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**A MAGNETIC TAPE ANALYSIS AND COPYING PROGRAM,
AECOPY, MODIFIED FOR IBM360/370 COMPUTERS**

by

R.P. BACKSTROM

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ABSTRACT

The program AECOPY can be used to inspect and copy IBM360/370 magnetic tapes. The number and length of physical records on the tape and the actual records may be printed, and a number of other typical magnetic tape operations performed. The record characteristics and format of input tapes need not be known beforehand, and the type of error handling required may be specified by the user. Input to AECOPY may also be given in free form English from a batch job submitted by the user or by the operator at the computer console.

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1. INTRODUCTION

AECOPY was originally a widely used program for the IBM7040 computer formerly installed at the Australian Atomic Energy Commission Research Establishment, Lucas Heights [Richardson 1966]. It was written to overcome difficulties with magnetic tapes from widely different sources, many of which had unknown record formats and persistent errors. The IBM360 version of the program was produced and reported on by Payne [1969]. The program has since been extensively modified by Backstrom, during 1972, 1980 and 1981, to run under MVT and MVS operating systems on the IBM360/370 computers; the current report includes all of these improvements.

There are three basic differences between AECOPY and conventional tape utilisation programs:

- (a) The user can specify the error handling, both in the number of times that errors are retried, and in the number of permanent errors allowed.
- (b) The record characteristics and format of the input tape being processed need not be known by the user. Any number of files and records and any number of operations can be processed with a single statement from the user.
- (c) Input to the program is in free form English (see Section 4.2) with very few linguistic restrictions, with keywords tested for, and others ignored.

AECOPY treats magnetic tape operations in two slightly different ways. Read, tape copy, tape print and tape punch are known as primary operations, and control functions such as rewind and backspace are known as secondary operations.

With primary operations, a listing is given by AECOPY which states the number and size of the records, the occurrence of tapemarks and the placement and size of permanent errors found. This listing can be suppressed if desired. The number of errors on input and output tapes is given at the completion of the particular operation, but these messages cannot be suppressed.

In the IBM360 version, all input and output (I/O) operations used the IOCP subroutine [Richardson 1968] which needed the supervisor call (SVC) number 255 to perform DD-less I/O (without the need for job control statements describing the magnetic tape units to the operating system). The current version, however, uses completely standard I/O calls and so needs neither user SVCs nor special authorisation. It does, however, need DD-cards to describe each magnetic tape unit. Appendices A-D contain allowable words for AECOPY, error messages, a listing of the catalogued procedure and notes on the installation of AECOPY respectively.

2. PRIMARY OPERATIONS

Four magnetic tape operations are basic to AECOPY, and are known as primary operations. They are read, copy from tape to tape, copy from tape to printer and copy from tape to cardpunch. These operations are specified to AECOPY by the keywords READ, COPY, PRINT and PUNCH. A limited tape to disk copy function is possible using the PUNCH keyword to copy output with a logical record length (LRECL) of 80 bytes to the dataset described on the SYSPUNCH DD-card. This may be SYSOUT=B (cards) or any disk dataset defined by the user, but is appropriate only to magnetic tape records with an LRECL of 80 bytes.

2.1 Method

From an analysis of the keywords in the English language input, AECOPY decides on an operation. A control block for the particular unit and a channel program are constructed and this information is given to the I/O subroutine. This subroutine carries out the channel program via the execute channel program (EXCP) macro and returns the channel status word to AECOPY in the control block.

2.1.1 Record size

For primary operations, it is unnecessary for the record format or record sizes of the input tape to be known beforehand. Each read operation of the input tape is initiated with the maximum tape blocksize of 65 535 bytes set in the channel command word. There is an option to restrict this if only the first 'n' bytes of each tape record are of interest. By specifying PARM='REC=n' on the EXEC card, the maximum record length is restricted to 'n'

bytes. This may be useful if searching for data known to be in the first 'n' bytes, thus saving paper by not printing the entire record. It may also be desirable to have a smaller buffer if the maximum tape record length is known or the region size of the user's job needs to be reduced. Note that all records on the tape with blocksize greater than or equal to 'n' will appear on the summary listing as 'n'-byte records. After the successful completion of a read operation which has not read a tapemark, the residual byte count of the channel status word is used to calculate the actual size of the record read.

For copy operations, the input data are then written to the output tape with the correct blocksize inserted in the channel command word. For print or punch operations, the input data are written out in 80- or 40-byte units, depending on the mode of output chosen.

2.1.2 Error handling

The user can specify the number of times that errors are retried and the number of permanent errors allowed during a particular operation (permanent errors are those tape records which are still found to be in error after the number of tries specified). Keywords tested for are TIMES and ERRORS. A statement such as:

```
ALLOW 30 ERRORS TRY 12 TIMES.
```

instructs AECOPY that any error found is to be backspaced and re-read 12 times. If one of these attempts finds that the record is not in error, the record is accepted and processing continues. If the record is still found to be in error, it is noted as a permanent error and both the output list and the count of errors are adjusted. The number of permanent errors allowed (in this case 30) is checked, and processing either continues or is terminated depending on the number of errors found so far.

At the conclusion of the particular operation, a message is written on the listing giving the number of permanent input and output errors found, but if no errors are found, no message is given. The default values for error handling are that errors are not retried, and that only one permanent error is allowed.

2.1.3 Number of records

The number of records to be processed is specified through the keywords FILES and RECORDS. A file is taken to be the information on a tape which is concluded by a tapemark, and a record is taken to be one physical record, which may be a tapemark. The input information:

```
READ 5 FILES AND SEVEN RECORDS FROM 'TAPE1.
```

instructs AECOPY to read all the information up to and including the fifth tapemark, and then a further seven records past the fifth tapemark. Either RECORDS or FILES may be specified. If neither RECORDS nor FILES is specified, the default value for primary operations is one file.

2.2 Listing

With primary operations, a summary listing of the input tape is given unless this listing is suppressed. Suppression of the listing is through the keywords NOT, NO, NOR, NEITHER, WITHOUT combined with LIST and TALLY. Thus, instructions such as NO LIST or WITHOUT TALLYING will cause the summary to be suppressed.

The listing takes the form:

```
A ERR. B*S1,C*S2,ES3,T
```

where

- A is the cumulative total of records read during this primary operation up to the end of the line on which it occurs,
- ERR is present if the summary line includes an error record, but is otherwise left blank,
- B is the number of records of size S1 bytes read consecutively,
- C is the number of records of size S2 bytes read consecutively,
- E signifies an error record of size S3 bytes, and
- T means that a tapemark has been read.

One line of the listing is printed when a tapemark is read, or when the output line is full. An example of the listing is:

```

104      3*80,100*800,T
137 ERR. 6*50,E50,25*50,T
138      T

```

Here, three files have been read. The first consists of three 80-byte records followed by one hundred 800-byte records then by a tapemark. The second file consists of six 50-byte records followed by one 50-byte record (which was still found to be in error after the number of tries specified) followed by twenty five 50-byte records and a tapemark. The 'ERR.' signifies that there is at least one error record noted somewhere on the second line. The third file consists of a single tapemark.

The cumulative total shows that there have been 104 records read up to the end of the first file, 137 records up to the end of the second file, and 138 records, including tapemarks, read altogether during this operation.

2.3 Operations

The primary operations are read, copy, print and punch. When a magnetic tape record is read, the whole physical record is read into an area of core storage, and the channel status word is checked to find if the record is in error, or if the record is a tapemark. The record size is then calculated for use in listing, copying, printing or punching.

Tape copying is carried out if the key verb COPY is used but, for a successful copy, it is essential for the keyword TO or ONTO to appear after the COPY verb for assignment of the tape unit to be used for output. When tapes are copied, all the information on the tapes is copied. Thus labels are copied intact, and the output tape produced contains the same label as the input tape.

If magnetic tape errors occur on the input tape, the record which is read into core is not in error; for example, a parity error on the input tape is not carried over to core storage. When this record is copied to another tape unit, the record will no longer be recognised as an error when the output tape is subsequently read.

If a permanent magnetic tape error is found during input for a read, copy, print or punch operation, the message:

READ ERROR. STATUS BYTES XXXX, SENSE BYTES YYYY

(where XXXX and YYYY are the STATUS and SENSE bytes in hexadecimal code respectively) is immediately written on the listing. This is to ensure that the user is informed that the output tape is suspect if later error counts are lost because the operator cancelled the program.

Tape printing and punching can be done in EBCDIC or in hexadecimal, with the default being in EBCDIC. If hexadecimal printing or punching is required, the keyword HEX must be used after the keywords PRINT or PUNCH.

EBCDIC printing or punching is done in 80-byte segments of the physical record, and hexadecimal printing or punching uses 40-byte segments expanded to 80 bytes. For example, a three-byte record containing the characters 'ABC' will be listed in hexadecimal as 'C1C2C3', thus taking up 6 print positions. If a record to be printed in hexadecimal does not contain an exact multiple of 40 bytes, the last line is filled with blanks to mark the extent of the record. The PRINT command uses the SYSPRINT dataset for printing, so the output appears with the normal AECOPY listing, including record counts and page headings. The PUNCH command, however, uses the SYSPUNCH dataset making it possible to direct output to a disk dataset, provided that the LRECL is 80 bytes.

3. SECONDARY OPERATIONS

The following secondary operations are allowed by AECOPY:

REWIND
UNLOAD
ERASE GAP
ENDFILE (write tapemark)
BACKSPACE RECORDS
BACKSPACE FILES
FORWARD SPACE RECORDS
FORWARD SPACE FILES

The keyword TIMES used with secondary operations specifies the number of times that the operation is to be carried out. For example:

```
ENDFILE 'TAPE1 20 TIMES.
```

means that 20 tapemarks are to be written on the tape described by the DD-card TAPE1.

FORWARD SPACE 1 FILE means forward space the magnetic tape and position it immediately after the next tapemark record. Similarly, BACKSPACE 1 FILE means backspace the tape and position it immediately in front of the previous tapemark record. BACKSPACE FILES and BACKSPACE RECORDS can be combined by use of the keywords FILES and RECORDS. For example:

```
BACKSPACE 2 FILES AND 3 RECORDS ON 'TAPE2.
```

tells AECOPY to backspace two files on the tape described by the DD-card TAPE2, and then to backspace three records on the same tape. Note that the requested number of FILES and RECORDS should only be specified in this order (not RECORDS and then FILES). FORWARD SPACE FILES and FORWARD SPACE RECORDS can be combined in the same way.

The default values for REWIND, UNLOAD, ERASE GAP and ENDFILE are to carry out the operation once. The default values for BACKSPACE and FORWARD SPACE are to move the tape one record.

4. INPUT TO THE PROGRAM

Instructions to AECOPY may be given in English through the SYSIN dataset. If the SYSIN DD-card is missing, or PARM='C' is coded on the EXEC card, input is requested at the computer operator's console. This is useful for an interactive operator-initiated started task. In this case, a series of write to operator with reply (WTOR) prompts is issued, to which the operator may enter AECOPY commands, terminating the input with a reply consisting of a single slash (/).

PARM='C' may also be combined with PARM='REC=n' if desired. Thus, PARM='C,REC=10000' and PARM='REC=80,C' are both valid. Any number of input records are allowed with any number of sentences or parts of sentences on each

line with the restrictions that words may not be continued from one line to another, and that numerals are restricted to five digits. Analysis is restricted to the first 72 bytes of each input record to allow sequence numbering of input data to have no adverse effect on AECOPY.

The magnetic tapes are referred to by their DDNAMES in the command input to AECOPY and, to distinguish these from normal words, a leading quote (') is used. For operator console input, however, two quote characters must be entered (to satisfy the operating system) for each quote required. This was found to be too clumsy and error prone (entering a single quote terminated the operator input line), and so an ampersand (&) may be used instead.

4.1 Macro Facility

Repetitive input to AECOPY may be programmed via the LOOP and END keywords in column 1. For example, to print the label information from 10 magnetic tapes, using the same tape unit, we could enter:

```

...
LOOP 10
REWIND 'TAPE1.
PRINT 3 RECORDS FROM 'TAPE1. ALLOW 3 ERR TRY 10 TIMES.
UNLOAD 'TAPE1.
END
...

```

These loops may not be nested, but may contain up to 20 input lines each.

4.2 Input Analysis

AECOPY analyses the input for four types of word: verbs, key nouns, numerals and other words.

Each operation attempted by AECOPY consists of the information given from one verb up to the last word before the following verb. This collection of information including a verb is referred to as a sentence and may optionally be concluded with a full stop. Once a verb, except the first, is found during the scanning of the input, the information taken from the preceding sentence is used in an operation. For example: ENDFILE 'TAPE2 5 TIMES READ 'TAPE1. The 5 TIMES would refer to the preceding verb ENDFILE, with ENDFILE 'TAPE2 5

TIMES being a sentence.

Once a numeral is found in the input, a check is made of the word immediately following. If this next word is one of the key nouns (FILES, RECORDS, ERRORS and TIMES), the numeral is taken to refer to the key noun.

If the word found in the input is not numeric, the first three letters of the word are tested against entries in the AECOPY dictionaries. Note that this may have the curious effect of turning a phrase such as ALLOW SEVERAL ERRORS into ALLOW SEVEN ERRORS. If a word is immediately preceded by NOT, NO, NOR, NEITHER or WITHOUT, it is tested against the dictionary of negatives. Words without an immediately preceding negative are tested against the normal dictionary.

If a word is found in the dictionaries, appropriate action is taken, with the finding of a verb initiating the requested operation. A word is ignored if it is not found, therefore words such as 'the' or 'then' may be inserted to improve the readability of the input. This means that keywords may not only appear with any number of intervening blanks but other words may also be present. Such input may be termed 'free form English'.

The concept of double units is introduced for secondary operations. If a sentence specifies two magnetic tape units, the operation will be carried out on both units. The instruction:

REWIND 'TAPE1 AND 'TAPE2.

will result in a rewind of each tape unit in turn.

5. CONCLUSIONS

AECOPY has proved to be an extremely useful program and should be of great interest to operators of IBM360/370 computers using magnetic tapes extensively.

Its main advantages result from the differences between AECOPY and conventional magnetic tape programs (user-specified error recovery, handling unknown magnetic tape record formats, and the use of free form English input).

Because of the flexible error handling capability, some persistent tape errors can be overcome if they are retried a sufficient number of times. If a tape contains readable information or information in which individual errors may not be vital, a large number of permanent errors can be allowed so that all the information on the tape can be read. If a tape whose record format is not known is to be read, an instruction such as:

READ 100 FILES FROM 'TAPE1.

will cause the tape to be read until one error is found, or until the occurrence of 100 tapemarks.

The English input to the program allows a wide range of operations to be specified with no intervention necessary at the end of each file or at the start of each new operation. There is no limit to the number of operations which can be specified, the number of words per line in the input or the number of lines. There is no fixed format for words within the lines, except for LOOP and END which must appear in column 1.

6. ACKNOWLEDGEMENT

Acknowledgement is gratefully given for the support and assistance of Dr D.J. Richardson.

7. REFERENCES

Richardson, D.J. [1966] - AECOPY - A Tape Utilisation Program for the IBM7040 Computer. AAEC unpublished document.

Richardson, D.J. [1968] - IOCP - An Input/Output Control Program for IBM360 System Computers. AAEC/TM483.

Payne, D.A. [1969] - AECOPY - A Magnetic Tape Analysis and Utility Program for the IBM System/360. AAEC/E196.

APPENDIX A
ALLOWABLE WORDS FOR INPUT TO AECOPY

(a) Normal DictionaryVerbs

| | |
|-----------|---------------|
| READ | FORWARD SPACE |
| COPY | ERASE GAP |
| PRINT | REWIND |
| PUNCH | ENDFILE |
| BACKSPACE | UNLOAD |

Key Nouns

FILES
RECORDS
ERRORS
TIMES

Other words

| | | |
|-------|-------|-------------|
| LIST | SIX | NO |
| TALLY | SEVEN | NEITHER |
| ONE | EIGHT | WITHOUT |
| TWO | NINE | PRINTER |
| THREE | TEN | HEXADECIMAL |
| FOUR | NOT | TO |
| FIVE | NOR | ONTO |

(b) Dictionary of Negatives

(Action is taken if one of these words immediately follows a negative.)

Verbs

| | |
|---------|---------------|
| READ | BACKSPACE |
| COPY | UNLOAD |
| REWIND | ERASE GAP |
| ENDFILE | FORWARD SPACE |

Other words

LIST
TALLY
HEXADECIMAL

APPENDIX B
ERROR MESSAGES GIVEN BY AECOPY

(a) REGION INSUFFICIENT FOR 65535 BYTE BUFFER - nnn BYTES AVAILABLE

Either the region specified on the EXEC card should be increased or the REC=n parameter specified to reduce the buffer size.

(b) TAPE IS NOT KNOWN TO AECOPY

An input sentence specifying a primary operation does not have tape units specified.

(c) *****DDNAME: dddddddd NOT LOCATED -- JOBSTEP TERMINATED

An AECOPY operation specified a tape by DDNAME without a corresponding job control DD-card.

(d) READ ERROR. STATUS BYTES XXXX, SENSE BYTES YYYY
OUTPUT ERROR. STATUS BYTES XXXX, SENSE BYTES YYYY

Input or output errors were found during an AECOPY operation. Status and sense-byte data are displayed in hexadecimal to provide more detailed information about the errors.

(e) AECOPY -- ATTEMPT TO WRITE ON FILE-PROTECTED TAPE XXX
REPLY C TO CANCEL IF INTENTIONALLY FILE-PROTECTED
OTHERWISE, INSERT RING AND REPLY U

This message to the operator means that an output operation has been requested for a tape which is file-protected. If the tape is not currently at load point, AECOPY terminates the job because the operator cannot insert the ring without unloading the tape, thus losing the current tape position. If the tape is at load point, the operator then has the choice of inserting the write-enable ring to allow the output operation or replying 'C' to cancel the job.

(f) NUMBER OF ERRORS ON INPUT TAPE WAS nnnnn

A count of the permanent errors found on the tape read.

(g) NUMBER OF ERRORS ON OUTPUT TAPE WAS nnnnn

A count of the permanent errors found on the tape receiving the copy.

(h) AN INVALID OPERATION HAS BEEN SPECIFIED

The verb in a secondary operation is incorrect.

(i) NUMBER OF CHANNEL ERRORS WAS nnnnn

This message gives the number of incorrect channel status words found during execution. These errors are always retried. This message should only appear if there are hardware errors.

(j) SHORT RECORDS - UNPREDICTABLE RESULTS

AECOPY will cope with the smallest possible record (1 byte) for all normal operations. However, if a very small record is found to be in error, and this error record is extremely close to the preceding record without sufficient interblock gap, unpredictable results may occur if a retry of errors is specified because the tape may backspace over two records instead of one.

APPENDIX C
THE AECOPY CATALOGUED PROCEDURE

The following is a sample AECOPY catalogued procedure for use with four magnetic tapes, although any number may be specified. AECOPY will not automatically tie up four magnetic tape drives, unless actually requested, because the unwanted 'tape units' are actually dummy zero-track datasets on disk.

Note the use of 'LABEL=(,BLP)' on the tape DD-cards. This allows unrestricted magnetic tape access to AECOPY users, but could be changed to 'LABEL=(,SL)' or 'LABEL=(,NL)' with some loss of AECOPY function if bypass label processing is not permitted at the installation.

```
//AECOPY PROC U1=SYSDA,U2=SYSDA,U3=SYSDA,U4=SYSDA,
//          V1=,V2=,V3=,V4=
//*
//* USE AS FOLLOWS:
//*
//* //COPY EXEC AECOPY,U1=TAPE,V1='SER=USR001',
//* //          U2=TAPE,V2='SER=USR002'
//* //SYSIN DD *
//* --AECOPY COMMANDS--
//* /*
//*
//AECOPY EXEC PGM=AECOPY,REGION=100K
//STEPLIB DD DSN=###,DISP=SHR
//SYSPRINT DD SYSOUT=A,
//          DCB=(RECFM=FBA,BLKSIZE=1210,LRECL=121)
//SYSPUNCH DD SYSOUT=B
//          DCB=(RECFM=FB,BLKSIZE=800,LRECL=80)
//*
//TAPE1 DD LABEL=(,BLP),DISP=(,DELETE),SPACE=(TRK,0),
//        UNIT=&U1,VOL=&V1
//TAPE2 DD LABEL=(,BLP),DISP=(,DELETE),SPACE=(TRK,0),
//        UNIT=&U2,VOL=&V2
//TAPE3 DD LABEL=(,BLP),DISP=(,DELETE),SPACE=(TRK,0),
//        UNIT=&U3,VOL=&V3
//TAPE4 DD LABEL=(,BLP),DISP=(,DELETE),SPACE=(TRK,0),
```

The installation job is as follows:

```
//UPD      EXEC  PGM=IEBGENER
//SYSIN    DD   DUMMY
//SYSPRINT DD   SYSOUT=A
//SYSUT1   DD   DSN=...(PROC),DISP=SHR    <-- EDITING DATASET
//SYSUT2   DD   DSN=$$$ (AECOPY),DISP=OLD  <-- PROCLIB DATASET
//*
//LINK     EXEC  LKED,PARM='MAP'
//SYSLIN   DD   DSN=...(AECOPY),DISP=SHR  <-- EDITING DATASET
//SYSLMOD  DD   DSN=###(AECOPY),DISP=SHR  <-- LOAD MODULE DATASET
```