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ABSTRACT

The purpose of the Nuclear Power Plant Modules, NPP-1, is to determine the total cost of electricity from a nuclear power plant in terms of all the components contributing to cost. The plan of analysis is in five parts: (1) general formulation of the cost equation: (2) capital cost and fixed charges thereon: (3) operational cost for labor, maintenance, and repair: (4) fuel cost, arising from the fuel cycle: and (5) the effective load factor during the cost analysis period. A parametric analysis of the generating cost of nuclear power is reduced to determining the effects of six independent variables, such as plant load factor (PLF), special plant cost (SPC), fixed charge on capital equipment (FC), specific fuel cost (SFC), average new plant efficiency during load cycle (EFF), fuel burnup (B) on the four dependent costs of capital cost of electricity (CCAP), operating cost of electricity (COP), fuel cost of electricity (CF), and total cost of electricity (CTOT) in mills/kwh. The computer program ECOST is shown with a description of how to perform the parametric analysis. The program assigns three values to each of the six independent variables, an initial normal value, and upper and lower abnormal values. (Author/SK)

NUCLEAR POWER PLANT MODULE, NPP-1

NUCLEAR POWER COST ANALYSIS

by

Robert L. Whitelaw

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TABLE OF CONTENTS

NUCLEAR POWER PLANT MODULE, NPP-1

NUCLEAR POWER COST ANALYSIS

1.0 PURPOSE

To determine the total cost of electricity from a [illegible] power plant in terms of all the components contributing to cost.

2.0 INTRODUCTION

The production cost of electricity is measured in mills/kwh, the mill being $0.001, so that mills/kwh = $/Mwh. The average U.S. cost of electrical power at the generating station busbar is shown in the table below, along with U.S. generating capacity from fossil, hydroelectric and nuclear plants.

		1965	1970	Expected 1980
Total energy cost, mills/kwh		5.5	6.3	~12
Total generating capacity, Mw		236,000	344,000	668,000
Fossil:	% total	80	76	61
Hydroelectric:	% total	18	15	10.2
Nuclear:	% total	neg.	3.4	23

The "busbar" or production cost of electricity today represents 55% of the average price charged the customer, the breakdown being:

Production	55%
Transmission	32%
Sales & administration	13%
	100

It is, therefore, important to be able to determine accurately both the total busbar cost of nuclear power, and the separate factors that contribute to this cost. This is of special importance in evaluating alternatives, where there is a small difference between power cost from a fossil-fueled plant and a nuclear plant. An error or lack of precision in determining power costs could lead to choosing to build the wrong kind of power plant, with penalties that would continue year after year.

3.0 PLAN OF ANALYSIS

The total cost of electricity in mills/kwh from a nuclear power plant is the sum of three principal components, (a) fixed charges on capital cost, (b) operating cost, (c) fuel cost. In addition, the load factor enters into the cost analysis since it determines the fraction of plant capacity that is productive.

Hence the plan of analysis is in five parts:

(1) General formulation of the cost equation.

(2) Capital cost and fixed charges thereon.

(3) Operational cost for labor, maintenance and repair.

(4) Fuel cost, arising from the fuel cycle

(5) The effective load factor during the cost analysis period.

4.0 COST ANALYSIS

4.1 General Cost Formulation

Capital cost: $$\frac{\Sigma(\text{Capital costs}) \times \Sigma(\text{Fixed charges})}{8.766(\text{Plant capacity})(\text{Load factor})} = C_{cap}$$

Operational cost: $$\frac{\Sigma(\text{Annual labor, maintenance \& repair costs})}{8.766(\text{Plant capacity})(\text{Load factor})} = C_{op}$$

Fuel cost: $$\frac{(\text{Specific fuel cost in \$ per Mwd reactor output})}{24 \times (\text{Plant average thermal efficiency})} = C_f$$

Total generating cost, $C_{tot} = [C_{cap} + C_{op} + C_f]$ mills/kwh

In the above formulation, individual factors are further defined as follows:

Σ(Capital costs): the sum total of all costs, in dollars, necessary to produce a power plant, i.e., the purchase price of a "Turnkey" plant, fully licensed and tested, and ready to produce power.

Σ(Fixed charges): the sum of all annual charges on a dollar of capital investment, such as interest lost, depreciation, taxes, insurance; i.e. all capital costs that are independent of power production.

(Plant capacity): the net power output in kilowatts for which the plant is designed;

(Load factor): the <u>average</u> power output divided by the plant capacity, taken over a ~~typical duty~~ on annual cycle.

Σ(Annual labor, maintenance and repair costs): the sum of all costs, in dollars per year, for wages and salaries and overhead necessary to operate and maintain the plant, plus the costs of all repairs and replacement parts and tools consumed.

Σ(Fuel costs per Mwd reactor output): the sum of all costs necessary to provide the initial and all subsequent cores, or a given amount of fuel in the reactor, (including the additional manpower and tools necessary for refuelling operations), divided by the total heat in Mwd that amount of fuel will release to the reactor coolant during the fuel life cycle in the reactor.

(Plant average thermal efficiency): the ratio of plant net energy output to energy released in the reactor, both in the same units, computed at the average operating power level.

4.2 Computation of Capital Cost, C_{cap} in mills/kwh

There should be no great difficulty in determining the total capital cost of a power plant, either in total dollars, or in dollars per kwe plant capacity, the latter being the usual usage.

Table 1 shows the increase in the contract cost of a typical 1000 Mwe PWR plant from 1967 to 1970. Table 2 shows a more detailed breakdown for a similar plant in 1970. Table 3 compares nuclear with non-nuclear plants, and shows expected escalation beyond 1971.

Table 1. COMPARISON OF 1000 Mwe PWR PLANT COST ESTIMATES
Thousands of dollars
(taken from reference 5)

	March 1967	June 1969	June 1970
Direct costs:			
Nuclear steam supply	33,780	40,420	45,800
Turbine generator	27,100	29,780	32,700
Construction materials and equipment	23,300	35,400	47,000
Construction labor	20,800	33,400	55,800
Total direct costs	104,980	139,000	181,300
Indirect costs:			
Owner's cost	5,490	5,900	6,200
A/E and construction management	6,280	11,500	11,800
Miscellaneous construction cost	2,050	1,700	1,700
Land and land rights	1,090	900	1,000
Total indirect costs	14,910	20,000	20,700
Contingency	3,010	9,400	12,900
Total construction cost	122,900	168,400	214,900
Escalation:			
Escalation, T&G 6 percent year [1]	[2]	1,700	2,000
Escalation, balance	[2]	[3] 19,200	[4] 57,400
Interest during construction	10,840	28,300	48,300
Total cost	133,740	217,600	323,100

[1] 6 to 12 months delay in T–G delivery.
[2] Escalation not generally estimated in 1967 due to more stable cost base and option of turnkey proposals which did not include escalation provisions.
[3] Estimated 4 percent per year.
[4] Estimated 12 percent on construction labor and 5 percent on materials and equipment per year.

Table 2. Total Construction Cost for a 1000 Mwe PWR Power Plant
(taken from ref. 3)

Account number and description		Capital cost	
20 Land and land rights			$ 1,000,000
21 Structures and improvements			34,000,000
211 Ground improvements		$ 2,000,000	
212 Buildings			
Turbine and auxiliary buildings		5,000,000	
Control, service, and office		2,000,000	
219 Reactor containment and building		18,000,000	
Other account 21		7,000,000	
22 Reactor-plant equipment			81,000,000
221 Reactor equipment		22,000,000	
Vessel	$11,000,000		
Control rods etc.	6,000,000		
Miscellaneous	5,000,000		
222 Heat-transfer system		32,000,000	
Reactor coolant system	8,000,000		
Steam generators	17,000,000		
Miscellaneous	7,000,000		
223 Fuel-handling and -storage facilities		4,000,000	
224 Fuel reprocessing and refabrication			
225 Waste disposal		2,000,000	
226 Instrumentation and control		6,000,000	
227 Feedwater supply and treatment		6,000,000	
228 Steam condenser and feedwater piping		9,000,000	
23 Turbogenerator plant			65,000,000
24 Accessory electrical equipment			10,000,000
25 Miscellaneous power-plant equipment			4,000,000
Total direct construction costs			$195,000,000
91 Construction facilities, equipment, and services (0.8% of direct cost)			1,500,000
92 Engineering Services			
921 Reactor engineering			2,300,000
922 Plant engineering (5.0% of direct cost)			10,000,000
93 Other costs (4.0% of direct cost)			8,000,000
94 Interest during construction at 8.2% per year (66-month period, 21% of direct cost)			41,000,000
Total construction cost			257,800,000
Allowance for escalation during construction*			55,000,000
Grand total construction cost (rounded)			$313,000,000

Table 3 -- Range of Estimated Capital Costs for Selected Central Station Electric Power Units (taken from ref. 1)
Mid-1971 Orders

Cost Element	Type of Unit, and Costs $ Per Kilowatt: Light Water Nuclear	Coal	Oil
Land	$ 1	$ 1	$ 1
Structures & Improvements	26-44	18-26	16-23
Reactor or Boiler Plant Equip.	49-57	53-62	42-50
Turbine-Generator Plant	58-67	45-51	45-51
Miscellaneous Electric and Power Plant Equipment	16-20	14-18	13-16
Other Costs (incl. Spares, Indirect, Cooling Towers, & Control)	55-66	63-76	35-42
Interest During Construction	50-62	31-38	25-35
Contingency	10-13	10-13	8-12
Total Cost, No Escalation	$265-330	$235-285	$185-230
Escalation Effect from Start of Const. to Commercial Operation			
at 3%	31-39	19-23	15-18
at 4%	42-53	25-31	20-25
at 5%	54-67	32-39	25-31
at 8%	90-112	53-64	41-52

Assumptions:

1. All plants are 1,000 Mwe capacity.
2. Interest is calculated at 7.5% per year.
3. Nuclear control equipment includes improved near-zero radiation; coal control equipment includes SO_2 removal; use of low sulfur oil in place of SO_2 control on oil plant.
4. Construction schedule is 6 1/2 years for nuclear, 4 1/2 years for coal or oil.

The total fixed charges on capital investment are regulated by the F. P. C. and usually lie between 9% and 16%, as shown in Table 4 depending on whether the plant is in a government or investor-owned system. Note that the non-depreciating portion of a plant (land and working capital) will rarely exceed* 5% of the total investment so that only the left-hand column in each case need be considered.

*Land about $1,000,000
Working capital about $15,000,000 per 1000 Mwe plant, principally for fuel acquisition.

Table 4. Scale of Fixed Charges on a Nuclear Power Plant

(Plant useful life, 30 yrs; salvage value is zero)
Sources: refs. 3 and 4

	Govt-owned		Investor-owned	
Typical cost of money**	6%		9%	
Component	Depreciating	Non-dep	Depreciating	Non-dep
Amortization*** (int. + dep'n.)	7.27%	6.00%	9.73%	9.00%
Insurance (liability)	.80	.25	.80	.25
Taxes: federal	----	----	2.00	4.75
State & local	1.00	1.00	3.00	0.80
	9.07%	7.25%	15.53%	14.80%

**The cost of money for a given power plant is the combined result of raising capital from three sources, (a) internal funds of the corporation, (b) bondholders' money, called debt capital, and (c) stockholders' money, called equity capital.
Ref. (7) shows the following trend in the proportion and interest rate for each source:

***See next page.

	"Past"		1969		"Future"	
	Propn	Rate	Propn	Rate	Propn	Rate
Internal capital	30%	4.5%	25%	6%	20%	7%
Debt capital	60%	5.0%	60%	7%	60%	8%
Equity capital	10%	9.0%	15%	13%	20%	15%
Cost of money	5.25%		7.85%		9.20%	

***The amortization of a depreciating investment is the "equivalent annual cost" which represents the sum of the interest lost on the money tied up plus the principal value lost by depreciation in that year. It is identical to the annual "sinking fund" deposit necessary to replace the plant at end of life, and is computed by the formula

$$\text{Amortization Rate} = (P - L)A/P(i,n) + L$$

where P = initial investment

L = salvage value (usually zero for power plants)

$$A/P(i,n) = \left[\frac{(1+i)^n}{(1+i)^n - 1}\right]$$

i = interest rate of money per annum

n = number of years depreciation

The amortization rate is totally independent of the depreciation schedule. Also where n is very large, note that A/P approaches i.

4.3 Estimation of Operating Cost, C_{op} in mills/kwh

Typical values of annual direct costs for plant operation are shown in Table 5 as derived from references (3), (4) and (6), to 1975.

The corresponding values of C_{op} in mills/kwh are shown at the bottom of each column, for load factors of about .8 and .6 (7000 and 5000 full-power hours per year respectively).

	"Past"		1969		"Future"	
	Propn	Rate	Propn	Rate	Propn	Rate
Internal capital	30%	4.5%	25%	6%	20%	7%
Debt capital	60%	5.0%	60%	7%	60%	8%
Equity capital	10%	9.0%	15%	13%	20%	15%
Cost of money	5.25%		7.85%		9.20%	

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Table 5.

Typical Annual Costs for Operation & Maintenance ($1000)

	Size of Plant (BWR & PWR Types)			
	500 Mwe	750 Mwe	1000 Mwe	1500 Mwe
Staff payroll	580	600	625	650
Admin. & overhead	170	185	200	220
Consumable supplies & equipment	300	340	400	500
Outside support services	100	120	140	175
Miscellaneous	55	70	80	95
Equipment repair and replacement	750	900	1000	1200
	$1955	$2215	$2445	$2840
Operating Cost (C_{op}) in mills/kwh				
P.L.F.∿.8	.56	.42	.35	.27
P.L.F.∿.6	.78	.59	.49	.38

4.4 Determination of Fuel Cost, C_f, in mills/kwh

The fuel cost component of the total generating cost is given by

$C_f = SFC/(24\ \bar{\eta}_{th}\ B)$ mills/kwh

where $\bar{\eta}_{th}$ is defined in section 4.5

SFC = specific fuel cost, in $/kgU, which is the sum of all costs associated with fabricating, fissioning, reprocessing and handling the reactor fuel expressed in terms of $/kg of the fresh fuel uranium inventory, oftentimes called the "fuel cycle cost." Table 6 shows typical fuel cycle costs and plutonium credit for PWR and BWR cores.

B = the "burnup factor," being the total heat release in Mwd/kgU, based on the same uranium inventory used in SFC, resulting from the fission process in the core. (i.e. excluding after-shutdown decay heat generation). B is thus proportional to the fraction of total U atoms fissioned and converted during the burnup life in the core. Typical values of B are shown in Table 7, taken from ref. (3), p. 75

Table 6. Typical Fuel Cycle Costs in $/kgU

for BWR or PWR cores, from refs. (2) and (3)

1. Cost of fuel consumed: $300-$340/kgU

   a) U mining and ore reduction to U_3O_8 ($90)
   b) Conversion $U_3O_8 \rightarrow UF_6$ ($12)
   c) Enrichment (separative work cost) ($110)
   d) Fixed charges on working capital in U inventory (core + storage) ($90)

2. Fuel fabrication and shipping costs $70-$90/kgU

   a) Fuel conversion, UF_6 UO_2
   b) Fuel assembly fabrication and shipping
   c) Fixed charges on working capital involved

3. Spent-fuel shipping and reprocessing $35-$45/kgU

   a) Core loading and unloading: manpower, tools and materials consumed
   b) Spent-fuel shipping
   c) Spent-fuel reprocessing
   d) Fixed charges on working capital involved

4. Plutonium credit, less fixed charges -$30/kgU

Table 7. Estimated Fuel-Fabrication Cost and Average Burnup

Reactor type	Fuel	Cladding	Fabrication cost,* $/kg of uranium	Average burnup, Mwd/tonne
Pressurized water	UO_2	Zircaloy	75	25,000
Boiling water	UO_2	Zircaloy	70	22,000
Heavy water--natural uranium	UO_2	Zircaloy	50	10,000
Fuel	PuO_2 - UO_2	Stainless steel	170†	75,000
Blanket	UO_2	Stainless steel	50†	

*Based on manufacturing throughput of 1000 kg/day.
†Updated.

4.5 Average Plant Thermal Efficiency, $\bar{\eta}_{th}$

The average thermal efficiency of the power plant will be net busbar energy in Mwh_e produced during a typical load cycle (daily or weekly) divided by the reactor heat generated, in Mwh_{th} during the same cycle.

Knowing the typical cycle curve of Power, P vs time, t, (see section 4.6), and the variation in plant efficiency, η_{th} with P, the average efficiency over time τ is given by

$$\eta_{th} = \frac{\int_0^\tau Pdt}{\int_0^\tau (P/\eta_{th})dt}$$

A typical variation of η_{th} with P may be derived from ref. (8) and (3) as follows:

Power level, P/P_{design}:	.40	.60	.80	1.00	1.20
Thermal eff'y ratio, η_{th}/(Design η_{th}):					
a) Constant temp. reactor op'n:	.90	.95	.975	1.00	.985
b) Reactor mean temp. falling with load	.85	.925	.95	1.00	1.01

4.6 Determination of Plant Load Factor (P.L.F.)

Plant load factor (P.L.F.) appears as a parameter in both C_{cap} and C_{op}. Figs. 1 and 2 show typical daily electric power demand P, on two systems each dominated by a large industrial city. If the system capacity is P_{cap}, the load factor in each case is defined by

$$P.L.F. = \frac{\bar{P}}{P_{cap}} = \int_0^\tau Pdt/\tau P_{cap}$$

The value of $\bar{P}/P_{max}$ for each daily cycle is about 5/6 but for a weekly cycle it might be lower due to low weekend demand. Since most systems keep a 20% capacity margin over peak demand ($P_{cap}/P_{max} \approx 1.20$), a typical <u>system</u> load factor therefore is

$$P.L.F. = \frac{\bar{P}}{P_{max}} \times \frac{P_{max}}{P_{cap}} \approx \left(\frac{5}{6}\right)\left(\frac{1}{1.2}\right) \approx \underline{\underline{.70}}$$

A single large power plant in such a system is likely to operate on a more level cycle closer to its capacity, especially if it is a modern nuclear unit, or if the system has pumped storage or gas turbine units to supply the peak power increments. Hence a reliable modern nuclear power plant will likely operate at a value of P.L.F. between 0.8 and 0.9.

5.0 COST FORMULATION FOR PARAMETRIC ANALYSIS

We can now recapitulate the general expression for total generating cost, in mills/kwh.

	Computer variable
$C_{tot} = C_{cap} + C_{op} + C_f$	CTOT
where $C_{cap} = \frac{(CC/P_{cap})(FC)}{8.766(LF)}$	CCAP
$C_{op} = \frac{(CLMR)/P_{cap}}{8.766(LF)}$	COP
$C_f = \frac{(SFC)}{24\,\bar{\eta}_{th}\,B}$	CF

and the independent variables are:

$(CC)/P_{cap}$:	specific plant cost in $ per kwe plant capacity	SPC
FC:	fixed charge on capital equipt, $/$-yr	FC
LF:	plant load factor, $\bar{P}/P_{cap}$	PLF
$(CLMR)/P_{cap}$:	specific annual operating cost in $ per yr per kwe plant capacity	SOC
SFC:	specific fuel cost in $ per kgU	SFC
B:	fuel burnup in Mwd/kgU	B
$\bar{\eta}_{th}$:	avge net plant efficiency during load cycle	EFF

Since the specific annual operating cost, SOC, is small and predictable from the values in Table 5, it may be given an assigned value as follows:

SOC = \$4/kwe-yr for a 500 Mwe plant

SOC = \$3/kwe-yr for a 750 Mwe plant

SOC = \$2.50/kwe-yr for a 1000 Mwe plant

A parametric analysis of the generating cost of nuclear power is thus reduced to determining the effects of the six independent variables (PLF, SPC, FC, SFC, EFF, B) on the four dependent costs (CCAP, COP, CF and CTOT) in mills/kwh.

Varying each independent variable by the same percentage, we can determine the relative effect of each on the four costs; and by choosing the worst and the best combination of the six variables we can determine the lowest and highest cost of nuclear power generation.

6.0 COMPUTER PROGRAM: "ECOST"

A computer program is shown by which to perform the parametric analysis described in Section 5. The program assigns three values to each of the six independent variables, an initial (normal) value, and upper and lower abnormal values, as follows:

a) the six variables at normal value
b) each variable at minimum, one at a time
c) each variable at maximum, one at a time

} 13 cases in all

By suitable changes in the statements the effect of any other combination of the variables can be obtained.

Table 8 gives a complete list of all eleven variables in the program, with typical values and ranges of the independent variables used.

Table 8

Variables				
Independent		Units	"Normal" Value	Range*
SOC	Spec. operating cost	$/kwe-yr	2.50	± 0
PLF	Plant load factor	----	0.80	± 20%
SPC	Spec. plant cost	$/kwe	300	± 20%
FC	Fixed charge on capital	1/yr	0.15	± 20%
SFC	Spec. fuel cost	$/kgU	400	± 20%
EFF	Plant efficiency	kwe/kwt	0.35	± 20%
B	Burnup factor	Mwd/kgU	25.00	± 20%
Dependent				
CCAP	Capital cost of elec.	mills/kwh	To be found	
COP	Operating cost of elec.	mills/kwh	To be found	
CF	Fuel cost of elec.	mills/kwh	To be found	
CTOT	Total cost of electricity	mills/kwh	To be found	

*The variable PC is used in the program to compute any % range desired.

7.0 References

1. "The Nuclear Industry, 1971," USAEC Rept. Wash 1174-71.

2. "Basic Nuclear Engineering," 2nd Edition, Foster & Wright, Bacon and Allyn, 1973.

3. "Nuclear Powerplant Design Analysis" by A. Sesonske, USAEC TID-26241 1973.

4. "Analyzing Power Costs for Nuclear Plants" by L. Geller, J. F. Hogerton, and S. M. Stoller, Nucleonics, 22(7) 64(1964).

5. "The 1970 National Power Survey, Part I & IV, U.S. Federal Power Comm.

6. "Guide for Economic Evaluation of Nuclear Powerplant Designs," NUS Corporation, USAEC Rept. NUS-531 Jan/69.

7. "A New Era of Power Supply Economics" Power Engineering, Mar/70.

Fig. 1. TYPICAL LOAD CURVES

DELAWARE POWER & LIGHT CO. 1973

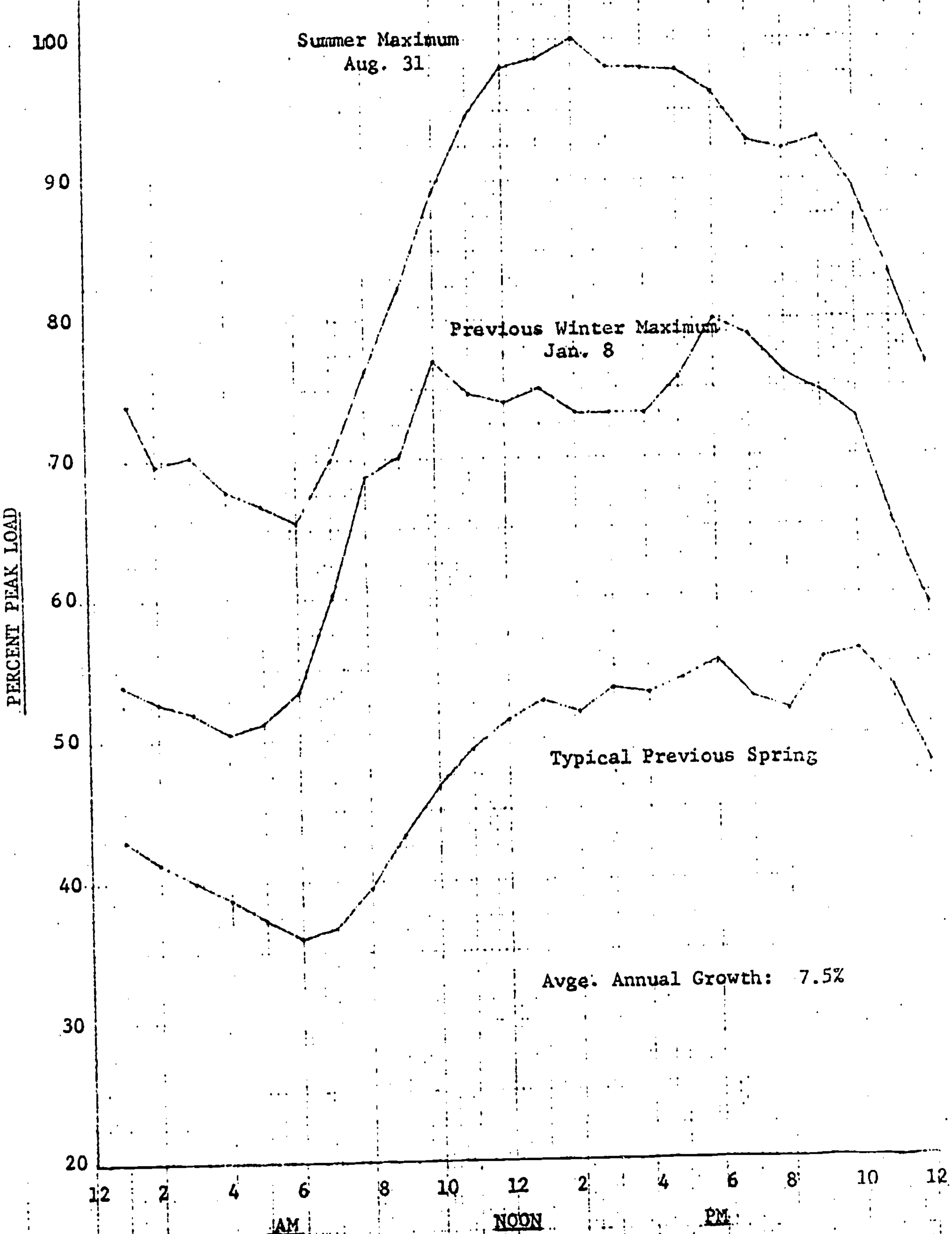
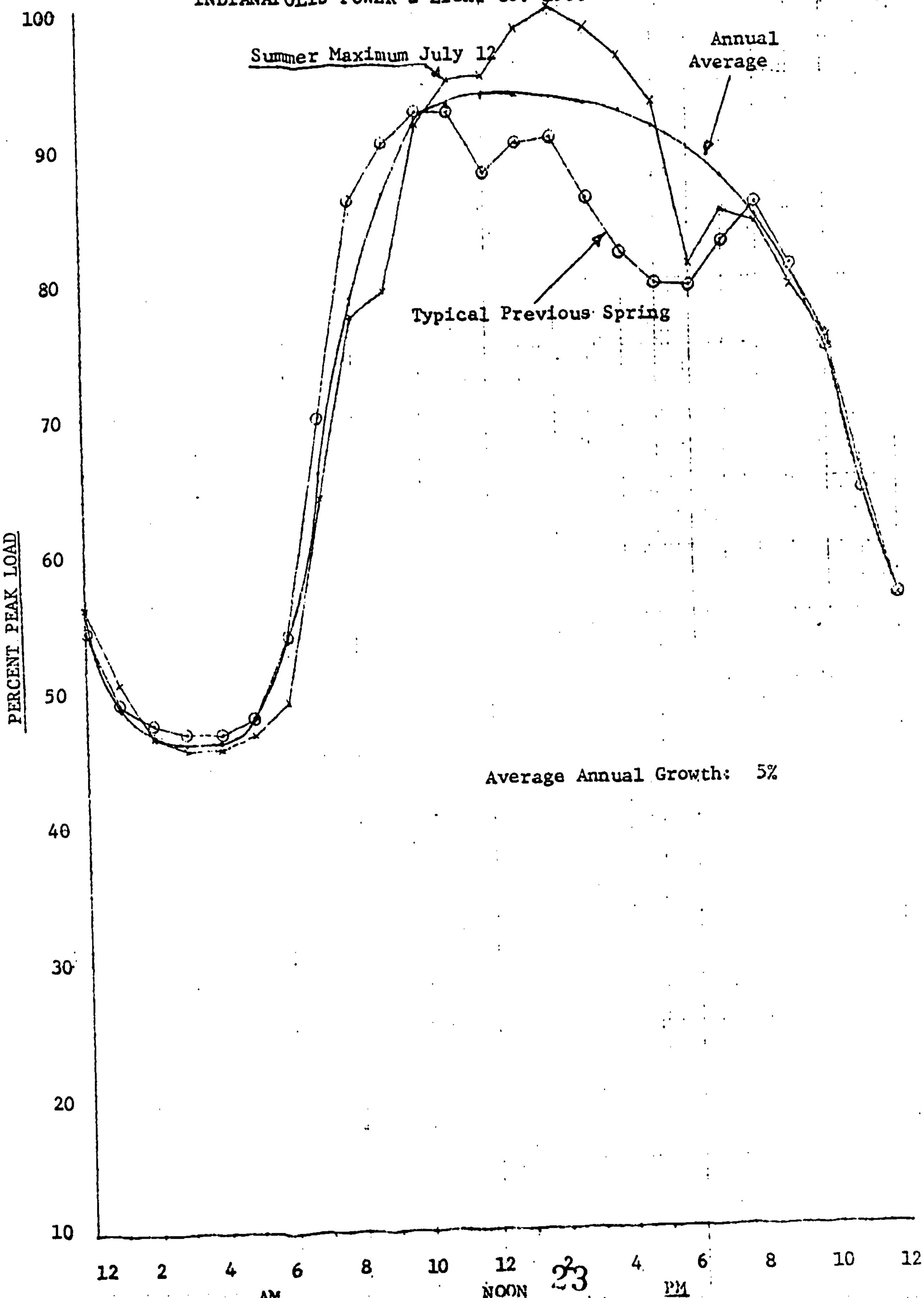


Fig. 2. TYPICAL LOAD CURVES

INDIANAPOLIS POWER & LIGHT CO. 1966



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//WATFIV        WHITELAW
C
C
C     PROGRAM ECOST CALCULATES (CTOT), THE TOTAL COST  OF ELECTRICITY
C     AND ITS COMPONENTS (CCAP), (COP), AND (CF) WHEN EACH OF THE
C     SIX PARAMETERS (PLF), (SPC), (FC), (SFC), (EFF) AND (B)
C     VARIES PLUS OR MINUS 20%.
C
      DIMENSION  CCAP(13),COP(13),CF(13),CTOT(13),PLF(13),SPC(13),FC(13)
     1   ,SFC(13),EFF(13),B(13)
C
C                         INITIALIZE VARIABLES
C
      READ (5,6) PC,SOC,PLF(1),SPC(1),FC(1),SFC(1),EFF(1),B(1)
      DO 1 I=2,13
      PLF(I)=PLF(1)
      SPC(I)=SPC(1)
      FC(I)=FC(1)
      SFC(I)=SFC(1)
      EFF(I)=EFF(1)
      B(I)=B(1)
1     CONTINUE
C
C                         SET OF VARIATIONS FOR CASES 2 - 13
C
      DO 2 I=1,2
      PLF(I+1)=PLF(I+1)*(1.+(PC*(-1.)**I))
      SPC(I+3)=SPC(I+3)*(1.+(PC*(-1.)**I))
      FC(I+5)=FC(I+5)*(1.+(PC*(-1.)**I))
      SFC(I+7)=SFC(I+7)*(1.+(PC*(-1.)**I))
      EFF(I+9)=EFF(I+9)*(1.+(PC*(-1.)**I))
      B(I+11)=B(I+11)*(1.+(PC*(-1.)**I))
2     CONTINUE
C
C                         CALCULATE COSTS
C
      DO 3 I=1,13
      CCAP(I)=SPC(I)*FC(I)/(8.766*PLF(I))
      COP(I)=SOC/(8.766*PLF(I))
      CF(I)=SFC(I)/(24.*EFF(I)*B(I))
      CTOT(I)=CCAP(I)+COP(I)+CF(I)
3     CONTINUE
C
C                         OUTPUT SECTION
C
      PC=PC*100.
      WRITE (6,4)
      WRITE (6,7) CCAP(1),COP(1),CF(1),CTOT(1)
      WRITE (6,8) CCAP(2),COP(2),CF(2),CTOT(2),PC
      WRITE (6,9) CCAP(3),COP(3),CF(3),CTOT(3),PC
      WRITE (6,10) CCAP(4),COP(4),CF(4),CTOT(4),PC
      WRITE (6,11) CCAP(5),COP(5),CF(5),CTOT(5),PC
      WRITE (6,12) CCAP(6),COP(6),CF(6),CTOT(6),PC
      WRITE (6,13) CCAP(7),COP(7),CF(7),CTOT(7),PC
      WRITE (6,14) CCAP(8),COP(8),CF(8),CTOT(8),PC
      WRITE (6,15) CCAP(9),COP(9),CF(9),CTOT(9),PC
      WRITE (6,16) CCAP(10),COP(10),CF(10),CTOT(10),PC
      WRITE (6,17) CCAP(11),COP(11),CF(11),CTOT(11),PC
      WRITE (6,18) CCAP(12),COP(12),CF(12),CTOT(12),PC
      WRITE (6,19) CCAP(13),COP(13),CF(13),CTOT(13),PC
```

```
      WRITE (6,5)
4     FORMAT (1H1,9(/),22X,28HTABLE OF COSTS (MILLS/KW-HR)///,5X,4HCCAP,
     111X,3HCOP,11X,2HCF,11X,4HCTOT,7X,12HCASE STUDIED)
5     FORMAT (1H1)
6     FORMAT (8F10.3)
7     FORMAT (/,4(4X,F5.2,5X),2X,9HBASE CASE)
8     FORMAT (/,4(4X,F5.2,5X),2X,6HPLF - ,F4.1,1H%)
9     FORMAT (/,4(4X,F5.2,5X),2X,6HPLF + ,F4.1,1H%)
10    FORMAT (/,4(4X,F5.2,5X),2X,6HSPC - ,F4.1,1H%)
11    FORMAT (/,4(4X,F5.2,5X),2X,6HSPC + ,F4.1,1H%)
12    FORMAT (/,4(4X,F5.2,5X),2X,5HFC - ,F4.1,1H%)
13    FORMAT (/,4(4X,F5.2,5X),2X,5HFC + ,F4.1,1H%)
14    FORMAT (/,4(4X,F5.2,5X),2X,6HSFC - ,F4.1,1H%)
15    FORMAT (/,4(4X,F5.2,5X),2X,6HSFC + ,F4.1,1H%)
16    FORMAT (/,4(4X,F5.2,5X),2X,6HEFF - ,F4.1,1H%)
17    FORMAT (/,4(4X,F5.2,5X),2X,6HEFF + ,F4.1,1H%)
18    FORMAT (/,4(4X,F5.2,5X),2X,4HB - ,F4.1,1H%)
19    FORMAT (/,4(4X,F5.2,5X),2X,4HB + ,F4.1,1H%)
      STOP
      END

//DATA
```

TABLE OF COSTS (MILLS/KW-HR)

CCAP	COP	CF	CTOT	CASE STUDIED
6.42	0.36	1.90	8.68	BASE CASE
8.02	0.45	1.90	10.37	PLF - 20.0%
5.35	0.30	1.90	7.55	PLF + 20.0%
5.13	0.36	1.90	7.39	SPC - 20.0%
7.70	0.36	1.90	9.96	SPC + 20.0%
5.13	0.36	1.90	7.39	FC - 20.0%
7.70	0.36	1.90	9.96	FC + 20.0%
6.42	0.36	1.52	8.30	SFC - 20.0%
6.42	0.36	2.29	9.06	SFC + 20.0%
6.42	0.36	2.38	9.15	EFF - 20.0%
6.42	0.36	1.59	8.36	EFF + 20.0%
6.42	0.36	2.38	9.15	B - 20.0%
6.42	0.36	1.59	8.36	B + 20.0%