ATLAS COMPUTER LABORATORY

USERS' HANDBOOK

CHILTON · DIDCOT · BERKSHIRE

H.E. Rolling.

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The Laboratory showing the computer block on the right

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GENERAL INFORMATION

Introduction

The Atlas Computer Laboratory is one of the laboratories of the National Institute for Research in Nuclear Science. Its main equipment is a large I.C.T. (formerly Ferranti) Atlas computer, supported by the services and ancillary machinery needed to operate a powerful computer efficiently. The machine was ordered in the Autumn of 1961; it is due to come into regular operation not later than 31st March 1965. The Laboratory is financed by the Treasury and its services are available to all Universities and Colleges of Advanced Technology and to Government supported research laboratories and institutes.

In common with the rest of the National Institute the Atlas Laboratory makes no charge to Universities or Colleges for any of its services; the Government supported users are charged at cost and the Laboratory is allowed to sell machine time, if there is any available after meeting the prime needs, to industry, charging at the current commercial rate. The Laboratory is not subject to security restrictions of any kind.

Situation

The Laboratory is situated on the west side of the A.34 (Birmingham/Southampton) trunk road, 14 miles south of Oxford (there is a map at Appendix I).

The nearest station is Didcot (4 miles); London Airport is 45 miles away; the City of Oxford No. 12 (Oxford/Newbury) 'bus passes the site.

The correct postal address is:

Atlas Computer Laboratory,
National Institute for Research in Nuclear Science,
Chilton, Didcot, Berkshire.

Telephone Number: Abingdon 1900 (some extensions which may help users are given in Appendix III)

Telex: 83159

Telegrams: RUTHLAB, Telex, Abingdon.

Laboratory Building

The Laboratory is in two parts: a computer block (total area 15,000 sq. ft.) and an office block (total area 10,000 sq. ft.) linked by the entrance hall and stairways.

The computer is on two floors: the operating equipment (input/output and magnetic tape decks) on the upper floor and the bays of electronics (central processor, stores and co-ordinators) below. The reception and data preparation area and the tape and card store surround the computer operating area on the upper floor. There is a "think room" just outside the entrance to the reception area, where users can look over their work before handing it in for processing or after getting results off the machine.

The office block houses the Laboratory's permanent staff and also provides accommodation, mostly in small single offices, for users who would like to spend some time in the Laboratory developing a program or supervising a big production job.

Appendix II shows the approach to the Laboratory and gives a plan of the building.

Equipment

Atlas Computer:

Store - 48K ferrite core (K = 1024 words of 48 bits each)

8K fixed store } not accessible to users
1K working store }
96K magnetic drum store

Magnetic Tape - 16 Ampex TM.2 decks
2 IBM 729 Mark IV decks

Console - Engineers' console with input and output peripherals

Input - Card readers 2 ICT - 600 card/minute
Paper tape 2 Ferranti - 300 character/second

Output - Printers 2 Anelex - 1000 lines/minute, 120 character/line
Card punch 1 ICT - 100 card/minute
Paper tape 2 Teletype - 110 character/second

N.B. The paper tape equipment will handle 5, 7 or 8 track tape.

Ancillaries:

- Graph plotter	1 Benson-Lehner Model J
Card sorter	1 ICT - 750 card/minute
Reproducers	2 ICT - 100 card/minute
Interpreters	3 ICT - 22 character/second

Data Preparation Machines
(mostly for use by the Operating Staff)

- Card punches	8 IBM Type 026
Card verifiers	4 IBM Type 056
Typewriter card punches	2 ICT Type 35
Flexowriters	6
Teleprinters	2

Speed of Atlas

Some of the results of timing tests carried out on the Chilton Atlas during its commissioning are given below. All of the tests were designed to measure the internal computing speed of the machine; the time required for input and output was not recorded nor was the test program time-shared with any other job. In each case the test program was coded in a simple assembly language (AEL or Intermediate Input): consequently no inefficiencies of machine code due to compilers was involved.

(i) Time required for single instructions

a. Add floating point number to accumulator	1.7 microseconds
b. Multiply accumulator by floating point number	5.9 microseconds
c. Divide accumulator by floating point number	~ 20 microseconds

(ii) Time for various subroutines

a. Compute e^x (using the extracode 1703)	154 microseconds
b. Sort 5000 floating point numbers into ascending order	1 second
c. Invert a 100 x 100 matrix (computation only)	17 seconds

Programming Languages

The general principle is that programs will be accepted in any language for which there is an Atlas compiler, and these will be obtained by writing

COMPILER ***

in the Job Description.

The compilers which are expected to be used by the majority of users are AA (Atlas Autocode), AEL (Atlas Basic Language), ALGOL, EMA (Extended Mercury Autocode) and HARTRAN. Hartran is the local operating system which will be used for a large amount of the machine time and consists of ASP and Fortran compilers producing binary cards to be loaded by the BAS loader. The system is similar to the Monitor system on the IBM 7090 with ASP corresponding to FAP. The dialect of Fortran is sufficiently extensive to include Fortran II and most of Fortran IV as subsets.

Further information on these languages is given in the following publications:

I.C.T. Literature

These publications can be obtained through Mr. S.J. Dawes, I.C.T. Limited, 21 Portland Place, London W.1. Telephone LANgham 9211.

Atlas Provisional Programming Manual	(CS348 Jan 1963)
amended by: Errata and Amendments No. 1	(Sep 1963)
Input and Output for Atlas Computers 1 and 2	(Apr 1964)
Preparing a Complete Program for Atlas 1	(Aug 1964)
Errata and Amendments No. 2	(Aug 1964)
Atlas Basic Language (AEL) - Provisional Description (currently being revised)	
A Primer of Algol 60 Programming for the Atlas Computer	(CS379 Nov 1963)
Provisional Reference Manual for Atlas Algol	(CS378 Feb 1964)
Provisional Specification of Input/output Procedures for Atlas Algol	(CS395 Nov 1963)
Extended Mercury Autocode for Atlas and Orion	(CS350 Oct 1962)
Making a Fortran II Program Suitable for Use with the Atlas Fortran Compiler	(CS318B Feb 1964)

Additional information appears from time to time in I.C.T. Atlas Bulletins.

H.M.S.O. Publications

These may be obtained through your local bookseller.

INTERASP - An Intermediate Atlas Symbolic Programming Language	(AERE - R4285)
Atlas Fortran Manual (Part I)	(AERE - R4599)
Atlas Fortran Manual (Part II)	(currently being written)

Services

The Laboratory has been set up to provide a powerful computing service to a wide variety of users and it will do all it can to help its users to get their work done quickly and efficiently and with the least possible trouble to themselves. To this end the Laboratory is organised into three groups.

Operations Group

Users may bring work to the Laboratory personally or send it by post; it can be in manuscript to be punched by the data preparation staff or on cards, paper tape or IBM magnetic tape.

Normally work will be put through the computer by the operating teams. There is usually no advantage in the programmer running his own work, and it is more efficient to leave this to the professional operators: but in special circumstances the opposite can be true, and whilst this will be discouraged there will not be a complete embargo on the programmer running or monitoring his work personally.

This group will provide a program library and information service; it will include programmers to advise on the operating system, who will be glad to hear comments on this and suggestions for changes.

Programming Group

The Laboratory will not in general undertake the writing of programs for its users, but it will give help and advice both by personal discussion and by formal courses in programming.

As well as providing this advisory and educational service, the Programming Group is responsible for the compilers and for the programs required for standard processes such as matrix operations, quadrature, integration of differential equations, minimisation of functions and sorting.

Administration

The Staff in this group are concerned with the Laboratory's finance and general administration. They will also be pleased to help visitors wherever they can be of assistance. In particular, The Receptionist is available to help arrange hotel accommodation and transport.

PUTTING A JOB ON THE MACHINE

(1) JOB NUMBERS

To allow for easy reference to jobs and for any accountancy, all users must label their work with a Job Number. It is intended as a reference for a complete problem or project rather than for an individual run of a program. This number appears in the title of the job which is a part of the Job Description section of the program (see page 6).

The General Form of Job Numbers

The Job Number is made up or six alphanumeric characters: the first distinguishes between the five principal groups of users; the next four distinguish sub-groups of users and the particular job; the final character is at the user's disposal and allows a job to be broken into sub-sections where this is helpful.

The five main groups of users and the general form of their Job Numbers are:

Main Groups of Users	Job Numbers
(i) A.E.R.E. Harwell	Hxxxxy
(ii) R.H.E.L. Chilton	Rxxxxy
(iii) Atlas Internal	Ixxxxy
(iv) Universities and C.A.Ts	Vaaxxy Vaxxxy
(v) Other External Users including Government Departments	Exxxxy

where a's are letters identifying Universities and C.A.Ts
x's are digits 0-9 identifying the job
y's are digits 0-9 for the programmer's use

Examples of Job Numbers

(i) A.E.R.E.

A.E.R.E. users will use the initial letter H followed by a zero and will be given Job Numbers or continue to use their existing Job Numbers in the range 000-999.

e.g. With a present Job Number A123 and the need to distinguish which one of a set of programs is in use, say 6, the Atlas Job Number will be:

H01236

(ii) R.H.E.L.

R.H.E.L. users will use the initial letter R followed by four digits for the project.

e.g. Given that a project is allocated the number 456, the Atlas Job Number will be:

R0456y

(y is defined above)

(iii) Atlas

The Staff of the Atlas Computer Laboratory will use the initial letter I followed by a number issued by the Laboratory in the range 0000-9999.

e.g.

I0789y

(y is defined above)

(iv) Universities and C.A.Ts

Users from the Universities and C.A.Ts will use the initial letter V followed by one or two letters to indicate the user's University or College. The next two or three characters will be a number issued by the Atlas Computer Laboratory.

e.g. Sussex will use S with the specific number for the job:

VS345y

Bristol C.A.T. will use BC with the specific number, say 24:

VBC24y

(y is defined above)

(v) Other External Users

All other external users, including Government Departments, will use the initial letter E followed by a number issued by the Atlas Computer Laboratory in the range 0000-9999.

e.g.

E1234y

(y is defined above)

Requests for Job Numbers

(i) A.E.R.E.

A.E.R.E. users will obtain their Job Numbers from the Theoretical Physics Division.

(ii) R.H.E.L.

R.H.E.L. users will obtain their Job Numbers from the Applied Physics Division.

(iii) Atlas

For internal users work will be authorised within the Laboratory.

(iv) Universities and C.A.Ts

Users from Universities and C.A.Ts must request a Job Number by submitting a Job Application Form (see facsimile on page 4). When delay would cause difficulty a Job Number can be obtained by telephoning Abingdon 1900 Extension 6284, but this should be supported by an Application Form sent as quickly as possible.

The Job Application Form asks for the user's name and address; a rough estimate of the time to be used; a brief description of the job and a broad classification by discipline.

It is important that the Director of the Computer Laboratory at the user's University or C.A.T. should sign the form so that he is aware of the use being made of the Atlas computer at Chilton. Unsigned forms will be returned to the prospective user with a request to obtain the necessary authorisation.

Job Application Forms may be obtained from, and when completed should be returned to:

External Reception,
Atlas Computer Laboratory,
N.I.R.N.S.,
Chilton,
Didcot,
Berkshire.

Telephone Number: Rowstock 321

The sponsor of a job (i.e. whoever has signed the Job Application Form) should be told if the work seems likely to need more machine time than was asked for; the Laboratory reserves the right to request a further authorisation. Users are asked to request a new Job Number if the nature of a piece of work changes significantly or if they move from one University to another.

(v) Other External Users

Other external users, including Government Departments, must make formal arrangements with the Director, Atlas Computer Laboratory.

NATIONAL INSTITUTE FOR RESEARCH IN NUCLEAR SCIENCE

ATLAS COMPUTER LABORATORY

Chilton . Didcot . Berkshire
Telephone: Abingdon 1900
Extension 6284

JOB APPLICATION FORM

Name :

University, College or Department :

Address :

Telephone No : Extension:

Short Description of Job :

Estimate of Atlas Time Required (Hours) :

Classification

(Please mark the relevant box)

(1)	Mathematics	☐
(2)	Physics	☐
(3)	Chemistry	☐
(4)	Biology	☐
(5)	Engineering	☐
(6)	Chemical Engineering	☐
(7)	Metallurgy	☐
(8)	Medicine	☐
(9)	Meteorology	☐
(10)	Economics	☐
(11)	Sociology	☐
(12)	Psychology	☐
(13)	Administration	☐
(14)	All other work	☐

Signature: .....

Director of the University or College Computing Laboratory

Date .....

(2) OPERATION REQUEST CARD

Each job submitted will be accompanied by an Operation Request card.

National Institute for Research in Nuclear Science
ATLAS COMPUTER LABORATORY
Chilton, Didcot, Berkshire
Telephone:
Abingdon 1900 Extension 429

OPERATION REQUEST

Job Number:
Name:
Title:
Estimated Computing Time:
Compiler:

INPUT:

Cards	☐
Paper Tape 8 Track	☐
7 Track	☐
5 Track	☐
I.B.M. Tape	☐

(Title): .....

OUTPUT:

Line Printer	☐
Cards	☐
Paper Tape 8 Track	☐
7 Track	☐
5 Track	☐
I.B.M. Tape	☐

(Title): .....

Graphical	☐
Magnetic Tape Common	☐

Magnetic Tapes:

Comments: P.T.O.

Job Number: See Section (1), page 1.

Title: This is the title given in the Job Description (see page 6).

Estimated Computing Time: This can be given in hours, minutes or seconds, e.g. 7.5 seconds.

Compiler: Indicate which compiler is to be used.

Input: Tick the relevant boxes to show the form of input used. If IBM tape is used the label or title shown on the reel should be given in the space provided.

Output: Indicate in the appropriate boxes the forms of output expected.

Graphical Output: If this is expected, indicate the number of separate graphs.

Magnetic Tape Common: Indicate the number of common tapes used (see page 12).

Magnetic Tapes: Give the tape numbers of tapes to be used. See Section (4) Use of Magnetic Tapes (page 16) for information about the tape numbers to be used and how to obtain them.

Comments (to be written on reverse side of card): Any other remarks which may be useful to the Operating Staff.

(3) JOB DESCRIPTION

Introduction

The Atlas computer has a high computing speed and it is important that this should be used as effectively as possible. The speed of Atlas is also such that many different input and output devices can be controlled by the machine without seriously impairing its overall computing capacity and speed. In general, the input and output devices have very much lower information transfer rates than the machine, and as a result these devices can effectively be controlled while some computing job is in progress.

To make this possible a program known as the Atlas Supervisor has been written as part of the basic software of the computer. The Supervisor controls all the input and output devices attached to the machine and also attempts to organise the work presented to the machine to make the best use of the computer as a whole. However, to enable the Supervisor to achieve this aim, the user has to provide some particulars about every job which he presents to the machine.

The Supervisor requires details about the size of the job and about the time which the job is estimated to take on the machine. The user must also give details about the various magnetic tape, input and output requirements of the job so that the Supervisor can determine when all the relevant information is available for the start of the job as well as produce the output on the right output devices. All these particulars are given by the user in a Job Description.

Simple Jobs

For a large number of jobs, the Job Description takes the form of a preamble to the program and data. To illustrate the preparation of a Job Description, consider first a trivial program written in Mercury Autocode. In printed form this might be:

```
JOB V97473, J.S. GOON, KINGQUEENS COLLEGE, TIMBUCTOO      )
OUTPUT 0 LINEPRINTER 200 LINES                            )
COMPUTING 2000 INSTRUCTIONS                               ) Job
STORE 10 BLOCKS                                           ) Description
COMPILER EMA                                              )

CHAPTER 0                                                 )
                                                          )
21) READ                                                  )
W = 0                                                     )
JUMP 22, N ≠ 0                                            ) Program
END                                                       )
22) I = 1(1)N                                             )
READ(X)                                                   )
```



```
W = W + X                                                 )
REPEAT                                                    )
NEWLINE                                                   ) Program
PRINT (N) 3,0                                             ) (cont.)
PRINT (W/N) 0,7                                           )
JUMP 21                                                   )
CLOSE                                                     )

5     1.21    2.47    3.65    8.49    10.83               )
3    -1.34    8.43    5.91                                ) Data
0                                                         )
```

End of Document Marker

For convenience on Atlas the whole unit of information (whether input or output) may be thought of in terms of its printed record, and this in turn can be regarded as a document. The document may be presented to the computer on punched cards or on punched paper tape or on any other suitable input medium which can be read by the Atlas computer.

The preamble at the beginning of the document in the example is the Job Description for this job. It gives the title of the job, which consists of the Job Number and other information about the job. It specifies that all the output including that produced by the Supervisor is to go to an Anelex lineprinter, and that not more than 200 lines are expected. The amount of time taken by this job is estimated at 2000 instruction interrupts (probably rather high in this case), where an instruction interrupt is a measure of about 2000 basic machine instructions executed, and is about 7 or 8 milliseconds. In all, the time for this job is estimated at between 14 and 16 seconds, but the estimate includes the time for compiling the program. The size of the job is estimated at 10 blocks, that is 5120 words of memory are expected to suffice for the program and its working space and data. Finally, the compiler to be used to compile the user's program is specified.

The more commonly used compilers on the N.I.R.N.S. Atlas are expected to be:

HARTRAN AHL	The local system including FORTRAN and ASP
EMA ALGOL	Extended Mercury Autocode
AA	Atlas Autocode

Jobs and Their Headings

A job is introduced by the word JOB followed by the title of the job, either on the same line or on the next line. The word JOB is usually placed at the left hand margin, e.g. in columns 1, 2 and 3 of a card. The title is then separated from the word JOB by a space or comma if it appears on the same line.

The title must start with a Job Number and must contain less than 80 characters in all. In the case of paper tape any shift characters must be included in the count, and the character "backspace" must never be used in any part of the Job Description.

For simple jobs on cards, we recommend that the title of the job be placed on the same card as the word JOB, while for paper tape we suggest that JOB is followed immediately by "newline" and then the title of the job.

Output

The standard devices for output on Atlas are:

```
LINEPRINTER
SEVEN HOLE PUNCH
FIVE HOLE PUNCH
EIGHT HOLE PUNCH
CARDS
ANY
```

The device ANY will on the Chilton Atlas be LINEPRINTER.

Each device is explicitly named and associated with a number which is the number given to the output stream generated by the program. The Supervisor and compilers always generate some output for stream zero, and consequently this stream must always be defined in the Job Description.

Some programs generate more than one stream of output. Each stream is given a distinct number in the range 0 to 15 and must be defined in the Job Description. It is not necessary for these streams to be associated with different output devices. Thus, for example, we could have three distinct streams for the card punch.

The definition of an output stream in the Job Description may be similar to that shown in the example, or alternatively the word OUTPUT may appear on a line by itself. Where several output streams are defined this is the usual way in which the definitions are introduced. Thus:

```
OUTPUT
0 LINEPRINTER      200 LINES
15 CARDS           20 BLOCKS
3 LINEPRINTER      25 BLOCKS
10 SEVEN HOLE PUNCH    2 BLOCKS
```

defines four output streams numbered 0, 3, 10 and 15. While the word LINES has an obvious meaning, the word BLOCKS is used to denote about 4000 characters. For the lineprinter, a block can just as well represent 100 lines of about 40 characters as 50 lines of about 80 characters, and is therefore not a particularly useful measure of output in this

context. For punched cards, a block represents either 24 binary or 46 non-binary cards. If the cards are mixed, then some number of cards between 24 and 46 is contained in a block. In all Output definitions the word LINES can be used wherever BLOCKS can, and vice versa.

Computing Time Estimates

The computing time estimate is provided in the Job Description in one of two ways: either in terms of time, SECONDS, MINUTES, or HOURS, or in terms of instruction interrupts occurring on the execution of every 2048 basic machine instructions. The latter is termed INSTRUCTIONS. For example, to specify the computing time in terms of real time units we write:

```
COMPUTING 7.5 MINUTES
or  COMPUTING 450 SECONDS
```

The number is either an integer or a decimal number containing a decimal point. When the alternative method is used, only integers may be used, as in:

```
COMPUTING 32000 INSTRUCTIONS
```

Assuming an average of 3.5 microseconds per instruction one INSTRUCTION is the equivalent of 7 milliseconds. No hard and fast rules can be given to help a programmer just beginning to test a new program on Atlas to judge the best estimate of computing time. However, all such users should be careful not to overestimate either times or output as the program may get into a loop through a mistake in the code.

All jobs have recorded at the end on stream zero some statistics about the job (see page 13), including the number of instruction interrupts occurring during execution. These figures should provide users with some guide on COMPUTING estimates. Two figures are provided, one giving the overall instruction interrupt count, the other usually a smaller one giving the instruction interrupt count in compiling.

Program Size

The importance of this section cannot be overemphasized, because the Supervisor may be able to schedule the use of the memory very efficiently if the information given in the Job Description is accurate.

Included in the Job Description is:

```
STORE M BLOCKS
```

and this means that up to M blocks of 512 words of store will be required by the program.

The user can consult the job statistics at the end of his output stream zero to discover how much store was actually required. Once again two figures are given; the left hand one the number of blocks requested and the right hand one the number of blocks which were actually written to or read from during the execution of the program. It is important to realise that those parts of the program or those operands which are not accessed in a particular run may not contribute to the number of store blocks actually used.

Compiler Definition

The particular compiler to be used is specified on a line with the word COMPILER and its name is separated from the word COMPILER by a space. There must be no other information on the line, and where the line is prepared on paper tape the compiler name must be terminated by "newline".

End of Document Markers

These markers are peculiar to the particular input medium.

(i) Paper Tape
The marker is introduced by the uninterrupted sequence *** followed by one of the letters C, A or Z. In this context Z is the most commonly used letter; it indicates the end of the document and usually also the end of the tape. The letter C indicates the end of the current document and also the presence of another following on the same paper tape. The letter A is used to erase all of the current document (see also page 14).

(ii) Punched Cards
The marker is simply a 7 and 8 punch in column 1 with the rest of the card, except column 80, left blank. Column 80 will normally contain the punching + and 3, i.e. the letter C. (At the time of writing it is hoped that a blank column 80 will have the same effect, but since no great hardship is enforced the recommended punching will be C. See also page 15.)

(iii) IBM Tape
A document will consist of a number of records terminated by a file mark. The file mark will constitute the end of document marker.

Input

Many programs may require the input data in separate documents. Each document must be given a distinct title different from the titles of all other documents in the machine at a particular point of time. The input document titles are listed after the word INPUT in the Job Description and are preceded by a stream number which is the logical number used in the program to select the document.

For example:

```
JOB R76031, RHEL DATA REDUCTION
INPUT
1 FRAMES ALPHA 9/9/64
2 FRAMES BETA 10/9/64
OUTPUT
0 LINEPRINTER 3000 LINES
1 LINEPRINTER 2000 LINES
COMPUTING 30.47 SECONDS
STORE 25 BLOCKS
COMPILER HARTRAN
```

and then the rest of the program document.

The input documents are mentioned with their titles. They are assigned stream numbers in the range 1 to 15, and are referred to in the program by the appropriate document or stream number. The numbers need not be distinct from the stream numbers used for output documents.

The documents themselves are introduced by the word DATA followed by the document title on the same or next line. The rules for the title are similar to those for job titles. For example:

```
DATA
FRAMES BETA 10/9/64
```

followed by the document content and in turn followed by an end of document marker. Such a document would become input stream 2 to the job R76031, RHEL DATA REDUCTION first mentioned.

Occasionally it is convenient to separate the program document from the Job Description. In this case the Job Description becomes a document on its own, and it should include an INPUT section giving details about a document having stream number zero. This is the only circumstance in which stream 0 appears after INPUT in a Job Description. An example of a Job Description document is:

```
JOB I1793, EBF
INPUT 0 NIRNS SYSTEMS
OUTPUT 0 LINEPRINTER 1000 LINES
COMPUTING 3000 INSTRUCTIONS
STORE 60 BLOCKS
```

End of Document Marker

The program document, whose title is specified by this Job Description as NIRNS SYSTEMS, would then be introduced by:

```
COMPILER ABL
NIRNS SYSTEMS
```

with the rest of the document following. It is important to notice that

COMPILER ABL becomes a document heading and that the title of the document follows on the next line. Further there is no compiler definition in the Job Description document. This is in direct contrast to the other examples where the Job Description is a preamble to the program document. Although the example names only INPUT 0, other input documents may be named as well.

The Supervisor activates a job only when all the input documents have been presented.

Magnetic Tape

Programs using magnetic tape will refer to them by a logical number in the range 1 to 99. Any numbers may be chosen at the programmer's convenience.

The Supervisor needs to know the logical numbers of the tapes and also the titles of the tapes. All tapes at Chilton will have a tape number as part of their title. The number must be quoted in the Job Description.

There are three categories of magnetic tape in the Job Description:

(i) TAPE

Private customer tapes must be requested under this section. Suppose we require logical tapes 5 and 7, N0517 WOBBLY DATA Y.Z. SMITH and N0642 SMOOTHED RESULTS Y.Z. SMITH respectively for the running of a job, then we write:

```
TAPE 5 N0517 WOBBLY DATA Y.Z. SMITH
TAPE
7 N0642 SMOOTHED RESULTS Y.Z. SMITH
```

Once again we may put the logical number and title on the same line or on the line below. At the time of writing the redundant word TAPE is still required if more than one tape is defined in this section. The Supervisor will request the operators to mount the particular tapes given in this part of the Job Description.

(ii) TAPE COMMON

Quite a number of jobs require a magnetic tape only temporarily for the duration of execution of a job and not to preserve information between runs. Such a tape is specified by writing:

```
TAPE COMMON
55
```

where 55 is the logical number of the tape referred to in the program. The tape will remain a COMMON tape at the end of the job. At the time of writing TAPE COMMON must precede the logical tape number for each common tape required.

(iii) TAPE NEW

When a magnetic tape is first wanted, the tape will have to be given the title by which the programmer will later refer to it. On subsequent runs the TAPE NEW request will have to be changed to TAPE. However, the section is in other respects like TAPE. The operator is requested to mount a free tape which is then titled and reserved to the programmer. For example:

```
TAPE NEW 6 FILE SEVEN MAGNAFON
```

An example of a Job Description with magnetic tape usage now follows:

```
JOB
H15470, T.H.O. MASON, BLDG 597
INPUT 1 SPECTRAL DATA
OUTPUT
0 LINEPRINTER 5000 LINES
15 CARDS 250 LINES
7 FIVE HOLE TAPE 2 BLOCKS
TAPE
1 N0034 THOM MASTER FILE
TAPE
2 N1706 THOM SPCY
TAPE COMMON
3
COMPUTING 25 MINUTES
EXECUTION 30 MINUTES
STORE 71 BLOCKS
COMPILER HARTRAN
```

Execution Time

When a magnetic tape job is likely to be held up waiting for the completion of tape transfers, an estimate of the waiting time should be added to the computing time. In the example at the end of the previous paragraph this has been done and is given in the line reading:

```
EXECUTION 30 MINUTES
```

Here we have estimated some 5 minutes of waiting time. This represents the waiting time due to the search through about 4000 blocks of tape at slow tape speed.

End of Job Statistics

The form of the statistics at the end of a job is:

```
INSTRUCTION     33117     184
STORE     32      /      25
2 DECKS     1294 TAPE BLOCKS     5 HALT TIME
INPUT 0     36 BLOCKS
OUTPUT 0     PRINT     403 RECORDS
OUTPUT 15     CARDS     25 RECORDS
END OUTPUT     5 BLOCKS
```