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The Economics of Nuclear Power

by

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The Development of Competitive Nuclear Power in the U. S.

1. The U. S. civilian power reactor program initiated in 1950 involved the development of five types of power reactors for civilian use (PWR, aqueous homogeneous, fast breeder, BWR, SGR) ----- Figure 1
2. Total AEC expenditures for civilian power through 1958 amounted to ~\$280 million compared to \$440 million for naval propulsion reactors and \$300 million for aircraft propulsion
3. Present civilian reactor development program is becoming larger than mobile reactor program ----- Figure 2
4. More than ten reactor types being developed at the present time ----- Figure 3
5. Most U. S. power reactors in operation, being built, or planned are for mobile power, however ----- Figure 4
6. Forecasts of the growth of nuclear power in the U. S. indicate an installed nuclear electric capacity of from 30 to 200 thousand Mwe by 1980 (1 thousand Mwe = 1 million kilowatts) ----- Figure 5
This capacity corresponds to an investment of from about \$10 billion to \$50 billion.
7. U. S. civilian nuclear power program smaller than many other countries because of greater availability of cheap fossil fuels in the U. S. ----- Figure 6

Technical Feasibility vs. Economic Desirability

1. The technical feasibility of power reactor systems depends mainly on the following factors:
 - a. The compatibility of the coolant with the metals used for cladding fuel and/or fabricating the reactor structure and heat removal-steam generation system
 - b. The stability of the fuel and coolant under reactor operating conditions
 - c. The ability of the system to avoid conditions which lead to excessive temperatures and/or release of radioactivity

2. The economic desirability of power reactor systems depends on a completely different set of factors such as:
 - a. Thermal efficiency
 - b. Neutron economy
 - c. Fuel lifetime
 - d. Material economy
 - e. Unit fuel cycle costs
3. Most power reactor designs represent a compromise between maximum technical feasibility and maximum economic desirability since these two objectives cannot be optimized simultaneously

Short Range vs. Long Range Approaches

1. Short range approaches involve combinations of fuel, coolant, moderator, and structural materials which have benefit of sufficient experience to insure reliable long term operation of the plant. Only gases, water, or organics which permit the use of conventional metals such as aluminum, carbon steel, or stainless steel fall in this category. Although these coolants have less long range potential, indications are that their heat removal capabilities can be pushed to the point where power costs are competitive with fossil fuels.
2. Long range approaches are aimed at: (a) reduction in capital costs through use of high temperature-low pressure coolants, (b) improvement in neutron economy through use of D_2O as the moderator, and (c) reduction in fuel costs by plutonium recycle or by using fluid fuels. The longer range systems, therefore, are based on the more venturesome coolants such as high temperature gases, steam, liquid metals, molten salts, or uranium solutions or slurries.

Short Range Reactors

1. Objective is competitive power in foreign countries by 1967 and in the U. S. by 1970

2. Technical considerations
 - a. Coolant cladding compatibility limits coolants to gases, water, organics
 - b. For reasonable fuel life ($\sim 10,000$ MWD/T) Zr- UO_2 or S.S.- UO_2 elements appear best
3. Promising reactor types include PWR, BWR, OMR, GCR. Natural U- D_2O reactors may be developed for foreign market.
4. Capital cost data ----- Figure 7
 - a. First generation and prototype plants
 $\$/\text{kw} = 2500 P^{-1/3}$
 - b. Advanced systems
 $\$/\text{kw} = 1300 P^{-1/3}$
5. Fuel cost data
 - a. Initial fuel costs in large scale plants ----- Figure 8
 - b. Effect of enrichment and burn-up ----- Figure 9
 - c. Unit fuel cycle costs ----- Figure 10
 - d. Projected fuel cycle costs in BWR "target" plants
 - e. Rock-bottom fuel cycle costs in solid fuel D_2O reactors ----- Figure 11
6. Power costs
 - a. Estimate for plants in operation by 1964 ----- Figure 12
 - b. BWR and PWR "target" plants

Long Range Reactors

1. Objectives are: (1) substantial reductions in power costs by 1980, and (2) better utilization of uranium and thorium by breeding
2. Technical considerations
 - a. Reduction in capital costs through use of high temperature coolants such as gases, superheated steam, liquid metals, molten salts
 - b. Improvement in neutron economy by use of D_2O or graphite moderator, elimination of cladding, removal of poisons, etc.

- c. Reduction in fuel cycle costs by improved performance of solid fuels (i.e., higher power density, long life) or use of liquid fuels

The Oak Ridge National Laboratory Civilian Reactor Development Program

1. Gas cooled reactors are being developed for the short and intermediate range objectives and fluid fuel reactors (molten fluoride and aqueous homogeneous) for the long range objectives

Gas Cooled Graphite Reactors

1. Technology started with Calder Hall ----- Figure 13
Main problem is to obtain a high heat output per unit weight of fuel. The development of gas cooled reactor technology has been in the direction of higher gas temperatures and pressures, and higher power outputs. Best performance not possible with natural uranium.
2. Calder Hall plant complex ----- Figure 14
3. GCR-2 ----- Figure 15
4. Use of unclad fuel elements may be required in advanced systems. Characteristics of gas cooled reactors --- Figure 16

Molten Fluoride Reactors

1. Physical properties of molten fluorides ----- Figure 17
2. Advantages of molten fluorides include: (1) high temperature, low pressure, (2) compatibility with high nickel base alloys (INOR-8 alloy containing 6-8% chromium, 5% iron, 15-18% molybdenum, balance mainly nickel developed at ORNL now available commercially), and (3) high solubility of uranium and thorium in molten salt
3. Disadvantages include: (1) high melting point of fluoride, and (2) incompatibility of steam and salt
4. Molten fluoride power reactor characteristics ----- Figure 18
5. Comparative fuel costs in fluid fuel reactors ----- Figure 19
6. Breeding may be possible with molten salt reactors. Recent calculations indicate a breeding ratio of 1.08. Requires unclad graphite, however, which may be a problem.

Aqueous Homogeneous Reactors

1. Primary advantages are high breeding ratio and relatively high power output per unit weight of fuel and fertile material. Estimated breeding ratio is 1.13 for U-233-thorium cycle (based on 2.28 neutrons produced per neutron captured in U-233)
2. Types of homogeneous reactors include: (1) two region reactors with uranium solution core and thorium oxide suspension blanket or uranium-thorium oxide suspension core and thorium oxide blanket, and (2) one region reactors with slightly enriched uranium oxide suspension or uranium-thorium oxide suspension
3. Comparison of circulating fluid fuel reactors ----- Figure 20
4. Main technical problems are: (1) solution stability, (2) zirconium corrosion, (3) difficulty of circulating suspensions, and (4) maintenance of large scale radioactive equipment
5. Homogeneous breeder reactor ----- Figure 21
6. Capital costs
7. Fuel costs ----- Figure 22
8. Comparative power costs in homogeneous vs. solid fuel reactors ----- Figure 23
- Trend in Power Costs ----- Figure 24

Appendix

- Capital cost data ----- Table 1
Table 2

FIGURE 1

CUMULATIVE COSTS FOR AEC POWER REACTOR DEVELOPMENT PROGRAMS

Figure 2

AEC Budget for Reactor Development

	\$ millions		
	<u>1958</u>	<u>1959</u>	<u>1960</u>
AEC Civilian Reactors	71.9	88.6	89.1
Cooperative Program	7.2	17.4	16.5
Euratom Cooperation	-	2.0	9.0
General Research and Development	30.3	40.3	50.9
Merchant Ship	1.5	4.5	6.0
Army Power	5.4	8.0	11.0
Navy Propulsion	90.2	90.9	93.0
Aircraft	62.2	68.5	68.7
Missile	12.0	22.9	25.9
Satellite Power	3.4	7.0	12.1
Operational Services	<u>24.7</u>	<u>22.3</u>	<u>19.0</u>
TOTAL	308.8	372.4	401.2

Figure 3

AEC Reactor Development Program for FY 1960

<u>Reactor Type</u>	<u>Laboratory</u>	<u>\$millions</u>
PWR	Shippingport (Westinghouse)	20.0
BWR	Argonne	8.5
Pa Recycle (D ₂ O)	Hanford	5.0
Components Test (Nat U-D ₂ O)	Savannah River	5.0
SCR	Atomics International	11.0
OMR	Atomics International	6.0
FBR	Argonne (Idaho)	10.0
Gas Cooled	Kaiser - ACF - ORNL	13.0
Fluid Fuels	BNL - ORNL	<u>11.0</u>
TOTAL		89.5

Figure 4

U. S. Nuclear Reactors (as of December 31, 1958)

	<u>Operable</u>	<u>Being Built</u>	<u>Planned</u>
Civilian power	1	6	7
Reactor experiments	7	2	2
Export		2	3
Maritime propulsion		1	2
Naval propulsion	5	41	-
Military prototypes	<u>9</u>	<u>5</u>	<u>6</u>
Totals	22	57	20

PROJECTED GROWTHS OF U.S. NUCLEAR POWER

FIGURE 5

PROJECTED WORLD NUCLEAR POWER CAPACITY

<u>COUNTRY</u>	<u>MWE</u>		<u>PRINCIPAL REACTOR TYPES</u>
	<u>1965</u>	<u>1975</u>	
CANADA	700	2800	D ₂ O, ORGANIC
FRANCE	800	4000	GAS COOLED
WEST GERMANY	700	7500	VARIOUS
ITALY	1000	7000	GCR, PWR, BWR
JAPAN	700	7000	VARIOUS
NETHERLANDS	400	3000	VARIOUS
SWEDEN	250	2000	NAT. U - D ₂ O
UNITED KINGDOM	5500	30000	GAS COOLED
UNITED STATES	1600	20000	VARIOUS
USSR	2200	—	VARIOUS

FIGURE 6

Capital Costs of Nuclear Power Plants (Excluding Fuel)

FIGURE 7

Figure 8

Initial Fuel Costs of Large U. S. Nuclear Plants

Plant	Mills/kwhr			
	Inventory @ 4%, 9%	Burn-Up, Fabrication, Processing	Pu Credit @ \$30/g	Total Net Fuel Cost
Shippingport	3.2	32.1	1.8	33.5
Enrico Fermi	2.9	10.7	3.7	9.9
Consolidated Edison	1.6	5.3	-	6.9
Yankee	1.2	6.3	2.5	5.0
Dresden	1.2	4.3	2.0	3.5

Figure 10

Unit Fuel Cycle Costs in Slightly Enriched

Uranium Fueled Converter Reactors⁽¹⁾

Process	\$ / kg of Uranium	
	Present	Long Range
UF ₆ to UO ₂	20-30	8-10
UF ₆ to metal or alloy	15-18	3-7
Fabrication of stainless steel clad oxide	25-75	15-50
Fabrication of zirconium clad oxide	50-150	25-75
Cooling and shipping	8	8
Separation of Pu, U, and fission products	20-25	15
Uranium nitrate to UF ₆	5.60	3
Total (stainless steel clad)	80-140	50-90
Total (zirconium clad)	105-220	60-110

(1) Herron, D. P., et al., Geneva Paper 1044 (1958)

FUEL COSTS IN SOLID FUEL H₂O AND D₂O MODERATED REACTORS

TABLE I

PROJECTED FUEL CYCLE COST FOR FUTURE D₂O MODERATED, Pu RECYCLE REACTORS

<u>ITEMS</u>	<u>BASIS</u>	<u>FUEL COSTS</u> <u>mills/kwh</u>
FUEL INVENTORY	0.16 ton 1.5% U/Mwe, \$145/kg, 4% CHARGE	0.12
D ₂ O INVENTORY	0.5 ton/Mwe, \$61/kg 8% CHARGE	0.35
FUEL FABRICATION	\$55/kg (Zr CLAD ELEMENTS) 15,000 Mwd/T CYCLE	0.43
URANIUM BURN-UP	15,000 Mwd/T NATURAL U	0.30
PROCESSING AND SHIPPING	\$24/kg	0.18
FUEL AND D ₂ O LOSSES	2%	0.12
TOTAL		1.50

FIGURE 11

Figure 12

Comparison of Total Power Costs in Nuclear Plants - 1964 Basis

	<u>Boiling Water</u>		<u>Sodium Graphite</u>		<u>Gas Cooled-Graphite</u>	
					<u>Natural</u>	<u>Enriched</u>
EMW	190	580	205	637	162	558
Plant capital charges at 80% load, 15%	4.8	4.2	5.7	4.5	8.1	5.0
First core capital charge	0.3	0.3	0.1	0.1	0.3	0.2
Net fuel cost, \$12 per gram of Pu	3.0	3.0	2.9	2.9	3.3	2.3
Operation and maintenance	<u>0.9</u>	<u>0.6</u>	<u>1.2</u>	<u>0.8</u>	<u>1.1</u>	<u>0.8</u>
Total, mills/kwhr	9.0	8.1	9.9	8.3	12.8	8.3

Simplified schematic diagram of coolant circuit.

FIGURE 13

The World's Reactors No. 6—CALDER HALL

KEY

- A. Biological and thermal shield cooling circuits
- C. Coolant circuits
 - 1. Heat exchanger
 - 2. Discharge machine
 - 3. Charge machine
 - 4. Travelling crane
 - 5. Cask storage tubes
 - 6. Discharge well
 - 7. Cross-transverse pit
 - 8. Graphite probe
 - 9. Flask lid
 - 10. Transport flask
 - 11. "A" frames
 - 12. Inlet manifold
 - 13. Pressure vessel
 - 14. Thermal shield
 - 15. Biological shield
 - 16. Diagrid
 - 17. Support plates
 - 18. Graphite
 - 19. Restraint rings
 - 20. Bursting detection tubes
 - 21. Charge tubes
 - 22. Control actuating mechanisms
 - 23. Shield plug
 - 24. Motorized duct valves
 - 25. Exhaust fans
 - 26. Duct bellows
 - 27. Cooling air filters
 - 28. HE. circulating pump
 - 29. Main CO₂ blower
 - 30. CO₂ purification plant
 - 31. Blower motor
 - 32. Pump motor
 - 33. Low-pressure steam drum
 - 34. High-pressure steam drum
 - 35. Ward-Leonard set
 - 36. Stand-by diesel generators
 - 37. Diesel auxiliaries
 - 38. Fuel-preparation room
 - 39. Bursting detection room
 - 40. Control room
 - 41. Cable gallery
 - 42. Battery room
 - 43. Switch room

FIGURE 14

FIGURE 15

ORNL GAS-COOLED REACTOR PROJECT

Figure 16

Characteristics of Gas Cooled-Graphite Reactors

	<u>Calder</u> <u>Hall</u>	<u>Hinkley</u> <u>Point</u>	<u>ORNL</u> <u>GCR-2</u>	<u>Kaiser-ACF</u> <u>Prototype</u>	<u>GA-HTGCR</u> <u>Prototype</u>	<u>ORNL</u> <u>HGCR-1</u>
Power, Mwe	35	250	215	26	40	1130
Fuel	U metal	U metal	UO ₂	UO ₂	ThC-UC-C	UO ₂ -C
Type of Element	Mg clad finned rod	Mg clad finned rod	S.S. clad 7-rod cluster	S.S. clad 7-rod cluster	Unclad 7-rod cluster	Unclad plates
Enrichment, %	0.7	0.7	2.0	2.0	95	2
Specific Power, Mw/MT	1.4	2.7	5.0	7.6	83	36.2
Vessel Diam., ht, ft	37 x 70	80	50	20 x 46	14 x 35	50
Fuel Surface Temp., °F	766	850	1200	1300	2370	2000
Gas Pressure, psia	110		300	315	300	300
Gas Exit Temp., °F	637	707	1000	1050	1382	1500
Net Station Eff., %	19	25.5	32.1	30.9	34.8	36.5

PHYSICAL PROPERTIES OF MOLTEN FLUORIDES

COMPOSITION mole %	MELTING POINT °C	DENSITY AT 600°C g/cc	HEAT CAPACITY AT 700°C cal/g	VISCOSITY AT 600°C CENTIPOISES	THERMAL CONDUCTIVITY Btu/hr (ft) °F
NaF-ZrF ₄ -UF ₄ (50-46-4)	520	3.37	0.26	8.5	1.3
LiF-BeF ₂ -UF ₄ (67-30.5-2.5)	464	2.14	0.57	8.4	
NaF-BeF ₂ -UF ₄ (55.5-42-2.5)	400	2.28	0.46	10.5	~2.4
LiF-NaF-KF (46.5-11.5-42)	454	2.09	0.45	8.5	2.6

-20-

FIGURE 17

MOLTEN FLUORIDE POWER REACTOR CHARACTERISTICS

POWER, MW	
ELECTRIC	260
HEAT	640
FUEL CONSTITUENTS	$\text{Li}^7\text{F}-\text{BeF}_2-\text{ThF}_4-\text{UF}_4$
MOLE %	(62-37-1-0.3)
U-235 ENRICHMENTS, %	93
BLANKET CONSTITUENTS	$\text{Li}^7\text{F}-\text{BeF}_2-\text{ThF}_4$
MOLE %	(71-16-13)
FUEL INVENTORY, kg U-235	600
CRITICAL MASS, CLEAN, kg U-235	267
CONVERSION RATIO, INITIAL	0.63
CORE DIAMETER, ft.	8
BLANKET THICKNESS, ft.	2
STRUCTURAL MATERIAL	
FUEL CIRCUIT	INOR-8
SECONDARY CIRCUIT	316 SS
EXIT FUEL TEMPERATURE, °F	1210 AT 83 psia
STEAM, °F/psia	1000/1800
THERMAL EFFICIENCY	40.6%

FIGURE 18

**PROJECTED FUEL CYCLE COSTS FOR NONAQUEOUS FLUID
FUEL REACTORS (315 MWE)**

<u>ITEMS</u>	<u>MILLS/KWHR</u>			
	<u>U-235 THORIUM MOLTEN SALT FUEL</u>	<u>1.4% ENRICHED MOLTEN SALT FUEL</u>	<u>U-235 THORIUM SINGLE REGION LIQUID METAL FUEL</u>	<u>U-235 THORIUM TWO REGION LIQUID METAL FUEL</u>
FUEL AND FERTILE MAT'L. USE CHARGE AT 4%	0.52	0.42	0.28	0.27
BISMUTH OR SALT INVENTORY AT 8%	0.09	0.10	0.13	0.11
SALT AMORTIZATION	0.09	0.11		
U-235 BURN-UP	0.58	0.79	0.49	0.28
PROCESSING AND SHIPPING	0.04*	0.23**	0.27	0.69
TOTAL	1.32	1.65	1.17	1.35

*PROCESSING AT END OF 9 YEARS

**PROCESSING AT END OF 4.5 YEARS

FIGURE 19

CIRCULATING FLUID FUEL REACTORS

<u>DESIGNATION</u>	<u>NUCLEAR FUEL</u>	<u>FUEL SYSTEM</u>	<u>FERTILE MATERIAL</u>	<u>MODERATOR</u>	<u>COOLANT</u>
U-235 BURNER	U-235	UO ₂ SO ₄	NONE	H ₂ O, D ₂ O	H ₂ O, D ₂ O
THORIUM BREEDER	U-233	UO ₃ , UO ₂ SO ₄	ThO ₂	D ₂ O	D ₂ O
HOMOGENEOUS CONVERTER	U-235 Pu-239	UO ₃	U-238	D ₂ O	D ₂ O
HOMOGENEOUS PLUTONIUM PRODUCER	U-235	UO ₂ SO ₄	U-238	D ₂ O	D ₂ O
LAPRE TYPE	U-235	UO ₂ +H ₃ PO ₄	NONE	H ₃ PO ₄	H ₃ PO ₄
HOMOGENEOUS MOLTEN FLUORIDE	U-235 U-233	LiF+BeF ₂ +UF ₄	ThF ₄	BeF ₂	MOLTEN FLUORIDE
HETEROGENEOUS MOLTEN FLUORIDE	U-235 U-233	LiF+BeF ₂ +UF ₄	ThF ₄	GRAPHITE	MOLTEN FLUORIDE
AIRCRAFT REACTOR EXPERIMENT	U-235	NaF+ZrF ₄ +UF ₄	NONE	BeO	MOLTEN FLUORIDE
LIQUID METAL FUELED	U-233	U+Bi	Th ₃ Bi ₅ +Bi	GRAPHITE	Bi

FIGURE 20

AQUEOUS HOMOGENEOUS THORIUM BREEDER REACTOR SYSTEM

FIGURE 21

FUEL COSTS FOR LARGE SCALE HOMOGENEOUS REACTORS (125 MWE CAPACITY)

<u>FUEL COST, mills/kwh</u>	<u>TWO REGION</u>		<u>ONE REGION SLURRY</u>	
	<u>SOLN. CORE</u>	<u>SLURRY CORE</u>	<u>ThO₂</u>	<u>UO₃ + PuO₂</u>
FUEL INVENTORY AT 4%	0.16	0.21	0.39	0.07
D ₂ O INVENTORY PLUS LOSSES AT 12%	0.33	0.33	0.60	0.45
U BURN-UP LESS F.M. CREDIT	-0.29	-0.26	-0.04	0.48
CHEMICAL PROCESSING	<u>1.01</u>	<u>1.01</u>	<u>0.95</u>	<u>1.08</u>
TOTAL FUEL COST	1.21	1.29	1.90	2.08

FIGURE 22

POWER COSTS IN LARGE SCALE NUCLEAR PLANTS

	<i>PWR (YANKEE)</i>	<i>BWR (DRESDEN)</i>	<i>GAS COOLED (HUNTERSTON)</i>	<i>AQUEOUS BREEDER (ORNL)</i>
CAPITAL COST, \$/kw	340	290	400	385
	<i>mills/kwh</i>			
FUEL INVENTORY CHARGES	1.3	0.8	0.7	0.6
D ₂ O INVENTORY	0	0	0	0.3
FUEL FABRICATION	1.1	1.7	0.4	0
CHEMICAL REPROCESSING	0.4	0.3	0.3	1.1
U BURN-UP LESS F. M. CREDIT	1.2	1.0	0.7	-0.3
<i>TOTAL NET FUEL COST</i>	4.0	3.8	2.1	1.7
CAPITAL COST	6.3	5.4	7.4	7.2
OPERATING COST	1.0	1.0	1.0	1.0
POWER COST	11.3	10.2	10.5	9.9

*BASIS, 13% ANNUAL CHARGES ON INVESTMENT, 8% CHARGES ON FUEL INVENTORIES, 80%
LOAD FACTOR, 140 - 200 Mw ELECTRICAL CAPACITY*

FIGURE 23

FIGURE 24

DAVIS-RODDIS FORECAST OF POWER
COST TRENDS, MARCH, 1957

TABLE 1

CAPITAL COSTS OF FIRST GENERATION AND PROTOTYPE NUCLEAR POWER PLANTS

<u>Plant Name</u>	<u>Reactor Type</u>	<u>Net Capability MWE</u>	<u>Unit Cost \$/Kw (net)</u>	<u>Status</u>	<u>Reference</u>
Shippingport	PWR	100	725	Operating	Nucleonics <u>16</u> , No. 4, (1958)
Indian Point	PWR	151 ⁽¹⁾	510	Construction	Geneva Paper 1885
Yankee	PWR	134	415	Construction	"Management and Atomic Energy," AIF-NICB, July 1958
APPR-1	PWR	1.9	2,000	Operating	APPR Contract, AT(11-1)-318
APPR-1a	PWR	3	1,780	Construction	Nucleonics <u>17</u> , No. 2, p. 57
Dresden	BWR	180	> 285	Construction	"Management and Atomic Energy," p. 362 July 1958
Elk River	BWR	15 ⁽²⁾	670	Construction	Nucleonics <u>16</u> , No. 6 p. 24
Northern States	BWR	62	463	Construction	Geneva Paper 1852
SENN	BWR	150	387	Design	Nucleonics <u>16</u> , No. 10, p. 26
Kaiser-ACF	GCR	44	960	Design Study	IDO-2023, Rev. 1
Kaiser-ACF	GCR	215	410	Design Study	IDO-2024, Rev. 1
ORNL-GCR-2	GCR	225	372	Design Study	ORNL-2500, April 1958
General Atomics	GCR	40	612	Design Study	
Hallam	SGR	75	570	Construction	Nucleonics <u>15</u> , No. 10, p. 25
Piqua	OMR	11.4	770 ⁽³⁾	Construction	Geneva Paper 606
Enrico Fermi	FBR	90	537	Construction	El. World, April 1958
GNEC	CO ₂ -D ₂ O	50	517	Design	Nucleonics <u>16</u> , No. 1, p. 17
CVNPA	D ₂ O	17	1,000	Design	Nucleonics <u>16</u> , No. 6, p. 25
Chugach	SDR	10	1,110	Design	AIF Memo, April 1958

(1) 104 MWE from oil-fired superheater not included

(2) 7 MW from oil-fired superheater not included

(3) Turbine plant cost added to bid price

TABLE 2

ESTIMATED CAPITAL COSTS OF ADVANCED NUCLEAR POWER PLANTS

<u>Plant Type</u>	<u>Net Capability MWE</u>	<u>Unit Cost \$/Kw</u>	<u>Reference</u>
PWR	1	2,100	"Management and Atomic Energy," AIF-NICB, June 1958, p. 89
(Package Reactors)	2	1,500	"Management and Atomic Energy," AIF-NICB, June 1958, p. 89
	5	^a 1,100	"Management and Atomic Energy," AIF-NICB, June 1958, p. 89
	125	250	"Management and Atomic Energy," AIF-NICB, June 1958, p. 142
	2	1,100	"Management and Atomic Energy," AIF-NICB, June 1958, p. 110
BWR	5	850	Nucleonics <u>16</u> , No. 11, p. 19
	15	666	Nucleonics <u>16</u> , No. 11, p. 25
	60	384	Nucleonics <u>16</u> , No. 11
	200	275	Nucleonics <u>17</u> , No. 1, p. 49
	300	200	Nucleonics <u>17</u> , No. 1, p. 49
FBR	150	350	"Management and Atomic Energy," June 1958, p. 357
	300	280	"Management and Atomic Energy," June 1958, p. 357
Pebble Bed	125	254	NYOO-8753, Vol. I, May 1958
SGR	150	300	Atoms International
	300	230	(Personal communication)
OMR	100	280	Geneva Paper 606
LMFR	315	225	Geneva Paper 2355
Molten Fluoride	260	268	Geneva Paper 605
Nat. U - D ₂ O	200	275	Geneva Paper 208, 209
Thorium Breeder	315	285-407	Fluid Fuel Reactors

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