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COMPLETION TECHNICAL REPORT
06

AN EVALUATION OF SOME EMPIRICAL METHODS FOR FLOOD FREQUENCY ANALYSIS
2. DATA AND COMPUTER PROGRAMS

by

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AN EVALUATION OF SOME EMPIRICAL METHODS FOR FLOOD FREQUENCY ANALYSIS
2. DATA AND COMPUTER PROGRAMS

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ABSTRACT

This report is the concluding part II in a series of two. In part I nine empirical methods, used to perform flood frequency analysis, were evaluated and compared using historical data from 55 river gaging stations. These data are presented in this part II. A computer-software was developed to analyze the data, and evaluate each method as well as compare different methods of flood frequency analysis. This software is included in this report.

ACKNOWLEDGEMENTS

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Chapter 1

HYDROLOGIC DATA

1.1 Selection of Gaging Stations

Record length: For an acceptable statistical analysis only those stations were chosen whose length of record was more than 30 years. Thus, 55 gaging stations were selected.

Homogeneity: Mann and Whitney and Kruskal-Wallis tests were conducted to test the homogeneity of data. All the 55 gaging stations have data belonging to the same population.

Completeness: The data series was chosen such that it was continuous over the period of record. Each selected gaging station has continuous record.

Representativeness: All the samples were chosen such that they should vary over a wide range of coefficient of variation and coefficient of skewness. These ranges are 0.291 to 1.22 for coefficient of variation and 0.16 to 5.66 for coefficient of skewness. This was done to ensure that the data represent varying types of watersheds.

Varying climatic characteristics: The gaging stations were selected from different geographical locations in the U.S. so that the data represent varying climatic conditions.

Varying areas: The gaging stations were selected such that the area of drainage basins ranged from 20 to 3000 square km.

1.2 Hydrologic Data Hydrologic data of the 55 gaging stations, which were used for analysis, are presented.

STATION DESCRIPTION - DATA FROM COMITE RIVER NEAR OLIVE BRANCH. LA.

AREA - 1405.0 (SQUARE KM.)

YEARS OF RECORD -1943 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
38	238.2	174.5	0.696	2.520	0.723

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	39.1	2	43.3	3	47.0
4	50.4	5	72.5	6	77.0
7	81.3	8	83.8	9	87.8
10	88.1	11	97.1	12	98.0
13	99.1	14	99.4	15	120.9
16	126.0	17	131.9	18	131.9
19	148.4	20	186.3	21	204.7
22	230.5	23	280.3	24	319.9
25	322.8	26	322.8	27	351.1
28	353.9	29	376.6	30	379.4
31	407.7	32	410.5	33	438.8
34	464.3	35	478.5	36	563.4
37	603.1	38	634.2		

STATION DESCRIPTION - DATA FROM COMITE RIVER NEAR COMITE, LA.

AREA - 1896.0 (SQUARE KM.)

YEARS OF RECORD -1943 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
38	315.7	166.8	0.543	2.768	0.521

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	66.8	2	68.5	3	94.6
4	102.8	5	122.3	6	136.5
7	141.6	8	170.2	9	180.1
10	196.8	11	202.4	12	205.3
13	207.0	14	241.5	15	260.8
16	267.6	17	273.5	18	283.1
19	286.0	20	291.6	21	300.1
22	305.8	23	308.6	24	325.6
25	359.6	26	373.7	27	390.7
28	430.4	29	436.0	30	444.5
31	464.3	32	467.2	33	498.3
34	569.1	35	580.4	36	586.1
37	676.7	38	682.3		

STATION DESCRIPTION - DATA FROM AMITE RIVER DEEPAK

AREA - 4092.0 (SQUARE KM.)

YEARS OF RECORD -1949 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
34	745.1	539.5	0.708	3.027	0.713

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	90.0	2	92.9	3	102.8
4	128.3	5	195.4	6	216.9
7	226.5	8	235.6	9	243.5
10	277.5	11	286.0	12	436.0
13	512.5	14	535.1	15	566.3
16	566.3	17	571.9	18	577.6
19	634.2	20	634.2	21	863.5
22	894.7	23	1073.0	24	1112.7
25	1152.3	26	1228.8	27	1228.8
28	1259.9	29	1259.9	30	1288.2
31	1344.8	32	1577.0	33	1758.2
34	2163.1				

STATION DESCRIPTION - DATA FROM AMITE RIVER AT MAGNOLIA, LA

AREA - 1804.0(SQUARE KM.)

YEARS OF RECORD -1949 - 1980;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
31	698.0	365.9	0.160	2.148	0.516

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	130.2	2	195.4	3	198.2
4	209.5	5	263.3	6	297.3
7	305.8	8	365.2	9	433.2
10	445.9	11	487.0	12	540.8
13	569.1	14	591.7	15	682.3
16	696.5	17	719.1	18	758.8
19	772.9	20	849.4	21	855.0
22	857.9	23	968.3	24	1070.2
25	1075.9	26	1112.7	27	1124.0
28	1146.7	29	1223.1	30	1333.5
31	1359.0				

STATION DESCRIPTION - DATA FROM ST MARY RIVER AT STILL WATER KIFE

AREA - 1653.0(SQUARE KM.)

YEARS OF RECORD -1915 - 1974;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
59	409.5	147.9	1.417	6.254	0.358

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	189.7	2	201.9	3	227.6
4	231.6	5	232.4	6	232.4

7	237.5	8	255.4	9	280.3
10	288.8	11	288.8	12	291.6
13	294.5	14	302.9	15	311.4
16	328.4	17	334.1	18	334.1
19	336.9	20	336.9	21	345.4
22	348.2	23	348.2	24	351.1
25	359.6	26	365.2	27	368.1
28	368.1	29	370.9	30	370.9
31	385.1	32	393.5	33	393.5
34	393.5	35	404.9	36	404.9
37	410.5	38	427.5	39	441.7
40	453.0	41	455.8	42	455.8
43	464.3	44	478.5	45	487.0
46	509.6	47	515.3	48	518.1
49	523.8	50	526.6	51	543.6
52	552.1	53	563.4	54	569.1
55	583.2	56	651.2	57	724.8
58	823.9	59	974.0		

STATION DESCRIPTION - ST. JOHN RIVER AT NINEMILE BRIDGE , ME

AREA - 1890.0(SQUARE KM.)

YEARS OF RECORD -1951 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
32	699.0	223.7	0.408	3.012	0.315

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	297.3	2	413.4	3	424.7
4	447.3	5	453.0	6	455.8
7	461.5	8	526.6	9	532.3
10	537.9	11	543.6	12	574.7
13	594.6	14	622.9	15	662.5
16	673.8	17	719.1	18	736.1
19	764.4	20	772.9	21	787.1
22	787.1	23	826.7	24	866.4
25	877.7	26	886.2	27	906.0
28	906.0	29	968.3	30	982.4
31	1104.2	32	1257.1		

STATION DESCRIPTION - ST. JOHN RIVER AT DICKEY, ME

AREA - 5085.0(SQUARE KM.)

YEARS OF RECORD -1947 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
36	1449.7	517.7	0.354	2.549	0.352

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	492.6	2	775.8	3	806.9
4	826.7	5	877.7	6	934.3
7	968.3	8	974.0	9	1019.3

10	1036.2	11	1058.9	12	1081.5
13	1166.5	14	1200.5	15	1208.9
16	1242.9	17	1276.9	18	1339.2
19	1398.6	20	1446.8	21	1483.6
22	1650.6	23	1659.1	24	1676.1
25	1749.7	26	1758.2	27	1792.2
28	1877.1	29	1945.1	30	2015.9
31	2030.0	32	2038.5	33	2134.8
34	2180.1	35	2468.9	36	2596.3

STATION DESCRIPTION - ALLAGASH RIVER NEAR ALLAGASH, ME

AREA - 1659.0 (SQUARE KM.)

YEARS OF RECORD -1932 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
51	438.8	159.8	0.705	3.296	0.361

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	149.2	2	219.1	3	230.7
4	244.1	5	252.5	6	265.3
7	274.6	8	283.1	9	288.8
10	294.5	11	305.8	12	305.8
13	311.4	14	314.3	15	314.3
16	317.1	17	339.8	18	345.4
19	353.9	20	356.7	21	368.1
22	373.7	23	404.9	24	416.2
25	438.8	26	438.8	27	447.3
28	450.2	29	450.2	30	450.2
31	467.2	32	470.0	33	478.5
34	478.5	35	498.3	36	501.1
37	509.6	38	512.5	39	515.3
40	518.1	41	537.9	42	571.9
43	577.6	44	608.7	45	631.4
46	637.0	47	662.5	48	747.5
49	804.1	50	815.4	51	832.4

STATION DESCRIPTION - ST. FRANCIS RIVER NEAR CONNORS, NEW BRUNSWI

AREA - 1105.0 (SQUARE KM.)

YEARS OF RECORD -1952 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
31	215.3	84.4	0.527	3.250	0.385

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	62.9	2	96.3	3	116.4
4	125.7	5	133.9	6	139.3
7	142.1	8	143.8	9	143.8
10	149.5	11	165.1	12	188.6
13	191.4	14	203.0	15	205.8
16	224.2	17	224.5	18	226.5

19	227.3	20	229.9	21	239.5
22	246.6	23	248.3	24	251.4
25	259.9	26	305.8	27	322.8
28	325.6	29	342.6	30	368.1
31	424.7				

STATION DESCRIPTION - FISH RIVER NEAR FORT KENT, ME

AREA - 890.0 (SQUARE KM.)

YEARS OF RECORD -1930 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
53	241.1	71.4	0.302	3.446	0.293

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	84.1	2	115.8	3	138.4
4	144.7	5	158.8	6	159.4
7	160.2	8	161.4	9	161.7
10	164.2	11	165.3	12	173.3
13	173.8	14	180.9	15	181.2
16	198.5	17	205.8	18	213.2
19	222.0	20	223.7	21	232.4
22	236.1	23	238.7	24	239.5
25	239.5	26	241.5	27	243.5
28	244.6	29	247.5	30	247.5
31	249.7	32	252.5	33	258.2
34	262.7	35	265.6	36	265.6
37	265.6	38	274.6	39	282.6
40	286.0	41	294.5	42	297.3
43	300.1	44	302.9	45	308.6
46	311.4	47	311.4	48	311.4
49	339.8	50	345.4	51	370.9
52	379.4	53	447.3		

STATION DESCRIPTION - ST. JOHN RIVER BELOW FISH R, AT FORT KENT, ME

AREA - 9097.0(SQUARE KM.)

YEARS OF RECORD -1927 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
56	2405.2	754.1	0.434	3.221	0.311

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	702.2	2	1322.2	3	1367.5
4	1370.3	5	1390.1	6	1443.9
7	1492.1	8	1585.5	9	1661.9
10	1701.6	11	1710.1	12	1718.6
13	1885.6	14	1905.4	15	1942.2
16	1956.4	17	1962.1	18	1979.0
19	1987.5	20	2078.1	21	2134.8
22	2134.8	23	2171.6	24	2202.7
25	2208.4	26	2214.0	27	2245.2

28	2321.6	29	2409.4	30	2463.2
31	2491.5	32	2517.0	33	2519.8
34	2536.8	35	2548.1	36	2567.9
37	2576.4	38	2689.7	39	2706.7
40	2709.5	41	2726.5	42	2726.5
43	2746.3	44	2777.5	45	2916.2
46	3086.1	47	3227.6	48	3255.9
49	3255.9	50	3340.9	51	3425.8
52	3652.3	53	3708.9	54	3850.5
55	4190.3	56	4275.2		

STATION DESCRIPTION - MACHIAS RIVER NEAR ASHLAND, ME

AREA - 1105.0(SQUARE KM.)

YEARS OF RECORD -1952 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
29	191.3	87.9	1.187	5.535	0.451

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	47.6	2	90.3	3	91.7
4	96.0	5	101.1	6	131.7
7	136.5	8	137.6	9	140.4
10	141.3	11	144.4	12	158.6
13	161.7	14	173.8	15	182.0
16	183.5	17	193.9	18	195.6
19	197.6	20	212.3	21	231.6
22	234.1	23	240.7	24	242.4
25	270.1	26	283.1	27	322.8
28	334.1	29	470.0		

STATION DESCRIPTION - AROOSTOOK RIVER AT WASHBURN, ME

AREA - 1884.0(SQUARE KM.)

YEARS OF RECORD -1931 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
51	687.4	236.7	0.353	2.647	0.341

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	217.2	2	353.9	3	379.4
4	382.2	5	385.1	6	396.4
7	402.0	8	410.5	9	424.7
10	438.8	11	487.0	12	495.5
13	504.0	14	521.0	15	529.4
16	543.6	17	543.6	18	571.9
19	571.9	20	591.7	21	594.6
22	625.7	23	648.4	24	651.2
25	651.2	26	659.7	27	679.5
28	685.2	29	690.8	30	707.8
31	724.8	32	736.1	33	767.3
34	770.1	35	781.4	36	792.8

37	826.7	38	852.2	39	874.9
40	891.8	41	900.3	42	911.7
43	917.3	44	923.0	45	1002.3
46	1024.9	47	1047.6	48	1067.4
49	1070.2	50	1211.8	51	1220.3

STATION DESCRIPTION - MEDUXNEKEAG RIVER NEAR HOULTON, ME

AREA - 589.0 (SQUARE KM.)

YEARS OF RECORD -1941 - 1984;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
42	103.4	41.3	0.784	2.898	0.395

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	40.2	2	42.2	3	54.1
4	56.1	5	58.9	6	61.2
7	69.4	8	69.9	9	71.1
10	73.0	11	75.6	12	76.4
13	78.7	14	81.3	15	83.5
16	83.8	17	85.5	18	86.4
19	86.6	20	90.0	21	90.3
22	93.7	23	94.0	24	98.0
25	99.7	26	101.1	27	102.2
28	109.3	29	110.1	30	118.9
31	122.6	32	123.2	33	126.3
34	131.1	35	152.9	36	154.0
37	173.6	38	174.4	39	182.9
40	186.6	41	187.4	42	188.0

STATION DESCRIPTION - NARRAGUAGUS RIVER AT CHERRYFIELD, ME

AREA - 685.0 (SQUARE KM.)

YEARS OF RECORD -1948 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
35	128.8	52.6	0.978	4.326	0.403

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	57.5	2	60.0	3	64.6
4	75.9	5	77.0	6	82.4
7	84.9	8	88.1	9	88.9
10	90.0	11	90.6	12	91.4
13	97.4	14	99.1	15	99.9
16	101.9	17	108.7	18	111.8
19	118.9	20	124.9	21	138.7
22	144.7	23	148.6	24	151.2
25	152.3	26	165.3	27	165.3
28	179.5	29	184.6	30	185.2
31	186.9	32	195.1	33	195.6
34	205.3	35	294.5		

STATION DESCRIPTION - MATTAWAMKEAG RIVER NEAR MATTAWAMKEAG, ME

AREA - 1640.0(SQUARE KM.)

YEARS OF RECORD -1935 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
47	487.9	142.0	0.366	2.587	0.288

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	277.2	2	281.1	3	281.7
4	288.8	5	297.3	6	311.4
7	317.1	8	345.4	9	356.7
10	356.7	11	365.2	12	365.2
13	365.2	14	365.2	15	370.9
16	379.4	17	385.1	18	438.8
19	453.0	20	458.7	21	467.2
22	481.3	23	489.8	24	492.6
25	509.6	26	512.5	27	515.3
28	521.0	29	529.4	30	532.3
31	532.3	32	535.1	33	537.9
34	543.6	35	560.6	36	588.9
37	591.7	38	597.4	39	622.9
40	665.3	41	668.2	42	673.8
43	676.7	44	696.5	45	719.1
46	781.4	47	826.7		

STATION DESCRIPTION - PISCATAQUIS RIVER NEAR DOVER-FOXCROFT, ME

AREA - 1136.0(SQUARE KM.)

YEARS OF RECORD -1903 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
79	259.8	125.0	1.161	4.065	0.478

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	68.2	2	87.8	3	113.5
4	113.5	5	116.4	6	126.8
7	127.7	8	132.5	9	133.4
10	139.3	11	145.5	12	145.8
13	148.6	14	150.3	15	152.3
16	158.3	17	168.7	18	168.7
19	168.7	20	172.7	21	175.5
22	176.7	23	178.4	24	187.4
25	192.8	26	193.1	27	194.5
28	196.2	29	196.8	30	197.3
31	201.9	32	203.6	33	203.6
34	204.4	35	208.9	36	210.1
37	215.2	38	220.3	39	224.8
40	227.6	41	227.6	42	227.6
43	227.6	44	229.6	45	231.9
46	236.4	47	244.9	48	246.0
49	254.5	50	270.7	51	271.8

52	272.9	53	286.0	54	288.8
55	291.6	56	294.5	57	294.5
58	300.1	59	305.8	60	311.4
61	328.4	62	362.4	63	365.2
64	373.7	65	376.6	66	379.4
67	382.2	68	387.9	69	387.9
70	396.4	71	413.4	72	430.4
73	492.6	74	492.6	75	543.6
76	546.4	77	546.4	78	608.7
79	645.5				

STATION DESCRIPTION - SHEEPSCOT RIVER AT NORTH WHITEFIELD, ME

AREA - 405 (SQUARE KM.)

YEARS OF RECORD -1938 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
43	63.9	32.6	1.738	6.501	0.505

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	28.6	2	29.2	3	31.4
4	34.5	5	37.1	6	38.5
7	39.1	8	39.1	9	39.4
10	40.2	11	40.5	12	41.3
13	45.6	14	46.1	15	46.4
16	47.3	17	47.8	18	49.0
19	49.3	20	51.5	21	51.8
22	52.4	23	54.1	24	54.6
25	54.6	26	55.2	27	57.8
28	58.0	29	63.4	30	66.0
31	69.4	32	77.9	33	84.1
34	84.9	35	87.5	36	89.8
37	98.0	38	103.3	39	103.9
40	113.5	41	113.8	42	148.9
43	181.8				

STATION DESCRIPTION - CARRABASSETT RIVER NEAR NORTH ANSON, ME

AREA - 897.0 (SQUARE KM.)

YEARS OF RECORD -1925 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
56	391.0	187.1	0.681	2.781	0.474

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	121.7	2	129.7	3	145.5
4	174.1	5	178.7	6	190.5
7	202.2	8	210.4	9	226.5
10	231.9	11	232.2	12	234.7
13	235.6	14	239.0	15	241.2
16	244.6	17	246.9	18	251.1
19	257.1	20	262.7	21	268.7

22	282.3	23	283.1	24	291.6
25	291.6	26	294.5	27	305.8
28	319.9	29	328.4	30	334.1
31	365.2	32	382.2	33	410.5
34	444.5	35	458.7	36	470.0
37	475.7	38	475.7	39	495.5
40	509.6	41	515.3	42	521.0
43	532.3	44	557.8	45	569.1
46	600.2	47	608.7	48	617.2
49	625.7	50	625.7	51	634.2
52	634.2	53	654.0	54	724.8
55	860.7	56	872.0		

STATION DESCRIPTION - SEBASTICOOK RIVER NEAR PITTSFIELD, ME

AREA - 2500.0 (SQUARE KM.)

YEARS OF RECORD -1929 - 1980;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
52	193.4	63.4	0.796	4.705	0.325

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	56.1	2	91.7	3	99.9
4	121.2	5	123.7	6	125.7
7	126.3	8	131.1	9	134.8
10	137.6	11	142.7	12	147.8
13	149.8	14	153.7	15	154.6
16	157.1	17	163.1	18	169.9
19	171.0	20	172.1	21	175.0
22	177.8	23	178.7	24	180.1
25	181.2	26	182.6	27	190.0
28	190.0	29	191.4	30	193.9
31	196.5	32	198.2	33	206.4
34	206.7	35	207.0	36	210.6
37	214.6	38	219.7	39	219.7
40	220.8	41	235.3	42	238.1
43	239.2	44	259.3	45	266.1
46	267.0	47	269.3	48	281.7
49	291.6	50	308.6	51	319.9
52	407.7				

STATION DESCRIPTION - DIAMOND RIVER NEAR WENTWORTH LOCATION, NH

AREA - 843.0 (SQUARE KM.)

YEARS OF RECORD -1942 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
40	135.5	40.1	0.621	4.336	0.292

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	53.8	2	56.3	3	79.8
4	86.6	5	100.2	6	102.5

7	103.1	8	103.9	9	108.2
10	111.0	11	114.4	12	116.6
13	119.8	14	120.0	15	122.0
16	122.9	17	124.6	18	129.1
19	130.2	20	131.9	21	132.5
22	133.4	23	135.3	24	135.9
25	137.3	26	143.3	27	145.2
28	147.2	29	148.1	30	149.2
31	158.6	32	159.7	33	166.5
34	169.9	35	169.9	36	173.8
37	184.9	38	223.4	39	226.2
40	244.3				

STATION DESCRIPTION - SWIFT RIVER NEAR ROXBURY, ME

AREA - 753.0 (SQUARE KM.)

YEARS OF RECORD -1930 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
51	182.8	97.9	0.933	3.471	0.531

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	53.8	2	67.4	3	72.5
4	73.0	5	79.6	6	84.9
7	86.4	8	90.3	9	92.3
10	97.7	11	101.4	12	101.4
13	101.6	14	104.2	15	106.2
16	113.8	17	115.5	18	117.8
19	129.4	20	131.7	21	134.5
22	134.5	23	137.0	24	139.0
25	145.8	26	146.1	27	146.9
28	148.4	29	158.8	30	175.0
31	203.9	32	207.5	33	209.8
34	217.4	35	220.8	36	228.2
37	233.3	38	250.3	39	257.1
40	258.2	41	282.3	42	288.8
43	288.8	44	297.3	45	300.1
46	302.9	47	311.4	48	322.8
49	368.1	50	410.5	51	475.7

STATION DESCRIPTION - NEZINSCOT RIVER AT TURNER CENTER, ME

AREA - 733.0 (SQUARE KM.)

YEARS OF RECORD -1942 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
41	105.2	61.2	3.027	14.946	0.575

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	39.1	2	49.8	3	52.7
4	56.6	5	59.5	6	60.3
7	61.7	8	67.1	9	67.7

10	72.2	11	72.2	12	73.6
13	73.9	14	77.0	15	77.9
16	79.6	17	84.1	18	84.9
19	86.4	20	88.3	21	91.7
22	93.1	23	93.4	24	97.7
25	99.7	26	100.8	27	107.9
28	109.0	29	111.8	30	115.8
31	118.1	32	118.1	33	121.2
34	125.4	35	127.4	36	135.1
37	155.7	38	177.2	39	195.9
40	241.5	41	393.5		

STATION DESCRIPTION - ROYAL RIVER AT YARMOUTH, ME

AREA - 642.0 (SQUARE KM.)

YEARS OF RECORD -1950 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
32	110.7	54.0	2.237	10.669	0.481

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	31.7	2	49.8	3	55.8
4	61.4	5	63.7	6	67.1
7	68.5	8	77.9	9	79.0
10	88.9	11	90.9	12	92.6
13	94.3	14	98.5	15	101.4
16	103.1	17	104.5	18	108.7
19	108.7	20	113.3	21	113.5
22	121.7	23	124.6	24	131.4
25	131.7	26	135.1	27	140.1
28	142.7	29	143.3	30	146.1
31	225.4	32	325.6		

STATION DESCRIPTION - OYSTER RIVER NEAR DURHAM, NH

AREA - 140.0 (SQUARE KM.)

YEARS OF RECORD -1935 - 1981;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
44	9.1	4.4	1.165	5.217	0.478

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	2.6	2	3.0	3	3.1
4	4.0	5	4.1	6	4.6
7	4.8	8	5.7	9	5.9
10	6.0	11	6.0	12	6.1
13	6.1	14	6.6	15	6.8
16	7.0	17	7.1	18	7.2
19	7.4	20	7.7	21	7.9
22	8.5	23	8.5	24	8.7
25	9.2	26	9.5	27	9.8
28	9.9	29	9.9	30	10.3

31	10.8	32	10.9	33	11.0
34	11.3	35	11.9	36	12.0
37	12.5	38	12.7	39	14.1
40	15.5	41	16.1	42	17.3
43	17.4	44	24.4		

STATION DESCRIPTION - PEMIGEWASSET RIVER AT PLYMOUTH, NH

AREA - 1243.0 (SQUARE KM.)

YEARS OF RECORD -1904 - 1981;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
75	658.6	297.6	2.195	8.357	0.449

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	248.3	2	356.7	3	365.2
4	365.2	5	404.9	6	410.5
7	410.5	8	424.7	9	424.7
10	427.5	11	430.4	12	433.2
13	450.2	14	450.2	15	453.0
16	455.8	17	458.7	18	481.3
19	481.3	20	481.3	21	481.3
22	487.0	23	492.6	24	501.1
25	504.0	26	515.3	27	521.0
28	523.8	29	523.8	30	540.8
31	543.6	32	557.8	33	560.6
34	563.4	35	566.3	36	574.7
37	577.6	38	580.4	39	600.2
40	608.7	41	622.9	42	622.9
43	631.4	44	634.2	45	634.2
46	639.9	47	639.9	48	648.4
49	648.4	50	651.2	51	651.2
52	662.5	53	685.2	54	696.5
55	707.8	56	710.6	57	719.1
58	719.1	59	722.0	60	772.9
61	775.8	62	775.8	63	801.2
64	809.7	65	823.9	66	829.6
67	891.8	68	951.3	69	979.6
70	1265.6	71	1347.7	72	1441.1
73	1492.1	74	1698.8	75	1851.6

STATION DESCRIPTION - SMITH RIVER NEAR BRISTOL, NH

AREA - 135.0 (SQUARE KM.)

YEARS OF RECORD -1919 - 1981;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
63	57.5	33.5	3.039	14.938	0.578

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	22.2	2	22.4	3	26.0
4	28.9	5	30.0	6	30.6

7	30.9	8	34.0	9	34.5
10	35.1	11	35.1	12	35.7
13	36.2	14	37.1	15	37.7
16	37.9	17	39.6	18	39.6
19	40.8	20	40.8	21	41.3
22	42.5	23	42.8	24	44.5
25	45.0	26	46.4	27	47.3
28	47.6	29	48.4	30	49.5
31	49.5	32	50.1	33	50.7
34	51.0	35	51.5	36	52.4
37	53.8	38	54.4	39	55.5
40	57.2	41	57.2	42	58.3
43	59.5	44	60.0	45	60.3
46	62.9	47	62.9	48	63.4
49	64.6	50	65.7	51	66.3
52	70.8	53	72.5	54	73.3
55	74.5	56	77.3	57	80.4
58	94.0	59	99.1	60	106.2
61	143.5	62	164.2	63	229.3

STATION DESCRIPTION - SOUCOOK RIVER NEAR CONCORD, NH

AREA - 103.0 (SQUARE KM.)

YEARS OF RECORD -1951 - 1981;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
30	41.2	19.3	1.515	6.260	0.462

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	11.6	2	21.6	3	21.8
4	23.1	5	24.0	6	24.3
7	28.6	8	28.9	9	29.2
10	30.3	11	32.0	12	33.7
13	36.8	14	36.8	15	37.1
16	38.2	17	38.8	18	39.1
19	39.9	20	40.2	21	44.2
22	48.1	23	49.0	24	51.5
25	53.8	26	53.8	27	66.0
28	67.4	29	81.5	30	104.8

STATION DESCRIPTION - SQUANNACOOK RIVER NEAR WEST GROTON, MA

AREA - 585.0 (SQUARE KM.)

YEARS OF RECORD -1950 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
32	43.8	23.0	0.947	4.399	0.517

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	8.6	2	13.9	3	17.4
4	19.6	5	21.2	6	21.4
7	25.7	8	26.2	9	26.4

10	28.2	11	28.3	12	33.7
13	34.0	14	34.5	15	35.7
16	38.8	17	40.8	18	42.5
19	44.7	20	49.5	21	51.2
22	52.1	23	53.8	24	56.6
25	60.0	26	63.1	27	64.0
28	66.3	29	69.9	30	78.1
31	82.1	32	113.5		

STATION DESCRIPTION - PARKER RIVER AT BYFIELD, MA

AREA - 50.0 (SQUARE KM.)

YEARS OF RECORD -1946 - 1932;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
37	6.5	2.8	0.922	3.889	0.421

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	2.8	2	3.0	3	3.0
4	3.0	5	3.2	6	3.5
7	4.1	8	4.2	9	4.3
10	4.4	11	4.4	12	4.6
13	5.2	14	5.5	15	5.5
16	5.5	17	6.1	18	6.2
19	6.2	20	6.3	21	6.7
22	6.8	23	6.9	24	7.0
25	7.0	26	7.0	27	7.4
28	7.5	29	7.9	30	8.3
31	9.0	32	9.7	33	10.0
34	10.2	35	10.9	36	13.6
37	13.8				

STATION DESCRIPTION - HOP R NR COLUMBIA, CT.

AREA - 65.0 (SQUARE KM.)

YEARS OF RECORD -1934 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
49	64.9	41.1	1.731	5.813	0.626

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	23.1	2	24.2	3	25.2
4	25.5	5	27.2	6	27.2
7	27.3	8	29.7	9	31.7
10	36.0	11	36.0	12	36.8
13	38.5	14	41.6	15	41.9
16	42.5	17	43.6	18	45.3
19	45.6	20	46.4	21	47.8
22	48.1	23	49.8	24	52.7
25	53.2	26	53.8	27	54.9
28	55.8	29	56.9	30	61.7
31	61.7	32	66.0	33	66.0

34	68.2	35	73.0	36	74.5
37	79.6	38	81.5	39	83.0
40	84.4	41	86.4	42	87.5
43	94.3	44	103.1	45	151.8
46	154.3	47	157.7	48	182.6
49	196.5				

STATION DESCRIPTION - SAFFORD BK NR WOODSTOCK VALLEY, CT.

AREA - 58.0 (SQUARE KM.)

YEARS OF RECORD -1950 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
31	10.6	6.0	1.392	4.806	0.555

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	3.8	2	4.4	3	4.4
4	5.0	5	5.3	6	5.5
7	6.1	8	6.6	9	6.7
10	7.1	11	7.3	12	7.6
13	7.7	14	8.2	15	8.4
16	8.7	17	8.9	18	9.6
19	11.0	20	11.0	21	11.3
22	11.4	23	11.4	24	11.7
25	14.9	26	16.1	27	17.0
28	18.3	29	21.7	30	23.5
31	28.3				

STATION DESCRIPTION - MOOSE RIVER AT VICTORY, VT

AREA - 120.0 (SQUARE KM.)

YEARS OF RECORD -1930 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
35	60.4	19.1	1.012	4.762	0.312

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	33.7	2	35.4	3	41.3
4	41.3	5	41.9	6	41.9
7	42.2	8	44.2	9	44.5
10	44.7	11	45.3	12	45.9
13	47.3	14	48.4	15	51.0
16	51.8	17	57.2	18	58.9
19	60.6	20	61.2	21	61.7
22	63.7	23	67.4	24	68.0
25	74.2	26	75.6	27	75.6
28	77.0	29	77.9	30	78.7
31	81.0	32	82.7	33	83.2
34	85.2	35	122.9		

STATION DESCRIPTION - MOOSE RIVER AT ST. JOHNSBURY, VT

AREA - 120.0 (SQUARE KM.)

YEARS OF RECORD -1930 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
53	84.3	34.6	0.782	3.026	0.406

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	33.4	2	33.8	3	41.1
4	43.0	5	44.5	6	46.1
7	51.2	8	53.8	9	53.8
10	56.1	11	56.3	12	56.6
13	57.2	14	57.2	15	57.5
16	57.5	17	60.0	18	60.3
19	63.7	20	64.8	21	65.1
22	66.5	23	66.8	24	68.8
25	70.5	26	71.6	27	77.0
28	78.7	29	84.1	30	84.9
31	88.9	32	90.6	33	91.7
34	92.6	35	92.6	36	96.3
37	97.1	38	98.2	39	99.1
40	100.5	41	106.5	42	107.6
43	113.3	44	117.2	45	120.3
46	124.6	47	132.2	48	133.1
49	135.3	50	159.1	51	160.2
52	164.2	53	164.8		

STATION DESCRIPTION - AMMONOOSUC RIVER AT BETHLEHEM JUNCTION, NH

AREA - 289.0 (SQUARE KM.)

YEARS OF RECORD -1927 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
36	139.2	61.8	1.375	4.556	0.437

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	69.1	2	71.9	3	73.9
4	76.7	5	79.6	6	82.4
7	90.3	8	97.7	9	97.7
10	98.2	11	99.4	12	101.4
13	106.2	14	108.7	15	112.4
16	115.8	17	116.1	18	117.8
19	122.9	20	124.0	21	127.7
22	136.5	23	149.8	24	149.8
25	154.0	26	156.9	27	159.1
28	160.8	29	165.1	30	168.7
31	173.0	32	235.0	33	246.0
34	262.5	35	300.1	36	305.8

STATION DESCRIPTION - AMMONOOSUC RIVER NEAR BATH, NH

AREA - 596.0 (SQUARE KM.)

YEARS OF RECORD -1941 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
42	343.1	163.5	1.512	4.811	0.471

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	139.9	2	147.2	3	186.9
4	188.8	5	218.0	6	220.6
7	227.3	8	228.5	9	229.3
10	233.0	11	234.1	12	236.1
13	242.6	14	243.5	15	254.8
16	261.0	17	263.9	18	271.2
19	274.9	20	286.0	21	286.0
22	288.8	23	302.9	24	302.9
25	322.8	26	334.1	27	336.9
28	339.8	29	359.6	30	359.6
31	365.2	32	373.7	33	390.7
34	402.0	35	470.0	36	487.0
37	504.0	38	620.0	39	665.3
40	758.8	41	761.6	42	789.9

STATION DESCRIPTION - WHITE RIVER AT WEST HARTFORD, VT

AREA - 1500.0 (SQUARE KM.)

YEARS OF RECORD -1918 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
65	592.0	428.3	4.683	31.581	0.718

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	116.1	2	196.8	3	252.5
4	259.9	5	281.7	6	302.9
7	328.4	8	334.1	9	353.9
10	356.7	11	362.4	12	373.7
13	376.6	14	385.1	15	402.0
16	402.0	17	404.9	18	404.9
19	410.5	20	419.0	21	427.5
22	433.2	23	433.2	24	436.0
25	447.3	26	450.2	27	450.2
28	453.0	29	453.0	30	464.3
31	467.2	32	487.0	33	498.3
34	504.0	35	509.6	36	523.8
37	526.6	38	526.6	39	537.9
40	543.6	41	552.1	42	557.8
43	566.3	44	569.1	45	571.9
46	594.6	47	597.4	48	631.4
49	639.9	50	656.9	51	659.7
52	659.7	53	659.7	54	744.6
55	823.9	56	849.4	57	877.7
58	880.5	59	883.4	60	971.1
61	1005.1	62	1197.6	63	1285.4
64	1347.7	65	3397.5		

STATION DESCRIPTION - MOSS BROOK AT WENDELL DEPOT, MA

AREA - 45.0 (SQUARE KM.)

YEARS OF RECORD -1917 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
66	9.1	6.7	2.979	14.737	0.729

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	1.6	2	2.7	3	3.2
4	3.2	5	3.3	6	3.3
7	3.5	8	3.7	9	4.4
10	4.6	11	4.6	12	4.7
13	4.8	14	5.0	15	5.1
16	5.2	17	5.2	18	5.4
19	5.5	20	5.5	21	5.6
22	5.8	23	6.4	24	6.5
25	6.7	26	6.9	27	6.9
28	7.2	29	7.2	30	7.2
31	7.2	32	7.2	33	7.4
34	7.4	35	7.4	36	7.5
37	7.6	38	7.9	39	8.0
40	8.3	41	8.5	42	8.7
43	8.7	44	9.1	45	9.5
46	9.5	47	9.8	48	9.9
49	10.3	50	10.3	51	10.3
52	10.3	53	10.3	54	10.5
55	11.2	56	13.4	57	14.0
58	14.2	59	15.2	60	15.5
61	15.9	62	16.2	63	20.8
64	25.1	65	30.3	66	43.6

STATION DESCRIPTION - NORTH RIVER AT SHATTUCKVILLE, MA

AREA - 270.0 (SQUARE KM.)

YEARS OF RECORD -1940 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
43	145.4	76.3	1.126	3.874	0.519

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	47.8	2	60.3	3	70.5
4	70.8	5	71.3	6	75.0
7	76.4	8	77.6	9	82.1
10	84.1	11	85.8	12	87.5
13	89.5	14	89.5	15	96.3
16	100.2	17	106.7	18	107.6
19	112.1	20	113.0	21	117.5
22	120.0	23	128.5	24	129.4
25	131.9	26	133.4	27	142.7
28	156.6	29	169.3	30	173.6
31	173.6	32	184.0	33	184.0

34	193.9	35	203.6	36	217.4
37	219.4	38	257.6	39	272.4
40	281.4	41	283.1	42	300.1
43	373.7				

STATION DESCRIPTION - HOP BROOK NEAR NEW SALEM, MA

AREA - 20.0 (SQUARE KM.)

YEARS OF RECORD -1949 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
34	4.5	2.0	0.331	2.539	0.425

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	0.8	2	1.4	3	2.2
4	2.3	5	2.6	6	3.0
7	3.0	8	3.0	9	3.1
10	3.1	11	3.2	12	3.5
13	3.6	14	3.7	15	4.0
16	4.1	17	4.2	18	4.2
19	4.3	20	4.4	21	4.8
22	4.8	23	5.0	24	5.4
25	5.5	26	5.6	27	6.5
28	7.0	29	7.0	30	7.4
31	7.6	32	7.8	33	7.8
34	8.2				

STATION DESCRIPTION - EAST BRANCH SWIFT RIVER NEAR HARDWICK, MA

AREA - 116.0 (SQUARE KM.)

YEARS OF RECORD -1936 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
47	26.1	27.5	5.063	32.378	1.044

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	5.7	2	7.7	3	10.6
4	11.4	5	11.9	6	12.0
7	12.1	8	12.2	9	12.6
10	13.5	11	13.5	12	13.9
13	15.3	14	15.5	15	15.7
16	15.8	17	16.1	18	16.3
19	16.3	20	18.3	21	18.9
22	19.3	23	19.8	24	19.8
25	20.8	26	20.8	27	22.0
28	23.4	29	23.4	30	24.0
31	24.1	32	25.0	33	25.0
34	25.0	35	26.8	36	26.8
37	28.3	38	30.9	39	31.7
40	32.6	41	34.5	42	34.5
43	35.1	44	46.7	45	61.7
46	65.1	47	192.0		

STATION DESCRIPTION - QUABOAG RIVER AT WEST BRIMFIELD, MA

AREA - 125.0 (SQUARE KM.)

YEARS OF RECORD -1903 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
70	43.5	47.6	5.548	36.093	1.086

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	15.3	2	15.7	3	17.7
4	19.0	5	19.5	6	20.8
7	22.1	8	22.7	9	22.7
10	24.2	11	24.8	12	24.9
13	25.2	14	26.0	15	26.7
16	27.2	17	27.5	18	27.5
19	27.9	20	28.2	21	28.2
22	28.9	23	29.4	24	29.7
25	29.7	26	30.3	27	30.6
28	31.1	29	32.3	30	32.3
31	32.3	32	32.6	33	33.1
34	33.4	35	33.4	36	33.7
37	34.0	38	35.1	39	35.4
40	35.4	41	36.0	42	36.2
43	37.7	44	38.5	45	38.5
46	40.5	47	40.8	48	41.1
49	42.5	50	42.8	51	43.6
52	43.6	53	43.9	54	44.7
55	46.7	56	46.7	57	47.0
58	47.0	59	47.6	60	49.0
61	49.5	62	50.1	63	52.4
64	52.7	65	54.1	66	56.1
67	62.0	68	102.5	69	239.8
70	362.4				

STATION DESCRIPTION - MIDDLE B WESTFIELD RIVER AT GOSS HEIGHTS, MA

AREA - 560.0 (SQUARE KM.)

YEARS OF RECORD -1930 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
53	112.3	97.3	3.069	13.938	0.858

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	28.0	2	34.5	3	37.7
4	45.3	5	47.0	6	48.1
7	48.4	8	51.0	9	52.1
10	52.9	11	55.2	12	56.9
13	63.7	14	63.7	15	64.3
16	65.1	17	65.4	18	65.7
19	66.0	20	66.3	21	67.1
22	68.5	23	70.2	24	72.5

25	73.6	26	75.0	27	80.7
28	87.8	29	89.2	30	92.0
31	94.8	32	100.8	33	103.3
34	103.6	35	103.9	36	107.3
37	107.6	38	115.8	39	119.8
40	120.3	41	127.4	42	133.1
43	141.0	44	142.1	45	153.5
46	153.5	47	165.9	48	227.1
49	235.6	50	237.8	51	271.8
52	467.2	53	563.4		

STATION DESCRIPTION - WEST BRANCH WESTFIELD RIVER AT HUNTINGTON, MA

AREA - 782.0 (SQUARE KM.)

YEARS OF RECORD -1937 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
46	186.4	144.4	2.142	8.203	0.766

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	29.2	2	41.1	3	60.6
4	68.0	5	70.8	6	78.1
7	78.7	8	92.6	9	95.1
10	95.7	11	99.7	12	102.2
13	106.7	14	106.7	15	107.0
16	107.3	17	117.2	18	118.1
19	124.0	20	126.3	21	127.4
22	129.4	23	130.2	24	137.0
25	139.3	26	141.6	27	142.4
28	153.5	29	153.7	30	158.8
31	184.9	32	191.7	33	219.1
34	224.2	35	229.9	36	242.1
37	265.6	38	266.1	39	300.1
40	300.1	41	302.9	42	345.4
43	407.7	44	498.3	45	617.2
46	739.0				

STATION DESCRIPTION - SCANTIC R AT BROAD BROOK, CT.

AREA - 178.0 (SQUARE KM.)

YEARS OF RECORD -1930 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
53	42.0	51.3	5.658	38.588	1.210

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	10.7	2	11.9	3	13.4
4	14.2	5	15.6	6	17.3
7	17.4	8	17.4	9	18.1
10	18.2	11	18.8	12	19.1
13	19.3	14	20.0	15	23.1
16	24.5	17	24.8	18	26.0

19	26.4	20	26.8	21	28.0
22	28.2	23	28.9	24	29.4
25	30.0	26	31.4	27	31.4
28	32.0	29	33.7	30	35.7
31	36.5	32	36.5	33	38.8
34	41.6	35	42.5	36	42.5
37	43.6	38	43.6	39	43.9
40	44.7	41	45.3	42	47.3
43	48.4	44	50.4	45	51.5
46	52.4	47	56.6	48	58.0
49	60.0	50	63.4	51	66.0
52	145.2	53	376.6		

STATION DESCRIPTION - BURLINGTON BK NR BURLINGTON, CT

AREA - 92.0 (SQUARE KM.)

YEARS OF RECORD -1937 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
46	9.7	7.3	3.351	18.999	0.740

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	1.8	2	2.2	3	2.3
4	3.3	5	3.7	6	4.1
7	4.6	8	4.7	9	5.0
10	5.4	11	5.4	12	5.5
13	5.9	14	5.9	15	6.3
16	6.4	17	6.9	18	6.9
19	7.2	20	7.6	21	8.1
22	8.2	23	8.3	24	8.6
25	8.6	26	8.7	27	8.8
28	8.8	29	9.8	30	10.0
31	10.0	32	10.6	33	10.9
34	10.9	35	11.2	36	12.1
37	12.3	38	12.5	39	14.7
40	15.1	41	16.7	42	17.6
43	17.9	44	19.0	45	19.1
46	47.8				

STATION DESCRIPTION - CONNECTICUT R, AT RAILROAD BR, AT HARTFORD, C

AREA - 3500.0(SQUARE KM.)

YEARS OF RECORD -1905 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
78	980.1	761.5	2.871	15.554	0.772

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	283.1	2	311.4	3	311.4
4	339.8	5	339.8	6	339.8
7	339.8	8	339.8	9	339.8
10	368.1	11	368.1	12	368.1

13	368.1	14	368.1	15	368.1
16	396.4	17	396.4	18	424.7
19	453.0	20	453.0	21	481.3
22	481.3	23	509.6	24	509.6
25	537.9	26	537.9	27	537.9
28	566.3	29	622.9	30	622.9
31	651.2	32	651.2	33	679.5
34	679.5	35	707.8	36	707.8
37	736.1	38	736.1	39	764.4
40	792.8	41	849.4	42	849.4
43	877.7	44	877.7	45	962.6
46	962.6	47	962.6	48	990.9
49	1019.3	50	1047.6	51	1047.6
52	1047.6	53	1047.6	54	1075.9
55	1075.9	56	1104.2	57	1160.8
58	1217.4	59	1245.8	60	1302.4
61	1302.4	62	1387.3	63	1387.3
64	1443.9	65	1472.3	66	1528.9
67	1557.2	68	1585.5	69	1585.5
70	1698.8	71	1755.4	72	1812.0
73	1840.3	74	1981.9	75	2548.1
76	2774.6	77	3001.1	78	5266.1

STATION DESCRIPTION - NORTH BRANCH PARK R AT HARTFORD, CT.

AREA - 125.0 (SQUARE KM.)

YEARS OF RECORD -1956 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
27	45.6	50.4	4.336	23.149	1.084

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	15.4	2	18.4	3	18.7
4	19.8	5	22.7	6	22.7
7	24.7	8	25.5	9	26.9
10	27.2	11	28.6	12	28.6
13	31.4	14	32.8	15	35.7
16	37.1	17	39.1	18	41.3
19	42.5	20	46.4	21	46.4
22	48.7	23	49.8	24	53.2
25	79.3	26	84.9	27	283.1

STATION DESCRIPTION - SALMON R NR EAST HAMPTON, CT

AREA - 575.0 (SQUARE KM.)

YEARS OF RECORD -1930 - 1981;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
52	107.4	93.6	2.588	10.767	0.863

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	26.6	2	29.7	3	32.8

4	37.9	5	37.9	6	38.8
7	42.8	8	48.1	9	49.8
10	50.1	11	50.1	12	51.2
13	52.7	14	53.8	15	58.6
16	58.9	17	60.0	18	64.8
19	65.7	20	66.0	21	70.2
22	71.3	23	71.3	24	72.5
25	72.5	26	73.6	27	74.7
28	79.3	29	79.6	30	81.0
31	81.0	32	85.8	33	87.2
34	95.1	35	98.2	36	98.2
37	98.5	38	106.5	39	116.6
40	120.0	41	124.3	42	136.2
43	140.4	44	167.0	45	170.7
46	177.0	47	221.1	48	258.5
49	266.1	50	339.8	51	351.1
52	523.8				

STATION DESCRIPTION - EIGHTMILE R AT NORTH PLAIN, CT.

AREA - 320.0 (SQUARE KM.)

YEARS OF RECORD -1938 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
45	30.4	26.0	3.442	18.388	0.848

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	9.5	2	10.6	3	11.3
4	12.0	5	12.7	6	12.9
7	13.6	8	14.0	9	14.2
10	14.7	11	15.6	12	16.6
13	17.0	14	17.1	15	17.4
16	18.4	17	18.4	18	18.5
19	19.8	20	20.4	21	21.2
22	21.2	23	21.2	24	21.9
25	23.5	26	24.3	27	24.3
28	25.5	29	27.7	30	28.9
31	31.1	32	32.8	33	33.4
34	35.1	35	38.2	36	40.8
37	41.9	38	42.5	39	45.9
40	51.0	41	51.5	42	66.5
43	69.9	44	77.3	45	164.2

STATION DESCRIPTION - EAST BRANCH EIGHTMILE R NEAR NORTH LYME, CT.

AREA - 197.0 (SQUARE KM.)

YEARS OF RECORD -1937 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
46	24.9	23.3	3.837	19.703	0.928

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	9.5	2	10.8	3	12.2
4	12.5	5	13.2	6	13.3
7	13.3	8	13.9	9	13.9
10	14.4	11	14.8	12	15.2
13	15.3	14	15.3	15	15.3
16	15.9	17	16.3	18	16.4
19	16.4	20	16.4	21	16.8
22	17.6	23	18.1	24	18.1
25	18.4	26	19.0	27	19.0
28	19.5	29	20.1	30	20.7
31	21.2	32	21.2	33	21.5
34	22.4	35	22.5	36	25.8
37	25.8	38	26.4	39	27.1
40	28.6	41	30.9	42	39.8
43	62.3	44	68.0	45	83.5
46	146.4				

STATION DESCRIPTION - QUINNIPIAC R AT WALLINGFORD, CT

AREA - 205.0 (SQUARE KM.)

YEARS OF RECORD -1932 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
51	62.3	37.9	2.383	10.744	0.603

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	18.5	2	21.5	3	24.1
4	25.2	5	31.7	6	32.0
7	32.6	8	33.4	9	33.4
10	34.0	11	34.5	12	35.4
13	36.8	14	37.7	15	38.8
16	41.3	17	44.5	18	47.8
19	47.8	20	49.3	21	49.5
22	50.7	23	51.2	24	51.2
25	52.9	26	53.2	27	53.5
28	53.5	29	56.9	30	58.6
31	59.5	32	60.3	33	60.6
34	62.3	35	64.3	36	64.3
37	70.8	38	70.8	39	71.6
40	75.9	41	76.4	42	78.7
43	81.8	44	88.3	45	101.6
46	104.8	47	106.7	48	107.3
49	148.1	50	158.0	51	232.2

STATION DESCRIPTION - BLACKBERRY R AT CANAAN, CT.

AREA - 215.0 (SQUARE KM.)

YEARS OF RECORD -1943 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
30	57.8	67.8	4.793	27.339	1.153

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	13.4	2	14.3	3	20.8
4	22.1	5	23.7	6	27.2
7	27.2	8	36.2	9	36.2
10	36.8	11	37.9	12	39.6
13	41.3	14	42.5	15	42.5
16	43.0	17	47.3	18	48.7
19	53.8	20	54.1	21	54.4
22	54.9	23	63.7	24	68.8
25	72.2	26	74.7	27	77.6
28	77.6	29	79.3	30	402.0

STATION DESCRIPTION - TENMILE R NR GAYLORDSVILLE, CT.

AREA - 430.0 (SQUARE KM.)

YEARS OF RECORD -1921 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
52	103.5	81.3	2.971	14.007	0.778

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	27.7	2	30.6	3	34.3
4	36.8	5	43.0	6	44.2
7	44.7	8	46.1	9	48.4
10	49.0	11	53.8	12	54.4
13	54.9	14	55.2	15	55.5
16	56.1	17	57.8	18	58.9
19	59.7	20	67.1	21	74.5
22	74.7	23	74.7	24	77.9
25	80.7	26	82.7	27	83.8
28	87.5	29	89.2	30	89.5
31	93.7	32	97.7	33	99.4
34	109.9	35	111.6	36	113.3
37	113.8	38	122.9	39	124.9
40	126.3	41	133.6	42	133.6
43	141.3	44	141.6	45	145.2
46	149.5	47	152.6	48	162.2
49	180.1	50	288.8	51	353.9
52	492.6				

STATION DESCRIPTION - STILL R AT LANESVILLE, CT.

AREA - 495.0 (SQUARE KM.)

YEARS OF RECORD -1935 - 1982;

N	AVG	ST. DEV	SKEW	KURTOSIS	VARIATION
48	45.7	37.9	2.737	12.999	0.822

THE DISCHARGE (M**3/SEC) DATA ARE ARRANGED IN ASCENDING ORDER OF MAGNITUDE

1	11.6	2	14.9	3	15.3
4	17.3	5	17.4	6	18.5
7	19.3	8	20.1	9	20.5

DSN=CEDEEP.SIN

10	20.7	11	22.4	12	22.9
13	24.1	14	24.8	15	25.1
16	25.8	17	25.8	18	26.6
19	26.9	20	28.6	21	28.9
22	31.1	23	31.4	24	31.4
25	33.4	26	33.4	27	34.0
28	35.7	29	36.0	30	39.1
31	41.1	32	45.0	33	47.6
34	47.6	35	49.0	36	51.0
37	52.1	38	56.1	39	61.7
40	63.4	41	75.6	42	90.0
43	92.3	44	101.6	45	104.8
46	107.6	47	117.2	48	225.9

FLOW CHART

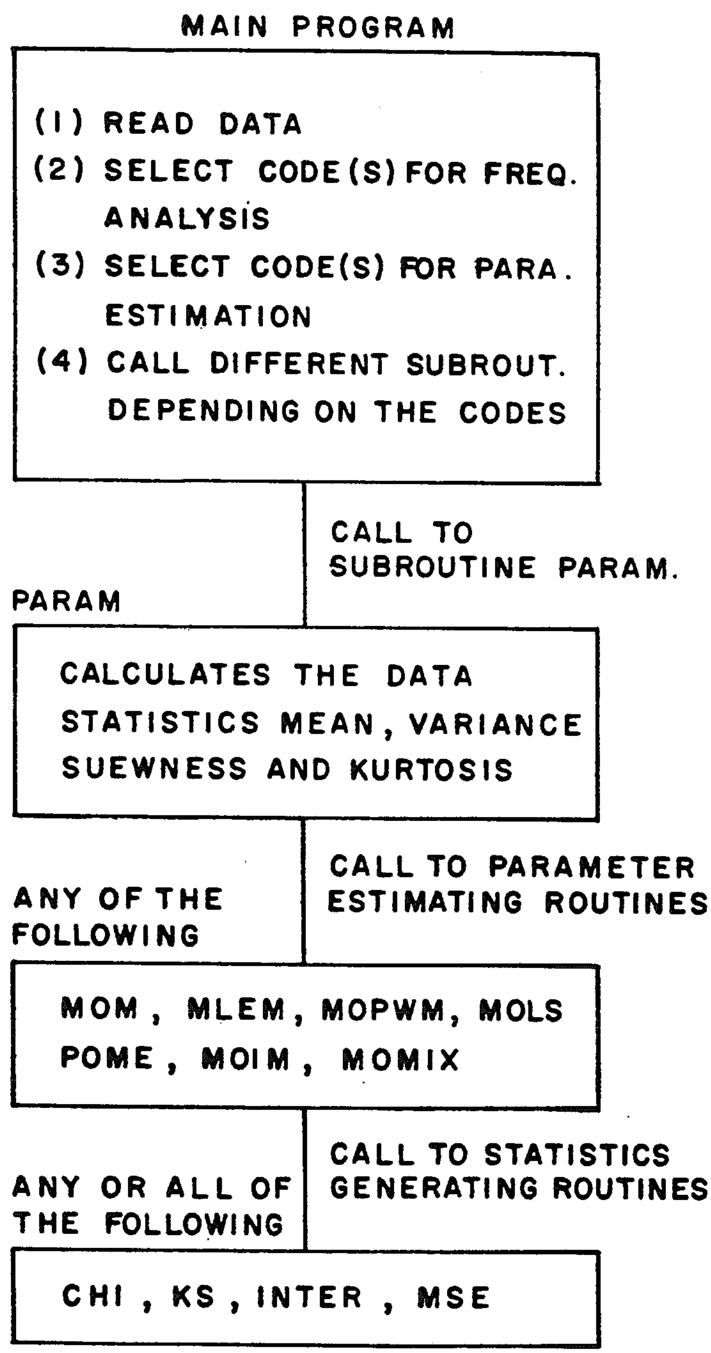

Figure 2.1

Chapter 2

COMPUTER SOFTWARE

Objectives: The computer software was developed in the form of a decision making program. It was designed such that the decision rules for selection of any of the nine methods of frequency analysis can be changed with the advent of new concepts in future. The software can be used for one or more methods of frequency analysis. A user-friendly interface has been added to make it easy to use. Figure 2.1 depicts the flow chart illustrating the main components of the software.

Data input: The data can be read from a tape or disk in format free mode. A sample example is given to illustrate the input data.

Results: After the data has been entered, the program, according to the requirements given by the user, calculates the parameters and test statistics for various methods. Before any calculation the data is checked for independence and homogenity. A sample calculation is provided to illustrate the results.

```
MEMBER M1                                DSN=CEDEEP.FOOL
--------------------------------------------------------------------------------
      WRITE (6,3)
 3    FORMAT(/,30X,'DATA STATISTICS')
      WRITE (6,4)N,XAVG,SIGMA,CS,TS
 4    FORMAT(/5X,1HN,11X,4HXAVG,14X,5HSIGMA,10X,4HSKEW,8X,8HKURTOSIS,
     *//,4X,I2,5X,F12.1,5X,F12.1,6X,F8.2,5X,F9.2,/)
      RETURN
      END
C
C
C*****************************************************************************
C
C  THIS SUBROUTINE IS THE MAIN ROUTINE FOR NORMAL DISTRIBUTION.
C THIS ROUTINE CALLS ALL THE APPROPRIATE ROUTINES FOR THE
C PARAMETER CALCULATION AND TEST STATISTICS.
C
C*****************************************************************************
C
      SUBROUTINE NORMAL
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/THEO/Y(3,100)
      COMMON/STAN/T(100)
      COMMON/PROBA/P(100),XKSTAT(2)
      COMMON/VARI/O(2,7)
      COMMON/RESU/CHISQ(2)
      COMMON/RMSE/XMSE(2),BIAS(2)
      COMMON/ESTIMT/QBARCV(2)
      COMMON/SELE/IFLAG(8),IFLAG1(8,7)
C*****************************************************************************
C CONTROL STATEMENTS FOR CALLING THE APPROPRIATE METHOD
C OF PARAMETER ESTIMATION.
C*****************************************************************************
      WRITE(6,1)
 1    FORMAT(25X,'NORMAL DISTRIBUTION',/)
      IF (IFLAG1(1,3) .EQ. 1) CALL LEAS1
C-----------------------------------------------------------------------------
      CALL TFLOOD(2,1)
      CALL PROB1
      WRITE (6,3)(XKSTAT(IJ),IJ=1,2)
 3    FORMAT(/27X,'K S STATISTIC',/25X,'MOM',10X,'MOLS',
     */,20X,F10.4,7X,F10.4)
C
      CALL CHI1
      CALL SQUAR1
      CALL ROERR1
C-----------------------------------------------------------------------------
C
      WRITE(6,4)(CHISQ(IJ),IJ=1,2)
 4    FORMAT(/25X,'CHI SQUARE STATISTIC',/,28X,'MOM',
     *10X,'MOLS',/,25X,F6.2,8X,F6.2)
C
      WRITE(6,5)(XMSE(IJ),IJ=1,2)
 5    FORMAT(/25X,'MEAN SQUARE ERROR',/,28X,'MOM',10X,'MOLS',
     */,25X,F10.2,5X,F10.2,/)
      WRITE(6,6)(BIAS(IJ),IJ=1,2)
 6    FORMAT(/25X,'MEAN ABSOLUTE DEVIATION',/,28X,'MOM',10X,'MOLS',
     */,25X,F8.2,5X,F8.2,/)
C-----------------------------------------------------------------------------
```

Chapter 3

RECOMMENDATIONS

In order to further enhance usefulness of this study it is recommended to develop this computer program into an expert system. It would analyze the data according to the criteria laid out in chapter 2. If the data satisfy the criteria then test statistics would be generated for all the methods specified by the user. It will then advise the user as to which method to use or will supply the neccessary parameters and test statistics according to the user requirement. The main theme is illustrated in figure 3.1

RECOMMENDATIONS

PROFILE OF AN EXPERT SYSTEM

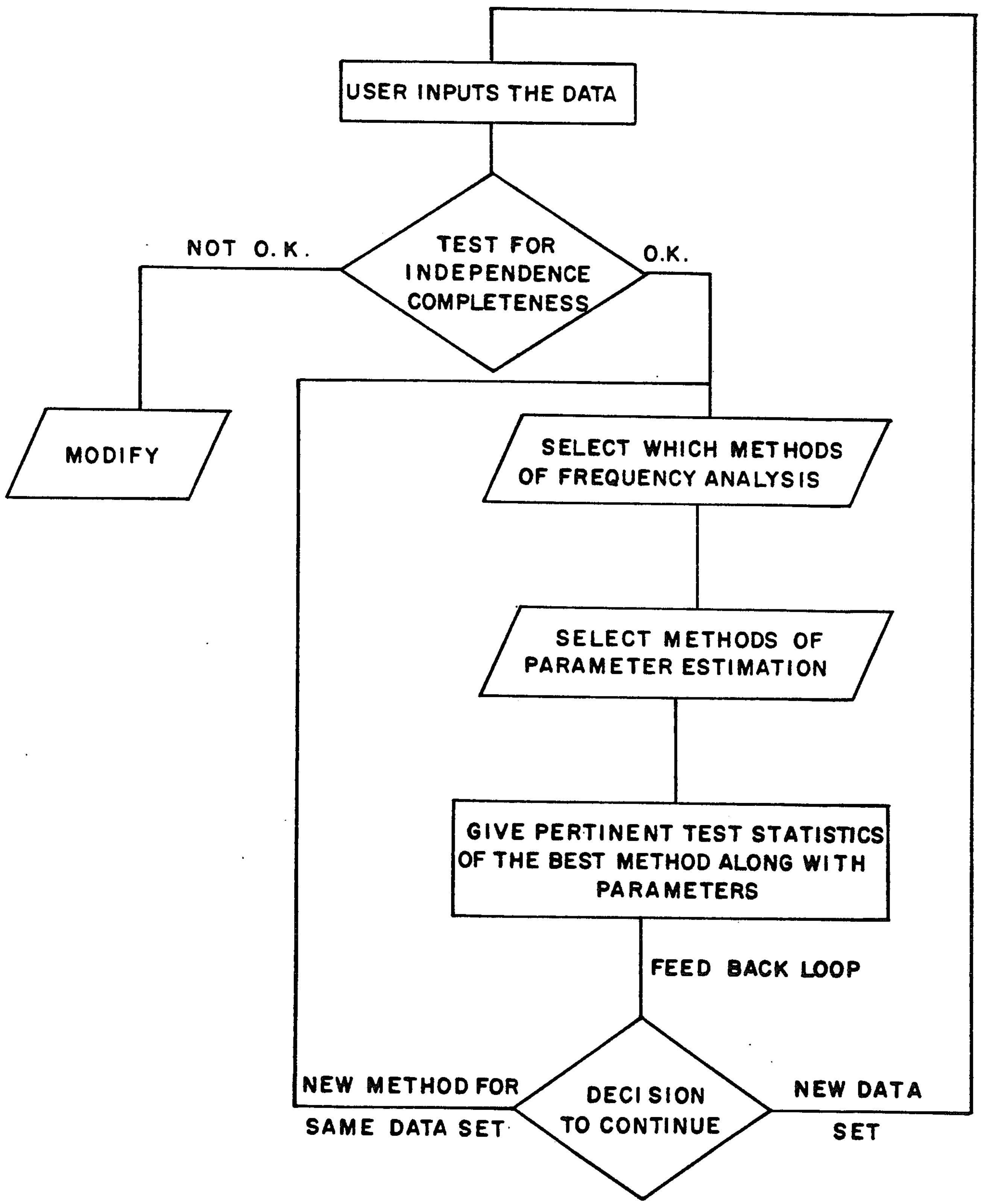

Figure 3.1

```
//FINALPR JOB (1304,52021,9,20),'DEEPAK',MSGCLASS=S
/*ROUTE PRINT CEBA
/*JOBPARM SHIFT=D
//      EXEC FORTVCLG,REGION.GO=4000K,TIME.GO=99
//FORT.SYSIN DD *
C
C*********************************************************************
C
C  MASTER PROGRAM FOR ALL DISTRIBUTIONS . THIS PROGRAM CALCULATES THE
C
C*********************************************************************
C
C     PARAMETERS FOR ALL DISTRIBUTIONS AND THE TEST STATISTICS.
C
C*********************************************************************
C
      DIMENSION TITLE(80)
      COMMON/PARA/X(100),N
      COMMON/NAME/Q(20)
      COMMON/SELE/IFLAG(8),IFLAG1(8,7)
      COMMON/STAT/XAVG,SIGMA,CS,TS
      CHARACTER *5 Q
C
C *******************************************************************
C
C   MAKE SELECTION FOR THE METHODS OF FREQUENCY ANALYSIS
C   SELECTION IS TO BE MADE IN THE ORDER LISTED BELOW.
C   THE SELECTION IS TO BE MADE FROM NORMAL(NORMAL),
C   2-PARA LOGNORMAL(LOGNO2),3PARA LOGNORMAL(LOGNO3),
C   GAMMA(GAMMA),PEARSON TYPE III(PEAR3),LOG PEARSON TYPE 3(LPEAR3),
C   BOUGHTON(BOUTON) AND GUMBEL(GUMBEL) DISTRIBUTIONS.
C (     ) : GIVE THE NAME OF THE APPROPRIATE SUBROUTINE.
C
C *******************************************************************
C
C   ENTER CODE ONE(1) FOR THE METHODS TO BE USED. CODE ZERO (0)
C    FOR THE ONES WHICH ARE NOT SELECTED.
C
C *******************************************************************
C
      READ (5,*) (IFLAG(I),I=1,8)
C
C *******************************************************************
C
C   MAKE SELECTION FOR THE METHODS OF PARAMETER ESTIMATION
C   SELECTION IS TO BE MADE IN THE ORDER LISTED BELOW.
C   THE SELECTION IS TO BE MADE FROM METHOD OF MOMENTS(MOM),METHOD OF
C   MAXIMUM LIKELIHOOD(MLEM),METHOD OF LEAST SQUARES(MOLS),
C   METHOD OF MAXIMUM ENTROPY(POME),METHOD OF PROBABILITY
C   WEIGHTED MOMENTS(MOPWM),METHOD OF MIXED MOMENTS(MOMIX)
C   AND METHOD OF INCOMPLETE MEANS(MOIM).
C   ADD NUMBER 1,2,3,4,5,6,7 AND 8 AT THE END OF EACH NAME
C   TO DIFFERENTIATE BETWEEN METHODS IN ORDER OF THEIR LISTING.
C
C *******************************************************************
C
C   ENTER CODE ONE(1) FOR THE METHODS TO BE USED. CODE ZERO (0)
C   FOR THE ONES WHICH ARE NOT SELECTED IN THE ORDER LISTED ABOVE.
```

```
C
C ****************************************************************
C

      DO 1 I =1,8
 1    READ (5,*) (IFLAG1(I,K),K=1,7)
C
C ****************************************************************
C
C   ENTER NUMBER OF DATA SETS FOR FREQUENCY ANALYSIS.
C
C ****************************************************************
      READ(5,*) NUMBER
C ****************************************************************
C
C   READ THE ABBREVIATED NAMES OF THE METHODS OF PARAMETER
C ESTIMATION IN ARRAY Q(I)
C
C ****************************************************************
      READ (5,2) (Q(I),I=1,7)
  2   FORMAT(7A5)
C ****************************************************************
C
C     BELOW IS THE LOOP FORREADING THE PERTINENT INFORMATION
C      FOR EACH DATA SET.
C     TITLE IS FOR THE NAME AND LOCATION OF GAGING STATION.
C     N = NUMBER OF OBSERVATIONS OR NUMBER OF ANNUAL FLOOD MAXIMA.
C     X(I) = ARRAY FOR STORING THE OBSERVATIONS.
C
C ****************************************************************
      DO 50 J=1,NUMBER
      READ(8,3)TITLE
  3   FORMAT(80A1)
      WRITE(6,4)TITLE
  4   FORMAT (80A1,/)
      READ (8,*) N
      READ (8,*) (X(I),I=1,N)
C ****************************************************************
C
C     SUBROUTINE PARAM CALCULATES THE MEAN,VARIANCE,SKEWNESS AND
C     KURTOSIS COEFFICIENTS OF THE DATA.
C
C ****************************************************************
      CALL PARAM
C
      IF (IFLAG(1) .EQ. 1) CALL NORMAL
      IF (IFLAG(2) .EQ. 1) CALL LOGNO2
      IF (IFLAG(3) .EQ. 1) CALL LOGNO3
      IF (IFLAG(4) .EQ. 1) CALL GAMMAU
      IF (IFLAG(5) .EQ. 1) CALL PEAR3
      IF (IFLAG(6) .EQ. 1) CALL LPEAR3
      IF (IFLAG(7) .EQ. 1) CALL BOUTON
C     IF (IFLAG(8) .EQ. 1) CALL GUMBEL
 50   CONTINUE
      STOP
      END
C
C
```

```
C------------------------------------------------------------------------
C                              (PARAM)
C
C     PROGRAM TO CALCULATE THE MEAN  VARIANCE  SKEWNESS AND
C
C                           KURTOSIS FOR THE DATA.
C
C------------------------------------------------------------------------
C
C
      SUBROUTINE PARAM
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/ESTIMT/QBARCV(2)
      COMMON/UPPS/XMEAN
      COMMON/STAT1/XCAL,YCAL
      COMMON/FOR/PAR1(3),PAR2(3)
      DIMENSION SIG(140),SUM(140),AUR(140)
      TOT=0.0
      CS=0.0
      SIGM=0.0
      XTOT=0.0
      TOSIS=0.0
      DO 1 I=1,N
 1    XTOT=XTOT+X(I)
      XAVG=XTOT/FLOAT(N)
      XMEAN = XAVG
      DO 2  I=1,N
      SIG(I)=(X(I)-XAVG)**2
      SUM(I)=(X(I)-XAVG)**3
      AUR(I)=(X(I)-XAVG)**4
      TOT=TOT+SUM(I)
      TOSIS=TOSIS+AUR(I)
 2    SIGM=SIGM+SIG(I)
      SIGMA= SQRT(SIGM/FLOAT(N-1))
      SIGMA1= SQRT(SIGM/FLOAT(N))
C------------------------------------------------------------------
C
C    QBARCV(1) AND XMEAN ARE THE PARAMETERS FOR NORMAL DISTRIBUTION
C     BY METHOD OF MOMENTS.
C
C------------------------------------------------------------------
      QBARCV(1)=SIGMA
      Z = SIGMA1/XAVG
      YCAC = ALOG(Z**2 +1.0)
      YCAL = SQRT(YCAC)
      XCAL = ALOG(XAVG)-(YCAC/2.0)
C------------------------------------------------------------------
C
C     PAR1(1) AND PAR2(1) ARE THE PARAMETERS BY MOM FOR 2 PARA
C     LOGNORMAL DISTRIBUTION.
C
C------------------------------------------------------------------
      PAR1(1)= XCAL
      PAR2(1)= YCAL
      CS=(FLOAT(N)/(FLOAT(N-1)*FLOAT(N-2)))*TOT/(SIGMA**3)
      TS=((FLOAT(N)**2)/(FLOAT(N-1)*FLOAT(N-2)*FLOAT(N-3)))*
     1TOSIS/(SIGMA**4)
```

FLOW CHART

The program is divided into two parts: (1) MAIN and (2) SUBROUTINE(S).

MAIN performs the following functions:

(i) Reading of Data

(ii) Selection of code(s) for methods of frequency analysis

(iii) Selection of code(s) for methods of parameter estimation

(iv) Various calls to subroutines for different methods of frequency analysis and parameter estimation.

SUBROUTINE(S) perform(s) the following functions:

For each method of frequency analysis the following subroutines are used:

(i) MOM, MLEM, MOPWM, MOLS, MOMIX, POME, MOIM. These are used for parameter estimation.

(ii) CHI, KS, INT, MSE are used for generating the test statistics CHI square, KS, Class intervals and mean absolute and mean square deviations.

The flow chart is given on the ensuing page.

```
      RETURN
      END
C
C-------------------------------------------------------------------
C
C-------------------------------------------------------------------
C
C     THIS SUBROUTINE CALCULATES THE LEAST SUARES PARAMETER
C     ESTIMATES FOR NORMAL DISTRIBUTION. THEY ARE XAVG AND QBARCV(2).
C
C-------------------------------------------------------------------
C
      SUBROUTINE LEAS1
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/STAN/T(100)
      COMMON/ESTIMT/QBARCV(2)
      SUM=0.0
      SUM1=0.0
      DO 10 J=1,N
      A=(X(J)-XAVG)**2
      B=(X(J)-XAVG)/SIGMA
      SUM=SUM+A
 10   SUM1=SUM1+B*X(J)
      QBARCV(2)=SUM/SUM1
      WRITE(6,11)XAVG,QBARCV(1)
 11   FORMAT(14X,'PARAMETERS OF NO DIST. BY METH. OF MOMENTS.',/,
     */,25X,'XBAR',10X,'SIGMA',/,22X,F8.2,7X,F8.2,/)
      WRITE(6,12)XAVG,QBARCV(2)
 12   FORMAT(14X,'PARAMETERS OF NO DIST. BY METH. OF LEAST SQ.',/,
     */,25X,'XBAR',10X,'SIGMA',/,22X,F8.2,7X,F8.2,/)
      RETURN
      END
C
C-------------------------------------------------------------------
C
C THIS SUBROUTINE CALCULATES THE STANDARD NORMAL DEVIATE
C FOR A GIVEN PROBABILITY LEVEL USEFUL FOR CHI SQUARE TEST
C AND ALSO THE THEORETICAL FLOOD VALUES FOR NORMAL DISTRIBUTION.
C THE THEORETICAL VALUES ARE STORED IN AN ARRAY Y(3,100).
C
C-------------------------------------------------------------------
C
      SUBROUTINE TFLOOD(LOOP,IFLAG2)
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/THEO/Y(3,100)
      COMMON/STAN/T(100)
      COMMON/ESTIMT/QBARCV(2)
      COMMON/STAT1/XCAL,YCAL
      COMMON/ESTI/AVG,SDM
      COMMON/SELE/IFLAG(8),IFLAG1(8,7)
      IF (IFLAG1(1,3) .NE. 1) LOOP = LOOP-1
      DO 9 I=1,LOOP
      DO 10 J=1,N
      P=(FLOAT(J)-0.44)/(FLOAT(N)+0.12)
      IF (P.GT.0.5) GO TO 30
       GO TO 20
```

```
 20    W=(ALOG(1.0/P**2))**0.5
       T(J)=W-(2.515517+.802853*W+.010328*W**2)/
      1(1.0+1.432788*W+.189269*W**2+.001308*W**3)
       T(J)=-T(J)
       IF (IFLAG2 .EQ. 1) THEN
       Y(I,J)=XAVG+T(J)*QBARCV(I)
       ENDIF
       IF (IFLAG2 .EQ. 2) THEN
       Y(1,J)=EXP(XCAL+T(J)*YCAL)
       Y(2,J)=EXP(AVG+T(J)*SDM)
       ELSE
       ENDIF
       GO TO 10
 30    P=P-1.0
       W=(ALOG(1.0/P**2))**0.5
       T(J)=W-(2.515517+.802853*W+.010328*W**2)/
      1(1.0+1.432788*W+.189269*W**2+.001308*W**3)
       IF (IFLAG2 .EQ. 1) THEN
       Y(I,J)=XAVG+T(J)*QBARCV(I)
       ENDIF
       IF (IFLAG2 .EQ. 2) THEN
       Y(1,J)=EXP(XCAL+T(J)*YCAL)
       Y(2,J)=EXP(AVG+T(J)*SDM)
       ELSE
       ENDIF
  10   CONTINUE
   9   CONTINUE
       RETURN
       END
C
C---------------------------------------------------------------------------
C
C      THIS SUBROUTINE IS USED FOR K-S TEST STATISTIC.
C
C      CALCULATES THE THEORETICAL PROBABILITY FOR NORMAL
C
C      OR LOGNORMAL DISTRIBUTION BY THE FORMULA GIVEN IN
C
C                   STEGUN AND ARBAMOWITZ
C
C---------------------------------------------------------------------------
C
C---------------------------------------------------------------------------
       SUBROUTINE PROB1
       COMMON/PARA/X(100),N
       COMMON/STAT/XAVG,SIGMA,CS,TS
       COMMON/PROBA/P(100),XKSTAT(2)
       COMMON/ESTIMT/QBARCV(2)
       DIMENSION U(100),Z(100),G(100),XP(100)
       DO 60 I =1,2
       DO 20 K=1,N
       XP(K)=X(K)
 20    XP(K)=(XP(K)-XAVG)/QBARCV(I)
       H=0.0
       DO 10 J=1,N
       IF (XP(J).LE.0.0)GO TO 30
       GO TO 40
 30    XP(J)=ABS(XP(J))
```

```
      T=1.0/(1.0+.33267*XP(J))
      U(J)=(2.490895+1.466003*XP(J)**2-.024393*XP(J)**4+.178257*XP(J)
     ***6)
      Z(J)=1.0/U(J)
      P(J)=1.0-Z(J)*(.43618*T-.12016*T**2+.93729*T**3)
      P(J)=1.0-P(J)
      GO TO 10
 40   T=1.0/(1.0+.33267*XP(J))
      U(J)=(2.490895+1.466003*XP(J)**2-.024393*XP(J)**4+.178257*XP(J)
     ***6)
      Z(J)=1.0/U(J)
      P(J)=1.0-Z(J)*(.4361836*T-.1201676*T**2+.9372980*T**3)
 10   CONTINUE
      DO 50 L=1,N
      F=(FLOAT(L)-0.44)/(FLOAT(N)+0.12)
      G(L)=ABS(F-P(L))
      IF(G(L).GE.H) H=G(L)
 50   CONTINUE
      XKSTAT(I)=H
 60   CONTINUE
      RETURN
      END
C-----------------------------------------------------------------------
C  THIS SUBROUTINE CALCULATES THE CLASS INTERVALS FOR NORMAL
C
C  DISTRIBUTION TO BE USED FOR CHI SQUARE TEST. IT ALSO COUNTS
C
C  THE NUMBER OF OBSERVATIONS IN EACH CLASS INTERVAL.
C
C-----------------------------------------------------------------------
C
      SUBROUTINE CHI1
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/VARI/O(2,7)
      COMMON/ESTIMT/QBARCV(2)
      DIMENSION T(10),CI(10),F(50)
      K=1
      T(1)=-1.08
      T(2)=-.585
      T(3)=-.2
      T(4)=.19
      T(5)=.565
      T(6)=1.07
      DO 15 I=1,2
      IXP=0
      JJ=1
      DO 14 J=1,6
      CI(J)=XAVG+T(J)*QBARCV(I)
      F(K)=CI(J)
      DO 20 L=JJ,N
      IF (X(L).LE.CI(J)) GO TO 20
      O(I,J)=L-1-IXP
      IXP=L-1
      GO TO 13
  20  CONTINUE
  13  JJ=L-1
      K=K+1
```

```
   14  CONTINUE
       O(I,7)=N-L+1
   15  CONTINUE
       RETURN
       END
C
C
C=====================================================================
C
C      THIS SUBROUTINE CALCULATES THE CHI SQUARE STATISTIC
C                     FOR NORMAL DISTRIBUTION.
C
C=====================================================================
C
       SUBROUTINE SQUAR1
       COMMON/PARA/X(100),N
       COMMON/VARI/O(2,7)
       COMMON/RESU/CHISQ(2)
       E=FLOAT(N)/7.0
       DO 20 I=1,2
       SUM=0.0
       DO 10 J=1,7
       DEV=(O(I,J)-E)**2
   10  SUM=SUM+DEV
       CHISQ(I)=SUM/E
   20  CONTINUE
       RETURN
       END
C
C=====================================================================
C
C      THIS SUBROUTINE CALCULATES THE ROOT MEAN SQUARE ERROR
C
C                   FOR NORMAL DISTRIBUTION.
C
C=====================================================================
C
       SUBROUTINE ROERR1
       COMMON/PARA/X(100),N
       COMMON/THEO/Y(2,100)
       COMMON/RMSE/XMSE(2),BIAS(2)
       DO 9 I=1,2
       SUM1=0.0
       SUM2=0.0
       DO 10 J=1,N
       DAS=Y(I,J)
       DAR=X(J)
       SUM=(DAS-DAR)/DAR
       RUM=ABS(DAS-DAR)
       SUM1=SUM1+SUM**2
   10  SUM2=SUM2+RUM/DAR
       XMSE(I)=SUM1*100.0/(FLOAT(N))
       BIAS(I)=SUM2*100.0/(FLOAT(N))
    9  CONTINUE
       RETURN
       END
C
C********************************************************************
```

```
C
C THIS SUBROUTINE IS THE MAIN ROUTINE FOR 2- PARA LOG NORMAL DIST.
C THIS ROUTINE CALLS ALL THE APPROPRIATE ROUTINES FOR THE
C PARAMETER CALCULATION AND TEST STATISTICS.
C
C*****************************************************************
C
      SUBROUTINE LOGNO2
C
      COMMON/SELE/IFLAG(8),IFLAG1(8,7)
C
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/UPPS/XMEAN
      COMMON/STAT1/XCAL,YCAL
      COMMON/ESTI/AVG,SDM
      COMMON/DEST/COV,PQ,R,S
      COMMON/THEO/Y(3,100)
      COMMON/STAN/T(100)
      COMMON/PROBA/P(100),SK(3)
      COMMON/VARI/O(3,7)
      COMMON/RESU/SUM1(3)
      COMMON/FOR/PAR1(3),PAR2(3)
      COMMON/RMSE/AMSE(5),BIAS(5)
      COMMON/UPON/UMSE(5),UBIAS(5)
      COMMON/NAME/Q(20)
      CHARACTER *5 Q
C===============================================================
C
C CONTROL STATEMENTS FOR CALLING THE APPROPRIATE METHOD
C OF PARAMETER ESTIMATION.
C
C===============================================================
      WRITE(6,1)
 1    FORMAT (//,25X,'2-PARA LOGNORMAL DISTRIBUTION',/)
      IF (IFLAG1(2,2) .EQ. 1) CALL MLEM2
      IF (IFLAG1(2,3) .EQ. 1) CALL LEAS2
      WRITE(6,5)(Q(I),I=1,3)
 5    FORMAT(/12X,A5,22X,A5,22X,A5)
      WRITE(6,6)
 6    FORMAT(4X,'YBAR',10X,'SDY',9X,'YBAR'
     1,10X,'SDY',9X,'YBAR',9X,'SDY')
      WRITE(6,7)XCAL,YCAL,AVG,SDM,S,R
 7    FORMAT(1X,F8.4,5X,F8.4,5X,F8.4,5X,F8.4,5X,F8.4,5X,F8.4,//)
C---------------------------------------------------------------
      CALL TFLOOD(1,2)
      CALL PROB2
      CALL CHI2
      CALL SQUAR2
      CALL ROERR2
C     CALL COMP2(J)
C
C
C---------------------------------------------------------------
      WRITE(6,5)(Q(1),I=1,3)
      WRITE (6,8)(SK(M),M=1,3)
 8    FORMAT(/1X,'K-S STAT',1X,F8.4,17X,F8.4,17X,F8.4)
      WRITE(6,5)(Q(I),I=1,3)
```

```
      WRITE(6,9)(SUM1(M),M=1,3)
    9 FORMAT (1X,'CHI STAT',1X,F8.2,17X,F8.2,19X,F8.2)
      WRITE(6,5)(Q(I),I=1,3)
      WRITE(6,10)
   10 FORMAT(6X,'MSE',7X,'BIAS',
     *10X,'MSE',7X,'BIAS',10X,'MSE',8X,'BIAS')
      WRITE(6,11)(AMSE(M),BIAS(M),M=1,3)
   11 FORMAT(1X,F10.2,2X,F8.2,8X
     *,F7.2,4X,F8.2,5X,F8.2,5X,F8.2)
C------------------------------------------------------------------------
C
      RETURN
      END
C
C------------------------------------------------------------------------
C------------------------------------------------------------------------
C
C      SUBROUTINE FOR CALCULATING MLE ESTIMATES
C
C      PARAMETERS ARE STORED IN PAR1(2),PAR2(2).
C
C------------------------------------------------------------------------
      SUBROUTINE MLEM2
      DIMENSION U(100)
      COMMON/PARA/X(100),N
      COMMON/ESTI/AVG,SDM
      COMMON/FOR/PAR1(3),PAR2(3)
      SUM=0.0
      SUM1=0.0
      DO 10 I=1,N
      U(I)=ALOG(X(I))
   10 SUM=SUM+U(I)
      AVG=SUM/FLOAT(N)
      DO 20 I=1,N
   20 SUM1=SUM1+(U(I)-AVG)**2
      SDM=SQRT(SUM1/FLOAT(N-1))
      PAR1(2)=AVG
      PAR2(2)=SDM
      RETURN
      END
C
C
C------------------------------------------------------------------------
C
C THIS SUBROUTINE CALCULATES THE PARAMETERS OF LN2 DISTRIBUTION
C
C                BY METHOD OF LEAST SQUARES
C
C       PARAMETERS ARE STORED IN PAR1(3) AND PAR2(3).
C
C------------------------------------------------------------------------
C
C
      SUBROUTINE LEAS2
      COMMON/PARA/( (100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/STAN/T(100)
      COMMON/DEST/COV,PQ,R,S
```

```
      COMMON/THEO/Y(3,100)
      COMMON/FOR/PAR1(3),PAR2(3)
      SUM=0.0
      SUM1=0.0
      DO 10 J=1,N
      C=ALOG(X(J))
      D=T(J)*C
      E=T(J)**2
      SUM=SUM+E
 10   SUM1=SUM1+D
      B=SUM1/SUM
      F=EXP(B**2)-1.0
      COV=SQRT(F)
      PQ=ALOG(F+1.0)
      R=SQRT(PQ)
      S=ALOG(XAVG)-(PQ/2.0)
      PAR1(3)=S
      PAR2(3)=R
      DO 20 J=1,N
 20   Y(3,J)=EXP(S+T(J)*R)
      RETURN
      END
C
C-----------------------------------------------------------------------
C     THIS PROGRAM CALCULATES THE THEORETICAL PROBABILITY
C
C     FOR LOGNORMAL DISTRIBUTION BY THE FORMULA GIVEN IN
C
C                  STEGUN AND ARBAMOWITZ
C
C-----------------------------------------------------------------------
C
      SUBROUTINE PROB2
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/STAT1/XCAL,YCAL
      COMMON/ESTI/AVG,SDM
      COMMON/DEST/COV,PQ,R,S
      COMMON/PROBA/P(100),SK(3)
      DIMENSION U(100),Z(100),G(100),XP(3,100)
      DO 20 K=1,N
      XP(1,K)=(ALOG(X(K))-XCAL)/YCAL
      XP(2,K)=(ALOG(X(K))-AVG)/SDM
 20   XP(3,K)=(ALOG(X(K))-S)/R
      H=0.0
      DO 22 I=1,3
      DO 10 J=1,N
      IF (XP(I,J).LE.0.0)GO TO 30
      GO TO 40
 30   XP(I,J)=ABS(XP(I,J))
      T=1.0/(1.0+.33267*XP(I,J))
      U(J)=(2.490895+1.466003*XP(I,J)
     1**2-.024393*XP(I,J)**4+.178257*XP(I,J)**6)
      Z(J)=1.0/U(J)
      P(J)=1.0-Z(J)*(.43618*T-.12016*T**2+.93729*T**3)
      P(J)=1.0-P(J)
      GO TO 10
 40   T=1.0/(1.0+.33267*XP(I,J))
```

```
      U(J)=(2.490895+1.466003*XP(I,J)**
     12-.024393*XP(I,J)**4+.178257*XP(I,J)**6)
      Z(J)=1.0/U(J)
      P(J)=1.0-Z(J)*(.4361836*T-.1201676*T**2+.9372980*T**3)
 10   CONTINUE
      DO 50 L=1,N
      F=(FLOAT(L)-0.44)/(FLOAT(N)+0.12)
      G(L)=ABS(F-P(L))
      IF(G(L).GE.H) H=G(L)
      SK(I)= H
 50   CONTINUE
 22   CONTINUE
      RETURN
      END
C-----------------------------------------------------------------------
C  THIS PROGRAM CALCULATES THE CLASS INTERVALS FOR LOG NORMAL
C
C         DISTRIBUTION TO BE USED FOR CHI SQUARE TEST
C
C-----------------------------------------------------------------------
C
      SUBROUTINE CHI2
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/VARI/O(3,7)
      COMMON/THEO/Y(3,100)
      COMMON/ESTI/AVG,SDM
      COMMON/DEST/COV,PQ,R,S
      DIMENSION T(10),CI(10),F(50)
      K=1
      T(1)=-1.08
      T(2)=-.585
      T(3)=-.2
      T(4)=.19
      T(5)=.565
      T(6)=1.07
      DO 15 I=1,3
      IXP=0
      JJ=1
      DO 14 J=1,6
      CI(J)=EXP(AVG+T(J)*SDM)
      F(K)=CI(J)
      DO 20 L=JJ,N
      IF (Y(I,L).LE.CI(J)) GO TO 20
      O(I,J)=L-1-IXP
      IXP=L-1
      GO TO 13
 20   CONTINUE
 13   JJ=L-1
      K=K+1
 14   CONTINUE
      O(I,7)=N-L+1
 15   CONTINUE
      RETURN
      END
C
C
C=======================================================================
```

```
-----------------------------------------------------------------------------
C
C
C THIS SUBROUTINE CALCULATES THE CHI SQUARE STATISTIC
C  FOR 2-PARA LOGNORMAL DISTRIBUTION.
C
C========================================================================
C
      SUBROUTINE SQUAR2
      COMMON/PARA/X(100),N
      COMMON/VARI/O(3,7)
      COMMON/RESU/SUM1(3)
      E=FLOAT(N)/7.0
      DO 20 I=1,3
      SUM=0.0
      DO 10 J=1,7
      DEV=(O(I,J)-E)**2
   10 SUM=SUM+DEV
      SUM1(I)=SUM/E
   20 CONTINUE
      RETURN
      END
C
C========================================================================
C
C
C   THIS SUBROUTINE CALCULATES THE MEAN SQUARE ERROR(MSE) AND
C
C   MEAN ABSOLUTE DEVIATION FOR 2-PARA LOGNORMAL DISTRIBUTION.
C
C
C========================================================================
C
      SUBROUTINE ROERR2
      COMMON/PARA/X(100),N
      COMMON/THEO/Y(3,100)
      COMMON/RMSE/AMSE(5),BIAS(5)
      DO 20 I=1,3
      SUM1=0.0
      SUM2=0.0
      DO 10 J=1,N
      SUM=((Y(I,J)-X(J))/X(J))**2
      RUM=ABS(Y(I,J)-X(J))
      SUM1=SUM1+SUM
   10 SUM2=SUM2+RUM/X(J)
      ERR=SUM1
      ERR1=SUM2
      AMSE(I)=ERR*100.0/(FLOAT(N))
      BIAS(I)=ERR1*100.0/(FLOAT(N))
   20 CONTINUE
      RETURN
      END
C========================================================================
C
C THIS SUBROUTINE CALCULATES THE THEORETICAL FLOOD VALUES FOR
C
C GIVEN PROBABILITIES CORRESPONDING TO GIVEN RETURN PERIODS.
C
C========================================================================
```

```
      SUBROUTINE COMP2(NUM)
      COMMON/NAME/Q(20)
      COMMON/FOR/PAR1(3),PAR2(3)
      CHARACTER *5 Q
      DIMENSION T(10),XOBS(10),XCALC(10)
      T(1)= 0.0
      T(2)= 0.8416
      T(3)= 1.282
      T(4)= 2.054
      T(5)= 2.326
      T(6)= 2.575
      T(7)= 2.880
      DO 20 J=1,3
      DO 10 I=1,7
   10 XCALC(I)=EXP( PAR1(J)+T(I)*PAR2(J))
      WRITE(6,1)Q(J),(XCALC(I),I=1,7)
  1   FORMAT(6X,A4,7(2X,F7.1))
 20   CONTINUE
      RETURN
      END
C-----------------------------------------------------------------------
C                                   (LNO3)
C
C THIS SUBROUTINE IS THE MAIN ROUTINE FOR 3- PARA LOG NORMAL DIST.
C
C     THIS ROUTINE CALLS ALL THE APPROPRIATE ROUTINES FOR THE
C
C       PARAMETER CALCULATION AND TEST STATISTICS.
C
C-----------------------------------------------------------------------
C
      SUBROUTINE LOGNO3
      COMMON/PARA/X(100),N
      COMMON/NAME/Q(20)
      COMMON/SELE/IFLAG(8),IFLAG1(8,7)
      COMMON/SING/PARA1(3),PARA2(3),PARA3(3)
      COMMON/PARAK/AMO,SY,MY
      CHARACTER *5 Q
      WRITE (6,1)
 1    FORMAT(/,25X,'3-PARA LOGNORMAL DISTRIBUTION',/)
      IF (IFLAG1(3,1) .EQ. 1) CALL MOM3
      IF (IFLAG1(3,2) .EQ. 1) CALL MLEM3
      IF (IFLAG1(3,4) .EQ. 1) CALL POME3
C
C     CALL COMP(JJ)
      CALL FLOOD
      CALL CHI
      CALL SQUARE
      CALL PROB
      CALL ROERR
      RETURN
      END
C=======================================================================
C
C  THIS SUBROUTINE CALCULATES THE PARAMETERS FOR 3 PARA LOGNORMAL
C
C  DISTRIBUTION BY THE METHODS OF MOMENTS. PARA1(1),PARA2(1) AND
C
```

```
C  PARA3(1) ARE THE THREE PARAMETERS BY MOM METHOD.
C
C=========================================================================
C
      SUBROUTINE MOM3
C
      COMMON/PARA/X(100),N
      COMMON/NAME/Q(20)
      COMMON/SELE/IFLAG(8),IFLAG1(8,7)
      CHARACTER *5 Q
C

      REAL M1,M2,M3,M4,M5,M6,MY,K,MU
      DIMENSION RAT(7),IT(7)
      COMMON/PARAK/AMO,SY,MY
      COMMON/CH/ERROR,PP,QQ,R
      COMMON/THEO/Y(3,100)
      COMMON/STAT/M1,M2,Z2
      COMMON/PROBA/P(100),SK(3)
      COMMON/VARI/O(3,7)
      COMMON/RESU/SUM1(3)
      COMMON/RMSE/ERR(5),BIAS(5)
      COMMON/SING/PARA1(3),PARA2(3),PARA3(3)
      COMMON/PPOM/AP,SIGMAY,YBAR
      XN=N
      A=0.0
      B=0.0
      C=0.0
      DO 1 I=1,N
      A=A+X(I)
      B=B+X(I)**2
      C=C+X(I)**3
 1    CONTINUE
      M1=A/XN
      M2=(B/XN)-(A/XN)**2
      M3=(C/XN)+2.0*M1**3-3.0*M1*(B/XN)
      M2=M2*XN/(XN-1.0)
      G=M3/(M2**1.5)
      WRITE (6,20)
      WRITE(6,11) M1
      WRITE(6,12) M2
      WRITE(6,13) G
      IF (G.LT.0.0) GO TO 3
      W=(-G+((G**2)+4.0)**0.5)/2.0
      Z2=(1.0-W**(2./3.))/(W**(1./3.))
      AMO=M1-(M2**0.5)/Z2
      WRITE (6,21) AMO
      SY=(ALOG(Z2**2+1.0))**0.5
      SY2=SY**2
      MY=ALOG((M2**0.5)/Z2)-0.5*ALOG(Z2**2+1.0)
      WRITE(6,22)MY
      WRITE(6,23)SY2
      PARA1(1)=AMO
      PARA2(1)=MY
      PARA3(1)=SY
      GO TO 4
3     WRITE(6,14)
4     WRITE(6,27)
```

```
C
C
C
C-------------------------------------------------------------------
C
C     FORMAT STATEMENTS
C
C-------------------------------------------------------------------
 11   FORMAT (20X,9HMEAN OF X,16X,E12.5)
 12   FORMAT (20X,13HVARIANCE OF X,12X,E12.5)
 13   FORMAT (20X,9HSKEW OF X,16X,E12.5)
 14   FORMAT (/,3X,52H NO MOMENTS SOLUTION IS POSSIBLE BECAUSE OF -VE SK
     1EW,/)
 15   FORMAT (20X,15HSKEW OF LN(X-A),10X,E12.5)
 16   FORMAT(80A1)
 19   FORMAT(1H1,/,80A1,//,21X,38HTHREE PARAMETER LOGNORMAL DISTRIBUTION
     *,/)
 20   FORMAT(31X,17HMETHOD OF MOMENTS,/)
 21   FORMAT(20X,1HA,24X,E12.5,/)
 22   FORMAT (20X,15HMEAN OF LN(X-A),10X,E12.5)
 23   FORMAT(20X,19HVARIANCE OF LN(X-A),6X,E12.5,/)
 27   FORMAT (25X,28HMAXIMUM LIKELIHOOD PROCEDURE,/)
 33   FORMAT(/,3X,73HFOR GOOD USE OF THIS DISTRIBUTION SKEW OF LN(X-A) S
     *HOULD BE CLOSE TO ZERO,/)
      RETURN
      END
C
C
C===================================================================
C
C  THIS SUBROUTINE CALCULATES THE PARAMETERS FOR 3 PARA LOGNORMAL
C
C  DISTRIBUTION BY THE METHODS OF MAXIMUM LIKELIHOOD.
C
C  PARA1(2),PARA2(2) AND PARA3(2) ARE THE THREE PARAMETERS
C
C                       BY MLEM3 METHOD.
C
C===================================================================
C
      SUBROUTINE MLEM3
      REAL MY
      COMMON/PARA/X(100),N
      COMMON/PARAK/AMO,SY,MY
      COMMON/CH/ERROR,PP,QQ,R
      COMMON/SING/PARA1(3),PARA2(3),PARA3(3)
      COMMON/NAME/Q(20)
      CHARACTER *5 Q
      SUM=0.0
      SUM1=0.0
      SUM2=0.0
      SUM3=0.0
      DO 10 I=1,N
      IF (X(I).LE.AMO)RETURN
 10   SUM=SUM+ALOG(X(I)-AMO)
      PP=SUM/FLOAT(N)
      WRITE(6,22)PP
      DO 20 I=1,N
```

```
 20    SUM1=SUM1+((ALOG(X(I)-AMO))-PP)**2
       QQ=SUM1/FLOAT(N)
       R=SQRT(QQ)
       PARA1(2)=AMO
       PARA2(2)=PP
       PARA3(2)=R
       WRITE(6,23)QQ
       WRITE(6,24)R
 24    FORMAT(20X,16HSIGMA OF LN(X-A),9X,E12.5)
       DO 30 I=1,N
       SUM2=SUM2+(1.0/(X(I)-AMO))
 30    SUM3=SUM3+(1.0/(X(I)-AMO))*(ALOG(X(I)-AMO))
       ERROR=SUM2*(PP-QQ)-SUM3
       WRITE(6,11)ERROR
 11    FORMAT(20X,'ERROR IN ITERATION    ',5X,E12.5)
 22    FORMAT (20X,15HMEAN OF LN(X-A),10X,E12.5)
 23    FORMAT(20X,19HVARIANCE OF LN(X-A),6X,E12.5)
       RETURN
       END
C
C
C*****************************************************************************
C
C
C   THIS SUBROUTINE CALCULATES THE PARAMETERS FOR 3 PARA LOGNORMAL
C
C   DISTRIBUTION BY THE METHOD OF MAXIMUM ENTROPY.
C
C   PARA1(3),PARA2(3) AND PARA3(3) ARE THE THREE PARAMETERS
C
C                        BY POME3  METHOD.
C
C
C*****************************************************************************
C
       SUBROUTINE POME3
       COMMON/PARA/X(100),N
       COMMON/PARAK/AMO,SY,MY
       COMMON/PPOM/AP,SIGMAY,YBAR
       ICOUNT=0
       A=AMO
       XN=N
       IF( A .GE. X(1)) A=(X(1)-1.0)
 14    SUM=0.0
       SUM1=0.0
       SUM2=0.0
       DO 10 I=1,N
       P=ALOG(X(I)-A)
       SUM=SUM+P
       SUM1=SUM1+P**2
 10    SUM2=SUM2+P**4
       YBAR=SUM/XN
       VARY=(SUM1/XN)-(YBAR**2)
       SP=(SUM1/XN)**2
       SIGMAY=SQRT(VARY)
       C=SUM2/XN
       SAD=VARY+(2.0*YBAR**2)
       FIND=C-SP-2.0*VARY*SAD
```

```
      IF(ICOUNT .EQ. 25) GO TO 15
      IF(ABS(FIND) .LE. .01)GO TO 12
      GO TO 13
 16   FORMAT(1X,'NO CONVERGENCE POSSIBLE')
 12   AP=A
C
      WRITE(6,27)
      WRITE(6,28)AP
      WRITE(6,22)YBAR
      WRITE(6,23)VARY
      WRITE(6,24)SIGMAY
      WRITE(6,18)FIND
 28   FORMAT(20X,1HA,24X,E12.5,/)
 24   FORMAT(20X,16HSIGMA OF LN(X-A),9X,E12.5)
 18   FORMAT(20X,'ERROR IN ITERATION OF POME=',F10.5,//)
 22   FORMAT (20X,15HMEAN OF LN(X-A),10X,E12.5)
 23   FORMAT(20X,19HVARIANCE OF LN(X-A),6X,E12.5)
 27   FORMAT (25X,28HMETHOD OF MAXIMUM ENTROPY    ,/)
C
C
      GO TO 17
 13   IF (FIND .LE. 0.09) GO TO 39
      A=A-50.0
      GO TO 40
 39   AP=A
      CALL FINER
      RETURN
 40   ICOUNT=ICOUNT+1
      GO TO 14
 15   WRITE(6,16)
 17   RETURN
      END
C
C-----------------------------------------------------------------
C
C   THIS SUBROUTINE IS USED TO DECIDE THE VALUE OF PARAMETER BY
C
C   POME3 METHOD IN A SMALLER INTERVAL ONCE THE CRUDE RANGE IS
C
C                    FOUND BY POME3 METHOD.
C
C-----------------------------------------------------------------
C
      SUBROUTINE FINER
      COMMON/PARA/X(100),N
      COMMON/PPOM/AP,SIGMAY,YBAR
      COMMON/SING/PARA1(3),PARA2(3),PARA3(3)
      A=AP
      IF( A .GE. X(1)) A=X(1)-.5
      XN=N
      DO 10 J=1,50
      SUM=0.0
      SUM1=0.0
      SUM2=0.0
      DO 20 I=1,N
      P=ALOG(X(I)-A)
      SUM=SUM+P
      SUM1=SUM1+P**2
```

```
 20     SUM2=SUM2+P**4
        YBAR=SUM/XN
        VARY=(SUM1/XN)-(YBAR**2)
        SP=(SUM1/XN)**2
        SIGMAY=SQRT(VARY)
        C=SUM2/XN
        SAD=VARY+(2.0*YBAR**2)
        FIND=C-SP-2.0*VARY*SAD
        IF(ABS(FIND) .LE. .05)GO TO 12
 10     A=A-0.5
 12     AP=A
        WRITE(6,27)
        WRITE(6,28)AP
        WRITE(6,22)YBAR
        WRITE(6,23)VARY
        WRITE(6,24)SIGMAY
        WRITE(6,18)FIND
 18     FORMAT(20X,'ERROR IN ITERATION OF POME=',F10.5,//)
 22     FORMAT (20X,15HMEAN OF LN(X-A),10X,E12.5)
 23     FORMAT(20X,19HVARIANCE OF LN(X-A),6X,E12.5)
 24     FORMAT(20X,16HSIGMA OF LN(X-A),9X,E12.5)
 27     FORMAT (25X,28HMETHOD OF MAXIMUM ENTROPY    ,/)
 28     FORMAT(20X,1HA,24X,E12.5,/)
        PARA1(3)=AP
        PARA2(3)=YBAR
        PARA3(3)=SIGMAY
        RETURN
        END
C
C-------------------------------------------------------------------
C
C THIS SUBROUTINE CALCULATES THE STANDARD NORMAL DEVIATE  FOR LNO3
C
C FOR A GIVEN PROBABILITY LEVEL USEFUL FOR CHI SQUARE TEST
C
C-------------------------------------------------------------------
C
        SUBROUTINE FLOOD
        REAL MY
        COMMON/PARA/X(100),N
        COMMON/PARAK/AMO,SY,MY
        COMMON/CH/ERROR,PP,QQ,R
        COMMON/THEO/Y(3,100)
        COMMON/STAN/T(100)
        COMMON/PPOM/AP,SIGMAY,YBAR
        DO 10 J=1,N
        P=(FLOAT(J)-0.375)/(FLOAT(N)+0.25)
        IF (P.GT.0.5) GO TO 30
         GO TO 20
 20     W=(ALOG(1.0/P**2))**0.5
        T(J)=W-(2.515517+.802853*W+.010328*W**2)/
       1(1.0+1.432788*W+.189269*W**2+.001308*W**3)
        Y(1,J)=AMO+EXP(MY-T(J)*SY)
        Y(2,J)=AMO+EXP(PP-T(J)*R)
        Y(3,J)=AP+EXP(YBAR-T(J)*SIGMAY)
        GO TO 10
 30     P=P-1.0
        W=(ALOG(1.0/P**2))**0.5
```

```
      T(J)=W-(2.515517+.802853*W+.010328*W**2)/
     1(1.0+1.432788*W+.189269*W**2+.001308*W**3)
      Y(1,J)=AMO+EXP(MY+T(J)*SY)
      Y(2,J)=AMO+EXP(PP+T(J)*R)
      Y(3,J)=AP+EXP(YBAR+T(J)*SIGMAY)
   10 CONTINUE
      RETURN
      END
C
C
C-----------------------------------------------------------------------
C
C     CALCULATES THE THEORETICAL PROBABILITY FOR LNO3
C
C                        DISTRIBUTION.
C
C-----------------------------------------------------------------------
C
      SUBROUTINE PROB
      REAL MY
      COMMON/PARA/X(100),N
      COMMON/PARAK/AMO,SY,MY
      COMMON/CH/ERROR,PP,QQ,R
      COMMON/PROBA/P(100),SK(3)
      COMMON/PPOM/AP,SIGMAY,YBAR
      DIMENSION U(100),Z(100),G(100),XP(3,100)
      DO 20 K=1,N
      IF ((X(K)-AMO).LE.0.0)RETURN
      XP(1,K)=(ALOG(X(K)-AMO)-MY)/SY
      XP(2,K)=(ALOG(X(K)-AMO)-PP)/R
 20   XP(3,K)=(ALOG(X(K)-AP)-YBAR)/SIGMAY
      H=0.0
      DO 22 I=1,3
      DO 10 J=1,N
      IF (XP(I,J).LE.0.0)GO TO 30
      GO TO 40
 30   XP(I,J)=ABS(XP(I,J))
      T=1.0/(1.0+.33267*XP(I,J))
      U(J)=(2.490895+1.466003*XP(I,J)**2-.024393*
     *XP(I,J)**4+.178257*XP(I,J)**6)
      Z(J)=1.0/U(J)
      P(J)=1.0-Z(J)*(.43618*T-.12016*T**2+.93729*T**3)
      P(J)=1.0-P(J)
      GO TO 10
 40   T=1.0/(1.0+.33267*XP(I,J))
      U(J)=(2.490895+1.466003*XP(I,J)**2-.024393*
     *XP(I,J)**4+.178257*XP(I,J)**6)
      Z(J)=1.0/U(J)
      P(J)=1.0-Z(J)*(.4361836*T-.1201676*T**2+.9372980*T**3)
 10   CONTINUE
      DO 50 L=1,N
      F=(FLOAT(L)-0.375)/(FLOAT(N)+0.25)
      G(L)=ABS(F-P(L))
      IF(G(L).GE.H) H=G(L)
 50   CONTINUE
      SK(I)=H
 22   CONTINUE
      WRITE(6,65)
```

```
 65    FORMAT(/10X,'MOM',12X,'MLEM',12X,'POME')
       WRITE (6,66)SK(1),SK(2),SK(3)
 66    FORMAT(1X,'KS1 =',F8.4,5X,'KS2 =',F8.4,5X,'KS3 =',F8.4)
       RETURN
       END
C-----------------------------------------------------------------------
C  THIS PROGRAM CALCULATES THE CLASS INTERVALS FOR LNO3
C
C        DISTRIBUTION TO BE USED FOR CHI SQUARE TEST.
C
C-----------------------------------------------------------------------
C
       SUBROUTINE CHI
       REAL M1,M2
       COMMON/PARA/X(100),N
       COMMON/STAT/M1,M2,Z2
       COMMON/THEO/Y(3,100)
       COMMON/VARI/O(3,7)
       DIMENSION T(10),CI(10),F(50),XL(20)
       PQ=ALOG(1.0+Z2**2)
       XPM=M2
       SD=SQRT(XPM)
       K=1
       T(1)=-1.08
       T(2)=-.585
       T(3)=-.2
       T(4)=.19
       T(5)=.565
       T(6)=1.07
       DO 10 IJ=1,6
       XKK=EXP(PQ**0.5*T(IJ)-(PQ/2.0))-1.0
 10    XL(IJ)=XKK/Z2
       DO 15 I=1,3
       IXP=0
       JJ=1
       DO 14 J=1,6
       CI(J)=M1+XL(J)*SD
       F(K)=CI(J)
       DO 20 L=JJ,N
       IF (Y(I,L).LE.CI(J)) GO TO 20
       O(I,J)=L-1-IXP
       IXP=L-1
       GO TO 13
 20    CONTINUE
 13    JJ=L-1
       K=K+1
 14    CONTINUE
       O(I,7)=N-L+1
 15    CONTINUE
       RETURN
       END
C
C
C=======================================================================
C THIS SUBROUTINE CALCULATES THE CHI SQUARE STATISTIC
C
C              FOR LNO3 DISTRIBUTION.
C
```

```
C==========================================================================
C
      SUBROUTINE SQUARE
      COMMON/PARA/X(100),N
      COMMON/VARI/O(3,7)
      COMMON/RESU/SUM1(3)
      E=FLOAT(N)/7.0
      DO 20 I=1,3
      SUM=0.0
      DO 10 J=1,7
      DEV=(O(I,J)-E)**2
   10 SUM=SUM+DEV
   20 SUM1(I)=SUM/E
      WRITE (6,32)
   32 FORMAT(/12X,'MOM',12X,'MLEM',12X,'POME',/)
      WRITE(6,33)SUM1(1),SUM1(2),SUM1(3)
   33 FORMAT(1X,'CHI1=',F10.2,5X,'CHI2 =',F10.2,5X,'CHI3 =',F10.2)
      RETURN
      END
C
C==========================================================================
C THIS SUBROUTINE CALCULATES THE ROOT MEAN SQUARE ERROR
C
C                  FOR LNO3 DISTRIBUTION.
C
C==========================================================================
C
      SUBROUTINE ROERR
      COMMON/PARA/X(100),N
      COMMON/THEO/Y(3,100)
      COMMON/RMSE/ERR(5),BIAS(5)
      COMMON/NAME/Q(20)
      CHARACTER *5 Q
      DO 20 I=1,3
      SUM1=0.0
      SUM2=0.0
      DO 10 J=1,N
      SUM=((Y(I,J)-X(J))/X(J))**2
      SUM2=SUM2+ABS((Y(I,J)-X(J))/X(J))
   10 SUM1=SUM1+SUM
      ERR(I)=SUM1*100.0/FLOAT(N)
      BIAS(I)=SUM2*100.0/FLOAT(N)
   20 WRITE(6,14)Q(I),ERR(I),BIAS(I)
   14 FORMAT (1X,A5,5X,'MSE =',F8.4,5X,'BIAS =',F8.4)
      RETURN
      END
C
      SUBROUTINE COMP(NUM)
      COMMON/SING/PARA1(3),PARA2(3),PARA3(3)
      COMMON/NAME/Q(10)
      DIMENSION T(10),XOBS(10),XCALC(10)
      CHARACTER *5 Q
      T(1)= 0.0
      T(2)= 0.8416
      T(3)= 1.282
      T(4)= 2.054
      T(5)= 2.326
      T(6)= 2.575
```

```
      T(7)= 2.880
      DO 20 J=1,3
      DO 10 I=1,7
   10 XCALC(I)=PARA1(J)+EXP( PARA2(J)+T(I)*PARA3(J))
  20  CONTINUE
      RETURN
      END
C
C
C
C-----------------------------------------------------------------------
C                               (GAMMAU)
C
C THIS SUBROUTINE IS THE MAIN ROUTINE FOR GAMMA DISTRIBUTION.
C
C     THIS ROUTINE CALLS ALL THE APPROPRIATE ROUTINES FOR THE
C
C       PARAMETER CALCULATION AND TEST STATISTICS.
C
C-----------------------------------------------------------------------
C
       SUBROUTINE GAMMAU
       COMMON/PARA/X(100),N
       COMMON/NAME/Q(20)
       COMMON/SELE/IFLAG(8),IFLAG1(8,7)
       COMMON/ICOUNT/NJ
        CHARACTER *5 Q
      IF (IFLAG1(4,1) .EQ. 1) CALL MOM4
      IF (IFLAG1(4,2) .EQ. 1) CALL MLEM4
C
      N=NJ
      RETURN
      END
C=======================================================================
C
C   THIS SUBROUTINE IS USED TO ESTIMATE THE PARAMETERS OF GAMMA
C
C   DISTRIBUTION BY METHOD OF MOMENTS GIVEN BY ARRAY VARIABLES GA(1)
C
C                             AND GB(1).
C=======================================================================
C
      SUBROUTINE MOM4
      COMMON/PARA/X(100),N
      COMMON/NAME/Q(20)
      COMMON/SELE/IFLAG(8),IFLAG1(8,7)
      COMMON/PARG/GA(10),GB(10)
      COMMON/MIST/QAVG,QLNAVG
       COMMON/ICOUNT/NJ
      CHARACTER *5 Q
       NJ=N
C
       SUM1=0.0
       SUM2=0.0
       SUM3=0.0
       DO 15 I=1,N
       SUM1=SUM1+X(I)
       SUM2=SUM2+X(I)*X(I)
```

```
      SUM3=SUM3+ALOG(X(I))
   15 CONTINUE
      QAVG=SUM1/FLOAT(N)
      QVAR=(SUM2/N-QAVG*QAVG)*(N/(N-1.0))
      QLNAVG=SUM3/FLOAT(N)
C
C     PARAMETER ESTIMATES BY M.O.M NOW.
C
      GB(1)=QVAR/QAVG
      GA(1)=QAVG/GB(1)
      WRITE(6,20)GA(1),GB(1)
   20 FORMAT(////,10X,'PARAMETER ESTIMATES : ',/,10X,19('-'),
     1 //,10X,'METHOD OF MOMENTS : N = ',F11.4,/
     1 ,30X,'K = ',F11.4)
      RETURN
      END
C
C=====================================================================
C
C   THIS SUBROUTINE IS USED TO ESTIMATE THE PARAMETERS OF GAMMA
C
C   DISTRIBUTION BY MLEM . THE PARA. ARE GIVEN BY ARRAY VARIABLES GA(2)
C
C                          AND GB(2).
C
C        IT ALSO CALLS APPROPRIATE ROUTINE FOR LEAST SQ .
C
C=====================================================================
C
      SUBROUTINE MLEM4
       EXTERNAL FUNC
      COMMON/PARA/X(100),N
      COMMON/NAME/Q(20)
      COMMON/SELE/IFLAG(8),IFLAG1(8,7)
       COMMON /ZSQ/QQ,CP
      COMMON/MIST/QAVG,QLNAVG
       COMMON/PARG/GA(10),GB(10)
       COMMON/ICOUNT/NJ
       COMMON/KSTST/XKS(3)
       COMMON/ROOT/XMSE(3),BIAS(3)
       COMMON/XCHI/CS
       DIMENSION NF(20),RF(20),PR1(90),PR2(90),PR1N(20),PR2N(20)
       DIMENSION CP(90),P(90),QQ(90),PR3(90)
       REAL MSE1,MSE2,MSE3 ,XTAB(3)
       REAL PARM(4),Y(2),F(60),XJAC(90,2),XJTJ(5),WORK(500)
       REAL EPS,DELTA,SGN,SSQ
       INTEGER IER
      CHARACTER *5 Q
C
C     PARAMETER ESTIMATES BY M.L.E. NOW.
C
      IF(GA(1).GT.2.0)GO TO 140
      XO=0.3
      GO TO 141
  140 XO=GA(1)-2.
  141 B=GA(1)+2.
      WRITE(6,*)QAVG,QLNAVG
      CALL ESTMLE(QAVG,QLNAVG,XO,B,GA(2),GB(2))
```

```
      WRITE(6,53)GA(2),GB(2)
   53 FORMAT(/,10X,'MAXIMUM LIKELIHOOD : N = ',F11.4,/
     1 ,31X,'K = ',F11.4,///)
C
C     CALCULATION OF PLOTTING POSITIONS NOW.....
C
      XNN=N+1.0
      P(1)=1.0/XNN
      DO 67 IK=1,N
      XM=IK
      CP(IK)=XM/XNN
   67 CONTINUE
      IA=1
      IK=1
      IKK=2
  112 IF(X(IKK).EQ.X(IK))GO TO 111
      P(IA+1)=CP(IKK)-CP(IK)
      QQ(IA)=X(IK)
      GO TO 113
  111 IKK=IKK+1
      GO TO 112
  113 IF(IKK.EQ.N)GO TO 114
      IA=IA+1
      IK=IKK
      IKK=IKK+1
      GO TO 112
  114 QQ(IA+1)=X(N)
      IA1=IA+1
      SIG=0.0
      DO 998 I=1,IA1
      SIG=SIG+P(I)
  998 CP(I)=SIG
C-----------------------------------------------
      M=IA1
      N=2
      IXJAC=90
      NSIG=5
      EPS=0.00001
      DELTA=0.0
      MAXFN=500
      IOPT=1
      Y(1)=1.2
      Y(2)=200.0
C
      CALL ZXSSQ(FUNC,M,N,NSIG,EPS,DELTA,MAXFN,IOPT,PARM,Y,SSQ,F,
     1 XJAC,IXJAC,XJTJ,WORK,INFER,IER)
C
      WRITE(6,888)Y(1),Y(2)
  888 FORMAT(/,10X,'LEAST  SQUARES (FROM IMSL) : N = ',F11.4,/
     1 ,40X,'K = ',F11.4,/)
      WRITE(6,889)SSQ
  889 FORMAT(/,5X,'RESIDUAL LEAST SQ. SUM = ',F11.6,//)
C-----------------------------------------------
C
C     PARAMETER ESTIMATES BY LEAST SQUARES' NOW.
C
C
      XN=GA(2)*6.0/10.0
```

```
      STEPN=GA(2)/40
      XK=GB(2)*3.0/10.0
      STEPK=GB(2)/10.0
      CALL ESTLSQ(QQ,P,IA1,XN,XK,STEPN,STEPK,XNC,XKC)
      WRITE(6,170)XNC,XKC
  170 FORMAT(/,10X,'LEAST  SQUARES    : N = ',F11.4,/
     1 ,31X,'K = ',F11.4,///)
      GA(3)=XNC
      GB(3)=XKC
C
C
C     CALCULATION OF CHI SQUARE STATISTIC NOW..
C
      K=IA1/5
      IDF=2
      WRITE(6,222)
  222 FORMAT(//,5X,'CHI SQUARE (M.O.M) : ',/,5X,20('-'),/)
      CALL CHI4(QQ,IA1,K,IDF,GA(1),GB(1))
      XTAB(1)=CS
      WRITE(6,223)
  223 FORMAT(/,5X,'CHI SQUARE (M.L.E) : ',/,5X,20('-'),/)
      CALL CHI4(QQ,IA1,K,IDF,GA(2),GB(2))
      XTAB(2)=CS
      WRITE(6,224)
  224 FORMAT(/,5X,'CHI SQUARE (LE.SQ.) : ',/,5X,20('-'),/)
      CALL CHI4(QQ,IA1,K,IDF,GA(3),GB(3))
      XTAB(3)=CS
C
C
C     CALCULATIONS OF ESTIMATED PROBABILITIES AT PLOTTING POSITIONS
C     NOW
C
C
      H0=0.0
      H1=0.0
      H2=0.0
      H3=0.0
      SUM=0.0
      SUM1=0.0
      SUM2=0.0
      SUM3=0.0
      SE1=0.0
      SE2=0.0
      SE3=0.0
      PSI1=0.0
      PSI2=0.0
      PSI3=0.0
      PROB1=0.0
      PROB2=0.0
      PROB3=0.0
C
C
      IAA=IA+1
      DO 31 I=1,IAA
      H0=H0-P(I)*ALOG(P(I))
      SUM=SUM+P(I)
      X1=QQ(I)/GB(1)
      CALL MDGAM(X1,GA(1),PROB,IER)
```

```
      PR1(I)=PROB-PROB1
      IF(PR1(I).EQ.0.0)PR1(I)=1.0E-12
      D1=ABS(PROB-SUM)
      SE1=D1*D1+SE1
      DIFF1=100.0*(PR1(I)-P(I))/P(I)
      PROB1=PROB
      H1=H1-PR1(I)*ALOG(PR1(I))
      SUM1=SUM1+PR1(I)
      PSI1=PSI1+P(I)*(ALOG(P(I)/PR1(I)))*N
C
      X2=QQ(I)/GB(2)
      CALL MDGAM(X2,GA(2),PROB,IER)
      PR2(I)=PROB-PROB2
      IF(PR2(I).EQ.0.0)PR2(I)=1.0E-12
      D2=ABS(PROB-SUM)
      SE2=D2*D2+SE2
      DIFF2=100.0*(PR2(I)-P(I))/P(I)
      PROB2=PROB
      H2=H2-PR2(I)*ALOG(PR2(I))
      SUM2=SUM2+PR2(I)
      PSI2=PSI2+P(I)*(ALOG(P(I)/PR2(I)))*N
C
C
      XNC=Y(1)
      XKC=Y(2)
C
      X3=QQ(I)/GB(3)
      CALL MDGAM(X3,GA(3),PROB,IER)
      PR3(I)=PROB-PROB3
C*****************************************************************
C     GIVES THE KS STATISTIC ALSO
C ****************************************************************
      IF(PR3(I).EQ.0.0)PR3(I)=1.0E-12
      D3=ABS(PROB-SUM)
      SE3=D3*D3+SE3
      DIFF3=100.0*(PR3(I)-P(I))/P(I)
      PROB3=PROB
      H3=H3-PR3(I)*ALOG(PR3(I))
      SUM3=SUM3+PR3(I)
      PSI3=PSI3+P(I)*(ALOG(P(I)/PR3(I)))*N
   31 CONTINUE
      EXSUM=1.-SUM
      EXSUM1=1.-SUM1
      EXSUM2=1.-SUM2
      EXSUM3=1.-SUM3
      WRITE(6,171)SE1,SE2,SE3
  171 FORMAT(//,10X,'SQ. ERROR (M.O.M.) = ',F15.6,/,
     1 10X,'SQ. ERROR (M.L.E.) = ',F15.6,/,
     1 10X,'SQ. ERROR (LE.SQ.) = ',F15.6,///)
C
C
      IF(EXSUM1.EQ.0.0)GO TO 147
      H1=H1-(EXSUM1)*ALOG(EXSUM1)
      PSI1=PSI1+EXSUM*(ALOG(EXSUM/EXSUM1))*N
  147 IF(EXSUM2.EQ.0.0)GO TO 148
      H2=H2-(EXSUM2)*ALOG(EXSUM2)
      PSI2=PSI2+EXSUM*(ALOG(EXSUM/EXSUM2))*N
  148 IF(EXSUM3.EQ.0.0)GO TO 149
```

```
      H3=H3-(EXSUM3)*ALOG(EXSUM3)
      PSI3=PSI3+EXSUM*(ALOG(EXSUM/EXSUM3))*N
  149 IF(EXSUM.EQ.0.0)GO TO 150
      HO=HO-(EXSUM)*ALOG(EXSUM)
C
  150 WRITE(6,76)PSI1,PSI2,PSI3
   76 FORMAT(//,10X,'PSI (M.O.M.) = ',F15.6,/,
     1 10X,'PSI (M.L.E.) = ',F15.6,/,
     1 10X,'PSI (LE.SQ.) = ',F15.6,///)
C
      WRITE(6,71)H1,H2,H3,HO
   71 FORMAT(//,10X,'ENTROPY (M.O.M.)    = ',F15.6,/,
     1 10X,'ENTROPY (M.L.E.)    = ',F15.6,/,
     1 10X,'ENTROPY (LE.SQ.)    = ',F15.6,//,
     1 10X,'ENTROPY (OBSERVED) = ',F15.6,///)
C
       CALL DEEP(JK)
       CALL KOL
C
C*****************************************************************************
      RETURN
      END
C
C
C     SUBROUTINE FOR FINDING THE PARAMETERS OF GAMMA DISTRIBUTION
C     BY M.L.E. METHOD
C     METHOD USED : REGULA FALSI
C
      SUBROUTINE ESTMLE(QAVG,QLNAVG,XO,B,XN,XK)
      INTEGER IER
      REAL XO,B,X1,MMPSI
      C=QLNAVG-ALOG(QAVG)
      ICOUNT=1
      ZI=MMPSI(XO,IER)
      FXO=ZI-ALOG(XO)-C
      ZI=MMPSI(B,IER)
      FB=ZI-ALOG(B)-C
      X1=(XO*FB-B*FXO)/(FB-FXO)
      ZI=MMPSI(X1,IER)
      FX1=ZI-ALOG(X1)-C
      PROD=FX1*FB
      IF(PROD.LE.0.0)GO TO 10
      B=XO
      FB=FXO
   10 X2=(X1*FB-B*FX1)/(FB-FX1)
      ZI=MMPSI(X2,IER)
      FX2=ZI-ALOG(X2)-C
      IF(ABS(FX2).LE.1.0E-07.OR.ICOUNT.EQ.197)GO TO 20
      X1=X2
      FX1=FX2
      ICOUNT=ICOUNT+1
      GO TO 10
   20 XN=X2
      XK=QAVG/XN
      RETURN
      END
C
C
```

```
C       SUBROUTINE FOR FINDING THE PARAMETERS OF GAMMA DISTRIBUTION
C       BY LEAST SQUARES' METHOD
C
        SUBROUTINE ESTLSQ(QQ,P,IA1,XN,XK,STEPN,STEPK,XNC,XKC)
        INTEGER IER
        REAL MIN
        DIMENSION QQ(100),P(100),E(25),PK(20)
        XKK=XK
        DO 50 II=1,15
        PK(II)=XK
        XK=XK+STEPK
   50   CONTINUE
        XK=XKK
        SUM=0.0
        SQD=0.0
        MIN=10000.0
        DO 10 K=1,40
        DO 20 J=1,15
        DO 30 I=1,IA1
        SUM=SUM+P(I)
        UX=QQ(I)/XK
        CALL MDGAM(UX,XN,PROB,IER)
        SS=ABS(SUM-PROB)
        SQD=(SS)**2.0+SQD
   30   CONTINUE
        E(J)=SQD
        IF(E(J).GT.MIN)GO TO 35
        MIN=E(J)
        XNC=XN
        XKC=XK
   35   XK=XK+STEPK
        SUM=0.0
        SQD=0.0
   20   CONTINUE
        XK=XKK
        XN=XN+STEPN
        SUM=0.0
        SQD=0.0
   10   CONTINUE
        RETURN
        END
C
C
        SUBROUTINE CHI4(QQ,IA1,K,IDF,XN,XK)
        DIMENSION QQ(80),OBS(80),CELLS(25),COMP(25)
        COMMON XN1,XK1
        COMMON/XCHI/CS
        EXTERNAL CDF
        XN1=XN
        XK1=XK
        DO 10 I=1,IA1
   10   OBS(I)=QQ(I)
        N=IA1
        CALL GFIT(CDF,K,OBS,N,CELLS,COMP,CS,IDF,Q,IER)
        WRITE(6,30)CS,Q
   30   FORMAT(//,5X,'CHI SQUARE = ',F10.5,10X,'PROB = ',
      1 F10.5,//)
        RETURN
```

```
      END
C
C
      SUBROUTINE CDF(UX,P)
      COMMON XN,XK
      INTEGER IER
      UX=UX/XK
      CALL MDGAM(UX,XN,P,IER)
      RETURN
      END
C
C
      SUBROUTINE FUNC(Y,M,N,F)
      DIMENSION QQ(90),CP(90),Y(2),F(60)
      COMMON /ZSQ/QQ,CP
      DO 5 I=1,M
      XX=QQ(I)/Y(2)
      CALL MDGAM(XX,Y(1),PROB,IER)
    5 F(I)=CP(I)-PROB
      RETURN
      END
C
       SUBROUTINE DEEP(NUM)
       INTEGER M,IOPT,IER
       REAL Y,F(500),B(500),C(1503),P,PS(7),PSP(7)
      COMMON/PARG/GA(10),GB(10)
      COMMON/PARA/X(100),N
      COMMON/ICOUNT/NJ
      COMMON/ROOT/XMSE(3),BIAS(3)
      PS(1)=.5
      PS(2)=.8
      PS(3)=.9
      PS(4)=.98
      PS(5)=.99
      PS(6)=.995
      PS(7)=.998
      DO 1 IP=1,3
      M=500
      MM1=M-1
      B(1)=0.0
      B(2)=X(NJ)+1000.0
      H = (B(2)-B(1))/MM1
      F(1)=0.0
      RI =0.0
      DO 5 I =2,M
      RI = RI+H
      S=GA(IP)
      D = 1.0/(GB(IP)*GAMMA(S))
      E = (RI/GB(IP))**(S-1)
      AP=-RI/GB(IP)
      F(I) = D * E *(EXP(AP))
    5 CONTINUE
      IOPT =3
      SUM=0.0
      SUM1=0.0
      DO 16 J =1,NJ
      P = (FLOAT(J)-0.44)/(FLOAT(NJ)+0.12)
      CALL MDGCI (P,F,M,IOPT,B,C,Y,IER)
```

```
      GO=(X(J)-Y)/X(J)
      SUM=SUM+GO ** 2
      SUM1=SUM1+ABS(GO)
 16   CONTINUE
      XMSE(IP)=SUM*100.0/FLOAT(NJ)
      BIAS(IP) = SUM1*100.0/FLOAT(NJ)
      WRITE(6,33)XMSE(IP),BIAS(IP)
 33   FORMAT(1X,'MSE BIAS',2X,F10.4,2X,F10.4)
C
C
      DO 88 J =1,7
      P = PS(J)
      CALL MDGCI (P,F,M,IOPT,B,C,Y,IER)
      PSP(J)=Y
 88   CONTINUE
  1   CONTINUE
      RETURN
      END
C
C
C
      SUBROUTINE KOL
      COMMON/KSTST/XKS(3)
      COMMON/PARG/GA(10),GB(10)
      COMMON/PARA/X(100),N
      COMMON/ICOUNT/NJ
      DO 2 I =1,3
      H=0.0
      DO 1 J =1,NJ
      P = (FLOAT(J)-0.44)/(FLOAT(NJ)+0.12)
      X1=X(J)/GB(I)
      CALL MDGAM (X1,GA(I),PROB,IER)
      P1=ABS(P-PROB)
      IF(P1 .GE. H) H=P1
  1   CONTINUE
      XKS(I)=H
      WRITE(6,3)H
  3   FORMAT(1X,'KS STAT=',F10.5)
  2   CONTINUE
      RETURN
      END
C
C=====================================================================
C
C                          (PEAR3)
C
C THIS SUBROUTINE IS THE MAIN ROUTINE FOR PEARSON TYPE 3 DIST.
C
C     THIS ROUTINE CALLS ALL THE APPROPRIATE ROUTINES FOR THE
C
C       PARAMETER CALCULATION AND TEST STATISTICS.
C
C=====================================================================
C
C
      SUBROUTINE PEAR3
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
```

```
      COMMON/STAN/T(100)
      COMMON/DATA/XT(100,3)
      COMMON/RMSE/ERR(3),BIAS(3)
      COMMON/INVAL/ID(10,10),F(50)
      COMMON/FOR/GAMMA
      COMMON/ESTI/XALPHA(3),XBETA(3),XGAMMA(3)
      COMMON/CHIS/R(3)
      COMMON/SELE/IFLAG(8),IFLAG1(8,7)
      WRITE(6,3)
    3 FORMAT (25X,23H,'PT III DISTRIBUTION',/)
      CALL FLOOD5
      IF (IFLAG1(5,1) .EQ. 1) CALL MOM5
      IF (IFLAG1(5,2) .EQ. 1) CALL MLEM5
      CALL THEOR5
      CALL COMPA5(J)
      CALL ROERR5
      CALL INTER5
      CALL CHI5
      WRITE(6,6)
    6 FORMAT(/1X,' M S E   FOR                 MOM            MLE         POME')
      WRITE(6,7)(ERR(MV),MV=1,3)
    7 FORMAT(18X,3(4X,F8.2))
      WRITE(6,8)
    8 FORMAT(/1X,'BIAS    FOR                  MOM            MLE         POME')
      WRITE(6,7)(BIAS(NV),NV=1,3)
      WRITE(6,10)
   10 FORMAT(/3X,'CHI(MM)      CHI(MLE)      CHI(POME)')
      WRITE(6,11)(R(I),I=1,3)
   11 FORMAT(1X,F8.3,5X,F8.3,5X,F8.3//)
C
      RETURN
      END
C THIS SUBROUTINE CALCULATES THE STANDARD NORMAL DEVIATE
C
C FOR A GIVEN PROBABILITY LEVEL USEFUL FOR CHI SQUARE TEST
C-----------------------------------------------------------------
C-----------------------------------------------------------------
C
      SUBROUTINE FLOOD5
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/STAN/T(100)
      DO 10 J=1,N
      P=(FLOAT(J)-0.44)/(FLOAT(N)+0.12)
      IF (P.GT.0.5) GO TO 30
       GO TO 20
   20 W=(ALOG(1.0/P**2))**0.5
      T(J)=W-(2.515517+.802853*W+.010328*W**2)/
     1(1.0+1.432788*W+.189269*W**2+.001308*W**3)
      T(J)=-T(J)
      GO TO 10
   30 P=P-1.0
      W=(ALOG(1.0/P**2))**0.5
      T(J)=W-(2.515517+.802853*W+.010328*W**2)/
     1(1.0+1.432788*W+.189269*W**2+.001308*W**3)
   10 CONTINUE
      RETURN
      END
```

```
------------------------------------------------------------------------
C
C
C
C-------------------------------------------------------------------
C                            SUBROUTINE (MOM5)
C
C      CALCULATES THE MOM ESTIMATE FOR PT 3 DISTRIBUTION    .
C
C
C
C-------------------------------------------------------------------
C
      SUBROUTINE MOM5
      COMMON/PARA/X(100),N
      COMMON/ESTI/XALPHA(3),XBETA(3),XGAMMA(3)
      COMMON/FOR/GAMMA
      REAL M1,M2,M3,K
      XN=N
      A=0.0
      B=0.0
      C=0.0
      DO 1 I=1,N
      A=A+X(I)
      B=B+X(I)**2
      C=C+X(I)**3
 1    CONTINUE
      M1=A/XN
      M2=(B/XN)-(A/XN)**2
      STAN=SQRT(M2)
      M3=(C/XN)+2.0*M1**3-3.0*M1*(B/XN)
      SKEW=M3/(M2**1.5)
      C1=(SQRT(XN*(XN-1.0)))/(XN-2.0)
      C2=1.0+8.5/XN
      C3=XN/(XN-1.0)
      SKEW=SKEW*C1*C2
      M2=M2*C3
      BETA=(2.0/SKEW)**2
      ALPHA=(M2**0.5)/(BETA**0.5)
      GAMMA=M1-(M2**0.5)*(BETA**0.5)
      XALPHA(1)=ALPHA
      XBETA(1) =BETA
      XGAMMA(1)=GAMMA
      WRITE (6,13)
      WRITE (6,22) ALPHA,M1
      WRITE (6,23) BETA,M2
      WRITE (6,24) GAMMA,SKEW
      WRITE (6,17)
C==================================================================
C
C      CALCULATION FOR METHOD OF MAXIMUM LIKELIHOOD
C
C                  FOR PEAR3 DISTRIBUTION.
C
C==================================================================
C
      SUBROUTINE MLEM5
      COMMON/PARA/X(100),N
      COMMON/ESTI/XALPHA(3),XBETA(3),XGAMMA(3)
```

```
      COMMON/FOR/GAMMA
      REAL M1,M2,M3,K
C
C
      ICOUNT=0
      XN =N
 32   SUM=0.0
      ICOUNT=ICOUNT+1
      SUM2=0.0
      DO 3 I=1,N
      IF (X(I).LE.GAMMA) GAMMA=X(I)-0.5
      SUM=SUM+(1.0/(X(I)-GAMMA))
 3    SUM2=SUM2+ALOG(X(I)-GAMMA)
      DEL=XN**2/(A-XN*GAMMA)
      DEL1=1.0-DEL*(1.0/SUM)
      Z=1.0/DEL1
      Y=M1-GAMMA-XN/SUM
      D=Z+2.0
      PSI=ALOG(D)-(1.0/(2.0*D))-(1.0/(12.0*D**2))+(1.0/(120.0*D
     1**4))-(1.0/(252.0*D**6))-(1.0/(Z+1.0))-(1.0/Z)
      P=SUM2-XN*PSI-XN*ALOG(Y)
      IF (ABS(P).LE.0.05)GO TO 35
      IF (ICOUNT.GE.100)GO TO 35
      GAMMA=GAMMA-1.0
      GO TO 32
 35   WRITE(6,22)Y,M1
      WRITE(6,23)Z,M2
      WRITE(6,24)GAMMA,SKEW
      WRITE(6,500)P
 500  FORMAT(1X,'ERROR IN MLE PARA. ESTIMATION = ',F7.4,/)
      XALPHA(2)=Y
      XBETA(2)=Z
      XGAMMA(2)=GAMMA
      IF ((ICOUNT .GE.100).AND.(ABS(P).GE.0.5))WRITE(6,37)
 13   FORMAT (31X,17HMETHOD OF MOMENTS,//)
 17   FORMAT (25X,28HMAXIMUM LIKELIHOOD PROCEDURE,//)
 20   FORMAT (//)
 22   FORMAT (9X,5HALPHA,5X,E12.5,14X,4HM1  ,6X,E12.5)
 23   FORMAT (9X,5HBETA ,5X,E12.5,14X,4HM2  ,6X,E12.5)
 24   FORMAT (9X,5HGAMMA,5X,E12.5,14X,4HSKEW,6X,E12.5,/)
 37   FORMAT(/4X,'NO CONVERGENCE POSSIBLE')
      RETURN
      END
C
C
C
C======================================================================
C
C            PROGRAM FOR FREQUENCY FACTOR FOR PT 3
C
C                          DISTRIBUTION
C
C======================================================================
      SUBROUTINE THEOR5
      COMMON/DATA/XT(100,3)
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/STAN/T(100)
```

```
      COMMON/ESTI/XALPHA(3),XBETA(3),XGAMMA(3)
      XALPHA(3)=XALPHA(2)
      XBETA(3)=XBETA(2)
      XGAMMA(3)=XGAMMA(2)
      DO 20 J=1,3
      IF (XBETA(J).EQ.0.0) GO TO 15
      DD=1.0/(9.0*XBETA(J))
      GO TO 16
 15   DD=0.0
 16   CONTINUE
      DO 10 I=1,N
      XT(I,J)=XALPHA(J)*XBETA(J)*(1.0-DD+
     1T(I)*SQRT(DD))**3+XGAMMA(J)
  10  CONTINUE
  20  CONTINUE
      RETURN
      END
C=====================================================================
C THIS SUBROUTINE CALCULATES THE ROOT MEAN SQUARE ERROR
C
C          FOR PEAR3 DISTRIBUTION.
C
C=====================================================================
C
      SUBROUTINE ROERR5
      COMMON/PARA/X(100),N
      COMMON/DATA/XT(100,3)
      COMMON/RMSE/ERR(3),BIAS(3)
      DO 20 J=1,3
      SUM1=0.0
      SUM2=0.0
      DO 10 I=1,N
      SUM=((XT(I,J)-X(I))/X(I))**2
      SUMP=(XT(I,J)-X(I))/X(I)
      SUM2=SUM2+ABS(SUMP)
  10  SUM1=SUM1+SUM
      BIAS(J)=SUM2*100.0/FLOAT(N)
      ERR(J)=SUM1*100.0/FLOAT(N)
  20  CONTINUE
      RETURN
      END
C
C
C=================================================================
C
C     THIS SUBROUTINE CALCULATES THE CHI SQUARE INTERVALS FOR
C
C     EQUAL PROBABILITY INTERVALS THEY ARE SEVEN IN NUMBER
C
C                         FOR PEAR3 DISTRIBUTION.
C
C=================================================================
C
      SUBROUTINE INTER5
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/DATA/XT(100,3)
      COMMON/INVAL/ID(10,10),F(50)
```

```
      DIMENSION TX(10),E(10),XK(10)
      K=1
      P=CS/6.0
      TX(1)= -1.08
      TX(2)=-.585
      TX(3)=-.2
      TX(4)=.2
      TX(5)=.585
      TX(6)=1.08
      DO 15 I=1,3
      IXP=0
      JJ=1
      DO 14 J=1,6
      XK(J)=TX(J)+(TX(J)**2-1.0)*P+(1.0/3.0)*(TX(J)**3-6.0*TX(J))
     1*P**2-(TX(J)**2-1.0)*P**3+TX(J)*P**4+(1.0/3.0)*P**5
      E(J)=XAVG+XK(J)*SIGMA
      F(K)=E(J)
      DO 12 L=JJ,N
      IF (XT(L,I).LE.E(J)) GO TO 12
      ID (I,J)=L-1-IXP
      IXP=L-1
      GO TO 13
   12 CONTINUE
   13 JJ=L-1
      K=K+1
   14 CONTINUE
      ID(I,7) = N-L+1
   15 CONTINUE
      RETURN
      END
C
C=======================================================================
C
C     SUBROUTINE TO CALCULATE THE CHI SQUARE STATISTIC
C
C              FOR PEAR3 DISTRIBUTION.
C
C=======================================================================
      SUBROUTINE CHI5
      COMMON/PARA/X(100),N
      COMMON/INVAL/ID(10,10),F(50)
      COMMON/CHIS/R(3)
      DO 50 K=1,3
      E=FLOAT(N)/7.0
      SUM=0.0
      DO 10 J=1,7
      DEV=(FLOAT(ID(K,J))-E)**2
 10   SUM = SUM+DEV
      SUM1=SUM/E
      R(K)=SUM1
 50   CONTINUE
      RETURN
      END
C
C   SUBROUTINE TO CALCULATE THE DISCHARGES FOR GIVEN RETURN PERIODS.
C
      SUBROUTINE COMPA5(NUM)
      DIMENSION TA(7),XTHEO(3,7),XOBS(7)
```

```
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/NAME/QN(3)
      COMMON/ESTI/XALPHA(3),XBETA(3),XGAMMA(3)
      TA(1)= 0.0
      TA(2)= 0.8416
      TA(3)= 1.282
      TA(4)= 2.054
      TA(5)= 2.326
      TA(6)= 2.575
      TA(7)= 2.880
      XALPHA(3)=XALPHA(2)
      XBETA(3)=XBETA(2)
      XGAMMA(3)=XGAMMA(2)
      DO 20 J=1,3
      IF (XBETA(J).EQ.0.0) GO TO 15
      DD=1.0/(9.0*XBETA(J))
      GO TO 16
 15   DD=0.0
 16   CONTINUE
      DO 10 I=1,7
      XTHEO(I,J)=XALPHA(J)*XBETA(J)*(1.0-DD+
     1TA(I)*SQRT(DD))**3+XGAMMA(J)
  10  CONTINUE
  20  CONTINUE
      RETURN
      END
C
C
C
C
C---------------------------------------------------------------------
C                              (LPEAR3)
C
C THIS SUBROUTINE IS THE MAIN ROUTINE FOR LOG PEARSON TYPE III.
C
C     THIS ROUTINE CALLS ALL THE APPROPRIATE ROUTINES FOR THE
C
C       PARAMETER CALCULATION AND TEST STATISTICS.
C
C
C
C
C
      SUBROUTINE LPEAR3
      REAL M1,M2,M3,K,L1,L2,L3
      DIMENSION XX(100)
      DOUBLE PRECISION AM,BM,CM
      COMMON/PARA/X(100),N
      COMMON/STAT1/L1,L2,L3
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/BVAL/B
      COMMON/MMPAR/ALPHA,BETA,GAMMA
      COMMON/ALL/BTAB(240),ALPTAB(240)
      COMMON/ESTI/XALPHA(5),XBETA(5),XGAMMA(5)
      COMMON/STAN/T(100)
      COMMON/THEO/XT(100,5)
      COMMON/RMSE/ERR(5),BIAS(5)
      COMMON/POME/G2
```

```
      COMMON/PPARA/PALPHA,PBETA,PGAMMA
      COMMON/CHIS/R(5)
      COMMON/SAMM/AM,BM,CM
      COMMON/NAME/Q(20)
      CHARACTER *5 Q
      READ (1,*) (BTAB(I),ALPTAB(I),I=1,240)
      XN=N
      C1=(SQRT(XN*(XN-1.0)))/(XN-2.0)
      C2=1.0+8.5/XN
      C3=XN/(XN-1.0)
      WRITE (6,19)
      WRITE (6,20)
      A=0.0
      B=0.0
      C=0.0
      DO 1 I=1,N
      A=A+X(I)
      B=B+X(I)**2
      C=C+X(I)**3
1     CONTINUE
      L1=A/XN
      L2=B/XN
      L3=C/XN
      M1=A/XN
      M2=(B/XN)-(A/XN)**2
      M3=(C/XN)+2.0*M1**3-3.0*M1*(B/XN)
      SKEW=M3/(M2**1.5)
      B=(ALOG(L3)-3.0*ALOG(L1))/(ALOG(L2)-2.0*ALOG(L1))
      CALL POLATE
      CALL MMDIR
      WRITE(6,34)L1,M1
      WRITE(6,35)L2,M2
      WRITE(6,36)L3,SKEW
      M1=GAMMA+ALPHA*BETA
      M2=BETA*ALPHA**2
      SS=ALPHA/ABS(ALPHA)
      SKEW=2.0*SS/SQRT(BETA)
      XALPHA(1)=ALPHA
      XBETA(1)=BETA
      XGAMMA(1)=GAMMA
      WRITE(6,23)ALPHA,M1
      WRITE(6,24)BETA,M2
      WRITE(6,25)GAMMA,SKEW
      IF (SKEW.LT.0.0) WRITE(6,33)
      DO 7 I=1,N
      XX(I)=X(I)
7     X(I)=ALOG(X(I))
      A=0.0
      B=0.0
      C=0.0
      DO 8 I=1,N
      A=A+X(I)
      B=B+X(I)**2
      C=C+X(I)**3
8     CONTINUE
      M1=A/XN
      M2=(B/XN)-(A/XN)**2
      M3=(C/XN)+2.0*M1**3-3.0*M1*(B/XN)
```

```
      SKEW=M3/(M2**1.5)
      SKEW=SKEW*C1*C2
      M2=M2*C3
      G2=M2
      BETA=(2.0/SKEW)**2
      ALPHA=(M2**0.5)/(BETA**0.5)
      GAMMA=M1-(M2**0.5)*(BETA**0.5)
      XALPHA(2)=ALPHA
      XBETA(2)=BETA
      XGAMMA(2)=GAMMA
      WRITE (6,22)
      WRITE (6,23) ALPHA,M1
      WRITE (6,24) BETA,M2
      WRITE (6,25) GAMMA,SKEW
      IF (SKEW.LT.0.0) WRITE(6,33)
      CALL ENTROP
      XALPHA(4)=PALPHA
      XBETA(4)=PBETA
      XGAMMA(4)=PGAMMA
      CALL MAXLIK
      XALPHA(3)=ALPHA
      XBETA(3)=BETA
      XGAMMA(3)=GAMMA
      DO 9 I=1,N
 9    X(I)=XX(I)
      CALL FLOOD6
      CALL THEOR6
      CALL COMPA6(L)
      CALL ROERR6
      WRITE(6,10)
 10   FORMAT(/14X,' MEAN SQUARE ERROR ( M S E)')
      WRITE(6,6)
 6    FORMAT(/15X,' MOM(D)       MOM(IN)          MLE          POME')
      WRITE(6,17)(ERR(MV),MV=1,4)
 17   FORMAT(10X,4(4X,F8.2))
      WRITE(6,11)
 11   FORMAT(/15X,'ABSOLUTE MEAN DEVIATIONS(BIAS)')
      WRITE(6,6)
      WRITE(6,17)(BIAS(NV),NV=1,4)
      CALL INTER6
      CALL CHI6
      WRITE(6,2)
 2    FORMAT(/18X,'CHI SQUARE STATISTIC')
      WRITE(6,3)
 3    FORMAT(/9X,'MOM(D)          MOM(IN)           MLE            POME')
      WRITE(6,44)(R(IP),IP=1,4)
 44   FORMAT(1X,4(4X,F10.3))
      CALL MIX
      RETURN
 19   FORMAT (24X,31HLOG-PEARSON TYPE 3 DISTRIBUTION,/)
 20   FORMAT (28X,26HMETHOD OF MOMENTS (DIRECT),/)
 21   FORMAT(/,3X,43HMETHOD NOT APPLICABLE BECAUSE OF B VALUE OF,9X,E12
     1.5,/)
 22   FORMAT (27X,28HMETHOD OF MOMENTS (INDIRECT),/)
 23   FORMAT (9X,5HALPHA,5X,E12.5,14X,5HM1(P),6X,E12.5)
 24   FORMAT (9X,5HBETA ,5X,E12.5,14X,6HM2(P) ,6X,E12.5)
 25   FORMAT (9X,5HGAMMA,5X,E12.5,14X,8HSKEW(P) ,4X,E12.5,/)
 32   FORMAT (/)
```

```
 33    FORMAT (/,3X,51HSKEW IS NEGATIVE - DISTRIBUTION HAS AN UPPER BOUND
      1),/)
 34    FORMAT (9X,5HL1    ,5X,E12.5,14X,4HM1   ,6X,E12.5)
 35    FORMAT (9X,5HL2    ,5X,E12.5,14X,4HM2   ,6X,E12.5)
 36    FORMAT (9X,5HL3    ,5X,E12.5,14X,4HSKEW,6X,E12.5/)
       END
C
C*****************************************************************
C      SUBROUTINE TO CALCULATE INTERPOLATE FOR DIRECT METHOD OF MOMENTS
C*****************************************************************
C
       SUBROUTINE POLATE
       COMMON/BVAL/B
       COMMON/EST/ALPEST
       COMMON/ALL/BTAB(240),ALPTAB(240)
       DO 10 I= 1,240
       IF((B .LT. 2.04079).OR. (B .GT.23.7204))GO TO 12
       IF((B.GE.BTAB(I)).AND. (B .LE. BTAB(I+1)))GO TO 50
 10    CONTINUE
 50    DELALP= (ALPTAB(I)-ALPTAB(I+1))/(BTAB(I)-BTAB(I+1))
      1*(B-BTAB(I+1))
       ALPEST= DELALP+ALPTAB(I+1)
       RETURN
 12    WRITE(6,3)
  3    FORMAT(1X,'NO DIRECT MOMENT SOLUTION POSSIBLE')
       RETURN
       END
C*****************************************************************
C
C      SUBROUTINE TO CALCULATE THE PARAMETERS BY METHOD OF MOMENTS
C
C*****************************************************************
       SUBROUTINE MMDIR
       REAL L1,L2,L3
       COMMON/EST/ALPEST
       COMMON/STAT1/L1,L2,L3
       COMMON/MMPAR/ALPHA,BETA,GAMMA
       ALPHA= ALOG(10.0)/ALPEST
       A1=ALOG(1.0-ALPHA)
       A2=ALOG(1.0-2.0*ALPHA)
       BETA=(ALOG(L2)-2.0*ALOG(L1))/(2.0*A1-A2)
       GAMMA=ALOG(L1)+BETA*A1
       RETURN
       END
C=================================================================
C
C      CALCULATION FOR METHOD OF MAXIMUM LIKELIHOOD
C
C                      LOG PEAR 3 DISTRIBUTION.
C
C=================================================================
       SUBROUTINE MAXLIK
       COMMON/PARA/X(100),N
       COMMON/MMPAR/ALPHA,BETA,GAMMA
       REAL M1,M2
       XN=N
       ICOUNT=0
       DO 10 I=1,N
```

```
-----------------------------------------------------------------------------------
 10    IF (X(I).LT.GAMMA) GAMMA=X(I)-0.1
 11    ICOUNT=ICOUNT+1
       A=0.0
       B=0.0
       C=0.0
       DO 12 I=1,N
       A=A+1.0/(X(I)-GAMMA)
       B=B+(X(I)-GAMMA)
       C=C+ALOG(X(I)-GAMMA)
 12    CONTINUE
       BETA=1.0/(1.0-(XN**2)/(B*A))
       IF(BETA .LE. -1.95)GO TO 13
       ALPHA=(B/XN)-(XN/A)
       D=BETA+2.0
       PSI=ALOG(D)-(1.0/(2.0*D))-(1.0/(12.0*D**2))+(1.0/(120.0*D
      1**4))-(1.0/(252.0*D**6))-(1.0/(BETA+1.0))-(1.0/BETA)
       FCN=-XN*PSI+C-XN*ALOG(ALPHA)
       IF (FCN .LT. 0.03) GO TO 13
       IF (ICOUNT.GT.25) GO TO 13
       GAMMA = GAMMA-0.1
       GO TO 11
 13    WRITE(6,17)ICOUNT
 17    FORMAT(/1X,'NO OF ITERATIONS =',I2)
       WRITE(6,18)FCN
 18    FORMAT(/1X,'ERROR OF CONVERGENCE =',F10.4)
       M1=GAMMA+ALPHA*BETA
       M2=BETA*ALPHA**2
       IF(BETA .LE. 0.0)BETA=-BETA
       SKEW=2.0/SQRT(BETA)
       WRITE(6,29)
       WRITE (6,23) ALPHA,M1
       WRITE (6,24) BETA,M2
       WRITE (6,25) GAMMA,SKEW
       IF(SKEW.LT.0.0) WRITE(6,33)
 23    FORMAT (9X,5HALPHA,5X,E12.5,14X,6HM1(P) ,6X,E12.5)
 24    FORMAT (9X,5HBETA ,5X,E12.5,14X,6HM2(P) ,6X,E12.5)
 25    FORMAT (9X,5HGAMMA,5X,E12.5,14X,8HSKEW(P) ,4X,E12.5,/)
 29    FORMAT (27X,28HMAXIMUM LIKELIHOOD PROCEDURE,/)
 33    FORMAT (/,3X,51HSKEW IS NEGATIVE - DISTRIBUTION HAS AN UPPER BOUND
      1),/)
       RETURN
       END
C=========================================================================
       SUBROUTINE ENTROP
       COMMON/PARA/X(100),N
       COMMON/MMPAR/ALPHA,BETA,GAMMA
       COMMON/PUME/G2
       COMMON/PPARA/PALPHA,PBETA,PGAMMA
       REAL M1,M2
       PALPHA=ALPHA
       PBETA=BETA
       PGAMMA=GAMMA
       XN=N
       ICOUNT=0
       DO 10 I=1,N
 10    IF (X(I).LT.PGAMMA) PGAMMA=X(I)-0.1
 11    ICOUNT=ICOUNT+1
       B=0.0
```

```
      C=0.0
      DO 12 I=1,N
      B=B+(X(I)-PGAMMA)
      C=C+ALOG(X(I)-PGAMMA)
 12   CONTINUE
      PALPHA=(XN*G2)/B
      PBETA=G2/(PALPHA**2)
      D=PBETA+2.0
      PSI=ALOG(D)-(1.0/(2.0*D))-(1.0/(12.0*D**2))+(1.0/(120.0*D
     1**4))-(1.0/(252.0*D**6))-(1.0/(PBETA+1.0))-(1.0/PBETA)
      FCN=-XN*PSI+C-XN*ALOG(PALPHA)
      IF (ABS(FCN).LT. 0.03) GO TO 13
      IF (ICOUNT.GT.30) GO TO 13
      PGAMMA = PGAMMA-0.1
      GO TO 11
 13   WRITE(6,17)ICOUNT
 17   FORMAT(/1X,'NO OF ITERATIONS =',I2)
      WRITE(6,18)FCN
 18   FORMAT(/1X,'ERROR OF CONVERGENCE =',F10.4)
      M1=PGAMMA+PALPHA*PBETA
      M2=PBETA*PALPHA**2
      SKEW=2.0/SQRT(PBETA)
      WRITE(6,29)
      WRITE (6,23)PALPHA,M1
      WRITE (6,24) PBETA,M2
      WRITE (6,25) PGAMMA,SKEW
      IF(SKEW.LT.0.0) WRITE(6,33)
 23   FORMAT (9X,5HALPHA,5X,E12.5,14X,6HM1(P) ,6X,E12.5)
 24   FORMAT (9X,5HBETA ,5X,E12.5,14X,6HM2(P) ,6X,E12.5)
 25   FORMAT (9X,5HGAMMA,5X,E12.5,14X,8HSKEW(P) ,4X,E12.5,/)
 29   FORMAT (27X,28HENTROPY PRINCIPLE  PROCEDURE,/)
 33   FORMAT (/,3X,51HSKEW IS NEGATIVE - DISTRIBUTION HAS AN UPPER BOUND
     1),/)
      RETURN
      END
C
C-----------------------------------------------------------------------
C THIS SUBROUTINE CALCULATES THE STANDARD NORMAL DEVIATE
C
C FOR A GIVEN PROBABILITY LEVEL USEFUL FOR CHI SQUARE TEST FOR LPT3
C-----------------------------------------------------------------------
C
      SUBROUTINE FLOOD6
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/STAN/T(100)
      DO 10 J=1,N
      P=(FLOAT(J)-0.44)/(FLOAT(N)+0.12)
      IF (P.GT.0.5) GO TO 30
       GO TO 20
 20   W=(ALOG(1.0/P**2))**0.5
      T(J)=W-(2.515517+.802853*W+.010328*W**2)/
     1(1.0+1.432788*W+.189269*W**2+.001308*W**3)
      T(J)=-T(J)
      GO TO 10
 30   P=P-1.0
      W=(ALOG(1.0/P**2))**0.5
      T(J)=W-(2.515517+.802853*W+.010328*W**2)/
```

```
     1(1.0+1.432788*W+.189269*W**2+.001308*W**3)
  10  CONTINUE
      RETURN
      END
C
C
C=====================================================================
C         USING THE CONDIE PAPER OF DECEMBER 1977 WRR
C=====================================================================
C
C            PROGRAM FOR THEORETICAL FLOOD VALUES FOR LPT 3
C
C                        DISTRIBUTION
C
C========================================================================
      SUBROUTINE THEOR6
      COMMON/THEO/XT(100,5)
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/STAN/T(100)
      COMMON/ESTI/XALPHA(5),XBETA(5),XGAMMA(5)
      A=2.0/3.0
      B=1.0/6.0
      C=1.0/3.0
      DO 20 J=1,4
      DD=1.0/(9.0*XBETA(J)**A)
      CD=XBETA(J)**C
      CE=3.0*XBETA(J)**B
      DO 10 I=1,N
C     XT(I,J)=XALPHA(J)*XBETA(J)*(1.0-DD+
C    1T(I)*SQRT(DD))**3+XGAMMA(J)
      XM=XGAMMA(J)+(XALPHA(J)*((T(I)/CE-DD+CD)**3.0))
      IF(XM.GT.170.0)XM=170.0
      XT(I,J)=EXP(XM)
  10  CONTINUE
  20  CONTINUE
      CALL SETQ
      RETURN
      END
C
C=========================================================================
C THIS SUBROUTINE SETS THE DIRECT MOMENT METHOD SERIES IN ORDER.
C=========================================================================
C
      SUBROUTINE SETQ
      DIMENSION G(100)
      COMMON/THEO/XT(100,5)
      COMMON/ARRAN/XTHEO(7,10)
      COMMON/DATA/X(100),N
      IF(XT(1,1) .LE. XT(2,1))RETURN
      DO 10 I=1,N
      G(I)= XT(I,1)
 10   CONTINUE
      DO 20 I=1,N
      XT(N-I+1,1)=G(I)
 20   CONTINUE
      RETURN
      END
```

```
C=====================================================================
C THIS SUBROUTINE CALCULATES THE ROOT MEAN SQUARE ERROR
C=====================================================================
C
      SUBROUTINE ROERR6
      COMMON/PARA/X(100),N
      COMMON/THEO/XT(100,5)
      COMMON/RMSE/ERR(5),BIAS(5)
      DO 20 J=1,4
      SUM1=0.0
      SUM2=0.0
      DO 10 I=1,N
      IF (XT(I,J) .GE. 10000000.0)XT(I,J)=10000000.0
      SUM=((XT(I,J)-X(I))/X(I))**2
      SUMP=(XT(I,J)-X(I))/X(I)
      SUM2=SUM2+ABS(SUMP)
   10 SUM1=SUM1+SUM
      BIAS(J)=SUM2*100.0/FLOAT(N)
      ERR(J)=SUM1*100.0/FLOAT(N)
   20 CONTINUE
      RETURN
      END
C
C=================================================================
C
C     THIS SUBROUTINE CALCULATES THE CHI SQUARE INTERVALS FOR
C
C     EQUAL PROBABILITY INTERVALS THEY ARE SEVEN IN NUMBER
C
C=================================================================
      SUBROUTINE INTER6
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/THEO/XT(100,5)
      COMMON/INVAL/ID(10,10),F(50)
      COMMON/ESTI/XALPHA(5),XBETA(5),XGAMMA(5)
      DIMENSION TX(10),E(10)
      K=1
      TX(1)= -1.08
      TX(2)=-.585
      TX(3)=-.2
      TX(4)=.2
      TX(5)=.585
      TX(6)=1.08
C
      A=2.0/3.0
      B=1.0/6.0
      C=1.0/3.0
C
      DO 15 I=1,4
      IXP=0
      JJ=1
      DD=1.0/(9.0*XBETA(I)**A)
      CD=XBETA(I)**C
      CE=3.0*XBETA(I)**B
      DO 14 J=1,6
      XM=XGAMMA(I)+(XALPHA(I)*((TX(J)/CE-DD+CD)**3.0))
      E(J)=EXP(XM)
```

```
      F(K)=E(J)
      DO 12 L=JJ,N
      IF (XT(L,I).LE.E(J)) GO TO 12
      ID (I,J)=L-1-IXP
      IXP=L-1
      GO TO 13
  12  CONTINUE
  13  JJ=L-1
      K=K+1
  14  CONTINUE
      ID(I,7) = N-L+1
  15  CONTINUE
      RETURN
      END
C
C=====================================================================
C
C     SUBROUTINE TO CALCULATE THE CHI SQUARE STATISTIC
C
C=====================================================================
      SUBROUTINE CHI6
      COMMON/PARA/X(100),N
      COMMON/INVAL/ID(10,10),F(50)
      COMMON/CHIS/R(5)
      DO 50 K=1,4
      E=FLOAT(N)/7.0
      SUM=0.0
      DO 10 J=1,7
      DEV=(FLOAT(ID(K,J))-E)**2
 10   SUM = SUM+DEV
      SUM1=SUM/E
      R(K)=SUM1
 50   CONTINUE
      RETURN
      END
C
C**********************************************************************
C
C     THIS PROGRAM IS USED FOR METHOD OF MIXED MOMENTS FOR LOG PEARSON
C     TYPE III DISTRIBUTION.
C
C**********************************************************************
C
      SUBROUTINE MIX
      COMMON/PARA/X(100),N
      COMMON/SAMM/AM,BM,CM
C
      DIMENSION XL(150),TITLE(19),QQ(50)
      DOUBLE PRECISION A,B,C,FB,FD,Z,GY,VA,BSAVE,AM,BM,CM
      NX=N
      CALL UBVSK(X,NX,XM,VAX,XSK)
      STDX=SQRT(VAX)
      WRITE (6,30)XM,STDX,XSK
      DO 16 I=1,NX
      X(I)=X(I)/XM
 16   XL(I)=ALOG(X(I))
      XMR=XM
      CALL UBVSK(X,NX,XM,VAK,XSK)
```

```
      CALL UBVSK(XL,NX,YB,VAL,XSKL)
      STDL=SQRT(VAL)
      WRITE(6,31) XM,VAK,XSK
      WRITE(6,32) YB,STDL,XSKL
      GY=ABS(XSKL)
      VA=VAK
      CC=ALOG(1.+VAK)
      CC1=-CC/2.
C ** CC1= LOG MEAN OF 2-PARAMETER LOGNORMAL
      IF(YB.LT.CC1) GY=-GY
      B=4./GY**2
      ITR=0
   20 Z=(1.+VAK)**(1./B)-1.
      IF (GY.GT.0.)A=1.+DSQRT(1.+1./Z)
      IF (GY.LT.0.)A=1.-DSQRT(1.+1./Z)
      C=B*DLOG(1.-1./A)
      CPMY=C+B/A
      FB=CPMY-YB
      ITR=ITR+1
      IF(DABS(FB).LE.0.00001) GO TO 40
      IF(ITR.EQ.100) GO TO 40
      FD=DLOG(1.-1./A)+1./A+DLOG(1.+VA)/(2.*Z*B*A**2)
      DB=-FB/FD
      BSAVE=B
      B=B+DB
      IF(B.LE.0.) B=BSAVE/2.
      GO TO 20
 30   FORMAT(/' *** LOG PEARSON TYPE 3 ANALYSIS BY MXM1 METHOD ***'
     1/' MEAN,STANDARD DEV. & SKEW OF REAL DATA:-'/2F12.1,F10.5)
 31   FORMAT(/' MEAN,VARIANCE & SKEW OF DIMENSIONLESS DATA:-'/3F10.5)
 32   FORMAT(/' MEAN, STD. DEV. & SKEW OF LOGARITHMIC DATA:-'/
     1'(NOTE: DIMENSIONLESS DATA ARE TRANSFORMED TO NATURAL LOGS)'/
     13F10.5)
 35   FORMAT(/' ESTIMATES OF PARAMETERS A,B, &C:-'/
     13F12.5,' (PARAMETER B OPTIMIZED IN ',I3,' ITERATIONS)'/
     1' ESTIMATES OF LOG MEAN, STANDARD DEV. & SKEW BY MXM1 METHOD:-'/
     13F12.5)
 40   STDL=B/A**2
      STDL=SQRT(STDL)
      SKL=2.*A/DABS(A)/B**0.5
      AM=A
      BM=B
      CM=C
      WRITE(6,35)A,B,C,ITR,CPMY,STDL,SKL
      IF (ABS(SKL).GT.5.5) GO TO 45
      CALL LPQNTL(CPMY,STDL,SKL,XMR)
      GO TO 50
 45   WRITE(6,46)
 46   FORMAT(' THE LOG SKEW EXCEEDS 5.5 WHICH IS OUT OF RANGE OF THIS
     1PROGRAM. USE MANUAL CALCULATIONS ')
 50   CONTINUE
      RETURN
      END
C************************************************************************
C     UBVSK: SUB-ROUTINE TO COMPUTE UNBIASED MEAN, VARIANCE, &
C     SKEWNESS COEFFICIENT
C************************************************************************
      SUBROUTINE UBVSK(V,N,VM,VAV,SKV)
```

```
      DIMENSION V(N)
      FN=FLOAT(N)
      C1=FN/(FN-1.)
      C2=FN**2/(FN-1.)/(FN-2.)
      C2=C2/C1**1.5
      X1=0.
      X2=0.
      X3=0.
      DO 10 I=1,N
      X1=X1+V(I)
      X2=X2+V(I)**2
 10   X3=X3+V(I)**3
      VM=X1/FN
      VAV=X2/FN-VM**2
      SKV=(X3/FN-3.*VM*VAV-VM**3)/VAV**1.5
      VAV=VAV*C1
      SKV=SKV*C2
      RETURN
      END
C*************************************************************************
C
C--LPQNTL - SUB-ROUTINE TO COMPUTE LOG PEARSON QUANTILES. PEARSON
C  FACTORS GIVEN IN WRC BULLETIN #17 (K-TABLES) ARE LINEARLY
C  INTERPOLATED
C*************************************************************************
C
      SUBROUTINE LPQNTL(XM,STD,SK,XMR)
      DIMENSION XK(15,111),CDF(15),RTPK(15),RTLF(15),K(15),Q(15),
     1XJ(111),X1(111),X2(111),X3(111),X4(111),X5(111),X6(111),
     1X7(111),X8(111),X9(111),X10(111),X11(111),X12(111),
     1X13(111),X14(111),X15(111)
      REAL K
      DATA CDF/.005,.01,.02,.04,.1,.2,.5,.8,.9,.96,.98,.99,.995,.998,
     1.999/
      DATA X1/-.36364,-.3704,-.3774,-.38462,-.3922,-.4,-.4082,-.4167,
     1-.4255,-.4348,-.44444,-.45455,-.46512,-.4762,-.4878,-.5,-.5128,
     2-.5263,-.5405,-.55556,-.5714,-.5882,-.606,-.625,-.6452,
     3-.6667,-.6896,-.7143,-.7407,-.7691,-.7997,-.8328,-.8686,-.9074,
     4-.9495,-.995,-1.0443,-1.0975,-1.1548,-1.2162,-1.2817,-1.3511,
     5-1.4244,-1.5011,-1.5811,-1.6639,-1.7492,-1.8366,-1.9258,-2.0164,
     6-2.10825,-2.2009,-2.2942,-2.388,-2.4819,-2.5758,
     70.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,
     80.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,25*0./
      DATA X2/-.36364,-.3704,-.3774,-.38462,-.3922,-.4,-.4082,-.4167,
     1-.4255,-.4348,-.44444,-.45455,-.46512,-.4762,-.4878,-.5,-.5128,
     2-.5263,-.5405,-.55556,-.5714,-.5882,-.6061,-.625,-.6451,
     1-0.6666,-0.6896,-.7145,-0.7405,-0.7688,-0.7992,-0.832,-0.8672,
     1-0.9052,-0.9461,-0.99,-1.037,-1.0871,-1.1404,-1.1968,-1.2561,
     2-1.3182,-1.3827,-1.4494,-1.5181,-1.5884,-1.66,-1.7327,-1.8062,
     3-1.8803,-1.9547,-2.0293,-2.1039,-2.1784,-2.2526,-2.3264,55*0./
      DATA X3/-.36364,-.3704,-.3774,-.38462,-.3922,-.4,-.4082,-.4167,
     1-.4255,-.4348,-.44444,-.45455,-.46512,-.4762,-.4878,-.5,-.5128,
     2-.5263,-.5405,-.55556,-.5714,-.5882,-.6061,-.625,-.6451,
     1-0.6665,-0.6894,-.7138,-0.7399,-0.7678,-0.79765,-0.8296,-0.8637,
     1-0.9001,-0.9388,-0.9798,-1.0231,-1.0686,-1.1163,-1.1658,-1.2172,
     1-1.27,-1.3241,-1.3793,-1.4353,-1.4919,-1.5489,-1.606,-1.6633,
     2-1.7203,-1.7772,-1.8336,-1.8896,-1.945,-1.9997,-2.0538,55*0./
      DATA X5/-.36364,-.3704,-.3774,-.38462,-.3922,-.4,-.4082,-.4167,
```

```
      1-.4255,-.4348,-.44443,-.45452,-.4651,-.4761,-.4877,-.4999,
      2-.5126,-.526,-.5401,-.5548,-.57035,-.5867,-.6038,-.62175,-.6406,
      1-0.6602,-0.6808,-.7021,-0.7242,-0.7471,-0.7706,-0.7947,
      1-0.8193,-0.8442,-0.8694,-0.8946,-0.9199,-0.945,-0.9698,-0.9942,
      2-1.0181,-1.0414,-1.0641,-1.0861,-1.1073,-1.1276,-1.1471,-1.1657,
      3-1.1835,-1.2003,-1.2162,-1.2311,-1.2452,-1.2582,-1.2704,-1.2816,
      455*0./
       DATA X6/-.3636,-.3704,-.37734,-.38458,-.39211,-.39993,-.40806,
      1-.4165,-.4253,-.4345,-.444,-.454,-.4643,-.475,-.4862,-.4978,
      2-.5099,-.5224,-.5353,-.5487,-.5624,-.5765,-.591,-.6057,-.6206,
      1-0.6357,-0.6509,-.666,-0.6811,-0.696,-0.7107,-0.725,-0.7388,
      1-0.7521,-0.7648,-0.7769,-0.7882,-0.7987,-0.8084,-0.8172,-0.8252,
      2-.8322,-.8384,-.8437,-.8481,-.8516,-.8543,-.8561,-.857,-.8572,
      3-.8565,-.8551,-.8529,-.8499,-.8461,-.8416,55*0./
       DATA X7/-.3546,-.3596,-.3645,-.3695,-.3743,-.379,-.3836,-.388,
      1-.3922,-.3962,-.3999,-.4032,-.4062,-.4088,-.411,-.4127,-.4138,
      2-.4144,-.4144,-.4138,-.4125,-.4106,-.4079,-.4045,-.4004,
      1-.3955,-.3899,-.3835,-.3764,-.3685,-.3599,-.3506,-.3406,
      1-.33,-.3187,-.3069,-.2944,-.2815,-.2681,-.2542,-.24,-.2254,
      2-.2104,-.1952,-.1797,-.164,-.1481,-.132,-.1158,-.0995,-.083,
      3-.0665,-.0499,-.0333,-.0166,0.,55*0./
       DATA X8/-.0103,.00243,.0156,.0293,.0434,.058,.073,.0885,.1044,
      1.1207,.1374,.1545,.1719,.1897,.2078,.2262,.2448,.2638,.2829,.3022,
      2.3217,.3413,.361,.3808,.4006,
      1.4204,.4402,.4598,.4793,.4987,.5179,.5368,.5555,.5738,
      1.5918,.6094,.6266,.6434,.6596,.6753,.6905,.7051,.7192,.7326,
      2.7454,.7575,.769,.7799,.79,.7995,.8083,.8164,.8238,.8304,.8364,
      3.8416,55*0./
       DATA X9/.6912,.712,.7328,.7536,.7746,.7955,.8164,.8373,.8582,
      1.879,.8996,.9202,.9406,.9609,.981,1.0008,1.0204,1.0397,1.0586,
      21.0773,1.0955,1.1134,1.1308,1.1477,1.1642,1.1801,1.1954,
      11.2101,1.2242,1.2377,1.2504,1.2624,1.2737,1.2841,1.2938,
      11.3026,1.3105,1.3176,1.3238,1.329,1.3333,1.3367,1.339,1.3405,
      21.3409,1.3404,1.3389,1.3364,1.3329,1.3285,1.3231,1.3167,1.3094,
      31.3011,1.2918,1.2816,55*0./
       DATA X10/2.0474,2.0637,2.0795,2.0949,2.1099,2.1243,2.1383,2.1517,
      12.1647,2.177,2.1887,2.1999,2.2104,2.2202,2.2294,2.2379,2.2456,
      22.2525,2.2587,2.2641,2.2686,2.2723,2.2751,2.2769,2.2779,2.2778,
      12.27676,2.2747,2.2716,2.2674,2.2622,2.2558,2.2483,2.2397,
      12.2299,2.2189,2.2067,2.1933,2.1787,2.1629,2.1459,2.1277,2.1082,
      22.0876,2.0657,2.0427,2.0185,1.9931,1.9666,1.939,1.9102,1.8804,
      31.8495,1.8176,1.7846,1.7507,1.7158,1.68,1.6433,1.6057,1.5674,
      41.5283,1.4885,1.4481,1.4072,1.3658,1.3241,1.2823,1.2403,1.1984,
      51.1568,1.1157,1.0751,1.0354,.9967,.9592,.923,.8881,.8549,.8232,
      6.7931,.7646,.7377,.7123,.6884,.6659,
      6.6447,.6247,.6059,.5881,.5714,.5555,.5405,.5263,.5128,.5,.4878,
      7.4762,.4651,.4546,.4444,.4348,.4255,.4167,.4082,.4,.3922,.3846,
      8.3774,.3704,.3636/
       DATA X11/3.2838,3.2884,3.2924,3.2957,3.2982,3.30007,3.3012,
      13.3015,3.301,3.2998,3.2977,3.2947,3.2909,3.2862,3.2806,3.274,
      23.2665,3.258,3.2485,3.238,3.2264,3.2138,3.2,3.1851,3.1691,
      33.1519,3.1336,3.114,3.0932,3.0712,3.0479,3.0233,2.9974,2.9703,
      42.9418,2.912,2.8809,2.8485,2.8147,2.7796,2.7433,2.7056,2.6666,
      52.6263,2.5848,2.5421,2.4981,2.453,2.4067,2.3593,2.3108,2.2613,
      62.2108,2.1594,2.107,2.0538,55*0./
       DATA X12/4.6402,4.6285,4.6159,4.6025,4.5882,4.573,4.5569,4.5399,
      14.5219,4.503,4.483,4.4621,4.4401,4.4171,4.393,4.3678,4.3415,4.314,
      24.2855,4.2557,4.2247,4.1926,4.1592,4.1245,4.0886,
```

```
     34.0514,4.0129,3.973,3.9318,3.8893,3.8454,3.8001,3.7535,3.7054,
     43.656,3.6052,3.553,3.4994,3.4444,3.388,3.3304,3.2713,3.211,
     53.1494,3.0866,3.0226,2.9574,2.891,2.8236,2.7551,2.6857,2.6154,
     62.5442,2.4723,2.3996,2.3264,55*0./
      DATA X13/6.08307,6.0517,6.0193,5.986,5.9517,5.9164,5.88,5.8427,
     15.8042,5.7646,5.724,5.6822,5.6393,5.5953,5.5501,5.5036,5.456,
     25.4071,5.357,5.3056,5.2529,5.1989,5.1436,5.087,5.029,
     34.9696,4.9088,4.8467,4.7831,4.7182,4.6518,4.5839,4.5147,4.444,
     44.3719,4.2983,4.2234,4.147,4.0693,3.9902,3.9097,3.828,3.745,
     53.6607,3.5753,3.4887,3.4011,3.3124,3.2228,3.1323,3.041,2.949,
     62.8564,2.7632,2.6697,2.5758,55*0./
      DATA X14/8.0869,8.0259,7.9639,7.9008,7.8366,7.7712,7.7048,
     17.6372,7.5684,7.4985,7.4273,7.355,7.2814,7.2065,7.1304,7.053,
     26.9744,6.8944,6.813,6.7303,6.6463,6.5608,6.474,6.3858,6.2961,
     16.20506,6.1125,6.0186,5.9232,5.8263,5.728,5.6282,5.5269,
     15.4243,5.3201,5.2146,5.1077,4.9994,4.8897,4.7788,4.6665,4.553,
     24.4384,4.3226,4.2058,4.088,3.9693,3.8498,3.7296,3.6087,3.4874,
     33.3657,3.2437,3.1217,2.9998,2.8782,2.7571,2.6367,2.5174,
     42.3994,2.2831,2.1688,2.057,1.9481,1.8424,1.7406,1.6431,1.5502,
     51.4623,1.3798,1.3023,1.2313,1.1653,1.1047,1.049,.998,.9513,.9085,
     6.8693,.8332,.7999,.7692,.7407,.7143,.6896,.6667,25*0./
      DATA X15/9.6577,9.5723,9.4859,9.3983,9.3095,9.2196,9.1285,9.0362,
     18.9427,8.848,8.752,8.6548,8.5563,8.4565,8.3553,8.2529,8.1491,
     28.044,7.9374,7.8295,7.7202,7.6095,7.4974,7.3838,7.2688,
     17.1524,7.0344,6.9151,6.7942,6.6719,6.5481,6.4229,6.2963,
     26.1682,6.0387,5.9078,5.7755,5.6419,5.507,5.3709,5.2335,5.0951,
     34.9555,4.8149,4.6734,4.5311,4.3881,4.2444,4.1002,3.9557,3.8109,
     43.6661,3.5214,3.377,3.2332,3.0902,2.9483,2.8079,2.6692,2.5326,
     52.3987,2.2678,2.1405,2.0174,1.8989,1.7857,1.6783,1.577,1.4822,
     61.3941,1.3128,1.2381,1.1697,1.1074,1.0507,.999,.9519,.9089,.8695,
     7.8333,.8,.7692,.7407,.7143,.6897,.6667,25*0./
      J=111
      DO 61 I=1,25
      X14(J)=-X1(I)
      X15(J)=-X1(I)
 61   J=J-1
      J=111
      DO 62 I=1,111
      X4(J)=-X10(I)
 62   J=J-1
      J=111
      DO 63 I=1,55
      X1(J)=-X13(I)
      X2(J)=-X12(I)
      X3(J)=-X11(I)
      X5(J)=-X9(I)
      X6(J)=-X8(I)
      X7(J)=-X7(I)
      X8(J)=-X6(I)
      X9(J)=-X5(I)
      X11(J)=-X3(I)
      X12(J)=-X2(I)
      X13(J)=-X1(I)
 63   J=J-1
      DO 1 J =1,111
      XK(1,J)=X1(J)
      XK(2,J)=X2(J)
      XK(3,J)=X3(J)
```

```
      XK(4,J)=X4(J)
      XK(5,J)=X5(J)
      XK(6,J)=X6(J)
      XK(7,J)=X7(J)
      XK(8,J)=X8(J)
      XK(9,J)=X9(J)
      XK(10,J)=X10(J)
      XK(11,J)=X11(J)
      XK(12,J)=X12(J)
      XK(13,J)=X13(J)
      XK(14,J)=X14(J)
      XK(15,J)=X15(J)
    1 CONTINUE
      DO 65 I=1,15
      RTLF(I)=1./CDF(I)
   65 RTPK(I)=1./(1.-CDF(I))
      RTPK(15)=1000.
      RTPK(14)=500.
      RTPK(13)=200.
      RTPK(12)=100.
      J=1
  301 W=J
      XJ(J)=5.6-W/10.0
      IF(XJ(J)-SK)303,303,302
  302 J=J+1
      GO TO 301
  303 DO 304 I=1,15
      VK =((SK-XJ(J))*(XK(I,J-1)-XK(I,J)))/(XJ(J-1)-XJ(J))+XK(I,J)
      K(I)=EXP(XM+VK*STD)
  304 CONTINUE
      DO 305 I=1,15
  305 Q(I)=K(I)*XMR
      WRITE(6,310)
  310 FORMAT(/' *** LOG PEARSON VARIATE ESTIMATES BY MXM1 METHOD ***'//
     19X,'CDF',2X,'T(FOR LOS)',2X,'T(FOR PKS)',5X,'VARIATE',//)
      DO 315 I=1,15
      WRITE(6,320) CDF(I),RTLF(I),RTPK(I),Q(I)
  315 CONTINUE
  320 FORMAT(3F12.3,F12.2)
      WRITE(6,325)
  325 FORMAT(' NOTE: T=RETURN PERIOD(YRS), LOS=MINIMUM VALUES LIKE LOW F
     1LOWS, PKS=MAXIMUM VALUES LIKE FLOOD FLOWS')
      RETURN
      END
C
C
C==================================================================
      SUBROUTINE COMPA6(NUM)
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/ESTI/XALPHA(5),XBETA(5),XGAMMA(5)
      COMMON/NAME/QN(4)
      COMMON/ARRAN/XTHEO(7,10)
      DIMENSION TA(7),XOBS(7)
      TA(1)= 0.0
      TA(2)= 0.8416
      TA(3)= 1.282
      TA(4)= 2.054
```

```
      TA(5)= 2.326
      TA(6)= 2.575
      TA(7)= 2.880
      A=2.0/3.0
      B=1.0/6.0
      C=1.0/3.0
      DO 20 J=1,4
      DD=1.0/(9.0*XBETA(J)**A)
      CD=XBETA(J)**C
      CE=3.0*XBETA(J)**B
      DO 10 I=1,7
      XM=XGAMMA(J)+(XALPHA(J)*((TA(I)/CE-DD+CD)**3.0))
      IF(XM.GT.170.0)XM=170.0
      XTHEO(I,J)=EXP(XM)
   10 CONTINUE
      CALL SETP
C ===========================================================
C
C
   20 CONTINUE
      RETURN
      END
C
C
      SUBROUTINE SETP
      DIMENSION G(100)
      COMMON/ARRAN/XTHEO(7,10)
      COMMON/PARA/X(100),N
      IF(XTHEO(1,1) .LE. XTHEO(2,1))RETURN
      DO 10 I=1,7
      G(I)= XTHEO(I,1)
   10 CONTINUE
      DO 20 I=1,7
      XTHEO(7-I+1,1)=G(I)
   20 CONTINUE
      RETURN
      END
C
C
C
C
C**************************************************************************
C
C THIS PROGRAM CALCULATES THE PARAMETERS OF BOUGHTON
C DISTRIBUTION . IT ALSO CALCULATES FOUR TEST STATISTICS.
C THEY ARE (CHI),(KS),(R M S E),AND (BIAS).
C
C**************************************************************************
C
      SUBROUTINE BOUTON
      DIMENSION UX(70),XK(70),XKGSUM(70),XKGSQ(70),DOG(70),XKSTAR(70)
      DIMENSION CAT(70),XLLLQT(70),XKG(70),S(70),RAT(70),HAT(70)
      REAL   KG
C     SETS THE DATA IN ASCENDING ORDER AND CALCULATES RETURN PERIOD
      REAL G(150)
      COMMON/RETURN/RETPER(150)
      COMMON/PARA/X(100),N
      COMMON/PARABO/A,C,XBAR,SSTAR
```

```
      COMMON/CHIS/SU
      COMMON/STAT/RMSE,BIAS
      COMMON/KOL/H
      WRITE(6,3)
    3 FORMAT (25X,25H,'BOUGHTON DISTRIBUTION',/)
      DO 100 I=1,N
  100 RETPER(I)= (N+0.2)/(FLOAT(I)-0.4)
      N1=N-1
      DO 10 K=1,N1
      DO 20 I=K,N1
      IF (X(K).GE.X(I+1)) GO TO 20
      TEMP=X(K)
      X(K)=X(I+1)
      X(I+1)=TEMP
   20 CONTINUE
   10 CONTINUE
      SUM = 0.0
      DO 120 I=1,N
      HAT(I)=(RETPER(I)/(RETPER(I)-1.0))
      G(I)=ALOG(ALOG(RETPER(I)/(RETPER(I)-1.0)))
      RAT(I)=(ALOG(RETPER(I)/(RETPER(I)-1.0)))
      UX(I) = ALOG10(X(I))
      SUM = SUM + UX(I)
  120 CONTINUE
      XM = SUM/FLOAT(N)
      SUM1 =0.0
      SUM2 = 0.0
      SUM3 = 0.0
      SUM4 = 0.0
      SUM5 = 0.0
      SUM6 = 0.0
      SUM7 = 0.0
      SUM8 = 0.0
      SUM9 = 0.0
      DO 121 I =1,N
      S(I) =(UX(I) - XM)**2
  121 SUM1 = SUM1 + S(I)
      SD =(SUM1/FLOAT(N-1))**0.5
      DO 122 I =1,N
      XK(I) =(UX(I) -  XM)/SD
      XKGSUM(I) = XK(I) + G(I)
      SUM3 = SUM3 + XKGSUM(I)
      XKGSQ(I) = XKGSUM(I)**2
      SUM4 = SUM4 + XKGSQ(I)
      XKG(I) = XK(I)*G(I)
      DOG(I) = XKG(I)*XKGSUM(I)
      SUM5 = SUM5 + DOG(I)
  122 SUM2 = SUM2 + XKG(I)
      KG = SUM2/FLOAT(N)
      XKG1 = SUM4/FLOAT(N)
      XKG2 = SUM5/FLOAT(N)
      XKG3 = SUM3/FLOAT(N)
      A =(XKG2 - XKG3*KG)/(XKG1 - XKG3**2)
      C = KG - XKG3*A + A**2
      WRITE (6,101) A,C
  101 FORMAT (/3X,'A = ',F8.5,2X,'C = ',F8.5,/)
      DO 125 I =1,N
      XKSTAR(I) = A + C/(G(I) - A)
```

```
      CAT(I) = XKSTAR(I)*UX(I)
      SUM6 = SUM6 + CAT(I)
      SUM7 = SUM7 + XKSTAR(I)
125   SUM8 = SUM8 + XKSTAR(I)**2
      SSTAR =(SUM6 - SUM7*SUM/FLOAT(N))/(SUM8 - SUM7**2/FLOAT(N))
      XBAR = XM -(SUM7/FLOAT(N))*SSTAR
      WRITE (6,102)XBAR,SSTAR
 102  FORMAT (3X,'XBAR= ',F8.5,2X,'SSTAR = ',F8.5)
      DO 126 I =1,N
 126  XLLLQT(I)= XBAR + XK(I)*STSAR
      CALL FLOOD7(J)
      CALL CLASS7
      CALL CHI7
      CALL TEST7
      CALL SMIR7
      WRITE(6,67)SU,H,RMSE,BIAS
 67   FORMAT(1X,'CHI= ',F8.4,4X,'K-S =',F8.4,4X,
     1'RMSE =',F8.4,4X,'BIAS=',F8.4)
C
C===============================================================
C
C=================================================================
C     WRITE STATEMENTS FOR GENERATING THE TWO TABLES.
C=================================================================
      RETURN
      END
C*****************************************************************
C
C     PROGRAM TO CALCULATE FLOOD VALUES FOR GIVEN RETURN PERIOD
C
C                         BY BOUGHTON METHOD
C
C*****************************************************************
      SUBROUTINE FLOOD7(NUM)
      COMMON/PARABO/A,C,XBAR,SSTAR
      COMMON/PARA/X(100),N
      DIMENSION T(10),G(10),Q(10),XOBS(10)
      REAL K(100)
      T(1)=2.0
      T(2)=5.0
      T(3)=10.0
      T(4)=50.0
      T(5)=100.0
      T(6)=200.0
      T(7)=500.0
      DO 10 I=1,7
      G(I)=ALOG(ALOG(T(I)/(T(I)-1.0)))
      K(I)=A+(C/(G(I)-A))
      Q(I)=10**(XBAR+K(I)*SSTAR)
  10  CONTINUE
      WRITE (6,14)
      WRITE (6,15) (Q(J),J=1,7)
 14   FORMAT (3X,7HT,YEARS,4X,1H2,11X,1H5,10X,2H10,10X,2H20,10X,
     12H50,9X,3H100,/)
 15   FORMAT (3X,1HQ,3X,6E12.5,/,4X,1HT)
C
      RETURN
      END
```

```
C
C****************************************************************************
C
C      PROGRAM TO CALCULATE CLASS INTERVALS FOR
C
C                BOUGHTON DISTRIBUTION
C
C****************************************************************************
      SUBROUTINE CLASS7
      COMMON/PARABO/A,C,XBAR,SSTAR
      COMMON/RETURN/RETPER(150)
      COMMON/VARI/O(1,7)
      COMMON/PARA/X(100),N
      DIMENSION T(10),G(10),Q(10),DAT(100),DUX(10)
      T(1)=1.16279
      T(2)=1.3888
      T(3)=1.72413
      T(4)=2.27272
      T(5)=3.33333
      T(6)=6.66667
      DO 10 I=1,6
      G(I)=ALOG(ALOG(T(I)/(T(I)-1.0)))
      DUX(I)=A+(C/(G(I)-A))
      Q(I)=10**(XBAR+DUX(I)*SSTAR)
   10 CONTINUE
      DO 90 I=1,N
      TEMP=DUX(I)
   90 DAT(N+1-I)=TEMP
      K=1
      DO 15 I=1,1
      IXP=0
      JJ=1
      DO 14 J=1,6
      DO 20 L=JJ,N
      IF (DAT(L).LE.Q(J)) GO TO 20
      O(I,J)=L-1-IXP
      IXP=L-1
      GO TO 13
   20 CONTINUE
   13 JJ=L-1
      K=K+1
   14 CONTINUE
      O(I,7)=N-L+1
   15 CONTINUE
      WRITE (6,24)
      WRITE (6,25) (Q(J),J=1,6)
   24 FORMAT (3X,14HCLASS INTERVAL,/)
   25 FORMAT (3X,1HQ,3X,6E12.5,/,4X,1HT)
      RETURN
      END
C
C
C=======================================================================
C
C THIS SUBROUTINE CALCULATES THE CHI SQUARE TEST
C STATISTIC FOR BOUGHTON DISTRIBUTION.
C
C=======================================================================
```

```
      SUBROUTINE CHI7
      COMMON/RETURN/RETPER(150)
      COMMON/VARI/O(1,7)
      COMMON/CHIS/SU
      E=FLOAT(N)/7.0
      SU=0.0
      DO 10 I=1,7
      RUM=(O(1,I)-E)**2/E
 10   SU=SU+RUM
      RETURN
      END
C
C==================================================================
C
C THIS SUBROUTINE CALCULATES THE RMSE
C AND BIAS FOR BOUGHTON DISTRIBUTION.
C
C==================================================================
C
      SUBROUTINE TEST7
      COMMON/RETURN/RETPER(150)
      COMMON/PARABO/A,C,XBAR,SSTAR
      COMMON/STAT/RMSE,BIAS
      COMMON/PARA/X(100),N
      DIMENSION G(100),Q(100),T(100)
      REAL K(100)
      SUM=0.0
      SUM1=0.0
      DO 10 I=1,N
      T(I)=RETPER(I)
      G(I)=ALOG(ALOG(T(I)/(T(I)-1.0)))
      K(I)=A+(C/(G(I)-A))
      Q(I)=10**(XBAR+K(I)*SSTAR)
      SUM=SUM+((X(I)-Q(I))/X(I))**2
      SUM1=SUM1+ABS(((X(I)-Q(I))/X(I)))
  10  CONTINUE
      RMSE=SUM*100.0/FLOAT(N)
      BIAS=SUM1*100.0/FLOAT(N)
      WRITE (6,15) (Q(J),J=1,N)
 15   FORMAT (3X,6(2X,F10.2))
      RETURN
      END
C
C
C==============================================================
C THIS SUBROUTINE CALCULATES THE (KS) TEST
C STATISTICS FOR BOUGHTON DISTRIBUTION.
C==============================================================
C
C
      SUBROUTINE SMIR7
      COMMON/RETURN/RETPER(150)
      COMMON/PARABO/A,C,XBAR,SSTAR
      COMMON/KOL/H
      COMMON/PARA/X(100),N
      REAL K(100),F(100),G(100),P(100)
      H=0.0
      DO 10 I=1,N
```

```
      K(I)=(ALOG10(X(I))-XBAR)/SSTAR
      D=K(I)-A
      G(I)=A+(C/D)
      Y=EXP(G(I))
      XUY=EXP(Y)
      P(I)=(XUY-1.0)/XUY
      PRO=(FLOAT(I)-0.4)/(FLOAT(N)+0.2)
      F(I)=ABS(PRO-P(I))
      IF (F(I).GE.H) H=F(I)
   10 CONTINUE
      RETURN
      END
C
C=======================================================================
C
C MASTER PROGRAM FOR GUMBEL DISTRIBUTION.
C
C=======================================================================
      SUBROUTINE GUMBEL
      DIMENSION ID(10,10)
      COMMON/PARA/X(100),N
      COMMON/RESUL/A(7),B(7)
      COMMON/TEST/C(7),CRIT
      COMMON/ENTR/ENT(7)
      COMMON/CLASS/F(42)
      COMMON/CHIS/R(7)
      COMMON/INTER/CIUP(6),CILO(6),T(6)
      COMMON/PEST/BIAS(7)
      COMMON/ERR/ERROR(7),ERRO(7)
      COMMON/NAME/Q(20)
      COMMON/SELE/IFLAG(8),IFLAG1(8,7)
      COMMON/STAT/XAVG,SIGMA,CS,TS
      CHARACTER *5 Q
      WRITE(6,3)
    3 FORMAT (/25X,23H,'GUMBEL DISTRIBUTION',/)
      CALL MOM8(1)
      CALL MLEM8(2)
      CALL MOPWM8(3)
      CALL POME8(4)
      CALL MOLS8(5)
      CALL MOMIX8(6)
      CALL MOIM8(7)
      CALL KSTES8
      CALL SURP8
      CALL CI8(ID)
      CALL CHI8(ID)
      CALL CONIN8
      CALL BIASA8
      CALL RMSE8
      WRITE(6,5)
    5 FORMAT(/15X,33HPARAMETERS OF GUMBEL DISTRIBUTION)
      WRITE(6,6)
    6 FORMAT(/2X,6HMETHOD,15X,11HA(SEC/M**3),13X,11HB(M**3/SEC))
      WRITE(6,7) (Q(I),A(I),B(I),I=1,7)
    7 FORMAT(/3X,A3,15X,E12.3,12X,E12.3)
      WRITE(6,8)CRIT
    8 FORMAT(/3X,46HCRITICAL VALUE FOR CHI SQUARE STATISTIC = 9.49,//
     1,3X,34HCRITICAL VALUE FOR K S STATISTIC =,F4.2)
```

```
      WRITE(6,9)
  9   FORMAT(/18X,2HKS,12X,3HENT,11X,3HCHI,10X,4HBIAS,8X,4HRMSE)
      WRITE(6,10) (Q(I),C(I),ENT(I),R(I),BIAS(I),ERROR(I),I=1,7)
 10   FORMAT(/3X,A3,8X,F7.3,8X,F7.4,8X,F7.3,7X,F6.3,6X,F6.4)
      WRITE(6,11)
 11   FORMAT(/1X,16HCLASS INTERVALS,/)
      WRITE(6,12)(F(L),L=1,42)
 12   FORMAT(1X,7(6F10.1,//))
C-----------------------------------------------------------------------
C
      WRITE(6,13)
 13   FORMAT(/3X,44HCONFIDENCE INTERVALS FOR GUMBEL DISTRIBUTION)
      WRITE(6,14)
 14   FORMAT(/3X,6HMETHOD,8X,13HRETURN PERIOD,10X,5HUPPER,
     114X,5HLOWER,/5X,2HMM,14X,5HYEARS,14X,5HVALUE,14X,5HVALUE)
      WRITE(6,15)(T(I),CIUP(I),CILO(I),I=1,6)
 15   FORMAT(/20X,F4.0,12X,F10.1,10X,F10.1)
C
C-----------------------------------------------------------------------
C
      RETURN
      END
C
C-----------------------------------------------------------------------
C
C     SUBROUTINE MOM8 CALCULATES THE PARAMETERS OF GUMBEL
C
C            DISTRIBUTION BY METHOD OF MOMENTS
C
C     N NUMBER OF ANNUAL MAXIMUM EVENTS
C     X SERIES OF EVENTS
C
C-----------------------------------------------------------------------
C
C
      SUBROUTINE MOM8(IS)
      COMMON/PARA/X(100),N
      COMMON/RESUL/A(7),B(7)
      REAL M1,M2,M3,K
      DIMENSION T(6)
      DIMENSION XT(6),SX(6)
      T(1)=2.
      T(2)=5.
      T(3)=10.
      T(4)=20.
      T(5)=50.
      T(6)=100.
      XN=N
      AP=0.0
      BP=0.0
      C=0.0
      DO 1 I=1,N
      AP=AP+X(I)
      BP=BP+X(I)**2
      C=C+X(I)**3
  1   CONTINUE
      M1=AP/XN
      M2=(BP/XN)-(AP/XN)**2
```

```
      M2=M2*XN/(XN-1.0)
      M3=(C/XN)+(2.0*M1**3)-((3.0*M1)*(BP/XN))
      SKEW=M3/(M2**1.5)
      A(IS)=1.2825/(SQRT(M2))
      B(IS)=M1-0.45*SQRT(M2)
      AP=0.0
      BP=0.0
      DO 2 I=1,N
      XI=I
      XN=N
      Y=-ALOG(-ALOG((XN+1.0-XI)/(XN+1.0)))
      AP=AP+Y
      BP=BP+Y**2
 2    CONTINUE
      YBAR=AP/XN
      YSTD=SQRT((BP/XN)-YBAR**2)
      DO 3 J=1,6
      YM=-ALOG(-ALOG((T(J)-1.0)/T(J)))
      K=(YM-YBAR)/YSTD
      XT(J)=M1+K*SQRT(M2)
      DELTA=1.0+1.139547093*K+1.100000027*K**2
      SX(J)=SQRT(M2*DELTA/XN)
 3    CONTINUE
      RETURN
      END
C
      SUBROUTINE MLEM8(IS)
C     COMPUTES  MAXIMUM LIKELIHOOD ESTIMATE FOR
C     T YEAR EVENTS AND STANDARD ERROR FOR TYPE 1 EXTREMAL DISTRIBUTION
C     INPUT
C     TITLE
C     N NUMBER OF ANNUAL MAXIMUM EVENTS
C     X SERIES OF EVENTS
      COMMON/PARA/X(100),N
      COMMON/RESUL/A(7),B(7)
      REAL M1,M2,M3,K
      DIMENSION T(6)
      DIMENSION XT(6),SX(6)
      T(1)=2.
      T(2)=5.
      T(3)=10.
      T(4)=20.
      T(5)=50.
      T(6)=100.
      XN=N
      AP=0.0
      BP=0.0
      C=0.0
      DO 1 I=1,N
      AP=AP+X(I)
      BP=BP+X(I)**2
      C=C+X(I)**3
 1    CONTINUE
      M1=AP/XN
      M2=(BP/XN)-(AP/XN)**2
      M2=M2*XN/(XN-1.0)
      M3=(C/XN)+(2.0*M1**3)-((3.0*M1)*(BP/XN))
      SKEW=M3/(M2**1.5)
```

```
      A(IS)=1.2825/(SQRT(M2))
      B(IS)=M1-0.45*SQRT(M2)
      AP=0.0
      BP=0.0
      DO 2 I=1,N
      XI=I
      XN=N
      Y=-ALOG(-ALOG((XN+1.0-XI)/(XN+1.0)))
      AP=AP+Y
      BP=BP+Y**2
 2    CONTINUE
      YBAR=AP/XN
      YSTD=SQRT((BP/XN)-YBAR**2)
      DO 3 J=1,6
      YM=-ALOG(-ALOG((T(J)-1.0)/T(J)))
      K=(YM-YBAR)/YSTD
      XT(J)=M1+K*SQRT(M2)
      DELTA=1.0+1.139547093*K+1.100000027*K**2
      SX(J)=SQRT(M2*DELTA/XN)
 3    CONTINUE
      ICOUNT=0
      AML=A(IS)
 4    ICOUNT=ICOUNT+1
      AP=1.0/(AML**2)
      BP=M1-1.0/AML
      C=0.0
      D=0.0
      E=0.0
      DO 5 I=1,N
      TEMP=EXP(-AML*X(I))
      C=C+TEMP
      D=D+TEMP*X(I)
      E=E+TEMP*X(I)**2
 5    CONTINUE
      FCN=D-BP*C
      FPN=BP*D-E-AP*C
      AS=AML-(FCN/FPN)
C     WRITE (6,19) ICOUNT,AS,FCN
      DELTA=ABS(0.0000001*AS)
      IF (ABS(AS-AML).LT.DELTA) GO TO 6
      IF (ICOUNT.GT.50) GO TO 6
      AML=AS
      GO TO 4
 6    CONTINUE
      A(IS)=AS
      B(IS)=(1.0/A(IS))*ALOG(XN/C)
      M2=1.2825/A(IS)
      M1=BETA+0.45*M2
      M2=M2**2
      DO 7 J=1,6
      YM=-ALOG(-ALOG(1.0-1.0/T(J)))
      XT(J)=BETA+YM/A(IS)
      SX(J)=SQRT((1.1086+0.5140*YM+0.6079*YM**2)/(XN*A(IS)**2))
 7    CONTINUE
      RETURN
      END
C
C
```

```
C*****************************************************************************
      SUBROUTINE MOPWM8(IS)
      COMMON/PARA/X(100),N
      COMMON/RESUL/A(7),B(7)
C*****************************************************************************
C
C     THIS PROGRAM CALCULATES THE PARAMETERS OF EV1 DISTRIBUTION
C
C     BY USING METHOD OF PROBABILITY WEIGHTED MOMENTS
C
C*****************************************************************************
C
C                   PARAMETERS ARE A AND B
C
C*****************************************************************************
C
C                   START OF MAIN PROGRAM
C
C*****************************************************************************
      REAL M0,M1
      SUM=0.0
      SUM1=0.0
      DO 10 I=1,N
   10 SUM=SUM+X(I)
      M0=SUM/FLOAT(N)
C*****************************************************************************
C
      M=N-1
      DO 20 I=1,M
      C=FLOAT(N-I)*X(I)
      SUM1=SUM1+C
   20 CONTINUE
C
C*****************************************************************************
      M1=SUM1/FLOAT(N*(N-1))
      A(IS)=ALOG(2.0)/(M0-2*M1)
      ALPHA=1/A(IS)
      B(IS)=M0-.5772*ALPHA
      RETURN
      END
C
C-----------------------------------------------------------------------------
      SUBROUTINE POME8(IS)
      COMMON/PARA/X(100),N
      COMMON/RESUL/A(7),B(7)
C-----------------------------------------------------------------------------
C
C     THIS PROGRAM CALCULATES THE PARAMETERS OF EV1 DISTRIBUTION
C
C     BY USING METHOD OF MAXIMUM ENTROPY PRINCIPLE
C
C
C*****************************************************************************
C
C                   PARAMETERS ARE A AND B
C
C*****************************************************************************
C
```

```
C                    START OF MAIN PROGRAM
C
C*************************************************************************
      DIMENSION Z(100),EZ(100)
      REAL NU
      PI=3.14159
C*************************************************************************
C
      SUM=0.0
      SUM1=0.0
      DO 10 I=1,N
   10 SUM=SUM+X(I)
      XBAR=SUM/FLOAT(N)
      DO 20 I=1,N
      STA=(X(I)-XBAR)**2
      SUM1=SUM1+STA
   20 CONTINUE
      VAR=SUM1/FLOAT(N-1)
      SD=SQRT(VAR)
      ALPHA=SD*SQRT(6.0)/(PI)
      U=XBAR-(.5772*ALPHA)
   21 SUM2=0.0
      SUM3=0.0
      DO 30 I=1,N
      Z(I)=(X(I)-U)/ALPHA
   30 SUM2=SUM2+Z(I)
      ZBAR=SUM2/FLOAT(N)
      DO 40 I=1,N
      EZ(I)=EXP(-Z(I))
      SUM3=SUM3+EZ(I)
   40 CONTINUE
      EZBAR=SUM3/FLOAT(N)
      BETA=ALOG(EZBAR)+ZBAR+.4228
      NU=ZBAR-.5772*BETA
      IF ((ABS(1.-BETA) .LE. 1.E-5) .AND. (ABS(NU) .LE. 1.E-5))GO TO 41
      ALPHA=ALPHA*BETA
      U=U+ALPHA*NU
      GO TO 21
   41 A(IS)=1./ALPHA
      B(IS)=U
      RETURN
      END
C
C-----------------------------------------------------------------------
C
C   SUBROUTINE LEAST CALCULATES THE PARAMETERS OF GUMBEL
C
C   DISTRIBUTION BY THE PRINCIPLE OF LEAST SQUARES
C
C-----------------------------------------------------------------------
C
C
      SUBROUTINE MOLS8(IS)
      COMMON/PARA/X(100),N
      COMMON/RESUL/A(7),B(7)
      SUM=0.0
      SUM1=0.0
      SUM2=0.0
```

```
      SUM3=0.0
      DO 100 I=1,N
      P= (FLOAT(I)-0.44)/(FLOAT(N)+0.12)
      Z=ALOG(-ALOG(P))
      Y=X(I)*Z
      SUM=SUM+Y
      SUM1=SUM1+Z
      SUM2=SUM2+X(I)
      SUM3=SUM3+X(I)**2
  100 CONTINUE
      A(IS)=((FLOAT(N)*SUM)-(SUM2*SUM1))/((SUM2**2)-(FLOAT(N)*SUM3))
      B(IS)=(SUM1+A(IS)*SUM2)/(A(IS)*FLOAT(N))
      RETURN
      END
C
C-----------------------------------------------------------------------
      SUBROUTINE MOMIX8(IS)
C
C-----------------------------------------------------------------------
C
C
C     THIS PROGRAM CALCULATES THE PARAMETERS OF EV1 DISTRIBUTION
C
C     BY USING METHOD OF MIXED MOMENTS
C
C
C***********************************************************************
C
C                       PARAMETERS ARE A AND B
C
C***********************************************************************
C
C                       START OF MAIN PROGRAM
C
C-----------------------------------------------------------------------
      COMMON/PARA/X(100),N
      COMMON/RESUL/A(7),B(7)
      REAL MO,M1
C-----------------------------------------------------------------------
C
C
C-----------------------------------------------------------------------
      SUM=0.0
      SUM1=0.0
      SUM2=0.0
      DO 10 I=1,N
   10 SUM=SUM+X(I)
      MO=SUM/FLOAT(N)
      DO 20 I=1,N
      C=(X(I)-MO)**2
      SUM1=SUM1+C
   20 CONTINUE
      VAR=SUM1/FLOAT(N-1)
      SX=SQRT(VAR)
C***********************************************************************
C
      DO 30 I=1,N
      D=X(I)**2
```

```
      SUM2=SUM2+D
   30 CONTINUE
C
C*********************************************************************
      M1=SUM2/FLOAT(N)
      A(IS)=1.2825498/SX
      B(IS)=ALOG(1.0+A(IS)*M0+A(IS)**2*M1/2.0)/A(IS)
      RETURN
      END
C
C---------------------------------------------------------------------
C
C        SUBROUTINE TO CALCULATE PARAMETERS OF GUMBEL
C
C        DISTRIBUTION BY METHOD OF INCOMPLETE MEANS
C
C---------------------------------------------------------------------
      SUBROUTINE MOIM8(IS)
      COMMON/PARA/X(100),N
      COMMON/RESUL/A(7),B(7)
      DIMENSION XM(100),NN(4)
      L=1
      XMEAN=0.
      DO 15 IDUM=1,3
      DO 16 M=L,N
      IF (X(M).LT.XMEAN) GO TO 16
      SUM1=0.
      L=M
      DO 12 K=M,N
   12 SUM1=SUM1+X(K)
      GO TO 17
   16 CONTINUE
   17 XMEAN=SUM1/FLOAT(N-L+1)
      XM(IDUM)=XMEAN
      IF(IDUM.EQ.1) GO TO 15
      NN(IDUM)=L-1
   15 CONTINUE
      XBAR1=XM(2)
      XBAR2=XM(3)
      N1=NN(2)
      N2=NN(3)
      V=ALOG(FLOAT(N)/FLOAT(N1))
      U=ALOG(FLOAT(N)/FLOAT(N2))
      Q=((V*ALOG(V)/24.)*(24.-12*V+4.*V**2-V**3))-(V/288.)*
     1(288.-72.*V+16.*V**2-3*V**3)
      P=((U*ALOG(U)/24.)*(24.-12*U+4.*U**2-U**3))-(U/288.)*
     1(288.-72.*U+16.*U**2-3*U**3)
      A(IS)=FLOAT(N)/(XBAR1-XBAR2)*(P/FLOAT(N-N2)-Q/FLOAT(N-N1))
      B(IS)=XBAR1+(FLOAT(N)*Q)/(A(IS)*(FLOAT(N-N1)))
      RETURN
      END
C
C
C
C*********************************************************************
C
C  THIS PROGRAM CALCULATES THE K S STATISTIC FOR EV1 DISTRIBUTION
C
```

```
C                         SUBROUTINE   KSTEST
C
C**********************************************************************
C
      SUBROUTINE KSTES8
      COMMON/PARA/X(100),N
      COMMON/RESUL/A(7),B(7)
      COMMON/TEST/C(7),CRIT
      DIMENSION G(100)
      CRIT=0.21
      IF (N.GT.50)GO TO 40
   40 CRIT=1.36/SQRT(FLOAT(N))
      DO  10 I=1,7
      H=0.0
      DO 20 J=1,N
      F=(FLOAT(J)-0.44)/(FLOAT(N)+0.12)
      Y=A(I)*(X(J)-B(I))
      P=EXP(-(EXP(-Y)))
      G(I)=ABS(F-P)
      IF (G(I).GE.H) H=G(I)
 20   CONTINUE
      C(I)=H
 10   CONTINUE
      END
C
C
      SUBROUTINE SURP8
C
C----------------------------------------------------------------
C
C  THIS PROGRAM CALCULATES THE MAXIMUM ENTROPY FOR TESTING
C
C  METHOD OF PARAMETER ESTIMATION
C
C----------------------------------------------------------------
C
      COMMON/PARA/X(100),N
      COMMON/RESUL/A(7),B(7)
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/ENTR/ENT(7)
      PI=3.1415927
      C=(SQRT(2*PI))*SIGMA
      D=ALOG(1.0/C)
      E=(1.0/(2.0*SIGMA**2))*D*1.2825**2
      WRITE (6,*)C,D,E
      DO 10 J=1,7
      ENT(J)=A(J)*XAVG-A(J)*B(J)+1.0-ALOG(A(J))+(E/A(J)**2)
   10 CONTINUE
      RETURN
      END
C
      SUBROUTINE CI8(ID)
C----------------------------------------------------------------
C
C  THIS PROGRAM CALCULATES THE CLASS INTERVALS FOR GUMBEL
C
C   DISTRIBUTION ALSO FINDS THE NUMBER OF FLOOD VALUES
C
```

```
C       FOR THAT INTERVAL FOR CHI SQUARE TEST
C
C-----------------------------------------------------------------------
C
      COMMON/PARA/X(100),N
      COMMON/RESUL/A(7),B(7)
      COMMON/CLASS/F(42)
      DIMENSION P(10),E(10),ID(10,10)
      K=1
      P(1)=.14286
      P(2)=.28571
      P(3)=.42857
      P(4)=.57143
      P(5)=.71429
      P(6)=.85714
C     READ(5,*)(P(I),I=1,6)
      DO 15 I=1,7
      IXP=0
      JJ=1
      DO 14 J=1,6
      E(J)=B(I)-(ALOG(-ALOG(P(J)))/A(I))
      F(K)=E(J)
      DO 12 L=JJ,N
      IF (X(L).LE.E(J))GO TO 12
      ID(I,J)=L-1-IXP
      IXP=L-1
      GO TO 13
   12 CONTINUE
   13 JJ=L-1
      K=K+1
   14 CONTINUE
      ID(I,7) = N-L+1
   15 CONTINUE
      RETURN
      END
C
C
      SUBROUTINE CHI8(IO)
C
C-----------------------------------------------------------------------
C
C  THIS PROGRAM CALCULATES THE CHI SQUARE STATISTIC FOR GUMBEL
C
C                                DISTRIBUTION
C
C-----------------------------------------------------------------------
C
C
      COMMON/PARA/X(100),N
      COMMON/CHIS/R(7)
      DIMENSION IO(10,10)
      DO 50 K=1,7
      E=FLOAT(N)/7.0
      SUM=0.0
      DO 10 J=1,7
      DEV=(FLOAT(IO(K,J))-E)**2
  10  SUM=SUM+DEV
      SUM1=SUM/E
```

```
      R(K)=SUM1
   50 CONTINUE
      RETURN
      END
C
C
C-----------------------------------------------------------------------
C
C                   PROGRAM TO GENERATE CONFIDENCE INTERVAL
C
C                   FOR EXPONENTIAL DISTRIBUTION (EV1)
C
C-----------------------------------------------------------------------
C
C                                MAIN PROGRAM
C
C-----------------------------------------------------------------------
      SUBROUTINE CONIN8T
      COMMON/PARA/X(100),N
      COMMON/STAT/XAVG,SIGMA,CS,TS
      COMMON/INTER/CIUP(6),CILO(6),T(6)
      DIMENSION VARX(10),XSTAR(10),G(10)
C-----------------------------------------------------------------------
C
C
C
C
C
C-----------------------------------------------------------------------
C
      T(1)=2.
      T(2)=5.
      T(3)=10.
      T(4)=20.
      T(5)=50.
      T(6)=100.
      DO 10 J=1,6
      G(J)=-(.45+.7797*ALOG((ALOG(T(J))-ALOG((T(J)-1.)))))
      VARX(J)=(SIGMA**2/FLOAT(N))*(.6+.5*FLOAT(N)/FLOAT(N-1))*
     1(1.0+1.14*G(J)+G(J)**2)
      XSTAR(J)=XAVG+SIGMA*G(J)
      CIUP(J)=XSTAR(J)+1.96*SQRT(VARX(J))
      CILO(J)=XSTAR(J)-1.96*SQRT(VARX(J))
   10 CONTINUE
      RETURN
      END
C
C=======================================================================
C
C THIS SUBROUTINE CALCULATES THE BIAS FOR GUMBEL DISTRIBUTION
C
C=======================================================================
C
      SUBROUTINE BIASA8
      DIMENSION U(10)
      COMMON/PARA/X(100),N
      COMMON/RESUL/A(7),B(7)
      COMMON/PEST/BIAS(7)
```

```
      T=(FLOAT(N)+0.12)/(FLOAT(1)-0.44)
      P=1.-(1./T)
      Y=-(ALOG(-ALOG(P)))
      DO 10 I=1,7
      U(I)=(Y/A(I))+B(I)
      BIAS(I)=(U(I)-X(N))/X(N)
   10 CONTINUE
      RETURN
      END
C
C
C=====================================================================
C
C  SUBROUTINE TO CALCULATE MEAN SQUARE ERROR FOR
C
C  GUMBEL DISTRIBUTION
C
C=====================================================================
      SUBROUTINE RMSE8
      DIMENSION V(100),R(100),S(100)
      COMMON/PARA/X(100),N
      COMMON/RESUL/A(7),B(7)
      COMMON/ERR/ERROR(7),ERRO(7)
      DO 10 J=1,7
      SUM=0.0
      SUM1=0.0
      K=N
      DO 20 I=1,N
      T=(FLOAT(N)+0.12)/(FLOAT(K)-0.44)
      P=1.-(1./T)
      Y=-(ALOG(-ALOG(P)))
      V(I)=(Y/A(J))+B(J)
      R(I)=((V(I)-X(I))/X(I))**2
      S(I)=(V(I)-X(I))/X(I)
      SUM1=SUM1+ABS(S(I))
      SUM=SUM+R(I)
      K=K-1
   20 CONTINUE
      ERROR(J)=(SUM/FLOAT(N))*100.0
      ERRO(J)=(SUM1/FLOAT(N))*100.0
   10 CONTINUE
      RETURN
      END
C
//GO.FT01F001 DD DSN=CEDEEP.LPT.DATA,DISP=SHR
//GO.FT08F001 DD DSN=CEDEEP.L.DATA,DISP=SHR
//GO.SYSIN DD *
1 1 1 1 1 1 0
1 0 1 0 0 0
0 1 1 0 0 0
1 1 0 1 0 0
1 1 0 0 0 0
1 0 0 0 0 0
1 0 0 0 0 0
1 0 0 0 0 0
1 0 0 0 0 0
1
 MOM MLEM MOLS POME MOPWMMOMIX MOIM
```