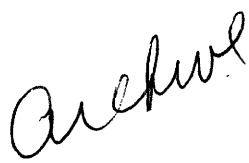

ELECTRA

Time Dependent Power Generation Operation Model
User Documentation

Susan Finger
MIT Energy Laboratory Technical Report MIT-EL 79-025
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List of Figures

Program Summary

TITLE: ELECTRA, Time Dependent Electric Power Generation Model

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PURPOSE: ELECTRA finds the net demand probability and frequency distributions from an electric utility with time dependent generators.

METHOD: The program uses convolution to find the hourly probability and frequency distributions

SCORE: The program can handle one customer hourly load curve and up to four hourly load reduction curves each with up to 8784 hours. Up to 10 cases can be run, but no one case can have more than 4 distinct units. A unit can be represented as any multiple of one of the load reduction curves. Up to 20 units can be entered.

INPUT: The program requires general information on how the output curves are to be structured, the original load curve, the load reduction curves, the unit characteristics, and the units to be included in each case.

OUTPUT: ELECTRA writes load probability and frequency curves into files to be read by SYSGEN. There are no reports.

I. Introduction

ELECTRA was written so that time dependent power generators could be included in the production costing model, SYSGEN.[1] The methodology used in ELECTRA is described in greater detail in the accompanying technical report: "Electric Power System Production Costing and Reliability."[2] There is also a third program, SCYLLA, that is run after ELECTRA and SYSGEN that evaluates the worth of the time dependent power plants to the utility system.[3]

ELECTRA models time dependent power plants as increases or decreases in the net load on the system. Up to four hourly load change curves can be entered in addition to the original customer demand curve. The hourly load curves are converted into load duration curves that represent the net load with and without the time dependent plants.

A basic assumption in ELECTRA is that the time dependent load modification does not depend on the output of the other generators. Therefore, ELECTRA can be used to model generators whose marginal cost is less than the marginal cost of all the other generators or generators with a predetermined dispatch strategy that does not depend on the other generators.

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[1]Finger, S., SYSGEN, "Production Costing and Reliability Modeling User Documentation," MIT Energy Lab Technical Report #MIT-EL 79-020, February 1979.

[2]Finger, S. "Electric Power System Production Costing and Reliability Analysis Including Hydro-electric Storage and Time Dependent Power Plants," MIT Energy Lab Technical Report #MIT-EL-79-006 February 1979.

[3]Finger, S., "SCYLLA, Time Dependent Electric Power Generation Evaluation Model, User Documentation," MIT Energy Lab Technical Report, forthcoming.

II. Operating Instructions

II.A. Time Structure

ELECTRA can have up to 8784 values in the customer demand curve and in each of the load modification curves. It is assumed that the times for the demand and the modification curves match, e.g., the first value for each curve corresponds to the first hour in the year.

There can be up to 52 output load duration curves, each with up to 100 values. The length of time represented by each load duration can be varied and all output curves do not need to represent the same length of time. Currently the output curves are created from sequential values, e.g. months. However, with slight modification, the program could create load curves for weekdays or weekends.

II.B Load Curves

The customer load curves and the load modification curves can be input either in standard EEI format or an extended format. The values are normally given hourly. If the load modifications decrease the net load on the system, then the load modifications are entered as positive numbers. If the load modifications increase the net load, then they are entered as negative numbers. Up to four load modification curves can be entered.

II.C. Unit Data

Each unit is specified by a load modification curve, a scale factor, a nominal rating, a forced outage rate and a mean time to repair. The load modification curve gives the time varying output for a nominal size generator. The scale factor is the ratio of the unit's output to the

output of the nominal size generator. For example, the first load reduction curve might represent a 100 MW solar thermal unit and first plant might be a 200 MW solar thermal unit, and be represented by twice the output of load reduction curve 1. The forced outage rate is the fraction of time that the unit is unavailable due to mechanical failure. The mean time to repair is the expected time that it takes to repair the unit after it has failed. There can be up to 20 units, but there can be at most 4 load modification curves that they reference.

II.D Case Structure

Within a single run, ELECTRA can run up to 10 cases. Each case can have up to 4 distinct units, specified by the unit index. The units can have the same unit index. All the cases within a run are based on the same customer load curve and load modification curves.

III Program Structure

III.A.1 Cumulative Load Probability Distribution (Subroutine ELECDF)

The cumulative load duration curve is created from the hourly load probability distributions. First, the probability for each load level is found using equation (76) from reference (1).

$$P_c(x) = \frac{\sum_t P_{ct}(x \mid t)}{T} \qquad (1)$$

where

$P_c(x)$ = Probability that the customer load = x

$P_{ct}(x|t)$ = Probability that the customer load = x at time t

T = length of the time period.

In creating the original customer curve, it is assumed that the customer demand is deterministic, i.e. $P_{ct}(x|t) = 1$. The load duration curve is found using the standard method of collapsing an hourly historical demand curve as shown in figure 1. Analytically, the load duration curve is found by sorting $P_c(x)$ from the smallest to largest load level and then summing:

$$F_c(y) = \sum_{x=y}^{x_{max}} P_c(x) \qquad (2)$$

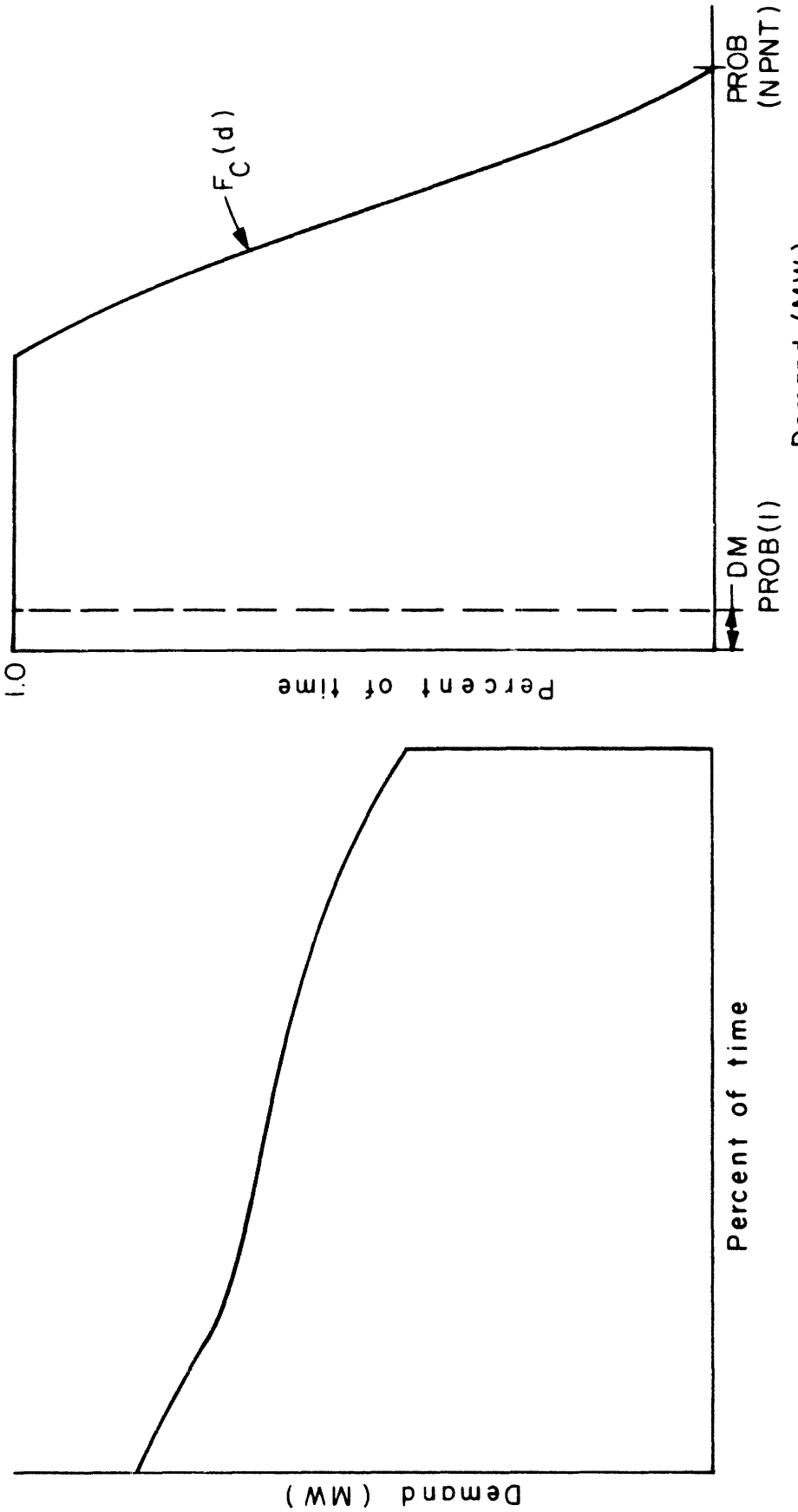
where $F_c(y)$ = load duration curve

x_{max} = peak demand.

Within the program, $F_c(x)$ must be put in the proper format for SYSGEN. The load duration curve as it is created in equation (2) can have as many entries as there are hours in the time period, and the curve is a step function. In SYSGEN, the probability curve is stored at equal intervals along the load axis and intermediate values are found using linear interpolation. In converting from the step function to a piecewise linear function, the original shape and total area should be preserved. The following algorithm is used (see figure 2 for illustration):

1) Set up the hourly values in the WORK array (done in ELESET). Sort the load in decreasing order, storing the largest value in WORK(IEND). (The sort is performed in ELECRV.)

2) Compute the load curve spacing, DM. DM = peak demand/NPNT, where NPNT is the number of points in each final load duration curve. (NPNT is input.)

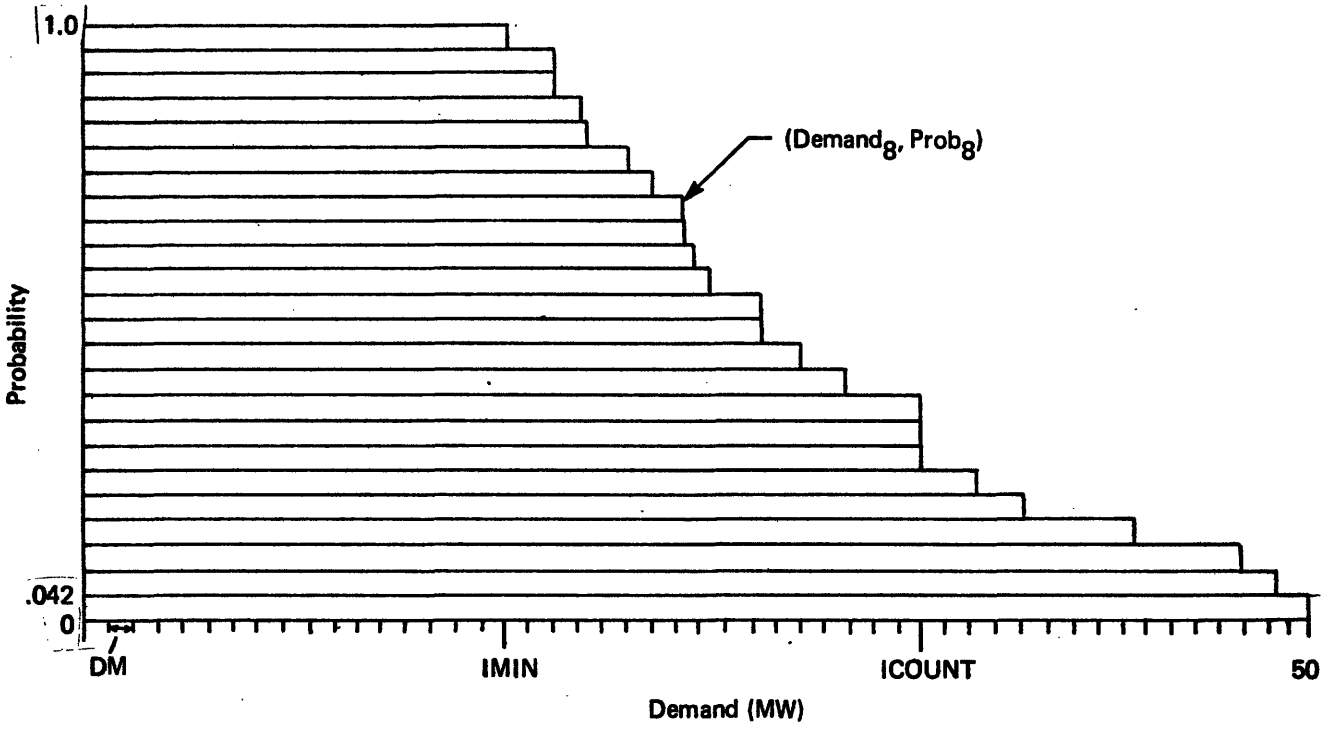


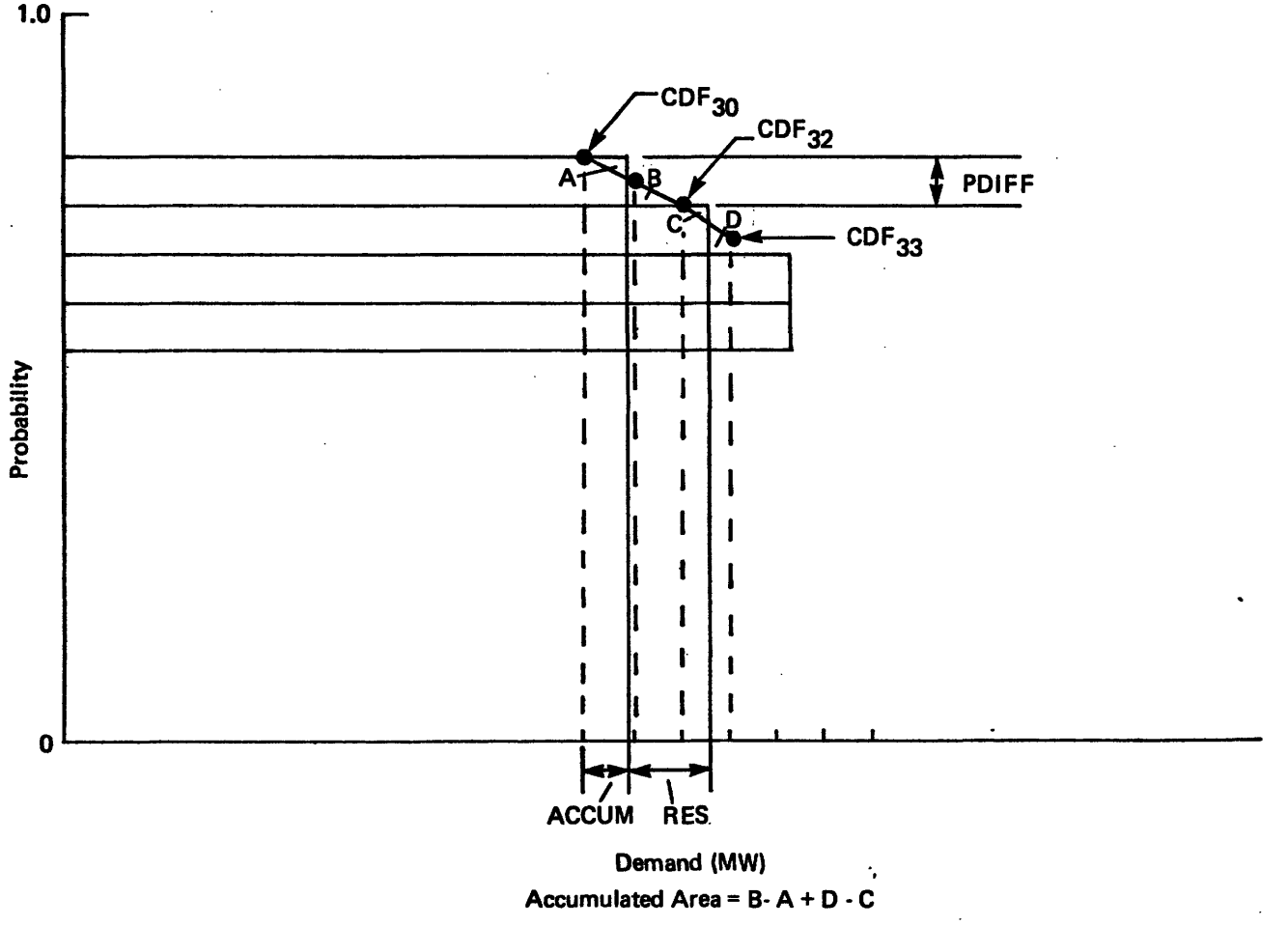
1a. Original load duration curve.

1b. Inverted load duration curve.

Figure 1. Conversion of load duration curve to cumulative probability curve.

Figure 2 CONVERSION FROM A STEP FUNCTION TO A PIECEWISE LINEAR FUNCTION





3) Set ICOUNT = the number of spacings for which the load duration curve = 1.0 (those values less than the minimum demand). Set the load duration curve, CDF, equal to 1.0 from 1 to ICOUNT.

4) Loop through the WORK array from smallest to largest (from IEND to 1) using J as the counter.

5) Compute the distance along the demand axis between WORK(J) and WORK(J + 1). Compute the integral number of spacings, INC, and the residual, RESX. If INC = 0, then go to 7.

6) Otherwise, compute the area under the curve, up to the current counter J that has not yet been included in the curve. Compute the change that must be made to PROB(J) so that all the area is accounted for. Fill in the load duration curve, CDF, and increment ICOUNT by the number of spacings found in step 5.

7) Compute the residual area from the remainder value, RESX, and PROB(J), and compute the accumulated distance along the demand axis which has not yet been included in CDF. (If the load levels are closely spaced, several may fall within an array spacing.)

8) Increment J. Go to 5 if J is less than NPNT.

9) Call the area routine from SYSGEN and compute the area under the CDF curve. Compute the difference between the true area and the actual area. Change all non-one values by the percentage error.

III.A.2 Cumulative Load Frequency Distribution (Subroutine: ELEBSE)

The load frequency curve is found by counting the number of times that the original customer load crosses a given load level. The load levels that are chosen correspond to the load levels at which the probability curve is stored. The number of counts is normalized by the number of hours in the time period. (See figure 3.) A reverse cumulative curve is then computed.

$$FQ_c(y) = \sum_{x=y}^{x_{max}} fq_c\ (x) \qquad (3)$$

where fq_c = number of times per hour the load moves from a state with the load less than x to a state with the load greater than x.

$FQ_c(x)$ = number of times per hour the load enters a state with load greater than x.

III.A.3 Hourly Unit Probability and Frequency Distributions (Subroutine: ELEPRB)

The hourly probability density function for the change in load due to time dependent sources is given in equation (74) of reference 1. Using convolution:

$$P_{Rt}\ (x|t) = p_i P'_{RT}\ (x|t) + q_i P'_{RT}\ (x-c_{it}|t) \qquad (4)$$

where $P_{Rt}\ (x|t)$ = probability that the net change in load, after plant i is added, equals x at time t

$P'_{Rt}\ (x|t)$ = probability that the net change in load, before plant i is added, equals x at time t

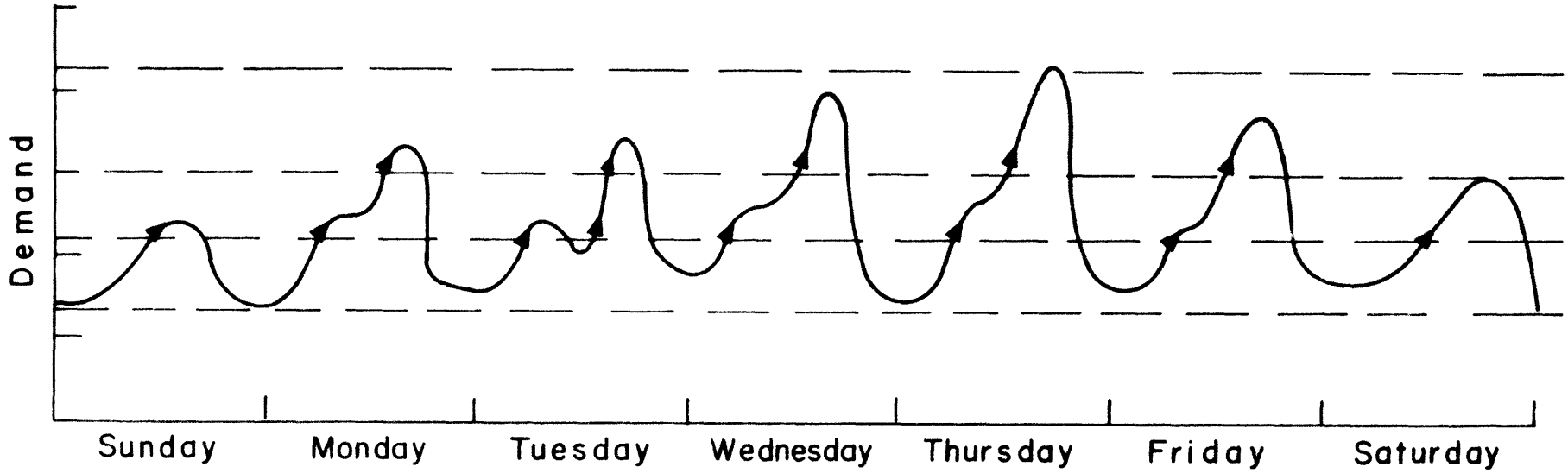


Figure 3a Weekly time dependent demand curve

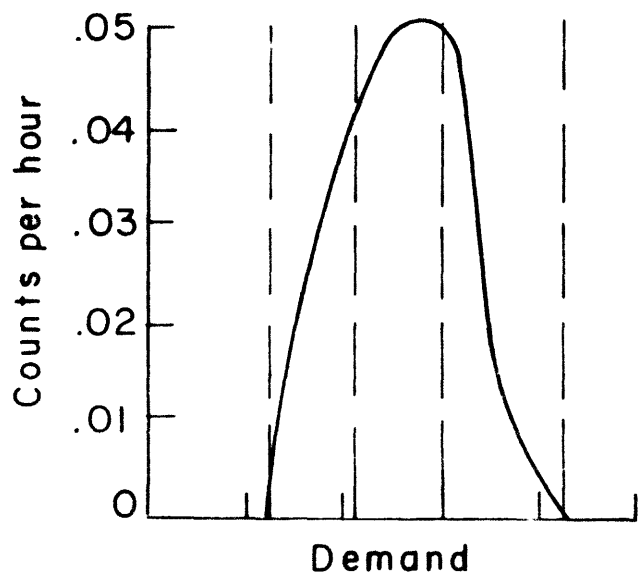


Figure 3b Frequency curve corresponding to curve 3a. The vertical axis plots the number of times the demand crosses a given level, normalized by the number of hours in a week

Figure 3 Demand frequency curve

q_i = forced outage rate of unit i (independent of time)

$p_i = 1-q_i$ = availability of unit i (independent of time)

c_{it} = power output of unit i at time t.

A similar equation exists for the frequency distribution of the change in load:

$$fq_{Rt}(x|t) = p_i\, fq'_{Rt}(x|t) + q_i\, fq'_{Rt}(x-c_{it}|t) \qquad (5)$$

$$+ \lambda_i p_i\, P'_{RT}(x|t) + \mu_i q_i\, P'_{Rt}(x-c_{it}|t)$$

where $fq_{Rt}(x|t)$ = number of times per hour that the load enters load state x (frequency that the load change equals x) at time t after unit i is added

$Fq'_{Rt}(x|t)$ = frequency that the load change equals x at time t before plant i is added

λ_i = forced outage occurence rate for unit i

μ_i = force outage restoral rate for unit i.

The probability and frequency functions for the load changes are impulse functions; that is, they have values only at discrete points and are zero otherwise. For the first unit, these distributions are:

$$P'_{Rt}(x|t) = \begin{cases} P_1 & \text{if } x = c_{t1} \\ q_1 & \text{if } x = 0 \\ 0 & \text{otherwise.} \end{cases} \qquad (6)$$

$$fq_{Rt}(x \mid t) = \begin{cases} p_1 \lambda_1 & \text{if } x = c_{t1} \\ q_1 \mu_1 & \text{if } x = 0 \\ 0 & \text{otherwise} \end{cases} \quad (7)$$

If a second unit is added, using equations (4) and (5) above, the distribution becomes:

$$P_{Rt}(x \mid t) = \begin{cases} P_1P_2 & \text{if } x = c_{t1} + c_{t2} \\ q_1p_2 & \text{if } x = c_{t2} \\ p_1q_2 & \text{if } x = c_{t1} \\ q_1q_2 & \text{if } x = 0 \\ 0 & \text{otherwise} \end{cases} \quad (8)$$

$$fq_{Rt}(x \mid t) = \begin{cases} P_1P_2[\lambda_1 + \lambda_2] & \text{if } x = c_{t1} + c_{t2} \\ q_1p_2[\mu_1 + \lambda_2] & \text{if } x = c_{t2} \\ p_1q_2[\lambda_1 + \mu_2] & \text{if } x = c_{t1} \\ q_1q_2[\mu_1 + \mu_2] & \text{if } x = 0 \\ 0 & \text{otherwise} \end{cases} \quad (9)$$

These sequences are generated in ELEPRB using a combinatorial algorithm. This algorithm is executed only once because the distribution themselves do not depend on time. However, the output of each unit and the customer load both depend on time, so ELEPRB is called for every hour to return the net load corresponding to each entry in the hourly probability and frequency arrays.

The frequency density functions are input as hourly distributions; i.e., the mean time to repair is given in hours. The probability

functions, however, have to be adjusted by the number of hours in each time period so that each hour is given equal weight and so that the sum of the probabilities of all possible states in the time period is equal to one. Therefore, whenever ELEPRB is called at the start of a new curve, the probability distribution is adjusted. The frequency distribution is also adjusted since it contains the probability distribution. This is done at the end of ELEPRB.

III.A.4. Equivalent Load Probability and Frequency Distribution

The equivalent load is the sum of the original load minus the load supplied by the time dependent power plants. The hourly distribution of the equivalent load is:

$$P_{Et}(y \mid t) = \sum_{x} P_{ct}(x \mid t)\, P_{Rt}(y-x \mid t). \qquad (10)$$

Then, the time independent distribution is:

$$P_E(y) = \sum_{t} \sum_{x} P_{ct}(x \mid t) P_{Rt}(y-x \mid t), \qquad (11)$$

and the cumulative is:

$$F_E(y) = \sum_{x=y}^{x_{max}} P_E(x) \qquad (12)$$

The cumulative distribution is converted into a linear curve using the algorithm given in section III.A.1 for the customer curve.

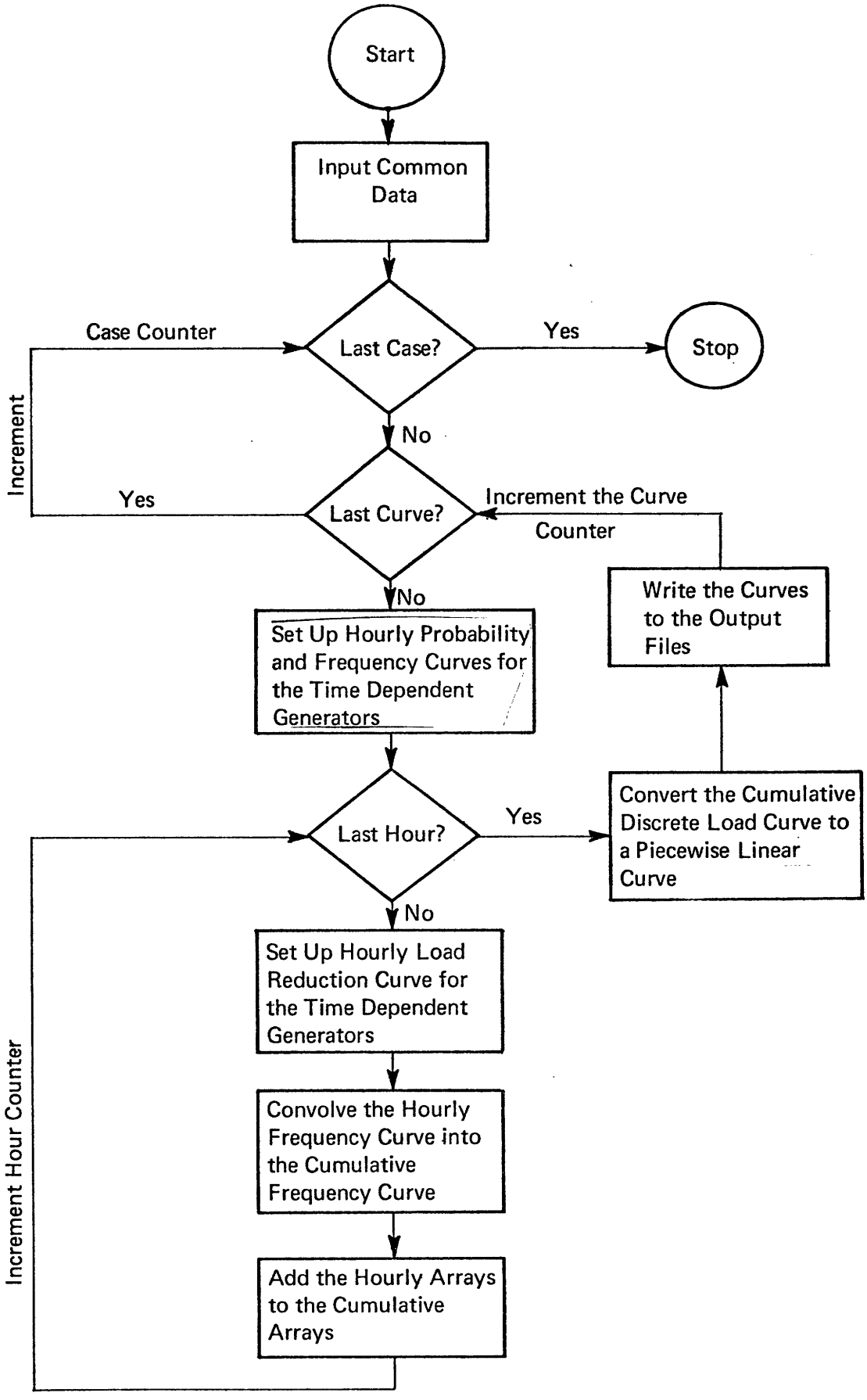
The hourly equivalent frequency curve is given by:

$$fq_{Et}(y \mid t) = \sum_{x} [P_c(x \mid t)\, fq_{Rt}(y-x \mid t) + fq_c(x \mid t)\, P_{Rt}(y-x \mid t)] \qquad (13)$$

This summations to convert fq_{Et} to a time independent cumulative are the same as for the probability distributions.

III.A.5. Transmission of Distribution Losses (Subroutine ELECTD)

ELECTD is a proxy for transmission and distribution loss and reliability analysis for decentralized generation. If the original customer demand includes demand due T&D losses, then when decentralized generation is used, these losses are not incurred. ELECTD computes the change in demand due soley to the reduction in losses. Currently the marginal loss factor is entered for five demand levels given as a percentage of the peak demand. Intermediate values are found using linear interpolation.



III. B. General Block Diagram

IV. Input File

IV.A Card Set Description

	File Unit Number	File Name	Card Number	Information to be Supplied
Input:				
	10	IGEN	A/1-5	General Information
			A/1/1	Debug options
			A/2/1	Print options
			A/2/2	Operating options
			A/2/3	Loading order option, spinning reserve
			A/2/4	Class identifiers
			A/2/5	Year dollars information
			A/2/6-9	Report headings
	10	IGEN		General Information
			B/1/1	Start, end of planning horizon
			B/2/1	Number of sub-periods, hours per week
			B/3/1-4	Number of weeks in a sub-period 13 sub-periods per card
			B/4-5	Time Dependent Unit Information
	25	ICLS	C	Class data
	11	LOADC	D	Customer Load Data
	12	LOADDD	F	Load Reduction
	13	ITD	F	T+D Data
	30	IPLNT	G	Unit Data
Output:				
	22	IBUG		ELECTRA debug file
	60-69	ICRV		Load duration curves for cases 1 to 10
	70-79	IFRQ		Frequency curves for cases 1 to 10
	80-89	ICOR		Correlation curves for cases 1 to 10

IV.B Input Format

Card	Columns	Variables	Format	Description
				Debug Option for:
A/1	42	IDEBUG (21)	L1	ELEBSE
	44	IDEBUG (22)	L1	ELECDF
	46	IDEBUG (23)	L1	ELECIN
	48	IDEBUG (24)	L1	ELECRV
	50	IDEBUG (25)	L1	ELEFRQ
	52	IDEBUG (26)	L1	ELEPRB
	54	IDEBUG (27)	L1	ELESET
A/2/1	64	MCORR	L1	If TRUE, load-generation correlation matrix is printed.
	72	MEEI	L1	If TRUE, load input is read in standard EEI format.
A/2/2	16	MFREQ	L1	If MFREQ=T, the frequency curves are computed.
A/2/3	blank card (SYSGEN information)			
A/2/4	2-5	ITDP	A4	Alpha identifier for time dependent units.
	7-10	ICHY	A4	Alpha identifier for conventional hydro unit. (See card E/2/1.) Normally set to ' CHY'.
	12-15	ISTO	A4	Alpha identifier for storage units. Normally set to ' STO'.
	17-20	IBASE	A4	Alpha identifier for base load class (see card E/2/1). Normally set to 'BASE'.
	22-25	INTR	A4	Alpha identifier for intermediate class. Normally set to 'INTR'.
	27-30	IPEAK	A4	Alpha identifier for peaking class. Normally set to 'PEAK'.
A/2/5	blank card (SYSGEN information)			

Card	Columns	Variables	Format	Description
A/2/6	2-41	TITLE(1-10)	10A4	Report Heading. A 40 character title (including blanks) to appear at the top of each page of each report.
A/2/7	2-41	TITLE(11-20)	10A4	Title Page Heading. A 40 character head to appear on the title page.
A/2/8	2-41	TITLE(21-30)	10A4	Title Page Heading. A second 40 character heading to appear on the title page.
A/2/9	2-41	TITLE(31-40)	10A4	Title Page Heading. A third 40 character heading to appear on the title page.
B/1/1	2-5	ISY	I4	Start year of planning horizon (e.g. 1985).
	7-10	IEY	I4	End year of planning horizon (e.g. 1995). (ISY $\leq$ IEY)
	12-13	NTP	I2	Number of time periods (years) in study (e.g. 10). [1 $\leq$ NTP $\leq$ 34] Note: NTP = IEY-ISY+1
	39-44	HOURS	F6.1	Number of hours in a time peiod (e.g. 8736).
	46-50	DR	F5.3	Discount rate used in present worth calculations. [DR $\geq$ 0.0]
B/2/1	2-3	NSTP	I2	Number of time sub-periods. A sub-period may represent a week, a month, a 4-week period, or any other fraction of a year. [1 $\leq$ NSTP $\leq$ 52]
	5-10	HRWEEK	F6.1	Hours in a week (e.g. 168.)
	12-15	WKDAY	A4	Alpha identifier used for reporting the length of HRWEEK (e.g. WKDAY = 'WEEK', if HRWEEK = 168.0)

Card	Columns	Variables	Format	Description
B/3/1	2-3	NWEEKS(1)	I2	Number of weeks in sub-period 1
	5-6	NWEEKS(2)	I2	Number of weeks in sub-period 2
	8-9	NWEEKS(3)	I2	Number of weeks in sub-period 3
	.	.		. . .
	.	.		. . .
	.	.		. . .
	38-39	NWEEKS(13)	I2	Number of weeks in sub-period 13
B/3/2				Same format as card B/3/1/ Information pertains to sub-periods 14-26. Used only if there are more than 13 sub-periods.
B/3/3				Same format as card B/3/1/ Information pertains to sub-periods 27-39. Used only if there are more than 26 sub-periods.
B/3/4				Same format as card B/3/1/ Information pertains to sub-periods 40-52. Used only if there are more than 39 sub-periods.
B/4	2-3	NCASE	I2	Number of runs with time dependent units [$0 \leq$ NCASE ≤ 20]
B/5/1	2-3	NOTD	I2	Number of time dependent units in the first case.
B/5/2	2-3	IDTD(1)	I2	Unit index of the first time dependent unit in case 1.

Card	Columns	Variables	Format	Description
	5-6	NPLNT(1)	I2	Number of units with index IDTD(1) in the first case.
	.	.	.	. . . .
	.	.	.	. . . .
	.	.	.	. . . .
	20-21	IDTD(4)	I2	Unit index of the fourth time dependent unit in case 1.
	23-24	NPLNT(4)	I2	Number of units with index IDTD(4) in the first case.

Cards B/5/1 and 2 are repeated for each time dependent case until NCASEs have been entered.

Group C/2 contains the class information and cross-reference table. Each unit in the system will have a class number (j) which refers to the information for the jth class, which is listed on the jth card in this group.

C/1/1	2-3	NCLASS	I2	Indicates the number of generation classes to be input. Each generation class wil occupy one card in Group 2. [1 $\leq$ NCLASS $\leq$ 34].
C/2/1	2-5	ICLASS(1,1)	A4	Class name of Class 1. Can be any character string up to 4 characters long including blanks. NOTE: For storage class ISTO must be entered in columns 2-5 (as defined on Card A/2/4).
	7-10	ICLASS(1,2)	A4	Class type of Class 1. 'BASE' = Base loaded unit. 'INTR' = Intermediate unit. 'PEAK' = Peaking unit NOTE: SYSGEN uses the class types in setting up the order under many of its loading order options.

Card sets D and E can be entered in either of two formats. If MEEI is set to true on card A/2/1, then the following format is used:

Card	Columns	Variables	Format	Description
D/1	21-25	CSTLD(1)	F5.0	Customer demand in hour 1
	26-30	CSTLD(2)	F5.0	Customer demand in hour 2
	.	.	.	. . .
	.	.	.	. . .
	.	.	.	. . .
	76-80	CSTLD(12)	F5.0	Customer demand in hour 12

Card D/1 is repeated until an entry has been made for each hour in the time period.

E/1	21-25	CRVRED(1,1)	Load change for curve 1 in hour 1.
	.	.	. . .
	.	.	. . .
	.	.	. . .
	76-80	CRVRED(1,12)	Load change for curve 1 in hour 12.

Card set E/1 is repeated until an entry has been made for each hour.

The value of NINC on card B/2/1 determines the number of load reduction curves to be read. Each curve follows immediately after the preceding one and is numbered in the order it is read.

If NINC is set to zero, card set E is not required.

If MEEI is set to false, then the following format is used:

D/1	2-7	CSTLD(1)	F6.0	Customer demand in hour 1
	8-13	CSTLD(2)	F6.0	Customer demand in hour 2
	.	.	.	. . .
	.	.	.	. . .
	.	.	.	. . .
	68-73	CSTLD(12)	F6.0	Customer demand in hour 12

The same format is repeated for Card Set E.

F/1	4-5	NLEVEL	I2	Number of TaD loss entries [1 $\leq$ NLEVEL $\leq$ 10]
F/2	2-7	DLEVEL(1)	F6.0	Load level 1 (as fraction of peak load)
	8-13	DLEVEL(2)	F6.0	Load level 2
	14-19	DLEVEL(3)	F6.0	Load level 3
	.	.	.	. . .
	.	.	.	. . .
	.	.	.	. . .
	56-61	DLEVEL(10)	F6.0	Load level 10 (as fraction of peak load)

Card	Columns	Variables	Format	Description
F/3	2-7	PLOSS(1)	F6.0	Marginal losses at load level 1.
	8-13	PLOSS(2)	F6.0	Marginal losses at load level 2.
	.	.	.	. . .
	.	.	.	. . .
	.	.	.	. . .
	56-61	PLOSS(10)	F6.0	Marginal losses at load level 10.
G/1/1	12-14	IC	I3	Class number for unit 1. Cross-references to data in Group E/2 [1 $\leq$ ICLNUM $\leq$ NCLASS]
	15-16	NVPT	I2	Number of valve points for unit 1.
	61-67	ATTR	F7.3	Mean time to repair after failure for unit 1 (hours) [0 $\leq$ ATTR $\leq$ HOURS]
G/1/2	2-8	TCAP(1)	F7.1	Total MW capacity of unit 1. Used only if MXVPT = 1.
	19-24	FOR (1)	F6.3	Forced outage rate for unit 1[0 $\leq$ TFOR $\leq$ 1.0]
G/1/3	1-3	NCRV(1)	I3	Curve number for the time dependent unit.
	5-10	RNUM(1)	F6.1	Capacity multiplier for the time dependent unit.

Note: This is all the information required for time-dependent units. If other units are included in the plant file in SYSGEN format, their data will be skipped and all the time-dependent units will be processed.

IV.C Output Format

The only outputs from ELECTRA are the load duration and frequency curves in SYSGEN format. (See reference 2, card sets C and D). Two separate files are written for each case.

Card	Columns	Variables	Format	Description
C/1	2-5	NPNT	I4	Number of points in each load shape
C/1/1	2-3	NUMYR	I2	Year number
	6-11	PEAK	F7.1	Peak demand for the first output curve
	12-16	IOUT	I5	Output curve number

Card C/1/1 is repeated for every output curve in current case

C/2/1	2-3	NOUTC	I2	Number of output load shapes
C/3/1	2-11	CDF(1, 1)	F10.8	First entry in the first load duration curve in current case
	14-23	CDF(1, 2)	F10.8	Second entry in the first load duration curve
	26-35	CDF(1, 3)	F10.8	Third entry in the first load duration curve
	38-47	CDF(1, 4)	F10.8	Fourth entry in the first load duration curve
	50-59	CDF(1, 4)	F10.8	Fifth entry in the first level duration curve

Card C/3 is repeated until all NPNT points have been written.
Card sets C/3/2 - C/3/NOUTC are the same format as C/3/1. These card sets follow one another directly without any spacing cards in between. Each case is written to a separate file.

The frequency data is written to a separate file. Its format is identical to that of C/3. There are no cross reference cards in the frequency file. In SYSGEN, the curves are assumed to match the load duration curve file with the matching name. The frequency curves are assumed to be given in the same order as the load duration curves and to have the same number of points.

The correlation matrix is written to a separate file also. This file is designed to interface with a long-range planning model that requires the joint distribution of load and time dependent output. Its current format is 7F11.8.

Eleven values are reported for each load level. These values correspond to Probability time dependent generation = y given the load $\geq$ x . The values for y are 0, .1 capacity, .2 capacity, ..., capacity.

V. Subroutine Documentation

NAME	ELECTRA
TYPE	MAIN
SYSTEM	SYSGEN
UPDATE	7/2/79
DESCRIPTION	ELECTRA is the main routine
ARGUMENTS	None
COMMONS	/ELEGEN/, /ELEIOS/, /DEBUGS/
SUBROUTINES	ELECIN, ELESET
LOGIC	1) Set up input file numbers. 2) Call ELECIN to set up common data blocks. 3) Loop through all cases calling ELESET for each output curve. 4) Stop.
ERRORS	IFLG = -98 Error in call to subroutine
IDEBUG	None.

NAME ELEBSE

TYPE SUBROUTINE

SYSTEM ELECTRA

UPDATE 8/8/79

DESCRIPTION ELEBSE computes the load and frequency curves for the base case.

ARGUMENTS

NAME	DESCRIPTION	TYPE
IFLG	error code (returned)	I*4
IOUT	output curve number	I*4
IFIRST	first hour in the curve	I*4
ILAST	last hour in the curve	I*4

COMMONS /ELEGEN/, /ELETDF/, /ELECVE/, /DEBUGS/

SUBROUTINES ELECRV, ELECWT

LOGIC

1) Set the base case load curve, CDF, and frequency curve, FLOAD, to zero.
2) Set the WORK array equal to the original customer demand. Set the PROB array equal to one divided by the number of entries. Compute the area under the curve and find the minimum and maximum load.
3) If the frequency curves are not required, go to 6) otherwise, divide the load curve into strata, and count the number of times the load crosses each stratum from below.
4) Accumulate the counts in the FREQ array.
5) Divide the number of counts by the number of hours in the curve. The division is performed in a separate operation due to the rounding errors that occur if it is performed as part of step 3.
6) Call ELECRV to create the cumulative load curve, CDF.
7) Set CLOAD equal to CDF so that it can be saved for the succeeding cases.
8) Call ELECWT to write the curves to the output files.
9) Return.

ERRORS

IFLG = -97 Number of possible probability states greater than allowed.

IFLG = -98 Error in call to subroutine.

DEBUG: If IDEBUG (21) = True, print the curve number, peak demand, minimum demand, and the unsorted load curve. If the frequency option is true, print the hour, load level, stratum value, and cumulative frequency value. Print the frequency count curve.

NAME ELECDF

TYPE SUBROUTINE

SYSTEM ELECTRA

UPDATE 7/2/79

DESCRIPTION ELECDF creates the reverse cumulative load curve for the equivalent net load

ARGUMENTS

NAME	DESCRIPTION	TYPE
IFLG	Error flag (returned)	I*4
IOUT	output curve number	I*4
IEND	number of points in the work array	I*4
PEAK	peak demand in MW for curve IOUT (returned)	R*4
ENERGY	total actual energy demand in MWH for curve IOUT (returned)	R*4
AREA1	total computed area in MWH under curve IOUT (returned)	R*4

COMMONS /ELEGEN/, /ELECVE/, /DEBUGS/, /DEMAND/, /MAXMUM/

SUBROUTINES AREADM (from SYSGEN)

LOGIC

1) Set up array counters and the /DEMAND/ and /MAXMUM/ common from SYSGEN.
2) Set the probability curve = 1 for all values less than the minimum load.
3) Loop through the sorted WORK array that contains each possible load level to find the probability of the load level corresponding to the equally spaced intervals. (See section III.A.1).
4) Set the probability array in /DEMAND/ equal to the computed curve
5) Call AREADM and compute the difference between the actual area and the area computed using linear interpolation. Correct each term in the new array by the percent error.
6) Return.

ERRORS

IFLG = - 96	Too many points in the new probability curve
IFLG = - 98	Error in call to subroutine

ELECDF (cont.)

DEBUG	If IDEBUG (22) = True, print the peak demand. For each new point, print the current WORK index; the probability corresponding to the current load level and the load level above it; the current position in the new probability array, CDF; the difference between the current load level and the previous one, RESIDUAL X (the distances along the load axis); the accumulated distance between the last CDF point created and the last load level, ACCUMULATED X; and the residual area under the curve that has not yet been accounted for.

NAME ELECIN

TYPE SUBROUTINE

SYSTEM ELECTRA

UPDATE 7/31/79

DESCRIPTION ELECIN reads the input files into the labeled common blocks.

ARGUMENTS

NAME	DESCRIPTION	TYPE
IFLG	error code (returned)	I*4

COMMONS /GGENRL/, /GCLASS/, /SYSDAT/, /TDPLNT/, /ELEGEN/, /ELECVE/, /ELECLS/, /ELETDF/, /ELEIOS/, /ELECOR/, /DEBUGS/

SUBROUTINES IRANGE

LOGIC

1) Read general information from file 10 into the /GGENRL/, /SYSDAT/, and /ELEGEN/ commons.
2) Read class data from file 25 into /GCLASS/ commons.
3) Read plant data from file 30 into /TDPLNT/.
4) Read T&D data from file 13 into /ELETDF/.
5) Read load data from file 11 into /ELECVE/.
6) Read load reduction data from file 12 into /ELECVE/.
7) Convert demand levels, entered as fraction.
8) Return.

ERRORS

IFLG = -97 End of file on input unit
IFLG = -98 Error in call to subroutine

DEBUG If IDEBUG(23) = True, echo print the input.

NAME ELECPK

TYPE FUNCTION

SYSTEM ELECTRA

UPDATE 5/24/79

DESCRIPTION ELECPK returns the smallest non-positive value in the load reduction curve. That is, if all entries are positive, ELECPK returns zero. If entries are negative, ELECPK returns the peak negative value.

ARGUMENTS

NAME	DESCRIPTION	TYPE
ICRV	curve number	I*4
IFIRST	starting array value to be searched	I*4
ILAST	last array value	I*4

COMMONS /ELECVE/

SUBROUTINES None

LOGIC
1) Set ELECPK = 0.0.
2) Loop through CRVRED(i,ICRV) from i = IFIRST to i = ILAST. If CRVRED(i,ICRV) is less than ELECPK, set ELECPK = CRVRED(i, ICRV)
3) Return.

ERRORS None

DEBUG None

NAME ELECRV

TYPE SUBROUTINE

SYSTEM ELECTRA

UPDATE 7/2/79

DESCRIPTION ELECRV sorts the load array from largest to smallest using a bubble sort and computes the cumulative probability for each load level.

ARGUMENTS

NAME	DESCRIPTION	TYPE
IFLG	error flag (returned)	I*4
IOUT	output curve number	I*4
IEND	number of entires in the probability array	I*4
PEAK	peak demand for curve IOUT (returned)	R*4
ENERGY	total energy demand for curve IOUT computed from the created piecewise linear curve (returned)	R*4
AREA	total energy demand for IOUT computed from the input curve (sent)	R*4

COMMONS /ELEGEN/, /ELECVE/, /DEBUGS/

SUBROUTINES ELECDF

LOGIC
1) Use a bubble sort to order the load from largest to smallest and store the sorted curve in the WORK array.
2) Compute the cumulative probability for each load level.
3) Call ELECDF to create the piecewise linear cumulative load duration curve.
4) Return.

ERRORS
IFLG = -97 Probability value greater than one or less than zero
IFLG = -98 Error in call to subroutine

DEBUG If IDEBUG(24) = True, print the curve number, end point, and the probability distribution

NAME ELECTD

TYPE FUNCTION

SYSTEM ELECTRA

UPDATE 5/24/79

DESCRIPTION ELECTD returns the marginal loss factor for the given demand level.

ARGUMENTS

NAME	DESCRIPTION	TYPE
DEMAND	Customer demand	R*4

COMMONS /ELETDF/

SUBROUTINES None

LOGIC
1) Use linear interpolation to find the marginal loss rate from the input loss rates.
2) Return.

ERRORS None

DEBUG None

NAME ELECWT

TYPE SUBROUTINE

SYSTEM ELECTRA

UPDATE 8/21/79

DESCRIPTION ELECWT writes the probability and frequency curves to the output file.

ARGUMENTS

NAME	DESCRIPTION	TYPE
IFLG	error code (returned)	I*4
ICASE	case number	I*4
PEAK	peak demand (MW)	R*4
ENERGY	energy demand (MWH)	R*4
IOUT	output curve number	I*4

COMMONS /ELEGEN/, /ELECVE/, /ELEIOS/, /ELCOR/

SUBROUTINES None

LOGIC

1) Write the case number, ICASE, and number of points in each curve, NPNT, at the top of the file
2) For each curve, write the peak, the energy, and the curve number to file ICRV.
3) Write the frequency curves to file IFRQ.
4) Write the correlation curve to file ICOR.
5) If this is not the last curve in the case, then RETURN.
6) Otherwise, write all the load duration curves to file ICRV below the peak and curve number information.
7) Increment all the output files by 1.
8) Return.

ERRORS None

DEBUG None

NAME ELEFRQ

TYPE SUBROUTINE

SYSTEM ELECTRA

UPDATE 8/2/79

DESCRIPTION ELEFRQ computes the equivalent frequency distribution for the load plus the generation in the current hour.

ARGUMENTS

NAME	DESCRIPTION	TYPE
IFLG	error flag (returned)	I*4
IOUT	output curve number	I*4
IHOUR	current hour	I*4

COMMONS /ELEGEN/, /ELECVE/, /ELECHR/, /DEBUGS/

SUBROUTINES None

LOGIC
1) If frequency curve is not required, then return.
2) Loop through the points of the output curve
3) For each point in the output curve, perform the frequency convolution (see Section III.A.4)
4) Return.

ERRORS None

DEBUG If IDEBUG (25) = true, print the output curve, hour, and new frequency distribution.

NAME ELEPRB

TYPE SUBROUTINE

SYSTEM ELECTRA

UPDATE 8/21/79

DESCRIPTION ELEPRB computes the hourly probability and frequency density functions.

ARGUMENTS

NAME	DESCRIPTION	TYPE
IFLG	error flag (returned)	I*4
ICASE	case number	I*4
IOUT	output curve number	I*4
IHOUR	current hour	I*4

COMMONS /TDPLNT/, /ELEGEN/, /ELECVE/, /ELECHR/, /ELECOR/, ELECLS/, /DEBUGS/

SUBROUTINES ELECTD

LOGIC

1) If this is the first hour, initialize the probability and frequency arrays.
2) If there are no units for the current case, then RETURN.
3) Set the T&D loss factor equal to the loss multiplier for the customer load in the current hour.
4) Initialize the load array to zero.
5) Loop through all the classes for the current case. Find the load reduction curve, JCRV, the number of plants, IPLNT, the forced outage occurrence rate, and the load reduction for the class in the current hour.
6) Loop through all possible combinations for the current class and compute the new load and, in the first hour, the proability and frequency distributions. (The distributions are independent of time and need only be computed once.)
7) At the end of the computation of curve, IOUT, normalize the probability and frequency arrays by the number of hours in the output curve.
8) Return.

ERRORS IFLG = - 97 Probability out of range

DEBUG If IDEBUG (26) = true, print case number, output curve number, total number of plants in the case, number of possible states. For each class, print the class number, number of plants in the class, reduced load, availability, forced outage rate, lambda and mu. At the end of the computation for IOUT, write the new probability density function.

NAME ELESET

TYPE SUBROUTINE

SYSTEM ELECTRA

UPDATE 8/21/79

DESCRIPTION ELESET sets up the probability and load arrays to sorted by ELECRV and converted to load and frequency curves by ELECDF.

ARGUMENTS

NAME	DESCRIPTION	TYPE
IFLG	error code (returned)	I*4
ICASE	case number	I*4
IOUT	output curve number	I*4
IFIRST	first hour in curve IOUT	I*4
ILAST	last hour in curve IOUT	I*4

COMMONS /TDPLNT/, /ELEGEN/, /ELECVE/, /ELECHR/, /ELECOR/, /ELECLS/, /DEBUGS/

SUBROUTINES ELEPRB, ELEFRQ, ELECRV, ELECWT, ELECPK, ELEBSE

LOGIC

1) If ICASE = 1, then call ELEBSE to set up base case curves.
2) Compute new peak and curve spacing.
3) Initilize curves to zero.
4) Loop through all hours calling ELEPRB and ELEFRQ to get the hourly probability and frequency density functions. For each hour compute all possible combinations of load and generation and, from these, set up the working arrays to be sent to ELECRV.
5) Create the reverse frequency curve by looping backwards through the frequency density function and summing.
6) Call ELECRV to create the reverse cumulative probability function.
7) Call ELECWT to write the curves to the output file.
8) Return.

ERRORS

IFLG = - 95	Number of points in the working array exceeds the maximum
IFLG = - 96	Number of combinations in any hour exceeds the maximum
IFLG = - 98	Error in call to subroutine

DEBUG If IDEBUG (27) = true, print the curve number and the unsorted work array.

NAME IRANGE

TYPE SUBROUTINE

SYSTEM LOLEV

UPDATE 4/23/79

DESCRIPTION IRANGE checks the range of integer variables.

ARGUMENTS

NAME	DESCRIPTION	TYPE
IFLG	error code (returned)	I*4
IVAR	variable to be tested	I*4
ILOW	lowest permissible value	I*4
IUP	highest permissible value	I*4
PRNAM	program name	A*8
VRNAM	variable name	A*8
IS1	1st subscript if IVAR is in an array	I*4
IS2	2nd subscript	I*4
IS3	3rd subscript	I*4
IS4	4th subscript	I*4

COMMONS None

SUBROUTINES None

LOGIC
1) Test variable.
2) If out of range, set IFLG, and print message.
3) Return.

ERRORS

IFLG = -10	Variable out of range
IFLG = -11	Invalid subscripts
IFLG = -12	IUP less than ILOW

DEBUG None

VI. Labeled Common Documentation

NAME /DEBUGS/

TYPE LABELED COMMON

SYSTEM ELECTRA

UPDATE 8/21/79

DESCRIPTION /DEBUGS/ contains the debug control variable.

ARGUMENTS

NAME	DESCRIPTION	TYPE
IBUG	output file for debut print	I*4
IDEBUG(40)	Logical variables for debug print 21 = ELEBSE 22 = ELECDF 23 = ELECIN 24 = ELECRV 25 = ELEFRQ 26 = ELEPBR 27 = ELESET	L*4

NAME /ELECHR/

TYPE LABELED COMMON

SYSTEM ELECTRA

UPDATE 8/21/79

DESCRIPTION /ELECHR/ contains the hourly probability, frequency, and load data.

ARGUMENTS

NAME	DESCRIPTION	TYPE
PHOUR(64)	Probability distribution of the load change	R*8
FHOUR(64)	Frequency distribution of the load change	R*8
CHOUR(64)	Load change corresponding to each probability level	R*4
NPRB	Number of load change Levels.	I*4

NAME /ELECLS/

TYPE LABELED COMMON

SYSTEM ELECTRA

UPDATE 8/21/79

DESCRIPTION /ELECLS/ contains data on the cases to be run.

ARGUMENTS

NAME	DESCRIPTION	TYPE
NUM(10)	total number of plants in case i	I*4
IDTD(10,4)	unit indices for up to four plants, to be included in case i	I*4
NPLNT(10,4)	number of units identical to IDTD(i,j) to be included in case i.	I*4

NAME /ELECOR/

TYPE LABELED COMMON

SYSTEM ELECTRA

UPDATE 8/21/79

DESCRIPTION /ELECOR/ contains the load-load reduction correlation curve.

ARGUMENTS

NAME	DESCRIPTION	TYPE
MCORR	Logical variable to control whether correlation curve is computed	L*4
SPACE3	Interval at which correlation curve is stored SPACE3 = peak rating/10.	R*4
CORR(100,11)	Correlation curve	R*4

NAME /ELECVE/

TYPE LABELED COMMON

SYSTEM ELECTRA

UPDATE 8/21/79

DESCRIPTION /ELECVE/ contains the input and output curves.

ARGUMENTS

NAME	DESCRIPTION	TYPE
PROB(8784)	Probability array containing the probability of each possible load level for the current output curve.	R*8
CSTLD(8784)	Original hourly customer demand	R*4
CRVRED(8784,4)	Load change curves.	R*4
WORK(8784)	Working array for sorting the probability curves	R*4
CDF(100,52)	Final load duration curves for the current case	R*4
CLOAD(100,52)	Final load duration curves for the base case.	R*4
FREQ(100)	Frequency duration curve for the current output curve of the current case	R*4
FLOAD(100,52)	Frequency duration curves for the base case	R*4
SPACE1	Length of each spacing in the base case load duration curve	R*4
SPACE2	Length of each spacing after the load change is added	R*4
IMIN	Array counter where minimum load is stored	I*4

NAME /ELEGEN/

TYPE LABELED COMMON

SYSTEM ELECTRA

UPDATE 8/21/79

DESCRIPTION /ELEGEN/ contains general information on the ELECTRA run.

ARGUMENTS

NAME	DESCRIPTION	TYPE
NHOUR	Total number of hours in the input curves	I*4
NINC	Number of load reduction curves	I*4
NOUTC	Number of output curves in each case	I*4
NPNT	Number of points in each output curve	I*4
NCASE	Number of cases to be run	I*4
NOTD	Number of time dependent units	I*4
NHRS(52)	Number of hours in each output curve	I*4
MFREQ	Logical control for frequency calculations	I*4

NAME /ELEIOS/

TYPE LABELED COMMON

SYSTEM ELECTRA

UPDATE 8/21/79

DESCRIPTION /ELEIOS/ contains the input and output file numbers

ARGUMENTS

NAME	DESCRIPTION	TYPE
IGEN	Input file for general information (Card Set A and B)	I*4
LOADC	Input file for general customer load (Card Set D)	I*4
LOADD	Input file for load change data (Card Set E)	I*4
ITD	Input file for T&D loss multipliers (Card Set F)	I*4
ICRV	Output file for load duration curve	I*4
IFRQ	Output file for frequency curve	I*4
ICOR	Output file for correlation each case	I*4
IPLNT	Input file for plant information (Card Set G)	I*4
ICLS	Input file for class information	I*4

NAME /ELETDF/

TYPE LABELED COMMON

SYSTEM ELECTRA

UPDATE 8/21/79

DESCRIPTION /ELETDF/ contains the marginal loss factors

ARGUMENTS

NAME	DESCRIPTION	TYPE
NLEVEL	number of loss levels input	I*4
DLEVEL(10)	demand levels	R*4
PLOSS(10)	marginal loss factor for corresponding demand level	R*4

NAME GCLASS

TYPE LABELED COMMON

SYSTEM GEM/SYSGEN

UPDATE 4/23/79

DESCRIPTION /GCLASS/ contains class data that pertain to all units in a class

ARGUMENTS

NAME	DESCRIPTION	TYPE
NCLASS	Number of classes	I*4
NCLSVR	Number of variables associated with each class in the ICLASS table	I*4
ICLASS(J,1)	Class name	A*4
ICLASS(J,2)	Class type	A*4
ICLASS(J,3)	Not used in SYSGEN	I*4
ICLASS(J,4)	Not used in SYSGEN	I*4
ICLASS(J,5)	Cross reference to O&M escalation rate	I*4
ICLASS(J,6)	Cross reference to fuel cost escalation rate	I*4
ICLASS(J,7)	Not used in SYSGEN	I*4
ICLASS(J,8)	Cross reference to immature forced outage rate multipliers table	I*4
ICLASS(J,9)	Not used in SYSGEN	I*4
ICLASS(J,10)	Not used in SYSGEN	
ICLASS(J,11)	Not used in SYSGEN	I*4
NFORML	Number of sets of immature forced outage rate multipliers	I*4
NIMYRS	Number of years in each set of immature forced outage rate multipliers	I*4
FORML(10,10)	Immature forced outage rate multiplers table	I*4

NAME GGENRL

TYPE LABELED COMMON

SYSTEM GEM/SYSGEN

UPDATE 4/23/79

DESCRIPTION /GGENRL/ contains general information about the current GEM run.

ARGUMENTS

NAME	DESCRIPTION	TYPE
ISY	Starting year of planning horizon (integer)(e.g. 1985)	I*4
IEY	Final year of the planning horizon (integer)	I*4
NTP	Number of yearly time periods [=(IEY-ISY)+1] (integer)	I*4
NUMWK(12)	Not used in SYSGEN	
HOURS	Number of hours per year (real number) (hours)	R*4
DR	Discount rate (fraction)	R*4
TITLE(40)	Name of the current run (words 1 to 10 appear at top of each reoport)	R*4
ECOENV	Not used in SYSGEN	A*4

NAME SYSDAT

TYPE LABELED COMMON

SYSTEM SYSGEN

UPDATE 4/23/79

DESCRIPTION /SYSDAT/ contains general system information.

ARGUMENTS

NAME	DESCRIPTION	TYPE
NOSTNS	Number of units in the system	I*4
HRWEEK	Number of hours in a week	R*4
PERCNT	Maximum percent of any plant that counts toward spinning reserve	R*4
RES	If ERVE = 'PER', then RES = percent of load that is kept in spinning reserve	R*4
ERVE	If ERVE = 'PER', then the spinning reserve is RES percent of the load If ERVE = 'ABS' then spinning reserve is kept at a constant level of RES megawatts. If ERVE = 'MAX', then spinning reserve is set equal to the largest plant on line (see section III.K)	A*4
WKDAY	WKDAY = 'WEEK' or 'DAY'. Used only in reporting as a reminder of how HRWEEK is set (see section II.B)	A*4
ITDP	Alphabetic test	A*4
ICHY	variables set in	A*4
ISTO	input card set	A*4
IBASE	A/2/2	A*4
INTR		A*4
IPEAK		A*4

NAME /TDPLNT/

TYPE LABELED COMMON

SYSTEM ELECTRA

UPDATE 8/21/79

DESCRIPTION /TDPLNT/ contains information on the time dependent power units

ARGUMENTS

NAME	DESCRIPTION	TYPE
NCRV(20)	load reduction curve number for the plant	I*4
RNUM(20)	number of units in the plant (scale factor for the values in NCRV)	R*4
TCAP(20)	nominal size of the plant	R*4
FOR(20)	forced outage rate of the plant	R*4
AVFORR(20)	average forced outage occurrence rate for the plant	R*4

```
FILE: TEST     GENERAL  A                CONVERSATIONAL MONITOR SYSTEM                PAGE 001

 F F F F F F F F F F F F F F F F F F T F F F F F F T T T T T T T T T T
MGRID=T   MINI=T   MIDI=T   MAXI=T MMAXI=T MLCAP=T MLRED=T MCORR=F   MEEI=F
 MULT=T MFREQ=T MLORD=T MSPIN=T MDLAY=T   MOVE=F MSTOR=T MAINT=F   MSUB=I
 123     300.0 ABS 50.0     5
SUN   CHY   STO   BASE INTR PEAK
 1975 1975         1.0        0.0
            TEST RUN (CASE 12)
            SYSGEN VERSION 4
                 MSPIN=T
 MULT=T MFREQ=T MOVE=F MDLAY=T MSTOR=T
1975 1975 01                              2688.0 0.030
 4   168.0 WEEK     1    50
 4   4   4   4   4   4   4
 2
 0
 0   0
 2
 1   1   2   1
```

```
15
COAL PEAK          1   3   2   1                37485.0
COAL INTR          1   3   2   1                37485.0
COAL BASE          1   3   2   1                37485.0
OIL  PEAK          1   3   2   1                28052.0
OIL  INTR          1   3   2   1                28052.0
OIL  BASE          1   3   2   1                28052.0
CT   PEAK          1   3   2   1                15834.0
NUC  BASE          1   3   2   1                68049.0
SIO  PEAK          1   3   2   1                98105.0
CHY  INTR          1   3   2   1                58908.0
CHY  BASE          1   3   2   1                58908.0
GAS  PEAK          1   3   2   1                28052.0
GAS  INTR          1   3   2   1                28052.0
GAS  BASE          1   3   2   1                28052.0
SUN  INTR          1   3   2   1                70000.0
 1  1
 1.0
 3
 9      .00  .00  .00  .00  .00  .00  .00  .00  .00
 9      .01  .01  .01  .01  .01  .01  .01  .01  .01
 9      .03  .03  .03  .03  .03  .03  .03  .03  .03
```

```
PV200  1    15 1 1973  1 2000 52  0.000  0.000  0.000  0.00  24.00 1.000
  200.0      0.000 0.010  200.0      0.000 0.010
    1   2.0
PV100  2    15 1 1973  1 2000 52  0.000  0.000  0.000  0.00  24.00 1.000
  100.0      0.000 0.010  100.0      0.000 0.010
    1   1.0
COAL6  1     3 5 1972  1 2000 52  0.880  1.390  1.010  0.10 108.00 1.000
  600.0      8.900 0.210  150.0     10.814 0.160   90.0      8.225 0.0
  120.0      8.179 0.0    120.0      8.161 0.0    120.0      8.544 0.250
COAL4  1     3 5 1950  1 2000 52  1.020  1.420  1.010  0.10  86.40 1.000
  400.0      9.000 0.130  100.0     10.674 0.095   60.0      8.298 0.0
   80.0      8.190 0.0     80.0      8.424 0.0     80.0      8.820 0.175
NUC    1     8 1 2000  1 2000 52  0.540  0.720  1.010  0.10 120.00 1.000
  700.0     10.400 0.150  700.0     10.400 0.150
NUC    2     8 1 1973  1 2000 52  0.540  0.720  1.010  0.10 120.00 1.000
  500.0     10.400 0.150  500.0     10.400 0.150
OIL2   1     5 5 1969  1 2000 52  1.750  0.280  1.010  0.10  72.00 1.000
  200.0      9.900 0.074   50.0     12.068 0.053   30.0      9.084 0.0
   40.0      8.960 0.0     40.0      9.058 0.0     40.0      9.584 0.105
COAL2  1     2 5 1963  1 2000 52  1.070  2.270  1.010  0.10  72.00 1.000
  200.0      9.500 0.074   50.0     11.581 0.053   30.0      8.717 0.0
   40.0      8.599 0.0     40.0      8.691 0.0     40.0      9.196 0.105
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COAL   1     1 5 1948  1 2000 52  1.020  2.040  1.010  0.10  57.60 1.000
   50.0     11.000 0.027   12.5     13.409 0.023    7.5     10.094 0.0
   10.0      9.955 0.0     10.0     10.065 0.0     10.0     10.648 0.020
COAL   2     1 5 1942  1 2000 52  1.020  2.040  1.010  0.10  57.60 1.000
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  300.0      0.000 0.050  300.0      0.000 0.050
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880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.
880.	1104.	1328.	1552.	1776.	2000.	2000.	1776.	1552.	1328.	1104.	880.

880. 1104. 1328. 1552. 1776. 2000. 2000. 1776. 1552. 1328. 1104. 880.
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880. 1104. 1328. 1552. 1776. 2000. 2000. 1776. 1552. 1328. 1104. 880.

0.	0.	0.	0.	0.	0.	0.	2.	18.	43.	46.	56.
80.	76.	60.	34.	11.	3.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	3.	17.	42.	63.	54.
33.	44.	44.	28.	11.	3.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	2.	14.	38.	60.	72.
71.	53.	46.	38.	12.	2.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	3.	18.	42.	61.	72.
65.	43.	34.	38.	17.	1.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	3.	19.	39.	43.	27.
37.	37.	23.	29.	4.	2.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.	10.	36.	63.	75.
79.	76.	55.	24.	10.	4.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	3.	16.	33.	45.	50.
54.	43.	25.	13.	1.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	3.	20.	40.	63.	82.
87.	86.	74.	49.	19.	4.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	5.	18.	34.	58.	81.
88.	83.	70.	49.	23.	7.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	3.	20.	44.	61.	77.
82.	81.	68.	46.	18.	4.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	4.	25.	49.	69.	81.
84.	81.	64.	38.	16.	4.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	4.	23.	50.	69.	80.
84.	83.	70.	46.	20.	5.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	4.	16.	36.	40.	43.
42.	24.	18.	10.	2.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	3.	23.	49.	70.	85.
87.	84.	74.	53.	26.	7.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.	15.	38.	60.	77.
79.	78.	60.	46.	20.	5.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	3.	14.	33.	43.	52.
73.	64.	55.	45.	21.	6.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.	3.	5.	8.	12.
25.	33.	31.	24.	11.	3.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	5.	17.	45.	79.	88.
88.	80.	67.	49.	20.	4.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	8.	22.	34.	56.	57.
53.	63.	60.	33.	11.	3.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	4.	21.	48.	66.	74.
58.	45.	46.	29.	10.	2.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.	3.	8.	11.	23.
49.	54.	30.	11.	4.	1.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	4.	23.	45.	44.	47.
66.	78.	73.	42.	14.	3.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	6.	18.	21.	29.	59.
74.	56.	47.	43.	22.	5.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	4.	26.	47.	58.	52.
62.	79.	60.	33.	17.	5.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	8.	32.	56.	72.	54.
30.	42.	54.	32.	11.	3.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.	13.	43.	55.	60.
66.	51.	29.	15.	8.	2.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	7.	28.	52.	70.	80.
81.	82.	74.	48.	21.	5.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	6.	23.	48.	70.	84.

90.	86.	72.	52.	24.	6.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	2.	20.	31.	52.	66.
67.	77.	75.	56.	23.	4.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	4.	23.	50.	47.	35.
45.	64.	70.	52.	23.	5.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	7.	31.	56.	74.	84.
86.	80.	68.	49.	23.	5.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	7.	31.	60.	65.	68.
82.	81.	64.	45.	23.	5.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	2.	11.	29.	67.	59.
74.	92.	76.	52.	23.	5.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	8.	32.	57.	74.	80.
87.	87.	73.	51.	26.	6.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	3.	22.	46.	39.	29.
24.	33.	27.	14.	7.	2.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	18.	51.	48.	68.
89.	85.	72.	46.	21.	4.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	5.	17.	27.	44.	43.
39.	61.	66.	39.	17.	4.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	8.	25.	37.	40.	41.
40.	38.	52.	47.	20.	4.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	8.	29.	55.	74.	80.
62.	53.	55.	40.	20.	6.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	8.	31.	56.	76.	87.
88.	83.	70.	51.	25.	6.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.	5.	8.	13.	29.
37.	27.	17.	18.	11.	1.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	10.	32.	56.	74.	83.
81.	47.	31.	37.	23.	6.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	11.	33.	56.	74.	84.
78.	71.	64.	47.	23.	6.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	7.	29.	49.	55.	68.
80.	72.	57.	36.	18.	6.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	3.	12.	38.	73.	90.
84.	72.	63.	38.	15.	4.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	9.	29.	50.	61.	63.
49.	26.	10.	2.	1.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	10.	34.	60.	77.	89.
87.	78.	68.	53.	26.	6.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	10.	34.	61.	81.	91.
92.	87.	72.	55.	29.	7.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	9.	35.	53.	76.	90.
89.	85.	72.	52.	28.	7.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	10.	24.	36.	45.	52.
53.	43.	29.	27.	21.	6.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	9.	31.	54.	66.	77.
64.	41.	45.	38.	20.	7.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	6.	24.	35.	61.	91.
92.	67.	52.	43.	22.	5.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	8.	20.	49.	78.	93.
87.	82.	77.	58.	31.	8.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	7.	30.	53.	72.	90.
94.	91.	72.	45.	21.	6.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	8.	25.	44.	66.	74.
55.	30.	14.	13.	14.	6.	1.	0.	0.	0.	0.	0.

0.	0.	0.	0.	0.	0.	0.	12.	33.	56.	77.	92.
92.	71.	64.	54.	31.	10.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	13.	39.	62.	79.	91.
93.	62.	26.	21.	15.	5.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	7.	17.	39.	71.	92.
78.	67.	65.	35.	17.	8.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	10.	32.	48.	68.	80.
83.	85.	49.	16.	8.	2.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	8.	26.	55.	79.	90.
87.	79.	66.	43.	23.	7.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	12.	36.	62.	82.	96.
91.	72.	54.	23.	5.	3.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	2.	15.	40.	64.	82.	94.
94.	89.	75.	54.	31.	9.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	16.	42.	64.	82.	93.
94.	88.	77.	60.	35.	10.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	7.	24.	31.	19.	15.
28.	51.	67.	61.	37.	11.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	15.	41.	64.	65.	52.
54.	55.	56.	55.	35.	12.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	14.	36.	59.	83.	95.
97.	89.	69.	54.	37.	12.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	15.	40.	63.	80.	91.
94.	90.	67.	44.	27.	8.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	2.	16.	42.	65.	83.	95.
94.	89.	78.	53.	28.	11.	2.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	2.	10.	33.	52.	73.	75.
62.	66.	65.	50.	26.	8.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	2.	16.	43.	64.	81.	81.
58.	69.	83.	68.	43.	16.	2.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	15.	41.	58.	70.	84.
89.	83.	67.	47.	26.	9.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	5.	22.	44.	61.	82.	98.
100.	93.	74.	41.	15.	5.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	2.	10.	27.	50.	63.	60.
51.	40.	32.	29.	21.	8.	2.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	6.	27.	46.	44.	32.
21.	17.	32.	28.	7.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	2.	14.	39.	63.	84.	98.
95.	90.	81.	55.	27.	9.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	2.	14.	38.	61.	78.	88.
90.	86.	74.	58.	33.	10.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	7.	30.	55.	68.	81.
85.	83.	78.	57.	35.	16.	3.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	2.	13.	31.	44.	52.	38.
23.	47.	67.	57.	35.	13.	2.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	13.	37.	60.	77.	89.
91.	90.	79.	62.	41.	18.	4.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	13.	40.	59.	71.	79.
88.	90.	78.	60.	40.	18.	2.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	11.	32.	45.	58.	75.
75.	56.	38.	35.	21.	10.	3.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	2.	12.	32.	56.	73.	81.
88.	80.	63.	45.	31.	15.	3.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	12.	36.	59.	75.	85.

88.	85.	74.	57.	36.	15.	2.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	9.	19.	30.	45.	55.
66.	72.	63.	41.	23.	11.	2.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	11.	32.	44.	55.	76.
73.	65.	62.	49.	31.	11.	2.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	3.	14.	28.	36.	41.	47.
49.	47.	42.	34.	20.	7.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	2.	13.	32.	44.	49.	62.
49.	20.	37.	42.	21.	7.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	7.	26.	56.	79.	86.
84.	71.	42.	31.	29.	8.	2.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	2.	11.	23.	29.	38.	49.
66.	80.	64.	33.	22.	14.	3.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	5.	18.	36.	57.	66.
60.	54.	29.	12.	4.	3.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	6.	25.	53.	72.	84.
88.	84.	74.	60.	40.	18.	4.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	2.	12.	35.	55.	67.	86.
88.	87.	78.	62.	42.	19.	4.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	3.	15.	38.	59.	79.	85.
79.	86.	78.	58.	38.	19.	4.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	3.	16.	39.	62.	80.	92.
92.	90.	79.	62.	41.	19.	4.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	3.	13.	35.	61.	78.	90.
92.	89.	79.	62.	41.	19.	4.	0.	0.	0.	0.	0.
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92.	89.	79.	61.	40.	19.	4.	0.	0.	0.	0.	0.
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84.	86.	78.	61.	41.	19.	5.	0.	0.	0.	0.	0.
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86.	64.	52.	52.	40.	21.	6.	0.	0.	0.	0.	0.
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84.	81.	71.	52.	34.	18.	3.	0.	0.	0.	0.	0.
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90.	86.	73.	60.	43.	21.	6.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	10.	25.	38.	60.	73.
75.	77.	67.	54.	37.	18.	5.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	9.	23.	37.	51.	66.
64.	38.	18.	24.	17.	7.	2.	0.	0.	0.	0.	0.
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74.	63.	38.	24.	21.	13.	2.	0.	0.	0.	0.	0.
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93.	90.	82.	67.	47.	25.	0.	0.	0.	0.	0.	0.
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98.	88.	68.	51.	38.	21.	0.	0.	0.	0.	0.	0.
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90.	87.	74.	62.	43.	22.	2.	0.	0.	0.	0.	0.

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43.	26.	35.	25.	25.	10.	3.	0.	0.	0.	0.	0.

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FILE: TEST     LDCDF1   A                CONVERSATIONAL MONITOR SYSTEM                PAGE 001

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