INTERNATIONAL COMPUTERS AND TABULATORS LIMITED

O R I O N

P R O G R A M M E R S' R E F E R E N C E M A N U A L

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P R E F A C E

This document is intended to be an up-to-date reference manual on the Orion Computer System for those programmers who are most intimately concerned with the system. It is not intended as an instruction manual, but should provide all the detailed knowledge needed by specialist programmers.

It is proposed to keep this document up to date by issuing numbered Amendment-Lists from time to time. Details of all such lists incorporated should be entered on page 0.2 so that it will be easy to find out if any Amendment-List has been missed. Each page of the document is dated.

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0.2 AMENDMENTS

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1	19.12.1961		
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40	13.8.1965		
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0.3 GLOSSARY

The following are brief definitions of some of the special words used with Orion. Many of them are used in a wider context, not necessarily with exactly the same meaning. Some of the definitions derive from the draft British Standard AA(TLE) 4043 on Terms Used In Automatic Data Processing. An underlined word in a definition is one defined elsewhere in this Glossary.

Abolish. To cause the Time Sharer to ignore a program and to release the reservations for that program. Any registers, drum locations and peripheral devices previously reserved to that program immediately become unallocated and are then free to be included as necessary within the reservations of any other program which is then in or which subsequently is taken into the working store or the drum store.

Accept Button. A manually operated button mounted on or near a peripheral device capable of input which, when operated, causes a Monitoring Interruption to allow the Monitor Program to read in a record from the device.

Accumulator. One of the first 64 registers reserved for a program; these registers have the basic addresses A0, A1,...,A63; of these A0 is a dummy accumulator.

Active Program. A program in the Time-Sharer' s directory, i.e. a program which might be obeyed at any moment due to a suitable combination of interruptions and lockouts.

Address. The designation of

(a) a register or block in the working store,
or (b) a location or block in the drum store,
or (c) a peripheral device (machine address only),
or (d) a pseudo-register,
or (e) an operand, in certain instructions (e.g. those of group 1) .

Address, Basic. A register address (or that of a working store block) written as a letter A followed by a number giving the amount by which the machine address of the designated register (or start of the block) exceeds the Datum-Point, or a drum address written as an integer giving the amount by which the machine address of the designated drum location exceeds that of the drum datum point.

Address, Block. (1) The address of a block in a store, usually the same as the address of the first register or location of the block.

Address, Block. (2) The number automatically recorded with a block on magnetic tape and used to identify the block (sometimes Block-Number).

Address, Drum. The address of a location or block in the drum-store. Machine drum addresses are those used by the hardware associated with the drum-store. Basic drum addresses are written as numbers (0,1,2,...) in a program; they designate those drum locations reserved to that program and are converted to the corresponding machine drum addresses (usually by the addition of a drum datum-point) on execution of a 141-instruction.

Address, Machine. An address in the binary form used by the actual hardware, or a numerical representation thereof.

Address, Main. An X-address or a Y-address in an instruction; these are the addresses which may be modified or replaced.

Address, Relative. A register address written in an instruction as a positive or negative number followed by a plus sign, the number giving the amount by which the machine address of the designated register exceeds that of the instruction in which the relative address is written.

Address, Symbolic. A group of letters and/or numerals constructed according to certain rules and used to represent an address or quantity. The value of a symbolic address is a 24-bit quantity which may be assigned either by an equation or by a label.

Address, Transfer. See Transfer Address.

Argument. See Fixed-Point Part.

Autonomous. Pertaining to a part of a computer system (e.g. a peripheral control unit) which continues to operate independently of the central parts of the system when once its operation has been initiated.

Backspace. A layout character used with 7-track paper tape. Often denoted by BS.

Block. (1) Any group of consecutive registers or locations or their contents regarded as a unit.

Block. (2) A group of words or characters stored on a peripheral medium and normally transferred as a unit.

Branch. One of a number of parts into which some programs are divided and which are treated by the Time-Sharer as though they were independent programs. Each branch of a program may, at any instant, be either "switched on" (i.e., active) or "switched off" (i.e., temporarily suspended), depending on its progress in relation to the other branches. Each of the branches communicates with one or more of the others and has the same reservations as the whole program.

A "branched" program could, for example, be made up of two branches: one repeatedly producing the data for several lines of print and the other (peripheral-limited) initiating the successive printer-transfers needed. These two branches would be suitably switched on and off to prevent either from getting too far ahead of the other.

Buffer, Code. A Buffer Store used to hold code tables for use by hardware during transformations of input or output data.

Buffer, Data. A Buffer Store used to hold data on input or output.

Buffer Store. A supplementary store provided in certain peripheral control units.

Built-in Program. A program permanently held in the drum-store.

Busy. The state of a peripheral device or control unit which is in the process of executing a peripheral transfer and consequently cannot currently be involved in any other transfer.

Carriage Return. A layout character (non-printing) used with 5-track paper tape and often denoted by CR or CR. It causes the carriage of a teleprinter to return but there is no upward movement of the paper. This character is nearly always followed by a Line Feed character.

Chapter. A part of a program normally transferred as a unit from the drum-store into the working store.

Character. A single printed or written symbol such as a letter, a numeral, a punctuation mark or other symbol (e.g. £ > + =); alternatively, a representation thereof or of a layout character, which controls the layout or appearance of printed characters, or the operation of a character-handling device. Examples of layout characters are: Newline, Tabulate, Upper Case. The representation is frequently by means of a row of holes in paper tape or by 6 bits of a word. A word can therefore, represent eight characters; these are commonly numbered from 0 (the character represented by digits D0 to D5) to 7 (represented by D42 to D47).

Character Code. A code for representing characters, often as small integers.

Character Repertory. The set of characters which may be used with a particular peripheral device or routine. Also Character Repertoire or, sometimes, Alphabet.

Characteristic. The exponent plus 128 in a standard, packed, floating-point number, i.e. the unsigned integer represented by the least significant eight bits (D40 to D47) of the word representing the number.

Clear, to. To set in a standard state of a register, to write zero into it.

Compound Instruction. A sequence of instructions obeyed as a unit by the hardware. Such a sequence is treated in many ways like a single instruction, e.g. interruptions cannot occur in the middle.

To describe permissible compound instructions we introduce the following terms:

(a) pre-modify instruction - one with function 116 or 117,
(b) select-peripheral instruction - with function 140 or 141,
(c) transfer instruction - with function 142,
(d) ordinary instruction - with any other function.

A compound instruction consists of one of the following:

(1) one or more pre-modify instructions followed by an ordinary instruction or a compound instruction,
(2) a transfer instruction or a select-peripheral instruction followed, either immediately or after a number of pre-modify instructions, by a transfer instruction.

No compound instruction may legally contain more than 13 instructions, but longer ones will be correctly interpreted by the Monitor Program at the expense of speed.

Computer - Limited. Such that the speed is limited by that of the central computer, rather than by that of a peripheral device. Sometimes also called "Mill-limited".

Console. A consoling word for control desk.

Content. The data held in a part of a store (plural: contents).

Control Desk. A desk provided with a set of keys, lights and, normally, a Flexowriter (and, probably, a tape reader) intended for use by an operator of the computer system. Also Console (deprecated).

Control Number. The working store address of the instruction currently being obeyed.

Control Unit. Part of the computer which controls peripheral transfers using one or more peripheral devices.

Core Store. The Working Store.

Cue. The instruction(s) needed to enter a subroutine at a specified entry-point.

Curtate. A subset of the rows of a punched card. The rows are often divided into two curtates: (a) the upper, usually consisting of fewer rows and including the uppermost row or rows, and (b) the lower, made up of all the other rows but occasionally including some of those in the upper curtate.

Datum-Point. The machine address of the first register (A0) reserved for a program. It is always a multiple of 64.

Declaration. A statement providing to a compiler some facts about a program written in a source-language, which are used to influence the compiling process applied to that program.

Directive. A written or punched item in a program which is not an instruction or an item of data but is designed to direct a program-input routine to carry out certain operations. For example, directives could be used to cause the input routine to read following items in a non-standard format, or to direct the assembly or storage of items, or to define macro-instructions, or to make corrections.

Directory. The list referred to by the Time-Sharer and made up of a Directory-Entry for each active program.

Directory-Entry. The data relating to one program in the Time-Sharer's Directory.

Disengaged. The state of a peripheral device in which it appears busy to all programs although it is not engaged in a transfer. Disengagement of e.g. a magnetic tape deck permits the operator to load, unload or change tape reels.

Document. (1) A document comprises the directive DOCUMENT followed by a document-name followed by a set of data (instructions and/or numbers etc.), the data constituting or being required or produced by a program or part of a program.

Document. (2) That part of a peripheral medium (other than paper for printing on) which carries a document as defined in (1) above.

Document. (3) Any reading matter. In this Reference Manual the word "document" in this sense, normally refers to matter relating to the Orion system, or programs etc. for it.

Drum-Label. Similar to a label but has two right parentheses. The value is set to the drum address of the labelled item. The labelled item must not be a declaration.

Drum Store. The store formed by the aggregate of the drums in an Orion system.

Dump, to. (1) To preserve by storage elsewhere the contents of a part of a store temporarily needed for another purpose, possibly to permit restarts.

Dump, to. (2) To preserve by peripheral transfers the entire contents of a program's store reservations (together, possibly, with other information for later use with a post-mortem routine.

Engage, to. To remove a peripheral device from the disengaged state (by manual operation of a key or button).

Enter, to. To start obeying the instructions of (a program or routine).

Entry-Point. The address of the first instruction to be obeyed in a routine; a single routine may have several entry-points.

Equation. A declaration explicitly giving the value of a symbolic address in terms of numbers, basic addresses or the values of other symbolic addresses, or a combination of these.

Erase. (1) A special character often used to obliterate characters punched in error in a paper tape; it has a hole in every track of the tape. This character is also used to delete printed characters when it is usually preceded by Backspace (BS). Often denoted by Er or ER.

Erase. (2) To obliterate all pulses recorded (on a length of magnetic tape).

Exponent. One of the parts of a floating-point number; it is an integer giving the power of 2 by which the fixed-point part has to be multiplied. In a standard, packed, floating-point number the exponent plus 128 is represented by D40 to D47 of the word; the exponent (x_e) being restricted to the range

$$-128 \leq x_e \leq 127.$$

(see also Characteristic)

Field. A part of a word or record (e.g. a group of consecutive bits) or of a peripheral medium (e.g. a group of consecutive characters on paper tape or of columns or parts of columns of a card) used to represent an item of data.

Figure shift. A non-printing character on 5-track paper tape and associated devices, analogous to letter shift (q.v.) When a device is in figure shift it remains so until a letter-shift character is encountered, or the letter-shift key is operated.

The printing characters available in figure shift include the numerals 0 to 9, the italic letters n and v, and certain symbols such as =, ≠, +, - etc., and ER. The non-printing characters "space", "carriage return", "line feed" "letter shift" and additional "figure shifts" are also available.

A series of consecutive figure shifts produces a length of tape in which only the sprocket holes are punched. Figure shift is often denoted in documents by the Greek letter φ (phi).

Fixed-Point Part. One of the parts of a floating-point number; the fraction representing the significant digits of the number. In a standard, packed, floating-point number it is represented by D0 to D39 of the word. Also called the argument of the number.

Floating-Point Representation. The representation of a number by means of two quantities:

(a) the fixed-point part (x_a, say), or argument, representing the significant digits, and

(b) the exponent (x_e, say) or integral power of 2 by which the fixed-point part must be multiplied to give the value of the number:

$$x_a.2^{x_e}$$

The fixed-point part, x_a, is stored as a signed fixed-point fraction and the exponent x_e is stored either directly as a signed integer or augmented by a suitable constant to ensure that the stored quantity is non-negative.

The two parts of a floating-point number may be represented by separate words but are commonly packed into a single word, the most-significant 40 bits (i.e. D0 to D39) representing the fixed-point part and the least-significant 8 bits (i.e. D40 to D47) representing 128 plus the exponent. Words used in this way represent standard, packed, floating-point numbers; the value of such a word w is denoted by w_G,

Format. Synonym for layout. Alternatively, the way in which an item of input or output data is written, printed or punched to satisfy certain rules, for example to make input data acceptable to an input routine.

Fraction. A number less than 1 in absolute magnitude. Conventionally, the value x_F, of a word x interpreted so as to lie in the range

$$-1 \leq x_F \leq 1 - \varepsilon$$

Gap, interblock. See Interblock gap.

Group of Instructions. The set of all instructions in which the first four Function Bits have a specified configuration, usually specified by its numerical value.

Hesitation. A very brief "interruption" of the operations of the computer caused by use of the working store by a peripheral control unit at the same time as its attempted use by the computer.

Identifier. Synonym for a Symbolic Address.

Illegal Instruction. An instruction of a form which is rejected by the computer.

Index. A table giving, explicitly or implicitly, the address of each record in a block or group of records.

Indirect Addressing. A method of addressing in which the address supplied is that of a register containing the address to be used, (Cf. replacement.)

Instruction Code. The code used to represent instructions.

Instruction-Format. The way in which an instruction-word is subdivided into fields.

Instruction Repertory. The set of available instructions in the computer. Also Instruction Repertoire.

Integer. A whole number, positive, negative, or zero. The term is often used of integers which can be represented by a word: such integers, x_I, represented by a word x must lie in the range

$$-2^{47} \leq x_I \leq 2^{47}-1$$

Interblock gap. The length of magnetic tape between the last stripe of data in one block and the first stripe of data in the next block. Part of the interblock gap is occupied by the checksum and block address, but most of the gap is blank and is needed for engineering reasons, e.g. to allow time to start or stop the tape between blocks.

The interblock gap may be "short" or "long" depending on the circumstances prevailing when the blocks were written.

Interlude. A small part of a program designed to do some staple preliminary operations, e.g. calculating parameters, depending in general on certain facts about both the program proper and its data, after which it is overwritten.

Interruption. The action of ceasing to obey a program and jumping to the first instruction of the Time-Sharer. Interruptions are of two kinds (a) time-sharing, when it is legitimate to return eventually to the program just left, and (b) monitoring, when one of the other built-in programs has to be called in. All interruptions cause entry to the Monitoring Mode.

Isolated. Pertaining to a store or part thereof whose contents are protected by hardware from accidental overwriting.

Justify, to. To adjust the representation of a double-length number so as to put it into standard form (i.e. with its less significant half non-negative) taking into account the state of OVR, assumed to have been determined by a simple addition or subtraction (or single-place shift) in the less-significant half.

Label. A symbolic address, followed by a right parenthesis, written on the left of an instruction or other item on a program sheet provided the labelled item is not a declaration. Such use causes the value of the symbolic address to be set equal to the address of the register which holds the labelled instruction or item.

Layout. (1) The way in which a word is subdivided into fields.

Layout. (2) The way in which a record is subdivided into words and fields representing items.

Leading End. The outer end of a coil of punched tape or magnetic tape or the first end to be processed.

Letter Shift. A non-printing character on 5-track paper tape which can be punched on the tape by depression of a particular key on 5-track paper tape keyboard devices. When the tape-character is encountered by a teleprinter or when the key is operated on a keyboard device, the device is said to be "in letter shift", and remains so until a "figure shift" tape-character is encountered or until the "figure shift" key is operated. When a device is in letter shift, only those type-bars carrying the letters of the alphabet, in capital Roman face, full-stop, ?, £, and ER can be used. The keys producing figure shift and letter shift can also be operated.

Letter shift is often denoted in documents by the Greek letter λ (lambda).

Line Feed. A layout character (non-printing) used with 5-track paper tape and often denoted by LF or LF. It causes the paper in a teleprinter to be fed forward (upwards) one line space without any horizontal motion of the carriage.

Link. A word whose sign-bit records the state of OVR (1 if set, 0 if clear) and whose modifier part is equal to the address of the next instruction to be obeyed in the current part of a program.

List. (1) A table

List. (2) An ordered sequence of stored records, each of which includes the address of, i.e. "points at", its immediate successor and/or predecessor in the list.

List Processing. Carrying out operations on list-structures.

List Structure. A list of records, each of which may itself be a list-structure.

Location (drum). A position in the drum store which holds one word.

Location (working store). A register.

Lockout. A condition imposed on a part of the working store to which access is temporarily prohibited because of a peripheral transfer. An interruption occurs if a program gets locked out of a register or a peripheral device (i.e. attempts to use a locked out register or a busy peripheral device).

Lockout, Advancing. A lockout whose extent is progressively reduced during a peripheral transfer - lockouts of the other kind are called non-advancing.

Lockout, Strong. A lockout which prohibits all reference to the affected part of the store. Imposed during a reading transfer.

Lockout, Weak. A lockout which permits reading from the affected part of the store, but not writing into it. Imposed during a writing transfer.

Lower Case. (1) Of Flexowriter characters, a subset of the character repertory comprising half of the available characters, including the minuscule letters (i.e. a, b, ..., z) and most of the miscellaneous special characters (e.g. £ ? * >).

Lower Case. (2) A 7-track paper tape character, often denoted by LC, causing all following tape characters up to the next UC character (Upper Case) to be interpreted as lower case characters (see (1)).

Machine Instruction. An instruction in a form which can be directly obeyed by the computer. Alternatively, a simple representation of this.

Macro-Instruction. An instruction (not in the computer's instruction repertory) written on a program-sheet and acceptable to a suitable program-input routine which converts it into more than one machine instruction (and possibly directives) according to pre-determined rules. Sometimes called a macro.

Main Address. An X-address or a Y-address in an instruction.

Mask. A word used as an operand in logical operations which has 1-bits throughout one (or possibly more) fields and 0-bits elsewhere, or vice versa. Masks are often used in packing and unpacking data.

Medium (Peripheral). A physical material capable of being used in a peripheral device to receive or emit data. E.g. punched paper tape, punched cards, paper for printing on, magnetic tape.

Mill-limited. See Computer-limited.

Mix. See Program-mix.

Mode. (1) In a 140 or 141-instruction, the specification of the kind of operation to be carried out on the named peripheral device. The mode is represented by five bits at the m.s. end of the X-address (mode-bits), which must include an odd number of ones.

Mode. (2) The regime of operation of an Orion system. There are three of these; (i) Programmers' Mode (Normal), (ii) Monitoring Mode (obeying built-in program with Monitor Staticiser on, (iii) Engineers' Mode (During certain parts of maintenance schedule).

Modification. The automatic addition of one or more modifiers to the X- or Y- address (or both) of an instruction as stored (the presumptive instruction) to produce the effective instruction about to be obeyed. The stored instruction is not itself altered during modification.

Modification, External. Modification caused by 116- or 117-instructions. Also known as pre-modification.

Modification, Internal. Modification in a two-address instruction in which the modifier is stored in the accumulator specified in the Z-address of the instruction.

Modifier. The less-significant half of a word, i.e. digits D24 to D47, when this is intended to be used for modification or replacement. The modifier in a word w is denoted by w_m.

Modifier Register. An accumulator or other register holding a modifier.

Monitoring. Action taken by the Monitor Program; this often results in a message being typed on a Flexowriter and, possibly, suspension of the program and dumping. (See also Mode).

Monitor Program. One of the Built-in Programs, chiefly responsible for input and output of messages.

Monitor Staticiser. A staticiser (one-bit store), not accessible to programs, which, is normally off (in the Programmers' Mode) and which is turned on when the computer enters the Monitoring Mode. This staticiser determines whether instructions of group 15 are legal and has other effects, e.g. on reservations; it is turned off by an instruction of group 15.

Newline. A layout character (non-printing) marking the end of one line of print and the start of another. In documents it is denoted by NL. When the 7-track paper tape representation of this character is read by a Flexowriter it causes the carriage to be returned and the paper to be fed forward (upwards) one line space.

Non-negative. Not negative, that is positive or zero.

Normalize, to. See Standardize, but has other meanings.

Numeral. A character representing a numerical digit.

Object Language. A language used by a compiler or translator for its main output.

Ordinary register. Any (working store) register of a program's reservations which is not an accumulator.

Overflow. The production of a number or field content outside of its intended representation.

Overwrite, to. To replace (a word or record) in a store.

OVR. The Overflow Indicator. It has two states: Set and Clear. It is represented in Orion by the contents of four pseudo-registers.

Pack, to. To insert several items of data into a single word by splitting it into fields.

Paper throw. A layout character, denoted by PT, used with line printers and some Flexowriters. The tape character can be produced on 7-track tape by a Flexowriter.

Parity Check. A check which tests whether the number of ones in a word or character is odd or even. Parity checks are used in the working and drum stores in Orion and on paper tape.

Partial-Justify. The operation of adjusting the representation of a double-length number so as to put it into standard form (i.e. with its less-significant half non-negative) disregarding the state of OVR.

Peripheral-Limited. Such that the speed is limited or restricted by that of a peripheral device.

Peripheral Transfer. See Transfer, Peripheral.

Post-Mortem Routine. A routine designed to reveal or locate a programming error after a program has unintentionally stopped.

Pre-modification. Modification caused by an 116- or 117- instruction. Also External Modification.

Preset Parameter. A parameter incorporated in a routine before or during input.

Problem Program. A program designed to solve a problem or to do "useful" work; in contrast to organisational programs such as program-input routines, compilers, Monitor programs, etc.

Program-Directory. The list comprising the current Program-records.

Program-Input Routine. A routine for reading in programs from a peripheral medium and translating them into machine instructions.

Program-mix. The set of all programs active at a particular moment.

Program Parameter. A parameter incorporated in a routine during execution of a program.

Program-record. A set of data relating to a program or branch of a program and required by the Time Sharer and Monitor Program. One program-record is associated with each branch of each program which is currently active or suspended. The set of current program-records forms a list called the Program-Directory.

Pseudo-Instruction. A written entry on a program sheet which satisfies the rules for writing instructions but which is not itself intended ever to be obeyed by the computer.

Pseudo-Off-Line. The operation of two or more peripheral devices in conjunction with one another by means of a small peripheral-limited program, usually carrying out a simple transcribing process.

Pseudo-Register. A special register, not in the working store, which may be read from by using certain instructions, e.g. those of group 2.

Rank. The nett number of times the datum point is added in when determining the value of a symbolic address.

Read, to. (1) To extract a copy of the data held in a part of a store.

Read, to. (2) To copy data recorded on the medium in a peripheral device and, usually, write it into the working store.

Record. A set of data constituting the broadest logical subdivision of a file. For example, a record might contain all the data relating to a particular Insurance Policy or Bank Account or item in a Stock List.

Register. A position in the working store which holds one word. Sometimes called (working store) location.

Replacement. The automatic substitution of an X- or Y-address, possibly after modification, in an instruction by the modifier part of the word stored at that address. Replacement, like modification, affects an instruction which is about to be obeyed; the stored instruction is not itself altered.

Replacement-bit. A bit in an instruction which indicates whether an address is to be replaced. Two such bits are available in each instruction to indicate replacement of the X- and/or Y-addresses.

Requirement. A record made in a program's Directory-Entry specifying which register is to be free of lockouts or which peripheral device is to be non-busy before the program can be re-entered.

Reservations. The aggregate of peripheral devices and parts of the working and drum stores available to a particular program.

Reservations, Strong. A set of reservations which prohibit the program to which they belong from referring in any way to unreserved parts of the machine. These are the normal kind of reservations.

Reservations, Weak. A set of reservations which permit the program to which they belong to read from unreserved parts of the working or drum stores.

Reserve, to. To include in a program's reservations.

Rewind, To. To wind tape (paper or magnetic) back to the beginning (or leading end).

Round, to. To operate on a number so as to reduce the bias (or average error) due to its subsequent truncation. Also Round-Off.

Round Down, to. To truncate a number or to replace it by an approximation not greater than it.

Round Up, to. To replace a number by an approximation not less than it.

Semi-built-in Program. A program, commonly a compiler or translator (e.g. the Symbolic Program Input Routine), which may be held in the drum-store (and then regarded as a Built-in-Program) but which may, at the operator's discretion, be overwritten.

Signal. (or Signal Instruction) An instruction whose Signal-Bit is zero.

Signal-Bit. The most significant bit of a machine instruction.

Source Language. A language used for writing programs (sometimes called a pseudocode), chosen for the programmers' convenience.

Space. (1) A layout character used with 5- or 7-track paper tape corresponding to the operation of the space bar (or key) on a Flexowriter or teleprinter. Often denoted by Sp or SP.

Space. (2) A part of the working or drum store or the extent thereof.

Standardize, to. To adjust the representation of a floating-point number so that the fixed-point part (or argument) x_a, lies in the range $\frac{1}{2} \leq x_a < 1$ or $-1 \leq x_a < -\frac{1}{2}$ if it is non-zero. The word "normalize" is also used but this can have other meanings.

Stripe. A narrow transverse region of a magnetic tape on which are recorded 12 bits of data together with other bits (e.g. clock-bits) needed for engineering reasons; four adjacent stripes are used to record one 48-bit word. A stripe occupies the whole width of the tape. There are 375 stripes to each longitudinal inch within a block.

Suspend, to. To cause the Time Sharer to ignore a program without freeing any of its reservations.

Switch. (1) A number which may be set to one of several values to select one of a number of alternative courses of action.

Switch. (2) One or more instructions selecting the course of action.

Table. An ordered sequence of systematically stored items of data (called entries).

Table-look-up. The operation of extracting data from a stored table when the data required is specified by its position or address in the table.

Table-Search. The operation of finding, in a stored table, an entry which satisfies certain criteria necessitating tests on the entries in the table. (See also Table-Look-Up).

Tabulate. A layout character, denoted by TB, used in connection with 7-track paper tape and line printers.

Tape Character. A character represented by a transverse row of holes in paper tape.

Time-Sharer. A built-in program which is entered whenever an interruption occurs which does not call for action by the Monitor or Organisation Programs. The Time-Sharer determines which of the currently active programs should next be obeyed.

Time-Sharing. A system for arranging that the facilities of parts of the central computer are made available to several programs in rapid succession. In Orion this system is automatic in the sense that it need not be taken into account when programs are prepared.

Track. (1) That part of a magnetic drum or tape which can be written on to or read from by a single head.

Track. (2) A lengthwise subdivision of a paper tape.

Track. (3) Part of a punched card machine along which the cards are moved.

Trailing End. The end of a punched tape or magnetic tape opposite to the leading end.

Transcribe, to. To copy by a relatively simple program, possibly with editing (code transformations, change of layout, simple checking), from one peripheral medium to another.

Transfer, to. Of data, to copy, exchange, read, record, store, transmit, transport or write.

Transfer Address. In an input routine, the address of the register or location in a store where the next word read from the input medium is to be placed. Usually used of the working store.

Transfer, Internal. A process whereby the contents of a register or block of registers in the working store are copied into another register or block of registers; on completion of the transfer the same data are present in both blocks except that in some cases the source and destination blocks may overlap, in that some registers are common to both blocks. In such a case, on completion of the transfer some of the data will exist only in the destination block.

Transfer, peripheral. The use of a peripheral device to read or write a block of data or to carry out some other operation, e.g. rewinding (magnetic tape).

Transfer, Reading. A Peripheral Transfer involving reading data from a peripheral medium or an input buffer and copying it into the working store.

Transfer, Writing. A Peripheral Transfer involving writing on to a peripheral medium or into an output buffer, a copy of data in the working store.

Truncate, to. (1) To omit intentionally some of the steps (usually all the steps from some stage onwards) of a, possibly infinite, process.

Truncate, to. (2) To omit, from some point onwards, all the digits of a number, retaining only the more significant.

Type. The category of an instruction determined by the number of addresses used for specifying operands or results. Orion instructions may be of 2-address or 3-address type.

Type-bits. The two bits in an instruction which specify whether the instruction is of two- or three-address type and, if it is two-address, which of the main addresses is to be modified.

Unallocated. Not included in the reservations of any program.

Underflow. The production of a very small floating-point number whose exponent is negative and exceeds capacity. Usually such a number is automatically replaced by zero.

Unpack, to. To extract individual items from fields within a single word and to store them in separate words.

Unreserved. Not included in a program's reservations.

Unrounded. (1) Of a number, truncated.

Unrounded. (2) Of an operation, yielding an unrounded result.

Unsigned. Without a sign, non-negative.

Upper Case. (1) Of Flexowriter characters, a subset of the character repertory comprising half of the available printed characters, including inter alia the capital letters (i.e. A,B,...,Z) and the numerals.

Upper Case. (2) A 7-track paper-tape character often denoted by UC, causing all following tape characters up to the next LC character (Lower Case) to be interpreted as upper case characters (see (1)).

Upper Half-Word. The more-significant half of a word, i.e. digits D0 to D23. The upper half of a word w is denoted by w_u.

Value. (1) Of a character - the numerical value of the binary representation (interpreted as a binary integer) of the character in a particular code.

Value. (2) Of a symbolic address - the 24-bit integer assigned to the symbolic address by an equation or a label; this integer may be used as a modifier or drum-address or its least-significant 15 bits may be used as a machine address in the working store.

Value. (3) Of a word - the 48-bit integer or fraction or the floating-point number or any other number represented by the word.

Value. (4) Of a field - the number represented by the field.

Violation. Breaking a rule about reservations, e.g. writing into an unreserved register. Attempted violation causes monitoring.

Visible Space. A conceptual character corresponding to a gap between two printed symbols on the same printed line. Often denoted by VS. May appear, for example, by use of Space (SP), Tabulate (TB) or a combination of these, possibly with Back Space (BS).

Volatile Store. A store whose content is lost when the power supplies are removed. In Orion the working store is volatile but the drum store is not volatile.

Wind On, to. To wind tape (paper or magnetic) forward to the (trailing) end.

Word. A set of 48 binary digits (bits) normally treated as a unit in operations. These digits are numbered D0, D1, D2 ....,D47; of these D0 is the most-significant digit (sign-bit) and D47 the least significant. The content of a register or drum location.

Working Space. Storage used temporarily to hold intermediate results.

Working Store. The store whose locations, called registers, are those designated by the addresses in most arithmetical instructions (e.g. those of group 0). Sometimes called the Core Store.

Write, to. (1) To place data into a part of a store, replacing any data previously stored there.

Write, to. (2) To record data on the medium in a peripheral device.

Write-Inhibit Switch. A switch on a tape-deck allowing that deck to be isolated so that the tape on that deck cannot be written on.

Write-Permit Ring. A ring which can be fitted into a groove on a spool of tape. If the ring is not so fitted the tape is isolated.

0.4 NOTATION

In this section are given definitions of the symbols and abbreviations more commonly used in Orion programming documents. The following rules apply generally.

(a) Single capital letters often denote addresses of registers and the corresponding small letters the contents of these registers.

(b) A capital letter as a suffix implies that the suffixed symbol denotes the value of a word according to some convention (given below). A small letter as a suffix denotes that only a part of a word (i.e. a field) is to be considered.

(c) Underlined pairs of capital letters denote particular characters, usually layout or non-printing characters.

Letters, possibly followed by numbers

A Followed by a number - basic working-store address.

a Suffix - "Argument" or Fixed-Point Part of a floating-point number (D0 to D39 of a word).

BS The Backspace character

C Followed by a number - character-number in a word (C0 to C7).

C( ) Content of the register or location whose address is in the parentheses.

c Control number = address of current instruction.

c Suffix - unsigned integer represented by the three most-significant bits of the word (D0, D1, D2).

CR The Carriage Return character (5-track paper tape).

D Followed by a number - digit-number in a word (D0 to D47).

d.l. Double-length or double-precision.

e	Suffix - exponent part of a floating-point number = 128 less than the integer represented by digits D40 to D47 of the word.
ER	(or Er) The Erase character
F	Function of an instruction.
F	Suffix - value of a word interpreted as a fraction.
FS	The Figure Shift character (5-track paper tape).
G	Suffix - value of a word interpreted as a standard floating-point number.
I	Suffix - value of a word interpreted as an integer.
i	The number of a character within a word.
L	Suffix - logical quantity.
LC	The Lower Case character.
LF	The Line Feed character (5-track paper tape).
LS	The Letter Shift character (5-track paper tape).
l.s.	Less or least significant.
M	Mode of a peripheral transfer.
M	Suffix - value of two words representing a double-length mid-point number.
m	Suffix - modifier part of a word (digits D24 to D47).
m.s.	More or most significant.
NL	The Newline character.
OVR	The Overflow-indicator.
P	Followed by a number - pseudo-register address.
p	Followed by a number - content of specified pseudo-register.
PF	The Punch-Off character.
PN	The Punch-On character.
PT	The Paper Throw character.
pY	The content of pseudo-register Y
r	Suffix - the result of rounding the suffixed quantity.
s	Suffix - the sign-bit of the suffixed quantity.
s.l.	Single-length or single precision.
SP	(or Sp) The Space character
ST	The Stop character.
TB	The Tabulate character

u Suffix - Upper half of a word (digits D0 to D23).

UC The Upper Case character.

UL The Underline character.

∨ Or (logical operation).

VS Visible Space (may be produced by SP or TB, or a combination of these possibly with BS).

X The X-address in an instruction

x The content of X

x Suffix - the X-address part of a word (digits D9 to D23).

Y The Y-address in an instruction

y The content of Y

y Suffix - the Y-address part of a word (digits D33 to D47).

Z The Z-address in an instruction.

z The content of Z

Greek Letters

ε 2^{-47}

λ The Letter Shift character in 5-track tape (also LS).

φ The Figure Shift character in 5-track tape (also FS).

Symbols

' A prime or apostrophe indicates a value after an instruction has been obeyed.

( ) Sometimes used to denote the content.

& And (logical operation).

≢ Not-equivalent (logical operation).

* The quantity in the next register to that named.

: The double-length quantity formed from the named quantity and that in the next register.

ā A bar over any quantity indicates the logical "not" operation (also written ¬, for example ¬a).

= Is equal to.

≠ Is not equal to.

$>$	Is greater than
$\not>$	Is not greater than.
$\geq$	Is greater than or equal to.
$<$	Is less than
$\not<$	Is not less than
$\leq$	Is less than or equal to.

0.5 Summarized Instruction Repertory

This section is a condensed description of the Orion Instruction Repertory for quick reference.

For a full description of the detailed effects of the various instructions and their times see section 3.

00 $x' = x + y$	10 $x' = x + Y$	20 $x' = x + \phi Y$	30 $x'_I = x_I\ y_I$	40* Unrounded: integral quotient to X, remainder to $X-1$
01 $x' = x - y$	11 $x' = x - Y$	21 $x' = x - \phi Y$	31 $x'_F = (x_F\ y_F)_F$	41* Rounded: rounded integral quotient to X
02 $x' = y - x$	12 $x' = Y - x$	22 $x' = \phi Y - x$	32 $x'' = x_I$	42* Rounded with d.l. mid-point quotient: integral part to X, fractional part to $X+1$
03 $x' = -y$	13 $x' = -Y$	23 $x' = -\phi Y$	33 $x'' = x' + xy$	43* Rounded: fractional quotient to X
04 $x' = y$	14 $x' = Y$	24 $x' = \phi Y$	34 $x' = xY$	44* Unrounded with d.l. dividend; integral quotient to X, remainder to $X-1$
05 $x' = x \,\&\, y$	15 $x' = x \,\&\, Y$	25 $x' = x \,\&\, \phi Y$	35 Unassigned; illegal	45* Rounded with d.l. dividend; fractional quotient to X
06 $x' = x \vee y$	16 $x' = x \vee Y$	26 $x' = x \vee \phi Y$	36 Unassigned; illegal	46 Unassigned; illegal.
07 $x' = x \not\vee y$	17 $x' = x \not\vee Y$	27 $x' = x \not\vee \phi Y$	37 Unassigned; illegal	47 Unassigned; illegal.

Y is treated as signed

50 $x' = x.2^Y$	s.l. arithmetical
51 $x' = x.2^{-Y}$	
52 $x' = x$ up Y bits	s.l. logical
53 $x' = x$ down Y bits	
54 $x' = x\dot{.}2^Y$	d.l. arithmetical, result in standard form
55 $x' = x\dot{.}2^{-Y}$	
56 $x'_L = x'_L$ up Y bits	d.l. logical
57 $x'_L = x'_L$ down Y bits	

See other side for note on timing.

Jump to Y if:-

60 $y = x$	
61 $y \neq x$	
62 $y > x$ $(x < y)$	
63 $y \not> x$ $(x \geq y)$	
64 $y < x$ $(x > y)$	
65 $y \not< x$ $(x \leq y)$	
66 $\phi Y = x$	
67 $\phi Y \neq x$	

For 2-address, put $x = 0$

Jump to X if:-

70 $Y = x_n$	
71 $Y \neq x_n$	
72 $Y > x_n$ $(x_n < Y)$	
73 $Y \not> x_n$ $(x_n \geq Y)$	
74 $Y < x_n$ $(x_n > Y)$	
75* $Y \not< x_n$ $(x_n \leq Y)$	
76* $\overline{Y}\ \&\ x = 0$	
77* $\overline{Y}\ \&\ x \neq 0$	

For 2-address, put $x = 0$ (not 76,77)

	3-address		2-address	
80	$x' = x - 1$	Jump to X if	$y' = y + 1$	Jump to X if
81	$x' = x - 1$	Jump to X if	$y' = y + 1$	Jump to X if
82	$x' = x - 1$	Jump to X if	$y' = y - 1$	Jump to X if
83	$x' = x - 1$	Jump to X if	$y' = y - 1$	Jump to X if
84	Jump to X if char. X	is in y / is not in y	Jump to X if char. SP	is in y / is not in y
85				
86	$x'_n = x + 1$, $x'_y =$ OVR; OVR' = 0, jump to X	Enter S/R	$y'_n = x - 1$, $y'_x =$ OVR, OVR' = 0, jump to X	
87	OVR' = OVR $\vee\ x_n$; Jump to $X - x_n$	Leave S/R	OVR' = OVR $\vee\ y_y$; Jump to $X - y_n$	

90	$x'_0 = x_0 + y_0$	
91	$x'_0 = x_0 - y_0$	
92	$x'_0 = y_0 - x_0$	
93	$x'_0 = -y_0$	
94	$x'_0 = x_0 . y_0$	
95	$x'_0 = x_0 / y_0$	
96	Unassigned; illegal.	
97	$x'_1 =$ no. of places to standardise $x_0 \div y_0$	

100*	Convert characters to binary
101*	Convert binary to characters
102*	$x'_0 = (x_y + c).2^Y$, Y signed
103	$x'_y = x_0.2^Y$, Y signed
104*	Convert card 2-character data
105	Unassigned; illegal.
106	
107	

110	$x' = (x \,\&\, \overline{y}) \vee (z \,\&\, y)$	(3) Insert field of z into x / or / (2) Clear field of x ($z = 0^{-S}$)	wherever mask (y, Y or ϕY) has 1-bits.
111	$x' = (x \,\&\, \overline{Y}) \vee (z \,\&\, Y)$		
112	$x' = (x \,\&\, \overline{\phi Y}) \vee (z \,\&\, \phi Y)$		
113	Unassigned; illegal		
114	(3) $x' = y$, $y' = z$ (2) $x' = y$, $y' = x$ (exchange)		
115	Add l.o. 8 bits of Y to m.s. 5 bits of x; add rest of Y to x_0; end-around carry		
116	Add Y and $\overline{Y}$ to corresponding addresses in next instruction	before / after	any replacements therein / Modify next instruction.
117			

120*	Count 1-bits
121*	Cyclic shift
122*	Table look-up
123*	Insert (append) field
124*	Find end-most 1-bit
125*	Standardize unpacked floating-point number
126*	Justify d.l. number
127 to 137	Unassigned; illegal.

140.9	0 DEVICE	Peripheral Transfer	List of Nodes on other side
142	FROM [ADDR]		
141.9	0 DRUMADDR	Drum Transfer	
142	TODRUMADDR [LENGTH]		
143	TO 0	Internal	
143	FROM LENGTH	Transfer	
143	(3) Copy x into X to $X + Y - 1$		
	(2) Clear to zero X to $X + Y - 1$		
144	Search table starting at X for first	$x \geq y$ (ascending) / $x \leq y$ (descending) / $x_n = y_n$ or $x_n = 0$	
145			
146			
	and set x' = address of n		
147	Unassigned; illegal.		

Standard Macro-Instructions

1000 CHAP ADDR
Load CHAP, enter at ADDR

1001 CHAP
Load CHAP, continue

1002 CHAP ADDR1 ADDR2 ADDR3
Load part of CHAP, enter at ADDR3

1003 CHAP ADDR1 ADDR2
Load part of CHAP, continue

1086 :SUB/E1
Ensure copy of Library S/R :SUB/ is in current chapter, enter S/R at E1

All addresses are working-store addresses.

Pseudo-Registers

Y	Content and Notes
0	Zero
2	Local Civil Time
4	OVR (0 if clear, 1^{46} if set); cleared if used
6	OVR (0 if clear, 1^{-0} if set)
8	$1^{35}\ 0^{24}$ (upper half-word mask)
10	$1^{1}\ 0^{47}$ (= -1.0)
12	$0^{1}\ 1^{1}\ 0^{46}$ (= ½)
14	$0^{9}\ 1^{15}\ 0^{24}$ (mask for X-address)
16	$0^{25}\ 1^{6}\ 0^{15}$ (mask for Y-address)
18	Handswitches

If Y is even, $\rho(Y{:}1) = \overline{\phi Y}$

Note: 3-address forms given. Unless stated otherwise, get 2-address by reading x',x'' for x', x'' and putting $\alpha = 0$.

* Individual notes overleaf.

FERRANTI LTD

ORION COMPUTER
SUMMARIZED PROGRAMMING INFORMATION

COMPUTER DEPARTMENT

LONDON COMPUTER CENTRE,
68 NEWMAN ST.,
LONDON, W.1.
Telephone: MUSeum 5040

Office and Works:
West Gorton,
Manchester 12
Telephone: East 1301

List C6 209A

40 $x_L' = (x_I^{*\prime}/y_I) - x_I/y_I$; $0 \leqslant x_I^{*\prime}/y_I < 1$

41 $x_I' = (x_I/y_I)_r$ or $(x_F/y_F)_r$; $-\frac{1}{2} \leqslant (x/y) - x_I' < \frac{1}{2}$

42 $x_F' = (x_I/y_I)_r$ or $(x_F/y_F)_r$; $-\frac{1}{2}c \leqslant (x/y) - x_F' < \frac{1}{2}c$

43 $x_F' = (x_F/y_F)_r$ or $(x_I/y_I)_r$; $-\frac{1}{2}c \leqslant (x/y) - x_F' < \frac{1}{2}c$

44 $x_I' = (x_I^{*\prime}/y_I) = x_I/y_I$; $0 \leqslant x_I^{*\prime}/y_I < 1$

45 $x_F' = (x_F/y_F)_r$ or $(x_F/y_I)_r$; $-\frac{1}{2}c \leqslant (x/y) - x_F' < \frac{1}{2}c$

50 to 53 } { The } { 24 } { places shifted take no time
54 to 57 } { last } { 48 } { if shift number ≥ stated number.

75 Z-address is recommended unconditional jump.

76 Z-address: Jump to Z if $Y = 0$

77 Z-address: Jump to Z if $Y \neq 0$

100 $x' = y_7(y_6(\ldots(y_1(y_0x + x_0) + x_1) + \ldots) + x_7$

If m.s. 2 bits of y_i are:
- 00 check that m.s. bit of x_i is 0
- 01 (+16) check m.s. 2 bits of x_i are 01
- 10 (+32) make no check
- 11 (+48) treat x_i as zero

101 (3) } { x' = characters resulting } { x_L } { y^* contains radices
(2) } { from conversion of } { x_I } { and y their product

To convert non-significant zeros as { SP / 0 (digit) / full stop / UC } add { 0 / 16 / 32 / 48 } to radix

102 $v = 0$ if OVR clear
$v = \pm 2$ if OVR set, sign of v opposite
to that of x_F. OVR$' = 0$ unless x_L' overflows

104 Convert 2-character data in x to 4 characters
according to code table starting in Y
(3) $x_L' = x_m$, x_m' = new characters
(2) $x_L' = 0$, x_m' = new characters

120 If { $Y \geqslant 0$ / $Y < 0$ } { x_m' = number of 1-bits in } { first / last } { $|Y|$ bits of x. x_L' = inverse of next bit of x

121 $x' = x$ shifted cyclically right Y bits (Y signed)
If $|Y| \geqslant 24$, last 24 places shifted take no time.

122 (3) } { $x' = y$ shifted } { Z } characters.
(2) } { cyclically left } { x_c }

123 (3) } { Leave unchanged } { Z } { characters of x_L, follow them
(2) } { the first } { x_c } { by all y, clear rest of x_L

124 (3) If { $Y \geqslant 0$ / $Y < 0$ } { $x' = x$ shifted logically } { left / right } until { left-most / right-most } { 1-bit shift off but not more than |
x' = shift number. If no 1-bit removed then $x_L' = |Y|$ and $x_L' = Y|$ places
(2) x' = shift number, etc., x and its shifted form overwritten. -1

125 (3) $x_F' = (x_F + v)2^n$ $[x^* \geqslant 0]$; $x_I' = x_I - n$; OVR$' = 0$
(a) $v = 0$ if OVR clear, $v = \pm 2$ if set (sign opposite
to that of x). OVR left clear.
(b) n is an integer such that
either (i) $\frac{1}{2} \leqslant x_F' < 1$ and $-1 \leqslant n \leqslant Y$
or (ii) $-1 \leqslant x_F' < -\frac{1}{2}$ and $-1 \leqslant n \leqslant Y$
or (iii) $-\frac{1}{2} \leqslant x_F' < \frac{1}{2}$ and $n = Y$
(c) If $n < 0$, shifting down is unrounded;
only happens if $v \neq 0$ (i.e. OVR set on entry)
(2) Illegal.

126 (2) $x' + \epsilon y' = x + \epsilon y + \epsilon v$; $y' \geqslant 0$; OVR$' = 0$
$v = 0$ if OVR clear, $v = \pm 2$ if set (sign opposite
to that of y). OVR left clear unless x' overflows
(3) As (2) but result is $x' + \epsilon y'$ = justified form of $x + \epsilon y$.

MODES IN 140 AND 141

Y denotes Y-address in the 142-instruction

Paper Tape
- 1 Read 7-tr. up to NL, at most Y chars.
- 2 Read 7-tr., Y chars.
- 8 Read 5-tr., Y chars.
- 16 Disengage
- 21 Punch 7-tr. up to NL, at most Y chars.
- 22 Punch 7-tr., Y chars.
- 28 Punch 5-tr., Y chars.

Magnetic Tape
- 1 Read forward
- 2 Read backward
- 14 Rewind
- 21 Write, long gap
- 23 Write, short gap
- 25 Erase

Punched Cards
- 1 Read, IBM
- 2 Read, ICT
- 4 Read, BULL
- 7 Read, IBM and binary
- 8 Read, ICT and binary
- 11 Read, BULL and binary
- 14 Read, binary
- 16 Disengage
- 19 Read normal and interstage
- 21 Fill data buffer, punch (coded)
- 22 Fill data & code buffers, punch (binary)
- 26 Fill code buffer

Xeronic Printer
- 16 Disengage
- 21 Print up to NL, at most Y chars.
- 22 Print Y chars.

Line Printers
- 16 Disengage
- 21 } { Fill data buffer } with full character set
- 22 } { and print a line } with part character set
- 26 Fill code buffer

Drum
- 1 Read Y words from drum-store
- 21 Write Y words into drum-store

All Devices
- 13 Interrogate

SOME SPECIAL 150-INSTRUCTIONS

Summary of events associated with the various values of Z
in the instruction 150 X Y Z

- 1 Timing flag
- 2 Branch interlock

- 10 Stop (Halt or Suspend)
- 11 Abolish
- 12 Date and time
- 13 Message to Flexowriter
- 14 Question to Flexowriter
- 15 Read Directory

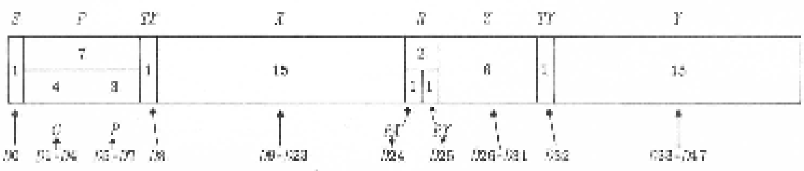
- 20 Set Monitoring style
- 21 Set peripheral incident
- 22 Set Monitoring peripheral
- 23 Return from private Monitoring
- 24 Start New Branch
- 25 Restore Branch Conditions

- 30 Reserve peripheral
- 31 Relinquish peripheral
- 32 Get geographical name
- 33 Load document
- 34 Get document if loaded
- 36 Change name of peripheral

- 40 Read block 0 } Magnetic tape
- 41 Write block 0 } Magnetic tape
- 42 Get current block number } Magnetic tape
- 43 Write non-sequential block } Magnetic tape

- 50 Chapter change
- 51 Load chapter of semi-built-in program
- 52 Change drum reservations
- 53 Change core reservations

Instruction Format



If X or Y is replaced in an internally modified instruction, the replacement occurs before the modification.

0.6 Bibliography of Literature Relating to Orion

Reference Name	Title	Date of Publication
DC41A	Orion Computer System	Oct. 63
CP2	Orion Computer	Sept. 61
MP2	Input and Output Operations on Orion using Time Sharing	Sept. 61
AUP3	Nebula Commercial Autocode	Sept. 61
AUP4	The Mercury Orion Atlas Autocode	Sept. 61
R32	Orion - time-shared data processing system	June 60
R51	Simulation of Orion Time-sharing system on Sirius	Sept. 61
R57	Nebula. A Programming Language for Data Processing	Oct. 61
R75	Integrated data processing at a Swedish chain store	Aug. 63
R79	Electronic Accounting in the Church of Scotland	Jan. 65
CS 281	Programming Sheets (in pads of 100)	
CS 299A	Summarised Programming Information	
CS 308A	Orion and Atlas Punched Tape Codes	
CS 313	Nebula Logical Description Sheet	
CS 314	" Physical " "	
CS 315	" Card " "	
CS 317A	Making a Fortran II Program suitable for Orion	June 64
CS 339	Operating instructions for Model "B" Flexowriter	Aug. 62

0.6 Bibliography of Literature Relating to Orion (Cont'd.)

CS 361	Keyboards used with Computers	Jan.63
CS 362	Operators Conventions for Punched Tapes	Jan.63
CS 363	Specification of Paper for Punched Tapes	Jan.63
CS 366	Model 'S' Flexowriter	Nov.62
CS 367	Creed Keyboard Punch for 7-track Tapes	Nov.62
CS 368	Creed Verifier for 7-track	Jan.63
CS 369	Extracoded Functions in Orion 2	Aug. 63
CS 390	A Primer of Fortran Programming for Atlas & Orion	Oct. 64
CS 391	A General Description of Orion 1 and Orion 2 Computers	Sept. 63
CS 401	The Analysis of Plane Structural Frames on Atlas and Orion Computers	April 64
CS 412	Punching Conventions for Orion Programs	Sept. 64
	Nebula Training Manual - this will replace CS 282.	
Tech.Pub. 5050	I.C.T. Orion Programming Manual Vols. 1 and 2	Dec. 64
Tech.Pub. 5052	I.C.T. Atlas and Orion Computers Extended Mercury Autocode (EMA)	Aug.64
Tech.Pub. 5059	Programming for Orion in Basic Input Language	Mar.65
Tech.Pub. 5064	I.C.T. Orion Programming Exercises {Symbolic Input)	Aug. 65
TL 721	I.C.T. Orion Opus Manual.	April 65