PDP-7 PROGRAM LIBRARY

1. IDENTIFICATION

1.1 Digital-7-20-10-FB PDP-7 DECTOG

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1.3 2-2-65

2. ABSTRACT

2.1 Purpose

To allow the user to perform various functions using DECtape and the toggle switches of a PDP-7 computer. The programs are designed to detect any errors in the DECtape Control. Separate binary tapes are available for either control 1 or for a second control.

General Description

The user simply sets the accumulator switches as required and starts the computer at the correct starting address for the particular program. The appropriate messages will be typed when the function is completed or when any error occurs. A brief description of each subroutine is given in the following paragraphs; however, a list of the current subroutines and their starting addresses follows:

	Starting Address	Mnemonic	Function
a)	100	TSTMM	Writes, reads, and compares up to 2000_8 words written from 3600.
b)	101	WRMKTR	Writes mark track and block mark numbers for unmodified controls with serial numbers 1 through 5.
c)	102	WRVIRG	Writes virgin tape in the forward direction.
d)	103	SUMF	Sum checks tape forward.
e)	104	SUMR	Sum checks tape in reverse.
f)	105	MMGEN	Generates 2000_8 words of desired pattern beginning at 3600.
g)	106	MMGENA	Generates 2000_8 words beginning at 3600 in arithmetic progression.
h)	107	MMWRT	Writes up to 2000_8 words from 3600.
i)	110	MMREAD	Reads up to 2000_8 words into core beginning at 5600.
j)	111	WRVIRR	Writes virgin tape in reverse direction.
k)	112	EXER	Exercises requested tapes by writing a virgin tape pattern and sum checking in both directions continuously.
l)	113	MMGENR	Generates 2000_8 random numbers beginning at 3600.
m)	114	ROCKER	Moves tape in both directions for constant time in variable modes.

	Starting Address	Mnemonic	Function
n)	115	BLROCK	Reads tape in both directions beginning at designated block number for constant number of blocks.
o)	116	RWMKTR	Revised mark track writer for PDP-compatible DECtapes (550 Control serial number 6 and higher). Used prior to WRNVT below.
p)	117	WRNVT	Second pass virgin tape program for revised mark track writer. (To be used for RWMKTR above, only.)
q)	120	STAP	Stop adjustment program. Provides suitable running and stopping delays for correct adjustment of DECtape delays.
r)	121	RBMN	Reads block numbers from requested tape into successive locations, beginning at 3600.
s)	122	SPEXER	Special exerciser. Operates as does the normal exerciser (see k) except that a predescribed pattern is written in place of the virgin tape pattern.

3. REQUIREMENTS

3.3 Equipment

Paper Tape Reader, Teleprinter, DECtapes

4. USAGE

4.5 Errors

1) All error messages except the compare error from the TSTMM program have the following format:

ERR XXX ZZZ (Y)*

where ERR is the code for the error, XXX is the block mark number of the block involved and ZZZ is the nine bits of the report of the DECtape status using the MMRS instruction. The bits can be interpreted as follows:

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*If an error occurs in the exerciser, Y will indicate the offending unit number (in octal).

Bit 0 = Data flag up
1 = Block flag up
2 = Error flag up
3 = End of tape
4 = Timing error
5 = Reverse
6 = Go
7 = Mark track error
8 = Unable

Error Codes are as follows:

FMT = Format Error. Check ACS (block number will indicate block requested).

NTF = Not found.

ERS = Error flag for other than end of tape, during search.

ERR = Error flag during reading.

SUM = Sum check error.

ERW = Error flag during writing.

BMW = Block mark read does not correspond to block mark predicted during writing.

BMC = Block mark read does not correspond to block mark predicted during sum checking.

INT = Program interrupt occurred from other than error or data flags of DECtape unit.

FLC = The block end flag occurred before or after 400 data flags had been found. Can occur only during writing virgin tape.* Register MMWA2 contains the count of the number of flags read; i.e., 400400 or 377377 etc.

NFL = No flags. Program has stopped receiving program interrupts from DECtape unit.

BUF = Contents of DECtape buffer were wrong after issuing MMWR command and checking by MMRD. Occurs during writing virgin tape only.

NWR = Actual check sums do not agree with predicted check sums using exerciser, indicating that probably nothing was written. In the exerciser, unit 10 (octal) will always appear with this message. Can also occur if for any reason the first block in a pass was not written (for example, NTF etc.).

NZB = No zero block. WRNVT could not successfully write the first zero block. Rerun WRNVT (see p).

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*Assuming 400_8 word blocks, FLC cannot occur if SPEXER is used.

2) Comparison errors will appear as follows:

CMP O ZZZ XXXXXX YYYYYY

where the first 3 words are as in 1) above, XXXXXX indicates the word written and YYYYYY indicates the word read. The block number indicators will always be zero.

3) When errors occur, the following registers may be of importance.

MMRVC	(3321)	The reverse check sum as read from the block.
MMRDC	(3320)	The forward check sum as read from the block.
MMCC	(3317)	The actual check sum calculated during reading. This should be 7777777.
MMWC	(3316)	The forward check sum as written on the tape during writing. This should agree with MMRDC if the same direction is used.
MMWDC	(3305)	The word count expressed as -N+1. After all words have been written or read, this should say +0.

NOTE: The forward check sum is the one read or written after the data and the reverse check sum is the one read or written before the data. Therefore, both are dependent on the direction being used.

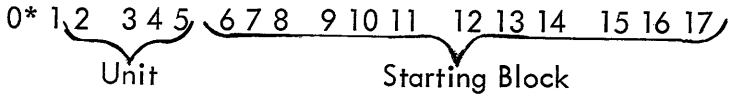
6. DESCRIPTION

a) TSTMM

Writes up to 2000_8 words beginning at 3600 into the indicated blocks in the forward direction, reads it back in the forward direction into 5600 and compares it against the original, word by word. Any error except a comparison error or a sum check error with $ACS_0 = 1$ will stop the program. In case of a comparison error, the program will continue until all words have been checked.

Use:

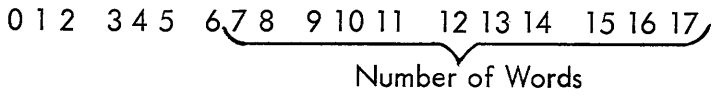
1) Set ACS as follows:



2) Start at 100

*If ACS Bit 0 = 1, sum check errors will be ignored.

3) At HLT set ACS as follows:



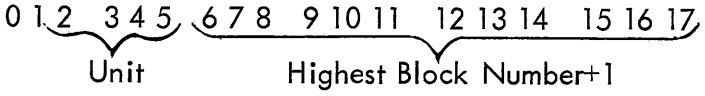
4) Press CONTINUE.

b) WRMKTR

Writes the timing and mark tracks and block mark numbers on the tape. (Note that block mark numbers will have the 6-bit mark track code in the high-order six bits. These must be ANDed out when reading block marks through a user's program.) The program can create blocks of various constant lengths. The tape must be placed as close as possible to the beginning of the reel, manually, before starting. This program should be used for unmodified DECtape controls serial numbered 1-5 only.

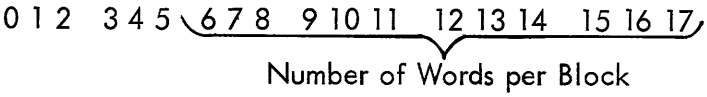
Use:

1) Set ACS as follows: Block number should indicate one higher than the highest block which can be found by the tape subroutines, i.e., if the routines should search for blocks up to 1100, the number 1101 should be used.



2) Start at 101.

3) At HLT, set ACS as follows to indicate the actual number of data words desired per block. (Do not confuse with the number of data marks per block.)



4) Press CONTINUE.

NOTE: This program will work only if the switch to allow writing on the mark track is on. The switch should be turned off immediately after the program is completed.

c) WRVIRG

Writes blocks with correct check sum, whose data portions consist of the numbers 0, 1001, 2002 etc., through 377377, in the forward direction on the tape.* Any error stops the program.

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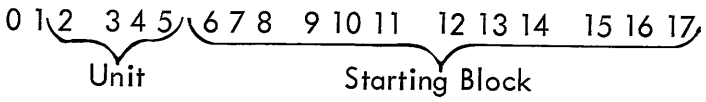
*If other than a 400_8 word block is written, the constant at MMVK (1756) must be changed so as to place the number of words desired in each half of the word. For example, for a 300_8 word block, make the constant 300300, etc. The check sum of a 400_8 word standard virgin tape block is 100100.

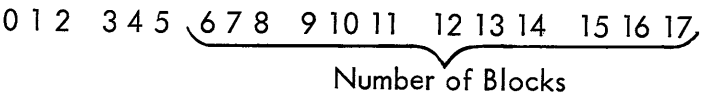
Use:

1) Set ACS as follows:



2) Start at 102.

3) When HLT occurs set ACS as follows:



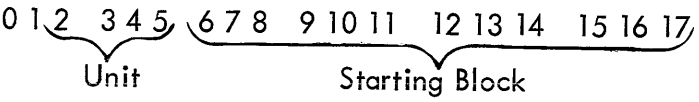
4) Press CONTINUE.

d) SUMF

Checks the validity of the data and block marks on the tape by sum checking the tape and checking the intervening block mark numbers in the forward direction. If an error occurs, the program will type a message and continue beginning with the next block until all indicated blocks have been read.

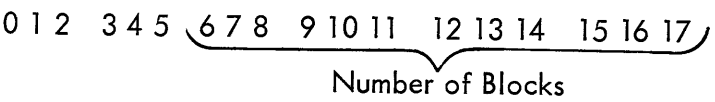
Use:

1) Set ACS as follows:



2) Start at 103.

3) When HLT occurs set ACS as follows:



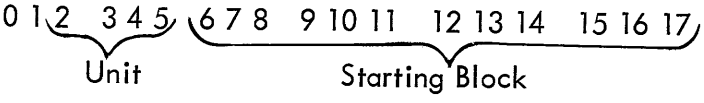
4) Press CONTINUE.

e) SUMR

Same as SUMF (see d) except that the tape is checked in reverse direction.

Use:

1) Set ACS as follows:



2) Start at 104.

3) When HLT occurs set ACS as follows:

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Number of Blocks

4) Press CONTINUE.

f) MMGEN

Will spread the pattern set in the ACS into memory from 3600 through 5577.

Use:

1) Set ACS to pattern desired.

2) Start at 105.

g) MMGENA

Spreads a pattern beginning with 0 and incremented by the contents of the ACS, into memory from 3600 to 5577. For example, if the ACS = 1, the numbers 0 through 1777 will be spread.

Use:

1) Set ACS to increment desired.

2) Start at 106.

h) MMWRT

Writes up to 2000_8 words in the forward direction from core locations 3600 through 5577.

Use:

1) Set ACS as follows:

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Unit Starting Block

2) Start at 107.

3) At HLT, set number of words to be written in ACS as follows:

(Max = 2000_8)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Number of Words

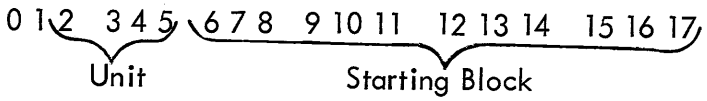
4) Press CONTINUE.

i) MMREAD

Reads up to 2000_8 words in the forward direction into core locations 5600 through 7577.

Use:

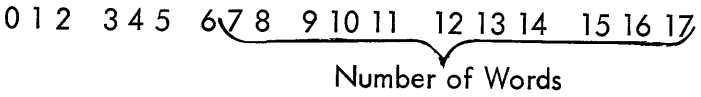
1) Set ACS as follows:



2) Start at 110.

3) At HLT, set number of words to read in ACS as follows:

(Max = 2000_8)



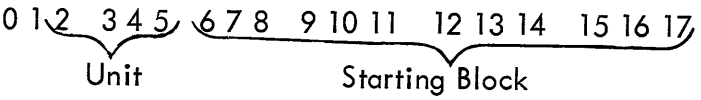
4) Press CONTINUE.

j) WRVIRR

Same as WRVIRG (see c) except that blocks are written in the reverse direction.

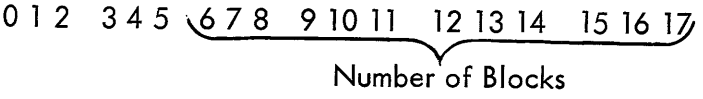
Use:

1) Set ACS as follows:



2) Start at 111.

3) When HLT occurs set ACS as follows:



4) Press CONTINUE.

k) EXER

Exercises a succession of tapes by writing modified virgin tape in the forward direction on all desired tapes, sum checking in the reverse direction on all tapes, sum checking in the forward direction on all tapes, writing modified virgin tape in the reverse direction on all tapes, sum checking in the forward direction on all tapes, and finally sum checking in

the reverse direction on all tapes. The entire cycle will be repeated continuously until ACS bit 0 is made a 1. A message is written at the end of each cycle giving the number of the cycle. The pattern written during each pass is incremented by the pass number. If an error occurs, the program will type a message and continue, beginning with the next block. All error messages will indicate the unit number at the end of the message. The NWR message will stop the program only if it occurs eight times.

Use:

1) Set ACS as follows:

0 1 2 3 4 5 (6 7 8 9 10 11 12 13 14 15 16 17)

Starting Block

2) Start at 112.

3) When HLT occurs set ACS as follows:

0 1 2 3 4 5 (6 7 8 9 10 11 12 13 14 15 16 17)

Number of Blocks

4) Press CONTINUE.

5) When HLT occurs, set AC switches 1-8 to a 1 to indicate which units numbered 1-8, respectively, are to be tested. For example, to exercise units 1-4 set only switches 1-4 to a 1; to exercise unit 3 only, set switch 3 to a 1 and all others to a 0. Any combination of bits may be used. Only bits 1-8 are examined. These switches can be reset at any time during the running of the program to add or delete units. If $ACS_0 = 1$, the program will stop at the end of a pass.

6) Press CONTINUE.

l) MMGENR

Spreads 2000_8 random numbers into locations 3600 through 5577. A different block will be created each time the program is used unless the program is reloaded or the location called RNK (1042) is reset to 736425.

Use:

1) Start at 113.

m) ROCKER

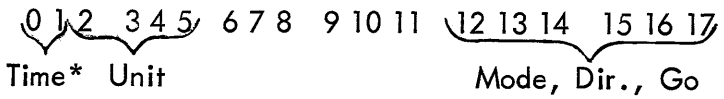
The program will move the tape in the mode indicated for multiples of approximately 5-second intervals in both directions. The switches can be changed at any time during the running of the program. The ERROR FLAG is cleared when a Block End Flag is detected.

Meaning of the AC bits:

12 = Go Flip-Flop On
13 = Reverse Flip-Flop On
14 = Not used
15 - 17 = Mode: 0 = Move
1 = Search
2 = Read
3 = Write
4 = Spare
5 = Read through block ends
6 = Write through block ends
7 = Write timing track

Use:

1) Set ACS as follows:



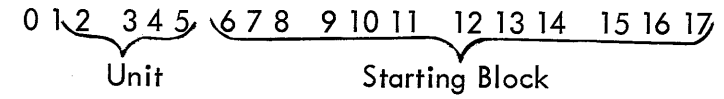
2) Start at 114.

n) BLROCK

Reads DECtape blocks beginning at the block specified, for a variable number of blocks in either direction. If end of tape is reached, repositioning at the starting block occurs automatically. All other errors are cleared when a Block End Flag is detected. Read Mode only, is used. To stop the program, set bit 0 of the ACS to 1.

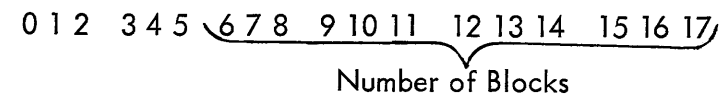
Use:

1) Set ACS as follows:



2) Start at 115.

3) At HLT, set ACS as follows:



4) Press CONTINUE.

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*00 = 5 seconds, 01 = 10 seconds, 10 = 15 seconds, 11 = 20 seconds approximately.

o) RWMKTR

For those tape controls using the revised bit format (serial number 6 and later), two new programs have been designed to write the mark track, virgin tape pattern, and to check the tape. These are described fully below: (WRMKTR should still be used for unmodified controls with serial numbers 1-5 as described in paragraph b, page 6.)

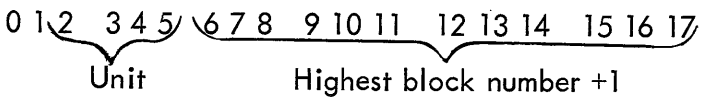
RWMKTR writes only the timing and mark tracks on the tape. The program can create any number of blocks of any desired constant length.

Use:

1) Place the reel as close as possible to the physical start of the tape.

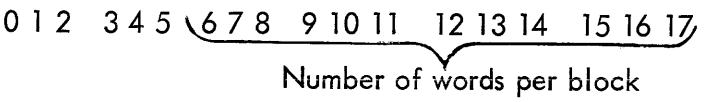
2) Set the switch which controls writing to ON.

3) Set ACS, as follows, to one higher than the highest block number to be legally found by the subroutines:



4) Start at 116.

5) At HLT, set ACS as follows to indicate the actual number of data words per block:



6) Press CONTINUE.

7) When program is finished, turn mark track switch off, remount tape if necessary, and continue with the virgin tape program (WRNVT) explained below.

p) WRNVT

Used to write the virgin tape pattern and the block mark numbers on a tape with a newly created timing and mark track. This program should never be used except after RWMKTR above. It is not a normal virgin tape program, but one which writes through block ends. After the block mark numbers and virgin tape have been written in the forward direction, the tape is automatically sum checked in reverse, showing all errors. In addition, the first block on the tape is rewritten to guarantee a 0 as the first block mark number. (There are two blocks numbered 0 at the front of the tape.)

Use:

1) Set ACS as follows:

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Unit

2) Start at 117.

3) The block mark track will be used to determine the length of each block, and the end of tape will be used to determine the number of blocks. Since block mark numbers are now put on in a second pass, it is no longer necessary to AND out bits 0-5 when reading block mark numbers produced with this program.

q) STAP

The program allows visual inspection and manual regulation of the DECtape Stop Adjustment by the following routine: If $ACS_0 = 0$ the tape will move forward (in move mode) from its present position for 1 second, stop for 1 second, move in reverse for 1 second, stop for 1 second, then repeat the cycle.

If $ACS_0 = 1$, the tape will move forward for 0.12 seconds, stop for 1 second, move in reverse for 0.12 seconds, stop for 1 second, then repeat the cycle.

Use:

1) Set ACS as follows:

0* 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Unit

2) Start at 120.

Any of the accumulator switches can be changed at any time. Care should be taken that the tape unit used is not presently in the end zones, as stopping will be premature.

r) RBMN

Rewinds the indicated tape unit, then searches forward reading all block mark numbers and placing them (without masking) in successive locations beginning at 3600. When the forward end of the tape is reached, the remainder of the area up through 7577 is filled with minus zeros (777777), thus making clear what the last block mark number found was. The area can be checked by using the Examine Key. For the standard tape, the first block number 0 will be in location 3600 and number 1101 will be in location 4702.

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*Move for 0.12 second if on.

Use:

1) Set ACS as follows:

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Unit

2) Start at 121.

s) SPEXER

This special exercise program operates for the most part as does the normal exercise program (see k) except for the following differences:

1) The user must generate the pattern to be written rather than use the standard virgin tape pattern.

2) The check for flag count errors (FLC) is omitted as it depends on a check of the pattern used.

Use:

1) Generate the pattern desired by using MMGEN (see f), MMGENA (see g) or MMGENR (see l). If no pattern is generated, the block written will contain the information currently in memory beginning at location 3600.

2) Set ACS as follows:

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Starting Block

3) Start at 122.

4) When HLT occurs, set ACS as follows:

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Number of Blocks

5) Press CONTINUE.

6) When HLT occurs, set Accumulator switches, bits 1-8, to a 1 to indicate which units numbered, 1-8 respectively, are to be tested. For example, to exercise units 1-4, set bits 1-4 only to a 1, to exercise units 1, 3, 5 and 8, set bits 1, 3, 5 and 8 to a 1 etc. Any combination of bits may be used. These switches can be reset at any time during the running of the program to add or delete units. Only bits 1-8 are examined. If $ACS_0 = 1$, the program will stop at the end of a pass.

7) Press CONTINUE.

9. PROGRAM

9.4 Listing

```
EWIN
          DECTOG
MMAUTO=17
21/
          CLA
          MMLC
          TIN
          LAW MSG1
          TSR
          LAC 20
          TAD (-0)
          AND (7777)
          JMS TWZ6
X1,       HLT
          JMP .-1
50/
          CLA
          MMLC
          JMP X1
DISMIS=JMP .
          LAC 0
          RAL
          LAC A#CSAVE
          ION
          JMP I 0
100/
          JMP TSTMM /READ, WRITE AND CHECK BLOCKS, 100
          JMP WRMKTR          /WRITE MARK TRACK, 101
          JMP WRVIRG          /WRITE VIRGIN TAPE, 102
          JMP SUMF  /SUMCHECK FWD, 103
          JMP SUMR  /SUMCHECK REV, 104
          JMP MMGEN /GENERATE 1 PATTERN BLOCKS, 105
          JMP MMGENA          /GENERATE ASCENDING BLOCKS, 106
          JMP MMWRT /WRITE BLOCKS, 107
          JMP MMREAD          /READ BLOCKS, 110
          JMP WRVIRR          /WRITE VIRGIN TAPE REVERSE, 111
          JMP EXER  /WVF,SCR,SCF,WVR,SCF,SCR, 112
          JMP MMGENR          /GENERATE RANDOM BLOCKS, 113
          JMP ROCKER          /MOVES TAPE IN TWO DIRECTIONS FOR FIXED TIME
          JMP BLROCK          /READS TAPE BIDIRECTIONALLY FOR FIXED LENGTH
          JMP RWMKTR          /REVISED MARK TRACK WRITER, 116
          JMP WRNVT /VIRGIN TAPE FOR NEW TAPE ONLY,  117
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          JMP STAP  /STOP ADJUSTMENT PROGRAM, 120
          JMP RBMN  /RECORD BLOCK MARK NUMBERS, 121
          JMP SPEXER          /EXERCISE WITH PREDETERMINED PATTERN, 122

130/
/TEST DECTAPE SUBROUTINES
MMWRA=3600
MMRDA=MMWRA+2000
TSTMM,    JMS CLRFLG
          LAS       /SELECTION AND BLOCK NUMBER
          DAC #K1
          DAC TSTMM2
          DAC TSTMM3
          SMA
          JMP .+3
          LAC (JMP MMRD4+10)
          DAC MMOD1+6
          JMS TSTNWD          /PICK UP NUMBER OF WORDS
          LAC C1
          CMA
          ADD (MMWRA)
          DAC TSTMM2+2
          ADD (MMRDA-MMWRA)
          DAC TSTMM3+2
          JMS MMWRS
          LAC K1    /BLOCK NUMBER
          JMP TSTMM6          /ERROR RETURN
TSTMM2,   0         /UNIT SELECTION
          MMWRA
          0         /CORE END
          JMS TSTMM8          /MULTI-PROGRAM
          JMS MMRDS
          LAC K1    /BLOCK NUMBER
          JMP TSTMM6          /ERROR RETURN
TSTMM3,   0         /UNIT SELECTION
          MMRDA     /CORE START
          0         /CORE END
          JMS TSTMM8          /MULTI-PROGRAM
          LAW MMWRA-1
          DAC 10
          LAW MMRDA-1
          DAC 11
          LAC C1
          DAC #C2
TSTMM4,   LAC I 10
          SAD I 11
          SKP
```

```
            JMP TSTMM7          /COMPARE ERROR
            ISZ C2
            JMP TSTMM4
            JMS TYPEND
            LAS
            SMA
            JMP X1      /DONE
            JMS LWRFLG
            JMP TSTMM2-3

TSTMM6,     JMS DECERR
            JMP X1

TSTMM7,     LAW
            JMS DECERR
            TSP
            LAC 10
            DAC #C3
            LAC I C3
            JMS TW6
            TSP
            LAC 11

            DAC C3
            LAC I C3
            JMS TW6
            JMP TSTMM4+4        /CONTINUE

TSTMM8,     0
            LAC MMWA1
            ISZ IF
            JMP .+4
            IOF
            LAW 1300
            JMP MMERRX-1
            ISZ MMDONE
            JMP TSTMM8+1
            IOF
            JMP I TSTMM8
/FOR INTERRUPT
TSTMM9,     DAC ACSAVE
            DZM IF
            MMEF
            SKP
            JMP MMERR
            MMDF
            SKP
            JMP MMDATA
            LAW 1100
            JMP MMERRX-1
```

```
/CONSTANTS AND SUBROUTINES
.TYPOK,     0
            TIN
            LAC (FLEX OK )
            TY3
            JMP I TYPOK
TYPEND,     0
            TIN
            LAC (FLEX END)
            TY3
            JMP I TYPEND
ERRTAB,     FLEX CMP   FLEX FMT   FLEX NTF
            FLEX ERS   FLEX ERR   FLEX SUM
            FLEX ERW   FLEX BMW   FLEX BMC
            FLEX INT   FLEX FLC   FLEX NFL
            FLEX BUF   FLEX NWR
ERRTAB+30/
DECERR,     0
            DAC ERRWA
            SAD (LAW)
            DZM MMWA1
            SAD (LAW 100)
            JMP .+4
            SAD (LAW 200)
            SKP
            JMP .+3
            LAC MMBLKM
            DAC MMWA1
            TIN
            LAC ERRWA
            RTR
            RTR
            RTR
            AND (77)
            ADD (LAC ERRTAB)
            DAC .+1
ERRWA,      LAC ERRTAB          /MODIFIED
            TY3
            TSP
            LAC MMWA1
            JMS TWZ6
            TSP
            LAC MMRSA
            TWORD
            3
            JMP I DECERR
```

```
TW6,        Ø
            TWORD
            6
            JMP I TW6
TW≠6,       Ø
            TWORD≠
            6
            JMP I TW≠6
MSG1,       FLEX CAL  FLEX  FR  FLEX M T-2

/WRITE VIRGIN TAPE
WRVIRG,     LAC (JMS MMVT)
            DAC WRV1-2
            JMS CLRFLG
            LAS         /UNIT SELECTION AND BLOCK NUMBER
            DAC K1
            DAC WRV1+2
            HLT
            LAS         /NUMBER OF BLOCKS
            AND (7777)
            CMA
            ADD (1)
            DAC WRV1
            LAC (1ØØ1)
            JMS GENRLA
            Ø           /NUMBER TO START AT

            JMS MMVT
            LAC K1      /BLOCK
WRV1,       Ø           /NO OF BLOCKS
            JMP TSTMM6            /ERROR
            Ø           /UNIT
            JMS TSTMM8
WRV2,       JMS TYPOK
            JMP X1

WRVIRR,     LAC (JMS MMVTR)
            JMP WRVIRG+1

/SUM CHECK PROGRAMS
SUMF,       LAC (JMS MMSCF)
            DAC SUMF1
            JMS CLRFLG
            LAS         /UNIT AND BLOCK NUMBER
            DAC SUMF1+4
            AND (7777)
            DAC K1
            HLT
```

```
                LAS         /NUMBER OF BLOCKS
                AND (7777)
                CMA
                ADD (1)
                DAC SUMF1+2
SUMF1,          JMS MMSCF /OR MMSCR, MODIFIED
                LAC K1      /BLOCK
                Ø           /NUMBER OF BLOCKS, -N+1
                JMP SUMF2 /ERROR
                Ø           /UNIT
                JMS TSTMM8
SUMF1A,         JMS TYPEND
                JMP X1
SUMF2,          JMS DECERR
                LAC MMWA1
                CMA
                ADD K1
                SPA
                CMA
                ADD SUMF1+2
                ADD (1)
                SMA
                JMP SUMF1A
                DAC SUMF1+2
                LAC MMWA1
                TAD MMSCFK
                DAC K1
                JMS LWRFLG
                JMP SUMF1
SUMR,           LAC (JMS MMSCR)
                JMP SUMF+1

/GENERATE BLOCKS
MMGEN,          LAC (CLA)
                DAC MMGEN1
                LAC (LAS)
                DAC MMGEN1-3
                LAW MMWRA-1
                DAC MMAUTO
                LAM -MMRDA+MMWRA+1
                DAC MMWA2
                LAS
                DAC MMWA1
                DAC I MMAUTO
MMGEN1,         CLA         /OR LAS
                ADD MMWA1
                DAC MMWA1
                ISZ MMWA2
                JMP MMGEN1-1
                JMP WRV2
```

```
MMGENA,    LAC (LAS)
           DAC MMGEN1
           LAC (CLA)
           JMP MMGEN+3

/READ BLOCKS
MMREAD,    LAC (JMS MMRDS)
           DAC MREAD2
           LAW MMRDA
           DAC MREAD2+4
           LAS         /UNIT AND BLOCK NUMBER
           DAC MREAD2+3
           JMS TSTNWD            /PICK UP NO OF WDS
           LAC C1
           CMA
           ADD MREAD2+4
           DAC MREAD2+5
           JMS CLRFLG

MREAD2,    JMS MMRDS /OR JMS MMWRS
           LAC .+2   /BLOCK NUMBER
           JMP TSTMM6            /ERROR
           0         /UNIT
           LAW MMRDA /OR LAW MMWRA, CORE START
           0         /CORE END, MODIFIED

           JMS TSTMM8
           JMP WRV2

/WRITE BLOCKS
MMWRT,     LAC (JMS MMWRS)
           DAC MREAD2
           LAW MMWRA
           JMP MMREAD+3


/CLEAR FLAGS, SET UP INTERRUPT, AND MODIFY READ AND WRITE RTNES
CLRFLG,    0
           IOF         DCF         CRRB
           CPCF        LPCF        LSCF
           700102      PCF         KRB
           TCF         MSI         CLOF
           CLA         707604      701604     /MMLC FOR 1ST AND 2ND CONTROLS
           LAC (JMP MMMOD1)
           DAC MMRD2-1
           LAC (JMP MMMOD1+3)
           DAC MMRD4+3
           LAC (JMP MMMOD1+7)
```

```
                DAC MMWR4+4
                LAC (JMP TSTMM9)
                DAC 1
                DZM #IF
                LAC (LAC MMVK)
                DAC MMVWR3+10
                LAC (JMP MMRD4+4)
                DAC MMMOD1+6
                LAC (JMS TYPEND)
                DAC SUMF1A
                JMP I CLRFLG

MMMOD1,         DAC MMSUM
                DAC M#MRVC
                JMP MMRD2

                DAC M#MRDC
                ADD MMSUM
                DAC M#MCC
                JMP MMRD4+4             /OR JMP MMRD4+10

                DAC M#MWC
                MMWR
                JMP MMWR4+5

TSTNWD,         0
                HLT
                LAS         /NUMBER OF WORDS
                AND (7777)
                CMA
                ADD (1)
                DAC #C1
                ADD (MMRDA-MMWRA)
                SMA         /TOO MANY WORDS
                JMP I TSTNWD
                LAM -MMRDA+MMWRA+1
                JMP .-5

MMOD1=MMMOD1

START


                CONSECUTIVE UNIT EXERCISER
EXER,           JMS CLRFLG
                LAC (JMP MVT2)
                DAC MMVWR3+10
                LAC (JMS GENBLA)
                DAC EXER1+3
                LAS         /BLOCK NUMBER
```

```
        AND (7777)
        DAC C2
        HLT
        LAS         /N
        AND (7777)
        DAC C3
        CMA
        ADD (1)
        DAC E#X1
        LAC C2
        ADD C3
        TAD (-Ø)
        DAC C3      /ENDING BLOCK
        DƵM TYPOK
        LAM -7
        DAC W#A6
        HLT         /SET UP UNITS TO WORK ON

EXER1,  LAC TYPOK
        DAC .+3
        LAC (1ØØ1)
        JMS GENBLA
        Ø           /MODIFIED, NUMBER TO START WITH

        LAC (JMS EXVT)
        JMS CONSEC
        LAC (JMS SUMSBR)
        JMS CONSEC
        JMS MWRCHK
        LAC (JMS SUMSBF)
        JMS CONSEC

        LAC (JMS EXVTR)
        JMS CONSEC
        LAC (JMS SUMSBF)
        JMS CONSFC
        JMS MWRCHK
        LAC (JMS SUMSBR)
        JMS CONSEC

        ISZ TYPOK
        JMS TYPEND
        TSP
        LAC TYPOK
        JMS TWƵ6

        LAS
        SPA
        JMP X1
        JMS LWRFLG
        JMP EXER1
```

```
CONSEC,   Ø
          DAC CONSC2
          LAM -7
          DAC W#A4
          LAS
          DAC W#A5
          CLA
CONSC1,   ADD (1ØØØØ)
          DAC SUMSBF+13
          LAC WA5

          RAL
          DAC WA5
          SPA
CONSC2,   JMS        /MODIFIED
          LAC SUMSBF+13
          ISZ WA4
          JMP CONSC1
          JMP I CONSEC

SUMSBF,   Ø
          LAC (JMS MMSCF)
          DAC .+5
          LAC C2
          DAC K1
          LAC EX1
          DAC .+3
          JMS MMSCF /OR MMSCR, MMVT, MMVTR
          LAC K1    /BLOCK NUMBER
          Ø         /-N+1
          JMP EXERR /ERROR
          Ø         /UNIT
          JMS TSTMM8
          JMP I SUMSBF

SUMSBR,   Ø
          LAC .-1
          DAC SUMSBF
          LAC (JMS MMSCR)
          DAC I SUMSBF+2
          LAC C3
          JMP SUMSBF+4

EXVT,     Ø
          LAC .-1
          DAC SUMSBF
          LAC (JMS MMVT)
          JMP SUMSBF+2
```

```
EXVTR,      0
            LAC .-1
            DAC SUMSBF
            LAC (JMS MMVTR)
            JMP SUMSBR+4

LWRFLG,     0
            TSF
            JMP .-1
            TCF
            JMP I LWRFLG

EXERR,      JMS DECERR
            TSP
            LAC SUMSBF+13
            TWORDZ
            2
            LAC MMWA1
            CMA
            ADD K1
            SPA
            CMA
            ADD SUMSBF+11
            ADD (1)
            SMA
            JMP .+7    /DONE IN THIS DIRECTION


            DAC SUMSBF+11
            LAC MMWA1
            TAD MMSCFK
            DAC K1
            JMS LWRFLG
            JMP SUMSBF+7

            JMS LWRFLG
            JMP I SUMSBF

RN,         0
            LAC RNK
            CLL!RAR
            SZL
            XOR (400000)
            XOR (335671)
            ADD (335671)
            DAC RNK
            JMP I RN
RNK,        736425
```

```
MMGENR,     LAW MMWRA-1             DAC MMAUTO
            LAM -MMRDA+MMWRA+1
            DAC MMWA2
            JMS RN
            DAC I MMAUTO
            ISZ MMWA2
            JMP .-3
            JMP WRV2

MWRCHK,     Ø
            LAC MMRVC
            SAD MMWC
            JMP I MWRCHK
            LAC (JMP X1)
            ISZ WA6
            LAC .-3
            DAC MVT2-1
            LAW 1500  /NWR
            JMS DECERR
            TSP
            LAC SUMSBF+13
            TWORDZ
            2
            JMS LWRFLG
            JMP I MWRCHK            /OR JMP X1

MVT2,       LAC TYPOK
            ADD MMVK
            JMP MMVWR3+11

/INTERNAL BLOCK GENERATORS

/GENERATE BLOCKS WITH SAME CONTENTS
/FORMAT     LAC CONTENTS
/           JMS GENBL

GENBL,      Ø
            DAC MMWA1
            LAM -MMRDA+MMWRA+1
            DAC MMWA2
            LAW MMWRA-1
            DAC MMAUTO
            LAC MMWA1
            DAC I MMAUTO
            ISZ MMWA2
            JMP .-2
            JMP I GENBL
```

```
/GENERATE BLOCKS IN ARITHMETIC PROGRESSION
/FORMAT   LAC FACTOR            /NUMBER TO ADD
/         JMS GENBLA
/         X           /NUMBER TO START WITH

GENBLA,   Ø


          DAC MMWA1
          LAM -MMRDA+MMWRA+1
          DAC MMWA2
          LAW MMWRA-1
          DAC MMAUTO
          LAC I GENBLA
          DAC I MMAUTO
          ADD MMWA1
          ISZ MMWA2
          JMP .-3
          ISZ GENBLA
          JMP I GENBLA

SPEXER,   JMS CLRFLG
          LAC MMVWR3+12
          DAC MMVWR3+1Ø
          LAC (SKP)
          JMP EXER+4

START


          ROCKER PROGRAM
ROCKER,   JMS CLRFLG
          DZM C1
          JMS MMWAIT
          LAS
          XOR C1
          MMSE
          MMLC
          RAL
          RTL
          AND (3)
          CMA
          DAC C3
```

```
ROCK1,    LAC (DECIMAL -89285 OCTAL)    /56 US LOOP
          DAC C2
          MMBF
          JMP .+5
          MMEF
          JMP .+3
          LAS
          MMSE
          MMDF
          SKP
          MMRD
          ISZ C2
          JMP ROCK1+2
          ISZ C3
          JMP ROCK1

          LAC C1
          XOR (2Ø)  /CHG DIRECTION
          DAC C1
          JMP ROCKER+2

/ROCK FOR CONSTANT NUMBER OF BLOCKS
BLROCK,   JMS CLRFLG
          DZM C1
          LAS       /UNIT AND BLOCK NUMBER
          DAC BLRCK1
          HLT
          LAS       /NUMBER OF BLOCKS
          AND (7777)
          CMA
          ADD (1)
          DAC C2    /BLOCK COUNTER
BLRCKA,   CLA
          MMLC
          JMS MMSCH1
          LAC .+3   /BLOCK NUMBER
          JMP .-2   /ERROR, SEARCH AGAIN
          DISMIS
BLRCK1,   Ø         /UNIT
          LAC MMWA1 /PRESENT BLOCK LOCATION
          ISZ MMDONE
          JMP .-2

          IOF
BLRCK2,   LAC C2
          DAC C3
          LAW 42    /READ FORWARD
          XOR C1    /GET DIRECTION
          MMLC      /READ FORWARD OR REVERSE
BLRCK3,   MMEF
          SKP
```

```
            JMP BLRCK5          /ERROR FLAG
            MMDF
            SKP
            MMRD
            MMBF
            JMP BLRCK3
            MMRD
            MMEF
            JMP .+3
            LAC BLRCK1
            MMSE
            ISZ C3
            JMP BLRCK3

BLRCK4,     LAS
            SPA
            JMP 50
            LAC C1
            XOR (20)
            DAC C1
            JMP BLRCK2

BLRCK5,     MMRS
            AND (40000)
            SAD (40000)         /EOT
            JMP BLRCKA          /REPOSITION TAPE
            JMP BLRCK3+3
START

PDP-7 DECTAPE SUBROUTINES, CONTROL 1,  LMH  12-2-64
/PDP-7 DECTAPE SEARCH SUBROUTINE
/DISMIS MUST BE DEFINED AS JMP TO DISMISS INTERRUPT ROUTINE

MMWR=707504
MMLC=707604
MMSE=707644
MMRS=707612
MMDF=707501
MMBF=707601
MMEF=707541
MMRD=707512
SKP7=703341

/FORMAT     JMS MMSCH /OR MMSCH1 OR MMSCHR
/           LAW B     /OR LAC (B), BLOCK NUMBER
/           JMP X     /ERROR RETURN
/           JMP Y     /SEARCH COMPLETED RETURN
/           ZZ0000    /UNIT SELECTION
/           MULTI-PROGRAM RETURN
```

```
/LEAVE IN SEARCH REVERSE MODE
MMSCHR,   Ø
          LAC .-1
          DAC MMSCH1
          LAC (JMP MMSCH6+2)
          DAC MMSCH3+1
          CLA
          JMP MMSCH1+4

/LEAVE IN FORWARD DIRECTION WITH TAPE STOPPED
MMSCH,    Ø
          LAC .-1
          DAC MMSCH1
          LAC (JMP MMSCH6)
          JMP MMSCH1+2

/LEAVE IN SEARCH FORWARD MODE
MMSCH1,   Ø
          LAC (JMP MMSCH6+2)
          DAC MMSCH3+1
          CLC
          DAC M#MSRK
          TAD (1)
          DAC M#MSFK
          LAW 61
          DAC M#MWA3          /CURRENT DIRECTION
          XCT I MMSCH1        /PICK UP BLOCK NUMBER
          ISZ MMSCH1          /POINTS TO ERROR RETURN
          AND (7777)
          DAC M#MBLKM         /BLOCK TO SEARCH FOR
          SNA
          JMP MMSCH4
          ADD MMEK
          SMA
          JMP MMSCH4          /FORMAT ERROR
          LAM -7
          DAC M#MSUM          /CHG OF DIRECTION COUNTER
          LAC I MMSCH1        /ERROR RETURN
          DAC MMERRX
          ISZ MMSCH1
          LAC I MMSCH1        /COMPLETION RETURN
          DAC MMSCH7
          ISZ MMSCH1
          JMS MMWAIT          /CHECK IF DELAY IS NECESSARY
          LAC I MMSCH1        /UNIT SELECTION
```

```
          MMSE
          ISZ MMSCH1          /POINTS TO MULTI-PROGRAM RETURN
          LAC (NOP)
          DAC MMSAVE
          ION
MMTURN,   ISZ MMSUM
          JMP MMERRX+2
          LAW 200   /NOT FOUND
          JMP MMEK+1
MMERRX,   JMP .     /ERROR EXIT
          HLT                 /ERROR EXIT WAS NOT JMP INSTR
          LAW 41
          SAD MMWA3
          JMP MMREV
          DAC MMWA3
          MMLC
          LAC (SMA)
          DAC MMSCH2
          LAC MMBLKM
          TAD MMSFK
          DAC M#MWA2          /BLOCK TO LOOK FOR IN THIS DIRECTION
          DZM M#MDONE
MMSAVE,   NOP       /OR DISMIS
          LAC (DISMIS)
          DAC MMSAVE
          JMP I MMSCH1        /CONTINUE MULTI-PROGRAMMING
MMREV,    LAW 61
          DAC MMWA3
          MMLC
          LAC (SPA)
          DAC MMSCH2
          LAC MMBLKM
          TAD MMSBK
          JMP MMSAVE-2
MMERR,    MMPS
          AND (40000)
          SAD (40000)
          JMP MMTURN
          LAW 300             /NON-EOT ERROR DURING SEARCH
          JMP MMERRX-1
MMDATA,   MMRD
          AND (7777)
          DAC M#MWA1
          SAD MMWA2
          JMP MMSCH3
          CMA
          ADD MMWA2
```

```
MMSCH2,   SMA                     /OR SPA FOR REVERSE
          JMP MMSAVE-1            /KEEP GOING
          JMP MMTURN              /TURN AROUND
MMSCH3,   SAD MMBLKM
          JMP MMSCH6              /OR MMSCH6+2
          JMP MMTURN
MMSCH4,   LAW 100                 /FORMAT ERROR
          MMLC
          JMP I MMSCH1
MMSCH5,   LAW 100
          JMP MMERRX-1            /FORMAT ERROR
MMSCH6,   CLA
          MMLC
          CLC
          DAC MMDONE
MMSCH7,   JMP .                   /EXIT
MMEK,     DECIMAL -576 OCTAL



          DAC MMSCH
          MMRS
          DAC M#MRSA
          LAC MMSCH
          MMLC
          JMP MMERRX

/35 MILLISECOND SELECT DELAY LOOP
MMWAIT,   0
          XCT I MMWAIT            /PICK UP SELECT
          AND (170000)            /CHECK SELECT ONLY
          SAD MMCHK-1
          JMP I MMWAIT            /SAME SELECT
          DAC MMCHK-1             /SAVE SELECT
          CLA
          MMSE                    /SELECT UNIT ZERO
          LAM DECIMAL -5000 OCTAL
          SKP7                    /IS THIS A PDP-7?
          LAM DECIMAL -1094+1 OCTAL     /COUNT 35 MS
          DAC MMSCH
          ISZ I .-1
          JMP .-1
          JMP I MMWAIT
          0                       /SAVE SELECTION
```

```
/PDP-7 DECTAPE READ AND WRITE FORWARD SUBROUTINES
/USES AUTO-INDEX REGISTER NAMED MMAUTO WHICH MUST BE DEFINED

/COMMON ROUTINE FOR PICKING UP CONSTANTS AND SEARCHING FOR BLOCK
MMCHK,    0
          ADD (-1)
          DAC MMAUTO
          LAC I MMAUTO          /BLOCK NUMBER
          DAC MMCHK1+1
          LAC I MMAUTO          /ERROR RETURN
          DAC MMERRX
          DAC MMCHK1+2
          LAC I MMAUTO          /UNIT SELECTION
          DAC MMCHK1+4
          CLC
          TAD I MMAUTO          /STARTING ADDRESS
          AND (17777)
          DAC M#MWA4
          CLC
          TAD I MMAUTO          /ENDING ADDRESS
          AND (17777)
          CMA
          ADD MMWA4
          SMA
          JMP MMSCH5            /ILLEGAL FORMAT
          DAC M#MWDC            /WORD COUNT
MMCHK1,   JMS MMSCH1
          LAW .                 /BLOCK NUMBER, MODIFIED
          JMP .                 /ERROR RETURN, MODIFIED
          JMP MMCHK2            /END RETURN
          0                     /UNIT SELECTION, MODIFIED
          JMP I MMAUTO          /MULTIPROCESS WITH MAIN PROGRAM
MMCHK2,   LAC MMWA4
          DAC MMAUTO
          LAC (DISMIS)
          DAC MMSCH7
          JMP I MMCHK


/DECTAPE READ SUBROUTINE
/FORMAT   JMS MMRDS
/         LAW B                 /OR LAC (B), BLOCK NUMBER
/         JMP X                 /ERROR RETURN
/         ŻŻ0000                /UNIT SELECTION
/         C1                    /CORE STARTING ADDRESS
/         C2                    /CORE ENDING ADDRESS, INCLUSIVE
/         MULTI-PROGRAM RETURN
```

```
MMRDS,    0
          LAC MMRDS
          JMS MMCHK
          LAW 42                  /READ FORWARD
          MMLC
          LAC (DAC I MMAUTO)
          DAC MMRD3
MMRD1,    MMEF
          JMP .+3
          LAW 400                 /ERROR FLAG DURING READING
          JMP MMERRX-1
          MMDF
          JMP MMRD1
          MMRD
          DAC MMSUM
MMRD2,    MMEF
          SKP
          JMP MMRD1+2             /ERROR FLAG DURING READING
          MMDF
          JMP MMRD4
          MMRD
MMRD3,    DAC I MMAUTO            /OR NOP
          ADD MMSUM
          DAC MMSUM
          ISZ MMWDC
          JMP MMRD2
          LAC (NOP)
          DAC MMRD3
          JMP MMRD2
MMRD4,    MMBF
          JMP MMRD2
          MMRD
          ADD MMSUM
          SAD (-0)
          JMP .+3
          LAW 500                 /SUM CHECK READING
          JMP MMERRX-1
          ISZ MMWA1 /UPDATE CURRENT BLOCK ADDRESS
          LAC (DAC I MMAUTO)
          SAD MMRD3
          JMP MMRD1
          JMP MMSCH6              /GOOD EXIT
```

/DECTAPE WRITE SUBROUTINE

```
/FORMAT   JMS MMWRS
/         LAW B      /OR LAC (B), BLOCK NUMBER
/         JMP X                   /ERROR RETURN
/         ZZ0000                  /UNIT SELECTION
/         C1                      /CORE STARTING ADDRESS
```

```
/           C2                      /CORE ENDING ADDRESS, INCLUSIVE
/           MULTI-PROGRAM RETURN

MMWRS,      Ø
            LAC MMWRS
            JMS MMCHK
            LAC (LAC I MMAUTO)
            DAC MMWR3
MMWR1,      CLC
            DAC MMSUM
            LAW 43                  /WRITE FORWARD
            MMLC
MMWR2,      MMEF
            JMP .+3
            LAW 6ØØ                 /ERROR FLAG DURING WRITING
            JMP MMERRX-1
            MMDF
            JMP MMWR4
MMWR3,      LAC I MMAUTO            /OR CLA
            MMWR
            ADD MMSUM
            DAC MMSUM
            ISZ MMWDC
            JMP MMWR2
            LAC (CLA)
            DAC MMWR3
            JMP MMWR2
MMWR4,      MMBF
            JMP MMWR2
            LAC MMSUM
            CMA
            MMWR
            LAW 41                  /SEARCH FORWARD
            MMLC
            MMEF
            SKP
            JMP MMWR2+2             /ERROR DURING WRITING
            MMDF
            JMP .-4
            MMRD
            ISZ MMWA1 /UPDATE CURRENT BLOCK ADDRESS
            AND (7777)
            SAD MMWA1
            JMP .+3
            LAW 7ØØ                 /BLOCK MARK ERROR DURING WRITING
            JMP MMERRX-1
            LAC (LAC I MMAUTO)
            SAD MMWR3
            JMP MMWR1
            JMP MMSCH6              /GOOD EXIT
START
```

DECTAPE VIRGIN TAPE AND SUMCHECK ROUTINES

```
/VIRGIN TAPE SUBROUTINE
/FORMAT    JMS MMVT   /OR MMVTR
/          LAW B      /OR LAC (B), BLOCK NUMBER
/          -N+1       /NUMBER OF BLOCKS
/          JMP X      /ERROR RETURN
/          ŻŻØØØ      /UNIT SELECTION
/MULTIPROGRAM RETURN

MMVT,      Ø
           LAC (JMS MMVCHK)
           DAC MMVWR1-1
           LAC (1)
           DAC MMSCFK
           LAW 41     /SEARCH FWD
MMVTR2,    DAC MMVWR3+6
           ADD (2)
           DAC MMVWR1
           LAC MMVT
           JMS MMVCHK          /OR MMVCHR
MMVWR1,    LAW 43     /WRITE FWD OR WRITE REV
           MMLC
           CLC
           DAC MMSUM
           LAC (SAD MMWRA-1)
           DAC MMAUTO
MMVWR2,    LAC I MMAUTO
           MMEF
           JMP .+3
           LAW 6ØØ.   /ERW, ERROR DURING WRITING
           JMP MMERRX-1
           MMDF
           JMP MMVWR3
           MMWR
           MMRD       /CHECK IF BUFFER IS CORRECT
           XCT MMAUTO
           JMP .+3
           LAW 14ØØ   /BUF, BUFFER INCORRECT
           JMP MMERRX-1
           ADD MMSUM
           DAC MMSUM
           JMP MMVWR2
MMVWR3,    MMBF
           JMP MMVWR2+1
           LAC MMSUM
           CMA
```

```
            DAC MMWC
            MMWR
            LAW 41      /SEARCH FORWARD OR REVERSE
            MMLC
            LAC MMVK   /MODIFIED BY EXERCISERS
            XCT MMAUTO
            JMP .+3
            LAW 1200   /FLC, INCORRECT NUMBER OF FLAGS
            JMP MMERRX-1
            LAC MMWA1
            TAD MMSCFK
            DAC MMWA1
            MMEF
            SKP
            JMP MMVWR2+3          /ERROR DURING WRITING
            MMDF
            JMP .-4
            MMRD
            AND (7777)


            SAD MMWA1
            JMP .+3
            LAW 700    /BMW, BLOCK MARK INCORRECT
            JMP MMERRX-1
            ISZ MMWDC
            JMP MMVWR1            /CONTINUE
            JMP MMSCH6            /EXIT

MMVTR,      0
            LAC .-1
            DAC MMVT
            LAC (JMS MMVCHR)
            DAC MMVWR1-1
            CLC
            DAC MMSCFK
            LAW 61      /SEARCH REV
            JMP MMVTR2

MMVK,       400400      /LAST VIRGIN TAPE WORD +1
```

/DECTAPE SUM CHECK PROGRAMS

```
/FORMAT     JMS MMSCF  /OR MMSCR
/           LAW B      /OR LAC (B), BLOCK NUMBER
/           -N+1       /N=NUMBER OF BLOCKS
/           JMP X      /ERROR RETURN
/           ŻŻ0000     /UNIT SELECTION
/           MULTI-PROGRAM RETURN
```

```
MMSCF,      0
            LAC (JMS MMVCHK)
            DAC MMSCF1
            LAC (1)
            DAC MMSCFK
            LAW 41      /SEARCH FORWARD
MMSCR2,     DAC MMSCF5
            ADD (1)     /READ MODE
            DAC MMSCF1+1
            LAC MMSCF
MMSCF1,     JMS MMVCHK              /OR MMVCHR
            LAW 42      /READ FWD OR REV, MODIFIED
            MMLC
MMSCF2,     MMEF
            JMP .+3
            LAW 400     /ERROR DURING READING, ERR
            JMP MMERRX-1
            MMDF
            JMP MMSCF2
            MMRD        /READ REVERSE CHECKSUM
            DAC MMSUM
            DAC MMRVC
MMSCF3,     MMEF
            SKP
            JMP MMSCF2+2            /ERROR DURING READING
            MMDF
            JMP MMSCF4
            MMRD        /DATA
            ADD MMSUM
            DAC MMSUM
            JMP MMSCF3
MMSCF4,     MMBF
            JMP MMSCF3
            MMRD
            DAC MMRDC
            ADD MMSUM
            DAC MMCC
            SAD (-0)
            JMP .+3
            LAW 500     /SUM CHECK
            JMP MMERRX-1
MMSCF5,     LAW 41      /SEARCH FWD OR REVERSE, MODIFIED
            MMLC
            LAC MMWA1
            TAD MMSCFK
            DAC MMWA1
            MMEF
```

```
            SKP
            JMP MMSCF2+2          /ERROR DURING READING
            MMDF
            JMP .-4
            MMRD
            AND (7777)
            DAC M#MRDB
            SAD MMWA1


            JMP .+3
            LAW 1000  /BLOCK MARK ERROR DURING READING, BME
            JMP MMERRX-1
            ISZ MMWDC /BLOCK COUNTER
            JMP MMSCF1+1          /READ NXT BLOCK
            JMP MMSCH6            /GOOD EXIT
MMSCFK,     1           /-0 FOR REVERSE, MODIFIED

/SUM CHECK REVERSE
MMSCR,      0
            LAC .-1
            DAC MMSCF
            LAC (JMS MMVCHR)
            DAC MMSCF1
            CLC
            DAC MMSCFK
            LAW 61     /SEARCH REVERSE
            JMP MMSCR2


/COMMON ROUTINE FOR PICKING UP VIRGIN TAPE CONSTANTS ETC
MMVCHK,     0
            ADD (-1)
            DAC MMAUTO
            LAC (JMS MMSCH1)
            DAC MMVCH1
            LAC I MMAUTO          /BLOCK NUMBER
            DAC MMVCH1+1
            LAC I MMAUTO          /NUMBER OF BLOCKS
            DAC MMWDC
            LAC I MMAUTO          /ERROR RETURN
            DAC MMVCH1+2
            LAC I MMAUTO          /UNIT SELECTION
            DAC MMVCH1+4
MMVCH1,     JMS MMSCH1            /OR MMSCHR
            LAW .       /BLOCK NUMBER, MODIFIED
            JMP .       /ERROR RETURN, MODIFIED
            JMP MMVCH2            /END RETURN
```

```
          0          /UNIT SELECTION
          JMP I MMAUTO          /CONTINUE MULTIPROGRAMMING
MMVCH2,   LAC (DISMIS)
          DAC MMSCH7
          JMP I MMVCHK

MMVCHR,   0
          ADD (-1)
          DAC MMAUTO
          LAC MMVCHR
          DAC MMVCHK
          LAC (JMS MMSCHR)
          JMP MMVCHK+4
START


88
          MARK TRACK PROGRAM FOR DECTOG
M=320000
B=670000
G=450000
D=070000
GBAR=260000
BBAR=040000
MBAR=510000
E=220000
EBAR=550000
/NOTE THAT THESE MARKS ARE THE REVERSE OF THE WAY THEY ACTUALLY APPEAR ON
/THE TAPE

WRMKTR,   JMS CLRFLG
          LAC (NOP)
          DAC WRMB2
EK,       LAM DECIMAL -7143 OCTAL        /NO OF END MARKS
          DAC C1     /NO OF E TO WRITE
          JMS MMWAIT
          LAS        /UNIT SELECTION AND HIGHEST BLOCK NUMBER
          MMSE
          AND (7777)
          CMA
          DAC INIT+2
          HLT
          LAS        /NO OF DATA WORDS PER BLOCK
          AND (7777)
          CMA
          ADD (5)
          DAC WRD
```

```
            LAC (47)  /WRITE BLOCK MARK TRACK, FORWARD
            MMLC
WRF,        LAC (EBAR)
            MMDF
            JMP .-1
            MMWR
            ISZ C1
            JMP WRF+1
INIT,       LAC (M)
            DAC MM
            LAM DECIMAL -577 OCTAL          /MODIFIED
            DAC C1    /NO OF BLOCKS TO WRITE -1
            LAC (JMP WRDATA)
            DAC 1
WRM,        MMFF
            JMP .+11
            LAC MM
            AND (7777)
            DAC MMWA1
            MMRS
            DAC MMRSA
            LAW 600   /ERW
            MMLC
            JMP TSTMM6
            LAC MM
            MMDF
            JMP .-1
            MMWR
WRGBAR,     LAC (GBAR)
            MMDF
            JMP .-1
            MMWR
WRBBAR,     LAM -3
            DAC C2
            LAC (BBAR)
WRBB,       MMDF
            JMP .-1
            MMWR


            ISZ C2
            JMP WRBB
WRD,        LAM DECIMAL -251 OCTAL          /NO OF DATA FLAGS -1, MODIFIED
            DAC C2
            ION
/CALCULATE OBVERSE MARK, 1800US
C01,        LAC MM
            RTL
            RTL
```

```
            RTL
            DAC WA1
            JMS COBV
            6
            RTR
            RTR
            RTR
            AND (7700)
            DAC WA2
C02,        LAC WA1
            RTL
            RTL
            RTL
            JMS COBV
            6
            RAL
            RTL
            RTL
            RTL
            AND (77)
            XOR WA2
            XOR (MBAR)
            DAC MMBAR
            JMP .       /WAIT FOR DATA TO FINISH
WRB,        LAM -3
            DAC C2
            LAC (B)
WRB2,       MMDF
            JMP .-1
            MMWR
            ISZ C2
            JMP WRB2
WRG,        LAC (G)
            MMDF
            JMP .-1
            MMWR
WRMBAR,     LAC MMBAR
            MMDF
            JMP .-1
            MMWR
WRMB2,      NOP         /OR JMP WRMB2+4
            LAC (JMP WRMB2+4)
            DAC WRMB2
            JMP WRM
            ISZ MM
            ISZ C1
            JMP WRM
WREBAR,     XCT EK
            DAC C1
            LAC (E)
```

```
WRE2,       MMDF
            JMP .-1
            MMWR
            ISZ C1
            JMP WRE2


            CLA
            MMLC
            JMP SUMF1A              /DONE
MM,         0
WA1,        0
WA2,        0
MMBAR,      0
WA3,        0
/WRITE DATA MARKS, 128US, TOTAL=18144US LEFT
WRDATA,     DAC WA3
            LAC (D)
            MMWR
            LAC WA3
            ISZ C2
            SKP
            JMP WRB
            ION
            JMP I 0
START

/OBVERSE LOOPS
/VARIABLE COMPLEMENT OBVERSE LOOP, 148US+104US PER CHAR
/FORMAT     JMS OBV
/           6           /NO OF CHARACTERS FROM LEFT TO OBVERSE
COBV,       0
            CMA
            DAC OBV2    /ORIGINAL WORD
COBV1,      LAC I CORV
            CMA
            DAC OBV3    /COUNTER
            ISZ OBV3
            DZM OBV4    /NEW WORD
OBV1,       LAC OBV2
            RAL
            DAC OBV2
            LAC OBV4
            RAR
            DAC OBV4
            ISZ OBV3
            JMP OBV1
            ISZ COBV
            JMP I CORV
```

```
OBV2,       0
OBV3,       0
OBV4,       0
/VARIABLE NON COMPLEMENT OBVERSE LOOP, 176US+104US PER CHARACTER
OBV,        0
            DAC OBV2
            LAC OBV
            DAC COBV
            JMP COBV1
START

TELETYPE ROUTINES WITH OCTAL PRINT LMH 8-8-63 (DLF 12-5-64)
/TURNS INTERRUPT OFF

/OCTAL PRINT, WITH ZERO SUPPRESSION
/FORMAT     LAC WD
/           TWORDZ
/           N           /N=NUMBER OF DIGITS TO PRINT FROM LEFT END OF WORD

OCTAL
TWORDZ=JMS .
            0
            DAC DCPN#UM
            LAC (SZA)
            DAC TWORDZ+17-JMS
            LAC I TWORDZ-JMS
            CMA
            DAC DCPC#NT
            ISZ DCPCNT
            ISZ TWORDZ-JMS
            LAC DCPNUM
            RTL
            RAL
            DAC DCPNUM
            RAL
            AND (7)
            SZA         /MODIFIED
            JMP TWORDZ+25-JMS
            ISZ DCPCNT
            JMP TWORDZ+11-JMS
            TDIGIT
            JMP I TWORDZ-JMS
            DAC DCPD#IG
            LAC (JMP TWORDZ+31-JMS)
            DAC TWORDZ+17-JMS
            LAC DCPDIG
            TDIGIT
            ISZ DCPCNT
            JMP TWORDZ+11-JMS
            JMP I TWORDZ-JMS
```

```
/OCTAL PRINT, NO ZERO SUPPRESSION
/FORMAT SAME AS TWORDZ

TWORD=JMS .
          0
          DAC DCPNUM
          LAC TWORD-JMS
          DAC TWORDZ-JMS
          LAC (JMP TWORDZ+31-JMS)
          JMP TWORDZ+3-JMS

/TABLE FOR OCTAL TO DECIMAL CONVERSION
DECIMAL
DCPTAB,   100000    10000     1000      100       10        1
OCTAL
```

/TELETYPE OUTPUT PACKAGE MODIFIED FOR DECTOG LMH (DLF) 12-5-64

```
EXT=JMP I-JMS        TTAB=10

/TYPE 1 CHARACTER FROM AC BITS 12-17

TY1=JMS .
          0
          RAR
          JMS TY1A
          EXT TY1

/TYPE 1 CHARACTER (5 BIT), LINK INDICATES CASE

TY1A,     0
          DAC T#EMY
          AND (37
          SNA
          JMP TY2
          703301
          SKP
          JMP TY1BBB
          LAC OCL
          SPL
          LAC OCU
          SAD OCS
          JMP .3
          JMS OTY
          DAC OCS
```

```
            LAC TEMY
            JMS OTY
            ISZ T#BC
TY2,        LAC TEMY
            JMP I TY1A

/TYPE 3 CHARACTERS FROM AC 0-5, 6-11,12-17 RESPECTIVELY

TY3=JMS .
            0
            JMS RL6
            JMS TY1A
            JMS RL6
            JMS TY1A
            JMS RL6
            JMS TY1A
            EXT TY3

/TYPE A CARRIAGE RETURN, AND LINE FEED

TCR=JMS .
            0
            703301
            JMP TCRSSS
            LAW 215
            JMS OTY
            LAW 212
            JMP TCRRRR
TCRSSS,     LAW 2
            JMS OTY
            LAW 10
TCRRRR,     JMS OTY
            DZM TBC
            EXT TCR


/TELETYPE OUTPUT PACKAGE - PAGE 2


/TYPE A SPACE

TSP=JMS .
            0
            LAW 4
            703301
            SKP
```

```
            LAW 240
            JMS OTY
            ISZ TBC
            EXT TSP

/TYPE A TABULATION

TYT=JMS .
TAB=TYT
            0
            LAC TBC
            ADD (-TTAB-1
            SMA
            JMP .-2
            ADD (1
            SMA
            LAC (-TTAB-1
            ADD (-1
            DAC T#EM
            TSP
            ISZ TEM
            JMP .-2
            EXT TYT

/TYPEWRITER INITIALIZE

TIN=JMS .
            0
            LAC OCL
            DAC OCS
            703301
            JMS OTY
            TCR
            EXT TIN

/TYPE THE DIGIT IN THE AC

TDIGIT=JMS .
            0
            AND (17
            ADD (LAC NCT
            DAC . 1
            XX
            703301
            JMP TDIGT1
            RCL
            JMS RL6
            JMS OTY
            EXT TDIGIT
TDIGT1,     TY1
            EXT TDIGIT
```

```
/TELETYPE OUTPUT PACKAGE - PAGE 3

/TYPE A STRING OF CHARACTERS

TSR=JMS .
          0
          DAC T#EMY1
          LAC (JMP TSR1
          DAC TY1A 4
          LAC I TEMY1
          TY3
          ISZ TEMY1
          JMP .-3
TSR1,     LAC (JMP TY2
          DAC TY1A 4
          LAC TEMY1
          EXT TSR
/OUTPUT ONE FIVE BIT CHARACTER
OTY,      0
          IOF
          DAC TWORD-JMS          /SAVE
          LAC NIOT
          703341                 /SKIP ON  PDP 7
          LAW        /COUNTER
          DAC RL6
          LAC TWORD-JMS
          TSF
          SKP
          JMP .+3
          ISZ RL6
          JMP .-4
          TLS
          JMP I 'OTY

/ROTATE LEFT 6

RL6,      0
          RTL
          RTL
          RTL
          JMP I RL6

/TABLE OF DIGITS

NCT,      600033    610073    620063    630041
          640025    650003    660053    670071
NIOT,     700031    710007
/CASE STORAGE

OCU,      33
OCL,      37
OCS,      0
```

```
/4-7 ADDENDUM DECTOG
TY1BBB,    RCR
           ADD (LAC MTATAB
           DAC . 1
           XX
           SZL
TY1DDD,    JMP TY2-2
           JMS RL6
           RTL
           RTL
           JMP TY2-2
/BAUDOT TO ASCII, ASSUMES LETTERS CASE
/ODD RIGHT HALF, EVEN LEFT HALF
MTATAB,    200324
           215317
           240310
           316315
           212314
           322307
           311320
           303326
           305332
           304302
           323331
           306330
           301327
           312377
           325321
           313377
START

           REVISED MARK TRACK PROGRAM
RM=040440 /26
RB=444044 /73
RG=404004 /51
RD=444000 /70
RGBAR=044040          /32
RBBAR=004000          /10
RMBAR=400404          /45
REBAR=404404          /55
RE=040040 /22
R25=040404            /25

WFLAGS,    0
           MMEF
           SKP
           JMS WRNVT8          /ERW
```

```
            MMDF
            JMP WFLAGS+1
            MMWR
            JMP I WFLAGS

RWMKTR,     JMS CLRFLG
            JMS MMWAIT
            LAS                 /UNIT AND HIGHEST BLOCK NUMBER
            MMSE
            AND (7777)
            CMA
            DAC MMWA1 /BLOCK COUNTER
            HLT
            LAS                 /NUMBER OF DATA WDS PER BLOCK
            AND (7777)
            CMA
            ADD (5)
            DAC MMWA2 /WDS PER BLOCK

            LAM DECIMAL -7143 OCTAL
            DAC MMWA4
            LAW 47              /WRITE TIMING AND MARK TRACK FORWARD
            MMLC
            LAC (REBAR)         /REVERSE END
            JMS WFL

RWRM,       LAC (R25)
            JMS WFLAGS
            LAC (RM)  /MARK
            JMS WFLAGS
            LAC (RGBAR)         /-G
            JMS WFLAGS
            LAM -3
            DAC MMWA4
            LAC (RBBAR)         /-B
            JMS WFL

            LAC MMWA2
            DAC MMWA4
            LAC (RD)            /DATA
            JMS WFL
            LAM -3
            DAC MMWA4
            LAC (RB)  /FINAL MARKS
            JMS WFL
            LAC (RG)            /G
            JMS WFLAGS
            LAC (RMBAR)         /REVERSE MARK
            JMS WFLAGS
            LAC (R25)
            JMS WFLAGS
            ISZ MMWA1
```

```
            JMP RWRM
            LAC (DECIMAL -14286 OCTAL)
            DAC MMWA4
            LAC (RE)
            JMS WFL
            JMP MM-3                    /DONE

WFL,        0
            JMS WFLAGS
            ISZ MMWA4
            JMP .-2
            JMP I WFL


/WRITE VIRGIN TAPE FOR MARK TRACK ONLY
WRNVT,      JMS CLRFLG
            LAC (1001)
            JMS GENBLA
            0
            DZM MM                      /MARK
            DZM MMWA1
            JMS MMWAIT
            LAS                         /UNIT
            MMSE
            DAC SUMF1+4
            DAC RVZB+4
            JMS REWIND

            LAW 41                      /SEARCH FWD
            MMLC
            CLC
            DAC MMSUM
            LAC (SAD MMWRA-1)
            DAC MMAUTO
            MMEF
            SKP
            JMS WRNVT8                  /ERW
            MMDF
            JMP .-4

WRNVT3,     LAW 43                      /WRITE FWD
            MMLC
/CALCULATE REVERSE MARK
            LAC MM
            RTR
            RTR
            AND (700000)
```

```
        DAC MMBAR /BITS 15-17
        LAC MM
        RTL         RTL         RTL         RTL
        RAL
        AND (70000)
        ADD MMBAR
        DAC MMBAR /BITS 12-14
        LAC MM
        RTL
        RAL
        AND (7000)
        ADD MMBAR
        DAC MMBAR /BITS 9-11
        LAC MM
        RTR
        RAR
        AND (700)
        ADD MMBAR
        CMA
        DAC MMBAR /BITS 6-8

WRNVT4, LAC I MMAUTO
        MMEF
        SKP
        JMS WRNVT8              /ERW
        MMDF
        JMP WRNVT5
        MMWR
        MMRD
        XCT MMAUTO
        JMP .+5
        MMRS
        DAC MMRSA
        LAW 1400                /BUF
        JMP WRM+10
        ADD MMSUM
        DAC MMSUM
        JMP WRNVT4

WRNVT5, MMBF
        JMP WRNVT4+1
        LAC MMSUM
        CMA
        DAC MMWC
        MMWR
        LAW 46                  /WRITE THRU ENDS
```

```
            MMLC
            CLC
            DAC MMSUM
            LAC (SAD MMWRA-1)
            DAC MMAUTO
            LAM -1
            DAC MMWA4
            CLA
            JMS WFL                 /WRITE -L AND G
            LAC MMBAR /REVERSE MARK
            JMS WFLAGS
            CLC                     /REVERSE 25
            JMS WFLAGS              /FORWARD 25
            CLA
            JMS WFLAGS
            ISZ MM                  /UPDATE MARK
            LAC MM
            DAC MMWA1
            JMS WFLAGS              /MARK
            CLA
            JMS WFLAGS              /-G
WRNVT6,     MMEF
            JMP .+6
            MMRS
            AND (40000)
            SZA
            JMP WRNVT7              /END OF TAPE
            JMS WRNVT8
            MMDF
            JMP WRNVT6
            JMP WRNVT3

/AUTOMATIC CHECK SUM
WRNVT7,     CLA
            MMLC
            LAM -1
            TAD MM
            DAC K1                  /STARTING BLOCK
            CMA
            ADD (1)
            DAC SUMF1+2
            LAC (JMS MMSCR)
            DAC SUMF1
            LAC (JMP RVZB)
            DAC SUMF1A
            JMP SUMF1

WRNVT8,     0
            JMP WRM+2

START
```

```
/STOP ADJUSTMENT PROGRAM
/IF ACSO=Ø, GO FOR 1 SECOND, OTHERWISE GO FOR Ø.12 SECONDS
STAP,     JMS CLRFLG
          JMS STAP3
          DŻM C1              /CLEAR DIRECTION
          JMS MMWAIT
          LAS
          MMSE
          LAW 4Ø              /MOVE FWD
          XOR C1              /GET DIRECTION
          MMLC
          LAS
          RAL
          LAC STAPK
          SPL
STAP2,    LAM DECIMAL -3750 OCTAL       /Ø.12 SECONDS
          JMS TIMER
          CLA
          MMLC
          LAC C1
          XOR (2Ø)
          DAC C1              /CHANGE DIRECTION
          LAC STAPK /STOP FOR 1 SECOND
          JMS TIMER
          JMP STAP+3
STAPK,    DECIMAL -31250 OCTAL          /1 SECOND
STAPK2,   DECIMAL -31250 OCTAL          /1 SECOND, PDP-4
STAPK3,   DECIMAL 119287 OCTAL          /1 SECOND, PDP-7
STAPK4,   DECIMAL -17143 OCTAL          /.12 SECONDS, PDP-7

/TIMING LOOP, 32 MICROSECONDS PER COUNT FOR PDP-4, 7 MS FOR PDP-7
/FORMAT   LAC (-N)  /WHERE 'N=MICROSECONDS OVER 32
/         JMS TIMER
TIMER,    Ø
          DAC C2
          ISŻ I .-1
          JMP .-1
          JMP I TIMER

STAP3,    Ø
          SKP7
          JMP STAP4
          LAC (LAC STAPK4)    /FOR PDP-7
          DAC STAP2
          LAC STAPK3
          DAC STAPK
          JMP I STAP3
STAP4,    LAM DECIMAL -3750 OCTAL       /FOR PDP-4
          DAC STAP2
          LAC STAPK2
          JMP STAP4-2
```

```
/RECORD BLOCK MARK NUMBERS
RBMN,     JMS CLRFLG
          JMS MMWAIT
          LAS
          MMSE
          LAW MMWRA-1
          DAC MMAUTO
          LAM -3777
          DAC WA1
          JMS REWIND
          LAW 41                  /SEARCH FWD
          MMLC
RBMN1,    MMEF
          JMP .+6
          MMRS
          AND (40000)             /END OF TAPE
          SAD (40000)
          JMP RBMN2
          JMP RBMN1-2
          MMDF
          JMP RBMN1
          MMRD
          DAC I MMAUTO
          ISZ WA1
          JMP RBMN1
          CLA
          MMLC
          JMP SUMF1A              /TYPE END
RBMN2,    LAM
          DAC I MMAUTO
          ISZ WA1
          JMP .-2
          JMP RBMN2-3

/RETURN FROM SUM CHECK TO WRITE FIRST BLOCK ZERO NUMBER
RVZB,     JMS MMSCHR
          LAW 1                   /BLOCK NUMBER 1
          JMP RVZB                /ERROR RETURN, SEARCH AGAIN
          JMP .+3                 /DONE RETURN
          0                       /UNIT
          JMP .                   /WAIT FOR SEARCH TO BE COMPLETED
          MMDF
          JMP .-1
          MMRD
          SZA
          JMP RVZB5 /NON-ZERO BLOCK FOUND
          LAW 62                  /READ REVERSE
```

```
            MMLC
RVŻB2,      MMDF
            JMP .+3
            MMRD
            JMP RVŻB2
            MMBF
            JMP RVŻB2
            MMRD
            LAW 66                  /WRITE ALL REVERSE
            MMLC
RVŻB3,      CLA
            MMEF
            SKP
            JMP RVŻB4
            MMDF
            JMP RVŻB3+1
            MMWR
            JMP RVŻB3
RVŻB4,      MMRS
            AND (40000)
            SAD (40000)
            JMP .+3
            DŻM MM
            JMS WRNVT8
            LAC (JMS TYPEND)
            DAC SUMF1A
            JMP SUMF1A
/NON-ŻERO BLOCK FOUND
RVŻB5,      CLA
            MMLC
            TIN
            LAC (FLEX NŻB)
            TY3
            JMP X1

/REWIND DECTAPE UNIT
REWIND,     0
            LAW 60                  /REWIND
            MMLC
            MMEF
            JMP .-1
            MMRS
            AND (40000)             /END OF TAPE
            SNA
            JMP REWIND+1            /IGNORE ERROR
            JMP I REWIND
START
```