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DATA ANALYSIS SOFTWARE FOR THE AUTORADIOGRAPHIC ENHANCEMENT PROCESS, Vols. 1, 2, and 3, and Appendix

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16. ABSTRACT

This report presents the computer software developed to set up a method for Wiener spectrum analysis of photographic films. This method is used for the quantitative analysis of the autoradiographic enhancement process.

Volume 1 presents the software requirements and design for the autoradiographic enhancement process, Volume 2 contains the program listings, and Volume 3 is the users manual. The Appendix, containing a software description and program listings, is a modification of the data analysis software presented in the main text of the report and should be used in conjunction with it.

17. KEY WORDS

Autoradiographic enhancement process

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VOLUME 1

SOFTWARE REQUIREMENTS AND DESIGN FOR EVALUATION OF THE AUTORADIOGRAPHIC ENHANCEMENT PROCESS

PREFACE

This is the Software Requirements and Software Design Document for the evaluation of the Wiener Spectrum and Modulation Transfer Function of the Autoradiographic Enhancement Process.

This report is Volume 1 of the Final Report prepared by ESPEE, INC. under Contract No. NAS8-33405 for the Space Sciences Laboratory of the George C. Marshall Space Flight Center. This Volume 1 is an update of and supersedes an earlier report dated December 31, 1978. The NASA COR for this contract is Dr. C. A. Lundquist.

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1. INTRODUCTION

1.1 Objective: The objective of this work is to develop capabilities to evaluate the Wiener Spectrum and Modulation Transfer Function of the autoradiographic enhancement process. The autoradiographic enhancement process is a technique for increasing the amount of information which is recovered from photographic film, plates and prints. The technique consists of radioactivating the image silver by chemically combining it with a beta emitting isotope, sulfur-35; the autoradiograph, an enhanced copy of the underexposed image, is made by exposing a second film to the radiation from the underexposed original. The efficient response of the photographic emulsion to beta radiation produces an autoradiograph image which is enhanced in density and contrast so that images which were invisible or only faintly visible on the original film can be easily seen on the autoradiograph.

The Perkin-Elmer 1010A Microdensitometer is used to generate raw data from film.

Evaluation of the Wiener Spectrum and Modulation Transfer Function provides a measure of effectiveness of image recovery in terms of signal-to-noise ratio and detective quantum efficiency. It is the quantitative evaluation of the information transfer due to autoradiographic intensification.

Software is being developed to provide data analysis capabilities for autoradiographic image processing and other image processing applications where the microdensitometer is being used. The data analysis capabilities shall be developed on the NOVA 2 computer located in room 369 of building 4481. While IDAPS provides many of the analysis capabilities to be developed on the NOVA, IDAPS is designed for only 8-bits of resolution while the microdensitometer output provides 12-bits of resolution. For the autoradiographic enhancement process, the 12-bits of resolution is definitely needed, especially for signal to noise ratio calculations. Also, the data on microdensitometer output tape cannot be used as is with IDAPS because of header information included in each data record and because of the 12-bit length of the data.

The effort reported in this document is the software requirements definition and the preliminary software design of the analysis capabilities to be implemented on NOVA 2.

2. SYSTEM CONFIGURATION

Figure 2.1 illustrates the system configuration for data analysis. The piece of film is scanned by the microdensitometer and the image density is recorded on a 9-track, 800 BPI magnetic tape. The tape is input to the NOVA 2 where the data is analyzed and a copy of the results is obtained from the Textronix 4014 hard copy unit.

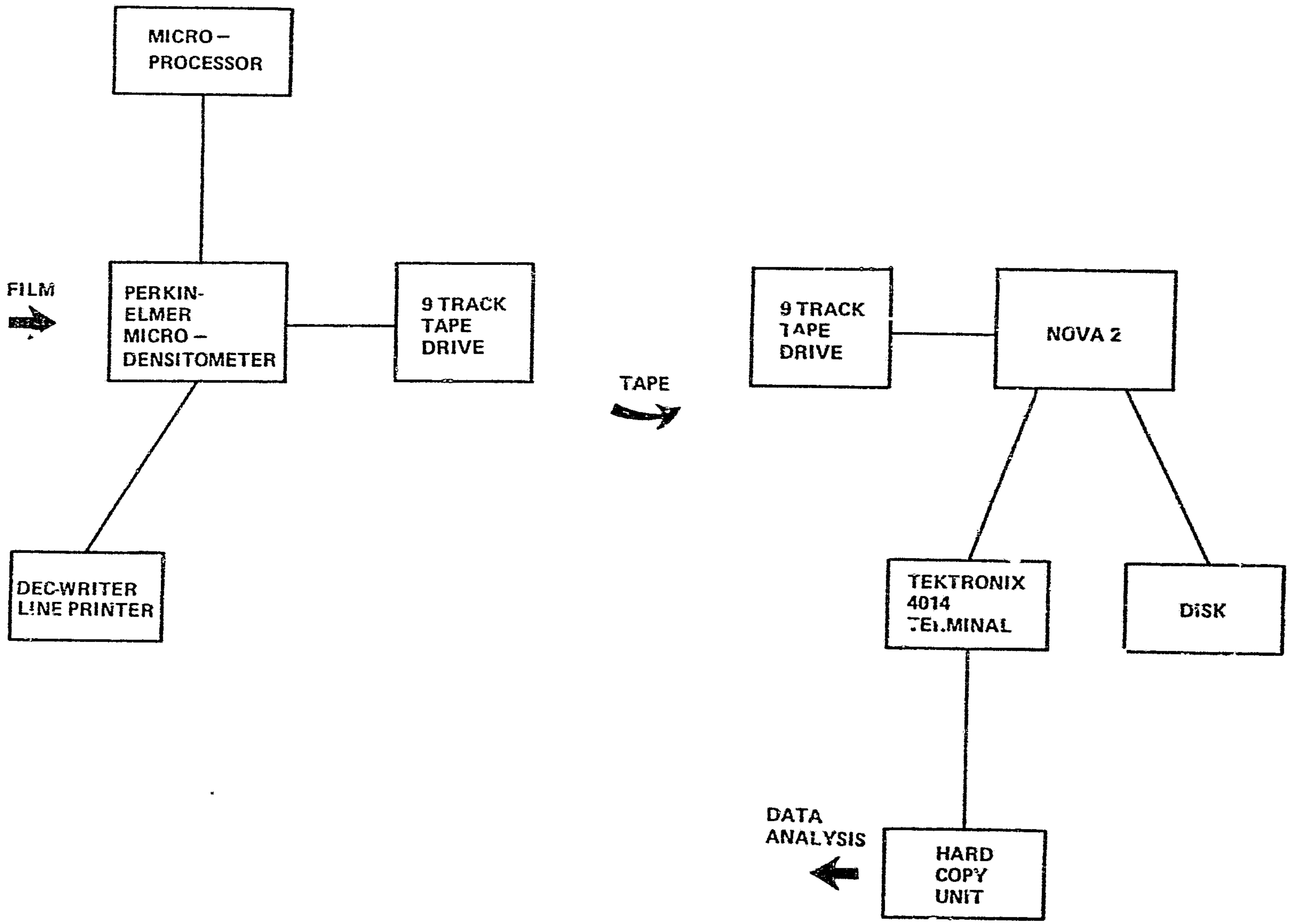


Figure 2.1 System Configuration

3. REQUIREMENTS FOR SOFTWARE DEVELOPMENT

The software shall be designed to analyze the film-scan data obtained from the Perkin-Elmers Microdensitometer.

3.1 Inputs

The Inputs to the software shall be:

(1) The microdensitometer output tape

(2) User-specified variables

3.1.1 Microdensitometer Output Tape

The data from the microdensitometer output tape is obtained via a 9-track magnetic tape. The tape data format is illustrated in Figure 3.1.

A magnetic tape record is generated by the microdensitometer control system at the conclusion of each scan line, or segment thereof. Termination of the record consists of an IBM-compatible Inter-Record-Gap.

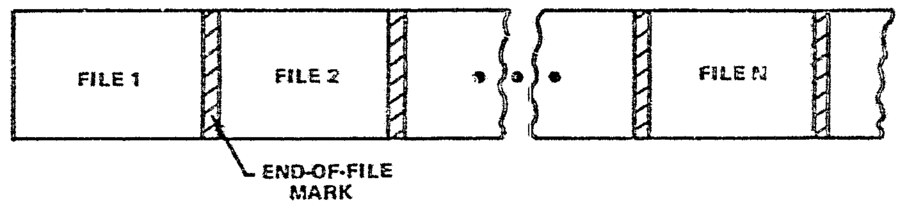
After the last record has been written for a given scanning program, the microdensitometer control system causes the writing of an IBM-compatible standard End of File Mark.

Tape Format:

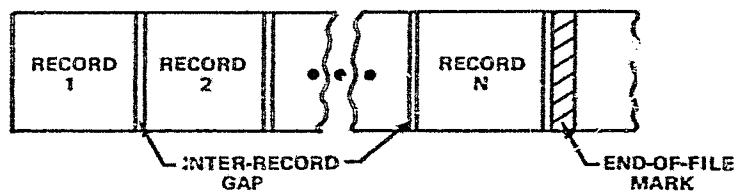
1. Start of Record - Two tape characters containing the hexidecimal characters "F F F F". These characters have no relation or value relative to any of the data to follow.

2. Identification - Forty tape characters, each containing an eight-bit byte representing the ASCII code for the alphanumeric characters entered during the IDENT mode of operation.

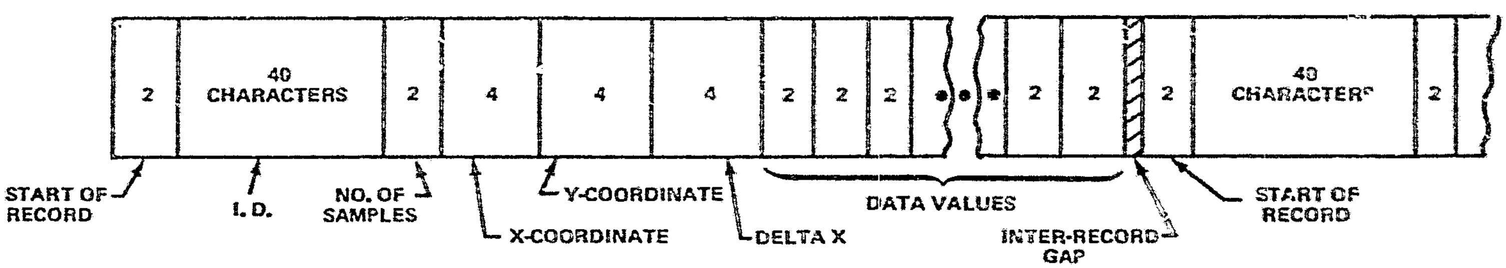
3. Number of Samples - Two tape characters containing a sixteen-bit binary number representing the (positive) number of data values included in the record, following completion of the coordinate information.



A. FILE FORMAT ON TAPE



B. RECORD FORMAT ON FILE



C. DATA FORMAT ON RECORD

Figure 3.1 Data Format of the Microdensitometer Output Tape

Tape Format (cont'd):

4. X-Coordinate - Four tape characters containing a thirty-two bit binary number representing the position along the X-axis at which the current scan line commenced. The number is justified to the LSB end of the word; a negative position is indicated as a two's complement of the absolute value. All position readings are in microns.

5. Y-Coordinate - Four tape characters containing a thirty-two bit binary number representing the Y-axis coordinate at which the current scan line commenced. Interpretation as noted above.

6. Delta X - Four tape characters containing a thirty-two bit binary number representing the sampling interval along the X-axis. Interpretation as above. (A negative number indicates that the direction of scanning was negative.)

7. Data Values in Buffer - Two tape characters for each of the data values enumerated in "3" above. Each pair of characters contains a sixteen-bit binary number, the leading twelve bits of which are significant. The final four bits are to be discarded. Interpretation of the data is as follows: Convert the binary number to decimal and divide by 800. The quotient is the data value for the density or transmittance reading, as recorded during the scan.

The data corresponding to a scan line is stored on one record provided the number of samples is no greater than 3200. If the number of samples per scan line is greater than 3200, then the scan line data is segmented and stored on more than one record on tape. Start of each new scan line, however, causes a new record to be written.

3.1.2 User-Specified Variables

The following user-specified variables are supplied in response to software-query:

(a) No. of File NF, to be read from the microdensitometer tape.

(b) The Diffuse Density Factor, DD

(c) The Maximum Lag Factor, M

(d) The Length of the scanning slit, SL

3.2 Analysis Capabilities

The software shall be designed to have the following data analysis capabilities:

(1) Compute Histograms

(2) Filter Data

(3) Compute Means

(4) Compute Standard Deviation

(5) Compute Autocorrelation Functions

(6) Compute Power Spectral Density Functions

The software shall be designed to permit future capabilities to be developed and integrated with the existing software.

3.2.1 Histograms

The density data range from a scan frame shall be divided into fifty classes. The data from a scan frame shall be distributed over these classes to generate a histogram.

3.2.2 Filters

The software shall have the capability to filter raw data from the microdensitometer. The specific filter or filters are yet to be determined.

3.2.3 Means

The software shall have the capability to compute mean of the raw data and mean of the data normalized by a diffuse density factor. The software shall normalize data to zero mean.

3.2.4 Standard Deviation

The software shall have the capability to compute mean square value and standard deviation of the data

3.2.5 Autocorrelation Functions

Using the user-specified maximum lag factor, the software shall be capable of computing autocorrelation functions and also of normalizing autocorrelations functions with respect to zero-lag autocorrelation function.

3.2.6 Power Spectral Density

The software shall be capable of computing power spectral density functions. It shall also compute smoothed power spectral density functions.

3.3 Outputs

The software shall have the following outputs:

(1) Data Identification from Microdensitometer Tape

(2) Raw data mean

(3) Mean Square Value

(4) Standard Deviation Value

(5) Histogram table

(6) Autocorrelation and Normalized Autocorrelation Functions

(7) Power Spectral Density and Smoothed Power Spectral Density Functions.

4. PRELIMINARY SOFTWARE DESIGN

The software design is modular. An overview of the preliminary software design showing the top-modules is illustrated in Figure 4.1. The main program calls independent modules which implement unique data input, data preparation and data analysis capabilities. The sequence of execution is top-down and left to right.

4.1 Structure Charts

The detailed software design is presented in structure charts shown in Figures 4.2 thru 4.4 and the HIPO's of section 4.2. The sequence of execution of modules in the structure chart is top-down and left to right. Each module has one entry and one exit. Control always returns to the next statement in the calling module. Arrows on a line indicate multiple calls. Arrows on a group of lines indicate multiple sequence of calls.

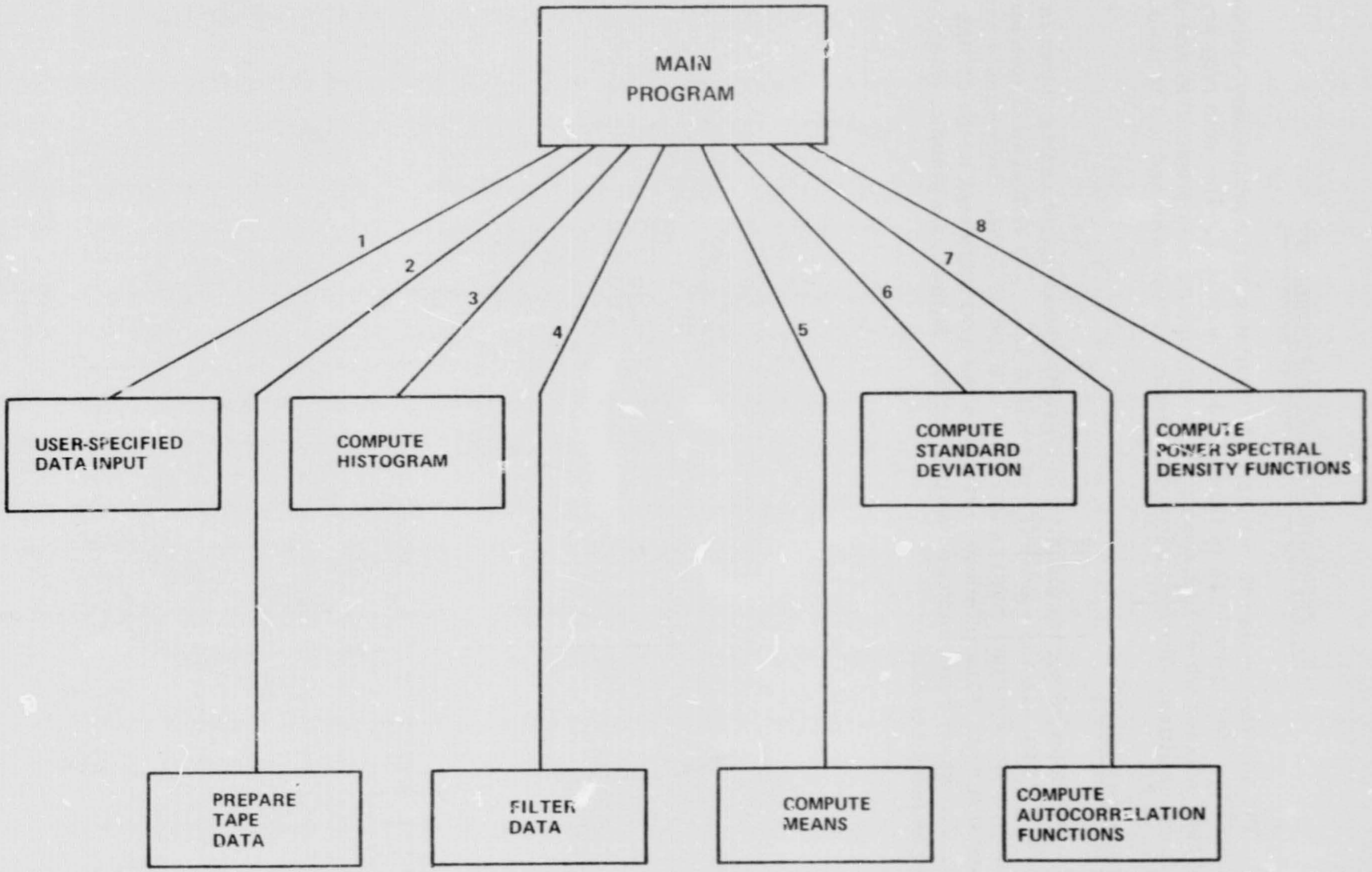


Figure 4.1 Microdensitometer Data Analysis Software Design Overview

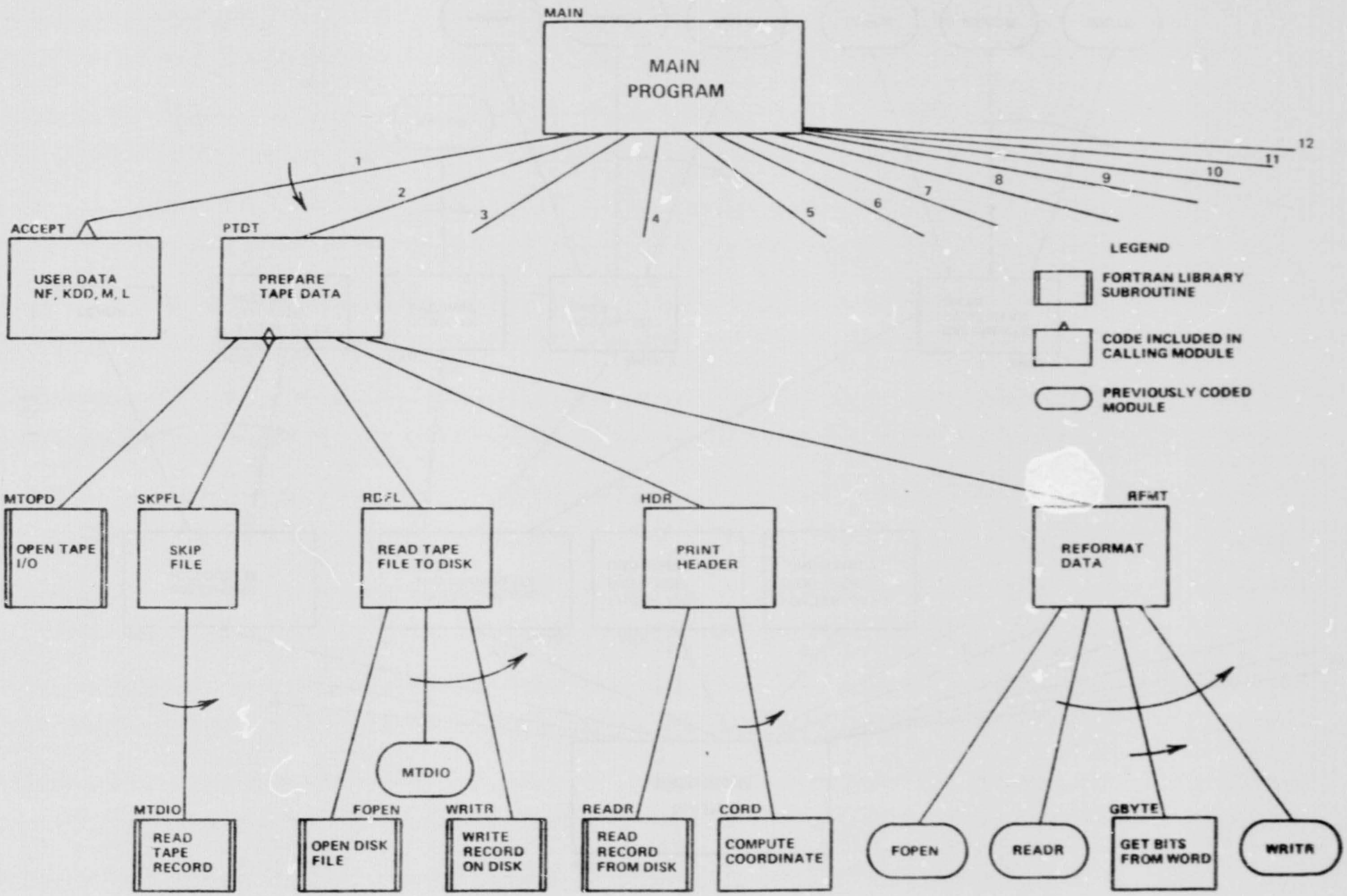


Figure 4.2 Partial Structure Chart – Data Preparation Modules

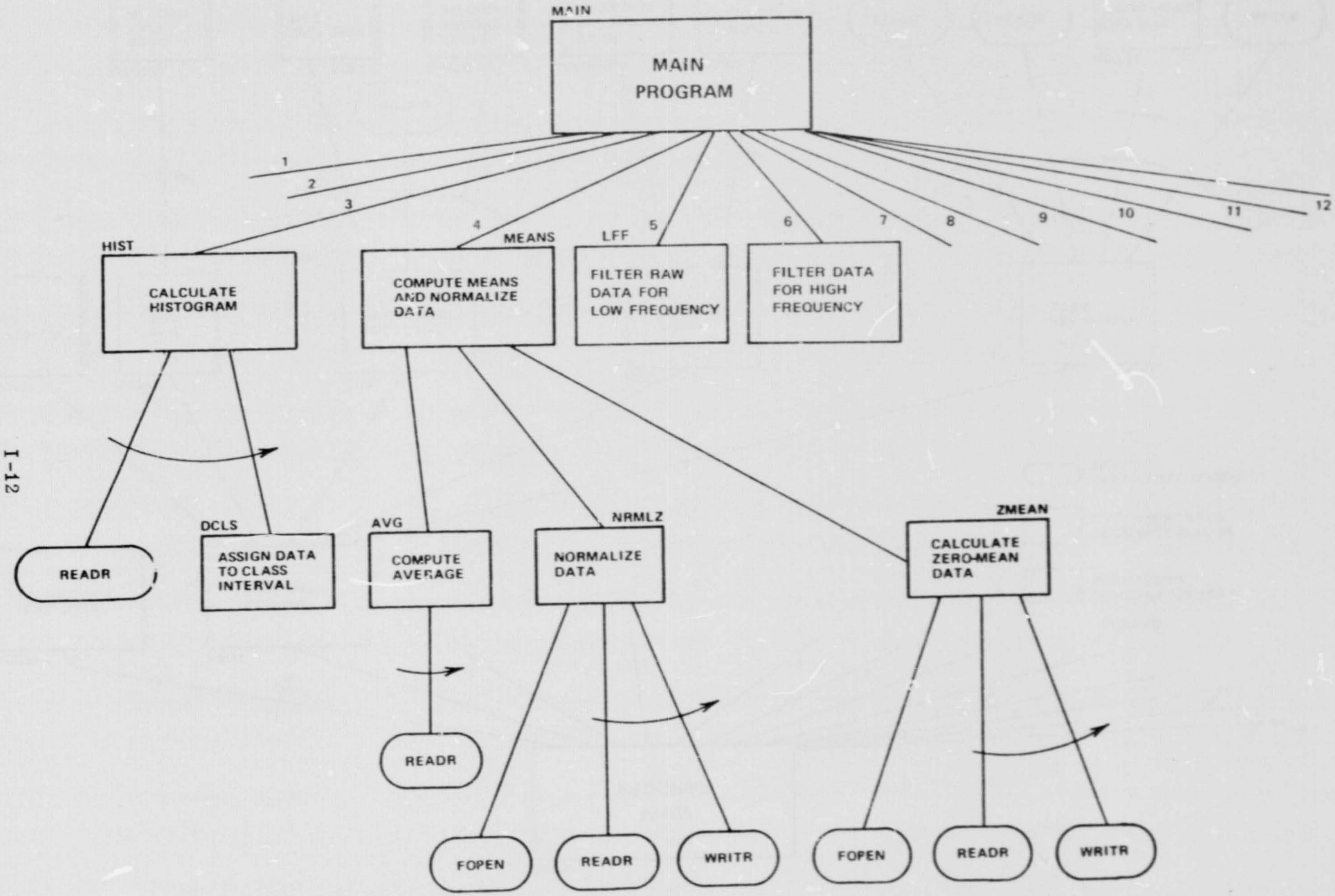


Figure 4.3 Partial Structure Chart – Data Analysis Modules (Part 1)

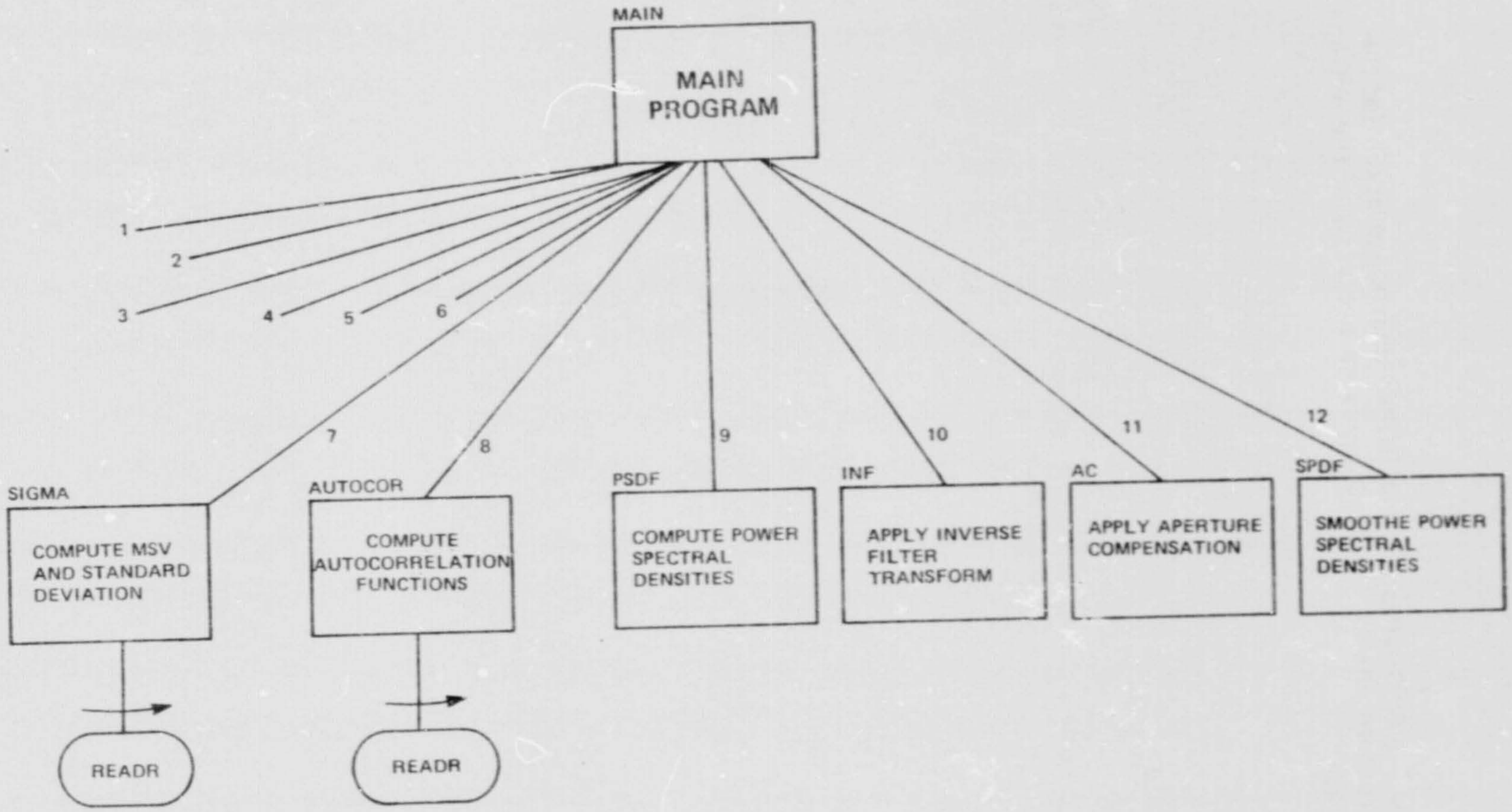


Figure 4.4 Partial Structure Chart – Data Analysis Modules (Part 2).

4.2 HIPO'S

The Hierarchical Input-Process-Output (HIPO) charts are given for the modules shown on the structure charts. A HIPO gives an overview of the actions performed within a module.

4.2.1 HIPO-MAIN

PURPOSE: Main accepts the user-supplied data and calls other modules for preparation of tape data and data analysis

Step No.	Input	Process	Output
1.	User supplied data	Ask for and Read from progremmer's console the File No. NF, the diffuse density factor KDD, the max lag factor M and length of scanning slit L.	NF, KDD M, L
2.	NF, tape	Call (a module) PTDT to prepare disk file from tape data and to get H = Delta X.	RD, NP, H
3.	RD, NP, A, B, NC	Call HIST to prepare histogram	
4.	RD, NP	Call FILT to filter raw data	FD
5.	RD, NP, KDD	Call MEANS to compute mean,convert data to density units and to normalize data to zero mean	ZRD
6.	ZRD, NP	Call SIGMA to compute standard deviation and Mean Square Value	
7.	ZRD NP, M	Call AUTOCOR to compute (M + 1) autocorrelation functions and to normalize w.r.t. autocorrelation with r = 0.	RRH
8.	RRH, H, L, M	Call PSDF to compute $\widetilde{G}_k$ AND $\hat{G}_k$.	GKC, GKH
9.		STOP	

1.2.2 HIFO-PTDT

Purpose: PTDT prepares disk file of raw data from tape data.

Step No.	Input	Process	Output
1.	Tape	Call MTOPD to position tape at device MTφ	
2.	NF	If (NF.GT.1) call SKPFL to skip files on tape to come to file no. NF	
3.		Call RDFL to read File No. NF from tape into disk file TD. NR is number of records. NW is array of no. of words in each record.	TD, NW, NR
4.		Call HDR to print header information and get delta X = NH	NH
5.	TD, NW NR	Call RFMT to reformat data in disk File TD to raw data in disk file RD	RD, NP
6.		RETURN	

1.2.3 HIPO-SKPFL

Purpose: SKPFL skips files on tape to read file no. NF.

Step No.	Input	Process	Output
1.	NF	Call MTDIO to read one record from tape and word-count ICNT in that record.	ICNT
2.	ICNT	If ICNT is greater than 1, go to step 1	
3.	ICNT	If ICNT = 1, this indicates EOF.	
4.	KFL	Increment file counter KFL.	KFL
5.	NF	If KFL = NF, RETURN	
6.		Else go to step 1.	

4.2.4 HIPO-RDFL

Purpose: RDFL reads data from a tape file into a disk file

Step No.	Input	Process	Output
1.		Call FOPEN to open a disk file TD to receive tape data	TD
2.		Call MTDIO to read one record from tape into Temporary array INPBUF	INPBUF, ICNT
3.	ICNT	If ICNT = 1 (EOF), then go to step 6.	
4.	INPBUF	Else record number of records, no. of words per record and call WRITR to put data in file TD.	TD
5.		Go to step 2	
6.		Return	

4.2.5 HIPO-HDR

Purpose: HDR reads first record in disk file TD and prints I.D. and computes H = Delta X.

Step No.	Input	Process	Output
1.	TD	Call READR to read first record from disk file TD to Temp. array ITEMP	ITEMP
2.	ITEMP	Print ID in words 2 through 21 of ITEMP	
3.	ITEMP	Print no. of samples = ITEMP (22)	
4.	ITEMP	Call CORD 3 times to compute X, Y coordinates and Delta X. After each call, print the coordinates and Delta X = NH.	NH
5.		Return	

4.2.6 HIPO-CORD

Purpose: CORD computes X, Y coordinates and Delta X from 2 input words for each value

Step No.	Input	Process	Output
1.	ITEMP, J	Load a double precision word IWD with 2 input words	IWD
2.	IWD	If an input word is negative, use special techniques for loading into IWD.	IWD
3.		Return	

4.2.7 HIPO-RFMT

Purpose: RFMT reformats sample values data in disk file TD and loads the data values only into disk file RD.

Step No.	Input	Process	Output
1.		Call FOPEN to open disk file RD	RD
2.	TD	Call READR to read a record from file TD into temporary array ITEMP	ITEMP
3.	ITEMP, NR, NW	Call GBYTE to get 12 most significant bits from each data point (words 29 through NW for each of NR records) and store them in Temp. array JTEMP.	JTEMP
4.	JTEMP, NR	Call WRITR to write JTEMP in file RD.	RD
5.		Repeat steps 3 and 4 NR times	
6.	NW	Compute No. of data points NP in each record	NP
7.		READ a record from file RD and print it for verification.	ITEMP
8.		RETURN	

4.2.8 HIPO-HIST

Purpose: HIST computes the histogram for the raw data.

Step No.	Input	Process	Output
1.	RD, NW	Call READR to read a record from RD file into temporary array ITEMP	ITEMP
2.	ITEMP, IC, NPI	Call DCLS to distribute data in ITEMP into class intervals.	NHST
3.	NHST	Sum NHST into MST by repeating steps 1 and 2 for NR records	MST
4.	MST	Find IMIN and IMAX such that MST has nonzero entires between IMIN and IMAX	IMIN, IMAX
5.	IMIN, IMAX, MST	Type MST values	
6.		Return	

4.2.9 HIPO-DCLS

Purpose: DCLS assigns each data value to a class interval for calculating histogram.

Step No.	Input	Process	Output
1.	ITEMP, IC, NPI	Compute integer part of (ITEMP (J)/IC) = I for one value of J.	I
2.	I	Increment NHST (I) by 1.	NHST
3.		Repeat steps 1 and 2 for NPI points	
4.		Return	

4.2.10 HIPO-MEANS

Purpose: MEANS calls other modules to compute mean of raw data and normalize data to diffuse density units and zero mean.

Step No.	Input	Process	Output
1.	ICH, NR, NP	Call AVG to compute raw mean.	RAWM
2.	KDD	Compute the diffuse density multiplier DDM from KDD as DDM = KDD/RAWM	DDM
3.	DDM, ICHR, NR, NP, ICHN	Call NRMLZ to normalize data to diffuse density units.	
4.	KDD	Print mean of normalized data KDD.	
5.	ICHN, ICHZ, NR, NP, KDD	Call ZMEAN to normalize data to zero mean	
6.		Return	

4.2.11 HIPO-AVG

Purpose: AVG computes the mean (average) of a group of records on a disk file.

Step No.	Input	Process	Output
1.		Call READR to read a record from file RD into Temp. array ITEMP.	ITEMP
2.	NP, ITEMP	Compute cumulative sum ISUM of points in ITEMP	ISUM
3.	NP	Compute cumulative sum of number of points in each record.	INP
4.	NR	Repeat steps 1, 2 and 3 for NR records	ISUM
5.	INP, ISUM	Compute Mean RAWM = ISUM/INP	RAWM
6.	RAWM	Print RAWM	
7.		Return	

4.2.12 HIPO-NRMLZ

Purpose: NRMLZ normalizes data in a disk file by multiplying it with a factor and stores it in another disk file.

Step No.	Input	Process	Output
1.	ICHN	Call FOPEN to open a file on disk	
2.		Call READR to read a record into Temp array	TEMP
3.	DDM,	Multiply each of NPI data values by DDM	TEMP
4.	TEMP	Call WRITR to write TEMP in disk file NRD	
5.	NR	Repeat steps 2, 3 and 4 for NR records	
6.		Return	

4.2.13 HIPO-ZMEAN

Purpose: ZMEAN normalizes data on a disk file by subtracting the data mean factor from each value. It stores the resulting data in another disk file.

Step No.	Input	Process	Output
1.	ICHZ	Call FOPEN to open a file on disk	
2.	ICHN	Call READR to read a record into temporary array TEMP	TEMP
3.	KDD, NPI	Subtract KDD from each of NPI data values	TEMP
4.	TEMP	Call WRITR to write TEMP into a disk file ZRD	
5.	NR	Repeat steps 2, 3 and 4 for NR records	
6.		Return	

4.2.14 HIPO-SIGMA

Purpose: SIGMA computes the mean square value and root mean square value of data in a disk file.

Step No.	Input	Process	Output
1.	ICH	Call READR to read a record from file ZRD into Temp array TEMP	TEMP
2.	NPI, TEMP	Compute cumulative sum of squares, SSQ for NPI data values in TEMP	SSQ
3.	NP	Compute sum of no. of values for NR records	INP
4.	NR	Repeat steps 1, 2 and 3 for NR records	SSQ
5.	INP, SSQ	Compute XSQ = SSQ/INP	XSQ
6.	XSQ, INP	Compute SIG = $(XSQ*NP/(NP-1))^{1/2}$	SIG
7.	XSQ, SIG	Print XSQ and SIG	
8.		Return	

4.2.15 HIPO-AUTOCOR

Purpose: AUTOCOR computes the autocorrelation and normalized autocorrelation functions.

Step No.	Input	Process	Output
1.		Set XT, RAT, TEMP to zero	XT
2.	ICHZ	Call READR to read a record from file ZRD into Temp	TEMP
3.	NP	Compute cumulative sum INP	INP
4.	TEMP, M	Shift data value contents of TEMP down by M	TEMP
5.	M, XT, TEMP	Transfer contents of XT into first M values of TEMP	TEMP
6.	M, XT, TEMP	Transfer last M data values in TEMP to XT	XT
7.	RAT, TEMP	For JR = 0 through M, compute cumulative sum for I = 1 to NPI,RAT (JR+1) = RAT (JR+1) + TEMP (I)* TEMP (I + JR)	RAT
8.	NR	Repeat steps 2 through 7 for NR records	
9.		Set TEMP to zero and do steps 5 and 7 one time	RAT
10.	RAT, MR	Compute RAT (J)/(INP-J+1) for J = 1, MR	RAT
11.	RAT, MR	Compute normalized autocorrelations function RATN (J) = RAT (J)/RAT (1) for J = 1 through MR	RATN
12.		Print J, RAT(J) and RATN(J)	
13.		Return	

4.2.16 HIPO:LFF

Purpose: LFF is the low frequency filter applied to raw data before standard deviation, autocorrelation and power spectral density functions are computed.

Step No	Input	Process	Output
1	NP,P	Compute number of records in which the first (2P+1) points lie.	NREC
2	P,NP	Compute the record number in which the (P+1)th point lies.	QUO
3	TEMP1,P	Calculate sum of first (2P+1) points.	SUM
4	QUO,P,NP	Calculate location of (P+1)th point in record no. QUO.	LOC1
5	TEMP1, LOC1, SUM, P	Compute new (P+1)th point as TEMP1(LOC1) = TEMP1(LOC1) - SUM/(2P+1) and store TEMP1 on disk.	TEMP1
6	NP,N,P	For I = (P+2) to (N-P), where N is the total number of points, compute record nos. in which points I, I-P-1 and I+P lie.	REC1, REC2, REC3
7	REC1, REC2, REC3, NP	Calculate location of points I, I-P-1 and I+P in their respective records.	LOC1, LOC2, LOC3
8	REC1, REC2, REC3	Read respective records from disk.	TEMP1, TEMP2, TEMP3
9	LOC2,LOC3 TEMP2, TEMP3	Calculate SUM = SUM-TEMP2(LOC2) + TEMP3(LOC3)	SUM
10	TEMP1,LOC1 SUM,P	Calculate XT = TEMP1(LOC1) - SUM/(2P+1) and store on disk at TEMP1(LOC1).	XT, TEMP1
11		Repeat steps 6 through 10 till done.	
12		Return.	

4.2.17 HIPO:HFF

Purpose: HFF is the high frequency filter applied to output data of the low frequency filter.

Step No	Input	Process	Output
1	NP,Q	Calculate number of records in which the first (2Q+1) points lie.	NREC
2	Q,NP	Compute the record numb-r in which the (Q+1)th point lies.	QUO
3	TEMP1,Q	Calculate sum of first (2Q+1) points	SUM
4	QUO,Q,, NP	Calculate location of (Q+1)th point in record No. QUO.	LOC1
5	Q,SUM	Calculate new (Q+1)th point as TEMP1(LOC1) = SUM/(2Q+1) and store TEMP1 on disk.	TEMP1 (LOC1)
6	NP,N,Q	For I = (Q+2) to (N-Q), where N is the total number of points, compute record numbers in which points I, I-Q-1 and I+Q lie.	REC1, REC2, REC3
7	REC1, REC2, REC3,NP	Calculate location of points I, I-Q-1 and I+Q in their respective records.	LOC1, LOC2, LOC3
8	REC1, REC2, REC3	Read REC1, REC2 and REC3 from disk.	TEMP1, TEMP2, TEMP3
9	LOC2, LOC3, TEMP2, TEMP3	Calculate SUM = SUM - TEMP2(LOC2) + TEMP3(LOC3)	SUM
10	SUM,Q	Calculate XT = SUM/(2Q+1) and store on disk at TEMP1(LOC1)	XT,TEMP1
11		Repeat steps 6 though 10 till done.	
12		Return.	

4.2.18 HIPO-PSDF

Purpose: PSDF computes the power spectral densities from the autocorrelation function.

Step No	Input	Process	Output
1	RAT, MR, L, H	For KR = 1, . . . , MR, compute $GKC(KR) = 2HL \left[RAT(1) + 2 \sum_{JR=1}^{MR-2} RAT(JR+1) \cdot \cos(\pi \cdot JR \cdot (KR-1)/(MR-1)) + RAT(MR)(-1)^{KR-1} \right.$	GKC
2		Return.	

4.2.19 HIPO: INF

Purpose: INF is the inverse filter used on power spectral density function $\tilde{G}_k$ as computed from filtered data.

Step No	Input	Process	Output
1	GKC, Q	For K = 0, Set GKCP (K+1) = $(2Q+1)^2$	GKCP(1)
2	GKC,Q,M	For K = 1,2,...,M, Compute GKCP(K+1) = GKC(K+1) · $\left[\left((2Q+1)\cdot \mathrm{Sin}(K\pi/2M)\right) / \mathrm{Sin}\left((2Q+1)\ K\pi/2M\right)\right]^2$	GKCP
3		Return.	

4.2.20 HIPO:AC

Purpose: AC is the Aperture Compensation applied to the power spectral density data output from INF.

Step No	Input	Process	Output
1	GKCP	For K=0, Set GKC3P(K+1) = 0	GKC3P(1)
2	GKCP,M,H, XA	For K=1,2,...,M, compute GKC3P(k+1) = GKCP(K+1) $\cdot$ $\left(K\cdot\pi\cdot XA/2H\cdot M\cdot Sin(k\cdot\pi\cdot XA/2H\cdot M)\right)^2$	GKC3P
3		Return.	

4.2.21 HIPO - SPDF

Purpose: SPDF computes the smoothed power spectral density functions from the power spectral density functions.

Step No	Input	Process	Output
1	GKC,MR	Compute GKH(1) = 0.5 [GKC(1) + GKC(2)] GKH(MR) = 0.5 [GKC(MR-1) + GKC(MR)]	GKH(1) GKH(MR)
2		For KR=2,.... (MR -1), compute GKH(KR) = 0.25(GKC(KR-1) + GKC(KR+1)) + 0.5 GKC(KR)	GKH
3	KR,GKC, GKH	Print KR, GKC(KR), GKH(KR)	
4		Return	

APPENDIX A

Appendix A contains the mathematical formulae and notations used for analysis of autoradiographic image data. These mathematical formulae form the basis for implementation into programs.

Notation

* l = Slit height

* a = Slit width

Δ or H = Sampling Interval

D_n = Raw Data Point

N = Total number of data points

$\bar{D}_n$ = Mean of raw data, D_n

SIG = Standard Deviation

d_n = Raw Data converted to diffuse density

Z_n = Zero Mean Data (in diffuse density)

Z'_n = Zero Mean Data after low frequency filtering

Z''_n = Zero Mean Data after high frequency filtering

* p = Parameter in low frequency filter

* q = Parameter in high frequency filter

$R(r)$ = Autocorrelation function

r = lag factor

* m = Maximum lag factor

* DDF = Diffuse density factor

$\check{G}''_k$ = Spectral density function

$\check{G}'_k$ = Spectral density function after inverse filter

$\tilde{G}_k$ = Spectral density function after aperture compensation

$\hat{G}_k$ = Smoothed spectral density function

$k = 0, 1, 2 \ldots m$

f = Frequency $= \dfrac{k}{2 \cdot \Delta \cdot m}$

---

* User-specified variables.

Raw Mean

$$\bar{D}_n = \frac{1}{N} \sum_{n=1}^{N} D_n$$

Normalized Data

$$U_n = D_n / \text{DDF}$$

Zero-Mean Data

$$Z_n = U_n - \bar{U}_n$$

Mean Square Value

$$\text{MSV} = \frac{1}{N} \sum_{n=1}^{N} D_n^2$$

Standard Deviation

$$\text{SIG} = \left(\sum_{n=1}^{N} (D_n^2/N-1) \right)^{\frac{1}{2}}$$

$$= \left(\frac{N}{N-1} \text{ MSV} \right)^{\frac{1}{2}}$$

Low-frequency Filter

$$Z'_n = Z_n - \frac{1}{2p+1} \sum_{j=-p}^{p} Z_{j+n} , \quad n = p+1, p+2, \ldots, N-p; \quad p = \text{appx. } 100 \text{ to } 1000$$

High Frequency Filter

$$Z''_n = \frac{1}{2q+1} \sum_{j=-q}^{q} Z'_{j+n} , \quad n = q+1, q+2, \ldots, N-q; \quad q = \text{appx. } 1 \text{ to } 3$$

Autocorrelation Function

$$\hat{R}_r = \frac{1}{N-r} \sum_{n=1}^{N-r} Z''_n \cdot Z''_{n+r} , \quad r = 0, 1, \ldots, m$$

Normalized Autocorrelation Function

$$\hat{R}_r / \hat{R}_o \quad , \quad r=0,1,2,\ldots,m$$

Note that: $-1 \leq \hat{R}_r / \hat{R}_o \leq 1$

Spectral Density Function

$$\tilde{G}'_k = 2H1 \left(\hat{R}_o + 2 \sum_{r=1}^{m-1} \hat{R}_r \operatorname{Cos}(\pi rk/m) + (-1)^k R_m \right)$$

$$k = 0,1,\ldots,m$$

Inverse Filter

$$\tilde{G}'_k = \tilde{G}''_k \left[(2q+1) \frac{\operatorname{Sin}\left(\frac{k\pi}{2m}\right)}{\operatorname{Sin}\left(\frac{k\pi}{2m} \cdot (2q+1)\right)} \right]^2$$

$$k = 1,2,\ldots,m$$

$$\tilde{G}'_o = \tilde{G}''_o (2q+1)^2$$

Aperture Compensation

$$\tilde{G}_k = \tilde{G}'_k \left[\frac{k\pi a/2Hm}{\operatorname{Sin}(k\pi a/2Hm)} \right]^2$$

$$k = 1,2,\ldots,m$$

$$\tilde{G}_o = 0$$

Smooth Power Spectral Density Function

$$\hat{G}_o = 0.5 (\tilde{G}_o + \tilde{G}_1)$$

$$\hat{G}_m = 0.5 (\tilde{G}_{m-1} + \tilde{G}_m)$$

$$\hat{G}_k = 0.5 \tilde{G}_k + 0.25 (\tilde{G}_{k-1} + \tilde{G}_{k+1})$$

$$k = 1,2,\ldots,m-1$$

Typical Values

.5mm x 20mm	Actual Slit Size
(4x) x (10x) = 40x	System Magnification
12.5 μ x 500 μ	Effective Aperture
$50mm^{-1}$	Max. Spatial Frequency
$10mm^{-1}$	$\Delta\omega$ (band width)
5%	s = error
20mm	Required Data Length (X)
$\frac{X}{\delta x} = 2 \times 10^3$	N = no. of data points
10 μ	$\delta x = \frac{1}{2f_{max}} = \frac{1}{(2)(50mm^{-1})}$
1200	DDF
10	$m = \frac{1}{\delta x \cdot \Delta\omega} = \frac{1}{.01mm \times 10mm^{-1}}$

VOLUME 2

PROGRAM LISTINGS
FOR
AUTORADIOGRAPHIC ENHANCEMENT PROCESS
DATA ANALYSIS SOFTWARE

PREFACE

This is the Program Listings for the software developed for the evaluation of the Wiener Spectrum and Modulation Transfer Function of the Autoradiographic Enhancement Process.

This report is Volume 2 of the Final Report prepared by ESPEE, INC. under Contract No. NAS8-33405 for the Space Sciences Laboratory of the George C. Marshall Space Flight Center. The NASA COR for this contract is Dr. C. A. Lundquist.

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```
TYPE SPLIST
        FILE SPLIST
        SP1A=RLDR/M FOR SP1
        SP2A=RLDR/M FOR SP2
        SPLA=RLDR/M FOR SPL
        SPHA=RLDR/M FOR SPH
        SP23A=RLDR/M FOR SP23
        SP24A=RLDR/M FOR SP24
        SP1=MAIN WITHOUT FILTERS
        SP2=MAIN WITH FILTERS
        SPL=MAIN WITH LOW FREQ. FILTER
        SP3=PTDT
        SP4=SKPFL
        SP5=RDFL
        SP6=HDR
        SP7=CORD
        SP8=RFMT
        SP9=GBYTE
        SP10=MEANS
        SP11=SIGMA
        SP12=AUTOCOR
        SP13=(DELETED)
        SP14=HIST
        SP15=DCLS
        SP16=AVG
        SP17=NRMLZ
        SP18=ZMEAN
        SP19=PSDF
        SP20=SPDF
        SP21=INF
        SP22=AC
        SP23=LFF
        SP24=HFF
        SP25=AC1
R
```

```
TYPE SP1A
RLDR/M SP1 SP3 SP4 SP5 SP6 SP7 SP8 SP9 SP10 SP11 SP12 SP14 SP15 ^
SP16 SP17 SP18 SP19 SP25 SP20 FORT.LB
R
TYPE SP2A
RLDR/M SP2 SP3 SP4 SP5 SP6 SP7 SP8 SP9 SP10 SP11 SP12 SP14 SP15 ^
SP16 SP17 SP18 SP19 SP21 SP22 SP20 FORT.LB
R
TYPE SPLA
RLDR/M SPL SP3 SP4 SP5 SP6 SP7 SP8 SP9 SP10  SP11 SP12  SP14 SP15 ^
SP16 SP17 SP18 SP19 SP21 SP25 SP20 FORT.LB
R
TYPE SPHA
RLDR/M SPH SP3 SP4 SP5 SP6 SP7 SP8 SP9 SP10 SP11 SP12 SP14 SP15 ^
SP16 SP17 SP18 SP19 SP21 SP22 SP20 FORT.LB
R
TYPE SP23A
RLDR/M SP23 FORT.LB
R
TYPE SP24A
RLDR/M SP24 FORT.LB
R
```

```
TYPE SP1
C       FILE SP1-MAIN WITHOUT FILTERS
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION:2
C       DATE:4/19/79
C       PURPOSE: THIS MODULE ACCEPTS USER INPUTS AND CALL ALL
C       SUBSEQUENT MODULES
C       RRH IS AUTOCORRELATION VALUES OF DATA
C       GKC IS POWER SPECTRAL DENSITY FUNCTION
C       GKH IS SMOOTHED POWER SPECTRAL DENSITY
C       GKCP IS THE INVERSE FILTER FUNCTION
C       GKC3P IS THE APERTURE COMPENSATION FUNCTION
C       ITEMP,XTEMP ARE BUFFERS
C       NW IS THE NUMBER OF WORDS PER RECORD
C       NP IS THE NUMBER OF POINTS PER RECORD
        INTEGER P,Q
        DIMENSION RRH(101),ITEMP(1000),
     1  GKC(101),GKH(101)
        DIMENSION GKCP(101),GKC3P(101)
        DIMENSION NW(50),NP(50)
        DIMENSION XTEMP(1000)
        ACCEPT 'FILE NUMBER,NF=',NF
        ACCEPT 'DIFFUSE DENSITY FACTOR,DDF=',DDF
        ACCEPT 'MAXIMUM LAG FACTOR,M=',M
        ACCEPT 'HEIGHT OF SCANNING SLIT,XL=',XL
        ACCEPT 'WIDTH OF SCANNING SLIT,XA=',XA
C       ACCEPT 'LOW FREQUENCY FILTER PARAMETER,P=',P
C       ACCEPT 'HIGH FREQUENCY FILTER PARAMETER,Q=',Q
        P=0
        Q=0
        CALL PTDT (ITEMP,NF,H,NR,NW,NP)
C       CALL FOPEN(4,'PAR')
C       WRITE BINARY (4) NP,P,Q,NR
C       CALL FCLOS(4)
        A=0
        B=3200
        NC=100
        CALL HIST (ITEMP,A,B,NC,NR,NP)
```

```
      CALL MEANS(ITEMP,XTEMP,NP,NR,DDF)
C     CALL SWAP('SP23.SV',IER);  CALL LFF(XTEMP,TEMP2,TEMP3,NP,P,NR)
C     CALL SWAP('SP24.SV',IER);  CALL HFF(XTEMP,TEMP2,TEMP3,NP,Q,NR)
      CALL SIGMA(XTEMP,NR,NP)
      CALL AUTOCOR(XTEMP,NP,NR,M,RRH,P,Q)
      CALL PSDF(RRH,M,H,XL,GKC)
C     CALL INF(GKC,GKCP,Q,M)
      CALL AC1(GKC,GKC3P,M,H,XA)
      CALL SPDF(M,GKC3P,GKH)
      CALL DELETE('RD')
      CALL DELETE('NRD')
      CALL DELETE('ZRD')
      CALL DELETE('ZP')
      CALL DELETE('TD')
      CALL DELETE('PAR')
      STOP
      END
R
```

```
TYPE SP2
C       FILE SP2-MAIN WITH FILTERS
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION:2
C       DATE:4/23/79
C       PURPOSE: THIS MODULE ACCEPTS USER INPUTS AND CALL ALL
C       SUBSEQUENT MODULES
C       RRH IS AUTOCORRELATION VALUES OF DATA
C       GKC IS POWER SPECTRAL DENSITY FUNCTION
C       GKH IS SMOOTHED POWER SPECTRAL DENSITY
C       GKCP IS THE INVERSE FILTER FUNCTION
C       GKC3P IS THE APERTURE COMPENSATION FUNCTION
C       ITEMP,XTEMP ARE BUFFERS
C       NW IS THE NUMBER OF WORDS PER RECORD
C       NP IS THE NUMBER OF POINTS PER RECORD
        INTEGER P,Q
        DIMENSION RRH(101),ITEMP(1000),
     1  GKC(101),GKH(101)
        DIMENSION GKCP(101),GKC3P(101)
        DIMENSION NW(50),NP(50)
        DIMENSION XTEMP(1000)
        ACCEPT 'FILE NUMBER,NF=',NF
        ACCEPT 'DIFFUSE DENSITY FACTOR,DDF=',DDF
        ACCEPT 'MAXIMUM LAG FACTOR,M=',M
        ACCEPT 'HEIGHT OF SCANNING SLIT,XL=',XL
        ACCEPT 'WIDTH OF SCANNING SLIT,XA=',XA
        ACCEPT 'LOW FREQUENCY FILTER PARAMETER,P=',P
        ACCEPT 'HIGH FREQUENCY FILTER PARAMETER,Q=',Q
        CALL PTDT (ITEMP,NF,H,NR,NW,NP)
        CALL FOPEN(4,'PAR')
        WRITE BINARY (4) NP,P,Q,NR
        CALL FCLOS(4)
        A=0
        B=3200
        NC=100
        CALL HIST (ITEMP,A,B,NC,NR,NP)
        CALL MEANS(ITEMP,XTEMP,NP,NR,DDF)
        CALL SWAP('SP23.SV',IER);  CALL LFF(XTEMP,TEMP2,TEMP3,NP,P,NR)
```

```
      CALL SWAP('SP24.SV',IER);  CALL HFF(XTEMP,TEMP2,TEMP3,NP,Q,NR)
      CALL DELETE ('ZRD')
      CALL RENAM ('ZPP','ZRD',IER)
      CALL SIGMA(XTEMP,NR,NP)
      CALL AUTOCOR(XTEMP,NP,NR,M,RRH,P,Q)
      CALL PSDF(RRH,M,H,XL,GKC)
      CALL INF(GKC,GKCP,Q,M)
      CALL AC(GKCP,GKC3P,M,H,XA)
      CALL SPDF(M,GKC3P,GKH)
      CALL DELETE('RD')
      CALL DELETE('NRD')
      CALL DELETE('ZRD')
      CALL DELETE('ZP')
      CALL DELETE('TD')
      CALL DELETE('PAR')
      STOP
      END
R
```

```
TYPE SPL
C       FILE SPL-MAIN WITH LOW FREQUENCY FILTER
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION:0
C       DATE:4/19/79
C       PURPOSE: THIS MODULE ACCEPTS USER INPUTS AND CALL ALL
C       SUBSEQUENT MODULES
C       RRH IS AUTOCORRELATION VALUES OF DATA
C       GKC IS POWER SPECTRAL DENSITY FUNCTION
C       GKH IS SMOOTHED POWER SPECTRAL DENSITY
C       GKCP IS THE INVERSE FILTER FUNCTION
C       GKC3P IS THE APERTURE COMPENSATION FUNCTION
C       ITEMP,XTEMP ARE BUFFERS
C       NW IS THE NUMBER OF WORDS PER RECORD
C       NP IS THE NUMBER OF POINTS PER RECORD
        INTEGER P,Q
        DIMENSION RRH(101),ITEMP(1000),
     1  GKC(101),GKH(101)
        DIMENSION GKCP(101),GKC3P(101)
        DIMENSION NW(50),NP(50)
        DIMENSION XTEMP(1000)
        ACCEPT 'FILE NUMBER,NF=',NF
        ACCEPT 'DIFFUSE DENSITY FACTOR,DDF=',DDF
        ACCEPT 'MAXIMUM LAG FACTOR,M=',M
        ACCEPT 'HEIGHT OF SCANNING SLIT,XL=',XL
        ACCEPT 'WIDTH OF SCANNING SLIT,XA=',XA
        ACCEPT 'LOW FREQUENCY FILTER PARAMETER,P=',P
C       ACCEPT 'HIGH FREQUENCY FILTER PARAMETER,Q=',Q
        Q=0
        CALL PTDT (ITEMP,NF,H,NR,NW,NP)
        CALL FOPEN(4,'PAR')
        WRITE BINARY (4) NP,P,Q,NR
        CALL FCLOS(4)
        A=0
        B=3200
        NC=100
        CALL HIST (ITEMP,A,B,NC,NR,NP)
        CALL MEANS(ITEMP,XTEMP,NP,NR,DDF)
```

```
            CALL SWAP('SP23.SV',IER);  CALL LFF(XTEMP,TEMP2,TEMP3,NP,P,NR)
            CALL DELETE ('ZRD')
            CALL RENAM ('ZP','ZRD',IER)
C           CALL SWAP('SP24.SV',IER);  CALL HFF(XTEMP,TEMP2,TEMP3,NP,Q,NR)
            CALL SIGMA(XTEMP,NR,NP)
            CALL AUTOCOR(XTEMP,NP,NR,M,RRH,P,Q)
            CALL PSDF(RRH,M,H,XL,GKC)
C           CALL INF(GKC,GKCP,Q,M)
            CALL AC1(GKC,GKC3P,M,H,XA)
            CALL SPDF(M,GKC3P,GKH)
            CALL DELETE('RD')
            CALL DELETE('NRD')
            CALL DELETE('ZRD')
            CALL DELETE('ZP')
            CALL DELETE('TD')
            CALL DELETE('PAR')
            STOP
            END
R
```

```
TYPE SPH
C       FILE SPH=MAIN WITH HIGH FREQ. FILTER ONLY
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION:0
C       DATE:4/24/79
C       PURPOSE: THIS MODULE ACCEPTS USER INPUTS AND CALL ALL
C       SUBSEQUENT MODULES
C       RRH IS AUTOCORRELATION VALUES OF DATA
C       GKC IS POWER SPECTRAL DENSITY FUNCTION
C       GKH IS SMOOTHED POWER SPECTRAL DENSITY
C       GKCP IS THE INVERSE FILTER FUNCTION
C       GKC3P IS THE APERTURE COMPENSATION FUNCTION
C       ITEMP,XTEMP ARE BUFFERS
C       NW IS THE NUMBER OF WORDS PER RECORD
C       NP IS THE NUMBER OF POINTS PER RECORD
        INTEGER P,Q
        DIMENSION RRH(101),ITEMP(1000),
     1  GKC(101),GKH(101)
        DIMENSION GKCP(101),GKC3P(101)
        DIMENSION NW(50),NP(50)
        DIMENSION XTEMP(1000)
        ACCEPT 'FILE NUMBER,NF=',NF
        ACCEPT 'DIFFUSE DENSITY FACTOR,DDF=',DDF
        ACCEPT 'MAXIMUM LAG FACTOR,M=',M
        ACCEPT 'HEIGHT OF SCANNING SLIT,XL=',XL
        ACCEPT 'WIDTH OF SCANNING SLIT,XA=',XA
C       ACCEPT 'LOW FREQUENCY FILTER PARAMETER,P=',P
        P=0
        ACCEPT 'HIGH FREQUENCY FILTER PARAMETER,Q=',Q
        CALL PTDT (ITEMP,NF,H,NR,NW,NP)
        CALL FOPEN(4,'PAR')
        WRITE BINARY (4) NP,P,Q,NR
        CALL FCLOS(4)
        A=0
        B=3200
        NC=100
        CALL HIST (ITEMP,A,B,NC,NR,NP)
        CALL MEANS(ITEMP,XTEMP,NP,NR,DDF)
```

```
C       CALL SWAP('SP23.SV',IER);  CALL LFF(XTEMP,TEMP2,TEMP3,NP,P,NR)
        CALL RENAM ('ZRD','ZP',IER)
        CALL SWAP('SP24.SV',IER);  CALL HFF(XTEMP,TEMP2,TEMP3,NP,Q,NR)
        CALL DELETE ('ZRD')
        CALL RENAM ('ZPP','ZRD',IER)
        CALL SIGMA(XTEMP,NR,NP)
        CALL AUTOCOR(XTEMP,NP,NR,M,RRH,P,Q)
        CALL PSDF(RRH,M,H,XL,GKC)
        CALL INF(GKC,GKCP,Q,M)
        CALL AC(GKCP,GKC3P,M,H,XA)
        CALL SPDF(M,GKC3P,GKH)
        CALL DELETE('RD')
        CALL DELETE('NRD')
        CALL DELETE('ZRD')
        CALL DELETE('ZP')
        CALL DELETE('TD')
        CALL DELETE('PAR')
        STOP
        END
R
```

```
TYPE SP3
C       FILE SP3-PTDT
C       PROGRAMMER NAME:S.P. SINGH
C       REVISION:0
C       DATE:1/26/79
C       PURPOSE: THIS MODULE CALLS MODULES TO READ THE
C       TAPE, REFORMAT IT, AND PRINT HEADER INFORMATION
        COMPILER NOSTACK
        SUBROUTINE PTDT(ITEMP,NF,H,NR,NW,NP)
        DIMENSION ITEMP(1000)
        DIMENSION NW(50),NP(50)
        TYPE ' DATA PREPARATION COMMENCED'
        CALL MTOPD (13,"MT0:0",256,IER)
        IF (NF.EQ.1) GO TO 10
        CALL SKPFL (ITEMP,NF)
10      CALL RDFL (ITEMP,NR,NW)
        IREC=1
        CALL HDR(ITEMP,IREC,H)
        CALL RFMT(ITEMP,NR,NW,NP)
        TYPE 'RAW DATA STORED ON DISK.'
        RETURN
        END
R
```

```
TYPE SP4
C       FILE SP4=SKPFL
C       PROGRAMMER NAME:S.P. SINGH
C       REVISION:0
C       DATE:1/30/79
C       PURPOSE: THIS MODULE SKIPS THE NUMBER OF FILES
C       SPECIFIED BY THE USER.
        COMPILER NOSTACK
        SUBROUTINE SKPFL (INPBUF,NF)
        DIMENSION INPBUF(1000)
        KFL=1
 10     CALL MTDIO(13,0,INPBUF,ISTAT,IER,ICNT)
        IF (ICNT.NE.1) GO TO 10
        KFL=KFL+1
        IF (KFL.EQ.NF) GO TO 20
        GO TO 10
 20     CONTINUE
        NF1=NF-1
        TYPE 'NUMBER OF FILES SKIPPED=',NF1
        RETURN
        END
R
```

```
                                                        END
TYPE SP5                                            R
C        FILE SP5-RDFL
C        PROGRAMMER NAME:S.P. SINGH
C        REVISION:0
C        DATE:2/2/79
         COMPILER NOSTACK
         SUBROUTINE RDFL (INPBUF,NR,NW)
C        PURPOSE:
C        RDFL READS ONE FILE FROM TAPE INTO INPBUF
C        AND WRITES IT IN DISK FILE TD.
C        ICNT IS NO. OF WORDS IN A RECORD
         DIMENSION NW(50),INPBUF(1000)
C
C        NR IS NO. OF RECORDS
C        NW IS ARRAY CONTAINING NO. OF WORDS IN EACH RECORD
         TYPE 'FILE IS BEING READ FROM TAPE'
         NR=0
         CALL FOPEN(2,"TD",2000)
C        TYPE 'FILE TD OPENED'
         DO 10 I=1,50
         NW(I)=0
 10      CONTINUE
         DO 20 I=1,1000
         INPBUF(I)=0
 20      CONTINUE
         CALL MTDIO(13,0,INPBUF,IST,IER,ICNT)
C        TYPE 'NO OF SAMPLES=',INPBUF(22)
C        TYPE 'RDFL ICNT=',ICNT
         IF (ICNT.EQ.1) GO TO 100
         NR=NR+1
         NW(NR)=ICNT
         CALL WRITR(2,NR,INPBUF,1,IER)
         GO TO 10
 100     CONTINUE
         TYPE 'NUMBER OF RECORDS READ=',NR
         TYPE 'FILE READ FROM TAPE AND WRITTEN ON DISK'
         CALL FCLOS(2)
         RETURN
```

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```
TYPE SP6
C       FILE SP6-HDR
C       PROGRAMMER NAME:S.P. SINGH
C       REVISION:0
C       DATE:2/7/79
C       PURPOSE: THIS MODULE READS THE TAPE DATA FROM FILE
C       'TD', PRINTS HEADER INFORMATION, AND COMPUTES H-DELTA X
        COMPILER NOSTACK
        SUBROUTINE HDR(ITEMP,IREC,H)
        DIMENSION ITEMP(1000)
        DOUBLE PRECISION IWD,IWD1,IWD2,II
        CALL FOPEN(2,'TD',2000)
        CALL READR(2,IREC,ITEMP,1,IER)
        WRITE (10,10) (ITEMP(J),J=2,21)
 10        FORMAT (1X,20A2)
        TYPE 'NUMBER OF SAMPLES=',ITEMP(22)
        CALL CORD(ITEMP,23,IWD)
        IX=IWD
        TYPE 'X COORDINATE (MICRONS)=', IX
        CALL CORD (ITEMP,25,IWD)
        IY=IWD
        TYPE 'Y COORDINATE (MICRONS)=',IY
        CALL CORD(ITEMP,27,IWD)
        IX=IWD
        TYPE 'DELTA X (H) (MICRONS)=',IX
        H=IX
        IF (H.LT.0) H=-H
        CALL FCLOS(2)
        RETURN
        END
R
```

```
TYPE SP7
C       FILE SP7=CORD
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION: 0
C       DATE: 2/14/79
C       PURPOSE: THIS MODULE DECODES X,Y COORDINATES AND
C       DELTA X FROM 2 INPUT WORDS
        COMPILER NOSTACK
        SUBROUTINE CORD(ITEMP,J,IWD)
        DIMENSION ITEMP(1000)
        DOUBLE PRECISION IWD,IWD1,IWD2,II
        DOUBLE PRECISION IJ,IK
C       TYPE 'CORD WAS CALLED'
        IK=1.0D0
        IJ=32768.0D0
        II=65536.0D0
        IX1=ITEMP(J)
        IX2=ITEMP(J+1)
C       TYPE 'IX1=',IX1
C       TYPE 'IX2=',IX2
        IF (IX1.LT.0) GO TO 10
        IF (IX2.LT.0) GO TO 20
        IWD1=IX1
        IWD2=IX2
        IWD=IWD1*II+IWD2
        GO TO 50
 20     CALL ICLR(IX2,15)
C       TYPE'IX2 AFTER ICLR',IX2
        IWD1=IX1
        IWD2=IX2
        IWD2=IWD2+IJ
        IWD=IWD1*II+IWD2
        GO TO 50
 10     IX3=-IX1-1
        IX4=-IX2-1
        IF(IX4.LT.0) GO TO 30
        IWD1=IX3
        IWD2=IX4
```

```
      IWD=IWD1*II+IWD2
      IWD=IWD+IK
      IWD=-IWD
      GO TO 50
30    CALL ICLR(IX4,15)
      IWD1=IX3
      IWD2=IX4
      IWD2=IWD2+IJ
      IWD=IWD1*II+IWD2
      IWD=IWD+IK
      IWD=-IWD
50    CONTINUE
      RETURN
      END
R
```

```
TYPE SP8
C       FILE SP8-RFMT
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION: 0
C       DATE: 2/12/79
C       PURPOSE: THIS MODULE REFORMATS EACH RECORD TO THE
C       16 BIT INTEGER FORMAT OF THE NOVA 1200 AND
C       PLACES IT IN FILE 'RD'
        COMPILER NOSTACK
        SUBROUTINE RFMT(ITEMP,NR,NW,NP)
        DIMENSION ITEMP(1000),XT(300)
        DIMENSION NP(50),NW(50)
        COMMON JTEMP(1000)
        EQUIVALENCE (ITEMP,JTEMP)
        CALL FOPEN(2,'TD',2000)
        CALL FOPEN (3,'RD',2000)
        TYPE'DATA IS BEING FORMATTED'
        DO 20 JR=1,NR
        DO 10 I=1,1000
        JTEMP(I)=0
C       ITEMP(I)=0
 10     CONTINUE
        CALL READR(2,JR,ITEMP,1,IER)
        NW1=NW(JR)
C       TYPE 'NW1=',NW1
        DO 30 J=29,NW1
C       TYPE 'ABOUT TO CALL GBYTE'
        INP=ITEMP(J)
        CALL GBYTE(INP,IOU,0,12)
C       TYPE 'GBYTE WAS CALLED'
        JTEMP(J-28)=IOU
 30     CONTINUE
C       TYPE 'ABOUT TO CALL WRITR'
        CALL WRITR (3,JR,JTEMP,1,IER)
C       TYPE 'WRITR CALLED'
        NP(JR)=NW(JR)-28
 20     CONTINUE
        CALL READR (3,1,JTEMP,1,IER)
```

```
      NP1=NP(1)
      IF (NP1.GT.300) NP1=300
      DO 40 I=1,NP1
      JK=JTEMP(I)/8
      XT(I)=JK/100.
 40   CONTINUE
      WRITE (10,50) (XT(I),I=1,NP1)
 50   FORMAT (10(1X,F5.2))
      TYPE 'DATA FORMATTING COMPLETED'
      CALL FCLOS(2)
      CALL FCLOS(3)
      RETURN
      END
R
```

```
TYPE SP9
C       FILE SP9=GBYTE
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION: 0
C       DATE: 2/16/79
C       PURPOSE: THIS MODULE EXTRACTS BIT PATTERNS FROM
C       A 16 BIT INTEGER WORD.
C       IPK IS THE 16 BIT WORD
C       IUPK IS THE BIT PATTERN REMOVED FROM IPK
C       NOFF IS THE STARTING BIT POSITION IN IPK
C       NBTS IS THE NUMBER OF BITS TO BE REMOVED FROM IPK
        COMPILER NOSTACK
        SUBROUTINE GBYTE(IPK,IUPK,NOFF,NBTS)
        INTEGER MASK(15),LOC(15)
        DATA LOC/1K,2K,4K,10K,20K,40K,100K,200K,400K,
     *  1000K,2000K,4000K,10000K,20000K,40000K/
        DATA MASK/77777K,37777K,17777K,7777K,3777K,1777K,
     *  777K,377K,177K,77K,37K,17K,7K,3K,1K/
        IUPK=IPK.AND.MASK(1)
        IF (NOFF.LT.2) GO TO 5
        IUPK=IUPK.AND.MASK(NOFF)
5       NSHFT=16-(NOFF+NBTS)
        IF(NSHFT.EQ.0.OR.NSHFT.EQ.15) GO TO 12
        IUPK=IUPK/(2**NSHFT)
 12     CONTINUE
        IF(NSHFT.EQ.15) IUPK=0
        IF(NOFF.GT.0.OR.IPK.GE.0) RETURN
        IUPK=IUPK.OR.LOC(NBTS)
        RETURN
        END
R
```

```
TYPE SP10
C       FILE SP10-MEANS
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION:1
C       DATE: 3/19/79
C       PURPOSE: THIS MODULE CALLS OTHER MODULES TO COMPUTE MEAN OF
C       RAW DATA AND NORMALIZE DATA TO DIFFUSE DENSITY UNITS AND ZERO MEAN
        COMPILER NOSTACK
        SUBROUTINE MEANS(ITEMP,XTEMP,NP,NR,DDF)
C       SS10 IS MEANS
        DIMENSION ITEMP(1000)
        DIMENSION XTEMP(1000)
        DIMENSION NP(50)
        ICHR=3
        ICHN=4
        ICHZ=5
        CALL AVG(ITEMP,ICHR,NR,NP,RAWM)
        CALL NRMLZ(ITEMP,XTEMP,DDF,ICHR,NR,NP,ICHN,RAWM)
        DDM=DDF
        TYPE 'MEAN OF NORMALIZED DATA= ',DDM
        CALL ZMEAN(XTEMP,ICHN,ICHZ,NR,NP,DDM)
        RETURN
        END
R
```

```
TYPE SP11
C        FILE SP11=SIGMA
C        PROGRAMMER NAME: S.P. SINGH
C        REVISION: 0
C        DATE: 3/13/79
C        PURPOSE: THIS MODULE COMPUTES THE MEAN SQUARE VALUE
C        AND THE ROOT MEAN SQUARE VALUE
         COMPILER NOSTACK
         SUBROUTINE SIGMA (TEMP,NR,NP)
         DIMENSION TEMP(1000),NP(50)
         ICHZ=5
         CALL FOPEN(ICHZ,'ZRD',4000)
         SSQ=0.0
         NPI=0
         DO 10 I=1,NR
         CALL READR(ICHZ,I,TEMP,1,IER)
         NPI=NP(I)
C
C        THIS COMPUTES THE  MEAN SQUARE
         DO 20 J=1,NPI
         SSQ=SSQ+(TEMP(J)**2)
20       CONTINUE
         INP=INP+NPI
10       CONTINUE
         XSQ=SSQ/INP
C
C        THIS COMPUTES THE ROOT MEAN SQUARE
         SIG=SQRT(XSQ*INP/(INP-1))
         TYPE 'MEAN SQUARE VALUE = ',XSQ
         TYPE 'ROOT MEAN SQUARE VALUE = ',SIG
         CALL FCLOS(ICHZ)
C        TYPE 'SIGMA WAS CALLED'
         RETURN
         END
R
```

```
TYPE SP12
C       FILE SP12-AUTOCOR
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION: 1
C       DATE: 4/4/79
C       PURPOSE: THIS MODULE COMPUTES THE AUTOCORRELATION AND
C       NORMALIZED AUTOCORRELATION FUNCTION OF ZMEAN DATA.
C       RAT IS THE AUTOCOR VALUES
C       RATN IS THE NORMALIZED AUTOCOR VAULES
C       TEMP,XT ARE BUFFERS
        COMPILER NOSTACK
        SUBROUTINE AUTOCOR(TEMP,NP,NR,M,RAT,P,Q)
        INTEGER P,Q
        DIMENSION NP(50)
        DIMENSION RATN(101),RAT(101)
        DIMENSION XT(101)
        DIMENSION TEMP(1000)
        TYPE 'AUTOCORRELATION IS BEING COMPUTED'
        ICHZ=5
        CALL FOPEN(ICHZ,'ZRD',4000)
        DO 5 I=1,1000
5       TEMP(I)=0
        DO 10 I=1,101
        RAT(I)=0.0
        XT(I)=0
10      CONTINUE
        MR=M+1
        NR1=NR+1
        INP=0
        DO 20 I=1,NR1
        IF(I.EQ.NR1) GO TO 90
        CALL READR(ICHZ,I,TEMP,1,IER)
        INP=INP+NP(I)
        NP1=NP(I)
        DO 30 I3=1,NP1
        TEMP(NP1+M-I3+1)=TEMP(NP1-I3+1)
30      CONTINUE
90      CONTINUE
```

```
      DO 40 I4=1,M
      TEMP(I4)=XT(I4)
 40   CONTINUE
      DO 50 I5=1,M
      XT(I5)=TEMP(NP1+I5)
 50   CONTINUE
      DO 60 J=1,MR
      SUM=0.0
      JR=J-1
      DO 70 I7=1,NP1
      SUM=SUM+TEMP(I7)*TEMP(I7+JR)
 70   CONTINUE
      RAT(J)=RAT(J)+SUM
 60   CONTINUE
      IF(I.NE.NR) GO TO 20
      DO 80 I8=1,1000
      TEMP(I8)=0.0
 80   CONTINUE
 20   CONTINUE
      DO 85 J=1,MR
      RAT(J)=RAT(J)/(INP-J+1-(2*(P+Q)))
 85   CONTINUE
      DO 100 J=1,MR
      RATN(J)=RAT(J)/RAT(1)
 100  CONTINUE
      TYPE  ' R              R-HAT                  NORM. R-HAT'
      DO 2000 J=1,MR
      IR=J-1
      WRITE(10,1000) IR,RAT(J),RATN(J)
 1000 FORMAT(1X,I3,8X,E11.4,8X,E11.4)
 2000 CONTINUE
      CALL FCLOS(ICHZ)
      RETURN
      END
R
```

```
TYPE SP14
C       FILE SP14=HIST
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION: 0
C       DATE: 2/20/79
C       PURPOSE: THIS MODULE COMPUTES A HISTOGRAM FOR THE DATA
        COMPILER NOSTACK
        SUBROUTINE HIST (ITEMP,A,B,NC,NR,NP)
        DIMENSION ITEMP(1000),NP(50),NHST(101),MST(101)
        CALL FOPEN(3,'RD',2000)
        TYPE 'HISTOGRAM BEING COMPUTED'
C
C       CI IS CLASS INTERVAL
        NC1=NC+1
        CI=(B-A)/NC
        DO 5 J=1,NC1
        MST(J)=0
5       CONTINUE
C
C       COMPUTE HISTOGRAM
C
        DO 10 J=1,NR
        CALL READR(3,J,ITEMP,1,IER)
        NP1=NP(J)
        CALL DCLS(ITEMP,NP1,CI,NHST)
        DO 20 I=1,NC1
        MST(I)=MST(I)+NHST(I)
 20     CONTINUE
 10     CONTINUE
C
C       COMPUTE FIRST CLASS CONTAINING AT LEAST ONE POINT
C
        DO 30 I=1,NC1
        IF (MST(I).GE.1) GO TO 40
 30     CONTINUE
 40     IMIN=I
C
C       COMPUTE LAST CLASS CONTAINING AT LEAST ONE POINT
```

```
C
      DO 50 I=1,NC1
      IF (MST(NC1-I+1).GE.1) GO TO 60
50    CONTINUE
60    IMAX=NC1-I+1
      TYPE ' '
      TYPE 'TOTAL NO. OF CLASSES=',NC
      TYPE '   CLASS NO.      NO. OF DATA POINTS'
      DO 70 I=IMIN,IMAX
      TYPE I,'            ',MST(I)
70    CONTINUE
      CALL FCLOS(3)
      RETURN
      END
R
```

```
TYPE SP15
C       FILE SP15-DCLS
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION: 0
C       DATE: 2/26/79
C       PURPOSE: THIS MODULE ASSIGNS A DATA VALUE TO A CLASS
C       INTERVAL FOR COMPUTING HISTOGRAM.
        COMPILER NOSTACK
        SUBROUTINE DCLS(ITEMP,NP1,CI,NHST)
        DIMENSION ITEMP(1000),NHST(101)
        DO 10 I=1,101
        NHST(I)=0
 10     CONTINUE
        DO 20 I=1,NP1
        J=IFIX(ITEMP(I)/CI)
        NHST(J+1)=NHST(J+1)+1
 20     CONTINUE
        RETURN
        END
R
```

```
TYPE SP16
C       FILE SP16=AVG
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION: 0
C       DATE: 3/6/79
C       PURPOSE: THIS MODULE COMPUTES THE RAW MEAN OF THE DATA.
        COMPILER NOSTACK
        SUBROUTINE AVG(ITEMP,ICHR,NR,NP,RAWM)
C       SP16 IS AVG
        REAL ISUM
        DIMENSION ITEMP(1000),NP(50)
        CALL FOPEN(ICHR,"RD",2000)
        INP=0
        ISUM=0
C
C       SUM ALL THE POINTS IN THE FILE
C
        DO 10 I=1,NR
        CALL READR(ICHR,I,ITEMP,1,IER)
        NPI=NP(I)
        DO 20 J=1,NPI
        ISUM=ISUM+ITEMP(J)
20      CONTINUE
        INP=INP+NPI
10      CONTINUE
        RAWM=ISUM/INP
        TYPE "RAW MEAN = ",RAWM
        CALL FCLOS(ICHR)
        RETURN
        END
R
```

```
TYPE SP17
C       FILE SP17=NRMLZ
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION:1
C       DATE: 3/19/79
C       PURPOSE: THIS MODULE NORMALIZES THE FILE
C        DATA BY MULTIPLYING THE DATA POINTS
C       BY THE DIFFUSE DENSITY FACTOR AND CREATES A NEW FILE.
        COMPILER NOSTACK
        SUBROUTINE NRMLZ(ITEMP,XTEMP,DDF,ICHR,NR,NP,ICHN,RAWM)
C       SP17 IS NRMLZ
        DIMENSION ITEMP(1000),NP(50)
        DIMENSION XTEMP(1000)
        CALL FOPEN(ICHN,'NRD',4000)
        CALL FOPEN(ICHR,'RD',2000)
        DO 10 I=1,NR
        CALL READR(ICHR,I,ITEMP,1,IER)
        NPI=NP(I)
        DO 20 J=1,NPI
        XTEMP(J)=ITEMP(J)*DDF/RAWM
20      CONTINUE
        CALL WRITR(ICHN,I,XTEMP,1,IER)
10      CONTINUE
        CALL FCLOS(ICHR)
        CALL FCLOS(ICHN)
        RETURN
        END
R
```

```
TYPE SP18
C       FILE SP18=ZMEAN
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION: 0
C       DATE: 3/9/79
C       PURPOSE: THIS MODULE NORMALIZES DATA BY SUBTRACTING
C       THE DIFFUSE DENSITY MULTIPLYER FROM THE NORMALIZED DATA,
C       CREATING A NEW FILE.
        COMPILER NOSTACK
        SUBROUTINE ZMEAN(ITEMP,ICHN,ICHZ,NR,NP,DDM)
C       SS18 IS ZMEAN
        DIMENSION ITEMP(1000),NP(50)
        REAL ITEMP
        CALL FOPEN(ICHZ,'ZRD',4000)
        CALL FOPEN(ICHN,'NRD',4000)
        DO 10 I=1,NR
        CALL READR(ICHN,I,ITEMP,1,IER)
        NPI=NP(I)
        DO 20 J=1,NPI
        ITEMP(J)=ITEMP(J)-DDM
20      CONTINUE
        CALL WRITR(ICHZ,I,ITEMP,1,IER)
10      CONTINUE
        CALL FCLOS(ICHN)
        CALL FCLOS(ICHZ)
        RETURN
        END
R
```

```
TYPE SP19
C       FILE SP19-PSDF
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION: 0
C       DATE: 3/19/79
C       PURPOSE: THIS MODULE COMPUTES THE POWER SPECTRAL DENSITY FUNCTION.
        COMPILER NOSTACK
        SUBROUTINE PSDF(RAT,M,H,XL,GKC)
        DIMENSION RAT(101),GKC(101),GKH(101)
        MR=M+1
C
C       COMPUTE THE POWER SPECTRAL DENSITY FUNCTION
C
        DO 10 KR=1,MR
        SUM=0.0
        MR2=MR-2
        DO 20 JR=1,MR2
        SUM=SUM+RAT(JR+1)*COS(3.14159*JR*(KR-1)/(MR-1))
20      CONTINUE
        GKC(KR)=2.*H*XL*(RAT(1)+2.*SUM+RAT(MR)*(-1)**(KR-1))
10      CONTINUE
        RETURN
        END
R
```

```
TYPE SP20
C         FILE SP20=SPDF
C         PROGRAMMER NAME: S.P. SINGH
C         REVISION: 1
C         DATE: 4/20/79
C         PURPOSE: THIS MODULE COMPUTES THE SMOOTHED POWER DENSITY FUNCTION.
          COMPILER NOSTACK
          SUBROUTINE SPDF(M,GKC,GKH)
          DIMENSION GKC(101),GKH(101)
          MR=M+1
          GKH(1)=0.5*(GKC(1)+GKC(2))
          GKH(MR)=0.5*(GKC(MR-1)+GKC(MR))
          MR1=MR-1
C
C         COMPUTE SMOOTHED DENSITY FUNCTION
C
          DO 10 KR=2,MR1
          GKH(KR)=0.25*(GKC(KR-1)+GKC(KR+1))+0.5*GKC(KR)
10        CONTINUE
          TYPE "  K               GKC3P(K)                           GH(K)   "
          DO 2000 J=1,MR
          IR=J-1
          WRITE(10,100) IR,GKC(J),GKH(J)
100       FORMAT(1X,I3,8X,E11.4,8X,E11.4)
2000      CONTINUE
          RETURN
          END
R
```

```
TYPE SP21
C       FILE SP21-INF
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION:1
C       DATE: 3/19/79
C       PURPOSE: THIS MODULE PERFORMS THE INVERSE FILTER OPERATION
C       ON THE POWER SPECTRAL DENSITY FUNCTION.
        COMPILER NOSTACK
        SUBROUTINE INF(GKC,GKCP,Q,M)
        DIMENSION GKC(101),GKCP(101)
        INTEGER Q
        PI=3.14159
        MR=M+1
C
C       COMPUTE THE FILTERED PSDF
C
        DO 10 K1=1,MR
        K=K1-1
        IF(K.GT.0) GO TO 5
        GKCP(K1)=GKC(K1)
        GO TO 10
5       IF(SIN((K*PI)*(2*Q+1)/(2*M)).LT.1.0E-06) TYPE
     *  'THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF'
        GKCP(K1)=GKC(K1)*((2*Q+1)*SIN((K*PI)/(2*M))/SIN((K*PI)*(2*Q+1)
     *  /(2*M)))**2
10      CONTINUE
        TYPE '  K             GKC(K)              GKCP(K)'
        DO 2000 J=1,MR
        IR=J-1
        WRITE(10,100) IR,GKC(J),GKCP(J)
100     FORMAT(1X,I3,8X,E11.4,8X,E11.4)
2000    CONTINUE
        RETURN
        END
R
```

```
TYPE SP22
C       SP22=AC
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION:1
C       DATE:3/19/79
C       PURPOSE: THIS MODULE PERFORMS THE APERTURE COMPENSATION
C       OPERATION ON THE INVERSE FILTERED PSDF.
        COMPILER NOSTACK
        SUBROUTINE AC(GKCP,GKC3P,M,H,XA)
        DIMENSION GKCP(101),GKC3P(101)
        PI=3.14159
        MR=M+1
        DO 10 K1=1,MR
        K=K1-1
        IF(K.GT.0) GO TO 5
        GKC3P(K1)=GKCP(K1)
        GO TO 10
5       IF(SIN((K*PI*XA)/(2*H*M)).LT.1.0E-06) TYPE
     *  'THE DENOMINATOR OF SINE FUNCTON BELOW 1.0E-06 ENCOUNTERED IN AC'
        GKC3P(K1)=GKCP(K1)*(((K*PI*XA)/(2*H*M))/SIN((K*PI*XA)/(2*H*M)))**2
10      CONTINUE
        TYPE '  K           GKCP(K)           GKC3P(K)'
        DO 2000 J=1,MR
        IR=J-1
        WRITE(10,100) IR,GKCP(J),GKC3P(J)
100     FORMAT(1X,I3,8X,E11.4,8X,E11.4)
2000    CONTINUE
        RETURN
        END
R
```

```
TYPE SP23
C       FILE SP23-LFF
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION: 2
C       DATE: 4/20/79
C       PURPOSE: THIS MODULE PERFORMS THE LOW FREQUENCY OPERATION
C       ON THE Z-NORMALIZED DATA.
        COMPILER NOSTACK
C       SUBROUTINE LFF(TEMP1,TEMP2,TEMP3,NP1,P,NR)
        DIMENSION TEMP1(1000),TEMP2(1000),TEMP3(1000)
        INTEGER QUO,P,Q,P2,NP1(50),REC1,REC2,REC3
        TYPE 'DATA IS BEING FILTERED FOR LOW FREQUENCY'
        CALL FOPEN(2,'ZRD',4000)
        CALL FOPEN(3,'ZP',4000)
        CALL FOPEN(4,'PAR')
        READ BINARY (4) NP1,P,Q,NR
        CALL FCLOS(4)
C
C       CALCULATE # OF RECORDS TO COMPUTE FIRST SUM AND
C       FIND REC. # OF FIRST POINT
C
        NP=NP1(1)
        NREC=(2*P+1)/NP
        IF(MOD(2*P+1,NP).GT.0) NREC=NREC+1
        QUO=P/NP
        IF(MOD(P,NP).GT.0) QUO=QUO+1
        IF (QUO.EQ.1) GO TO 3
        JQUO=QUO-1
        DO 2 I=1,JQUO
        CALL READR (2,I,TEMP1,1,IER)
        CALL WRITR (3,I,TEMP1,1,IER)
 2      CONTINUE
 3      CONTINUE
C
C       CALCULATE FIRST SUM (POINT P+1)
C
        N1=0
        SUM=0.0
```

```
      DO 10 I=1,NREC
      CALL READR(2,I,TEMP1,1,IER)
      DO 20 J=1,NP
      SUM=SUM+TEMP1(J)
      N1=N1+1
      IF(N1.EQ.(2*P+1)) GO TO 5
20    CONTINUE
10    CONTINUE
5     CONTINUE
C
C     FIND LOCATION OF FIRST POINT
C
      CALL READR(2,QUO,TEMP1,1,IER)
      LOC1=P+1-(NP*(QUO-1))
      TEMP1(LOC1)=TEMP1(LOC1)-(SUM/FLOAT(2*P+1))
      CALL WRITR(3,QUO,TEMP1,1,IER)
      P2=P+2
      N=NP*NR
      NMP=N-P
      DO 30 I=P2,NMP
C
C     CALCULATE REC # OF PTS. I,I-P-1,I+P
C
      REC1=I/NP
      IF(MOD(I,NP).GT.0) REC1=REC1+1
      REC2=(I-P-1)/NP
      IF(MOD(I-P-1,NP).GT.0) REC2=REC2+1
      REC3=(I+P)/NP
      IF(MOD(I+P,NP).GT.0) REC3=REC3+1
      IF (I.NE.P2) GO TO 40
      IREC1=REC1
      IREC2=REC2
      IREC3=REC3
      CALL READR (2,REC1,TEMP1,1,IER)
      CALL READR (2,REC2,TEMP2,1,IER)
      CALL READR (2,REC3,TEMP3,1,IER)
40    CONTINUE
C
```

```
C         CALCULATE LOC. OF PTS. I,I-P-1,I+P IN RESPECTIVE RECORDS
          LOC1=I-(NP*(REC1-1))
          LOC2=(I-P-1)-(NP*(REC2-1))
          LOC3=(I+P)-(NP*(REC3-1))
C
C         READ RESPECTIVE RECORDS TO OBTAIN I,I-P-1,I+P
          IF (IREC1.EQ.REC1) GO TO 50
          CALL READR(2,REC1,TEMP1,1,IER)
          IREC1=REC1
 50       CONTINUE
          IF (IREC2.EQ.REC2) GO TO 60
          CALL READR(2,REC2,TEMP2,1,IER)
          IREC2=REC2
 60       CONTINUE
          IF (IREC3.EQ.REC3) GO TO 70
          CALL READR(2,REC3,TEMP3,1,IER)
          IREC3=REC3
 70       CONTINUE
          SUM=SUM-TEMP2(LOC2)+TEMP3(LOC3)
          XT=TEMP1(LOC1)-(SUM/FLOAT(2*P+1))
          CALL READR(3,REC1,TEMP1,1,IER)
          TEMP1(LOC1)=XT
          CALL WRITR(3,REC1,TEMP1,1,IER)
30        CONTINUE
          IF (REC1.EQ.NR) GO TO 90
          REC1=REC1+1
          DO 80 I=REC1,NR
          CALL READR (2,I,TEMP1,1,IER)
          CALL WRITR (3,I,TEMP1,1,IER)
 80       CONTINUE
 90       CONTINUE
C         QUO=P/NP
C         IF(MOD(P,NP).GT.0) QUO=QUO+1
C         IP=P-((QUO-1)*NP)
C         CALL READR(3,QUO,TEMP1,1,IER)
C         TYPE "Z'"
C         TYPE (TEMP1(I),I=IP,NP)
C
```

```
C       ZERO OUT BEGINNING AND LAST P POINTS FROM FILE ZP
C
        ICNT=0
        NP2=NP1(1)
        NR2=NR
        DO 1 I=1,NR
        CALL READR(3,I,TEMP1,1,IER)
        CALL READR(3,NR2,TEMP2,1,IER)
        DO 200 J=1,NP2
        TEMP1(J)=0.0
        TEMP2(J)=0.0
        ICNT=ICNT+1
        IF(ICNT.EQ.P) GO TO 300
200     CONTINUE
        CALL WRITR(3,I,TEMP1,1,IER)
        CALL WRITR(3,NR2,TEMP2,1,IER)
        NR2=NR2-1
1       CONTINUE
300     CALL WRITR(3,I,TEMP1,1,IER)
        CALL WRITR(3,NR2,TEMP2,1,IER)
C
C
        CALL FCLOS(2)
        CALL FCLOS(3)
        CALL BACK
        END
R
```

```
TYPE SP24
C       FILE SP24-HFF
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION: 2
C       DATE: 4/20/79
C       PURPOSE: THIS MODULE PERFORMS THE HIGH FREQUENCY OPERATION ON
C       THE LOW FREQUENCY DATA.
        COMPILER NOSTACK
C       SUBROUTINE HFF(TEMP1,TEMP2,TEMP3,NP1,P,NR)
        DIMENSION TEMP1(1000),TEMP2(1000),TEMP3(1000)
        INTEGER QUO,P,Q,P2,NP1(50),REC1,REC2,REC3
        TYPE 'DATA IS BEING FILTERED FOR HIGH FREQUENCY'
        CALL FOPEN(2,'ZP',4000)
        CALL FOPEN(3,'ZPP',4000)
        CALL FOPEN(4,'PAR')
        READ BINARY (4) NP1,Q,P,NR
        CALL FCLOS(4)
C
C       CALCULATE # OF RECORDS TO COMPUTE FIRST SUM AND
C       FIND REC. # OF FIRST POINT
C
        NP=NP1(1)
        NREC=(2*P+1)/NP
        IF(MOD(2*P+1,NP).GT.0) NREC=NREC+1
        QUO=P/NP
        IF(MOD(P,NP).GT.0) QUO=QUO+1
C
C       CALCULATE FIRST SUM (POINT P+1)
C
        N1=0
        SUM=0.0
        DO 10 I=1,NREC
        CALL READR(2,I,TEMP1,1,IER)
        DO 20 J=1,NP
        SUM=SUM+TEMP1(J)
        N1=N1+1
        IF(N1.EQ.(2*P+1)) GO TO 5
20      CONTINUE
```

```
10      CONTINUE
5       CONTINUE
C
C       FIND LOCATION OF FIRST POINT
C
        CALL READR(2,QUO,TEMP1,1,IER)
        LOC1=P+1-(NP*(QUO-1))
        TEMP1(LOC1)=SUM/FLOAT(2*P+1)
        CALL WRITR(3,QUO,TEMP1,1,IER)
        P2=P+2
        N=NP*NR
        NMP=N-P
        DO 30 I=P2,NMP
C
C       CALCULATE REC # OF PTS. I,I-P-1,I+P
C
        REC1=I/NP
        IF(MOD(I,NP).GT.0) REC1=REC1+1
        REC2=(I-P-1)/NP
        IF(MOD(I-P-1,NP).GT.0) REC2=REC2+1
        REC3=(I+P)/NP
        IF(MOD(I+P,NP).GT.0) REC3=REC3+1
        IF (I.NE.P2) GO TO 40
        IREC1=REC1
        IREC2=REC2
        IREC3=REC3
        CALL READR (2,REC1,TEMP1,1,IER)
        CALL READR (2,REC2,TEMP2,1,IER)
        CALL READR (2,REC3,TEMP3,1,IER)
 46     CONTINUE
C
C       CALCULATE LOC. OF PTS. I,I-P-1,I+P IN RESPECTIVE RECORDS
        LOC1=I-(NP*(REC1-1))
        LOC2=(I-P-1)-(NP*(REC2-1))
        LOC3=(I+P)-(NP*(REC3-1))
C
C       READ RESPECTIVE RECORDS TO OBTAIN I,I-P-1,I+P
C
```

```
      IF (IREC1.EQ.REC1) GO TO 50
      CALL READR (2,REC1,TEMP1,1,IER)
      IREC1=REC1
50    CONTINUE
      IF (IREC2.EQ.REC2) GO TO 60
      CALL READR (2,REC2,TEMP2,1,IER)
      IREC2=REC2
60    CONTINUE
      IF (IREC3.EQ.REC3) GO TO 70
      CALL READR (2,REC3,TEMP3,1,IER)
      IREC3=REC3
70    CONTINUE
      SUM=SUM-TEMP2(LOC2)+TEMP3(LOC3)
      XT=SUM/FLOAT(2*P+1)
      CALL READR(3,REC1,TEMP1,1,IER)
      TEMP1(LOC1)=XT
      CALL WRITR(3,REC1,TEMP1,1,IER)
30    CONTINUE
C     QUO=Q/NP
C     IF(MOD(Q,NP).GT.0) QUO=QUO+1
C     IP=Q-((QUO-1)*NP)+P
C     CALL READR(3,QUO,TEMP1,1,IER)
C     TYPE 'Z//'
C     TYPE (TEMP1(I),I=IP,NP)
C
C     ZERO OUT BEGINNING AND LAST P+Q POINTS FROM FILE ZPP
C
      ICNT=0
      NP2=NP1(1)
      NR1=NR
      DO 1 I=1,NR
      CALL READR(3,I,TEMP1,1,IER)
      CALL READR(3,NR1,TEMP2,1,IER)
      DO 200 J=1,NP2
      TEMP1(J)=0.0
      TEMP2(J)=0.0
      ICNT=ICNT+1
      IF(ICNT.EQ.(P+Q)) GO TO 300
```

```
200     CONTINUE
        CALL WRITR(3,I,TEMP1,1,IER)
        CALL WRITR(3,NR1,TEMP2,1,IER)
        NR1=NR1-1
1       CONTINUE
300     CALL WRITR(3,I,TEMP1,1,IER)
        CALL WRITR(3,NR1,TEMP2,1,IER)
C
C
        CALL FCLOS(2)
        CALL FCLOS(3)
        CALL BACK
        END
R
```

```
TYPE SP25
C       SP25=AC1
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION:0
C       DATE:4/20/79
C       PURPOSE: THIS MODULE PERFORMS THE APERTURE COMPENSATION
C       OPERATION ON THE INVERSE FILTERED PSDF FOR SP1 AND SPL.
        COMPILER NOSTACK
        SUBROUTINE AC1(GKCP,GKC3P,M,H,XA)
        DIMENSION GKCP(101),GKC3P(101)
        PI=3.14159
        MR=M+1
        DO 10 K1=1,MR
        K=K1-1
        IF(K.GT.0) GO TO 5
        GKC3P(K1)=GKCP(K1)
        GO TO 10
5       IF(SIN((K*PI*XA)/(2*H*M)).LT.1.0E-06) TYPE
     *  'THE DENOMINATOR OF SINE FUNCTON BELOW 1.0E-06 ENCOUNTERED IN AC'
        GKC3P(K1)=GKCP(K1)*(((K*PI*XA)/(2*H*M))/SIN((K*PI*XA)/(2*H*M)))**2
10      CONTINUE
        TYPE '  K           GKC(K)          GKC3P(K)'
        DO 2000 J=1,MR
        IR=J-1
        WRITE(10,100) IR,GKCP(J),GKC3P(J)
100     FORMAT(1X,I3,8X,E11.4,8X,E11.4)
2000    CONTINUE
        RETURN
        END
R
```

SP1
FILE NUMBER,NF=5
DIFFUSE DENSITY FACTOR,DDF=1.27
MAXIMUM LAG FACTOR,M=28
HEIGHT OF SCANNING SLIT,XL=1000
WIDTH OF SCANNING SLIT,XA=25
DATA PREPARATION COMMENCED
NUMBER OF FILES SKIPPED= 4
FILE IS BEING READ FROM TAPE
NUMBER OF RECORDS READ= 3
FILE READ FROM TAPE AND WRITTEN ON DISK
BSA-2 1804-1 E-1 3\27\79STEP 10) 1p/0
NUMBER OF SAMPLES= 281
X COORDINATE (MICRONS)= -1
Y COORDINATE (MICRONS)= 4
DELTA X (H) (MICRONS)= 18
DATA IS BEING FORMATTED

1.62	1.60	1.69	1.80	1.83	1.82	1.81	1.78	1.82	1.79
1.76	1.79	1.85	1.92	1.84	1.87	1.87	1.80	1.79	1.81
1.81	1.77	1.79	1.83	1.82	1.82	1.84	1.81	1.80	1.85
1.86	1.82	1.51	1.84	1.82	1.84	1.81	1.78	1.81	1.85
1.86	1.89	1.89	1.85	1.82	1.80	1.79	1.79	1.80	1.81
1.82	1.85	1.82	1.80	1.81	1.82	1.82	1.83	1.85	1.82
1.79	1.82	1.81	1.84	1.87	1.84	1.80	1.81	1.82	1.85
1.86	1.88	1.87	1.84	1.79	1.79	1.82	1.80	1.81	1.86
1.84	1.84	1.89	1.85	1.80	1.81	1.83	1.85	1.83	1.84
1.84	1.84	1.86	1.82	1.79	1.81	1.81	1.79	1.78	1.81
1.82	1.80	1.79	1.79	1.85	1.85	1.81	1.80	1.79	1.80
1.79	1.78	1.80	1.92	1.85	1.84	1.78	1.77	1.79	1.78
1.76	1.74	1.75	1.78	1.79	1.78	1.76	1.74	1.76	1.77
1.77	1.79	1.82	1.78	1.78	1.78	1.78	1.77	1.77	1.80
1.80	1.83	1.83	1.80	1.80	1.81	1.77	1.78	1.84	1.83
1.82	1.82	1.85	1.83	1.84	1.81	1.78	1.77	1.80	1.77
1.82	1.87	1.83	1.81	1.80	1.81	1.82	1.82	1.80	1.81
1.81	1.75	1.73	1.78	1.79	1.75	1.76	1.81	1.82	1.80
1.80	1.82	1.82	1.84	1.83	1.80	1.81	1.82	1.86	1.86
1.87	1.85	1.84	1.84	1.83	1.88	1.84	1.86	1.88	1.88
1.83	1.81	1.82	1.84	1.84	1.83	1.83	1.85	1.83	1.79
1.77	1.77	1.81	1.77	1.84	1.89	1.81	1.80	1.81	1.80
1.78	1.79	1.83	1.79	1.78	1.77	1.76	1.77	1.77	1.80
1.78	1.76	1.81	1.85	1.84	1.85	1.83	1.81	1.80	1.80
1.77	1.78	1.79	1.77	1.81	1.79	1.76	1.79	1.77	1.80
1.84	1.85	1.87	1.84	1.75	1.79	1.82	1.82	1.78	1.76
1.78	1.78	1.80	1.80	1.80	1.78	1.79	1.81	1.79	1.80
1.77	1.75	1.79	1.81	1.77	1.77	1.78	1.74	1.74	1.77
1.79									

DATA FORMATTING COMPLETED
RAW DATA STORED ON DISK.
HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES= 100

CLASS NO.	NO. OF DATA POINTS
41	2
42	2
43	2
44	34
45	206
46	349
47	206
48	41
49	1

RAW MEAN = 0.145498E 4
MEAN OF NORMALIZED DATA= 0.127000E 1
MEAN SQUARE VALUE = 0.687189E -3

ROOT MEAN SQUARE VALUE = 0.262298E -1
AUTOCORRELATION IS BEING COMPUTED

R	R-HAT	NORM. R-HAT
0	0.6872E -3	0.1000E 1
1	0.4953E -3	0.7207E 0
2	0.2693E -3	0.3919E 0
3	0.1711E -3	0.2490E 0
4	0.1170E -3	0.1702E 0
5	0.8441E -4	0.1228E 0
6	0.9061E -4	0.1319E 0
7	0.1202E -3	0.1749E 0
8	0.1556E -3	0.2264E 0
9	0.1870E -3	0.2721E 0
10	0.1820E -3	0.2648E 0
11	0.1519E -3	0.2211E 0
12	0.1382E -3	0.2011E 0
13	0.1321E -3	0.1922E 0
14	0.1163E -3	0.1692E 0
15	0.1180E -3	0.1718E 0
16	0.1301E -3	0.1893E 0
17	0.1392E -3	0.2026E 0
18	0.1405E -3	0.2044E 0
19	0.1396E -3	0.2031E 0
20	0.1395E -3	0.2030E 0
21	0.1408E -3	0.2049E 0
22	0.1327E -3	0.1930E 0
23	0.1172E -3	0.1706E 0
24	0.1035E -3	0.1507E 0
25	0.9151E -4	0.1332E 0
26	0.7764E -4	0.1130E 0
27	0.8014E -4	0.1166E 0
28	0.9431E -4	0.1372E 0

K	GKC(K)	GKC3P(K)
0	0.3133E 3	0.3133E 3
1	0.6974E 2	0.6988E 2
2	0.3646E 2	0.3676E 2
3	0.5742E 2	0.5847E 2
4	0.4173E 2	0.4311E 2
5	0.6281E 2	0.6608E 2
6	0.5883E 2	0.6331E 2
7	0.3970E 2	0.4388E 2
8	0.2616E 2	0.2983E 2
9	0.1585E 2	0.1873E 2
10	0.1834E 2	0.2255E 2
11	0.1460E 2	0.1877E 2
12	0.1650E 2	0.2228E 2
13	0.1496E 2	0.2132E 2
14	0.1193E 2	0.1804E 2
15	0.6408E 1	0.1034E 2
16	0.8821E 1	0.1526E 2
17	0.7324E 1	0.1366E 2
18	0.8074E 1	0.1634E 2
19	0.3621E 1	0.9002E 1
20	0.3235E 1	0.7857E 1
21	0.2194E 1	0.5900E 1
22	0.2883E 1	0.8646E 1
23	0.1766E 1	0.5960E 1
24	0.1882E 1	0.7206E 1
25	0.1269E 1	0.5572E 1
26	0.1815E 1	0.9231E 1
27	0.1160E 1	0.6917E 1
28	0.1087E 1	0.7709E 1

K	GKC3P(K)	GH(K)
0	0.3133E 3	0.1916E 3

1	0.6988E	2	0.1225E	3
2	0.3676E	2	0.5047E	2
3	0.5847E	2	0.4920E	2
4	0.4311E	2	0.5269E	2
5	0.6608E	2	0.5964E	2
6	0.6331E	2	0.5915E	2
7	0.4388E	2	0.4523E	2
8	0.2983E	2	0.3057E	2
9	0.1873E	2	0.2246E	2
10	0.2255E	2	0.2065E	2
11	0.1877E	2	0.2059E	2
12	0.2228E	2	0.2116E	2
13	0.2132E	2	0.2074E	2
14	0.1804E	2	0.1694E	2
15	0.1034E	2	0.1349E	2
16	0.1526E	2	0.1363E	2
17	0.1366E	2	0.1473E	2
18	0.1634E	2	0.1359E	2
19	0.8002E	1	0.1005E	2
20	0.7857E	1	0.7404E	1
21	0.5900E	1	0.7076E	1
22	0.6646E	1	0.7288E	1
23	0.5960E	1	0.6943E	1
24	0.7206E	1	0.6486E	1
25	0.5572E	1	0.6895E	1
26	0.9231E	1	0.7738E	1
27	0.6917E	1	0.7694E	1
28	0.7709E	1	0.7313E	1

STOP
R

SPL
FILE NUMBER,NF=5
DIFFUSE DENSITY FACTOR,DDF=1.27
MAXIMUM LAG FACTOR,M=28
HEIGHT OF SCANNING SLIT,XL=1000
WIDTH OF SCANNING SLIT,XA=25
LOW FREQUENCY FILTER PARAMETER,P=30
DATA PREPARATION COMMENCED
NUMBER OF FILES SKIPPED= 4
FILE IS BEING READ FROM TAPE
NUMBER OF RECORDS READ= 3
FILE READ FROM TAPE AND WRITTEN ON DISK
BSA-2 1804-L E-1 3\27\79STEP 10) 1p/0
NUMBER OF SAMPLES= 281
X COORDINATE (MICRONS)= -1
Y COORDINATE (MICRONS)= 4
DELTA X (H) (MICRONS)= 18
DATA IS BEING FORMATTED

1.62	1.60	1.69	1.80	1.83	1.82	1.81	1.78	1.82	1.79
1.76	1.79	1.85	1.82	1.84	1.87	1.87	1.80	1.79	1.81
1.81	1.77	1.79	1.83	1.82	1.82	1.84	1.81	1.80	1.85
1.86	1.82	1.81	1.84	1.82	1.84	1.81	1.78	1.81	1.85
1.86	1.89	1.89	1.85	1.82	1.80	1.79	1.79	1.80	1.81
1.82	1.85	1.82	1.80	1.81	1.82	1.82	1.83	1.85	1.82
1.79	1.82	1.81	1.84	1.87	1.84	1.80	1.81	1.82	1.85
1.86	1.88	1.87	1.84	1.79	1.79	1.82	1.80	1.81	1.86
1.84	1.84	1.89	1.85	1.80	1.81	1.83	1.85	1.83	1.84
1.84	1.84	1.86	1.82	1.79	1.81	1.81	1.79	1.78	1.81
1.82	1.80	1.79	1.79	1.85	1.85	1.81	1.80	1.79	1.80
1.79	1.78	1.80	1.82	1.85	1.84	1.78	1.77	1.79	1.78
1.76	1.74	1.75	1.78	1.79	1.78	1.76	1.74	1.76	1.77
1.77	1.79	1.82	1.78	1.78	1.78	1.78	1.77	1.77	1.80
1.80	1.83	1.83	1.80	1.80	1.81	1.77	1.78	1.84	1.83
1.82	1.82	1.85	1.83	1.84	1.81	1.78	1.77	1.80	1.77
1.82	1.87	1.83	1.81	1.80	1.81	1.82	1.82	1.80	1.81
1.81	1.75	1.73	1.78	1.79	1.75	1.76	1.81	1.82	1.80
1.80	1.82	1.82	1.84	1.83	1.80	1.81	1.82	1.86	1.86
1.87	1.85	1.84	1.84	1.88	1.88	1.84	1.86	1.88	1.88
1.83	1.81	1.82	1.84	1.84	1.83	1.83	1.85	1.83	1.79
1.77	1.77	1.81	1.77	1.84	1.88	1.81	1.80	1.81	1.80
1.78	1.79	1.83	1.79	1.78	1.77	1.76	1.77	1.77	1.80
1.78	1.75	1.81	1.85	1.84	1.85	1.83	1.81	1.80	1.80
1.77	1.78	1.79	1.77	1.81	1.79	1.76	1.79	1.77	1.80
1.84	1.85	1.87	1.84	1.75	1.79	1.82	1.82	1.78	1.76
1.78	1.78	1.80	1.80	1.80	1.78	1.79	1.81	1.79	1.80
1.77	1.75	1.79	1.81	1.77	1.77	1.78	1.74	1.74	1.77
1.79									

DATA FORMATTING COMPLETED
RAW DATA STORED ON DISK.
HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES= 100

CLASS NO.	NO. OF DATA POINTS
41	2
42	2
43	2
44	34
45	206
46	349
47	206
48	41
49	1

RAW MEAN = 0.145498E 4
MEAN OF NORMALIZED DATA= 0.127000E 1

DATA IS BEING FILTERED FOR LOW FREQUENCY
MEAN SQUARE VALUE = 0.437882E -3
ROOT MEAN SQUARE VALUE = 0.209380E -1
AUTOCORRELATION IS BEING COMPUTED

R	R-HAT	NORM. R-HAT
0	0.4714E -3	0.1000E 1
1	0.2918E -3	0.6189E 0
2	0.9730E -4	0.2064E 0
3	0.2736E -4	0.5803E -1
4	-0.1573E -4	-0.3336E -1
5	-0.4244E -4	-0.9001E -1
6	-0.4077E -4	-0.8648E -1
7	-0.2055E -4	-0.4358E -1
8	0.4914E -5	0.1042E -1
9	0.2241E -4	0.4754E -1
10	0.9430E -5	0.2000E -1
11	-0.1482E -4	-0.3144E -1
12	-0.1328E -4	-0.2816E -1
13	-0.1152E -4	-0.2443E -1
14	-0.2003E -4	-0.4249E -1
15	-0.1543E -4	-0.3273E -1
16	-0.4060E -5	-0.8612E -2
17	-0.2292E -6	-0.4862E -3
18	-0.8391E -5	-0.1780E -1
19	-0.2072E -4	-0.4396E -1
20	-0.2593E -4	-0.5500E -1
21	-0.2456E -4	-0.5209E -1
22	-0.2420E -4	-0.5132E -1
23	-0.3434E -4	-0.7285E -1
24	-0.4920E -4	-0.1044E 0
25	-0.5663E -4	-0.1201E 0
26	-0.7060E -4	-0.1498E 0
27	-0.7054E -4	-0.1496E 0
28	-0.4194E -4	-0.8897E -1

K	GKC(K)	GKC3P(K)
0	0.6046E 1	0.6046E 1
1	0.6598E 2	0.6611E 2
2	0.3026E 2	0.3051E 2
3	0.5156E 2	0.5251E 2
4	0.3955E 2	0.4086E 2
5	0.4519E 2	0.4754E 2
6	0.4379E 2	0.4712E 2
7	0.3648E 2	0.4033E 2
8	0.2371E 2	0.2703E 2
9	0.1355E 2	0.1600E 2
10	0.1747E 2	0.2148E 2
11	0.1095E 2	0.1407E 2
12	0.1540E 2	0.2030E 2
13	0.1479E 2	0.2108E 2
14	0.1215E 2	0.1837E 2
15	0.6169E 1	0.9951E 1
16	0.8443E 1	0.1460E 2
17	0.6477E 1	0.1208E 2
18	0.8799E 1	0.1781E 2
19	0.3404E 1	0.7521E 1
20	0.4602E 1	0.1118E 2
21	0.1429E 1	0.3843E 1
22	0.3939E 1	0.1181E 2
23	0.1409E 1	0.4755E 1
24	0.2528E 1	0.9683E 1
25	0.7372E 0	0.3236E 1
26	0.1925E 1	0.9791E 1
27	0.6203E 0	0.3700E 1
28	0.1759E 1	0.1247E 2

K	GKC3P(K)	GH(K)
0	0.6046E 1	0.3608E 2
1	0.6611E 2	0.4220E 2
2	0.3051E 2	0.4491E 2
3	0.5251E 2	0.4410E 2
4	0.4086E 2	0.4544E 2
5	0.4754E 2	0.4577E 2
6	0.4712E 2	0.4553E 2
7	0.4033E 2	0.3870E 2
8	0.2703E 2	0.2760E 2
9	0.1600E 2	0.2013E 2
10	0.2148E 2	0.1826E 2
11	0.1407E 2	0.1761E 2
12	0.2080E 2	0.1919E 2
13	0.2108E 2	0.2034E 2
14	0.1837E 2	0.1695E 2
15	0.9951E 1	0.1322E 2
16	0.1460E 2	0.1281E 2
17	0.1208E 2	0.1414E 2
18	0.1781E 2	0.1380E 2
19	0.7521E 1	0.1101E 2
20	0.1118E 2	0.8429E 1
21	0.3843E 1	0.7669E 1
22	0.1181E 2	0.8057E 1
23	0.4755E 1	0.7752E 1
24	0.9683E 1	0.6839E 1
25	0.3236E 1	0.6486E 1
26	0.9791E 1	0.6630E 1
27	0.3700E 1	0.7417E 1
28	0.1247E 2	0.8088E 1

STOP
R

```
SPH
FILE NUMBER,NF=5
DIFFUSE DENSITY FACTOR,DDF=1.27
MAXIMUM LAG FACTOR,M=28
HEIGHT OF SCANNING SLIT,XL=1000
WIDTH OF SCANNING SLIT,XA=25
HIGH FREQUENCY FILTER PARAMETER,Q=1
 DATA PREPARATION COMMENCED
NUMBER OF FILES SKIPPED=          4
FILE IS BEING READ FROM TAPE
NUMBER OF RECORDS READ=           3
FILE READ FROM TAPE AND WRITTEN ON DISK
BSA-2 1[illegible] L E-1  3\27\79STEP 10) 1p/0
NUMBER OF SAMPLES=         281
X COORDINATE (MICRONS)=          -1
Y COORDINATE (MICRONS)=           4
DELTA X (H) (MICRONS)=           18
DATA IS BEING FORMATTED
 1.62  1.60  1.69  1.80  1.83  1.82  1.81  1.78  1.82  1.79
 1.76  1.79  1.85  1.82  1.84  1.87  1.87  1.80  1.79  1.81
 1.81  1.77  1.79  1.83  1.82  1.82  1.84  1.81  1.80  1.85
 1.86  1.82  1.81  1.84  1.82  1.84  1.81  1.78  1.81  1.85
 1.86  1.89  1.89  1.85  1.82  1.80  1.79  1.79  1.80  1.81
 1.82  1.85  1.82  1.80  1.81  1.82  1.82  1.83  1.85  1.82
 1.79  1.82  1.81  1.84  1.87  1.84  1.80  1.81  1.82  1.85
 1.86  1.88  1.87  1.84  1.79  1.79  1.82  1.80  1.81  1.86
 1.84  1.84  1.89  1.85  1.80  1.81  1.83  1.85  1.83  1.84
 1.84  1.84  1.86  1.82  1.79  1.81  1.81  1.79  1.78  1.81
 1.82  1.80  1.79  1.79  1.85  1.85  1.81  1.80  1.79  1.80
 1.79  1.78  1.80  1.82  1.85  1.84  1.78  1.77  1.79  1.78
 1.76  1.74  1.75  1.78  1.79  1.78  1.76  1.74  1.76  1.77
 1.77  1.79  1.82  1.78  1.78  1.78  1.78  1.77  1.77  1.80
 1.80  1.83  1.83  1.80  1.80  1.81  1.77  1.78  1.84  1.83
 1.82  1.82  1.85  1.83  1.84  1.81  1.78  1.77  1.80  1.77
 1.82  1.87  1.83  1.81  1.80  1.81  1.82  1.82  1.80  1.81
 1.81  1.75  1.73  1.78  1.79  1.75  1.76  1.81  1.82  1.80
 1.80  1.82  1.82  1.84  1.83  1.80  1.81  1.82  1.86  1.86
 1.87  1.85  1.84  1.84  1.88  1.88  1.84  1.86  1.88  1.88
 1.83  1.81  1.82  1.84  1.84  1.83  1.83  1.85  1.83  1.79
 1.77  1.77  1.81  1.77  1.84  1.88  1.81  1.80  1.81  1.80
 1.78  1.79  1.83  1.79  1.78  1.77  1.76  1.77  1.77  1.80
 1.78  1.76  1.81  1.85  1.84  1.85  1.83  1.81  1.80  1.80
 1.77  1.78  1.79  1.77  1.81  1.79  1.76  1.79  1.77  1.80
 1.84  1.85  1.87  1.84  1.75  1.79  1.82  1.82  1.78  1.76
 1.78  1.78  1.80  1.80  1.80  1.78  1.79  1.81  1.79  1.80
 1.77  1.75  1.79  1.81  1.77  1.77  1.78  1.74  1.74  1.77
 1.79
DATA FORMATTING COMPLETED
RAW DATA STORED ON DISK.
HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES=      100
   CLASS NO.        NO. OF DATA POINTS
      41                   2
      42                   2
      43                   2
      44                  34
      45                 206
      46                 349
      47                 206
      48                  41
      49                   1
RAW MEAN =      0.145498E  4
MEAN OF NORMALIZED DATA=      0.127000E  1
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DATA IS BEING FILTERED FOR HIGH FREQUENCY
MEAN SQUARE VALUE =       0.485342E -3
ROOT MEAN SQUARE VALUE =       0.220435E -1
AUTOCORRELATION IS BEING COMPUTED
  R          R-HAT              NORM. R-HAT
  0      0.4865E -3           0.1000E  1
  1      0.4173E -3           0.8578E  0
  2      0.3050E -3           0.6269E  0
  3      0.2019E -3           0.4150E  0
  4      0.1415E -3           0.2909E  0
  5      0.1157E -3           0.2377E  0
  6      0.1138E -3           0.2340E  0
  7      0.1305E -3           0.2683E  0
  8      0.1524E -3           0.3132E  0
  9      0.1668E -3           0.3429E  0
 10      0.1657E -3           0.3407E  0
 11      0.1558E -3           0.3203E  0
 12      0.1424E -3           0.2927E  0
 13      0.1336E -3           0.2745E  0
 14      0.1295E -3           0.2661E  0
 15      0.1329E -3           0.2733E  0
 16      0.1376E -3           0.2829E  0
 17      0.1399E -3           0.2876E  0
 18      0.1387E -3           0.2851E  0
 19      0.1381E -3           0.2839E  0
 20      0.1357E -3           0.2789E  0
 21      0.1303E -3           0.2677E  0
 22      0.1224E -3           0.2516E  0
 23      0.1138E -3           0.2340E  0
 24      0.1041E -3           0.2139E  0
 25      0.9556E -4           0.1964E  0
 26      0.8979E -4           0.1846E  0
 27      0.8953E -4           0.1840E  0
 28      0.9297E -4           0.1911E  0
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
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THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
  K          GKC(K)             GKCP(K)
  0      0.3113E  3           0.3118E  3
  1      0.6518E  2           0.6573E  2
  2      0.3012E  2           0.3115E  2
  3      0.4723E  2           0.5097E  2
  4      0.3455E  2           0.3961E  2
  5      0.4220E  2           0.5236E  2
  6      0.3829E  2           0.5244E  2
  7      0.2415E  2           0.3729E  2
  8      0.1368E  2           0.2438E  2
  9      0.6902E  1           0.1458E  2
 10      0.7107E  1           0.1833E  2
 11      0.5214E  1           0.1702E  2
 12      0.4350E  1           0.1875E  2
 13      0.2841E  1           0.1707E  2
 14      0.2779E  1           0.2501E  2
 15      0.1070E  1           0.1599E  2
 16      0.1647E  1           0.3055E  2
 17      0.7627E  0           0.5957E  2
 18      0.8311E  0           0.4277E  3
```

19	0.4630E 0	0.1015E 4
20	0.7795E 0	0.1150E 3
21	0.5110E 0	0.2681E 2
22	0.7462E 0	0.2114E 2
23	0.5456E 0	0.1021E 2
24	0.749[illegible] 0	0.1048E 2
25	0.6676E 0	0.7624E 1
26	0.9020E 0	0.8998E 1
27	0.6060E 0	0.5594E 1
28	0.4739E 0	0.4265E 1

K	GKCP(K)	GKC3P(K)
0	0.3118E 3	0.3118E 3
1	0.6573E 2	0.6586E 2
2	0.3115E 2	0.3140E 2
3	0.5097E 2	0.5191E 2
4	0.3961E 2	0.4092E 2
5	0.5236E 2	0.5509E 2
6	0.5244E 2	0.5643E 2
7	0.3729E 2	0.4121E 2
8	0.2438E 2	0.2780E 2
9	0.1458E 2	0.1722E 2
10	0.1833E 2	0.2254E 2
11	0.1702E 2	0.2188E 2
12	0.1875E 2	0.2532E 2
13	0.1707E 2	0.2433E 2
14	0.2501E 2	0.3782E 2
15	0.1599E 2	0.2580E 2
16	0.3059E 2	0.5290E 2
17	0.5957E 2	0.1111E 3
18	0.4277E 3	0.8656E 3
19	0.1015E 4	0.2244E 4
20	0.1150E 3	0.2793E 3
21	0.2681E 2	0.7207E 2
22	0.2114E 2	0.6341E 2
23	0.1021E 2	0.3445E 2
24	0.1048E 2	0.4014E 2
25	0.7624E 1	0.3347E 2
26	0.8998E 1	0.4577E 2
27	0.5594E 1	0.3337E 2
28	0.4265E 1	0.3025E 2

K	GKC3P(K)	GH(K)
0	0.3118E 3	0.1888E 3
1	0.6586E 2	0.1187E 3
2	0.3140E 2	0.4514E 2
3	0.5191E 2	0.4404E 2
4	0.4092E 2	0.4721E 2
5	0.5509E 2	0.5188E 2
6	0.5643E 2	0.5229E 2
7	0.4121E 2	0.4166E 2
8	0.2780E 2	0.2851E 2
9	0.1722E 2	0.2120E 2
10	0.2254E 2	0.2105E 2
11	0.2188E 2	0.2290E 2
12	0.2532E 2	0.2421E 2
13	0.2433E 2	0.2795E 2
14	0.3782E 2	0.3144E 2
15	0.2580E 2	0.3558E 2
16	0.5290E 2	0.6068E 2
17	0.1111E 3	0.2852E 3
18	0.8656E 3	0.1022E 4
19	0.2244E 4	0.1408E 4
20	0.2793E 3	0.7186E 3
21	0.7207E 2	0.1217E 3
22	0.6341E 2	0.5833E 2
23	0.3445E 2	0.4311E 2
24	0.4014E 2	0.3705E 2
25	0.3347E 2	0.3821E 2
26	0.4577E 2	0.3959E 2
27	0.3337E 2	0.3569E 2
28	0.3025E 2	0.3181E 2

STOP
R

C-2

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SP2
FILE NUMBER,NF-5
DIFFUSE DENSITY FACTOR,DDF-1.27
MAXIMUM LAG FACTOR,M-28
HEIGHT OF SCANNING SLIT,XL-1000
WIDTH OF SCANNING SLIT,XA-25
LOW FREQUENCY FILTER PARAMETER,P-28
HIGH FREQUENCY FILTER PARAMETER,Q-1
 DATA PREPARATION COMMENCED
NUMBER OF FILES SKIPPED-          4
FILE IS BEING READ FROM TAPE
NUMBER OF RECORDS READ-          3
FILE READ FROM TAPE AND WRITTEN ON DISK
BSA-2 1804-L E-1  3\27\79STEP 10) 1p/0
NUMBER OF SAMPLES-       281
X COORDINATE (MICRONS)-          -1
Y COORDINATE (MICRONS)-           4
DELTA X (H) (MICRONS)-       18
DATA IS BEING FORMATTED
  1.62  1.60  1.69  1.80  1.83  1.82  1.81  1.78  1.82  1.79
  1.76  1.79  1.85  1.82  1.84  1.87  1.87  1.80  1.79  1.81
  1.81  1.77  1.79  1.83  1.82  1.82  1.84  1.81  1.80  1.85
  1.86  1.82  1.81  1.84  1.82  1.84  1.81  1.78  1.81  1.85
  1.86  1.89  1.89  1.85  1.82  1.80  1.79  1.79  1.80  1.81
  1.82  1.85  1.82  1.80  1.81  1.82  1.82  1.83  1.85  1.82
  1.79  1.82  1.81  1.84  1.87  1.84  1.80  1.81  1.82  1.85
  1.86  1.88  1.87  1.84  1.79  1.79  1.82  1.80  1.81  1.86
  1.84  1.84  1.89  1.85  1.80  1.81  1.83  1.85  1.83  1.84
  1.84  1.84  1.86  1.82  1.79  1.81  1.81  1.79  1.78  1.81
  1.82  1.80  1.79  1.79  1.85  1.85  1.81  1.80  1.79  1.80
  1.79  1.78  1.80  1.82  1.85  1.84  1.78  1.77  1.79  1.78
  1.76  1.74  1.75  1.78  1.79  1.78  1.76  1.74  1.76  1.77
  1.77  1.79  1.82  1.78  1.78  1.78  1.78  1.77  1.77  1.80
  1.80  1.83  1.83  1.80  1.80  1.81  1.77  1.78  1.84  1.83
  1.82  1.82  1.85  1.83  1.84  1.81  1.78  1.77  1.80  1.77
  1.82  1.87  1.83  1.81  1.80  1.81  1.82  1.82  1.80  1.81
  1.81  1.75  1.73  1.78  1.79  1.75  1.76  1.81  1.82  1.80
  1.80  1.82  1.82  1.84  1.83  1.80  1.81  1.82  1.86  1.86
  1.87  1.85  1.84  1.84  1.88  1.88  1.84  1.86  1.88  1.88
  1.83  1.81  1.82  1.84  1.84  1.83  1.83  1.85  1.83  1.79
  1.77  1.77  1.81  1.77  1.84  1.88  1.81  1.80  1.81  1.80
  1.78  1.79  1.83  1.79  1.78  1.77  1.76  1.77  1.77  1.80
  1.78  1.76  1.81  1.85  1.84  1.85  1.83  1.81  1.80  1.80
  1.77  1.78  1.79  1.77  1.81  1.79  1.76  1.79  1.77  1.80
  1.84  1.85  1.87  1.84  1.75  1.79  1.82  1.82  1.78  1.76
  1.78  1.78  1.80  1.80  1.80  1.78  1.79  1.81  1.79  1.80
  1.77  1.75  1.79  1.81  1.77  1.77  1.78  1.74  1.74  1.77
  1.79
DATA FORMATTING COMPLETED
RAW DATA STORED ON DISK.
HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES-        100
   CLASS NO.      NO. OF DATA POINTS
      41                  2
      42                  2
      43                  2
      44                 24
      45                206
      46                349
      47                206
      48                 41
      49                  1
RAW MEAN -      0.145498E  4
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MEAN OF NORMALIZED DATA-        0.127000E  1
DATA IS BEING FILTERED FOR LOW FREQUENCY
DATA IS BEING FILTERED FOR HIGH FREQUENCY
MEAN SQUARE VALUE -        0.281856E -3
ROOT MEAN SQUARE VALUE -        0.167885E -1
AUTOCORRELATION IS BEING COMPUTED
 R          R-HAT              NORM. R-HAT
 0       0.3027E -3          0.1000E  1
 1       0.2512E -3          0.8300E  0
 2       0.1447E -3          0.4772E  0
 3       0.4692E -4          0.1550E  0
 4      -0.8266E -5         -0.2731E -1
 5      -0.3060E -4         -0.1011E  0
 6      -0.3224E -4         -0.1065E  0
 7      -0.1975E -4         -0.6524E -1
 8      -0.3478E -5         -0.1149E -1
 9       0.5086E -5          0.1680E -1
10       0.2094E -5          0.6917E -2
11      -0.6602E -5         -0.2181E -1
12      -0.1374E -4         -0.4541E -1
13      -0.1670E -4         -0.5518E -1
14      -0.1678E -4         -0.5545E -1
15      -0.1347E -4         -0.4451E -1
16      -0.8883E -5         -0.2935E -1
17      -0.7328E -5         -0.2421E -1
18      -0.1154E -4         -0.3811E -1
19      -0.1863E -4         -0.6154E -1
20      -0.2469E -4         -0.8156E -1
21      -0.2891E -4         -0.9550E -1
22      -0.3405E -4         -0.1125E  0
23      -0.4171E -4         -0.1378E  0
24      -0.5154E -4         -0.1703E  0
25      -0.6007E -4         -0.1985E  0
26      -0.6175E -4         -0.2040E  0
27      -0.5262E -4         -0.1739E  0
28      -0.3465E -4         -0.1145E  0
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
 K         GKC(K)              GKCP(K)
 0       0.1486E  1          0.1466E  1
 1       0.6189E  2          0.6242E  2
 2       0.2910E  2          0.3010E  2
 3       0.4481E  2          0.4836E  2
 4       0.3623E  2          0.4153E  2
 5       0.3357E  2          0.4164E  2
 6       0.3451E  2          0.4725E  2
 7       0.2216E  2          0.3422E  2
 8       0.1492E  2          0.2659E  2
 9       0.5370E  1          0.1134E  2
10       0.8238E  1          0.2125E  2
11       0.2544E  1          0.8304E  1
12       0.4784E  1          0.2062E  2
13       0.1839E  1          0.1105E  2
14       0.2379E  1          0.2141E  2
15      -0.2208E  0         -0.3300E  1
16       0.1087E  1          0.3177E  2
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17	-0.3959E 0	-0.3092E 2
18	0.6698E 0	0.3448E 3
19	-0.4542E 0	-0.9961E 3
20	0.5371E 0	0.7925E 2
21	-0.3520E 0	-0.1846E 2
22	0.5479E 0	0.1552E 2
23	-0.2975E 0	-0.5[illegible]7E 1
24	0.5345E 0	0.7480E 1
25	-0.2425E 0	-0.2769E 1
26	0.5649E 0	0.5635E 1
27	-0.2123E 0	-0.1960E 1
28	0.5012E 0	0.4510E 1

K	GKCP(K)	GKC3P(K)
0	0.1486E 1	0.1486E 1
1	0.62[illegible]E 2	0.6254E 2
2	0.30[illegible]E 2	0.3034E 2
3	0.4836E 2	0.4925E 2
4	0.4153E 2	0.4291E 2
5	0.4164E 2	0.4381E 2
6	0.4725E 2	0.5085E 2
7	0.3422E 2	0.3783E 2
8	0.2659E 2	0.3032E 2
9	0.1134E 2	0.1340E 2
10	0.2125E 2	0.2613E 2
11	0.8304E 1	0.1067E 2
12	0.2062E 2	0.2784E 2
13	0.1105E 2	0.1575E 2
14	0.2141E 2	0.3238E 2
15	-0.3300E 1	-0.5322E 1
16	0.3177E 2	0.5495E 2
17	-0.3092E 2	-0.5768E 2
18	0.3448E 3	0.6977E 3
19	-0.9961E 3	-0.2201E 4
20	0.7925E 2	0.1925E 3
21	-0.1846E 2	-0.4965E 2
22	0.1552E 2	0.4656E 2
23	-0.5[illegible]7E 1	-0.1878E 2
24	0.7480E 1	0.2864E 2
25	-0.2769E 1	-0.1216E 2
26	0.5635E 1	0.2866E 2
27	-0.1960E 1	-0.1169E 2
28	0.4510E 1	0.3199E 2

K	GKC3P(K)	GH(K)
0	0.1486E 1	0.3201E 2
1	0.6254E 2	0.3923E 2
2	0.3034E 2	0.4312E 2
3	0.4925E 2	0.4294E 2
4	0.4291E 2	0.4472E 2
5	0.4381E 2	0.4535E 2
6	0.5085E 2	0.4584E 2
7	0.3783E 2	0.3921E 2
8	0.3032E 2	0.2797E 2
9	0.1340E 2	0.2081E 2
10	0.2613E 2	0.1909E 2
11	0.1067E 2	0.1883E 2
12	0.2784E 2	0.2053E 2
13	0.1575E 2	0.2293E 2
14	0.3238E 2	0.1879E 2
15	-0.5322E 1	0.1917E 2
16	0.5495E 2	0.1172E 2
17	-0.5768E 2	0.1593E 3
18	0.6977E 3	-0.2158E 3
19	-0.2201E 4	-0.8779E 3
20	0.1925E 3	-0.4664E 3
21	-0.4965E 2	0.3494E 2
22	0.4656E 2	0.6170E 1
23	-0.1878E 2	0.9408E 1
24	0.2864E 2	0.6587E 1
25	-0.1216E 2	0.8249E 1
26	0.2866E 2	0.8376E 1
27	-0.1169E 2	0.9319E 1
28	0.3199E 2	0.1015E 2

STOP
R

VOLUME 3

USERS MANUAL
FOR
AUTORADIOGRAPHIC ENHANCEMENT PROCESS
DATA ANALYSIS SOFTWARE

PREFACE

This is the User Manual for the software developed for the evaluation of the Wiener Spectrum and Modulation Transfer Function of the Autoradiographic Enhancement Process.

This report is Volume 3 of the Final Report prepared by ESPEE, INC. under Contract No. NAS8-33405 for the Space Sciences Laboratory of the George C. Marshall Space Flight Center. The NASA COR for this contract is Dr. C. A. Lundquist.

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1. INTRODUCTION

This manual is a description of the use of the Autoradiographic Data Analysis software package with the Data General NOVA 1200 computer system.

In the following description, the symbol ↲ means a carriage return on the tektronix. If at any time a typing mistake is made, the character typed may be deleted by typing the RUBOUT key. Any execution of a program or command may be nullified by pressing the CNTRL and A keys simultaneously.

In case of problems, call the person in charge of the computer system.

2. NOVA POWER-UP PROCEDURE

Before the Autoradiographic Data Analysis software package may be used, the NOVA system must be powered up and the operating system placed into the computer. The procedure for doing this is as follows:

1. Turn power on to the NOVA computer using the front panel key.
2. Turn power on to the disk controller (mounted on the DATA GENERAL rack) using the front panel key.
3. Make sure the pack labelled ESPEE is mounted in the disk drive.

   If it is not, the pack labelled ESPEE may be mounted as follows:

   (a). Remove the pack inside the drive by following these steps:

   (i). Raise the lid of the disk drive.

   (ii). Set the clear plastic cover onto the disk pack.

   (iii). Turn the handle counterclockwise until a pop is heard.

   (iv). Raise the disk pack out and place it on the bottom cover.

   (v). Lock the bottom cover.

   (b). Replace the pack marked ESPEE inside the drive by following these steps:

   (i). Unlock and remove the bottom cover from the disk pack.

   (ii). Place the pack in the drive.

   (iii). Turn the handle clockwise until tight.

   (iv). Remove the clear plastic cover.

   (v). Close the lid of the disk drive.
4. Turn power on to the disk drive by pressing the on button on the drive. Wait for the green light on the disk drive

to come on before proceeding.

5. Turn power on to the Tektronix graphics display. After the screen brightens, press the CLEAR button. Flip the LINE/LOCAL switch to LOCAL. Press the ESC key. Press the ; key. Flip the LINE/LOCAL switch back to LINE. This sets the character size for the terminal to the smallest. For medium and large character sizes respectively, press 9 and 8 instead of ; in the above procedure.
6. Turn power on to the Hard Copy Unit. The unit requires about 10 minutes to warm up.
7. Set the switches on the NOVA computer panel to octal 00033. (This corresponds to switches 11,12,14 and 15 up; all other down). Raise the RESET switch momentarily. Next, raise the switch 0 on the computer panel up. Now raise momentarily the PROGRAM LOAD switch on the computer panel. This series of operations loads the operating system into the computer memory. The word FILENAME? will appear on the Tektronix screen.
8. Type the word SYS32K ⤸. When requested by the computer, enter the date using the format MM/DD/YY ⤸,and the time using the format HH:MM:SS ⤸. Computer types R.

This completes the steps required to get the computer powered-up. The next series of steps are required to prepare for using the Autoradiographic Data Analysis package.

3. TAPE MOUNTING PROCEDURE

The source of input data for the Autoradiographic Data Analysis package is the Microdensitometer output tape. The procedure for mounting the tape is as follows:

1. Turn power on to the magnetic tape recorder.
2. Pull out the lever marked:OVERRIDE
3. Mount the tape on the available slot and turn the handle clockwise until tight.
4. Thread the tape as shown in the diagram on the tape recorder unit, and a few feet of tape on the empty reel.
5. Press the LOAD/UNLOAD button on the recorder.
6. Press the FORWARD button on the recorder.
7. When the tape stops winding, press the REMOTE button on the recorder.

The tape recorder is now ready for operation. Type INIT MTØ ⤶ on the Tektronix terminal. The system is now ready for program execution.

4. PROGRAM EXECUTION

The program can be executed with four options: (1) Without Filters, (2) With Low Frequency Filter Only, (3) With High Frequency Filter Only, and (4) With Both Filters. For program execution the following steps are followed:

1. <u>Without Filters</u>
   1. Type DIR ESPEE ↵. Computer types R.
   2. Type SP1 ↵.

      The computer will now ask for the user-specified inputs to the program, one at a time. These inputs are:

      FILE NUMBER, NF=
      DIFFUSE DENSITY FACTOR,DDF=
      MAXIMUM LAG FACTOR,M=
      HEIGHT OF SCANNING SLIT,XL=
      WIDTH OF SCANNING SLIT,XA=
   3. After typing each value, type ↵. When all values are specified, the computer will halt after program execution is complete.

2. <u>With Low Frequency Filters Only</u>
   1. Type DIR ESPEE ↵. Computer types R.
   2. Type SPL ↵.

      The computer will now ask for user-specified inputs to the program, one at a time. These inputs are:

      FILE NUMBER, NF=
      DIFFUSE DENSITY FACTOR, DDF=
      MAXIMUM LAG FACTOR,M=
      HEIGHT OF SCANNING SLIT,XL=
      WIDTH OF SCANNING SLIT,XA=
      LOW FREQUENCY FILTER PARAMETER,P=
   3. After typing each value, type ↵. When all values are specified, the computer will halt after program execution is complete.

3. <u>With High Frequency Filters Only</u>

   1. Type DIR ESPEE ⤸. Computer types R.
   2. Type SPH ⤸.

   The computer will now ask for user-specified inputs to the program, one at a time. These inputs are:

      FILE NUMBER,NF=
      DIFFUSE DENSITY FACTOR, DDF=
      MAXIMUM LAG FACTOR,M=
      HEIGHT OF SCANNING SLIT,XL=
      WIDTH OF SCANNING SLIT,XA=
      HIGH FREQUENCY FILTER PARAMETER,Q=

   3. After typing each value, type ⤸. When all values are specified, the computer will halt after program execution is complete.

4. <u>With Both Filters</u>

   1. Type DIR ESPEE ⤸. Computer types R.
   2. Type SP2 ⤸.

   The computer will now ask for user-specified inputs to the program, one at a time. These inputs are:

      FILE NUMBER, NF=
      DIFFUSE DENSITY FACTOR, DDF=
      MAXIMUM LAG FACTOR,M=
      HEIGHT OF SCANNING SLIT,XL=
      WIDTH OF SCANNING SLIT,XA=
      LOW FREQUENCY FILTER PARAMETER,P=
      HIGH FREQUENCY FILTER PARAMETER,Q=

   3. After typing each value, type ⤸. When all values are specified, the computer will halt after program execution is complete.

5. OBTAINING A HARD COPY

The results of the program execution may be recorded by using the Hard Copy Unit. A copy of the Tektronix display may be obtained by pressing the AUTO PRINT/COPY switch on the Tektronix keyboard to COPY.

In case the results take more than one page, automatic copying of the results may be accomplished as follows:

1. Set the AUTO PRINT/COPY switch to AUTO PRINT.
2. Set the MARGIN CONTROL switch on the Tektronix terminal to 2.

6. SYSTEM SHUT DOWN PROCEDURE

The procedure for shutting down the system is as follows:

1. Type RELEASE MTϕ ⤶.
2. Type RELEASE DPϕ ⤶. This will cause the computer to halt.
3. Turn power off to the hard copy unit.
4. Turn power off to the Tektronix terminal.
5. Turn power off to the disk drive by pushing the ON button.
6. Press the LOAD/UNLOAD button on the tape recorder. Manually rewind the tape and remove it from the tape recorder.
7. (Caution: Before executing this step, make sure that the disk has stopped spinning.) Turn power off to the disk controller.
8. Turn power off to the NOVA computer.

The shut down procedure is now complete.

7. PROGRAM LIMITATIONS

The following are some of the limitations of the program. In actual practice, these limitations are not likely to be violated.

1. The maximum no. of data points on a record on the microdensitometer tape is 1000.
2. The maximum no. of records per file on the microdensitometer tape is 50.
3. The maximum value of the Maximum Lag Factor, M is 100.
4. For comparison with the microdensitometer printout, at most 300 data points will be printed from the first data record.

SP1
FILE NUMBER,NF-5
DIFFUSE DENSITY FACTOR,DDF-1.27
MAXIMUM LAG FACTOR,M-28
HEIGHT OF SCANNING SLIT,XL-1000
WIDTH OF SCANNING SLIT,XA-25
DATA PREPARATION COMMENCED
NUMBER OF FILES SKIPPED- 4
FILE IS BEING READ FROM TAPE
NUMBER OF RECORDS READ- 3
FILE READ FROM TAPE AND WRITTEN ON DISK
BSA-2 1804-L E-1 3\27\79STEP 10) 1p/0
NUMBER OF SAMPLES- 281
X COORDINATE (MICRONS)- -1
Y COORDINATE (MICRONS)- 4
DELTA . (H) (MICRONS)- 18
DATA 1 BEING FORMATTED

1.62	1.60	1.69	1.80	1.83	1.82	1.81	1.78	1.82	1.79
1.76	1.75	1.85	1.82	1.84	1.87	1.87	1.80	1.79	1.81
1.81	1.77	1.79	1.83	1.82	1.82	1.84	1.81	1.80	1.85
1.86	1.82	1.81	1.84	1.82	1.84	1.81	1.78	1.81	1.85
1.86	1.89	1.89	1.85	1.82	1.80	1.79	1.79	1.80	1.81
1.82	1.85	1.82	1.80	1.81	1.82	1.82	1.83	1.85	1.82
1.79	1.82	1.81	1.84	1.87	1.84	1.80	1.81	1.82	1.85
1.86	1.88	1.87	1.84	1.79	1.79	1.82	1.80	1.81	1.86
1.84	1.84	1.89	1.85	1.80	1.81	1.83	1.85	1.83	1.84
1.84	1.84	1.86	1.82	1.79	1.81	1.81	1.79	1.78	1.81
1.82	1.80	1.79	1.79	1.85	1.85	1.81	1.80	1.79	1.80
1.79	1.78	1.80	1.82	1.85	1.84	1.78	1.77	1.79	1.78
1.76	1.74	1.75	1.78	1.79	1.78	1.76	1.74	1.76	1.77
1.77	1.79	1.82	1.78	1.78	1.78	1.78	1.77	1.77	1.80
1.80	1.83	1.83	1.80	1.80	1.81	1.77	1.78	1.84	1.83
1.82	1.82	1.85	1.83	1.84	1.81	1.78	1.77	1.80	1.77
1.82	1.87	1.83	1.81	1.80	1.81	1.82	1.82	1.80	1.81
1.81	1.75	1.73	1.78	1.79	1.75	1.76	1.81	1.82	1.80
1.80	1.82	1.82	1.84	1.83	1.80	1.81	1.82	1.86	1.86
1.87	1.85	1.84	1.84	1.88	1.88	1.84	1.86	1.88	1.88
1.83	1.81	1.82	1.84	1.84	1.83	1.83	1.85	1.83	1.79
1.77	1.77	1.81	1.77	1.84	1.88	1.81	1.80	1.81	1.80
1.78	1.79	1.83	1.79	1.78	1.77	1.76	1.77	1.77	1.80
1.78	1.76	1.81	1.85	1.84	1.85	1.83	1.81	1.80	1.80
1.77	1.78	1.79	1.77	1.81	1.79	1.76	1.79	1.77	1.80
1.84	1.85	1.87	1.84	1.75	1.79	1.82	1.82	1.78	1.76
1.78	1.78	1.80	1.80	1.80	1.78	1.79	1.81	1.79	1.80
1.77	1.75	1.79	1.81	1.77	1.77	1.78	1.74	1.74	1.77
1.79									

DATA FORMATTING COMPLETED
RAW DATA STORED ON DISK.
HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES- 100

CLASS NO.	NO. OF DATA POINTS
41	2
42	2
43	2
44	34
45	206
46	349
47	206
48	41
49	1

RAW MEAN - 0.145498E 4
MEAN OF NORMALIZED DATA- 0.127000E 1
MEAN SQUARE VALUE - 0.687189E -3

ROOT MEAN SQUARE VALUE - 0.262298E -1
AUTOCORRELATION IS BEING COMPUTED

R	R-HAT	NORM. R-HAT
0	0.6872E -3	0.1000E 1
1	0.4953E -3	0.7207E 0
2	0.2693E -3	0.3919E 0
3	0.1711E -3	0.2490E 0
4	0.1170E -3	0.1702E 0
5	0.8441E -4	0.1228E 0
6	0.9061E -4	0.1319E 0
7	0.1202E -3	0.1749E 0
8	0.1556E -3	0.2264E 0
9	0.1870E -3	0.2721E 0
10	0.1820E -3	0.2648E 0
11	0.1519E -3	0.2211E 0
12	0.1382E -3	0.2011E 0
13	0.1321E -3	0.1922E 0
14	0.1163E -3	0.1692E 0
15	0.1180E -3	0.1718E 0
16	0.1301E -3	0.1893E 0
17	0.1392E -3	0.2026E 0
18	0.1405E -3	0.2044E 0
19	0.1396E -3	0.2031E 0
20	0.1395E -3	0.2030E 0
21	0.1408E -3	0.2049E 0
22	0.1327E -3	0.1930E 0
23	0.1172E -3	0.1706E 0
24	0.1035E -3	0.1507E 0
25	0.9151E -4	0.1332E 0
26	0.7764E -4	0.1130E 0
27	0.8014E -4	0.1166E 0
28	0.9431E -4	0.1372E 0

K	GKC(K)	GKC3P(K)
0	0.3133E 3	0.3133E 3
1	0.6974E 2	0.6988E 2
2	0.3646E 2	0.3676E 2
3	0.5742E 2	0.5847E 2
4	0.4173E 2	0.4311E 2
5	0.6281E 2	0.6608E 2
6	0.5883E 2	0.6331E 2
7	0.3970E 2	0.4388E 2
8	0.2616E 2	0.2983E 2
9	0.1585E 2	0.1973E 2
10	0.1834E 2	0.2255E 2
11	0.1460E 2	0.1877E 2
12	0.1650E 2	0.2228E 2
13	0.1496E 2	0.2132E 2
14	0.1193E 2	0.1804E 2
15	0.6408E 1	0.1034E 2
16	0.8821E 1	0.1526E 2
17	0.7324E 1	0.1366E 2
18	0.8074E 1	0.1634E 2
19	0.3621E 1	0.9002E 1
20	0.3235E 1	0.7857E 1
21	0.2194E 1	0.5900E 1
22	0.2883E 1	0.8646E 1
23	0.1766E 1	0.5960E 1
24	0.1882E 1	0.7206E 1
25	0.1269E 1	0.5572E 1
26	0.1815E 1	0.9231E 1
27	0.1160E 1	0.6917E 1
28	0.1087E 1	0.7709E 1

K	GKC3P(K)	GH(K)
0	0.3133E 3	0.1916E 3

1	0.6988E	2	0.1225E	3
2	0.3676E	2	0.5047E	2
3	0.5847E	2	0.4920E	2
4	0.4311E	2	0.5269E	2
5	0.6608E	2	0.5964E	2
6	0.6331E	2	0.5915E	2
7	0.4388E	2	0.4523E	2
8	0.2983E	2	0.3057E	2
9	0.1873E	2	0.2246E	2
10	0.2255E	2	0.2065E	2
11	0.1877E	2	0.2059E	2
12	0.2228E	2	0.2116E	2
13	0.2132E	2	0.2074E	2
14	0.1804E	2	0.1694E	2
15	0.1034E	2	0.1349E	2
16	0.1526E	2	0.1363E	2
17	0.1356E	2	0.1473E	2
18	0.1634E	2	0.1359E	2
19	0.8002E	1	0.1005E	2
20	0.7857E	1	0.7404E	1
21	0.5900E	1	0.7076E	1
22	0.8646E	1	0.7288E	1
23	0.5960E	1	0.6943E	1
24	0.7206E	1	0.6486E	1
25	0.5572E	1	0.6895E	1
26	0.9231E	1	0.7738E	1
27	0.6917E	1	0.7694E	1
28	0.7709E	1	0.7313E	1

STOP
R

SPL
FILE NUMBER,NF=5
DIFFUSE DENSITY FACTOR,DDF=1.27
MAXIMUM LAG FACTOR,M=28
HEIGHT OF SCANNING SLIT,XL=1000
WIDTH OF SCANNING SLIT,XA=25
LOW FREQUENCY FILTER PARAMETER,P=30
DATA PREPARATION COMMENCED
NUMBER OF FILES SKIPPED= 4
FILE IS BEING READ FROM TAPE
NUMBER OF RECORDS READ= 3
FILE READ FROM TAPE AND WRITTEN ON DISK
BSA-2 1804-L E-1 3\27\79STEP 10) 1p/0
NUMBER OF SAMPLES= 281
X COORDINATE (MICRONS)= -1
Y COORDINATE (MICRONS)= 4
DELTA X (H) (MICRONS)= 18
DATA IS BEING FORMATTED

1.62	1.60	1.69	1.80	1.83	1.82	1.81	1.78	1.82	1.79
1.76	1.79	1.85	1.82	1.84	1.87	1.87	1.80	1.79	1.81
1.81	1.77	1.79	1.83	1.82	1.82	1.84	1.81	1.80	1.85
1.86	1.82	1.81	1.84	1.82	1.84	1.81	1.78	1.81	1.85
1.86	1.89	1.89	1.85	1.82	1.80	1.79	1.79	1.80	1.81
1.82	1.85	1.82	1.80	1.81	1.82	1.82	1.83	1.85	1.82
1.79	1.82	1.81	1.84	1.87	1.84	1.80	1.81	1.82	1.85
1.86	1.88	1.87	1.84	1.79	1.79	1.82	1.80	1.81	1.86
1.84	1.84	1.89	1.85	1.80	1.81	1.83	1.85	1.83	1.84
1.84	1.84	1.86	1.82	1.79	1.81	1.81	1.79	1.78	1.81
1.82	1.80	1.79	1.79	1.85	1.85	1.81	1.80	1.79	1.80
1.79	1.78	1.80	1.82	1.85	1.84	1.78	1.77	1.79	1.78
1.76	1.74	1.75	1.76	1.79	1.78	1.76	1.74	1.76	1.77
1.77	1.79	1.82	1.78	1.78	1.78	1.78	1.77	1.77	1.80
1.80	1.83	1.83	1.80	1.80	1.81	1.77	1.78	1.84	1.83
1.82	1.82	1.85	1.83	1.84	1.81	1.78	1.77	1.80	1.77
1.82	1.87	1.83	1.81	1.80	1.81	1.82	1.82	1.80	1.81
1.81	1.75	1.73	1.78	1.79	1.75	1.76	1.81	1.82	1.80
1.80	1.82	1.82	1.84	1.83	1.80	1.81	1.82	1.86	1.86
1.87	1.85	1.84	1.84	1.88	1.88	1.84	1.86	1.88	1.88
1.83	1.81	1.82	1.84	1.84	1.83	1.83	1.85	1.83	1.79
1.77	1.77	1.81	1.77	1.84	1.88	1.81	1.80	1.81	1.80
1.78	1.79	1.83	1.79	1.78	1.77	1.76	1.77	1.77	1.80
1.78	1.76	1.81	1.85	1.84	1.85	1.83	1.81	1.80	1.80
1.77	1.78	1.79	1.77	1.81	1.79	1.76	1.79	1.77	1.80
1.84	1.85	1.87	1.84	1.75	1.79	1.82	1.82	1.78	1.76
1.78	1.78	1.80	1.80	1.80	1.78	1.79	1.81	1.79	1.80
1.77	1.75	1.79	1.81	1.77	1.77	1.78	1.74	1.74	1.77
1.79									

DATA FORMATTING COMPLETED
RAW DATA STORED ON DISK.
HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES= 100

CLASS NO.	NO. OF DATA POINTS
41	2
42	2
43	2
44	34
45	206
46	349
47	206
48	41
49	1

RAW MEAN = 0.145498E 4
MEAN OF NORMALIZED DATA= 0.127000E 1

DATA IS BEING FILTERED FOR LOW FREQUENCY
MEAN SQUARE VALUE = 0.437882E -3
ROOT MEAN SQUARE VALUE = 0.209380E -1
AUTOCORRELATION IS BEING COMPUTED

R	R-HAT	NORM. R-HAT
0	0.4714E -3	0.1000E 1
1	0.2918E -3	0.6189E 0
2	0.9730E -4	0.2064E 0
3	0.2736E -4	0.5803E -1
4	-0.1573E -4	-0.3336E -1
5	-0.4244E -4	-0.9001E -1
6	-0.4077E -4	-0.8648E -1
7	-0.2055E -4	-0.4358E -1
8	0.4914E -5	0.1042E -1
9	0.2241E -4	0.4754E -1
10	0.9430E -5	0.2000E -1
11	-0.1482E -4	-0.3144E -1
12	-0.1328E -4	-0.2816E -1
13	-0.1152E -4	-0.2443E -1
14	-0.2003E -4	-0.4249E -1
15	-0.1543E -4	-0.3273E -1
16	-0.4060E -5	-0.8612E -2
17	-0.2292E -6	-0.4862E -3
18	-0.8391E -5	-0.1780E -1
19	-0.2072E -4	-0.4396E -1
20	-0.2593E -4	-0.5500E -1
21	-0.2456E -4	-0.5209E -1
22	-0.2420E -4	-0.5132E -1
23	-0.3434E -4	-0.7285E -1
24	-0.4920E -4	-0.1044E 0
25	-0.5663E -4	-0.1201E 0
26	-0.7060E -4	-0.1498E 0
27	-0.7054E -4	-0.1496E 0
28	-0.4194E -4	-0.8897E -1

K	GKC(K)	GKC3P(K)
0	0.6046E 1	0.6046E 1
1	0.6598E 2	0.6611E 2
2	0.3026E 2	0.3051E 2
3	0.5156E 2	[illegible] 2
4	0.3955E 2	0.4086E 2
5	0.4519E 2	0.4754E 2
6	0.4379E 2	0.4712E 2
7	0.3648E 2	0.4033E 2
8	0.2371E 2	0.2703E 2
9	0.1355E 2	0.1600E 2
10	0.1747E 2	0.2148E 2
11	0.1095E 2	0.1407E 2
12	0.1540E 2	0.2080E 2
13	0.1479E 2	0.2108E 2
14	0.1215E 2	0.1837E 2
15	0.6169E 1	0.9951E 1
16	0.8443E 1	0.1460E 2
17	0.6477E 1	0.1208E 2
18	0.8799E 1	0.1781E 2
19	0.3404E 1	0.7521E 1
20	0.4602E 1	0.1118E 2
21	0.1429E 1	0.3843E 1
22	0.3939E 1	0.1181E 2
23	0.1409E 1	0.4755E 1
24	0.2528E 1	0.9683E 1
25	0.7372E 0	0.3236E 1
26	0.1925E 1	0.9791E 1
27	0.6203E 0	0.3700E 1
28	0.1759E 1	0.1247E 2

K	GKC3P(K)	GH(K)
0	0.6046E 1	0.3608E 2
1	0.6611E 2	0.4220E 2
2	0.3051E 2	0.4491E 2
3	0.5251E 2	0.4410E 2
4	0.4086E 2	0.4544E 2
5	0.4754E 2	0.4577E 2
6	0.4712E 2	0.4553E 2
7	0.4033E 2	0.3870E 2
8	0.2703E 2	0.2760E 2
9	0.1600E 2	0.2013E 2
10	0.2148E 2	0.1826E 2
11	0.1407E 2	0.1761E 2
12	0.2080E 2	0.1919E 2
13	0.2108E 2	0.2034E 2
14	0.1837E 2	0.1695E 2
15	0.9951E 1	0.1322E 2
16	0.1460E 2	0.1281E 2
17	0.1208E 2	0.1414E 2
18	0.1781E 2	0.1380E 2
19	0.7521E 1	0.1101E 2
20	0.1118E 2	0.8429E 1
21	0.3843E 1	0.7669E 1
22	0.1181E 2	0.8057E 1
23	0.4755E 1	0.7752E 1
24	0.9683E 1	0.6839E 1
25	0.3236E 1	0.6486E 1
26	0.9791E 1	0.6630E 1
27	0.3700E 1	0.7417E 1
28	0.1247E 2	0.8088E 1

STOP
R

SPM
FILE NUMBER,NF-5
DIFFUSE DENSITY FACTOR,DDF-1.27
MAXIMUM LAG FACTOR,M-28
HEIGHT OF SCANNING SLIT,XL-1000
WIDTH OF SCANNING SLIT,XA-25
HIGH FREQUENCY FILTER PARAMETER,Q-1
DATA PREPARATION COMMENCED
NUMBER OF FILES SKIPPED- 4
FILE IS BEING READ FROM TAPE
NUMBER OF RECORDS READ- 3
FILE READ FROM TAPE AND WRITTEN ON DISK
[illegible] 1804-L E-1 3\27\79STEP 10) 1p/0
NUMBER OF SAMPLES- 281
X COORDINATE (MICRONS)- -1
Y COORDINATE (MICRONS)- 4
FILTER X (H) (MICRONS)- 18
DATA IS BEING FORMATTED

1.[illegible]	1.60	1.69	1.80	1.83	1.82	1.81	1.78	1.82	1.79
1.[illegible]	1.79	1.85	1.82	1.84	1.87	1.87	1.80	1.79	1.81
1.[illegible]	1.77	1.79	1.83	1.82	1.82	1.84	1.81	1.80	1.85
1.[illegible]	1.82	1.81	1.84	1.82	1.84	1.81	1.78	1.81	1.85
1.[illegible]	1.89	1.89	1.85	1.82	1.80	1.79	1.79	1.80	1.81
1.[illegible]	1.85	1.82	1.80	1.81	1.82	1.82	1.83	1.85	1.82
1.[illegible]	1.82	1.81	1.84	1.87	1.84	1.80	1.81	1.82	1.85
1.[illegible]	1.88	1.87	1.84	1.79	1.79	1.82	1.80	1.81	1.86
1.[illegible]	1.84	1.89	1.85	1.80	1.81	1.83	1.85	1.83	1.84
1.[illegible]	1.84	1.86	1.82	1.79	1.81	1.81	1.79	1.78	1.81
1.[illegible]	1.80	1.79	1.79	1.85	1.85	1.81	1.80	1.79	1.90
1.[illegible]	1.78	1.80	1.82	1.85	1.84	1.78	1.77	1.79	1.78
1.[illegible]	1.74	1.75	1.78	1.79	1.78	1.76	1.74	1.76	1.77
1.[illegible]	1.79	1.82	1.78	1.78	1.78	1.78	1.77	1.77	1.80
1.[illegible]	1.83	1.83	1.80	1.80	1.81	1.77	1.78	1.84	1.83
1.[illegible]	1.82	1.85	1.83	1.84	1.81	1.78	1.77	1.80	1.77
1.[illegible]	1.87	1.83	1.81	1.80	1.81	1.82	1.82	1.80	1.81
1.[illegible]	1.75	1.73	1.78	1.79	1.75	1.76	1.81	1.82	1.80
1.[illegible]	1.82	1.82	1.84	1.83	1.80	1.81	1.82	1.86	1.86
1.[illegible]	1.85	1.84	1.84	1.88	1.88	1.84	1.86	1.88	1.88
1.[illegible]	1.81	1.82	1.84	1.84	1.83	1.83	1.85	1.83	1.79
1.[illegible]	1.77	1.81	1.77	1.84	1.88	1.81	1.80	1.81	1.80
1.[illegible]	1.79	1.83	1.79	1.78	1.77	1.76	1.77	1.77	1.80
1.[illegible]	1.76	1.81	1.85	1.84	1.85	1.83	1.81	1.80	1.80
1.[illegible]	1.78	1.79	1.77	1.81	1.79	1.76	1.79	1.77	1.80
1.[illegible]	1.85	1.87	1.84	1.75	1.79	1.82	1.82	1.78	1.76
1.[illegible]	1.78	1.80	1.80	1.80	1.78	1.79	1.81	1.79	1.80
1.[illegible]	1.75	1.79	1.81	1.77	1.77	1.78	1.74	1.74	1.77
1.[illegible]9									

DATA FORMATTING COMPLETED
RAW DATA STORED ON DISK.
HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES- 100

CLASS NO.	NO. OF DATA POINTS
41	2
42	2
43	2
44	34
45	206
46	349
47	206
48	41
49	1

RAW MEAN - 0.145498E 4
MEAN OF NORMALIZED DATA- 0.127000E 1

DATA IS BEING FILTERED FOR HIGH FREQUENCY
MEAN SQUARE VALUE - 0.485342E -3
ROOT MEAN SQUARE VALUE - 0.220435E -1
AUTOCORRELATION IS BEING COMPUTED

R	R-HAT	NORM. R-HAT
0	0.4865E -3	0.1000E 1
1	0.4173E -3	0.8578E 0
2	0.3050E -3	0.6269E 0
3	0.2019E -3	0.4150E 0
4	0.1415E -3	0.2909E 0
5	0.1157E -3	0.2377E 0
6	0.1138E -3	0.2340E 0
7	0.1305E -3	0.2683E 0
8	0.1524E -3	0.3132E 0
9	0.1668E -3	0.3429E 0
10	0.1657E -3	0.3407E 0
11	0.1558E -3	0.3263E 0
12	0.1424E -3	0.2927E 0
13	0.1336E -3	0.2745E 0
14	0.1295E -3	0.2661E 0
15	0.1329E -3	0.2733E 0
16	0.1376E -3	0.2829E 0
17	0.1399E -3	0.2876E 0
18	0.1387E -3	0.2851E 0
19	0.1381E -3	0.2839E 0
20	0.1357E -3	0.2789E 0
21	0.1303E -3	0.2677E 0
22	0.1224E -3	0.2516E 0
23	0.1138E -3	0.2340E 0
24	0.1041E -3	0.2139E 0
25	0.9556E -4	0.1964E 0
26	0.8979E -4	0.1846E 0
27	0.8953E -4	0.1840E 0
28	0.9297E -4	0.1911E 0

THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
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THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF

K	GKC(K)	GKCP(K)
0	0.3113E 3	0.3118E 3
1	0.6518E 2	0.6573E 2
2	0.3012E 2	0.3115E 2
3	0.4723E 2	0.5097E 2
4	0.3455E 2	0.3961E 2
5	0.4220E 2	0.5236E 2
6	0.3829E 2	0.5244E 2
7	0.2415E 2	0.3729E 2
8	0.1368E 2	0.2438E 2
9	0.6902E 1	0.1458E 2
10	0.7107E 1	0.1833E 2
11	0.5214E 1	0.1702E 2
12	0.4350E 1	0.1875E 2
13	0.2841E 1	0.1707E 2
14	0.2779E 1	0.2501E 2
15	0.1070E 1	0.1599E 2
16	0.1047E 1	0.3059E 2
17	0.7627E 0	0.5957E 2
18	0.8311E 0	0.4277E 3

19	0.4630E 0	0.1015E 4
20	0.7795E 0	0.1150E 3
21	0.5110E 0	0.2681E 2
22	0.7462E 0	0.2114E 2
23	0.5456E 0	0.1021E 2
24	0.7490E 0	0.1048E 2
25	0.6676E 0	0.7624E 1
26	0.9020E 0	0.8998E 1
27	0.6060E 0	0.5594E 1
28	0.4739E 0	0.4265E 1

K	GKCP(K)	GKC3P(K)
0	0.3118E 3	0.3118E 3
1	0.6573E 2	0.6586E 2
2	0.3115E 2	0.3140E 2
3	0.5097E 2	0.5191E 2
4	0.3961E 2	0.4092E 2
5	0.5236E 2	0.5509E 2
6	0.5244E 2	0.5643E 2
7	0.3729E 2	0.4121E 2
8	0.2438E 2	0.2780E 2
9	0.1458E 2	0.1722E 2
10	0.1833E 2	0.2254E 2
11	0.1702E 2	0.2188E 2
12	0.1875E 2	0.2532E 2
13	0.1707E 2	0.2433E 2
14	0.2501E 2	0.3782E 2
15	0.1599E 2	0.2580E 2
16	0.3059E 2	0.5290E 2
17	0.5957E 2	0.1111E 3
18	0.4277E 3	0.8656E 3
19	0.1015E 4	0.2244E 4
20	0.1150E 3	0.2793E 3
21	0.2681E 2	0.7207E 2
22	0.2114E 2	0.6341E 2
23	0.1021E 2	0.3445E 2
24	0.1048E 2	0.4014E 2
25	0.7624E 1	0.3347E 2
26	0.8998E 1	0.4577E 2
27	0.5594E 1	0.3337E 2
28	0.4265E 1	0.3025E 2

K	GKC3P(K)	GH(K)
0	0.3118E 3	0.1888E 3
1	0.6586E 2	0.1187E 3
2	0.3140E 2	0.4514E 2
3	0.5191E 2	0.4404E 2
4	0.4092E 2	0.4721E 2
5	0.5509E 2	0.5188E 2
6	0.5643E 2	0.5229E 2
7	0.4121E 2	0.4166E 2
8	0.2780E 2	0.2851E 2
9	0.1722E 2	0.2120E 2
10	0.2254E 2	0.2105E 2
11	0.2188E 2	0.2290E 2
12	0.2532E 2	0.2421E 2
13	0.2433E 2	0.2795E 2
14	0.3782E 2	0.3144E 2
15	0.2580E 2	0.3558E 2
16	0.5290E 2	0.6068E 2
17	0.1111E 3	0.2852E 3
18	0.8656E 3	0.1022E 4
19	0.2244E 4	0.1408E 4
20	0.2793E 3	0.7186E 3
21	0.7207E 2	0.1217E 3
22	0.6341E 2	0.5833E 2
23	0.3445E 2	0.4311E 2
24	0.4014E 2	0.3705E 2
25	0.3347E 2	0.3821E 2
26	0.4577E 2	0.3959E 2
27	0.3337E 2	0.3569E 2
28	0.3025E 2	0.3181E 2

STOP
R

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SP2
FILE NUMBER,NF-5
DIFFUSE DENSITY FACTOR,DDF-1.27
MAXIMUM LAG FACTOR,M-28
HEIGHT OF SCANNING SLIT,XL-1000
WIDTH OF SCANNING SLIT,XA-25
LOW FREQUENCY FILTER PARAMETER,P-28
HIGH FREQUENCY FILTER PARAMETER,Q-1
 DATA PREPARATION COMMENCED
NUMBER OF FILES SKIPPED-         4
FILE IS BEING READ FROM TAPE
NUMBER OF RECORDS READ-          3
FILE READ FROM TAPE AND WRITTEN ON DISK
BSA-2 1804-L E-1  3\27\79STEP 10) 1p/0
NUMBER OF SAMPLES-      281
X COORDINATE (MICRONS)-         -1
Y COORDINATE (MICRONS)-          4
DELTA X (H) (MICRONS)-         18
DATA IS BEING FORMATTED
```

1.62	1.60	1.69	1.80	1.83	1.82	1.81	1.78	1.82	1.79
1.76	1.79	1.85	1.82	1.84	1.87	1.87	1.80	1.79	1.81
1.81	1.77	1.79	1.83	1.82	1.82	1.84	1.81	1.80	1.85
1.86	1.82	1.81	1.84	1.82	1.84	1.81	1.78	1.81	1.85
1.86	1.89	1.89	1.85	1.82	1.80	1.79	1.79	1.80	1.81
1.82	1.85	1.62	1.80	1.81	1.82	1.82	1.83	1.85	1.82
1.79	1.92	1.81	1.84	1.87	1.84	1.80	1.81	1.82	1.85
1.86	1.88	1.87	1.84	1.79	1.79	1.82	1.80	1.81	1.86
1.84	1.84	1.89	1.85	1.80	1.81	1.83	1.85	1.83	1.84
1.84	1.84	1.86	1.82	1.79	1.81	1.81	1.79	1.78	1.81
1.82	1.80	1.79	1.79	1.85	1.85	1.81	1.80	1.79	1.80
1.79	1.78	1.80	1.82	1.85	1.84	1.78	1.77	1.79	1.78
1.76	1.74	1.75	1.78	1.79	1.78	1.76	1.74	1.76	1.77
1.77	1.79	1.82	1.78	1.78	1.78	1.78	1.77	1.77	1.80
1.80	1.83	1.83	1.80	1.80	1.81	1.77	1.78	1.84	1.83
1.82	1.82	1.85	1.83	1.84	1.81	1.78	1.77	1.80	1.77
1.82	1.87	1.83	1.81	1.80	1.81	1.82	1.82	1.80	1.81
1.81	1.75	1.73	1.78	1.79	1.75	1.76	1.81	1.82	1.80
1.80	1.82	1.82	1.84	1.83	1.80	1.81	1.82	1.86	1.86
1.87	1.85	1.84	1.84	1.88	1.88	1.84	1.86	1.88	1.88
1.83	1.81	1.82	1.84	1.84	1.83	1.83	1.85	1.83	1.79
1.77	1.77	1.81	1.77	1.84	1.88	1.81	1.80	1.81	1.80
1.78	1.79	1.83	1.79	1.78	1.77	1.76	1.77	1.77	1.80
1.78	1.76	1.81	1.85	1.84	1.85	1.83	1.81	1.80	1.80
1.77	1.78	1.79	1.77	1.81	1.79	1.76	1.79	1.77	1.80
1.84	1.85	1.87	1.84	1.75	1.79	1.82	1.82	1.78	1.76
1.78	1.78	1.80	1.80	1.80	1.78	1.79	1.81	1.79	1.80
1.77	1.75	1.79	1.81	1.77	1.77	1.78	1.74	1.74	1.77
1.79									

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DATA FORMATTING COMPLETED
RAW DATA STORED ON DISK.
HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES-      100
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CLASS NO.	NO. OF DATA POINTS
41	2
42	2
43	2
44	34
45	206
46	349
47	206
48	41
49	1

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RAW MEAN -      0.145498E  4
MEAN OF NORMALIZED DATA-      0.127000E  1
DATA IS BEING FILTERED FOR LOW FREQUENCY
DATA IS BEING FILTERED FOR HIGH FREQUENCY
MEAN SQUARE VALUE -       0.281856E -3
ROOT MEAN SQUARE VALUE -       0.167985E -1
AUTOCORRELATION IS BEING COMPUTED
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R	R-HAT	NORM. R-HAT
0	0.3027E -3	0.1000E 1
1	0.2512E -3	0.8300E 0
2	0.1447E -3	0.4779E 0
3	0.4692E -4	0.1550E 0
4	-0.8266E -5	-0.2731E -1
5	-0.3060E -4	-0.1011E 0
6	-0.3224E -4	-0.1065E 0
7	-0.1975E -4	-0.6524E -1
8	-0.3478E -5	-0.1149E -1
9	0.5086E -5	0.1680E -1
10	0.2094E -5	0.6917E -2
11	-0.6602E -5	-0.2181E -1
12	-0.1374E -4	-0.4541E -1
13	-0.1670E -4	-0.5518E -1
14	-0.1678E -4	-0.5545E -1
15	-0.1347E -4	-0.4451E -1
16	-0.8833E -5	-0.2935E -1
17	-0.7328E -5	-0.2421E -1
18	-0.1154E -4	-0.3811E -1
19	-0.1863E -4	-0.6154E -1
20	-0.2469E -4	-0.8156E -1
21	-0.2891E -4	-0.9550E -1
22	-0.3405E -4	-0.1125E 0
23	-0.4171E -4	-0.1378E 0
24	-0.5154E -4	-0.1703E 0
25	-0.6007E -4	-0.1985E 0
26	-0.6175E -4	-0.2040E 0
27	-0.5262E -4	-0.1739E 0
28	-0.3465E -4	-0.1145E 0

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THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
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THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
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K	GKC(K)	GKCP(K)
0	0.1486E 1	0.1486E 1
1	0.6189E 2	0.6242E 2
2	0.2910E 2	0.3010E 2
3	0.4481E 2	0.4836E 2
4	0.3623E 2	0.4153E 2
5	0.3357E 2	0.4164E 2
6	0.3451E 2	0.4725E 2
7	0.2216E 2	0.3422E 2
8	0.1492E 2	0.2659E 2
9	0.5370E 1	0.1134E 2
10	0.8238E 1	0.2125E 2
11	0.2544E 1	0.8304E 1
12	0.4784E 1	0.2062E 2
13	0.1839E 1	0.1105E 2
14	0.2379E 1	0.2141E 2
15	-0.2208E 0	-0.3300E 1
16	0.1087E 1	0.3177E 2

17	-0.3959E	0	-0.3092E	2
18	0.6698E	0	0.3448E	3
19	-0.4542E	0	-0.9961E	3
20	0.5371E	0	0.7925E	2
21	-0.3520E	0	-0.1846E	2
22	0.5479E	0	0.1552E	2
23	-0.2975E	0	-0.5567E	1
24	0.5345E	0	0.7480E	1
25	-0.2425E	0	-0.2769E	1
26	0.5649E	0	0.5635E	1
27	-0.2123E	0	-0.1960E	1
28	0.5012E	0	0.4510E	1

K	GKCP(K)		GKC3P(K)	
0	0.1486E	1	0.1486E	1
1	0.6242E	2	0.6254E	2
2	0.3010E	2	0.3034E	2
3	0.4836E	2	0.4925E	2
4	0.4153E	2	0.4291E	2
5	0.4164E	2	0.4381E	2
6	0.4725E	2	0.5085E	2
7	0.3422E	2	0.3783E	2
8	0.2659E	2	0.3032E	2
9	0.1134E	2	0.1340E	2
10	0.2125E	2	0.2613E	2
11	0.8304E	1	0.1067E	2
12	0.2062E	2	0.2784E	2
13	0.1105E	2	0.1575E	2
14	0.2141E	2	0.3238E	2
15	-0.3300E	1	-0.5322E	1
16	0.3177E	2	0.5495E	2
17	-0.3092E	2	-0.5768E	2
18	0.3448E	3	0.6977E	3
19	-0.9961E	3	-0.2201E	4
20	0.7925E	2	0.1925E	3
21	-0.1846E	2	-0.4965E	2
22	0.1552E	2	0.4656E	2
23	-0.5567E	1	-0.1878E	2
24	0.7480E	1	0.2864E	2
25	-0.2769E	1	-0.1216E	2
26	0.5635E	1	0.2866E	2
27	-0.1960E	1	-0.1169E	2
28	0.4510E	1	0.3199E	2

K	GKC3P(K)		GH(K)	
0	0.1486E	1	0.3201E	2
1	0.6254E	2	0.3923E	2
2	0.3034E	2	0.4312E	2
3	0.4925E	2	0.4294E	2
4	6.4291E	2	0.4472E	2
5	0.4381E	2	0.4535E	2
6	0.5085E	2	0.4584E	2
7	0.3783E	2	0.3921E	2
8	0.3032E	2	0.2797E	2
9	0.1340E	2	0.2081E	2
10	0.2613E	2	0.1909E	2
11	0.1067E	2	0.1883E	2
12	0.2784E	2	0.2053E	2
13	0.1575E	2	0.2293E	2
14	0.3238E	2	0.1879E	2
15	-0.5322E	1	0.1917E	2
16	0.5495E	2	0.1172E	2
17	-0.5768E	2	0.1593E	3
18	0.6977E	3	-0.2158E	3
19	-0.2201E	4	-0.8779E	3
20	0.1925E	3	-0.4664E	3
21	-0.4965E	2	0.3494E	2
22	0.4656E	2	0.6170E	1
23	-0.1878E	2	0.9408E	1
24	0.2864E	2	0.6587E	1
25	-0.1216E	2	0.8249E	1
26	0.2866E	2	0.8370E	1
27	-0.1169E	2	0.9319E	1
28	0.3199E	2	0.1015E	2

STOP
R

APPENDIX

MODIFICATION OF DATA ANALYSIS SOFTWARE FOR AUTORADIOGRAPHIC ENHANCEMENT PROCESS

PREFACE

This is the Description and Program Listings of the modification of Data Analysis Software developed for the evaluation of the Wiener Spectrum and Modulation Transfer Function of the Autoradiographic Enchancement Process.

This report is an addendum to the three-volume report No. 79-01 of Contract No. NAS8-33405 and is the Final Report prepared by ESPEE, INC. under Contract No. P.O. H-30573B for the Space Sciences Laboratory of the George C. Marshall Space Flight Center.

The NASA COR for this Contract is Mr. Ray Hembree.

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1. MODIFICATION OF DATA ANALYSIS SOFTWARE

The following modifications have been done to data analysis software developed under an earlier contract No. NAS8-33405:

1.1 Individual Record Processing

The data from each record in a file on micordensitometer tape is individually processed. All processes, namely compute histogram, compute average, normalize data ,calculate zero-mean data, filter data for low frequency, filter data for high frequency, compute standard deviation compute autocorrelation, compute power spectral density function, apply inverse filter transform, apply aperture compensation and smoothe power spectral densities are applied to each record separetely. These processes were formerly applied to all records in a file combined into one record.

1.2. Averaging Results of all Records

After the autocorrelation and smoothed power spectral density function arrays are computed for each record, an average of these arrays is computed.

1.3. Computing Standard Deviation and Error

The standard deviation and error are computed for the averaged autocorrelation and smoothed power spectral density arrays. The standard deviation is computed as follows:

$$\text{Standard Deviation} = \left[\left(\sum_{n=1}^{m+1} D_n^2 \right) / M \right]^{\frac{1}{2}}$$

where M is the max lag factor and D_n is the N-th data point

The error is computed as follows:

$$\text{Error} = \text{Standard Deviation} / (N)^{\frac{1}{2}}$$

where N is the No. of records.

1.4. Four Cases

The above modifications have been applied to all four cases, namely without filters, with low frequency filter only, with high frequency filter only and with both filters.

2. SOFTWARE MODULES AFFECTED

The following software modules were changed:

SP1

SP2

SPL

SPH

A new module named LAST has been added to the software. This module computes the standard deviation and error for the averaged autocorrelation and power spectral density functions. This module is the last module called by the main modules SP1, SP2, SPL and SPH.

The modifications have been made in a manner such that the use of the program is unchanged from the way described in the users manual.

3. PROGRAM LISTINGS

The program listings for the modified modules and the new module are given in the following pages. Also included are the updated list of modules and code for loading compiled modules.

```
TYPE SPLIST
        FILE SPLIST
        SP1A-RLDR/M FOR SP1
        SP2A-RLDR/M FOR SP2
        SPLA-RLDR/M FOR SPL
        SPHA-RLDR/M FOR SPH
        SP23A-RLDR/M FOR SP23
        SP24A-RLDR/M FOR SP24
        SP1-MAIN WITHOUT FILTERS
        SP2-MAIN WITH FILTERS
        SPL-MAIN WITH LOW FREQ. FILTER
        SPH-MAIN WITH HIGH FREQ. FILTER
        SP3-PTDT
        SP4-SKPFL
        SP5-RDFL
        SP6-HDR
        SP7-CORD
        SP8-RFMT
        SP9-GBYTE
        SP10-MEANS
        SP11-SIGMA
        SP12-AUTOCOR
        SP13-(DELETED)
        SP14-HIST
        SP15-DCLS
        SP16-AVG
        SP17-NRMLZ
        SP18-ZMEAN
        SP19-PSDF
        SP20-SPDF
        SP21-INF
        SP22-AC
        SP23-LFF
        SP24-HFF
        SP25-AC1
        SP26-LAST
R
```

```
TYPE SP1A
RLDR/M SP1 SP3 SP4 SP5 SP6 SP7 SP8 SP9 SP10 SP11 SP12 SP14 SP15 ^
SP16 SP17 SP18 SP19 SP25 SP20 SP26 FORT.LB
R
TYPE SP2A
RLDR/M SP2 SP3 SP4 SP5 SP6 SP7 SP8 SP9 SP10 SP11 SP12 SP14 SP15 ^
SP16 SP17 SP18 SP19 SP21 SP22 SP20 SP26 FORT.LB
R
TYPE SPLA
RLDR/M SPL SP3 SP4 SP5 SP6 SP7 SP8 SP9 SP10  SP11 SP12  SP14 SP15 ^
SP16 SP17 SP18 SP19 SP21 SP25 SP20 SP26 FORT.LB
R
TYPE SPHA
RLDR/M SPH SP3 SP4 SP5 SP6 SP7 SP8 SP9 SP10 SP11 SP12 SP14 SP15 ^
SP16 SP17 SP18 SP19 SP21 SP22 SP20 SP26 FORT.LB
R
TYPE SP23A
RLDR/M SP23 FORT.LB
R
TYPE SP24A
RLDR/M SP24 FORT.LB
R
```

```
TYPE SP1
C        FILE SP1-MAIN WITHOUT FILTERS
C        PROGRAMMER NAME: S.P. SINGH
C        REVISION:3, MULTIPLE RECORDS/FILE
C        DATE:7/31/79
C        PURPOSE: THIS MODULE ACCEPTS USER INPUTS AND CALLS ALL
C        SUBSEQUENT MODULES
C        RRH IS AUTOCORRELATION VALUES OF DATA
C        GKC IS POWER SPECTRAL DENSITY FUNCTION
C        GKH IS SMOOTHED POWER SPECTRAL DENSITY
C        GKCP IS THE INVERSE FILTER FUNCTION
C        GKC3P IS THE APERTURE COMPENSATION FUNCTION
C        ITEMP,XTEMP ARE BUFFERS
C        NR IS THE NUMBER OF RECORDS IN THE FILE
C        NW IS THE NUMBER OF WORDS PER RECORD
C        NP IS THE NUMBER OF POINTS PER RECORD
         INTEGER P,Q
         DIMENSION RRH(101),ITEMP(1000),
      1  GKC(101),GKH(101)
         DIMENSION GKCP(101),GKC3P(101)
         DIMENSION NW(50),NP(50)
         DIMENSION XTEMP(1000)
         DIMENSION RR(101),GH(101)
         ACCEPT "FILE NUMBER,NF=",NF
         ACCEPT "DIFFUSE DENSITY FACTOR,DDF=",DDF
         ACCEPT "MAXIMUM LAG FACTOR,M=",M
         ACCEPT "HEIGHT OF SCANNING SLIT,XL=",XL
         ACCEPT "WIDTH OF SCANNING SLIT,XA=",XA
C        ACCEPT "LOW FREQUENCY FILTER PARAMETER,P=",P
C        ACCEPT "HIGH FREQUENCY FILTER PARAMETER,Q=",Q
         P=0
         Q=0
         CALL PTDT (ITEMP,NF,H,NR,NW,NP)
C        TRANSFER RAW DATA RECORDS INTO A FILE SRD
         CALL FOPEN(3,"RD",2000)
         CALL FOPEN(2,"SRD",2000)
         DO 10 I=1,NR
         CALL READR(3,I,ITEMP,1,IER)
```

```
      CALL WRITR(2,I,ITEMP,1,IER)
10    CONTINUE
      CALL FCLOS(2)
      CALL FCLOS(3)
      NRK=1
C     CALL FOPEN(4,'PAR')
C     WRITE BINARY (4) NP,P,Q,NRK
C     CALL FCLOS(4)
      A=0
      B=3200
      NC=100
      DO 15 J=1,101
      RR(J)=0.
      GH(J)=0.
15    CONTINUE
      DO 20 I=1,NR
      TYPE ' '
      TYPE 'RECORD NO.',I
      TYPE ' '
      CALL HIST (ITEMP,A,B,NC,NRK,NP)
      CALL MEANS(ITEMP,XTEMP,NP,NRK,DDF)
C     CALL SWAP('SP23.SV',IER);  CALL LFF(XTEMP,TEMP2,TEMP3,NP,P,NRK)
C     CALL SWAP('SP24.SV',IER);  CALL HFF(XTEMP,TEMP2,TEMP3,NP,Q,NRK)
      CALL SIGMA(XTEMP,NRK,NP)
      CALL AUTOCOR(XTEMP,NP,NRK,M,RRH,P,Q)
      MP1=M+1
      DO 30 J=1,MP1
      RR(J)=RRH(J)+RR(J)
30    CONTINUE
      CALL PSDF(RRH,M,H,XL,GKC)
C     CALL INF(GKC,GKCP,Q,M)
      CALL AC1(GKC,GKC3P,M,H,XA)
      CALL SPDF(M,GKC3P,GKH)
      DO 40 J=1,MP1
      GH(J)=GH(J)+GKH(J)
40    CONTINUE
      CALL DELETE('RD')
      CALL DELETE('NRD')
```

```
      CALL DELETE('ZRD')
      CALL DELETE('ZP')
      CALL DELETE('TD')
      CALL FOPEN(3,'RD',2000)
      CALL FOPEN(2,'SRD',2000)
      IF (I.GE.NR)GO TO 20
      I1=I+1
      CALL READR(2,I1,ITEMP,1,IER)
      CALL WRITR(3,1,ITEMP,1,IER)
      CALL FCLOS(2)
      CALL FCLOS(3)
20    CONTINUE
      CALL DELETE('PAR')
      DO 50 J=1,MP1
      RR(J)=RR(J)/NR
      GH(J)=GH(J)/NR
50    CONTINUE
      TYPE' R                   AVERAGE R-HAT'
      DO 60 J=1,MP1
      IR=J-1
      WRITE (10,100)IR,RR(J)
100   FORMAT(1X,I3,8X,E11.4)
60    CONTINUE
      TYPE'  K                  AVERAGE GH(K)'
      DO 70 J=1,MP1
      IR=J-1
      WRITE(10,100) IR,GH(J)
70    CONTINUE
      CALL LAST (RR,GH,MP1,NR)
      STOP
      END
R
```

```
TYPE SPL
C       FILE SPL=MAIN WITH LOW FREQ. FILTER
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION:3, MULTIPLE RECORDS/FILE
C       DATE:8/14/79
C       PURPOSE: THIS MODULE ACCEPTS USER INPUTS AND CALLS ALL
C       SUBSEQUENT MODULES
C       RRH IS AUTOCORRELATION VALUES OF DATA
C       GKC IS POWER SPECTRAL DENSITY FUNCTION
C       GKH IS SMOOTHED POWER SPECTRAL DENSITY
C       GKCP IS THE INVERSE FILTER FUNCTION
C       GKC3P IS THE APERTURE COMPENSATION FUNCTION
C       ITEMP,XTEMP ARE BUFFERS
C       NR IS THE NUMBER OF RECORDS IN THE FILE
C       NW IS THE NUMBER OF WORDS PER RECORD
C       NP IS THE NUMBER OF POINTS PER RECORD
        INTEGER P,Q
        DIMENSION RRH(101),ITEMP(1000),
     1  GKC(101),GKH(101)
        DIMENSION GKCP(101),GKC3P(101)
        DIMENSION NW(50),NP(50)
        DIMENSION XTEMP(1000)
        DIMENSION RR(101),GH(101)
        ACCEPT "FILE NUMBER,NF=",NF
        ACCEPT "DIFFUSE DENSITY FACTOR,DDF=",DDF
        ACCEPT "MAXIMUM LAG FACTOR,M=",M
        ACCEPT "HEIGHT OF SCANNING SLIT,XL=",XL
        ACCEPT "WIDTH OF SCANNING SLIT,XA=",XA
        ACCEPT "LOW FREQUENCY FILTER PARAMETER,P=",P
C       ACCEPT "HIGH FREQUENCY FILTER PARAMETER,Q=",Q
        Q=0
        CALL PTDT (ITEMP,NF,H,NR,NW,NP)
C       TRANSFER RAW DATA RECORDS INTO A FILE SRD
        CALL FOPEN(3,"RD",2000)
        IS=1
        CALL FOPEN(IS,"SRD",2000)
        DO 10 I=1,NR
        CALL READR(3,I,ITEMP,1,IER)
```

```
      CALL WRITR(IS,I,ITEMP,1,IER)
10    CONTINUE
      CALL FCLOS(IS)
      CALL FCLOS(3)
      NRK=1
      CALL FOPEN(4,'PAR')
      WRITE BINARY (4) NP,P,Q,NRK
      CALL FCLOS(4)
      A=0
      B=3200
      NC=100
      DO 15 J=1,101
      RR(J)=0.
      GH(J)=0.
15    CONTINUE
      DO 20 I=1,NR
      TYPE ' '
      TYPE 'RECORD NO.',I
      TYPE ' '
      CALL HIST (ITEMP,A,B,NC,NRK,NP)
      CALL MEANS(ITEMP,XTEMP,NP,NRK,DDF)
      CALL SWAP('SP23.SV',IER);  CALL LFF(XTEMP,TEMP2,TEMP3,NP,P,NRK)
C     TYPE 'IER=',IER
      CALL DELETE ('ZRD')
      CALL RENAM('ZP','ZRD',IER)
C     CALL SWAP('SP24.SV',IER);  CALL HFF(XTEMP,TEMP2,TEMP3,NP,Q,NRK)
      CALL SIGMA(XTEMP,NRK,NP)
      CALL AUTOCOR(XTEMP,NP,NRK,M,RRH,P,Q)
      MP1=M+1
      DO 30 J=1,MP1
      RR(J)=RRH(J)+RR(J)
30    CONTINUE
      CALL PSDF(RRH,M,H,XL,GKC)
C     CALL INF(GKC,GKCP,Q,M)
      CALL AC1(GKC,GKC3P,M,H,XA)
      CALL SPDF(M,GKC3P,GKH)
      DO 40 J=1,MP1
      GH(J)=GH(J)+GKH(J)
```

```
40      CONTINUE
        CALL DELETE('RD')
        CALL DELETE('NRD')
        CALL DELETE('ZRD')
        CALL DELETE('ZP')
        CALL DELETE('TD')
        CALL FOPEN(3,'RD',2000)
        CALL FOPEN(IS,'SRD',2000)
        IF (I.GE.NR)GO TO 20
        I1=I+1
        CALL READR(IS,I1,ITEMP,1,IER)
        CALL WRITR(3,1,ITEMP,1,IER)
        CALL FCLOS(IS)
        CALL FCLOS(3)
20      CONTINUE
        CALL DELETE('PAR')
        DO 50 J=1,MP1
        RR(J)=RR(J)/NR
        GH(J)=GH(J)/NR
50      CONTINUE
        TYPE' R              AVERAGE R-HAT'
        DO 60 J=1,MP1
        IR=J-1
        WRITE (10,100)IR,RR(J)
100     FORMAT(1X,I3,8X,E11.4)
60      CONTINUE
        TYPE'  K             AVERAGE GH(K)'
        DO 70 J=1,MP1
        IR=J-1
        WRITE(10,100) IR,GH(J)
70      CONTINUE
        CALL LAST (RR,GH,MP1,NR)
        STOP
        END
R
```

```
TYPE SPH
C       FILE SPH=MAIN WITH HIGH FREQ. FILTER ONLY
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION:3, MULTIPLE RECORDS/FILE
C       DATE:8/20/79
C       PURPOSE: THIS MODULE ACCEPTS USER INPUTS AND CALLS ALL
C       SUBSEQUENT MODULES
C       RRH IS AUTOCORRELATION VALUES OF DATA
C       GKC IS POWER SPECTRAL DENSITY FUNCTION
C       GKH IS SMOOTHED POWER SPECTRAL DENSITY
C       GKCP IS THE INVERSE FILTER FUNCTION
C       GKC3P IS THE APERTURE COMPENSATION FUNCTION
C       ITEMP,XTEMP ARE BUFFERS
C       NR IS THE NUMBER OF RECORDS IN THE FILE
C       NW IS THE NUMBER OF WORDS PER RECORD
C       NP IS THE NUMBER OF POINTS PER RECORD
        INTEGER P,Q
        DIMENSION RRH(101),ITEMP(1000),
     1  GKC(101),GKH(101)
        DIMENSION GKCP(101),GKC3P(101)
        DIMENSION NW(50),NP(50)
        DIMENSION XTEMP(1000)
        DIMENSION RR(101),GH(101)
        ACCEPT 'FILE NUMBER,NF=',NF
        ACCEPT 'DIFFUSE DENSITY FACTOR,DDF=',DDF
        ACCEPT 'MAXIMUM LAG FACTOR,M=',M
        ACCEPT 'HEIGHT OF SCANNING SLIT,XL=',XL
        ACCEPT 'WIDTH OF SCANNING SLIT,XA=',XA
C       ACCEPT 'LOW FREQUENCY FILTER PARAMETER,P=',P
        P=0
        ACCEPT 'HIGH FREQUENCY FILTER PARAMETER,Q=',Q
        CALL PTDT (ITEMP,NF,H,NR,NW,NP)
C       TRANSFER RAW DATA RECORDS INTO A FILE SRD
        CALL FOPEN(3,'RD',2000)
        IS=1
        CALL FOPEN(IS,'SRD',2000)
        DO 10 I=1,NR
        CALL READR(3,I,ITEMP,1,IER)
```

```
      CALL WRITR(IS,I,ITEMP,1,IER)
10    CONTINUE
      CALL FCLOS(IS)
      CALL FCLOS(3)
      NRK=1
      CALL FOPEN(4,'PAR')
      WRITE BINARY (4) NP,P,Q,NRK
      CALL FCLOS(4)
      A=0
      B=3200
      NC=100
      DO 15 J=1,101
      RR(J)=0.
      GH(J)=0.
15    CONTINUE
      DO 20 I=1,NR
      TYPE ' '
      TYPE 'RECORD NO.',I
      TYPE ' '
      CALL HIST (ITEMP,A,B,NC,NRK,NP)
      CALL MEANS(ITEMP,XTEMP,NP,NRK,DDF)
C     CALL SWAP('SP23.SV',IER);  CALL LFF(XTEMP,TEMP2,TEMP3,NP,P,NRK)
      CALL RENAM ('ZRD','ZP',IER)
      CALL SWAP('SP24.SV',IER);  CALL HFF(XTEMP,TEMP2,TEMP3,NP,Q,NRK)
      CALL DELETE ('ZRD')
      CALL RENAM ('ZPP','ZRD',IER)
      CALL SIGMA(XTEMP,NRK,NP)
      CALL AUTOCOR(XTEMP,NP,NRK,M,RRH,P,Q)
      MP1=M+1
      DO 30 J=1,MP1
      RR(J)=RRH(J)+RR(J)
30    CONTINUE
      CALL PSDF(RRH,M,H,XL,GKC)
      CALL INF(GKC,GKCP,Q,M)
      CALL AC(GKCP,GKC3P,M,H,XA)
      CALL SPDF(M,GKC3P,GKH)
      DO 40 J=1,MP1
      GH(J)=GH(J)+GKH(J)
```

```
40      CONTINUE
        CALL DELETE('RD')
        CALL DELETE('NRD')
        CALL DELETE('ZRD')
        CALL DELETE('ZP')
        CALL DELETE('TD')
        CALL FOPEN(3,'RD',2000)
        CALL FOPEN(IS,'SRD',2000)
        IF (I.GE.NR)GO TO 20
        I1=I+1
        CALL READR(IS,I1,ITEMP,1,IER)
        CALL WRITR(3,1,ITEMP,1,IER)
        CALL FCLOS(IS)
        CALL FCLOS(3)
20      CONTINUE
        CALL DELETE('PAR')
        DO 50 J=1,MP1
        RR(J)=RR(J)/NR
        GH(J)=GH(J)/NR
50      CONTINUE
        TYPE' R              AVERAGE R-HAT'
        DO 60 J=1,MP1
        IR=J-1
        WRITE (10,100)IR,RR(J)
100     FORMAT(1X,I3,8X,E11.4)
60      CONTINUE
        TYPE'  K             AVERAGE GH(K)'
        DO 70 J=1,MP1
        IR=J-1
        WRITE(10,100) IR,GH(J)
70      CONTINUE
        CALL LAST (RR,GH,MP1,NR)
        STOP
        END
R
```

```
TYPE SP2
C       FILE SP2-MAIN WITH FILTERS
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION:3, MULTIPLE RECORDS/FILE
C       DATE:8/24/79
C       PURPOSE: THIS MODULE ACCEPTS USER INPUTS AND CALLS ALL
C       SUBSEQUENT MODULES
C       RRH IS AUTOCORRELATION VALUES OF DATA
C       GKC IS POWER SPECTRAL DENSITY FUNCTION
C       GKH IS SMOOTHED POWER SPECTRAL DENSITY
C       GKCP IS THE INVERSE FILTER FUNCTION
C       GKC3P IS THE APERTURE COMPENSATION FUNCTION
C       ITEMP,XTEMP ARE BUFFERS
C       NR IS THE NUMBER OF RECORDS IN THE FILE
C       NW IS THE NUMBER OF WORDS PER RECORD
C       NP IS THE NUMBER OF POINTS PER RECORD
        INTEGER P,Q
        DIMENSION RRH(101),ITEMP(1000),
     1  GKC(101),GKH(101)
        DIMENSION GKCP(101),GKC3P(101)
        DIMENSION NW(50),NP(50)
        DIMENSION XTEMP(1000)
        DIMENSION RR(101),GH(101)
        ACCEPT 'FILE NUMBER,NF=',NF
        ACCEPT 'DIFFUSE DENSITY FACTOR,DDF=',DDF
        ACCEPT 'MAXIMUM LAG FACTOR,M=',M
        ACCEPT 'HEIGHT OF SCANNING SLIT,XL=',XL
        ACCEPT 'WIDTH OF SCANNING SLIT,XA=',XA
        ACCEPT 'LOW FREQUENCY FILTER PARAMETER,P=',P
        ACCEPT 'HIGH FREQUENCY FILTER PARAMETER,Q=',Q
        CALL PTDT (ITEMP,NF,H,NR,NW,NP)
C       TRANSFER RAW DATA RECORDS INTO A FILE SRD
        CALL FOPEN(3,'RD',2000)
        IS=1
        CALL FOPEN(IS,'SRD',2000)
        DO 10 I=1,NR
        CALL READR(3,I,ITEMP,1,IER)
        CALL WRITR(IS,I,ITEMP,1,IER)
```

```
10      CONTINUE
        CALL FCLOS(IS)
        CALL FCLOS(3)
        NRK=1
        CALL FOPEN(4,"PAR")
        WRITE BINARY (4) NP,P,Q,NRK
        CALL FCLOS(4)
        A=0
        B=3200
        NC=100
        DO 15 J=1,101
        RR(J)=0.
        GH(J)=0.
15      CONTINUE
        DO 20 I=1,NR
        TYPE " "
        TYPE "RECORD NO.",I
        TYPE " "
        CALL HIST (ITEMP,A,B,NC,NRK,NP)
        CALL MEANS(ITEMP,XTEMP,NP,NRK,DDF)
        CALL SWAP("SP23.SV",IER);  CALL LFF(XTEMP,TEMP2,TEMP3,NP,P,NRK)
        CALL SWAP("SP24.SV",IER);  CALL HFF(XTEMP,TEMP2,TEMP3,NP,Q,NRK)
        CALL DELETE ("ZRD")
        CALL RENAM ("ZPP","ZRD",IER)
        CALL SIGMA(XTEMP,NRK,NP)
        CALL AUTOCOR(XTEMP,NP,NRK,M,RRH,P,Q)
        MP1=M+1
        DO 30 J=1,MP1
        RR(J)=RRH(J)+RR(J)
30      CONTINUE
        CALL PSDF(RRH,M,H,XL,GKC)
        CALL INF(GKC,GKCP,Q,M)
        CALL AC(GKCP,GKC3P,M,H,XA)
        CALL SPDF(M,GKC3P[illegible]H)
        DO 40 J=1,MP1
        GH(J)=GH(J)+GKH(J)
40      CONTINUE
        CALL DELETE("RD")
```

```
      CALL DELETE('NRD')
      CALL DELETE('ZRD')
      CALL DELETE('ZP')
      CALL DELETE('TD')
      CALL FOPEN(3,'RD',2000)
      CALL FOPEN(IS,'SRD',2000)
      IF (I.GE.NR)GO TO 20
      I1=I+1
      CALL READR(IS,I1,ITEMP,1,IER)
      CALL WRITR(3,1,ITEMP,1,IER)
      CALL FCLOS(IS)
      CALL FCLOS(3)
20    CONTINUE
      CALL DELETE('PAR')
      DO 50 J=1,MP1
      RR(J)=RR(J)/NR
      GH(J)=GH(J)/NR
50    CONTINUE
      TYPE' R            AVERAGE R-HAT'
      DO 60 J=1,MP1
      IR=J-1
      WRITE (10,100)IR,RR(J)
100   FORMAT(1X,I3,8X,E11.4)
60    CONTINUE
      TYPE'  K           AVERAGE GH(K)'
      DO 70 J=1,MP1
      IR=J-1
      WRITE(10,100) IR,GH(J)
70    CONTINUE
      CALL LAST (RR,GH,MP1,NR)
      STOP
      END
R
```

```
TYPE SP26
C       FILE SP26-LAST
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION:0
C       DATE:8/3/79
C       PURPOSE:THIS MODULE COMPUTES STANDARD
C       DEVIATION AND ERROR FOR THE AVERAGED
C       R-HAT AND G-HAT ARRAYS.
        COMPILER NOSTACK
        SUBROUTINE LAST(RR,GH,MP1,NR)
        DIMENSION RR(101),GH(101)
        RSQ=0.
        GSQ=0.
        DO 80 I=1,MP1
        RSQ=RSQ+(RR(I)**2)
        GSQ=GSQ+GH(I)**2
80      CONTINUE
        RSD=SQRT(RSQ/(MP1-1))
        GSD=SQRT(GSQ/(MP1-1))
        RN=NR
        ERH=RSD/SQRT(RN)
        EGH=GSD/SQRT(RN)
        TYPE 'STANDARD DEVIATION FOR R-HAT',RSD
        TYPE 'STANDARD DEVIATION FOR G-HAT',GSD
        TYPE 'ERROR FOR R-HAT',ERH
        TYPE 'ERROR FOR G-HAT',EGH
        STOP
        END
R
```

4. SAMPLE RUNS

Sample run results are included in the following pages for a file containing 3 records. Same data is used for each of the four cases namely without filters (SP1), with low frequency filter only (SPL), with high frequency filter only (SPH) and with both filters (SP2).

```
SP1
FILE NUMBER,NF=1
DIFFUSE DENSITY FACTOR,DDF=1
MAXIMUM LAG FACTOR,M=2
HEIGHT OF SCANNING SLIT,XL=1
WIDTH OF SCANNING SLIT,XA=1
 DATA PREPARATION COMMENCED
FILE IS BEING READ FROM TAPE
NUMBER OF RECORDS READ=       3
FILE READ FROM TAPE AND WRITTEN ON DISK
8y    h(0(h),)oz0xy)8
NUMBER OF SAMPLES=      101
X COORDINATE (MICRONS)=     -3607
Y COORDINATE (MICRONS)=         0
DELTA X (H) (MICRONS)=         12
DATA IS BEING FORMATTED
 3.34  3.38  3.39  3.32  3.35  3.32  3.31  3.30  3.38  3.38
 3.42  3.30  3.22  3.29  3.37  3.41  3.28  3.32  3.36  3.34
 3.25  3.29  3.29  3.39  3.52  3.29  3.13  3.22  3.36  3.51
 3.40  3.27  3.36  3.47  3.36  3.36  3.50  3.34  3.39  3.35
 3.42  3.43  3.30  3.29  3.41  3.33  3.33  3.43  3.35  3.36
 3.34  3.26  3.36  3.28  3.30  3.24  3.34  3.36  3.35  3.31
 3.31  3.37  3.43  3.14  3.32  3.30  3.39  3.34  3.34  3.27
 3.31  3.48  3.37  3.27  3.47  3.42  3.51  3.30  3.27  3.32
 3.31  3.38  3.52  3.52  3.43  3.43  3.34  3.33  3.31  3.35
 3.34  3.31  3.42  3.46  3.41  3.29  3.46  3.30  3.40  3.41
 3.40
DATA FORMATTING COMPLETED
RAW DATA STORED ON DISK.

RECORD NO.        1

HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES=      100
   CLASS NO.      NO. OF DATA POINTS
      79                 2
      80                 0
      81                 2
      82                 7
      83                22
      84                23
      85                18
      86                16
      87                 4
      88                 4
      89                 3
RAW MEAN =      0.268596E  4
MEAN OF NORMALIZED DATA=      0.100000E  1
MEAN SQUARE VALUE =      0.493768E -3
ROOT MEAN SQUARE VALUE =      0.223317E -1
AUTOCORRELATION IS BEING COMPUTED
  R           R-HAT               NORM. R-HAT
  0         0.4938E -3             0.1000E  1
  1         0.1130E -3             0.2289E  0
  2        -0.6913E -4            -0.1400E  0
  K           GKC(K)           GKC3P(K)
  0         0.1562E -1             0.1562E -1
  1         0.1361E -1             0.1353E -1
  2         0.4766E -2             0.4793E -2
  K          GKC3P(K)                  GH(K)
  0         0.1562E -1             0.1457E -1
  1         0.1353E -1             0.1187E -1
  2         0.4793E -2             0.9161E -2
```

```
RECORD NO.        2

HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES=      100
   CLASS NO.      NO. OF DATA POINTS
      80                 1
      81                 9
      82                10
      83                13
      84                18
      85                22
      86                12
      87                 9
      88                 3
      89                 2
      90                 1
      91                 1
RAW MEAN =      0.268336E  4
MEAN OF NORMALIZED DATA=      0.100000E  1
MEAN SQUARE VALUE =      0.319853E -3
ROOT MEAN SQUARE VALUE =      0.178288E -1
AUTOCORRELATION IS BEING COMPUTED
  R           R-HAT               NORM. R-HAT
  0         0.6397E -3             0.1000E  1
  1         0.1568E -3             0.2451E  0
  2         0.3106E -4             0.4856E -1
  K           GKC(K)           GKC3P(K)
  0         0.2362E -1             0.2362E -1
  1         0.1461E -1             0.1463E -1
  2         0.8572E -2             0.8622E -2
  K          GKC3P(K)                  GH(K)
  0         0.2362E -1             0.1913E -1
  1         0.1463E -1             0.1538E -1
  2         0.8622E -2             0.1162E -1

RECORD NO.        3

HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES=      100
   CLASS NO.      NO. OF DATA POINTS
      79                 1
      80                 1
      81                 3
      82                 9
      83                16
      84                18
      85                27
      86                18
      87                 7
      88                 1
RAW MEAN =      0.268165E  4
MEAN OF NORMALIZED DATA=      0.100000E  1
MEAN SQUARE VALUE =      0.134011E -3
ROOT MEAN SQUARE VALUE =      0.115954E -1
AUTOCORRELATION IS BEING COMPUTED
  R           R-HAT               NORM. R-HAT
  0         0.4020E -3             0.1000E  1
  1         0.1298E -3             0.3230E  0
  2        -0.9915E -6            -0.2466E -1
  K           GKC(K)           GKC3P(K)
  0         0.1564E -1             0.1564E -1
```

```
  1          0.9887E -2          0.9901E -2
  2          0.3179E -2          0.3197E -2
  K           GKC3P(K)              GH(K)
  0          0.1564E -1          0.1277E -1
  1          0.9901E -2          0.9660E -2
  2          0.3197E -2          0.6549E -2
 R             AVERAGE R-HAT
  0          0.5118E -3
  1          0.1332E -3
  2         -0.1599E -4
  K            AVERAGE GH(K)
  0          0.1549E -1
  1          0.1230E -1
  2          0.9112E -2
STANDARD DEVIATION FOR R-HAT     0.374153E -3
STANDARD DEVIATION FOR G-HAT     0.153996E -1
ERROR FOR R-HAT     0.216017E -3
ERROR FOR G-HAT     0.889092E -2
STOP
R
```

```
SPL
FILE NUMBER,NF-1
DIFFUSE DENSITY FACTOR,DDF-1
MAXIMUM LAG FACTOR,M-2
HEIGHT OF SCANNING SLIT,KL-1
WIDTH OF SCANNING SLIT,XA-1
LOW FREQUENCY FILTER PARAMETER,P-10
 DATA PREPARATION COMMENCED
FILE IS BEING READ FROM TAPE
NUMBER OF RECORDS READ-       3
FILE READ FROM TAPE AND WRITTEN ON DISK
Sy    h(θ(h),>ozθxy)S
NUMBER OF SAMPLES-       101
X COORDINATE (MICRONS)-     -3607
Y COORDINATE (MICRONS)-         0
DELTA X (H) (MICRONS)-        12
DATA IS BEING FORMATTED
 3.34  3.38  3.39  3.32  3.35  3.32  3.31  3.30  3.38  3.38
 3.42  3.30  3.22  3.29  3.37  3.41  3.28  3.32  3.36  3.34
 3.25  3.29  3.29  3.30  3.52  3.29  3.13  3.22  3.36  3.51
 3.40  3.27  3.36  3.47  3.36  3.35  3.50  3.34  3.39  3.35
 3.42  3.43  3.30  3.29  3.41  3.33  3.33  3.43  3.35  3.36
 3.34  3.26  3.36  3.28  3.30  3.24  3.34  3.36  3.35  3.31
 3.31  3.37  3.43  3.14  3.32  3.30  3.39  3.34  3.34  3.27
 3.31  3.48  3.37  3.27  3.47  3.42  3.51  3.30  3.27  3.32
 3.31  3.38  3.52  3.52  3.43  3.43  3.34  3.33  3.31  3.35
 3.34  3.31  3.42  3.46  3.41  3.29  3.46  3.30  3.40  3.41
 3.40
DATA FORMATTING COMPLETED
RAW DATA STORED ON DISK.

RECORD NO.       1

HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES-      100
   CLASS NO.     NO. OF DATA POINTS
      79               2
      80               0
      81               2
      82               7
      83              22
      84              23
      85              18
      86              16
      87               4
      88               4
      89               3
RAW MEAN -      0.268596E  4
MEAN OF NORMALIZED DATA-       0.100000E  1
DATA IS BEING FILTERED FOR LOW FREQUENCY
MEAN SQUARE VALUE -      0.430541E -3
ROOT MEAN SQUARE VALUE -        0.208529E -1
AUTOCORRELATION IS BEING COMPUTED
 R          R-HAT            NORM. R-HAT
 0        0.5368E -3          0.1000E  1
 1        0.7376E -4          0.1374E  0
 2       -0.1429E -3         -0.2662E  0
 K          GKC(K)          GKC3P(K)
 0        0.1300E -1          0.1300E -1
 1        0.1631E -1          0.1634E -1
 2        0.5914E -2          0.5948E -2
 K         GKC3P(K)             GH(K)
 0        0.1300E -1          0.1467E -1
 1        0.1634E -1          0.1290E -1
 2        0.5948E -2          0.1114E -1

RECORD NO.       2

HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES-      100
   CLASS NO.     NO. OF DATA POINTS
      80               1
      81               9
      82              10
      83              13
      84              18
      85              22
      86              12
      87               9
      88               3
      89               2
      90               1
      91               1
RAW MEAN -      0.268336E  4
MEAN OF NORMALIZED DATA-       0.100000E  1
DATA IS BEING FILTERED FOR LOW FREQUENCY
MEAN SQUARE VALUE -      0.248947E -3
ROOT MEAN SQUARE VALUE -        0.158172E -1
AUTOCORRELATION IS BEING COMPUTED
 R          R-HAT            NORM. R-HAT
 0        0.6208E -3          0.1000E  1
 1        0.1090E -3          0.1756E  0
 2       -0.2685E -4         -0.4325E -1
 K          GKC(K)          GKC3P(K)
 0        0.1949E -1          0.1949E -1
 1        0.1554E -1          0.1557E -1
 2        0.9022E -2          0.9074E -2
 K         GKC3P(K)             GH(K)
 0        0.1949E -1          0.1753E -1
 1        0.1557E -1          0.1492E -1
 2        0.9074E -2          0.1232E -1

RECORD NO.       3

HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES-      100
   CLASS NO.     NO. OF DATA POINTS
      79               1
      80               1
      81               3
      82               9
      83              16
      84              18
      85              27
      86              18
      87               7
      88               1
RAW MEAN -      0.268165E  4
MEAN OF NORMALIZED DATA-       0.100000E  1
DATA IS BEING FILTERED FOR LOW FREQUENCY
MEAN SQUARE VALUE -      0.123531E -3
ROOT MEAN SQUARE VALUE -        0.111328E -1
AUTOCORRELATION IS BEING COMPUTED
 R          R-HAT            NORM. R-HAT
 0        0.4621E -3          0.1000E  1
```

```
 1      0.1327E -3        0.2871E  0
 2     -0.5625E -4       -0.1817E  0
 K        GKC(K)         GKC3P(K)
 0      0.1611E -1        0.1611E -1
 1      0.1244E -1        0.1246E -1
 2      0.3372E -2        0.3392E -2
 K       GKC3P(K)             GH(K)
 0      0.1611E -1        0.1428E -1
 1      0.1246E -1        0.1110E -1
 2      0.3392E -2        0.7925E -2
R         AVERAGE R-HAT
 0      0.5309E -3
 1      0.1052E -3
 2     -0.7534E -4
 K        AVERAGE GH(K)
 0      0.1549E -1
 1      0.1298E -1
 2      0.1046E -1
STANDARD DEVIATION FOR R-HAT    0.392589E -3
STANDARD DEVIATION FOR G-HAT    0.160919E -1
ERROR FOR R-HAT     0.226661E -3
ERROR FOR G-HAT     0.929666E -2
STOP
R
```

```
SPH
FILE NUMBER,NF=1
DIFFUSE DENSITY FACTOR,DDF=1
MAXIMUM LAG FACTOR,M=2
HEIGHT OF SCANNING SLIT,XL=1
WIDTH OF SCANNING SLIT,XA=1
HIGH FREQUENCY FILTER PARAMETER,Q=2
 DATA PREPARATION COMMENCED
FILE IS BEING READ FROM TAPE
NUMBER OF RECORDS READ=        3
FILE READ FROM TAPE AND WRITTEN ON DISK
8y     h(@(h),>oz@xy)$
NUMBER OF SAMPLES=      101
X COORDINATE (MICRONS)=     -3607
Y COORDINATE (MICRONS)=         0
DELTA X (H) (MICRONS)=        12
DATA IS BEING FORMATTED
  3.34  3.38  3.38  3.32  3.36  3.32  3.31  3.30  3.38  3.38
  3.42  3.30  3.22  3.29  3.37  3.41  3.28  3.32  3.36  3.34
  3.25  3.29  3.29  3.39  3.52  3.29  3.13  3.22  3.36  3.51
  3.40  3.27  3.36  3.47  3.36  3.35  3.50  3.34  3.39  3.35
  3.42  3.43  3.30  3.29  3.41  3.33  3.33  3.43  3.35  3.36
  3.34  3.26  3.36  3.28  3.30  3.24  3.34  3.36  3.36  3.31
  3.31  3.37  3.43  3.14  3.32  3.30  3.39  3.34  3.34  3.27
  3.31  3.48  3.37  3.27  3.47  3.42  3.51  3.30  3.27  3.32
  3.31  3.38  3.52  3.52  3.43  3.43  3.34  3.33  3.31  3.35
  3.34  3.31  3.42  3.46  3.41  3.29  3.46  3.30  3.40  3.41
  3.40
DATA FORMATTING COMPLETED
RAW DATA STORED ON DISK.

RECORD NO.       1

HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES=      100
   CLASS NO.      NO. OF DATA POINTS
      79               2
      80               0
      81               2
      82               7
      83              22
      84              23
      85              18
      86              16
      87               4
      88               4
      89               3
RAW MEAN =       0.268586E  4
MEAN OF NORMALIZED DATA=      0.100000E  1
DATA IS BEING FILTERED FOR HIGH FREQUENCY
MEAN SQUARE VALUE =      0.127497E -3
ROOT MEAN SQUARE VALUE =       0.113477E -1
AUTOCORRELATION IS BEING COMPUTED
 R          R-HAT             NORM. R-HAT
 0        0.1328E -3           0.1000E  1
 1        0.1190E -3           0.8965E  0
 2        0.9768E -4           0.7358E  0
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
 K          GKC(K)             GKCP(K)
 0        0.1124E -1           0.1124E -1
 1        0.8417E -3           0.2104E -1
 2       -0.1821E -3          -0.4552E -2
 K          GKCP(K)            GKC3P(K)
 0        0.1124E -1           0.1124E -1
 1        0.2104E -1           0.2107E -1
 2       -0.4552E -2          -0.4678E -2
 K          GKC3P(K)             GH(K)
 0        0.1124E -1           0.1618E -1
 1        0.2107E -1           0.1228E -1
 2       -0.4678E -2           0.8247E -2

RECORD NO.       2

HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES=      100
   CLASS NO.      NO. OF DATA POINTS
      80               1
      81               9
      82              10
      83              13
      84              18
      85              22
      86              12
      87               9
      88               3
      89               2
      90               1
      91               1
RAW MEAN =       0.268336E  4
MEAN OF NORMALIZED DATA=      0.100000E  1
DATA IS BEING FILTERED FOR HIGH FREQUENCY
MEAN SQUARE VALUE =      0.872958E -4
ROOT MEAN SQUARE VALUE =       0.936643E -2
AUTOCORRELATION IS BEING COMPUTED
 R          R-HAT             NORM. R-HAT
 0        0.1818E -3           0.1000E  1
 1        0.1608E -3           0.8844E  0
 2        0.1292E -3           0.7105E  0
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
 K          GKC(K)             GKCP(K)
 0        0.1518E -1           0.1518E -1
 1        0.1263E -2           0.3158E -1
 2       -0.2542E -3          -0.6356E -2
 K          GKCP(K)            GKC3P(K)
 0        0.1518E -1           0.1518E -1
 1        0.3158E -1           0.3162E -1
 2       -0.6356E -2          -0.6393E -2
 K          GKC3P(K)             GH(K)
 0        0.1518E -1           0.2340E -1
 1        0.3162E -1           0.1801E -1
 2       -0.6393E -2           0.1262E -1

RECORD NO.       3

HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES=      100
   CLASS NO.      NO. OF DATA POINTS
      79               1
      80               1
      81               3
      82               9
      83              16
      84              18
      85              27
      86              18
```

```
     87               7
     88               1
RAW MEAN =      0.268165E  4
MEAN OF NORMALIZED DATA=       0.100000E  1
DATA IS BEING FILTERED FOR HIGH FREQUENCY
MEAN SQUARE VALUE =      0.424990E -4
ROOT MEAN SQUARE VALUE =       0.652990E -2
AUTOCORRELATION IS BEING COMPUTED
  R           R-HAT              NORM. R-HAT
  0         0.1328E -3           0.1000E  1
  1         0.1190E -3           0.8965E  0
  2         0.9768E -4           0.7358E  0
 THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
  K            GKC(K)            GKCP(K)
  0         0.1124E -1           0.1124E -1
  1         0.8417E -3           0.2104E -1
  2        -0.1821E -3          -0.4552E -2
  K           GKCP(K)           GKC3P(K)
  0         0.1124E -1           0.1124E -1
  1         0.2104E -1           0.2107E -1
  2        -0.4552E -2          -0.4578E -2
  K           GKC3P(K)                GH(K)
  0         0.1124E -1           0.1616E -1
  1         0.2107E -1           0.1220E -1
  2        -0.4578E -2           0.8247E -2
 R             AVERAGE R-HAT
  0         0.1491E -3
  1         0.1329E -3
  2         0.1082E -3
  K            AVERAGE GH(K)
  0         0.1857E -1
  1         0.1414E -1
  2         0.9703E -2
STANDARD DEVIATION FOR R-HAT     0.160630E -3
STANDARD DEVIATION FOR G-HAT     0.178743E -1
ERROR FOR R-HAT     0.927398E -4
ERROR FOR G-HAT     0.103197E -1
STOP
R
```

```
SP2
FILE NUMBER,NF=1
DIFFUSE DENSITY FACTOR,DDF=1
MAXIMUM LAG FACTOR,M=2
HEIGHT OF SCANNING SLIT,XL=1
WIDTH OF SCANNING SLIT,XA=1
LOW FREQUENCY FILTER PARAMETER,P=10
HIGH FREQUENCY FILTER PARAMETER,Q=2
 DATA PREPARATION COMMENCED
FILE IS BEING READ FROM TAPE
NUMBER OF RECORDS READ=        3
FILE READ FROM TAPE AND WRITTEN ON DISK
By    h(0(h;,)oz0xy)8
NUMBER OF SAMPLES=      101
X COORDINATE (MICRONS)=    -3607
Y COORDINATE (MICRONS)=        0
DELTA X (H) (MICRONS)=      12
DATA IS BEING FORMATTED
 3.34  3.38  3.39  3.32  3.35  3.32  3.31  3.30  3.38  3.38
 3.42  3.30  3.22  3.29  3.37  3.41  3.28  3.32  3.36  3.34
 3.25  3.29  3.29  3.39  3.52  3.29  3.13  3.22  3.36  3.51
 3.40  3.27  3.36  3.47  3.36  3.35  3.50  3.34  3.39  3.35
 3.42  3.43  3.30  3.29  3.41  3.33  3.33  3.43  3.35  3.36
 3.34  3.26  3.36  3.28  3.30  3.24  3.34  3.36  3.35  3.31
 3.31  3.37  3.43  3.14  3.32  3.30  3.39  3.34  3.34  3.27
 3.31  3.48  3.37  3.27  3.47  3.42  3.51  3.30  3.27  3.32
 3.31  3.38  3.52  3.52  3.43  3.43  3.34  3.33  3.31  3.35
 3.34  3.31  3.42  3.46  3.41  3.29  3.46  3.30  3.40  3.41
 3.40
DATA FORMATTING COMPLETED
RAW DATA STORED ON DISK.

RECORD NO.        1

HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES=      100
   CLASS NO.      NO. OF DATA POINTS
      79                 2
      80                 0
      81                 2
      82                 7
      83                22
      84                23
      85                18
      86                16
      87                 4
      88                 4
      89                 3
RAW MEAN =      0.268596E  4
MEAN OF NORMALIZED DATA=      0.100000E  1
DATA IS BEING FILTERED FOR LOW FREQUENCY
DATA IS BEING FILTERED FOR HIGH FREQUENCY
MEAN SQUARE VALUE =      0.617079E -4
ROOT MEAN SQUARE VALUE =      0.789462E -2
AUTOCORRELATION IS BEING COMPUTED
  R            R-HAT              NORM. R-HAT
  0          0.8094E -4            0.1000E  1
  1          0.5958E -4            0.7361E  0
  2          0.2832E -4            0.3499E  0
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
  K            GKC(K)              GKCP(K)
  0          0.5482E -2            0.5482E -2
  1    -     0.1863E -2            0.3157E -1
  2         -0.2378E -3           -0.5944E -2
  K            GKCP(K)             GKC3P(K)
  0          0.5482E -2            0.5482E -2
  1          0.3157E -1            0.3162E -1
  2         -0.5944E -2           -0.5978E -2
  K            GKC3P(K)              GH(K)
  0          0.5482E -2            0.1855E -1
  1          0.3162E -1            0.1569E -1
  2         -0.5978E -2            0.1282E -1

RECORD NO.        2

HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES=      100
   CLASS NO.      NO. OF DATA POINTS
      80                 1
      81                 9
      82                10
      83                13
      84                18
      85                22
      86                12
      87                 9
      88                 3
      89                 2
      90                 1
      91                 1
RAW MEAN =      0.268336E  4
MEAN OF NORMALIZED DATA=      0.100000E  1
DATA IS BEING FILTERED FOR LOW FREQUENCY
DATA IS BEING FILTERED FOR HIGH FREQUENCY
MEAN SQUARE VALUE =      0.487693E -4
ROOT MEAN SQUARE VALUE =      0.700085E -2
AUTOCORRELATION IS BEING COMPUTED
  R            R-HAT              NORM. R-HAT
  0          0.1279E -3            0.1000E  1
  1          0.1044E -3            0.8159E  0
  2          0.7163E -4            0.5598E  0
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
  K            GKC(K)              GKCP(K)
  0          0.9800E -2            0.9800E -2
  1          0.1352E -2            0.3379E -1
  2         -0.2211E -3           -0.5528E -2
  K            GKCP(K)             GKC3P(K)
  0          0.9800E -2            0.9800E -2
  1          0.3379E -1            0.3384E -1
  2         -0.5528E -2           -0.5560E -2
  K            GKC3P(K)              GH(K)
  0          0.9800E -2            0.2182E -1
  1          0.3384E -1            0.1798E -1
  2         -0.5560E -2            0.1414E -1

RECORD NO.        3

HISTOGRAM BEING COMPUTED

TOTAL NO. OF CLASSES=      100
   CLASS NO.      NO. OF DATA POINTS
      79                 1
      80                 1
      81                 3
      82                 9
      83                16
```

```
    84               18
    85               27
    86               18
    87                7
    88                1
RAW MEAN =      0.268165E  4
MEAN OF NORMALIZED DATA=      0.100000E  1
DATA IS BEING FILTERED FOR LOW FREQUENCY
DATA IS BEING FILTERED FOR HIGH FREQUENCY
MEAN SQUARE VALUE =      0.310466E -4
ROOT MEAN SQUARE VALUE =      0.558117E -2
AUTOCORRELATION IS BEING COMPUTED
  R           R-HAT           NORM. R-HAT
  0        0.1222E -3          0.1000E  1
  1        0.1051E -3          0.8606E  0
  2        0.7683E -4          0.6288E  0
THE DENOMINATOR OF SINE FUNCTION BELOW 1.0E-06 ENCOUNTERED IN INF
  K          GKC(K)           GKCP(K)
  0        0.9823E -2          0.9823E -2
  1        0.1088E -2          0.2721E -1
  2       -0.2710E -3         -0.6776E -2
  K          GKCP(K)          GKC3P(K)
  0        0.9823E -2          0.9823E -2
  1        0.2721E -1          0.2725E -1
  2       -0.6776E -2         -0.6815E -2
  K          GKC3P(K)              GH(K)
  0        0.9823E -2          0.1853E -1
  1        0.2725E -1          0.1437E -1
  2       -0.6815E -2          0.1022E -1
   R          AVERAGE R-HAT
  0        0.1104E -3
  1        0.8971E -4
  2        0.5892E -4
  K          AVERAGE GH(K)
  0        0.1963E -1
  1        0.1601E -1
  2        0.1239E -1
 STANDARD DEVIATION FOR R-HAT     0.108849E -3
 STANDARD DEVIATION FOR G-HAT     0.199434E -1
 ERROR FOR R-HAT     0.628445E -4
 ERROR FOR G-HAT     0.115143E -1
 STOP
 R
```

```
TYPE SP16
C       FILE SP16=AVG
C       PROGRAMMER NAME: S.P. SINGH
C       REVISION: 0
C       DATE: 3/6/79
C       PURPOSE: THIS MODULE COMPUTES THE RAW MEAN OF THE DATA.
        COMPILER NOSTACK
        SUBROUTINE AVG(ITEMP,ICHR,NR,NP,RAWM)
C       SP16 IS AVG
        REAL ISUM
        DIMENSION ITEMP(1000),NP(50)
        CALL FOPEN(ICHR,"RD",2000)
        INP=0
        ISUM=0
C
C       SUM ALL THE POINTS IN THE FILE
C
        DO 10 I=1,NR
        CALL READR(ICHR,I,ITEMP,1,IER)
        NPI=NP(I)
        DO 20 J=1,NPI
        ISUM=ISUM+ITEMP(J)
20      CONTINUE
        INP=INP+NPI
10      CONTINUE
        RAWM=ISUM/INP
        TYPE "RAW MEAN = ",RAWM
        CALL FCLOS(ICHR)
        RETURN
        END
R
```