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POWER TRANSFORMATION TECHNIQUE
IN BASIC
FOR FLOOD FREQUENCY ANALYSIS

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ABSTRACT

Flood frequency analysis is a very useful technique for the estimation of design flood corresponding to a specified recurrence interval from the limited data. Generally, sample data is fit to several frequency distributions and then a suitabele distribution is considered for estimating the floods of required recurrence intervals. Instead of fitting a probability distribution to raw data, sometimes the data is transformed, so that it conforms to a particular distribution of known characteristics for the purpose of flood frequency analysis. Power transformation (Box and Cox) is one of the powerful techniques for transforming any data series to near normal series.

The present user's manual describes the power transformation technique in details and the computer programme transforms the given series of annual maximum peak flood to near normal distribution using power transformation. It then performs the flood frequency analysis on this transformed series using the method of moments for estimating 50,100,200,500,1000 and 10,000 years return period floods using two approaches based on the criteria that (i) coefficient of skewness is nearly zero and (ii) coefficient of skewness is nearly zero and coefficient of Kurtosis nearly equal to 3.0

The programme of this user s manual is usable both on VAX-11/780 computer system as well as on IBM compatible Personal Computer with minor changes, which

has been described in the programme itself. This user's manual also lists the sample input and corresponding generated output of one example.

1.0 INTRODUCTION

1.1 General

The estimation of design flood of desired frequency from fairly short series of observed data is one of the major problems faced in hydrology. The sample data is used to fit frequency or probability distribution which in turn is used to extrapolate from recorded events to design events either graphically or analytically.

Graphical method has the advantage of simplicity and visual presentation. But the main disadvantage is that different persons will fit different curves. In theoretical analysis, either the data are fitted to the most appropriate frequency distribution or the data are transformed to a particular frequency distribution of known characteristics.

Since the properties of a normal distribution are completely defined, so this distribution is generally used. But the hydrological data in its original form are rarely normally distributed. Many of the hydrological data are positively skewed and so the application of normal distribution to the original data is not appropriate. However, various methods are available to transform the data to normal distribution e.g. log transformation (Chow, 1954), inverse pearson type III transformation (Beard, 1967), Square root transformation, (Richardson, 1978), cube root transformation (Stidd, 1953), and inverse log pearson type III transformation. All these transformations have been shown to be special cases of power transformation (Box and Cox, 1964).

Goodness of fit of various distribution is examined based on some statistical criteria. Chi-square test, Kolmorov-Smirnov and Crammer-Von Mises test are some of the well known tests for this purpose.

1.2 BASIC Language

Although BASIC stands for Beginner's All-purpose Symbolic Instruction Code, it is an extremely powerful and useful language.

Within the last few years, BASIC has become one of the leading programming languages because of widespread popularity and proliferation of microcomputers, nearly all of which now have BASIC interpreters or compilers.

BASIC is easy to earn and use. It is very flexible and is very well suited for use in an interactive environment. It has the facility for manipulation of character strings and carrying out arithmatical operations on matrices.

BASIC is relatively standardized, though there may be minor differences between one version of BASIC and another. Thus the language is largely machine-independent. Consequently, most BASIC programmes can be run of many different computers with little or no modification.

1.3 Purpose

The computer programme has been developed in BASIC on the basis of the logic given by Seth and Perumal (1982). It performs the flood frequency analysis using the power transformation for estimating the floods of 50,100,200, 500,1000, 10,000 years return periods. This analysis is based on the two approaches viz. (i) the coefficient of skewness is nearly zero and (ii) the coefficient of kurtosis is nearly equal to 3.0 as well as coefficient of skewness is nearly zero.

1.4 Scope

The programme can be used to estimate the peak flood of specified return periods. Statistical parameters e.g. mean, standard deviation, coefficient of skewness, coefficient of kurtosis and Chi-Square statistic etc. can also be computed.

2.0 FLOOD FREQUENCY ANALYSIS

The basic objective in the use of statistical methods and statistical distribution is the analysis of outcomes of real observations of random phenomena such as floods. For solving the practical statistical problems, generally the following steps are involved:

i) Application of various statistical distribution.

ii) Estimation of their parameters

iii) A check of the goodness of the distribution in fitting the given sample of annual maximum peak series by various statistical tests.

iv) Selection of most appropriate statistical distribution.

v) Prediction of future floods using this distribution.

In this user's manual, power transformation has been discussed and used. The parameters of the distribution are estimated by the method of moments.

2.1 Power Transformation Technique for flood Frequency Analysis:

The given annual peak flood series can be transformed to the nearly normal distribution by using power transformation (Box & Cox) i.e.

$$Z_i = \frac{X_i^{\lambda} - 1}{\lambda} \quad \text{for} \quad \lambda \neq 0$$

and

$$Z_i = \ln X_i \quad \text{for} \quad \lambda \to 0 \qquad \ldots(i)$$

in which,

X_i = the variate of given series

Z_i = the transformed variates

λ = an exponent which near normalizes the series and its value is found by trial and error.

Eqn.(i) is a more general power transformation and it can be shown that the logarithmic, reciprocal, and square root transformation are special cases of it.

The near normalization is considered to be achieved when the coefficient of skewness (CS) of the transformed series approaches to zero.

The unbiased coefficient of skewness of the sample data is computed as:

$$CS = \frac{N}{(N-1)(N-2)} \left[\frac{\sum_{i=1}^{N} (Z_i - \bar{Z}_i)^3}{S^3} \right] \qquad \ldots(ii)$$

where,

N = the sample size

Z_i = the power transformed variate

$\bar{Z}_i$ = the mean of the power transformed variates

$$= \frac{1}{N} \sum_{i=1}^{N} Z_i \qquad \ldots(iii)$$

S = Sample standard deviation

$$= \frac{1}{(N-1)} \left[\sum_{i=1}^{N} (Z_i - \bar{Z}_i)^2 \right]^{1/2} \qquad \ldots(iv)$$

The value of λ which near normalizes the data series is obtained by grid search technique by using the criterion that there is a systematic variation of CS for variation of λ. For near normality the value of CSL (deviation of coefficient of skewness) is specified depending upon the accuracy required. It is found that 0.001 is a quite reasonable value. So in present programme this value has been inputted.

The unbiased coefficient of kurtosis of the sample data is computed as:

$$CK = \frac{N^2}{(N-1)(N-2)(N-3)} \left[\frac{\sum_{i=1}^{N} (Z_i - \bar{Z}_i)^4}{S^4} \right] \quad \ldots(v)$$

The transformed series is said to be near normalized if the coefficient of kurtosis (CK) of the transformed series may be near to, if not equal to 3.0, as required for normal distribution.

Estimation of flood peaks:

Neglecting the kurtosis in the transformed series, the flood peak X(T) of recurrence interval T can be estimated from the following expression-

$$X_T = (Z_T \lambda + 1)^{1/\lambda} \quad \ldots\ldots(vi)$$

where,

X_T = Flood peak magnitude in the original series.

Z_T = Flood peak magnitude in the transformed series.

$= \bar{Z} + K(T)S \quad (vii)$

K(T) = Standard deviate corresponding to recurrence interval T

For taking into consideration the effect of kurtosis K(T) should be adjusted for estimating X_T by eqn.(vi) so, in spite of standard deviate, it will be a function of Kurtosis CK to account for non-normality.

Box and Tio (1973) have introduced a factor β as a measure of symmetrical distribution (Table 1 and 2). Thus the transformed series can be adjusted for Kurtosis by using the value of the adjusted standard deviate K corresponding to the calculated value of β. The programme computes the estimates of different recurrence intervals based on kurtosis correction procedure.

Although, log transformation is a particular case of power transformation, its identification due to the required division of the quantity $(X^{\lambda} - 1)$ by λ, which is nearly equal to zero. Therefore, provision is made in the programme to compute, in variably, the log transformation of the series for the purpose of computing flood peak estimates for 50, 100,200,500, 1000 and 10,000 year return periods.

The goodness of fit test:

The goodness of fit is evaluated by the most commonly used Chi-Square statistic viz.,(i) equal class interval method and (ii) equal probability method. The latter approach has been used in present programme. The observed data are grouped into NCLASS Classes. The number of classes is supplied by the user. The Chi-Square Statistic is computed as:

$$\chi_{\alpha}^2 = \sum_{i=1}^{NCLASS} \left[\frac{(f_{oi} - f_{ei})^2}{f_{ei}} \right] \qquad \ldots\text{(viii)}$$

where

f_{oi} = the observed frequency in the i^{th} class interval

f_{ei} = the expected frequency in the i^{th} class interval

TABLE-1

RELATIONSHIP BETWEEN BETA AND CK REQUIRED FOR CURTOSIS CORRECTED STANDARD NORMAL DEVIATES

DATA	VALUES								
BETA	-1.00	-0.75	-0.50	-0.25	0.00	0.25	0.50	0.75	1.00
CK	-1.20	-1.07	-0.81	-0.45	0.00	0.55	1.22	2.03	3.00

TABLE-2

ADJUSTED STANDARD DEVIATE K FOR SMALLER PROBABILITIES ALPHA FOR VALUES OF BETA

BETA	ALPHA 0.25	ALPHA 0.10	ALPHA 0.05	ALPHA 0.025	ALPHA 0.01	ALPHA 0.005	ALPHA 0.001
-1.00	0.87	1.39	1.56	1.65	1.70	1.71	1.73
-0.75	0.84	1.36	1.57	1.71	1.84	1.91	2.05
-0.50	0.80	1.35	1.61	1.81	2.03	2.16	2.41
-0.25	0.73	1.31	1.63	1.89	2.18	2.37	2.75
0.00	0.67	1.28	1.64	1.96	2.33	2.58	3.09
0.25	0.62	1.25	1.65	2.02	2.46	2.77	3.43
0.50	0.58	1.22	1.65	2.06	2.58	2.94	3.75
0.75	0.53	1.18	1.64	2.09	2.68	3.10	4.08
1.00	0.49	1.14	1.63	2.12	2.77	3.28	4.39

α = the level of significance at which the distribution of fitting the data is being tested.

The programme only computes χ^2 statistic and it is left to the user for verifying the goodness of fit.

2.2 Programme Description

Much of the programme is explained by remark cards. However, subroutines used in the programme are explained in details:

(a) Subroutine STAPS

This subroutine calculates the statistical parameters e.g. Mean, Unbiased standard deviation, Unbiased coefficient of skewness and unbiased coefficient of kurtosis of the given series.

(b) Subroutine ASCOR

This subroutine has been used for arranging the given series in ascending order.

(c) Subroutine INPOL and Subroutine AKIMA

These subroutines are used for interpolation based on smooth curve fitting using procedure given by AKIMA (1970). It interpolates linearly if only two points are available.

(d) Subroutine CHIST

This subroutine computes the Chi-Square statistic based on equal probability criterion for each class interval

(e) Subroutine PROND

The purpose of this sub-routine is to calculate standard normal variate and the corresponding ordinate of the normal distribution for the given probability of non-exceedence.

The listing of computer programme has been given in Appendix I.

2.3 Hardware and Software Requirements

The programme has been written in BASIC and has been implemented and tested on VAX-11/780 version 4.2 computer system of National Institute of Hydrology, Roorkee. Same programme has also been tested and implemented on IBM Compatible Personal Computer with minor differences which have been explained in the programme itself by Remark Cards. It requires BASIC compiler and simple BASIC instruction to run the programme on VAX and Microsoft BASIC version 1.12 software on personal computer.

For VAX the CPU time required is 11.53 secs and total elapsed time is 16.57 sec. For P.C. total elapsed time required is 3 mins 4 secs.

3.0 DATA REQUIREMENTS

Description of input variables is given below:

Variable	Description
N	Number of annual maximum values to be analysed.
NCLASS	Number of classes used in the Chi-Square test
CSL	Specified accuracy limit for coefficient of skewness
RI	Recurrence interval for which flood estimate are made.
DL	Grid size used in the search method for determining the power transformation exponent which near normalizes the series.
IYEAR	Year corresponding to the annual maximum series
X	the annual maximum series

3.1 Preparation of Input Data

Five input cards which are read in free format are required. The form in which the data to be supplied is as given below:

Card 1

N, NCLASS, CSL

Card 2

RI(1), RI(2), RI(3)........RI(6)

Card 3

DL(1), DL(2), DL(3)

Card 4

IYEAR(1), IYEAR(2),.........IYEAR(N)

Card 5

X(1), X(2), X(3)...........X(N)

The declared dimensions of the variables of last four cards which are read by Mat input statement should be exactly the same numbers as used for programme and not more or less.

3.2 Output Description

The output tabulates the original, log transformed and power transformed series in chronological order along with years and it arranges these in ascending order of magnitude and corresponding year of occurance. It assigns the rank to them and computes the probability of non-exceedances using Blom's plotting position. The statistical parameters of the series are written. Chi-Square statistics are also written for log-transformed and for power transformed series. The flood peak estimate of log-transformed and power-transformed corresponding to required recurrence intervals of 50,100,200,500,1000,1000 years are given.

4.0 CASE STUDY

For running the programme and for an example, the data has been taken from Varshney (5).

4.1 Data Used for Case Study

The information required for input data is as follows:-

Card 1

The number of years of annual peak flow series (N) =77

The number of class interval used in Chi-Square test (NCLASS)=8

Limit of accuracy for coefficient of skewness=0.001

So input of Card

77,8,0.001

Card2

The recurrence interval for which the flood magnitudes are to be estimated are

RI(4) = 50, RI(2) =100, RI(3)=200

RI(4) = 500, RI(5)=1000, RI(6) =10000

So input of the card

50,100,200,500,1000,10000

Card 3

The grid size used in grid search technique for estimating the exponent are-

DL(1)=0.1, DL(2)=0.01, DL(3)=0.001

So input of Card

0.1, 0.01, 0.001

Card 4

The year of occurrence of the given magnitude of flood e.g.IYEAR (1), IYEAR(2),......IYEAR(77)

So input of card

1901, 1902, 1903,.........1977

Card 5

The peak flood series arranged in chronological order e.g.X(1), X(2), X(3),...... X(77).

So input of the card

11400, 9250, 7400,......5710

The test input and the test output of the programme are given in Appendix II and III respectively.

5.0 CONCLUSIONS

Application of the power transformation to flood frequency studies does not require the assumption of the population distribution. It is more efficient than other transformations in normalizing the skewed flood distribution. Power transformation method can also incorporate the effect of the kurtosis in the estimation of flood.

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4. Seth, S.M., and M.Perumal (1982-83),"Flood Frequency Analysis Using Power Transformation", report DP-1, National Institute of Hydrology, Roorkee (U.P.).
5. Varshney, R.S.(1979) ,"Engineering Hydrology", Nem Chand and Brothers, Roorkee, U.P., pp 604-605.

APPENDIX - I : LISTING OF PROGRAMME

```
05  REM THIS PROGRAMME PERFORMS THE FLOOD FREQUENCY ANALYSIS  &
06  ' OF ANNUAL MAXIMUM SERIES USING LOG TRANSFORMATION AND   &
07  ' POWER TRANSFORMATION (BOX-COX TRANSFORMATION),ASSUMING  &
08  ' THE TRANSFORMED SERIES FOLLOWS THE NORMAL DISTRIBUTION

10  REM  DESCRIPTION OF TERMS
11  REM  --------------------
12  REM  X      = ANNUAL MAXIMUM SERIES
15  REM  Y      = POWER TRANSFORMED ANNUAL MAXIMUM SERIES
20  REM  Z      = LOG TRANSFORMED ANNUAL MAXIMUM SERIES      &
21  '             ARRANGED IN DESCENDING ORDER
25  REM  DL     = GRID SIZE USED IN THE SEARCH METHOD FOR   &
26  '             DETERMINING THE EXPONENT ,LAMDA WHICH     &
27  '             NEAR NORMALISES THE SERIES
30  REM  SK     = ARRAY FOR STORING KURTOSIS VALUES
35  REM  X1     = ARRAY FOR STORING THE ANNUAL MAXIMUM      &
36  '             SERIES IN CHRONOLOGICAL ORDER
40  REM  P      = PROBABILITY USING BLOM'S PLOTTING POSITION
45  REM  IYEAR = YEAR CORRESPONDING TO  ANNUAL MAX. VALUES
50  REM  ALPHA = TABLE OF STANDARD NORMAL DEVIATES          &
51  '             CORRECTED FOR KURTOSIS
52  REM  ALPHAS = TEMPORARY ARRAY FOR STORING ALPHA
53  REM  ALINPI = ARRAY OF INTERPOLATED STANDARD NORMAL     &
54  '              DEVIATES CORRESPONDING TO THE DIFFERENT  &
55  '              PROBABILITY OF EXCEEDENCE LEVEL
56  REM  IYEAR1 = ARRAY OF YEARS IN CHRONOLOGICAL ORDER
58  REM  X2    = TABLE OF DEVIATION OF THE COEFFICIENT OF  &
59  '            KURTOSIS VALUES AWAY FROM 3.00
60  REM  Y2    = TABLE OF CORRECTION FACTORS CORRESPONDING TO X2
62  REM  Z1    = LOG TRANSFORMED FLOOD FLOW VALUES IN       &
63  '            CHRONOLOGICAL ORDER
64  REM  Y1    = POWER TRANSFORMED FLOOD FLOW VALUES IN     &
65  '            CHRONOLOGICAL ORDER
66  REM  RI    = RECURRENCE INTERVAL FOR WHICH FLOOD        &
67  '            ESTIMATE ARE MADE
68  REM  TD    = STANDARD NORMAL DEVIATE OBTAINED FROM      &
69  '            THE PROBABILITY OF EXCEEDENCE
70  REM  ESTP = ESTIMATED FLOOD PEAK USING POWER TRANSFORMATION
71  REM  PEX   = TABLE OF EXCEEDENCE PROBABILITIES FOR       &
72  '            WHICH KURTOSIS CORRECTED STANDARD NORMAL    &
73  '            DEVIATES ARE AVAILABLE
74  REM  ALINPI1 = TEMPORARY ARRAY FOR STORING ALINPI
76  REM  PEX1     = TEMPORARY ARRAY FOR STORING PEX
78  REM  IRI      = TEMPORARY ARRAY FOR STORING RI
80  REM  NPTS     = NO. OF CK VALUES AVAILABLE FOR KURTOSIS &
81  '               CORRECTION
82  REM  NALPHA   = NO. OF EXCEEDENCE PROBABILITIES FOR      &
83  '               WHICH KURTOSIS CORRECTED STANDARD NORMAL &
84  '               DEVIATES ARE AVAILABLE
85  REM  NCLASS = NUMBER OF CLASSES USED IN THE CHI-SQUARE TEST
86  REM  N      = NUMBER OF ANNUAL MAXIMUM VALUES
90  REM  ************************************************************
```

```
100  DIM  X(77),Y(100),Z(100),DL(3),SK(100),X1(100),P(100),X2(9)
101  DIM  IYEAR(77),ALPHA(9,7),YYY(9),ALPHAS(9),ALINPI(9),Y2(9)
102  DIM  IYEAR1(100),Z1(100),Y1(100),RI(6),TD(10),ESTP(10)
103  DIM  ALINPI1(9),PEX1(7),IRI(10),T(81),XX(100),XXX(9),PEX(7)

107   REM  ************************************************
108   REM  ******   FOR USE ON IBM COMPATIBLE PC'S  **********
109   REM  ************************************************
110   REM  THE FOLLOWING STATEMENTS (115-155) ARE FOR USING  &
111   '     PROGRAMME ON IBM COMBATIBLE PERSONAL COMPUTERS    &
112   '     (PC'S).FOR USING IT ON MAIN FRAME PUT ' REM '     &
113   '     STATEMENT ON THESE.
120   OPEN "I",#1,"PTP.INP"
125   OPEN "O",#2,"PT.OUT"
126   OPEN "O",#3,"PT1.OUT"
130   REM  *******  READ INPUT INFORMATION (FOR PC)  ********
135   INPUT#1,N,NCLASS,CKL
140   FOR I = 1 TO 6 : INPUT#1,RI(I) : NEXT I
145   FOR I = 1 TO 3 : INPUT#1,DL(I) : NEXT I
150   FOR I = 1 TO 77 : INPUT#1,IYEAR(I) : NEXT I
155   FOR I = 1 TO 77 : INPUT#1,X(I) : NEXT I
156   REM *************************************************


164   REM *************************************************
165   REM ********  FOR USE ON VAX-11/780 COMPUTER  **********
166   REM *************************************************
170   REM  THE FOLLOWING STATEMENTS (180-245) ARE FOR USING  &
171   '     PROGRAMME ON VAX-11/780 COMPUTER . FOR  USING IT  &
172   '     ON IBM COMBATIBLE PERSONAL COMPUTERS (PC'S) PUT   &
173   '      ' REM ' STATEMENT ON THESE.

180   REM OPEN "PTV.INP" FOR INPUT AS FILE #1
185   REM OPEN "PT.OUT" FOR OUTPUT AS FILE #2,RECORDSIZE 131%
190   REM OPEN "P1.OUT" FOR OUTPUT AS FILE #3,RECORDSIZE 131%

220   REM  ****   READ INPUT INFORMATION (FOR VAX COMP.)  ****
225   REM INPUT#1,N,NCLASS,CKL
230   REM MAT INPUT#1,RI
235   REM MAT INPUT#1,DL
240   REM MAT INPUT#1,IYEAR
245   REM MAT INPUT#1,X
246   REM *************************************************


249   REM *************************************************
250   REM *** FROM THIS POINT ONWARDS PROGRAMME CAN BE USED  &
251   '    EITHER ON VAX-11/780 COMPUTER OR ON IBM COMBATIBLE &
252   '    PC'S WITH MINOR CHANGES IN STATEMENTS CONTAING     &
253   '    PRINT USING STATEMENTS(                            &
254   '    FORMAT IS GIVEN BELOW:                             &
255   '      FOR VAX-11/780   ----    PRINT#2 USING A$;B;C    &
256   '      FOR  PC'S        ----    PRINT#2,USING A$,B;C
257   REM *************************************************
```

```
260   FOR I = 1 TO 9
261   READ X2(I)
262   NEXT I
265   FOR J = 1 TO 9
266   READ Y2(J)
267   NEXT J
270   FOR K = 1 TO 7
271   READ PEX(K)
272   NEXT K
275   FOR M = 1 TO 7
276   FOR L = 1 TO 9
277   READ ALPHA(L,M)
278   NEXT L
279   NEXT M

285   DATA -1.20,-1.07,-0.81,-0.45,0.0,0.55,1.22,2.03,3.00
290   DATA -1.00,-0.75,-0.50,-0.25,0.0,0.25,0.50,0.75,1.00
295   DATA 0.25,0.10,0.05,0.025,0.01,0.005,0.001
300   DATA 0.87,0.84,0.80,0.73,0.67,0.62,0.58,0.53,0.49
301   DATA 1.39,1.36,1.35,1.31,1.28,1.25,1.22,1.18,1.14
302   DATA 1.56,1.57,1.61,1.63,1.64,1.65,1.65,1.64,1.63
303   DATA 1.65,1.71,1.81,1.89,1.96,2.02,2.06,2.09,2.12
304   DATA 1.70,1.84,2.03,2.18,2.33,2.46,2.58,2.68,2.77
305   DATA 1.71,1.91,2.16,2.37,2.58,2.77,2.94,3.10,3.28
306   DATA 1.73,2.05,2.41,2.75,3.09,3.43,3.75,4.08,4.39


310   PRINT#2,TAB(13);
315   OS$="THE TOTAL VALUES IN THE ORIGNAL SERIES ARE = ####"
320   PRINT#2,USING OS$;N
325   PRINT#2,CHR$(10);TAB(15);"NOTE: BLOMS PLOTTING POSIT ";
327   PRINT#2,"ION IS USED THROUGHOUT";CHR$(10),CHR$(10)
330   PRINT#2,TAB(22);
331   FOR I= 1 TO 35
332   PRINT#2, CHR$(42);
333   NEXT I
335   PRINT#2,
336   PRINT#2,TAB(22);"* ANALYSIS OF THE ORIGINAL SERIES *"
337   PRINT#2,TAB(22);
338   FOR I= 1 TO 35
339   PRINT#2, CHR$(42);
340   NEXT I
341   PRINT#2,CHR$(10)
342   REM ***   ARRANGING THE DATA IN ASCENDING ORDER    ****
345   FOR I = 1 TO N
350   P(I)=(I-0.375)/(N+0.25)
355   P = P(1)
360   REM CALL PROND(P,T,D,IE)
365   GO SUB 8000
370   IYEAR1(I)=IYEAR(I)
380   X1(I)=X(I)
385   XX(I)=X(I)
390   NEXT I
400   REM CALL ASCOR(N,IYEAR(),X())
405   GO SUB 4000
```

```
420   FOR I=1 TO 76
422   PRINT#2, CHR$(95);
424   NEXT I
426   PRINT#2,
430   DC$="! DATA IN CHRONOLOGICAL !"
432   DA$=" DATA IN ASCENDING !"
433   O$="ORDER"
434   P$="! PROBABILITY !"
435   S$="! SL.NO.!"
436   R$="! RANK !   OF NON-    !"
437   EX$="! EXCEEDENCE  !"
438   Y$="!  YEAR  !   DISCHARGE  !  YEAR   ! DISCHARGE !"
440   PRINT#2,"!";TAB(9);DC$;TAB(36);DA$;TAB(62);"!";TAB(76);"!"
450   PRINT#2, "!";TAB(9);"!";TAB(19);O$;TAB(33);"!";
451   PRINT#2, TAB(42);O$;TAB(55);"!";TAB(62);P$
460   PRINT#2, S$;
465   FOR I = 1 TO 45
466   PRINT#2, CHR$(45);
467   NEXT I
468   PRINT#2, R$
470   PRINT#2, "!";TAB(9);Y$;TAB(62);EX$
480   FOR I=1 TO 76
482   PRINT#2, CHR$(45);
484   NEXT I
486   PRINT#2,
490   FOR I = 1 TO N
500   PRINT#2, "!  ";I;TAB(9);"!  ";IYEAR1(I);TAB(18);"!     ";
501   PRINT#2, X1(I);TAB(33);"!  ";IYEAR(I);TAB(43);"!  ";X(I);
502   PRINT#2, TAB(55);"!  ";I;TAB(62);"!";
505   PRINT#2,USING "     #.####";P(I);
507   PRINT#2, TAB(76);"!"
510   NEXT I
520   FOR I=1 TO 76
521   PRINT#2, CHR$(45);
522   NEXT I
524   PRINT#2, CHR$(10) ,CHR$(10),CHR$(10)
526   A$="STATISTICAL ESTIMSATES OF THE"
528   B$="SERIES ARE AS FOLLOWS :"
529   C$=" ORIGINAL "
530   D$=" LOG TRANSFORMED "
531   E$=" POWER TRANSFORMED "
532   MEAN$="MEAN OF THE SERIES                      =  ###.#####^^^^"
534   SSD$ ="STANDARD DEV OF THE SERIES              =  ###.#####^^^^"
536   SK$  ="COEFF. OF SKEWNESS OF THE SERIES        =  ###.#####^^^^"
538   SKU$ ="COEFF. OF KURTOSIS OF THE SERIES        =  ###.#####^^^^"
539   VL$  ="VALUE  OF  LAMDA                        =  ###.#####^^^^"
541   PRINT#2, A$;C$;B$
542   REM **  COMPUTE MEAN,STANDARD DEVIATION,COEF. OF SKEWNESS
543   REM       AND KURTOSIS OF THE GIVEN ORIGINAL SERIES    ***
545   FOR I=1 TO 62
546   PRINT#2, CHR$(45);
547   NEXT I
548   PRINT#2,
550   REM CALL STAPS(X(),N,SMEAN,SSD,SKEW,SKUR)
555   GO SUB 3000
```

```
560   AVEGE=SMEAN
570   PRINT#2, CHR$(10);TAB(4);
580   PRINT#2,USING MEAN$;SMEAN
585   PRINT#2, CHR$(10);TAB(4);
590   PRINT#2,USING SSD$;SSD
595   PRINT#2, CHR$(10);TAB(4);
600   PRINT#2, USING SK$;SKEW
605   PRINT#2, CHR$(10);TAB(4);
610   PRINT#2,USING SKU$;SKUR

615   REM  *********   FREQUENCY ANALYSIS USING
616   REM  LOG TRANSFORMED SERIES   ***********
625   PRINT#2,CHR$(10);TAB(17);
626   FOR I= 1 TO 41
627   PRINT#2, CHR$(42);
628   NEXT I
629   PRINT#2,
631   PRINT#2,TAB(17);"* ANALYSIS OF THE LOG";TS$
630   TS$ = " TRANSFORMED SERIES *"
640   PRINT#2, TAB(17);
642   FOR I= 1 TO 41
643   PRINT#2, CHR$(42);
645   NEXT I
650   PRINT#2, CHR$(10)
660   FOR I=1 TO 76
665   PRINT#2, CHR$(95);
670   NEXT I
675   PRINT#2,
680   PRINT#2,"!";TAB(9);DC$;TAB(36);DA$;TAB(62);"!";TAB(76);"!"
690   PRINT#2,"!";TAB(9);"!";TAB(19);O$;TAB(33);"!";TAB(42);
691   PRINT#2, O$;TAB(55);"!";TAB(62);P$
695   PRINT#2, S$;
700   FOR I = 1 TO 45
702   PRINT#2, CHR$(45);
704   NEXT I
710   PRINT#2, R$
720   PRINT#2, "!";TAB(9);Y$;TAB(62);EX$
730   FOR I=1 TO 76
732   PRINT#2, CHR$(45);
734   NEXT I
736   PRINT#2,
740   FOR I = 1 TO N
770   Z(I)=LOG(X(I))/LOG(10)
780   Z1(I)=LOG(X1(I))/LOG(10)
782   XX(I)=Z(I)
790   PRINT#2, "!  ";I;TAB(9);"!  ";IYEAR1(I);TAB(18);"! ";
791   PRINT#2, Z1(I);TAB(33);"!";IYEAR(I);TAB(43);"!";Z(I);
792   PRINT#2, TAB(55);"!  ";I;TAB(62);"!";
800   PRINT#2,USING "    #.####";P(I);
802   PRINT#2, TAB(76);"!"
805   NEXT I
810   FOR I=1 TO 76
812   PRINT#2, CHR$(45);
813   NEXT I
816   PRINT#2, CHR$(10) ,CHR$(10),CHR$(10)
```

```
820   PRINT#2, A$;D$;B$
825   FOR I=1 TO 69
830   PRINT#2, CHR$(45);
835   NEXT I
838   PRINT#2,

840   REM ***   COMPUTATION OF STATISTICAL PARAMETERS OF  &
841         THE LOG TRANSFORMED SERIES   ***
850   REM CALL STAPS(Z(),N,SMEAN,SSD,SKEW,SKUR)
852   GO SUB 3000
855   PRINT#2, CHR$(10);TAB(4);
860   PRINT#2,USING MEAN$;SMEAN
865   PRINT#2, CHR$(10);TAB(4);
870   PRINT#2,USING SSD$;SSD
875   PRINT#2, CHR$(10);TAB(4);
880   PRINT#2,USING SK$;SKEW
885   PRINT#2, CHR$(10);TAB(4);
890   PRINT#2,USING SKU$;SKUR
892   PRINT#2,CHR$(10)

915   REM  ********   COMPUTATION OF CHI-SQUARE  &
916        STATISTIC FOR LOG NORMAL FITTING   ****
920   REM CALL CHIST(N,NCLASS,Z(),SMEAN,SSD)
922   GO SUB 7000

925   REM  ********   COMPUTATION  OF  PEAKS  FOR
926   REM  DIFFERENT RECURRENCE INTERVALS  ******
930   FOR I =1 TO 6
940   P = 1-1/RI(I)
950   IRI(I)=RI(I)
960   REM CALL PROND(P1,T,D,IE)
965   GO SUB 8000
970   TD(I)=TT
980   ESTP(I)=SMEAN+SSD*TT
990   ESTP(I)=10^ESTP(I)
1000  NEXT I
1010  FP$="ESTIMATED FLOOD PEAKS"
1012  SL$=": SL.NO.  :  RECURRENCE   :  ESTIMATED  :"
1014  IN$=":    INTERNAL     :      FLOOD     :"
1016  J$ =":     #     :    ##### YEARS :  #########. :"
1018  PRINT#2, CHR$(10),CHR$(10)
1020  PRINT#2, TAB(30);FP$
1030  PRINT#2, TAB(18);
1032  FOR I = 1 TO 41
1034  PRINT#2, CHR$(95);
1036  NEXT I
1040  PRINT#2,
1042  PRINT#2, TAB(18);SL$
1045  PRINT#2, TAB(18);":";TAB(28);IN$
1050  PRINT#2, TAB(18);
1051  FOR I = 1 TO 41
1052  PRINT#2, CHR$(45);
1053  NEXT I
1055  PRINT#2,
1056  FOR I = 1 TO 6
```

```
1057  PRINT#2, TAB(18);
1058  PRINT#2,USING J$;I;IRI(I);ESTP(I)
1060  NEXT I
1062  PRINT#2, TAB(18);
1063  FOR I = 1 TO 41
1064  PRINT#2, CHR$(45);
1065  NEXT I
1066  FOR I = 1 TO 4
1067  PRINT#2, CHR$(10);
1068  NEXT I
1069  REM ** FREQUENCY ANALYSIS USING POWER TRANSFORMED SERIES
1070  REM COMPUTATION OF THE VALUE OF EXPONENT WHICH MAKES   &
1071      THE SERIES SYMMETRICALLY DISTRIBUTED    ***
1072  PRINT#2,
1073  PRINT#2, TAB(16);
1074  FOR I= 1 TO 44
1075  PRINT#2, CHR$(42);
1076  NEXT I
1077  PRINT#2,
1078  PRINT#2, TAB(16);"* ANALYSIS OF THE POWER";TS$
1079  PRINT#2, TAB(16);
1080  FOR I= 1 TO 44
1081  PRINT#2, CHR$(42);
1082  NEXT I
1083  PRINT#2, CHR$(10)
1085  FOR I = 1 TO 76
1087  PRINT#2, CHR$(95);
1090  NEXT I
1095  PRINT#2,
1100  PRINT#2,"!";TAB(9);DC$;TAB(36);DA$;TAB(62);"!";TAB(76);"!"
1105  PRINT#2,"!";TAB(9);"!";TAB(19);O$;TAB(33);"!";TAB(42);
1106  PRINT#2, O$;TAB(55);"!";TAB(62);P$
1110  PRINT#2, S$;
1115  FOR I = 1 TO 45
1116  PRINT#2, CHR$(45);
1118  NEXT I
1120  PRINT#2, R$
1125  PRINT#2, "!";TAB(9);Y$;TAB(62);EX$
1130  FOR I = 1 TO 76
1131  PRINT#2, CHR$(45);
1132  NEXT I
1133  PRINT#2,
1135  AL=1.5
1136  FOR K = 1 TO 3
1137  J = 0
1140  AL = AL-DL(K)
1145  J = J+1
1150  IF(K=2 AND J=10) GO TO 1207
1155  IF(K=3 AND J=10) GO TO 1207
1160  FOR I = 1 TO N
1161  Y(I)=(X(I)^AL-1.)/AL
1162  NEXT I
1163  FOR I = 1 TO N
1164  XX(I)=Y(I)
1165  NEXT I
```

```
1166  REM CALL STAPS(XX(),N,SMEAN,SSD,SKEW,SKUR)
1167  GO SUB 3000
1170  SK(J)=SKEW
1175  IF(ABS(SK(J))<=CKL) GO TO 1217
1180  IF(J=1) GO TO 1140
1185  IF((SK(J)*SK(J-1))<0.0) GO TO 1200
1190  GO TO 1140
1200  AL=AL+DL(K)
1205  NEXT K
1207  AL=AL+10.*DL(K)
1210  FOR I = 1 TO N
1211  Y(I)=(X(I)^AL-1.)/AL
1212  XX(I)=Y(I)
1213  NEXT I
1214  REM ***   COMPUTATION OF STATISTICAL PARAMETERS OF
1215  REM THE POWERTRANSFORMED SERIES    ***
1216  REM CALL STAPS(XX(),N,SMEAN,SSD,SKEW,SKUR)
1217  GO SUB 3000
1218  FOR I = 1 TO N
1220  Y1(I)=(X1(I)^AL-1)/AL
1230  PRINT#2, "!  ";I;TAB(9);"!  ";IYEAR1(I);TAB(18);
1231  PRINT#2,"!  ";Y1(I);TAB(33);"!  ";IYEAR(I);TAB(43);"!";
1232  PRINT#2, XX(I);TAB(55);"!  ";I;TAB(62);"!";
1235  PRINT#2,USING "     #.####";P(I);
1236  PRINT#2, TAB(76);"!"
1237  NEXT I
1240  FOR I = 1 TO 76
1241  PRINT#2, CHR$(45);
1242  NEXT I
1245  FOR I = 1 TO 4
1246  PRINT#2, CHR$(10)
1247  NEXT I
1248  PRINT#2, A$;E$;B$
1250  FOR I = 1 TO 69
1251  PRINT#2, CHR$(45);
1252  NEXT I
1253  PRINT#2,
1254  PRINT#2, CHR$(10);TAB(4);
1255  PRINT#2,USING VL$;AL
1256  PRINT#2, CHR$(10);TAB(4);
1257  PRINT#2,USING MEAN$;SMEAN
1258  PRINT#2, CHR$(10);TAB(4);
1260  PRINT#2,USING SSD$;SSD
1262  PRINT#2, CHR$(10);TAB(4);
1264  PRINT#2,USING SK$;SKEW
1266  PRINT#2, CHR$(10);TAB(4);
1268  PRINT#2,USING SKU$;SKUR
1269  PRINT#2, CHR$(10),CHR$(10)
1270  REM ***   COMPUTATION OF CHI-SQARE STATISTIC FOR
1271  REM POWER TRANSFORMATION FITTING    ***
1280  REM CALL CHIST(N,NCLASS,Y(),SMEAN,SSD)
1285  GO SUB 7000

1290  REM ***   COMPUTATION OF PEAKS FOR DIFFERENT RECU-
1291  REM RRENCE INTERVALS (WITHOUT KURTOSIS CORRECTION)   *
```

```
1300  FOR I = 1 TO 6
1310  ESTP(I)=SMEAN+SSD*TD(I)
1312  ESTP(I)=(ESTP(I)*AL+1.)^(1./AL)
1315  NEXT I
1317  PRINT#2, CHR$(10),CHR$(10),CHR$(10)
1320  PRINT#2, TAB(29);FP$
1330  PRINT#2, TAB(18);
1331  FOR I = 1 TO 41
1332  PRINT#2, CHR$(95);
1333  NEXT I
1335  PRINT#2,
1340  PRINT#2,TAB(18);SL$
1345  PRINT#2,TAB(18);":";TAB(28);IN$
1350  PRINT#2, TAB(18);
1351  FOR I = 1 TO 41
1352  PRINT#2, CHR$(45);
1354  NEXT I
1355  PRINT#2,
1356  FOR I = 1 TO 6
1357  PRINT#2, TAB(18);
1358  PRINT#2,USING J$;I;IRI(I);ESTP(I)
1360  NEXT I
1380  PRINT#2, TAB(18);
1382  FOR I = 1 TO 41
1384  PRINT#2, CHR$(45);
1386  NEXT I
1390  PRINT#2,
1400  CK = SKUR-3.0
1410  XINP=CK

1420  REM ***   COMPUTATION OF THE STANDARD NORMAL DEVIATE
1425  REM CORRECTED FOR KURTOSIS DEVIATION AWAY FROM 3.00
1440  NPTS=9
1450  NALPHA=7
1455  FOR I=1 TO 9
1456  XXX(I)=X2(I)
1457  YYY(I)=Y2(I)
1458  NEXT I
1460  REM CALL INPOL(NPTS,XXX(),YYY(),XINP,YINP)
1465  GO SUB 5000
1467  XINP=YINP
1468  FOR I=1 TO 9
1469  XXX(I)=Y2(I)
1470  NEXT I
1475  FOR J = 1 TO NALPHA
1480  FOR I = 1 TO NPTS
1490  REM ALPHAS(I)=ALPHA(I,J)
1495  YYY(I)=ALPHA(I,J)
1497  NEXT I
1500  REM CALL INPOL(NPTS,Y2(),ALPHAS(),YINP,ALINP)
1505  GO SUB 5000
1510  REM ALINPI(J)=ALINP
1515  ALINPI(J)=YINP
1517  NEXT J
1520  PRINT#2, CHR$(10),CHR$(10)
```

```
1700  PRINT#2, "REQUIRED VALUES FOR KURTOSIS CORRECTION ARE:"
1701  FOR I = 1 TO 44
1702  PRINT#2, CHR$(45);
1703  NEXT I
1704  PRINT#2,
1705  PRINT#2, CHR$(10);TAB(4);
1706  PRINT#2,USING "COEFF. OF KURTOSIS      (CK) = ##.##";CK
1710  PRINT#2, TAB(4);
1715  PRINT#2,USING "CORRESPONDING VALUE OF BETA = ##.##";XINP
1720  PRINT#2, CHR$(10);CHR$(10);"KURTOSIS CORRECTED ";
1725  PRINT#2,"STANDARD DEVIATES CORRESPONDING TO THE ";
1726  PRINT#2,"COMPUTED CK "
1730  FOR I = 1 TO 71
1732  PRINT#2, CHR$(95);
1734  NEXT I
1736  PRINT#2,
1740  PRINT#2, "! BETA !";
1745  FOR I = 1 TO 7
1746  PRINT#2, " ALPHA  !";
1747  NEXT I
1748  PRINT#2,
1750  PRINT#2, "!";TAB(8);"!  0.25  !  0.10  ! ";
1751  PRINT#2, " 0.05  ! 0.025  !  0.01  ! 0.005  ! 0.001  !"
1760  FOR I = 1 TO 71
1762  PRINT#2, CHR$(45);
1764  NEXT I
1766  PRINT#2,
1770  PRINT#2,
1771  AL$=" #.###   !"
1772  PRINT#2,USING " ##.##  !";XINP;
1774  FOR I = 1 TO 6
1775  PRINT#2,USING AL$;ALINPI(I);
1776  NEXT I
1778  PRINT#2,USING AL$;ALINPI(7)
1780  FOR I = 1 TO 71
1782  PRINT#2, CHR$(45);
1784  NEXT I
1790  PRINT#2,
1800  REM ***    COMPUTATION OF PEAKS FOR DIFFERENT       &
1805    RECURRENCE INTERVALS (WITH KURTOSIS CORRECTION) **

1810  FOR I = 1 TO NALPHA
1820  PEX1(I)=PEX(I)
1830  ALINPI1(I)=ALINPI(I)
1840  NEXT I
1850  FOR I = 1 TO NALPHA
1860  K = NALPHA-I+1
1870  PEX(I)=PEX1(K)
1880  ALINPI(I)=ALINPI1(K)
1885  NEXT I
1890  FOR I = 1 TO 6
1900  XINP=1./RI(I)
1905  REM CALL INPOL(NALPHA,PEX(),ALINPI(),P1,T1)
1906  FOR J=1 TO 7
1907  XXX(J)=PEX(J)
```

```
1908  NEXT J
1909  FOR J=1 TO 9
1910  YYY(J)=ALINPI(J)
1911  NEXT J
1913  GO SUB 5000
1914  T1=YINP
1915  ESTP(I)=SMEAN+SSD*T1
1920  ESTP(I)=(ESTP(I)*AL+1.)^(1./AL)
1922  NEXT I
1925  PRINT#2, CHR$(10);CHR$(10);TAB(30);FP$
1930  PRINT#2, TAB(21);
1931  FOR I = 1 TO 41
1932  PRINT#2, CHR$(95);
1933  NEXT I
1935  PRINT#2,
1940  PRINT#2, TAB(21);SL$
1945  PRINT#2, TAB(21);":";TAB(31);IN$
1950  PRINT#2, TAB(21);
1951  FOR I = 1 TO 41
1952  PRINT#2, CHR$(45);
1953  NEXT I
1954  PRINT#2,
1956  FOR I = 1 TO 6
1957  PRINT#2, TAB(21);
1958  PRINT#2,USING J$;I;IRI(I);ESTP(I)
1960  NEXT I
1965  PRINT#2, TAB(21);
1970  FOR I = 1 TO 41
1975  PRINT#2, CHR$(45);
1980  NEXT I
2000  GOTO 9000


3000  REM SUB STAPS(XX(),N,SMEAN,SSD,SKEW,SKUR)
3100  REM ------------------------------------
3110  REM  FOR COMPUTING THE STATISTICAL PARAMETERS OF THE DATA
3120  REM  COMPUTES  MEAN, STANDARD  DEVIATION, COEF.  OF
3125  REM            SKEWNESS  AND   COEF.  OF KURTOSIS
3140  REM  INPUT DATA ARE AS FOLLOWS:
3145  REM  ==========================
3150  REM     XX = GIVEN SERIES FOR WHICH STATISTICAL PARAMETERS
3155  REM            ARE REQUIRED
3160  REM      N = NUMBER OF X VALUES
3170  REM  OUTPUT DETAILS ARE AS FOLLOWS:
3175  REM  ==============================
3180  REM     SMEAN = MEAN OF THE SERIES
3190  REM     SSD   = UNBIASED STANDARD DEVIATION OF THE SERIES
3200  REM     SKEW  = COEFFICIENT OF SKEWNESS OF THE SERIES
3210  REM     SKUR  = COEFFICIENT OF KURTOSIS OF THE SERIES
3220  REM  ***************************************************
3310  SUMG=0.0
3320  FOR I= 1 TO N
3322  SUMG=SUMG+XX(I)
```

```
3325  NEXT I
3330  SMEAN=SUMG/N
3335  SUM=0.0
3336  ASUM=0.0
3337  BSUM=0.0
3340  FOR M = 1 TO N
3350  SUM=SUM+(XX(M)-SMEAN)^2
3360  ASUM=ASUM+(XX(M)-SMEAN)^3
3370  BSUM=BSUM+(XX(M)-SMEAN)^4
3380  NEXT M
3390  SSD=SQR(SUM/(N-1))
3400  B=(N*N)/((N-1)*(N-2))
3410  C=(B*N)/(N-3)
3420  SKEW=(ASUM/(SSD^3))*(1/N)
3430  SKEW=SKEW*B
3440  SKUR=(BSUM/(SSD^4))*(1/N)
3450  SKUR=SKUR*C
3460  RETURN


4000  REM  SUB ASCOR(N,IYEAR(),X())
4100  REM  ------------------------
4110  REM  FOR ARRANGING THE SERIES IN  ASCENDING  ORDER
4120  REM  INPUT DATA ARE AS FOLLOWS:
4125  REM  ==========================
4130  REM     N      = NUMBER OF VALUES TO BE ARRANGED
4140  REM     X      = DATA SERIES IN CHRONOLOGICAL ORDER
4150  REM     IYEAR = YEAR IN CHRONOLOGICAL ORDER
4160  REM  OUTPUT RESULTS ARE AS FOLLOWS:
4165  REM  ==============================
4170  REM    X     = DATA SERIES IN ASCENDING ORDER
4180  REM    IYEAR = YEAR CORRESPONDING TO X
4190  REM  **********************************************
4300  J=0
4350  J=J+1
4400  FOR I = J TO N
4450  IF X(I)>X(J) THEN  4800
4500  XT=X(J)
4550  XTY=IYEAR(J)
4600  X(J)=X(I)
4650  IYEAR(J)=IYEAR(I)
4700  X(I)=XT
4750  IYEAR(I)=XTY
4800  NEXT I
4850  IF J<=(N-1) THEN  4350
4900  RETURN
```

```
5000  REM  SUB INPOL(NPTS,XXX(),YYY(),XINP,YINP)
5100  REM  --------------------------------------
5110  REM  PROGRAMME FOR SPLINE INTERPOLATION
5120  REM  NPTS  -  NO. OF POINTS
5130  REM  DIMENSIONS SET FOR DAMAGE CLACULATION IN HEC-1 .
5140  REM  ARRAY NAME   DIMENSION
5150  REM  ----------   ---------
5160  REM    EM , T      KPTS=(10*(KRTIO-1)+1)
5170  REM  *** COMPUTES SPLINE COEFFICIENTS BY AKIMA METHOD
5172  REM  ---  A NEW METHOD OF INTERPOLATION AND SMOOTH   &
5174  '    CURVE FITTING BASED ON LOCAL PROCEDURE
5176  REM  H. AKIMA, J.A.C.M., 17, 589-602, 1970.   ***
5180  REM  PROGRAM BY H.KUBIK, HYDROLOGIC ENGINEERING CENTER
5185  REM  -- AUGUST 1976
5200  REM    XXX = X ARRAY, VALUES MUST BE UNIQUE AND INCREASE.
5210  REM    YYY = Y ARRAY.
5215  REM    NP  = NUMBER OF POINTS IN ARRAY.
5220  REM    T   = COEFFICIENT ARRAY
5230  REM **  IF ONLY TWO POINTS, USE LINEAR INTERPOLATION  **
5240  REM  ************************************************
5300  KPTS=81
5340  NP=NPTS
5350  IF NP<=2 THEN  5720
5360  IF NP>KPTS THEN  5730
5370  FOR MI = 2 TO NP
5380  MJ=MI
5390  TMP=XXX(MI)-XXX(MI-1)
5400  IF TMP<=0 THEN  5750
5410  EM(MI-1)=(YYY(MI)-YYY(MI-1))/TMP
5420  NEXT MI
5430  FOR MI = 1 TO NP
5440  IF MI=1 THEN 5520
5445  IF MI= 2 THEN 5570
5450  IF MI=(N-1) THEN 5588
5460  IF MI=N THEN 5620
5470  TEMP1= ABS(EM(MI+1)-EM(MI))
5480  TEMP2= ABS(EM(MI-1)-EM(MI-2))
5490  TEMP3= EM(MI-1)
5500  TEMP4= EM(MI)
5510  GO TO 5660
5520  TEMP1= ABS(EM(2)-EM(1))
5530  TEMP2= TEMP1
5540  TEMP3= 2.*EM(1)-EM(2)
5550  TEMP4= EM(1)
5560  GO TO 5660
5570  TEMP1= ABS(EM(3)-EM(2))
5580  TEMP2= ABS(EM(2)-EM(1))
5582  TEMP3= EM(1)
5584  TEMP4= EM(2)
5586  GO TO 5660
5588  TEMP1= ABS(EM(N-1)-EM(N-2))
5590  TEMP2= ABS(EM(N-2)-EM(N-3))
5595  TEMP3= EM(N-2)
5600  TEMP4=EM(N-1)
5610  GO TO 5660
```

```
5620  TEMP1= ABS(EM(N-1)-EM(N-2))
5630  TEMP2= TEMP1
5640  TEMP3= EM(N-1)
5650  TEMP4= 2.*EM(N-1)-EM(N-2)
5660  IF TEMP1 <=0 THEN 5665
5665  IF TEMP2 <=0 THEN 5690
5670  T(MI)=(TEMP3*TEMP1+TEMP4*TEMP2)/(TEMP1+TEMP2)
5680  GO TO 5700
5690  T(MI)=(TEMP4+TEMP3)/2.
5700  NEXT MI
5709  REM CALL AKIM(NPTS,X(),Y(),XINP,YINP,T())
5710  GO SUB 6000
5719  REM CALL AKIM(NPTS,X(),Y(),XINP,YINP,T())
5720  GO SUB 6000
5730  PRINT#3,CHR$(10)
5740  ER1$="** ERROr ** ARRAY SIZE EXCEEDED IN AKIMA,"
5742  ER2$="DIM=,####,  BUT NPTS =,####"
5745  PRINT#3,ER1$;
5747  PRINT#3,USING ER2$;KPTS;N
5750  HE1$="*** ERROR  *** X VALUES ARE NOT "
5751  HE2$="UNIQUE, AND/OR INCREASING FOR CUBIC SPLINE"
5752  CU$=" INTERPOLATION                    MJ=,"
5754  CU1$="###,XXX(MJ-1)=,#####.##, XXX(MJ)=,#####.##"
5760  PRINT#3,CHR$(10),HE$;CU$;
5765  PRINT#3,USING CU1$;MJ;XXX(MJ-1);XXX(MJ)
5770  RETURN


6000  REM  SUB AKIM(NPTS,XXX(),YYY(),XINP,FUNCT,T())
6100  REM  ----------------------------------------
6110  REM  *** INTEROLATION BY AKIMA METHOD.
6115  REM  SEE SUBROUTINE AKIMA FOR REF. PROGRAM BY
6120  REM  H.KUBIK,HYDROLOGIC ENGG. CENTER - AUG 1976
6220  REM  ****************************************
6300  NP=NPTS
6320  XIN=XINP
6340  IF NP<2 THEN  6620
6360  IF NP>2 THEN  6440
6380  REM USE LINEAR INTERPOLATION IF ONLY TWO POINTS
6400  YINP=YYY(1)+(XIN-XXX(1))/(XXX(2)-XXX(1))*(YYY(2)-YYY(1))
6420  GO TO 6600
6440  FOR II = 2 TO NP
6460  LI=II-1
6480  IF XIN<XXX(II) THEN  6520
6500  NEXT II
6520  TP1=XIN-XXX(LI)
6540  TP2=YYY(LI+1)-YYY(LI)
6560  TP3=XXX(LI+1)-XXX(LI)
6565  FUN1=((3.*TP2)/TP3-2.*T(LI)-T(LI+1))
6570  FUN2=(T(LI)+T(LI+1)-2.*TP2/TP3)
6580  YINP=YYY(LI)+T(LI)*TP1+FUN1/TP3*TP1^2+FUN2*TP1^3/TP3^2
6600  GO TO 6640
6620  PRINT#3,"** ERROR ** ONLY 1 DATA POINT FOR INTERPO."
6640  RETURN
```

```
7000  REM  SUB CHIST(N,NCLASS,XX(),SMEAN,SSD)
7100  REM  -----------------------------------
7110  REM  SUBROUTINE CHIST FINDS CHI-SQUARE STATISTIC  &
7120  '    USING EQUAL PROBABILITY METHOD
7130  REM  INPUT INFORMATION ARE AS FOLLOWS:
7135  REM  ==================================
7140  REM     XX     = THE PEAK FLOOD SERIES
7150  REM     N      = NUMBER OF XX
7160  REM     NCLASS = NO. OF CLASSES USED IN COMPUTING THE
7165  REM              CHI-SQUARE STATISTIC
7170  REM     SMEAN  = MEAN OF THE XX SERIES
7180  REM     SSD    = STANDARD DEVIATION OF THE XX SERIES
7190  REM     NDF    = NO. OF DEGREES OF FREEDOM (NCLASS-NO.
7195  REM              OF PARAMETERS -1)
7200  REM  ************************************************
7360  FOR I=1 TO NCLASS
7380  FL(I)=1/NCLASS
7400  EXPF(I)=FL(I)*N
7420  NEXT I
7440  NCLAS=NCLASS-1
7460  FOR I= 1 TO NCLAS
7480  K=I
7500  THFL(I)=K*FL(I)
7520  P=THFL(I)
7540  REM CALL PROND(P,Y,D,IE)
7545  GO SUB 8000
7560  SND(I)=TT
7580  MINP(I)=SMEAN+SSD*SND(I)
7600  OBSF(I)=0.0
7620  NEXT I
7630  TNUM=0.0
7640  J=1
7650  OBSF=0.0
7660  FOR I= 1 TO N
7680  IF (XX(I)-MINP(J))>0 THEN  7760
7700  OBSF(J)=OBSF(J)+1.
7720  TNUM=TNUM+1.
7740  GO TO 7840
7760  IF J<NCLAS THEN  7800
7780  GO TO 7860
7800  J=J+1
7820  GO TO 7680
7840  NEXT I
7860  OBSF(NCLASS)=N-TNUM
7880  REM CALCULATION OF CHI-SQUARE STATISTIC
7885  CHISQ=0.0
7900  FOR I = 1 TO NCLASS
7910  CHIS=(OBSF(I)-EXPF(I))^2/EXPF(I)
7920  CHISQ=CHISQ+CHIS
7935  NEXT I
7940  NDF=NCLASS-3
7950  PRINT#2, CHR$(10);TAB(10);
7955  NCL$="NO. OF CLASS USED    (NCLASS) =  ####"
7956  NOD$="NO. OF DEGREE OF FREEDOM (NDF)=  ####"
7957  CSS$="CHI-SQUARE STATISTIC  (CHISQ) =  ##.###"
```

```
7960  PRINT#2,USING NCL$;NCLASS
7965  PRINT#2, CHR$(10);TAB(10);
7970  PRINT#2,USING NOD$;NDF
7975  PRINT#2, CHR$(10);TAB(10);
7980  PRINT#2,USING CSS$;CHISQ
7990  RETURN


8000  REM  SUB PROND(P,TT,D,IE)
8100  REM  --------------------
8120  REM    COMPUTES X=P^(-y), THE ARGUMENT X SUCH THAT
8130  REM    Y = P(X) = THE PROBABILITY THAT THE  RANDOM
8135  REM    VARIABLE U, DISTRIBUTED NORMALLY(0,1),IS <=
8140  REM    X. F(X), THE ORDINATE OF THE NORMAL DENSITY,
8150  REM    AT X, IS ALSO COMPUTED
8190  REM  DESCRIPTION OF PARAMETERS :
8195  REM  ===========================
8200  REM     P   = INPUT PROBABILITY
8210  REM     TT  = OUTPUT ARGUMENT SUCH THAT P = Y = THE
8220  REM           PROBABILITY THAT  THE RANDOM VARIABLE
8225  REM           IS LESS THAN OR EQUAL TO TT
8230  REM     C   = OUTPUT DENSITY,F(X)
8240  REM     IE  = OUTPUT ERROR CODE
8250  REM         = -1 IF P IS NOT IN THE INTERVAL
8255  REM           (0,1),INCLUSIVE
8260  REM     TT  = C = .99999E+37 IN THIS CASE
8270  REM         = C  IF THERE IS NO ERROR
8280  REM  *********   ` SEE REMARKS BELOW '   *********
8290  REM  REMARKS  -   MAXIMUM ERROR IS 0.00045
8310  REM   IF P=0,TT IS SET TO -(10)**74. D IS SET TO C
8320  REM   IF P=1,TT IS SET TO  (10)**74. D IS SET TO C
8330  REM  SUBROUTINES AND SUBPROGRAMS REQUIRED - NONE
8360  REM  METHOD BASED ON APPROXIMATIONS IN C.HASTINGS,
8365  REM  "APPROXIMATIONS FOR DIGITAL COMPUTERS",PRINCETON
8370  REM  UNIV.PRESS,PRINCETON,N.J..,1955. SEE EQUATION 26.2.23
8375  REM  HAND BOOK OF MATHEMAICAL FUNCTIONS,ABRAMOWITZ AND
8380  REM  STEGUN, DOVER PUBLICATIONS, INC., NEW YORK.
8410  REM  ********************************************
8510  IE=C
8520  TT=0.99999E+37
8530  D=TT
8540  IF P=0 THEN 8590
8545  IF P>0 THEN 8570
8550  IE=-1
8560  GOTO 8720
8570  IF P<1.0 THEN 8620
8580  IF P=1 THEN 8600
8585  IF P>1 THEN 8550
8590  TT=-0.999999E+37
8600  D=0.0
8610  GOTO 8720
8620  D=P
8630  IF D<=0.5 THEN 8660
```

```
8650  D=1.0-D
8660  T2=LOG(1.0/(D*D))
8670  T=SQR(T2)
8680  TT1 = (2.515517+0.802853*T+0.010328*T2)
8682  TT2 = (1.0+1.432788*T+0.189269*T2+0.001308*T*T2)
8685  TT = T-TT1/TT2
8690  IF P>0.5 THEN 8710
8700  TT=-TT
8710  D=0.3989423*EXP(-TT*TT/2.0)
8720  RETURN
9000  END
```

APPENDIX - II

TEST INPUT FOR P.C.

```
77,8,0.001
   50,  100,  200,  500, 1000,10000
0.1,0.01,0.001
1901,1902,1903,1904,1905,1906,1907,1908,1909,1910,1911
1912,1913,1914,1915,1916,1917,1918,1919,1920,1921,1922
1923,1924,1925,1926,1927,1928,1929,1930,1931,1932,1933
1934,1935,1936,1937,1938,1939,1940,1941,1942,1943,1944
1945,1946,1947,1948,1949,1950,1951,1952,1953,1954,1955
1956,1957,1958,1959,1960,1961,1962,1963,1964,1965,1966
1967,1968,1969,1970,1971,1972,1973,1974,1975,1976,1977
11400,9250,7400,8550,9070,7070,7530,11500,8320,11880,6940
8320,3510,9230,7400,4700,8410,4640,6280,8150,9070,7400
5480,19130,9650,3680,7240,3680,4540,6160,3460,6150,5270
9000,5280,3310,3220,3520,2340,2430,3130,6620,4400,4220
5100,4620,4340,4880,3610,6190,4760,3810,5470,6375,4610
6365,4520,4050,5020,3880,4850,5750,6350,4010,2430,4750
5920,3320,5360,6310,5700,4920,7400,5160,3810,6790,5710
```

TEST INPUT FOR VAX - 11 / 780 COMPUTER

```
77,8,0.001
   50,  100,  200,  500, 1000,10000
0.1,0.01,0.001
1901,1902,1903,1904,1905,1906,1907,1908,1909,1910,1911 &
1912,1913,1914,1915,1916,1917,1918,1919,1920,1921,1922 &
1923,1924,1925,1926,1927,1928,1929,1930,1931,1932,1933 &
1934,1935,1936,1937,1938,1939,1940,1941,1942,1943,1944 &
1945,1946,1947,1948,1949,1950,1951,1952,1953,1954,1955 &
1956,1957,1958,1959,1960,1961,1962,1963,1964,1965,1966 &
1967,1968,1969,1970,1971,1972,1973,1974,1975,1976,1977
11400,9250,7400,8550,9070,7070,7530,11500,8320,11880,6940 &
8320,3510,9230,7400,4700,8410,4640,6280,8150,9070,7400 &
5480,19130,9650,3680,7240,3680,4540,6160,3460,6150,5270 &
9000,5280,3310,3220,3520,2340,2430,3130,6620,4400,4220 &
5100,4620,4340,4880,3610,6190,4760,3810,5470,6375,4610 &
6365,4520,4050,5020,3880,4850,5750,6350,4010,2430,4750 &
5920,3320,5360,6310,5700,4920,7400,5160,3810,6790,5710
```

APPENDIX - III : TEST OUTPUT

THE TOTAL NO. VALUES IN THE ORIGNAL SERIES ARE =

NOTE: BLOMS PLOTTING POSITION IS USED THROUGHOUT

****
* ANALYSIS OF THE ORIGINAL SERIES *
****

SL.NO.	DATA IN CHRONOLOGICAL ORDER		DATA IN ASCENDING ORDER		RANK	PROBABILITY OF NON-EXCEEDENCE
	YEAR	DISCHARGE	YEAR	DISCHARGE		
1	1901	11400	1939	2340	1	0.0081
2	1902	9250	1965	2430	2	0.0210
3	1903	7400	1940	2430	3	0.0340
4	1904	8550	1941	3130	4	0.0469
5	1905	9070	1937	3220	5	0.0599
6	1906	7070	1936	3310	6	0.0728
7	1907	7530	1968	3320	7	0.0858
8	1908	11500	1931	3460	8	0.0987
9	1909	8320	1913	3510	9	0.1117
10	1910	11880	1938	3520	10	0.1246
11	1911	6940	1949	3610	11	0.1375
12	1912	8320	1928	3680	12	0.1505
13	1913	3510	1926	3680	13	0.1634
14	1914	9230	1975	3810	14	0.1764
15	1915	7400	1952	3810	15	0.1893
16	1916	4700	1960	3880	16	0.2023
17	1917	8410	1964	4010	17	0.2152
18	1918	4640	1958	4050	18	0.2282
19	1919	6280	1944	4220	19	0.2411
20	1920	8150	1947	4340	20	0.2540
21	1921	9070	1943	4400	21	0.2670
22	1922	7400	1957	4520	22	0.2799
23	1923	5480	1929	4540	23	0.2929
24	1924	19130	1955	4610	24	0.3058
25	1925	9650	1946	4620	25	0.3188
26	1926	3680	1918	4640	26	0.3317
27	1927	7240	1916	4700	27	0.3447
28	1928	3680	1966	4750	28	0.3576
29	1929	4540	1951	4760	29	0.3706
30	1930	6160	1961	4850	30	0.3835
31	1931	3460	1948	4880	31	0.3964
32	1932	6150	1972	4920	32	0.4094
33	1933	5270	1959	5020	33	0.4223
34	1934	9000	1945	5100	34	0.4353
35	1935	5280	1974	5160	35	0.4482
36	1936	3310	1933	5270	36	0.4612
37	1937	3220	1935	5280	37	0.4741
38	1938	3520	1969	5360	38	0.4871

39	1939	2340	1953	5470	39	0.5000
40	1940	2430	1923	5480	40	0.5129
41	1941	3130	1971	5700	41	0.5259
42	1942	6620	1977	5710	42	0.5388
43	1943	4400	1962	5750	43	0.5518
44	1944	4220	1967	5920	44	0.5647
45	1945	5100	1932	6150	45	0.5777
46	1946	4620	1930	6160	46	0.5906
47	1947	4340	1950	6190	47	0.6036
48	1948	4880	1919	6280	48	0.6165
49	1949	3610	1970	6310	49	0.6294
50	1950	6190	1963	6350	50	0.6424
51	1951	4760	1956	6365	51	0.6553
52	1952	3810	1954	6375	52	0.6683
53	1953	5470	1942	6620	53	0.6812
54	1954	6375	1976	6790	54	0.6942
55	1955	4610	1911	6940	55	0.7071
56	1956	6365	1906	7070	56	0.7201
57	1957	4520	1927	7240	57	0.7330
58	1958	4050	1973	7400	58	0.7460
59	1959	5020	1922	7400	59	0.7589
60	1960	3880	1915	7400	60	0.7718
61	1961	4850	1903	7400	61	0.7848
62	1962	5750	1907	7530	62	0.7977
63	1963	6350	1920	8150	63	0.8107
64	1964	4010	1912	8320	64	0.8236
65	1965	2430	1909	8320	65	0.8366
66	1966	4750	1917	8410	66	0.8495
67	1967	5920	1904	8550	67	0.8625
68	1968	3320	1934	9000	68	0.8754
69	1969	5360	1921	9070	69	0.8883
70	1970	6310	1905	9070	70	0.9013
71	1971	5700	1914	9230	71	0.9142
72	1972	4920	1902	9250	72	0.9272
73	1973	7400	1925	9650	73	0.9401
74	1974	5160	1901	11400	74	0.9531
75	1975	3810	1908	11500	75	0.9660
76	1976	6790	1910	11880	76	0.9790
77	1977	5710	1924	19130	77	0.9919

STATISTICAL ESTIMSATES OF THE ORIGINAL SERIES ARE AS FOLLOWS :

MEAN OF THE SERIES = 60.26884E+02

STANDARD DEV OF THE SERIES = 26.40165E+02

COEFF. OF SKEWNESS OF THE SERIES = 19.35438E-01

COEFF. OF KURTOSIS OF THE SERIES = 99.32779E-01

****
* ANALYSIS OF THE LOG TANSFORMED SERIES *
****

SL.NO.	DATA IN CHRONOLOGICAL ORDER		DATA IN ASCENDING ORDER		RANK	PROBABILITY OF NON-EXCEEDENCE
	YEAR	DISCHARGE	YEAR	DISCHARGE		
1	1901	4.056904	1939	3.369216	1	0.0081
2	1902	3.966142	1965	3.385606	2	0.0210
3	1903	3.869232	1940	3.385606	3	0.0340
4	1904	3.931966	1941	3.495544	4	0.0469
5	1905	3.957607	1937	3.507856	5	0.0599
6	1906	3.849419	1936	3.519828	6	0.0728
7	1907	3.876795	1968	3.521138	7	0.0858
8	1908	4.060698	1931	3.539076	8	0.0987
9	1909	3.920123	1913	3.545307	9	0.1117
10	1910	4.074816	1938	3.546543	10	0.1246
11	1911	3.841359	1949	3.557507	11	0.1375
12	1912	3.920123	1928	3.565848	12	0.1505
13	1913	3.545307	1926	3.565848	13	0.1634
14	1914	3.965202	1975	3.580925	14	0.1764
15	1915	3.869232	1952	3.580925	15	0.1893
16	1916	3.672098	1960	3.588832	16	0.2023
17	1917	3.924796	1964	3.603144	17	0.2152
18	1918	3.666518	1958	3.607455	18	0.2282
19	1919	3.797959	1944	3.625312	19	0.2411
20	1920	3.911158	1947	3.63749	20	0.2540
21	1921	3.957607	1943	3.643453	21	0.2670
22	1922	3.869232	1957	3.655139	22	0.2799
23	1923	3.73878	1929	3.657056	23	0.2929
24	1924	4.281715	1955	3.663701	24	0.3058
25	1925	3.984527	1946	3.664642	25	0.3188
26	1926	3.565848	1918	3.666518	26	0.3317
27	1927	3.859738	1916	3.672098	27	0.3447
28	1928	3.565848	1966	3.676694	28	0.3576
29	1929	3.657056	1951	3.677607	29	0.3706
30	1930	3.789581	1961	3.685742	30	0.3835
31	1931	3.539076	1948	3.68842	31	0.3964
32	1932	3.788875	1972	3.691965	32	0.4094
33	1933	3.721811	1959	3.700704	33	0.4223
34	1934	3.954243	1945	3.70757	34	0.4353
35	1935	3.722634	1974	3.71265	35	0.4482
36	1936	3.519828	1933	3.721811	36	0.4612
37	1937	3.507856	1935	3.722634	37	0.4741
38	1938	3.546543	1969	3.729165	38	0.4871
39	1939	3.369216	1953	3.737987	39	0.5000
40	1940	3.385606	1923	3.73878	40	0.5129
41	1941	3.495544	1971	3.755875	41	0.5259
42	1942	3.820858	1977	3.756636	42	0.5388
43	1943	3.643453	1962	3.759668	43	0.5518
44	1944	3.625312	1967	3.772322	44	0.5647
45	1945	3.70757	1932	3.788875	45	0.5777

46	1946	3.664642	1930	3.789581	46	0.5906
47	1947	3.63749	1950	3.791691	47	0.6036
48	1948	3.68842	1919	3.797959	48	0.6165
49	1949	3.557507	1970	3.80003	49	0.6294
50	1950	3.791691	1963	3.802774	50	0.6424
51	1951	3.677607	1956	3.803798	51	0.6553
52	1952	3.580925	1954	3.80448	52	0.6683
53	1953	3.737987	1942	3.820858	53	0.6812
54	1954	3.80448	1976	3.83187	54	0.6942
55	1955	3.663701	1911	3.841359	55	0.7071
56	1956	3.803798	1906	3.849419	56	0.7201
57	1957	3.655139	1927	3.859738	57	0.7330
58	1958	3.607455	1973	3.869232	58	0.7460
59	1959	3.700704	1922	3.869232	59	0.7589
60	1960	3.588832	1915	3.869232	60	0.7718
61	1961	3.685742	1903	3.869232	61	0.7848
62	1962	3.759668	1907	3.876795	62	0.7977
63	1963	3.802774	1920	3.911158	63	0.8107
64	1964	3.603144	1912	3.920123	64	0.8236
65	1965	3.385606	1909	3.920123	65	0.8366
66	1966	3.676694	1917	3.924796	66	0.8495
67	1967	3.772322	1904	3.931966	67	0.8625
68	1968	3.521138	1934	3.954243	68	0.8754
69	1969	3.729165	1921	3.957607	69	0.8883
70	1970	3.80003	1905	3.957607	70	0.9013
71	1971	3.755875	1914	3.965202	71	0.9142
72	1972	3.691965	1902	3.966142	72	0.9272
73	1973	3.869232	1925	3.984527	73	0.9401
74	1974	3.71265	1901	4.056904	74	0.9531
75	1975	3.580925	1908	4.060698	75	0.9660
76	1976	3.83187	1910	4.074816	76	0.9790
77	1977	3.756636	1924	4.281715	77	0.9919

STATISTICAL ESTIMSATES OF THE LOG TRANSFORMED SERIES ARE AS FOLLOWS :

MEAN OF THE SERIES = 37.45347E-01

STANDARD DEV OF THE SERIES = 17.19228E-02

COEFF. OF SKEWNESS OF THE SERIES = 23.99446E-02

COEFF. OF KURTOSIS OF THE SERIES = 34.12415E-01

NO. OF CLASS USED (NCLASS) = 8

NO. OF DEGREE OF FREEDOM (NDF)= 5

CHI-SQUARE STATISTIC (CHISQ) = 1.026

ESTIMATED FLOOD PEAKS

SL.NO.	RECURRENCE INTERNAL	ESTIMATED FLOOD
1	50 YEARS	12546.
2	100 YEARS	13976.
3	200 YEARS	15426.
4	500 YEARS	17387.
5	1000 YEARS	18909.
6	10000 YEARS	24252.

****
* ANALYSIS OF THE POWER TRANSFORMED SERIES *
****

SL.NO.	DATA IN CHRONOLOGICAL ORDER		DATA IN ASCENDING ORDER		RANK	PROBABILITY OF NON-EXCEEDENCE
	YEAR	DISCHARGE	YEAR	DISCHARGE		
1	1901	4.385721	1939	4.069888	1	0.0081
2	1902	4.349248	1965	4.078567	2	0.0210
3	1903	4.308681	1940	4.078567	3	0.0340
4	1904	4.335137	1941	4.135209	4	0.0469
5	1905	4.345744	1937	4.141385	5	0.0599
6	1906	4.300175	1936	4.147359	6	0.0728
7	1907	4.311909	1968	4.14801	7	0.0858
8	1908	4.387214	1931	4.156899	8	0.0987
9	1909	4.330198	1913	4.159969	9	0.1117
10	1910	4.392751	1938	4.160578	10	0.1246
11	1911	4.296694	1949	4.165959	11	0.1375
12	1912	4.330198	1928	4.170035	12	0.1505
13	1913	4.159969	1926	4.170035	13	0.1634
14	1914	4.348862	1975	4.177366	14	0.1764
15	1915	4.308681	1952	4.177366	15	0.1893
16	1916	4.220687	1960	4.181192	16	0.2023
17	1917	4.33215	1964	4.188082	17	0.2152
18	1918	4.218085	1958	4.190149	18	0.2282
19	1919	4.277735	1944	4.198672	19	0.2411
20	1920	4.326442	1947	4.204445	20	0.2540
21	1921	4.345744	1943	4.207261	21	0.2670
22	1922	4.308681	1957	4.212759	22	0.2799
23	1923	4.251301	1929	4.213658	23	0.2929
24	1924	4.470094	1955	4.216769	24	0.3058
25	1925	4.356753	1946	4.217209	25	0.3188
26	1926	4.170035	1918	4.218085	26	0.3317
27	1927	4.304615	1916	4.220687	27	0.3447
28	1928	4.170035	1966	4.222825	28	0.3576
29	1929	4.213658	1951	4.22325	29	0.3706

30	1930	4.274034	1961	4.227023	30	0.3835
31	1931	4.156899	1948	4.228263	31	0.3964
32	1932	4.273721	1972	4.229901	32	0.4094
33	1933	4.243594	1959	4.233928	33	0.4223
34	1934	4.344359	1945	4.237083	34	0.4353
35	1935	4.243969	1974	4.23941	35	0.4482
36	1936	4.147359	1933	4.243594	36	0.4612
37	1937	4.141385	1935	4.243969	37	0.4741
38	1938	4.160578	1969	4.246941	38	0.4871
39	1939	4.069888	1953	4.250942	39	0.5000
40	1940	4.078567	1923	4.251301	40	0.5129
41	1941	4.135209	1971	4.259007	41	0.5259
42	1942	4.287783	1977	4.259349	42	0.5388
43	1943	4.207261	1962	4.260709	43	0.5518
44	1944	4.198672	1967	4.266367	44	0.5647
45	1945	4.237083	1932	4.273721	45	0.5777
46	1946	4.217209	1930	4.274034	46	0.5906
47	1947	4.204445	1950	4.274967	47	0.6036
48	1948	4.228263	1919	4.277735	48	0.6165
49	1949	4.165959	1970	4.278648	49	0.6294
50	1950	4.274967	1963	4.279856	50	0.6424
51	1951	4.22325	1956	4.280307	51	0.6553
52	1952	4.177366	1954	4.280607	52	0.6683
53	1953	4.250942	1942	4.287783	53	0.6812
54	1954	4.280607	1976	4.292578	54	0.6942
55	1955	4.216769	1911	4.296694	55	0.7071
56	1956	4.280307	1906	4.300175	56	0.7201
57	1957	4.212759	1927	4.304615	57	0.7330
58	1958	4.190149	1973	4.308681	58	0.7460
59	1959	4.233928	1922	4.308681	59	0.7589
60	1960	4.181192	1915	4.308681	60	0.7718
61	1961	4.227023	1903	4.308681	61	0.7848
62	1962	4.260709	1907	4.311909	62	0.7977
63	1963	4.279856	1920	4.326442	63	0.8107
64	1964	4.188082	1912	4.330198	64	0.8236
65	1965	4.078567	1909	4.330198	65	0.8366
66	1966	4.222825	1917	4.33215	66	0.8495
67	1967	4.266367	1904	4.335137	67	0.8625
68	1968	4.14801	1934	4.344359	68	0.8754
69	1969	4.246941	1921	4.345744	69	0.8883
70	1970	4.278648	1905	4.345744	70	0.9013
71	1971	4.259007	1914	4.348862	71	0.9142
72	1972	4.229901	1902	4.349248	72	0.9272
73	1973	4.308681	1925	4.356753	73	0.9401
74	1974	4.23941	1901	4.385721	74	0.9531
75	1975	4.177366	1908	4.387214	75	0.9660
76	1976	4.292578	1910	4.392751	76	0.9790
77	1977	4.259349	1924	4.470094	77	0.9919

STATISTICAL ESTIMSATES OF THE POWER TRANSFORMED SERIES ARE AS FOLLOWS :

VALUE OF LAMDA = -18.90002E-02

MEAN OF THE SERIES = 42.51416E-01

STANDARD DEV OF THE SERIES = 77.22943E-03

COEFF. OF SKEWNESS OF THE SERIES = -81.22850E-06

COEFF. OF KURTOSIS OF THE SERIES = 32.02708E-01

NO. OF CLASS USED (NCLASS) = 8

NO. OF DEGREE OF FREEDOM (NDF)= 5

CHI-SQUARE STATISTIC (CHISQ) = 1.234

ESTIMATED FLOOD PEAKS

SL.NO.	RECURRENCE INTERNAL	ESTIMATED FLOOD
1	50 YEARS	13168.
2	100 YEARS	14966.
3	200 YEARS	16872.
4	500 YEARS	19583.
5	1000 YEARS	21797.
6	10000 YEARS	30344.

REQUIRED VALUES FOR KURTOSIS CORRECTION ARE:

COEFF. OF KURTOSIS (CK) = 0.20

CORRESPONDING VALUE OF BETA = 0.10

KURTOSIS CORRECTED STANDARD DEVIATES CORRESPONDING TO THE COMPUTED CK

BETA	ALPHA 0.25	ALPHA 0.10	ALPHA 0.05	ALPHA 0.025	ALPHA 0.01	ALPHA 0.005	ALPHA 0.001
0.10	0.649	1.268	1.644	1.985	2.384	2.658	3.223

ESTIMATED FLOOD PEAKS

SL.NO.	RECURRENCE INTERNAL	ESTIMATED FLOOD
1	50 YEARS	13392.
2	100 YEARS	15380.
3	200 YEARS	17561.
4	500 YEARS	21298.
5	1000 YEARS	23326.
6	10000 YEARS	25475.