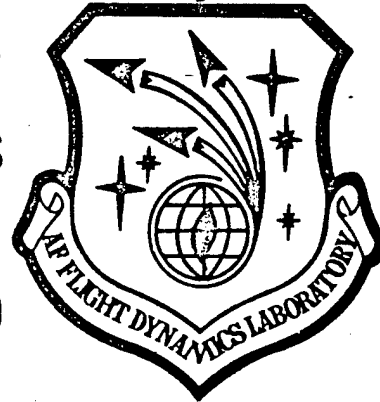


704  
VT

**AIR FORCE FLIGHT DYNAMICS LABORATORY  
DIRECTOR OF LABORATORIES  
AIR FORCE SYSTEMS COMMAND  
WRIGHT PATTERSON AIR FORCE BASE OHIO**



A Computer Program for Counting Load Spectrum Cycles

based on the

Range Pair Cycle Counting Method

V. A. Tischler

Technical Memorandum FBR 72-4

November 1972

This document has been approved for public  
release and sale; its distribution is unlimited.

19990701 027

TM-72-4-FBR

A Computer Program for Counting Load Spectrum Cycles  
based on the  
Range Pair Cycle Counting Method  
V.A. Tischler

This document has been approved for public  
release and sale; its distribution is unlimited.

FOREWORD

This report was prepared by V.A. Tischler of the Solid Mechanics Branch, Structures Division, Air Force Flight Dynamics Laboratory. The work was conducted in-house under Project 1467, "Structural Analysis Methods," Task 146702, "Analysis Methods for Damaged Structures". Mr. Howard A. Wood is the Project Engineer.

The manuscript was released by the author in November 1972.

This technical memorandum has been reviewed and is approved.



FRANCIS J. JANIK, JR.  
Chief, Solid Mechanics Branch  
Structures Division

## ABSTRACT

This report presents a detailed description of a computer program based on the Range Pair Cycle Counting Method, as given in Reference 3. The Range Pair Cycle Counting Method is a procedure for generating an analysis spectrum from a given load spectrum. Examples are presented where the resulting analysis spectrum will be used as input to a crack growth analysis program.

## CONTENTS

Section		Page
I	Introduction	1
II	Program Organization	3
III	Input Instructions	5
IV	Tabular Output	6
References		7
Figures		8
Appendix I	Sample Problems	11
	1. 14 Mission C5-A A Spectrum	12
	2. 5.0g Flight by Flight Spectrum	33
Appendix II	Program Listing	40

SECTION I  
INTRODUCTION

In crack propagation analysis it is necessary to have a correct representation of the load spectrum. A load spectrum obtained from tests may not be directly applicable to analysis. The Range Pair Cycle Counting Method is a means of determining an accurate analysis spectrum from the actual load spectrum. This method is briefly discussed and compared with other counting methods in References 1 and 2. A more comprehensive discussion which forms the basis for the development of the present computer program is given in Reference 3.

The computer program treats a load spectrum  $S$  as a collection of  $n$  peaks and valleys designated by  $x_i$ ,  $i = 1, \dots, 2n$ , such that if  $x_i$  is a peak then  $x_{i+1}$  is a valley,  $1 \leq i \leq 2n-1$ . The analysis spectrum is represented by a collection of  $m$  cycles  $\{(a, b)_i\}$ ,  $i = 1, \dots, m$ , such that  $a_i$  and  $b_i$  are elements of  $S$ . The Range Pair Cycle Counting Method considers four points  $(x_1, x_2, x_3, x_4)$  at a time and the conditions for counting a cycle  $(x_2, x_3)$  are as follows:

If  $x_2 > x_1$ , then a cycle is counted if

$$x_2 \leq x_4 \text{ and } x_3 \geq x_1.$$

Conversely, if  $x_2 < x_1$ , then a cycle is counted if

$$x_2 \geq x_4 \text{ and } x_3 \leq x_1.$$

This method is illustrated in Figure 1.

Thus, starting at the beginning of the load spectrum the first four points  $x_1, x_2, x_3$  and  $x_4$  are considered. If  $x_2$  and  $x_3$  meet the above conditions, a cycle is defined and these two points are deleted from the spectrum. Consequently  $x_4$  becomes  $x_2$  and the next two points of the spectrum are added to again give four points. Counting continues until the four points considered do not define a cycle. Then  $x_1$  is omitted from consideration and becomes an element of a residue spectrum. The three remaining points are updated, i.e.  $x_2$  becomes  $x_1$ ,  $x_3$  becomes  $x_2$ ,  $x_4$  becomes  $x_3$ , and  $x_4$  is added sequentially from the load spectrum. This process continues until there are only two or three points remaining. These points are added to the residue spectrum, which is then analyzed in the same manner as the original load spectrum. Continuing in this manner a residue spectrum is

finally generated which will yield no cycles by the Range Pair Cycle Counting Method. This residue spectrum diverges to a maximum range and then converges as shown in Figure 2. Cycles are generated from the final residue spectrum as follows: Pair the highest peak with the lowest valley to form a cycle. Then moving away from this cycle in both directions, each successive peak and valley are paired together. If there is an extra peak or valley left on either side, it is omitted. This counting method is illustrated in Figure 2.

In summary, an original load spectrum is analyzed using the Range Pair Cycle Counting Method to produce an analysis spectrum plus a final residue spectrum. This final residue spectrum is then analyzed by a pairing technique to determine the remaining cycles, which are then added to those previously counted. The result is a complete analysis spectrum for use in analytical predictions.

## SECTION II

### PROGRAM ORGANIZATION

The Range Pair Cycle Counting program, RPCM, assumes that the input load spectrum,  $S$ , is defined by  $n$  peaks and valleys,  $(x_i, y_i)$ , and  $n$  counters  $k_i$ ,  $i=1, \dots, n$ , where  $k_i$  is a count of the number of times the  $i$ th peak and valley are to be repeated sequentially. The program then assigns a step number  $j$ ,  $j=1, \dots, n$  to each peak and valley of  $S$ . Since the analysis spectrum is generated in disjoint parts, i.e. from the input load spectrum, from each residue spectrum, and from the final residue spectrum, the step numbers are used to sort the analysis spectrum relative to the sequencing of the initial load spectrum. Sequence becomes important particularly in crack growth analysis. When the counter  $k$  is less than 1, as can occur in a flight by flight load spectrum, the peak and valley associated with  $k$  is not analyzed by the program, but is transferred directly into the analysis spectrum and subsequently sequenced relative to its step number.

The program RPCM is divided into three parts. Each part is described below in a step-by-step manner.

#### Part I

1. The initial load spectrum  $S$  is adjusted by removing those peaks and valleys whose counter  $k$  is less than one.
2. The initial load spectrum  $S$  is further adjusted if for some  $i$ , the  $i$ th peak and valley are equal to the  $(i+1)$ th peak and valley, by maximizing the counter  $k_i$ .
3. The Range Pair Cycle Counting Method is now applied to the adjusted load spectrum,  $S$ . Program RPCM calls Subroutine DECIDE with four elements from  $S$ . Subroutine DECIDE determines whether a cycle is to be generated or whether  $x_j$  goes to the residue spectrum. Cycles are generated in Subroutine CYCGEN.

#### Part II

1. The Range Pair Cycle Counting Method is applied to the residue spectrum. Program RPCM calls Subroutine DECRES with four elements from the residue spectrum. Subroutine DECRES determines whether a cycle is to be generated or whether  $x_j$  goes to the next residue spectrum. Cycles are generated in Subroutine CYCRES.

2. If the current residue spectrum has less than three points or if no additional cycles can be generated by the Range Pair Cycle Counting Method, proceed to Part III, otherwise return to Step 1.

Part III

1. The remaining cycles are generated from the final residue spectrum.

2. The analysis spectrum is sorted relative to the sequencing of the input load spectrum.

SECTION III  
INPUT INSTRUCTIONS

<u>Card No.</u> (Format)	<u>Variable Name</u>	<u>Definition</u>
1 (8A10)	TITLE	An alphanumeric description of the load spectrum, S
2 (2I5)	NPKS	Number of peaks or valleys in the load spectrum, S
	NPUNCH	Punch flag NPUNCH $\neq$ 0 implies the analysis spectrum will be punched in the input format.
3, ..., NPKS+2 (5x, 3E10.3)	SIGMAX(I)	Ith peak of the load spectrum, S
	SIGMIN(I)	Ith valley of the load spectrum, S
	RNCYC(I)	counter $k_i$ of the Ith peak and valley

## SECTION IV

### TABULAR OUTPUT

Program RPCM gives the following output:

1. The input load spectrum, S.
2. The adjusted load spectrum as discussed in Section II.
3. The elements and step numbers of Residue Spectrum 1.
4. The elements, the step number and the counter k of the cycles generated from the adjusted load spectrum.
5. The elements and step numbers of Residue Spectrum 2.
6. Step 4 output is repeated plus any additional cycle information generated from Residue Spectrum 1.
7. Steps 5 and 6 are repeated for each residue spectrum until the final residue spectrum is generated.
8. All previous cycle output plus any additional cycle information generated from the final residue spectrum.
9. The Range Pair Cycle Counted spectrum, i.e., the analysis spectrum.

#### REFERENCES

1. J.B. de Jonge, "The Monitoring of Fatigue Loads," National Aerospace Laboratory NLR, The Netherlands, Report MP 70010 U.
2. N.E. Dowling, "Fatigue Failure Predictions for Complicated Stress - Strain Histories", University of Illinois, Urbana, T.&A.M., Report No. 337, January 1971.
3. S. Streitmatter, "A Method of Counting Spectrum Load Cycles", North American Rockwell, Los Angeles Division, TFD-72-358, March 1972.

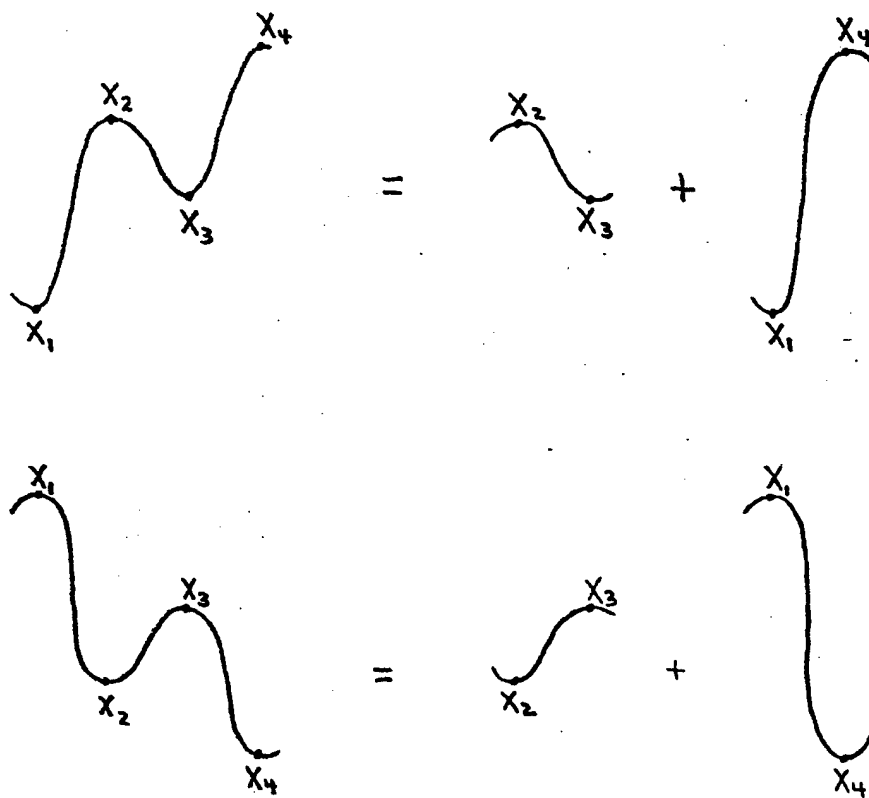


Figure 1

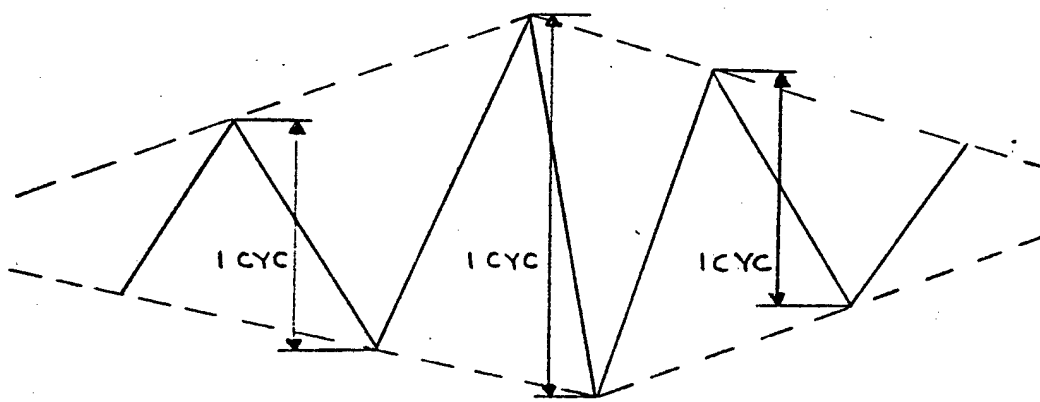


Figure 2

PARTIAL SCHEMATIC OF THE 14 MISSION CS-A A SPECTRUM

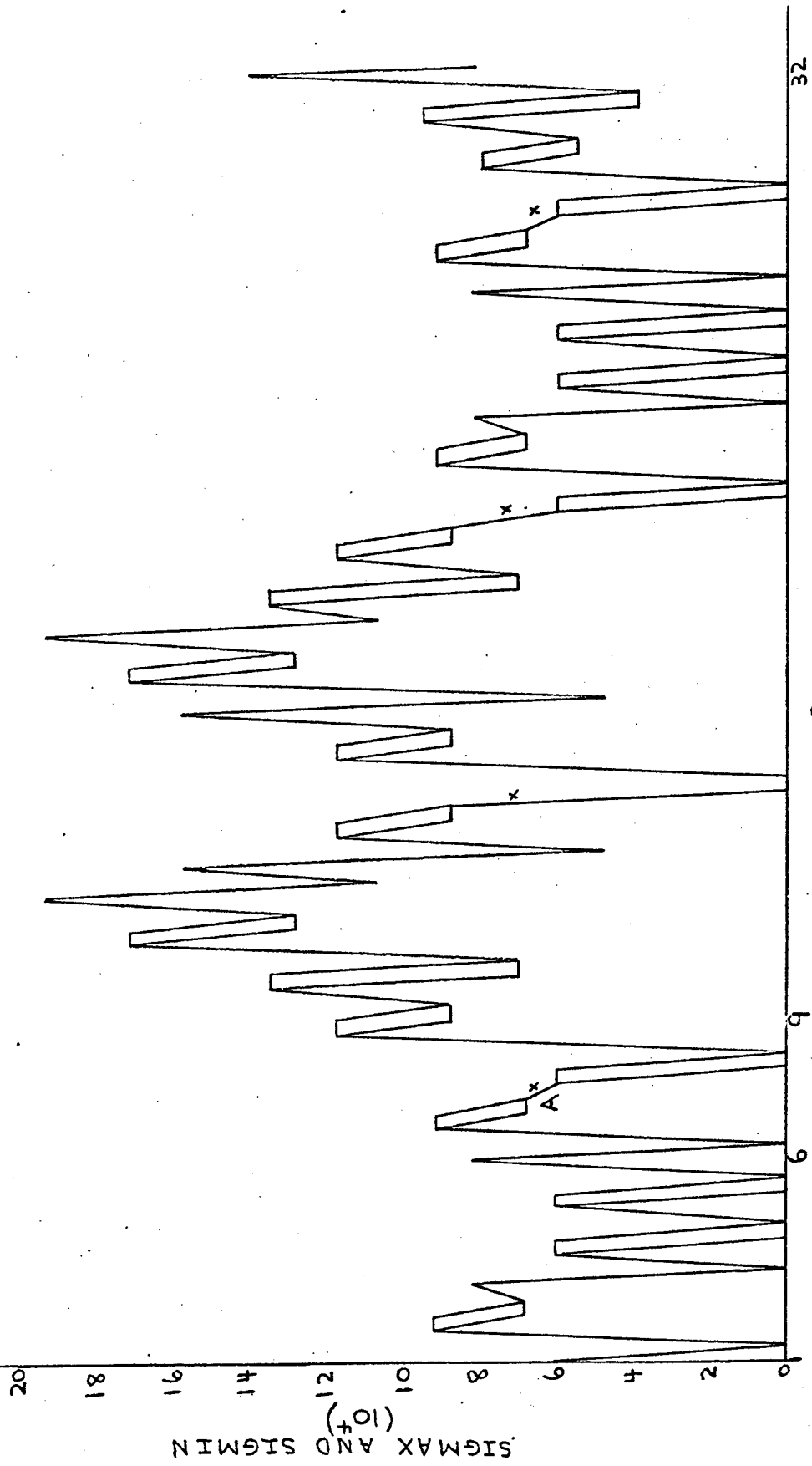


Figure 3

AN EXPANDED VIEW ABOUT  
THE POINT A OF THE  
LOAD SPECTRUM IN FIGURE 3

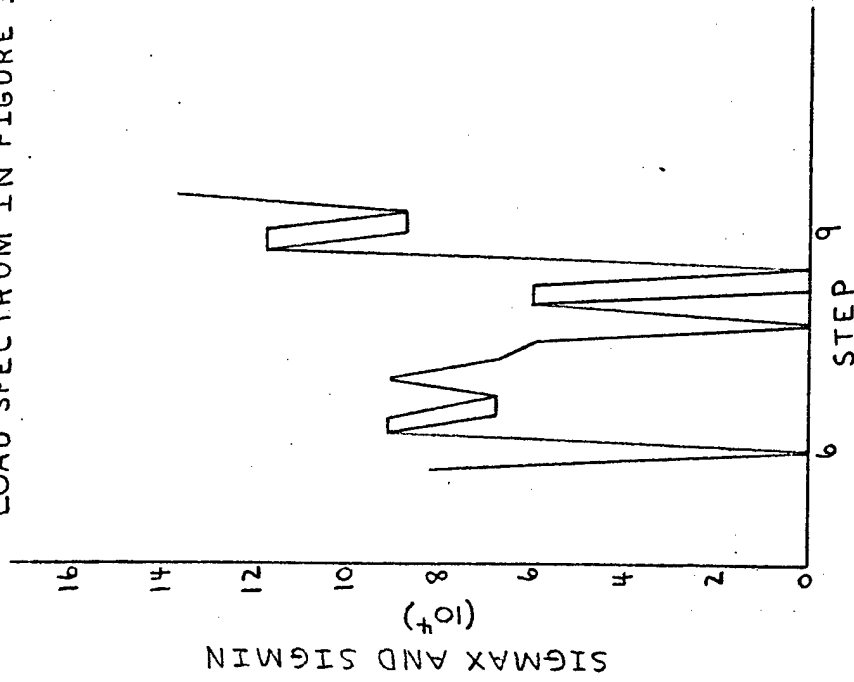


Figure 4

APPENDIX I  
SAMPLE PROBLEMS

1. 14 Mission C5-A A Spectrum

A partial plot of the input load spectrum S is given in Figure 3. The full spectrum is listed on P . It has been observed that the spectrum listing may not be a good representation of the load spectrum since some of the peaks or valley values given in the spectrum listing do not match the actual peaks and valleys on the load spectrum. This can be illustrated by steps 6 through 9 of the spectrum listing.

6	8215.0	0.0	1
7	9146.0	6846.0	5
8	6065.0	0.0	12
9	11790.0	8790.0	50

The load spectrum that these 4 steps would produce is given in Figure 4. Now considering the actual peaks and valleys shown in Figure 4, steps 6 through 9 should become

8215.0	0.0	1
9146.0	6846.0	4
9146.0	0.0	1
6065.0	0.0	11
11790.0	8790.0	50

These five steps may now be range pair counted according to the rules given. The x's on Figure 3 indicate additional places where the above type of behaviour occurs.

The program as written can handle such discrepancies in the initial load spectrum.

14 MISSION C5-A A SPECTRUM

THE NUMBER OF PEAKS OR VALLEYS IN THE INPUT LOAD SPECTRUM = 78

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+14	0.	0.	12.00000
2	.914630E+14	0.	.684600E+04	5.00000
3	.821500E+14	0.	0.	1.00000
4	.606500E+14	0.	0.	12.00000
5	.606500E+14	0.	0.	12.00000
6	.821500E+14	0.	0.	1.00000
7	.914600E+14	0.	.684600E+04	5.00000
8	.606500E+14	0.	0.	12.00000
9	.117900E+15	0.	.879300E+04	50.00000
10	.135400E+05	0.	.704000E+04	29.00000
11	.172000E+15	0.	.129000E+05	14.00000
12	.194600E+15	0.	.117300E+05	1.00000
13	.157900E+15	0.	.479000E+04	1.00000
14	.117900E+15	0.	.879300E+04	50.00000
15	.100000E+11	0.	0.	1.00000
16	.117900E+15	0.	.879000E+04	50.00000
17	.157900E+15	0.	.479000E+04	1.00000
18	.172000E+15	0.	.129000E+05	14.00000
19	.194600E+15	0.	.107300E+05	1.00000
20	.135400E+05	0.	.704000E+04	29.00000
21	.117900E+15	0.	.879000E+04	50.00000
22	.606500E+14	0.	.684600E+04	5.00000
23	.914600E+14	0.	0.	1.00000
24	.821500E+14	0.	0.	12.00000
25	.606500E+14	0.	0.	12.00000
26	.606500E+14	0.	0.	1.00000
27	.821500E+14	0.	.684600E+04	5.00000
28	.914600E+14	0.	0.	12.00000
29	.606500E+14	0.	0.	50.00000
30	.794700E+04	0.	.544700E+04	12.00000
31	.949700E+14	0.	.389700E+04	24.00000
32	.140000E+15	0.	.813000E+04	1.00000
33	.122500E+15	0.	.985000E+04	24.00000
34	.1139700E+15	0.	.199700E+04	1.00000
35	.794700E+14	0.	.544700E+04	50.00000
36	.606500E+14	0.	0.	12.00000
37	.914600E+14	0.	.684600E+04	5.00000
38	.821500E+14	0.	0.	1.00000
39	.606500E+14	0.	0.	12.00000
40	.606500E+14	0.	0.	12.00000
41	.821500E+14	0.	0.	1.00000
42	.914600E+14	0.	.684600E+04	5.00000
43	.606500E+14	0.	0.	12.00000
44	.794700E+14	0.	.544700E+04	50.00000
45	.1139700E+15	0.	.199700E+04	1.00000
46	.122500E+15	0.	.985000E+04	24.00000
47	.140000E+15	0.	.813000E+04	1.00000
48	.949700E+14	0.	.389700E+04	24.00000
49	.794700E+14	0.	.544700E+04	50.00000
50	.606500E+14	0.	0.	12.00000
51	.914600E+14	0.	.684600E+04	5.00000
52	.821500E+14	0.	0.	1.00000
53	.606500E+14	0.	0.	12.00000
54	.606500E+14	0.	0.	12.00000

55	.821500E+J4	0.	.684600E+04	1.00000
56	.914600E+J4	0.	.684600E+04	5.00000
57	.606500E+04	0.	.879000E+04	12.00000
58	.117900E+J5	.704000E+04	.704000E+04	50.00000
59	.135400E+J5	.129000E+05	.129000E+05	29.00000
60	.172000E+05	.107000E+05	.107000E+05	14.00000
61	.194000E+J5	.479000E+04	.479000E+04	1.00000
62	.157900E+J5	.879000E+04	.879000E+04	50.00000
63	.117900E+J5	0.	.879000E+04	1.00000
64	.100000E+J1	.879000E+J4	.879000E+J4	50.00000
65	.117900E+J5	.479000E+04	.479000E+04	1.00000
66	.157900E+J5	.129000E+05	.129000E+05	14.00000
67	.172000E+05	.107000E+05	.107000E+05	1.00000
68	.194000E+J5	.704000E+04	.704000E+04	29.00000
69	.135400E+J5	.879000E+04	.879000E+04	50.00000
70	.117900E+05	0.	.684600E+04	12.00000
71	.606500E+J4	.879000E+04	.879000E+04	5.00000
72	.914600E+J4	0.	.684600E+04	1.00000
73	.821500E+J4	0.	.684600E+04	12.00000
74	.606500E+J4	0.	.684600E+04	12.00000
75	.606500E+J4	0.	.684600E+04	1.00000
76	.821500E+J4	0.	.684600E+04	5.00000
77	.914600E+J4	0.	.684600E+04	12.00000
78	.606500E+J4	0.	.684600E+04	12.00000

STEP NUMBERS OF IDENTICAL PEAKS AND VALLEYS WHICH OCCUR CONSECUTIVELY IN THE LOAD SPECTRUM

5 26 40 54 75

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+J4		0.	12.00000
2	.914600E+J4		.684600E+04	5.00000
3	.821500E+J4		0.	1.00000
4	.606500E+J4		0.	24.00000
5	.821500E+J4		0.	1.00000
6	.914600E+J4		.684600E+04	5.00000
7	.606500E+J4		0.	12.00000
8	.117900E+J5		.879000E+04	50.00000
9	.135400E+J5		.704000E+04	29.00000
10	.172000E+J5		.129000E+05	14.00000
11	.194000E+J5		.107000E+05	1.00000
12	.157900E+J5		.479000E+04	1.00000
13	.117900E+J5		.879000E+04	50.00000
14	.100000E+J5		0.	1.00000
15	.117900E+J5		.879000E+04	50.00000
16	.157900E+J5		.479000E+04	1.00000
17	.172000E+J5		.129000E+05	14.00000
18	.194000E+J5		.107000E+05	1.00000
19	.135400E+J5		.704000E+04	29.00000
20	.117900E+J5		.879000E+04	50.00000
21	.606500E+J4		0.	12.00000
22	.914600E+J4		.684600E+04	5.00000
23	.821500E+J4		0.	1.00000
24	.606500E+J4		0.	24.00000
25	.821500E+J4		0.	1.00000
26	.914600E+J4		.684600E+04	5.00000
27	.606500E+J4		0.	12.00000
28	.117900E+J5		.879000E+04	50.00000
29	.135400E+J5		.704000E+04	29.00000
30	.172000E+J5		.129000E+05	14.00000
31	.194000E+J5		.107000E+05	1.00000
32	.157900E+J5		.479000E+04	1.00000
33	.117900E+J5		.879000E+04	50.00000
34	.100000E+J5		0.	1.00000
35	.117900E+J5		.879000E+04	50.00000
36	.157900E+J5		.479000E+04	1.00000
37	.172000E+J5		.129000E+05	14.00000
38	.194000E+J5		.107000E+05	1.00000
39	.135400E+J5		.704000E+04	29.00000
40	.117900E+J5		.879000E+04	50.00000
41	.606500E+J4		0.	12.00000
42	.914600E+J4		.684600E+04	5.00000
43	.821500E+J4		0.	1.00000
44	.606500E+J4		0.	24.00000
45	.821500E+J4		0.	1.00000
46	.914600E+J4		.684600E+04	5.00000
47	.606500E+J4		0.	12.00000
48	.117900E+J5		.879000E+04	50.00000
49	.135400E+J5		.704000E+04	29.00000
50	.172000E+J5		.129000E+05	14.00000
51	.194000E+J5		.107000E+05	1.00000
52	.157900E+J5		.479000E+04	1.00000
53	.117900E+J5		.879000E+04	50.00000
54	.100000E+J5		0.	1.00000
55	.117900E+J5		.879000E+04	50.00000
56	.157900E+J5		.479000E+04	1.00000
57	.172000E+J5		.129000E+05	14.00000
58	.194000E+J5		.107000E+05	1.00000
59	.135400E+J5		.704000E+04	29.00000
60	.117900E+J5		.879000E+04	50.00000

61  
62  
63  
64  
65  
66  
67  
68  
69  
70  
71  
72  
73  
74  
76  
77  
78

.194000E+15  
.157900E+15  
.117900E+15  
.100000E+11  
.117900E+05  
.157900E+15  
.172000E+15  
.194000E+15  
.135400E+15  
.117900E+15  
.606500E+14  
.914600E+14  
.821500E+14  
.606500E+14  
.821500E+04  
.914600E+14  
.606500E+14

.107000E+05  
.479000E+04  
.879000E+04  
0.  
.879000E+04  
.479000E+04  
.129000E+05  
.107000E+05  
.704000E+04  
.879000E+04  
0.  
.684600E+04  
0.  
0.  
0.  
.684600E+04  
0.

1.00000  
1.00000  
50.00000  
1.00000  
50.00000  
1.00000  
14.00000  
1.00000  
29.00000  
50.00000  
12.00000  
5.00000  
1.00000  
24.00000  
1.00000  
5.00000  
12.00000

VALUE	STEP
.506500E+04	1
0.	1
.314600E+04	2
0.	6
.314600E+04	7
0.	8
.194000E+05	12
.479000E+04	13
.117900E+05	14
0.	15
.194000E+05	19
.704000E+04	20
.117900E+05	21
0.	22
.314600E+04	23
0.	27
.314600E+04	28
0.	29
.140000E+05	32
.310000E+04	32
.122500E+05	33
.199700E+04	34
.794700E+04	35
0.	36
.314600E+04	37
0.	41
.314600E+04	42
0.	43
.140000E+05	47
.389700E+04	48
.794700E+04	49
0.	50
.914600E+04	51
0.	55
.314600E+04	56
0.	57
.194000E+05	61
.479000E+04	62
.117900E+05	63
0.	64
.194000E+05	68
.704000E+04	69
.117900E+05	70
0.	71
.914600E+04	72
0.	76
.314600E+04	77
0.	78

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+J4		0.	11.00000
2	.914600E+J4		.684600E+J4	4.00000
3	.821500E+J4		.684600E+J4	1.00000
4	.606500E+J4		0.	24.00000
6	.821500E+J4		0.	1.00000
7	.914600E+J4		.684600E+J4	4.00000
8	.606500E+J4		0.	11.00000
9	.117900E+J5		.879300E+J4	50.00000
10	.135400E+J5		.704300E+J4	29.00000
11	.172000E+J5		.129000E+J5	14.00000
13	.157900E+J5		.107300E+J5	1.00000
14	.117900E+J5		.879300E+J4	99.00000
18	.157900E+J5		.479300E+J4	1.00000
20	.135400E+J5		.129000E+J5	14.00000
22	.117900E+J5		.107300E+J5	1.00000
24	.914600E+J4		.704300E+J4	28.00000
25	.821500E+J4		.684600E+J4	49.00000
27	.821500E+J4		0.	11.00000
28	.914600E+J4		.684600E+J4	4.00000
29	.606500E+J4		.684600E+J4	1.00000
30	.794700E+J4		0.	24.00000
31	.949700E+J4		.684600E+J4	1.00000
33	.122500E+J5		.684600E+J4	4.00000
34	.113970E+J5		.544700E+J4	11.00000
35	.794700E+J4		.544700E+J4	4.00000
36	.606500E+J4		.684600E+J4	1.00000
37	.914600E+J4		.684600E+J4	4.00000
38	.821500E+J4		0.	24.00000
39	.606500E+J4		0.	1.00000
41	.821500E+J4		.684600E+J4	4.00000
42	.914600E+J4		0.	11.00000
43	.606500E+J4		.544700E+J4	50.00000
44	.794700E+J4		.199700E+J4	50.00000
46	.113970E+J5		.985000E+J4	1.00000
48	.949700E+J4		.810000E+J4	24.00000
48	.949700E+J4		.389700E+J4	1.00000
49	.794700E+J4		.544700E+J4	23.00000
50	.606500E+J4		.544700E+J4	49.00000
51	.914600E+J4		0.	1.00000
52	.821500E+J4		.684600E+J4	4.00000
53	.606500E+J4		.684600E+J4	1.00000
55	.821500E+J4		0.	24.00000
56	.914600E+J4		.684600E+J4	1.00000
57	.606500E+J4		0.	4.00000
58	.117900E+J5		.879300E+J4	11.00000
59	.135400E+J5		.704300E+J4	50.00000
60	.172000E+J5		.129000E+J5	29.00000
62	.157900E+J5		.107300E+J5	14.00000
63	.117900E+J5		.879300E+J4	99.00000

67	.157900E+05	.479300E+04	1.00000
67	.172000E+05	.129000E+05	14.00000
69	.135400E+05	.107000E+05	1.00000
69	.135400E+05	.704000E+04	28.00000
70	.117900E+05	.879000E+04	49.00000
71	.606500E+04	0.	11.00000
72	.914600E+04	.684600E+04	4.00000
73	.821500E+04	.684600E+04	1.00000
74	.606500E+04	0.	24.00000
76	.821500E+04	0.	1.00000
77	.914600E+04	.684600E+04	4.00000
78	.606500E+04	0.	11.00000

VALUE	STEP
.506500E+04	1
0.	1
.194000E+05	12
0.	15
.194000E+05	19
0.	29
.140000E+05	32
0.	43
.140000E+05	47
0.	57
.194000E+05	61
0.	64
.194000E+05	68
0.	78

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+14	0.	.684600E+04	11.00000
2	.914600E+14	0.	.684600E+04	4.00000
3	.821500E+14	0.	.684600E+04	1.00000
4	.606500E+04	0.	0.	24.00000
6	.821500E+14	0.	0.	1.00000
7	.914600E+14	0.	.684600E+04	4.00000
8	.606500E+14	0.	0.	11.00000
9	.117900E+15	0.	.879000E+04	50.00000
10	.135400E+15	0.	.704000E+04	29.00000
11	.172000E+15	0.	.129000E+05	14.00000
13	.157900E+15	0.	.107000E+05	1.00000
14	.117900E+15	0.	.879000E+04	99.00000
18	.157900E+15	0.	.479000E+04	1.00000
18	.172000E+15	0.	.129000E+05	14.00000
20	.135400E+15	0.	.107000E+05	1.00000
21	.117900E+15	0.	.879000E+04	28.00000
21	.117900E+15	0.	.879000E+04	49.00000
22	.606500E+14	0.	0.	11.00000
23	.914600E+14	0.	.684600E+04	4.00000
24	.821500E+14	0.	.684600E+04	1.00000
25	.606500E+14	0.	0.	24.00000
27	.821500E+14	0.	.684600E+04	1.00000
28	.914600E+14	0.	.684600E+04	4.00000
29	.606500E+14	0.	0.	11.00000
31	.794700E+14	0.	.544700E+04	50.00000
31	.949700E+14	0.	.389700E+04	24.00000
33	.122500E+05	0.	.985000E+04	23.00000
34	.113970E+15	0.	.885000E+04	1.00000
35	.794700E+14	0.	.544700E+04	49.00000
36	.606500E+14	0.	.544700E+04	1.00000
36	.606500E+14	0.	.544700E+04	11.00000
37	.914600E+14	0.	.684600E+04	4.00000
38	.821500E+14	0.	.684600E+04	1.00000
39	.606500E+14	0.	0.	24.00000
41	.821500E+14	0.	.684600E+04	1.00000
42	.914600E+14	0.	.684600E+04	4.00000
43	.606500E+14	0.	0.	11.00000
44	.794700E+14	0.	.544700E+04	50.00000
46	.113970E+15	0.	.199700E+04	1.00000
46	.122500E+05	0.	.985000E+04	24.00000
48	.949700E+14	0.	.810000E+04	1.00000
48	.949700E+14	0.	.389700E+04	23.00000
49	.794700E+14	0.	.544700E+04	49.00000
50	.606500E+14	0.	.544700E+04	1.00000
51	.914600E+14	0.	.684600E+04	11.00000
52	.821500E+14	0.	.684600E+04	4.00000
53	.606500E+14	0.	0.	1.00000
55	.821500E+14	0.	.684600E+04	24.00000
56	.914600E+14	0.	.684600E+04	4.00000
57	.606500E+14	0.	0.	11.00000
58	.117900E+15	0.	.879000E+04	50.00000
59	.135400E+15	0.	.704000E+04	29.00000
60	.172000E+15	0.	.129000E+05	14.00000
62	.157900E+15	0.	.107000E+05	1.00000
63	.117900E+15	0.	.879000E+04	99.00000

67	.157900E+05	.479000E+04	1.00000
67	.172000E+15	.129300E+05	14.00000
68	.135400E+15	.107300E+05	1.00000
69	.135400E+05	.704000E+04	28.00000
70	.117900E+15	.879000E+04	49.00000
71	.606500E+14	0.	11.00000
72	.914600E+14	.684600E+04	4.00000
73	.821500E+14	.684600E+04	1.00000
74	.606500E+14	0.	24.00000
76	.821500E+14	0.	1.00000
77	.914600E+14	.684600E+04	4.00000
78	.606500E+14	0.	11.00000
2	.914600E+14	0.	1.00000
7	.914600E+04	0.	1.00000
14	.117900E+15	.479000E+04	1.00000
21	.117900E+15	.704000E+04	1.00000
23	.914600E+14	0.	1.00000
28	.914600E+14	0.	1.00000
33	.122500E+15	.810300E+04	1.00000
35	.794700E+14	.199700E+04	1.00000
37	.914600E+14	0.	1.00000
42	.914600E+14	0.	1.00000
49	.794700E+14	.389700E+04	1.00000
51	.914600E+14	0.	1.00000
56	.914600E+14	0.	1.00000
63	.117900E+15	.479000E+04	1.00000
70	.117900E+15	.704000E+04	1.00000
72	.914600E+14	0.	1.00000
77	.914600E+14	0.	1.00000

MEMBERS OF RESIDUE SPECTRUM 3 = 4

VALUE STEP

0.006500E+04	1
0.	1
0.194000E+05	19
0.	78

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+J4	0.	0.	11.00000
2	.914600E+J4	0.	.684600E+04	4.00000
3	.821500E+J4	0.	.684600E+04	1.00000
4	.606500E+J4	0.	0.	24.00000
6	.821500E+04	0.	0.	1.00000
7	.914600E+J4	0.	.684600E+04	4.00000
8	.606500E+J4	0.	0.	11.00000
9	.117900E+J5	0.	.879000E+04	50.00000
10	.135400E+J5	0.	.769300E+04	29.00000
11	.172000E+J5	0.	.129300E+05	14.00000
13	.157900E+J5	0.	.107000E+05	1.00000
14	.117900E+J5	0.	.879000E+04	99.00000
18	.157900E+J5	0.	.479000E+04	1.00000
19	.172000E+J5	0.	.129300E+05	14.00000
20	.135400E+J5	0.	.107000E+05	1.00000
20	.135400E+J5	0.	.704500E+04	28.00000
21	.117900E+J5	0.	.879000E+J4	49.00000
22	.606500E+J4	0.	0.	11.00000
23	.914600E+J4	0.	.684600E+04	4.00000
24	.821500E+J4	0.	.684600E+04	1.00000
25	.606500E+J4	0.	0.	24.00000
27	.821500E+J4	0.	0.	1.00000
28	.914600E+J4	0.	.684600E+04	4.00000
29	.606500E+J4	0.	0.	11.00000
30	.794700E+J4	0.	.544700E+04	50.00000
31	.949700E+J4	0.	.389700E+04	24.00000
33	.122500E+J5	0.	.985000E+J4	23.00000
34	.113970E+J5	0.	.585000E+04	1.00000
35	.794700E+J4	0.	.544700E+04	49.00000
36	.606500E+J4	0.	0.	1.00000
36	.606500E+J4	0.	.684600E+04	11.00000
37	.914600E+J4	0.	.684600E+J4	4.00000
38	.821500E+J4	0.	0.	1.00000
39	.606500E+J4	0.	0.	24.00000
41	.821500E+04	0.	.684600E+04	1.00000
42	.914600E+J4	0.	.684600E+04	4.00000
43	.606500E+J4	0.	0.	11.00000
44	.794700E+J4	0.	.544700E+04	50.00000
46	.113970E+J5	0.	.199700E+04	1.00000
46	.122500E+J5	0.	.995300E+04	24.00000
48	.949700E+J4	0.	.810000E+04	1.00000
48	.949700E+J4	0.	.389700E+04	23.00000
49	.794700E+J4	0.	.544700E+04	49.00000
50	.606500E+J4	0.	0.	1.00000
50	.606500E+J4	0.	.684600E+04	11.00000
51	.914600E+J4	0.	.684600E+04	4.00000
52	.821500E+J4	0.	0.	1.00000
53	.606500E+J4	0.	.684600E+04	24.00000
55	.821500E+J4	0.	0.	1.00000
55	.914600E+J4	0.	.684600E+04	4.00000
57	.606500E+J4	0.	0.	11.00000
58	.117900E+J5	0.	.879000E+04	50.00000
59	.135400E+J5	0.	.769300E+04	29.00000
60	.172000E+J5	0.	.129300E+05	14.00000
62	.157900E+J5	0.	.107000E+05	1.00000
63	.117900E+J5	0.	.879000E+04	99.00000

67	.157900E+15	.479000E+04	1.00000
67	.172000E+05	.129000E+05	14.00000
69	.135400E+15	.107000E+05	1.00000
69	.135400E+15	.704000E+04	28.00000
70	.117900E+15	.879000E+04	49.00000
71	.606500E+14	0.	11.00000
72	.914600E+14	.684600E+04	4.00000
73	.821500E+14	.684600E+04	1.00000
74	.606500E+14	0.	24.00000
76	.821500E+14	0.	1.00000
77	.914600E+14	.684600E+04	1.00000
78	.606500E+14	0.	4.00000
2	.914600E+14	0.	11.00000
7	.914600E+14	0.	1.00000
14	.117900E+15	.479000E+04	1.00000
21	.117900E+15	.764000E+04	1.00000
23	.914600E+14	0.	1.00000
28	.914600E+14	0.	1.00000
33	.122500E+15	.810000E+04	1.00000
35	.794700E+14	.199700E+04	1.00000
37	.914600E+14	0.	1.00000
42	.914600E+14	0.	1.00000
49	.794700E+14	.389700E+04	1.00000
51	.914600E+14	0.	1.00000
56	.914600E+14	0.	1.00000
63	.117900E+15	.479000E+04	1.00000
70	.117900E+15	.764000E+04	1.00000
72	.914600E+14	0.	1.00000
77	.914600E+14	0.	1.00000
12	.194000E+15	0.	1.00000
32	.140000E+15	0.	1.00000
47	.140000E+15	0.	1.00000
61	.194000E+15	0.	1.00000
68	.194000E+15	0.	1.00000

MENDERS OF RESIDUE SPECTRUM 4 = 4

VALUE	STEP
.506500E+04	1
0.	1
.194000E+05	19
0.	78

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+14	0.	0.	11.000000
2	.914600E+14	.684600E+04	.684600E+04	4.000000
3	.821500E+14	0.	0.	1.000000
4	.606500E+14	0.	0.	24.000000
6	.821500E+14	0.	0.	1.000000
7	.914600E+14	0.	.684600E+04	4.000000
8	.606500E+14	0.	0.	11.000000
9	.117900E+15	.879000E+04	.879000E+04	50.000000
10	.135400E+15	.704000E+04	.704000E+04	29.000000
11	.172000E+15	.129000E+05	.129000E+05	14.000000
13	.157900E+15	.167000E+05	.167000E+05	1.000000
14	.117900E+15	.157900E+15	.879000E+04	99.000000
16	.157900E+15	.179000E+15	.479000E+04	1.000000
18	.172000E+15	.129000E+05	.129000E+05	14.000000
20	.135400E+15	.107000E+05	.107000E+05	1.000000
22	.135400E+15	.704000E+04	.704000E+04	28.000000
24	.117900E+15	.879000E+04	.879000E+04	49.000000
25	.606500E+14	0.	0.	11.000000
27	.914600E+14	.684600E+04	.684600E+04	4.000000
28	.914600E+14	0.	0.	24.000000
29	.606500E+14	0.	0.	1.000000
30	.794700E+14	.684600E+04	.684600E+04	4.000000
31	.949700E+14	0.	0.	11.000000
33	.122500E+15	.544700E+04	.544700E+04	50.000000
34	.113970E+15	.985000E+04	.985000E+04	24.000000
35	.794700E+14	.985000E+04	.985000E+04	23.000000
36	.606500E+14	.544700E+04	.544700E+04	1.000000
37	.606500E+14	0.	0.	49.000000
38	.821500E+14	.684600E+04	.684600E+04	1.000000
39	.606500E+14	0.	0.	4.000000
41	.821500E+14	0.	0.	1.000000
42	.914600E+14	.684600E+04	.684600E+04	24.000000
43	.606500E+14	0.	0.	1.000000
44	.794700E+14	.544700E+04	.544700E+04	4.000000
46	.113970E+15	.199700E+04	.199700E+04	11.000000
46	.122500E+15	.985000E+04	.985000E+04	50.000000
48	.949700E+14	.810000E+04	.810000E+04	24.000000
48	.949700E+14	.389700E+04	.389700E+04	23.000000
49	.794700E+14	.544700E+04	.544700E+04	49.000000
50	.606500E+14	0.	0.	1.000000
51	.914600E+14	.684600E+04	.684600E+04	11.000000
52	.821500E+14	0.	0.	4.000000
53	.606500E+14	.684600E+04	.684600E+04	1.000000
55	.821500E+14	0.	0.	24.000000
56	.914600E+14	0.	0.	1.000000
57	.606500E+14	.684600E+04	.684600E+04	4.000000
58	.117900E+15	.879000E+04	.879000E+04	11.000000
59	.135400E+15	.704000E+04	.704000E+04	50.000000
60	.172000E+15	.129000E+05	.129000E+05	29.000000
62	.157900E+15	.107000E+05	.107000E+05	14.000000
63	.117900E+15	.879000E+04	.879000E+04	1.000000

67	.157900E+J5	.479000E+J4	1.00000
67	.172000E+05	.129000E+05	14.00000
69	.135400E+J5	.107000E+05	1.00000
69	.135400E+J5	.28.00000	28.00000
70	.117900E+J5	.704000E+04	49.00000
71	.606500E+J4	.879000E+04	11.00000
72	.914600E+J4	0.	4.00000
73	.821500E+J4	.684600E+04	1.00000
74	.606500E+04	0.	24.00000
76	.821500E+J4	0.	1.00000
77	.914600E+J4	.684600E+04	4.00000
78	.606500E+J4	0.	11.00000
2	.914600E+J4	.684600E+J4	1.00000
7	.914600E+J4	0.	1.00000
14	.117900E+J5	.479000E+04	1.00000
21	.117900E+J5	.704000E+04	1.00000
21	.614600E+J4	0.	1.00000
28	.914600E+J4	0.	1.00000
33	.122500E+J5	.810000E+04	1.00000
35	.794700E+J4	.199700E+04	1.00000
37	.914600E+J4	0.	1.00000
42	.794700E+J4	.389700E+04	1.00000
49	.914600E+J4	0.	1.00000
51	.914600E+J4	0.	1.00000
56	.117900E+J5	.479000E+04	1.00000
63	.117900E+J5	.704000E+04	1.00000
70	.914600E+J4	0.	1.00000
72	.914600E+J4	0.	1.00000
77	.194000E+J5	0.	1.00000
12	.140000E+J5	0.	1.00000
32	.140000E+J5	0.	1.00000
47	.194000E+J5	0.	1.00000
61	.194000E+J5	0.	1.00000
68	.194000E+J5	0.	1.00000

CYCLES GENERATED FROM LAST RESIDUE SPECTRUM - NO RANGE PAIR COUNTING = 2

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+14	0.	0.	11.00000
2	.914630E+14		.684630E+04	4.00000
3	.821500E+14		.684600E+04	1.00000
4	.606500E+14	3.	3.	24.00000
6	.821500E+14	3.	3.	1.00000
7	.914630E+14		.684630E+04	4.00000
8	.606500E+04			11.00000
9	.117900E+15	3.	.879300E+04	50.00000
10	.135400E+15		.754330E+04	29.00000
11	.172000E+05		.189000E+05	14.00000
13	.157900E+15		.157900E+05	1.00000
14	.117900E+15		.879300E+04	99.00000
18	.157900E+15		.479300E+04	1.00000
18	.172000E+15		.189000E+05	14.00000
20	.135400E+15		.157900E+05	1.00000
20	.135400E+15		.157900E+05	28.00000
21	.117900E+15		.879300E+04	49.00000
22	.606500E+14	3.	.379300E+04	11.00000
23	.914630E+14		.684630E+04	4.00000
24	.821500E+04		.684600E+04	1.00000
25	.606500E+14	0.	0.	24.00000
27	.821500E+14	3.	3.	1.00000
28	.914630E+14		.684630E+04	4.00000
29	.606500E+14	0.	0.	11.00000
30	.794700E+14		.544700E+04	50.00000
31	.949700E+14		.389700E+04	24.00000
33	.122500E+15		.885300E+04	23.00000
34	.113970E+15		.985300E+04	1.00000
35	.794700E+14		.544700E+04	49.00000
36	.606500E+04		.544700E+04	1.00000
36	.606500E+14	3.	3.	11.00000
37	.914630E+14		.684630E+04	4.00000
38	.821500E+14		.684600E+04	1.00000
39	.606500E+14	0.	0.	24.00000
41	.821500E+14	3.	3.	1.00000
42	.914630E+14		.684630E+04	4.00000
43	.606500E+14		.684600E+04	1.00000
44	.794700E+14	0.	0.	11.00000
46	.113970E+15		.544700E+04	50.00000
46	.122500E+05		.199700E+04	1.00000
48	.949700E+14		.885300E+04	24.00000
48	.949700E+14		.885300E+04	1.00000
48	.949700E+14		.885300E+04	23.00000
49	.794700E+14		.544700E+04	49.00000
50	.606500E+14		.544700E+04	1.00000
50	.606500E+14	0.	0.	11.00000
51	.914630E+14		.684630E+04	4.00000
52	.821500E+04		.684600E+04	1.00000
53	.606500E+14	3.	3.	24.00000
55	.821500E+14	3.	3.	1.00000
56	.914630E+14		.684630E+04	4.00000
57	.606500E+14		.684600E+04	1.00000
58	.117900E+15	0.	0.	11.00000
59	.135400E+15		.754330E+04	50.00000
60	.172000E+15		.189000E+05	29.00000
62	.157900E+15		.157900E+05	14.00000
63	.117900E+15		.879300E+04	1.00000
67	.157900E+05		.479300E+04	99.00000
67	.172000E+15		.189000E+05	1.00000
67	.172000E+15		.189000E+05	14.00000

69	.135400E+J5	.107000E+J5	1.00000
69	.135400E+J5	.704000E+04	28.00000
70	.117900E+J5	0.	49.00000
71	.606500E+J4	.879000E+J4	1.00000
72	.914600E+J4	.684600E+04	4.00000
73	.821500E+J4	.684600E+04	1.00000
74	.606500E+J4	0.	24.00000
76	.821500E+J4	0.	1.00000
77	.914600E+04	.684600E+04	4.00000
78	.606500E+J4	0.	11.00000
2	.914600E+J4	0.	1.00000
7	.914600E+J4	0.	1.00000
14	.117900E+J5	.479000E+04	1.00000
21	.117900E+J5	.764000E+04	1.00000
23	.914600E+J4	0.	1.00000
28	.914600E+J4	0.	1.00000
33	.122500E+J5	0.	1.00000
35	.794700E+J4	.810000E+04	1.00000
37	.914600E+J4	.199700E+04	1.00000
42	.914600E+J4	0.	1.00000
49	.794700E+J4	0.	1.00000
51	.914600E+J4	.389700E+04	1.00000
56	.914600E+J4	0.	1.00000
63	.117900E+J5	0.	1.00000
70	.117900E+J5	.479000E+04	1.00000
72	.914600E+J4	.704000E+04	1.00000
77	.914600E+J4	0.	1.00000
12	.194000E+J5	0.	1.00000
32	.140000E+J5	0.	1.00000
47	.140000E+J5	0.	1.00000
61	.194000E+J5	0.	1.00000
68	.194000E+J5	0.	1.00000
19	.194000E+J5	0.	1.00000
1	.606500E+J4	0.	1.00000

RANGE PAIR CYCLE COUNTED SPECTRUM

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+J4	0.	0.	12.00000
2	.914600E+J4	.684600E+04	.684600E+04	4.00000
3	.914600E+J4	0.	0.	1.00000
4	.821500E+J4	.684600E+04	.684600E+04	1.00000
5	.606500E+J4	0.	0.	24.00000
6	.821500E+04	0.	0.	1.00000
7	.914600E+J4	.684600E+04	.684600E+04	4.00000
8	.914600E+J4	0.	0.	1.00000
9	.606500E+04	0.	0.	11.00000
10	.117900E+J5	.879000E+04	.879000E+04	50.00000
11	.135400E+J5	.764300E+04	.764300E+04	29.00000
12	.172000E+J5	.129000E+05	.129000E+05	14.00000
13	.194000E+J5	0.	0.	1.00000
14	.157900E+J5	.117000E+05	.117000E+05	1.00000
15	.117900E+J5	.879000E+04	.879000E+04	1.00000
16	.117900E+05	.479000E+04	.479000E+04	1.00000
17	.157900E+J5	.479000E+04	.479000E+04	1.00000
18	.172000E+J5	.129000E+05	.129000E+05	14.00000
19	.194000E+05	0.	0.	1.00000
20	.135400E+J5	.117000E+05	.117000E+05	1.00000
21	.135400E+J5	.764300E+04	.764300E+04	28.00000
22	.117900E+J5	.879000E+04	.879000E+04	49.00000
23	.117900E+J5	.704000E+04	.704000E+04	1.00000
24	.606500E+J4	0.	0.	11.00000
25	.914600E+J4	.684600E+04	.684600E+04	4.00000
26	.914600E+04	0.	0.	1.00000
27	.821500E+J4	.684600E+04	.684600E+04	1.00000
28	.606500E+J4	0.	0.	24.00000
29	.821500E+04	0.	0.	1.00000
30	.914600E+J4	.684600E+04	.684600E+04	4.00000
31	.914600E+J4	0.	0.	1.00000
32	.606500E+J4	0.	0.	11.00000
33	.794700E+J4	.544700E+04	.544700E+04	50.00000
34	.949700E+J4	.389700E+04	.389700E+04	24.00000
35	.140000E+05	0.	0.	1.00000
36	.122500E+J5	.985000E+04	.985000E+04	23.00000
37	.122500E+J5	.810300E+04	.810300E+04	1.00000
38	.113970E+J5	.985000E+04	.985000E+04	1.00000
39	.794700E+J4	.544700E+04	.544700E+04	49.00000
40	.794700E+J4	.199700E+04	.199700E+04	1.00000
41	.606500E+J4	.544700E+04	.544700E+04	1.00000
42	.606500E+J4	0.	0.	11.00000
43	.914600E+J4	.684600E+04	.684600E+04	4.00000
44	.914600E+J4	0.	0.	1.00000
45	.821500E+04	.684600E+04	.684600E+04	1.00000
46	.606500E+J4	0.	0.	24.00000
47	.821500E+04	0.	0.	1.00000
48	.914600E+04	.684600E+04	.684600E+04	4.00000
49	.914600E+J4	0.	0.	1.00000
50	.606500E+J4	0.	0.	11.00000
51	.794700E+J4	.544700E+04	.544700E+04	50.00000
52	.113970E+J5	.199700E+04	.199700E+04	1.00000
53	.122500E+J5	.985000E+04	.985000E+04	24.00000
54	.140000E+J5	0.	0.	1.00000
55	.949700E+04	.810300E+04	.810300E+04	1.00000
56	.949700E+J4	.389700E+04	.389700E+04	23.00000

57	.794700E+14	.544700E+14	49.00000
58	.794700E+14	.389700E+14	1.00000
59	.606500E+14	.544700E+14	1.00000
60	.606500E+14	0.	11.00000
61	.914600E+14	.684600E+14	4.00000
62	.914600E+14	0.	1.00000
63	.821500E+14	.684600E+14	1.00000
64	.606500E+14	0.	24.00000
65	.821500E+14	0.	1.00000
66	.914600E+14	.684600E+14	4.00000
67	.914600E+14	0.	1.00000
68	.606500E+14	0.	11.00000
69	.117900E+15	.879000E+14	50.00000
70	.135400E+15	.704300E+14	29.00000
71	.172000E+15	.129000E+15	14.00000
72	.194000E+15	0.	1.00000
73	.157900E+15	.107000E+15	1.00000
74	.117900E+15	.879000E+14	99.00000
75	.117900E+15	.479000E+14	1.00000
76	.157900E+15	.479000E+14	1.00000
77	.172000E+15	.129000E+15	14.00000
78	.194000E+15	0.	1.00000
79	.135400E+15	.107000E+15	1.00000
80	.135400E+15	.704300E+14	28.00000
81	.117900E+15	.879000E+14	49.00000
82	.117900E+15	.704300E+14	1.00000
83	.606500E+14	0.	11.00000
84	.914600E+14	.684600E+14	4.00000
85	.914600E+14	0.	1.00000
86	.821500E+14	.684600E+14	1.00000
87	.606500E+14	0.	24.00000
88	.821500E+14	0.	1.00000
89	.914600E+14	.684600E+14	4.00000
90	.914600E+14	0.	1.00000
91	.606500E+14	0.	11.00000

---

2. 5.0g Flight by Flight Spectrum

5. JG FLIGHT BY FLIGHT SPECTRUM

THE NUMBER OF PEAKS OR VALLEYS IN THE INPUT LOAD SPECTRUM = 74

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.42300E+12		.27700E+12	1.00000
2	.49300E+12		.23100E+12	1.00000
3	.39600E+12		.23100E+12	1.00000
4	.39600E+12		.23100E+12	1.00000
5	.49300E+12		.23100E+12	1.00000
6	.45600E+12		.23000E+12	1.00000
7	.47900E+12			1.00000
8	.42300E+12			4.00000
9	.28300E+12		.23000E+12	1.00000
10	.30800E+12		.15200E+12	1.00000
11	.58300E+12		.23000E+12	1.00000
12	.30800E+12		.15200E+12	1.00000
13	.30800E+12		.15200E+12	1.00000
14	.66800E+12		.23000E+12	1.00000
15	.45600E+12		.23000E+12	1.00000
16	.30800E+12		.15200E+12	2.00000
17	.30800E+12		.15200E+12	2.00000
18	.49000E+12		.22700E+12	1.00000
19	.30800E+12		.15200E+12	1.00000
20	.30800E+12		.15200E+12	1.00000
21	.34500E+12		.11200E+12	1.00000
22	.30800E+12		.15200E+12	1.00000
23	.30800E+12		.15200E+12	1.00000
24	.29900E+12		.11100E+12	5.00000
25	.29900E+12		.22000E+12	4.00000
26	.40800E+12		.11600E+12	3.00000
27	.50400E+12		.22000E+12	1.00000
28	.29900E+12		.11600E+12	7.00000
29	.29900E+12		.22000E+12	13.00000
30	.29900E+12		.11600E+12	8.00000
31	.40800E+12		.22000E+12	5.00000
32	.50400E+12		.11600E+12	1.00000
33	.40800E+12		.11100E+12	1.00000
34	.59300E+12		.22000E+12	1.00000
35	.51700E+12		.26300E+12	1.00000
36	.40200E+12		.26300E+12	1.00000
37	.40200E+12		.20300E+12	1.00000
38	.73600E+12		.26300E+12	1.00000
39	.77800E+12		.26300E+12	1.00000
40	.51700E+12		.26300E+12	1.00000
41	.51700E+12		.26300E+12	1.00000
42	.64800E+12		.20300E+12	1.00000
43	.64800E+12		.20300E+12	1.00000
44	.36600E+12		.19800E+12	1.00000
45	.36600E+12		.19800E+12	1.00000
46	.46400E+12		.14300E+12	1.00000
47	.39500E+12		.10400E+12	1.00000
48	.39500E+12		.10400E+12	5.00000
49	.30700E+12		.10400E+12	1.00000
50	.39500E+12		.10400E+12	1.00000
51	.49800E+12		.14000E+12	1.00000
52	.30700E+12		.10400E+12	6.00000
53	.30700E+12		.14000E+12	17.00000

54	.428000E+J2	.200000E+J2	1.00000
55	.502000E+J2	.200000E+J2	1.00000
56	.366000E+J2	.200000E+J2	1.00000
57	.564000E+J2	.200000E+J2	1.00000
58	.470000E+J2	.200000E+J2	1.00000
59	.526000E+J2	.200000E+J2	1.00000
60	.470000E+J2	.200000E+J2	1.00000
61	.254000E+J2	.470000E+J1	1.00000
62	.184000E+J2	-.160000E+J1	1.00000
63	.338000E+J2	-.160000E+J1	3.00000
64	.356000E+J2	.114000E+J2	1.00000
65	.366000E+J2	.151000E+J2	1.00000
66	.396000E+J2	.151000E+J2	1.00000
67	.456000E+J2	.230000E+J2	1.00000
68	.356000E+J2	.228000E+J2	1.00000
69	.583000E+J2	.151000E+J2	1.00000
70	.366000E+J2	.228000E+J2	1.00000
71	.583000E+J2	.151000E+J2	1.00000
72	.366000E+J2	.228000E+J2	1.00000
73	.583000E+J2	.151000E+J2	1.00000
74	.366000E+J2	.228000E+J2	2.00000

STEP NUMBERS OF IDENTICAL PEAKS AND VALLEYS WHICH OCCUR CONSECUTIVELY IN THE LOAD SPECTRUM

4 13 17 20 23 37 41 43 45 66

LOAD SPECTRUM DATA ADJUSTED FOR RANGE PAIR COUNTING = 64

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.42300E+02		.27730E+02	1.00000
2	.49300E+02		.23100E+02	1.00000
3	.39600E+02		.23100E+02	2.00000
5	.49300E+02		.23100E+02	1.00000
6	.45600E+02		.23100E+02	1.00000
7	.47900E+02		0.	1.00000
8	.34200E+02		0.	4.60000
9	.28300E+02		.23000E+02	1.19000
10	.30800E+02		.19200E+02	1.00000
11	.58300E+02		.23000E+02	2.30000
12	.30800E+02		.15200E+02	2.00000
14	.68000E+02		.23000E+02	1.00000
15	.45600E+02		.23000E+02	1.00000
16	.39600E+02		.15200E+02	4.00000
18	.49000E+02		.22700E+02	1.00000
19	.30800E+02		.15200E+02	2.00000
21	.34900E+02		.11200E+02	1.00000
22	.30800E+02		.15200E+02	2.00000
24	.29900E+02		.11100E+02	5.00000
25	.29900E+02		.22000E+02	4.00000
26	.40600E+02		.11600E+02	3.00000
27	.50400E+02		.22000E+02	1.00000
28	.29900E+02		.11600E+02	7.00000
29	.29900E+02		.22000E+02	13.00000
31	.40600E+02		.11600E+02	8.00000
32	.50400E+02		.22000E+02	5.00000
33	.40600E+02		.11100E+02	1.00000
34	.59300E+02		.22000E+02	1.00000
35	.51700E+02		.23300E+02	1.00000
36	.42000E+02		.20300E+02	2.00000
38	.73600E+02		.23300E+02	1.00000
39	.77800E+02		.20300E+02	1.00000
40	.51700E+02		.20300E+02	2.00000
42	.64900E+02		.20300E+02	2.00000
44	.36600E+02		.19900E+02	2.00000
46	.46400E+02		.14000E+02	1.00000
47	.39500E+02		.14000E+02	5.00000
48	.39500E+02		.14000E+02	1.00000
49	.30700E+02		.10400E+02	1.00000
50	.39500E+02		.10400E+02	1.00000
51	.49800E+02		.14000E+02	1.00000
52	.30700E+02		.10400E+02	6.00000
53	.30700E+02		.14000E+02	17.00000
54	.42800E+02		.20000E+02	1.00000
55	.50200E+02		.20000E+02	1.00000
56	.36600E+02		.20000E+02	1.00000
57	.56400E+02		.20000E+02	1.00000
58	.47000E+02		.20000E+02	1.00000
59	.52600E+02		.20000E+02	1.00000
60	.47000E+02		.20000E+02	1.00000
61	.25400E+02		.47000E+02	1.00000
62	.25400E+02		.16500E+02	1.00000
63	.18400E+02		.16500E+02	3.00000
64	.33800E+02		.11400E+02	1.00000

65	.306000E+12	.151000E+02	2.00000
67	.396000E+12	.230000E+02	1.00000
68	.456000E+12	.280000E+02	1.00000
69	.306000E+12	.151000E+02	1.00000
70	.583000E+12	.280000E+02	1.00000
71	.306000E+12	.151000E+02	1.00000
72	.583000E+12	.280000E+02	1.00000
73	.366000E+12	.220000E+02	1.00000
74	.503000E+12	.294000E+02	2.00000

RANGE PAIR CYCLE COUNTED SPECTRUM

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.42300E+12		.27700E+02	1.00000
2	.49300E+12			1.00000
3	.39600E+12		.23100E+02	2.00000
4	.49300E+12		.23100E+02	1.00000
5	.45600E+12		.23100E+02	1.00000
6	.47900E+12		.23000E+02	1.00000
7	.34200E+12			4.00000
8	.28300E+12		.23000E+02	1.00000
9	.30800E+12		.15200E+02	1.00000
10	.59300E+12		.15200E+02	1.50000
11	.38800E+12		.23000E+02	1.00000
12	.38000E+12		.15200E+02	1.00000
13	.66800E+12		.22000E+02	1.00000
14	.45600E+12		.23000E+02	1.00000
15	.38000E+12		.23000E+02	1.00000
16	.30800E+12		.15200E+02	3.00000
17	.49000E+12		.15200E+02	1.00000
18	.38800E+12		.22700E+02	1.00000
19	.30800E+12		.15200E+02	1.00000
20	.34500E+12		.15200E+02	1.00000
21	.30800E+12		.15200E+02	1.00000
22	.30800E+12		.11200E+02	1.00000
23	.29900E+12		.15200E+02	1.00000
24	.29900E+12		.11000E+02	5.00000
25	.29900E+12		.22000E+02	3.00000
26	.40800E+12		.11600E+02	3.00000
27	.58400E+12		.22000E+02	1.00000
28	.29900E+12		.11600E+02	7.00000
29	.29900E+12		.23000E+02	13.00000
30	.29900E+12		.11600E+02	3.00000
31	.40800E+12		.22000E+02	3.00000
32	.50400E+12		.11000E+02	1.00000
33	.48000E+12		.11600E+02	1.00000
34	.59300E+12		.22000E+02	1.00000
35	.51700E+12		.23000E+02	1.00000
36	.40200E+12		.23000E+02	2.00000
37	.73600E+12		.20300E+02	1.00000
38	.77800E+12		.16000E+02	1.00000
39	.51700E+12		.23000E+02	2.00000
40	.64800E+12		.23000E+02	2.00000
41	.36600E+12		.20300E+02	1.00000
42	.36600E+12		.19300E+02	1.00000
43	.46400E+12		.19800E+02	1.00000
44	.39500E+12		.16400E+02	1.00000
45	.29500E+12		.14000E+02	5.00000
46	.30700E+12		.15400E+02	11.00000
47	.39500E+12		.10400E+02	1.00000
48	.49800E+12		.14000E+02	1.00000
49	.30700E+12		.14000E+02	17.00000
50	.30700E+12		.14000E+02	1.00000
51	.52200E+12		.20000E+02	1.00000
52	.36600E+12		.20000E+02	1.00000
53	.36600E+12		.20000E+02	1.00000
54	.56400E+12		.14000E+02	1.00000
55	.47000E+12		.25000E+02	1.00000

1.00000  
1.00000  
1.00000  
1.00000  
3.00000  
1.00000  
2.00000  
1.00000  
1.00000  
2.00000  
1.00000  
1.00000  
1.00000  
2.00000

.200000E+02  
.200000E+02  
.200000E+02  
.470000E+01  
.160000E+01  
.114000E+02  
.151000E+02  
.230000E+02  
.151000E+02  
.228000E+02  
.151000E+02  
.222000E+02  
.228000E+02  
.294000E+02

.526000E+02  
.470000E+02  
.254000E+02  
.254000E+02  
.184000E+02  
.338000E+02  
.336000E+02  
.396000E+02  
.456000E+02  
.306000E+02  
.583000E+02  
.365000E+02  
.503000E+02

56  
57  
58  
59  
60  
61  
62  
63  
64  
65  
66  
67  
68  
69

**APPENDIX II**  
**PROGRAM LISTING**

PROGRAM RPCM(INPUT, TAP5=INPUT, OUTPUT, TAP5=OUTPUT, PUNCH)  
 THIS PROGRAM EMPLOYS THE RANGE PAIR CYCLE COUNTING METHOD TO GENERATE AN ANALYSIS SPECTRUM FROM A GIVEN LOAD SPECTRUM

INPUT  
 CARD 1. TITLE = DESCRIPTION OF THE INPUT LOAD SPECTRUM, S  
 CARD 2. FORMAT 8A10  
 NPXS = NUMBER OF PEAKS OR VALLEYS IN THE LOAD SPECTRUM  
 NPUNCH = PUNCH FLAG SUCH THAT NPUNCH NOT EQUAL TO ZERO IMPLIES PUNCH IN THE RANGE PAIR COUNTED SPECTRUM IN THE INPUT FORMAT  
 FORMAT 2I5  
 SIGMAX(I) = ITH PEAK OF THE LOAD SPECTRUM  
 SIGMIN(I) = ITH VALLEY OF THE LOAD SPECTRUM  
 RNCYC(I) = COUNTER K OF THE ITH PEAK AND VALLEY  
 FORMAT 5X, 3E10.0

PROGRAM ARRAYS  
 (INFORMATION NEEDED TO CHANGE DIMENSIONS)

ARRAY NAME	DEFINITION	DIMENSION
SIGMAX	PEAKS OF THE INPUT LOAD SPECTRUM	NPXS + KK
KK	THE NUMBER OF ADDITIONAL CYCLES (EXCLUDING INPUT CYCLES) WHICH THE PROGRAM WILL GENERATE	NPXS + KK
SIGMIN	VALLEYS OF THE INPUT LOAD SPECTRUM	NPXS + KK
RNCYC	K COUNTERS OF THE PEAKS AND VALLEYS	NPXS + KK
NSTEP	STEP NUMBERS OF THE INPUT SPECTRUM	2*NPXS
RES	RESIDUE SPECTRUM	2*NPXS
INDEX	STEP NUMBERS OF ELEMENTS IN RES	NPXS + KK
CYCLE	RANGE PAIR COUNTED CYCLES	NPXS + KK
RNECYC	K COUNTERS OF THE CYCLES OF THE UNSORTED ANALYSIS SPECTRUM	NPXS + KK
MNSTEP	STEP NUMBERS OF ELEMENTS OF THE UNSORTED ANALYSIS SPECTRUM	NPXS + KK
ISAVE	VALUES OF NSTEP(J) SUCH THAT RNCYC(J) IS < 1.0 AND VALUES OF NSTEP(J) SUCH THAT SIGMAX(J-1) = SIGMAX(J) AND SIGMIN(J-1) = SIGMIN(J)	99

COMMON/MDEC/SIGMAX(900), SIGMIN(900), NSTEP(900), LR, KMAX, KMIN, K31  
 COMMON/MD=CR/RES(1400), INDEX(1400), IND1, IND2, IND3, IND4, KIND  
 COMMON/HCYG/CYCLE(900, 2), RNECYC(900), MNSTEP(900)  
 COMMON/PCGDE/L, LIND  
 DIMENSION RNCYC(900), ISAVE(99), TITLE(8)

9999 NPUNCH = 0  
 READ(5, 10) (TITLE(I), I = 1, 8)  
 IF (EOF(5)) 9000, 9100  
 10 FORMAT(8A10)  
 9000 STOP  
 9100 READ(5, 95) NPXS, NPUNCH  
 95 FORMAT(1X15)

```

60 READ(5,101) (SIGMAX(I),SIGHIN(I),RNCYC(I), I = 1,NPKS)
101 FORMAT(5X,SE10.3)
DO 8000 I = 1,NPKS
8000 NSTEP(I) = I
19 WRITE(6,19) (TITLE(I), I = 1,9)
19 FORMAT(1H1,8A10)
WRITE(6,20) NPKS
20 FORMAT(1H1,60H THE NUMBER OF PEAKS OR VALLEYS IN THE INPUT LOAD) SPE
19RUM = ,15//
WRITE(6,22)
22 FORMAT(63X,5HSIGMA/31X,4HSTEP,13X,7HMAXIMUM,16X,7HMINIMUM,13X,
9HCOUNTER K/)
1 WRITE(6,25) (NSTEP(I),SIGMAX(I),SIGHIN(I),RNCYC(I), I = 1,NPKS)
25 FORMAT(29X,I5,10X,E13.6,10X,E13.6,10X,F10.5)
70 C SORT THROUGH THE LOAD SPECTRUM - PULL OUT THOSE PEAKS AND VALLEYS WHOSE
C COUNTER K IS LESS THAN 1.0
C
75 J = 1
L = 6
NPES = 1
NCYNO = 100
JMAX = 0
DO 100 I = 1,NPKS
IF (RNCYC(I) .GE. 1.0) GO TO 100
X1 = SIGMAX(I)
X2 = SIGHIN(I)
CALL CYCGEN(X1,X2 ,RNCYC(I),VSTEP(I))
ISAVE(I) = I
J = J + 1
100 CONTINUE
JMAX = J - 1
NPKN = NPKS - J
IF (I .EQ. 0) GO TO 200
IF (JMAX .EQ. 0) GO TO 200
WRITE(6,23) (ISAJE(K), K = 1,JMAX)
23 FORMAT(1H0,9HSTEP NUMBERS OF THOSE PEAKS AND VALLEYS IN THE LOAD
1SPECTRUM WHOSE COUNTER K IS LESS THAN 1.0// (17I))
DO 110 J = 1,JMAX
I = ISAVE(J) - (J-1)
NPKN = NPKS - J
IF (I .EQ. NPKN) GO TO 110
DO 115 II = I,NPKN
SIGMAX(II) = SIGMAX(II+1)
SIGHIN(II) = SIGHIN(II+1)
NSTEP(II) = NSTEP(II+1)
RNCYC(II) = RNCYC(II+1)
115 CONTINUE
110 CONTINUE
WRITE(6,24) NPKSN
105 WRITE(6,25) (NSTEP(I),SIGMAX(I),SIGHIN(I),RNCYC(I), I = 1,NPKSN)
200 CONTINUE
C
C SORT THROUGH THE LOAD SPECTRUM DATA - COMBINE STEPS WITH IDENTICAL PEAKS
C AND VALLEYS WHICH OCCUR CONSECUTIVELY
110

```



```

170                   KMAX = 0
                  K31 = 0
                  IF (RNCYC(I) .EQ. 1.0) GO TO 5
                  KEY = 1
                  KIND = 1
                  GO TO 415
                  6 KEY = 0
                  CYCNO = RNCYC(I)
                  CALL DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)
175                   1000 GO TO (12,13,30),KCYGEN
                  13 KB = 1
                  IF (KMIN .NE. 1) GO TO 36
                  I = I + 1
                  IF (I .LE. NPKSN) GO TO 5
                  RES(LR+1) = X1
                  RES(LR+2) = X2
                  INDEX(LR+1) = IND1
                  INDEX(LR+2) = IND2
                  LRMAX = LR + 2
                  GO TO 200J
185                   30 IF (KMIN .NE. 1) GO TO 35
                  12 I = I + 1
                  IF (I .LE. NPKSN) GO TO 31
                  RES(LR+1) = X1
                  RES(LR+2) = X2
                  RES(LR+3) = X3
                  INDEX(LR+1) = IND1
                  INDEX(LR+2) = IND2
                  INDEX(LR+3) = IND3
                  LRMAX = LR + 3
                  GO TO 200J
195                   31 X4 = SIGMAX(I)
                  IND4 = NSTEP(I)
                  KMAX = 1
                  KMIN = 0
                  K31 = 1
200                   32 IF (RNCYC(I) .GT. 1.0) GO TO 40
                  40 KEY = 1
                  KIND = 0
                  GO TO 415
205                   35 X4 = SIGMIN(I)
                  IND4 = NSTEP(I)
                  KMIN = 1
                  KMAX = 0
                  K31 = 0
                  GO TO 32
210                   36 X3 = SIGMIN(I)
                  IND3 = NSTEP(I)
                  KMIN = 1
                  KMAX = 0
                  GO TO 12
215                   400 KEY = 1
                  IF (KB .NE. 0) GO TO 410
                  X1 = SIGMAX(I)

```

```

225      X2 = SIGMIN(I)
          X3 = SIGMAX(I)
          X4 = SIGMIN(I)
          IND1 = NSTEP(I)
          IND2 = IND1
          IND3 = IND1
          IND4 = IND1
          KHIN = 1
          KMAX = 0
          K31 = 0
          IF (RNCYC(I) .LE. 2.0) GO TO 401
          RNCYC(I) = RNCYC(I) - 1.0
          GO TO 402
          401 RNCYC(I) = RNCYC(I) - 2.0
          402 KIND = 0
              GO TO 415
          410 X3 = SIGMAX(I)
              X4 = SIGMIN(I)
              IND3 = NSTEP(I)
              IND4 = IND3
              KHIN = 1
              KMAX = 0
              K31 = 0
              KIND = 1
              RNCYC(I) = RNCYC(I) - 1.0
              KB = 0
          415 CYCNO = RNCYC(I)
              CALL DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)
              GO TO 1000
          2000 LMAX = L
              WRITE(6,2001) NRES,LRMAX
          2001 FORMAT(1H1,27HMEMBERS OF RESIDUE SPECTRUM,15,3H = , 15//,55X,
              15HVALUE,10X,4HSTEP//)
          2102 FOPMAT(50X,15.6,10X,15)
              WRITE(6,2103) NRES,LRMAX
          2203 FORMAT(1H1,40HCYCLES GENERATED BEFORE RESIDUE SPECTRUM,15,3H = ,
              115//)
              WRITE(6,22)
              WRITE(6,25)                    (NNSTEP(I),CYCLE(I,1),CYCLE(I,2),RNECYC(I),
          1                    I = 1,LRMAX)
              IF (LRMAX .LT. 4) GO TO 5000
              IF (NCYNO .EQ. 0) GO TO 5000
          C                    RANGE PAIR COUNT OF RESIDUE SPECTRUMS
          C
          265                    NRES = NRES + 1
              CALL DECRES(LRMAX,NCYNO)
              GO TO 2000
          270                    5300 IF (LRMAX .LE. 1) GO TO 3000
          C                    COUNT THE LAST RESIDUE SPECTRUM - RANGE PAIR COUNTING WILL YIELD NO
          C                    ADDITIONAL CYCLES
          C                    KK = 0
          275
    
```

```

280 RESMAX = RES(1)
    RESMIN = RES(1)
    IMAX = 1
    IMIN = 1
    DO 500 I = 2,LRMAX
    IF (RES(I) .LT. RESMAX) GO TO 490
    RESMAX = RES(I)
    IMAX = I
    GO TO 500
295 IF (RES(I) .GT. RESMIN) GO TO 500
    RESMIN = RES(I)
    IMIN = I
500 CONTINUE
    CALL CYCRES(RESMAX,RESMIN,1.0,INDEX(IMAX))
    KK = KK + 1
510 J = IMAX - 2
    IF (J .LE. 0) GO TO 550
    CALL CYCRES(RES(J),RES(J+1),1.0,INDEX(J))
    KK = KK + 1
    IMAX = J
    GO TO 510
295 550 J = IMIN + 2
    IF (J .GT. LRMAX) GO TO 575
    CALL CYCRES(RES(J-1),RES(J),1.0,INDEX(J-1))
    KK = KK + 1
    IMIN = J
    GO TO 550
575 KMAX = KK
    LMAX = L
    WRITE(6,2005) KMAX
305 2005 FORMAT(1H1,71HCYCLES GENERATED FROM LAST RESIDUE SPECTRUM - NO RAN
    1GE PAIR COUNTING = ,15)
    WRITE(6,22)
    WRITE(6,25) (NNSTEP(I),CYCLE(I,1),CYCLE(I,2),RNECYC(I),
    1 I = 1,LMAX)
310 C
    C
    C
315 3000 KP = 0
    DO 605 JJ = 1,NPKS
    KC = 0
    DO 600 I = 1,LMAX
    IF (NNSTEP(I) .NE. JJ) GO TO 600
    KP = KP + 1
    KC = KC + 1
    NSTEP(KP) = KP
    SIGNAX(KP) = CYCLE(I,1)
    SIGNIN(KP) = CYCLE(I,2)
    RNECYC(KP) = RNECYC(I)
    IF (KC .LT. 2) GO TO 600
    IF (SIGNAX(KP) .NE. SIGNAX(KP-1)) GO TO 600
    IF (SIGNIN(KP) .NE. SIGNIN(KP-1)) GO TO 600
595 KP = KP - 1
    RNECYC(KP) = RNECYC(KP) + 1.0
600 CONTINUE

```

```
335                    605 CONTINUE  
                      KPMAX = KP  
                      WRITE(6,2030)  
2311                    FORMAT(1H1,48X,33H RANGE PAIR CYCLE COUNTED SPECTRUM//)  
                      WRITE(6,22)  
                      WRITE(6,25) (NSTEP(I),SIGMAX(I),SIGHIN(I),RNCYC(I),I = 1,KPMAX)  
                      IF (NPUNCH .EQ. G) GO TO 9999  
                      PUNCH 102, (SIGMAX(I),SIGHIN(I),RNCYC(I), I = 1,KPMAX)  
340                    102                    FORMAT(5X,3F10.2)  
                      GO TO 9999  
                      END
```

```

SUBROUTINE DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)
COMMON/MDEC/SIGMAX(900),SIGHI(900),NSTEP(900),LR,KMAX,KMIN,K31
COMMON/MDEC/RES(1400),INDEX(1400),IND1,IND2,IND3,IND4,KIND
COMMON/MCYG/CYCLE(900,2),RNECYC(900),MNSTEP(900)
COMMON/MGDE/L,LIND
    
```

```

C THIS SUBROUTINE DECIDES WHETHER OR NOT THE VALUES X1, X2, X3, AND X4
C FROM THE ADJUSTED LOAD SPECTRUM SATISFY THE RANGE PAIR COUNTING CONDITIONS
    
```

```

10 KFIRST = 0
    IF (K31 .NE. 0) GO TO 11
    IF (X3 .LE. X2) GO TO 200
    11 IF (X2 .GT. X1) GO TO 210
    
```

```

15 IF (X2 .LT. X4 .OR. X3 .GT. X1) GO TO 500
    CALL CYCGEN(X3,X2,1.0,NSTEP(I))
    GO TO 152
    
```

```

20 151 CALL CYCGEN(X2,X3, 1.0,NSTEP(I))
    152 X1 = X1
    X2 = X4
    IF (IND3 .NE. IND2) LIND = 1
    IND2 = IND4
    KCYGEN = 1
    
```

```

25 IF (KEY .NE. 0) GO TO 110
    RETURN
    210 IF (X2 .GT. X4 .OR. X3 .LT. X1) GO TO 500
    GO TO 150
    
```

```

30 200 X1 = X1
    X2 = X4
    IND2 = IND4
    KCYGEN = 2
    IF (KEY .EQ. 0) RETURN
    CYCNO = CYCNO - 1.0
    GO TO 110
    
```

```

35 C ADD X1 TO THE RESIDUE SPECTRUM
    C
    500 LR = LR + 1
    RES(LR) = X1
    INDEX(LR) = IND1
    X1 = X2
    X2 = X3
    X3 = X4
    
```

```

40 IND1 = IND2
    IND2 = IND3
    IND3 = IND4
    KCYGEN = 3
    IF (KEY .NE. 0) GO TO 110
    RETURN
    
```

```

45 110 GO TO (1150,1200,1500),KCYGEN
    1150 IF (CYCNO .GT. 1.0) GO TO 1151
    IF (CYCNO .EQ. 0.0) RETURN
    1153 CYCNO = CYCNO - 1.0
    GO TO 1152
    
```

```

50 1151 IF (LIND .EQ. 1) GO TO 1153
    
```

SUBROUTINE DECIDE TRACE

```
IF (IND3 .NE. IND4) GO TO 1153
RNECYC(L) = RNECYC(L) + CYCNO - 2.0
CYCNO = 1.0
1152 IF (KMAX .NE. 1) GO TO 111
X3 = SIGMIN(I)
IND3 = NSTEP(I)
IF (CYCNO .NE. 0.0) GO TO 112
KMIN = 1
KMAX = 6
KCYGEN = 3
RETURN
```

60

```
1200 IF (CYCNO .EQ. 0.0) RETURN
CYCNO = CYCNO - 1.0
X3 = SIGMAX(I)
X4 = SIGMIN(I)
KFIRST = 1
GO TO 113
```

65

```
111 X3 = SIGMAX(I)
X4 = SIGMIN(I)
IF (KFIRST .NE. 0) GO TO 113
CYCNO = CYCNO - 1.0
KFIRST = 1
```

75

```
113 IND3 = NSTEP(I)
IND4 = IND3
KMIN = 1
KMAX = 0
GO TO 10
```

80

```
1503 IF (KMAX .NE. 0) GO TO 1510
IF (CYCNO .EQ. 0.0) RETURN
CYCNO = CYCNO - 1.0
```

85

```
112 X4 = SIGMAX (I)
IND4 = NSTEP(I)
KMAX = 1
KMIN = 6
GO TO 11
```

90

```
1510 X4 = SIGMIN(I)
IND4 = NSTEP(I)
KMAX = 6
KMIN = 1
GO TO 10
END
```

95

SUBROUTINE CYCGEN(Y1,Y2, CYCPF,NSTPEP)  
COMMON/MCYG/CYCLE(3),RNECYC(900),NNSTEP(900)  
COMMON/MCGDE/L,LIND

5 C THIS SUBROUTINE GENERATES CYCLES FOR THE ANALYSIS SPECTRUM FROM DATA  
C SUPPLIED BY SUBROUTINE DECIDE  
C

```
10 LIND = 6  
L = L + 1  
CYCLE(L,1) = Y1  
CYCLE(L,2) = Y2  
RNECYC(L) = CYCPF  
NNSTEP(L) = NSTPEP  
15 IF (L.EQ. 1) GO TO 100  
IF (CYCLE(L-1,1) .NE. CYCLE(L,1)) GO TO 130  
IF (CYCLE(L-1,2) .NE. CYCLE(L,2)) GO TO 130  
10 L = L - 1  
RNECYC(L) = RNECYC(L) + 1.0  
LIND = 1  
20 RETURN  
END
```

SUBROUTINE DEGRES(LRMAX, NCYNO)  
 COMMON/PCGDE/L, LIND  
 COMMON/HDECR/RES(1400), INDEX(1400), IND1, IND2, IND3, IND4, KIND  
 THIS SUBROUTINE DECIDES WHETHER OR NOT THE ELEMENTS OF THE RESIDUE  
 SPECTRUM SATISFY THE RANGE PAIR COUNTING CONDITIONS

```

K = 0
NCYNO = 0
10 X1 = RES(1)
    X2 = RES(2)
    X3 = RES(3)
    X4 = RES(4)
    IND1 = INDEX(1)
    IND2 = INDEX(2)
    IND3 = INDEX(3)
    IND4 = INDEX(4)
    J = 4
15 IF (X2 .GT. X1) GO TO 100
    IF (X2 .LT. X4 .OR. X3 .GT. X1) GO TO 500
150 IF (X2 .GT. X3) GO TO 151
    CALL CYGRES(X3, X2, 1.0, IND3)
    GO TO 152
151 CALL CYGRES(X2, X3, 1.0, IND2)
152 NCYNO = NCYNO + 1
    X1 = X1
    X2 = X4
    IND2 = IND4
    IF (J .EQ. LRMAX) GO TO 300
    IF ((J + 1) .EQ. LRMAX) GO TO 315
    X3 = RES(J+1)
    X4 = RES(J+2)
    IND3 = INDEX(J+1)
    IND4 = INDEX(J+2)
    J = J+2
    GO TO 10
100 IF (X2 .GT. X4 .OR. X3 .LT. X1) GO TO 500
500 K = K + 1
    RES(K) = X1
    INDEX(K) = IND1
    J = J + 1
    IF (J .GT. LRMAX) GO TO 330
    X1 = X2
    X2 = X3
    X3 = X4
    X4 = RES(J)
    IND1 = IND2
    IND2 = IND3
    IND3 = IND4
    IND4 = INDEX(J)
    GO TO 10
300 K = K + 1
    RES(K) = X1
    RES(K+1) = X2
  
```

SUBROUTINE DEGRES TRACE

```
60 INDEX(K) = IND1
   INDEX(K+1) = IND2
   LRMAX = K + 1
   RETURN
315 K = K + 1
   RES(K) = X1
   RES(K+1) = X2
   RES(K+2) = RES(J+1)
   INDEX(K) = IND1
   INDEX(K+1) = IND2
   INDEX(K+2) = INDEX(J+1)
   LRMAX = K + 2
   RETURN
330 K = K + 1
   RES(K) = X2
   RES(K+1) = X3
   RES(K+2) = X4
   INDEX(K) = IND2
   INDEX(K+1) = IND3
   INDEX(K+2) = IND4
   LRMAX = K + 2
   RETURN
   END
75
```

SUBROUTINE CYCRES TRACE

CDC 6600 FTH V3.0-32.A OPT=0 11/20/72 15.44.26.

PAGE 1

SUBROUTINE CYCRES(Y1,Y2, CYCZF,NSTEPP)  
COMMON/NCYG/CYCLE(900,2),RNECYC(900),NNSTEP(900)  
COMMON/PCGDE/L,LIND

5 C  
C  
C

THIS SUBROUTINE GENERATES CYCLES FOR THE ANALYSIS SPECTRUM FROM DATA  
SUPPLIED BY SUBROUTINE DECRES

L = L + 1  
CYCLE(L,1) = Y1  
CYCLE(L,2) = Y2  
RNECYC(L) = CYCZF  
NNSTEP(L) = NSTEPP  
RETURN  
END

10