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TEXAS A&M TRAFFIC ASSIGNMENT LINK DATA EDITOR FOR IBM 1401 DATA PROCESSING SYSTEM

in cooperation with the
Department of Commerce
Bureau of Public Roads

PROGRESS REPORT

PROJECT 2-8-63-60

TEXAS A&M TRAFFIC ASSIGNMENT LINK DATA EDITOR

for

IBM 1401 DATA PROCESSING SYSTEM

by

GLEN N. WILLIAMS

Research Project 2-8-63-60

Cooperative Research With The
Texas Highway Department
and the
Department of Commerce, Bureau of Public Roads

Project Supervisor
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INTRODUCTION

Many groups responsible for traffic assignments do not have ready access to a large digital computer but may have access to a smaller data processing system. This access can be used to improve the likelihood that the representation of a transportation system will be acceptable to the large computer.

The program described in this write-up was prepared to edit the network description link data cards used in the Bureau of Public Roads IBM 709/90 traffic assignment system. The system is well described in papers by Brokke and Sosslau available from the Bureau of Public Roads. The program will detect the most frequently encountered network errors which are checked for in the Build Network Description program in the IBM 709/90 system. These errors include duplicate cards and excess connections to a node.

The program was prepared as a part of the cooperative research activity of the Texas Transportation Institute for the Texas Highway Department and is available to those requesting it through the latter agency.

Donald E. Cleveland

Project Supervisor

TEXAS A&M TRAFFIC ASSIGNMENT

LINK DATA EDITOR

I. Identification

Name of Program - Texas A&M Link Data Editor (TAMULDE)
Machine - IBM 1401 Data Processing System
Name of Programmer - Glen N. Williams

II. Purpose

The purpose of the TAMULDE is to edit and link data of a traffic network for which link data cards are punched according to the Bureau of Public Roads format (see IX 2). This edit program checks for the 12 errors shown in Table 1. It also computes and prints longest distance and time parameters and lists the number of entries to and exits from each node. A sample output is shown in Figure 2.

TABLE 1

LINK DATA ERROR TYPES

Error Type	Error Description	Comments
1	Cards not in sort by A Node	Columns 3-6 of link data card Program halts if this occurs
2	Duplicate link card for this A Node	A Nodes and B Nodes the same
3	More than 4 entries to this Node	At least 5 entries to this Node
4	More than 4 exits from this Node	At least 5 exits from this Node
5	No entry to this centroid	
6	No exit from this centroid	

TABLE 1 (Continued)

Error Type	Error Description	Comments
7	A Node same as B Node	
8	No S (or 1) or T (or 2) in card column 20	
9	Improper card preparation (non-blank columns)	Columns 2,7,12,15,19, 21,31,34,46 should be blank
10	Node has exits without entries	Denoted by *in Entry-Exit Table Listing - Sense Switch C Option
11	Node has entries without exits	Denoted by $ in Entry-Exit Table Listing - Sense Switch C Option
12	A Node not linked in higher numbered B Node	Sense Switch B Option

III. Restrictions

1) The IBM 1401 system necessary for this program must have the following:

   a) Index Registers

   b) Sense Switches A, B, and C

   c) Store Address Register Feature

   d) High-Low-Equal Compare

   e) 8000 Locations

   f) Two Tape Drives

   g) Printer (132 Characters)

IV. Method (Flow chart is shown in Figure 1)

1) All multiplications are performed by a series of additions, and divisions by a series of subtractions in order to make the

multiply-divide feature unnecessary, a feature which extends operating time substantially.

2) Method of centroid storage: Determine if error type 5 or 6 has occurred.

   a) Tables for entered and for exited centroids are necessary. Six centroids are stored in each location, e.g., one per bit. Thus for the maximum of 1000 centroids, 334 machine locations are necessary.

   b) The proper centroid location for either entry or exit is found by dividing the centroid being processed by six, with the remainder denoting which bit is to be checked. Then this location is compared to a table of all possible combinations of bits without the bit to be checked. If a match is found, the corresponding location in another table which has all possible combinations of bits with the bit to be checked is moved into the centroid location. If no match is found, then the bit to be checked is already in the location and the program has completed its centroid entry and exit storage for this node.

   c) In checking the centroid entry and exit tables, all locations are checked against a Group Mark. If unequal, the location is checked against every 5th location of an error table until a match is found. When the match occurs, the next 4 locations of the error table contain the number of the missing bits which subsequently gives the number of the non-entered or non-exited centroid.

   d) All zones in the centroid entry and exit table building and checking are processed separately.

3) Method of over-entered and over-exited node storage: Determine if errors type 3 or 4 have occurred.

   a) Tables for entered and for exited nodes are necessary. Nodes are stored 2 per location, thus it takes 4000 locations for 4000 nodes.

   b) The location is split into sections, 1-2-4 and 8-A-B bits. Since four entries or exits are the limits, then for the numbers 1,2,3,4,5 the following bit pattern is utilized:

No.	Upper Bits	Lower Bits
1	8	1
2	A	2
3	8-A	1-2
4	B	4
5	8-B	1-4

c) A table is used which has the n + 1st bit configuration in sequential locations for the lower bits and the n + 1st bit configuration in every 7th location for the upper bits where n represents the current number of entries or exits.

d) The entry or exit is entered into the table by using the low order 3 digits of the node number as the address in the bank of 1000 locations which is predetermined by the first digit of the node number. The bank storage is as follows:

	B	
First	A	nodes 1000-1999
1000	8	
loc.	4	
	2	nodes 0000-0999
	1	
	B	
Second	A	nodes 3000-3999
1000	8	
loc.	4	
	2	nodes 2000-2999
	1	

The program is written to accommodate 4100 nodes.

e) When the proper address of the node number is obtained, this location is compared to the previously mentioned table (IV 3c) until a match is found, and if the lower bits are being processed, then the (m + 1)st table location is inserted into the node location. If the upper bits are being processed, then the (m + 7)th table location is inserted into the node location, where m represents the location of the table match.

f) In checking the entry and exit count arrays, only the table items which represent over-entries and over-exits are used and the location and upper-lower processing gives the error node number.

V. Usage

1) Link Data Cards must be in A Node sort (CC 3-6)

2) Ready Tapes 1 and 2

   a) Tape 1 is a self-generated system tape and may be either low or high density.

   b) Tape 2 is the BCD Link Data Output Tape and must be in the density prescribed for input to Build Network Description for the IBM 709/90 system.

3) Ready Printer.
Put Sense Switch A on. (Last Card Option)
Sense Switch B off tests for error Type 12.
Sense Switch C off prints Node entry-exit Table.

4) Place Program, Parameter Card and Link Data Cards in Read Hopper. Execute normal load cards routine.

5) Program pauses for any operator action necessary. Press Start. During processing, the program will stop if a Type 1 error is detected.

6) Press start to read last card.

7) Final Program stop occurs after Parameter Card Information is printed or after node entry-exit table has been presented.

8) If there were no errors, Tape 2 is ready for processing by the IBM 709/90 computer. A tape acceptable to the IBM 709/90 will be produced even if error types 3,4,5,6,10, and 11 are reported.

VI. Coding Information

The program was coded in TAMP II (Texas A&M Processor, Phase II) and further information is available from Mr. Robert L. Smith, Jr., Director, Data Processing Center, Texas A&M University, College Station, Texas.

VII. Timing

Time estimations are based on checkout trials and are as follows:

1) 1800 link data cards - 13 min.

2) 3800 link data cards - 27 min.

VIII. Checkout

The program has been checked out on five link data decks with all error types represented. Systems ranged from 200 to 404 centroids, 1000 to 3200 nodes, and 1500 to 3800 link data cards.

IX. Input Data Specifications

1) Parameter Input Card

Field	Card Column	Characteristic
1	1	Specifies Speed-Time field to be used 1; Link Data card column 22-4 and 37-9 2; Link Data card columns 25-7 and 40-2 Other; Link Data card columns 28-30 and 43-5
2	10-12	Turn penalty - minutes (x,xx)
3	13-16	Last centroid - right adjusted
4	18-21	First turn node - right adjusted
5	23-26	Last turn node - right adjusted
6	28-31	First freeway node - right adjusted
7	33-36	Last freeway node - right adjusted
8	38-80	Identification Information

NOTE: ALL FIELDS MUST HAVE LEAD ZEROS PUNCHED

2) Link Data Card

Field	Card Column	Characteristic
1	1	Jurisdiction
2	3-6	A Node
3	8-11	B Node
4	13	Sign

Field	Card Column	Characteristic
5	14	Flag
6	16-18	Distance
7	20	T (or 1) or S (or 2)
8	22-24	Field 1 Impedance (A-B)
9	25-27	Field 2 Impedance (A-B)
10	28-30	Field 3 Impedance (A-B)
11	35	T (or 1), S (or 2), or Blank
12	37-39	Field 1 Impedance (B-A)
13	40-42	Field 2 Impedance (B-A)
14	43-45	Field 3 Impedance (B-A)

NOTE: Fields 2 and 3 MUST HAVE LEAD ZEROS PUNCHED

FIGURE I

FLOW CHART FOR LINK DATA EDITOR
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PHASE I

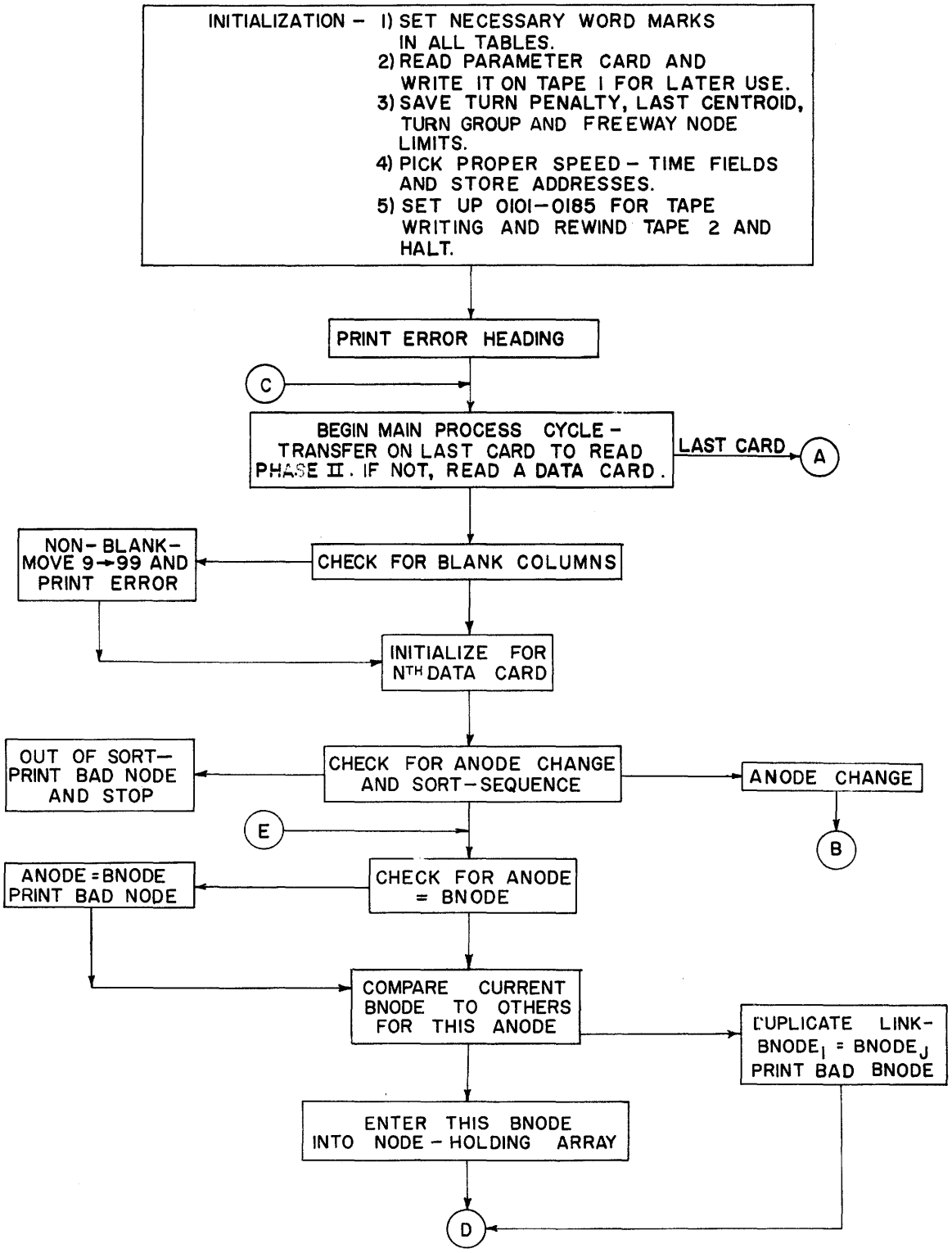


FIGURE I-A

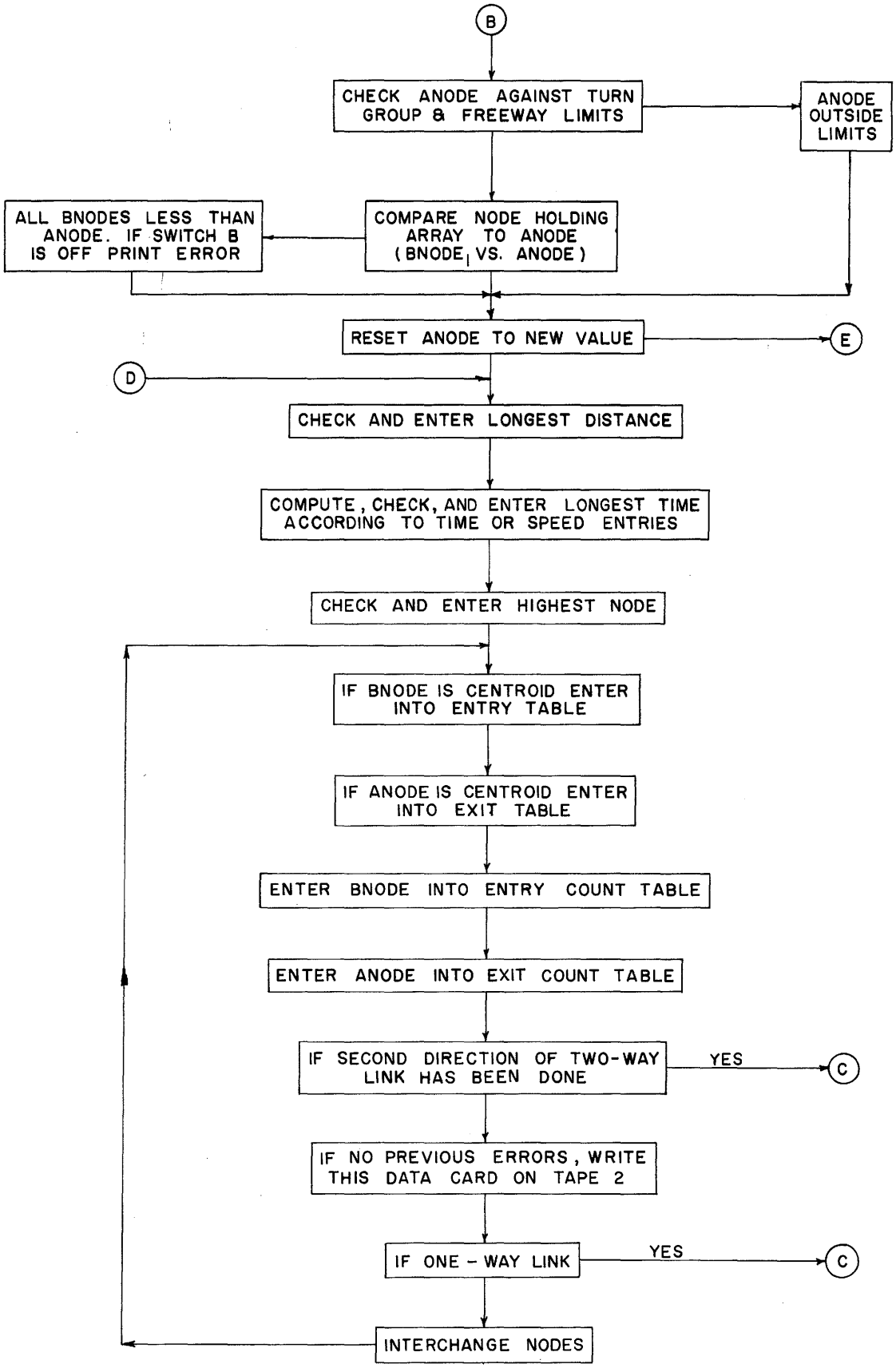
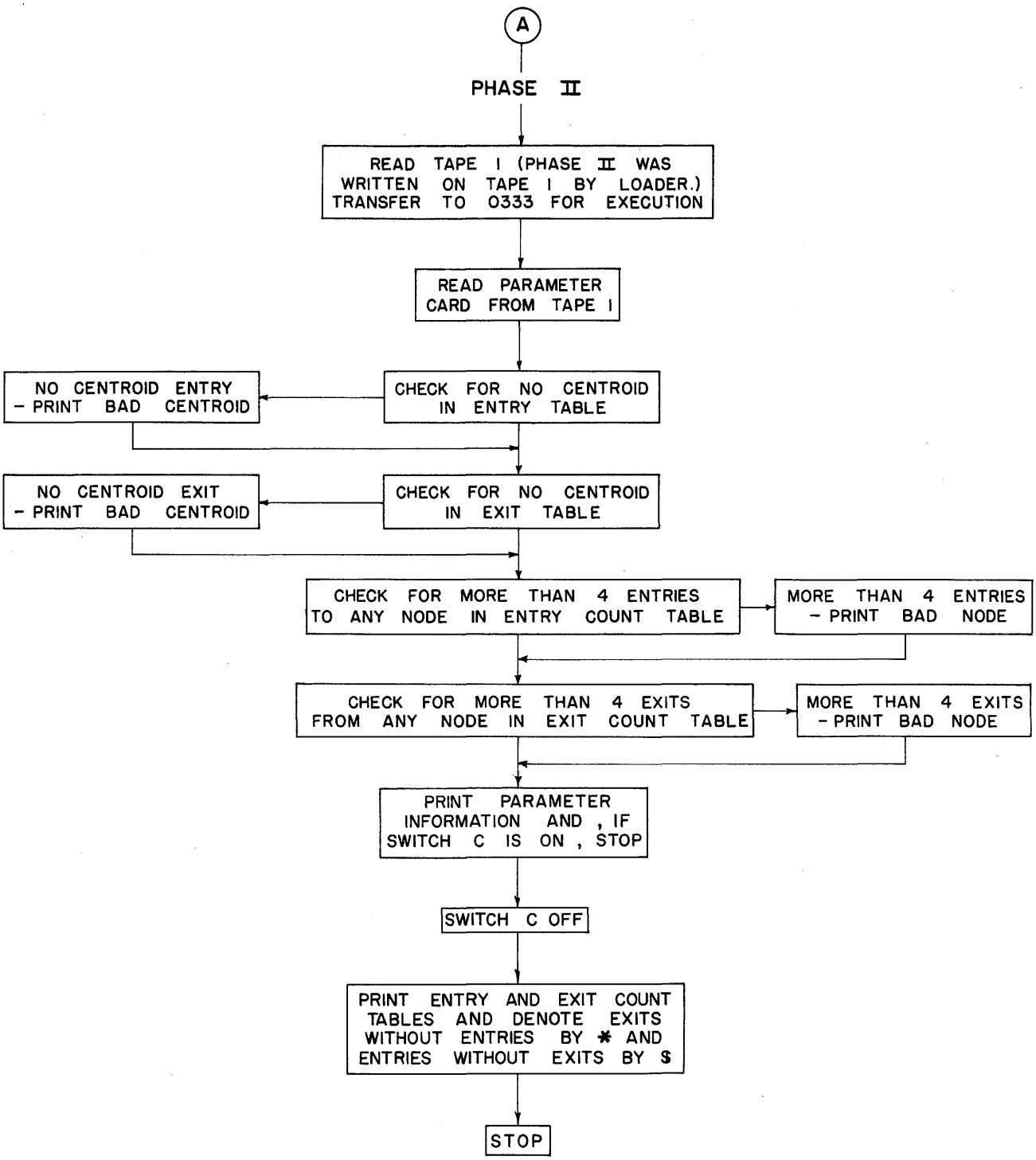

B
CHECK ANODE AGAINST TURN GROUP & FREEWAY LIMITS
ANODE OUTSIDE LIMITS
ALL BNODES LESS THAN ANODE. IF SWITCH B IS OFF PRINT ERROR
COMPARE NODE HOLDING ARRAY TO ANODE (BNODE$_I$ VS. ANODE)
RESET ANODE TO NEW VALUE
E
D
CHECK AND ENTER LONGEST DISTANCE
COMPUTE, CHECK, AND ENTER LONGEST TIME ACCORDING TO TIME OR SPEED ENTRIES
CHECK AND ENTER HIGHEST NODE
IF BNODE IS CENTROID ENTER INTO ENTRY TABLE
IF ANODE IS CENTROID ENTER INTO EXIT TABLE
ENTER BNODE INTO ENTRY COUNT TABLE
ENTER ANODE INTO EXIT COUNT TABLE
IF SECOND DIRECTION OF TWO-WAY LINK HAS BEEN DONE
YES
C
IF NO PREVIOUS ERRORS, WRITE THIS DATA CARD ON TAPE 2
IF ONE - WAY LINK
YES
C
INTERCHANGE NODES

FIGURE I-B


A
PHASE II
READ TAPE I (PHASE II WAS WRITTEN ON TAPE I BY LOADER.) TRANSFER TO 0333 FOR EXECUTION
READ PARAMETER CARD FROM TAPE I
CHECK FOR NO CENTROID IN ENTRY TABLE
NO CENTROID ENTRY - PRINT BAD CENTROID
CHECK FOR NO CENTROID IN EXIT TABLE
NO CENTROID EXIT - PRINT BAD CENTROID
CHECK FOR MORE THAN 4 ENTRIES TO ANY NODE IN ENTRY COUNT TABLE
MORE THAN 4 ENTRIES - PRINT BAD NODE
CHECK FOR MORE THAN 4 EXITS FROM ANY NODE IN EXIT COUNT TABLE
MORE THAN 4 EXITS - PRINT BAD NODE
PRINT PARAMETER INFORMATION AND , IF SWITCH C IS ON , STOP
SWITCH C OFF
PRINT ENTRY AND EXIT COUNT TABLES AND DENOTE EXITS WITHOUT ENTRIES BY * AND ENTRIES WITHOUT EXITS BY $
STOP

```
ERROR ITEM                ANYTOWN, U.S.A.                                ERROR TYPE

0 0188/0592 11 111 S       11                    ERROR CARD                 9
0 0188 0592 00 012 S       12      S       12    ZONE 188 AND CHESTNUT      2
 0312                                                                     12
0 0414 0866 11 111         11                    ERROR CARD                 2
0 0414 0866 11 111         11                    ERROR CARD                 8
0 0442 0443 11 111 S       11                    ERROR CARD                 2
0 0635 0640 11 111 S       11                    ERROR CARD                 2
0 0834 0833 11 111         11                    ERROR CARD                 2
0 0834 0833 11 111         11                    ERROR CARD                 8
 0835                                                                     12
0 0902 0902 11 111 S       11                    ERROR CARD                 7
0X1074 1075 11 111 S       11                    ERROR CARD                 9
0 1074 1075 00 028 S       25      S       25    BERKMAN AT 51ST            2
0 1209 1209 11 111 S       11                    ERROR CARD                 7
   23                                                                      5
  159                                                                      5
  225                                                                      5
  261                                                                      5
   23                                                                      6
  225                                                                      6
    7                                                                      3
 1209                                                                      3
 1210                                                                      3
  443                                                                      3
  592                                                                      3
  640                                                                      3
  682                                                                      3
    5                                                                      4
    7                                                                      4
  188                                                                      4
 1209                                                                      4
 1210                                                                      4
  414                                                                      4
  442                                                                      4
  635                                                                      4
  682                                                                      4
PARAMETER CARD INFORMATION FOR  ANYTOWN, U.S.A.

LONGEST DISTANCE  167    LONGEST TIME PLUS TURN PENALTY  626    TURN PENALTY 020    LAST CENTROID  283    HIGHEST NODE 1312
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FIGURE 2-A

LIST OF NODE ENTRY AND EXIT COUNT TABLES FOR ANYTOWN, U.S.A.

NODE	T	F	NODE	T	F	NODE	T	F	NODE	T	F	NODE	T	F	NODE	T	F	NODE	T	F	NODE	T	F
1	3	3	2	3	3	3	4	4	4	3	3	5	4	5	6	4	4	7	5	5	8	4	4
9	4	4	10	3	3	11	3	3	12	3	3	13	3	3	14	2	2	15	2	2	16	3	3
17	3	3	18	3	3	19	3	3	20	3	3	21	4	4	22	3	3	23			24	3	3
25	2	2	26	2	2	27	3	3	28	3	3	29	3	3	30	2	2	31	2	2	32	1	1
33	2	2	34	2	2	35	3	3	36	2	2	37	2	2	38	2	2	39	3	3	40	2	2
41	2	2	42	3	3	43	2	2	44	2	2	45	3	3	46	2	2	47	3	3	48	2	2
49	1	1	50	2	2	51	3	3	52	3	3	53	4	4	54	4	4	55	4	4	56	4	4
57	3	3	58	2	2	59	3	3	60	2	2	61	3	3	62	2	2	63	1	1	64	3	3
65	3	3	66	4	4	67	4	4	68	3	3	69	2	2	70	2	2	71	2	2	72	3	3
73	3	3	74	4	4	75	3	3	76	3	3	77	4	4	78	2	2	79	2	2	80	4	4
81	2	2	82	3	3	83	3	3	84	3	3	85	3	3	86	2	2	87	4	4	88	4	4
89	4	4	90	3	3	91	3	3	92	2	2	93	2	2	94	4	4	95	4	4	96	3	3
97	3	3	98	3	3	99	2	2	100	3	3	101	3	3	102	3	3	103	3	3	104	3	3
105	2	2	106	2	2	107	3	3	108	2	2	109	2	2	110	2	2	111	3	3	112	2	2
113	2	2	114	3	3	115	3	3	116	2	2	117	2	2	118	2	2	119	3	3	120	2	2
121	3	3	122	3	3	123	3	3	124	2	2	125	2	2	126	1	1	127	3	3	128	4	4
129	3	3	130	3	3	131	3	3	132	3	3	133	3	3	134	3	3	135	1	1	136	3	3
137	2	2	138	3	3	139	2	2	140	3	3	141	2	2	142	3	3	143	3	3	144	3	3
145	4	4	146	2	2	147	3	3	148	2	2	149	2	2	150	3	3	151	3	3	152	2	2
153	2	2	154	3	3	155	2	2	156	2	2	157	1	1	158	2	2	* 159		1	160	1	1
161	1	1	162	3	3	163	3	3	164	3	3	165	2	2	166	4	4	167	3	3	168	2	2
169	3	3	170	3	3	171	2	2	172	1	1	173	1	1	174	4	4	175	3	3	176	2	2
177	4	4	178	3	3	179	3	3	180	3	3	181	3	3	182	3	3	183	4	4	184	3	3
185	3	3	186	3	3	187	3	3	188	4	5	189	3	3	190	4	4	191	4	4	192	2	2
193	1	1	194	2	2	195	2	2	196	2	2	197	3	3	198	3	3	199	3	3	200	1	1
201	1	1	202	2	2	203	1	1	204	2	2	205	2	2	206	2	2	207	2	2	208	2	2
209	2	2	210	2	2	211	1	1	212	2	2	213	3	3	214	2	2	215	3	3	216	1	1
217	3	3	218	3	3	219	2	2	220	2	2	221	4	4	222	2	2	223	1	1	224	1	1
225			226	2	2	227	2	2	228	2	2	229	1	1	230	2	2	231	3	3	232	2	2
233	2	2	234	3	3	235	3	3	236	4	4	237	3	3	238	4	4	239	2	2	240	2	2
241	1	1	242	1	1	243	2	2	244	1	1	245	1	1	246	2	2	247	2	2	248	1	1
249	2	2	250	1	1	251	3	3	252	2	2	253	3	3	254	4	4	255	3	3	256	3	3
257	3	3	258	3	3	259	2	2	260	3	3	* 261		2	262	3	3	263	2	2	264	3	3
265	2	3	266	3	3	267	1	1	268	1	1	269	1	1	270	1	1	271	1	1	272	2	2
273	1	1	274	1	1	275	1	1	276	1	1	277	2	2	278	1	1	279	1	1	280	1	1
281	1	1	282	1	1	283	1	1	$ 284	1		285			286			287			288		
289			290			291			292			293			294			295			296		
297			298			299			300			301	4	4	302	4	4	303	4	4	304	4	4
305	4	4	306	4	4	307	4	4	308	4	4	309	4	4	310			311	4	4	312	4	4
313	4	4	314	4	4	315	4	4	316	4	4	317	4	4	318	4	4	319	4	4	320	4	4
321	4	4	322	4	4	323	4	4	324	4	4	325	4	4	326	4	4	327	4	4	328	4	4
329	4	4	330	4	4	331	4	4	332	4	4	333	4	4	334	4	4	335	4	4	336	4	4
337	4	4	338	4	4	339	4	4	340	4	4	341	4	4	342	4	4	343	4	4	344	4	4
345	4	4	346	4	4	347	4	4	348	4	4	349	4	4	350	4	4	351	4	4	352		
353	4	4	354	4	4	355	4	4	356	4	4	357	4	4	358	4	4	359	4	4	360	4	4
361	4	4	362	4	4	363	4	4	364	4	4	365	4	4	366	4	4	367	4	4	368	4	4
369	4	4	370	4	4	371	4	4	372	4	4	373	4	4	374	4	4	375	4	4	376	4	4
377	4	4	378	4	4	379	4	3	380	4	4	381	4	4	382	4	4	383	4	4	384	4	4
385	4	4	386	4	4	387	4	4	388	4	4	389	4	4	390	4	4	391			392	4	4
393	4	3	394	4	4	395	4	4	396	4	4	397	4	4	398			399	4	4	400	4	4
401			402	4	4	403	4	4	404	4	4	405	4	4	406	4	4	407	4	4	408	4	4
409	4	4	410	4	4	411	4	4	412	4	4	413	4	4	414	4	5	415	4	4	416	4	4
417	4	4	418	4	4	419	4	4	420	4	4	421	4	4	422	4	4	423	4	4	424	4	4
425	4	4	426	4	4	427	4	4	428	4	4	429	4	4	430	4	4	431	4	4	432	4	4
433	4	4	434			435	4	4	436	4	4	437	4	4	438	4	4	439	4	4	440	4	4
441	4	4	442	4	5	443	5	4	444	4	4	445	4	4	446	4	4	447	4	4	448	4	4
449	4	4	450	4	4	451	4	4	452	4	4	453	4	4	454	4	4	455	4	4	456	4	4
457	4	4	458	4	4	459	4	4	460	4	4	461	4	4	462	4	4	463	4	4	464	4	4
465	4	4	466	4	4	467	4	4	468	4	4	469	4	4	470	4	4	471	4	4	472	4	4
473	4	4	474	4	4	475	4	4	476	4	4	477	4	4	478	4	4	479	4	4	480	4	4
481	4	4	482	4	4	483	4	4	484	4	4	485			486	4	4	487	4	4	488	4	4
489	4	4	490	4	4	491	4	4	492	4	4	493	4	4	494	4	4	495	4	4	496	4	4
497	4	4	498	4	4	499	4	4	500	4	4												

FIGURE 2-B