

UNIVERSITY OF ILLINOIS
DIGITAL COMPUTER LABORATORY

LIBRARY ROUTINE M 28 - 270

TITLE: Matrix Multiplication with or without rescaling (SADOI)
TYPE: Entire program
ACCURACY: 11 decimal places (see Note 1)
DESCRIPTION: The routine will form the product of two matrices,

$$A_{ij} B_{jk} = C_{ik}$$

Features of the routine are:

1. Matrix C can either be punched on tape or stored on the drum.
2. Matrix B can be rescaled by any power of ten prior to the multiplication; this enables the user to scale down the elements of C to prevent overflow or otherwise to adjust the scaling of C.
3. A set of products of various sizes, $A^{(p)} B^{(p)} = C^{(p)}$, can be produced without rereading parameters, and these products can all be stored on the drum for use in subsequent operations.
4. Multiple products such as $A^{(3)} A^{(2)} A^{(1)} B = C$ can be formed without punching intermediate results on tape.

METHOD OF USE:

CASE I, $A_{ij} B_{jk} = C_{ik}$	<u>Stops</u>
1. Master tape	3402L
2. Parameter tape, type T	24060
3. Data tape B	240J7
4. Data tape A (with J term. sym.)	2402L

To begin a new problem at stop 2402L reading different parameters, raise the black switch.

Matrix C is either punched on tape by rows, each element to "d" decimal places, or else, starting at location "D" on the drum, matrix C is stored by rows with a row sum check at the end of each row. This option is specified by the parameter tape.

If matrix C is punched on tape, i, the rows of C, is not limited. The capacity of the computer for j and k can be

determined from the chart shown in the section on STORAGE OF MATRIX B. See also section on STORAGE OF MATRIX C. For alternate methods of use, see sections on CASE II, CASE III, and CASE IV.

PREPARATION OF DATA TAPES:

The elements of both B and A matrices are punched by rows as signed fractions with an N at the end of each row. If any row terminating symbol is an F instead of an N, the computer will stop. By raising the black switch, the reading of the matrix is resumed. (See Note 2)

In addition to row terminating symbols, each matrix has a matrix terminating symbol. After the final row symbol, a J or an L is punched. No distinction is made between a J or an L at the end of a B matrix. For each, the computer will stop. When the black switch is raised, the computer will begin to read an A matrix.

If a J terminates an A tape, when reading is resumed by raising the black switch, the computer will interpret the next tape as a parameter tape. If an L terminates an A tape, the previous parameters are retained, and the reading of a parameter tape is bypassed.

METHOD OF USE:

CASE II, $A^{(p)} B^{(p)} = C^{(p)}$	<u>Stops</u>
1. Master tape	3402L
2. Parameter tape, type T	24060
3. Data tape B ⁽¹⁾	240J7
4. Data tape A ⁽¹⁾ (with L term. sym.)	24060
5. Data tape B ⁽²⁾	240J7
6. Data tape A ⁽²⁾ (with L term. sym.)	24060
etc.	

If the several C matrices are punched on tape, 30 single hole delays, 3 carriage returns, and a figure shift will separate matrices.

If the C matrices are stored on the drum, they will be stored one following the other in successive locations by rows with a row sum check at the end of each row.

PARAMETER TAPE PREPARATION:

Except for CASE IV, there are three parameters. The order in which they must appear is as follows:

d	space	number of decimal places or drum address
<u>+</u>	S	scaling exponent
X		directive

Print or drum store parameter, d.

The parameter, d, must be followed by a fifth-hole character. If $d < 13$, the computer will punch the elements of matrix C to d decimal places. If $d \geq 13$, d will be interpreted as a drum address at which to store matrix C. Hereafter a drum address will be designated by a capital letter, D. See section called STORAGE OF MATRIX C.

Scaling exponent, + S.

The parameter, + S, may be omitted if no rescaling on matrix B is desired. Otherwise, + S or -S is an integer exponent of 10. Each element of the B matrix will be multiplied by this power of 10 before B is stored on the drum. This has the effect of rescaling the product matrix C. There are no restraints on the value of + S other than those imposed by the data. Of course, if the scaler is -12, matrix B becomes a null matrix. Similarly, the largest sensible positive value for the scaler would be a value which would not cause overflow on the elements of C.

The directive, X

The directive, X, must be either an N, J, F, or L. When the directive is an odd number (J or L) and also d is less than 13, the rows of C will be punched in columnar form with a carriage return after each element. An N will be punched at the end of each row and a J at the end of the matrix.

When the directive is an even number (N or F) and also d is less than 13, the rows of matrix C will be printed across the teletype page. A carriage return and two delays

will be punched after each n elements where n is the integer part of the quotient, $70/(d + 1)$. At the end of each row of C , an N followed by two carriage returns and two delays will be punched. A J will be punched at the end of the matrix.

Whenever d is 13 or greater, matrix C is stored on the drum, and no distinction is made between odd and even directives.

Type T and Type D

The directive at the end of a Type T parameter tape is either an N or a J . When a Type T tape is read, the computer will stop on 24060. If the black switch is raised, a B matrix will be read from tape. (See Note 3)

The directive at the end of a Type D parameter tape is either an F or an L . When a Type D tape is read, the computer will stop on 240SJ. If the black switch is raised at stop 240SJ, a B matrix will be read from the drum. This matrix will be in fact the previously formed product matrix of size i by k stored at drum location D . The matrix will be read a row at a time, rescaled, and restored as a B matrix at location 2560. The method of use for this is explained under the heading CASE III. It is also possible to specify the size and drum location of a matrix which is to be treated as a B matrix. After a Type D parameter tape has been read and the machine stops on 240SJ, if the white switch is raised up and down, three additional parameters will be read as follows:

*
D space drum location of matrix
r space number of rows
c space number of columns

To exercise this option, the matrix must have been stored on the drum at any time previously in successive locations by rows with a sum check at the end of each row. This is illustrated under the heading CASE IV.

ILLUSTRATIVE EXAMPLES OF PARAMETER TAPES:

Type T Both B and A matrices are read from tape

<u>Parameters</u>	<u>Meaning</u>
10 space N	Print the elements of C to 10 decimal places by rows across the teletype page.
4 space +2J	Multiply each element of B by 100 prior to the matrix multiplication; print the elements of C to 4 decimal places by rows with a carriage return after each element.
4558 space N	Store C by rows with a row sum check at the end of each row in successive locations starting at drum location 4558.

Type D The B matrix is read from the drum, A matrix from tape

6 space -1F	Read rows of previously formed product from the drum, multiply each element by 1/10, and store as a B matrix; form the new product C and print each element to 6 places; print by rows across the page.
6400 space F wh. switch	A matrix $M_{53, 21}$ is read from drum location 53, 21,
6100 space	and restored at 2560 as a B matrix;
53 space	matrix A is read from tape and the product matrix C is stored by rows with a
21 space	sum check at the end of each row in successive locations starting at 6400.

METHOD OF USE:

CASE III, $A^{(p)} \dots A^{(2)} A^{(1)} B = C$

It is necessary first to form the product, $A^{(1)} \overbrace{B=C}^{\text{Stops}}^{(1)}$, and to store this on the drum at location D.

1. Master tape 3402L
2. Parameter tape, Type T 24060
3. Data tape B 240J7
4. Data tape $A^{(1)}$ (J term. sym.) 2402L

Next a Type D parameter tape is read. If it is not necessary to change the scaler or to change the store location on the drum, the parameter tape can be followed by several A matrices terminated by L symbols.

5. Parameter tape, Type D 240SJ
- 6a. Data tape $A^{(2)}$ (L term. sym.) 240SJ

6b. Data tape A⁽³⁾ (L term. sym.) 240SJ
etc.

If it is necessary to change the scaler or the drum store location, or, if it is the end of the sequence, and it is desired to print the final product, an A matrix can be terminated with a J, which enables the user to read a new parameter tape.

6x. Data tape A^(p-1) (J term. sym.) 2402L

7. Parameter tape, Type D (with "d") 240SJ

8. Data tape A^(p) (J term. sym.) 2402L

METHOD OF USE:

CASE IV, $A_{ir} M_{rc} = C_{ic}$ Stops

Let us assume that a series of steps (perhaps CASE I or CASE II) formed the matrix, M_{rc} , at drum location D* by rows with a sum check at the end of each row. Subsequent operations have cleared the Williams memory but not the drum. To form the product, $A_{ir} M_{rc}$, the steps are as follows:

1. Master tape 3402L

2a. Parameter tape, Type D 240SJ

2b. Parameters:

D* space r space c space

Raise white switch up and down 240SF

3. Data tape A (with J term. sym.) 2402L

STOPS AND ERROR DIAGNOSIS:

Stops	Loc.	Diagnosis
3402L	18J	Master tape has read correctly; bl. sw. to read par. tape.
24060	053	End Type T par. tape; bl. sw. to read B; wh. sw. to convert to a Type D tape.
240SJ	053	End Type D par. tape; bl. sw. to restore B and read A; wh. sw. to read D*, r, c.
240SF	05L	D*, r, c, have been read; bl. sw. to restore M and read A; wh. sw. to read B from tape.
240J7	08S	End of tape B; bl. sw. to read A.
2402L	0JJ	End of tape A with J term. sym.; bl. sw. to read par.
24088	06S	F term. sym. end of 1st row of B; bl. sw. to continue.

Stops	Loc.	Diagnosis
200B0	087	F term. sym. end of subsequent rows of B; bl. sw. to continue.
200F5	0JL	F term. sym. end of row of A; bl. sw. to continue.
FF001	06K	J or L end of 1st row of B; wh. sw. to continue.
FF002	084	Number of elements in rows of B are not equal; wh. sw. to continue as if =.
FF003	0F8	Row vector of A does not conform to column vector of B; wh. sw. to new par. tape.
FF004	0S2	Improper drum address for store of C; wh. sw. will calculate first available address and store C. (See Storage of C on Drum)
FF005	10K	Overflow on element of C; wh. sw. to read par.
FF006	109	B sum check failure; wh. sw. to try again.
FF007	18F	Master tape sum check failure; Reread.
FF008	0JO	Row of C read incorrectly from drum; wh. sw. to try again.

STORAGE OF MATRIX B:

In order that the columns of B can be read from the drum in minimum access time, the first element in each row is stored at $2560 + (j - 1)I$. I is determined by the size of k. The capacity for B using the entire drum is shown in the chart below:

k	I	max. j
$0 < k \leq 65$	65	157
$65 < k \leq 129$	129	79
$129 < k \leq 193$	193	53
$193 < k \leq 257$	257	39
$257 < k \leq 311$	321	31

If matrix C is not stored on the drum, i, the rows of A, is not limited. k and j can be determined from the chart. In any event, the maximum k is 311.

STORAGE OF MATRIX C:

The first available location for the storage of matrix C on the drum will be after the final element of matrix B. This can be determined from the following formula,

$$D = 2560 + (j - 1) I + k$$

where I is the increment between rows of B.

Matrix C is stored on the drum by rows with a row sum check at the end of each row. The number of locations required will be $i(k + 1)$ and

$$D + i(k + 1) < 12,800.$$

To direct the computer to store C on the drum, the parameter, d, must be greater than 12, and d will be interpreted as the drum address, D, at which to store C. If d is any number greater than 12, but less than D, the first available drum address, the computer will consider this to be an error and will stop on FFO04. If the white switch is raised up and down, the computer will print a 5-place decimal address which is D, the first available address. Matrix C will be stored in successive locations starting at D.

For CASE III when multiple products are formed D must be chosen to be large enough to accommodate the largest B matrix.

DURATION IN SECONDS:

About 30 seconds for the reading of the master and parameter tapes.

Time depends upon options exercised which are listed below:

1a. To read matrix B from tape and store on drum
 $jk (.005 d_b + .013)$

1b. To read matrix C from drum and restore as a B matrix

$$i (.005 k + .018)$$

2. To read matrix A and calculate

$$ij (.005 d_a + .010) + ik (.004 j + .009)$$

3a. To punch matrix C

$$ik (.0167 d_c + .034) + .067 i$$

3b. To store matrix C on the drum

$$i (.002 k + .008)$$

NOTE 1:

Whenever matrix B is rescaled by a positive power of 10, + S, the accuracy of C is reduced from 11 decimal places to (11 - S) places.

NOTE 2:

It is not necessary to reproduce a large tape to punch a J or an L terminating symbol. The final row terminating symbol N can be hand punched to an F. After the computer stops, insert a single J or L character in the reader and raise the black switch.

NOTE 3:

A Type T parameter tape can be converted to a Type D tape merely by raising the white switch up and down at the stop 24060.

DATE	September 28, 1959
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ns

LOCATION		ORDER	NOTES	PAGE 1	M 28
Abs.	Rel.	Sym.			
			003K		
3			00F 00397F		Location of A vector
4			00F 00554F		Location of B vector
5			00F 00711F		Location of C vector
6			00F 00F		
7			40F L521(N12)		
			0017K		
17	(A)		00S3 00S3		
	(B)		00S4 00S4		
	(C)		00S5 00S5		
	(N)		40S4 L521(N12)		
	(NL)		80F 00F	by 11, 34(P)	Counter for number of elements, n, per line
	(-)		00F 001000 0000 0000J		
	(+)		00F 006250 0000 0000J		
	(0)		00F 00F		
	(1)		00F 001F		
	(1-1)		001F 001F		
	(10)		00F 0010F		
	(12)		00F 0012F		
	(64)		00F 0064F		
	(70)		00F 0070F		
	(D1)		8511F 00F		
	(D2)		8611F 00F		
	(D3)		00F 002560F		
	(D4)		00F 00F	by 4, 14	
	(D5)		00F 00F	by 48(P), 7(B5)	Store of matrix C on drum
	(D6)		01F 00F		
	(T1)		L5F 40F	by 4, 8(B2)	
	(T2)		J013F 75F	} by 5(B2)	
	(T3)		N09F L5F		
	(T4)		756F L4F	} by 6(B2)	
	(T5)		N0F 40F		by 5(B5)
	(T6)		S68(A2) L5F	by 4(B5)	
	(T7)		J0F 74F	by 3, 5(B5)	
	(T8)		75F 40F	} by 2(B2)	

LOCATION			ORDER	NOTES	PAGE 2	M 28
Abs.	Rel.	Sym.				
		(T9)	801F L5F	} by 2(B2) by 7(B2)		
		(T10)	N114F L5F			
			00K			Read parameters
47	0	(P)	414F 41F	from sum check		
	1		814F 50F	6(A1)		
	2		74(10) S5F			
	3		40F 914F			
	4		321L 41(D4)			
	5		L5F 403F			* Store "d" at loc. 3
	6		F0(12) 3213L			test: d < 13
	7		F53F 50(0)			
	8		007F 40F			
	9		L5(70) 66F			Calculate N, no. elements per line
	10		S5F 1032F			
	11		42(NL) L53F			
	12		0020F 463(A4)			
	13		2215L L53F			
	14		L4(D2) 40(D4)			
	15		524F 5015L	} read scaler and directive; Store at loc. 4 and 5		
	16		26(N12) 405F			
	17		L34F 3230L			
	18		L54F 3223L			
	19		402F L5(-)			Negative scaling multiplier at loc.13
67	20		4013F F52F			
	21		402F 3230L			
	22		5013F 7J(-)			
	23		2620L 50(0)			
	24		L54F 0022F			
	25		4612(B4) L14F			
	26		402F L5(+)			positive scaling multiplier at loc.13
	27		4013F F52F			
	28		402F 3230L			
	29		5013F 7J(+)			
	30		2627L 4116F			
	31		50(0) L55F			

LOCATION			ORDER	NOTES	PAGE 3	M 28
Abs.	Rel.	Sym.				
	32		101F S3F			
	33		3234L L5(1)		test: directive is odd or even	
	34		42(NL) L55F	from 12,14(A1)		
	35		F0(1) 3236L		test: directive is F or L	
	36		24(B1) 24(B6)		stop: 24060 - 240SJ	
	37		192F 401F			
	38		L5(10) 4243L		white switch to read	
	39		41F 814F		D*, r, c.	
87	40		50F 74(10)			
	41		S5F 40F			
	42		914F 3640L			
	43		L5F 40F			
	44		F543L 4243L			
	45		L51F L41F			
	46		401F 3639L			
	47		L510F L4(D2)			
	48		40(D5) 241(B6)		Stop: 240SF	
			OOK			
96	0	(B1)	50S4 50L	from 36(P)	Read first row of B	
	1		26(N12) 401F			
	2		L521(N12) 407F		N12 store order at loc. 7	
	3		L0(N) 1020F			
	4		4012F 504L		"k" at loc. 12	
	5		26(B2) L5(1)		tally "j" at loc. 11	
	6		4011F 416F			
	7		L51F L0(1)			
	8		369L 2210(B3)			
	9		L0(1) 3210L		FF1: J or L at end first row of B	
	10		FF1F L0(1)		wh. sw. to continue	
	11		3610L 2410(B3)		Stop on F: 24088	
			OOK			
108	0	(B2)	K5F 4217L	from 5(B1)	Set test constants	
	1		L5(C) L412F	2(B6)		
	2		42(T8) 42(T9)			
	3		427(A3) L5(B)			
	4		L412F 42(T1)			

LOCATION			ORDER	NOTES	PAGE 4	M 28
Abs.	Rel.	Sym.				
	5		42(T2) 42(T3)			
	6		42(T4) 42(T5)			
	7		42(T10) 0020F			
	8		46(T1) L512F			
	9		L0(1) 402F			
	10		F5(64) 408F	Calculate drum increment, I,		
	11		L52F F0(64)	for store of B at loc. 8		
	12		3613L 2215L			
	13		L4(1) 402F			
	14		F58F L4(64)			
	15		2210L L5(D2)			
	16		L4(D3) L08F	preset drum store order at loc. 9		
	17		409F 22F			
			00K			
126	0	(B3)	50S4 50L	Read subsequent rows of B		
	1		26(N12) L0(1)			
	2		367L F511F	tally "j" at loc. 11		
	3		4211F L521(N12)			
	4		L07F 40F			
	5		L3F 3210L	test: elements of rows are equal?		
	6		FF2F 2210L	FF2: elements \neq ; wh. sw. to		
	7		L0(1) 328L	continue		
	8		2212L L0(1)			
	9		3212L 202L	Stop on F: 20080		
	10		50(0) 5010L	from 8,11, (B1)		
	11		26(B4) 22(B3)			
	12		50(0) 5012L			
	13		26(B5) 24(A1)	Stop on J or L: 240J7		
			00K			
140	0	(B4)	K5F 4225L	from 11(B3),21(B6)	Rescale row of B and	
	1		L5(B) 427L			
	2		467L 4211L	store on drum		
	3		4212L 4217L			
	4		4222L L34F			
145	5		3215L L54F			
	6		3611L 5013F	negative rescaling		
	7		75F 40F			

LOCATION			ORDER	NOTES	PAGE 5	M 28
Abs.	Rel.	Sym.				
	8		L57L L4(1-1)			
	9		407L L0(T1)			
	10		326L 2215L			
	11		50L3F 75F			
	12		00F 40F	by 25(P)	positive rescaling	
	13		F511L 4211L			
	14		4214L L0(T2)			
	15		3611L L59F			
	16		L48F 4018L			
	17		409F L5F	by 3L		
	18		00F 00F	by 16L	Store on drum	
	19		F518L 4018L			
	20		F517L 4217L			
	21		L0(T3) 3217L			
	22		L56F L4F		sum check for B at loc. 6	
	23		406F F522L			
	24		4222L L0(T4)			
	25		3622L 22F			
			00K			
166	0	(B5)	K5F 4221L	from 13(B3),25(B6)		
	1		L5(A) L411F		Set additional test constants	
	2		0020F 467F			
	3		46(T7) L5(B)			
	4		L411F 42(T6)			
	5		42(T7) 42(T5)			
	6		4110F L5(D4)		clear row counter for A at loc.10	
	7		40(D5) L3(D4)			
	8		3219L L316F			
	9		3610L 2221L			
	10		L5(D4) 409(A3)			
	11		L018(B4) 3221L			
	12		FF4F 92131F		FF4: Drum address too small	
	13		L518(B4) 409(A3)		for store of C; wh. sw. to	
	14		40(D5) L0(D2)		find first available address and to	
	15		40F 5022L		Print corrected address	

LOCATION			ORDER	NOTES	PAGE 6	M 28
Abs.	Rel.	Sym.				
	16		75F 85F			
	17		505F 5017L			
	18		26(PL7) 92131F			
	19		2221L 9259F	from 8L		
186	20		9259F 92139F			
	21		92707F 22F			
	22		00F 00 0000 1000 0000J 00K			
189	0	(B6)	L510F 4011F	from 36(P)	Replace B with C	
	1		416F 501L	from 49(P)		
	2		26(B2) L5(D5)			
	3		L0(D6) 408L			
	4		L5(B) L412F			
	5		4217L 4114F			
	6		4115F L5(B)			
	7		429L 4213L			
	8		00F 00F	by 3L	Read row of C from drum with sum check	
	9		40F 40F			
	10		F58L 408L			
	11		F59L 429L			
	12		F0(T5) 368L			
	13		4114F L5F	by 7L	Sum check for row at loc. 14	
	14		L414F 4014F			
	15		F513L 4213L			
	16		L0(T10) 3213L			
	17		L514F L0F	by 4L		
	18		40F L3F			
	19		3220L FF8F		FF8: Row of C read from drum; incorrectly; wh. sw. to try again	
	20		261L 5020L			
	21		26(B4) F515F			
	22		4215F L011F			
	23		3224L 226L			
	24		00F 5024L			
	25		26(B5) 26(A1)			

LOCATION			ORDER	NOTES	PAGE 7	M 28
Abs.	Rel.	Sym.				
215	0	(A1)	OOK 50S 350L	from 13(B3), 25(B6)	Read rows of A	
	1		26(NI2) L0(1)	13(A3), 14(A4)		
	2		363L 2214L			
	3		L0(1) 367L			
	4		L3(D4) 325L			
	5		226L 92834F		Print "J"	
	6		92135F 24(P)		Stop: End of A; 2402L	
	7		L0(1) 328L			
	8		2014L L3(D4)		Stop on F: 200F5	
	9		3613L L55F			
	10		101F L0(1)			
	11		3234(P) L5(D1)			
	12		4016F 2234(P)			
	13		92834F 92135F		Print "J"	
	14		2234(P) L521(NI2)			
	15		L07F 40F			
	16		L3F 36(A2)			
17		FF3F 26(P)		FF3: row vector of A does not conform to B; wh. sw. to new parameter.		
233	0	(A2)	OOK 4114F L5(D1)	from 16(A1)		
	1		L4(D3) L0(1)			
	2		409F F510F		tally "i" at loc. 10	
	3		4010F 41F			
	4		L5(C) 4227L			
	5		L5(B) 429L			
	6		4213L F59F			
	7		409F 408L			
	8		00F 00F		Read column of B from drum	
	9		40F 40F			
	10		L58L L48F			
	11		408L F59L			
	12		429L L0(T5)			
	13		368L L5F			
	14		L414F 4014F			
15		F513L 4213L		form sum of b_{ij} at loc. 14		

LOCATION			ORDER	NOTES	PAGE 8	M 28	
Abs.	Rel.	Sym.					
253	16		L0(T6) 3213L				
	17		L5(A) 4620L				
	18		L5(B) 4220L				
	19		41F S5F				
	20		50F 74F	by 17, 18L		vector multiplication	
	21		401F 3235L				
	22		L5F 3234L				
	23		L41F 3233L				
	24		40F L520L				
	25		L4(1-1) 4020L				
	26		L0(T7) 3219L				
	27		L5F 40F	by 4L		store C _{ik}	
	28		F527L 4227L				
	29		L0(T8) 365L				
	30		L56F L014F				
	31		40F L3F				
	32		36(A3) FF6F			FF6: B sum check failure;	
	33		26L FF5F			wh. sw. to try again	
	34		26(P) L41F				
	35		2624L L5F			FF5: Overflow on element	
36		3637L 2234L			of C; wh. sw. to read a		
37		L41F 3624L			new parameter		
272	38		2233L OOF				
	0	(A3)	^{00K} L3(D4) 36(A4)	from 32(A2)			
	1		L5(C) 423L			Store row of C on drum with	
	2		428L 41F			row sum check at end of each	
	3		001F L5F			row.	
	4		L4F 40F				
	5		F53L 423L				
	6		L0(T9) 323L				
	279	7		L5F 40F	by 3(B2)		
		8		001F L5F			
9			00F 00F	by 10, 13(B5)		Store on drum	
10			F59L 409L				

LOCATION			ORDER	NOTES	PAGE 9	M 28
Abs.	Rel.	Sym.				
	11		F58L 428L			
	12		F0(T9) 328L			
	13		22(A1) 00F			
286	0	(A4)	00K I5(C) 422L	from 0(A3)	Print row of C	
	1		4114F 001F			
	2		4115F I5F			
	3		50F 503L	by 12(P)		
	4		26(P17) F52L			
	5		422L F514F			
	6		4214F I012F			
	7		3611L F515F		test: end of row?	
	8		4215F I0(NL)			
	9		322L 92131F		test: end of n elements	
	10		92519F 262L			
	11		92770F 92135F			
	12		92519F 22(A1)			
299		(NL2)	00K		Input Routine (NL2)	
338		(P17)	00K (P17)		Print Routine (P17)	
			00K			
397			L3F 34(P)			
398			FF7F 26(P)		FF7: Read failure on	
399			F43691F 580478F		master tape.	
			26L 261N			