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TM-(L)-734/037/00

404658

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TECHNICAL MEMORANDUM

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1604 Simulation Program Descriptions

SYSTEM

Milestone 11

DEVELOPMENT

Tracking Data Paper Tape Generation Routine
(SRADTPE)

CORPORATION

by

2500 COLORADO AVE.

P. T. Kastama

SANTA MONICA

15 March 1963

Approved

CALIFORNIA

J. B. Munson

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1.0 IDENTIFICATION

1.1 Title

Tracking Data Paper Tape Generation Routine (SRADTPE)

Ident: K12, Mod. 02

1.2 Programmed

February 1963, P. T. Kastama, System Development Corporation

D. Lee, Lockheed Missiles and Space Company*

1.3 Documented

March 1963, P. T. Kastama, System Development Corporation

2.0 PURPOSE

This program is intended to provide a simulation capability, which will produce tracking data on paper tape for unaugmented tracking stations. This data is intended to represent the actual data generated by various antennas during vehicle pass-over for a given station, vehicle, and revolution number. The antennas for which data will be produced are: VERLORT, TLM18, DOPPLER (400 mc), SHIP MODII (AN/SPQ-2), SHIP TLM18, and SHIP PMR DOPPLER.

3.0 USAGE

3.1 Calling Sequence

L	RTJ	SRADTPE
L+1	NORMAL RETURN	
L+2	ZRØ ZRØ	0 Vehicle Number
L+3	ZRØ ZRØ	0 Delta T

*Part of the program "PREDICT" was extracted to complete the paper tape output from SRADTPE.

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L+4	Antenna Name....Left justified, with trailing blanks.
	20.....20
L+5	ZRØ 0 ZRØ Revolution Number
L+6	ZRØ 0 ZRØ Reset Tape Unit Number
L+7	ZRØ 0 ZRØ Station Number
L+8	ZRØ 0 ZRØ Print Option (1=Print)

3.2 Operating Procedures

SRADTFE may be called upon in two different ways. One way utilizes the standard COP function card, while the second method is to use the SIPSA system and control deck. Both card formats are described in Section 3.7.

3.3 Input Parameters

Several input parameters, in addition to a Reset Tape, are necessary to generate tracking data. These parameters are defined as follows:

a. Vehicle Number

This number can be any number. However, it must compare with the vehicle number on the Reset Tape.

b. Time Increment

The data punched on paper tape are usually spaced at four-second intervals (excluding the Doppler antennas, whose data are spaced at two-second intervals). However, if a different time increment is desired, the user has an option to specify a value.

c. Antenna Name

Antenna type must be specified in order that the appropriate format and output can be simulated.

d. Revolution Number

This number specifies the particular revolution for which data is desired.

e. Reset Tape Unit Number

This number indicates which tape unit should be read for the Reset Tape.

f. Station Number

This number must define any legal unaugmented station for which the station coordinates are available in the Reference Pool.

g. Off-Line Data Printout Option

The program will provide an optional off-line listable BCD dump for every point generated. The off-line data dump consists of TAU (Machine time); System time; the X,Y,Z,X,Y,Z inertial vector; local antenna position; and the polar elements. The data will be on Tape 3 in BCD listable format. This off-line data printout option is provided to minimize 1604 computer run time.

3.4 On-Line Messages and Printouts

a. PLEASE READY PAPER TAPE PUNCH FOR 5 LEVEL TAPE. I WILL REQUIRE APPROXIMATELY XXX FEET OF UNUSED PAPER TAPE TO COMPLETE THE RUN. WHEN PUNCH IS READY PRESS START TO CONTINUE.

This printout indicates to the operator that paper tape is about to be punched. XXX is a decimal number computed by the program as a function of duration to indicate about how much paper tape will be needed.

b. ALL TRACKING DATA HAS BEEN PUNCHED ON PAPER TAPE. PRESS START TO RETURN TO CONTROL PROGRAM.

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When all data for each function request card has been punched on a paper tape, the above on-line printout will be provided.

3.5 Error Printouts

- a. NO ANTENNA OR WRONG ANTENNA SPECIFIED. CORRECT FUNCTION CARD AND PRESS START TO RETURN TO CONTROL PROGRAM.

Illegal antenna name on function card. Correct card, load deck in reader, and press start to return to control program, which will re-read the deck.

- b. STATION OR REV NUMBER NOT IN ACQUISITION TABLE. CORRECT FUNCTION CARD AND PRESS START TO RETURN TO CONTROL PROGRAM.

Information in Acquisition Table is not available for given revolution and station numbers. Correct the function card, load deck in reader, and press start to return to control program to re-read the deck.

- c. LATITUDE AND LONGITUDE ARE NOT AVAILABLE FOR THIS STATION. PRESS START TO RETURN TO CONTROL PROGRAM.

Change function card to request data for a different station or insert latitude, longitude, and height in the particular station cells in SLAT, SLONG, and SH in the Reference Pool.

3.6 Tape Assignments

Tape 1 must contain the 1604 Augmentation System Utility Master.

Tape 3 will contain a listable BCD dump of every data point upon completion of SRADITE, if requested.

The Reset Tape may be placed on Tape Unit 2, or 4-12, as long as the unit number is specified on the function card.

3.7 Control Card Formats

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3.7.1 The Tracking Data Paper Tape Punch Request Card (PUNCH).

PUNCH	P ₁	P ₂	P ₃	P ₄	P ₅	P ₆	P ₇

<u>Columns</u>	<u>Content</u>	<u>Meaning</u>
1-8	PUNCH	Name of request, left justified with trailing blanks.
9-13	P ₁	Vehicle number, right justified (decimal integer ≤ 99999).
15-16	P ₂	Δt in seconds (blank if not required), right justified (decimal integer ≤ 99 seconds).
18-21	P ₃	Antenna name in BCD, left justified with trailing blanks. Choices are: VELT (Verlort) TL18 (TLM18) DOPR (Doppler) ANQ2 (AN/SPQ-2) SHIP (Ship TLM18) SPMR (Ship PMR Doppler)
23-26	P ₄	Revolution number, right justified (decimal integer ≤ 9999).
28-29	P ₅	Reset Tape Unit number, right justified, unit=2, 4-12.
31-32	P ₆	Station number, right justified (must be unaugmented station number).
34	P ₇	List option. If P ₇ =1, data will be written on Logical Tape Unit 3 to be listed after the run is complete.

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In addition to the PUNCH card, certain system control cards are necessary to operate SRADTPE with the SIPSA system. (See Operating Instructions, Milestone 7, TM-(L)-734/022/00).

3.7.2 The MTCII Function Request Card Format

*N SRADTPE P ₁ P ₂ P ₃ P ₄ P ₅ P ₆ P ₇

where:

- * Identifies the card as a function request, and must be in Column 1.
- N is an optional decimal integer specifying a logical equipment unit on which a storage analysis is to be output.
- P₁, P₂, P₃, P₄, P₅, P₆, P₇ are the same input parameters described in Section 3.7.1. From these parameters, MTCII generates the calling sequence described in Section 3.1.

3.8 Jump Key Settings

There is one jump key setting involved in the operation of SRADTPE. If it is desired to use an old format (pre-augmentation) Reset Tape, it is necessary to set Jump Key 3 on the 1604 console. If a new format (augmentation) Reset Tape is used, no jump key settings are necessary.

3.9 Output Data Formats

See SIPSA Operating Instructions, Milestone 7, TM-(L)-734/022/00 for Paper Tape formats and a sample output listing.

4.0 METHOD

4.1 Tracking Data Generation

The method employed to generate tracking data is to utilize the information from a Reset Tape (which contains a filled Breakwell Matrix and a filled Station Acquisition Table) to calculate the rise and set vectors ($T, X, Y, Z, \dot{X}, \dot{Y}, \dot{Z}$), and duration of a pass over a tracking station by the Breakwell Closed-Form Equations. Then, using the rise vector as the initial condition, the Satellite inertial position at a specified time increment (Δt) can be calculated by the Runge-Kutta advance integration method. By converting these inertial positions into the appropriate station local polar coordinates, the result can be formatted, and scaled to represent various antennas, and used as input data for checkout of operational tracking programs. In addition, System Time will be calculated and updated from the initial condition. Polar coordinates for the antennas consist of azimuth, elevation, and slant range. During conversion, an inverse-refraction correction is added onto the elevation for all antennas. (See Appendix A for a flow diagram of SRADTPE.)

4.2 Angular Noise Error

In order to produce meaningful simulated tracking data, antenna noise error is added to all the simulated data. The method employed is to define the maximum elevation error as ϵ_{el} . Then a random number N is generated ranging from -1 to +1. Thus the elevation error at any time, t_1 , is $\epsilon_{el} N_1$. The maximum azimuth error is defined as $\epsilon_{az}/\cos(\text{elevation})$. For simulation purposes, ϵ_{el} and ϵ_{az} are set equal to 0.003 radians.

5.0 RESTRICTIONS

5.1 Hardware Components

A 1604 Computer, card reader, paper tape punch, printer, and three tape units are required.

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5.2 Subroutines Required

ATAN1	FIX	OUTPUT	SIMRESET
COS	FLOAT	PTR	SIN
COTRANS	FLOATBIN	RTP	SUBERR
SDIFEQ	MACGUT	SACQTIME	TAN
DIGITS	OUTERR	SETUP	TTE

5.3 RIPOOL Items Set and/or Used

AMPM	GAMMA	OMEGA	TAU
AZM	HRS	RA	VEL
CLOCK	JAE2	RAD	X
COMMON	LAT	REV	XD
DAY	LONG	SECD	Y
DT	MIN	SEC	YD
FORCE	MONTH	SNO	Z
FORMAT	MU	ST	ZD

5.4 Other Restrictions

5.4.1 A Reset Tape must be specified and provided.

5.4.2 Jump Key 3 must be set if the Reset Tape is of pre-augmentation format.

5.4.3 Data punched is for unaugmented stations only. A paper tape for the augmented Indian Ocean Station will be punched in SRGR. (See TM-(L)-734/023/00, Milestone 11, for SRGR.)

6.0 TIMING

The operating time for SRADTPE is variable. The amount of time depends on the amount and type of data and duration of a pass. If an off-line listable output is requested, more time is required. For the test vehicle, an average run took 10 to 15 minutes not including set up time.

7.0 STORAGE REQUIREMENTS

	<u>Decimal</u>	<u>Octal</u>
Main Program	833	1501
Tables and Constants	<u>168</u>	<u>250</u>
Total Storage Requirement	1001	1751

8.0 VALIDATION TEST

Since most of the subroutines used by SRADTPE are routines written by LMSC and have either been previously validated or operationally proven, mathematical validation of the tracking data is unnecessary. The validation tests on SRADTPE have been oriented mainly towards the reasonableness of the output.

8.1 Description of Input Parameters

The validation test of SRADTPE has been divided into two parts. The first part involved the request of tracking data from all radar antennas from many tracking stations. The data generated was then examined for reasonableness and output format. The second part involved the generation of radar data for a few revolutions and selectively comparing the output results against the ephemeris (for the identical revolutions) generated by the function "EPHFUN", using the same Reset Tape.

8.1.1 First Part

Several runs were made for all types of antenna data. Data was punched on paper tapes for antennas TLM18, DOPPLER, AN/SPQ-2, SHIP-TLM18, VERLORT, and the SHIP-PMR-DOPPLER. The data punched on paper tapes was then read in through the paper tape reader by the PT program. The output of the PT program was a readable printout of the paper tape, which was later examined for reasonableness and format.

8.1.2 Second Part

Using the identical Reset Tape, the "EPHFUN" function was used to

generate an ephemeris, using the Breakwell Closed-Form method, for the same revolution. Then the result was compared, selectively, against the data generated by SRADTPE for accuracy.

8.1.3 Hardware Configuration Control

- a. Input Control Cards: Card Reader
- b. Augmentation System Utility Master Tape: Tape Unit No. 1
- c. Scratch Tape (Utility and Simulation): Tape Unit No. 3
- d. Reset Tape (Simulation): Tape Unit 5

8.1.4 Input Control Cards

The following control cards were used for the validation tests:

- a. *SIPSA (SIPSA system calling card)
- b. START (Initialization request card)
- c. PUNCH (Radar tracking data request card)

(See Appendix B for a listing of validation deck.)

8.1.5 Running Procedure

- a. Input Control Cards placed in the card reader.
- b. Tape Units 1, 3, 5 ready.
- c. Read cards in and execute.

8.2 Expected Output from Test

- a. On-line printout indicating all cards were read in.
- b. Off-line BCD listing of every point generated.
- c. On-line printout to indicate paper tape should be ready.

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- d. On-line printout to indicate data for one pass has been punched on paper tape.
- e. Data from the paper tape printout should match very closely with the data from the "EPHFUN" function.

9.0 REFERENCES

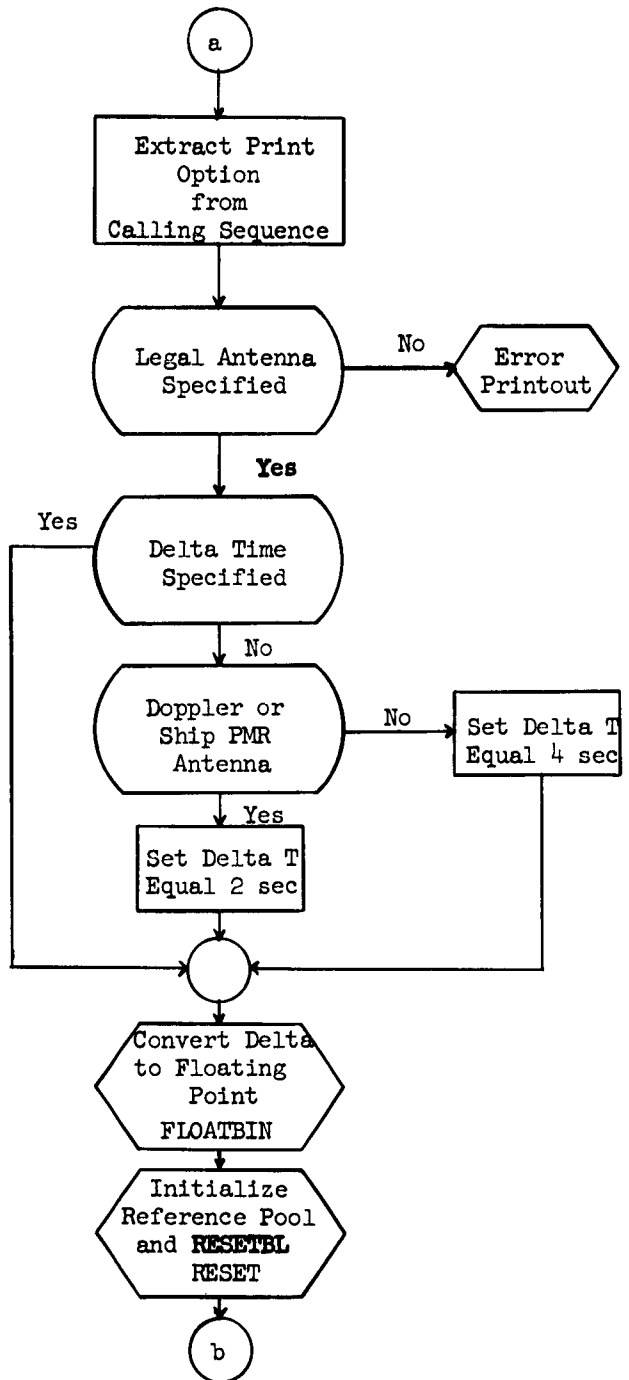
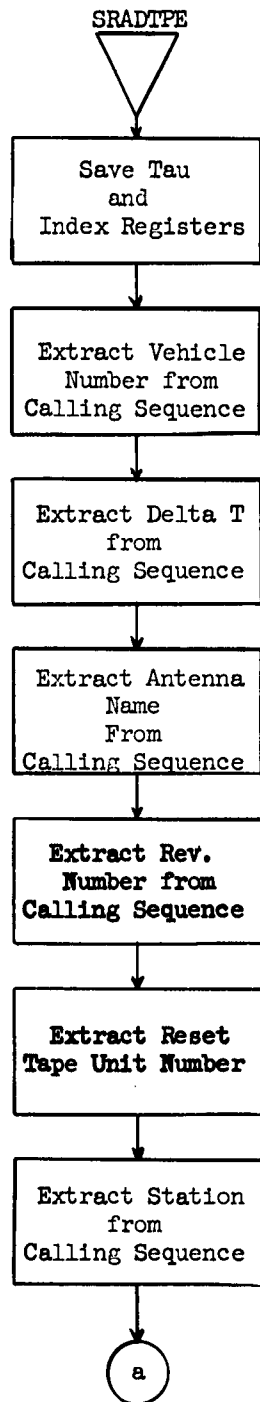
- 9.1 TM-(L)-734/015/00, Computer Program Design Specifications for the Simulation of the Augmented SCF Environment at the STA and CPDC (Milestone 4), System Development Corporation, 20 November 1962.
- 9.2 TM-(L)-734/022/00, Computer Operating Instructions for the Simulated Input Preparation System for the Augmented SCF Environment at the STA and CPDC (SIPSA), Milestone 7, System Development Corporation, 1 February 1963.
- 9.3 LMSD-447578, 1604 System Manual, Lockheed Missiles and Space Company.

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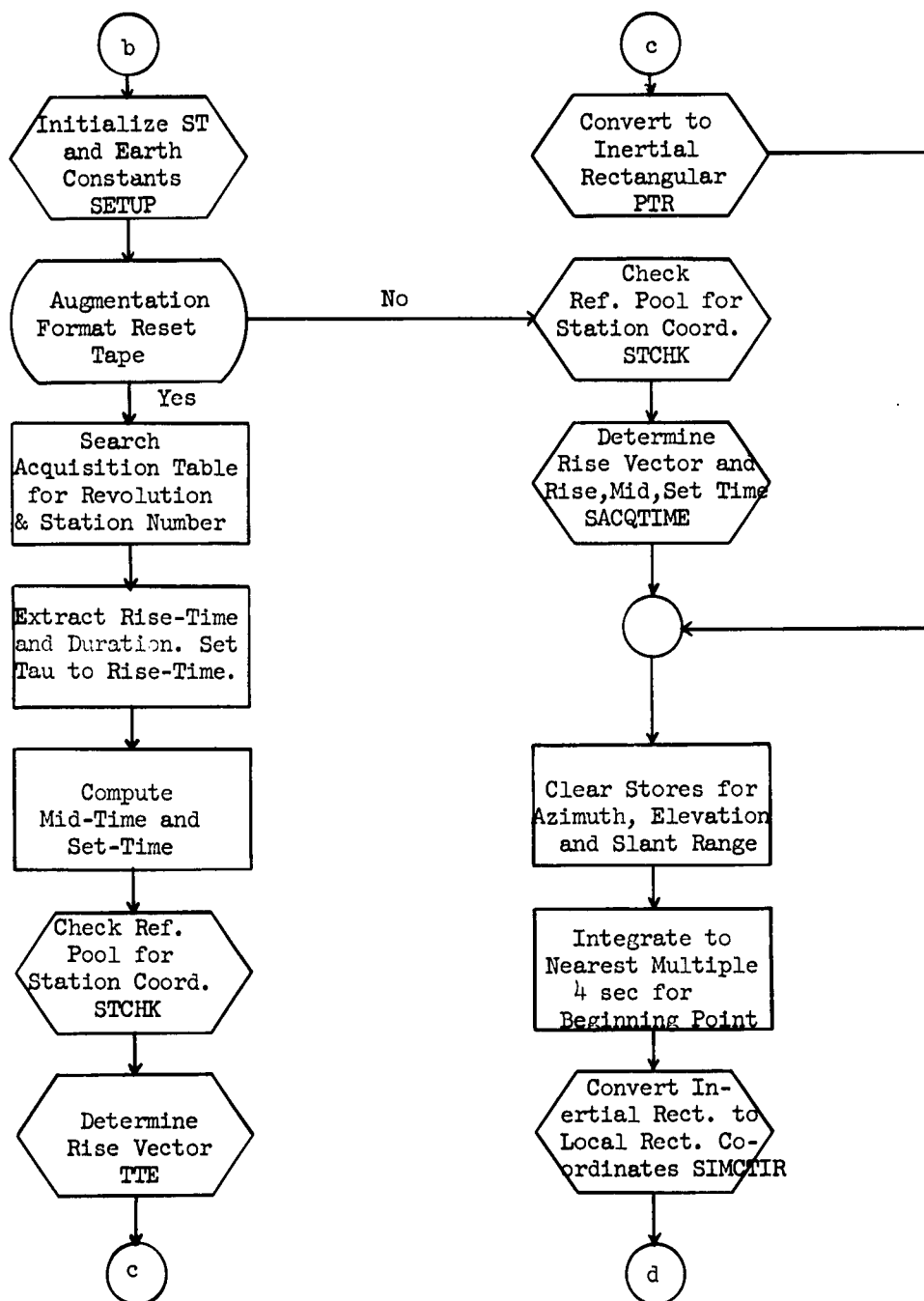
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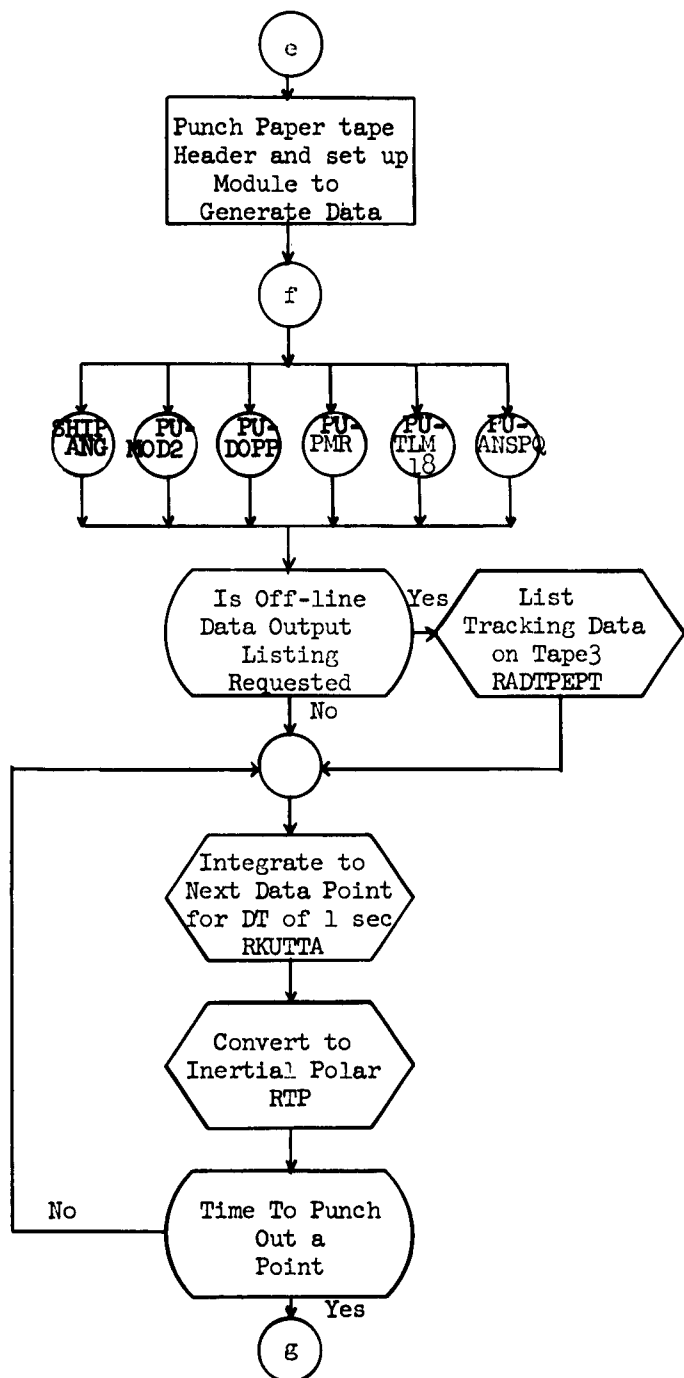
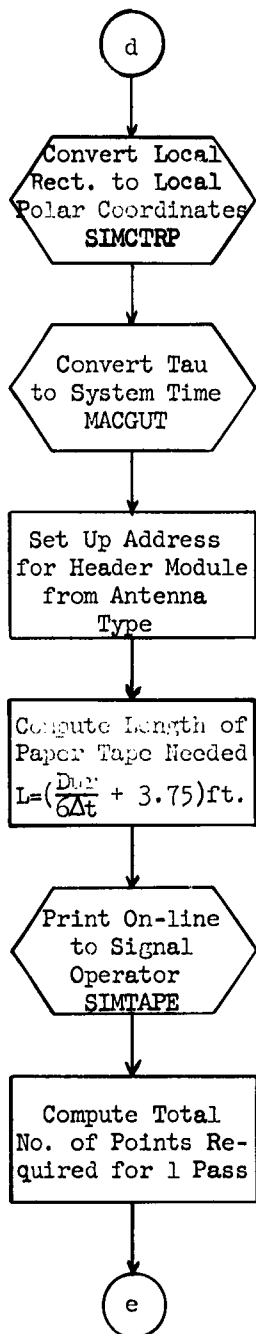
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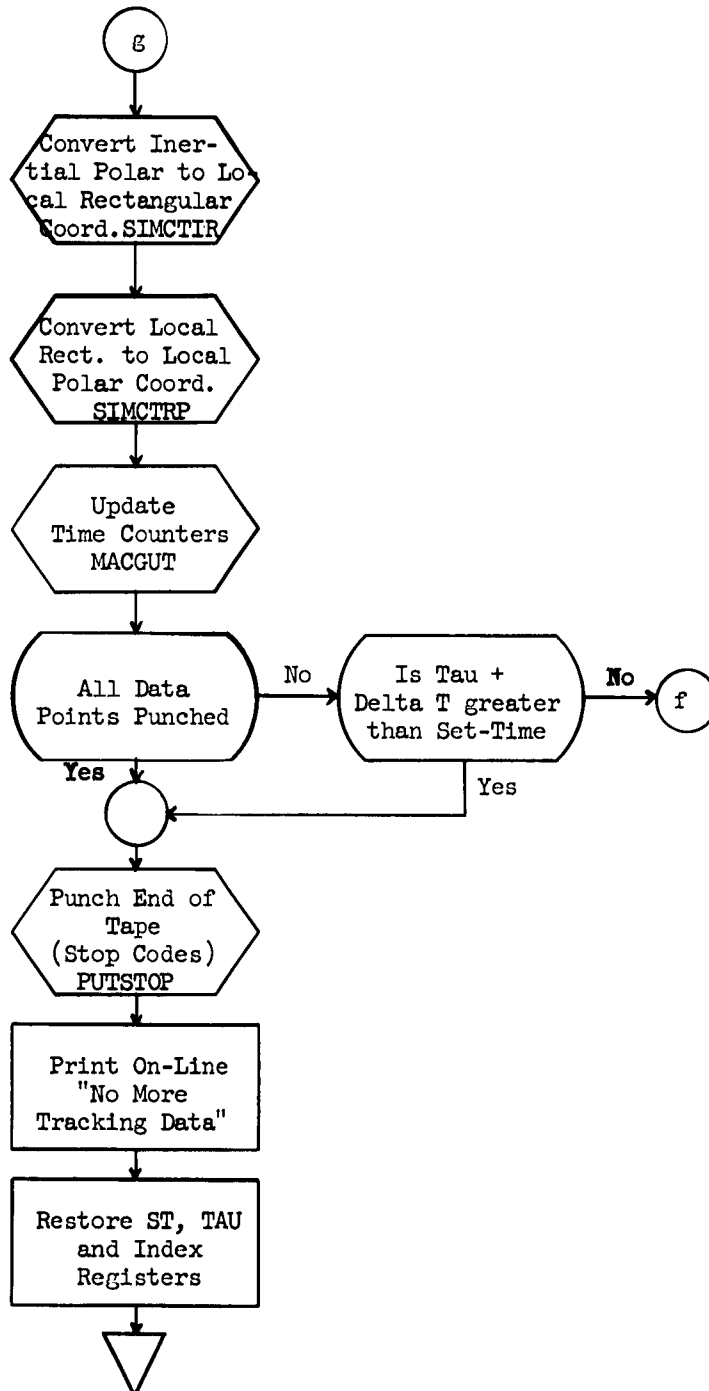
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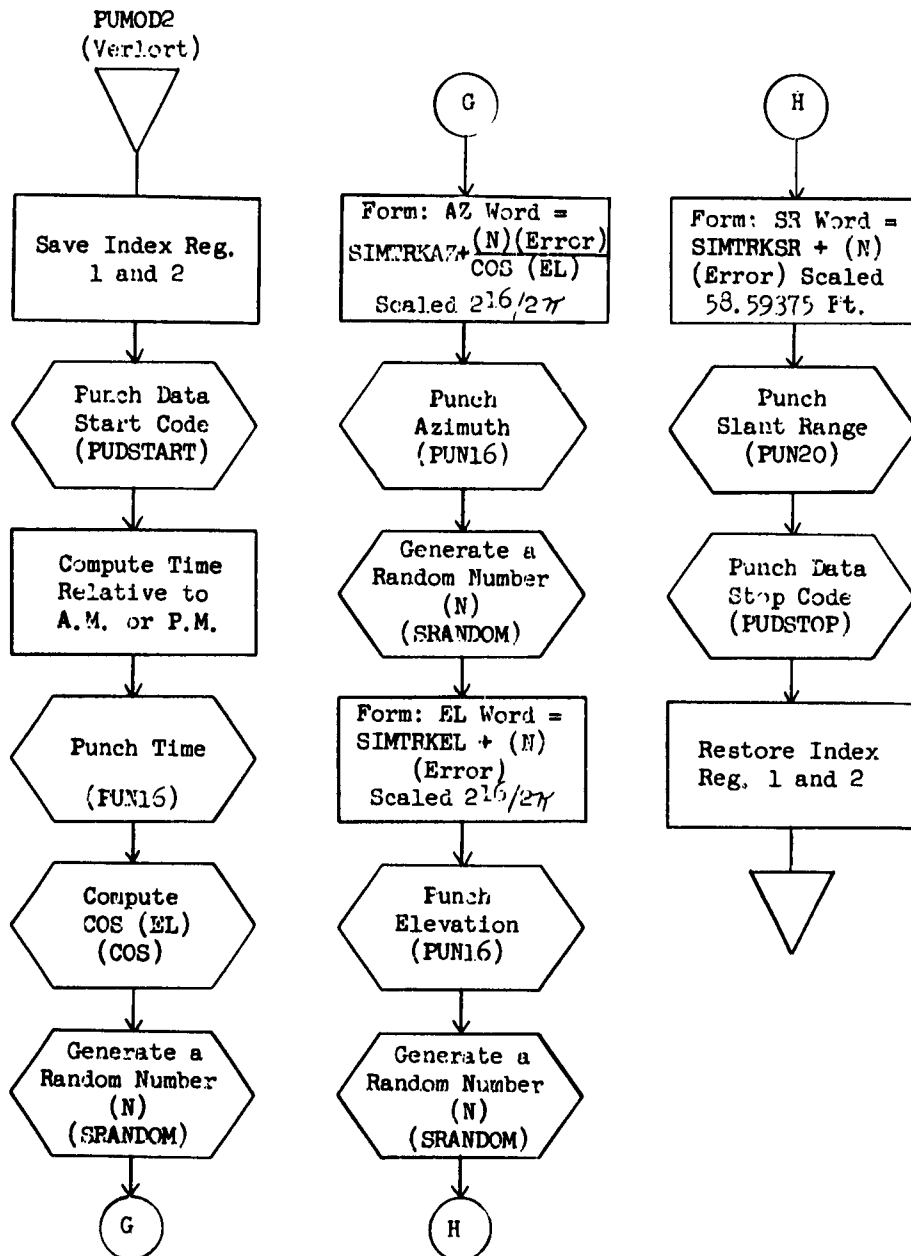
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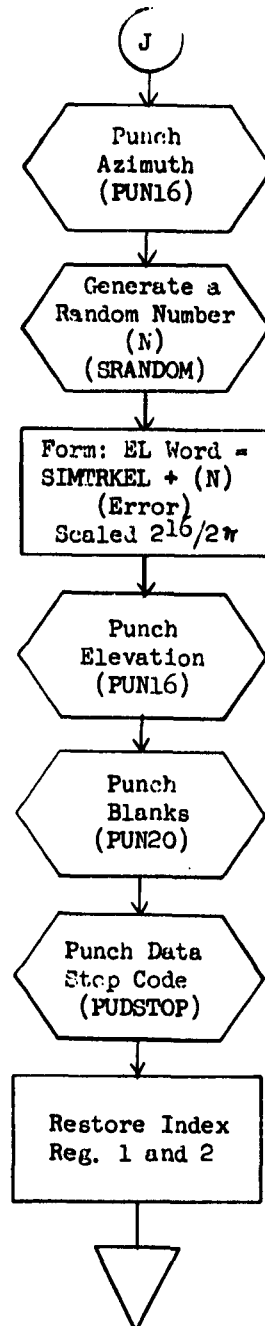
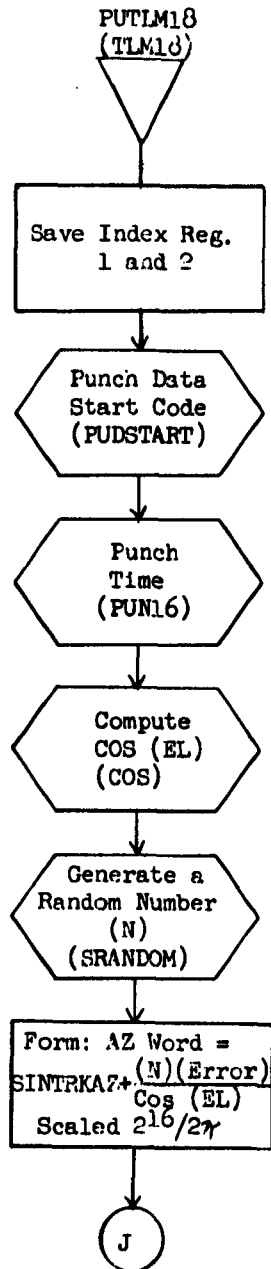
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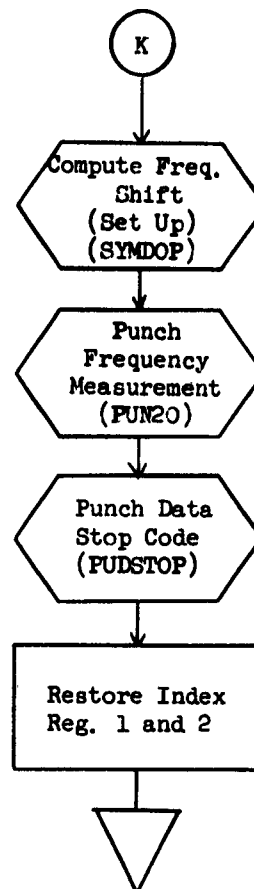
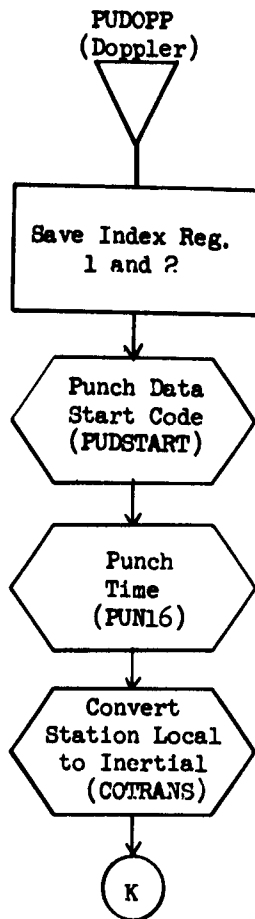
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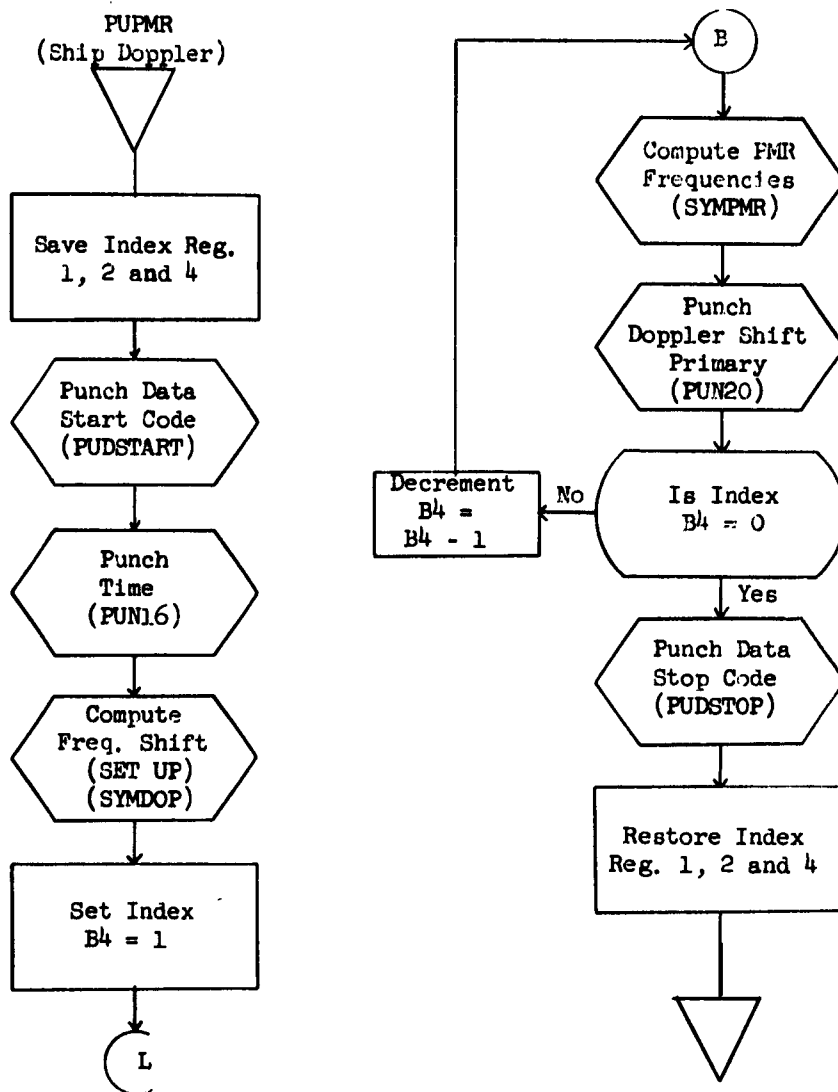
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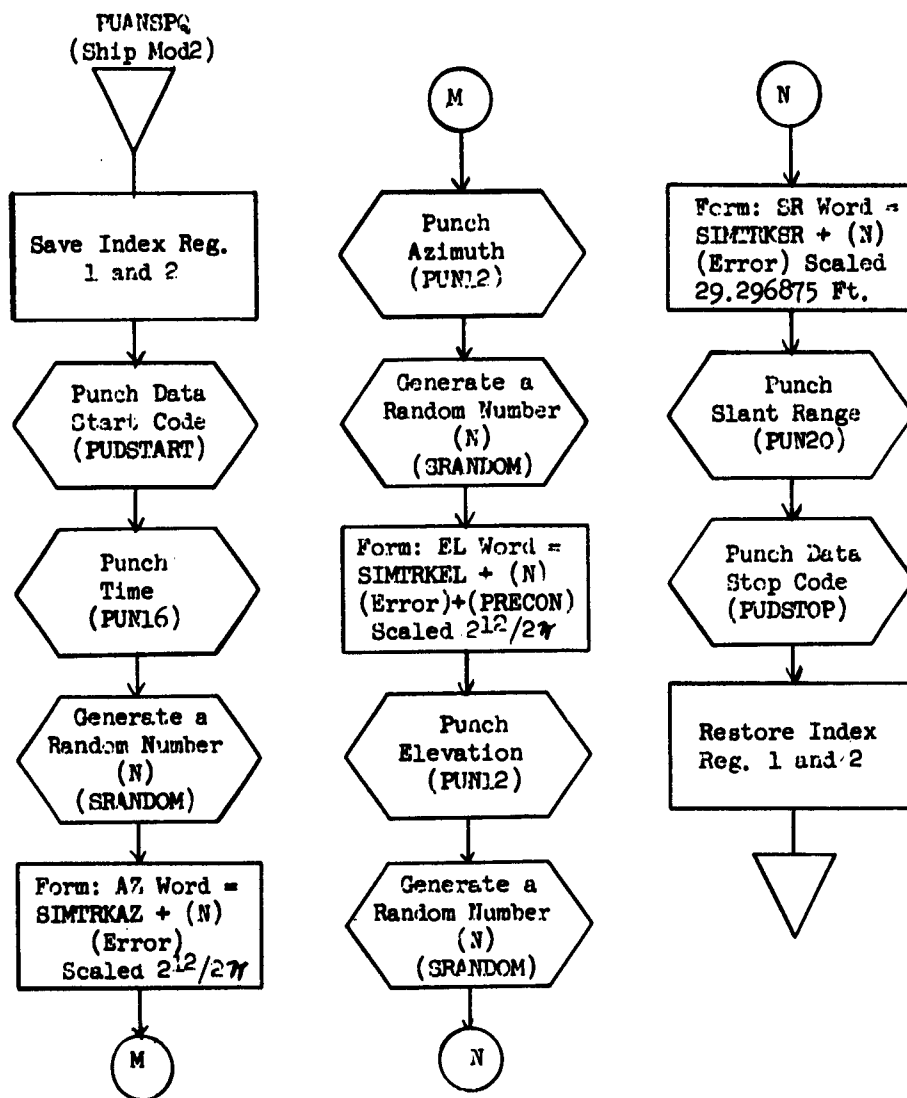
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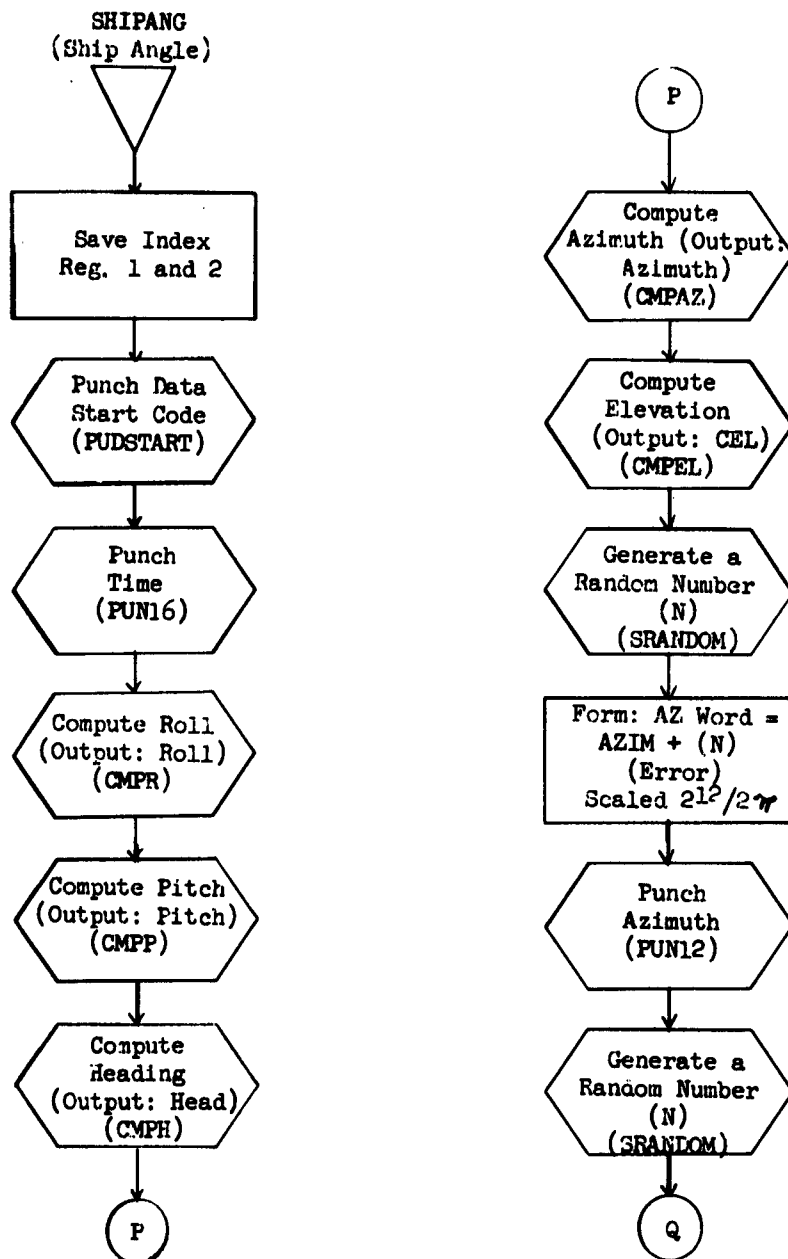
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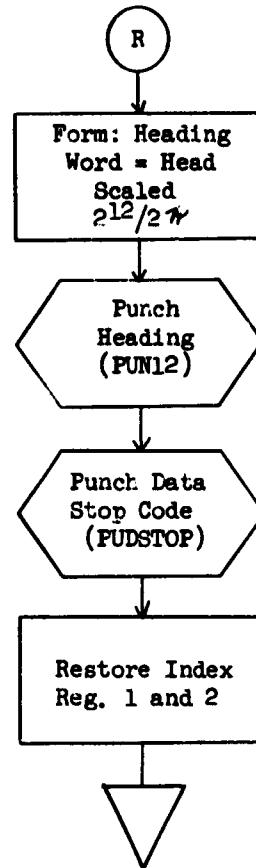
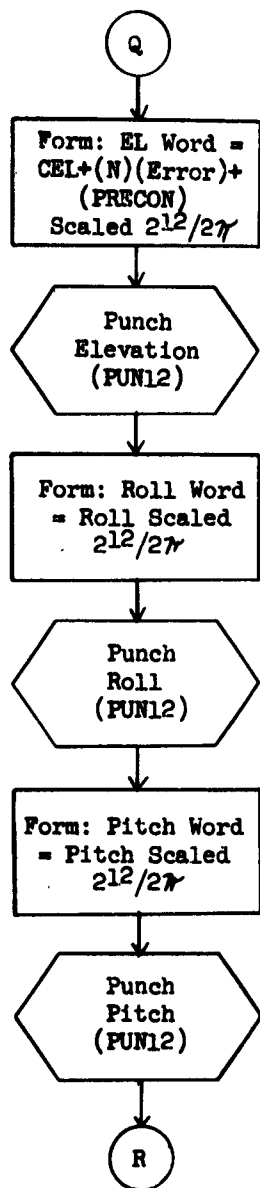
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APPENDIX B

*13 SIPSA 0 5

START

PUNCH	2404	TL18	8	5	1	1
PUNCH	2404	VELT	8	5	1	1
PUNCH	2404	DOPR	5	5	6	1
PUNCH	2404	ANQ2	8	5	20	1
PUNCH	2404	SPMR	8	5	20	1
PUNCH	2404	SHIP	8	5	20	1

*13 SRADTPE	2404	4	VELT	2	5	5	1
*13 SRADTPE	2404	2	TL18	8	5	1	1
*13 SRADTPE	2404	0	DOPR	5	5	6	1
*13 SRADTPE	2404	1	ANQ2	8	5	20	1
*13 SRADTPE	2404	2	SPMR	8	5	20	1
*13 SRADTPE	2404	4	SHIP	8	5	20	1

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<u>NAME</u>	<u>ROOM</u>
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J. Schroeder	24124
R. Scott	24110
C. Seacat	Sunnyvale
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R. Shapiro	24110
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R. Skelton	22152
N. Speer	24086
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M. Sweeney	25026
W. Taber	22101
T. Tennant	27029
J. Thompson	24088
C. Toche	24121
R. Totschek	24120
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A. Vorhaus	24076
M. Weinstock	22131
S. Weems	22109
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H. Williams	22110
G. Wilson	24124
M. Winsor	22156
J. Winter	24117
R. Wise	22085
J. Wong	Sunnyvale
C. Zubris	24075
AFCPL (5)	14059

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DISTRIBUTION
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<u>NAME</u>	<u>ROOM</u>	<u>NAME</u>	<u>ROOM</u>
D. Allfree	24083	J. Haake	22153
J. Aldana	22131	D. Henley	22094
L. Alexander	22134	C. Hill	22101
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		J. Lytton	24077
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		J. Milanese	22155
R. Ellis	22131	J. Munson	22087
R. Ericksen	22113	G. Myers	22095
H. Feldstein	24128	P. Nelson	24075
C. Francis	25013	J. Ng	22077
H. Franks	24122	L. Ngou	24127
R. Frey	22078		
L. Friedman	22122	M. Olson	22161
S. Gardner	25026	L. Padgett	24110
V. Gergen	25014	E. Patin	Sunnyvale
I. Greenwald	22094	D. Persico	24083
		T. Polk	24113

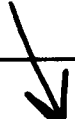
UNCLASSIFIED

System Development Corporation,
Santa Monica, California
1604 SIMULATION PROGRAM DESCRIPTIONS
MILESTONE 11 TRACKING DATA PAPER TAPE
GENERATION ROUTINE (SRADTPE).
Scientific rept., TM(L)-734/037/00,
by P. T. Kastama, 15 March 1963,
23p., 3 refs.
(Contract AF 19(628)-1648, Space
Systems Division Program, for Space
Systems Division, AFSC)

Unclassified report

DESCRIPTORS: Programming (Computers).
Satellite Networks.

UNCLASSIFIED

 ~~Reports that~~ SRADTPE (Tracking Data
Paper Tape Generation Routine)
provides a simulation capability,
which will produce tracking data on
paper tape for unaugmented tracking
stations. ~~Reports that this data is~~ ^{are} intended to represent the actual data
generated by various antennas during
vehicle pass-over for a given station,
vehicle, and revolution number.

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