UNIVAC 1108/PDP-7 MAGNETIC TAPE
COMPATIBILITY PROGRAM I

E. L. Wells

AEC RESEARCH &
DEVELOPMENT REPORT

DT Aase 30190 328 MAY 1 1968

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

PACIFIC NORTHWEST LABORATORY

RICHLAND, WASHINGTON

operated by

BATTELLE MEMORIAL INSTITUTE

for the

UNITED STATES ATOMIC ENERGY COMMISSION UNDER CONTRACT AT(45-1)-1830

3 3679 00060 7152

BNWL-610

Univac 1108/PDP-7 Magnetic Tape

Compatibility Program I

By

E. L. Wells
Mathematical Analysis Section
Mathematics Department
Battelle-Northwest

FIRST UNRESTRICTED
DISTRIBUTION MADE

DEC 4 '67

Univac 1108/PDP-7 Magnetic Tape
Compatibility Program I

Abstract

A magnetic tape compatibility program has been developed to allow for expansion of CSE PDP-7 computer programs. This program has been restricted to the conversion of integer words only. Details of the codes which have been written to convert PDP-7 18-bit words to Univac 1108 (IBM 7090) 36-bit words, are given.

TABLE OF CONTENTS

	<u>Page</u>
Abstract	ii
I. Introduction	1
II. General Hardware Information and Specifications	1
III. General Description of the Tape Compatibility Program	2
IV. Operational Details	4
V. References	6
VI. Figure 1 Schematic of IBM Tape Path	7
VII. IBM Magnetic Tape Specifications Charts (Figures 12-14)	8
VIII. Nomenclature for Main Program (TAPE)	11
IX. TAPE Program Listing	12
X. ZERO Program Listing	14
XI. BLOCK 1 Program Listing	15
XII. RET Program Listing	17
XIII. Sample Input	22
XIV. Program Flow Charts	24

I. Introduction

The PDP-7 digital computer produced by Digital Equipment Corp., is capable of controlling experiments, small scale data reduction, and logging required data on several magnetic tapes (DECTAPEs)² but because of its small core, it is virtually impossible to perform any large scale probability and statistical computations. It was because of this limitation that the Univac 1108 computer was selected to do these computations.

An incremental tape unit was purchased by CSE* and interfaced with the PDP-7 computer. This unit will allow the user to write on a Univac 1108 (IBM) 2400 ft. magnetic tape at a low density of 200 BPI. Inter-record gaps of .75 inch and EOF (End of File) gaps of 3.5 inches are written when commanded. Writing at 200 BPI generates a 7.7 inch record of 256_{10} 36-bit words. With the above specifications, it is possible to store approximately eleven PDP-7 DECTAPEs on one Univac 1108 (IBM) 2400 ft. magnetic tape.

II. General Hardware Information and Specifications

The CSEMPLEX¹ program logs data from low and high speed multiplexers and stores it on Decsys magnetic tapes (DECTAPEs). The data must then be retrieved, converted, and processed. For the Univac 1108 to do this, the data must first be retrieved from the DECTAPEs and written onto a 2400 ft. magnetic tape according to the specifications necessary for the Univac 1108 (IBM 7090) computer (Figures 12, 13, and 14). Some of these specifications are supplied by the hardware, reducing the amount of labor

*Late in 1963, a program entitled, "The Containment System Experiment," was undertaken by the Battelle Memorial Institute, Pacific Northwest Laboratory. The primary purpose of the CSE program is to evaluate on a significant engineering scale the effectiveness of natural processes and safeguards in limiting the release of fission products from nuclear reactor accidents to the environment.³

involved. The hardware is designed to write 6-bits plus parity (supplied by the user) at 200 BPI, longitudinal parity, inter-record gaps of .75 inch, and EOF (End of File) gaps of 3.5 inches. This essentially leaves only two important specifications for the user to supply. One, the user must convert or pack the PDP-7 data words to adjust to the Univac 1108 36-bit words, and two, the user must supply the correct parity (vertical or lateral parity) on each 6-bits of data to be written. It is standard procedure to write 256_{10} (400_8) 36-bit word records. This is equivalent to 512_{10} (1000_8) 18-bit words.

III. General Description of the Tape Compatibility Program

The program, TAPE, which has been written to convert PDP-7 18-bit words to Univac 1108 36-bit words and write onto a 2400 ft. IBM magnetic tape, consists of a main FORTRAN program and three symbolic subroutines.

Subroutine ZERO is a symbolic subroutine that is called previous to any storing of data. Its function is to zero out core locations 5000_8 - 5777_8 inclusive for a working area and return control to the calling program. Initially, subroutine ZERO is called by the main program TAPE. After the first call, subroutine ZERO is called by subroutine RET.

Subroutine BLOCK1 is a symbolic subroutine that writes the first record (400_8 36-bit words) onto the IBM 2400 ft. magnetic tape. This first record is used only as a communications block between the CSE personnel and the Univac 1108 programmers. It is reserved for operating instructions and specific controlling data such as time variables, tables, etc.

The main program allows for a Read-In paper tape to be loaded in location 5000_8 - 5777_8 , and subroutine BLOCK1 retrieves this controlling

data 6 bits at a time, adjusts the parity to odd, and stores the data (6 bits plus parity) in locations $6000_8 - 10777_8$. When all data in locations $5000_8 - 5777_8$ has been converted and stored, the routine then writes the contents of core locations $6000_8 - 10777_8$ onto the IBM magnetic tape.

Control is returned to the main program after the first record has been written.

DECTAPEs are then mounted on Decsys units 1-4. The DECTAPE on unit 1 will be the first DECTAPE processed and then the program will automatically transfer to the next sequential unit if more than one DECTAPE is to be processed. When the processing of DECTAPE on unit 4 has been completed, unit 1 will again be selected.

The main program then requests the number of DECTAPEs to be processed, the number of bad blocks on each DECTAPE, and the octal numbers of the bad blocks, if any bad blocks exist. A maximum of 10 DECTAPEs can be processed with a maximum of 10 bad blocks on each DECTAPE.

The main program then calls subroutine RET.

Subroutine RET is a symbolic subroutine that writes an inter-record gap, zeros out core location $6000_8 - 10777_8$ and calls subroutine ZERO which zeros out core location $5000_8 - 5777_8$ and returns control to RET. The subroutine then retrieves two blocks of data, (1000_8 18-bit words) and stores them in core locations $5000_8 - 5777_8$. The same process is used here as was used to write the first record in BLOCK1. The data in core locations $5000_8 - 5777_8$ is unpacked into 6-bit words and the parity is set to odd and each 6 bits plus parity is stored in core locations $6000_8 - 10777_8$. When all data in locations $5000_8 - 5777_8$ has been unpacked, converted, and

stored, the data in locations $6000_8 - 10777_8$ is written onto the IBM magnetic tape as one record (400_8 36-bit words).

Control is then returned to the main program after each record has been written. New indexes for the next two blocks are then computed and the blocks are checked against the list of bad blocks on that DECTAPE. If the index is an index of a bad block, a new index is computed until a good block is found. When indexes for two good blocks* have been found, control is again returned to subroutine RET.

This process is repeated until a special word is encountered on the DECTAPE. If the word is a 777000_8 , this indicates there will be no more data on that DECTAPE and the next DECTAPE on the next sequential Decsys unit will be read. If the word is a 777777_8 , this indicates no more data and an EOF gap will be written on the IBM magnetic tape.

IV. Operational Details

1. The IBM 2400 ft. tape must be mounted (see Figure 1) and positioned with write switch on. The initial loadpoint reflective marker should be positioned under the photo cell.
2. Mount program tape on any unit with write lock.
3. Set ADS to 17600, ACS 0-5 to unit, ACS 12-17 to program block number, and Read-In DSD paper tape.
4. The program will type some operating instructions and halt at PC = 126. The operator must remove the program tape and mount the Data tapes (DECTAPES) on Unit 1-4.

*It is possible that only one block is to be retrieved rather than two blocks. This happens most frequently at the physical ends of the DECTAPES.

5. The Read-In paper tape must be loaded in the paper tape reader now and the ADS set to 5000.
6. Press "Read-In" switch.
7. Reset ADS to 126.
8. Press START.

***Note: If a typing error occurs, ADS set incorrectly, or any error occurs and the operator wishes to restart, he must set ADS to 100, rewind incremental tape as in first operation, and press START. Instructions 5-8 are now repeated.

V. References

1. N. P. Wilburn, Multiplexer Codes for the PDP-7, BNWL-CC-796, August 24, 1966.
2. PDP-7 Users Handbook (F-75), Digital Equipment Corporation.
3. G. J. Rogers, Program for Containment System Experiment, USAEC Report HW-83607, September, 1964.

FIGURE 1

Schematic of Tape Path.

VII. IBM Magnetic Tape Specifications

NOTES:

1. Tape is shown with oxide side up, Read/Write head on same side as oxide.
2. Tape shown representing 1 bits in all tracks, NRZI recording; 1 bit produced by reversal of flux polarity, tape fully saturated in each direction.
3. Variation permitted in the location of the Check Character assuming nominal values for tape speed and all oscillator timings in the Tape Control. No longitudinal check bit is written if longitudinal count in the track is even.
4. Mylar Tape: $3/4'' \pm 1/8''$, $-1/16''$. Acetate Tape: $3/4'' \pm 1/8''$, $-1/8''$. Zero backward creep. Forward creep less than 0.2" per cycle.
5. Dimensions of tape measured at 50% relative humidity and 70°F. Tape thickness (Mylar or Acetate) is $0.0022''$, $+.0003''$, $-.0004''$.
6. To insure complete interchangeability, skew of each tape unit is adjusted to 0.25 usec or less at the read bus of the tape unit and 0.5 usec or less at the read register (final amplifiers) of the control unit when reading-while-writing continuous 1 bits. Maximum skew for any reel of tape, read by any tape unit connected to any tape control, must be equal to or less than the read character gate for the bit density and tape speed at which the tape was written.
7. Write Skew Gate $\pm 5\%$:
For 729 II: @ 556 BPI = 7.5 usec, @ 200 BPI = 20.8 usec.
For 729 IV: @ 556 BPI = 5.5 usec, @ 200 BPI = 15.5 usec.
8. Read Char Gate $\pm 5\%$:
For 729 II: @ 556 BPI = 10.5 usec, @ 200 BPI = 29.2 usec.
For 729 IV: @ 556 BPI = 7.5 usec, @ 200 BPI = 21 usec.
9. Tape purchased to IBM Engineering Specs: 896817 for Mylar & 895152 for Acetate.

Figure 12. Recorded Tape Specifications

Figure 13. Read Operation

NOTES: When at load point, total delay is Wr Dly plus Wr LP Dly. For tape motion start & stop times see Note 8 of Figure 13.

	729 II	729 IV		729 II	729 IV
1. Write Delay $\pm 1\%$	7.5 ms	5.0 ms	5. Wr Echo Pulse Width $\pm 1\%$	1.0 usec	1.0 usec
Write LP Delay $\pm 1\%$	115 ms	76 ms	Constant for both character rates	1.0 usec	1.0 usec
2. Write Stop Delay $\pm 3\%$	3.0 ms	2.0 ms	6. Wr Check Char Dly $\pm 1\%$: 556 BPI	97.5 usec	65.0 usec
3. Rep Rate $\pm 1\%$: 556 BPI	24.0 usec	16.0 usec	200 BPI	271.0 usec	181.0 usec
200 BPI	66.7 usec	44.5 usec	7. Read Dly While Wr $\pm 1\%$	4.0 ms	2.67ms
4. Wr Pulse Width $\pm 1\%$: 556 BPI	1.5 usec	1.0 usec	8. Lines marked (C) are from Control to Tape Unit,		
200 BPI	4.16 usec	2.78 usec	Lines marked (T) are from Tape Unit to Control.		
			9. Timings and tolerances are those when the Tape Unit is connected to an IBM Tape Control.		

Figure 14. Write Operation

VIII. Nomenclature

I = Input
C = Computed internally

<u>Program Name</u>	<u>Description</u>	<u>Mode</u>
NBAD (I)	Number of bad blocks on DECTAPE I. Dimensioned 10.	I
NBLOCK (I,J)	The octal number of the Jth bad block on DECTAPE I. Dimensioned 10 x 10.	I
NTAPES	Number of DECTAPES.	I
IUNIT	Decsys Magnetic tape unit.	C
J	Index of 1st DECTAPE block to be retrieved.	C
JPl	Index of 2nd DECTAPE block to be retrieved.	C
ISKP	Number of blocks to be skipped between 1st block to be retrieved and 2nd block to be retrieved.	C
IE	Stop indicator. IE = 1 when stop word 777777 ₈ is encountered.	C
IRIB	Indicator that controls whether 1 block or 2 blocks are to be retrieved.	C


```

      INCREMENTAL TAPE ROUTINE
C STUFFS 2-18 BIT WORDS INTO 1-36 BIT WORD
C FOR UNIVAC 1108 COMPATIBILITY
      DIMENSION NBAD(10),NBLOCK(10,10)
C ZERO OUT CORE LOCATION 5000-5777 FOR WORKING AREA
      CALL ZERO
      WRITE 2,2080
      WRITE 2,2085
C READ IN CONTROL DATA TO BE WRITTEN ON BLOCK 1 OF INC. TAPE

```

```

S      HLT
      CALL BLOCK1
      WRITE 2,2060
C READ IN NO. OF DATA TAPES TO BE TRANSFERED TO INC. TAPE
      READ 1,1000,NTAPES
      DO 30 I=1,NTAPES
      DO 25 J=1,10
      NBLOCK(I,J)=0
25      CONTINUE
      NBAD(I)=0
30      CONTINUE
      DO 120 I=1,NTAPES
      WRITE 2,2020,I
C READ NO. OF BAD BLOCKS ON TAPE I (MAX. OF 10)
      READ 1,1010,NBAD(I)
      WRITE 2,2000
120     CONTINUE
      DO 135 I=1,NTAPES
      N=NBAD(I)
      IF(N)135,135,125
125     WRITE 2,2030,I
      DO 130 K=1,N
C READ THE BLOCK NO. OF THE BAD BLOCKS
      READ 1,1020,NBLOCK(I,K)
      NADD1=0
      NADD2=0
      NB=NBLOCK(I,K)
      IF(NB-1000)127,126,126
126     NADD2=512
      NB=NB-1000
127     IF(NB-100)129,128,128
128     NADD1=(NB/100)*64
      NB=NB-(NB/100)*100
129     KB=NB/10
      NBLOCK(I,K)=8*KB+(NB-10*KB)+NADD1+NADD2
      WRITE 2,2000
130     CONTINUE
135     CONTINUE
      IUNIT=1
      IRIB=0
      IE=0
      DO 500 I=1,NTAPES

```

```

J=1
136 N=NBAD(I)
    JP1=J+1
    ISKP=0
    IF(N)185,185,137
137 DO 180 K=1,N
    IF(NBLOCK(I,K)-J)138,150,138
138 IF(NBLOCK(I,K)-JP1)180,160,180
150 CONTINUE
    J=J+1
    IF(J-576)155,155,400
155 JP1=J+1
    GO TO 180
160 CONTINUE
    JP1=JP1+1
    ISKP=ISKP+1
180 CONTINUE
185 CALL RET(IUNIT,I,J,ISKP,IRIB,IE)
    IF(IE)187,187,500
187 IF(IRIB)500,190,190
190 J=J+2+ISKP
    IF(J-576)136,200,400
200 IRIB=1
    JP1=J
    GO TO 137
400 CONTINUE
    KTAPE=IUNIT+4
    WRITE 2,2050,KTAPE,IUNIT
S    OCTAL
S    LAC IUNIT.
S    ADD (1
S    SAD (5
S    ADD (-4
S    DAC IUNIT.
S    HLT
S    DECIMAL
500 CONTINUE
S    OCTAL
S    703524 /PUT EOF ON INC. TAPE
S    DECIMAL
S    HLT
1000 FORMAT(I3)
2000 FORMAT(1H /)
2020 FORMAT(25HNO. OF BAD BLOCKS ON TAPE,I3)
2030 FORMAT(30HNOS. OF THE BAD BLOCKS ON TAPE,I3)
1010 FORMAT(I3)
1020 FORMAT(I4)
2050 FORMAT(10HMOUNT TAPE,I3,8H ON UNIT,I3)
2060 FORMAT(29HNO. OF MULTIPLEXER DATA TAPES )
2080 FORMAT(15HSET ADS TO 5000 /23HPUT PAPERTAPE IN
S    READER /20HPRESS READ-IN SWITCH )
2085 FORMAT(14HSET ADS TO 127 /11HPRESS START )
END

```

/ ROUTINE THAT ZEROS OUT CORE LOCATION 5000-6000

	FIDEC
	QCTAL
	INTERNAL ZERO.
ZERO.,	JMP M1
M1,	NOP
	LAM -777
	DAC COUNS
	LAC CORE
	DAC 12
	DZM 1 12
	ISZ COUNS
	JMP .-2
	NOP
	RETUR
	HLT
COUNS,	0
CORE,	4777
START	

/ SUBROUTINE TO WRITE MPGEN2 PAPER TAPE
/TABLES ON BLOCK 1 OF INCREMENTAL
/TAPE FOR UNIVAC 1108

FIQDEC
OCTAL
INTERNAL BLOCK1.

BLOCK1., JMP M1
M1, NOP
/ZERO OUT CORE LOCATION 6000-11000

LAC M3000
DAC COUNS
LAC COR2
DAC 12
DZM I 12
ISZ COUNS
JMP .-2
NOP

LAM -777
DAC WPB
LAC COR1
DAC 11
LAC COR2
DAC 13
RET1, LAC I 11
DAC SAVE
NOP

LAC MN2
DAC ROT2C
LAC SAVE

RET2, RTR RTR RTR
RET3, RTR RTR RTR
AND BITB

NOP
JMS PARITY
DAC I 13
LAC ROT2C
SAD MN1
JMP .+4
LAC SAVE
ISZ ROT2C
JMP RET2
LAC SAVE
AND BITB
NOP

JMS PARITY
DAC I 13
ISZ WPB
JMP RET1
LAC M3000
DAC WPB

```

COR1, 4777
COR2, 5777
COUNS, 0
SAVE, 0
WPB, 0
PAR, 0
NUMB, 0
ROT2C, 0
M3000, 775000
MN2, 777776
MN1, 777777
BITB, 000077
PARITY, 0
DAC NUMB
DZM PAR
RCR
SZL
ISZ PAR
SZA
JMP .-4
LAC PAR
RAR
SNL!CLA
LAC (100
ADD NUMB
JMP I PARITY

START
```

```

/TAPE RETRIEVAL ROUTINE FOR INCREMENTAL TAPE PROGRAM
      FIDEC
      EXTERNAL .I01,.I02,.I03,.I04,.I05,.I06,.I07
      EXTERNAL .I08,.I09,.I057A,.IODEC
      QCTAL
      .BF1=5000
      .BF2=5400
      INTERNAL RET.
RET.,  JMS GTARG
      JMP .AAA
IUNIT, 0
I1,    0
J,      0
ISKP,   0
IR1B,   0
IE,     0
.AAA,   JMP M1
IBF1,   JMS CALSB
      LAW 1
      .BF1
IBF2,   JMS CALSB
      LAW 1
      .BF2
M1,     703544
/ZERO OUT CORE LOCATION 6000-11000
      LAC M3000
      DAC COUNS
      LAC COR2
      DAC 11
      DZM I 11
      ISZ COUNS
      JMP .-2
      EXTERNAL ZERO.
      CAL ZERO.
      LFM
      CLA
      MMLC
      MMSE
      JMS OLC
      CLL
      CLA
      LAC I IUNIT
      RTL          RTL          RTL          RTL
      RTL          RTL
      ADD I J
      DAC SV1
      JMS MTAPE
      LAC IBF1+2
      LAC .BF1+377
      SAD (777777

```

```

                JMP A1
                SAD (777000
                JMP A2
                LAC I IR1B
                SZA
                JMP A3
                LAC I ISKP
                DAC NSKP
                SZA
                JMP SKPB
                NOP
M2,            LAC SV1
                ADD (1
                NOP
M3,            JMS MTAPE
                LAC IBF2+2
                LAC .BF2+377
                SAD (777777
                JMP A1
                SAD (777000
                JMP A2
                JMP A3
/2 BLOCKS HAVE NOW BEE READ INTO CORE LOCATION
/ 5000-5777 INCLUSIVE
OLC,          0
                LAC TTC
                DAC COUNS
                ISZ COUNS
                JMP .-1
                JMP I OLC
COUNS,        0
TTC,          754300
SV1,          0
NSKP,         0
A1,           LAC (1
                DAC I IE
                JMP A3
A2,           LAC (1
                DAC I J
                LAC I IUNIT
                SAD (5
                ADD (2
                ADD (-1
                DAC I IUNIT
                RTL          RTL          RTL          RTL
                RTL          RTL
                ADD I J
                DAC SV1
                LAC (-1
                DAC I IR1B

```

```

LAC .BF2+1
SZA
JMP A3
LAC SV1
JMP M3
SKPB, DZM I ISKP
LAC SV1
ADD NSKP
JMP M3
MTAPE, 0
MMSE
AND (1777
DAC BLOCK
S1, LAW 41
MMLC
SEARCH, JMS RED
AND (1777
SAD BLOCK
JMP FOUND
CMA
TAD BLOCK
SMA
JMP SEARCH
S2, LAW 61
MMLC
JMS RED
AND (1777
CMA
TAD BLOCK
TAD MN2
SPA
JMP S2
JMP S1

MN2, 777776
BLOCK, 0
MN1, LAM -0
CHECK, 0
FOUND, XGT I MTAPE
TAD MN1
DAC 10
LAM -377
DAC COUNS
LAW 42
MMLC
JMS RED
DAC CHECK
LOAD, JMS RED
DAC I 10
ADD CHECK
```



```

DAC CHECK
ISZ COUNS
JMP LOAD
MMBF
JMP .-1
MMRD
ADD CHECK
DAC CHECK
CLA
MMLC
MMSE
JMS OLC
ISZ MTAPE
JMP I MTAPE
RED, 0
MMEF
SKP
JMP STAT
MMDF
JMP RED+1

MMRD
JMP I RED
STAT, MMRS
SAD (150000
JMP S1
SAD (140000
JMP S2
HLT
A3, LAM -777
DAC WPB /WORDS PER BLOCK
LAG COR1
DAC 13
LAG COR2
DAC 12
RET1, LAG I 13
SAD (777777
JMP .+6
SAD (777000
JMP .+4
RCL
CML
RAR
DAC SAVE
LAG MN2
DAC ROT2C
LAG SAVE
RET2, RTR RTR RTR
RTR RTR RTR
RET3, AND BITB

```

	JMS PARITY
	DAC I 12
	LAC ROT2C
	SAD MN1
	JMP .+4
	LAC SAVE
	ISZ ROT2C
	JMP RET2
	LAC SAVE
	AND BITB
	JMS PARITY
	DAC I 12
	ISZ WPB
	JMP RET1
	LAC M3000
	DAC WPB
	LAC COR2
	DAC 13
	LAC I 13
	703402
	703401
	JMP .-1
	ISZ WPB
	JMP .-5
	NOP
PARITY,	RETUR
	0
	DAC NUMB
	DZM PAR
	RCR
	SZL
	ISZ PAR
	SZA
	JMP .-4
	LAC PAR
	RAR
	SNL!CLA
	LAC C100
	ADD NUMB
	JMP I PARITY
WPB,	0
ROT2C,	0
SAVE,	0
BITB,	000077
M3000,	775000
COR1,	4777
COR2,	5777
START	

SET ADS TO 5000
PUT PAPERTAPE INREADER
PRESS READ-IN SWITCH
SET ADS TO 127
PRESS START
NO. OF MULTIPLEXER DATA TAPES
1
NO. OF BAD BLOCKS ON TAPE 1
0

SET ADS TO 5000
PUT PAPERTAPE INREADER
PRESS READ-IN SWITCH
SET ADS TO 127
PRESS START
NO. OF MULTIPLEXER DATA TAPES
1
NO. OF BAD BLOCKS ON TAPE 1
3

NOS. OF THE BAD BLOCKS ON TAPE 1
1

2

3

TAPE

RET

BLOCK 1

ZERO

DISTRIBUTIONNumber
of Copies

43

Battelle-Northwest

R. T. Alleman
J. M. Atwood
J. M. Batch
F. P. Brauer
J. C. Campbell
L. D. Coffin
L. F. Coleman
R. E. Connally
R. Y. Dean
J. L. Deichman
B. H. Duane
G. E. Driver
F. E. Holt
J. H. Kaye
C. E. Linderorth
W. L. Nicholson
J. D. McCormack
W. H. Payzant
H. J. Rieck
G. J. Rogers
J. T. Russell
S. J. Simmons
R. W. Walker
W. R. Weissenberger
E. L. Wells (10)
N. P. Wilburn (3)
M. E. Witherspoon
Tech. Info. (3)

12

AEC - Washington

R. R. Newton, DRD&T

3

Division of Technical Information Extension

Oak Ridge

2

AEC, DRDT Site Representative

P. G. Holsted

2

AEC, RL

C. L. Robinson
Technical Library

2

AEC, Chicago Patent Group

G. H. Lee
R. K. Sharp

3

Battelle Memorial Institute