERSITY • APPLIED PHYSICS LABORATORY
JOHNS HOPKINS ROAD • LAUREL, MARYLAND • 20810

SEPTEMBER 1976

FINAL REPORT

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
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An Addendum to this work, concerned with beacon ringaround problems, is scheduled for publication in August 1977.

16. Abstract

The objective of this program was twofold: (1) to define requirements from the primary radar system and from the Air Traffic Control Radar Beacon System (ATCRBS) for the en route automation portion of the National Airspace System and (2) to unload the data line from the on-site surveillance system. The primary thrust of this investigation was directed towards the Common Digitizer (CD); the requirements placed on the CD by the Air Route Traffic Control Center's Central Computer Complex, the processing capabilities and limitations of the CD and the requirements the CD places on the surveillance sensors. This report documents the analytical and empirical investigations that were conducted in these areas in support of the stated objectives.

Due to the magnitude of the results of this program, this report has been prepared in three volumes. This volume III contains the appendices which present backup information in support of the Volume I and II discussions.

Volume I consists of (1) a summary of major results, conclusions, and recommendations for the entire program (2) a description of the work accomplished and results obtained in the area of primary radar processing and (3) a discussion of the ATCRBS jitter problem from the overall surveillance system standpoint. Volume II discusses processing of the ATCRBS (secondary radar) information within the Common Digitizer. Volumes I and II are essentially independent.

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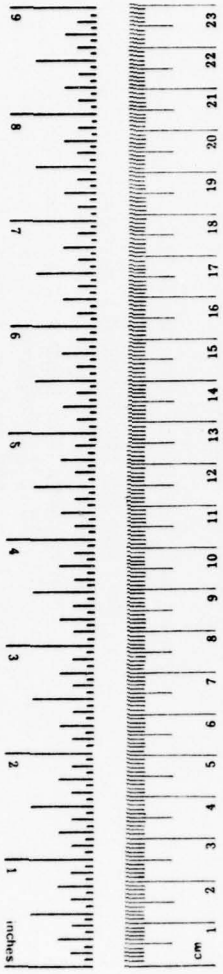
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

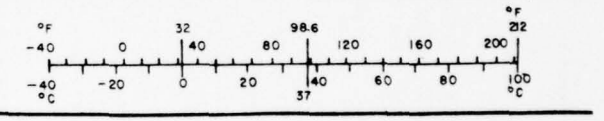
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

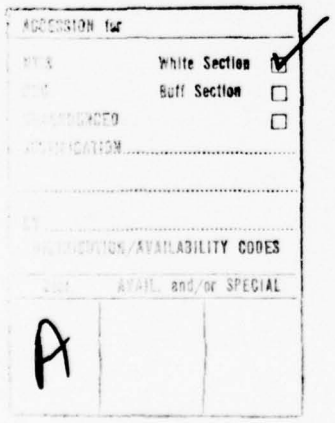


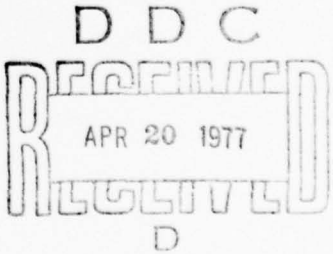
THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
LAUREL MARYLAND

PREFACE

This report describes the work performed by The Johns Hopkins University Applied Physics Laboratory (APL) for the Federal Aviation Administration under contract DOT-FA75WA-3553. The Technical Representative for this effort is Dr. James A. Shannon of Air Traffic Control System Division (ARD-111) of the Systems Research and Development Service (SRDS).

This report is divided into three separate volumes. Volume III contains the appendices for this report. Volume I consists of a summary of major results, conclusions, and recommendations from the entire report. In addition, Volume I also describes work completed in the area of primary radar processing (one exception to this is Section 4.2 which discusses jitter in the beacon system). Volume II discusses processing of the secondary radar (beacon) information within the CD. Volumes I and II are essentially independent so that the reader mainly concerned with beacon processing can concentrate on Volume II and vice versa.





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APPENDIX A

SPECIFICATIONS FOR COMMON DIGITIZER DATA LIST AND ANALYSIS PROGRAM are presented

1. GENERAL INFORMATION

Program Name: Common Digitizer Data List and Analysis Program
Machine: UNIVAC 1230 (AN/USQ-20A)
Language: NELIAC

Task Description: The Common Digitizer Data List and Analysis Program will provide listings of selected MODE 1 and MODE 3 Common Digitizer (CD) "D" machine recorded data and generate selected statistical information of this data. The data will be used in the analysis and evaluation of several CD modifications.

2. PROGRAM DESCRIPTION

The Common Digitizer Data List and Analysis Program will process Common Digitizer "D" machine scan correlation feedback data and target data for CD enhancement test analysis. The program will provide lists of the data and perform statistical calculations on the data.

Four "D" machine recording modes are available for the recording of test data. They are labelled MODE's 1, 2, 3, and 4. The CD Data List and Analysis Program will process only the MODE 1 and 3 data. Only one mode can be recorded for each test. The data recorded in each mode is as follows:

MODE 1 - MODE 1 records Monitor Data for each radar sweep for all 64 azimuth sectors and the first 48 range zones in each sector.

MODE 3 - MODE 3 records Monitor, Accumulator, Control and Target data for 3 selected contiguous sectors and 64 range zones in each sector. The CD is usually operated with a range of about 200 miles, so only the first 48 range zones will be of interest.

The following is a brief description of each data type i.e., Monitor, Accumulator, Control and Target Data.

(1) Monitor - Monitor Data consists of those parameters that are measured in order to select the control quantizer operation. The range zone sum for parameters PN1, PN2, ACE, C1, C2, and Q2 limit is recorded for each sweep. PN1 and PN2 are the quantizer 1 and 2 hit counts, ACE (Automatic Clutter Elimination) is the number of times ACE blanking occurred, C1 and C2 is the number of times clutter was detected for quantizers 1 and 2 respectively, and Q2 limit is the number of times the video to quantizer 2 was limited.

(2) Accumulator - Accumulator Data is equal to the sum of the Monitor Data for each range zone in a sector.

(3) Control - Control Data consists of the Logical Indicator Flags, Quantizer selected and the quantizer gain control. In addition, the Leading Edge (TL) second threshold change is also recorded. The Logical Indicator Flags indicate whether the Accumulator Parameters exceeded maximum/minimum control values, if Manual MTI was selected and whether ACE blanking occurred on the present and previous scan.

(4) Target - Target Data consists of the range, azimuth and target run length for all Beacon and Search targets in three selected contiguous sectors. Only Search targets will be processed by the CD Data List and Analysis Program.

A typical CD enhancement test will consist of a 10 to 20 minute test interval whereby an FR950 radar video tape recording is played into the CD. MODE 1 or 3 data is recorded for the duration of the test so that the processing of the radar video signal by the CD can be analyzed and the CD enhancement evaluated.

Seven Data list options and five statistical options are available to process the recorded data for each test. The program options provide for processing by individual parameters and control over the data base by scan, sector, and range zone. The program is controlled by four sets of input cards; the Identification Card, Control Card, Option Card, and Option Control Cards. A brief description of each option and the card input is presented in paragraph 3.2, Card Input.

Figure 1 presents a basic input/output diagram of the program. Detailed specifications of each of the program inputs and outputs are presented subsequently in the appropriate sections of this document. Figure 2 presents a basic program functional diagram for use as a basic starting guide for the programmer.

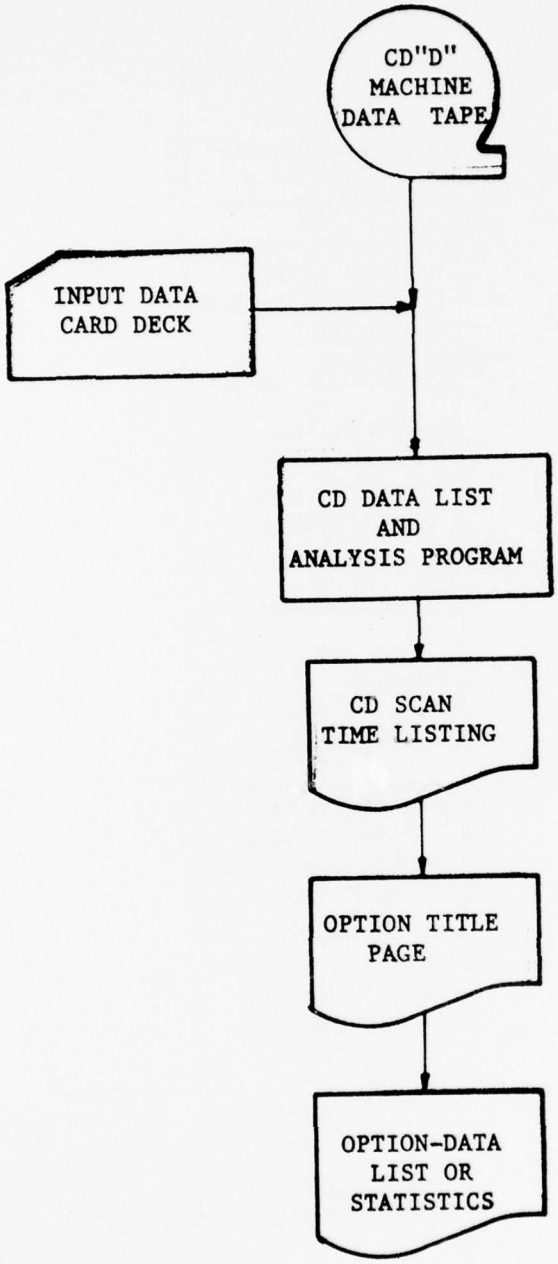


FIGURE 1

INPUT/OUTPUT DIAGRAM

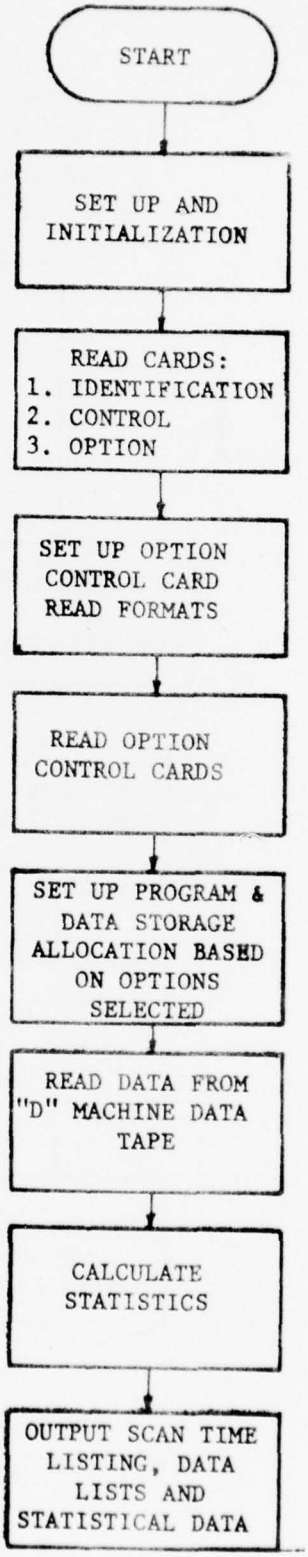


FIGURE 2

GENERALIZED FUNCTIONAL DIAGRAM

2.1 Scan Time Information

Time information must be calculated since there is no time data recorded on the "D" machine data logging tape. In order to provide time information, the scan period, the time and scan number of the reference Azimuth Reference Pulse (ARP), the Azimuth Change Pulse (ACP) count of the ARP, and the scan number of the reference ARP must be known. This information establishes a time reference from which the time of all scans can be calculated. Time information for the two recording modes is calculated as follows:

(1) $$\text{Reference Scan (I) Time} = \text{TARP} + \frac{4096 + (\text{SECTOR ACP} - \text{ARP ACP})}{4096} \text{ TSCAN}$$

(2) Scan (N) Time = Reference Scan (I) Time + (N-I) TSCAN

where:

(a) TARP = The time of the ARP for reference Scan (I)

(b) Reference Scan Time = The scan times of reference scan I.

(c) Scan Time = The time of the first sector recorded (Sector ACP) and the time of that sector for each following scan.

(d) TSCAN = The scan period; the time between the occurrence of ARP's.

(e) Scan:

MODE 1 - A count of 64 records (98,432 words) starting with the first record recorded.

MODE 3 - A count of 6 records (7564 words) starting with the first record recorded.

In order that the time information be valid it will be mandatory that the record/word count not be interrupted. Checks should be established and a method determined to account for bad data. One method for the MODE 1 data would be to count the number of odd/even sectors (records) in a scan. When bit 27 is set (9 track recording) the buffer with data from an even sector is being recorded.

2.2 Accumulator Data

Accumulator Data generated by the CD "D" machine is only recorded for the MODE 3 recording option. Accumulator Data, however, can be calculated from Monitor Data recorded by both the MODE 1 and 3 recording options. It is calculated by summing the Monitor Data by Range Zone for all sweeps occurring in this sector. Accumulator Data calculated from Monitor Data may differ

from that calculated by the CD since some parameters are summed every fourth or sixteenth radar trigger pulse (sweep). If the number of sweeps per sector is less than a multiple of 4 or 16, all of the sweep data will not be included in the accumulator sum.

2.3 Statistical Calculations

Statistical results required for data analysis are the calculation of the mean, standard deviation, autocorrelation and probability density function (histogram) of the data samples. The equations required to perform these calculations are presented as follows:

(1) Mean and Standard Deviation

$$\text{Mean} = \frac{1}{N} \sum_{I=1}^{N} x(I)$$

$$\text{Standard Deviation} = \left[\frac{\sum_{I=1}^{N} (x(I))^2 - \frac{\left(\sum_{I=1}^{N} x(I) \right)^2}{N}}{N-1} \right]^{1/2}$$

where:

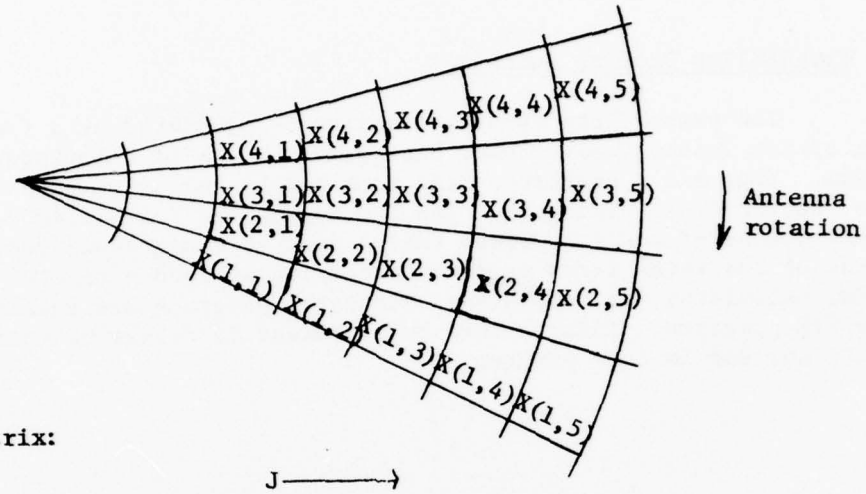
X(I) is the I sample and N is the total number of samples.

Mean and standard deviation calculations are applied to data samples for an individual zone or over a zone area.

(2) Autocorrelation

Autocorrelation calculations will be performed to measure the data sample correlation (Lag) in range and azimuth. Correlation of data on a zone basis or sweep basis (within a sector) will be obtained. The following equations apply for range zone correlation. Reversing the I, J designations in the equations, not the data base, will make them applicable to the azimuth case.

(1) Data sample (zone basis)



Matrix:

J ⟶

I ↓

$\chi(1,1)$	$\chi(1,2)$	$\chi(1,3)$	$\chi(1,4)$	$\chi(1,5)$
$\chi(2,1)$	$\chi(2,2)$	$\chi(2,3)$	$\chi(2,4)$	$\chi(2,5)$
$\chi(3,1)$	$\chi(3,2)$	$\chi(3,3)$	$\chi(3,4)$	$\chi(3,5)$
$\chi(4,1)$	$\chi(4,2)$	$\chi(4,3)$	$\chi(4,4)$	$\chi(4,5)$

(2) Calculate sample mean

$$XM(I) = \frac{1}{N} \sum_{J=1}^{N} \chi(I,J)$$

(3) Calculate Differences from sample mean

$$XD(I,J) = \chi(I,J) - XM(I)$$

(4) Calculate sample autocovariance

$$COV(K,I) = \frac{1}{N} \sum_{J=1}^{N} XD(I,J) * XD(I,J+K)$$

K = 0,4 lag

(5) Calculate sample autocorrelation

$$CORR(K,I) = \frac{COV(K,I)}{COV(0,I)}$$

(3) Probability Density Function

The probability density function is presented by a frequency distribution (histogram). Three histograms are to be calculated by the program. They are a parameter mean zone count, parameter scan zone count, and a target count histogram. The histograms are calculated by determining the number of scans or zones that a parameter magnitude occurred. The percent of the total scans or zones occurring at each parameter magnitude is also calculated and tabulated. Histogram programs are available in other F3E programs. These should be consulted to determine their applicability for use in this program.

3. PROGRAM INPUT FORMATS

The data input to the program consists of the CD "D" Machine Data Tape and the Data Cards as shown in Figure 1. The formats of each of these data inputs and explanations of each of the input parameters are presented in the following sections.

3.1 CD "D" Machine Data Tape

The CD "D" Machine Data Tape contains either MODE 1 or MODE 3 type data. MODE's 2 and 4 type data can be recorded, however, they will not be used for input to this program. The "D" machine can only record in one mode at a time. The specific mode is selected during "D" machine initialization.

MODE 1 recorded data contains only scan correlated feedback Monitor Data. It is recorded for all azimuth sectors, by sweep, for the first 48 range zones. MODE 3 recorded data contains scan correlated feedback Monitor, Accumulator, and Control Data as well as Search and Beacon Target Report Data. The Beacon Target Report Data will not be processed by this program. MODE 3 data is recorded for three contiguous azimuth sectors for 64 range zones.

"D" machine recorded data is grouped on a 9 track magnetic tape in records consisting of 32 bit words. The NELIAC computer has a 30 bit word format and uses a 7 track tape input. The 9 track 32 bit word tape thus must be converted to a 7 track 30 bit word format for input to the NELIAC computer. Figures 3 and 4 present the magnetic tape layout for each recording mode. The first two words of each record are used as a header word. The second word is presently a spare and is loaded with all zero's. The word bit designation for the 9 and 7 track cases for the first header word, Monitor, Accumulator, Control and Target Report Data is presented in Tables 1 to 5.

3.2 Card Input

There are four categories of data cards which together constitute the normal Data Card input to the program.

These are:

(1) Identification Card (ID01)
(2) Control Card (ID02)
(3) Option Card (ID03)
(4) Option Control Cards (ID04)
    (4a) Data List Option Cards
    (4b) Statistical Option Cards

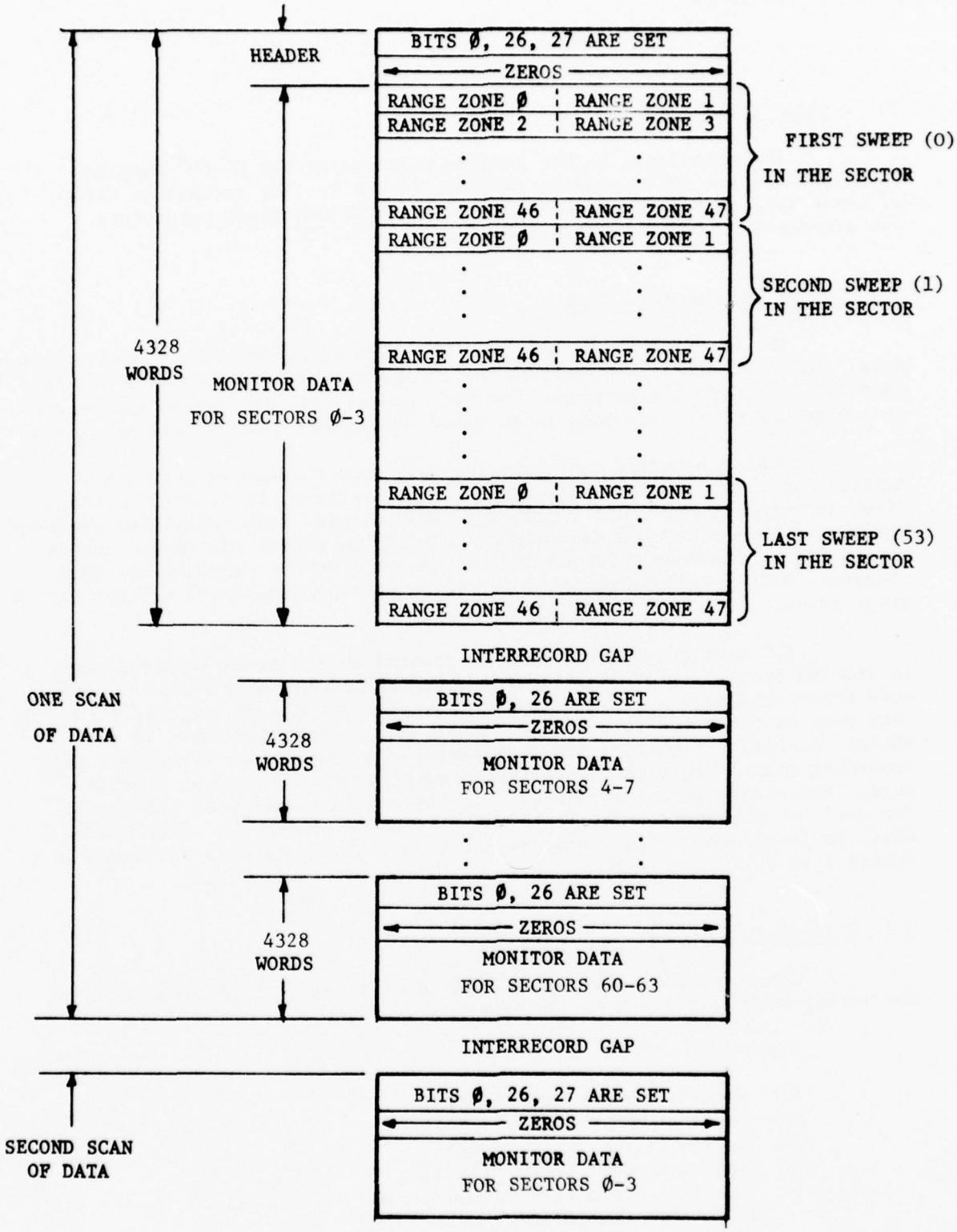


FIGURE 3

MODE 1 MAGNETIC TAPE LAYOUT

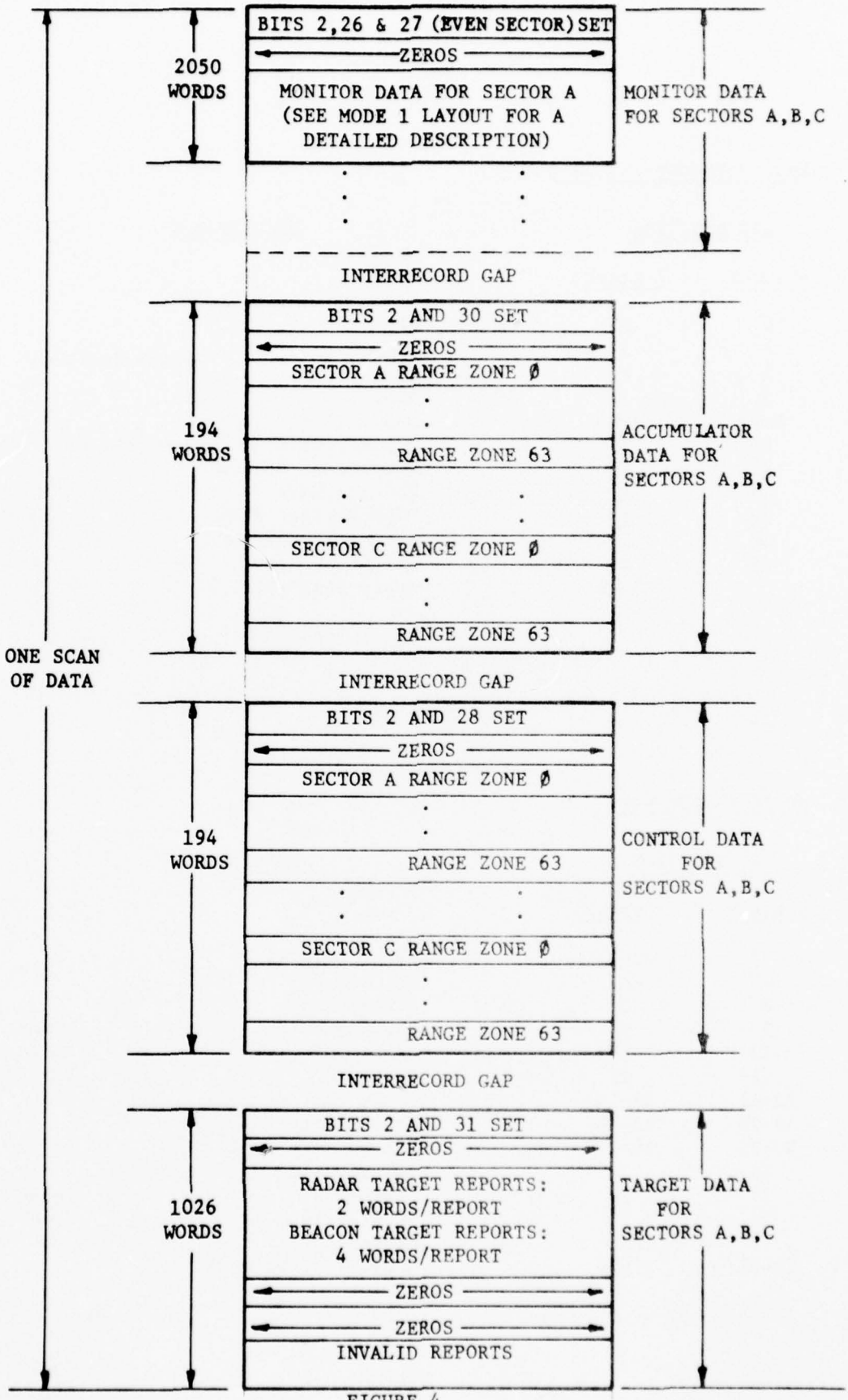


FIGURE 4
MODE 3 MAGNETIC TAPE LAYOUT

TABLE 1

Record Header: Word 1

BIT POSITION		DESCRIPTION	
9 track	7 track		
0	0	Mode 1	Recording Mode
1	1	Mode 2	
2	2	Mode 3	
3	3	Mode 4	
4-25	4-14	Spare (all zero's)	Type of Data
26	15	Monitor Data or Beacon Replies	
27	16	Dumping of Buffer	
28	17	Control Data	
29	18	MODE History File	
30	19	Accumulator Data	
31	20	Target Reports	
	21-29	Spare (all zero's)	

TABLE 2

Monitor Data Word

BIT POSITION		DESCRIPTION	
9 track	7 track		
0-3	0-3	Hit Density 2	Range Zone N+1
4-7	4-7	Hit Density 1	
8	8	ACE Blanking	
9	9	Clutter 2	
10	10	Clutter 1	
11	11	Q2 Limit	
12-15	12-14	Spare (all zero's)	
16-19	15-18	Hit Density 2	Range Zone N
20-23	19-22	Hit Density 1	
24	23	ACE Blanking	
25	24	Clutter 2	
26	25	Clutter 1	
27	26	Q2 Limit	
28-31	27-29	Spare (all zero's)	

TABLE 3

Accumulator Data Word

BIT POSITION		DESCRIPTION
9 track	7 track	
0-7	0-7	Q1 Hit Density Sum
8-15	8-15	Q2 Hit Density Sum
16-19	16-19	Q1 Clutter Sum
20-23	20-23	Q2 Clutter Sum
24-27	24-27	Q2 Limit Sum
28-29	28-29	ACE Blanking Sum
30-31		Spare (all zero's)

TABLE 4

Control Data Word

BIT POSITION		DESCRIPTION	
9 track	7 track		
0-3	0-3	ΔTL (target lead edge change)	Control Passed To CD
4-8	4-8	Q2 Gain	
9-13	9-13	Q1 Gain	
14-15	14-15	Quantizer Select	
16-18	16	Spare (all zero's)	
19	17	Manual MTI	Logical Indicator To Build Controls On The Next Scan
20	18	ACE Blanking	
21	19	Clutter 1	
22	20	Clutter 2	
23	21	Q2 Limit	
24	22	Q1 Hit Density Sum > Q1 Hit Density Maximum Sum	
25	23	Q1 Hit Density Sum < Q1 Hit Density Minimum Sum	
26	24	Q2 Hit Density Sum > Q2 Hit Density Maximum Sum	
27	25	Q2 Hit Density Sum < Q2 Hit Density Minimum Sum	
28-30	26-28	Spare (all zero's)	
31	29	ACE blanking on previous scan	

TABLE 5

Target Reports

Search Target Word 1

BIT POSITION		DESCRIPTION
9 track	7 track	
0	0	MOTE Flag
1-11	1-11	Range (LSB = 1/8 nmi)
12-15	12-14	Zero's
16	15	AF Flag
17	16	FAA Flag
18-19	17-18	Zero's
20-21	19-20	One's
22	21	Zero's
23-24	22-23	One's
25-26	24-25	Zero's
27	26	Test
28-31	27-29	Zero's

Search Target Word 2

BIT POSITION		DESCRIPTION
9 track	7 track	
0-6	0-6	Storage time (LSB = 1/8 second)
7-11	7-11	Run Length, ACP's (LSB = ACP)
12-15	12-13	Zero's
16-27	15-26	Azimuth ACP's (LSB = 1 ACP)
28-31	27-29	Zero's

These data cards must be input in the order specified above. Due to the variation in information required for each option, a unique option card exists for each of the 12 options. The option control cards must be input in numerical order with the Data list options first. The following sections present the formats for each of these data inputs, along with explanations of each of the input parameters. Figure 5 illustrates the required input Data Card arrangement.

3.2.1 Identification Card

The Identification Card contains all the information required to identify the test event to be processed. The Identification Card is the first card included in the input data deck. The format is specified in Table 6.

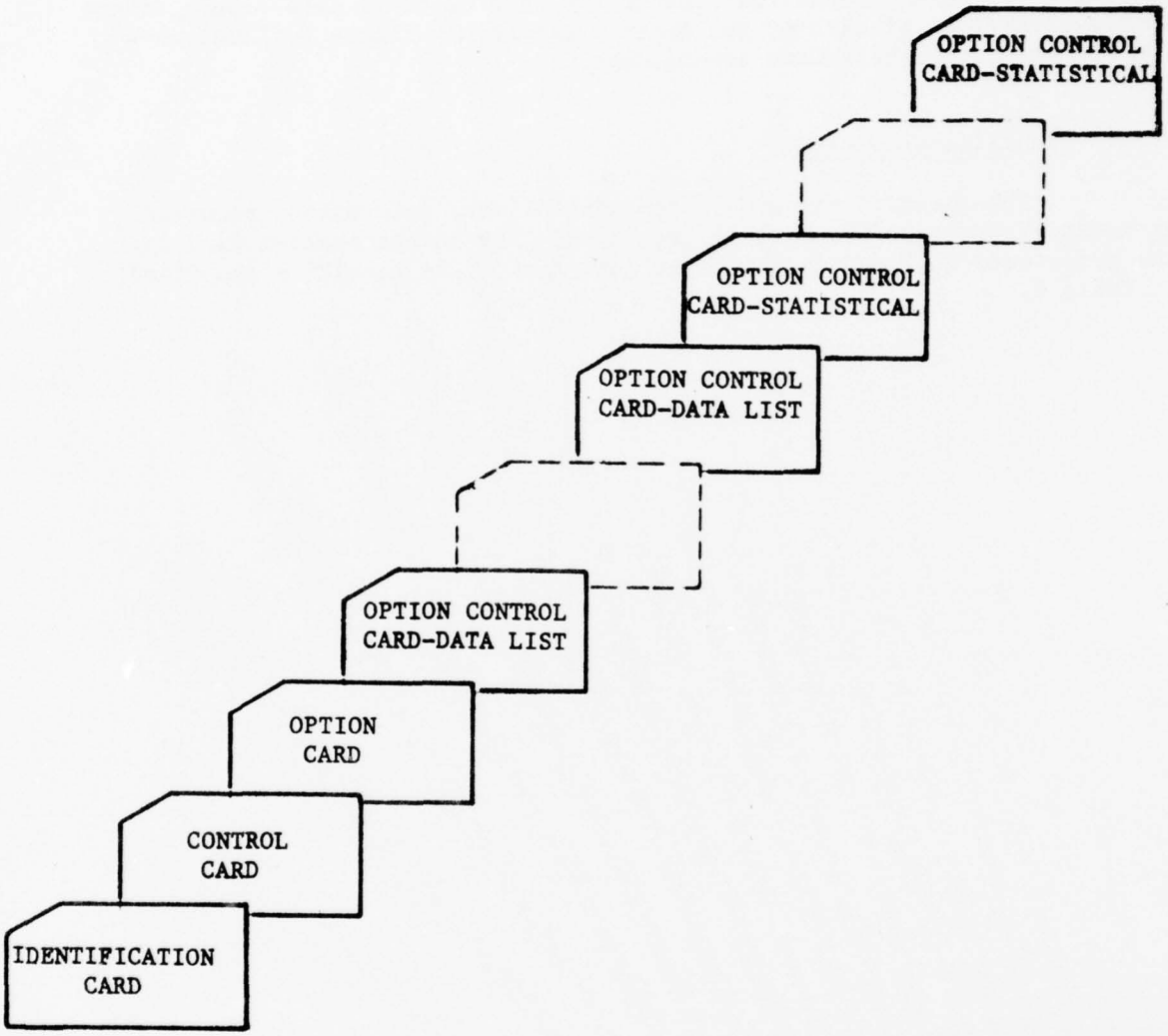


FIGURE 5

DATA CARD INPUT

TABLE 6

IDENTIFICATION CARD

Character Number	Description	Format
1-8	Date of computer run	
	Month, day, year (xx/xx/xx)	H8
9-10	Blank	'2'
11-15	CD Test Number (x.x-x)	H5
16-17	Blank	'2'
18-25	Date of CD Test	
	Month, day, year (xx/xx/xx)	H8
26-27	Blank	'2'
28-32	FR-950 Tape Identification	
	Radar Location (ELW, PR), No. of Tape	H5
33	Blank	'1'
34-41	Date of FR-950 Tape Recording	
	Month, day, year (xx/xx/xx)	H8
42-43	Blank	'2'
44-49	Type of Data Recorded (MODE 1, 3)	H6
50-51	Blank	'2'
52-59	MODE 3 SECTORS RECORDED	
52-53	Sector A	I2
54	Blank	'1'
55-56	Sector B	I2
57	Blank	'1'
58-59	Sector C	I2
60-68	Blank	'9'
69-72	"IDOL"	H4

3.2.2 Control Card

The Control Card contains all information to control the data tape. A time reference is set up and the portion of the tape to be processed is established. The Control Card is the second card included in the input data deck. The format is specified in Table 7.

TABLE 7

CONTROL CARD

Character Number	Description	Format
1	Blank	'1'
2-3	Initial Sector Recorded	I2
4	Blank	'1'
5-6	ARP Sector Number	I2
7	Blank	'1'
8-11	ARP ACP	I4
12-13	Blank	'2'
14-33	Time Reference Setup	
14-16	Scan number of reference time	I3
17	Blank	'1'
18-22	Scan period; seconds, hundreds of seconds	F5
23	Blank	'1'
	Scan Reference Time (Time of ARP)	
24-25	Hours of Day (24 Hours)	I2
26-27	Minutes of Day	I2
28	Blank	'1'
29-33	Seconds, hundreds of seconds of day	F5
34-35	Blank	'2'
36-38	Scan No. to Start Processing	I3
39	Blank	'1'
40-42	Number of Scans to Process	I3
43-68	Blank	'26'
69-72	"ID02"	H4

TABLE 8

PROGRAM OPTIONS

An option is selected when a "1" is placed in the appropriate column number. A blank or zero indicates that the option is not selected. Data list options 5, 6, and 7 and Statistical options 4 and 5 apply only to MODE 3 recorded data.

Option Number	Column Number	Description
		Data List Options
1	10	Monitor Data Range Zone Count per Sweep for a selected sector and scan.
2	11	Monitor/Accumulator Data for a Selected scan for all zones.
3	12	Monitor/Accumulator Data per scan for a selected sector and range zone interval.
4	13	Monitor/Accumulator Data per scan for a selected range zone and sector interval.
5	14	Control Data for a selected scan and sector for all range zones in the sector.
6	15	Control Data per scan for a selected zone (sector xx, range zone xx).
7	16	Target Data per scan for three contiguous sectors.

TABLE 8 (cont'd)

Option Number	Column Number	Description
		Statistical Options
1	30	The selection of this option allows one to select the following suboptions on the Statistical Option 1 Control Card: 1. The mean and Standard Deviation of parameter for a selected sector and range zone interval for all scans. 2. A histogram of parameter zone mean by zones for a selected sector and range zone interval for all scans. 3. A histogram of parameter zone count by scan for a selected zone.
2	31	Range and Azimuth Correlation over a sector (individual sweeps) for Monitor Data.
3	32	Range and Aximuth Correlation of a range zone interval and sector interval.
4	33	Control Data Statistics (mean and Standard Deviation) for all range zones in a selected sector for all scans.
5	34	Target Count and/or Run Length Histogram for all scans for three sectors.

3.2.3 Option Card

The Option Card is used to indicate which options are to be processed. This information is required in order for the program to set up the option control card read format statement order. A definition of each option and the Option Control Card format is presented in Tables 8 and 9 respectively. The Option Control Card is the third card in the input data deck.

TABLE 9

OPTION CARD

Character Number	Description	Format
1	Type of data to be processed (MODE 1,3)	I1
2-9	Blank	'8'
10-23	Option Key for Data List Options	
10	Option Key for Option No. 1	I1
11	Option Key for Option No. 2	I1
12	Option Key for Option No. 3	I1
13	Option Key for Option No. 4	I1
14	Option Key for Option No. 5	I1
15	Option Key for Option No. 6	I1
16	Option Key for Option No. 7	I1
24-29	Blank	'6'
30-34	Option Key for Statistical Options	
30	Option Key for Option No. 1	I1
31	Option Key for Option No. 2	I1
32	Option Key for Option No. 3	I1
33	Option Key for Option No. 4	I1
34	Option Key for Option No. 5	I1
44-49	Blank	'6'
50-52	Histogram Length	I3
53-68	Blank	"16"
69-72	"IDO3"	H4

TABLE 10

OPTION CONTROL CARD - DATA LIST OPTION 1

Character Number	Description	Format
1	MODE 1,3	I1
2	Blank	'1'
3-5	Option Type (1 - Data List, 2-Statistics) Option No.	I3
6	Blank	'1'
7	Data Source (Blank - Does Not Apply) (1 - Monitor Data) (2 - Accumulator Data)	I1
8-9	Blank	'2'
10-15	Parameter Select Key	
10	PN1	I1
11	PN2	I1
12	ACE	I1
13	C1	I1
14	C2	I1
15	Q3 Limit	I1
16-19	Blank	'4'
20-37	Scan Selection	
20-22	Scan xxx	I3
23-25	Scan xxx	I3
26-28	Scan xxx	I3
29-31	Scan xxx	I3
32-34	Scan xxx	I3
35-37	Scan xxx	I3
38-39	Blank	'2'
40-57	Sector Selection	
40-42	Sector xx	I3
43-45	Sector xx	I3
46-48	Sector xx	I3
49-51	Sector xx	I3
52-54	Sector xx	I3
55-57	Sector xx	I3
58-68	Blank	'11'
69-72	"IDO4"	H4

3.2.4 Option Control Cards

The Option Control Cards are last in the input data deck. Option Control Cards selected with the Option Card should be grouped according to the Data List or Statistical Category and be placed in numerical order within each category. The Option Control provides the necessary information to select a particular parameter(s) for listing or analysis and controls the data base to be input from the data tape, i.e., scan(s), sector(s), range zone(s), etc. Tables 10 through 21 present the Option Control Card format for each of the 12 options.

TABLE 11

OPTION CONTROL CARD - DATA LIST OPTION 2

Character Number	Description	Format
1-37	See Table 10, Same as Data List Option 1	
38-68	Blank	'31'
69-72	"IDO4"	H4

TABLE 12

OPTION CONTROL CARD - DATA LIST OPTION 3

Character Number	Description	Format
1-15	See Table 10, Same as Data List Option 1	
16-19	Blank	'4'
20-37	Sector Selection	
20-22	Sector xx	I3
23-25	Sector xx	I3
26-28	Sector xx	I3
29-31	Sector xx	I3
32-34	Sector xx	I3
35-37	Sector xx	I3
38-39	Blank	'2'
40-53	Range Zone Interval Selection	
40-42	Range Zone Start xx	I3
43-45	Range Zone Stop xx	I3
46-47	Blank	'2'
48-50	Range Zone Start xx	I3
51-53	Range Zone Stop xx	I3
	(each interval limited to 24 range zones)	
54-68	Blank	'15'
69-72	"ID04"	H4

TABLE 13

OPTION CONTROL CARD - DATA LIST OPTION 4

Character Number	Description	Format
1-15	See Table 10, Same as Data List Option 1	
16-19	Blank	'4'
20-38	Sector Interval Selection	
20-22	Sector Start xx	I3
23-25	Sector Stop xx	I3
26-27	Blank	'2'
28-30	Sector Start xx	I3
31-33	Sector Stop xx	I3
34-35	Blank	'2'
36-38	Sector Start xx	I3
39-41	Sector Stop xx	I3
42-44	Blank	'3'
45-62	Range Zone Selection	
45-47	Range Zone xx	I3
48-50	Range Zone xx	I3
51-53	Range Zone xx	I3
54-56	Range Zone xx	I3
57-59	Range Zone xx	I3
60-62	Range Zone xx	I3
63-68	Blank	'6'
69-72	"ID04"	H4

TABLE 14

OPTION CONTROL CARD - DATA LIST OPTION 5

Character Number	Description	Format
1	MODE 3 (Does not apply to MODE 1)	I1
2	Blank	'1'
3-5	Option Type (1-Data List, 2-Statistics) Option No.	I3
6	Blank	'1'
7	Data Source (Blank-Does not apply for this option)	I1
8-9	Blank	'2'
10-27	Scan Selection	
10-12	Scan xxx	I3
13-15	Scan xxx	I3
16-18	Scan xxx	I3
19-21	Scan xxx	I3
22-24	Scan xxx	I3
25-27	Scan xxx	I3
28-29	Blank	'2'
30-38	Sector Selection	
30-32	Sector A	I3
33-35	Sector B	I3
36-38	Sector C	I3
39-68	Blank	
69-72	"ID04"	

TABLE 15

OPTION CONTROL CARD - DATA LIST OPTION 6

Character Number	Description	Format
1-7	See Table 14, Same as Data List Option 5	
8-9	Blank	'2'
10-45	Zone Selection	
10-12	Sector xx	I3
13-15	Range Zone xx	I3
16-18	Sector xx	I3
19-21	Range Zone xx	I3
22-24	Sector xx	I3
25-27	Range Zone xx	I3
28-30	Sector xx	I3
31-33	Range Zone xx	I3
34-36	Sector xx	I3
37-39	Range Zone xx	I3
40-42	Sector xx	I3
43-45	Range Zone xx	I3
46-68	Blank	'23'
69-72	"IDO4"	H4

TABLE 16

OPTION CONTROL CARD - DATA LIST OPTION 7

Character Number	Description	Format
1-7	See Table 14, Same as Data List Option 5	
8-9	Blank	'2'
10-18	Sector Selection	
10-12	Sector xx	I3
13-15	Sector xx	I3
16-18	Sector xx	I3
19-68	Blank	'50'
69-72	"IDO4"	H4

TABLE 17

OPTION CONTROL CARD - STATISTICAL OPTION 1

Character Number	Description	Format
1	MODE 1, 3	I1
2	Blank	'1'
3-5	Option Type (1-Data List, 2-Statistics) Option No.	I3
6	Blank	
7	Data Source (Blank - Does not apply) (1-Monitor Data) (2-Accumulator Data)	I1
8-9	Blank	'2'
10-15	Parameter Select Key	
10	PN1	I1
11	PN2	I1
12	ACE	I1
13	C1	I1
14	C2	I1
15	Q3 Limit	I1
16	Blank	'1'
17-31	Option 1 Suboptions A, B, C	
17	Suboption A - Mean and Std. Dev.	I1
18	Suboption B - Mean Count Histogram	I1
19	Suboption C - Scan Zone Count for a Region	I1
	Sector and Range Zone Interval	
20-22	Sector Start xx	I3
23-25	Sector End xx	I3
26-28	Range Zone Start xx	I3
29-31	Range Zone End xx	I3
32-68	Option 1 Suboption 3	
32	Suboption 3 - Scan Zone Count Histogram	I1
	Zone Selection	
33-35	Sector xx	I3
36-38	Range Zone xx	I3
39-41	Sector xx	I3
42-44	Range Zone xx	I3
45-47	Sector xx	I3
48-50	Range Zone	I3
51-53	Sector xx	I3
54-56	Range Zone	I3
57-59	Sector xx	I3
60-62	Range Zone xx	I3
63-65	Sector xx	I3
66-68	Range Zone xx	I3
69-72	"IDO4"	H4

TABLE 18

OPTION CONTROL CARD - STATISTICAL OPTION 2

Character Number	Description	Format
1-15	See Table 17, Same as Statistical Option 1	
16-19	Blank	'4'
20-28	Scan Selection	
20-22	Scan xxx	I3
23-25	Scan xxx	I3
26-28	Scan xxx	I3
29-39	Blank	'11'
40-57	Sector Selection	
40-42	Sector xx	I3
43-45	Sector xx	I3
46-48	Sector xx	I3
49-51	Sector xx	I3
52-54	Sector xx	I3
55-57	Sector xx	I3
58-60	Blank	'3'
61-66	Range Zone Interval Selection	
61-63	Range Zone Start xx	I3
64-66	Range Zone Stop xx	I3
67-68	Blank	'2'
69-72	"IDO4"	H4

TABLE 19

OPTION CONTROL CARD - STATISTICAL OPTION 3

Character Number	Description	Format
1-15	See Table 17, Same as Statistical Option 1	
16-19	Blank	'4'
20-25	Sector Interval Selection	
20-22	Sector Start xx	I3
23-25	Sector End xx	I3
26-29	Blank	'4'
30-35	Range Zone Interval Selection	
30-32	Range Zone Start xx	I3
33-35	Range Zone Stop xx	I3
36-68		'33'
69-72	"IDO4"	H4

TABLE 20

OPTION CONTROL CARD - STATISTICAL OPTION 4

Character Number	Description	Format
1-7	See Table 17, Same as Statistical Option 1	
8-9	Blank	'2'
10-18	Sector Selection	
10-12	Sector xx	I3
13-15	Sector xx	I3
16-18	Sector xx	I3
19-68	Blank	'50'
69-72	"ID04"	H4

TABLE 21

OPTION CONTROL CARD - STATISTICAL OPTION 5

Character Number	Description	Format
1-7	See table 17, Same as Statistical Option 1	
8	Target Count or Run Length Histogram Selection (Blank - Target Count) (1 - Run Length) (2 - Target Count and Run Length)	I1
9-68	Blank	'60'
69-72	"ID04"	H4

4. PROGRAM OUTPUT REQUIREMENTS

The Common Digitizer Data List and Analysis Program will provide to the user output information for seven Data List Options and five Statistical options. In addition to the tabulated data output, there are three graphs (histograms) included in the Statistical data output and numerous Diagnostic/Error message outputs. A title page describing the information to be presented precedes the output of each option. A scan time listing of calculated time information is provided.

Each page of output will contain the following general descriptive information:

(1) Page number

(2) Revision number and revision date of program in the upper left corner of the page

(3) Option title

(4) Date of computer run

(5) CD test number

(6) Date of CD test

(7) Location of FR 950 tape recording and the tape number

(8) Date of FR 950 tape recording

Figures 6 through 34 present the output formats. Those areas requiring additional comments are discussed in the following paragraphs.

4.1 Data List and Statistical Output

All dates are output as month/day/year (xx/xx/xx). The test number x.x-x represents a test, such as 2.3-2. The first two digits present the test number while the last digit indicates a sequence in the test. The location where the FR 950 video tape recording was made and the number of the tape recording is output as xxxxx. A typical output would be ELW 2 or PR 3, representing the Elwood, N. J. or Paso Robles, California radar sites. On title pages those parameters which are available to be processed by the option are listed. Those parameters selected for processing are indicated with an "x" under the respective parameter.

Data List options 1 through 4 and Statistical options 1 through 3 have a variable title depending on the paramenter selected and whether Monitor or Accumulator data was used as the data source. This is represented as xxxxxxxx (xxxxxxxxxxx).in the sample format. A typical output

would be Q2 Limit (Accumulator). Data List options 1, 2, and 3 have a separate output format for the ACE parameter. This was done to save paper. The ACE parameter has a lesser number of digits in its format than the other parameters.

Statistical options 1 and 5 present a histogram output. The histogram can be presented on one or two pages and should be centered about the mean of the parameter. The graph should present at least two standard deviations worth of data. Histogram programs have already been developed by the F3 group. These should be consulted prior to programming the output.

Statistical option 4 (Control Data) presents the mean and standard deviation of all Control Data parameters except for the Quantizer Select parameter. The number of times each quantizer was selected for cumulative scans is presented.

COMMON DIGITIZER SCAN TIME LISTING

DATE: XX/XX/XX TEST: X.X-X, XX/XX/XX FR 950 TAPE: XXXXX, XX/XX/XX

TIME REFERENCE SCAN NO.: XXX TIME OF REFERENCE SCAN: XXXX:XX.XX SCAN PERIOD: XX.XX SECONDS

SCAN NO. TO START PROCESSING: XXX NO. OF SCANS TO BE PROCESSED: XXX

SCAN NO.	TIME (HHMM:SS.SS)	SCAN NO.	TIME (HHMM:SS.SS)	SCAN NO.	TIME (HHMM:SS.SS)	SCAN NO.	TIME (HHMM:SS.SS)
1	XXXX:XX.XX	26	XXXX:XX.XX	51	XXXX:XX.XX	76	XXXX:XX.XX
2	XXXX:XX.XX	27	XXXX:XX.XX	52	XXXX:XX.XX	77	XXXX:XX.XX
3	XXXX:XX.XX	28	XXXX:XX.XX	53	XXXX:XX.XX	78	XXXX:XX.XX
4		29		54		79	
5		30		55		80	
6		31		56		81	
7		32		57		82	
8		33		58		83	
9		34		59		84	
10*		35		60		85	
11		36		61		86	
12		37		62		87	
13		38		63		88	
14		39		64		89	
15**		40		65		90	
16		41		66		91	
17		42		67		92	
18		43		68		93	
19		44		69		94	
20		45		70		95	
21		46		71		96	
22		47		72		97	
23		48		73		98	
24		49		74		99	
25		50		75		100	

NOTE: * SCAN TO START PROCESSING

** TIME REFERENCE SCAN

COMMON DIGITIZER SCAN TIME LISTING

FIGURE 6

COMMON DIGITIZER

DATA LIST OPTION 1

THE FOLLOWING PAGES PRESENT A LISTING OF CD MONITOR DATA FOR A SELECTED SCAN AND SECTOR FOR ALL SWEEPS AND RANGE ZONES IN THE SECTOR. THE DATA WAS OBTAINED FROM CD TEST X.X-X PERFORMED ON XX/XX/XX UTILIZING THE FR 950 VIDEO RECORDING XXXXX, XX/XX/XX. THE DATE OF THIS COMPUTER RUN IS XX/XX/XX.

PARAMETERS SELECTED:	PN1	PN2	ACE	C1	C2	Q2	LIMIT
	X	X	X	X	X		X

SCANS SELECTED: XXX, XXX, XXX, XXX, XXX, XXX

SECTORS SELECTED: XX, XX, XX, XX, XX, XX

TITLE PAGE
COMMON DIGITIZER DATA LIST OPTION 1

FIGURE 7

CD DATA LIST OPTION 1

XXXXXXXX (XXXXXXXXXXX) RANGE ZONE COUNT

DATE: XX/XX/XX DATA SELECTION: SCAN XXX SECTOR XX TEST: X.X-X, XX/XX/XX FR 950 TAPE: XXXXX, XX/XX/XX

SWEEP	RANGE ZONE																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
2	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
3	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
4																								
5																								
6																								
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NOTE: THERE ARE 48 RANGE ZONES. DIVIDE LISTING INTO TWO SECTIONS; 0 TO 23 AND 24 TO 47. LIST ALL SWEEPS UNDER EACH SECTION.

CD DATA LIST OPTION 1; MONITOR DATA - RANGE ZONE COUNT PER SWEEP FOR PARAMETERS PN1, AND PN2

FIGURE 8

CD DATA LIST OPTION 1

ACE (XXXXXXXXXXX) RANGE ZONE COUNT

DATE: XX/XX/XX DATA SELECTION: SCAN XXX SECTOR XX TEST: X.X-X, XX/XX/XX FR 950 TAPE: XXXXX, XX/XX/XX

SWEEP RANGE ZONE

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
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CD DATA LIST OPTION 1; MONITOR
DATA - RANGE ZONE COUNT PER SWEEP
FOR ACE, C1, C2, Q2 LIMIT PARAMETERS

FIGURE 9

COMMON DIGITIZER

DATA LIST OPTION 2

THE FOLLOWING PAGES PRESENT A LISTING OF CD MONITOR/ ACCUMULATOR DATA FOR A SELECTED SCAN FOR ALL ZONES (48 RANGE ZONES BY 64 AZIMUTH SECTORS). THE DATA WAS OBTAINED FROM CD TEST X.X-X PERFORMED ON XX/XX/XX UTILIZING THE FR 950 RECORDING XXXXX, XX/XX/XX. THE DATE OF THIS COMPUTER RUN IS XX/XX/XX.

PARAMETERS SELECTED:	PN1	PN2	ACE	C1	C2	Q2	LIMIT
	X	X	X	X	X	X	

SCANS SELECTED : XXX, XXX, XXX, XXX, XXX, XXX

TITLE PAGE

COMMON DIGITIZER DATA LIST OPTION 2

FIGURE 10

CD DATA LIST OPTION 2

XXXXXXXX (XXXXXXXXXXX) ZONE COUNT

DATE: XX/XX/XX DATA SELECTION: SCAN XXX TEST: X.X-X, XX/XX/XX FR 950 TAPE: XXXXX, XX/XX/XX

SECTOR	RANGE ZONE																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
1	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
2	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
3																								
4																								
5																								
6																								
7																								
8																								
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NOTE: THERE ARE 48 RANGE ZONES. DIVIDE LISTING INTO TWO SECTIONS; 0 TO 23 AND 24 TO 47. LIST ALL SECTORS UNDER EACH SECTION.

CD DATA LIST OPTION 2; MONITOR/ACCUMULATOR DATA - ZONE COUNT FOR A SELECTED SCAN FOR PARAMETERS PN1, PN2, ACE, C1, C2, AND Q2 LIMIT

FIGURE 11

COMMON DIGITIZER

DATA LIST OPTION 3

THE FOLLOWING PAGES PRESENT A LISTING OF CD MONITOR/ACCUMULATOR DATA FOR A SELECTED SECTOR AND RANGE ZONE INTERVAL FOR ALL SCANS. THE DATA WAS OBTAINED FROM CD TEST X.X-X PERFORMED ON XX/XX/XX UTILIZING THE FR 950 VIDEO RECORDING XXXXX, XX/XX/XX. THE DATE OF THIS COMPUTER RUN IS XX/XX/XX.

PARAMETERS SELECTED:	PN1	PN2	ACE	C1	C2	Q2	LIMIT
	X	X	X	X	X	X	

SECTORS SELECTED: XX, XX, XX, XX, XX, XX

RANGE ZONE INTERVALS SELECTED: XX TO XX, XX TO XX (LIMIT TO 24 ZONES PER INTERVAL)

TITLE PAGE

COMMON DIGITIZER DATA LIST OPTION 3

FIGURE 12

CD DATA LIST OPTION 3

XXXXXXXX (XXXXXXXXXXX) ZONE COUNT

DATE: XX/XX/XX DATA SELECTION: SECTOR XX TEST: X.X-X, XX/XX/XX FR 950 TAPE: XXXXX, XX/XX/XX

RANGE ZONE XX TO XX

SCAN	RANGE ZONE																							
	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XXX	XX
1	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
2	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
3	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
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5																								
6																								
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NOTE: TWO RANGE ZONE INTERVALS OF UP TO 24 ZONES FOR EACH INTERVAL CAN BE SELECTED. ALL SCANS SHOULD BE LISTED FOR A GIVEN INTERVAL PRIOR TO THE LISTING OF A NEW INTERVAL.

CD DATA LIST OPTION 3; MONITOR/ ACCUMULATOR DATA - ZONE COUNT FOR A SELECTED SECTOR AND RANGE ZONE INTERVAL FOR PARAMETERS PN1, PN2, ACE, C1, C2, AND Q2 LIMIT

FIGURE 13

COMMON DIGITIZER

DATA LIST OPTION 4

THE FOLLOWING PAGES PRESENT A LISTING OF CD MONITOR/ACCUMULATOR DATA FOR A SELECTED RANGE ZONE FOR ALL SCANS AND FOR SELECTED SECTOR INTERVALS IN THE RANGE ZONE. THE DATA WAS OBTAINED FROM CD TEST X.X-X PERFORMED ON XX/XX/XX UTILIZING THE FR950 VIDEO RECORDING XXXXX, XX/XX/SS. THE DATE OF THIS COMPUTER RUN IS XX/XX/XX.

PARAMETERS SELECTED:	PN1	PN2	ACE	C1	C2	Q2	LIMIT
	X	X	X	X	X		X

RANGE ZONES SELECTED: XX, XX, XX, XX, XX, XX

SECTOR INTERVALS SELECTED: XX TO XX, XX TO XX, XX TO XX
SECTOR INTERVALS ARE LIMITED TO 24 SECTORS DUE TO OUTPUT FORMAT LIMITATION.

TITLE PAGE

COMMON DIGITIZER DATA LIST OPTION 4

FIGURE 14

CD DATA LIST OPTION 4

XXXXXXXX (XXXXXXXXXXX) ZONE COUNT

DATE: XX/XX/XX DATA SELECTION: RANGE ZONE XX TEST: X.X-X, XX/XX/XX FR 950 TAPE: XXXXX, XX/XX/XX
SECTOR XX TO XX

SCAN	SECTOR																							
	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
1	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
2	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
3	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
4																								
5																								
6																								
7																								
8																								
9																								
10																								
11																								
12																								
13																								
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..																								
..																								
30																								

NOTE: THREE SECTOR INTERVALS OF UP TO 24 SECTORS FOR EACH INTERVAL CAN BE SELECTED. ALL SCANS SHOULD BE LISTED FOR A GIVEN INTERVAL PRIOR TO THE LISTING OF A NEW INTERVAL.

CD DATA LIST OPTION 4; MONITOR/ ACCUMULATOR DATA - ZONE COUNT FOR A SELECTED RANGE ZONE AND SECTOR INTERVAL FOR PARAMETERS PN1, PN2, ACE, C1, C2, AND Q2 LIMIT

FIGURE 15

COMMON DIGITIZER

STATISTICS OPTION 1

THE FOLLOWING PAGES PRESENT STATISTICS FOR ANALYSIS OF MONITOR/ ACCUMULATOR DATA. PARAMETERS PN1, PN2, ACE, C1, C2, AND Q2 LIMIT. THREE STATISTICAL PRESENTATIONS CAN BE SELECTED. THEY ARE:

1. THE MEAN AND STANDARD DEVIATION OF PARAMETER FOR A SELECTED SECTOR AND RANGE ZONE INTERVAL FOR ALL SCANS.

2. A HISTOGRAM OF PARAMETER ZONE MEAN BY ZONES FOR A SELECTED SECTOR AND RANGE ZONE INTERVAL FOR ALL SCANS.

3. A HISTOGRAM OF PARAMETER ZONE COUNT BY SCAN FOR A SELECTED ZONE.

PARAMETER SELECTED:	PN1	PN2	ACE	C1	C2	Q2 LIMIT
	X	X	X	X	X	X

STATISTIC SELECTED:	1	2	SECTOR XX TO XX	3	ZONES (XX,XX) (XX,XX) (XX,XX)
	X	X	RANGE ZONE XX TO XX	X	

NOTE:

ZONE (XX,XX) = ZONE (SECTOR, RANGE ZONE)

TITLE PAGE

COMMON DIGITIZER STATISTICS OPTION 1

FIGURE 16

CD STATISTICS OPTION 1

XXXXXXXX (XXXXXXXXXXX) ZONE COUNT

(STANDARD MEAN DEVIATION)

DATE: XX/XX/XX DATA SELECT:XXX SCANS, SECTOR XX TO XX TEST: X.X-X,XX/XX/XX FR950 TAPE: XXXXX, XX/XX/XX
RANGE ZONE XX TO XX

SECTOR	RANGE ZONE											
	0	1	2	3	4	5	6	7	8	9	10	11
0	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)
1	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)	XXX (XX.X)
2												
3												
4												
5												
6												
7												
8												
9												
..												
15												

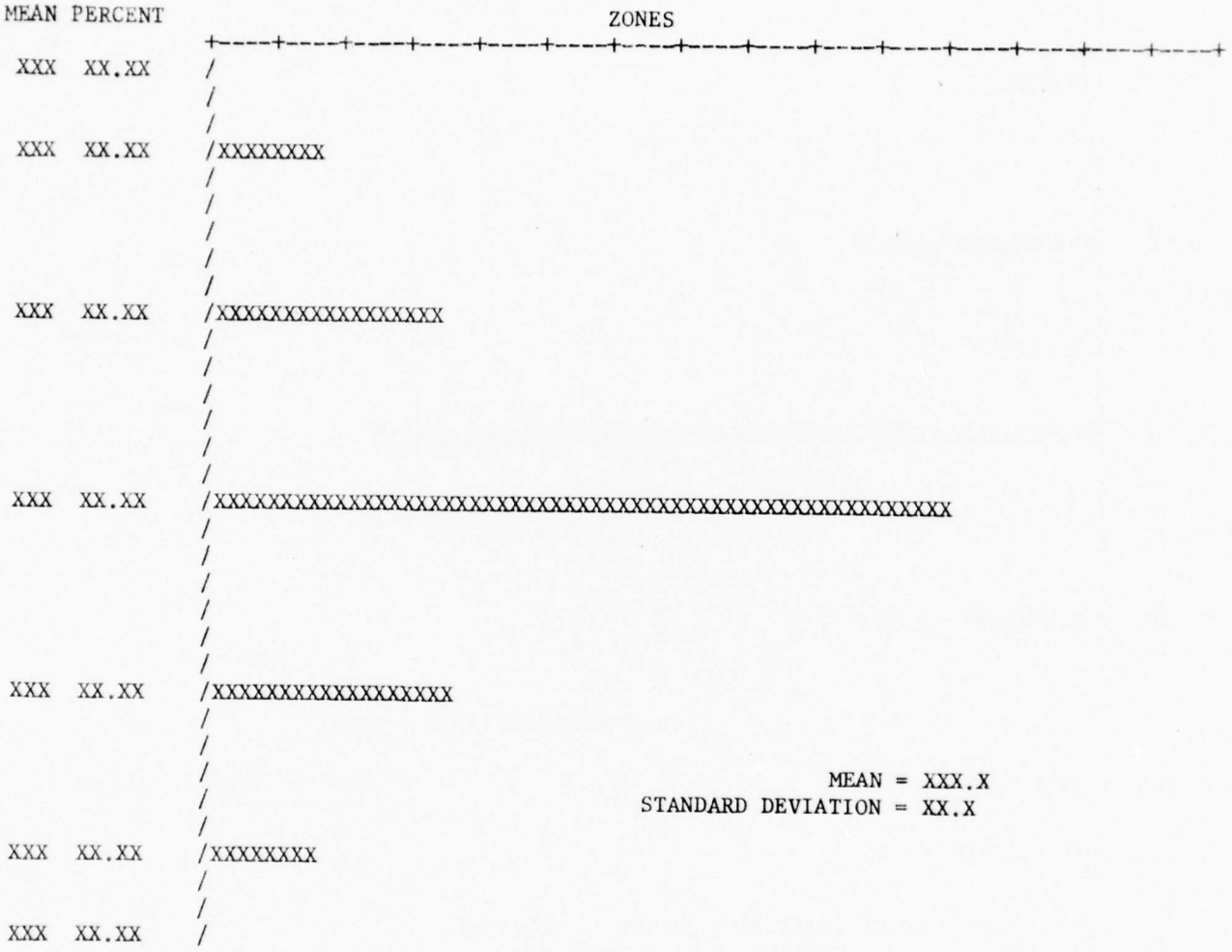
NOTE: THERE ARE 48 RANGE ZONES AND 64 SECTORS. LIST ALL SECTORS PRIOR TO REPEATING THE NEXT SET OF 12 RANGE ZONES.

CD STATISTICS OPTION 1; MONITOR/ ACCUMULATOR DATA ZONE COUNT MEAN AND STANDARD DEVIATION FOR CUMULATIVE SCANS FOR PARAMETERS PN1, PN2, ACE, C1, C2, AND Q2 LIMIT

FIGURE 17

CD STATISTICS OPTION 1
XXXXXXXX (XXXXXXXXXXX) MEAN ZONE COUNT HISTOGRAM

DATE: XX/XX/XX DATA SELECT:XXX SCANS SECTOR XX TO XX TEST: X.X-X,XX/XX/XX FR950 TAPE:XXXXX,XX/XX/XX
RANGE ZONE XX TO XX



CD STATISTICS OPTION 1; MONITOR/ ACCUMULATOR DATA MEAN ZONE COUNT HISTOGRAM FOR CUMULATIVE SCANS FOR PARAMETERS PN1, PN2, ACE, C1, C2, AND Q2 LIMIT.

FIGURE 18

```
                         CD STATISTICS OPTION 1
              XXXXXXXX (XXXXXXXXXXX) SCAN ZONE COUNT HISTOGRAM

DATE: XX/XX/XX DATA SELECT:XXX SCANS, ZONE (XX,XX) TEST: X.X-X, XX/XX/XX FR950 TAPE: XXXXX,XX/XX/XX

 COUNT PERCENT                          SCANS
               +----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+---+
 XXX   XX.XX   /
               /
               /
               /
               /
 XXX   XX.XX   /XXXXXXXX
               /
               /
               /
               /
               /
 XXX   XX.XX   /XXXXXXXXXXXXXXXXXX
               /
               /
               /
               /
               /
               /
 XXX   XX.XX   /XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
               /
               /
               /
               /
               /
               /
 XXX   XX.XX   /XXXXXXXXXXXXXXXXXX
               /
               /                                      MEAN = XXX.X
               /                        STANDARD DEVIATION = XX.X
               /
               /
 XXX   XX.XX   /XXXXXXXX
               /
               /
               /
```

CD STATISTICS OPTION 1; MONITOR/
ACCUMULATOR DATA ZONE COUNT
HISTOGRAM FOR A SELECTED ZONE FOR
PARAMETERS PN1, PN2, ACE, C1, C2, AND
Q2 LIMIT.

FIGURE 19

COMMON DIGITIZER

STATISTICS OPTION 2

THE FOLLOWING PAGES PRESENT STATISTICS FOR THE RANGE AND AZIMUTH CORRELATION ANALYSIS OF A SECTOR BY SWEEPS OVER A RANGE INTERVAL FOR PARAMETERS PN1, PN2, ACE, C1, C2, AND Q2 LIMIT.

PARAMETERS SELECTED:	PN1	PN2	ACE	C1	C2	Q2 LIMIT
	X	X	X	X	X	X

SCAN SELECTED: XXX, XXX, XXX

RANGE ZONE INTERVAL: XX TO XX (INTERVAL OF 30 ZONES OR LESS)

SECTORS SELECTED: XX, XX, XX, XX, XX, XX

TITLE PAGE

COMMON DIGITIZER STATISTICS OPTION 2

FIGURE 20

CD STATISTICS OPTION 2
XXXXXXXX (XXXXXXXXXXX) RANGE ZONE COUNT RANGE ANALYSIS

DATE: XX/XX/XX DATA SELECTION: SCAN XXX SECTOR XX TEST: X.X-X, XX/XX/XX FR 950 TAPE: XXXXX, XX/XX/XX
RANGE ZONES XX TO XX

SWEEP	MEAN	AUTOCOVARIANCE LAG					AUTOCORRELATION LAG			
		0	1	2	3	4	1	2	3	4
1	XXX	XXX.X	XXX.X	XXX.X	XXX.X	XXX.X	±XXX.X	±XXX.X	±XXX.X	±XXX.X
2	XXX	XXX.X	XXX.X	XXX.X	XXX.X	XXX.X	±XXX.X	±XXX.X	±XXX.X	±XXX.X
3	XXX	XXX.X	XXX.X	XXX.X	XXX.X	XXX.X	±XXX.X	±XXX.X	±XXX.X	±XXX.X
4										
5										
6										
7										
8										
9										
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11										
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16										
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20										
21										
..										
..										
30										

NOTE: THE FIGURE ILLUSTRATES RANGE ANALYSIS. FOR AZIMUTH ANALYSIS, REPLACE "RANGE ANALYSIS" WITH "AZIMUTH ANALYSIS" IN TITLE AND CHANGE "SWEEP" LISTING TO "RANGE ZONES".

CD STATISTICS OPTION 2; MONITOR DATA - RANGE AND AZIMUTH ANALYSIS OF A SECTOR AND RANGE ZONE INTERVAL BY SWEEPS FOR PARAMETERS PN1, PN2, ACE, C1, C2, AND Q2 LIMIT.

FIGURE 21

COMMON DIGITIZER

STATISTICS OPTION 3

THE FOLLOWING PAGES PRESENT STATISTICS FOR THE RANGE AND AZIMUTH CORRELATION ANALYSIS OF A RANGE ZONE AND SECTOR INTERVAL FOR CUMULATIVE SWEEPS FOR MONITOR/ACCUMULATOR PARAMETERS PN1, PN2, ACE, C1, C2, AND Q2 LIMIT.

PARAMETERS SELECTED:	PN1	PN2	ACE	C1	C2	Q2 LIMIT
	X	X	X	X	X	X

RANGE ZONE INTERVAL: XX TO XX (INTERVAL OF 16 ZONES OR LESS)

SECTOR INTERVAL: XX TO XX (INTERVAL OF 16 SECTORS OR LESS)

TITLE PAGE

COMMON DIGITIZER STATISTICS OPTION 3

FIGURE 22

CD STATISTICS OPTION 3

XXXXXXXX (XXXXXXXXXXX) MEAN ZONE COUNT RANGE ANALYSIS

DATE: XX/XX/XX DATA SELECTION: XXX SCANS TEST: X.X-X, XX/XX/XX FR950 TAPE: XXXXX, XX/XX/XX
SECTOR INTERVAL XX TO XX
RANGE INTERVAL XX TO XX

SECTOR	MEAN	AUTOCOVARIANCE LAG					AUTOCORRELATION LAG			
		0	1	2	3	4	1	2	3	4
XX	XXX	XXX.X	XXX.X	XXX.X	XXX.X	XXX.X	±XXX.X	±XXX.X	±XXX.X	±XXX.X
XX	XXX	XXX.X	XXX.X	XXX.X	XXX.X	XXX.X	±XXX.X	±XXX.X	±XXX.X	±XXX.X
XX	XXX	XXX.X	XXX.X	XXX.X	XXX.X	XXX.X	±XXX.X	±XXX.X	±XXX.X	±XXX.X
XX										
XX										
XX										
XX										
XX										
XX										
XX										
XX										
XX										
XX										
XX										
XX										

NOTE: THE FIGURE ILLUSTRATES RANGE ANALYSIS. FOR AZIMUTH ANALYSIS, REPLACE "RANGE ANALYSIS" WITH "AZIMUTH ANALYSIS" IN TITLE AND CHANGE "SECTOR" TO "RANGE ZONE" IN LISTING.

CD STATISTICS OPTION 3; MONITOR/ACCUMULATOR DATA RANGE AND AZIMUTH ANALYSIS OF A RANGE ZONE INTERVAL AND SECTOR INTERVAL (ZONE AREA) FOR CUMULATIVE SCANS FOR PARAMETER PN1, PN2, ACE, C1, C2, AND Q2 LIMIT.

FIGURE 23

COMMON DIGITIZER DATA LIST OPTION 5

CONTROL DATA

THE FOLLOWING PAGES PRESENT A LISTING OF CD CONTROL DATA FOR A SELECTED SCAN AND SECTOR FOR ALL RANGE ZONES IN THE SECTOR. THE DATA WAS OBTAINED FROM CD TEST X.X-X PERFORMED ON XX/XX/XX UTILIZING THE FR 950 VIDEO RECORDING XXXXX, XX/XX/XX. THE DATE OF THIS COMPUTER RUN IS XX/XX/XX.

SCANS SELECTED: XXX, XXX, XXX, XXX, XXX, XXX

SECTORS SELECTED: XX, XX, XX

TITLE PAGE

COMMON DIGITIZER DATA LIST OPTION 5

FIGURE 24

CD DATA LIST OPTION 5

CONTROL DATA

DATE: XX/XX/XX DATA SELECTION: SCAN XXX SECTOR XX TEST: X.X-X, XX/XX/XX FR 950 TAPE: XXXXX, XX/XX/XX

	LOGICAL INDICATOR FLAGS										CD CONTROLS			
ZONE	ACE1	H2MIN	H2MAX	H1MIN	H1MAX	Q2 LIMIT	C1	C2	ACE	MAN MTI	Q SELECT	GAIN Q1	GAIN Q2	DELTA TL
0	X	X	X	X	X	X	X	X	X	X	XXX	XX	XX	X
1	X	X	X	X	X	X	X	X	X	X	XXX	XX	XX	X
2	X	X	X	X	X	X	X	X	X	X	XXX	XX	XX	X
3														
4														
5														
6														
7														
8														
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19														
20														
21														
22														
23														

NOTE: TO CHANGE FORMAT TO DATA LIST OPTION 6
MODIFY THE TITLE, DATA SELECTION
AND LISTING AS FOLLOWS:

1. TITLE: CD DATA LIST OPTION 6
2. DATA SELECTION: SECTOR XX ZONE XX
3. ZONE: SCAN

CD DATA LIST OPTION 5
CONTROL DATA

FIGURE 25

COMMON DIGITIZER DATA LIST OPTION 6

CONTROL DATA

THE FOLLOWING PAGES PRESENT A LISTING OF CD MODE 3 CONTROL DATA FOR A SELECTED ZONE (SECTOR XX, RANGE ZONE XX) FOR EACH SCAN. THE DATA WAS OBTAINED FROM CD TEST X.X-X, PERFORMED ON XX/XX/XX UTILIZING THE FR 950 VIDEO RECORDING XXXXX, XX/XX/XX. THE DATE OF THIS COMPUTER RUN IS XX/XX/XX.

ZONES SELECTED: (XX,XX) (XX,XX) (XX,XX)
(XX,XX) (XX,XX) (XX,XX)

NOTE: ZONE (XX,XX) = ZONE (SECTOR XX, RANGE ZONE XX)

TITLE PAGE

COMMON DIGITIZER DATA LIST OPTION 6

FIGURE 26

COMMON DIGITIZER DATA LIST OPTION 7

TARGET DATA

THE FOLLOWING PAGES PRESENT A LISTING OF CD MODE 3
TARGET DATA FOR THREE SECTORS FOR EACH SCAN.
THE DATA WAS OBTAINED FROM CD TEST X.X-X, PERFORMED
ON XX/XX/XX UTILIZING THE FR 950 VIDEO RECORDING
XXXXX, XX/XX/XX. THE DATE OF THIS COMPUTER RUN
IS XX/XX/XX.

SECTORS SELECTED: XX, XX, XX

TITLE PAGE

COMMON DIGITIZER DATA LIST OPTION 7

FIGURE 27

CD DATA LIST OPTION 7

TARGET DATA

DATE: XX/XX/XX DATA SELECTION: SECTORS XX, XX, XX TEST: X.X-X, XX/XX/XX FR950 TAPE: XXXXX, XX/XX/XX

LIST	SCAN	---RANGE----- (NMI)	(ZONE)	----AZIMUTH---- (DEGREES)	(ACP)	RUN LENGTH (ACP)
1	XX	XXX.XXX	XX	XXX.XXX	XXXX	XXX
2	XX	XXX.XXX	XX	XXX.XXX	XXXX	XXX
3	XX	XXX.XXX	XX	XXX.XXX	XXXX	XXX
4						
5						
6						
7						
8						
9						
10						
1	XX	XXX.XXX	XX	XXX.XXX	XXXX	XXX
2	XX	XXX.XXX	XX	XXX.XXX	XXXX	XXX
3	XX	XXX.XXX	XX	XXX.XXX	XXXX	XXX
4						
5						
6						
7						
8						
9						
10						

NOTE: LIST IS NOT A TARGET NUMBER.

NOTE: LIMIT LIST TO 30 LINES PER PAGE. INITIALIZE LIST COUNT FOR EACH SCAN. THERE WILL BE APPROXIMATELY 10 TARGETS FOR EACH SCAN OVER THE THREE SECTORS.

CD DATA LIST OPTION 7

TARGET DATA

FIGURE 28

COMMON DIGITIZER STATISTICS OPTION 4

CONTROL DATA

THE FOLLOWING PAGES PRESENT A LISTING OF CD MODE 3 CONTROL DATA STATISTICS FOR ALL ZONES IN A SELECTED SECTOR FOR ALL SCANS. THE STATISTICS PRESENT, FOR EACH ZONE, THE NUMBER OF SCANS EACH QUANTIZER WAS SELECTED, THE MEAN AND STANDARD DEVIATION OF THE NUMBER OF SCANS EACH LOGICAL INDICATOR FLAG WAS SET, AND THE MEAN AND STANDARD DEVIATION OF THE QUANTIZER FEEDBACK GAIN WORDS AND DELTA TL VALUE FOR ALL SCANS.

THE DATA WAS OBTAINED FROM CD TEST X.X-X, PERFORMED ON XX/XX/XX UTILIZING THE FR 950 VIDEO RECORDING XXXXX, XX/XX/XX. THE DATE OF THIS COMPUTER RUN IS XX/XX/XX.

SECTORS SELECTED: XX, XX, XX

TITLE PAGE

COMMON DIGITIZER STATISTICS OPTION 4

FIGURE 29

CD STATISTICS OPTION 4

CONTROL DATA

MEAN
(STANDARD DEVIATION)

DATE: XX/XX/XX DATA SELECT: XXX SCANS, SECTOR XX TEST: X.X-X, XX/XX/XX FR 950 TAPE: XXXXX, XX/XX/XX

	LOGICAL INDICATOR FLAGS										CD CONTROLS						
											Q SELECT (SCANS)						
						Q2				MAN	---Q1---		---Q2---		---GAIN--		DELTA
ZONE	ACE1	H2MIN	H2MAX	H1MIN	H1MAX	LIMIT	C1	C2	ACE	MTI	T	C	T	C	Q1	Q2	TL
0	X.X	X.X	X.X	X.X	X.X	X.X	X.X	X.X	X.X	X.X	XX	XX	XX	XX	XX.X	XX.X	X.X
	(.X)	(.X)	(.X)	(.X)	(.X)	(.X)	(.X)	(.X)	(.X)	(.X)					(X.X)	(X.X)	(.X)
1	X.X	X.X	X.X	X.X	X.X	X.X	X.X	X.X	X.X	X.X	XX	XX	XX	XX	XX.X	XX.X	X.X
	(.X)	(.X)	(.X)	(.X)	(.X)	(.X)	(.X)	(.X)	(.X)	(.X)					(X.X)	(X.X)	(.X)
2	X.X	X.X	X.X	X.X	X.X	X.X	X.X	X.X	X.X	X.X	XX	XX	XX	XX	XX.X	XX.X	X.X
	(.X)	(.X)	(.X)	(.X)	(.X)	(.X)	(.X)	(.X)	(.X)	(.X)					(X.X)	(X.X)	(.X)
3																	
4																	
5																	
6																	

CD STATISTICS OPTION 4

CONTROL DATA

FIGURE 30

COMMON DIGITIZER STATISTICS OPTION 5

TARGET COUNT HISTOGRAM

THE FOLLOWING PAGES PRESENT A TARGET COUNT AND/OR RUN LENGTH HISTOGRAM FOR ALL SCANS FOR THREE SELECTED SECTORS. THE DATA WAS OBTAINED FROM CD TEST X X.X-X, PERFORMED ON XX/XX/XX UTILIZING THE FR 950 VIDEO RECORDING XXXXX, XX/XX/XX. THE DATE OF THIS COMPUTER RUN IS XX/XX/XX.

SECTORS SELECTED: XX, XX, XX

TITLE PAGE

COMMON DIGITIZER STATISTICS OPTION 5

FIGURE 31

CD STATISTICS OPTION 5

TARGET COUNT HISTOGRAM

DATE: XX/XX/XX DATA SELECTION: XXX SCANS TEST: X.X-X, XX/XX/XX FR950 TAPE: XXXXX, XX/XX/XX
SECTORS XX,XX,XX

NOTE: THIS FIGURE ILLUSTRATES THE TARGET COUNT HISTOGRAM. TO OBTAIN A TARGET RUN LENGTH HISTOGRAM CHANGE THE TITLE, CHANGE "SCANS" TO "TARGETS" AND "COUNT" TO "RUN LENGTH.

CD STATISTICS OPTION 5

TARGET COUNT AND/OR RUN LENGTH HISTOGRAM

FIGURE 32

4.2 Diagnostic/Error Messages

The program should provide for error messages which will indicate to the user those conditions which may be indicative of errors in actual data or oversights in the preparation of the program input data. Some examples for each situation are as follows:

(1) Condition - The Input Data Cards are out of order or a card is missing.

Program - Do not process data tape.

Message - Print on line printer which card is out of order or missing.

(2) Condition - An Input Data Card has an incorrect format.

Program Action - Do not process data tape.

Message - Print on line printer which Input Data Card has the incorrect format.

(3) Condition - The option 3 Control Card Input Range Zone Interval Selection "stop range zone" is blank.

Program Action - Do not process option 3

Message - Print condition statement on line printer.

(4) Condition - A parity error occurred in the Monitor data of sector XX.

Program Action - Do not use Monitor Data for scan in which parity error occurred.

Message - Print on line printer page following option output the scan number in which the parity error occurred. Indicate that this data was ommitted from Data List or Statistical option.

APPENDIX B

RANK QUANTIZER WITH SCF - CALCULATION OF P_{fa} WHEN MINIMUM DETECTABLE SIGNAL (MDS) TARGET IS PRESENT

The minimum detectable signal (MDS) is defined as the S/N ratio such that the probability of detecting the target is 50%. Since a target detection occurs when the number of target hits in azimuth, Z_t, exceeds M in the M/N second threshold, the MDS is the S/N ratio such that the median number of azimuth hits is M.

The SCF loop attempts to hold Z, the expected number of hits per zone, constant. In particular, if the desired P_n value is $P_{n,ref}$ and the number of hit opportunities per zone is N_{zone} then the SCF loop constrains:

$$E[Z] = (N_{zone})\ P_{n,ref}$$

providing the number of hits due to targets Z_t is less than $(N_{zone})\ P_{n,ref}$ plus the minimum number of noise hits. Otherwise, no matter what the variable bias the expected value of Z will exceed the desired value. In this case, the SCF loop will continually raise the quantizer threshold until some minimum P_n value $P_n(min)$ is reached.

Suppose now that a target has entered the zone, the SCF loop has responded by lowering P_n, and that this increase in threshold has given the target a S/N ratio equal to the MDS. What is P_n in the zone? To a good approximation, the total number of hits in the zone is the sum of the hits due to noise and those due to the target:

$$Z = Z_N + Z_t \quad .$$

It follows:

$$E[Z] = E[Z_N] + E[Z_t] \quad .$$

Or, when $Z_t < (N_{zone})\ P_{n,ref} + Z_N(min)$ $(P_{n,ref} > {}^{M}/_{N_{zone}} + P_n(min)$ for MDS)

then:

$$(N_{zone})\ P_{n,ref} = E[Z_N] + E[Z_t]$$

$$= (N_{zone})\ P_n + E[Z_t] \quad .$$

The distribution of Z_t is not calculated here. For a uniform beampattern, Z_t would be binomially distributed with N=# of pulses/beamwidth and p = the first threshold detection probability. Since the mean of a binomial distribution is equal to the median:

$$E[Z_t] = M$$

when the MDS target is in the zone. Assuming that this relation also holds in the non-uniform beamshape case, one can substitute for $E[Z_t]$ giving

$$(N_{zone})\ P_{n,ref} = P_n N_{zone} + M$$

or, $P_n = P_{n,ref} - M/N_{zone}$

which is the value of P_n when the MDS target is in the zone and $P_{n,ref} > {}^{M}/_{N_{zone}} + P_n(min)$.

It follows for thermal noise or uncorrelated clutter:

$$P_{fa} = \sum_{i=M}^{12} \binom{12}{i} \left(P_{n,ref} - {}^{M}/_{N_{zone}}\right)^{i} \left(1-P_{n,ref} + {}^{M}/_{N_{zone}}\right)^{12-i}$$

when $P_{n,ref} > {}^{M}/_{N_{zone}} + P_n(min)$.

And when $P_{n,ref} < {}^{M}/_{N_{zone}} + P_n(min)$, P_n is driven to its lowest value, $P_n(min)$, and:

$$P_{fa} = \sum_{i=M}^{12} \binom{12}{i} \left(P_n(min)\right)^{i} \left(1-P_n(min)\right)^{12-i} .$$

APPENDIX C

RANK ORDER QUANTIZER - NONPARAMETRIC OPERATION CALIBRATION PROCEDURE

The following procedure should be performed to calibrate the rank quantizer for nonparametric operation. A block diagram schematic is provided on the next page for reference purposes.

1. Disable the parametric D/A gain control by grounding all bits via wire strap WS1 located on card Q3DS1 in location DE-DD89.

2. Input 2 volts peak to peak (0.41 true Vrms) Log Video receiver noise to delay line. Radar receiver antenna should be disconnected and properly terminated.

3. Adjust the center tap GAIN control resistor R2 (card DE-DD45) until the center tap true rms voltage at the input to the tap (0) comparator (pin 2) is equal to the delay line input voltage. The delay line input voltage also appears at pin 3 of the tap (0) comparator.

4. Display the rank summation network output levels on an oscilloscope (pin 6 of U6 on card DE-DD01). Display the rank threshold voltage (pin 2 of U7) coincidently with the summation signal. Adjust resistor R38 until the INCREMENTAL VOLTAGE change of the threshold voltage from rank to rank is equal to the voltage difference between ranks of the summation signal.

5. Measure the number of hits out of the rank quantizer per second (pin 7 of U7 on card DE-DD01) with an electronic counter and a sampling circuit. A sample circuit with a period of 386 nanoseconds (1/32 nmi) and 100 nanosecond pulse is provided with the CD enhancements. Determine the 100 percent count per second (count all sample pulses) and use this as a reference to calculate the rank false hit rate percentage.

5a. With the rank threshold set to 24 (P_N = 4%), adjust BIAS VOLTAGE resistor R40 (card DE-DD01) to obtain a count equal to 4% of the 100% count.

5b. Input 250 millivolts peak to peak (0.05 Vrms) Log receiver noise to the delay line. Adjust BALANCE resistor R29 (card DE-DD45) to obtain a 4% hit count.

6. Repeat steps 5a and 5b until the 4% hit count is obtained at voltage inputs of 2 and 0.25 volts peak to peak.

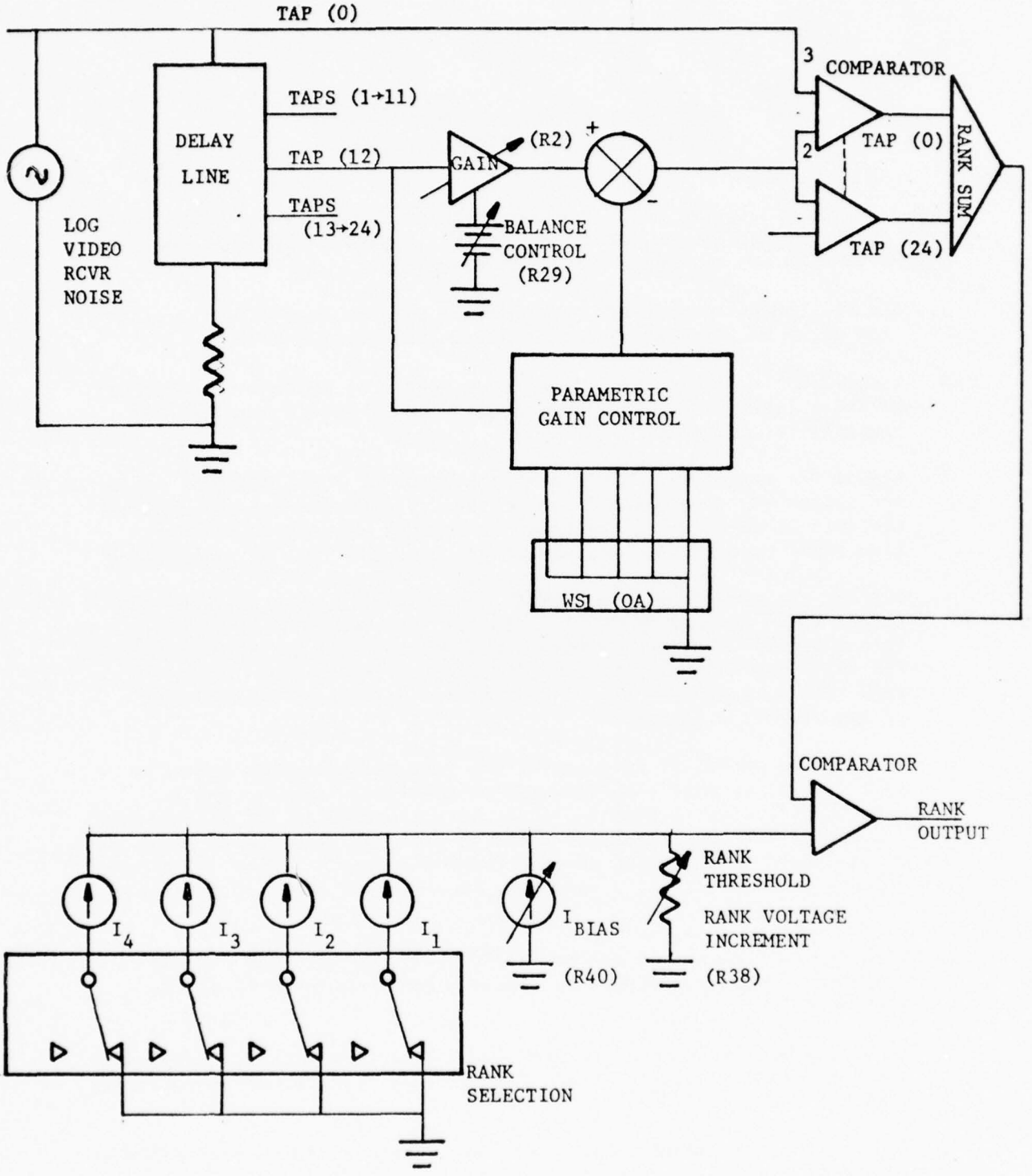


FIGURE C-1

RANK ORDER QUANTIZER SCHEMATIC DIAGRAM

RANK ORDER QUANTIZER - NONPARAMETRIC OPERATION CALIBRATION PROCEDURE

THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
LAUREL, MARYLAND

APPENDIX

DESCRIPTION OF THE ARSR TRACKER USED IN THE DATA REDUCTION OF THE OUTPUT SIGNAL CHARACTERISTICS ANALYSIS

ARSR Centroid Tracker

Centroid data is input from 7 track, 556 bpi mag tape. The centroids are stored in bearing order in the Centroid Store and are used to update existing tracks and declare new tracks.

There are four types of tracks:

1) fixed - slow moving or stationary radar-only track that has established a definite scan-to-scan correlation

2) firm - track which has established a definite scan-to-scan correlation. If the track is radar-only, its velocity must be at least 70 knots.

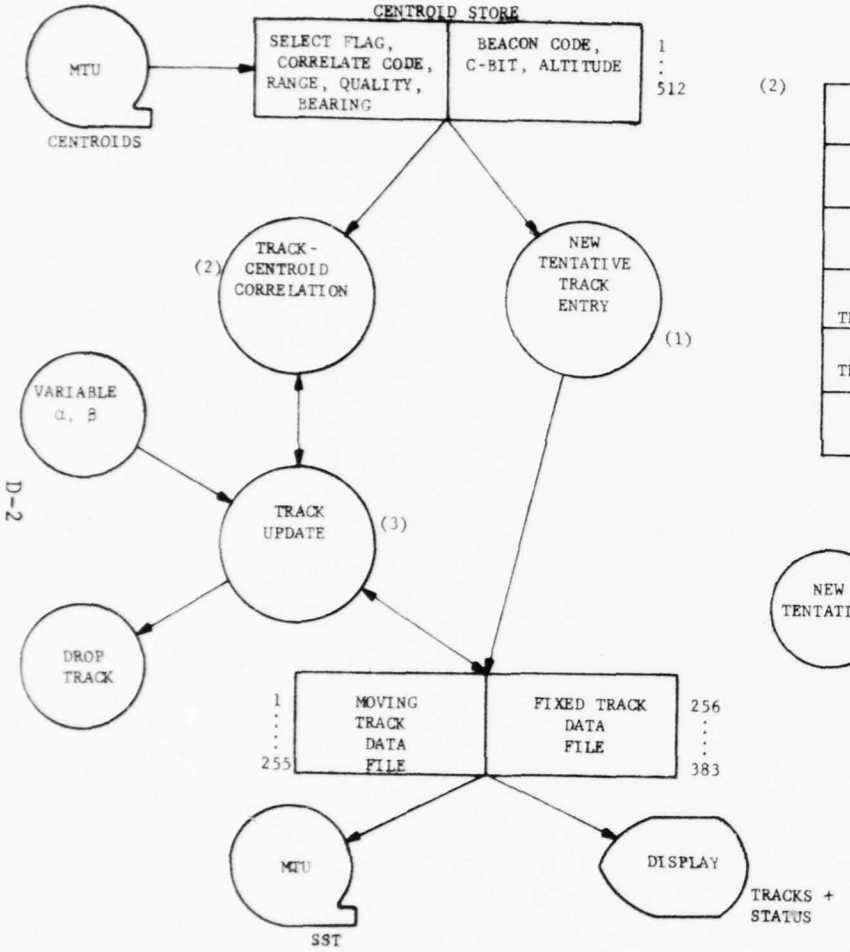
3) tentative - track which has not yet established a definite scan-to-scan correlation

4) new tentative - track which has just entered the system

A track is updated "n" zones behind the zone of the centroids being input from mag tape. There are 256 zones per scan. For example, fixed tracks are updated four zones (approximately 5.6°) behind the zone of centroids being input.

For radar-only tracks, a window is placed around the predicted position of the track for the present scan and the Centroid Store is searched for a centroid within the window. If no centroids are found, a second search may be used. For beacon tracks, both primary and secondary windows are always used in an attempt to find the best centroid to update a track.

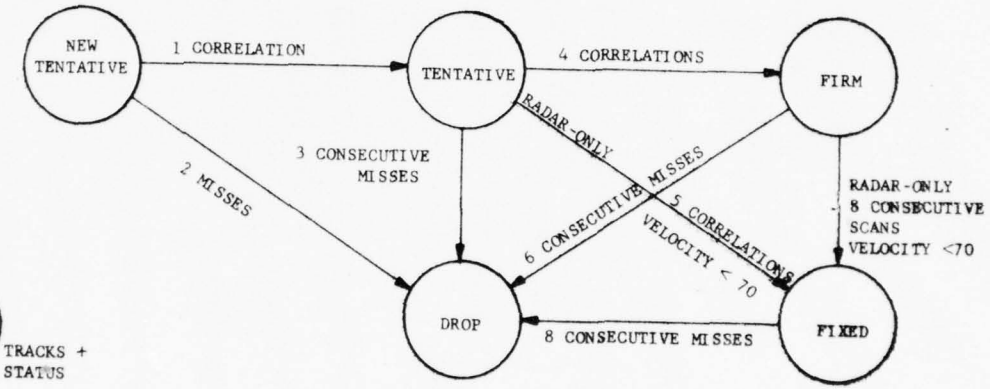
If no centroids are found, a miss is declared and the track is coasted or dropped. Tracks that find a centroid are updated with a variable α, β filter. Range α, β vary as a function of time and correlation success. Bearing α, β vary as a function of range, time, and correlation success. When a track is coasted, $\alpha=\beta=0$. After all tracks in a zone have been updated, enter an unselected beacon centroid or a radar-only uncorrelated centroid as a new tentative track. Track promotion or drop is detailed in the state diagram in Figure D.1 which also details the major features and data flow of the program.



(2)

TRACK TYPE	UPDATE POSITION	RANGE WINDOW	BEARING WINDOW	2'ND WINDOW
FIXED	ZONE - 4	.563 NMI	$\pm(1.12^\circ+\frac{11.0^\circ}{R})$	NO
FIRM	ZONE - 16	.375 NMI	$\pm(1.12^\circ+\frac{28.2^\circ}{R})$	YES
TENTATIVE	ZONE - 33	.375 NMI	$\pm(1.12^\circ+\frac{28.2^\circ}{R})$	YES
NEW TENTATIVE	ZONE - 50	1.94 NMI	$\pm(11.12^\circ+\frac{109.8^\circ}{R})$	NO
2'ND WINDOW	SAME AS FIRST	.563 NMI	$\pm(1.69^\circ+\frac{42.2^\circ}{R})$	—

ALTITUDE WINDOW = ± 400 FEET



(1) AFTER ALL TRACKS IN A ZONE HAVE BEEN UPDATED, ENTER A BEACON UNSELECTED CENTROID OR A RADAR-ONLY UNCORRELATED CENTROID AS A NEW TENTATIVE.

FIGURE D.1

MAJOR FEATURE OF TRACK LOGIC.

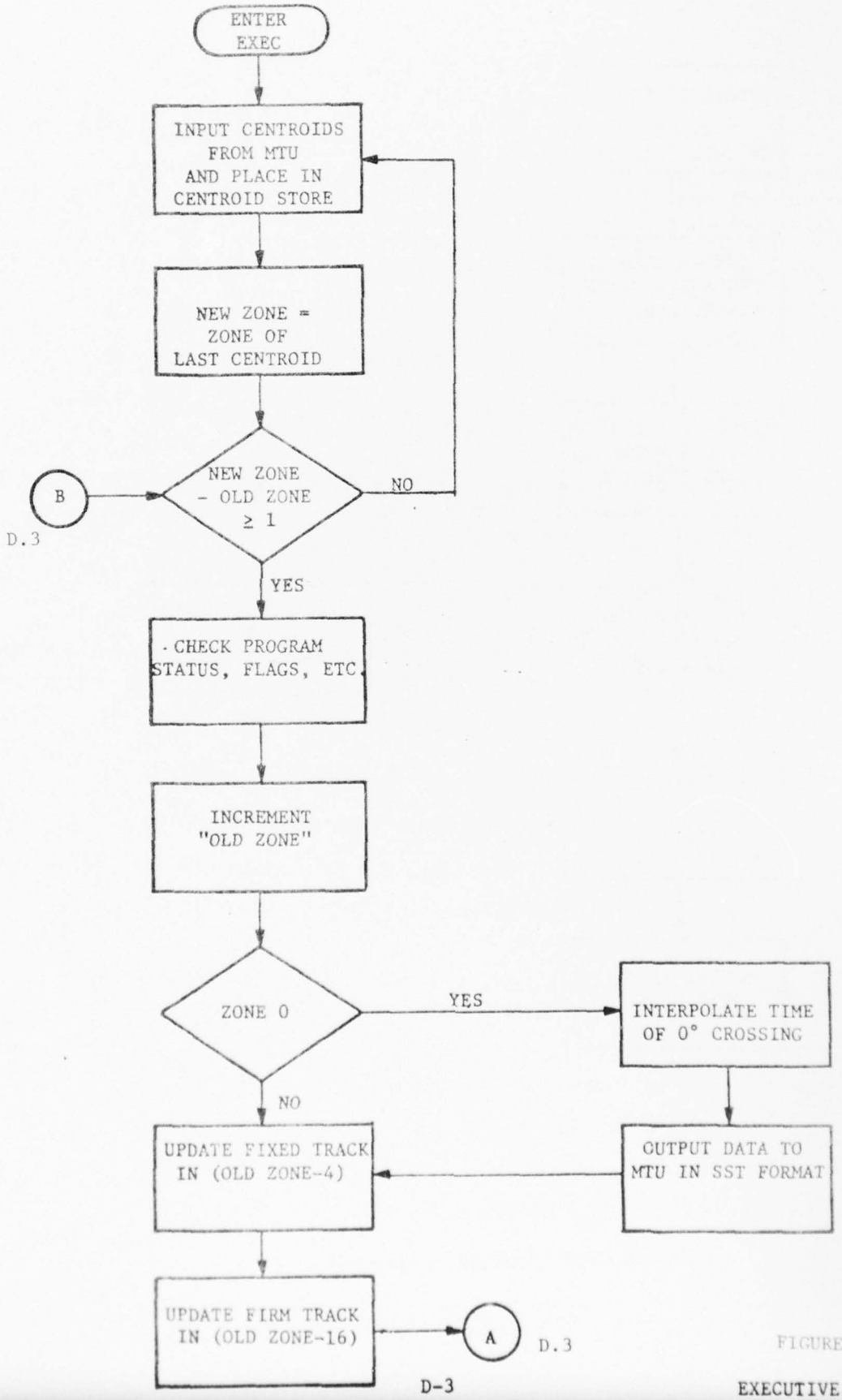


FIGURE D.2

EXECUTIVE ROUTINE

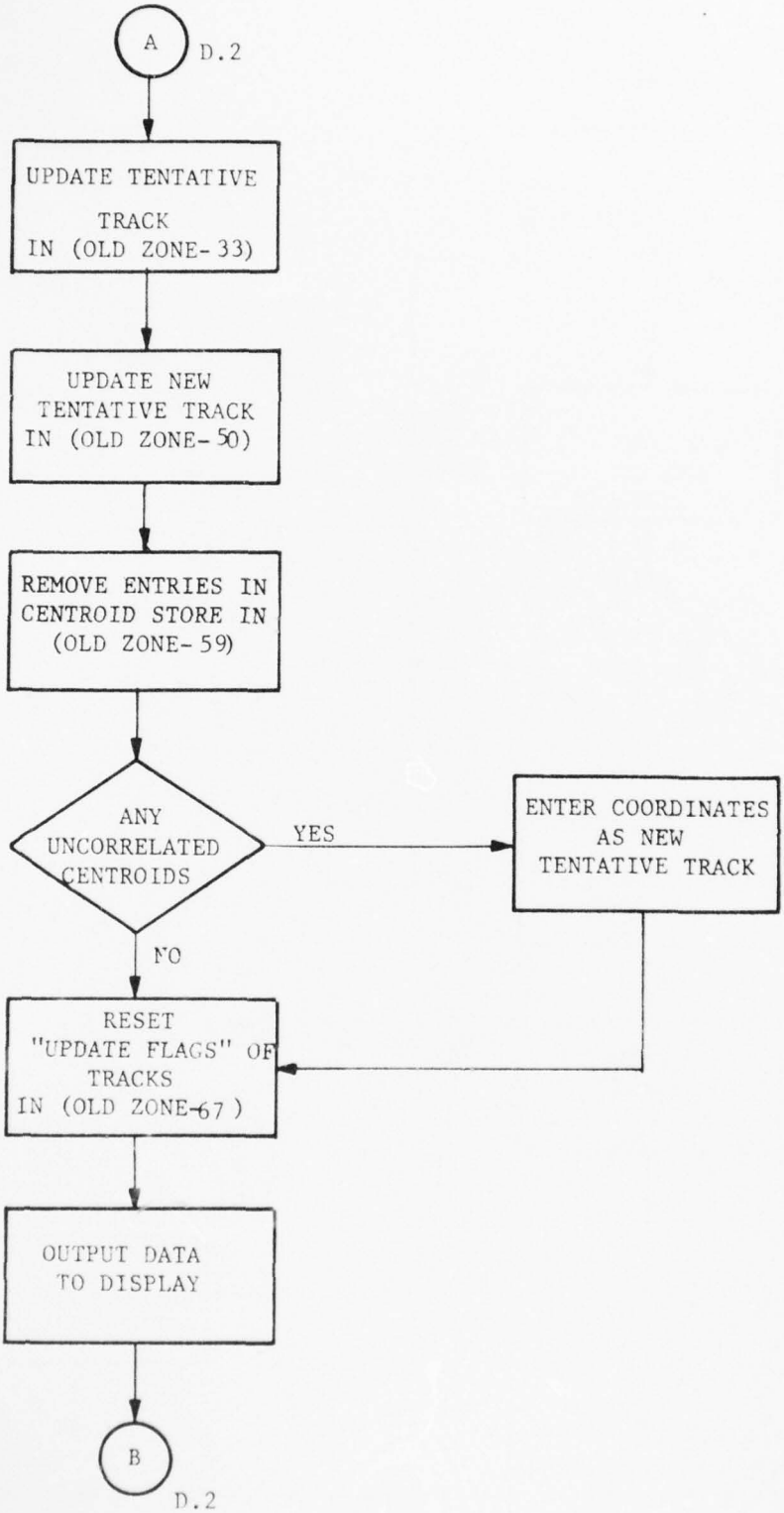


FIGURE D.3

EXECUTIVE ROUTINE, CONTINUED.

Executive Routine (EXEC)

The Executive routine insures that the program is running properly, controls data I/O, and updates tracks in an orderly fashion. The routine begins (Figure D.2) by reading a block of centroid data from the mag tape unit, processes it, and places it in the Centroid Store in bearing order. The Centroid Store will hold 512 centroids with two 30-bit words per centroid. The first word contains:

1) range - twelve bits with an LSB = 1/16 nmi

2) bearing - twelve bits BAM

3) selected flag - one bit which is set when the centroid is selected to update a track

4) correlated flag - two bit code which indicates that the centroid correlated with a tentative (including new tentative), firm, or fixed track

5) radar quality - four bit code indicating radar-only centroid quality

Note that twelve bits of range with an LSB = 1/16 nmi only allows centroids to 286 nmi. Centroids beyond that range will be discarded. The second word contains:

1) beacon code - twelve bits

2) C flag - one bit which is set if the target gave an altitude reply

3) altitude - nine bits with an LSB - 100 ft.

Altitude will be set to zero if the mode-C validity is less than three ($V_C < 3$) or if the reported altitude is negative. The second word is cleared for radar-only centroids.

The bearing of the last centroid input from the block of mag tape is used to determine the "new zone." If (new zone - old zone) ≥ 1, the "old zone" is incremented and a check is made for data output to the MTU. Output data is to be in an SST format. Output will occur at zone zero. The time to be written on the MTU with the data will be the interpolation of the time when the radar crossed 0°.

Next, all fixed tracks whose update flag is not set in (old zone-4) are updated, firm tracks in (old zone-16), tentative tracks in (old zone-33), and new tentative tracks in (old zone-50). Entries in the Centroid Store in (old zone-59) are removed. Any removed beacon centroids whose "selected" flag has not been set or any radar-only centroid whose "correlated" flag has not been set is entered as a new tentative track. Then the "update" flag is reset for all tracks in (old zone-67). New data is output to the display and the EXEC loop is repeated.

Fixed Track Update Routine (FXUP)

The Fixed Track Update routine starts by searching the Centroid Store. Any radar-only centroid which was not previously selected to update another track will be used to update a fixed track. The update procedure merely inserts the centroid coordinates into the fixed track coordinate stores and clears the "missed scans" count. If a suitable centroid is not found, the "missed scans" count is incremented. A fixed track is dropped on the eighth consecutive miss.

Firm Track Update Routine (FMUP)

The Firm Track Update routine begins by checking if the track is radar-only (Figure D.5). If it is, the Centroid Store is searched with the primary window. If one uncorrelated centroid or one unselected centroid is found, it is used to update the track. If more than one, multiple track logic is entered (Figure D.7). If none, the secondary window is searched and the same questions asked. If no suitable centroids are found in the secondary window, the "missed scans" counter is incremented and the track is coasted. A firm track is dropped on the sixth consecutive miss.

After a radar-only track is updated, its velocity is checked. If track velocity $\geq$ 756 knots on eight consecutive scans, the track is dropped. The track is promoted to a fixed track if its velocity is less than 70 knots on eight consecutive scans.

If the track has been updated with a centroid, FMUP next checks if the track beacon code equals the centroid beacon code. Remember that for radar-only tracks and centroids, the beacon code=0. If the two codes are not the same, the centroid code is compared to the last measured code (the beacon code of the centroid last used to update the track). If they are not the same, the centroid code is entered as the last measured code. If equal, the "change code" count is incremented and when the count = 2, the last measured beacon code is entered as the track beacon code. A similar process is used for the mode-C flag. This logic allows a radar-only track to become a beacon track, allows beacon tracks to change codes, etc.

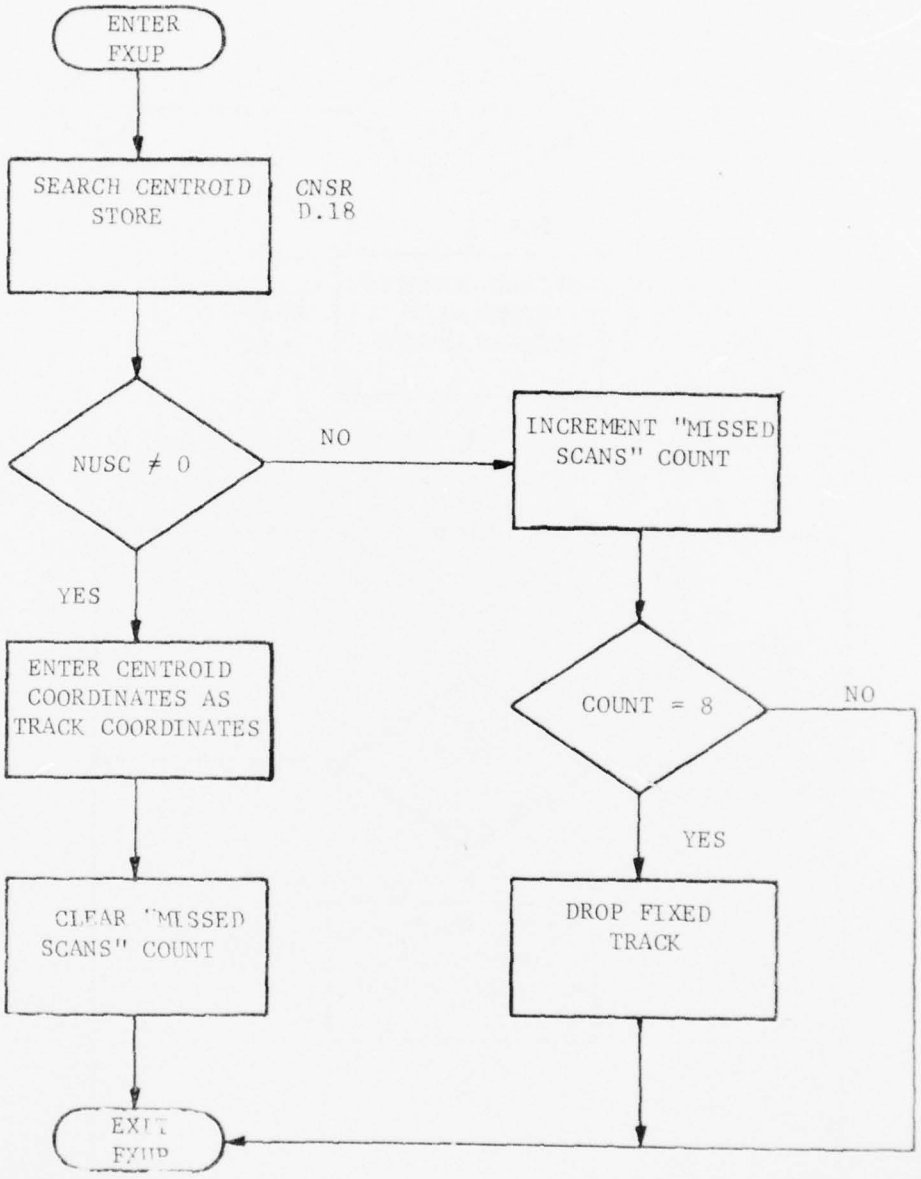


FIGURE D.4

FIXED TRACK UPDATE ROUTINE.

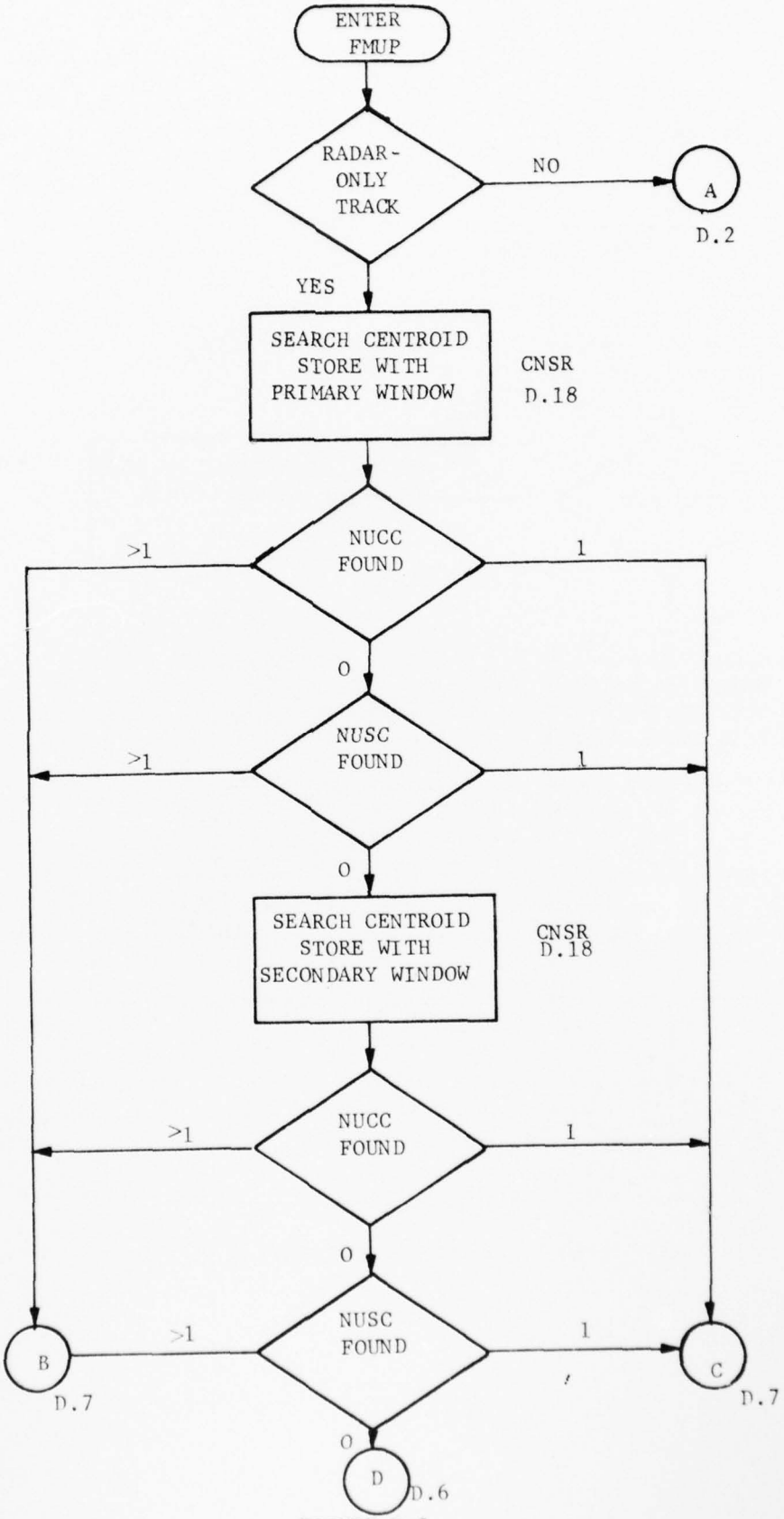
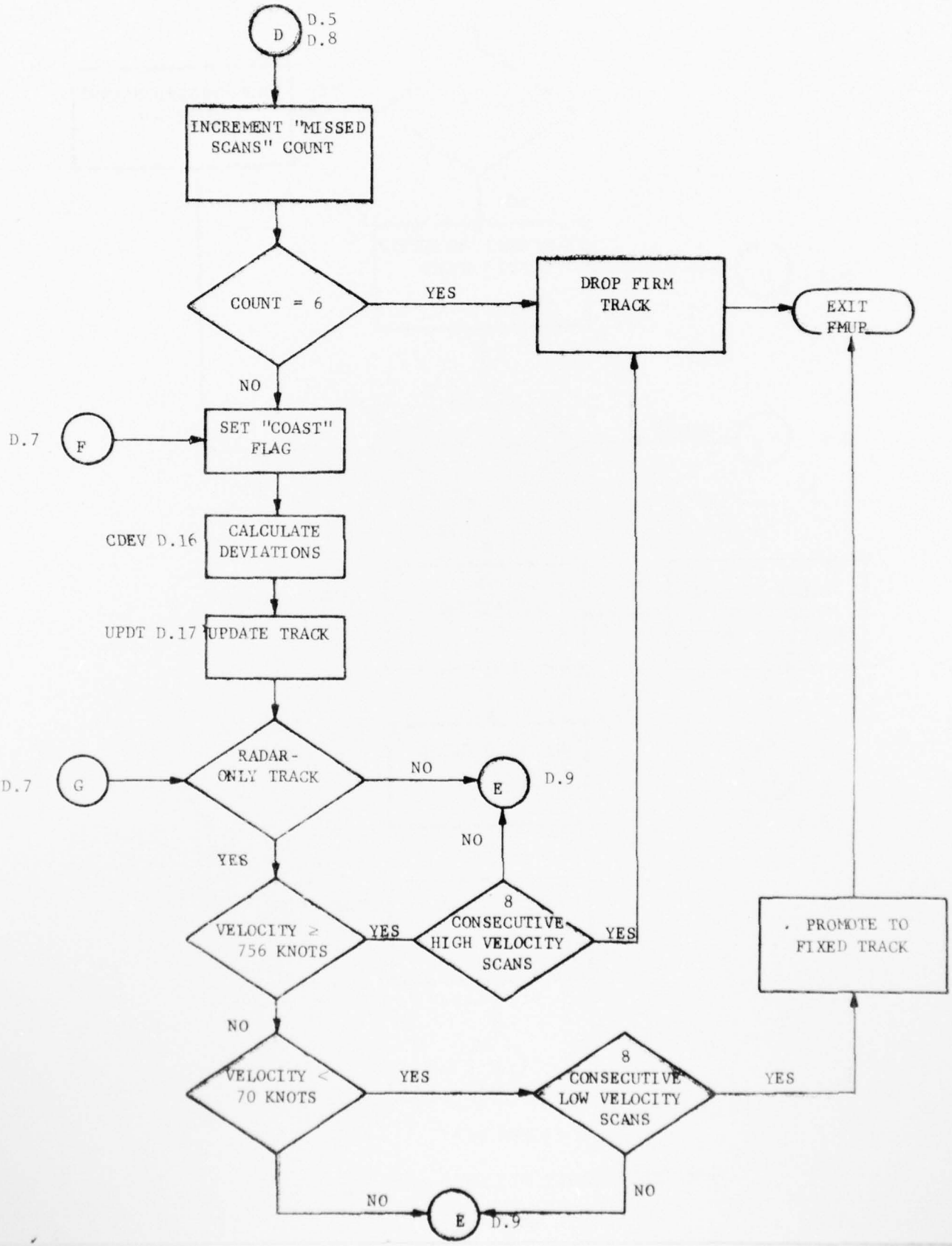


FIGURE D.5

FIRM TRACK UPDATE ROUTINE

FIGURE D.6. FIRM TRACK UPDATE ROUTINE, CONTINUED.



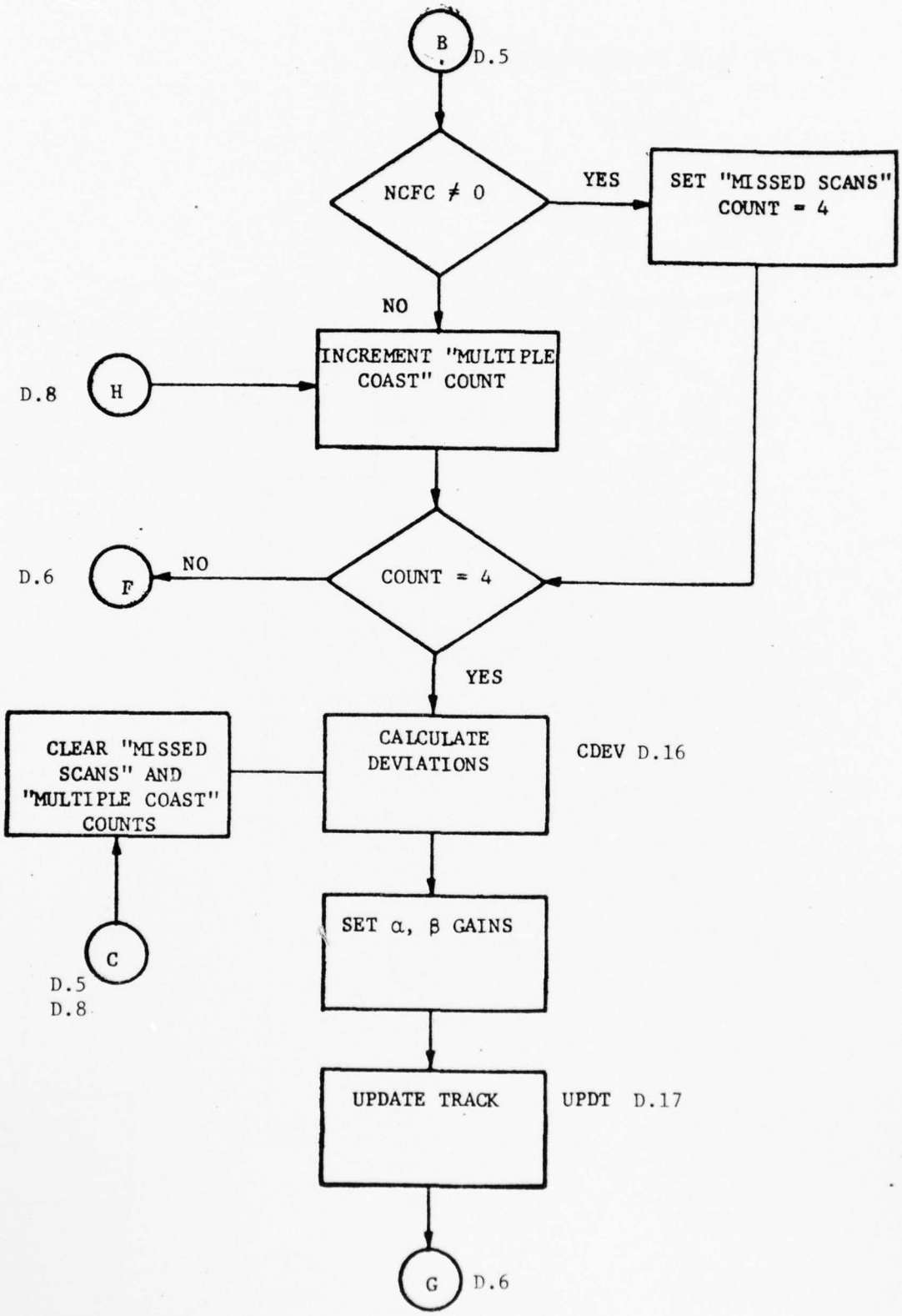


FIGURE D.7

FIRM TRACK UPDATE ROUTINE, CONTINUED.

Beacon firm track update begins in Figure D.8. The Centroid Store is searched with both a primary and secondary window. If no centroids are found (score = 0) the track is coasted and dropped on the sixth consecutive miss. If a centroid is found whose score $\geq 100_2$, it is used to update the track. If no scores were $\geq 100_2$ but only one centroid was found with a lower score, it is used to update the track. If several low-scoring centroids were found, the track is coasted (Figure D.7). Beacon tracks are not subjected to velocity tests. After update, the beacon code and C-flag are checked as described previously.

Tentative Track Update (TTUP)

The Tentative Track Update routine begins by checking if the track is radar-only. If it is, the Centroid Store is searched with the primary window and if an uncorrelated centroid is found, the track is updated. If none are found, the Centroid Store is searched with the secondary window. The track is updated if an uncorrelated centroid is found or an unselected centroid is found and no "previously correlated with fixed" centroids are found.

For beacon tracks, the Centroid Store is searched with the primary and secondary windows and if a centroid is found whose score $\geq 100_2$, the track is updated. If a suitable centroid is not found to update the tentative track, the "missed scans" count is incremented and the track is dropped on the third consecutive miss.

After update, the centroid beacon code and "mode-C flag" are entered as the track beacon code and "mode-C flag." The "updated with centroid" count is incremented and TTUP exited. On the fifth update, beacon tracks are entered as firm tracks as are radar-only tracks whose (70 knots $\leq$ velocity $\leq$ 700 knots). Radar only tracks with lower velocity are entered as fixed tracks while those with higher velocity are dropped.

New Tentative Track Update (NTUP)

The New Tentative Track Update routine starts by searching the Centroid Store. If it is a beacon track and a centroid is found whose score $\geq 1000_2$, the track is promoted to tentative and its update completed in TTUP (Figure D.13). If the track is radar-only and any centroids are found which "previously correlated with fixed" the track is dropped. If none of those are found and an uncorrelated centroid is found, the track is promoted to tentative and update completed in TTUP. If a suitable centroid is not found for a track, it is dropped on the second miss.

Tracking Subroutines (CDEV and UPDT)

See Figure D.16 for the Calculate Deviations subroutine and Figure D.17 for the Update subroutine.

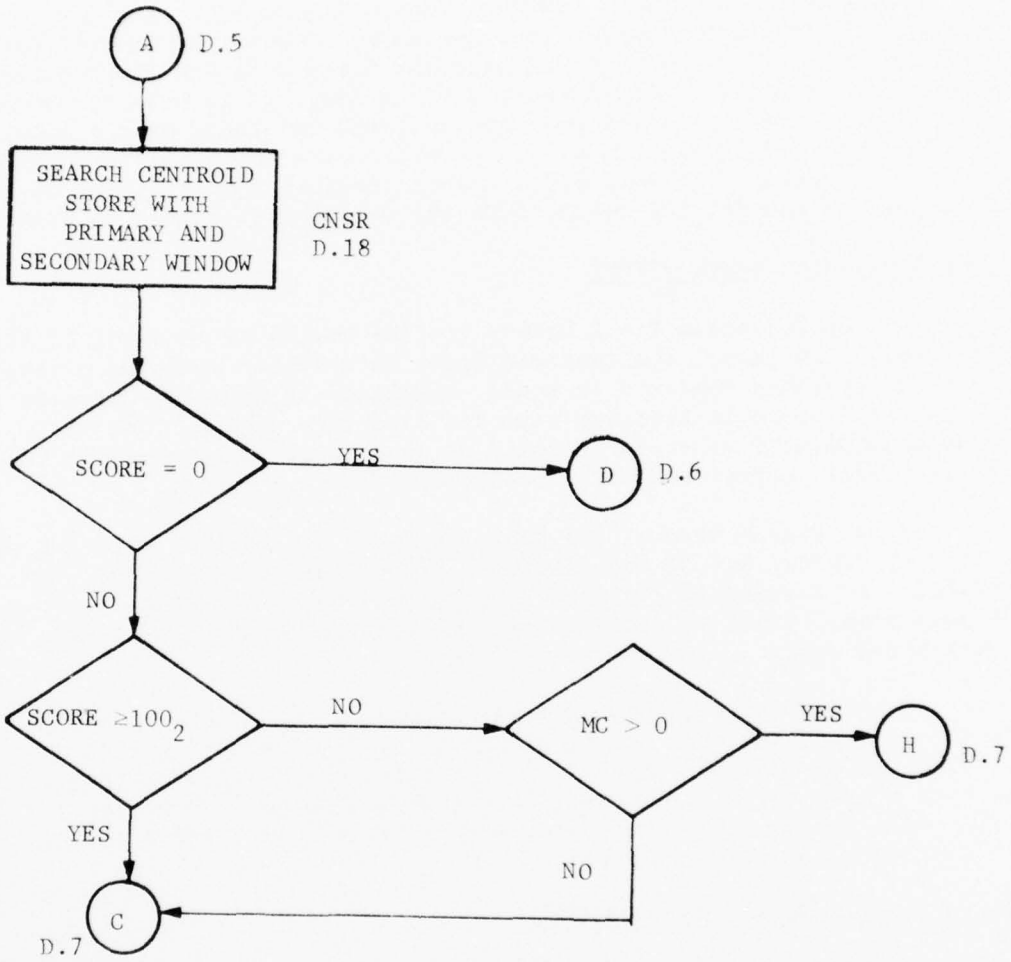


FIGURE D.8

FIRM TRACK UPDATE ROUTINE, CONTINUED.

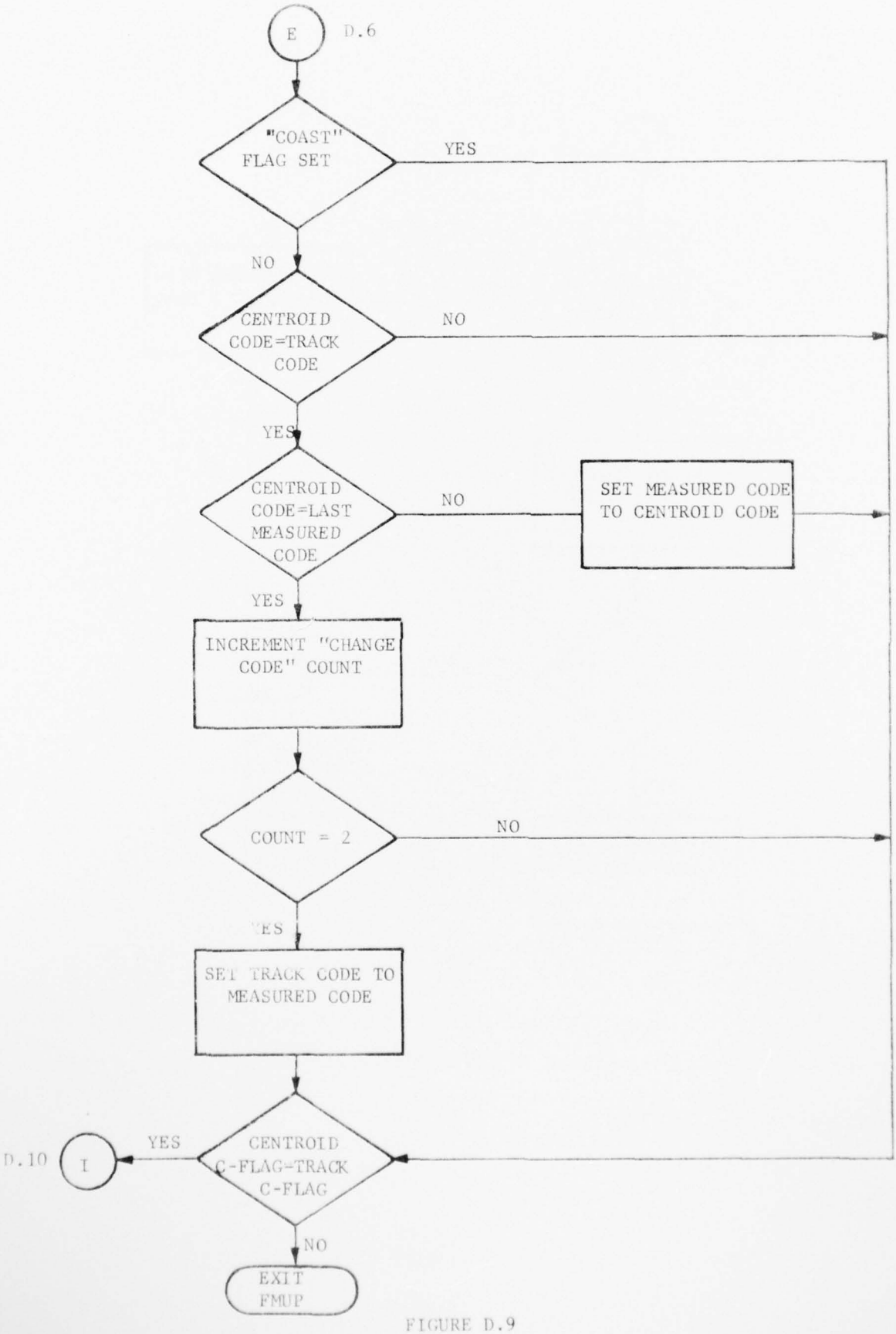


FIGURE D.9

FIRM TRACK UPDATE ROUTINE, CONTINUED.

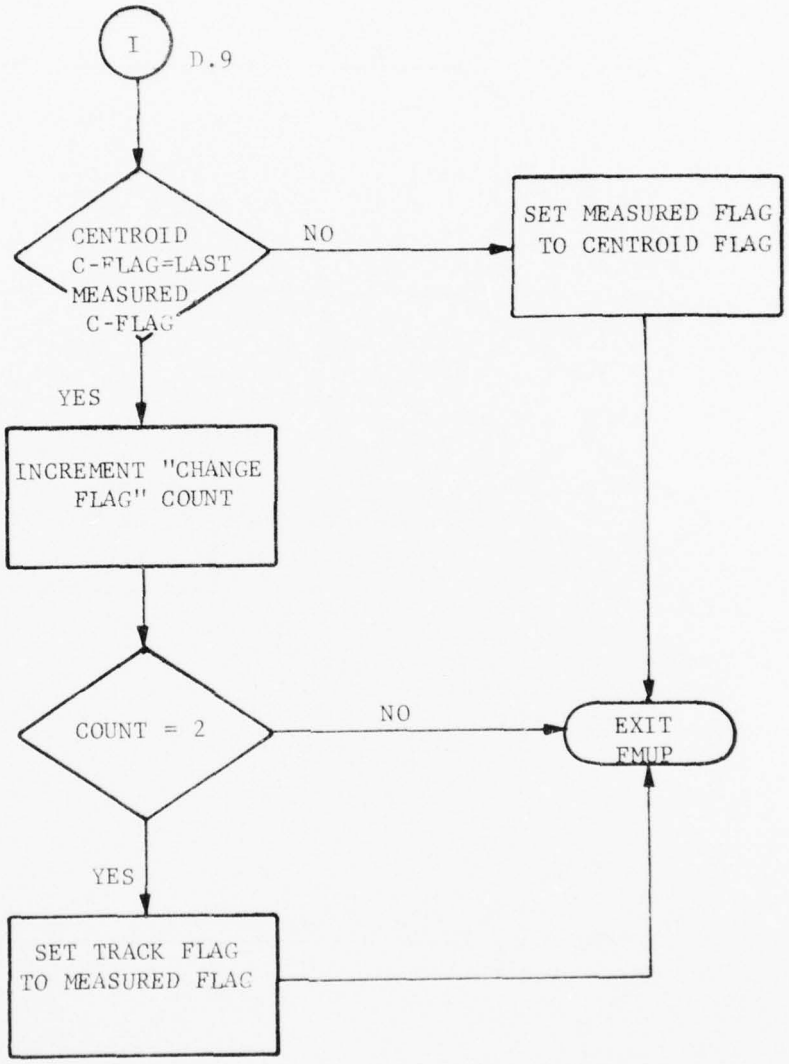


FIGURE D.10

FIRM TRACK UPDATE ROUTINE, CONTINUED.

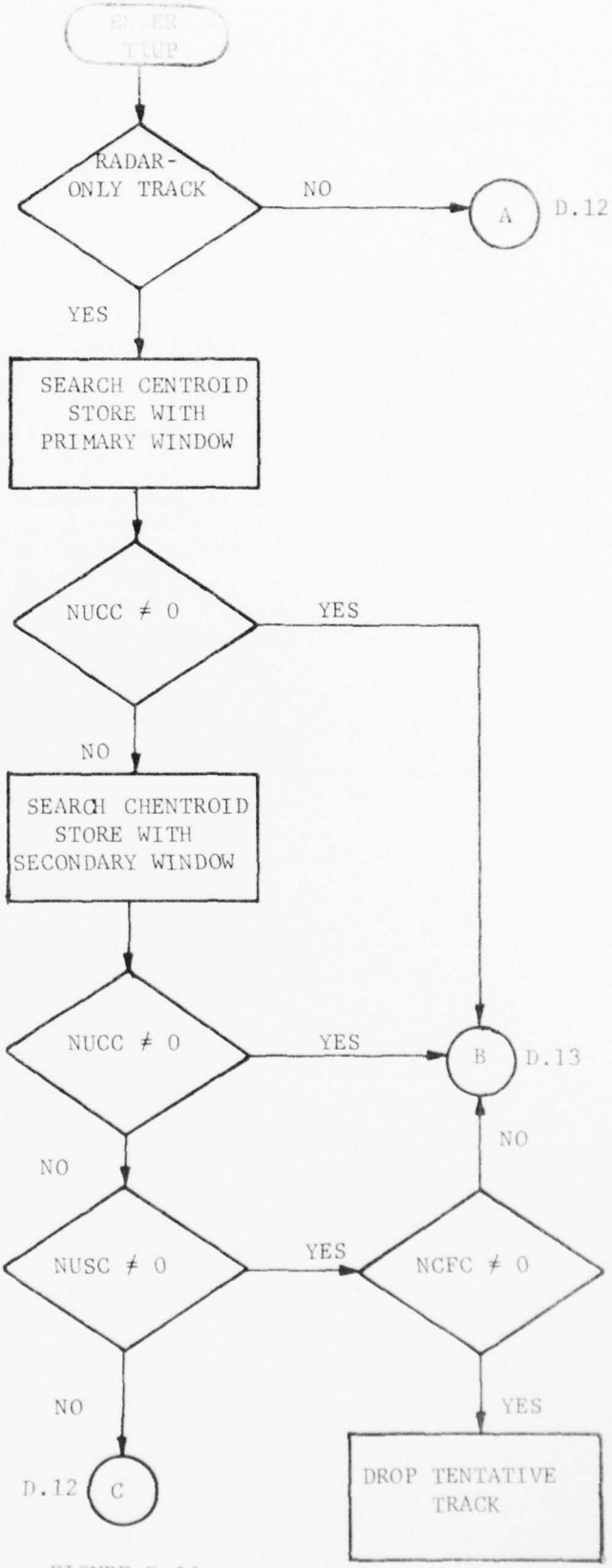


FIGURE D.11

TENTATIVE TRACK UPDATE ROUTINE

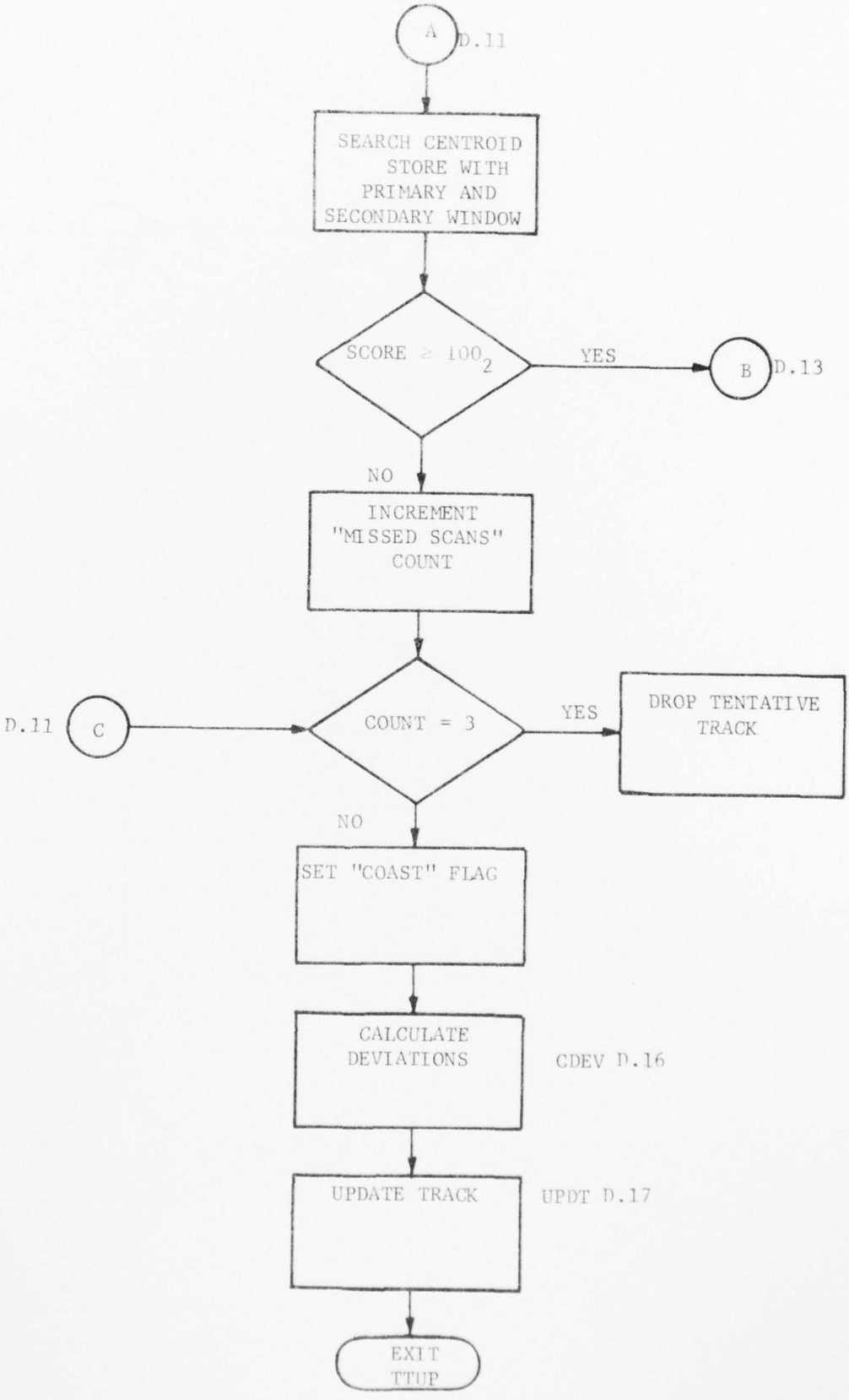


FIGURE D.12

TENTATIVE TRACK UPDATE ROUTINE, CONTINUED.

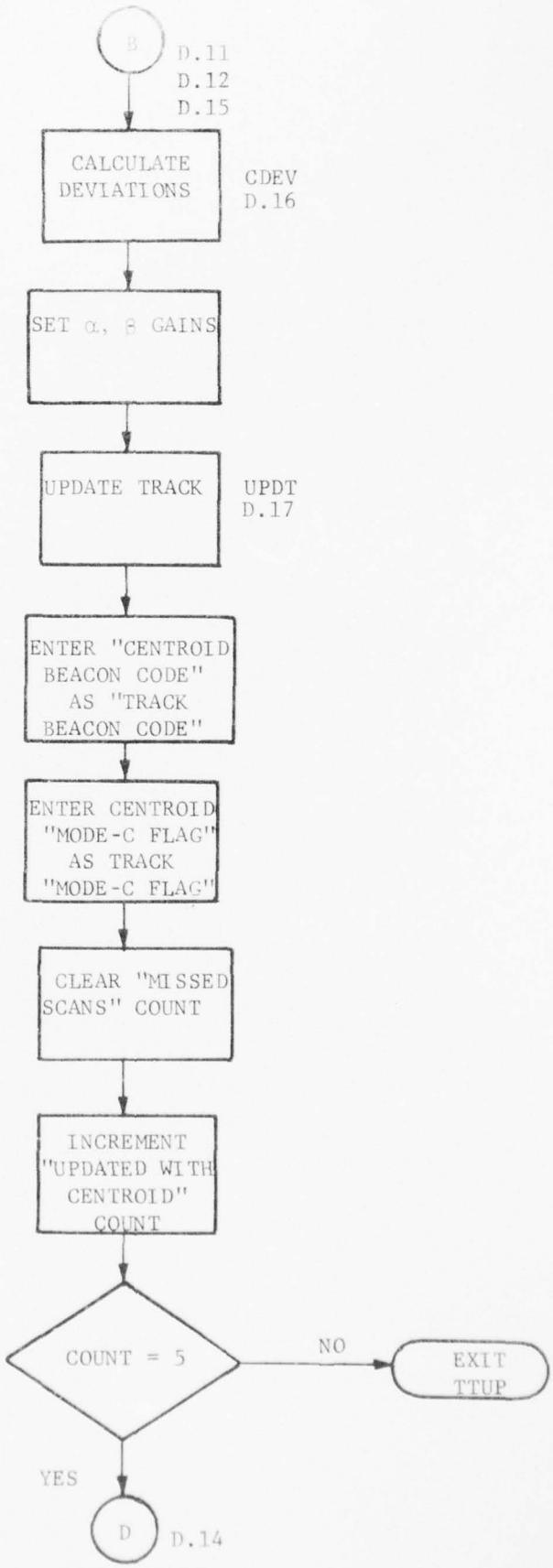


FIGURE D.13
TENTATIVE TRACK UPDATE ROUTINE, CONTINUED.

AD-A038 493 JOHNS HOPKINS UNIV LAUREL MD APPLIED PHYSICS LAB F/G 17/7
SYSTEM DEFINITION AND INVESTIGATION OF THE ON-SITE PROCESSING O--ETC(U)
SEP 76 E C WETZLER, L H ZITMAN DOT-FA75WA-3553
UNCLASSIFIED APL/JHU-FP8-E-024-3 FAA-RD-77-12-3 NL

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AD A038 493

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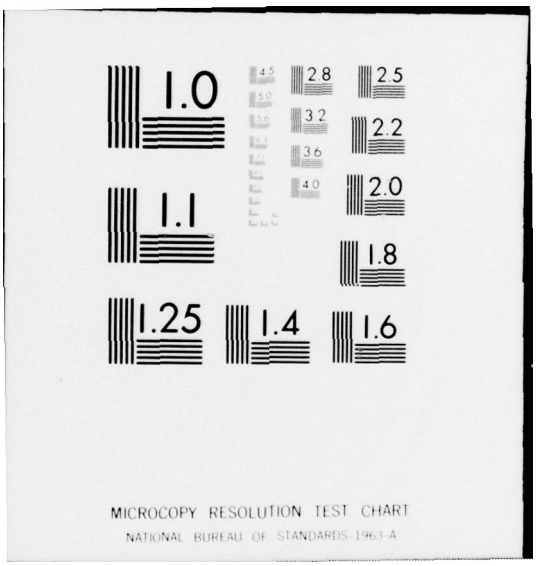
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

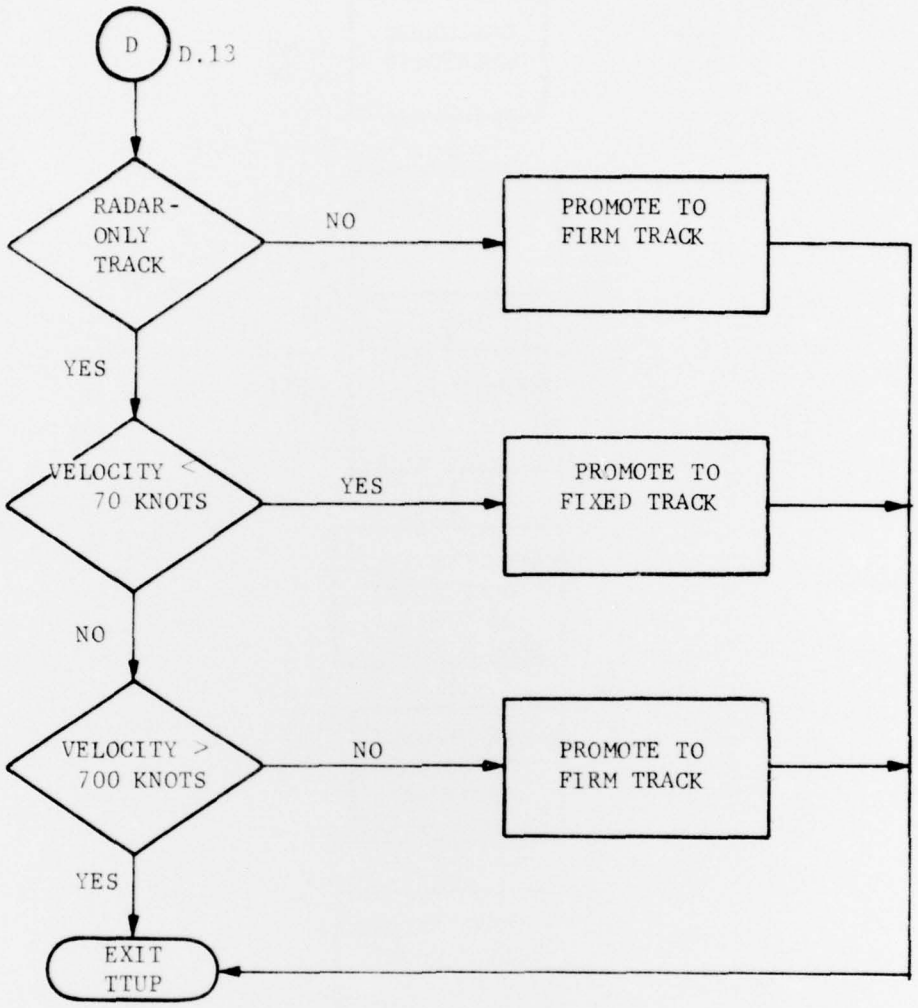

FIGURE D.14

TENTATIVE TRACK UPDATE ROUTINE, CONTINUED.

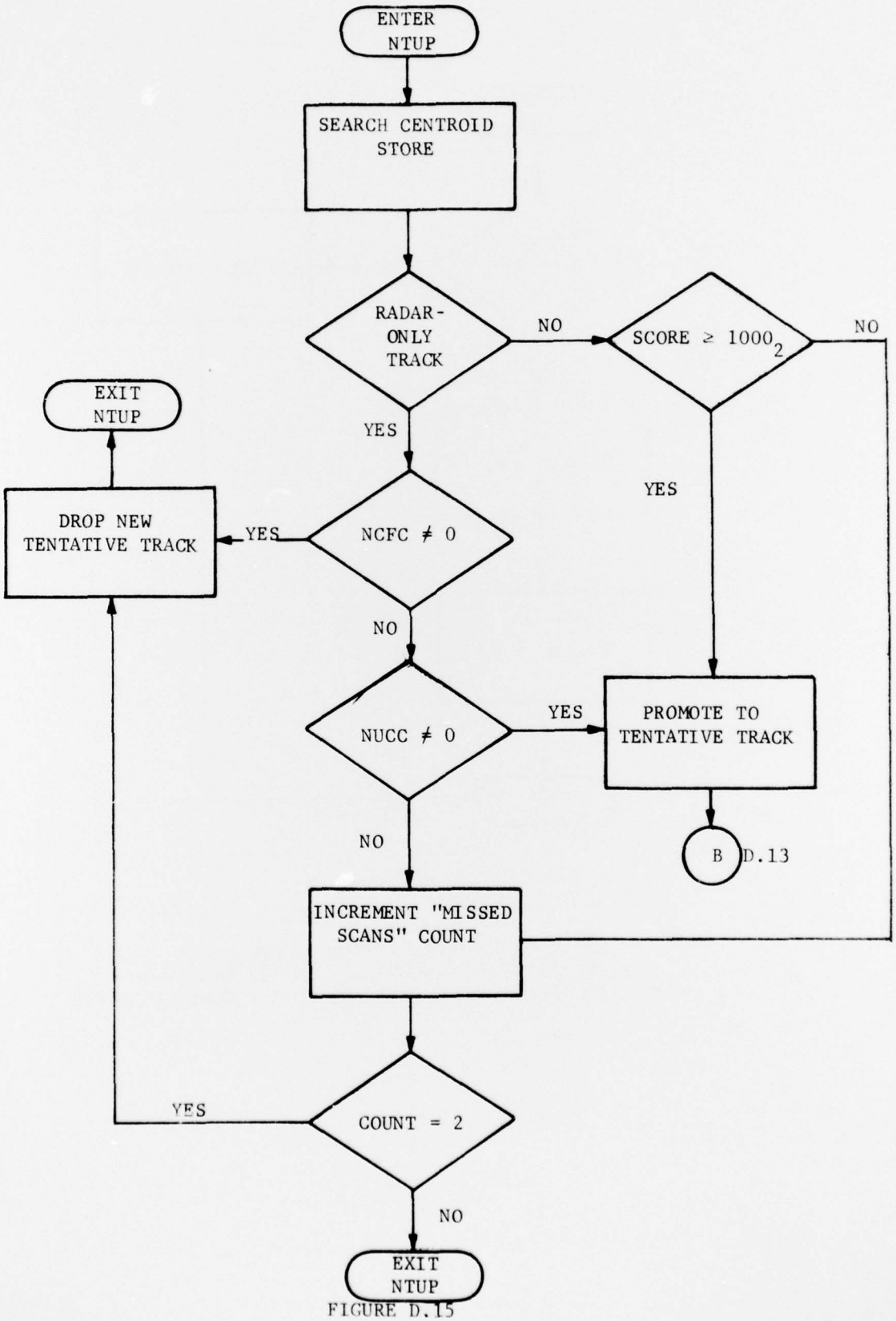

FIGURE D.15

NEW TENTATIVE TRACK UPDATE ROUTINE, CONTINUED.

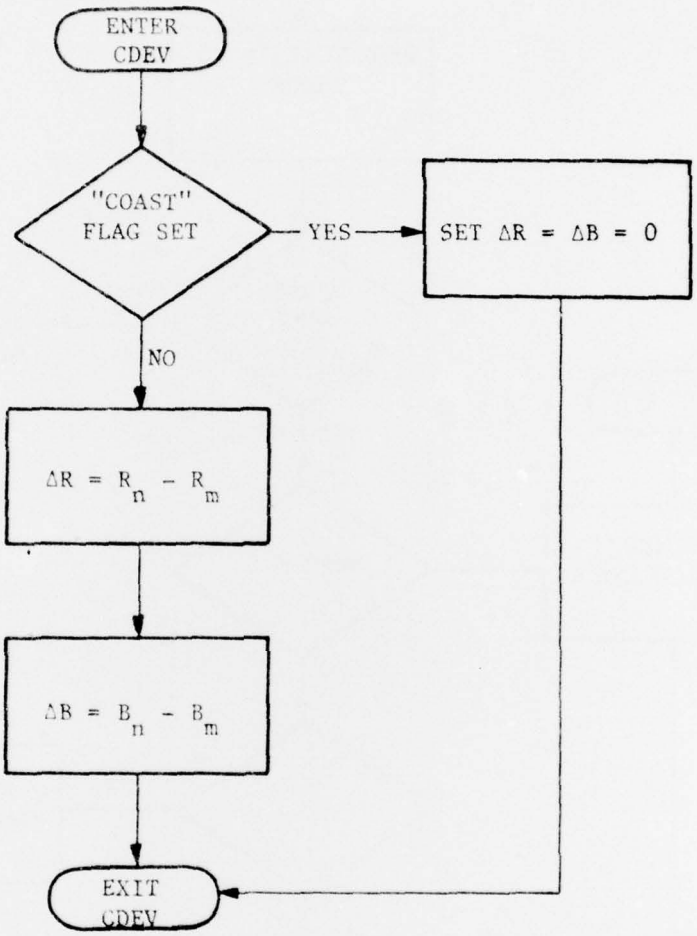

FIGURE D.16
CALCULATE DEVIATIONS SUBROUTINE (CDEV)
R_n = PREDICTED RANGE CALCULATED ON THE PREVIOUS SCAN.
R_m = MEASURED RANGE ON THE PRESENT SCAN = CENTROID RANGE.

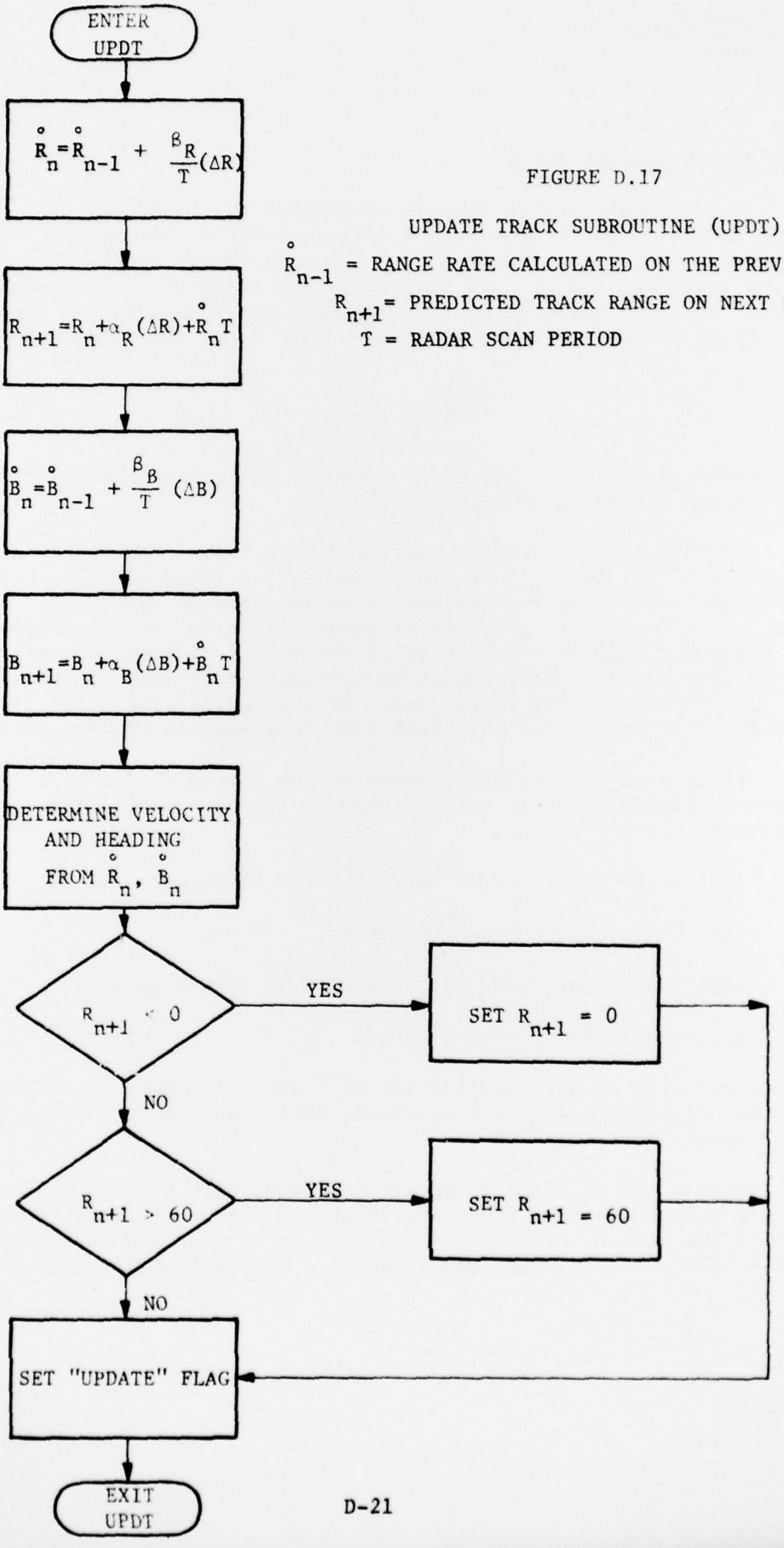

FIGURE D.17

UPDATE TRACK SUBROUTINE (UPDT).

$\dot{R}_{n-1}$ = RANGE RATE CALCULATED ON THE PREVIOUS SCAN.

R_{n+1} = PREDICTED TRACK RANGE ON NEXT SCAN.

T = RADAR SCAN PERIOD

Centroid Search Routine (CNSR)

The Centroid Search routine determines the best centroid to be used for track update. The routine starts (Figure D.19) by determining if the track is radar-only (track beacon code = 0). For radar-only tracks, a window is placed around the predicted position of the track if a tentative or firm track is being processed. The last measured position is used for fixed and new tentative tracks. Range window sizes are given in Figure D.18. Bearing windows are given by:

$$B.W. = \pm \left(C_1 + \frac{C_2}{R} \right)$$

where C_1 and C_2 are given in Figure D.18 and R is the track range in nautical miles. Maximum bearing window is 11.25°.

If this is the primary search for this track, the window sizes are saved for use by the Set α, β routine. Next, if a fixed track is being processed, only radar-only centroids are searched (centroid beacon code = 0). The Centroid Store is searched and if a centroid is found within the search window, the "correlated" flag is checked. NCFC is incremented if the flag indicates the centroid previously correlated with a fixed track. NUSC is incremented if the "correlated" flag is set but the "selected" flag is not set. If the "correlated" flag is not set, NUCC and NUSC are incremented and the track code is placed in the "correlated" flag.

If several centroids are found in the search window of a non-fixed track, the following priority will be used to select a centroid for updating the radar-only track:

(1) uncorrelated radar-only centroid of larger quality

(2) uncorrelated beacon centroid

(3) unselected radar-only centroid of larger quality

(4) unselected beacon centroid

The "selected" flag is set only for the centroid selected for update. Its coordinates, along with the counters NCFC, NUCC, and NUSC are saved for use by the track update routine.

When a beacon track is being processed, both primary and secondary windows are searched at the same time (Figure D.22). Only "unselected" centroids are checked for beacon tracks. The centroid to be selected to update a track is determined by score. The centroid score is a four bit binary number:

$$BWCH_2$$

Track Type	Range Window	C_1	C_2	Altitude Window
Fixed (primary + secondary)	.563 nmi	1.12°	11°	-------
New Tentative (primary + secondary)	1.94 nmi	1.12°	110°	± 400 ft
Tentative + Firm (primary)	.375 nmi	1.12°	28.2°	± 400 ft
Tentative + Firm (secondary)	.563 nmi	1.69°	42.2°	± 400 ft

FIGURE D.18

SEARCH WINDOW PARAMETERS

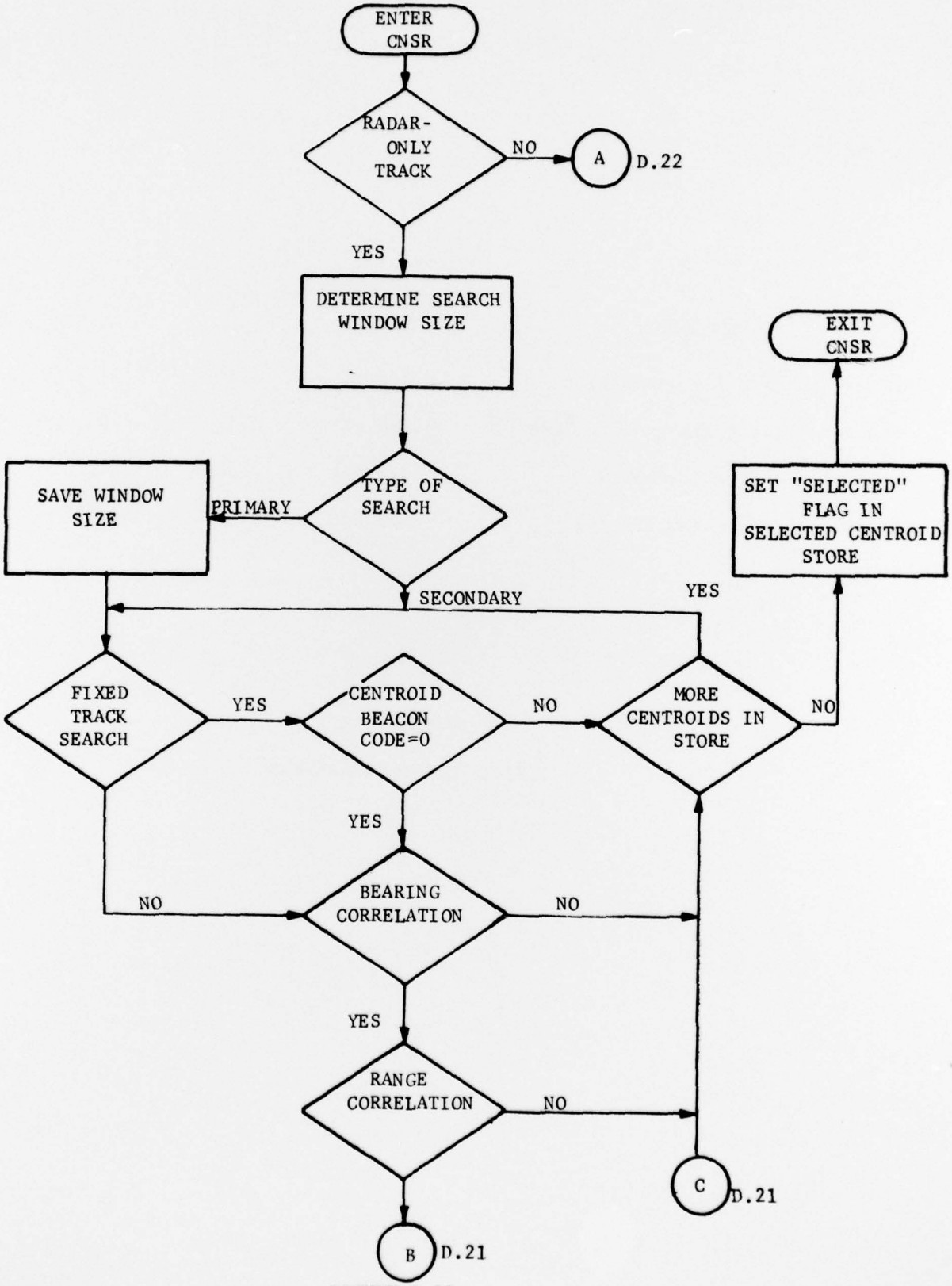

FIGURE D.19

CENTROID SEARCH ROUTINE

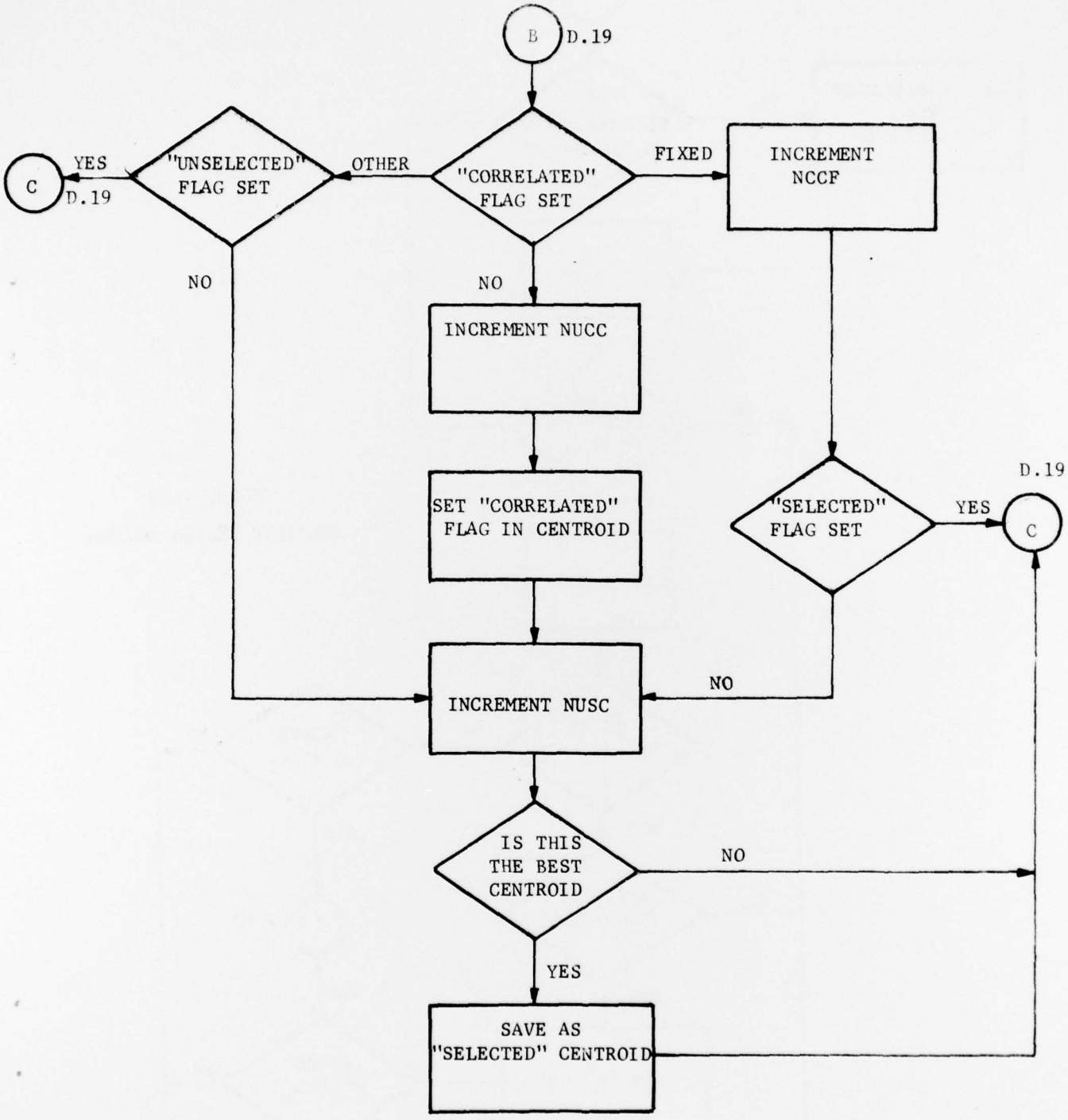

FIGURE D.20

CENTROID SEARCH ROUTINE, CONTINUED.

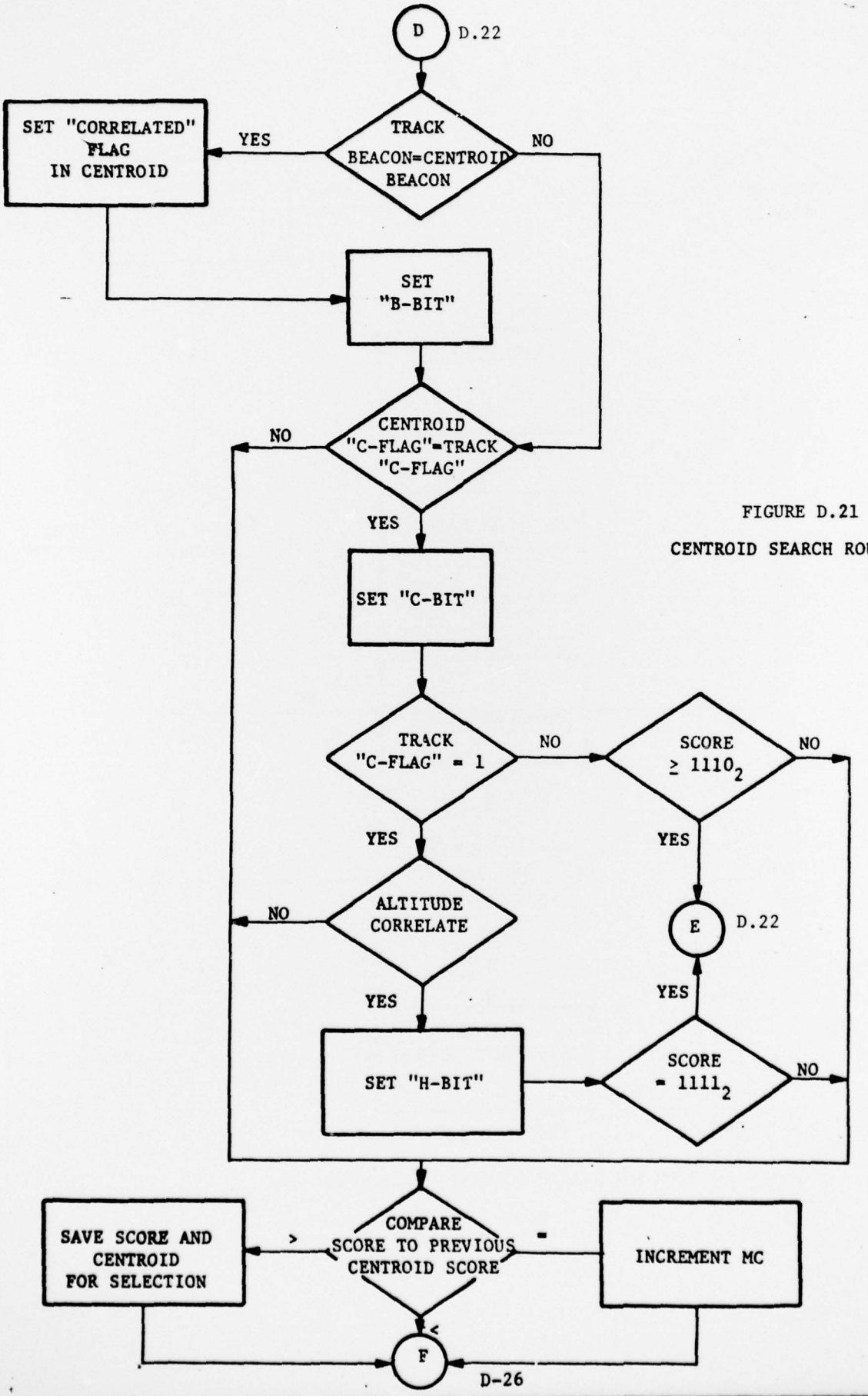

FIGURE D.21

CENTROID SEARCH ROUTINE

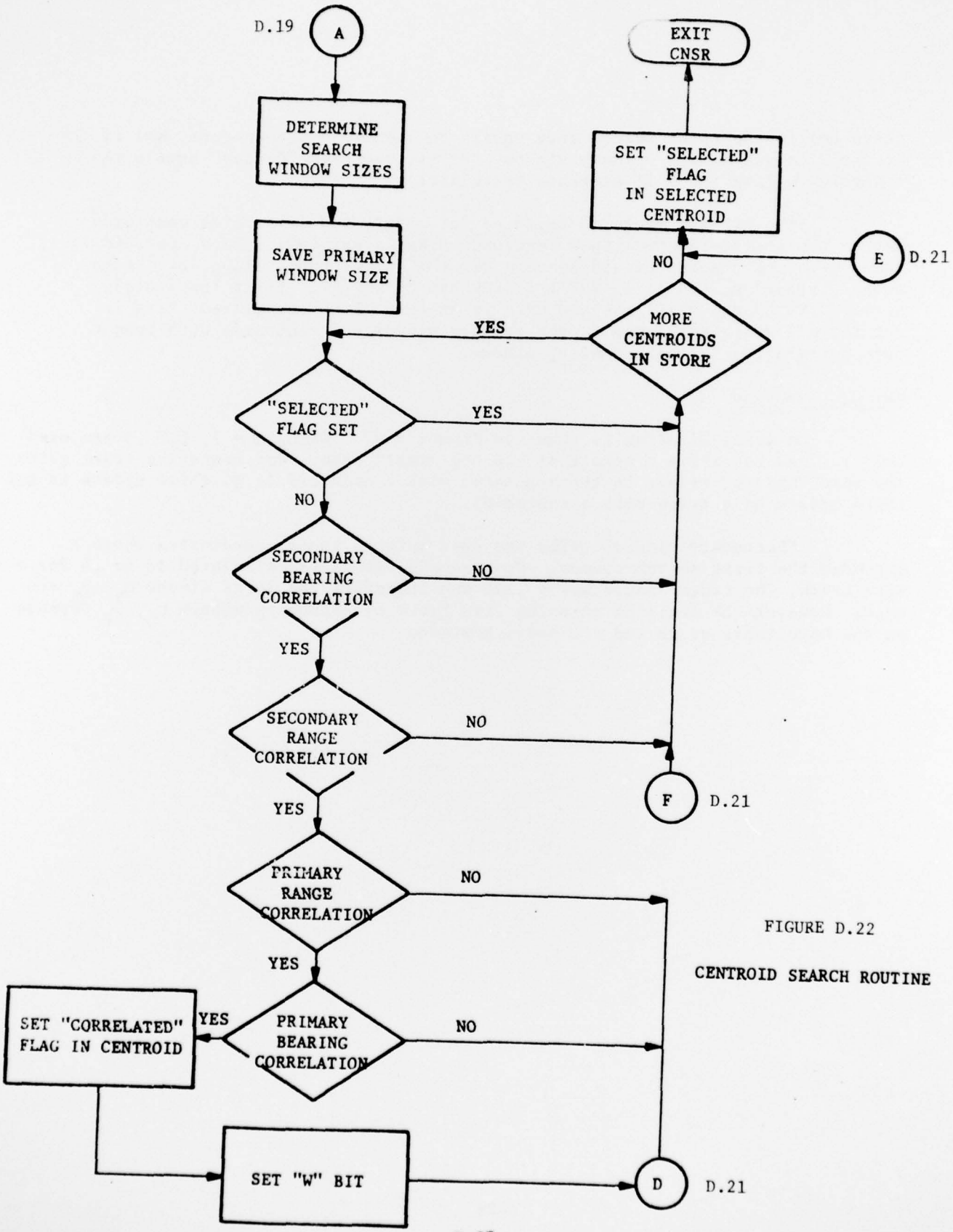

FIGURE D.22

CENTROID SEARCH ROUTINE

where B=1 if the track beacon code equals the centroid beacon code, W=1 if the centroid is within the primary window, C=1 if the track "C-flag" equals the centroid "C-flag", H=1 if altitude correlates.

The highest score is selected for update and if several centroids have a tie score, the "multiple centroid" flag is set (MC). If a centroid is found with the highest possible score for that track type, 1110_2 for tracks whose "C-flag"=0, and 1111_2 for tracks whose "C-flag"=1, it is immediately selected to update the track and CNSR is exited. The "correlated" flag is set for all centroids found in the primary window and centroids with beacon code correlation in the secondary window.

Set α, β Routine

A table of gains is shown in Figure D.23. Gains $\alpha = 1$, $\beta = .5$ are used only for new tentative tracks that had one missed scan. For tentative track gains, the word "update" refers to track updates with a centroid (e.g. third update is the third update of a track with a centroid).

"Secondary window" gains are used only on those coordinates whose Δ exceeded the first search window. For example, if ΔR is calculated to be .4 for a firm track, the range window was $\pm$ .375 and therefore the large window α_R, β_R are used. However, the decision on using firm track or secondary window α_B, β_B depends on the magnitudes of ΔB and the bearing window.

α_R	β_R	α_B	β_B	Time of Use
1	1	1	1	Update of new tentative track
1	.5	1	.5	Update of new tentative track that missed one scan
.867	.602	.914	.742	Tentative track, second update, short range
.867	.602	.848	.547	, medium "
.867	.602	.836	.516	, long "
.816	.547	.902	.742	Tentative track, third update, SR
.816	.547	.762	.43	, MR
.816	.547	.719	.344	, LR
.805	.547	.902	.742	Tentative track, fourth update, SR
.805	.547	.734	.414	, MR
.805	.547	.648	.273	, LR
.805	.547	.902	.742	Tentative track, fifth update, SR
.805	.547	.727	.414	, MR
.805	.547	.613	.258	, LR
.805	.547	.902	.742	Firm track update, SR
.805	.547	.727	.414	, MR
.805	.547	.598	.25	, LR
.867	.602	.914	.742	Firm + tentative track secondary window, SR
.867	.602	.848	.547	, MR
.867	.602	.719	.344	, LR

FIGURE D.23 TRACKER GAINS

SR = (range < 32 nmi)

MR = (32 nmi ≤ range ≤ 64 nmi)

LR = (range > 64 nmi)

GPO 914-703