

BURROUGHS
B 1700 EMULATOR
OF IBM 1401/1440/1460 SYSTEMS
REFERENCE MANUAL

PRELIMINARY EDITION

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Table of Contents

Section	Title	Page
	INTRODUCTION	v
1	EMULATOR FEATURES	1-1
	General	1-1
2	EMULATED INSTRUCTIONS	2-1
	General	2-1
	Input/Output Instructions	2-1
	Arithmetic Instructions	2-1
	Logic Instructions	2-2
	Move and Load Instructions	2-2
	Magnetic Tape Instructions	2-2
	Disk Instructions	2-3
	Console Printer Instructions	2-3
	Miscellaneous Instructions	2-3
3	OPERATING INSTRUCTIONS FOR FREE	
	STANDING EMULATION	3-1
	General	3-1
	Emulator Load Procedures	3-1
	Control Card Sequence	3-2
	Emulate Card	3-2
	Emopt Card	3-3
	User Specifications for the Assignment of	
	Pseudo 1311 Disk Addressing	3-5
	Altering Sense Switches	3-6
	Obtaining Program Status	3-6
	Emulator Halt Message	3-7
	Operator Response to Emulator Halt Message . .	3-7
	Debugging 1400 Input Messages	3-7
	Miscellaneous Input Messages	3-9
	Output Messages	3-11
	Emulator Debugging Input Messages	3-13
4	B 1700 ERROR HALTS	4-1
	General	4-1
5	DEVICE ALTERNATES	5-1
	Card Reader	5-1
APPENDIX A	1400 EMULATOR TRACE OPTION	A-1
APPENDIX B	SINGLE INSTRUCTION OPTION	B-1
APPENDIX C	1400 MEMORY DUMP	C-1
APPENDIX D	EMULATED INSTRUCTIONS FOR THE IBM 1401/1440/1460	
	SYSTEM	D-1

Table of Contents (cont)

Section	Title	Page
APPENDIX E	EMULATION ERROR CODES	E-1

List of Illustrations

Figure	Title	Page
A-1	Emulator Trace Listing	A-2
B-1	1400 Emulator Single Instruction Option	B-1

List of Tables

Table	Title	Page
D-1	Emulated Instructions for the IBM 1401/1440/1460 System	D-2
D-2	Key to Abbreviations	D-33

INTRODUCTION

The Burroughs B 1700 Emulator of the IBM 1401/1440/1460 Systems is designed to provide the means for executing object programs, which are written for the IBM 1401/1440/1460 Systems, on the B 1700 System. The Emulator creates an IBM environment within the B 1700 memory to perform the originally intended functions of the IBM 1401/1440/1460 Systems.

The intent of this system software package is to provide IBM 1401/1440/1460 and IBM 360 users emulating 1400 systems with the ability to take the object program, data, and operating instructions of an IBM 1401/1440/1460 System and execute the program on a B 1700 as if the system were an IBM 1401/1440/1460. The overall performance level of the Emulator is competitive with that of an IBM 360/30 System emulating the 1401/1440/1460 serially (assuming equal peripheral speeds).

The operating requirements of the Emulator are as follows:

- a. Memory - 48KB main memory (B 1710 and B 1720 Systems).
4KB control memory (B 1720 Systems).
- b. Console Printer - for communication with the Emulator.
- c. Peripherals - similar I/O devices to execute IBM 1401, 1440, or 1460 program requirements.

This Emulator is available to those IBM users who desire an efficient transition to Burroughs Computer Systems.

SECTION 1
EMULATOR FEATURES

GENERAL.

The IBM 1401/1440/1460 Emulator provides the following features:

- a. The Emulator has the same operating environment as defined for the IBM 1401/1440/1460 object program.
- b. All halts allow the operator to continue, reset, load a new program, start at another 1401/1440/1460 address, go to End-of-Job, or execute any other operator command.
- c. The 1401/1440/1460 arithmetic logic is maintained during execution.
- d. The 1401/1440/1460 comparison-indicator logic is maintained during execution.
- e. The indexing feature is implemented.
- f. The A- and B-Address registers are maintained during execution.
- g. The process-overlap feature is implemented.
- h. The sense switches are implemented.
- i. The following hardware configuration represents the maximum environment that may be emulated in a single IBM 1401/1440/1460 object program:
 - 1) Card reader - one (80-column).
 - 2) Card punch - one (80-column).
 - 3) Line printer - one (132-character).
 - 4) Console printer - one.
 - 5) Magnetic tape units - six.
 - 6) 1311 Disk pack storage units - five.
 - 7) Core memory - 4K, 8K, 12K, or 16K characters.

SECTION 2

EMULATED INSTRUCTIONS

GENERAL.

The following instructions are executed by the IBM 1401/1440/1460 Emulator:

- a. Input/Output.
- b. Arithmetic.
- c. Logic.
- d. Move and Load.
- e. Magnetic Tape.
- f. Disk.
- g. Console Printer.
- h. Miscellaneous.

INPUT/OUTPUT INSTRUCTIONS.

The following Input/Output instructions are emulated:

- a. Read Card (and Branch) - R.
- b. Write Line (and Branch) - W.
- c. Write Word Marks (and Branch) - WM.
- d. Write and Read (and Branch) - WR.
- e. Punch Card (and Branch) - P.
- f. Read and Punch (and Branch) - RP.
- g. Write and Punch (and Branch) - WP.
- h. Write, Read, and Punch (and Branch) - WRP.
- i. Start Read Feed (same as NOP) - SRF.
- j. Start Punch Feed (same as NOP) - SPF.

ARITHMETIC INSTRUCTIONS.

The 1401/1440/1460 Emulator emulates the following Arithmetic instructions:

- a. Add - A.
- b. Subtract - S.
- c. Zero and Add - ZA.
- d. Zero and Subtract - ZS.
- e. Multiply - M.
- f. Divide - D.

LOGIC INSTRUCTIONS.

The following Logic instructions are emulated:

- a. Branch Unconditional - B.
- b. Branch if Equal Compare - BE.
- c. Branch if High Compare - BH.
- d. Branch if Low Compare - BL.
- e. Branch if Unequal Compare - BU.
- f. Branch if Arithmetic Overflow - BAV.
- g. Branch if Character Equal - BCE.
- h. Branch Bit Equal - BBE.
- i. Branch if End of Reel - BEF.
- j. Branch if Tape Error - BER.
- k. Branch on I/O Check Stops or Busy (same as NOP) - BIN.
- l. Branch After Console Write - BIN-Q.
- m. Branch if Last Card Switch ON - BLC.
- n. Branch if Sense Switch B (C-G) ON - BSS.
- o. Branch on Word Mark and/or Zone Condition - BWZ.
- p. Branch if Validity Error - BIN.
- q. Branch if Wrong - Length Record - BIN.
- r. Branch if Unequal - Address Compare - BIN.
- s. Branch if Any Disk Condition - BIN.
- t. Branch if Disk Access Busy - BIN.

MOVE AND LOAD INSTRUCTIONS.

The 1401/1440/1460 Emulator emulates the following Move and Load instructions:

- a. Load Characters to a Word Mark - LCA.
- b. Move Numeric - MN.
- c. Move Zone - MZ.
- d. Move Characters and Edit - MCE.
- e. Move Characters to Record Mark or Group Mark Word Mark - MCM.
- f. Move Characters and Suppress Zeros - MCS.
- g. Move Characters to A or B Word Mark - MCW.

MAGNETIC TAPE INSTRUCTIONS.

The following Magnetic Tape instructions (for both 7-channel and 9-channel tape) are emulated:

- a. Back Space Tape Record - BSP.
- ~~b. Read/Write Tape in Overlap - MU.~~
- c. Read Tape - RT.
- d. Read Tape with Word Marks - RTW.
- e. Rewind Tape - RWD.
- f. Rewind Tape and Unload - RWU.
- g. Skip and Blank Tape - SKP.
- h. Write Tape - WT.
- i. Write Tape with Word Marks - WTW.
- j. Write Tape Mark - WTM.
- k. Diagnostic Read - CU.

also SCAN DISK

DISK INSTRUCTIONS.

The following Disk instructions are emulated:

- a. Read Disk Sectors - RD.
- b. Read Disk with Sector Count Overlay - RDCO.
- c. Read Disk with Sector Count Overlay with Word Marks - RDCOW.
- d. Read Disk Track Sectors with Addresses - RDT.
- e. Read Disk Track Sectors with Addresses and Word Marks - RDTW.
- f. Read Disk Sector with Word Marks - RDW.
- g. Seek Disk - SD.
- h. Write Disk Sectors - WD.
- i. Write Disk Check - WDC.
- j. Write Disk with Sector Count Overlay - WDCO.
- k. Write Disk with Sector Count Overlay with Word Marks - WDCOW.
- l. Write Disk Check with Word Mark - WDCW.
- m. Write Disk Track Sectors with Address - WDT.
- n. Write Disk Track Sectors with Addresses and Word Marks - WDTW.
- o. Write Disk Sectors with Word Marks - WDW.

CONSOLE PRINTER INSTRUCTIONS.

A maximum of 60 characters is allowed during a Console Printer Read instruction. The 1401/1440/1460 Emulator emulates the following Console Printer instructions:

- a. Read Console - MU-R.
- b. Write Console - MU-W.
- c. Read Console with Word Marks - LU-R.
- d. Write Console with Word Marks - LU-W.

MISCELLANEOUS INSTRUCTIONS.

The following miscellaneous instructions are emulated:

- a. Compare - C.
- b. Control Carriage on Printer - CC.
- c. Clear Storage (and Branch) - CS.
- d. Clear Word Mark - CW.
- e. Halt (and Branch) - H.
- f. Modify Address - MA.
- g. No Operation - NOP.
- h. Store A-Address register - SAR.
- i. Store B-Address register - SBR.
- j. Overlap ON, OFF, Reset (and Branch) - same as NOP.
- k. Set Word Mark - SW.
- l. Select Stacker Pocket (and Branch) - SS. Punch stacker number four goes to auxiliary; otherwise, NOP.

NOTES

1. Arithmetic overflow and sign control are exactly the same as for the 1401.
2. Full indexing is applicable for all instructions.
3. Single or double operands may be used.

4. Chaining or dependence on register settings is completely emulated and available.

SECTION 3

OPERATING INSTRUCTIONS FOR FREE STANDING EMULATION

GENERAL.

The operation of the IBM 1401/1440/1460 Emulator is divided into two general areas: Emulator Load and actual operation of the Emulator.

The Emulator Load requires only a simple load from the tape cassette which prepares the B 1700 processor for execution of 1401/1440/1460 programs.

This section describes the required Emulator Load procedures, the control cards, and the console printer messages which are displayed by the Emulator and require an operator response.

EMULATOR LOAD PROCEDURES.

To load the Emulator from the tape cassette the following operating procedures must be followed in sequence:

- a. Power on the Tape Cassette unit.
- b. Mount the Emulation Loader Cassette. If the BOT (Beginning-of-Tape) indicator is not ON, press the REWIND button.
- c. Turn CONTROL MODE switch to TAPE.
- d. Turn REGISTER SELECT switch to 2.
- e. Turn REGISTER SELECT dial to L.
- f. Press the CLEAR button.
- g. Press the START button.

Once the bootstrap loader has been loaded from the tape cassette, the processor halts with all console display lights ON (HEXADECIMAL "AAAAAA") following a valid load. If the L register does not display all A's, press the cassette REWIND button and repeat step g. If errors persist try a different Emulator Loader cassette.

If any light on the console is not ON, the bootstrap loader has not loaded correctly; and the process must be repeated; otherwise,

- h. Turn the CONTROL MODE switch to RUN and press the START button.
- i. When the loader has been successfully loaded a console message, ~~REWIND CASSETTE, is displayed. It is very important that this is done immediately to prevent the cassette from warping.~~
- j. Following this action another message (EMULATOR INPUT?) is displayed on the console printer.

- k. Ready the device from which the Emulator is to be loaded: CRA, CAS, or MT^(X).
- l. Enter the correct device type from which the Emulator is to be loaded via the console printer:
 - 1) CRA - Input from 80-column card reader. A ?END card must follow the Emulator card deck to terminate the load.
 - 2) CAS - Input from cassette. If a cassette parity is detected by the hardware, the processor halts with the parity light ON. If this condition should occur, rewind the cassette, press CLEAR and START on the console, and try again. It is not necessary to read the Emulator Loader cassette again.
 - 3) MT^(X) - Input from magnetic tape unit ^(X). Only 9-track drives A through H are acceptable.

not present

Once the Emulator obtains control the following message is displayed (DD = today's date, MMM = the month, and YYYY = the year):

ENTER DATE DD MMM YYYY

After the operator enters the date the Emulator displays the following message (X = the version number and yy = the level number):

EM1400 Version X Level YY 7 MAR 1974

The Emulator is now in a ready status to execute 1400 programs.

CONTROL CARD SEQUENCE.

To execute the 1401/1440/1460 Emulator the following cards must be entered into the card reader in the following sequence:

- a. ?EMULATE <Program - ID>
- b. EMOPT CARD
- c. 1400 object card deck.
- d. 1400 data card deck.
- e. ?END

The above cards are described in detail in the paragraphs which follow.

The last card indicator is turned ON only when the ?END card is read.

EMULATE CARD.

The Emulate card is of free format.

Columns	Field	Field Description
1	?	Invalid character.
	EMULATE	Start emulation of a new 1401/1440/1460 program.
	Program-ID	1400 Program-ID to be Emulated.

EMOPT CARD.

The ~~EMULATE OPTION~~ card is of fixed format and is defined as follows:

EMOPT

Columns	Field	Field Description										
1	Blank	Blank.										
2-6	EMOPT	Designates EMOPT OPTION card.										
8		Specifies 1401/1440/1460 memory core.										
		<table border="1"> <thead> <tr> <th>Code</th> <th>Memory Size</th> </tr> </thead> <tbody> <tr> <td></td> <td>16K character memory</td> </tr> <tr> <td>8 and 4</td> <td>12K character memory</td> </tr> <tr> <td>8</td> <td>8K character memory</td> </tr> <tr> <td>4</td> <td>4K character memory</td> </tr> </tbody> </table>	Code	Memory Size		16K character memory	8 and 4	12K character memory	8	8K character memory	4	4K character memory
Code	Memory Size											
	16K character memory											
8 and 4	12K character memory											
8	8K character memory											
4	4K character memory											
10-14	LOAD=	This field contains the value LOAD=.										
15-18		This field specifies the hardware device from which the 1400 object program is to be loaded.										
	CARD	CARD - specifies the object program is in object deck form.										
	TAPE	TAPE - specifies the object program is to be loaded from tape.										
	Blank	If field does not contain either CARD or TAPE the default indicates that the object program is in object deck form.										
20-29	SW=ABCDEFG	The sense switch option specified the initial settings of the sense switches. The alpha character representing a particular switch must be in its relative position or else the switch is not SET. The default is all switches are OFF.										

<u>Columns</u>	<u>Field</u>	<u>Field_Description</u>
31-40	EOJ=AAABBB	This option indicates the values of the A- and B-Address registers during a 1400 HALT command that signifies the End-of-Job condition. The AAA portion must be an actual 1400 address and not the decimal equivalent of that address. The BBB option is not required.
42-52	TAPE=ABCDEF	This option specifies the tape units required by the 1400 program. Card columns 47 through 52 represent 1400 tape units 1 through 6 respectively. B 1700 tape units are alphabetically assigned A through F for 9-track, J through R for 7-track, and S through Z for phase-encoded tape. Example: If a 1400 program requires tape drives 1, 2, 4, and tape 1 is mounted on tape unit A, tape 2 is mounted on tape B, and tape 4 is mounted on tape unit C the following tape assignments are required. TAPE=ABbCbb Card columns representing unused tape units should be left blank.
54-58	DISK= CART= PAEK=	If disk is specified, the value DISK= is contained in this field.
59-68		This field represents 1400/1311 disk drive assignments required by the 1400 program. B 1700 disk drives are alphabetically assigned A through D. For example, if a 1400 program requires disk drives 2, 4, and 6, drive 2 is on disk unit C, drive 4 is on disk unit A, and drive 6 is on disk unit D, the following specification is required: DISK=bbCbAbDbbb
70-79	STOP=III or STOP=DDDD	This option is normally used as a debugging aid that causes the 1400 object program to stop at the machine address indicated by III (actual 3-character 1400 address) or DDDD (5-digit decimal

looked

Columns	Field	Field Description
---------	-------	-------------------

1400 address).

Providing an emulation of all five 1311 disk drives requires the user to have Burroughs double-density disk cartridges. The emulation of five 1400 disk drives is then accomplished by having two 1311 disk drives assigned to one Burroughs disk cartridge, thereby requiring the user to have a minimum of three double-density drives.

When 1311 disk drives reside or are to be assigned as the second drive on double-density disk cartridges, a numeric value of 2 is punched with the associated disk cartridge identifier.

Example:

To assign 1311 drives 0 and 2 to Burroughs cartridge A, either of the following may be punched:

DISK=AbA2bbbbbb	1311 drive 0 on first half
DISK=A1A2bbbbbb	1311 drive 2 on second half

Example:

To assign 1311 drives 0, 4, and 8, the following should be punched:

DISK=C2bbC1bbBb

With this assignment, 1311 drive 0 would be assigned as the second drive on unit C, drive 4 would be assigned as the first drive on unit C, and drive 8 would be assigned as the first drive on unit B.

USER SPECIFICATIONS FOR THE ASSIGNMENT OF PSEUDO 1311 DISK ADDRESSING.

The 1700/1400 Emulator provides a built-in safeguard against utilizing disk cartridges not properly established for use during emulation. This provision has been implemented to prevent the user from inadvertently destroying a disk that has not been initialized for emulation.

Before any disk operations can be executed under emulation, the user must execute the 1401/Diskinitialize Program under MCP control. 1401/Diskinitialize writes a bit pattern on disk that the Emulator can recognize, allowing the disk to be used under emulation. Another benefit as a result of running 1401/Diskinitialize is that an entry in the disk directory is made for this file, allowing the user to access the file under MCP control.

MCP
important

Created (VIR 134)

Because the Emulator uses absolute disk address, the file must start at disk address hexadecimal 40, which is where the MCP places the first file on a scratch disk. For users with 200 TPI disk and who wish to have two PSEUDO 1311 disks reside on one 1700 disk cartridge, the address of the second file must start at hexadecimal location 2751. The address may be verified by doing a KA under MCP control.

If this procedure is not executed and the user attempts to use a disk that is not initialized, the Emulator displays WRONG DISK CARTRIDGE on the console printer.

CAUTION

Because the 1400/1700 Emulator is emulating IBM 1311 disk completely, the operator must execute the IBM utility **clear disk** to set the PSEUDO 1311 disk addresses and output areas to an initial condition.

ALTERING SENSE SWITCHES.

Sense switches may be altered by the following keyboard message:

```
SW=AB DEFG
```

In the previous example sense switches A, B, D, E, F, and G are SET. Sense switch C is not SET because the position that sets this sense switch contains a blank rather than a C.

After the previous message is entered, the Emulator displays the sense switch settings. An example might be:

```
SW=AB DEFG
```

To interrogate the sense switch settings, the operator can type in the following keyboard message:

```
SW=
```

OBTAINING PROGRAM STATUS.

Obtaining the status of the 1401/1440/1460 program may be achieved with the following message:

```
WYE
```

In response to the above message the Emulator displays the Instruction Address register (IAR), the instruction, A- and B-Address registers before execution, sense switch settings, the arithmetic overflow indicator, and the comparison indicator. The following is an example:

```
IAR=02436  OP=A081061  A=00080  B=00060  SW=AB DEFG  O=
```

After the above message is displayed by the Emulator, the operator must reply with the OK message or by pressing the END-OF-MESSAGE button. This allows the Emulator to continue processing the 1400 program.

EMULATOR HALT MESSAGE.

This message is displayed on the console printer whenever a 1401/1440/1460 Halt instruction is encountered. The display shows the settings of the Instruction Address register (IAR), the instruction, the A- and B-Address registers, the sense switch settings, the arithmetic overflow indicator, and the comparison indicator. The message format is as follows:

```
1400 HALT IAR= 673
IAR=00673 OP=.999999 A=00999 B=00999 SW=AB DEFG O=
```

OPERATOR RESPONSE TO EMULATOR HALT MESSAGE.

The operator may respond to the Emulator HALT message with the following input text:

- a. To continue emulation of the object program reply with OK.
- b. To negate the branch of the HALT command reply with START followed by OK.
- c. To emulate at a new start address reply with TRA(III), where III is the 3-character actual address, or TRA (DDDDD), where DDDDD is the decimal equivalent of the actual 1400 3-character address.
- d. To bring the current 1400 program to an end, enter END. The free-standing Emulator displays an EOJ message and waits to execute the next 1400 program.

DEBUGGING 1400 INPUT MESSAGES.

The following is a list of 1400 console printer input messages that are normally used as debugging aids:

Text	Definition
TRN	Start 1400 trace (refer to appendix A).
TRN (1400 address)	Start 1400 trace at the address specified by (1400 address).
TGF	Stop 1400 trace.
SIN < 1401 address >	Start single instruction mode (refer to appendix B). optional 1401 address
SOF	End single instruction mode.
DUMP	Dump 1400 memory (refer to appendix C).

of TRN

<u>Text</u>	<u>Definition</u>
DUMP (1400 address)	A 1400 memory dump is produced starting at the address specified by (1400 address).
TRA (1400 address)	Start execution of object code at the address specified by (1400 address).
STOP (1400 address)	Stop execution of object code at the address specified by (1400 address).
ALT (1400 address) ↑DATA	Alter data in 1400 memory starting at the address specified by (1400 address). If a character is to be accompanied by a word mark in 1400 memory then the special character (↑) must precede that character. A maximum of 60 characters may be entered with each ALTER message.
DIS (1400 address)	Display 25 characters of 1400 memory starting at the address specified by (1400 address). The special character (↑) precedes any character that has a word mark associated with it.
SET C	All of 1400 memory is set to the character designated by C, also if a word mark is to accompany the character (↑) must precede the character to be inserted.
***	Any comment to the right of the *** message is transferred to the printer.
*CO	Any comment to the right of the *CO message is considered to be remarks.
EQU(III)	This message converts the 3-character actual address specified by III to its decimal equivalent and displays that value.
EQU(DDDDD)	This message converts the 5-digit decimal address specified by (DDDDD) to the equivalent 1400 3-character address.

The preceding debugging input messages, that require an operand after the command, require a space between the text and address, except for the EQU messages.

MISCELLANEOUS INPUT MESSAGES.

The following is a list of miscellaneous 1400 console printer input messages.

<u>Text</u>	<u>Definition</u>
INQ	Turns ON the 1407/1447 INQUIRY INDICATOR.
CLR	SETS the 1407/1447 CLEAR INQUIRY and terminates any 1407/1447 console printer operation currently in progress.
TAPE	Displays the current tape assignments. Example: AB-D-F The (-) specifies unassigned tape units.
IGNORE (DEVICE)	This message may be used to inform the Emulator that all 1400 I/O instructions that reference the designated peripheral unit are to be ignored. READER PUNCH PRINTER CONSOLE DISK TAPE
TAPE=ABCDEF	Tape units may be assigned through the console printer. Example: If a 1400 program requires tape drives 1, 2, 4, and tape 1 is mounted on tape unit A, tape 2 is mounted tape unit B, and tape 4 is mounted on tape unit C the following message is entered. TAPE=AB C.
ASSIGN MTa=#	A single tape unit may be assigned with this message (a = B 1700 tape units A through F, # = 1400 tape units 1 through 6).
ASSIGN DCa=#	A single B 1700 disk cartridge may be assigned with this message. a = B 1700 disk cartridge identified A through D.

J-R (74)
S-2 (PE)

<u>Text</u>	<u>Definition</u>
	# = 1400 disk identifier 0, 2, 4, 6, and 8.
	Example:
	ASSIGN DCA=6
	This input message allows the assignment of 1400 drive 6 to B 1700 disk cartridge A.
ASSIGN DCa1=#	A single B 1700 double-density disk cartridge may be assigned with this message.
ASSIGN DCa2=#	a = B 1700 disk cartridge Identifier A through D.
	# = 1400 disk Identifier 0, 2, 4, 6, and 8.
	The values 1 or 2 represent the half of the B 1700 cartridge to which the 1400 disk drive is to be assigned.
WY	Displays the Emulator sign on message.
MX	Displays the Emulator sign on message.
ON DIS	This message turns ON the disable disk address compare key.
OFF DIS	This message turns OFF the disable disk address compare key.
ON ADD	This message turns ON the write address key, allowing address operations on disk to be performed.
OFF ADD	This message turns OFF the write address key.
ON WRI	This message turns ON the write disk switch.
OFF WRI	This message turns OFF the write disk switch.
LOAD	This message may be used to emulate the LOAD key on the 1400.
LOAD=TAPE	This message may be used to emulate the LOAD TAPE key on the 1400 processor.
CAR	This displays the current disk assignments.

<u>Text</u>	<u>Definition</u>
LIST	After entering this message the operator may list all cards on the printer until a "?END" card is sensed.
RUN	This message resets the STOP ADDRESS and TRN debugging input messages.
START	This message provides the same function as the 1400 START/RESET key.
END <i><AAR BAR></i>	This message terminates the 1400 program. If an emulate card has been supplied at execution time, the program-ID is displayed with the EOJ message.
	Example: (Operator) END
DTE DD MMM YYYY <i><name of day></i>	The date may be changed in the Emulator with this message. (DD is the day, MMM is the month, and YYYY is the year.)
RESET	This message simulates the actuation of the HALT/CLEAR/START switch on the B 1700 processor. Upon its generation, the emulator is reinitialized, the following IBM 1400 items being reset: <ul style="list-style-type: none"> a. All tape assignments. b. All disk assignments. c. All ignored devices. d. All sense switches (except switch A). e. All processor and I/O indicators. f. All Emulator debugging functions.
TR <i><HHMMSS></i>	

QUIPUI_MESSAGES.

The following is a list of 1400 console printer output messages.

<u>Message</u>	<u>Description</u>
ENTER 1400 DATA	When a read from console printer instruction is encountered this message is displayed to notify the operator that the 1400 program is requesting input data.

< >

Message	Description
(ADDRESS) S-MEM PAR	An S-Memory parity error has been detected and the Emulator must be reloaded.
{ 1400 PROCESS ERROR a 750 ERROR CODE = C { IAR=00750 OP=A007165 A=00007 B=00165 SW=A =	This message specifies that a 1400 process error has occurred (refer to appendix E). <i>2 lines only.</i>
READER NOT READY	Card reader not ready.
READER ERROR	Card read incorrectly.
READER VALIDITY COL XX	Card contains invalid character.
PUNCH NOT READY	Card punch not ready.
DCa # RQD	1400/1311 disk assignment is required.
MT # RQD	1400 tape assignment is required.
NO EMOPT CARD	This message is displayed when an EMOPT card is not present or when LOAD is not entered through the console keyboard prior to loading the object program. To resolve this condition, one of two steps must be taken. <ol style="list-style-type: none">1. Enter LOAD or LOADN through the console keyboard.2. Place an EMOPT card preceding the object program and restart the job.
PUNCH ERROR	Nonrecoverable error; the program must be restarted.
PRINTER NOT READY	Printer not ready.
PRINTER ERROR	Possible nonrecoverable error.
Tape Messages:	
MTa = # LOCKED.	Rewind and unload tape.
MTa = # NOT READY.	Tape unit not ready.
MTa = # LOCKOUT.	No write ring.

<u>Message</u>	<u>Description</u>
MTa = # TIMEOUT.	Nonrecoverable tape error. (a = tape units A through H # = 1400 tape units 1 through 6.)

EMULATOR DEBUGGING INPUT MESSAGES.

The following describe emulator debugging input messages.

<u>Message</u>	<u>Description</u>
APRINT	Prints the B 1700 A stack values on the printer.
SPRINT	Prints the B 1700 scratch pad values on the printer.
SDUMP	Dumps the contents of B 1700 S memory on the printer.
MDUMP	Dumps the contents of B 1726 control memory on the printer.
SMA aaaaaa XXXXX a = S MEMORY ADDRESS X = INFORMATION	Allows the contents of S memory to be altered. *
SMD aaaaaa a = S MEMORY ADDRESS	Allows the contents of S memory to be displayed on the console printer. *
ADISPLAY	Displays the B 1700 A stack values on the console printer.
SDISPLAY	Displays the B 1700 scratch pad values on the console printer.

SECTION 4

B 1700 ERROR HALTS

GENERAL.

All halts require the operator to reload the Emulator and to record register contents on the Emulator trouble report form.

The following table gives a description of the Emulation soft I/O halts.

<u>L Register in_Hexadecimal</u>	<u>Description_of_Halt</u>
21	Status of a peripheral control is not proper. The current status of the control is displayed in the T register.
22	Invalid service request. Mask of service lines is in the T register (15-0), i.e., channel 8 (0000 0000 1000 0000).
23	An I/O request from an unknown type of device. The status and control identification is in the T register. The valid control identifications are listed in the B 1700 Systems Reference Manual.
24	A bad reference address has been returned from a peripheral control. The correct reference address is in the X register and the bad reference address is in the Y register. T register contains the device channel number in hexadecimal.
25	Second operation complete bit is missing from the Result Status field. The T register contains a copy of the Result Status.

The following table gives a description of the Emulator halts.

<u>L Register in_Hexadecimal</u>	<u>Description_of_Halt</u>
E14A01	S-Memory parity error during Emulator load has occurred.
E14A02	Missing device has been detected after exit from standard soft I/O driver.

L Register
in_Hexadecimal

Description_of_Halt

E14A03	Parity error has been detected after exit from standard soft I/O driver during descriptor fetch from S-Memory.
E14A04	Interrupt has not been returned by soft I/O when expected.
E14A05	Undefined error after exit from standard soft I/O driver.
E14A06	Error in device ignore table.
E14A07	Error in device hardware table.
E14A08	Timing error in punch buffer.
E14A09	Timing error in punch buffer.
E14A10	Probable A-Stack overflow.
E14B01	Unknown interrupt. The appropriate operator action is to reload the 1400 Emulator and to record the STATE light and the following registers: A, M, FA, FB, TAS, X, Y, T, and L.
E14C01	Console printer not ready.
E14C03	Tape assignment problem.
E14E01	9210 punch error. If an error card can be manually corrected, the appropriate operator action is to press START or else rerun the job.

F01 (FUN)

Listed below are the Emulator loader halt codes.

L Register
in_Hexadecimal

Description_of_Halt

AAAAAA	MTR mode good load indication. Turn MODE switch to RUN mode, press START.
0000FF	Unknown error halt. Start load again.
000001	Bad data from cassette during load of Emulator loader. Start load again.

L Register
in_Hexadecimal

Description_of_Halt

000002	Missing console printing device. Get a console printer control.
000003	Unacceptable magnetic tape unit designation. Acceptable units are MTA through MTH. Press START and re-enter.
000004	S-Memory parity error, start load again.
000005	Magnetic tape exception from rewind operation. Ready tape unit and press START.
000006	Awaiting Emulator cassette. Load cassette, press START.
000007	Unassigned character set I.D. from printer control. Value of in T register.
000008	Printer exception during load translator. Press START and try again.
000009	Invalid unit I.D. has been returned from HPT disk control. Try load again.
00000A	Invalid S-Memory address has been specified in Emulator constant table area. Correct Emulator and reload.
00000B	Zero length without END in Emulator constant table area.
00000C	Problem when attempting to fetch an interrupt. Try load again.
00000D	Operation complete bit OFF after I/O complete. Try load again.
00000E	Console printer not ready. Ready console printer and press START.
00000F	S-Memory parity error has occurred during SP0 I/O. Try load again.
000010	Validity error or read check on card reader. Correct, re-enter card, and press START.
000011	Invalid load card format. Correct card, re-enter, and press START.

L Register
in Hexadecimal

Description of Halt

000012	Bad data from Emulator cassette. Rewind cassette, press START.
000013	Magnetic tape not ready on a read attempt. Ready unit and press START.
000014	Unrecoverable error on magnetic tape. Press START to retry entire tape again.

15

Address out of range

SECTION 5
DEVICE ALTERNATES

CARD_READER.

Object decks and/or data cards may be stored on magnetic tape (80 characters unblocked) as acceptable input to the Emulator as an alternate device. When the Emulator encounters the following control card the Emulator reads the card images from magnetic tape as though it were a card reader. The Emulator continues to read the card images from tape until an End-of-File condition is reached. Once the End-of-File condition is encountered the Emulator returns for future card reads to the card reader.

Control card:

? SYSIN (X)

where X is the tape unit from which the Emulator reads the card images.

(X) = Tape units A through H.

MT@

J-R
S-Z

APPENDIX A

1400 EMULATOR TRACE OPTION

This appendix illustrates an example of the 1400 Emulator Trace option. The Trace option gives the operator an analysis of what is actually being performed by the Emulator. If any variances do occur, they may be easily located.

The contents (before instruction execution) of figure A-1 are described as follows:

- A. The decimal address of the instruction.
- B. The instruction.
- C. The decimal address of the A-Address.
- D. The decimal address of the B-Address.
- E. The sense switch settings.
- F. The overflow indicator.
- G. The comparison indicator
- H. Contents of Index Register One.
- I. Contents of Index Register Two.
- J. Contents of Index Register Three.
- K. The first 24 characters of the A-Address.
- L. The first 24 characters of the B-Address.

APPENDIX B

SINGLE INSTRUCTION OPTION

This appendix illustrates an example of the 1400 Emulator Single Instruction option. This option gives the operator an analysis of what is actually being performed by the Emulator. If any variances do occur, they may be easily located.

Before each 1400 instruction is executed that instruction, the address registers, the sense switch settings, the arithmetic overflow indicator, and the comparison indicator are displayed on the console printer; also the Emulator does not execute the next 1400 instruction until the END-OF-MESSAGE button is pressed or the operator enters SDF, which terminates the Single Instruction processing.

The contents of figure B-1 are described as follows:

- A. The decimal address of the instruction.
- B. The instruction.
- C. The decimal address of the A-Address after execution of the previous instruction.
- D. The decimal address of the B-Address after execution of the previous instruction.
- E. The sense switch settings.
- F. The arithmetic overflow indicator.
- G. The comparison indicator.

A	B	C	D	E	F	G
IAR=00603	OP=B417	A=00367	B=00088	SW=ABC	E G	<
IAR=00417	OP=M345340	A=00417	B=00607	SW=ABC	E G	<
IAR=00424	OP=S8T3340	A=00340	B=00335	SW=ABC	E G	<
IAR=00431	OP=Y819340	A=00878	B=00335	SW=ABC	E G	<
IAR=00438	OP=C3409T3	A=00818	B=00339	SW=ABC	E G	<
IAR=00445	OP=B607U	A=00335	B=00878	SW=ABC	E G	<
IAR=00450	OP=+345569	A=00607	B=00878	SW=ABC	E G	<
IAR=00457	OP=Z8T3565	A=00340	B=00558	SW=ABC	E G O	<
IAR=00464	OP=,565	A=00878	B=00562	SW=ABC	E G O	<
IAR=00468	OP=Y819569	A=00564	B=00564	SW=ABC	E G O	<

lower case

Figure B-1. 1400 Emulator Single Instruction Option

DUMP

IAR=00338 OP=R434A A=00080 B=15999 SM=A > X1=00080 X2=C0C8C X3=00080

EM1400 VERSION 3 LEVEL 21

29 APR 1974

080 C8C 08C /C9

```

000-000 .....09.....19.....29.....39.....49.....59.....69.....79.....89.....99
                                                080 080 08C
                                                1 1 1

100-100 .....09.....19.....29.....39.....49.....59.....69.....79.....89.....99
/0991,001/001117
1 11 1 1

200-200 .....09.....19.....29.....39.....49.....59.....69.....79.....89.....99
EMULATION TEST CARD # 1
1

300-300 .....09.....19.....29.....39.....49.....59.....69.....79.....89.....99
N/0808434A1,001M441C89,501P080510A436438C438437B434SM441094,601M51C
11 1 11 1 1 1 1 1 1 1 1 1 1 1

400-400 .....09.....19.....29.....39.....49.....59.....69.....79.....89.....99
6!D/332/299M441099,201M6!02+C2B334..151080
1 1 1 1 1 11 111111

500-500 .....09.....19.....29.....39.....49.....59.....69.....79.....89.....99
EMULATION TEST CARD # 1
1

600-600 .....09.....19.....29.....39.....49.....59.....69.....79.....89.....99
EMULATION TEST CARD # 1
1

```

1400 MEMORY DUMP

APPENDIX C

APPENDIX D

EMULATED INSTRUCTIONS FOR THE IBM 1401/1440/1460 SYSTEM

This appendix specifies the op codes and the operand (or operands) with corresponding address registers. Table D-1 lists the emulated instructions for the IBM 1401/1440/1460 System, and table D-2 defines the abbreviations which are used in table D-1.

Table D-1
Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format				Address Registers After Operation			Comments
OP	Operands			IR	AR	BR	
	A	B	d				
H	.			NSI	Ap	Bp	Halt.
H	.	AAA		BI	BI	NSI	With Indexing.
CW	◻	AAA		NSI	A-1	A-1	Clear Word Mark.
CW	◻	AAA	BBB	NSI	A-1	B-1	Clear Word Mark. Word marks are cleared at the locations which are specified by the A- and B-Addresses, without disturbing the data at these locations.
CS	/	AAA		NSI	A	x 00-1	Clear Storage. Core storage is cleared to blanks starting at the A-Address and continues downward in core to the nearest hundreds position.
CS	/	AAA	BBB	BI	BI	NSI	Storage is cleared starting at the B-Address and a Branch Unconditional

Table D-1 (cont)

Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format				Address Registers After Operation			Comments
OP	Operands			IR	AR	BR	
	A	B	d				
SW	,	AAA		NSI	A-1	A-1	is taken to the address specified by the A-Address. Set Word Mark. A word mark is set at the location specified by the A-Address, the data at that address is not disturbed.
SW	,	AAA	BBB	NSI	A-1	B-1	Set Word Mark.
D	x	AAA	BBB	NSI	A-La	A-Lq	Divide. The B-Field data is divided by the A-Field data and the quotient is developed in the high-order positions of the B-Field; the remainder is in the low-order positions of the B-Field. A word mark must be associated with the high-order position of the divisor.
MA	#	AAA		NSI	A-3	A-1	Modify Address. This instruction causes the 3-position field specified by the A-Address to be added to itself.

Table D-1 (cont)
 Emulated Instructions
 for the IBM 1401/1440/1460 System

Instruction Format		Operands			Address Registers After Operation			Comments
OP		A	B	d	IR	AR	BR	
MA	#	AAA	BBB		NSI	A-3	B-1	Modify Address. The 3-position field specified by the A-Address is added to the B-Address.
M	⊗	AAA	BBB		NSI	A-La	B-Lp	Multiply. Both fields must have a word mark associated with them. The units position of the product is located at the B-Address.
ZA	+ 0	AAA			NSI	A-La	A-La	Zero and Add.
ZA	+ 0	AAA	BBB		NSI	A-Lw	B-Lb	Zero and Add. The B-Field data is set to zero before the A-Field data is added to the B-Field data. The zone bits are removed from all positions except the units.
A	A	AAA			NSI	A-La	A-La	Add. The A-Field data is added to itself. The A-Field must have a word mark.
A	A	AAA	BBB		NSI	A-Lw	B-Lb	Add. The contents of the A-Address

Table D-1 (cont)

Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format			Address Registers After Operation			Comments	
OP	Operands			IR	AR		BR
	A	B	d				
B	B	AAA		BI	BI	NSI	are added to the contents of the B-Address. The B-Field must have a word mark. If the A-Field is shorter than the B-Field, a word mark must be associated with the A-Field.
B	B	AAA	/	BI	BI	NSI NSI	With Indexing. A Branch Unconditional is taken to the instruction specified by the A-Address.
B	B	AAA	A	NSI	BI	NSI NSI	No Branch. If the B-Field is longer than the A-Field, an unequal compare results.
B	B	AAA		BI	BI	NSI NSI	Branch if Last Card Switch ON.

Table D-1 (cont)
 Emulated Instructions
 for the IBM 1401/1440/1460 System

Instruction Format					Address Registers After Operation			Comments
OP	Operands			IR	AR	BR		
	A	B	d					
B	B	AAA		K	NSI	BI	NSI A/B	No Branch. This instruction tests the last card condition and branches to the instruction specified by the A-Address if this condition exists. Branch if End-of-Reel.
					BI	BI	NSI	
B	B	AAA		L	NSI	BI	NSI K/B	No Branch. If a tape mark or a reflective spot is sensed during a Write Tape operation, an automatic branch is taken to the instruction specified by the A-Address. Branch if Tape Error.
					BI	BI	NSI	
					NSI	BI	NSI L/B	No Branch. If a transmission error occurs between the tape unit and the processor, this indicator is turned ON; and an automatic branch occurs.

Table D-1 (cont)

Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format		Address Registers After Operation			Comments		
OP	Operands	IR	AR	BR			
						A	P
B	B	AAA	Q	BI	BI	NSI	Branch if Inquiry Request.
				NSI	BI	NSI Q16	No Branch. The branch is taken if the ENTER key is pressed on the console inquiry station.
B	B	AAA	S	BI	BI	NSI	Branch if Equal Compare.
				NSI	BI	NSI S16	No Branch. The branch is taken to the instruction specified by the A-Address if the compare indicator has been set to equal by the previous compare operation.
B	B	AAA	T	BI	BI	NSI	Branch if Low Compare.

Table D-1 (cont)
 Emulated Instructions
 for the IBM 1401/1440/1460 System

Instruction Format					Address Registers After Operation			Comments
OP	Operands			IR	AR	BR		
	A	B	d					
B	B	AAA		U	NSI	BI	dbi T166	No Branch. The branch is taken to the instruction specified by the A-Address if the compare indicator has been set to low by the previous compare operation.
					BI	BI	NSI	Branch if High compare.
B	B	AAA		Z	NSI	BI	dbi U166	No Branch. The branch is taken to the instruction specified by the A-Address if the compare indicator has been set to high by the previous compare operation.
					BI	BI	NSI	Branch if Arithmetic Overflow.
					NSI	BI	dbi Z166	No Branch. If an overflow condition is detected in the result field, a branch is taken to the instruction specified by the A-Address.

Table D-1 (cont)

Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format			Address Registers After Operation			Comments		
OP	Operands			IR	AR		BR	
	A	B	d					
B	B	AAA		9	BI	BI	NSI	Branch if Carriage Channel No. 9.
					NSI	BI	dbi 9164	No Branch. The branch is taken to the instruction specified by the A-Address if Channel No. 9 is sensed.
B	B	AAA		a	BI	BI	NSI	Branch if Carriage Channel No. 12.
					NSI	BI	dbi @ 166	No Branch. The branch is taken to the instruction specified by the A-Address if Channel No. 12 is sensed.
B	B	AAA		d	BI	BI	NSI	Branch if Sense Switch ON.
					NSI	BI	dbi d166	No Branch.

Table D-1 (cont)
 Emulated Instructions
 for the IBM 1401/1440/1460 System

Instruction Format					Address Registers After Operation			Comments
OP	Operands			IR	AR	BR		
	A	B	d					
B	B	AAA	d	BI NSI	BI BI	NSI <i>dbi</i> <i>dB</i>	<p>d-Character Sense Switch</p> <p>B B</p> <p>C C</p> <p>D D</p> <p>E E</p> <p>F F</p> <p>G G</p> <p>The branch is taken to the instruction specified by the A-Address if the sense switch specified by the d-Character is ON.</p> <p>Branch if I/O Check Stop.</p> <p>No Branch.</p> <p>d-Character I/O Device</p> <p>+0 Reader</p>	

Table D-1 (cont)

Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format					Address Registers After Operation			Comments
OP	Operands				IR	AR	BR	
	A	B	d					
BIN	B	AAA	d		BI NSI	BI BI	NSI BI d/bb	+ Printer -0 Punch The branch is taken to the instruction specified by the A-Address if the I/O indicator specified by the d-Character is OFF. No Branch.

Table D-1 (cont)
 Emulated Instructions
 for the IBM 1401/1440/1460 System

Instruction Format					Address Registers After Operation			Comments
OP	Operands				IR	AR	BR	
	A	R	d					
B	B	AAA		d	BI NSI	BI BI	NSI BI d BB	<p>d-Character Indicator</p> <p>N Access Inoperable</p> <p>V Validity Error</p> <p>W Wrong-Length Record</p> <p>X Unequal-Address Compare</p> <p>Y Any Disk Condition</p> <p>\ Access Busy</p> <p>The branch is taken to the instruction specified by the A-Address if the disk indicator tested is DN.</p> <p>Branch if I/O Busy.</p> <p>No Branch.</p> <p>d-Character I/O</p> <p>J Tape</p> <p>R Printer</p>

Table D-1 (cont)

Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format					Address Registers After Operation			Comments
OP	Operands				IR	AR	BR	
	A	R	d					
B	B	AAA	BBB	d	BI NSI	BI	NSI B-1	The branch is taken to the instruction specified by the A-Address if the I/O indicator specified by the d-Character is busy. Branch if Character Equal. No Branch. The branch is taken to the instruction specified by the A-Address if the character specified by the B-Address has the same bit configuration as the d-Character. The d-Character may be any configuration of the six BCD bits.
C	C	AAA			NSI	A-La	A-La	Compare.
C	C	AAA	BBB		NSI	A-Lw	B-Lw	Compare. The B-Field data is compared to the A-Field data. The B-Field word mark terminates the operation. If the B-Field is longer than the A-Field, the compare indi-

Table D-1 (cont)
 Emulated Instructions
 for the IBM 1401/1440/1460 System

Instruction Format		Operands			Address Registers After Operation			Comments
OP		A	B	d	IR	AR	BR	
		MN	D	AAA			NSI	
MN	D	AAA	BBB		NSI	A-1	B-1	Move Numeric. A single digit (8-4-2-1 bits) is moved to the B-Address. The zone bits are undisturbed.
MCE	E	AAA	BBB		NSI	A-La	B-Lb	Move Character and Edit. The A-Field data is modified by the B-Field edit control word. With zero suppression the A-Address register contains the location of the control zero + 1.
CC	F			d	NSI	dBb dpp	dLb dpp	Control Carriage.
CC	F	AAA		d	BI	BI	NSI	Control Carriage and Branch.
								d-Character Immediate Skip to 1 Channel 1

Table D-1 (cont)
Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format				Address Registers After Operation			Comments
OP	Operands						
	A	B	d				
							2 Channel 2 3 Channel 3 4 Channel 4 5 Channel 5 6 Channel 6 7 Channel 7 8 Channel 8 9 Channel 9 0 Channel 10 # Channel 11 a Channel 12 d-Character Skip After Print to A Channel 1 B Channel 2 C Channel 3 D Channel 4 E Channel 5 F Channel 6 G Channel 7 H Channel 8 I Channel 9

Table D-1 (cont)
Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format				Address Registers After Operation			Comments
OP	Operands			IR	AR	BR	
	A	B	d				
SBR	H	AAA		NSI	A-3	BP	<p>+0 Channel 10 . Channel 11 Channel 12</p> <p>d-Character Immediate Space</p> <p>J 1 space K 2 spaces L 3 spaces</p> <p>d-Character After Print Space</p> <p>/ 1 space S 2 spaces T 3 spaces</p> <p>Store B-Address register. The contents of the B-Address register are stored in a 3-position field specified by the A-Address.</p>

Table D-1 (cont)

Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format					Address Registers After Operation			Comments
OP	Operands				IR	AR	BR	
	A	B	d					
SBR	H	AAA	BBB		NSI	A-3	Bp	Store B-Address register. The contents of the B-Address register are stored in a 3-position field specified by the A-Address. The B-Address register contains the address of this present instruction.
ZS	-0	AAA			NSI	A-La	A-La	Zero and Subtract. The sign of the A-Field is changed. A word mark must be associated with the A-Field data.
ZS	-0	AAA	BBB		NSI	A-LW	B-1b	Zero and Subtract. The A-Field data is subtracted from the zeroed 9-Field and the sign is changed.
SS	K				NSI	dbb	dbb	Overlap OFF. This instruction returns the processing unit to normal operation.
SS	K	AAA			NSI	BI	dbb	Overlap OFF and Branch. A branch is taken to the instruction specified the A-Address.

Table D-1 (cont)
Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format				Address Registers After Operation			Comments	
OP	Operands			IR	AR	BR		
	A	B	d					
SS	K			⊠	NSI	dbb	dbb	Reset Overlap. This instruction resets the overlap mode and returns the processing unit to normal.
SS	K	AAA		⊠	NSI	BI	dbb	Reset Overlap and Branch. A branch is taken to the instruction specified by the A-Address.
SS	K			§	NSI	dbb	dbb	Overlap ON. The processing unit is set in overlap mode.
SS	K	AAA		§	NSI	BI	dbb	Overlap ON and Branch. A branch is taken to the instruction specified by the A-Address.
SS	K			d	NSI	dbb	dbb	Select Stacker. The card that has been read or punched goes to the pocket specified by the d-Character.
					d-Character	Feed	Pocket	
					1	Read	1	
					2	Read	8/2	

Table D-1 (cont)

Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format		Operands			Address Registers After Operation			Comments
OP		A	R	d	IR	AR	BR	
		SS	K	AAA		d	NSI	
LCA	L	AAA			NSI	A-La	BP-La	Load Characters to a Word Mark.
LCA	L	AAA	BBB		NSI	A-La	B-La	Load Characters to a Word Mark. The A-Field data and word mark are moved to the B-Field. The move is stopped by the A-Field word mark. The B-Field word marks are cleared, if present.
MCW	M	AAA			NSI	A-Lw	BP-La	Move Characters to a Word Mark. The B-Address is taken from the B-Address register. The first word Mark sensed terminates the operation.
MCW	M	AAA	BBB		NSI	A-Lw	B-Lw	Move Characters to A or B Word Mark. The A-Field data is unchanged by

Table D-1 (cont)

Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format					Address Registers After Operation			Comments
OP		Operands			IR	AR	BR	
		A	B	d				
R(*1)	M	%G1	BBB	R	NSI	BBB	B+Lb	<p>this instruction.</p> <p>Read a Card. The B-Address specifies the beginning address of the input card area. The data is transferred to core until a group mark word mark is sense which terminates the instruction.</p>
P(*1)	M	%G1	BBB	G	NSI	BBB	B+Lb	<p>Punch a Card. The B-Address specifies the beginning address of the output card area. The data is transferred from core to the card punch until a group mark word mark is sensed which then terminates the instruction.</p>
W(*1)	M	%Y1	BBB	W	NSI	BBB	B+Lb	<p>Write a Line. The B-Address specifies the beginning address of the print area. The data is transferred</p>

1 Applicable only to the 1440.

Table D-1 (cont)

Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format					Address Registers After Operation			Comments
OP	Operands			IR	AR	BR		
	A	B	d					
SD	M	%F0	BBB	R	NSI	B+6	B+7	<p>from core to the printer until a group mark word mark is sensed which terminates the instruction.</p> <p>Seek Disk. The A-Address specifies that a seek operation is to be performed. The B-Address specifies the high-order position of the disk-control field in core storage.</p>
RD	M	%F1	BBB	R	NSI	B+6	B+Lb+11	<p>Read Disk Sectors. The B-Address specifies the high-order position of the disk-control field. The data is read into storage beginning at the B-Address plus 10 positions and continues until a group mark word mark is sense in core or the end of sector is reached. If a group mark word mark is detected before reading of the record is completed, the wrong-length-record indicator is turned ON.</p>

Table D-1 (cont)
Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format					Address Registers After Operation			Comments
OP	Operands				IR	AR	BR	
	A	R	d					
WD	M	ZF1	BBB	W	NSI	B+6	B+Lb+11	Write Disk Sectors. The B-Address specifies the high-order position of the disk-control field. The data to be written begins at the B-Address plus 10 positions and continues until a group mark word mark is sensed in core or the end of sector is reached.
WDC	M	ZF3	BBB	W	NSI	Ap	Bp	Write Disk Check. The B-Address specifies the high-order position of the disk-control field. The operation causes the data on disk to be compared against the data in core.
RDCO	M	ZF5	BBB	R	NSI	B+6	B+Lb+3	Read Disk with Sector-Count Overlay. The B-Address specifies the high-order position of the disk-control field. The number of sectors to be read is taken from the first three positions of the disk record and placed in the sector-count field.
WDCO	M	ZF5	BBB	W	NSI	B+6	B+Lb+8	Write Disk with Sector-Count Over-

6'8'7'9 JB

Table D-1 (cont)

Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format					Address Registers After Operation			Comments
OP	Operands				IR	AR	BR	
	A	B	d					
MU	M	QU#	BBB	R	NSI		GM+1	lay. The B-Address specifies the high-order position of the disk-control field. The sector-count field in the disk-control field is decremented by one and then written in the first three positions of the first sector written.
MU	M	QU#	BBB	W	NSI		GM+1	Read Tape in <u>Overlap</u> Mode. The <u>Q</u> in the A-Address signifies that the tape operation is to be performed in overlap mode. The B-Address references the high-order position of the input area. An inter-record gap on tape or a group mark word mark in core terminates the operation.
MU	M	QU#	BBB	R	NSI	%4#	B+Lb+1	Write Tape in <u>Overlap</u> Mode. A group mark word mark in core causes an inter-record gap on tape.
MU	M	QU#	BBB	R	NSI	%4#	B+Lb+1	Read Tape. The # in the A-Address signifies the tape unit from which the record is to be read. The oper-

Table D-1 (cont)
 Emulated Instructions
 for the IBM 1401/1440/1460 System

Instruction Format					Address Registers After Operation			Comments
OP	Operands				IR	AR	BR	
	A	B	d					
MU	M	ZTO	BBB	R	NSI	Z30	B+Lb+1	ation is terminated by an inter-record gap on tape or a group mark word mark in core storage. Read from Console Printer. The B-Address specifies the high-order position of the B-Field into which the data from the console is to be read.
MU	M	ZU#	BBB	W	NSI	Z4#	B+Lb+1	Write Tape. The B-Address specifies the high-order position of the record in core storage.
MU	M	ZTO	BBB	W	BSI	Z30	B+Lb+1	Write on Console Printer. A group mark word mark terminates the instruction.
NOP	N				NSI	Ap	Bp	No Operation. If characters without word marks follow this instruction they enter the A and B-Address registers.
MCM	P	AAA			NSI	A+La	A+La	Move Characters to Record Mark or

Table D-1 (cont)

Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format					Address Registers After Operation			Comments
OP	Operands				IR	AR	BR	
	A	B	d					
MCM	P	AAA	BBB		NSI	A+La	B+La	Group Mark. Move Characters to Record Mark or Group Mark. Characters are moved from the A-Field to the B-Field. The A and B-Addresses specifies the the high-order positions of the fields. The operation is terminated by a record mark or group mark word mark.
SAR	Q	AAA			NSI	A-3	Ap	Store A-Address Register. The contents of the A-Address register of the previous operation are stored in a 3-position field specified by the A-Address.
S	S	AAA			NSI	A-La	A-La	Subtract. The A-Field data is not affected by the instruction.
S	S	AAA	BBB		NSI	A-Lw	B-Lb	Subtract. The A-Field data is subtracted from the B-Field data and the result is stored in the B-Field. Algebraic sign control is implemen-

Table D-1 (cont)
Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format		Operands			Address Registers After Operation			Comments
OP		A	B	d	IR	AR	BR	
CU	U	%U#		B	NSI	%4#	d4x	ted. Backspace Tape Record. The tape unit specified by the A-Address is backspaced until an inter-record gap on the tape is sensed.
CU	U	%U#		E	NSI	%4#	d4x	Skip and Blank Tape. The tape unit specified by the A-Address moves forward and erases approximately seven inches of tape.
CU	U	%U#		M	NSI	%4#	d4x	Write Tape Mark. A special character (8421) is recorded following the last tape record and specifies an End-of-Reel condition.
CU	U	%U#		R	NSI	%4#	d4x	Rewind Tape. The tape unit specified by the A-Address rewinds its tape.
CU	U	%U#		U	NSI	%4#	d4x	Rewind Tape and Unload. At the end of the rewind, the tape unit is out

Table D-1 (cont)
Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format					Address Registers After Operation			Comments												
OP		Operands																		
		A	R	d	IR	AR	BR													
BWZ	V	AAA	BBB	d	BI NSI	BI BI	NSI B-1	<p>to a Not Ready status. Branch if Word Mark and/or Zone.</p> <p>No Branch.</p> <p>d-Character Condition</p> <table style="margin-left: 40px; border: none;"> <tr> <td style="padding-right: 20px;">1</td> <td>Word Mark</td> </tr> <tr> <td>2</td> <td>No Zone</td> </tr> <tr> <td>B</td> <td>12-Zone (AB-bits)</td> </tr> <tr> <td>K</td> <td>11-Zone (B, No A bit.)</td> </tr> <tr> <td>S</td> <td>Zero Zone (A, No B bit.)</td> </tr> <tr> <td>3</td> <td>Either a word</td> </tr> </table>	1	Word Mark	2	No Zone	B	12-Zone (AB-bits)	K	11-Zone (B, No A bit.)	S	Zero Zone (A, No B bit.)	3	Either a word
1	Word Mark																			
2	No Zone																			
B	12-Zone (AB-bits)																			
K	11-Zone (B, No A bit.)																			
S	Zero Zone (A, No B bit.)																			
3	Either a word																			

Table D-1 (cont)

Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format					Address Registers After Operation			Comments
OP	Operands			IR	AR	BR		
	A	R	d					
R	1	AAA					<p>mark or no zone.</p> <p>C Either a word mark or 12-zone.</p> <p>L Either a word mark or 11-zone.</p> <p>T Either a word mark or zero-zone.</p> <p>Read and Branch.</p> <p>BI BI NSI</p> <p>After the card has been read, an automatic branch is taken to the instruction specified by the A-Address.</p>	
W	2			NSI	Ap	333	<p>Write a Line. The data in the print area is transferred to the printer.</p>	

Table D-1 (cont)

Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format			Address Registers After Operation			Comments	
OP	Operands			IR	AR		BR
	A	B	d				
W	2	AAA				<p>After the printing is completed, the printer advances one line.</p> <p>Write and Branch.</p>	
W	2			BI	BI	NSI	<p>An automatic branch is taken to the instruction specified by the A-Address after the print operation is completed.</p>
W	2			NSI	dpp	333	<p>Write Word Marks. All word marks in the print area are printed as a numeric 1.</p>
W	2			BI	BI	NSI	<p>Write Word Marks and Branch.</p> <p>After the word marks are printed, an automatic branch is taken to the instruction specified by the A-Address.</p>
WR	3			NSI	Ad	081	<p>Write and Read. The print operation is performed.</p>

Table D-1 (cont)
Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format		Operands			Address Registers After Operation			Comments
OP		A	B	d	IR	AR	BR	
		WR	3	AAA			BI	
P	4				NSI	Ap	181	Punch a Card. The data in storage positions 101 through 180 is punched into a card.
P	4	AAA			BI	BI	NSI	Punch and Branch. After the punch operation is completed, an automatic branch is taken to the instruction specified by the A-Address.
RP	5				NSI	Ap	181	Read and Punch. The two operations overlap and the B-Address register may stand at 081, depending on which operation is completed first.
RP	5	AAA						Read, Punch, and Branch.

Table D-1 (cont)

Emulated Instructions
for the IBM 1401/1440/1460 System

Instruction Format		Address Registers After Operation			Comments		
OP	Operands			IR		AR	BR
	A	B	d				
				BI	BI	NSI	After the I/O operations are completed, an automatic branch is taken to the instruction specified by the A-Address.
WP	6			NSI	Ap	181	Write and Punch. The print operation is completed first and then the punch operation is performed.
WP	6	AAA		BI	BI	NSI	Write, Punch, and Branch.
WRP	7			NSI	Ap	181	Write, Read, and Punch. The print operation is completed first, then the read and punch operations are performed. The B-Address register may stand at 081, depending on which operation is completed first.

Table D-1 (cont)
 Emulated Instructions
 for the IBM 1401/1440/1460 System

Instruction Format		Operands			Address Registers After Operation			Comments
OP		A	B	d	IR	AR	BR	
		WRP	7	AAA			BI	
SRF	3				NSI	Ad	Bp	Treated as NOP.
SPF	9				NSI	Ad	Bp	Treated as NOP.

Table D-2

Key to Abbreviations

Abbreviation	Definition
A	The A-Address of the instruction.
Ap	The previous contents of the A-Address register.
B	The B-Address of the instruction.
Bp	The previous contents of the B-Address register.
dbi	The d-Character is at the hundreds position; the tens and units positions are those of the branch instruction.
d/bb dpp	The d-Character is at the hundreds position; the tens and units positions are those of the previous instruction. BLANKS
GM	A group mark with a word mark.
La	The number of positions in the A-Field.
Lb	The number of positions in the B-Field.
Lp	The number of positions in the product field.
Lq	The number of positions in the quotient field.
Lw	The number of positions in the A- or B-Field whichever is shorter.
NSI	The address of the next sequential instruction.

APPENDIX E

EMULATION ERROR CODES

GENERAL.

The following list of error codes is generated by the Emulator program. They reflect those error conditions that would normally be designated hardware errors in the 1400 series. Certain error codes reflect error conditions unique to the Emulator program itself.

<u>Error Code</u>	<u>Definition of Error</u>
A	Decoded memory address exceeds 1401 memory size.
C	Op code error. Either invalid op code or missing word mark detected during fetch cycle.
D	Invalid d-Character.
E	Edit op code. A 1-position field cannot be edited.
L	Instruction length error. Error may be an incomplete A- or B-Field in SAR or SBR or during initial decoding of instruction in AAR and BAR.
M	Multiply op code. Error denotes premature word mark in B-Field.
N	Instruction not implemented.
S	Memory size error in encoding 1401 address.
T	Magnetic tape operation. Instruction has attempted to write a zero-length tape record.
U	Tape unit unassigned. The unit number is contained in the X register.
W	Load op code. Instruction has attempted to write past location 0 in 1401 memory.
Y	Tape buffer is too small.
Z	Magnetic tape/disk/SPD/op. Write instruction has reached end of 1400 memory without encountering a word mark group mark.

BCD TO EBCDIC
CONVERSION CHART

BCD CHARACTER	EBCDIC	CARD CODE	TAPE CODE 7-TRACK	TAPE CODE 9-TRACK	TRANSLATE TABLE ADDRESS
Blank	Same			40	000
. Period	Same	12-3-8	BA 8 2 1	4B	166
⋈ Lozenge	<	12-4-8	BA 8 4	4C	170
(Left Parenthesis	Same	12-5-8	BA 8 4 1	4D	172
< Less Than	+	12-6-8	BA 8 4 2	4E	174
⌘ Group Mark		12-7-8	BA 8 4 2 1	4F	176
& Ampersand	Same	12	BA	50	140
\$ Dollar Sign	Same	11-3-8	BA 8 2 1	5B	126
* Asterisk	Same	11-4-8	B 8 4	5C	130
) Right Parenthesis	Same	11-5-8	B 8 4 1	5D	132
; Semicolon	Same	11-6-8	B 8 4 2	5E	134
Δ Delta	⌘	11-7-8	B 8 4 2 1	5F	136
- Minus	Same	11	B	60	100
/ Slash	Same	0-1	A 1	61	042
, Comma	Same	0-3-8	A 8 2 1	6B	066
% Per Cent	Same	0-4-8	A 8 4	6C	070
∪ Word Separator	—	0-5-8	A 8 4 1	6D	072

BCD CHARACTER	EBCDIC	CARD CODE	TAPE CODE 7-TRACK	TAPE CODE 9-TRACK	TRANSLATE TABLE ADDRESS
' Apostrophe	>	0-6-8	A 8 4 2	6E	074
## Tape Segment Mark	?	0-7-8	A 8 4 2 1	6F	076
¢ Cent			A	7A	040
# Pound Sign	Same	3-8	8 2 1	7B	026
@ Commercial At	Same	4-8	8 4	7C	030
: Colon	'	5-8	8 4 1	7D	032
> Greater Than	=	6-8	8 4 2	7E	034
✓ Tape Mark	"	7-8	8 4 2 1	7F	036
? Plus Zero		12-0	BA 8 2	C0	164
A	Same	12-1	BA 1	C1	142
B	Same	12-2	BA 2	C2	144
C	Same	12-3	BA 2 1	C3	146
D	Same	12-4	BA 4	C4	150
E	Same	12-5	BA 4 1	C5	152
F	Same	12-6	BA 4 2	C6	154
G	Same	12-7	BA 4 2 1	C7	156
H	Same	12-8	BA 8	C8	160
I	Same	12-9	BA 8	C9	162
! Minus Zero		11-0	B 8 2	D0	124
J	Same	11-1	B 1	D1	102

BCD CHARACTER	EBCDIC	CARD CODE	TAPE CODE 7-TRACK	TAPE CODE 9-TRACK	TRANSLATE TABLE ADDRESS
K	Same	11-2	B 2	D2	104
L	Same	11-3	B 2 1	D3	106
M	Same	11-4	B 4	D4	110
N	Same	11-5	B 4 1	D5	112
O	Same	11-6	B 4 2	D6	114
P	Same	11-7	B 4 2 1	D7	116
Q	Same	11-8	B 8	D8	120
R	Same	11-9	B 8 1	D9	122
# Record Mark		0-2-8	A 8 2	E0	064
S	Same	0-2	A 2	E2	044
T	Same	0-3	A 2 1	E3	046
U	Same	0-4	A 4	E4	050
V	Same	0-5	A 4 1	E5	052
W	Same	0-6	A 4 2	E6	054
X	Same	0-7	A 4 2 1	E7	056
Y	Same	0-8	A 8	E8	060
Z	Same	0-9	A 8 1	E9	062
0	Same	0	8 2	F0	024
1	Same	1	1	F1	002
2	Same	2	2	F2	004

BCD CHARACTER	EBCDIC	CARD CODE	TAPE CODE 7-TRACK	TAPE CODE 9-TRACK	TRANSLATE TABLE ADDRESS
3	Same	3	2 1	F3	006
4	Same	4	4	F4	010
5	Smae	5	4 1	F5	012
6	Same	6	4 2	F6	014
7	Same	7	4 2 1	F7	016
8	Same	8	8	F8	020
9	Same	9	8 1	F9	022

SECTION 3
OPERATING INSTRUCTIONS
FOR FREE STANDING EMULATION

GENERAL.

The operation of the IBM 1401/1440/1460 Emulator is divided into two general areas: Emulator Load and actual operation of the Emulator.

The Emulator Load requires only a simple load from the cassette which prepares the B1700 processor for execution of 1401/1440/1460 programs.

This section describes the required Emulator Load procedures, the control cards and the CONSOLE PRINTER messages which are displayed by the Emulator and which are entered by the operator.

EMULATOR LOAD PROCEDURES.

To load the Emulator from the tape cassette the following operating procedures must be followed in sequence:

- a. Turn the Control Mode Switch to Tape.
- b. Turn the Select Switch to Two (2).
- c. Turn the Register Dial to X.
- d. Power on the Tape Cassette Unit.
- e. Mount the Emulation Cassette (if the Beginning of Tape (BOT) indicator is not on depress the Rewind Button).
- f. Depress the Clear Button.
- g. Depress the Start Button.

Once the Bootstrap Loader has been loaded from the cassette the B1700 processor will HALT and all of the Console Display Lights will be on. HEXADECIMAL "FFFFFF" *L=AAAAAAA*

Exception Conditions: *X=4=1*

If any light on the Console is not lit then the Bootstrap Loader did not load correctly and the process must be repeated.

- h. Turn the Mode Switch to RUN.
- i. Depress the Start Button.

After the Start Button is depressed the Bootstrap Loader will load the Emulator from the cassette into B1700 memory and turn control over to the Emulator. Once the Emulator obtains control the following message will be displayed: (DD = today's date,

MMM = the month and YYYY = the year):

ENTER DATE DD MMM YYYY

After the operator enters the date the emulator will display the following message (X = the version number and YY = the level number):

EM1400 Version X Level YY 21 June 1973

The Emulator is in a ready status to execute 1400 programs.

CONTROL CARD SEQUENCE.

To execute the 1401/1440/1460 Emulator the following cards must be entered into the card reader in the following sequence:

- a. ?EMULATE EM1401 <Program - ID>.
- b. EMOPT CARD SW=ABC E G EOJ=999999.
- c. 1400 object card deck.
- d. 1400 data card deck.
- e. ?END.

The above cards are described in detail in the paragraphs which follow.

EMULATE CARD.

The EMULATE CARD is ~~fixed~~ format and is defined as follows:

<u>Columns</u>	<u>Field</u>	<u>Field Description</u>
1	?	Invalid Character
2-8	EMULATE	Start Emulation of a new 1401/1440/1460 Program
10-15	EM1401	} Emulator ID } 1400 Program-ID to be Emulated
17-26	Program-ID	

EMOPT CARD.

The EMULATE OPTION CARD is fixed format and is defined as follows:

<u>Columns</u>	<u>Field</u>	<u>Field Description</u>										
1	Blank	Blank										
2-6	EMOPT	Designates EMULATE-OPTION CARD										
8		Specifies 1401/1440/1460 Card										
		<table border="1"> <thead> <tr> <th><u>Code</u></th> <th><u>Memory Size</u></th> </tr> </thead> <tbody> <tr> <td></td> <td>16k character memory</td> </tr> <tr> <td>8-4</td> <td>12k character memory</td> </tr> <tr> <td>8</td> <td>8k character memory</td> </tr> <tr> <td>4</td> <td>4k character memory</td> </tr> </tbody> </table>	<u>Code</u>	<u>Memory Size</u>		16k character memory	8-4	12k character memory	8	8k character memory	4	4k character memory
<u>Code</u>	<u>Memory Size</u>											
	16k character memory											
8-4	12k character memory											
8	8k character memory											
4	4k character memory											
10-13		This field specifies the hardware device from which the 1400 object program is to be loaded.										
	15											
	LOAD = CARD	CARD - specifies the 1400 object program is <i>default</i> object deck form.										
	LOAD = TAPE	TAPE - specifies the 1400 object program is to be loaded from tape.										
	LOAD blank	If field does not contain either CARD or TAPE the default will be that the object program is in object deck form.										
20-29	SW=ABCDEFG	The sense switch option specified the initial settings of the sense switches. The alpha character representing a particular switch must be in its relative position or else the switch will not be set. The default is all switches are off.										
35-44	EOJ=AAABBB	This option indicates the value of the A and B address register during a 1400 halt command that signifies the										

30

ColumnsFieldField Description

55-62

STOP=III
or
STOP=DDDDD

end of job condition. The AAA portion must be an actual 1400 address and not the decimal equivalent of that address. The BBB option is not required.

This option is normally used as a debugging aid that will cause the 1400 object program to stop at the machine address indicated by "III" (actual 3-character 1400 address) or "DDDDD" (5-digit decimal 1400 address).

66-76

TAPE= 123456

This option specifies the tape units required by the 1400 program. Card columns 71 through 76 represent 1400 tape units 1 through 6 respectively. B1700 tape units are alphabetically assigned A through N.

Example: If a 1400 program requires tape drives 1, 2, 4 and tape 1 is mounted on tape unit A, tape 2 is mounted on tape B, and tape 4 is mounted on tape unit C the following tape assignments would be required.

TAPE=AB C

NOTE: card columns representing unused tape units should be left blank.

TO ALTER SENSE SWITCHES.

Sense switches may be altered by the following message:

```
SW=AB DEFG
```

In the above example sense switches A, B, D, E, F, G are set. Sense switch "C" is not set because the position that sets this sense switch contains a blank rather than a "C".

After the above message is entered the emulator will display the sense switch settings. An example might be:

```
SW=AB DEFG
```

TO OBTAIN PROGRAM STATUS.

To obtain the status of the 1401/1440/1460 program the operator may enter the following message:

```
WYE
```

In response to the above message the emulator will display the INSTRUCTION ADDRESS REGISTER (IAR), the instruction, A and B - Address Registers before execution, sense switch settings, the arithmetic overflow indicator, and the comparison indicator.

The following is an example:

```
IAR=02436 OP=A081061 A=00080 B=00060 SW=AB DEFG O=
```

After the above message is displayed by the emulator the operator must reply with the "OK" message or by depressing the END-OF-MESSAGE key. This will allow the emulator to continue processing of the 1400 program.

EMULATOR HALT MESSAGE.

This message is displayed on the Console Printer whenever a 1401/1440/1460 Halt instruction is encountered. The display shows the settings of the Instruction Address Register (IAR) the instruction, the A and B-address Registers, the sense switch settings, the arithmetic overflow indicator, and the comparison indicator. The message format is as follows:

```
1400 HALT IAR= 673
IAR=00673 OP=.999999 A=00999 B=00999 SW=AB DEFG O=
```

OPERATOR REPLIES TO EMULATOR HALT MESSAGE.

The operator may respond to the Emulator HALT message with the following input text:

- a. To continue emulation of the object program reply with "OK".
- b. To negate the branch of the HALT command reply with "START".
- c. To emulate at a new start address reply with "TRA<III>" where III is the 3-character actual address, or "TRA<DDDDD>", where DDDDD is the decimal equivalent of the actual 1400 3-character address.
- d. To bring the current 1400 program enter "END" this message is used to CLOSE Files when using the EMV or B1700 MCP. Free Standing Emulator will display EOJ message and wait to execute the next 1400 program.

DEBUGGING 1400 INPUT MESSAGES.

The following is a list of 1400 Console Printer input messages that are normally used as debugging aids:

<u>Text</u>	<u>Definition</u>
TRN	Start 1400 trace (see Appendix A).
TRN <1400 ADDRESS>	Start 1400 trace at the address specified by <1400 ADDRESS>.
TOF	Stop 1400 trace.
SIN < " >	Start single instruction mode (see Appendix B).

<u>Text</u>	<u>Definition</u>
SOF	End single instruction mode.
DUMP	Dump 1400 memory (see Appendix C).
DUMP <1400 ADDRESS>	1400 memory will be dumped starting at the address specified by <1400 ADDRESS>.
TRA <1400 ADDRESS>	Start execution of object code at the address specified by <1400 ADDRESS>.
STOP <1400 ADDRESS>	Stop execution of object code at the address specified by <1400 ADDRESS>.
ALT <1400 ADDRESS> ↑DATA	Alter data in 1400 memory starting at the address specified by <1400 ADDRESS>. If a character is to be accompanied by a word mark in 1400 memory then the special character (↑) must precede that character. A maximum of 60 characters may be entered with each ALTER message.
DIS <1400 ADDRESS>	Display 25 characters of 1400 memory starting at the address specified by <1400 ADDRESS>. The special character (↑) will precede any character that has a word mark associated with it.
SET ↑C	All of 1400 memory will be set to the character by "C" also if a word mark is to accompany the character then the special character (↑) must precede the character to be inserted.
***	Any comment to the right of the "***" message will be transferred to the printer.
*CO	Any comment to the right of the "*CO" message will be considered remarks.

RESET.

Re-initializes emulator
≡ Halt/clear/Start from console

END <address>

≡ EDS addresses reached

OUTPUT MESSAGES

<u>Message</u>	<u>Description</u>
Enter 1400 Data	When a read from console printer instruction is encountered this message is displayed to modify the operator that the 1400 program is requesting input data.
<ADDRESS> S-MEM PAR	A S-Memory parity was detected and the emulator must be reloaded.
1400 process error @ 750 error code = C IAR=00750 OP=A007165 A=00007 B=00165 SW=A =	This message specifies that a 1400 process error has occurred (see appendix F).
Reader not ready	Card reader not ready
Reader error	Card read incorrectly
Reader validity col XX	Card contains invalid character
Punch not ready	Card punch not ready
Punch error	Non recoverable error 1400 program must be restarted
Printer not ready	Printer not ready
Printer error	Possible non recoverable error
Tape Messages:	
MTX = Locked.	Rewind and unload tape
MTX = # Not ready.	Tape unit not ready
MTX = Lock out.	No write ring
MTX = Time out.	Non recoverable tape error
	(X = tape units A thru H # = 1400 tape units 1 thru 6)

B-1700 ERROR HALTS

All halts require the operator to re-load the emulator and to record register contents on the emulator trouble report form.

SOFT I/O HALTS

<u>L REGISTER IN HEX</u>	<u>DESCRIPTION OF HALT</u>
21	Status of a peripheral control is not proper. The current status of the control is displayed in the T register.
22	Invalid service request. Mask of service lines is in the T register (15-0). i.e. Channel 8 (0000 0000 1000 0000)
23	An I/O request from an unknown type of device. The status and control ID is in the T register. The valid control ID's are listed in the Systems Reference Manual.
24	A bad reference address was returned from a peripheral control. The correct reference address is in the X register and the bad reference address is in the Y register. T will contain the device channel number in Hex.
25	Second operation complete bit is missing from the Result Status field. The T register contains a copy of the Result Status.

EMULATOR HALTS

<u>L REGISTER IN HEX</u>	<u>DESCRIPTION OF HALT</u>
E14A01	S-Memory parity during emulator load.
E14A02	Missing device detected after exit from standard soft I/O driver.
E14A03	Parity error detected after exit from standard soft I/O driver during descriptor fetch from S-Memory.

L REGISTER
IN HEX

DESCRIPTION OF HALT

E14A04	Interrupt not returned by soft I/O when expected.
E14A05	Undefined error after exit from standard soft I/O driver.
E14A06	Error in device ignore table.
E14A07	Error in device hardware table.
E14A08	Timing error in punch buffer.
E14A09	Timing error in punch buffer.
E14A10	Probable A-Stack overflow.
E14B01	Unknown interrupt.

CO1

SPS with latency

CO2

to be used as a backup for computer

DO1

HP DISK

XXX
X
X OPERATION: X
X X
XXX

PLACE THE EMULATOR LOADER CASSETTE INTO THE CASSETTE READER,
TURN DIAL TO MTR (TAPE) MODE, REGISTER SELECT TO 2, AND THE
REGISTER DIAL TO L ... PRESS START. IF THE MTR LOAD WAS
SUCCESSFUL, THE PROCESSOR WILL HALT WITH HEX A'S IN THE L
REGISTER. IF THERE IS ANY OTHER VALUE IN L, START AGAIN.
TURN DIAL TO RUN MODE AND PRESS START. THE NEXT LOADER
RESPONSE WILL BE TO PRINT "REWIND CASSETTE" ON SPO. IT IS
IMPORTANT THAT THIS BE DONE IMMEDIATELY TO PREVENT THE
CASSETTE TAPE FROM WARPING. FOLLOWING "EMULATOR INPUT?"
MESSAGE, ENTER LOAD MEDIA INTO SPO;

1. CRA = INPUT FROM 80 COLUMN CARD READER
NOTE -

A ?END MUST FOLLOW EMULATOR CARD DECK TO
TERMINATE LOAD.

2. CAS = INPUT FROM CASSETTE.
NOTE -

IF A CASSETTE PARITY IS DETECTED BY THE
HARDWARE THE PROCESSOR WILL HALT WITH THE
PARITY LIGHT ON. IF THIS SHOULD OCCUR,
REWIND THE CASSETTE, PRESS CLEAR, START
ON CONSOLE AND TRY AGAIN. IT IS NOT
NECESSARY TO READ THE LOADER CASSETTE AGAIN.

3. MT = INPUT FROM MAGNETIC TAPE.
NOTE -

ONLY 9-TRACK, DRIVES A - I ARE ACCEPTABLE.

MAKE SURE INPUT DEVICE IS READY.
THE LOADER WILL LOAD THE EMULATOR FROM THE SPECIFIED MEDIA
AND TRANSFER CONTROL TO IT.

WHEN ANY PROCESSOR HALT OCCURS, REFER TO HALT CODE
DOCUMENTATION.

XXX
PAGE

TAPE I/O CONSIDERATIONS FOR 1401 EMV

Seven/Nine track tape will be read/written in either MOVE mode or LOAD mode.

MOVE Mode - any word marks in the 1401 data area will be removed on a WRITE or untouched on a READ operation.

LOAD Mode - WRITE operation - word marks will be converted to a word separator character (6D) and inserted before its associated character on the tape. Word marks remain untouched in core. If a word separator appears in a record to be written in LOAD mode, the two consecutive word separators will be written on to the tape. Thus a word separator character with a word mark will be written as three consecutive word separator characters on the tape.

READ - word separator characters will be inserted into 1401 core as a word mark associated with the following character from tape.

Two consecutive word separator characters will be inserted into 1401 core as one word separator, while three consecutive word separator characters will be inserted into 1401 core as a word separator; and a word mark on the following character which is not a word mark. Thus full compatibility is maintained with 1401 produced magnetic tapes.

1401 Word Marks in Magnetic Tape Operations

	READ	WRITE
MOVE	Untouched in core	<u>Removed</u> before writing on tape
LOAD	Removed from core & re-inserted only if on tape	Translate to word separator character then removed before writing on tape

USER SPECIFICATION OF NON-STANDARD 1401 DISK ADDRESSES

1. The standard ranges of 1401 Disk Addresses on IBM 1311 disks are:

<u>Drive</u>	<u>Sector Addresses</u>
0	000,000 - 019,999
2	020,000 - 039,999
4	040,000 - 059,999
6	060,000 - 079,999
8	080,000 - 099,999

2. As the disk addresses are not actually written onto Burroughs disk cartridges by the emulator a table of starting addresses (one for each 1401 disk drive) is maintained by the emulator. The table is initialized at emulator load time, or at "RESET" time, to the starting sector addresses (c.f. §1). Before each emulated 1401 disk instruction, the sector address from the 1401 disk control field is checked to ensure that it is in the expected range for that drive, i.e.:-

Starting sector address for current 1401 drive (=SSA) \leq sector address from 1401 disk control field $< SSA + 20,000$. If the sector address is outside the expected range an error "R" message will be typed and control given to the operator.

3. In order to provide a basic file protect system a 1401 user may use non-standard addressing (i.e., different from §1) on some or all disk drives. A mandatory EMDISK card will inform the emulator if any non-standard disk addresses are to be expected. It will precede the "EMOPT" card. The fixed format of the "EMDISK" card is:-

```
Card Column
  12....7  10      20      30      40      50

  ØEMDISK  0=0aaaaa  2=0aaaaa  4=0aaaaa  6=0aaaaa  8=0aaaaa
```

Where "aaaaa" is the starting sector address for each particular 1401 drive. If any 1401 drive number is omitted from Columns 10, 20, 30, 40, or 50, then no change will be made to the previous value of the starting sector address for that 1401 drive. The standard sector address assignment can be restored by the following "EMDISK" card without having to reload the emulator, nor use the "RESET" command:-

```
Card Column
  12....7  10      20      30      40      50

  ØEMDISK  0=000000  2=020000  4=040000  6=060000  8=080000
```

4. It is proposed to implement a "DRIVE" operator command so that the operator may override an "EMDISK" card. The syntax would be:

```
"DRIVE Ø n=0aaaaa"
```

Where "n" = 1401 disk drive number and "aaaaa" is the starting sector address.

USER SPECIFICATION OF NON-STANDARD 1311 DISK ADDRESSES
(Continued)

5. As none of the above involves a special "?" control card (where "?" stands for an invalid character in column 1) this implementation of non-standard disk addresses for the 1401 emulator is equally applicable to the free-standing, the EMV, and the B1700 MCP versions of the emulator.

INDEX

expand ?

Altering Sense Switches, 3-6

B 1700 Error Halts, 4-1

Control Card Sequence, 3-2

Debugging 1400 Input Messages, 3-7

Device Alternates, 5-1

EMOPT Card, 3-3

Emulate Card, 3-2

Emulated Instruction, D-1 through D-32

Emulated Instructions, 2-1

Emulation Error Codes, E-1

Emulator Features, 1-1

Emulator Halt Message, 3-7

Emulator Load Procedures, 3-1

Emulator Loader Stat Codes, 4-2

Emulator Trace Listing, A-2

Emulator Trace Option, A-1

Halts,

Emulator, 4-1

Soft I/O, 4-1

Instructions,

Arithmetic, 2-1

Console Printer, 2-3

Disk, 2-3

Input/Output, 2-1

Logic, 2-2

Magnetic Tape, 2-2

Miscellaneous, 2-3

Move and Load, 2-2

- Miscellaneous Input Messages, 3-9

- Obtaining Program Status, 3-6

- Operator Response to Emulator Halt Message, 3-7

Option,

Emulator Trace, A-1

Single Instruction, B-1