# DESCRIPTION OF DAILY WEATHER FACTOR (DWF) FORMULA

Prior to estimating future peak loads, it is necessary to adjust actual historical peak loads to a standard weather condition. This aids in determining what actual growths have been and in checking if the growth pattern of future estimates is reasonable.

Analyses to date indicate that the weather variable most highly correlated with daily peak demands consists of 29 hours of weighted dry bulb temperatures and one hour of weighted wet bulb temperature. The formula for this weather variable referred to as DWF (daily weather factor) follows:

$$DWF = \left[ \frac{1}{29} \sum_{n=1}^{29} T_{(n)_{DB}} \frac{n+27}{56} \right] + 0.5\ T_{(29)_{WB}}$$

$T_{(29)_{DB}}$ = Dry Bulb Temp. @ hour of peak weather

$T_{(1)_{DB}}$ = Dry Bulb Temp. 28 hours prior

$T_{(29)_{WB}}$ = Wet Bulb Temp. @ hour of peak weather

Daily peaks have a high correlation with this DWF. Generally, during hot weather, the higher the DWF, the higher will be the daily peak load.

USE OF DAILY WEATHER FACTOR (DWF) FORMULA IN ANALYZING HISTORICAL PEAKS

Exhibit A is a plot of peak load vs. daily weather factor for all weekdays, excluding holidays, of April through October 1984. Examination of similar plots for past years indicated a constant demand value for daily weather factors between 64 and 77 and a uniformly rising trend for all daily weather factors above 86. The sloping line of Exhibit A is the linear regression for all points above 86 DWF. A vertical dashed line is drawn at the most probable peak weather value (standard weather) as determined from analysis of past weather records. The intersection of the sloping line and the vertical dashed line is defined as the regression demand. The most probable peak demand (standard demand) for a year has been determined to be a value slightly above the regression demand. Data for calculating standard weather is given in Exhibit B.

Exhibit C is a tabulation of the historical relationships between the regression demands and actual peak demands. The next to the last column shows the difference in percent between the actual peak demand that occurred in each year and the regression demand at standard weather. The "running average" difference is given in the last column. The standard demand for a year is determined by increasing the regression demand by the standard demand (running average) factor.

The inter-relationships of the above discussed factors are shown in Exhibit D. The solid sloping line is the linear regression line for 1984. Its intersection with the standard weather line gives a regression demand of 5885 MW. The standard demand for 1984 is 3.6% above this, or 6097 MW. The actual peak demand for 1984 was 5925 MW.

## 1984 DEMAND VERSUS WEATHER

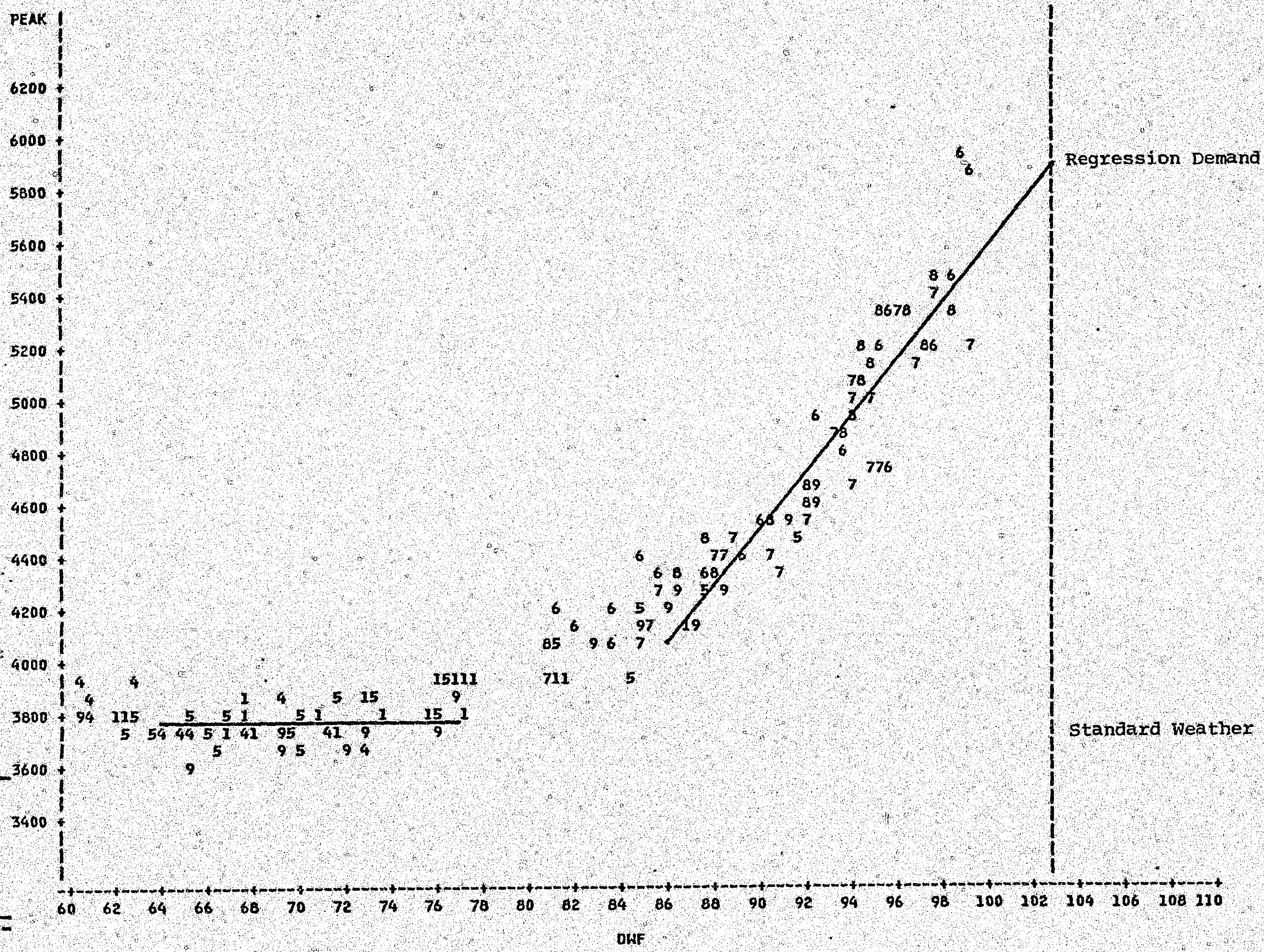



EXHIBIT A

## MAXIMUM DWF BETWEEN 10 AM AND TIME OF PEAK DEMAND

| | DWF | Date | Standard Weather (Running Average) |
|---|---|---|---|
| 1968 | 102.7 | 7/18 | |
| 1969 | 104.0 | 7/17 | |
| 1970 | 102.8 | 9/23 | |
| 1971 | 100.7 | 7/1 | |
| 1972 | 104.3 | 7/20 | |
| 1973 | 104.7 | 8/30 | |
| 1974 | 101.6 | 7/9 | |
| 1975 | 104.5 | 8/4 | |
| 1976 | 96.9 | 6/28 | |
| 1977 | 106.3 | 7/21 | |
| 1978 | 101.6 | 8/17 | 102.7 |
| 1979 | 101.7 | 8/1 | 102.7 |
| 1980 | 105.4 | 7/21 | 102.9 |
| 1981 | 104.3 | 7/9 | 103.0 |
| 1982 | 103.4 | 7/19 | 103.0 |
| 1983 | 100.4 | 9/6 | 102.8 |
| 1984 | 98.7 | 6/13 | 102.6 |

NOTE: 102.7 has been established as the standard weather to be used for forecasting purposes.

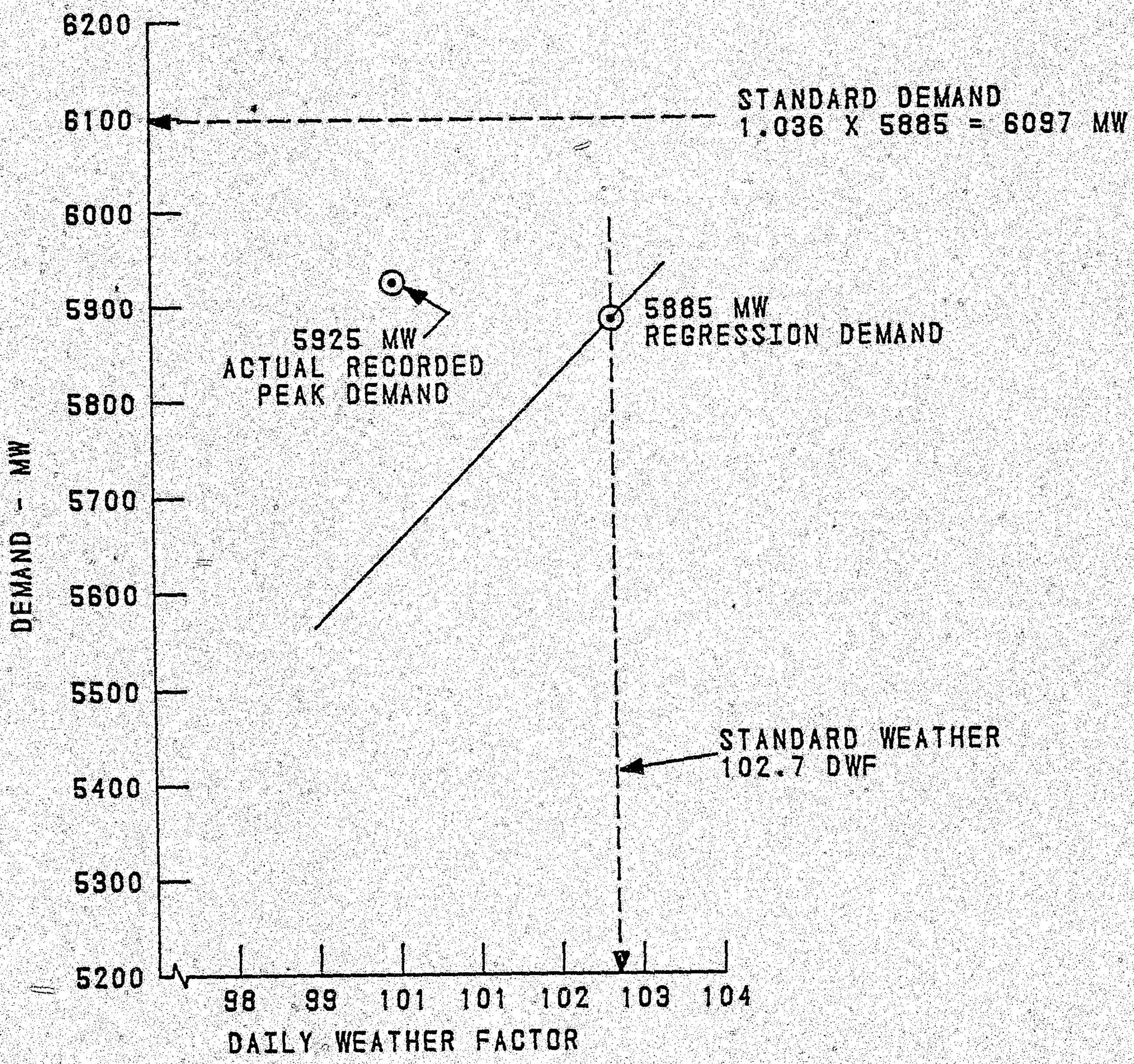
# STANDARD DEMAND FACTOR

| | Regression Demand @ 102.7 DWF | Net Actual Peak Demand | Corrected Peak Demand | Corrected Demand ÷ Demand @ 102.7 DWF | Standard Demand Factor (Running Average) |
|---|---|---|---|---|---|
| 1968 | 4316 | 4375 | (4445) | 1.030 | |
| 1969 | 4661 | 4592 | (4746) | 1.018 | |
| 1970 | 4750 | 4712 | (4954) | 1.043 | |
| 1971 | 4878 | 4922 | (5034) | 1.032 | |
| 1972 | 5162 | 5313 | 5313 | 1.029 | |
| 1973 | 5448 | 5760 | 5760 | 1.057 | |
| 1974 | 5434 | 5431 | (5492) | 1.011 | |
| 1975 | 5344 | 5530 | (5545) | 1.038 | |
| 1976 | 5462 | 5346 | 5346 | .979 | |
| 1977 | 5397 | 5888 | 5888 | 1.091 | |
| 1978 | 5445 | 5667 | 5667 | 1.041 | 1.034 |
| 1979 | 5562 | 5641 | 5641 | 1.014 | 1.032 |
| 1980 | 5598 | 6095 | (6145) | 1.098 | 1.037 |
| 1981 | 5522 | 5731 | 5731 | 1.038 | 1.037 |
| 1982 | 5407 | 5691 | 5691 | 1.053 | 1.038 |
| 1983 | 5821 | 5879 | 5879 | 1.010 | 1.036 |
| 1984 | 5885 | 5925 | 5925 | 1.007 | 1.034* |

( ) Corrected for voltage reduction and load curtailment.

NOTE: Latest Running average standard Demand Factor used for determining current year's standard demand and for forecasting future demands.

* Because of unresolved meter error during summer regression period, it was decided to retain 1.036 as the standard demand factor for this forecast.


STANDARD DEMAND
1.036 X 5885 = 6097 MW
5925 MW
ACTUAL RECORDED
PEAK DEMAND
5885 MW
REGRESSION DEMAND
STANDARD WEATHER
102.7 DWF
DEMAND - MW
6200
6100
6000
5900
5800
5700
5600
5500
5400
5300
5200
98
99
101
101
102
103
104
DAILY WEATHER FACTOR

## USE OF DWF APPROACH IN ESTIMATING FUTURE PEAKS

The demand weather characteristic line for 1983 (Exhibit E) illustrates the foundation for the development of the demand forecast procedure. The horizontal segment is defined as base demand. The sloping segment is a function of weather sensitive demand. Coincident weather sensitive demand is derived by subtracting base demand from the regression demand.

The base demand as defined above has been found to have a high correlation with the average April and October output.

The coincident weather sensitive demand has been found to have reasonably good correlation with the estimates of actual MW's of connected air conditioning.

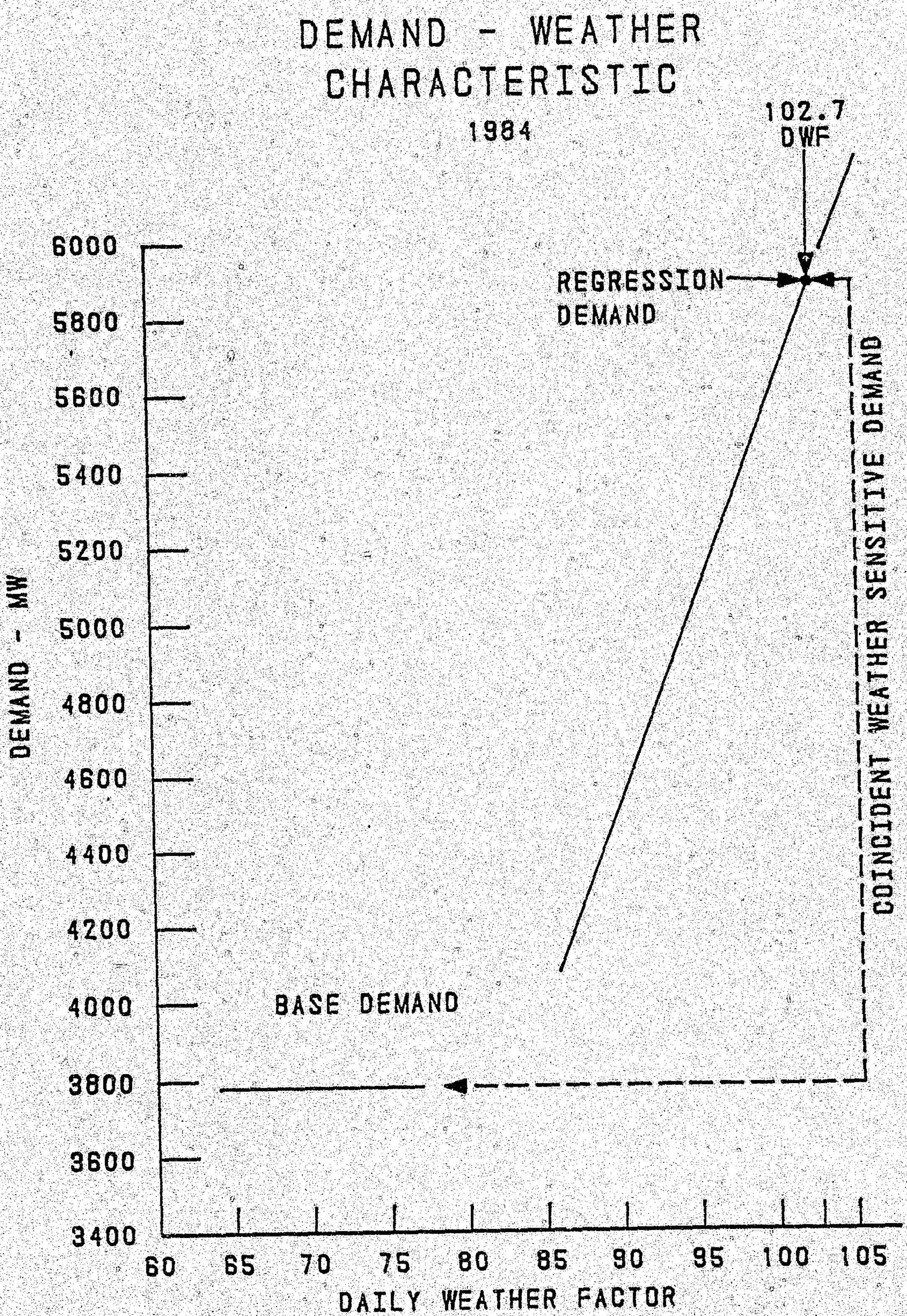
Exhibit F is a tabulation of historical average total monthly outputs of April and October. Also shown in Exhibit F in the last column is a historical tabulation of the ratio of base demand to base output. These historical ratios and extrapolation into the future are plotted in Exhibit G. A flat projection is used because of economic uncertainties. The extrapolated base demand factors are applied to the forecast of base output to compute the base demand forecast. The base output forecasts do not include any off-peak sales which result from new, non-typical loads such as off-peak electric car charging.

Exhibit H shows how the coincident weather sensitive demand as developed for the years 1968 through 1984. The last column shows estimates of connected air conditioning load for all years. These estimates of connected load are year-end values and are obtained from the Commercial Operations Department.

Exhibit I is a plot of a multiplier showing the relationship between coincident weather sensitive demand and connected air conditioning load for the years 1968-1984. The multiplier is determined by dividing the coincident weather sensitive demand by the connected air conditioning each year. During the 1969-78 period this multiplier has decreased and then shown a tendency to increase from 1978 to 1984. For forecast purposes the current value of .478 was used throughout.

This multiplier is applied to the forecast of connected air conditioning load to compute the coincident weather sensitive demand forecast.

The sum of the base demand and coincident weather sensitive demand produced a forecast of the regression demand (value of demand on the regression line at standard weather). As noted earlier, the regression demand must be increased by 3.6% (Standard Demand Factor) to obtain a forecast of most probable (standard) demand.


DEMAND - WEATHER
CHARACTERISTIC
1984
102.7
DWF
REGRESSION
DEMAND
COINCIDENT WEATHER SENSITIVE DEMAND
BASE DEMAND
DEMAND - MW
6000
5800
5600
5400
5200
5000
4800
4600
4400
4200
4000
3800
3600
3400
60
65
70
75
80
85
90
95
100
105
DAILY WEATHER FACTOR

## PHILADELPHIA ELECTRIC COMPANY SYSTEM

## ACTUAL AVERAGE OF APRIL AND OCTOBER OUTPUT

| | Base Output-GWH | Base Demand-MW | Demand ÷ Output |
|---|---|---|---|
| 1968 | 1734.2 | 2998 | 1.729 |
| 1969 | 1840.1 | 3142 | 1.708 |
| 1970 | 1906.3 | 3255 | 1.707 |
| 1971 | 1938.5 | 3326 | 1.716 |
| 1972 | 2059.6 | 3493 | 1.696 |
| 1973 | 2168.8 | 3668 | 1.691 |
| 1974 | 2138.4 | 3612 | 1.689 |
| 1975 | 2126.7 | 3632 | 1.708 |
| 1976 | 2209.9 | 3723 | 1.685 |
| 1977 | 2196.2 | 3763 | 1.713 |
| 1978 | 2246.2 | 3813 | 1.698 |
| 1979 | 2311.5 | 3830 | 1.657 |
| 1980 | 2246.0 | 3739 | 1.665 |
| 1981 | 2210.2 | 3696 | 1.672 |
| 1982 | 2190.0 | 3644 | 1.664 |
| 1983 | 2242.0 | 3697 | 1.649 |
| 1984 | 2290.0 (est.) | 3781 (est.) | 1.651 |

# BASE DEMAND FACTOR

BASE DEMAND = BASE DEMAND FACTOR x MONTHLY OUTPUT
MW GWHR

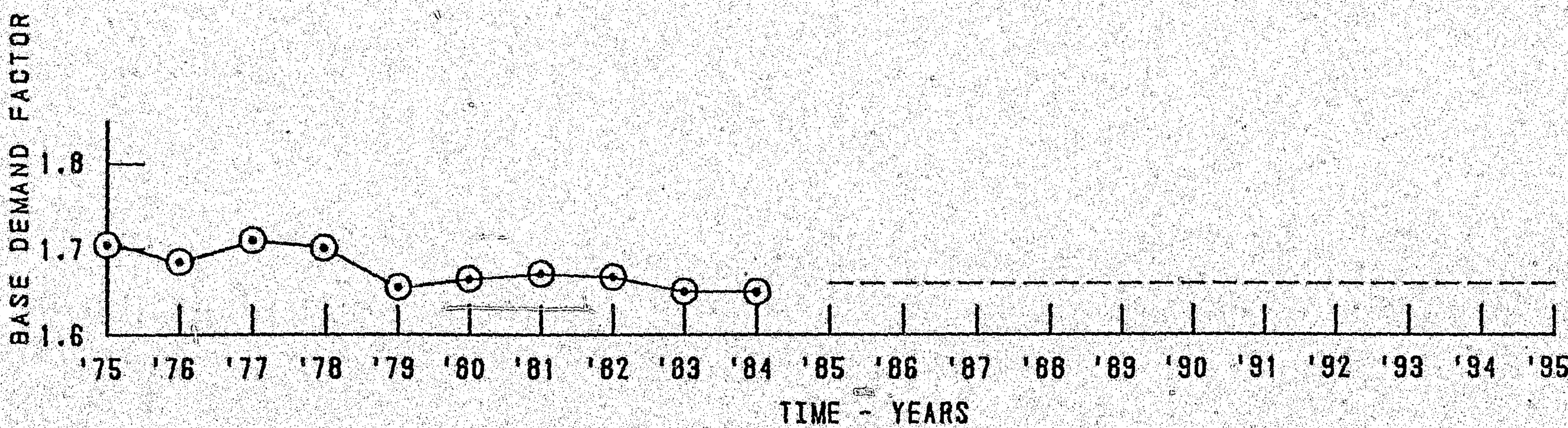





EXHIBIT G

## WEATHER SENSITIVE DEMAND - MW

| | Regression Demand | - | Base Demand | = | Coincident Weather Sensitive Demand | Connected Air Cond. | Multiplier |
|---|---|---|---|---|---|---|---|
| 1968 | 4316 | | 2998 | | 1318 | 2470 | .534 |
| 1969 | 4661 | | 3142 | | 1519 | 2755 | .551 |
| 1970 | 4750 | | 3255 | | 1495 | 3041 | .492 |
| 1971 | 4878 | | 3326 | | 1552 | 3298 | .471 |
| 1972 | 5162 | | 3493 | | 1669 | 3524 | .474 |
| 1973 | 5448 | | 3668 | | 1780 | 3758 | .473 |
| 1974 | 5434 | | 3612 | | 1822 | 3966 | .459 |
| 1975 | 5344 | | 3632 | | 1712 | 4050 | .428 |
| 1976 | 5462 | | 3723 | | 1738 | 4085 | .426 |
| 1977 | 5397 | | 3763 | | 1634 | 4124 | .395 |
| 1978 | 5445 | | 3813 | | 1632 | 4200 | .388 |
| 1979 | 5562 | | 3830 | | 1732 | 4289 | .405 |
| 1980 | 5598 | | 3739 | | 1859 | 4352 | .429 |
| 1981 | 5522 | | 3696 | | 1826 | 4387 | .416 |
| 1982 | 5407 | | 3644 | | 1763 | 4351 | .405 |
| 1983 | 5821 | | 3697 | | 2124 | 4400 | .483 |
| 1984 | 5885 | | 3781 (est.) | | 2104 | 4393 | .478 |

AIR CONDITIONING MULTIPLIER

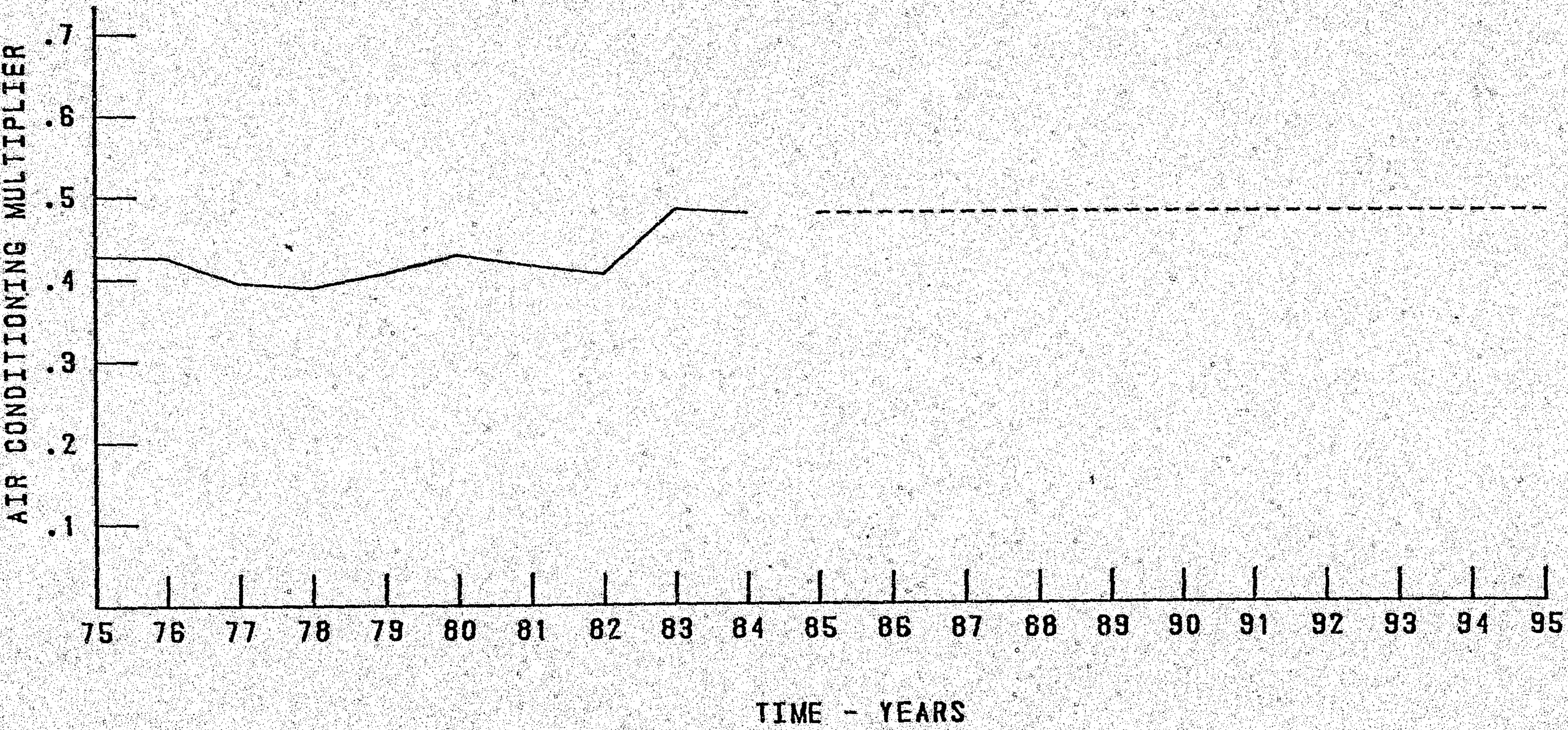



EXHIBIT I

## SAMPLE CALCULATION OF 1985 PEAK DEMAND FORECAST

**Base Demand**

| | |
|---|---|
| Base Monthly Output | 2307 GWHRS |
| Base Demand Factor | x 1.66 |
| Base Demand | 3829 MW |

**Coincident Weather Sensitive Demand**

| | |
|---|---|
| Connected Air Conditioning Load | = 4381 MW |
| Coincident Weather Sensitive Demand obtained from Exhibit I (.478 x 4381) | = 2094 MW |

Base Demand + Weather Sensitive Demand = Regression Demand

3829 + 2094 = 5923 MW

Regression Demand x Standard Demand Factor = Standard Demand

5923 x 1.036 = 6136 MW

6140 MW (rounded)

## MAXIMUM, MINIMUM AND PROBABLE TWENTY YEAR DEMAND FORECAST

The twenty year probable forecast in Exhibit J was computed using the same procedure as described for the ten year forecast.

The maximum and minimum demand forecasts were computed by observing the ratios of maximum and minimum annual energy forecasts to the probable annual energy forecast and applying these ratios to the probable demand forecast.

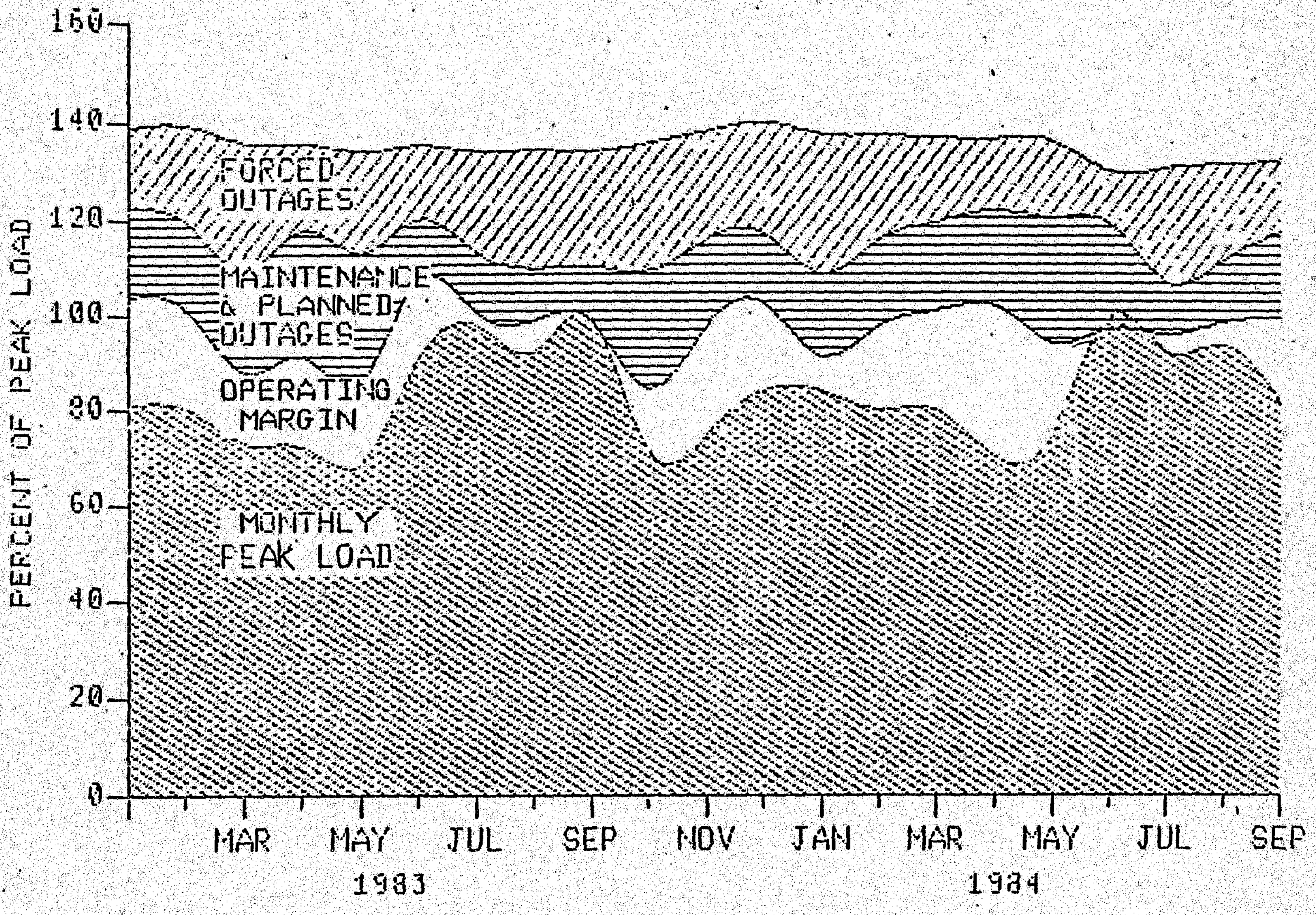
The twenty year projections are more approximate than the ten year and are presented merely to indicate present thinking as to the range in load demand that could occur in the nineteen nineties.

# PHILADELPHIA ELECTRIC COMPANY SYSTEM
## ANNUAL PEAK DEMAND
## 20 YEAR FORECAST - MW

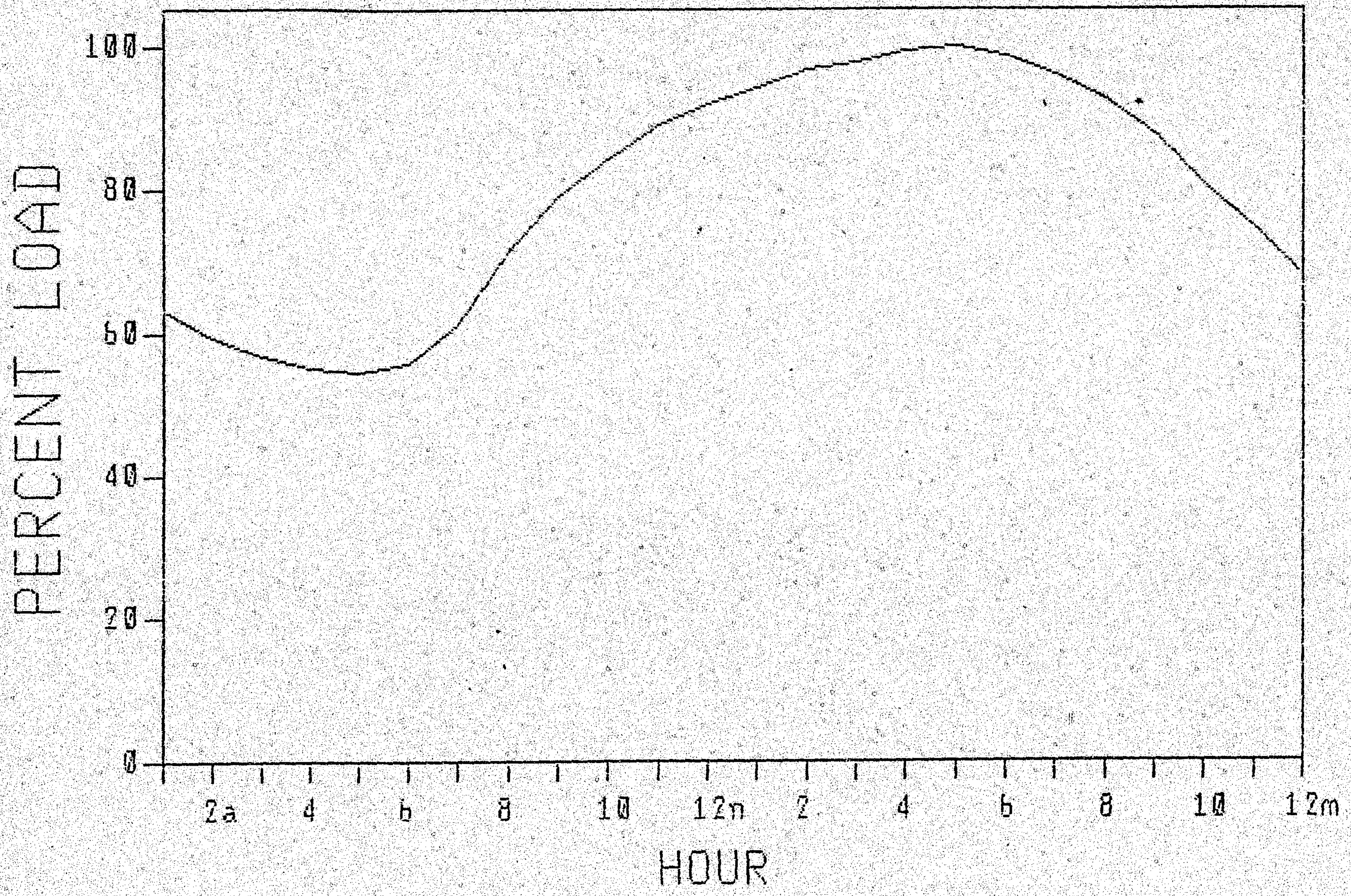
| | Probable | Maximum | Minimum |
|---|---|---|---|
| 1985 | 6140 | 6310 | 5970 |
| 1986 | 6160 | 6450 | 5910 |
| 1987 | 6180 | 6590 | 5850 |
| 1988 | 6200 | 6730 | 5790 |
| 1989 | 6220 | 6870 | 5730 |
| 1990 | 6240 | 7010 | 5670 |
| 1991 | 6260 | 7150 | 5610 |
| 1992 | 6320 | 7330 | 5580 |
| 1993 | 6380 | 7510 | 5550 |
| 1994 | 6440 | 7690 | 5520 |
| 1995 | 6500 | 7870 | 5490 |
| 1996 | 6560 | 8050 | 5460 |
| 1997 | 6620 | 8230 | 5430 |
| 1998 | 6700 | 8440 | 5430 |
| 1999 | 6780 | 8650 | 5430 |
| 2000 | 6860 | 8860 | 5430 |
| 2001 | 6940 | 9070 | 5430 |
| 2002 | 7020 | 9280 | 5430 |
| 2003 | 7100 | 9490 | 5430 |
| 2004 | 7180 | 9700 | 5430 |

# 1983-84 MONTHLY PJM CAPACITY PROFILE

Total Capacity = System Capacity - Misc. Capacity

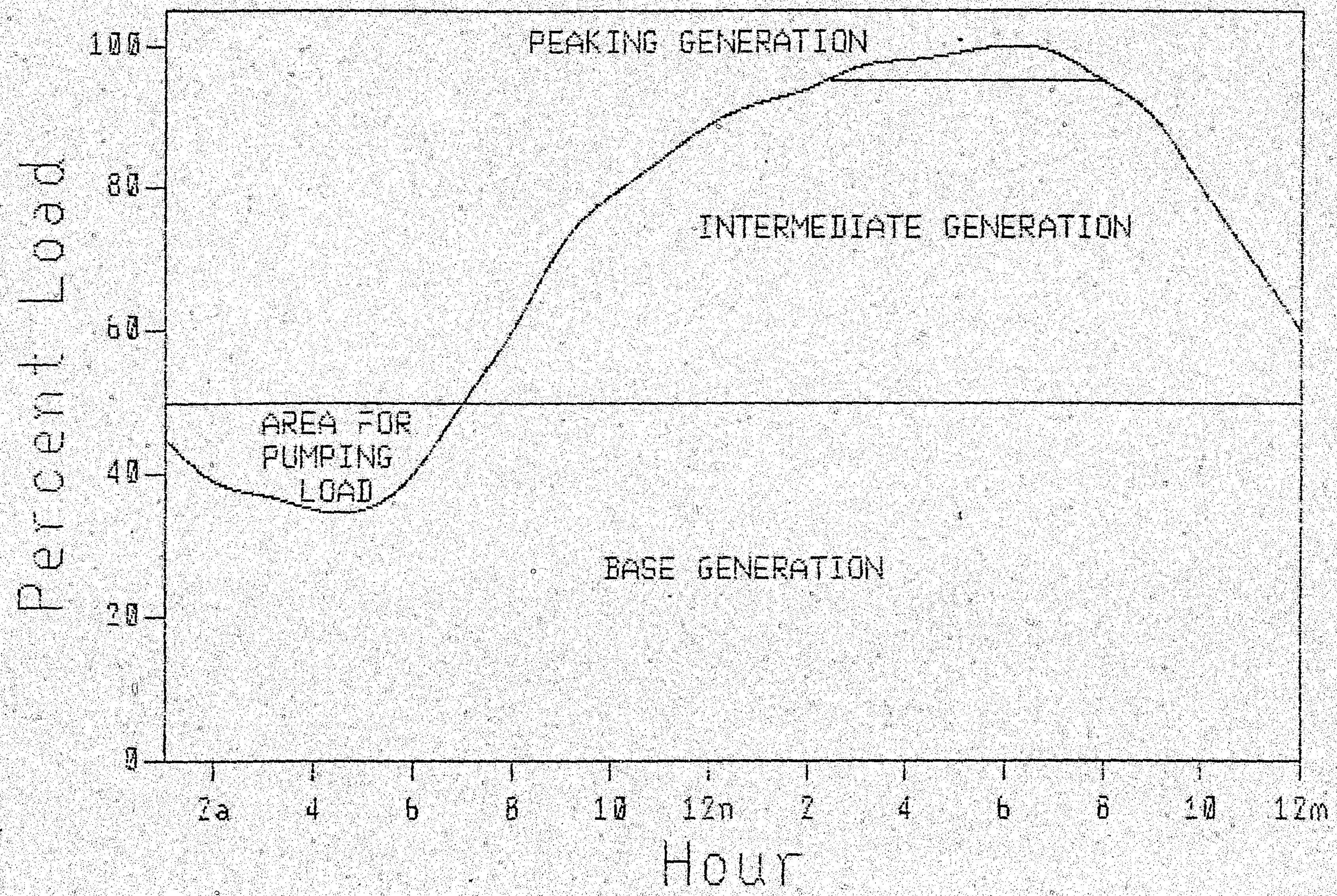


# PECO - DAILY LOAD CYCLE




SCHEDULE – 5

PECO Composite Daily Load Cycle
With Generation Type



# PECO LOAD & CAPACITY PROGRAM

## LIMERICK 2 (7-90)

### 1984-1994 (Year ending June 1)

| YEAR | MW | DATE | CHANGES | REASON | CAPACITY | LOAD | PERCENT RESERVE | MW EXCESS OR DEFICIT OVER 25% |
|---|---|---|---|---|---|---|---|---|
| 1984 | | | | | 7282 | 6100 | 19 | -343 |
| | 12 | 9-84 | Eddy. 1 | Rerate | | | | |
| | 471 | 1-85 | Salem 2 | End of Sale to GPU | | | | |
| 1985 | -166 | 5-85 | Retire Richmond 9 | Econ Retirement | 7599 | 6140 | 24 | -76 |
| | -338 | 12-85 | Retire Swk. 1,2&D | Econ Ret. 38 Yr | | | | |
| | 1055 | 2-86 | Limerick 1 | Service Date | | | | |
| 1986 | -458 | 4-86 | Retire Misc CT's | Econ Retirement | 7858 | 6160 | 28 | 158 |
| 1987 | | | | | 7858 | 6180 | 27 | 133 |
| 1988 | | | | | 7858 | 6200 | 27 | 108 |
| | -253 | 12-88 | Retire Del. 7,8&D | End of 35 Yr Life | | | | |
| 1989 | -12 | 12-88 | Retire Sch. 3 | End of 50 Yr Life | 7593 | 6220 | 22 | -182 |
| 1990 | | | | | 7593 | 6240 | 22 | -207 |
| | 1055 | 7-90 | Limerick 2 | Service Date | | | | |
| 1991 | -201 | 12-90 | Retire Cromby 2 | End of 35 Yr Life | 8447 | 6260 | 35 | 622 |
| 1992 | | | | | 8447 | 6320 | 34 | 547 |
| 1993 | | | | | 8447 | 6380 | 32 | 472 |
| 1994 | -169 | 12-93 | Retire Sch. 1&D | End of 35 Yr Life | 8278 | 6440 | 29 | 228 |

PECO 1986 Capacity &
Energy Projections With and
Without Limerick #1

| | No Limerick #1 Unit and No 1985/86 Retirements* | | | | Limerick #1 Unit In Service with Scheduled Retirements | | | |
|---|---|---|---|---|---|---|---|---|
| | Capacity | | Energy | | Capacity | | Energy | |
| | MW | % | GWh | % | MW | % | GWh | % |
| IMPORTS | - | - | 7937 | 26.2 | - | - | 3275 | 10.8 |
| **Peaking Units** | | | | | | | | |
| Non reheat oil steam | 336 | | 137 | 0.4 | 0 | | 0 | |
| Internal Combustion | 1280 | | 425 | 1.4 | 820 | | 88 | 0.3 |
| Pumped Hydro Gen. | 880 | | 1111 | 3.7 | 880 | | 1147 | 3.8 |
| | 2496 | 32.8 | 1673 | 5.5 | 1700 | 21.6 | 1235 | 4.1 |
| Pumped Hydro Load | - | - | (1620) | (5.3) | - | - | (1672) | (5.5) |
| Hydro** | 410 | 5.4 | 1785 | 5.9 | 410 | 5.2 | 1785 | 5.9 |
| **Intermediate Units** | | | | | | | | |
| Reheat oil steam | 1389 | 18.3 | 2309 | 7.6 | 1389 | 17.7 | 1873 | 6.2 |
| **Base Units** | | | | | | | | |
| Coal | 1488 | | 7709 | | 1488 | | 7569 | |
| Nuclear | 1816 | | 10512 | | 2871 | | 16240 | |
| | 3304 | 43.5 | 18221 | 60.1 | 4359 | 55.5 | 23809 | 78.5 |
| Total | 7599 | 100 | 30305 | 100 | 7858 | 100 | 30305 | 100 |

* Southwark 1&2, Combustion Turbines

** The hydro (Conowingo) will vary from base to peaking depending on the time of the year. For most of the summer peak load season, the hydro will be peaking.

# Economic Comparisons

| Date | Study Description |
|---|---|
| 7-19-76 | Limerick Economic Comparison<br>2-1055 MW Units<br>Service Dates 1984-86 |
| 10-21-76 | Limerick Economic Comparison<br>2-1055 MW Units<br>Service Dates 1983-85 |
| 6-2-77 | Pencil Update of 10-21-76 Comparison. Uses Peach Bottom Actual Fuel and O&M Costs |
| 7-3-78 | Fossil-Nuclear Economic Comparison<br>2400 MW Station 1232(C)<br>Service Dates 1983-85<br>2-1200 MW Nuclear Units<br>3-800 MW Fossil Units |
| 5-27-80 | V.S.B. statement to U.S. House of Representative Committee of Interior & Insular Affairs |
| 5-28-80 | PECO Annual Review (Part 2) (Presentation of Limerick history costs and savings as part of a 4 part presentation to PUC) |
| 9-5-80 | Comparison of the Limerick Nuclear Station compared with other alternatives updated to September 1980 |
| 10-9-80 | 35 Year Life Cycle Cost Limerick 2-1055 MW Nuclear Units 1985-87 Service Dates vs. 3-703 MW Generic Coal-Fired Units 1985-86 87 Service Dates |
| 11-17-80 | Economic Comparison 1083(A) - Limerick 2-1055 BWR's vs. Generic Coal 3-703 MW With Limestone Scrubbing |

| Date | Study Description |
|---|---|
| 1-27-81 | Comparison of the Limerick Nuclear Station with other alternatives updated to January 1981 |
| 1-29-81 | Limerick Briefing Book |
| 3-9-81 | Outline of Need for Limerick 4 Plans |