APPENDIXES

APPENDIX A

HOSPITAL INVENTORY MANAGEMENT SURVEYS

Reference was made in chapter four to surveys undertaken by this writer. Detailed evaluations of the results have been published: Crowe (1973, 1976). This appendix shows results of bivariate and multivariate studies performed upon the data.

Questionnaires were despatched to Canadian and American medium and large size hospitals: a copy of the 1975 version is included. The objective was to obtain an indication of the extent to which modern inventory and supplies management is utilised by hospitals.

Table 59 shows results of the 1972 survey, and table 61 gives a similar presentation for the 1975 study.

In order to discover how general hospital values are associated with inventories, a multiple regression analysis programme was run; results are shown in tables 60 and 62 for the two years.

MODERN INVENTORY MANAGEMENT

IN HOSPITALS

1975

* *

1. Name and Location of Hospital ____________________

   ____

2. Bedsize: ____________________

3. Average $ value of inventory of stores items: ____________________

4. Approximate number of stores items maintained: ____________________

5. What is your "holding costs" estimate (stores overheads, depreciation, interest etc.) ____________________
   % of annual average inventory

6. How much does it cost to place an order? ____________________

7. When considering a reorder, do you:

   Reorder at a regular interval ____________________

   Use a two-bin system ____________________

   Decide by experience ____________________

   Base it upon 'normal usage' plus safety stocks ____________________

   Use a calculated reorder point ____________________

8. How do you determine the quantity to order?

   Your estimate of likely usage ____________________

   EOQ, using a computer ____________________

   EOQ, by tables, manually or by nomograph ____________________

   Request by major using department ____________________

   Standard call-forward quantity (contract) ____________________

Dataphone or other direct system ______________

Other ______________

9. Do you have access to a computer for inventory control?

To print stock status reports ______________

To calculate EOQ ______________

To calculate discounts ______________

To prepare orders and other documents ______________

Other ______________

10. Is any statistical calculation used to assist in estimating future requirements:

No specific techniques used ______________

Simple average of past usage ______________

Moving average ______________

Exponential Smoothing ______________

Box Jenkins ______________

Other ______________

11. If you use Exponential Smoothing:

Is single smoothing used ______________

Trend adjustment ______________

Seasonal adjustment ______________

Fully adaptive, including tracking signals ______________

Other ______________

Table 59

RESULTS OF 1972 SURVEY

Hospital Code	Beds	Expenses ($000)	Admn (00)	Stocks ($000)	Items	Order Costs	Holding Costs	US	FOREC	EOQ	ROP	STA	EXP
						$	%						
A1	488	18938	180	235	2800	0.00	24	0	00100	3	4	1	0
A2	663	24200	200	300	2800	0.00	0	1	10010	2	5	3	0
A3	582	16520	220	179	4700	4.92	23	1	10010	2	4	4	0
A4	580	16300	210	170	1300	0.00	15	0	10000	1	5	2	0
A5	540	25000	144	540	1424	0.00	0	0	11000	8	3	0	0
A6	675	18400	118	380	10400	0.00	0	0	10100	2	4	0	0
A7	960	12100	241	400	2017	18.00	7	0	10000	2	3	3	0
A8	843	26200	231	174	3080	12.00	21	0	00010	3	2	2	6
A9	1157	45284	286	400	1700	0.00	25	0	11110	3	4	2	6
A10	676	20561	193	138	1500	20.00	18	0	11110	5	6	3	6
A11	318	5330	87	70	697	18.00	35	0	11100	3	6	1	6
A12	2239	67874	457	620	10000	35.00	0	0	11000	4	6	1	6
A13	560	25173	186	300	2700	15.00	0	0	00111	3	3	4	6
A14	770	5273	176	120	1300	0.15	3	0	10010	2	1	3	6
A15	1300	16896	24	42	500	0.00	0	0	10100	3	6	0	6
A16	824	23282	210	392	1377	7.75	0	0	00010	8	4	1	6
A17	440	10554	129	60	2600	11.00	0	1	01000	3	6	2	4
A18	549	11604	170	150	2000	0.00	0	0	00010	8	4	0	0
A19	680	28862	192	180	1080	0.00	13	0	11100	3	2	0	0
A20	840	12482	226	150	1600	1.80	0	0	00100	8	2	0	0
A21	540	19901	211	200	1765	5.80	0	0	00100	8	2	2	6

cont. . .

Table 59 cont. . .

Hospital Code	Beds	Expenses ($000)	Admn (00)	Stocks ($000)	Items	Order Costs	Holding Costs	US	FOREC	EOQ	ROP	STA	EXP
						$	%						
A22	650	21440	169	275	3500	5.00	0	0	00100	8	6	2	0
A23	350	9698	114	26	600	0.00	9	0	10000	3	2	2	0
A24	301	10655	142	137	2000	15.00	20	0	10010	2	4	4	0
A25	641	16800	168	225	1750	15.00	24	0	00010	1	2	3	0
A26	784	31494	217	403	9628	1.89	12	0	10110	2	2	2	0
A27	943	40600	211	115	1890	8.50	0	0	00100	2	2	0	0
A28	1300	5140	19	158	1800	0.00	0	0	00100	3	2	1	6
A29	565	21800	150	200	1300	3.00	19	1	00010	1	4	3	0
A30	912	8400	146	170	1360	0.00	7	0	00010	2	3	3	0
A31	536	18427	200	235	1400	0.00	0	0	11110	1	3	2	6
A32	432	21700	141	76	836	0.00	0	0	00110	8	1	1	0
A33	462	15000	106	205	1500	0.00	9	0	00110	3	2	4	0
A34	435	12300	81	540	3000	52.50	10	0	00100	1	2	2	0
A35	319	4951	110	200	5000	2.00	26	0	10100	8	6	0	6
C1	953	11000	229	130	2000	9.50	20	0	11010	8	2	1	0
C2	513	14600	70	200	3200	0.00	0	0	00100	3	2	0	0
C3	900	23800	208	87	770	0.00	0	0	10110	3	3	2	0
C4	633	17400	105	237	3000	0.00	15	0	10100	6	1	2	0
C5	429	13200	77	190	3600	6.50	16	0	11110	8	3	3	0
C6	560	16200	110	62	1300	0.00	0	0	00010	3	4	1	0
C7	1761	49000	345	200	1100	2.55	22	0	00010	2	4	3	0
C8	955	25300	194	500	3000	0.00	0	0	00010	3	2	2	0

cont. . .

Table 59 cont. . .

Hospital Code	Beds	Expenses ($000)	Admn (00)	Stocks ($000)	Items	Order Costs	Holding Costs	US	FOREC	EOQ	ROP	STA	EXP
						$	%						
C9	470	10700	62	75	1600	0.00	20	0	10010	1	2	2	0
C10	709	10700	94	203	4000	0.00	0	1	10010	3	2	0	0
C11	500	13300	84	110	2990	10.15	0	0	00010	1	2	0	4
C12	870	13800	176	600	8000	0.00	6	0	10100	1	2	3	0
C13	500	11800	73	55	1800	2.50	20	0	00110	3	2	2	0
C14	348	6830	80	100	5500	0.00	14	0	10010	2	2	0	6
C15	574	14100	92	83	1750	0.00	0	1	00010	8	2	2	0
C16	322	6805	91	219	3000	2.00	14	0	10000	5	2	2	6
C17	850	17100	188	130	3450	0.00	0	0	00000	9	2	0	0
C18	593	16300	160	800	6000	11.00	0	0	10010	3	1	2	2
C19	400	12000	59	30	3300	8.00	8	0	11011	6	4	2	0
C20	1044	33000	260	225	1800	5.00	17	0	10000	3	4	4	0
C21	615	16500	138	256	3062	4.00	10	0	10000	3	1	1	0
C22	640	21100	116	128	738	0.00	10	0	11000	8	2	1	0
C23	800	27600	265	120	1300	7.00	24	1	10000	3	4	4	0
C24	894	18200	199	316	6000	0.00	15	0	10000	3	1	0	0
C25	800	19500	181	240	4000	0.00	0	0	10000	3	2	3	0
C26	979	22200	190	638	10000	0.00	40	0	11110	5	2	1	0
C27	343	12300	108	42	1270	0.00	0	0	00100	3	2	4	0
C28	400	5800	76	181	2350	0.00	0	0	00010	3	5	3	0
C29	340	10000	52	63	812	9.79	0	0	10111	8	4	3	4
C30	546	10500	139	100	2000	7.50	11	0	10000	2	4	1	0

NOTES TO TABLE 59

1.	Expenses $000:	total 1971 budgetary expenditure	
2.	Admn:	number of admissions 1971	
3.	Stocks $ and Items:	reported inventory value, for the given number of items held	
4.	Holding Costs:	Percentage holding costs. Zero represents an unanswered question.	
5.	US:	1 indicates that an analysis by value is produced.	
6.	FOREC:	1 indicates a method used for forecasting:	
		by purchasing manager's experience	
		user dept. estimation	
		based on normal usage & safety stocks	
		use of statistical techniques	
		other methods	
7.	EOQ:	How is order quantity determined?	Code
		EOQ via slide rule or nomograph	1
		EOQ via computer programme	2
		PM or stores mgr. estimation	3
		Major user dept. estimation	4
		Std. release qty. contract	5
		Dataphone	6
		Other	7
		More than one method	8
		Not entered on form	9
8.	ROP:	To place a reorder:	
		Low shelf stock	1
		Stock cards approach minimum	2
		Regular review period	3
		ROP formula	4
		Other	5
		More than one	6
9.	STA:	Statistical methods for demand:	
		Simple averaging	1
		Trend adjustment	2
		Seasonal adjustment & trend	3
		Method of moving average	4
		Exponential smoothing	5
		Other	6
		Not entered	0

10. EXP: If exponentially weighted:

10. EXP:	If exponentially weighted:	
	Single smoothing	1
	Trend	2
	Seasonal	3
	Adaptive with tracking signal	4
	Other	5
	Not entered	0, 6

The analysis was based upon the dependent variable '$ value of stocks held', termed VARB. Variables were added in a hierarchial manner from VARD through to VARE, the choice of sequence being made subjectively. The F values suggest that only the VARD variable has significant impact on the value of stocks held; this is in no way surprising. A bivariate analysis carried out confirmed that of all pairings with VARB, value of stocks were most highly associated.

Research was attempted to discover whether any relationship could be identified between admissions, and subsequent demand for food, medical, surgical and other supplies. Hospital records did not permit the tracing of patients at all stages of their stay; it was not feasible to determine the requirements of even routine, uncomplicated cases.

Table 60

MULTIPLE REGRESSION ANALYSIS

1972 SURVEY

	Variable	R^2	B	F
VARB	$ Value, stock items			
VARD	Stock items held	.3284	.4134	32.083
VARC	Annual budget	.3939	.0208	0.638
VARA	Rated bed allocation	.3976	.2458	0.117
VARE	Inpatient Admissions	.4104	3.8795	1.282
Constant			-90.8105	

Table 61

RESULTS OF 1975 SURVEY

Hospital Code	Beds	Budget ($000)	Admissions (00)	Stocks ($000)	Items	Order Costs	Holding Costs	EOQ	ROP	STA
						$	%			
C1	766	17600	207	350	1500	14.00	16	1	4	1
C2	560	9850	156	200	2000	20.00	20	8	4	1
C3	550	10506	178	200	4800	22.00	20	1	4	1
C4	457	6100	98	53	2000	10.00	8	3	4	1
C5	394	5760	90	16	650	8.00	16	3	4	1
C6	409	11373	144	300	341	20.00	16	8	1	7
C7	238	4050	59	196	2560	3.50	24	1	4	7
C8	600	16700	191	75	2200	15.00	8	8	3	1
C9	433	5855	85	120	2500	8.50	8	8	4	1
C10	678	12986	203	165	2000	11.00	16	1	4	1
A1	682	38300	206	300	2200	16.00	5	2	4	4
A2	518	12232	177	125	1400	16.00	15	2	4	1
A3	305	10540	113	240	2200	16.00	15	4	4	1
A4	332	12800	86	175	1200	16.00	15	4	4	4
A5	601	22750	31	60	1800	16.00	7	3	4	1
A6	820	28700	261	119	1400	8.00	10	8	2	1
A7	500	39026	95	600	2100	40.00	16	2	4	7
A8	389	12570	148	210	1278	16.00	16	8	4	4
A9	665	27700	246	92	700	12.00	16	1	3	4
A10	487	15200	143	120	1051	5.63	33	1	4	1
A11	431	17477	153	500	2400	13.29	16	3	2	7
A12	376	13453	119	60	1900	11.00	12	1	4	7
A13	432	13636	135	78	740	15.00	33	1	4	1
A14	500	18425	162	75	900	10.00	20	7	4	7
A15	650	16580	167	150	350	3.00	1	7	4	7
A16	469	9917	169	163	2000	16.00	16	1	1	7
A17	650	25600	147	610	2600	25.00	16	4	4	7
A18	666	40470	168	230	700	35.00	16	2	1	4
A19	360	14633	125	196	1650	19.00	16	8	4	1

NOTES TO TABLE 61

1. EOQ: How is order quantity determined?

EOQ via slide rule or nomograph:	1
EOQ via computer programme	2
PM or stores mgr. estimation	3
Major user dept. estimation	4
Std. release qty. contract	5
Dataphone	6
Other	7
More than one method	8

2. ROP: To place a reorder

Low shelf stock	1
Normal usage & safety stock	2
Regular review period	3
ROP formula	4
Other	5

3. STA: If use statistical methods for demand forecasting:

Simple averaging	1
Box-Jenkins method	2
Seasonal adjustment & trend	3
Method of moving average	4
Exponential smoothing	5
Other	6
Not entered	7

Results shown in table 62 are derived from a small sample of 29 hospitals, compared with 64 in the 1972 survey. At every stage of the procedure of introducing new variables, the F values were much smaller. Limited conclusions can be drawn, since the hospitals differed, though broadly from the same population. There is some evidence that stores holdings in 1975 were more influenced by budgetary considerations than in 1972. If this were true, the implications for improved inventory management would be substantial and important.

Table 62

MULTIPLE REGRESSION ANALYSIS

1975 SURVEY

	Variable	R^2	B	F
VARB	$ Value, stock items			
VARD	Stock items held	.0768	.5854	.3493
VARC	Annual budget	.3000	.0976	.6300
VARA	Rated bed allocation	.3393	-2.9321	-.2770
VARE	Inpatient Admissions	.3400	1.0908	.0380
Constant			694.1309	

A bivariate analysis performed on the 1975 data involved all possible pairs of variables. Two pairs were shown to have relationships of significance - bed rating and value of budget (as in 1972), and annual budget and stocks held.

Inventory investment is a function of the numerous complex demands of diverse sectors of the hospital, subject only to overall budgetary restraints. It seems unlikely that close examination of individual variable behaviour would be profitable as an aid to demand forecasting.

APPENDIX B

PROBABILITY DISTRIBUTION IDENTIFICATION: GOODNESS OF FIT

In chapter five, methods of testing demand data for goodness of fit were described, and the computer programme GOF prepared by Phillips (1972) was used. This allows the experimenter to test any series of data for possible fit with one of several probability distributions.

The programme is included in this appendix, together with examples of output. The first uses forecasting errors arising from use of the SIMPAVE programme with item six, face tissues data. Two tests were run using the null hypothesis for normal and exponential distributions. Kolmogorov-Smirnov statistics were 0.0484 and 11.8206 respectively, the former supporting the null hypothesis and the latter causing rejection of the appropriate hypothesis. A test for biased measures of normality using sample moments (skewness and kurtosis) also supported the normal distribution hypothesis, as did the computed chi-square value.

The second series of output, item 43 Gypsona bandages, consists of Cramér-von Mises tests for exponential and normal distributions, and a Kolmogorov-Smirnov test for lognormal distribution. Use of tables of critical values suggests that the underlying probability may be lognormal.

The GOF programme is easy to use, and if sufficient evidence were found from sample data to identify distributions for individual or groups of items, added accuracy would be gained when preparing forecasts of demand.

```
$JOB          .PAGES=400.TIME=720
C
C
C
C
C                               PROGRAMME  GOF
C                              * * * * * * * *
C
C                        APPLIED GOODNESS OF FIT TESTING
C                       * * * * * * * * * * * * * * * * *
C
C                        D.T.PHILLIPS, PURDUE UNIVERSITY
C                       * * * * * * * * * * * * * * * * *
C
C
C                               A.I.I.E.  1972
C                              * * * * * * * *
C
C
C                            USING THE PROGRAMME.
C                            - - - - - - - - - -
C
C                                  INPUT
C                                 * * * *
C
C                              DATA CARD ONE
C   NDATA DCODE CHISQ KANDS CANDM THEORY NCELS MOMT IBIAS DON
C     I5    I5    I5    I5    I5    I5    I5    I5    I5   A6
C
C                              DATA CARD TWO (+)
C
C          EIGHT VALUES PER CARD. MAX = 500 CARDS
C
C                              DATA CARD  THREE
C
C          ONLY USED IF THEORY GT. ZERO. IF DCODE BETWEEN 1 AND7
C          XBAR (F10.2).           VAR (F10.2)
C                                         IF DCODE  8. XHIGH (F10.2)
C          XLOW (F10.2) AND XPEAK(F10.2).
C
C                              DATA CARD FOUR
C
C          A BLANK TRAILER CARD ENDS DATA SET
C
C                           CAUTIONS IN USING GOF:
C
C          1.POISSON: ONLY REQUEST IF DATA SEEMS LIKELY TO FIT
C                     AND NOT MANY OUTLIERS
C          4.GAMMA  :              DITTO
```

```
C                    5.WEIBULL:                DITTO
C                    6.CHISQUARE: DO NOT REQUEST IF FEWER THAN 30 ITEMS.
C                    7.LOGNORM: AVOID IF DATA CONTAINS ZEROS.
C                    8. TRIANG: DIFFICULT TO USE.
C
C                    ERRORS WITHIN THE PROGRAMME ASSOCIATED
C                    WITH GAMMA, WEIBULL ETC., HAVE NOT BEEN
C                    CORRECTED. BUT CAN BE DONE AS REQUIRED.
C
C                           THE MAIN PROGRAMME
C                           * * * * * * * * * *
```

```
C
      CCMMON X(500),XCELS(500),PXCELS(500),YCELS(500),ZCELS(500)
       COMMON ZZCELS(500),FROM(500),TO(500)
       CCMMCN NDATA,DCODE,XMAX,XMIN,J50
       COMMON A,NCELS,JUMP
       CCMMON XM(10),XJAY(10),GAMM1,GAMM2,BETA1,BETA2,Z(10)
      REAL*8 GSER, DBLE
       INTEGER DCODE,CHISQ,CANDM,THEORY, DON1,DON2,AL1, AL2
       DATA AL1,AL2/4HNORM,2HAL/
C                                INPUTS AND PRINTING HEADINGS
C                               - - - - - - - - - - - - - - - -
C
  101 READ 209,NDATA,DCODE,CHISQ,KANDS,CANDM,THEORY,NCELS,MOMT,
     1 IBIAS,DON1, DON2
       JUMP = NCELS
      IF(NDATA.EQ.0) GO TO 182
       PRINT 231
  231 FORMAT('1',56X,'G O F'/56X,'* * * *'/43X,'TESTING DATA FOR GOJDNES
     1S OF FIT'/42X,'* * * * * * * * * * * * * * * *'/)
       READ 207,(X(I),I=1,NDATA)
       PRINT 210,(X(I),I=1,NDATA)
C                INITIALIZE VARIABLES
      IF (NCELS.EQ.0) NCELS=15
       BIAS = IBIAS
       XNDATA = NDATA
       NDATA1 = NDATA+1
       DO 102 I=1,NDATA1
       XCELS(I)= 0.0
      PXCELS(I)=0.0
       YCELS(I)=0.0
       ZCELS(I)=0.0
       ZZCELS(I)=0.0
       FROM(I)=0.0
       TO(I)=0.0
  102 CONTINUE
       DEV3=0.0
       DEV2=DEV3
       DEV1=DEV2
       SUMXX= DEV1
       SUMX= SUMXX
       SUMBR = SUMX
       SUMDV1=SUMBR
      IF(MOMT.GT.0.AND.DCODE.NE.6) GO TO 167
C                ARRANGE DATA IN NUMERICAL ORDER, THEN PRINT IT OUT
  103 DO 105 K=1,NDATA
      DO 105 L=K,NDATA
      IF (X(K).GT.X(L)) GO TO 104
      GC TO 105
  104  AA = X(K)
```

```
          X(K)=X(L)
          X(L)=AA
   105  CONTINUE
          XMIN = X(1)
          XMAX = X(NDATA)
          PRINT 211,(X(I),I=1,NDATA)
C                SUBROUTINE HIST PRINTS HISTOGRAM. VARIABLE NOBS IN
C                THIS SUBROUTINE IS FOR NUMBER OF SAMPLES AND NOT
C                APPLICABLE SINCE SUB. IS IN A DO-LOOP OF EACH SAMPLE.
          CALL HIST
C                IF YOU KNOW THE PARAMETERS OF THE UNIVERSE,READ THEM
```

```
C                IN. IF NOT.ESTIMATE BY COMPUTING SAMPLE MEAN, VAR.
C                THEN PRINT THEM OUT.
          IF (DCODE.EQ.8) GO TO 107
          IF(THEORY.GT.0) GO TO 106
          GO TO 108
  106     READ 212,XBAR,VAR
          GO TO 108
  107     IF (THEORY.EQ.0) GO TO 114
          READ 212,XHIGH,XLOW,XPEAK
          GO TC 118
  108     IF(DCODE.NE.6) GO TC 113
          DC 110 I=1,NDATA
          DT=X(I)
          IF (DT.NE.0.0) GO TO 109
          X(I)= -10.0
          PRINT 183
          GO TO 110
  109     X(I)= ALOG(DT)
  110    CONTINUE
          IF (XMIN.EQ.0.0) GO TO 111
          XMIN= ALOG(XMIN)
          GO TO 112
  111    XMIN = -10.0
   112    XMAX= ALOG(XMAX)
          PRINT 184
          PRINT 185, (X(I),I=1,NDATA)
           IF(MOMT.GT.0) GO TC 167
          IF(THEORY.GT.0) GO TO 117
  113     IF (THEORY.GT.0) GO TO 118
  114      DO 115 I=1,NDATA
  115    SUMX=X(I) + SUMX
          XBAR = SUMX/XNDATA
          DO 116 I=1,NDATA
  116    SUMXX=(X(I)-XBAR)**2 + SUMXX
          VAR=SUMXX/(XNDATA-1.0)
         IF(DCCDE.EQ.6) GO TO 119
         IF(THEORY.GT.0) GO TC 118
          PRINT 215,XBAR,VAR
          GC TC 119
  117    TBAR=XBAR
          TVAR=VAR
          XBAR=ALOG(RBAR)-(VAR/2.0)
          VR=(RBAR**2 +RVAR**2)/(RBAR**2)
          VAR = ALOG(VR)
  118     PRINT 214,XBAR,VAR
  119     BXBAR=XBAR
         IF(DCODE.EQ.1.AND.XMIN.GT.0.0) GO TO 120
          GO TC 122
  120     DO 121 I=1,NDATA
```

```
121   X(I)=X(I)-XMIN
      XBAR=XBAR-XMIN
      XMIN=X(1)
      XMAX=X(NDATA)
      PRINT 186,XBAR,BXBAR
122   PRINT 187
      PRINT 188,DON1,DON2, XBAR,DON1,DON2, XBAR
      PRINT 187
     IF(DCODE.LE.3.OR.DCODE.GE.6) GO TO 123
      ALPHA=(XBAR**2)/ VAR
      IF(DCODE.EQ.4.AND.ALPHA.GT.30.0) GO TO 181
```

```
      BETA=XBAR/ALPHA
      IF(DCODE.EQ.5) CALL EST (NDATA,WALPHA,WBETA)
  123 PRINT 213,NDATA
C              COUNT THE XCELS(I) VALUES.
  124 IF(DCODE.EQ.1)NCELS=XMAX+1.0
      J=NCELS
      J50= NCELS
      CALL CELL(J)
      IF(JUMP.GT.J) PRINT 189,JUMP,XMAX
      NCELS=J
      J50=J
      GO TO (132,136,147,125,127,129,138,142),DCODE
  125 A1=X(1)/BETA
      A2=TAMMA(ALPHA)
      YCELS(1)=1.0-(GAMMA(ALPHA,A1)/A2)
      ZCELS(1)=YCELS(1)
      DO 126 I=2,J50
      A1=TO(I)/BETA
      ZCELS(I)=1.0-(GAMMA(ALPHA,A1)/A2)
  126 YCELS(I)=ZCELS(I)-ZCELS(I-1)
      GO TO 149
  127 A1=X(1)
      A2=WALPHA*A1**WBETA
      YCELS(1)=1.0-(1.0/EXP(A2))
      ZCELS(1)=YCELS(1)
       DO 128 I=2,J50
      A1=TO(I)
      A2=WALPHA*A1**WBETA
      ZCELS(I)=1.0-(1.0/EXP(A2))
  128  YCELS(I)=ZCELS(I)-ZCELS(I-1)
      GO TO 149
  129 IF(THEORY.GT.0) GO TO 130
      CAN=XBAR+0.50*VAR
      TBAR=EXP(CAN)
      CAN=2.0*CAN
      BAN=EXP(VAR)-1.0
      TVAR=EXP(CAN)*BAN
      FROM(1)=XMIN
     IF (THEORY.GT.0) GO TO 130
      PRINT 215,TBAR,TVAR
      GO TO 131
  130 PRINT 214,TBAR,TVAR
  131 CONTINUE
      GO TO 147
C              IF YOU ARE WORKING WITH POISSON, CALC. THEORETICAL
C              FREQUENCIES FOR EACH CELL(YCELS) AND CUMULATIVE
C              FREQUENCIES(ZCELS).
  132  J7=XMAX+1
      YCELS(1)=EXP(-XBAR)
```

```
      K=J
       CALL OVERFL(K)
     IF(K.EQ.1) YCELS(1)=2.0**24
      ZCELS(1)=YCELS(1)
      YCELS(2)=XBAR*YCELS(1)
      ZCELS(2)=YCELS(1)+YCELS(2)
      DO 133 I=3,J7
      JJ=I-1
      XI=JJ+0.00001
      YCELS(I)=YCELS(JJ)*(XBAR/XI)
  133 ZCELS(I)=YCELS(I)+ZCELS(JJ)
```

```
      IF(JUMP.EQ.0) GO TO 149
      DO 135 L=1,JUMP
      I5=FROM(L)+1.00001
       I6=TO(L)+1.00001
      TIM=0.0
      DO 134 I=I5,I6
  134  TIM=YCELS(I)+TIM
      YCELS(L)=TIM
  135 ZCELS(L)=ZCELS(I6)
      GC TC 149
C              IF WORKING WITH EXPONENTIAL, CALC. THEORETICAL
C              FREQUENCIES FOR EACH CELL (YCELS), THEN CUM.
C              FREQUENCIES (ZCELS).
  136 TBAR=1.0/XBAR
      RDE=-TBAR*TO(1)
      YCELS(1)=1.0-EXP(RDE)
      ZCELS(1)=YCELS(1)
      DC 137 I=2,J50
     ZCELS(I)=1.0 -EXP(-(TBAR*TO(I)))
  137 YCELS(I)=ZCELS(I)-ZCELS(I-1)
      GO TO 149
C              CONTINUOUS UNIFORM
   138 IF(THEORY.EQ.0) GO TO 139
      D3= 12.0 *VAR
       A=XBAR-SQRT(D3)
      B=2.0*XBAR-A
      GO TO 140
  139 B=XMAX
       A=XMIN
  140 YCELS(1) = (TO(1)-A)/(B-A)
      ZCELS(1)=YCELS(1)
      FROM(1)=A
      TC(NCELS)=B
      DO 141 I=2,NCELS
      ZCELS(I)=(TO(I)-A)/(B-A)
  141 YCELS(I)=ZCELS(I)-ZCELS(I-1)
      GO TO 149
C              ...TRIANGULAR DISTRIBUTION
  142 IF(THEORY.GT.0) GO TO 143
      XHIGH=XMAX
      XLOW=XMIN
      XPEAK=(3.0**XBAR)-XHIGH-XLOW
  143 B1=XHIGH-XLOW
      B2=XPEAK-XLOW
      B3=XHIGH-XPEAK
      FROM(1)=XLOW
      TO(NCELS)=XHIGH
      DO 146 I=1,NCELS
      T1=TC(I)
```

```
      IF(XPEAK.EQ.XLOW.OR.T1.GT.XPEAK) GO TO 145
      B4=TC(I)-XLOW
      ZCELS(I)=B4**2/(B1*B2)
     IF(I.EQ.1) GO TO 144
      YCELS(I)=ZCELS(I)-ZCELS(I-1)
      GO TO 146
 144  ZCELS(1)=YCELS(1)
      GO TO 146
 145  B4= TO(I)-XHIGH
      ZCELS(I)=1.0-(B4**2/(B1*B3))
     IF(I.EQ.1) GO TO 144
```

```
          YCELS(I)=ZCELS(I) - ZCELS(I-1)
  146     CCNTINUE
          GC TO 149
C                 IF WORKING WITH NORMAL, CALC. THEORETICAL FREQUENCIES
C                 FOR EACH CELL (YCELS) AND CUMULATIVE FREQ. (ZCELS).
  147       AI=(X(1)-XBAR)/SQRT(VAR)
          YCELS(1)=ERF(AI)
          ZCELS(1)=YCELS(1)
          DO 148 I=2,J50
          AI=(TC(I)-XBAR)/SQRT(VAR)
          ZCELS(I)=ERF(AI)
  148     YCELS(I)=ZCELS(I)-ZCELS(I-1)
C                 NOW DO THE TESTING
   149     IF(KANDS.GT.0)  GO TO 152
  150     IF(CANDM.GT.0) GO TO 156
  151     IF(CHISQ.GT.0) GO TC 158
          GO TO 170
C                 DO KOLMOGORCV-SMIRNOV TEST
  152     IF(DCODE.EQ.1) JF=J
          IF(DCODE.NE.1) JF=J50
          PRINT 216
          PRINT 217
          DO 153 I=1,JF
  153     PXCELS(I)=XCELS(I)/XNDATA
          ZZCELS(1)=PXCELS(1)
          DC 154 I=2,JF
          K=I-1
  154     ZZCELS(I)=PXCELS(I)+ZZCELS(K)
          DEV2=ABS(ZCELS(1)-ZZCELS(1))
         PRINT 218,FROM(1),TO(1),XCELS(1),                  ZZCELS(1),YCELS(1),
        1 ZCELS(1),DEV2
             DO 155 I=2,JF
          DEV=ABS(ZCELS(I)-ZZCELS(I))
           IF(DEV.GT.DEV2)DEV2=DEV
  155    PRINT 219,I,FROM(I),TO(I),XCELS(I),                 ZZCELS(I),
        1YCELS(I),ZCELS(I),DEV
            PRINT 220,DEV2
          PRINT 192,NCELS
          GO TO 150
C                 DO CRAMER- VON MISES TEST
  156     PRINT 225
          PRINT 226
          FIRST=1.0/(12.0*XNDATA)
         BR=(((1.0)/(2.0*XNDATA)-ZCELS(1))**2)
          PRINT 208,X(1),ZCELS(1),BR
          L=1
          SUMBR=BR
          DC 157 I=2,NDATA
          K=I-1
```

```
          IF(X(I).NE.X(K))L=L+1
           BR=((((2.0*I)-1.0)/(2.0*XNDATA)-ZCELS(L))**2)
           SUMBR=BR+SUMBR
    157    PRINT 227,I,X(I),ZCELS(L),BR
           DEV3=SUMBR+FIRST
           PRINT 228,DEV3
           GO TO 151
C                  BEFORE THE CHI-SQUARE TEST,GROUP DISTRIBUTIONS
C                  (THEORETICAL OR EXPECTED) SO EACH CELL HAS FREQ. OF
C                  AT LEAST FIVE
    158   IF(DCODE.GT.1)J=J50
```

```
           TO(J)=999.999
           DO 159 I=1,J
  159      YCELS(I)=YCELS(I)*XNDATA
           TAIL=XNDATA-ZCELS(J)*XNDATA
           YCELS(J)=YCELS(J)+TAIL
  160      JJ=J
           DO 162 NM=1,JJ
           IF(YCELS(NM).GE.5.0) GO TO 162
           IF(NM.EQ.J) GO TO 161
           CALL FIX(NM,J)
           GO TC 160
  161     CALL ENDRN(NM,J)
           GO TO 160
  162      CONTINUE
          IF(THEORY.GE.0.0) DEGRF=J
          IF(THEORY.LE.0.0.AND.DCODE.EQ.1.0.OR.DCODE.EQ.2) DEGRF=J-2
          IF(THEORY.LE.0.0.AND.DCODE.GE.3) DEGRF=J-3
          IF(DEGRF.LT.4.0)GO TC 164
          IF(JUMP.GT.J) GO TO 163
           GO TO 165
  163     PRINT 190
           GO TO 165
  164     PRINT 191
          GO TO 170
C                  DO CHI-SQUARE TEST
  165     PRINT 221
           PRINT 222
           DO 166 I=1,J
           OBS=XCELS(I)
           EX=YCELS(I)
           DEV1=  (((OBS-EX)**2)/EX)
           SUMDV1=SUMDV1+DEV1
  166      PRINT 223,I,FROM(I),TO(I),OBS,EX,DEV1
           DEV1=SUMDV1
           PRINT 224,DEV1
           JFREE=DEGRF
           PRINT 192,JFREE
           GC TC 170
  167      CALL MOMENT(BIAS)
           PRINT 193
C                  MOMT: IF POSITIVE,RUN MOMENTS TEST
C                  BIAS: IF POSITIVE,USE BIASED ESTIMATE
C                  IF AT OR BELOW ZERO, USE UNBIASED ESTIMATE
           PRINT 194
          IF(BIAS.GT.0.0) GO TC 168
           PRINT 195,GAMMA1,GAMMA2
           GC TO 169
  168     PRINT 196,BETA1,BETA2
  169     IF(DCODE.EQ.6)GO TO 113
```

```
      IF(KANDS.GT.0)  GO TO 103
      IF(CHISQ.GT.0)  GO TC 103
      IF(CANDM.GT.0)  GO TO 103
  170 PRINT 197,DON1, DON2
       GO TO (171,173,174,175,176,177,178,179),DCODE
  171 IF(XBAR.NE.BXBAR)GO TO 172
       PRINT 198,XBAR
       GO TO 180
  172 PRINT 199,XBAR,BXBAR
       GC TO 180
  173  PRINT 200,XBAR
```

```
      GO TO 180
  174 PRINT 201,XBAR,VAR
      GO TO 180
  175 PRINT 202,ALPHA,BETA
      GO TO 180
  176 PRINT 203,WALPHA,WBETA
      GO TO 180
  177 PRINT 204,TBAR,TVAR
      GO TO 180
  178 PRINT 205,XMAX,XMIN
      GO TO 180
  179 PRINT 206,XHIGH,XLOW,XPEAK
  180 GC TC 101
  181 PRINT 229,ALPHA
      DCODE=3
      DCN1 = AL1
      DON2 = AL2
      PRINT 187
      PRINT 188,DON1,DON2,XBAR,DON1,DON2,XBAR
      PRINT 187
      GC TC 124
  182 CONTINUE
      CALL EXIT
C
C                         HEADINGS AND MESSAGES
C                         * * * * * * * * * * * *
C
  183 FORMAT(//,'LOGNORMAL DISTRIBUTION IS NOT DEFINED AT X=0'/10X,'HOWE
     1VER,TEST CONTINUES WITH LN(0)=-10.0',//)
  184 FORMAT(////28X,'THE LOGNCRMAL TEST USES TRANSFORMED DATA OF THE FO
     1RM Y=LN(X)' ///)
  185 FCRMAT(///50X,'TRANSFORMED DATA'//,(20X,10F8.3))
  186 FORMAT(///,'ALL GOODNESS OF FIT TESTS WILL USE TRANSFORMED DATA..
     1DATA IS ASSUMED POISSON WITH LAMDA=',F10.2/10X,'ORIGINAL MEAN WAS
     2LAMDA=',F10.2)
  187 FORMAT(//, 42X, 16('* ') )
  188 FORMAT(///,49X,'HYPOTHESIS STATEMENT',//,26X,'NULL HYPOTHESIS : PO
     1PULATION IS',2X,A4,A2,2X,' ;TRUE MEAN =',2X, F8.2,/,20X,'THE ALTER
     2NATE HYPOTHESIS: ',2X,'THE POPULATION IS NOT',2X,A4,A2,2X,' ;TRUE
     3MEAN =',2X, F8.2)
  189 FORMAT(//,23H DATA WILL NOT SUPPORT ,I5,21H CELLS....XMAX ONLY= ,
     1F10.2,16H TEST CONTINUES ,//)
  190 FORMAT(//,40H NOT ENOUGH DATA FOR CELL SPECIFICATION ,//)
  191 FORMAT(///,31X,'CHI SQUARE TEST CANNOT BE RUN......INSUFFICIENT DA
     1TA'///)
  192 FORMAT('0',45X,'DEGREES OF FREEDOM =',I5)
  193 FORMAT(//,40X,'TEST FOR NORMALITY USING SAMPLE MOMENTS',/// )
  194 FCRMAT(/37X,'NULL HYPOTHESIS (POPULATION IS NORMAL)'//33X,'ALTERNA
     1TE HYPOTHESIS (POPULATION IS NOT NORMAL)'///)
```

```
195  FORMAT( 31X,'UNBIASED MEASURE OF SKEWNESS IS GAMMA1=',F9.2,///,32X
    1,'  UNBIASED MEASURE OF KURTOSIS IS GAMMA2=',F9.2,////)
196  FORMAT(31X,'BIASED MEASURE OF SKEWNESS  : BETA1 =',F8.2,///,32X,'
    1 BIASED MEASURE OF KURTOSIS  : BETA2 =',F8.2,////)
197  FORMAT(///,37X,'PARAMETERS OF THE',2X,A4,A2,2X,'DISTRIBUTIONS',
    1 ///)
198  FORMAT(9X,'LAMDA : ',F12.2)
199  FORMAT(9X,'GOODNESS CF FIT TEST USED TRANSFORMED DATA WITH LAMDA='
    1,F12.2/9X,'TRUE MEAN :LAMDA = ',F10.2)
200   FORMAT( 47X,'THETA =', F12.2 )
201   FORMAT(38X, 'MU =', F12.2,2X, 'SIGMA =',F12.2)
```

```
  202 FORMAT(9X,'ALPHA =',F12.2,1X,'BETA =',F12.2)
  203 FORMAT(5H FEE=,F15.2,4H SI=,F15.2)
  204 FORMAT( 37X,'MUT=', F13.2,'   SIGMAT2=',F13.2)
  205 FORMAT(3H B=,F16.5,3H A=,F16.5)
  206 FORMAT(4H XH=,F16.5,4H XL=,F16.5,4H XP=,F16.5)
  207 FORMAT(8F10.2)
  208 FORMAT(37X, 1H1,3(5X,F10.5) )
  209 FORMAT(9I5,A4,A2)
  210 FORMAT('0',51X,'OBSERVED DATA'//,(20X,10F8.0))
  211 FORMAT(////,53X,'ARRAYED DATA'//,(20X,10F8.0))
  212 FORMAT(8F10.2)
  213 FORMAT(//,  45X, 'NUMBER OF OBSERVATIONS=',I5)
  214 FORMAT(18H THEORETICAL MEAN=,F10.5,22H THEORETICAL VARIANCE=,F10.5
     1 )
  215 FORMAT(35X,          'MEAN =',F9.2,2X,'AND CALCULATED VARIANCE =',
     1  1X, F9.2)
  216 FORMAT(///,47X,25HKOLMOGOROV - SMIRNOV TEST,/)
  217 FORMAT('0',10X,'CELLS',8X,'RANGE',13X,'OBSERVED',5X,'CUM.OBSERV. K
     1OLMOGOROV',4X,'THEORET.',6X,'SMIRNOV'/18X,'FROM:',9X,'TO:', 8X,'DE
     2MAND',6X,'FREQUENCY    FREQUENCY',4X,'FREQUENCY',4X,'STATISTIC'/)
  218 FORMAT(10X,'     1', 2(F9.3,4X), F9.2, 4(4X,F9.3) )
  219 FORMAT(10X,I5,2(F9.3,4X),F9.2,4(4X,F9.3) )
  220 FORMAT(//,36X,  'THE KOLMOGOROV - SMIRNOV STATISTIC =',F9.4/)
  221 FORMAT(///,48X,17HCHI - SQUARE TEST,/)
  222 FORMAT(94X,'2'/16X,'CELLS',14X,'RANGE',15X,'CBSERVED',7X,'EXPECTED
     1',7X,'(OBS-EXP)/EXP'/27X,'FROM',15X,'TO'/27X,'(INCLUSIVE)   (EXCLU
     2SIVE)')
  223 FORMAT(15X, I5, 2(5X,F10.4), 2X,F10.4, 5X,F10.4,5X,F10.4)
  224 FORMAT(//,47X,14HCHI - SQUARE =,F10.4)
  225 FORMAT(///,48X,23HCRAMER - VON MISES TEST,//)
  226 FORMAT( 30X,'OBSERVATION',6X,'DATA',12X,'AREA',7X,'STATISTIC')
  227 FORMAT(33X, I5,5X,F10.5,5X,F10.5,5X,F10.5)
   228 FORMAT(/,39X,32HCRAMER VON MISES TEST STATISTIC=,F10.3)
  229 FORMAT(//     'AS ALPHA GETS LARGER,THE GAMMA DENSITY APPROACHES NO
     1RMAL'//  'ALPHA=',E20.4, 'GOODNESS OF FIT TESTING IS SWITCHED TO T
     2HE NORMAL DENSITY'////)
      STCP
       END
C
C                         THE SUBROUTINES SECTOR
C                         ______________________
C

       SUBROUTINE CELL(J)
      COMMON X(500),XCELS(500),PXCELS(500), YCELS(500),ZCELS(500)
       COMMON ZZCELS(500),FROM(500),TO(500)
      COMMON NDATA,DCODE,XMAX,XMIN,J50
      COMMON A,NCELS,JUMP
      COMMON XM(10),XJAY(10),GAMMA1,GAMMA2,BETA1,BETA2,Z(10)
```

```
      INTEGER DCODE,CHISQ,CANDM,THEORY
      IF(DCODE.EQ.1) GO TC 101
      IF(NCELS.EQ.NDATA)GO TO 111
      N=NCELS
       Y=0.0
      XN=NCELS
      WIDTH=(XMAX-XMIN)/XN
      A=XMIN+WIDTH
      GO TO 104
101   DO 102 I=1,NDATA
      IC=X(I)+1.0
```

```
102   XCELS(IC)=XCELS(IC)+1.0
      J=XMAX+1.0
      DO 103 I=1,J
      FROM(I)=I-1
103   TO(I)=I-1
      IF(JUMP.GT.0) GO TO 115
      GO TO 110
104   DC 108 I=1,NDATA
      X1=X(I)-A- 0.0000001
      IF(X1)105,106,106
105  IC=1
      GO TO 107
106   IC=X1/WIDTH+2.0
107  XCELS(IC)=XCELS(IC)+1.0
108  CONTINUE
      Y=A
      DO 109 I=2,N
      FROM(I)=Y
      TO(I-1)=Y
109  Y=Y+WIDTH
      IF(DCODE.NE.3) FROM(1)=0.0
      IF(DCODE.EQ.3) FROM(1)= -999.999
      TO(N) = XMAX
110  RETURN
111  CONTINUE
      IF(DCODE.EQ.3)GO TO 114
      FROM(1)=0.0
      TO(1)=X(1)
112  DO 113 I=2,NDATA
      XCELS(I)=1.0
113  TO(I)=X(I)
     FROM(I)=TO(I)
      XCELS(1)=1.0
      RETURN
114  FROM(1)= -9999.99
      TO(1)=X(1)
      GO TO 112
115  KF=1
116  IF(JUMP.GE.J) RETURN
C                  FIND SMALLEST CELL
      SMALL=XCELS(1)
      NSCELL=1
      DO 117 I=2,J
      KF=KF+1
      IF(XCELS(I).GE.SMALL) GO TO 117
      SMALL=XCELS(I)
      NSCELL=I
117  CONTINUE
      IF(NSCELL.EQ.J)GO TC 118
```

```
      CALL FIX(NSCELL,J)
      GC TO 116
  118 CALL ENDRN(NSCELL,J)
      GO TO 116
      END

      SUBROUTINE FIX(NM,J)
      CCMMON X(500),XCELS(500),PXCELS(500),YCELS(500),ZCELS(500)
      COMMON ZZCELS(500),FROM(500),TO(500)
      COMMON NDATA,DCODE,XMAX,XMIN,J50
      COMMON A,NCELS,JUMP
```

```
      COMMON XM(10),XJAY(10),GAMMA1,GAMMA2,BETA1,BETA2,Z(10)
C               NM = DEFICIENT CELL
C                J  = NO. OF CELLS
        YCELS(NM)=YCELS(NM)+YCELS(NM+1)
        XCELS(NM)=XCELS(NM)+XCELS(NM+1)
        TO(NM)=TO(NM+1)
        NNM=NM+2
        IF(NNM.GT.J) GO TO 102
C               NUMBER OF CELLS AFTER GROUPING
        DO 101 I=NNM,J
        FROM(I-1) =FROM(I)
        TO(I-1) =TO(I)
        XCELS(I-1) =XCELS(I)
  101   YCELS(I-1)=YCELS(I)
        FROM(J) =0.0
        TO(J)= 0.0
  102   J=J-1
        RETURN
        END

       SUBROUTINE ENDRN (NM,J)
       COMMON X(500),XCELS(500),PXCELS(500),YCELS(500),ZCELS(500)
       COMMON ZZCELS(500),FROM(500),TO(500)
      COMMON NDATA,DCODE,XMAX,XMIN,J50
      COMMON A,NCELS,JUMP
      COMMON XM(10),XJAY(10),GAMMA1,GAMMA2,BETA1,BETA2,Z(10)
        DO 101 I=NM,J
        YCELS(I-1)=YCELS(I-1)+YCELS(I)
        XCELS(I-1)=XCELS(I-1)+XCELS(I)
        FROM(I)=FROM(I+1)
        TO(I-1)=TO(I)
  101 CONTINUE
        XCELS(J)=0.0
        YCELS(J)=0.0
        FROM(J) =0.0
        TO(J)   =0.0
        J = J-1
        RETURN
        END

      SUBROUTINE MOMENT(BIAS)
      COMMON X(500),XCELS(500),PXCELS(500),YCELS(500),ZCELS(500)
      COMMON ZZCELS(500),FROM(500),TO(500)
      COMMON NDATA,DCODE,XMAX,XMIN,J50
      COMMON A,NCELS,JUMP
      COMMON XM(10),XJAY(10),GAMMA1,GAMMA2,BETA1,BETA2,Z(10)
        Y1 =0.0
        Y2=0.0
        Y3=0.0
```

```
      Y4=0.0
      YN=NDATA
      XN=NDATA
      DO 101 I=1,NDATA
      Y1=X(I)+Y1
      Y2=X(I)**2+Y2
      Y3=X(I)**3+Y3
  101 Y4=X(I)**4+Y4
      IF(BIAS.LE.0.0)GOTO 102
      Z(1)=Y1/YN
      Z(2)=Y2/YN
```

```
      Z(3)=Y3/YN
      Z(4)=Y4/YN
      XM(1)=0.0
      XM(2)= Z(2)-(Z(1)**2)
      XM(3)= Z(3)-(3.0*Z(2)*Z(1)) +(2.0*Z(1)**3)
      XM(4)= Z(4)-(4.0*Z(3)*Z(1)) +(6.0*Z(2)*Z(1)**2)-3.*Z(1)**4
      GO TO 103
  102 XJAY(1)= Y1/XN
      XJAY(2)= ((XN*Y2)-(Y1**2))/(XN*(XN-1.0))
      XJAY(3)= (((XN**2)*Y3)-(3.0*XN*Y2*Y1)+(2.0*Y1**3))/(XN*(XN-1.0)
     1*(XN-2.0))
      XJAY(4)=((XN**3+XN**2)*Y4-(4.0*((XN**2) +XN)*Y3*Y1)-(3.0*((XN**2
     1)-XN)*Y2**2) +(12.0*XN*Y2*(Y1**2)) -(6.0*Y1**4))/(XN*(XN-1.0)*(XN-
     22.0)*(XN-3.0))
     GAMMA1= XJAY(3)/(XJAY(2)**1.50)
     GAMMA2=(XJAY(4)/(XJAY(2)**2))
      RETURN
  103 BETA1=XM(3)/(XM(2)**1.50)
      BETA2=XM(4)/(XM(2)**2)
      RETURN
      END
C
      SUBROUTINE HIST
      COMMON X(500),XCELS(500),PXCELS(500),YCELS(500),ZCELS(500)
      COMMON ZZCELS(500),FROM(500),TO(500)
      COMMON NDATA,DCODE,XMAX,XMIN, J50
      COMMON A,NCELS, JUMP
      COMMON XM(10),XJAY(10),GAMMA1,GAMMA2,BETA1,BETA2,Z(10)
      DIMENSION JFREQ(30),JOUT(30),ARRAY(500)
       INTEGER FH/'____'/,AST/'*'/,BL/' '/
      INTV=5
      NOBS=NDATA
      IF(NOBS.GE.20)INTV=10
      IF(NOBS.GE.50)INTV=20
      IF(NOBS.GE.200) INTV=30
      AHIGH =X(1)
        ALOW=X(1)
        DO 101 I=1,NDATA
  101   ARRAY(I)=X(I)
        DO 102 I=1,NOBS
         IF(ARRAY(I).GT.AHIGH)AHIGH=ARRAY(I)
  102    IF(ARRAY(I).LT.ALOW)ALOW=ARRAY(I)
         IF(ARRAY(1).EQ.IFIX(ARRAY(1)))GO TO 112
         RNGE=AHIGH-ALOW
C             RS IS USED TO TRY TO MAKE THE INTERVAL BETWEEN COLS
C             AS EVEN AS POSSIBLE. THUS OF THE INTERVAL VALUES
C             DETERMINED BETWEEN COLS. SOME ROUNDING IS REQUIRED
         SIZE=RNGE/INTV
```

```
RS=0.001
IF(SIZE.GE..1)RS=.1
IF(SIZE.GE.1.0) RS=1.0
IF(SIZE.GE.10.0)RS=10.0
ILCW=ALOW/RS
IF (ALOW.LT.0.0)ILOW=ILOW-1
ALOW=ILOW*RS
IHIGH =AHIGH/RS+1.0
IF (AHIGH.LT.0.0)IHIGH =IHIGH -1
AHIGH =IHIGH*RS
SIZE =(AHIGH-ALOW)/INTV
```

```
 103     DO 104 J=1,INTV
 104      JFREQ(J)=0
          DO 105 I=1,NOBS
          K=(ARRAY(I)-ALOW)/SIZE +1.000000001
         IF(K.GT.INTV) K=INTV
 105     JFREQ(K)=JFREQ(K)+1
         PRINT 115
         JFMAX=0
         DO 106 J=1,INTV
         IF(JFREQ(J).GT.JFMAX) JFMAX=JFREQ(J)
 106     CONTINUE
         JSCAL= (JFMAX-1)/20 +1
         IF (JSCAL.GT.1) PRINT 116,JSCAL
C                  THIS DO-LOOP USED, TO BLANK THE HISTOGRAM.
         DO 107     J=1,INTV
 107     JOUT(J)=BL
         NUMLN=(JFMAX-1)/JSCAL +1
         DO 109 LN=1,NUMLN
         IVAL =(NUMLN +1 -LN)*JSCAL
         DO 108 J=1,INTV
         IF(JFREQ(J)+JSCAL-1.GE.IVAL) JOUT(J)=AST
 108     CONTINUE
C                  VALUE OF A FORMAT ABOVE IS FOR SPACING BETWEEN COLS
C                  THIS DO-LOOP USED TO DRAW LINE UNDER HISTOGRAM
 109     PRINT 117,IVAL,(JOUT(J),J=1,INTV)
         DO 110 J=1,INTV
C                  THIS DO-LOOF USED TO NUMBER CLASSES
 110     JOUT(J)=FH
         PRINT 118,(JOUT(J),J=1,INTV)
C                  THIS DO-LOOP USED TO PRINT THE NUMBER IN EACH CLASS
         PRINT 119,(JFREQ(J),J=1,INTV )
         DO 111 J=1,INTV
 111     JOUT(J)=J
         PRINT 120,(JOUT(J),J=1,INTV)
         PRINT 121,ALOW,AHIGH,SIZE
         RETURN
 112     SIZE =1.0
 113     IF(INTV*SIZE.GE. AHIGH-ALOW +SIZE) GO TO 114
         SIZE = SIZE +1.0
         GC TC 113
 114     INTV=(AHIGH-ALOW)/SIZE +1.0
         AHIGH =ALOW +INTV *SIZE-1.0
         GO TO 103
 115      FORMAT('1',42X,  '*****   HISTOGRAM   *****'/)
 116      FORMAT(42X,  'EACH * REPRESENTS', I2, 'POINTS'/)
 117     FORMAT(18X, I4, 4X, 30A4 )
 118      FORMAT(22X, 30A4 )
 119      FORMAT(16X,'NUMBER ', 30I4)
 120      FORMAT(/,17X,'CLASS ', 30I4)
```

```
      121  FORMAT(/,33X,'START',F7.1,2X,'STOP',2X,F6.1,2X,'SIZE OF INTERVAL',
          1F8.1)
           END

           FUNCTION ERF(Z)
     C              FUNCTION SUBROUTINE TO INTEGRATE NORMAL DIST. FUNCTION
     C              A SOLUTION BY HASTINGS GIVES THE APPROXIMATION
     C              THE MAXIMUM ERROR OF THE APPROXIMATION IS .0000003
           IF(Z.GT.4.17)GO TO 104
           IF(Z.LT.-4.17)GO TO 105
           ZZ =Z
```

```
      IF(Z.LT.0.0) ZZ = -Z
      T= ZZ/1.4142142
     D= ((((((.430638E-4*T +.2765672E-3)*T +.1520143E-3)*T +.9270527E-2
    1) *T +.4228201E-1) *T +.7052307E-1) *T +1.0)**2
      D=D*D
      D=D*D
      D=D*D
      ERF=.5-.5/D
      IF(Z) 101,102,103
  101 ERF =.5-ERF
      GO TO 106
  102 ERF=.5
      GC TO 106
  103 ERF =.5+ERF
      GO TO 106
  104 ERF=1.0
      RETURN
  105 ERF=0.0
  106 CONTINUE
      RETURN
     END

      FUNCTION TAMMA(XX)
      REAL BIG/Z7FFFFFFF/
      X=XX
      IF(X-34.82)102,102,101
  101 PRINT 117,X
      TAMMA =BIG
      RETURN
  102 IF(X+28.5)103,104,104
  103 PRINT 118,X
      TAMMA= BIG
      RETURN
  104 ERR=1.E-6
      TAMMA =1.0
      IF(X-2.0)107,107,106
  105 IF(X-2.0)113,113,106
  106 X= X-1.0
      TAMMA= TAMMA*X
      GC TC 105
  107 IF(X-1.0) 108,114,113
  108 IF(X-ERR) 109,109,112
  109 Y = FLCAT(INT(X)) -X
      IF (ABS(Y)-ERR) 115,115,110
  110 IF (1.0-Y -ERR) 115,115,111
  111 IF(X-1.0) 112,112,113
  112 TAMMA  =TAMMA/X
      X= X+1.0
      GO TO 111
```

```
113   Y=X- 1.0
      GY=1.0+Y*(-.5771017+Y*(.985854+Y*(-.8764218+Y*(.8328212+Y*(-.5684
     1729+Y*(.2548205+Y*(-.05149930)))))))
      TAMMA=TAMMA*GY
114   RETURN
115   PRINT 116,X
      TAMMA= BIG
      RETURN
116   FORMAT(/5X,'#GAMMA# ERROR 1. X WITHIN 1.E-6 OF A NEGATIVE, INTEGE
     1R OR ZERO'/22X,'RETURNED TO EXECUTION. X=',E15.8/)
117   FORMAT(/5X,'#GAMMA# ERROR 2, X GT 34.82'/22X,'RETURNED TO EXECUTI
```

```
      1ON,X=',E15.8/)
  118 FORMAT(/5X,'#GAMMA# ERROR 3, X LT -28.5'/22X,'RETURNED TO EXECUTI
     1ON, X=',E15.8/)
      END

      FUNCTION GAMMA(A,X)
C                INTEGRAL,FROM X TO INFINITY,OF EXP(-U)*U**(A-1)DU.
C             USAGE: EITHER AN IMPLICIT REFERENCE TO GAMMA(A,X) OR
C             IN AN ASSIGNMENT,SUCH AS Y=GAMMA(A,X)
      REAL*8 EULER/0.57721566490153300/
      REAL*8 GSER
      IF (A) 101,106,107
  101 FA=A+1.0
      INK=1
  102 IF(FA) 103,104,105
  103 IF(ABS(FA).LE.1.E-10) GO TO 104
      FA= FA+1.0
      INK=INK+1
      GO TO 102
  104 IA=INK
      IF(X.EQ.0.0) GO TO 108
      GAMMA = GAMNEG(-IA,X)
      RETURN
  105 IF(FA.LE.1.E-10) GO TO 104
      GO TO 107
  106 IF (X.EQ.0.0) RETURN
      GAMMA = -(EULER + ALOG(X)+GSER(0.0,X))
      RETURN
  107 IF(ABS(X).LT.1.E-15) GO TO 108
      IF(X.LT.SQRT(ABS(A)+1.0)) GO TO 109
      GAMMA=GFRAC(A,X)
      RETURN
  108 GAMMA=GCHEB(A)
      RETURN
  109 GAMMA = GCHEB(A)-EXP(A*ALOG(X))*GSER(A,X)
      RETURN
      END
C

      FUNCTION GFRAC(A,X)
      TEMP1 =25.0
      TEMP2 = X
  101 TEMP3 =TEMP1/TEMP2
      TEMP2 =TEMP3+1.0
      TEMP3 =(TEMP1-A)/TEMP2
      TEMP2 = TEMP3+X
      TEMP1 = TEMP1-1.0
      IF(TEMP1.GT.0.0)GO TO 101
      GFRAC =EXP(ALOG(X)*A -X)/TEMP2
```

```
      RETURN
      END

       FUNCTION GCHEB(A)
      DIMENSION Q(7), B(7)
      REAL*8       Q/.99999999999998D0,.553387692385769D0,.27964391578
1538D0,
2.073094836414370D0,.020449630823590D0,.002619307282746D0,.00053969
389588080D0/,B/1.D0,.113060335728656D1,-.056810335086194D0,-.1704479
432874746D0,.022523834747260D0,.004698658079622D0,-.0008327247086840
50/
```

```
C
          IF (A.LT.1.0) GO TO 104
          IF (A.LT.2.)  GO TO 103
          T4 =A-1.
          T5 =T4
   101    IF (T4.LT.2.0) GO TC 102
          T4 = T4-1.0
          T5 = T4*T5
          GO TO 101
   102    FRACA =T4-1.0
          FMULT =T5
          GO TO 107
   103  FRACA=A-1.0
          FMULT=T5
          GO TC 107
   104    T3 =A
          T31=T3
   105    IF(T3.GE.0.0) GO TO 106
          T3 =T3+1.0
          T31= T3*T31
          GO TO 105
   106    FRACA =T3
          FMULT =T31
   107    AMQR1 =FRACA
          GAMTOP =0.0
          GAMBTM =0.0
          DO 108 I=2,7
          GAMTOP =AMQR1 * Q(I)+GAMTOP
          GAMBTM =AMQR1 * B(I)+GAMBTM
   108    AMQR1  =AMQR1 *FRACA
          AMQR   =(GAMTOP+Q(1))/(GAMBTM+B(1))
          IF(A.LT.1.0) GO TO 109
          IF(A.LE.2.0) GO TO 110
          GCHEB  =AMQR *FMULT
          RETURN
   109    GCHEB =AMQR/T31
          RETURN
   110    GCHEB =AMQR
          RETURN
          END
C
C
           FUNCTION GAMNEG(MINUS,X)
          REAL*8 GSER
        REAL*8 EULER/.5772156649015330D0/
           N = -MINUS
           NMIN1= N-1
           FACTJ =1.0
```

```
      XTERM =X
      J =1
      SUM =1.0/XTERM
      SIGN = 1.0
101   SIGN = -SIGN
      XTERM =XTERM*X
      SUM = SUM +SIGN*FACTJ/XTERM
      J= J+1
      IF(J.GT.NMIN1) GO TO 102
      XF=J
      FACTJ =FACTJ* XF
```

```
           GO TO 101
      102  XF=N
           FACTN= FACTJ*XF
           SIGN = -SIGN
          E1X =-(EULER +ALOG(X)+GSER(0.0,X))
          RETURN
          END
C
C
          DOUBLE PRECISION FUNCTION GSER(A,X)
          IF (A.EQ.0.0) GO TO 101
          GSER =1.0D0 /DBLE(A)
          GO TO 102
      101 GSER= 0.0D0
      102 FNUM =X
          SIGN =-1.
          FACTN =1.
          FN    =1.
          DENOM =A
      103 DENOM =DENOM+ 1.
          TERM =SIGN * FNUM/(DENOM *FACTN)
          IF(ABS(TERM).LE.1.0E-10) RETURN
          IF(ABS(SNGL(GSER)-TERM).LE.1.0E-07*AMAX1(ABS(SNGL(GSER)),0.10))
         1 RETURN
          GSER =GSER +DBLE(TERM)
          FN =FN+1.
          FACTN =FACTN *FN
          SIGN = -SIGN
          FNUM = FNUM*X
          IF(FACTN.GT.1.0E +10.OR.FNUM.LT.1.0E-10) RETURN
          IF(ABS(TERM).LT.1.E-20.AND.ABS(FNUM).GT.1.E-15) RETURN
          GO TO 103
          END
C
C
           SUBROUTINE EST(NDATA,WALPHA,WBETA)
           COMMON X(500)
           DIMENSION FT(500),Y(500),XT(500)
C
C                IF WEIBULL IS USED WITH LIFE TESTS...SET POINTS
C                EQUAL TO NO OF ITEMS ON LIFE TEST
          POINTS =NDATA
          TOTX   =0.0
          TOTX2  =0.0
          TOTY   =0.0
          TOTXY  =0.0
          XNDATA =NDATA
```

```
      DC 101 I=1.NDATA
       XI= X(I)
       YI=I
      FT(I) =(YI-0.50)/POINTS
       Z = 1.0/(1.0-FT(I))
     IF (ALOG( Z).LE.0.) GO TO 997
       Z1 =ALOG(Z)
     IF (ALOG(Z1).LE.0.) GO TO 997
       Y(I) =ALOG(Z1)
       Z2 =X(I)
     IF (ALOG(Z2).LE.0.) GO TO 997
```

```
            XT(I) =ALOG(Z2)
            TOTX =TOTX +XT(I)
            TOTY =TOTY +Y(I)
            TOTXY =TOTXY+XT(I)*Y(I)
      101   TOTX2 =TOTX2+XT(I)**2
            XNUM =(TOTX2*TOTY)-(TOTX *TOTXY)
            XDEN =(XNDATA* TOTX2)-(TOTX**2)
            A = XNUM/XDEN
            XNUM =(XNDATA*TOTXY)-(TOTX*TOTY)
            XDEN =(XNDATA*TOTX2)-(TOTX**2)
            WBETA =XNUM/XDEN
            XBAR  =TOTX/NDATA
            YBAR  =TOTY/XNDATA
            WALPHA  =EXP(A)
            GO TO 999
      997    PRINT 998
      998  FORMAT('0',20X,'THE ALOG VALUE IN SUBROUTINE EST'/22X,'IS ZERO OR
          1NEGATIVE'/)
      999  CONTINUE
            RETURN
            END
C
C                       * * * * * * * * * * *
C                        END OF PROGRAMME  GOF
C                       * * * * * * * * * * *
C
C
:*WARNING**  COMMON BLOCK //     HAS A DIFFERENT LENGTH THAN WAS SPECIFIED IN A PREVIOUS SUBPROGRAM;GREATER LENGTH U

       $ENTRY
```

G O F

* * * *

TESTING DATA FOR GOODNESS OF FIT

OBSERVED DATA

-120.	366.	-110.	186.	-83.	-1.	227.	-592.	-205.	105.
27.	-67.	304.	3.	99.	311.	-153.	-61.	293.	-113.
-74.	-115.	7.	-215.	-147.	159.	23.	450.	-217.	-963.
-361.	241.	-247.	653.	-679.	-112.	718.	907.	1441.	885.
758.	1095.	255.	467.	387.	848.	743.	692.	887.	1085.
929.	899.	1384.	884.	605.	583.	455.	470.	479.	478.
482.	480.								

TEST FOR NORMALITY USING SAMPLE MOMENTS

NULL HYPOTHESIS (POPULATION IS NORMAL)

ALTERNATE HYPOTHESIS (POPULATION IS NOT NORMAL)

BIASED MEASURE OF SKEWNESS : BETA1 = 0.08

BIASED MEASURE OF KURTOSIS : BETA2 = 2.83

ARRAYED DATA

-963.	-679.	-592.	-361.	-247.	-217.	-215.	-205.	-153.	-147.
-120.	-115.	-113.	-112.	-110.	-83.	-74.	-67.	-61.	-1.
3.	7.	23.	27.	99.	105.	159.	186.	227.	241.
255.	293.	304.	311.	366.	387.	450.	455.	467.	470.
478.	479.	480.	482.	583.	605.	653.	692.	718.	743.
758.	848.	884.	885.	887.	899.	907.	929.	1085.	1095.
1384.	1441.								

```
                        *****   HISTOGRAM   *****

      8                            *   *               *
      7                            *   *               *           *
      6                            *   *       *       *           *
      5                            *   *       *       *           *
      4                        *   *   *       *       *       *   *
      3                        *   *   *   *   *   *   *   *   *   *
      2            *           *   *   *   *   *   *   *   *   *   *       *       *
      1    *       *       *   *   *   *   *   *   *   *   *   *   *       *       *
        ----------------------------------------------------------------------------
NUMBER     1   0   2   0   1   4   8   8   3   6   3   8   3   4   7   0   2   0   2

CLASS      1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19
```

START -963.0   STOP   1449.0   SIZE OF INTERVAL   127.0
MEAN =   292.18   AND CALCULATED VARIANCE = 240554.60

* * * * * * * * * * * * * * * *

HYPOTHESIS STATEMENT

NULL HYPOTHESIS : POPULATION IS NORMAL ;TRUE MEAN = 292.18
THE ALTERNATE HYPOTHESIS: THE POPULATION IS NOT NORMAL ;TRUE MEAN = 292.18

* * * * * * * * * * * * * * * *

NUMBER OF OBSERVATIONS= 62

KOLMOGOROV - SMIRNOV TEST

CELLS	RANGE FROM:	TO:	OBSERVED DEMAND	CUM.OBSERV. FREQUENCY	KOLMOGOROV FREQUENCY	THEORET. FREQUENCY	SMIRNOV STATISTIC
1	-999.999	-802.733	1.00	0.016	0.005	0.005	0.011
2	-802.733	-642.466	1.00	0.032	0.023	0.028	0.004
3	-642.466	-482.199	1.00	0.048	0.029	0.057	0.009
4	-482.199	-321.933	1.00	0.065	0.043	0.105	0.041
5	-321.933	-161.666	4.00	0.129	0.072	0.177	0.048
6	-161.666	-1.399	11.00	0.306	0.097	0.275	0.032
7	-1.399	158.867	7.00	0.419	0.113	0.393	0.026

8	158.867	319.134	8.00	0.548	0.129	0.522	0.026
9	319.134	479.401	8.00	0.677	0.127	0.649	0.029
10	479.401	639.667	4.00	0.742	0.112	0.761	0.019
11	639.667	799.934	5.00	0.823	0.089	0.850	0.027
12	799.934	960.200	7.00	0.935	0.064	0.913	0.022
13	960.200	1120.467	2.00	0.968	0.041	0.954	0.013
14	1120.467	1280.734	0.00	0.968	0.024	0.978	0.010
15	1280.734	1441.000	2.00	1.000	0.012	0.990	0.010

THE KOLMOGOROV - SMIRNOV STATISTIC = 0.0484

DEGREES OF FREEDOM = 15

CHI - SQUARE TEST

CELLS	RANGE FROM (INCLUSIVE)	RANGE TO (EXCLUSIVE)	OBSERVED	EXPECTED	$(OBS-EXP)^2/EXP$
1	-999.9990	-321.9326	4.0000	6.5266	0.9781
2	-321.9326	-1.3993	15.0000	10.5070	1.9213
3	-1.3993	158.8674	7.0000	7.3257	0.0145
4	158.8674	319.1340	8.0000	7.9991	0.0000
5	319.1340	479.4006	8.0000	7.8588	0.0025
6	479.4006	639.6672	4.0000	6.9447	1.2486
7	639.6672	799.9338	5.0000	5.5209	0.0491
8	799.9338	999.9990	11.0000	9.3172	0.3039

CHI - SQUARE = 4.5182

DEGREES OF FREEDOM = 5

PARAMETERS OF THE NORMAL DISTRIBUTIONS

MU = 292.18 SIGMA = 240554.60

***** HISTOGRAM *****

```
8                                      *               *
7                              *   *               *           *
6                              *   *       *       *           *
5                              *   *       *       *           *
4                          *   *   *   *   *       *   *   *   *
3                          *   *   *   *   *   *   *   *   *   *
2                          *   *   *   *   *   *   *   *   *   *       *       *
1          *       *       *   *   *   *   *   *   *   *   *   *   *       *       *
       ----------------------------------------------------------------------------
NUMBER    1   0   1   0   1   4   7   8   4   6   3   8   4   4   7   0   2   0   2
CLASS     1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19
```

START -963.0 STOP 1449.0 SIZE OF INTERVAL 127.0
MEAN = 314.82 AND CALCULATED VARIANCE = 226583.60

* * * * * * * * * * * * * * * *

HYPOTHESIS STATEMENT

NULL HYPOTHESIS : POPULATION IS EXPON ;TRUE MEAN = 314.82
THE ALTERNATE HYPOTHESIS: THE POPULATION IS NOT EXPON ;TRUE MEAN = 314.82

* * * * * * * * * * * * * * * *

NUMBER OF OBSERVATIONS= 62

KOLMOGOROV - SMIRNOV TEST

CELLS	RANGE FROM:	TO:	OBSERVED DEMAND	CUM.OBSERV. FREQUENCY	KOLMOGOROV FREQUENCY	THEORET. FREQUENCY	SMIRNOV STATISTIC
1	0.000	-802.733	1.00	0.016	-11.804	-11.804	11.821
2	-802.733	-642.466	1.00	0.032	5.108	-6.696	6.728
3	-642.466	-482.199	0.00	0.032	3.070	-3.626	3.658
4	-482.199	-321.933	1.00	0.048	1.845	-1.780	1.829
5	-321.933	-161.666	4.00	0.113	1.109	-0.671	0.784
6	-161.666	-1.399	10.00	0.274	0.667	-0.004	0.279
7	-1.399	158.867	8.00	0.403	0.401	0.396	0.007

8	158.867	319.134	8.00	0.532	0.241	0.637	0.105
9	319.134	479.401	8.00	0.661	0.145	0.782	0.121
10	479.401	639.667	5.00	0.742	0.087	0.869	0.127
11	639.667	799.934	5.00	0.823	0.052	0.921	0.099
12	799.934	960.200	7.00	0.935	0.031	0.953	0.017
13	960.200	1120.467	2.00	0.968	0.019	0.972	0.004
14	1120.467	1280.734	0.00	0.968	0.011	0.983	0.015
15	1280.734	1441.000	2.00	1.000	0.007	0.990	0.010

THE KOLMOGOROV - SMIRNOV STATISTIC = 11.8206

G O F

* * * *

TESTING DATA FOR GOODNESS OF FIT

* * * * * * * * * * * * * * * * *

OBSERVED DATA

5.	6.	6.	1.	5.	8.	1.	13.	6.	2.
5.	6.	9.	7.	4.	8.	2.	1.	5.	4.
1.	1.	2.	3.	19.	2.	6.	1.	5.	4.
4.	4.	9.	9.	9.	8.	13.	11.	8.	4.
2.	4.	5.	4.	8.	5.	12.	13.	6.	10.
11.	8.	6.	6.	9.	8.	16.	5.	17.	6.

TEST FOR NORMALITY USING SAMPLE MOMENTS

NULL HYPOTHESIS (POPULATION IS NORMAL)

ALTERNATE HYPOTHESIS (POPULATION IS NOT NORMAL)

BIASED MEASURE OF SKEWNESS : BETA1 = 0.94

BIASED MEASURE OF KURTOSIS : BETA2 = 3.80

ARRAYED DATA

1.	1.	1.	1.	1.	1.	2.	2.	2.	2.
2.	3.	4.	4.	4.	4.	4.	4.	4.	4.
5.	5.	5.	5.	5.	5.	5.	5.	6.	6.
6.	6.	6.	6.	6.	6.	6.	7.	8.	8.
8.	8.	8.	8.	8.	9.	9.	9.	9.	9.
10.	11.	11.	12.	13.	13.	13.	16.	17.	19.

```
                      *****   HISTOGRAM   *****
      9                       *
      8               *   *   *
      7               *   *   *       *
      6   *           *   *   *       *
      5   *   *       *   *   *       *   *
      4   *   *       *   *   *       *   *
      3   *   *       *   *   *       *   *               *
      2   *   *       *   *   *       *   *       *       *
      1   *   *   *   *   *   *   *   *   *   *   *   *   *           *   *       *
NUMBER ---6---5---1---8---8---9---1---7---5---1---2---1---3---0---0---1---1---0---1
CLASS     1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19
            START     1.0  STOP     19.0  SIZE OF INTERVAL      1.0
             MEAN =        6.47  AND CALCULATED VARIANCE =      16.59
```

* * * * * * * * * * * * * * * *

HYPOTHESIS STATEMENT

NULL HYPOTHESIS : POPULATION IS NORMAL ;TRUE MEAN = 6.47
THE ALTERNATE HYPOTHESIS: THE POPULATION IS NOT NORMAL ;TRUE MEAN = 6.47

* * * * * * * * * * * * * * * *

NUMBER OF OBSERVATIONS= 60

CRAMER - VON MISES TEST

OBSERVATION	DATA	AREA	STATISTIC
1	1.00000	0.08979	0.00663
2	1.00000	0.08979	0.00420
3	1.00000	0.08979	0.00232
4	1.00000	0.08979	0.00099
5	1.00000	0.08979	0.00022
6	1.00000	0.08979	0.00000
7	2.00000	0.08979	0.00034
8	2.00000	0.08979	0.00124

9	2.00000	0.08979	0.00269
10	2.00000	0.08979	0.00470
11	2.00000	0.08979	0.00726
12	3.00000	0.08979	0.01038
13	4.00000	0.08979	0.01405
14	4.00000	0.08979	0.01828
15	4.00000	0.08979	0.02307
16	4.00000	0.08979	0.02841
17	4.00000	0.08979	0.03430
18	4.00000	0.08979	0.04075
19	4.00000	0.08979	0.04776

20	4.00000	0.08979	0.05532
21	5.00000	0.08979	0.06344
22	5.00000	0.08979	0.07212
23	5.00000	0.08979	0.08135
24	5.00000	0.08979	0.09113
25	5.00000	0.08979	0.10147
26	5.00000	0.08979	0.11237
27	5.00000	0.08979	0.12382
28	5.00000	0.08979	0.13582
29	6.00000	0.08979	0.14839
30	6.00000	0.08979	0.16151
31	6.00000	0.08979	0.17518
32	6.00000	0.08979	0.18941
33	6.00000	0.08979	0.20419
34	6.00000	0.08979	0.21953
35	6.00000	0.08979	0.23543
36	6.00000	0.08979	0.25188
37	6.00000	0.08979	0.26889
38	7.00000	0.13642	0.23871
39	8.00000	0.13642	0.25528
40	8.00000	0.13642	0.27240
41	8.00000	0.13642	0.29007
42	8.00000	0.13642	0.30830
43	8.00000	0.13642	0.32709
44	8.00000	0.13642	0.34643
45	8.00000	0.13642	0.36633
46	9.00000	0.13642	0.38678
47	9.00000	0.13642	0.40779
48	9.00000	0.13642	0.42935
49	9.00000	0.13642	0.45147
50	9.00000	0.13642	0.47415
51	10.00000	0.13642	0.49738
52	11.00000	0.13642	0.52116
53	11.00000	0.13642	0.54550
54	12.00000	0.19737	0.48205
55	13.00000	0.27240	0.40441
56	13.00000	0.27240	0.42588
57	13.00000	0.27240	0.44791
58	16.00000	0.27240	0.47050
59	17.00000	0.27240	0.49364
60	19.00000	0.27240	0.51734

CRAMER VON MISES TEST STATISTIC= 12.300

PARAMETERS OF THE NORMAL DISTRIBUTIONS

G O F
* * * *

TESTING DATA FOR GOODNESS OF FIT
* * * * * * * * * * * * * * * * *

OBSERVED DATA

5.	6.	6.	1.	5.	8.	1.	13.	6.	2.
5.	6.	9.	7.	4.	8.	2.	1.	5.	4.
1.	1.	2.	3.	19.	2.	6.	1.	5.	4.
4.	4.	9.	9.	9.	8.	13.	11.	3.	4.
2.	4.	5.	4.	8.	5.	12.	13.	6.	10.
11.	8.	6.	6.	9.	8.	16.	5.	17.	6.

ARRAYED DATA

1.	1.	1.	1.	1.	1.	2.	2.	2.	2.
2.	3.	4.	4.	4.	4.	4.	4.	4.	4.
5.	5.	5.	5.	5.	5.	5.	5.	6.	6.
6.	6.	6.	6.	6.	6.	6.	7.	8.	8.
8.	8.	8.	8.	8.	9.	9.	9.	9.	9.
10.	11.	11.	12.	13.	13.	13.	16.	17.	19.

```
                         *****   HISTOGRAM   *****
     9                       *
     8               *   *   *
     7               *   *   *       *
     6   *           *   *   *       *
     5   *   *       *   *   *       *   *
     4   *   *       *   *   *       *   *
     3   *   *       *   *   *       *   *               *
     2   *   *       *   *   *       *   *       *       *
     1   *   *   *   *   *   *   *   *   *   *   *   *   *           *   *       *
NUMBER ----------------------------------------------------------------------------
         6   5   1   8   8   9   1   7   5   1   2   1   3   0   0   1   1   0   1
CLASS    1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19
```

START 1.0 STOP 19.0 SIZE OF INTERVAL 1.0
MEAN = 6.47 AND CALCULATED VARIANCE = 16.59

* * * * * * * * * * * * * * * *

HYPOTHESIS STATEMENT

NULL HYPOTHESIS : POPULATION IS EXPON ;TRUE MEAN = 6.47
THE ALTERNATE HYPOTHESIS: THE POPULATION IS NOT EXPON ;TRUE MEAN = 6.47

* * * * * * * * * * * * * * * *

NUMBER OF OBSERVATIONS= 60

CRAMER - VON MISES TEST

OBSERVATION	DATA	AREA	STATISTIC
1	1.00000	0.14328	0.01821
2	1.00000	0.14328	0.01399
3	1.00000	0.14328	0.01032
4	1.00000	0.14328	0.00722
5	1.00000	0.14328	0.00466
6	1.00000	0.14328	0.00266
7	2.00000	0.14328	0.00122
8	2.00000	0.14328	0.00033

9	2.00000	0.14328	0.00000
10	2.00000	0.14328	0.00023
11	2.00000	0.14328	0.00101
12	3.00000	0.14328	0.00234
13	4.00000	0.14328	0.00423
14	4.00000	0.14328	0.00668
15	4.00000	0.14328	0.00968
16	4.00000	0.14328	0.01324
17	4.00000	0.14328	0.01735
18	4.00000	0.14328	0.02202
19	4.00000	0.14328	0.02724

20	4.00000	0.14328	0.03302
21	5.00000	0.14328	0.03936
22	5.00000	0.14328	0.04625
23	5.00000	0.14328	0.05370
24	5.00000	0.14328	0.06170
25	5.00000	0.14328	0.07026
26	5.00000	0.14328	0.07937
27	5.00000	0.14328	0.08904
28	5.00000	0.14328	0.09926
29	6.00000	0.14328	0.11004
30	6.00000	0.14328	0.12138
31	6.00000	0.14328	0.13327
32	6.00000	0.14328	0.14571
33	6.00000	0.14328	0.15872
34	6.00000	0.14328	0.17227
35	6.00000	0.14328	0.18639
36	6.00000	0.14328	0.20105
37	6.00000	0.14328	0.21628
38	7.00000	0.26602	0.12886
39	8.00000	0.26602	0.14111
40	8.00000	0.26602	0.15391
41	8.00000	0.26602	0.16726
42	8.00000	0.26602	0.18117
43	8.00000	0.26602	0.19564
44	8.00000	0.26602	0.21066
45	8.00000	0.26602	0.22624
46	9.00000	0.26602	0.24237
47	9.00000	0.26602	0.25906
48	9.00000	0.26602	0.27630
49	9.00000	0.26602	0.29410
50	9.00000	0.26602	0.31245
51	10.00000	0.26602	0.33136
52	11.00000	0.26602	0.35083
53	11.00000	0.26602	0.37085
54	12.00000	0.37118	0.27090
55	13.00000	0.46128	0.19986
56	13.00000	0.46128	0.21504
57	13.00000	0.46128	0.23077
58	16.00000	0.46128	0.24706
59	17.00000	0.46128	0.26391
60	19.00000	0.46128	0.28131

CRAMER VON MISES TEST STATISTIC= 7.732

PARAMETERS OF THE EXPON DISTRIBUTIONS

```
                        *****    HISTOGRAM    *****
      9                          *
      8                 *   *    *
      7                 *   *    *       *
      6   *             *   *    *       *
      5   *    *        *   *    *       *    *
      4   *    *        *   *    *       *    *
      3   *    *        *   *    *       *    *              *
      2   *    *        *   *    *       *    *        *     *
      1   *    *   *    *   *    *   *   *    *    *   *  *  *          *   *       *
NUMBER ---6----5---1----8---8----9---1---7----5----1---2--1--3---0---0--1---1---0---1
CLASS     1    2   3    4   5    6   7   8    9   10  11  12 13  14  15 16  17  18  19
                START    1.0   STOP    19.0   SIZE OF INTERVAL     1.0
```

THE LOGNORMAL TEST USES TRANSFORMED DATA OF THE FORM Y=LN(X)

TRANSFORMED DATA

0.000	0.000	0.000	0.000	0.000	0.000	0.693	0.693	0.693	0.693
0.693	1.099	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386
1.609	1.609	1.609	1.609	1.609	1.609	1.609	1.609	1.792	1.792
1.792	1.792	1.792	1.792	1.792	1.792	1.792	1.946	2.079	2.079
2.079	2.079	2.079	2.079	2.079	2.197	2.197	2.197	2.197	2.197
2.303	2.398	2.398	2.485	2.565	2.565	2.565	2.773	2.833	2.944

* * * * * * * * * * * * * * * *

HYPOTHESIS STATEMENT

NULL HYPOTHESIS : POPULATION IS LOGNO ;TRUE MEAN = 1.63
THE ALTERNATE HYPOTHESIS: THE POPULATION IS NOT LOGNO ;TRUE MEAN = 1.63

* * * * * * * * * * * * * * * *

NUMBER OF OBSERVATIONS= 60

MEAN = 6.82 AND CALCULATED VARIANCE = 35.16

KOLMOGOROV - SMIRNOV TEST

CELLS	RANGE	OBSERVED	CUM.OBSERV.	KOLMOGOROV	THEORET.	SMIRNOV

	FROM:	TO:	DEMAND	FREQUENCY	FREQUENCY	FREQUENCY	STATISTIC
1	C.000	0.000	1.00	0.017	0.016	0.016	0.001
2	C.000	0.000	1.00	0.033	0.000	0.016	0.018
3	0.000	0.000	1.00	0.050	0.000	0.016	0.034
4	C.000	0.000	1.00	0.067	0.000	0.016	0.051
5	C.000	0.000	1.00	0.083	0.000	0.016	0.068
6	0.000	0.000	1.00	0.100	0.000	0.016	0.084
7	0.000	0.693	1.00	0.117	0.092	0.108	0.009
8	0.000	0.693	1.00	0.133	0.000	0.108	0.026
9	0.000	0.693	1.00	0.150	0.000	0.108	0.042
10	C.000	0.693	1.00	0.167	0.000	0.108	0.059
11	0.000	0.693	1.00	0.183	0.000	0.108	0.076
12	C.000	1.099	1.00	0.200	0.133	0.241	0.041
13	C.000	1.386	1.00	0.217	0.132	0.373	0.156
14	C.000	1.386	1.00	0.233	0.000	0.373	0.139
15	C.000	1.386	1.00	0.250	0.000	0.373	0.123
16	C.000	1.386	1.00	0.267	0.000	0.373	0.106
17	C.000	1.386	1.00	0.283	0.000	0.373	0.089
18	C.000	1.386	1.00	0.300	0.000	0.373	0.073
19	0.000	1.386	1.00	0.317	0.000	0.373	0.056
20	0.000	1.386	1.00	0.333	0.000	0.373	0.039
21	0.000	1.609	1.00	0.350	0.115	0.488	0.138
22	0.000	1.609	1.00	0.367	0.000	0.488	0.121
23	0.000	1.609	1.00	0.383	0.000	0.488	0.104
24	0.000	1.609	1.00	0.400	0.000	0.488	0.088
25	0.000	1.609	1.00	0.417	0.000	0.488	0.071
26	0.000	1.609	1.00	0.433	0.000	0.488	0.054
27	0.000	1.609	1.00	0.450	0.000	0.488	0.038
28	0.000	1.609	1.00	0.467	0.000	0.488	0.021
29	0.000	1.792	1.00	0.483	0.095	0.583	0.100
30	0.000	1.792	1.00	0.500	0.000	0.583	0.083
31	0.000	1.792	1.00	0.517	0.000	0.583	0.066
32	0.000	1.792	1.00	0.533	0.000	0.583	0.050
33	C.000	1.792	1.00	0.550	0.000	0.583	0.033
34	C.000	1.792	1.00	0.567	0.000	0.583	0.016
35	0.000	1.792	1.00	0.583	0.000	0.583	0.000
36	0.000	1.792	1.00	0.600	0.000	0.583	0.017
37	0.000	1.792	1.00	0.617	0.000	0.583	0.034
38	0.000	1.946	1.00	0.633	0.077	0.660	0.027
39	0.000	2.079	1.00	0.650	0.062	0.722	0.072
40	C.000	2.079	1.00	0.667	0.000	0.722	0.055
41	C.000	2.079	1.00	0.683	0.000	0.722	0.039
42	0.000	2.079	1.00	0.700	0.000	0.722	0.022
43	0.000	2.079	1.00	0.717	0.000	0.722	0.005
44	0.000	2.079	1.00	0.733	0.000	0.722	0.011
45	C.000	2.079	1.00	0.750	0.000	0.722	0.028
46	C.000	2.197	1.00	0.767	0.050	0.772	0.005
47	0.000	2.197	1.00	0.783	0.000	0.772	0.012

48	0.000	2.197	1.00	0.800	0.000	0.772	0.028
49	0.000	2.197	1.00	0.817	0.000	0.772	0.045
50	0.000	2.197	1.00	0.833	0.000	0.772	0.062
51	0.000	2.303	1.00	0.850	0.040	0.811	0.039
52	0.000	2.398	1.00	0.867	0.032	0.844	0.023
53	0.000	2.398	1.00	0.883	0.000	0.844	0.040
54	0.000	2.485	1.00	0.900	0.026	0.869	0.031
55	0.000	2.565	1.00	0.917	0.021	0.891	0.026
56	0.000	2.565	1.00	0.933	0.000	0.891	0.043
57	0.000	2.565	1.00	0.950	0.000	0.891	0.059
58	0.000	2.773	1.00	0.967	0.043	0.934	0.033

59	C.000	2.833	1.00	0.983	0.010	0.943	0.040
60	0.000	2.944	1.00	1.000	0.015	0.958	0.042

THE KOLMOGOROV - SMIRNOV STATISTIC = 0.1558

DEGREES OF FREEDOM = 60

PARAMETERS OF THE LOGNO DISTRIBUTIONS

MUT= 6.82 SIGMAT2= 36.16

```
CORE USAGE      OBJECT CODE=   39360 BYTES,ARRAY AREA=   24576 BYTES,TOTAL AREA AVAILABLE=  225280  BYTES
DIAGNOSTICS       NUMBER OF ERRORS=      0, NUMBER OF WARNINGS=      1, NUMBER OF EXTENSIONS=      0
COMPILE TIME=    43.42 SEC,EXECUTION TIME=    34.01 SEC,  WATFIV - JUL 1973 V1L4      5.00.22   TUESDAY      27 SE
```

APPENDIX C

SIMPLE FORECASTING METHODS

Simple methods are described in chapter six. Three programmes are included in this appendix, and three items compared: Table 63.

Table 63

SIMPLE FORECASTING METHODS

THREE ITEMS OUTPUT

Item	SIMPAVE	LASTAVE	LINFOR	MOVAVE	M'TREND
			OVERALL M.A.D.		
6	664.0	353.0	324.0	256.0	230.0*
43	4.1	4.0	3.2	2.7	2.4*
2129	34.2	35.3	22.6*	28.1	23.1
			R.M.S.E.		
6	705.0	436.0	414.0	304.0	284.0*
43	4.6	5.6	3.9	3.1*	3.1*
2129	38.7	44.4	29.5*	31.1	29.5*
			A.C.S.E.		
6	458.0	14.2	21.9	23.9	20.9
43	1.9	0.0*	0.1	3.1	3.1
2129	12.6	0.1*	0.4	31.1	29.5

Experience would indicate which measurement of error would be the most informative. Results of the small sample indicate that moving average forecasting has advantages over other simple methods in terms of small errors. Average Cumulative Signed Error method shows that LASTAVE and LINFOR produce the smallest overall errors, but in practice do not control the width of the swings around the zero error.

```
$JOB          ,PAGES=400,TIME=720
C
C
C
C
C                        * * * * * * * * * * * * *
C                        BRUSTART SIMPAVE AND LASTAVE
C                         SIMPLE FORECASTING METHODS
C                        * * * * * * * * * * * * *
C
C                                  * * * *
C                                  BRUSTART
C                                  * * * *
C
C                           LEAST SQUARES LINE TO
C                          PROVIDE A FIRST FORECAST
C
C             RGBROWN:MANAGEMENT DECISIONS FOR PRODUCTION OPERATIONS
C                       DRYDEN PRESS(1971),64-65
C
C                                DICTIONARY
C
C             ABSAV     MEAN ABS.DEVIATION    (LASTAVE)
C             ABSER     RUNNING TOTAL,ABS.ERRORS  (LASTAVE)
C             ACCUR     PERCENTAGE ACCURACY MEASURE
C             ALLAV     AVERAGE OF TOTAL SIGNED ERRORS
C             ALLER     RUNNING TOTAL,ERRORS (LASTAVE)
C             ALLMAD    RUNNING TOTAL,MAD     (LASTAVE)
C             AVERR     MEAN OF SIGNED ERRORS
C             BALER     PERCENTAGE ERROR RATING
C             BALR      PERCENT BALANCED ERROR
C             DAMICO    FORECASTABILITY INDEX
C             EMSQ      MEAN SQUARE ERROR (SIMPAVE)
C             FMSQ      MEAN SQUARE ERROR (LASTAVE)
C             FORAV     SIMPLE AVERAGE  FORECAST
C             MADAV     SIMPLE AVERAGE  MAD
C             MADSUM    SIMPLE AVERAGE  AVERAGE M.A.D.
C             PRODUCT   SIMPLE AVERAGE  RUNNING TOTAL OF DEMANDS
C             PREDIC    FORECAST              (LASTAVE)
C             PX        LABEL FOR PERIODS IN PRELIM. FORECAST
C             RTMSE     ROOT MEAN SQUARE ERROR
C             SQERR     SUM OF SQUARED ERRORS (SIMPAVE)
C             SUMERR    TOTAL SIGNED ERROR
C             TOEROR    SIMPLE AVERAGE  RUNNING TOTAL OF ERRORS
C             TOMAD     SIMPLE AVERAGE  CUMULATED MAD
C             TQERR     SUM OF SQUARED ERRORS (LASTAVE)
C             WRONG     MONTHLY ERROR         (LASTAVE)
C             YEST      TREND ESTIMATE
C
```

```
      DIMENSION DATES(20),FORAV(100),MADAV(100),ERRAV(100),PRDUCT(100)
      DIMENSION PX(84), YEST(100),Y(100),JNWMD1(100),        HOSP(20)
       DIMENSION KDATA(100),SQER(100), TQER(100)
      DIMENSION PREDIC(100),WRONG(100),ABSER(100),ABSAV(100)
      REAL MADAV,MADTOT,MADSUM, JNWMD1
       READ,ML
       PRINT 65
   65  FORMAT('1',45X,'BRUSTART'/28X,'BROWN METHOD OF OBTAINING STARTING
     1 VALUES.'/45X,'********'/)
      DO 560 KL=1,ML
       READ 554, HOSP
```

```
554   FORMAT(20A4)
        READ 556,DATES
556   FORMAT(20A4)
        READ,N
        READ 600,(KDATA(I),I=1,N)
600   FORMAT(12I6)
        READ, XLCL, CI
          SUMY = 0.0
        SUMSQ = 0.0
        DO 1 K=1,N
        Y(K) = FLOAT(KDATA(K))
        SUMY = SUMY + Y(K)
        SUMSC = SUMSQ + Y(K)**2
 1      CONTINUE
        ZN = N
        YBAR = SUMY/ZN
        VAR = (ZN*SUMSQ- SUMY**2)/(ZN*(ZN-1.0))
        STDEV = SQRT(VAR)
        ST3DEV = STDEV*3.0
       IF (N.GE.72) MG=24
       IF (N.GE.72) GO TO 900
       IF (N.GE.60) MG=18
       IF (N.GE.60) GO TO 900
       IF (N.GE.48) MG=12
       IF (N.GE.48) GO TO 900
       IF (N.LT.48) MG=6
  900     CONTINUE
C                THESE GIVE SIZE OF PRELIM. FORECAST
C
        A=0.
        B=0.
       BALER = 0.
        SUM =0.
        SUMERR = 0.
        TOTERR=0.
        TPROD =0.
C                NUMBER THE PRELIM.MONTHS IN ORDER
       DO 8 I=1,MG
     8 PX(I)=I
       DO 22 I=1,MG
       TPROD =TPROD +(Y(I)*I)
       SUM = SUM + Y(I)
    22 CONTINUE
C
C                CALCULATE INTERCEPT A, AND SLOPE B
C
       PG = MG
       A =((2*((2 *PG)+1)/(PG*(PG-1)))* SUM)-(6/(PG*(PG-1))* TPROD)
       B =((12/(PG*(PG**2)-1))*TPROD)- ((6/( PG*(PG-1))) * SUM)
```

```
54          MG =PG
      C
      C              EVALUATE LINEAR EXPRESSION FOR EACH VALUE OF Y
      C
55          DO 23  I=1,MG
56          YEST(I) =A+(B*I)
      C
      C              FIND THE ERRORS AND THE (ABSOLUTE) TOTAL
      C
57          ERR = Y(I) - YEST(I)
58          SUMERR = SUMERR + ERR
```

```
      TOTERR = TOTERR + ABS(ERR)
   23   CCNTINUE
C
        IF ( N.LE.12) GO TO 440
C                 FIND MEAN ABSOLUTE DEVIATION
C
      CG = MG *(MG-2)
       IF (CG.GT. 0.) GO TO  44
        IF ( CG.LE. 0.) GO TO 440
  440   PRINT 45, KL
   45 FORMAT('0',30X,'DEMAND ANALYSIS,ITEM:',I3/30X,'* * * * * * * * * *
     1 * * *'/25X,'THERE ARE TOO FEW ITEMS TO COMPUTE A FORECAST.'/)
        GO TO 560
   44 JNWMD1(1)= TOTERR/SQRT(CG)
C                 TO FORECAST,THE (N+1)TH. PERIOD VALUES ARE:
C                   FORECAST= YEST(MG) ;TREND = B ; MAD =JNWMD1.
C
        PRINT 28,KL
   28 FORMAT('1',40X,'DEMAND DATA,ITEM : ',I3/41X,'* * * * * * * * * *
     1 *'/)
        PRINT 41
   41 FORMAT('0',36X,'INITIAL SIMULATION: BRUSTART.'/36X,'* * * * * *
     1* * * * * * * *'/)
       PRINT 55
   55 FORMAT ('0',21X,'PERIOD           DEMAND           FORECAST
     1 ERROR'/22X,'******           ******          ********          ***
     2**')
       DO 57 I=1,MG
       ERR = Y(I)- YEST(I)
        PRINT 58, I,Y(I),YEST(I),ERR
   58 FORMAT('0',22X,I2,13X,F5.0,10X,F8.2,8X,F8.2)
   57 CONTINUE
       IF(TCTERR.LE.0.) TOTERR = 1.
        BALER = (SUMERR * 100.)/ (TOTERR* 0.5)
C                 THIS MEASURES RELATIVE OVERALL ERROR
        PRINT 61
   61 FORMAT('0',31X,'THE VALUES OF THE FIRST FORECAST ARE:')
        PRINT 63,YEST(MG),B,JNWMD1(1),BALER,YBAR,STDEV
   63 FORMAT('0',22X,'FORECAST =',1X,F7.1,1X,'TREND VALUE =',1X,F7.3,1X,
     1 'M.A.D. = ',1X,F7.1 / 31X,'AND PERCENTAGE BALANCED ERROR =', 1X,
     2 F6.2/23X,'MEAN OF DEMAND DATA: ',F7.2,1X,'AND STD. DEV. IS:'
     3,1X, F7.2/)
        PRINT 213
  213  FORMAT('0',24X,'IDENTIFICATION OF OUTLIERS: 3 S.D. BEYOND MEAN'/)
         PRINT 205
  205  FORMAT('0',30X,'PERIOD       DEMAND        DEVIATION'/31X,
     1 '______      ______        __________'/)
         DO 200 IM=1,N
          DISP = Y(IM) - YBAR
```

```
      IF(ABS(DISP).GT.ST3DEV) PRINT 240,IM,Y(IM),DISP
  240 FORMAT('0',32X,I3,6X,F7.0,6X,F8.0/)
  200   CONTINUE
C
C
C                                          * * * * *
C                                           SIMPAVE
C                                          * * * * *
C                              FORECAST BASED ON THE METHOD OF
C                                       SIMPLE AVERAGES
C
```

```
C
C                 THIS PROGRAMME BEGINS WITH A PRELIMINARY FORECAST:
C                  BRUSTART. SUBSEQUENTLY,EACH MONTHLY FORECAST IS A
C                  SIMPLE AVERAGE OF THE  N  EARLIER MONTHS.
C                  A SELECTION OF FORECASTING ERROR SUMMARIES
C                  AND FORECAST EVALUATIONS ARE INCLUDED.
          ACCUR = 0.
          AVERR = 0.
          BALERR = 0.
          FORAV(1)= 0.
          MADAV(1)= 0.
          MADTCT  = 0.
           SQERR = 0.
          SUMACT = 0.
          SUMERQ = 0.
          SUMFSQ = 0.
          THEIL = 0.
          TOEROR  = 0.
          TOMAD   = 0.
          ZACT = 0.
          ZDISP = 0.
          ZVAR = 0.
          LH = (MG+1)
          LG = (MG+2)
          MLH = (( N-LH) +1)
          MADAV(MG) = JNWMD1(1)
          FORAV(MG) = YEST(MG-1)
           ERRAV(MG) = Y(MG) - FORAV(MG)
          PRDUCT(MG) = (YEST(MG-1)*(MG-1))+Y(MG-1)
         MADAV(MG+1) = JNWMD1(1)
         FORAV(MG+1) = YEST(MG)
         ERRAV(MG+1) =  Y(MG+1)- FORAV(MG+1)
         PRDUCT(MG+1)=  (YEST(MG) *MG) +Y(MG)
         MADTCT  =(JNWMD1(1)* MG)
C                 ABOVE CARRIES FORWARD VALUES FROM BRUSTART
         TOMAD  = TOMAD + MADTOT
         TCERCR = TCEROR+ ERRAV(MG+1)
          PRINT 372
  372 FORMAT('1',44X,'SIMPAVE'/45X,'*******'/36X,'SIMPLE AVERAGE FORECAS
     1TING'/                                                   23X,'COMME
     2NCING WITH ESTIMATES MADE BY BRUSTART PROGRAM.'/46X,'*******'/)
          PRINT 373,KL
  373 FORMAT('0',33X,'DEMAND ANALYSIS,ITEM:',   I3,1X,'SIMPAVE'/34X,'* *
     1 * * * * * * * * * * * * * * *'/)
          PRINT 374
 374  FORMAT('0',23X,'PERICD',12X,'ACTUAL',4X,'SIGNED'/  25X,'NUMBER FOR
     1ECAST  DEMAND    ERROR        M.A.D.'/24X,'_ _ _ _ _ _ _ _ _ _ _ _
     2_ _ _ _ _ _ _ _ _ _ _ _'/)
C
```

```
 TCEROR = 0.
 MADTOT = 0.
DO 370  II =LH,N
PRDUCT(II) = PRDUCT(II-1) +Y(II-1)
FORAV(II)  = PRDUCT(II)/(II-1)
ERRAV(II)  = Y(II)-FORAV(II)
 SQER(II) = (ERRAV(II)** 2)
 SQERR = SQERR + SQER(II)
MADTOT  =MADTOT + ABS(ERRAV(II))
MADAV(II) = MADTOT /(II-1)
TOMAD =TOMAD + ABS(ERRAV(II))
```

```
      TOERCR= TCEROR +ERRAV(II)
       ERSQ = (ERRAV(II)**2)
       SUMERQ = SUMERQ + ERSQ
       FORSQ = (FORAV(II) **2)
       SUMFSQ = SUMFSQ + FORSQ
       ACTSQ = (Y(II) **2)
       SUMACT = SUMACT + ACTSQ
       EMSQ = SQRT((SQERR/MLH))
C               MEAN SQUARE ERROR
       PRINT 376, II,FORAV(II), Y(II),ERRAV(II),MADAV(II)
  376 FORMAT('0',25X,I2,3X,F8.2,2X,F7.0,2X,F8.1,4X,F8.1 )
  370  CCNTINUE
       ZVAR = SUMERQ/MLH
       ZDISP = SUMFSQ/MLH
       ZACT = SUMACT/MLH
       THEIL = (SQRT(ZVAR))/ ((SQRT(ZDISP)) + (SQRT(ZACT)))
       IF(MADTOT.LE.0.) MACTOT = 1.
      MADSUM = TOMAD/N-1
       AVERR = TOEROR/MLH
C               MEAN OF SIGNED ERRORS
       BALERR = (TOEROR * 100.) / (MADTOT * 0.5)
C               BALERR   PERCENTAGE ERROR RATING.
       ACCUR = ((MADSUM/YBAR)*100.)
        PRINT 380, AVERR,BALERR,MADSUM,TOEROR
  380  FORMAT('0',23X,'FORECASTING ERRORS AND FORECAST EVALUATION'/24X,'*
     1 * * * * * * * * * * * * * * * * * * * *'/24X,'AVERAGE CUMULATIVE
     2SIGNED ERROR : ',F9.1/24X,'PERCENTAGE BALANCED ERROR : ',8X,F7.1/
     324X,'CVERALL MEAN ABSOLUTE DEVIATION :  ',F8.1/24X,'TOTAL SIGNED E
     4RROR                 :  ',F8.1)
       PRINT 371, EMSQ,THEIL
  371  FORMAT('0',23X,'ROOT MEAN SQUARE ERROR            :  ',F8.1/24X,'THE
     2IL COEFFICIENT                :           ',F5.2)
C
       IF(ABS(THEIL).LT.0.10) GO TO 70
       IF(ABS(THEIL).LT.0.25)  GO TO 34
       IF(ABS(THEIL).LE. 0.65) GO TO 35
       IF(ABS(THEIL).GT.0.65)  GC TO 32
   70  PRINT 71
   71  FORMAT('0',23X,'THEIL INDICATES HIGH FORECASTING ABILITY.'/)
       GO TO 37
   34  PRINT  36
   36  FORMAT('0',23X,'THIS VALUE SUGGESTS A FAIRLY ACCURATE FORECAST.')
       GO TO  37
   32  PRINT  38
   38  FORMAT('0',23X,'THIS VALUE SUGGESTS A RATHER POOR FORECAST.' )
       GO TO 37
   35  PRINT  39
   39  FORMAT('0',23X,'THIS VALUE INDICATES MODERATE FORECASTING EFFICIEN
     1CY.' )
```

```
   37 CONTINUE
      CUMER = 0.
      SAMICO = 0.
      DO 48  JJJ = MG,N
      SAMICO = SAMICO + Y(JJJ)
   48 CONTINUE
      KYL = ((N-MG) - 1)
      SYL = FLOAT(KYL)
      CUMER = TOMAD/SYL
      DAMICO = ((SAMICO/SYL)/(CUMER*1.25))
       PRINT  68,  DAMICO ,ACCUR
```

```
 68  FORMAT('0',23X,'FORECASTABILITY INDEX              :          ',F4.1/24X,
    1'ACCURACY PERCENTAGE                  :    ',F8.2/)
     IF ( DAMICO.LT.1.5 ) GO TO  53
     IF ( DAMICO.LE. 2.5) GO TO 56
     IF ( DAMICO.GT. 2.5) GO TO 64
 53  PRINT  54
 54  FORMAT('0',29X,'THE FORECASTABILITY INDEX IS LOW.'/24X,'A MANUAL
    1SYSTEM MAY BE PREFERRED FOR THIS ITEM.'/)
     GO TO  67
 56  PRINT  59
 59  FORMAT('0',23X,'THE FORECASTABILITY INDEX SUGGESTS THAT THE METHO
    1D'/24X,'SHOULD GIVE REASONABLE RESULTS FOR THIS ITEM.'/)
     GO TO 67
 64  PRINT  66
 66  FORMAT('0',29X,'THE FORECASTABILITY INDEX IS HIGH.'/21X,'THIS SUG
    1GESTS THAT THE METHOD IS VERY EFFECTIVE.'/)
 67  CONTINUE
C
C             TO TEST TREND, USING A METHOD ADVOCATED BY WHYBARK :
C             SEE R.DANCER AND C. GRAY, AN EMPIRICAL EVALUATION
C             OF CONSTANT AND ADAPTIVE COMPUTER FORECASTING
C             MODELS FOR INVENTORY CONTROL.  DECISION SCIENCES
C             8 JAN., 1977, 228-238 .
C
     CALL TRENDY (YBAR,N,Y)
C
C
C                                     * * * * *
C                                      LASTAVE
C                                     * * * * *
C                             FORECAST THE SAME AS LAST ACTUAL
C                                      -------
C
C
C             THIS METHOD SIMPLY USES LAST MONTH DEMAND TO REPRESENT
C              THE NEXT MONTH FORECAST. FOR THIS, NO PRELIMINARY
C                           ESTIMATES ARE REQUIRED
C                                      -------
C
     PRINT 271
 271 FORMAT('1',39X,'LASTAVE'/40X,'*******'/21X,'THIS MONTH FORECAST IS
    1 SAME AS LAST MONTH DEMAND.'/)
     PRINT 272,KL
 272 FORMAT ('0',26X,'DEMAND ANALYSIS,ITEM:',1X,I3,1X,'LASTAVE'/27X,'*
    1* * * * * * * * * * * * * * *'/)
     PRINT 273
 273 FORMAT('0',21X,'PERIOD',12X,'ACTUAL',4X,'SIGNED' /22X,'NUMBER  FOR
    1ECAST  DEMAND     ERROR      M.A.D.'/22X,'______  ________  ______
    2  _____        ______'/)
C
```

```
      ABSER(1) = 0.
  ALLAV = 0.
  ALLER =0.
  ALLMAD=0.
   BACCUR = 0.
  BALR = 0.
  RTMSE = 0.
   THEL = 0.
  TQERR = 0.
  TUMACT = 0.
   TUMERQ = 0.
```

```
      TUMFSQ = 0.
      WACT = 0.
      WVAR = 0.
      WDISP = 0.
C
      DO 270 IJ=2,N
      PREDIC(IJ) =Y(IJ-1)
      WRONG(IJ)  =Y(IJ)-PREDIC(IJ)
      ABSER(IJ)  = ABS(WRONG(IJ))+ABSER(IJ-1)
      ABSAV(IJ)  =ABSER(IJ) / (IJ-1)
      ALLER = ALLER + WRONG(IJ)
       TQER(IJ) = (WRONG(IJ) **2)
       TQERR = TQERR + TQER(IJ)
       ALLMAD = ALLMAD + ABS(WRONG(IJ))
       FERSQ = (WRONG(IJ)**2)
        TUMERQ = TUMERQ+FERSQ
       TORSQ = (PREDIC(IJ)**2)
       TUMFSQ = TUMFSQ + TORSQ
       WACTSQ = (Y(IJ)**2)
        TUMACT = TUMACT + WACTSQ
       PRINT 274,IJ,PREDIC(IJ),Y(IJ),WRONG(IJ),ABSAV(IJ)
  274 FORMAT('0',23X,I2,3X,F8.2,2X,F7.0,2X,F8.1,2X,F8.1)
  270   CONTINUE
       ALLAV = ALLER /(N-1)
       RTMSE = (SQRT(TUMERQ/(N-1) ))
       WVAR = TUMERQ/(N-1)
        WDISP = TUMFSQ /(N-1)
        WACT = TUMACT / (N-1)
       THEL = (SQRT(WVAR))/((SQRT (WDISP)) + (SQRT(WACT)))
       IF (ABSER(N).LE.0.) ABSER(N)= 1.
       BALR = (ALLER * 100.)/(ABSER(N)* 0.5)
      AVMAD = ALLMAD/(N-1)
       FMSQ = SQRT((TQERR/(N-1) ))
C             FMSQ  MEAN SQUARE ERROR
C             AVMAD     AVERAGE M.A.D. END OF LASTAVE RUN
        BACCUR  = ((AVMAD/YBAR)*100.)
       PRINT 275, ALLAV,BALR,AVMAD,ALLER
  275 FORMAT('0',23X,'FORECASTING ERRORS AND FORECAST EVALUATION.'/24X,
     1'* * * * * * * * * * * * * * * * * * *'/24X,'AVERAGE CUMULATIV
     2E SIGNED ERROR : ',F8.1/24X,'PERCENTAGE BALANCED ERROR : ',8X,F7.2
     3/24X,'OVERALL MEAN ABSOLUTE DEVIATION :  ',F7.1/24X,'TOTAL SIGNED
     4ERROR                   : ', F8.1)
       PRINT 601, RTMSE, THEL
  601 FORMAT('0',23X,'ROOT MEAN SQUARE ERROR',10X,':',F9.1 /24X,'THEIL C
     1OEFFICIENT',15X,':         ' ,F6.2)
       IF(ABS(THEL) .LT.0.10) GO TO 680
       IF(ABS(THEL ).LT.0.25)  GO TO 634
       IF(ABS(THEL).LE.0.65)  GO TO 635
       IF(ABS(THEL ).GT.0.65)  GO TO 632
```

```
680    PRINT 681
681   FORMAT('0',26X,'THEIL INDICATES A VERY ACCURATE FORECAST.'/)
        GO TO 637
634   PRINT 636
636   FORMAT('0',26X,'THIS VALUE SUGGESTS A FAIRLY ACCURATE FORECAST.'/
     1  )
      GO TO 637
632   PRINT  638
638   FORMAT('0',26X,'THIS VALUE SUGGESTS A RATHER POOR FORECAST.'/)
      GO TO 637
635   PRINT 639
```

```
639  FORMAT('0',20X,'THIS VALUE INDICATES MODERATE FORECASTING EFFICIEN
    1CY.'/)
637   CONTINUE
      TUMER = 0.
      TAMICO = 0.
      DO 648  JJJ= 2,N
      TAMICO = TAMICO + Y(JJJ)
648   CONTINUE
      KZL = (N-3)
      TYL = FLOAT(KZL)
      TUMER = ALLMAD/TYL
      ZAMICO = ((TAMICO/TYL)/(TUMER*1.25))
       PRINT 668,  ZAMICO, BACCUR
668  FORMAT('0',23X,'FORECASTABILITY INDEX',11X,':',5X,F4.1/24X,'ACCURA
    1CY PERCENTAGE',13X,':       ',F6.2)
      IF ( ZAMICO.LT.1.5 ) GO TO 653
      IF ( ZAMICO.LE. 2.5) GO TO  656
      IF ( ZAMICO.GT. 2.5) GO TO 664
653   PRINT 654
654   FORMAT('0',23X,'THE FORECASTABILITY INDEX IS LOW. A MANUAL'/24X,
    1'SYSTEM MAY BE PREFERRED FOR THIS ITEM.'/)
      GO TO 667
656   PRINT 659
659   FORMAT('0',23X,'THE FORECASTABILITY INDEX SUGGESTS THAT THE METHO
    1D'/24X,'SHOULD GIVE REASONABLE RESULTS FOR THIS ITEM.'/)
      GO TO 667
664   PRINT 666
666   FORMAT('0',23X,'THE FORECASTABILITY INDEX IS HIGH.'/24X,'THIS SUG
    1GESTS THAT THE METHOD IS VERY EFFECTIVE.'/)
667   CONTINUE
 560  CONTINUE
      STOP
      END

      SUBROUTINE TRENDY (YBAR,N,X)
C             THE WHYBARK METHOD OF TESTING FOR TREND.
C
C             CALCULATES THE DEVIATION FROM THE REGRESSION LINE,
C             AND USES A  T  TEST FOR SIGNIFICANCE.
      DIMENSION XJ(100), X(100)
      A = 0.
      B = 0.
      BB = 0.
      BS = 0.
      D = 0.
      SB = 0.
      SUMXJ = 0.
      T = 0.
      DO 10 I=1,N
```

```
          XJ(I) = X(I) * I
          SUMXJ = SUMXJ + XJ(I)
   10     CONTINUE
          AN = N
          D = SUMXJ /AN
C                 THE SLOPE OF THE LINE
          B=(6./(AN-1. )) * (((2. * D)/(AN+1.)) - YBAR)
          A =(4.* YBAR) +((6./( AN-1.)) * (YBAR-D ))
          DO 20 I=1,N
          BB = (X(I)-A-(B*I))**2
          BS = BS + BB
```

```
   20    CONTINUE
         SB = SQRT((BS/(AN-2.))* ( 12./ (AN*((AN**2 ) -1. ))))
         IF (SB.LE.0.00) SB = 0.01
         T = B / SB
         NDF = (N-2)
         PRINT 28
   28    FORMAT('0',35X,'WHYBARK TREND TEST'/35X,'* * * * * * * * * * *'/)
         PRINT 25,B,A, SB
   25    FORMAT('0',24X,'THE SLOPE AND INTERCEPT VALUES ARE :'/30X,
        1F9.4,1X,'AND ',F9.4/25X,'AND THE STANDARD ERROR OF REGRESSION :',
        2 F9.4/)
         PRINT 30,NDF,T
   30    FORMAT('0',24X,'WITH ',I3,' DEGREES OF FREEDOM,THE COMPUTED'
        1/25X,'T TEST VALUE, AT .01 IS ',F9.4/)
         RETURN
         END
C
C
C                    * * * * * * * * * * * * * *
C                       END OF PROGRAMMES :
C                    BRUSTART, SIMPAVE, LASTAVE
C                    * * * * * * * * * * * * * *

$ENTRY
```

DEMAND DATA.ITEM : 1
* * * * * * * * * * * *

INITIAL SIMULATION: BRUSTART.
* * * * * * * * * * * * * * * *

PERIOD ******	DEMAND ******	FORECAST ********	ERROR *****
1	1222.	1342.00	-120.00
2	1707.	1340.56	366.44
3	1229.	1339.12	-110.12
4	1524.	1337.68	186.32
5	1253.	1336.24	-83.24
6	1334.	1334.80	-0.80
7	1560.	1333.36	226.64
8	740.	1331.92	-591.92
9	1125.	1330.48	-205.48
10	1434.	1329.04	104.96
11	1355.	1327.60	27.40
12	1259.	1326.16	-67.16
13	1629.	1324.72	304.28
14	1326.	1323.29	2.71
15	1421.	1321.85	99.15
16	1631.	1320.41	310.59
17	1166.	1318.97	-152.97
18	1257.	1317.53	-60.53

THE VALUES OF THE FIRST FORECAST ARE:

```
FORECAST =  1317.5 TREND VALUE =  -1.439 M.A.D. =     178.0
        AND PERCENTAGE BALANCED ERROR =  15.64
MEAN OF DEMAND DATA: 1771.89 AND STD. DEV. IS:  611.59

  IDENTIFICATION OF OUTLIERS: 3 S.D. BEYOND MEAN

        PERIOD      DEMAND      DEVIATION
        ------      ------      ---------
```

SIMPAVE
****

SIMPLE AVERAGE FORECASTING
COMMENCING WITH ESTIMATES MADE BY BRUSTART PROGRAM.
****

DEMAND ANALYSIS.ITEM: 1 SIMPAVE
* * * * * * * * * * * * * * * * *

PERIOD NUMBER	FORECAST	ACTUAL DEMAND	SIGNED ERROR	M.A.D.
19	1380.30	1673.	292.7	16.3
20	1395.71	1283.	-112.7	21.3
21	1390.07	1316.	-74.1	24.0
22	1386.54	1501.	114.5	28.3
23	1391.75	1399.	7.3	27.3
24	1392.06	1177.	-215.1	35.5
25	1383.10	1236.	-147.1	40.1
26	1377.22	1536.	158.8	44.9
27	1383.32	1406.	22.7	44.0
28	1384.16	1834.	449.8	59.1
29	1400.23	1183.	-217.2	64.7
30	1392.74	430.	-962.7	95.7
31	1360.65	1000.	-360.6	104.5
32	1349.01	1590.	241.0	108.9
33	1356.54	1110.	-246.5	113.2
34	1349.07	2002.	652.9	129.6
35	1368.28	689.	-679.3	145.7

36	1348.87	1237.	-111.9	144.8
37	1345.76	2064.	718.2	160.7
38	1365.17	2272.	906.8	180.9
39	1389.04	2830.	1441.0	214.0
40	1425.99	2311.	885.0	231.2

41	1448.11	2206.	757.9	244.4
42	1466.60	2562.	1095.4	265.2
43	1492.68	1748.	255.3	264.9
44	1498.61	1966.	467.4	269.6
45	1509.24	1896.	386.8	272.3
46	1517.83	2366.	848.2	285.1
47	1536.27	2279.	742.7	295.0
48	1552.07	2244.	691.9	303.5
49	1566.49	2453.	886.5	315.6
50	1584.58	2670.	1085.4	331.3
51	1606.29	2536.	929.7	343.3
52	1624.52	2523.	898.5	354.2
53	1641.80	3026.	1384.2	374.0
54	1667.91	2552.	884.1	383.6
55	1684.28	2289.	604.7	387.7
56	1695.28	2278.	582.7	391.3
57	1705.69	2476.	770.3	398.0
58	1719.20	3032.	1312.8	414.1
59	1741.83	2756.	1014.2	424.4
60	1759.02	2176.	417.0	424.3
61	1765.97	2482.	716.0	429.2
62	1777.71	2090.	312.3	427.2

FORECASTING ERRORS AND FORECAST EVALUATION
* *
AVERAGE CUMULATIVE SIGNED ERROR : 450.2
PERCENTAGE BALANCED ERROR : 152.0
OVERALL MEAN ABSOLUTE DEVIATION : 471.0

```
TOTAL SIGNED ERROR              :   19807.4

ROOT MEAN SQUARE ERROR          :     704.8
THEIL COEFFICIENT               :      0.20

THIS VALUE SUGGESTS A FAIRLY ACCURATE FORECAST.

FORECASTABILITY INDEX           :       2.4
ACCURACY PERCENTAGE             :     26.58
```

```
THE FORECASTABILITY INDEX SUGGESTS THAT THE METHOD
SHOULD GIVE REASONABLE RESULTS FOR THIS ITEM.

          WHYBARK TREND TEST
         * * * * * * * * * *

 THE SLOPE AND INTERCEPT VALUES ARE :
       25.2547 AND  976.3633
 AND THE STANDARD ERROR OF REGRESSION :   2.9192

 WITH  60 DEGREES OF FREEDOM,THE COMPUTED
 T TEST VALUE, AT .01 IS    8.6512
```

LASTAVE
****
THIS MONTH FORECAST IS SAME AS LAST MONTH DEMAND.

DEMAND ANALYSIS,ITEM: 1 LASTAVE
* * * * * * * * * * * * * * * * *

PERIOD NUMBER	FORECAST	ACTUAL DEMAND	SIGNED ERROR	M.A.D.
2	1222.00	1707.	485.0	485.0
3	1707.00	1229.	-478.0	481.5
4	1229.00	1524.	295.0	419.3
5	1524.00	1253.	-271.0	382.3
6	1253.00	1334.	81.0	322.0
7	1334.00	1560.	226.0	306.0
8	1560.00	740.	-820.0	379.4
9	740.00	1125.	385.0	380.1
10	1125.00	1434.	309.0	372.2
11	1434.00	1355.	-79.0	342.9
12	1355.00	1259.	-96.0	320.5
13	1259.00	1629.	370.0	324.6
14	1629.00	1326.	-303.0	322.9
15	1326.00	1421.	95.0	306.6
16	1421.00	1631.	210.0	300.2
17	1631.00	1166.	-465.0	310.5
18	1166.00	1257.	91.0	297.6
19	1257.00	1673.	416.0	304.2

20	1673.00	1283.	-390.0	308.7
21	1283.00	1316.	33.0	294.9
22	1316.00	1501.	185.0	289.7
23	1501.00	1399.	-102.0	281.1
24	1399.00	1177.	-222.0	278.6

25	1177.00	1236.	59.0	269.4
26	1236.00	1536.	300.0	270.6
27	1536.00	1406.	-130.0	265.2
28	1406.00	1834.	428.0	271.3
29	1834.00	1183.	-651.0	284.8
30	1183.00	430.	-753.0	301.0
31	430.00	1000.	570.0	309.9
32	1000.00	1590.	590.0	319.0
33	1590.00	1110.	-480.0	324.0
34	1110.00	2002.	892.0	341.2
35	2002.00	689.	-1313.0	369.8
36	689.00	1237.	548.0	374.9
37	1237.00	2064.	827.0	387.4
38	2064.00	2272.	208.0	382.6
39	2272.00	2830.	558.0	387.2
40	2830.00	2311.	-519.0	390.6
41	2311.00	2206.	-105.0	383.4
42	2206.00	2562.	356.0	382.8
43	2562.00	1748.	-814.0	393.0
44	1748.00	1966.	218.0	389.0
45	1966.00	1896.	-70.0	381.7
46	1896.00	2366.	470.0	383.7
47	2366.00	2279.	-87.0	377.2
48	2279.00	2244.	-35.0	370.0
49	2244.00	2453.	209.0	366.6

50	2453.0C	2670.	217.0	363.6
51	2670.00	2536.	-134.0	359.0
52	2536.00	2523.	-13.0	352.2
53	2523.00	3026.	503.0	355.1
54	3026.00	2552.	-474.0	357.3

55	2552.0C	2289.	-263.0	355.6
56	2289.00	2278.	-11.0	349.3
57	2278.00	2476.	198.0	346.6
58	2476.0C	3032.	556.0	350.3
59	3032.00	2756.	-276.0	349.0
60	2756.0C	2176.	-580.0	352.9
61	2176.00	2482.	306.0	352.1
62	2482.00	2090.	-392.0	352.8

```
FORECASTING ERRORS AND FORECAST EVALUATION.
* * * * * * * * * * * * * * * * * * * * *
AVERAGE CUMULATIVE SIGNED ERROR :      14.2
PERCENTAGE BALANCED ERROR :             8.07
OVERALL MEAN ABSOLUTE DEVIATION :     352.8
TOTAL SIGNED ERROR              :     868.0

ROOT MEAN SQUARE ERROR          :     436.1
THEIL COEFFICIENT               :       0.12

   THIS VALUE SUGGESTS A FAIRLY ACCURATE FORECAST.

FORECASTABILITY INDEX           :       4.0
ACCURACY PERCENTAGE             :      19.91

THE FORECASTABILITY INDEX IS HIGH.
THIS SUGGESTS THAT THE METHOD IS VERY EFFECTIVE.
```

DEMAND DATA,ITEM : 2
* * * * * * * * * * * *

INITIAL SIMULATION: BRUSTART.
* * * * * * * * * * * * * * * *

PERIOD	DEMAND	FORECAST	ERROR
******	******	********	*****
1	5.	5.53	-0.53
2	6.	5.47	0.53
3	6.	5.42	0.58
4	0.	5.36	-5.36
5	5.	5.31	-0.31
6	8.	5.25	2.75
7	0.	5.20	-5.20
8	13.	5.14	7.86
9	6.	5.09	0.91
10	2.	5.04	-3.04
11	5.	4.98	0.02
12	6.	4.93	1.07
13	9.	4.87	4.13
14	7.	4.82	2.18
15	4.	4.76	-0.76
16	8.	4.71	3.29
17	2.	4.65	-2.65
18	0.	4.60	-4.60

THE VALUES OF THE FIRST FORECAST ARE:

SIMPAVE
****
SIMPLE AVERAGE FORECASTING
COMMENCING WITH ESTIMATES MADE BY BRUSTART PROGRAM.
****

DEMAND ANALYSIS, ITEM: 2 SIMPAVE
* * * * * * * * * * * * * * * * *

PERIOD NUMBER	FORECAST	ACTUAL DEMAND	SIGNED ERROR	M.A.D.
19	4.51	5.	0.5	0.0
20	4.53	4.	-0.5	0.1
21	4.50	0.	-4.5	0.3
22	4.29	0.	-4.3	0.5
23	4.10	2.	-2.1	0.5
24	4.00	3.	-1.0	0.6
25	3.96	19.	15.0	1.2
26	4.56	2.	-2.6	1.2
27	4.47	6.	1.5	1.2
28	4.52	0.	-4.5	1.4
29	4.36	5.	0.6	1.3
30	4.38	4.	-0.4	1.3
31	4.37	4.	-0.4	1.3
32	4.36	4.	-0.4	1.2
33	4.35	9.	4.7	1.3
34	4.49	9.	4.5	1.4
35	4.62	9.	4.4	1.5

36	4.75	8.	3.3	1.6
37	4.84	13.	8.2	1.8
38	5.06	11.	5.9	1.9
39	5.21	8.	2.8	1.9
40	5.28	4.	-1.3	1.9

41	5.25	2.	-3.3	1.9
42	5.17	4.	-1.2	1.9
43	5.15	5.	-0.1	1.9
44	5.14	4.	-1.1	1.8
45	5.12	8.	2.9	1.9
46	5.18	5.	-0.2	1.8
47	5.18	12.	6.8	1.9
48	5.32	13.	7.7	2.1
49	5.48	6.	0.5	2.0
50	5.49	10.	4.5	2.1
51	5.58	11.	5.4	2.1
52	5.69	8.	2.3	2.1
53	5.73	6.	0.3	2.1
54	5.74	6.	0.3	2.1
55	5.74	9.	3.3	2.1
56	5.80	8.	2.2	2.1
57	5.84	16.	10.2	2.2
58	6.02	5.	-1.0	2.2
59	6.00	17.	11.0	2.4
60	6.19	6.	-0.2	2.3

FORECASTING ERRORS AND FORECAST EVALUATION
* *

AVERAGE CUMULATIVE SIGNED ERROR	:	1.9
PERCENTAGE BALANCED ERROR	:	115.7
OVERALL MEAN ABSOLUTE DEVIATION	:	2.1
TOTAL SIGNED ERROR	:	79.7
ROOT MEAN SQUARE ERROR	:	4.6
THEIL COEFFICIENT	:	0.35

```
THIS VALUE INDICATES MODERATE FORECASTING EFFICIENCY.

FORECASTABILITY INDEX           :       1.2
ACCURACY PERCENTAGE             :      33.05

      THE FORECASTABILITY INDEX IS LOW.
A MANUAL SYSTEM MAY BE PREFERRED FOR THIS ITEM.
```

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           WHYBARK TREND TEST
          * * * * * * * * * *

THE SLOPE AND INTERCEPT VALUES ARE :
        0.0897 AND     3.6294
AND THE STANDARD ERROR OF REGRESSION :   0.0294

WITH  58 DEGREES OF FREEDOM,THE COMPUTED
T TEST VALUE, AT .01 IS    3.0478
```

LASTAVE
****
THIS MONTH FORECAST IS SAME AS LAST MONTH DEMAND.

DEMAND ANALYSIS, ITEM: 2 LASTAVE
* * * * * * * * * * * * * * * * *

PERIOD NUMBER	FORECAST	ACTUAL DEMAND	SIGNED ERROR	M.A.D.
2	5.00	6.	1.0	1.0
3	6.00	6.	0.0	0.5
4	6.00	0.	-6.0	2.3
5	0.00	5.	5.0	3.0
6	5.00	8.	3.0	3.0
7	8.00	0.	-8.0	3.8
8	0.00	13.	13.0	5.1
9	13.00	6.	-7.0	5.4
10	6.00	2.	-4.0	5.2
11	2.00	5.	3.0	5.0
12	5.00	6.	1.0	4.6
13	6.00	9.	3.0	4.5
14	9.00	7.	-2.0	4.3
15	7.00	4.	-3.0	4.2
16	4.00	8.	4.0	4.2
17	8.00	2.	-6.0	4.3
18	2.00	0.	-2.0	4.2
19	0.00	5.	5.0	4.2

20	5.00	4.	-1.0	4.1
21	4.00	0.	-4.0	4.0
22	0.00	0.	0.0	3.9
23	0.00	2.	2.0	3.8
24	2.00	3.	1.0	3.7

25	3.00	19.	16.0	4.2
26	19.00	2.	-17.0	4.7
27	2.00	6.	4.0	4.7
28	6.00	0.	-6.0	4.7
29	0.00	5.	5.0	4.7
30	5.00	4.	-1.0	4.6
31	4.00	4.	0.0	4.4
32	4.00	4.	0.0	4.3
33	4.00	9.	5.0	4.3
34	9.00	9.	0.0	4.2
35	9.00	9.	0.0	4.1
36	9.00	8.	-1.0	4.0
37	8.00	13.	5.0	4.0
38	13.00	11.	-2.0	3.9
39	11.00	8.	-3.0	3.9
40	8.00	4.	-4.0	3.9
41	4.00	2.	-2.0	3.9
42	2.00	4.	2.0	3.8
43	4.00	5.	1.0	3.8
44	5.00	4.	-1.0	3.7
45	4.00	8.	4.0	3.7
46	8.00	5.	-3.0	3.7
47	5.00	12.	7.0	3.8
48	12.00	13.	1.0	3.7
49	13.00	6.	-7.0	3.8

50	6.00	10.	4.0	3.8
51	10.00	11.	1.0	3.7
52	11.00	8.	-3.0	3.7
53	8.00	6.	-2.0	3.7
54	6.00	6.	0.0	3.6

55	6.00	9.	3.0	3.6
56	9.00	8.	-1.0	3.5
57	8.00	16.	8.0	3.6
58	16.00	5.	-11.0	3.8
59	5.00	17.	12.0	3.9
60	17.00	6.	-11.0	4.0

FORECASTING ERRORS AND FORECAST EVALUATION.
* *

AVERAGE CUMULATIVE SIGNED ERROR	:	0.0
PERCENTAGE BALANCED ERROR	:	0.84
OVERALL MEAN ABSOLUTE DEVIATION	:	4.0
TOTAL SIGNED ERROR	:	1.0
ROOT MEAN SQUARE ERROR	:	5.6
THEIL COEFFICIENT	:	0.36

THIS VALUE INDICATES MODERATE FORECASTING EFFICIENCY.

FORECASTABILITY INDEX	:	1.3
ACCURACY PERCENTAGE	:	63.09

THE FORECASTABILITY INDEX IS LOW. A MANUAL
SYSTEM MAY BE PREFERRED FOR THIS ITEM.

DEMAND DATA,ITEM : 3
* * * * * * * * * * * *

INITIAL SIMULATION: BRUSTART.
* * * * * * * * * * * * * * * *

PERIOD ******	DEMAND ******	FORECAST ********	ERROR *****
1	60.	42.49	17.51
2	38.	43.16	-5.16
3	24.	43.83	-19.83
4	42.	44.50	-2.50
5	39.	45.16	-6.16
6	53.	45.83	7.17
7	68.	46.50	21.50
8	61.	47.17	13.83
9	50.	47.84	2.16
10	42.	48.51	-6.51
11	26.	49.17	-23.17
12	35.	49.84	-14.84
13	82.	50.51	31.49
14	42.	51.18	-9.18
15	19.	51.85	-32.85
16	75.	52.51	22.49
17	57.	53.18	3.32
18	63.	53.85	9.15

THE VALUES OF THE FIRST FORECAST ARE:

SIMPAVE
****
SIMPLE AVERAGE FORECASTING
COMMENCING WITH ESTIMATES MADE BY BRUSTART PROGRAM.
****

DEMAND ANALYSIS,ITEM: 3 SIMPAVE
* * * * * * * * * * * * * * * * *

PERIOD NUMBER	FORECAST	ACTUAL DEMAND	SIGNED ERROR	M.A.D.
19	56.89	93.	36.1	2.0
20	58.79	71.	12.2	2.5
21	59.40	46.	-13.4	3.1
22	58.77	28.	-30.8	4.4
23	57.37	38.	-19.4	5.1
24	56.53	42.	-14.5	5.5
25	55.92	139.	83.1	8.7
26	59.24	75.	15.8	9.0
27	59.85	0.	-59.8	11.0
28	57.63	75.	17.4	11.2
29	58.25	63.	4.7	11.0
30	58.42	48.	-10.4	11.0
31	58.07	142.	83.9	13.4
32	60.78	98.	37.2	14.2
33	61.94	74.	12.1	14.1
34	62.31	62.	-0.3	13.7
35	62.30	29.	-33.3	14.2

36	61.35	60.	-1.3	13.9
37	61.31	108.	46.7	14.8
38	62.57	60.	-2.6	14.5
39	62.50	3.	-59.5	15.6
40	60.98	58.	-3.0	15.3

41	60.90	42.	-18.9	15.4
42	60.44	67.	6.6	15.2
43	60.60	121.	60.4	16.3
44	62.00	68.	6.0	16.0
45	62.14	47.	-15.1	16.0
46	61.80	79.	17.2	16.0
47	62.18	34.	-28.2	16.3
48	61.58	45.	-16.6	16.3
49	61.23	131.	69.8	17.4
50	62.66	97.	34.3	17.8
51	63.34	28.	-35.3	18.1
52	62.65	48.	-14.6	18.0
53	62.37	76.	13.6	18.0
54	62.62	54.	-8.6	17.8
55	62.46	167.	104.5	19.4
56	64.37	63.	-1.4	19.1
57	64.34	85.	20.7	19.1
58	64.70	111.	46.3	19.6
59	65.50	48.	-17.5	19.5
60	65.21	121.	55.8	20.2
61	66.13	141.	74.9	21.1
62	67.36	138.	70.6	21.9
63	68.50	66.	-2.5	21.6
64	68.46	98.	29.5	21.7
65	68.92	87.	18.1	21.6

```
 66      69.20      66.      -3.2       21.4

FORECASTING ERRORS AND FORECAST EVALUATION
* * * * * * * * * * * * * * * * * * * * *
AVERAGE CUMULATIVE SIGNED ERROR :      11.8
PERCENTAGE BALANCED ERROR :            81.7
OVERALL MEAN ABSOLUTE DEVIATION :      24.0
TOTAL SIGNED ERROR              :     567.2

ROOT MEAN SQUARE ERROR          :      38.7
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THEIL COEFFICIENT                   :        0.27

THIS VALUE INDICATES MODERATE FORECASTING EFFICIENCY.

FORECASTABILITY INDEX               :        1.7
ACCURACY PERCENTAGE                 :       35.92

THE FORECASTABILITY INDEX SUGGESTS THAT THE METHOD
SHOULD GIVE REASONABLE RESULTS FOR THIS ITEM.

          *HYBARK TREND TEST
         * * * * * * * * * *

 THE SLOPE AND INTERCEPT VALUES ARE :
        0.7605 AND    41.4335
 AND THE STANDARD ERROR OF REGRESSION :    0.2076

 WITH  64 DEGREES OF FREEDOM,THE COMPUTED
 T TEST VALUE, AT .01 IS     3.6633
```

LASTAVE
****
THIS MONTH FORECAST IS SAME AS LAST MONTH DEMAND.

DEMAND ANALYSIS.ITEM: 3 LASTAVE
* * * * * * * * * * * * * * * * *

PERIOD NUMBER	FORECAST	ACTUAL DEMAND	SIGNED ERROR	M.A.D.
2	60.00	38.	-22.0	22.0
3	38.00	24.	-14.0	18.0
4	24.00	42.	18.0	18.0
5	42.00	39.	-3.0	14.3
6	39.00	53.	14.0	14.2
7	53.00	68.	15.0	14.3
8	68.00	61.	-7.0	13.3
9	61.00	50.	-11.0	13.0
10	50.0C	42.	-8.0	12.4
11	42.00	26.	-16.0	12.8
12	26.00	35.	9.0	12.5
13	35.00	82.	47.0	15.3
14	82.00	42.	-40.0	17.2
15	42.00	19.	-23.0	17.6
16	19.00	75.	56.0	20.2
17	75.00	57.	-18.0	20.1
18	57.0C	63.	6.0	19.2
19	63.00	93.	30.0	19.8

20	93.00	71.	-22.0	19.9
21	71.00	46.	-25.0	20.2
22	46.00	28.	-18.0	20.1
23	28.00	38.	10.0	19.6
24	38.00	42.	4.0	19.0

25	42.00	139.	97.0	22.2
26	139.00	75.	-64.0	23.9
27	75.00	0.	-75.0	25.8
28	0.00	75.	75.0	27.7
29	75.00	63.	-12.0	27.1
30	63.00	48.	-15.0	26.7
31	48.00	142.	94.0	28.9
32	142.00	98.	-44.0	29.4
33	98.00	74.	-24.0	29.3
34	74.00	62.	-12.0	28.7
35	62.00	29.	-33.0	28.9
36	29.00	60.	31.0	28.9
37	60.00	108.	48.0	29.4
38	108.00	60.	-48.0	29.9
39	60.00	3.	-57.0	30.7
40	3.00	58.	55.0	31.3
41	58.00	42.	-16.0	30.9
42	42.00	67.	25.0	30.8
43	67.00	121.	54.0	31.3
44	121.00	68.	-53.0	31.8
45	68.00	47.	-21.0	31.6
46	47.00	79.	32.0	31.6
47	79.00	34.	-45.0	31.9
48	34.00	45.	11.0	31.4
49	45.00	131.	86.0	32.6

50	131.00	97.	-34.0	32.6
51	97.00	28.	-69.0	33.3
52	28.00	48.	20.0	33.1
53	48.00	76.	28.0	33.0
54	76.00	54.	-22.0	32.8

363

55	54.00	167.	113.0	34.2
56	167.00	63.	-104.0	35.5
57	63.00	85.	22.0	35.3
58	85.00	111.	26.0	35.1
59	111.00	48.	-63.0	35.6
60	48.00	121.	73.0	36.2
61	121.00	141.	20.0	35.9
62	141.00	138.	-3.0	35.4
63	138.00	66.	-72.0	36.0
64	66.00	98.	32.0	35.9
65	98.00	87.	-11.0	35.5
66	87.00	66.	-21.0	35.3

```
FORECASTING ERRORS AND FORECAST EVALUATION.
* * * * * * * * * * * * * * * * * * * * * *
AVERAGE CUMULATIVE SIGNED ERROR :         0.1
PERCENTAGE BALANCED ERROR :               0.52
OVERALL MEAN ABSOLUTE DEVIATION :        35.3
TOTAL SIGNED ERROR              :         6.0

ROOT MEAN SQUARE ERROR          :        44.4
THEIL COEFFICIENT               :         0.29

THIS VALUE INDICATES MODERATE FORECASTING EFFICIENCY.

FORECASTABILITY INDEX           :         1.5
ACCURACY PERCENTAGE             :        52.79

THE FORECASTABILITY INDEX SUGGESTS THAT THE METHOD
SHOULD GIVE REASONABLE RESULTS FOR THIS ITEM.

ORE USAGE      OBJECT CODE=   16848 BYTES,ARRAY AREA=    6496 BYTES,TOTAL AREA AVAILABLE=  102400  BYTES
IAGNOSTICS       NUMBER OF ERRORS=        0, NUMBER OF WARNINGS=        0, NUMBER OF EXTENSIONS=       0
OMPILE TIME=   21.49 SEC,EXECUTION TIME=   22.80 SEC,  WATFIV - JUL 1973 V1L4       4.51.51    TUESDAY      27 SE
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$JOB              ,PAGES=400,TIME=720
C
C
C
C              SIMPLE FORECASTING METHODS
C
C                        * * * *
C                         LINFOR
C                        * * * *
C
C               LINE OF BEST FIT FORECAST
C               -------------------------
C
C
C
C         PROGRAM COMPUTES LINE OF BEST FIT & FORECAST.
C         IT INCLUDES TREND AND SEASONALS; DESEASONALIZED
C         VALUES,AND FORECASTS WITH ERROR MEASUREMENT.
C          A ROUGH EVALUATION IS GIVEN WITH THEIL'S
C          COEFFICIENT :SEE BRUFICH FOR DESCRIPTION.
C         LINFOR CAN BE USED AS A FORECAST,OR AS INPUT
C         OF PRELIMINARY DATA TO BRUFICH.
C
C                   DICTIONARY
C                   ----------
C         AMAD      AVERAGE ABSOLUTE ERROR (FORECAST SECTOR)
C         AVER      AVERAGE OF SIGNED ERRORS
C         BALDR     PERCENT BALANCED ERROR, SEAS. ADJUSTED
C         BALERR    PERCENT BALANCED ERROR, UNADJUSTED DATA
C         BALLR     BALANCED ERROR (FORECAST SECTOR)
C         CYCBAS    SEASONAL RATIO
C         DESES     DESEASONALIZED DATA
C         DSEROR    ERROR (ACTUAL - DESEAS. VALUES)
C         EMSQ      MEAN SQUARE ERROR
C         ERR       DIFFERENCE (ACTUAL - TREND)
C         ERROR     ACTUAL - FORECAST
C         FORX      FORECAST FOR COMING 12 MONTHS
C         ML        NUMBER OF SETS OF DATA
C         N    DATA QUANTITY IN ITEM UNDER REVIEW
C         NN   COUNTER FOR LEAST SQUARES LOOP
C               (PREFERABLY 24 OF 36 PERIODS)
C         PEROR      SUM OF SIGNED ERRORS
C         PRMAD    OVERALL ABS.ERROR AVERAGE (PRELIM)
C         SEASER   SUM OF DESEASONALIZED ERRORS
C         SMAD     AVERAGE ABSOLUTE ERROR (FORECAST,DESEAS.)
C         SQERR     SUM OF SQUARED ERRORS
C         STDERR   STATISTICAL STANDARD ERROR
C         SUMERQ   RUNNING TOTAL OF SQUARED ERRORS
C         SUMFSQ   TOTAL, SQUARED FORECAST VALUES
C         SUMACT   TOTAL, SQUARED ACTUAL VALUES
```

```
C                 SUMDSR   TOTAL OF SIGNED. SEAS. ADJUSTED ERRORS
C                 SUMER     TOTAL OF UNADJUSTED SIGNED ERRORS
C                 THEIL    MEASURE OF FORECAST ACCURACY
C                 TOTER    SUM OF ABSOLUTE ERRORS (FORECAST SECTOR)
C                 TOTERR   SUM OF ABSOLUTE ERRORS (TREND SECTOR)
C                 X(I)     NUMBER OF PERIODS OF DATA
C                 Y(I)     ACTUAL DEMAND DATA FOR N MONTHS
C                 YEST     TREND VALUES BASED ON LINE
C                 ZACT     COMPONENT OF THEIL FORMULA
C                 ZDISP    COMPONENT OF THEIL FORMULA
C                 ZVAR     COMPONENT OF THEIL FORMULA
```

```
C
C                             DATA SEQUENCE
C                             -------------
C                        ML
C                        HOSP
C                        DATES(NOT USED IN PROGRAM)
C                        N
C                        X(I) PERIOD COUNTER (1 TO N):NOT CARD READ
C                        Y(I) ACTUAL DATA
C                        XLCL,CI  (NOT USED)
C
      DIMENSION RATIO(100),K(100),CYCBAS(100),X(100),Y(100)
      DIMENSION FORX(100), DESES(100), YEST(100)
      DIMENSICN HOSP(20),DATES(20),SQER(100)
       PRINT 110
  110 FORMAT('1',31X,'LINE OF BEST FIT FORECASTING'/42X,'LINFOR'/41X,'**
     1******'/)
       READ,ML
      DO 4 J=1,ML
       PRINT 101,J
  101 FORMAT('1',34X,'FORECAST FOR ITEM',    I3 )
       READ 23,HOSP
   23 FORMAT (20A4)
       PRINT 51,HOSP
   51 FORMAT('0',20A4/)
       READ 25,DATES
   25 FORMAT(20A4)
C                 DATES ARE NOT PRINTED
       PRINT 100
  100 FORMAT('0',35X,'* * * * * * * * * * '/)
       READ,N
C
C                  X(I) NUMBERS THE MONTHS
      DO 18 I=1,N
   18 X(I) =I
      READ 105, (Y(I),I=1,N)
  105 FORMAT (12F6.0)
      READ,XLCL,CI
C                  NOT USED IN PROGRAM
       PRINT 1
    1 FORMAT('0',36X,'LINE OF BEST FIT'/37X,'- - - - - - - - -'/)
       PRINT 32
   32 FCRMAT('0',21X,'PERICD  ACTUAL DATA   TREND        RATIO         ERR
     1OR'/)
       IF (N.LT.18) GO TO 150
C                  THE SUM OF SQUARES CALCULATION
C
        AVEP = 0.
        BALDR = 0.
```

```
      BALERR = 0.
      BALLR = 0.
      PEROR = 0.
     SEASER =0.
      SQERR = 0.
     SUMACT =0.
      SUMDSR = 0.
      SUMER = 0.
     SUMERQ =0.
     SUMFSQ =0.
     SUMX=0.
```

```
      SUMXY  =0.
      SUMXSQ =0.
      SUMY=0.
      SUMYSQ =0.
      TOTER  =0.
      TOTERR =0.
      NN = N-12
      DO 2 I=1,NN
      SUMX= SUMX + X(I)
      SUMY= SUMY + Y(I)
      SUMXY= SUMXY + X(I)* Y(I)
      SUMYSQ = SUMYSQ +Y(I)*Y(I)
    2 SUMXSQ = SUMXSQ +X(I)*X(I)
      XBAR =  SUMX/NN
      YBAR =  SUMY/NN
C
C              THE SLOPE AND INTERCEPT ARE CALCULATED
C
      B = (SUMXY -(XBAR*SUMY))/ (SUMXSQ -(XBAR *SUMX))
      A =  YBAR -(B * XBAR)
C
C              THE STANDARD ERROR
C
      STDERR = SQRT(SUMYSQ -(A*SUMY)- (B*SUMXY)) /(NN-2)
C
C              SEASONAL INDEX BY RATIO TO TREND METHOD
      DO 3 I= 1,NN
      YEST(I)  =A+B *(I-1)
      RATIO(I) = Y(I) /YEST(I)
C              MEASURE DIFFERENCE BETWEEN ACTUAL AND TREND
C
      ERR =  Y(I)-YEST(I)
       PEROR = PEROR + ERR
      K(I) = X(I)
       SQER(I) = (ERR**2)
       SQERR = SQERR + SQER(I)
       PRINT 5, K(I),Y(I), YEST(I), RATIO(I),ERR
    5 FORMAT (23X,I3,5X,F6.0,4X,F8.2,4X,F8.2,4X,F9.2)
      TOTERR =TOTERR +ABS(ERR)
    3  CONTINUE
       AVER = PEROR/NN
       BALLR = ((PEROR * 100.)/ (TOTERR * 0.5))
C              BALANCED ERRORS FOR FORECAST SECTION
C
C              TO COMPUTE SEASONAL RATIO :
       IF (NN.GE.48) GO TO 160
       IF (NN.LT.24) GO TO 30
       IF (NN.LE.35) GO TO 40
       IF (NN.GE.36) GO TO 50
```

```
      CONTINUE
30   DO 33 I =1,12
     CYCBAS(I)= RATIO(I)
       IF(CYCBAS(I).LT.0.10) CYCBAS(I) = 0.10
33    CONTINUE
     GO TO 82
40   DO 43 I=1,12
     CYCBAS(I) =(RATIO(I)+RATIO(I+12)) /2
      IF (CYCBAS(I) .LT.0.10) CYCBAS(I)= 0.10
43   CONTINUE
     GO TO 82
```

```
 50   DO 53 I=1,12
      CYCBAS(I)  =(RATIO(I) +RATIO(I+12)+RATIO(I+24)) /3
       IF (CYCBAS(I) .LT.0.10) CYCBAS(I)= 0.10
 53   CONTINUE
      GC TC 82
160   IF (NN.GE.60) GO TO 165
      DO 163  I=1,12
      CYCBAS(I) = (RATIO(I)+RATIO(I+12)+RATIO(I+24)+RATIO(I+36)) /4
       IF (CYCBAS(I) .LT.0.10) CYCBAS(I)= 0.10
163   CONTINUE
      GO TO 82
165   DO 168 I=1,12
      CYCBAS(I)= (RATIO(I)+RATIO(I+12)+RATIO(I+24)+RATIO(I+36)+RATIO(I+
     1 48) )/5
       IF (CYCBAS(I) .LT.0.10) CYCBAS(I)= 0.10
168   CONTINUE
 82    CCNTINUE
      PRINT 8, A,B
  8   FORMAT('0',29X,'FORECASTING EVALUATION AND ERRORS'/35X,'FOR ALL BU
     1T FINAL YEAR.'/35X,'* * * * * * * * * * *'/26X,'THE EQUATION IS:
     2 Y*= ',F7.2,1X,'+',F7.2,1X,'X'/)
       IF(B-0) 11,13,15
 11    PRINT 12
 12   FORMAT( 30X,' THE LINE HAS A DOWNWARD SLOPE'/)
      GO TO 17
 13   PRINT 14
 14   FORMAT( 30X,'THE LINE SUGGESTS LITTLE TREND'/)
      GO TC 17
 15    PRINT 16
 16   FORMAT(30X,'THE LINE SHOWS POSITIVE SLOPE'/)
      GO TO 17
 17    CONTINUE
C
C                 CALCULATE PRELIMINARY M.A.D.
C
       CN = NN*(NN-2)
       PRMAD = TOTERR/ SQRT(CN)
        EMSQ = SQRT(SQERR/NN)
        PRINT 55,STDERR, PRMAD, EMSQ, AVER, PEROR, BALLR
 55     FORMAT('0',25X,'STANDARD ERROR',13X,':', F8.1/26X,'MEAN ABSOLUTE
     1DEVIATION     :',F8.1/26X,'ROOT MEAN SQUARE ERROR',5X,': ',F7.1/
     2 26X,'AVERAGE CUM. SIGNED ERROR :',F9.1/26X,'TOTAL SIGNED ERROR
     3      :',F9.1/26X,'PERCENTAGE BALANCED ERROR    :',F7.1/)
 45     PRINT 46
 46    FORMAT ('0',36X,'SEASONAL INDEX'/37X,'**************'/)
        IF (NN.LT.12) PRINT 70
 70    FCRMAT('0',18X,'WARNING  THIS IS BASED ON LIMITED DATA'/)
 47     PRINT 48, (CYCBAS(I),I=1,12)
 48    FORMAT( 38X,F9.4)
```

```
   60   PRINT 61
   61  FORMAT('0',22X,'SEASONAL',29X,'DESEASONALISED  SEAS.ADJ.'/ 19X,
      1'FORECAST AHEAD   ACTUAL DATA      ERROR      FORECAST     ERROR'
      2/)
C                FORECASTS FOR THE YEAR AHEAD ARE SEASONALLY ADJUSTED,
C                BY USE OF THE APPROPRIATE BASE SERIES VALUE
C                APPLIED EACH MONTH TO THE STRAIGHT LINE VALUE.
C
        MN =NN+1
        KN= NN+12
     90 DO 83 I= MN,KN
```

```
C                     USE BASE SERIES HERE. TO AVOID ZERO,GIVE A
C                     SMALL POSITIVE QUANTITY IF NECESSARY.
C
          IF (CYCBAS((I) -NN).LT. 0.001) CYCBAS((I)-NN) =0.100
          FORX(I) =(A+ (B *(I))) * CYCBAS((I) -NN)
C
C                     DESEASONALISED VALUES ARE ALSO COMPUTED.
C                     AMENDING THE ACTUAL DEMAND BY MEANS OF
C                     THE BASE SERIES VALUE.
C
          DESES(I) =Y(I) /(CYCEAS((I)- NN))
          DSEROR   =Y(I)-DESES(I)
           SUMDSR = SUMDSR + DSEROR
          DN =(N-NN)*((N-NN)-2 )
          SEASER = SEASER + ABS(DSEROR)
          ERRCR  =Y(I) -FORX(I)
           SUMER = SUMER + ERRCR
          ERSQ   =(ERROR**2)
          FORSQ  =(FORX(I)**2)
          ACTSQ  =((Y(I))**2)
          TOTER  =TOTER +ABS(ERROR)
          SUMERQ = SUMERQ +ERSQ
          SUMACT = SUMACT +ACTSQ
          SUMFSQ = SUMFSQ +FORSQ
       83  PRINT 54, FORX(I), Y(I), ERROR, DESES(I),DSEROR
       54 FORMAT (22X,F8.1,5X,F8.0,6X,F8.0,6X,F8.1,4X,F8.1)
           CONTINUE
C                     THEIL COEFFICIENT
C
          ZVAR =(SUMERQ)/12
          ZDISP=(SUMFSQ)/12
          ZACT =(SUMACT)/12
          AMAD = TOTER/ SQRT(DN)
           THEIL =(SQRT(ZVAR))/((SQRT(ZDISP))+(SQRT(ZACT)))
C
          SMAC =SEASER/SQRT(DN)
           IF(SEASER.LE.0.) SEASER = 1.
           IF(TOTER .LE.0.) TOTER = 1.
           BALERR = (SUMER * 100.)/(TOTER*0.5)
           BALDR = (SUMDSR * 100.)/(SEASER * 0.5)
           ACCUR = 0.
           CUMER = 0.
           SAMICO = 0.
           DC 248 JJJ= 1,NN
           SAMICO = SAMICO + Y(JJJ)
      248 CONTINUE
           ACCUR = ((PRMAD/YBAR)*100.)
            KYL = (NN-2)
           SYL = FLOAT(KYL)
```

```
      CUMER = TOTER/NN
      DAMICO = (( SAMICO/SYL)/(CUMER*1.25))
      PRINT 91, BALERR, BALDR, AMAD, SMAD
   91 FORMAT('0',34X,'FORECASTING ERRORS AND EVALUATIONS'/40X,'FOR LATES
     1T TWELVE MONTHS.'/40X,'* * * * * * * * * * * * * '/31X,'PERCENTAGE B
     2ALANCED ERRORS : ' /42X,'UNADJUSTED DATA : ',F7.1/38X,'SEASONALLY
     3ADJUSTED : ',F7.1/34X,'MEAN ABSOLUTE DEVIATION : '/42X,'UNADJUSTED
     4 DATA : ',F7.1/38X,'SEASONALLY ADJUSTED : ',F7.1/)
      PRINT 93,THEIL
   93 FORMAT('0',39X,'THEIL COEFFICIENT :',5X,F4.2)
      IF (ABS(THEIL).LT.0.10) GO TO 71
```

```
      IF (ABS(THEIL).LT.0.25) GO TO 94
      IF (ABS(THEIL).LE.0.65) GO TO 98
      IF (ABS(THEIL).GT.0.65) GO TO 96
   71 PRINT 72
   72 FORMAT('0',30X,'THEIL INDICATES HIGH FORECASTING ABILITY.')
      GO TO 400
   94  PRINT 95
   95 FORMAT('0',30X,     'THEIL SUGGESTS A FAIRLY ACCURATE FORECAST')
      GO TO 400
   96 PRINT 97
   97 FORMAT('0',30X,     'THEIL SUGGESTS A POOR FORECAST.')
      GO TO 400
   98 PRINT 99
   99 FORMAT('0',30X,     'THEIL INDICATES MODERATE FORECASTING EFFICIEN
     1CY')
      GC TC 400
  150 CONTINUE
      PRINT 151
  151 FORMAT ('0',20X,'THERE IS INSUFFICIENT DATA FOR FORECASTING')
      GO TO 4
  400 CONTINUE
       PRINT   268,DAMICO
  268 FORMAT('0',35X,'FORECASTABILITY INDEX : ',3X,F4.1/)
      IF ( DAMICO.LT.1.5 ) GO TO 253
      IF ( DAMICO.LE. 2.5) GO TO 256
      IF ( DAMICO.GT. 2.5) GO TO 264
  253 PRINT 254
  254 FORMAT('0',34X,'THE FORECASTABILITY INDEX IS LOW.'/28X,'A MANUAL
     1SYSTEM MAY BE PREFERRED FOR THIS ITEM.'/)
      GO TO 267
  256 PRINT 259
  259 FORMAT('0',29X,'THE FORECASTABILITY INDEX SUGGESTS THAT THE METHO
     1D'/30X,'SHOULD GIVE REASONABLE RESULTS FOR THIS ITEM.'/)
      GC TC 267
  264 PRINT 266
  266 FORMAT('0',33X,'THE FORECASTABILITY INDEX IS HIGH.'/26X,'THIS SUG
     1GESTS THAT THE METHOD IS VERY EFFECTIVE.'/)
  267 CONTINUE
C
      PRINT 200, ACCUR
  200 FORMAT('0',37X,'ACCURACY PERCENTAGE : ',1X,F6.1/)
    4 CONTINUE
      PRINT 10
   10 FORMAT('0',34X,'* * * * * * * * * * * * * * * *'/35X,'END OF LIN
     1E OF BEST FIT PROCEDURE.'/35X,'* * * * * * * * * * * * * * * * *'/
     2  )
    7   STOP
        END
C
```

FORECAST FOR ITEM 1

88100010 FACE TISSUE

* * * * * * * * * *

LINE OF BEST FIT

PERIOD	ACTUAL DATA	TREND	RATIO	ERROR
1	1222.	1034.98	1.18	187.02
2	1707.	1056.86	1.62	650.14
3	1229.	1078.74	1.14	150.26
4	1524.	1100.61	1.38	423.39
5	1253.	1122.49	1.12	130.51
6	1334.	1144.36	1.17	189.64
7	1560.	1166.24	1.34	393.76
8	740.	1188.12	0.62	-448.12
9	1125.	1209.99	0.93	-84.99
10	1434.	1231.87	1.16	202.13
11	1355.	1253.74	1.08	101.26
12	1259.	1275.62	0.99	-16.62
13	1629.	1297.50	1.26	331.50
14	1326.	1319.37	1.01	6.63
15	1421.	1341.25	1.06	79.75
16	1631.	1363.12	1.20	267.88
17	1166.	1385.00	0.84	-219.00
18	1257.	1406.87	0.89	-149.87
19	1673.	1428.75	1.17	244.25
20	1283.	1450.63	0.88	-167.63
21	1316.	1472.50	0.89	-156.50
22	1501.	1494.38	1.00	6.62
23	1399.	1516.25	0.92	-117.25
24	1177.	1538.13	0.77	-361.13
25	1236.	1560.01	0.79	-324.01
26	1536.	1581.88	0.97	-45.88
27	1406.	1603.76	0.88	-197.76
28	1834.	1625.63	1.13	208.37
29	1183.	1647.51	0.72	-464.51
30	430.	1669.39	0.26	-1239.39
31	1000.	1691.26	0.59	-691.26
32	1590.	1713.14	0.93	-123.14
33	1110.	1735.01	0.64	-625.01
34	2002.	1756.89	1.14	245.11
35	689.	1778.77	0.39	-1089.77

36	1237.	1800.64	0.69	-563.64
37	2064.	1822.52	1.13	241.48
38	2272.	1844.39	1.23	427.61
39	2830.	1866.27	1.52	963.73
40	2311.	1888.14	1.22	422.86
41	2206.	1910.02	1.15	295.98
42	2562.	1931.90	1.33	630.10
43	1748.	1953.77	0.89	-205.77
44	1966.	1975.65	1.00	-9.65
45	1896.	1997.52	0.95	-101.52
46	2366.	2019.40	1.17	346.60

47	2279.	2041.28	1.12	237.72
48	2244.	2063.15	1.09	180.85
49	2453.	2085.03	1.18	367.97
50	2670.	2106.90	1.27	563.10

FORECASTING EVALUATION AND ERRORS
FOR ALL BUT FINAL YEAR.
* * * * * * * * * * * *

THE EQUATION IS: Y*= 1034.98 + 21.88 X

THE LINE SHOWS POSITIVE SLOPE

STANDARD ERROR :	60.9
MEAN ABSOLUTE DEVIATION :	324.5
ROOT MEAN SQUARE ERROR :	414.3
AVERAGE CUM. SIGNED ERROR :	21.9
TOTAL SIGNED ERROR :	1093.8
PERCENTAGE BALANCED ERROR :	13.8

SEASONAL INDEX
****

1.0902
1.2058
1.1480
1.2333
0.9578
0.9107
0.9986
0.8576
0.8531
1.1199
0.8768
0.8817

SEASONAL FORECAST AHEAD	ACTUAL DATA	ERROR	DESEASONALISED FORECAST	SEAS.ADJ. ERROR
2344.7	2536.	191.	2326.1	209.9
2619.5	2523.	-97.	2092.5	430.5
2519.1	3026.	507.	2636.0	390.0
2733.4	2552.	-181.	2069.2	482.8
2143.7	2289.	145.	2389.9	-100.9
2058.3	2278.	220.	2501.3	-223.3
2278.8	2476.	197.	2479.4	-3.4
1975.8	3032.	1056.	3535.3	-503.3
1984.0	2756.	772.	3230.6	-474.6

2629.0	2176.	-453.	1943.0	233.0
2077.5	2482.	404.	2830.7	-348.7
2108.4	2090.	-18.	2370.4	-280.4

FORECASTING ERRORS AND EVALUATIONS
FOR LATEST TWELVE MONTHS.
* * * * * * * * * * * *

PERCENTAGE BALANCED ERRORS :
UNADJUSTED DATA : 129.3
SEASONALLY ADJUSTED : -10.2
MEAN ABSOLUTE DEVIATION :

UNADJUSTED DATA : 387.3
SEASONALLY ADJUSTED : 336.0

THEIL COEFFICIENT : 0.09

THEIL INDICATES HIGH FORECASTING ABILITY.

FORECASTABILITY INDEX : 15.6

THE FORECASTABILITY INDEX IS HIGH.
THIS SUGGESTS THAT THE METHOD IS VERY EFFECTIVE.

ACCURACY PERCENTAGE : 20.4

FORECAST FOR ITEM 2

59100040 B31 BANDAGE GYPS. 4"

* * * * * * * * * *

LINE OF BEST FIT

PERIOD	ACTUAL DATA	TREND	RATIO	ERROR
1	5.	4.03	1.24	0.97
2	6.	4.10	1.46	1.90
3	6.	4.16	1.44	1.84
4	0.	4.23	0.00	-4.23
5	5.	4.30	1.16	0.70
6	8.	4.37	1.83	3.63
7	0.	4.44	0.00	-4.44
8	13.	4.51	2.88	8.49
9	6.	4.58	1.31	1.42
10	2.	4.64	0.43	-2.64
11	5.	4.71	1.06	0.29
12	6.	4.78	1.25	1.22
13	9.	4.85	1.86	4.15
14	7.	4.92	1.42	2.08
15	4.	4.99	0.80	-0.99
16	8.	5.06	1.58	2.94
17	2.	5.13	0.39	-3.13
18	0.	5.19	0.00	-5.19
19	5.	5.26	0.95	-0.26
20	4.	5.33	0.75	-1.33
21	0.	5.40	0.00	-5.40
22	0.	5.47	0.00	-5.47
23	2.	5.54	0.36	-3.54
24	3.	5.61	0.54	-2.61
25	19.	5.67	3.35	13.33
26	2.	5.74	0.35	-3.74
27	6.	5.81	1.03	0.19
28	0.	5.88	0.00	-5.88
29	5.	5.95	0.84	-0.95
30	4.	6.02	0.66	-2.02
31	4.	6.09	0.66	-2.09
32	4.	6.15	0.65	-2.15
33	9.	6.22	1.45	2.78
34	9.	6.29	1.43	2.71
35	9.	6.36	1.42	2.64

36	8.	6.43	1.24	1.57
37	13.	6.50	2.00	6.50
38	11.	6.57	1.68	4.43
39	8.	6.63	1.21	1.37
40	4.	6.70	0.60	-2.70
41	2.	6.77	0.30	-4.77
42	4.	6.84	0.58	-2.84
43	5.	6.91	0.72	-1.91
44	4.	6.98	0.57	-2.98
45	8.	7.05	1.14	0.95
46	5.	7.11	0.70	-2.11

47	12.	7.18	1.67	4.82
48	13.	7.25	1.79	5.75

FORECASTING EVALUATION AND ERRORS
FOR ALL BUT FINAL YEAR.
* * * * * * * * * * * *

THE EQUATION IS: Y*= 4.03 + 0.07 X

THE LINE SHOWS POSITIVE SLOPE

STANDARD ERROR :	0.6
MEAN ABSOLUTE DEVIATION :	3.2
ROOT MEAN SQUARE ERROR :	3.9
AVERAGE CUM. SIGNED ERROR :	0.1
TOTAL SIGNED ERROR :	3.3
PERCENTAGE BALANCED ERROR :	4.4

SEASONAL INDEX
****

2.1116
1.2278
1.1202
0.5447
0.6721
0.7700
0.5828
1.2144
0.9732
0.6410
1.1269
1.2067

SEASONAL FORECAST AHEAD	ACTUAL DATA	ERROR	DESEASONALISED FORECAST	SEAS.ADJ. ERROR
15.6	6.	-10.	2.8	3.2
9.2	10.	1.	8.1	1.9
8.4	11.	3.	9.8	1.2
4.1	8.	4.	14.7	-6.7
5.2	6.	1.	8.9	-2.9
6.0	6.	0.	7.8	-1.8
4.5	9.	4.	15.4	-6.4
9.6	8.	-2.	6.6	1.4
7.7	16.	8.	16.4	-0.4
5.1	5.	-0.	7.8	-2.8
9.1	17.	8.	15.1	1.9

9.8	6.	-4.	5.0	1.0

FORECASTING ERRORS AND EVALUATIONS
FOR LATEST TWELVE MONTHS.
* * * * * * * * * * * *

PERCENTAGE BALANCED ERRORS	:	
UNADJUSTED DATA	:	62.3
SEASONALLY ADJUSTED	:	-66.6
MEAN ABSOLUTE DEVIATION	:	
UNADJUSTED DATA	:	4.0
SEASONALLY ADJUSTED	:	2.9

THEIL COEFFICIENT : 0.27

THEIL INDICATES MODERATE FORECASTING EFFICIENCY

FORECASTABILITY INDEX : 5.2

THE FORECASTABILITY INDEX IS HIGH.
THIS SUGGESTS THAT THE METHOD IS VERY EFFECTIVE.

ACCURACY PERCENTAGE : 55.9

FORECAST FOR ITEM 3

2129 STRICT SEASONAL

* * * * * * * * * *

LINE OF BEST FIT

PERIOD	ACTUAL DATA	TREND	RATIO	ERROR
1	60.	47.61	1.26	12.39
2	38.	48.05	0.79	-10.05
3	24.	48.49	0.49	-24.49
4	42.	48.93	0.86	-6.93
5	39.	49.37	0.79	-10.37
6	53.	49.81	1.06	3.19
7	68.	50.25	1.35	17.75
8	61.	50.69	1.20	10.31
9	50.	51.13	0.98	-1.13
10	42.	51.57	0.81	-9.57
11	26.	52.01	0.50	-26.01
12	35.	52.45	0.67	-17.45
13	82.	52.90	1.55	29.10
14	42.	53.34	0.79	-11.34
15	19.	53.78	0.35	-34.78
16	75.	54.22	1.38	20.78
17	57.	54.66	1.04	2.34
18	63.	55.10	1.14	7.90
19	93.	55.54	1.67	37.46
20	71.	55.98	1.27	15.02
21	46.	56.42	0.82	-10.42
22	28.	56.86	0.49	-28.86
23	38.	57.30	0.66	-19.30
24	42.	57.74	0.73	-15.74
25	139.	58.18	2.39	80.82
26	75.	58.62	1.28	16.38
27	0.	59.06	0.00	-59.06
28	75.	59.50	1.26	15.50
29	63.	59.94	1.05	3.06
30	48.	60.38	0.79	-12.38
31	142.	60.82	2.33	81.18
32	98.	61.26	1.60	36.74
33	74.	61.70	1.20	12.30
34	62.	62.14	1.00	-0.14
35	29.	62.59	0.46	-33.59

36	60.	63.03	0.95	-3.03
37	108.	63.47	1.70	44.53
38	60.	63.91	0.94	-3.91
39	3.	64.35	0.05	-61.35
40	58.	64.79	0.90	-6.79
41	42.	65.23	0.64	-23.23
42	67.	65.67	1.02	1.33
43	121.	66.11	1.83	54.89
44	68.	66.55	1.02	1.45
45	47.	66.99	0.70	-19.99
46	79.	67.43	1.17	11.57

47	34.	67.87	0.50	-33.87
48	45.	68.31	0.66	-23.31
49	131.	68.75	1.91	62.25
50	97.	69.19	1.40	27.81
51	28.	69.63	0.40	-41.63
52	48.	70.07	0.69	-22.07
53	76.	70.51	1.08	5.49
54	54.	70.95	0.76	-16.95

FORECASTING EVALUATION AND ERRORS
FOR ALL BUT FINAL YEAR.
* * * * * * * * * * * *

THE EQUATION IS: Y*= 47.61 + 0.44 X

THE LINE SHOWS POSITIVE SLOPE

STANDARD ERROR	:	4.2
MEAN ABSOLUTE DEVIATION	:	22.6
ROOT MEAN SQUARE ERROR	:	29.5
AVERAGE CUM. SIGNED ERROR	:	0.4
TOTAL SIGNED ERROR	:	23.8
PERCENTAGE BALANCED ERROR	:	4.0

SEASONAL INDEX
****

1.7253
0.9491
0.2237
1.0993
0.8819
1.0057
1.7982
1.2733
0.9235
0.8690
0.5318
0.7513

SEASONAL FORECAST AHEAD	ACTUAL DATA	ERROR	DESEASONALISED FORECAST	SEAS.ADJ. ERROR
123.9	167.	43.	96.8	70.2
68.6	63.	-6.	66.4	-3.4
16.3	85.	69.	379.9	-294.9
80.4	111.	31.	101.0	10.0
64.9	48.	-17.	54.4	-6.4

74.5	121.	47.	120.3	0.7
133.9	141.	7.	78.4	62.6
95.4	138.	43.	108.4	29.6
69.6	66.	-4.	71.5	-5.5
65.9	98.	32.	112.8	-14.8
40.5	87.	46.	163.6	-76.6
57.6	66.	8.	87.8	-21.8

FORECASTING ERRORS AND EVALUATIONS
FOR LATEST TWELVE MONTHS.
* * * * * * * * * * * *

```
          PERCENTAGE BALANCED ERRORS :
                     UNADJUSTED DATA :   170.3
                SEASONALLY ADJUSTED :    -83.9
            MEAN ABSOLUTE DEVIATION :
                     UNADJUSTED DATA :    32.1
                SEASONALLY ADJUSTED :     54.5

                   THEIL COEFFICIENT :     0.19

          THEIL SUGGESTS A FAIRLY ACCURATE FORECAST

               FORECASTABILITY INDEX :     7.6

            THE FORECASTABILITY INDEX IS HIGH.
       THIS SUGGESTS THAT THE METHOD IS VERY EFFECTIVE.

                 ACCURACY PERCENTAGE :    37.9

              * * * * * * * * * * * * * * * * *
              END OF LINE OF BEST FIT PROCEDURE.
              * * * * * * * * * * * * * * * * *

CORE USAGE       OBJECT CODE=    10640 BYTES,ARRAY AREA=     3760 BYTES,TOTAL AREA AVAILABLE=  102400  BYTES
DIAGNOSTICS        NUMBER OF ERRORS=       0, NUMBER OF WARNINGS=       0, NUMBER OF EXTENSIONS=       0
COMPILE TIME=    14.51 SEC,EXECUTION TIME=    12.91 SEC,  WATFIV - JUL 1973 V1L4        4.55.40    TUESDAY       27 SE
```

```
$JOB            ,PAGES=400,TIME=720
C
C
C
C
C                      SIMPLE FORECASTING METHODS
C
C                       * * * * * * * * * * *
C                        MOVAVE AND MOVETREND
C                       * * * * * * * * * * *
C
C                              * * * *
C                              MOVAVE
C                              * * * *
C
C
C                      TWELVE MONTH MOVING AVERAGE
C                      - - - - - - - - - - - - - -
C
C               USING 12 MONTH DATA,FOR SETS OF AT LEAST 2 YEARS RUN,
C               PROGRAM FORECASTS USING ACTUAL DEMAND HISTORY.
C
C                              DICTIONARY
C                              ----------
C              AMAD    MEAN ABSOLUTE DEVIATION
C              AVCER   AVERAGE CUMULATIVE SIGNED ERROR
C              BALER   PERCENTAGE BALANCED ERROR
C              EMSQ    MEAN SQUARE ERROR
C              ERAVIM  TREND AVERAGE CUMULATIVE ERROR
C              ERROR   ACTUAL - FORECAST
C              FMSQ    MEAN SQUARE ERROR (MOVETREND)
C              FORX    THE TREND,OR FORECAST
C              IYR     SUBSCRIPT OF A PARTICULAR YEAR
C              M       A MONTH WITHIN THAT YEAR
C              NYR     NUMBER OF EVEN YEARS DATA
C              SQER    INDIVIDUAL SQUARED ERROR
C              SQERR   SUM OF SQUARED ERRORS
C              SUMER   TOTAL OF SIGNED ERRORS
C              TOTAL   TO ACCUMULATE MOVING TOTALS
C              TOTERR  SUM OF ABSCLUTE ERRORS
C              TQERR   SUM OF SQUARED ERRORS (MOVETREND)
C
C                              DATA ENTRY
C                              ----------
C              ML      NUMBER OF COMPLETE DATA SETS
C              HOSP    DETAILS OF ITEM
C              DATES   THE DATA PERIOD
C              N       NUMBER OF DATA UNITS IN SET
C              G OR Y  ACTUAL DATA
```

```
C                 XLCL,CI CLASS SIZE (NOT USED)
C
          DIMENSION G(100),Y(12,20),TOTAL(240),FORX(240)
          DIMENSION HOSP(20),DATES(20),YT(100),TQER(100)
           DIMENSION TOT(100), AVER(100), TREND(100),EXPDEM(100),ALEADM(100)
         1 , DEMLT(100), ERR1MC(100), ERRLT(100)
           PRINT 65
   65     FORMAT('1',31X,'MOVING AVERAGE FORECASTING'/41X,'MOVAVE'/40X,'****
         1****'/)
           READ, ML
          DO 55 KK=1,ML
```

```
      PRINT 20,KK
   20 FORMAT('1',35X,'FORECAST FOR ITEM',1X,I3/36X,'USING MOVING AVERAGE
     1S'/43X,'MOVAVE'/)
      READ 13,HOSP
   13 FORMAT(20A4)
      PRINT 50,HOSP
   50 FORMAT('0',20A4/)
      READ 15,DATES
   15 FORMAT(20A4)
      PRINT 52
   52 FORMAT('0',34X,'* * * * * * * * * * * * * * '/)
      ID=0
      READ,N
      IF (N.LT.24) GO TO 75
      NYR= (N/12)
      IF (((N/12)*12).EQ.N) GO TO 70
      IF (((N/12)*12).NE.N) GO TO 72
   72   CONTINUE
      IF (N.LT.36) NM = 24
C
      IF (N.LT.36) GO TO 80
      IF (N.LT.48) NM = 36
      IF (N.LT.48) GO TO 80
      IF (N.LT.60) NM = 48
      IF (N.LT.60) GO TO 80
      IF (N.LT.72) NM = 60
      IF (N.LT.72) GO TO 80
      IF (N.LT.84) NM= 72
      IF (N.LT.84) GO TO 80
      IF (N.GT.84) NM =84
C
      GO TO 80
   75 PRINT 60
   60 FORMAT('0',29X,'THERE IS INSUFFICIENT DATA FOR'/31X,'MOVING AVERAG
     1E FORECASTING'/32X,'* * * * * * * * * * * * * *'/)
C                NOW DUMMY STATEMENTS FOR SMALL DATA SETS :
      READ 18,(G(II),II=1,N)
   18 FORMAT(12F6.0)
      READ,XLCL,CI
      GO TO 55
   70 CONTINUE
      NM= N
   80 CONTINUE
      NYR =(NM/12)
      READ 76,(YT(I),I=1,N)
   76 FORMAT(12F6.0)
      ID =(N- (NYR*12)) +1
      SUMYT = 0.
      DO 12  II= 1,N
```

```
          SUMYT = SUMYT + YT(II)
   12     CCNTINUE
          YYT = SUMYT/N
         DO 14 IYR =1.NYR
         DC 14 M   =1.12
         KZ= ID +((IYR-1)*12)+M
          IF(KZ.GT.N) KZ=N
   14    Y(M.IYR) =YT(KZ)
          READ. XLCL.CI
          ACCUR = 0.
         AMAD  =0.
```

```
      BALER = 0.
      ERRCR =0.
        SQER = 0.
       SQERR = 0.
       SUMERQ = 0.
       SUMFSQ = 0.
       SUMACT = 0.
       THEIL = 0.
      TOTERR=0.
       ZACT = 0.
       ZDISP = 0.
       ZVAR = 0.
C
    4 CCNTINUE
       AVCER = 0.
      DO 5 J=1,NM
      TOTAL(J) =0.0
      SUMER    =0.0
      FORX(J)=0.0
    5 CONTINUE
      DO 6 M= 1,12
      TCTAL(7) = TOTAL(7)+Y(M,1)
    6 CONTINUE
C               THE COMMENCING MOVING AVERAGE
      DO 7 IYR =2,NYR
      DO 7 M   =1,12
      J = 12* IYR +(M-17)
      TOTAL(J) =TOTAL(J-1) +Y(M,IYR)- Y(M,IYR-1)
      FORX(J) =TOTAL(J)/12.0
    7 CONTINUE
       PRINT 8
    8 FORMAT('0',19X,'YEAR     MONTH**   ACTUAL          FORECAST      E
     1RROR'/20X,'----     -----     ------          --------      -----'
     2/)
      DO 9 IYR = 1,NYR
      DO 9 M   = 1,12
      J = 12*(IYR-1)+M
C               COMPUTE ACTUAL ERRORS AND PRINT OVERALL ERRORS
      IF(((IYR.EQ.1).AND.(M.LE.6)).OR.((IYR.EQ.NYR).AND.(M.GT.7))) GO TO
     1 27
      ERROR = Y(M,IYR) -FORX(J)
        IF((IYR.EQ.1).AND.(M.EQ.7)) ERROR = 0.
       SCER = (ERROR**2)
       SQERR = SQERR + SQER
      TOTERR =TOTERR +ABS(ERROR)
   11 SUMER =SUMER + ERROR
C
      GO TO 28
   27 ERROR = 0.
```

```
   28 PRINT 10, IYR,M,Y(M,IYR),FORX(J),ERROR
   10 FORMAT( 21X,I3,4X,I4,7X,F5.0,8X,F10.2,3X,F9.1)
      IF(ABS(ERROR).GT.(0.75* Y(M,IYR))) PRINT 36
   36 FORMAT('0',22X,'NOTE: ERROR IS GREATER THAN'/25X,'75% OF ACTUAL DA
     1TA.'/)
      ERSQ = (TOTERR**2)
       SUMERQ = SUMERQ+SQER
       FORSQ = (FORX(J)**2)
      SUMFSQ = SUMFSQ+ FORSQ
      ACTSQ = (( Y(M,IYR) )**2)
      SUMACT = SUMACT + ACTSQ
```

```
    9 CONTINUE
C             CALCULATE MEAN ABSOLUTE DEVIATION
        CN = (( NM-12) * (NM-14 ))
C             TO COMPUTE AVERAGE CUM. SIGNED ERROR
       AVCER = SUMER/ (SQRT(CN) )
      AMAD = TOTERR/ SQRT(CN)
       ZVAR = SUMERQ/ SQRT(CN)
       ZDISP = SUMFSQ/SQRT(CN)
        ZACT = SUMACT/SQRT(CN)
       THEIL = (SQRT(ZVAR))/ ((SQRT(ZDISP)) + (SQRT(ZACT)))
        PRINT 151 , AVCER
  151 FORMAT('0',27X,'FORECASTING ERRORS AND FORECAST EVALUATION.'/27X,
     1'* * * * * * * * * * * * * * * * * * * * * '/28X,'AVERAGE CUMULA
     2TIVE SIGNED ERROR : ',F8.1/)
       IF( (SQERR/NM).LE.0.) EMSQ = 0.0
       IF( (SQERR/NM).LE.0.) GO TO 130
       EMSQ = SQRT(( SQERR/NM))
  130 CONTINUE
C             CALCULATE THE BALANCED ERRORS:
       IF ( TOTERR .LE. 0.) TOTERR = 1.
       ACCUR = (AMAD/YYT)*100.
       BALER = (SUMER*100.)/ (TOTERR*0.5)
       PRINT 44, BALER,AMAD, SUMER, EMSQ, THEIL
   44  FORMAT('0',27X,'PERCENTAGE BALANCED ERROR',7X,':',F10.1/28X,'OVER
     1ALL MEAN ABSOLUTE DEVIATION :  ' ,F7.1/28X,'TOTAL SIGNED ERROR
     2          : ',F8.1/28X,'ROOT MEAN SQUARE ERROR            : ',F8.1/
     328X,'THEIL COEFFICIENT                 :       ', F5.2/)
       IF(ABS(THEIL).LT.0.10) GO TO 180
       IF(ABS(THEIL). LT.0.25)  GO TO 134
       IF(ABS(THEIL).LE.0.65) GO TO 135
       IF(ABS(THEIL). GT.0.65)  GO TO 132
  180  PRINT 181
  181 FORMAT('0',26X,'THEIL INDICATES VERY GOOD FORECASTING ABILITY.'/)
       GO TO 137
  134 PRINT 136
  136  FORMAT('0',26X,'THIS VALUE SUGGESTS A FAIRLY ACCURATE FORECAST.'
     1 /)
       GO TO 137
  132     PRINT 138
  138 FORMAT('0',26X,'THIS VALUE SUGGESTS A RATHER POOR FORECAST.'/)
       GO TO 137
  135 PRINT 139
  139 FORMAT('0',26X,'THIS VALUE INDICATES MODERATE FORECASTING EFFICIEN
     1CY.'/)
  137 CONTINUE
       PRINT 122, ACCUR
  122 FORMAT('0',27X,'ACCURACY PERCENTAGE                     :',F7.1/)
       PRINT 110
  110 FORMAT('0',27X,'**  DUE TO CENTERING, MONTHS SHOWN ABOVE'/28X,
```

```
      1 'ARE OUT OF REGULAR SEQUENCE.'/)
   45  PRINT 46
   46 FORMAT('0',27X,'- - - - - - - END OF MOVAVE - - - - - - - -'/)
C
C                               * * * * * *
C                                MOVETREND
C                               * * * * * *
C
C
C                  THIS PROGRAMME CONSTRUCTS A SIMPLE MOVING AVERAGE
C                  FORECAST. AND A TREND BY THE DIFFERENCE BETWEEN THE
```

```
C                      ACTUAL FOR THIS AND THE PREVIOUS PERIOD.
C                      AN ASSUMED LEAD TIME OF TWO MONTHS IS USED,
C                      BUT ANY VALUE REQUIRED CAN BE INSERTED.
C                      NOTE... A SIX MONTH MOVING PERIOD IS USED,
C                      RATHER THAN THE 12 PERIODS OF  MOVAVE
             ID = 6
             IE = N-6
             ACURE = 0.
             BALTER = 0.0
             CMAD = 0.0
             ERAV1M = 0.
             SUMERR = 0.0
             TQERR = 0.
             TTERR = 0.0
C                      CALCULATE SIX MONTH MOVING TOTALS (SUM)
C                      AND STORE IN TOT
             MP = 1
             MQ = 6
             DO 90 JJ=1, IE
             SUM = 0.0
              DO 91 KX= MP,MQ
             SUM = YT(KX) + SUM
        91   CONTINUE
            MP=MP+1
              MQ = MQ+1
             TOT(JJ+5) = SUM
             AVER(JJ+5) = SUM/6.
        90   CONTINUE
             DO 92 KLM=1,6
              TREND(KLM)= 0.
C                      THIS SETS THE VALUE OF THE TREND FOR EACH
C                      OF THE FIRST SIX MONTHS TO ZERO.
C
        92   CONTINUE
             PRINT 96
        96   FORMAT('1',35X,'MOVING AVERAGE WITH TREND'/36X,'_ _ _ _ _ _ _ _ _ _
           1 _ _ _ _ _'/)
             PRINT 97
        97  FORMAT('0',13X,'PERIOD  ACTUAL     MOVING    TREND    EXPECT    LE
           1AD T.   LEAD T.      ONE     LEAD'/22X,'DEMAND      AVERAGE
           2   DEMAND     EXPECT     ACTUAL       PERIOD    TIME'/
           333X,'6 MOS.                              DEMAND      DEMAND        ERROR    ER
           4ROR'/14X, '______    ______    ______    ______    ______    ______
           5  ______    ______    ______'/)
              AVER(N) = AVER(N-1)
              DO 93 KLM = 6,N
              AVER(5) = YT(5)
              TREND(6) =0.
              TREND(KLM) = AVER(KLM)-AVER(KLM-1)
```

```
      EXPDEM(KLM) = AVER(KLM)+ TREND(KLM)
   93  CONTINUE
C                USING ANY REQUIRED LEAD TIME, COMPUTE LEAD TIME
C                EXPECTED DEMAND.
C                HERE WE USE TWO MONTHS.
C
      ALEADT = 2.
      DO 94 KLM = 6,N
      ALEADM(KLM) = (ALEADT*EXPDEM(KLM))+((( ALEADT*(ALEADT+1.))/2.)
     1 *TREND(KLM))
      DEMLT(KLM)= YT(KLM)+YT(KLM-1)
```

```
          ERR1MO(KLM) = YT(KLM)-(EXPDEM(KLM))
          ERRLT(KLM) = DEMLT(KLM)-ALEADM(KLM)
          TTERR = TTERR+ABS(ERR1MO(KLM))
          SUMERR  = SUMERR + ERR1MO(KLM)
          TQER(KLM) = (ERR1MO(KLM)**2)
          TQERR = TQERR + TQER(KLM)
   94     CONTINUE
          DC 98 KLM=6,N
          PRINT 95, KLM,YT(KLN),AVER(KLM),TREND(KLM),EXPDEM(KLM),
        1 ALEADM(KLM),DEMLT(KLM),ERR1MO(KLM),ERRLT(KLM)
   95    FORMAT('0',15X,I2,2X,F9.2,1X,F9.2,F9.2,1X,F9.2,1X,F9.2,1X,F9.2,
        1 1X,F9.2,F9.2 )
          IF(ABS(ERR1MO(KLM)) .GT.(0.75*YT(KLM))) PRINT 120
  120    FORMAT('0',30X,'NUTE: ERROR IS GREATER THAN'/23X,'75% OF ACTUAL DE
        1MAND. ADVISE MANAGEMENT.'/)
   98     CONTINUE
          ERAVIM = SUMERR / (N-5)
C                   CALCULATE MEAN ABSOLUTE DEVIATION
          DN = IE*(IE-2)
          CMAD = TTERR / SQRT(DN)
          ACURE = (( CMAD/YYT ) * 100.)
          FMSQ = SQRT((TQERR/(N-5)))
C                   CALCULATE PERCENTAGE BALANCED ERRORS:
          IF(TTERR.LE.0.)  TTERR = 1.
          BALTER = (SUMERR*100.)/ (TTERR*0.5)
          PRINT 105, ERAVIM, EALTER, CMAD, SUMERR, FMSQ
  105    FORMAT('0',36X,'FORECASTING ERRORS:MOVETREND'/37X,'* * * * * * * *
        1 * * * * * *    '/30X,'AVERAGE CUMULATIVE SIGNED ERROR : ',F8.1/
        230X,'PERCENTAGE BALANCED ERROR       : ',F8.1/30X,'OVERALL MEAN AB
        3SOLUTE DEVIATION : ',F8.1/30X,'TOTAL SIGNED ERROR            : '
        4,F8.1/30X,'ROOT MEAN SQUARE ERROR           : ',F8.1/)
           PRINT 123, ACURE
  123    FORMAT('0',29X,'ACCURACY PERCENTAGE                :',F7.1/)
   55     CCNTINUE
          PRINT 111
  111    FORMAT('0',35X,' _ _ _ _ _ _END OF MOVETREND_ _ _ _ _ _ _'/)
              STOP
              END
C
C                             * * * * * * * * * * * *
C                              END OF PROGRAMMES
C                             MOVAVE AND MOVETREND
C                             * * * * * * * * * * * *
C
C

$ENTRY
```

FORECAST FOR ITEM 1
USING MOVING AVERAGES
MOVAVE

8E100010 FACE TISSUE

* * * * * * * * * * * * *

YEAR	MONTH**	ACTUAL	FORECAST	ERROR
1	1	1524.	0.00	0.0
1	2	1253.	0.00	0.0
1	3	1334.	0.00	0.0
1	4	1560.	0.00	0.0
1	5	740.	0.00	0.0
1	6	1125.	0.00	0.0
1	7	1434.	0.00	0.0
1	8	1355.	1338.92	16.1
1	9	1259.	1331.67	-72.7
1	10	1629.	1325.25	303.8
1	11	1326.	1334.67	-8.7
1	12	1421.	1379.92	41.1
2	1	1631.	1395.83	235.2
2	2	1166.	1401.42	-235.4
2	3	1257.	1405.08	-148.1
2	4	1673.	1398.25	274.8
2	5	1283.	1365.50	-82.5
2	6	1316.	1383.00	-67.0
2	7	1501.	1381.75	119.3
2	8	1399.	1398.67	0.3
2	9	1177.	1400.08	-223.1
2	10	1236.	1331.17	-95.2
2	11	1536.	1275.08	260.9
2	12	1406.	1300.67	105.3
3	1	1834.	1283.50	550.5
3	2	1183.	1325.25	-142.3
3	3	430.	1266.08	-836.1

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

3	4	1000.	1271.08	-271.1
3	5	1590.	1340.08	249.9
3	6	1110.	1401.42	-291.4
3	7	2002.	1520.08	481.9

3	8	689.	1559.83	-870.8

NOTE: ERROR IS GREATER THAN 75% OF ACTUAL DATA.

3	9	1237.	1645.08	-408.1
3	10	2064.	1822.75	241.3
3	11	2272.	1885.08	386.9
3	12	2830.	1916.42	913.6
4	1	2311.	1981.92	329.1
4	2	2206.	2012.25	193.8

4	3	2562.	2144.75	417.3
4	4	1748.	2228.67	-480.7
4	5	1966.	2261.08	-295.1
4	6	1896.	2294.25	-398.3
4	7	2366.	2269.75	96.3
4	8	2279.	2287.42	-8.4
4	9	2244.	2355.75	-111.8
4	10	2453.	2354.92	98.1
4	11	2670.	2400.00	270.0
4	12	2536.	2426.00	110.0
5	1	2523.	2474.33	48.7
5	2	3026.	2529.83	496.2
5	3	2552.	2569.58	-17.6
5	4	2289.	2563.92	-274.9
5	5	2278.	2566.33	-288.3
5	6	2476.	2518.00	-42.0
5	7	3032.	2480.83	551.2
5	8	2756.	0.00	0.0
5	9	2176.	0.00	0.0
5	10	2482.	0.00	0.0
5	11	2090.	0.00	0.0
5	12	2090.	0.00	0.0

FORECASTING ERRORS AND FORECAST EVALUATION.
* *
AVERAGE CUMULATIVE SIGNED ERROR : 23.9

PERCENTAGE BALANCED ERROR : 18.0
OVERALL MEAN ABSOLUTE DEVIATION : 265.2
TOTAL SIGNED ERROR : 1121.8
ROOT MEAN SQUARE ERROR : 303.9
THEIL COEFFICIENT : 0.10

THEIL INDICATES VERY GOOD FORECASTING ABILITY.

ACCURACY PERCENTAGE : 15.0

** DUE TO CENTERING, MONTHS SHOWN ABOVE
ARE OUT OF REGULAR SEQUENCE.

- - - - - - - END OF MOVAVE - - - - - - -

MOVING AVERAGE WITH TREND

PERIOD	ACTUAL DEMAND	MOVING AVERAGE 6 MOS.	TREND	EXPECT DEMAND	LEAD T. EXPECT DEMAND	LEAD T. ACTUAL DEMAND	ONE PERIOD ERROR	LEAD TIME ERROR
6	1334.00	1378.17	0.00	1503.33	3006.67	2587.00	-169.33	-419.67
7	1560.00	1434.50	56.33	1490.83	3150.67	2894.00	69.17	-256.67
8	740.00	1273.33	-161.17	1112.17	1740.83	2300.00	-372.17	559.17
9	1125.00	1256.00	-17.33	1238.67	2425.33	1865.00	-113.67	-560.33
10	1434.00	1241.00	-15.00	1226.00	2407.00	2559.00	208.00	152.00
11	1355.00	1258.00	17.00	1275.00	2601.00	2789.00	30.00	188.00
12	1259.00	1245.50	-12.50	1233.00	2428.50	2614.00	26.00	185.50
13	1629.00	1257.00	11.50	1268.50	2571.50	2888.00	360.50	316.50
14	1326.00	1354.67	97.67	1452.33	3197.67	2955.00	-126.33	-242.67
15	1421.00	1404.00	49.33	1453.33	3054.67	2747.00	-32.33	-307.67
16	1631.00	1436.83	32.83	1469.67	3037.83	3052.00	161.33	14.17
17	1166.00	1405.33	-31.50	1373.83	2653.17	2797.00	-207.83	143.83
18	1257.00	1405.00	-0.33	1404.67	2808.33	2423.00	-147.67	-385.33
19	1673.00	1412.33	7.33	1419.67	2861.33	2930.00	253.33	68.67
20	1283.00	1405.17	-7.17	1398.00	2774.50	2956.00	-115.00	181.50
21	1316.00	1387.67	-17.50	1370.17	2687.83	2599.00	-54.17	-88.83
22	1501.00	1366.00	-21.67	1344.33	2623.67	2817.00	156.67	193.33
23	1399.00	1404.83	38.83	1443.67	3003.83	2900.00	-44.67	-103.83
24	1177.00	1391.50	-13.33	1378.17	2716.33	2576.00	-201.17	-140.33
25	1236.00	1318.67	-72.83	1245.83	2273.17	2413.00	-9.83	139.83

26	1536.00	1360.83	42.17	1403.00	2932.50	2772.00	133.00	-160.50
27	1406.00	1375.83	15.00	1390.83	2826.67	2942.00	15.17	115.33
28	1834.00	1431.33	55.50	1486.83	3140.17	3240.00	347.17	99.83
29	1183.00	1395.33	-36.00	1359.33	2610.67	3017.00	-176.33	406.33
30	430.00	1270.83	-124.50	1146.33	1919.17	1613.00	-716.33	-306.17

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

31	1000.00	1231.50	-39.33	1192.17	2266.33	1430.00	-192.17	-836.33
32	1590.00	1240.50	9.00	1249.50	2526.00	2590.00	340.50	64.00
33	1110.00	1191.17	-49.33	1141.83	2135.67	2700.00	-31.83	564.33
34	2002.00	1219.17	28.00	1247.17	2578.33	3112.00	754.83	533.67
35	689.00	1136.83	-82.33	1054.50	1862.00	2691.00	-365.50	829.00
36	1237.00	1271.33	134.50	1405.83	3215.17	1926.00	-168.83	-1289.17
37	2064.00	1448.67	177.33	1626.00	3784.00	3301.00	438.00	-483.00
38	2272.00	1562.33	113.67	1676.00	3693.00	4336.00	596.00	643.00
39	2830.00	1849.00	286.67	2135.67	5131.33	5102.00	694.33	-29.33
40	2311.00	1900.50	51.50	1952.00	4058.50	5141.00	359.00	1082.50
41	2206.00	2153.33	252.83	2406.17	5570.83	4517.00	-200.17	-1053.83
42	2562.00	2374.17	220.83	2595.00	5852.49	4768.00	-33.00	-1084.49
43	1748.00	2321.50	-52.67	2268.83	4379.66	4310.00	-520.83	-69.66
44	1966.00	2270.50	-51.00	2219.50	4286.00	3714.00	-253.50	-572.00
45	1896.00	2114.83	-155.67	1959.17	3451.33	3862.00	-63.17	410.67
46	2366.00	2124.00	9.17	2133.17	4293.83	4262.00	232.83	-31.83
47	2279.00	2136.17	12.17	2148.33	4333.16	4645.00	130.67	311.84
48	2244.00	2083.17	-53.00	2030.17	3901.33	4523.00	213.83	621.67
49	2453.00	2200.67	117.50	2318.17	4988.83	4697.00	134.83	-291.83
50	2670.00	2318.00	117.33	2435.33	5222.66	5123.00	234.67	-99.66
51	2536.00	2424.67	106.67	2531.33	5382.66	5206.00	4.67	-176.66
52	2523.00	2450.83	26.17	2477.00	5032.50	5059.00	46.00	26.50
53	3026.00	2575.33	124.50	2699.83	5773.16	5549.00	326.17	-224.16

54	2552.00	2626.67	51.33	2678.00	5509.99	5578.00	-126.00	68.01
55	2289.00	2599.33	-27.33	2572.00	5062.00	4841.00	-283.00	-221.00
56	2278.00	2534.00	-65.33	2468.67	4741.33	4567.00	-190.67	-174.33
57	2476.00	2524.00	-10.00	2514.00	4998.00	4754.00	-38.00	-244.00
58	3032.00	2608.83	84.83	2693.67	5641.83	5508.00	338.33	-133.83

59	2756.00	2563.83	-45.00	2518.83	4902.66	5788.00	237.17	885.34
60	2176.00	2501.17	-62.67	2438.50	4688.99	4932.00	-262.50	243.01
61	2482.00	2533.33	32.17	2565.50	5227.50	4658.00	-83.50	-569.50
62	2090.00	2533.33	0.00	2533.33	5066.66	4572.00	-443.33	-494.66

FORECASTING ERRORS:MOVETREND
* * * * * * * * * * * * * * *

AVERAGE CUMULATIVE SIGNED ERROR : 20.2
PERCENTAGE BALANCED ERROR : 18.2
OVERALL MEAN ABSOLUTE DEVIATION : 229.8
TOTAL SIGNED ERROR : 1149.3
ROOT MEAN SQUARE ERROR : 284.2

ACCURACY PERCENTAGE : 13.0

FORECAST FOR ITEM 3
USING MOVING AVERAGES
MOVAVE

2129 STRICT SEASONAL

* * * * * * * * * * * * *

YEAR	MONTH**	ACTUAL	FORECAST	ERROR
1	1	61.	0.00	0.0
1	2	50.	0.00	0.0
1	3	42.	0.00	0.0
1	4	26.	0.00	0.0
1	5	35.	0.00	0.0
1	6	82.	0.00	0.0
1	7	42.	0.00	0.0
1	8	19.	54.58	-35.6

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

1	9	75.	54.25	20.8
1	10	57.	53.08	3.9
1	11	63.	54.08	8.9
1	12	93.	54.67	38.3
2	1	71.	59.42	11.6
2	2	46.	62.17	-16.2
2	3	28.	60.58	-32.6

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

2	4	38.	60.58	-22.6
2	5	42.	61.08	-19.1
2	6	139.	59.83	79.2
2	7	75.	63.92	11.1
2	8	0.	66.17	-66.2

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

2	9	75.	68.50	6.5
2	10	63.	71.33	-8.3
2	11	48.	70.58	-22.6

2	12	142.	72.08	69.9
3	1	98.	69.50	28.5
3	2	74.	68.25	5.8
3	3	62.	68.50	-6.5
3	4	29.	67.08	-38.1

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

3	5	60.	65.33	-5.3
3	6	108.	66.92	41.1

3	7	60.	65.17	-5.2
3	8	3.	62.67	-59.7

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

3	9	58.	60.42	-2.4
3	10	42.	61.83	-19.8
3	11	67.	62.25	4.8
3	12	121.	61.00	60.0
4	1	68.	62.92	5.1
4	2	47.	66.00	-19.0
4	3	79.	68.08	10.9
4	4	34.	67.25	-33.3

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

4	5	45.	70.08	-25.1
4	6	131.	69.00	62.0
4	7	97.	72.83	24.2
4	8	28.	72.42	-44.4

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

4	9	48.	75.58	-27.6
4	10	76.	78.25	-2.3
4	11	54.	79.42	-25.4
4	12	167.	85.75	81.3
5	1	63.	86.58	-23.6
5	2	85.	90.00	-5.0
5	3	111.	93.17	17.8
5	4	48.	97.33	-49.3

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

5	5	121.	98.25	22.8
5	6	141.	99.25	41.8
5	7	138.	90.83	47.2
5	8	66.	0.00	0.0
5	9	98.	0.00	0.0
5	10	87.	0.00	0.0
5	11	66.	0.00	0.0
5	12	66.	0.00	0.0

FORECASTING ERRORS AND FORECAST EVALUATION.
* *

AVERAGE CUMULATIVE SIGNED ERROR : 1.9

PERCENTAGE BALANCED ERROR	:	13.4
OVERALL MEAN ABSOLUTE DEVIATION	:	28.1
TOTAL SIGNED ERROR	:	88.2
ROOT MEAN SQUARE ERROR	:	31.1
THEIL COEFFICIENT	:	0.24

THIS VALUE SUGGESTS A FAIRLY ACCURATE FORECAST.

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ACCURACY PERCENTAGE                    :    41.9

**  DUE TO CENTERING, MONTHS SHOWN ABOVE
ARE OUT OF REGULAR SEQUENCE.

- - - - - - - END OF MOVAVE - - - - - - -
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MOVING AVERAGE WITH TREND

PERIOD	ACTUAL DEMAND	MOVING AVERAGE 6 MOS.	TREND	EXPECT DEMAND	LEAD T. EXPECT DEMAND	LEAD T. ACTUAL DEMAND	ONE PERIOD ERROR	LEAD TIME ERROR
6	53.00	42.67	0.00	46.33	92.67	92.00	6.67	-0.67
7	68.00	44.00	1.33	45.33	94.67	121.00	22.67	26.33
8	61.00	47.83	3.83	51.67	114.83	129.00	9.33	14.17
9	50.00	52.17	4.33	56.50	126.00	111.00	-6.50	-15.00
10	42.00	52.17	0.00	52.17	104.33	92.00	-10.17	-12.33
11	26.00	50.00	-2.17	47.83	89.17	68.00	-21.83	-21.17

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

12	35.00	47.00	-3.00	44.00	79.00	61.00	-9.00	-18.00
13	82.00	49.33	2.33	51.67	110.33	117.00	30.33	6.67
14	42.00	46.17	-3.17	43.00	76.50	124.00	-1.00	47.50
15	19.00	41.00	-5.17	35.83	56.17	61.00	-16.83	4.83

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

16	75.00	46.50	5.50	52.00	120.50	94.00	23.00	-26.50
17	57.00	51.67	5.17	56.83	129.17	132.00	0.17	2.83
18	63.00	56.33	4.67	61.00	136.00	120.00	2.00	-16.00
19	93.00	58.17	1.83	60.00	125.50	156.00	33.00	30.50
20	71.00	63.00	4.83	67.83	150.17	164.00	3.17	13.83
21	46.00	67.50	4.50	72.00	157.50	117.00	-26.00	-40.50

22	28.00	59.67	-7.83	51.83	80.17	74.00	-23.83	-6.17

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

23	38.00	56.50	-3.17	53.33	97.17	66.00	-15.33	-31.17
24	42.00	53.00	-3.50	49.50	88.50	80.00	-7.50	-8.50

25	139.00	60.67	7.67	68.33	159.67	181.00	70.67	21.33
26	75.00	61.33	0.67	62.00	126.00	214.00	13.00	88.00
27	0.00	53.67	-7.67	46.00	69.00	75.00	-46.00	6.00

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

28	75.00	61.50	7.83	69.33	162.17	75.00	5.67	-87.17
29	63.00	65.67	4.17	69.83	152.17	138.00	-6.83	-14.17
30	48.00	66.67	1.00	67.67	138.33	111.00	-19.67	-27.33
31	142.00	67.17	0.50	67.67	136.83	190.00	74.33	53.17
32	98.00	71.00	3.83	74.83	161.17	240.00	23.17	78.83
33	74.00	83.33	12.33	95.67	228.33	172.00	-21.67	-56.33
34	62.00	81.17	-2.17	79.00	151.50	136.00	-17.00	-15.50
35	29.00	75.50	-5.67	69.83	122.67	91.00	-40.83	-31.67

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

36	60.00	77.50	2.00	79.50	165.00	89.00	-19.50	-76.00
37	108.00	71.83	-5.67	66.17	115.33	168.00	41.83	52.67
38	60.00	65.50	-6.33	59.17	99.33	168.00	0.83	68.67
39	3.00	53.67	-11.83	41.83	48.17	63.00	-38.83	14.83

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

40	58.00	53.00	-0.67	52.33	102.67	61.00	5.67	-41.67
41	42.00	55.17	2.17	57.33	121.17	100.00	-15.33	-21.17
42	67.00	56.33	1.17	57.50	118.50	109.00	9.50	-9.50
43	121.00	58.50	2.17	60.67	127.83	188.00	60.33	60.17

44	68.00	59.83	1.33	61.17	126.33	189.00	6.83	62.67
45	47.00	67.17	7.33	74.50	171.00	115.00	-27.50	-56.00
46	79.00	70.67	3.50	74.17	158.83	126.00	4.83	-32.83
47	34.00	69.33	-1.33	68.00	132.00	113.00	-34.00	-19.00

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

48	45.00	65.67	-3.67	62.00	113.00	79.00	-17.00	-34.00
49	131.00	67.33	1.67	69.00	143.00	176.00	62.00	33.00
50	97.00	72.17	4.83	77.00	168.50	228.00	20.00	59.50
51	28.00	69.00	-3.17	65.83	122.17	125.00	-37.83	2.83

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

52	48.00	63.83	-5.17	58.67	101.83	76.00	-10.67	-25.83
53	76.00	70.83	7.00	77.83	176.67	124.00	-1.83	-52.67
54	54.00	72.33	1.50	73.83	152.17	130.00	-19.83	-22.17
55	167.00	78.33	6.00	84.33	186.67	221.00	82.67	34.33
56	63.00	72.67	-5.67	67.00	117.00	230.00	-4.00	113.00
57	85.00	82.17	9.50	91.67	211.83	148.00	-6.67	-63.83
58	111.00	92.67	10.50	103.17	237.83	196.00	7.83	-41.83
59	48.00	88.00	-4.67	83.33	152.67	159.00	-35.33	6.33
60	121.00	99.17	11.17	110.33	254.17	169.00	10.67	-85.17
61	141.00	94.83	-4.33	90.50	168.00	262.00	50.50	94.00
62	138.00	107.33	12.50	119.83	277.17	279.00	18.17	1.83
63	66.00	104.17	-3.17	101.00	192.50	204.00	-35.00	11.50
64	98.00	102.00	-2.17	99.83	193.17	164.00	-1.83	-29.17
65	87.00	108.50	6.50	115.00	249.50	185.00	-28.00	-64.50
66	66.00	108.50	0.00	108.50	217.00	153.00	-42.50	-64.00

FORECASTING ERRORS:MOVETREND
* * * * * * * * * * * * * * *
AVERAGE CUMULATIVE SIGNED ERROR : 0.5
PERCENTAGE BALANCED ERROR : 4.9
OVERALL MEAN ABSOLUTE DEVIATION : 23.1

FORECAST FOR ITEM 2
USING MOVING AVERAGES
MOVAVE

59100040 B31 BANDAGE GYPS. 4"

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YEAR	MONTH**	ACTUAL	FORECAST	ERROR
1	1	6.	0.00	0.0
1	2	6.	0.00	0.0
1	3	0.	0.00	0.0
1	4	5.	0.00	0.0
1	5	8.	0.00	0.0
1	6	0.	0.00	0.0
1	7	13.	0.00	0.0
1	8	6.	5.58	0.4
1	9	2.	5.42	-3.4

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

1	10	5.	6.08	-1.1
1	11	6.	5.83	0.2
1	12	9.	5.17	3.8
2	1	7.	5.58	1.4
2	2	4.	4.83	-0.8
2	3	8.	4.33	3.7
2	4	2.	4.17	-2.2

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

2	5	0.	3.92	-3.9

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

2	6	5.	3.67	1.3
2	7	4.	4.50	-0.5
2	8	0.	4.08	-4.1

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

2	9	0.	4.25	-4.3

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

2	10	2.	3.58	-1.6

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

2	11	3.	3.83	-0.8
2	12	19.	4.17	14.8

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

3	1	2.	4.08	-2.1

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

3	2	6.	4.08	1.9
3	3	0.	4.83	-4.8

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

3	4	5.	5.58	-0.6
3	5	4.	6.17	-2.2
3	6	4.	6.58	-2.6
3	7	4.	6.08	-2.1
3	8	9.	6.83	2.2
3	9	9.	7.00	2.0
3	10	9.	7.33	1.7
3	11	8.	7.08	0.9
3	12	13.	7.08	5.9
4	1	11.	7.17	3.8
4	2	8.	7.17	0.8
4	3	4.	7.08	-3.1

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

4	4	2.	6.75	-4.8

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DATA.

4	5	4.	7.00	-3.0
4	6	5.	7.42	-2.4
4	7	4.	6.83	-2.8
4	8	8.	6.75	1.3
4	9	5.	7.00	-2.0
4	10	12.	7.33	4.7
4	11	13.	7.67	5.3
4	12	6.	7.83	-1.8
5	1	10.	8.17	1.8
5	2	11.	8.50	2.5
5	3	8.	9.17	-1.2

5	4	6.	9.17	-3.2
5	5	6.	9.58	-3.6
5	6	9.	9.00	0.0
5	7	8.	9.00	-1.0
5	8	16.	0.00	0.0
5	9	5.	0.00	0.0
5	10	17.	0.00	0.0
5	11	6.	0.00	0.0
5	12	6.	0.00	0.0

FORECASTING ERRORS AND FORECAST EVALUATION.

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 AVERAGE CUMULATIVE SIGNED ERROR :     -0.1

 PERCENTAGE BALANCED ERROR         :      -8.4
 OVERALL MEAN ABSOLUTE DEVIATION :      2.7
 TOTAL SIGNED ERROR                :     -5.3
 ROOT MEAN SQUARE ERROR            :      3.1
 THEIL COEFFICIENT                 :       0.23

THIS VALUE SUGGESTS A FAIRLY ACCURATE FORECAST.

 ACCURACY PERCENTAGE                 :    42.2

 **  DUE TO CENTERING, MONTHS SHOWN ABOVE
 ARE OUT OF REGULAR SEQUENCE.

 - - - - - - - END OF MOVAVE - - - - - - -
```

MOVING AVERAGE WITH TREND

PERIOD	ACTUAL DEMAND	MOVING AVERAGE 6 MOS.	TREND	EXPECT DEMAND	LEAD T. EXPECT DEMAND	LEAD T. ACTUAL DEMAND	ONE PERIOD ERROR	LEAD TIME ERROR
6	8.00	5.00	0.00	5.00	10.00	13.00	3.00	3.00
7	0.00	4.17	-0.83	3.33	4.17	8.00	-3.33	3.83

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

PERIOD	ACTUAL DEMAND	MOVING AVERAGE 6 MOS.	TREND	EXPECT DEMAND	LEAD T. EXPECT DEMAND	LEAD T. ACTUAL DEMAND	ONE PERIOD ERROR	LEAD TIME ERROR
8	13.00	5.33	1.17	6.50	16.50	13.00	6.50	-3.50
9	6.00	5.33	0.00	5.33	10.67	19.00	0.67	8.33
10	2.00	5.67	0.33	6.00	13.00	8.00	-4.00	-5.00

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

PERIOD	ACTUAL DEMAND	MOVING AVERAGE 6 MOS.	TREND	EXPECT DEMAND	LEAD T. EXPECT DEMAND	LEAD T. ACTUAL DEMAND	ONE PERIOD ERROR	LEAD TIME ERROR
11	5.00	5.67	0.00	5.67	11.33	7.00	-0.67	-4.33
12	6.00	5.33	-0.33	5.00	9.00	11.00	1.00	2.00
13	9.00	6.83	1.50	8.33	21.17	15.00	0.67	-6.17
14	7.00	5.83	-1.00	4.83	6.67	16.00	2.17	9.33
15	4.00	5.50	-0.33	5.17	9.33	11.00	-1.17	1.67
16	8.00	6.50	1.00	7.50	18.00	12.00	0.50	-6.00
17	2.00	6.00	-0.50	5.50	9.50	10.00	-3.50	0.50

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

PERIOD	ACTUAL DEMAND	MOVING AVERAGE 6 MOS.	TREND	EXPECT DEMAND	LEAD T. EXPECT DEMAND	LEAD T. ACTUAL DEMAND	ONE PERIOD ERROR	LEAD TIME ERROR
18	0.00	5.00	-1.00	4.00	5.00	2.00	-4.00	-3.00

NOTE: ERROR IS GREATER THAN

75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

19	5.00	4.33	-0.67	3.67	5.33	5.00	1.33	-0.33
20	4.00	3.83	-0.50	3.33	5.17	9.00	0.67	3.83
21	0.00	3.17	-0.67	2.50	3.00	4.00	-2.50	1.00

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

22	0.00	1.83	-1.33	0.50	-3.00	0.00	-0.50	3.00

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

23	2.00	1.83	0.00	1.83	3.67	2.00	0.17	-1.67
24	3.00	2.33	0.50	2.83	7.17	5.00	0.17	-2.17
25	19.00	4.67	2.33	7.00	21.00	22.00	12.00	1.00
26	2.00	4.33	-0.33	4.00	7.00	21.00	-2.00	14.00

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

27	6.00	5.33	1.00	6.33	15.67	8.00	-0.33	-7.67
28	0.00	5.33	0.00	5.33	10.67	6.00	-5.33	-4.67

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

29	5.00	5.83	0.50	6.33	14.17	5.00	-1.33	-9.17
30	4.00	6.00	0.17	6.17	12.83	9.00	-2.17	-3.83
31	4.00	3.50	-2.50	1.00	-5.50	8.00	3.00	13.50
32	4.00	3.83	0.33	4.17	9.33	8.00	-0.17	-1.33
33	9.00	4.33	0.50	4.83	11.17	13.00	4.17	1.83
34	9.00	5.83	1.50	7.33	19.17	18.00	1.67	-1.17
35	9.00	6.50	0.67	7.17	16.33	18.00	1.83	1.67
36	8.00	7.17	0.67	7.83	17.67	17.00	0.17	-0.67
37	13.00	8.67	1.50	10.17	24.83	21.00	2.83	-3.83
38	11.00	9.83	1.17	11.00	25.50	24.00	0.00	-1.50
39	8.00	9.67	-0.17	9.50	18.50	19.00	-1.50	0.50

40	4.00	8.83	-0.83	8.00	13.50	12.00	-4.00	-1.50

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

41	2.00	7.67	-1.17	6.50	9.50	6.00	-4.50	-3.50

NOTE: ERROR IS GREATER THAN
75% OF ACTUAL DEMAND. ADVISE MANAGEMENT.

42	4.00	7.00	-0.67	6.33	10.67	6.00	-2.33	-4.67
43	5.00	5.67	-1.33	4.33	4.67	9.00	0.67	4.33
44	4.00	4.50	-1.17	3.33	3.17	9.00	0.67	5.83
45	8.00	4.50	0.00	4.50	9.00	12.00	3.50	3.00
46	5.00	4.67	0.17	4.83	10.17	13.00	0.17	2.83
47	12.00	6.33	1.67	8.00	21.00	17.00	4.00	-4.00
48	13.00	7.83	1.50	9.33	23.17	25.00	3.67	1.83
49	6.00	8.00	0.17	8.17	16.83	19.00	-2.17	2.17
50	10.00	9.00	1.00	10.00	23.00	16.00	0.00	-7.00
51	11.00	9.50	0.50	10.00	21.50	21.00	1.00	-0.50
52	8.00	10.00	0.50	10.50	22.50	19.00	-2.50	-3.50
53	6.00	9.00	-1.00	8.00	13.00	14.00	-2.00	1.00
54	6.00	7.83	-1.17	6.67	9.83	12.00	-0.67	2.17
55	9.00	8.33	0.50	8.83	19.17	15.00	0.17	-4.17
56	8.00	8.00	-0.33	7.67	14.33	17.00	0.33	2.67
57	16.00	8.83	0.83	9.67	21.83	24.00	6.33	2.17
58	5.00	8.33	-0.50	7.83	14.17	21.00	-2.83	6.83
59	17.00	10.17	1.83	12.00	29.50	22.00	5.00	-7.50
60	6.00	10.17	0.00	10.17	20.33	23.00	-4.17	2.67

FORECASTING ERRORS:MOVETREND
* * * * * * * * * * * * * * *

AVERAGE CUMULATIVE SIGNED ERROR	:	0.2
PERCENTAGE BALANCED ERROR	:	16.4
OVERALL MEAN ABSOLUTE DEVIATION	:	2.4
TOTAL SIGNED ERROR	:	10.3
ROOT MEAN SQUARE ERROR	:	3.1

APPENDIX D

BOX-JENKINS UNIVARIATE METHODS

In chapter seven Box-Jenkins procedures are described. This appendix contains the two computer programmes: APCORR which computes and plots autocorrelation and partial correlation coefficients; and TYMPAC, to estimate parameters in a multiplicative, autoregressive integrated moving-average time series model. Examples of twelve month ahead forecasting, with error evaluations are given.

It is not known whether these methods have been adopted by individual hospitals. It is considered necessary to include the univariate Box-Jenkins method in this thesis, since the writer is attempting to recommend an advanced computer-based system, and Box-Jenkins is sophisticated and efficient when used by experts.

Following the programme APCORR, one example is given of output for item 2129. Several runs must be made, with a variety of changes to lags, data points to be used etc. before the nature of the model can be chosen. Output consists of correlation and partial correlation using 30 lags and 54 data points, with one seasonal differencing over twelve periods.

Following the programme TYMPAC, two runs of item 2129 are included in this appendix, to show the effect of small parameter changes. The user is instructed to choose 'the best possible parameters, to speed convergence' but specification requires skill and experience. The first run was made with parameters θ_1 = .01 and θ_2 = .07, and eight iterations were needed until the change in each parameter became less than the limit specified (here, .004). The second run used -.10 and .60 and iterations ceased after six runs.

Forecasts and error evaluations included in this section show sums of signed errors of 331 and 421 respectively; these being the lowest attained during several experiments. Newbold (1975) remarked: "the freedom of choice afforded by the Box-Jenkins approach leaves the user free to make a bad choice and hence to produce forecasts of unnecessarily low quality."

Figures XLVII and XLVIII show actual data, calculated function values and twelve months forecasts, for both runs of the item. The superior tracking ability is obvious in figure XLVII.

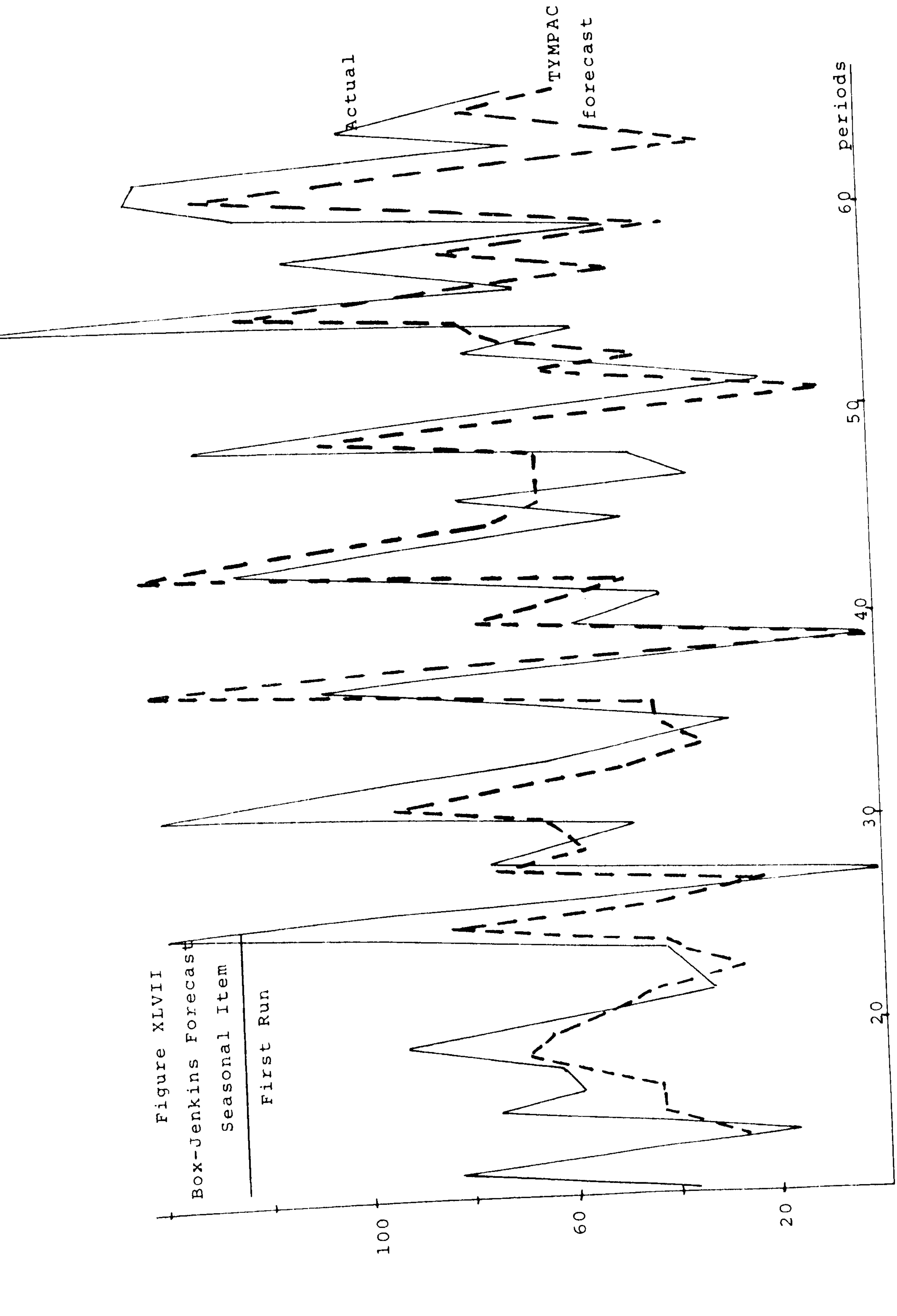

Figure XLVII
Box-Jenkins Forecast
Seasonal Item
First Run

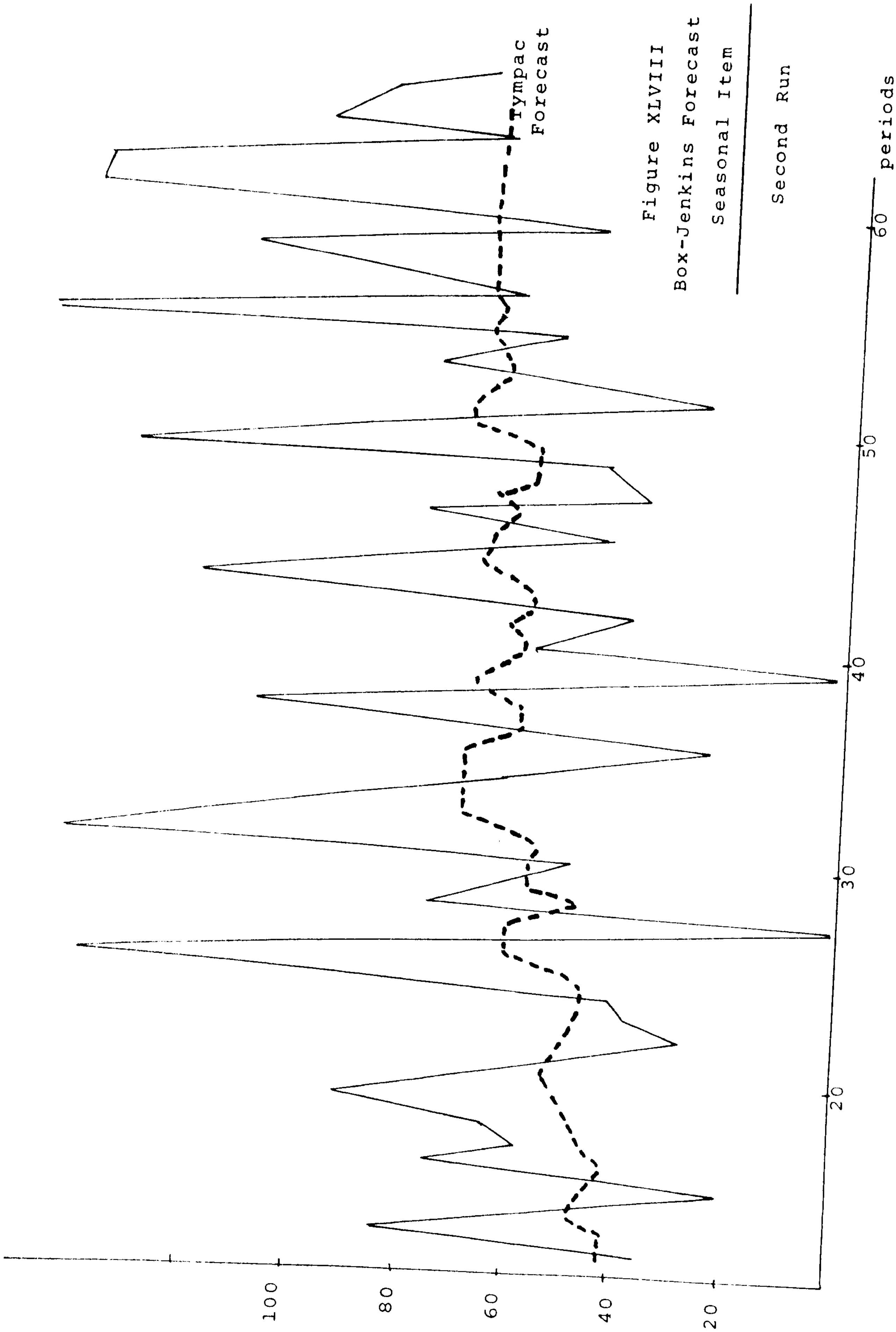

Figure XLVIII
Box-Jenkins Forecast
Seasonal Item

Second Run

```
$JOB             .TIME=2100
C
C
C
C
C
C                BOX-JENKINS METHOD OF
C                 TIME SERIES ANALYSIS
C                ************
C
C          THIS PROCEDURE CONSISTS OF TWO SECTIONS
C
C               APCORR   AND   TYMPAC
C
C          BOTH HAVE BEEN DEVELOPED AT
C          QUEEN'S UNIVERSITY, KINGSTON CANADA
C          - - - - - - - - - - - - - - - - - -
C
C
C          THE FIRST ROUTINE:
C
C                *********
C                 PROGRAMME APCORR
C                *********
C
C          COMPUTES AND PLOTS THE AUTOCORRELATION AND
C          PARTIAL CORRELATION COEFFICIENTS
C          FOR A SINGLE DATA SERIES.
C
C                DATA ADMINISTRATION
C
C                - - - - - - - - - -
C
C          TWO CARDS PRECEDE THE DATA DECK.  SEVERAL SETS
C          OF DATA MAY BE PROCESSED IN ONE RUN,
C          EACH BEING PRECEDED BY A  CONTROL CARD
C          AND A TITLE CARD.
C          THE CONTROL CARD DESCRIBES THE DATA FOLLOWING:
C                                                              APCR0008
      COMMON ITITLE                                            APCR0009
      COMMON /A/COR(600),PCOR(60)                              APCR0010
      DIMENSION COV(600),ALAG(601),RETAIN(600),Y(5,600)        APCR0011
      DIMENSION PRETAI(121)                                    APCR0012
      DIMENSION X(4000),XS(4000)                               APCR0013
      INTEGER S1,S2                                            APCR0014
      DIMENSION VARFOR(18),ITITLE(22)                          APCR0015
      DIMENSION ITITL(4)                                       APCR0016
      DATA ITITL/' COR','RELA','TION',' OF '/                  APCR0017
      DATA ILOG/'LOG '/                                        APCR0018
      DO 17 I=1,4                                              APCR0019
```

```
      ITITLE(I)=ITITL(I)                                              APCR0020
   17 CONTINUE                                                        APCR0021
C                                                                     APCR0022
C  READS IN A CONTROL CARD DESCRIBING THE DATA FOLLOWING              APCR0023
C                                                                     APCR0024
C**** PROGRAM CONTROL CARD                                            APCR0025
C     COL  NAME  FORMAT  DESCRIPTION                                  APCR0026
C        1 NCARD   I1    CARD IDENTIFICATION NUMBER = 1               APCR0027
C      3-5  M      I3    NUMBER OF LAGS (NOT > 200)                   APCR0028
C      8-9  NP     I2    NUMBER OF PARTIALS (NOT > 60)                APCR0029
C     12-14 S1     I3    FIRST  SEASONAL DIFFERENCING PERIOD (<1000)  APCR0030
```

```
C       17-19 S2         I3    SECOND SEASONAL DIFFERENCING PERIOD (<1000)      APCR0031
C                                                                               APCR0032
C                                                                               APCR0033
     16 READ(5,510,END=4000)NCARD,M,NP,S1,S2                                    APCR0034
        IF(NCARD.NE.1)GO TO 7000                                                APCR0035
C                                                                               APCR0036
        READ(5,520,END=7000)NCARD,NDATA,(ITITLE(J),J=5,22)                      APCR0037
C                                                                               APCR0038
C       COL  NAME   FORMAT  DESCRIPTION                                         APCR0039
C         1  NCARD    I1    CARD IDENTIFICATION NUMBER = 2                      APCR0040
C                                                                               APCR0041
        IF(NCARD.NE.2) GO TO 7000                                               APCR0042
C                      -----------                                              APCR0043
C                                                                               APCR0044
        IF(NDATA.GT.4000) GO TO 3000                                            APCR0045
C                         ----------                                            APCR0046
C                                                                               APCR0047
C       DEFAULT VALUES                                                          APCR0048
C                                                                               APCR0049
        IF(M.GT.600) M=600                                                      APCR0050
        IF(NP.GT.60) NP=60                                                      APCR0051
        IF(NP.LT.3) NP=3                                                        APCR0052
        IFLG=1                                                                  APCR0053
C                                                                               APCR0054
C       COL  NAME   FORMAT  DESCRIPTION                                         APCR0055
C         1  NCARD    I1    CARD IDENTIFICATION NUMBER = 3                      APCR0056
C                                                                               APCR0057
        READ(5,530,END=7000)NCARD,VARFOR                                        APCR0058
        IF(NCARD.NE.3) GO TO 7000                                               APCR0059
C                      -----------                                              APCR0060
C                                                                               APCR0061
C     READS IN THE SERIES OF DATA ACCORDING TO FORMAT VARFOR.                   APCR0062
C                                                                               APCR0063
        READ(5,VARFOR)(X(I),I=1,NDATA)                                          APCR0064
C                                                                               APCR0065
        IF(ITITLE(5).EQ.ILOG) CALL CONVT(X,NDATA,&7099)                         APCR0066
        YS=0.0                                                                  APCR0067
        DO 29 I=1,NDATA                                                         APCR0068
        YS=YS+1.0                                                               APCR0069
        XS(I)=YS                                                                APCR0070
     29 CONTINUE                                                                APCR0071
         PRINT 400
    400 FORMAT('1',50X,'PROGRAMME APCORR'/50X,'________________'/35X,
       1'AUTOCORRELATION AND PARTIAL CORRELATION PROCEDURES'/35X,
       2 26('* ') /)
        WRITE(6,509)(ITITLE(I),I=5,22)                                          APCR0072
    509 FORMAT('0',48X,'GRAPH OF ORIGINAL DATA'/23X,18A4/)
        CALL GRAPHL(XS,X,1,NDATA)                                               APCR0074
     31 CONTINUE                                                                APCR0075
```

```
      IF(M.GE.NDATA-3) M=NDATA-4                                        APCR0076
      DO 5000 I=1,600                                                   APCR0077
      COR(I)=0.0                                                        APCR0078
      DO 5000 J=1,5                                                     APCR0079
 5000 Y(J,I)=0.0                                                        APCR0080
      DC 5080 J=1,60                                                    APCR0081
      PCOR(J)=0.0                                                       APCR0082
 5080 CONTINUE                                                          APCR0083
      CALL HEADER(IFLG,S1,S2)                                           APCR0084
       PRINT 606                                                        APC0085A
      PRINT 607 ,(X(I),I=1,NDATA)                                       APCR0085
```

```
C                                                                       APCR0086
C     COMPUTE MEAN AND SUM OF SQUARED DEVIATIONS FROM THE MEAN.         APCR0087
C                                                                       APCR0088
      SUM=0.                                                            APCR0089
      SSDEV=0.                                                          APCR0090
      FNDATA=NDATA                                                      APCR0091
      DO 50 I=1,NDATA                                                   APCR0092
50    SUM=SUM+X(I)                                                      APCR0093
      AVG=SUM/FNDATA                                                    APCR0094
      DO 60 I=1,NDATA                                                   APCR0095
      X(I)=X(I)-AVG                                                     APCR0096
60    SSDEV=SSDEV+X(I)*X(I)                                             APCR0097
      RETAIZ=SSDEV                                                      APCR0098
C                                                                       APCR0099
      VAR=SSDEV/(FNDATA - 1.0)                                          APCR0100
      COVIZ=SSDEV/FNDATA                                                APCR0101
      CALL HEADER(IFLG,S1,S2)                                           APCR0102
      PRINT 600,ITITLE,M,NDATA                                          APCR0103
      PRINT 605,AVG,VAR                                                 APCR0104
C                                                                       APCR0105
C     COMPUTE COVARIANCE AND CORRELATION, PRINT AND PLOT.               APCR0106
C                                                                       APCR0107
      MM1 = M-1                                                         APCR0108
      MP1 = M + 1                                                       APCR0109
      MM2 = M-2                                                         APCR0110
      CORIZ=1.0                                                         APCR0111
      NCOR=NP                                                           APCR0112
      NCOR1=NP                                                          APCR0113
      NCOR2=NP                                                          APCR0114
      IF(NP.GT.M)NCOR=M                                                 APCR0115
      Y(1,1)=1.0                                                        APCR0116
      Y(2,1)=-1.0                                                       APCR0117
      YS=0.0                                                            APCR0118
      DO 90 I=1,MP1                                                     APCR0119
      ALAG(I)=YS                                                        APCR0120
      YS=YS+1.0                                                         APCR0121
   90 CONTINUE                                                          APCR0122
      DO 80 LAG=1,M                                                     APCR0123
      COV(LAG)=0.                                                       APCR0124
      LIMIT=NDATA - LAG                                                 APCR0125
      DO 70 I=1,LIMIT                                                   APCR0126
   70 COV(LAG)=COV(LAG)+X(I)*X(I+LAG)                                   APCR0127
C                                                                       APCR0128
C  STORES COVARIANCES OF ORIGINAL DATA FOR CALCULATION OF COVARIANCES   APCR0129
C  OF FIRST DIFFERENCES.                                                APCR0130
C                                                                       APCR0131
      RETAIN(LAG)=COV(LAG)                                              APCR0132
      COR(LAG)=COV(LAG)/SSDEV                                           APCR0133
80    COV(LAG)=COV(LAG)/FNCATA                                          APCR0134
```

```
      C                                                                    APCR0135
      C   CALCULATES PARTIAL CORRELATIONS OF ORIGINAL DATA.                APCR0136
      C                                                                    APCR0137
 87          CALL PARTIA(NCOR)                                             APCR0138
      C                                                                    APCR0139
 88          PRINT 610,(I,I=1,20),(COR(I),I=1,M)                           APCR0140
 89          PRINT 612,(I,I=1,20)                                          APCR0141
 90          PRINT 613,(PCOR(I),I=1,NCOR)                                  APCR0142
      C                                                                    APCR0143
      C   STORES PARTIAL CORRELATIONS OF ORIGINAL DATA FOR USE BY GRAPHL.  APCR0144
      C                                                                    APCR0145
```

```
      DO 85 J=1,NCOR                                                    APCR0146
   85 PRETAI(J)=PCOR(J)                                                 APCR0147
      LIM=MP1                                                           APCR0148
      LIM1=M                                                            APCR0149
C                                                                       APCR0150
C  CALCULATES CONFIDENCE LIMITS AND STORES IN MATRIX Y FOR GRAPHL.      APCR0151
C                                                                       APCR0152
      CON=2./SQRT(FNDATA)                                               APCR0153
      CON1=-1.*CON                                                      APCR0154
      DO 288 K=2,LIM1                                                   APCR0155
      Y(1,K)=CON1                                                       APCR0156
      Y(2,K)=CON                                                        APCR0157
  288 CONTINUE                                                          APCR0158
C                                                                       APCR0159
C  STORES CORRELATIONS OF ORIGINAL DATA IN GRAPH MATRIX.                APCR0160
C                                                                       APCR0161
      Y(3,1)=CORIZ                                                      APCR0162
      DO 5020 K=2,LIM                                                   APCR0163
 5020 Y(3,K)=COR(K-1)                                                   APCR0164
C                                                                       APCR0165
C  CALCULATES COVARIANCES OF FIRST DIFFERENCES USING RETAINED DATA.     APCR0166
C                                                                       APCR0167
      COVIZ=2.*RETAIZ-2.*RETAIN(1)-X(1)*X(1)-X(NDATA)*X(NDATA)          APCR0168
      COV(1)=2.*RETAIN(1)-RETAIZ-RETAIN(2)                              APCR0169
     *+X(1)*(X(1)-X(2))+X(NDATA)*(X(NDATA)-X(NDATA-1))                  APCR0170
      COR(1)=COV(1)/COVIZ                                               APCR0171
      DO 100 I=2,MM1                                                    APCR0172
      COV(I)=2.*RETAIN(I)-RETAIN(I+1)-RETAIN(I-1)                       APCR0173
     *        +X(1)*(X(I)-X(I+1))+X(NDATA)*(X(NDATA-I+1)-X(NDATA-I))    APCR0174
  100 COR(I)=COV(I)/COVIZ                                               APCR0175
C                                                                       APCR0176
C  STORES COVARIANCES OF FIRST DIFFERENCES FOR CALCULATION OF COVARIANCEAPCR0177
C  OF SECOND DIFFERENCES.                                               APCR0178
C                                                                       APCR0179
      RETAIZ=COVIZ                                                      APCR0180
      DO 101 I=1,MM1                                                    APCR0181
  101 RETAIN(I)=COV(I)                                                  APCR0182
C                                                                       APCR0183
C  CALCULATES PARTIAL CORRELATIONS OF FIRST DIFFERENCES.                APCR0184
C                                                                       APCR0185
      IF(NP.GT.MM1)NCOR1=MM1                                            APCR0186
      CALL PARTIA(NCOR1)                                                APCR0187
C                                                                       APCR0188
      PRINT 620,(I,I=1,20),(COR(I),I=1,MM1)                             APCR0189
      PRINT 622,(I,I=1,20)                                              APCR0190
      WRITE(6,613)(PCOR(I),I=1,NCOR1)                                   APCR0191
C                                                                       APCR0192
C  STORES PARTIAL CORRELATIONS OF FIRST DIFFERENCES FOR LATER GRAPH.    APCR0193
C                                                                       APCR0194
```

```
      DO 95 J=1,NCOR                                                    APCR0195
   95 PRETAI(60+J)=PCOR(J)                                              APCR0196
C                                                                       APCR0197
C  STORES CORRELATIONS OF FIRST DIFFERENCES IN GRAPH MATRIX (Y).        APCR0198
C                                                                       APCR0199
      LIM = M                                                           APCR0200
      Y(4,1)=CORIZ                                                      APCR0201
      DO 5030 K=2,LIM                                                   APCR0202
 5030 Y(4,K)=COR(K-1)                                                   APCR0203
C                                                                       APCR0204
C  CALCULATES COVARIANCES OF SECOND DIFFERENCES USING RETAINED          APCR0205
```

```
C   COVARIANCES OF FIRST DIFFERENCES.
C
          CCVIZ=2.*RETAIZ-2.*RETAIN(1)-(X(1)-X(2))*(X(1)-X(2))-
         *         (X(NDATA)-X(NDATA-1))*(X(NDATA)-X(NDATA-1))
          COV(1)=2.*RETAIN(1)-RETAIZ-RETAIN(2)+
         *(X(3)-2.*X(2)+X(1))*(X(1)-X(2))+
         * (X(NDATA)-2.*X(NDATA-1)+X(NDATA-2))*(X(NDATA)-X(NDATA-1))
          COR(1)=COV(1)/COVIZ
          DO 110 I=2,MM2
          COV(I)=2.*RETAIN(I)-RETAIN(I-1)-RETAIN(I+1)+
         *(X(I+2)-2.*X(I+1)+X(I))*(X(1)-X(2))+
         *         (X(NDATA-I+1)-2.*X(NDATA-I)+X(NDATA-I-1))*
         *         (X(NDATA)-X(NDATA-1))
      110 COR(I)=COV(I)/COVIZ
C
C   CALCULATES PARTIAL CORRELATIONS OF SECOND DIFFERENCES.
C
          IF(NP.GT.MM2)NCOR2=MM2
          CALL PARTIA(NCOR2)
C
          PRINT 626,(I,I=1,20),(COR(I),I=1,MM2)
          PRINT 628,(I,I=1,20)
          WRITE(6,613)(PCOR(I),I=1,NCOR2)
C
C   STCRES CORRELATIONS OF SECOND DIFFERENCES IN GRAPH MATRIX.
C
          LIM = MM1
          Y(5,1)=CORIZ
          DO 5040 K=2,LIM
     5040 Y(5,K)=COR(K-1)
C
C   PRINTS GRAPH OF CORRELATIONS OF ORIGINAL DATA PLUS FIRST AND
C   SECOND DIFFERENCES, PLUS CONFIDENCE LIMITS
C
          CALL HEADER(IFLG,S1,S2)
          PRINT 5100,ITITLE
          CALL GRAPHL(ALAG,Y,5,MM1)
C
          PRINT 632,M,NDATA
C
C********** PLOT PARTIAL CORRELATIONS.
C
          Y(3,1)=-1.0
          Y(4,1)=-1.0
          Y(5,1)=-1.0
          DO 5060 K=2,NCOR2
C
C   STORES PARTIAL CORRELATIONS OF FIRST DIFFERENCES IN GRAPH MATRIX.
C
```

```
147           Y(4,K)=PRETAI(59+K)                                                  APCR0255
        C                                                                          APCR0256
        C  STORES PARTIAL CORRELATIONS OF SECOND DIFFERENCES IN GRAPH MATRIX.      APCR0257
        C                                                                          APCR0258
148           Y(5,K)=PCOR(K-1)                                                     APCR0259
        C                                                                          APCR0260
        C  STORES PARTIAL CORRELATIONS OF ORIGINAL DATA  IN GRAPH MATRIX.          APCR0261
        C                                                                          APCR0262
149      5060 Y(3,K)=PRETAI(K-1)                                                   APCR0263
150           IF(NCOR2.EQ.NP) GO TO 5070                                           APCR0264
151           Y(4,MM1)=PRETAI(59+MM1)                                              APCR0265
```

```
      Y(4,M)=0.0
      Y(3,MM1)=0.0
      Y(3,M)=0.0
      Y(5,MM1)=PCOR(MM2)
      Y(5,M)=0.0
C
C  PRINTS GRAPH OF PARTIAL CORRELATIONS OF ORIGINAL DATA PLUS FIRST
C  AND SECOND DIFFERENCES. CONFIDENCE LIMITS ARE UNALTERED.
C
 5070 CALL HEADER(IFLG,S1,S2)
      WRITE(6,5200)(ITITLE(J),J=5,22)
      CALL GRAPHL(ALAG,Y,5,NCOR1)
C
      IF(S1.LT.2.OR.IFLG.EQ.4) GO TO 15
C
C
C     PERFORM SEASONAL DIFFERENCING
C
      GO TO(6000,6010,6020),IFLG
 6000 CONTINUE
      IFLG=2
C
C     STORE ARRAY X ONLY IF S2.GE.2 FOR REUSE
C
      IF(S2.LT.2) GO TO 6005
      DO 6002 I=1,NDATA
      XS(I)=X(I)
 6002 CONTINUE
 6005 CONTINUE
C
C     SEASONAL DIFFERENCING WITH PERIOD S1
C
      NDATA=NDATA-S1
      DO 6006 I=1,NDATA
      X(I)=X(S1+I)-X(I)
 6006 CONTINUE
      GO TO 31
 6010 CONTINUE
      IF(S2.LT.2) GO TO 15
      IFLG=3
C     SEASONAL DIFFERENCING WITH PERIOD S2
      NDATA=NDATA-S2
      DO 6012 I=1,NDATA
      X(I)=XS(S2+I) - XS(I)
 6012 CONTINUE
      GO TO 31
 6020 CONTINUE
      IFLG=4
      GO TO 6005
```

```
185         15 WRITE(6,635)(ITITLE(I),I=5,22)                APCR0315
186            GO TO 16                                      APCR0316
          C    --------                                      APCR0317
          C                                                  APCR0318
          C                                                  APCR0319
187       3000 PRINT 630                                     APCR0320
          C                                                  APCR0321
188       4000 PRINT 640                                     APCR0322
189            STOP                                          APCR0323
190       7099 WRITE (6,7210)                                APCR0324
191            GO TO 15                                      APCR0325
```

```
C      --------                                                          APCR0326
C                                                                        APCR0327
C                                                                        APCR0328
  7000 WRITE(6,7100)                                                     APCR0329
       STOP                                                              APCR0330
   510 FORMAT(I1,T3,I3,T8,I2,T12,I3,T17,I3)                              APCR0331
   520 FORMAT(I1,T5,I4,18A4)                                             APCR0332
   530 FORMAT(I1,T9,18A4)                                                APCR0333
   600 FORMAT(' ',25X,22A4/30X,'OUT TO ',I3,' LAGS, USING ',I4,' DATA POIAPCR0334
      1NTS'/)                                                            APCR0335
   605 FORMAT(30X,'SAMPLE MEAN =',F10.2,4X,'SAMPLE VARIANCE =',F10.2)
   606 FORMAT('0',49X,'ORIGINAL DATA'/50X,7('* ') /)
   607 FORMAT(20X,10F9.1)
   610 FORMAT(///40X,' CORRELATION OF ORIGINAL DATA'//7X,'LAG',I2,I5,18I6APCR0338
      1/ (7X,19F6.3,F5.2))                                               APCR0339
   612 FORMAT(/38X,'PARTIAL CORRELATION OF ORIGINAL DATA'//6X,'ORDER'/10XAPCR0340
      1,    '=',I2,I5,18I6)                                              APCR0341
   613 FORMAT(/(7X,19F6.3,F5.2))                                         APCR0342
   620 FORMAT(///38X, 'CORRELATION OF FIRST DIFFERENCES.'//              APCR0343
      *7X,'LAG'   ,I2,I5,18I6/(7X,19F6.3,F5.2))                          APCR0344
   622 FORMAT(//35X, 'PARTIAL CORRELATION OF FIRST DIFFERENCES.'//       APCR0345
      *    6X,'ORDER'/10X,'=', I2,I5,18I6)                               APCR0346
   626 FORMAT(////38X,'CORRELATION OF SECOND DIFFERENCES.'//             APCR0347
      *  7X,'LAG',I2,I5,18I6/(7X,19F6.3,F5.2))                           APCR0348
   628 FORMAT(// 35X,'PARTIAL CORRELATION OF SECOND DIFFERENCES.'//      APCR0349
      *6X,'ORDER'/10X,'=',  I2,I5,18I6)                                  APCR0350
   630 FORMAT(64H PARAMETERS SPECIFIED ON THE DATA CONTROL CARD ARE OUT OAPCR0351
      *F LIMIT.)                                                         APCR0352
   632 FORMAT(/// 30X,I3,'  LAGS,USING',I4,' DATA POINTS.')              APCR0353
   635 FORMAT(//20X,'END OF ANALYSIS OF ',18A4/)                         APCR0354
   640 FORMAT(50X,'END OF RUN')                                          APCR0355
  5200 FORMAT(27X,'PARTIAL CORRELATION OF ',18A4/
      1 35X,'PLUS FIRST AND SECOND DIFFERENCES'///)
  5100 FORMAT(20X,22A4/30X,'PLUS FIRST AND SECOND DIFFERENCES'///)       APCR0356
  7100 FORMAT('1 CONTROL CARDS OUT OF ORDER OR MISSING - ABORT')         APCR0359
  7210 FORMAT(' NEGATIVE VALUE ENCOUNTERED TAKING LOGS-NEXT DATA SET')   APCR0360
       END                                                               APCR0361
       SUBROUTINE GRAPHL(X,Y,NG,NPCINT)                                  GPHL0001
C                                                                        GPHL0002
C      ..................................................................GPHL0003
C                                                                        GPHL0004
C                                                                        GPHL0005
C      GRAPHL IS A SUBROUTINE WHICH PLOTS N(N.LE.6) GRAPHS OF A          GPHL0006
C      SERIES OF FUNCTIONS OF THE FORM Y=F(X) SIMULTANEOUSLY             GPHL0007
C                                                                        GPHL0008
C      DESCRIPTION OF VARIABLES:                                         GPHL0009
C                                                                        GPHL0010
C      NPCINT: THE NUMBER OF X-VALUES TO BE PLOTTED                      GPHL0011
C                                                                        GPHL0012
C
```

```
C        NG: THE NUMBER OF SIMULTANEOUS PLOTS                          GPHL0013
C                                                                      GPHL0014
C         X: X IS A VECTOR CONTAINING NPOINT EQUALLY SPACED POINTS     GPHL0015
C                                                                      GPHL0016
C         Y: Y IS AN NG BY NPOINT MATRIX WHOSE COLUMNS CONTAIN THE     GPHL0017
C            VALUES ASSUMED BY THE VARIOUS FUNCTIONS.  FOR EXAMPLE,    GPHL0018
C            THE FIRST CCLUMN OF Y, Y(1,I), CONTAINS ELEMENTS SUCH     GPHL0019
C            THAT Y(1,I)=F1(X(I)) WHERE F1(X) IS THE FIRST FUNCTION    GPHL0020
C            BEING PLOTTED                                             GPHL0021
C                                                                      GPHL0022
C     TO USE GRAPHL                                                    GPHL0023
```

```
C                                                                       GPHL0024
C       CALL GRAPHL(X,Y,NG,NPOINT)                                      GPHL0025
C                                                                       GPHL0026
C                                                                       GPHL0027
C     ..................................................................GPHL0028
C                                                                       GPHL0029
        REAL*4 PA/'.'/,BLANK/' '/,A(110)/110*' '/                       GPHL0030
        REAL*4 GRIDMK(6)/'.','.','.','0','1','2','*'/,                  GPHL0031
       2STORE(16),LOW,X(NPOINT),Y(NG,NPOINT)                            GPHL0032
        REAL INDEX(11)                                                  GPHL0033
        INTEGER*2 AXIS                                                  GPHL0034
    702 FORMAT(/17X,11F10.1)                                            GPHL0035
   706  FORMAT(19X, 'LAGS   ',10('+---------') , '+')
    708 FORMAT(/11X,F13.0,1X,101A1)                                     GPHL0037
        IF(NG.GT.6)NG=6                                                 GPHL0038
        IF(NG.EQ.1)GRIDMK(1)=GRIDMK(6)                                  GPHL0039
        LOW=Y(1,1)                                                      GPHL0040
        HIGH=Y(1,1)                                                     GPHL0041
        DO 140 J=1,NG                                                   GPHL0042
        DO 140 I=1,NPOINT                                               GPHL0043
        IF(Y(J,I).LT.LOW)LOW=Y(J,I)                                     GPHL0044
   140  IF(Y(J,I).GT.HIGH)HIGH=Y(J,I)                                   GPHL0045
        SPREAD=HIGH-LOW                                                 GPHL0046
        DO 150 I=1,11                                                   GPHL0047
        K=I-1                                                           GPHL0048
        SCALE=LOW+FLOAT(K)*SPREAD/10.                                   GPHL0049
        INDEX(I)=SCALE                                                  GPHL0050
    150 CONTINUE                                                        GPHL0051
        SPACE=100./SPREAD                                               GPHL0052
        IF(LOW)161,170,160                                              GPHL0053
    161 IF(HIGH)160,170,170                                             GPHL0054
   160  NO=0                                                            GPHL0055
        GC TC 200                                                       GPHL0056
   170  NO=1                                                            GPHL0057
        AXIS=1.5-LOW*SPACE                                              GPHL0058
   200  WRITE(6,702)INDEX                                               GPHL0059
        WRITE(6,706)                                                    GPHL0060
        DC 220 I=1,NPOINT                                               GPHL0061
        IF(NO.EQ.1)A(AXIS)=PA                                           GPHL0062
        DO 218 J=1,NG                                                   GPHL0063
        N=(Y(J,I)-LOW)*SPACE+1.5                                        GPHL0064
        STORE(J)=N                                                      GPHL0065
   218  A(N)=GRIDMK(J)                                                  GPHL0066
        WRITF(6,708)X(I),(A(K),K=1,101)                                 GPHL0067
        DO 219 J=1,NG                                                   GPHL0068
   219  A(STCRE(J))=BLANK                                               GPHL0069
   220  CONTINUE                                                        GPHL0070
        WRITE(6,706)                                                    GPHL0071
        WRITE(6,702)INDEX                                               GPHL0072
```

```
      GRIDMK(1)=PA                                                      GPHL0073
      RETURN                                                            GPHL0074
      END                                                               GPHL0075
      SUBROUTINE PARTIA(NCOR)                                           PRTL0001
C                                                                       PRTL0002
C  THIS ROUTINE CREATES THE LAURENT MATRIX, USING THE CORRELATIONS      PRTL0003
C  EVALUATED IN THE MAIN PROGRAM. THE MATRIX IS USED AS INPUT TO        PRTL0004
C  SUBROUTINES DELTA AND SOLVEQ WHICH TOGETHER EVALUATE THE PARTIAL     PRTL0005
C  CORRELATIONS AND STORE THEM IN VECTOR PCOR.                          PRTL0006
C                                                                       PRTL0007
```

```
C   COR IS THE VECTOR OF CORRELATIONS, AND CORMAT IS THE LAURENT MATRIX.  PRTL0008
C   NCCR IS THE DIMENSIONS OF THE SQUARE MATRIX WHICH IS CREATED.         PRTL0009
C                                                                         PRTL0010
      COMMON /A/COR(600),PCOR(60)                                         PRTL0011
      DIMENSION CORMAT(60,60)                                             PRTL0012
      IF(NCCR.GT.60)NCOR=60                                               PRTL0013
      K=NCOR-2                                                            PRTL0014
       IF(K.LE.0)  PRINT 15
   15 FORMAT('0',20X,'SMALL AMOUNT OF DATA AVAILABLE. USE WITH CARE'/)
       IF(K.LE.0) K=1
      DO 10 I=1,K                                                         PRTL0015
      CORMAT(I,I)=1.0                                                     PRTL0016
      L=I+1                                                               PRTL0017
      DC 10 J=L,NCOR                                                      PRTL0018
      F=COR(J-I)                                                          PRTL0019
      CORMAT(I,J)=F                                                       PRTL0020
      CORMAT(J,I)=F                                                       PRTL0021
   10 CONTINUE                                                            PRTL0022
      K=NCOR-1                                                            PRTL0023
       IF(K.LE.0) K=1
      CORMAT(K,K)=1.0                                                     PRTL0024
      F=CCR(1)                                                            PRTL0025
      CORMAT(K,NCOR)=F                                                    PRTL0026
      CORMAT(NCOR,K)=F                                                    PRTL0027
      CORMAT(NCOR,NCOR)=1.0                                               PRTL0028
C                                                                         PRTL0029
      CALL DELTA(60,CORMAT,DET,NCOR)                                      PRTL0030
C                                                                         PRTL0031
      CALL SOLVEQ(CORMAT,CCR,DET,PCOR,60,NCOR)                            PRTL0032
C                                                                         PRTL0033
      RETURN                                                              PRTL0034
      END                                                                 PRTL0035

      SUBROUTINE DELTA(NPAR,UL,DET,NORD)                                  DLTA0001
C          THIS ROUTINE CALCULATES THE DETERMINANT OF A MATRIX. THE       DLTA0002
C          ORDER OF THE MATRIX IS NORD. THE MATRIX IS UL THE UPPER        DLTA0003
C          TRIANGULAR DECOMPOSITION IS UL AND THE DETERMINANT IS DET.     DLTA0004
      DIMENSION UL(NPAR,NPAR)                                             DLTA0005
      REAL*8 FAC1,FAC2,UL1C,UL2D,DBLE                                     DLTA0006
C                                                                         DLTA0007
      EPS=1.0 E-50                                                        DLTA0008
C                                                                         DLTA0009
C          DECOMPOSE MATRIX TO UPPER TRIANGULAR FORM                      DLTA0010
C                                                                         DLTA0011
      DC 101 K=2,NORD                                                     DLTA0012
      KK=K-1                                                              DLTA0013
      IF(ABS(UL(KK,KK)).GT.EPS) GO TO 103                                 DLTA0014
      DET=0.0                                                             DLTA0015
      GO TO 104                                                           DLTA0016
```

```
  103 FAC1=1.0D00/DBLE(UL(KK,KK))                                          DLTA0017
      DO 101 I=K,NORD                                                       DLTA0018
      FAC2=DBLE(UL(I,KK))*FAC1                                              DLTA0019
      UL(I,KK)=SNGL(FAC2)                                                   DLTA0020
      DO 101 J=K,NORD                                                       DLTA0021
      UL1D=DBLE(UL(I,J))                                                    DLTA0022
      UL2D=DBLE(UL(KK,J))                                                   DLTA0023
      UL1D=UL1D-FAC2*UL2D                                                   DLTA0024
      UL(I,J)=SNGL(UL1D)                                                    DLTA0025
  101 CONTINUE                                                              DLTA0026
C                                                                           DLTA0027
```

```
C           CALCULATE DETERMINANT                                       DLTA0028
C                                                                       DLTA0029
      DET=1.0                                                           DLTA0030
      DO 102 I=1,NORD                                                   DLTA0031
  102 DET=DET*UL(I,I)                                                   DLTA0032
  104 CONTINUE                                                          DLTA0033
      RETURN                                                            DLTA0034
      END                                                               DLTA0035
      SUBROUTINE SOLVEQ(UL,B,DET,X,NPAR,NORD)                           SLVQ0001
C                                                                       SLVQ0002
C          THIS ROUTINE SOLVES THE PARTIAL CORRELATIONS. ITS INPUT IS THESLVQ0003
C          TRIANGULAR FORM OF THE MATRIX UL AND THE  VECTOR OF RIGHT    SLVQ0004
C          HAND SIDES B . THESE SHOULD BE OBTAINED FROM THE SUBROUTINE  SLVQ0005
C          DELTA.DET IS THE DETERMINANT AND NPAR IS THE ORDER OF THE    SLVQ0006
C          SYSTEM. X IS THE OUTPUT VECTOR OF PARTIAL CORRELATIONS.      SLVQ0007
C                                                                       SLVQ0008
      DIMENSION UL(NPAR,NPAR),B(NPAR),X(NPAR)                           SLVQ0009
      REAL*8 ANS1,ANS2,DBLE                                             SLVQ0010
    1 FORMAT(10X,'THE VALUE OF THE DETERMINANT IS',2X,E10.5,2X,'THIS IS SLVQ0011
     1TOO SMALL AND THE EQUATIONS HAVE NOT BEEN SOLVED.')               SLVQ0012
      IF(ABS(DET).GT.1.0E-50) GO TO 100                                 SLVQ0013
      WRITE(6,1) DET                                                    SLVQ0014
      GO TO 104                                                         SLVQ0015
  100 CONTINUE                                                          SLVQ0016
C                                                                       SLVQ0017
C          TRANSFORM THE RIGHT HAND SIDE SIMILARLY TO THE LEFT HAND     SLVQ0018
C          SIDE                                                         SLVQ0019
C                                                                       SLVQ0020
      DO 106 I=1,NORD                                                   SLVQ0021
      X(I)=B(I)                                                         SLVQ0022
  106 CONTINUE                                                          SLVQ0023
      DO 107 K=2,NORD                                                   SLVQ0024
      KK=K-1                                                            SLVQ0025
      DO 107 I=K,NORD                                                   SLVQ0026
      X(I)=SNGL(DBLE(X(I))-DBLE(X(KK))*DBLE(UL(I,KK)))                  SLVQ0027
  107 CONTINUE                                                          SLVQ0028
      DO 108 I=1,NORD                                                   SLVQ0029
      X(I) = X(I) / UL(I,I)                                             SLVQ0030
  108 CONTINUE                                                          SLVQ0031
  104 CONTINUE                                                          SLVQ0032
      RETURN                                                            SLVQ0033
      END                                                               SLVQ0034
      SUBROUTINE HEADER(IFLG,IS1,IS2)                                   HDER0001
C                                                                       HDER0002
C     THIS SUBROUTINE PRINTS PAGE HEADERS FOR SEASONAL DIFFERENCING     HDER0003
C                                                                       HDER0004
      COMMON ITITLE(22)                                                 HDER0005
```

```
      GO TO (1,2,3,4),IFLG                                               HDER0006
    1 WRITE(6,100)(ITITLE(I),I=5,22)                                     HDER0007
      RETURN                                                             HDER0008
    2 WRITE(6,200)IS1,(ITITLE(I),I=5,22)                                 HDER0009
      RETURN                                                             HDER0010
    3 WRITE(6,200)IS2,(ITITLE(I),I=5,22)                                 HDER0011
      RETURN                                                             HDER0012
    4 WRITE(6,300)IS1,IS2,(ITITLE(I),I=5,22)                             HDER0013
      RETURN                                                             HDER0014
  100 FORMAT('1',40X,'NO SEASONAL DIFFERENCING APPLIED'/20X,18A4//)
  200 FORMAT('1',30X,'ONE SEASONAL DIFFERENCING PERIOD:',1X,I3/10X,18A4
```

```
     1//)
 300 FORMAT('1',30X,'TWO SEASONAL DIFFERENCING PERIODS',2X,I3,1X,I3/10XHDER0017
     1, 18A4//)
      END                                                               HDER0019

      SUBROUTINE CONVT(X,NDATA,*)                                       CNVT0001
      DIMENSION X(1)                                                    CNVT0002
C                                                                       CNVT0003
C     THIS SUBROUTINE CONVERTS THE VALUES IN THE ORIGINAL ARRAY X       CNVT0004
C     BY LOGARITHMIC TRANSFORMATION                                     CNVT0005
C                                                                       CNVT0006
      DO 1  I=1,NDATA                                                   CNVT0007
      IF(X(I).LT.0.0) GO TO 2                                           CNVT0008
      X(I)=ALOG10(X(I))                                                 CNVT0009
    1 CONTINUE                                                          CNVT0010
      RETURN                                                            CNVT0011
    2 RETURN 1                                                          CNVT0012
      END                                                               CNVT0013
C                END OF PART ONE : APCORR
C                * * * * * * * * * * * * *

$ENTRY
```

```
                    NO SEASONAL DIFFERENCING APPLIED
                SEASONAL ITEM

          CORRELATION OF                  SEASONAL ITEM
            OUT TO  30 LAGS, USING   66 DATA POINTS

            SAMPLE MEAN =       66.91     SAMPLE VARIANCE =    1229.40

                      CORRELATION OF ORIGINAL DATA

LAG 1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18
 0.197-0.055 0.178-0.089 0.143 0.480 0.127-0.108 0.069-0.220 0.032 0.534 0.049-0.216 0.027-0.192 0.026 0.330-
-0.035-0.219-0.086 0.349 0.036-0.130 0.003-0.148 0.063 0.248
                 PARTIAL CORRELATION OF ORIGINAL DATA

ORDER
   = 1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18

 0.197-0.098 0.220-0.201 0.292 0.350 0.040-0.186 0.041-0.294 0.147 0.341-0.074-0.280 0.064-0.029 0.123-0.125-
 0.054-0.001-0.103 0.002 0.133 0.139-0.042-0.031 0.099-0.067


                 CORRELATION OF FIRST DIFFERENCES.

LAG 1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18
-0.344-0.303 0.312-0.310-0.065 0.431-0.075-0.257 0.290-0.338-0.155 0.617-0.139-0.318 0.291-0.273-0.052 0.407-
 0.187-0.197-0.187 0.471-0.095-0.190 0.180-0.226 0.016

              PARTIAL CORRELATION OF FIRST DIFFERENCES.

ORDER
   = 1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18

-0.344-0.478-0.009-0.441-0.421-0.091 0.134-0.093 0.234-0.216-0.387 0.033 0.235-0.117-0.015-0.159 0.089-0.010
-0.044 0.059-0.050-0.169-0.169 0.014 0.003-0.120 0.046


                 CORRELATION OF SECOND DIFFERENCES.

LAG 1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18
-0.515-0.210 0.454-0.319-0.092 0.375-0.129-0.267 0.438-0.309-0.204 0.556-0.211-0.289 0.427-0.289-0.080 0.366-
```

```
0.270-0.149-0.230 0.445-0.179-0.159 0.277-0.241

                  PARTIAL CORRELATION OF SECOND DIFFERENCES.

ORDER
    = 1      2      3      4      5      6      7      8      9     10     11     12     13     14     15     16     17     18

 -0.515-0.647-0.135-0.293-0.501-0.417-0.057-0.253 0.230 0.231-0.237-0.270 0.153 0.030 0.137-0.093 0.051 0.001
 -0.113 0.021 0.095 0.023-0.137-0.057 0.092-0.074
```

ONE SEASONAL DIFFERENCING PERIOD: 12
SEASONAL ITEM

ORIGINAL DATA
* * * * * * *

22.0	4.0	-5.0	33.0	18.0	10.0	25.0	10.0	-4.0	-14.0
12.0	7.0	57.0	33.0	-19.0	0.0	6.0	-15.0	49.0	27.0
28.0	34.0	-9.0	18.0	-31.0	-15.0	3.0	-17.0	-21.0	19.0
-21.0	-30.0	-27.0	17.0	5.0	-15.0	23.0	37.0	25.0	-10.0
34.0	-13.0	46.0	-5.0	38.0	32.0	14.0	76.0	10.0	41.0
38.0	50.0	11.0	12.0						

```
                  ONE SEASONAL DIFFERENCING PERIOD:  12
              SEASONAL ITEM

               CORRELATION OF                  SEASONAL ITEM
                 OUT TO  30 LAGS, USING   54 DATA POINTS

                 SAMPLE MEAN =      12.09    SAMPLE VARIANCE =    587.18


                             CORRELATION OF ORIGINAL DATA

LAG 1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18
 0.149 0.258 0.178 0.061 0.100 0.031 0.208 0.108 0.062-0.104-0.017-0.272-0.031-0.082-0.060-0.111-0.053-0.105-(
-0.092-0.094-0.174 0.033-0.101 0.054-0.062-0.046 0.040 0.044
                           PARTIAL CORRELATION OF ORIGINAL DATA

ORDER
   = 1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18

 0.149 0.241 0.122-0.034 0.028-0.008 0.193 0.061-0.047-0.230-0.022-0.250 0.087-0.004 0.005-0.159 0.089-0.052-(
 0.086-0.087-0.002-0.016 0.041 0.063 0.085-0.125 0.094 0.004


                           CORRELATION OF FIRST DIFFERENCES.

LAG 1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18
-0.562 0.113 0.014-0.089 0.064-0.147 0.166-0.029 0.073-0.154 0.203-0.302 0.177-0.034 0.040-0.065 0.068 0.014-(
 0.090 0.054-0.174 0.211-0.174 0.157-0.074-0.040 0.040

                         PARTIAL CORRELATION OF FIRST DIFFERENCES.

ORDER
   = 1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18

-0.562-0.296-0.111-0.158-0.101-0.273-0.117 0.001 0.173-0.055 0.158-0.206-0.099-0.077 0.087-0.173-0.017-0.064 (
 0.006-0.093-0.073-0.113-0.098-0.107 0.116-0.117-0.017


                           CORRELATION OF SECOND DIFFERENCES.

LAG 1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18
-0.716 0.253-0.004-0.082 0.120-0.172 0.163-0.095 0.109-0.190 0.282-0.323 0.218-0.083 0.056-0.079 0.069-0.013 (
```

```
0.072 0.069-0.205 0.253-0.229 0.176-0.083-0.010

                     PARTIAL CORRELATION OF SECOND DIFFERENCES.

ORDER
   = 1      2      3      4      5      6      7      8      9     10     11     12     13     14     15     16     17     18

-0.716-0.534-0.312-0.283-0.098-0.252-0.274-0.306-0.002-0.163 0.220 0.055-0.021-0.171 0.105-0.074 0.018-0.139
 0.042 0.005 0.019-0.049-0.061-0.239 0.056-0.032
```

TWO SEASONAL DIFFERENCING PERIODS 12 6
SEASONAL ITEM

ORIGINAL DATA
* * * * * * *

3.0	6.0	1.0	-47.0	-6.0	-3.0	32.0	23.0	-15.0	14.0
-6.0	-22.0	-8.0	-6.0	47.0	34.0	-15.0	33.0	-80.0	-42.0
-25.0	-51.0	-12.0	1.0	10.0	-15.0	-30.0	34.0	26.0	-34.0
44.0	67.0	52.0	-27.0	29.0	2.0				

```
          TWO SEASONAL DIFFERENCING PERIODS    12    6
       SEASONAL ITEM

        CORRELATION OF                   SEASONAL ITEM
           OUT TO  30 LAGS, USING   36 DATA POINTS

           SAMPLE MEAN =       0.39    SAMPLE VARIANCE =   1029.10


                       CORRELATION OF ORIGINAL DATA

LAG 1      2      3      4      5      6      7      8      9     10     11     12     13     14     15     16     17     18
 0.186  0.038  0.103-0.057-0.089-0.200  0.074  0.184-0.177-0.055-0.192-0.382-0.113-0.119  0.117  0.038  0.181  0.107-
 0.024  0.030  0.008-0.006  0.076  0.051-0.075-0.071-0.059  0.045

                    PARTIAL CORRELATION OF ORIGINAL DATA

ORDER
   = 1     2      3      4      5      6      7      8      9     10     11     12     13     14     15     16     17     18

 0.186  0.004  0.099-0.098-0.066-0.192  0.177  0.170-0.240-0.062-0.258-0.319  0.097-0.005  0.108-0.099  0.173-0.177
-0.026  0.018-0.175-0.154-0.079  0.182  0.044-0.044  0.016-0.091


                    CORRELATION OF FIRST DIFFERENCES.

LAG 1      2      3      4      5      6      7      8      9     10     11     12     13     14     15     16     17     18
-0.410-0.129  0.138-0.081  0.050-0.236  0.100  0.290-0.296  0.159  0.033-0.282  0.168-0.150  0.193-0.134  0.133  0.074-
 0.047  0.018-0.006-0.059  0.066  0.062-0.082-0.006-0.054

                 PARTIAL CORRELATION OF FIRST DIFFERENCES.

ORDER
   = 1     2      3      4      5      6      7      8      9     10     11     12     13     14     15     16     17     18

-0.410-0.357-0.110-0.137-0.022-0.349-0.279  0.137-0.063  0.110  0.100-0.315-0.164-0.237-0.015-0.263  0.093-0.132-
-0.088  0.104  0.061-0.029-0.267-0.110-0.016-0.071  0.037


                    CORRELATION OF SECOND DIFFERENCES.

LAG 1      2      3      4      5      6      7      8      9     10     11     12     13     14     15     16     17     18
-0.589-0.016  0.182-0.118  0.157-0.243  0.061  0.287-0.383  0.205  0.072-0.272  0.277-0.245  0.246-0.210  0.094  0.077-
```

0.050-0.010 0.013-0.068 0.045 0.057-0.088 0.050

PARTIAL CORRELATION OF SECOND DIFFERENCES.

```
ORDER
   = 1      2      3      4      5      6      7      8      9     10     11     12     13     14     15     16     17     18

-0.589-0.555-0.353-0.348 0.030-0.137-0.406-0.054-0.146-0.019 0.337 0.032 0.043-0.177 0.075-0.245 0.052-0.078-
-0.131 0.035 0.138 0.255-0.016-0.096 0.011-0.070
```

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```
              C
              C
              C
              C
              C
              C
              C
              C                  ----------
              C              BOX-JENKINS METHOD OF
              C              TIME SERIES ANALYSIS
              C              * * * * * * * * * * *
              C
              C                    TYMPAC
              C
              C                  ----------
              C
              C            QUEEN'S UNIVERSITY, ONTARIO, CANADA
              C
              C            PROGRAMME TO ESTIMATE PARAMETERS IN
              C            LINEAR TIME SERIES MODELS BY METHODS
              C            DESIGNED BY G.E.P.BOX AND G.M.JENKINS.
              C            TIME SERIES ANALYSIS, FORECASTING AND CONTROL,
              C            SAN FRANCISCO, HOLDEN-DAY INC.., 1970
              C
              C            THE PROGRAMME ESTIMATES THE PARAMETERS IN A
              C            MULTIPLICATIVE AUTOREGRESSIVE INTEGRATED
              C            MOVING AVERAGE TIME SERIES MODEL.
              C
              C
0001                DIMENSION SCRAT(6000), B(500), C(500), F(500),  E(10), PA(50),
                   X        FMT(18),ITITLE(18)
0002                COMMON  NPROE,     EPS1, EPS2, FLAM, FNU, MIT,    NDR,    Z(500),
                   X        MAX1, NP, NRD, NSD, NSEA, NL, NF, NY, NTO,NLOG,ND,MCE,MP,
                   X        Y(100),   INC(6), IOPA(50),               NT(10),
                   X        NOB, NDRPNF, MBO, MAX11, NDIMS, DIFF(50), SIGNS(50),
                   X        ZZ(500), A(500)
0003                INTEGER LLOG /'LOG '/
              C
              C     READ IN THE SERIES CARD
              C
0004                READ 2, NOCARD, NREP
0005              2 FORMAT (I1, 26I3)
0006                IF (NOCARD.NE.0)  GO TO 72
0007                DO 20 NN=1,NREF
0008                NPROB=NN
              C
              C     READ IN THE SPECS CARD
```

```
      C
0009        READ 2, NOCARD, MAX,NP,NRD,NSD,NSEA,LDATA
0010        IF (NOCARD.NE.1)  GO TO 72
      C
      C     READ IN THE MODEL CARD
      C
0011        READ 2, NOCARD, (INC( J), J=1,6)
0012        IF (NOCARD.NE.2)  GO TO 72
      C
      C     READ IN THE ORDER CARD
      C
```

```
 0013            READ 2, NOCARD, (IOPA(J), J=1,NP)                           00030000
 0014            IF (NOCARD.NE.3)  GO TO 72                                  00031000
           C                                                                 00032000
           C     READ IN THE PARAMETER CARD                                  00033000
           C                                                                 00034000
 0015            READ 8, NOCARD, (PA(J), J=1,NP)                             00035000
 0016          8 FORMAT ( I1, 7X,(9F8.4))
 0017            IF (NOCARD.NE.4)  GO TO 72                                  00037000
 0018            IF (LDATA.EQ.0) GO TO 5                                     00038000
           C                                                                 00039000
           C     READ IN THE OPTIONAL SPECS CARD                             00040000
           C                                                                 00041000
 0019            READ 2, NOCARD, NL, NF, NY, NTO                             00042000
           C                                                                 00043000
           C     READ IN THE "ITERATION CARD"                                00044000
           C                                                                 00045000
 0020            READ 14,EPS1,EPS2,FLAM,FNU,MIT                              00046000
 0021         14 FORMAT(4F8.4,I4)                                            00047000
           C                                                                 00048000
           C     IF ANY "FUTURE" DATA FOINTS ARE AVAILABLE, READ THEM IN.    00049000
           C                                                                 00050000
 0022            IF(NY .EQ. 0) GO TO 4                                       00051000
 0023            READ 8, NOCARD, (Y(I), I=1,NY)                              00052000
           C                                                                 00053000
           C     IF FORECASTS ARE TO BE MADE FOR A NUMBER OF DIFFERENT TIME  00054000
           C     ORIGINS, THEN READ IN THESE TIME ORIGINS                    00055000
           C                                                                 00056000
 0024          4 IF(NTO .EQ. 0) GO TO 10                                     00057000
 0025            READ 2, NOCARD, (NT(I), I=1, NTO)                           00058000
 0026            GO TO 10                                                    00059000
 0027          5 EPS1=0.0                                                    00060000
 0028            EPS2=0.004                                                  00061000
 0029            FLAM = 0.001                                                00062000
 0030            FNU = 10.0                                                  00063000
 0031            MIT = 25                                                    00064000
 0032            NL=24                                                       00065000
 0033            NF=12                                                       00066000
 0034            NY =0                                                       00067000
 0035            NTO =1                                                      00068000
 0036         10 CONTINUE                                                    00069000
 0037            ND =0                                                       00070000
 0038            MCE=0                                                       00071000
 0039            MP = 1                                                      00072000
           C                                                                 00073000
           C     READ IN THE "TITLE CARD".                                   00074000
           C                                                                 00075000
 0040            READ 6, NOCARD, NDR,ITITLE                                  00076000
```

```
0041          6 FORMAT (I1, 3X, I4, 18A4)
0042            IF (NOCARD.NE.5)  GO TO 72
0043            IF(NDR.GT.500.CR.NDR.LE.0)  GO TO 70
0044            IF (LDATA.EQ.0) NT(1)=NDR
0045            NLOG = 0
0046            IF (ITITLE(1).EQ.LLOG)  NLOG =1
          C
          C     READ IN THE FORMAT CARD
          C
0047            READ 3, NOCARD, FMT
0048          3 FORMAT  (I1, 7X, 18A4 )
```

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```
 0049             IF (NOCARD.NE.6)  GO TO 72                                   00088000
            C                                                                  00089000
            C     READ IN THE DATA POINTS                                      00090000
            C                                                                  00091000
 0050             READ (5,FMT)   (Z(I), I=1,NDR)                               00092000
            C                                                                  00093000
            C     PRINT THE HEADING                                            00094000
            C                                                                  00095000
 0051               PRINT 200                                                     95100
 0052         200 FORMAT('1',35X,'QUEENS UNIVERSITY  TYMPAC  '/ 30X,'BOX-JENKINS EST  96200
                 1IMATOR OF PARAMETERS.'/30X,'* * * * * * * * * * * * * * * * * *'/   96300
                 2  45X,'TYMPAC'/30X,18('* ')/)                                  96350
 0053             PRINT 7, NPROB,ITITLE                                        00096400
 0054           7 FORMAT (1H0, //1H0, 23X,'ITEM NUMBER',1X,I4,' : ', 18A4/30X,    97000
                 1 '* * * * * * * * * *'/)
            C                                                                  00098000
            C     CHECK THE "ITERATION CARD".                                  00099000
            C                                                                  00100000
 0055             IF (MIT.LE.0.OR.MIT.GT.999) GO TO 52                         00101000
 0056             IF (FNU.LE.1)  GO TO 52                                      00102000
            C                                                                  00103000
            C     CHECK THE SPECS CARD                                         00104000
            C                                                                  00105000
 0057             NOB = NDR-MAX                                                00106000
 0058             IF( NOB.LE.0)  GO TO 54                                      00107000
 0059             IF (NOB.LT.NP) GO TO 54                                      00108000
 0060             IF (NP.LE.0.OR.NP.GT.50) GO TO 54                            00109000
 0061             IF(NRD .LT. 0 .OR. NSD .LT. 0) GO TO 54                      00110000
 0062             IF(NSD .GT. 0 .AND. NSEA .LE. 1) GO TO 54                    00111000
 0063             IF(NSEA .LT. 0) GO TO 54                                     00112000
 0064             IF (NL.LE.0)  GO TO 54                                       00113000
 0065             IF (NF .LE. 0 .OR. NF .GT. 200) GO TO 54                     00114000
 0066             NDRPNF=NDR+NF                                                00115000
 0067             IF(NDRPNF .GT. 500) GO TO 54                                 00116000
 0068             MAXZ = NDR+NY                                                00117000
 0069             IF(MAXZ .GT. 500) GO TO 54                                   00118000
 0070             IF(NTO .LE. 0 .OR. NY .LT. 0) GO TO 54                       00119000
 0071             IF (ND  .LT. 0) GO TO 54                                     00120000
            C                                                                  00121000
            C     CHECK THE MODEL CARD                                         00122000
            C                                                                  00123000
 0072             IF(INC(3) .GT. 1 .OR. INC(4) .GT. 1) GO TO 56                00124000
 0073             IF (NRD .GT. 0 .AND. INC(3) .EQ. 1) GO TO 56                 00125000
 0074             IF (NSD .GT. 0 .AND. INC(3) .EQ. 1) GO TO 56                 00126000
 0075             KK = 0                                                       00127000
 0076             DO 23 J=1,6                                                  00128000
 0077             KK = KK+INC(J)                                               00129000
```

```
      IF(INC(J) .LT. 0) GO TO 56
   23 CONTINUE
      IF(KK .LE. 0 .OR. KK .GT. 50) GO TO 56
C
C     CHECK THE ORDER CARD
C
      DO 25  J=1,NP
      IF (IOPA(J) .LT. 0) GO TO 58
   25 CONTINUE
C
C     CHECK THE PARAMETER CARD
```

```
              C
 0084               DO 13  I=1,NP
 0085               IF (PA(I).EQ.0) GO TO 60
 0086            13 CONTINUE
              C
              C     CHECK IF MAX AS READ IN IS CONSISTENT WITH THE MODEL CARD AND THE
              C     ORDER CARD
              C
 0087               MAX1 = NRD + NSD * NSEA
 0088               KK = INC(1)
 0089               IF(INC(1) .NE. 0)MAX1 = MAX1+IOPA(KK)
 0090               KK = KK+INC(2)
 0091               IF(INC(2) .NE. 0) MAX1=MAX1+IOPA(KK)
 0092               IF (MAX.NE.MAX1) GO TO 62
              C
              C     DETERMINE THE MAXIMUM POWER OF  B  ON THE RIGHT HAND SIDE OF
              C     THE MODEL  (THE REGULAR AND SEASONAL MOVING AVERAGE TERMS).
              C
 0093               KK = KK+INC(3)+INC(4)+INC(5)
 0094               MAX2 = 0
 0095               IF(INC(5) .NE. 0) MAX2 = IOPA(KK)
 0096               IF (INC(6) .NE. 0)MAX2=MAX2+IOPA(NP)
              C
              C     FIND THE MAXIMUM BACK ORDER OF THE MODEL, AND CHECK THAT IT DOES
              C     NOT EXCEED THE NUMBER OF DATA POINTS AVAILABLE
              C
 0097               MBO = MAX1
 0098               IF(MAX2 .GT. MAX1) MBO = MAX2
 0099               IF(NDR .LE. MBO .OR. MBO .GT. 100) GO TO 64
              C
              C     CALCULATE THE QUANTITIES MAX11, DIFF(NP), SIGNS(NP) FOR FUTURE USE
              C
 0100               MAX11 = MAX1+1
 0101               DO 12 J=1,NP
 0102               SIGNS(J)=0
 0103            12 DIFF(J)=.01
              C
              C     LOG DATA IF REQUESTED
              C
 0104               IF (NLOG.EQ.0)  GO TO 27
 0105               DO 26   J=1,NDR
 0106            26 Z(J)=ALOG10(Z(J))
 0107            27 CONTINUE
              C
              C     SET ASIDE THE FIRST "MAX1" DATA POINTS OF THE TIME SERIES AND
              C     PUT THE REMAINDER OF THE SERIES IN ARRAY "ZZ".
              C
```

```
      DO 30 J=MAX11,NDR
      K=J-MAX1
   30 ZZ(K) = Z(J)
C
C     SET INITIAL VALUES IN ARRAY  "A" EQUAL TO ZERO.
C
      DO 32 J=1,MAX1
   32 A(J) = 0.0
C
C     CHECK IF SUFFICIENT MEMORY IS ALLOCATED TO SCRAT  FOR THE NEEDS OF
C     SUBROUTINE HAUS59
```

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```
                C
 0113                 NDIMS = 5*NP + 2*NP**2 + NOB*NP
 0114                 IF (NDIMS.GT.6000)   GO TO 50
                C
                C     CALL NON-LINEAR ESTIMATION  SUBROUTINE HAUS59
                C
 0115                 I1 = 1
 0116                 I2 = I1 + NP
 0117                 I3 = I2 + NP
 0118                 I4 = I3 + NP
 0119                 I5 = I4 + NP
 0120                 I6 = I5 + NP
 0121                 I7 = I6 + NP*NP
 0122                 I8 = I7 + NP*NP
 0123                 CALL HAUS59 (F,B,C, SCRAT(I1), SCRAT(I2), SCRAT(I3), SCRAT(I4),
                     *    SCRAT(I5),SCRAT(I6),SCRAT(I7),SCRAT(I8),PA,NP,NOB)
                C
                C     PRINT THE TITLE FOR THE GRAPH OF THE RESULTS
                C
 0124                 PRINT 35, NPROE,ITITLE
 0125              35 FORMAT (1H1, 30X,'GRAPH FOR ITEM',1X,I4,' : ',18A4)
 0126                 PRINT 36
 0127              36 FORMAT (1H , 30X, 24H"0"S ARE OBSERVED DATA.  )
 0128                 PRINT 37
 0129              37 FORMAT (1H , 30X, 37H"1"S ARE CALCULATED FUNCTION VALUES.  )
                C
                C     CALL THE GRAPH PLOTTING SUBROUTINE "GRAPHL "
                C
 0130                 DO 33  J=1,NOB
 0131                 K=4*(J-1)+ 1
 0132                 SCRAT(K) =ZZ(J)
 0133                 K = K + 1
 0134                 SCRAT(K) =ZZ(J)
 0135                 K = K + 1
 0136                 SCRAT(K)=ZZ(J)
 0137                 K = K + 1
 0138                 SCRAT(K) = F(J)
 0139              33 F(J) = J
 0140                 CALL GRAPHL(F,SCRAT,4,NOB)
 0141                 CALL TSMOD(PA, B)
 0142                 DO 34 I=MAX11,NDR
 0143                 J=I-MAX1
 0144              34 C(J) = A(I)
 0145                 PRINT 17
 0146              17 FORMAT(1H1,43X,25HRESIDUAL AUTOCORRELATIONS//)
                C     USE SUBROUTINE ACOR FOR DIAGNOSTIC CHECK
 0147                 CALL    ACOR(C,SCRAT(1),SCRAT(501),E,NL,NOB)
```

```
0148          FDIV = NOB - NP
0149          ALIM = 2.0 / SQRT(FDIV)
0150          PRINT 430, ALIM
0151      430 FORMAT (///22X, 66HAPPROXIMATE 95 PERCENT LIMITS FOR CORRELATICNS
             1ARE PLUS AND MINUS    , F6.3)
0152          SUM = 0
        C     DETERMINE IF MEAN OF RESIDUALS SUFFICIENTLY CLOSE TO ZERO
0153          DO 40 I=MAX11,NDR
0154       40 SUM=SUM+(A(I)-E(I))**2
0155          DIV = NOB*(NOB-NP)
0156          VABAR = SUM/DIV
```

```
0157          TNSTD = ABS(E(1))/SQRT(VABAR)                                     00257000
0158          PRINT 43,TNSTD                                                    00258000
0159       43 FORMAT(///22X,40HMEAN OF ORIGINAL SERIES OF RESIDUALS IS ,F6.3,31H00259000
             X STANDARD DEVIATIONS FROM ZERO.)                                  00260000
0160          DO 46 J=1,NDR                                                     00261000
0161       46 B(J)=A(J)                                                         00262000
0162       16 IF(NF .EQ. 0) GO TO 20                                            00263000
0163          CALL   TSFCST(SCRAT(1),SCRAT(2001),SCRAT(4001),F,B,C,PA,NF,NTO)   00264000
0164      410 PRINT 1033, NPROB                                                 00265000
0165     1033  FORMAT(//40X,'END OF TYMPAC RUN'/43X,'FOR ITEM ',I3/)
0166          GO TO 20                                                          00267000
0167       50 PRINT 51, NDIMS                                                   00268000
0168       51 FORMAT (1H1,  83HTHE DIMENSION OF SCRAT IN THE MAIN PROGRAM IS INS00269000
             XUFFICIENT.  IT SHOULD BE AT LEAST  , I6 )                         00270000
0169          GO TO 20                                                          00271000
0170       52 PRINT 53, NPROB                                                   00272000
0171       53 FORMAT (1H1, 46HTHE "ITERATION CARD" IS INCORRECT FOR PROBLEM ,I4)00273000
0172          GO TO 20                                                          00274000
0173       54 PRINT 55, NPROB                                                   00275000
0174       55 FORMAT (1H1, 54HTHE "    SPECS    CARD     " IS INCORRECT FOR PROB00276000
             XLEM , I4)                                                         00277000
0175          GO TO 20                                                          00278000
0176       56 PRINT 57, NPROB                                                   00279000
0177       57 FORMAT (1H1, 59HTHE                 MODEL CARD      IS INCORRECT FOR00280000
             X PROBLEM , I4)                                                    00281000
0178          GO TO 20                                                          00282000
0179       58 PRINT 59, NPROB                                                   00283000
0180       59 FORMAT (1H1, 59HTHE                 ORDER CARD      IS INCORRECT FOR00284000
             X PROBLEM , I4)                                                    00285000
0181          GO TO 20                                                          00286000
0182       60 PRINT 61, NPROB                                                   00287000
0183       61 FORMAT (1H1, 59HTHE                 PARAMETER CARD  IS INCORRECT FOR00288000
             X PROBLEM , I4)                                                    00289000
0184          GO TO 20                                                          00290000
0185       62 PRINT 63, NPROB                                                   00291000
0186       63 FORMAT (1H1, 37HERROR IN PARAMETER "MAX" FOR PROBLEM , I4)        00292000
0187          GO TO 20                                                          00293000
0188       64 PRINT 65, NPROB                                                   00294000
0189       65 FORMAT (1H1, 59HERROR IN PARAMETER "MBO " (MAXIMUM BACK ORDER) FOR00295000
             X PROBLEM ,I4)                                                     00296000
0190       20 CONTINUE                                                          00297000
0191          GO TO 99                                                          00298000
0192       70 PRINT 71, NPROB                                                   00299000
0193       71 FORMAT(1H1,51HTHE NUMBER OF DATA POINTS IS INCORRECT FOR PROBLEM ,00300000
             X I4)                                                              00301000
0194          GO TO 99                                                          00302000
0195       72 PRINT 73                                                          00303000
```

```
0196           73 FORMAT (1H1, 58HTHE DATA CARDS ARE NOT IN ORDER OR NOT NUMBERED CO00304000
                 XRRECTLY   )                                                      00305000
0197           99 CONTINUE                                                         00306000
0198              STOP                                                             00307000
0199              END                                                              00308000
```

```
0001          SUBROUTINE   TSFCST(CLL,CUL,ZP,F,W,R,PA,NF,NTO)                    00309000
0002          COMMON  NPROB,    EPS1, EPS2, FLAM, FNU, MIT,   NDR,   Z(500),     00310000
             *  MAX1, NP, NRD, NSD, NSEA, NL, $$, NY, $$$, NLOG, ND, MCE, MP,    00311000
             X        Y(100),    INC(6), IOPA(50),              NT(10),          00312000
             X        NOB, NDRPNF, MBO, MAX11, NDIMS, DIFF(50), SIGNS(50),       00313000
             X        ZZ(500), A(500)                                            00314000
0003          COMMON /ONE/C,CF                                                   00315000
0004          DIMENSION W(500), R(500), CLL(NF,NTO), CUL(NF,NTO), C(100),        00316000
             X        CF(100), F(500), PS(200), ZP(NF, NTO), PA(50)              00317000
0005          INTEGER FF                                                         00318000
0006          MAXZ = NDR+NY                                                      00319000
0007          NDRPNF=NDR+NF                                                      00320000
        C             SUBROUTINE  TSFCST  CONSTRUCTS AND RECORDS
        C             A 12 MONTH AHEAD FORECAST IF REQUESTED.
        C             IT ALSO REPORTS THE SIMPLE FORECAST ERRORS.
        C
0008          DO 9 J=1,NDRPNF                                                    00321000
0009          R(J)=0                                                             00322000
0010        9 A(J) =0                                                            00323000
0011           JXJ = 0                                                             323100
0012          ERROR = 0.                                                           323150
0013           ERRUP = 0.                                                          323160
0014           ERRLO = 0.                                                          323170
0015          NDR1=NDR+1                                                         00324000
0016          DO 13 J=NDR1,NDRPNF                                                00325000
0017          NN=J-NDR                                                           00326000
0018          IF(J .LE. MAXZ)Z(J)=Y(NN)                                          00327000
0019       13 IF(J .GT. MAXZ)Z(J)=0                                              00328000
        C     LOG DATA IF REQUESTED                                              00329000
0020          DO 16  J=NDR1,NDRPNF                                               00330000
0021          IF(NLOG .NE. 0 .AND. (Z(J)-.001) .GT. 0) Z(J)=ALOG10(Z(J))         00331000
0022       16 CONTINUE                                                           00332000
0023          DO 17  J=1,NDRPNF                                                  00333000
0024       17 W(J) = Z(J)                                                        00334000
0025          NOB=NDR-MAX1                                                       00335000
        C     USE TSMOD TO DETERMINE C AND CF AND RESIDUALS                      00336000
0026          CALL TSMOD (PA, F)                                                 00337000
0027          SUM = 0                                                            00338000
0028          DIV=NDR-MAX1                                                       00339000
0029          DO 19 J=MAX11,NDR                                                  00340000
0030          SUM=SUM+A(J)                                                       00341000
0031       19 R(J)=A(J)                                                          00342000
0032          ABAR=SUM/DIV                                                       00343000
0033          DIV=NDR-MAX1-NP                                                    00344000
0034          SUM=0                                                              00345000
        C     DETERMINE ESTIMATED VARIANCE OF RESIDUALS                          00346000
0035          DO 23 K=MAX11,NDR                                                  00347000
```

```
   23 SUM=SUM+(A(K)-ABAR)**2
      SGM2=SUM/DIV
      PS(1)=C(1)-CF(1)
      IF(NF .LE. MBO) GO TO 26
      MAX= MBO
      GO TO 29
   26 MAX=NF
C     LOOPS THROUGH 42 TO DETERMINE PSI VALUES
   29 DO 35 J=2,MAX
      PS(J) = C(J)-CF(J)
      L=J-1
```

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```
0046          DO 32 K=1,L                                                00359000
0047          KK=K-1                                                     00360000
0048       32 PS(J)=PS(J)+PS(K)*C(L-KK)                                  00361000
0049       35 CONTINUE                                                   00362000
0050          IF(NF .LE. MBO) GO TO 45                                   00363000
0051          MBOP1 = MBO + 1                                            00364000
0052          DO 42 J=MBOP1,NF                                           00365000
0053          PS(J)=0                                                    00366000
0054          L=J-1                                                      00367000
0055          I=J-MBO                                                    00368000
0056          DO 38 K=I,L                                                00369000
0057          KK=K-1                                                     00370000
0058       38 PS(J)=PS(J)+PS(K)*C(L-KK)                                  00371000
0059       42 CONTINUE                                                   00372000
0060       45 KK=INC(1)+INC(2)+INC(3)                                    00373000
0061          RMEAN=0                                                    00374000
0062          IF(INC(3) .EQ. 0) GO TO 51                                 00375000
0063          DO 48 J=1,NDR                                              00376000
0064       48 Z(J) = Z(J)-PA(KK)                                         00377000
0065          RMEAN = PA(KK)                                             00378000
0066       51 KK=KK+INC(4)                                               00379000
0067          IF(INC(4) .EQ. 1) CONST=PA(KK)                             00380000
0068          IF (INC(4) .EQ. 0) CONST=0                                 00381000
        C     LOOP FOR EACH TIME ORIGIN FOR WHICH FORECASTS DESIRED      00382000
0069          DO 95 IT=1,NTO                                             00383000
0070          FF=NT(IT)+1                                                00384000
0071          IF(FF .GT. NDR1 .OR. FF . LE. MBO) GO TO 100               00385000
0072          LF = NT(IT)+NF                                             00386000
0073          VAR=SGM2                                                   00387000
        C     LOOP TO DETERMINE FORECASTS                                00388000
0074          DO 58 K=FF,LF                                              00389000
0075          A(K) = 0                                                   00390000
0076          Z(K) = CONST                                               00391000
0077          DO 54 J=1,MBO                                              00392000
0078       54 Z(K)=Z(K)+C(J)*Z(K-J)-CF(J)*A(K-J)                         00393000
0079       58 CONTINUE                                                   00394000
0080          DO 62 J=FF,LF                                              00395000
0081          Z(J)=Z(J)+RMEAN                                            00396000
0082          L=J+1-FF                                                   00397000
0083       62 ZP(L,IT)=Z(J)                                              00398000
0084          DO 66 J=1,NF                                               00399000
0085          CLL(J,IT)=ZP(J,IT)-1.96*(VAR)**.5                          00400000
0086          CUL(J,IT)=ZP(J,IT)+1.96*(VAR)**.5                          00401000
0087       66 VAR=VAR+(PS(J)**2)*SGM2                                    00402000
0088          PRINT 70,NPROB,NT(IT)                                      00403000
0089       70 FORMAT(1H1,40X, 'ITEM '   ,I2,1X,'FORECASTS AT BASE PERIOD',I3//)  00404000
0090          PRINT 74                                                   00405000
```

```
0091          74 FORMAT(10X,'PERIODS AHEAD',8X,15HLOW CONF. LIMIT,10X,8HFORECAST, 9  406000
                XX,15HUP. CONF. LIMIT, 7X,16HACTUAL, IF KNOWN//)                   00407000
            C     LOOP TO PRINT RESULTS                                            00408000
0092              DO 78 J=1,NF                                                     00409000
0093              K=J+NT(IT)                                                       00410000
0094                IF(K.LE.MAXZ) JXJ = 99                                           410900
0095                IF(K.GT.MAXZ) JXJ=1                                              410950
0096              IF(K .LE. MAXZ) GO TO 77                                         00411000
0097              PRINT 85,J,CLL(J,IT),ZP(J,IT),CUL(J,IT)                          00412000
0098              GO TO 78                                                         00413000
0099          77 PRINT 85,J,CLL(J,IT),ZP(J,IT),CUL(J,IT),W(K)                     00414000
```

```
0100      85  FORMAT(16X,I3,15X,F7.1,15X,F7.1,14X,F7.1,14X,F7.1)                  414500
0101       78 CONTINUE                                                          00415000
0102            IF(JXJ.EQ.1)  GO TO 120                                           415050
0103           IF(JXJ.EQ.99)  GO TO 130                                           415055
0104     130  PRINT 131                                                           416010
0105     131  FORMAT('1',43X,'ERROR EVALUATION'/44X,'* * * * * * * * '/22X,'ACTU  416020
             1AL                HIGH SIDE              MEAN              LOW SIDE'/22X  416030
             2,'DEMAND                      ERROR                ERROR                ERROR  416040
             3 '//)                                                               416041
0106           DO 132 J=1,NF                                                      416050
0107           K= J+NT(IT)                                                        416052
0108           ERROR = W(K) - ZP(J,IT)                                            416055
0109           ERRUP = W(K) - CUL(J,IT)                                           416058
0110           ERRLO = W(K) - CLL(J,IT)                                           416060
0111           PRINT 136,W(K),ERRLO,ERROR,ERRUP                                   416070
0112     136  FORMAT('0',19X,F8.1,12X,F8.1,11X,F8.1,11X,F8.1/)                    416075
0113     132   CONTINUE                                                           416078
0114           PRINT 150
0115     150  FORMAT('0',20X,'NOTE:  HIGH SIDE ERROR IS  ACTUAL DEMAND - LOWER C  416080
             1ONFIDENCE LIMIT'/28X,'MEAN ERROR (DEMAND - FORECAST)'  /28X,'LOW S  416081
             2IDE ERROR IS (DEMAND - UPPER CONFIDENCE LIMIT).'/)                  416082
0116     120     CONTINUE                                                         416090
0117          DO 90 J=1,NDR                                                     00417000
0118          A(J) = R(J)                                                       00418000
0119       90 Z(J) = W(J)-RMEAN                                                 00419000
0120       95 CONTINUE                                                          00420000
0121          GO TO 110                                                         00421000
0122      100 PRINT 105                                                         00422000
0123      105 FORMAT(1H1,10X,25HPARAMETER ERROR IN TSFCST//)                    00423000
0124      110 RETURN                                                            00424000
0125          END                                                               00425000
```

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```
0001          SUBROUTINE TSMOD(PA, F)                                          00426000
0002          COMMON  NPROB,     EPS1, EPS2, FLAM, FNU, MIT,    NDR,   Z(500),  00427000
             X          MAX1, NP, NRD, NSD, NSEA, NL, NF, NY, NTO,NLOG,ND,MCE,MP, 00428000
             X          Y(100),   INC(6), IOPA(50),              NT(10),        00429000
             X          NOB, NDRPNF, MBO, MAX11, NDIMS, DIFF(50), SIGNS(50),    00430000
             X          ZZ(500), A(500)                                         00431000
0003          COMMON /ONE/C,CF                                                 00432000
0004          DIMENSION F(500), T(100), C(100), CF(100), D(10,10), DS(10,100), 00433000
             X          W(500), PA(50)                                          00434000
0005          IF (MBO .EQ. 0) GO TO 68                                         00435000
0006          DO 3 J=1,MBO                                                     00436000
0007          T(J)=0                                                           00437000
0008          C(J)=0                                                           00438000
0009        3 CF(J)=0                                                          00439000
0010          IF(NRD .EQ. 0) GO TO 17                                          00440000
0011          D(1,1)=-1.0                                                      00441000
0012          IF(NRD .EQ. 1) GO TO 8                                           00442000
           C      LOOPS THROUGH 13 TO EXPAND REGULAR DIFFERENCE TERM           00443000
0013          DO 4 J=2,NRD                                                     00444000
0014        4 D(J,1) = D(J-1,1) - 1.0                                          00445000
0015        8 DO 13 J=1,NRD                                                    00446000
0016          DO 13 K=2,NRD                                                    00447000
0017          IF(K .GT. J) GC TO 10                                            00448000
0018          D(J,K)=D(J-1,K)-D(J-1,K-1)                                       00449000
0019          GO TO 13                                                         00450000
0020       10 D(J,K)=0                                                         00451000
0021       13 CONTINUE                                                         00452000
0022          DO 15 K=1,NRD                                                    00453000
0023       15 C(K)=D(NRD,K)                                                    00454000
0024       17 IF(NSD .EQ. 0) GO TO 43                                          00455000
0025          MAX=NSD*NSEA                                                     00456000
           C      LOOPS THROUGH 33 TO EXPAND SEASONAL DIFFERENCE TERM          00457000
0026          DO 20 J=1,NSD                                                    00458000
0027          DO 20 K=1,MAX                                                    00459000
0028       20 DS(J,K)=0                                                        00460000
0029          DS(1,NSEA) = -1.0                                                00461000
0030          MIN=2*NSEA                                                       00462000
0031          IF(NSD .EQ. 1) GO TO 35                                          00463000
0032          DO 24 J=2,NSD                                                    00464000
0033       24 DS(J,NSEA)= DS(J-1,NSEA)-1.0                                     00465000
0034       28 DO 33 J=1,NSD                                                    00466000
0035          DO 33 K=MIN,MAX,NSEA                                             00467000
0036          IF((K/NSEA) .GT. J) GC TO 30                                     00468000
0037          DS(J,K)=DS(J-1,K)-DS(J-1,K-NSEA)                                 00469000
0038          GO TO 33                                                         00470000
0039       30 DS(J,K)=0                                                        00471000
0040       33 CONTINUE                                                         00472000
```

```
   35 L=NSEA*NSD
      DO 38 J=NSEA,L,NSEA
      T(J) = T(J) + DS(NSD,J)
      IF (NRD .EQ. 0) GO TO 38
      DO 37 M=1,NRD
      IF (J .EQ. NSEA) T(M) = T(M) + C(M)
      N=J+M
   37 T(N)=T(N)+C(M)*DS(NSD,J)
   38 CONTINUE
      L=L+NRD
      DO 40 J=1,L
```

```
0052           C(J)=T(J)
0053        40 T(J)=0
0054        43 MIN=1
0055           MAX=0
0056           L = NRD + NSEA*NSD
         C
         C     LOOP TO EXPAND TWO FACTORS INVOLVING PHIS AND COMBINE WITH
         C     PREVIOUS EXPANSION OF DIFFERENCE TERMS TO GET FINAL C VALUES,
         C     AND TO EXPAND TWO FACTORS INVOLVING THETAS TO OBTAIN FINAL
         C     CF VALUES
         C
0057           DO 60 I=1,6
0058           IF(I .EQ. 3)L=0
0059           IF(INC(I) .EQ. 0) GO TO 60
0060           MAX=MAX+INC(I)
0061           IF(I .EQ. 3 .OR. I .EQ. 4) GO TO 60
0062           DO 48 M=MIN,MAX
0063           K=IOPA(M)
0064           T(K)=T(K)-PA(M)
0065           IF(L .EQ. 0) GO TO 48
0066           DO 45 J=1,L
0067           IF(M .EQ. MIN .AND. I .LE. 2) T(J)=T(J)+C(J)
0068           IF(M .EQ. MIN .AND. I .EQ. 6)T(J)=T(J)+CF(J)
0069           N=J+IOPA(M)
0070           IF(I .EQ. 6)T(N)=T(N)-PA(M)*CF(J)
0071        45 IF(I .LE. 2)T(N)=T(N)-PA(M)*C(J)
0072        48 CONTINUE
0073           L=L+IOPA(MAX)
0074           DO 51 J=1,L
0075           IF(I .GE. 5)CF(J)=T(J)
0076           IF(I .LE. 2)C(J)=T(J)
0077        51 T(J)=0
0078        60 MIN=MIN+INC(I)
0079           DO 66 J=1,MBO
0080           CF(J)=-CF(J)
0081        66 C(J)=-C(J)
0082        68 KK=INC(1)+INC(2)+INC(3)
0083           DO 70 J=1,NDR
0084           W(J)=Z(J)
0085        70 IF(INC(3) .EQ. 1)Z(J)=Z(J)-PA(KK)
0086           KK=KK+INC(4)
0087           IF(INC(4) .EQ. 0)CONST=0
0088           IF(INC(4) .EQ. 1)CONST=PA(KK)
         C     LOOP TO CALCULATE RESUDUALS
0089           DO 79 K=MAX11,NDR
0090           A(K)=Z(K)-CONST
0091           KK = K - 1
```

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```
      IF (MBO .EQ. 0 .OR. KK .EQ. 0) GO TO 79
      IF(K .GT. MBO) GO TO 76
      DO 74 J=1,KK
   74 A(K)=A(K)-C(J)*Z(K-J)+CF(J)*A(K-J)
      GO TO 79
   76 DO 78 J=1,MBO
   78 A(K)=A(K)-C(J)*Z(K-J)+CF(J)*A(K-J)
   79 CONTINUE
      DO 81 J=1,NDR
   81 Z(J)=W(J)
      MAX1=MAX11-1
```

```
              C      LOOP TO CALCULATE FITTED VALUES                      00542000
 0103                DO 83 J=1,NOB                                        00543000
 0104                LL=J+MAX1                                            00544000
 0105             83 F(J)=Z(LL)-A(LL)                                     00545000
 0106                RETURN                                               00546000
 0107                END                                                  00547000
```

```
0001            SUBROUTINE   ACOR(C,RHO,STE,E,NL,NOB)                      00548000
0002            COMMON  NPROB,     EPS1, EPS2, FLAM, FNU, MIT,   NDR,   Z(500),  00549000
               *  MAX1 , NP, NRD, NSD, NSEA, $$, NF, NY, NTO, NLOG, ND, MCE, MP,  00550000
               X        Y(100),    INC(6), IOPA(50),           NT(10),     00551000
               *  $$$, NDRPNF, MBO, MAX11, NDIMS, DIFF(50), SIGNS(50),     00552000
               X        ZZ(500), A(500)                                    00553000
0003            DIMENSION C(NOB),RHO(NL,10),STE(NL,10),E(10)               00554000
          C     ERROR CHECKS                                               00555000
0004            IF(NL .LE. 0 .OR. NOB .LE. 0) GO TO 50                     00556000
0005            IF(ND .LT. 0) GO TO 50                                     00557000
0006            MIN=NOB-ND-NL                                              00558000
0007            IF(MIN .LE. 1) GO TO 50                                    00559000
0008            NOBD = NOB                                                 00560000
0009            L=1                                                        00561000
0010            SUM=0.0                                                    00562000
0011            DIV = NOBD                                                 00563000
          C     LOOP TO CALCULATE OVERALL MEAN                             00564000
0012            DO 4 J = 1,NOBD                                            00565000
0013          4 SUM = SUM + C(J)                                           00566000
0014            E(L) = SUM/DIV                                             00567000
          C     LOOP TO CALCULATE DEVIATIONS                               00568000
0015            TOT=0.0                                                    00569000
0016            DO 13 J=1,NOBD                                             00570000
0017            C(J)=C(J)-E(L)                                             00571000
0018      13    TOT=TOT+C(J)**2                                            00572000
          C     LOOP TO CALCULATE KTH AUTOCORRELATION                      00573000
0019            DO 14 K=1,NL                                               00574000
0020            M=NOBD-K                                                   00575000
0021            DENOM=M                                                    00576000
0022            SUM=0                                                      00577000
          C     LOOP TO DETERMINE SUMS USED IN AUTOCORRELATION             00578000
0023            DO 9 J=1,M                                                 00579000
0024      9     SUM=SUM+C(J)*C(J+K)                                        00580000
0025      14    RHO(K,L)=SUM/TCT                                           00581000
0026            IF(MCE .EQ. 0) GO TO 27                                    00582000
          C     LOOP TO DETERMINE STANDARD ERRORS                          00583000
0027            LL = L-1                                                   00584000
0028            DIV = NOB-LL                                               00585000
0029            STE(1,L) = 1.0                                             00586000
0030            DO 22 K=2,NL                                               00587000
0031         22 STE(K,L) = STE(K-1,L) + 2.0*RHO(K-1,L)**2                  00588000
0032            STE(1,L)=(1.0/DIV)**.5                                     00589000
0033            DO 23 K=2,NL                                               00590000
0034         23 STE(K,L) = (STE(K,L)/DIV)**.5                              00591000
0035         27 IF(MP .EQ. 0) GO TO 100                                    00592000
          C     LCCP TO PRINT CUT RESULTS                                  00593000
0036            PRINT 90,E(1)                                              00594000
```

```
   32 DO 37 KK=1,NL,12
      JJ = KK+11
      IF(NL .LT. JJ) GO TO 34
      PRINT 92,KK,JJ,(RHO(K,L),K=KK,JJ)
      IF(MCE .EQ. 0) GO TO 37
      PRINT 93,(STE(K,L),K=KK,JJ)
      GO TO 37
   34 IF(NL .EQ. KK) GO TO 35
      PRINT 92,KK,NL,(RHO(K,L),K=KK,NL)
      GO TO 36
   35 PRINT 95,KK,RHO(KK,L)
```

```
   36 IF (MCE .EQ. 0) GO TO 37                                              00606000
      PRINT 93,(STE(K,L),K=KK,NL)                                           00607000
   37 CONTINUE                                                              00608000
   40 CONTINUE                                                              00609000
      GO TO 100                                                             00610000
   50 PRINT 94                                                              00611000
      GO TO 100                                                             00612000
  90  FORMAT(///46X,'MEAN = ',F9.2/)
   91 FORMAT(//39X,11HDIFFERENCE ,I2,2X,6H(MEAN=,E12.5,2H ))                00614000
   92 FORMAT(/20X,I2,1H-,I2,5X,12(F5.2,2X))                                 00615000
   93 FORMAT(10X,5HST.E.,5X,12(F5.2,2X)//)                                  00616000
   94 FORMAT(1H1,10X,45HPARAMETER ERROR IN AUTOCORRELATION SUBROUTINE//)00617000
   95 FORMAT (/10X,I2,8X,F5.2)                                              00618000
  100 RETURN                                                                00619000
      END                                                                   00620000
```

```
0001            SUBROUTINE   HAUS59(F,S,R,Q,P,E,PHI,TB,A,D,DELZ,TH,NP,NOB)          00621000
0002            DIMENSION F(500), S(500), R(500), Q(NP), P(NP), E(NP), PHI(NP),     00622000
               X     TB(NP), A(NP,NP), D(NP,NP), DELZ(NOB,NP), TH(50)               00623000
0003            COMMON  NPROB,    EPS1, EPS2, FLAM, FNU, MIT,   NDR,   Z(500),      00624000
               *  MAX1, $$, NRD, NSD, NSEA, NL, NF, NY, NTO, NLOG, ND, MCE, MP,     00625000
               X      HAUSY(100),     INC(6), IOPA(50),            NT(10),          00626000
               *  $$$, NDRPNF, MBO, MAX11, NDIMS, DIFZ(50), SIGNS(50),              00627000
               X      Y(500), HAUSA(500)                                            00628000
0004            REAL   $EMP(1) , $$MP(1,1) , $$$P(1)                                00629000
          C                                                                         00630000
          C     NOTE THE FOLLOWING CHANGES IN NAME :                                00631000
          C     Y(100) IN MAIN WILL BE CALLED HAUSY(100) IN HAUS59                  00632000
          C     DIFF(50) IN MAIN WILL BE CALLED DIFZ(50) IN HAUS59                  00633000
          C     ZZ(500) IN MAIN WILL BE CALLED Y(500) IN HAUS59                     00634000
          C     A(500) IN MAIN WILL BE CALLED HAUSA(500) IN HAUS59                  00635000
          C                                                                         00636000
          C                                                                         00637000
          C     THE FOLLOWING VARIABLES WHICH ARE IN COMMON ARE USED IN THIS        00638000
          C     SUBROUTINE :   NPROB, EPS1, EPS2, FLAM, FNU, MIT, NP, TH(50),       00639000
          C                    DIFZ(50), SIGNS(50), Y(500), NDIMS                   00640000
          C                                                                         00641000
          C                                                                         00642000
          C     THE FOLLOWING SUBROUTINES ARE CALLED BY THIS SUBROUTINE : GASS60,   00643000
          C                                                    TSMOD, MATIN.        00644000
          C                                                                         00645000
0005              PRINT 1000, NPROB, NOB, NP                                        00646000
0006            PRINT 1001                                                          00647000
0007            CALL    GASS60 ( 1 , NP , TH , $EMP , $$MP )                        00648000
0008            PRINT 1002                                                          00649000
0009            CALL    GASS60 ( 1 , NP , DIFZ , $EMP , $$MP )                      00650000
0010            GA = FLAM                                                           00651000
0011            NIT = 1                                                             00652000
0012            ASSIGN 131 TO LAOS                                                  00653000
0013            ASSIGN 225 TO IRAN                                                  00654000
0014            ASSIGN 265 TO JORDAN                                                00655000
0015            IF (EPS1.GT.0.AND.EPS2.GT.0) GO TO 70                               00656000
0016            IF (EPS1.GT.0.AND.EPS2.LE.0) GO TO 40                               00657000
0017            EPS1=0                                                              00658000
0018            IF (EPS2.LE.0) GO TO 5                                              00659000
0019            IF (EPS2.GT.0) GO TO 10                                             00660000
0020          5 ASSIGN 270 TO IRAN                                                  00661000
0021            GO TO 70                                                            00662000
0022         10 ASSIGN 270 TO JORDAN                                                00663000
0023            GO TO 70                                                            00664000
0024         40 ASSIGN 265 TO IRAN                                                  00665000
0025         70 SSQ = 0                                                             00666000
0026            CALL TSMOD(TH, F)                                                   00667000
```

```
      DO 90 I = 1, NOB
      R(I) = Y(I) - F(I)
   90 SSQ=SSQ+R(I)*R(I)
      PRINT 1003,SSQ
C
C                                                   BEGIN ITERATIJN
C
  100 GA = GA / FNU
      INTCNT = 0
      PRINT 1004, NIT
C
```

```
                C       MINIMIZE THE SUM FROM 1 TO  NOB  OF A(T)**2 BY FINDING THE
                C       PARTIAL DERIVATIVE W.R.T. EACH PARAMETER OF THIS SUM.
                C       D/D(TH)  (SUM A(T)**2)    = SUM (D/D(TH) (A(T)**2)
                C                                 = SUM ( 2*A(T)*  D/D(TH) A(T) )
                C       THE CONSTANT FACTOR 2 IS NEGLECTED.  A(T) = R(I) IN THE NOTATION
                C       OF THIS PROGRAM.  THE PARTIAL DERIVATIVE D/D(TH(J)) IS FOUND
                C       BY ADDING THE INCREMENTAL QUANTITY P(J) TO EACH PARAMETER TH(J)
                C       IN TURN, AND FINDING THE DIFFERENCE QUOTIENT (A(TH+P)-A(TH))/P
                C       WHICH IN THE NOTATION OF THE PROGRAM IS (S(I) - F(I))/ P.
                C       THE  NP  NUMERICAL PARTIAL DERIVATIVES ARE STORED IN THE ARRAY  Q
                C
 0034              101 DO 130 J=1,NP
 0035                  TEMP = TH(J)
 0036                  P(J)=DIFZ(J)*TH(J)
 0037                  TH(J) = TH(J) + P(J)
 0038                  Q(J) = 0
 0039                  CALL TSMOD (TH, S)
 0040                  DO 120 I=1,NOB
 0041                  DELZ(I,J) = S(I) - F(I)
 0042              120 Q(J) = Q(J) + DELZ(I,J)*R(I)
 0043                  Q(J) = Q(J)/P(J)
                C
                C       Q WHICH IS THE MATRIX PRODUCT X(TRANSPOSE) * R IS THE VECTOR OF
                C       STEEPEST DESCENT ON THE LEAST SQUARES SURFACE WITH PARAMETERS
                C       TH(I), I=1,NP.
                C
 0044              130 TH(J) = TEMP
 0045                  GO TO LAOS,(131,414)
                C
                C       LOOP TO FIND THE MATRIX PRODUCT X(TRANSPOSE)*X = D(I,J)  WHICH
                C       IS NEEDED FOR THE "LINEARIZED LEAST SQUARES" METHOD.
                C       FOR REFERENCE SEE : DRAPER AND SMITH.
                C
 0046              131 DO 150 I=1,NP
 0047                  DO 151 J=1,I
 0048                  SUM = 0
 0049                  DO 160 K = 1, NOB
 0050              160 SUM = SUM + DELZ(K,I) * DELZ(K,J)
 0051                  TEMP = SUM/(P(I)*P(J))
 0052                  D(J,I) = TEMP
 0053              151 D(I,J) = TEMP
 0054              150 E(I) = SQRT(TEMP)
 0055              666 CONTINUE
                C
                C       IN ORDER TO COMPROMISE BETWEEN THE "STEEPEST DESCENT" AND
                C       "LINEARIZED LEAST SQUARES" METHODS, THE MATRIX D(I,J) IS
                C       NORMALIZED TO OBTAIN MATRIX A(I,J).
```

```
C
      DO 153 I = 1, NP
      DO 153 J=1,I
      A(I,J)=D(I,J) / (E(I)*E(J))
  153 A(J,I) = A(I,J)
C                                A = SCALED MOMENT MATRIX
C
C     LOOP TO ADD THE QUANTITY GA TO THE DIAGONAL ELEMENTS OF A(I,J)
C     THIS OPERATION IS EQUIVALENT TO IMPOSING THE CONSTRAINT THAT THE
C     PARAMETERS MUST LIE ON A SPHERE IN THE PARAMETER SPACE WHICH
C     HAS CENTRE TH(I) AND WHOSE RADIUS IS A FUNCTION OF GA.
```

```
C      THE THEORY OF LAGRANGIAN MULTIPLIERS MAY BE USED TO DETERMINE
C      THE EXACT FUNCTIONAL RELATIONSHIP BETWEEN GA AND THE RADIUS OF
C      THE SPHERE. IF THE READER IS SUFFICIENTLY INTERESTED.
C
       DO 155 I=1,NP
       P(I) = Q(I)/E(I)
       PHI(I) = P(I)
   155 A(I,I) = A(I,I) + GA
C
C      IN THE SUBROUTINE MATIN, THE MATRIX A(I,J) IS INVERTED AND
C      THE INVERSE IS MATRIX MULTIPLIED TIMES P.  THE RESULT IS
C      RETURNED IN THE MATRIX (VECTOR IN THIS CASE) P.
C
       I = 1
       CALL MATIN (A, NP, P, I, DET)
C                                    P/E = CORRECTION VECTOR
       STEP = 1.0
       SUM1 = 0.
       SUM2 = 0.
       SUM3 = 0.
C
C      LOOP TO FIND THE DOT PRODUCTS P.PHI, P.P, PHI.PHI  .
C
       DO 231 I = 1,NP
       SUM1 = P(I) * PHI(I) + SUM1
       SUM2 = P(I) * P(I) + SUM2
       SUM3 = PHI(I) * PHI(I) + SUM3
   231 PHI(I) = P(I)
C
C      FIND THE ANGLE BETWEEN THE STEEPEST DESCENT VECTOR (PHI) AND
C      THE "COMPROMISED LINEARIZED LEAST SQUARES VECTOR" (P).
C
       TEMP = SUM1/SQRT(SUM2 * SUM3)
       IF(TEMP.GT.0.9999)GO TO 232
       TEMP = 57.295 *ARCOS(TEMP)
       GO TO 233
   232 TEMP = 0.0
   233 PRINT 1041, DET, TEMP
C
C      LOOP TO ADJUST THE PARAMETER VALUES.
C
   170 DO 220 I = 1,NP
       P(I) = PHI(I) * STEP / E(I)
       TB(I) = TH(I) + P(I)
   220 CONTINUE
   215 PRINT 7000
  7000 FORMAT(36X,'TEST POINT PARAMETER VALUES'    )
```

```
0087            PRINT 2006, (TB(I), I = 1, NP)
          C
          C     CHECK TO SEE IF THE AMENDED PARAMETERS CONTRADICT THE "SIGNS"
          C     CONSTRAINT.
          C
0088            DO 221 I = 1, NP
0089            IF(SIGNS(I)) 221, 221, 222
0090        222 IF(SIGN(1.0,TH(I))*SIGN(1.0,TB(I))) 663, 221, 221
0091        221 CONTINUE
          C
          C     CALL TSMOD AND THEN LOOP TO FIND THE VALUE OF THE SUM OF SQUARES
```

```
             C       USING THE AMENDED VALUES OF THE PARAMETERS.
             C
0092                 SUMB = 0
0093                 CALL TSMOD(TB,F)
0094                 DO 230 I=1, NOB
0095                 R(I) = Y(I)-F(I)
0096                 SUMB = SUMB + R(I) * R(I)
0097                 IF(SUMB.LT.1.0E40) GO TO 230
0098                 PRINT 229
0099             229 FORMAT(1H0,40X,42HTHE SUM OF SQUARES IS GREATER THAN 1.0E40    )
0100                 GO TO 665
0101             230 CONTINUE
0102                 PRINT 1043, SUMB
             C
             C       COMPARE THE SUM OF SQUARES USING AMENDED PARAMETERS(SUMB) WITH
             C       THE SUM OF SQUARES USING THE OLD VALUES OF THE PARAMETERS (SSQ).
             C
0103                 IF(SUMB - (1.0+EPS1)*SSQ) 662, 662, 663
0104             663 IF(AMIN1(TEMP-30.0, GA)) 665, 665, 664
0105             665 STEP = STEP/2.0
0106                 INTCNT = INTCNT + 1
0107                 DO 217 I=1,NP
0108                 TEST = (ABS(P(I))) /  (1.0E-20 + ABS(TH(I)))
0109                 IF (TEST.GT.EPS2)  GO TO 219
0110             217 CONTINUE
0111                 IF (INTCNT.GT.20)       GO TO 2700
0112                 DO 218  I=1,NP
0113             218 TB(I) = TH(I)
0114                 GO TO 215
0115             219 IF(INTCNT - 36) 170, 2700, 2700
0116             664 GA = GA*FNU
0117                 INTCNT = INTCNT + 1
0118                 IF(INTCNT - 36) 666, 2700, 2700
0119             662 PRINT 1007
0120                 DO 669 I=1,NP
0121             669 TH(I) = TB(I)
0122                 CALL    GASS60 ( 1 ,  NP   , TH , $EMP , $$MP )
0123                 PRINT 1040, GA, SUMB
0124                 GO TO IRAN,(225,265,270)
0125             225 DO 240 I = 1, NP
0126                 IF (ABS(P(I))/(1.E-20+ABS(TH(I)))-EPS2) 240,240,241
0127             241 GO TO JORDAN,(265,270)
0128             240 CONTINUE
0129                 PRINT 1009, EPS2
0130                 GO TO 280
0131             265 IF(ABS(SUMB - SSQ) - EPS1*SSQ) 266, 266, 270
0132             266 PRINT 1010, EPS1
```

```
0133          GO TO 280                                                                00842000
0134      270 SSQ = SUMB                                                               00843000
0135          NIT = NIT + 1                                                            00844000
0136          IF(NIT - MIT) 100, 100, 280                                              00845000
0137     2700 PRINT 2710                                                               00846000
0138     2710 FORMAT(//115H0**** THE SUM OF SQUARES CANNOT BE REDUCED TO THE SUM00847000
             1OF SQUARES AT THE END OF THE LAST ITERATION - ITERATING STOPS    /)00848000
        C                                                   END ITERATION              00849000
        C                                                                              00850000
0139      280 PRINT 1011                                                               00851000
0140          PRINT 2001, (F(I), I = 1, NOB)                                           00852000
```

```
      PRINT 1012
      PRINT 2001, (R(I), I = 1, NOB)
      SSQ = SUMB
      IDF = NOB-NP
      PRINT 1015
      I = 0
      CALL MATIN (D, NP, P, I, DET)
      DO 7692 I=1,NP
 7692 E(I) = SQRT(D(I,I))
      DO 340 I=1, NP
      DO 340 J = I, NP
      A(J,I) = D(J,I)  / (E(I)*E(J))
  340 A(I,J) = A(J,I)
      CALL   GASS60 ( 3 ,  NP  , $$$P , $EMP , A )
      PRINT 1016
      CALL   GASS60 ( 1 ,  NP  , E  , $EMP , $$MP )
      IF(IDF) 341, 410, 341
  341 SDEV = SSQ / IDF
      PRINT 1014, SDEV, IDF
      SDEV = SQRT(SDEV)
      DO 391 I=1, NP
      P(I) = TH(I) + 2.0 * E(I) * SDEV
  391 TB(I) = TH(I) -2.0 * E(I) * SDEV
      PRINT 1039
      CALL   GASS60 ( 2 ,  NP  , TB ,  P  , $$MP )
      ASSIGN 414 TO LAOS
      GO TO 101
  414 DO 415 K = 1, NOB
      TEMP = 0
      DO 420 I=1,NP
      DO 420 J=1,NP
      DEBUG1 = DELZ(K,I)
      DEBUG2 = DELZ(K,J)
      DEBUG3 = D(I,J) /  ( DIFZ(I)*TH(I)*DIFZ(J)*TH(J) )
  420 TEMP = TEMP + DEBUG1 * DEBUG2 * DEBUG3
      TEMP = 2.0*SQRT(TEMP)*SDEV
      R(K) = F(K) + TEMP
  415 S(K) = F(K) - TEMP
      PRINT 1008
      IE = 0
      DO 425 I=1, NOB, 10
      IE = IE + 10
      IF(NOB-IE) 430,435,435
  430 IE = NOB
  435 PRINT 2001, (R(J), J=I, IE)
  425 PRINT 2006, (S(J), J=I, IE)
  410 CONTINUE
```

```
      RETURN                                                            00900000
 1000 FORMAT('0',30X,'NON-LINEAR ESTIMATION, ITEM ',I3,//28X,I5,' OBSERV  901000
     1ATIONS',I5,' PARAMETERS'/)
 1001  FORMAT(/30X,'INITIAL PARAMETER VALUES')                            903000
 1002 FORMAT(/24X,'PROPORTIONS USED TO CALCULATE DIFFERENCE QUOTIENTS')   904000
 1003 FORMAT(/25X, 'INITIAL SUM OF SQUARES = ',F12.1)                     905000
 1004 FORMAT(/////45X,13HITERATION NO. I4/45X,'_ _ _ _ _ - - - - - _'/)  0906000
 1007  FORMAT(/34X,'PARAMETER VALUES VIA REGRESSION ')                    907000
 1008 FORMAT(///37X,'APPROXIMATE CONFIDENCE LIMITS FOR EACH FUNCTION VAL  908000
     1UE'     )                                                           909000
 10090FORMAT(/25X,'STOP ITERATING - RELATIVE CHANGE IN EACH PARAMETER LE00910000
```

```
                1SS THAN ',E12.4//)                                          911000
0197     10100FORMAT(/20X,'STOP ITERATING - RELATIVE CHANGE IN SUM OF SQUARES LE  912000
                1SS THAN ',E12.4)                                            913000
0198     1011  FORMAT(45X, 'FINAL FUNCTION VALUES '/45X,12('* ') /)           914000
0199     1012 FORMAT(///50X,'RESIDUALS ')                                     915000
0200     1014  FORMAT(//25X,'VARIANCE OF RESIDUALS = ',E12.4,1H,I4,1X,'DEGREES O  916000
                1F FREEDOM ')                                                917000
0201     1015 FORMAT(///40X,'CORRELATION MATRIX ')                            918000
0202     1016  FORMAT(///40X,'NORMALIZING ELEMENTS')                          919000
0203     10390FORMAT(/25X,'INDIVIDUAL CONFIDENCE LIMITS ,  EACH PARAMETER (ON LI00920000
                1NEAR HYPOTHESIS ) ')                                        921000
0204     1040 FORMAT(/24X, 'LAMBDA = ',F12.4,  8X,'SUM OF SQUARES AFTER REGRESSI  922000
                1ON = ',F12.2)                                               922300
0205     1041 FORMAT(20X,'DETERMINANT = ',E12.4,4X,  'ANGLE IN SCALED COORD. = '00924000
                1,F5.2, 8HDEGREES   )                                      00925000
0206     1043 FORMAT('0',33X,'TEST POINT SUM OF SQUARES = ',1X,F16.1)         926000
0207     2001  FORMAT(/14X,10F9.2)                                            927000
0208     2006 FORMAT(14X,10F9.2)                                              928000
0209           END                                                          00929000
```

```
      SUBROUTINE MATIN(A, NVAR, B, NB, DET)
      DIMENSION A(NVAR,NVAR), B(NVAR,NB), C(50,1)
C
C     THIS SUBROUTINE FINDS THE INVERSE OF A POSITIVE DEFINITE
C     SYMMETRIC MATRIX BY THE PIVOTAL CONDENSATION METHOD.
C     IF NB IS NOT 0, IT MULTIPLIES THE INVERSE MATRIX TIMES B.
C
      DET = 1.0
      DO 550 ICOL = 1, NVAR
      PIVOT = A(ICOL, ICOL)
      DET = PIVOT * DET
C
C     DIVIDE PIVOT ROW BY PIVOT ELEMENT
C
      A(ICOL, ICOL) = 1.0
C
      PIVOT = AMAX1(PIVOT, 1.E-20)
      PIVOT = 1.0 / PIVOT
      DO 350 L=1,NVAR
  350 A(ICOL, L) = A(ICOL, L)*PIVOT
C
C     REDUCE NON-PIVOT ROWS
C
  371 DO 550 L1=1,NVAR
      IF(L1 .EQ. ICOL) GO TO 550
      T = A(L1, ICOL)
      A(L1, ICOL) = 0.
      DO 450 L=1,NVAR
  450 A(L1, L) = A(L1, L) - A(ICOL, L) * T
  550 CONTINUE
      IF ( NB.EQ.0 )   GO TO 600
      DO 560  I=1,NVAR
      DO 560   J=1,NB
      C(I,J) = 0.
      DO 560  K=1,NVAR
  560 C(I,J) = C(I,J) + A(I,K) * B(K,J)
      DO 570   I=1,NVAR
      DO 570   J=1,NE
  570 B(I,J) = C(I,J)
  600 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE GASS60(ITYPE, NQ, A, B, C)
      DIMENSION A(NQ),B(NQ),C(NC,NQ)
      NP = NQ
      NR = NP/10
      LOW = 1
      LUP = 10
   10 IF( NR ) 15, 2C, 30
   15 RETURN
   20 LUP = NP
      IF(LOW .GT. LUP) RETURN
   30 PRINT 500, (J,J=LOW,LUP)
      GO TO (40,60,80),ITYPE
   40 PRINT 600,(A(J),J=LOW,LUP)
      GO TO 100
   60 PRINT 600, (B(J),J=LCW,LUP)
      GO TO 40
   80 DO 90 I=LOW,LUP
   90 PRINT 720, I, (C(J, I), J=LOW, I)
      LOW2 = LUP + 1
      IF(LOW2 .GT. NP) GO TO 100
      DO 95 I=LOW2, NP
   95 PRINT 720, I, (C(J, I), J=LOW, LUP)
  100 LOW = LOW + 10
      LUP = LUP + 10
      NR = NR - 1
      GO TO 10
  500 FORMAT(/35X,I8,7I12)
  600 FORMAT(35X,8F10.3)
  720 FORMAT('0',35X,I3, 1X, F7.4,7F12.4)
    1 CONTINUE
      RETURN
      END
```

500

```
0001          SUBROUTINE GRAPHL(X,Y,NG,NPOINT)
        C
        C     ......................................................................
        C
        C
        C     GRAPHL IS A SUBROUTINE WHICH PLOTS N(N.LE.6) GRAPHS OF A
        C     SERIES OF FUNCTIONS OF THE FORM Y=F(X) SIMULTANEOUSLY
        C
        C     DESCRIPTION OF VARIABLES:
        C
        C     NPOINT: THE NUMBER OF X-VALUES TO BE PLOTTED
        C
        C         NG: THE NUMBER OF SIMULTANEOUS PLOTS
        C
        C          X: X IS A VECTOR CONTAINING NPOINT EQUALLY SPACED POINTS
        C
        C          Y: Y IS AN NG BY NPOINT MATRIX WHOSE COLUMNS CONTAIN THE
        C             VALUES ASSUMED BY THE VARIOUS FUNCTIONS.  FOR EXAMPLE,
        C             THE FIRST CCLUMN OF Y, Y(1,I), CONTAINS ELEMENTS SUCH
        C             THAT Y(1,I)=F1(X(I)) WHERE F1(X) IS THE FIRST FUNCTION
        C             BEING PLOTTED
        C
        C     TO USE GRAPHL
        C
        C     CALL GRAPHL(X,Y,NG,NPOINT)
        C
        C
        C
        C     ......................................................................
        C
0002          REAL*4 PA/'.'/,BLANK/' '/,A(110)/110*' '/
0003          REAL*4 GRIDMK(6)/'.','.','0','1','2','*'/,
             2STORE(16),LOW,X(NPOINT),Y(NG,NPOINT)
0004          REAL INDEX(11)
0005          INTEGER*2 AXIS
0006      702 FORMAT(/17X,11F10.1)
0007     706  FCRMAT(25X,10('+---------'),'+')
0008      708 FORMAT(/11X,F13.0,1X,101A1)
0009          IF(NG.GT.6)NG=6
0010          IF(NG.EQ.1)GRIDMK(1)=GRIDMK(6)
0011          LOW=Y(1,1)
0012          HIGH=Y(1,1)
0013          DO 140 J=1,NG
0014          DO 140 I=1,NPOINT
0015          IF(Y(J,I).LT.LCW)LOW=Y(J,I)
0016   140    IF(Y(J,I).GT.HIGH)HIGH=Y(J,I)
0017          SPREAD=HIGH-LOW
0018          DO 150 I=1,11
```

```
      K=I-1
      SCALE=LOW+FLOAT(K)*SPREAD/10.
      INDEX(I)=SCALE
  150 CONTINUE
      SPACE=100./SPREAD
      IF(LOW)161,170,160
  161 IF(HIGH)160,170,170
  160 NO=0
      GO TO 200
  170 NO=1
      AXIS=1.5-LOW*SPACE
```

```
0030       200  WRITE(6,702)INDEX                                       01062000
0031            WRITE(6,706)                                            01063000
0032            DO 220 I=1,NPOINT                                       01064000
0033            IF(NO.EQ.1)A(AXIS)=PA                                   01065000
0034            DO 218 J=1,NG                                           01066000
0035            N=(Y(J,I)-LOW)*SPACE+1.5                                01067000
0036            STORE(J)=N                                              01068000
0037       218  A(N)=GRIDMK(J)                                          01069000
0038            WRITE(6,708)X(I),(A(K),K=1,101)                         01070000
0039            DO 219 J=1,NG                                           01071000
0040       219  A(STORE(J))=BLANK                                       01072000
0041       220  CONTINUE                                                01073000
0042            WRITE(6,706)                                            01074000
0043            WRITE(6,702)INDEX                                       01075000
          C
          C
          C                        END OF PROGRAMME
          C
          C                            TYMPAC
          C
          C
0044            RETURN                                                  01076000
0045            END                                                     01077000
```

```
                QUEENS UNIVERSITY  TYMPAC
           BOX-JENKINS ESTIMATOR OF PARAMETERS.
           * * * * * * * * * * * * * * * * * *
                          TYMPAC
           * * * * * * * * * * * * * * * * * *


 ITEM NUMBER     1 :          SEASONAL DATA: FORECAST AHEAD (1)
           * * * * * * * * * *

           NON-LINEAR ESTIMATION, ITEM    1

           40 OBSERVATIONS     2 PARAMETERS

          INITIAL PARAMETER VALUES

                      1          2
                    0.100      0.700
 PROPORTIONS USED TO CALCULATE DIFFERENCE QUOTIENTS

                      1          2
                    0.010      0.010
  INITIAL SUM OF SQUARES =       22761.9


                          ITERATION NO.   1
                          - - - - - - - - -
DETERMINANT =    0.4330E 00    ANGLE IN SCALED COORD. = 44.97DEGREES
                 TEST POINT PARAMETER VALUES
0.15     0.90

                TEST POINT SUM OF SQUARES =           21225.0

                PARAMETER VALUES VIA REGRESSION

                      1          2
                    0.152      0.898
```

```
LAMBDA =        0.0001        SUM OF SQUARES AFTER REGRESSION =     21225.03


                          ITERATION NO.   2
                          - - - - - - - - -
DETERMINANT =     0.8496E 00    ANGLE IN SCALED COORD. = 18.43DEGREES
                  TEST POINT PARAMETER VALUES
0.14      0.95

                TEST POINT SUM OF SQUARES =            20732.2

                PARAMETER VALUES VIA REGRESSION

                      1          2
                    0.136      0.954
LAMBDA =        0.0000        SUM OF SQUARES AFTER REGRESSION =     20732.22


                          ITERATION NO.   3
                          - - - - - - - - -
DETERMINANT =     0.9987E 00    ANGLE IN SCALED COORD. =  1.80DEGREES
                  TEST POINT PARAMETER VALUES
0.11      0.99

                TEST POINT SUM OF SQUARES =            20431.4

                PARAMETER VALUES VIA REGRESSION

                      1          2
                    0.115      0.989
LAMBDA =        0.0000        SUM OF SQUARES AFTER REGRESSION =     20431.44


                          ITERATION NO.   4
                          - - - - - - - - -
```

```
DETERMINANT =    0.8715E 00    ANGLE IN SCALED COORD. =  4.43DEGREES
                 TEST POINT PARAMETER VALUES
0.07     1.00

               TEST POINT SUM OF SQUARES =            20373.9

               PARAMETER VALUES VIA REGRESSION

                       1          2
                     0.075      0.996

    LAMBDA =         0.0000        SUM OF SQUARES AFTER REGRESSION =     20373.92


                            ITERATION NO.   5
                            - - - - - - - - -

DETERMINANT =    0.8126E 00    ANGLE IN SCALED COORD. = 17.41DEGREES
                 TEST POINT PARAMETER VALUES
0.07     1.00

               TEST POINT SUM OF SQUARES =            20367.2

               PARAMETER VALUES VIA REGRESSION

                       1          2
                     0.065      0.999

    LAMBDA =         0.0000        SUM OF SQUARES AFTER REGRESSION =     20367.19


                            ITERATION NO.   6
                            - - - - - - - - -

DETERMINANT =    0.7755E 00    ANGLE IN SCALED COORD. = 10.69DEGREES
                 TEST POINT PARAMETER VALUES
0.06     1.00

               TEST POINT SUM OF SQUARES =            20366.3

               PARAMETER VALUES VIA REGRESSION

                       1          2
```

```
                0.061      1.000
LAMBDA =        0.0000          SUM OF SQUARES AFTER REGRESSION =     20366.29


                        ITERATION NO.   7
                        - - - - - - - - -
DETERMINANT =   0.7692E 00    ANGLE IN SCALED COORD. = 27.45DEGREES
                TEST POINT PARAMETER VALUES
0.06     1.00

               TEST POINT SUM OF SQUARES =            20366.2

               PARAMETER VALUES VIA REGRESSION

                   1          2
                 0.060      1.000
LAMBDA =        0.0000          SUM OF SQUARES AFTER REGRESSION =     20366.19


                        ITERATION NO.   8
                        - - - - - - - - -
DETERMINANT =   0.7653E 00    ANGLE IN SCALED COORD. = 28.51DEGREES
                TEST POINT PARAMETER VALUES
0.06     1.00

               TEST POINT SUM OF SQUARES =            20366.2

               PARAMETER VALUES VIA REGRESSION

                   1          2
                 0.060      1.000
LAMBDA =        0.0000          SUM OF SQUARES AFTER REGRESSION =     20366.15
 STOP ITERATING - RELATIVE CHANGE IN EACH PARAMETER LESS THAN   0.4000E-02

                        FINAL FUNCTION VALUES
                        * * * * * * * * * * * *
```

26.92	44.38	43.65	56.74	71.26	65.15	53.24	44.41	27.81	38.37
85.07	48.05	23.59	76.48	59.62	65.98	94.73	76.55	50.22	32.27
42.61	44.03	142.65	75.72	1.69	77.77	64.58	49.35	145.75	99.35
74.83	63.02	32.66	62.94	109.74	64.02	7.84	62.11	44.01	71.64

RESIDUALS

-7.92	30.62	13.35	6.26	21.74	5.85	-7.24	-16.41	10.19	3.63
53.93	26.95	-23.59	-1.48	3.38	-17.98	47.27	21.45	23.78	29.73
-13.61	15.97	-34.65	-15.72	1.31	-19.77	-22.58	17.65	-24.75	-31.35
-27.83	15.98	1.34	-17.94	21.26	32.98	20.16	-14.11	31.99	-17.64

CORRELATION MATRIX

	1	2
1	1.0000	
2	-0.4844	1.0000

NORMALIZING ELEMENTS

1	2
0.007	0.001

VARIANCE OF RESIDUALS = 0.5360E 03, 38 DEGREES OF FREEDOM

INDIVIDUAL CONFIDENCE LIMITS , EACH PARAMETER (ON LINEAR HYPOTHESIS)

1	2
0.372	1.056
-0.251	0.945

APPROXIMATE CONFIDENCE LIMITS FOR EACH FUNCTION VALUE

32.53	53.02	47.83	58.53	74.58	69.31	57.18	51.51	38.00	41.67
21.31	35.74	39.47	54.95	67.94	60.99	49.31	37.30	17.63	35.07
89.37	63.31	33.92	87.67	66.64	72.48	104.84	91.56	61.36	45.02
80.77	32.79	13.27	65.28	52.60	59.48	84.61	61.55	39.07	19.51
58.30	55.83	156.03	90.74	13.32	87.91	76.21	61.45	155.86	111.41
26.93	32.24	129.27	60.71	-9.94	67.63	52.95	37.24	135.64	87.29
89.03	76.46	39.14	69.53	119.89	71.72	20.25	73.29	54.19	85.75
60.63	49.58	26.18	56.34	99.60	56.32	-4.56	50.93	33.83	57.53

RESIDUAL AUTOCORRELATIONS

MEAN = 3.55

1-12	0.10	0.04	0.11	-0.12	-0.11	0.00	0.10	0.15	-0.06	-0.13	-0.06	-0.34
13-24	-0.10	-0.04	0.08	-0.00	0.19	-0.03	-0.06	-0.08	-0.08	0.01	-0.10	0.02

APPROXIMATE 95 PERCENT LIMITS FOR CORRELATIONS ARE PLUS AND MINUS 0.324

MEAN OF ORIGINAL SERIES OF RESIDUALS IS 0.983 STANDARD DEVIATIONS FROM ZERO.

ITEM 1 FORECASTS AT BASE PERIOD 54

PERIODS AHEAD	LOW CONF. LIMIT	FORECAST	UP. CONF. LIMIT	ACTUAL, IF KNOWN
1	78.0	122.8	167.6	167.0
2	25.8	70.7	115.6	63.0
3	4.9	49.8	94.7	85.0
4	36.9	81.8	126.7	111.0
5	-8.1	36.8	81.7	48.0
6	2.9	47.8	92.7	121.0
7	88.9	133.8	178.7	141.0
8	54.9	99.8	144.7	138.0
9	-14.1	30.8	75.7	66.0
10	5.9	50.8	95.7	98.0
11	33.9	78.8	123.7	87.0
12	11.9	56.8	101.7	66.0

ERROR EVALUATION
* * * * * * * *

ACTUAL DEMAND	HIGH SIDE ERROR	MEAN ERROR	LOW SIDE ERROR
167.0	89.0	44.2	-0.6
63.0	37.2	-7.7	-52.6
85.0	80.1	35.2	-9.7
111.0	74.1	29.2	-15.7
48.0	56.1	11.2	-33.7
121.0	118.1	73.2	28.3
141.0	52.1	7.2	-37.7
138.0	83.1	38.2	-6.7
66.0	80.1	35.2	-9.7
98.0	92.1	47.2	2.3
87.0	53.1	8.2	-36.7
66.0	54.1	9.2	-35.7

NOTE: HIGH SIDE ERROR IS ACTUAL DEMAND - LOWER CONFIDENCE LIMIT
MEAN ERROR (DEMAND - FORECAST)
LOW SIDE ERROR IS (DEMAND - UPPER CONFIDENCE LIMIT).

```
               QUEENS UNIVERSITY  TYMPAC
           BOX-JENKINS ESTIMATOR OF PARAMETERS.
           * * * * * * * * * * * * * * * * * *
                        TYMPAC
           * * * * * * * * * * * * * * * * * *


ITEM NUMBER     2 :          SEASONAL DATA: FORECAST AHEAD (2)
    * * * * * * * * * *

       NON-LINEAR ESTIMATION. ITEM    2

       52 OBSERVATIONS     2 PARAMETERS

      INITIAL PARAMETER VALUES

                 1          2
              -0.100      0.600
PROPORTIONS USED TO CALCULATE DIFFERENCE QUOTIENTS

                 1          2
               0.010      0.010
  INITIAL SUM OF SQUARES =       63240.9


                      ITERATION NO.    1
                      - - - - - - - - -
 DETERMINANT =    0.4257E 00    ANGLE IN SCALED COORD. = 23.71DEGREES
                  TEST POINT PARAMETER VALUES
0.59     1.38

                TEST POINT SUM OF SQUARES =  ***************
                  TEST POINT PARAMETER VALUES
0.24     0.99

                TEST POINT SUM OF SQUARES =           66616.3
                  TEST POINT PARAMETER VALUES
0.07     0.80
```

```
TEST POINT SUM OF SQUARES =              55321.3

PARAMETER VALUES VIA REGRESSION

            1           2
          0.072       0.796

LAMBDA =  0.0001      SUM OF SQUARES AFTER REGRESSION =      55321.34


                    ITERATION NO.  2
                    - - - - - - - - -

DETERMINANT =   0.5631E 00    ANGLE IN SCALED COORD. = 37.24DEGREES
                TEST POINT PARAMETER VALUES
0.37     1.25

              TEST POINT SUM OF SQUARES =   4228266328064.0
DETERMINANT =   0.5633E 00    ANGLE IN SCALED COORD. = 37.24DEGREES
                TEST POINT PARAMETER VALUES
0.37     1.25

              TEST POINT SUM OF SQUARES =   4194789490688.0
DETERMINANT =   0.5651E 00    ANGLE IN SCALED COORD. = 37.21DEGREES
                TEST POINT PARAMETER VALUES
0.37     1.25

              TEST POINT SUM OF SQUARES =   3873203814400.0
DETERMINANT =   0.5832E 00    ANGLE IN SCALED COORD. = 36.92DEGREES
                TEST POINT PARAMETER VALUES
0.36     1.24

              TEST POINT SUM OF SQUARES =   1780495679488.0
DETERMINANT =   0.7731E 00    ANGLE IN SCALED COORD. = 34.21DEGREES
                TEST POINT PARAMETER VALUES
0.28     1.17

              TEST POINT SUM OF SQUARES =      3751522048.0
DETERMINANT =   0.3563E 01    ANGLE IN SCALED COORD. = 19.20DEGREES
                TEST POINT PARAMETER VALUES
0.11     0.95

              TEST POINT SUM OF SQUARES =           52866.4

              PARAMETER VALUES VIA REGRESSION
```

```
                1          2
              0.109      0.947
LAMBDA =      1.0000         SUM OF SQUARES AFTER REGRESSION =      52866.43


                        ITERATION NO.    3
                        - - - - - - - - -
DETERMINANT =   0.1155E 01    ANGLE IN SCALED COORD. =  9.96DEGREES
                TEST POINT PARAMETER VALUES
0.05     0.92
             TEST POINT SUM OF SQUARES =            52012.6
             PARAMETER VALUES VIA REGRESSION
                1          2
              0.046      0.916
LAMBDA =      0.1000         SUM OF SQUARES AFTER REGRESSION =      52012.64


                        ITERATION NO.    4
                        - - - - - - - - -
DETERMINANT =   0.9176E 00    ANGLE IN SCALED COORD. =  9.15DEGREES
                TEST POINT PARAMETER VALUES
0.06     0.91
             TEST POINT SUM OF SQUARES =            51998.6
             PARAMETER VALUES VIA REGRESSION
                1          2
              0.062      0.913
LAMBDA =      0.0100         SUM OF SQUARES AFTER REGRESSION =      51998.58
```

```
                    ITERATION NO.   5
                    - - - - - - - - -
DETERMINANT =    0.8846E 00    ANGLE IN SCALED COORD. =  9.97DEGREES
                  TEST POINT PARAMETER VALUES
0.07      0.91

                TEST POINT SUM OF SQUARES =          51996.6

                PARAMETER VALUES VIA REGRESSION

                       1          2
                     0.066      0.914
     LAMBDA =        0.0010        SUM OF SQUARES AFTER REGRESSION =     51996.64


                    ITERATION NO.   6
                    - - - - - - - - -
DETERMINANT =    0.8846E 00    ANGLE IN SCALED COORD. = 16.23DEGREES
                  TEST POINT PARAMETER VALUES
0.06      0.91

                TEST POINT SUM OF SQUARES =          51999.0
                  TEST POINT PARAMETER VALUES
0.06      0.91

                TEST POINT SUM OF SQUARES =          51997.6
                  TEST POINT PARAMETER VALUES
0.07      0.91

                TEST POINT SUM OF SQUARES =          51996.9
                  TEST POINT PARAMETER VALUES
0.07      0.91

                TEST POINT SUM OF SQUARES =          51996.7
                  TEST POINT PARAMETER VALUES
0.07      0.91

                TEST POINT SUM OF SQUARES =          51996.6

                PARAMETER VALUES VIA REGRESSION

                       1          2
                     0.066      0.914
```

LAMBDA = 0.0001 SUM OF SQUARES AFTER REGRESSION = 51996.64

STOP ITERATING - RELATIVE CHANGE IN EACH PARAMETER LESS THAN 0.4000E-02

FINAL FUNCTION VALUES
* * * * * * * * * * * *

36.56	34.57	36.38	36.41	38.75	42.23	43.38	43.22	42.59	40.12
40.28	46.93	43.88	40.25	46.89	46.57	48.37	54.16	54.15	51.82
48.60	48.35	48.07	62.20	59.10	49.13	56.26	56.05	54.38	68.03
67.71	66.68	65.49	60.20	62.22	69.28	65.34	56.27	60.03	57.44
59.89	68.66	65.13	62.20	65.73	60.07	59.50	71.26	71.23	63.01
63.03	65.98								

RESIDUALS

-12.56	7.43	2.62	16.59	29.25	18.77	6.62	-1.22	-16.59	-5.12
41.72	-4.93	-24.88	34.75	10.11	16.43	44.63	16.84	-8.15	-23.82
-10.60	-6.35	90.93	12.80	-59.10	25.87	6.74	-8.05	87.62	29.97
6.29	-4.68	-36.49	-0.20	45.78	-9.28	-62.34	1.73	-18.03	9.56
61.11	-0.66	-18.13	16.80	-31.73	-15.07	71.50	25.74	-43.23	-15.01
12.97	-11.98								

CORRELATION MATRIX

	1	2
1	1.0000	
2	0.3401	1.0000

NORMALIZING ELEMENTS

1	2
0.005	0.002

VARIANCE OF RESIDUALS = 0.1040E 04, 50 DEGREES OF FREEDOM

INDIVIDUAL CONFIDENCE LIMITS . EACH PARAMETER (ON LINEAR HYPOTHESIS)

1	2
0.366	1.030
-0.235	0.799

APPROXIMATE CONFIDENCE LIMITS FOR EACH FUNCTION VALUE

43.16	44.42	40.20	40.87	40.50	47.78	49.78	50.84	50.94	50.32
29.95	24.71	32.56	31.95	36.99	36.68	36.97	35.60	34.25	29.93
46.73	57.13	51.94	51.39	55.50	53.70	56.73	68.91	67.57	65.50
33.82	36.72	35.82	29.10	38.28	39.45	40.02	39.40	40.74	38.13
62.46	57.69	55.14	87.89	73.97	71.08	66.17	65.73	64.11	93.97
34.74	39.01	41.00	36.52	44.23	27.18	46.35	46.37	44.64	42.10
86.88	85.24	83.27	79.01	73.37	85.87	79.16	77.40	65.01	64.09
48.55	48.11	47.71	41.40	51.07	52.69	51.52	35.14	55.04	50.78
63.15	86.44	73.96	71.81	73.34	70.99	65.31	91.35	83.54	78.45
56.63	50.88	56.30	52.59	58.13	49.15	53.70	51.16	58.92	47.57
70.50	71.06								
55.57	60.89								

RESIDUAL AUTOCORRELATIONS

MEAN = 5.83

1-12	0.02	-0.41	0.06	-0.27	-0.07	0.49	0.01	-0.25	0.01	-0.31	-0.06	0.63
13-24	0.06	-0.31	0.02	-0.19	0.05	0.39	-0.05	-0.19	0.01	-0.25	-0.09	0.39

APPROXIMATE 95 PERCENT LIMITS FOR CORRELATIONS ARE PLUS AND MINUS 0.283

MEAN OF ORIGINAL SERIES OF RESIDUALS IS 1.326 STANDARD DEVIATIONS FROM ZERO.

ITEM 2 FORECASTS AT BASE PERIOD 54

PERIODS AHEAD	LOW CONF. LIMIT	FORECAST	UP. CONF. LIMIT	ACTUAL, IF KNOWN
1	1.4	63.5	125.6	167.0
2	1.3	64.1	127.0	63.0
3	1.1	64.2	127.3	85.0
4	0.8	64.2	127.5	111.0
5	0.6	64.2	127.8	48.0
6	0.3	64.2	128.1	121.0
7	0.1	64.2	128.3	141.0
8	-0.2	64.2	128.6	138.0
9	-0.4	64.2	128.8	66.0
10	-0.7	64.2	129.1	98.0
11	-0.9	64.2	129.3	87.0
12	-1.2	64.2	129.6	66.0

ERROR EVALUATION

ACTUAL DEMAND	HIGH SIDE ERROR	MEAN ERROR	LOW SIDE ERROR
167.0	165.6	103.5	41.4
63.0	61.7	-1.1	-64.0
85.0	83.9	20.8	-42.3
111.0	110.2	46.8	-16.5
48.0	47.4	-16.2	-79.8
121.0	120.7	56.8	-7.1
141.0	140.9	76.8	12.7
138.0	138.2	73.8	9.4
66.0	66.4	1.8	-62.8
98.0	98.7	33.8	-31.1
87.0	87.9	22.8	-42.3
66.0	67.2	1.8	-63.6

NOTE: HIGH SIDE ERROR IS ACTUAL DEMAND - LOWER CONFIDENCE LIMIT
MEAN ERRCR (DEMAND - FORECAST)
LOW SIDE ERROR IS (DEMAND - UPPER CONFIDENCE LIMIT).

APPENDIX E

EVALUATION OF FORECASTING PERFORMANCE

In chapter eight several methods of forecasting using exponential smoothing are described. Choice of an appropriate smoothing constant is discussed, with examples based on a test by Chow (1965). The programme developed by the writer is included in this appendix: CHOWTEST, with selected output.

The programme BRUFICH combines the requirements of an actual inventory management system (with certain routines removed) with experimental sub-programmes to examine the performance of a range of exponentially smoothed forecasting methods. These are described in chapter eight: single smoothing; trend adjustments and double smoothing; tracking signal methods; seasonal forecasting and lead time forecasting. Beginning at statement 13721, the programme consists of economic order quantity, discount, reorder point, ABC classification and other inventory management routines.

Brief description of the major routines is given in chapter four. Simplicity is maintained without sacrifice of efficiency or management control.

Programme COMPARE is included in this appendix, with selected output. Each forecast is accompanied by extrapolation for several periods ahead of the latest data; input of demand was limited so that comparison with actual outcome is possible. For item six, face tissues, actual demands for the six periods 57 to 62 were: 2476, 3032, 2756, 2176, 2482 and 2090 units. Forecasts for the 62nd month were:

Regression:	3117	
Moving Average:	3095	
Single Smoothing:	2441	(Alpha = 0.30)
Double Smoothing:	2316	
Triple Smoothing:	2840	(Alpha = 0.10)
Winters Seasonal:	3607	
Mean actual value:	2502	

indicating the wide dispersion of some methods from the outcome.

This appendix contains examples of output from the most commonly recommended exponential smoothing methods. Computer requirements and especially needs of data storage, are reduced compared with moving average methods; whether management will be impressed by the results of any statistical forecasting methods compared with presently used subjective predictions, is doubtful.

The programme RESTRAIN is described in chapter nine; it is included with selected output in this section of the appendix. Codes indicate each period whether the signed error from the specific forecasting method is within the predetermined number of standard errors. To be an effective control, action would be taken when the situation warranted it. In this simulation, no attempt was made to do this.

The final programme is INVENT. Its three sections are described and illustrated in chapter 9; this appendix includes the programme and output for face tissues demand. It is intended that the systems analyst could easily determine the effect upon the economic order quantity, reorder level or any of the major costs, of a variety of other components. In particular, management specification of high service levels result in certain safety stock reactions, the nature of which may easily be seen in the output. The result of different methods of forecasting, and the outcomes in terms of E.O.Q. and reorder levels, is also plain.

The programmes included in these appendixes are all experimental, but once management has decided upon the main components, they would each contribute to the entire system: BRUFICH. This is a simple, yet powerful inventory management system for hospital purposes.

```
$JOB             ,PAGES=400,TIME=720
C
C
C
C
C                                  * * * * * *
C                                  * CHOWTEST*
C                                  * * * * * *
C
C                   ADAPTED FROM W.M.CHOW,"ADAPTIVE CONTROL OF THE
C                   EXPONENTIAL SMOOTHING CONSTANT".JIIE,1965,314-7
C
C                   TO TEST THE EFFICIENCY OF THREE LEVELS OF SMOOTHING
C                   CONSTANT USING THE SIMPLE BROWN FORECAST METHOD.
C                   TEST CRITERION IS VALUE OF SUM OF SIGNED ERRORS.
C
C                                   PROCEDURE
C
C
C                   A DATA SET IS READ, AND THREE ALPHA VALUES SELECTED.
C                   CHOW SUGGESTS .05  .10 AND .15 TO START.
C                   AFTER FORECASTING, SUMS OF ERRORS ARE COMPARED AND
C                   THE LOWEST ONE IS MATCHED WITH ITS CONSTANT. THIS
C                   VALUE BECOMES THE MIDDLE CONSTANT NEXT ITERATION.
C                   A PREDETERMINED NUMBER OF RUNS ARE MADE, WITH
C                   AMENDED CONSTANTS; FOLLOWING WHICH A TABULATION IS
C                   PRINTED OF ALL THE VALUES. BY INSPECTION, THE BEST
C                   SMOOTHING CONSTANT CAN BE CHOSEN, ALTHOUGH THIS
C                   COULD BE PROGRAMMED AS A COMPUTER DECISION.
C
C
C                                   --------
C
C
      DIMENSION KDATA(100),ALO(15),AMED(15),AHI(15),T(100),TM(100)
      DIMENSION TH(100),A(100),AM(100),AH(100),FORM(100),FORC(100),
     1FORH(100),ERLO(100),ERMED(100),ERHI(100),ABEST(20),ALOSUM(20),
     2 AMEDSM(20),HISUM(20)
      PRINT 1
    1 FORMAT('1',43X,'CHOWTEST SMOOTHING CONSTANT EXPERIMENT'/42X,
     1'ADAPTED FROM WORK BY W.M.CHOW, (JIIE 1965)'/42X,21('* ') /)
C
C                   THE NUMBER OF DATA SETS INCLUDED:
      READ, MK
      DO 50 IZ = 1,MK
C
C                   THE NUMBER OF ITERATIONS TO BE RUN:
      ML = 10
C
C                   THE NUMBER OF PERIODS IN A DATA SET:
```

```
      READ,N
C
C                 FEED IN THE DATA:
      READ 3, (KDATA(I), I=1,N)
    3 FORMAT(12I6)
      PRINT 6,IZ, N,(KDATA(I),I=1,N)
    6 FORMAT('0',49X,'CHOWTEST  ITEM NUMBER',1X,I2/50X,'_ _ _ - - - - -
     1_ _ _ _ ' /32X,'THE',2X,I2,1X,'ITEMS ARE:'//(32X,10I6))
C
C                 THE SELECTED CONSTANTS:
      ALO(1) = 0.05
```

```
      AMED(1) = 0.10
      AHI(1) = 0.15
C
C              FORECASTING BEGINS USING THE AVERAGE OF
C              FIRST SIX MONTHS DEMAND, AND ZERO TREND:
      NSUM = 0
      DO 8 IX=1, 6
      NSUM = NSUM + KDATA(IX)
    8 CONTINUE
      ASUM = NSUM
      PROG = ASUM/6.
      T(6) = 0.0
      TM(6) = 0.0
      TH(6) = 0.0
      A(6) = PROG
      AM(6) = PROG
      AH(6) = PROG
C
C              ITERATIONS TO FIND THE BEST VALUES:
      DO 10 IL=1, ML
      SUMLO = 0.0
      SUMMED = 0.0
      SUMHI = 0.0
C
C              FORECASTS FOR EACH ITEM, PER ITERATION:
      PRINT 40,IZ,IL,ALO(IL),AMED(IL),AHI(IL)
   40 FORMAT('0',40X,'CHOWTEST  ITEM NUMBER',1X,I2,1X,' ITERATION NUMBER'
     1,1X,I2/40X,'USING CONSTANT VALUES OF:',1X,F4.2,2X,F4.2,1X,'AND',1X
     2,F4.2/55X,'_______________'/)
      PRINT 41
   41 FORMAT('0',34X,'PERIOD  FORECAST  ERROR FORECAST  ERROR  FORECAST
     1 ERROR'/44X,'LOW A    LOW A  MED A    MED A   HIGH A  HIGH A'/
     2 35X,'______  _____  _____  _____  _____  ______  ______'/)
        MM = (N-1)
       DO 12 K=7,N
      AM(K) = (AMED(IL) * KDATA(K))+((1. - AMED(IL))*AM(K-1))
      A(K) = (ALO(IL) * KDATA(K))+((1.-ALO(IL)) * A(K-1))
      AH(K) = (AHI(IL) * KDATA(K))+((1. - AHI(IL))* AH(K-1))
      T(K) =(ALO(IL)* (A(K) - A(K-1)))+((1.-ALO(IL)) * T(K-1))
      TM(K) = (AMED(IL)*(AM(K) - AM(K-1)))+(( 1.-AMED(IL))*TM(K-1))
      TH(K) = (AHI(IL)*(AH(K) - AH(K-1)))+((1.-AHI(IL))*TH(K-1))
      FORC(7) = PROG
      FORM(7) = PROG
      FORH(7) = PROG
      FORC(K+1) = A(K) +(((1.-ALO(IL))/ALO(IL))*T(K))
      FORM(K+1) = AM(K) + (((1.-AMED(IL))/AMED(IL))*TM(K))
      FORH(K+1)=  AH(K)+ (((1.-AHI(IL))/AHI(IL))*TH(K))
      ERLO(K)= KDATA(K) - FORC(K)
      ERMED(K) = KDATA(K) - FORM(K)
```

```
      ERHI(K) = KDATA(K) - FORH(K)
      SUMLO = SUMLO + ERLO(K)
      SUMMED = SUMMED + ERMED(K)
      SUMHI = SUMHI + ERHI(K)
      PRINT 42,K,FORC(K), ERLO(K), FORM(K),ERMED(K), FORH(K),ERHI(K)
   42 FORMAT('0',35X,I2,6X,F6.0,2X,F7.1,1X,F6.0,2X,F7.1,2X,F6.0,1X,F7.1
     1 )
   12 CONTINUE
      ALOSUM(IL) = SUMLO
      AMEDSM(IL) = SUMMED
      HISUM(IL) = SUMHI
```

```
C
C                 COMPARE TOTALS OF ERRORS. SELECT SMOOTHING CONSTANT
C                 RELATED TO THE LOWEST TOTAL ERROR, AND USE AS THE
C                 NEW CENTRAL SMOOTHING CONSTANT. ADJUST THE VALUES
C                 OF THE CONSTANTS ABOVE AND BELOW THE NEW ONE.
         IF(((SUMLO-SUMMED).LE.0.).AND.((SUMLO-SUMHI).LE.0.)) GO TO 20
         IF(((SUMMED-SUMLO).LE.0.).AND.((SUMMED-SUMHI).LE.0.))  GO TO 21
         IF(((SUMHI-SUMLO).LE.0.).AND.((SUMHI-SUMMED).LE.0.)) GO TO 22
   20    ABEST(IL) = ALO(IL)
         GO TO 23
   21    ABEST(IL) = AMED(IL)
         GO TO 23
   22    ABEST(IL) = AHI(IL)
         GO TO 23
   23    AMED(IL+1) = ABEST(IL)
         ALO(IL+1) = AMED(IL+1)- .05
         IF(ALO(IL+1).LE.0.02) ALO(IL+1) = 0.02
         AHI(IL+1) = AMED(IL+1) + 0.05
   10    CONTINUE
C
C                 RESULTS OF ITERATIONS ARE TABULATED. THE BEST VALUE
C                 FOR ALPHA CAN BE SELECTED BY INSPECTION OF PRINTOUT.
         PRINT 60, IZ
   60    FORMAT('1',43X,'SUMMARY OF ALPHAS AND SUMS OF ERRORS.'/51X,'ONE L
        1INE PER ITERATION'/55X,'ITEM NUMBER:',I4/55X,'_________________'/)
         PRINT 61
   61    FORMAT('0',31X,'ITERATION   LOW  SUM OF MEDIUM  SUM OF  HIGH  SUM
        1 OF  SELECTED'/33X, 'NUMBER    ALPHA ERRORS  ALPHA  ERRORS  ALPHA
        2ERRORS   ALPHA'/ 33X, 30('- ')/)
         DO 30 IL=1,ML
         PRINT 13,IL,ALO(IL),ALOSUM(IL),AMED(IL),AMEDSM(IL),AHI(IL),
        1 HISUM(IL), ABEST(IL)
   13   FORMAT('0',35X,I2,6X,F4.2,1X,F6.0,2X,F4.2,3X,F6.0,2X,F4.2,2X,F6.0,
        1 4X, F4.2/)
   30     CONTINUE
         PRINT 15,IZ
   15    FORMAT('0',40X,'THE BEST VALUE OF ALPHA, ITEM',1X,I2,1X,'IS THUS
        1 ......'/)
   50    CONTINUE
          PRINT 70
   70   FORMAT('0',40X,'END OF CHOWTEST PROGRAMME.'/)
         STOP
         END

$ENTRY
```

CHOWTEST SMOOTHING CONSTANT EXPERIMENT
ADAPTED FROM WORK BY W.M.CHOW. (JIIE 1965)
* *

CHOWTEST ITEM NUMBER 1

THE 62 ITEMS ARE:

1222	1707	1229	1524	1253	1334	1560	740	1125	1434
1355	1259	1629	1326	1421	1631	1166	1257	1673	1283
1316	1501	1399	1177	1236	1536	1406	1834	1183	430
1000	1590	1110	2002	689	1237	2064	2272	2830	2311
2206	2562	1748	1966	1896	2366	2279	2244	2453	2670
2536	2523	3026	2552	2289	2278	2476	3032	2756	2176
2482	2090								

CHOWTEST ITEM NUMBER 1 ITERATION NUMBER 1
USING CONSTANT VALUES OF: 0.05 0.10 AND 0.15

PERIOD	FORECAST LOW A	ERROR LOW A	FORECAST MED A	ERROR MED A	FORECAST HIGH A	ERROR HIGH A
7	1378.	181.8	1378.	181.8	1378.	181.8
8	1396.	-655.9	1413.	-672.7	1429.	-688.6
9	1332.	-207.4	1286.	-161.4	1240.	-115.5
10	1311.	122.9	1252.	182.3	1200.	233.9
11	1322.	33.5	1281.	73.9	1255.	100.0
12	1324.	-64.5	1291.	-32.4	1277.	-17.8
13	1316.	312.9	1282.	346.8	1268.	361.3
14	1345.	-19.3	1345.	-18.7	1364.	-37.5
15	1343.	78.2	1341.	80.3	1355.	66.3
16	1350.	281.3	1355.	275.7	1374.	257.0
17	1377.	-210.7	1408.	-241.7	1447.	-281.3

18	1356.	-99.3	1364.	-107.1	1375.	-118.4
19	1346.	326.7	1344.	329.0	1344.	329.1
20	1378.	-94.6	1406.	-122.9	1435.	-151.7
21	1369.	-52.6	1385.	-68.6	1397.	-81.4
22	1363.	137.5	1373.	128.3	1377.	124.0
23	1377.	22.3	1398.	1.5	1412.	-13.3

24	1379.	-202.1	1399.	-222.4	1411.	-234.5
25	1360.	-123.6	1359.	-122.6	1349.	-113.0
26	1347.	188.7	1335.	201.0	1316.	219.7
27	1365.	40.8	1372.	34.1	1374.	31.8
28	1369.	464.9	1379.	455.2	1384.	450.4
29	1414.	-231.5	1466.	-282.9	1510.	-326.6
30	1393.	-963.0	1416.	-986.5	1427.	-997.3
31	1300.	-299.6	1231.	-231.0	1153.	-153.4
32	1269.	321.2	1181.	408.9	1097.	492.6
33	1298.	-187.8	1251.	-140.9	1218.	-108.5
34	1278.	724.1	1220.	782.3	1181.	820.9
35	1346.	-657.5	1363.	-673.8	1400.	-711.0
36	1282.	-45.0	1236.	1.4	1207.	29.6
37	1276.	788.2	1231.	832.7	1209.	855.4
38	1351.	921.3	1385.	887.1	1440.	832.3
39	1440.	1389.6	1556.	1274.3	1678.	1151.7
40	1578.	733.2	1807.	503.8	2019.	292.0
41	1654.	551.7	1923.	283.5	2139.	66.7
42	1715.	847.2	2000.	562.1	2201.	361.0
43	1805.	-57.3	2132.	-384.3	2344.	-596.5
44	1810.	156.4	2089.	-123.1	2227.	-261.1
45	1834.	61.5	2092.	-196.2	2192.	-296.1
46	1850.	515.5	2080.	285.9	2142.	223.8
47	1911.	368.2	2158.	121.2	2231.	47.9
48	1958.	286.0	2206.	37.8	2274.	-30.2

49	1998.	455.1	2240.	213.4	2296.	157.3
50	2055.	615.1	2306.	363.7	2368.	301.9
51	2129.	407.4	2403.	132.9	2483.	53.4
52	2183.	339.7	2459.	64.3	2532.	-9.3
53	2232.	793.7	2502.	524.0	2565.	461.3

54	2326.	225.7	2633.	-80.9	2727.	-174.7
55	2367.	-77.7	2653.	-363.8	2719.	-430.0
56	2378.	-99.9	2618.	-339.9	2637.	-358.7
57	2387.	89.2	2584.	-108.3	2566.	-90.3
58	2414.	618.2	2592.	440.4	2564.	468.1
59	2493.	263.4	2702.	54.0	2715.	41.5
60	2538.	-362.1	2742.	-566.3	2754.	-577.9
61	2523.	-41.2	2665.	-182.9	2621.	-139.4
62	2539.	-448.7	2655.	-565.4	2601.	-510.6

CHOWTEST ITEM NUMBER 1 ITERATION NUMBER 2
USING CONSTANT VALUES OF: 0.10 0.15 AND 0.20

PERIOD	FORECAST LOW A	ERROR LOW A	FORECAST MED A	ERROR MED A	FORECAST HIGH A	ERROR HIGH A
7	1378.	181.8	1378.	181.8	1378.	181.8
8	1413.	-672.7	1429.	-688.6	1444.	-703.6
9	1286.	-161.4	1240.	-115.5	1195.	-70.0
10	1252.	182.3	1200.	233.9	1155.	277.8
11	1281.	73.9	1255.	100.0	1241.	113.6
12	1291.	-32.4	1277.	-17.8	1275.	-16.2
13	1282.	346.8	1268.	361.3	1265.	363.5
14	1345.	-18.7	1364.	-37.5	1392.	-66.2
15	1341.	80.3	1355.	66.3	1374.	47.3
16	1355.	275.7	1374.	257.0	1394.	236.9
17	1408.	-241.7	1447.	-281.3	1484.	-317.9

18	1364.	-107.1	1375.	-118.4	1380.	-122.8
19	1344.	329.0	1344.	329.1	1337.	335.6
20	1406.	-122.9	1435.	-151.7	1457.	-173.8
21	1385.	-68.6	1397.	-81.4	1401.	-85.5
22	1373.	128.3	1377.	124.0	1373.	127.8

23	1398.	1.5	1412.	-13.3	1419.	-20.4
24	1399.	-222.4	1411.	-234.5	1416.	-238.6
25	1359.	-122.6	1349.	-113.0	1332.	-96.5
26	1335.	201.0	1316.	219.7	1294.	241.6
27	1372.	34.1	1374.	31.8	1376.	30.4
28	1379.	455.2	1384.	450.4	1387.	446.8
29	1466.	-282.9	1510.	-326.6	1549.	-366.5
30	1416.	-986.5	1427.	-997.3	1430.	-1000.4
31	1231.	-231.0	1153.	-153.4	1073.	-73.1
32	1181.	408.9	1097.	492.6	1024.	566.0
33	1251.	-140.9	1218.	-108.5	1204.	-94.0
34	1220.	782.3	1181.	820.9	1162.	840.2
35	1363.	-673.8	1400.	-711.0	1454.	-764.9
36	1236.	1.4	1207.	29.6	1190.	47.0
37	1231.	832.7	1209.	855.4	1198.	865.6
38	1385.	887.1	1440.	832.3	1503.	768.9
39	1556.	1274.3	1678.	1151.7	1795.	1034.7
40	1807.	503.8	2019.	292.0	2202.	108.7
41	1923.	283.5	2139.	66.7	2301.	-95.1
42	2000.	562.1	2201.	361.0	2327.	235.1
43	2132.	-384.3	2344.	-596.5	2467.	-718.7
44	2089.	-123.1	2227.	-261.1	2267.	-301.0
45	2092.	-196.2	2192.	-296.1	2197.	-300.9
46	2080.	285.9	2142.	223.8	2118.	248.4
47	2158.	121.2	2231.	47.9	2227.	51.8

48	2206.	37.8	2274.	-30.2	2272.	-27.5
49	2240.	213.4	2296.	157.3	2288.	165.4
50	2306.	363.7	2368.	301.9	2371.	298.6
51	2403.	132.9	2483.	53.4	2506.	29.6
52	2459.	64.3	2532.	-9.3	2551.	-28.1

53	2502.	524.0	2565.	461.3	2574.	451.5
54	2633.	-80.9	2727.	-174.7	2768.	-216.4
55	2653.	-363.8	2719.	-430.0	2732.	-443.2
56	2618.	-339.9	2637.	-358.7	2607.	-329.1
57	2584.	-108.3	2566.	-90.3	2510.	-34.4
58	2592.	440.4	2564.	468.1	2511.	521.5
59	2702.	54.0	2715.	41.5	2709.	46.7
60	2742.	-566.3	2754.	-577.9	2750.	-574.1
61	2665.	-182.9	2621.	-139.4	2568.	-85.7
62	2655.	-565.4	2601.	-510.6	2545.	-455.4

CHOWTEST ITEM NUMBER 1 ITERATION NUMBER 3
USING CONSTANT VALUES OF: 0.15 0.20 AND 0.25

PERIOD	FORECAST LOW A	ERROR LOW A	FORECAST MED A	ERROR MED A	FORECAST HIGH A	ERROR HIGH A
7	1378.	181.8	1378.	181.8	1378.	181.8
8	1429.	-688.6	1444.	-703.6	1458.	-717.7
9	1240.	-115.5	1195.	-70.0	1150.	-25.1
10	1200.	233.9	1156.	277.8	1120.	314.1
11	1255.	100.0	1241.	113.6	1238.	116.6
12	1277.	-17.8	1275.	-16.2	1283.	-23.7
13	1268.	361.3	1265.	363.5	1270.	358.8
14	1364.	-37.5	1392.	-66.2	1424.	-98.3
15	1355.	66.3	1374.	47.3	1391.	29.8
16	1374.	257.0	1394.	236.9	1410.	220.9

SUMMARY OF ALPHAS AND SUMS OF ERRORS.
ONE LINE PER ITERATION
ITEM NUMBER: 1

ITERATION NUMBER	LOW ALPHA	SUM OF ERRORS	MEDIUM ALPHA	SUM OF ERRORS	HIGH ALPHA	SUM OF ERRORS	SELECTED ALPHA
1	0.05	8462.	0.10	3067.	0.15	1388.	0.15
2	0.10	3067.	0.15	1388.	0.20	863.	0.20
3	0.15	1388.	0.20	863.	0.25	696.	0.25
4	0.20	863.	0.25	696.	0.30	645.	0.30
5	0.25	696.	0.30	645.	0.35	636.	0.35
6	0.30	645.	0.35	636.	0.40	642.	0.35
7	0.30	645.	0.35	636.	0.40	642.	0.35
8	0.30	645.	0.35	636.	0.40	642.	0.35
9	0.30	645.	0.35	636.	0.40	642.	0.35
10	0.30	645.	0.35	636.	0.40	642.	0.35

THE BEST VALUE OF ALPHA, ITEM 1 IS THUS 0.35 ....

CHOWTEST ITEM NUMBER 2

THE 66 ITEMS ARE:

60 38 24 42 39 53 68 61 50 42

26	35	82	42	19	75	57	63	93	71
46	28	38	42	139	75	0	75	63	48
142	98	74	62	29	60	108	60	3	58
42	67	121	68	47	79	34	45	131	97
28	48	76	54	167	63	85	111	48	121
141	138	66	98	87	66				

CHOWTEST ITEM NUMBER 2 ITERATION NUMBER 1
USING CONSTANT VALUES OF: 0.05 0.10 AND 0.15

PERIOD	FORECAST LOW A	ERROR LOW A	FORECAST MED A	ERROR MED A	FORECAST HIGH A	ERROR HIGH A
7	43.	25.3	43.	25.3	43.	25.3
8	45.	15.9	47.	13.5	50.	11.3
9	47.	3.3	50.	-0.3	53.	-3.2
10	47.	-5.2	51.	-8.5	53.	-10.9
11	47.	-20.7	49.	-23.2	50.	-24.4
12	45.	-9.8	45.	-10.0	44.	-9.0
13	44.	38.1	43.	38.8	41.	40.6
14	48.	-5.6	51.	-8.5	52.	-10.5
15	47.	-28.2	49.	-30.2	50.	-31.0
16	45.	30.5	44.	31.4	42.	33.3
17	48.	9.5	50.	7.4	51.	6.3
18	49.	14.5	51.	11.8	53.	10.3
19	50.	42.9	54.	39.3	56.	37.0
20	54.	16.6	62.	9.5	67.	4.2
21	56.	-10.3	64.	-18.0	69.	-23.1
22	56.	-27.6	61.	-33.3	64.	-35.9
23	53.	-15.1	56.	-17.6	55.	-16.7
24	52.	-9.9	53.	-10.6	50.	-8.3
25	51.	87.9	51.	88.3	43.	91.1
26	60.	15.2	68.	7.4	73.	2.1
27	62.	-61.6	70.	-69.3	75.	-74.8
28	56.	19.0	57.	17.6	55.	19.7

29	58.	5.0	61.	2.0	61.	2.2
30	59.	-10.8	62.	-13.8	62.	-13.7
31	58.	84.0	60.	82.4	58.	83.7
32	66.	31.5	76.	22.4	82.	16.3
33	70.	4.0	81.	-6.8	88.	-13.7
34	71.	-8.9	81.	-18.7	86.	-23.6

35	71.	-41.6	78.	-49.2	81.	-51.5
36	67.	-7.0	70.	-9.8	67.	-7.3
37	67.	41.3	68.	39.6	65.	42.5
38	71.	-11.2	76.	-16.4	77.	-17.3
39	71.	-67.6	74.	-71.0	73.	-70.3
40	64.	-6.4	61.	-3.1	54.	3.8
41	64.	-22.1	61.	-18.6	55.	-12.6
42	62.	4.8	57.	10.0	50.	16.5
43	63.	58.1	59.	62.2	54.	66.7
44	69.	-0.8	71.	-2.5	72.	-4.3
45	69.	-22.1	70.	-23.5	72.	-24.6
46	67.	11.6	66.	12.6	65.	13.7
47	69.	-34.8	69.	-35.0	69.	-35.2
48	66.	-20.8	63.	-17.7	60.	-14.7
49	64.	67.0	59.	71.6	55.	75.6
50	71.	26.2	73.	24.1	76.	21.2
51	74.	-45.7	78.	-49.9	82.	-54.4
52	70.	-21.7	69.	-21.1	68.	-20.4
53	68.	8.1	65.	10.7	63.	13.1
54	69.	-15.0	67.	-13.4	66.	-12.3
55	68.	99.2	65.	102.0	63.	104.1
56	78.	-14.7	84.	-21.5	92.	-28.7
57	77.	8.2	81.	3.7	85.	-0.2
58	78.	33.0	83.	28.3	86.	24.8
59	82.	-33.7	89.	-40.8	94.	-46.1

60	79.	42.0	82.	39.0	83.	38.3
61	84.	57.5	90.	51.0	94.	47.1
62	90.	48.3	101.	37.4	108.	29.8
63	95.	-29.1	109.	-43.0	118.	-52.4
64	93.	5.0	102.	-4.4	106.	-8.3

SUMMARY OF ALPHAS AND SUMS OF ERRORS.
ONE LINE PER ITERATION
ITEM NUMBER: 2

ITERATION NUMBER	LOW ALPHA	SUM OF ERRORS	MEDIUM ALPHA	SUM OF ERRORS	HIGH ALPHA	SUM OF ERRORS	SELECTED ALPHA
1	0.05	310.	0.10	128.	0.15	67.	0.15
2	0.10	128.	0.15	67.	0.20	38.	0.20
3	0.15	67.	0.20	38.	0.25	24.	0.25
4	0.20	38.	0.25	24.	0.30	18.	0.30
5	0.25	24.	0.30	18.	0.35	16.	0.35
6	0.30	18.	0.35	16.	0.40	16.	0.35
7	0.30	18.	0.35	16.	0.40	16.	0.35
8	0.30	18.	0.35	16.	0.40	16.	0.35
9	0.30	18.	0.35	16.	0.40	16.	0.35
10	0.30	18.	0.35	16.	0.40	16.	0.35

THE BEST VALUE OF ALPHA, ITEM 2 IS THUS 0.35 ......

END OF CHOWTEST PROGRAMME.

ORE USAGE OBJECT CODE= 5860 BYTES, ARRAY AREA= 5700 BYTES, TOTAL AREA AVAILABLE= 143360 BYTES

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$JOB            ,PAGES=400,TIME=720
C
C
C
C
C                                      *********
C                                       BRUFICH
C                                      *********
C
C                             ** BRUNEL  UNIVERSITY **
C                        FORECASTING AND INVENTORY CONTROL
C                                ** FOR HOSPITALS **
C                                      *********
C
C                         W.R.CROWE  LAKEHEAD UNIVERSITY
C                          THUNDER BAY, ONTARIO, CANADA
C                      * * * * * * * * * * * * * * * * *
C
C
C
C                       * * * * * * * * * * * * * * * * *
C                       *           STAGE ONE           *
C                       * NAMES AND STORAGE ALLOCATION  *
C                       * * * * * * * * * * * * * * * * *
C
C                                      TABULATOR
C                                     ***********
C
C                            INVENTORY AND FORECASTING INPUT
C                            -------------------------------
C
C               THIS PROGRAMME ASSEMBLES A SAMPLE OF THE DATA
C               AND LAYS OUT THE FORMATS FOR THE MAIN FILES
C
C                 (A) E.O.Q.
C               EOQ FILE  :  ECONOMIC CRDER QUANTITY
C                   ITEM BASIC COSTS AND DISCOUNTS
C                 (B) A.F.M.
C               AFM FILE  :  ADAPTIVE FORECAST MASTER
C                   THREE CARDS WITH DEMAND, TREND,LT, AND SMOOTHING
C                 (C) R.O.P.
C               ROP FILE  :  REORDER POINT
C                   FULL EOQ AND ROP INFORMATION
C                 (D) DISCO
C               DISCO FILE:  DISCOUNTS, ALL INFORMATION
C                 (E) S.R.I.M.
C               SRIM FILE :  STOCK RECORD INVENTORY MASTER
C                                   ***************
C
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C                                DATABASE
C                               **********
C
C             THIS PROGRAMME RECORDS AND GRAPHS THE HOSPITAL DATA.
C           THE CATALOGUE IS PRINTED ELSEWHERE
C           THE CODE IN COLS 6 AND 7 IS
C           01 : H.S.C. TORONTO
C           02 : TORONTO GENERAL HOSPITAL
C           03 : WINNIPEG GENERAL HOSPITAL
C           04 : ST. JOSEPHS, THUNDER BAY
C           05 : NORTHWICK PARK
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C              06 : LAYCOCK ENGINEERING
C              07 : MISCELLANEOUS
C                             ***************
C
C                               DICTIONARY
C                               **********
C                             OPERATOR NAMES
C                             * * * * * * * *
C
C                ML   NO OF SETS OF DATA
C                N    NO OF DATA UNITS
C                KDATA(I) ACTUAL DATA
C                NM   NO OF ALPHAS
C                A(KI) ACTUAL ALPHAS
C                LM   NO.OF BETAS
C                B(JI) BETAS
C                LP   NO OF GAMMAS
C                G(LI) GAMMAS
C              M          NUMBER IN FIRST AVERAGE
C              JC     N-M             GN     N-1           LR    N/2
C              JY     N-11            JJ     M+1           LU    M+3
C              KP     K+1             KT     K+2           KV    K+3
C              JXJ     M+2            JVJ     M+3          GZXZ N-JJ
C              LS     LR+1
C              MG      TREND: ITEMS IN PRE-FORECAST
C              MNM     N-26           NSY    MMM-11
C              MON     SUBSCRIPTED N
C              NAN     N-1            NIN     N-2           NON    N-3
C              NUN      I-24          NXN      I-12         NWN    N-5
C              NG     I+12            NP     I+24           NQ    I+36
C              NT     I+60
C                             VARIABLE NAMES
C                             * * * * * * * *
C
C              ABC1,-2,-3  ABC CLASSIFICATION
C              ADEROR    RUNNING TOTAL OF ERRORS (TRIGG MODULUS)
C              ALOPRI    HOLDS TEMP. LOWEST DISC. PRICE.
C              ALPHA  NORMAL SMOOTHING CONSTANT
C              ALFY     FINAL ALPHA.. NORMAL FORECAST
C              AMEDIN   MEDIAN VALUE OF DEMAND DATA
C              AMID1    ARITHMETIC MEAN FOR LOWER DATA (TREND TEST)
C              AMID2    ARITHMETIC MEAN FOR HIGHER DATA (TREND TEST)
C              AVERD. -2,-3   AVERAGE TOTAL SIGNED ERRORS
C              AVERER    AVERAGE OF SIGNED ERRORS
C              AVSER     AV. CUM. SIGNED ERROR, SEASONAL.
C              AVTER     TREND, AVERAGE CUM. SIGNED ERROR
C              AVLT1,-2,-3   AVERAGE LEAD TIME
C              BALER    PROPORTIONAL DIFFERENCE FORECAST:
C                          ONE DIRECTION ERROR/SUM OF ERRORS
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C     BALERD, BALER2, -3   BALANCED ERRORS, DOUB SM.                    714
C     BALTRE   FORECAST PROPORTIONAL DIFFERENCE: TREND DATA             715
C     BALSER   SEASONAL ERROR: BALANCE BETWEEN + AND - ERRORS           717
C     BETA  A SMOOTHING CONSTANT                                        720
C     BIFFY   FINAL BETA.. NORMAL FORECAST                              725
C     BSIG   ABS. VALUE OF TRIGG T/S (TRIGG MODULUS)               00000730
C     CBMAV   AVERAGE OF PREV. 2 YEARS DATA.                       00000740
C     CBMEAN  AVERAGE BASE SERIES FLUCTUATION                      00000750
C     CSTORD  COST TO PLACE AN ORDER                               00000760
C     CUMER   OVERALL MAD AT END OF DATA SEQUENCE                  00000770
C     CURAT  CURRENT RATIO (SEASONAL)                              00000780
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C     CURTR  TREND DIFFERENCE FROM LAST PERIOD                          00000790
C     CYCBAS   BASE SERIES AVERAGE OF 2 EARLIER YEARS (SEAS.)           00000800
C     DAMICO   THE DAMICO FORECASTABILITY INDEX.                             806
C     DATES  INCLUSIVE DATES OF DATA                                    00000810
C     DISEOQ   FLOATING VERSION OF EOQ (DISCOUNT)                       00000820
C     DISPR1,-2  SELECTED BEST DISC. PRICE                              00000830
C     DISPRN  DISPERSION OF NRUNS                                       00000840
C     ECONI   BASIC EOQ, IN FLOATING POINT                              00000850
C     EQDUB   DOUBLE SM. ANNUAL DEMAND, FOR EOQ                              862
C     EQSB    ANNUAL DEMAND, NORMAL, FOR EOQ                                 863
C     EOQ1,-2,-3,-4   ECON ORDER QTY, WITH DISCOUNTS.                   00000860
C     ERROR  DIFFERENCE (FORECAST - ACTUAL)                             00000870
C     EXPEC1,-2,-3  FORECAST FOR PERIODS AHEAD (TREND)                       880
C     FEWRAT  NEW RATIO (SEASONAL)                                      00000890
C     FORK   SMOOTHED FORECAST (TRIGG MODULUS)                          00000900
C     FORKT:   TREND FORECAST: VALUE OF DEMAND FORECAST                 00000910
C       (JXPECD) USED WITH EOQ FORMULA.                                      920
C     GAMMA  SEASONAL SMOOTHING CONSTANT                                00000930
C     GIFFY   FINAL GAMMA.. SEASONAL FORECASTING                             935
C     HLDCST  COST TO HOLD IN STOCK                                     00000940
C     HOSP  CODED ITEM AND DESCRIPTION                                  00000950
C     ITEMNO,-1,-2,-3,-4,-5,-6   STOCK CATALOGUE NUMBER.                00000960
C     JBKORD  BALANCE BACK-ORDERED                                      00000970
C     JDMAND  EXPEC. DEMAND IN COMING 12 MONTHS                         00000980
C     JECONI,  -2,  -4   ECON ORDER QUANTITY                            00000990
C     JXPECD   TREND ADJUSTED FORECAST                                      1000
C     JFREST   FREE STOCKS (O/H + O/O - B/O )                           00001010
C     JNEWAV  SMOOTHED FORECAST: CURRENT                                00001020
C     JNWMD1, -2  SMOOTHED MAD, CURRENT                                 00001030
C     JOLDAV  SMOOTHED FORECAST : PREVIOUS                              00001040
C     JOLDMD  SMOOTHED MAD, PREVIOUS                                    00001050
C     JONORD  BALANCE ON ORDER                                          00001060
C     JPATT   TREND ROUGH TEST STRENGTH ESTIMATOR                       00001070
C     JQUAN1  MIN. QTY. TO GET LOWEST PRICE                             00001080
C     JQUAN2,-3,-4  QTY. ASSOC. WITH PRI'S                              00001090
C     JQUBAS  MAX. QUANTITY WITH PRIBAS                                 00001100
C     JSTOX   TOTAL OF STOCKS ON HAND                                   00001110
C     JTRDEM   FORECAST(BY TREND): THE LATEST VALUE                     00001120
C     JTREND   STRENGTH OF TREND MEASURE                                00001130
C     KDATA   AN INDIVIDUAL ITEM OF DATA.                               00001140
C     KDISQI  LOW QTY AT BEST DISC PRICE                                00001150
C     KDTOT   ACCUMULATED PAST DEMANDS (12 MONTHS)                      00001160
C     KFORX  12 MOS. FORECAST (JNEWAV*12) AFM                           00001170
C     KLAST   LATEST MONTHLY DEMAND REPORTED.                           00001180
C     KONF    ACTUAL LEVEL OF CONFIDENCE                                00001190
C     KONO    NUMBER OF CONFIDENCE LEVELS                               00001200
C     KONT:  CODE IF UNDER CONTRACT                                     00001210
C     KPATT   TREND RUNS TEST STRENGTH ESTIMATOR                        00001220
C     KROP  REORDER POINT                                               00001230
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C           KSUPNO  HOW MANY COMPETING SUPPLIERS                        00001240
C           KTOTAL  SUM OF PAST 12 OR LESS DEMANDS                          1246
C           KUNIT,L-,M-,  CODED UNIT OF RECEIPT                         00001250
C           KVENDR  VENDOR OFFERING DISCOUNT                            00001260
C           KYL       NUMBER OF DATA POINTS, LESS ONE, IN FORE.             1264
C           LACT  SEE MCODE                                             00001270
C           LDISC  1= DISCOUNT OFFERED; 0 = NONE                        00001280
C           LEOQ1, 2, 3, 4   TEMP. EOQ VALUES, DISCCUNT SEARCH.         00001290
C           LOPRI   "LOWEST" DISCOUNT PRICE (EOQ SEARCH)                00001300
C           LOCOST   "LCWEST" COST DURING EOQ SEARCH ROUTINE            00001310
C           LOWCST  LOWEST TOTAL COST (DISC)                            00001320
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C                LROP  SEE KROP                                              00001330
C                LSAFTY  SAFETY STOCK (ROP)                                  00001340
C                LTDEM1,-2  DEMAND IN LEAD TIME                              00001350
C                MADLT  SMOOTHED ERROR IN LEAD TIME                          00001360
C                MADSS  LAST VALUE OF MAD, PER ITEM (ROP).                   00001370
C                MCODE  LIST OF ACTION CODES (SEE ALSO MSAGE.LACT)           00001380
C                MDATE1, -2   TIME OF LATEST UPDATE                          00001390
C                MDISC:  SEE LDISC                                           00001400
C                MFORX   VALUE OF LAST FORECAST.                             00001410
C                MMAD   MEAN ABS. DEVIATION (TRIGG MODULUS)                  00001420
C                MNEWTR   VALUE OF LAST TREND, OF A SET OF DATA.             00001430
C                NALL   TOTAL OF TWO YEARS DATA(SEASONAL).                   00001440
C                NAMICO   FORECASTABILITY INDEX: SUM OF DEMANDS                  1444
C                MSAGE  SEE MCODE                                            00001450
C                NCOSTS   COUNTER FOR NUMBER OF PRICE BREAKS                 00001460
C                NDEM  SUM OF UP TO 36 DEMANDS (AFM)                         00001470
C                NDISC  UP TO 5 DISCOUNT STEPS                               00001480
C                NEWDEM  CURRENT DATA FOR SEAS.                              00001490
C                NOD  NO. OF DEMANDS, MAX. 12 (SRIM)                         00001510
C                NORD1, 2, 3, 4   TEMP. NO. OF ORDERS AT A DISCOUNT.         00001520
C                NOORDS  NO. OF ORDERS/YEAR AT DISC. LEVEL                   00001530
C                NRPSIG  A MASTER SRIM SIGNAL                                00001540
C                NSUMDM  SUM OF UP TO 12 PAST KDATA (AFM)                    00001550
C                NTEST   COUNTER FOR "RUNNING DOWN" TABULATION               00001560
C                NTS1,-2  DEMAND PATTERN                                     00001570
C                NUMDEM  SEE NSUMDM (SRIM)                                   00001580
C                OLDEM1  FIRST 12 MONTHS ACTUAL DATA                         00001590
C                OLDEM2  SECOND 12 MONTHS DATA                               00001600
C                OLDTR  PREVIOUS SMOOTHED TREND                              00001610
C                OLRAT  OLD RATIO (SEASONAL)                                 00001620
C                PNEWTR   CURRENT SMOOTHED TREND                             00001630
C                PRIBAS  BASIC PRICE (HIGH) WITH DISCOUNT (SEE UNITPA)       00001640
C                PRI1  LOWEST PRICE OFFERED                                  00001650
C                PRI2,-3,-4  SECOND, 3RD,4TH LOWEST PRICES                   00001660
C                PROD1,-2,-3,-4   PRODUCT OF HOLDCOST*UNIT PRICE.            00001670
C                PX        LABEL FOR PERIODS IN PRELIM. FORECAST                 1675
C                Q   A FLOATING POINT VALUE OF KDATA.                            1677
C                SA        SEASONAL SMOOTHING CONSTANT                           1679
C                SAFACT  SAFETY FACTOR                                       00001680
C                SEAFX   LATEST 12 MONTHS SEASONAL FORECASTS                     1685
C                SEASOR  ACTUAL SEAS.ADJ. RUNN. TOTAL ERROR                  00001690
C                SCURTR   SEASONAL: SEE CURTR                                    1700
C                SEFORX  SEASONALLY ADJ. FORECAST                            00001710
C                SEMAD   MAD VALUE, END OF SEAS.ROUTINE                      00001720
C                SEMRSE  SEASONAL ROOT MEAN SQUARE ERROR                         1725
C                SERROR  ACTUAL - (SEAS.ADJ. FORECAST)                       00001730
C                SFORC   LATEST SEASONAL FORECAST VALUE                      00001740
C                SIGMA   STANDARD DEVIATION (TREND)                          00001750
C                SINDX   SEASONAL INDEX, FULL RUN.                           00001760
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C       SINDEX    SEASONAL INDEX                                      00001770
C       SISERR   INDIVIDUAL SIGNED ERROR (DESEAS.)                        1775
C       SISSUM   CUMULATIVE SIGNED ERROR (DESEAS.)                        1776
C       SLEVEL   SERVICE LEVEL %                                      00001780
C       SMER    SMOOTHED ERROR (T/S SECTOR)                           00001800
C       SMEROR   SMOOTHED ACTUAL ERROR                                00001810
C       SMRSE    INDIVIDUAL SQUARE ERROR (SEASONAL)                       1815
C       SMTRER   SMOOTHED ACTUAL ERROR (TREND SECTOR)                 00001820
C       SNEWTR    SEASONAL: SEE NEWTR                                     1823
C       SNWMD    SEASONAL MONTHLY SMOOTHED MAD                            1825
C       SORT     SUBPROGRAM TO COMPUTE MEDIAN ARRAY                       1830
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C              SPEND    ANNUAL $ USAGE OF ITEM (ABC)                                  1840
C              SQSUMR   TREND ROOT MEAN SQUARE ERROR                                  1844
C              SQUMR    INDIVIDUAL SQUARE ERROR (TREND)                               1846
C              SROTER   RUN TOTAL SEASONA ADJ. ABS. ERRORS                            1850
C              STFORX    SEASONAL: SEE TFORX                                          1855
C              SUMER    SIGNED,SUMMED ERRCR,NOT TREND ADJ.                            1860
C              SUMIER,-2,-3 ERROR SUMS, FORECAST AHEAD (TREND)                        1862
C              SVFUNC   SERVICE FUNCTION                                              1870
C              SXPECD    SEASONAL: SEE JXPECD                                         1873
C              TCST1, 2, 3, 4    TOTAL COST AT GIVEN PRICE (DISCOUNT)                 1880
C              TORIG    TRIGG T.S.(TREND SECTOR)                                      1890
C              TDSIG    TRACK SIGNAL (TREND)                                          1900
C              TEROR    ACTUAL - (TREND ADJ.FORECAST)                                 1910
C              T1EROR, -2, -3 TREND ERRORS, FORECASTING AHEAD                         1912
C              TFORX    FORECAST TO BEGIN TREND PROCEDURE                             1920
C              THEIL    ACCURACY OF FORECAST COEFFICIENT                              1928
C              TOTCST    DISCOUNT: TOTAL INVENTORY COST OF ITEM.                      1930
C              TOTER    SUM OF ABS. ERRORS                                            1940
C              TOTLOW    NUMBERS BELOW MEDIAN IN TOTAL (TREND TEST)                   1950
C              TOTUPP    NUMBERS ABOVE MEDIAN IN TOTAL (TREND TEST)                   1960
C              TRIGG    TRIGG T.S.                                                    1970
C              TRIGGY    TRIGG TRACKING SIGNAL (TRIGG MODULUS)                        1980
C              TRFX     TOTAL OF LATEST 12 TREND FORECASTS                            1985
C              TRMAD    OVERALL MAD AT END OF DATA SECTION(TREND)                     1990
C              TROTER   RUN TOT. TREND ADJ. ABS. ERRORS                               2000
C              TRSIG   TRACKING SIGNAL FOR ERRORS                                     2010
C              TSIG    VALUE OF LAST TRACKING SIGNAL                                  2020
C                       IN A SET OF DATA (SIMPLE FORECASTING)                         2030
C              TSSIG    SEASONAL TRACKING SIGNAL                                      2032
C              TSUMER   RUN TOT. TREND ADJ.ERRORS                                     2040
C              UDIFF,-A,-B,-C,-D,-E    DIFFERENCE FOR VERTICAL                        2043
C                                      SCALING OF GRAPHS.                             2044
C              UNITPA,B  AGREED NON-DISC. PRICE                                       2050
C              XBAR     THE FIRST (ESTIMATED) FORECAST                                2060
C              XMAD     MAD VALUES,TREND SECTOR                                       2070
C              Y    A FLOATING POINT VALUE OF KDATA.                                  2072
C              YEST     TREND ESTIMATE                                                2073
C              ZACT    COMPONENT OF THEIL FORMULA                                     2075
C              ZDISP    COMPONENT OF THEIL FORMULA                                    2076
C              ZVAR    COMPONENT OF THEIL FORMULA                                     2078
C                   * * * * * * * * * * * * * * * * *                                 2080
C                                                                                     2085
C                       TRACERS AND COUNTERS                                          2090
C                       * * * * * * * * * *                                           2100
C                                                                                     2101
C              CBTOT    BASE SERIES VALUES ACCUMULATOR                            00002110
C              INDEX1, 2, 3   SEASONAL "BELOW" COUNTERS                           00002120
C              ISEAS    SEASONAL TOTAL OF ALL "UPS" OVER 2 OR 3 YEARS             00002130
C              JBDUP    3X COUNTER FOR TRIGG AT 95%                               00002140
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C     JTRAD   3X COUNTER FOR TRIGG(TREND)                           00002150
C     KONO    NUMBER OF CONFIDENCE LEVELS                           00002160
C     KOUNT  TRACER WHEN CONSTANT RAISED (AFM)                      00002170
C     LADD1, 2, 3   SEASONAL "ABOVE" COUNTERS                       00002180
C     LDOWN   SEASONAL "DOWN" TOTAL FOR 2 OR 3 YEARS                00002190
C     LOOP    TO RAISE ALPHA(TREND)                                 00002200
C     LSEAS   SEASONAL TOTAL OF ALL "DOWNS" OVER 2 OR 3 YEARS       00002210
C     LSETOT  COUNTER TO REDUCE CONSTANT (SEASONAL)                     2213
C     LTOT    TO REDUCE ALPHA                                       00002220
C     LTRTOT  TO REDUCE ALPHA(TREND)                                00002230
C     LUPP   SEASONAL TOTAL OF "ABOVES" FOR 2 OR 3 YEARS            00002240
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    C               MCONTA    TREND RUNS COUNTER: ABOVE                         00002250
    C               MCONTB    TREND RUNS COUNTER: BELOW                         00002260
    C               NRUNA   TREND RUNS TEST: RUNS COUNTER ABOVE                 00002270
    C               NRUNB   TREND RUNS TEST: RUNS COUNTER BELOW                 00002280
    C               NSLOOP  TRACER TO RAISE CONSTANT (SEASONAL)                     2283
    C               NTRIP  COUNTER FOR TRACKING SIGNAL TRIPS                        2290
    C               ZTOT   SEASONAL ACCUMULATOR,PAST 6 MONTHS                       2300
    C                                                                               2305
    C                                                                               2310
    C                           CODE FOR UNITS OF ISSUE                             2320
    C                           * * * * * * * * * * * *                             2321
    C                                                                                   
    C               01    EACH            02    DOZEN            03    TEN          2340
    C               04    HUNDRED         05    THOUSAND         06    GROSS        2350
    C               07    PAIR                                                      2352
    C               10    INCH            11    FOOT             12    YARD         2360
    C               13    BOLT            14    BALE                                2370
    C               15    MILLIMETRE      16    CENTIMETRE       17    METRE        2380
    C               21    CASE            22    DRUM             23    ROLL         2390
    C               24    CARTON          25    BOX              26    SHEET        2400
    C               27    BUNDLE          28    CYLINDER         29    PACKAGE      2410
    C               30    OUNCE           31    POUND            32    GRAMME       2420
    C               33    KILOGRAMME                                                2430
    C               40    BOTTLE          41    MILLILITRE                          2440
    C               43    QUART           44    PINT             45    GALLON       2450
    C               46    LITRE                                                     2460
    C               50    BARREL          51    CAN              52    PAIL         2462
    C               60    QUIRE                                                     2463
    C                                     65    PAD                                 2464
    C               71    TUBE            72    AMPOULE          73    VIAL         2466
    C               74    JAR                                                       2467
    C               80    KIT             81    BAG                                 2469
    C                                                                               2470
    C                         * * * * * * * * * * * * * * *                         2471
    C                         INPUT AND PRINTING PROCEDURES                         2472
    C                         * * * * * * * * * * * * * * *                         2473
    C                                                                               2474
    C                                                                               2475
    C                                                                               2505
1           DIMENSION A(10),ALPHA(100),AVLT1(100),AVLT2(100),AVLT3(100),        2510
          1 B(10),BETA(100),CSTORD(100),CURAT(100),CURTR(100),CYCBAS(100),      2520
          2 ALFY(100), BIFFY(100)                                               2521
2           DIMENSION COMP1(100),COMP2(100),COMP3(100),COMP4(100),COMP5(100),   2522
          1COMP6(100),COMP7(100),COMP8(100),COMP9(100),COMP10(100),COMP11(100   2523
          2),COMP12(100),COMP13(100),CCMP14(100),COMP15(100),COMP16(100),       2524
          3 COMP17(100),COMP18(100), COMP19(100),COMP20(100), COMP21(100)       2525
3           DIMENSION DATES(20),DISPR1(100),DISPR2(100),DDF(100),DOUBLE(100),   2530
          1 ECON1(100),EOQ1(100),EOQ2(100),EOQ3(100),EOQ4(100),ERROR(100),      2540
          2DDLT(100),  EXPEC1(100), EXPEC2(100), EXPEC3(100), EQSB(100),        2541
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     3 EQDUB(100)                                                               2542
4     DIMENSION    FEWRAT(100),FORK(100),FORX(100)                              2550
5      DIMENSION G(10),GAMMA(100),HOSP(100,9),HLDCST(100),GIFFY(100)            2560
6      DIMENSION  INDEX1(100),INDEX2(100),INDEX3(100),ITEMNO(100),              2570
     1  ITEMN1(100),ITEMN2(100),ITEMN3(100),ITEMN4(100),ITEMN5(100),            2580
     2  ITEMN6(100)                                                             2590
7      DIMENSION  JBKORD(100),JDMAND(100),JECON1(100),JECON2(100),              2600
     1JECON4(100),JFREST(100),   JCNORD(100),  JQUAN1(100),  JQUAN2(100),       2620
     2  JQUAN3(100),JQUAN4(100),  JQUBAS(100),JSTOX(100)                        2630
8      DIMENSION  JTRDEM(100),  KDATA(100),KDISQI(100),KLAST(100),          00002640
     1KONF(100),KDTOT(100),KFORX(100),KONT(100),KROP(100),KSUPNO(100),      00002650
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          2 KUNIT(100),KVENDR(100),KTOTAL(100)                                00002660
 9           DIMENSION LADD1(100),LADD2(100),LADD3(100),LACT(100),LDISC(100),00002670
          1LDOWN(100),LEOQ1(100),LEOQ2(100),LEOQ3(100),LEOQ4(100),            00002680
          2LOWCST(100),LROP(100),LTDEM1(100),LTDEM2(100),LUNIT(100),LUPP(100)00002690
                                                                              00002700
10          DIMENSION MADSS(100),MON(100)                                     00002710
11           DIMENSION MADLT(100),MCODE(100),MDATE1(100),MDATE2(100),         00002720
          1MDISC(100),MFORX(100),MMAD(100),MUNIT(100),MSAGE(100),MNEWTR(100)     02730
12           DIMENSION NDEM(100),NDISC(100),NEWDEM(100),NOD(100),
          1NOORDS(100),NORD1(100),NORD2(100),NORD3(100),NORD4(100),           00002740
          2NRPSIG(100),NSUMDM(100),NTRIP(100),NUMDEM(100)                     00002750
13           DIMENSION OLDTR(100),OLRAT(100),OLDEM1(100),OLDEM2(100),         00002760
          1PNEWTR(100),PRI1(100),PRI2(100),PRI3(100),PRI4(100),PRIBAS(100)    00002770
14         DIMENSION PROD1(100),PROD2(100),PROD3(100),PROD4(100),PX(100)          2780
15          DIMENSION Q(100)                                                      2782
16           DIMENSION ROP(100), SAFACT(100),SA(10),     SEFORX(100),             2790
          1SAFTY(100),SFORC(100),SMER(100),SCURTR(100),SMEROR(100),               2800
          2SMTRER(100),SLEVEL(100),SPEND(100),SVFUNC(100),SERROR(100)             2810
17          DIMENSION SINDEX(100), SINDX(100),SNWMD(100),SNEWTR(100),             2820
          1 STFORX(100), SXPECD(100)                                              2821
18           DIMENSION TDRIG(100),TDSIG(100),TRIGG(100),TFORX(100),               2830
          1 T1EROR(100), T2EROR(100),T3EROR(100),                                 2831
          2 TOTCST(100),TCST1(100),TCST2(100),TCST3(100),TCST4(100),              2832
          3TRIGGY(100),TRSIG(100),TSIG(100),TSSIG(100)                            2833
19           DIMENSION UNITPA(100),UNITPB(100)                                    2860
20           DIMENSION X(100),XV(100),XT(100),XX(100),XY(100),XMAD(100),          2870
          1Y(100),YG(100),YT(100),YV(100),YY(100),YZ(100), YEST(100)              2880
21           DIMENSION ZV(100),ZW(100)                                            2890
22         REAL JNEWAV(100),JNWMD1(100),JNWMD2(100),JOLDMD(100),JOLDAV(100)       2892
23         REAL JXPECD(100)                                                       2894
24         INTEGER ABC1(100),ABC2(100), ABC3(100), ABC4(100)                  00002900
25         INTEGER AAA/'A'/,BBB/'B'/,CCC/'C'/                                 00002910
26         INTEGER NTS1(100), NTS2(100)                                       00002920
27         INTEGER NNN/'N'/,TTT/'T'/,SSS/'S'/                                 00002930
                                                                              00002940
      C                                                                       00002950
      C                                                                       00002960
28         EQUIVALENCE(ITEMN1,ITEMN2,ITEMN4,                 ITEMNO),(JECON1,  00002970
          1JECON2,JECON4),(KUNIT,LUNIT,MUNIT),(MDATE1,MDATE2),(ABC1,              2980
          2ABC3),(NTS1,NTS2),(AVLT1,AVLT2,AVLT3),(UNITPA,UNITPB)                  2990
      C                                                                           2991
      C                                                                           2992
      C                     * * * * * * * * * *                                   3010
      C                     *   STAGE  TWO     *                                  3020
      C                     * * DATA  INPUT  * *                                  3040
      C                     * * * * * * * * * *                                   3050
      C                                                                           3060
      C              THIS SECTOR READS IN THE VALUES                              3065
      C              - - - - - - -- - - - - - - -                                 3066
      C                                                                           3067
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```
C           THE INPUT DATA SEQUENCE IS:
C
C      ML        NUMBER OF FULL DATA SETS
C      ITEMNO.   HOSP   ITEM NUMBER, AND PRODUCT NAME
C      DATES     INCLUSIVE DEMAND DATA DATES
C      N         NUMBER OF MONTHS, ONE DATA SET
C      KDATA     ACTUAL DEMANDS, ONE ITEM
C      NM        NUMBER OF ALPHAS
C      A         INDIVIDUAL ALPHA VALUES
C      LM        NUMEER OF BETAS
C      BM        INDIVIDUAL BETA VALUES
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C                  LP        NUMBER OF GAMMAS
C                  G         INDIVIDUAL GAMMA VALUES
C
C
          READ,ML
          PRINT 510
  510    FORMAT('1',50X,'BRUNEL  UNIVERSITY'/43X,'FORECASTING AND INVENTORY
        1 CONTROL'/53X,'FOR HOSPITALS:'/51X,'THE BRUFICH SYSTEM'/52X,
        2'* * * * * * * * *'/)
         PRINT 511
  511    FORMAT('0',47X,              'DATA INPUT AND TABULATION'/46X,
        1      '_ _ _ _ _ _ _ _ _ _ _ _ _ _ _'/)
          PRINT 512,ML
  512    FORMAT('0',48X,'FOR THE',1X,I3,1X,'DATA ITEMS'/49X,'_ _ _ _ _ _ _ _
        1_ _ _ _'/)
C               THIS MAIN DO LOOP ITERATES EACH SET OF DATA
C
          DO 560 KL=1,ML
          READ 554,ITEMNO(KL),(HOSP(KL,I),I=1,9)
  554    FORMAT(34X,I8,9A4)
          READ 556,DATES
  556    FORMAT(20A4)
          READ,N
          MON(KL) = N
          READ 600,(KDATA(I),I=1,N)
  600    FORMAT(12I6)
         IF(N.LT.12) MFORX(KL)=  (KDATA(N)+KDATA(N-1) )
          KLAST(KL)=KDATA(N)
          DO 1 K=1,N
    1     Y(K) = FLOAT(KDATA(K))
         READ,NM
         READ,(A(KI),KI=1,NM)
         READ,LM
         READ,(B(JI),JI=1,LM)
         READ,LP
         READ,(G(LI),LI=1,LP)
          PRINT 520,ITEMNO(KL),(HOSP(KL,I),I=1,9)
  520    FORMAT('1',(34X,I8,9A4)/)
         PRINT 521,DATES
  521     FORMAT('0',(20A4)/35X,'***************************'/)
         PRINT 561,(A(KI),KI=1,NM)
C               THESE LOOPS ALLOW ITERATION OF SMOOTHING CONSTANTS
  561    FORMAT('0',20X,'ALPHA = ',2X(6F8.2/))
          PRINT 562,(B(JI),JI=1,LM)
  562    FORMAT('0',20X,'BETA  = ',2X(6F8.2/))
           PRINT 563,(G(LI),LI=1,LP)
  563    FORMAT('0',20X,'GAMMA = ',2X(6F8.2/))
          PRINT 564
  564    FORMAT('0',20X,'_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _'/)
```

```
67           PRINT 565,N,(KDATA(I),I=1,N)
68     565 FORMAT('0',20X,'THE',2X,I2,2X,'ITEMS ARE: '//(20X,10I6))
69            PRINT 566
70     566  FORMAT('0',21X,'*   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
          1 *   *   *   '/)
     C
     C                THE E.O.Q. FILE
     C
71           READ 700,ITEMN1(KL),CSTORD(KL),HLDCST(KL),JDMAND(KL),LDISC(KL),
          1KUNIT(KL),UNITPA(KL),JECON1(KL),NOORDS(KL), LOWCST(KL),DISPR1(KL),
          2 KDISQI(KL),MCODE(KL)
```

```
72     700  FORMAT(I8,F5.2,F4.2,I6,I1,I2,F6.2,I6,I2,I6,F6.2,I5,I2,21X)           3610
      C                THE A.F.M. FILE                                            3620
      C                - - - - - - - - -                                          3630
      C                                                                           3640
73          READ 702, ITEMN2(KL),MDATE1(KL),NDEM(KL),NSUMDM(KL),ABC1(KL),         3650
           1NTS1(KL),AVLT1(KL),ALPHA(KL),BETA(KL),GAMMA(KL),KOUNT,                3660
           2JOLDAV(KL),JNEWAV(KL),JOLDMD(KL),JNWMD1(KL),TRSIG(KL),NTRIP(KL)       3670
74     702  FORMAT(I8,I6,I2,I6,A1,A1,F4.1,F3.1,F3.1,F3.1,I2,4F7.1,F6.1,I2,5X)     3690
      C                                                                       00003710
      C               A.F.M. INPUT SPLIT TO AVOID TOO MANY CARDS              00003720
      C                                                                       00003730
75          READ 703, CURTR(KL),OLDTR(KL),PNEWTR(KL),JXPECD(KL),ERROR(KL),        3740
           1 KFORX(KL),CURAT(KL),OLRAT(KL),FEWRAT(KL),          LTDEM1(KL),       3741
           2 MSAGE(KL)                                                            3742
76     703  FORMAT(F7.1,F6.1,F6.1,I6,F7.1,I6, 42X/5X,3F6.3,6X,I6,I2,43X)          3760
      C                                                                       00003770
      C               THE R.O.P. FILE                                         00003780
      C               - - - - - - - - - -                                     00003790
      C                                                                       00003800
77          READ 704,ITEMN3(KL),ABC2(KL),AVLT2(KL),JECON2(KL),SLEVEL(KL),     00003810
           1JNWMD2(KL),MADLT(KL),LTDEM2(KL), SAFTY(KL),KROP(KL)               00003820
78     704  FORMAT(I8,A1,F4.1,I6,F4.2,F7.1,I5,I6,F5.0,I6,28X)                     3830
      C               THE DISCO FILE                                          00003840
      C               - - - - - - -                                           00003850
      C                                                                       00003860
79          READ 706,ITEMN4(KL),KVENDR(KL),MDATE2(KL),LUNIT(KL),PRIBAS(KL),   00003870
           1JQUBAS(KL),PRI1(KL),JQUAN1(KL),PRI2(KL),JQUAN2(KL),PRI3(KL),      00003880
           2JQUAN3(KL),PRI4(KL),JQUAN4(KL),NDISC(KL),KSUPNO(KL),LACT(KL)      00003890
80     706  FORMAT(I8,I3,I6,I2,2(F6.2,I5),3(F6.2,I5),I1,I1,I2,2X)             00003900
      C                                                                       00003910
      C               THE S.R.I.M. FILE                                       00003920
      C               - - - - - - - - - - -                                   00003930
      C                                                                       00003940
81          READ 708,ITEMN5(KL),ABC3(KL),NTS2(KL),MUNIT(KL),UNITPB(KL),MDISC( 00003950
           1KL),KONT(KL),JSTOX(KL),JONORD(KL),JBKORD(KL),NOD(KL),NUMDEM(KL),  00003960
           2LROP(KL),NRPSIG(KL),JECON4(KL),AVLT3(KL),DISPR2(KL)               00003970
82     708  FORMAT(I8,A1,A1,I2,F6.2,I1,I1,I5,I5,I5,I2,I6,I6,I1,I6,F4.1,F6.2,  00003980
           1 14X)                                                             00003990
83          NTS1(KL)=NNN                                                      00004000
84          NTS2(KL)=NNN                                                      00004010
      C               THIS ESTABLISHES THE DEMAND PATTERN                     00004020
      C               AS "NORMAL" UNTIL OTHER EVIDENCE IS AVAILABLE           00004030
85          DO 530 I=1,N                                                      00004040
86     530  X(I) =I                                                           00004050
87          IF(N.LT.12) PRINT 532,N                                           00004060
88     532  FORMAT('0',20X,'SINCE THERE ARE ONLY',2X,I2,2X,'DATA ITEMS AT PRE 00004070
           1SENT,FORECASTING IS DELAYED.'/)                                   00004080
89          IF(N.LT.12) GO TO 586                                             00004090
90          PRINT 531                                                             4100
```

```
      531 FORMAT('0',53X,'PLOT OF DEMAND DATA'/54X,'_ _ _ _ _ _ _ _ _ _ _ _'/)    4110
            JIM = ITEMNO(KL)                                                     4118
          CALL PLOT (X,Y,N, .5, .9, 100., 60., '*',JIM)                          4120
C                                                  * * GRAPH ONE * *             4130
C                                                                        00004140
C               THE FIRST PLOT, ORIGINAL DATA, IS MADE NOW               00004150
C                    NOTE *** ALL EXCEPT THE FIRST AND SEASONAL          00004160
C               GRAPHS ARE OF (N-M) DATA POINTS.                         00004170
          TIP = 0.                                                           4171
          TOP = 0.                                                           4172
          TOP = Y(1)                                                         4173
```

```
C           TO FIND THE LARGEST VALUE                              4174
          DO 533 IT=2,N                                            4175
          IF(Y(IT)-TOP) 533,533,534                                4176
   534    TOP = Y(IT)                                              4177
   533    CONTINUE                                                 4178
          ABIG = TOP                                               4180
C           TO FIND THE SMALLEST VALUE                             4181
          TIP = Y(1)                                               4182
          DO 535 IQ=2,N                                            4183
          IF(TIP-Y(IQ)) 535,535,536                                4184
   536    TIP = Y(IQ)                                              4185
   535    CONTINUE                                                 4186
          ASMALL = TIP                                             4190
          UDIFF = ABIG-ASMALL                                      4191
          UDIFFA  = UDIFF                                          4192
          IF(UDIFFA.LE.0.)  UDIFFA = 1.0                           4193
                          * * * * * * * * *                        4194
C                                                              00004197
C                                                              00004220
C                    WARNING * * *                             00004230
C         THE TWO MAJOR DO LOOPS IN FORECASTING ARE:           00004240
C           560   CONTROLLING THE NUMBER OF DATA SETS;         00004250
C            6   WHICH CONTROLS ALPHA ITERATIONS.              00004260
C                                                              00004270
C         THIS SECTION IS WITHIN THE DO LOOP 560               00004280
C         MOVE THE 560 CARD WHEN REPLACING SECTIONS.           00004290
C                                                              00004300
C                                                                  4305
C                                                                  4306
C                * * * * * * * * * * * * *                         4310
C                *     STAGE   THREE       *                       4320
C               * DEMAND FORECAST ROUTINES *                       4340
C                * * * * * * * * * * * * *                         4360
C                                                              00004362
C                                                              00004370
C         EXPONENTIALLY SMOOTHED FORECAST WITH                 00004380
C             SINGLE AND DOUBLE SMOOTHING,                     00004390
C         ABSOLUTE AND ACTUAL ERROR MEASUREMENTS,              00004400
C             PLUS THE SUM OF THE ERRORS.                      00004410
C         INCLUDES TREND AND SEASONAL ADJUSTMENTS              00004420
C                                                              00004430
C         ROUTINES INCLUDED TO IDENTIFY THREE DEMAND PATTERNS: 00004440
C           NORMAL      TREND      SEASONAL                    00004450
C                                                              00004460
C         OTHER PATTERNS (RAMP,STEP) CAN BE TRACED THROUGH     00004470
C         ERROR SIGNALS : 2 ARE INCORPORATED. ONE IS SIMPLE    00004480
C                 AND THE OTHER TRIGG.                         00004490
C                                                              00004500
C         TESTING WAS AT FIRST DONE USING A SIMPLE                 4510
C
```

564

```
C      AVERAGE OF THE FIRST  M  PERIODS AS THE                         4511
C      VALUE FOR THE FIRST FORECAST. THIS METHOD                       4513
C      IS RECOMMENDED BY HOLT. BUT K.O.COGGER IS CRITICAL:             4514
C      ("EXTENSIONS OF THE FUNDAMENTAL THEOREM OF                      4515
C      EXPONENTIAL SMOOTHING", MGT. SCI. 19.5. JAN. 1973.552)          4516
C      IT IS "AT BEST. A MISUSE OF THE USUALLY SMALL                   4517
C      NUMBER OF OBSERVATIONS AVAILABLE IN PRACTICE".                  4518
C                                                                      4520
C      THE FIRST VALUE IS NOW CONSTRUCTED WITH * BRUSTART *            4521
C                                                                      4540
C                * * * * * * * * *                                     4550
```

```
C                         * DEMAND PATTERN  *
C                         *     NORMAL      *
C                            * * * * *  * *
      PRINT 10
   10  FCRMAT('0',44X,       'EXPONENTIAL MONTHLY FORECAST'/43X,'WITH TR
     1END AND SEASONAL SECTORS.'/43X,'* * * * * * * * * * * * * * *'/)
C              THE PRE-SMOOTHING CALCULATIONS:
C
C                                  BRUSTART
C                                  --------
C                             LEAST SQUARES LINE TO
C                           PROVIDE A FIRST FORECAST
C
C              RGBROWN:MANAGEMENT DECISIONS FOR PRODUCTION OPERATIONS
C                             DRYDEN PRESS(1971),64-65
C
       PRINT 65
   65  FORMAT('1' ,                    38X,'BROWN METHOD OF OBTAINING STARTING
     1 VALUES.'/55X,'*********'/)
      IF (N.GE.72) MG=24
      IF (N.GE.72) GO TO 900
      IF (N.GE.60) MG=18
      IF (N.GE.60) GO TO 900
      IF (N.GE.48) MG=12
      IF (N.GE.48) GO TO 900
      IF (N.LT.48) MG=6
  900    CONTINUE
      GNX = ( (N-MG)-1)
C              THESE GIVE SIZE OF PRELIM. FORECAST
C
       AA = 0.
       BB = 0.
       M = MG
       TDSIG(M)=0.
       TRSIG(M)=0.
C              WARNING ..      SINCE Y IS SORTED BY THE GRAPH
C              SCALING ROUTINE, Q IS USED TO REPLACE IT.
C              TO REPRESENT THE DEMAND DATA.
       DO 46 I=1,N
   46  Q(I) = FLOAT(KDATA(I))
       TPRCD =0.
       SUM =0.
      DO 22 I=1,MG
      TPROD =TPROD +(Q(I)*I)
      SUM = SUM + Q(I)
   22 CONTINUE
C
       XM = M
       XBAR = SUM/XM
```

```
      ERROR(1)=0.                                                       00004720
      TOTER =0.                                                         00004730
      TSUMER = 0.                                                       00004740
      TROTER = 0.                                                       00004750
C                NUMBER THE PRELIM.MONTHS IN ORDER                          4755
      DO 8 I=1,MG                                                           4756
    8 PX(I)=I                                                               4757
      XM = M                                                                4762
C                CALCULATE INTERCEPT AA, AND SLOPE BB                       4764
C                                                                           4765
      PG = NG                                                               4766
```

```
      AA=((2*((2 *PG)+1)/(PG*(PG-1)))* SUM)-(6/(PG*(PG-1))* TPROD)
      BB=((12/(PG*(PG**2)-1))*TPROD)- ((6/( PG*(PG-1))) * SUM)
      MG =PG
C
C               EVALUATE LINEAR EXPRESSION FOR EACH VALUE OF Q
C
      DO 23  I=1,MG
       YEST(I)  = AA+(BB*I)
C
C               FIND THE ERRORS AND THE (ABSOLUTE) TOTAL
C
       ERROR(I)= Q(I) - YEST(I)
      TOTER  = TOTER  + ABS(ERROR(I))
   23   CONTINUE
C
C               FIND MEAN ABSOLUTE DEVIATION
C
      CG = MG *(MG-2)
      IF (CG.GT. 0.) GO TO  44
      IF (CG.LE. 0.) PRINT 45, KL
   45 FORMAT('0',30X,'DEMAND ANALYSIS,ITEM:',I3/30X,'* * * * * * * * * *
     1 * * *'/25X,'THERE ARE TOO FEW ITEMS TO COMPUTE A FORECAST.'/)
       GO TO 586
   44 JNWMD1(1)= TOTER /SQRT(CG)
        XMAD(1) = TOTER/SQRT(CG)
       SMTRER(1) = XMAD(1) /2.
C               SMEROR(1) HAS VALUE OF HALF THE FIRST M.A.D.
       SMEROR(1) = JNWMD1(1) / 2.
C
C               THE ABOVE ARE STARTING VALUES.....
C
C                                   SINGLE SMOOTHING
C                                   ----------------
C
C                             BROWN SINGLE EXPONENTIAL SMOOTHING
C
C                            R.G.BROWN, STATISTICAL FORECASTING FOR
C                            INVENTORY CONTROL,MCGRAW-HILL,1959.
C                                   ----------------
C               REGULAR FORECASTING IS NOW BEGUN.
C               ITERATING WITH ALPHA AND BETA SMOOTHING CONSTANTS.
C               THE SIZE OF ALPHA IS RELATED TO THE LENGTH OF
C               THE RUN OF PAST DATA, AND CAN BE APPROXIMATED BY:
C                            N = ( 2-ALPHA)/(ALPHA)
C               SOME COMMONLY USED VALUES ARE:
C                  ALPHA      PERIODS      ALPHA      PERIODS
C                  -----      -------      -----      -------
C                  0.01         199         0.4         4.0
C                  0.05          39         0.5         3.0
```

```
      C                             0.10          19        0.6         2.34                      4868
      C                             0.20           9        0.7         1.86                      4869
      C                             0.30           5.8      0.8         1.5                       4870
      C
164           ERROR(1) = 0.                                                                       4880
165           CUMER =0.                                                                           4890
166           TOTER =0.                                                                           4900
167           AVERER = 0.                                                                         4902
168           SUMER =0.                                                                           4910
169           SROTER=0.                                                                           4920
170           BALSER = 0.                                                                         4925
```

```
      BALER = 0.                                                          4926
      BALTRE = 0.                                                         4927
      SEASOR=0.                                                           4930
C              TO FORECAST,THE (N+1)TH. PERIOD VALUES ARE:                4940
C                FORECAST= YEST(MG) ;TREND =BB ; MAD =JNWMD1.             4941
C                                                                         4942
      IF (KL.NE.1) GO TO 29                                               4943
      IF (KL.EQ.1) PRINT 41                                               4944
   41 FORMAT('0',45X,'INITIAL SIMULATION: BRUSTART.'/45X,'* * * * * * *   4946
     1* * * * * * * * *'/)                                                4947
   29  CONTINUE                                                           4948
     PRINT 55                                                             4960
   55 FORMAT ('0',31X,'PERIOD          DEMAND          FORECAST           4961
     1 ERROR'/32X,'******          ******          ********          ***  4962
     2**')                                                                4963
     DO 57 I=1,MG                                                         4970
      ERROR(I)= Q(I) - YEST(I)                                            4971
      PRINT 58, I,Q(I)     ,YEST(I),ERROR(I)                              4975
   58 FORMAT('0',32X,I2,13X,F5.0, 11X, F7.2, 8X, F8.2 )                   4976
   57 CONTINUE                                                            4977
      PRINT 61                                                            4980
   61 FORMAT('0',32X,'THE VALUES OF THE FINAL FORECAST OF BRUSTART :')    4981
      PRINT 63,YEST(MG),BB,JNWMD1(1)                                      4990
   63 FORMAT('0',32X,'FORECAST =',1X,F7.1,1X,'TREND VALUE =',1X,F7.2,1X,  4991
     1 'AND M.A.D.=',1X,F6.1)                                             4992
  586  CONTINUE                                                           5040
C                                                                     00005050
C              ITEMN6 IS USED TO AVOID PERMANENT MISPLACEMENT         00005060
C                             OF ITEM NUMBERS.                        00005070
       ITEMN6(KL)=ITEMN5(KL)                                          00005080
       KDTOT(KL)=0                                                    00005090
      JC =(N-M)                                                           5095
      NAN = N-1                                                       00005100
      NIN = N-2                                                       00005110
      NON = N-3                                                       00005120
      IF (N.LT.18) GIFFY(KL) = G(1)                                       5125
     IF(N.LT.12)KTOTAL(KL)=6*(KDATA(N)+KDATA(NAN) )                      05130
     IF(N.GE.12) GO TO 756                                            00005140
     IF(N.LT.12) CONTINUE                                             00005150
      IF ( N.LT.12) ALFY(KL) = A(1)                                       5155
      IF ( N.LT.12) BIFFY(KL) = B(1)                                      5156
      JNWMD1(KL) = 1.                                                     5160
      MADSS(KL) = 1                                                   00005170
     IF(N.LE.6) GO TO 560                                             00005180
      IF (N.LT.12) EQSB(KL)= KTOTAL(KL)                                   5185
      KTOTAL(KL)= 3*(KDATA(N)+KDATA(NAN)+KDATA(NIN)+KDATA(NON))       00005190
      IF(N.LT.12) GO TO 560                                           00005200
  756  CONTINUE                                                       00005210
C              NOW CONCENTRATE ON ITEMS HAVING TWELVE                 00005220
```

```
      C                  OR MORE MONTHS DATA AVAILABLE:                            00005230
209            JY= (N-11)                                                          00005240
      C                  TO FIND ANNUAL USAGE, AND PAST 12 MONTH $ VALUE           00005250
210            DO 581 IX =JY,N                                                     00005260
211      581  KDTOT(KL)=KDTOT(KL)+KDATA(IX)                                        00005270
212             KTOTAL(KL)=KDTOT(KL)                                               00005280
      C                  THIS IS SUM OF PREVIOUS 12 MONTHS DEMANDS.                00005290
      C                  THIS PROCEDURE ITERATES ALL VALUES OF ALPHA.              00005300
      C                  AND BETA. IF GAMMA REQUIRED, PLACE LOOP HERE.                 5310
      C                  IF BETA IS BEING ITERATED THERE IS A LOOP:                    5311
      C                  DO7, AND AN ALLOCATION TO B(1), CARD 5977                     5312
```

```
C                                                                          00005320
         DO 7 JI=1, LM                                                         5323
         DO 6 KI=1,NM                                                      00005330
         BET = B(JI)                                                           5338
         ALP = A(KI)                                                       00005340
         SA(KI) = A(KI)                                                        5345
        JJ =M+1                                                                5350
        PRINT 243                                                          00005420
  243   FORMAT('1',48X,'THE FIRST PROCEDURE :'/45X,'TABLE 1: NON-TREND FOR     5430
       1ECASTING'/49X,'USING SINGLE SMOOTHING'/45X,'* * * * * * * * * *        5440
       2* * * * '/)                                                            5441
         PRINT 27, ALP , BET                                                   5444
   27   FORMAT('0',29X,'PARAMETER VALUES ARE: ',2X,'ALPHA =: ',F5.2,2X,        5445
       1 'BETA =: ',F5.2/)                                                     5446
          PRINT 24                                                         00005450
   24   FORMAT('0',26X,'* TR.SIG. UNSMOOTHED,ADAPTIVE. IF ABOVE (4*MAD) A      5460
       1MESSAGE IS PRINTED.'/40X,'IF CHANGE PERSISTS, ALPHA RAISED.'/36X,      5461
       2     'IF ABOVE (6*MAD), ALPHA IS RAISED AT ONCE.'/)                    5462
         PRINT 25                                                              5480
   25   FORMAT('0',24X,'* TRIGG * BASED ON BATTY DECISION RULES: MESSAGE P     5490
       1RINTED, NO ACTION TAKEN.'/45X,'* * * * * * * * * * * * * * *'/)        5500
        PRINT 9                                                                5510
    9   FORMAT('0',15X,'ACTUAL DATA   FORECAST         ERROR       TR.SIGNAL   5520
       1     MAD            SM.ERROR   TRIGG T.S '/12X,'_ _ _ _ _ _     _ _ _  5530
       2 _        _ _ _       _ _ _ _ _    _ _            _ _ _ _ _    _ _ _   5540
       3_ _    '/)                                                             5550
         JNEWAV(M)= YEST(M)                                                    5560
         AMSQE = 0.                                                            5562
         SUMER = 0.                                                            5563
         TOTER = 0.                                                            5564
         THEIL = 0.                                                            5565
          SUMERQ = 0.                                                          5566
         SUMACT = 0.                                                           5567
         SUMFSQ = 0.                                                           5568
         KCUNT = 0                                                         00005570
         LTOT  =0                                                          00005580
         JBDUP =0                                                          00005590
         LU =M+3                                                           00005600
         DO 2 K=JJ,N                                                       00005610
         TRSIG(M)= 0.                                                      00005620
         IF (LTOT .GT.0)LTOT=LTOT+1                                        00005630
         JNEWAV(K)=((ALP)*KDATA(K-1)) + ((1.-ALP)*JNEWAV(K-1))                 5640
C               CURRENT FORECAST IS THE SIMPLE SMOOTHED RESULT OF              5645
C               COMBINING LAST PERIOD FORECAST AND ACTUAL DEMAND.              5646
C               ERRORS ARE CALCULATED,ACTUAL AND ABSOLUTE,SMOOTHED         00005650
C               WITH BETA (HERE A FIXED VALUE BUT CAN BE ITERATED)         00005660
C               USES A 4*MAD CONTROL OVER T/S,ALLOWED TO EXCEED THE        00005670
C               LIMIT 3 TIMES BEFORE ALPHA IS RAISED.                      00005680
         ERROR(K) = (KDATA(K)-JNEWAV(K))                                   00005690
```

```
      ERSQ = (ERROR(K)**2)                                              5692
      FORSQ = (JNEWAV(K)**2)                                            5694
      ACTSQ = (KDATA(K)**2)                                             5696
      SUMER = SUMER + ERROR(K)                                      00005700
      SUMERQ = SUMERQ+ERSQ                                              5702
      SUMACT = SUMACT+ACTSQ                                             5704
      SUMFSQ = SUMFSQ+FORSQ                                             5706
      JNWMD1(M) = JNWMD1(1)                                         00005710
      B(1) = B(JI)                                                      5718
      JNWMD1(K)=B(1)*ABS(ERROR(K))+((1.-B(1))*(JNWMD1(K-1)))        00005720
C             TRSIG IS UNSMOOTHED.VALUE DEPENDS ON ERROR AND SIGN.      00005730
```

```
C                    TRIGG VALUE LIES BETWEEN -1 AND +1. USED WITH TABLE      00005740
C                    OF LEVELS OF CONFIDENCE (HERE USE 95% ONLY). USE         00005750
C                    BATTY'S MODIFICATION OF TRIGG.                           00005760
C                                                                             00005770
C                    SEE: D.W.TRIGG(1964).'MONITORING A FORECASTING           00005780
C                    SYSTEM'.O.R.Q. 15.271; AND M.BATTY(1969)                 00005790
C                    'MONITORING AN EXPONENTIAL SMOOTHING FORECASTING         00005800
C                    SYSTEM'.O.R.Q. 20.319.  BATTY USES A BETA  OF            00005810
C                    0.1 THROUGH 0.5  . HIS VALUES DIFFER FRCM TRIGG          00005820
C                                                                             00005830
C                    TRIGG MUST BE OVER LIMIT 3 CONSECUTIVE PERIODS BEFORE    00005840
C                    MESSAGE IS PRINTED: NO OTHER ACTION TAKEN HERE.          00005850
C                    IN PRACTICE. THE STOCK CONTROLLER WILL EXAMINE               5851
C                    THE OUTPUT. AND DECIDE WHETHER ACTION IS REQUIRED.           5852
C                    THIS MAY INCLUDE RAISING THE SMOOTHING CONSTANT.             5853
C                    TRIGG AND LEACH MODULUS METHOD IS INCORPORATED               5854
C                    INTO THE BRUSIM ROUTINE: SEE 53000                           5855
             SMEROR(M)= SMEROR(1)                                             00005860
             B(1) = B(JI)                                                         5868
             SMEROR(K)=B(1)*ERROR(K)+((1.-B(1))*SMEROR(K-1))                  00005870
             IF( JNWMD1(K) .EQ.0.) JNWMD1(K) =1.                                  5880
C                    THIS IS TO AVOID DIVISION BY ZERO                        00005890
C                    CHECK WHETHER THERE IS A ROUTINE                         00005900
C                    TO AVOID THIS PROCEDURE                                  00005910
C                    (A)    TRIGG/BATTY TRACKING METHOD                       00005920
C                                                                             00005930
             TRIGG(K) =SMEROR(K)/JNWMD1(K)  - - - - - - -                     00005940
             IF (ABS(TRIGG(K)).LE.0.41) GO TO 116                             00005950
C                    LET FORECAST SETTLE FOR THREE PERIODS                    00005960
             IF(K.LE.LU)GO TO 116                                             00005970
             B(1) = B(JI)                                                         5977
             IF(B(1).LE.0.10)GO TO 71                                         00005980
             IF(B(1).GT.0.10) GO TO 81                                        00005990
      71     IF(ABS(TRIGG(K)).LT.0.42) GO TO 116                              00006000
             IF(ABS(TRIGG(K)).GE.0.42) GO TO 110                              00006010
      81     IF(B(1).EQ.0.20) GO TO 72                                        00006020
             IF(B(1).GT.0.20) GO TO 82                                        00006030
      72     IF(ABS(TRIGG(K)).LT.0.58) GO TO 116                              00006040
             IF(ABS(TRIGG(K)).GE.0.58) GO TO 110                              00006050
      82     IF(B(1).EQ.0.30) GO TO 73                                        00006060
             IF(B(1).GT.0.30) GO TO 83                                        00006070
      73     IF(ABS(TRIGG(K)).LT.0.71)GO TO 116                               00006080
             IF(ABS(TRIGG(K)).GE.0.71)GO TO 110                               00006090
      83     IF(B(1).EQ.0.40)GO TO 74                                         00006100
             IF(B(1).GT.0.40) GO TO 84                                        00006110
      74     IF(ABS(TRIGG(K)).LT.0.80) GO TO 116                              00006120
             IF(ABS(TRIGG(K)).GE.0.80) GO TO 110                              00006130
      84     IF(B(1).EQ.0.50) GO TO 75                                        00006140
      75     IF(ABS(TRIGG(K)).LT.0.88) GO TO 116                              00006150
```

```
          IF(ABS(TRIGG(K)).GE.0.88) GO TO 110
  110       JBDUP = JBDUP + 1
C                  JBDUP COUNTS THE TRIPS OF TRIGG SIGNAL
          IF(JBDUP.GE.4) GO TC 111
  115     IF(JBDUP.LT.4) GO TO  90
  111       PRINT 112
  112   FORMAT ('0',45X,'TRIGG SIGNAL INDICATES WITH 95% CONFIDENCE THAT'/
       145X,'CONTROL IS LOST THROUGH A CHANGE IN DEMAND PATTERN'/)
            JBDUP = 0
            GO TO 90
C                 (B)   SIMPLE TRACKING METHOD (TRSIG)
```

```
C
  116  JBDUP = 0- - - - - - - - - - - - - - - - - -                          00006270
   90  TRSIG(K) = TRSIG(K-1)+ERROR(K)                                        00006280
      IF(((ABS(TRSIG(K)))/JNWMD1(K)).GE.4.) GO TO 50                        00006290
      IF(((ABS(TRSIG(K)))/JNWMD1(K)).LT.4.) KOUNT = 0                       00006300
       GC TO 60                                                             00006310
   50 KOUNT = KOUNT+1                                                       00006320
C              THIS IS COUNTER TO RAISE ALPHA                               00006330
      IF(KOUNT   .LT.3) GO TO 60                                            00006340
      IF(KOUNT   .GE.3) GO TO 51                                            00006350
      CONTINUE                                                              00006360
   51  IF(((ABS(TRSIG(K)))/JNWMD1(K)).GT.6.) PRINT 70                       00006370
   70 FORMAT('0',14X,'TRSIG INDICATES SIMPLE SMOOTHING IS UNSATISFACTORY00006380
     1. USE ALTERNATIVE METHOD?'/)                                              6391
      CONTINUE                                                              00006410
       IF(ALP.GT.0.3) ALP= 0.6                                              00006420
       IF(ALP.EQ.0.3) ALP= 0.5                                              00006430
       IF(ALP.LT.0.3) ALP= 0.3                                              00006440
        LTOT =1                                                             00006450
   52   TRSIG(K)=0.0                                                        00006460
        PRINT 62,ALP                                                        00006470
   62 FORMAT('0',15X, 'TR.SIG  ERROR EXCEEDS CONTROL LIMIT.ALP WILL BE R       6480
     1AISED TO :',1X,F5.2,1X,'NEXT PERIOD.'/)                                  6481
       KOUNT =0                                                             00006500
        GO TO 60                                                            00006510
   60  TOTER = TOTER+ ABS(ERROR(K))                                         00006520
       IF(LTOT.LT.4) GO TO 2                                                00006530
       IF(LTOT.GE.4) ALP = A(KI)                                            00006540
        PRINT 4,ALP                                                         00006550
    4 FORMAT('0',15X,'ALPHA WILL REVERT TO ITS FORMER VALUE OF',1X,F4.2,       6560
     1 1X,'THE NEXT PERIOD.'/)                                                 6561
C             COUNTER LTOT REDUCES ALPHA TO ITS ORIGINAL VALUE                 6570
C              AFTER THREE PERIODS                                             6580
       IF(LTOT.GE.3) LTOT = 0                                                  6584
    2  PRINT 43,KDATA(K),JNEWAV(K),ERROR(K),TRSIG(K),JNWMD1(K),                6585
     1 SMERCR(K), TRIGG(K)                                                     6586
   43 FORMAT(15X,I6,8X,F7.1,6X,F9.2,4X,F9.2,3X,F7.1,8X,F9.2,5X,F6.2)           6587
       IF (N.GE.12) MFORX(KL)=JNEWAV(N)                                        6588
C                  ANNUAL DEMAND FORECAST FOR EOQ                              6590
       NWN = (N-5)                                                             6591
       EOQSUB = 0.                                                             6592
       DO 42 ILW = NWN, N                                                      6593
       EOQSUB = EOQSUB + JNEWAV(ILW)                                           6594
   42  CONTINUE                                                                6595
C                EXTEND FINAL SIX FORECASTS TO ANNUAL BASIS:                   6596
       EQSB(KL) = (EOQSUB * 2.)                                                6597
C              EQSB IS NORMAL DEMAND FOR LATEST SIX PERIODS                    6597
C              EXTENDED TO ANNUAL BASIS FOR SUMMARY TABLES.                    6598
C              FINAL VALUES OF SMOOTHING CONSTANTS TO USE WITH                 6600
```

```
      C          SUMMARY TABLES ARE:                                        6601
326        ALFY(KL) = ALP                                                   6602
327        BIFFY(KL) = B(1)                                                 6603
328        JC =(N-M)                                                        6605
      C          THEIL COEFFICIENT IS A SIMPLE TEST OF                      6610
      C          FORECAST ACCURACY. SEE H.THEIL. ECONOMIC                   6611
      C          FORECASTS AND POLICY.(AMSTERDAM.NORTH-HOLLAND              6612
      C          PUBLISHING COMPANY), 1961, 32-35.                          6613
      C          SEE ALSO: H.O.STEKLER, FORECASTING WITH ECONOMETRIC        6614
      C          MODELS, AN EVALUATION. ECONOMETRICA,                       6615
      C          36, 3-4 JULY-OCT.1968, 438-440.                            6616
```

```
C              THEIL IS DESIGNED TO MEASURE THE ABSOLUTE DIFFERENCE            6617
C              BETWEEN PREDICTED CHANGES AND OUTCOME. THE COEFFICIENT          6618
C              IS VALID IN CASES WHERE THE FORECAST TENDS                      6619
C              TO REGULARLY OVER OR UNDER ESTIMATE.                            6620
C                 A 0  MEANS PERFECT PREDICTION...                             6621
C                 A 1  REPRESENTS COMPLETE INEQUALITY.                         6622
C                                                                              6623
C              THE NUMERATOR IS THE MEAN SQUARE ERROR                          6624
C                                                                              6625
      ABJC = FLOAT(JC)                                                         6634
      ZVAR = SUMERQ/ ABJC                                                      6635
      ZDISP = SUMFSQ/ ABJC                                                     6636
       ZACT = SUMACT/ABJC                                                      6637
      THEIL = (SQRT(ZVAR))/((SQRT(ZDISP))+(SQRT(ZACT)))                        6638
      AMSQE = SQRT(ZVAR)                                                       6639
       TSIG(KL)=TRSIG(N)                                                   00006640
      M = MG                                                                   6645
      DO 569 IL=1,JC                                                       00006660
      YV(IL)=JNEWAV(IL+M)                                                  00006670
  569 XV(IL)= IL+M                                                             6671
C              SORT FORECAST VALUES INTO LARGEST AND SMALLEST.                 6675
C              THESE ARE ASSOCIATED WITH THE SIZE OF THE ORIGINAL              6676
C              DATA, AND THE VERTICAL AXIS OF EACH FORECAST                    6677
C              GRAPH IS ADJUSTED ACCORDINGLY.                                  6678
      XIV = 0.                                                                 6682
       YIV = 0.                                                                6683
       YIV = YV(1)                                                             6684
      DO 283 IT=2,JC                                                           6685
      IF(YV(IT)-YIV) 283,283,284                                               6686
  284 YIV = YV(IT)                                                             6687
  283  CONTINUE                                                                6688
       BBIG = YIV                                                              6689
C              TO FIND THE SMALLEST VALUE                                      6690
      XIV = YV(1)                                                              6691
       DO 286 IS=2,JC                                                          6692
      IF(XIV-YV(IS)) 286,286,287                                               6693
  287  XIV=YV(IS)                                                              6694
  286 CONTINUE                                                                 6695
      BSMALL=XIV                                                               6696
       UDIFFB=(BBIG-BSMALL)                                                    6697
       USETB=(70.*(UDIFFB/UDIFFA))                                             6698
       GN=N-1                                                                  6699
       CUMER = TOTER / ABJC                                                    6700
       AVERER = SUMER / ABJC                                                   6710
C              BALER IS NOW COMPUTED. GIVEN THAT THERE IS                      6711
C              A TENDENCY FOR SIGNED ERRORS TO CANCEL OUT,                     6712
C              WE AVERAGE THE TOTAL ABSOLUTE ERROR, AND CALCULATE              6713
C              THE PERCENTAGE FORMED BY:                                       6714
C                 ( ACTUAL SIGNED ERROR / AVERAGE ERROR).                      6715
```

```
      IF(TOTER.LE.0.) TOTER =1.                                         6716
      BALER=(SUMER*100.)/(TOTER * .5)                                   6717
      PRINT 288, AVERER,BALER,CUMER,SUMER, AMSQE                        6718
  288 FORMAT('0',50X,'MEASUREMENTS OF OVERALL'/50X,'FORECASTING EFFECTIV 6719
     1ENESS'/49X,'* * * * * * * * * * * * *'//39X,'THE AVERAGE CUMULAT  6720
     2IVE SIGNED ERROR :',F7.1/39X,        'BALANCED ERROR',12X,':',F   6721
     37.1/39X,'OVERALL MEAN ABSOLUTE DEVIATION ',5X,':',F7.1/39X,'TOTAL 6722
     4SIGNED ERROR',19X,':',F7.1/39X,'ROOT MEAN SQUARE ERROR',15X,':',  6723
     5 F7.1/)                                                           6724
      COMP1(KL) = AVERER                                                6730
      COMP2(KL) = BALER                                                 6731
```

```
365           COMP3(KL) = CUMER                                                6732
366           COMP4(KL) = SUMER                                                6733
367           COMP19(KL) = AMSQE                                               6735
368           PRINT 31,THEIL                                                   6738
369      31  FORMAT('0',38X,'THE THEIL COEFFICIENT',16X,':',F8.2/)             6739
370          IF(ABS(THEIL).LT.0.10) GO TO 85                                   6741
371          IF(ABS(THEIL).LT.0.25) GO TO 34                                   6742
372          IF(ABS(THEIL).LE.0.65) GO TO 35                                   6743
373          IF(ABS(THEIL).GT.0.65) GO TO 32                                   6744
374      85   PRINT 86                                                         6745
375      86   FORMAT('0',38X,'THEIL INDICATES EXCELLENT FORECASTING ABILITY.'/) 6746
376            GO TO 37
377      34   PRINT 36                                                         6747
378      36   FORMAT('0',38X,'THEIL SUGGESTS A FAIRLY ACCURATE FORECAST.'/)    6748
379            GO TO 37                                                        6749
380      32   PRINT 38                                                         6750
381      38  FORMAT('0',38X,'THEIL SUGGESTS A RATHER POOR FORECAST.'/)         6752
382           GO TO 37                                                         6753
383      35   PRINT 39                                                         6754
384      39  FORMAT('0',38X,'THEIL VALUE INDICATES MODERATE FORECASTING EFFICIE 6755
            1NCY.'/)                                                           6756
385      37   CONTINUE                                                         6757
      C                        AN INDEX OF FORECASTABILITY                     6760
      C                        ---------------------------                     6761
      C                                                                        6762
      C               P.DAMICO, FORECASTING SYSTEM USES MODIFIED SMOOTHING,    6763
      C                   J.I.I.E. , JUNE 1971, 15-20.                         6764
      C                                                                        6765
      C               A ROUGH GUIDE TO THE LIKELIHOOD THAT A SERIES            6766
      C               IS AMENABLE TO FORECASTING, MAY BE GIVEN                 6767
      C               BY REFERENCE TO THE INDEX:                               6768
      C               ((SUM OF DEMANDS)/N-1)/STD. DEV.                         6769
      C               IF THE RESULTING INDEX IS SMALL, MANUAL METHODS          6770
      C               MAY BE PREFERRED. WE ASSUME THAT VALUES                  6771
      C               OF 1 OR LESS ARE SMALL.                                  6772
      C                                                                        6773
      C                          ACCURACY PERCENTAGE                           6774
      C                                                                        6775
      C                          - - - - - - - - - -
      C                                                                        
      C               ANOTHER EVALUATION USES THE ACCURACY PERCENTAGE,         6776
      C               OR  MEAN ABSOLUTE DEVIATIONS SUMMED / MEAN DEMAND.       6777
      C               THE LOWER THE VALUE, THE LESS ERRATIC THE DATA.          6778
386            ACCUR = 0.                                                      6779
387            NAMICO = 0                                                      6780
388           DO 48 JJJ=MG,N                                                   6782
389           NAMICO = NAMICO + KDATA(JJJ)                                     6783
390      48   CONTINUE                                                         6784
391           ACCUR = ((CUMER/XBAR) * 100.)                                    6788
392           KYL = ((N-MG)-1)                                                 6790
```

```
      DAMICO = ((NAMICO/KYL)/(CUMER* 1.25))
       PRINT 68, DAMICO , ACCUR
   68 FORMAT('0',38X,'THE INDEX OF FORECASTABILITY',9X,':',F7.1/39X,'ACC
     1URACY PERCENTAGE',18X,':',F7.1/
     2  39X,'BALANCED ERROR SHOWS EXTENT OF ERROR CANCELLATION IN DATA.'
     3/39X,'A THEIL VALUE CF ZERO INDICATES PERFECT PREDICTION.'/)
       IF(DAMICO .LT.1.5)  GO TO 53
       IF(DAMICO .LE.2.5)  GO TO 56
       IF(DAMICO .GT.2.5)  GO TO 64
   53 PRINT 54
   54 FORMAT('0',38X,'THE LOW INDEX OF FORECASTABILITY SUGGESTS THAT'/39
```

```
     1X,'A MANUAL METHOD MAY BE PREFERRED FOR THIS ITEM.'/)
        GO TO 67
   56 PRINT 59
   59 FORMAT('0',38X,'THE FORECASTABILITY INDEX SUGGESTS THAT BRUFICH'/
     139X,'SHOULD GIVE REASONABLE RESULTS.'/)
        GO TO 67
   64   PRINT 66
   66 FORMAT('0',38X,'THE FORECASTABILITY INDEX IS HIGH, SUGGESTING THAT
     1'/39X,'BRUFICH IS VERY SUITABLE FOR THIS ITEM.'/)
   67 CONTINUE
        PRINT 40
   40   FORMAT('0',38X,'* * * * * * * * * * * * * * * * * * * * * * * *
     1 * '/)
        CONTINUE
C                                                     * * GRAPH TWO * *
C
        PRINT 570
  570 FORMAT('0',51X,'PLOT OF SIMPLE SMOOTHING.'/53X,'* * * * * * * * *
     1* * *'/)
C
C                      THIS PLOT IS OF SIMPLE SMOOTHING
C                                * * * * * * * * *
        WDTH = 0.
        WLN = N
        WIN = (WLN -6.)
        WDTH = 100.*(WIN/WLN)
        IF(WDTH.LE.0.) WDTH = 0.50
        JIM = ITEMNO(KL)
        CALL PLOT (XV,YV,(N-M), .9, .9, WDTH,USETB,'*',JIM)
C
C                               * * * * * * * * * *
C                               * DEMAND PATTERN  *
C                               *     TREND       *
C                               * * * * * * * * * *
C
C                TWO TREND TESTS ARE APPLIED TO THE DATA.
C                IF THERE ARE FEWER THAN 18 POINTS,
C                NO ANALYSIS IS PERFORMED.
        IF ( N.GE.18) GO TO 321
        TRFX = 0.
        IF(N.LT.18) EQDUB(KL) = KTOTAL(KL)
        IF(N.LT.18) PRINT 76
   76 FORMAT('1',45X,'TREND AND SEASONAL FORECASTING.'/47X,'* * * * * *
     1* * * * * * * *'/30X,'THERE ARE FEWER THAN 18 DATA POINTS: NO FO
     2RECASTS PERFORMED.'/36X,'* * * * * * * * * * * * * * * * * * * '/)
        IF ( N.LT.18) TRFX = KTOTAL(KL)
        IF(N.LT.18) GO TO 560
  321   CONTINUE
        JPATT=0
```

```
429              KPATT=0                                                       00006960
430              AMEDIN =0.                                                    00006970
431              DO 670 IIL= 1,N                                               00006980
432       670    YG(IIL)= KDATA(IIL)                                           00006990
433              CALL SORT (YG,N,AMEDIN)                                       00007000
434       322    PRINT 323                                                     00007010
435       323   FORMAT('0',51X,'THE  SECOND  PROCEDURE:'/50X,'TREND ADJUSTED FORECAS      7020
               1TING'/50X,'* * * * * * * * * * * * *'/44X,'IF RUN OF DATA IS LES      7030
               2S THAN 18 PERIODS'/48X,'NO TREND ROUTINE IS PERFORMED.'/48X,'_ _ _      7040
               3 _ _ _ _                   ' )                                       7050
      C                   HERE IS A ROUGH TEST FOR TREND. DIVIDE THE UNSORTED   00007060
```

```
C                   VECTOR IN TWO. FIND MEAN OF OLDER AND OF NEWER HALVES,    00007070
C                   AND CONSIDER SIZE OF DIFFERENCE.                          00007080
C                                                                             00007090
C                          (A) ROUGH TREND TEST.                              00007100
C                          - - - - - - - - - - - -                            00007110
C                                                                                 7115
            LR= N/2                                                           00007120
            LTRTOT = 0                                                        00007130
            TCTLOW = 0.                                                       00007140
            DO 330 LK=1,LR                                                    00007150
            TOTLOW =TOTLOW +KDATA(LK)                                         00007160
      330   CONTINUE                                                          00007170
            TOTUPP=0.                                                         00007180
            LS =LR+1                                                          00007190
            DO 331 LK=LS,N                                                    00007200
            TOTUPP = TOTUPP+KDATA(LK)                                         00007210
      331   CONTINUE                                                          00007220
            AMID1 =TOTLOW/  LR                                                00007230
            AMID2 =TOTUPP/LR                                                  00007240
C                   TOTLOW,TOTUPP TEST TOTALS                                 00007250
            PRINT 313,AMEDIN,AMID1,AMID2, AVLT1(KL)                               7260
      313  FORMAT('0',24X,'THE MEDIAN OF THE DATA IS:',F7.1,2X,'THE MEAN OF T     7270
          1HE EARLIER DATA IS:',F7.1,2X/41X,'AND THE MEAN OF THE RECENT DATA      7271
          2IS:',F7.1/49X,'LEAD TIME IS',2X,F4.1,1X,'MONTHS' )                     7272
C                   ASSUME THAT A RISE OR FALL OF 60 PERCENT                      7300
C                   REPRESENTS A STRONG TREND; AND THAT                           7301
C                   30 PERCENT INDICATES A LESSER TREND.                          7302
            IF(AMEDIN.LE.0.) PRINT 347                                            7312
      347   FORMAT('0',43X,'THE MEDIAN IS ZERO. FOR THIS ANALYSIS'/45X,           7313
          1 'A VALUE OF 1 HAS BEEN ASSUMED.' )                                    7314
            IF (AMEDIN.LE.0.) AMEDIN = 1.0                                        7315
           IF((((ABS(AMID2-AMID1))/AMEDIN)*100.).LE.30.) GO TO 335                7330
           IF((((ABS(AMID2-AMID1))/AMEDIN)*100.).LE.60.) GO TO 338                7340
           IF((((ABS(AMID2-AMID1))/AMEDIN)*100.).GT.60.) GO TO 336                7350
C                   JPATT IS ESTIMATOR OF TREND STRENGTH,                         7360
C                   ON A SCALE OF 0,1,2; AND IS COMPARED                          7370
C                   WITH KPATT OF THE RUNS TEST.                                  7380
      335   PRINT 342                                                             7390
      342   FORMAT('0',48X,'LITTLE EVIDENCE OF A TREND'/49X,'* * * * * * * *      7400
          1* * * * * *'/)                                                         7410
            JPATT=0                                                               7420
            GO TO 345                                                             7430
      336   PRINT 337                                                             7440
      337   FORMAT('0',40X,'THERE APPEARS TO BE A FAIRLY STRONG TREND.'/41X,      7450
          1'* * * * * * * * * * * * * * * * * * * * *'/)                          7451
            JPATT=2                                                           00007470
            GO TO 354                                                         00007480
      338    PRINT 339                                                        00007490
      339   FORMAT ('0',38X,'THERE IS SOME EVIDENCE THAT A TREND IS PRESENT.'     7500
```

```
     1/40X,'* * * * * * * * * * * * * * * * * * * * * * * * * ' )
        JPATT=1
       GC TO 354
 354   CONTINUE
      IF(AMID2-AMID1) 360,345,362
 360   PRINT 361
 361   FORMAT('0',51X,'THE SLOPE IS DOWNWARD' )
       GC TC 345
 362   PRINT 363
 363  FORMAT('0', 52X,'THE SLOPE IS UPWARD' )
       GC TO 345
```

```
  345   CONTINUE
C
C                       (B) RUNS TREND TEST
C
C                      - - - - - - - - - - - -
C
C               THIS SINGLE SAMPLE RUNS TEST IS DESCRIBED IN S. SIEGEL:
C               "NON-PARAMETRIC STATISTICS",MCGRAW-HILL, 1956, 52-58.
C                EXPERIMENTS INDICATE THAT THE RUNS TEST,
C               THOUGH OPERATING CORRECTLY, IS NOT INDICATIVE
C               OF REAL TREND, SINCE IT CAN BE MISLEAD
C                       BY NON-LINEAR MOVEMENTS.
C
         AMEDIN =0.
         SIGMA = 0.
        MCONTA=0
         MCONTB=0
         NRUNA=0
         NRUNB=0
         U=0.
         NNS=0
         NNR=0
         DO 671  IIL=1,N
  671    YG(IIL)=KDATA(IIL)
         CALL  SORT(YG,N,AMEDIN)
         PRINT 324
  324   FORMAT('0',54X,'RUNS TREND TEST'/55X,'_ _ _ _ _ _ _ _ _ _ _ ')
C
C               NOW MEASURE THE RUNS ABOVE AND BELOW
C               THE MEDIAN. EACH INDIVIDUAL  A  AND  B
C               IS A RUN. THE PRESENCE OF A TREND SHOULD
C               DISTURB THE RANDOM MIX OF A AND B,
C               AND THE  Z  VALUE EXCEED 1.96
C
C
         DO 99 LK=2,N
        IF((KDATA(LK)).GT.AMEDIN.AND.(KDATA(LK-1)).GT.AMEDIN)GO TO 97
        IF((KDATA(LK)).LT.AMEDIN.AND.(KDATA(LK-1)).LT.AMEDIN)GO TO 94
        IF((KDATA(LK)).LT.AMEDIN.AND.(KDATA(LK-1)).GT.AMEDIN)GO TO 91
        IF((KDATA(LK)).GT.AMEDIN.AND.(KDATA(LK-1)).LT.AMEDIN)GO TO 93
        IF((KDATA(LK)).LT.AMEDIN.AND.(KDATA(LK-1)).EQ.AMEDIN)GO TO 94
        IF((KDATA(LK)).EQ.AMEDIN.AND.(KDATA(LK-1)).EQ.AMEDIN)GO TO 99
        IF((KDATA(LK)).EQ.AMEDIN.AND.(KDATA(LK-1)).GT.AMEDIN)GO TO 95
        IF((KDATA(LK)).EQ.AMEDIN.AND.(KDATA(LK-1)).LT.AMEDIN)GO TO 96
        IF((KDATA(LK)).GT.AMEDIN.AND.(KDATA(LK-1)).EQ.AMEDIN)GO TO 97
   91    NRUNA = NRUNA +1
         MCONTB = MCONTB+1
         GO TO 99
   93    NRUNB = NRUNB +1
         MCONTA=MCONTA+1
```

```
      GO TO 99                                                          00008120
   94 MCONTB=MCONTB+1                                                   00008130
      GC TO 99                                                          00008150
   95 NRUNA = NRUNA +1                                                  00008160
      GO TO 99                                                          00008190
   96 NRUNB = NRUNB +1                                                  00008200
      GO TO 99                                                          00008230
   97 MCONTA=MCONTA+1                                                   00008270
      GC TC 99                                                          00008290
   99 CONTINUE                                                          00008300
C              PICK UP THE VALUE OF THE LAST ITEM NOW                   00008310
```

```
      C                                                                  00008320
517         IF(( KDATA(N).LT.AMEDIN).AND. (KDATA(N-1).LE. AMEDIN)) NRUNB =    8330
          1 NRUNB + 1                                                         8331
518         IF (( KDATA(N).GT.AMEDIN ).AND. (KDATA(N-1).GE.AMEDIN)) NRUNA     8333
          1 = NRUNA +1                                                        8334
519         CONTINUE                                                     00008350
      C           THEN THE RUNS SIGNIFICANCE TEST                        00008360
520         GNS=FLOAT(NRUNA)                                             00008370
521         PPP = FLOAT(MCONTA)                                               8372
522         QQQ = FLOAT(MCONTB)                                               8374
523         GNR=FLOAT(NRUNB)                                             00008380
524         V = (GNS + GNR)                                              00008390
525         IF( (GNS+GNR).LT.1.00) GO TO 329                             00008400
526         IF (( PPP+QQQ-1.) .LT.0.01)  GO TO 329                            8420
527          IF ((PPP*QQQ) .LE.0.01)  GO TO 329                               8421
528         U = ((2.* PPP*QQQ)/(PPP + QQQ)) + 1.                              8422
529         SIGMA = SQRT (((2.*PPP*QQQ ) * ((2.*PPP*QQQ ) -PPP-QQQ))/         8430
          1 (((PPP+QQQ) **2) * (PPP+QQQ -1.)))                                8431
530         IF (SIGMA.LT.0.01) SIGMA=0.01                                00008440
      C           HERE WE DECIDE ON THE CONFIDENCE LEVEL.                00008450
      C           FOR THIS WE USE 1.96S.D.. OR 95%                       00008460
531         Z=((V-U)/ SIGMA)                                             00008470
532         IF (ABS(Z) .GE.3.0) GO TO 101                                     8475
533        IF(ABS(Z).GE.1.96) GO TO 102                                  00008480
534        IF(ABS(Z).LT.1.96) GO TO 104                                  00008490
535   101   PRINT 107,Z                                                       8492
536   107   FORMAT('0',25X,   'SIEGEL RUNS TEST INDICATES A STRONG TREND IN T     8493
          1HE DATA, WITH A Z VALUE OF',1X,F6.1 )                              8494
537         KPATT = 2                                                         8495
538         GO TO 793                                                         8496
539   102   PRINT 105,Z                                                       8500
540   105  FORMAT('0',26X,   'SIEGEL RUNS TEST INDICATES A TREND IS PRESENT.  8510
          1 WITH A Z VALUE OF',1X,F6.1 )                                      8511
541        IF(ABS(Z).GT.3.00) KPATT=2                                         8530
542        IF(ABS(Z).GT.3.00) GO TO 793                                       8531
543         IF(ABS(Z).GT.1.96) KPATT=1                                   00008540
544         GO TO 793                                                    00008550
545   104   PRINT 103,Z                                                  00008560
546   103  FORMAT('0',38X,'THE SIEGEL TEST SUGGESTS THE DATA IS * RANDOM *'/  8570
          1 28X,'THERE IS 95% CONFIDENCE THAT NO REAL TREND EXISTS. THE Z VAL 8580
          2UE IS:',1X,F6.2 )                                                  8581
547         KPATT=0                                                      00008600
548         GO TO 793                                                    00008610
549   793  CONTINUE                                                      00008620
550        IF((KPATT+JPATT).EQ.4) GO TO 790                              00008630
551        IF((KPATT+JPATT).EQ.0) GO TO 791                              00008640
552         IF( (KPATT+JPATT).EQ.3) GO TO 794                            00008650
553        IF((KPATT.EQ.1).AND.(JPATT.EQ.1)) GO TO 794                   00008660
554        IF(((KPATT.EQ.2).AND.( JPATT.EQ.0)).OR.((KPATT.EQ.0).AND.(JPATT.EQ00008670
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      1.2))) GO TO 792
      IF((KPATT+JPATT).EQ.1) GO TO 795
790   PRINT 325
325   FORMAT('0',41X,'THE TWO TESTS SHOW A STRONG TREND PRESENT'/)
       NTS1(KL)=TTT
       NTS2(KL) = TTT
       GO TO 106
791   PRINT 326
326    FORMAT('0',39X,'THE TWO TESTS SHOW THERE IS PROBABLY NO TREND' )
       GO TO 106
794   PRINT 328
```

```
328  FORMAT('0',38X,'* BOTH TREND TESTS INDICATE SOME TREND IS PRESENT      8790
    1*' )                                                                   8800
      NTS1(KL)=TTT                                                      00008810
      NTS2(KL)=TTT                                                      00008820
      GO TO 106                                                         00008830
792  PRINT 327                                                          00008840
327  FORMAT('0',51X,'THE TWO TESTS STRONGLY DISAGREE' )                     8850
     GO TO 106                                                          00008860
795   PRINT 334                                                         00008870
334  FORMAT('0',41X,'THERE IS LACK OF AGREEMENT BETWEEN THE TREND TESTS     8880
    1' )                                                                    8890
      GO TO 106                                                         00008900
329   CONTINUE                                                          00008910
      PRINT 332,V , PPP, QQQ                                                8920
332  FORMAT('0',44X,'THE NUMBER OF RUNS (ABOVE AND BELOW) IS:',2X,F3.0/     8930
    1 47X,'NUMBER OF SCORES ABOVE :',F3.0,1X,'AND BELOW :',F3.0/            8931
    2 55X,'NO RUNS TEST IS POSSIBLE.' )                                     8932
     GO TO 106                                                              8950
106  CONTINUE                                                               8960
C                                                                           8962
        SQUMR = 0.                                                          9045
        SQSUMR = 0.                                                         9046
        TEROR = 0.                                                          9050
     AVTER = 0.                                                             9051
        TSUMER= 0.                                                          9060
        TROTER= 0.                                                          9070
        LOOP  = 0                                                           9080
        LTRTOT = 0                                                          9090
        JTRAD  = 0                                                          9100
      M = MG                                                                9105
      JJ= M+1                                                               9110
      GZX = ( (N-JJ) -1 )                                                   9115
      LU= M+3                                                           00009120
      DO 333 K=JJ,N                                                     00009130
       CURTR(M) =0.                                                     00009140
      PNEWTR(M)=0.                                                      00009150
       TFORX(M)  =  YEST(M)                                                 9160
       TDSIG(M) =0.                                                     00009170
       JXPECD(M)= YEST(M)                                                   9180
     IF(LTRTOT.GT.0) LTRTOT=LTRTOT+1                                    00009190
C              NOW EVALUATE SIMPLE TREND DIFFERENCE:CURTR               00009200
       TFORX(K)=(A(KI)*KDATA(K-1))+ ((1.-A(KI))*TFORX(K-1))                 9210
       CURTR(K) =TFORX(K)- TFORX(K-1)                                   00009220
C              EXPON. SMOOTH OLD TREND TO OBTAIN PNEWTR                     9230
      PNEWTR(K)=(A(KI)*CURTR(K))+((1.-A(KI)) * PNEWTR(K-1))             00009240
C              CORRECT FOR LAG : JXPECD IS EXPECTED DEMAND              00009250
C                   FOR THE PERIOD JUST PASSED                          00009260
       JXPECD(K) = (TFORX(K)) +((((1.-A(KI))/ A(KI))*PNEWTR(K))         00009270
       SUMER  = SUMER + ERROR(K)                                        00009280
```

```
                                                                          00009290
605            TEROR   =(KDATA(K)-JXPECD(K))                                  9292
606           SQUMR = SQUMR + (TEROR**2)                                      9293
      C              FOR THE MEAN SQUARE ERRCR ROUTINE.                       9300
607            TSUMER = TSUMER + TEROR                                        9310
      C              XMAD IS TREND SMOOTHED MEAN ABSOLUTE DEVIATION           9320
608            XMAD(M)= XMAD(1)                                               9326
609           B(1) = B(JI)                                                    9330
610            XMAD(K)= (B( 1)*ABS(TERCR)) +((1.-B( 1))*(XMAD(K-1)))          9331
      C                             DEMAND DURING LEAD TIME                   9332
      C                                                                       9333
      C                 FOR LEAD TIMES IN EXCESS OF ONE MONTH
```

```
      IF(AVLT1(KL) .LE.1.0)   DDLT(K) = JXPECD(K)
      IF(AVLT1(KL) .LE.1.0)  GO TO 176
      DDLT(K) = (AVLT1(KL) * JXPECD(K)) + (((AVLT1(KL) * (AVLT1(KL)+1.)
     1) / 2.) * PNEWTR(K))
  176 CCNTINUE
C
C                         (A) TRIGG/BATTY TRACKING: TDRIG
C                         - - - - - - - - - - - - - - - -
C
C           TDRIG IS TRIGG T/S
      SMTRER(M) = SMTRER(1)
      SMTRER(K)= B( 1)*TEROR +((1.-B( 1))*SMTRER(K-1))
      TDRIG(K) = SMTRER(K)/XMAD(K)
      IF(ABS(TDRIG(K)).LE.0.41) GO TO 216
      IF  (K.LE.LU)  GO TO 216
      IF (B( 1).EQ.0.10)   GO TO 171
      IF (B( 1).GT.0.10)   GO TO 181
  171 IF (ABS(TDRIG(K)).LT.0.42) GO TO 216
      IF (ABS(TDRIG(K)).GE.0.42) GO TO 210
  131 IF (B( 1).EQ.0.20) GC TO 172
      IF (B( 1).GT.0.20) GC TO 182
  172 IF (ABS(TDRIG(K)).LT.0.58) GO TO 216
      IF (ABS(TDRIG(K)).GE.0.58) GO TO 210
  182 IF (B( 1).EQ.0.30) GC TO 173
      IF (B( 1).GT.0.30) GC TO 183
  173 IF (ABS(TDRIG(K)).LT.0.71) GO TO 216
      IF (ABS(TDRIG(K)).GE.0.71) GO TO 210
  183 IF (B( 1).EQ.0.40) GC TO  174
      IF (B( 1).GT.0.40) GC TO  184
  174 IF (ABS(TDRIG(K)).LT.0.80)  GO TO 216
      IF (ABS(TDRIG(K)).GE.0.80)  GO TO 210
  184 IF (B( 1).EQ.0.50) GO TO  175
  175 IF(ABS(TDRIG(K)).LT.0.88) GO TO 216
      IF(ABS(TDRIG(K)).GE.0.88) GO TO 210
  210  JTRAD = JTRAD+1
      IF(JTRAD.GE.4) GO TO 211
  215 IF(JTRAD.LT.4) GO TO 190
  211  CONTINUE
       JTRAD=0
       GC TC 190
  216  JTRAD= 0
C                          (B) SIMPLE TRACKING METHOD: TDSIG
C                          - - - - - - - - - - - - - - - - -
C
  190  TDSIG(K) =TDSIG(K-1)+TEROR
      IF (((ABS(TDSIG(K)))/ XMAD(K)).GE.4) GO TO 150
      IF (((ABS(TDSIG(K)))/ XMAD(K)).LT.4) LOOP= 0
       GC TC 160
  150  LOOP = LOOP +1
```

```
      IF (LOOP.GE.3) GO TO 151                                          00009770
      IF (LOOP.LT.3) GO TO 160                                          C0009780
  151 CONTINUE                                                              9790
       CCNTINUE                                                         00009820
      IF (A(KI).GT.0.3) A(KI) =0.6                                      00009830
      IF (A(KI).EQ.0.3) A(KI) =0.5                                      00009840
      IF (A(KI).LT.0.3) A(KI)=0.3                                       00009850
       LTRTOT =1                                                        00009860
C               THE TREND COUNTER TO REDUCE ALPHA                       G0009870
  152  TDSIG(K) =0.0                                                    C0009880
       LOOP =0                                                          00009920
```

```
      GC TC 160                                                         C0009930
  160  TRCTER =TROTER + ABS(TEROR)                                      C0009940
      IF (LTRTOT.LT.4) GO TO 333                                        00009950
      IF (LTRTOT.GE.4) A(KI)=(A(KI)-0.2)                                C0009960
      IF (LTRTOT.GE.3) LTRTOT=0                                             9990
      IF (A(KI).LT.0.05) A(KI)=0.05                                        10000
C             TREND FOR THE CURRENT MONTH IS PRINTED:                      10008
  333 CONTINUE                                                             10010
       TRFX = 0.                                                           10032
       DO 144 IV = JY, N                                                   10033
C             TO TOTAL LATEST 12 FORECASTS FOR SUMMARY TABLES:             10034
       TRFX = TRFX + JXPECD(IV)                                            10035
  144  CONTINUE                                                            10036
        PNEWTR(KL)=PNEWTR(N)                                               10040
        JTRDEM(KL)=JXPECD(N)                                               10050
C             AVTER ESTIMATES THE AVERAGE DIFFERENCE OF THE                10052
C             SIGNED ERRORS FROM THE IDEAL OF ZERO.                        10053
C
       AVTER = TSUMER/GZX                                                  10054
       GZXZ = (N-JJ)                                                       10055
       IF( (SQUMR/(GZXZ)) .LE.0.)  SQSUMR = 0.                             10056
       IF( (SQUMR/(GZXZ)) .LE.0.)  GO TO 232                               10057
       SQSUMR = (SQRT(SQUMR/(GZXZ)))                                       10058
  232 CONTINUE                                                             10059
       GN=N-1                                                              10060
       TRMAD= TROTER/GNX                                                   10070
C             BALTRE ESTIMATES THE BALANCE BETWEEN                         10071
C             POSITIVE AND NEGATIVE ERRORS: PERCENTAGE DIFFERENCE.         10072
C             IT IS A ROUGH INDICATOR OF FORECAST EFFICIENCY.              10073
       IF(TROTER.LE.0.) TRCTER= 1.                                         10074
       BALTRE= (TSUMER*100.)/(TROTER * 0.5)                                10075
       CCMP5(KL) = AVTER                                                   10095
       COMP6(KL) = BALTRE                                                  10096
       CCMP7(KL) = TRMAD                                                   10097
       COMP8(KL) = TSUMER                                                  10098
       COMP20(KL) = SQSUMR                                                 10099
       JC=N-M                                                              10140
       DO 540 II=1,JC                                                      10150
       YY(II) =TFORX(II+M)                                                 10160
  540  XX(II)=II+M                                                         10161
C             SORT FORECAST VALUES INTO LARGEST AND SMALLEST.              10163
C             THESE ARE ASSOCIATED WITH THE SIZE OF THE ORIGINAL           10164
C             DATA, AND THE VERTICAL AXIS OF EACH FORECAST                 10165
C             GRAPH IS ADJUSTED ACCORDINGLY.                               10166
      YYP=0.                                                               10172
       YXP = 0.                                                            10173
       YYP=YY(1)                                                           10174
      DO 281 IT=2,JC                                                       10175
      IF(YY(IT)-YYP) 281,281,282                                           10176
```

```
  282  YYP=YY(IT)
  281   CONTINUE
        CBIG = YYP
C               TO FIND THE SMALLEST VALUE
       YXP=YY(1)
        DC 289 IS=2,JC
       IF(YXP-YY(IS)) 289,289,290
  290  YXP=YY(IS)
  289   CONTINUE
        CSMALL=YXP
       UDIFFC =(CBIG-CSMALL)
```

```
      USETC = (70.*(UDIFFC/UDIFFA))                                     10188
       AWDTH = 0.                                                       10206
C                                                                       10230
      WLN = N                                                           10232
      WIN = (WLN -6.)                                                   10233
     AWDTH = 100.*(WIN/WLN)                                             10234
      IF(AWDTH.LE.0.)  AWDTH = 0.50                                     10235
      JIM = ITEMNO(KL)                                                  10236
      CONTINUE                                                          10250
      JC= (N-M)                                                         10260
      DO 550 IK= 1,JC                                                   10270
      YZ(IK)=JXPECD(IK+M)                                               10280
  550 XY(IK) =IK+M                                                      10281
       TYP=0.                                                           10292
     TXP=0.                                                             10293
     TYP=YZ(1)                                                          10294
      DO 291  IT=2,JC                                                   10295
      IF(YZ(IT)-TYP) 291,291,292                                        10296
  292 TYP = YZ(IT)                                                      10297
  291 CONTINUE                                                          10298
      DBIG = TYP                                                        10299
C             TO FIND THE SMALLEST VALUE                                10300
     TXP=YZ(1)                                                          10301
     DO 294 IS=2,JC                                                     10302
     IF(TXP-YZ(IS))294,294,295                                          10303
  295 TXP=YZ(IS)                                                        10304
  294 CONTINUE                                                          10305
      DSMALL=TXP                                                        10306
       UDIFFD =(DBIG-DSMALL)                                            10307
      USETD=(60.*(UDIFFD/UDIFFA) )                                      10308
C                                                                       10330
      BWDTH = 0.                                                        10336
C                                                                       10360
      WLN = N                                                           10362
      WIN = (WLN -6.)                                                   10363
     BWDTH = 100.*(WIN/WLN)                                             10364
      IF(BWDTH.LE.0.)  BWDTH = 0.50                                     10365
       JIM = ITEMNO(KL)                                                 10366
      CONTINUE                                                          10368
      CONTINUE                                                          10371
C                                                                       10372
      BETAB = B(1)                                                      10373
C                     * * * * * * * * * * *
C                     *  DOUBLE SMOOTHING  *                            10374
C                     * * * * * * * * * * *
C
C                        - - - - - - - -                                10375
C
C               TO OVERCOME TENDENCY TO LAG IF TREND PRESENT.           10376
```

```
C                    BROWN DOUBLE SMOOTHING METHOD IS USED.                      10377
C                                                                                10378
C                    R.G.BROWN,SMOOTHING,FORECASTING AND PREDICTION OF           10379
C                    DISCRETE TIME SERIES.PRENTICE-HALL 1963,128-132             10380
C                                                                                10381
C                    FOR DETAILS OF DOUBLE SMOOTHING, SEE                        10382
C                    SUBROUTINE SECTION 52000                                    10383
745      CALL DUB   (M, ALP, YEST, Q, JJ, N, BETAB,COMP9,COMP10,                 10384
       1 COMP11,COMP12,KL,EQDUB, DOUBLE , XBAR, GNX)                             10385
C                                   *  BRUSIM  *                                 10389
C                                   ************                                 10390
```

```
C
C                    ADAPTIVE RESPONSE RATE FORECASTING
C
C              FOR DETAILS. SEE SUBROUTINE SECTION 53000
C
C              BRUSIM RUNS ONCE ONLY PER ITEM.
C              EXPONENTIAL SMOOTHING CAN BE CONTROLLED BY THE
C              TRIGG AND LEACH (1967) METHOD, OF SETTING
C              ALPHA EQUAL TO MODULUS OF THE TRACKING SIGNAL.
C              THE  BRUSIM  SUBROUTINE SHOWS THIS IN THE
C              LAST TABLE OF OUTPUT, MODIFIED BY THE
C              ONE PERIOD DELAY RECOMMENDED BY SHORE
          IF ( KI.NE. 1) GO TC  659
          IF ( JI.NE. 1) GO TC  659
C              TO LOOP PAST BRUSIM EXCEPT FIRST ITERATION
          DO 69 IIL=1,N
   69    DDF(IIL) = KDATA(IIL)
          CALL BRUSIM(DDF,N)
C
  659     CONTINUE
C                             *  FUTURE  TREND  *
C                             *  * * * * * * *  *
C
C
          TEROR = 0.
          TEROR = 0.
          JJ = M+1
          JXJ = M+2
          JVJ = M+3
          SUM1ER = 0.
          SUM2ER = 0.
          SUM3ER = 0.
          NON = N-3
          FNX = ((NON - MG) -1)
          DO 655 K=JJ,NON
          KP = K+1
          KT = K+2
          KV = K+3
          TEROR = KDATA(K) - JXPECD(K)
         IF(K.EQ.JJ) EXPEC1(K) = JXPECD(K) + PNEWTR(K)
         IF(K.EQ.JJ) EXPEC2(K) = JXPECD(K) + (2*PNEWTR(K))
         IF(K.EQ.JJ) EXPEC3(K) = JXPECD(K) + (3*PNEWTR(K))
          IF(K.EQ.JJ) EXPEC1(KP)= JXPECD(K)+ PNEWTR(K)
          IF(K.EQ.JJ) EXPEC2(KT)= JXPECD(K)+ (2*PNEWTR(K))
          IF(K.EQ.JJ) EXPEC3(KV)= JXPECD(K)+ (3*PNEWTR(K))
          IF(K.EQ.JJ) GO TO 662
          EXPEC1(KP) = JXPECD(K) + PNEWTR(K)
         IF(K.EQ.JXJ) EXPEC2(K) = JXPECD(K) + (2*PNEWTR(K))
         IF(K.EQ.JXJ) EXPEC3(K) = JXPECD(K) + (3*PNEWTR(K))
```

```
      IF(K.EQ.JXJ) EXPEC2(KT)= JXPECD(K) + (2*PNEWTR(K))          10499
      IF(K.EQ.JXJ) EXPEC3(KV)= JXPECD(K) + (3*PNEWTR(K))          10500
      IF(K.EQ.JXJ) GO TO 662                                      10501
      EXPEC2(KT) = JXPECD(K) + (2*PNEWTR(K))                      10505
      IF(K.EQ.JVJ) EXPEC3(K) = JXPECD(K)+ (3*PNEWTR(K))           10510
      IF(K.EQ.JVJ) EXPEC3(KV)= JXPECD(K)+ (3*PNEWTR(K))           10511
      IF(K.EQ.JVJ)  GO TO 662                                     10512
       EXPEC3(KV) = JXPECD(K)+ (3*PNEWTR(K))                      10513
  662 CONTINUE                                                    10515
       T1EROR(K) = KDATA(K) - EXPEC1(K)                           10516
       T2EROR(K) = KDATA(K) - EXPEC2(K)                           10517
```

```
      T3EROR(K) = KDATA(K) - EXPEC3(K)                                    10518
     SUM1ER = SUM1ER + T1EROR(K)                                          10520
     SUM2ER = SUM2ER + T2EROR(K)                                          10521
     SUM3ER = SUM3ER + T3EROR(K)                                          10522
 655  CONTINUE                                                            10540
      AVFER = SUM1ER / FNX                                                10543
      COMP13(KL) = SUM1ER                                                 10557
       COMP14(KL) = AVFER                                                 10558
C                                                                         10560
C                                                                         10562
C                               * * * * * * * * *                         10564
C                              *    SEASONAL     *                        10566
C                              * DEMAND PATTERN  *                        10568
C                               * * * * * * * * *                         10570
C                                                                         10572
C              AT LEAST TWO YEARS DATA MUST BE AVAILABLE                  10580
 400  PRINT 401                                                           10582
 401  FORMAT('1',41X,'THE THIRD PROCEDURE:'/29X,'FORECASTING WITH TREND   10584
     1 AND SEASONAL ADJUSTMENT'/29X,'* * * * * * * * * * * * * * * * *    10586
     2 * * * * * '/)                                                      10588
       SEAFX = 0.                                                         10589
      IF(N.GE.36) GO TO 460                                               10590
      IF(N.LT.36) GO TO 410                                               10592
 410  PRINT 411                                                           10594
 411  FORMAT('0',32X,'THERE ARE TOO FEW DATA ITEMS FOR VALID SEASONAL AN  10598
     1ALYSIS'/)                                                           10599
       IF ( N.LT.36) SEAFX = KTOTAL(KL)                                   10603
       IF ( N.LT.36) GIFFY(KL) = G(1)                                     10604
       GO TO 475                                                          10605
 460   CONTINUE                                                           10610
       ZTOT =0.                                                           10615
       DO 465 I=19,24                                                  00010620
       ZTOT =ZTOT +KDATA(I)                                            00010630
 465   CONTINUE                                                        00010640
C              IN THIS SECTOR,FIRST FORECAST IS SIMPLE AVERAGE OF      00010650
C              LAST SIX MONTHS OF SECOND PRELIMINARY YEAR              00010660
       SEFORX(25) = ZTOT/6.                                            00010670
       DC 403 I=1,N                                                    00010730
 403   NEWDEM(I)= KDATA(I)                                             00010740
       CBTOT= 0.0                                                      00010750
       DC 406 I=1,12                                                   00010760
       LUPP(I)=0                                                       00010770
       LDOWN(I)=0                                                      00010780
      LADD1(I) = 0                                                     00010790
      LADD2(I) = 0                                                     00010800
      LADD3(I) = 0                                                     00010810
       INDEX1(I) = 0                                                   00010820
       INDEX2(I) = 0                                                   00010830
       INDEX3(I) = 0                                                   00010840
```

```
824      406    CONTINUE                                                         00010850
          C                    FIRST PERIOD SEASONALITY.                             10860
          C                    - - - - - - - - - - - - -                             10861
          C                                                                          10880
          C              THE BASE SERIES IS COMPUTED, USING                          10890
          C              THE FIRST 24 MONTHS DATA, IN PAIRS.                         10891
          C                                                                          10910
825              DO 408 I=1,12                                                       10920
826             NG = (I+12)                                                          10930
827             CYCBAS(I)=(KDATA(I)+KDATA(NG))/2.                                    10940
828             IF(CYCBAS(I).LT.0.1) CYCBAS(I)=0.1                                   10950
```

```
      CBTCT =CBTOT+CYCBAS(I)
  408 CONTINUE
C               THE SEASONAL TEST USED IS:
C                  ARE THERE AT LEAST TWO PEAKS 50% ABOVE,
C                  AND TWO LCWS 50% BELOW THE MEAN..
      CBMEAN= CBTOT/12.
      IF ( CBMEAN.LE.0.) CBMEAN = 1.
      DO 412 I=1,12
      IF(CYCEAS(I).GE.(1.50*CBMEAN)) LADD1(I)=1
     IF(CYCBAS(I).LE. (0.50*CBMEAN)) INDEX1(I) = 1
  412 CONTINUE
C                        SECOND PERIOD SEASONALITY
C                        - - - - - - - - - - - - - -
      CBTCT=0.0
      DO 437 I=1,12
      NG = (I+12)
      NP = (I+24)
      CYCBAS(I)=(KDATA(NG)+KDATA(NP))/2.
      IF(CYCBAS(I).LT.0.1) CYCBAS(I)=0.1
      CBTCT= CBTOT+CYCBAS(I)
  437 CONTINUE
      CBMEAN=CBTOT/12.
      IF ( CBMEAN.LE.0.) CBMEAN = 1.
      DO 430 I=1,12
      IF(CYCEAS(I).GE.(1.50*CBMEAN)) LADD2(I)=1
     IF(CYCBAS(I).LE. (0.50*CBMEAN)) INDEX2(I) = 1
  430 CONTINUE
C                       THIRD PERIOD SEASONALITY
C                       ----- ------ -----------
C
C              IF THERE ARE 48 OR MORE PERIODS, REPEAT THE ANALYSIS
     IF( N.LT.48) GO TO 417
     IF( N.GE.48) GO TO 421
  417 CONTINUE
       DC 422  I=1,12
      INDEX3(I)=0
      LADD3(I)=0
  422 CONTINUE
      GO TO 453
  421 CONTINUE
       CBTOT=0.
      DO 452 I=1,12
      NP = (I+24)
      NQ = (I+36)
      CYCBAS(I)=(KDATA(NP)+KDATA(NQ))/2.
      IF(CYCBAS(I).LT.0.1) CYCBAS(I)=0.1
      CBTOT = CBTOT + CYCBAS(I)
  452  CONTINUE
      CBMEAN = CBTOT/12.
```

```
      IF ( CBMEAN.LE.0.) CBMEAN = 1.                                    00011460
      DO 454 I=1,12                                                     00011470
      IF(CYCBAS(I).GE.(1.50*CBMEAN)) LADD3(I)=1                         00011480
     IF(CYCBAS(I).LE. (0.50*CBMEAN)) INDEX3(I) = 1                      00011490
  454 CONTINUE                                                          00011500
  453 CONTINUE                                                          00011510
C                                                                       00011520
C           HERE ARE THE STATISTICAL SUMMARIES FOR THE TESTS            00011530
C           FOR POSSIBLE SEASONALITY OF THE DATA. IN THE EVENT          00011540
C           HOWEVER, MANAGEMENT MUST DECIDE.                               11550
C                                                                       00011560
```

```
875         PRINT 470, N                                                        00011570
876    470  FORMAT('0',21X,'NOTE * MANAGEMENT MUST DECIDE WHETHER AN ITEM IS T     11580
           1RULY SEASONAL. *'/20X,'IF LESS THAN 48 DATA POINTS ARE AVAILABLE,     11581
           2ONLY TWO YEARS ARE COMPARED.'/34X,'FOR THIS ITEM THERE ARE',1X,       11582
           3I3,1X,'DATA POINTS.'/)                                                11583
877         PRINT 461                                                              11630
878    461  FORMAT('0',37X,'STATISTICAL TEST FOR SEASONALITY.'/38X,'* * * * *     11640
           1* * * * * * * * * * * '/26X,'EACH YEAR COMPARE PEAKS AND LOWS. IF     11650
           2SOME ARE 50 PERCENT'/34X,'FROM THE MEAN, FOR TWO OUT OF THREE YEAR    11660
           3S'/39X,'ASSUME EVIDENCE OF SEASONALITY'/39X,'* * * * * * * * * * *    11670
           4 * * * * '/)                                                          11680
879         DO 487 I=1,12                                                       00011690
880        LUPP(I)=LADD1(I)+LADD2(I)+LADD3(I)                                   00011700
881         LDOWN(I)=INDEX1(I)+INDEX2(I)+INDEX3(I)                              00011710
882    487  CONTINUE                                                               11720
883         PRINT 488                                                              11730
884    488  FORMAT('0',36X,'FIFTY PERCENT PEAKS/LOWS ANALYSIS:'/ 37X,'ABOVE TH     11740
           1E MEAN       BELOW THE MEAN'/37X,'______________   ______________'    11750
           2/37X,'FREQUENCY MONTH    FREQUENCY   MONTH'/46X,'NUMBER               11760
           3NUMBER'/39X,'____     ____       ____      ____'/)                     11770
885         ISEAS =0                                                            00011780
886         LSEAS=0                                                             00011790
887          DO 489 I=1,12                                                      00011800
888        IF(LUPP(I).GE.2) ISEAS=ISEAS+1                                       00011810
889        IF(LDOWN(I).GE.2) LSEAS=LSEAS+1                                      00011820
890        IF((LUPP(I).GE.2).AND.(LDOWN(I).LT.2)) GO TO 490                     00011830
891        IF((LUPP(I).LT.2).AND.(LDOWN(I).GE.2)) GO TO 491                     00011840
892        IF((LUPP(I).GE.2).AND.(LDOWN(I).GE.2)) GO TO 474                     00011850
893        IF((LUPP(I).LT.2).AND.(LDOWN(I).LT.2)) GO TO 489                     00011860
894    490  PRINT 492,LUPP(I),I                                                 00011870
895    492  FORMAT('0',32X,I2,5X,'(',I2,')'/)                                   00011880
896         GO TO 489                                                           00011890
897    491  PRINT 493,LDOWN(I),I                                                00011900
898    493  FORMAT('0',50X,I2,6X,'(',I2,')'/)                                   00011910
899         GO TO 489                                                           00011920
900    474  PRINT 481,LUPP(I),I,LDOWN(I),I                                      00011930
901    481  FORMAT('0',39X,I2,5X,'(',I2,')',8X,I2,6X,'(',I2,')'/)                  11940
902         GO TO 489                                                           00011950
903    489  CONTINUE                                                            00011960
904         PRINT 494,ISEAS,LSEAS                                               00011970
905    494  FORMAT('0',24X,'THE NUMBER OF PAIRS OR TRIPLES DURING TWO OR THREE     11980
           1 YEARS WAS'/29X,'ABOVE AVERAGE:',2X,I2,6X,'BELOW AVERAGE:',2X,I2/)     11990
906         CONTINUE                                                            00012000
907        IF((ISEAS.EQ.1).AND.(LSEAS.EQ.1)) GO TO 476                          00012010
908        IF(((ISEAS.EQ.0).AND.(LSEAS.EQ.1)).OR.((ISEAS.EQ.1).AND.( LSEAS.EQ00012020
           1.0)).OR.((ISEAS.EQ.0).AND.(LSEAS.EQ.0))) GO TO 477                  00012030
909        IF((( ISEAS.GT.1).AND.(LSEAS.GT.1)).OR.((ISEAS.GT.1).AND.(LSEAS.EQ00012040
           1.1)).OR.((ISEAS.EQ.1).AND.(LSEAS.GT.1))) GO TO 478                  00012050
910        IF((( ISEAS.GE.2).AND.(LSEAS.EQ.0)).OR.((ISEAS.EQ.0).AND.(LSEAS.GE00012060
```

```
             1.2)))  GO TO 479                                                  00012070
 911    476    PRINT 480                                                        00012080
 912    480  FORMAT('0',32X,'THUS, THE LIKELIHOOD OF SEASONALITY SEEMS * REASON    12090
            1ABLE * '/)                                                         00012100
 913           GO TO 469                                                        00012110
 914    477    PRINT 471                                                        00012120
 915    471  FORMAT('0',32X,'THUS, THE LIKELIHOOD OF SEASONALITY SEEMS * VERY L    12130
            1OW *'/)                                                               12131
 916           GO TO 469                                                        00012150
 917    478    PRINT 467                                                        00012160
 918    467    FORMAT('0',32X,'THUS, THE LIKELIHOOD OF SEASONALITY SEEMS * HIGH    12170
```

```
     1*'/)                                                                  00012180
C                 IF SEASONALITY SEEMS LIKELY, RECLASSIFY THE               00012190
C                 NTS SIGNAL; THIS OVERRIDES N OR T                         00012200
      NTS1(KL) = SSS                                                        00012210
      NTS2(KL) = SSS                                                        00012220
      GO TO 469                                                             00012230
  479 PRINT 468                                                             00012240
  468 FORMAT('0',29X,'THUS, IT IS NOT POSSIBLE TO DETERMINE SEASONALITY        12250
     1BY THIS TEST'/)                                                       00012260
      GO TO 469                                                             00012270
  469 CONTINUE                                                              00012280
  472 CONTINUE                                                              00012290
C                                                                              12295
C                       SEASONAL FORECASTING PROCEEDS.                         12300
C                       - - - - - - - - - - - - - - -                          12301
       SEASOR = 0.                                                             12320
      ACTSQS = 0.                                                              12321
      ERSQS = 0.                                                               12322
      FORSQS = 0.                                                              12323
       SISERR = 0.                                                             12325
       SISSUM = 0.                                                             12326
       SROTER = 0.                                                             12330
       SEMAD  = 0.                                                             12340
      SEAFX = 0.                                                               12341
      SUMACS = 0.                                                              12342
      SUMFQS = 0.                                                              12343
      SUMRQS = 0.                                                              12344
      ZACTS = 0.                                                               12345
      THEILS = 0.                                                              12346
      ZDISPS = 0.                                                              12347
      ZVARS = 0.                                                               12348
      CBMAV = 0.                                                            00012350
      TSSIG(25) = 0.                                                           12367
      NALL1 = 0                                                             00012370
      NALL2 = 0                                                             00012380
      NALL3 = 0                                                             00012390
      NALL4 = 0                                                             00012400
      LSETCT = 0                                                               12402
      NSLOOP = 0                                                               12404
      SMRSE = 0.                                                               12406
      SEMRSE = 0.                                                              12407
      CBMAV1 = 0.                                                           00012410
      CBMAV2 = 0.                                                           00012420
      CBMAV3 = 0.                                                           00012430
      CBMAV4 = 0.                                                           00012440
       ADJDEM = 0.                                                             12441
      AVSER = 0.                                                               12442
C                                                                              12443
C                 A SIMPLE BROWN FORECASTING METHOD WAS FIRST ATTEMPTED.       12444
```

```
C         IT FAILED BECAUSE SOME SERIES WERE TOO ERRATIC,                    12445
C         LEADING TO EXCESSIVE DEMAND RATIOS.                                12446
C         THE SYSTEM PROGRAMMED HERE USES THE BASE SERIES FROM               12447
C         THE PREVIOUS TWO YEARS, TOGETHER WITH THE                          12448
C         TREND ADJUSTED FORECAST FROM THE PREVIOUS ROUTINE.                 12449
C         EACH MONTH A QUANTITY IS ADDED TO, OR TAKEN FROM  JXPECD           12450
C         DEPENDING UPON THE VALUE OF  SINDX FOR THAT MONTH.                 12451
C                                                                            12470
C         AN ADAPTIVE SIMPLE TRACKING SIGNAL IS USED.                        12475
C         START WITH THE FIRST VALUE OF GAMMA, AND                           12476
C         AUTOMATICALLY RAISE OR LOWER IT, DEPENDING                         12477
```

```
C               UPON THE SIZE OF ERROR AND THUS  TSSIG .                        12478
C                                                                               12600
C                                                                               12610
      PRINT 149                                                                 12620
  149 FORMAT('0',44X,'TABLE 3: SEASONAL FORECASTING.'/44X,'* * * * * * *        12630
     1 * * * * * * * * * '/)                                                    12640
      PRINT 402                                                                 12650
  402 FORMAT('0',35X,'TREND',43X,'TRIGG'/17X,'MONTH    BASE    ADJUSTED         12651
     1 SEASONAL  ACTUAL   SIGNED   SMOOTHED  TRACKING   DESEAS'  /17X,'N        12652
     2UMBER  SERIES   FORECAST  FORECAST  DEMAND   ERROR      M.A.D.    S       12653
     3IGNAL     DEMAND'/17X,42('* ') /)                                         12654
       IF (N .GE.72) MMM= 72                                                 00012690
      IF(N.GE.72) GO TO 416                                                  00012700
       IF (N .LT. 48) MMM=36                                                 00012710
      IF(N.LT.48)  GO TO 416                                                 00012720
       IF (N .LT. 60) MMM=48                                                 00012730
      IF(N.LT.60)  GO TO 416                                                 00012740
       IF (N.LT.72) MMM=60                                                   00012750
  416  CONTINUE                                                              00012760
C               24 MONTH TOTAL OF PAST DEMANDS:                              00012770
      DO 419 J=1,24                                                          00012780
  419  NALL1 = NALL1 + NEWDEM(J)                                             00012790
       CBMAV1 = NALL1/24.                                                    00012800
C               THE SEASONAL INDEX IS FORMED BY COMPARING                       12810
C               EACH MONTH DEMAND WITH THE AVERAGE                              12811
C               OF THE PRECEDING 24 MONTHS DEMAND.                              12812
       IF(CBMAV1.LE.0.) CBMAV1 = 1.                                          00012840
      IF(MMM.EQ.36) GO TO 418                                                   12850
       DC 423  J=13,36                                                          12860
  423 NALL2 = NALL2+ NEWDEM(J)                                                  12870
       CBMAV2 = NALL2/24.                                                       12880
       IF(CBMAV2.LE.0.) CBMAV2 = 1.                                             12890
      IF(MMM.EQ.48) GO TO 418                                                  012900
        DO 424 J=25,48                                                          12910
  424  NALL3 = NALL3 + NEWCEM(J)                                                12920
       CBMAV3 = NALL3/24.                                                       12930
       IF(CBMAV3.LE.0.) CBMAV3 = 1.                                             12940
      IF(MMM.EQ.60) GO TO 418                                                   12950
       DO 425 J=37,60                                                           12960
  425  NALL4 = NALL4 + NEWCEM(J)                                                12970
       CBMAV4 = NALL4/24.                                                       12980
       IF(CBMAV4.LE.0.) CBMAV4 = 1.                                             12990
  418  CONTINUE                                                                 13000
C                          SEASONAL INDEX                                       13001
C                          --------------                                       13002
C                                                                               13003
C               DIVIDE EACH CORRESPONDING PAIR OF MONTHS                        13004
C               OF THE PREVIOUS TWO YEARS BY  CBMAV  .                          13005
C               TO OBTAIN THE SEASONAL INDEX TO BE APPLIED                      13006
```

```
C               TO THAT SAME MONTH OF THE PRESENT YEAR.                      13007
            DC 426 I=25,36                                               00013010
            SINDX(I) = ((NEWDEM(I-24) + NEWDEM(I-12))/2)/CBMAV1              13020
           IF(SINDX(I).LE.0.) SINDX(I)= ((1./CBMAV1)/2.)                     13030
            IF(SINDX(I). LT.0.005) SINDX(I) = 0.005                          13031
      426  CONTINUE                                                      00013040
            IF(MMM.EQ.36) GO TO 420                                      00013050
            DO 427 I=37,48                                               00013060
            SINDX(I) = ((NEWDEM(I-24) + NEWDEM(I-12))/2)/CBMAV2              13070
           IF(SINDX(I).LE.0.) SINDX(I)= ((1./CBMAV2)/2.)                     13080
            IF(SINDX(I). LT.0.005) SINDX(I) = 0.005                          13081
```

```
  427 CONTINUE                                                          00013090
       IF(MMM.EQ.48) GO TO 420                                          00013100
       DO 428 I=49,60                                                   00013110
       SINDX(I) = ((NEWDEM(I-24) + NEWDEM(I-12))/2)/CBMAV3                 13120
      IF(SINDX(I).LE.0.) SINDX(I)= ((1./CBMAV3)/2.)                        13130
       IF(SINDX(I). LT.0.005) SINDX(I) = 0.005                             13131
  428 CONTINUE                                                          00013140
       IF(MMM.EQ.60) GO TO 420                                             13150
       DO 429  I=61,72                                                  00013160
       SINDX(I) = ((NEWDEM(I-24) + NEWDEM(I-12))/2)/CBMAV4                 13170
      IF(SINDX(I).LE.0.) SINDX(I)= ((1./CBMAV4)/2.)                        13180
       IF(SINDX(I). LT.0.005) SINDX(I) = 0.005                             13181
  429 CONTINUE                                                          00013190
  420  CONTINUE                                                         00013200
       SERROR(25) = NEWDEM(25) - SEFORX(25)                             00013210
       SNWMD(25) = ABS(SERROR(25) )                                        13213
       IF(N.GT.72) N=72                                                    13215
C                                                                          13218
C                                                                          13219
C               MAIN SEASONAL FORECASTING PROCEEDS.                        13220
C                                                                          13221
C               WE BEGIN WITH THE TREND ADJUSTED FORECAST: SXPECD ,        13223
C               WHICH IS ADJUSTED FOR SEASONAL VARIATION WITH SINDX        13224
C               AND THE SMOOTHING CONSTANT: ALPHA .                        13225
C               FORECAST ERRORS ARE CONTROLLED BY TRACKING SIGNAL.         13226
C               USING THE ADAPTIVE CONSTANT, ALPHA.                        13227
       DO 436 I=26, MMM                                                    13230
       STFORX(25) = TFORX(25)                                              13231
       SNEWTR(25) = PNEWTR(25)                                             13232
       IF(LSETOT.GT.0) LSETOT = LSETOT + 1                                 13235
C               CALCULATE THE SEASONAL FORECAST:                           13240
       STFORX(I) = (SA(KI)* KDATA(I-1)) + ((1.-SA(KI))* STFORX(I-1))       13245
       SCURTR(I) = STFORX(I) - STFORX(I-1)                                 13247
       SNEWTR(I) = (SA(KI)* SCURTR(I)) + ((1.-SA(KI))*SNEWTR(I-1))         13249
       SXPECD(I) = (STFORX(I))+ (((1.-SA(KI)) /SA(KI))* SNEWTR(I))         13251
      IF(SINDX(I).GT.1.00) SEFORX(I)=(SXPECD(I) * SINDX(I))                13260
      IF(SINDX(I).EQ.1.00)  SEFORX(I) = SXPECD(I)                          13261
      IF(SINDX(I).LT.1.00) SEFORX(I)= (SXPECD(I)-(SXPECD(I)*(1.-SINDX (I   13262
     1  ))))                                                               13263
       IF(SEFORX(I) .LT.1.0)  SEFORX(I) = 1.0                              13265
C               DESEASONALISED DEMAND IS COMPUTED BY DIVIDING              13270
C               ACTUAL DEMAND BY THE APPROPRIATE SEASONAL INDEX.           13271
C               THE RESULT  ADJDEM , SHOULD RESEMBLE THE TREND.            13272
       ADJDEM = KDATA(I) / SINDX(I)                                        13274
       SISERR = NEWDEM(I) - ADJDEM                                         13276
C               SIGNED ERROR, DESEASONALISED VALUES.                       13277
       SISSUM = SISSUM + SISERR                                            13278
C                                                                          13279
C                         ERROR EVALUATION.                                13281
```

```
      C            ___________________                                     13282
      C         A SIMPLE ADAPTIVE TRACKING SIGNAL IS USED: TSSIG           13283
1033          SERROR(I) = NEWDEM(I) - SEFORX(I)                            13284
1034          SEASOR = SEASOR + SERROR(I)                                  13285
      C         THE MEAN ABSOLUTE DEVIATION:                               13286
1035          SNWMD(I) = ((G(1)*AES(SERROR(I)))+ ((1.-G(1))* SNWMD(I-1)))  13287
1036          TSSIG(I) = TSSIG(I-1) + SERROR(I)                            13288
      C         TO COMPUTE THE ROOT MEAN SQUARE ERROR
1037          SMRSE = (SERROR(I)**2)                                       13289
1038          IF(((ABS(TSSIG(I)))/ SNWMD(I)).GE.4.) GO TO 380              13290
1039          IF(((ABS(TSSIG(I)))/ SNWMD(I)).LT.4.) NSLOOP = 0             13292
```

```
      GC TC 386
C              THE CUUNTER TO RAISE THE SMOOTHING CONSTANTS:
  380  NSLOOP = NSLOOP + 1
      IF ( NSLOOP.GE.3) GC TO 381
      IF ( NSLOOP.LT.3) GC TO 386
  381 IF(((ABS(TSSIG(I))) / SNWMD(I)).GE.6)  PRINT 390
  390 FORMAT('0',25X,'SEASCNAL ADJUSTMENT SEEMS UNSATISFACTORY: ADVISE M
     1ANAGEMENT *'/)
      IF(G(1).GT.0.3) G(1) = 0.6
      IF(G(1).EQ.0.3) G(1) = 0.5
      IF(G(1).LT.0.3) G(1) = 0.3
      IF (SA(KI).GT.0.3)  SA(KI) = 0.6
      IF (SA(KI).EQ.0.3)  SA(KI) = 0.5
      IF (SA(KI).LT.0.3)  SA(KI) = 0.3
C              START THE COUNTER TO REDUCE SMOOTHING CONSTANTS
      LSETOT = 1
      TSSIG(I) = 0.0
      PRINT 382, SA(KI) ,G(1)
  382 FORMAT('0',25X,'TR.SIG. SHOWS CCNTROL LIMIT IS EXCEEDED.'/25X,
     1'NEXT BUT ONE PERIOD ALPHA WILL INCREASE TO ',F4.2,' AND GAMMA TO
     2',F4.2/)
      NSLCCP = 0
      GO TO 386
  386 SROTER = SROTER + ABS(SERROR(I))
      IF(LSETOT.LT.4)  GO TO 432
      IF(LSETOT.GE.4) G(1) = (G(1) - 0.2)
      IF(LSETOT.GE.4)  SA(KI) = (SA(KI) - 0.2)
      PRINT 385, SA(KI), G(1)
  385 FORMAT('0',25X,'NEXT BUT ONE PERIOD ALPHA WILL REDUCE TO ',F4.2,'
     1AND GAMMA TO  ',F4.2/)
      IF(LSETOT.GE.3) LSETOT = 0
      IF(G(1).LT.0.05) G(1) = 0.05
      IF(G(1).LT.0.05)  SA(KI) = 0.05
  432 CONTINUE
      ERSQS = (SERROR(I) **2)
      FORSQS = (SEFORX(I)**2)
      SUMRQS = SUMRQS + ERSQS
      SUMFCS = SUMFQS + FCRSQS
      ACTSQS = (NEWDEM(I) **2)
      SUMACS = SUMACS + ACTSQS
  383 PRINT 384,I, SINDX(I), SXPECD(I), SEFORX(I), NEWDEM(I),SERROR(I),
     1  SNWMD(I), TSSIG(I), ADJDEM
  384 FORMAT('0',18X,I2,4X,F6.3,3X,2(F8.1,2X),I6,2X,2(F8.1,2X),F8.1,
     1 2X,F8.1/)
  436 CONTINUE
       GIFFY(KL) = G(1)
      MNM = (MMM-26)
      SEMAD = SROTER/MNM
      IF(N.GT.72) N=72
```

```
      AVSER = SEASOR/GNX
      NSY = (MMM-11)
C          COMPUTE ERROR EVALUATOR:
      ZVARS = SUMRQS/ MNM
      ZDISPS = SUMFQS / MNM
      ZACTS = SUMACS /MNM
      THEILS = (SQRT(ZVARS))/((SQRT(ZDISPS))+(SQRT(ZACTS)))
      IF (SMRSE.LE.0.) SEMRSE = 0.
      IF (SMRSE.LE.0.) GO TO  387
      SEMRSE = SQRT(SMRSE)
  387 CONTINUE
```

```
      DO 145  IV=NSY,MMM                                                13396
      SEAFX = SEAFX + SEFORX(IV)                                        13397
  145  CONTINUE                                                         13398
      SEFORX(KL) = SEFORX(MMM)                                          13400
C             BALSER MEASURES BALANCE (%) BETWEEN POSITIVE              13401
C             AND NEGATIVE ERROR VALUES OVER FORECAST PERIOD.           13402
C             A LOW VALUE INDICATES AN EVEN FORECAST.                   13403
      IF(SROTER.LE.0.) SRCTER=1.                                        13404
      BALSER = (SEASUR*100.)/(SROTER * .5)                              13405
      PRINT 415,AVSER, BALSER, SEMAD, SEASOR                            13406
  415 FORMAT('0',47X,'FORECASTING ERRORS AND EVALUATION.'/48X,'* * * * *13407
     1 * * * * * * * * * * *'/44X,'AVERAGE CUMULATIVE SIGNED ERROR :',  13408
     2F8.1/44X,'PERCENTAGE BALANCED ERROR',7X,':',F8.1/44X,'OVERALL MEAN 13409
     3 ABSOLUTE DEVIATION :',F8.1/44X,'TOTAL SIGNED ERROR',14X,':',F8.1 13410
     4 /)                                                               13411
      PRINT 440,SEMRSE, SISSUM, THEILS                                  13418
  440 FORMAT('0',43X,'ROOT MEAN SQUARE ERROR',10X,':',F8.1/44X,'TOTAL SI13419
     1GNED ERROR, DESEAS. DATA:', F8.1/44X,'THE THEIL COEFFICIENT',11X,'13420
     1:', F8.1/51X,13('* ') /)                                          13421
      PRINT 495                                                         13470
  495 FORMAT('0',50X,'SEASONAL FORECASTING PLOT.'/51X,'* * * * * * * * *13480
     1 * * * *'/)                                                       13490
      COMP15(KL) = AVSER                                                13492
      COMP16(KL) = BALSER                                               13493
      COMP17(KL) = SEMAD                                                13494
      COMP18(KL) = SEASOR                                               13495
       COMP21(KL) = SEMRSE                                              13496
      IF(N.LT.25)  GO TO 475                                            13500
      IF(N.GE.72) KZK = 72                                              13510
      IF(N.LT.72) KZK = MMM                                             13520
       KPK = (KZK-24)                                                   13530
        DC 568 IL=1,KPK                                                 13540
        ZV(IL)= SEFORX(IL+24)                                           13550
       ZW(IL) = (IL+24)                                                 13560
  568   CCNTINUE                                                        13562
        CWDTH = 0.                                                      13565
       WLN = N                                                          13566
       WON = (WLN -26.)                                                 13567
       CWDTF = 100.*(WON/WLN)                                           13568
       IF(CWDTH.LE.0.)  CWDTH = 0.50                                    13569
C               SORT FORECAST VALUES INTO LARGEST AND SMALLEST.         13580
C               THESE ARE ASSOCIATED WITH THE SIZE OF THE ORIGINAL      13581
C               DATA, AND THE VERTICAL AXIS OF EACH FORECAST            13582
C               GRAPH IS ADJUSTED ACCORDINGLY.                          13583
        SYP=0.                                                          13592
       SXP=0.                                                           13593
       SYP=ZV(1)                                                        13594
        DC 295 IT=2,KPK                                                 13595
       IF(ZV(IT)-SYP)296,296,297                                        13596
```

```
 297    SYP=ZV(IT)
 296    CONTINUE
        EBIG=SYP
C                 TO FIND THE SMALLEST VALUE
         SXP=ZV(1)
         DO 298 IS=2,KPK
        IF(SXP-ZV(IS)) 298,298,299
 299     SXP=ZV(IS)
 298     CONTINUE
        ESMALL=SXP
         UDIFFE=(EBIG-ESMALL)
```

```
          USETE=(60.*(UDIFFE/UDIFFA))                                    13608
          IF(USETE.GT.80.) USETE=80.                                     13609
C                 A PLOT IS MADE OF SEASONALLY ADJUSTED FORECAST         13610
C                                                * * GRAPH FIVE * *      13611
C                                                                        13612
                                                 ------------------      
          JIM = ITEMNO(KL)                                               13613
          CALL PLOT (ZW, ZV, (KZK-24), .9, .9, CWDTH,USETE,'*',JIM)      13614
          CONTINUE                                                       13618
          IF(N.LE.72) GO TO 500                                          13620
         IF (N.GT.72) PRINT 499                                          13630
  499    FORMAT('0',16X,'MORE DATA IS AVAILABLE. IT CAN BE USED IF THE PROG13640
        1RAMME IS SUITABLY EXTENDED.'/26X,'* * * * * * * * * * * * * * * * 13650
        2* * * * * * * * * * * * '/)                                     13660
          GO TO 475                                                      13670
  500     PRINT 473                                                      13680
  473    FORMAT('0',24X,'SUFFICIENT DATA IS LACKING FOR ADDITIONAL SEASONAL13690
        1 ANALYSIS.'/30X,'* * * * * * * * * * * * * * * * * * * * * * * *'/13700
        2 )                                                              13710
  475     CONTINUE                                                       13720
C                                                                        13721
C                             * * * * * * * * * * * * *                  13722
C                             EOQ SIMULATION SUBROUTINE                  13723
C                             * * * * * * * * * * * * *                  13724
           CALL EOQSIM ( UNITPB,EQSB,TRFX,SEAFX,EQDUB,KTOTAL,KL,ITEMN1)  13725
C
    6     CONTINUE                                                       13730
    7     CONTINUE                                                       13735
  148     PRINT 33                                                       13740
   33    FORMAT('0',31X,'* * * * * * * * * * * * * * * * * * * * * *'/)  13750
  560    CONTINUE                                                        13760
          MON(KL)=N                                                      13770
C                THIS ASSIGNS A SPECIFIC N VALUE TO EACH ITEM.           13780
C
          PRINT 21                                                       13800
   21    FORMAT('1',46X,'BRUNEL  UNIVERSITY'/39X,'FORECASTING AND INVENTORY 13801
        1 CONTROL'/48X,'FOR  HOSPITALS'/48X,'SUMMARY TABLES'/42X,'* * * * * 13802
        2 * * * * * * * * '/)                                            13803
C                                                                        13830
C                                                                        13831
C                        * * * * * * * * * * *                           13840
C                        *     STAGE FOUR     *                          13850
C                        * ANALYSIS BY VALUE  *                          13860
C                        *        A B C       *                          13870
C                        * * * * * * * * * * *                           13880
C                                                                        13885
C                FOR EACH DATA SET, COMPUTE ANNUAL EXPENDITURE: SPEND    13891
C                COMPARE BY USING DECISION RULE, SUCH AS:                13892
C                    A:    GREATER THAN $2000                            13893
C                    B:    BETWEEN $500 AND $2000                        13894
```

```
      C                     C:    LESS THAN $500                                          13895
      C                                                                                   13896
      C                 THEN SORT INTO DESCENDING ORDER                                   13897
      C                 THIS ROUTINE IS PERFORMED EVERY SIX MONTHS                        13898
      C                            OR AS REQUIRED.                                        13899
1157          PRINT 14                                                                    13900
1158       14 FORMAT('0',50X,'* TABLE 1 *'/45X,'* * A.B.C. ROUTINES * *'/49X,             13910
             1 '* * * * * * * * * *'/)                                                    13911
1159          PRINT 585                                                                   13920
1160      585 FORMAT('0',                     42X,'A.B.C. ROUTINES: INPUT SEQUENCE'       13930
             1/      39X,'ITEM           QUANTITY  $VALUE    A.B.C.'/38X,'NUMBER          13950
```

```
     2      USED      /YEAR '/38X,'______          ____     _____     _____'
     3/)
        DO 580 KL=1,ML
        SPEND(KL)=KTOTAL(KL)*UNITPA(KL)
       IF(SPEND(KL).GE.2000.) ABC1(KL)= AAA
       IF(SPEND(KL) .GE.2000.) GO TO 592
       IF( SPEND(KL).GE.500.) ABC1(KL) = BBB
       IF(SPEND(KL) .GE. 500.) GO TO 592
        IF( SPEND(KL).LT.500.) ABC1(KL)=CCC
  592   CONTINUE
        ABC2(KL)=ABC1(KL)
        ABC3(KL)= ABC1(KL)
        ABC4(KL) = ABC1(KL)
        PRINT 587, ITEMNO(KL),KTOTAL(KL),SPEND(KL),ABC1(KL)
  587  FORMAT('0',36X,I8,5X,I7,3X,F8.0,5X,A1/)
  580   CONTINUE
C                THE END OF THE A B C  CLASSIFICATION
C                NOW SORT INTO $VALUE ORDER:
        PRINT  755
  755  FORMAT('0',38X,          'A VERY LOW VALUE ABOVE MAY INDICATE'/
     138X,'AN ITEM WITH LESS THAN SIX MONTHS DATA.'/)
        PRINT 594
  594   FORMAT('1',52X,'* TABLE 2 *'/52X,'* * * * * * *'/)
        PRINT 584
  584  FORMAT('0',42X,'A.B.C. ANALYSIS IN VALUE ORDER.'/
     1                      47X,'ITEM        ANNUAL'/46X,'NUMBER
     2$VALUE   A.B.C.'/46X,'______      ______    ______'/)
       IF( ML.GE.2) GO TO 578
       IF( ML.LT.2) PRINT 579
  579  FORMAT('0',42X,'TOO FEW ITEMS TO PERMIT SORTING.'/)
        GO TO 591
  578  CONTINUE
       ML1=(ML-1)
        DO 582 JB=1,ML1
        JB1=JB+1
        DO 582 JI=JB1,ML
       IF(SPEND(JI)-SPEND(JB)) 582,583,583
  583   XTEMP=SPEND(JB)
        XTEMPO = ITEMN6(JB)
        XTEMPA = ABC4(JB)
        SPEND(JB)=SPEND(JI)
        ITEMN6(JB)=ITEMN6(JI)
        ABC4(JB) = ABC4(JI)
        SPEND(JI)=XTEMP
        ITEMN6(JI)= XTEMPO
        ABC4(JI)=XTEMPA
  582  CONTINUE
        DC 590  JI=1,ML
       IF(SPEND(JI).GE.2000.)ABC4(JI) = AAA
```

```
      IF (SPEND(JI).GE.2000.)  GO TO 593                                00014400
      IF(SPEND(JI).GE.500.)ABC4(JI) = BBB                               00014410
      IF (SPEND(JI).GE.500. )  GO TO 593                                00014420
      IF(SPEND(JI).LT.500.) ABC4(JI)=CCC                                00014430
  593 CONTINUE                                                          00014440
       ABC1(JI)=ABC4(JI)                                                00014450
        ABC3(JI)=ABC1(JI)                                               00014460
       PRINT 589, ITEMN6(JI),SPEND(JI),ABC1(JI)                         00014470
  589 FORMAT('0',43X,I8,4X,F8.0,6X,A1/)                                    14480
  590 CONTINUE                                                          00014490
  591  CONTINUE                                                            14492
```

```
C                                                                                 14493
C                                                                                 14494
C              * * * * * * * * * * * * * * * * * *                             00014510
C              *              STAGE  FIVE          *                              14520
C              *                                   *                           00014530
C              * BIANNUAL ECONOMIC ORDER QUANTITY*                             00014540
C              *           DETERMINATION           *                           00014550
C              * * * * * * * * * * * * * * * * * *                             00014570
C                                                                              00014580
      PRINT 803                                                                00014590
  803 FORMAT('1',54X,'* TABLE 3 *'/54X,'* * * * * * *'/)                          14600
      PRINT 800                                                                00014610
  800 FORMAT('0',45X,'ECONOMIC ORDER QUANTITY REPORT'/46X,'_ _ _ _ _ _ _ _ _ _00014620
     1         '/28X,'ITEM    COST    COST   BASIC   DISC  DEMAND                 14630
     2BASIC   BEST  LOWEST MARGIN.'/27X,'NUMBER     TO      TO     PRICE  C         14640
     3ODE  FOREC.  E.O.Q   DISC.  DISC.   COST'/35X,'ORDER    HOLD                 14650
     4                          PRICE    QTY     IN $          '/28X,'_ _          14660
     5_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _'/)                                  14670
      DO 801 LL=1,ML                                                           00014680
      N = MON(LL)                                                              00014690
C             THE MAIN LOOP FOR EOQ ROUTINES                                   00014700
      ALCPRI = 0.                                                              00014710
      NOORDS(LL)=0                                                             00014720
      NORD1(LL)=0                                                              00014730
      NORD2(LL)=0                                                              00014740
      NORD3(LL)=0                                                              00014750
      NORD4(LL)=0                                                              00014760
      DISEOQ =0.                                                               00014770
      LEOQ1(LL)=0                                                              00014780
      LEOQ2(LL)=0                                                              00014790
      LEOQ3(LL)=0                                                              00014800
      LEOQ4(LL)=0                                                              00014810
      TCST1(LL)=0.                                                             00014820
      TCST2(LL)=0.                                                             00014830
      TCST3(LL)=0.                                                             00014840
      TCST4(LL)=0.                                                             00014850
      TOTCST(LL)=0.                                                            00014860
      JDMAND(LL)=0                                                             00014870
      NCOSTS=0                                                                 00014880
C             TEST IF THE ITEM IS BEING RUN DOWN                               00014890
C             FOR ITEMS BELOW 12, A ROUGH E.O.Q. IS CALCULATED:                00014900
      IF(N.LT.12) JDMAND(LL) = (KDATA(N)+KDATA(N-1) + KDATA(N-2))*4            00014910
      IF(N.LT.12) GO TO 806                                                    00014920
      IF(N.GE.12) CONTINUE                                                     00014930
C             TEST FOR TREND ITEM, AND ADJUST                                  00014940
C             ANNUAL DEMAND ACCORDINGLY.                                       00014950
      JTREND=0                                                                 00014960
C             IF TREND APPEARS WEAK, USE REGULAR DEMAND EVALUATION             00014970
      IF(JPATT.LT.1) GO TO 804                                                 00014980
```

```
     C                 IF TREND APPEARS STRONG, ADD (OR SUBTRACT)
     C                 HALF THE RISE (FALL) OVER THE PAST YEAR,
     C                 TO THE ANTICIPATED DEMAND FOR THE NEXT 12 MONTHS.
1243           IF(( JPATT.GE.1).AND.(AMID2.LT.AMID1)) JTREND=1
1244           IF(( JPATT.GE.1).AND.(AMID2.GT.AMID1)) JTREND=2
     C                 NOW CALCULATE THE ANNUAL DEMAND EXPECTED
     C                 FOR "REGULAR" DATA:
1245      804  CONTINUE
1246           JDMAND(LL)=KTOTAL(LL)
1247           IF(JTREND.EQ.0) GO TC 806
1248           IF(JTREND.EQ.1) JDMAND(LL)=EQDUB(LL) * 0.75
```

```
1249          IF(JTREND.EQ.2) JDMAND(LL)=EQDUB(LL) * 1.25                    15100
1250    806    CCNTINUE                                                   00015110
1251          IF(JDMAND(LL).LE.0) JDMAND(LL) = 2                          00015120
1252           PRCD1(LL) = (HLDCST(LL)*UNITPA(LL))                        00015130
1253          IF(PRCD1(LL).LE.0) PROD1(LL)=0.02                           00015140
       C               THESE SHOULD AVOID THE DANGER OF ZERO DIVISION.    00015150
       C               COMPUTE EOQ FOR ALL DATA ITEMS.                    00015160
       C               SEASONALS MAY REQUIRE SPECIAL TREATMENT:           00015170
       C               THE PROBLEM IS AT PRESENT IGNORED.                 00015180
1254           ECCN1(LL)=SQRT((2.0*JDMAND(LL)*CSTORD(LL)) / PROD1(LL))    00015190
       C               WE COULD LOOP DIFFERENT HOLDING AND ORDER COSTS    00015200
       C               IF REQUIRED, THUS: DO XXX J=1,IT                   00015210
       C                                  DO XXX I=1,IN                   00015220
       C                                  DO XXX K=1,KN                   00015230
       C               WHERE THESE HAVE BEEN ENTERED AS DATA EARLIER.     00015240
       C               THEN    JECON1(J,I,K)=     (J),      (I),      (K) 00015250
       C                                   XXX CONTINUE                   00015260
       C                                                                     15270
       C                           DISCOUNT ALLOWANCE                        15272
       C                                                                     15273
       C                           - - - - - - - - - -                       15274
       C               IF DISCOUNTS ARE ALLOWED: 1    IF NOT, 0              15280
1255           JECON1(LL)=ECON1(LL)                                          15290
1256           IF(JECON1(LL).LE.0)JECCN1(LL)=2                               15300
1257           NOORDS(LL)=JDMAND(LL)/JECON1(LL)                              15310
1258          IF(LDISC(LL).EQ.1) GC TO 807                                   15320
1259          IF(LDISC(LL).NE.1) GC TO 825                                   15330
1260     807   CONTINUE                                                      15340
1261           NOCRDS(LL)=JDMAND(LL)/JECON1(LL)                              15350
1262           TOTCST(LL)=((JDMAND(LL)*UNITPA(LL))+(CSTORD(LL)*NOORDS(LL))+  15360
             1(HLDCST(LL)*(JECON1(LL)/2)*UNITPA(LL)))                        15370
1263           NCCSTS=1                                                      15380
       C               THIS PROVIDES TOTAL INVENTORY COST AT BASE PRICE.     15390
       C               NOW ITERATE ALL THE PRICE BREAKS: MAXIMUM             15400
       C               OF FOUR ALLCWED( INCLUDING BASE, NDISC CAN BE 5)      15410
1264          IF(NDISC(LL).LT.2) GO TO 826                                   15420
       C               TAKE CARE THAT DATA CARDS DO HAVE THE NUMBER          15430
       C               OF PRICE BREAKS PUNCHED IN.                           15440
       C               IF OMITTED, THE PROGRAMME WILL ALWAYS LCOP OUT.       15450
1265           PRCD1(LL) = (HLDCST(LL)*UNITPA(LL))                           15460
1266          IF(PROD1(LL).LE.0) PROD1(LL)=0.02                              15470
1267           EOQ1(LL)=SQRT((2.0*JDMAND(LL)*CSTORD(LL))/PROD1(LL) )         15480
1268           LECC1(LL)= EOQ1(LL)                                           15490
1269          IF(LEOQ1(LL).LE.0)   LEOQ1(LL)=2                               15500
1270           NORD1(LL) = JDMAND(LL)/LEOQ1(LL)                              15510
1271             TCST1(LL)=((JDMAND(LL)*PRI1(LL))   +(CSTORD(LL)*NORD1(LL)) + 15520
             1(HLDCST(LL)*( LEOQ1(LL) /2)*PRI1(LL)))                      00015530
1272           NCCSTS = 2                                                 00015540
1273          IF(NDISC(LL).LT.3) GC TO 826                                00015550
```

```
1274      PRCD2(LL) = (HLDCST(LL)*UNITPA(LL))
1275     IF(PROD2(LL).LE.0) PROD2(LL)=0.02
1276      ECQ2(LL)=SQRT((2.0*JDMAND(LL)*CSTORD(LL))/ PROD2(LL) )
1277      LECQ2(LL)= EOQ2(LL)
1278     IF(LEOQ2(LL).LE.0)  LEOQ2(LL)=2
1279      NORD2(LL) = JDMAND(LL)/LEOQ2(LL)
1280       TCST2(LL)=((JDMAND(LL)*PRI2(LL))   +(CSTORD(LL)*NORD2(LL)) +
         1(HLDCST(LL)*( LEOQ2(LL) /2)*PRI2(LL)))
1281      NCOSTS = 3
1282     IF(NDISC(LL).LT.4) GO TO 826
1283      PRCD3(LL) = (HLDCST(LL)*UNITPA(LL))
```

```
      IF(PROD3(LL).LE.0) PROD3(LL)=0.02
       EOQ3(LL)=SQRT((2.0*JDMAND(LL)*CSTORD(LL))/ PROD3(LL) )
       LEOQ3(LL)= EOQ3(LL)
      IF(LEOQ3(LL).LE.0)  LEOQ3(LL)=2
       NORD3(LL) = JDMAND(LL)/LEOQ3(LL)
        TCST3(LL)=((JDMAND(LL)*PRI3(LL))  +(CSTORD(LL)*NORD3(LL)) +
     1(HLDCST(LL)*( LEOQ3(LL) /2)*PRI3(LL)))
       NCOSTS = 4
       IF(NDISC(LL).LT.5) GO TO 826
       PROD4(LL) = (HLDCST(LL)*UNITPA(LL))
      IF(PROD4(LL).LE.0) PROD4(LL)=0.02
       EOQ4(LL)=SQRT((2.0*JDMAND(LL)*CSTORD(LL))/ PROD4(LL) )
       LEOQ4(LL)= EOQ4(LL)
      IF(LEOQ4(LL).LE.0)  LEOQ4(LL)=2
       NORD4(LL) = JDMAND(LL)/LEOQ4(LL)
        TCST4(LL)=((JDMAND(LL)*PRI4(LL))  +(CSTORD(LL)*NORD4(LL)) +
     1(HLDCST(LL)*( LEOQ4(LL) /2)*PRI4(LL)))
        NCOSTS=5
  826 CONTINUE
C              NOW COMPUTE THE LOWEST OF THE FIVE TOTAL COSTS.
C              AND SELECT THE EOQ AND PRICE AT THAT COST LEVEL
C              NCOSTS IS A COUNTER TO ASSIST
C              THE LOOPING OF LOCOST.
       LOCOST = TOTCST(LL)
      ALOPRI = UNITPA(LL)
       DISEOQ = JECON1(LL)
       IF(NCOSTS.EQ.1) GO TO 820
       IF(TCST1(LL) .GE.LOCOST) GO TO 821
      IF(TCST1(LL).LT.LOCOST) LOCOST=TCST1(LL)
      ALOPRI=PRI1(LL)
      DISEOQ = JQUAN1(LL)
  821  CONTINUE
       IF(NCOSTS.EQ.2) GO TO 820
       IF(TCST2(LL) .GE.LOCOST) GO TO 822
      IF(TCST2(LL).LT.LOCOST) LOCOST=TCST2(LL)
      ALOPRI=PRI2(LL)
      DISEOQ = JQUAN2(LL)
  822  CONTINUE
       IF(NCOSTS.EQ.3) GO TO 820
       IF(TCST3(LL) .GE.LOCOST) GO TO 823
      IF(TCST3(LL).LT.LOCOST) LOCOST=TCST3(LL)
      ALOPRI=PRI3(LL)
      DISEOG = JQUAN3(LL)
  823  CONTINUE
       IF(NCOSTS.EQ.4) GO TO 820
       IF(TCST4(LL) .GE.LOCOST) GO TO 824
      IF(TCST4(LL).LT.LOCOST) LOCOST=TCST4(LL)
      ALOPRI=PRI4(LL)
      DISEOG = JQUAN4(LL)
```

```
 824   CONTINUE
       JECON2(LL) = JECON1(LL)
       JECON4(LL) = JECON1(LL)
 820   CONTINUE
      LOWCST(LL) = LOCOST
      DISPR1(LL) =ALOPRI
       KDISQI(LL) = DISEOQ
 825  CONTINUE
      IF(LDISC(LL).EQ.1) GC TO 827
      IF(LDISC(LL).NE.1) DISPR1(LL)=UNITPA(LL)
       KDISQI(LL)= JECON1(LL)
```

```
1338          TCTCST(LL)=((JDMAND(LL)*UNITPA(LL))+(CSTORD(LL)*NOORDS(LL)) +      00016270
             1(HLDCST(LL)*(JECUNI(LL)/2)*UNITPA(LL)))                            00016280
1339           LOWCST(LL)=TOTCST(LL)                                              00016290
1340      827  CONTINUE                                                           00016300
1341           IF( N.LT.12) DISPRI(LL)=UNITPA(LL)                                 00016310
1342           IF(NRPSIG(LL).EQ.9)  JECONI(LL)= 0                                 00016320
1343            PRINT 809,ITEMNI(LL),CSTORD(LL),HLDCST(LL),UNITPA(LL),LDISC(LL), 00016330
             1JDMAND(LL),JECONI(LL),DISPRI(LL),KDISQI(LL),LOWCST(LL)              00016340
1344      809  FORMAT('0',24X,I8,2X,F5.2,3X,F4.2,2X,F6.2,3X,I1,3X,I6,2X,I6,1X,       16350
             1  F6.2,2X,I5,2X,I6/)                                                00016360
1345      801   CONTINUE                                                          00016370
       C                                                                          00016380
       C                    THE END OF HALF YEARLY E.O.Q. RUN.                    00016390
       C                    * * * * * * * * * * * * * * * * * *                      16400
       C                                                                             16401
       C                                                                             16402
       C                      * * * * * * * * * * * * * *                            16420
       C                      *       * STAGE  SIX *     *                           16430
       C                      * QUARTERLY REORDER POINT  *                           16450
       C                      *       *  UPDATE    *     *                           16460
       C                      * * * * * * * * * * * * * *                            16470
       C                                                                          00016472
       C                                                                          00016480
       C               HEADINGS FOR ROP REPORTS                                   00016490
1346            PRINT 639                                                         00016500
1347      639  FORMAT('1',57X,'* TABLE 4 *'/)                                     00016510
1348            PRINT 640                                                         00016520
1349      640  FORMAT('0',45X,'REORDER POINT:QUARTERLY CALCULATION'/45X,'* * * *  00016530
             1 * * * * * * * * * * * * * * *'/)                                   00016540
1350            PRINT 641                                                         00016550
1351      641  FORMAT('0',34X,'ITEM              AV    LT  SERVICE        SAFETY REORD  16560
             1ER ACTION'/34X,'NUMBER    ABC    LT    DEM.  LEVEL   EOQ    STOCK  POI   16561
             2NT   CODE'/34X,'_______   ___    __    ____  _____   ___    _____  ___   16562
             3__   _____'/)                                                          16563
       C                     CODE IDENTIFICATIONS                                    16565
       C                     * * * * * * * * * *                                     16566
       C                                                                             16567
       C               THE SRIM FILE HOLDS NRPSIG WHICH INDICATES:                00016600
       C                                                                          00016610
       C                0   NORMAL SITUATION WITH REGULAR CALCULATIONS            00016620
       C                1   STOCKS ARE AT OR BELOW ROP: MANAGEMENT ADVISED        00016630
       C                2   NOD IS LESS THAN 12. SINCE STCX NOW AT ROP, NEW       00016640
       C                   ORDER RECOMMENDED. WHEN FINI DONE, CODE BECOMES 0      00016650
       C                5   NOD BELOW 6: MANAGEMENT CAN PROVIDE VALUES IF DESIRE00016660
       C                6   NOD ABOVE 6: TEMP. ROUTINES BEING PERFORMED           00016670
       C                7   THERE IS A QUERY FOR MANAGEMENT                       00016680
       C                8   NOD IS NOW 6: PRELIM. FORECASTING                     00016690
       C                    WILL BEGIN NEXT PERIOD                                00016700
       C                9   STOCKS BEING RUN DOWN. GO TO NEXT ITEM                00016710
```

```
C                   * * * * * * * * *
C
C       OTHER CODES ARE MSAGE (IN AFM) AND MCODE (IN EOQ):
C       90   NEW ITEM WITH 6 DATA PCINTS: PRELIMS WILL COMMENCE
C       94   12 ITEMS NOW: CAN DO REGULAR ROUTINES
C       95   BETWEEN 6 AND 12: PRELIMS ARE STILL OPERATING
C       97   EOQ IS SUPP. BY MGT. DO NOT ALTER UNLESS ADVISED
C       98   MGT. DECIDED TO RUN DOWN THE ITEM. IGNORE ROP
C       99   NEW ITEM (LESS THAN 6): GO TO NEXT ITEM
C                 * * * * * * * * * *
1352       DO 650 KL=1,ML
```

```
      N = MON(KL)
      IF(N.LT.6) GO TO 602
      IF(N.EQ.6) GO TO 604
      IF(N.GT.6.AND.N.LT.12) GO TO 615
      IF(N.EQ.12) GO TO 614
      IF(N.GT.12) GO TO 612
  602 IF(NRPSIG(KL).NE.9)  NRPSIG(KL)=5
      IF(  NRPSIG(KL).NE.9) MCODE(KL) = 99
      IF(  NRPSIG(KL).NE.9) MSAGE(KL)=99
      NOD(KL)=N
      GC TO 690
  604 IF(NRPSIG(KL).NE.9)  NRPSIG(KL)=8
      IF(  NRPSIG(KL).NE.9) MCODE(KL) = 90
      IF(  NRPSIG(KL).NE.9) MSAGE(KL)=90
      NOD(KL)=6
      GO TO 690
  615 IF(NRPSIG(KL).NE.9)  NRPSIG(KL)=6
      IF(  NRPSIG(KL).NE.9) MCODE(KL) = 95
      IF(  NRPSIG(KL).NE.9) MSAGE(KL)=95
      NOD(KL)=N
      GO TO 690
C             THIS APPLIES TO ITEMS FOR WHICH 12 VALUES
C             ARE NOW AVAILABLE. A FULL FORECAST RUN OF THE
C             PRELIMINARY KIND WILL BE PERFORMED FOR ABC,
C             NEWMAD, AVLT ETC. THEN ROP DONE.
  614 IF(NRPSIG(KL).NE.9)  NRPSIG(KL)=0
      IF(  NRPSIG(KL).NE.9) MCODE(KL) = 94
      IF(  NRPSIG(KL).NE.9) MSAGE(KL)=94
      NOD(KL)=12
      GC TO 616
  612 IF(NRPSIG(KL).NE.9)  NRPSIG(KL)=0
      IF(  NRPSIG(KL).NE.9) MCODE(KL) = 94
      IF(  NRPSIG(KL).NE.9) MSAGE(KL)=94
      NOD(KL)=12
C             LEAD TIMES ARE ROUNDED UP TO NEAREST HALF MONTH.
C             IF SHORTER THAN 0.5 MONTH, USE 0.5 TO ALLOW
C             FOR THE TIME REQUIRED TO PROCESS THE ORDER.
  616 IF(AVLT1(KL) .LE.0.5) GO TO 622
      IF(AVLT1(KL).GT.0.5.AND.AVLT1(KL).LE.1.0) GO TO 619
      IF(AVLT1(KL).GT.1.0.AND.AVLT1(KL).LE.1.5) GO TO 620
      IF(AVLT1(KL).GT.1.5.AND.AVLT1(KL).LE.2.0) GO TO 621
      IF(AVLT1(KL).GT.2.0) PRINT 617,ITEMNI(KL),AVLT1(KL)
  617 FORMAT('0',23X,    'ITEM',1X,I8,1X,'AVERAGE LEAD TIME IS',2X,F4.1,
     1 1X,'MONTHS. HERE WE USE THREE MONTHS.'/)
      AVLT1(KL)=3.0
       GC TO 618
  622 AVLT1(KL)=0.5
      GO TO 618
  619 AVLT1(KL)=1.0
```

```
      GO TO 618                                                         00017300
  620 AVLT1(KL)=1.5                                                     00017310
      GO TO 618                                                         00017320
  621 AVLT1(KL)=2.0                                                     00017330
      GO TO 618                                                         00017340
  618 AVLT2(KL)=AVLT1(KL)                                               00017350
      AVLT3(KL)=AVLT1(KL)                                               00017360
  690 CONTINUE                                                          00017370
C                                                                       00017380
C                         SAFETY STOCK CALCULATIONS.                       17390
C                         - - - - - - - - - - - - -                        17391
```

```
C
      MADSS(KL) = JNWMD1(N)                                             00017410
      IF(MADSS(KL).LE.0) MADSS(KL)=1                                    00017420
C              THIS FINAL MAD VALUE IS USED LATER (REORDER).            00017430
      IF(N.LT.12) MADSS(KL) = 1                                         00017440
      IF(N.LT.12) JNWMD1(KL) = 1                                        00017450
       MADLT(KL)=(1.25*AVLT1(KL)*MADSS(KL))                             00017460
      IF (MADLT(KL).LE.0)  MADLT(KL)=1                                  00017470
C              THIS IS TO AVOID DIVISION BY ZERO                        00017480
      IF( JECON1(KL).LE.0) JECON1(KL)=2                                 00017490
      IF( JECON1(KL).LE.0) KDISQI(KL)=2                                    17491
      IF(NRPSIG(KL).EQ.9) JECON1(KL)=2                                  00017500
      IF(NRPSIG(KL).EQ.9) KDISQI(KL)=2                                     17501
C              A SIMPLE ESTIMATOR OF SAFETY STOCKS IS NOW                  17510
C              PROVIDED, BASED ON RECENT M.A.D.,                           17511
C              A CHOSEN SERVICE LEVEL, AND RECENT FORECAST.                17512
C              WE ASSUME THAT ERRORS ARE NORMALLY DISTRIBUTED.             17513
       LTDEM1(KL)= MFORX(KL)* AVLT1(KL)                                    17600
      IF(AVLT1(KL).LT.1.0)LTDEM1(KL)=MFORX(KL)                             17610
       IF( SLEVEL(KL).LT.0.95) SAFACT(KL) = 1.30                           17620
       IF( SLEVEL(KL).EQ.0.95) SAFACT(KL) = 1.65                           17621
       IF( SLEVEL(KL).EQ.0.97) SAFACT(KL) = 1.90                           17622
       IF( SLEVEL(KL).EQ.0.98) SAFACT(KL) = 2.06                           17625
       IF( SLEVEL(KL).EQ.0.99) SAFACT(KL) = 2.34                           17626
       IF( SLEVEL(KL).GT.0.99) SAFACT(KL) = 2.60                           17627
        SAFTY(KL)=MADLT(KL)*SAFACT(KL)                                  00017660
      IF(SAFTY(KL).LT.1.) SAFTY(KL) = 1.                                00017670
C                                                                          17672
C                       REORDER LEVEL CALCULATIONS.                        17695
C                       - - - - - - - - - - - - - - -                      17696
C                                                                          17697
       RCP(KL) = (SAFTY(KL)*(SQRT(AVLT1(KL))) + LTDEM1(KL))                17700
        KROP(KL)=ROP(KL)                                                00017710
       LRCP(KL)=KROP(KL)                                                00017720
      IF(N.GE.12) GO TO 802                                             00017730
      IF(N.LT.12) SAFTY(KL)=0.5*JDMAND(KL)                              00017740
      IF(JDMAND(KL).LT.1) JDMAND(KL)=1                                  00017750
       IF(SAFTY(KL).LT.1.)SAFTY(KL)=1.                                  00017760
      KROP(KL)= SAFTY(KL)+KDATA(N)+KDATA(N-1)                           00017770
C              THESE ARE ESTIMATES OF FINAL VALUES. IF ITEMS BELOW 12.  00017780
  802 CONTINUE                                                          00017790
       IF(NRPSIG(KL).EQ.9) SAFTY(KL)=0.                                 00017800
       IF(NRPSIG(KL).EQ.9)  KROP(KL)=0                                  00017810
      IF(NRPSIG(KL).EQ.9) KDISQI(KL)=0                                     17820
  698  PRINT 699,ITEMN3(KL),ABC2(KL),AVLT2(KL),LTDEM1(KL),SLEVEL(KL),   00017830
     1 KDISQI(KL), SAFTY(KL),KROP(KL),MCODE(KL)                            17840
  699 FORMAT('0',31X,I8,4X,A1,2X,F4.1,1X,I5,3X,F4.2,1X,I6,2X,F5.0,1X,I6,   17850
     1 5X,I2/)                                                             17860
  650  CONTINUE                                                            17870
```

```
      NTEST = 0
      DO 799 KL=1,ML
       IF(NRPSIG(KL).NE.9) GO TO 799
       IF(NRPSIG(KL).EQ.9) GO TO 613
613   MCODE(KL)=98
      MSAGE(KL)=98
      NRPSIG(KL)=9
      NTEST=NTEST + 1
      IF(NTEST.EQ.1) GO TO 798
      IF (NTEST.GT.1) GO TO 797
798   CONTINUE
```

```
      PRINT 605
605  FORMAT('1',50X,'* TABLE 5 *'/46X,' QUARTERLY REORDER POINT:'/48X,
    1'ITEMS BEING RUN DOWN'/48X,'* * * * * * * * * *'/34X,'PLEASE CHECK
    2.......'/49X,'ITEM      CURRENT '/48X,'NUMBER     BALANCE'/48X,
    3 '______      ______'/)
610   CONTINUE
797   CONTINUE
      PRINT 611,ITEMN1(KL),JSTOX(KL)
611  FORMAT('0',47X,I8,3X,I5/)
799   CONTINUE
C                                   *
C         END OF THE QUARTERLY REORDER POINT ROUTINES
C              * * * * * * * * * * * * * * * * *
C
C
C                   * * * * * * * * * * * * *
C                   *    * STAGE  SEVEN *    *
C                   *  DAILY REORDER REVIEW  *
C                   * * * * * * * * * * * * *
C
C              TO FOLLOW THE QUARTERLY ROP ROUTINE.
      PRINT 683
683  FORMAT('1',54X,'* TABLE 6 *'/54X,'* * * * * * *'/)
      PRINT 681
681  FORMAT('0',46X,'REORDER POINT DAILY ROUTINE.'/
    1                 32X,' ITEM    CRDER   STOCK   ON       BACK    FREE
    2       ROP'/31X,'NUMBER   POINT   ON HAND ORDER   ORDER   STOCK     E.O.
    3Q.  SIGNAL '/31X,'_ _ _   _ _ _  _ _ _ _ _ _ _ _  _ _ _  _ _ _   _ _
    4 _ _ _ _'/)
      DO 680 KL = 1,ML
      N = MON(KL)
      JFREST(KL) =(JSTOX(KL)+JONORD(KL)- JBKORD(KL))
      IF(N.LT.6) GO TO 676
      IF(NRPSIG(KL).NE.9) GO TO 632
      IF(NRPSIG(KL).EQ.9) GO TO 631
631   MCODE(KL) = 98
      MSAGE(KL) = 98
      GO TO 676
632   CONTINUE
      IF(KROP(KL).LT.JFREST(KL)) NRPSIG(KL)=0
      IF(KROP(KL).LT.JFREST(KL)) GO TO 679
C             THIS SIGNALS THAT THERE IS NO EVIDENT NEED
C             TO PLACE A NEW ORDER.
      IF(KROP(KL).GE.JFREST(KL)) NRPSIG(KL) = 1
C             AN ORDER IS PLACED FOR THE E.O.Q.
C             UNLESS OTHERWISE DETERMINED.
      JONORD(KL) = JONORD(KL)+KDISQI(KL)
C             TO ADJUST FOR THE POSSIBILITY THAT THIS MAY NOT
C             BRING THE BALANCE ABOVE THE ROP, WE AMEND:
```

```
      IF(JONORD(KL).LT.KROP(KL)) JONORD(KL)=(JONORD(KL)+JBKORD(KL)-
     1 JSTOX(KL) )
      IF(JONORD(KL).LT.KROP(KL)) JONORD(KL)=KROP(KL)+JBKORD(KL)
C               IF SEVERAL MONTHS ARE BEING SIMULATED,
C               WE WOULD PROVIDE STOCK BALANCES FOR
C               EACH MONTH, AND DETAILED TRANSACTIONS.
       GO TO 676
  679  CCNTINUE
  676  CONTINUE
      IF(N.LT.6) NRPSIG(KL ) = 5
C               THE TABULATION SHOWS THE END OF DAY POSITION,
```

```
      C                 AFTER THE ORDERS HAVE BEEN PLACED.                                18586
1479           PRINT 677,ITEMN3(KL),KROP(KL),JSTOX(KL),JONORD(KL),JBKORD(KL),          00018590
             1 JFREST(KL),KDISQI(KL),NRPSIG(KL)                                           18600
1480     677  FORMAT('0',28X,I8,1X,I6,3X,4(I5,2X),I6,5X,I1/)                           00018610
      C                                                                                00018620
1481     680   CONTINUE                                                                00018630
      C                                                                                00018640
      C                                                                                00018650
      C                       END OF DAILY R.O.P. ROUTINE.                                18660
      C                       * * * * * * * * * * * * * *.                                18670
      C                                                                                00018680
      C
      C                        * * * * * * * * * * * * *                                  18700
      C                        *      STAGE EIGHT      *                                  18710
      C                        * DATA OUTPUT TABULATION*                                  18740
      C                        * * * * * * * * * * * * *                                  18750
      C
      C                     THIS SECTOR TABULATES AND PRINTS.                             18760
      C                     * * * * * * * * * * * * * * * * *                             18761
      C                                                                                   18780
      C                       MAJOR FORECASTING TABULATION                                18781
      C                       - - - - - - - - - - - - - -                                 18782
      C                                                                                   18783
1482           PRINT 733                                                                  18790
1483     733  FORMAT('1',52X,'* TABLE 7 *'/48X,'EXPONENTIALLY SMOOTHED'/50X,'DEM          18800
             1AND FORECASTING'/50X,'* * * * * * * * *'/)                                  18801
1484           PRINT 731                                                                  18802
1485     731  FCRMAT('0',22X,'NUM. USAGE',3X,'ALPHA',12X,'SIMPLE  LATEST LATEST           18803
             1TREND  DOUBLE   SEASCNAL  LEAD'/15X,'ITEM',5X,'OF  LAST',10X,'BETA          18804
             2',7X,'DEMAND  TREND  TRACK  DEMAND  SMOOTH',3X,'DEMAND',3X,'TIME'/          18805
             314X,'NUMBER   DEMS YEAR',14X,'GAMMA FORECAST',8X,'SIGNAL FORECAST           18806
             4FCST   FORECAST DEMAND'/)                                                   18807
1486           PRINT 732                                                                  18860
1487     732  FORMAT('0',13X,32('_  ')/)                                                  18870
      C
1488           DC  735 KL=1,ML                                                            18890
1489            N = MON(KL)                                                               18900
1490           NDEM(KL) = N                                                               18910
1491          IF(N.GE.36) NDEM(KL)=36                                                     18920
1492           IF(N.GE.18) GO TO 811                                                      18930
1493          IF(N.LT.12) MFORX(KL)= (KDATA(N)+KDATA(N-1))                                18940
      C                 ASSUME THE NEXT PERIOD FORECAST IS THE SAME AS                    18950
      C                     THE PAST TWO MONTHS ACTUAL DEMAND.                            18960
1494          IF(N.LT.18) MNEWTR(KL)=(KDATA(N)-KDATA(N-1))                                18970
1495          IF(N.LT.18) PNEWTR(KL)=MNEWTR(KL)                                           18980
1496          IF(N.LT.18) JTRDEM(KL)=0                                                    18990
1497           IF(N.LT.12) TSIG(KL)=0.                                                    19000
1498           IF(N.LT.12) LTDEMI(KL)  = KDATA(N)                                         19010
1499     811  CONTINUE                                                                    19020
```

```
1500          IF(N.LT.36) SEFORX(KL)=0.
1501            IF(N.LT.12) ALFY(KL) = A(1)
1502            IF(N.LT.12) BIFFY(KL) = B(1)
1503            IF(N.LT.36) GIFFY(KL) = G(1)
1504          PRINT 736,ITEMN3(KL),NDEM(KL),KTOTAL(KL),
             1ALFY(KL),BIFFY(KL),GIFFY(KL),MFORX(KL) ,PNEWTR(KL), TSIG(KL),
             2JTRDEM(KL),DOUBLE(KL),SEFORX(KL),LTDEM1(KL)
1505     736  FORMAT('0',12X,I8,I5,2X,I6,4X,F3.1,2(2X,F3.1),2X,I5,2X,F6.1,1X,
             1 F7.1,1X,I6, 2(2X,F7.1),1X, I7/)
1506     735  CONTINUE
       C
```

```
                                     DISCOUNT TABULATION                                      19092
      C                                                                                         19093
      C                              - - - - - - - - - - -                                   C0019100
1507          PRINT 745                                                                      
1508     745  FORMAT('1',54X,'* TABLE 8 *'/51X,'TABLE OF DISCOUNTS'/51X,'* * * *00019110
            1 * * * * * '/37X,'** FOR THE BEST PRICE/QUANTITY SEE TABLE 3 **'/)00019120
                                                                                         00019130
1509          PRINT 746                                                                      
1510     746  FORMAT('0',18X,'ITEM   VENDOR  DISC  UNIT     -BASIC-       -MINIMUM-      19140
            1        -SECOND-         -THIRD-          -FOURTH-    NO.OF'/17X,'NUMBER    C   19150
            2CDE    DATE  CODE  PRICE/ QTY       PRICE/QTY      PRICE/ QTY      PRICE/    19160
            3 QTY      PRICE/ QTY   DISC'        /17X,'_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _    19170
            4 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -    19180
            5 - - - - '/)                                                                    19181
1511          DO  747 KL=1,ML                                                           00019190
1512            N = MON(KL)                                                              C0019200
                          TO PREVENT NO-DISCOUNT ITEMS BEING TABULATED:                 00019210
      C                                                                                 00019220
1513           IF(LDISC(KL).NE.1) GO TO 747                                             00019230
1514          PRINT 748,ITEMN4(KL),KVENDR(KL),MDATE2(KL),LUNIT(KL),PRIBAS(KL),           00019240
            1JQUBAS(KL),PRI1(KL),JQUAN1(KL),PRI2(KL),JQUAN2(KL),PRI3(KL),                  19250
            2JQUAN3(KL),PRI4(KL),JQUAN4(KL),NDISC(KL)                                          19260
1515     748  FORMAT('0',12X,I8,2X,I3,2X,I6,2X,I2,2X,5(F6.2,1X,I5,2X),I3/)             00019270
1516     747  CONTINUE                                                                        19272
      C                                                                                          19273
      C                      TABULATION OF MAJOR VALUES.                                         19274
      C                      - - - - - - - - - - - - - - -                                   00019280
1517          PRINT 750                                                                          19290
1518     750  FORMAT('1',51X,'* TABLE 9 *'/44X,'BRUFICH SUMMARY TABULATION'/              00019300
            1 44X,'* * * * * * * * * * * * * * '/)                                        00019310
1519          PRINT 752                                                                          19320
1520     752  FORMAT('0',26X,'ITEM    ABC NTS UNIT      BEST                    ON   LE      19330
            1AD DISC  FREE          '/26X,'NUMBER              PRICE   PRICE      ROP     E    19340
            2CQ ORDER TIME          STOCK'        /26X,'_ - - - - - - - - - -                19350
            3 - - - - - - - - - - - - - '/)                                                     19360
1521          DO  753 KL=1,ML                                                                   19370
1522            N = MON(KL)                                                                     19380
1523          IF(N.LT.12) DISPR1(KL)= UNITPA(KL)                                               19390
1524           PRINT 754,ITEMN3(KL),ABC2(KL),NTS1(KL),UNITPA(KL),DISPR1(KL),                   19395
            1KROP(KL),KDISQI(KL),JONORD(KL),AVLT1(KL),MDISC(KL),JFREST(KL)                     19396
1525     754  FORMAT('0',26X,I8,3X,A1,3X,A1,1X,F6.2,1X,F6.2,1X,I6,1X,I6,1X,I5,            19397
            1  1X,F4.1,3X,I1,2X,I5/)                                                            19398
1526     753  CONTINUE                                                                          19399
1527          PRINT 154                                                                          19400
1528     154  FORMAT('1',56X,'* TABLE 10 *'/51X,'* CATALOGUE OF ITEMS *'/51X,                   19401
            1'* * * * * * * * * * * *'/24X,'SEQUENCE      ITEM                                  19402
            2                                RECENT'/25X,'NUMBER       NUMBER                   19403
            3 PRODUCT  DESCRIPTION                      PRICE     UNIT'/25X,'______            19404
            4_____                          _______  ___________          ______   ____        19405
            5   '/)                                                                              19408
1529          DO 155 KL=1,ML                                                                     19410
1530          PRINT 156 , KL,ITEMNO(KL),(HOSP(KL,I),I=1,9),UNITPA(KL),KUNIT(KL)
```

```
1531      156  FORMAT('0',26X,I2,5X,I8,9X,9A4,    F6.2,5X,I2)
1532      155   CONTINUE
          C
1533             PRINT 304
1534      304  FORMAT('1',56X,'* TABLE 11 *'/)
1535            PRINT 301
1536      301  FORMAT('0',46X,'SUMMARY OF FORECASTING ERRORS'/47X,'* * * * * * *
              1* * * * * * * *'/39X,'* * NOTE * * A VALUE OF 9999.9 INDICATES'
              2 /36X,'NO FORECAST WAS MADE DUE TO LACK OF DATA   * * * '/)
1537            PRINT 302
1538      302  FORMAT('0',31X,'ITEM',4X,'METHOD',5X,'AVERAGE',4X,'BALANCED',2X,'O
```

```
           1VERALL',4X,'SUM OF',5X,'MEAN'/ 31X, 'NUMBER    USED' ,7X,'SIGNED',    19422
           25X,'ERROR',5X,'M.A.D.',4X,'SIGNED' ,4X,'SQUARE'/ 52X, 'ERROR', 26X,  19423
           3 'ERRCRS',5X, 'ERROR'/ 29X, 36('_ ')  /)                              19424
1539         DO 157 KL = 1,ML                                                     19425
1540          IF(N.LT.12) COMP1(KL)  = 9999.9
1541          IF(N.LT.12) COMP2(KL)  = 9999.9
1542          IF(N.LT.12) COMP3(KL)  = 9999.9
1543          IF(N.LT.12) COMP4(KL)  = 9999.9
1544          IF(N.LT.12) COMP19(KL) = 9999.9
1545          IF(N.LT.18) COMP5(KL)  =  9999.9
1546          IF(N.LT.18) COMP6(KL)  =  9999.9
1547          IF(N.LT.18) COMP7(KL)  =  9999.9
1548          IF(N.LT.18) COMP8(KL)  =  9999.9
1549          IF(N.LT.18) COMP9(KL)  =  9999.9
1550          IF(N.LT.18) COMP10(KL) =  9999.9
1551          IF(N.LT.18) COMP11(KL) =  9999.9
1552          IF(N.LT.18) COMP12(KL) =  9999.9
1553          IF(N.LT.18) COMP20(KL) =  9999.9
1554          IF(N.LT.36) COMP13(KL) =  9999.9
1555          IF(N.LT.36) COMP14(KL) =  9999.9
1556          IF(N.LT.36) COMP15(KL) =  9999.9
1557          IF(N.LT.36) COMP16(KL) =  9999.9
1558          IF(N.LT.36) COMP17(KL) =  9999.9
1559          IF(N.LT.36) COMP18(KL) =  9999.9
1560          IF(N.LT.36) COMP21(KL) =  9999.9
      C
      C               NOTE THAT THE PRINTED ERROR VALUES ARE THOSE
      C               ARISING FRON THE FINAL ITERATION OF ALPHA:
      C
1561        PRINT 303,ITEMN1(KL),COMP1(KL),COMP2(KL),COMP3(KL),COMP4(KL),COMP1  19426
           19(KL),COMP5(KL),COMP6(KL),COMP7(KL),COMP8(KL),COMP20(KL),COMP9(KL)  19427
           2, COMP10(KL),  COMP11(KL),                                          19428
           3 COMP12(KL),COMP14(KL),COMP13(KL),COMP15(KL),COMP16(KL),COMP17(KL)  19429
           3 ,COMP18(KL), COMP21(KL)                                            19430
1562    303 FORMAT('0',28X,I8,3X,'NORMAL',4X, 5(2X,F8.1) / 40X,'TREND',5X, 5(2  19431
           1X,F8.1) / 40X,'D.SMOOTH  ', 4(2X,F8.1) /40X,'FU. TREND'  ,3X,F8.1,  19432
           222X,F8.1/ 40X,'SEASONAL  ', 5(2X,F8.1) /59X, 15('*') /)             19433
1563    157  CONTINUE                                                           19436
      C                                                                         19438
      C                                                                         19439
      C                    NOTES CCNCERNING THE TABLES.                         19441
      C                                                                         19442
      C                    - - - - - - - - - - - - - - -                        19443
      C                                                                         19444
1564         PRINT 16                                                           19450
1565     16 FORMAT('1',44X,'NOTES CONCERNING THE ABOVE TABLES.'/45X,'* * * * *  19460
           1 * * * * * * * * * * * *'/)                                         19490
1566         PRINT 17                                                           19500
1567     17  FORMAT('0',54X,'TABLES 1 AND 2'/55X,'* * * * * * *'/40X,'VALUES A  19510
           1RE BASED ON MARGINS CF $500 AND $2000'/58X,'TABLE 3'/58X,'* * * *
```

```
             2'/30X,  'A 1 OR  2  IN DEMAND FORECAST OR EOQ INDICATES'/31X,'THAT
             3 ONE OR THE OTHER IS ZERO.'/31X,'IF NO DISCOUNT OFFERED, DISC QTY
             4SHOWS EOQ VALUE.'/31X,'DISCOUNT PRICE IS THEN BASE PRICE.'/31X,'MA
             5RGINAL COST IS HOLD + ORDER + ITEM COST (BEST OFFER).'/)
1568           PRINT 812
1569      812  FORMAT('0',57X,'TABLE 4'/57X,'* * * *'/31X,'ACTION CODES ARE:'/44X
             1,'90   NEW ITEM, 6 DATA POINTS.'/44X,'94   12 ITEMS: REGULAR ROUTI
             2NES'/44X,'95   E.O.Q. SUPPLIED BY MANAGEMENT'/44X,         '98
             3ITEM BEING RUN DOWN.'/44X,'99   NEW ITEM, NOT BEING FORECAST.'/)
1570           PRINT 805
1571      805  FORMAT('0',31X,'IF DEMAND HISTORY IS LESS THAN TWELVE MONTHS, FORE
```

```
          1CASTS MAY BE HIGH.'/
          2    29X,'L.T. DEMAND VALUES ARE BASED ON LAST PERIOD FORECAST,WITH
          3SIMPLE SMOOTHING.'/29X,'EOQ MAY BE EITHER THE BASIC VALUE OR DISCO
          4UNT O.Q., WHICHEVER PREFERABLE.'/)
1572        PRINT 18
1573   18   FORMAT('0',57X,'TABLE 6'/58X,'* * * *'/31X,'THE  ROP SIGNAL CODE
          1IS:'/41X,'0:  BALANCE ABOVE ROP. NO ORDER NEEDED.'/41X,'1:  BALANC
          2E AT/BELOW ROP. AN ORDER PLACED.'/41X,'5:  NO REGULAR ROP COMPUTED
          3, FEW DATA ITEMS.'/41X,'6:  TEMPORARY ROP(LESS THAN 12 POINTS)'/
          441X,'9:  STOCKS BEING REDUCED. IGNORE ROP'/33X,       'FREE STOCK
          5DOES NOT INCLUDE ORDER JUST PLACED. ON ORDER DOES.'/)
1574        PRINT 19
1575   19  FORMAT('0',57X,'TABLE 7'/57X,'* * * * *'/
          1      31X,'NDEM: MAX SHOWN IS 36 DEMANDS. IF BELOW 12'/31X,'SOME VA
          2LUES ARE APPROXIMATE.'/                  31X, 'FORECAST:THE LAST VALUE,
          3 SIMPLE SMOOTHING'/31X,'TREND: ROUGH INDICATOR OF SIZE OF MOVEMENT
          4 '/31X,'SMOOTHING CONSTANTS: LATEST VALUES, SIMPLE SMOOTHING, AND
          5SEAS. FORECAST.'/)
1576        PRINT 20
1577   20  FORMAT('0',31X,'TREND EXPEC. DEMAND; SMOOTHED TREND FORECAST, LAST
          1 VALUE'/31X,'SEASON FOREC.: LAST VALUE OF SEASONAL FORECAST'/31X,
          2'IF LESS THAN 36 MONTHS, RECORDED AS ZERO IN OUTPUT.'/31X,
          3'LAST YEAR USAGE: IF BELOW 12 MONTHS, USE EXTRAPOLATION'/)
1578        PRINT 121
1579  121  FORMAT('0',57X,'TABLE 8'/58X,'* * * *'/31X,'PROGRAM ALLOWS FOUR PR
          1ICE BREAKS. IF MORE OFFERED, MODIFY THE ROUTINE.'/
          231X,'UNIT AND VENDOR CODE: SEE CATALOGUE.'/
          3      31X,'CODE: SEE NOTES TO TABLE 6'/)
1580        PRINT 122
1581  122  FORMAT('0',57X,'TABLE 9'/58X,'* * * * '/33X,'NTS SHOULD BE INTERPR
          1ETED WITH CARE.'/31X,'FOR EXAMPLE,  S  COULD ALSO INCLUDE   T  :EXA
          2MINE THE CHARTS.'/33X,'E.O.Q.: THE BEST ORDER QUANTITY.'/)
1582        PRINT 47
1583   47  FORMAT('0',57X,'TABLE 10'/58X,'* * * *'/31X,'CODE NUMBERS WOULD BE
          1 DESCRIBED IN CATALOGUE.'/31X,'FINAL DIGITS REPRESENT NAME OF INDI
          2VIDUAL HOSPITAL.'/31X,'UNIT: RECEIPT CODE IS GIVEN IN THE PROGRAMM
          3E'/)
1584        PRINT 49
1585   49  FORMAT('0',34X,'01: HSC, TORONTO.'/35X,'02: TORONTO GENERAL HOSPIT
          1AL.'/35X,'03: WINNIPEG MEDICAL CENTRE.'/35X,'04: ST. JOSEPHS, THUN
          2DER BAY.'/35X,'05: NORTHWICK PARK, HARROW.'/35X,'06: SHEFFIELD ENG
          3INEERING.'/35X,'07: MISCELLANEOUS.'/)
1586        PRINT 158
1587  158  FORMAT('0',57X,'TABLE 11'/58X,'* * * * ' /31X,    'NOTE: ERRORS AR
          1E THOSE ARISING FROM THE FINAL SET'/31X,'OF SMOOTHING CONSTANTS US
          3ED WHEN ITERATIONS COMPLETED.'/)
1588        PRINT 760
1589  760  FORMAT('0',57X,'* END  OF *'/51X,'** BRUFICH TABULATIONS **'/
          1 49X,'* * * * * * * * * * '/)
```

```
      C                                                                  19803
1590            STOP                                                     19900
1591            END                                                      19901
      C                                                                  50300
      C                         * * * * * * * * *                        50310
      C                           STAGE  NINE                            50350
      C                         SUBROUTINE SECTOR                        50360
      C                         * * * * * * * * *                        50370
      C                                                                  50380
      C                       * SORTING SUBROUTINE *                     50390
      C                       * * * * * * * * * * * *                    50391
```

```
C
      SUBROUTINE SORT(Y,N,AMEDIN)
      DIMENSION Y(100),T(100)
      AMEDIN =0.
      DO 365 I=1,N
      T(I) = Y(I)
  365 CONTINUE
      N1 =N-1
      DO 300 J=1,N1
      J1 = J+1
      DO 300 I=J1,N
     IF(T(I)- T(J)) 301,300,300
  301 TTEMP= T(J)
      T(J)=T(I)
      T(I)=TTEMP
  300 CONTINUE
      NZ =(N/2) *2
      IF(N-NZ) 310,311,310
C
C                COMPUTE THE MEDIAN
  311 MM =N/2
      MK =((N+2)/2)
      AMEDIN =(T(MM)+T(MK))/2.
      GO TO 312
  310 MR =(N+1)/2
      AMEDIN =T(MR)
  312 CONTINUE
      RETURN
      END
C
C                          * GRAPH PLOTTING SUBROUTINE *
C                          * * * * * * * * * * * * * *
C
C               WITHIN THE MAIN PROGRAMME, EACH GRAPH HAS THE
C               X  AXIS SCALED ACCORDING TO THE QUANTITY OF DATA
C               CONTAINED IN THE ITEM.  THE  Y  AXIS IS ADJUSTED
C               ACCORDING TO THE RANGE OF VALUES MET WITH,
C               IN PROPORTION TO THE ORIGINAL DATA PLOT.

      SUBROUTINE PLOT (X,Y,N, MX,MY,W,H,CHAR, JIM)
     REAL X(N),Y(N),MX,MY
       CHARACTER BUF(110),CHAR,GMT(220),FMT*220
     INTEGER XPOS,YPOS,YNEXT,IX*2(110)
      EQUIVALENCE (FMT,IX(1),GMT(1))
C
C             X:VECTOR OF X VALUES
C             Y:VECTOR OF Y VALUES
C             N:PAIRS OF VALUES
```

```
C         W:COL. WIDTH INCLUDING MARGINS                                        50800
C         H:HEIGHT.    DITTO                                                    50810
C         MX:FRACTION OF W FOR GRAPH                                            50820
C         MY:     DITTO, H                                                      50830
C         CHAR:TO REPRESENT POINTS                                              50840
C         JIM: ITEM NUMBER                                                      50841
C         BUF:PRINTING STORE                                                    50850
C                                                                               50860
C         IX:RESET TO BLANKS                                                    50870
C         FMT:(GMT) RUN-TIME FORMAT STATEMENT                                   50880
C         XPOS:HORIZ. PRINT POS. CURRENT POINT                                  50890
```

```
C              YPOS: VERT DITTO
C              YNEXT:VERT PRINT POS, NEXT POINT
      IF(N.LE.1) GO TO 999
      XMAX = X(1)
      XMIN = X(1)
      DO 19 L=2,N
      IF (XMIN.LE.X(L)) GC TO 11
      XMIN = X(L)
   11   IF(XMAX.GE.X(L)) GO TO 19
      XMAX = X(L)
   19  CONTINUE
     XS = MX*W/(XMIN-XMAX)
      XC = (W+(XMIN+XMAX)*XS) * 0.5 + 1.5
      XS = -XS
      M = N-1
   22    IS=0
      DO 24 L=1,M
      IF(Y(L).GE.Y(L+1)) GO TO 24
      A=Y(L)
      Y(L)=Y(L+1)
      Y(L+1) = A
      A = X(L)
       X(L)= X(L+1)
       X(L+1)=A
       IS=1
   24   CONTINUE
      M=N-1
       IF(IS.EQ.1) GO TO 22
       YS = MY*H/(Y(1)-Y(N))
      YC = (H+(Y(1)+Y(N))*YS)*0.5 + 1.5
      YS = -YS
      PRINT 59
   59 FORMAT('0',47X,'ITEM  FIRST  LAST  LOWEST  HIGHEST'/47X,
     1 'NUMBER MONTH  MONTF  VALUE   VALUE'/)
      PRINT 61, JIM, XMIN, XMAX, Y(N), Y(1)
   61 FORMAT(45X,               I8,2X,F3.0,3X,F4.0,2X,F7.0,1X,F7.0)
      PRINT 60
   60 FORMAT(46X,' - - - - - - - - - - - - - - - - -     ')
      PRINT 8
    8 FORMAT('1')
     BUF(1) ='|'
      DC 79 L=2,110
   79  BUF(L)=' '
      K=0
      I=1
      J=2
      YPOS=YC+YS*Y(1)
  100 IF(J.GT.N) GO TO 200
      YNEXT=YC+YS*Y(J)
```

```
      IF(YNEXT.NE.YPOS)GO TO 200                                        00051380
  150 J=J+1                                                             00051390
      GO TO 100                                                         00051400
  200 L=K+1                                                             00051410
  210 IF(L.GE.YPOS) GO TO 300                                           00051420
      PRINT 360,BUF                                                     00051430
      IF(MOD(L,5).NE.0.AND.L.NE.1) GO TO 250                            00051440
C              VALUES FOR THE VERTICAL AXIS:                               51445
     A=(L-YC)/YS                                                        00051450
      B=(L-(YC-0.999999))/YS                                            00051460
       C= ((A+B)/2. )                                                      51470
```

```
      PRINT 240,C                                                   51472
  240 FORMAT('+',9X,F8.0,'_')                                        51474
  250  L=L+1                                                      00051490
       GO TO 210                                                  00051500
C                                                                 00051510
  300 LL=J-1                                                      00051520
       DO 350 L=I,LL                                              00051530
       XPCS=XC+XS*X(L)                                            00051540
       IX(L-I+1)=XPOS                                             00051550
  350  BUF(XPOS)=CHAR                                             00051560
       PRINT 360,BUF                                              00051570
  360  FORMAT(' ',20X,110A1)                                      00051580
       IF(MOD(YPOS,5).NE.0.AND.J.NE.N+1) GO TO 370                00051590
C                                                                 00051600
       A=(YPOS-YC)/YS                                             00051610
       B=(YPOS-(YC-0.999999))/YS                                  00051620
        D = ((A+B) /2.)                                              51625
       PRINT 260,D                                                   51630
  260 FORMAT('+',9X,F8.0,'-')                                        51635
  370        CONTINUE                                             00051640
        DO 380 L=I,LL                                             00051650
  380   BUF(IX(L-I+1))=' '                                        00051660
       IF(J.GT.N)GO TO 500                                        00051670
       I=J                                                        00051680
       K=YPOS                                                     00051690
       YPOS=YNEXT                                                 00051700
       GO TO 150                                                  00051710
C                 VALUES FOR THE HCRIZONTAL AXIS:                    51715
  500   LL=MINO(IFIX(XC+XS*XMAX+1.5),122)                            51720
       L=MINO(  122,LL+12)                                           51730
       PRINT 510,('-',I=1,L)                                         51740
  510  FORMAT('-',9X,122A1)                                          51750
        DC 520 I=1,LL,15                                             51760
  520   BUF(I)='|'                                                   51770
       PRINT 530,BUF                                                 51780
  530   FCRMAT(     22X,110A1)                                       51790
       PRINT 550,(+(I-(XC-0.999999)) / XS,I=1, LL,15)                51800
*EXTENSION*  OTHER CCMPILERS MAY NOT ALLOW EXPRESSIONS IN OUTPUT LISTS
  550  FORMAT(' ',7X,8F15.0)                                         51801
       PRINT 590                                                     51850
  590   FORMAT('1')                                                  51860
       RETURN                                                        51870
  999  PRINT,'TOO FEW PAIRS OF VALUES'                               51880
       RETURN                                                        51890
             END                                                     51900
C                                                                    51960
C             * BROWN DOUBLE SMOOTHING SUBROUTINE *                  51990
C             * * * * * * * * * * * * * * * * * * *                  51991
C
```

```
1720          SUBROUTINE DUB    (M, ALP, YES, Y, JJ, N, B, COMP9,COMP10,           52000
            1 CCMP11,COMP12, KL, EQDUB, DOUBLE, XBAR , GNX)
        C                                                                           52001
        C                THIS PROGRAMME CONSTRUCTS A DOUBLE SMOOTHED FURECAST      52003
        C                DESIGNED TO OVERCOME ANY TREND PRESENT CAUSING LAG.       52004
        C                OUTPUT COMPRISES FORECASTS FOR NEXT PERIOD, AND           52005
        C                FOR PERIODS 2 AND THREE AHEAD                             52006
        C
1721          DIMENSION SINGSM(100),DUBSM(100),YES(100),Y(100),POINT(100),        52010
            1 SLCPE(100),DOUBLE(100), DOUBL2(100),DOUBL3(100),ERROR(100),         52011
```

```
      2 ERR2(100),ERR3(100), AMAD1(100),AMAD2(100),AMAD3(100),              52013
      3 COMP9(100), COMP10(100),COMP11(100),COMP12(100), EQDUB(100)         52014
C
C                              DICTIONARY                                   52020
C                              ----------                                   52021
C                CUMP9 - 12   ARRAYED ERROR VALUES                          52024
C                POINT    POINT ON LINE,A                                   52025
C                SLOPE    SLOPE OF LINE, B                                  52026
C                ALP      SMOOTHING CONSTANT, ALPHA                         52027
C                B        ERROR SMOOTHING CONSTANT, BETA                    52028
C                DUBSM    DOUBLE SMOOTHED VALUE, S(2)                       52029
C                SINGSM   SINGLE SMOOTHED VALUE, S(1)                       52030
C                ERROR    ACTUAL DATA LESS NEW FORECAST                     52031
C                ERR2      ACTUAL DATA LESS 2 MONTH AHEAD FORECAST          52032
C                ERR3      ACTUAL DATA LESS 3 MONTH AHEAD FORECAST          52033
C                DOUBLE   FORECAST, FOLLOWING PERIOD                        52034
C                DOUBL2   FORECAST, TWO PERIODS AHEAD                       52035
C                DOUBL3   FORECAST, THREE PERIODS AHEAD                     52036
C
      DUBSM(M) = YES(M)
      ACURY = 0.                                                            52039
      CUMIL = 0.                                                            52040
      HERSQ = 0.                                                            52041
      HMSQE = 0.                                                            52042
      SUMHER = 0.                                                           52043
      TOTIL = 0.                                                            52044
       ZHAR = 0.                                                            52045
      SINGSM(M) = YES(M)                                                    52050
      DO 10  K=JJ,N                                                         52051
      SINGSM(K) = (ALP*Y(K-1)) + ((1.-ALP)*SINGSM(K-1))                     52052
      DUBSM(K) = (ALP*SINGSM(K)) + ((1.-ALP) * DUBSM(K-1))                  52053
      POINT(K) = (2*SINGSM(K)) - DUBSM(K)                                   52058
     SLOPE(K) = (ALP/(1.-ALP)) *(SINGSM(K)-DUBSM(K))                        52059
      DOUBLE(K) = POINT(K) + SLOPE(K)                                       52060
      ERROR(K) = Y(K) - DOUBLE(K)                                           52061
      HERSQ = ERROR(K)**2                                                   52062
      SUMHER = SUMHER + HERSQ                                               52063
      TOTIL = TOTIL + ABS(ERROR(K))                                         52064
C              THIS IS THE VALUE OF THE DOUBLE SMOOTHED FORECAST            52065
C              APPLICABLE TO THE PRESENT PERIOD.                            52066
C              FUTURE PERIODS MAY BE FORECAST REASONABLY FAR AHEAD.         52067
      DOUBL2(K+1) = POINT(K) + (SLOPE(K) * 2.)                              52070
      DOUBL3(K+2) = POINT(K) + (SLOPE(K) * 3.)                              52071
   10 CONTINUE                                                              52075
      CUMIL = TOTIL/GNX                                                     52076
      ACURY = ((CUMIL/XBAR) * 100.)                                         52077
       DOUBLE(KL) = DOUBLE(N)                                               52078
      PRINT 12                                                              52080
   12 FORMAT('1',60X,'* TABLE  2 *'/61X,'* * * * * *'/56X,'BROWN DOUBLE     52081
```

```
          1 SMOOTHING'/56X,'- - - - - - - - - - - - - -'/)                        52082
            PRINT 14                                                              52084
1749     14  FORMAT('0',69X,'2 MONTH  2 MONTH  3 MONTH  3 MONTH'/30X,'PERIOD SI   52087
1750         1NGLE   DOUBLE   CURRENT CURRENT   AHEAD    AHEAD    AHEAD    AHEAD'  52088
             2 /37X,'SMOOTH   SMOOTH  FORECAST ERROR  FORECAST   ERROR   FORECAS  52089
             3T  ERROR'/30X, 38('- ') /)                                          52090
1751           SUMER = 0.0                                                        52100
1752           SUM2R = 0.0                                                        52101
1753           SUM3R = 0.0                                                        52102
1754           TOTER = 0.0                                                        52103
1755           TOT2ER = 0.0                                                       52104
```

```
      TOT3ER = 0.0
      CUMER = 0.0
      CUM2ER = 0.0
      CUM3ER = 0.0
      AVERD  = 0.0
      AVERD2 = 0.0
      AVERD3 = 0.0
       BALERD = 0.0
       BALER2 = 0.0
       BALER3 = 0.0
      AMAD1(M) = ABS(Y(M) - DUBSM(M))
      AMAD2(M) =AMAD1(M)
      AMAD3(M) =AMAD1(M)
      GNX = ((N-M) -1)
      ZHAR = SUMHER / GNX
      HMSQE = (SQRT(ZHAR))
C              VALUE OF ROOT MEAN SQUARE ERROR
      DO 16  K=JJ, N
      JT = JJ+1
      DOUBL2(JJ) = DOUBLE(JJ)
      DOUBL3(JJ) = DOUBLE(JJ)
      ERR2(JJ) = ERROR(JJ)
      ERR3(JJ) = ERROR(JJ)
      DOUBL3(JT) = DOUBL2(JT)
      ERR2(K) = Y(K) - DOUBL2(K)
      ERR2(JT) = Y(JT) - DOUBL2(JT)
      ERR3(JT) = ERR2(JT)
      ERR3(K) = Y(K) - DOUBL3(K)
      NN = (N+1)
      NM = (N+2)
      SUMER = SUMER + ERROR(K)
      SUM2R = SUM2R + ERR2(K)
      SUM3R = SUM3R + ERR3(K)
      AMAD1(K) = (B* ABS(ERROR(K))) + ((1.-B) * (AMAD1(K-1)))
      AMAD2(K) = (B* ABS(ERR2(K))) + ((1.-B)* (AMAD2(K-1)))
      AMAD3(K) = (B* ABS(ERR3(K))) + ((1.-B)* (AMAD3(K-1)))
      TOTER = TOTER + ABS(ERROR(K))
      TOT2ER = TOT2ER + ABS(ERR2(K))
      TOT3ER = TOT3ER + ABS(ERR3(K))
   16  CONTINUE
       DO 18  K = JJ , N
      PRINT 20,K,SINGSM(K), DUBSM(K), DOUBLE(K),ERROR(K),DOUBL2(K),
     1 ERR2(K), DOUBL3(K), ERR3(K)
   20 FORMAT('0',31X,I2,2X,F7.1, 2X,F7.1,1X,F7.1,2X,4(F7.1,2X),F7.1 )
   18    CONTINUE
      PRINT 22,NN, DOUBL2(NN), DOUBL3(NN),NM, DOUBL3(NM)
   22 FORMAT('0',36X,'FORECAST VALUES FOR LATER PERIODS ARE:'/37X,
     1'PERIOD:',I3,'=',   1X,F7.1,1X,'AND',   F7.1,2X,'AND PERIOD:',I3,
     2'='  ,F7.1/)
```

```
C                 SUMMARY VALUES OF SIGNED AND ABSCLUTE ERRORS:            52168
          CUMER = TOTER/GNX                                                52170
          CUM2ER = TOT2ER/GNX                                              52171
          CUM3ER = TOT3ER/GNX                                              52172
          AVERD  =  SUMER/GNX                                              52173
          AVERD2 = SUM2R/GNX                                               52174
          AVERD3 = SUM3R/GNX                                               52175
          BALERD = (SUMER * 100.) / (TOTER * .5)                           52176
          BALER2 = (SUM2R * 100.) / (TOT2ER* .5)                           52177
          BALER3 = (SUM3R * 100.) / (TOT3FR* .5)                           52178
           COMP9(KL) = AVERD                                               52179
```

```
         COMP10(KL) = BALERD                                                52180
         COMP11(KL) = CUMER                                                 52181
         COMP12(KL) = SUMER                                                 52182
         PRINT 30                                                           52184
   30    FORMAT('0',48X,'ERROR SUMMARY TABLE: DOUBLE SMOOTHING'/49X,        52185
        1'_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _'/)    52186
         PRINT 35,AVERD,AVERD2,AVERD3                                       52187
   35   FORMAT('0',50X,'AVERAGE OF SIGNED ERRORS : '/56X,'CURRENT FORECAST  52188
        1',3X,F7.1/56X,'TWO MONTHS AHEAD',3X,F7.1/56X,'THREE MONTHS AHEAD', 52189
        2    F8.1/)                                                         52190
         PRINT 36,BALERD,BALER2,BALER3, HMSQE                               52192
   36   FORMAT('0',50X,'BALANCED ERRORS : '/56X,'CURRENT FORECAST',3X,F7.1  52193
        1/56X,'TWO MONTHS AHEAD',3X,F7.1/56X,'THREE MONTHS AHEAD',1X,F7.1   52194
        2/ 51X,'ROOT MEAN SQUARE ERROR :',F8.1/)                            52195
         PRINT 31, CUMER,CUM2ER,CUM3ER,SUMER,SUM2R,SUM3R,ALP, B             52196
   31   FORMAT('0',50X,'OVERALL MEAN ABSOLUTE DEVIATIONS : '/               52197
        1                56X,'CURRENT FORECAST',3X,F7.1/56X,'TWO MONTHS AHE 52198
        2AD',3X,F7.1/56X,'THREE MONTHS AHEAD',1X,F7.1/51X,'SUM OF SIGNED ER 52199
        3RORS :'/56X,'CURRENT FORECAST',2X,F8.1/56X,'TWO MONTHS AHEAD',2X,F 52200
        48.1/56X,'THREE MONTHS AHEAD',F8.1/44X,'CONSTANT VALUES ARE: ALPHA  52201
        5',F6.2,' AND BETA ',F6.2/)                                         52202
C                                                                           52207
C                  FOR TREND ITEMS, CALCULATE ANNUAL DEMAND FORECAST:       52208
C                  USE THE LATEST TWELVE MONTH FORECAST.                    52209
         EOQDUB = 0.                                                        52210
         JY = (N-11)                                                        52211
         DO 45 I = JY,N                                                     52212
         EOQDUB = EOQDUB + DOUBLE(I)                                        52213
   45    CONTINUE                                                           52220
         EQDUE(KL) = EOQDUB                                                 52221
         PRINT 50, ACURY                                                    52222
   50   FORMAT('0',50X,'ACCURACY PERCENTAGE :',F7.1/)                       52223
         RETURN                                                             52230
         END                                                                52231
C                                                                           52240
C                     * BRUSIM FORECASTING SUBROUTINE *                     53000
C                     * * * * * * * * * * * * * * * * *                     53001
C
          SUBROUTINE BRUSIM(DDF, M)                                         53003
          DIMENSION DF(100)                                                 53005
          INTEGER Z                                                         53006
         REAL DDF(100)                                                      53007
C                              BRUSIM                                       53010
C                                                                           53012
C                              ******                                       53015
C                     FORECASTING BY EXPONENTIAL SMOOTHING                  53016
C                     * * * * * * * * * * * * * * * * * *                   53017
C                                                                           53020
```

```
C           CARTER AND FUZAN : PRACTICAL APPROACH TO COMPUTER           53022
C             SIMULATION IN BUSINESS.  ALLEN AND UNWIN, 1973            53023
C                                                                       53024
C         USES PAST DEMAND DATA, WITH FOUR METHODS.                     53025
C         CONTROLLED BY VALUE OF K, INITIALLY 1                         53026
C         INCREASED BY 1 TO 4 IN PROGRAM                                53027
C                                                                       53028
C         AT K =1 SIMPLE EXP. SMOOTH, 5 RUNS, ALPHA                     53030
C         INCREMENTED BY 0.2, FROM 0.1 TO 0.9                           53031
C         AT K=2  TREND SMOOTHING, CONSTANT ALPHA 0.1                   53032
C                                                                       53033
```

```
C              K=3 USE MEAN DEMAND FOR 5 CONSTANT FORECAST
C              RUNS AT 60, 8C, 100, 120 AND 140 P.C. OF
C              CALCULATED MEAN.
C              K=4 SAME METHOD AS K=1 BUT ALPHA SET TO
C              PENULTIMATE VALUE OF TRACKING SIGNAL. THIS IS THE
C              TRIGG AND LEACH MODULUS METHOD, WITH
C              SHONE MODIFICATION, OF ONE PERIOD DELAY.
C              (CP. RES.QRLY. (1967), 53, 318 )
C
C              OUTPUT OF METHODS 1,2 AND 4 ONLY ARE PRINTED.
C                        DICTIONARY
C
C                        - - - - -
C
C                ADMX    GREATEST M.A.D. VALUE
C                AVE     MEAN OF DEMAND DATA
C                CMAX    CUMULATED ERROR, ONE RUN
C                DF      INDIVIDUAL DATA ITEM
C                EMAX    GREATEST SIGNED ERROR, DATA RUN
C                M       NUMBER OF UNITS IN A DATA RUN
C                SADMX   SMALLEST OVERALL MAX. M.A.D. VALUE
C                SCMAX   SMALLEST OVERALL MAX. CUM. ERROR
C                SEMAX   SMALLEST OVERALL MAX. SIGNED ERROR
C                TMAX    GREATEST ABS. VALUE OF TRACKING SIGNAL
C
          DO 166  I=1,M
           DF(I) = DDF(I)
  166  CONTINUE
        Z=M+1
          DF(Z) = -99.0
          PRINT 100
  100  FORMAT('1',56X,'BRUSIM SIMULATION'/56X,'* * * * * * * * *'/62X,
      1'NOTES'/48X,'1: FORECAST IS PRINTED ON PREVIOUS LINE.'/24X,
      2 '2: ADAPTIVE METHOD: VALUE OF PREVIOUS MONTHS TRACKING SIGNAL BEC
      3OMES THE NEW ALPHA.'/48X,'THREE SIMULATIONS ARE USED, NAMELY:'/)
        PRINT 105
  105  FORMAT('0',34X,'(A) NON TREND FORECASTING, ALPHA 0.1 TO 0.9 BY 0.2
      1'/35X,'(B) TREND FORECASTING, ALPHA ITERATED FROM 0.1 TO 0.5 BY 0.
      22'/    35X,'(C) ADAPTIVE TRIGG WITH SHONE AMENDMENT.'/)
C                INITIALISE VALUES : B IS VALUE OF ALPHA DURING
C                ANY PARTICULAR RUN BUT C = VALUE OF ALPHA FOR
C                FIRST 3 CALCULATIONS OF EACH RUN
C
       B=0.1
       C=0.7
       K=1
          SADMX = 9999.
       SEMAX =9999.
       SAMAX =9999.
       STMAX =9999.
```

```
          SCMAX =9999.
          TCT = 0.
          I= 1
          TL =0.7
   16      IF(DF(I) .LT.0.) GO TO 14
C                  CALCULATE AVE, DATA MEAN
   13     TOT = TOT +DF(I)
          N= I
          I= I+1
           IF(I-100)  16,  16,  14
   14     AVE = TOT/N
```

```
      CON =(0.8)*AVE
      ADD =(0.1)*AVE
      J = 1
C            OUTPUT HEADING
   80 A = B
   25 IF (K-2) 17,15,110
   17 PRINT 19, A
   19 FORMAT('1',42X,'EXPONENTIAL SMOOTHING, NO TREND', 3X,'ALPHA =',
     1 2X,F4.1)
      GO TO 27
  110 CONTINUE
       IF (K.EQ.3) GO TO 115
   67  PRINT  64
   64 FORMAT('1',46X,'ADAPTIVE EXPONENTIAL SMOOTHING.'/48X,'TRIGG AND LE
     1ACH MODULUS WITH'/51X,  'SHONE ONE PERIOD DELAY'/)
      GO TO 27
   15  PRINT 11, A
   11 FORMAT ('1',42X,'EXPONENTIAL SMOOTHING WITH TREND', 3X,'ALPHA =',
     1 2X,F4.1)
   27 PRINT 12
   12 FORMAT('0',36X,'DEMAND    FORECAST   ERROR   CUM ERROR',  '    MAD
     1    TRACKING'/ 37X,28('- ') /)
  115  CONTINUE
C             INITIALISE BEGINNING OF EACH RUN
      ADM = 0.8*((DF(1))**0.5)
      OE  = 0
      OF  = DF(1)
      OT = 0
      EMAX = 0.
      ADMX = 0.
      TMAX = 0.
      CMAX = 0.
      OA = DF(I)
      I = 1
      CE = 0.
      TL = 0.7
   20 D  = DF(I)
C             READ NEXT FIGURE
C             FIRST 3 CALCULATIONS DONE WITH SM. CONSTANTS SET
C             TO 0.7 TO ALLOW RAPID SETTLING IN
      IF (I-3) 31,31,39
   31 A = C
      Y = C
      GO TO 32
   39 IF (J-5) 65,65,66
   66 A = ABS(TOLD)
      Y = 0.1
      GO TO 32
   65 A = B
```

```
      Y= 0.1
   32 SA = A*D+ (1-A) *OA
C              TEST VALUE OF K TO DECIDE FORECAST METHOD
      IF(K-4) 68,22,68
   68 IF (K-2) 22,21,23
   21 CT = SA- OA
      NT =Y*CT +(1-Y)*OT
      F =SA+((1.-A)/A)*NT
      GO TO 24
   22 F =SA
       GO TO 24
```

```
   23 F = CON
      A = CON
   24 E= D - OF
      SE= Y*E+(1-Y)*OE
      CE =CE+E
      AD =ABS(D-OF)
      ADM =Y*AD+(1-Y)*ADM
      IF (ADM-0)60,60,70
   60 ADM = 1
   70 T =SE/ADM
      IF(T)73,72,73
   72 T =0.01
C     TEST TO FIND LARGEST ABS. VALUES AFTER  FIRST 4 RESULTS
   73 IF (I-4) 33,33,71
   71 AE =ABS(E)
      IF (AE- EMAX) 35,35,34
   34 EMAX =AE
   35 IF(ADM-ADMX)37,37,36
   36 ADMX =ADM
   37 ATX =ABS(T)
      IF(ATX-TMAX)48,48,38
   38 TMAX =ATX
   48 ACE =ABS(CE)
      IF(ACE-CMAX)33,33,90
   90 CMAX =ACE
   33  CONTINUE
       IF (K.EQ.3) GO TO 125
C               OUTPUT LINE OF RESULTS
      PRINT 30, D, F, E, CE, ADM, T
   30 FORMAT('0',32X, 5F10.1,F10.2)
  125  CONTINUE
      TOLD =TL
      TL = T
      OF = F
      OA = SA
       CT = SA-OA
       NT = Y* CT +(1-Y) * OT
      OT =NT
      OE =SE
      I =I+1
      IF(I-N)20,20,40
   40 IF(EMAX- SEMAX)42,43,43
   42 SEMAX =EMAX
      SEE = A
      M1 =K
   43 IF (ADMX-SADMX)44,45,45
   44 SADMX =ADMX
      SAA=A
      M3 =K
```

```
   45 IF (TMAX-STMAX)46,47,47
   46 STMAX =TMAX
      STA =A
      M4 =K
   47 IF(CMAX-SCMAX)91,92,92
   91 SCMAX =CMAX
      SCE =A
      M2 =K
   92  PRINT 41, EMAX, CMAX, ADMX, TMAX
   41 FORMAT('0',34X,'ABSOLUTE MAXIMUM',2X,3F10.1,F10.2//)
C               TEST FOR END OF RUN AND METHOD
```

```
      IF(K-3)54,62,51
   54 B = B+0.2
       IF(B-0.50) 80, 80, 50
   50 IF (K-3)61,62,62
   61 K = K+1
      B = 0.1
      GO TO 80
   62 CON = CON +ADD
      J =J+1
      IF(J-5)25,25,63
   63 K =4
      TOLD =0.7
      GO TO 67
C            AFTER LAST RUN OF METHOD 4, OUTPUT FINAL SUMMARY
   51  PRINT 52
   52 FORMAT('1',47X,'THE SMALLEST VALUES OF THE LARGEST ABSOLUTES'/48X,
     1'_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _'/)
       PRINT 94
   94 FORMAT('0',49X,'SUMMARY OF RESULTS OF BRUSIM SIMULATIONS :'/)
       PRINT 57
   57 FORMAT('0',47X,'PARAMETER       VALUE       METHOD      CONSTANT')
       PRINT 53, SEMAX, M1, SEE
   53 FORMAT('0',48X,'ERROR',7X, F8.2, 8X, I1,7X, F8.2)
       PRINT 55, SCMAX, M2, SCE
   55 FORMAT('0',47X,'CUM ERROR', 4X,F8.2, 8X,I1,7X, F8.2)
       PRINT 56, SADMX, M3, SAA
   56 FORMAT('0',50X,'MAD',7X, F8.2, 8X, I1, 7X, F8.2)
        PRINT 58, STMAX, M4, STA
   58  FORMAT('0',45X,'TRACKING', 7X, F8.2, 8X,I1,7X, F8.2/46X,'_ _ _ _
     1_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _'/)
  120  CONTINUE
       RETURN
      END
       SUBROUTINE EOQSIM (PRICE,EQSB,TRFX,SEAFX,EQDUB,KTOTAL,KL,ITEMN1      54000
     1   )                                                                  54001
C                                                                           54003
C                       EOQSIM SUBROUTINE                                   54004
C                       * * * * * * * * *                                   54005
C                                                                           54006
C              TO COMPUTE ECONOMIC ORDER QUANTITIES                         54008
C              GIVEN A SAMPLE OF ANNUAL DEMANDS FROM BRUFICH.               54009
C              THE FINAL TWELVE MONTHS OF FIVE ROUTINES ARE USED            54010
C                  (A):  NON-TREND                                          54011
C                  (B):  TREND ADJUSTED                                     54012
C                  (C):  SEASONAL                                           54013
C                  (D):  DOUBLE SMOOTHING                                   54014
C                  (E):  ACTUAL DEMAND                                      54015
C              WITH EACH SET, HOLDING AND ORDERING COSTS                    54020
C
```

```
C                 ARE ITERATED. ANY COMBINATION OF COSTS MAY BE USED.
C
          DIMENSION ANDEM(20), CORDER(20), CCOST(20),QE(20,20,20)
         1,PRICE(20),EQSB(100),ITEMNI(100),EQDUB(100),KTOTAL(100)
          PRINT 1
    1     FORMAT('1', 34X, 'TABLE 4:  ORDER QUANTITY SIMULATION'/35X,'* * *
         1* * * * * * * * * * * * * * *'/)
    6     FORMAT(30X,'THE ECONOMIC ORDER QUANTITY WITH ANNUAL DEMAND OF:',
         1 F10.0/)
    7       FORMAT(27X,'ORDER/HOLDING''',2X,F6.2,(5(9X,F6.2)) )
    8     FORMAT(16X,F7.2, 12X,5F15.0)
```

```
      JN = 5
C              NUMBER OF DEMANDS BEING ITERATED
      IN = 4
C              NUMBER OF ORDER COSTS ITERATED
       KN = 4
C              NUMBER OF HOLDING COSTS ITERATED
       CCRDER(1) = 5.
       CORDER(2) = 8.
       CORDER(3) = 15.
       CORDER(4) = 30.
      CCOST(1) = 0.15
      CCOST(2) = 0.24
      CCOST(3) = 0.30
      CCOST(4) = 0.36
       ANDEM(1) = EQSB(KL)
       ANDEM(2) = TRFX
      ANDEM(3) = SEAFX
      ANDEM(4) = EQDUB(KL)
      ANDEM(5) = KTOTAL(KL)
C              PRICE      PURCHASE COST OF THE ITEM.
C              ANDEM     FORECAST DEMANDS (JN OF THEM)
C              CORDER      ORDER COSTS IN $ (IN OF THEM)
C              CCOST      HOLDING COSTS, PERCENTAGE (KN OF THEM)
         DO 10      J=1,JN
          DO 10      I=1,  IN
           DO 10       K=1,KN
C              EOQ      QE(IJK) REPRESENTS THE ITH ORDER COST,
C                       THE JTH YEARLY DEMAND, AND KTH HOLDING COST.
      IF (PRICE(KL) .LE. 0.10)  PRICE(KL) = 0.10
      IF(ANDEM(J) .LT.10.) ANDEM(J) = 10.
       QE(J,I,K) = SQRT((2.0*(ANDEM(J)*CORDER(I)))/ CCOST(K)*PRICE(KL))
   10    CONTINUE
      PRINT 21,    ITEMNI(KL)
   21 FORMAT('0',31X,'E.O.Q. SIMULATION, ITEM NUMBER:',1X,I8/)
      PRINT 30
   30 FORMAT('0',34X,'DEMANDS AND FORECASTS USED ARE:'/ 25X,'NORMAL: TRE
     1ND; SEASONAL; DOUBLE SMOOTHED; AND ACTUAL DEMAND.'/)
      DO 11     J = 1,JN
         PRINT 6,   ANDEM(J)
        PRINT 7,(CCOST(K), K=1,KN)
         DO 11    I = 1,IN
         PRINT 8, CORDER(I), (QE(J,I,K), K=1,KN)
   11     CONTINUE
C
        PRINT 25
   25  FORMAT('0',22X,'A DEMAND SHOWN AS 10. MEANS A LOW OR NEGATIVE FOR
     1ECAST.'/24X,'INSERTED TO PREVENT A NEGATIVE WITH THE SQUARE ROOT.'
     2 /)
C                    END OF THE BRUFICH PROGRAMME.
```

```
      C                                * * * * * * * * * * * * * * * *              54156
2041            RETURN                                                              54170
2042               END                                                              54171
        $ENTRY
```

BRUNEL UNIVERSITY
FORECASTING AND INVENTORY CONTROL
FOR HOSPITALS:
THE BRUFICH SYSTEM
* * * * * * * * *

DATA INPUT AND TABULATION

FOR THE 2 DATA ITEMS

BROWN METHOD OF OBTAINING STARTING VALUES.
****

INITIAL SIMULATION: BRUSTART.
* * * * * * * * * * * * * * * *

PERIOD ******	DEMAND ******	FORECAST ********	ERROR *****
1	1222.	1342.00	-120.00
2	1707.	1340.56	366.44
3	1229.	1339.12	-110.12
4	1524.	1337.68	186.32
5	1253.	1336.24	-83.24
6	1334.	1334.80	-0.80
7	1560.	1333.36	226.64
8	740.	1331.92	-591.92
9	1125.	1330.48	-205.48
10	1434.	1329.04	104.96
11	1355.	1327.60	27.40
12	1259.	1326.16	-67.16
13	1629.	1324.72	304.28
14	1326.	1323.29	2.71
15	1421.	1321.85	99.15
16	1631.	1320.41	310.59
17	1166.	1318.97	-152.97
18	1257.	1317.53	-60.53

THE VALUES OF THE FINAL FORECAST OF BRUSTART :

FORECAST = 1317.5 TREND VALUE = -1.44 AND M.A.D.= 173.0

THE FIRST PROCEDURE :
TABLE 1: NON-TREND FORECASTING
USING SINGLE SMOOTHING
* * * * * * * * * * * * * * *

PARAMETER VALUES ARE: ALPHA =: 0.10 BETA =: 0.10

* TR.SIG. UNSMOOTHED.ADAPTIVE. IF ABOVE (4*MAD) A MESSAGE IS PRINTED.
IF CHANGE PERSISTS, ALPHA RAISED.
IF ABOVE (6*MAD). ALPHA IS RAISED AT ONCE.

* TRIGG * BASED ON BATTY DECISION RULES: MESSAGE PRINTED. NO ACTION TAKEN.
* * * * * * * * * * * * * * *

ACTUAL DATA	FORECAST	ERROR	TR.SIGNAL	MAD	SM.ERROR	TRIGG T.S
1673	1311.5	361.53	361.53	136.4	116.25	0.59
1283	1347.6	-64.63	296.90	183.2	98.16	0.54
1316	1341.2	-25.16	271.74	167.4	85.83	0.51
1501	1338.6	162.35	434.09	166.9	93.48	0.56
1399	1354.9	44.12	478.21	154.6	88.55	0.57
1177	1359.3	-182.29	295.91	157.4	61.46	0.39
1236	1341.1	-105.06	190.85	152.1	44.81	0.29
1536	1330.6	205.44	396.29	157.5	60.87	0.39
1406	1351.1	54.90	451.19	147.2	60.28	0.41
1834	1356.6	477.41	928.60	180.2	101.99	0.57
1183	1404.3	-221.33	707.27	184.3	69.66	0.38
430	1382.2	-952.20	-244.93	261.1	-32.53	-0.12
1000	1287.0	-286.98	-531.91	263.7	-57.97	-0.22
1590	1258.3	331.72	-200.19	270.5	-19.00	-0.07
1110	1291.5	-181.45	-381.64	261.6	-35.25	-0.13
2002	1273.3	728.69	347.05	308.3	41.15	0.13
689	1346.2	-657.18	-310.12	343.2	-28.69	-0.08
1237	1280.5	-43.46	-353.58	313.2	-30.16	-0.10
2064	1276.1	787.89	434.31	360.7	51.64	0.14
2272	1354.9	917.10	1351.41	416.3	138.19	0.33
2830	1446.6	1383.39	2734.80	513.0	262.71	0.51
2311	1584.9	726.05	3460.85	534.3	309.04	0.58

TRSIG INDICATES SIMPLE SMOOTHING IS UNSATISFACTORY. USE ALTERNATIVE METHOD?

TR.SIG ERROR EXCEEDS CONTROL LIMIT.ALP WILL BE RAISED TO : 0.30 NEXT PERIOD.

2206	1657.6	548.45	0.00	535.7	332.98	0.62

TRIGG SIGNAL INDICATES WITH 95% CONFIDENCE THAT
CONTROL IS LOST THROUGH A CHANGE IN DEMAND PATTERN

2562	1822.1	739.91	739.91	556.2	373.67	0.67
1748	2044.1	-296.06	443.85	530.2	306.70	0.58

ALPHA WILL REVERT TO ITS FORMER VALUE OF 0.10 THE NEXT PERIOD.

1966	1955.2	10.76	454.61	478.2	277.11	0.58

1896	1956.3	-60.32	394.29	436.4	243.36	0.56

TRIGG SIGNAL INDICATES WITH 95% CONFIDENCE THAT
CONTROL IS LOST THROUGH A CHANGE IN DEMAND PATTERN

2366	1950.3	415.71	810.01	434.4	260.60	0.60
2279	1991.9	287.14	1097.15	419.6	263.25	0.63
2244	2020.6	223.43	1320.58	400.0	259.27	0.65
2453	2042.9	410.09	1730.66	401.0	274.35	0.68

TRIGG SIGNAL INDICATES WITH 95% CONFIDENCE THAT
CONTROL IS LOST THROUGH A CHANGE IN DEMAND PATTERN

2670	2083.9	586.08	2316.74	419.5	305.52	0.73

TRSIG INDICATES SIMPLE SMOOTHING IS UNSATISFACTORY. USE ALTERNATIVE METHOD?

TR.SIG ERROR EXCEEDS CONTROL LIMIT.ALP WILL BE RAISED TO : 0.30 NEXT PERIOD.

2536	2142.5	393.47	0.00	416.9	314.32	0.75
2523	2260.6	262.43	262.43	401.5	309.13	0.77
3026	2339.3	686.70	949.13	430.0	346.89	0.81

TRIGG SIGNAL INDICATES WITH 95% CONFIDENCE THAT
CONTROL IS LOST THROUGH A CHANGE IN DEMAND PATTERN

ALPHA WILL REVERT TO ITS FORMER VALUE OF 0.10 THE NEXT PERIOD.

2552	2545.3	6.69	955.82	387.7	312.87	0.81
2289	2546.0	-256.98	698.84	374.6	255.88	0.68
2278	2520.3	-242.28	456.56	361.4	206.07	0.57
2476	2496.1	-20.05	436.51	327.2	183.45	0.56

TRIGG SIGNAL INDICATES WITH 95% CONFIDENCE THAT
CONTROL IS LOST THROUGH A CHANGE IN DEMAND PATTERN

3032	2494.0	537.95	974.46	348.3	218.90	0.63
2756	2547.8	208.16	1182.62	334.3	217.83	0.65
2176	2568.7	-392.66	789.97	340.1	156.78	0.46
2482	2529.4	-47.39	742.58	310.9	136.36	0.44
2090	2524.7	-434.65	307.92	323.2	79.26	0.25

MEASUREMENTS OF OVERALL
FORECASTING EFFECTIVENESS
* * * * * * * * * * * * * *

THE AVERAGE CUMULATIVE SIGNED ERROR : 159.7

```
BALANCED ERROR                    :   88.0
OVERALL MEAN ABSOLUTE DEVIATION        :  362.9
TOTAL SIGNED ERROR                     : 7027.4
ROOT MEAN SQUARE ERROR                 :  471.6

THE THEIL COEFFICIENT                  :    0.12

THEIL SUGGESTS A FAIRLY ACCURATE FORECAST.
```

THE INDEX OF FORECASTABILITY : 4.5
ACCURACY PERCENTAGE : 27.0
BALANCED ERROR SHOWS EXTENT OF ERROR CANCELLATION IN DATA.
A THEIL VALUE OF ZERO INDICATES PERFECT PREDICTION.

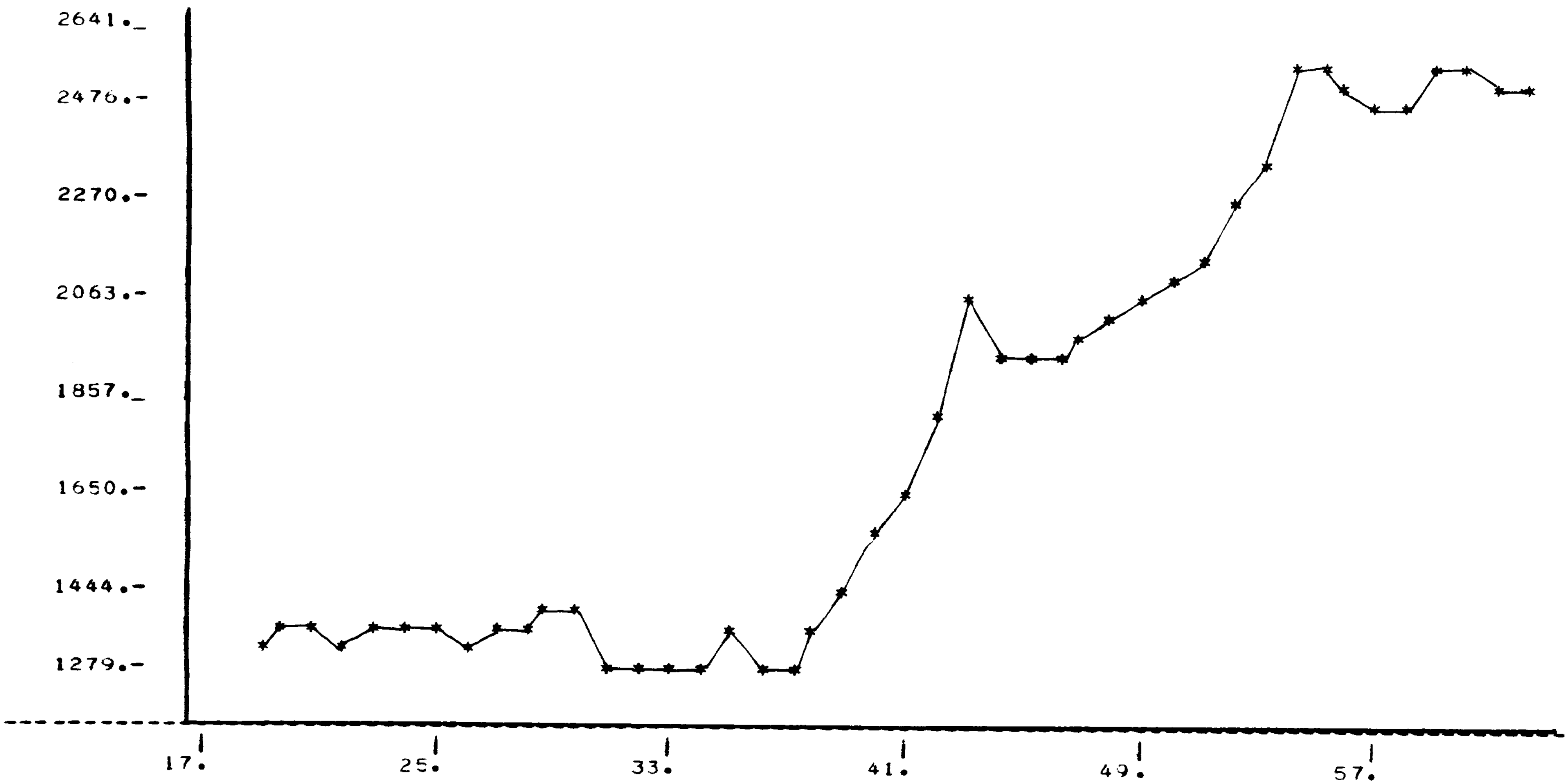
THE FORECASTABILITY INDEX IS HIGH, SUGGESTING THAT
BRUFICH IS VERY SUITABLE FOR THIS ITEM.

* *

PLOT OF SIMPLE SMOOTHING.
* * * * * * * * * * * *

ITEM NUMBER	FIRST MONTH	LAST MONTH	LOWEST VALUE	HIGHEST VALUE
88100010	19.	62.	1258.	2569.

- - - - - - - - - - - - - - - - - -



Face Tissues
Single Smoothed Forecast

THE SECOND PROCEDURE:
TREND ADJUSTED FORECASTING
* * * * * * * * * * * * * *
IF RUN OF DATA IS LESS THAN 18 PERIODS
NO TREND ROUTINE IS PERFORMED.

- - - - - - - - - - - - - - - - - - -

THE MEDIAN OF THE DATA IS: 1630.0 THE MEAN OF THE EARLIER DATA IS: 1327.3
AND THE MEAN OF THE RECENT DATA IS: 2216.5
LEAD TIME IS   0.5 MONTHS

THERE IS SOME EVIDENCE THAT A TREND IS PRESENT.
* *

THE SLOPE IS UPWARD

RUNS TREND TEST

- - - - - - - - -

SIEGEL RUNS TEST INDICATES A STRONG TREND IN THE DATA, WITH A Z VALUE OF   -5.0

* BOTH TREND TESTS INDICATE SOME TREND IS PRESENT *

* TABLE 2 *
* * * * * *
BROWN DOUBLE SMOOTHING

$\alpha = 0{\cdot}10$

PERIOD	SINGLE SMOOTH	DOUBLE SMOOTH	CURRENT FORECAST	CURRENT ERROR	2 MONTH AHEAD FORECAST	2 MONTH AHEAD ERROR	3 MONTH AHEAD FORECAST	3 MONTH AHEAD ERROR
19	1311.5	1316.9	1305.4	367.6	1305.4	367.6	1305.4	367.6
20	1347.6	1320.0	1378.3	-95.3	1304.8	-21.8	1304.8	-21.8
21	1341.2	1322.1	1362.3	-46.3	1381.4	-65.4	1304.2	11.8
22	1338.6	1323.8	1355.2	145.8	1364.5	136.5	1384.5	116.5
23	1354.9	1326.9	1386.0	13.0	1356.8	42.2	1366.6	32.4
24	1359.3	1330.1	1391.7	-214.7	1389.1	-212.1	1358.5	-181.5
25	1341.1	1331.2	1352.0	-116.0	1395.0	-159.0	1392.2	-156.2
26	1330.6	1331.1	1329.9	206.1	1353.1	182.9	1398.2	137.8
27	1351.1	1333.1	1371.1	34.9	1329.8	76.2	1354.2	51.8
28	1356.6	1335.5	1380.0	454.0	1373.1	460.9	1329.8	504.2
29	1404.3	1342.4	1473.2	-290.2	1382.4	-199.4	1375.0	-192.0
30	1382.2	1346.4	1422.0	-992.0	1480.1	-1050.1	1384.7	-954.7
31	1287.0	1340.4	1227.6	-227.6	1426.0	-426.0	1486.9	-486.9
32	1258.3	1332.2	1176.1	413.9	1221.7	368.3	1430.0	160.0
33	1291.5	1328.1	1250.7	-140.7	1167.9	-57.9	1215.7	-105.7
34	1273.3	1322.6	1218.5	783.5	1246.6	755.4	1159.7	842.3
35	1346.2	1325.0	1369.7	-680.7	1213.0	-524.0	1242.6	-553.6
36	1280.5	1320.5	1235.9	1.1	1372.1	-135.1	1207.5	29.5
37	1276.1	1316.1	1231.7	832.3	1231.5	832.5	1374.4	689.6

38	1354.9	1320.0	1393.7	878.3	1227.2	1044.8	1227.0	1045.0
39	1446.6	1332.6	1573.2	1256.8	1397.6	1432.4	1222.8	1607.2
40	1584.9	1357.9	1837.3	473.7	1585.9	725.1	1401.5	909.5
41	1657.6	1387.8	1957.2	248.8	1862.5	343.5	1598.6	607.4
42	1712.4	1420.3	2037.0	525.0	1987.2	574.8	1887.7	674.3

43	1797.4	1458.0	2174.4	-426.4	2069.4	-321.4	2017.2	-269.2
44	1792.4	1491.4	2126.8	-160.8	2212.1	-246.1	2101.9	-135.9
45	1809.8	1523.3	2128.1	-232.1	2160.3	-264.3	2249.8	-353.8
46	1818.4	1552.8	2113.5	252.5	2159.9	206.1	2193.7	172.3
47	1873.2	1584.8	2193.5	85.5	2143.0	136.0	2191.8	87.2
48	1913.7	1617.7	2242.7	1.3	2225.6	18.4	2172.6	71.4
49	1946.8	1650.6	2275.8	177.2	2275.6	177.4	2257.6	195.4
50	1997.4	1685.3	2344.2	325.8	2308.7	361.3	2308.4	361.6
51	2064.7	1723.2	2444.0	92.0	2378.8	157.2	2341.6	194.4
52	2111.8	1762.1	2500.3	22.7	2481.9	41.1	2413.5	109.5
53	2152.9	1801.2	2543.7	482.3	2539.2	486.8	2519.9	506.1
54	2240.2	1845.1	2679.3	-127.3	2582.8	-30.8	2578.1	-26.1
55	2271.4	1887.7	2697.7	-408.7	2723.2	-434.2	2621.9	-332.9
56	2273.2	1926.3	2658.6	-380.6	2740.3	-462.3	2767.1	-489.1
57	2273.6	1961.0	2621.0	-145.0	2697.1	-221.1	2783.0	-307.0
58	2293.9	1994.3	2626.8	405.2	2655.8	376.2	2735.7	296.3
59	2367.7	2031.6	2741.1	14.9	2660.0	96.0	2690.5	65.5
60	2406.5	2069.1	2781.4	-605.4	2778.4	-602.4	2693.3	-517.3
61	2383.5	2100.5	2697.8	-215.8	2813.9	-336.9	2815.8	-333.8
62	2393.3	2129.8	2686.1	-596.1	2729.3	-639.3	2856.4	-766.4

FORECAST VALUES FOR LATER PERIODS ARE:
PERIOD: 63= 2715.4 AND 2760.7 AND PERIOD: 64= 2744.6

ERROR SUMMARY TABLE: DOUBLE SMOOTHING
- - - - - - - - - - - - - - - - - - -

AVERAGE OF SIGNED ERRORS :

CURRENT FORECAST	55.6
TWO MONTHS AHEAD	69.5
THREE MONTHS AHEAD	85.2
BALANCED ERRORS :	
CURRENT FORECAST	32.8
TWO MONTHS AHEAD	37.8
THREE MONTHS AHEAD	45.7
ROOT MEAN SQUARE ERROR :	443.7

```
OVERALL MEAN ABSOLUTE DEVIATIONS :
     CURRENT FORECAST        339.4
     TWO MONTHS AHEAD        367.7
     THREE MONTHS AHEAD      372.8
SUM OF SIGNED ERRORS :
     CURRENT FORECAST       2392.2
     TWO MONTHS AHEAD       2989.8
     THREE MONTHS AHEAD     3662.7
CONSTANT VALUES ARE: ALPHA   0.10 AND BETA   0.10

ACCURACY PERCENTAGE :   25.3
```

* TABLE 2 *
* * * * * *
BROWN DOUBLE SMOOTHING

$\alpha = 0.5$

PERIOD	SINGLE SMOOTH	DOUBLE SMOOTH	CURRENT FORECAST	CURRENT ERROR	2 MONTH AHEAD FORECAST	2 MONTH AHEAD ERROR	3 MONTH AHEAD FORECAST	3 MONTH AHEAD ERROR
19	1287.3	1302.4	1257.0	416.0	1257.0	416.0	1257.0	416.0
20	1480.1	1391.3	1657.9	-374.9	1241.9	41.1	1241.9	41.1
21	1381.6	1386.4	1371.9	-55.9	1746.7	-430.7	1226.7	89.3
22	1348.8	1367.6	1311.2	189.8	1367.0	134.0	1835.6	-334.6
23	1424.9	1396.2	1482.2	-83.2	1292.3	106.7	1362.2	36.8
24	1411.9	1404.1	1427.6	-250.6	1510.8	-333.8	1273.5	-96.5
25	1294.5	1349.3	1184.9	51.1	1435.5	-199.5	1539.5	-303.5
26	1265.2	1307.3	1181.2	354.8	1130.0	406.0	1443.3	92.7
27	1400.6	1353.9	1494.0	-88.0	1139.2	266.8	1075.2	330.8
28	1403.3	1378.6	1452.7	381.3	1540.7	293.3	1097.1	736.9
29	1618.7	1498.6	1858.7	-675.7	1477.4	-294.4	1587.3	-404.3
30	1400.8	1449.7	1303.0	-873.0	1978.7	-1548.7	1502.0	-1072.0
31	915.4	1182.6	381.1	618.9	1254.1	-254.1	2098.7	-1098.7
32	957.7	1070.1	732.8	857.2	113.9	1476.1	1205.2	384.8
33	1273.9	1172.0	1477.6	-367.6	620.4	489.6	-153.2	1263.2
34	1191.9	1182.0	1211.9	790.1	1579.4	422.6	508.0	1494.0
35	1597.0	1389.5	2012.0	-1323.0	1221.8	-532.8	1681.3	-992.3
36	1143.0	1266.2	896.5	340.5	2219.5	-982.5	1231.8	5.2
37	1190.0	1228.1	1113.8	950.2	773.3	1290.7	2427.0	-363.0

38	1627.0	1427.6	2025.9	246.1	1075.6	1196.4	650.0	1622.0
39	1949.5	1688.5	2471.4	358.6	2225.3	604.7	1037.5	1792.5
40	2389.7	2039.1	3091.0	-780.0	2732.4	-421.4	2424.8	-113.8
41	2350.4	2194.8	2661.6	-455.6	3441.6	-1235.6	2993.4	-787.4
42	2278.2	2236.5	2361.6	200.4	2817.2	-255.2	3792.2	-1230.2

43	2420.1	2328.3	2603.7	-855.7	2403.3	-655.3	2972.8	-1224.8
44	2084.0	2206.2	1839.8	126.2	2695.5	-729.5	2445.0	-479.0
45	2025.0	2115.6	1843.9	52.1	1717.7	178.3	2787.3	-891.3
46	1960.5	2038.1	1805.4	560.6	1753.3	612.7	1595.6	770.4
47	2163.3	2100.7	2288.5	-9.5	1727.9	551.1	1662.7	616.3
48	2221.1	2160.9	2341.6	-97.6	2351.1	-107.1	1650.3	593.7
49	2232.6	2196.7	2304.2	148.8	2401.8	51.2	2413.7	39.3
50	2342.8	2269.8	2488.8	181.2	2340.1	329.9	2462.1	207.9
51	2506.4	2388.1	2743.0	-207.0	2561.9	-25.9	2375.9	160.1
52	2521.2	2454.6	2654.3	-131.3	2861.3	-338.3	2634.9	-111.9
53	2522.1	2488.4	2589.6	436.4	2720.9	305.1	2979.7	46.3
54	2774.0	2631.2	3059.7	-507.7	2623.3	-71.3	2787.4	-235.4
55	2663.0	2647.1	2694.8	-405.8	3202.6	-913.6	2657.0	-368.0
56	2476.0	2561.6	2304.9	-26.9	2710.7	-432.7	3345.4	-1067.4
57	2377.0	2469.3	2192.4	283.6	2219.4	256.6	2726.7	-250.7
58	2426.5	2447.9	2383.7	648.3	2100.2	931.8	2133.8	898.2
59	2729.3	2588.6	3010.6	-254.6	2362.3	393.7	2007.9	748.1
60	2742.6	2665.6	2896.7	-720.7	3151.3	-975.3	2340.9	-164.9
61	2459.3	2562.5	2253.0	229.0	2973.7	-491.7	3292.0	-810.0
62	2470.7	2516.6	2378.9	-288.9	2149.9	-59.9	3050.7	-960.7

FORECAST VALUES FOR LATER PERIODS ARE:
PERIOD: 63= 2333.0 AND 2046.7 AND PERIOD: 64= 2287.1

ERROR SUMMARY TABLE: DOUBLE SMOOTHING
- - - - - - - - - - - - - - - - - - -

AVERAGE OF SIGNED ERRORS :

CURRENT FORECAST	-9.6
TWO MONTHS AHEAD	-12.4
THREE MONTHS AHEAD	-22.7
BALANCED ERRORS :	
CURRENT FORECAST	-4.8
TWO MONTHS AHEAD	-4.9
THREE MONTHS AHEAD	-7.6
ROOT MEAN SQUARE ERROR :	497.4

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OVERALL MEAN ABSOLUTE DEVIATIONS :
        CURRENT FORECAST       401.3
        TWO MONTHS AHEAD       512.6
        THREE MONTHS AHEAD     598.7
SUM OF SIGNED ERRORS :
        CURRENT FORECAST      -411.9
        TWO MONTHS AHEAD      -535.0
        THREE MONTHS AHEAD    -975.1
CONSTANT VALUES ARE: ALPHA   0.50 AND BETA   0.10

ACCURACY PERCENTAGE :   29.9
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BRUSIM SIMULATION

* * * * * * * * *

NOTES

1: FORECAST IS PRINTED ON PREVIOUS LINE.

2: ADAPTIVE METHOD: VALUE OF PREVIOUS MONTHS TRACKING SIGNAL BECOMES THE NEW ALPHA.
THREE SIMULATIONS ARE USED, NAMELY:

(A) NON TREND FORECASTING, ALPHA 0.1 TO 0.9 BY 0.2
(B) TREND FORECASTING, ALPHA ITERATED FROM 0.1 TO 0.5 BY 0.2
(C) ADAPTIVE TRIGG WITH SHONE AMENDMENT.

EXPONENTIAL SMOOTHING, NO TREND   ALPHA = 0.1

DEMAND	FORECAST	ERROR	CUM ERROR	MAD	TRACKING
1222.0	825.7	0.0	0.0	8.4	0.01
1707.0	1442.6	881.3	881.3	619.4	1.00
1229.0	1293.1	-213.6	667.7	335.4	0.11
1524.0	1316.2	230.9	898.6	324.9	0.17
1253.0	1309.9	-63.2	835.4	298.7	0.14
1334.0	1312.3	24.1	859.6	271.3	0.15
1560.0	1337.0	247.7	1107.3	268.9	0.23
740.0	1277.3	-597.0	510.3	301.7	-0.01
1125.0	1262.1	-152.3	357.9	286.8	-0.07
1434.0	1279.3	171.9	529.8	275.3	0.00
1355.0	1286.9	75.7	605.5	255.3	0.03
1259.0	1284.1	-27.9	577.7	232.6	0.02
1629.0	1318.6	344.9	922.6	243.8	0.16
1326.0	1319.3	7.4	930.0	220.2	0.16
1421.0	1329.5	101.7	1031.7	208.3	0.20
1631.0	1359.6	301.5	1333.2	217.7	0.31
1166.0	1340.3	-193.6	1139.6	215.3	0.19
1257.0	1331.9	-83.3	1056.3	202.1	0.14
1673.0	1366.0	341.1	1397.4	216.0	0.28
1283.0	1357.7	-83.0	1314.3	202.7	0.23
1316.0	1353.6	-41.7	1272.6	186.6	0.20
1501.0	1368.3	147.4	1420.0	182.7	0.26

1399.0	1371.4	30.7	1450.7	167.5	0.28
1177.0	1351.9	-194.4	1256.3	170.2	0.13
1236.0	1340.3	-115.9	1140.4	164.7	0.05
1536.0	1359.9	195.7	1336.0	167.8	0.16
1406.0	1364.5	46.1	1382.1	155.7	0.19

1834.0	1411.5	469.5	1851.6	187.0	0.39
1183.0	1388.6	-228.5	1623.1	191.2	0.23
430.0	1292.8	-958.6	664.5	267.9	-0.21
1000.0	1263.5	-292.8	371.8	270.4	-0.30
1590.0	1296.1	326.5	698.3	276.0	-0.14
1110.0	1277.5	-186.1	512.2	267.0	-0.20
2002.0	1350.0	724.5	1236.6	312.8	0.07
689.0	1283.9	-661.0	575.7	347.6	-0.13
1237.0	1279.2	-46.9	528.8	317.5	-0.14
2064.0	1357.7	784.8	1313.6	364.2	0.10
2272.0	1449.1	914.3	2227.9	419.3	0.30
2830.0	1587.2	1380.9	3608.8	515.4	0.49
2311.0	1659.6	723.8	4332.7	536.3	0.56
2206.0	1714.2	546.4	4879.1	537.3	0.60
2562.0	1799.0	847.8	5726.9	568.3	0.66
1748.0	1793.9	-51.0	5675.9	516.6	0.64
1966.0	1811.1	172.1	5848.0	482.1	0.66
1896.0	1819.6	84.9	5932.9	442.4	0.66
2366.0	1874.2	546.4	6479.3	452.8	0.70
2279.0	1914.7	404.8	6884.1	448.0	0.73
2244.0	1947.6	329.3	7213.3	436.1	0.75
2453.0	1998.2	505.4	7718.7	443.1	0.78
2670.0	2065.4	671.8	8390.5	465.9	0.81
2536.0	2112.4	470.6	8861.2	466.4	0.83
2523.0	2153.5	410.6	9271.7	460.8	0.85

3026.0	2240.7	872.5	10144.3	502.0	0.87
2552.0	2271.9	311.3	10455.5	482.9	0.88
2289.0	2273.6	17.1	10472.7	436.3	0.88
2278.0	2274.0	4.4	10477.1	393.2	0.88
2476.0	2294.2	202.0	10679.1	374.0	0.89

3032.0	2368.0	737.8	11416.9	410.4	0.91
2756.0	2406.8	388.0	11804.9	408.2	0.92
2176.0	2383.7	-230.8	11574.1	390.4	0.80
2482.0	2393.5	98.3	11672.4	361.2	0.81
2090.0	2363.2	-303.5	11368.8	355.4	0.65
ABSOLUTE MAXIMUM		1380.9	11804.9	568.3	0.92

EXPONENTIAL SMOOTHING WITH TREND ALPHA = 0.1

DEMAND	FORECAST	ERROR	CUM ERROR	MAD	TRACKING
1222.0	1103.0	0.0	0.0	8.4	0.01
1707.0	1627.3	604.0	604.0	425.3	0.99
1229.0	1248.5	-398.3	205.7	406.4	-0.37
1524.0	1334.2	275.5	481.2	393.3	-0.28
1253.0	1309.9	-81.2	400.0	362.1	-0.29
1334.0	1312.3	24.1	424.1	328.3	-0.28
1560.0	1355.0	247.7	671.9	320.3	-0.19
740.0	1232.3	-615.0	56.8	349.7	-0.33
1125.0	1253.1	-107.3	-50.5	325.5	-0.35
1434.0	1288.3	180.9	130.4	311.0	-0.27
1355.0	1286.9	66.7	197.1	286.6	-0.24
1259.0	1284.1	-27.9	169.2	260.7	-0.25
1629.0	1345.6	344.9	514.2	269.1	-0.09
1326.0	1319.3	-19.6	494.6	244.2	-0.10
1421.0	1338.5	101.7	596.3	229.9	-0.05
1631.0	1386.6	292.5	888.8	236.2	0.08
1166.0	1331.3	-220.6	668.2	234.6	-0.02
1257.0	1331.9	-74.3	593.9	218.6	-0.05
1673.0	1393.0	341.1	935.0	230.8	0.10
1283.0	1357.7	-110.0	824.9	218.8	0.05
1316.0	1353.6	-41.7	783.2	201.1	0.02
1501.0	1377.3	147.4	930.6	195.7	0.10

1399.0	1371.4	21.7	952.3	178.3	0.11
1177.0	1342.9	-194.4	757.9	179.9	-0.01
1236.0	1331.3	-106.9	651.0	172.6	-0.07
1536.0	1368.9	204.7	855.6	175.8	0.05
1406.0	1364.5	37.1	892.7	161.9	0.07

1834.0	1447.5	469.5	1362.2	192.7	0.30
1183.0	1370.6	-264.5	1097.7	199.9	0.13
430.0	1211.8	-940.6	157.1	273.9	-0.26
1000.0	1245.5	-211.8	-54.7	267.7	-0.32
1590.0	1323.1	344.5	289.9	275.4	-0.15
1110.0	1268.5	-213.1	76.7	269.2	-0.22
2002.0	1413.0	733.5	810.2	315.6	0.06
689.0	1229.9	-724.0	86.2	356.4	-0.15
1237.0	1279.2	7.1	93.4	321.5	-0.15
2064.0	1420.7	784.8	878.2	367.8	0.10
2272.0	1530.1	851.3	1729.5	416.2	0.28
2830.0	1704.2	1299.9	3029.4	504.6	0.47
2311.0	1722.6	606.8	3636.2	514.8	0.53
2206.0	1759.2	483.4	4119.7	511.7	0.57
2562.0	1871.0	802.8	4922.4	540.8	0.64
1748.0	1793.9	-123.0	4799.5	499.0	0.60
1966.0	1820.1	172.1	4971.6	466.3	0.61
1896.0	1819.6	75.9	5047.5	427.3	0.62
2366.0	1919.2	546.4	5593.9	439.2	0.67
2279.0	1950.7	359.8	5953.6	431.2	0.69
2244.0	1974.6	293.3	6246.9	417.4	0.72
2453.0	2043.2	478.4	6725.3	423.5	0.75
2670.0	2119.4	626.8	7352.1	443.9	0.78
2536.0	2148.4	416.6	7763.7	441.1	0.80
2523.0	2189.5	374.6	8143.3	434.5	0.82

3026.0	2312.7	836.5	8979.8	474.7	0.85
2552.0	2298.9	239.3	9219.1	451.1	0.86
2289.0	2273.6	-9.9	9209.2	407.0	0.86
2278.0	2274.0	4.4	9213.7	366.8	0.86
2476.0	2312.2	202.0	9415.7	350.3	0.86

3032.0	2431.0	719.8	10135.4	387.2	0.89
2756.0	2433.8	325.0	10460.4	381.0	0.90
2176.0	2365.7	-257.8	10202.7	368.7	0.77
2482.0	2393.5	116.3	10318.9	343.4	0.77
2090.0	2336.2	-303.5	10015.4	339.5	0.62
ABSOLUTE MAXIMUM		1299.9	10460.4	540.8	0.90

ADAPTIVE EXPONENTIAL SMOOTHING.
TRIGG AND LEACH MODULUS WITH
SHONE ONE PERIOD DELAY

DEMAND	FORECAST	ERROR	CUM ERROR	MAD	TRACKING
1222.0	825.7	0.0	0.0	8.4	0.01
1707.0	1442.6	881.3	881.3	619.4	1.00
1229.0	1293.1	-213.6	667.7	335.4	0.11
1524.0	1523.1	230.9	898.6	324.9	0.17
1253.0	1494.4	-270.1	628.5	319.4	0.07
1334.0	1467.2	-160.4	468.1	303.5	0.01
1560.0	1473.8	92.8	560.9	282.4	0.05
740.0	1463.5	-733.8	-172.9	327.6	-0.19
1125.0	1447.8	-338.5	-511.4	328.7	-0.27
1434.0	1445.2	-13.8	-525.1	297.2	-0.27
1355.0	1420.7	-90.2	-615.3	276.5	-0.30
1259.0	1376.2	-161.7	-777.0	265.0	-0.34
1629.0	1451.7	252.8	-524.2	263.8	-0.21
1326.0	1408.8	-125.7	-649.9	250.0	-0.25
1421.0	1411.4	12.2	-637.7	226.2	-0.25
1631.0	1466.8	219.6	-418.1	225.5	-0.12
1166.0	1392.9	-300.3	-718.9	233.1	-0.24
1257.0	1376.0	-135.9	-854.8	223.3	-0.28
1673.0	1446.5	297.0	-557.8	230.7	-0.12
1283.0	1400.1	-163.5	-721.4	224.0	-0.18

1316.0	1390.1	-84.1	-805.5	210.0	-0.22
1501.0	1410.4	110.9	-694.6	200.1	-0.15
1399.0	1408.0	-11.4	-706.0	181.2	-0.15
1177.0	1373.7	-231.0	-937.0	186.2	-0.26
1236.0	1352.6	-137.7	-1074.7	181.3	-0.31
1536.0	1400.0	183.4	-891.2	181.6	-0.18

1406.0	1401.9	6.0	-885.2	164.0	-0.18
1834.0	1480.6	432.1	-453.1	190.8	0.09
1183.0	1427.7	-297.6	-750.7	201.5	-0.07
430.0	1338.9	-997.7	-1748.3	281.1	-0.40
1000.0	1314.6	-338.9	-2087.2	286.9	-0.47
1590.0	1425.1	275.4	-1811.8	285.7	-0.33
1110.0	1276.4	-315.1	-2126.9	288.7	-0.40
2002.0	1515.9	725.6	-1401.2	332.4	-0.10
689.0	1182.5	-826.9	-2228.1	381.8	-0.29
1237.0	1187.8	54.5	-2173.6	349.1	-0.27
2064.0	1444.0	876.2	-1297.4	401.8	0.01
2272.0	1669.4	828.0	-469.4	444.4	0.19
2830.0	1675.5	1160.6	691.2	516.0	0.37
2311.0	1796.5	635.5	1326.7	528.0	0.45
2206.0	1949.1	409.5	1736.2	516.1	0.49
2562.0	2223.7	612.9	2349.1	525.8	0.55
1748.0	1989.7	-475.7	1873.3	520.8	0.41
1966.0	1976.7	-23.7	1849.6	471.1	0.40
1896.0	1943.6	-80.7	1769.0	432.1	0.38
2366.0	2113.6	422.4	2191.3	431.1	0.44
2279.0	2175.8	165.4	2356.8	404.5	0.46
2244.0	2205.6	68.2	2425.0	370.9	0.47
2453.0	2319.5	247.4	2672.4	358.5	0.51
2670.0	2484.3	350.5	3022.9	357.7	0.56
2536.0	2510.5	51.7	3074.6	327.1	0.56

2523.0	2517.4	12.5	3087.1	295.7	0.56
3026.0	2803.3	508.6	3595.6	317.0	0.63
2552.0	2661.6	-251.3	3344.3	310.4	0.50
2289.0	2425.4	-372.6	2971.8	316.6	0.32
2278.0	2351.5	-147.4	2824.4	299.7	0.26

2476.0	2391.9	124.5	2948.9	282.2	0.29
3032.0	2558.2	640.1	3589.0	318.0	0.43
2756.0	2616.0	197.8	3786.8	305.9	0.47
2176.0	2424.7	-440.0	3346.8	319.4	0.27
2482.0	2451.7	57.3	3404.1	293.2	0.28
2090.0	2354.5	-361.7	3042.4	300.0	0.13
ABSOLUTE MAXIMUM		1160.6	3786.8	528.0	0.63

THE THIRD PROCEDURE:
FORECASTING WITH TREND AND SEASONAL ADJUSTMENT
* *

NOTE * MANAGEMENT MUST DECIDE WHETHER AN ITEM IS TRULY SEASONAL. *
IF LESS THAN 48 DATA POINTS ARE AVAILABLE, ONLY TWO YEARS ARE COMPARED.
FOR THIS ITEM THERE ARE 62 DATA POINTS.

STATISTICAL TEST FOR SEASONALITY.
* * * * * * * * * * * * * * *
EACH YEAR COMPARE PEAKS AND LOWS. IF SOME ARE 50 PERCENT
FROM THE MEAN, FOR TWO OUT OF THREE YEARS
ASSUME EVIDENCE OF SEASONALITY
* * * * * * * * * * * * * * *

FIFTY PERCENT PEAKS/LOWS ANALYSIS:

ABOVE THE MEAN		BELOW THE MEAN	
FREQUENCY	MONTH NUMBER	FREQUENCY	MONTH NUMBER
----	----	----	----

THE NUMBER OF PAIRS OR TRIPLES DURING TWO OR THREE YEARS WAS
ABOVE AVERAGE: 0 BELOW AVERAGE: 0

THUS, THE LIKELIHOOD OF SEASONALITY SEEMS * VERY LOW *

TABLE 3: SEASONAL FORECASTING.
* * * * * * * * * * * * * * * *

MONTH NUMBER	BASE SERIES	TREND ADJUSTED FORECAST	SEASONAL FORECAST	ACTUAL DEMAND	SIGNED ERROR	SMOOTHED M.A.D.	TRIGG TRACKING SIGNAL	DESEAS DEMAND
26	1.119	1330.0	1487.9	1536	48.1	144.8	48.1	1372.9
27	0.978	1369.1	1338.7	1406	67.3	137.0	115.3	1437.9

28	1.164	1377.7	1603.4	1834	230.6	146.4	346.0	1575.9
29	0.892	1466.3	1308.3	1183	-125.3	144.3	220.7	1325.9
30	0.956	1418.0	1355.2	430	-925.2	222.4	-704.5	449.9
31	1.193	1233.5	1471.1	1000	-471.1	247.2	-1175.6	838.5

32	0.746	1184.4	883.7	1590	706.3	293.1	-469.2	2131.1
33	0.900	1254.8	1129.7	1110	-19.7	265.8	-489.0	1232.9
34	1.083	1224.0	1325.1	2002	676.9	306.9	187.9	1849.2
35	1.016	1367.4	1389.5	689	-700.5	346.3	-512.6	678.0
36	0.899	1240.4	1114.9	1237	122.1	323.9	-390.5	1376.2
37	1.073	1236.1	1326.3	2064	737.7	365.2	347.2	1923.7
38	1.072	1389.8	1490.1	2272	781.9	406.9	1129.1	2119.1
39	1.059	1560.6	1652.2	2830	1177.8	484.0	2306.9	2673.1
40	1.298	1812.0	2351.5	2311	-40.5	439.6	2266.5	1780.8

SEASONAL ADJUSTMENT SEEMS UNSATISFACTORY: ADVISE MANAGEMENT *

TR.SIG. SHOWS CONTROL LIMIT IS EXCEEDED.
NEXT BUT ONE PERIOD ALPHA WILL INCREASE TO 0.30 AND GAMMA TO 0.30

41	0.880	1927.3	1695.3	2206	510.7	446.8	0.0	2507.9
42	0.632	1936.2	1254.5	2562	1307.5	705.0	1307.5	4056.2
43	1.001	2314.3	2316.6	1748	-568.6	664.1	738.8	1746.3

NEXT BUT ONE PERIOD ALPHA WILL REDUCE TO 0.10 AND GAMMA TO 0.10

44	1.076	2082.3	2240.3	1966	-274.3	547.2	464.5	1827.3

45	0.909	2398.2	2179.6	1896	-283.6	520.8	180.9	2086.2
46	1.312	2342.6	3073.3	2366	-707.3	539.4	-526.4	1803.4
47	0.782	2382.3	1863.5	2279	415.5	527.1	-110.9	2913.5
48	0.904	2397.8	2168.5	2244	75.5	481.9	-35.3	2481.4

49	0.943	2402.5	2265.4	2453	187.6	452.5	152.2	2601.5
50	1.088	2444.5	2659.8	2670	10.2	408.2	162.4	2453.9
51	1.210	2519.8	3049.9	2536	-513.9	418.8	-351.4	2095.2
52	1.184	2556.8	3027.5	2523	-504.5	427.4	-856.0	2130.8
53	0.968	2584.1	2501.6	3026	524.4	437.1	-331.6	3125.8
54	0.855	2701.2	2309.3	2552	242.7	417.6	-88.9	2985.1
55	0.785	2709.3	2127.3	2289	161.7	392.0	72.8	2915.2
56	1.016	2664.2	2707.0	2278	-429.0	395.7	-356.3	2242.0
57	0.859	2621.9	2252.0	2476	224.0	378.6	-132.3	2882.7
58	1.248	2621.8	3272.2	3032	-240.2	364.7	-372.5	2429.3
59	0.848	2725.9	2311.7	2756	444.3	372.7	71.8	3249.8
60	0.994	2760.8	2745.3	2176	-569.3	392.3	-497.5	2188.3

FORECASTING ERRORS AND EVALUATION.
* * * * * * * * * * * * * * * * *

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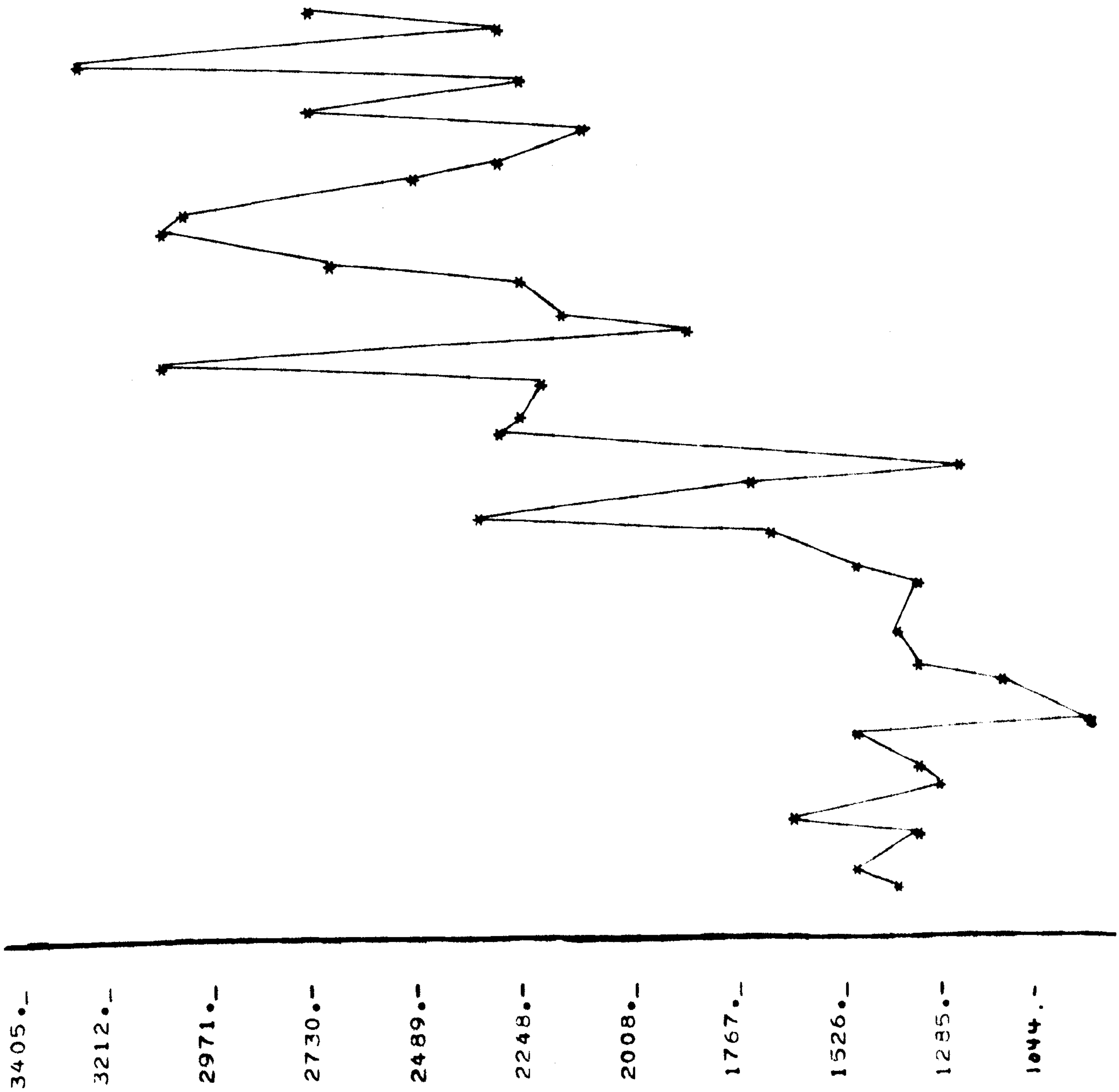
AVERAGE CUMULATIVE SIGNED ERROR :      53.0
PERCENTAGE BALANCED ERROR       :      30.3
OVERALL MEAN ABSOLUTE DEVIATION :     441.9
TOTAL SIGNED ERROR              :    2279.7

ROOT MEAN SQUARE ERROR          :     569.3
TOTAL SIGNED ERROR, DESEAS. DATA:   -1958.7
THE THEIL COEFFICIENT           :       0.1
          * * * * * * * * * * * * *
```


3405.
3212.
2971.
2730.
2489.
2248.
2008.
1767.
1526.
1285.
1044.

2129 SEASONAL PATTERN

BROWN METHOD OF OBTAINING STARTING VALUES.
****

PERIOD ******	DEMAND ******	FORECAST ********	ERROR *****
1	60.	42.49	17.51
2	38.	43.16	-5.16
3	24.	43.83	-19.83
4	42.	44.50	-2.50
5	39.	45.16	-6.16
6	53.	45.83	7.17
7	68.	46.50	21.50
8	61.	47.17	13.83
9	50.	47.84	2.16
10	42.	48.51	-6.51
11	26.	49.17	-23.17
12	35.	49.84	-14.84
13	82.	50.51	31.49
14	42.	51.18	-9.18
15	19.	51.85	-32.85
16	75.	52.51	22.49
17	57.	53.18	3.82
18	63.	53.85	9.15

THE VALUES OF THE FINAL FORECAST OF BRUSTART :

FORECAST = 53.9 TREND VALUE = 0.67 AND M.A.D.= 14.7

THE FIRST PROCEDURE :
TABLE 1: NON-TREND FORECASTING
USING SINGLE SMOOTHING
* * * * * * * * * * * * * * *

PARAMETER VALUES ARE: ALPHA =: 0.10 BETA =: 0.10

* TR.SIG. UNSMOOTHED,ADAPTIVE. IF ABOVE (4*MAD) A MESSAGE IS PRINTED.
IF CHANGE PERSISTS, ALPHA RAISED.
IF ABOVE (6*MAD), ALPHA IS RAISED AT ONCE.

* TRIGG * BASED ON BATTY DECISION RULES: MESSAGE PRINTED, NO ACTION TAKEN.
* * * * * * * * * * * * * * *

ACTUAL DATA	FORECAST	ERROR	TR.SIGNAL	MAD	SM.ERROR	TRIGG T.S
93	54.8	38.23	38.23	17.0	10.43	0.61
71	58.6	12.41	50.65	16.6	10.63	0.64
46	59.8	-13.83	36.82	16.3	8.19	0.50
28	58.4	-30.45	6.37	17.7	4.32	0.24
38	55.4	-17.40	-11.03	17.7	2.15	0.12
42	53.7	-11.66	-22.69	17.1	0.77	0.04
139	52.5	86.50	63.81	24.0	9.34	0.39
75	61.1	13.85	77.66	23.0	9.79	0.43
0	62.5	-62.53	15.13	27.0	2.56	0.09
75	56.3	18.72	33.85	26.1	4.18	0.16
63	58.2	4.85	38.70	24.0	4.24	0.18
48	58.6	-10.64	28.07	22.7	2.76	0.12
142	57.6	84.43	112.50	28.8	10.92	0.38
98	66.0	31.99	144.48	29.2	13.03	0.45
74	69.2	4.79	149.27	26.7	12.21	0.46
TR.SIG ERROR EXCEEDS CONTROL LIMIT.ALP WILL BE RAISED TO : 0.30 NEXT PERIOD.						
62	69.7	-7.69	0.00	24.8	10.22	0.41
29	67.4	-38.38	-38.38	26.2	5.36	0.20
60	55.9	4.13	-34.25	24.0	5.23	0.22
ALPHA WILL REVERT TO ITS FORMER VALUE OF 0.10 THE NEXT PERIOD.						
108	57.1	50.89	16.64	26.7	9.80	0.37
60	62.2	-2.20	14.44	24.2	8.60	0.36
3	62.0	-58.98	-44.54	27.7	1.84	0.07
58	56.1	1.92	-42.62	25.1	1.85	0.07

42	56.3	-14.27	-56.89	24.0	0.24	0.01
67	54.8	12.16	-44.73	22.8	1.43	0.06
121	56.1	64.94	20.21	27.1	7.78	0.29
68	62.6	5.45	25.65	24.9	7.55	0.30
47	63.1	-16.10	9.55	24.0	5.18	0.22
79	61.5	17.51	27.07	23.4	6.42	0.27
34	63.2	-29.24	-2.17	24.0	2.85	0.12
45	60.3	-15.32	-17.49	23.1	1.03	0.04
131	58.8	72.22	54.72	28.0	8.15	0.29
97	66.0	30.99	85.72	28.3	10.44	0.37
28	69.1	-41.11	44.61	29.6	5.28	0.18

48	65.0	-16.99	27.62	28.3	3.05	0.11
76	63.3	12.70	40.32	26.8	4.02	0.15
54	64.6	-10.57	29.76	25.1	2.56	0.10
167	63.5	103.49	133.25	33.0	12.65	0.38
63	73.9	-10.86	122.39	30.8	10.30	0.33
85	72.8	12.23	134.62	28.9	10.49	0.36
111	74.0	37.00	171.62	29.7	13.15	0.44

TR.SIG ERROR EXCEEDS CONTROL LIMIT.ALP WILL BE RAISED TO : 0.30 NEXT PERIOD.

48	77.7	-29.70	0.00	29.7	8.86	0.30
121	68.8	52.21	52.21	32.0	13.20	0.41
141	84.5	56.55	108.76	34.4	17.53	0.51

ALPHA WILL REVERT TO ITS FORMER VALUE OF 0.10 THE NEXT PERIOD.

138	101.4	36.58	145.35	34.6	19.44	0.56
66	105.1	-39.07	106.27	35.1	13.59	0.39
98	101.2	-3.17	103.11	31.9	11.91	0.37
87	100.8	-13.85	89.26	30.1	9.33	0.31
66	99.5	-33.46	55.79	30.4	5.05	0.17

MEASUREMENTS OF OVERALL
FORECASTING EFFECTIVENESS
* * * * * * * * * * * * * *

THE AVERAGE CUMULATIVE SIGNED ERROR : 7.1
BALANCED ERROR : 48.7
OVERALL MEAN ABSOLUTE DEVIATION : 29.0
TOTAL SIGNED ERROR : 339.3
ROOT MEAN SQUARE ERROR : 37.9

THE THEIL COEFFICIENT : 0.25

THEIL VALUE INDICATES MODERATE FORECASTING EFFICIENCY.

THE INDEX OF FORECASTABILITY : 2.1
ACCURACY PERCENTAGE : 59.7
BALANCED ERROR SHOWS EXTENT OF ERROR CANCELLATION IN DATA.
A THEIL VALUE OF ZERO INDICATES PERFECT PREDICTION.

THE FORECASTABILITY INDEX SUGGESTS THAT BROFICH
SHOULD GIVE REASONABLE RESULTS.

THE THIRD PROCEDURE:
FORECASTING WITH TREND AND SEASONAL ADJUSTMENT
* *

NOTE * MANAGEMENT MUST DECIDE WHETHER AN ITEM IS TRULY SEASONAL. *
IF LESS THAN 48 DATA POINTS ARE AVAILABLE, ONLY TWO YEARS ARE COMPARED.
FOR THIS ITEM THERE ARE 66 DATA POINTS.

STATISTICAL TEST FOR SEASONALITY.
* * * * * * * * * * * * * * * *
EACH YEAR COMPARE PEAKS AND LOWS. IF SOME ARE 50 PERCENT
FROM THE MEAN, FOR TWO OUT OF THREE YEARS
ASSUME EVIDENCE OF SEASONALITY
* * * * * * * * * * * * * * *

FIFTY PERCENT PEAKS/LOWS ANALYSIS:

ABOVE THE MEAN		BELOW THE MEAN	
FREQUENCY	MONTH NUMBER	FREQUENCY	MONTH NUMBER
----	----	----	----
2	(1)		
		3	(3)
3	(7)		

THE NUMBER OF PAIRS OR TRIPLES DURING TWO OR THREE YEARS WAS
ABOVE AVERAGE: 2 BELOW AVERAGE: 1

THUS, THE LIKELIHOOD OF SEASONALITY SEEMS * HIGH *

TABLE 3: SEASONAL FORECASTING.
* * * * * * * * * * * * * * * *

MONTH NUMBER	BASE SERIES	TREND ADJUSTED FORECAST	SEASONAL FORECAST	ACTUAL DEMAND	SIGNED ERROR	SMOOTHED M.A.D.	TRIGG TRACKING SIGNAL	DESEAS DEMAND

* *

26	0.804	66.8	53.7	75	21.3	79.5	21.3	93.3
27	0.422	68.9	29.1	0	-29.1	74.5	-7.8	0.0
28	1.166	56.3	65.7	75	9.3	68.0	1.6	64.3

29	0.965	59.9	57.8	63	5.2	61.7	6.8	65.3
30	1.166	60.6	70.7	48	-22.7	57.8	-15.9	41.2
31	1.608	58.4	93.9	142	48.1	56.8	32.1	88.3
32	1.327	74.4	98.7	98	-0.7	51.2	31.5	73.9
33	0.965	79.6	76.8	74	-2.8	46.4	28.7	76.7
34	0.704	79.5	55.9	62	6.1	42.3	34.7	88.1
35	0.643	77.0	49.6	29	-20.6	40.2	14.2	45.1
36	0.764	68.6	52.4	60	7.6	36.9	21.7	78.6
37	1.736	67.3	116.9	108	-8.9	34.1	12.9	62.2
38	0.915	75.3	68.9	60	-8.9	31.6	3.9	65.6
39	0.142	73.0	10.4	3	-7.4	29.2	-3.4	21.1
40	1.183	60.2	71.2	58	-13.2	27.6	-16.6	49.0
41	0.947	59.6	56.5	42	-14.5	26.3	-31.1	44.4
42	0.863	56.2	48.7	67	18.3	25.5	-12.8	77.2
43	1.846	57.9	107.0	121	14.0	24.3	1.2	65.5
44	1.325	69.7	92.4	68	-24.4	24.3	-23.2	51.3
45	0.947	69.7	66.0	47	-19.0	23.8	-42.3	49.6

46	0.710	65.7	46.7	79	32.3	24.6	-9.9	111.3
47	0.521	68.4	35.6	34	-1.6	22.3	-11.5	65.3
48	0.805	62.1	50.0	45	-5.0	20.6	-16.5	55.9

49	1.848	58.8	108.7	131	22.3	20.8	5.8	70.9
50	1.007	72.3	72.8	97	24.2	21.1	30.0	96.3
51	0.015	77.4	1.2	28	26.8	21.7	56.8	1863.2
52	0.992	68.6	68.1	48	-20.1	21.5	36.8	48.4
53	0.781	64.9	50.7	76	25.3	21.9	62.1	97.3
54	0.857	67.0	57.4	54	-3.4	20.1	58.6	63.0
55	1.969	64.7	127.3	167	39.7	22.0	98.3	84.8
56	1.247	84.1	104.9	63	-41.9	24.0	56.4	50.5
57	0.902	80.9	73.0	85	12.0	22.8	68.5	94.3
58	1.052	82.4	86.6	111	24.4	23.0	92.8	105.5
59	0.466	88.5	41.2	48	6.8	21.3	99.6	103.0

SEASONAL ADJUSTMENT SEEMS UNSATISFACTORY: ADVISE MANAGEMENT *

TR.SIG. SHOWS CONTROL LIMIT IS EXCEEDED.
NEXT BUT ONE PERIOD ALPHA WILL INCREASE TO 0.30 AND GAMMA TO 0.30

60	0.781	81.7	63.8	121	57.2	24.9	0.0	154.8

FORECASTING ERRORS AND EVALUATION.
* * * * * * * * * * * * * * * * *

AVERAGE CUMULATIVE SIGNED ERROR : 3.3
PERCENTAGE BALANCED ERROR : 48.6
OVERALL MEAN ABSOLUTE DEVIATION : 19.0
TOTAL SIGNED ERROR : 156.8

THE FIRST PROCEDURE :
TABLE 1: NON-TREND FORECASTING
USING SINGLE SMOOTHING
* * * * * * * * * * * * * * *

PARAMETER VALUES ARE: ALPHA =: 0.30 BETA =: 0.30

* TR.SIG. UNSMOOTHED.ADAPTIVE. IF ABOVE (4*MAD) A MESSAGE IS PRINTED.
IF CHANGE PERSISTS, ALPHA RAISED.
IF ABOVE (6*MAD), ALPHA IS RAISED AT ONCE.

* TRIGG * BASED ON BATTY DECISION RULES: MESSAGE PRINTED, NO ACTION TAKEN.
* * * * * * * * * * * * * * *

ACTUAL DATA	FORECAST	ERROR	TR.SIGNAL	MAD	SM.ERROR	TRIGG T.S
93	56.6	36.40	36.40	21.2	16.06	0.76
71	67.5	3.48	39.89	15.9	12.29	0.77
46	68.6	-22.56	17.33	17.9	1.83	0.10
28	61.8	-33.79	-16.47	22.7	-8.85	-0.39
38	51.7	-13.66	-30.12	20.0	-10.29	-0.52
42	47.6	-5.56	-35.68	15.6	-8.87	-0.57
139	45.9	93.11	57.43	38.9	21.72	0.56
75	73.8	1.18	58.61	27.6	15.56	0.56
0	74.2	-74.18	-15.57	41.6	-11.36	-0.27
75	51.9	23.08	7.50	36.0	-1.03	-0.03
63	58.8	4.15	11.66	26.5	0.52	0.02
48	60.1	-12.09	-0.43	22.1	-3.26	-0.15
142	56.5	85.54	85.10	41.2	23.38	0.57
98	82.1	15.87	100.98	33.6	21.13	0.63
74	86.9	-12.89	88.09	27.4	10.92	0.40
62	83.0	-21.02	67.07	25.5	1.34	0.05
29	76.7	-47.71	19.35	32.1	-13.38	-0.42
60	62.4	-2.40	16.95	23.2	-10.08	-0.43
108	61.7	46.32	63.27	30.1	6.84	0.23
60	75.6	-15.58	47.69	25.8	0.11	0.00
3	70.9	-67.90	-20.21	38.4	-20.29	-0.53
58	50.5	7.47	-12.74	29.1	-11.96	-0.41
42	52.8	-10.77	-23.51	23.6	-11.61	-0.49
67	49.5	17.46	-6.05	21.8	-2.89	-0.13
121	54.8	66.22	60.17	35.1	17.85	0.51
68	74.6	-6.64	53.52	26.6	10.50	0.40
47	72.7	-25.65	27.87	26.3	-0.35	-0.01
79	65.0	14.04	41.91	22.6	3.97	0.18

34	69.2	-35.17	6.75	26.4	-7.77	-0.29
45	58.6	-13.62	-6.87	22.6	-9.53	-0.42
131	54.5	76.47	69.59	38.7	16.27	0.42
97	77.5	19.53	89.12	33.0	17.25	0.52
28	83.3	-55.33	33.79	39.7	-4.53	-0.11
48	66.7	-18.73	15.06	33.4	-8.79	-0.26
76	61.1	14.89	29.95	27.8	-1.68	-0.06
54	65.6	-11.58	18.37	23.0	-4.65	-0.20
167	62.1	104.90	123.26	47.5	28.21	0.59
63	93.6	-30.57	92.69	42.5	10.58	0.25
85	84.4	0.60	93.29	29.9	7.58	0.25

111	84.6	26.42	119.71	28.9	13.23	0.46
48	92.5	-44.51	75.20	33.5	-4.09	-0.12
121	79.2	41.85	117.05	36.0	9.69	0.27
141	91.7	49.29	166.34	40.0	21.57	0.54
138	106.5	31.50	197.84	37.5	24.55	0.66
66	115.9	-49.95	147.89	41.2	2.20	0.05
98	101.0	-2.96	144.93	29.7	0.65	0.02
87	100.1	-13.07	131.86	24.7	-3.47	-0.14
66	96.2	-30.15	101.71	26.4	-11.47	-0.44

MEASUREMENTS OF OVERALL
FORECASTING EFFECTIVENESS
* * * * * * * * * * * * *

THE AVERAGE CUMULATIVE SIGNED ERROR : 2.1
BALANCED ERROR : 14.0
OVERALL MEAN ABSOLUTE DEVIATION : 30.4
TOTAL SIGNED ERROR : 101.7
ROOT MEAN SQUARE ERROR : 39.8

THE THEIL COEFFICIENT : 0.25

THEIL VALUE INDICATES MODERATE FORECASTING EFFICIENCY.

THE INDEX OF FORECASTABILITY : 2.0
ACCURACY PERCENTAGE : 62.4
BALANCED ERROR SHOWS EXTENT OF ERROR CANCELLATION IN DATA.
A THEIL VALUE OF ZERO INDICATES PERFECT PREDICTION.

THE FORECASTABILITY INDEX SUGGESTS THAT BRUFICH
SHOULD GIVE REASONABLE RESULTS.

* *

PLOT OF SIMPLE SMOOTHING.
* * * * * * * * * * * *

ITEM NUMBER	FIRST MONTH	LAST MONTH	LOWEST VALUE	HIGHEST VALUE
2129	19.	66.	46.	116.

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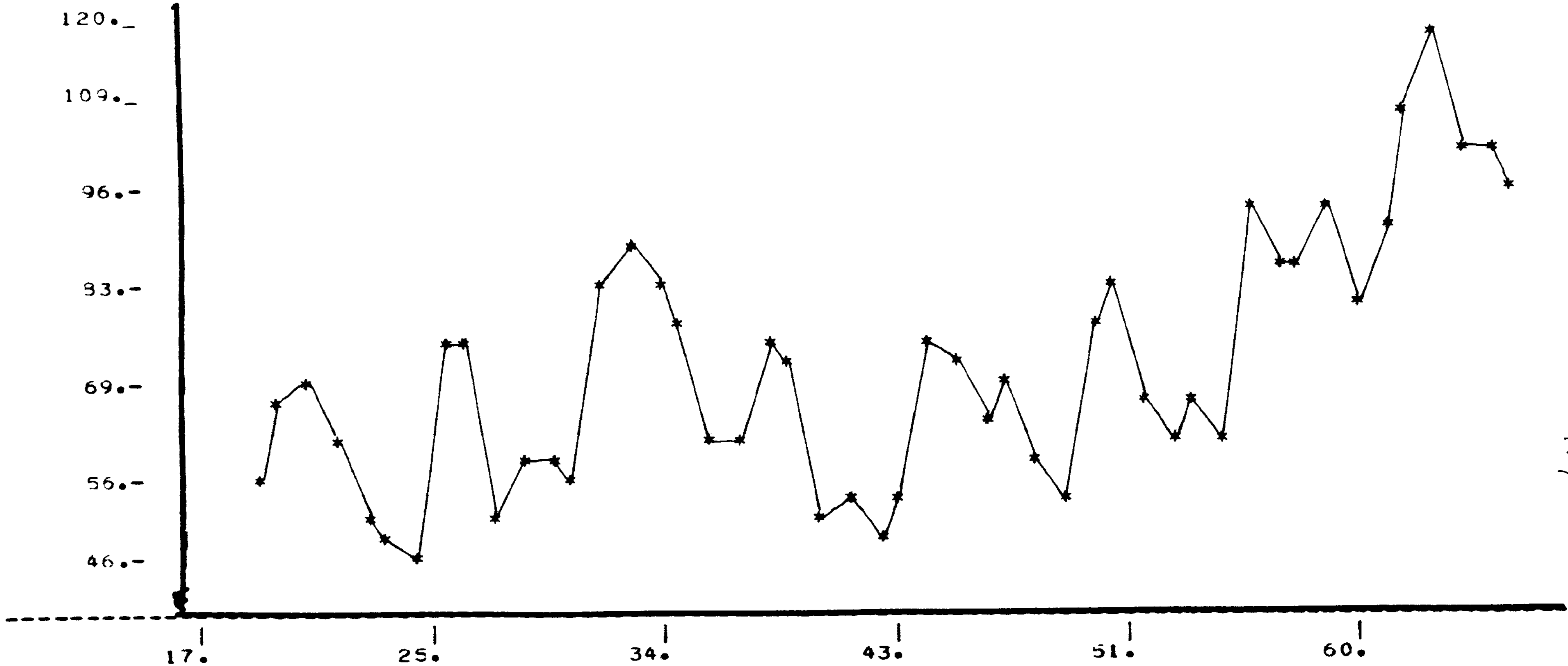

SEASONAL ITEM

SINGLE SMOOTHED FORECASTING

THE SECOND PROCEDURE:
TREND ADJUSTED FORECASTING
* * * * * * * * * * * * * *
IF RUN OF DATA IS LESS THAN 18 PERIODS
NO TREND ROUTINE IS PERFORMED.

- - - - - - - - - - - - - - -

THE MEDIAN OF THE DATA IS: 61.5 THE MEAN OF THE EARLIER DATA IS: 57.8
AND THE MEAN OF THE RECENT DATA IS: 76.0
LEAD TIME IS 2.0 MONTHS

LITTLE EVIDENCE OF A TREND
* * * * * * * * * * * * * *

RUNS TREND TEST

- - - - - - - -

THE SIEGEL TEST SUGGESTS THE DATA IS * RANDOM *
THERE IS 95% CONFIDENCE THAT NO REAL TREND EXISTS. THE Z VALUE IS: -1.37

THE TWO TESTS SHOW THERE IS PROBABLY NO TREND

* TABLE 2 *
* * * * * *
BROWN DOUBLE SMOOTHING

PERIOD	SINGLE SMOOTH	DOUBLE SMOOTH	CURRENT FORECAST	CURRENT ERROR	2 MONTH AHEAD FORECAST	2 MONTH AHEAD ERROR	3 MONTH AHEAD FORECAST	3 MONTH AHEAD ERROR
19	56.6	54.7	59.3	33.7	59.3	33.7	59.3	33.7
20	67.5	58.5	80.4	-9.4	60.2	10.8	60.2	10.8
21	68.6	61.5	78.6	-32.6	84.2	-38.2	61.0	-15.0
22	61.8	61.6	62.0	-34.0	81.6	-53.6	88.1	-60.1
23	51.7	58.6	41.7	-3.7	62.1	-24.1	84.6	-46.6
24	47.6	55.3	36.5	5.5	38.7	3.3	62.2	-20.2
25	45.9	52.5	36.5	102.5	33.2	105.8	35.7	103.3
26	73.8	58.9	95.2	-20.2	33.7	41.3	29.9	45.1
27	74.2	63.5	89.5	-89.5	101.6	-101.6	30.8	-30.8
28	51.9	60.0	40.4	34.6	94.1	-19.1	108.0	-33.0
29	58.8	59.7	57.7	5.3	36.9	26.1	98.6	-35.6
30	60.1	59.8	60.5	-12.5	57.3	-9.3	33.4	14.6
31	56.5	58.8	53.1	88.9	60.7	81.3	57.0	85.0
32	82.1	65.8	105.5	-7.5	52.1	45.9	60.8	37.2
33	86.9	72.1	108.0	-34.0	112.5	-38.5	51.1	22.9
34	83.0	75.4	93.9	-31.9	114.3	-52.3	119.5	-57.5
35	76.7	75.8	78.0	-49.0	97.2	-68.2	120.6	-91.6
36	62.4	71.8	49.0	11.0	78.4	-18.4	100.5	-40.5
37	61.7	68.7	51.6	56.4	45.0	63.0	78.8	29.2

38	75.6	70.8	82.4	-22.4	48.6	11.4	41.0	19.0
39	70.9	70.8	71.0	-68.0	84.5	-81.5	45.5	-42.5
40	50.5	64.7	30.2	27.8	71.0	-13.0	86.5	-28.5
41	52.8	61.1	40.8	1.2	24.1	17.9	71.1	-29.1
42	49.5	57.7	37.9	29.1	37.2	29.8	18.1	48.9

43	54.8	56.8	51.9	69.1	34.5	86.5	33.6	87.4
44	74.6	62.2	92.5	-24.5	51.0	17.0	31.0	37.0
45	72.7	65.3	83.1	-36.1	97.8	-50.8	50.2	-3.2
46	65.0	65.2	64.6	14.4	86.3	-7.3	103.2	-24.2
47	69.2	66.4	73.1	-39.1	64.5	-30.5	89.4	-55.4
48	58.6	64.1	50.8	-5.8	74.3	-29.3	64.4	-19.4
49	54.5	61.2	45.0	86.0	48.5	82.5	75.5	55.5
50	77.5	66.1	93.7	3.3	42.1	54.9	46.2	50.8
51	83.3	71.3	100.6	-72.6	98.6	-70.6	39.3	-11.3
52	66.7	69.9	62.2	-14.2	105.8	-57.8	103.5	-55.5
53	61.1	67.3	52.3	23.7	60.8	15.2	110.9	-34.9
54	65.6	66.8	63.9	-9.9	49.7	4.3	59.5	-5.5
55	62.1	65.4	57.5	109.5	63.4	103.6	47.1	119.9
56	93.6	73.8	121.8	-58.8	56.1	6.9	62.9	0.1
57	84.4	77.0	95.0	-10.0	130.2	-45.2	54.7	30.3
58	84.6	79.3	92.2	18.8	98.2	12.8	138.7	-27.7
59	92.5	83.2	105.7	-57.7	94.4	-46.4	101.3	-53.3
60	79.2	82.0	75.1	45.9	109.7	11.3	96.7	24.3
61	91.7	84.9	101.4	39.6	73.8	67.2	113.7	27.3
62	106.5	91.4	128.1	9.9	104.3	33.7	72.6	65.4
63	115.9	98.8	140.5	-74.5	134.5	-68.5	107.2	-41.2
64	101.0	99.4	103.2	-5.2	147.9	-49.9	141.0	-43.0
65	100.1	99.6	100.7	-13.7	103.8	-16.8	155.2	-68.2
66	96.2	98.6	92.7	-26.7	100.9	-34.9	104.5	-38.5

FORECAST VALUES FOR LATER PERIODS ARE:

PERIOD: 67= 91.6 AND 101.1 AND PERIOD: 68= 90.6

ERROR SUMMARY TABLE: DOUBLE SMOOTHING

AVERAGE OF SIGNED ERRORS :

CURRENT FORECAST	-1.0
TWO MONTHS AHEAD	-1.3
THREE MONTHS AHEAD	-1.4

```
BALANCED ERRORS :
       CURRENT FORECAST          -5.6
       TWO MONTHS AHEAD          -6.0
       THREE MONTHS AHEAD        -6.6
ROOT MEAN SQUARE ERROR :          45.6

OVERALL MEAN ABSOLUTE DEVIATIONS :
       CURRENT FORECAST          35.7
       TWO MONTHS AHEAD          42.4
       THREE MONTHS AHEAD        41.7
SUM OF SIGNED ERRORS :
       CURRENT FORECAST         -47.4
       TWO MONTHS AHEAD         -59.8
       THREE MONTHS AHEAD       -64.6
CONSTANT VALUES ARE: ALPHA    0.30 AND BETA    0.30

ACCURACY PERCENTAGE :    73.4
```

```
    $JOB           ,PAGES=400,TIME=720
    C
    C
    C
    C
    C                                COMPARE
    C                                _______
    C
    C
    C              A SERIES OF FORECASTING ROUTINES,TO PERMIT
    C              COMPARISONS TO BE MADE BETWEEN METHODS.
    C
    C              ALTHOUGH ADAPTED,THE PROGRAM DERIVES FROM
    C                  W.G.SULLIVAN AND W.W.CLAYCOMBE :
    C                  FUNDAMENTALS OF FORECASTING,
    C                  RESTON PUBLISHING CO. 1977
    C
    C                 * * * * * * * * * * * * * *
    C
 1          INTEGER X,T,REM,SM1,DM1,DM2, SM2
 2          DIMENSION X(70),Y(70),DX(70),DY(70),DXSQ(70),DYSQ(70),
          1 EST(70),E(70),ESQ(70),SMA(70),DES(70),YESTSQ(70),YEST(70),
          2 DMA(70),MA(70),MB(70),FDMA(70),SES(70),EA(70),EB(70),FDES(70),
          3 ESMA(70),ESMASQ(70),EDMA(70),EDMASQ(70),ESES(70),EDESSQ(70),
          4 EDES(70),ESESSQ(70),SMASQ(70),FDMASQ(70),SESSQ(70),FDESSQ(70)
 3          DIMENSION SF1(70),SF2(70),SF(70),AA(70),BB(70),SSF(70),FW(70),
          1EFW(70),EFWSQ(70),FWSQ(70),EMA(70),EES(70),EW(70),TES(70),
          2 TA(70),TB(70),TC(70),FTES(70),ETES(70),FTESSQ(70),ETESSQ(70),
          3 FSES(70)
 4          DATA  FDMA/70*0.0/
 5          DATA  FSES / 70*0.0/
 6          DATA  FDES / 70*0.0/
 7          DATA  FTES / 70*0.0/
    C
 8           READ,MXM
 9          PRINT 130
10     130 FORMAT('1',40X,'*** PROGRAMME COMPARE ***'/40X,14('_ ')/44X,'FOREC
          1ASTING USING :'/ 45X,'SIMPLE REGRESSION'/37X,'SINGLE AND DOUBLE MO
          2VING AVERAGES'/30X,'SINGLE, DOUBLE AND TRIPLE EXPONENTIAL SMOOTHIN
          3G'/44X,'AND  WINTERS METHOD '/43X,11('* ')/)
11          PRINT 131, MXM
12     131 FORMAT('0',40X,'THERE ARE ',I2,' SETS OF DATA.'/)
13          DO 123  KK=1,MXM
    C                THE NUMBER OF SETS OF DATA
    C
14          SUMY = 0.
15          SUMDY = 0.
16          SUMX = 0.
17          SDYSG = 0.
```

```
      SDXSQ = 0.
      SUMXY = 0.
      SUMXSQ = 0.
      S1  = 0.
      S2  = 0.
      S3  = 0.
      S4  = 0.
      S5  = 0.
      S6  = 0.
      S7  = 0.
      S8  = 0.
```

```
      SS1  =  0.
      SS2  =  0.
      SS3  =  0.
      SS4  =  0.
      SS5  =  0.
      SS6  =  0.
      SS7  =  0.
      SS8  =  0.
      SS9  =  0.
      SS10 = 0.
      SS11 = 0.
      SS12 = 0.
      SS13 = 0.
       SRS1  = 0.
       SRS2  = 0.
       SRS4  = 0.
       SRS6  = 0.
       SRS8  = 0.
       SRS10 = 0.
       SRS12 = 0.
       SMRS1   = 0.
       SMRS2   = 0.
       SMRS4   = 0.
       SMRS6   = 0.
       SMRS8   = 0.
       SMRS10  = 0.
       SMRS12  = 0.
      SDEROR = 0.
      SIEROR = 0.
      SWEROR = 0.
      TOTED  = 0.
      TOTES  = 0.
      TOTET  = 0.
C
C
C                          INPUT SEQUENCE
C                          --------------
C
C               MXM : NUMBER OF SETS OF DATA
C               N   : NUMBER OF DATA POINTS
C               X,Y : PERIOD NUMBER AND DEMAND VALUE,
C                     ONE CARD PER PAIR
C               NUM : PERIOD OF SINGLE AND DOUBLE
C                     MOVING AVERAGES (6,12...)
C               ALPHA: VALUE FOR ALL THREE EXPONENTIAL
C                      SMOOTHING TECHNIQUES.
C
C               T   : NUMBER OF THE MONTH AHEAD TO BE FORECAST
C               L   : WINTER'S PERIODICITY
```

```
C                  WALPHA,WBETA,WDELTA : WINTER'S SMOOTHING
C                       CONSTANTS (NEED NOT BE IDENTICAL)
C
          READ 7, N
    7     FORMAT (I2)
          J = N+1
          JIMMY = (J-2)
          X(1) = 0
          Y(1) = 0.0
          READ10, (X(I),Y(I), I=2,J)
   10      FCRMAT(I2,1X,F4.0)
```

```
      READ 470, NUM
 470  FORMAT(I3)
      READ 9,  ALPHA
 9   FORMAT(F5.3)
      READ 19, T
 19   FORMAT(I2)
      READ 41, L
 41   FORMAT(I2)
      READ 42, WALPHA, WBETA, WDELTA
 42   FORMAT (F4.2,1X,F4.2,1X,F4.2)
C
C                         * * * * * * * * *
C                         SIMPLE REGRESSION
C                         * * * * * * * * *
C
      DO 2 I=2, J
      SUMY = SUMY + Y(I)
  2   SUMX = SUMX + X(I)
      AVGY = SUMY/N
      AVGX = SUMX/N
      DC 3 I=2,J
      DY(I) = Y(I) - AVGY
      SUMDY = SUMDY + DY(I)
      DX(I) = X(I) - AVGX
      DYSQ(I) = DY(I)**2
      SDYSQ = SDYSQ + DYSQ(I)
      DXSQ(I) = DX(I)**2
      SDXSQ = SDXSQ + DXSQ(I)
      SUMXY = SUMXY + (X(I)*Y(I) )
  3   SUMXSQ = SUMXSQ + X(I)**2
C
C             COEFFICIENTS OF SIMPLE REGRESSION
C
C
       B= (SUMXY-(AVGX*SUMY))/ (SUMXSQ-(AVGX*SUMX))
      A = AVGY - (B*AVGX)
C
C             ESTIMATED VALUES AND RESIDUALS
C             YEST = ESTIMATED Y VALUE AT TIME I
C             E = DIFF. BETWEEN EST. Y VALUE AND ACTUAL
C                  VALUE AT TIME  I
C
      DO 4  I=2,J
      YEST(I) = A+B*X(I)
      YESTSQ(I) = YEST(I)**2
      E(I) = Y(I) - YEST(I)
      ESQ(I) = E(I)**2
  4   CONTINUE
      PRINT 140, KK
```

```
 140  FORMAT('1',42X,'ITEM NUMBER ',I3/42X,'_ _ _ _ _ _ _ _ _ _ _ _'/)
        PRINT 12
  12   FORMAT(//,47X,'TABLE A'/42X,'SIMPLE REGRESSION'/)
        PRINT  15
   15 FORMAT(//,27X,' X',5X,' Y',6X,'FORECAST',7X,'E',12X,'ESQ'/26X,49('-'
     1) /)
        DO 5 I=2,J
        PRINT 16,X(I),Y(I), YEST(I), E(I), ESQ(I)
  16  FORMAT(26X,I2,2X,F5.0,3X,F10.2,2X,F9.2,2X,F13.2)
  5     CONTINUE
C
```

```
C                SS1 = SUM OF SQUARES OF RESIDUALS IN SIMPLE REGRESSION
C
          DO 6 I=2,J
          S1 = S1+YEST(I)
          S2 = S2 + YESTSQ(I)
    6    SS1 = SS1 + ESQ(I)
          PRINT 17, S1,SS1
   17    FORMAT('0',/,33X,F15.4,10X,F15.3)
          SRS1 = SS1 / J
          SMRS1 =  SQRT(SRS1)
          PRINT 142,SMRS1
  142    FORMAT('0',34X,'ROOT MEAN SQUARE ERROR-= ',F12.2/)
          PRINT 18, AVGX,AVGY,A,B
   18     FORMAT ('0',///,28X,'AVERAGE X =',F8.4,/,28X,'AVERAGE Y =',F12.4,
        1/,28X,'A OF SIMPLE REGRESSION =',F10.4,/,28X,'B CF SIMPLE REGRESSI
        2ON =',F10.4)
C
C
C                * * * * * * * * * * * * * * * * * * * * * *
C                MOVING AVERAGES AND EXPONENTIAL SMOOTHING
C                * * * * * * * * * * * * * * * * * * * * * *
C
C
C                SMA = SIMPLE MCVING AVERAGES
C                DMA = DOUBLE MOVING AVERAGES
C                FDMA = FORECAST WITH DMA
C
           NP1 = N+2
           NUM1 = NUM
           NUM = NUM1 + 2
           SM1 = 1
           SM2 = NUM1
            DO 8 I=NUM,NP1
           SM = 0.0
           DO 450 M=SM1,SM2
           SM = SM+Y(M+1)
  450    CONTINUE
           SM1 = SM1+1
            SM2 = SM2 + 1
           SMA(I) = SM/NUM1
           SMASQ(I) = SMA(I)**2
    8    CONTINUE
           NUM = NUM1*2+1
           DM1 = 1
           DM2 = NUM1
           DC 45 I=NUM,NP1
           DM=0.0
           DO 460 M=DM1,DM2
           DM = DM+SMA(M+1+NUM1)
```

```
  460   CONTINUE
        DM1 = DM1+1
        DM2 = DM2+1
        DMA(I) = DM/NUM1
        MA(I)=SMA(I)*2. - DMA(I)
        MB(I) = (SMA(I)-DMA(I))*2/3
        FDMA(I+1) = MA(I)+ME(I)
        FDMASQ(I+1) = FDMA(I+1)**2
   45   CONTINUE
        FORDMA = MA(J)+ MB(J)*T
C
```

```
C                 SES = SMOOTHED STATISTIC FOR SINGLE EXPO. SM.
C                 DES = SMOOTHED STATISTIC, DOUBLE EXP. SM.
C                 TES = SMOOTHED STATISTIC, TRIPLE EXP. SM.
C                 EA,EB: COEFF. IN THE FORECAST EQN., DOUBLE EXP. SM.
C                 TA,TB: COEFF. IN FORECAST EQN., TRIPLE EXP. SM.
C                 FDES = FORECAST, DOUBLE EXPO. SMOOTHING
C                 FTES = FORECAST, TRIPLE EXPO. SMOOTHING
C
            SES(1) = Y(2)
            DO 46 I=2,J
            SES(I) =ALPHA*(Y(I)-SES(I-1))+SES(I-1)
    46      CONTINUE
            DC 410 I=3,J
            FSES(I) = SES(I-1)
            SESSQ(I) = FSES(I)**2
   410      CONTINUE
            SESFOR = SES(J)
            DES(1) = Y(2)
            DO 55 I=2,J
            DES(I) = ALPHA*SES(I)+ (1.-ALPHA)* DES(I-1)
            EA(I)= 2.* SES(I)- DES(I)
            EB(I) = (SES(I)-DES(I)) *ALPHA /(1.-ALPHA )
    55      CONTINUE
            DC 420 I=3,J
            FDES(I) = EA(I-1)+ EB(I-1)
            FDESSQ(I)= FDES(I)**2
   420      CONTINUE
            DESFOR = EA(J)+ T*EB(J)
            TES(1)= Y(2)
            DO 51 I=2,J
            TES(I) = ALPHA *DES(I)+(1.-ALPHA) * TES(I-1)
            TA(I)=3.*SES(I)-3. * DES(I)+ TES(I-1)
            TB(I) = (ALPHA/(2. *(1.-ALPHA)**2)) * ((6.-5.*ALPHA) * SES(I)
         1-(10.-8.*ALPHA)* DES(I)+(4.-3.*ALPHA)* TES(I))
            TC(I) = (ALPHA/(1.-ALPHA))**2* (SES(I)-2.0* DES(I) + TES(I))
    51      CONTINUE
            DO 430 I=3,J
            FTES(I)= TA(I-1)+TB(I-1)+TC(I-1)/2.
            FTESSQ(I)= FTES(I)**2
   430      CCNTINUE
            TESFOR = TA(J)+TB(J)*T+TC(J)/ 2.0*T**2
C
C                 ESMA,EDMA,ESES,EDES= DIFFERENCE BETWEEN ESTIMATED AND
C                 ACTUAL VALUE IN SIMPLE, DOUBLE MOVING AVERAGES AND
C                 SINGLE, DOUBLE EXPONENTIAL SMOOTHING.
C                 ETES = DIFFERENCE BETWEEN ESTIMATED AND ACTUAL
C                 VALUE IN TRIPLE EXPONENTIAL SMOOTHING.
C
            NUM = NUM1 + 2
```

```
      DO 11 I=NUM,J
      ESMA(I)  = Y(I) - SMA(I)
      ESMASQ(I) = ESMA(I)**2
   11 CONTINUE
      NUM = NUM1 + 2
      DO 47 I=NUM,J
      EDMA(I)  =  Y(I) - FDMA(I)
      EDMASQ(I) = EDMA(I)**2
   47 CONTINUE
      DO 48 I=3,J
      ESES(I)  =   Y(I) - FSES(I)
```

```
      ESESSQ(I) = ESES(I)**2
      EDES(I)  =  Y(I) - FDES(I)
      EDESSQ(I) = EDES(I)**2
      ETES(I)  =  Y(I) - FTES(I)
       ETESSQ(I)= ETES(I)**2
      TOTES = TOTES + ESES(I)
      TOTED = TOTED + EDES(I)
      TOTET = TOTET + ETES(I)
   48 CONTINUE
C
      SIEROR = TOTES/JIMMY
      SDEROR = TOTED/JIMMY
      STEROR = TOTET/JIMMY
C
C             THESE COMPUTE AVERAGE SIGNED ERRORS, FOR
C             SINGLE,DOUBLE AND TRIPLE SMOOTHING RESPECTIVELY.
C
C
C                          MOVING AVERAGES
C                         _________________
C
C             SINGLE MOVING AVERAGE : USEFUL IF NO TREND;
C                                     LACKS PROPER WEIGHTING.
C             DOUBLE MOVING AVERAGE : USEFUL WITH TREND BUT USUALLY
C                         LESS EFFECTIVE THAN EXPONENTIAL SMOOTHING
C                         NOT APPROPRIATE IF TREND ITSELF CHANGING.
C
C
      PRINT 20
   20 FORMAT('1',58X, 'TABLE B'/52X,'***MOVING AVERAGES***')
      PRINT  22
   22 FORMAT('0',28X,'SINGLE MOVING AVERAGE',42X,'DOUBLE MOVING AVERAGE
     1 '/)
      PRINT 23
   23 FORMAT(15X,'PERIOD  ACTUAL',   1X,'FORECAST',2X,'RESIDUAL',2X,'RES
     1IDUAL-SQ',10X,'M(2)',4X,'FORECAST',5X,'RESIDUAL',2X,'RESIDUAL-SQ')
      DO 98 I=2,J
      PRINT 24, X(I),Y(I),SMA(I),ESMA(I),ESMASQ(I),DMA(I),
     1 FDMA(I),EDMA(I),EDMASQ(I)
   24 FORMAT(18X,I2,3X,F5.0,2X,F8.2,2X,F8.2,2X,F11.2, 8X,F8.2,2X,
     1 F8.2,2X,F11.2,2X,F11.2)
   98 CONTINUE
      NUM = NUM1 +2
      DO 13 I=NUM, J
      S3 = S3+SMA(I)
      SS2 = SS2 + ESMASQ(I)
   13 SS3 = SS3 + SMASQ(I)
      NUM = NUM1 * 2+2
      DC 49 I=NUM,J
```

```
          IINUM = (J-NUM)
          S4 = S4 + FDMA(I)
          SS4 = SS4 + EDMASQ(I)
   49     SS5 = SS5 + FDMASQ(I)
          PRINT 25,S3,SS2,S4, SS4
   25     FORMAT ('0',/,23X,F15.3,12X,F11.3,11X,F15.3,11X,F15.3)
          SRS2 = SS2 / IINUM
          SMRS2 = SQRT(SRS2)
          SRS4 = SS4 / IINUM
           SMRS4 = SQRT(SRS4)
          PRINT 143, SMRS2, SMRS4
```

```
  143 FORMAT('0',18X,'THE ROOT MEAN SQUARE ERROR = ',F12.2,41X,F12.2/)
      PRINT 59,T, FORDMA
   59 FORMAT(/,68X,'FORECAST FOR ',I2,1X,'PERIOD(S) AHEAD IS',1X,
     1 F8.0)
C
C
C                             EXPONENTIAL SMOOTHING
C                            ______________________
C
C              SINGLE EXPONENTIAL SMOOTHING : GOOD WITH STEADY DATA.
C              DOUBLE SMOOTHING : SUPERIOR RESULTS WITH TREND DATA,
C                                 AND EQUALLY GOOD WITH STEADY DATA.
C              TRIPLE SMOOTHING : FOR TRENDS THAT ARE CHANGING.
C
C
       PRINT   26
   26 FORMAT('1',47X,'TABLE C'/37X,'***EXPONENTIAL SMOOTHING***')
      PRINT 27
   27 FORMAT(//,37X,'SINGLE EXPONENTIAL SMOOTHING')
      PRINT  28
   28 FORMAT(21X,'PERIOD',2X,'ACTUAL',4X,'SES' ,4X,'FORECAST',2X,
     1'RESIDUAL',2X,'RESIDUAL-SQ'/ 21X,29('- ') /)
      DO 14 I=1,J
      PRINT 29, X(I), Y(I), SES(I), FSES(I), ESES(I),ESESSQ(I)
   29 FORMAT(24X,I2,3X,F5.0, 3(2X,F8.2),2X, F11.2)
   14 CONTINUE
      DO 38 I=3,J
       IJNUM = (J-3)
      S5 = S5 + FSES(I)
      S6 = S6+ FDES(I)
      S8 = S8+FTES(I)
      SS6 = SS6 + ESESSQ(I)
      SS7 = SS7 + SESSQ(I)
      SS8 = SS8 + EDESSQ(I)
      SS12 = ETESSQ(I) + SS12
      SS13 = SS13 + FTESSG(I)
   38 SS9 = SS9 + FDESSQ(I)
      PRINT 35,S5,SS6
   35 FORMAT('0',/,40X,F14.2,11X,F13.0)
      SRS6 = SS6 / IJNUM
      SMRS6 = SQRT(SRS6)
      PRINT 144,SMRS6 , SIERCR
  144 FORMAT('0',34X,'THE ROOT MEAN SQUARE ERROR = ',F12.2/35X,'THE MEAN
     1 SIGNED ERROR      = ',F12.2/)
      PRINT 21, T,SESFOR
      PRINT 110,ALPHA
  110 FORMAT('0',35X,'THE ALPHA VALUE USED IS:',F5.3/36X,15('* ')/)
      PRINT 74
   74 FORMAT('1',37X,'DOUBLE EXPONENTIAL SMOOTHING'/)
```

```
      PRINT  76
   76 FORMAT(14X,'PERIOD',2X,'ACTUAL',4X,'DES',8X,'EA',8X,'FR',6X,
     1'FORECAST',3X,'RESIDUAL',2X,'RESIDUAL-SQ')
      DO 77 I=1,J
      PRINT 78, X(I),Y(I),DES(I),EA(I),EB(I),FDES(I),EDES(I),EDESSQ(I)
   78 FORMAT(17X,I2,  F8.0,1X,F8.2,3X,F8.2,2X,F8.2,4X,F8.2,3X,
     1F8.2,2X,F11.2)
   77 CONTINUE
      PRINT 79,S6,SS8
   79 FORMAT('0',/,58X,F11.3, 8X,F13.0)
      SRS8 = SS8 /J
```

```
      SMRS8 = SQRT(SRS8)
      PRINT 145, SMRS8, SDEROR
 145  FORMAT('0',50X,'THE ROOT MEAN SQUARE ERROR = ',F12.2/51X,'THE MEAN
     1 SIGNED ERROR       = ',F12.2/)
      PRINT 21, T, DESFOR
  21  FORMAT(/,30X,'FORECAST FOR ',I2,' PERIODS AHEAD IS',1X,F8.3)
      PRINT 110, ALPHA
      PRINT   31
  31  FORMAT('1',40X,'TRIPLE EXPONENTIAL SMOOTHING'/)
      PRINT 32
  32  FORMAT(14X,'PERIOD   ACTUAL'    ,4X,'TES',7X,'TA',8X,'TB',6X,'TC',
     14X,'FORECAST',2X,'RESIDUAL',2X,'RESIDUAL-SQ'/14X,42('- ')/)
      DO 97 I=1,J
      PRINT 33, X(I),Y(I),TES(I),TA(I),TB(I),TC(I),FTES(I),ETES(I),
     1 ETESSQ(I)
  33  FORMAT(17X,I2,3X,F5.0,2X,F8.2,2X,F8.2,1X,F7.2,1X,F7.2,3X,
     1 2(F8.2,2X),F11.2)
  97  CONTINUE
      PRINT 36,S8,SS12
  36  FORMAT('0',/,60X,F15.3, 6X,F13.0)
      SRS12 = SS12/J
      SMRS12 = SQRT(SRS12)
      PRINT 146, SMRS12,STEROR
 146  FORMAT('0',54X,'THE ROOT MEAN SQUARE ERROR = ',F12.2/55X,'THE MEAN
     1 SIGNED ERROR       = ',F12.2/)
      PRINT 30, T, TESFOR
  30  FORMAT(/,26X,'FORECAST FOR ',I2,' PERIODS AHEAD IS ',F8.3)
      PRINT 110, ALPHA
C
C
C                           * * * * * * * *
C                            WINTERS METHOD
C                           * * * * * * * *
C          WINTERS,P.R., 'FORECASTING SALES BY EXPONENTIALLY
C          WEIGHTED MOVING AVERAGES', MGT. SCI., 6,1960
C          USES DECOMPOSITION ANALYSIS TO DETERMINE THE
C          SEASONAL FACTOR, TO ESTIMATE THE TREND.
C          A DIRECT, SIMPLE METHOD OF FORECASTING
C          SEASONAL DATA.
C
C
C
C
C          FOR INITIAL TREND LINE, USE SIMPLE LINEAR REGRESSION.
C                YEST(I) = A + BX(I)
C          INITIAL MULTIPLICATIVE SEASONAL FACTORS ('MSF')
C          BY USING THE 1ST AND 2ND YEAR IN THE DATA
C
C        1.  FOR THE FIRST YEAR
```

```
C
      L = L+1
      DO 170 I=2,L
  170 SF1(I) = Y(I)/YEST(I)
C
C                 2. FOR THE SECOND YEAR
C
      LP1 = 1+L
      LT2 = 2*L-1
      DO 175 I=LP1,LT2
  175 SF2(I)= Y(I) / YEST(I)
```

```
C
C                 INITIAL ESTIMATES OF FUTURE SEASONAL FACTORS ('SF)
C
          DC 180 I=2,L
          M = I+L-1
          SF(I) = (SF1(I)+SF2(M))/2
  180    SF(M) = SF(I)
          PRINT  345
  345    FORMAT('1', 40X,'TABLE D'/35X,'** WINTERS METHOD **')
          PRINT  350
  350    FORMAT(/,18X,'PERIOD',3X,'ACTUAL',3X,'TREND LINE VALUE',3X,
        1 'MULT.SEAS.FACTOR'/)
          DO 185 I=2,L
          PRINT 355, X(I),Y(I), YEST(I),SF1(I)
  355     FORMAT(20X,I2,6X,F5.0,6X,F10.4,13X,F4.2)
  185     CONTINUE
         DO 190  I=LP1,LT2
          PRINT 360, X(I),Y(I),YEST(I),SF2(I)
  360    FORMAT( 20X,I2, 6X, F5.0,6X, F10.2, 13X,F4.2)
  190     CONTINUE
          PRINT  365
  365     FORMAT(//,30X,'PERIOD',5X,'AVERAGE OF MULT.'/41X,'SEASONAL FACTOR
        1S'/)
          DO 195  I=2,L
          PRINT 370,X(I),SF(I)
  370    FORMAT (32X,I2,11X,F5.2)
  195    CONTINUE
C
C                 UPDATE THE ESTIMATE OF THE INTERCEPT, SLOPE AND
C                 MULT. SEASONAL FACTOR BY USING EXPONENTIAL SMOOTHING
C
C                 AA(I)  = ESTIM. VALUE OF TREND LINE, PERIOD 1
C                 BB(I) = ESTIM. SLOPE OF TREND AT PERIOD I
C                 SSF(I)= REVISED ESTIMATE OF SEASONAL FACTOR
C                 FW(I) = FORECAST BY WINTER'S METHOD
C
          LP3 = 1+ LT2
          LT3 = 3* L-2
          K = LT3-1
          DC 200 I=LP3,K
          AA(LT2) = YEST(LT2)
          BB(LT2) = B
          AA(I) = WALPHA*Y(I)/SF(I+1-L)+( 1.-WALPHA)*(AA(I-1) + BB(I-1))
          BB(I) = WBETA*(AA(I)-AA(I-1))+ (1.-WBETA)*BB(I-1)
          SSF(I)=WDELTA*Y(I)/ AA(I)+ (1.-WDELTA)*SF(I+1-L)
          FW(I+1)=(AA(I)+BB(I)*1.)*SF(I+2-L)
  200     CONTINUE
          DC 205 I=LT3,J
          SSF(LT2)= SF(LT2)
```

```
          AA(I) = WALPHA*Y(I)/ SSF(I+1-L)+ (1.-WALPHA)*(AA(I-1)+BB(I-1))
          BB(I) = WBETA*(AA(I)-AA(I-1))+ (1.-WBETA)*BB(I-1)
          SSF(I) = WDELTA*Y(I)/AA(I)+(1.-WDELTA)*SSF(I+1-L)
          FW(I+1)= (AA(I)+BB(I)*1. ) *SSF(I+2-L)
    205   CONTINUE
          MOA = J+T-1
          MOB = L-1
          REM = MOD(MOA,MOB)
          WINFOR = (AA(J)+BB(J)*T)* SSF(REM+LT2)
          LP5= 1+LP3
          DO 210 I=LP5,J
```

```
          EFW(I)  =  Y(I) - FW(I)
          EFWSQ(I) = EFW(I)**2
          FWSQ(I)= FW(I)**2
  210     CONTINUE
          DO 215 I=LP5,J
          S7 = S7+FW(I)
          SS10 = SS10+EFWSQ(I)
          SS11= SS11+FWSQ(I)
  215     CONTINUE
          PRINT 375
  375   FORMAT(//,27X,'***FORECAST BY WINTERS METHOD***'/)
          PRINT 118, WALPHA,WBETA,WDELTA
  118   FORMAT('0',28X, 'THE WINTERS PARAMETERS ARE :'/ 23X,'ALPHA = ',
       1F4.2,1X,'BETA = ',F4.2,1X,'AND SIGMA = ',F4.2/)
          PRINT  380
  380   FORMAT(//,15X,'PERIOD',6X,'ACTUAL',3X,'FORECAST',5X,'RESIDUAL',
       12X,'RESIDUAL -SQ')
          DO 220  I=LP3,J
          IKNUM = (J- LP3)
          PRINT 385, X(I),Y(I),FW(I),EFW(I),EFWSQ(I)
  385   FORMAT(17X,I2, 9X, F5.0,3X, F8.2,5X, F8.2, 1X,F12.2)
  220     CONTINUE
          PRINT 390,S7,SS10
  390   FORMAT(/,33X,F11.3,12X,F14.2)
          SRS10 = SS10 / IKNUM
          SMRS10 = SQRT(SRS10)
          PRINT 147,SMRS10
  147   FORMAT('0',28X,'THE ROOT MEAN SQUARE ERROR = ',F12.2/)
          PRINT 21,T,WINFOR
  115     CONTINUE
  123   CONTINUE
          PRINT 135
  135   FORMAT('0',40X,'END OF PROGRAMME COMPARE.'/40X,13('* ')/)
          STOP
          END

$ENTRY
```

```
*** PROGRAMME COMPARE ***
-------------------------
    FORECASTING USING :
     SIMPLE REGRESSION
SINGLE AND DOUBLE MOVING AVERAGES
SINGLE, DOUBLE AND TRIPLE EXPONENTIAL SMOOTHING
    AND  WINTERS METHOD
   * * * * * * * * * * *

THERE ARE  4 SETS OF DATA.
```

ITEM NUMBER 1

TABLE A
SIMPLE REGRESSION

X	Y	FORECAST	E	ESQ
1	1222.	1002.44	219.56	48204.58
2	1707.	1027.58	679.42	461611.70
3	1229.	1052.71	176.29	31076.45
4	1524.	1077.85	446.15	199049.60
5	1253.	1102.99	150.01	22504.46
6	1334.	1128.12	205.88	42386.42
7	1560.	1153.26	406.74	165441.10
8	740.	1178.39	-438.39	192186.30
9	1125.	1203.53	-78.53	6166.27
10	1434.	1228.66	205.34	42164.15
11	1355.	1253.80	101.20	10242.27
12	1259.	1278.93	-19.93	397.25
13	1629.	1304.07	324.93	105581.90
14	1326.	1329.20	-3.20	10.25
15	1421.	1354.34	66.66	4444.03
16	1631.	1379.47	251.53	63266.49
17	1166.	1404.61	-238.61	56933.15
18	1257.	1429.74	-172.74	29839.78
19	1673.	1454.88	218.12	47577.66
20	1283.	1480.01	-197.01	38813.81
21	1316.	1505.15	-189.15	35776.67
22	1501.	1530.28	-29.28	857.46
23	1399.	1555.42	-156.42	24466.43
24	1177.	1580.55	-403.55	162854.70
25	1236.	1605.69	-369.69	136669.00
26	1536.	1630.82	-94.82	8991.40
27	1406.	1655.96	-249.96	62479.00
28	1834.	1681.09	152.91	23380.47
29	1183.	1706.23	-523.23	273767.80
30	430.	1731.36	-1301.36	1693547.00
31	1000.	1756.50	-756.50	572290.00
32	1590.	1781.63	-191.63	36723.51
33	1110.	1806.77	-696.77	485486.70
34	2002.	1831.90	170.10	28932.63
35	689.	1857.04	-1168.04	1364315.00
36	1237.	1882.17	-645.17	416249.80

37	2064.	1907.31	156.69	24551.96
38	2272.	1932.44	339.56	115297.80
39	2830.	1957.58	872.42	761117.30
40	2311.	1982.71	328.29	107771.10
41	2206.	2007.85	198.15	39263.48
42	2562.	2032.99	529.01	279856.70
43	1748.	2058.12	-310.12	96174.44
44	1966.	2083.26	-117.26	13748.82
45	1896.	2108.39	-212.39	45109.67
46	2366.	2133.53	232.47	54044.33
47	2279.	2158.66	120.34	14481.56

48	2244.	2183.80	60.20	3624.53
49	2453.	2208.93	244.07	59569.72
50	2670.	2234.07	435.93	190038.20
51	2536.	2259.20	276.80	76617.56
52	2523.	2284.34	238.66	56960.30
53	3026.	2309.47	716.53	513413.10
54	2552.	2334.61	217.39	47259.85
55	2289.	2359.74	-70.74	5004.39
56	2278.	2384.88	-106.88	11422.68
		94844.5600		9409990.000

ROOT MEAN SQUARE ERROR-= 406.31

AVERAGE X = 28.5000
AVERAGE Y = 1693.6600
A OF SIMPLE REGRESSION = 977.3096
B OF SIMPLE REGRESSION = 25.1351

TABLE 8
MOVING AVERAGES

PERIOD	ACTUAL	SINGLE MOVING AVERAGE FORECAST	RESIDUAL	RESIDUAL-SQ	M(2)	DOUBLE MOVING AVERAGE FORECAST	RESIDUAL	RESIDUAL-SQ
1	1222.	UUUUUUUU	UUUUUUUU	UUUUUUUUUUU	UUUUUUUU	0.00	UUUUUUUUUUU	UUUUUUUUUUU
2	1707.	UUUUUUUU	UUUUUUUU	UUUUUUUUUUU	UUUUUUUU	0.00	UUUUUUUUUUU	UUUUUUUUUUU
3	1229.	UUUUUUUU	UUUUUUUU	UUUUUUUUUUU	UUUUUUUU	0.00	UUUUUUUUUUU	UUUUUUUUUUU
4	1524.	UUUUUUUU	UUUUUUUU	UUUUUUUUUUU	UUUUUUUU	0.00	UUUUUUUUUUU	UUUUUUUUUUU
5	1253.	UUUUUUUU	UUUUUUUU	UUUUUUUUUUU	UUUUUUUU	0.00	UUUUUUUUUUU	UUUUUUUUUUU
6	1334.	UUUUUUUU	UUUUUUUU	UUUUUUUUUUU	UUUUUUUU	0.00	UUUUUUUUUUU	UUUUUUUUUUU
7	1560.	1378.17	181.83	33063.42	UUUUUUUU	0.00	1560.00	2433600.00
8	740.	1434.50	-694.50	482330.20	UUUUUUUU	0.00	740.00	547600.00
9	1125.	1273.33	-148.33	22002.75	UUUUUUUU	0.00	1125.00	1265625.00
10	1434.	1256.00	178.00	31684.00	UUUUUUUU	0.00	1434.00	2056356.00
11	1355.	1241.00	114.00	12996.00	UUUUUUUU	0.00	1355.00	1836025.00
12	1259.	1258.00	1.00	1.00	1306.83	0.00	1259.00	1585081.00
13	1629.	1245.50	383.50	147072.20	1284.72	1177.00	452.00	204304.00
14	1326.	1257.00	69.00	4761.00	1255.14	1180.00	146.00	21316.00
15	1421.	1354.67	66.33	4400.13	1268.69	1259.00	162.00	26244.00
16	1631.	1404.00	227.00	51529.00	1293.36	1497.00	134.00	17956.00
17	1166.	1436.83	-270.83	73350.63	1326.00	1587.00	-421.00	177241.00
18	1257.	1405.33	-148.33	22002.75	1350.55	1620.00	-363.00	131769.00
19	1673.	1405.00	268.00	71824.00	1377.14	1496.00	177.00	31329.00
20	1283.	1412.33	-129.33	16727.09	1403.03	1450.00	-167.00	27889.00
21	1316.	1405.17	-89.17	7950.66	1411.44	1427.00	-111.00	12321.00
22	1501.	1387.67	113.33	12844.48	1408.72	1394.00	107.00	11449.00
23	1399.	1366.00	33.00	1089.00	1396.92	1352.00	47.00	2209.00
24	1177.	1404.83	-227.83	51907.99	1396.83	1315.00	-138.00	19044.00
25	1236.	1391.50	-155.50	24180.25	1394.58	1417.00	-181.00	32761.00
26	1536.	1318.67	217.33	47233.85	1378.97	1386.00	150.00	22500.00
27	1406.	1360.83	45.17	2040.03	1371.58	1218.00	188.00	35344.00
28	1834.	1375.83	458.17	209916.70	1369.61	1343.00	491.00	241081.00
29	1183.	1431.33	-248.33	61669.40	1380.50	1386.00	-203.00	41209.00
30	430.	1395.33	-965.33	931868.20	1378.92	1515.00	-1085.00	1177225.00
31	1000.	1270.83	-270.83	73350.63	1358.80	1421.00	-421.00	177241.00
32	1590.	1231.50	358.50	128522.20	1344.28	1124.00	466.00	217156.00
33	1110.	1240.50	-130.50	17030.25	1324.22	1043.00	67.00	4489.00
34	2002.	1191.17	810.83	657450.90	1293.44	1101.00	901.00	811801.00
35	689.	1219.17	-530.17	281076.50	1258.08	1020.00	-331.00	109561.00
36	1237.	1136.83	100.17	10033.38	1215.00	1155.00	82.00	6724.00
37	2064.	1271.33	792.67	628320.50	1215.08	1006.00	1058.00	1119364.00
38	2272.	1448.67	823.33	677878.00	1251.28	1364.00	908.00	824464.00
39	2830.	1562.33	1267.67	1606978.00	1304.92	1777.00	1053.00	1108809.00
40	2311.	1849.00	462.00	213444.00	1414.55	1990.00	321.00	103041.00
41	2206.	1900.50	305.50	93330.25	1528.11	2572.00	-366.00	133956.00
42	2562.	2153.33	408.67	167008.50	1697.53	2520.00	42.00	1764.00
43	1748.	2374.17	-626.17	392084.40	1881.33	2912.00	-1164.00	1354896.00

44	1966.	2321.50	-355.50	126380.20	2026.80	3195.00	-1229.00	1510441.00
45	1896.	2270.50	-374.50	140250.20	2144.83	2812.00	-916.00	839056.00
46	2366.	2114.83	251.17	63084.73	2189.14	2479.00	-113.00	12769.00
47	2279.	2124.00	155.00	24025.00	2226.39	1991.00	288.00	82944.00
48	2244.	2136.17	107.83	11628.06	2223.53	1953.00	291.00	84681.00
49	2453.	2083.17	369.83	136776.80	2175.03	1990.00	463.00	214369.00
50	2670.	2200.67	469.33	220273.80	2154.89	1930.00	740.00	547600.00
51	2536.	2318.00	218.00	47524.00	2162.80	2276.00	260.00	67600.00
52	2523.	2424.67	98.33	9669.47	2214.44	2576.00	-53.00	2809.00
53	3026.	2450.83	575.17	330816.70	2268.92	2774.00	252.00	63504.00
54	2552.	2575.33	-23.33	544.44	2342.11	2753.00	-201.00	40401.00

55	2289.	2626.67	-337.67	114018.60	2432.69	2963.00	-674.00	454276.00
56	2278.	2599.33	-321.33	103255.00	2499.14	2949.00	-671.00	450241.00
		82693.620		8599187.000		78665.000		12577140.000

THE ROOT MEAN SQUARE ERROR = 447.19 540.82

FORECAST FOR 6 PERIOD(S) AHEAD IS 3095.

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TABLE C
EXPONENTIAL SMOOTHING

PERIOD	ACTUAL	SINGLE EXPONENTIAL SMOOTHING SES	FORECAST	RESIDUAL	RESIDUAL-SQ
0	0.	1222.00	0.00	UUUUUUUU	UUUUUUUUUUU
1	1222.	1222.00	0.00	UUUUUUUU	UUUUUUUUUUU
2	1707.	1270.50	1222.00	485.00	235225.00
3	1229.	1266.35	1270.50	-41.50	1722.25
4	1524.	1292.11	1266.35	257.65	66383.56
5	1253.	1288.20	1292.11	-39.11	1529.96
6	1334.	1292.78	1288.20	45.80	2097.35
7	1560.	1319.50	1292.78	267.22	71405.06
8	740.	1261.55	1319.50	-579.50	335825.30
9	1125.	1247.90	1261.55	-136.55	18646.98
10	1434.	1266.51	1247.90	186.10	34633.79
11	1355.	1275.36	1266.51	88.49	7830.73
12	1259.	1273.72	1275.36	-16.36	267.57
13	1629.	1309.25	1273.72	355.28	126222.60
14	1326.	1310.92	1309.25	16.75	280.58
15	1421.	1321.93	1310.92	110.08	12116.60
16	1631.	1352.84	1321.93	309.07	95523.06
17	1166.	1334.15	1352.84	-186.84	34908.67
18	1257.	1326.44	1334.15	-77.15	5952.82
19	1673.	1361.09	1326.44	346.56	120104.50
20	1283.	1353.29	1361.09	-78.09	6098.82
21	1316.	1349.56	1353.29	-37.29	1390.20
22	1501.	1364.70	1349.56	151.44	22935.09
23	1399.	1368.13	1364.70	34.30	1176.43
24	1177.	1349.02	1368.13	-191.13	36530.91
25	1236.	1337.72	1349.02	-113.02	12772.91
26	1536.	1357.54	1337.72	198.28	39316.71
27	1406.	1362.39	1357.54	48.46	2347.99
28	1834.	1409.55	1362.39	471.61	222416.50
29	1183.	1386.90	1409.55	-226.55	51325.04
30	430.	1291.21	1386.90	-956.90	915648.50
31	1000.	1262.08	1291.21	-291.21	84800.63
32	1590.	1294.88	1262.08	327.92	107528.20
33	1110.	1276.39	1294.88	-184.88	34179.30
34	2002.	1348.95	1276.39	725.61	526511.70
35	689.	1282.95	1348.95	-659.95	435533.50
36	1237.	1278.36	1282.95	-45.95	2111.82
37	2064.	1356.92	1278.36	785.64	617231.50
38	2272.	1448.43	1356.92	915.08	837365.60
39	2830.	1586.59	1448.43	1381.57	1908733.00
40	2311.	1659.03	1586.59	724.41	524773.50

41	2206.	1713.73	1659.03	546.97	299177.70
42	2562.	1798.55	1713.73	848.27	719569.40
43	1748.	1793.50	1798.55	-50.55	2555.60
44	1966.	1810.75	1793.50	172.50	29757.09
45	1896.	1819.27	1810.75	85.25	7267.93
46	2366.	1873.95	1819.27	546.73	298910.40
47	2279.	1914.45	1873.95	405.05	164069.00
48	2244.	1947.41	1914.45	329.55	108602.50
49	2453.	1997.97	1947.41	505.59	255625.50
50	2670.	2065.17	1997.97	672.03	451630.80
51	2536.	2112.25	2065.17	470.83	221682.30

52	2523.	2153.33	2112.25	410.75	168714.30
53	3026.	2240.59	2153.33	872.67	761559.50
54	2552.	2271.73	2240.59	311.41	96974.00
55	2289.	2273.46	2271.73	17.27	298.11
56	2278.	2273.91	2273.46	4.54	20.61
			83103.50		11147800.

THE ROOT MEAN SQUARE ERROR = 454.36
THE MEAN SIGNED ERROR = 191.26

FORECAST FOR 6 PERIODS AHEAD IS 2273.915

THE ALPHA VALUE USED IS:0.100
* * * * * * * * * * * * * * *

DOUBLE EXPONENTIAL SMOOTHING

PERIOD	ACTUAL	DES	EA	FR	FORECAST	RESIDUAL	RESIDUAL-SQ
0	0.	1222.00	UUUUUUUU	UUUUUUUU	0.00	UUUUUUUU	UUUUUUUUUUU
1	1222.	1222.00	1222.00	0.00	0.00	UUUUUUUU	UUUUUUUUUUU
2	1707.	1226.85	1314.15	4.85	1222.00	485.00	235224.70
3	1229.	1230.80	1301.90	3.95	1319.00	-90.00	8100.09
4	1524.	1236.93	1347.30	6.13	1305.85	218.15	47589.27
5	1253.	1242.06	1334.35	5.13	1353.43	-100.43	10086.22
6	1334.	1247.13	1338.44	5.07	1339.48	-5.48	29.98
7	1560.	1254.37	1384.64	7.24	1343.51	216.49	46868.76
8	740.	1255.09	1268.02	0.72	1391.88	-651.88	424946.00
9	1125.	1254.37	1241.43	-0.72	1268.74	-143.74	20661.39
10	1434.	1255.58	1277.44	1.21	1240.71	193.29	37360.47
11	1355.	1257.56	1293.16	1.98	1278.65	76.35	5829.26
12	1259.	1259.17	1288.27	1.62	1295.13	-36.13	1305.72
13	1629.	1264.18	1354.32	5.01	1289.89	339.11	114998.70
14	1326.	1268.86	1352.99	4.67	1359.32	-33.32	1110.54
15	1421.	1274.16	1369.70	5.31	1357.67	63.33	4010.98
16	1631.	1282.03	1423.65	7.87	1375.01	255.99	65531.75
17	1166.	1287.24	1381.07	5.21	1431.51	-265.51	70497.88
18	1257.	1291.16	1361.72	3.92	1386.28	-129.28	16713.07
19	1673.	1298.15	1424.04	6.99	1365.64	307.36	94472.75
20	1283.	1303.67	1402.90	5.51	1431.03	-148.03	21912.38
21	1316.	1308.26	1390.86	4.59	1408.42	-92.42	8540.76
22	1501.	1313.90	1415.50	5.64	1395.45	105.55	11141.64
23	1399.	1319.32	1416.94	5.42	1421.15	-22.15	490.43
24	1177.	1322.29	1375.74	2.97	1422.36	-245.36	60201.94
25	1236.	1323.83	1351.60	1.54	1378.71	-142.71	20366.55
26	1536.	1327.21	1387.88	3.37	1353.14	182.86	33438.18
27	1406.	1330.72	1394.06	3.52	1391.25	14.75	217.46
28	1834.	1338.61	1480.49	7.88	1397.57	436.43	190467.80
29	1183.	1343.43	1430.36	4.83	1488.38	-305.38	93255.38
30	430.	1338.21	1244.20	-5.22	1435.19	-1005.19	1010397.00
31	1000.	1330.60	1193.57	-7.61	1238.98	-238.98	57110.03
32	1590.	1327.03	1262.73	-3.57	1185.96	404.04	163249.30
33	1110.	1321.96	1230.82	-5.06	1259.15	-149.15	22247.15
34	2002.	1324.66	1373.24	2.70	1225.75	776.25	602561.30
35	689.	1320.49	1245.42	-4.17	1375.94	-686.94	471883.40
36	1237.	1316.28	1240.44	-4.21	1241.25	-4.25	18.05
37	2064.	1320.34	1393.51	4.06	1236.23	827.77	685205.10
38	2272.	1333.15	1563.71	12.81	1397.57	874.43	764627.60
39	2830.	1358.49	1814.68	25.34	1576.52	1253.48	1571210.00
40	2311.	1388.55	1929.51	30.05	1840.03	470.97	221817.00
41	2206.	1421.06	2006.39	32.52	1959.56	246.44	60730.72
42	2562.	1458.81	2138.29	37.75	2038.90	523.10	273628.80
43	1748.	1492.28	2094.71	33.47	2176.04	-428.04	183219.60
44	1966.	1524.13	2097.37	31.85	2128.18	-162.18	26303.04
45	1896.	1553.64	2084.90	29.51	2129.21	-233.21	54389.05

46	2366.	1585.67	2162.22	32.03	2114.42	251.58	63293.39
47	2279.	1618.55	2210.35	32.88	2194.25	84.75	7182.73
48	2244.	1651.44	2243.38	32.89	2243.23	0.77	0.59
49	2453.	1686.09	2309.84	34.65	2276.26	176.74	31236.42
50	2670.	1724.00	2406.34	37.91	2344.50	325.50	105953.30
51	2536.	1762.82	2461.68	38.83	2444.25	91.75	8418.42
52	2523.	1801.87	2504.78	39.05	2500.50	22.50	506.06
53	3026.	1845.74	2635.44	43.87	2543.83	482.17	232486.80
54	2552.	1888.34	2655.12	42.60	2679.31	-127.31	16208.35
55	2289.	1926.85	2620.06	38.51	2697.72	-408.72	167053.00
56	2278.	1961.56	2586.27	34.71	2658.58	-380.58	144837.80

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                              90152.000            8591128.

                         THE ROOT MEAN SQUARE ERROR =      388.23
                         THE MEAN SIGNED ERROR      =       63.10

FORECAST FOR  6 PERIODS AHEAD IS 2794.505

     THE ALPHA VALUE USED IS:0.100
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TRIPLE EXPONENTIAL SMOOTHING

PERIOD	ACTUAL	TES	TA	TB	TC	FORECAST	RESIDUAL	RESIDUAL-SQ
0	0.	1222.00	UUUUUUUU	UUUUUUU	UUUUUUU	0.00	UUUUUUUU	UUUUUUUUUUU
1	1222.	1222.00	1222.00	0.00	0.00	0.00	UUUUUUUU	UUUUUUUUUUU
2	1707.	1222.48	1352.95	13.82	0.49	1222.00	485.00	235224.20
3	1229.	1223.32	1329.14	10.36	0.35	1367.02	-138.02	19048.58
4	1524.	1224.68	1388.87	15.94	0.53	1339.67	184.33	33977.85
5	1253.	1226.41	1363.11	12.09	0.38	1405.07	-152.07	23125.01
6	1334.	1228.49	1363.37	11.24	0.33	1375.39	-41.39	1713.49
7	1560.	1231.07	1423.90	16.79	0.52	1374.78	185.22	34306.25
8	740.	1233.47	1250.48	-2.74	-0.19	1440.95	-700.95	491330.40
9	1125.	1235.56	1214.07	-6.49	-0.31	1247.65	-122.65	15041.80
10	1434.	1237.57	1268.35	-0.40	-0.09	1207.42	226.58	51337.09
11	1355.	1239.56	1290.96	1.93	-0.00	1267.90	87.10	7586.77
12	1259.	1241.52	1283.21	0.91	-0.04	1292.90	-33.90	1148.94
13	1629.	1243.79	1376.73	10.64	0.30	1284.09	344.91	118959.80
14	1326.	1246.30	1370.00	9.13	0.24	1387.52	-61.52	3785.19
15	1421.	1249.08	1389.60	10.49	0.28	1379.25	41.75	1743.29
16	1631.	1252.38	1461.51	17.27	0.51	1400.23	230.77	53253.79
17	1166.	1255.86	1393.11	8.76	0.19	1479.03	-313.03	97987.00
18	1257.	1259.39	1361.70	4.72	0.04	1401.97	-144.97	21016.15
19	1673.	1263.27	1448.21	13.40	0.35	1366.44	306.56	93980.69
20	1283.	1267.31	1412.12	8.54	0.16	1461.79	-178.79	31965.00
21	1316.	1271.40	1391.21	5.60	0.05	1420.75	-104.75	10971.79
22	1501.	1275.65	1423.81	8.51	0.15	1396.84	104.16	10848.73
23	1399.	1280.02	1422.07	7.59	0.12	1432.39	-33.39	1115.15
24	1177.	1284.25	1360.19	0.38	-0.14	1429.73	-252.73	63870.22
25	1236.	1288.21	1325.89	-3.42	-0.27	1360.51	-124.51	15502.13
26	1536.	1292.10	1379.22	2.28	-0.06	1322.33	213.67	45654.63
27	1406.	1295.97	1387.10	2.81	-0.04	1381.47	24.53	601.49
28	1834.	1300.23	1508.80	15.32	0.40	1389.90	444.10	197228.30
29	1183.	1304.55	1430.61	5.87	0.06	1524.32	-341.32	116499.10
30	430.	1307.92	1163.53	-22.88	-0.95	1436.51	-1006.51	1013068.00
31	1000.	1310.18	1102.38	-27.92	-1.10	1140.18	-140.18	19649.93
32	1590.	1311.87	1213.74	-14.38	-0.58	1073.90	516.10	266355.70
33	1110.	1312.88	1175.15	-17.55	-0.67	1199.07	-89.07	7932.87
34	2002.	1314.06	1385.75	5.82	0.17	1157.26	844.74	713579.80
35	689.	1314.70	1201.45	-14.07	-0.53	1391.65	-702.65	493721.30
36	1237.	1314.86	1200.95	-13.20	-0.49	1187.12	49.88	2488.32
37	2064.	1315.40	1424.60	11.29	0.39	1187.51	876.49	768241.90
38	2272.	1317.18	1661.24	35.49	1.23	1436.09	835.91	698745.30
39	2830.	1321.31	2001.46	68.95	2.36	1697.35	1132.65	1282901.00
40	2311.	1328.03	2132.75	78.01	2.59	2071.59	239.41	57319.32
41	2206.	1337.34	2206.02	80.24	2.58	2212.06	-6.06	36.72
42	2562.	1349.48	2356.55	90.37	2.84	2287.54	274.46	75326.25
43	1748.	1363.76	2253.13	72.91	2.13	2448.35	-700.35	490489.80

44	1966.	1379.80	2223.62	64.35	1.76	2327.11	-361.11	130399.90
45	1896.	1397.18	2176.69	54.45	1.35	2288.85	-392.85	154327.50
46	2366.	1416.03	2262.00	59.13	1.46	2231.81	134.19	18006.41
47	2279.	1436.28	2303.73	58.83	1.40	2321.86	-42.86	1837.03
48	2244.	1457.80	2324.19	56.26	1.26	2363.27	-119.27	14224.70
49	2453.	1480.63	2393.43	58.96	1.31	2381.08	71.92	5172.09
50	2670.	1504.96	2504.15	65.80	1.51	2453.05	216.95	47069.08
51	2536.	1530.75	2553.26	65.63	1.45	2570.70	-34.70	1204.41
52	2523.	1557.86	2585.11	63.59	1.33	2619.61	-96.61	9333.51
53	3026.	1586.65	2742.41	74.88	1.68	2649.37	376.63	141853.60
54	2552.	1616.82	2736.82	68.15	1.38	2818.12	-266.12	70821.69

55	2289.	1647.82	2656.64	53.95	0.83	2805.66	-516.66	266937.40
56	2278.	1679.20	2584.89	41.56	0.37	2711.00	-433.00	187489.60
						92826.500		8737338.

THE ROOT MEAN SQUARE ERROR = 391.52
THE MEAN SIGNED ERROR = 14.47

FORECAST FOR 6 PERIODS AHEAD IS 2840.885

THE ALPHA VALUE USED IS:0.100
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TABLE D
** WINTERS METHOD **

PERIOD	ACTUAL	TREND LINE VALUE	MULT.SEAS.FACTOR
1	1222.	1002.4440	1.22
2	1707.	1027.5790	1.66
3	1229.	1052.7140	1.17
4	1524.	1077.8500	1.41
5	1253.	1102.9850	1.14
6	1334.	1128.1200	1.18
7	1560.	1153.2550	1.35
8	740.	1178.3900	0.63
9	1125.	1203.5250	0.93
10	1434.	1228.6600	1.17
11	1355.	1253.7950	1.08
12	1259.	1278.9310	0.98
13	1629.	1304.07	1.25
14	1326.	1329.20	1.00
15	1421.	1354.34	1.05
16	1631.	1379.47	1.18
17	1166.	1404.61	0.83
18	1257.	1429.74	0.88
19	1673.	1454.88	1.15
20	1283.	1480.01	0.87
21	1316.	1505.15	0.87
22	1501.	1530.28	0.98
23	1399.	1555.42	0.90
24	1177.	1580.55	0.74

PERIOD	AVERAGE OF MULT. SEASONAL FACTORS
1	1.23
2	1.33
3	1.11
4	1.30
5	0.98
6	1.03
7	1.25
8	0.75
9	0.90
10	1.07
11	0.99
12	0.86

FORECAST BY WINTERS METHOD

THE WINTERS PARAMETERS ARE :
ALPHA = 0.10 BETA = 0.10 AND SIGMA = 0.10

PFRIOD	ACTUAL	FORECAST	RESIDUAL	RESIDUAL -SQ
25	1236.	UUUUUUUU	UUUUUUUU	UUUUUUUUUUUU
26	1536.	2079.65	-543.65	295554.90
27	1406.	1705.15	-299.15	89492.38

761

28	1834.	1978.08	-144.08	20758.08
29	1183.	1498.08	-315.08	99275.13
30	430.	1546.08	-1116.08	1245623.00
31	1000.	1737.71	-737.71	544222.00
32	1590.	987.38	602.62	363154.80
33	1110.	1267.25	-157.25	24727.95
34	2002.	1483.39	518.61	268954.60
35	689.	1417.69	-728.69	530991.50
36	1237.	1170.04	66.96	4483.37
37	2064.	1615.67	448.33	201002.20
38	2272.	1808.64	463.36	214698.00
39	2830.	1562.81	1267.19	1605761.00
40	2311.	2016.96	294.04	86457.63
41	2206.	1546.30	659.70	435207.10
42	2562.	1626.16	935.84	875800.30
43	1748.	2195.62	-447.62	200367.00
44	1966.	1430.97	535.03	286262.00
45	1896.	1721.64	174.36	30401.45
46	2366.	2194.81	171.19	29307.41
47	2279.	1920.34	358.66	128637.70
48	2244.	1843.23	400.77	160612.60
49	2453.	2702.59	-249.59	62293.38
50	2670.	2974.02	-304.02	92428.44
51	2536.	2635.06	-99.06	9813.67
52	2523.	3002.39	-479.39	229810.60
53	3026.	2300.61	725.39	526194.60
54	2552.	2434.83	117.17	13728.45
55	2289.	2924.96	-635.96	404449.60
56	2278.	2004.75	273.25	74667.38
		59332.810		9155127.00

THE ROOT MEAN SQUARE ERROR = 543.44

FORECAST FOR 6 PERIODS AHEAD IS 3607.651

ITEM NUMBER 3

TABLE A
SIMPLE REGRESSION

X	Y	FORECAST	E	ESQ
1	60.	42.01	17.99	323.74
2	38.	42.77	-4.77	22.75
3	24.	43.53	-19.53	381.54
4	42.	44.30	-2.30	5.27
5	39.	45.06	-6.06	36.71
6	53.	45.82	7.18	51.52
7	68.	46.58	21.42	458.61
8	61.	47.35	13.65	186.38
9	50.	48.11	1.89	3.57
10	42.	48.87	-6.87	47.25
11	26.	49.64	-23.64	558.69
12	35.	50.40	-15.40	237.15
13	82.	51.16	30.84	950.95
14	42.	51.93	-9.93	98.52
15	19.	52.69	-33.69	1134.91
16	75.	53.45	21.55	464.34
17	57.	54.21	2.79	7.76
18	63.	54.98	8.02	64.36
19	93.	55.74	37.26	1388.29
20	71.	56.50	14.50	210.16
21	46.	57.27	-11.27	126.93
22	28.	58.03	-30.03	901.75
23	38.	58.79	-20.79	432.31
24	42.	59.56	-17.56	308.18
25	132.	60.32	71.68	5138.31
26	75.	61.08	13.92	193.74
27	0.	61.84	-61.84	3824.66
28	75.	62.61	12.39	153.59
29	63.	63.37	-0.37	0.14
30	48.	64.13	-16.13	260.26
31	142.	64.90	77.10	5945.08
32	98.	65.66	32.34	1045.97
33	74.	66.42	7.58	57.43
34	62.	67.18	-5.18	26.88
35	29.	67.95	-38.95	1516.90
36	60.	68.71	-8.71	75.87

762

37	108.	69.47	38.53	1484.30
38	60.	70.24	-10.24	104.78
39	3.	71.00	-68.00	4623.89
40	58.	71.76	-13.76	189.40
41	42.	72.53	-30.53	931.78
42	67.	73.29	-6.29	39.54
43	121.	74.05	46.95	2204.21
44	68.	74.81	-6.81	46.43
45	47.	75.58	-28.58	816.64
46	79.	76.34	2.66	7.08
47	34.	77.10	-43.10	1857.85

48	45.	77.87	-32.87	1080.16
49	131.	78.63	52.37	2742.75
50	97.	79.39	17.61	310.05
51	28.	80.15	-52.15	2720.10
52	48.	80.92	-32.92	1083.57
53	76.	81.68	-5.68	32.27
54	54.	82.44	-28.44	809.03
55	167.	83.21	83.79	7021.36
56	63.	83.97	-20.97	439.71
57	85.	84.73	0.27	0.07
58	111.	85.50	25.50	650.49
59	48.	86.26	-38.26	1463.69
60	121.	87.02	33.98	1154.56
61	141.	87.78	53.22	2831.93
62	138.	88.55	49.45	2445.60
63	66.	89.31	-23.31	543.36
64	98.	90.07	7.93	62.84
65	87.	90.84	-3.84	14.71
66	66.	91.60	-25.60	655.30
		4408.9840		65007.840

RCOT MEAN SQUARE ERROR-= 31.15

AVERAGE X = 33.5000
AVERAGE Y = 66.8030
A OF SIMPLE REGRESSION = 41.2443
B OF SIMPLE REGRESSION = 0.7629

765

TABLE B
MOVING AVERAGES

		SINGLE MOVING AVERAGE			DOUBLE MOVING AVERAGE			
PERIOD	ACTUAL	FORECAST	RESIDUAL	RESIDUAL-SQ	M(2)	FORECAST	RESIDUAL	RESIDUAL-SQ
1	60.	UUUUUUUU	UUUUUUUU	UUUUUUUUUUU	UUUUUUUU	0.00	UUUUUUUUUUU	UUUUUUUUUUU
2	38.	UUUUUUUU	UUUUUUUU	UUUUUUUUUUU	UUUUUUUU	0.00	UUUUUUUUUUU	UUUUUUUUUUU
3	24.	UUUUUUUU	UUUUUUUU	UUUUUUUUUUU	UUUUUUUU	0.00	UUUUUUUUUUU	UUUUUUUUUUU
4	42.	UUUUUUUU	UUUUUUUU	UUUUUUUUUUU	UUUUUUUU	0.00	UUUUUUUUUUU	UUUUUUUUUUU
5	39.	UUUUUUUU	UUUUUUUU	UUUUUUUUUUU	UUUUUUUU	0.00	UUUUUUUUUUU	UUUUUUUUUUU
6	53.	UUUUUUUU	UUUUUUUU	UUUUUUUUUUU	UUUUUUUU	0.00	UUUUUUUUUUU	UUUUUUUUUUU
7	68.	42.67	25.33	641.78	UUUUUUUU	0.00	68.00	4624.00
8	61.	44.00	17.00	289.00	UUUUUUUU	0.00	61.00	3721.00
9	50.	47.83	2.17	4.69	UUUUUUUU	0.00	50.00	2500.00
10	42.	52.17	-10.17	103.36	UUUUUUUU	0.00	42.00	1764.00
11	26.	52.17	-26.17	684.69	UUUUUUUU	0.00	26.00	676.00
12	35.	50.00	-15.00	225.00	48.14	0.00	35.00	1225.00
13	82.	47.00	35.00	1225.00	48.86	52.00	30.00	900.00
14	42.	49.33	-7.33	53.78	49.75	44.00	-2.00	4.00
15	19.	46.17	-27.17	738.03	49.47	48.00	-29.00	841.00
16	75.	41.00	34.00	1156.00	47.61	40.00	35.00	1225.00
17	57.	46.50	10.50	110.25	46.67	30.00	27.00	729.00
18	63.	51.67	11.33	128.44	46.94	46.00	17.00	289.00
19	93.	56.33	36.67	1344.44	48.50	59.00	34.00	1156.00
20	71.	58.17	12.83	164.69	49.97	69.00	2.00	4.00
21	46.	63.00	-17.00	289.00	52.78	71.00	-25.00	625.00
22	28.	67.50	-39.50	1560.25	57.19	79.00	-51.00	2601.00
23	38.	59.67	-21.67	469.44	59.39	83.00	-45.00	2025.00
24	42.	56.50	-14.50	210.25	60.19	59.00	-17.00	289.00
25	132.	53.00	79.00	6241.00	59.64	50.00	82.00	6724.00
26	75.	59.50	15.50	240.25	59.86	42.00	33.00	1089.00
27	0.	60.17	-60.17	3620.03	59.39	59.00	-59.00	3481.00
28	75.	52.50	22.50	506.25	56.89	60.00	15.00	225.00
29	63.	60.33	2.67	7.11	57.00	46.00	17.00	289.00
30	48.	64.50	-16.50	272.25	58.33	65.00	-17.00	289.00
31	142.	65.50	76.50	5852.25	60.42	74.00	68.00	4624.00
32	98.	67.17	30.83	950.70	61.69	73.00	25.00	625.00
33	74.	71.00	3.00	9.00	63.50	75.00	-1.00	1.00
34	62.	83.33	-21.33	455.11	68.64	83.00	-21.00	441.00
35	29.	81.17	-52.17	2721.36	72.11	107.00	-78.00	6084.00
36	60.	75.50	-15.50	240.25	73.94	96.00	-36.00	1296.00
37	108.	77.50	30.50	930.25	75.94	78.00	30.00	900.00
38	60.	71.83	-11.83	140.03	76.72	80.00	-20.00	400.00
39	3.	65.50	-62.50	3906.25	75.81	63.00	-60.00	3600.00
40	58.	53.67	4.33	18.78	70.86	49.00	9.00	81.00
41	42.	53.00	-11.00	121.00	66.17	25.00	17.00	289.00
42	67.	55.17	11.83	140.03	62.78	31.00	36.00	1296.00
43	121.	56.33	64.67	4181.78	59.25	42.00	79.00	6241.00

44	68.	58.50	9.50	90.25	57.03	52.00	16.00	256.00
45	47.	59.83	-12.83	164.69	56.08	59.00	-12.00	144.00
46	79.	67.17	11.83	140.03	58.33	65.00	14.00	196.00
47	34.	70.67	-36.67	1344.44	61.28	81.00	-47.00	2209.00
48	45.	69.33	-24.33	592.11	63.64	86.00	-41.00	1681.00
49	131.	65.67	65.33	4268.45	65.19	78.00	53.00	2809.00
50	97.	67.33	29.67	880.11	66.67	66.00	31.00	961.00
51	28.	72.17	-44.17	1950.69	68.72	68.00	-40.00	1600.00
52	48.	69.00	-21.00	441.00	69.03	77.00	-29.00	841.00
53	76.	63.83	12.17	148.03	67.89	68.00	8.00	64.00
54	54.	70.83	-16.83	283.36	68.14	57.00	-3.00	9.00

55	167.	72.33	94.67	8961.78	69.25	74.00	93.00	8649.00
56	63.	78.33	-15.33	235.11	71.08	77.00	-14.00	196.00
57	85.	72.67	12.33	152.11	71.17	89.00	-4.00	16.00
58	111.	82.17	28.83	831.36	73.36	75.00	36.00	1296.00
59	48.	92.67	-44.67	1995.11	78.17	95.00	-47.00	2209.00
60	121.	88.00	33.00	1089.00	81.03	116.00	5.00	25.00
61	141.	99.17	41.83	1750.03	85.50	98.00	43.00	1849.00
62	138.	94.83	43.17	1863.36	88.25	121.00	17.00	289.00
63	66.	107.33	-41.33	1708.44	94.03	105.00	-39.00	1521.00
64	98.	104.17	-6.17	38.03	97.69	128.00	-30.00	900.00
65	87.	102.00	-15.00	225.00	99.25	114.00	-27.00	729.00
66	66.	108.50	-42.50	1806.25	102.67	105.00	-39.00	1521.00
		3994.829		70910.430		3832.000		78633.000

THE ROOT MEAN SQUARE ERROR = 36.58 38.52

FORECAST FOR 10 PERIOD(S) AHEAD IS 144.

767

TABLE C
EXPONENTIAL SMOOTHING

PERIOD	ACTUAL	SINGLE EXPONENTIAL SMOOTHING SES	FORECAST	RESIDUAL	RESIDUAL-SQ
0	0.	60.00	0.00	UUUUUUUU	UUUUUUUUUUU
1	60.	60.00	0.00	UUUUUUUU	UUUUUUUUUUU
2	38.	57.80	60.00	-22.00	484.00
3	24.	54.42	57.80	-33.80	1142.44
4	42.	53.18	54.42	-12.42	154.26
5	39.	51.76	53.18	-14.18	201.02
6	53.	51.88	51.76	1.24	1.54
7	68.	53.50	51.88	16.12	259.72
8	61.	54.25	53.50	7.50	56.31
9	50.	53.82	54.25	-4.25	18.03
10	42.	52.64	53.82	-11.82	139.75
11	26.	49.98	52.64	-26.64	709.66
12	35.	48.48	49.98	-14.98	224.26
13	82.	51.83	48.48	33.52	1123.73
14	42.	50.85	51.83	-9.83	96.63
15	19.	47.66	50.85	-31.85	1014.24
16	75.	50.40	47.66	27.34	747.35
17	57.	51.06	50.40	6.60	43.61
18	63.	52.25	51.06	11.94	142.65
19	93.	56.33	52.25	40.75	1660.49
20	71.	57.79	56.33	14.67	215.33
21	46.	56.61	57.79	-11.79	139.08
22	28.	53.75	56.61	-28.61	818.75
23	38.	52.18	53.75	-15.75	248.14
24	42.	51.16	52.18	-10.18	103.58
25	132.	59.24	51.16	80.84	6535.19
26	75.	60.82	59.24	15.76	248.27
27	0.	54.74	60.82	-60.82	3698.97
28	75.	56.76	54.74	20.26	410.58
29	63.	57.39	56.76	6.24	38.89
30	48.	56.45	57.39	-9.39	88.12
31	142.	65.00	56.45	85.55	7319.07
32	98.	68.30	65.00	33.00	1088.76
33	74.	68.87	68.30	5.70	32.45
34	62.	68.19	68.87	-6.87	47.24
35	29.	64.27	68.19	-39.19	1535.51
36	60.	63.84	64.27	-4.27	18.21
37	108.	68.26	63.84	44.16	1950.08
38	60.	67.43	68.26	-8.26	68.17
39	3.	60.99	67.43	-64.43	4151.30
40	58.	60.69	60.99	-2.99	8.93

41	42.	58.82	60.69	-18.69	349.27
42	67.	59.64	58.82	8.18	66.91
43	121.	65.77	59.64	61.36	3765.30
44	68.	66.00	65.77	2.23	4.95
45	47.	64.10	66.00	-19.00	360.87
46	79.	65.59	64.10	14.90	222.10
47	34.	62.43	65.59	-31.59	997.76
48	45.	60.69	62.43	-17.43	303.76
49	131.	67.72	60.69	70.31	4944.09
50	97.	70.65	67.72	29.28	857.49
51	28.	66.38	70.65	-42.65	1818.63

52	48.	64.54	66.38	-18.38	337.86
53	76.	65.69	64.54	11.46	131.27
54	54.	64.52	65.69	-11.69	136.62
55	167.	74.77	64.52	102.48	10502.22
56	63.	73.59	74.77	-11.77	138.48
57	85.	74.73	73.59	11.41	130.17
58	111.	78.36	74.73	36.27	1315.38
59	48.	75.32	78.36	-30.36	921.65
60	121.	79.89	75.32	45.68	2086.41
61	141.	86.00	79.89	61.11	3734.37
62	138.	91.20	86.00	52.00	2703.85
63	66.	88.68	91.20	-25.20	635.10
64	98.	89.61	88.68	9.32	86.84
65	87.	89.35	89.61	-2.61	6.83
66	66.	87.02	89.35	-23.35	545.30
			4078.82		74087.

THE ROOT MEAN SQUARE ERROR = 34.02
THE MEAN SIGNED ERROR = 4.16

FORECAST FOR 10 PERIODS AHEAD IS 87.017

THE ALPHA VALUE USED IS:0.100
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DOUBLE EXPONENTIAL SMOOTHING

PERIOD	ACTUAL	DES	EA	FR	FORECAST	RESIDUAL	RESIDUAL-SQ
0	0.	60.00	UUUUUUUU	UUUUUUUU	0.00	UUUUUUUU	UUUUUUUUUUU
1	60.	60.00	60.00	0.00	0.00	UUUUUUUU	UUUUUUUUUUU
2	38.	59.78	55.82	-0.22	60.00	-22.00	484.00
3	24.	59.24	49.60	-0.54	55.60	-31.60	998.56
4	42.	58.64	47.72	-0.61	49.06	-7.06	49.84
5	39.	57.95	45.57	-0.69	47.11	-8.11	65.80
6	53.	57.34	46.43	-0.61	44.88	8.12	65.89
7	68.	56.96	50.03	-0.38	45.82	22.18	492.01
8	61.	56.69	51.81	-0.27	49.65	11.35	128.86
9	50.	56.40	51.24	-0.29	51.53	-1.53	2.35
10	42.	56.02	49.25	-0.38	50.96	-8.96	80.21
11	26.	55.42	44.53	-0.60	48.88	-22.88	523.41
12	35.	54.73	42.23	-0.69	43.93	-8.93	79.68
13	82.	54.44	49.22	-0.29	41.54	40.46	1637.31
14	42.	54.08	47.62	-0.36	48.93	-6.93	48.09
15	19.	53.44	41.89	-0.64	47.26	-28.26	798.54
16	75.	53.13	47.66	-0.30	41.25	33.75	1139.20
17	57.	52.92	49.19	-0.21	47.36	9.64	92.99
18	63.	52.86	51.65	-0.07	48.98	14.02	196.52
19	93.	53.20	59.45	0.35	51.58	41.42	1715.80
20	71.	53.66	61.92	0.46	59.79	11.21	125.55
21	46.	53.96	59.27	0.30	62.38	-16.38	268.40
22	28.	53.94	53.57	-0.02	59.57	-31.57	996.36
23	38.	53.76	50.59	-0.18	53.55	-15.55	241.72
24	42.	53.50	48.82	-0.26	50.42	-8.42	70.85
25	132.	54.08	64.41	0.57	48.56	83.44	6962.58
26	75.	54.75	66.89	0.67	64.99	10.01	100.28
27	0.	54.75	54.73	-0.00	67.56	-67.56	4564.78
28	75.	54.95	58.58	0.20	54.72	20.28	411.08
29	63.	55.19	59.58	0.24	58.78	4.22	17.82
30	48.	55.32	57.58	0.13	59.82	-11.82	139.82
31	142.	56.29	73.72	0.97	57.70	84.30	7105.92
32	98.	57.49	79.12	1.20	74.69	23.31	543.44
33	74.	58.63	79.12	1.14	80.32	-6.32	39.93
34	62.	59.58	76.79	0.96	80.26	-18.26	333.31
35	29.	60.05	68.48	0.47	77.74	-48.74	2375.96
36	60.	60.43	67.25	0.38	68.95	-8.95	80.12
37	108.	61.21	75.30	0.78	67.63	40.37	1629.81
38	60.	61.83	73.03	0.62	76.08	-16.08	258.63
39	3.	61.75	60.23	-0.08	73.65	-70.65	4991.18
40	58.	61.64	59.73	-0.11	60.14	-2.14	4.58
41	42.	61.36	56.28	-0.28	59.63	-17.63	310.73
42	67.	61.19	56.09	-0.17	56.00	11.00	121.09
43	121.	61.65	69.90	0.46	57.91	63.09	3979.80
44	68.	62.05	69.91	0.43	70.36	-2.36	5.57
45	47.	62.28	65.91	0.20	70.35	-23.35	545.03

46	79.	62.61	68.56	0.33	66.11	12.89	166.11
47	34.	62.60	62.26	-0.02	68.89	-34.89	1217.36
48	45.	62.40	58.97	-0.19	62.24	-17.24	297.32
49	131.	62.94	72.50	0.53	58.78	72.22	5216.34
50	97.	63.71	77.58	0.77	73.03	23.97	574.58
51	28.	63.97	68.79	0.27	78.35	-50.35	2535.62
52	48.	64.03	65.05	0.06	69.05	-21.05	443.31
53	76.	64.20	67.18	0.17	65.11	10.89	118.56
54	54.	64.23	64.81	0.03	67.35	-13.35	178.11
55	167.	65.28	84.25	1.05	64.84	102.16	10436.16
56	63.	66.11	81.07	0.83	85.31	-22.31	497.57

57	85.	66.98	82.49	0.86	81.90	3.10	9.62
58	111.	68.11	88.60	1.14	83.35	27.65	764.53
59	48.	68.83	81.81	0.72	89.74	-41.74	1742.37
60	121.	69.94	89.84	1.11	82.53	38.47	1479.81
61	141.	71.55	100.46	1.61	90.95	50.05	2505.38
62	138.	73.51	108.89	1.97	102.06	35.94	1291.50
63	66.	75.03	102.33	1.52	110.86	-44.86	2012.08
64	98.	76.49	102.74	1.46	103.85	-5.85	34.23
65	87.	77.77	100.93	1.29	104.20	-17.20	295.75
66	66.	78.70	95.34	0.92	102.22	-36.22	1311.62
					4256.566		77951.

THE ROOT MEAN SQUARE ERROR = 34.11
THE MEAN SIGNED ERROR = 1.42

FORECAST FOR 10 PERIODS AHEAD IS 104.578

THE ALPHA VALUE USED IS:0.100
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TRIPLE EXPONENTIAL SMOOTHING

PERIOD	ACTUAL	TES	TA	TB	TC	FORECAST	RESIDUAL	RESIDUAL-SQ
0	0.	60.00	UUUUUUUU	UUUUUUU	UUUUUUU	0.00	UUUUUUUU	UUUUUUUUUUU
1	60.	60.00	60.00	-0.00	0.00	0.00	UUUUUUUU	UUUUUUUUUUU
2	38.	59.98	54.06	-0.63	-0.02	60.00	-22.00	484.00
3	24.	59.90	45.51	-1.49	-0.05	53.42	-29.42	865.65
4	42.	59.78	43.53	-1.59	-0.05	43.99	-1.99	3.97
5	39.	59.59	41.21	-1.73	-0.06	41.91	-2.91	8.45
6	53.	59.37	43.22	-1.39	-0.04	39.46	13.54	183.44
7	68.	59.13	48.98	-0.68	-0.02	41.81	26.19	686.09
8	61.	58.88	51.81	-0.33	-0.00	48.29	12.71	161.44
9	50.	58.64	51.15	-0.36	-0.00	51.48	-1.48	2.18
10	42.	58.37	48.48	-0.61	-0.01	50.78	-8.78	77.10
11	26.	58.08	42.04	-1.24	-0.03	47.86	-21.86	477.96
12	35.	57.74	39.34	-1.43	-0.04	40.78	-5.78	33.46
13	82.	57.41	49.93	-0.20	0.00	37.89	44.11	1946.08
14	42.	57.08	47.72	-0.41	-0.00	49.72	-7.72	59.67
15	19.	56.72	39.76	-1.21	-0.03	47.31	-28.31	801.54
16	75.	56.36	48.51	-0.19	0.01	38.53	36.47	1329.77
17	57.	56.01	50.75	0.07	0.02	48.32	8.68	75.34
18	63.	55.70	54.20	0.44	0.03	50.83	12.17	148.02
19	93.	55.45	65.06	1.57	0.07	54.65	38.35	1470.49
20	71.	55.27	67.84	1.77	0.07	66.67	4.33	18.75
21	46.	55.14	63.24	1.17	0.05	69.65	-23.65	559.10
22	28.	55.02	54.58	0.18	0.01	64.43	-36.43	1327.41
23	38.	54.89	50.27	-0.28	-0.01	54.77	-16.77	281.38
24	42.	54.75	47.87	-0.51	-0.01	49.93	-7.93	63.75
25	132.	54.69	70.26	1.89	0.07	47.35	84.65	7165.17
26	75.	54.69	72.89	2.05	0.07	72.19	2.81	7.91
27	0.	54.70	54.66	-0.02	-0.00	74.98	-74.98	5621.85
28	75.	54.72	60.14	0.56	0.02	54.64	20.36	414.41
29	63.	54.77	61.30	0.65	0.02	60.71	2.29	5.23
30	48.	54.82	58.16	0.27	0.01	61.96	-13.96	194.95
31	142.	54.97	80.97	2.66	0.09	58.43	83.57	6983.51
32	98.	55.22	87.41	3.15	0.11	83.68	14.32	205.14
33	74.	55.56	85.96	2.78	0.09	90.62	-16.62	276.23
34	62.	55.97	81.37	2.09	0.06	88.78	-26.78	717.28
35	29.	56.37	68.61	0.59	0.01	83.50	-54.50	2969.74
36	60.	56.78	66.60	0.32	-0.00	69.21	-9.21	84.75
37	108.	57.22	77.91	1.48	0.04	66.93	41.07	1687.09
38	60.	57.68	74.01	0.95	0.02	79.41	-19.41	376.67
39	3.	58.09	55.40	-1.09	-0.05	74.97	-71.97	5179.85
40	58.	58.45	55.23	-1.05	-0.05	54.27	3.73	13.88
41	42.	58.74	50.82	-1.46	-0.06	54.14	-12.14	147.50
42	67.	58.98	54.08	-1.03	-0.05	49.33	17.67	312.33
43	121.	59.25	71.36	0.85	0.02	53.03	67.97	4619.92

44	68.	59.53	70.99	0.75	0.02	72.23	-4.23	17.86
45	47.	59.81	64.97	0.05	-0.01	71.75	-24.75	612.39
46	79.	60.09	68.73	0.43	0.01	65.02	13.98	195.51
47	34.	60.34	59.59	-0.57	-0.03	69.16	-35.16	1236.36
48	45.	60.55	55.18	-1.01	-0.04	59.00	-14.00	195.99
49	131.	60.78	74.89	1.13	0.03	54.15	76.85	5905.66
50	97.	61.08	81.60	1.75	0.05	76.04	20.96	439.44
51	28.	61.37	68.30	0.22	-0.00	83.38	-55.38	3067.13
52	48.	61.63	62.90	-0.37	-0.02	68.52	-20.52	420.94
53	76.	61.89	66.11	-0.02	-0.01	62.52	13.48	181.82
54	54.	62.12	62.76	-0.38	-0.02	66.08	-12.08	145.98

55	167.	62.44	90.58	2.57	0.08	62.37	104.63	10947.97
56	63.	62.81	84.87	1.78	0.05	93.19	-30.19	911.38
57	85.	63.22	86.08	1.78	0.05	86.68	-1.68	2.82
58	111.	63.71	93.96	2.47	0.07	87.88	23.12	534.69
59	48.	64.22	83.18	1.15	0.02	96.47	-48.47	2349.05
60	121.	64.80	94.08	2.20	0.06	84.34	36.66	1344.09
61	141.	65.47	108.16	3.52	0.10	96.31	44.69	1997.34
62	138.	66.28	118.54	4.35	0.13	111.73	26.27	689.95
63	66.	67.15	107.23	2.84	0.07	122.96	-56.96	3244.09
64	98.	68.08	106.53	2.54	0.06	110.10	-12.10	146.50
65	87.	69.05	102.82	1.94	0.04	109.09	-22.09	488.16
66	66.	70.02	94.01	0.84	-0.00	104.73	-38.78	1503.51
						4344.402		84627.

THE ROOT MEAN SQUARE ERROR = 35.54
THE MEAN SIGNED ERROR = 0.07

FORECAST FCR 10 PERIODS AHEAD IS 102.203

THE ALPHA VALUE USED IS:0.100
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TABLE D
** WINTERS METHOD **

PERIOD	ACTUAL	TREND LINE VALUE	MULT.SEAS.FACTOR
1	60.	42.0072	1.43
2	38.	42.7702	0.89
3	24.	43.5331	0.55
4	42.	44.2961	0.95
5	39.	45.0590	0.87
6	53.	45.8220	1.16
7	68.	46.5849	1.46
8	61.	47.3479	1.29
9	50.	48.1108	1.04
10	42.	48.8738	0.86
11	26.	49.6367	0.52
12	35.	50.3997	0.69
13	82.	51.16	1.60
14	42.	51.93	0.81
15	19.	52.69	0.36
16	75.	53.45	1.40
17	57.	54.21	1.05
18	63.	54.98	1.15
19	93.	55.74	1.67
20	71.	56.50	1.26
21	46.	57.27	0.80
22	28.	58.03	0.48
23	38.	58.79	0.65
24	42.	59.56	0.71

PERIOD	AVERAGE OF MULT. SEASONAL FACTORS
1	1.52
2	0.85
3	0.46
4	1.18
5	0.96
6	1.15
7	1.56
8	1.27
9	0.92
10	0.67
11	0.59
12	0.70

FORECAST BY WINTERS METHOD

THE WINTERS PARAMETERS ARE :
ALPHA = 0.10 EETA = 0.10 AND SIGMA = 0.10

PERIOD	ACTUAL	FORECAST	RESIDUAL	RESIDUAL -SQ
25	132.	UUUUUUUU	UUUUUUUU	UUUUUUUUUUUU
26	75.	54.34	20.66	426.96
27	0.	30.88	-30.88	953.86

28	75.	72.37	2.63	6.91
29	63.	59.81	3.19	10.18
30	48.	72.98	-24.98	623.84
31	142.	96.43	45.57	2076.61
32	98.	83.08	14.92	222.52
33	74.	62.01	11.99	143.75
34	62.	46.69	15.31	234.47
35	29.	42.75	-13.75	189.11
36	60.	50.17	9.83	96.63
37	108.	116.75	-8.75	76.64
38	60.	65.48	-5.48	30.05
39	3.	30.80	-27.80	772.94
40	58.	80.91	-22.91	524.84
41	42.	64.30	-22.30	497.50
42	67.	71.72	-4.72	22.23
43	121.	103.78	17.22	296.44
44	68.	83.73	-15.73	247.36
45	47.	59.39	-12.39	153.51
46	79.	42.62	36.38	1323.55
47	34.	38.17	-4.17	17.39
48	45.	47.46	-2.46	6.07
49	131.	103.83	27.17	738.38
50	97.	59.56	37.44	1401.61
51	28.	27.46	0.54	0.29
52	48.	85.41	-37.41	1399.49
53	76.	66.64	9.36	87.55
54	54.	80.91	-26.91	724.04
55	167.	117.03	49.97	2496.96
56	63.	94.59	-31.59	997.81
57	85.	66.44	18.56	344.62
58	111.	55.30	55.70	3102.82
59	48.	47.00	1.00	1.00
60	121.	60.31	60.69	3683.00
61	141.	153.20	-12.20	148.82
62	138.	89.01	48.99	2400.39
63	66.	39.34	26.66	710.54
64	98.	127.22	-29.22	854.05
65	87.	109.38	-22.38	501.01
66	66.	124.95	-58.95	3474.64
		2984.210		32020.28

THE ROOT MEAN SQUARE ERROR = 27.95

FORECAST FOR 10 PERIODS AHEAD IS 157.541

```
$JOB
C
C
C
C                               * * * * *
C                               RESTRAIN
C                               * * * * *
C
C
C           A PROGRAMME TO CONTROL MONTHLY FORECAST ERRORS
C            BY USE OF STATISTICAL CONTROL METHODS.
C
C                        -------------
C           INPUT : SIGNED FORECASTING ERRORS
C           THESE ARE CUMULATED MONTHLY. AFTER A SETTLING PERIOD
C           OF 18 MONTHS, STANDARD ERROR OF THE FORECAST IS
C           COMPUTED USING 19 MONTHS EXPERIENCE.
C           THE NUMBER OF STANDARD ERRORS TO USE IS  K  .
C
C           AT MONTH 20 A FURTHER 21 MONTHS EXPERIENCE
C           IS USED TO UPDATE THE STANDARD ERROR, AND THIS
C           CONTROLS THE REMAINDER OF THE DATA.
C           THE RELATIONSHIP BETWEEN  K TIMES STANDARD ERROR
C           AND CUMULATED ERROR IS MEASURED AND CODED :
C                 1 :  ERROR BEYOND CONTROL LIMIT.
C                 5 :  ERROR AT CONTROL LIMIT.
C                 10:  ERROR WITHIN CONTROL LIMITS.
C
C           TABLES ARE PRINTED, FROM WHICH CHARTS MAY BE DRAWN
C           TO SHOW THE PATTERN OF ERRORS.
C           IN THIS PROGRAMME  K  IS 2 BUT WIDER LIMITS MAY
C           BE INSERTED BY CHANGING ONE CARD.
C           ANY SERIES CF FORECASTING ERRORS CAN BE USED.
C
C
      DIMENSION  SOOT(70)
      DIMENSION XKERR(70), STOTER(70), TEROR(70)
      DIMENSION KEROR(70), MTOTER(70), SEANER(70),XKRSQ(70),
     1 TAVER(70),  STDER(70),  UCL(70), TABS(70), NA(70)
      READ, ML
C           NUMBER OF SETS OF DATA BEING STUDIED.
      DO 100  L=1, ML
      READ, N
C           NUMBER OF PERIODS PER SET OF DATA.
       IF(L.EQ.  1)  PRINT  60
       IF(L.EQ.  2)  PRINT  61
       IF(L.EQ.  3)  PRINT  62
       IF(L.EQ.  4)  PRINT  63
       IF(L.EQ.  5)  PRINT  64
```

```
      IF(L.EQ.  6)  PRINT  65
      IF(L.EQ.  7)  PRINT  66
      IF(L.EQ.  8)  PRINT  67
      IF(L.EQ.  9)  PRINT  68
      IF(L.EQ. 10)  PRINT  69
      IF(L.EQ. 11)  PRINT  70
 60  FORMAT('1', 50X,'SIMPAVE SIMPLE FORECASTING.'/)
 61  FORMAT('1', 47X,'LASTAVE SIMPLE FORECASTING.'/)
 62  FORMAT('1', 47X,'LINFOR SIMPLE FORECASTING.'/)
 63  FORMAT('1', 47X,'MOVAVE MOVING AVERAGE FORECASTING.'/)
 64  FORMAT('1', 45X,'MOVETREND SIMPLE FORECASTING.'/)
```

```
   65 FORMAT('1', 47X,'EXPON. SINGLE SMOOTHING.'/)
   66 FORMAT('1', 45X,'EXPON. SEASONAL FORECASTING.'/)
   67 FORMAT('1', 44X,'EXPON. HIGH ALPHA SINGLE SMOOTHING.'/)
   68 FORMAT('1', 48X,'EXPON. DOUBLE SMOOTHING.'/)
   69 FORMAT('1', 48X,'EXPON. TRIPLE SMOOTHING.'/)
   70 FORMAT('1', 48X,'WINTERS SEASONAL METHOD.'/)
      PRINT 41
   41 FORMAT('0',40X,'CONTROL BY STANDARD ERRORS OF FORECAST ERRORS.'/
     1 44X,'FROM FORECASTING METHOD MENTIONED ABOVE.'/)
      PRINT 42
   42 FORMAT('0',38X,'PERIOD  SIGNED  CUMULATIVE  STANDARD CONTROL  ACT
     1ION'/48X,'ERROR     ERROR     ERROR    LIMITS   CODE'/39X,
     2  26('- ')/)
      READ 1, (KEROR(I), I=1,N)
    1 FORMAT(12I6)
C               THESE ARE THE SIGNED ERROR DATA.
      K=2
C               THE NUMBER CF STANDARD ERRORS FOR CONTROL
C               PURPOSES.  THIS IS A MANAGEMENT DECISION.
C
      MTOTER(1)  =  KEROR(1)
      DO 2  I=2,19
      MTOTER(I)  =   (MTOTER(I-1) + KEROR(I) )
      STOTER(I) = MTOTER(I)
      SOOT(I) = ABS(STOTER(I) )
      TERCR(I) = KEROR(I)
    2 CONTINUE
C
C               THIS PROVIDES A RUN OF CUMULATED ERRORS.
C               CONTROLS BEGIN FROM MONTH NINETEEN.
C
      SEANER(19) = STOTER(19)/18.
      TAVER(19)= TEROR(19)-(SEANER(19))
      XKRSQ(19)= (TAVER(19)**2)
      XKERR(19)  = XKRSQ(19)/18.
       STDER(19)= SQRT(XKERR(19))
C
C               THIS IS THE STANDARD ERROR AT MONTH  I
      DO 75  I=20,N
      MTOTER(I)  = MTOTER(I-1) + KEROR(I)
      STOTER(I)  =  MTOTER(I)
      SOOT(I) = ABS(STOTER(I) )
      TEROR(I) = KEROR(I)
   75 CONTINUE
      DO 3 I=19, 39
       UCL(I) =  K*STDER(19)
      STDER(I)  = STDER(19)
C
C               UPPER AND LCWER CONTROL LIMIT SET IN
```

```
C                     TERMS OF ONE STANDARD ERROR TIMES  K
C
            TABS(I) = ABS (UCL(I))
            IF (SOOT(I) .GT. TABS(I) )  GO TO 10
            IF (SOOT(I) .EQ. TABS(I) )  GO TO 15
            IF (SOOT(I) .LT. TABS(I) )  GO TO 20
   10       NA(I) = 1
            GO TO 25
   15       NA(I) = 5
            GC TO 25
   20       NA(I) = 10
```

```
   25  CONTINUE
   3  CONTINUE
       SEANER(40) = STOTER(40)/21.
       TAVER(40) = TEROR(40) - SEANER(40)
       XKRSQ(40) = (TAVER(40) **2)
       XKERR(40) = XKRSQ(40) /21.
       STDER(40)  = SQRT(XKERR(40))
C               THIS IS THE STANDARD ERROR FOR MONTHS
C               41 TO THE END OF THE SERIES.
       DO 80  I=40,N
       UCL(I) = K *STDER(40)
       STDER(I)  = STDER(40)
       TABS(I) = ABS(UCL(I))
       IF (SOOT(I) .GT. TABS(I) )  GO TO 90
       IF (SOOT(I) .EQ. TABS(I) )  GO TO 95
       IF (SOOT(I) .LT. TABS(I) )  GO TO 97
   90  NA(I) = 1
       GO TO 98
   95    NA(I) = 5
       GO TO 98
   97  NA(I) = 10
   98  CONTINUE
   80   CONTINUE
       DO 85  I=19,N
       PRINT 30 , I, KEROR(I),  STOTER(I), STDER(I),UCL(I),NA(I)
   30  FORMAT('0',39X,I3, 2X, I7, 5X,F7.1,3X,F7.1,2X, F7.1,4X,I3)
   85  CONTINUE
       PRINT 43
   43  FORMAT('0',41X,'CODE: 1 INDICATES ERROR OUTSIDE LIMIT.'/48X,
      1 '5 INDICATES ERROR AT THE LIMIT.'/ 48X,'10 SHOWS ERROR WITHIN K L
      2IMIT.'/ 48X,16('* ')/)
  100    CONTINUE
         STOP
         END

$ENTRY
```

SIMPAVE SIMPLE FORECASTING.

CONTROL BY STANDARD ERRORS OF FORECAST ERRORS.
FROM FORECASTING METHOD MENTIONED ABOVE.

PERIOD	SIGNED ERROR	CUMULATIVE ERROR	STANDARD ERROR	CONTROL LIMITS	ACTION CODE
19	36	43.0	7.9	15.8	1
20	12	55.0	7.9	15.8	1
21	-13	42.0	7.9	15.8	1
22	-31	11.0	7.9	15.8	10
23	-19	-8.0	7.9	15.8	10
24	-15	-23.0	7.9	15.8	1
25	83	60.0	7.9	15.8	1
26	16	76.0	7.9	15.8	1
27	-60	16.0	7.9	15.8	1
28	17	33.0	7.9	15.8	1
29	5	38.0	7.9	15.8	1
30	-10	28.0	7.9	15.8	1
31	84	112.0	7.9	15.8	1
32	37	149.0	7.9	15.8	1
33	12	161.0	7.9	15.8	1
34	0	161.0	7.9	15.8	1
35	-33	128.0	7.9	15.8	1
36	-1	127.0	7.9	15.8	1
37	47	174.0	7.9	15.8	1

38	-3	171.0	7.9	15.8	1
39	-60	111.0	7.9	15.8	1
40	-3	108.0	1.8	3.6	1
41	-19	89.0	1.8	3.6	1
42	7	96.0	1.8	3.6	1

43	60	156.0	1.8	3.6	1
44	6	162.0	1.8	3.6	1
45	-13	149.0	1.8	3.6	1
46	17	166.0	1.8	3.6	1
47	-28	138.0	1.8	3.6	1
48	-17	121.0	1.8	3.6	1
49	70	191.0	1.8	3.6	1
50	34	225.0	1.8	3.6	1
51	-35	190.0	1.8	3.6	1
52	-15	175.0	1.8	3.6	1
53	13	188.0	1.8	3.6	1
54	-9	179.0	1.8	3.6	1
55	105	284.0	1.8	3.6	1
56	-1	283.0	1.8	3.6	1
57	21	304.0	1.8	3.6	1
58	46	350.0	1.8	3.6	1
59	-17	333.0	1.8	3.6	1
60	56	389.0	1.8	3.6	1
61	75	464.0	1.8	3.6	1
62	71	535.0	1.8	3.6	1
63	-3	532.0	1.8	3.6	1
64	30	562.0	1.8	3.6	1
65	18	580.0	1.8	3.6	1
66	-3	577.0	1.8	3.6	1

CODE: 1 INDICATES ERROR OUTSIDE LIMIT.

5 INDICATES ERROR AT THE LIMIT.
10 SHOWS ERROR WITHIN K LIMIT.
* * * * * * * * * * * * * * * *

EXPON. SINGLE SMOOTHING.

CONTROL BY STANDARD ERRORS OF FORECAST ERRORS.
FROM FORECASTING METHOD MENTIONED ABOVE.

PERIOD	SIGNED ERROR	CUMULATIVE ERROR	STANDARD ERROR	CONTROL LIMITS	ACTION CODE
19	38	45.0	8.4	16.7	1
20	12	57.0	8.4	16.7	1
21	-14	43.0	8.4	16.7	1
22	-30	13.0	8.4	16.7	10
23	-17	-4.0	8.4	16.7	10
24	-12	-16.0	8.4	16.7	10
25	87	71.0	8.4	16.7	1
26	14	85.0	8.4	16.7	1
27	-63	22.0	8.4	16.7	1
28	19	41.0	8.4	16.7	1
29	5	46.0	8.4	16.7	1
30	-11	35.0	8.4	16.7	1
31	84	119.0	8.4	16.7	1
32	32	151.0	8.4	16.7	1
33	5	156.0	8.4	16.7	1
34	-8	148.0	8.4	16.7	1
35	-38	110.0	8.4	16.7	1
36	4	114.0	8.4	16.7	1
37	51	165.0	8.4	16.7	1

38	-2	163.0	8.4	16.7	1
39	-60	103.0	8.4	16.7	1
40	2	105.0	0.7	1.3	1
41	-14	91.0	0.7	1.3	1
42	12	103.0	0.7	1.3	1

43	65	168.0	0.7	1.3	1
44	5	173.0	0.7	1.3	1
45	-16	157.0	0.7	1.3	1
46	18	175.0	0.7	1.3	1
47	-29	146.0	0.7	1.3	1
48	-15	131.0	0.7	1.3	1
49	72	203.0	0.7	1.3	1
50	31	234.0	0.7	1.3	1
51	-41	193.0	0.7	1.3	1
52	-17	176.0	0.7	1.3	1
53	13	189.0	0.7	1.3	1
54	-11	178.0	0.7	1.3	1
55	103	281.0	0.7	1.3	1
56	-11	270.0	0.7	1.3	1
57	12	282.0	0.7	1.3	1
58	37	319.0	0.7	1.3	1
59	-30	289.0	0.7	1.3	1
60	52	341.0	0.7	1.3	1
61	57	398.0	0.7	1.3	1
62	37	435.0	0.7	1.3	1
63	-39	396.0	0.7	1.3	1
64	-3	393.0	0.7	1.3	1
65	-14	379.0	0.7	1.3	1
66	-33	346.0	0.7	1.3	1

CODE: 1 INDICATES ERROR OUTSIDE LIMIT.

WINTERS SEASONAL METHOD.

CONTROL BY STANDARD ERRORS OF FORECAST ERRORS.
FROM FORECASTING METHOD MENTIONED ABOVE.

PERIOD	SIGNED ERROR	CUMULATIVE ERROR	STANDARD ERROR	CONTROL LIMITS	ACTION CODE
19	16	36.0	3.3	6.6	1
20	12	48.0	3.3	6.6	1
21	-36	12.0	3.3	6.6	1
22	4	16.0	3.3	6.6	1
23	2	18.0	3.3	6.6	1
24	-27	-9.0	3.3	6.6	1
25	-37	-46.0	3.3	6.6	1
26	-1	-47.0	3.3	6.6	1
27	37	-10.0	3.3	6.6	1
28	-9	-19.0	3.3	6.6	1
29	27	8.0	3.3	6.6	1
30	-50	-42.0	3.3	6.6	1
31	32	-10.0	3.3	6.6	1
32	-19	-29.0	3.3	6.6	1
33	-56	-85.0	3.3	6.6	1
34	-1	-86.0	3.3	6.6	1
35	60	-26.0	3.3	6.6	1
36	12	-14.0	3.3	6.6	1
37	-49	-63.0	3.3	6.6	1

38	-27	-90.0	3.3	6.6	1
39	29	-61.0	3.3	6.6	1
40	22	-39.0	5.2	10.4	1
41	59	20.0	5.2	10.4	1

CODE: 1 INDICATES ERROR OUTSIDE LIMIT.
5 INDICATES ERROR AT THE LIMIT.

```
$JOB          ,PAGES=400,TIME=720
C
C
C
C                              * * * * *
C                             *  INVENT  *
C                              * * * *
C
C                     INVENTORY CONTROL SIMULATION
C
C                              W.R.CROWE
C
C                            * * * * * *
C
C     THIS PROGRAMME TESTS THE EFFECT OF DIFFERENT ORDER
C     QUANTITY AND ORDER POINT VALUES, USING ITERATED ORDERING
C     AND HOLDING COST VALUES, AND A VARIETY OF SERVICE LEVELS.
C
C                              DICTIONARY
C                             * * * * * *
C
C     ALT    LEAD TIME IN MONTHS
C     ANDEM  LATEST 12 MONTH DEMAND OR FORECAST
C     BETA   NOT USED
C     BFR    3RD PROCEDURE SAFETY STOCKS
C     BMAD   3RD PROCEDURE AVERAGE ABSOLUTE ERROR
C     CORDER COST TO PLACE ONE ORDER
C     DATES  PERIOD OF DATA
C     ECQ    3RD PROCEDURE ECON.ORDER QUANTITY
C     ECONO  E.O.C.FOR SECOND PROCEDURE
C     EOQ    OPTIMAL ORDER QUANTITY, PROCEDURE 1
C     HCOST  COST OF STORAGE
C     HOSP   NAME AND CODE NUMBER OF ITEM
C     LTFOR  FORECAST OVER LEAD TIME
C     PRICE  RECENT AVERAGE PRICE
C     ROP    REORDER POINT
C     RP     3RD PROCEDURE REORDER POINT
C     SAFACT SAFETY FACTOR
C     SFA    3RD PROCEDURE SAFETY FACTOR
C     SFC    3RD PROCEDURE SERVICE FUNCTION
C     SLEVEL SERVICE LEVEL
C     SVFUNC SERVICE FUNCTION
C
C                              DATA ENTRY
C                             * * * * * *
C
C     ML     NUMBER OF SETS OF DATA
C     KS     NUMBER OF SERVICE LEVELS
C     SLEVEL ACTUAL SERVICE LEVELS
```

```
C                    IL      NUMBER OF LEAD TIMES
C                    ALT     ACTUAL LEAD TIMES
C                    IN      NUMBER OF ORDER COSTS
C                    CORDER  ORDERING COSTS
C                    KN      NUMBER GF HOLDING COSTS
C                    HCOST   ACTUAL HOLDING COSTS
C                    HOSP    DETAILS OF ITEM
C                    DATES   PERICD
C                    N       NUMBER OF DATA POINTS IN A SET
C                    Y       ACTUAL DATA VALUES
C                    NM      NUMBER OF ALPHAS
```

```
C                 ALPHA
C                 IB      LOOP FOR BETA
C                 BETA
C                 ID      NUMBER OF FORECASTS
C                 ANDEM   ANNUAL DEMAND FORECASTS
C                 PRICE   COST PRICE OF ITEM
C                 BMAD    M.A.D. FOR EACH FORECAST METHOD
C
      DIMENSION  FORX(100),ALPHA(10),AMAD(100),SLEVEL(10),SVFUNC(10),
     1 SAFACT(10),BUFR(10),ROP(10),Y(100),CORDER(10),HCOST(10),LTFOR(10)
      DIMENSION EOQ(10,10,10),         HOSP(20),DATES(20),ALT(10),
     1 AMADLT(10),BETA(10),HCO(10), ANDEM(10)
      DIMENSION BMAD(10),SFC(20),BFR(10),SFACT(10),RP(10)
C
      READ,ML
C
C                 THE SAME RANGE OF SERVICE LEVELS AND LEAD TIMES ARE
C                 USED FOR EACH SET OF DATA. ONE PRICE PER DATA SET
C                 IS USED.
       DO 300 JM=1,ML
      PRINT 20
   20 FORMAT('1', 33X,'**************'/38X,'INVENT'/38X,'******'/)
      PRINT 5,JM
    5 FORMAT  ('0',29X,'ANALYSIS FOR ITEM :' ,I3/30X,'* * * * * * * * *
     1* * * '/)
       IF (JM.NE.4) GO TO 73
       IF (JM.EQ.4) PRINT 72
   72 FORMAT('0',18X,'THE FORECAST FOR THIS ITEM IS BASED UPON'/18X,'THE
     1 YEAR BEFORE LAST DATA. THIS WILL ALLOW'/28X,'EVALUATION OF COST I
     2MPLICATIONS OF GOOD CR BAD'/32X,'FORECASTS IN RELATION TO EOQ AND
     3ROP.'/32X,'* * * * * * * * * * * * * * * * * *'/)
   73  CONTINUE
      READ,KS
      READ, (SLEVEL(L),L=1,KS)
      READ,IL
      READ, (ALT(MM),MM=1, IL)
      READ,IN
      READ, (CORDER(I),I=1,IN)
      READ,KN
      READ, (HCOST(K),K=1,KN)
      READ 6,HOSP
    6 FORMAT (20A4)
      PRINT 7,HOSP
    7 FORMAT ('0',20A4/)
      READ 8, DATES
    8 FORMAT (20A4)
      PRINT 9,DATES
    9 FORMAT ('0',20A4)
      PRINT 12
```

```
12    FORMAT('0',31X,'THE FIRST PROCEDURE :'/ 26X,'CALCULATES E.O.Q. US
     1ING DIFFERENT'/23X,'FORECAST DEMANDS, HOLDING AND ORDER COSTS.'/
     2 23X,20('* ')/)
       M = 6
      READ,N
      READ, (Y(I),I=1,N)
      READ,NM
      READ,(ALPHA(KI),KI=1,NM)
      READ,IB
      READ,(BETA(IC),IC=1,IB)
                      READ,ID
```

```
      READ,(ANDEM(IE),IE=1,ID)
      READ,PRICE
      READ,(BMAD(IH),IH=1,ID)
      MQ=(N-13)
   75 MP=(N-19)
      SUM = 0.
      ERROR =0.
      TOTER =0.
  101 IF(N.GE.24) GO TO 102
      IF(N.LT.24) PRINT 100
  100 FORMAT ('0',25X,'FOR THE ABOVE ITEM, THERE ARE TOO FEW'/25X,'DATA
     1RECORDS FOR USEFUL E.O.Q. ANALYSIS'/25X,'* * * * * * * * * * * * *
     2 * * * * * * *'/)
      GO TO 300
  102  CONTINUE
       DO 50 K= MP,MQ
   50  SUM = SUM + Y(K)
       XBAR = SUM/7.
       DO 51 K=MP,MQ
       ERRCR = Y(K) - XBAR
   51  TOTER = TOTER + ABS(ERROR)
       AMAD(1) = TOTER/7.
C                  THIS PROVIDES A STARTING FORECAST.
C
C                         * * * * * * * * * * * * * *
C
C                              FIRST PROCEDURE
C                              * * * * * * * *
C                         ECONOMIC ORDER QUANTITY :
C                         * * * * * * * * * * * * * *
C
C                  ALL VALUES ARE CARD INPUT, EXCEPT DEMAND.
C                  THE FIRST DEMAND IS TOTAL ACTUAL DEMAND
C                  FOR THE PREVIOUS TWELVE MONTHS.
C                  THIS FIRST PROCEDURE USES ACTUAL ANNUAL DEMAND
C                  (FOR THE LATEST TWELVE MONTHS) AND A VARIETY
C                              CF FORECASTING TECHNIQUES.
C
C                      FIRST ITEM : FACE TISSUES
C
C                      - - - - - - - - - - - - -
C
C                         ANDEM1  ACTUAL 12 MONTHS DEMAND
C                         ANDEM2  SIMPAVE
C                         ANDEM3  LASTAVE
C                         ANDEM4  MOVETREND
C                         ANDEM5  BOX-JENKINS
C                         ANDEM6  EXPONENTIAL:SINGLE SMOOTHING
C                         ANDEM7  COMPARE: DOUBLE SMOOTHING  .1
C                         ANDEM8  COMPARE: TRIPLE SMOOTHING .1
```

```
C                  ANDEM9  BRUSIM: NO TREND
C                  ANDEM10 BRUSIM: ADAPTIVE
C
C
C              SECONC ITEM : SEASONAL PATTERN
C
C              - - - - - - - - - - - - - - -
C                  ANDEM1  ACTUAL 12 MONTHS DEMAND
C                  ANDEM2  SIMPAVE
C                  ANDEM3  LINFOR
C                  ANDEM4  MOVAVE
```

```
C                                 ANDEM5   SEASONAL
C                                 ANDEM6   SINGLE SMOOTHING
C                                 ANDEM7   COMPARE REGRESSION
C                                 ANDEM8   WINTERS SEASONAL
C                                 ANDEM9   BRUSIM NOTREND
C                                 ANDEM10  BRUSIM TREND
C
C
C                             THIRD ITEM : GYPSONA BANDAGE
C                             - - - - - - - - - - - - - -
C
C
C                                 ANDEM1    ACTUAL 12 MONTH DEMAND
C                                 ANDEM2    EXPONENTIAL: SINGLE SMOOTHING
C                                 ANDEM3    EXPONENTIAL: TREND ADJUSTED
C                                 ANDEM4    EXPONENTIAL: DOUBLE SMOOTHING
C                                 ANDEM5    BRUSIM: TREND ADJ. ALPHA = 0.3
C                                 ANDEM6    BRUSIM: ADAPTIVE FORECASTING
C                                 ANDEM7    EXPONENTIAL: SEASONAL
C                                 ANDEM8   LINFOR
C                                 ANDEM9   MOVAVE
C                                 ANDEM10  MOVETREND
C
C
        IT=ID
        DC 10 J=1,IT
       DO 10 I=1,IN
        DO 10 K=1,KN
         HCO(K) = (HCOST(K) * PRICE)
          IF ( HCO(K) .LT.0.01)  HCO(K) = 0.01
       IF (ANDEM(J).LT. 1. ) ANDEM(J)=1.
       EOQ(J,I,K)=SQRT((2.0* ANDEM(J) *CORDER(I)) /(HCO(K)))
   10   CONTINUE
        DO 141 J=1,IT
       PRINT 130, ANDEM(J),PRICE
  130  FORMAT(/23X,'THE E.O.Q. WITH ANNUAL DEMAND OF :',F8.0/33X,'AND PRI
      1CE CF :',F7.2/40X,'AND'/)
       PRINT 296,J
  296  FORMAT('0', 22X,'USING FORECASTING METHOD',I3,1X,'FOR ANNUAL DEMAN
      1D:'/)
       PRINT 127,(HCOST(K),K=1,KN)
  127  FORMAT(7X,'URDER/HOLDING''',3X,F6.2,9X,F6.2,9X,F6.2,19X,F6.2)
        DO 141 I=1,IN
       PRINT 88, CORDER(I),(EOQ(J,I,K),K=1,KN)
   88  FORMAT ( 5X,F7.2,4X,5F15.2/30X,'* * * * * * * * * * * *'/)
  141  CONTINUE
C
C                                 * * * * * * * * * * * *
C
```

```
C                       SECOND PROCEDURE
C                       * * * * * * * *
C
C                     REORDER POINT SYSTEM
C                     --------------------
C                    * * * * * * * * * * * *
C
C       * (A) * NORMAL DEMAND PATTERN, LEAD TIME OF 1 *
C                      * * * * * * * * *
C
C       FOR THIS STAGE, NORMAL DEMAND ASSUMED.  TO REDUCE THE
```

```
C
C              OUTPUT.HOLDING COST IS TAKEN AS 24 PERCENT OF PRICE.
C              AND ORDER COST $20.00. THESE VALUES COULD BE CHANGED
C              IN THE EOQ FORMULA BELOW. THE ANNUAL DEMAND FORECAST
C              IS BASED UPON SIMPLE EXPONENTIAL SMOOTHING WITH
C              SELECTED SMOOTHING CONSTANTS. OVERALL MEAN ABSOLUTE
C              DEVIATION IS PRINTED AFTER EACH ITERATION.
C
C
      PRINT 15
   15 FORMAT('1',36X,'THE SECOND PROCEDURE :'/35X,'REORDER POINT CALCULA
     1TION.'/ 31X,'SMOOTHING CONSTANTS ITERATED;'/ 34X,'HOLDING AND ORDE
     2R COSTS FIXED.'//35X,'LEAD TIME IS CONSTANT: 1'/35X,13('- ')/)
       FORX(MQ)=XBAR
       MR = (MQ+1)
      MS =(N-5)
       DO 4 KI= 1,NM
      STDEV = 0.
      YRFORX= 0.
      ERRCR = 0.
      TOTER = 0.
      CUMER = 0.
       PRZ = 0.
       AHP = 0.
      PRINT 202,KI
  202 FORMAT ('0',36X,'ITERATION NUMBER',    I3/37X,'********************
     1'/)
      PRINT 19,ALPHA(KI)
   19 FORMAT('0',34X,'THE ALPHA VALUE IS: ',F5.2)
      AMAD(MQ)=AMAD(1)
       DO 60 K= MR,N
C
C              FORECAST FOR MOST RECENT 13 MONTHS:
C
      FORX(K) =(ALPHA(KI)* Y(K)) + ((1.-ALPHA(KI)) * FORX(K-1))
      ERROR = (Y(K)-FORX(K))
      AMAD(K)= (ALPHA(KI) *ABS(ERROR)) +((1.-ALPHA(KI)) * AMAD(K-1))
      TOTER =TOTER +ABS(ERROR)
   60 CONTINUE
      DO 81 K= MS,N
   81 YRFORX = YRFORX+ FORX(K)
      CONTINUE
C
C              DEMAND FORECAST FOR NEXT YEAR (THE TWELVE MONTHS
C              FOLLOWING THOSE FOR WHICH WE HAVE DATA),ASSUMING
C              NO TREND IS (TWICE SUM OF PAST SIX MONTHS DEMAND)
C
      CUMER =TOTER/13.
      YRDEV =YRFORX * 2.
       PRZ = (PRICE * 0.24)
```

```
110            IF ( PRZ .LT. 0.01)  PRZ = 0.01
       C                E.O.Q. USES FIXED VALUES EXCEPT FOR DEMAND: YRDEM
       C
111           ECONQ =  SQRT((2.0 *YRDEM *20.0) / (PRZ))
112            PRINT 61, AMAD(N), YRDEM, ECONQ
113         61  FORMAT('0',29X,'MEAN ABSOLUTE DEVIATION IS: ',   F7.1//21X,'THE DE
          1MAND FORECAST FOR THE COMING YEAR IS: ',   F8.0// 31X,'THE E.O.Q.
          2USING YRDEM IS:' ,   F8.0/29X,'* * * * * * * * * * * * * * * * * *
          3 *'/)
       C
       C                            SERVICE LEVELS AND SERVICE FUNCTIONS
```

```
C
C                    SERVICE FUNCTION: THE QUANTITY OF DEMAND DURING
C                    AN ORDER CYCLE THAT IS UNFILLED, EXPRESSED IN
C                    UNITS OF MAD IN LEAD TIME:
C                       SFUNC = (EOQ/MADLT) TIMES (1 - DESIRED SLEVEL )
C
C                    SAFETY FACTOR: BASED ON NORMAL OR OTHER DISTRIBUTION.
C                    IT IS A MULTIPLIER FOR THE  NUMBER OF MAD
C                    OR STDEV TO GIVE A SPECIFIED PROBABILITY OF
C                    NOT RUNNING OUT OF STOCK.
C
C                    SERVICE LEVEL: PERCENTAGE OF DEMAND TO BE
C                    FILLED ROUTINELY FROM THE SHELF.
C
C                    USUALLY ONE SERVICE LEVEL IS CHOSEN BY MANAGEMENT.
C                    BUT FOR THIS SIMULATION A RANGE OF VALUES IS USED,
C                    INCLUDING ONE THAT IS EXCEPTIONALLY LOW, AND THE
C                    VERY HIGHEST VALUE.  ONE SERVICE FUNCTION IS COMPUTED
C                    FOR EACH SERVICE LEVEL.
C
C
C                                PARR'S APPROXIMATION TO
C                                BROWN'S SERVICE FUNCTION
C                                * * * * * * * * * * * *
C
C                    THE PROGRAMME INCLUDES A FORMULA DEVISED BY
C                    J.O.PARR: FORMULA APPROXIMATIONS TO BROWN'S
C                    SERVICE FUNCTIONS, PRODUCTION AND INVENTORY
C                    MANAGEMENT, Q1,1972,84-86, AMENDED BY W.CROWE.
C                    THE FORMULA SHOULD SUPPLY TIGHTER RESULTS THAN
C                    THE BROWN INTERPOLATION METHOD.
C
C
          PRINT 40
   40  FORMAT('0',33X,'REORDER POINT CALCULATION'/27X,'USING J.O.PARR : F
      1ORMULA APPROXIMATIONS'/32X,'TO BROWNS SERVICE FUNCTIONS'/35X,'(AME
      2NDED BY W.CROWE.)'/30X,'PRODUCTION AND INVENTORY MANAGEMENT'/37X,
      3 'Q1, 1972 : 84-86'/25X,9('_ ')/)
          PRINT 41
    41  FORMAT('0',19X,'SERVICE    SERVICE    SAFETY        BUFFER       REO
      1RDER'/21X,'LEVEL     FUNCTION    FACTOR       STOCKS        POINT'/)
          DO 78 L=1,KS
        IF (CUMER.LE.0.) CUMER =1.0
        SVFUNC(L)=(( ECONQ /AMAD(N))*( 1.-SLEVEL(L)))
C
C                    PROCESS USES MAD INSTEAD OF STD.DEV.
C
          IF (SVFUNC(L).GE.     0.0833) GO TO 23
          IF (SVFUNC(L).LT. 0.0833)GO TO 16
    16    IF (SVFUNC(L).GE. 0.0085)  GO TO 18
```

```
      IF (SVFUNC(L).LT. 0.0085)  GO TO 14
C
C           CALCULATE THE SAFETY FACTOR (K).ASSUMING MAD IS
C           NORMALLY DISTRIBUTED  : R.G.BROWN (1967)
C
   23  SAFACT(L)= 1000/(133.2+(86.72*SQRT(SVFUNC(L))))- 5.32
      GO TO 28
   18  SAFACT(L)= 1000/(247.9 +(748.3 *SQRT(SVFUNC(L)))) -1.156
      GO TO 28
   14  SAFACT(L)= 1000/(354.6 +(5753 *SQRT(SVFUNC(L)))) + 0.87
   28  CONTINUE
```

```
      BUFR(L)=AMAD(N) * SAFACT(L)
C
C               THIS COMPUTES THE SAFETY STOCK
C
C               NOW THE REORDER POINT:
C
      ROP(L) =BUFR(L) +FORX(N)
      PRINT 82,SLEVEL(L),SVFUNC(L),SAFACT(L),BUFR(L),ROP(L)
   82 FORMAT ('0',20X,F5.2,5X,F7.4,4X,F6.2,4X,F8.2,5X,F8.2 )
   78 CONTINUE
      PRINT 201
  201 FORMAT('0',20X,'* * * * * * * * * * * * * * * * * * * * * * * *
     1 * *'/)
C
C                          * (B) * NORMAL DEMAND PATTERN
C
C                           WITH VARIABLE LEAD TIMES
C                           USING BROWN MADLT RELATIONSHIP
C                               AND PARRS FORMULA.
C
C                           * * * * * * * * * * * * * * * *
C
      PRINT 140
  140 FORMAT('0',29X,'R.O.P. WITH VARIABLE LEAD TIMES.'/34X,'AND USING P
     1ARRS FORMULA.'/34X,'* * * * * * * * * * * *'/)
      DO 90 MM=1,IL
      PRINT 142,ALT(MM)
  142 FORMAT('0',33X,'WITH LEAD TIME OF',1X,F5.1/34X,'* * * * * * * * *
     1 * * * '/)
      PRINT 181
  181 FORMAT('0',19X,'SERVICE     SERVICE      SAFETY        BUFFER       REO
     1RDER'/21X,'LEVEL     FUNCTION     FACTOR         STOCKS          POINT'/)
      DO 90 L=1,KS
C
C               USING BROWN APPROXIMATION OF LEAD TIME M.A.D.
C
      AMADLT(MM)=(AMAD(N)*(0.56+(0.34*ALT(MM))))
C
      IF (AMADLT(MM).LE.1.) AMADLT(MM)=1.
      SVFUNC(L) = ((ECONQ/AMADLT(MM)) * (1.-SLEVEL(L) ))
      IF(SVFUNC(L) .GE.0.0833) GO TO 91
      IF(SVFUNC(L) .LT.0.0833) GO TO 92
   92 IF(SVFUNC(L).GE.0.0085) GO TO 93
      IF(SVFUNC(L).LT.0.0085) GO TO 94
   91  SAFACT(L)=  1000/(133.2 +(86.72 *SQRT(SVFUNC(L))))-5.32
      GO TO 95
   93  SAFACT(L)=  1000/(247.9 +(748.3 *SQRT(SVFUNC(L))))-1.156
      GO TO 95
   94  SAFACT(L)=  1000/(354.6+ (5753  *SQRT(SVFUNC(L)))) +0.370
```

```
   95 CONTINUE
C
C              EXTENSION OF FORECAST THROUGH LEAD TIME.
C              IF LESS THAN ONE MONTH, ASSUME LT= 1 MONTH.
C
      BUFR(L) =AMADLT(MM)* SAFACT(L)
      LTFOR(L)=FORX(N) * ALT(MM)
      IF(ALT(MM).LT.1.0)LTFOR(L)=FORX(N)
C
      ROP(L)=BUFR(L)+LTFOR(L)
       PRINT 99,SLEVEL(L), SVFUNC(L),SAFACT(L),BUFR(L), ROP(L)
```

```
  99  FORMAT('0',20X,F5.2,5X,F7.4,4X,F6.2,4X,F8.2,5X,F8.2 )
  90   CONTINUE
      PRINT 150
 150  FORMAT ('0',20X,'* * * * * * * * * * * * * * * * * * * * * * * * *
     1* * * *'/)
   4    CONTINUE
C              THESE ARE AES.DEVIATIONS FOR EACH FORECAST METHOD.
C
C                        * * * * * * * * * * * * * * * *
C
C                              THIRD PROCEDURE
C                              * * * * * * * *
C
C                          ORDER POINT AND SAFETY STOCKS
C                      USING A VARIETY OF FORECASTING METHODS.
C                      _______________________________________
C                        * * * * * * * * * * * * * * * *
C
C               LEAD TIME IS ASSUMED TO BE 1.5 MONTHS.
C                    HOLDING AND ORDER COSTS ARE FIXED.
C             THE MONTHLY FORECAST IS ASSUMED TO BE 1/12 OF
C             THE ANNUAL FORECAST. THE FIRST ITERATION IS ACTUAL
C             DEMAND; SINCE MAD IS THEREFORE ZERO IT MUST BE
C             PROGRAMMED AS A SMALL POSITIVE VALUE
C             TO PREVENT DIVISION BY ZERO.
C
      PRINT 412
 412  FORMAT('1',36X,'THE THIRD PROCEDURE:'/26X,'E.O.Q. USING SELECTED F
     1ORECASTING METHODS,'/23X,'ITERATING ALPHAS;FIXED LEAD TIMES AND CO
     2STS.'/37X,10('* ')/)
C             ITERATE BY TYPE OF FORECAST:
      DO 305  J=1,ID
       ORD =20.00
       AHOLD= 0.24
      AHP = (AHOLD * PRICE)
      IF( AHP.LE.0.01)  AHP = 0.01
       YRDE =0.
       ECQ  =0.
       YRDE =ANDEM(J)
C             COMPUTE EOQ:
       ECQ= SQRT((2.0*YRDE*ORD) / (AHP))
      PRINT 306, J, BMAD(J), YRDE, ECQ
 306  FORMAT ('0',17X,'THE E.O.Q. USING FORECAST METHOD :',I2,1X,'AND M.
     1A.D. OF ' ,F6.1/ 20X,' WITH ANNUAL DEMAND FORECAST OF :',F7.0,1X,
     2'IS : ',F6.0/18X,29('* ')/)
       IF(J.NE.1) GO TO 330
       IF ( J.EQ.1) PRINT 332
 332  FORMAT('0',17X,'FIRST ITERATION USES ACTUAL ANNUAL DEMAND,WITH ZER
     1O ERRORS.'/18X,'M.A.D. IS TAKEN AS 0.1 BELOW TO PREVENT ZERO DIVIS
```

```
        2ION.'/)
  330     CONTINUE
          PRINT 310
  310     FORMAT('0',19X,'SERVICE     SERVICE     SAFETY       BUFFER       REOR
        1DER'/21X,'LEVEL      FUNCTION     FACTOR       STOCKS        POINT'/)
              DO 312 L=1,KS
C                        ITERATION BY SERVICE LEVELS TO CALCULATE SERVICE
C                        FUNCTION, SAFETY FACTORS AND SAFETY STOCKS: PARRS
C                        FORMULA IS AGAIN USED.
C
          IF (BMAD(J) .LT. 0.1 ) BMAD(J) = 0.1
```

```
          SFC(L)= ((ECQ/BMAD(J ))* (1.-SLEVEL(L)))
         IF(SFC(L).GE.0.0833) GO TO 323
         IF(SFC(L).LT.0.0833) GO TO 316
  316    IF(SFC(L).GE.0.0085) GO TO 318
         IF(SFC(L).LT.0.0085) GO TO 314
  323    SFACT(L)= 1000./(133.2+(86.72 * SQRT(SFC(L)))) -5.32
           GO TO 328
  318    SFACT(L)= 1000./(247.9 +(748.3 *SQRT(SFC(L)))) -1.156
           GO TO 328
  314    SFACT(L)= 1000./(354.6 +(5753. *SQRT(SFC(L)))) +0.870
  328      CONTINUE
         BFR(L) =BMAD(J ) * SFACT(L)*1.5
C                ASSUMED LEAD TIME :THIS CAN BE REPLACED IF NECESSARY.
C                REORDER POINT:
         RP(L)= BFR(L)+(YRDE /12.)
           PRINT 382, SLEVEL(L),SFC(L),SFACT(L),BFR(L),RP(L)
  382      FORMAT ('0',20X,F5.2,4X,F8.3,5X,F5.2,5X,F8.2,5X,F8.2)
  312      CONTINUE
  305      CONTINUE
  300     CONTINUE
          PRINT 301
   301    FORMAT('0',40X,'* * * * * * * * * *'/41X,'END OF SIMULATION'/41X,
        1'* * * * * * * * * *'/)
             STOP
             END

$ENTRY
```

****
INVENT
******

ANALYSIS FOR ITEM : 1
* * * * * * * * * * * *

88100010 FACE TISSUES

JAN. 1968 - FEB. 1973

THE FIRST PROCEDURE :
CALCULATES E.O.Q. USING DIFFERENT
FORECAST DEMANDS, HOLDING AND ORDER COSTS.
* * * * * * * * * * * * * * * * * * * *

THE E.O.Q. WITH ANNUAL DEMAND OF : 30218.
AND PRICE OF : 1.12
AND

USING FORECASTING METHOD 1 FOR ANNUAL DEMAND:

ORDER/HOLDING'	0.18	0.24	0.50
3.00	948.34	821.28	569.00
20.00	2448.60	2120.55	1469.16
35.00	3239.19	2805.22	1943.51

THE E.O.Q. WITH ANNUAL DEMAND OF : 20389.
AND PRICE OF : 1.12
AND

USING FORECASTING METHOD 2 FOR ANNUAL DEMAND:

ORDER/HOLDING'	0.18	0.24	0.50
3.00	778.98	674.62	467.39
20.00	2011.33	1741.86	1206.80
35.00	2660.74	2304.26	1596.44

THE E.O.Q. WITH ANNUAL DEMAND OF : 30796.
AND PRICE OF : 1.12
AND

USING FORECASTING METHOD 3 FOR ANNUAL DEMAND:

ORDER/HOLDING'	0.18	0.24	0.50
3.00	957.36	829.10	574.42
20.00	2471.91	2140.73	1483.14
35.00	3270.02	2831.92	1962.01

THE E.O.Q. WITH ANNUAL DEMAND OF : 30691.
AND PRICE OF : 1.12
AND

USING FORECASTING METHOD 4 FOR ANNUAL DEMAND:

ORDER/HOLDING•	0.18	0.24	0.50
3.00	955.73	827.69	573.44
20.00	2467.69	2137.08	1480.61
35.00	3264.44	2827.09	1958.67

THE E.O.Q. WITH ANNUAL DEMAND OF : 37563.
AND PRICE OF : 1.12
AND

USING FORECASTING METHOD 5 FOR ANNUAL DEMAND:

ORDER/HOLDING•	0.18	0.24	0.50
3.00	1057.33	915.67	634.40
20.00	2730.01	2364.26	1638.01
35.00	3611.47	3127.62	2166.88

THE E.O.Q. WITH ANNUAL DEMAND OF : 29514.
AND PRICE OF : 1.12
AND

USING FORECASTING METHOD 6 FOR ANNUAL DEMAND:

ORDER/HOLDING•	0.18	0.24	0.50
3.00	937.23	811.66	562.34
20.00	2419.91	2095.70	1451.94
35.00	3201.24	2772.35	1920.74

THE E.O.Q. WITH ANNUAL DEMAND OF : 28825.
AND PRICE OF : 1.12
AND

USING FORECASTING METHOD 7 FOR ANNUAL DEMAND:

ORDER/HOLDING•	0.18	0.24	0.50
3.00	926.22	802.13	555.73
20.00	2391.49	2071.09	1434.90
35.00	3163.65	2739.80	1898.19

THE E.O.Q. WITH ANNUAL DEMAND OF : 30211.
AND PRICE OF : 1.12
AND

USING FORECASTING METHOD 8 FOR ANNUAL DEMAND:

ORDER/HOLDING'	0.18	0.24	0.50
3.00	948.23	821.19	568.94
20.00	2448.31	2120.30	1468.99
35.00	3238.82	2804.90	1943.29

THE E.O.Q. WITH ANNUAL DEMAND OF : 27532.
AND PRICE OF : 1.12
AND

USING FORECASTING METHOD 9 FOR ANNUAL DEMAND:

ORDER/HOLDING'	0.18	0.24	0.50
3.00	905.21	783.93	543.13
20.00	2337.24	2024.11	1402.34
35.00	3091.88	2677.65	1855.13

THE E.O.Q. WITH ANNUAL DEMAND OF : 30063.
AND PRICE OF : 1.12
AND

USING FORECASTING METHOD 10 FOR ANNUAL DEMAND:

ORDER/HOLDING'	0.18	0.24	0.50
3.00	945.90	819.18	567.54
20.00	2442.31	2115.10	1465.39
35.00	3230.87	2798.02	1938.52

THE SECOND PROCEDURE :
REORDER POINT CALCULATION.
SMOOTHING CONSTANTS ITERATED;
HOLDING AND ORDER COSTS FIXED.

LEAD TIME IS CONSTANT: 1
- - - - - - - - - - - - -

ITERATION NUMBER 1
****

THE ALPHA VALUE IS: 0.10

MEAN ABSOLUTE DEVIATION IS: 257.1

THE DEMAND FORECAST FOR THE COMING YEAR IS: 28975.

THE E.O.Q. USING YRDEM IS: 2076.
* * * * * * * * * * * * * * * * * * *

RECRDER POINT CALCULATION
USING J.O.PARR : FORMULA APPROXIMATIONS
TO BROWNS SERVICE FUNCTIONS
(AMENDED BY W.CROWE.)
PRODUCTION AND INVENTORY MANAGEMENT
Q1, 1972 : 84-86
- - - - - - - - -

SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	0.8077	-0.07	-17.88	2380.34
0.95	0.4038	0.23	58.18	2456.39
0.98	0.1615	0.67	171.38	2569.60
0.99	0.0808	1.02	261.00	2659.22
1.00	0.0000	3.69	948.66	3346.88

* *

R.O.P. WITH VARIABLE LEAD TIMES,
AND USING PARRS FORMULA.
* * * * * * * * * * * *

WITH LEAD TIME OF 0.5
* * * * * * * * * * * *

SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT

0.90	1.1064	-0.86	-162.16	2235.84
0.95	0.5532	-0.26	-49.14	2348.86
0.98	0.2213	0.43	80.20	2478.20
0.99	0.1106	0.85	159.73	2557.73
1.00	0.0000	3.69	692.52	3090.52

WITH LEAD TIME OF 1.0
* * * * * * * * * * * *

SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	0.8974	-0.68	-156.52	2241.48
0.95	0.4487	-0.09	-21.37	2376.63
0.98	0.1795	0.56	130.60	2528.60
0.99	0.0897	0.96	222.64	2620.64
1.00	0.0000	3.69	853.80	3251.80

WITH LEAD TIME OF 2.0
* * * * * * * * * * * *

SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	0.6514	-0.40	-127.03	4668.96
0.95	0.3257	0.15	49.01	4845.01
0.98	0.1303	0.76	241.96	5037.96
0.99	0.0651	1.12	357.84	5153.84
1.00	0.0000	3.69	1176.34	5972.34

WITH LEAD TIME OF 3.0

* * * * * * * * * * * *

SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	0.5112	-0.20	-80.08	7113.92
0.95	0.2556	0.33	133.37	7327.37

0.98	0.1022	0.89	363.11	7557.11
0.99	0.0511	1.24	504.32	7698.32
1.00	0.0000	3.69	1498.89	8692.89

*

ITERATION NUMBER 2
****

THE ALPHA VALUE IS: 0.30

MEAN ABSOLUTE DEVIATION IS: 205.0

THE DEMAND FORECAST FOR THE COMING YEAR IS: 30255.

THE E.O.Q. USING YRDEM IS: 2122.
* * * * * * * * * * * * * * * * * * *

RECRDER POINT CALCULATION
USING J.O.PARR : FORMULA APPROXIMATIONS
TO BROWNS SERVICE FUNCTIONS
(AMENDED BY W.CROWE.)
PRODUCTION AND INVENTORY MANAGEMENT
Q1. 1972 : 84-86

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SERVICE LEVEL	SERVICE FUNCTICN	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	1.0349	-0.17	-33.84	2347.01
0.95	0.5175	0.12	23.77	2404.62
0.98	0.2070	0.54	111.47	2492.32
0.99	0.1035	0.89	182.58	2563.43
1.00	0.0000	3.69	756.56	3137.41

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R.O.P. WITH VARIABLE LEAD TIMES,
AND USING PARRS FORMULA.
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WITH LEAD TIME OF 0.5
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SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT

821

0.90	1.4177	-1.09	-163.27	2216.73
0.95	0.7089	-0.47	-70.44	2309.56
0.98	0.2835	0.25	38.14	2418.14
0.99	0.1418	0.71	106.18	2486.18
1.00	0.0000	3.69	552.29	2932.29

WITH LEAD TIME OF 1.0
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SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	1.1499	-0.90	-165.89	2214.11
0.95	0.5750	-0.29	-54.21	2325.79
0.98	0.2300	0.40	74.03	2454.03
0.99	0.1150	0.83	153.12	2533.12
1.00	0.0000	3.69	680.90	3060.90

WITH LEAD TIME OF 2.0
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SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	0.8346	-0.61	-155.71	4605.29
0.95	0.4173	-0.04	-8.94	4752.06
0.98	0.1669	0.61	155.11	4916.11
0.99	0.0835	1.00	253.97	5014.97
1.00	0.0000	3.69	938.13	5699.13

WITH LEAD TIME OF 3.0

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SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	0.6550	-0.40	-130.62	7011.38
0.95	0.3275	0.15	48.46	7190.46

0.98	0.1310	0.76	244.83	7386.83
0.99	0.0655	1.12	362.73	7504.73
1.00	0.0000	3.69	1195.36	8337.36

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THE THIRD PROCEDURE:
E.O.Q. USING SELECTED FORECASTING METHODS.
ITERATING ALPHAS;FIXED LEAD TIMES AND COSTS.
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THE E.O.Q. USING FORECAST METHOD : 1 AND M.A.D. OF 0.0
WITH ANNUAL DEMAND FORECAST OF : 30218. IS : 2121.
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FIRST ITERATION USES ACTUAL ANNUAL DEMAND.WITH ZERO ERRORS.
M.A.D. IS TAKEN AS 0.1 BELOW TO PREVENT ZERO DIVISION.

SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	2120.548	-5.08	-0.76	2517.40
0.95	1060.274	-4.98	-0.75	2517.42
0.98	424.109	-4.80	-0.72	2517.45
0.99	212.055	-4.60	-0.69	2517.48
1.00	0.000	3.69	0.55	2518.72

THE E.O.Q. USING FORECAST METHOD : 2 AND M.A.D. OF 479.0
WITH ANNUAL DEMAND FORECAST OF : 20389. IS : 1742.
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SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	0.364	0.07	51.00	1750.09
0.95	0.182	0.56	399.63	2098.71
0.98	0.073	1.07	767.13	2466.22
0.99	0.036	1.40	1008.91	2707.99
1.00	0.000	3.69	2651.32	4350.40

THE E.O.Q. USING FORECAST METHOD : 3 AND M.A.D. OF 353.0

WITH ANNUAL DEMAND FORECAST OF : 30796. IS : 2141.
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SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	0.606	-0.34	-179.10	2387.23
0.95	0.303	0.21	109.24	2675.57

0.98	0.121	0.80	423.55	2989.88
0.99	0.061	1.16	613.09	3179.43
1.00	0.000	3.69	1953.90	4520.23

THE E.O.Q. USING FORECAST METHOD : 4 AND M.A.D. OF 229.0
WITH ANNUAL DEMAND FORECAST OF : 30691. IS : 2137.
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SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	0.933	-0.71	-244.28	2313.30
0.95	0.467	-0.12	-42.43	2515.16
0.98	0.187	0.54	185.29	2742.88
0.99	0.093	0.94	323.60	2881.18
1.00	0.000	3.69	1267.54	3825.12

THE E.O.Q. USING FORECAST METHOD : 5 AND M.A.D. OF 578.0
WITH ANNUAL DEMAND FORECAST OF : 37563. IS : 2364.
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SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	0.409	-0.02	-16.94	3113.31
0.95	0.205	0.48	416.03	3546.28
0.98	0.082	1.01	874.66	4004.91
0.99	0.041	1.35	1169.36	4299.61
1.00	0.000	3.69	3199.30	6329.55

THE E.O.Q. USING FORECAST METHOD : 6 AND M.A.D. OF 291.0
WITH ANNUAL DEMAND FORECAST OF : 29514. IS : 2096.
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SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	0.720	-0.48	-211.38	2248.12
0.95	0.360	0.08	34.25	2493.75
0.98	0.144	0.70	305.57	2765.07
0.99	0.072	1.07	468.19	2927.69

1.00	0.000	3.69	1610.72	4070.22

THE E.O.Q. USING FORECAST METHOD : 7 AND M.A.D. OF 363.0
WITH ANNUAL DEMAND FORECAST OF : 28825. IS : 2071.
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SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	0.571	-0.29	-156.48	2245.60
0.95	0.285	0.25	136.38	2538.46
0.98	0.114	0.83	454.15	2856.23
0.99	0.057	1.19	646.81	3048.89
1.00	0.000	3.69	2009.25	4411.33

THE E.O.Q. USING FORECAST METHOD : 8 AND M.A.D. OF 319.0
WITH ANNUAL DEMAND FORECAST OF : 30211. IS : 2120.
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SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	0.665	-0.42	-198.89	2318.70
0.95	0.332	0.14	66.38	2583.96
0.98	0.133	0.75	357.58	2875.16
0.99	0.066	1.11	532.33	3049.91
1.00	0.000	3.69	1765.70	4283.29

THE E.O.Q. USING FORECAST METHOD : 9 AND M.A.D. OF 355.0
WITH ANNUAL DEMAND FORECAST OF : 27532. IS : 2024.
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SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT

0.90	0.570	-0.29	-152.74	2141.59
0.95	0.285	0.25	133.63	2427.96
0.98	0.114	0.83	444.34	2738.67
0.99	0.057	1.19	632.73	2927.06
1.00	0.000	3.69	1964.97	4259.30

THE E.O.Q. USING FORECAST METHOD :10 AND M.A.D. OF 300.0

WITH ANNUAL DEMAND FORECAST OF : 30063. IS : 2115.
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SERVICE LEVEL	SERVICE FUNCTION	SAFETY FACTOR	BUFFER STOCKS	REORDER POINT
0.90	0.705	-0.47	-209.70	2295.55
0.95	0.353	0.09	42.54	2547.79
0.98	0.141	0.71	320.70	2825.95
0.99	0.071	1.08	487.43	2992.68
1.00	0.000	3.69	1660.53	4165.78