DEUCE Programme No. 699 (ZC01T/6).

General Interpretive Programme (G.I.P.8).

SUMMARY.

This report contains details of a programme to interpret and obey a master routine written in a 3-address pseudo-code. This master routine uses codewords to cause other programmes to be obeyed in any required sequence, or to perform certain arithmetic or discrimination functions on other codewords.

This programme (G.I.P.8) is developed from earlier versions, and is the result of work carried out at N.P.L., Liverpool University, and the two E.E. Co. Computing Centres. It should be used in preference to earlier versions, except on Mk. 0 machines.

Changes from earlier versions are given in Para. 10.

There are no "Operating Instructions" cards for this programme.

DEUCE Programme No. 699 (ZC01T/6).

General Interpretive Programme (G.I.P.8).

1. DESCRIPTION.

The General Interpretive Programme (G.I.P.8) will interpret and obey a master routine written in a 3-address pseudo-code.

The master routine is called a G.I.P. programme, and consists of a sequence of G.I.P. instructions, usually referred to as codewords.

The codewords are stored in a 96 word codeword store (stored on the drum) in tracks 15/9 to 15/11). An instruction may cause any of a series of programmes stored on the magnetic drum to be obeyed, with the three addresses as parameters, or the addresses may be used to refer to the codeword stores so that codewords can be modified or conditional jumps made. The programmes stored on the drum are usually referred to as "bricks".

If the bricks to perform each of the individual functions required for a G.I.P. programme already exist, (as is usually the case for matrix algebra problems) the writer need have no detailed knowledge of conventional DEUCE Programming.

2. STANDARD BRICKS.

For a DEUCE programme to be sequenced by G.I.P.8, it must satisfy certain rules. If it does, it is called a standard brick. The rules for writing a standard brick are given in DEUCE News No. 10, but for use with G.I.P.8 bricks may be punched in both α and β fields, or just in the α field. However, 1_0 must be used as the blank minor cycle between triads (this concerns the "fillers" on the D.L. triads) and D.L.1 must be filled last (if it is required).

For the writer of G.I.P. programmes, however, all that need be known is the basic facts of brick design:-

(a) A brick consists of an initial card followed by one or more sections of programme.

(b) Each section consists of D.L.'s of instructions. (These D.L.'s are stored by G.I.P. on some whole number (from one up to ten) of tracks on the drum).

(c) Each section can occupy any or all of D.L.'s 1-10; it can use D.L.11 and 12_{16-28} but should not use D.L.$12_{0-15,\ 29-31}$.
A section can use 12_{0-15} but this is not desirable (since it interferes with things like the scalar stores). If 12_{29-31} are used they must be replaced by the section.

3. CODEWORDS.

Codewords are written in columns thus:

Codeword No.	a	b	c	r	D	G
0						
1						
2						
.						
.						
.						

a,b and c are integers in the range 0-255 inclusive.
r is an integer in the range 0-62 inclusive.
Column D is normally blank but it may contain a "D" to indicate a DEUCE-like instruction.

DEUCE Programme No. 699 (ZC01T/6).

General Interpretive Programme (G.I.P.8).

Column G is either blank or contains a "G". This indicates either the GO digit in a DEUCE instruction or that when $r \geqslant 32$ it nevertheless refers to brick r and not one of the special functions listed in para. 5.

Note that codewords are numbered from 0 onwards. They are punched in triad formation, with the first four rows of the first card of each triad ignored by G.I.P. - they can either be blank or contain identifying information.

Codewords are punched as follows:

a in card cols 17-24
b in card cols 25-32
c in card cols 33-40
r in card cols 41-46
D in card col 47
G in card col 48

DEUCE-like instructions are punched in normal instruction format, leading to 8_0, with an added punching in P_{31} (the D in col 47). The general form thus becomes:

0, S-D (c) W, 0 (1) G. (See para. 6).

Each codeword leads to the one following in sequence, except for the special codewords described below (para. 5) or for DEUCE-like instructions which involve discrimination - for a successful discrimination, the codeword next but one in the sequence is obeyed.

The first 32 codewords (numbered 0-31) are always read in immediately following the bricks. If any further codewords are required, they must be read using the special function r = 47 (see para. 5). Up to 96 codewords may be stored at any one time, but they can be replaced in blocks of 32 if required.

4. CODEWORDS THAT CAUSE BRICKS TO BE OBEYED.

A codeword having:

(a) $1 \leqslant r \leqslant 31$ and G = 0

or

(b) $32 \leqslant r \leqslant 62$ and G = 1

can be used to cause brick number r to be fetched from the drum and obeyed. For this purpose, the required bricks are stacked in an arbitrary order and all sections numbered from 1 onwards. (Up to 62 sections are allowed). To cause a selected brick to be obeyed, it is therefore necessary only to quote the appropriate r for its first section. The sequencing of the various sections within the brick (if it contains more than one section) is then performed automatically until the required operations are complete, when the next codeword is called. The first section to be obeyed is provided with the three parameters a, b, c. Auxiliary parameters a_1, b_1, c_1 may be provided in addition if function r = 48 is used in addition (see para. 5).

A completely zero codeword leads to the next codeword without having any effect.

If r = 0 and G = 0, but $c \neq 0$, section c will be obeyed, but no parameters will be set (i.e. 18_{0-3} will contain rubbish). However, any auxiliary parameters set by the previous codeword will be found in 17_{0-3}.

5. CODEWORDS OPERATING ON CODEWORD STORES.

In codewords having $32 \leqslant r \leqslant 48$ and $G = 0$ the numbers a, b, c are used to refer to the G.I.P. stores (numbered 0-127). In this context, A, B, C, are used to indicate the contents of G.I.P. stores a, b, c respectively.

The effect of such codewords is:

r = 32 $a \neq 0$; $b = 0$; $c \neq 0$. Replace the c sections numbered a to (a + c - 1) by c sections in the reader (which must not occupy more tracks than those they replace).

r = 32 b = 0 ; c = 0. Read N. P_{17} on data card and then perform previous operation with a = 1, b = 0, c = N.

r = 32 $b \neq 0$. Pass one brick through the reader and obey it with parameters a, b, c.

r = 33 Jump to codeword number c. (a and b ignored).

r = 34 Jump to codeword c if A negative, otherwise jump to codeword b.

r = 35 Jump to codeword c if A is non-zero, otherwise jump to codeword b.

r = 36 Jump to codeword c if B > A, otherwise continue normally.

r = 37 Jump to codeword c if $B \neq A$, otherwise continue normally.

r = 38 Replace C with (A + B) and continue normally.

r = 39 Replace C with (A - B) and continue normally.

r = 40 Put a copy of A into C and continue normally.

r = 41* Obey (A + B), add P_1 to B, jump to codeword c.

r = 42* Obey (A + B), add P_9 to B, jump to codeword c.

r = 43* Obey (A + B), add P_{17} to B, jump to codeword c.

r = 44* Obey (A + B), add C to B, and continue normally.

r = 45 Obey (A + B), jump to codeword c.

r = 46 Obey the codewords in stores a to b inclusive then jump to codeword c.

r = 47 Read a triad of 32 codewords into store 32c onwards, then jump to b. (c = 0, 1 or 2).

r = 48 Place a_1, b_1, c_1 as auxiliary parameters for the next brick to be obeyed.

* NOTE that the order of the operations carried out by these codewords is: form A + B = K say, then modify B, then obey K, then jump to c.

6. DEUCE-LIKE INSTRUCTIONS.

Codewords may be written in standard DEUCE instruction format 0, S-D (c) W T. This is written across the a, b, c, r, columns with a D in the D column, to indicate a P_{31} is required. (It is customary to write a G in the G column - and obligatory to punch it in card column 48 - for 'GO' instructions). This is termed a DEUCE-like instruction, and has the effect of a similar DEUCE instruction obeyed from m.c.30, except in the selection of the next instruction to be obeyed, which is determined as follows:

(a) T may take the values 31, 0, (or 1 if the instruction is <u>not</u> a discrimination).

(b) If T = 31, the instruction will loop back to itself until a successful discrimination occurs, when the next codeword will be selected.

(c) If T = 0, the instruction leads to the next codeword, unless it is a successful discrimination, when the next but one codeword is obeyed.

(d) If T = 1, the next but one codeword will be obeyed.

DEUCE-like instructions may be obeyed on successive rows of a card if desired, provided they have no 'G'.

DEUCE-like instructions will find the following information in the mercury:

TS13 TS14)	whatever was left there by the last DEUCE-like instruction obeyed.
TS15 TS16 DS19 DS20 DS21 QS17 QS18)	whatever was left by the last DEUCE-like instruction (if this was the last codeword). Otherwise nonesense.
DL 1- 8	Instructions for G.I.P.8. These must not be disturbed.
DL 9-12	Contents of G.I.P. stores 0-127 (see para. 7).

If a DEUCE-like instruction with destination 31 is obeyed then the heads so moved must be returned to position 15 before obeying a normal codeword.

The main uses of DEUCE-like instructions are:

(a) transferring parameters from binary cards to G.I.P. stores.

(b) transferring blocks of 32 codewords from the drum to G.I.P. stores.

(c) performing arithmetic operations on G.I.P. stores.

7. <u>USE OF THE STORE</u>.

G.I.P.8 occupies 23 tracks (i.e. tracks 233-255 inclusive). These include a G.I.P. store of 128 words numbered 0-127 (which are kept on tracks 249-252) of which the first 96 (0-95) are the codeword stores. Of the remaining 32 (96-127) the following are useful:

96-99	contents of 17_{0-3})	
101	contents of 16)	
104-5	contents of 19_{2-3})	as left by the last section obeyed, and will be found there by the next section.
106-7	contents of 20_{2-3})	
11 12 108-9	contents of 21_{2-3})	
3 110	contents of 13)	as left by the last DEUCE-like instruction, and will be found there by the next DEUCE-like instruction.
4 111	contents of 14)	

120	Zero
121	P_1
122	P_9
123	$P_1 + P_9$
124	P_{17}
125	$P_1 + P_{17}$
126	$P_9 + P_{17}$
127	$P_1 + P_9 + P_{17}$

NOTE: If the P_1 P_9 P_{17} digits are considered as a 3 bit binary number, the value of this number is equal to the last digit of the decimal store number.

e.g. 125 5 = 101

$\therefore$ $P_1 + P_{17}$

N.B. Except for stores 96-99, 101, 104-111, the stores listed here <u>must not be altered</u>. Also stores 100, 102-3, 112-119 <u>must not be referred to at all</u>.

Each section finds in the mercury what was left by the preceding section except for:

(a) The D.L.'s it occupies itself.

(b) The section parameters a, b, c and r in QS18 (unless r = 0 in which case QS18 contains rubbish).

(c) Auxiliary parameters, left by a code with r = 48, in QS17.

(d) Any alterations made by intervening codewords or DEUCE-like instructions.

(e) TS13 and D.L.11 which are always changed, and contain rubbish at entry to a new section.

N.B. The first section to be obeyed finds rubbish in the mercury, left behind by the "Read Programmes" section of G.I.P.

The bricks are stored on consecutive tracks backwards starting in track 232. Up to 62 sections, occupying up to 233 tracks may be stored at any one time. These sections are numbered from 1 onwards in the order in which they are read, and are referred to by these numbers in the codewords. The remaining tracks are available for storing data and results and can be used in any order at the programmer's discretion. (N.B. Some bricks, notably Multiplication, require tracks from 0 upwards to store partial results).

8. <u>PACK ASSEMBLY INSTRUCTIONS</u>.

To use a G.I.P. programme, the following pack must be assembled:

(a) G.I.P.8, cards 0-33.

(b) A parameter card with N . P_{17} on the Y row, where N is the total number of brick sections. (Remember some standard bricks contain more than one section).

(c) N brick sections, in the order they are numbered for the purpose of referring to them in codewords.

(d) A triad of cards containing the first 32 codewords.

(e) Data, bricks, or triads of codewords in the order required by the particular application.

DEUCE Programme No. 699 (ZC01T/6).

General Interpretive Programme (G.I.P.8).

After the first triad of codewords has been read, the first codeword (numbered 0) is obeyed. Thereafter, the sequence is determined by the particular set of codewords.

9. PROGRAMME TESTING FACILITIES.

(a) Codeword Display Facility.

Each codeword is displayed on the O.S. lights whilst it is being obeyed (except for DEUCE instructions). This enables the operator to know which brick is being obeyed (from the r number) in the event of failure.

NOTE: that the code 0, 0, 0, 32 will be displayed whilst bricks are being read, and 0, 5, 0, 47 whilst the first triad of codewords is being read.

(b) G.I.P. Stop Facility.

If a P_{32} is put on the I.D., G.I.P. will stop (0, 8-24 X) on each codeword with the codeword about to be obeyed displayed on the O.S. lights. After a single shot, the programme will continue in the usual way. (This does not operate on a sequence of codewords obeyed under the direction of function r = 46 or for DEUCE-like instructions).

(c) G.I.P. Request Stop Facility.

If the number of a codeword (remember the codewords start at number 0) is set (times P_{17}) on the I.D. (N.B. without a P_{32}) G.I.P. will stop as soon as it reaches this codeword and before it obeys it. The machine stops on 0, 8-24 X and will continue normally if given a single shot. (This does not operate for a sequence of codewords obeyed under function 46, or for DEUCE instructions).

(d) G.I.P. External Tree Facility.

If the programme is stopped at 0, 8-24 X by either of the two preceding facilities, the codeword about to be obeyed may be altered by setting the required codeword on the I.D. keys, putting CONT. TIL ON, giving a single shot, and putting CONT. TIL OFF. The revised codeword now appears on the O.S. lights. If this is correct (check presence or absence of P_{32}), a single shot will cause it to be obeyed. The previous codeword will not now be obeyed. Note that this only takes effect for the one occasion - if the incorrect codeword is in a loop, it will need modification each time round the loop.

A codeword 0, 0, c, 33 inserted in this manner will cause the programme to jump to codeword c and continue normally from there.

10. DIFFERENCES BETWEEN G.I.P.8 AND EARLIER VERSIONS.

G.I.P.8 differs from G.I.P.7 in that

(i) It obeys DEUCE instructions with the O.S. clear.

(ii) It has a slight internal interchange that facilitates matrix work on magnetic tape. This change will not affect its normal working.

DEUCE Programme No. 699 (ZC01T/6).

General Interpretive Programme (G.I.P.8).

11. FAILURE INSTRUCTIONS.

There is only one failure instruction in G.I.P.8, (3, 7-18 X) caused by incorrectly punched D.L. filling instructions.

It can arise in three separate ways:

(a) Both α and β fields refer to the same D.L. (In the machine $21_2 \equiv 21_3$).

(b) For a two-field triad, the wait and timing numbers are incorrect. (TS15 = P_{18-21} and P_{27-30}, TS14 is non-zero).

(c) For a single field triad, the wait and timing numbers are wrong. (19_2 or 19_3 non-zero).

After a failure, a single shot will re-read the corrected SECTION.

N.B. In tested programmes, this failure only arises if the machine misreads a card, or the pack is out of order in some way.

DEUCE Programme No. 699 (ZC01T/6).

General Interpretive Programme (G.I.P.8).

```
3_28  15-3_30
3_31  15-31        Bring codes 64-95
3_0   15-31 ℓ      into DL 11.
3_1   11-30
        |
2_10  13-28
   0 /     \ φ
2_13  11-30
3_30  LINK.

2_14  14-30
3_13  13-1_15
3_11  3_24-25      Fetch information
                   about next
1_28  13-0         brick from
Q_30  [11_1-14]    directory.
spill
3_8   28-26 (32mc)
3_29  13-30

3_7   12-11 (32mc)
3_20  0-30 ℓ
4_0   4_2-15   P_5-12
4_17  25-21_2          1st track
4_6   21-22 (24mc)     of brick.
4_1   4_4-15   P_17-20
4_5   25-21_3          No. of tracks.
4_7   4_9-15   P_2-4,21-30
3_16  25-15
4_12  15-14            Entry
4_14  23-14 (9mc)      information
4_24  26-1_27
4_15  12_5-16
4_11  12_0-17 (4mc)
4_3   12_8-19 (d)
4_13  12_10-20 (d)
4_16  4_18-15  P_3-8
4_19  15-30            Track
4_21  11-12 (32mc)     directory.
```

```
3_19  21_3-28
   φ 1         0
3_23  3_25-13              3_22  15-31
3_6   21_2-14              4_20  1_0-14
3_9   23-14 (16mc)         4_22  28-1_0    Set Marker.
3_26  25-25                4_25  0-30
1_29  13-0                 4_8   11_12-21 (d)   From next sheet.
Q_30  [0-31]
3_5   2_6-13               2_1   2_3-15  P_8
3_21  24-14 (4mc)
3_26  25-25
1_28  13-0
Q_30  [0-30]        Put brick in
3_2   4_30-13       representative
4_23  21_2-25       tracks.
1_28  13-0
Q_30  [12_0-14]
3_12  21_2-13
3_4   28-26 (32mc)
3_14  28-26 (32mc)
3_15  13-27
   +        -
3_17  23-14 (4mc)
3_18  3_20-13
3_21  24-14 (4mc)
3_26  25-25
1_29  13-0
Q_30  [0-30 ℓ]
4_10  28-23 (d)
```

```
2_18  2_20-13
1_26  15-25
1_28  13-0
Q_30  [2-30]
2_15  2_16-13
2_24  11-12 (32mc)
1_26  15-25
1_28  13-0
Q_30  [2-11 (32mc)]
2_22  2_8-13         Interchange
1_26  15-25          DL 10-13
1_28  13-0           with
Q_30  [2-30 ℓ]       representative
2_2   15-13          tracks.
2_4   27-26 (16mc)
2_21  13-15
2_23  13-25 (5mc)
2_26  2_28-25
1_28  13-0
Q_30  [12-3 (32mc)]
1_14  15-28
   φ      1_0
2_17  1_0-28
leaving a brick.  0        φ
2_6   0-30               2_7  NEXT PAGE
3_10  11-12 (32mc)       ( Entering a brick ).
4_29  14-1_0
4_31  16-12_5
2_9   17-12_0 (4mc)
3_3   19-12_8 (d)
4_26  20-12_10 (d)
2_25  21-12_12 (d)
4_27  1_27-13
4_28  13-27              Select next
   +      -              brick.
2_11  1_15-13
3_27  28-25
```

DEUCE Programme No. 699 (ZC01T/6).

General Interpretive Programme (G.I.P.8).

2_7 2_{29} - 15
2_{20} 2 - 30
2_5 11 - 12 (32mc) Interchange
2_{16} 2 - 11 (32mc) DL 2 and
2_8 2 - 30 ℓ track 15/2
2_{12} 12 - 30
2_0 1 - 11_{29-31}
2_{31} 12 - 2 (32mc)
1_{21} 11 - 12 (32mc)
1_1 1 - 30 Put 15/1
1_{11} 12 - 30 ℓ in 15/12.
1_{25} 1_{27} - 13
1_{23} 27 - 1_{27}
1_5 1 - 11 (32mc) Store DL 1
1_6 1 - 30 ℓ of Control routine
1_8 12 - 30 in 15/1
1_{22} 1_{24} - 25 Fetch DL 1 of
1_{28} 13 - 0 brick and enter.
Q_{30} [11 - 1 (32mc)]
N_T. $\boxed{\text{ENTER SELECTED PROGRAMME}}$
1_{30} 15 - 31
1_{29} 1 - 30
1_{31} 11 - 1 (32mc)

INITIAL ENTRY FROM CARDS.

1_{31} 9 - 24
1_2 30 - 11 (32mc)
1_3 30 - 7 (32mc)
1_4 1_0 - 11 (d)
1_5 14 - 30 ℓ
1_6 30 - 11 (32mc)
1_7 1_9 - 11 (9mc)
1_{17} 30 - 11_{17}
1_{19} 15 - 30 ℓ
1_{21} 30 - 13
1_{23} 30 - 17 (4mc)
1_{28} 15 - 31
1_{29} 1 - 30
1_{30} 11 - 1 (32mc)

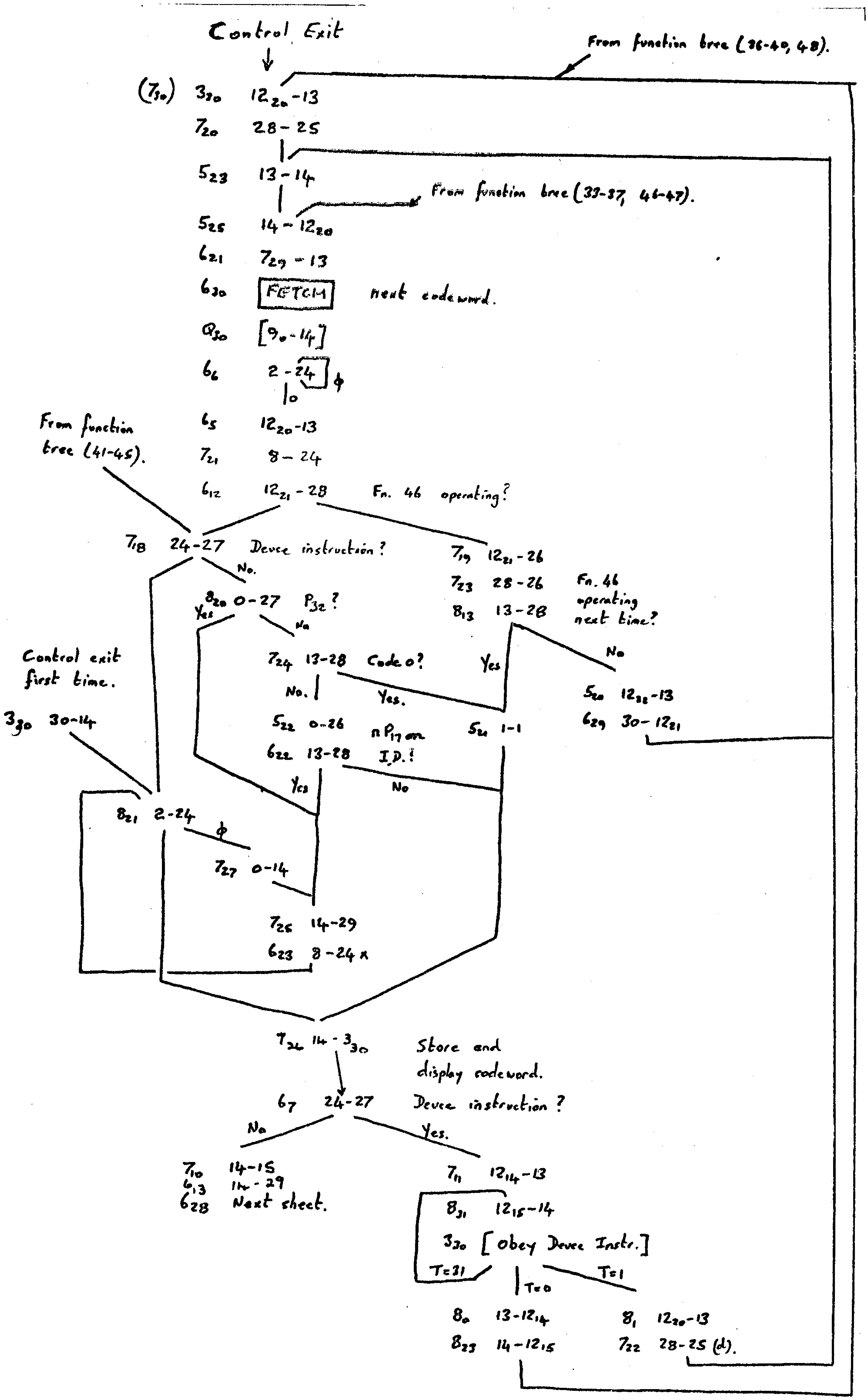
1_2 30 - 1_0
1_4 15 - 31 ℓ
1_3 11_{15} - 27

+ : 1_{16} 13 - 1_{27}

− : 1_{17} 13 - 27

+ :
1_{19} 12 - 11 (32mc) Write
1_7 12 - 30 ℓ DL 12 on 15/12.
1_9 2 - 12 (32mc)
1_{10} 2 - 30
1_{12} 11 - 2 (32mc) Interchange
2_{19} 12 - 11 (32mc) DL 2 and
2_{30} 2 - 30 ℓ track 15/2
2_{27} 15 - 2_{29}
↓
2_1 PREVIOUS SHEET.

− :
1_{20} 12 - 24
1_{18} 30 - 11_{27} Read and obey
1_{13} 1 - 30 ℓ one programme section.
1_0 ↓


Control Exit
From function tree (36-40, 48).
(7₃₀) 3₃₀ 12₂₀-13
7₂₀ 28-25
5₂₃ 13-14
From function tree (33-37, 46-47).
5₂₅ 14-12₂₀
6₂₁ 7₂₉-13
6₃₀ FETCH next codeword.
9₃₀ [9₀-14]
6₆ 2-24 φ
0
From function tree (41-45).
6₅ 12₂₀-13
7₂₁ 8-24
6₁₂ 12₂₁-28 Fn. 46 operating?
7₁₈ 24-27 Deuce instruction?
No.
7₁₉ 12₂₁-26
7₂₃ 28-26
8₁₃ 13-28
Fn. 46 operating next time?
8₂₀ 0-27 P₃₂?
Yes
No
No
7₂₄ 13-28 Code 0?
Yes
No.
Yes.
Control exit first time.
5₂₀ 12₃₂-13
6₂₉ 30-12₂₁
3₃₀ 30-14
5₂₂ 0-26
6₂₂ 13-28
n P₁₇ on I.D.!
5₂₄ 1-1
Yes
No
8₂₁ 2-24
φ
7₂₇ 0-14
7₂₅ 14-29
6₂₃ 8-24 x
7₂₆ 14-3₃₀
Store and display codeword.
6₇ 24-27 Deuce instruction?
No
Yes.
7₁₀ 14-15
6₁₃ 14-29
6₂₈ Next sheet.
7₁₁ 12₁₄-13
8₃₁ 12₁₅-14
3₃₀ [Obey Deuce Instr.]
T=31
T=0
T=1
8₀ 13-12₁₄
8₂₃ 14-12₁₅
8₁ 12₂₀-13
7₂₂ 28-25 (d).

DEUCE Programme No. 699 (ZC01T/6).

General Interpretive Programme (G.I.P.8).

m6 - 15/6   m7 15/7   m8 15/8

6_{28} $6_{31}-14$ P_{25-30}
7_1 $25-14$ r
7_3 $26-21_2$ a, b, c.
8_{27} $24-13$ r P_{26}
6_9 $6_{11}-25$
8_{11} $13-5_{28}$
7_6 $23-14$ (8mc)
7_{16} $14-12_{19}$ r P_{17}
7_0 4_2-15 P_{5-12}
6_{24} $21-22$ (8mc)
6_1 6_3-13
7_4 $\boxed{SR}$
Q_{30} [9_0-16]
7_8 21_3-13
7_{14} $13-12_{16}$ a P_5
6_2 6_4-13
7_4 $\boxed{SR}$
Q_{30} [9_0-13]
7_2 $13-15$
8_4 $16-25$ A:B
8_{14} $21-12_{17}$ (d) bP_5, cP_5
5_{15} $21-22$ (24mc)
8_{17} $12_{19}-28$

0: 6_{19} 21_2-13

ϕ: 6_{20} $3_{30}-27$ P_{32} ?

− Yes / + No.

8_{24} $13-3_{30}$
8_{30} $5_{28}-27$

+ / − $r \geq 32$

8_{25} $12_{19}-13$ 8_{26} 21_2-14

From function 32 5_{28} NEXT SHEET.

6_{14} $12_{16}-18$ (4mc)

5_{19} 7_0-15 Link. 7, 12-13 20, 27
3_{28} $\boxed{CONTROL}$

(7_0) 3_{30} Link.

$\boxed{SR}$

7_4 21_2-14
7_7 $25-14$ P_{5-12}.
7_9 $30-21_3$
7_{12} $22-21$ (24mc) Drop P_{1-12} and move down 8 places
7_5 $21-22$ (8mc)
7_{15} $14-21_3$
7_{17} $24-14$ (12mc) Move to P_{17} position.
6_{30} $\boxed{FETCH}$
Q_{30}

$\boxed{FETCH}$

6_{30} $14-25$
6_0 $22-14$ (21mc)
8_{22} $24-14$ (3mc)
6_{26} $24-25$
1_{28} $13-0$
Q_{30}.

$\boxed{CARRY}$

6_{25} $14-25$
6_{27} $23-14$ (21mc)
6_{17} $24-14$ (8mc)
6_{26} $24-25$
1_{28} $13-0$
Q_{30}

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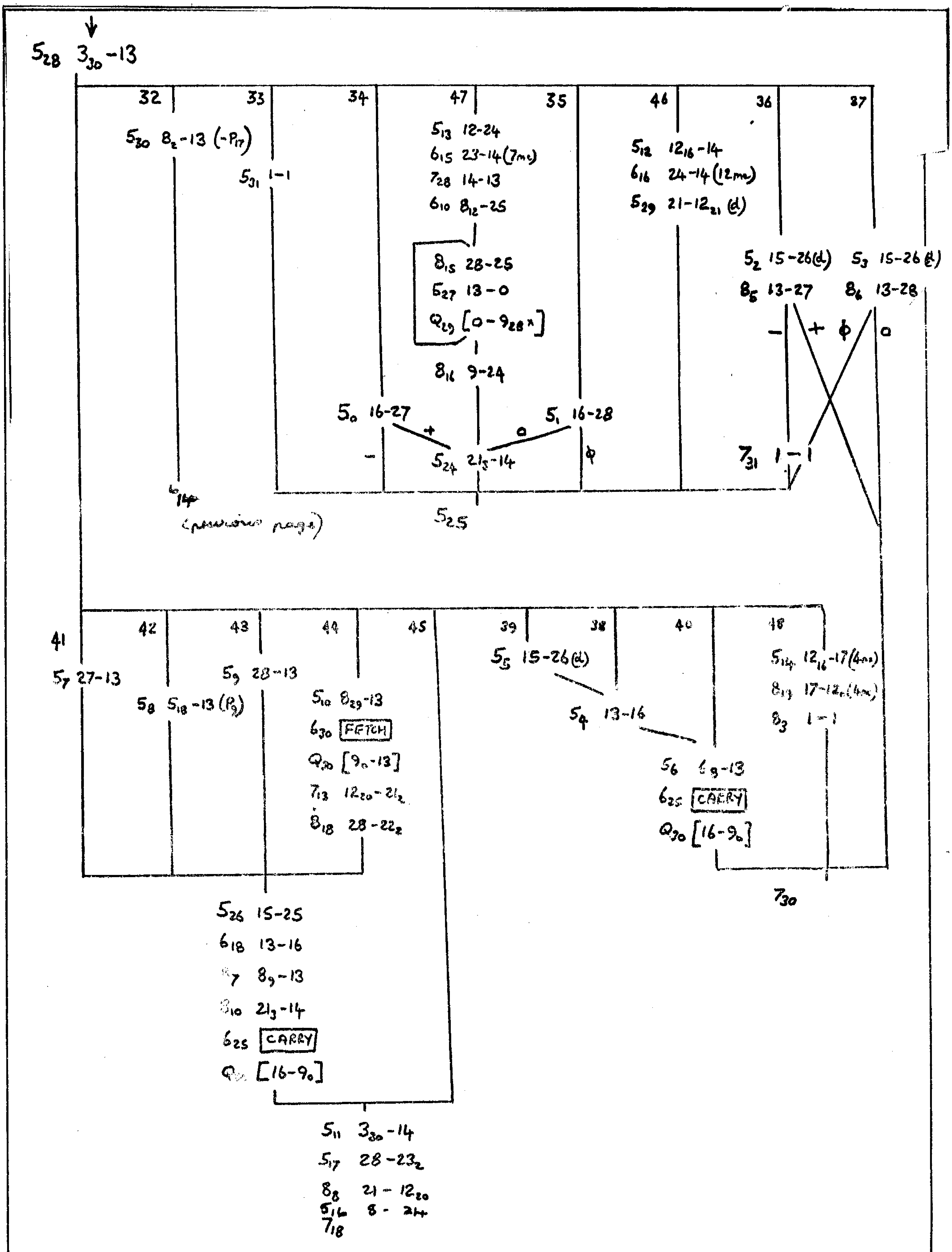
General Interpretive Programme (G.I.P.8).



DEUCE Programme No. 699 (ZC01T/6).

General Interpretive Programme (G.I.P.8).

I_{27} 18_1-28 Is b zero.

0:

I_{28} 9-24
I_0 18_2-13 (c)
I_3 $13-21_3$
I_5 13-28

ϕ:

I_{29} 12-1 (32mc)
I_{30} EXIT.

0:

I_7 $28-21_2$

ϕ:

I_8 18_0-21_2 (a)
I_{31} 21-22 (24mc)

I_9 $21-18_{3,0}$
I_{16} 15-31
I_{18} 14-30
I_{20} 11-4 (32mc)
I_{21} 13-30
I_{23} 11-5 (32mc)

Programme codes of the form:-
E_N T_0 n E_T
P_{2-4} P_{5-12} P_{17-20} P_{26-30}

E_N, E_T = entry information
n = no. of tracks.
T = no. of first track.

I_{24} 16-30
I_{22} 11-6 (32mc) Track codes.
I_{25} 1_1-4_1 Prog. code for Read programmes section 2.
I_2 1_4-22_2

I_{26} 21_2-0
Q_{20} [4_0-14]

spill:

T731
I_{12} 1_4-22_2

I_{11} $14-21_2$
I_{15} 23-14 (12mc)
I_4 $14-23_2$
I_{10} 21_2-14
I_{13} $1_{17}-15$ P_{5-12}
I_{19} $25-18_1$
I_{29} 12-1 (32mc)
I_{30} EXIT.

General Interpretive Programme (G.C.I.P.8).

DL1 10-9 2 12-12 3 14-11

7_{25} $7_2 - 18_2$ Re-entry after failure.

2_1 30-16 Clear 'Write' marker.

7_{20} 7_{27}-21 (d)

8_{28} 8_{27}-15 P_{5-8}

8_{31} 18_1-14 no. of first track.

1_7 $25-22_2$

8_{10} 23-14 (4mc)

7_{15} $25-22_3$ Form magnetic instructions

7_{17} 8_{19}-15 P_{12-25}

8_{20} 24-14 (21mc)

8_{12} $25-22_2$

2_{12} $21-17_2$ (d)

2_{30} $\boxed{\text{SHIFT}}$

Q_{30} normal: [12-24] after failure: [$30-17_0$]

Entry: Read next brick.

3_3 3_6-18_2 count for directory no.

8_9 18_0 - 0, $\ell(+P_{17})$ w/T

Q_{14} (18_3 - 28) Do we read N?

0: 8_{29} $0-18_2$ x

8_{30} $30-18_0$ Clear counter. (No. of tracks)

Entry: Read next triad.

3_7 $18-7_{25}$

7_{30} 1_{22}-15 X P_{10-13}

1_{23} 2_{25}-13

1_{25} 9-11 (32mc)

1_{26} 16-28

0: 1_{28} 13-0 ϕ: 1_{29} $\boxed{\text{WRITE}}$

Q_{30} [0-14 x]

1_{24} $14-19_2$

1_{11} 25-13 Is this an initial card?

8_{23} 30-16

7_{27} 13-28

Yes 0: 1_6 2-24 x

ϕ No.: 1_{17} 0-14

2_8 $14-20_3$

3_{12} $25-21_3$

2_{28} $2_{14}-18_2$

2_{13} $\boxed{\text{SHIFT}}$

Q_{30} [$0-19_2$ x]

2_2 0-14

1_{31} $14-20_2$

1_8 $25-21_2$

Two field punching. 7_4 21-28 (d) α-field only.

ϕ: 2_7 $30-19_3$

3_4 21_2-13

1_{12} 21_3-26

α≡β. 1_{15} 13-28

ϕ: 2_{19} 7_{24}-15

8_{24} 26-13

3_{26} 20_3-14

3_{23} 3_{31}-15

7_{31} 26-25

7_1 21-26 (d)

3_{10} 13-14

7_{12} 23-14 (5mc)

3_8 14-28

ϕ: 2_{18} $\boxed{\text{FAIL}}$

0: 2_{17} 21_2-13

3_{19} 0-14 x

2_{21} 27-16

8_7 0-14

0: 2_6 1_{13}-15

3_{13} 19_2-14

2_{16} $25-19_2$

1_{18} 19_3-14

3_{21} $25-19_3$

3_{24} 19-28 (d)

ϕ: 1_{10} $\boxed{\text{FAIL}}$

0: 1_9 $13-21_3$

2_{25} 0-14 x

Check filling instructions of triad.

1_{19} 7_{22}-15

7_{26} $25-20_3$

1_{30} 7_0-26

1_1 13-28 DL1?

Yes. 0: 1_3 $27-19_3$

ϕ No.

Inspect β-field.

1_4 17_0 - 0 $+P_{17}$

3_9 18_1-13

7_{19} $1_{22}-21_2$

3_{22} 22-21 (18mc)

2_9 3_{11}-26 $2P_{10}$

7_{11} 13-27

+: 7_{13} 21-22 (8mc)

2_{23} 7_0-26 P_{10}

−: 7_{14} 3_{16}-13

7_{16} 18_1-14

7_{21} 24-14 (12mc)

7_3 14-25

1_{28} 13-0

Q_{30} [6_0-15]

3_1 $15-22_3$

3_5 21_2-14

7_8 $25-23_3$

8_{11} 21_3-15

8_{13}

8_{13} 3_{15}-13
7_{16} 18_1-14
7_{21} 24-14 (12mc)
7_3 14-25 Store brick details in Programme codes.
1_{28} 13-0
Q_{30} [15-6_0]
8_0 19_2-28 single field.
Double field.
7_6 19_2-27 7_5 0-11_0 x
after α. after β.
7_{10} 18_1-0 -P_8 7_9 3_{14}-18_2
8_{16} 0-11_0 x 1_{21} 2_{29}-17_1
8_1 20_2-14 2_{31} 18_2-0 +P_{17}
8_6 27-19_2 Q_{30} [0-11_1] x
8_{14} 1_{22}-15 2_4 17_1-0 +P_{17}
3_{25} 25-21_3 Q_{29} [0-9_1]
3_{28} 0-9_0 spill.
1_4 Previous sheet. (Inspect β-field)
2_1 20-21_3
2_3 2_5-23_3
8_3 7_{10}-13
1_{29} $\boxed{\text{WRITE}}$
Q_{30} 16-0 -P_{18}
8_{17} 21_3-28 Entry at 1_0?
Yes 0
2_{26} 19_3-28 DL field? 2_{27} 1-1
No. 0 Yes.
2_{10} 3_{18}-18_2 2_{11} 18_3-0 -P_{17}
2_{13} $\boxed{\text{SHIFT}}$ 3_{20} 18_3-28 last brick?
Q_{30} 12-24 Yes. 0 No
7_{30} Read next tried. 8_2 9-24
8_3 1_6-18_2
2_{13} $\boxed{\text{SHIFT}}$
Q_{30} [17_0-13]
1_{20} 20_3-25
7_{23} 7_{25}-25
8_{25} 13-15
3_{27} 3_{29}-13
3_{30} 18_0-14
1_0 11_4-25
1_2 27-14 (21mc)
2_{24} 24-14 (9mc)
7_1 14-25
1_{28} 13-0
Q_{30} [15-4_0]
3_0 19_3-28
3_3 Read next brick. 3_2

3_2 8_5-13
1_{25} 9-11 (32mc)
1_{26} 16-28
1_{28} 13-0 1_{29} $\boxed{\text{WRITE}}$
Q_{30} [15-31 ℓ]
8_{15} 4 - 11 (32)
8_{17} 14 -30, ℓ
8_{18} 5 - 11 (32) Write up brick details.
8_{21} 13 - 30, ℓ
7_7 6 - 11 (32)
3_{17} 15 - 30, ℓ
8_{22} 30-13
1_5 12-1 (32mc)
1_{30}

$\boxed{\text{WRITE}}$
1_{29} 17_2-0 -P_8-P_{22}
Q_{18} [0-30ℓ] spill down.
1_{27} 1_{14}-17_2
2_{20} 30-17_1
1_{28} 13-0
Q_{30}

$\boxed{\text{SHIFT}}$
2_{13} 17_1-28
2_{30} 17_3-0 (-P_s)
Q_3 [0-31ℓ]
2_{15} 29-17_1
2_{31} 18_2-0 +P_{17}
Q_{30}

$\boxed{\text{FAIL}}$
1_{10} 9-24 2_{18} 9-24
8_{26} 7_{25}-18_1 x
3_{19} 12-24
7_{18} 2_{22}-18_2
2_1 Re-entry after failure.

DEUCE Programme No. 699 (ZC01T/6).

General Interpretive Programme (G.I.P.8).

D.L. 1 Track 14/9

Card Nos. 4–6 α field.

mc	A	NIS	S	D	C	W	T	
		$9P_1 + 14P_5$						
0		1	14	25		0	0	
1		1	13	28		0	0	
2		2	23	14	1	0	20	
3		1	27	19		0	31	
4		$6P_1$	17	0		2	3	
5		1	12	1	1	24	28	
6		1	17	13		3	20	
7		8	25	22		1	1	
8		7	25	21		0	26	
9		2	13	21		0	14	
10		8	9	24		0	14	
11		8	25	13		0	10	
12		1	21	26		1	1	
13		$P_1 + P_{5-9} + P_{16} + P_{22-25} + P_{31-12}$						
14		1	16	30	1	0 (15)	8	
15		2	13	28		0	1	
16		7	2	24		0	11	x
17		2	0	14		0	21	
18		3	19	14		1	1	
19		7	7	15		1	5	
20		7	20	25		1	1	
21		2	2	17		6	9	
22			P_{10-13}					
23		1	2	13		0	0	
24		1	14	19		0	17	
25		1	9	11	1	0	31	
26		1	16	28		0	0	
27		2	1	17		17	23	
28		0	13	0		0	0	
29		$12P_1$	17	0	1	3 (15)	19	
30		1	7	26		0	1	
31		1	14	20		1	7	

D.L. 2 Track 14/10

Card Nos. 4–6 β field.

mc	A	NIS	S	D	C	W	T	
		$10P_1 + 14P_5$						
0		2	20	21		1	1	
1		7	30	16		0	17	
2		1	0	14		26	27	
3		8	2	23		0	3	
4		$2P_1$	17	0		23	23	
5		1	0	0		0	31	x
6		3	1	15		5	5	
7		3	30	19		0	27	
8		3	14	20		1	2	
9		7	3	26		0	0	
10		2	3	18		6	1	
11		$6P_1$	18	0		2	7	
12		2	21	17	2	0	16	
13		2	17	28		2	15	
14		2	0	19		0	2	x
15		2	29	17		0	14	
16		1	25	19		0	0	
17		3	21	13		1	0	
18		8	9	24		0	6	
19		8	7	15		3	3	
20		1	30	17		3	6	
21		8	27	16		0	16	
22		3	30	17		15	7	
23		7	7	26		7	18	
24		7	24	14	1	1	9	
25		1	0	14		0	24	x
26		2	19	28		1	14	
27		2	1	1		14	14	
28		2	2	18		16	15	
29		2	0	9		1 (15)	0	
30		$8P_1$	17	0	1	3	3	
31		$10P_1$	18	0	1	1	29	

D.L. 3 Track 14/11

Card Nos. 7–9 α field.

mc	A	NIS	S	D	C	W	T	
		$11P_1 + 14P_5$						
0		3	18	28		1	0	
1		3	15	22		0	2	
2		1	8	13		1	21	
3		8	3	18		1	4	
4		1	21	13		0	6	
5		7	21	14		1	1	
6		8	18	28		3	13	
7		7	18	7		16	21	
8		2	14	20		0	7	
9		7	18	13		2	8	
10		7	13	14		0	0	
11			P_{11}					
12		2	25	21		1	14	
13		2	19	14		1	1	
14		2	0	11		0	4	x
15		8	15	6		0	0	
16		3	6	15		0	1	
17		8	15	30	2	0	3	
18		7	12	24		0	30	
19		2	0	14		0	0	x
20		8	18	28		1	12	
21		3	25	19		0	1	
22		2	22	21	1	0	17	
23		7	3	15		6	6	
24		1	19	28	2	0	15	
25		3	25	21		0	1	
26		3	20	14		1	27	
27		3	3	13		0	1	
28		1	0	9		2	6	
29		3	15	4		0	0	
30		1	18	14		0	0	
31		0	0	0		30	30	x

DEUCE Programme No. 699 (ZC01T/6).

General Interpretive Programme (G.I.P.8).

D.L. 7 Track 14/12
Card Nos. 7-9 β field.

mc	A	NIS	S	D	C	W	T	
		$12P_1 + 14P_5$						
0			P_{10}					
1		3	21	26	2	1	7	
2		3	12	24		0	3	
3		1	14	25		0	23	
4		2	21	28	2	0	0	
5		7	0	11		25	2	x
6		7	19	27		0	1	
7		3	6	11	e	9	8	
8		8	25	23		1	1	
9		1	3	18		3	10	
10		0	18	0		1	4	
11		7	13	27		0	0	
12		3	23	16	e	22	26	
13		2	21	22	1	1	8	
14		7	3	13		0	0	
15		7	25	22		0	0	
16		7	18	14		3	3	
17		8	8	15		0	1	
18		2	2	18		2	13	
19		3	1	21		1	1	
20		8	7	21	2	5	6	
21		7	24	14	1	1	12	
22		7	0	0		0	31	x
23		8	7	25		0	0	
24		0	0	0		30	31	
25		2	7	18		7	6	
26		1	25	20		1	2	
27		2	1	31	1	0	10	
28		1	1	30	1	0	8	
29		1	13	28		0	17	
30		1	1	15		22	23	x
31		7	26	25		0	0	

D.L. 8 Track 14/13
Card Nos. 10-12 α field

mc	A	NIS	S	D	C	W	T	
		$13P_1 + 14P_5$						
0		7	19	28		0	3	
1		8	20	14		1	3	
2		8	9	24		0	31	
3		2	1	18		1	8	
4		2	21	28		1	20	
5		8	15	31	1	0	15	
6		8	27	19		0	6	
7		1	0	14		11	10	
8		1	7	13		0	19	
9		$1cP_1$	18	0	e	1	3	
10		7	23	14	1	0	3	
11		8	21	15		0	0	
12		2	25	22		0	30	
13		7	3	13		0	1	
14		3	1	15		6	9	
15		8	4	11	e	1	9	
16		8	0	11		14	15	x
17		8	14	30	e	0	31	
18		8	5	11	e	2	1	
19			P_{22-25}					
20		8	24	14	1	2	22	
21		7	13	30	e	0	16	
22		1	30	13		0	13	
23		7	30	16		0	4	
24		3	26	13		0	0	
25		3	13	15		0	0	
26		3	7	18		29	22	x
27			P_{5-8}					
28		8	8	15		29	1	
29		8	0	18		0	31	x
30		3	30	17		0	7	
31		1	18	14		0	6	

D.L. 1 Track 14/14
Card Nos. 10-12 β field.

mc	A	NIS	S	D	C	W	T	
		$14P_1 + 14P_5$						
0		1	18	13		0	1	
1		7	13	7		5	24	x
2		1	1	22		0	22	
3		1	13	21		0	0	
4		1	4	14		0(15)	11	
5		1	13	28		0	0	
6		1	14	23		0	2	
7		1	28	21		1	0	
8		1	18	21		2	21	
9		1	21	18	2	0	5	
10		1	21	14		0	1	
11		1	14	21		1	2	
12		1	1	22		0	12	
13		1	1	15		2	4	
14			$P_5 - P_{17}$					
15		1	23	14	1	10	21	
16		1	15	31		0	0	
17			P_{5-12}					
18		1	14	30		0	0	
19		1	25	18		0	8	
20		1	11	4	1	0	31	
21		1	13	30		0	0	
22		1	11	6	1	2	1	
23		1	11	5	1	0	31	
24		1	15	30		0	28	
25		1	1	4		6	7	
26		0	21	0		2	2	
27		1	18	28		0	31	
28		1	9	24		0	2	
29		1	12	1	1	0	31	
30								
31		1	21	22	1	17	8	

DEUCE Programme No. 699 (ZC01T/6).

General Interpretive Programme (G.I.P.8).

D.L. 1 Track 14/15.
Card Nos. 13-15 β field.

mc	A	NIS	S	D	C	W	T	
		$15P_1$	$+14P_5$					
0		1	30	13		0	0	
1		1	1	1		0	29	
2		1	15	31		0	0	
3		1	1	1		0	27	
4		1	1	30		0	0	
5		1	1	1		0	25	
6		1	11	1	1	27	26	
7		1	1	1		0	23	
8		1	1	1		0	22	
9		1	1	1		0	21	
10		1	1	1		0	20	
11		1	1	1		0	19	
12		1	1	1		0	18	
13		1	1	1		0	17	
14		1	1	1		0	16	
15		1	1	1		0	15	
16		1	1	1		0	14	
17		1	1	1		0	13	
18		1	1	1		0	12	
19		1	1	1		0	11	
20		1	1	1		0	10	
21		1	1	1		0	9	
22		1	1	1		0	8	
23		1	1	1		0	7	
24		1	1	1		0	6	
25		1	1	1		0	5	
26		1	1	1		0	4	
27		1	1	1		0	3	
28		1	1	1		0	2	
29		1	1	1		0	1	
30		1	1	1		0	0	
31		1	1	1		0	31	

D.L. Track 15/0
Card Nos. 16-18 α field

mc	A	NIS	S	D	C	W	T	
		$0P_1$	$+15P_5$					
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20						P_{17}		
21						$4P_{17}$		
22								
23								
24								
25			P_1					
26			P_9					
27			P_1+P_9					
28			P_{17}					
29			P_1+P_{17}					
30			P_9+P_{17}					
31			$P_1+P_9+P_{17}$					

D.L. 1 Track 15/1
Card Nos. 16-18 β field

mc	A	NIS	S	D	C	W	T	
		$1P_1$	$+15P_5$					
0			STORE					
1		1	1	30		0	8	
2		1	30	1		28	0	
3		1	11	27		10	11	
4		1	15	31	1	0	29	
5		1	1	11	1	0	31	
6		1	1	30	1	0	0	
7		1	12	30	1	0	0	
8		1	12	30		0	12	
9		1	2	12	1	0	31	
10		1	2	30		0	0	
11		1	12	30	1	0	12	
12		2	11	2	1	6	5	
13		1	1	30	1	0	17	
14		2	15	28		0	1	
15			STORE					
16		1	13	1		9	1	
17		1	13	27		0	0	
18		1	30	11		7	25	
19		1	12	11	1	19	18	
20		1	12	24		0	28	
21		1	11	12	1	11	10	
22		1	1	25		0	4	
23		1	27	1		2	12	
24		3	11	1	1	2	1	
25		1	1	13		0	28	
26		1	15	25		0	0	
27			STORE					
28		0	13	0		0	0	
29		1	1	30		0	0	
30		1	15	31		0	29	
31		1	11	1	1	2	1	

DEUCE Programme No. 699 (ZC01T/6).

General Interpretive Programme (G.I.P.8).

D.L. 2 Track 15/2
Card Nos. 19-21 α field

mc	A	NIS	S	D	C	W	T	
		$2P_1 + 15P_s$						
0		2	1	11	1	27	29	
1		2	2	15		0	15	
2		2	15	13		0	0	
3			8Ps					
4		2	27	26	1	0	15	
5		2	11	12	1	10	9	
6		3	0	30		0	2	
7		2	2	15		20	11	
8		2	2	30	1	0	2	
9		3	17	12	1	21	24	
10		2	13	28		0	1	
11		3	1	13		2	14	
12		2	12	30		0	18	
13		3	11	30		0	15	
14		3	14	30		0	29	
15		2	2	13		31	7	
16		2	2	11	1	23	22	
17		2	1	28		13	19	
18		1	2	13		0	6	
19		2	12	11	1	10	9	
20		2	2	30		0	15	
21		2	13	15		0	0	
22		1	2	13		16	2	
23		2	13	25	1	29	1	
24		1	11	12	1	1	0	
25		4	21	12	2	17	0	
26		1	2	25		0	0	
27		2	15	2		0	4	
28		1	12	3	1	15	14	
29			STORE					
30		2	2	30	1	0	27	
31		1	12	2	1	21	20	

D.L. 3 Track 15/3
Card Nos. 19-21 β field.

mc	A	NIS	S	D	C	W	T	
		$3P_1 + 15P_s$						
0		3	15	31	1	0	31	
1		2	11	30	1	0	7	
2		4	4	13		26	19	
3		4	19	12	2	3	21	
4		3	28	26	1	9	8	
5		3	2	13		31	14	
6		3	21	14		0	1	
7		3	12	11	1	12	11	
8		3	28	26	1	20	19	
9		3	23	14	1	0	15	
10		4	11	12	1	18	17	
11		1	3	25		11	15	
12		3	21	13		0	22	
13		3	13	1		0	28	
14		3	28	26	1	0	31	
15		3	13	27		0	0	
16		4	25	15		0	26	
17		3	23	14	1	24	27	
18		3	3	13		0	1	
19		3	21	28		0	1	
20		4	0	30	1	0	10	
21		3	24	14	1	0	3	
22		4	15	31		0	28	
23		3	3	13		0	13	
24		3	11	14		1(15)	7	
25		3	0	31		0	5	
26		1	25	25		0	0	
27		2	28	25		0	13	
28		3	15	3		0	1	
29		1	13	30		0	29	
30		8	30	14		20	21	
31		3	15	31		0	31	

D.L. 4 Track 15/4
Card Nos. 22-24 α field.

mc	A	NIS	S	D	C	W	T	
		$4P_1 + 15P_s$						
0		4	4	15		0	15	
1		4	4	15		1	2	
2			P_{s-12}					
3		4	12	19	2	3	8	
4			P_{17-20}					
5		4	25	21		0	0	
6		4	21	22	1	2	25	
7		3	4	15		0	7	
8		2	11	21	2	2	23	
9		7	0	0		0	31	X
10		3	28	23	2	0	7	
11		4	12	17	1	19	22	
12		4	15	14		0	0	
13		4	12	20	2	27	1	
14		4	23	16	1	0	8	
15		4	12	16		20	26	
16		4	4	15		0	1	
17		4	25	21		1	19	
18			P_{s-8}					
19		4	15	30		0	0	
20		4	1	14		10	0	
21		3	11	12	1	29	28	
22		4	28	1		8	1	
23		1	21	25		1	3	
24		4	26	1		1	21	
25		4	0	30		0	13	
26		2	20	12	2	14	29	
27		4	1	13		30	31	
28		2	13	27		0	12	
29		4	14	1		1	0	
30		3	12	14		0	12	
31		2	16	12		4	8	

DEUCE Programme No. 699 (ZC01T/6).

General Interpretive Programme (G.I.P.8).

D.L. 5 Track 15/5
Card Nos. 22-24 β field.

mc	A	NIS	S	D	C	W	T	
		5P1	+ 15 P5					
0		5	16	27		0	22	
1		5	16	28		0	21	
2		8	15	26	2	0	1	
3		8	15	26	2	0	1	
4		5	13	16		0	0	
5		5	15	26	2	0	29	
6		6	6	13		0	17	
7		5	27	13		0	17	
8		5	5	13		8	16	
9		5	28	13		0	15	
10		6	8	13		17	18	
11		5	3	14		17	4	
12		6	12	14		2	2	
13		6	12	24		0	0	
14		8	12	17	1	0	3	
15		8	21	22	1	9	0	
16		7	8	24		0	0	
17		8	28	23		1	21	
18			P9					
19		3	7	15		9	7	
20		6	12	13		0	7	
21		7	1	1		0	3	
22		6	0	26		0	30	
23		5	13	14		0	0	
24		5	21	14		1	31	
25		6	14	12		25	26	
26		6	15	25		0	22	
27		0	13	0		0	0	
28			PLANTED					
29		5	21	12	2	22	26	
30		6	8	13		2	14	
31		5	1	1		0	24	

D.L. 6 Track 15/6
Card Nos. 25-27 α field

mc	A	NIS	S	D	C	W	T	
		6P1	+15P5					
0		8	23	14	1	0	20	
1		7	6	13		0	1	
2		7	6	13		0	0	
3		7	9	16		0	8	
4		7	9	13		0	2	
5		7	12	13		13	14	
6		6	2	24		0	29	
7		7	24	27		0	1	
8		7	16	9		0	30	
9		8	6	25		0	0	
10		8	8	25		0	3	
11		5	3	13		0	0	(1)X
12		7	12	28		7	4	
13		6	14	29		0	13	
14		5	12	18	1	0	3	
15		7	23	14	1	5	11	
16		5	24	14	1	0	11	
17		6	24	14	1	0	7	
18		8	13	16		0	19	
19		5	21	13		1	30	
20		8	3	27		8	2	
21		6	7	13		6	7	
22		7	13	28		0	1	
23		8	8	24		0	28	X
24		6	21	22	1	0	7	
25		6	14	25		0	0	
26		1	24	25		0	0	
27		6	23	14	1	0	20	
28		7	6	14		1	3	
29		5	30	12		22	24	
30		6	14	25		0	0	
31			P25-30					

D.L. 7 Track 15/7
Card Nos. 25-27 β field.

mc	A	NIS	S	D	C	W	T	
		7P1	+15P5					
0		6	4	15		0	22	
1		7	25	14		0	0	
2		8	13	15		0	0	
3		8	26	21		1	22.	
4		7	21	14		0	1	
5		7	21	22	1	1	8	
6		7	23	14	1	1	8	
7		7	25	14		0	0	
8		7	21	13		1	4	
9		7	30	21		0	1	
10		6	14	15		0	1	
11		8	12	13		1	18	
12		7	22	21	1	0	23	
13		8	12	21		5	3	
14		6	13	12		0	18	
15		7	14	21		0	0	
16		7	14	12		1	14	
17		6	24	14	1	0	11	
18		8	24	27		0	0	
19		7	12	26		0	2	
20		5	28	25		0	1	
21		6	8	24		0	21	
22		5	28	25	2	0	31	
23		8	28	26		0	20	
24		5	13	28		0	27	
25		6	14	29		0	28	
26		6	14	3		2	11	
27		7	0	14		0	28	
28		6	14	13		0	12	
29		6	9	14		0	6	
30		7	12	13		20	20	
31		5	1	1		0	24	