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TSPOOND

MATHEMATICAL AND SUBROUTINE DESCRIPTION

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ACKNOWLEDGEMENT

The TSPOOND program, described in this document, was designed and developed through the combined effort of:

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ILLUSTRATIONS

1. INTRODUCTION

The purpose of this document is to describe the mathematical models, capabilities, and detailed computational methods of the TSPOOND study computer program. The information contained in this document is intended to supplement the TSPOOND User's Manual (Reference 1) by providing, in detail, the logic and computational methods employed by the program.

Section 2 of this document describes the mathematical models and capabilities. Section 3 contains descriptions of the program sub-routines including computational methods and detailed flow diagrams. TSPOOND usage and operating instructions along with required program interfaces may be obtained from Reference 1.

The version of the TSPOOND program currently being used resides on the SOFT 11-05 U flight support tape along with the study program TWONDER and its environment. This tape has been copied and delivered to SAMSO and contains the following programs:

Element No.	Name	ID, Mod	Codes No.
1	DIRCTY	Directory	1777
2	DUMPL	B65CA	35
3	LTAB	P41AA	102
4	SIPHON	R69AA	103
5	STTOMT	G80RB	346
6	TANGVEL	P16DA	626
7	TBCD	Q33WH	130
8	TCOIN	S03EC	446
9	TDETAIL	Q34AL	131
10	TDISPLAY	A76AN	632
11	TDMERGE	P08EG	341
12	TEPHSPAN	P06FA	334
13	TIRCOS	P12DA	622
14	TITANIC	Q30EB	464
15	TNTERP	P10EA	620
16	TOVER	P11DA	621
17	TSIGMA	P17DD	627
18	TSTACOR	P15DA	625

Element No.	Name	ID, Mod	Codes No.
19	TSTAVEC	P14DA	624
20	TWONDER	U06AA	612
21	TWONDER2	U07AI	613
22	TWOPIN	U01BA	1272
23	TWPATW	U03AI	1276
24	TWOPS	U02AR	1274
25	TWACQPR	U10AO	572
26	TWEEDOFF	U04AP	1123
27	TWASCON	U08CA	333
28	TWMOSP	U11BT	575
29	TWMOSP2	U12AS	1005
30	TWPLOT1	U30AS	1030
31	TWASSP2	U32AS	1033
32	TWLIST	U09AC	573
33	TWOUT	U13BD	1227
34	TWASSP1	U32AD	1032
35	TSPOOND	X40BH	1271

Element numbers 1 through 5 are SDC programs. Element 7, TBCD and 9, TDETAIL are part of TDISPLAY's operating environment. TWASSP1 is a table generating program used in TWONDER checkout, and TWLIST is a secure tape listing program. The remaining programs, except for TSPOOND, have specific TWONDER functions. TSPOOND can operate as a stand-alone program, but a prerequisite run must be made on TWONDER to generate a BIT containing the optimum target acquisition strategy for the main optics and the acquisition telescope(s). TSPOOND requires the BIT as a primary input. Consequently, TSPOOND and TWONDER environments have been placed on the same flight support tape.

2.0 TSPOOND MATHEMATICAL MODES

2.1 GENERAL DISCUSSION

The purpose of the computer program TSPOOND (Statistical Program of On-Board Decisions) is to simulate the actual conditions of target visibility and activity, crew voting and consequent main optics selections for the MOL/DORIAN missions. Two general types of results are generated over a given rev span: (1) typical sample information describing crew performance, target visibility and activity, and main optics selections, and (2) statistical summary data of specified output parameters derived from a specified number of samples including the means, variances, maximum and minimum values.

TSPOOND accomplishes the simulation using a Monte Carlo technique, sampling at random certain variables such as target visibility, activity, scope dwell times, crew recognition and false alarm. Using the path selections for the main optics and acquisition telescopes from the TWONDER BIT, TSPOOND simulates the effects of different crew voting strategies and other relevant factors on overall mission results.

A basic flow diagram showing the hierarchy of operations is shown in Figure 2-1.

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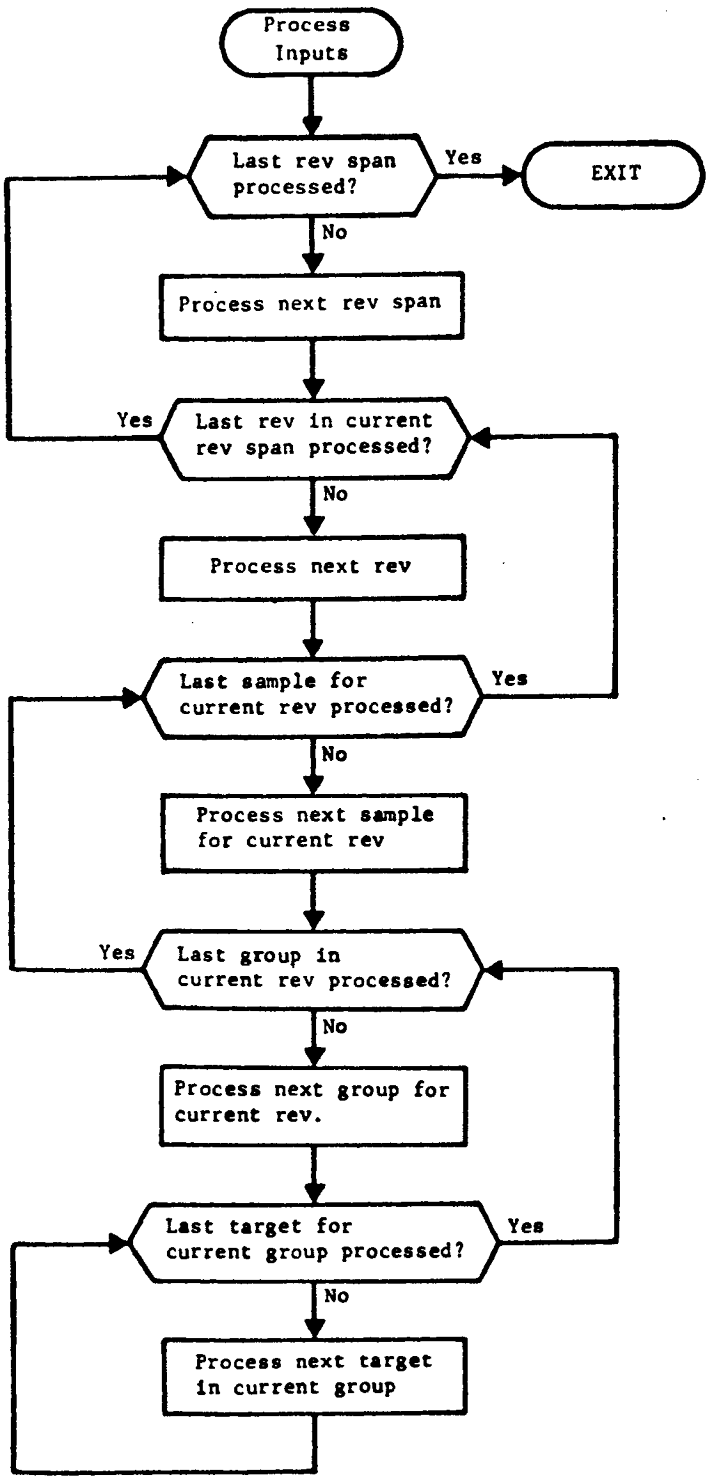

Figure 2-1. TSPOOND Basic Functional Flow

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2.2 MONTE CARLO APPROACH

The Monte Carlo technique employed in TSPOOND answers questions about various mission results by constructing a random process corresponding, as close as possible, to what a typical mission is like. The program accomplishes the simulation by representing the relevant physical and performance parameters as random variables. The cummulative distribution functions for the random variables are chosen based on historical data. The specific random variables used in TSPOOND are listed in the following table.

Variable	Description
V	visibility of a target ($V=1$ target visible; $V=0$ not visible)
δt	scope dwell time
α	target activity ($\alpha=1$ target active; $\alpha=0$ target inactive)
ξ	astronaut recognition of target activity ($\xi=1$ recognition; $\xi=0$ failure to recognize)
η	astronaut false alarm, i.e., reporting a target active when it is actually inactive ($\eta=1$ false alarm; $\eta=0$ correct report)

On the basis of these random variables, the program can effectively simulate a mission, and hence determine those parameters which depend on the random variables. Thus the mission parameters of interest are also random variables which depend in a complex way on those listed above. If the dependence were simple, an analytic approach could be utilized to immediately determine the statistical properties of the pertinent mission parameters. If, as in the present case, the dependence in complex, the Monte Carlo approach provides an effective means.

Basically, the Monte Carlo approach repeats the complete mission a large number of times (each repetition called a cycle) and tabulates the variations in the parameters of interest. For example, if r represents one such parameter, r is a function of the V_i, δt_i, α_i, ξ_i and η_i where the subscript i ranges over N, the number of targets involved, i.e.,

$$r = f(V_1, \ldots, V_N; \delta t_1, \ldots, \delta t_N; \alpha_1, \ldots, \alpha_N; \xi_1, \ldots, \xi_N; \eta_1, \ldots, \eta_N).$$

If the program then processes M cycles, M different values of r result, $r_1, \ldots r_M$. The statistical properties of r are then inferred from the sample values. An approximation to the mean of r, for example, is found from

$$\bar{r} = \sum_{j=1}^{M} r_j / M \quad ,$$

and the variance from

$$\sigma^2(r) = \sum_{j=1}^{M} (r_j - \bar{r})^2 / M \quad .$$

The program also records the largest and smallest value assumed by r over the M cycles.

2.3 RANDOM NUMBER GENERATORS

Two types of random number generators (RNG) are used by TSPOOND to generate the (pseudo) random numbers needed to compute the values of the random variables involved in the Monte Carlo sampling: (1) a zero-one generator, and (2) a generator that samples from a triangular density function. Both of these RNG use a subroutine RDM1J (section 3.24) which computes random numbers between 0 and 1 with a uniform distribution. The two RNG are described below.

2.3.1 Zero-One RNG

Many of the variables in the program are so-called "zero-one" random variables that assume the value 1 with some probability α_1 and 0 with probability $1 - \alpha_1$. If Z is such a variable, its value for each sample is determined by obtaining a number r from RDM1J falling between 0 and 1 and comparing it with α_1. If $r < \alpha_1$, Z is set to 1. If $r \geq \alpha_1$, Z is set to 0.

That Z has probability α_1 of being equal to 1 follows from:

$$\Pr\{Z = 1\} = \Pr\{r < \alpha_1\} = \frac{\alpha_1}{1} = \alpha_1$$

since r is uniformly distributed on [0, 1].

2.3.2 Triangular Density RNG

The simulation of the acquisition scope dwell time requires the generation of random variables with a specified triangular density function. Let f be the required triangular density function with mean Q and let r_1Q and r_2Q be the two base points (See Figure 2-2).

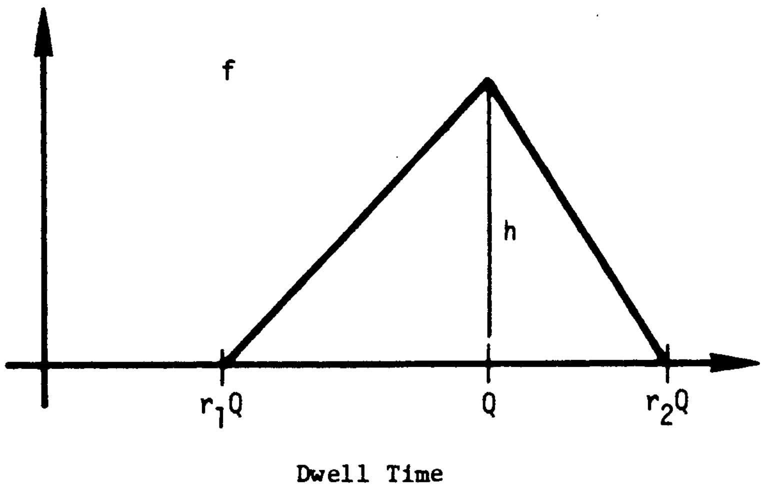


Figure 2-2. Dwell Time Probability Density Function

Since f is a density function, the area of the triangle must equal 1. Thus, the altitude h is given by

$$1 = \frac{1}{2} (r_2Q - r_1Q)h \quad , \tag{1}$$

or

$$h = \frac{2}{Q(r_2 - r_1)} \quad . \tag{2}$$

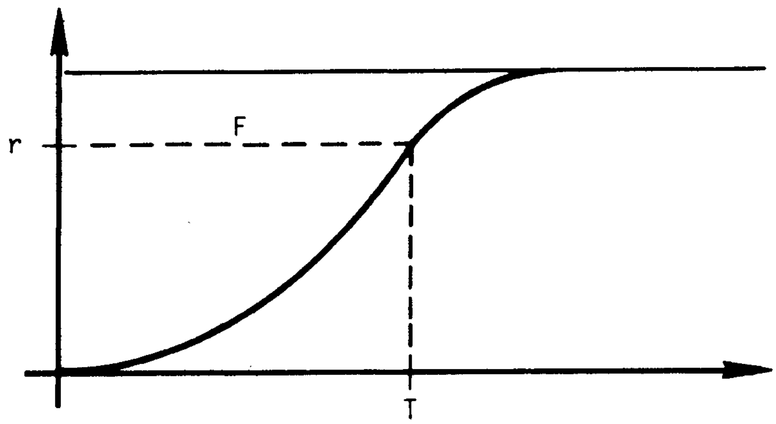
Thus, the definition of f(x) is

$$f(x) = \begin{cases} \dfrac{h(x - r_1Q)}{Q(1 - r_1)} & \text{if } x \leq Q \\[2ex] \dfrac{h(r_2Q - x)}{Q(r_2 - 1)} & \text{if } x > Q \end{cases} \quad .$$

The distribution function for x is then given by the integral of f,

$$F(x) = \int_{-\infty}^{x} f(t)dt = \begin{cases} \dfrac{h(x - r_1Q)^2}{2Q(1 - r_1)} & \text{if } x \leq Q \\ 1 - \dfrac{h(r_2Q - x)^2}{2Q(r_2 - 1)} & \text{if } x > Q \end{cases}$$

One property of F as a distribution function then guarantees that if a random variable r with uniform distribution on [0, 1] is generated, the variable $T = F^{-1}(r)$ will have the distribution function F. TSPOOND uses this method of generating the variable T with the required triangular density function.



Dwell Time

Figure 2-3. Dwell Time Cumulative Distribution Function.

Solving for T from the inverse of F yields

$$T = \begin{cases} r_1Q - \sqrt{\dfrac{2Qr(1 - r_1)}{h}} & \text{if } r \leq \left(\dfrac{1 - r_1}{r_2 - r_1}\right) \\ r_2Q - \sqrt{\dfrac{2Q(1 - r)(r_2 - 1)}{h}} & \text{if } r > \left(\dfrac{1 - r_1}{r_2 - r_1}\right) \end{cases} \qquad (3)$$

2.4 ACQUISITION SCOPE SIMULATION

The amount of time that a crew member spends viewing a target is a variable that depends on whether or not the target is visible, and, if visible, on whether or not the crew member notices activity. TWONDER uses a recommended dwell time for each target which is then transmitted to TSPOOND on the Binary Interface Tape. If the target is clear, TSPOOND uses the TWONDER recommended dwell time, δt_R, as a basis for determining a triangular density function, f, for the sample dwell time, δt. If the target is cloudy, the density function $f(\delta t)$ will be determined entirely from parameters input on the TSPOOND function card.

More precisely, if the target is visible, two ratios, Q_1 and Q_2 are read from the function card, and $f(\delta t)$ has the following form:

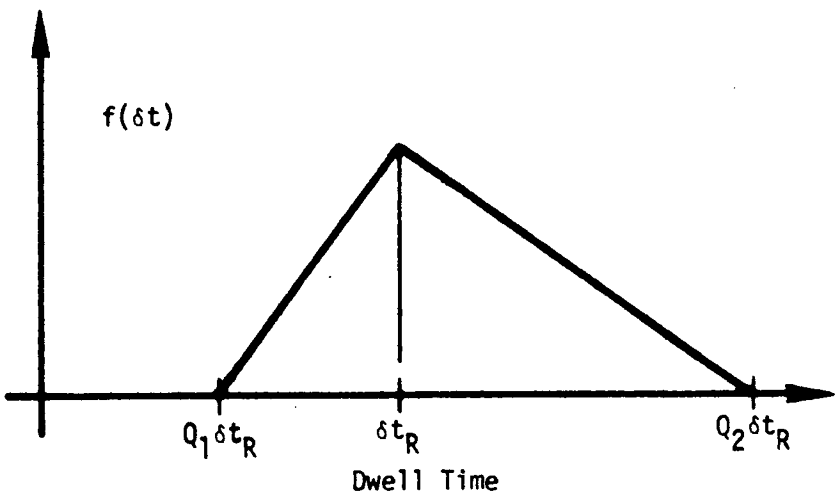


Figure 2-4 Dwell Time Density Function When Target is Clear

If the target is cloudy, three numbers, X_1, X_2 and X_3, are read from the function card and $f(\delta t)$ has the form:

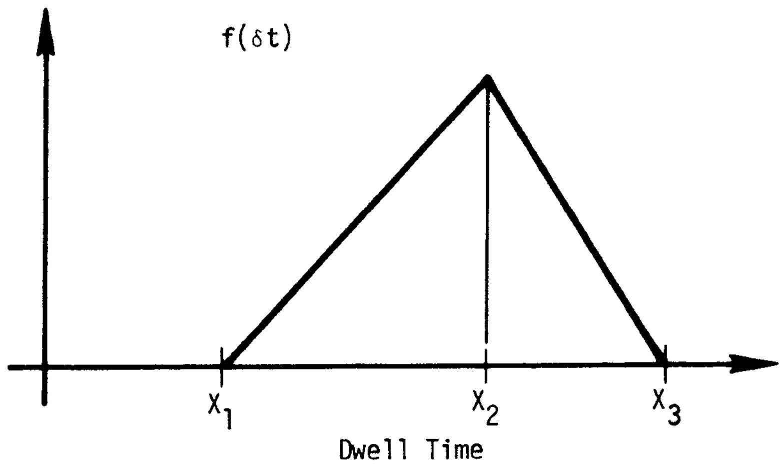


Figure 2-5 Dwell Time Density Function When Target is Cloudy

The TSPOOND scope on and off times are generated for each group using the sampled dwell times. The time between targets, SST, is approximated by the corresponding time in TWONDER, so that the equations for each scope are:

$$t_{on}^{(1)} = \bar{t}_{on}^{(1)}$$

$$t_{off}^{(i)} = t_{on}^{(i)} + \delta t^{(i)} \qquad i \geq 1$$

$$t_{on}^{(i)} = t_{off}^{(i-1)} + (\bar{t}_{on}^{(i)} - \bar{t}_{off}^{(i-1)}) \qquad i \geq 2$$

where the bar denotes the TWONDER values and the superscripts refer to the target numbers within each group for the scope. The $\delta t^{(i)}$ is the actual (or sampled) dwell time.

The situation is illustrated in Figure 2-6.

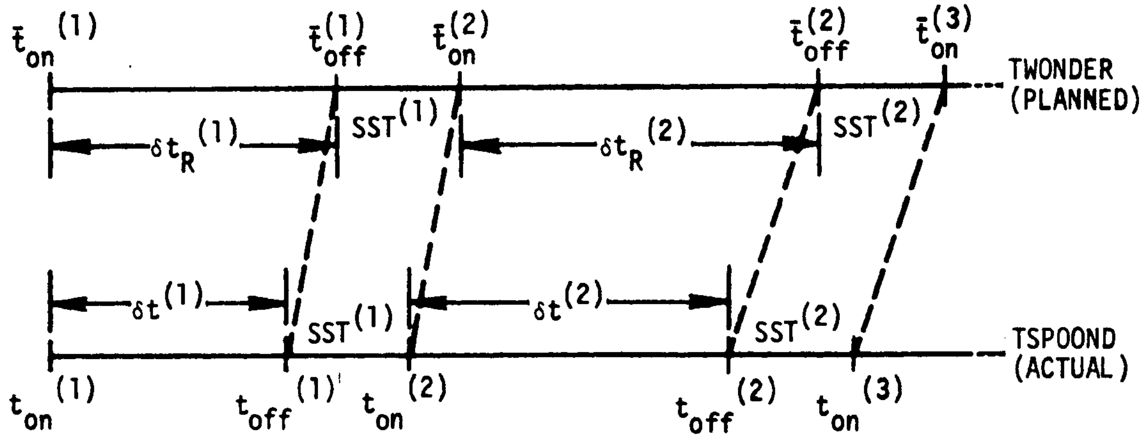


Figure 2-6 TWONDER and TSPOOND Scope on and off Times

2.5 INTRA-GROUP WEATHER CORRELATION

The term "intra-group correlation" refers to the correlation between the visibility of targets within the same group. If one target is known to be visible, the probability that another target within the same group (and hence geographically close) is visible is enhanced. TSPOOND models this correlation by assuming that the correlation between any two targets is the same, i.e.,

$$\bar{\rho} \quad (V_i, V_j) = \bar{\rho} \qquad \text{for} \quad i, j = 1, 2, \ldots, N \tag{1}$$

where V_i is a zero-one variable for the i^{th} target which is 1 if the target is visible and 0 if not. The probability of visibility $\bar{P}$ for the targets satisfies

$$Pr\{V_i = 1\} = \bar{P} \qquad \text{for} \quad i=1, \ldots, N \tag{2}$$

Thus TSPOOND must generate the N variables $V_1, \ldots, V_N$ satisfying (1) and (2). To accomplish this, TSPOOND uses the following conditional sampling technique: First an auxiliary zero-one random variable C is introduced with $Pr\{C=1\} = P_c$ and $Pr\{C=0\} = 1-P_c$. Then the distribution functions for the V_i are determined conditionally so that

$$\begin{array}{ll} Pr\{V_i=1 \mid C=1\} = P_1 & (Pr\{V_i=0 \mid C=1\} = 1-P_1) \\ Pr\{V_i=0 \mid C=0\} = P_1 & (Pr\{V_i=1 \mid C=0\} = 1-P_1) \end{array} \tag{3}$$

The basic problem, then, is to determine P_c and P_1 in order to satisfy (1) and (2).

Equation (2) implies that

$$E\ (V_i) = P_c P_1 + (1-P_c)\ (1-P_1) = \bar{P} \tag{4}$$

The covariance of V_i and V_j is given by

$$\mathrm{COV}(V_i, V_j) = E(V_i V_j) - E(V_i)\, E(V_j)$$

where $$E(V_i V_j) = P_c P_1^2 + (1-P_c)(1-P_1)^2$$

and $$E(V_i) = E(V_j) = P_c P_1 + (1-P_c)(1-P_1) \tag{5}$$

So, carrying out the algebra,

$$\mathrm{COV}(V_i, V_j) = P_c(1-P_c)(2P_1-1)^2.$$

Finally, the correlation coefficient between V_i and V_j is

$$\rho(V_i, V_j) = \frac{\mathrm{COV}(V_i, V_j)}{\sigma(V_i)\,\sigma(V_j)} \tag{6}$$

where $\sigma(V_i) = \sigma(V_j) = E(V_i)\left[1-E(V_i)\right]$.

So (6) becomes (using (2))

$$\rho(V_i, V_j) = \frac{P_c(1-P_c)(2P_1-1)^2}{\overline{P}(1-\overline{P})} \tag{7}$$

Applying condition (1) to (7) yields

$$\overline{\rho} = \frac{P_c(1-P_c)(2P_1-1)^2}{\overline{P}(1-\overline{P})}. \tag{8}$$

Thus the problem reduces to the simultaneous solution of (4) and (8) for P_c and P_1.

Letting $K = \overline{\rho}\,\overline{P}(1-\overline{P})$ in (8) yields

$$K = (P_c - P_c^2)(2P_1-1)^2 \tag{9}$$

Solving (6) for P_1,

$$P_1 = \frac{\overline{P}+P_c-1}{2P_c-1} \tag{10}$$

Returning to (9),

$$K = (P_c - P_c^2)\left[\frac{2\overline{P} + 2P_c - 2}{2P_c - 1} - 1\right]^2 \tag{11}$$

or

$$K = (P_c - P_c^2)\left[\frac{2\overline{P} - 1}{2P_c - 1}\right]^2 \tag{12}$$

Now define

$$K' = \frac{K}{(2\overline{P} - 1)^2} \tag{13}$$

Equation (12) now becomes

$$K' \ (2P_c - 1)^2 = P_c - P_c^2$$

$$K' \ (4P_c^2 - 4P_c + 1) = P_c - P_c^2$$

where finally

$$P_c^2 - P_c + \frac{K'}{4K' + 1} = 0 \tag{14}$$

The solution of (14) is

$$P_c = \frac{1}{2} + \frac{1}{2}\sqrt{\frac{1}{4K' + 1}} \qquad (15)$$

Substituting P_c into (10) results in

$$P_1 = \frac{1}{2} + (\overline{P} - \frac{1}{2})\sqrt{4K' + 1} \qquad (16)$$

Thus the values for P_c and P_1 in (15) and (16) will guarantee the generation of the N variables V_1, ..., V_N satisfying (1) and (2). This method is particularly convenient for computational purposes because the visibility of the targets in a group can be accomplished by a succession of calls to a simple Bernoulli random number generator.

2.6 INTER-GROUP WEATHER CORRELATION

Inter-group weather correlation refers to the correlation between the visibility of targets in adjacent groups. The model used in TSPOOND assumes that the weather for group i+1 is dependent only upon the weather for group i but not upon that for any other group. The amount of correlation is determined as a function of the time interval between their group decision times. A quantity t_{max} (input on the TSPOOND function card) specifies the time at which the inter-group correlation coefficient falls to 0.

More precisely, define two zero-one random variables, $V^{(i)}$ and $V^{(i+1)}$, representing the visibility of group i and group i+1 respectively, with

$$Pr\{V^{(i)} = 1\} = \mu_1 \qquad (Pr\{V^{(i)} = 0\} = 1-\mu_1) \tag{1}$$

$$Pr\{V^{(i+1)} = 1\} = \mu_2 \qquad (Pr\{V^{(i+1)} = 0\} = 1-\mu_2) \tag{2}$$

Further let $\bar{\rho}$ be the specified correlation coefficient between $V^{(i)}$ and $V^{(i+1)}$,

$$\rho(V^{(i)}, V^{(i+1)}) = \bar{\rho} \tag{3}$$

The variable $V^{(i)}$ and $V^{(i+1)}$ satisfying (1) - (3) are generated by a conditional sampling technique. The value of $V^{(i)}$ is first selected to satisfy (1) and then the value of $V^{(i+1)}$ is selected conditionally so that

$$Pr\{V^{(i+1)} = 1 \mid V^{(i)} = 1\} = P_1 \tag{4}$$

and

$$Pr\{V^{(i+1)} = 1 \mid V^{(i)} = 0\} = P_2. \tag{5}$$

From equations (1) and (2) and the definition of expectation,

$$E(V^{(i+1)}) = \mu_2 = \mu_1 P_1 + (1-\mu_1)P_2 \tag{6}$$

Also the variances of $V^{(i)}$ and $V^{(i+1)}$ are given by

$$\sigma^2(V^{(i)}) = \mu_1(1-\mu_1) \tag{7}$$

and

$$\sigma^2(V^{(i+1)}) = \mu_2\ (1-\mu_2) \tag{8}$$

The expected value of the product of $V^{(i)}$ and $V^{(i+1)}$ is

$$E(V^{(i)}\ V^{(i+1)}) = \mu_1 P_1 \ .$$

Hence the correlation coefficient between $V^{(i)}$ and $V^{(i+1)}$ is

$$\rho(V^{(i)}, V^{(i+1)}) = \frac{E(V^{(i)}\ V^{(i+1)}) - E(V^{(i)})\ E\ (V^{(i+1)})}{\sigma(V^{(i)})\ \sigma\ (V^{(i+1)})}$$

$$= \frac{\mu_1 P_1 - \mu_1\mu_2}{\sqrt{\mu_1(1-\mu_1)\mu_2\ (1-\mu_2)}} \tag{9}$$

So from (3),

$$\bar{\rho} = \frac{\mu_1 P_1 - \mu_1\mu_2}{\sqrt{\mu_1(1-\mu_1)\ \mu_2\ (1-\mu_2)}} \tag{10}$$

Thus the problem has reduced to the simultaneous solution of (6) and (10) for P_1 and P_2. Solving (10) for P_1 yields

$$P_1 = \frac{\bar{\rho}}{\mu_1}\sqrt{\mu_1(1-\mu_1)\ \mu_2\ (1-\mu_2)} + \mu_2 \tag{11}$$

Substituting P_1 from (11) into (10) produces

$$P_2 = \mu_2 - \frac{\bar{\rho}}{(1-\mu_1)}\sqrt{\mu_1(1-\mu_1)\ \mu_2\ (1-\mu_2)} \tag{12}$$

The solutions, P_1 and P_2, given in (11) and (12) must fall between 0 and 1, however. Applying this inherent constraint to (11) yields

$$\frac{\bar{\rho}}{\mu_1} \sqrt{\mu_1(1-\mu_1)\,\mu_2\,(1-\mu_2)} + \mu_2 < 1$$

$$\bar{\rho} < \frac{\mu_1(1-\mu_2)}{\sqrt{\mu_1(1-\mu_1)\,\mu_2\,(1-\mu_2)}}$$

and finally

$$\bar{\rho} < \sqrt{\frac{\mu_1(1-\mu_2)}{\mu_2(1-\mu_1)}} \qquad (13)$$

A similar computation applied to (12) results in

$$\bar{\rho} < \sqrt{\frac{\mu_2(1-\mu_1)}{\mu_1(1-\mu_2)}} \qquad (14)$$

so that the final constraint on $\bar{\rho}$ is given by

$$\bar{\rho} < \min \left\{ \sqrt{\frac{\mu_1(1-\mu_2)}{\mu_2(1-\mu_1)}}, \sqrt{\frac{\mu_2(1-\mu_1)}{\mu_1(1-\mu_2)}} \right\} \qquad (15)$$

The maximum value $\bar{\rho}$ can have is denoted $\bar{\rho}_{max}$. TSPOOND computes $\bar{\rho}$ from $\bar{\rho}_{max}$ and the time interval, T, between the group decision times for groups i and i+1 as follows:

$$\bar{\rho} = \begin{cases} 0 & \text{if} \quad T > t_{max} \\ \bar{\rho}_{max} \left(1 - \frac{T}{t_{max}}\right) & \text{otherwise} \end{cases}$$

Thus the correlation coefficient linearly decays to zero at time t_{max} from its maximum value $\bar{\rho}_{max}$.

3. TSPOOND SUBROUTINE DESCRIPTIONS

3.1 GLOSSARY OF TSPOOND COMMON STORAGE

JOVIAL Symbol	Dimension	Description and Units
ALTERN	5	Array containing the count of active, inactive, reject, unobserved, and total alternate targets over a rev span
ASDT		Actual acquisition telescope dwell time (sec)
AV		Actual visibility flag 0 not actually visible 1 actually visible
AVOT		Vote on reported and active status 0 - no vote recorded 1 - voted active 2 - voted inactive 3 - voted reject 4 - not voted upon (unobserved)
BLNK		Item consisting of all blanks used mainly for output
BTBF	1000	Input buffer for the TWONDER BIT information (first two files)
BUFOUT		120 byte BCD output buffer
CBERN		Bernoulli variable visibility flag taken from previous group (used in the inter-group correlation model) 0 - clouded 1 - visible
CLEART	2	Two cell array containing the count of clear targets with and without interdiction
CNFLG		Conflict flag indicating conflict status of group CNFLG = 0 group contains no targets in conflict with previous group's target selection

JOVIAL Symbol	Dimension	
CNFLG (Cont'd.)		CNFLG ≠ 0 Group contains at least one target in conflict with previous group's target selection
CNFLT		Conflict flag indicating conflict status of target CNFLT = 0 Present target not in conflict with previous group's target selection CNFLT ≠ 0 Present target in conflict with previous group's target selection
DBITS	15	720 bit array whose bits, when set non-zero, indicate a typical sample detail output is desired on those corresponding rev numbers (e.g., when bit 35 of DBITS is set non-zero typical sample detail output for rev 35 is desired)
DECEPT	7	(0) Number of false alarms (1) Not used (2) Number of failures to recognize (3) Number of false alarm primaries (4) Number of false alarm alternates (5) Number of failure to recognize primaries (6) Number of failure to recognize alternates
DETFLG		Boolean flag used to indicate when typical sample detail output has been written on KSPOUT DETFLG ≠ 0 Write end of file on KSPOUT DETFLG = 0 No action taken
DT		Sum of the scope slew and settle time plus actual scope dwell time (sec)
EOF		Boolean flag used to check for end-of-files or end-of-tapes after an I/O operation
EXTBITS		Item whose first 30 bits indicate which extended statistics have been requested of the corresponding 30 summary output parameters
FDET		Boolean flag which, when true, indicates typical sample detail output is desired on the current rev

JOVIAL Symbol	Dimension	Description and Units
FSUM		Boolean flag which, when true, indicates summary output desired on current rev
F78IT	21	1000 bit array whose bits, when set non-zero, indicate decimal integer output for those corresponding File 7 and File 8 reset parameters
GDT1		Previous group's group decision time in sec (used in the inter-group visibility correlation model)
GN		Present group number
GNMAX		Number of groups on the current rev
ICOM		Current rev span summary being processed by TSPOOND
IGCC		ρ - intra group visibility correlation coefficient, $0 \leq \rho \leq 1.0$
IMAGE		The start address of the buffer which contains the converted image of the last card read by CARDIO
INPUT	10	The buffer used to contain the data card images
IPVIS		Option flag for selection of probability of visibility used by TSPOOND IPVIS = 0 Intra/Inter group visibility correlation considered - probability of visibility from File 8 IPVIS = 1 Intra/Inter group visibility correlation considered - probability of visibility from target specific selection files of BIT IPVIS = 2 Intra/Inter group visibility correlation considered - probability of visibility from function card IPVIS = 3 Independent (no correlation) using probability of visibility from File 8

JOVIAL Symbol	Dimension	Description and Units
IPVIS (continued)		IPVIS = 4 Independent (no correlation) using probability of visibility from function card
IRN		Initial random number seed $0 \leq IRN \leq 2^{36}$
ITOPG		The selected target index referenced from the beginning of the group
ITOPT		The selected target index referenced from the beginning of the rev
IVO		Decision strategy flag for determining target selection. At present no options exist for this strategy
KBIT		TWONDER BIT tape logical symbolic unit
KIN		Symbolic unit assignment for input unit
KOL		Symbolic unit assignment for Monte Carlo specific detail and summary output
KON		On-line printer symbolic unit
KOUT		Symbolic unit assignment for listable secure output tape
KSPOUT		Symbolic unit assignment for TSPOOND users interface tape
KSPTFG		Flag used to control KSPOUT output KSPTFG ≠ 0 KSPOUT not written KSPTFG = 0 Information in buffer to be output on KSPOUT
LINECNT		Line counter used in the formatted output of the Monte Carlo specific information (KOL Tape)
LPIL		Boolean flag used to check success of the last I/O operation
MAX		Item containing the maximum value of a particular summary output parameter on a rev by rev basis; used in extended statistics output logic

JOVIAL Symbol	Dimension	Description and Units
MCBUF		120 byte BCD output buffer; used primarily to buffer the Monte Carlo specific formatted output
MEAN		Item containing the mean value of a particular summary output parameter on a rev by rev basis; part of the extended statistics output
MIN		Minimum value of a particular summary output parameter
NALTN		Total number of alternate targets accumulated over a rev span
NCNFLT		Total number of groups eliminated due to conflict within a rev span
NCOM		Total number of rev span summaries to be processed by TSPOOND
NGPRS		Total number of groups accumulated over a rev span
NPRIM		Total number of primary targets accumulated over a rev span
NS		Current sample number
NTPRS		Total number of photographed targets on the TWONDER BIT accumulated over the present rev span
NULLREV		Boolean flag used to indicate a null rev (no targets on a particular rev) occurring on the TWONDER BIT
NVIT		Total number of visual intelligence targets accumulated over a rev span
PFAL		Function card probability of false alarm (i.e., probability that a crew member reports a target active when it is inactive), $0. \le PFAL \le 1.0$
PFALM		TSPOOND working cell for probability of false alarm, $0. \le PFALM \le 1.0$

JOVIAL Symbol	Dimension	Description and Units
PRCNTRL		Boolean flag to control printing of Monte Carlo specific output PRCNTRL ≠ 0, No Monte Carlo specific output written PRCNTRL = 0, Monte Carlo specific output written on KOL
PRCONFL		Conflict matrix of target selected in previous group
PREC		Probability of recognition, 0. ≤ PREC ≤ 1.0
PRECOG		TSPOOND working cell for probability of recognition, 0. ≤ PRECOG ≤ 1.0
PRIM		Flag indicating whether the group being processed contains a primary target PRIM = 1 current group contains a primary target PRIM = 0 current group does not contain a primary target
PRIMRY	5	Array containing the count of active, inactive, reject, unobserved, and total primary targets over a rev span
PROBA		Probability of activity off Reset File 8 of the TWONDER BIT, 0. ≤ PROBA ≤ 1.0
PROBFA		Probability of false alarm off Reset File 8 of the TWONDER BIT, 0. ≤ PROBFA ≤ 1.0
PROBREC		Probability of recognition off Reset File 8 of the TWONDER BIT, 0. ≤ PROBEC ≤ 1.0
PROBV		Probability of visibility off Reset File 8 of the TWONDER BIT, 0. ≤ PROBV ≤ 1.0

JOVIAL Symbol	Dimension	Description and Units
PROL		Function card input parameter controlling which output tapes will be written PROL > 0 BCD interface tape (KSPOUT), and listable output tape (KOUT) will be written PROL < 0 KSPOUT, KOUT, and Monte Carlo specific output tape (KOL) will be written
PV		Working cell for the probability of visibility, 0. ≤ PV ≤ 1.0
PVINP		Probability of visibility input on TSPOOND function card, 0. ≤ PVINP ≤ 1.0
PVIS		Working cell for the probability of visibility of the group being processed, 0. ≤ PVIS ≤ 1.0
PVIS1		Working cell for the previous group's probability of visibility, 0. ≤ PVIS1 ≤ 1.0
RA		Reported activity of current target RA = 0 reported not active = 1 reported active = 2 not reported
RATIO1, RATIO2		Dwell time density ratios for clear votes. The recommended dwell time is multiplied by each of these ratios to form the vertices of the dwell time triangular density function for clear votes
REVTAB		Name of table containing the selection file parameters (one rev's worth)
REN		Rev number of ending rev of the current rev span
RN		Current rev number

JOVIAL Symbol	Dimension	Description and Units
RR1, RR2		Dwell time density ratios for reject votes. X_1, X_2, X_3 represent (in sec.) the three vertices of the dwell time triangular density function for reject votes $RR1 \equiv \frac{X_1}{X_2}$ $RR2 \equiv \frac{X_3}{X_2}$
RV		Reported visibility of current target RV = 0 reported not visible RV = 1 reported visible RV = 2 not reported
SCOF	2	Scope on flags, set to non zero for each scope after first viewing bv each scope, initialize once for each group
SIGMA	30	Array containing the standard deviations of the 30 output parameters when extended statistics are desired
SIGT	2	Current time for scope SN (sec)
SMAX	30	Array containing the maximum of the 30 output parameters when extended statistics are desired
SMIN	30	Array containing the minimum of the 30 output parameters when extended statistics are desired
SN		Number of scope viewing current target
SNN		Index of scope number viewing current target SNN = SN-1
STAT	30	Array containing running sums of the 30 output parameters of the extended statistics output over one sample
STATS	30	Array containing sums of the 30 output parameters of the extended statistics output over all samples

JOVIAL Symbol	Dimension	Description and Units
STOF		Scope off time for viewing of current target (sec)
STON		Scope on time for viewing of current target (sec)
TALT*		Target altitude (ft X 10^{-2})
TAON*		ATS on time, seconds, machine time
TASSNO*		Scope number used (target specific) 0 - not viewed by ATS; 1 - scope 1 used; 2 - scope 2 used
TATSMO2*		Off time for MO photography of alternate targets, seconds, machine time
TAWGT*		ATS relative target weight (non-dimensional)
TBAB13*		Time between forward and vertical acquisition (sec)
TBACD*		Specifies alter option used 0 - none; 1 - add; 2 - change; 3 - delete
TBAHT*		Vehicle altitude at time of vertical acquisition (nautical miles)
TBAMS*		Mission number
TBAPR*		Probability factor (%)
TBARV*		Revolution of acquisition requested on target card
TBASA*		Sun elevation angle (rad)
TBASR*		Slant range at time of vertical acquisition (naut. mi.)

*Indicates items are passed from the selection files of the TWONDER BIT input tape.

SECRET/D

JOVIAL Symbol	Dimension	Description and Units
TBAVY*		Azimuth flag 0 - descending 1 - ascending
TBA16*		Obliquity of vertical acquisition
TBA23*		Obliquity deletion angle (deg). A limit for obliquity beyond which targets are deleted from consideration
TBENCHF*		Flag indicating target is a bench mark target (1 - yes, 0 - no)
TDDD*		Target diameter (ft X 10)
TDECIS*		Latest time at which decision can be made to take primary target of a group or substitute an alternate (sec)
TDWELL*		Nominal ATS dwell time (sec)
TEEE*		Sun deviation angle at time TT2 (radians)
TFLICT*		Conflict matrix (or word). 24-bit array in which a bit is set to 1 for each photographable target in the following group which the target conflicts with
TFSUM		Flags indicating rev span summary desired or not 0 - Summary desired for corresponding rev span 1 - Rev span summary not desired for corresponding rev span
TGRNO*		Target group number
TIDA*		First 8 characters of target's alpha numeric identifier
TIDB*		Final 2 characters of target's alpha numeric identifier
TIDX		Target index within current rev 0 - 1st target 1 - 2nd target, etc.

*Indicates items are passed from the selection files of the TWONDER BIT input tape.

JOVIAL Symbol	Dimension	Description and Units
TLAT*		Target latitude (radians)
TLONG*		Target longitude (radians)
TMATSF*		Mandatory ATS flag, indicates target must be viewed with ATS (1 - yes, 0 - no)
TMAX		The maximum time within which inter-group visibility correlation is considered (sec)
TMODE*		Requested photographic mode (0-9)
TMPF*		Mandatory primary flag. If set, target is to be taken by main optics and is assigned a priority of 0. (1 - yes, 0 - no)
TMSIG*		Mid stereo angle (deg), the stereo angle at the average time between TT1 and TT3
TN		Target number within group (1 to TNMAX)
TNASSTE*		Number of ATS entries for rev
TNBITE*		Number of entries on BIT for entire rev
TNMAX	100	Maximum number of targets within each group of current rev
TNMOSTE*		Number of main optics entries on BIT for entire rev
TNN		Target index within current group 0 - 1st target in group 1 - 2nd target in group, etc.
TNP	2	Rev specific target numbers of the last target within current group taken by current scope
TNSF*		Direction of vehicle pass over target 0 - North to South 1 - South to North

*Indicates items are passed from the selection files of the TWONDER BIT input tape.

JOVIAL Symbol	Dimension	Description and Units
TOMEGA1*		Obliquity at time TT1 (radians)
TOMEGA2*		Obliquity at time TT2 (radians)
TOMEGA3*		Obliquity at time TT3 (radians)
TONS		Total number of samples requested on current rev span summary
TONSN	100, 2	Array containing ATS time on (both scopes) for each group within rev (sec)
TPRIA*		Active priority of target (0-99)
TPRII*		Inactive priority of target (0-99)
TPROBA*		Probability of activity for a given target (%)
TREN		Ending rev number of the current requested rev span
TREV*		Rev number incremented at passage of ascending node
TRR*		Resolution requirement in inches (0-99)
TRST		Beginning rev number of the current requested rev span
TSC*		Scan target flag, (1 - yes, 0 - no)
TSCC*		Special category code, designating a target which falls in a special category (000-999)
TSHAPE*		Pitch weighting function (0-9) (See File 8 Description, TWONDER User's Manual, Reference 3)
TSIGMAD*		Desired pitch angle (deg)

*Indicates items are passed from the selection files of the TWONDER BIT input tape.

JOVIAL Symbol	Dimension	Description and Units
TSMODE*		Main optics selected photographic mode (0-9) (See File 8 Description, TWONDER User's Manual, Reference 3)
TTDWELL*		ATS dwell time from File 8 (sec)
TTIME*		Time of vertical acquisition (when vehicle is closest to target) in minutes from base date
TTLV*		Target location validity code (0-9)
TTOFF*		Main optics off time in seconds, machine time
TTON*		Main optics on time in seconds, machine time
TTONS		Array containing total number of samples for each requested rev span
TT1*		Forward acquisition time (machine time sec)
TT2*		Vertical acquisition time (machine time sec)
TT3*		Aft acquisition time (machine time sec)
TVAP*		Target type flag 0 - VIT 1 - Primary 2 - Alternate
TVELI*		Inertial velocity vector magnitude of vehicle at time of vertical acquisition (ft/sec)
TVIF*		VIT flag, designates target to be viewed by ATS only, non-photographable (1 - yes, 0 - no)
TWA*		Active target weight, non-dimensional
TWEIGHT*		Main optics relative weight of selected target, a measure of target worth, non-dimensional

*Indicates items are passed from the selection files of the TWONDER BIT input tape.

JOVIAL Symbol	Dimension	Description and Units
TWI*		Inactive target weight, non-dimensional
TWX*		Weather factor (0-99)
VDICT	100	Index for the VTAB array indicating the beginning entry of the voting table corresponding to each group within the rev.
VEHNO		Vehicle number
VIV	15	Array containing the correlated intra-group visibility variables for each target within a group 0 - clouded 1 - visible
VOTESA	5	Array containing number of active, inactive, reject, unobserved and total alternate target votes
VOTESP	5	Array containing number of active, inactive, reject, unobserved and total primary target votes
VTAB	1000	Voting table array for each target within each group of the rev. Contains the active, inactive, reject, and unobserved weights for each target
VV		Flag denoting visibility for current target 0 - clouded 1 - visible
WEIGHT	2	Average selected target weights with and without interdiction
WRN		Working random number seed
WTOP		The weight (active, inactive, reject, unobserved) assigned to the actual vote of the selected target within a group

*Indicates items are passed from the selection files of the TWONDER BIT input tape.

JOVIAL Symbol	Dimension	Description and Units
XX1, XX2, XX3		Dwell time density parameters for reject votes (sec) representing the three vertices of the dwell time triangular density function

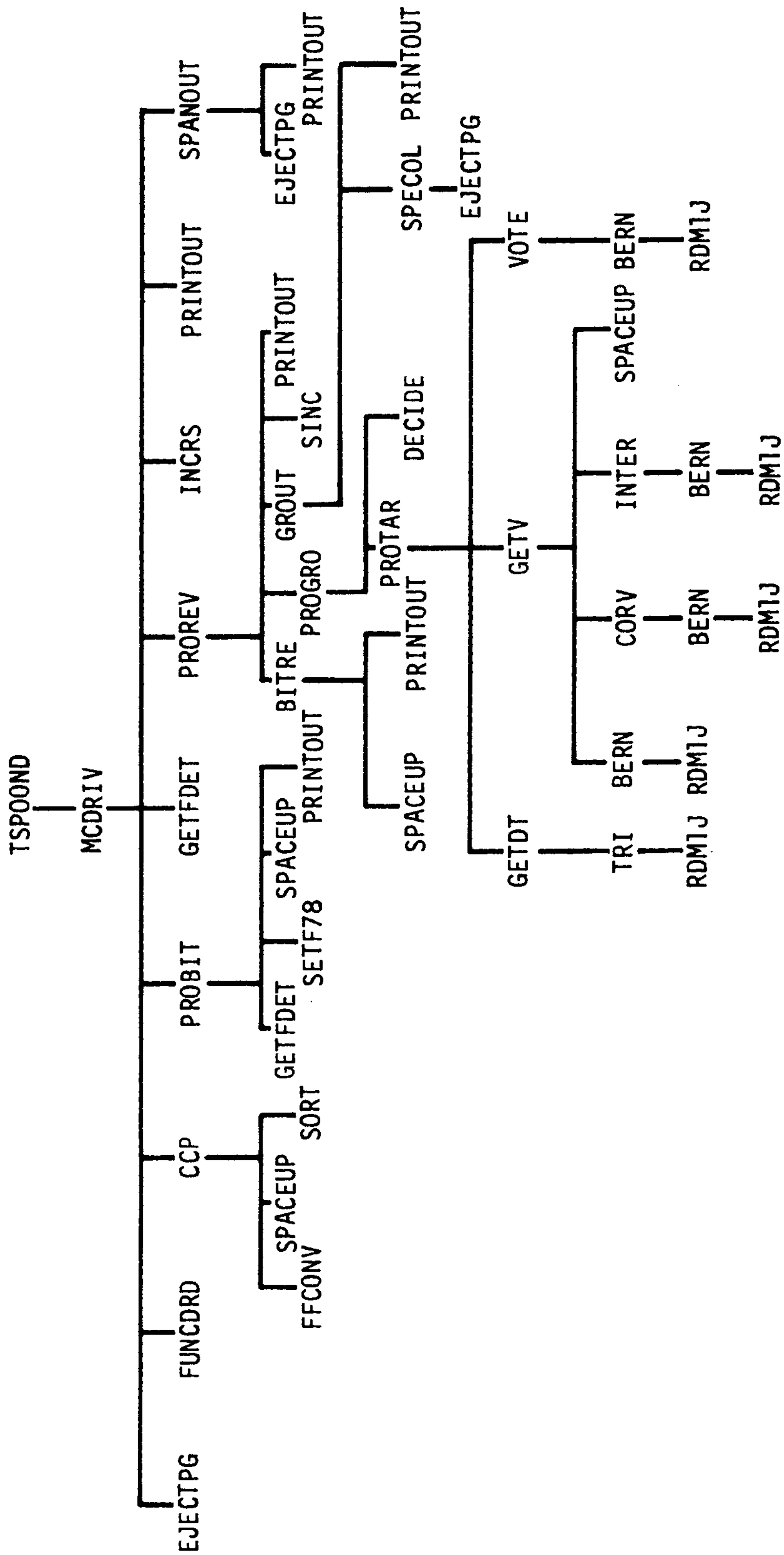


Figure 3-1 TSPOOND Subroutine Hierarchy

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3.2 TSPOOND

3.2.1 Purpose

TSPOOND serves as the highest level control routine for the Statistical Program of On Board Decisions (TSPOOND). Its primary function is to initialize core storage properly; in addition, it contains the main body of program item, array and table data declarations. TSPOOND performs no computations but merely passes execution control to the next TSPOOND sub-module to accomplish the TSPOOND task.

3.2.2 Usage

3.2.2.1 Calling Sequence

TSPOOND is the main routine in the TSPOOND computer program and is initiated by input of the TSPOOND function card to the SMTC executive control program.

3.2.2.2 Input

CLANK	Cell containing the current location counter; i.e., the first available memory location
KOUT	Symbolic listable output tape (logical tape 8)

3.2.2.3 Output

None

3.2.2.4 Error/Action Messages

None

3.2.2.5 Subroutines Called

MCDRIV	Main driver for TSPOOND
WEOF	Tape/disk output routines
CHECKW	Tape/disk output routines

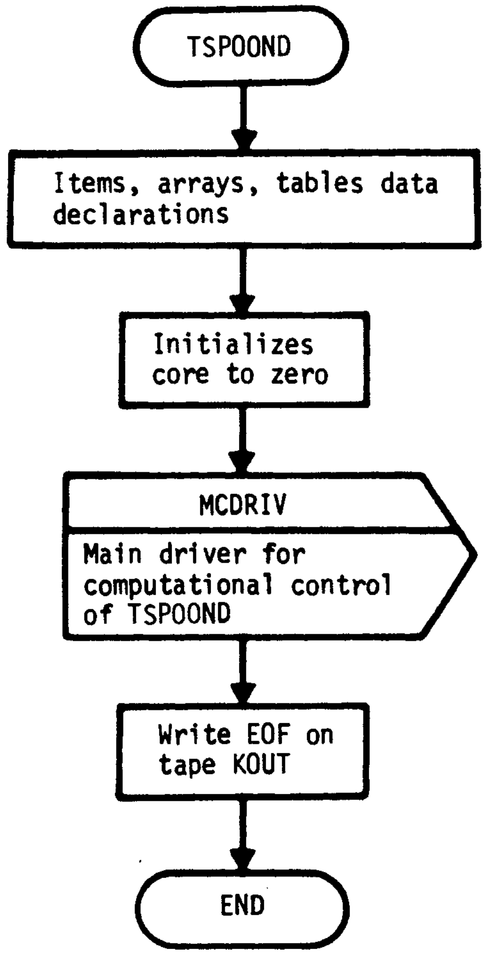

Figure 3-2 Main Program TSPOOND Flow Diagram

3.3 SUBROUTINE BERN

3.3.1 Purpose

BERN is a Bernoulli random number generator which will output either a zero or a one as a function of a random number obtained from RDM1J. If the random number from RDM1J is less than or equal to a specified probability, BERN will output the number one. If the random number from RDM1J is greater, BERN will output zero.

3.3.2 Usage

3.3.2.1 Calling Sequence

BERN (PRØB) $

3.3.2.2 Input

a. Calling Sequence

Program Symbol	Description
PRØB	Input probability. A floating point number between zero and one

b. Inputs through common locations

WRN

3.3.2.3 Output

a. Calling Sequence

Program Symbol	Description
BERN	An integer number, either zero or one

b. Outputs through common locations

None

3.3.2.4 Working Symbols

Program Symbol	Description
ANS	A random number between zero and one.

3.3.2.5 Error/Action Messages

None

3.3.2.6 Subroutines Called

RDM1J

3.3.2.7 Called By

GETV
CØRV
VØTE
INTER

3.3.3 Method

Figure 3-3 shows the flow logic for BERN.

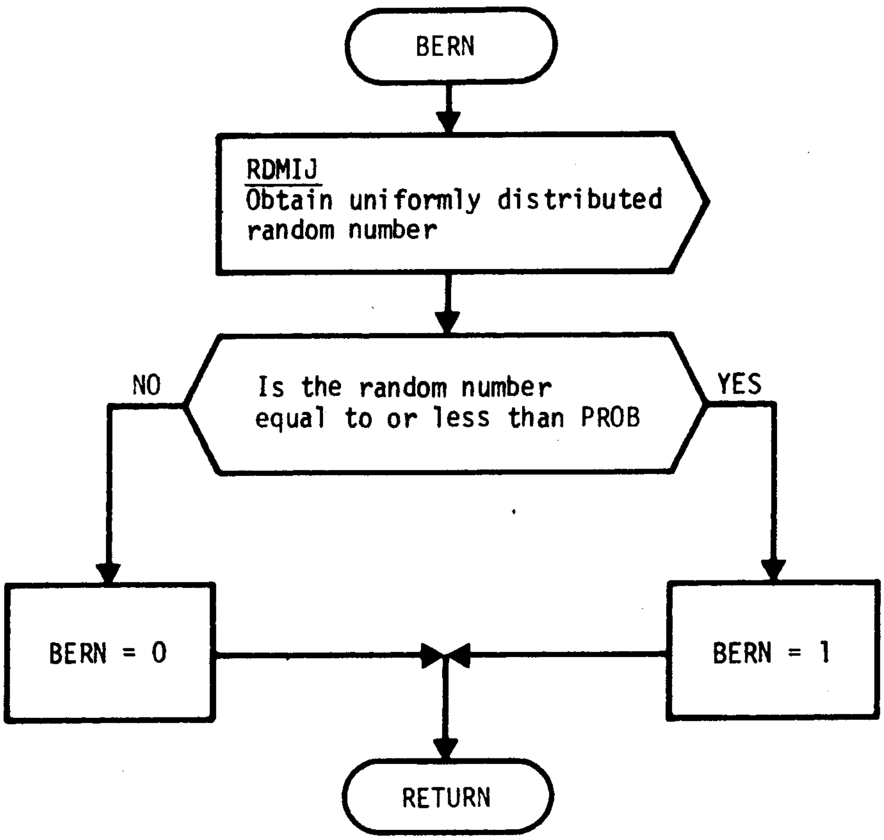

Figure 3-3 Subroutine BERN Flow Diagram

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3.4 SUBROUTINE BITRE

3.4.1 Purpose

The function of subroutine BITRE is to read into core storage the MO and ATS selection file(s) of the TWONDER BIT, one file (rev) at a time corresponding to the current rev being processed. Secondary functions of BITRE are to calculate the total number of groups within a rev and the number of targets within each group, to set up the voting table weights corresponding to each target, and to tabulate the scope on-times for the scopes in each group.

3.4.2 Usage

3.4.2.1 Calling Sequence

BITRE ∅

3.4.2.2 Inputs

a. Calling sequence inputs

None

b. Inputs via common locations

BLNK
IPVIS
KBIT
RN

3.4.2.3 Output

a. Calling sequence outputs

None

b. Outputs via common locations

BUFOUT
EOF
GNMAX
KSPTFG
LPIL
NULLREV
PV
REVTAB
TAON
TASSNO
TBAPR
TGRNO
TNMAX
TONSN
TPROBA
TWA
TWI
VDICT
VTAB

3.4.2.4 Working Storage Within Routine

INDX	Target working index within rev
NG	Group counter
NT	Working cell for number of targets processed
NTPG	Target counter
NTR	Total number of targets on current rev
NTT	Total number of targets on current rev left to be processed
PA	Probability of activity

3.4.2.5 Error/Action Messages

In searching the TWONDER BIT for the current rev, if an end-of-tape is encountered before the rev is found, the following error message appears on-line and execution is halted:

"REV XX NOT FOUND ON BIT"

This message indicates that the current rev selection file cannot be located on the TWONDER BIT. Either a new BIT should be mounted and the TSPOOND run restarted, or the GO button should be depressed to continue program processing on the next requested rev.

3.4.2.6 Subroutines Called

READ	Binary read routine
CHECKR	Checks last read operation
OCTBCD	Octal to BCD conversion routine
SKIPF	Spaces a magnetic tape a number of files
SPACEUP	Spaces on-line printer up 16 lines for readability
PRINTOUT	Generalized BCD output routine
TAPERR4	Read error action routine

3.4.2.7 Called By Following Routines

PROREV	Rev processing driver

3.4.3 Method

BITRE reads a file (or one rev of information) from the TWONDER BIT into the rev table (REVTAB) buffer storage. By comparing group numbers of each target, the number of groups within the rev as well as the number of targets within each group is calculated. Next, the voting table weights (active, inactive, reject, unobserved weights) are computed and stored for each target. The active (TWA) and inactive (TWI) weights are extracted directly from the rev table, with the unobserved weight, W_{unob} computed as follows:

$$W_{unob} = P_V[P_A(TWA) + (1-P_A)\ TWI]$$

where P_V = probability of visibility
P_A = probability of activity

The reject weights are set to zero. An array of indexes, VDICT, are logged which serve as pointers to each group's position in the voting table of weights. The individual scope on-times for each group are extracted directly from the rev table and stored at this time for future reference.

3.4.4 Restrictions

BITRE can only process tapes written in the TWONDER BIT format (Reference 2). The tapes must be spaced to the selection file(s) and the revs must be processed in ascending order; i.e., BITRE does not search backwards on the BIT for a specified rev.

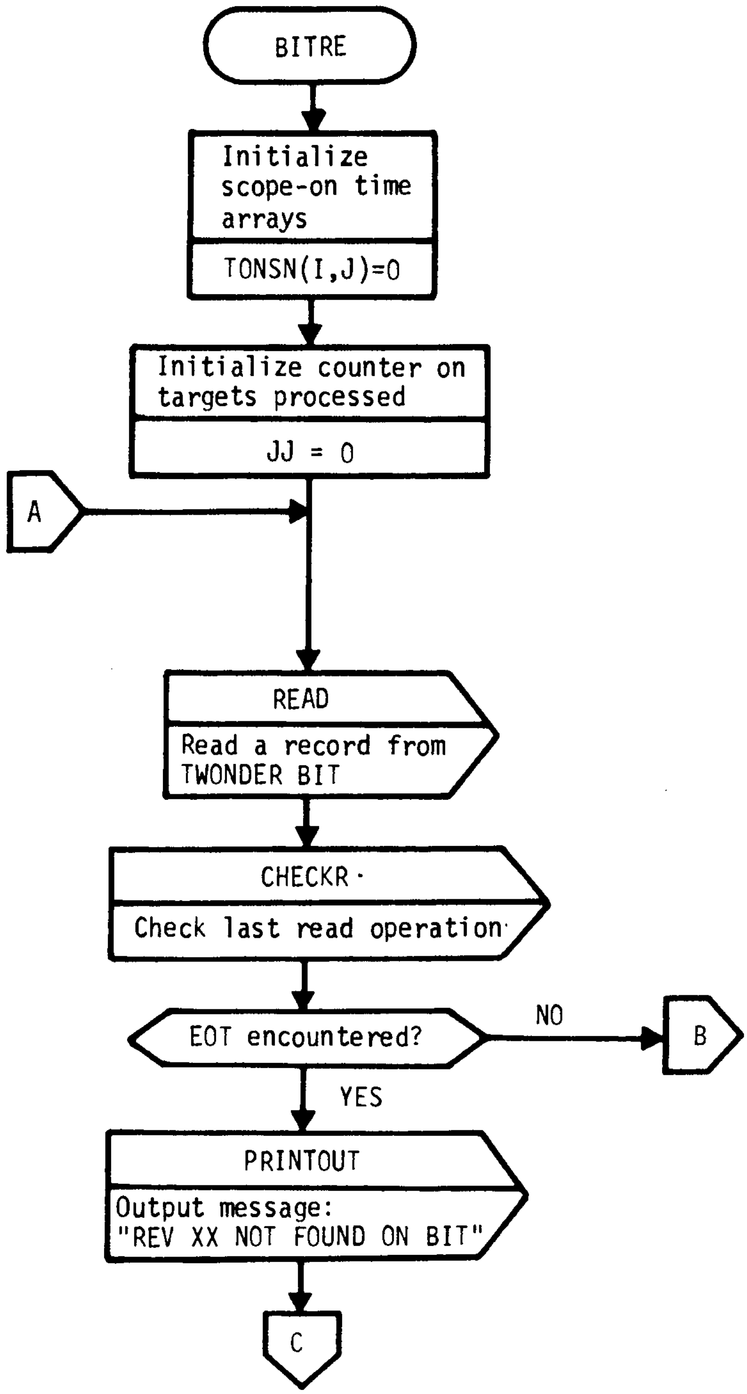

Figure 3-4 Subroutine BITRE Flow Diagram

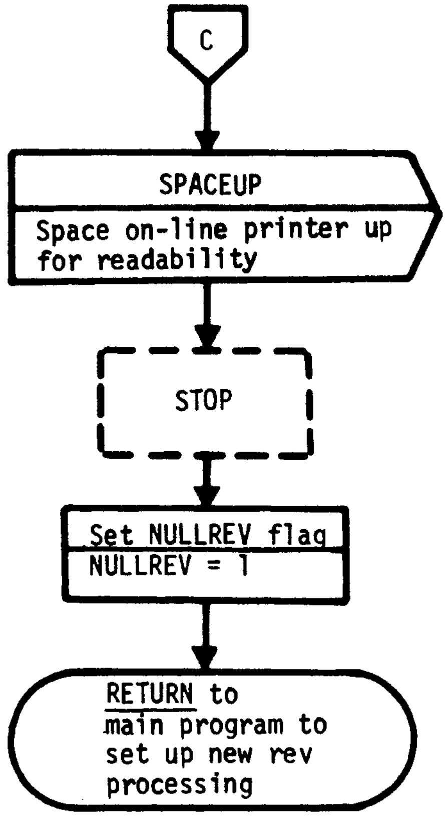

Figure 3- 4 Subroutine BITRE Flow Diagram (Continued)

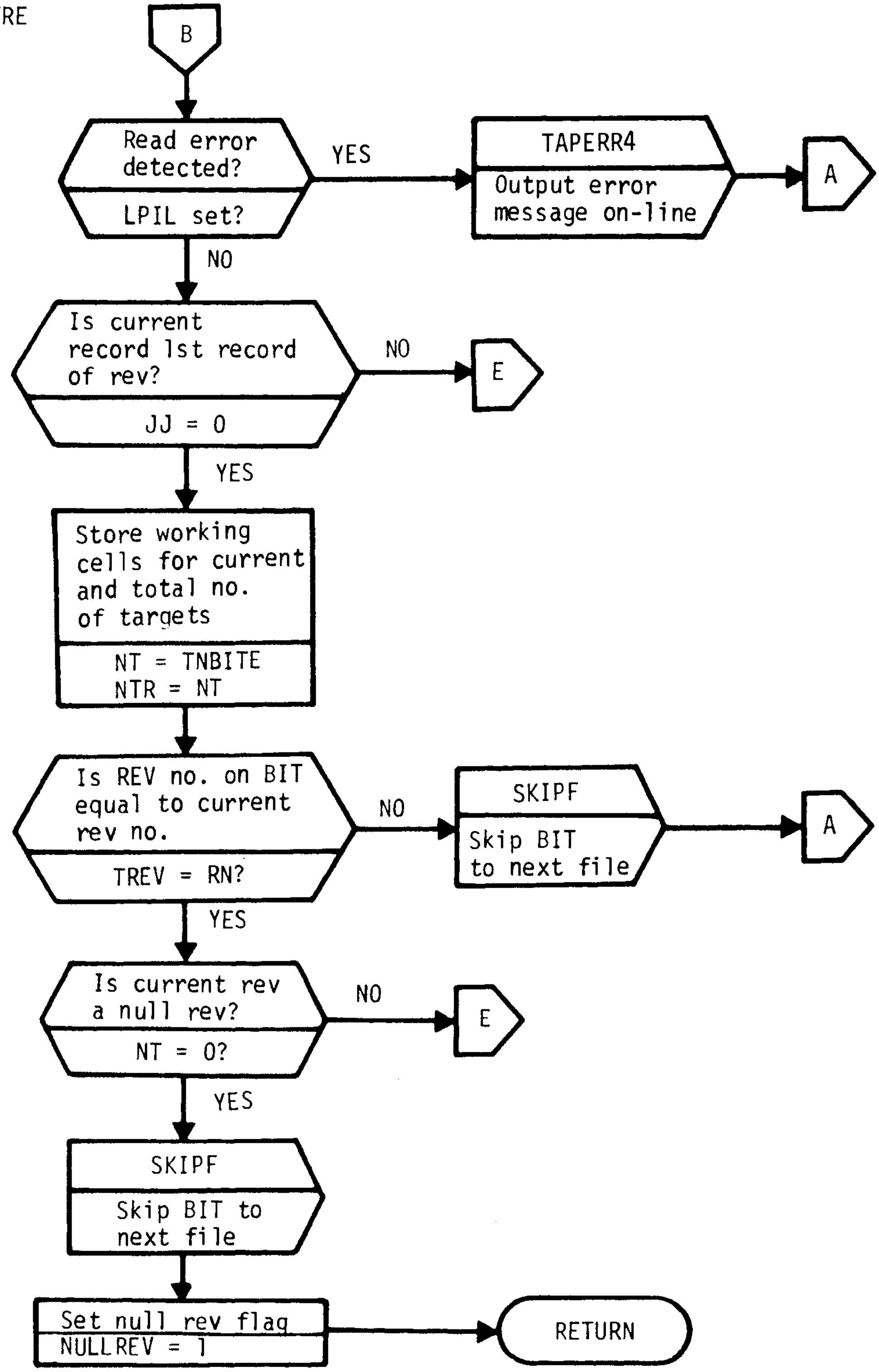

Figure 3-4 Subroutine BITRE Flow Diagram (Continued)

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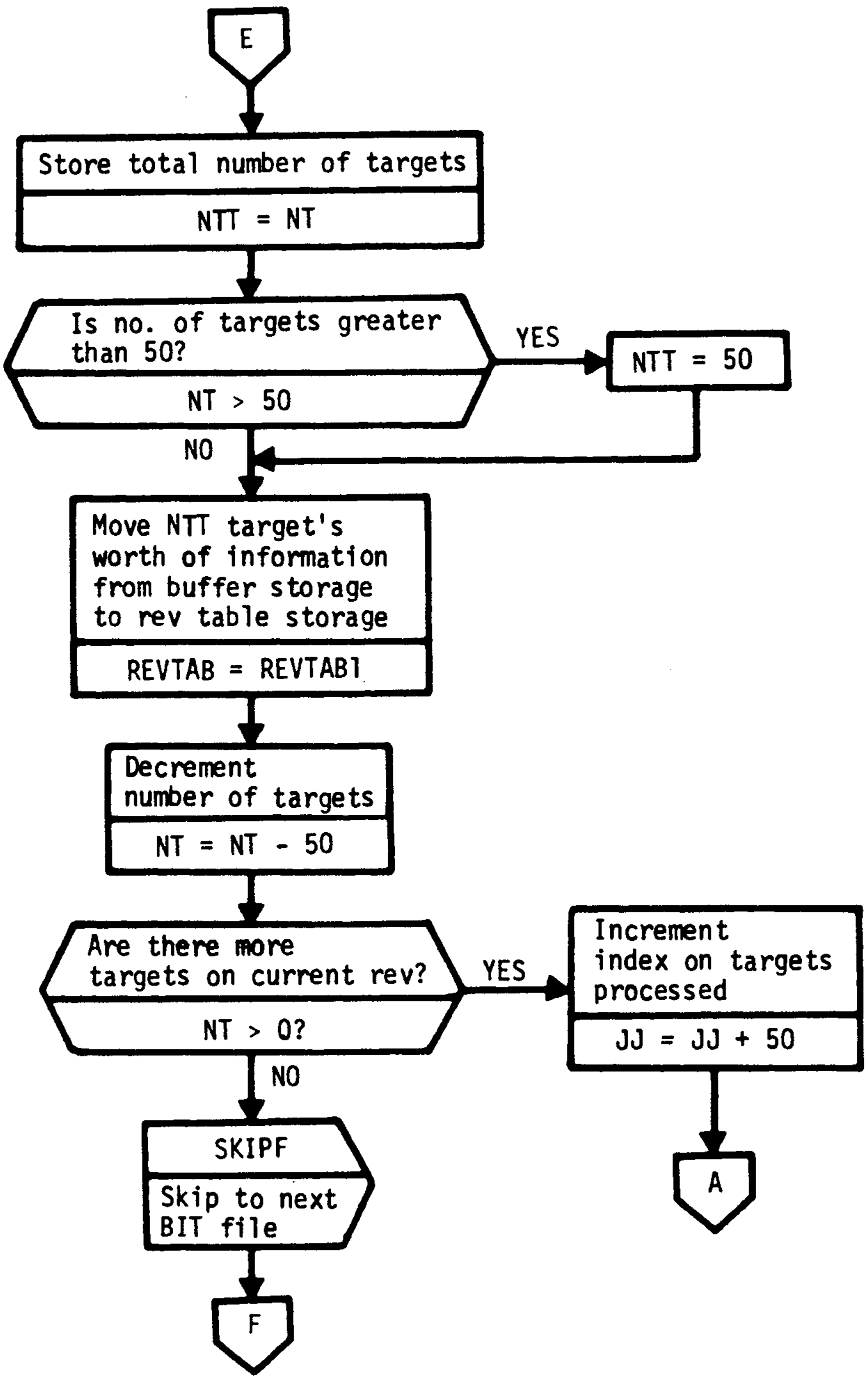

Figure 3-4 Subroutine BITRE Flow Diagram (Continued)

SECRET/D

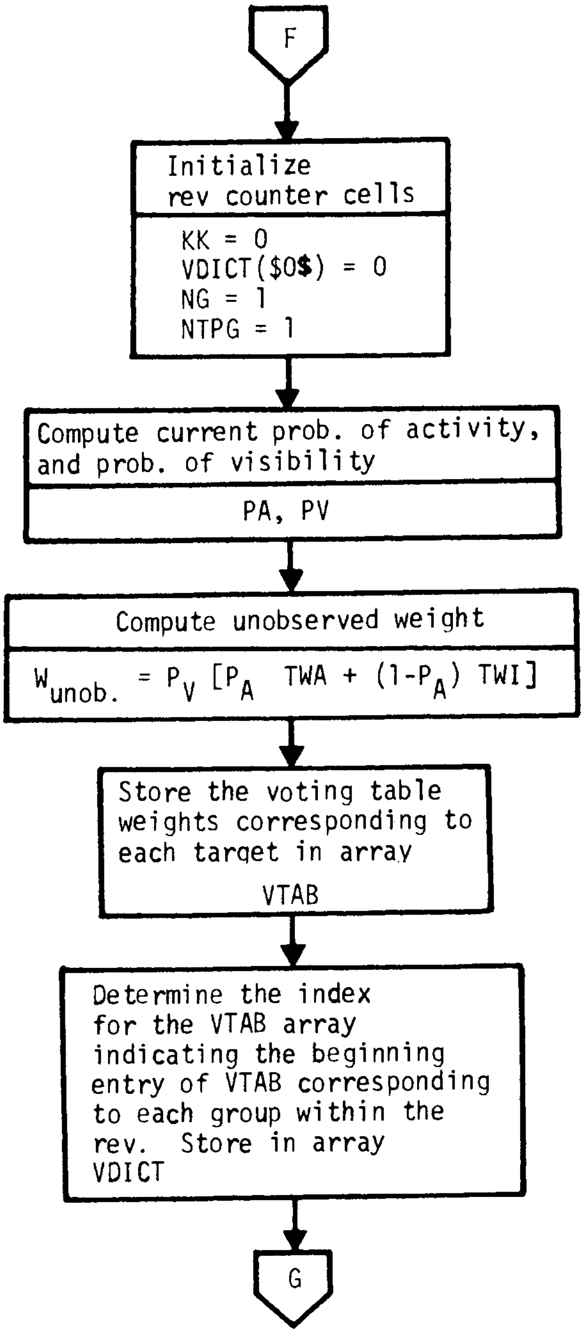

Figure 3-4 Subroutine BITRE Flow Diagram (Continued)

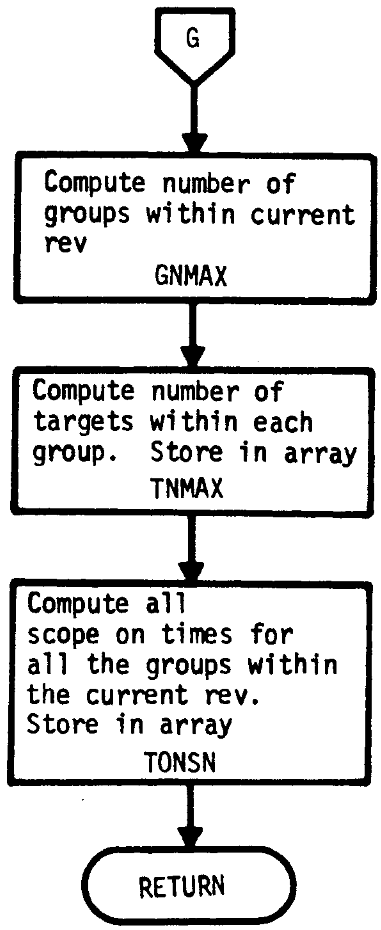

Figure 3-4 Subroutine BITRE Flow Diagram (Continued)

SECRET/D

3.5 SUBROUTINE BUFSET

3.5.1 Purpose

BUFSET is used to transfer values from an input buffer to fixed locations within an output buffer (BUFOUT) and to convert those values from a binary floating point to a BCD floating point format. The result of printing this output buffer will be a listing that displays the output, five BCD words per line.

3.5.2 Usage

3.5.2.1 Calling Sequence

BUFSET (BUFFER) $

3.5.2.2 Input

a. Calling sequence

Program Symbol	Description
BUFFER	The address of a location within the input array BTBF which contains the first of five words to be moved

b. Input through common locations

None

3.5.2.3 Output

a. Calling sequence

None

b. Output through common locations

BUFOUT

3.5.2.4 Working Symbols

None

3.5.2.5 Error/Action Messages

None

3.5.2.6 Subroutines Called

System subroutines: OUTERR
OUTPUT

3.5.2.7 Called By

PROBIT

3.5.3 Method

BUFSET transfers five words at a time from the input array to the output buffer, constituting one record of information. The five words of each record are arranged in the following characters of the record:

Word 1 - Characters 15 to 30
Word 2 - Characters 35 to 50
Word 3 - Characters 55 to 70
Word 4 - Characters 75 to 90
Word 5 - Characters 95 to 110

3.6 SUBROUTINE CCP

3.6.1 Purpose

The purpose of subroutine CCP is to read and process all command cards, (SUMMARY, DETAIL, EXTENDED data cards), set up the command table sorted by rev number, and determine which revs require output of typical detail statistics and rev span summary statistics. Based upon EXTENDED card input, CCP also determines those rev span summary output parameters for which extended statistics are to be computed.

3.6.2 Usage

3.6.2.1 Calling Sequence

CCP $

3.6.2.2 Input

a. Calling sequence inputs

   None

b. Inputs via common locations

   EOF
   INPUT
   KIN
   KOL
   KON
   KOUT
   KSPOUT
   LPIL

3.6.2.3 Output

a. Calling sequence outputs

   None

b. Outputs via common locations

DBITS
EXTBITS
NCOM
TFSUM
TREN
TRST
TTONS

3.6.2.4 Working Storage Within Routine

Name	Description
BITNO	Contains bit number extracted from a word
DWDS	Number of words read by last read operation
INSPAN	Current rev number within the rev span during input processing phase
NCOMTB	Counter on number of entries in the command table
OUTPUT	Array containing the command card items converted from a free field format
SORTAB	Starting address of the table to be sorted

3.6.2.5 Error/Action Messages

When CCP encounters a command data card with an incorrect format, the following message appears on-line:

SYSTEM DETECTED ERROR ON LAST CARD READ, INSERT CARD AND TRY AGAIN

To continue program execution, the data card should be corrected and re-input.

If the input data deck does not contain any SUMMARY or DETAIL command cards, the following message appears on-line and program execution is aborted:

NO SUMMARY OR DETAIL CARDS PROCESSED, PROGRAM CANNOT CONTINUE

If either a SUMMARY or a DETAIL data card shows a requested rev number greater than rev 720, the following message appears on-line:

REV NUMBER GREATER THAN 720, INSERT CARD AND TRY AGAIN

Program execution may be continued after the data card is corrected and re-input.

3.6.2.6 Subroutines Called

CHECKN CHECKW CREAD CWRITE	JOVIAL I/O procedures
FFCONV	Free field conversion routine
SORT	Sorts tables with parallel entries in ascending or descending order.
SPACEUP	Spaces on-line printer up 16 lines for readability

3.6.2.7 Called By Following Routines

MCDRIV

3.6.3 Method

CCP performs no computations and is primarily concerned with processing command card input information. These command cards (SUMMARY, DETAIL, EXTENDED cards) are read one card at a time and the rev span information thereon is placed in a contiguous table in core storage. In the case of DETAIL and EXTENDED card information, corresponding bits of the DETAIL and EXTENDED arrays are set to indicate (1) those revs where typical sample detail output is requested, and (2) those rev span summary output parameters for which extended statistics have been requested, respectively. After all command data cards have been read and processed, the rev span command table is then sorted by rev number to facilitate the rev by rev TSPOOND processing.

3.6.4 <u>Restrictions</u>

3.6.4.1 When both SUMMARY and DETAIL command cards are present in the data deck, CCP expects all the SUMMARY data cards to precede the DETAIL cards, although the SUMMARY cards as well as the DETAIL cards may appear in any order within themselves.

3.6.4.2 There must exist at least one SUMMARY or one DETAIL card in the data card deck setup. SUMMARY cards only or DETAIL cards only are acceptable data decks.

3.6.4.3 One DETAIL or EXTENDED command data card may contain at most 25 items. The inclusive "TO" descriptor should be used to meet this limitation if necessary (See Reference 1, section 2.3, Data Card Input).

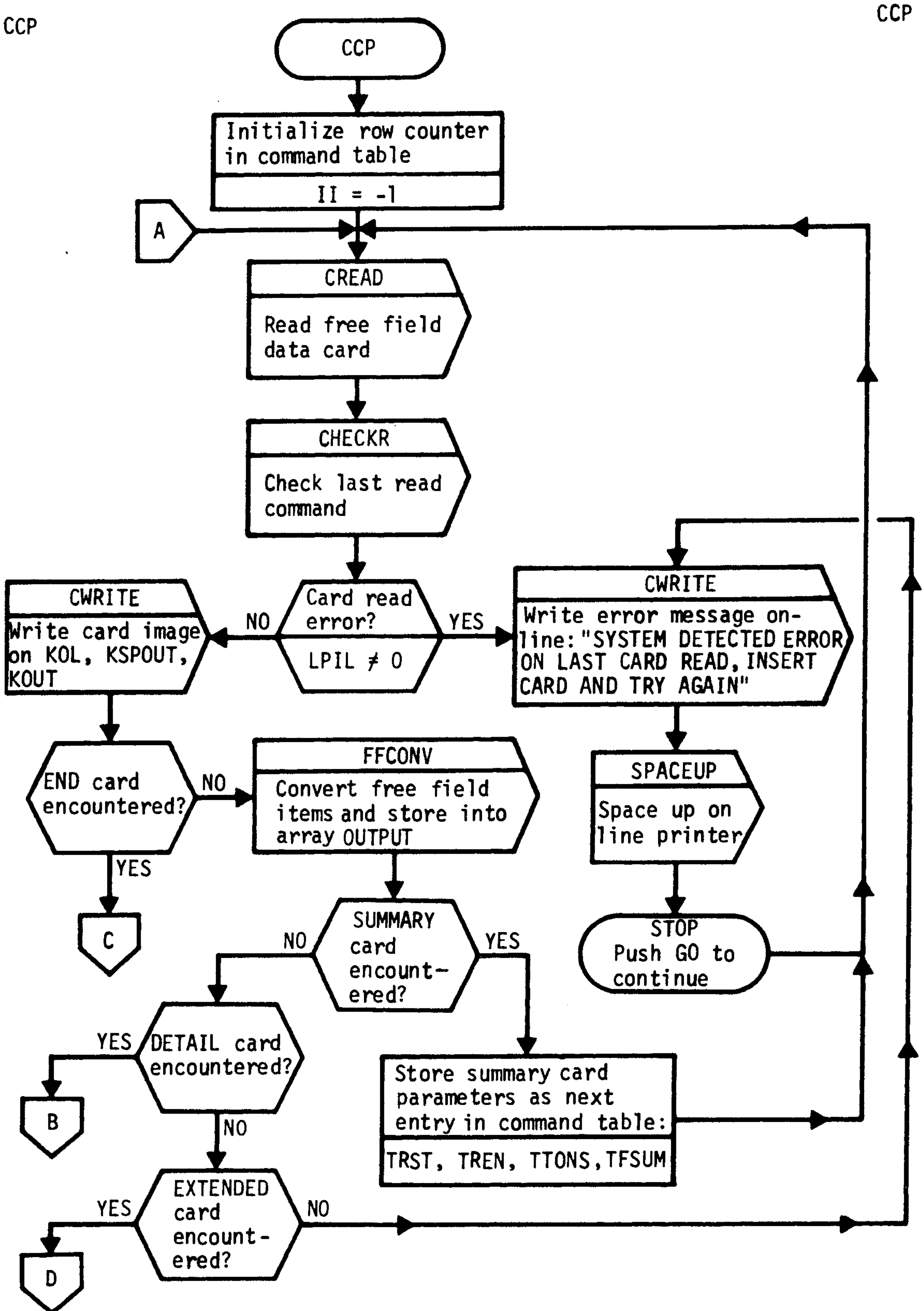

Figure 3-5 Subroutine CCP Flow Diagram

SECRET/D

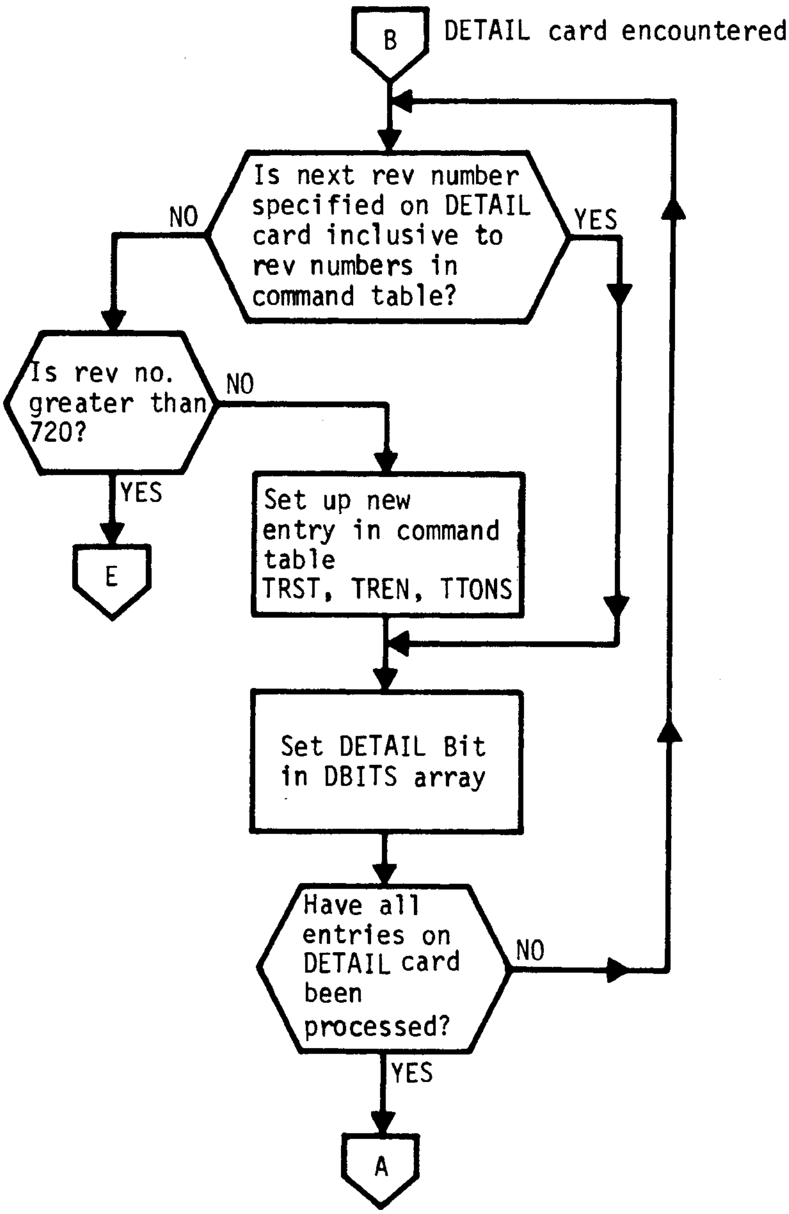

Figure 3-5 Subroutine CCP Flow Diagram (continued)

SECRET/D

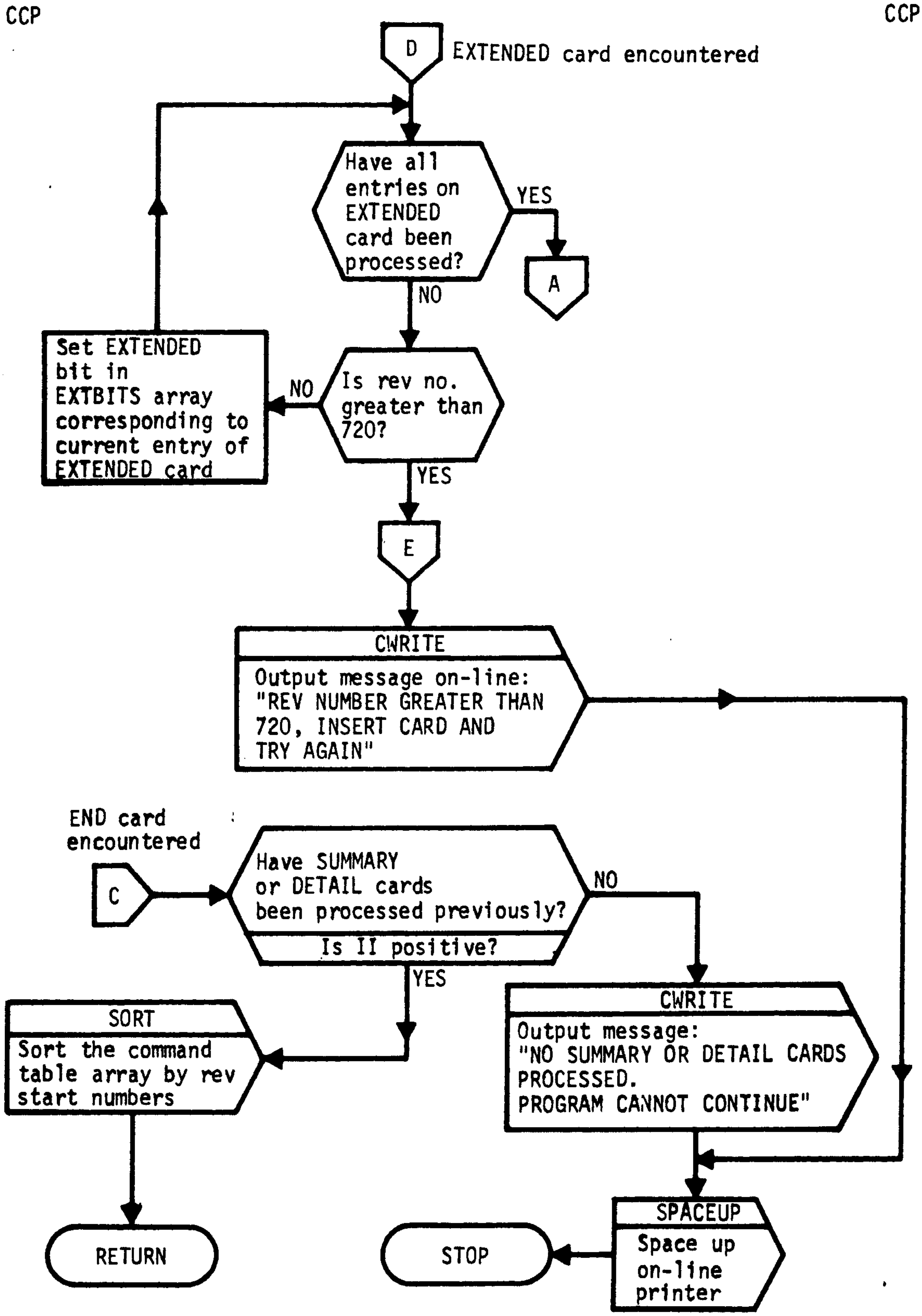

Figure 3-5 Subroutine CCP Flow Diagram (continued)

3.7 SUBROUTINE CORV

3.7.1 Purpose

CORV computes the visibility of each target within a group taking into account that the weather of targets within the same group (and hence geographically close) is correlated to the extent specified by the input parameter, ρ.

3.7.2 Usage

3.7.2.1 Calling Sequence

CORV (MAXTN) $

3.7.2.2 Inputs

a. Calling sequence

MAXTN	The total number of targets within the current group

b. Inputs via common locations

Equation Symbol	JOVIAL Symbol	Description
$\bar{p}$	PVIS	Probability of visibility
$\bar{\rho}$	IGCC	Intra-group correlation coefficient

3.7.2.3 Outputs

a. Calling sequence

None

b. Outputs through common locations

CBERN

VIV

3.7.2.4 Working Storage Within Routine

Equation Symbol	JOVIAL Symbol	Description
K'	KP	$\frac{\bar{\rho}\,\bar{p}\,(1-\bar{p})}{(2\,\bar{p}-1)^2}$
-	SQ	$\sqrt{4\,K'+1}$
P_c	PC	$\frac{1}{2}+\frac{1}{2}\sqrt{\frac{1}{4K'+1}}$
P_1	PONE	$\frac{1}{2}+(\bar{p}-\frac{1}{2})\sqrt{4K'+1}$
p	PR	$p = P_1$ if $C = 1$ $p = 1-P_1$ if $C = 0$

3.7.2.5 Error/Action Messages

None

3.7.2.6 Subroutines Called

BERN Bernoulli random number generator
SQRT System square root routine

3.7.2.7 Called By Following Routine

GETV

3.7.3 Method

The intra-group weather correlation model (see Section 2.5) assumes that the correlation between any two targets within a group is the same, with the amount of correlation given as input. The probabilities of visibility P_c and P_1 are determined in CORV and the visibility of each target in the group is simulated as a function of these probabilities by a succession of calls to a Bernoulli random number generator. The computational equations for generating the probabilities P_c and P_1 are shown as follows:

$$K' = \frac{\bar{\rho}\,\bar{p}\,(1-\bar{p})}{(2\,\bar{p} - 1)^2}$$

$$P_c = \frac{1}{2}\left(1 + \frac{1}{\sqrt{4K' + 1}}\right)$$

$$P_1 = \frac{1}{2} + \left(\bar{p} - \frac{1}{2}\right)\sqrt{4K' + 1}$$

Figure 3-6 shows the computational flow of Subroutine CORV.

~~SECRET/D~~

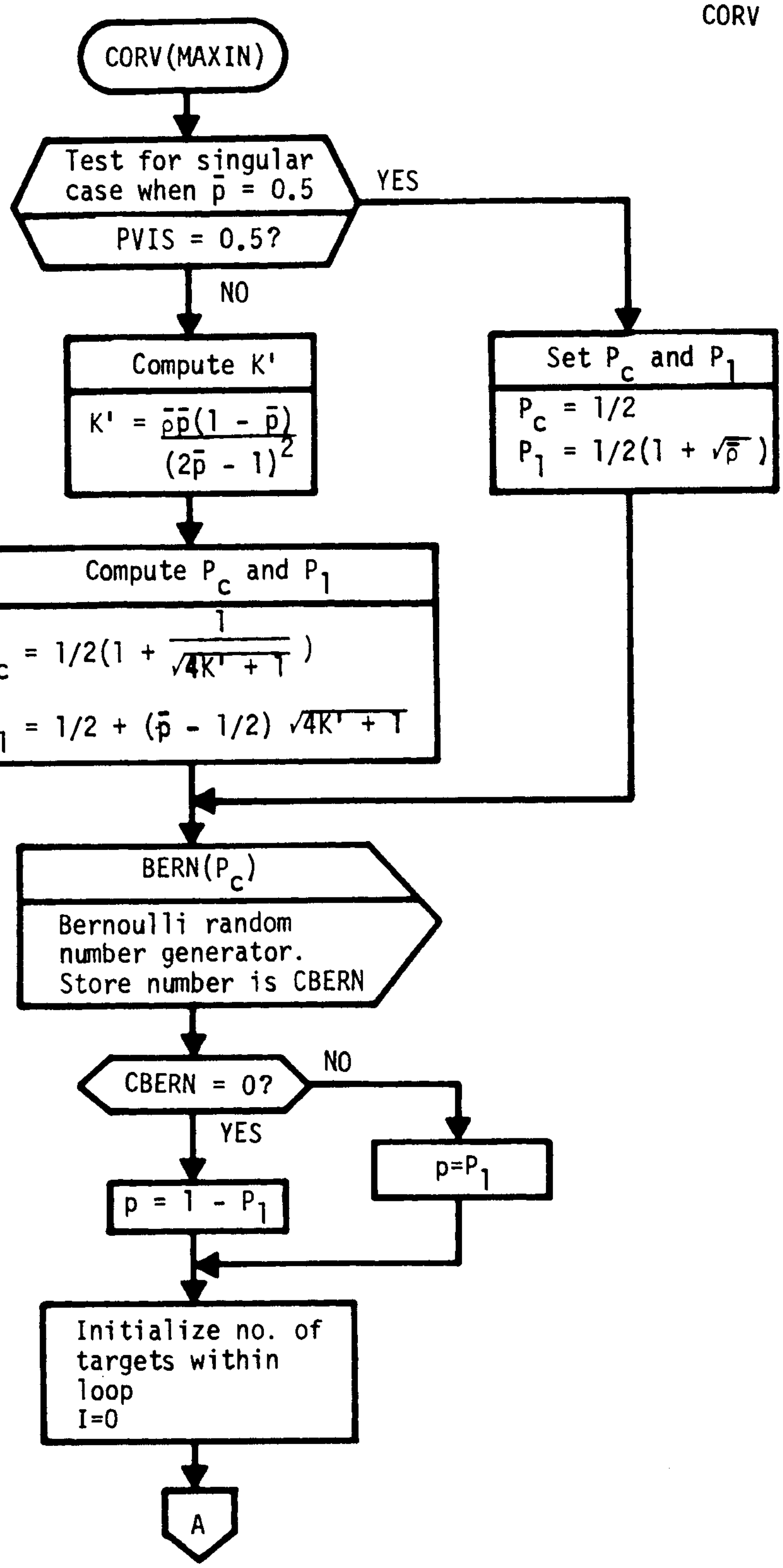

Figure 3-6 Subroutine CORV Flow Diagram

~~SECRET/D~~

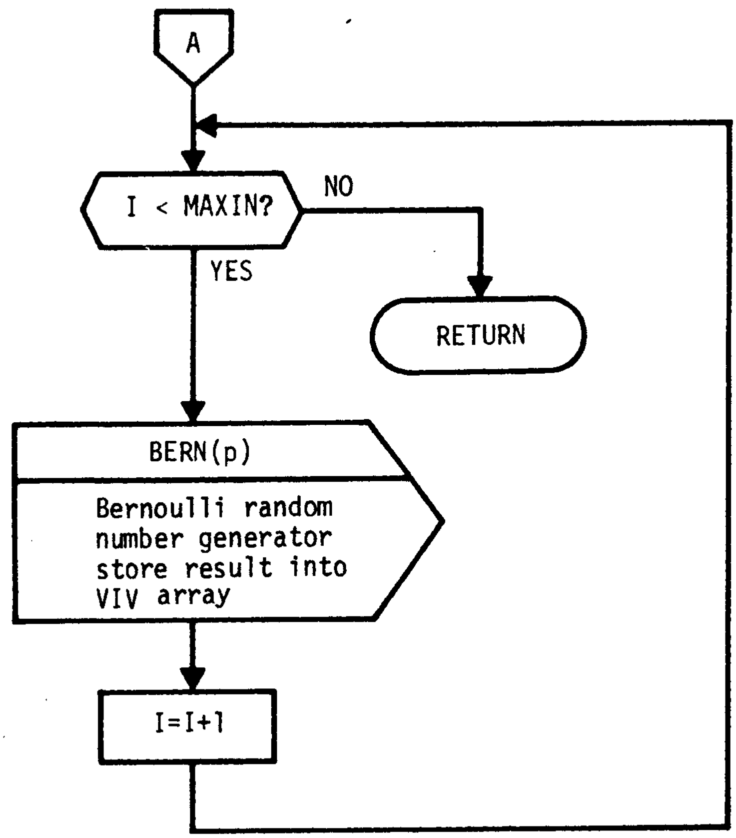

Figure 3-6 Subroutine CORV Flow Diagram (Continued)

3.8 SUBROUTINE DECIDE

3.8.1 Purpose

Subroutine DECIDE determines the "winning" target of a group (target within the group chosen for photography) according to the following decision strategy:

- Simulate the vote (active, inactive, reject or unobserved) for each target in the group
- Determine the magnitudes of the corresponding vote weights for each target in the group (vote weight refers to that weight associated with an active, inactive, reject, or unobserved vote)
- Compare the magnitudes of all the vote weights and select that target corresponding to the largest vote weight as the "winner"

In addition to applying the above decision strategy, DECIDE records the weights with and without interdiction, and the number of clear targets with and without interdiction, for the rev span summary output.

3.8.2 Usage

3.8.2.1 Calling sequence

DECIDE $

3.8.2.2 Inputs

a. Calling sequence inputs

None

b. Inputs via common locations

AV
GN
IVO
KON
KOUT
PRCONFL
RA

RV
TIDX
TNMAX
TVAP
VDICT
VTAB

3.8.2.3 Output

a. Calling sequence outputs

None

b. Outputs through common locations

AVOT
CLEART
CNFLG
CNFLT
ITOPG
ITOPT
PRIM
STAT
VOTESA
VOTESP
WEIGHT
WTOP

3.82.4 Working Storage Within Routine

JOVIAL Symbol	Description
DECFLG	Flag, when true, indicates error message has previously been written
ICOL	Used to record simulated vote ICOL = 0 Active vote ICOL = 1 Inactive vote ICOL = 2 Reject vote ICOL = 3 Unobserved vote
IDX	Working target index within group
INDEX	Voting table of weights index
TARIDX	Rev specific target index of the first target in group

3.8.2.5 Error/Action Messages

IVO, a function card input parameter (see Reference 1), dictates the decision strategy to be applied for the selection of a "winning" target within a group. At the present time, only one strategy exists in TSPOOND. If IVO is input non-zero (indicative of an alternate decision strategy desired) the following error message is displayed on-line, and execution continues utilizing the selection strategy of DECIDE:

"NO OTHER DECISION STRATEGY FOR IVO NQ 0"

3.8.2.6 Subroutines Called

CWRITE CHECKW	System BCD output routines

3.8.2.7 Called by Following Routines

PROGRO	Target group processor

3.8.3 Method

The decision algorithm, as explained in Section 3.8.1, is accomplished in DECIDE using the predetermined votes and corresponding vote weights of each target in the group. The active vote weights, W_A, and inactive vote weights, W_I, are extracted directly from the TWONDER rev table with the reject vote weights always stored as zeros. DECIDE computes the target specific unobserved vote weights, W_U, as follows:

$$W_U = P_V[P_A\ W_A + (1-P_A)\ W_I]$$

where P_V is the probability of visibility and P_A is the probability of activity.

Figure 3-7 shows the computational flow of subroutine DECIDE.

SECRET/D

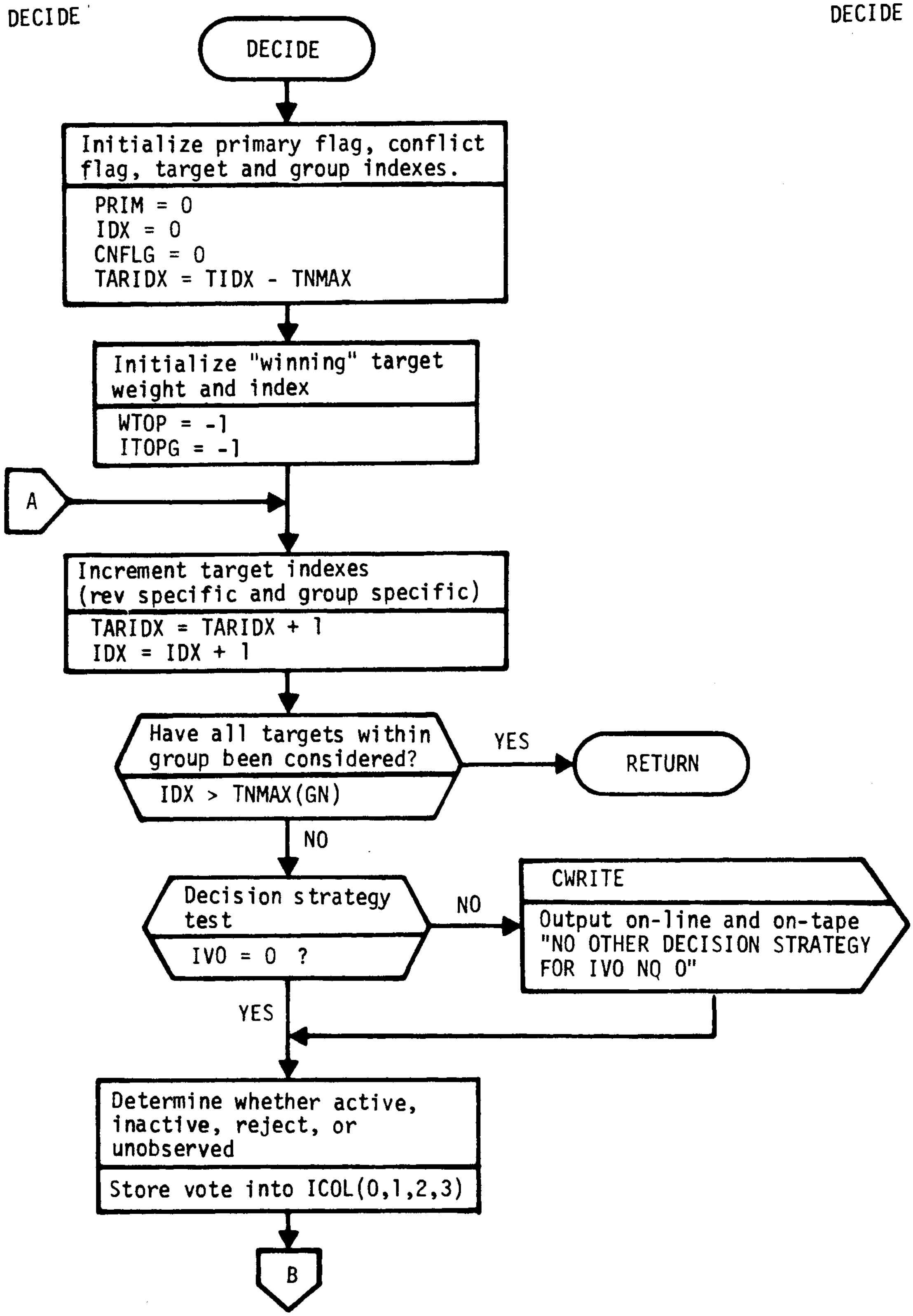

Figure 3-7 Subroutine DECIDE Flow Diagram

SECRET/D

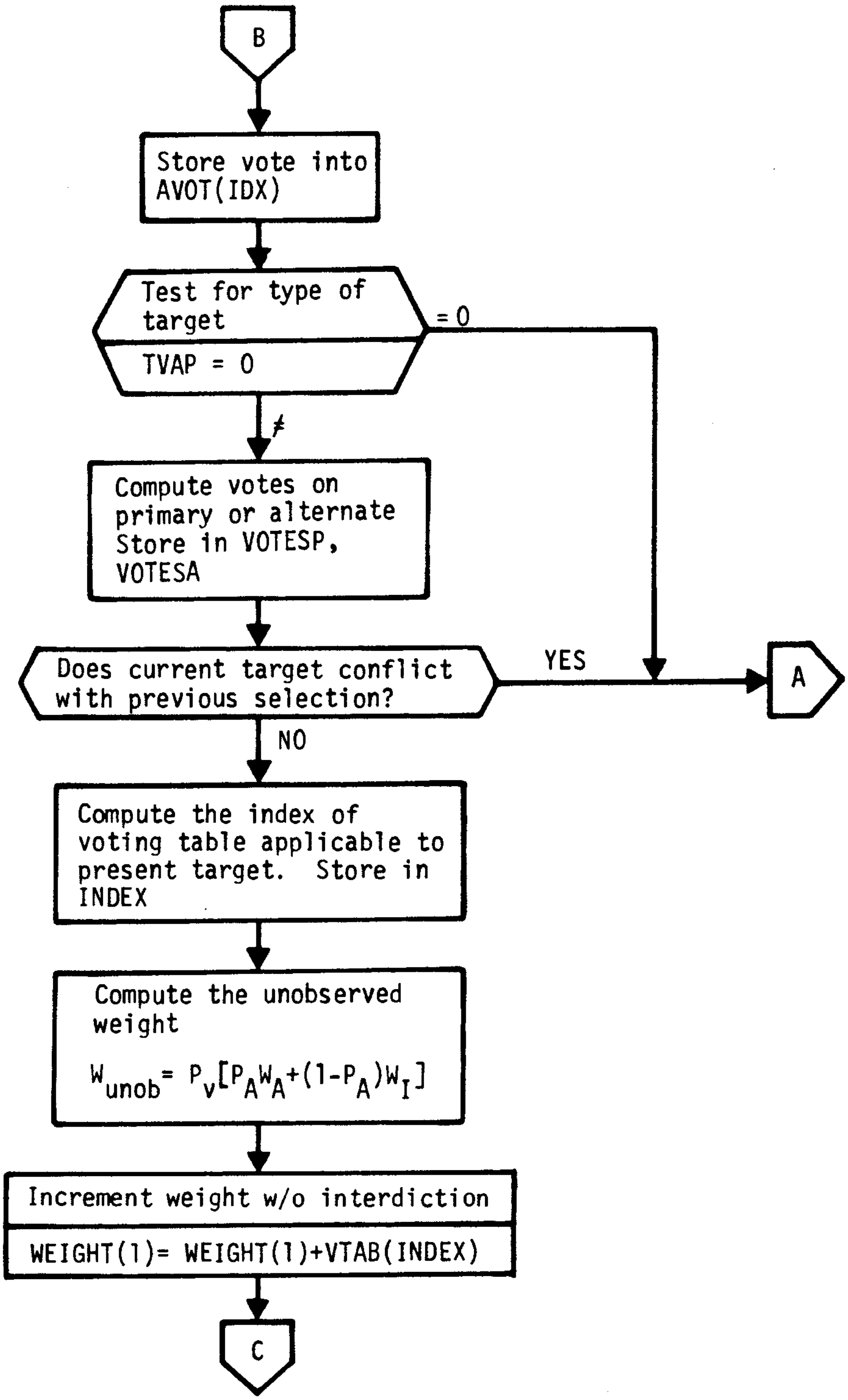

Figure 3-7 Subroutine DECIDE Flow Diagram (Continued)

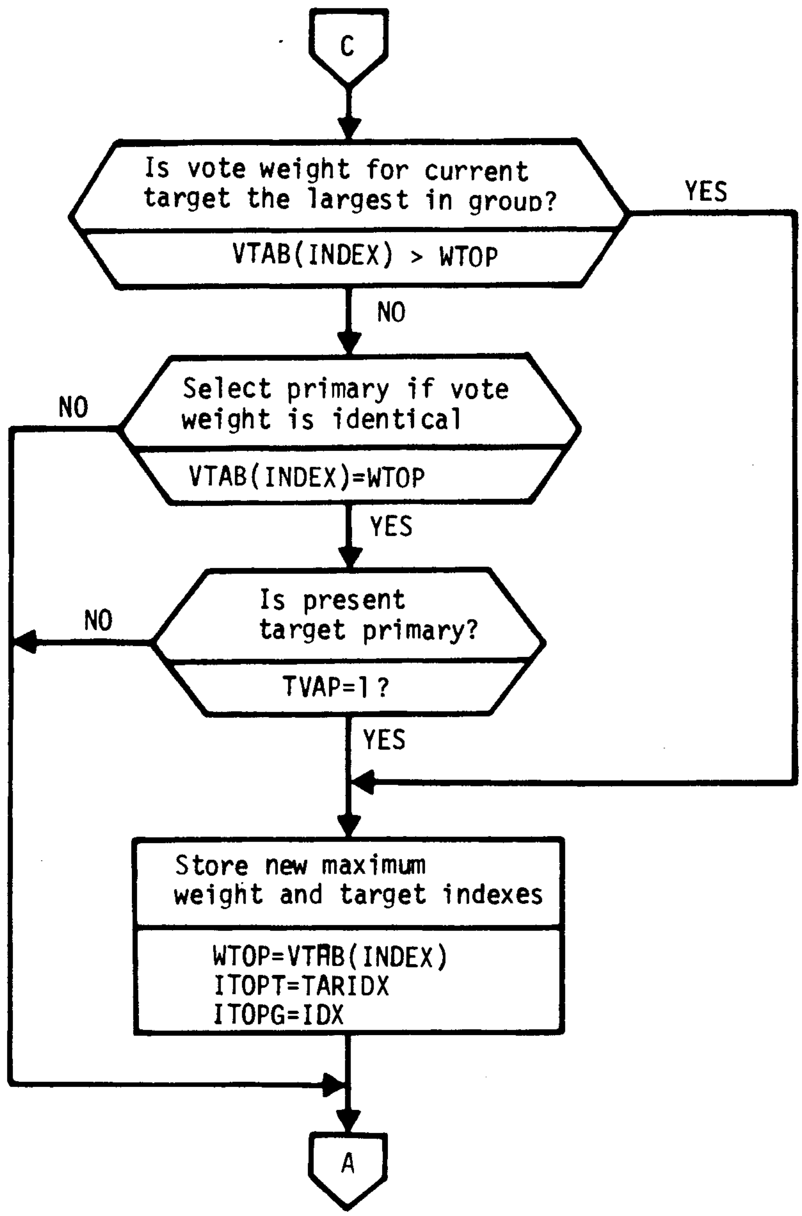

Figure 3-7 Subroutine DECIDE Flow Diagram (Continued)

3.9 SUBROUTINE DUMPLOC

3.9.1 Purpose

Utilizing the system dump routine, DUMPL, DUMPLOC displays on-line the contents of requested areas of core in a floating point decimal format with a console scoop. The area of core to be displayed is a variable specified by inputs to DUMPLOC.

3.9.2 Usage

3.9.2.1 Calling Sequence

DUMPLOC (START, STOP) $

3.9.2.2 Input

a. Calling sequence

Program Symbol	Description
START	Beginning address of requested dump
STOP	Ending address of requested dump

b. Input through common locations

None

3.9.2.3 Output

None

3.9.2.4 Working Symbols

None

3.9.2.5 Error/Action Messages

None

3.9.2.6 Subroutines Called

System subroutine DUMPL

3.9.2.7 Called By

None

3.9.3 Method

At present, no references to DUMPLOC are made by the TSPOOND environment, although the routine was used extensively during program checkout. However, as a debug tool for any future modifications to TSPOOND, DUMPLOC may prove useful. By inserting the DUMPLOC calling sequence at any point in the program and by depressing jump switch 3 during execution, core contents beginning at START and ending at STOP will be displayed on-line whenever program execution encounters the DUMPLOC instruction.

3.10 SUBROUTINE EJECTPG

3.10.1 Purpose

Upon each reference to EJECTPG, a page eject carriage control character is written on the Monte Carlo specific output tape (KOL).

3.10.2 Usage

3.10.2.1 Calling Sequence

EJECTPG $

3.10.2.2 Input

a. Calling sequence

None

b. Input through common locations

BLNK
KOL

3.10.2.3 Output

None

3.10.2.4 Working Symbols

None

3.10.2.5 Error/Action Messages

None

3.10.2.6 Subroutines Called

System subroutines: OUTERR
OUTPUT

3.10.2.7 Called By

MCDRIV
SPANOUT
SPECOL

3.10.3 Method

The formatted Monte Carlo specific output is displayed at approximately 40 targets per page of output. EJECTPG provides a convenient means of beginning a new page of output at each request.

3.11 SUBROUTINE FUNCDRD

3.11.1 Purpose

FUNCDRD extracts the values of the TSPOOND function card input parameters from the system buffer area and stores these values in their corresponding working cells within TSPOOND. The TSPOOND function card image is then written on the output tapes KSPOUT, KOUT, and KOL by FUNCDRD.

3.11.2 Usage

3.11.2.1 Calling Sequence

a. Calling sequence

None

b. Input through common locations

VEHNO

c. Input through system locations

System Symbols	Description
IMAGE	The start address of the buffer which contains the converted image of the TSPOOND function card
LOCPAR	The cell which contains the start address of the parameters on the TSPOOND function card
PAR	The cell which contains the total number of parameters read from the TSPOOND function card

3.11.2.3 Output

a. Calling sequence

None

b. Output through common locations

KOL
KOUT
KSPOUT

SECRET/D

3.11.2.4 Working Symbols

None

3.11.2.5 Error/Action Messages

None

3.11.2.6 Subroutines Called

System subroutines: CHECKW, CWRITE

3.11.2.7 Called By

MCDRIV

3.11.3 Method

See Figure 3-8 for FUNCDRD flow logic.

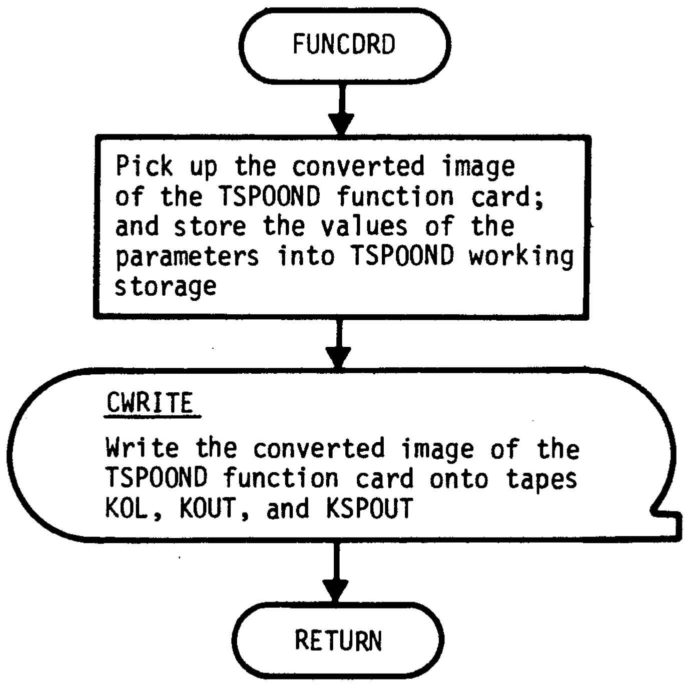

Figure 3-8 Subroutine FUNCDRD Flow Diagram

3.12 SUBROUTINE GETDT

3.12.1 Purpose

Subroutine GETDT determines the actual scope dwell time as a function of the recommended scope dwell time for each target. The planned scope slew and settle time is summed with this actual dwell time to determine the time interval, DT, between the previous target's scope off time and the current target's scope off time.

3.12.2 Usage

3.12.2.1 Calling Sequence

GETDT $

3.12.2.2 Inputs

a. Calling sequence

None

b. Inputs via common locations

Equation Symbol	JOVIAL Symbol
x_1/x_2	RR1
x_3/x_2	RR2
Q_1	RATIØ1
Q_2	RATIØ2
---	SCØF
---	SNN
$t_{on}^{(i)}$	TAØN
---	TIDX
---	TNN
$t_{on}^{(i-1)}$	TNP
δt_R	TTDWELL
---	VV
x_2	XX2

3.12.2.3 Outputs

a. Calling Sequence

None

b. Outputs through common locations

Math Symbol	JOVIAL Symbol
δt	ASDT
$SST + \delta t$	DT

3.12.2.4 Working Storage Within Routine

Math Symbol	JOVIAL Symbol	Description
r_1	R1	That number which, when multiplied by Q, will give the smallest dwell time within the triangular density function
r_2	R2	That number which, when multiplied by Q, will give the largest dwell time within the triangular density function
Q	QQ	The most probable dwell time within the given triangular density function
SST	SST	Scope slew and settle time (sec)

3.12.2.5 Error/Action Messages

None

3.12.2.6 Subroutines Called

TRI — Computes the random variable representing dwell time, with the triangular density function as specified by input

3.12.2.7 Called by Following Routine

PROTAR — Target processor

3.12.3 Method

The TSPOOND acquisition scope simulation is explained in detail in Section 2.4 of this document. The actual scope dwell time and the time increment between target scope off times computed by GETDT along with the planned scope slew and settle times determine directly the actual target specific scope on and off times. Figure 3-9 shows the computational flow of GETDT.

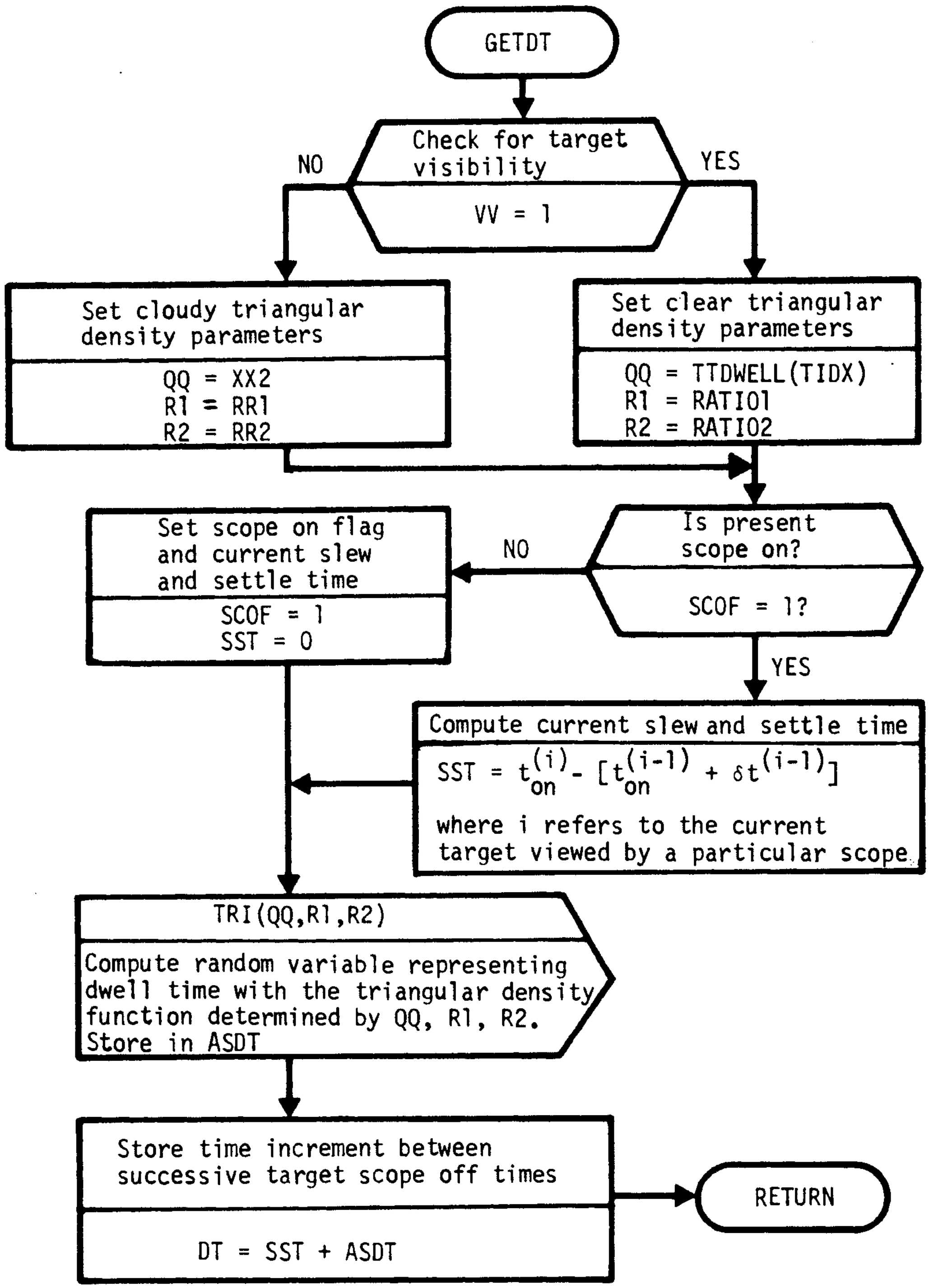

Figure 3-9 Subroutine GETDT Flow Diagram

3.13 SUBROUTINE GETFDET

3.13.1 Purpose

GETFDET is a function used to determine the value of a requested bit in a given array.

3.13.2 Usage

3.13.2.1 Calling Sequence

GETFDET (RNO, BITS) $

3.13.2.2 Input

a. Calling sequence

Program Symbol	Description
BITS	The address of an integer array within which bits have been preset
RNO	The sequential number of the requested bit

b. Inputs through common locations

None

3.13.2.3 Output

a. Calling sequence

Program Symbol	Description
GETFDET	An integer word that contains either a zero or a one depending upon how the requested bit was set

b. Outputs through common locations

None

3.13.2.4 Working Symbols

Program Symbols	Description
BITNO	An integer between 0 and 47 computed from the input number RNO
LL	An integer corresponding to the word number within the input array BITS that contains the requested bit to be investigated

3.13.2.5 Error/Action Messages

None

3.13.2.6 Subroutines Called

None

3.13.2.7 Called By

MCDRIV
PROBIT

3.13.3 Method

Compute the word number within the array, BITS, containing the requested bit to be investigated:

LL = (RNO - 1)/48

The bit number of BITS(LL) is determined directly

BITNO = (RNO - 1) - LL(48)

Using the BIT modifier, the value of the requested bit becomes

GETFDET = BIT(BITNO)(BITS(LL))

3.14 SUBROUTINE GETV

3.14.1 Purpose

Based upon the input parameter flag, IPVIS, GETV determines the probability of visibility of each target processed, considering both intra-group visibility correlation (the correlation between the visibility of targets within the same group), and inter-group visibility correlation (the correlation between the visibility of targets in adjacent groups). GETV then simulates the specific target visibility as a function of the probability of visibility using a Bernoulli random number generator.

3.14.2 Usage

3.14.2.1 Calling Sequence

GETV $

3.14.2.2 Inputs

a. Calling sequence

None

b. Inputs via common locations

BLNK
GN
IPVIS
KON
KOUT
PROBV
PVINP
TBAPR
TDECIS
TIDX
TN
TNMAX
TNN
VIV

3.14.2.3 Outputs

a. Calling sequence

None

b. Outputs through common locations

BUFOUT
GDT1
PVIS
PVIS1
VV

3.14.2.4 Working Storage Within Routine

None

3.14.2.5 Error/Action Messages

IPVIS is a TSPOOND function card input parameter taking on the range of values $0 \leq$ IPVIS ≤ 4. If IPVIS falls outside of this range, the following error message is output both on-line and off-line and execution is halted:

"IPVIS INCORRECTLY INPUT. PUSH GO TO USE FILE 8 CORRELATED"

Upon depressing the GO button, execution continues in subroutine GETV using the intra-group visibility correlation model with the probability of visibility taken from reset File 8.

3.14.2.6 Subroutines Called

INTER
CORV

3.14.2.7 Called by Following Routine

PROTAR

3.14.3 Method

The inter-group weather correlation model is simulated in subroutine INTER with the intra-group weather correlation, assuming that the correlation between any two targets is the same, being modeled in subroutine CORV. Sections 2.5 and 2.6 present a thorough discussion of the two mathematical models. Both of these routines are referenced by GETV during the course of determining each target's visibility. See Figure 3-10 for the GETV detailed flow diagram.

GETV

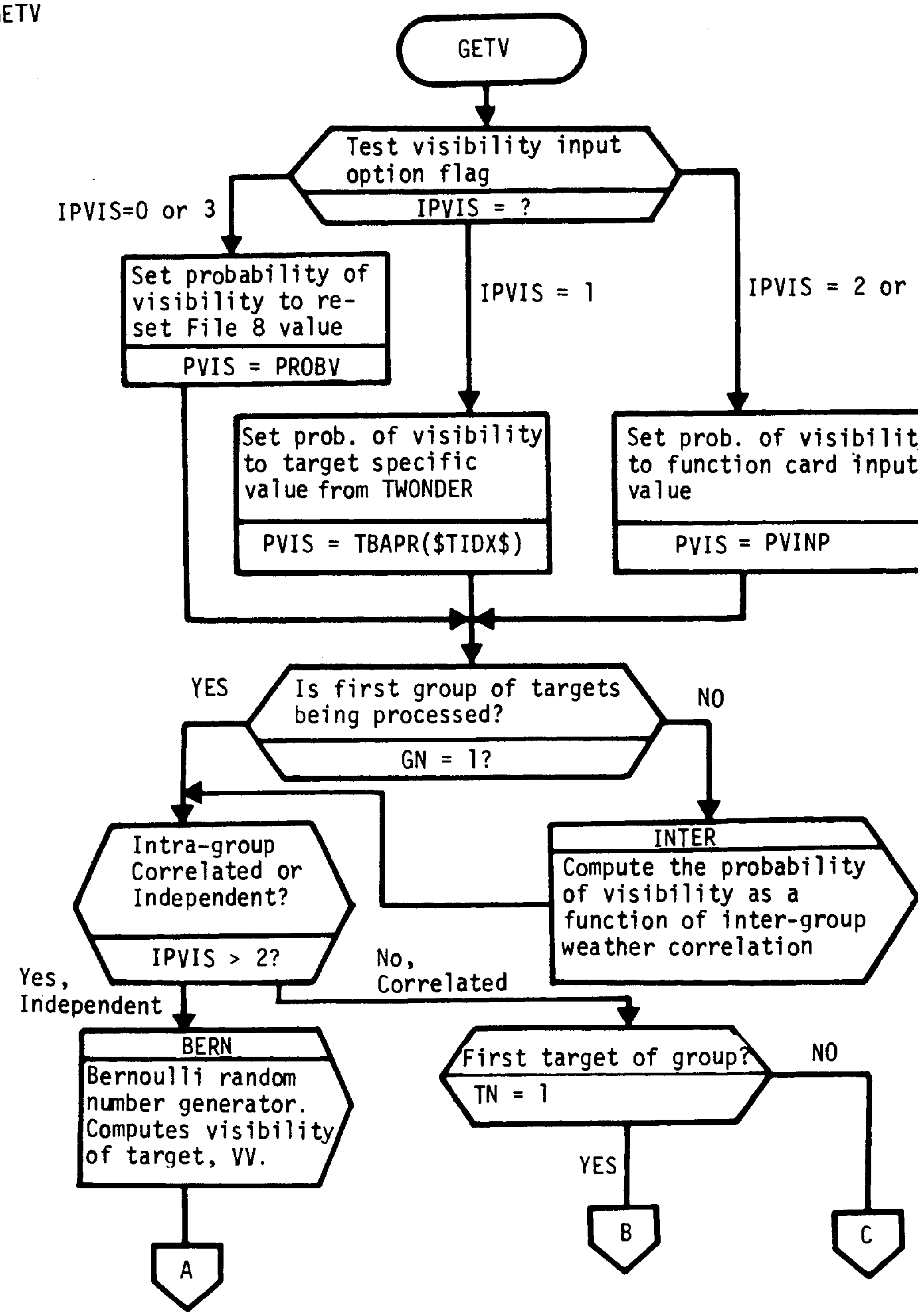

Figure 3-10 Subroutine GETV Flow Diagram

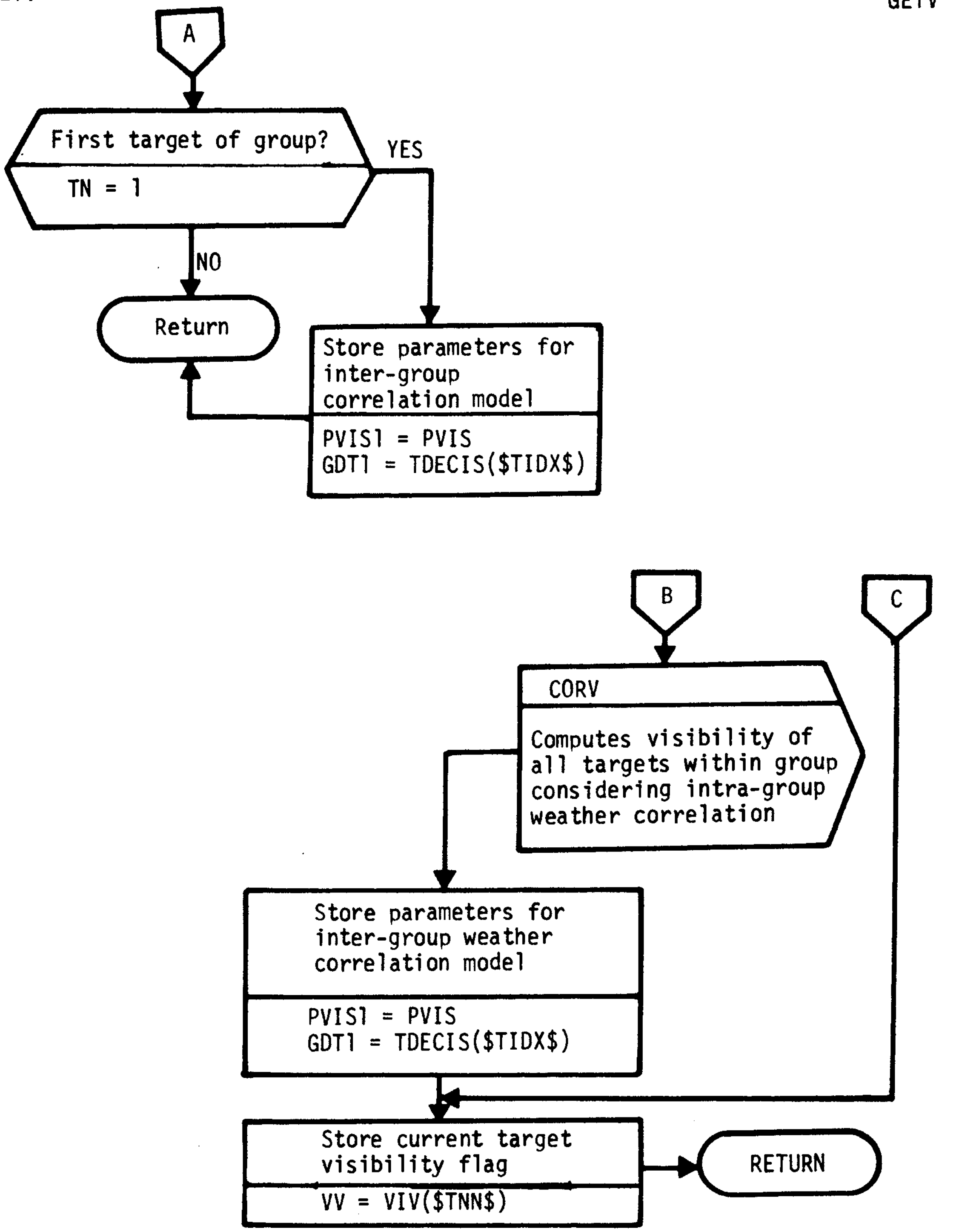

Figure 3-10 Subroutine GETV Flow Diagram (Continued)

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3.15 SUBROUTINE GROUT

3.15.1 Purpose

GROUT is used to set up the output buffer (BUFOUT) for writing the typical sample expanded detailed output. This subroutine is executed once for each target processed.

3.15.2 Usage

3.15.2.1 Calling Sequence

GROUT $

3.15.2.2 Input

a. Calling sequence

None

b. Input through common locations

Program Symbol	Units
AA	n.a.
ASDT	sec
AV	n.d.
AVØT	n.d.
BLNK	n.d.
CNFLT	n.d.
GN	n.d.
ITØPG	n.d.
PRØL	n.d.
RA	n.d.
RV	n.d.
STØF	sec
STØN	sec
TALT	ft x 10^{-2}
TAØN	sec
TASSNØ	n.d.
TATSMØ2	sec
TAWGT	n.d.
TBAB13	sec
TBACD	n.d.
TBACH	rad
TBAHT	naut mi

Program Symbol	Units
TBAMS	n.d.
TBAPR	percent
TBARV	n.d.
TBASA	rad
TBASR	naut mi
TBAVF	in/sec
TBAVY	n.d.
TBA16	rad
TBA23	deg
TBENCHF	n.d.
TDDD	ft x 10
TDECIS	sec
TDWELL	sec
TEEE	rad
TFLICT	n.d.
TGRNØ	n.d.
TIDA	n.d.
TIDB	n.d.
TIDX	n.d.
TLAT	rad
TLØNG	rad
TMATSF	n.d.
TMØDE	n.d.
TMPF	n.d.
TMSIG	deg
TNASSTE	n.d.
TNBITE	n.d.
TNMAX	n.d.
TNMØSTE	n.d.
TNSF	n.d.
TØMEGA1	rad
TØMEGA2	rad
TØMEGA3	rad
TPRIA	n.d.
TPRII	n.d.
TPRØBA	percent
TREV	n.d.
TRR	in.
TSC	n.d.
TSCC	n.d.
TSHAPE	n.d.
TSIGMAD	deg
TSMØDE	n.d.
TTDWELL	sec
TTIME	min

Program Symbol	Units
TTLV	n.d.
TTØFF	sec
TTØN	sec
TT1	sec
TT2	sec
TT3	sec
TVAP	n.d.
TVELI	ft/sec
TVIF	n.d.
TWA	n.d.
TWEIGHT	n.d.
TWI	n.d.
TWX	n.d.

3.15.2.3 Output

a. Calling sequence

None

b. Output through common locations

BUFOUT
LINECNT
MCBUF
PRCNTRL

3.15.2.4 Working Symbols

Program Symbols	Description
HTEMP	A one word hollerith buffer
II	An integer counter for the number of targets processed in each group
INTR	An integer buffer for the conflict matrix
NN	An integer set equal to the maximum number of targets in each group
TX	The target index used for printing
WBIT	A seven word floating point array used as a buffer for conversion of data to a BCD format

Program Symbols	Description
WGN	The present group number
WITOPG	The number of the target within the group that was selected for photography

3.15.2.5 Error/Action Messages

None

3.15.2.6 Subroutines Called

PRINTOUT
SPECOL

3.15.2.6.1 System Subroutines

CHECKW
CWRITE
OCTBCD

3.15.2.7 Called By

PROREV

3.15.3 Method

See Figure 3-11 for the flow logic.

3.15.4 Restrictions

None

3.15.5 References

None

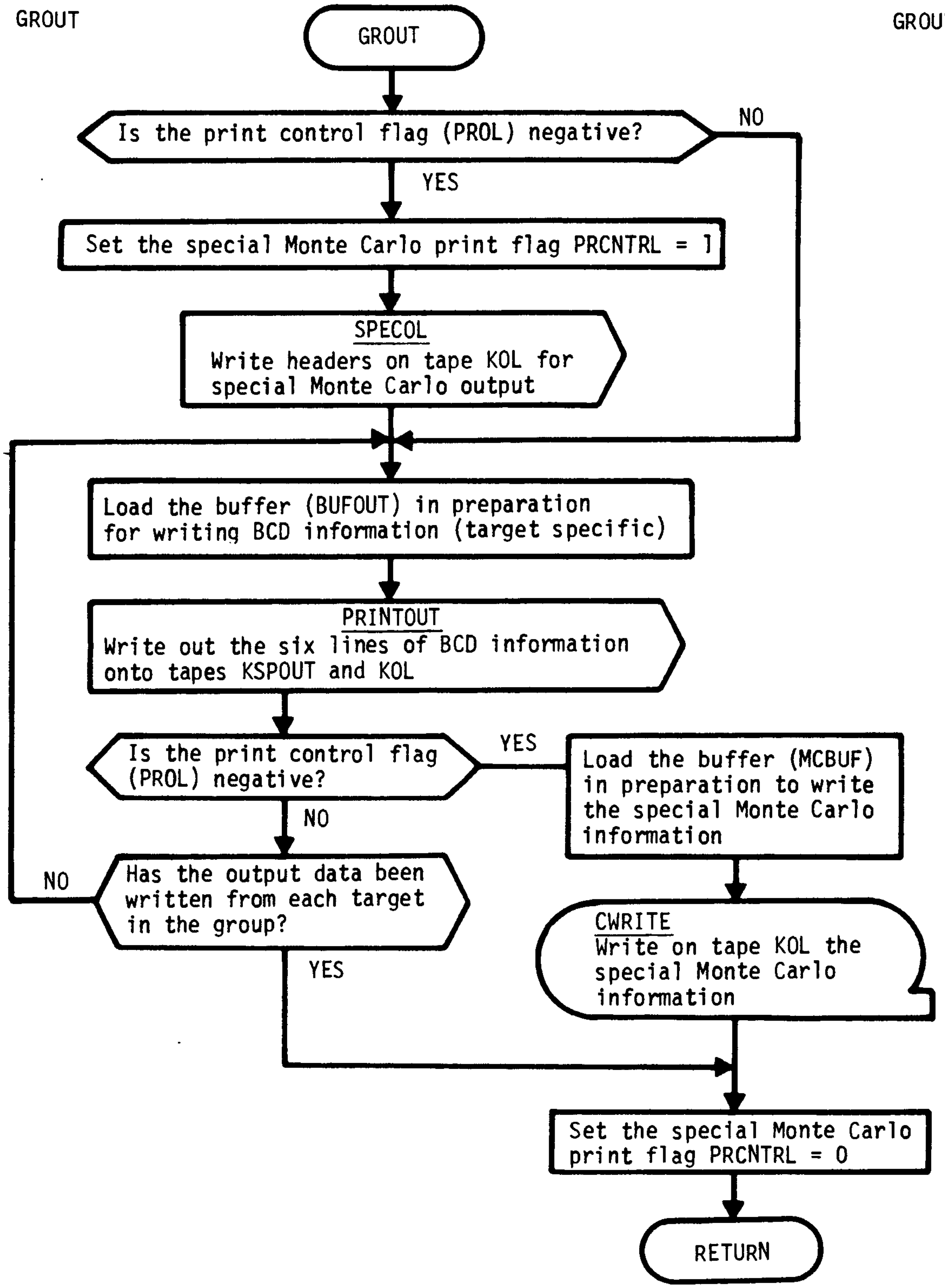

Figure 3-11 Subroutine GROUT Flow Diagram

3.16 SUBROUTINE INCRS

3.16.1 Purpose

After processing all requested samples on each rev, INCRS is referenced to accumulate totals on five rev span summary output parameters. The following parameters are accumulated:

- Number of groups in rev span
- Number of targets in rev span
- Number of primary targets in rev span
- Number of alternate targets in rev span
- Number of visual intelligence targets in rev span

3.16.2 Usage

3.16.2.1 Calling Sequence

INCRS $

3.16.2.2 Input

a. Calling sequence

None

b. Inputs through common locations

GNMAX
TNBITE
TVAP

3.16.2.3 Output

a. Calling sequence

None

b. Outputs through common locations

NALTN
NGPRS
NPRIM
NTPRS
NVIT

3.16.2.4 Working Symbols

None

3.16.2.5 Error/Action Messages

None

3.16.2.6 Subroutines Called

None

3.16.2.7 Called By

MCDRIV

3.16.3 Method

Figure 3-12 shows the flow logic for INCRS.

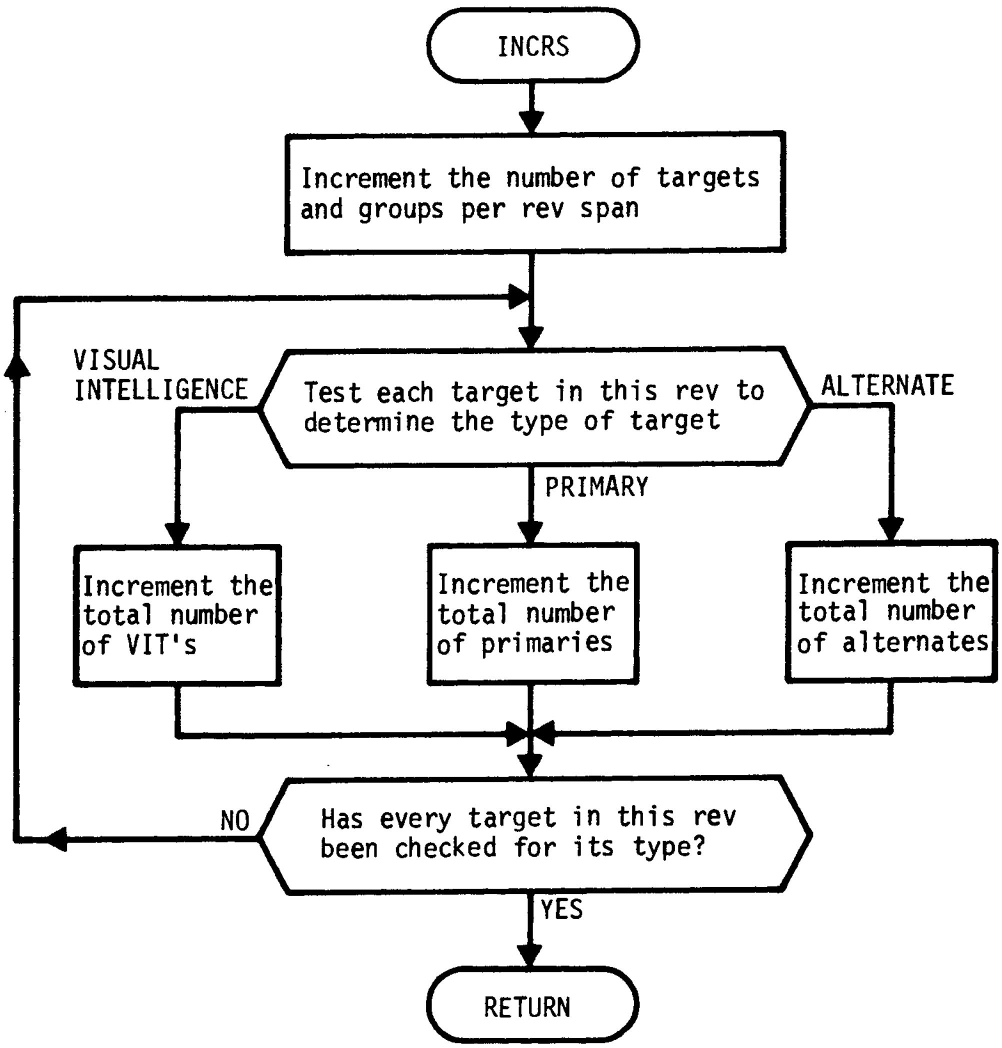

Figure 3-12 Subroutine INCRS Flow Diagram

3.17 SUBROUTINE INTER

3.17.1 Purpose

Subroutine INTER computes the probability of visibility for each group of targets considering the correlation between the visibility of targets in adjacent groups. The amount of correlation is determined as a function of the time interval between their group decision times where both groups are ordered chronologically.

3.17.2 Usage

3.17.2.1 Calling Sequence

INTER Ø

3.17.2.2 Inputs

a. Calling sequence

None

b. Inputs via common locations

CBERN
GDT1
IPVIS
PVIS1
TDECIS
TIDX
TMAX
TN

3.17.2.3 Outputs

a. Calling sequence

None

b. Outputs through common locations

PVIS

3.17.2.4 Working Storage Within Routine

Math Symbol	JOVIAL Symbol	Description	Units
β	BETA	Intermediate quantity used in computation of P_{MAX}	-
ρ_{max}	PMAX	The maximum value of correlation between current group and previous group	-
$P_V^{(1)}$	PRPVIS	Previous group's probability of visibility	-
$GDT^{(1)}$	PRDECIS	Previous group's group decision time	sec
ΔT	DGDT	Time interval between current group's group decision time and previous group's group decision time	sec
$\rho*$	PSTR	Final correlation coefficient computed as a function of ΔT and TMAX, the maximum time within which inter-group weather correlation is considered	-
-	PRBERN	Bernoulli variable visibility flag from first target of previous group	-
x_1	XONE	Value of visibility Bernoulli variable (with or without intra-group correlation considered whichever the case may be)	-
Q	QQQ	Intermediate quantity used in the computations $Q = \rho^* \sqrt{P_V^{(1)}(1-P_V^{(1)})P_V^{(2)}(1-P_V^{(2)})}$	-

3.17.2.5 Error/Action Messages

None

3.17.2.6 Subroutines Called

BERN Bernoulli random number generator

SQRT System square root routine

3.17.2.7 Called By Following Routine

GETV

3.17.3 Method

The inter-group weather correlation model (see Section 2.6) assumes that visibility for the present group of targets is dependent only upon the visibility of the previous group of targets. The amount of correlation is a function of both the time interval between their group decision times and the time, t_{max}, at which the inter-group correlation coefficient becomes 0. INTER computes the probability of visibility as a function of the weather correlation coefficient for every sample of each group (except the first group of the rev).

$$\beta = \sqrt{\frac{P_V^{(1)}(1-P_V^{(2)})}{P_V^{(2)}(1-P_V^{(1)})}}$$

where $P_V^{(1)}$ is the probability of visibility of the previous group's first target, and $P_V^{(2)}$ is the probability of visibility of the current group's first target. The maximum value of correlation between both groups is

$$\rho_{max} = \min \{\beta, \frac{1}{\beta}\}$$

The correlation coefficient is then computed as

$$\rho^* = \left(\frac{t_{max} - \Delta T}{t_{max}}\right)\rho_{max}$$

where ΔT is the time interval between group decision times. A quantity Q is computed,

$$Q = \rho^* \sqrt{P_V^{(1)}(1-P_V^{(1)})\, P_V^{(2)}(1-P_V^{(2)})}$$

If the first target in the previous group was <u>not</u> visible, the probability of visibility, $P_V^{(2)}$ becomes

$$P_V^{'(2)} = P_V^{(2)} - \left(\frac{Q}{1-P_V^{(1)}}\right)$$

and in the case where the previous group's first target is visible

$$P_V^{'(2)} = P_V^{(2)} + \left(\frac{Q}{P_V^{(1)}}\right) .$$

The functional flow diagram of INTER is shown as Figure 3-13.

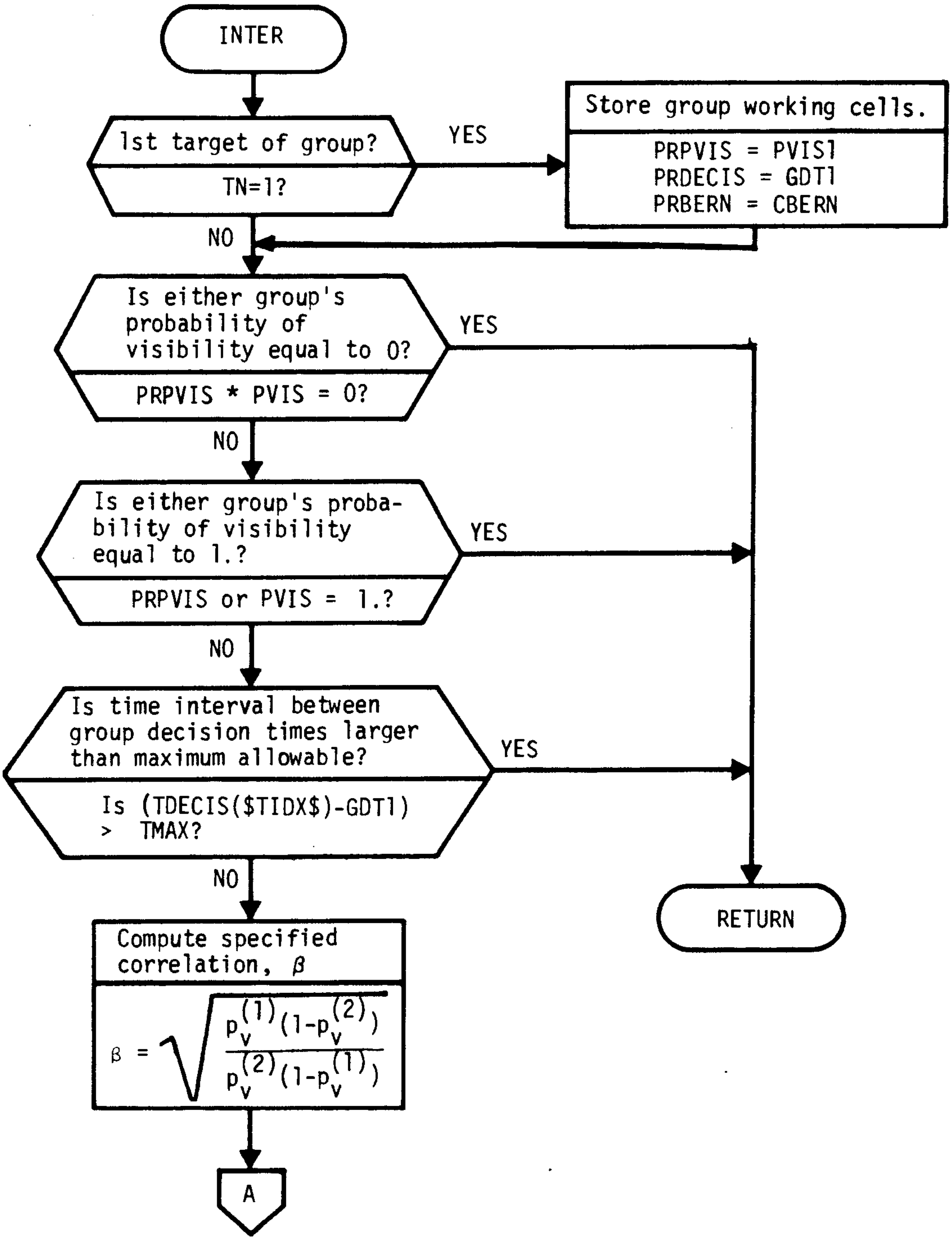

Figure 3-13 Subroutine INTER Flow Diagram

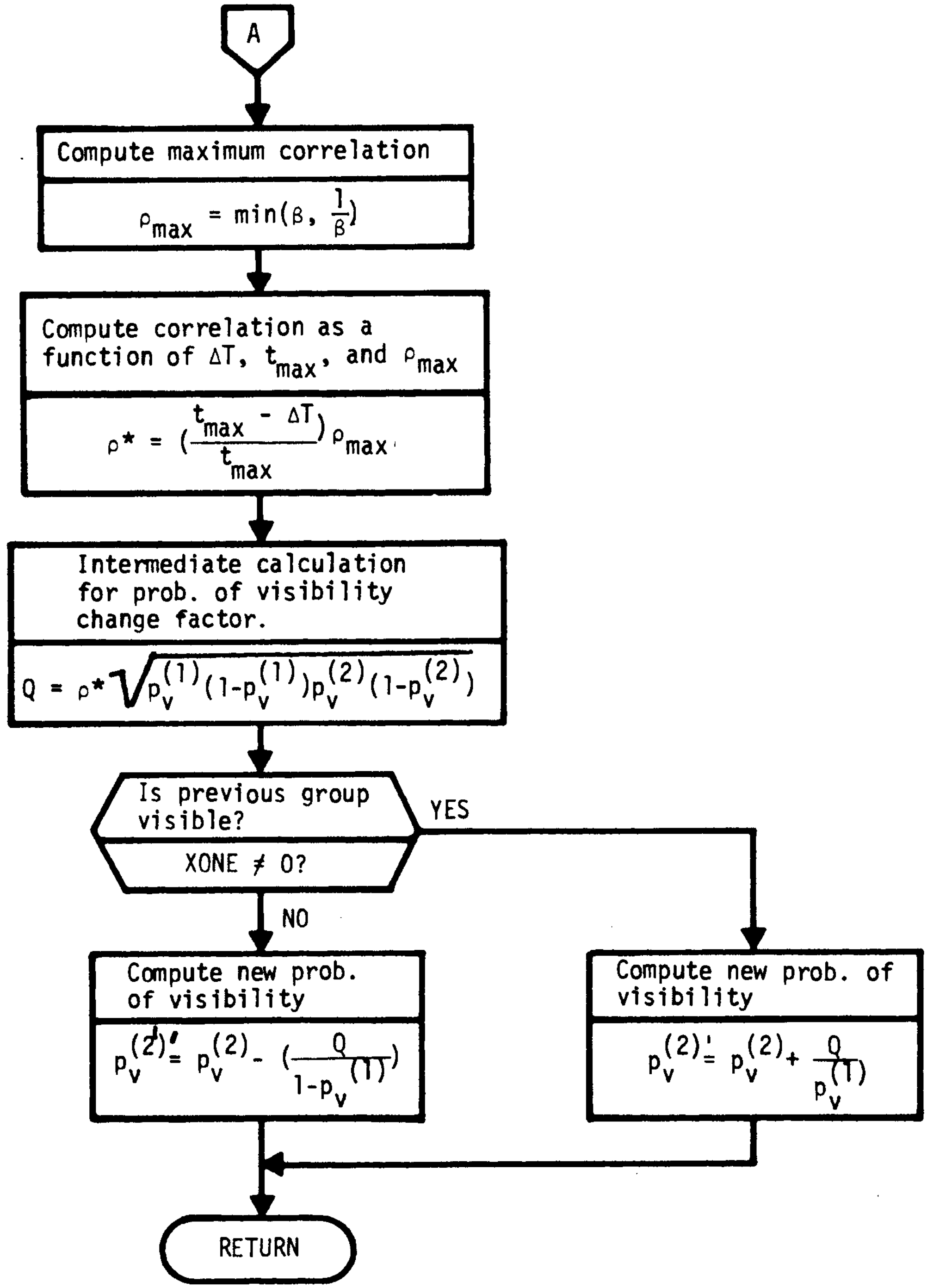

Figure 3-13 Subroutine INTER Flow Diagram (Continued)

3.18 SUBROUTINE MCDRIV

3.18.1 Purpose

MCDRIV is the main driver for the logic associated with the execution of a given TSPOOND run. Its main function is to control the order of execution necessary to accomplish the following subfunctions of TSPOOND:

- Initialization of logical tape units and other buffer storage areas.
- Processing of function card and command data card input information.
- Processing and transfer to KSPOUT of all TSPOOND pertinent information from first two files of the TWONDER BIT:

  a) ID records
  b) Ephemeris information
  c) Reset files 7 and 8.

- Control logic associated with processing of rev span summaries and typical sample detail output requests on a single rev or rev span basis.
- Computation of extended statistics on requested rev span summary output parameters.

3.18.2 Usage

3.18.2.1 Calling Sequence

MCDRIV $

3.18.2.2 Input

a. Calling sequence inputs

None

b. Inputs via common locations

Program Symbol	Units
BLNK	-
DBITS	-
EXTBITS	-
IRN	-
NCOM	-
NULLREV	-
PFAL	0 ≤ PFAL ≤ 1
PREC	0 ≤ PREC ≤ 1
PROBFA	0 ≤ PROBFA ≤ 1
PROBREC	0 ≤ PROBREC ≤ 1
PROL	-
TFSUM	-
TREN	-
TRST	-
TTONS	-
XX1	sec
XX2	sec
XX3	sec

3.18.2.3 Output

a. Calling sequence outputs

None

b. Outputs via common locations

Program Symbol	Units
ALTERN	-
BUFOUT	-
CLEART	-
DECEPT	-
FDET	-
FSUM	-
ICOM	-
KBIT	-
KIN	-
KOL	-
KON	-
KOUT	-
KSPOUT	-
KSPTFG	-
LINECNT	-
NALTN	-

Program Symbol	Units
NCNFLT	-
NGPRS	-
NPRIM	-
NS	-
NTPRS	-
NVIT	-
PFALM	-
PRCNTRL	-
PRCONFL	-
PRECOG	-
PRIMRY	-
REN	-
RN	-
RR1	-
RR2	-
SIGMA	-
SMAX	-
SMIN	-
STAT	-
STATS	-
TIDX	-
TONS	-
VOTESA	-
VOTESP	-
WEIGHT	-
WRN	-

3.18.2.4 Working Storage Within Routine

Name	Description
AA	Loop variable on extended statistics bits. $0 \leq AA \leq 29$
CSTTWO	Constant integer 2
DETFLG	Detailed statistics flag 0 - not desired on current rev 1 - desired on current rev
HOL1 - HOL15	Array containing descriptions associated with extended statistics output variables
MAX	Maximum value of current extended statistics output variable
MEAN	Mean value of current extended statistics output variable

MIN	Minimum value of current extended statistics output variable
NSAMP	Number of samples taken on current rev span
SIG	Standard deviation of current extended statistics output variable

3.18.2.5 Error/Action Messages

None

3.18.2.6 Subroutines Called

CCP	Command card processor routine
CHECKW	Output check-write routine
EJECTPG	Write page eject carriage control on output tape KOL
FUNCDRD	Processes function card parameters
GETFDET	Determines whether typical sample detail information has been requested for current rev
INCRS	Increments and sums rev span summary information
OCTBCD	Converts on octal number to a BCD format
PRINTOUT	Generalized BCD tape output routine
PROBIT	Processes the first two files from the TWONDER BIT
PROREV	Reads BIT for current rev selection information; processes all groups within rev and produces typical sample detail output for each group
REWIND	Initiates rewind of specified IO device
SPANOUT	Outputs rev span summary information
SQRT	System square root routine
WEOF	Writes end-of-file on specified IO device

3.18.2.7 Called By Following Routines

TSPOOND (main program)

3.18.3 Method

MCDRIV is primarily concerned with sequencing and controlling the subroutines for a TSPOOND run. Figure 3-14 is a flow chart which illustrates the execution order of MCDRIV. As shown on the flow diagram, the number of samples are completed on a rev by rev basis rather than on a rev-span by rev-span basis. This was necessitated by core size limitations which allowed only a rev's worth of data to reside in core at any one time.

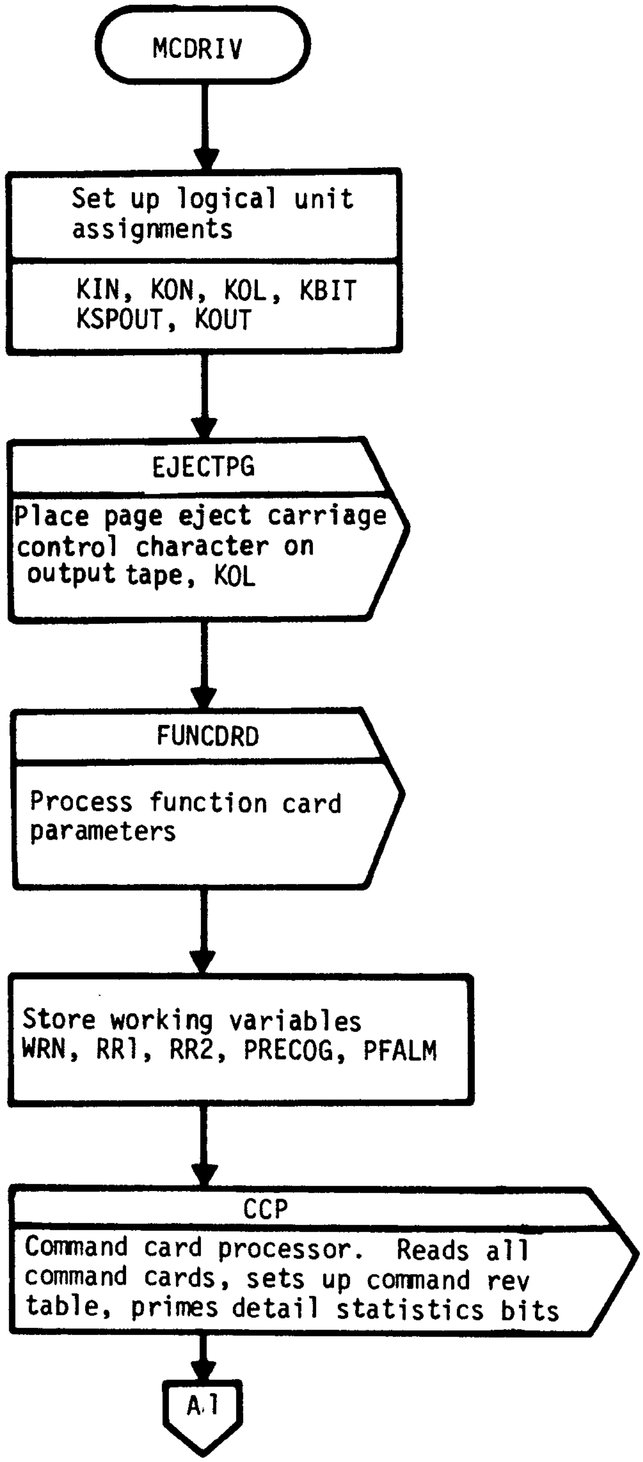

Figure 3-14 Subroutine MCDRIV Flow Diagram

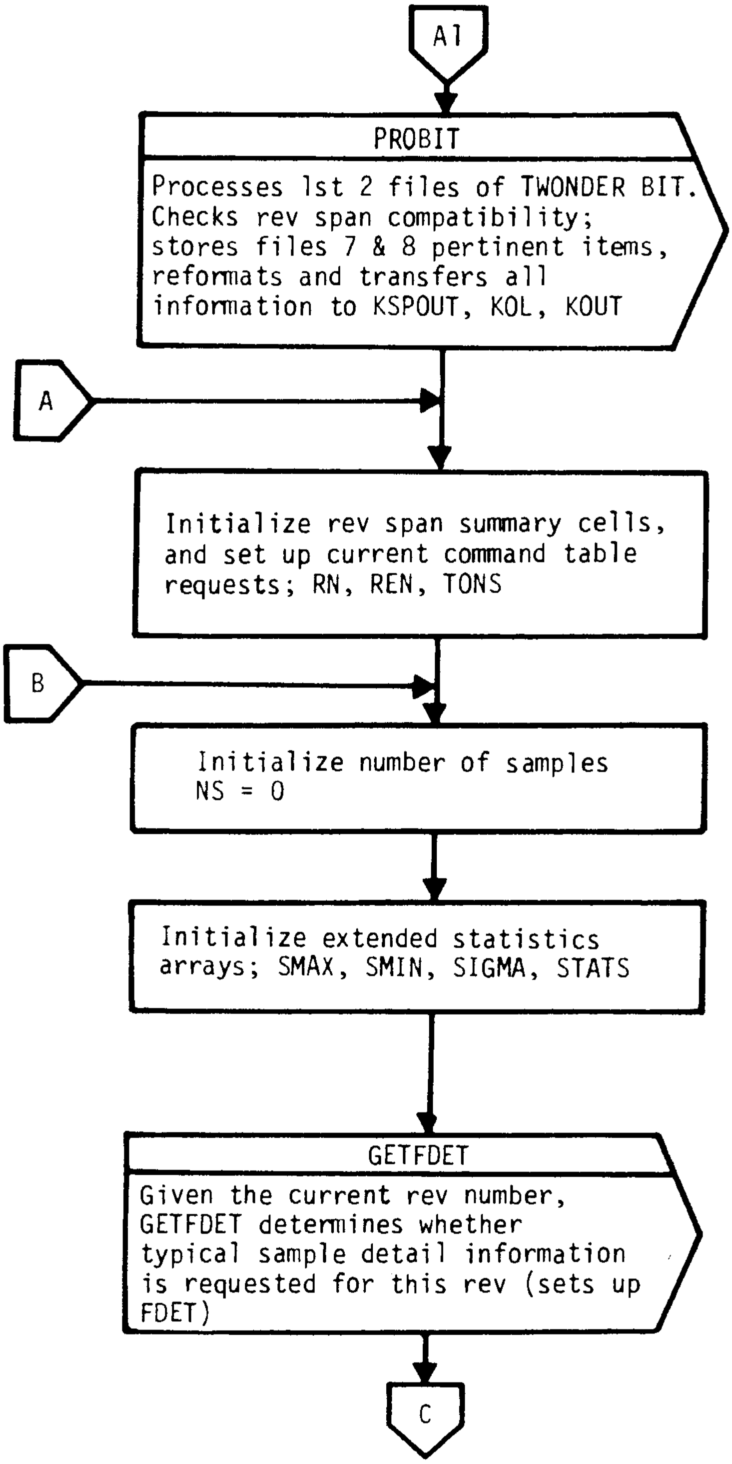

Figure 3-14 Subroutine MCDRIV Flow Diagram (Continued)

SECRET/D

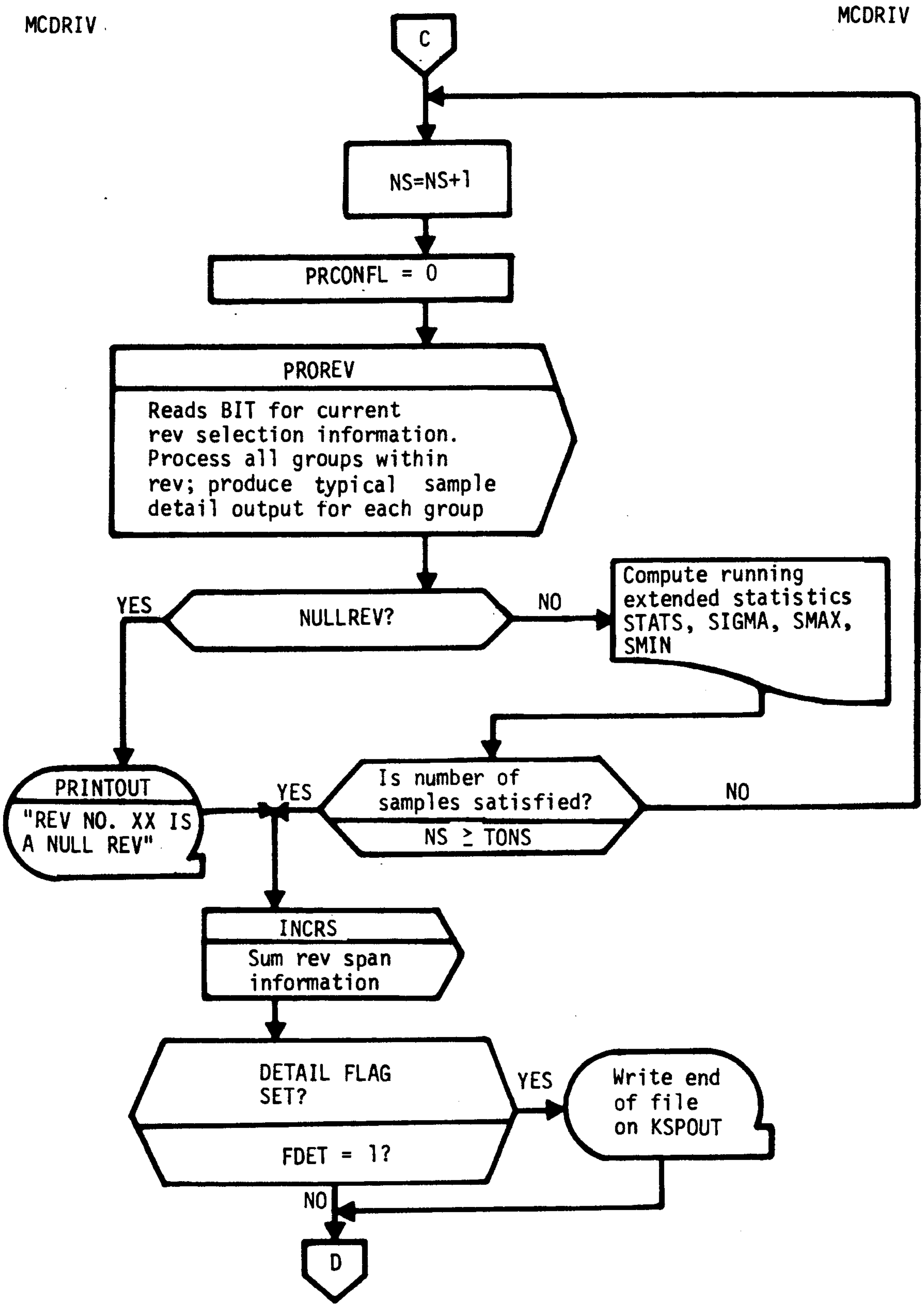

Figure 3-14 Subroutine MCDRIV Flow Diagram (Continued)

SECRET/D

MCDRIV MCDRIV

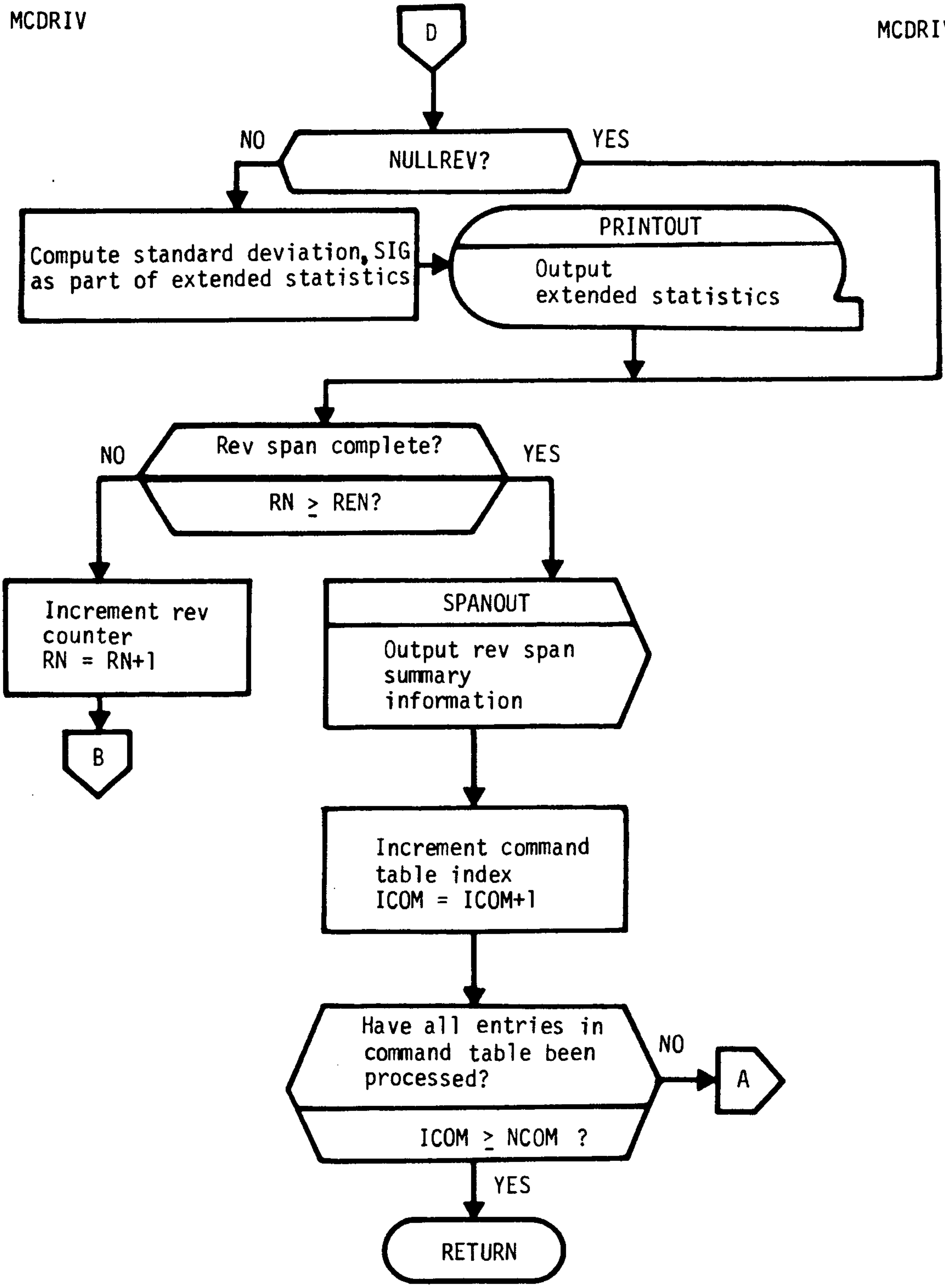

Figure 3-14 Subroutine MCDRIV Flow Diagram (Continued)

3.19 SUBROUTINE PRINTOUT

3.19.1 Purpose

PRINTOUT is used to write requested output on the magnetic tapes KSPOUT, KOL, and KOUT in a BCD format of fifteen words per record.

3.19.2 Usage

3.19.2.1 Calling Sequence

GOTO PRINTOUT $

3.19.2.2 Input

a. Calling sequence

   None

b. Input through common locations

   BUFOUT
   KSPTFG
   PRCNTRL
   PROL
   EØF
   LPIL

3.19.2.3 Output

a. Calling sequence

   None

b. Output through common locations

   KOL
   KOUT
   KSPOUT

3.19.2.4 Working Symbols

None

3.19.2.5 Error/Action Messages

None

3.19.2.6 Subroutines Called

TAPERR2
CHECKW
CWRITE

3.19.2.7 Called By

BITRE
GROUT
MCDRIV
PROBIT
PROREV
SPANOUT

3.19.3 Method

By interrogating input flags, PRINTOUT distinguishes which of the output tapes (KSPOUT, KOL, KØUT) should be written with the information contained in the (BUFØUT) 15 word BCD buffer. In general, the Monte Carlo specific output is written on tape KOL, the detailed typical sample output is written on tape KSPOUT, and the rev span summary information along with the Monte Carlo output is written on tape KOUT. Reference 1 contains detailed descriptions of information and format of output written on each of these tapes.

See Figure 3-15 for the PRINTOUT flow logic.

3.19.4 Restrictions

None

3.19.5 References

None

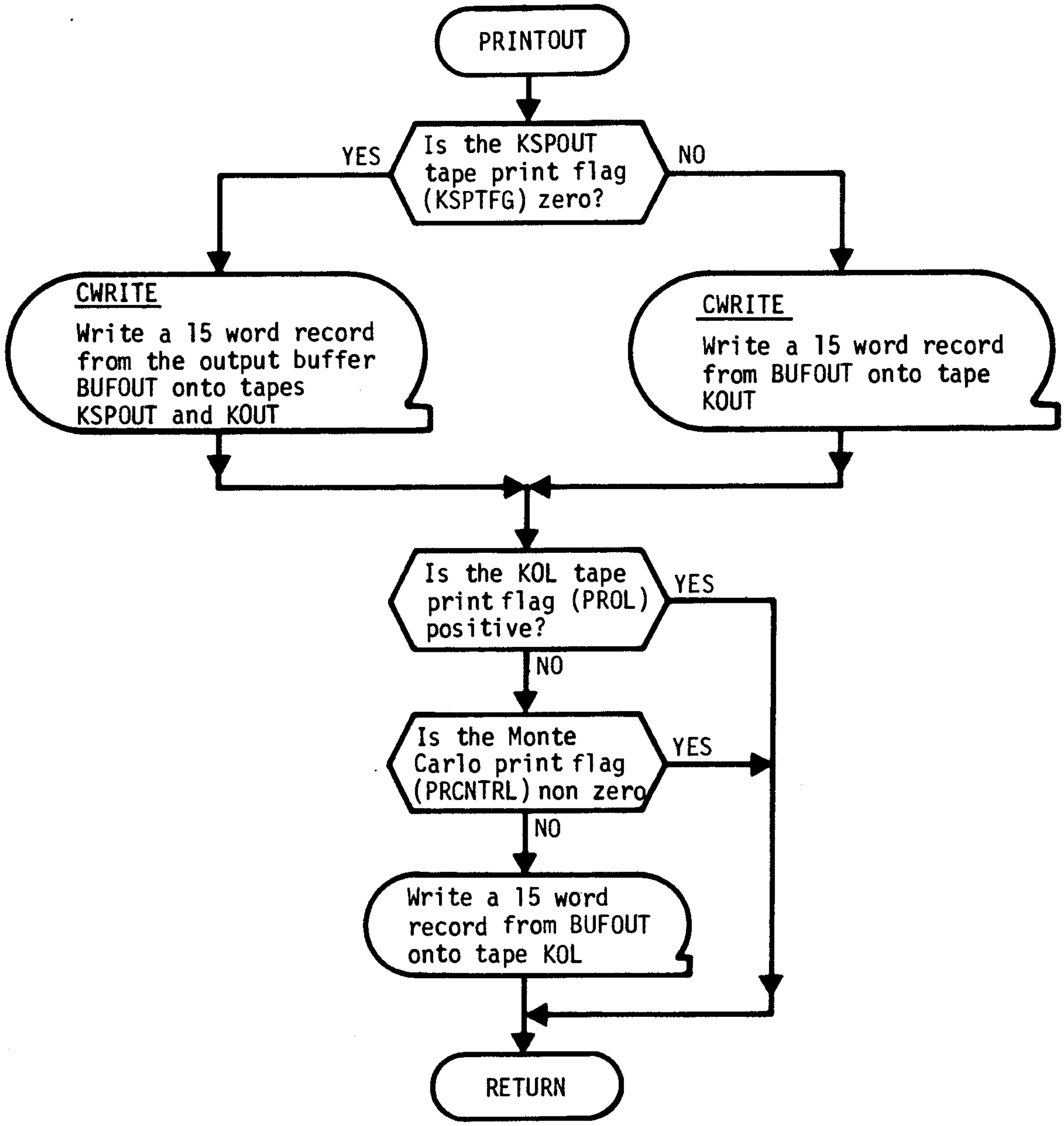

Figure 3-15 Subroutine PRINTOUT Flow Diagram

3.20 SUBROUTINE PROBIT

3.20.1 Purpose

PROBIT converts the binary information contained on the first two files of the TWONDER BIT to a BCD format and transfers this information onto the KSPOUT, KOUT, and KOL magnetic output tapes. Auxillary functions of PROBIT are to check for TWONDER and TSPOOND compatibility in vehicle number and rev span.

3.20.2 Usage

3.20.2.1 Calling Sequence

PROBIT $

3.20.2.2 Input

a. Calling sequence

   None

b. Inputs through common locations

   BLNK
   BTBF
   BUFOUT
   F78IT
   INPUT
   INTBUF
   IPVIS
   KBIT
   KON
   KOUT
   KSPOUT
   KSPTFG
   NCOM
   PVINP
   TREN
   TRST
   VEHNO

3.20.2.3 Output

a. Calling sequence

   None

b. Outputs through common locations

PROBA
PROBFA
PROBREC
PROBV
PV

3.20.2.4 Working Symbols

Program Symbol	Description
BGN	An integer working cell
BGN2	An integer counter
CØUNT	An integer counter
DWDS	The number of words output parameter in the calling sequence of the system subroutine CHECKN
EØF	The end of file output parameter in the calling sequence of the system subroutine CHECKN
JJ	The sequential number of the requested bit in the calling sequence of GETFDET
KK	A processing pointer for the byte number within BUFØUT
LL	An intermediate processing pointer
LPIL	An output parameter in the calling sequence of the system subroutine CHECKN
NDN	An integer working cell
NDN2	A counter for the number of lines printed
SAVE	A Hollerith working cell

3.20.2.5 Error/Action Messages

The following error and or action messages may be output by the procedure PROBIT:

MESSAGE	RECOVERY PROCEDURE
SYSTEM FOUND ERROR ON LAST READ ON UNIT XX PUSH START, TRY AGAIN	An unexpected error was encountered during a read operation on the BIT. Push GO to continue. PROBIT will attempt to read the same record again

MESSAGE	RECOVERY PROCEDURE
NO RECORDS ON 1ST FILE-RELOAD BIT - PUSH ON	An end of file was encountered on the first read operation of the BIT. Remount the proper tape and push GO.
WRONG REV SPAN ON BIT OR INPUT CARD-RESTART AFTER CORRECTION	The requested rev span on the input data cards is outside the rev span range available on the BIT. Either the wrong BIT has been mounted or the data cards are incorrect. Correct and restart.
TWONDER FUNCTION CARD NOT FOUND-HIT GO	The word TWONDER was not found on the function card while searching the image of the third record of the first file of the BIT. Push GO to ignore.
VEHICLE NO. NOT ON FUNCTION CARD-HIT GO	The vehicle number was not found on the TWONDER function card image (third record of the first file of the BIT). Push GO to continue.
BIT VEHICLE NO. TOO LARGE HIT-GO	While searching the image of the third record of the first file of the BIT, no blanks were found following the vehicle number. No vehicle number match up can be performed. Push GO to continue.
VEHICLE NO. IS XXX DOES NOT MATCH INPUT CARD, CORRECT, RESTART-OR HIT GO TO CONTINUE	The vehicle numbers on the TSPOOND and the TWONDER function cards do not match. If the correct BIT is mounted push GO to continue. Otherwise mount the proper BIT and restart.

3.20.2.6 Subroutines Called

BUFSET
GETFDET
SETF78
PRINTOUT
SPACEUP
TAPERR4
BCDOCT
CHECKN
CHECKR

CHECKW
CREAD
CWRITE
OCTBCD
READ
REWIND
WEOF

3.20.2.7 Called By

MCDRIV

3.20.3 Method

PROBIT reads the first two files of the BIT input tape record by record. As each record is read, the information thereon is converted to BCD and written onto the magnetic tapes KSPOUT, KOUT, and KOL. The rev span of the BIT is compared to the rev span on the input data cards to determine compatibility between TWONDER and TSPOOND. The vehicle number on the BIT is compared to the one on the TSPOOND input function card as another compatibility check.

Four cells of core are loaded from the File 8 data on the BIT. These are PROBA (probability of activity), PROBFA (probability of false alarm), PROBREC (probability of recognition), and PROBV (probability that target is visible). PROBIT sets PV (probability of visibility) equal to PROBV from File 8 if the input parameter flag IPVIS is zero or three; otherwise it sets PV equal to the input parameter PVINP.

PROBIT returns to MCDRIV with the BIT input tape positioned at the beginning of the third file.

Figure 3-16 shows the flow logic for PROBIT.

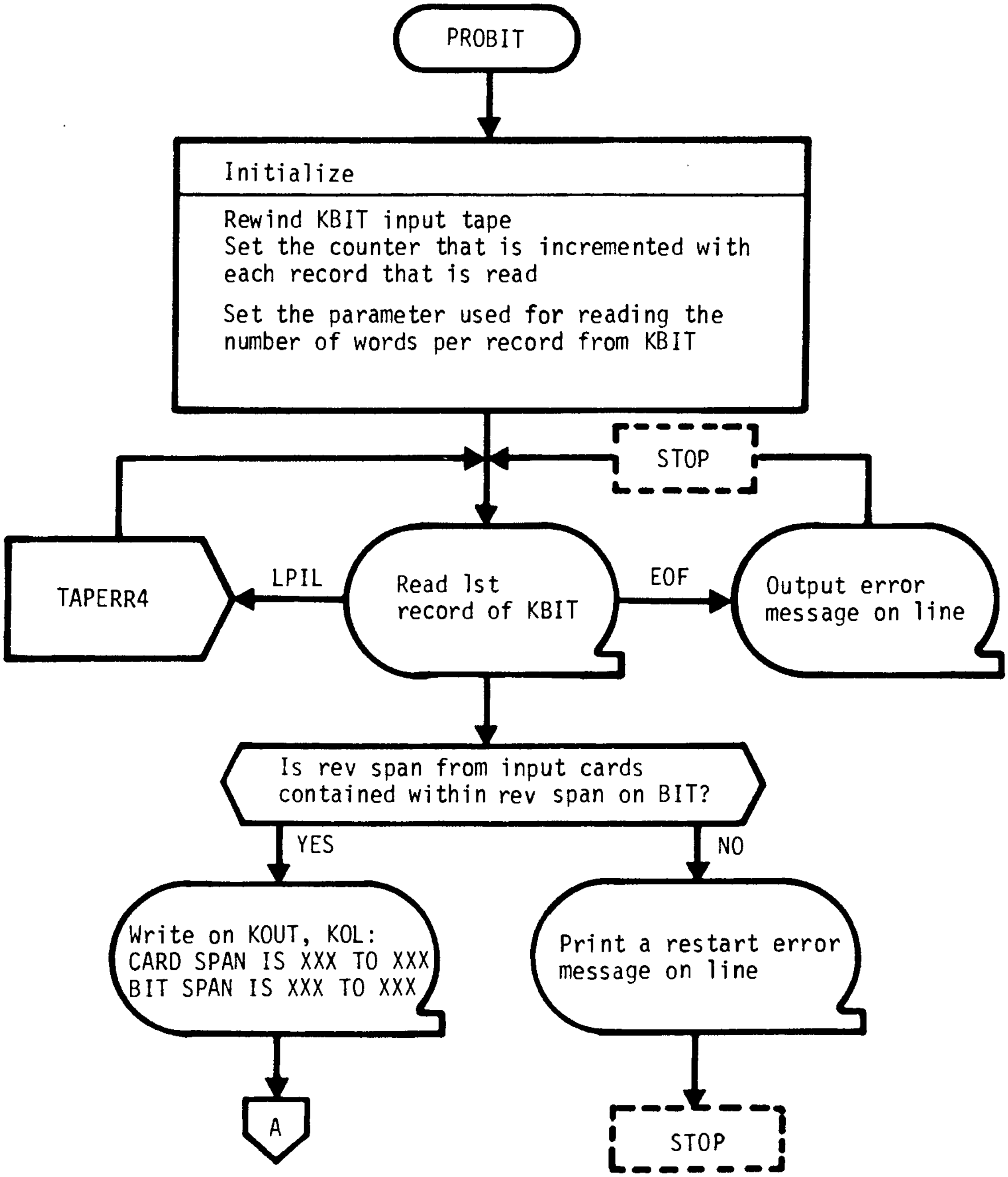

Figure 3-16 Subroutine PROBIT Flow Diagram

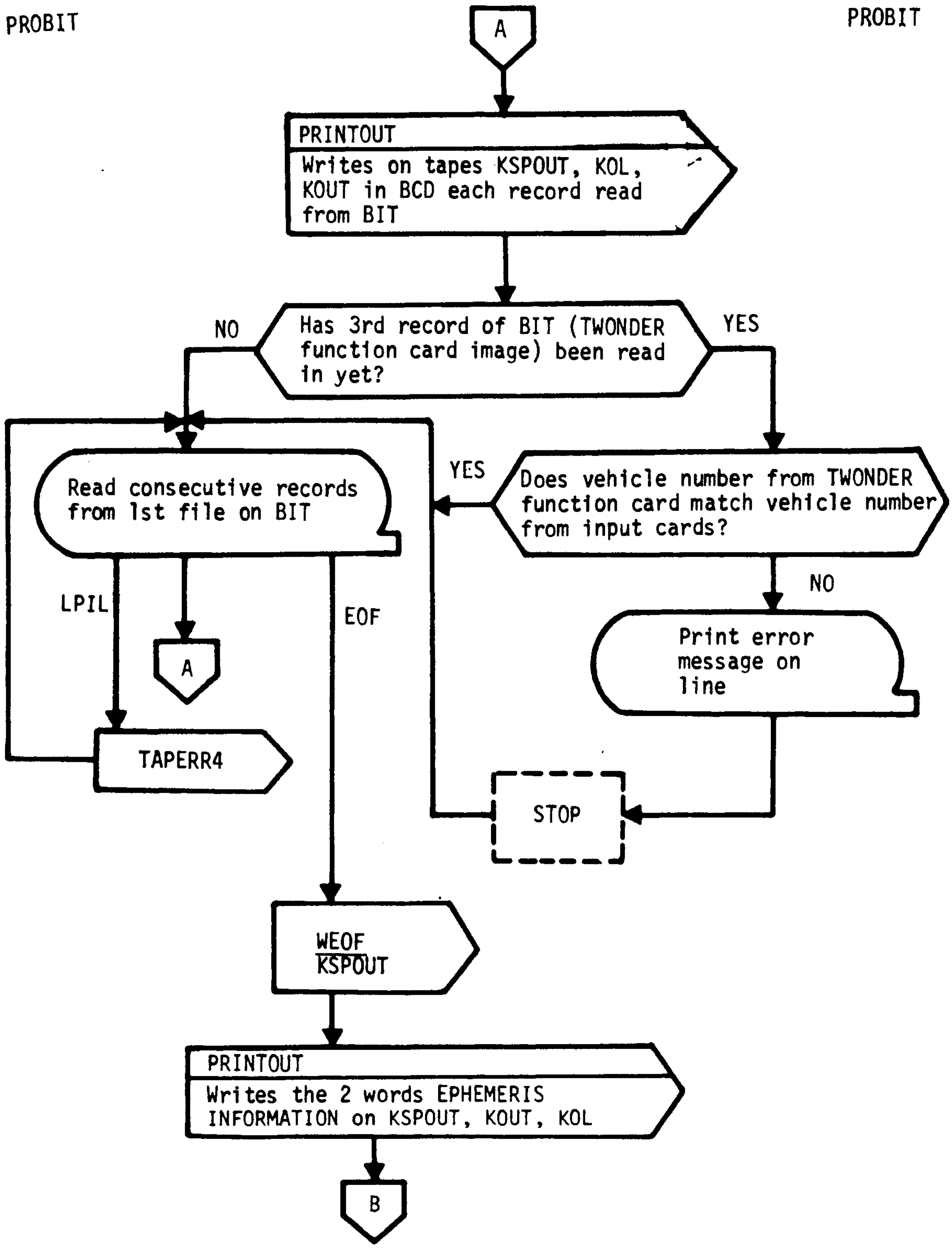

Figure 3-16 Subroutine PROBIT Flow Diagram (Continued)

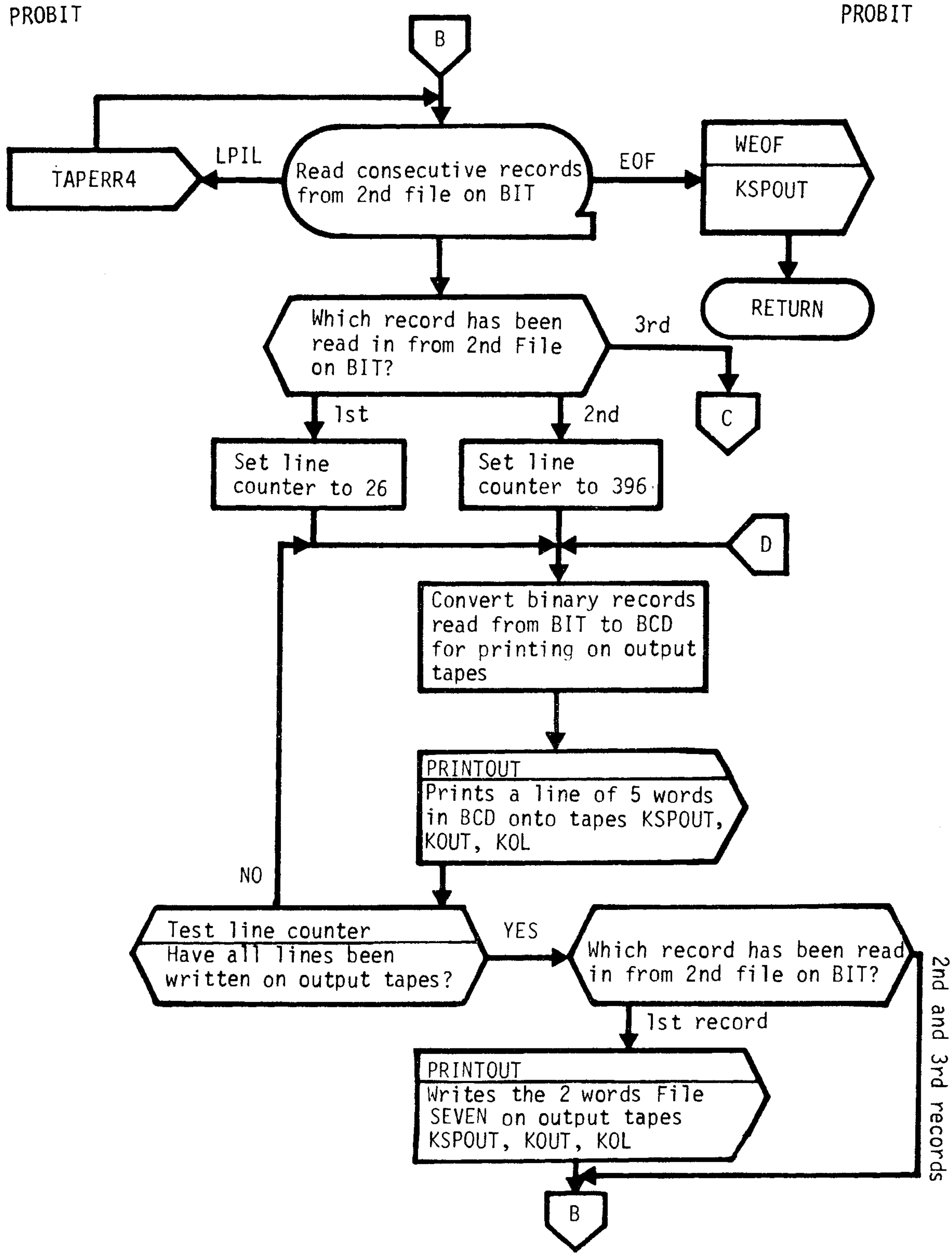

Figure 3-16 Subroutine PROBIT Flow Diagram (Continued)

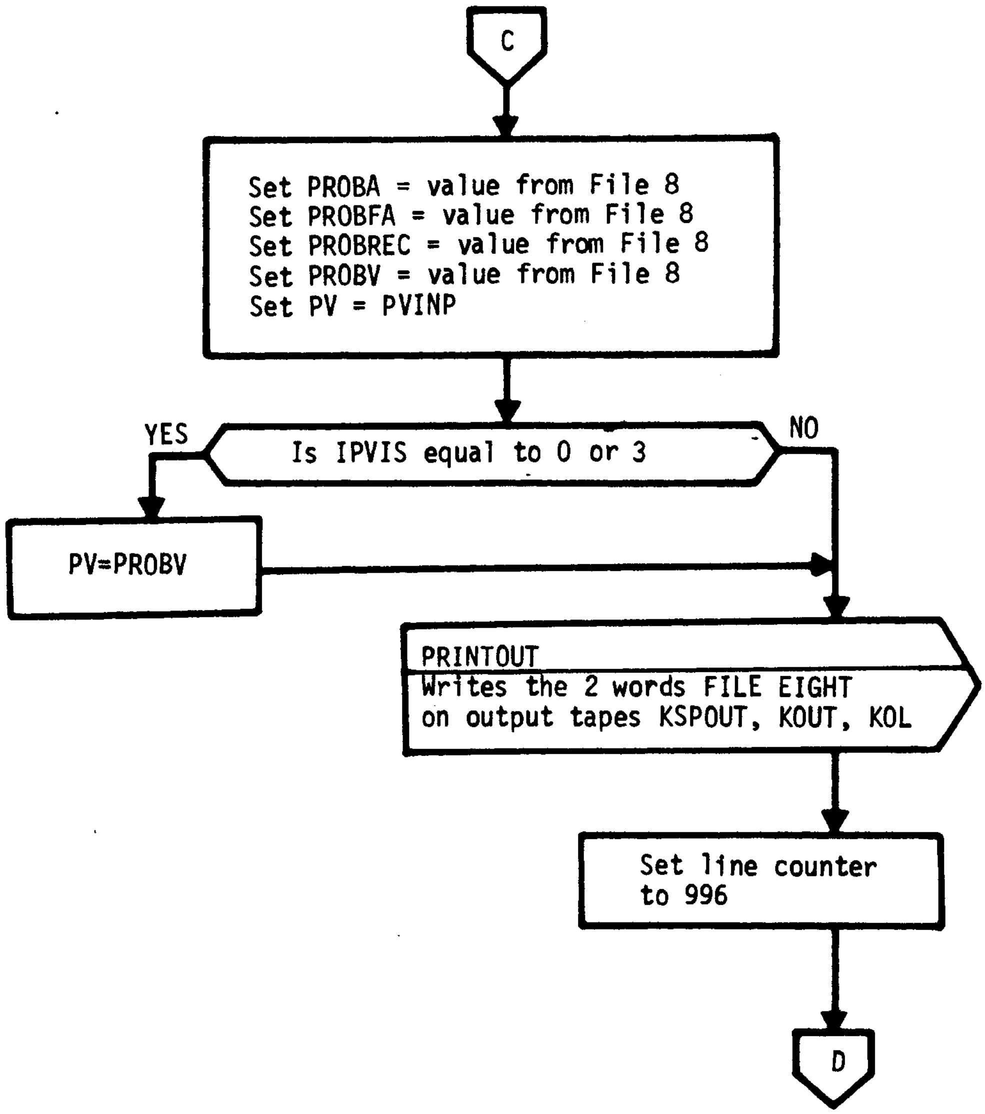

Figure 3-16 Subroutine PROBIT Flow Diagram (Continued)

3.21 SUBROUTINE PROGRO

3.21.1 Purpose

The purpose of PROGRO is to process all the targets within the present group, to apply the decision strategy, and to determine that target within the group selected for photography.

3.21.2 Usage

3.21.2.1 Calling Sequence

PROGRO ∅

3.21.2.2 Inputs

a. Calling sequence inputs

None

b. Inputs via common locations

GN
TASSNO
TIDX
TNMAX
TONSN

3.21.2.3 Outputs

a. Calling sequence outputs

None

b. Outputs via common locations

SCOF
SIGT
SN
SNN
TIDX
TN
TNN
TNP

3.21.2.4 Working Storage Within Routine

None

3.21.2.5 Error/Action Messages

None

3.21.2.6 Subroutines Called

PROTAR	Specific target processor. Computes visibility for current target, slew and settle and dwell times, scope on and off times, processes voting logic, and sets up voting table
DECIDE	Applies decision strategy to determine the target within each group to be photographed

3.21.2.7 Called By Following Routine

PROREV

3.21.3 Method

PROGRO controls the logic necessary to simulate the main optics selection within the group. All targets within the group are processed with crew voting simulated and the decision strategy applied to determine the selection. The logic flow diagram is shown as Figure 3-17.

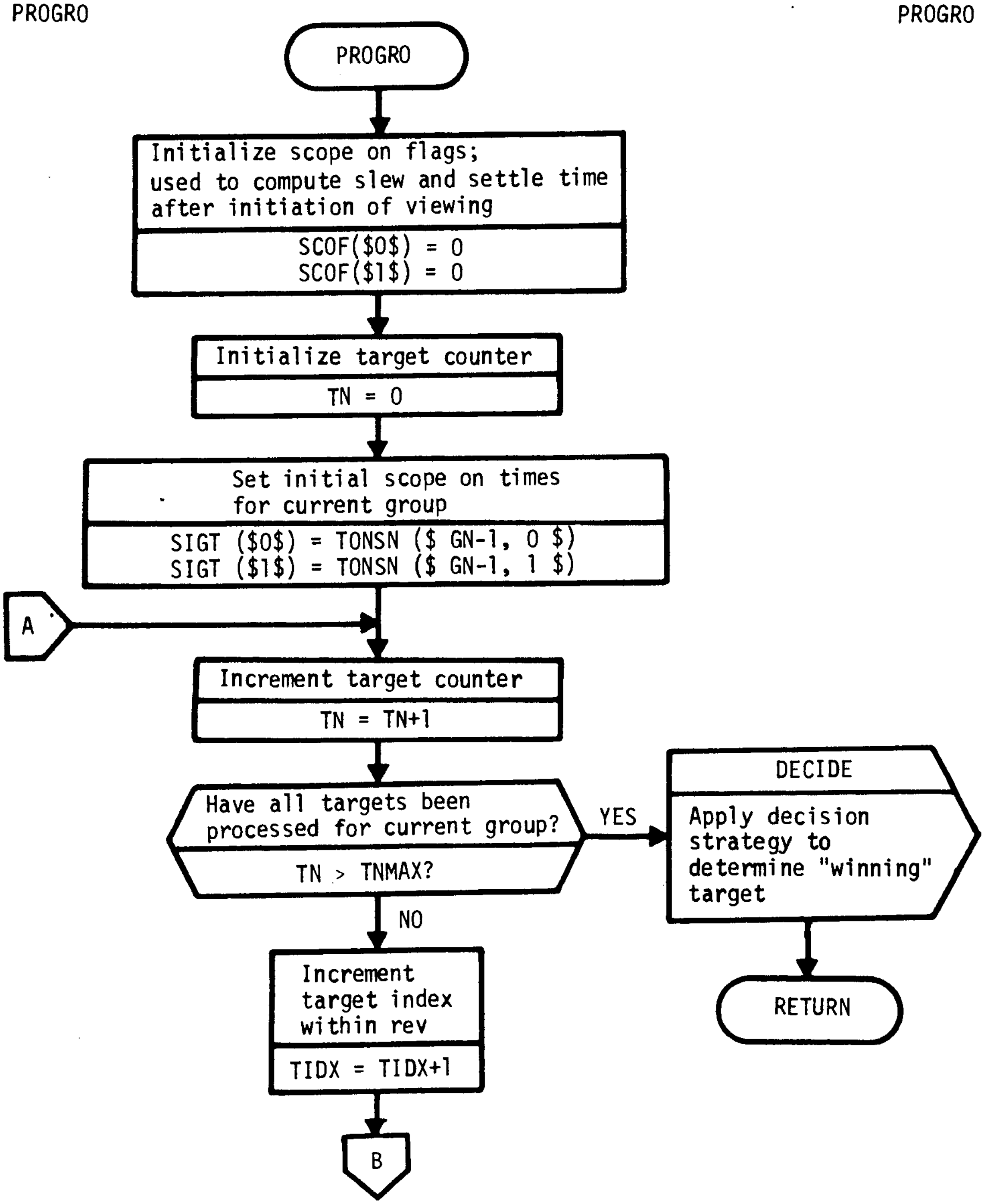

Figure 3-17 Subroutine PROGRO Flow Diagram

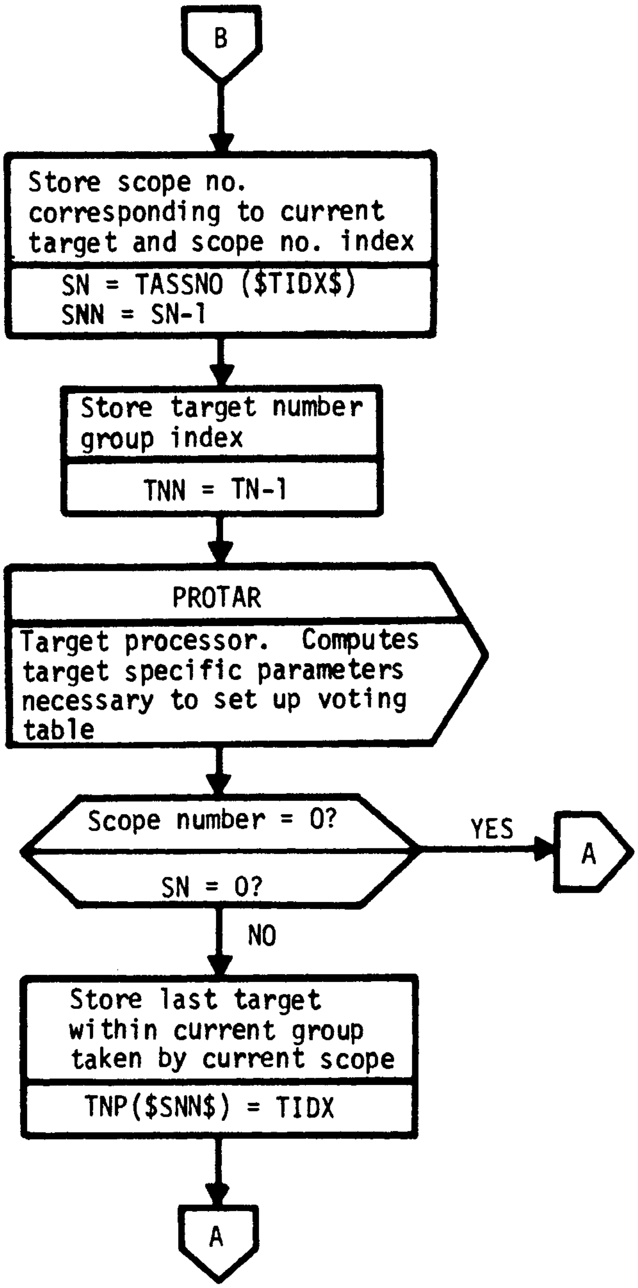

Figure 3-17 Subroutine PROGRO Flow Diagram (Continued)

3.22 SUBROUTINE PROREV

3.22.1 Purpose

Subroutine PROREV's primary function is to control the flow of logic associated with the processing of information for one complete rev. This is accomplished through the following steps:

- Extract the rev selection information from the TWONDER BIT and store into core memory
- Produce typical sample detail output on a group by group basis for the entire rev
- Update rev span summary outputs over the requested multi-sample duration

3.22.2 Usage

3.22.2.1 Calling Sequence

PROREV ∅

3.22.2.2 Inputs

a. Calling sequence inputs

None

b. Inputs via common locations

BLNK
CNFLG
FDET
GNMAX
ITOPT
NS
NULLREV
RN
TFLICT
TIDX
TREV
WTOP

3.22.2.3 Outputs

a. Calling sequence outputs

None

b. Outputs via common locations

BUFOUT
FDET
GN
KSPTFG
NCNFLT
PRCONFL

3.22.2.4 Working Storage Within Routine

RLAST	Rev which was processed on the previous pass through PROREV

3.22.2.5 Error/Action Messages

The following message is an information message appearing on the BCD output tapes when subroutine PROREV detects a group of targets containing all visual intelligence targets or targets which conflict with the previous groups selection. No special action is taken when this occurs as the program proceeds to process the next group of targets.

GROUP XX OF REV XX CONTAINS ALL VISUAL INTELLIGENCE
TARGETS OR CONFLICTS

3.22.2.6 Subroutines Called

BITRE	Reads TWONDER BIT for rev selection file(s)
PROGRO	Controls logic associated with processing the path selections for an entire group
GROUT	Group output routine. Displays the typical sample detail output broken down by groups
SINC	As a function of the target selected and the vote recorded, SINC updates the table containing the count of the primary and alternate target selections over the entire rev span

PRINTOUT	Outputs BCD buffer on KOL, KSPOUT, KOUT, output tapes

3.22.2.7 Called By Following Routines

MCDRIV

3.22.3 Method

PROREV controls the use of the subroutines necessary to simulate the target visibility and activity, crew voting and consequent main optics selections over an entire rev. Figure 3-18 shows the flow of logic required to accomplish this task.

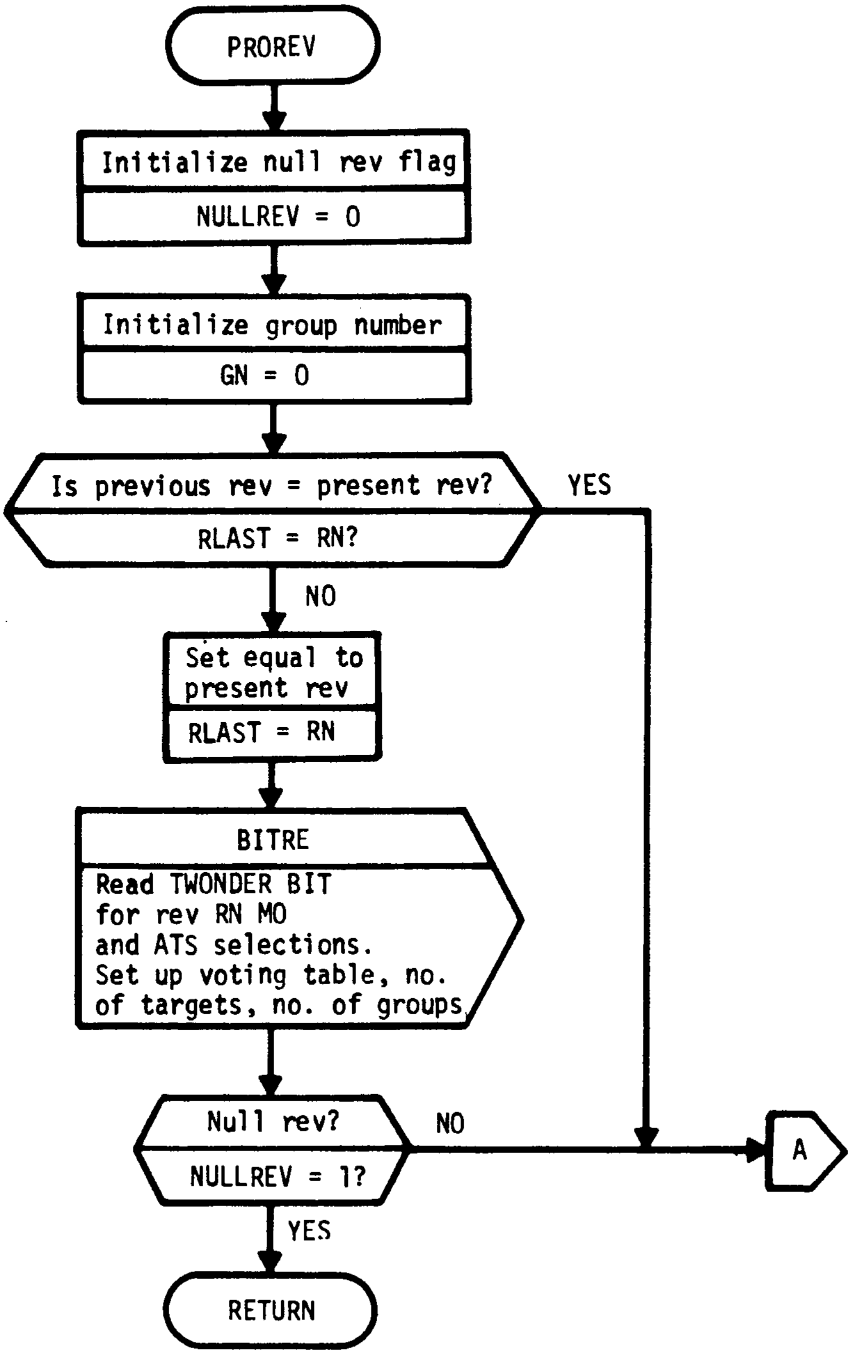

Figure 3-18 Subroutine PROREV Flow Diagram

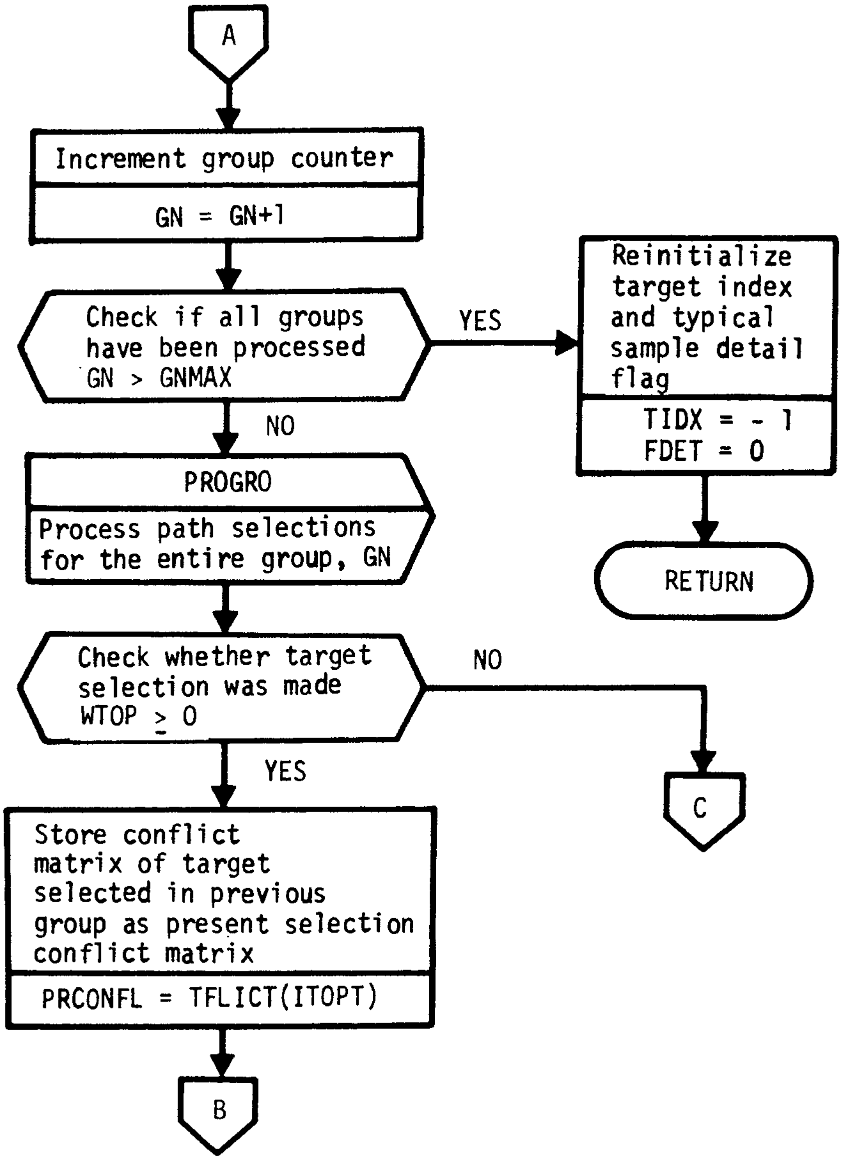

Figure 3-18 Subroutine PROREV Flow Diagram (Continued)

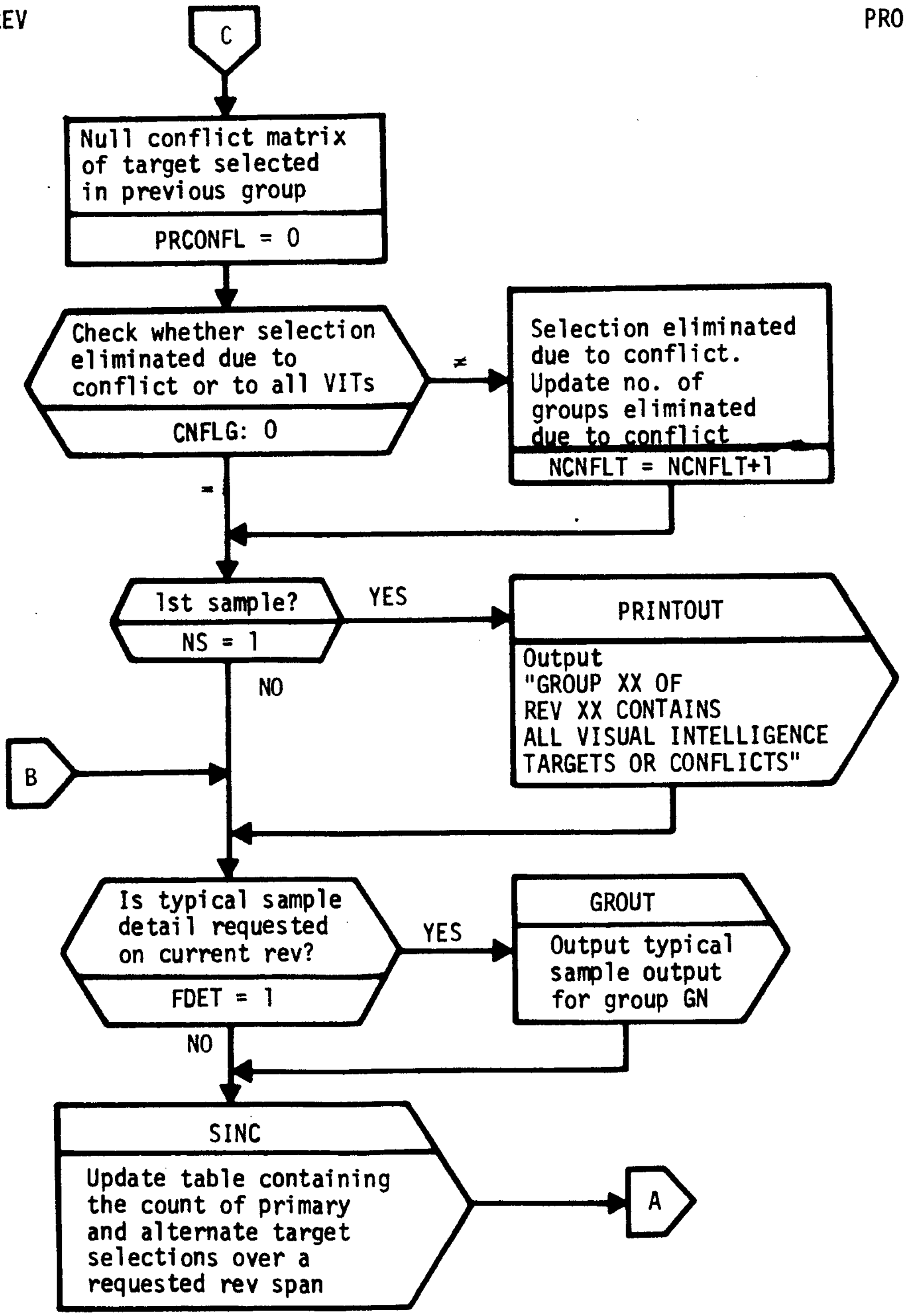

Figure 3-18 Subroutine PROREV Flow Diagram (Continued)

3.23 SUBROUTINE PROTAR

3.23.1 Purpose

PROTAR is the individual target processor which computes the following target specific parameters:

- Visibility of current target
- Scope specific slew and settle, dwell times, and on and off times
- Reported and actual states of target visibility and activity taking into account crew false alarms and failures to recognize

3.23.2 Usage

3.23.2.1 Calling Sequence

PROTAR ∅

3.23.2.2 Inputs

a. Calling sequence

None

b. Inputs via common locations

SIGT
SN
SNN
TNN

3.23.2.3 Outputs

a. Calling sequence

None

b. Outputs through common locations

ASDT
DT
SIGT
STOF
STON

3.23.2.4 Working Storage Within Routine

None

3.23.2.5 Error/Action Messages

None

3.23.2.6 Subroutines Called

GETV	Computes probability of visibility and determines target visibility considering both inter-group (between groups) as well as intra-group (within a group) visibility correlation
GETDT	Computes scope slew and settle times along with actual scope dwell time
VOTE	Simulates the reported and actual states of target visibility and activity

3.23.2.7 Called By Following Routine

PROGRO

3.23.3 Method

PROTAR is entered once per target and follows the order of computation indicated below:

1. Subroutine GETV computes the probability of visibility as a function of the input parameter, IPVIS. IPVIS also dictates whether intra-group visibility correlation should be considered or not. The inter-group visibility correlation model (Section 2.6) is always simulated.
2. Simulates target visibility within a group by generating, at random, a visibility flag corresponding to each target indicating either visibility or non-visibility.
3. Calculates dwell time and scope time on and off for each target using the recommended slew and settle time from the TWONDER selection files. (Subroutine GETDT).
4. Processes voting logic and determines the reported and actual states of visibility and activity (Subroutine VOTE).

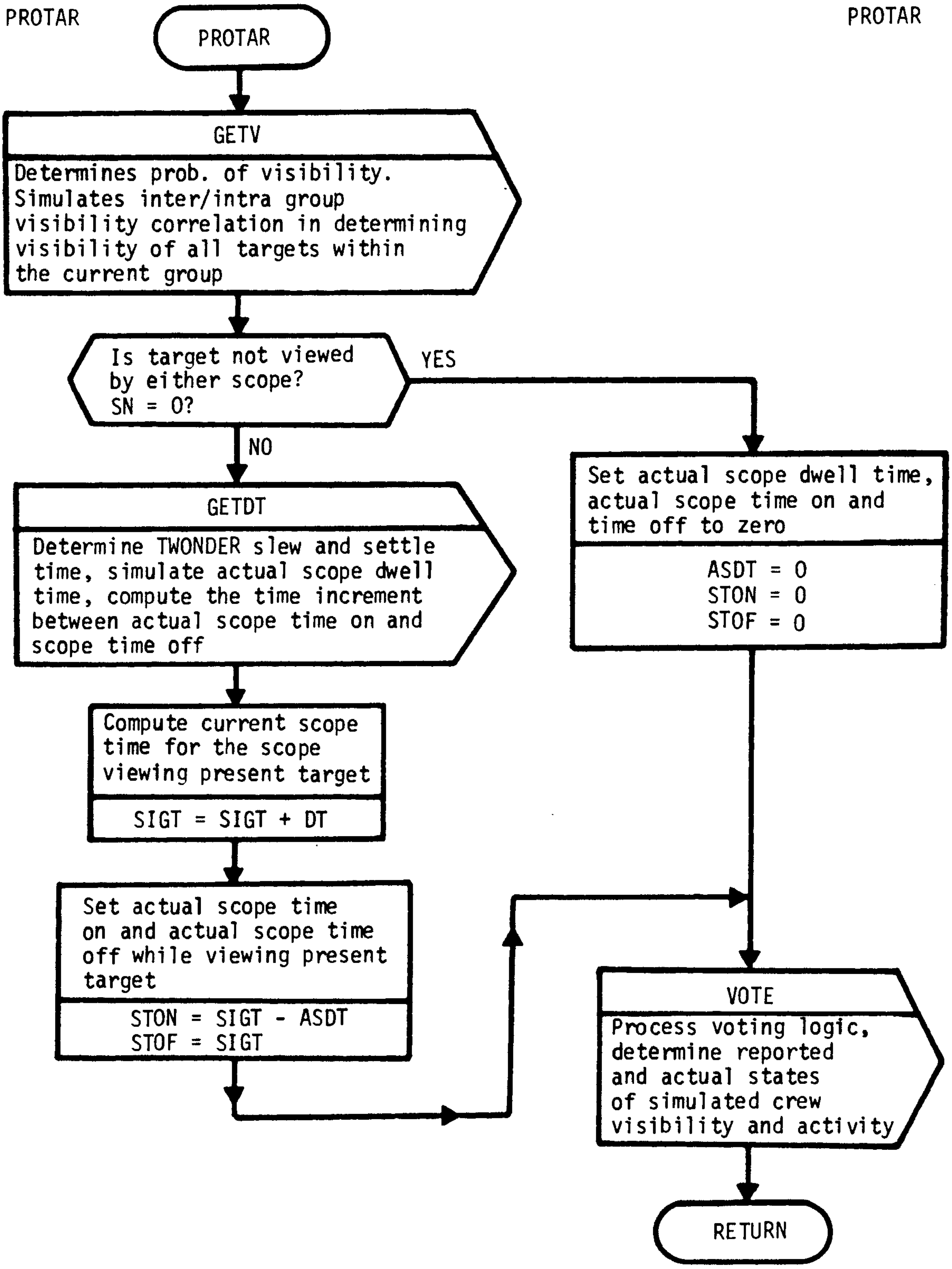

Figure 3-19 Subroutine PROTAR Flow Diagram

3.24 SUBROUTINE RDM1J

3.24.1 Purpose

RDM1J generates a uniformly distributed pseudo-random number between zero and one.

3.24.2 Usage

3.24.2.1 Calling Sequence

RDM1J (LZ = UU, LLL) $

3.24.2.2 Input

a. Calling sequence

Program Symbol	Equation Symbol	Description
LZ	l_{i-1}	An integer random number between one and 2^{35} used to start the sequence. (A "seed")

b. Inputs through common locations

None

3.24.2.3 Output

a. Calling sequence

Program Symbol	Equation Symbol	Description
UU	u_i	The generated floating point pseudo-random number, (greater than 2^{-28} and less than 1.0)
LLL	l_i	An integer used in the algorithm (contains 12 octal digits)

b. Output through common locations

None

3.24.2.4 Working Symbols

Program Symbol	Description
CD	A floating point number equal to 2^{27}
II	An integer number equal to 5^{15}

3.24.2.5 Error/Action Messages

None

3.24.2.6 Subroutines Called

None

3.24.2.7 Called By

BERN
TRI

3.24.3 Method

To start the sequence an integer number consisting of twelve octal digits is loaded into LZ. Normally the "seed" number is 1 but it can be as large as 2^{35}.

A new random number 1_i (LLL) is generated from the previously generated number 1_{i-1} (LZ) by extracting the least significant portion of the integer product of 5^{15} times 1_{i-1}. The left most 27 bits of the 35 bit result are converted to a normalized floating point number between 2^{-28} and one.

$$x = (5^{15})\ (1_{i-1})$$

$$1_i = \text{least significant 35 bits of } x$$

$$y = \frac{1_i}{2^8}$$

$$u_1 = \frac{\text{(Integer part of y)}}{2^{27}}$$

Figure 3-20 shows the flow logic for RDM1J.

3.24.4 Restrictions

1. This routine will repeat after 2^{33} generated numbers.

3.24.5 Reference

National Bureau of Standards Report 3370, "Generation and Testing of Pseudo-random Numbers" by Olga Taussky and John Todd.

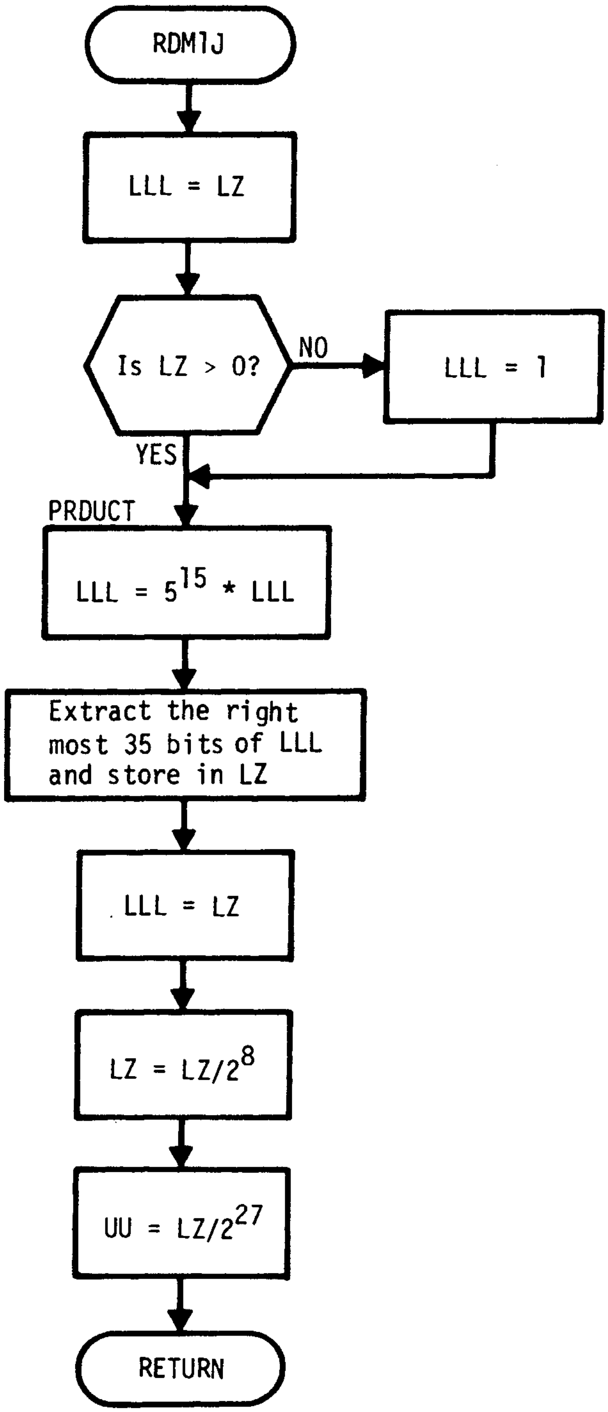

Figure 3-20 Subroutine RDM1J Flow Diagram

3.25 SUBROUTINE SETF78

3.25.1 Purpose

SETF78 sets to non-zero those bits in the array F78IT that correspond to the locations of integer words within Reset Files 7 and 8.

3.25.2 Usage

3.25.2.1 Calling Sequence

SETF78 (ARG1, ARG2, ARG3) $

3.25.2.2 Input

a. Calling sequence

Program Symbol	Description
ARG1	The number of the first bit within a sequence that must be set non-zero
ARG2	The number of the last bit within a sequence that must be set non-zero
ARG3	The number of the word in the array within which the sequence of bits are to be set non-zero

b. Input through common locations

None

3.25.2.3 Output

a. Calling sequence

None

b. Output through common locations

F78IT

3.25.2.4 Working Symbols

None

3.25.2.5 Error/Action Symbols

None

3.25.2.6 Subroutines Called

None

3.25.2.7 Called By

PROBIT

3.25.3 Method

Reset Files 7 and 8 parameters, as contained on the TWONDER BIT, are converted from binary to BCD for TSPOOND output display. Two types of conversions are necessitated, floating point and integer. SETF78 indicates those parameters within Files 7 and 8 requiring integer BCD conversion. This is effected by setting those bits in the array F78IT, corresponding to the locations of the integer words within Files 7 and 8, to non-zero. Subsequent interrogation of the bits of array F78IT will identify those parameters requiring integer BCD conversion for output.

3.26 SUBROUTINE SINC

3.26.1 Purpose

Subroutine SINC computes the following rev span output parameters, updating these parameters on a rev by rev basis: target weight with interdiction, number of clear targets with interdiction, number of active primaries and alternates, number of inactive primaries and alternates, number of rejected primaries and alternates, number of unobserved primaries and alternates, and the total number of primaries and alternates.

3.26.2 Usage

3.26.2.1 Calling Sequence

SINC $

3.26.2.2 Input

a. Calling sequence

None

b. Inputs through common locations

ALTERN, AV, AVØT, CLEART, DECEPT, ITØPG, ITØPT,
PRIM, PRIMRY, STAT, TVAP, WEIGHT, WTØP

3.26.2.3 Output

a. Calling sequence

None

b. Outputs through common locations

ALTERN, CLEART, DECEPT, PRIMRY, STAT, WEIGHT

3.26.2.4 Working Symbol

Program Symbol	Description
ICØL	A processing pointer to determine if the target is active, inactive, rejected or unobserved.

3.26.2.5 Error/Action Messages

None

3.26.2.6 Subroutines Called

None

3.26.2.7 Called By

PRØREV

3.26.3 Method

The above mentioned rev span output parameters are accumulated by SINC on a rev by rev basis; i.e., the total number of each rev span parameter accumulated over one sample of one rev is summed to the total upon each reference to SINC.

See Figure 3-21 for the SINC flow logic.

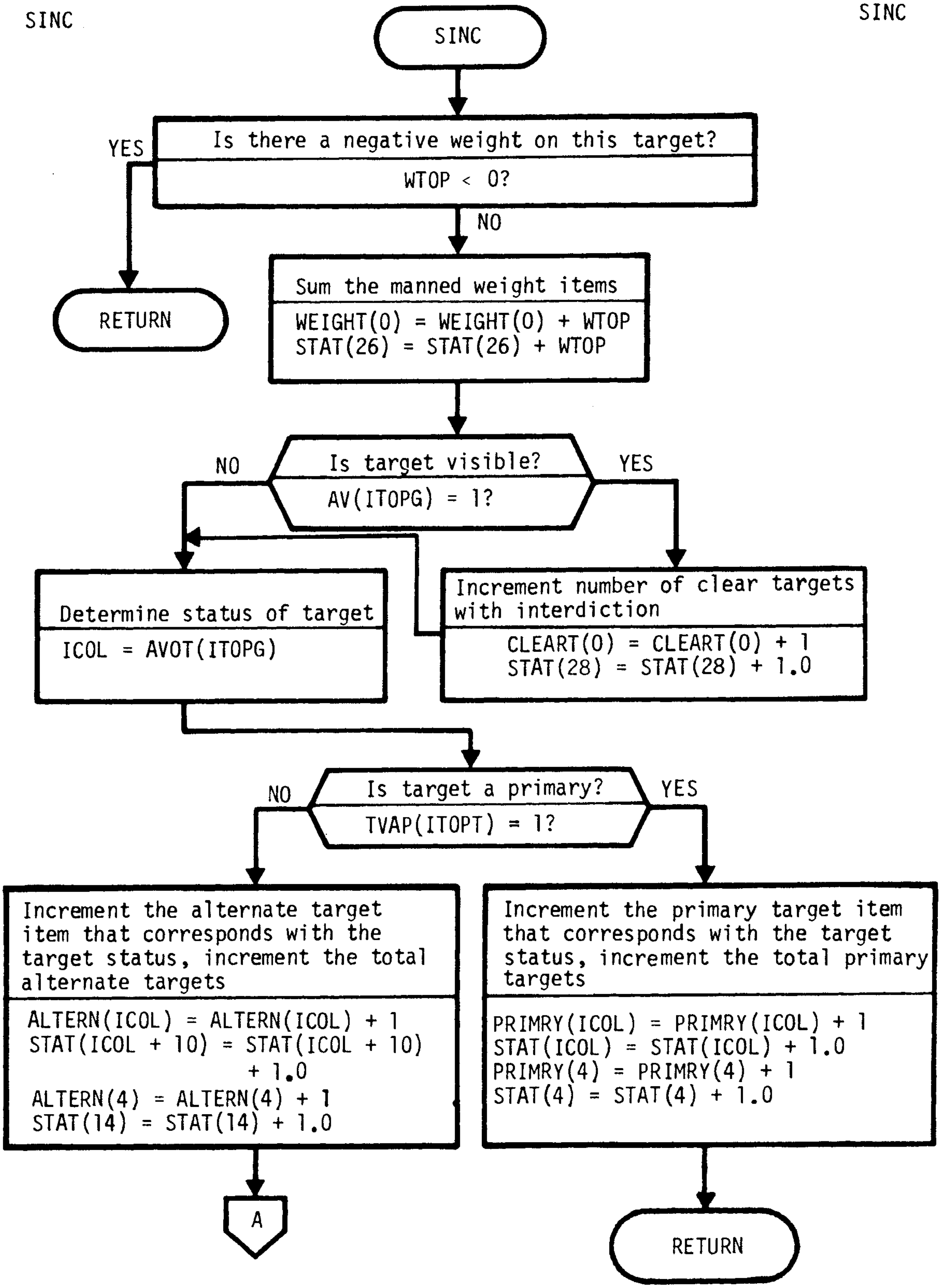

Figure 3-21 Subroutine SINC Flow Diagram

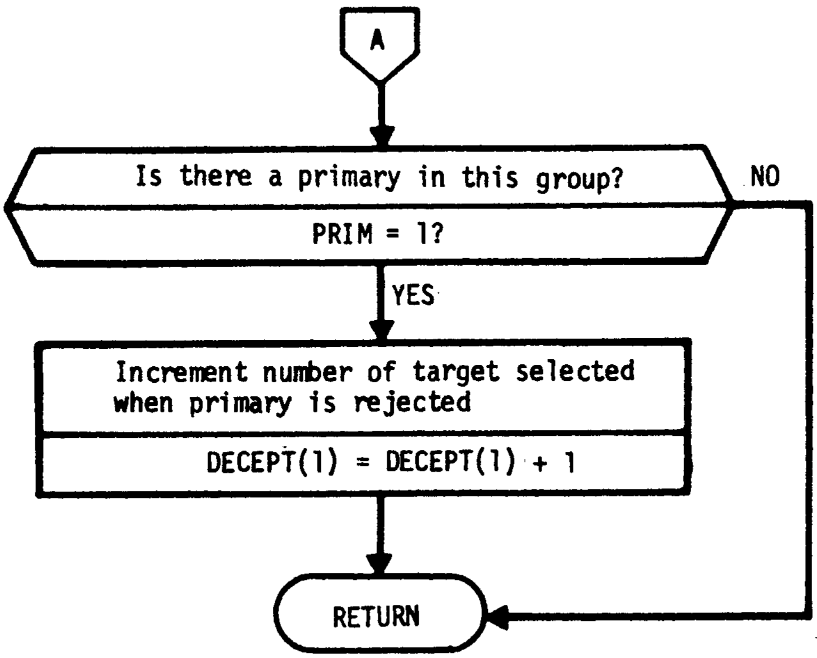

Figure 3-21 Subroutine SINC Flow Diagram (Continued)

3.27 SUBROUTINE SPACEUP

3.27.1 Purpose

SPACEUP writes 16 blank lines on the on-line printer following an error/action message, which effectively spaces the error/action message away from the printer ribbon and into readable view.

3.27.2 Usage

3.27.2.1 Calling Sequence

SPACEUP $

3.27.2.2 Input

None

3.27.2.3 Output

None

3.27.2.4 Working Symbols

None

3.27.2.5 Error/Action Messages

None

3.27.2.6 Subroutines Called

System subroutines: CHECKW
CWRITE

3.27.2.7 Called By

BITRE
CCP
GETV
PROBIT
TAPERR2
TAPERR4

3.28 SUBROUTINE SPANØUT

3.28.1 Purpose

SPANØUT, at the end of each requested rev span, summarizes and displays the summary of the statistical data generated during that rev span.

3.28.2 Usage

3.28.2.1 Calling Sequence

SPANØUT $

3.28.2.2 Input

a. Calling sequence

None

b. Inputs through common locations

BLNK	NVIT
CLEART	PRIMRY
DECEPT	REN
ICØM	SET77
NALTN	TØNS
NCNFLT	TRST
NGPRS	VØTESP
NPRIM	WEIGHT
NTPRS	

3.28.2.3 Output

a. Calling sequence

None

b. Outputs through common locations

BUFØUT
KØL
KØUT
KSPTFG
PRØL

3.28.2.4 Working Symbols

Program Symbols	Description
BB	An integer print loop counter
CSTØNE	An integer constant one
CSTTHR	An integer constant three
FNMTS	Number of samples in floating point
HACT	A preset hollerith item of 16 bytes
HALTN	" " " " " 16 "
HCLTG	" " " " " 13 "
HDVD	" " " " "119 "
HFLAL	" " " " " 12 "
HFLRG	" " " " " 18 "
HINACT	" " " " " 16 "
HINT	" " " " " 12 "
HNØF	" " " " " 9 "
HØLRITH	" " " " " 80 "
HØUTINT	" " " " " 16 "
HPRM	" " " " " 16 "
HREJ	" " " " " 16 "
HUNBS	" " " " " 16 "
HWGT	" " " " " 11 "
HWITH	" " " " " 8 "
HWTHØUT	" " " " " 8 "
NMTS	An integer equal to number of samples
PTFG	A print flag used to output the rev span summary output border
SKPFLG	A flag dictating what sections to write out
VPRIMRY	A floating point array of 5 locations that contains the average votes
WCTMND	A floating point array of 2 locations that contains the average number of clear targets
WDCPFA	A floating point array of 3 locations that contains the average number of false alarms

Program Symbols	Description
WDCPFR	A floating point array of 3 locations that contains the average number of failures to recognize
WGTMND	A floating point array of 2 locations that contains the average number of weights
WNCNFLT	A floating point item that contains the average number of conflicts
WNGTPAV	An integer array of 5 locations that contains the total targets, primaries, alternates, VIT's, and groups
WPRIMRY	A floating point array of 5 locations that contains the average number of selections

3.28.2.5 Error/Action Messages

None

3.28.2.6 Subroutines Called

EJECTPG
PRINTØUT

3.28.2.6.1 System subroutines

ØCTBCD
ØUTERR
ØUTPUT

3.28.2.7 Called By

MCDRIV

3.28.3 Method

SPANØUT takes the rev span summary output parameters which have been accumulated over both the current rev span of interest and the requested range of samples, and computes averages of these parameters. An approximation to the mean of each of these output parameters, then, is displayed on output tapes KØL, KØUT. A complete description of the rev span output parameters along with a sample of the output is given in Section 3.2.3 of Reference 1.

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Figure 3-22 shows the flow logic for SPANØUT.

3.28.4 Restrictions

None

3.28.5 References

None

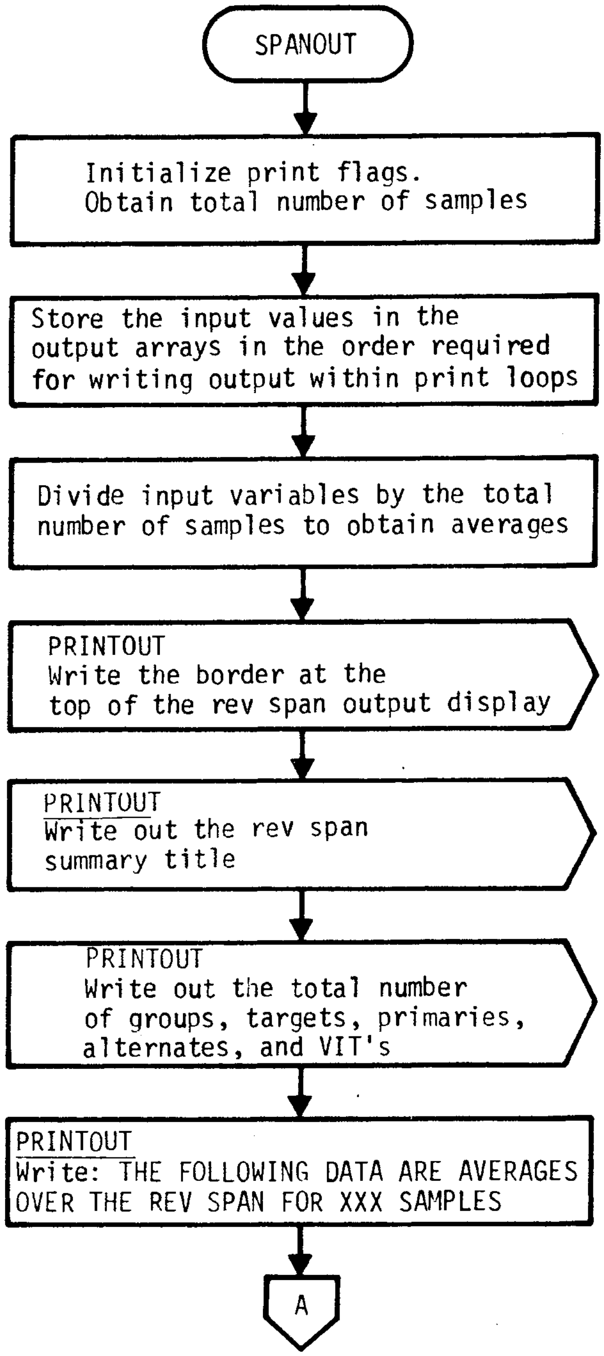

Figure 3-22 Subroutine SPANOUT Flow Diagram

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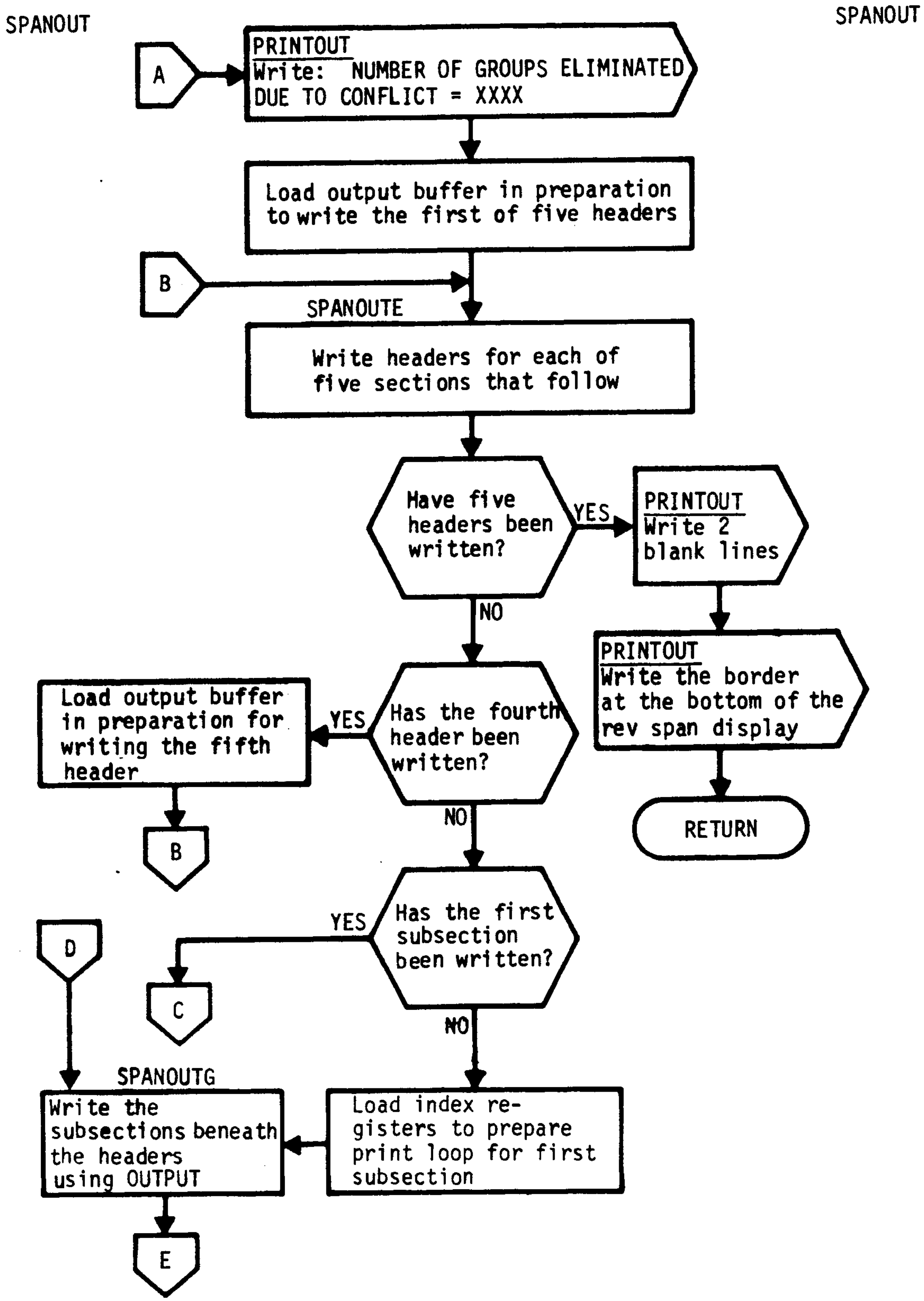

Figure 3-22 Subroutine SPANOUT Flow Diagram (continued)

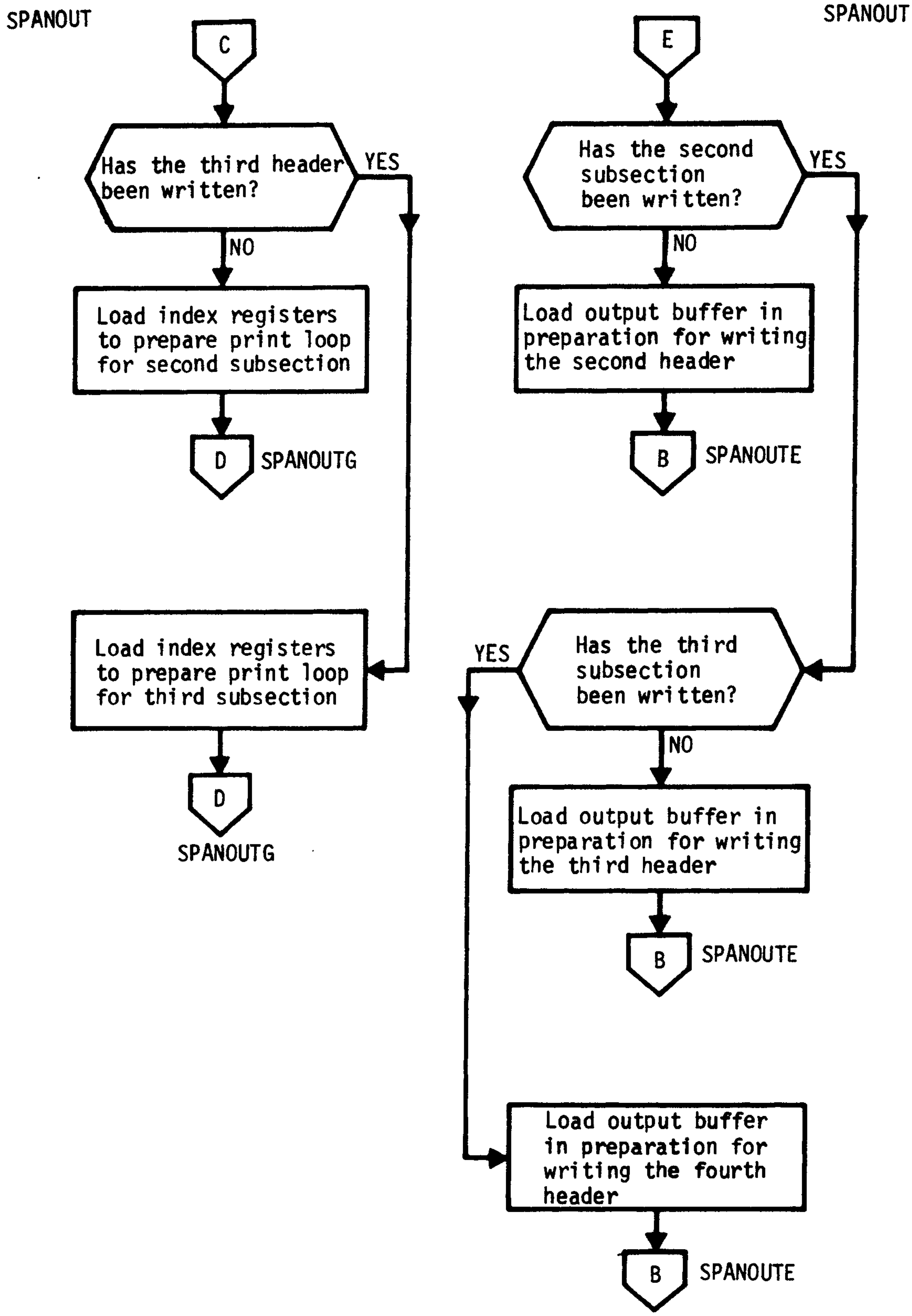

Figure 3-22 Subroutine SPANOUT Flow Diagram (continued)

3.29 SUBROUTINE SPECOL

3.29.1 Purpose

SPECOL sets up the output buffer (MCBUF) and writes the page headers and column headers for each page of the special Monte Carlo output. If a new page of output is not being initiated, SPECOL writes only the first two columns (group number and target selected within the group) of the group specific Monte Carlo output.

3.29.2 Usage

3.29.2.1 Calling Sequence

SPECOL $

3.29.2.2 Input

a. Calling sequence

None

b. Input through common locations

BLNK
GN
ITOPG
LINECNT
RN

3.29.2.3 Output

a. Calling sequence

None

b. Output through common locations

KOL
LINECNT
MCBUF

3.29.2.4 Working Symbols

None

3.29.2.5 Error/Action Messages

None

3.29.2.6 Subroutines Called

EJECTPG

3.29.2.6.1 System Subroutines

CHECKW
CWRITE
OCTBCD

3.29.2.7 Called By

GROUT

3.29.3 Method

See Figure 3-23 for flow logic.

3.29.4 Restrictions

None

3.29.5 References

None

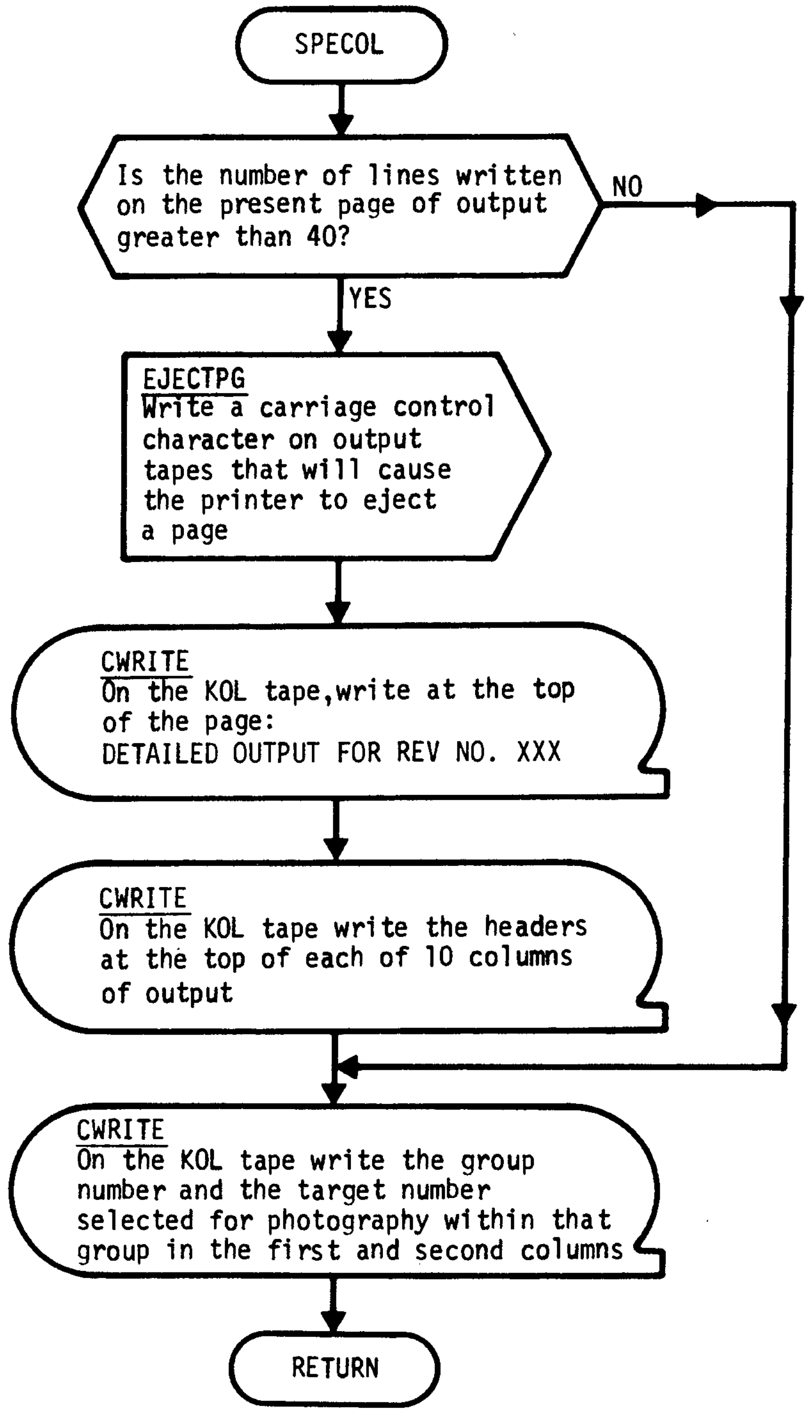

Figure 3-23 Subroutine SPECOL Flow Diagram

3.30 SUBROUTINE TAPERR2

3.30.1 Purpose

TAPERR2 displays an error message on the on-line printer when a physical end of tape is encountered in writing an output tape.

3.30.2 Usage

3.30.2.1 Calling Sequence

TAPERR2 (TAP2NØ = TRY2.) $

3.30.2.2 Input

a. Calling sequence

Program Symbol	Description
TAP2NØ	The logical tape unit being written upon
TRY2.	The return address

b. Input through common locations

None

3.30.2.3 Output

a. Calling sequence

None

b. Output through common locations

None

3.30.2.4 Working Symbols

Program Symbol	Description
ENDTP	Hollerith descriptor of error message

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3.30.2.5 Error/Action Messages

The following message is displayed when the physical end of tape is encountered:

"MOUNT NEW TAPE ØN UNIT XX HIT GO"

Section 3.30.3 indicates the desired operator action when this occurs.

3.30.2.6 Subroutine Called

SPACEUP	Spaces on-line printer for readability
OUTPUT	System output routine

3.30.2.7 Called By

PRINTØUT

3.30.3 Method

When the physical end of tape is encountered, program execution halts after the error message has been displayed on-line. At this point, the TSPOOND user or machine operator should mount a new tape reel on the designated tape drive and depress the "GO" button to continue program execution. The program will proceed to rewrite the record which caused the halt and resume execution as normal.

See Figure 3-24 for the flow logic.

3.30.4 Restrictions

None

3.30.5 References

None

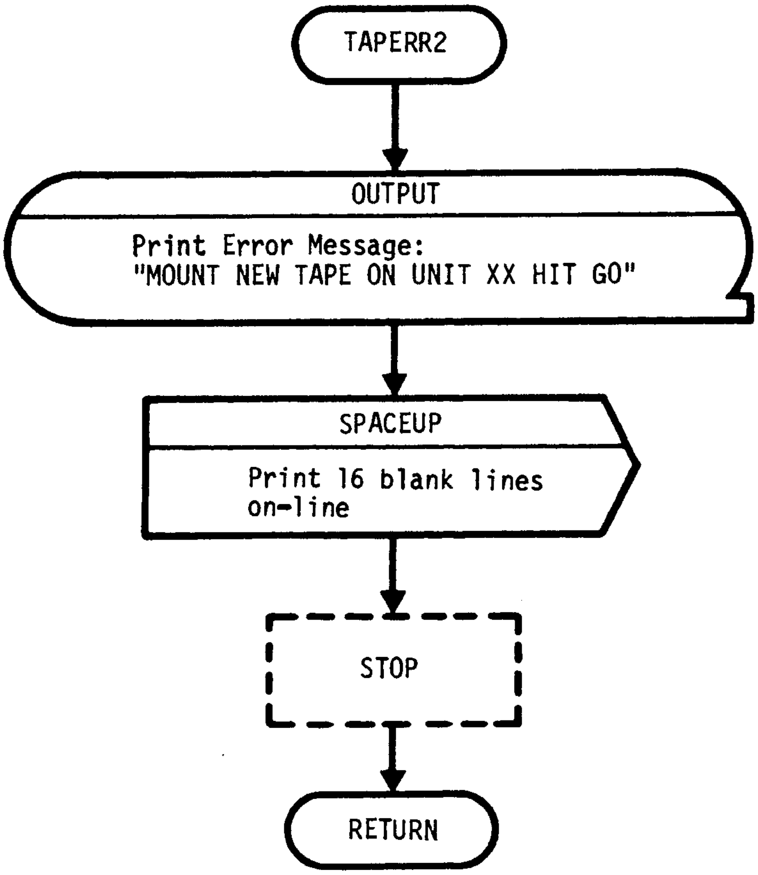

Figure 3-24 Subroutine TAPERR2 Flow Diagram

3.31 SUBROUTINE TAPERR4

3.31.1 Purpose

TAPERR4 is used to write an error message on the printer when a system error in reading a tape is detected. When this occurs, program execution halts awaiting the operator action requested by the error message.

3.31.2 Usage

3.31.2.1 Calling Sequence

TAPERR4 (TAP4NO = TRY4.) $

3.31.2.2 Input

a. Calling sequence

Program Symbol	Description
TAP4NO	The tape unit being read from
TRY4	The return address from the calling program to which execution returns

b. Inputs through common locations

None

3.31.2.3 Output

a. Calling sequence

None

b. Outputs through common locations

None

3.31.2.4 Working Symbols

Program Symbol	Description
HPSTA	A Hollerith item preset to "PUSH START TRY AGAIN"
HSER	A Hollerith item preset to "SYSTEM FOUND ERROR ØN LAST READ ØN UNIT"

3.31.2.5 Error/Action Messages

SYSTEM FOUND ERROR ON LAST READ ON UNIT - XX PUSH START, TRY AGAIN.

3.31.2.6 Subroutines Called

SPACEUP
OUTPUT
OUTERR
SKIPR

3.31.2.7 Called By

BITRE
PROBIT

3.31.3 Method

After the error/action message is displayed on-line, program execution terminates awaiting the operator action requested by the message. If the operator elects to attempt the read instruction again, the console START button should be depressed. TAPERR4, at this point, returns execution control back to the previously executed read instructions for another attempt.

Figure 3-25 shows the TAPERR4 flow logic.

3.31.4 Restrictions

None

3.31.5 References

None

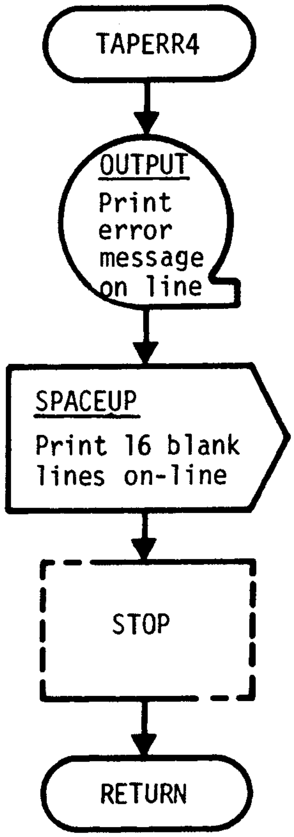

Figure 3-25 Subroutine TAPERR4 Flow Diagram

3.32 SUBROUTINE TRI

3.32.1 Purpose

TRI computes a random variable, x, representing dwell time, that has the required triangular density function. A different triangular density function is used to compute x depending upon whether the target is clear or cloudy.

3.32.2 Usage

3.32.2.1 Calling Sequence

TRI (QS, RØNE, RTWØ) $

3.32.2.2 Input

a. Calling sequence

Program Symbol	Equation Symbol	Units	Description
QS	Q	Sec	The most probable dwell time within the given triangular density function
RØNE	R_1	n.d.	That number which, when multiplied by QS, will give the smallest dwell time within the triangular density function
RTWØ	R_2	n.d.	That number which, when multiplied by QS, will give the largest dwell time within the triangular density function

b. Inputs through common locations

WRN

3.32.2.3 Output

a. Calling sequence

Program Symbol	Equation Symbol	Units	Description
TRI	X	Sec	A floating point number representing the dwell time in seconds

b. Outputs through common locations

None

3.32.2.4 Working Symbols

Program Symbol	Equation Symbol	Units	Description
RQH	---	Sec^2	An intermediate variable equal to $Q^2(R_2 - R_1)$
UØ	U	n.d.	A random number between zero and one

3.32.2.5 Error/Action Messages

None

3.32.2.6 Subroutines Called

RDM1J Uniform random number generator

SQRT System square root

3.32.2.7 Called By

GETDT

3.32.3 Method

The altitude of the triangular density function is given by

$$h = \frac{2}{(R_2-R_1)Q}$$

A random number, U, between zero and one is obtained from the random number generator, RDM1J and is compared with

$$\frac{1-R_1}{R_2-R_1}$$

The dwell time, X, is determined conditionally so that

$$X = R_2Q - \sqrt{\frac{2Q(1-U)\ (R_2-1)}{h}}$$

$$\text{for } U > \frac{1-R_1}{R_2-R_1}$$

or

$$X = R_1Q + \sqrt{\frac{2\ QU(1-R_1)}{h}}$$

for

$$U \leq \frac{1 - R_1}{R_2 - R_1}$$

Figure 3-26 shows the flow logic for TRI.

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TRI TRI

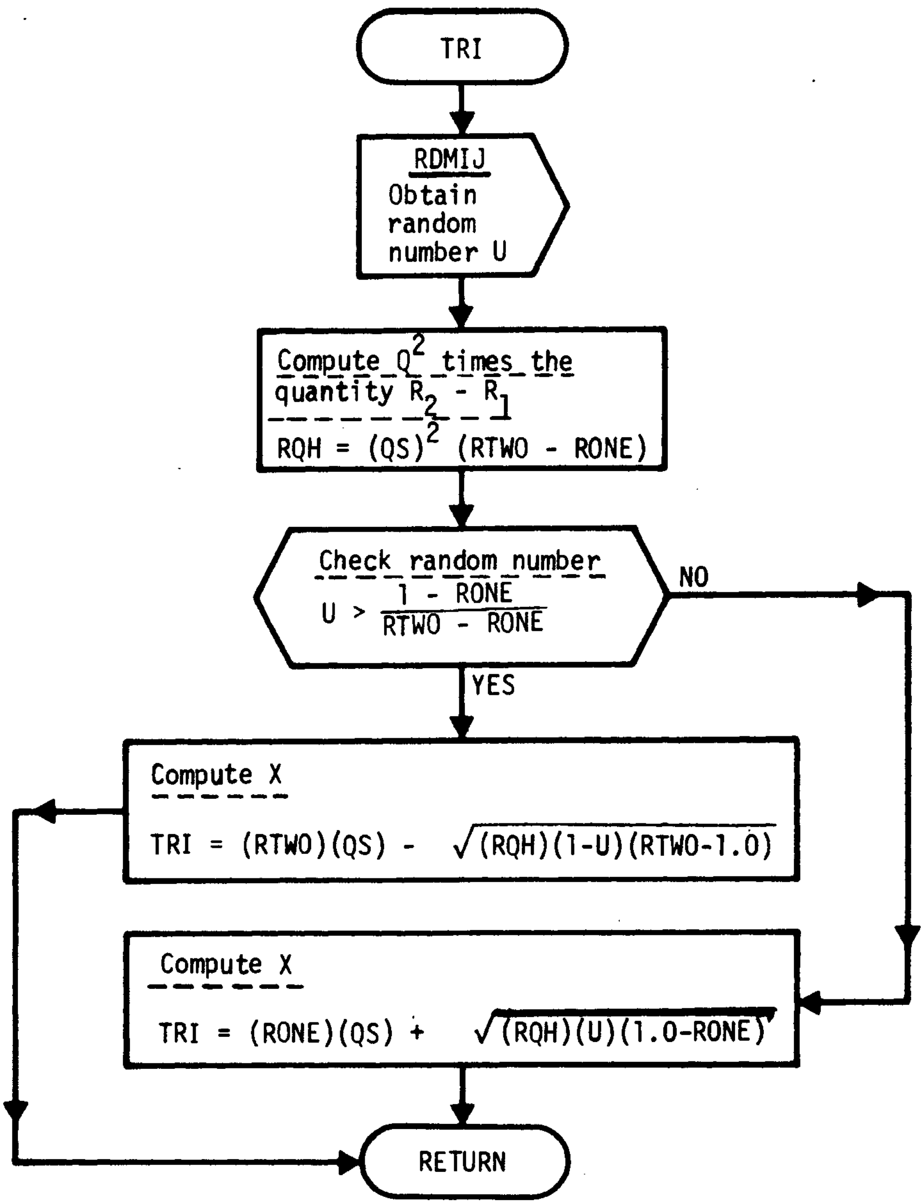

Figure 3-26 Subroutine TRI Flow Diagram

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3.33 SUBROUTINE VOTE

3.33.1 Purpose

Subroutine VOTE simulates the crew reported and actual states of target visibility and activity given the probabilities of visibility, activity, false alarm, and recognition. A secondary function of VOTE updates for rev span output the number of false alarms and number of failures to recognize categorized by primary and alternate targets.

3.33.2 Usage

3.33.2.1 Calling Sequence

VOTE $

3.33.2.2 Inputs

a. Calling sequence

None

b. Inputs via common locations

PFALM	TDECIS
PRECØG	TIDX
SIGT	TNN
SN	TPRØBA
SNN	TVAP
	VV

3.33.2.3 Outputs

a. Calling sequence

None

b. Outputs through common locations

AA
AV
DECEPT
RA
RV
STAT

3.33.2.4 Working Storage Within Routine

PRØB	Temporary cell containing current probability of activity
DIDX	Index used as a DECEPT array pointer
KØUNT	Index used as a STAT array pointer (extended statistics computations)

3.33.2.5 Error/Action Messages

None

3.33.2.6 Subroutines Called

BERN	Bernoulli random number generator

3.33.2.7 Called by Following Routine

PROTAR

3.33.3 Method

VOTE is entered once per target and the reported and actual states of target visibility and activity are used by the decision strategy for the selection of the "winning" target for photography within a group. The reported visibility, RV, actual visibility, AV, reported activity, RA, and actual activity, AA, are simulated by random sampling and the false alarm and failure to recognize states are recorded and summed as they are encountered.

Figure 3-27 shows the detailed VOTE flow diagram.

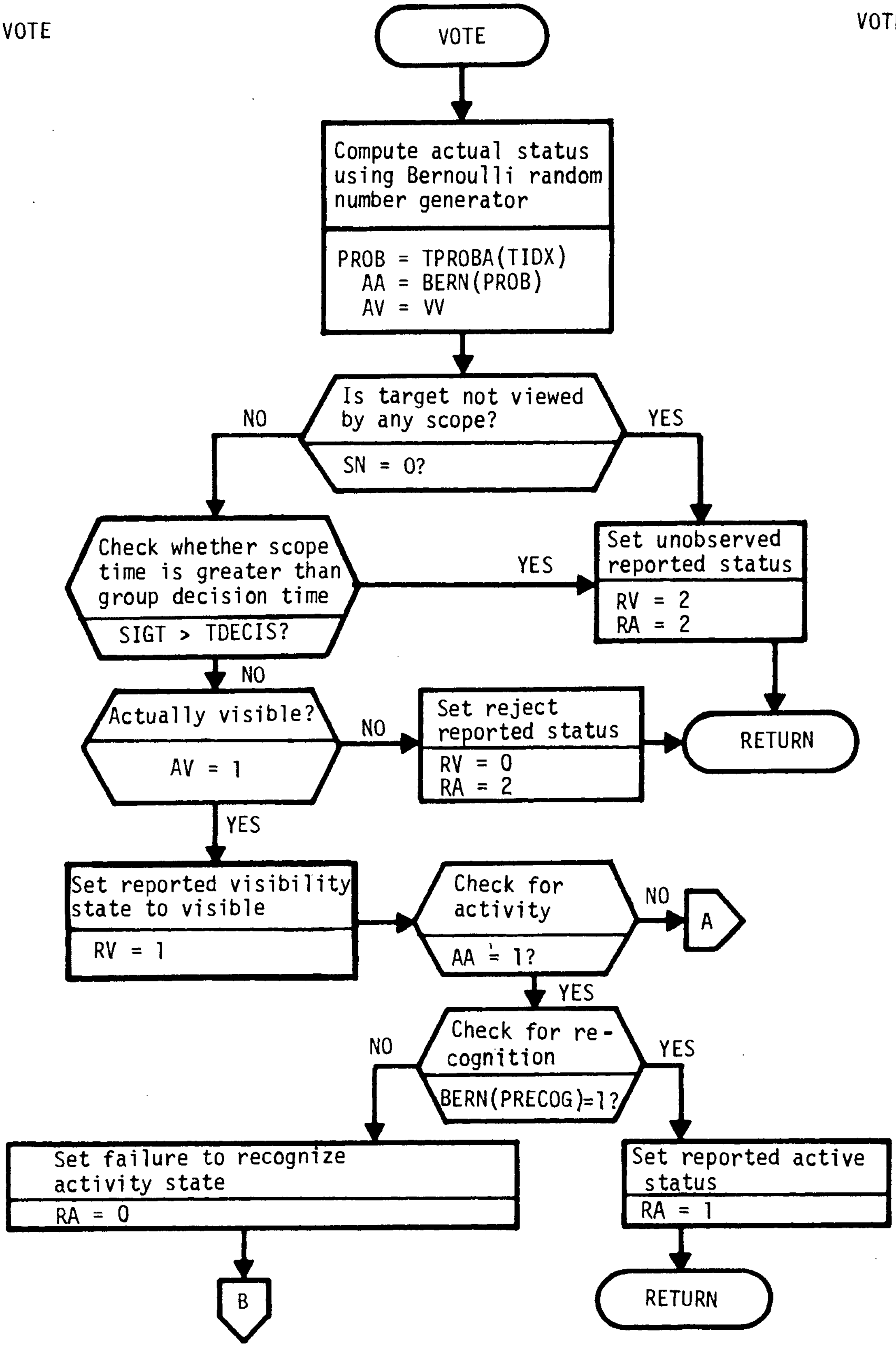

Figure 3-27 Subroutine VOTE Flow Diagram

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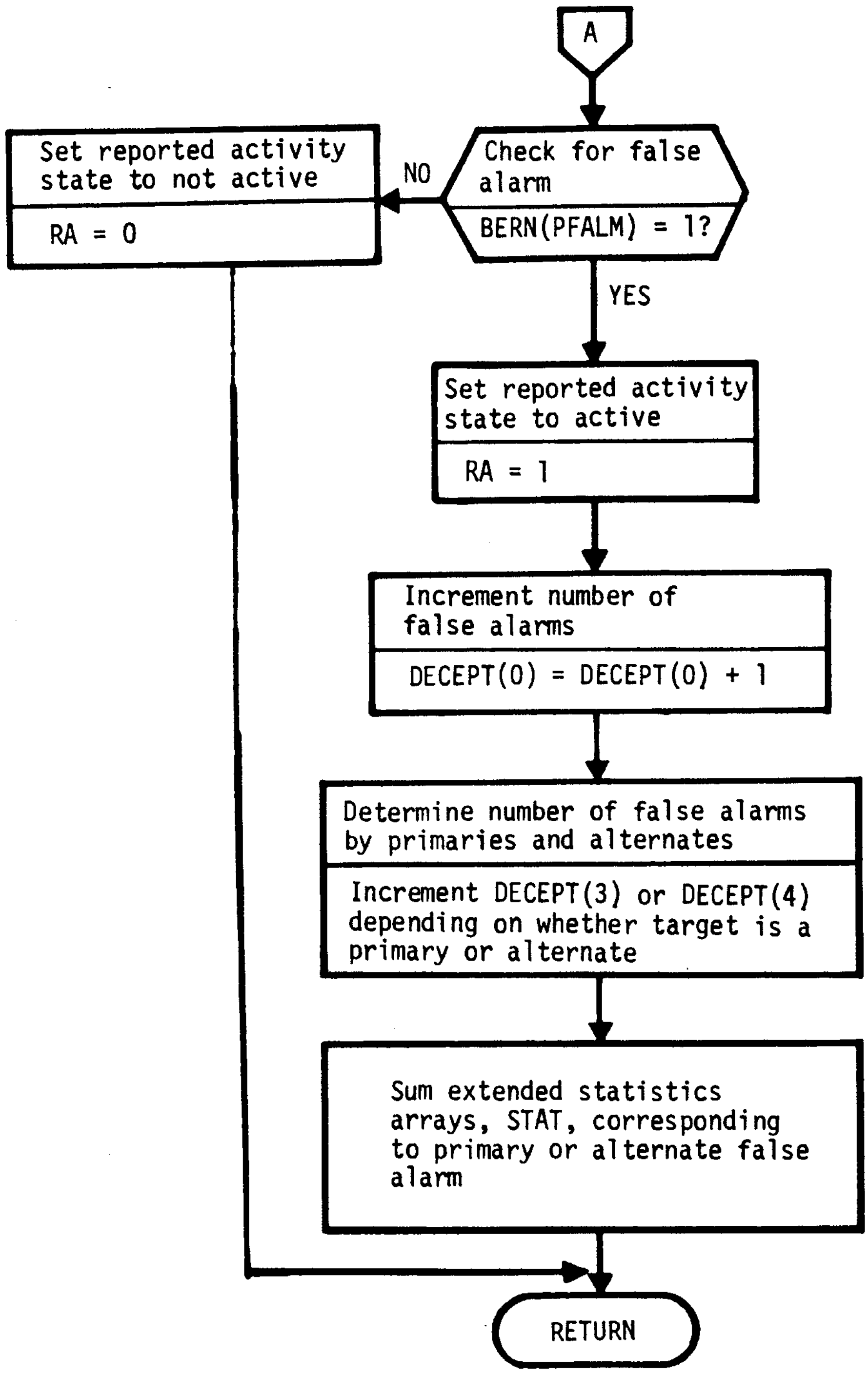

Figure 3-27 Subroutine VOTE Flow Diagram (Continued)

~~SECRET/D~~

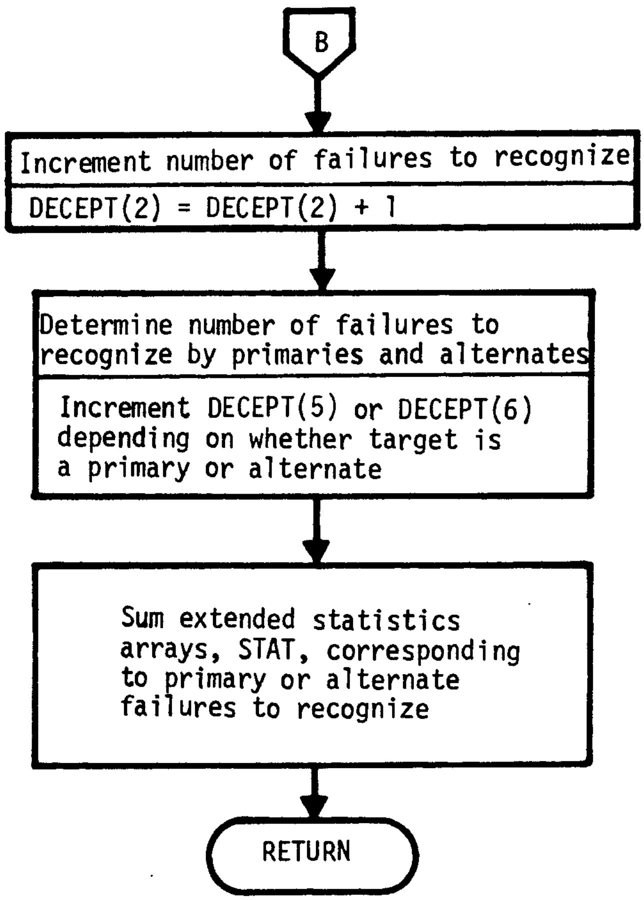

Figure 3-27 Subroutine VOTE Flow Diagram (Continued)

4. REFERENCES

1. BIF-4-B30009-68 (D), "User's Manual for TSPOOND", 15 December 1968, TRW Systems Group.

2. BIF-4-B10039-68 (D), "TWONDER Binary Interface Tape Description", 22 November 1968, TRW Systems Group.

3. DM 38-0071 (D), "User's Manual for TWONDER (Revised)", 24 June 1968, TRW Systems Group.

4. BIF-4-B10009-68 (D), "TWONDER Mathematical Description", 12 September 1968, TRW Systems Group.

5. P. L. Mc Entire, "A Method of Generating a Correlated Set of N Zero-One Random Variables with a Specified Mean", TRW Systems, Sunnyvale.

6. P. L. Mc Entire, "A Method of Generating Two Zero-One Random Variables with Specified Means and Correlation Coefficient", TRW Systems, Sunnyvale.