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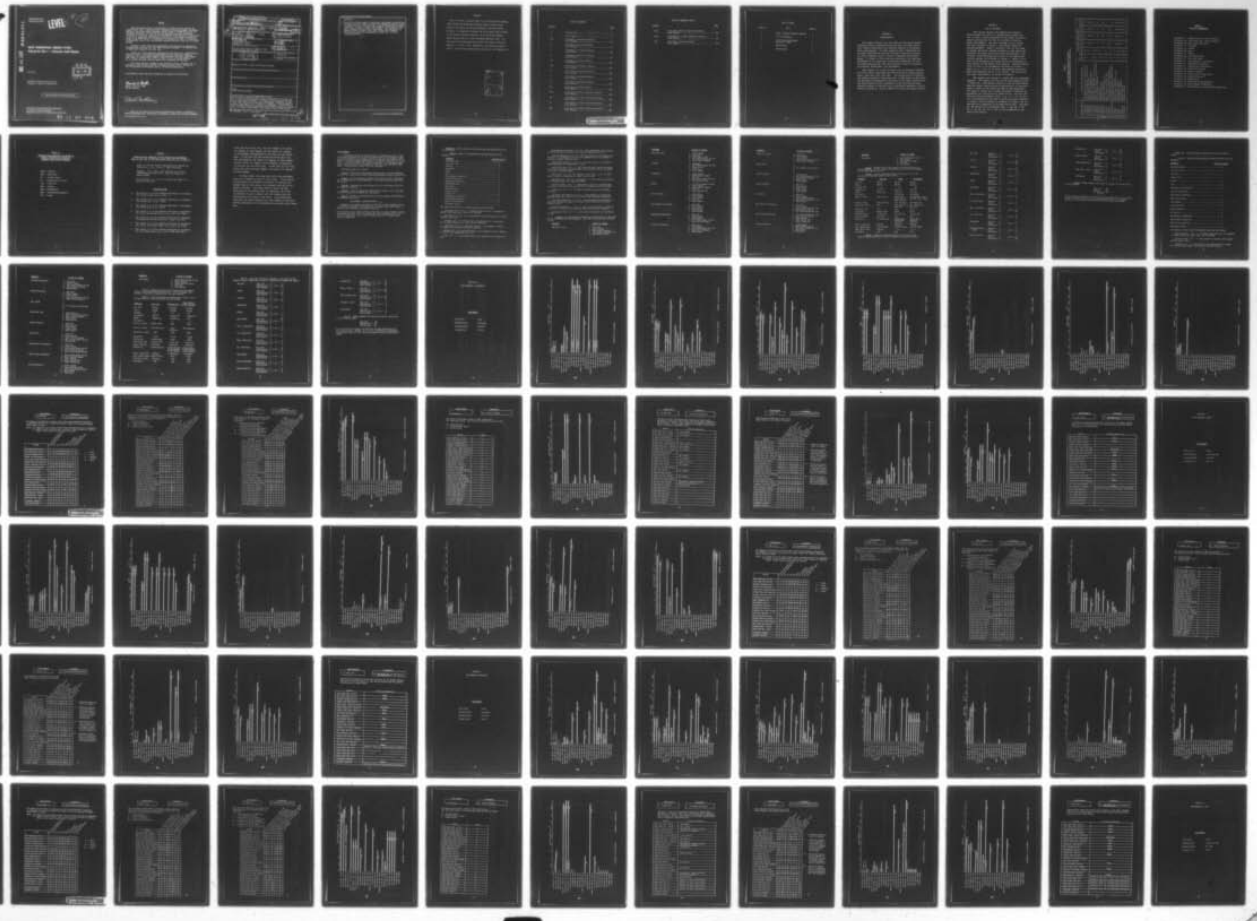

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Volume III, Part 1

LEVEL II

USAF TERRESTRIAL ENERGY STUDY

Volume III, Part 1 — Summary Data Display

MAY 1978

TECHNICAL REPORT AFAPL-TR-78-19
Final Report – April 1976 - February 1978

AIR FORCE AERO PROPULSION LABORATORY
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

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Section I of this report was accomplished by the Energy Conversion Branch Aerospace Power Division, Air Force Aero Propulsion Laboratory. Lt. David C. Hall is technically responsible for the work.

Section II of this report was submitted by Burns & Roe, Inc., under Contract F33615-77-C-3159. The effort was sponsored by the Air Force Aero Propulsion Laboratory, Air Force Systems Command, Wright-Patterson AFB, Ohio, under Project 3145, Task 23, and Work Unit 12 with Lt. David C. Hall as Project Engineer. Dr. A. Carlson of Burns & Roe was technically responsible for the work.

This report has been reviewed by the Information Office, (ASD/OIP) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

David C. Hall

David C. Hall, Lt, USAF
Project Engineer

Robert R Barthelemy

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This report was prepared by Burns & Roe, Inc. to serve as a guide for the U.S. Air Force in selecting types of energy conversion systems to meet their future ground power requirements. The electric power requirements included in this report range from 10 kilowatts to 50 megawatts. Twenty-one types of systems, conventional as well as advanced, are considered. These include 19 types of energy conversion systems which utilize either chemical fuel, nuclear fuel, solar energy or wind energy and two types of energy storage systems

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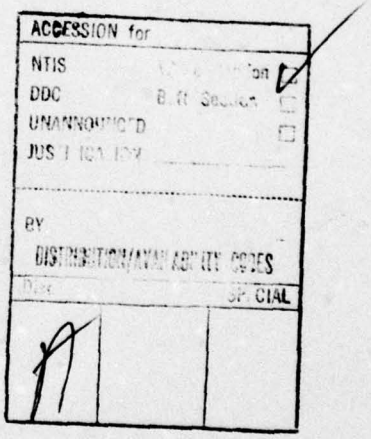
which utilize electric power for recharging. Each system is characterized in terms of a set of economic, physical and performance parameters including acquisition costs, life cycle costs, size, efficiency and environmental constraints. A total of eighteen such parameters are presented for each type of system for several sets of requirements. The requirements are defined in terms of electric power level, voltage level, frequency and duration of operation corresponding to typical U.S. Air Force ground applications.

FOREWORD

This is the final Technical Report on the USAF Terrestrial Energy Study conducted by the Energy Conversion Branch, Aerospace Power Division. The effort was jointly sponsored by the Power Systems Division, U.S. Department of Energy, and the Aerospace Power Division, Air Force Aero Propulsion Laboratory, Air Force Systems Command, Wright Patterson AFB, Ohio under Interagency Agreement #1013. The work herein was accomplished under Project 3145, Task 23, Work Unit Number 12. Lt David C. Hall, AFAPL/POE, is the responsible project officer. The work was accomplished by Burns & Roe, Inc. Woodbury, NY.



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SECTION I

INTRODUCTION

This report details over two years of work by the Energy Conversion Branch, Aerospace Power Division, on USAF terrestrial energy requirements and possible methods of satisfying those requirements. Our main objective was to determine how the USAF could achieve the most efficient terrestrial energy use state possible, both in terms of resources and mission impact. In order to fully meet this objective, the governing parameters of the study were formulated considering not only the technology options, but also practical areas of logistics, utilization, maintenance, and management.

This report is in three sections plus an Executive Summary. The first section describes the USAF terrestrial energy requirements, both base level and lower. The second section indicates the energy conversion technology that is applicable to USAF needs and includes a comprehensive data base on all these technologies. The third section gives a breakdown of the technologies most generally useful to the USAF and a preliminary estimate of their amount of potential, both in numbers of units and energy savings.

SECTION II

USE OF THE REPORT

This Volume contains the Summary Data Display which presents the data in a format which enables the user to make a rapid comparison of the energy conversion system alternatives for each of the sets of electric power requirements. The data included in this volume are also included in Volume I, the Energy Conversion Systems Handbook. Table I contains a list of the types of energy conversion systems included in this report and indicates the power levels for which each system is considered. Brief descriptions of each of the energy conversion systems are included in Volume I. Table II is a list of the parameters for which charts are presented in each chapter of the Summary data display. Detailed definitions of each of the parameters are given in Volume I. Table III is a list of the power requirements which have been established by the U. S. Air Force. Definitions of the power requirements are given in Volume I.

The Summary Data Display is subdivided into seventeen chapters: one chapter for each of the requirements listed in Table III. Each chapter contains a set of charts which show the values (quantitative or qualitative) of the parameters. There is one chart for each of the parameters. Two types of charts are included according to whether the parameters are qualitative or quantitative. The data for the qualitative parameters (Nos. 7, 8, 9, 11, 13, 14 and 17) are presented in the form in which they were presented in Volume I and the reader is referred to Volume I for an explanation of meanings of the qualitative data. The data for the quantitative parameters (Nos. 1, 2A, 2B, 3, 4A, 4B, 5, 6A, 6B, 10, 12, 15 and 16) are presented in the form of bar charts.

TABLE 1

TYPES OF ENERGY CONVERSION SYSTEMS
AND CORRESPONDING ELECTRICAL POWER LEVELS

Energy Source	Energy Conversion System	ELECTRICAL POWER LEVELS					
		50 Mw	10 Mw	750 kw	250 kw	50 kw	10 kw
1) Chemical	Gas Turbine Generator (simple cycle)	X	X	X	X	X	X
2) Chemical	Gas Turbine Generator (regenerative)	X	X				
3) Chemical	Diesel Engine Generator		X	X	X	X	X
4) Chemical	Spark Ignition Engine Generator			X	X	X	X
5) Chemical	Fuel Cell - Phosphoric Acid	X	X	X	X	X	X
6) Chemical	Steam Turbine Generator (coal fired)	X	X	X			
7) Chemical	Steam Turbine Generator (oil/gas fired)	X	X				
8) Chemical	Stirling Engine Generator		X	X	X	X	X
9a) Chemical	MHD Generator	X	X				
9b) Chemical	MHD/Steam Generator	X					
10a) Chemical	Thermionic Generator			X	X	X	X
10b) Chemical	Thermionic/Steam Generator	X	X				
11) Nuclear	Steam Turbine Generator (PWR)	X					
12) Nuclear	Organic Vapor Turbine Generator			X	X	X	
13) Nuclear	Gas Turbine Generator (closed cycle)	X	X	X	X	X	
14) Radioisotope	Gas Turbine Generator (closed cycle)						X
15) Solar	Steam Turbine Generator	X	X				
16) Solar	Organic Vapor Turbine Generator			X	X	X	X
17) Solar	Gas Turbine Generator	X	X	X	X	X	X
18) Solar	Photovoltaic System	X	X	X	X	X	X
19) Wind	Wind Turbine Generator		X	X	X	X	X
20) External	Flywheel Storage	X	X			X	X
21) External	Battery Storage	X	X			X	X

TABLE 2

LIST OF PARAMETERS

Parameter 1. Acquistion Cost (1977 dollars)
Parameter 2A. Life Cycle Cost (1977 dollars)
Parameter 2B. Life Cycle Cost/Year
Parameter 3. Lifetime
Parameter 4A. Volume
Parameter 4B. Area
Parameter 5. Weight
Parameter 6A. Fuel Amount/Year
Parameter 6B. Fuel Cost/Year
Parameter 7. Environmental Constraints
Parameter 8. Location Constraints
Parameter 9. Operational Constraints
Parameter 10. System Efficiency
Parameter 11. Type of System
Parameter 12. Start-up/Shut-down Times
Parameter 13. Growth Potential
Parameter 14. Reliability
Parameter 15. Maintenance and Operation
Parameter 16. Other Energy Production
Parameter 17. Availability of Raw Building Materials

TABLE 3

U.S. AIR FORCE GROUND POWER REQUIREMENTS INCLUDED IN REPORT

	Power Level	Operating Mode	Frequency/Phase	Voltage Level
1.	50 Mw	Continuous	60 Hz/3Ø	13.8 kv
2.	50 Mw	1 hour per day	60 Hz/3Ø	13.8 kv
3.	10 Mw	Continuous	60 Hz/3Ø	4160 V
4.	10 Mw	8 hours per day	60 Hz/3Ø	4160 V
5.	10 Mw	1 hour per day	60 Hz/3Ø	4160 V
6.	750 kw	Continuous	60 Hz/3Ø	4160 V
7.	250 kw	Continuous	60 Hz/3Ø	480 V
8.	50 kw	Continuous	60 Hz/3Ø	480 V
9.	50 kw	8 hours per day	60 Hz/3Ø	480 V
10.	50 kw	1 hour per day	60 Hz/3Ø	480 V
11.	10 kw	Continuous	DC	28 V
12.	10 kw	Continuous	60 Hz/3Ø	240 V
13.	10 kw	Continuous	60 Hz/1Ø	240 V
14.	10 kw	Continuous	60 Hz/1Ø	120 V
15.	10 kw	8 hours per day	DC	28 V
16.	10 kw	8 hours per day	60 Hz/3Ø	240 V
17.	10 kw	1 hour per day	60 Hz/3Ø	240 V

On each bar chart, the requirement and the parameter in question are stated at the bottom of the chart. The scale varies from chart to chart and is indicated at the top of each chart. The energy conversion systems are shown in a column at the left side of each chart. The abbreviations employed in the names of the systems are defined in Table IV. There is one bar for each system considered to be appropriate for the indicated requirement and parameter. If no bar is shown for a given system, this means that the system was not considered to be suitable for the indicated requirement and parameter.

The years for which the data are established for each system are shown under each bar. For example, if the data for a particular system are established for the years 1977, 1985 and 1990, then the notation A)77 B)85 C)90 would appear under the bar for that system. The bar itself will then, in general, contain the letters A, B and C to indicate the values of the parameter in question for each of the three designated years. However, since each bar is composed of finite segments or boxes, it is possible for the data for more than one of the designated years to fall within the same segment. When this occurs, a code is employed to indicate which of the dates falls into a particular segment.

The code is summarized in Table V and works in the following manner. If the data for the first and second years fall into one segment, the letter "D" appears in that segment and the letter "C" appears in the segment corresponding to the data for the third year. If the data for the

TABLE 4

ABBREVIATIONS EMPLOYED IN NAMES OF ENERGY CONVERSION SYSTEMS IN SUMMARY DATA DISPLAY CHARTS

TURB = Turbine

GEN = Generator

SC = Simple Cycle

RC = Regenerative Cycle

IGN = Ignition

ENG = Engine

PHOS = Phosphoric

MHD = Magnetohydrodynamic

VAP = Vapor

TABLE 5

ABBREVIATIONS EMPLOYED IN BAR CHARTS FOR PARAMETER NOS. 1, 2A, 2B, 3, 4A, 4B, 5, 6A, 6B, 10, 12, 15 AND 16

Dates of initial system implementation denoted by letters A)__, B)__ and C)__ below each bar.

Example: A)77, B)85, C)90 denotes the initial implementation dates 1977, 1985 and 1990 for a given system.

The letters A, B, C, D, E, F and G may appear as parts of each bar.

ABBREVIATIONS

1. The letter A in a bar denotes magnitude of parameter for initial date (e.g., 1977).

2. The letter B in a bar denotes magnitude of parameter for second date (e.g., 1985).

3. The letter C in a bar denotes magnitude of parameter for third date (e.g., 1990).

4. The letter D in a bar denotes magnitude of parameter for first and second dates (e.g., 1977 and 1985).

5. The letter E in a bar denotes magnitude of parameter for second and third dates (e.g., 1985 and 1990).

6. The letter F in a bar denotes magnitude of parameter for first and third dates (e.g., 1977 and 1990).

7. The letter G in a bar denotes magnitude of parameter for all three dates (e.g., 1977, 1985 and 1990).

first and third years fall into one segment, the letter "F" appears in that segment and the letter "B" appears in the segment corresponding to the data for the second year. If the data for the second and third years fall into one segment, the letter "E" appears in that segment and the letter "A" appears in the segment corresponding to the data for the first year. If the data for all three years fall into the same segment, the letter "G" appears in that segment.

In many cases, the range over which the parameters vary for a single bar chart is very large. If the scales of the charts are selected on the basis of fitting the largest bars on the charts, the shortest bars may be too small to discern. For those cases in which the data exhibited by the shortest bars is important, the scale is selected in such a manner that the largest bars may extend beyond the range of the chart. Such excessively long bars are shown extending the full length of the chart and the magnitudes of the parameters are printed under these bars.

LOGIC EXAMPLE

To illustrate the use of this data base, two examples are given. The first example demonstrates the preferred method used in selecting an energy conversion system for a site where reliability and cost are important parameters. The second example demonstrates the preferred method used for a site where low logistics burden (fuel delivery, manpower) is of paramount importance. The site used for both examples is the test range near Nellis AFB, Nevada. The power level chosen is 250 KW continuous.

The method used is as follows:

Step #1. Establish an appropriate weighting factor for each parameter. Use a 0 to 10 scale, with the most important parameters having a factor of 10.

Step #2. Use the appropriate Summary Data Display charts to determine the top five systems for each parameter. List them in priority order from one to five.

Step #3. Determine the three systems that are consistently in the six most important parameters.

Step #4. Using the appropriate Handbook data charts, fill in the quantitative or qualitative numbers for each system.

Step #5. Combine the weighting factors and the numbers from Step #4 by the equation shown below.

DATA NUMBER x WEIGHTING FACTOR = ____

Step #6. Add together the results of Step #5 for each parameter to get a total for each system. The system with the lowest total is the "best" system for your particular requirement and site.

This procedure should enable personnel requiring an energy conversion system to establish the best one or two systems for their particular need. Once this is accomplished, a more rigorous design study of the chosen system should be undertaken.

EXAMPLE #1 - 250 KW continuous system requiring high reliability and low life cycle cost.

Step #1. Establish the appropriate weighting factors for each parameter.

PARAMETER	WEIGHTING FACTOR
Acquisition Cost	6
Life Cycle Cost	10
Lifetime	8
Volume/Size	1
Weight	1
Fuel	7
Environmental Constraints	3
Location Constraints	1
Operational Constraints	8
System Efficiency	3
Type System	0
Start/Stop Time	0
Growth Potential	4
Reliability	10
Maintenance and Operation	1
Other Energy Production	5
Materials Availability	0
Development Status	4

The reasons for each choice of weighting factor are given below.

Acquisition Cost - W.F. = 6. A higher acquisition cost is acceptable if greater reliability and/or lower LCC is provided.

Life Cycle Cost - W.F. = 10. The system is to provide power at the lowest possible overall cost.

Lifetime - W.F. = 8. The facility to be powered will be a remote site and the power system is to be built into the structure.

Volume/Size - W.F. = 1. The power system is to be permanent. However, the system must be truck transported to the site.

Weight - W.F. = 1. The power system is to be permanently fixed. However, it must be truck transported to the site.

Fuel - W.F. = 7. The necessary fuel for the system must be trucked to the site.

Environmental Constraints - W.F. = 3. Some consideration is to be given to pollution; however, the site is a necessary communications link.

Location Constraints - W.F. = 1. The power system is to be used at only one site. If the system was to be used at numerous sites, this paramater would have a higher weighting factor.

Operational Constraints - W.F. = 8. The power system is to be able to operate unattended for long periods of time.

System Efficiency - W.F. = 3. The system efficiency impacts the amount of fuel used (for fossil fueled systems) or the physical size of the systems (for solar or nuclear systems).

Type System - W.F. = 0. The system is to be fixed. Any of the three systems (mobile, transportable, or fixed) could be used.

Start/Stop Time - W.F. = 0. The system is to be in continuous operation, with emergency backup for unexpected outages.

Growth Potential - W.F. = 4. Some growth of the site is expected and, if possible, the existing power system will be expanded to meet that growth.

Reliability - W.F. = 10. The power system must operate with minimum down time.

Maintenance and Operation - W.F. = 1. This parameter is covered, for this particular case, under the LCC and Operational Constraints parameters.

Other Energy Production - W.F. = 5. A system capable of providing both electrical and thermal energy in the proper proportions would be the most energy efficient.

Materials Availability - W.F. = 0. Only one of this system is necessary. If more were to be built, this parameter would assume greater importance.

Development Status - W.F. = 4. This system is scheduled to be purchased in FY82.

Step #2. Use the appropriate Summary Data Display charts to determine the top five systems for each parameter. List them in priority order from one to five.

PARAMETER	LISTING OF SYSTEMS
Acquisition Cost	1. Fuel Cell 2. Diesel Engine 3. Spark Ignition Engine 4. Gas Turbine Engine (SC, CF) 5. Wind Turbine (20-5)

PARAMETER	LISTING OF SYSTEMS
Life Cycle Cost	1. Diesel Engine 2. Fuel Cell 3. Wind Turbine (20-1) 4. Gas Turbine Engine (SC, CF) 5. Spark Ignition Engine
Lifetime	1. Thermionic 2. Gas Turbine Engine (SC, CF) 3. Solar Turbine 4. Fuel Cell 5. Diesel Engine
Volume/Size	1. Diesel Engine 2. Spark Ignition Engine 3. Fuel Cell 4. Gas Turbine Engine (SC, CF) 5. Wind Turbine (20-1)
Weight	1. Gas Turbine Engine (SC,CF) 2. Diesel Engine 3. Spark Ignition Engine 4. Fuel Cell 5. Vapor Turbine (NF)
Fuel (Use/Year)	1. Wind Turbine 2. Photovoltaics 3. Solar Turbine 4. Fuel Cell 5. Diesel Engine
Environmental Constraints	1. Fuel Cell 2. Photovoltaics 3. Wind Turbine 4. Radioisotope 5. Solar Turbine
Operational Constraints	1. Fuel Cell 2. Diesel Engine 3. Wind Turbine 4. Gas Turbine Engine (SC,CF) 5. Spark Ignition Engine
Location Constraints	1. Fuel Cell 2. Diesel Engine 3. Gas Turbine Engine (SC, CF) 4. Spark Ignition Engine 5. Radioisotope

PARAMETER	LISTING OF SYSTEMS
System Efficiency	1. Fuel Cell 2. Diesel Engine 3. Wind Turbine 4. Gas Turbine Engine (SC, CF) 5. Spark Ignition Engine
Type System	1. 2. 3. All systems could be used 4. 5.
Start/Stop Time	1. Diesel Engine 2. Gas Turbine Engine (SC, CF) 3. Spark Ignition Engine 4. Wind Turbine 5. Photovoltaics
Growth Potential	1. Fuel Cell 2. Photovoltaics 3. Wind Turbine 4. Diesel Engine 5. Radioisotope
Reliability	1. Fuel Cell 2. Diesel Engine 3. Spark Ignition Engine 4. Gas Turbine Engine (SC, CF) 5. Radioisotope
Maintenance and Operation	1. Fuel Cell 2. Diesel Engine 3. Gas Turbine Engine (SC, CF) 4. Spark Ignition Engine 5. Gas Turbine Engine (SC, NF)
Other Energy Production	1. Gas Turbine Engine (SC, CF) 2. Spark Ignition Engine 3. Solar Turbine 4. Vapor Turbine (NF) 5. Diesel Generation
Building Materials	1. Diesel Engine 2. Spark Ignition Engine 3. Gas Turbine Engine (SC, CF) 4. Wind Turbine 5. Thermionics

PARAMETER	LISTING OF SYSTEMS
Development	1. Gas Turbine Engine (SC, CF) 2. Diesel Engine 3. Spark Ignition Engine 4. Fuel Cell 5. Wind Turbine

Step #3. Determine the top three systems that consistently show up in the parameters. For this example, the systems are Fuel Cells, Diesel Engines, and Gas Turbine Engines (SC,CF).

Step #4. Using the appropriate Handbook data charts, fill in the quantitative or qualitative data for each system.

PARAMETER	FUEL CELL	DIESEL	GAS TURBINE
Acq. Cost	$60,000	$35,000	$90,000
LCC/Yr.	$66,400	$64,700	$120,200
Lifetime (Yrs)	20	20	29
Volume/Size	300 $ft.^3$	200 $ft.^3$	150 $ft.^3$
Weight	18,800 lb_m	7,100 lb_m	4,500 lb_m
Fuel Use/Yr.		115,000 gal.	210,000 gal.
Environ. Constr.	Therm. Disch.	Therm. Disch. CO,HC, NO_x, SO_x Part., Noise	Hi-Temp Therm. Disch. NO_x, SO_x, Part., Noise
Location Constr.	Fuel Deliveries	Fuel Deliveries	Fuel Deliveries
Operational Constr.	None	Eff. reduction at part load	Eff. reduction at part load
System Eff. (%)	36.7	30.6	17.5
Type System	Transportable	Mobile	Mobile
Start/Stop Time	3 hrs/45 min	10 sec/10 sec	10 sec/1 min.
Growth Potential	Excellent	None	None
Reliability	No moving parts	Moving parts, medium temp., corrosion	Moving parts, high temp., corrosion
Maint. & Operation	$3373/yr	$6925/yr	$6205/yr
Other Energy Prods.	$778x10^3$ BTU/hr	$1.16x10^6$ BTU/hr	$2.41x10^6$ BTU/hr
Bldg. Matls. Avail.	Platinum	-------	-------
Development	1980	1977	1977

Step #5. Using the information contained in the chart and the weighting factors established in Step #1, determine the appropriate numbers.

Acq. Cost	Fuel Cell	- 2		12
	Diesel	- 1	x W.F. =	6
	Gas Turbine	- 3		18
LCC/yr	Fuel Cell	- 2		20
	Diesel	- 1	x W.F. =	10
	Gas Turbine	- 3		30
Lifetime	Fuel Cell	- 1		8
	Diesel	- 1	x W.F. =	8
	Gas Turbine	- 2		16
Volume/Size	Fuel Cell	- 3		3
	Diesel	- 2	x W.F. =	2
	Gas Turbine	- 1		1
Weight	Fuel Cell	- 3		3
	Diesel	- 2	x W.F. =	2
	Gas Turbine	- 1		1
Fuel Use/yr	Fuel Cell	- 1		7
	Diesel	- 2	x W.F. =	14
	Gas Turbine	- 3		21
Envir. Constraints	Fuel Cell	- 1		3
	Diesel	- 2	x W.F. =	6
	Gas Turbine	- 3		9
Loc. Constraints	Fuel Cell	- 1		1
	Diesel	- 2	x W.F. =	2
	Gas Turbine	- 2		2
Oper. Constraints	Fuel Cell	- 0		0
	Diesel	- 2	x W.F. =	16
	Gas Turbine	- 2		16
Sys. Efficiency	Fuel Cell	- 1		3
	Diesel	- 2	x W.F. =	6
	Gas Turbine	- 3		9
Type System	Fuel Cell	- 2		0
	Diesel	- 1	x W.F. =	0
	Gas Turbine	- 1		0
Start-up/Shutdown Time	Fuel Cell	- 3		0
	Diesel	- 1	x W.F. =	0
	Gas Turbine	- 2		0
Growth Potential	Fuel Cell	- 1		4
	Diesel	- 4	x W.F. =	16
	Gas Turbine	- 4		16

Reliability	Fuel Cell	- 1		10
	Diesel	- 4	x W.F. =	40
	Gas Turbine	- 4		40
Maint. & Oper.	Fuel Cell	- 1		1
	Diesel	- 3	x W.F. =	3
	Gas Turbine	- 2		2
Other Energy Prod.	Fuel Cell	- 3		15
	Diesel	- 2	x W.F. =	10
	Gas Turbine	- 1		5
Bldg. Matl. Avail.	Fuel Cell	- 4		0
	Diesel	- 1	x W.F. =	0
	Gas Turbine	- 1		0
Development	Fuel Cell	- 2		8
	Diesel	- 0	x W.F. =	0
	Gas Turbine	- 0		0

Step #6. Adding together the results of Step #5, one arrives at the following totals:

Fuel Cell - 98
Diesel - 141
Gas Turbine - 186
(SC, CF)

For this particular example, the fuel cell has been determined to be the optimal system. However, this is only a preliminary determination. Each engineer should go into much greater detail before choosing a particular system.

EXAMPLE #2 - 250 KW continuous system requiring a low logistics burden.

Step #1. Establish the appropriate weighting factors for each parameter.

PARAMETER	WEIGHTING FACTOR
Acquisition Cost	5
Life Cycle Cost	5
Lifetime	7
Volume/Size	1
Weight	1
Fuel	10
Environmental Constraints	3
Location Constraints	1
Operational Constraints	6
System Efficiency	3
Type System	0
Start/Stop Time	0
Growth Potential	4
Reliability	9
Maintenance and Operation	8
Other Energy Production	5
Materials Availability	0
Development Status	4

The reasons for each choice of weighting factor are given below.

Acquisition Cost - W.F. = 5. A higher acquisition cost is acceptable if greater reliability and/or lower LCC is provided.

Life Cycle Cost - W.F. = 6. The system is to provide at the lowest possible overall cost.

Lifetime - W.F. = 7. The facility to be powered will be a remote site and the power system is to be built into the structure.

Volume/Size - W.F. - 1. The power system is to be permanent. However, the system must be truck transported to the site.

Weight - W.F. = 1. The power system is to be permanently fixed. However, it must be truck transported to the site.

Fuel - W.F. = 10. The necessary fuel for the system must be trucked to the site. This is the largest logistics burden for the system.

Environmental Constraints - W.F. = 3. Some consideration is to be given to pollution; however, the site is a necessary communications link.

Location Constraints - W.F. = 1. The power system is to be used at only one site. If the system was to be used at numerous sites, this parameter would have a higher weighting factor.

Operational Constraints - W.F. = 6. The power system is to be able to operate unattended for long periods of time. Adequate solar insulation and a 10 mph average wind speed is available at the site.

System Efficiency - W.F. = 3. The system efficiency impacts the amount of fuel used (for fossil fueled systems) or the physical size of the systems (for solar or nuclear systems). If physical size of a power system is unimportant, the W.F. for this parameter for them should be zero.

Type System - W.F. = 0. The system is to be fixed. Any of the three systems (mobile, transportable, or fixed) could be used.

Start/Stop Time - W.F. = 0. The system is to be in continuous operation, with emergency backup for unexpected outages.

Growth Potential - W.F. = 4. Some growth of the site is expected and, if possible, the existing power system will be expanded to meet that growth.

Reliability - W.F. = 9. The power system must operate with minimum down time.

Maintenance and Operation - W.F. = 8. This parameter covers the second largest logistics burden for a power system.

Other Energy Production - W.F. = 5. A system capable of providing both electrical and thermal energy in the proper proportions would be the most energy efficient.

Materials Availability - W.F. = 0. Only one of this system is necessary. If more were to be built, this parameter would assume greater importance.

Development Status - W.F. = 4. This system is scheduled to be purchased in FY85.

Step #2. Use the appropriate Summary Data Display charts to determine the top five systems for each parameter. List them in priority order for one to five.

PARAMETER	LISTING OF SYSTEMS
Acquisition Cost	1. Fuel Cell 2. Diesel Engine 3. Spark Ignition Engine 4. Gas Turbine Engine (SC,CF) 5. Wind Turbine (20-5)
Life Cycle Cost	1. Diesel Engine 2. Fuel Cell 3. Wind Turbine (20-1) 4. Gas Turbine Engine (SC,CF) 5. Spark Ignition Engine
Lifetime	1. Thermionic 2. Gas Turbine Engine (SC,CF) 3. Solar Turbine 4. Fuel Cell 5. Diesel Engine
Volume/Size	1. Diesel Engine 2. Spark Ignition Engine 3. Fue Cell 4. Gas Turbine Engine (SC,CF) 5. Wind Turbine (20-1)
Weight	1. Gas Turbine Engine (SC,CF) 2. Diesel Engine 3. Spark Ignition Engine 4. Fuel Cell 5. Vapor Turbine (NF)
Fuel (Use/Year)	1. Wind Turbine 2. Photovoltaics 3. Solar Turbine 4. Fuel Cell 5. Diesel Engine
Environmental Constraints	1. Fuel Cell 2. Photovoltaics 3. Wind Turbine 4. Radioisotope 5. Solar Turbine
Operational Constraints	1. Fuel Cell 2. Diesel Engine 3. Wind Turbine 4. Gas Turbine Engine (SC,CF) 5. Spark Ignition Engine

PARAMETER	LISTING OF SYSTEMS
Location Constraints	1. Fuel Cell 2. Diesel Engine 3. Gas Turbine Engine (SC,CF) 4. Spark Ignition Engine 5. Radioisotope
System Efficiency	1. Fuel Cell 2. Diesel Engine 3. Wind Turbine 4. Gas Turbine Engine (SC,CF) 5. Spark Ignition Engine.
Type System	1. 2. 3. All systems could be used 4. 5.
Start/Stop Time	1. Diesel Engine 2. Gas Turbine Engine (SC,CF) 3. Spark Ignition Engine 4. Wind Turbine 5. Photovoltaics
Growth Potential	1. Fuel Cell 2. Photovoltaics 3. Wind Turbine 4. Diesel Engine 5. Radioisotope
Reliability	1. Fuel Cell 2. Diesel Engine 3. Spark Ignition Engine 4. Gas Turbine Engine (SC,CF) 5. Radioisotope
Maintenance and Operation	1. Fuel Cell 2. Diesel Engine 3. Gas Turbine Engine (SC,CF) 4. Spark Ignition Engine 5. Gas Turbine Engine (SC,NF)
Other Energy Production	1. Gas Turbine Engine (SC,CF) 2. Spark Ignition Engine 3. Solar Turbine 4. Vapor Turbine (NF) 5. Diesel Generation
Building Materials	1. Diesel Engine 2. Spark Ignition Engine 3. Gas Turbine Engine (SC,CF) 4. Wind Turbine 5. Thermionics

PARAMETER	LISTING OF SYSTEMS
Development	1. Gas Turbine Engine (SC,CF) 2. Diesel Engine 3. Spark Ignition Engine 4. Fuel Cell 5. Wind Turbine

Step #3. Determine the top three systems that consistently show up in the high priority parameter(s). For this example, the systems are Fuel Cells, Photovoltaics, and Wind Turbines.

Step #4. Using the appropriate Handbook data charts, fill in the quantitative or qualitative data for each system.

PARAMETER	FUEL CELL	PHOTOVOLTAICS	WIND TURBINE (10 MPH Avg Wind)
Acq. Cost	60,000	2,730,000	781,000
LCC/Yr.	64,000	409,000	92,700
Lifetime	20	10	20
Volume/Size	300 ft^3	125,000 ft^2	49,300 ft^2
Weight	18,800 lb_m	755,000 lb_m	N/A
Fuel Use/Yr		0	0
Environ. Constr.	Therm. Disch.	None	None
Location Constr.	Fuel Deliveries	Solar Insolation	Wind Required
Operational Constr.	None	None	None
System Eff.	36.7%	10-15%	20-28%
Type System	Transportable	Fixed	Fixed
Start/Stop Time	3 hrs/45 mins.	1 sec/1 sec	1 sec/1 sec
Growth Potential	Excellent	Excellent	Excellent
Reliability	No moving parts	no moving parts system exposed to environment	moving parts system exposed to environment
Maint. & Operation	$3373/yr	$136,000/yr	$53,660/yr
Other Energy Prods.	778x10^3 BTU/hr	None	None
Bldg Matls. Avail.	Platinum	Lead	Lead
Development	1980	1985	1985

Step #5. Using the information contained in the chart and the weighting factors established in Step #1, determine the appropriate numbers.

Acq Cost	Fuel Cell	- 1		5
	Photovoltaics	- 3	x N.F. =	15
	Wind Turbine	- 2		10
LCC/YR	Fuel Cell	- 1		5
	Photovoltaics	- 3	x N.F. =	15
	Wind Turbine	- 2		10
Lifetime	Fuel Cell	- 1		7
	Photovoltaics	- 2	x W.F. =	14
	Wind Turbine	- 1		7
Volume/Size	Fuel Cell	- 1		1
	Photovoltaics	- 3	x W.F. =	3
	Wind Turbine	- 2		2
Weight	Fuel Cell	- 1		1
	Photovoltaics	- 2	x W.F. =	2
	Wind Turbine	- 2		2
Fuel Use/YR	Fuel Cell	- 2		20
	Photovoltaics	- 0	x W.F. =	0
	Wind Turbine	- 0		0
Envir. Constraints	Fuel Cell	- 1		3
	Photovoltaics	- 0	x W.F. =	0
	Wind Turbine	- 0		0
Loc. Constraints	Fuel Cell	- 1		1
	Photovoltaics	- 3	x W.F. =	3
	Wind Turbine	- 3		3
Oper. Constraints	Fuel Cell	- 0		0
	Photovoltaics	- 0	x W.F. =	0
	Wind Turbine	- 0		0
Sys. Efficiency	Fuel Cell	- 1		3
	Photovoltaics	- 3	x W.F. =	9
	Wind Turbine	- 2		6
Type System	Fuel Cell	- 1		0
	Photovoltaics	- 1	x W.F. =	0
	Wind Turbine	- 1		0
Start-up/Shutdown	Fuel Cell	- 2		0
	Photovoltaics	- 1	x W.F. =	0
	Wind Turbine	- 1		0
Growth Potential	Fuel Cell	- 1		4
	Photovoltaics	- 1	x W.F. =	4
	Wind Turbine	- 1		4

Reliability	Fuel Cell	- 2		18
	Photovoltaics	- 1	x W.F. =	9
	Wind Turbine	- 3		27
Maint. & Oper.	Fuel Cell	- 1		8
	Photovoltaics	- 3	x W.F. =	24
	Wind Turbine	- 2		16
Other Energy Prod.	Fuel Cell	- 0		0
	Photovoltaics	- 2	x W.F. =	10
	Wind Turbine	- 2		10
Bldg Matl. Avail.	Fuel Cell	- 2		0
	Photovoltaics	- 1	x W.F. =	0
	Wind Turbine	- 1		0
Development	Fuel Cell	- 1		4
	Photovoltaics	- 1	x W.F. =	4
	Wind Turbine	- 1		4

Step #6. Adding together the results of Step #5, one arrives at the following totals:

Fuel Cell	- 80
Photovoltaics	- 112
Wind Turbine	- 101

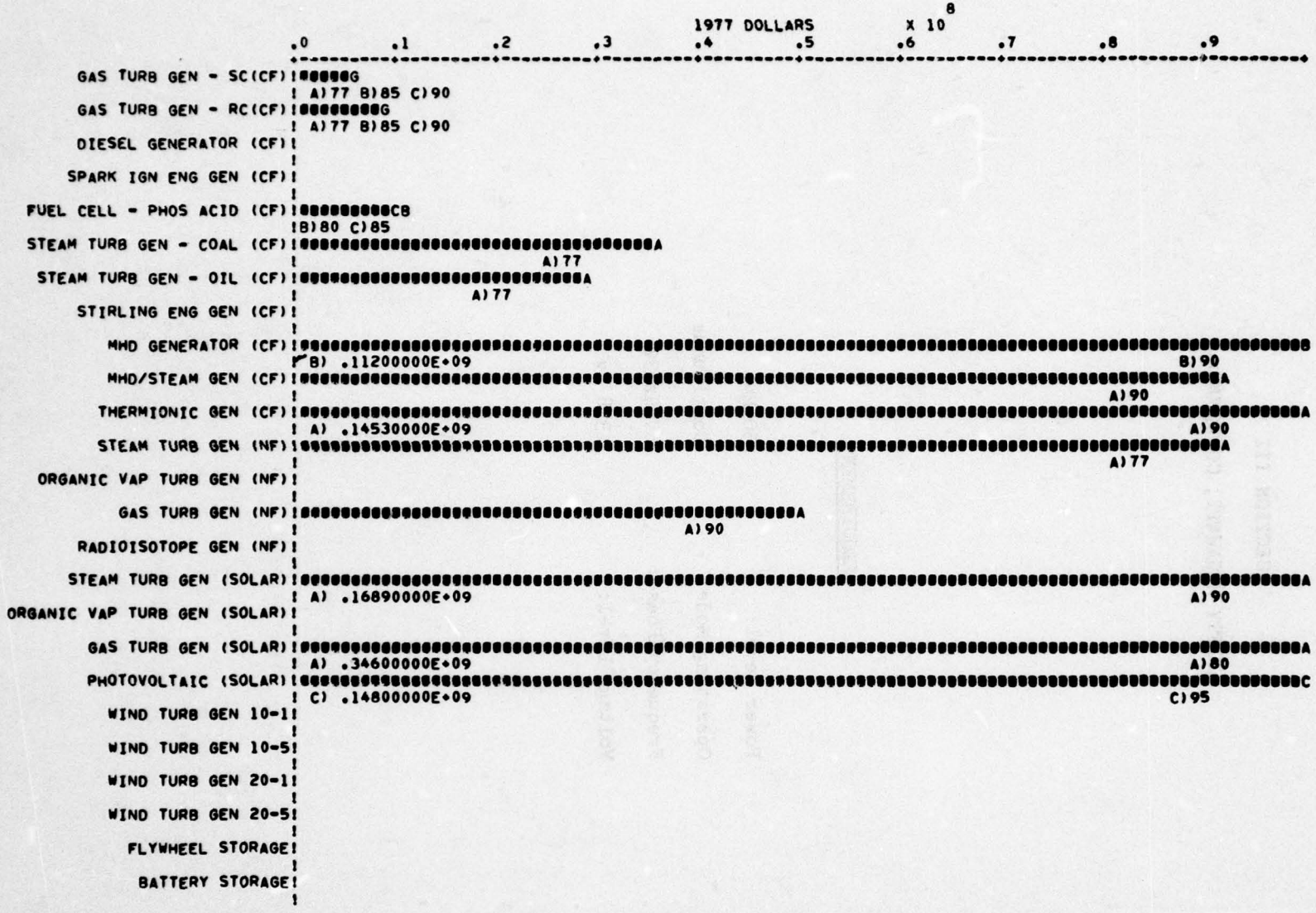
For this particular example, the fuel cell has been determined to be the optimal system. However, this is only a preliminary determination. Each engineer should go into much greater before choosing a particular sytems.

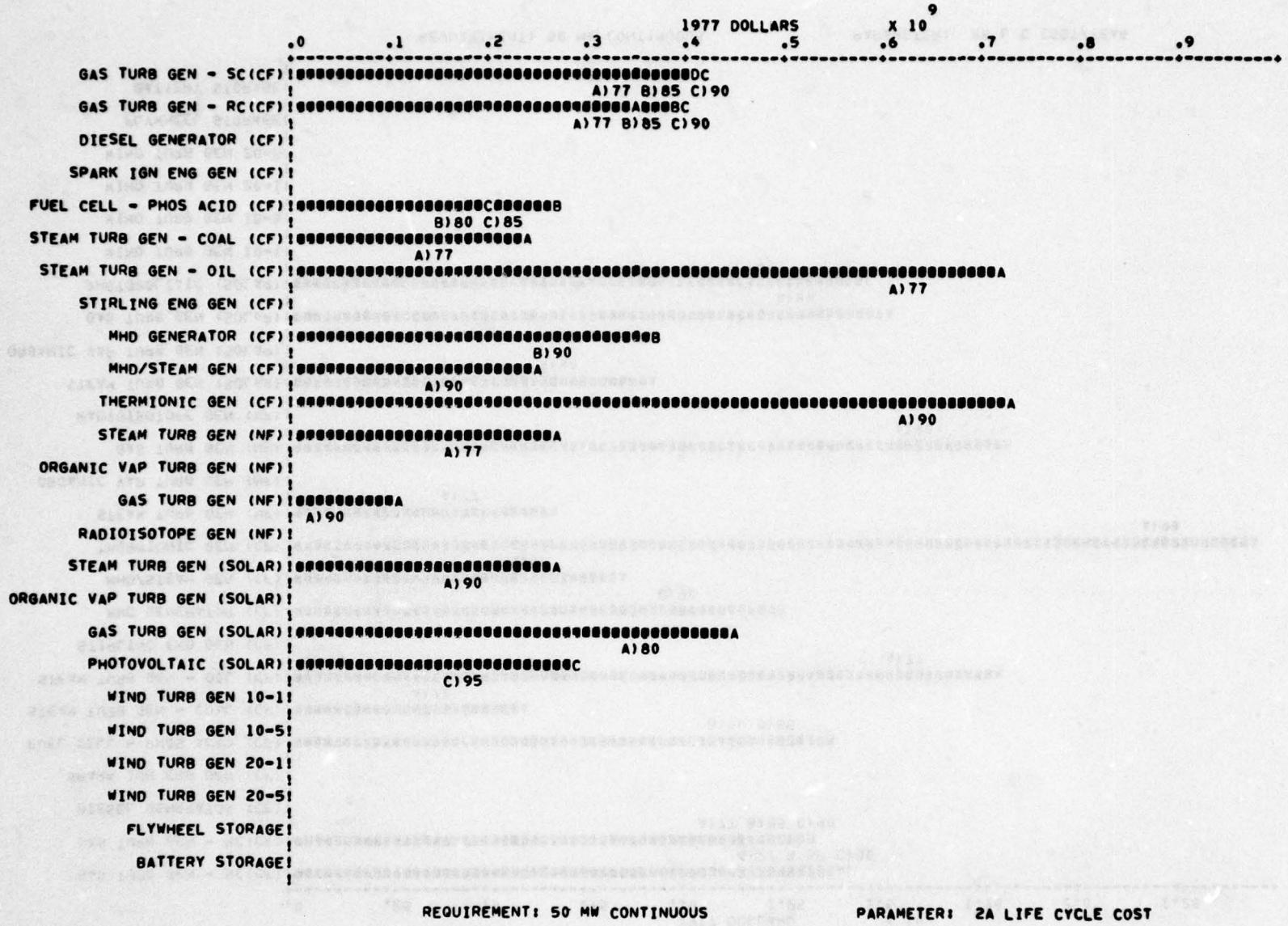
SECTION III

FIFTY MEGAWATT, CONTINUOUS

REQUIREMENT

Power Level:	50 Mw
Operating Mode:	Continuous
Frequency/Phase:	60 Hz/3Ø
Voltage Level:	13.8 Kv


1977 DOLLARS
x 10^8
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
B) .11200000E+09
B)90
MHD/STEAM GEN (CF)
A)90
THERMIONIC GEN (CF)
A) .14530000E+09
A)90
STEAM TURB GEN (NF)
A)77
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A) .16890000E+09
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A) .34600000E+09
A)80
PHOTOVOLTAIC (SOLAR)
C) .14800000E+09
C)95
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 MW CONTINUOUS
PARAMETER: 1 ACQUISITION COST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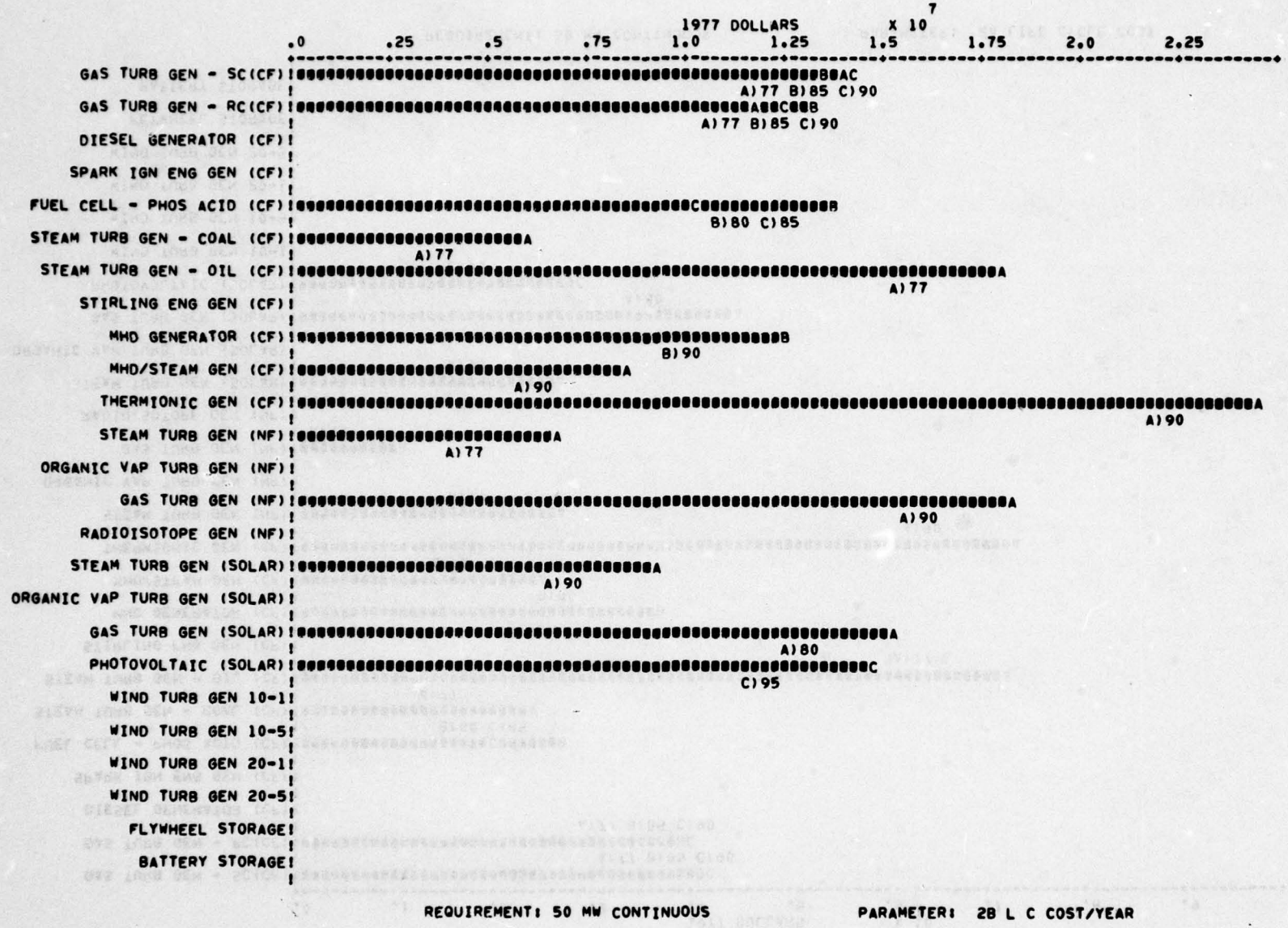
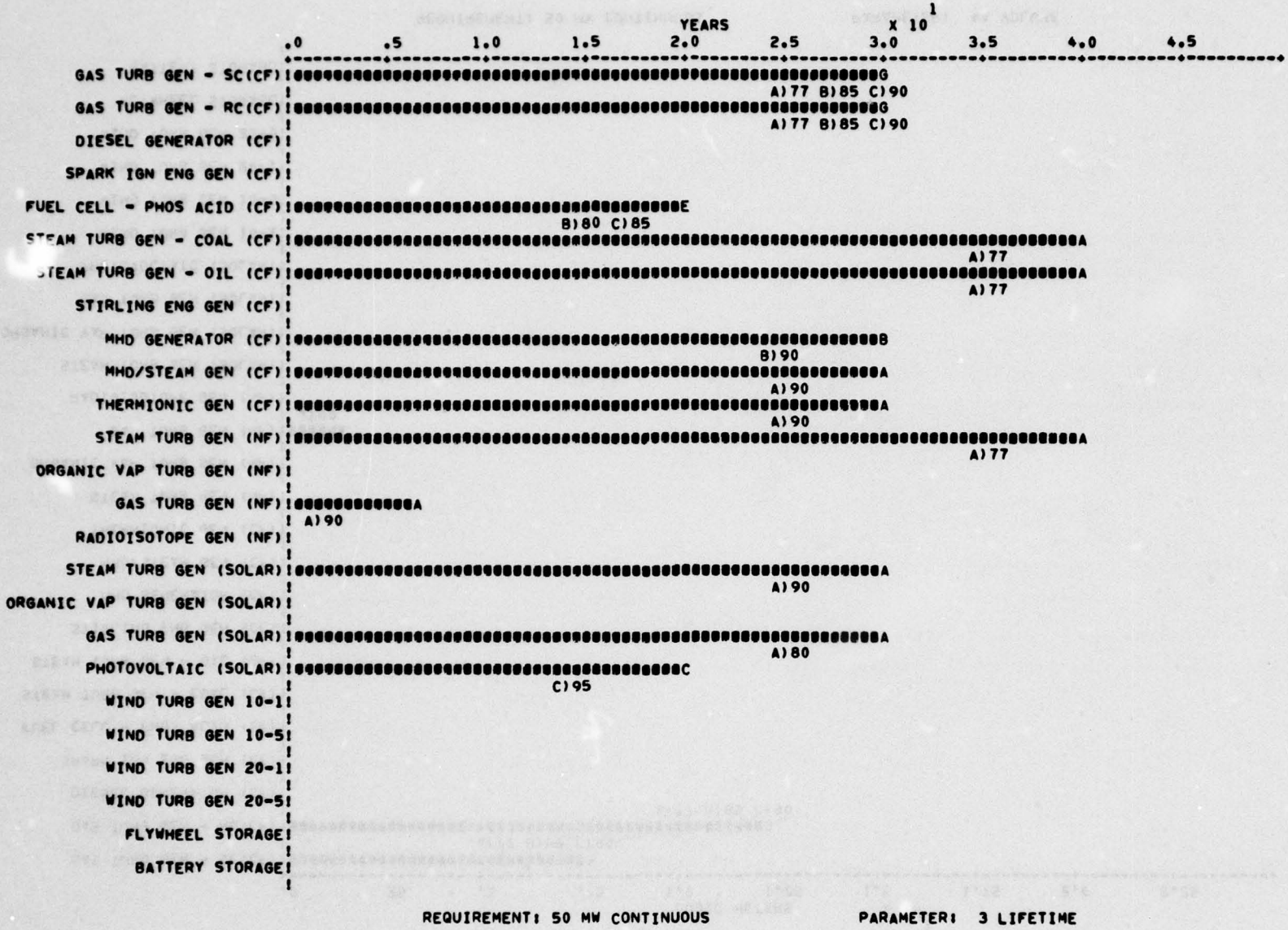
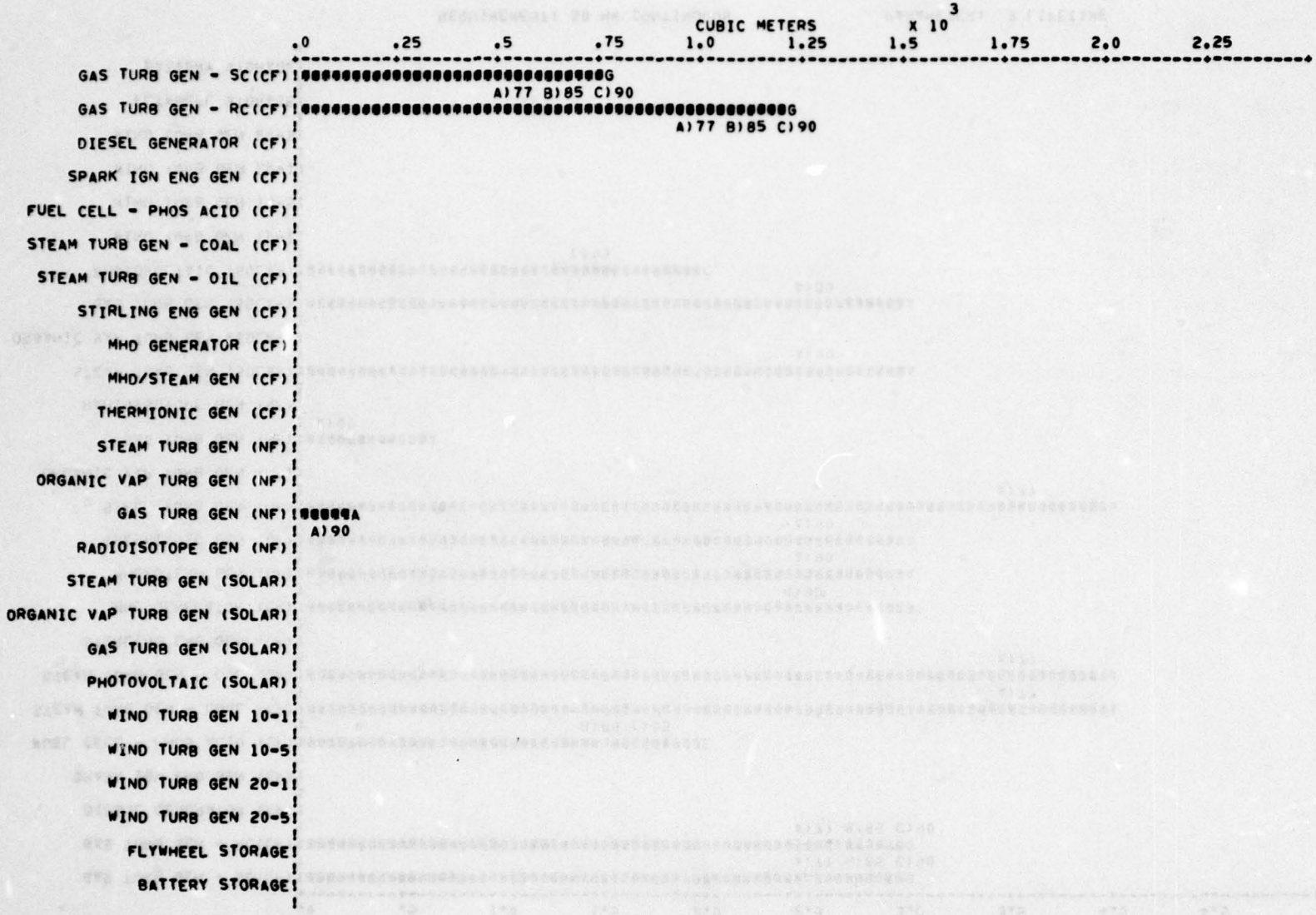
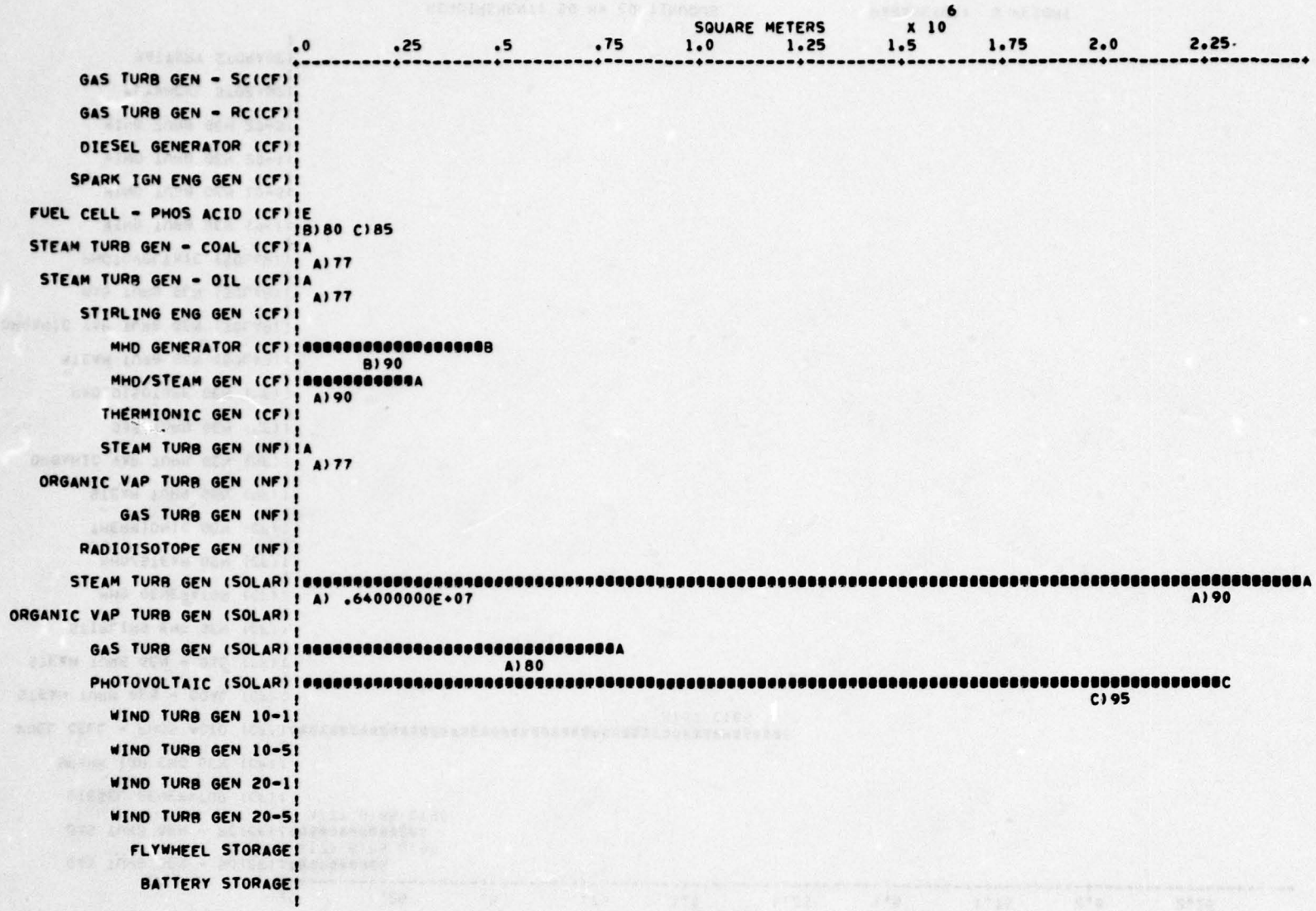
X 10^9
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
B)90
MHD/STEAM GEN (CF)
A)90
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
A)77
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
C)95
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 MW CONTINUOUS
PARAMETER: 2A LIFE CYCLE COST

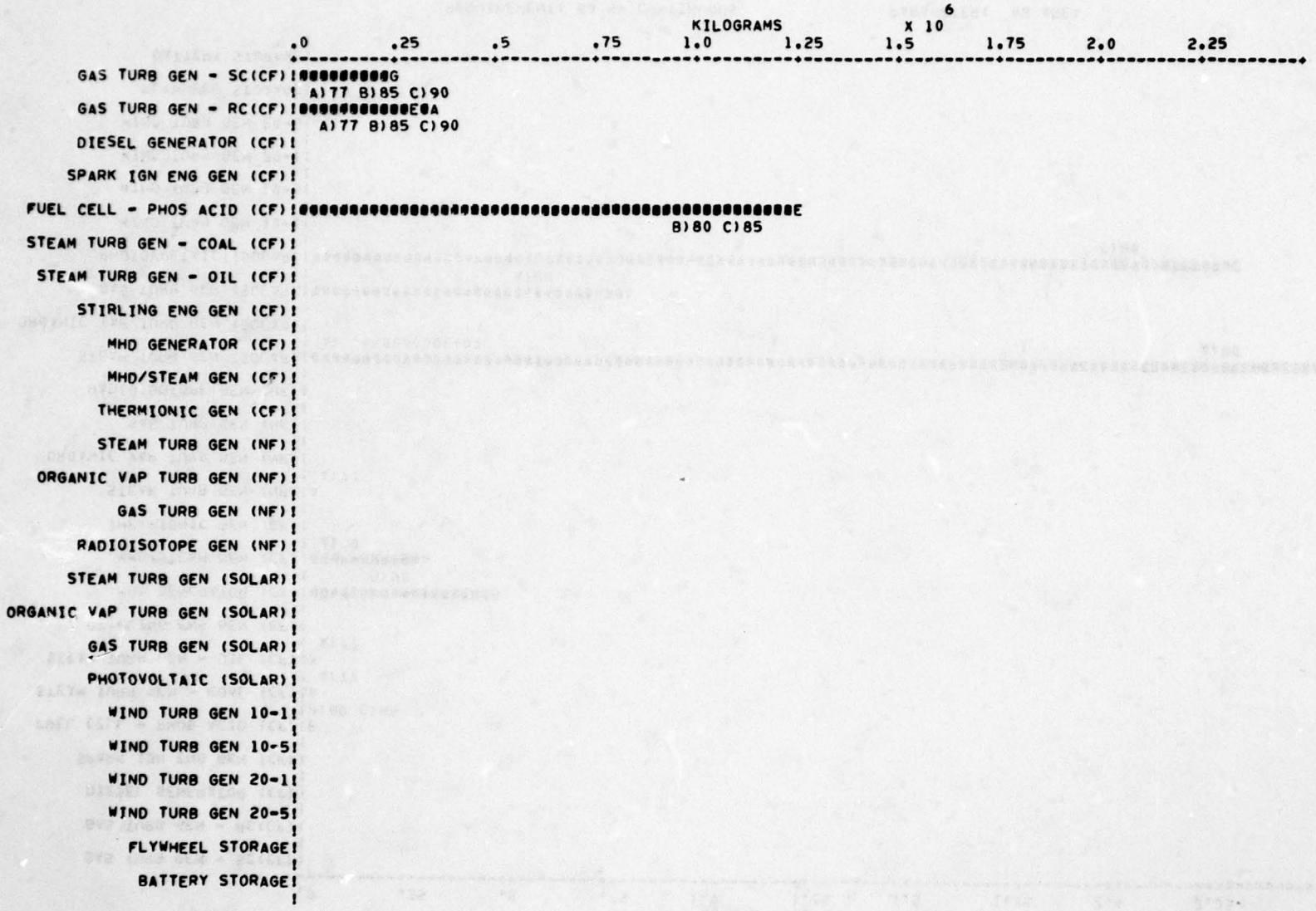

1977 DOLLARS
X 10^7
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
B)90
MHD/STEAM GEN (CF)
A)90
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
A)77
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
C)95
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 MW CONTINUOUS
PARAMETER: 28 L C COST/YEAR


YEARS
X 10 1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
B)90
MHD/STEAM GEN (CF)
A)90
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
A)77
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
C)95
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 MW CONTINUOUS
PARAMETER: 3 LIFETIME

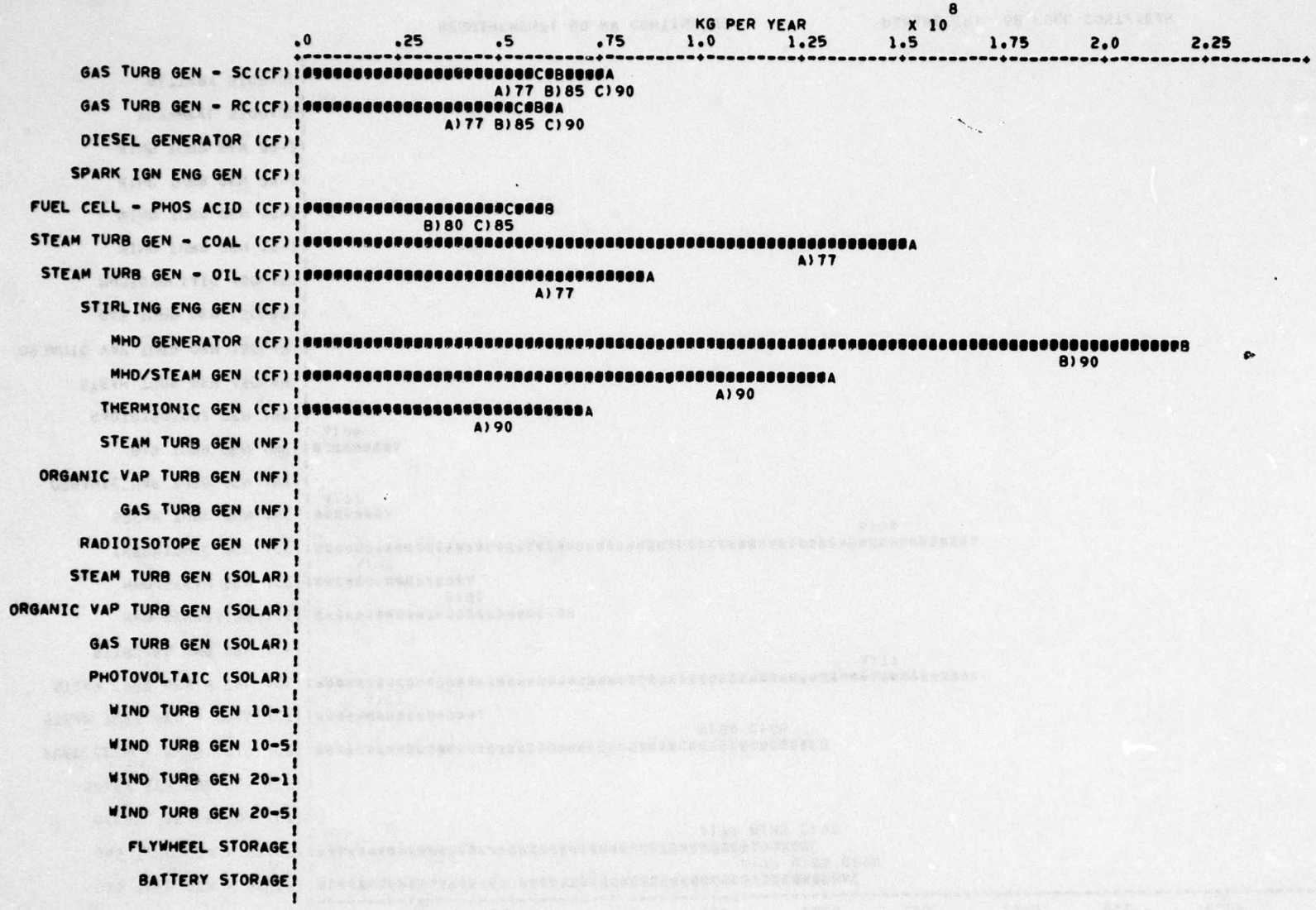


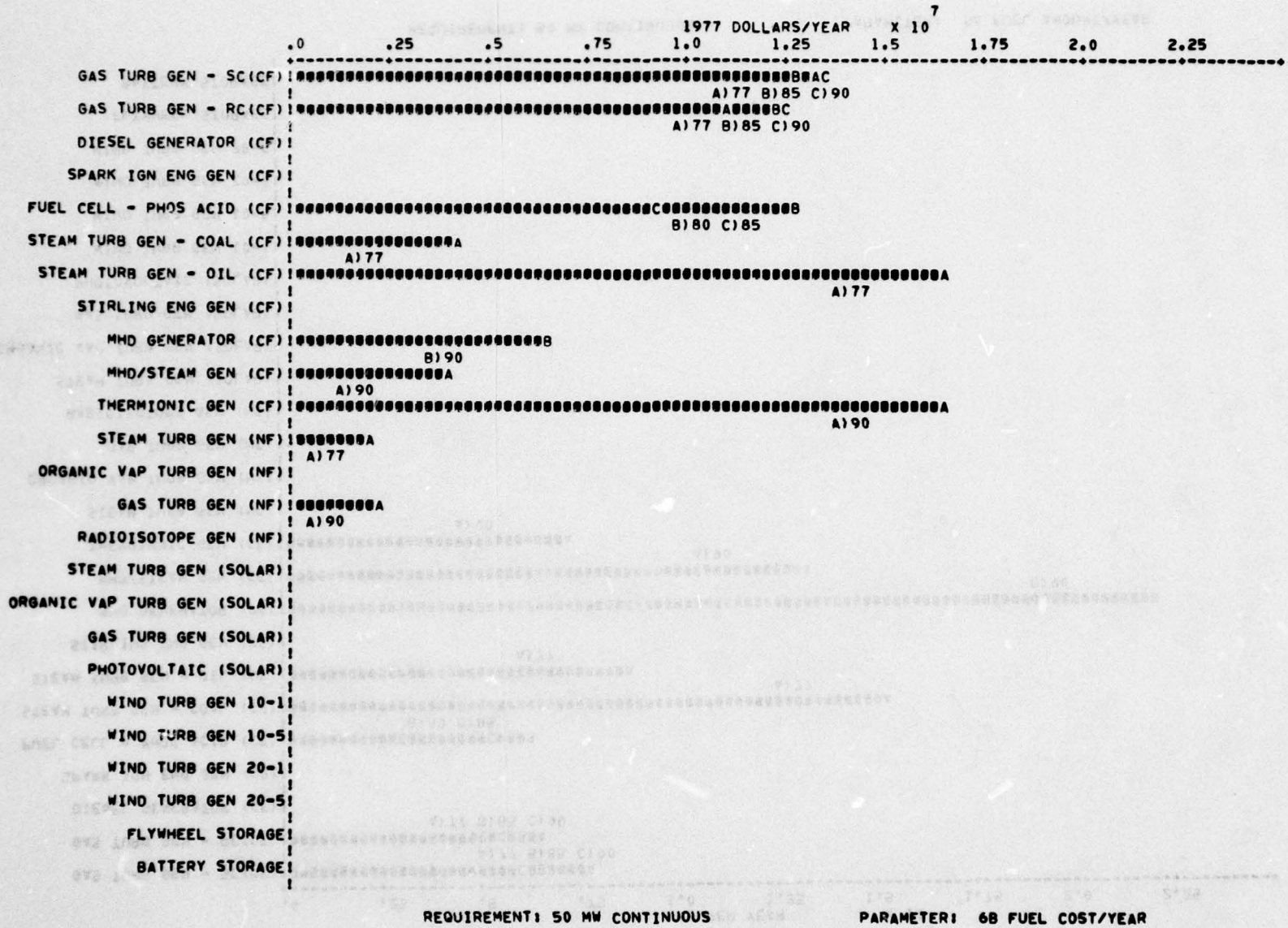
REQUIREMENT: 50 MW CONTINUOUS PARAMETER: 4A VOLUME


SQUARE METERS X 10^6
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
E
B)80 C)85
STEAM TURB GEN - COAL (CF)
A
A)77
STEAM TURB GEN - OIL (CF)
A
A)77
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
B
B)90
MHD/STEAM GEN (CF)
A
A)90
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
A
A)77
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A
A) .64000000E+07
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A
A)80
PHOTOVOLTAIC (SOLAR)
C
C)95
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 MW CONTINUOUS
PARAMETER: 48 AREA



REQUIREMENT: 50 MW CONTINUOUS PARAMETER: 5 WEIGHT


KG PER YEAR
X 10^8
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
B)90
MHD/STEAM GEN (CF)
A)90
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 MW CONTINUOUS
PARAMETER: 6A FUEL AMOUNT/YEAR


1977 DOLLARS/YEAR X 10^7
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
B)90
MHD/STEAM GEN (CF)
A)90
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
A)77
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 MW CONTINUOUS
PARAMETER: 68 FUEL COST/YEAR

REQUIREMENT	PARAMETER
50 MW Cont.	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
GAS TURB GEN - RC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
DIESEL GENERATOR(CF)											
SPARK IGN ENG GEN(CF)											
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	◐	-	-	-	-
STEAM TURB GEN - COAL(CF)	-	●	◐	0	◐	●	◐	●	●	0	-
STEAM TURB GEN - OIL(CF)	-	●	0	0	◐	●	◐	◐	●	0	-
STIRLING ENG GEN(CF)											
MHD GENERATOR(CF)	-	-	0	0	●	◐	◐	●	●	-	-
MHD/STEAM GEN(CF)	-	●	0	0	●	◐	◐	●	●	-	-
THERMIONIC GEN(CF)	-	-	0	0	●	◐	0	◐	-	-	-
STEAM TURB GEN(NF)	-	●	-	-	-	-	◐	-	-	0	◐
ORGANIC VAP TURB GEN(NF)											
GAS TURB GEN(NF)	-	●	-	-	-	-	◐	-	-	0	◐
RADIOISOTOPE GEN(NF)											
STEAM TURB GEN (SOLAR)	-	●	-	-	-	-	◐	-	-	0	-
ORGANIC VAP TURB (SOLAR)	.										-
GAS TURB GEN (SOLAR)	-	-	-	-	-	-	◐	-	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
WIND TURB GEN (ALL)											
FLYWHEEL STORAGE										.	
BATTERY STORAGE											

- - none
0 - minor
◐ - moderate
● - major

REQUIREMENT

50 MW Cont.

PARAMETER

8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- - - no limitation
O - minor limitation
◐ - major limitation
● - overriding limitation

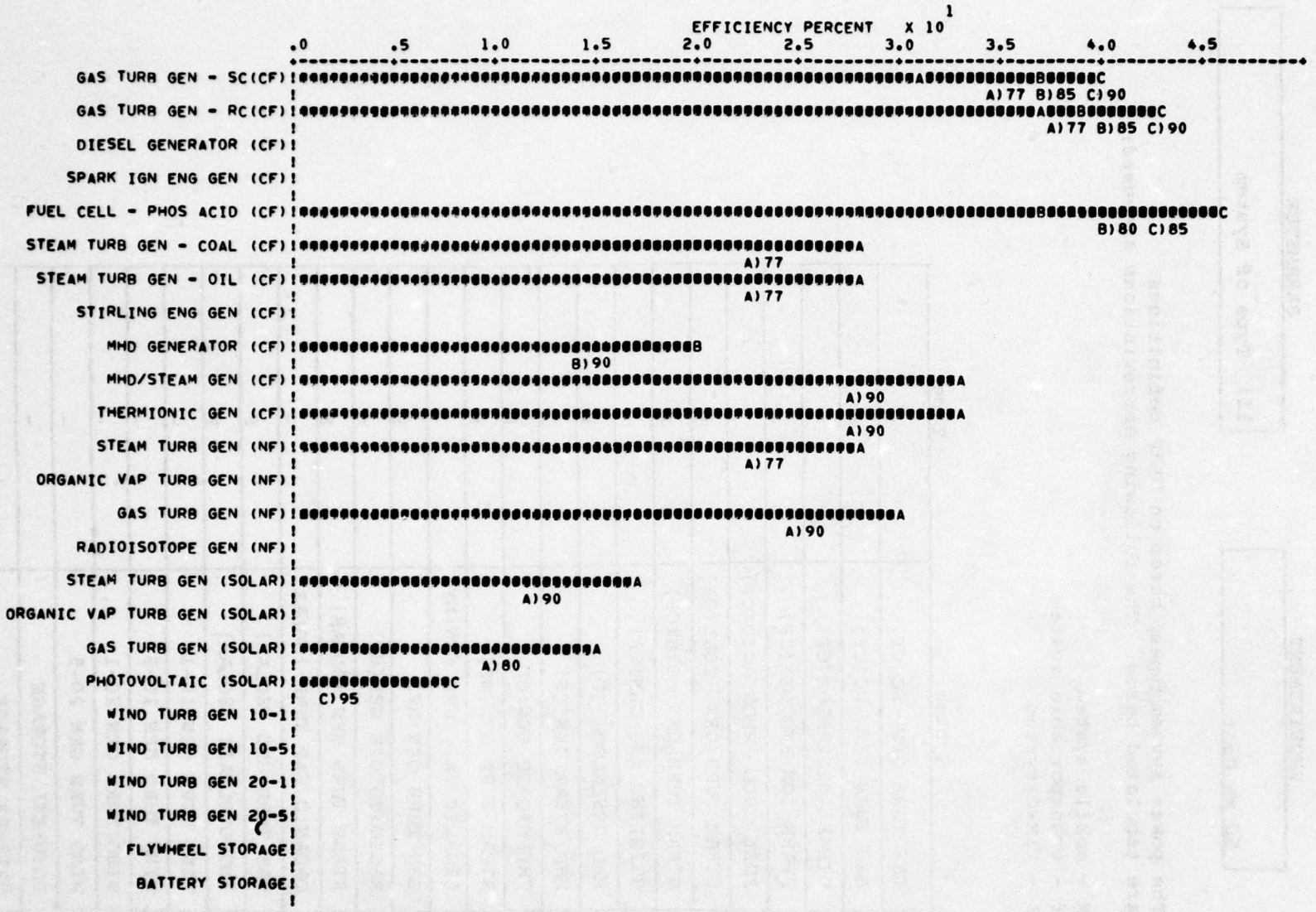
SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	O	●	-	-	-	-
GAS TURB GEN - RC(CF)	-	-	O	●	-	-	-	-
DIESEL GENERATOR(CF)								
SPARK IGN ENG GEN(CF)								
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)	◐	◐	●	●	-	-	-	-
STEAM TURB GEN - OIL(CF)	◐	◐	●	●	-	-	-	-
STIRLING ENG GEN(CF)								
MHD GENERATOR(CF)	O	O	O	●	-	-	-	-
MHD/STEAM GEN(CF)	◐	◐	●	●	-	-	-	-
THERMIONIC GEN(CF)	O	O	O	●	-	-	-	-
STEAM TURB GEN(NF)	◐	◐	●	O	-	-	●	-
ORGANIC VAP TURB GEN(NF)								
GAS TURB GEN(NF)	◐	-	●	O	-	-	●	-
RADIOISOTOPE GEN(NF)								
STEAM TURB GEN (SOLAR)	◐	◐	●	-	●	-	-	-
ORGANIC VAP TURB (SOLAR)								
GAS TURB GEN (SOLAR)	-	-	O	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1								
WIND TURB GEN 10-5								
WIND TURB GEN 20-1								
WIND TURB GEN 20-5								
FLYWHEEL STORAGE								
BATTERY STORAGE								

REQUIREMENT	PARAMETER
50 MW Cont.	9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
0 - Characteristic has minor effect on system performance
⊖ - Characteristic has moderate effect on system performance
● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	⊖	0	-	-	0	0	0
GAS TURB GEN - RC(CF)	⊖	0	-	-	0	⊖	⊖
DIESEL GENERATOR(CF)							
SPARK IGN ENG GEN(CF)							
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)	⊖	⊖	-	-	⊖	⊖	⊖
STEAM TURB GEN - OIL(CF)	⊖	⊖	-	-	⊖	⊖	⊖
STIRLING ENG GEN(CF)							
MHD GENERATOR(CF)	⊖	⊖	-	-	●	-	-
MHD/STEAM GEN(CF)	⊖	⊖	-	-	●	⊖	⊖
THERMIONIC GEN(CF)	0	0	-	-	⊖	0	0
STEAM TURB GEN(NF)	⊖	⊖	-	-	⊖	⊖	⊖
ORGANIC VAP TURB GEN(NF)							
GAS TURB GEN(NF)	0	⊖	-	-	⊖	0	⊖
RADIOISOTOPE GEN(NF)							
STEAM TURB GEN (SOLAR)	⊖	⊖	●	-	⊖	⊖	⊖
ORGANIC VAP TURB (SOLAR)							
GAS TURB GEN (SOLAR)	-	-	●	-	⊖	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1							
WIND TURB GEN 10-5							
WIND TURB GEN 20-1							
WIND TURB GEN 20-5							
FLYWHEEL STORAGE							
BATTERY STORAGE							

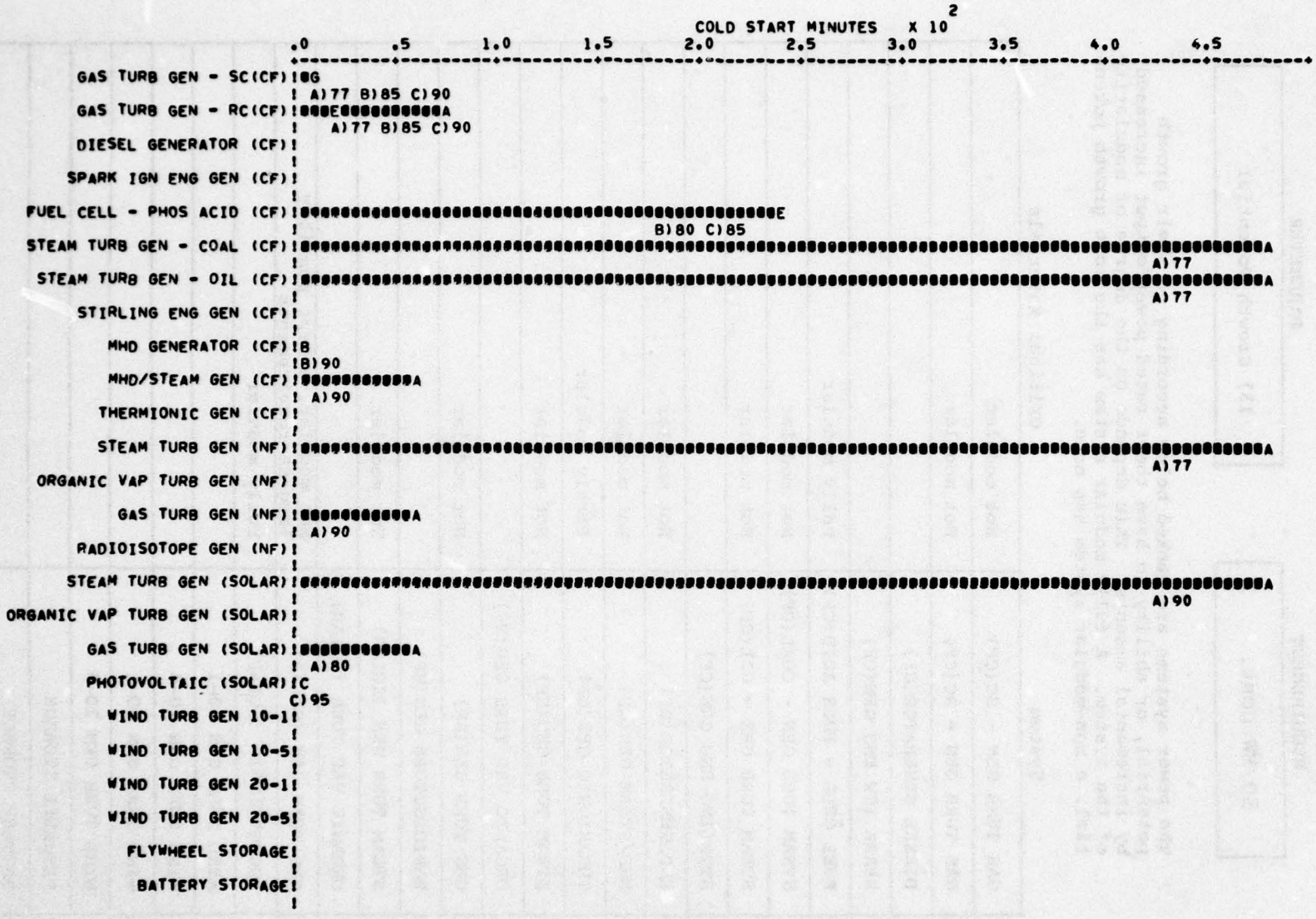

EFFICIENCY PERCENT X 10^1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
B)90
MHD/STEAM GEN (CF)
A)90
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
A)77
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
C)95
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 MW CONTINUOUS
PARAMETER: SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
50 MW Cont	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	F
GAS TURB GEN - RC(CF)	F
DIESEL GENERATOR(CF)	-
SPARK IGN ENG GEN(CF)	-
FUEL CELL - PHOS ACID(CF)	F
STEAM TURB GEN - COAL(CF)	F
STEAM TURB GEN - OIL(CF)	F
STIRLING ENG GEN(CF)	-
MHD GENERATOR(CF)	F
MHD/STEAM GEN(CF)	F
THERMIONIC GEN(CF)	F
STEAM TURB GEN(NF)	F
ORGANIC VAP TURB GEN(NF)	-
GAS TURB GEN(NF)	F
RADIOISOTOPE GEN(NF)	-
STEAM TURB GEN (SOLAR)	F
ORGANIC VAP TURB (SOLAR)	-
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	-
WIND TURB GEN 10-5	-
WIND TURB GEN 20-1	-
WIND TURB GEN 20-5	-
FLYWHEEL STORAGE	-
BATTERY STORAGE	-



REQUIREMENT: 50 MW CONTINUOUS PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
50 MW Cont.	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

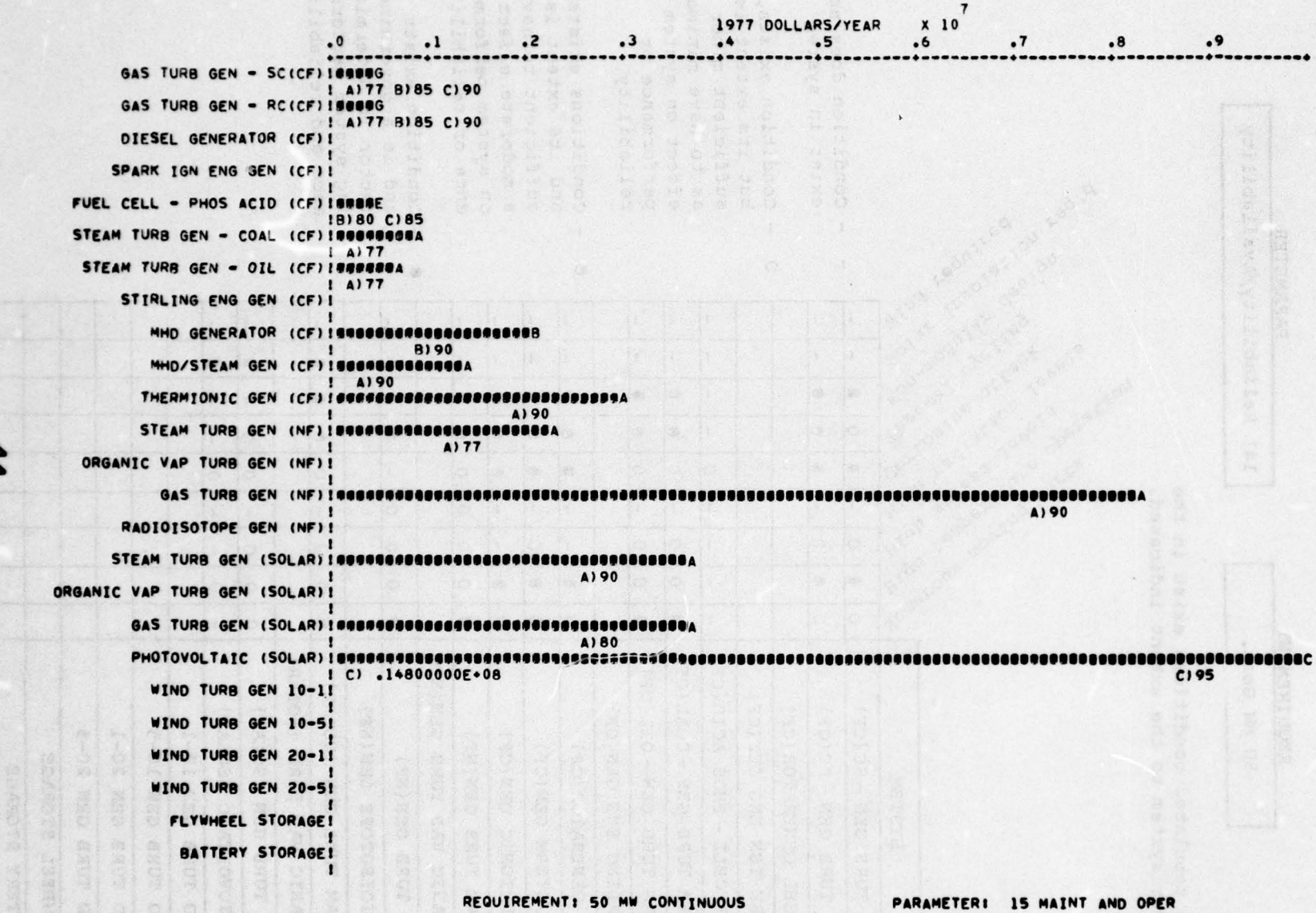
System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	Not modular
DIESEL GENERATOR(CF)	
SPARK IGN.ENG GEN(CF)	
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	Not modular
STEAM TURB GEN - OIL(CF)	Not modular
STIRLING ENG GEN(CF)	
MHD GENERATOR(CF)	Not modular
MHD/STEAM GEN(CF)	Not modular
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	Not modular
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	Not modular
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	Not modular
ORGANIC VAP TURB (SOLAR)	
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	
WIND TURB GEN 10-5	
WIND TURB GEN 20-1	
WIND TURB GEN 20-5	
FLYWHEEL STORAGE	
BATTERY STORAGE	

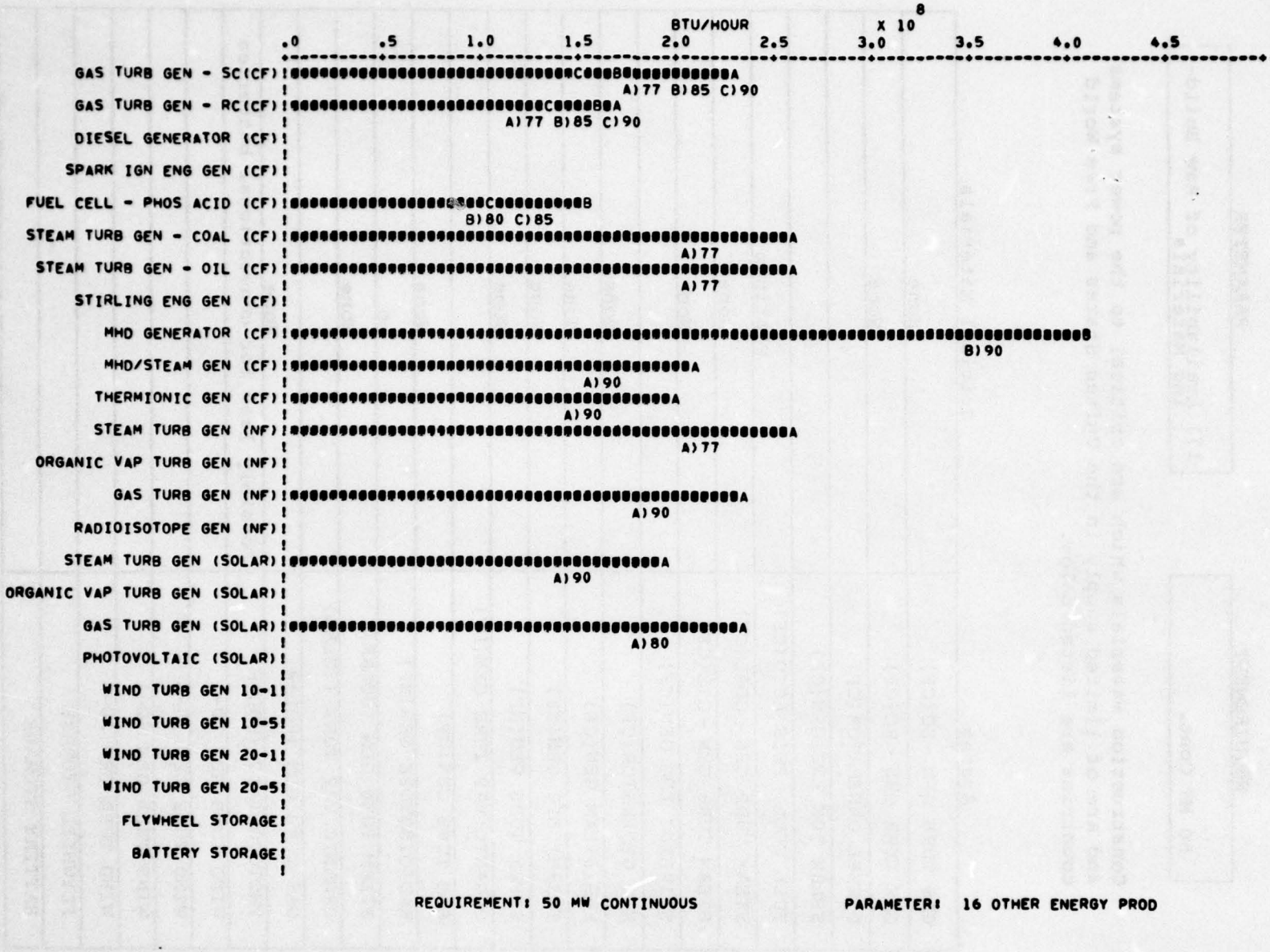
REQUIREMENT	PARAMETER
50 MW Cont.	14) Reliability/Availability

The tabulated conditions exist in the power system to the extent indicated.

SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	0	●	0	-	●	0	●	-	-
GAS TURB GEN - RC(CF)	0	●	0	-	●	◐	●	-	-
DIESEL GENERATOR(CF)									
SPARK IGN ENG GEN(CF)									
FUEL CELL - PHOS ACID(CF)	-	-	-	-	0	-	-	-	-
STEAM TURB GEN - COAL(CF)	●	0	0	-	0	◐	●	-	-
STEAM TURB GEN - OIL(CF)	●	0	0	-	0	◐	●	-	-
STIRLING ENG GEN(CF)									
MHD GENERATOR(CF)	0	●	-	-	●	◐	●	-	-
MHD/STEAM GEN(CF)	●	●	0	-	●	◐	●	-	-
THERMIONIC GEN(CF)	0	●	-	-	◐	0	0	-	-
STEAM TURB GEN(NF)	●	0	0	0	0	◐	●	-	-
ORGANIC VAP TURB GEN(NF)									
GAS TURB GEN(NF)	●	0	0	0	-	◐	●	-	-
RADIOISOTOPE GEN(NF)									
STEAM TURB GEN (SOLAR)	●	0	0	-	0	◐	●	●	-
ORGANIC VAP TURB (SOLAR)									
GAS TURB GEN (SOLAR)	0	0	0	-	0	0	-	●	-
PHOTOVOLTAIC (SOLAR)	-	0	-	-	0	-	-	●	-
WIND TURB GEN 10-1									
WIND TURB GEN 10-5									
WIND TURB GEN 20-1									
WIND TURB GEN 20-5									
FLYWHEEL STORAGE									
BATTERY STORAGE									

- \- - Condition does not exist in system
- 0 - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability
- ◐ - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability
- ● - Condition exists and is a governing factor in determining system performance and reliability


1977 DOLLARS/YEAR X 10^7
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
B)90
MHD/STEAM GEN (CF)
A)90
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
A)77
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
C) .14800000E+08
C)95
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 MW CONTINUOUS
PARAMETER: 15 MAINT AND OPER


BTU/HOUR
X 10 8
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
B)90
MHD/STEAM GEN (CF)
A)90
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
A)77
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 MW CONTINUOUS
PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
50 MW Cont.	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

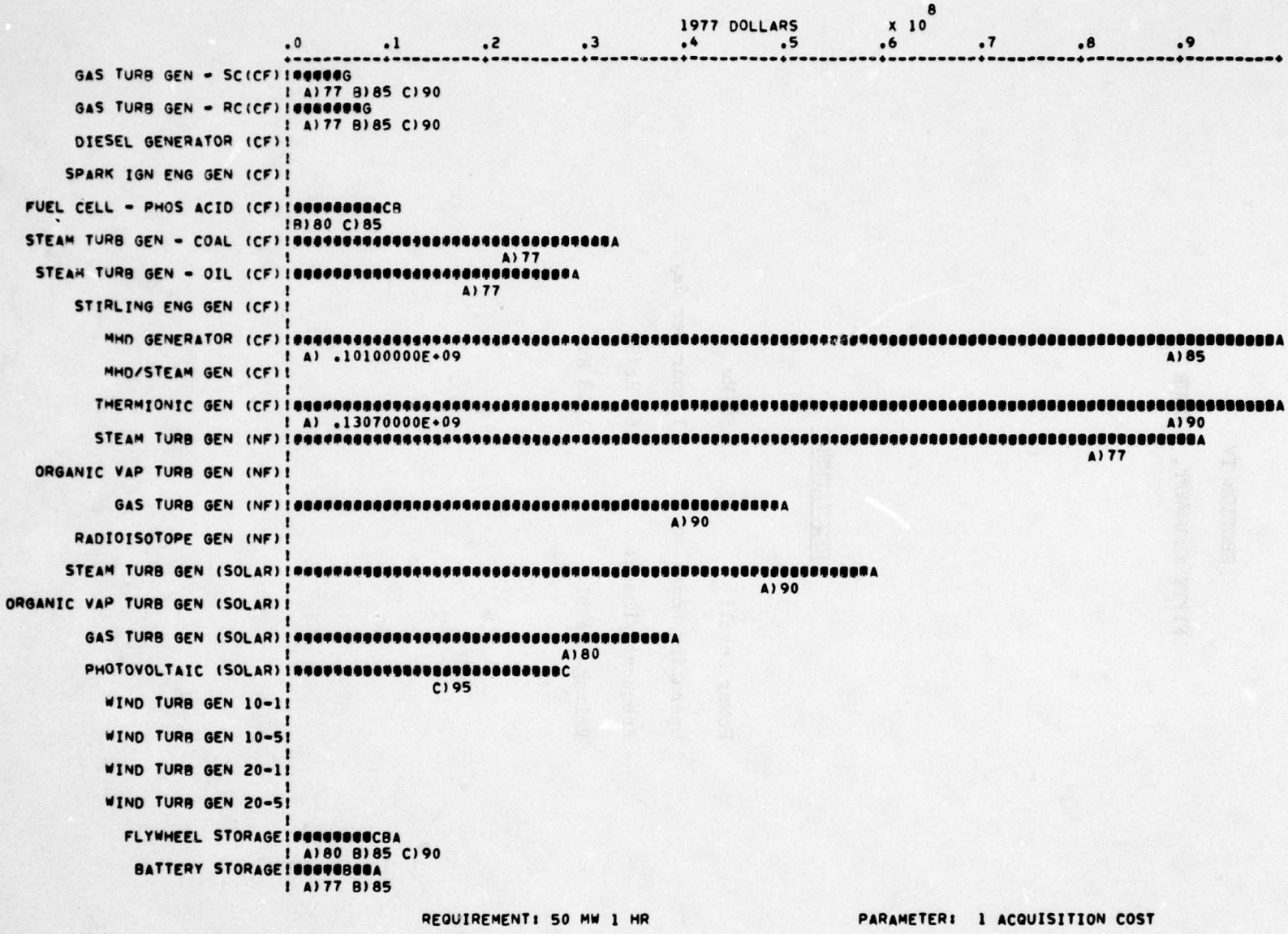
System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	None
DIESEL GENERATOR(CF)	
SPARK IGN ENG GEN(CF)	
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	None
STEAM TURB GEN - OIL(CF)	None
STIRLING ENG GEN(CF)	
MHD GENERATOR(CF)	None
MHD/STEAM GEN(CF)	None
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	None
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	None
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	None
ORGANIC VAP TURB (SOLAR)	
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	
WIND TURB GEN 10-5	
WIND TURB GEN 20-1	
WIND TURB GEN 20-5	
FLYWHEEL STORAGE	
BATTERY STORAGE	

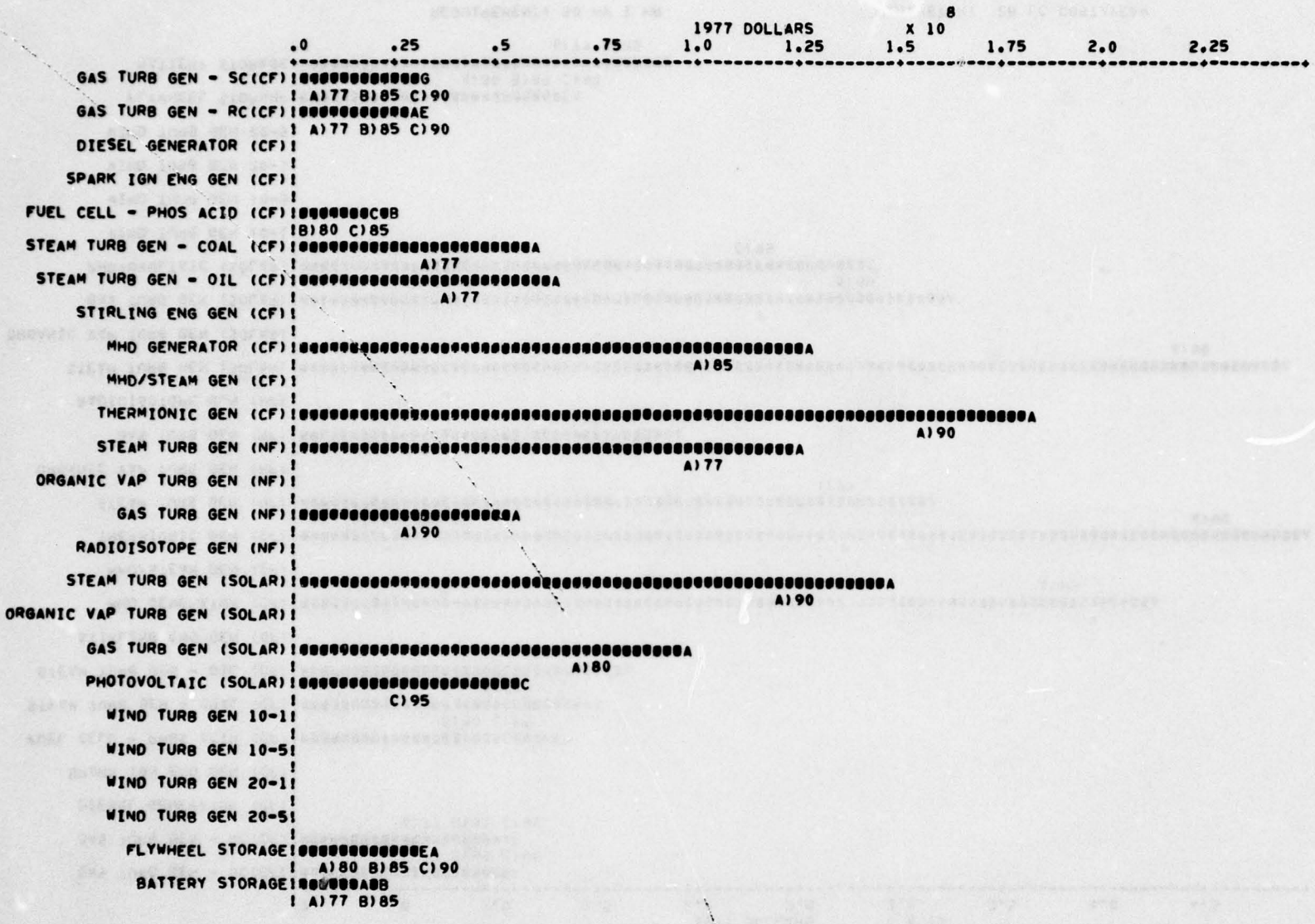
SECTION IV

FIFTY MEGAWATT, 1 HOUR

REQUIREMENT

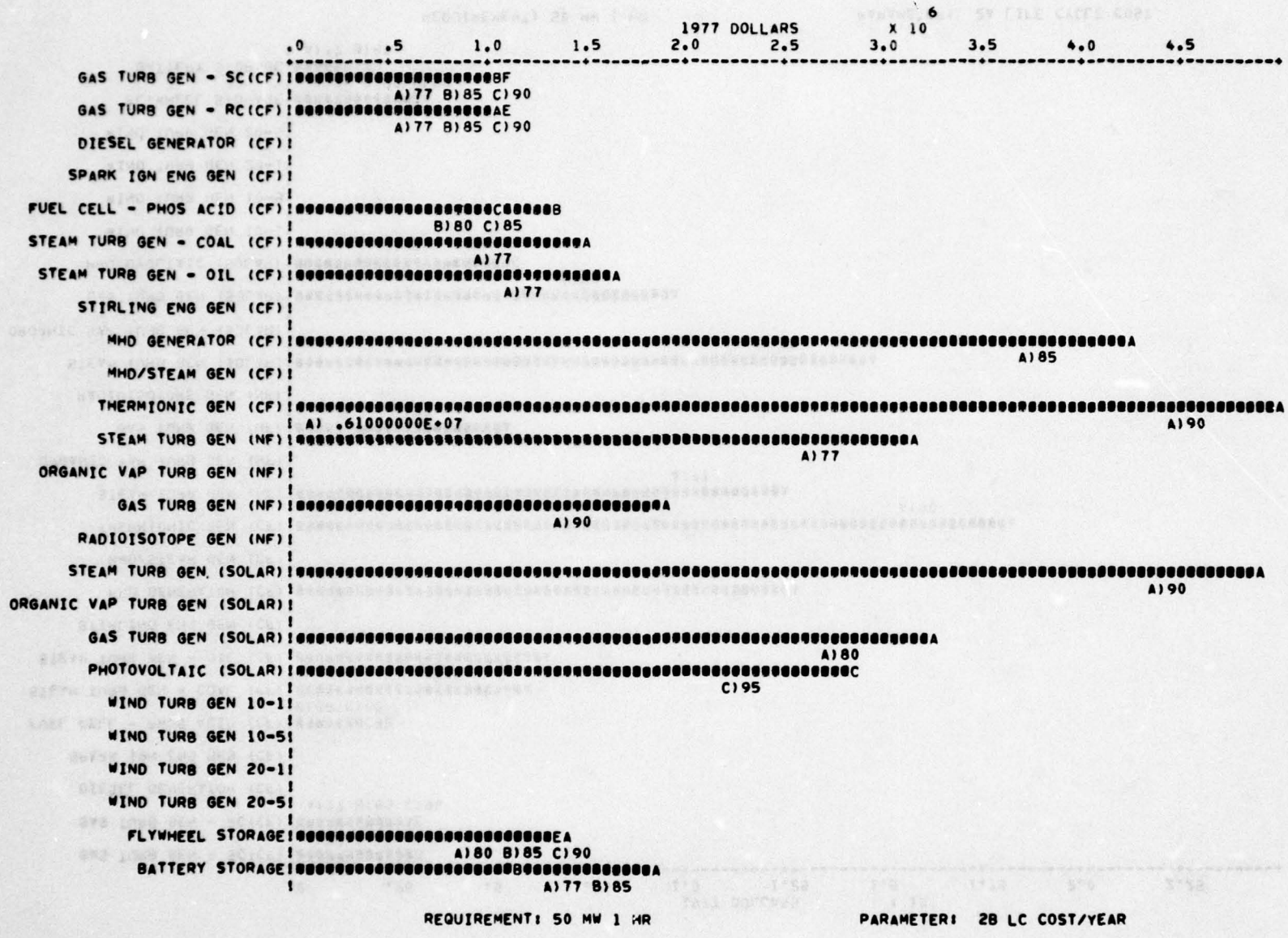
Power Level:	50 Mw
Operating Mode:	1 hour per day
Frequency/Phase:	60 Hz/3Ø
Voltage Level:	13.8 Kv

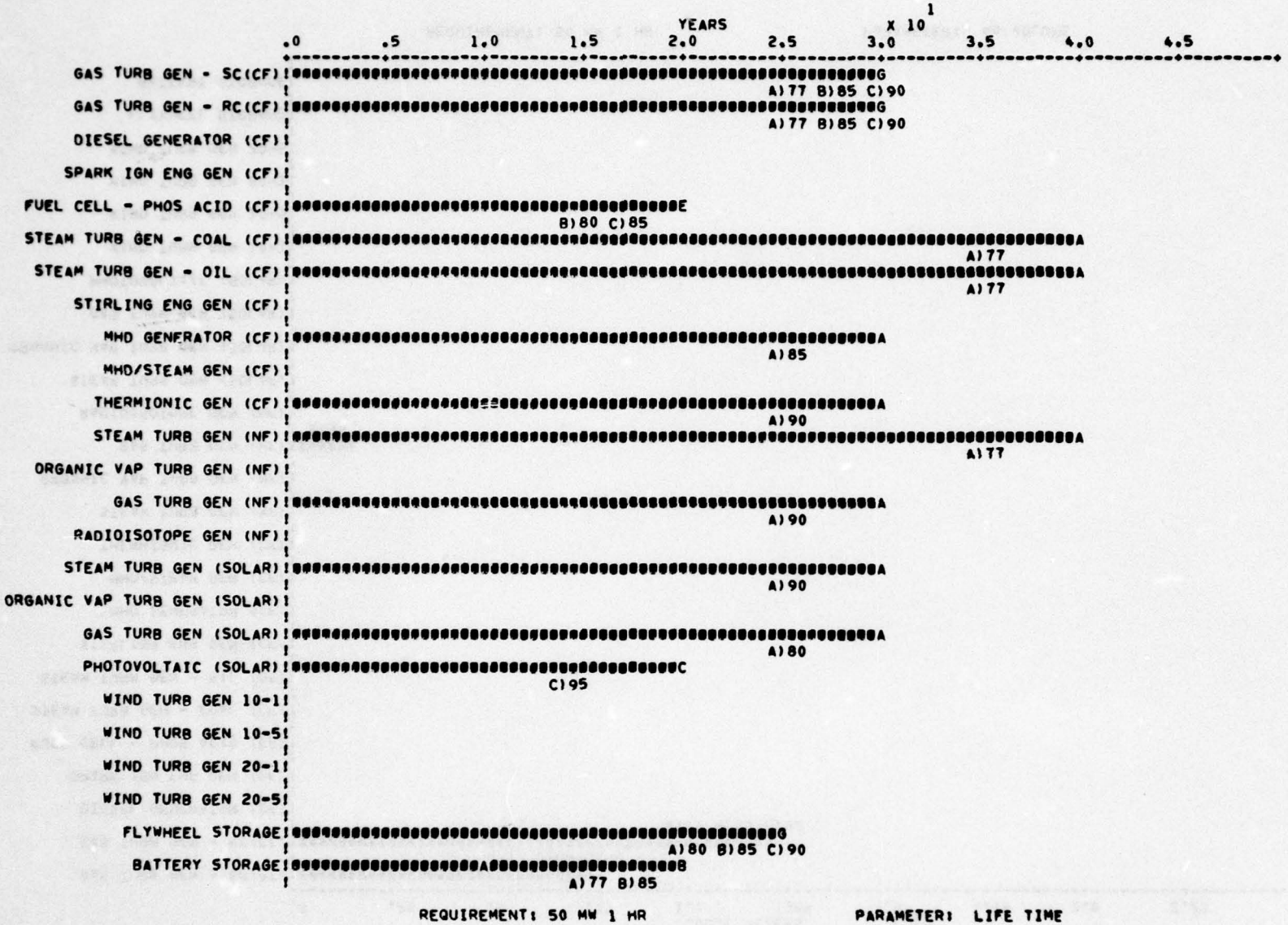

1977 DOLLARS x 10^8
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
A) .10100000E+09
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A) .13070000E+09
A)90
STEAM TURB GEN (NF)
A)77
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
C)95
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 50 MW 1 HR
PARAMETER: 1 ACQUISITION COST

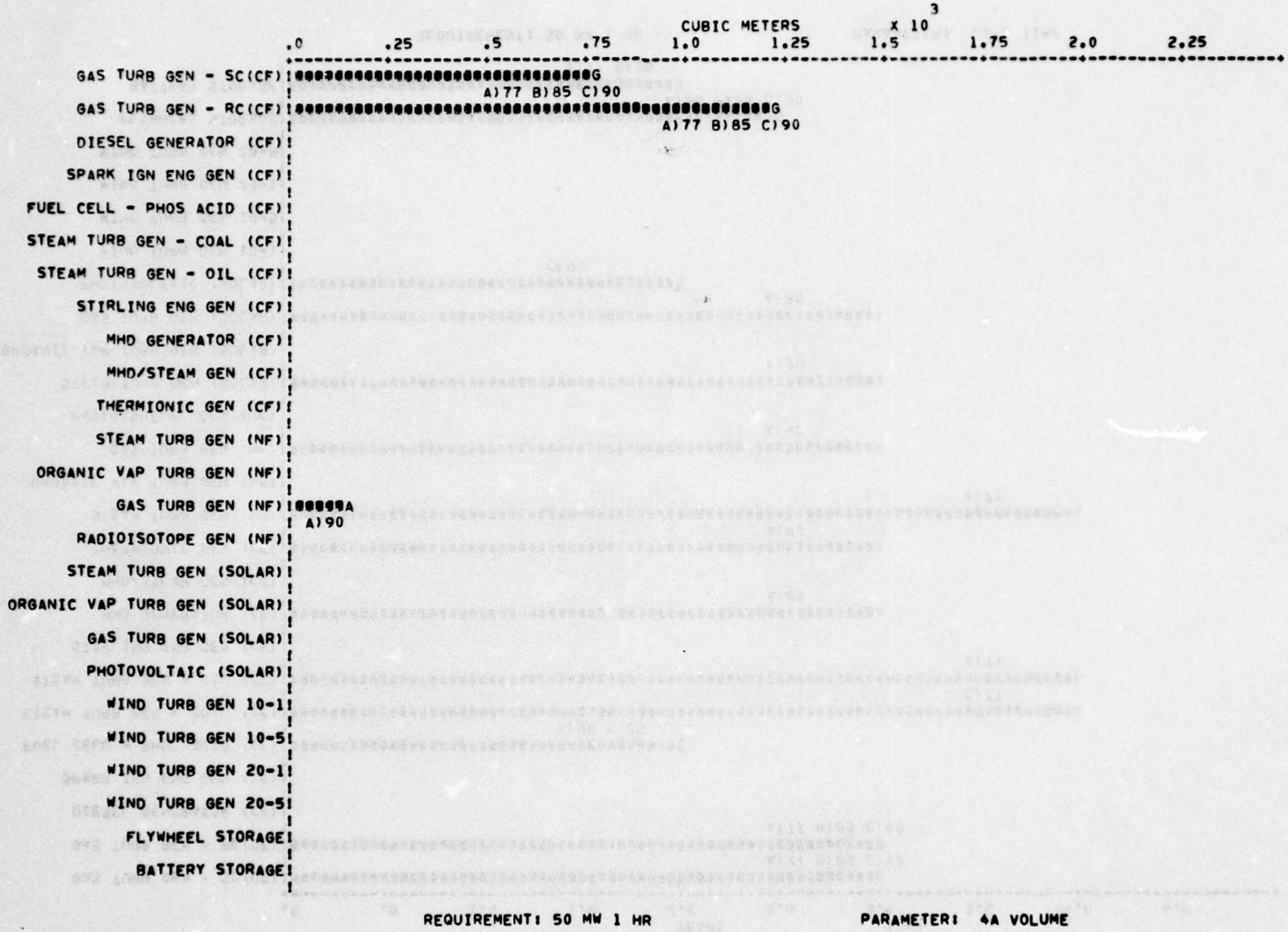


REQUIREMENT: 50 MW 1 HR

PARAMETER: 2A LIFE CYCLE COST

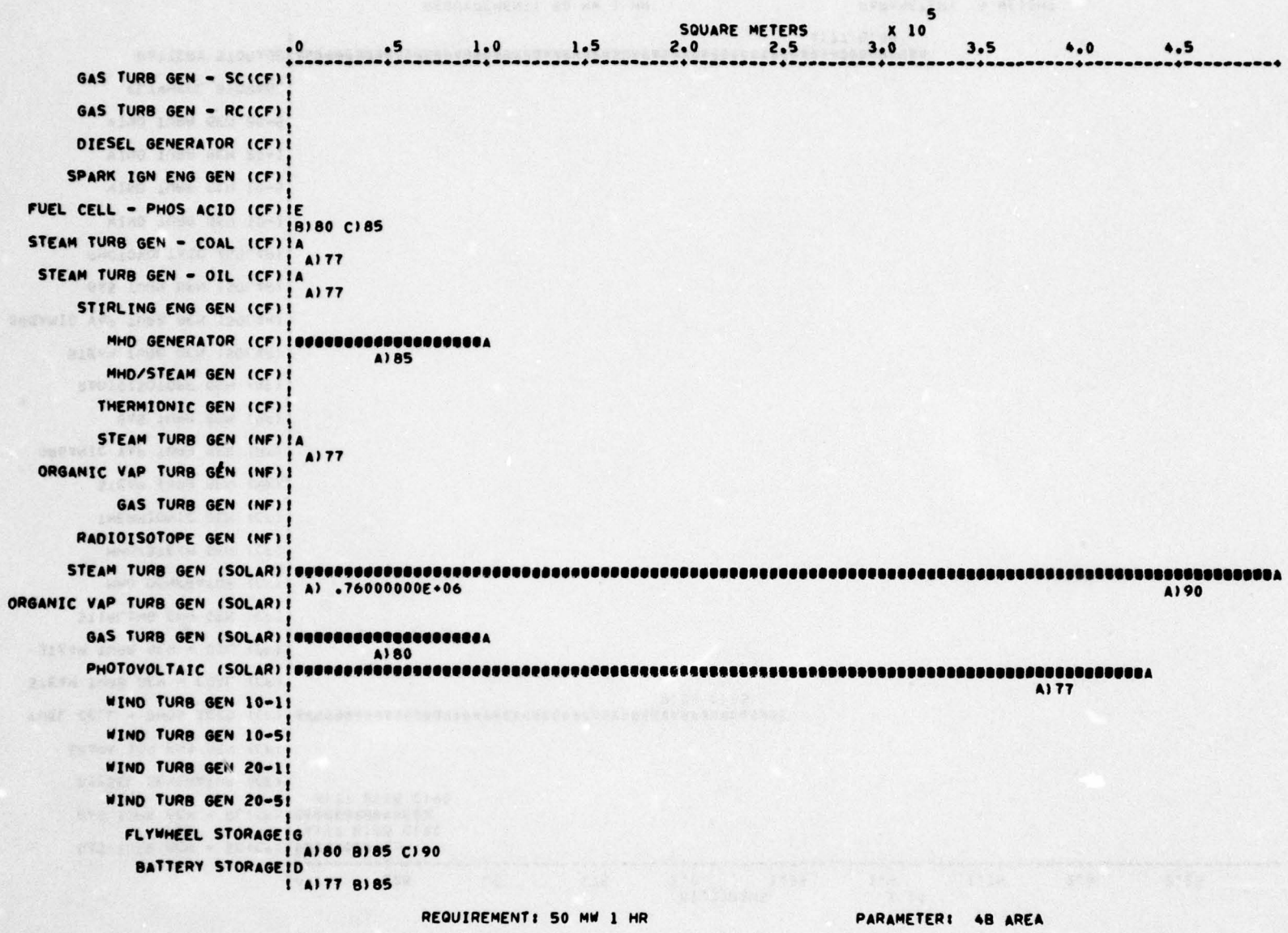

1977 DOLLARS
X 10^6
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A) .61000000E+07
A)90
STEAM TURB GEN (NF)
A)77
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
C)95
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 50 MW 1 HR
PARAMETER: 28 LC COST/YEAR

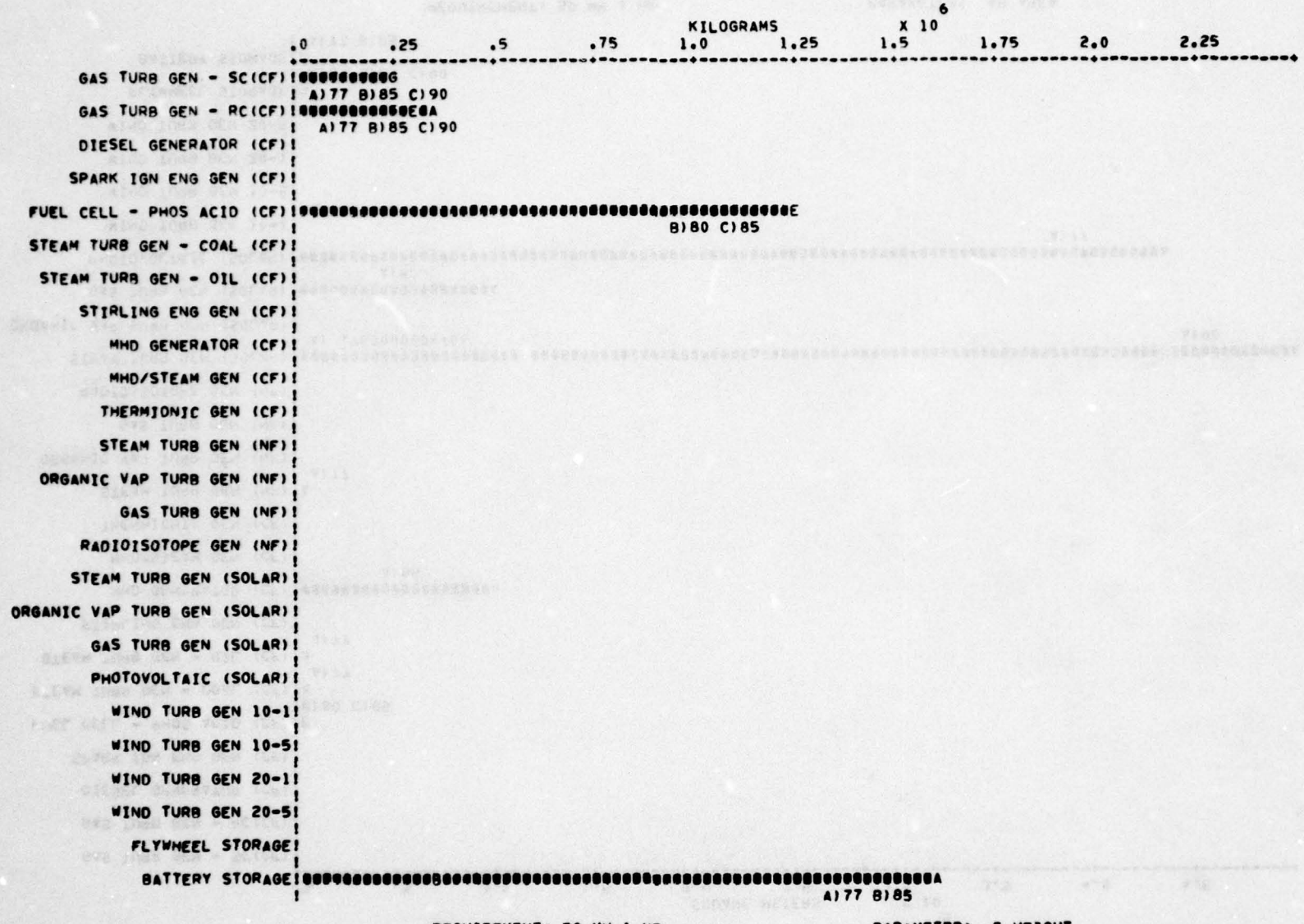

YEARS
X 10 1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
A)77
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
C)95
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 50 MW 1 HR
PARAMETER: LIFE TIME

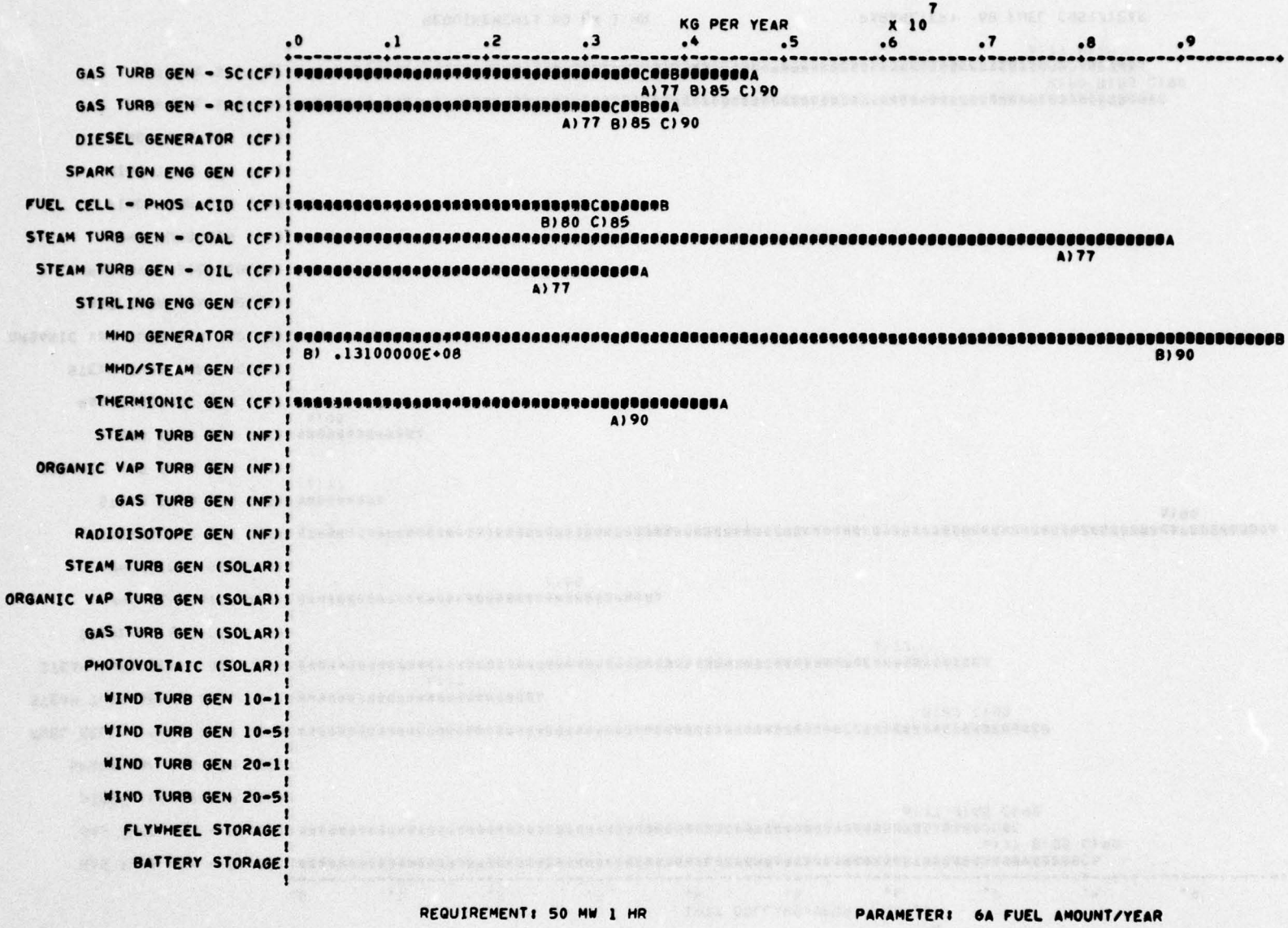


REQUIREMENT: 50 MW 1 HR

PARAMETER: 4A VOLUME

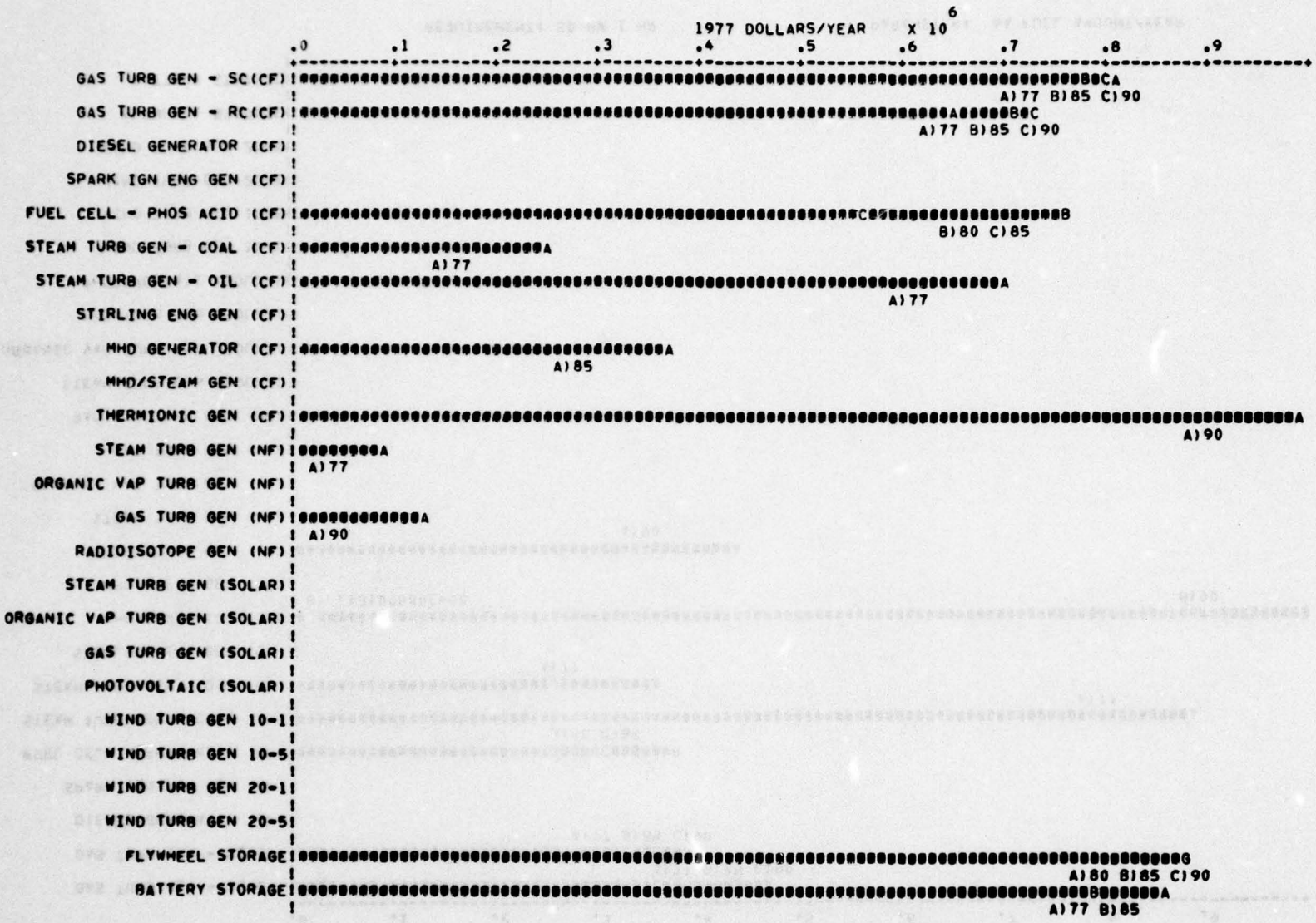

SQUARE METERS X 10^5
.0 .5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
E
B)80 C)85
STEAM TURB GEN - COAL (CF)
A
A)77
STEAM TURB GEN - OIL (CF)
A
A)77
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
A
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
A
A)77
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A
A) .76000000E+06
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A
A)80
PHOTOVOLTAIC (SOLAR)
A
A)77
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
G
A)80 B)85 C)90
BATTERY STORAGE
D
A)77 B)85
REQUIREMENT: 50 MW 1 HR
PARAMETER: 48 AREA


KILOGRAMS
X 10^6
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 50 MW 1 HR
PARAMETER: 5 WEIGHT



REQUIREMENT: 50 MW 1 HR

PARAMETER: 6A FUEL AMOUNT/YEAR


1977 DOLLARS/YEAR X 10^6
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
A)77 B)85 C)90
A)77 B)85 C)90
A)77 B)85 C)90
B)80 C)85
A)77
A)77
A)85
A)90
A)77
A)90
A)80 B)85 C)90
A)77 B)85
REQUIREMENT: 50 MW 1 HR
PARAMETER: 68 FUEL COST/YEAR

REQUIREMENT	PARAMETER
50 MW 1 Hr.	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
GAS TURB GEN - RC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
DIESEL GENERATOR(CF)											
SPARK IGN ENG GEN(CF)											
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	0	-	-	-	-
STEAM TURB GEN - COAL(CF)	-	●	0	0	◐	●	◐	◐	●	0	-
STEAM TURB GEN - OIL(CF)	-	●	0	0	◐	●	◐	◐	●	0	-
STIRLING ENG GEN(CF)											
MHD GENERATOR(CF)	-	-	0	0	●	◐	◐	●	●	-	-
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)	-	-	0	0	●	◐	0	◐	-	-	-
STEAM TURB GEN(NF)	-	●	-	-	-	-	◐	-	-	0	◐
ORGANIC VAP TURB GEN(NF)											
GAS TURB GEN(NF)	-	●	-	-	-	-	◐	-	-	0	◐
RADIOISOTOPE GEN(NF)											
STEAM TURB GEN (SOLAR)	-	●	-	-	-	-	◐	-	-	0	-
ORGANIC VAP TURB (SOLAR)											
GAS TURB GEN (SOLAR)	-	-	-	-	-	-	◐	-	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
WIND TURB GEN (ALL)											
FLYWHEEL STORAGE											
BATTERY STORAGE											

- - none
0 - minor
◐ - moderate
● - major

REQUIREMENT	PARAMETER
50 MW 1 Hr.	8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- - - no limitation
- O - minor limitation
- ⊖ - major limitation
- ● - overriding limitation

SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	O	●	-	-	-	-
GAS TURB GEN - RC(CF)	-	-	O	●	-	-	-	-
DIESEL GENERATOR(CF)								
SPARK IGN ENG GEN(CF)								
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)	⊖	⊖	●	●	-	-	-	-
STEAM TURB GEN - OIL(CF)	⊖	⊖	●	●	-	-	-	-
STIRLING ENG GEN(CF)								
MHD GENERATOR(CF)	O	O	O	●	-	-	-	-
MHD/STEAM GEN(CF)								
THERMIONIC GEN(CF)	O	O	O	●	-	-	-	-
STEAM TURB GEN(NF)	⊖	⊖	●	O	-	-	●	-
ORGANIC VAP TURB GEN(NF)								
GAS TURB GEN(NF)	⊖	-	●	O	-	-	●	-
RADIOISOTOPE GEN(NF)								
STEAM TURB GEN (SOLAR)	⊖	⊖	●	-	●	-	-	-
ORGANIC VAP TURB (SOLAR)								
GAS TURB GEN (SOLAR)	-	-	O	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1								
WIND TURB GEN 10-5								
WIND TURB GEN 20-1								
WIND TURB GEN 20-5								
FLYWHEEL STORAGE	-	-	-	-	-	-	-	●
BATTERY STORAGE	-	O	-	-	-	-	-	●

REQUIREMENT

50 MW 1 Hr.

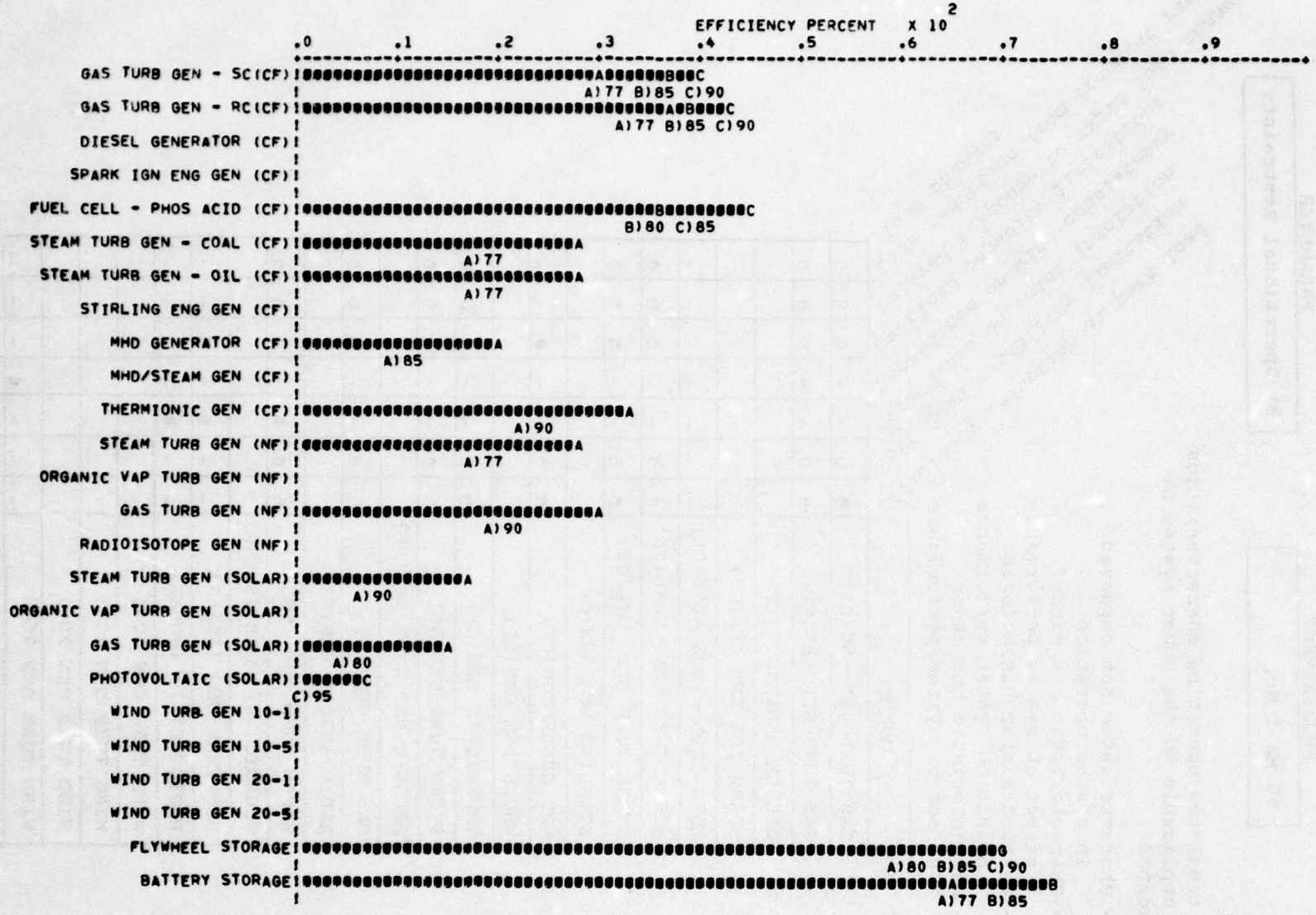
PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
0 - Characteristic has minor effect on system performance
◐ - Characteristic has moderate effect on system performance
● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	◐	0	-	-	0	0	0
GAS TURB GEN - RC(CF)	◐	0	-	-	0	◐	◐
DIESEL GENERATOR(CF)							
SPARK IGN ENG GEN(CF)							
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)	◐	◐	-	-	◐	◐	◐
STEAM TURB GEN - OIL(CF)	◐	◐	-	-	◐	◐	◐
STIRLING ENG GEN(CF)							
MHD GENERATOR(CF)	◐	◐	-	-	●	-	-
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	◐	0	0
STEAM TURB GEN(NF)	◐	◐	-	-	◐	◐	◐
ORGANIC VAP TURB GEN(NF)							
GAS TURB GEN(NF)	0	◐	-	-	◐	0	◐
RADIOISOTOPE GEN(NF)							
STEAM TURB GEN (SOLAR)	◐	◐	●	-	◐	◐	◐
ORGANIC VAP TURB (SOLAR)							
GAS TURB GEN (SOLAR)	-	-	●	-	◐	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1							
WIND TURB GEN 10-5							
WIND TURB GEN 20-1							
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-
BATTERY STORAGE	-	-	-	-	-	-	-

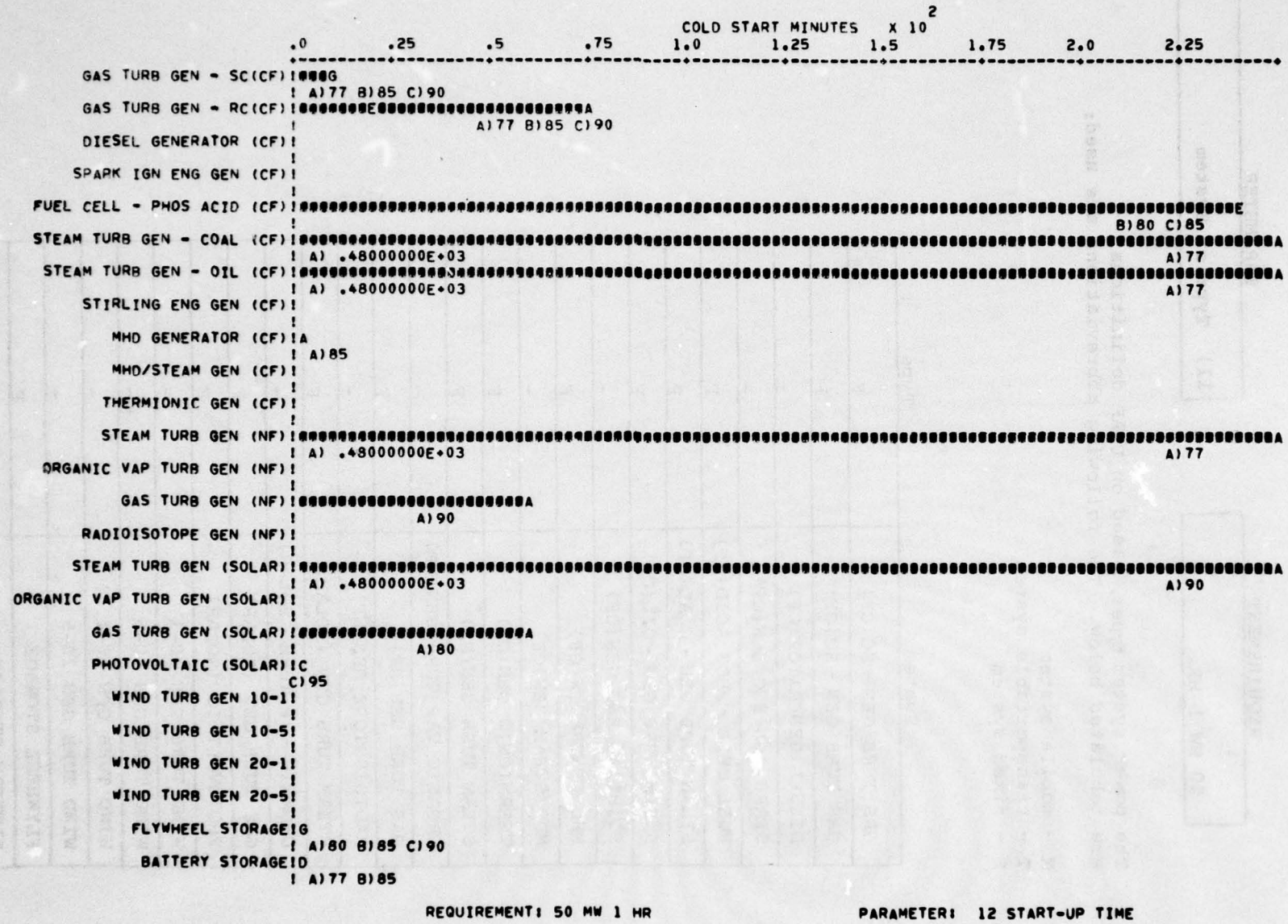

EFFICIENCY PERCENT X 10^2
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
A)77
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
C)95
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 50 MW 1 HR
PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
50 MW 1 HR.	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	F
GAS TURB GEN - RC(CF)	F
DIESEL GENERATOR(CF)	-
SPARK IGN ENG GEN(CF)	-
FUEL CELL - PHOS ACID(CF)	F
STEAM TURB GEN - COAL(CF)	F
STEAM TURB GEN - OIL(CF)	F
STIRLING ENG GEN(CF)	-
MHD GENERATOR(CF)	F
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	F
STEAM TURB GEN(NF)	F
ORGANIC VAP TURB GEN(NF)	-
GAS TURB GEN(NF)	F
RADIOISOTOPE GEN(NF)	-
STEAM TURB GEN (SOLAR)	F
ORGANIC VAP TURB (SOLAR)	-
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	-
WIND TURB GEN 10-5	-
WIND TURB GEN 20-1	-
WIND TURB GEN 20-5	-
FLYWHEEL STORAGE	F
BATTERY STORAGE	F



REQUIREMENT: 50 MW 1 HR

PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
50 MW 1 Hr.	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	Not modular
DIESEL GENERATOR(CF)	
SPARK IGN ENG GEN(CF)	
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	Not modular
STEAM TURB GEN - OIL(CF)	Not modular
STIRLING ENG GEN(CF)	
MHD GENERATOR(CF)	Not modular
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	Not modular
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	Not modular
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	Not modular
ORGANIC VAP TURB (SOLAR)	
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	
WIND TURB GEN 10-5	
WIND TURB GEN 20-1	
WIND TURB GEN 20-5	
FLYWHEEL STORAGE	Modular for most requirements
BATTERY STORAGE	Fully modular

REQUIREMENT	PARAMETER
50 MW 1 Hr.	14) Reliability/Availability

The tabulated conditions exist in the power system to the extent indicated.

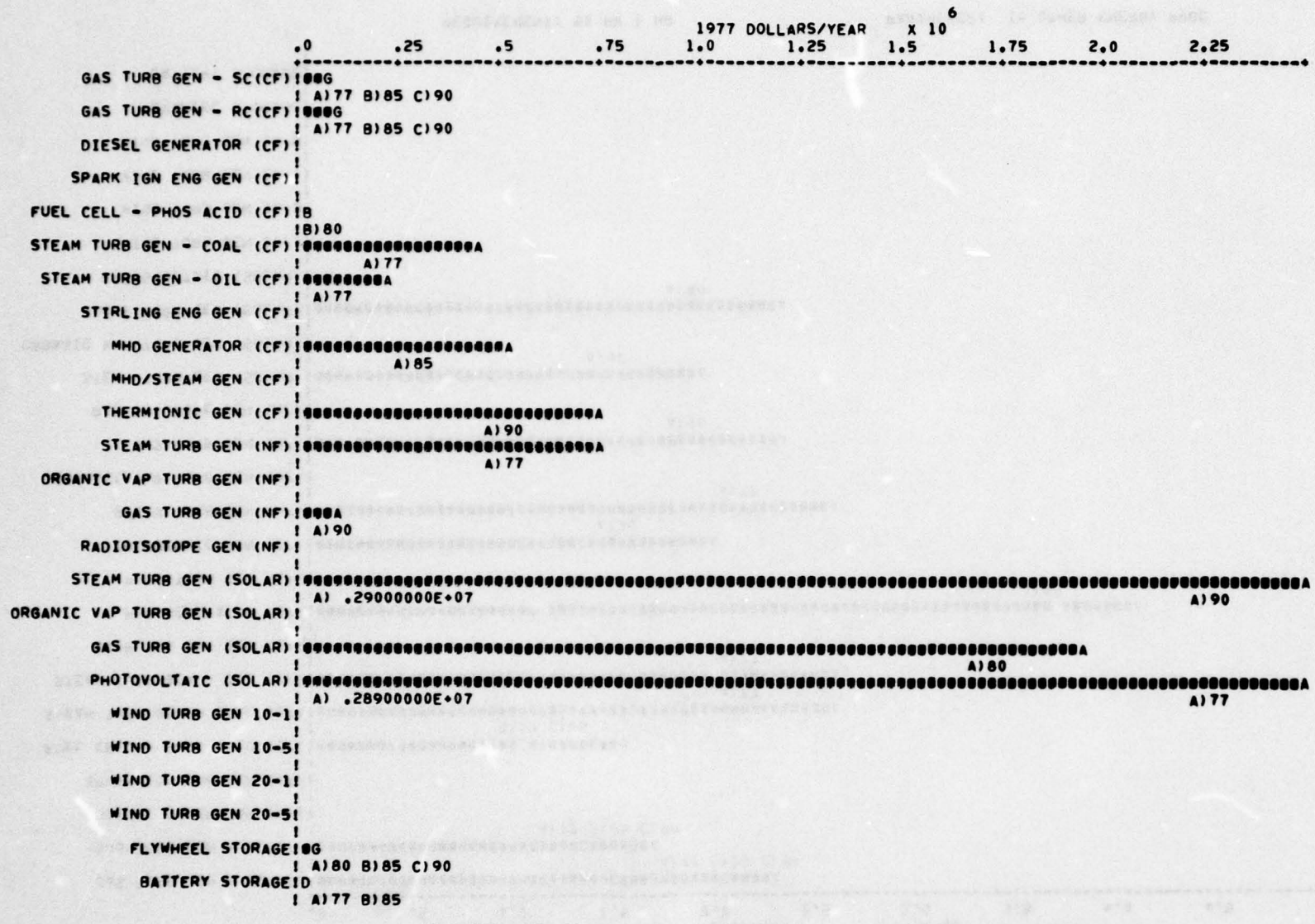
SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	0	●	0	-	●	0	●	-	-
GAS TURB GEN - RC(CF)	0	●	0	-	●	⊖	●	-	-
DIESEL GENERATOR(CF)									
SPARK IGN ENG GEN(CF)									
FUEL CELL - PHOS ACID(CF)	-	-	-	-	0	-	-	-	-
STEAM TURB GEN - COAL(CF)	●	0	0	-	0	⊖	●	-	-
STEAM TURB GEN - OIL(CF)	●	0	0	-	0	⊖	●	-	-
STIRLING ENG GEN(CF)									
MHD GENERATOR(CF)	0	●	-	-	●	⊖	●	-	-
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	0	●	-	-	⊖	0	0	-	-
STEAM TURB GEN(NF)	●	0	0	0	0	⊖	●	-	-
ORGANIC VAP TURB GEN(NF)									
GAS TURB GEN(NF)	●	0	0	0	-	⊖	●	-	-
RADIOISOTOPE GEN(NF)									
STEAM TURB GEN (SOLAR)	●	0	0	-	0	⊖	●	●	-
ORGANIC VAP TURB (SOLAR)									
GAS TURB GEN (SOLAR)	0	0	0	-	0	0	-	●	-
PHOTOVOLTAIC (SOLAR)	-	0	-	-	0	-	-	●	-
WIND TURB GEN 10-1									
WIND TURB GEN 10-5									
WIND TURB GEN 20-1									
WIND TURB GEN 20-5									
FLYWHEEL STORAGE	0	-	●	-	-	-	⊖	-	-
BATTERY STORAGE	-	0	-	-	0	-	-	-	-

- \- Condition does not exist in system

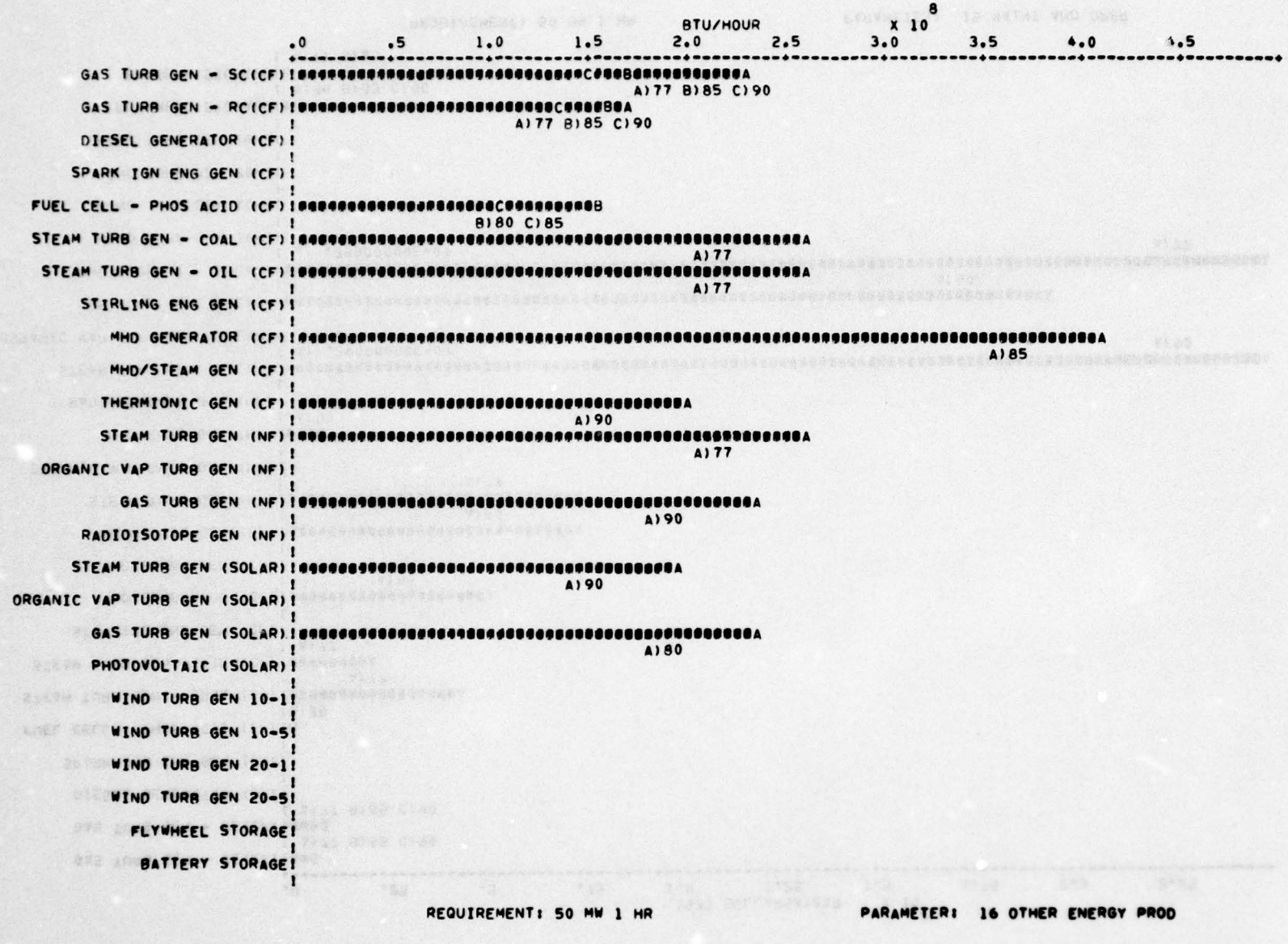
0 - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability

⊖ - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability

● - Condition exists and is a governing factor in determining system performance and reliability



REQUIREMENT: 50 MW 1 HR PARAMETER: 15 MAINT AND OPER



REQUIREMENT: 50 MW 1 HR

PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
50 MW 1 Hr.	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

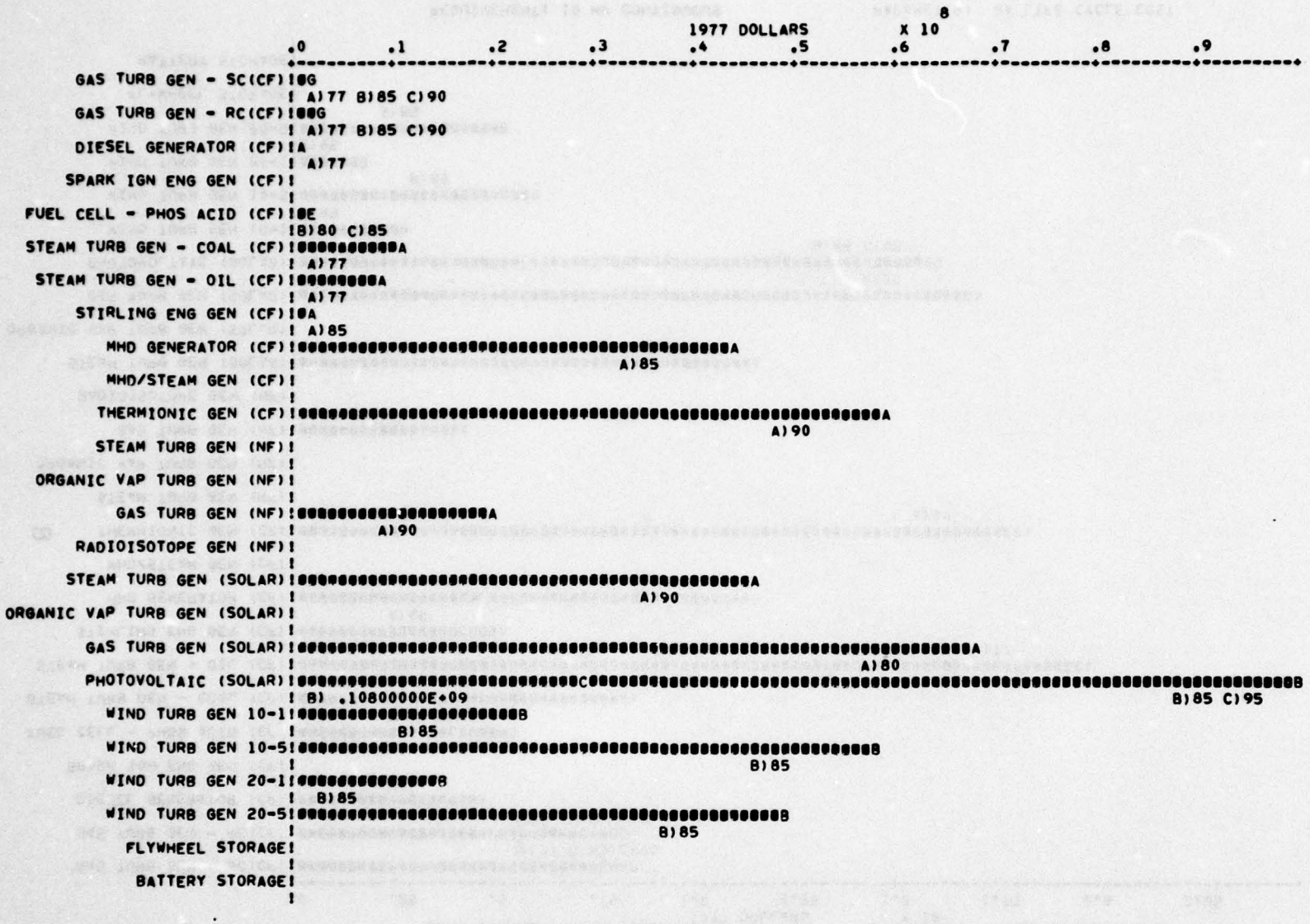
System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	None
DIESEL GENERATOR(CF)	
SPARK IGN ENG GEN(CF)	
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	None
STEAM TURB GEN - OIL(CF)	None
STIRLING ENG GEN(CF)	
MHD GENERATOR(CF)	None
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	None
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	None
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	None
ORGANIC VAP TURB (SOLAR)	
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	
WIND TURB GEN 10-5	
WIND TURB GEN 20-1	
WIND TURB GEN 20-5	
FLYWHEEL STORAGE	None
BATTERY STORAGE	Possibly lead for conventional batteries

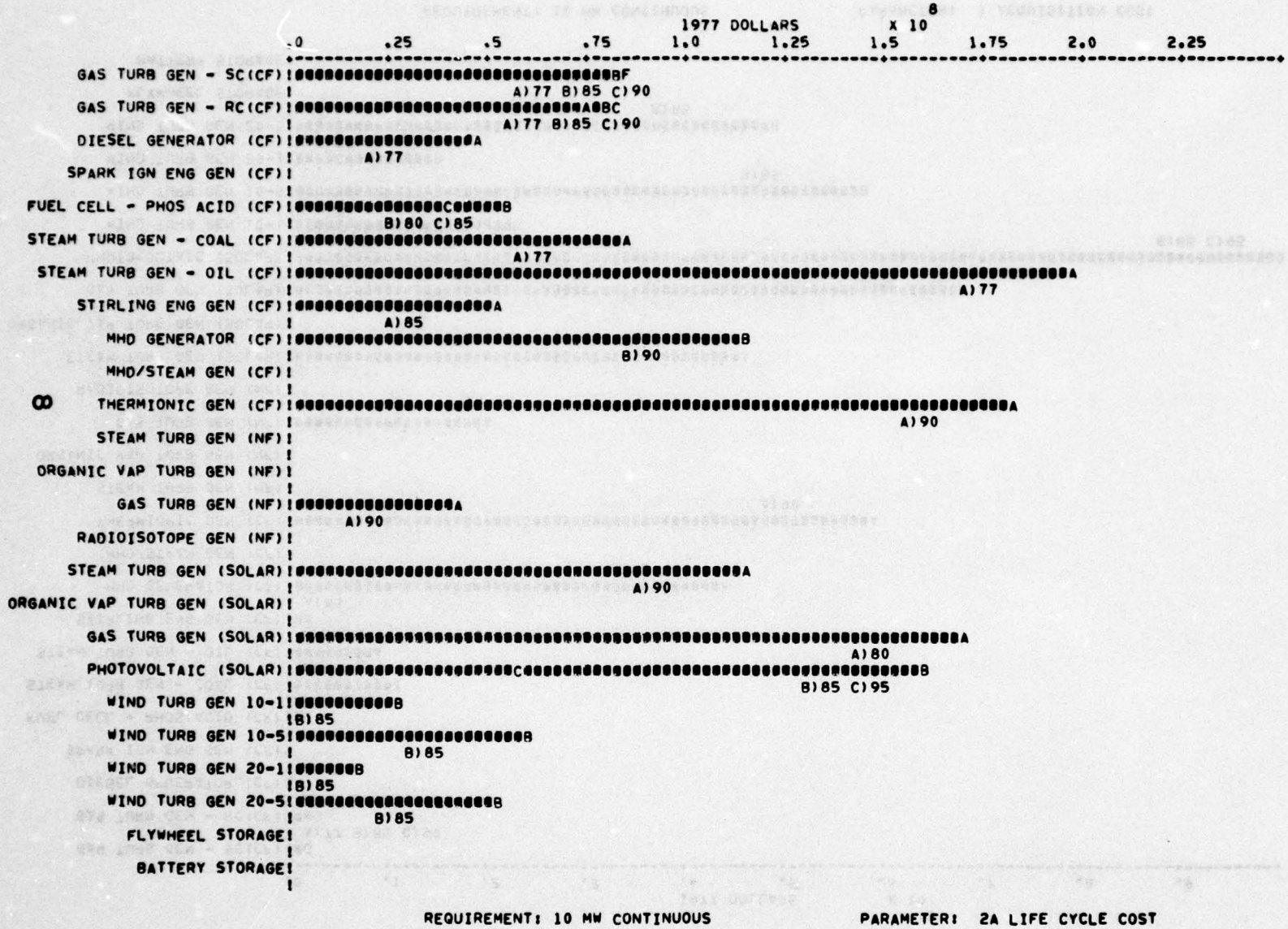
SECTION V

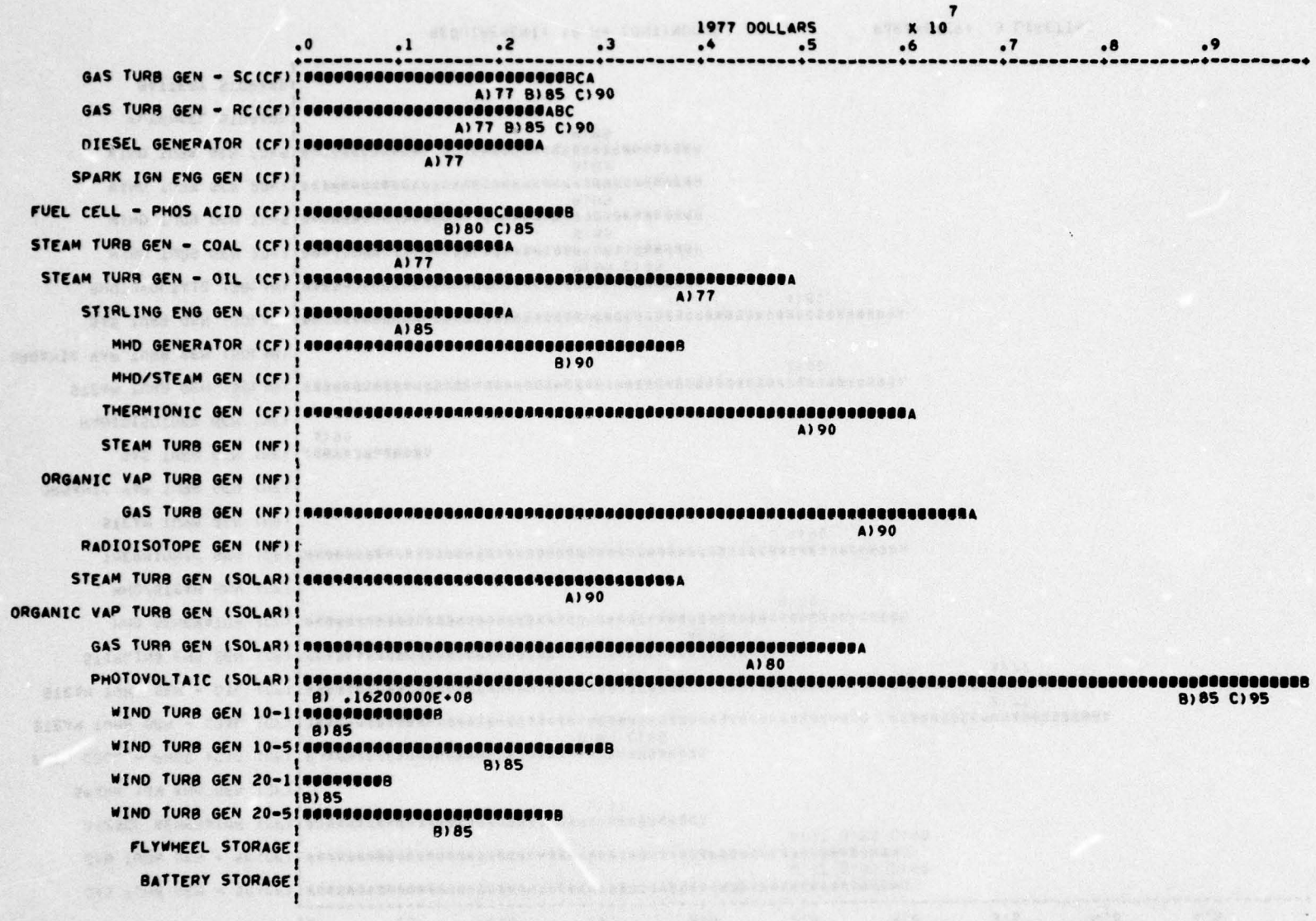
TEN MEGAWATT, CONTINUOUS

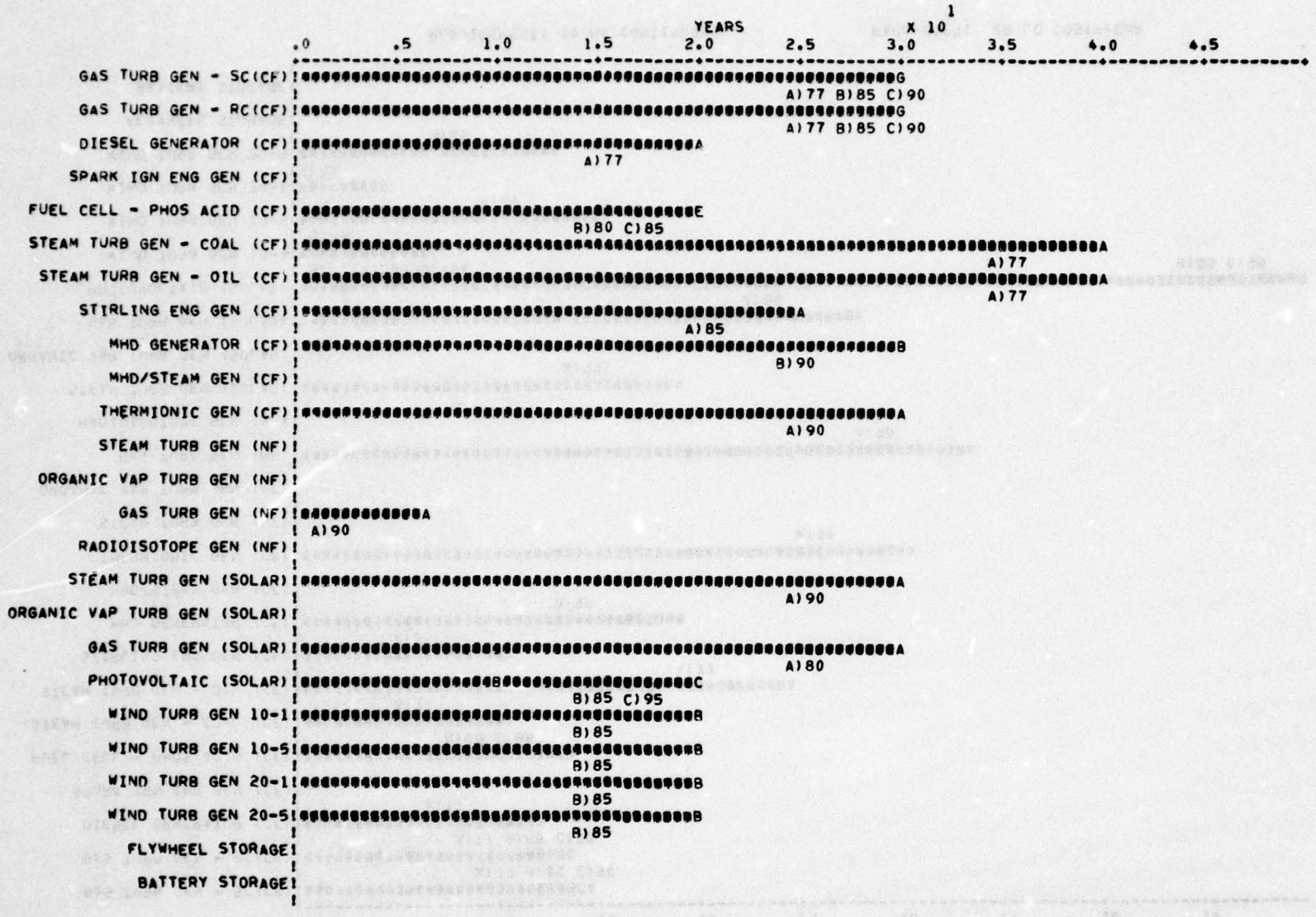
REQUIREMENT

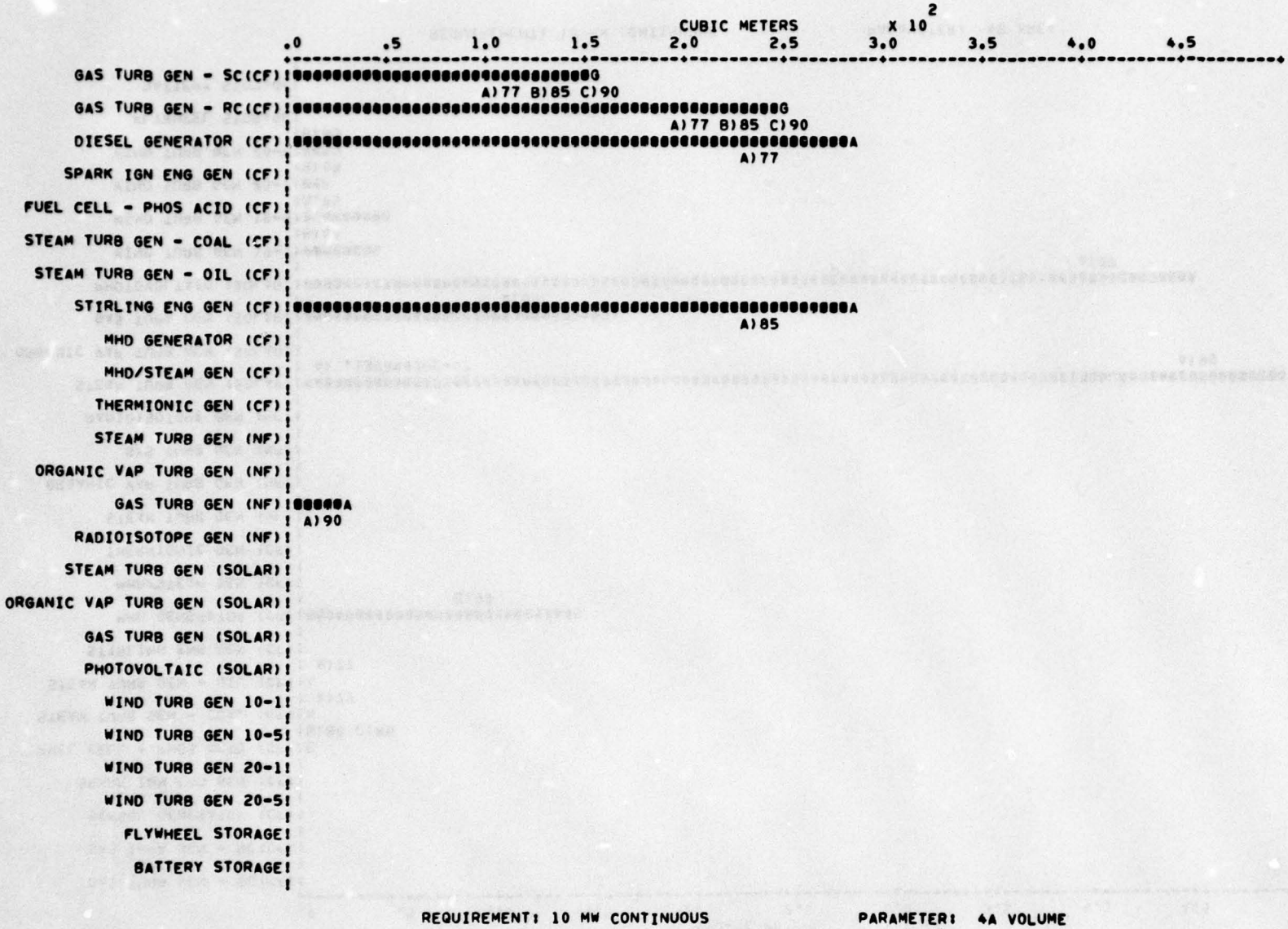
Power Level:	10 Mw
Operating Mode:	Continuous
Frequency/Phase:	60 Hz/3Ø
Voltage Level:	4160 V


1977 DOLLARS
X 10^8
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B) .10800000E+09
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 MW CONTINUOUS
PARAMETER: 1 ACQUISITION COST

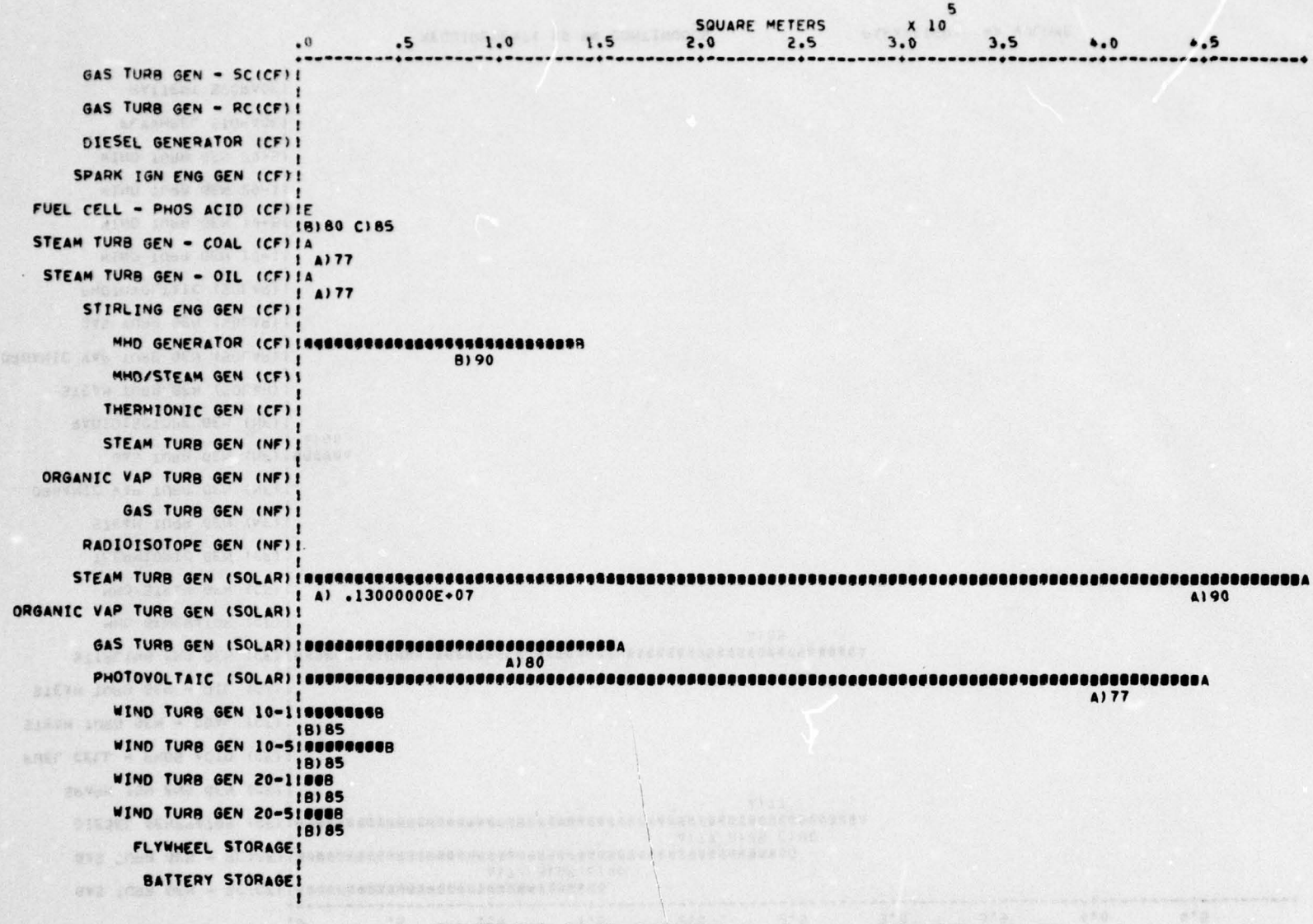

1977 DOLLARS
8
X 10
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
B)90
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 MW CONTINUOUS
PARAMETER: 2A LIFE CYCLE COST

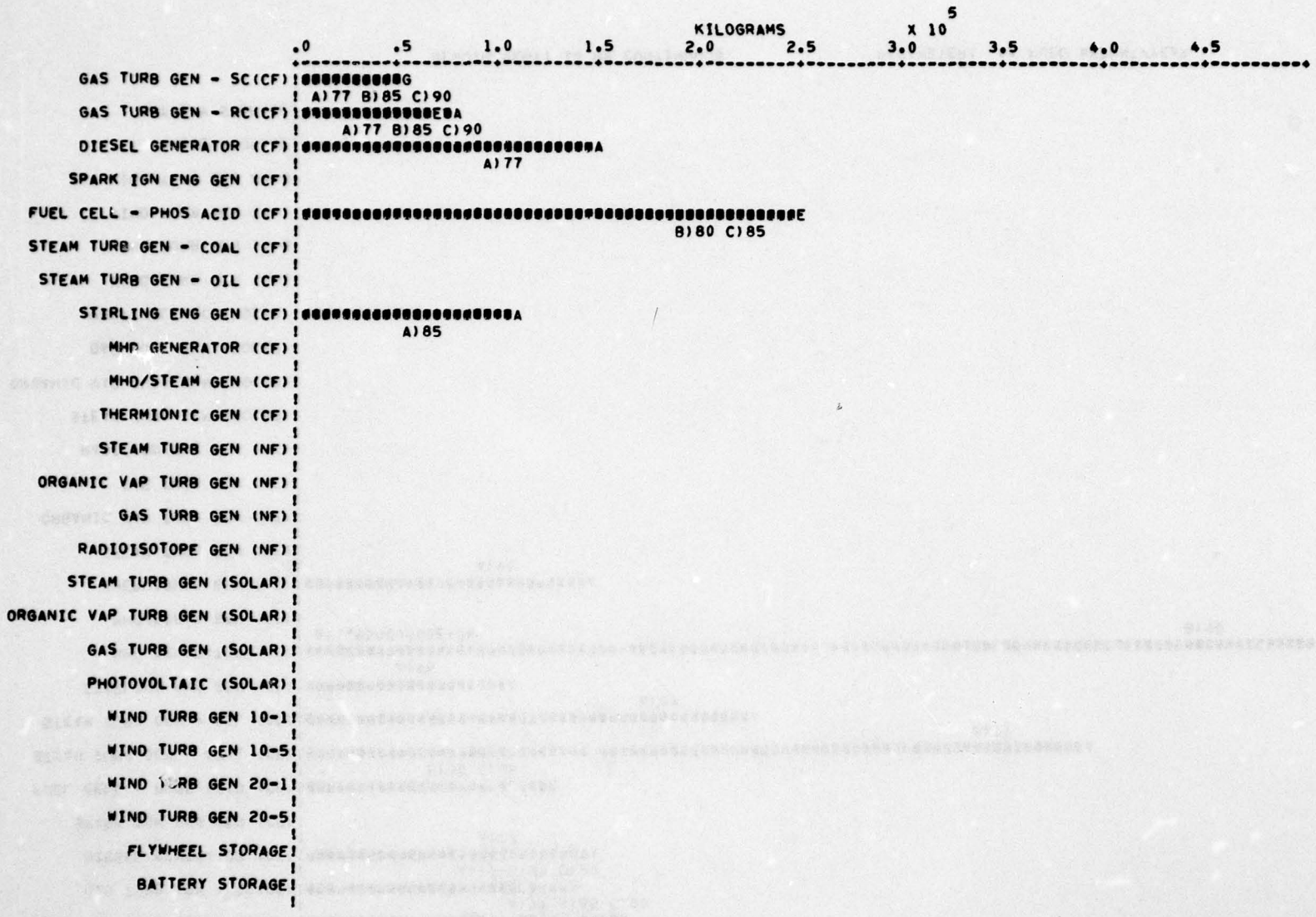

1977 DOLLARS
X 10^7
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
B)90
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B) .16200000E+08
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 MW CONTINUOUS
PARAMETER: 28 LC COST/YEAR

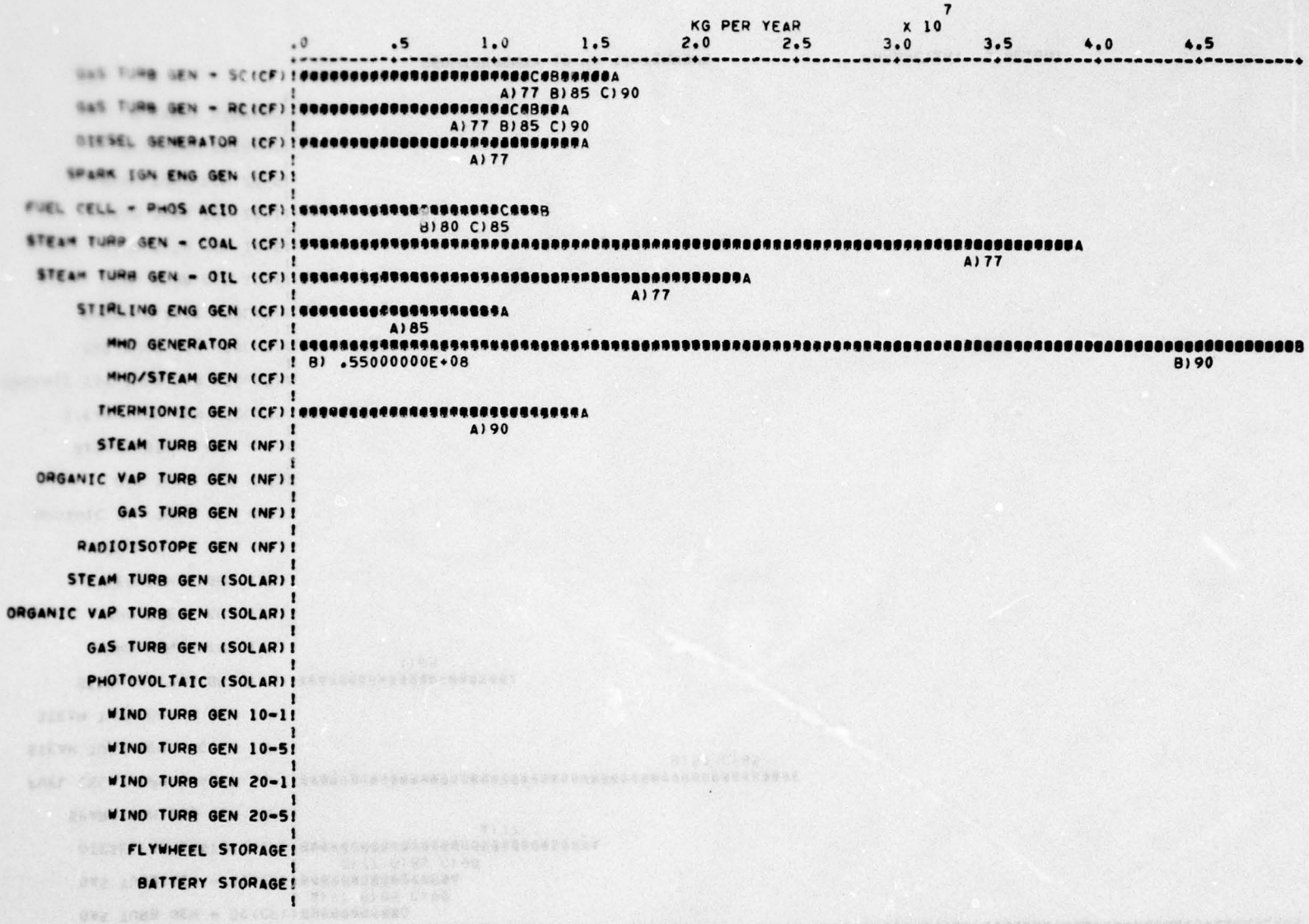

YEARS
X 10
1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
B)90
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 MW CONTINUOUS
PARAMETER: 3 LIFETIME

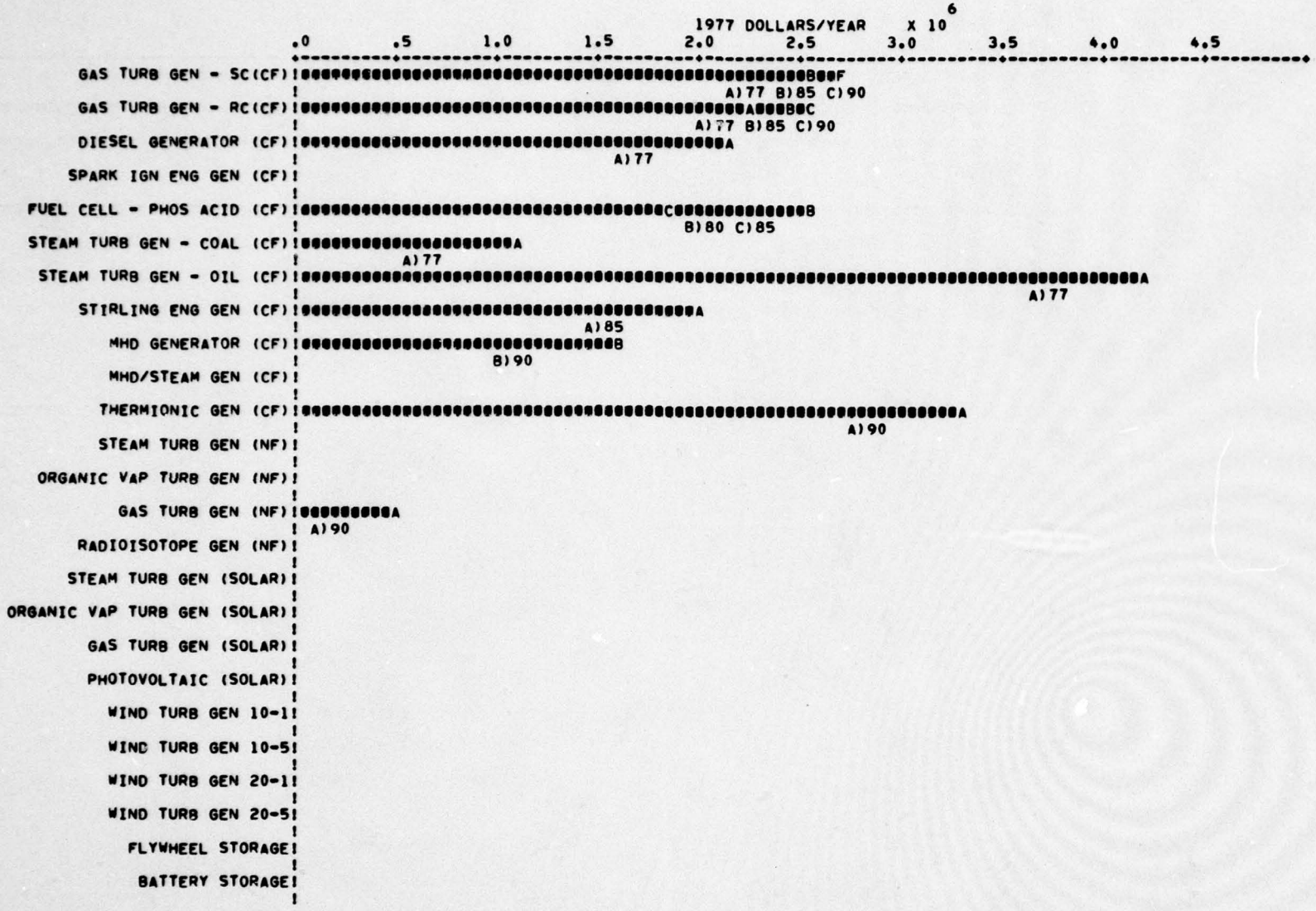


REQUIREMENT: 10 MW CONTINUOUS PARAMETER: 4A VOLUME


SQUARE METERS x 10^5
.0 .5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
A) .13000000E+07
A)90
B)90
A)80
A)77
B)85
C)85
REQUIREMENT: 10 MW CONTINUOUS
PARAMETER: 4B AREA


KILOGRAMS
X 10^5
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 MW CONTINUOUS
PARAMETER: 5 WEIGHT


KG PER YEAR
X 10^7
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
B) .55000000E+08
B)90
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 MW CONTINUOUS
PARAMETER: 6A FUEL AMOUNT/YEAR



REQUIREMENT: 10 MW CONTINUOUS

PARAMETER: 68 FUEL COST/YEAR

REQUIREMENT	PARAMETER
10 MW Cont.	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
GAS TURB GEN - RC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
DIESEL GENERATOR(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
SPARK IGN ENG GEN(CF)											
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	◐	-	-	-	-
STEAM TURB GEN - COAL(CF)	-	●	◐	0	◐	●	◐	●	●	0	-
STEAM TURB GEN - OIL(CF)	-	●	0	0	◐	●	◐	◐	●	0	-
STIRLING ENG GEN(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
MHD GENERATOR(CF)	-	-	0	0	●	◐	◐	●	●	-	-
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)	-	-	0	0	●	◐	0	◐	-	-	-
STEAM TURB GEN(NF)											
ORGANIC VAP TURB GEN(NF)											
GAS TURB GEN(NF)	-	●	-	-	-	-	◐	-	-	0	◐
RADIOISOTOPE GEN(NF)											
STEAM TURB GEN (SOLAR)	-	●	-	-	-	-	◐	-	-	0	-
ORGANIC VAP TURB (SOLAR)											
GAS TURB GEN (SOLAR)	-	-	-	-	-	-	◐	-	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
WIND TURB GEN (ALL)	-	-	-	-	-	-	-	-	-	-	-
FLYWHEEL STORAGE											
BATTERY STORAGE											

- - none
0 - minor
◐ - moderate
● - major

REQUIREMENT	PARAMETER
10 MW Cont.	8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- - - no limitation
- o - minor limitation
- ⊖ - major limitation
- ● - overriding limitation

SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	o	●	-	-	-	-
GAS TURB GEN - RC(CF)	-	-	o	●	-	-	-	-
DIESEL GENERATOR(CF)	-	-	-	●	-	-	-	-
SPARK IGN ENG GEN(CF)								
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)	⊖	⊖	●	●	-	-	-	-
STEAM TURB GEN - OIL(CF)	⊖	⊖	●	●	-	-	-	-
STIRLING ENG GEN(CF)	-	-	o	●	-	-	-	-
MHD GENERATOR(CF)	o	o	o	●	-	-	-	-
MHD/STEAM GEN(CF)								-
THERMIONIC GEN(CF)	o	o	o	●	-	-	-	-
STEAM TURB GEN(NF)								
ORGANIC VAP TURB GEN(NF)	-		-	-			-	
GAS TURB GEN(NF)	⊖	-	●	o	-	-	●	-
RADIOISOTOPE GEN(NF)							-	
STEAM TURB GEN (SOLAR)	⊖	⊖	●	-	●	-	-	-
ORGANIC VAP TURB (SOLAR)								
GAS TURB GEN (SOLAR)	-	-	o	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1	-	-	-	-	-	●	-	-
WIND TURB GEN 10-5	-	-	-	-	-	●	-	-
WIND TURB GEN 20-1	-	-	-	-	-	●	-	-
WIND TURB GEN 20-5	-	-	-	-	-	●	-	-
FLYWHEEL STORAGE								-
BATTERY STORAGE								-

REQUIREMENT

10 MW Cont.

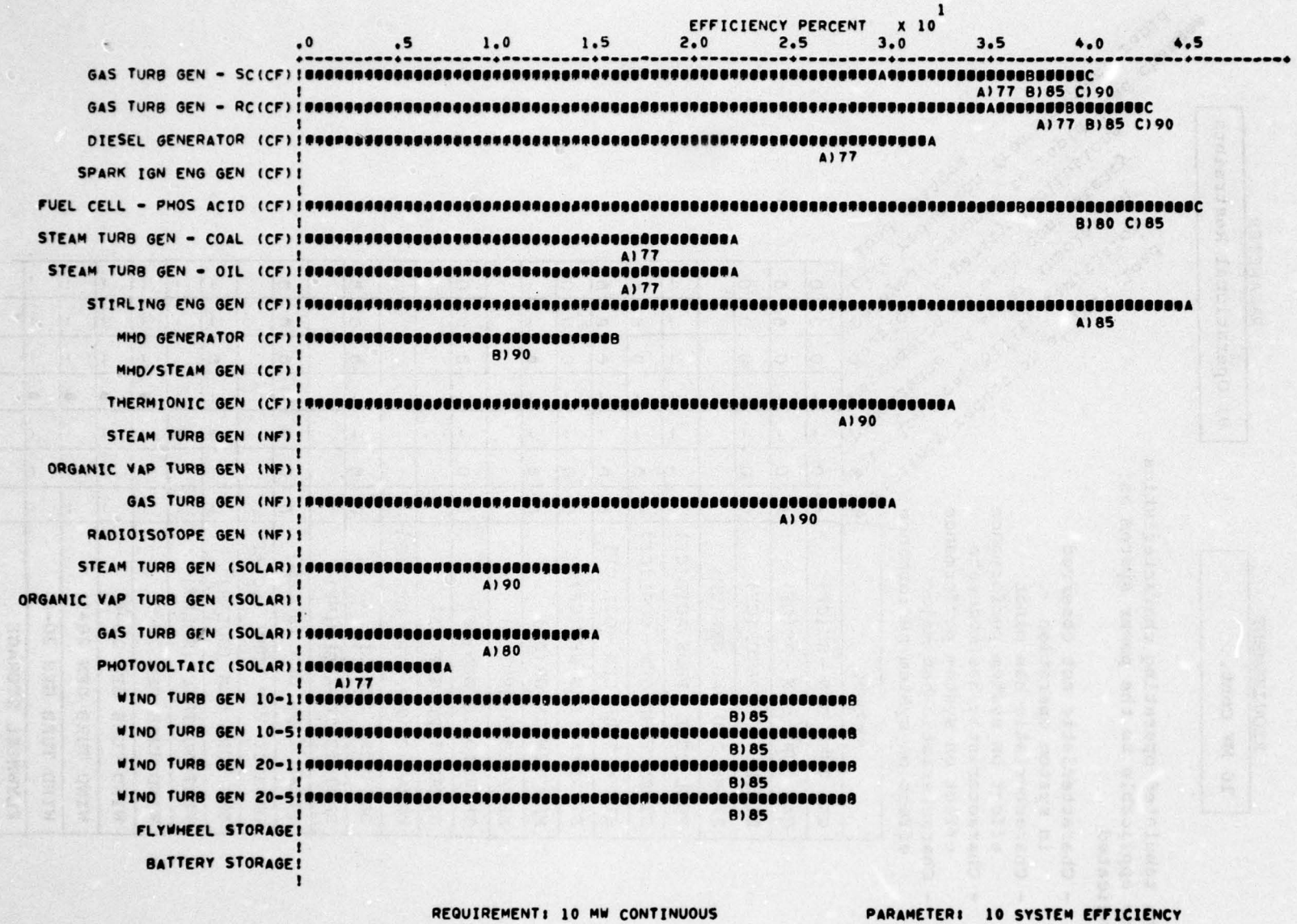
PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
0 - Characteristic has minor effect on system performance
◐ - Characteristic has moderate effect on system performance
● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	◐	0	-	-	0	0	0
GAS TURB GEN - RC(CF)	◐	0	-	-	0	◐	◐
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)							
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)	◐	◐	-	-	◐	◐	◐
STEAM TURB GEN - OIL(CF)	◐	◐	-	-	◐	◐	◐
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)	◐	◐	-	-	●	-	-
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	◐	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)							
GAS TURB GEN(NF)	0	◐	-	-	◐	0	◐
RADIOISOTOPE GEN(NF)							
STEAM TURB GEN (SOLAR)	◐	◐	●	-	◐	◐	◐
ORGANIC VAP TURB (SOLAR)							
GAS TURB GEN (SOLAR)	-	-	●	-	◐	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE							
BATTERY STORAGE							

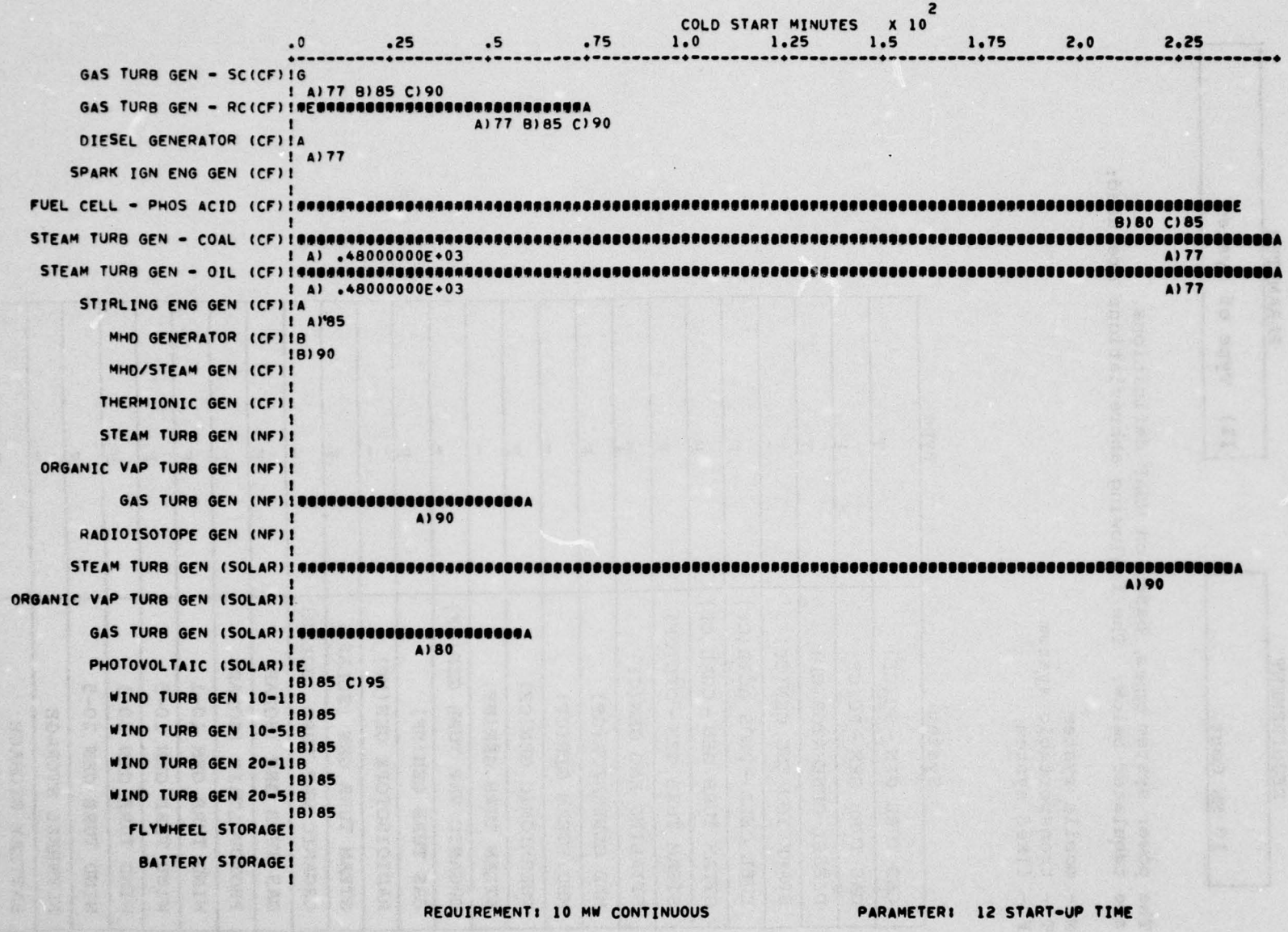

EFFICIENCY PERCENT X 10^1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
B)90
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 MW CONTINUOUS
PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
10 MW Cont	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	T
GAS TURB GEN - RC(CF)	F
DIESEL GENERATOR(CF)	T
SPARK IGN ENG GEN(CF)	-
FUEL CELL - PHOS ACID(CF)	F
STEAM TURB GEN - COAL(CF)	F
STEAM TURB GEN - OIL(CF)	F
STIRLING ENG GEN(CF)	T
MHD GENERATOR(CF)	F
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	F
STEAM TURB GEN(NF)	-
ORGANIC VAP TURB GEN(NF)	-
GAS TURB GEN(NF)	F
RADIOISOTOPE GEN(NF)	-
STEAM TURB GEN (SOLAR)	F
ORGANIC VAP TURB (SOLAR)	-
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	F
WIND TURB GEN 10-5	F
WIND TURB GEN 20-1	F
WIND TURB GEN 20-5	F
FLYWHEEL STORAGE	-
BATTERY STORAGE	-


COLD START MINUTES X 10^2
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A) .48000000E+03
A)77
STEAM TURB GEN - OIL (CF)
A) .48000000E+03
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
B)90
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 MW CONTINUOUS
PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
10 MW Cont.	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	Not modular
DIESEL GENERATOR(CF)	Not modular, except possibly largest requirements
SPARK IGN ENG GEN(CF)	
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	Not modular
STEAM TURB GEN - OIL(CF)	Not modular
STIRLING ENG GEN(CF)	Not modular, except possibly largest requirements
MHD GENERATOR(CF)	Not modular
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	Not modular
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	Not modular
ORGANIC VAP TURB (SOLAR)	
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	Modular for most requirements
WIND TURB GEN 10-5	Modular for most requirements
WIND TURB GEN 20-1	Modular for most requirements
WIND TURB GEN 20-5	Modular for most requirements
FLYWHEEL STORAGE	
BATTERY STORAGE	

REQUIREMENT	PARAMETER
10 MW Cont.	14) Reliability/Availability

The tabulated conditions exist in the power system to the extent indicated.

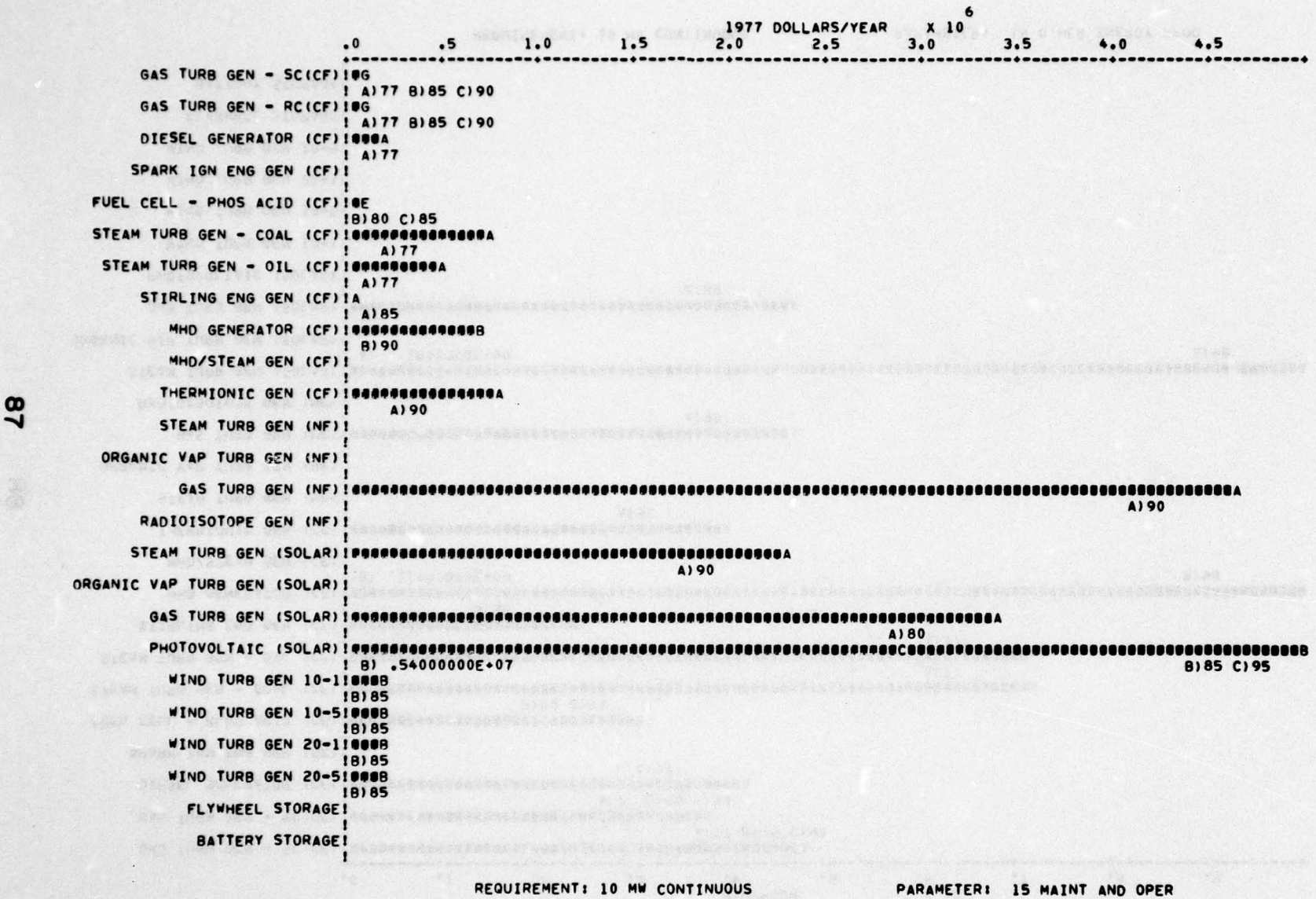
SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	O	●	O	-	●	O	●	-	-
GAS TURB GEN - RC(CF)	O	●	O	-	●	⊖	●	-	-
DIESEL GENERATOR(CF)	●	O	O	-	O	O	●	-	-
SPARK IGN ENG GEN(CF)									
FUEL CELL - PHOS ACID(CF)	-	-	-	-	O	-	-	-	-
STEAM TURB GEN - COAL(CF)	●	O	O	-	O	⊖	●	-	-
STEAM TURB GEN - OIL(CF)	●	O	O	-	O	⊖	●	-	-
STIRLING ENG GEN(CF)	O	O	O	-	O	O	●	-	-
MHD GENERATOR(CF)	O	●	-	-	●	⊖	●	-	-
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	O	●	-	-	⊖	O	O	-	-
STEAM TURB GEN(NF)									
ORGANIC VAP TURB GEN(NF)									
GAS TURB GEN(NF)	●	O	O	O	-	⊖	●	-	-
RADIOISOTOPE GEN(NF)									
STEAM TURB GEN (SOLAR)	●	O	O	-	O	⊖	●	●	-
ORGANIC VAP TURB (SOLAR)									
GAS TURB GEN (SOLAR)	O	O	O	-	O	O	-	●	-
PHOTOVOLTAIC (SOLAR)	-	O	-	-	O	-	-	●	-
WIND TURB GEN 10-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 10-5	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-5	O	O	●	-	O	-	-	-	●
FLYWHEEL STORAGE	O	-	●	-	-	-	⊖	-	-
BATTERY STORAGE	-	O	-	-	O	-	-	-	-

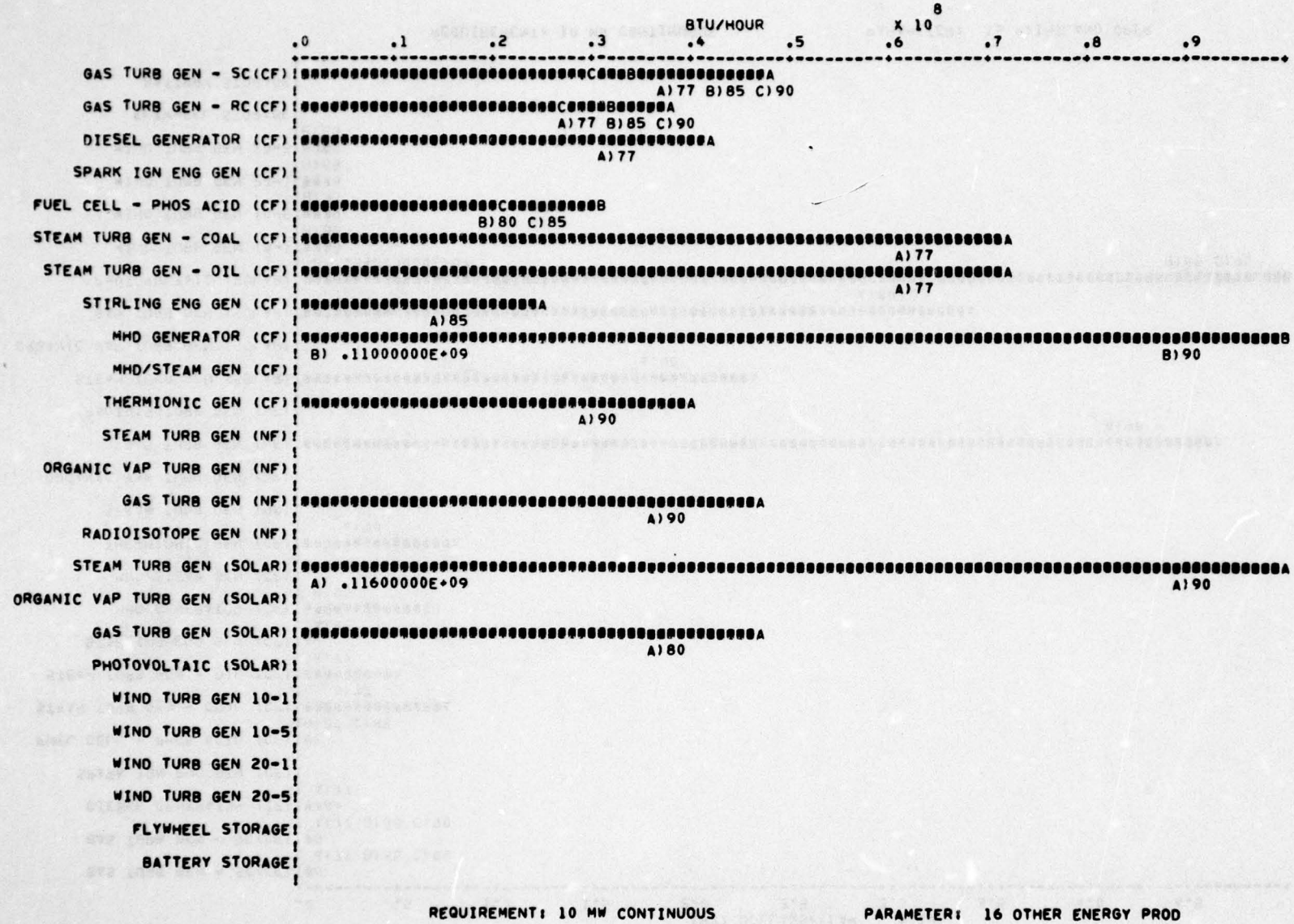
- \- - Condition does not exist in system

O - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability

⊖ - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability

● - Condition exists and is a governing factor in determining system performance and reliability


1977 DOLLARS/YEAR X 10^6
.0 .5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
B)90
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B) .54000000E+07
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 MW CONTINUOUS
PARAMETER: 15 MAINT AND OPER


BTU/HOUR
X 10 8
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
B) .11000000E+09
B)90
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A) .11600000E+09
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 MW CONTINUOUS
PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
10 MW Cont.	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	None
DIESEL GENERATOR(CF)	None
SPARK IGN ENG GEN(CF)	
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	None
STEAM TURB GEN - OIL(CF)	None
STIRLING ENG GEN(CF)	None
MHD GENERATOR(CF)	None
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	None
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	None
ORGANIC VAP TURB (SOLAR)	
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	Possibly lead for conventional batteries
WIND TURB GEN 10-5	Possibly lead for conventional batteries
WIND TURB GEN 20-1	Possibly lead for conventional batteries
WIND TURB GEN 20-5	Possibly lead for conventional batteries
FLYWHEEL STORAGE	
BATTERY STORAGE	

SECTION VI

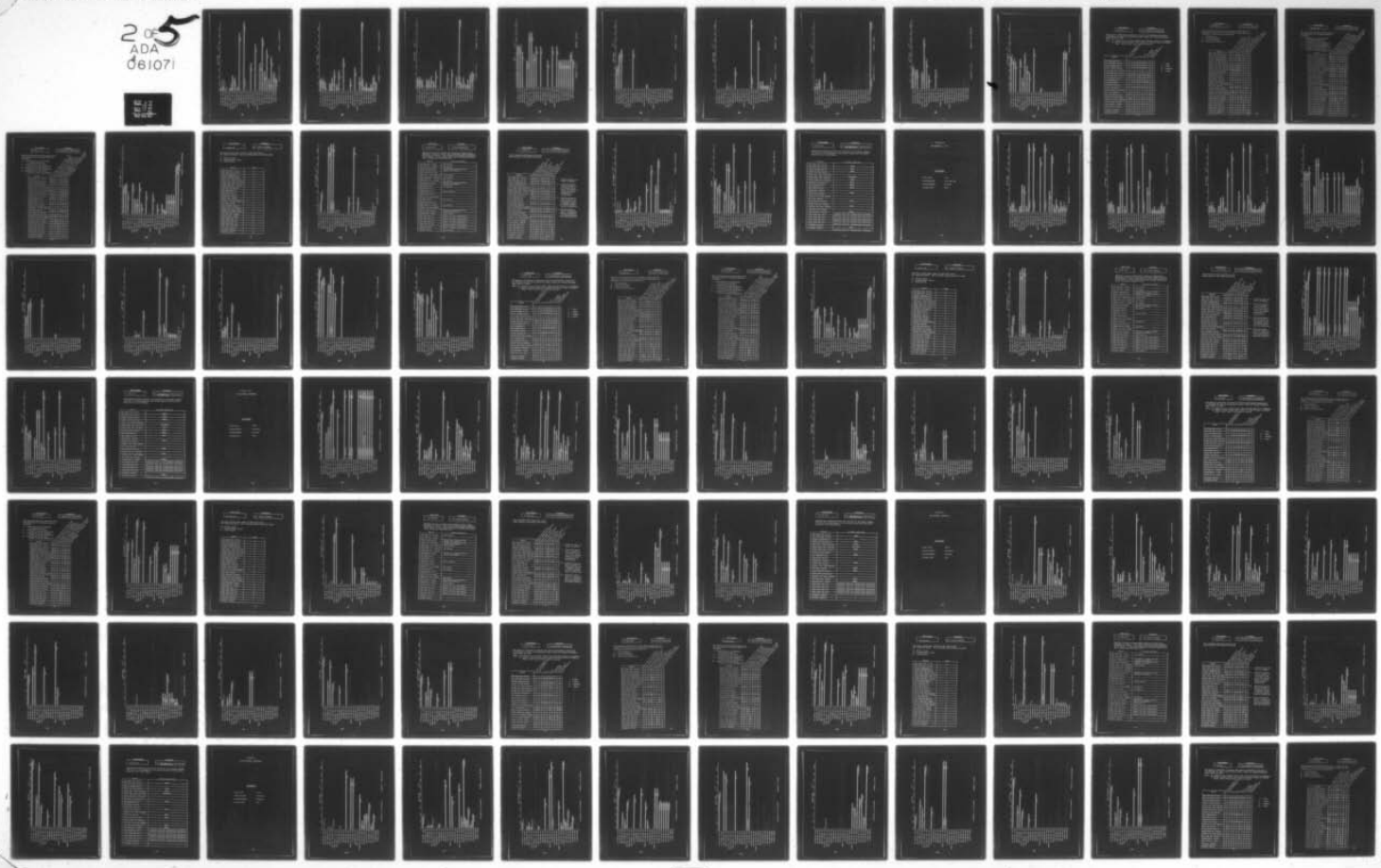
TEN MEGAWATT, 8 HOUR

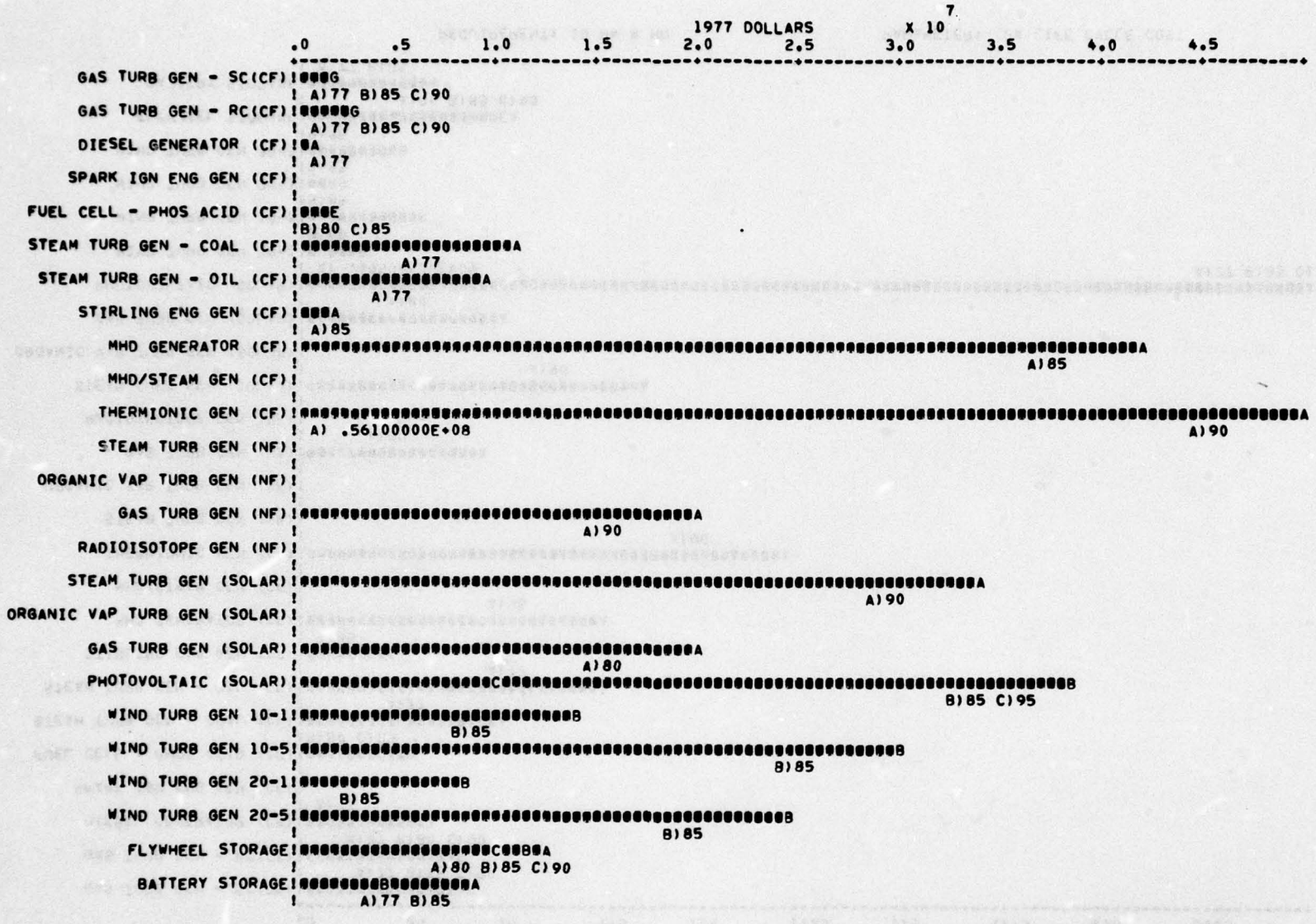
REQUIREMENT

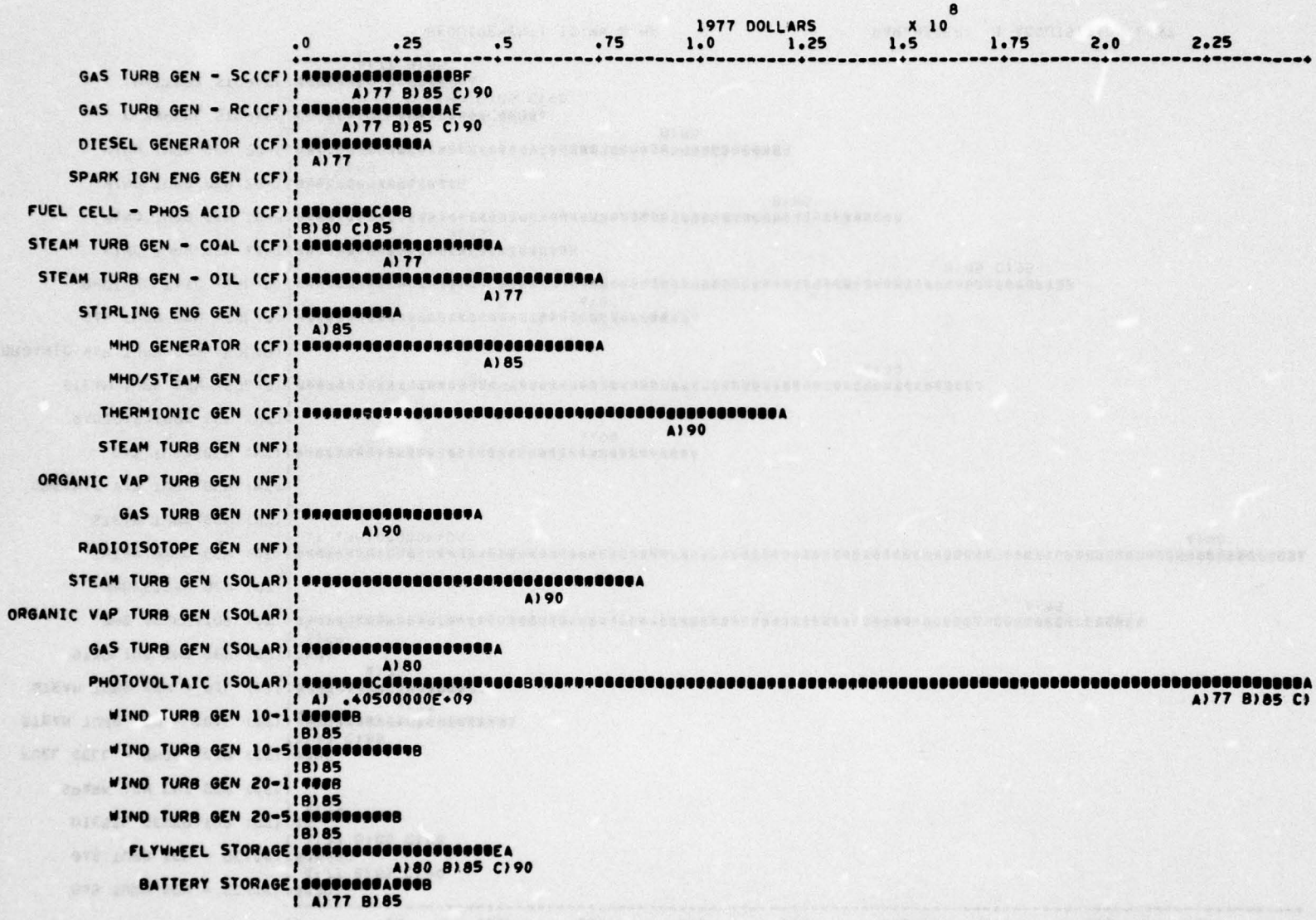
Power Level:	10 Mw
Operating Mode:	8 hours per day
Frequency/Phase:	60 Hz/3Ø
Voltage Level:	4160 V

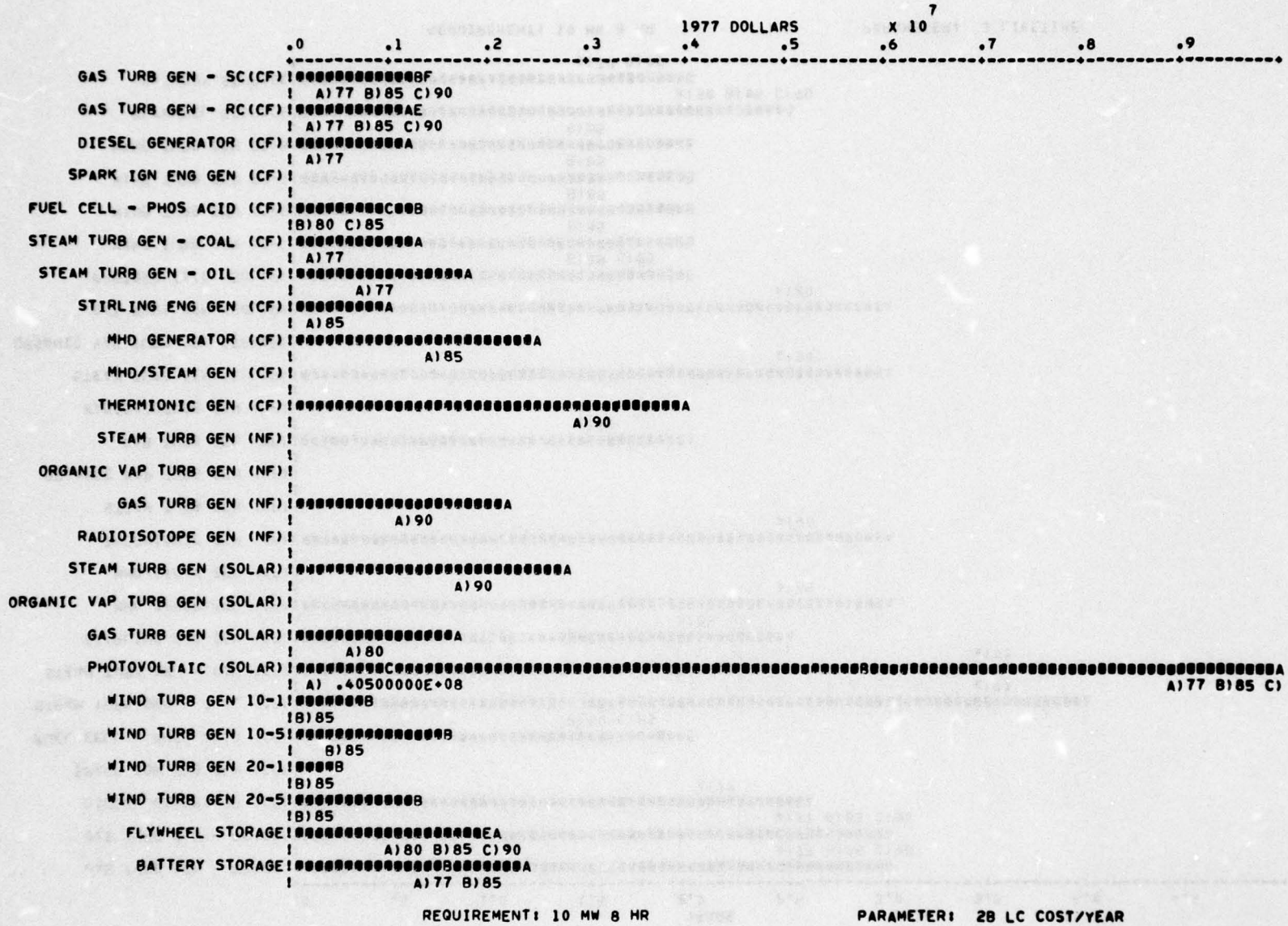
AD-A061 071 BURNS AND ROE INC WOODBURY NY F/G 10/2
USAF TERRESTRIAL ENERGY STUDY. VOLUME III. PART I. SUMMARY DATA--ETC(U)
MAY 78 D C HALL, A CARLSON, D FULLER, R REYER F33615-76-C-2171
UNCLASSIFIED AFAPL-TR-78-19-VOL-3-PT-1 NL

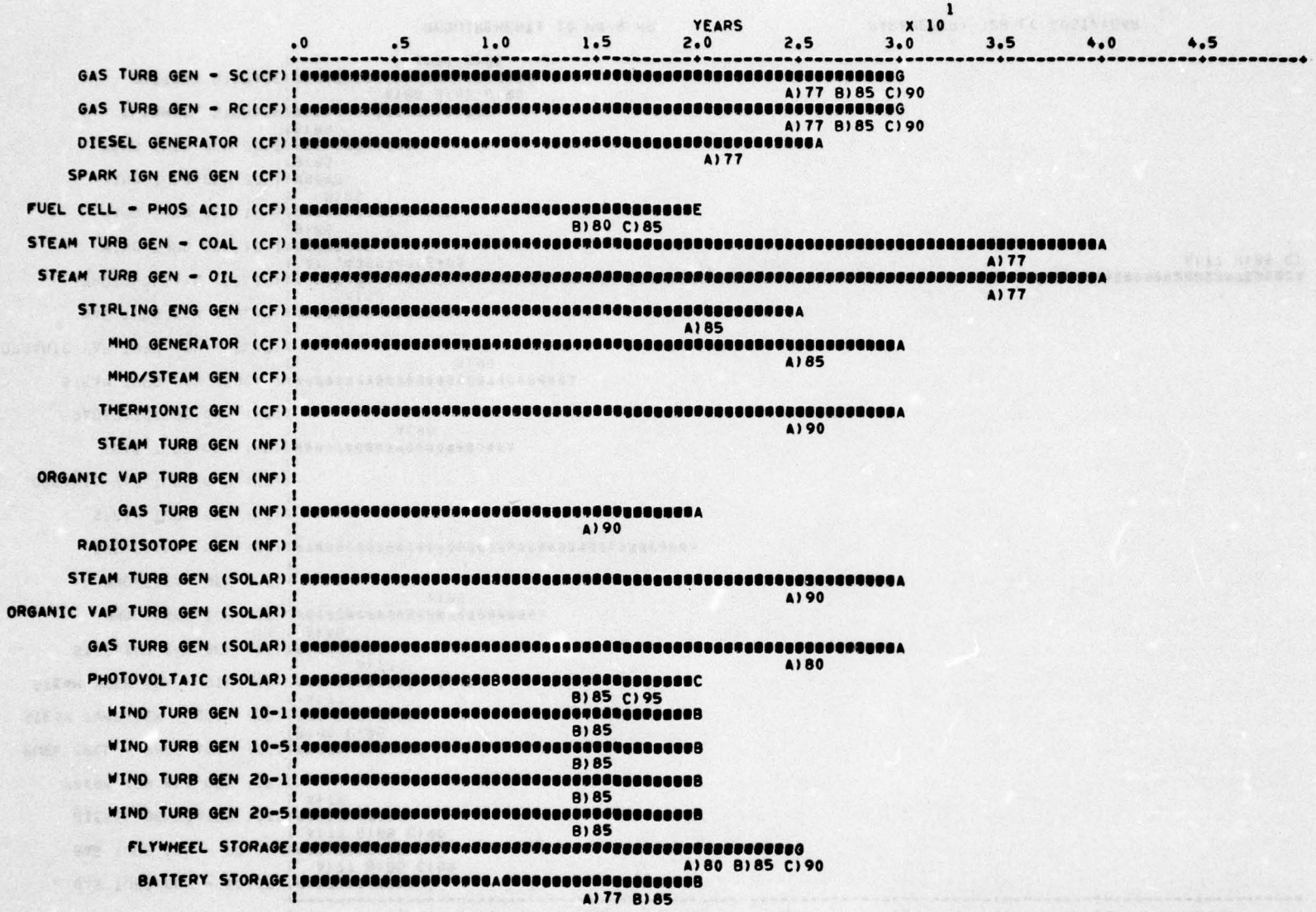
2 OF 5
ADA
061071

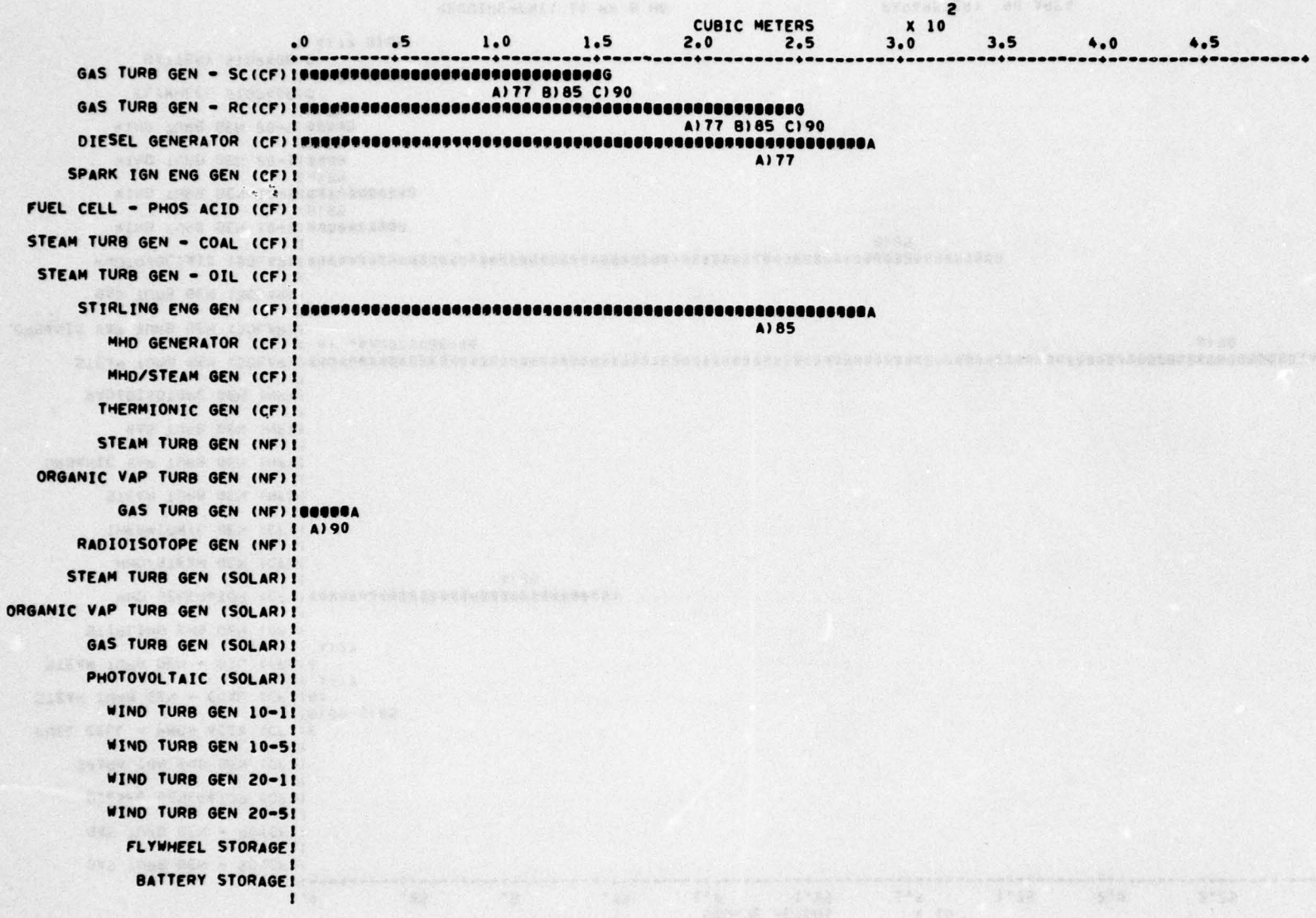



1977 DOLLARS
X 10 7
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A) .56100000E+08
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 MW 8 HR
PARAMETER: 1 ACQUISITION COST


1977 DOLLARS
X 10^8
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A) .40500000E+09
A)77 B)85 C)
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 MW 8 HR
PARAMETER: 2A LIFE CYCLE COST

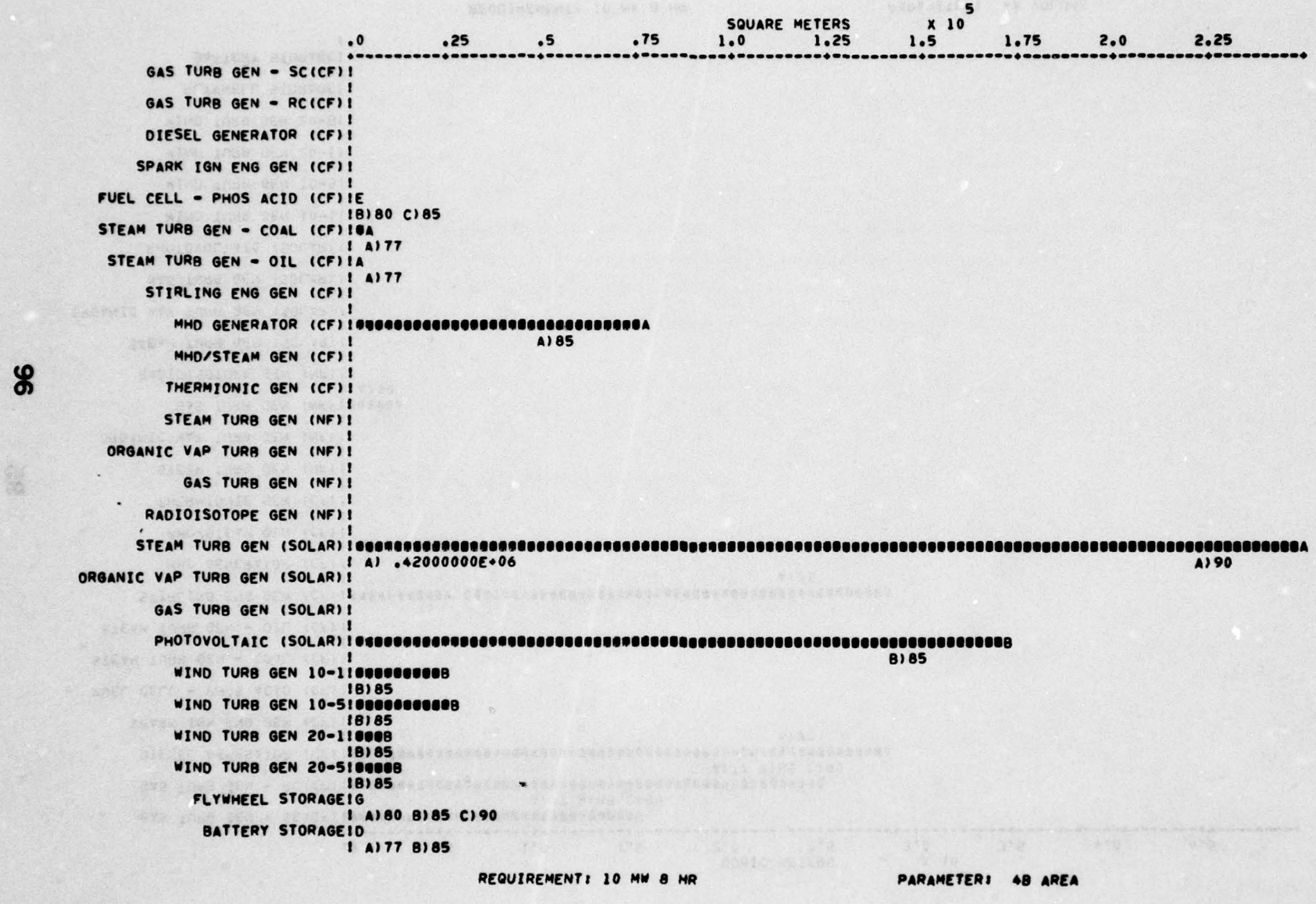

1977 DOLLARS
X 10^7
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A) .40500000E+08
A)77 B)85 C)
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 MW 8 HR
PARAMETER: 28 LC COST/YEAR


YEARS
X 10
1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 MW 8 HR
PARAMETER: 3 LIFETIME

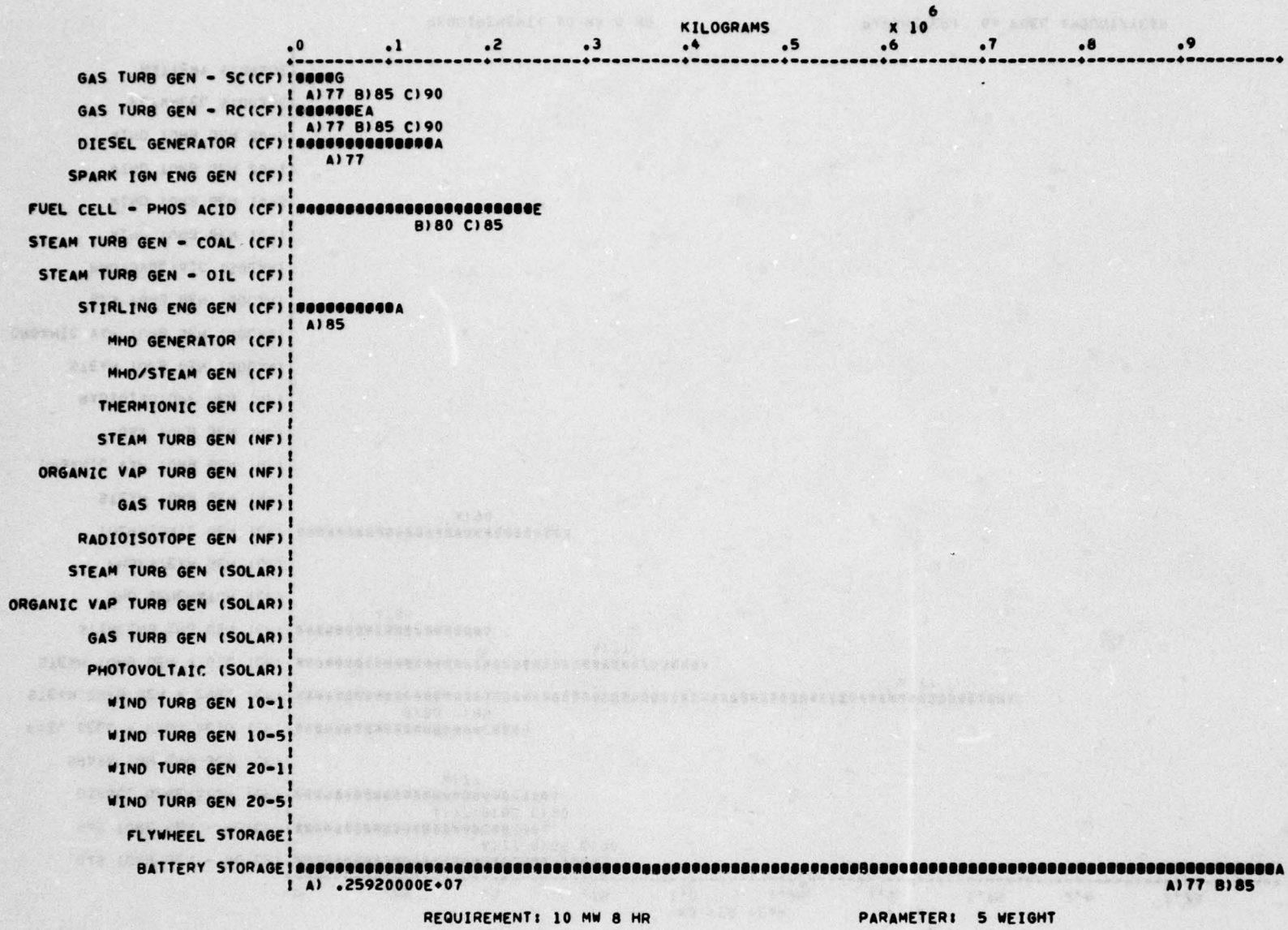


REQUIREMENT: 10 MW 8 HR

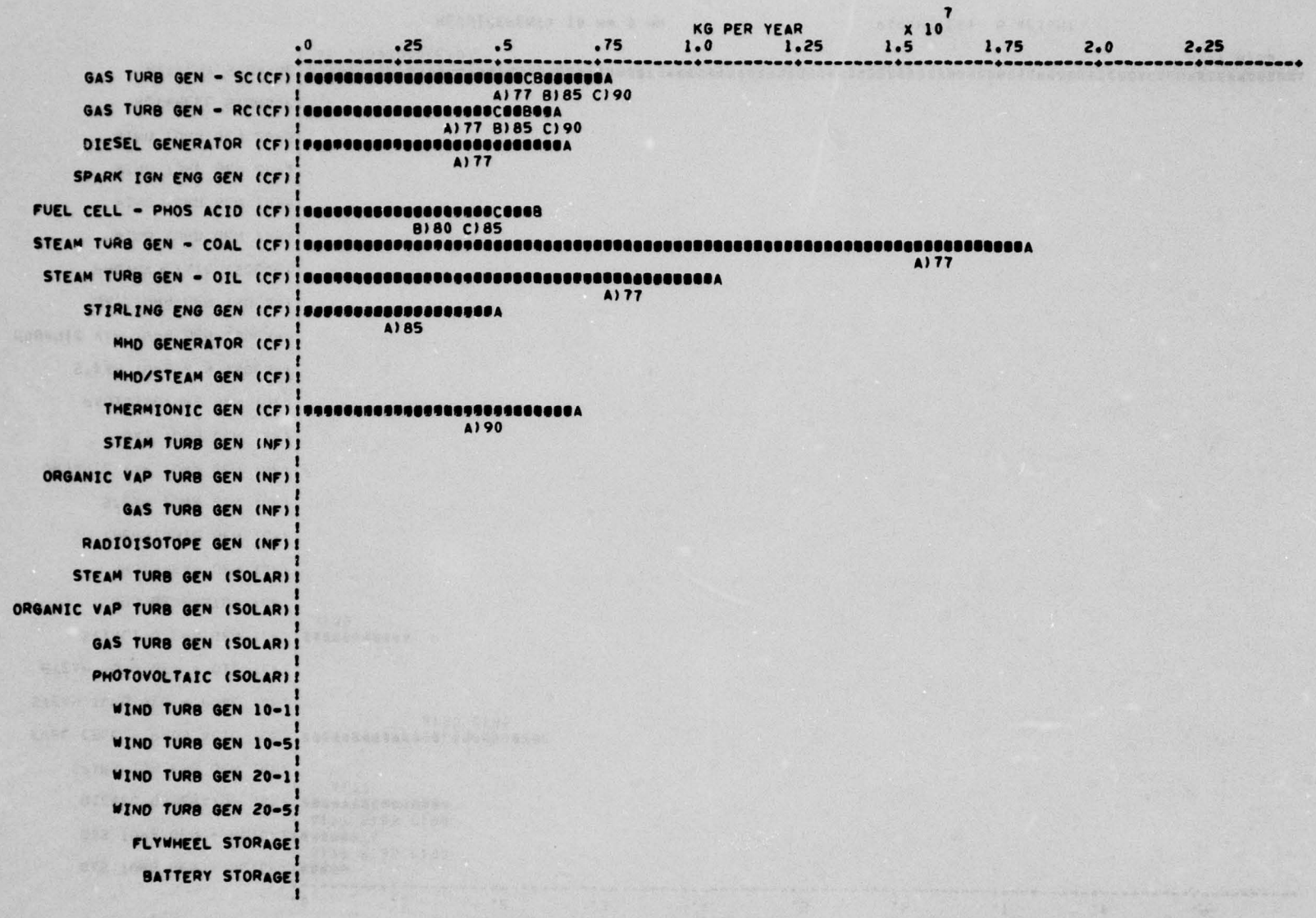
PARAMETER: 4A VOLUME



REQUIREMENT: 10 MW 8 HR PARAMETER: 48 AREA

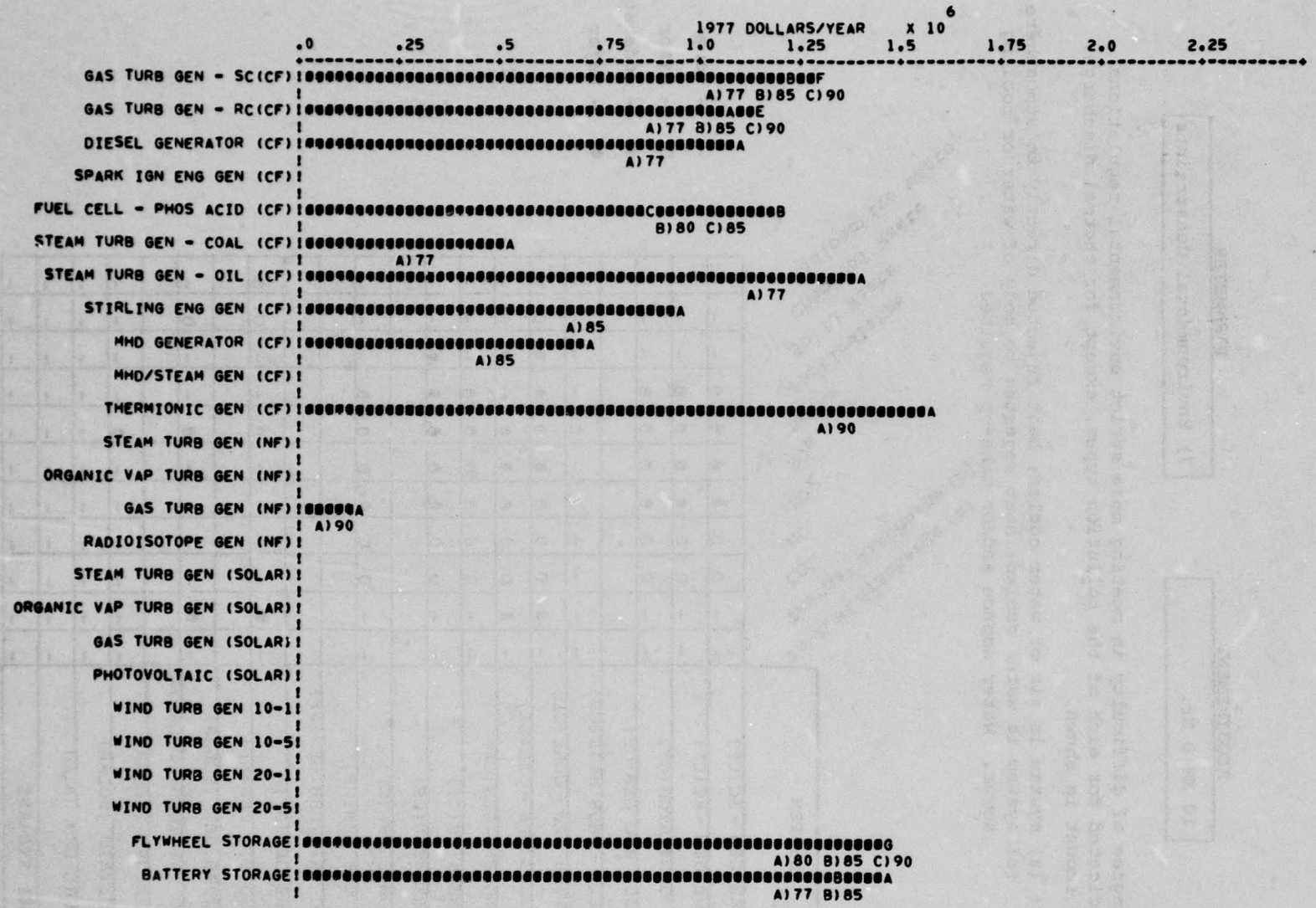


REQUIREMENT: 10 MW 8 HR PARAMETER: 5 WEIGHT



REQUIREMENT: 10 MW 8 HR

PARAMETER: 6A FUEL AMOUNT/YEAR


1977 DOLLARS/YEAR X 10^6
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 MW 8 HR
PARAMETER: 68 FUEL COST/YEAR

REQUIREMENT	PARAMETER
10 MW 8 Hr.	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
GAS TURB GEN - RC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
DIESEL GENERATOR(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
SPARK IGN ENG GEN(CF)											
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	◐	-	-	-	-
STEAM TURB GEN - COAL(CF)	-	●	0	0	◐	●	◐	●	●	0	-
STEAM TURB GEN - OIL(CF)	-	●	0	0	◐	●	◐	◐	●	0	-
STIRLING ENG GEN(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
MHD GENERATOR(CF)	-	-	0	0	●	◐	◐	●	●	-	-
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)	-	-	0	0	●	◐	0	◐	-	-	-
STEAM TURB GEN(NF)											
ORGANIC VAP TURB GEN(NF)											
GAS TURB GEN(NF)	-	●	-	-	-	-	◐	-	-	0	◐
RADIOISOTOPE GEN(NF)											
STEAM TURB GEN (SOLAR)	-	●	-	-	-	-	◐	-	-	0	-
ORGANIC VAP TURB (SOLAR)											
GAS TURB GEN (SOLAR)	-	-	-	-	-	-	◐	-	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
WIND TURB GEN (ALL)	-	-	-	-	-	-	-	-	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	-	-	-	-
BATTERY STORAGE	-	-	-	-	-	-	-	-	-	-	-

- - none
0 - minor
◐ - moderate
● - major

REQUIREMENT	PARAMETER
10 MW 8 Hr.	8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- - - no limitation
- O - minor limitation
- ⊖ - major limitation
- ● - overriding limitation

SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	O	●	-	-	-	-
GAS TURB GEN - RC(CF)	-	-	O	●	-	-	-	-
DIESEL GENERATOR(CF)	-	-	-	●	-	-	-	-
SPARK IGN ENG GEN(CF)								
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)	⊖	⊖	●	●	-	-	-	-
STEAM TURB GEN - OIL(CF)	⊖	⊖	●	●	-	-	-	-
STIRLING ENG GEN(CF)	-	-	O	●	-	-	-	-
MHD GENERATOR(CF)	O	O	O	●	-	-	-	-
MHD/STEAM GEN(CF)								
THERMIONIC GEN(CF)	O	O	O	●	-	-	-	-
STEAM TURB GEN(NF)								
ORGANIC VAP TURB GEN(NF)								
GAS TURB GEN(NF)	⊖	-	●	O	-	-	●	-
RADIOISOTOPE GEN(NF)								
STEAM TURB GEN (SOLAR)	⊖	⊖	●	-	●	-	-	-
ORGANIC VAP TURB (SOLAR)								
GAS TURB GEN (SOLAR)	-	-	O	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1	-	-	-	-	-	●	-	-
WIND TURB GEN 10-5	-	-	-	-	-	●	-	-
WIND TURB GEN 20-1	-	-	-	-	-	●	-	-
WIND TURB GEN 20-5	-	-	-	-	-	●	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	●
BATTERY STORAGE	-	O	-	-	-	-	-	●

REQUIREMENT

10 MW 8 Hr.

PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- \- - Characteristic not observed in system operation
- 0 - Characteristic has minor effect on system performance
- ⊖ - Characteristic has moderate effect on system performance
- ● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	⊖	0	-	-	0	0	0
GAS TURB GEN - RC(CF)	⊖	0	-	-	0	⊖	⊖
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)							
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)	⊖	⊖	-	-	⊖	⊖	⊖
STEAM TURB GEN - OIL(CF)	⊖	⊖	-	-	⊖	⊖	⊖
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)	⊖	⊖	-	-	●	-	-
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	⊖	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)							
GAS TURB GEN(NF)	0	⊖	-	-	⊖	⊖	⊖
RADIOISOTOPE GEN(NF)							
STEAM TURB GEN (SOLAR)	⊖	⊖	●	-	⊖	⊖	⊖
ORGANIC VAP TURB (SOLAR)							
GAS TURB GEN (SOLAR)	-	-	●	-	⊖	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-
BATTERY STORAGE	-	-	-	-	-	-	-

REQUIREMENT

10. MW 1 Hr.

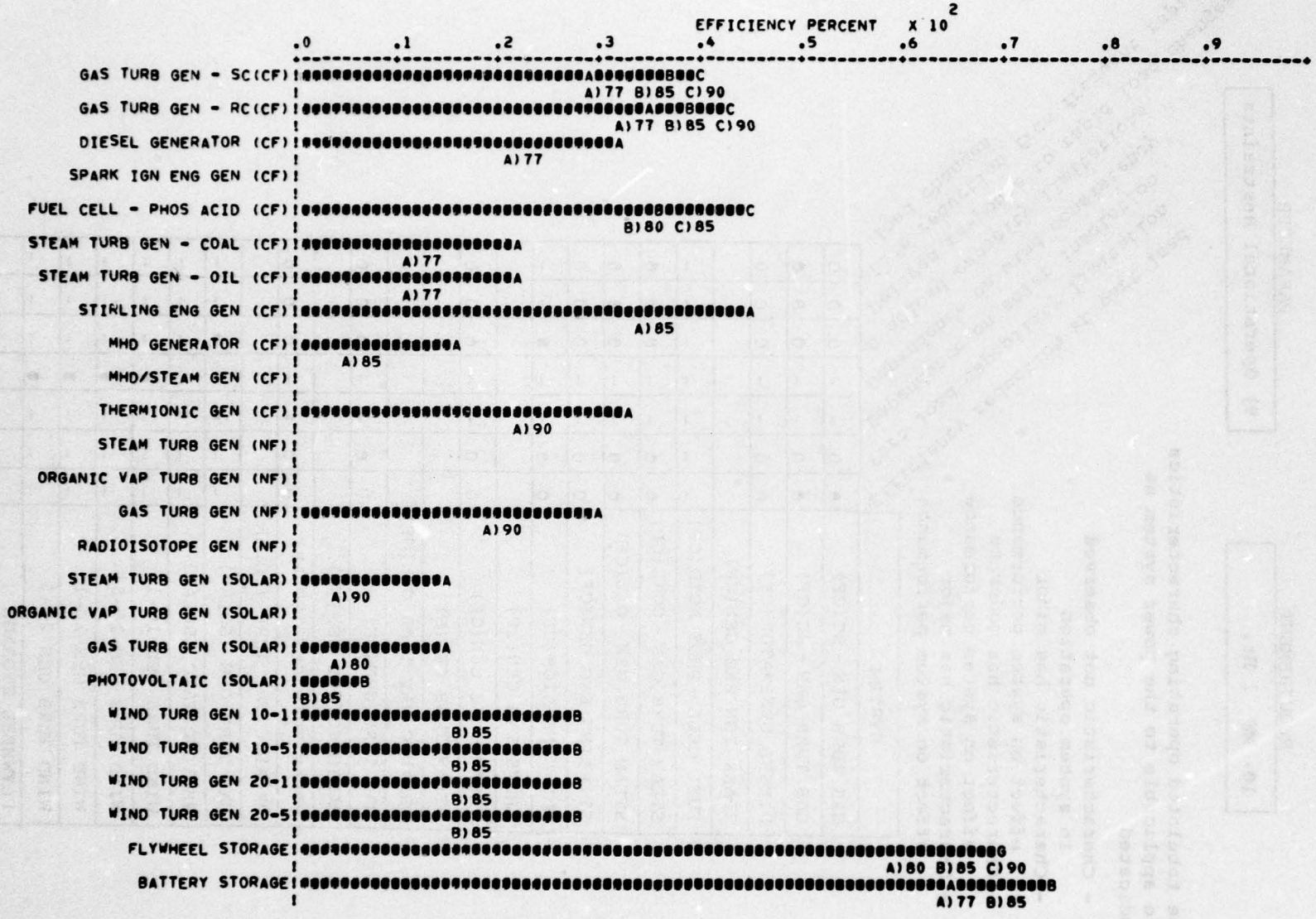
PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
0 - Characteristic has minor effect on system performance
◐ - Characteristic has moderate effect on system performance
● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	◐	0	-	-	0	0	0
GAS TURB GEN - RC(CF)	◐	0	-	-	0	◐	◐
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)							
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)	◐	◐	-	-	◐	◐	◐
STEAM TURB GEN - OIL(CF)	◐	◐	-	-	◐	◐	◐
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)	◐	◐	-	-	●	-	-
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	◐	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)							
GAS TURB GEN(NF)	0	◐	-	-	◐	0	◐
RADIOISOTOPE GEN(NF)							
STEAM TURB GEN (SOLAR)	◐	◐	●	-	◐	◐	◐
ORGANIC VAP TURB (SOLAR)							
GAS TURB GEN (SOLAR)	-	-	●	-	◐	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-
BATTERY STORAGE	-	-	-	-	-	-	-

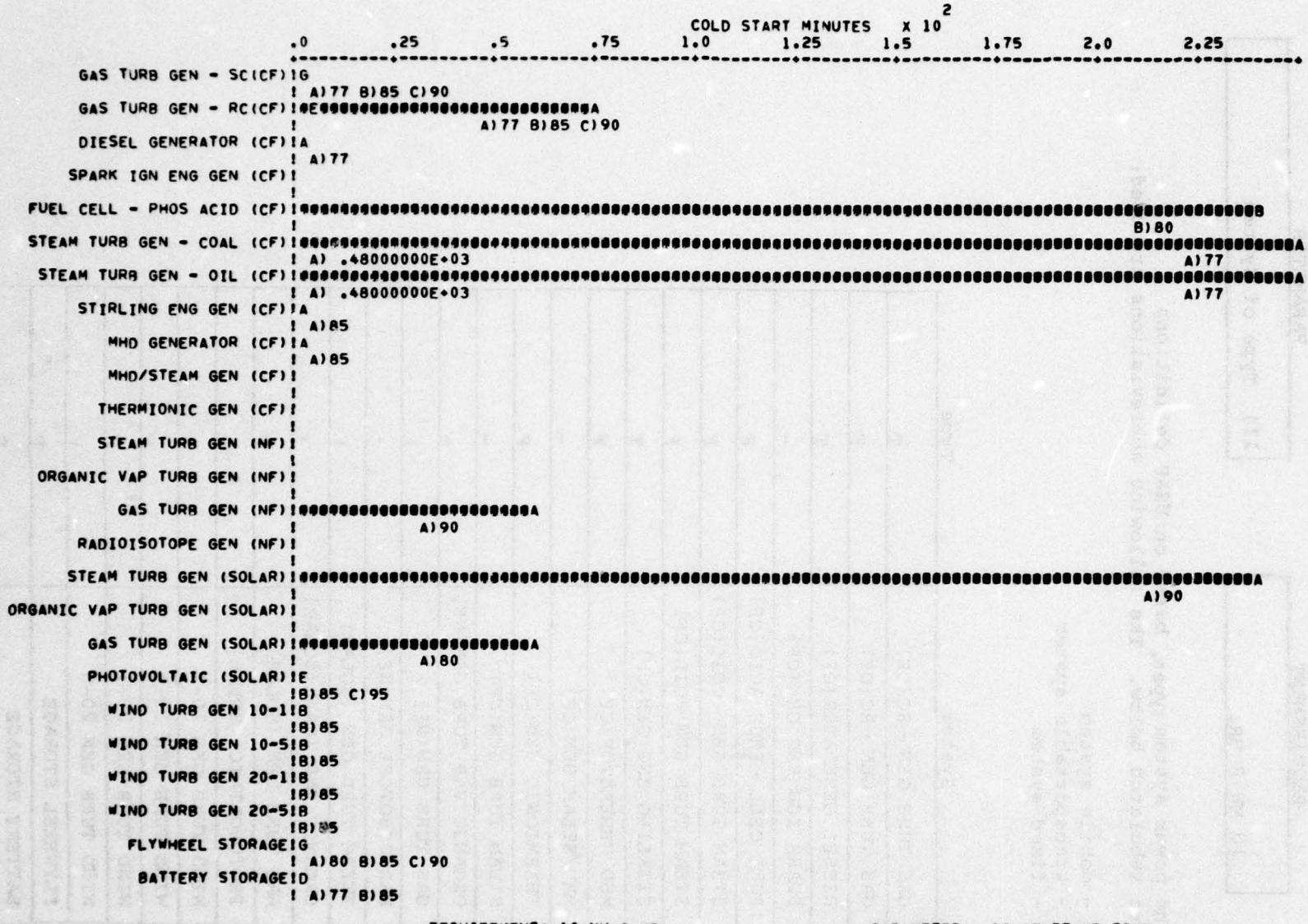

EFFICIENCY PERCENT X 10^2
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 MW 8 HR
PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
10 MW 8 HR.	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	T
GAS TURB GEN - RC(CF)	F
DIESEL GENERATOR(CF)	T
SPARK IGN ENG GEN(CF)	-
FUEL CELL - PHOS ACID(CF)	F
STEAM TURB GEN - COAL(CF)	F
STEAM TURB GEN - OIL(CF)	F
STIRLING ENG GEN(CF)	T
MHD GENERATOR(CF)	F
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	F
STEAM TURB GEN(NF)	-
ORGANIC VAP TURB GEN(NF)	-
GAS TURB GEN(NF)	F
RADIOISOTOPE GEN(NF)	-
STEAM TURB GEN (SOLAR)	F
ORGANIC VAP TURB (SOLAR)	-
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	F
WIND TURB GEN 10-5	F
WIND TURB GEN 20-1	F
WIND TURB GEN 20-5	F
FLYWHEEL STORAGE	F
BATTERY STORAGE	F



REQUIREMENT: 10 MW 8 HR

PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
10 MW 8 Hr.	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

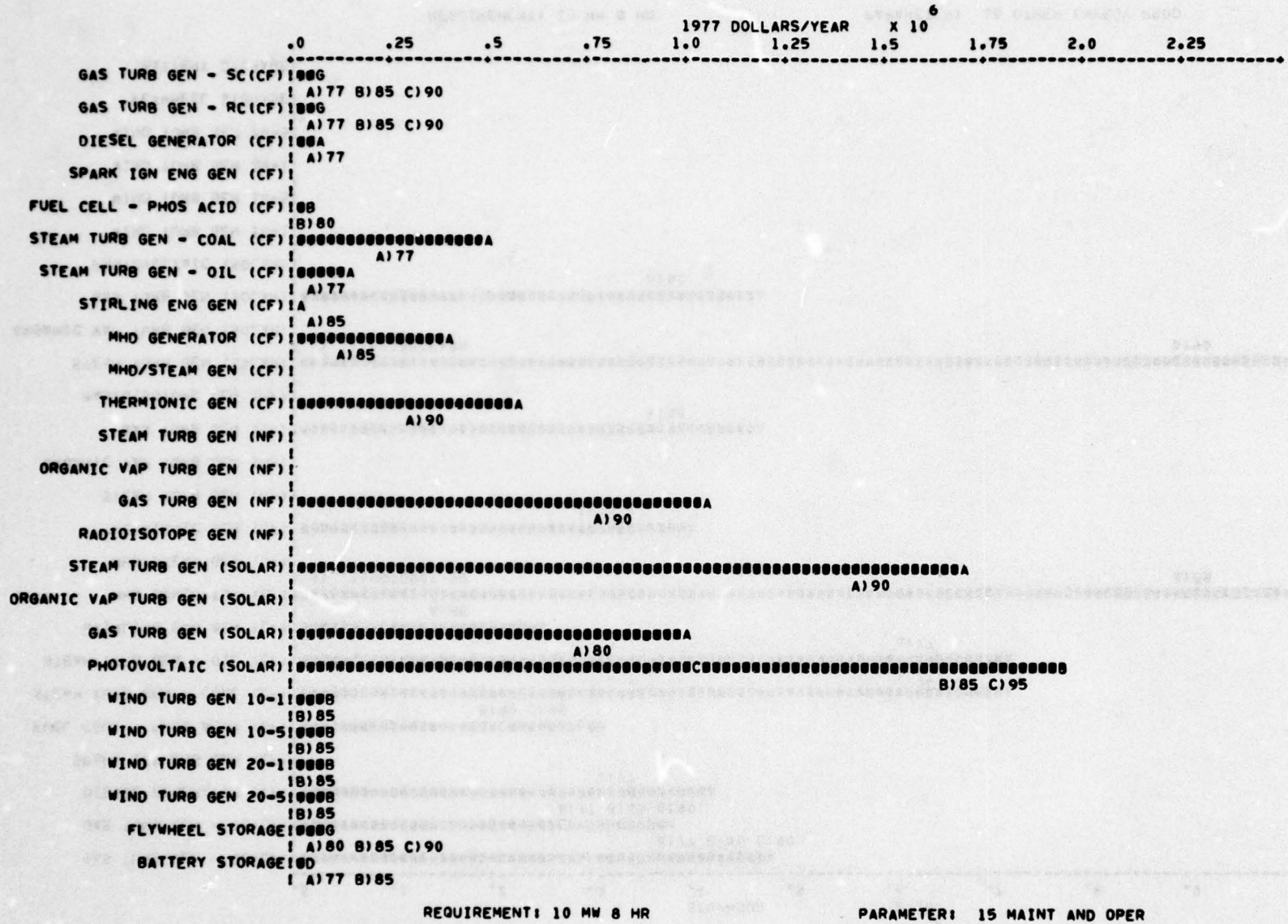
System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	Not modular
DIESEL GENERATOR(CF)	Not modular, except possibly largest requirements
SPARK IGN.ENG GEN(CF)	
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	Not modular
STEAM TURB GEN - OIL(CF)	Not modular
STIRLING ENG GEN(CF)	Not modular, except possibly largest requirements
MHD GENERATOR(CF)	Not modular
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	Not modular
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	Not modular
ORGANIC VAP TURB (SOLAR)	
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	Modular for most requirements
WIND TURB GEN 10-5	Modular for most requirements
WIND TURB GEN 20-1	Modular for most requirements
WIND TURB GEN 20-5	Modular for most requirements
FLYWHEEL STORAGE	Modular for most requirements
BATTERY STORAGE	Fully modular

REQUIREMENT	PARAMETER
10 MW 8 Hr.	14) Reliability/Availability

The tabulated conditions exist in the power system to the extent indicated.

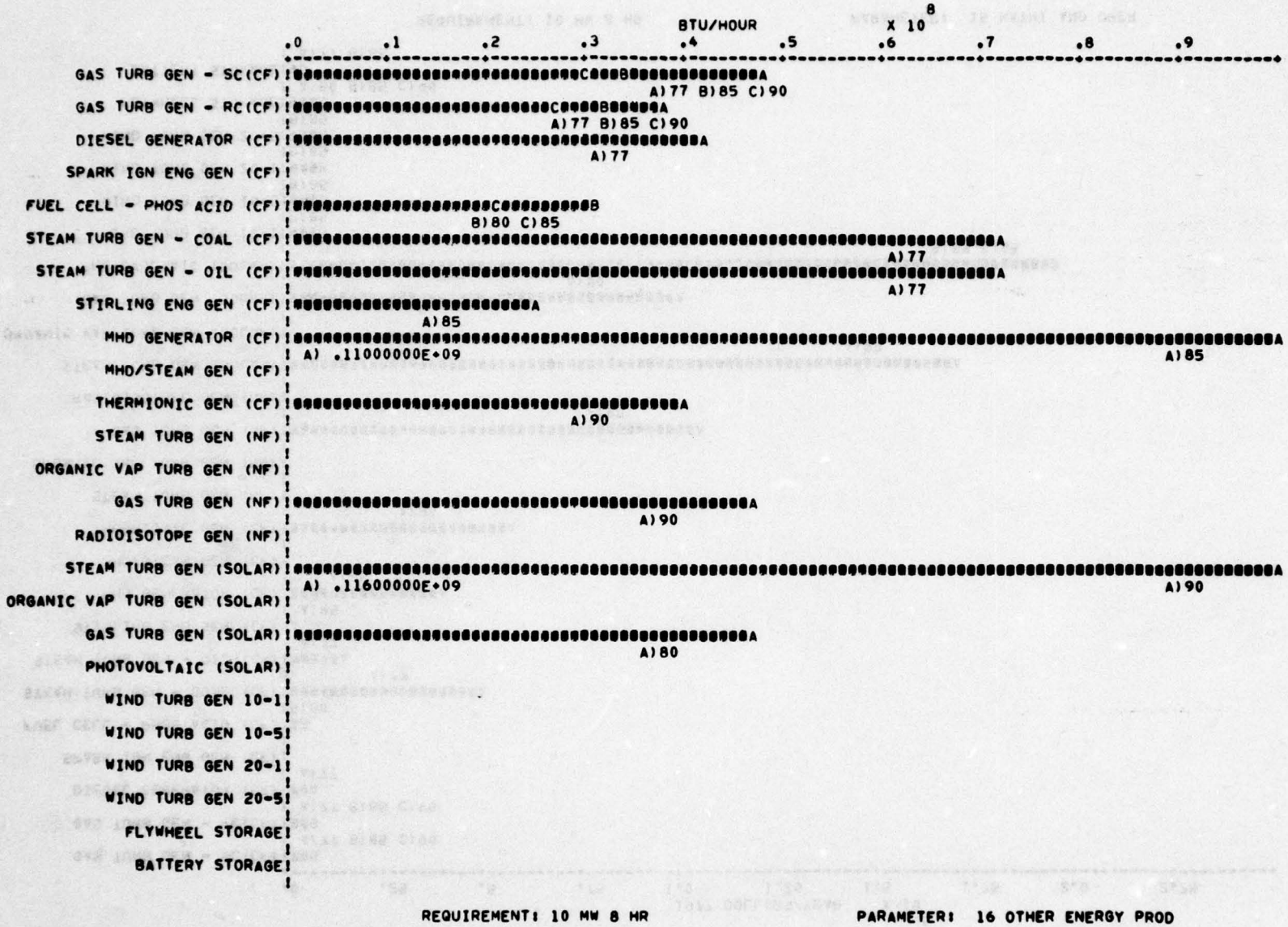
SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	O	●	O	-	●	O	●	-	-
GAS TURB GEN - RC(CF)	O	●	O	-	●	⊖	●	-	-
DIESEL GENERATOR(CF)	●	O	O	-	O	O	●	-	-
SPARK IGN ENG GEN(CF)									
FUEL CELL - PHOS ACID(CF)	-	-	-	-	O	-	-	-	-
STEAM TURB GEN - COAL(CF)	●	O	O	-	O	⊖	●	-	-
STEAM TURB GEN - OIL(CF)	●	O	O	-	O	⊖	●	-	-
STIRLING ENG GEN(CF)	O	O	O	-	O	O	●	-	-
MHD GENERATOR(CF)	O	●	-	-	●	⊖	●	-	-
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	O	●	-	-	⊖	O	O	-	-
STEAM TURB GEN(NF)									
ORGANIC VAP TURB GEN(NF)	O	O	O	O	-	O	●	-	-
GAS TURB GEN(NF)	●	O	O	O	-	⊖	●	-	-
RADIOISOTOPE GEN(NF)									
STEAM TURB GEN (SOLAR)	●	O	O	-	O	⊖	●	●	-
ORGANIC VAP TURB (SOLAR)									
GAS TURB GEN (SOLAR)	O	O	O	-	O	O	-	●	-
PHOTOVOLTAIC (SOLAR)	-	O	-	-	O	-	-	●	-
WIND TURB GEN 10-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 10-5	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-5	O	O	●	-	O	-	-	-	●
FLYWHEEL STORAGE	O	-	●	-	-	-	⊖	-	-
BATTERY STORAGE	-	O	-	-	O	-	-	-	-

- \- - Condition does not exist in system
- O - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability
- ⊖ - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability
- ● - Condition exists and is a governing factor in determining system performance and reliability



REQUIREMENT: 10 MW 8 HR

PARAMETER: 15 MAINT AND OPER



REQUIREMENT: 10 MW 8 HR

PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
10 MW 8 Hr.	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

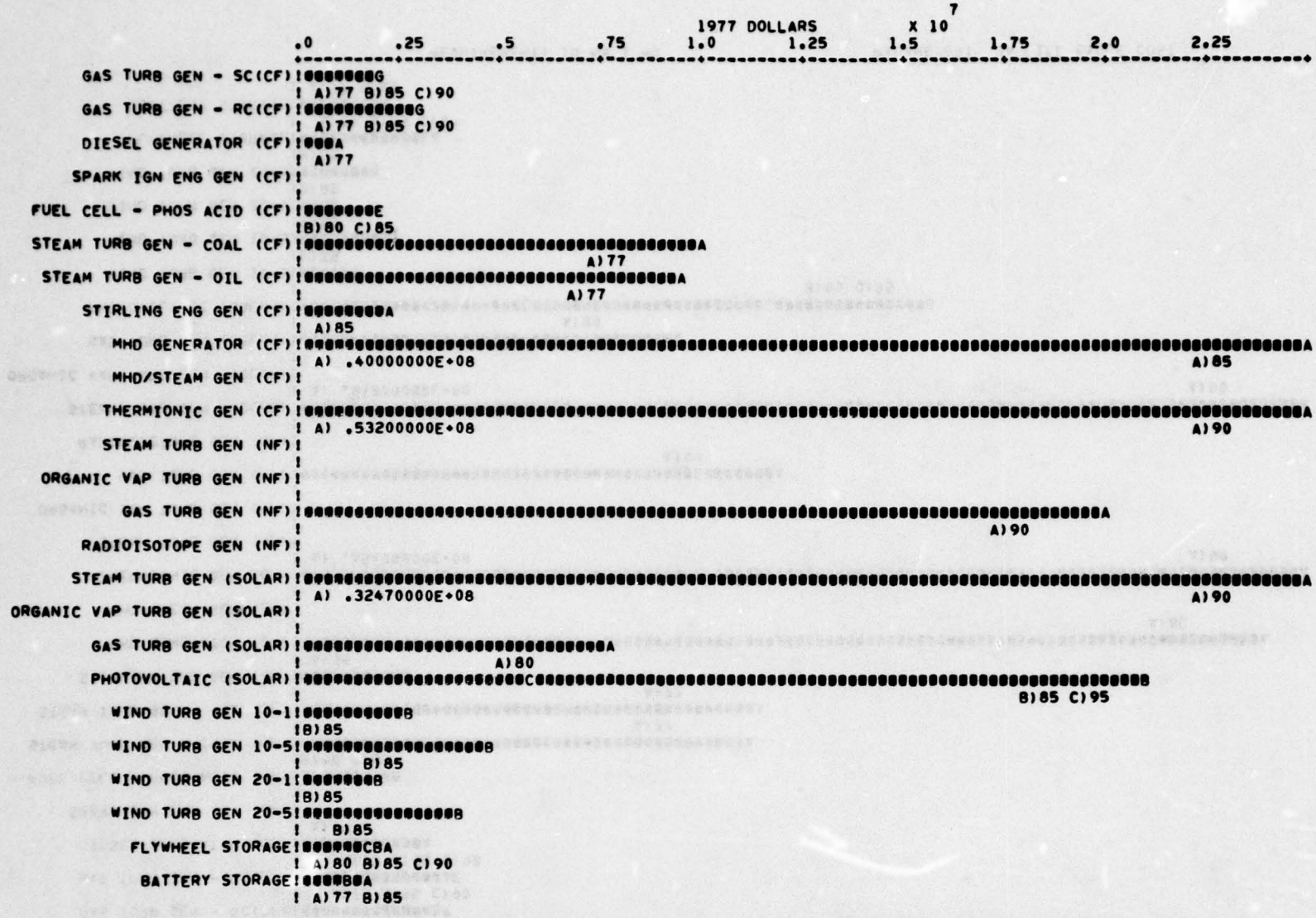
System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	None
DIESEL GENERATOR(CF)	None
SPARK IGN ENG GEN(CF)	
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	None
STEAM TURB GEN - OIL(CF)	None
STIRLING ENG GEN(CF)	None
MHD GENERATOR(CF)	None
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	None
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	None
ORGANIC VAP TURB (SOLAR)	
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	Possibly lead for conventional batteries
WIND TURB GEN 10-5	Possibly lead for conventional batteries
WIND TURB GEN 20-1	Possibly lead for conventional batteries
WIND TURB GEN 20-5	Possibly lead for conventional batteries
FLYWHEEL STORAGE	None
BATTERY STORAGE	possibly lead for conventional batteries

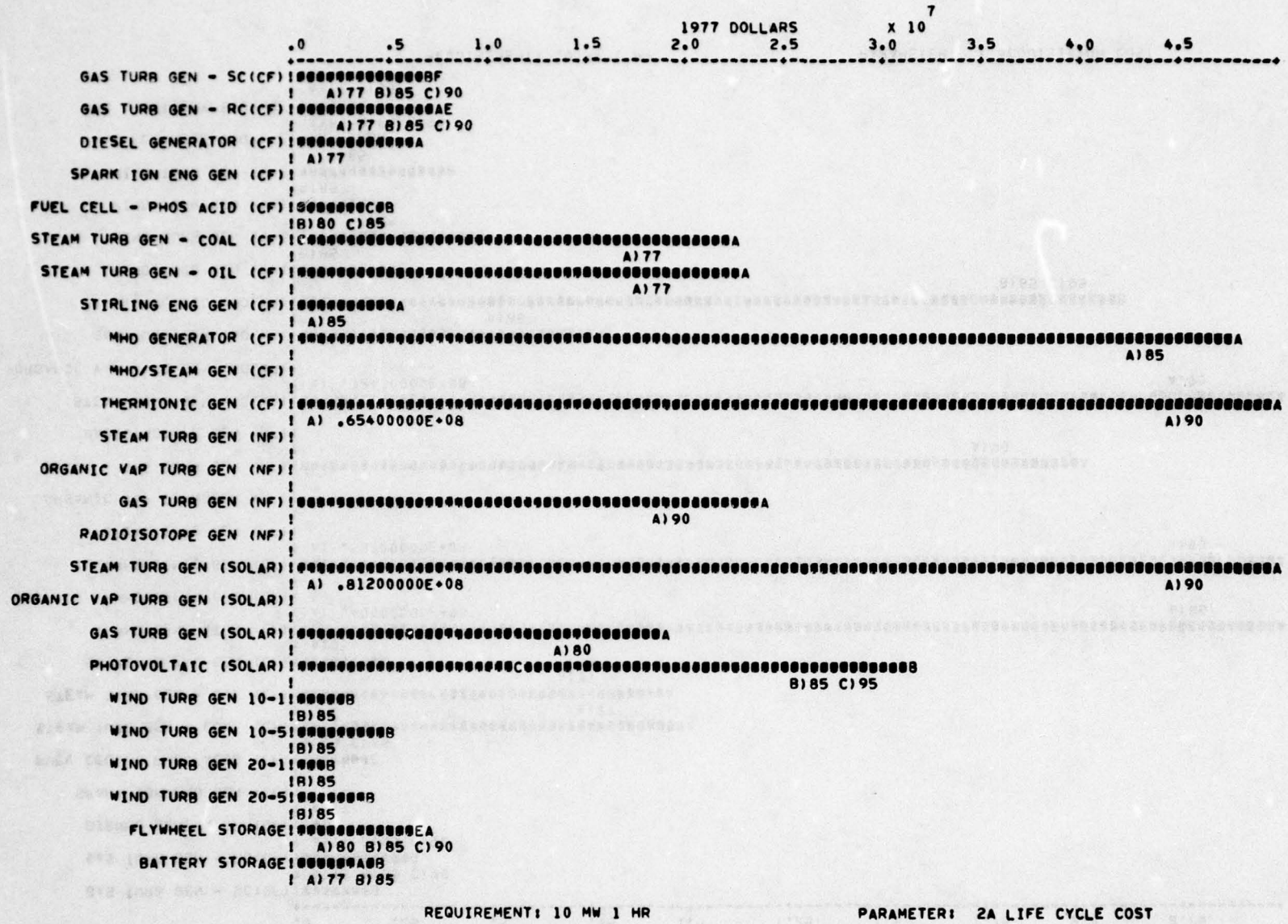
SECTION VII

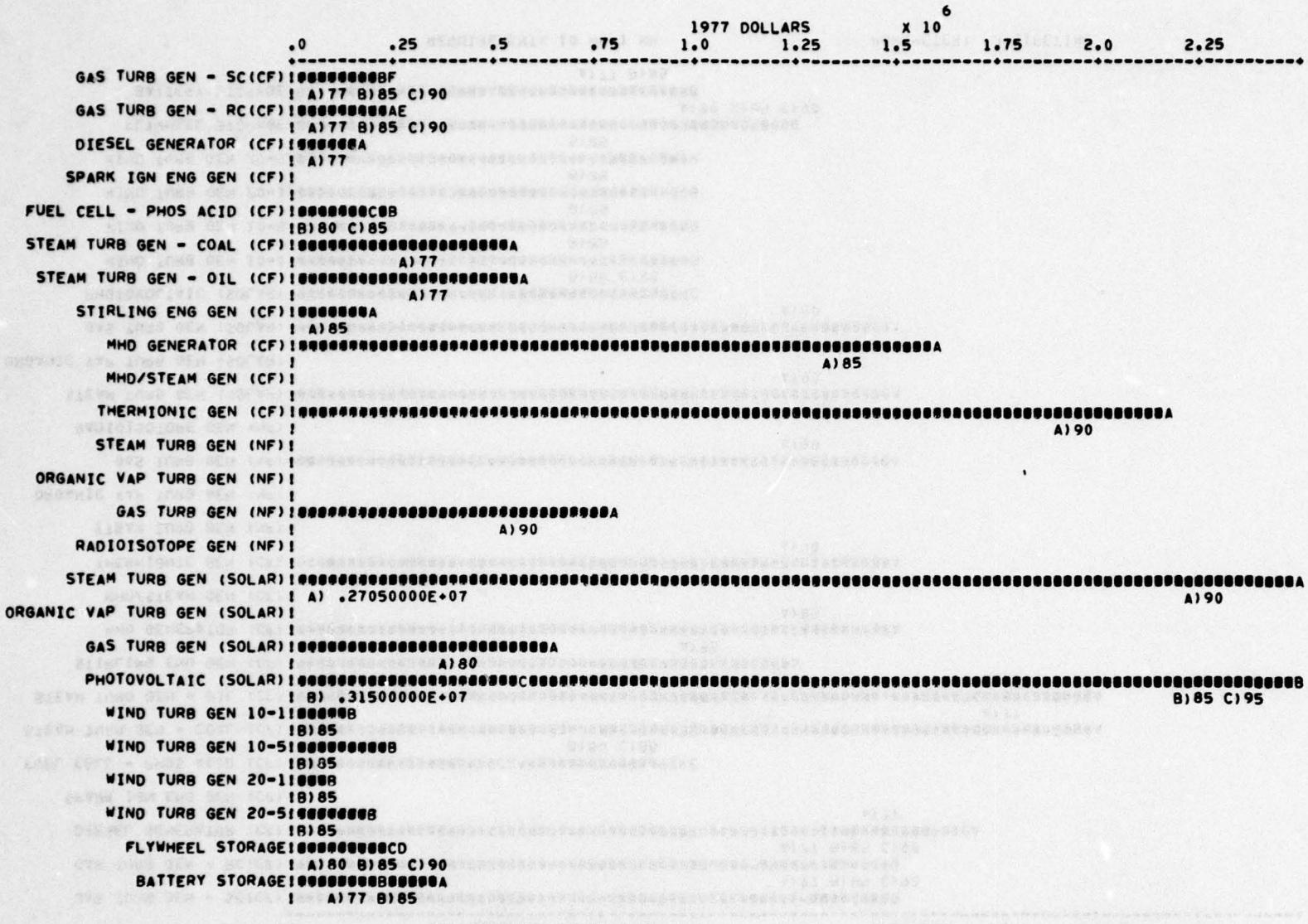
TEN MEGAWATT, 1 HOUR

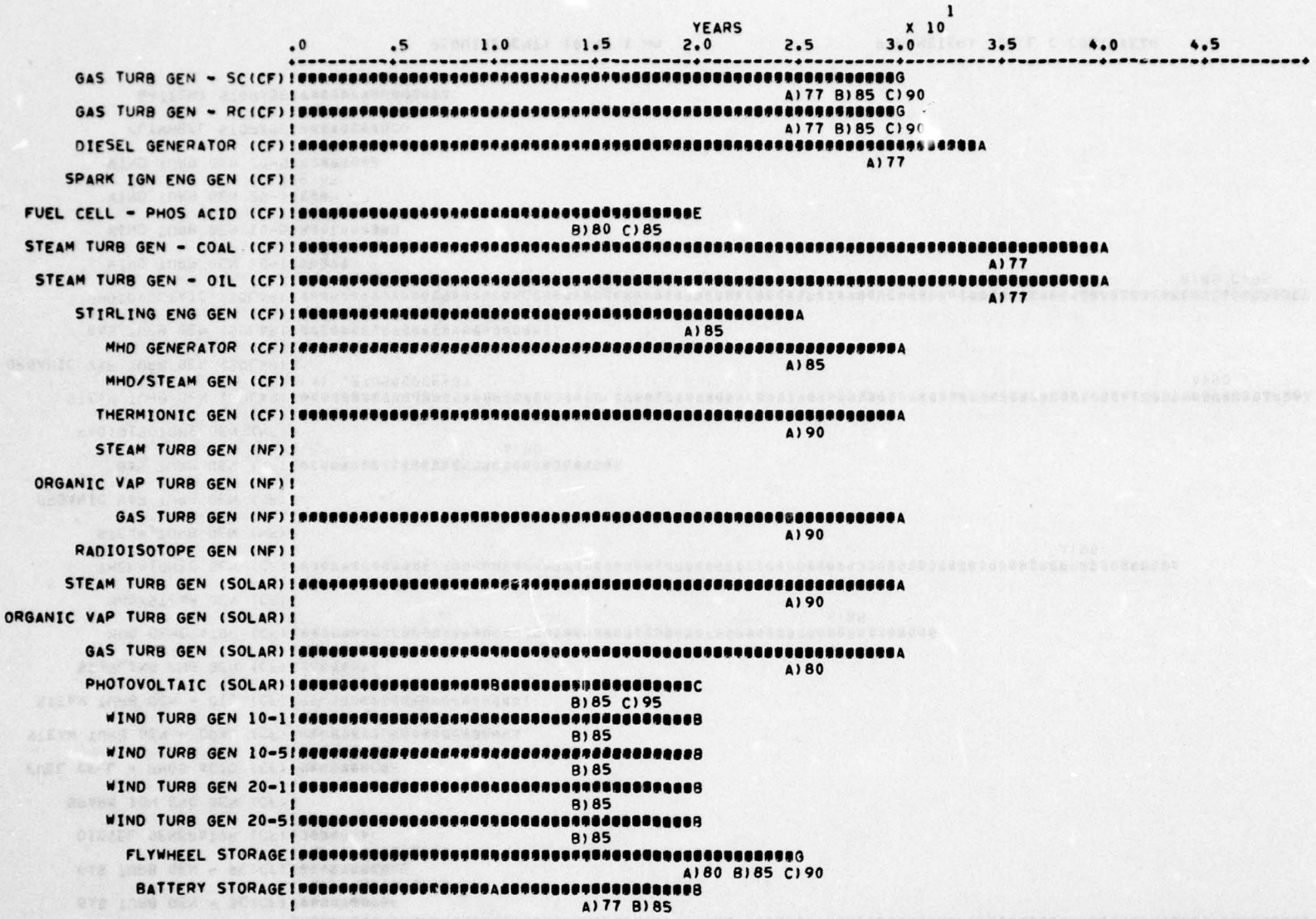
REQUIREMENT

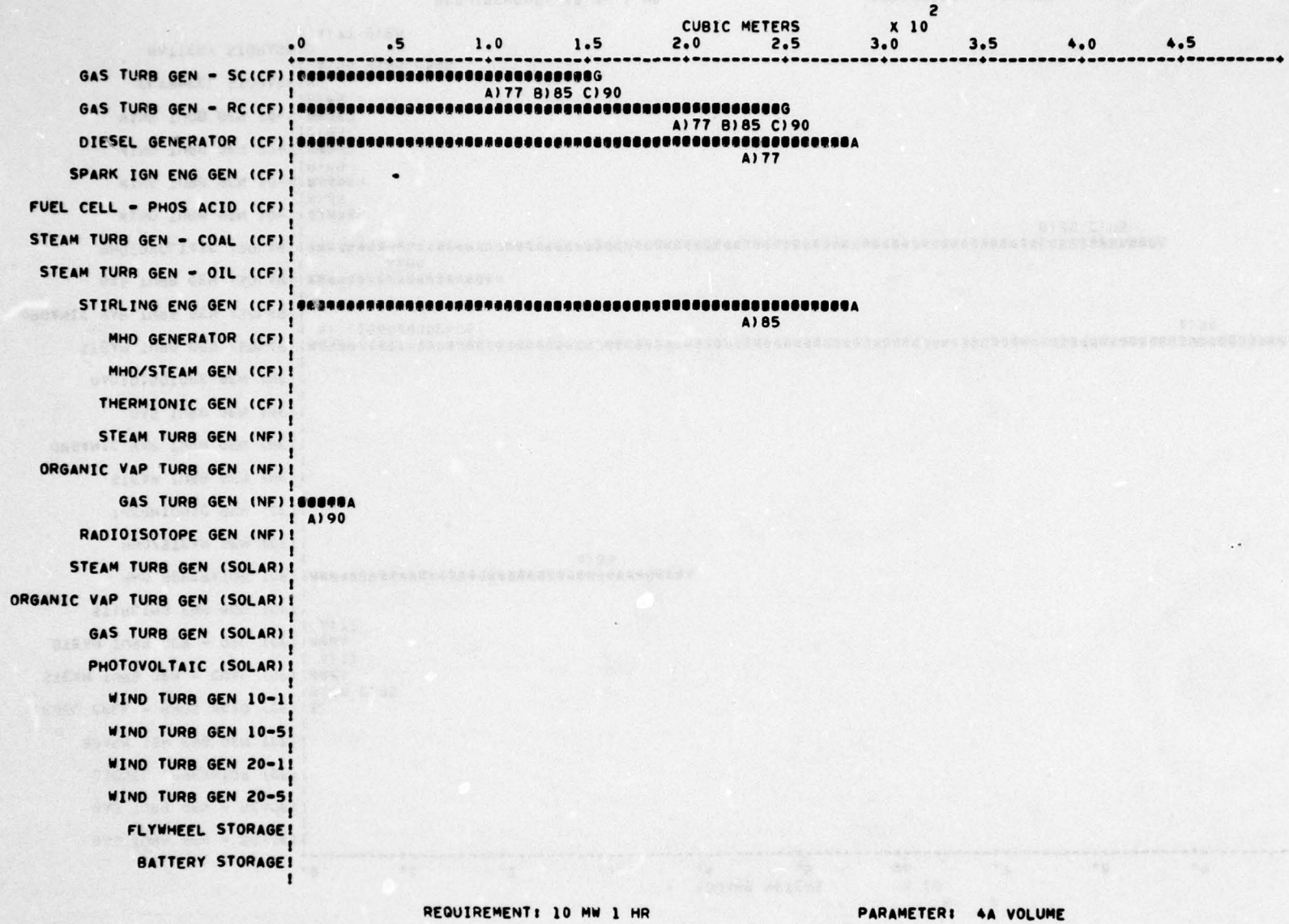
Power Level:	10 Mw
Operating Mode:	1 hour per day
Frequency/Phase:	60 Hz/3Ø
Voltage Level:	4160 V


1977 DOLLARS
X 10^7
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
A) .40000000E+08
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A) .53200000E+08
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A) .32470000E+08
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 MW 1 HR
PARAMETER: 1 ACQUISITION COST


1977 DOLLARS
x 10^7
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A) .65400000E+08
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A) .81200000E+08
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 MW 1 HR
PARAMETER: 2A LIFE CYCLE COST

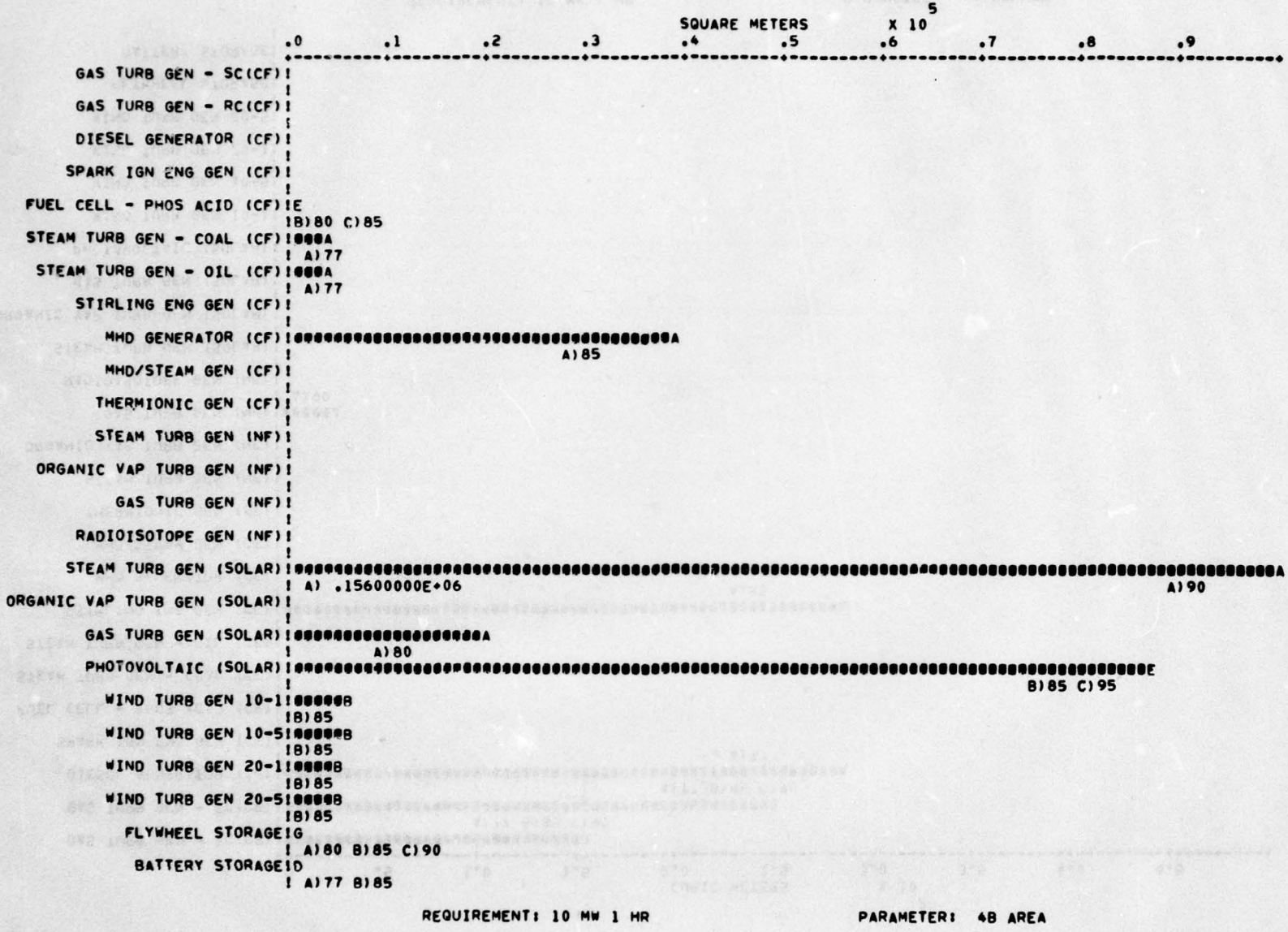

1977 DOLLARS
X 10^6
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A) .27050000E+07
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B) .31500000E+07
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 MW 1 HR
PARAMETER: 28 L C COST/YEAR


YEARS
X 10
1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 MW 1 HR
PARAMETER: 3 LIFETIME

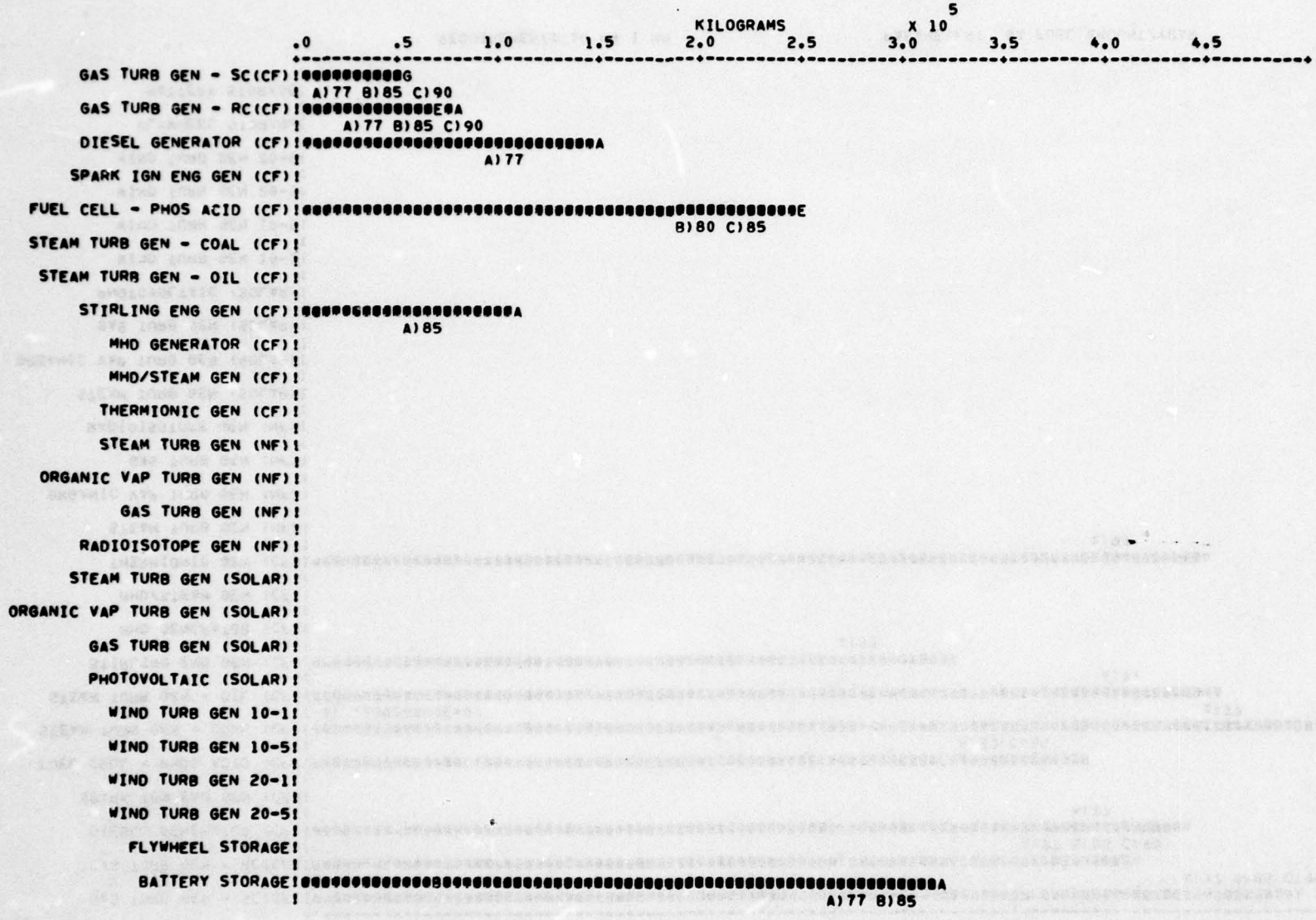


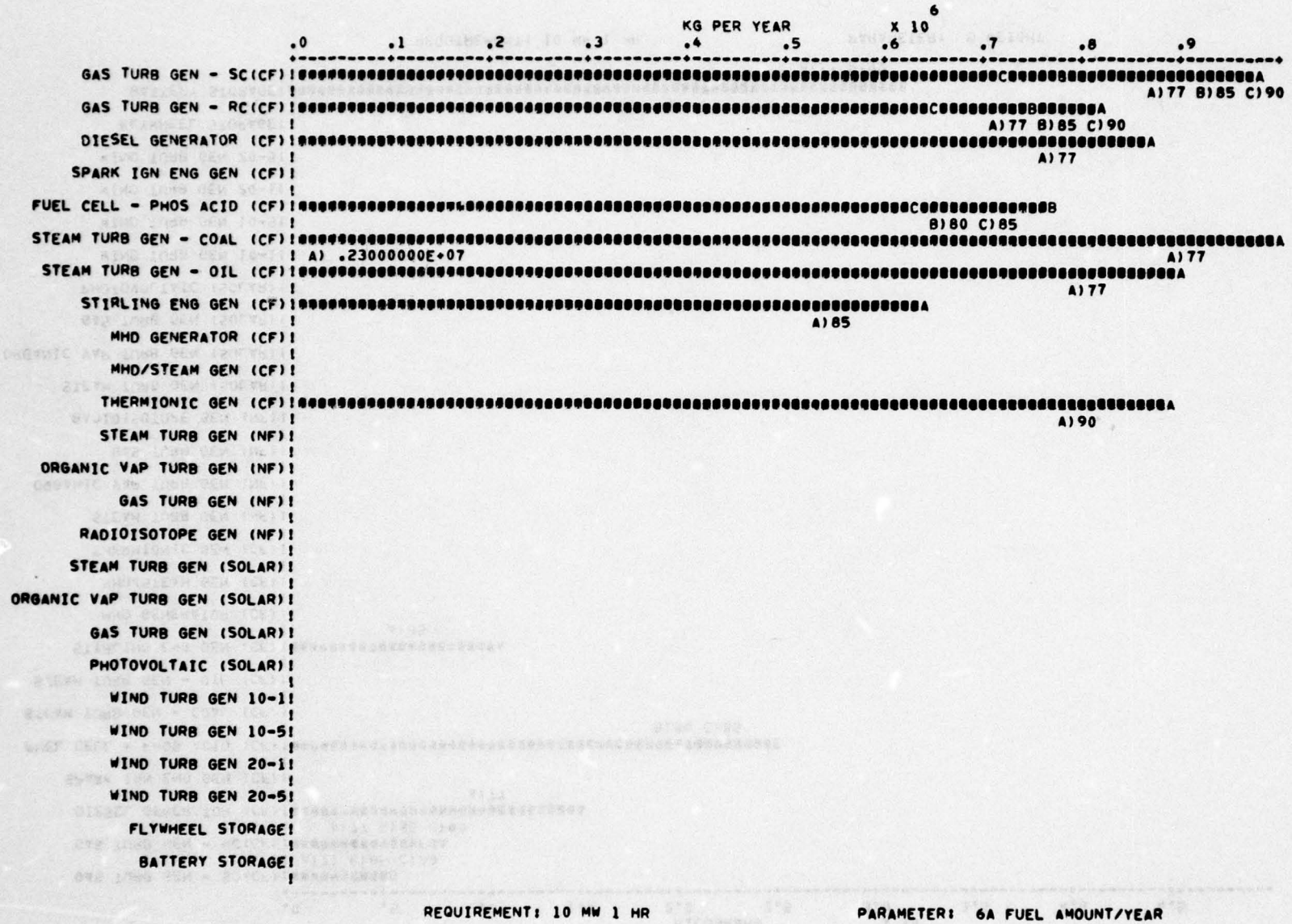
REQUIREMENT: 10 MW 1 HR

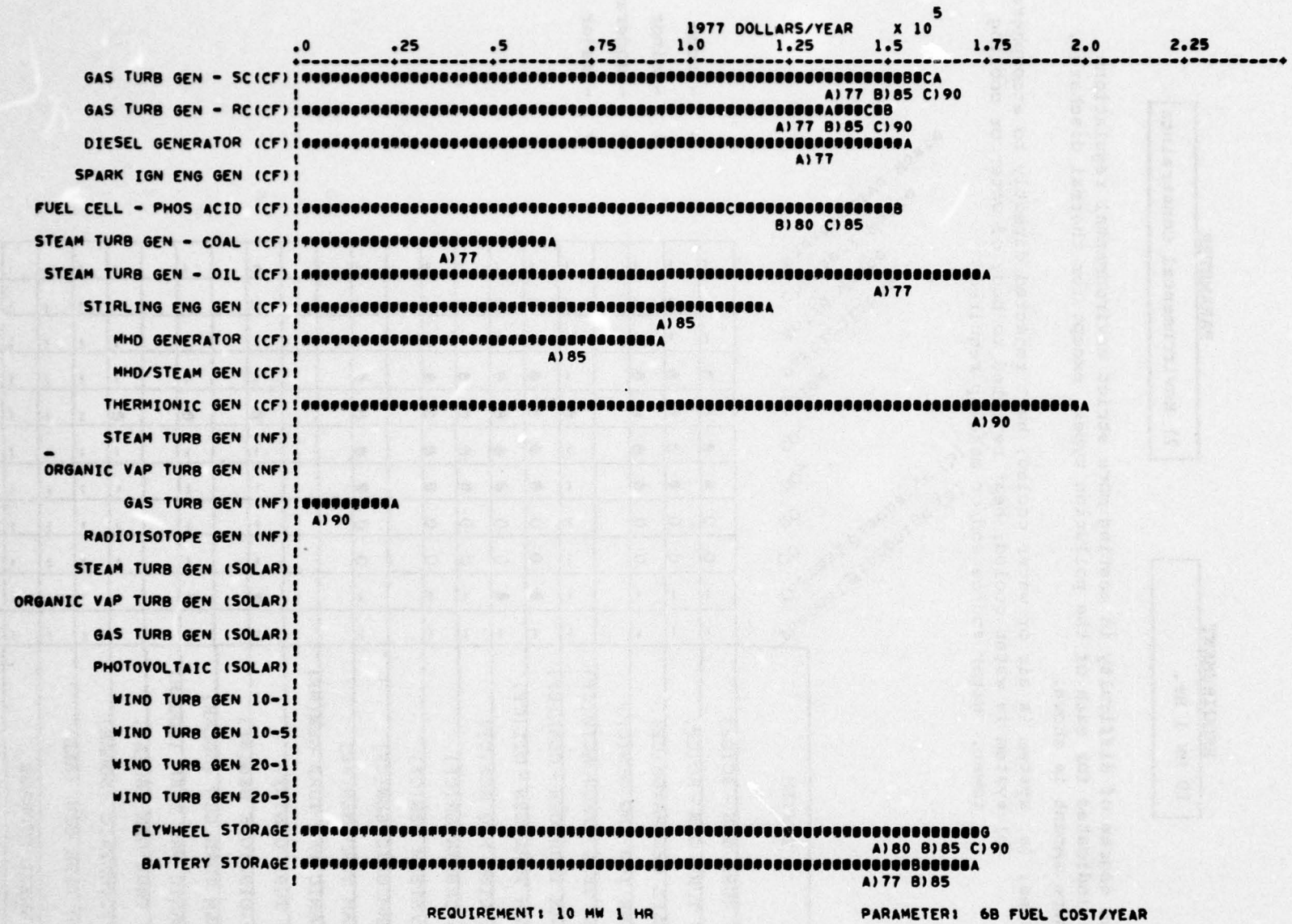
PARAMETER: 4A VOLUME



REQUIREMENT: 10 MW 1 HR PARAMETER: 48 AREA


KILOGRAMS
X 10^5
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 MW 1 HR
PARAMETER: 5 WEIGHT


KG PER YEAR X 10^6
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A) .23000000E+07
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 MW 1 HR
PARAMETER: 6A FUEL AMOUNT/YEAR


1977 DOLLARS/YEAR X 10^5
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 MW 1 HR
PARAMETER: 6B FUEL COST/YEAR

REQUIREMENT	PARAMETER
10 MW 1 Hr.	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	●	●	●	-	-	-
GAS TURB GEN - RC(CF)	-	-	0	0	●	●	●	●	-	-	-
DIESEL GENERATOR(CF)	-	-	0	0	●	●	●	●	-	-	-
SPARK IGN ENG GEN(CF)											
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)	-	●	●	0	●	●	●	●	●	0	-
STEAM TURB GEN - OIL(CF)	-	●	0	0	●	●	●	●	●	0	-
STIRLING ENG GEN(CF)	-	-	0	0	●	●	●	●	-	-	-
MHD GENERATOR(CF)	-	-	0	0	●	●	●	●	●	-	-
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)	-	-	0	0	●	●	0	●	-	-	-
STEAM TURB GEN(NF)											
ORGANIC VAP TURB GEN(NF)											
GAS TURB GEN(NF)	-	●	-	-	-	-	●	-	-	0	●
RADIOISOTOPE GEN(NF)											
STEAM TURB GEN (SOLAR)	-	●	-	-	-	-	●	-	-	0	-
ORGANIC VAP TURB (SOLAR)											
GAS TURB GEN (SOLAR)	-	-	-	-	-	-	●	-	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
WIND TURB GEN (ALL)	-	-	-	-	-	-	-	-	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	-	-	-	-
BATTERY STORAGE	-	-	-	-	-	-	-	-	-	-	-

- - none
0 - minor
● - moderate
● - major

REQUIREMENT

10 MW 1 Hr.

PARAMETER

8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- - - no limitation
- o - minor limitation
- ⊖ - major limitation
- ● - overriding limitation

SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	o	●	-	-	-	-
GAS TURB GEN - RC(CF)	-	-	o	●	-	-	-	-
DIESEL GENERATOR(CF)	-	-	-	●	-	-	-	-
SPARK IGN ENG GEN(CF)								
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)	⊖	⊖	●	●	-	-	-	-
STEAM TURB GEN - OIL(CF)	⊖	⊖	●	●	-	-	-	-
STIRLING ENG GEN(CF)	-	-	o	●	-	-	-	-
MHD GENERATOR(CF)	o	o	o	●	-	-	-	-
MHD/STEAM GEN(CF)								
THERMIONIC GEN(CF)	o	o	o	●	-	-	-	-
STEAM TURB GEN(NF)								
ORGANIC VAP TURB GEN(NF)	⊖	-	o	o	-	-	●	-
GAS TURB GEN(NF)	⊖	-	●	o	-	-	●	-
RADIOISOTOPE GEN(NF)								
STEAM TURB GEN (SOLAR)	⊖	⊖	●	-	●	-	-	-
ORGANIC VAP TURB (SOLAR)								
GAS TURB GEN (SOLAR)	-	-	o	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1	-	-	-	-	-	●	-	-
WIND TURB GEN 10-5	-	-	-	-	-	●	-	-
WIND TURB GEN 20-1	-	-	-	-	-	●	-	-
WIND TURB GEN 20-5	-	⊖	-	-	-	●	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	●
BATTERY STORAGE	-	o	-	-	-	-	-	●

REQUIREMENT

750 KW Cont.

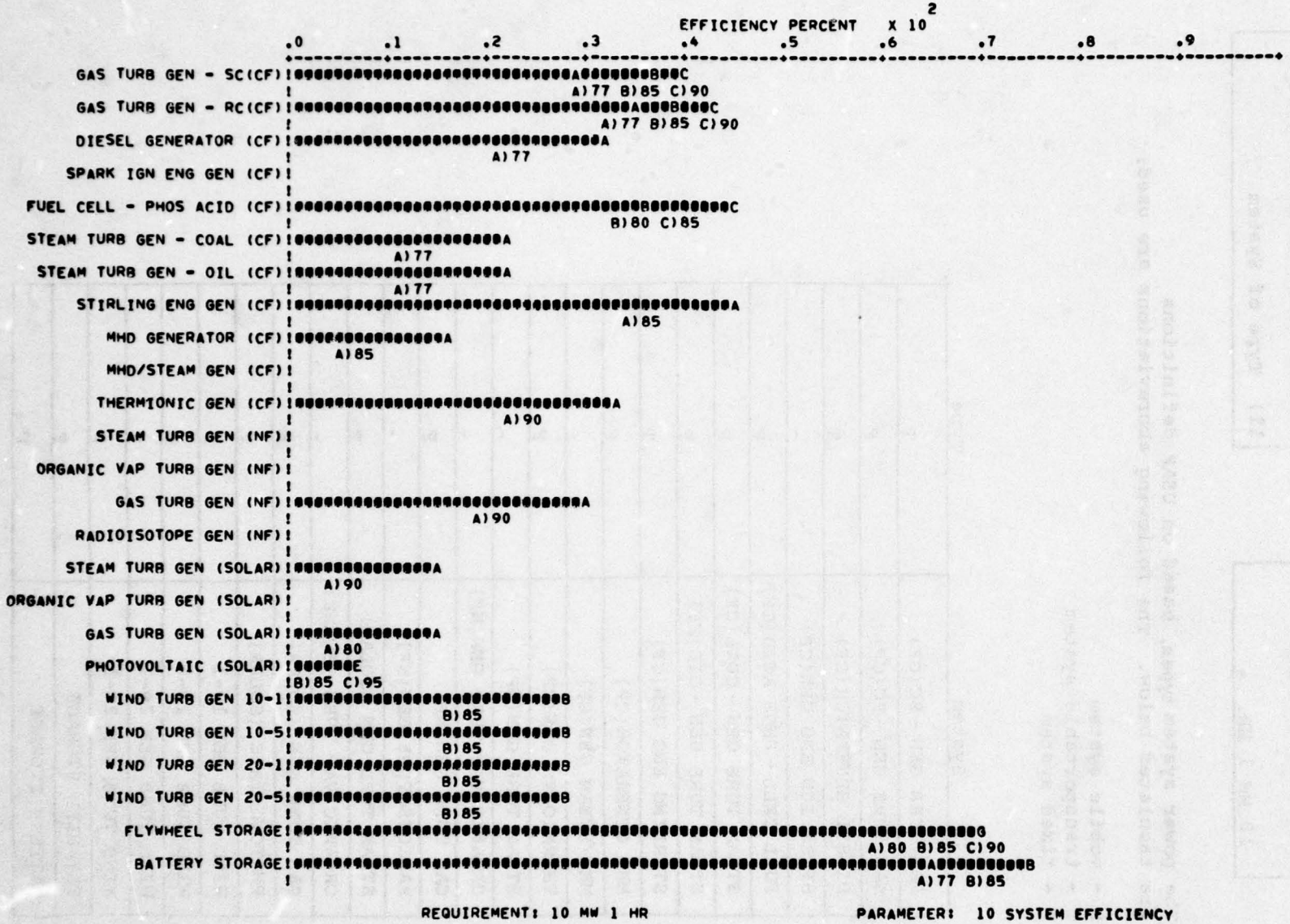
PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
- 0 - Characteristic has minor effect on system performance
- ⊖ - Characteristic has moderate effect on system performance
- ● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	⊖	0	-	-	0	0	0
GAS TURB GEN - RC(CF)							
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)	⊖	0	-	-	0	0	0
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)	⊖	⊖	-	-	⊖	⊖	⊖
STEAM TURB GEN - OIL(CF)							
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)							
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	⊖	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)	0	0	-	-	0	⊖	⊖
GAS TURB GEN(NF)	0	⊖	-	-	⊖	0	⊖
RADIOISOTOPE GEN(NF)							
STEAM TURB GEN (SOLAR)							
ORGANIC VAP TURB (SOLAR)	-	0	●	-	⊖	⊖	-
GAS TURB GEN (SOLAR)	-	-	●	-	⊖	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE							
BATTERY STORAGE							

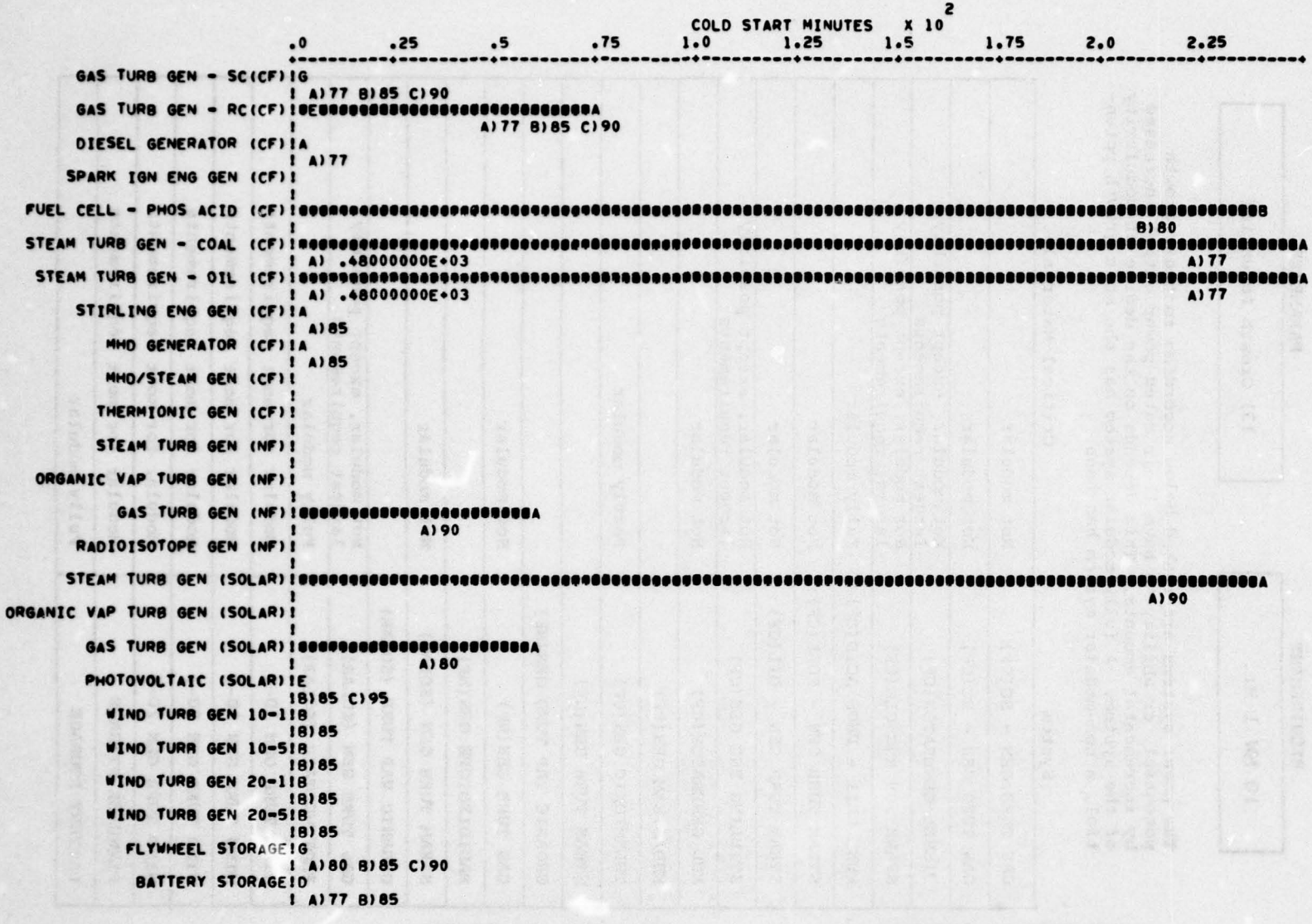

EFFICIENCY PERCENT X 10^2
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 MW 1 HR
PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
10 MW 1 HR.	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	T
GAS TURB GEN - RC(CF)	F
DIESEL GENERATOR(CF)	T
SPARK IGN ENG GEN(CF)	-
FUEL CELL - PHOS ACID(CF)	F
STEAM TURB GEN - COAL(CF)	F
STEAM TURB GEN - OIL(CF)	F
STIRLING ENG GEN(CF)	T
MHD GENERATOR(CF)	F
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	F
STEAM TURB GEN(NF)	-
ORGANIC VAP TURB GEN(NF)	-
GAS TURB GEN(NF)	F
RADIOISOTOPE GEN(NF)	-
STEAM TURB GEN (SOLAR)	F
ORGANIC VAP TURB (SOLAR)	-
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	F
WIND TURB GEN 10-5	F
WIND TURB GEN 20-1	F
WIND TURB GEN 20-5	F
FLYWHEEL STORAGE	F
BATTERY STORAGE	F



REQUIREMENT: 10 MW 1 HR

PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
10 MW 1 Hr.	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

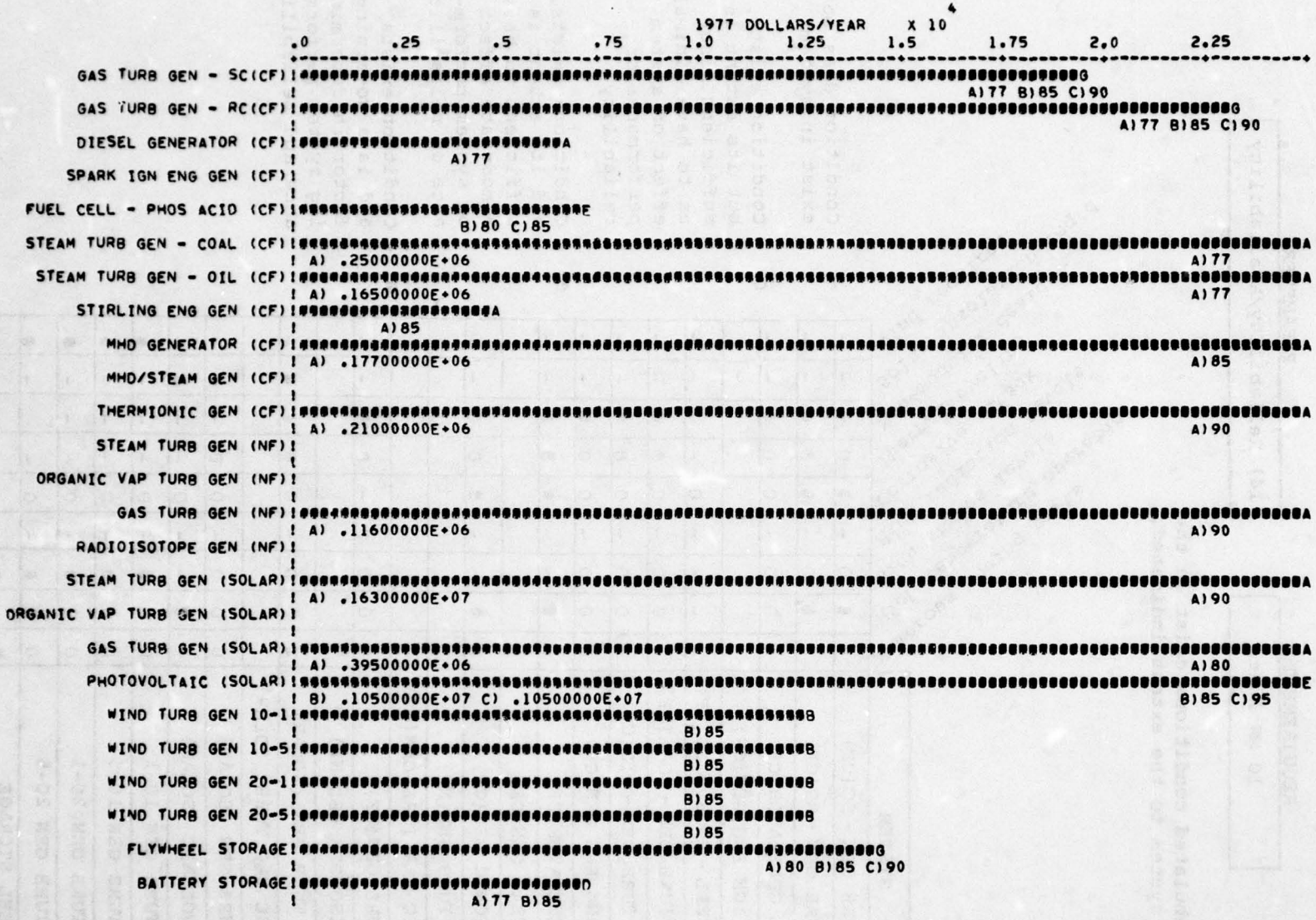
System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	Not modular
DIESEL GENERATOR(CF)	Not modular, except possibly largest requirements
SPARK IGN ENG GEN(CF)	Not modular, except possibly largest requirements
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	Not modular
STEAM TURB GEN - OIL(CF)	Not modular
STIRLING ENG GEN(CF)	Not modular, except possibly largest requirements
MHD GENERATOR(CF)	Not modular
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	Not modular
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	Not modular
ORGANIC VAP TURB (SOLAR)	
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	Modular for most requirements
WIND TURB GEN 10-5	Modular for most requirements
WIND TURB GEN 20-1	Modular for most requirements
WIND TURB GEN 20-5	Modular for most requirements
FLYWHEEL STORAGE	Modular for most requirements
BATTERY STORAGE	Fully modular

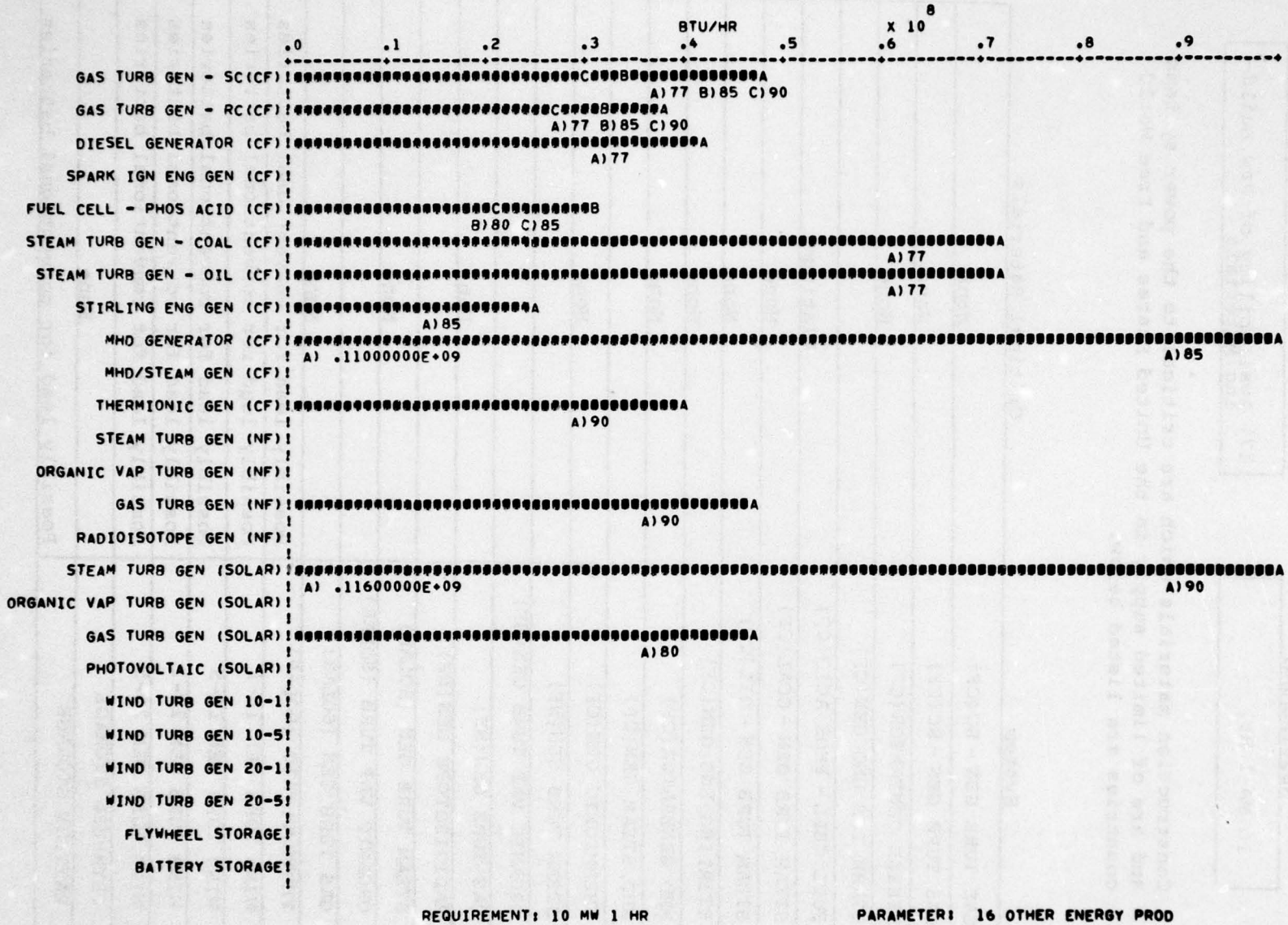
REQUIREMENT	PARAMETER
10 MW 1 Hr.	14) Reliability/Availability

The tabulated conditions exist in the power system to the extent indicated.

SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	0	●	0	-	●	0	●	-	-
GAS TURB GEN - RC(CF)	0	●	0	-	●	⊖	●	-	-
DIESEL GENERATOR(CF)	●	0	0	-	0	0	●	-	-
SPARK IGN ENG GEN(CF)									
FUEL CELL - PHOS ACID(CF)	-	-	-	-	0	-	-	-	-
STEAM TURB GEN - COAL(CF)	●	0	0	-	0	⊖	●	-	-
STEAM TURB GEN - OIL(CF)	●	0	0	-	0	⊖	●	-	-
STIRLING ENG GEN(CF)	0	0	0	-	0	0	●	-	-
MHD GENERATOR(CF)	0	●	-	-	●	⊖	●	-	-
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	0	●	-	-	⊖	0	0	-	-
STEAM TURB GEN(NF)									
ORGANIC VAP TURB GEN(NF)									
GAS TURB GEN(NF)	●	0	0	0	-	⊖	●	-	-
RADIOISOTOPE GEN(NF)									
STEAM TURB GEN (SOLAR)	●	0	0	-	0	⊖	●	●	-
ORGANIC VAP TURB (SOLAR)									
GAS TURB GEN (SOLAR)	0	0	0	-	0	0	-	●	-
PHOTOVOLTAIC (SOLAR)	-	0	-	-	0	-	-	●	-
WIND TURB GEN 10-1	0	0	●	-	0	-	-	-	●
WIND TURB GEN 10-5	0	0	●	-	0	-	-	-	●
WIND TURB GEN 20-1	0	0	●	-	0	-	-	-	●
WIND TURB GEN 20-5	0	0	●	-	0	-	.	-	●
FLYWHEEL STORAGE	0	-	●	-	-	-	⊖	-	-
BATTERY STORAGE	-	0	-	-	0	-	-	-	-

- \- Condition does not exist in system
- 0 - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability
- ⊖ - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability
- ● - Condition exists and is a governing factor in determining system performance and reliability


1977 DOLLARS/YEAR X 10^4
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A) .25000000E+06
A)77
STEAM TURB GEN - OIL (CF)
A) .16500000E+06
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
A) .17700000E+06
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A) .21000000E+06
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A) .11600000E+06
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A) .16300000E+07
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A) .39500000E+06
A)80
PHOTOVOLTAIC (SOLAR)
B) .10500000E+07 C) .10500000E+07
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 MW 1 HR
PARAMETER: 15 MAINT AND OPER


BTU/HR
X 10 8
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
A)77 B)85 C)90
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
A)77
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
A) .11000000E+09
A)85
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
A) .11600000E+09
A)90
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 MW 1 HR
PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
10 MW 1 Hr.	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

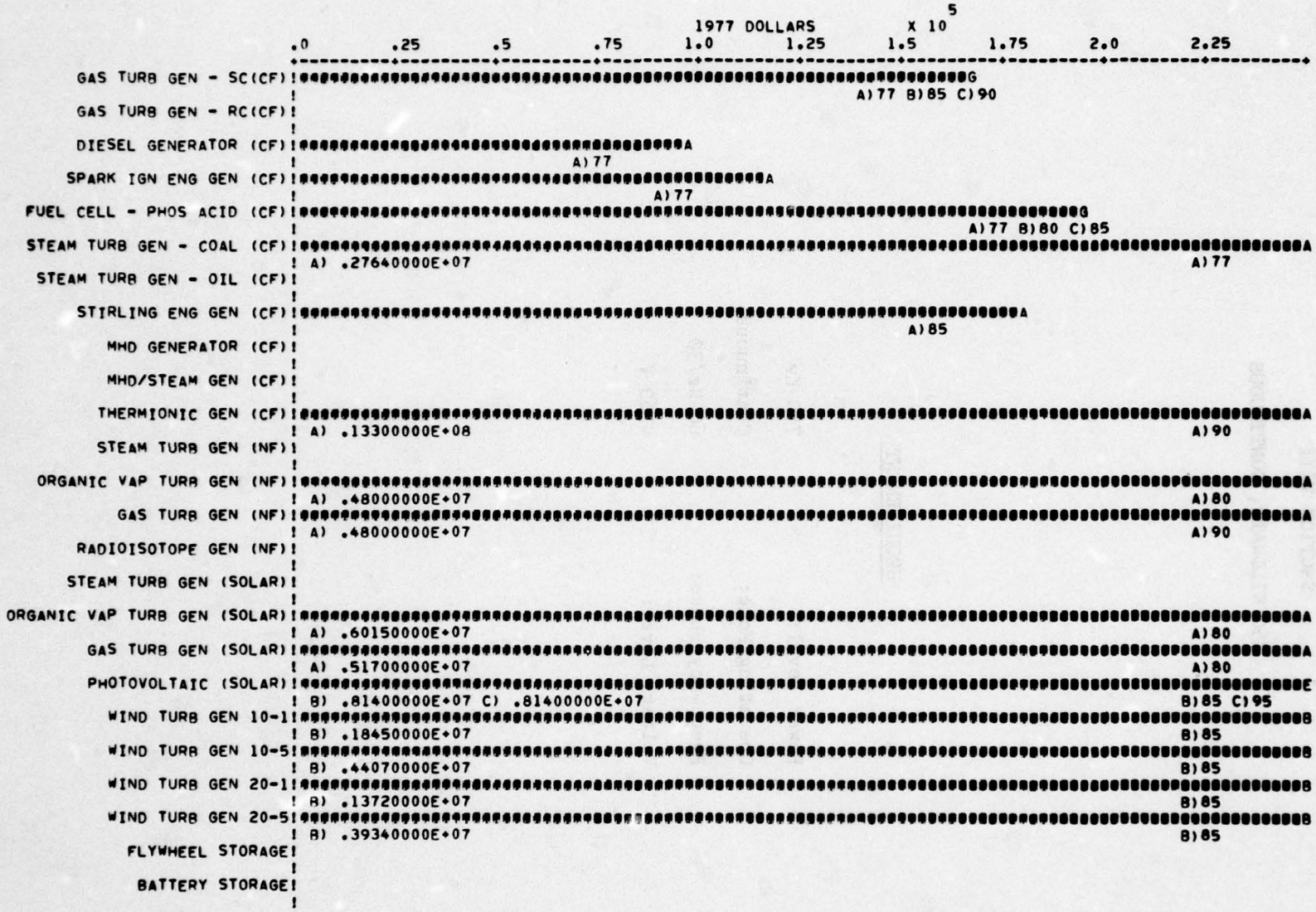
System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	None
DIESEL GENERATOR(CF)	None
SPARK IGN ENG GEN(CF)	
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	None
STEAM TURB GEN - OIL(CF)	None
STIRLING ENG GEN(CF)	None
MHD GENERATOR(CF)	None
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	None
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	None
ORGANIC VAP TURB (SOLAR)	
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	Possibly lead for conventional batteries
WIND TURB GEN 10-5	Possibly lead for conventional batteries
WIND TURB GEN 20-1	Possibly lead for conventional batteries
WIND TURB GEN 20-5	Possibly lead for conventional batteries
FLYWHEEL STORAGE	None
BATTERY STORAGE	Possibly lead for conventional batteries

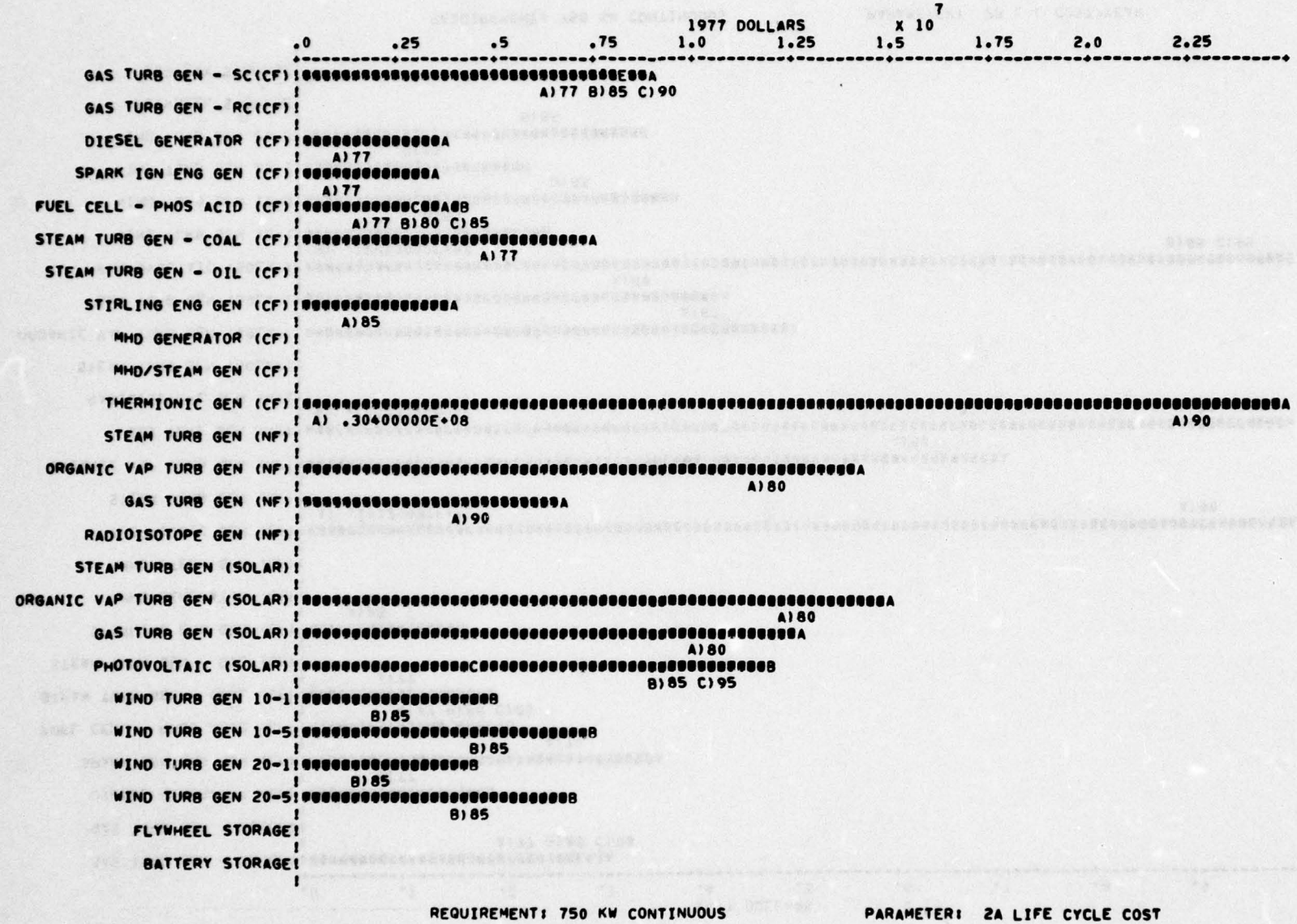
SECTION VIII

750 KILOWATT, CONTINUOUS

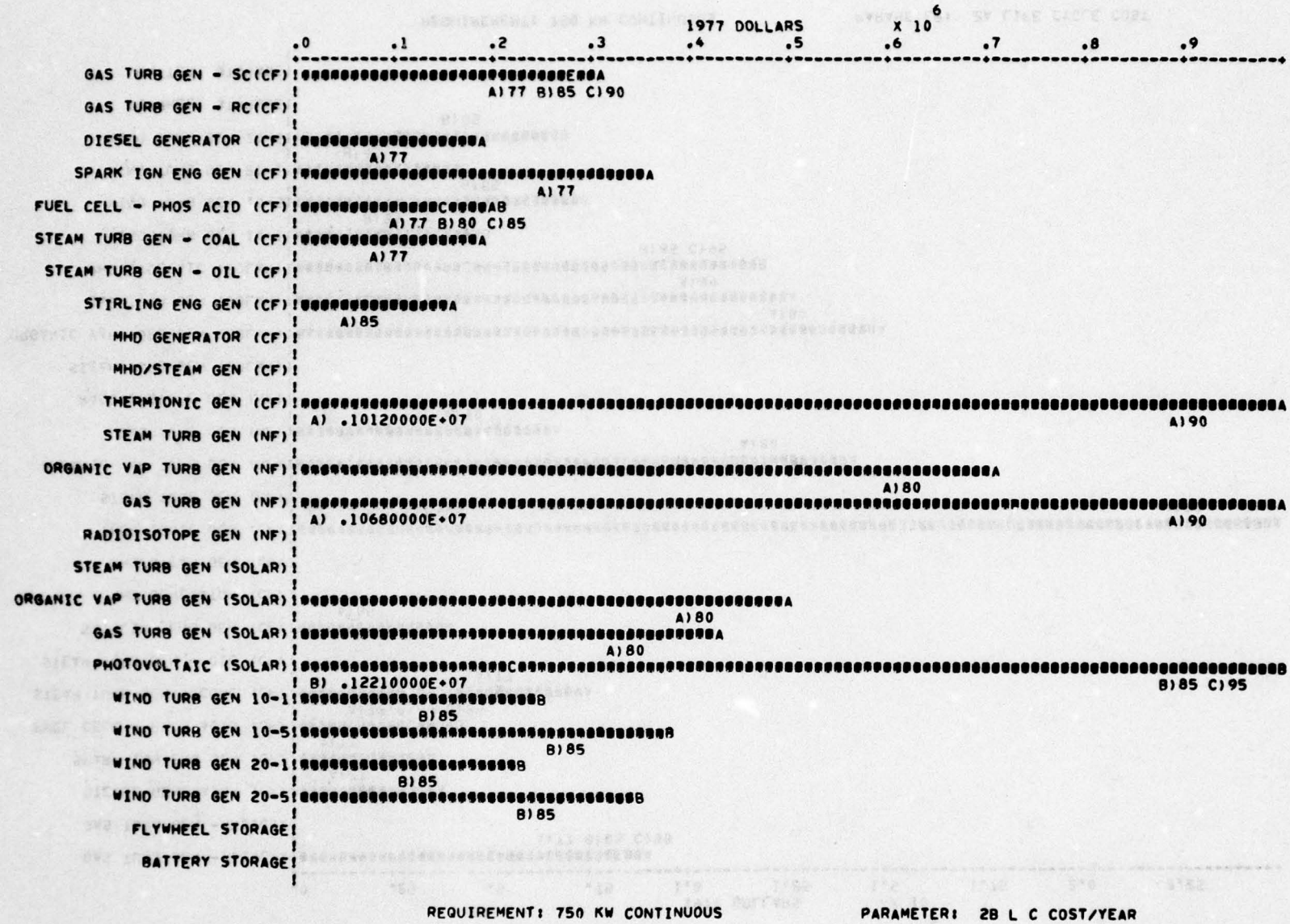
REQUIREMENT

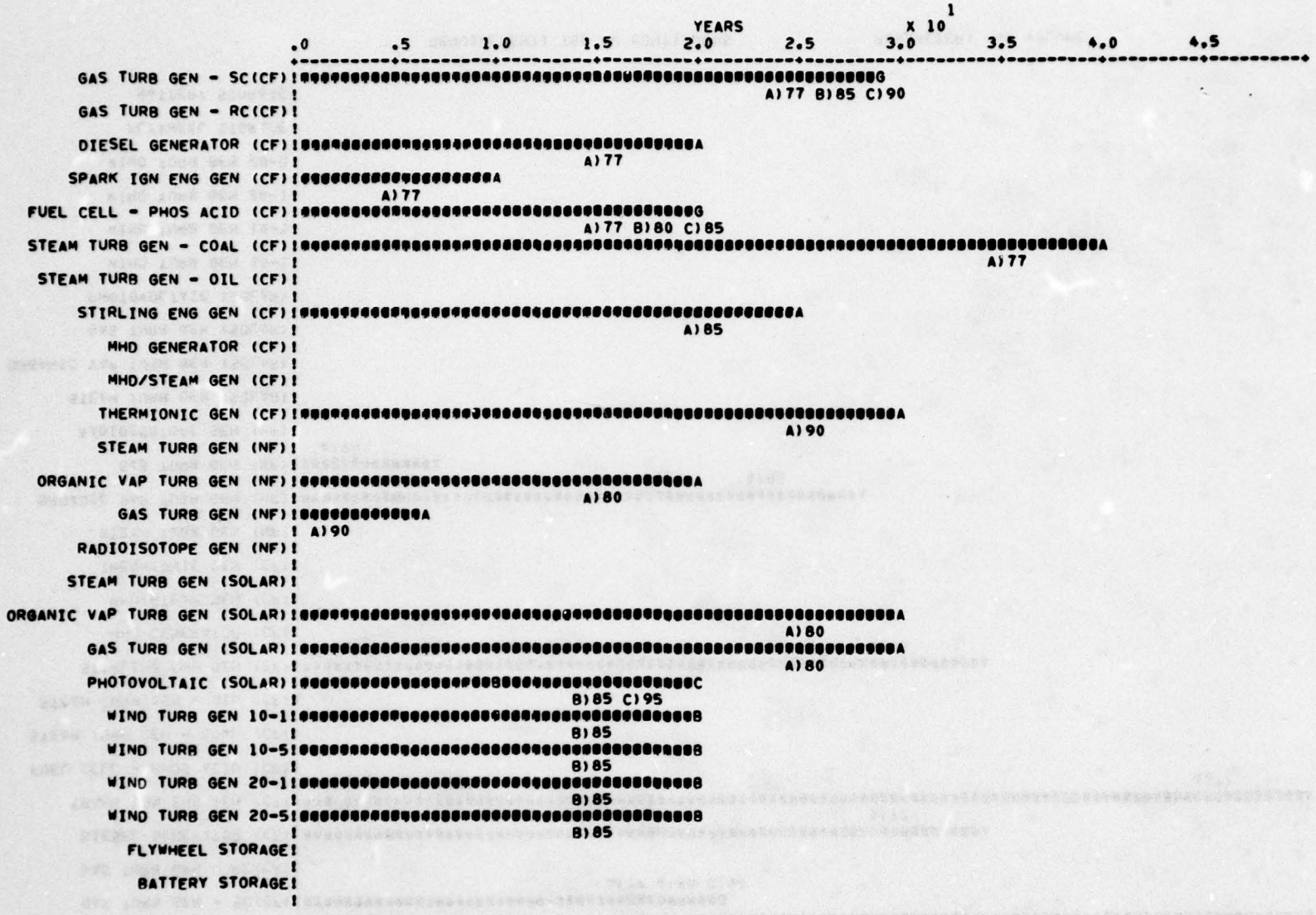
Power Level:	750 Kw
Operating Mode:	Continuous
Frequency/Phase:	60 Hz/3Ø
Voltage Level:	4160 V

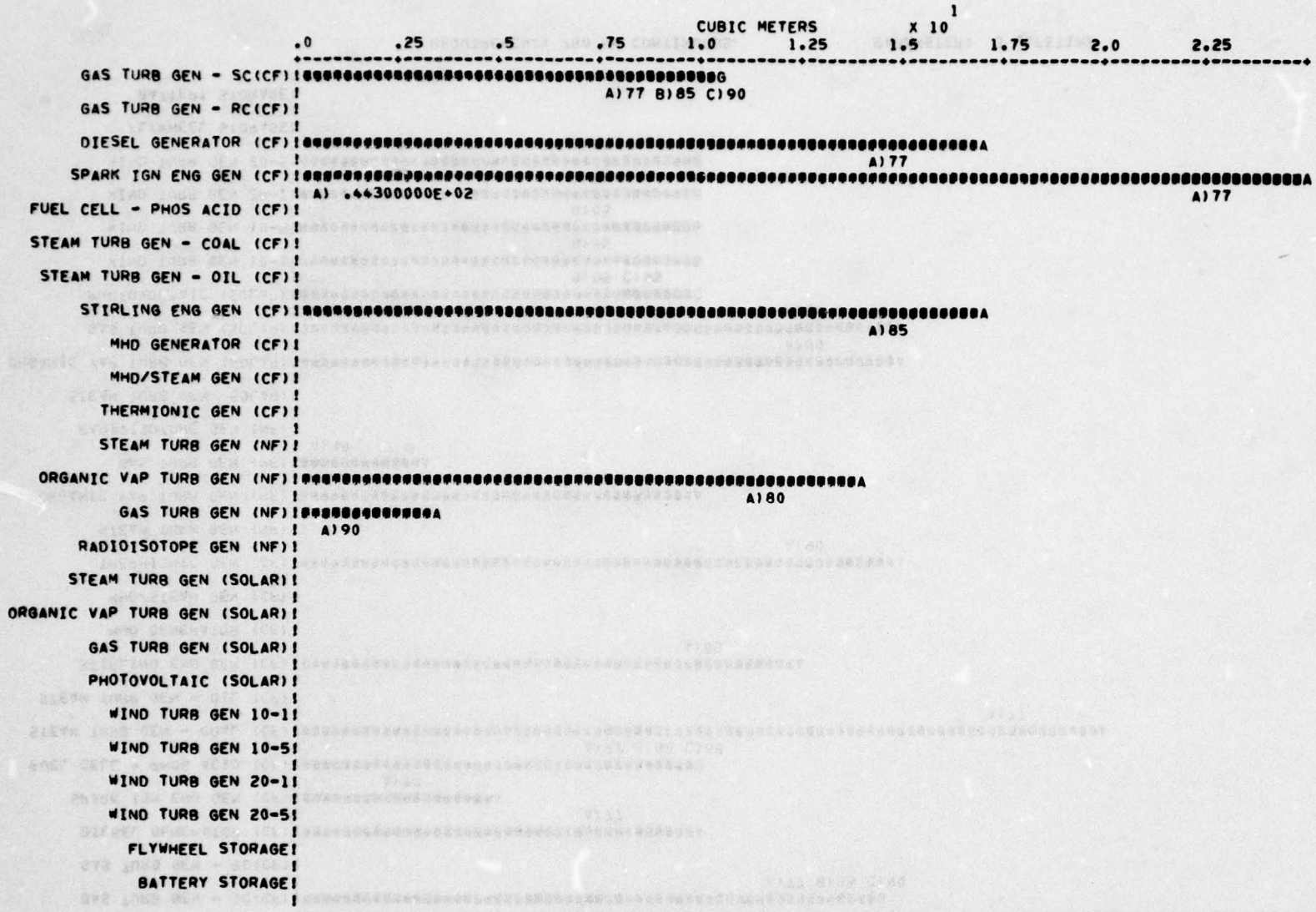

1977 DOLLARS
X 10^5
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
A) .27640000E+07
A)77
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A) .13300000E+08
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A) .48000000E+07
A)80
GAS TURB GEN (NF)
A) .48000000E+07
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A) .60150000E+07
A)80
GAS TURB GEN (SOLAR)
A) .51700000E+07
A)80
PHOTOVOLTAIC (SOLAR)
B) .81400000E+07 C) .81400000E+07
B)85 C)95
WIND TURB GEN 10-1
B) .18450000E+07
B)85
WIND TURB GEN 10-5
B) .44070000E+07
B)85
WIND TURB GEN 20-1
B) .13720000E+07
B)85
WIND TURB GEN 20-5
B) .39340000E+07
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 750 KW CONTINUOUS
PARAMETER: 1 ACQUISITION COST



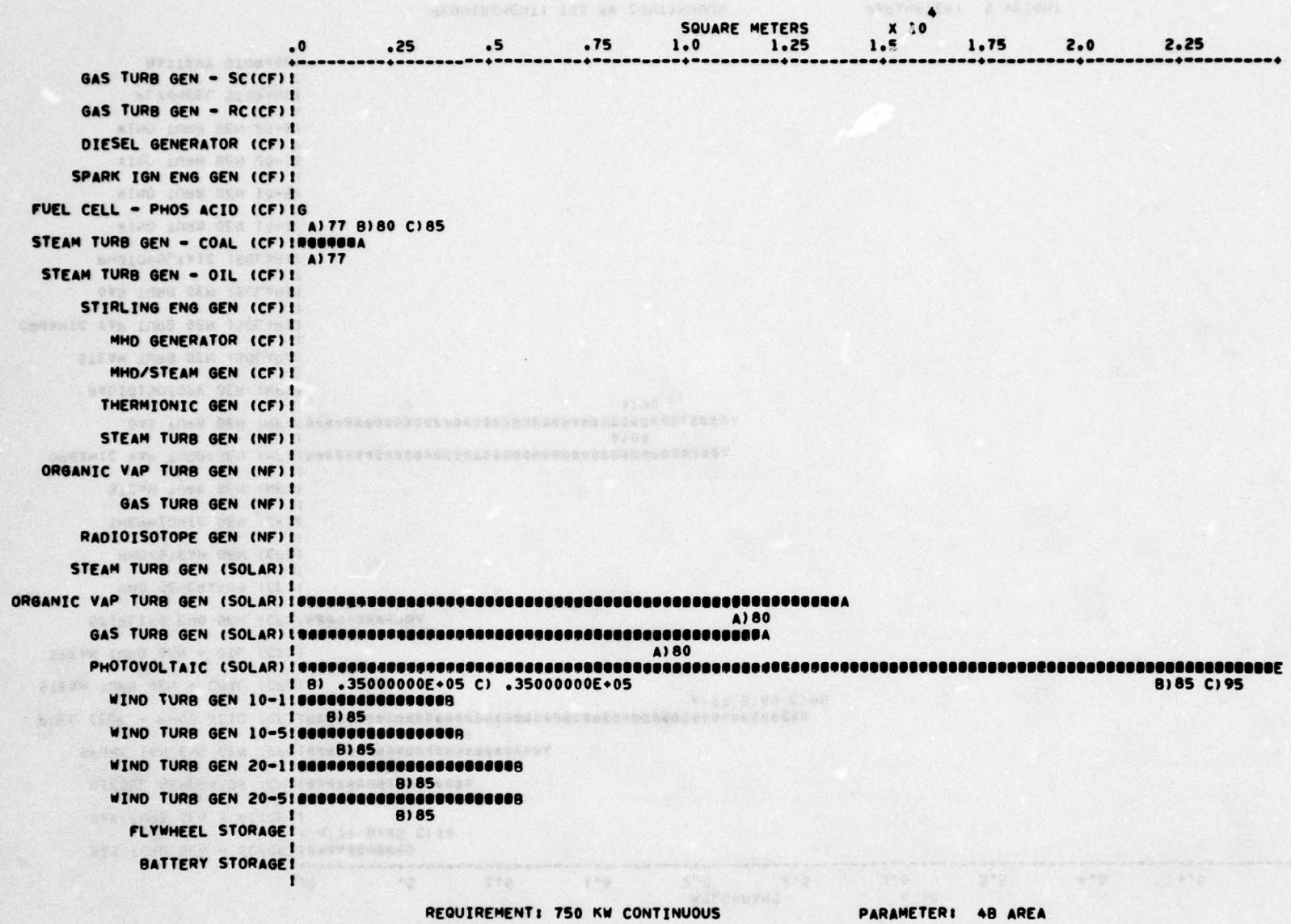
REQUIREMENT: 750 KW CONTINUOUS PARAMETER: 2A LIFE CYCLE COST

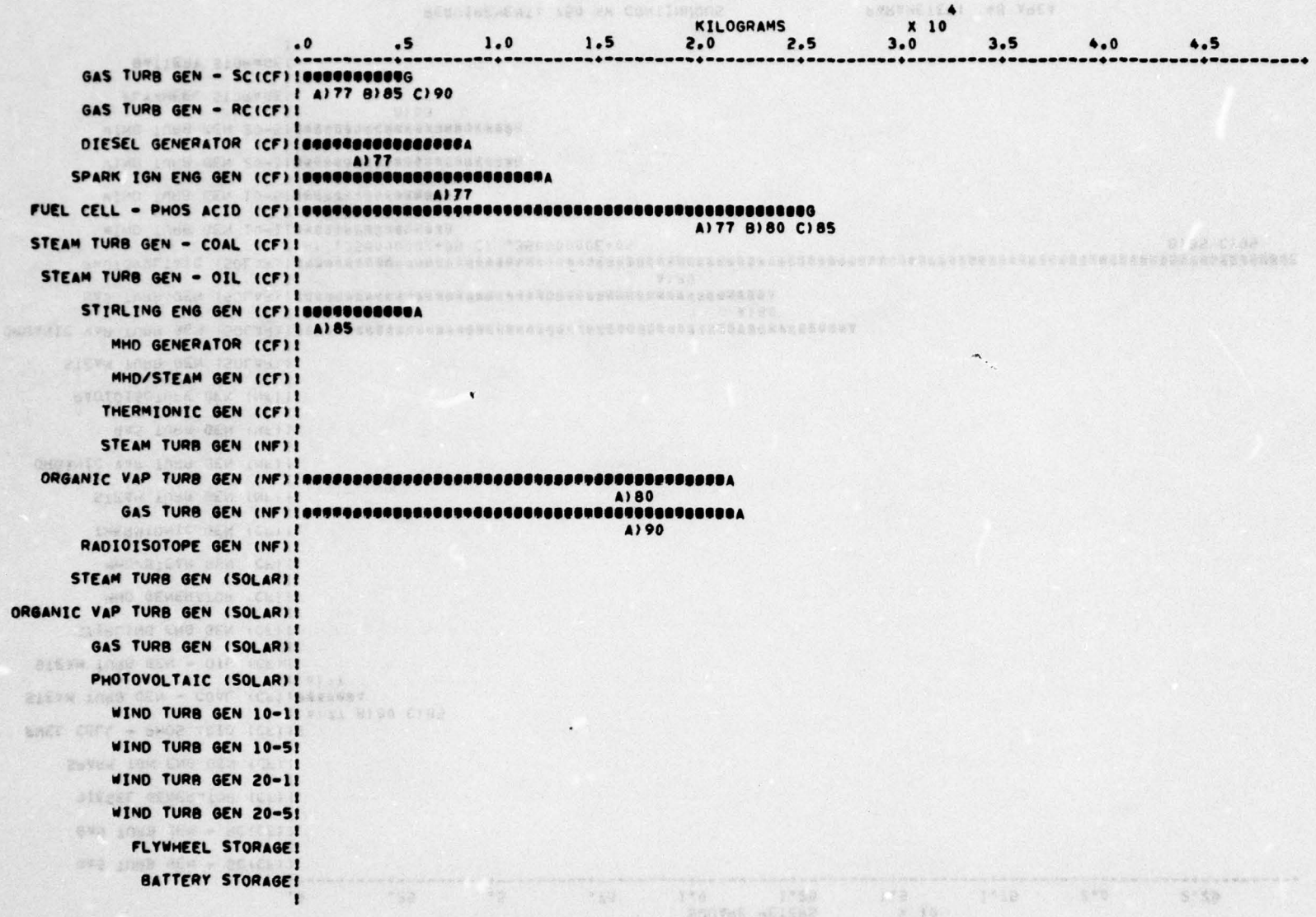

1977 DOLLARS
X 10^6
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A) .10120000E+07
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A) .10680000E+07
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B) .12210000E+07
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 750 KW CONTINUOUS
PARAMETER: 28 L C COST/YEAR

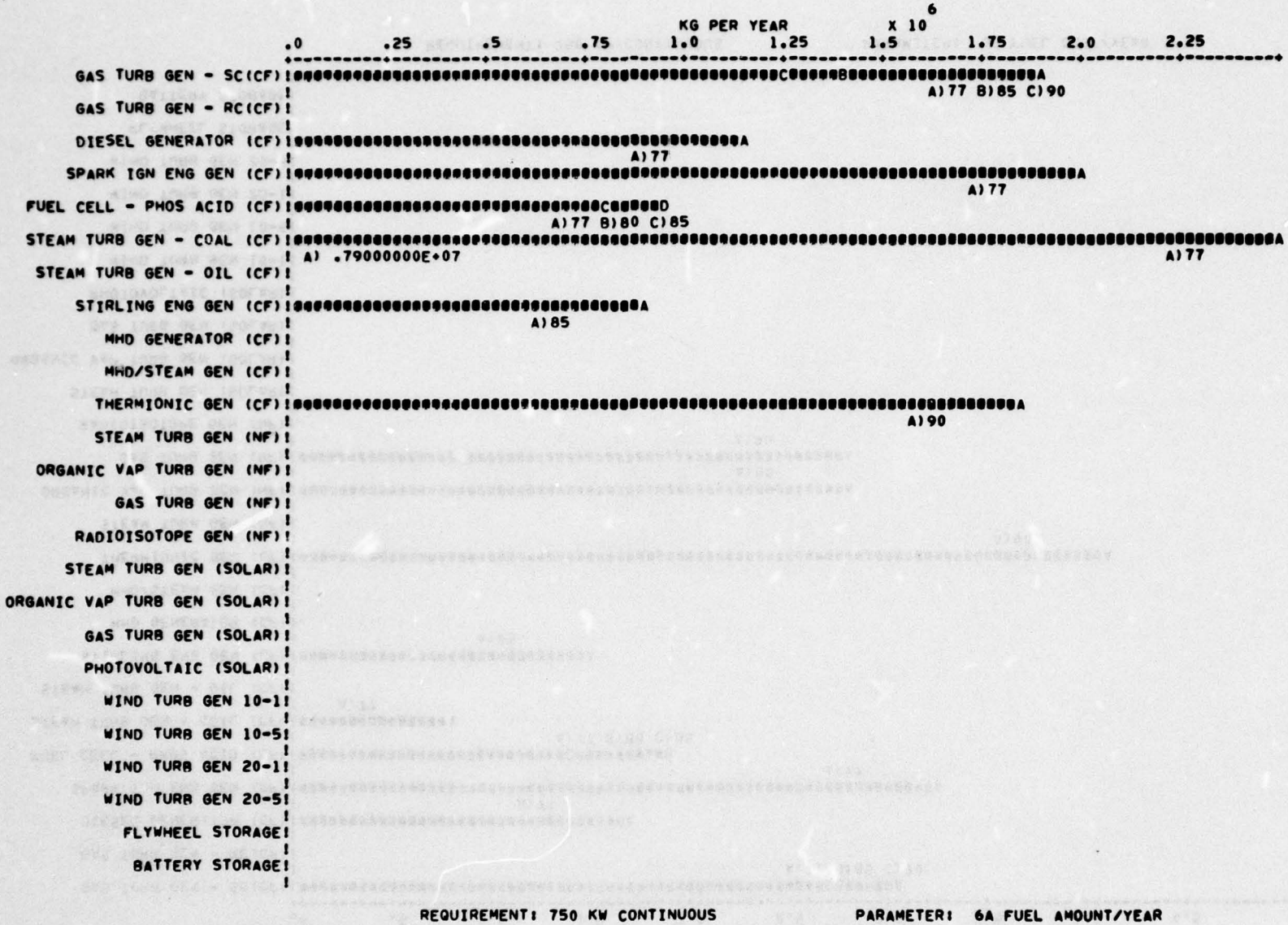

YEARS
X 10^1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 750 KW CONTINUOUS
PARAMETER: 3 LIFETIME



REQUIREMENT: 750 KW CONTINUOUS PARAMETER: 4A VOLUME

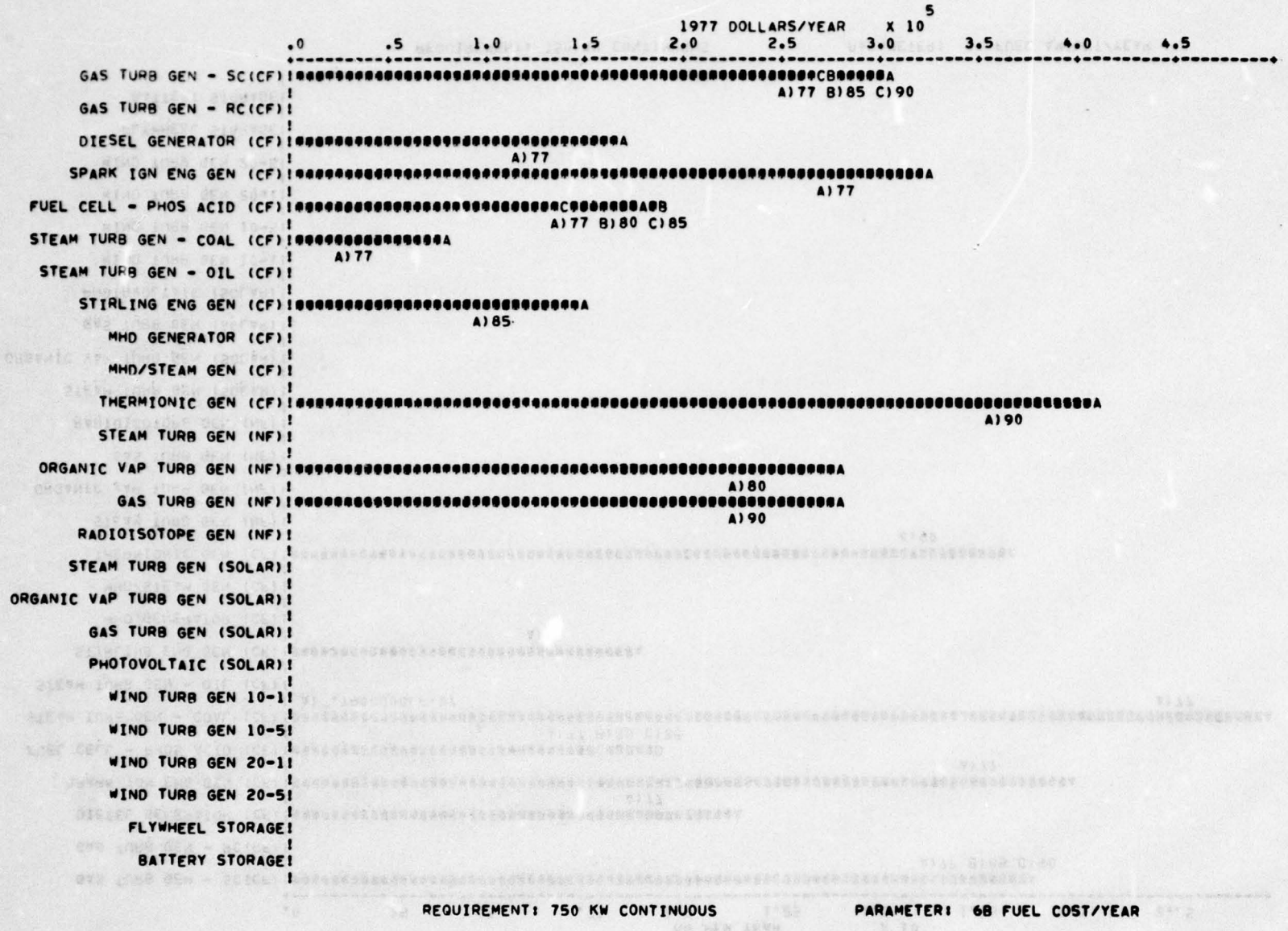

SQUARE METERS X 10
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B) .35000000E+05 C) .35000000E+05
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 750 KW CONTINUOUS
PARAMETER: 48 AREA


KILOGRAMS
X 10 4
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 750 KW CONTINUOUS
PARAMETER: 5 WEIGHT



REQUIREMENT: 750 KW CONTINUOUS

PARAMETER: 6A FUEL AMOUNT/YEAR


1977 DOLLARS/YEAR X 10^5
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 750 KW CONTINUOUS
PARAMETER: 6B FUEL COST/YEAR

REQUIREMENT	PARAMETER
750 KW Cont.	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
GAS TURB GEN - RC(CF)											
DIESEL GENERATOR(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
SPARK IGN ENG GEN(CF)											
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	0	-	-	-	-
STEAM TURB GEN - COAL(CF)	-	●	◐	0	◐	●	◐	●	●	0	-
STEAM TURB GEN - OIL(CF)											
STIRLING ENG GEN(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
MHD GENERATOR(CF)											
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)	-	-	0	0	●	◐	0	◐	-	-	-
STEAM TURB GEN(NF)											
ORGANIC VAP TURB GEN(NF)	-	●	-	-	-	-	◐	-	-	0	◐
GAS TURB GEN(NF)	-	●	-	-	-	-	◐	-	-	0	◐
RADIOISOTOPE GEN(NF)											
STEAM TURB GEN (SOLAR)											
ORGANIC VAP TURB (SOLAR)	-	●	-	-	-	-	◐	-	-	0	-
GAS TURB GEN (SOLAR)	-	-	-	-	-	-	◐	-	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
WIND TURB GEN (ALL)	-	-	-	-	-	-	-	-	-	-	-
FLYWHEEL STORAGE											
BATTERY STORAGE											

- - none
0 - minor
◐ - moderate
● - major

REQUIREMENT	PARAMETER
750 KW Cont.	8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- - - no limitation
- O - minor limitation
- ⊖ - major limitation
- ● - overriding limitation

SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	O	●	-	-	-	-
GAS TURB GEN - RC(CF)								
DIESEL GENERATOR(CF)	-	-	-	●	-	-	-	-
SPARK IGN ENG GEN(CF)	-	-	-	●	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)	⊖	⊖	●	●	-	-	-	-
STEAM TURB GEN - OIL(CF)								
STIRLING ENG GEN(CF)	-	-	O	●	-	-	-	-
MHD GENERATOR(CF)								
MHD/STEAM GEN(CF)								
THERMIONIC GEN(CF)	O	O	O	●	-	-	-	-
STEAM TURB GEN(NF)								
ORGANIC VAP TURB GEN(NF)	⊖	-	O	O	-	-	●	-
GAS TURB GEN(NF)	⊖	-	●	O	-	-	●	-
RADIOISOTOPE GEN(NF)								
STEAM TURB GEN (SOLAR)								
ORGANIC VAP TURB (SOLAR)	⊖	-	O	-	●	-	-	-
GAS TURB GEN (SOLAR)	-	-	O	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1	-	-	-	-	-	●	-	-
WIND TURB GEN 10-5	-	-	-	-	-	●	-	-
WIND TURB GEN 20-1	-	-	-	-	-	●	-	-
WIND TURB GEN 20-5	-	-	-	-	-	●	-	-
FLYWHEEL STORAGE								
BATTERY STORAGE								

REQUIREMENT

750 KW Cont.

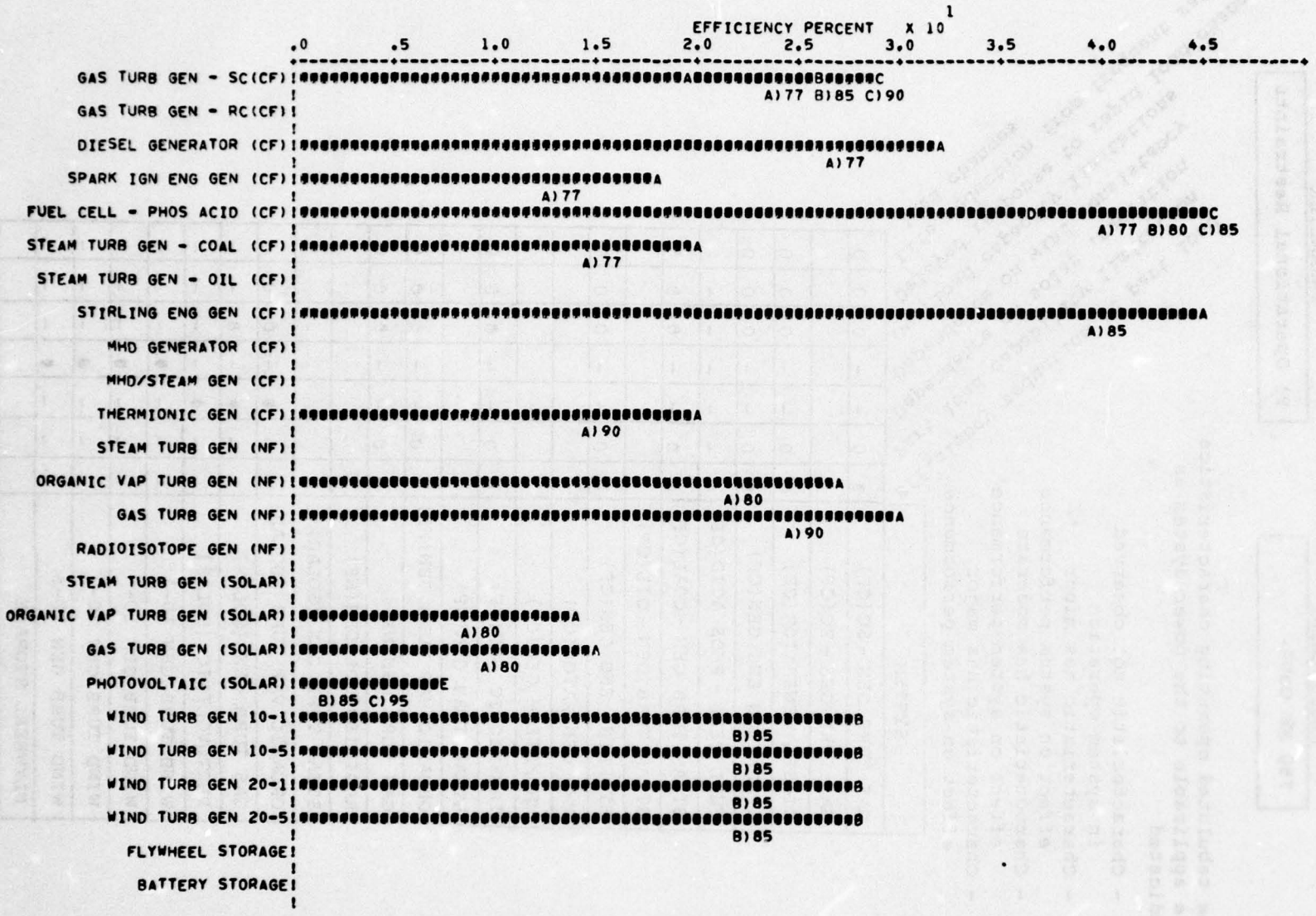
PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
0 - Characteristic has minor effect on system performance
◐ - Characteristic has moderate effect on system performance
● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	◐	0	-	-	0	0	0
GAS TURB GEN - RC(CF)							
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)	◐	0	-	-	0	0	0
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)	◐	◐	-	-	◐	◐	◐
STEAM TURB GEN - OIL(CF)							
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)							
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	◐	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)	0	0	-	-	◐	◐	◐
GAS TURB GEN(NF)	0	◐	-	-	◐	◐	◐
RADIOISOTOPE GEN(NF)							
STEAM TURB GEN (SOLAR)							
ORGANIC VAP TURB (SOLAR)	-	0	●	-	◐	◐	-
GAS TURB GEN (SOLAR)	-	-	●	-	◐	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE							
BATTERY STORAGE							

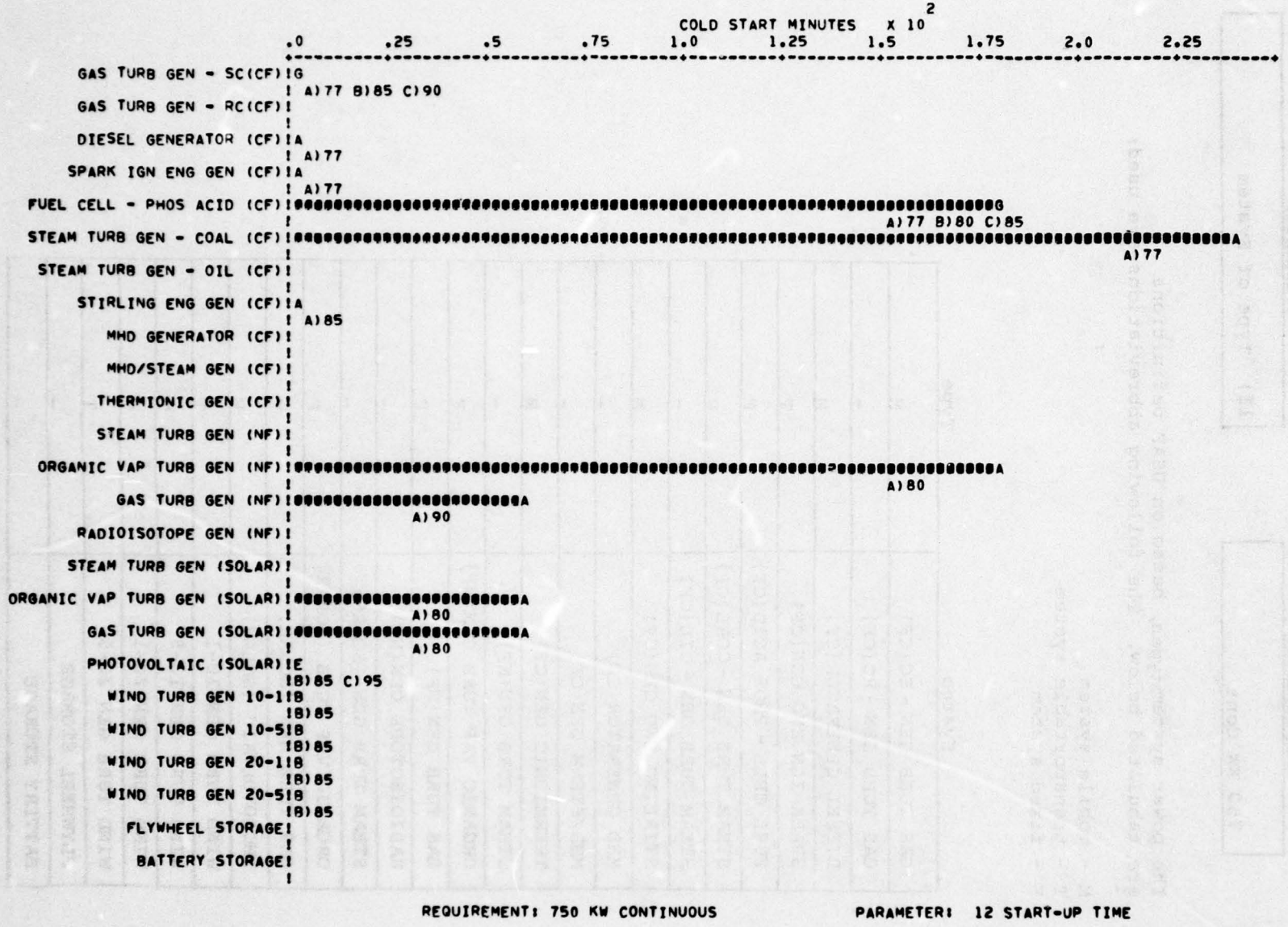

EFFICIENCY PERCENT X 10^1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 750 KW CONTINUOUS
PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
750 KW Cont	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	M
GAS TURB GEN - RC(CF)	-
DIESEL GENERATOR(CF)	M
SPARK IGN ENG GEN(CF)	T
FUEL CELL - PHOS ACID(CF)	F
STEAM TURB GEN - COAL(CF)	F
STEAM TURB GEN - OIL(CF)	-
STIRLING ENG GEN(CF)	M
MHD GENERATOR(CF)	-
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	M
STEAM TURB GEN(NF)	-
ORGANIC VAP TURB GEN(NF)	F
GAS TURB GEN(NF)	F
RADIOISOTOPE GEN(NF)	-
STEAM TURB GEN (SOLAR)	-
ORGANIC VAP TURB (SOLAR)	F
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	T
WIND TURB GEN 10-5	T
WIND TURB GEN 20-1	T
WIND TURB GEN 20-5	T
FLYWHEEL STORAGE	-
BATTERY STORAGE	-



REQUIREMENT: 750 KW CONTINUOUS PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
750 KW Cont.	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

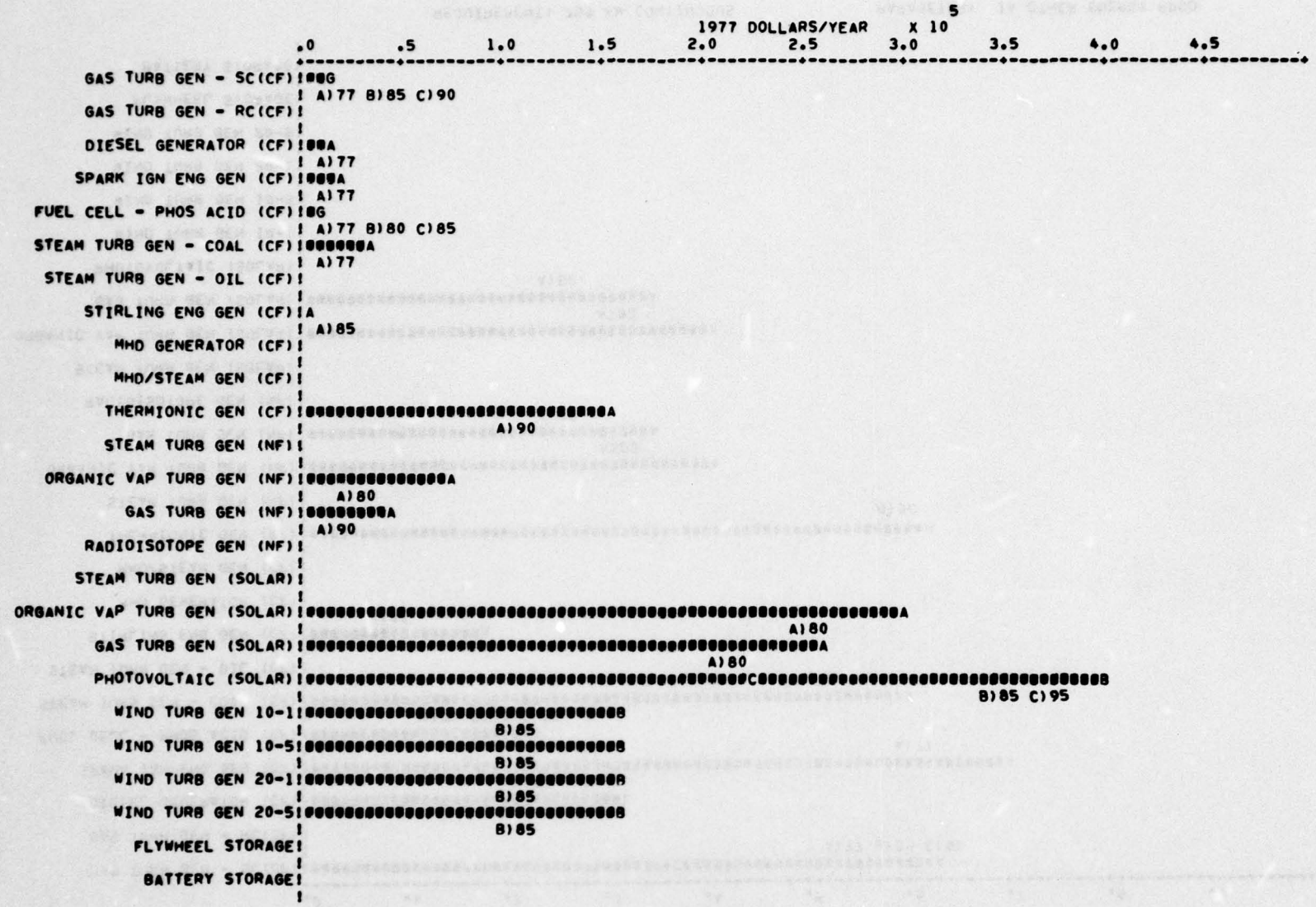
System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	Not modular, except possibly largest requirements
SPARK IGN ENG GEN(CF)	Not modular, except possibly largest requirements
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	Not modular
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	Not modular, except possibly largest requirements
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	Not modular
GAS TURB GEN(NF)	Not modular
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	Not modular
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	Modular for most requirements
WIND TURB GEN 10-5	Modular for most requirements
WIND TURB GEN 20-1	Modular for most requirements
WIND TURB GEN 20-5	Modular for most requirements
FLYWHEEL STORAGE	
BATTERY STORAGE	

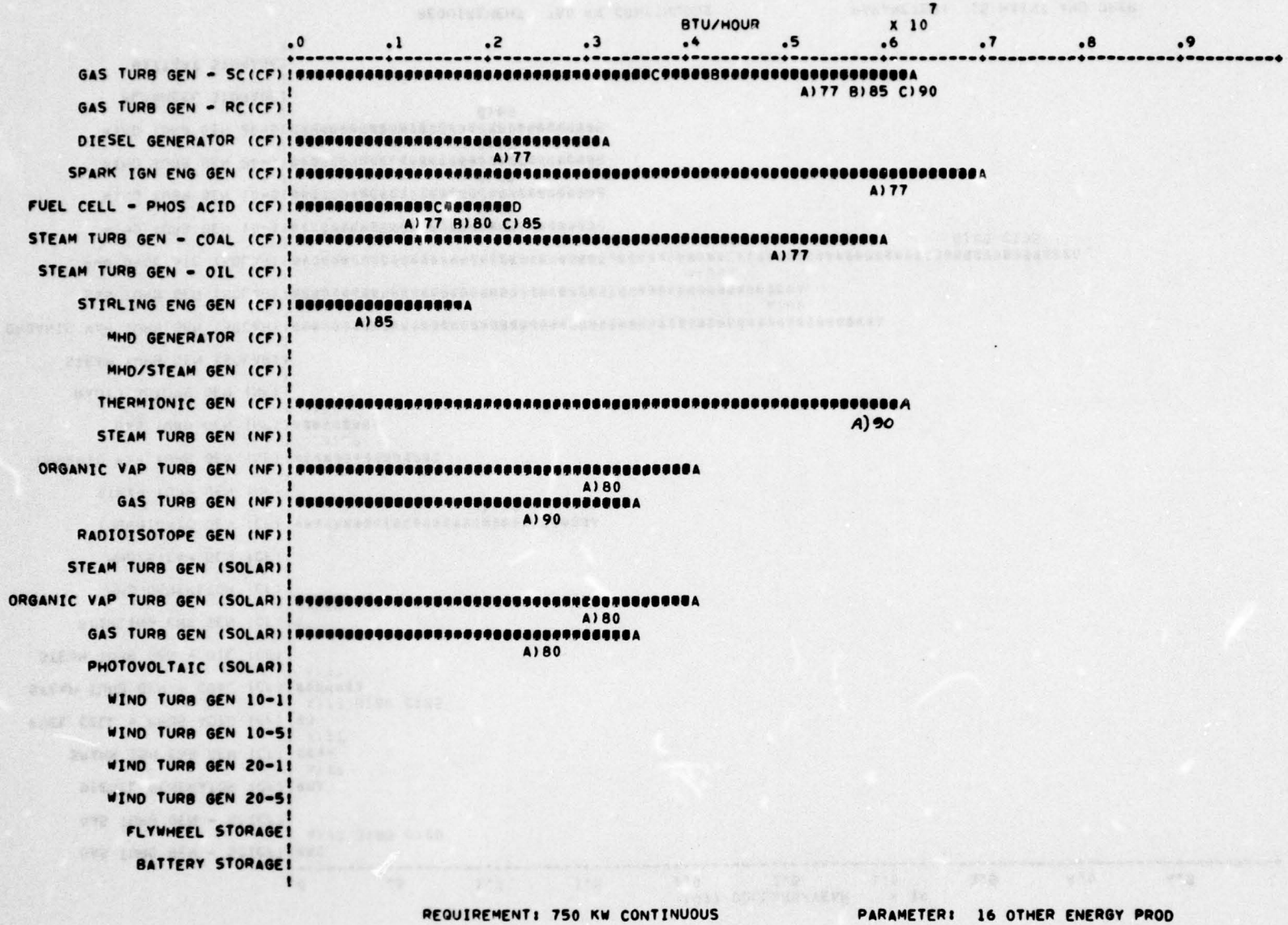
REQUIREMENT	PARAMETER
750 KW Cont.	14) Reliability/Availability

The tabulated conditions exist in the power system to the extent indicated.

SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	O	●	O	-	●	O	●	-	-
GAS TURB GEN - RC(CF)									
DIESEL GENERATOR(CF)	●	O	O	-	O	O	●	-	-
SPARK IGN ENG GEN(CF)	●	O	O	-	O	O	●	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	O	-	-	-	-
STEAM TURB GEN - COAL(CF)	●	O	O	-	O	⊖	●	-	-
STEAM TURB GEN - OIL(CF)									
STIRLING ENG GEN(CF)	O	O	O	-	O	O	●	-	-
MHD GENERATOR(CF)									
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	O	●	-	-	⊖	O	O	-	-
STEAM TURB GEN(NF)									
ORGANIC VAP TURB GEN(NF)	O	O	O	O	-	O	●	-	-
GAS TURB GEN(NF)	●	O	O	O	-	⊖	●	-	-
RADIOISOTOPE GEN(NF)									
STEAM TURB GEN (SOLAR)									
ORGANIC VAP TURB (SOLAR)	O	O	O	-	-	O	-	●	-
GAS TURB GEN (SOLAR)	O	O	O	-	O	O	-	●	-
PHOTOVOLTAIC (SOLAR)	-	O	-	-	O	-	-	●	-
WIND TURB GEN 10-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 10-5	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-5	O	O	●	-	O	-	-	-	●
FLYWHEEL STORAGE									
BATTERY STORAGE									

- \- - Condition does not exist in system
- O - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability
- ⊖ - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability
- ● - Condition exists and is a governing factor in determining system performance and reliability


1977 DOLLARS/YEAR X 10^5
.0 .5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 750 KW CONTINUOUS
PARAMETER: 15 MAINT AND OPER


BTU/HOUR
X 10^7
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
A)77
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 750 KW CONTINUOUS
PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
750 KW Cont.	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

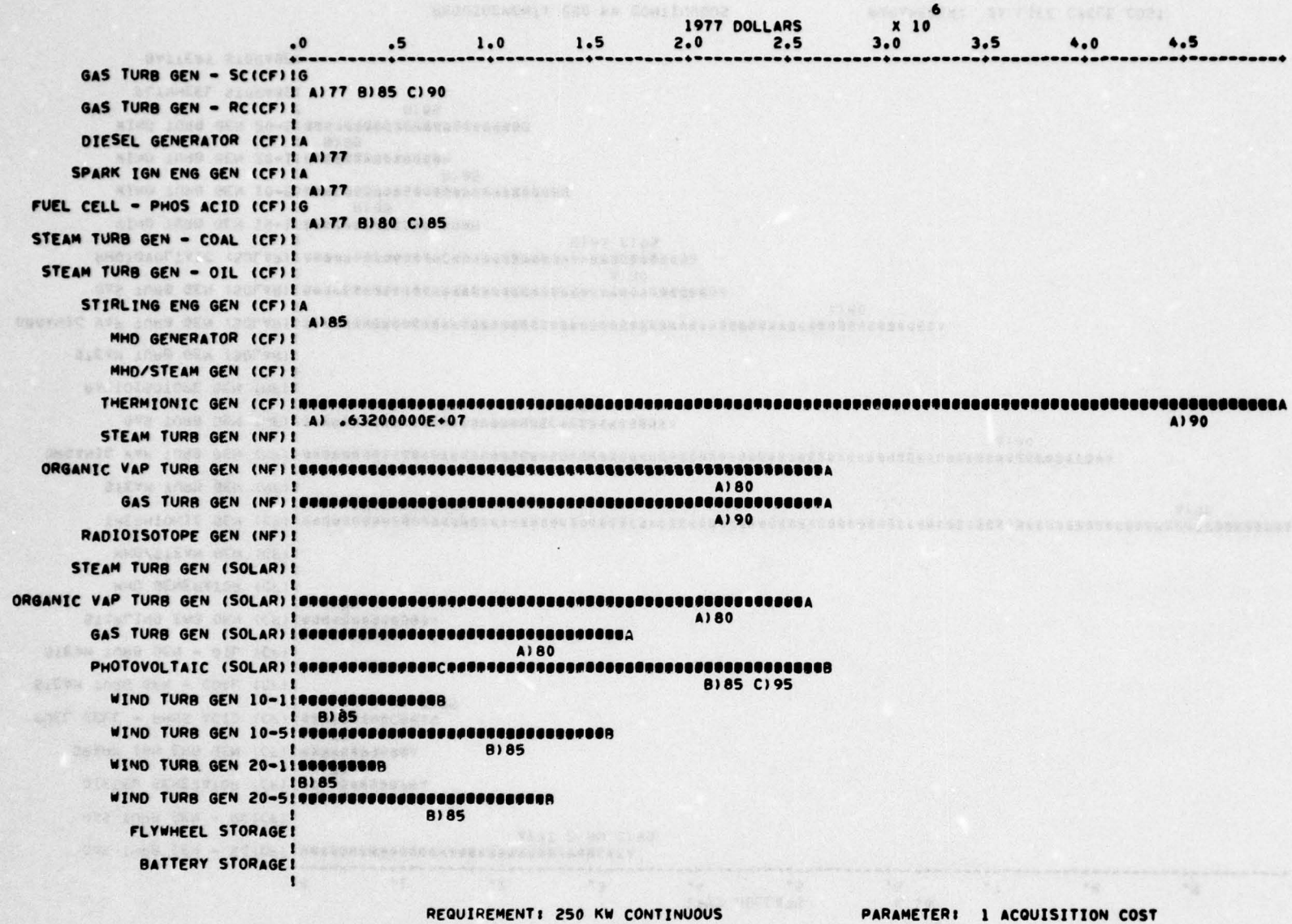
System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	None
SPARK IGN ENG GEN(CF)	None
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	None
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	None
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	None
GAS TURB GEN(NF)	None
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	None
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	Possibly lead for conventional batteries
WIND TURB GEN 10-5	Possibly lead for conventional batteries
WIND TURB GEN 20-1	Possibly lead for conventional batteries
WIND TURB GEN 20-5	Possibly lead for conventional batteries
FLYWHEEL STORAGE	
BATTERY STORAGE	

SECTION IX

250 KILOWATT, CONTINUOUS

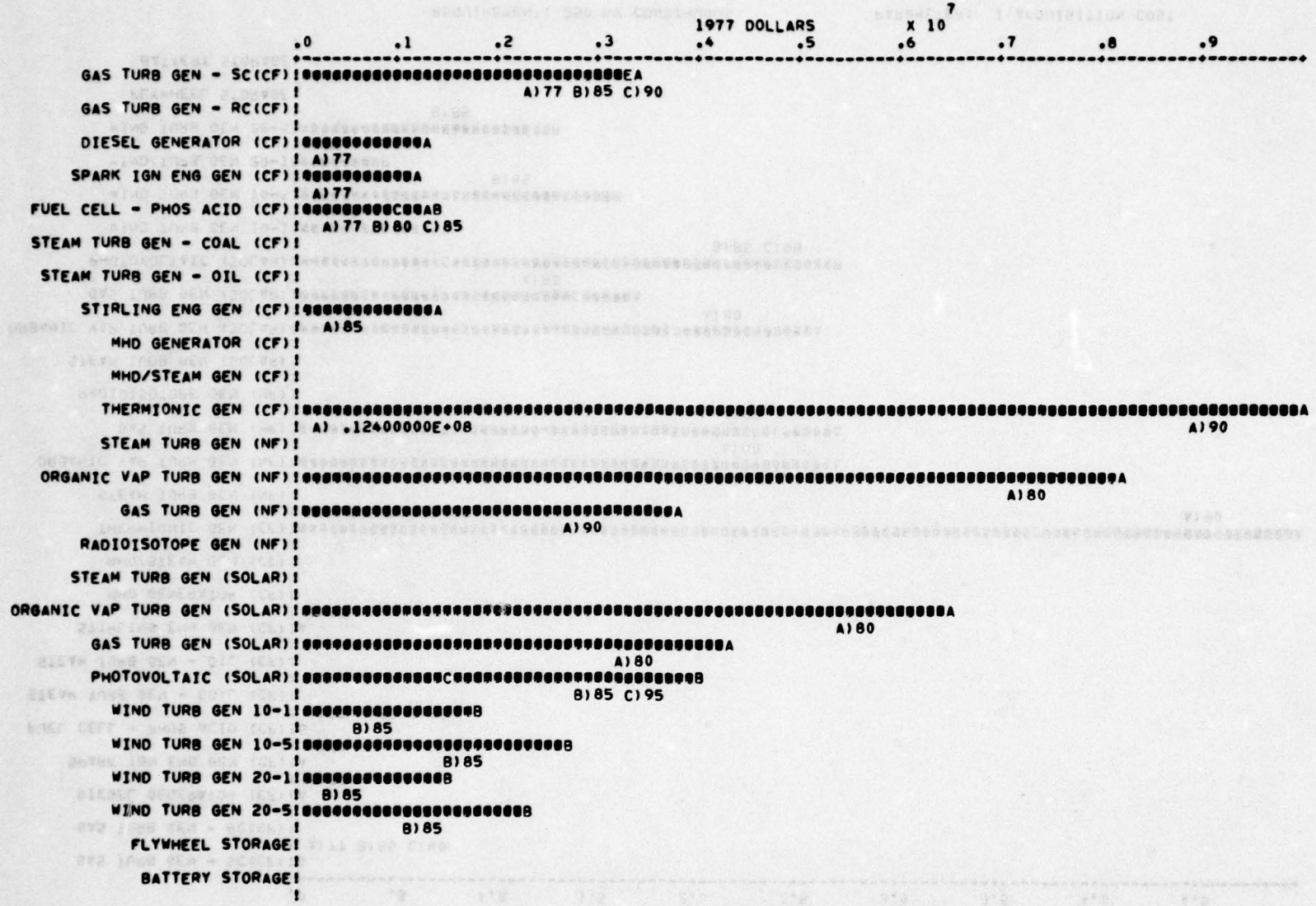
REQUIREMENT

Power Level:	250 Kw
Operating Mode:	Continuous
Frequency/Phase:	60 Hz/3Ø
Voltage Level:	480 V

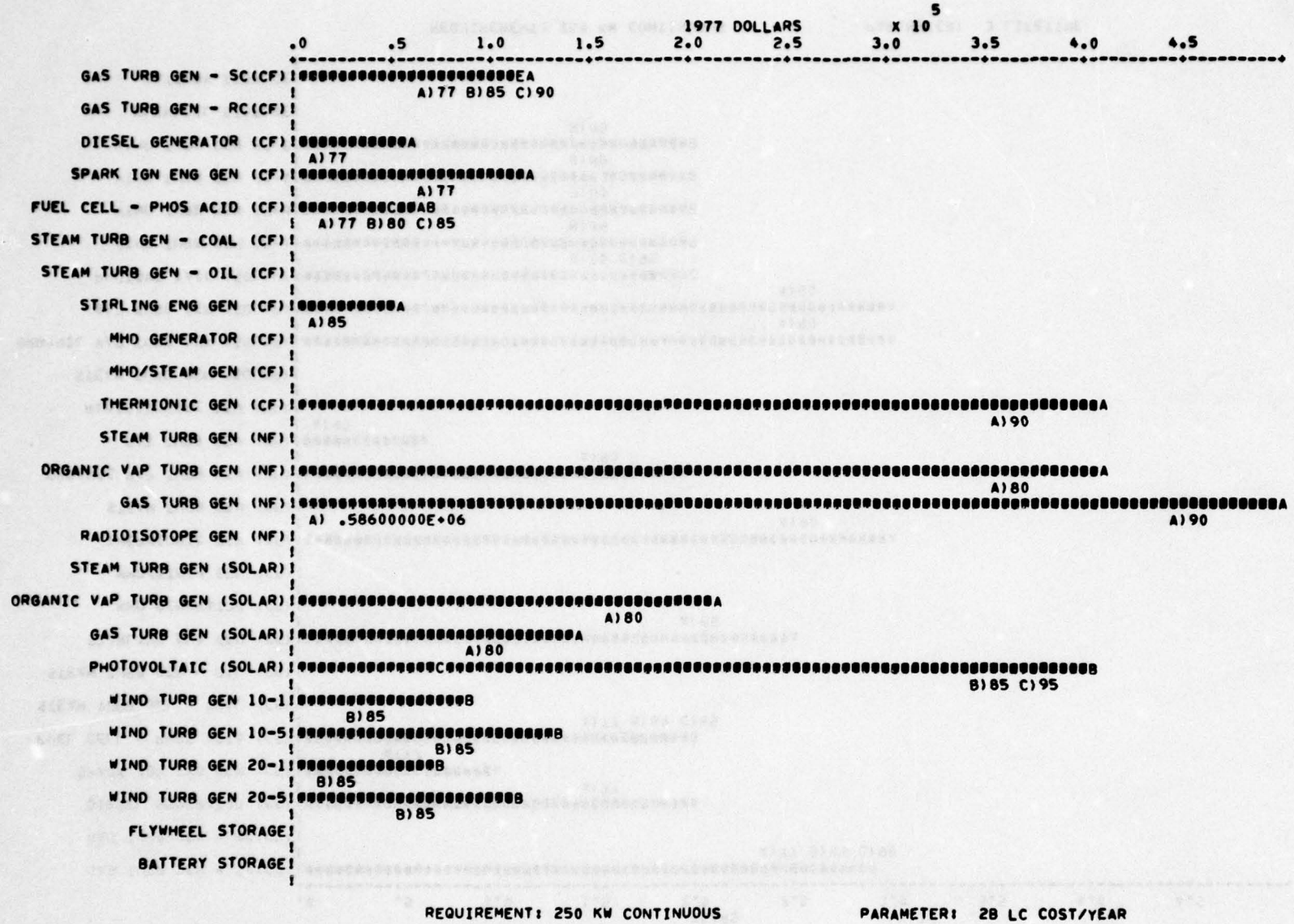


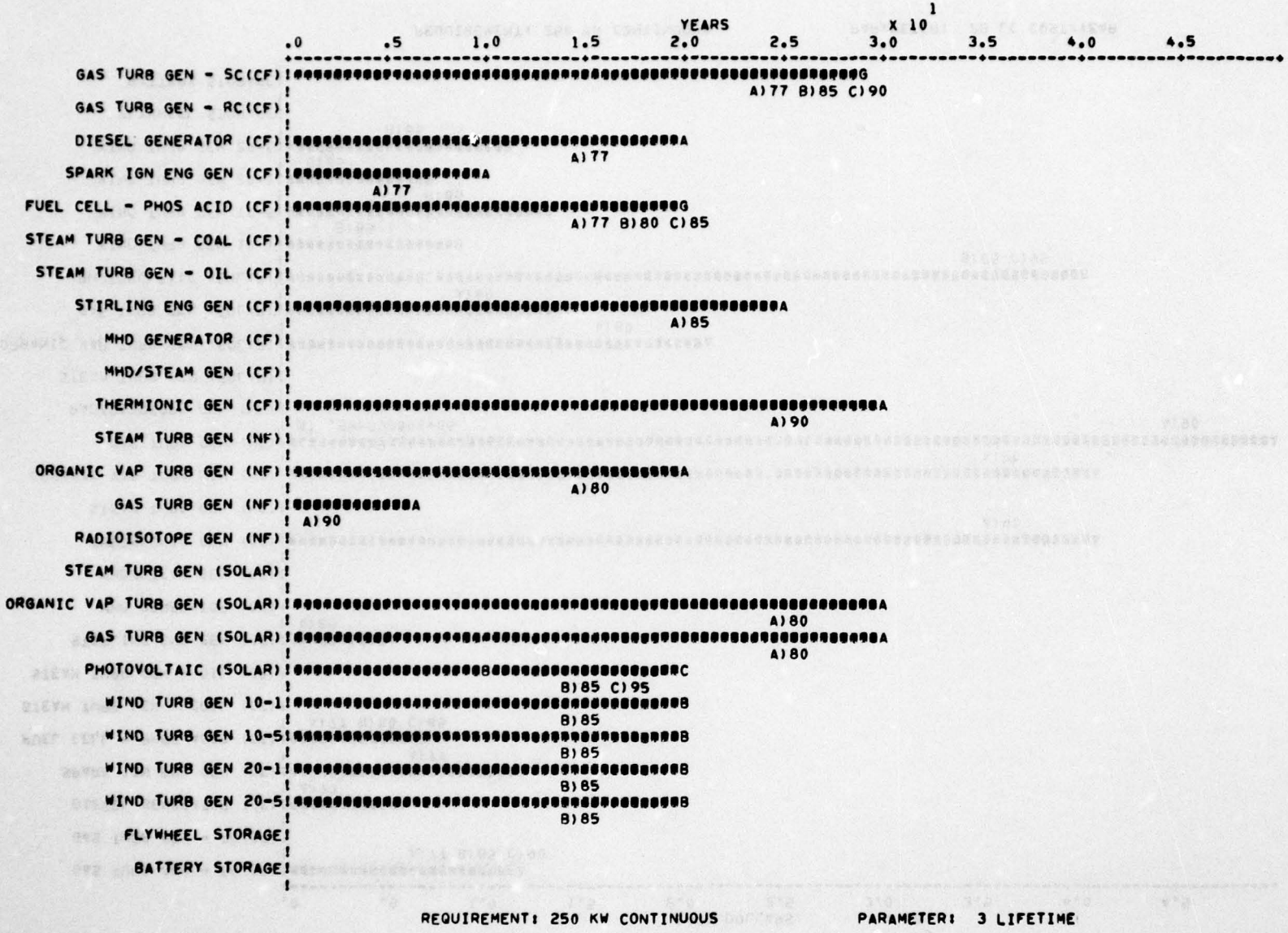
REQUIREMENT: 250 KW CONTINUOUS

PARAMETER: 1 ACQUISITION COST

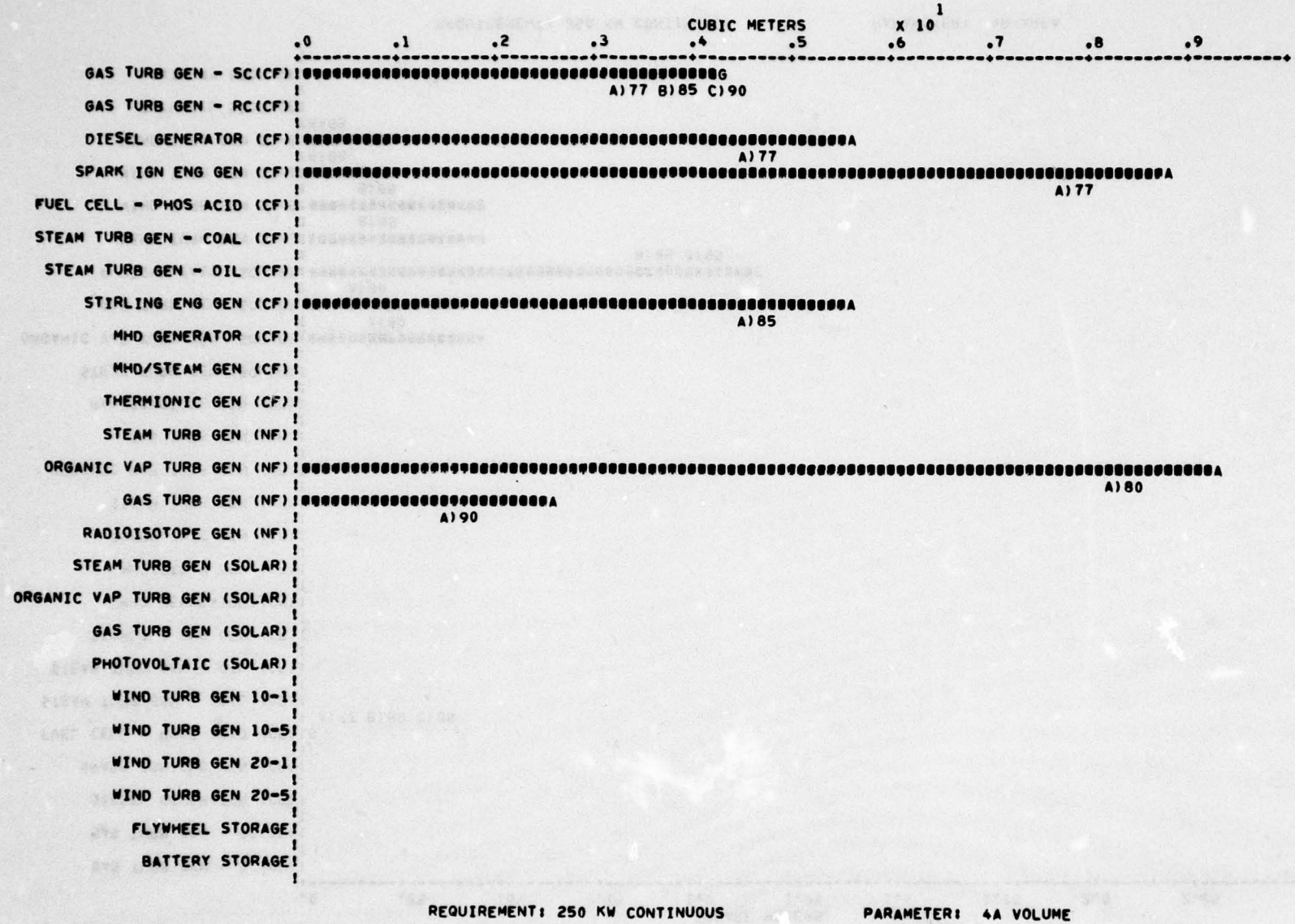


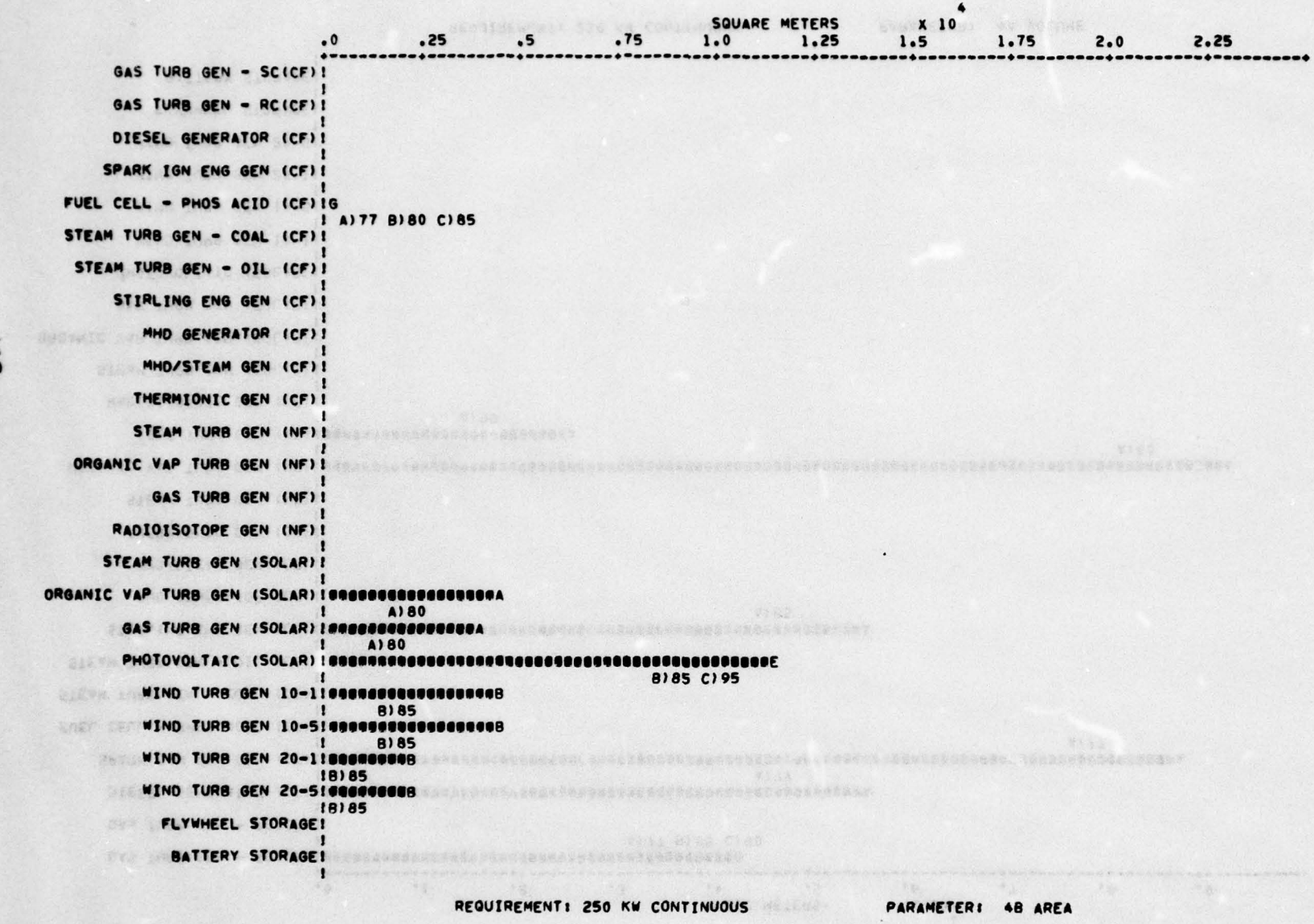
REQUIREMENT: 250 KW CONTINUOUS PARAMETER: 2A LIFE CYCLE COST

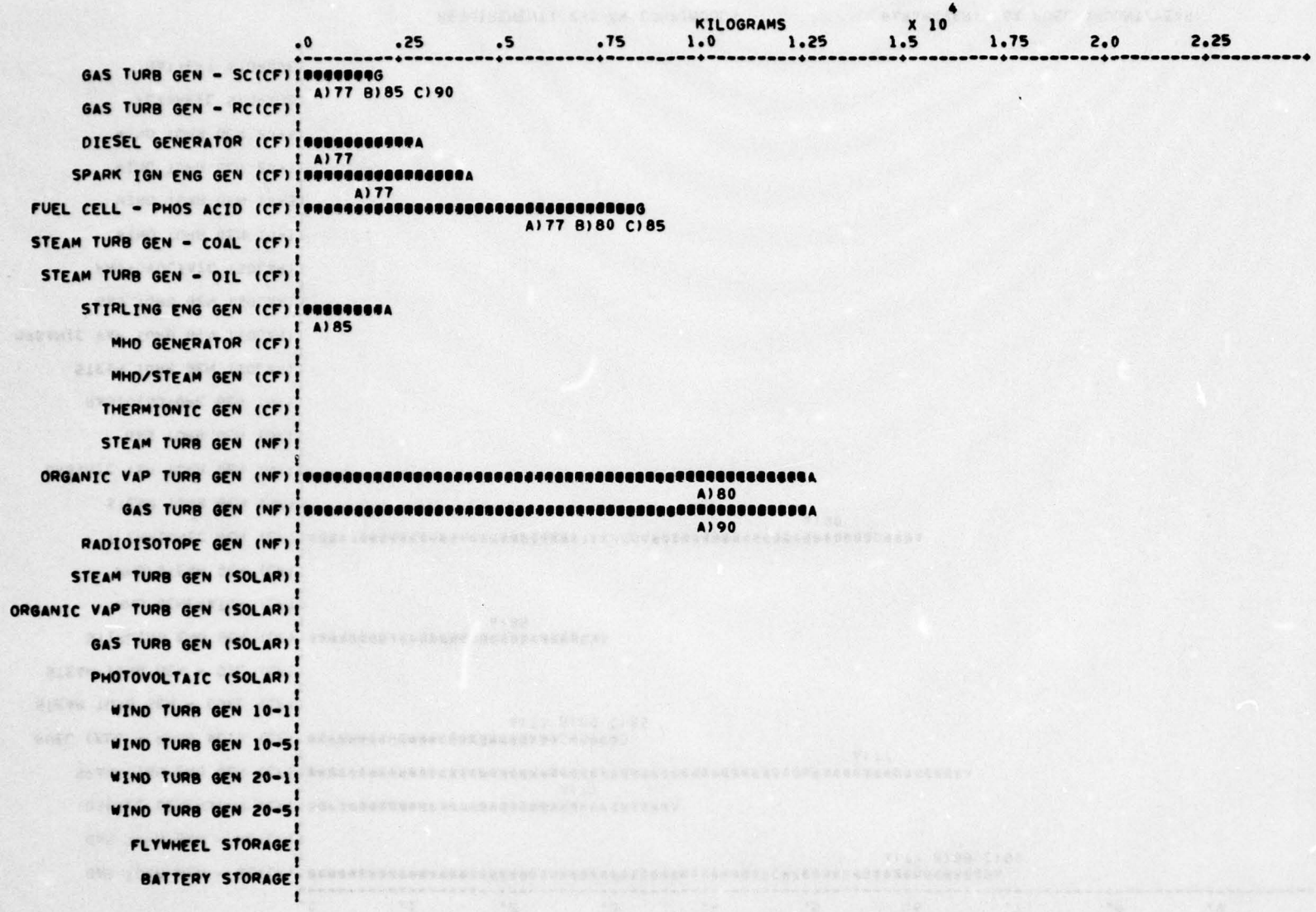

1977 DOLLARS
X 10 5
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A) .58600000E+06
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 250 KW CONTINUOUS
PARAMETER: 28 LC COST/YEAR



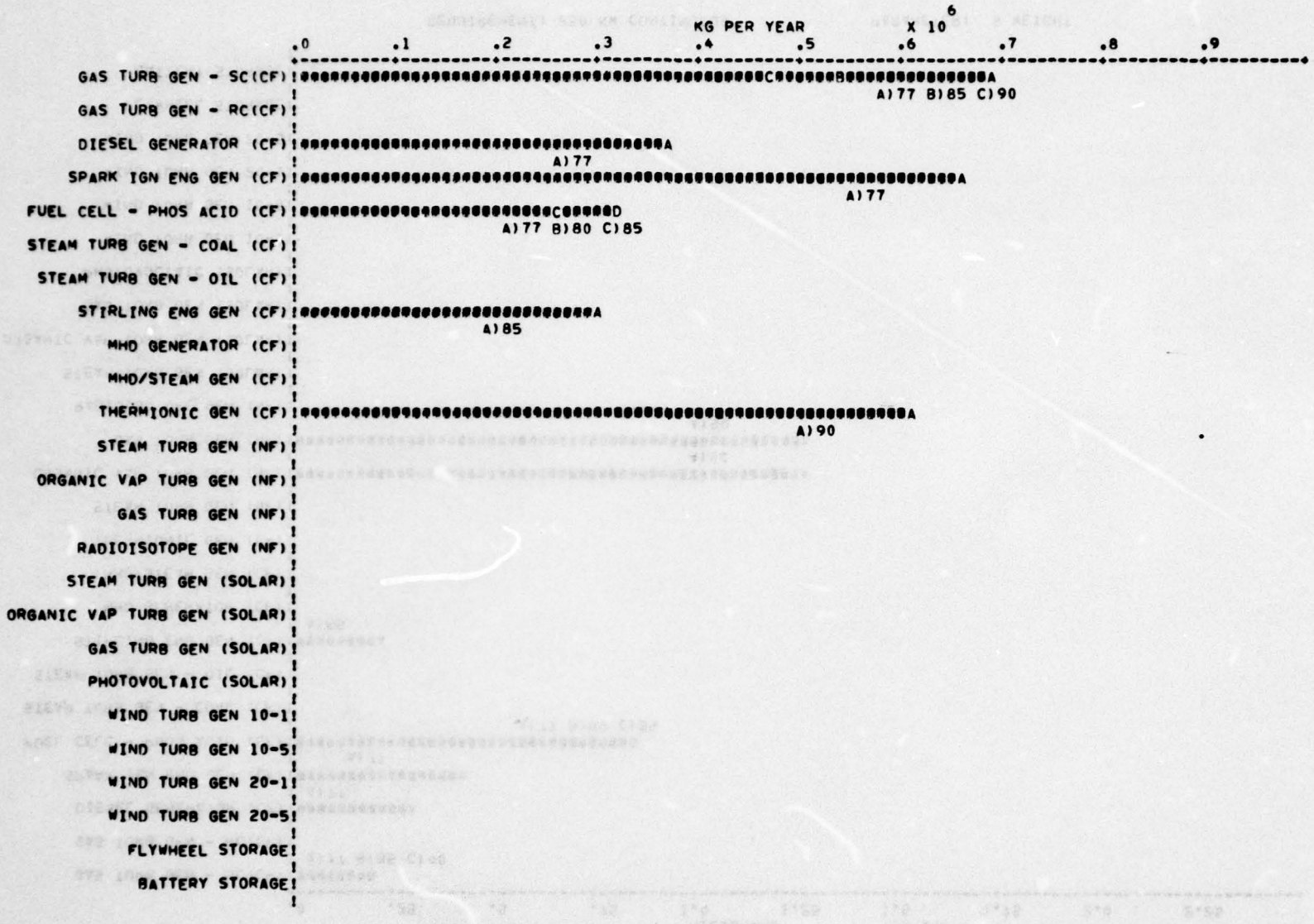
REQUIREMENT: 250 KW CONTINUOUS PARAMETER: 3 LIFETIME

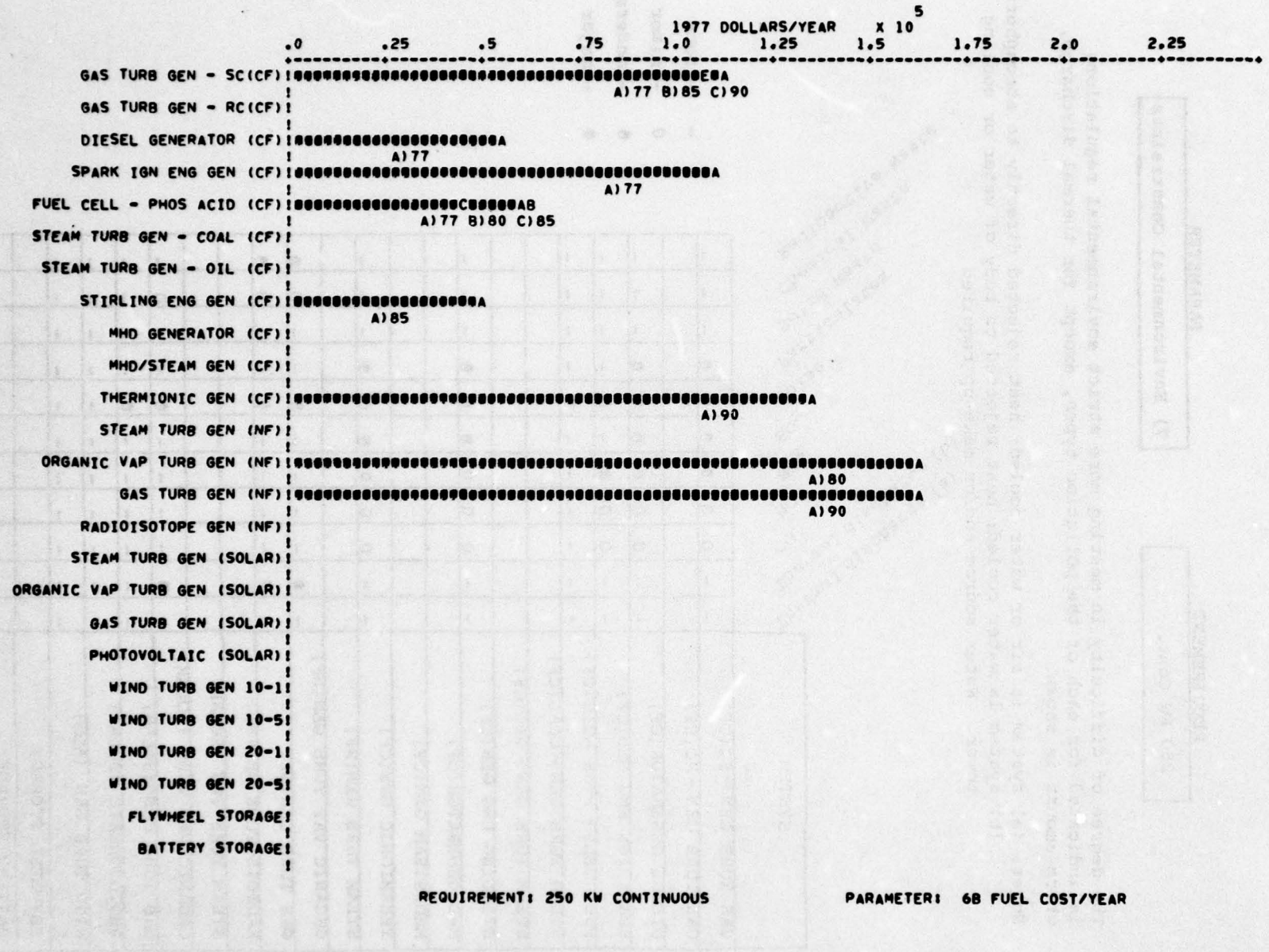

CUBIC METERS
X 10^1
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
G
A)77 B)85 C)90
A
A)77
A
A)77
A
A)85
A
A)80
A
A)90
REQUIREMENT: 250 KW CONTINUOUS
PARAMETER: 4A VOLUME


SQUARE METERS X 10^4
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 250 KW CONTINUOUS
PARAMETER: 48 AREA



REQUIREMENT: 250 KW CONTINUOUS PARAMETER: 5 WEIGHT


KG PER YEAR
X 10^6
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 250 KW CONTINUOUS
PARAMETER: 6A FUEL AMOUNT/YEAR


1977 DOLLARS/YEAR X 10^5
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 250 KW CONTINUOUS
PARAMETER: 6B FUEL COST/YEAR

REQUIREMENT	PARAMETER
250 KW Cont.	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	●	●	●	-	-	-
GAS TURB GEN - RC(CF)											
DIESEL GENERATOR(CF)	-	-	0	0	●	●	●	●	-	-	-
SPARK IGN ENG GEN(CF)	-	-	0	0	●	-	●	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)											
STEAM TURB GEN - OIL(CF)											
STIRLING ENG GEN(CF)	-	-	0	0	●	●	●	●	-	-	-
MHD GENERATOR(CF)											
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)	-	-	0	0	●	●	0	●	-	-	-
STEAM TURB GEN(NF)											
ORGANIC VAP TURB GEN(NF)	-	●	-	-	-	-	●	-	-	0	0
GAS TURB GEN(NF)	-	●	-	-	-	-	●	-	-	0	0
RADIOISOTOPE GEN(NF)											
STEAM TURB GEN (SOLAR)											
ORGANIC VAP TURB (SOLAR)	-	●	-	-	-	-	●	-	-	0	-
GAS TURB GEN (SOLAR)	-	-	-	-	-	-	●	-	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
WIND TURB GEN (ALL)	-	-	-	-	-	-	-	-	-	-	-
FLYWHEEL STORAGE											
BATTERY STORAGE											

- - none
0 - minor
● - moderate
● - major

REQUIREMENT

250 KW Cont.

PARAMETER

8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- - - no limitation
- o - minor limitation
- ⊖ - major limitation
- ● - overriding limitation

SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	o	●	-	-	-	-
GAS TURB GEN - RC(CF)								
DIESEL GENERATOR(CF)	-	-	-	●	-	-	-	-
SPARK IGN ENG GEN(CF)	-	-	-	●	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)								
STEAM TURB GEN - OIL(CF)								
STIRLING ENG GEN(CF)	-	-	o	●	-	-	-	-
MHD GENERATOR(CF)								
MHD/STEAM GEN(CF)								
THERMIONIC GEN(CF)	o	o	o	●	-	-	-	-
STEAM TURB GEN(NF)								-
ORGANIC VAP TURB GEN(NF)	⊖	-	o	o	-	-	●	-
GAS TURB GEN(NF)	⊖	-	●	o	-	-	●	-
RADIOISOTOPE GEN(NF)								
STEAM TURB GEN (SOLAR)								
ORGANIC VAP TURB (SOLAR)	⊖	-	o	-	●	-	-	-
GAS TURB GEN (SOLAR)	-	-	o	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1	-	-	-	-	-	●	-	-
WIND TURB GEN 10-5	-	-	-	-	-	●	-	-
WIND TURB GEN 20-1	-	-	-	-	-	●	-	-
WIND TURB GEN 20-5	-	-	-	-	-	●	-	-
FLYWHEEL STORAGE								
BATTERY STORAGE								-

REQUIREMENT

250 KW Cont.

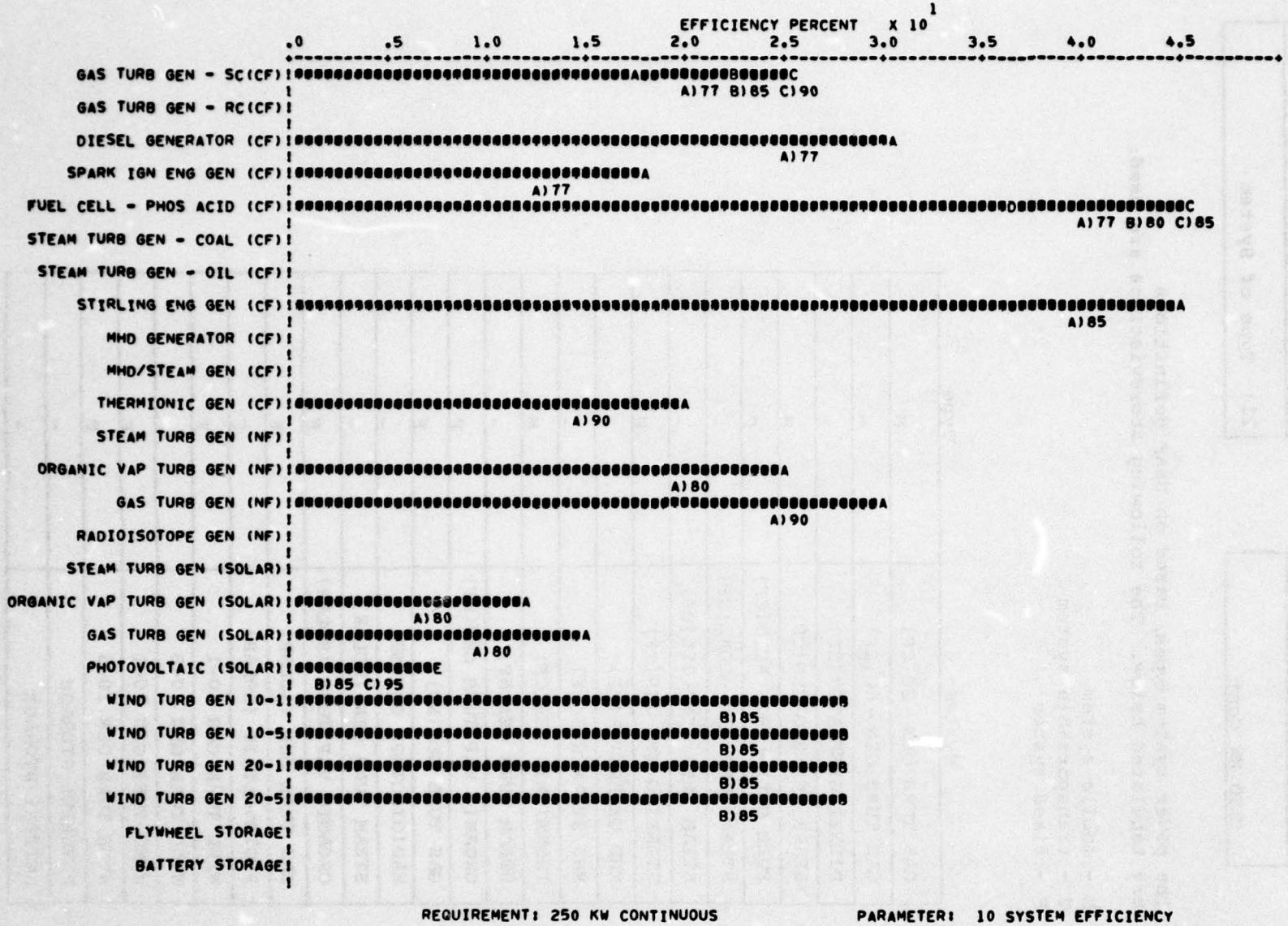
PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
0 - Characteristic has minor effect on system performance
◐ - Characteristic has moderate effect on system performance
● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	◐	0	-	-	0	0	0
GAS TURB GEN - RC(CF)							
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)	◐	0	-	-	0	0	0
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)							
STEAM TURB GEN - OIL(CF)							
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)							
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	◐	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)	0	0	-	-	◐	◐	◐
GAS TURB GEN(NF)	0	◐	-	-	◐	0	◐
RADIOISOTOPE GEN(NF)							
STEAM TURB GEN (SOLAR)							
ORGANIC VAP TURB (SOLAR)	-	0	●	-	◐	◐	-
GAS TURB GEN (SOLAR)	-	-	●	-	◐	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE							
BATTERY STORAGE							

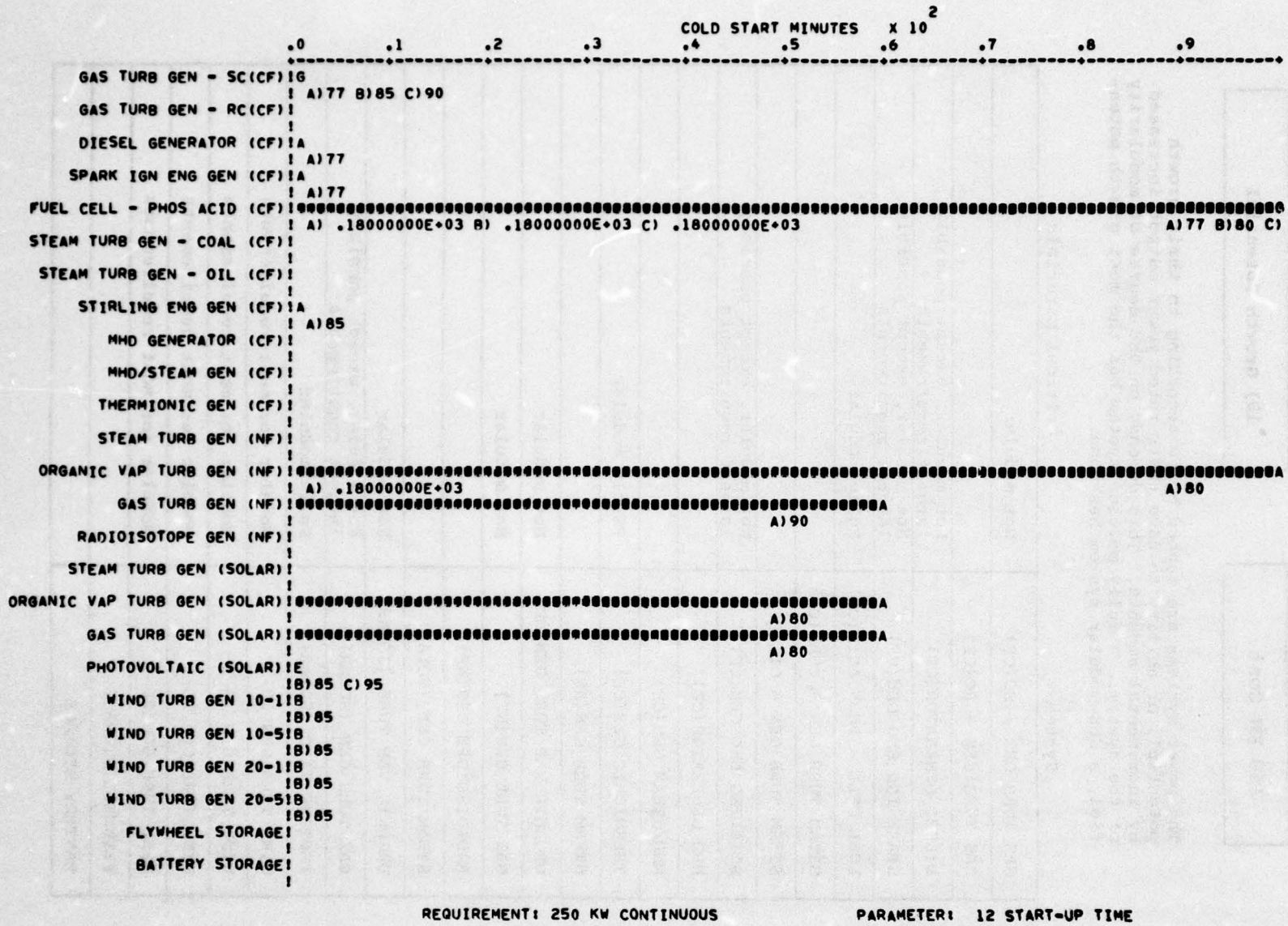

EFFICIENCY PERCENT X 10 1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
B)85 C)95
WIND TURB GEN 10-1
B)85
WIND TURB GEN 10-5
B)85
WIND TURB GEN 20-1
B)85
WIND TURB GEN 20-5
B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 250 KW CONTINUOUS
PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
250 KW Cont	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	M
GAS TURB GEN - RC(CF)	-
DIESEL GENERATOR(CF)	M
SPARK IGN ENG GEN(CF)	M
FUEL CELL - PHOS ACID(CF)	F
STEAM TURB GEN - COAL(CF)	-
STEAM TURB GEN - OIL(CF)	-
STIRLING ENG GEN(CF)	M
MHD GENERATOR(CF)	-
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	M
STEAM TURB GEN(NF)	-
ORGANIC VAP TURB GEN(NF)	F
GAS TURB GEN(NF)	F
RADIOISOTOPE GEN(NF)	-
STEAM TURB GEN (SOLAR)	-
ORGANIC VAP TURB (SOLAR)	F
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	F
WIND TURB GEN 10-5	F
WIND TURB GEN 20-1	F
WIND TURB GEN 20-5	F
FLYWHEEL STORAGE	-
BATTERY STORAGE	-



REQUIREMENT: 250 KW CONTINUOUS PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
250 KW Cont.	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	Not modular, except possibly largest requirements
SPARK IGN ENG GEN(CF)	Not modular, except possibly largest requirements
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	Not modular, except possibly largest requirements
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	Not modular
GAS TURB GEN(NF)	Not modular
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	Not modular
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	Modular for most requirements
WIND TURB GEN 10-5	Modular for most requirements
WIND TURB GEN 20-1	Modular for most requirements
WIND TURB GEN 20-5	Modular for most requirements
FLYWHEEL STORAGE	
BATTERY STORAGE	

REQUIREMENT	PARAMETER
250 KW Cont.	14) Reliability/Availability

The tabulated conditions exist in the power system to the extent indicated.

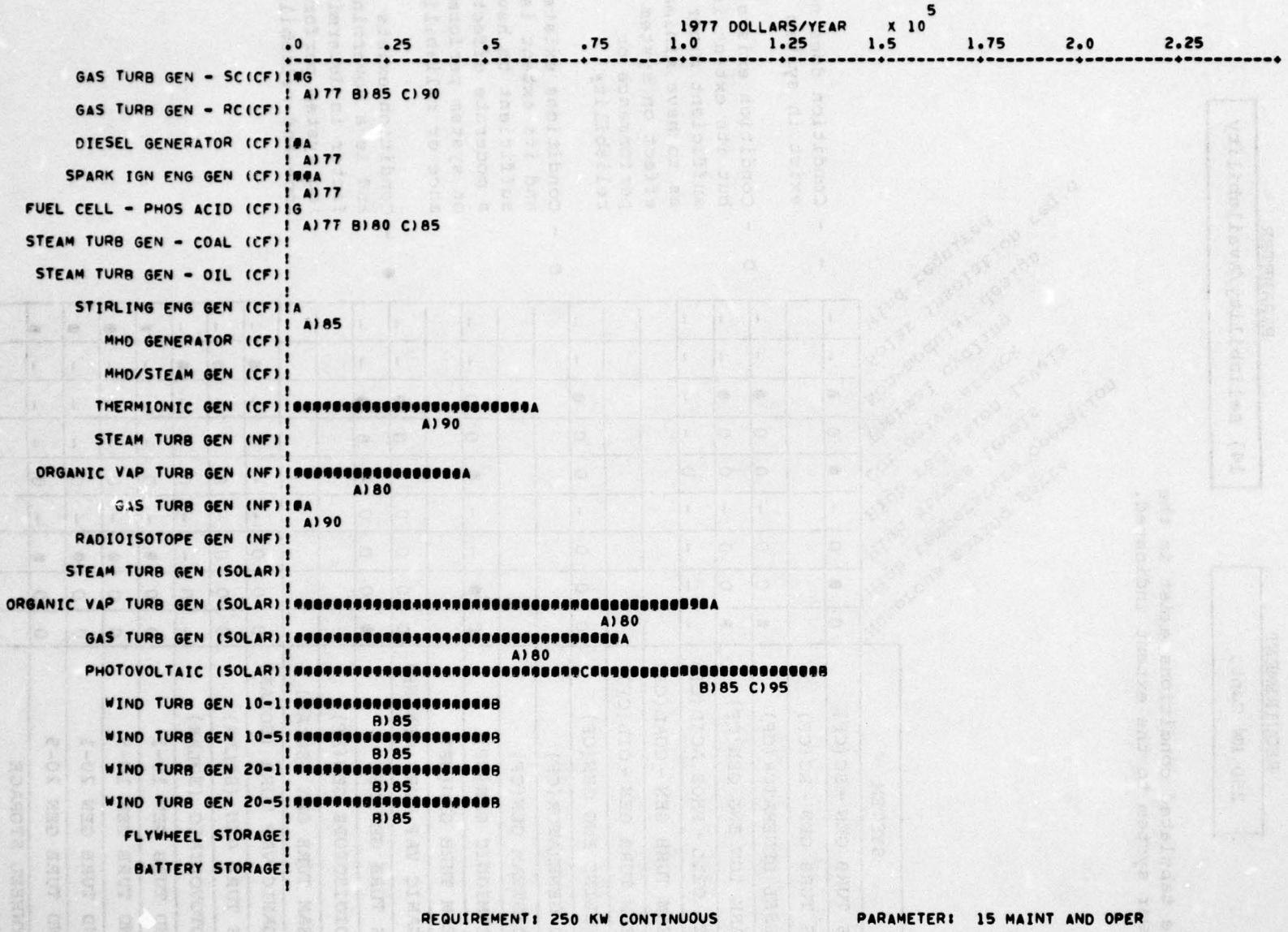
SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	0	●	0	-	●	0	●	-	-
GAS TURB GEN - RC(CF)									
DIESEL GENERATOR(CF)	●	0	0	-	0	0	●	-	-
SPARK IGN ENG GEN(CF)	●	0	0	-	0	0	●	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	0	-	-	-	-
STEAM TURB GEN - COAL(CF)									
STEAM TURB GEN - OIL(CF)									
STIRLING ENG GEN(CF)	0	0	0	-	0	0	●	-	-
MHD GENERATOR(CF)									
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	0	●	-	-	●	0	0	-	-
STEAM TURB GEN(NF)									
ORGANIC VAP TURB GEN(NF)	0	0	0	0	-	0	●	-	-
GAS TURB GEN(NF)	●	0	0	0	-	●	●	-	-
RADIOISOTOPE GEN(NF)									
STEAM TURB GEN (SOLAR)									
ORGANIC VAP TURB (SOLAR)	0	0	0	-	-	0	-	●	-
GAS TURB GEN (SOLAR)	0	0	0	-	0	0	-	●	-
PHOTOVOLTAIC (SOLAR)	-	0	-	-	0	-	-	●	-
WIND TURB GEN 10-1	0	0	●	-	0	-	-	-	●
WIND TURB GEN 10-5	0	0	●	-	0	-	-	-	●
WIND TURB GEN 20-1	0	0	●	-	0	-	-	-	●
WIND TURB GEN 20-5	0	0	●	-	0	-	-	-	●
FLYWHEEL STORAGE									
BATTERY STORAGE									

- \- Condition does not exist in system

0 - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability

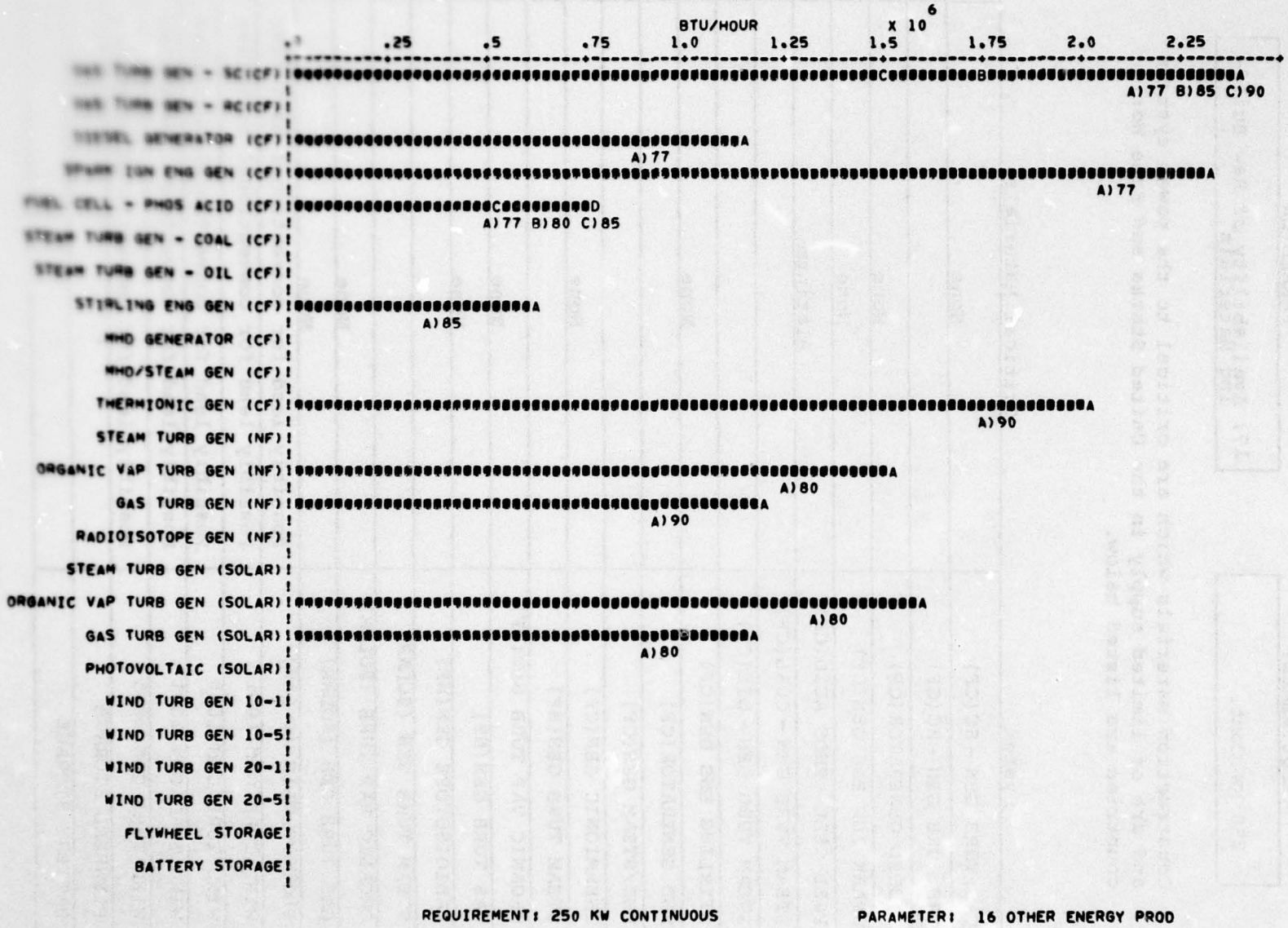
⊖ - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability

● - Condition exists and is a governing factor in determining system performance and reliability



REQUIREMENT: 250 KW CONTINUOUS

PARAMETER: 15 MAINT AND OPER


BTU/HOUR
X 10^6
.1
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
A)77 B)85 C)90
A)77
A)77
A)77 B)80 C)85
A)85
A)90
A)80
A)90
A)80
A)80
REQUIREMENT: 250 KW CONTINUOUS
PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
250 KW.Cont.	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

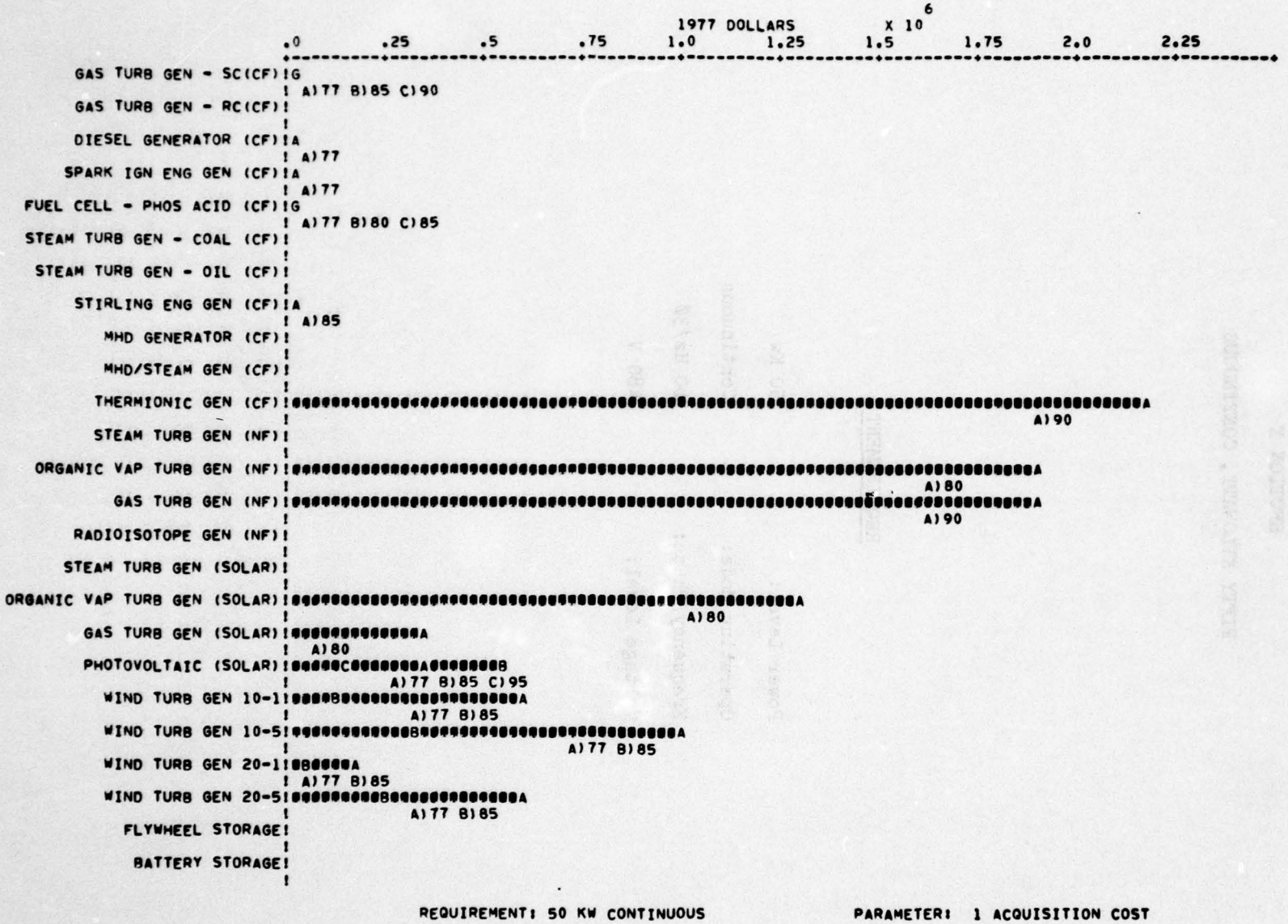
System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	None
SPARK IGN ENG GEN(CF)	None
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	None
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	None
GAS TURB GEN(NF)	None
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	None
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	Possibly lead for conventional batteries
WIND TURB GEN 10-5	Possibly lead for conventional batteries
WIND TURB GEN 20-1	Possibly lead for conventional batteries
WIND TURB GEN 20-5	Possibly lead for conventional batteries
FLYWHEEL STORAGE	
BATTERY STORAGE	

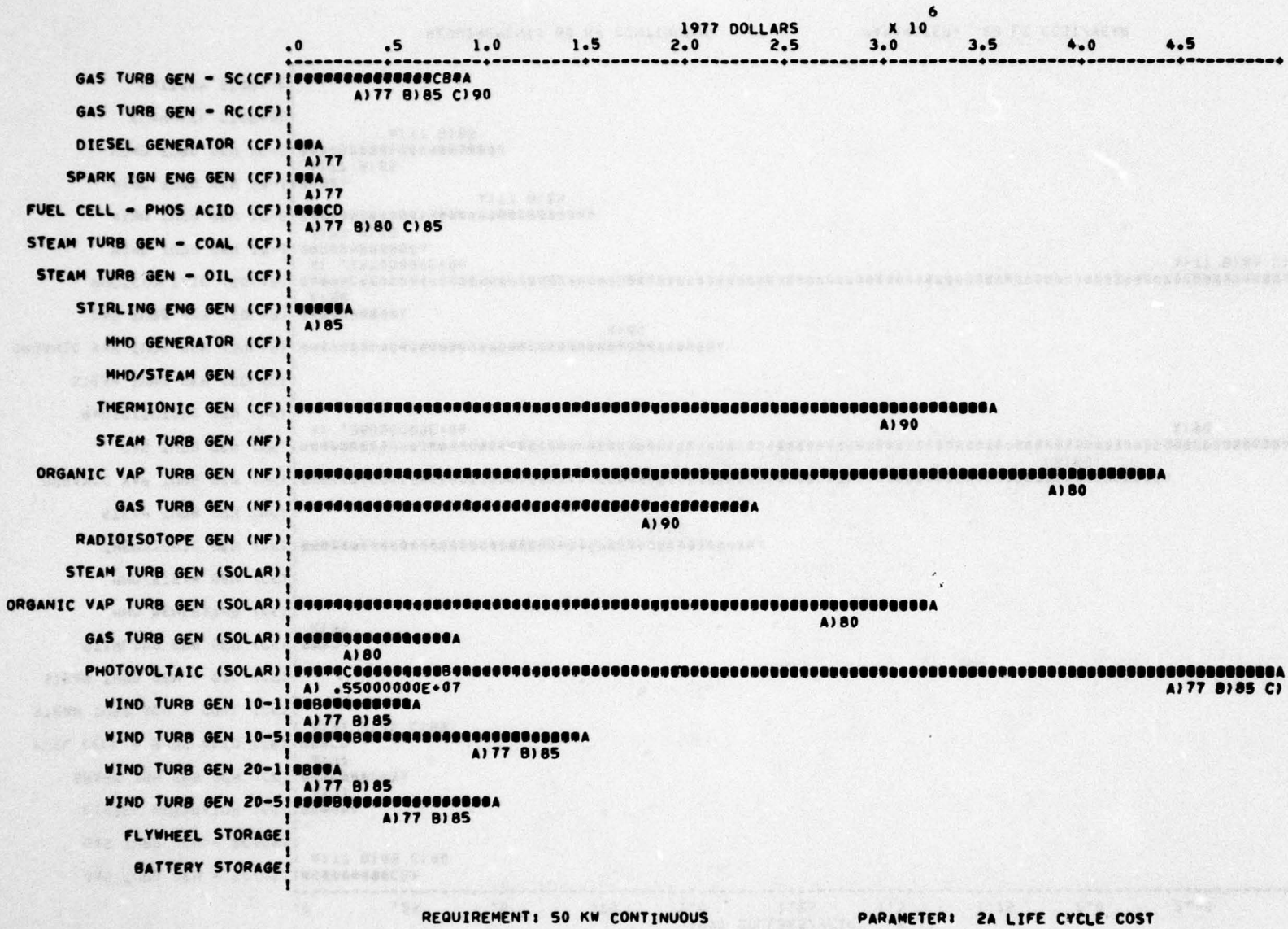
SECTION X

FIFTY KILOWATT, CONTINUOUS

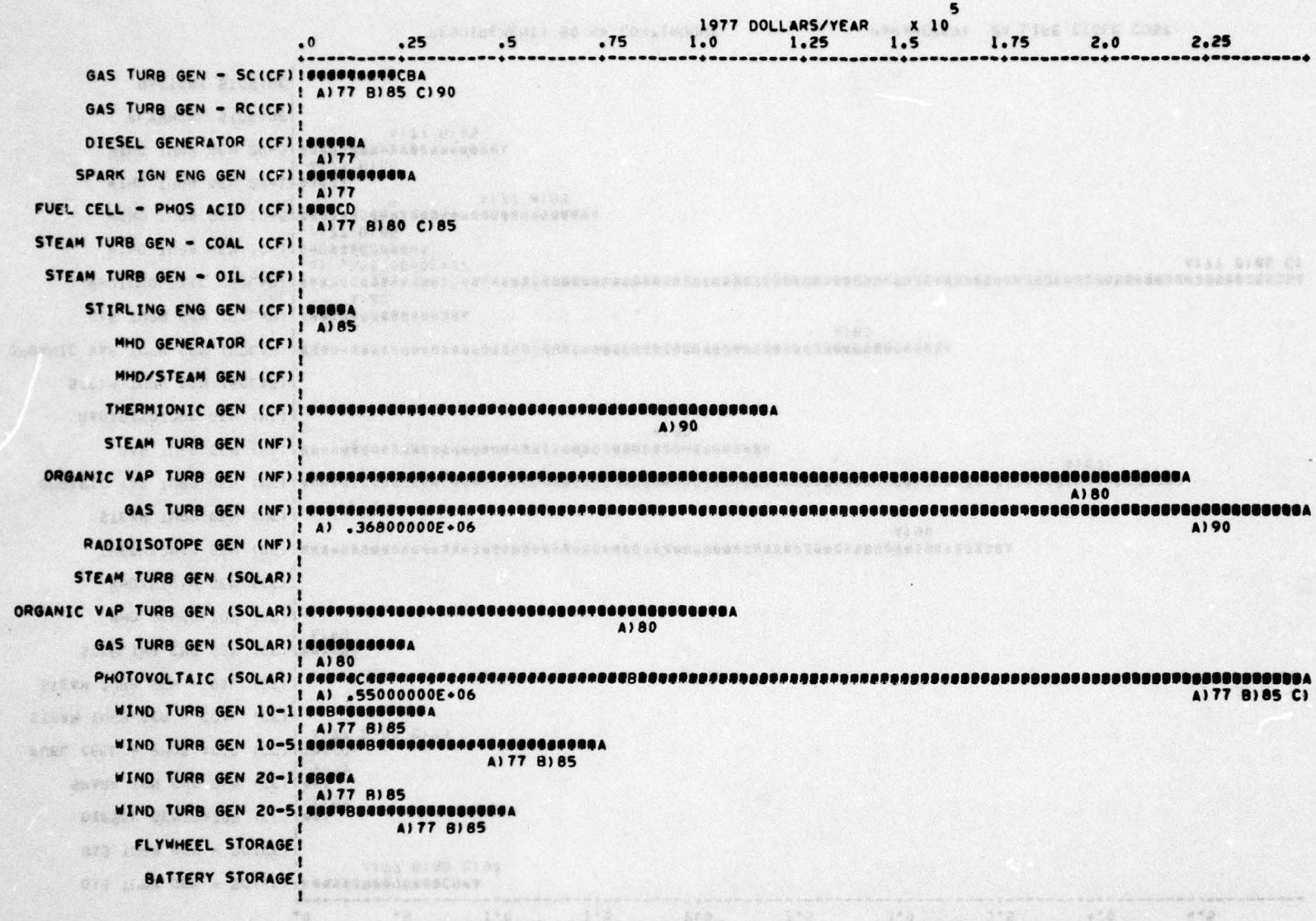
REQUIREMENT

Power Level:	50 Kw
Operating Mode:	Continuous
Frequency/Phase:	60 Hz/3Ø
Voltage Level:	480 V

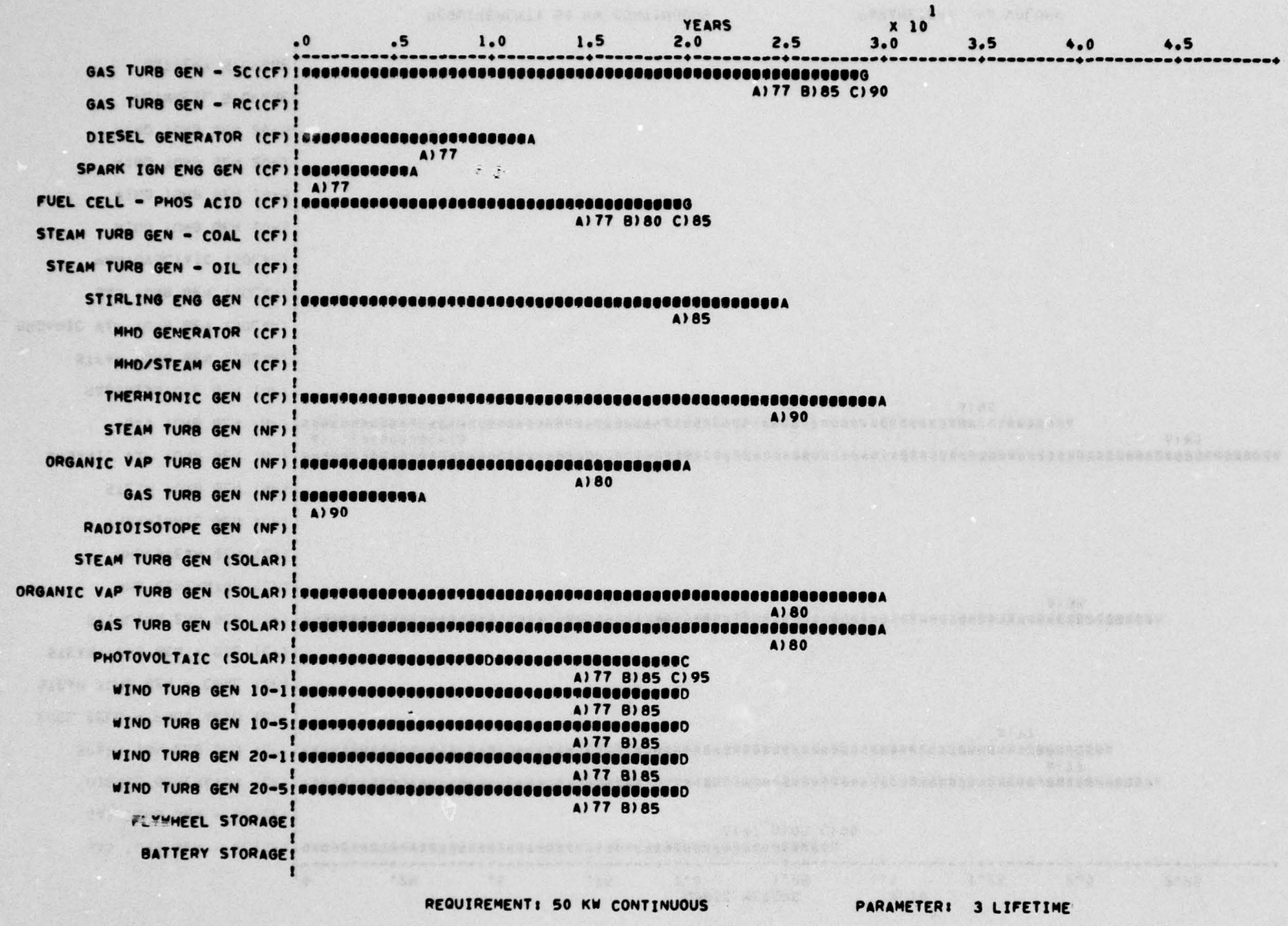

1977 DOLLARS
X 10^6
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 KW CONTINUOUS
PARAMETER: 1 ACQUISITION COST

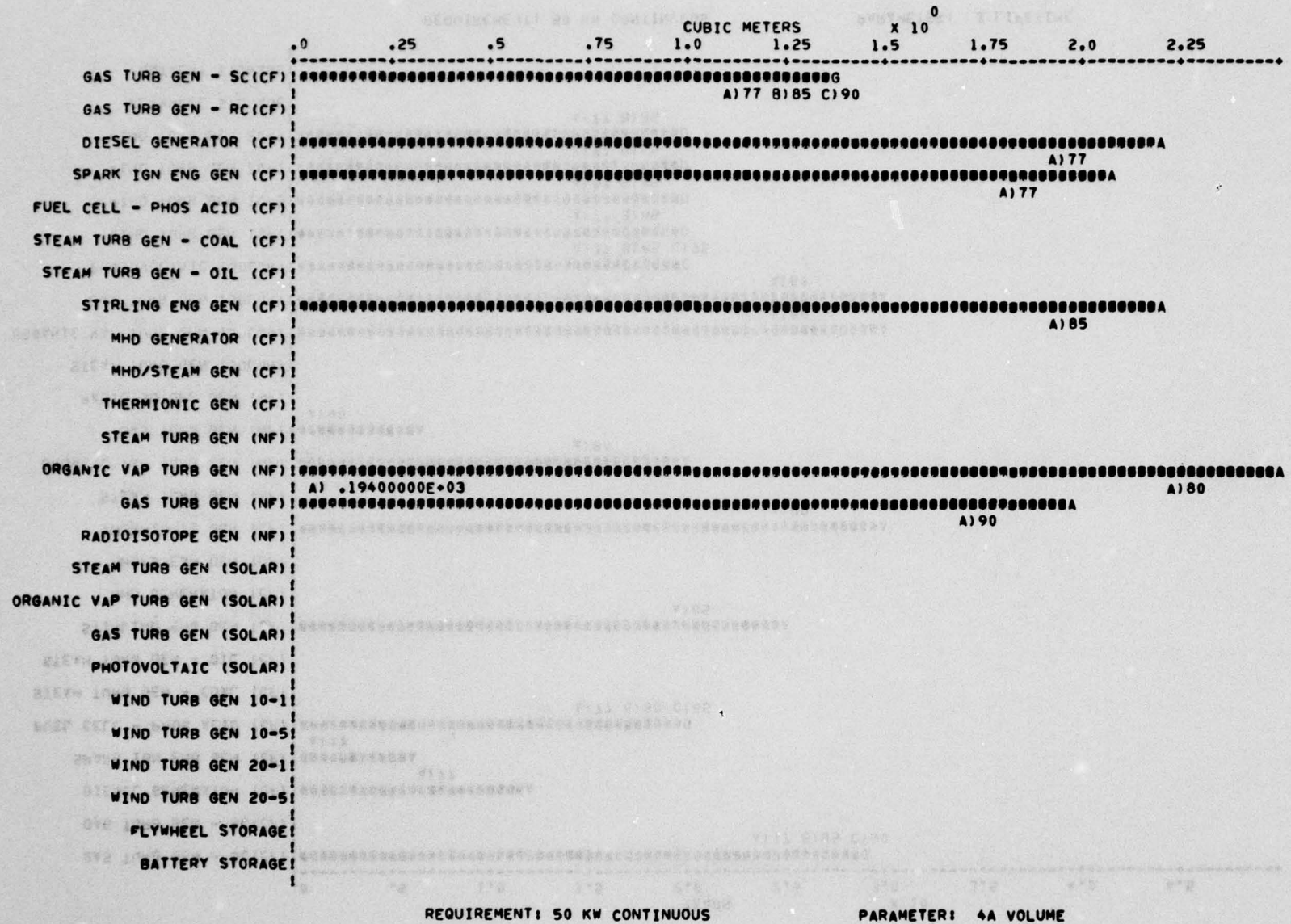


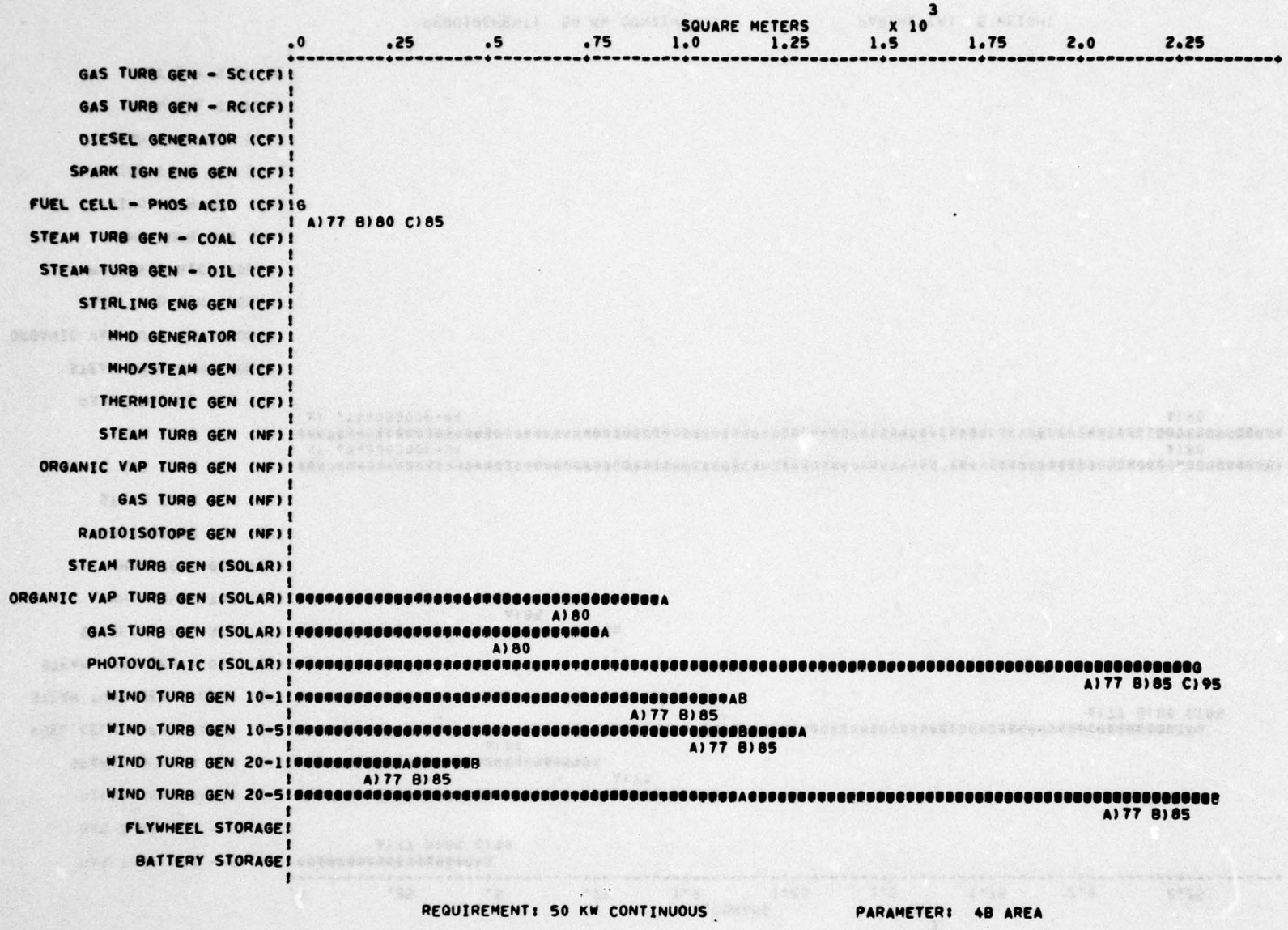
REQUIREMENT: 50 KW CONTINUOUS PARAMETER: 2A LIFE CYCLE COST

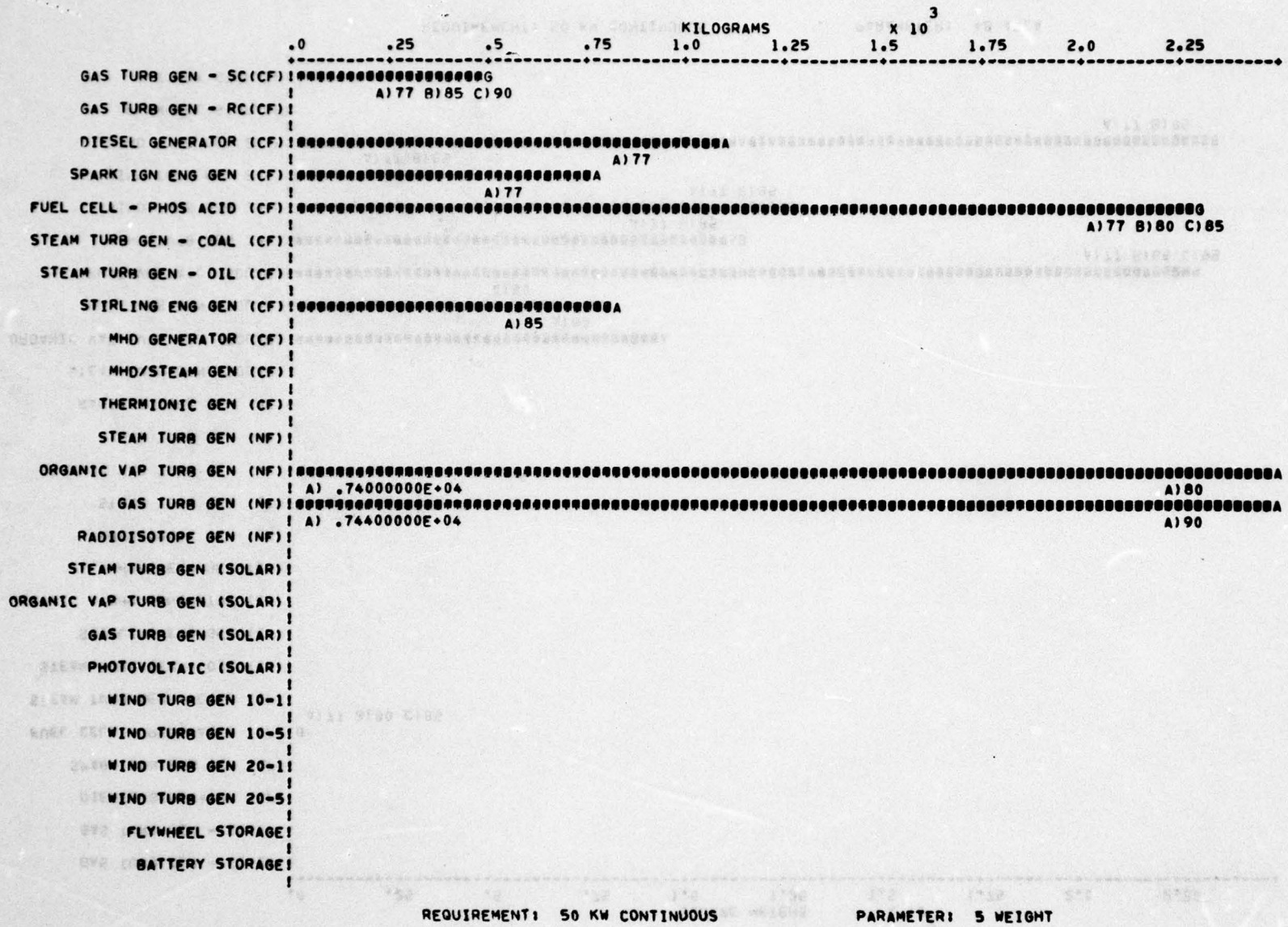


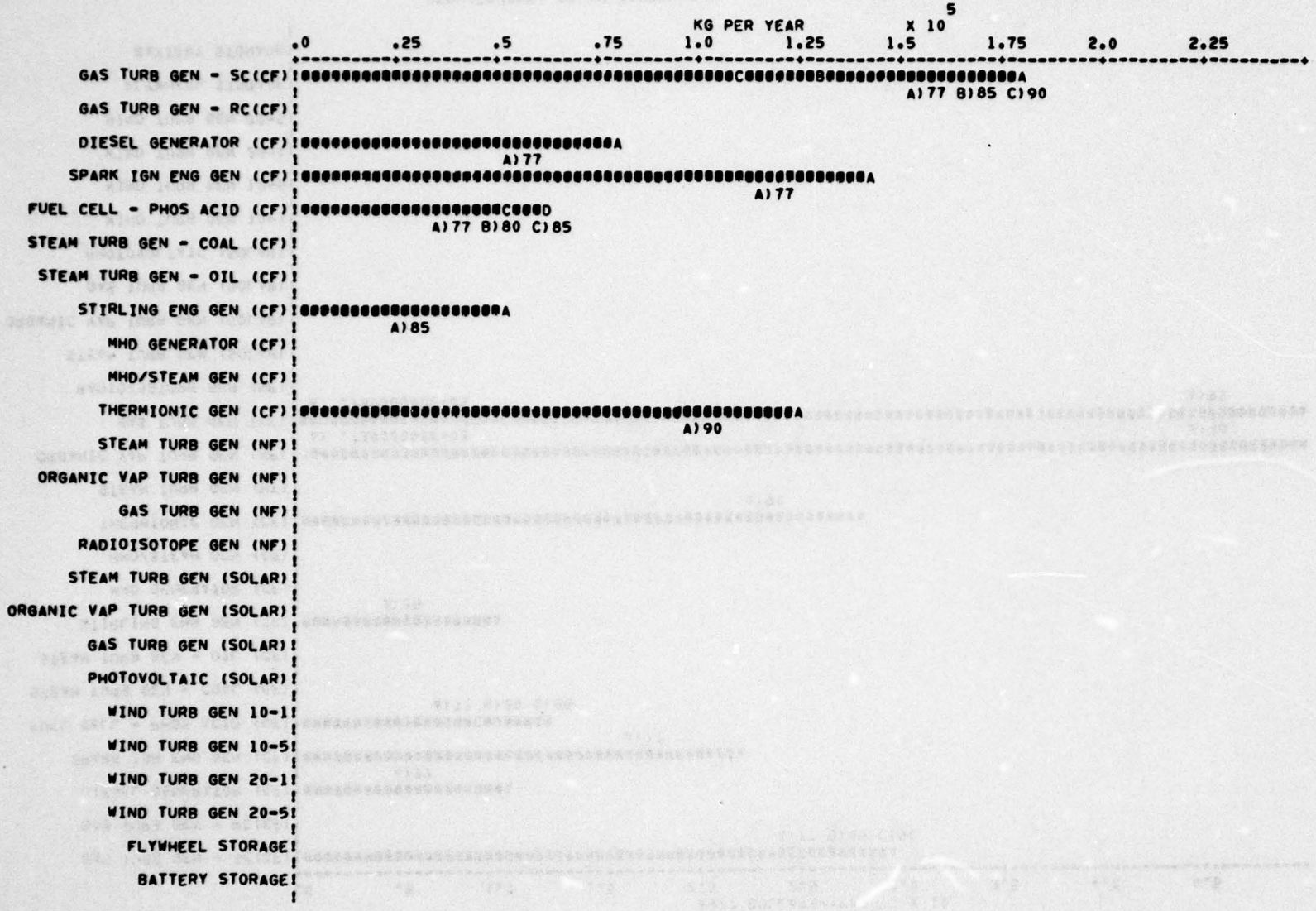
REQUIREMENT: 50 KW CONTINUOUS PARAMETER: 28 LC COST/YEAR


YEARS
X 10^1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 KW CONTINUOUS
PARAMETER: 3 LIFETIME


CUBIC METERS X 10^0
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A) .19400000E+03
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 KW CONTINUOUS
PARAMETER: 4A VOLUME

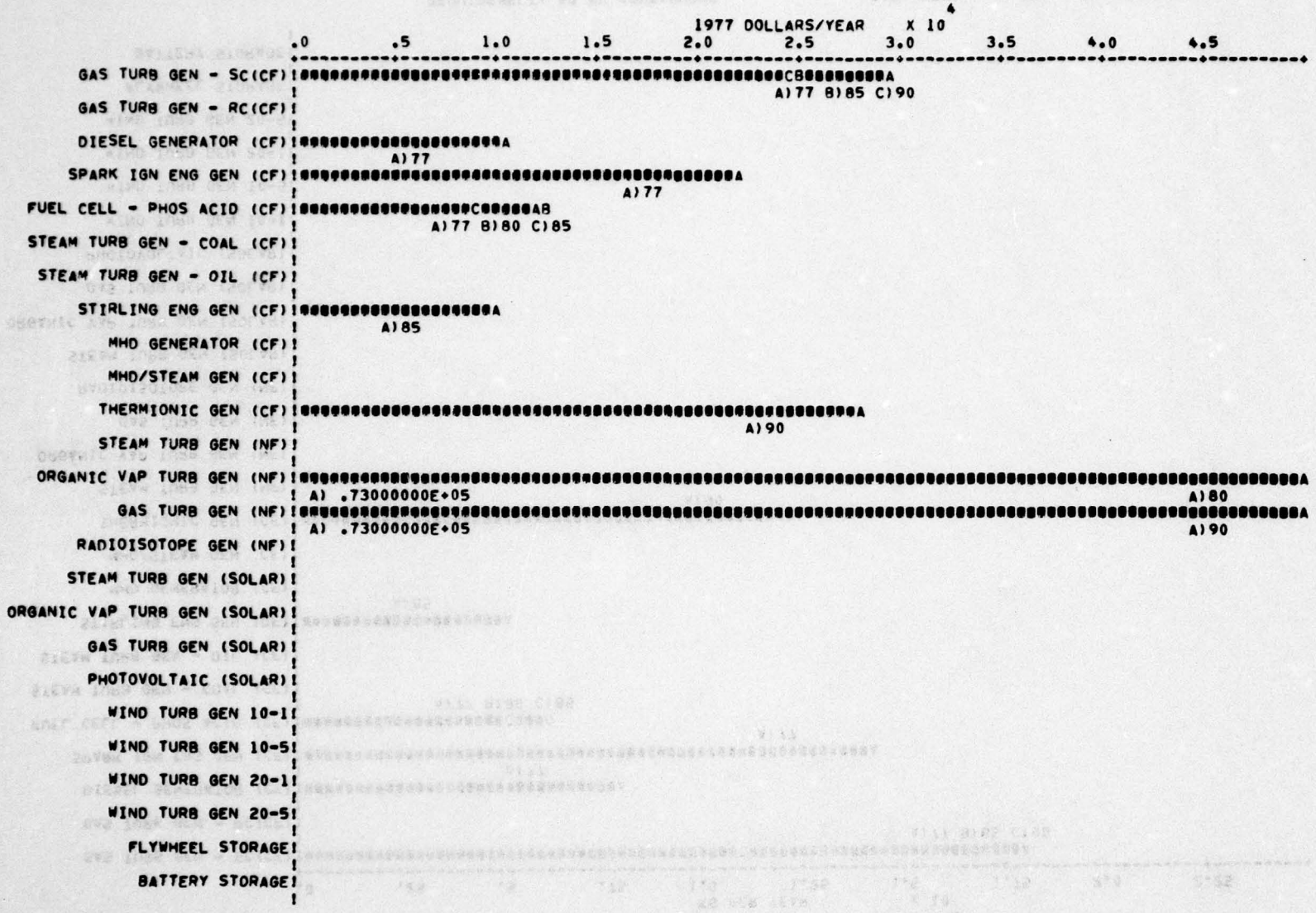

SQUARE METERS X 10^3
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 KW CONTINUOUS
PARAMETER: 4B AREA


KILOGRAMS
X 10^3
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A) .74000000E+04
A)80
GAS TURB GEN (NF)
A) .74400000E+04
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 KW CONTINUOUS
PARAMETER: 5 WEIGHT



REQUIREMENT: 50 KW CONTINUOUS

PARAMETER: 6A FUEL AMOUNT/YEAR


1977 DOLLARS/YEAR X 10^4
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A) .73000000E+05
A)80
GAS TURB GEN (NF)
A) .73000000E+05
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 KW CONTINUOUS
PARAMETER: 68 FUEL COST/YEAR

REQUIREMENT	PARAMETER
50 KW Cont.	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
GAS TURB GEN - RC(CF)											
DIESEL GENERATOR(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
SPARK IGN ENG GEN(CF)	-	-	0	0	◐	-	◐	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	◐	-	-	-	-
STEAM TURB GEN - COAL(CF)											
STEAM TURB GEN - OIL(CF)											
STIRLING ENG GEN(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
MHD GENERATOR(CF)											
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)	-	-	0	0	●	◐	0	◐	-	-	-
STEAM TURB GEN(NF)											
ORGANIC VAP TURB GEN(NF)	-	●	-	-	-	-	◐	-	-	0	◐
GAS TURB GEN(NF)	-	●	-	-	-	-	◐	-	-	0	◐
RADIOISOTOPE GEN(NF)											
STEAM TURB GEN (SOLAR)											
ORGANIC VAP TURB (SOLAR)	-	●	-	-	-	-	◐	-	-	0	-
GAS TURB GEN (SOLAR)	-	-	-	-	-	-	◐	-	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
WIND TURB GEN (ALL)	-	-	-	-	-	-	-	-	-	-	-
FLYWHEEL STORAGE											
BATTERY STORAGE											

- - none
0 - minor
◐ - moderate
● - major

REQUIREMENT	PARAMETER
50 KW Cont.	8) Location Restraint

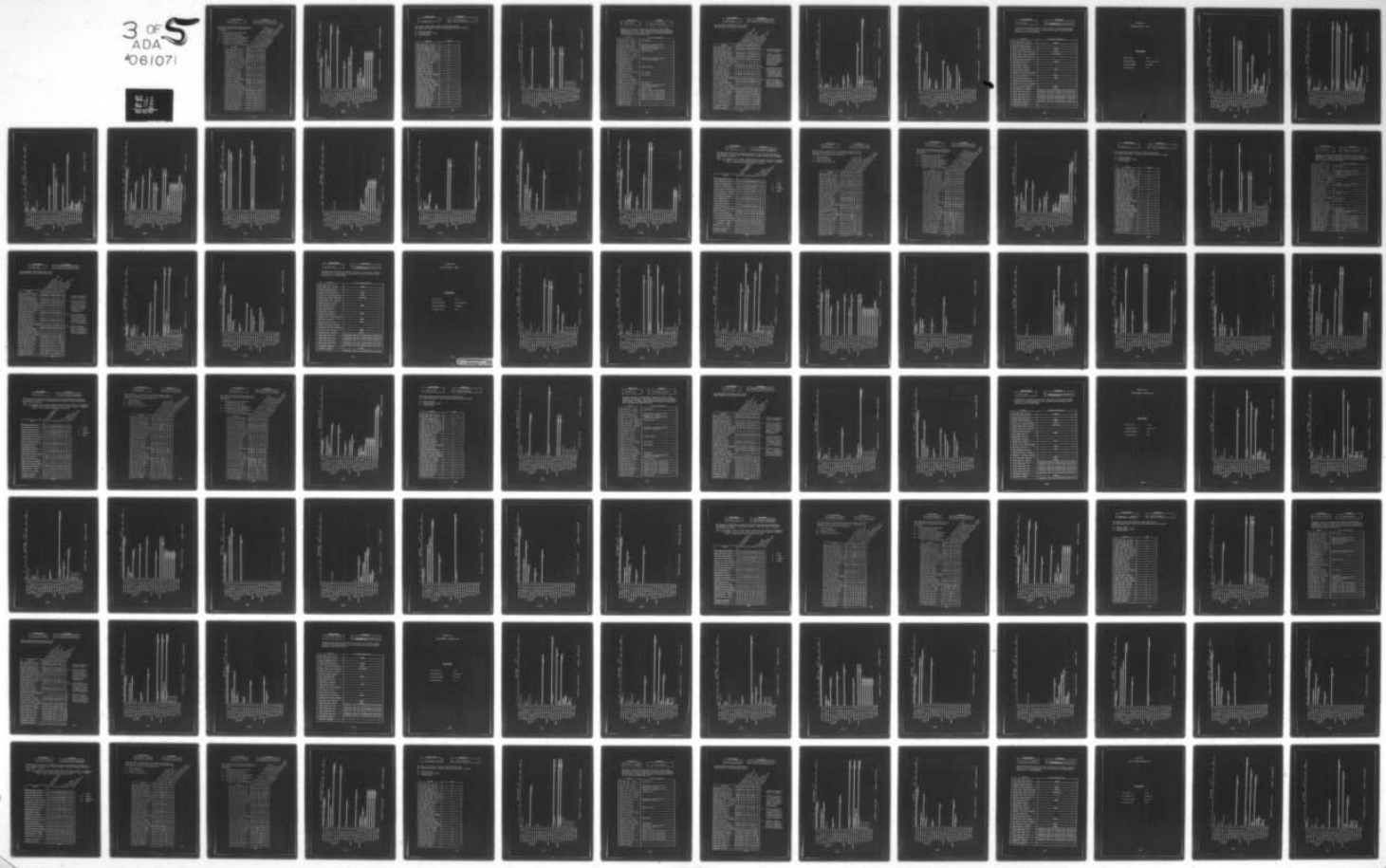
The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- \- - no limitation
- O - minor limitation
- ⊖ - major limitation
- ● - overriding limitation

SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	O	●	-	-	-	-
GAS TURB GEN - RC(CF)								
DIESEL GENERATOR(CF)	-	-	-	●	-	-	-	-
SPARK IGN ENG GEN(CF)	-	-	-	●	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)								
STEAM TURB GEN - OIL(CF)								
STIRLING ENG GEN(CF)	-	-	O	●	-	-	-	-
MHD GENERATOR(CF)								
MHD/STEAM GEN(CF)								
THERMIONIC GEN(CF)	O	O	O	●	-	-	-	-
STEAM TURB GEN(NF)								
ORGANIC VAP TURB GEN(NF)	⊖	-	O	O	-	-	●	-
GAS TURB GEN(NF)	⊖	-	●	O	-	-	●	-
RADIOISOTOPE GEN(NF)								
STEAM TURB GEN (SOLAR)								
ORGANIC VAP TURB (SOLAR)	⊖	-	O	-	●	-	-	-
GAS TURB GEN (SOLAR)	-	-	O	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1	-	-	-	-	-	●	-	-
WIND TURB GEN 10-5	-	-	-	-	-	●	-	-
WIND TURB GEN 20-1	-	-	-	-	-	●	-	-
WIND TURB GEN 20-5	-	-	-	-	-	●	-	-
FLYWHEEL STORAGE								
BATTERY STORAGE								

AD-A061 071 BURNS AND ROE INC WOODBURY NY F/G 10/2
USAF TERRESTRIAL ENERGY STUDY. VOLUME III. PART I. SUMMARY DATA--ETC(U)
MAY 78 D C HALL, A CARLSON, D FULLER, R REYER F33615-76-C-2171
UNCLASSIFIED AFAPL-TR-78-19-VOL-3-PT-1 NL

3 OF 5
ADA
061071



REQUIREMENT

50 KW Cont.

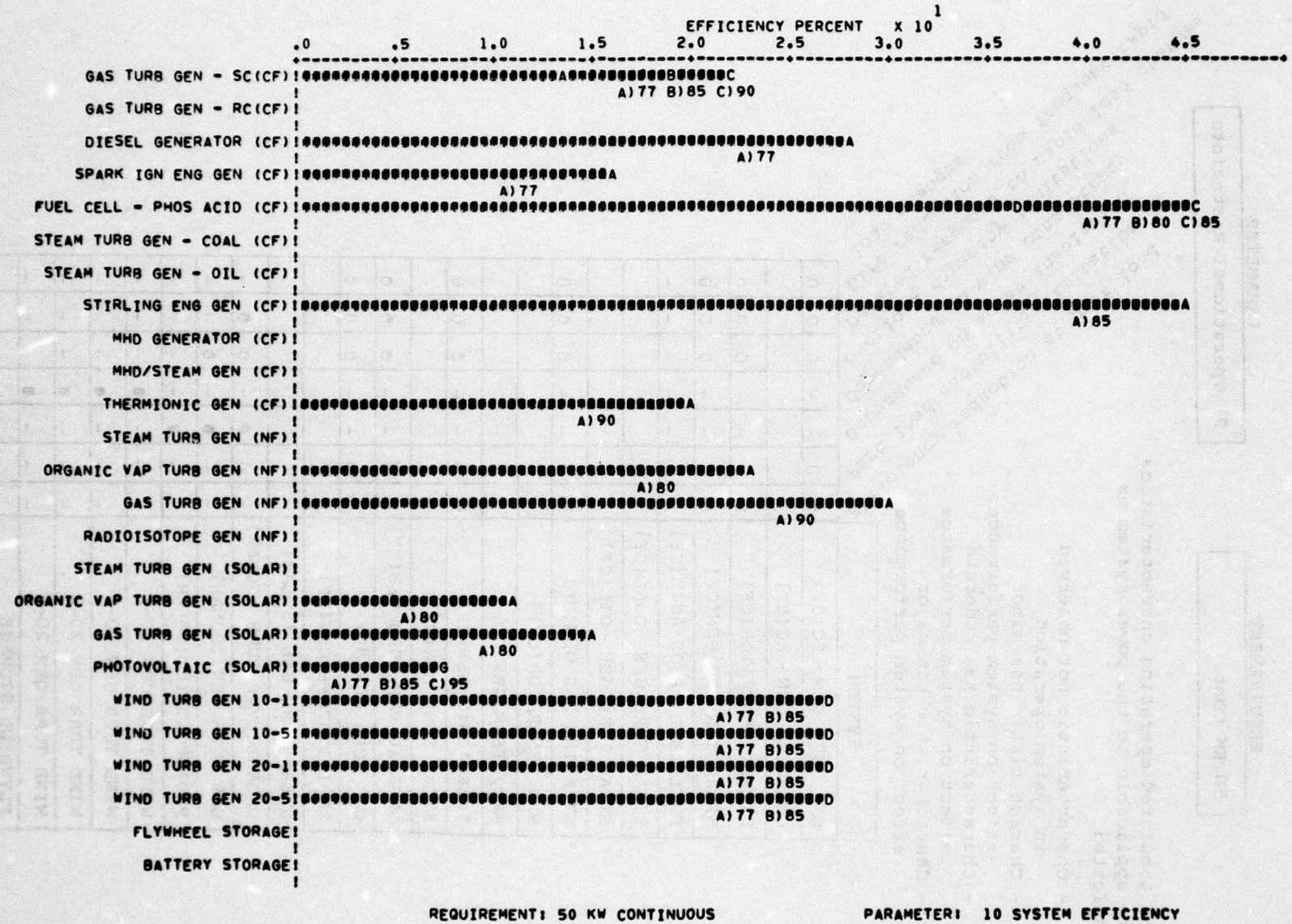
PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
- 0 - Characteristic has minor effect on system performance
- ⊖ - Characteristic has moderate effect on system performance
- ● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	⊖	0	-	-	0	0	0
GAS TURB GEN - RC(CF)							
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)	⊖	0	-	-	0	0	0
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)							
STEAM TURB GEN - OIL(CF)							
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)							
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	⊖	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)	0	0	-	-	⊖	⊖	⊖
GAS TURB GEN(NF)	0	⊖	-	-	⊖	⊖	⊖
RADIOISOTOPE GEN(NF)							
STEAM TURB GEN (SOLAR)							
ORGANIC VAP TURB (SOLAR)	-	0	●	-	⊖	⊖	-
GAS TURB GEN (SOLAR)	-	-	●	-	⊖	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE							
BATTERY STORAGE							



REQUIREMENT: 50 KW CONTINUOUS

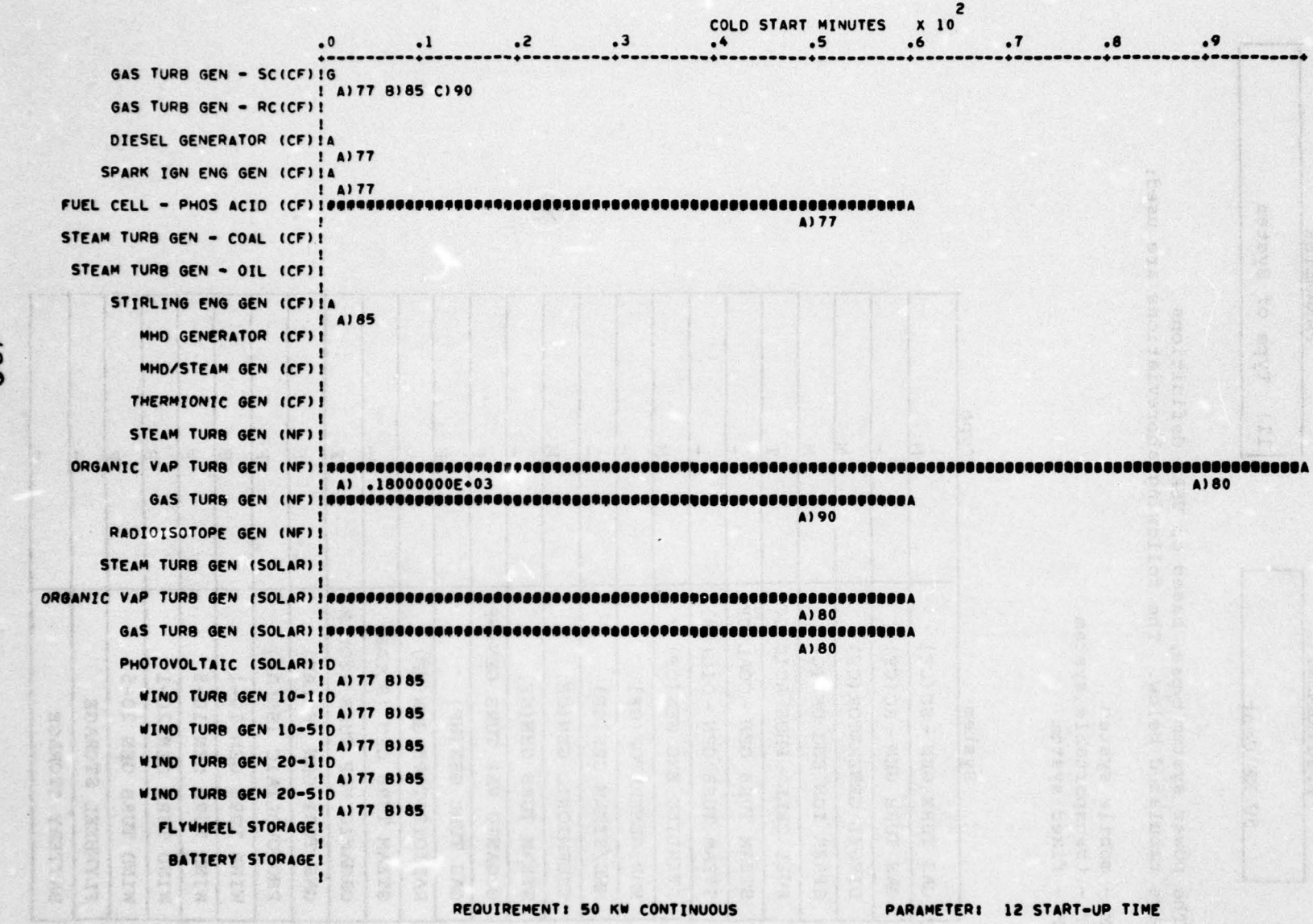
PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
50 KW Cont	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	M
GAS TURB GEN - RC(CF)	-
DIESEL GENERATOR(CF)	M
SPARK IGN ENG GEN(CF)	M
FUEL CELL - PHOS ACID(CF)	T
STEAM TURB GEN - COAL(CF)	-
STEAM TURB GEN - OIL(CF)	-
STIRLING ENG GEN(CF)	M
MHD GENERATOR(CF)	-
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	M
STEAM TURB GEN(NF)	-
ORGANIC VAP TURB GEN(NF)	F
GAS TURB GEN(NF)	F
RADIOISOTOPE GEN(NF)	-
STEAM TURB GEN (SOLAR)	-
ORGANIC VAP TURB (SOLAR)	F
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	F
WIND TURB GEN 10-5	F
WIND TURB GEN 20-1	F
WIND TURB GEN 20-5	F
FLYWHEEL STORAGE	-
BATTERY STORAGE	-


COLD START MINUTES X 10²
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A) .18000000E+03
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 KW CONTINUOUS
PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
50 KW Cont.	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

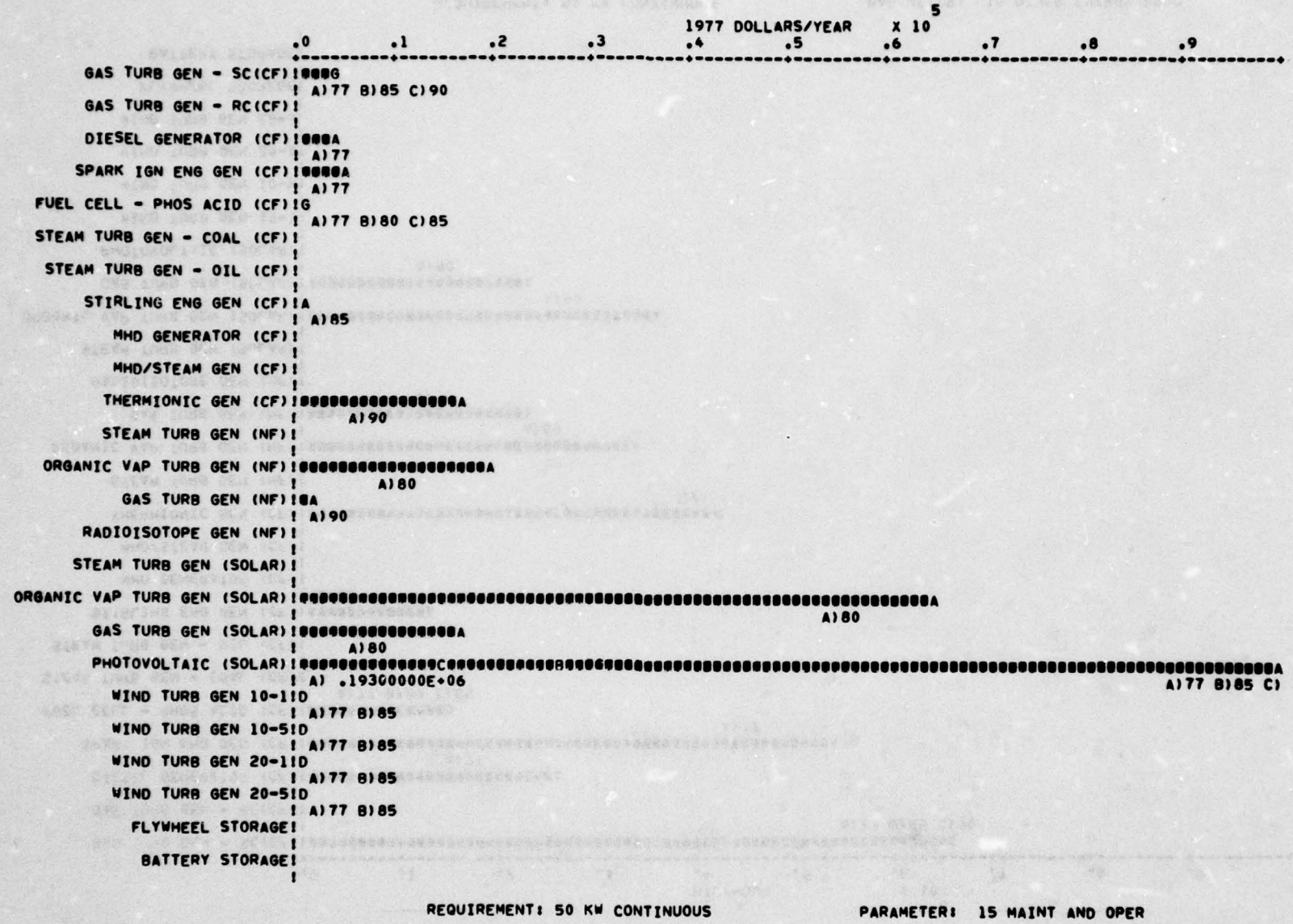
System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	Not modular, except possibly largest requirements
SPARK IGN ENG GEN(CF)	Not modular, except possibly largest requirements
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	Not modular, except possibly largest requirements
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	Not modular
GAS TURB GEN(NF)	Not modular
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	Not modular
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	Modular for most requirements
WIND TURB GEN 10-5	Modular for most requirements
WIND TURB GEN 20-1	Modular for most requirements
WIND TURB GEN 20-5	Modular for most requirements
FLYWHEEL STORAGE	
BATTERY STORAGE	

REQUIREMENT	PARAMETER
50 KW Cont.	14) Reliability/Availability

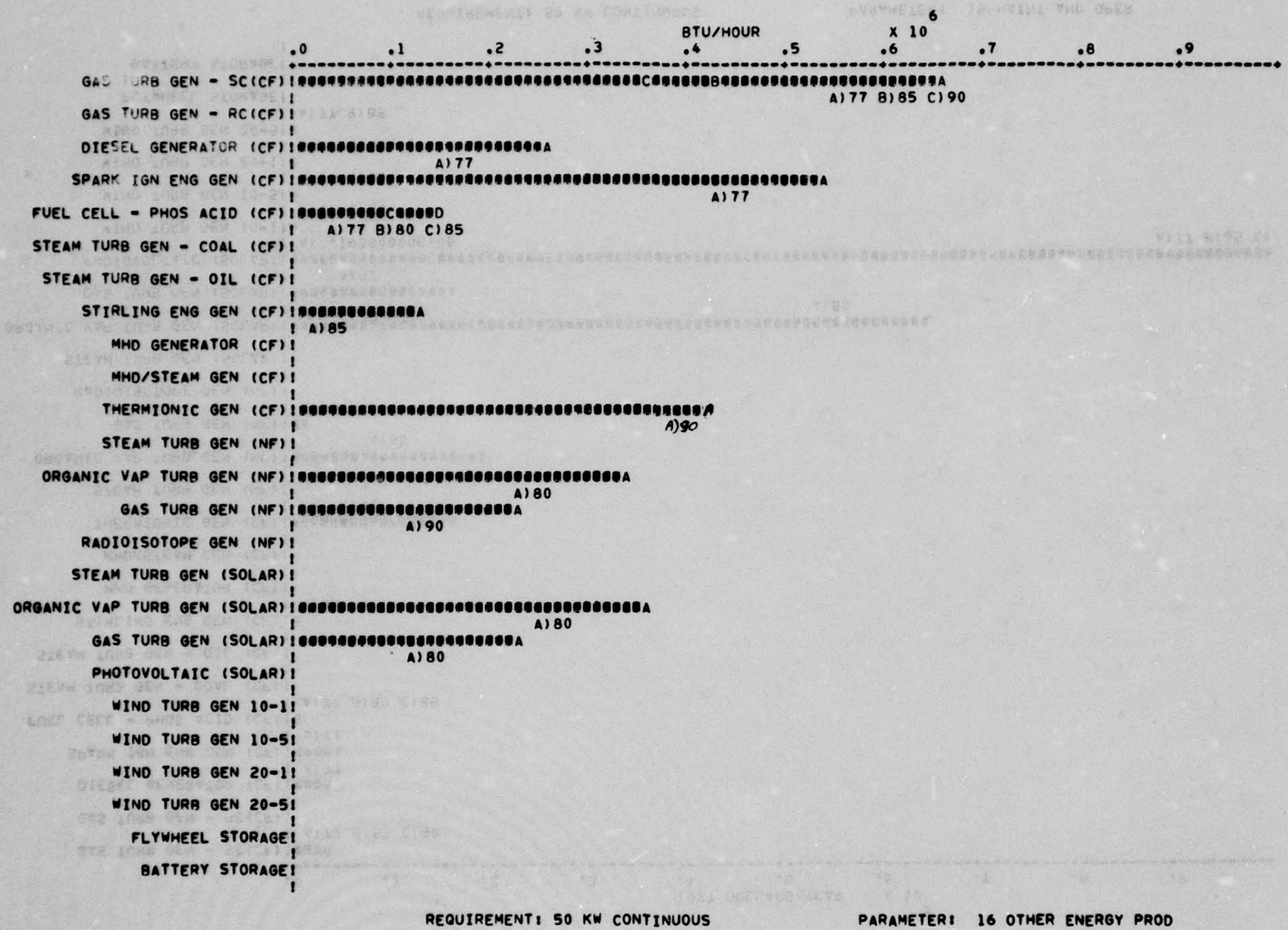
The tabulated conditions exist in the power system to the extent indicated.

SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	0	●	0	-	●	0	●	-	-
GAS TURB GEN - RC(CF)									
DIESEL GENERATOR(CF)	●	0	0	-	0	0	●	-	-
SPARK IGN ENG GEN(CF)	●	0	0	-	0	0	●	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	0	-	-	-	-
STEAM TURB GEN - COAL(CF)									
STEAM TURB GEN - OIL(CF)									
STIRLING ENG GEN(CF)	0	0	0	-	0	0	●	-	-
MHD GENERATOR(CF)									
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	0	●	-	-	●	0	0	-	-
STEAM TURB GEN(NF)									
ORGANIC VAP TURB GEN(NF)	0	0	0	0	-	0	●	-	-
GAS TURB GEN(NF)	●	0	0	0	-	●	●	-	-
RADIOISOTOPE GEN(NF)									
STEAM TURB GEN (SOLAR)									
ORGANIC VAP TURB (SOLAR)	0	0	0	-	-	0	-	●	-
GAS TURB GEN (SOLAR)	0	0	0	-	0	0	-	●	-
PHOTOVOLTAIC (SOLAR)	-	0	-	-	0	-	-	●	-
WIND TURB GEN 10-1	0	0	●	-	0	-	-	-	●
WIND TURB GEN 10-5	0	0	●	-	0	-	-	-	●
WIND TURB GEN 20-1	0	0	●	-	0	-	-	-	●
WIND TURB GEN 20-5	0	0	●	-	0	-	-	-	●
FLYWHEEL STORAGE									
BATTERY STORAGE									

- \- - Condition does not exist in system
- 0 - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability
- ⊖ - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability
- ● - Condition exists and is a governing factor in determining system performance and reliability



REQUIREMENT: 50 KW CONTINUOUS PARAMETER: 15 MAINT AND OPER



REQUIREMENT: 50 KW CONTINUOUS

PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
50 KW Cont.	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

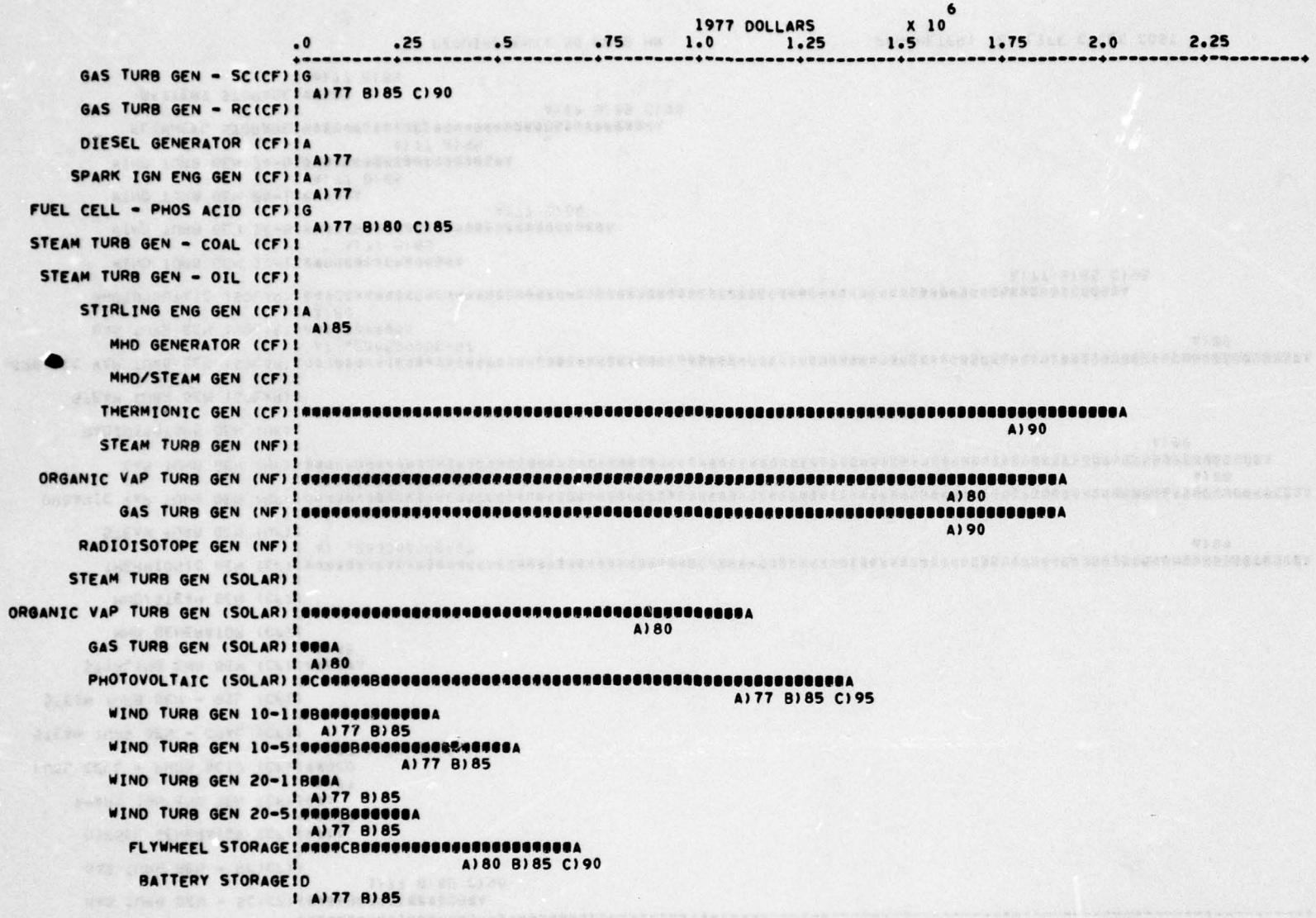
System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	None
SPARK IGN ENG GEN(CF)	None
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	None
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	None
GAS TURB GEN(NF)	None
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	None
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	Possibly lead for conventional batteries
WIND TURB GEN 10-5	Possibly lead for conventional batteries
WIND TURB GEN 20-1	Possibly lead for conventional batteries
WIND TURB GEN 20-5	Possibly lead for conventional batteries
FLYWHEEL STORAGE	
BATTERY STORAGE	

SECTION XI

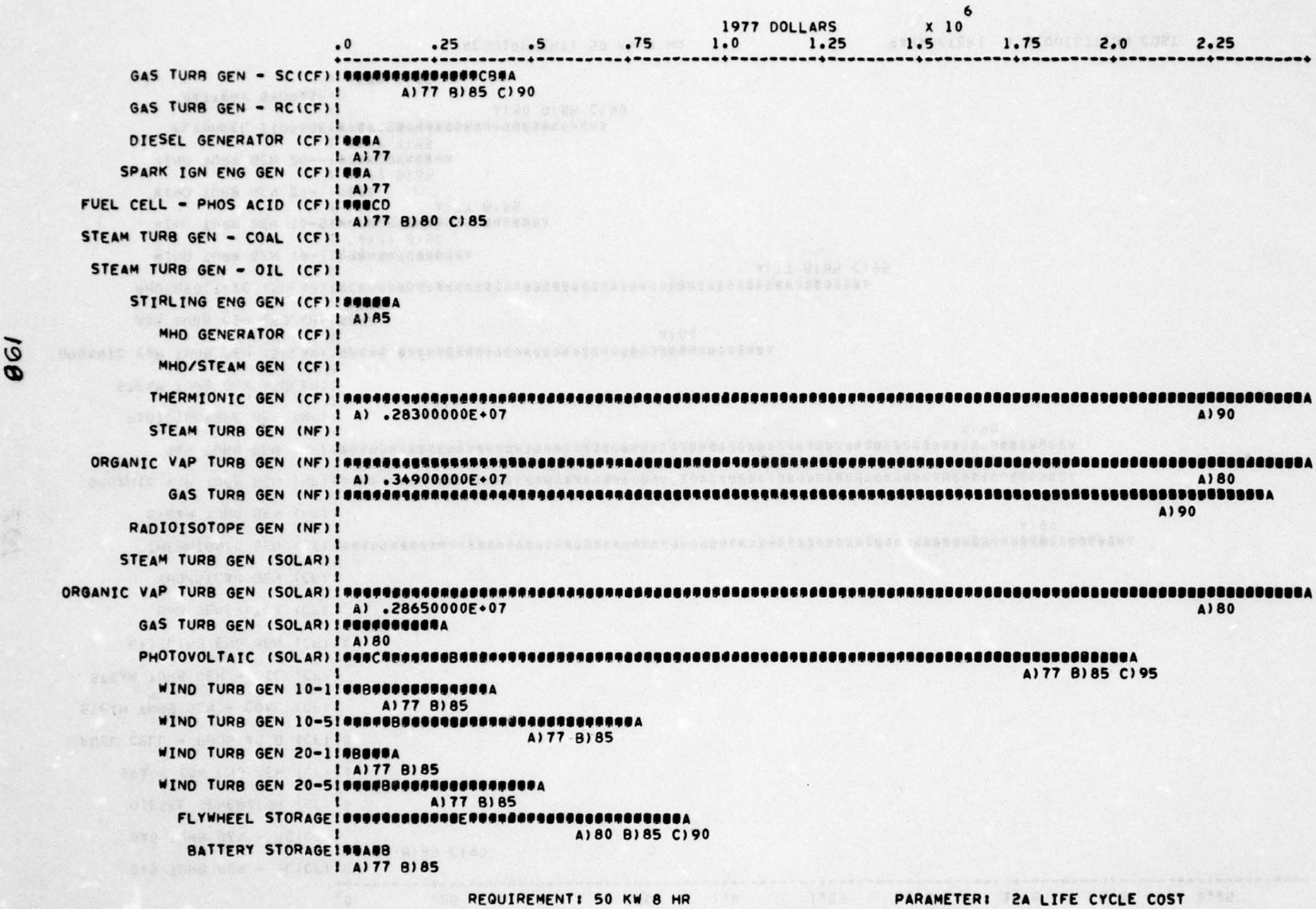
FIFTY KILOWATT, 8 HOUR

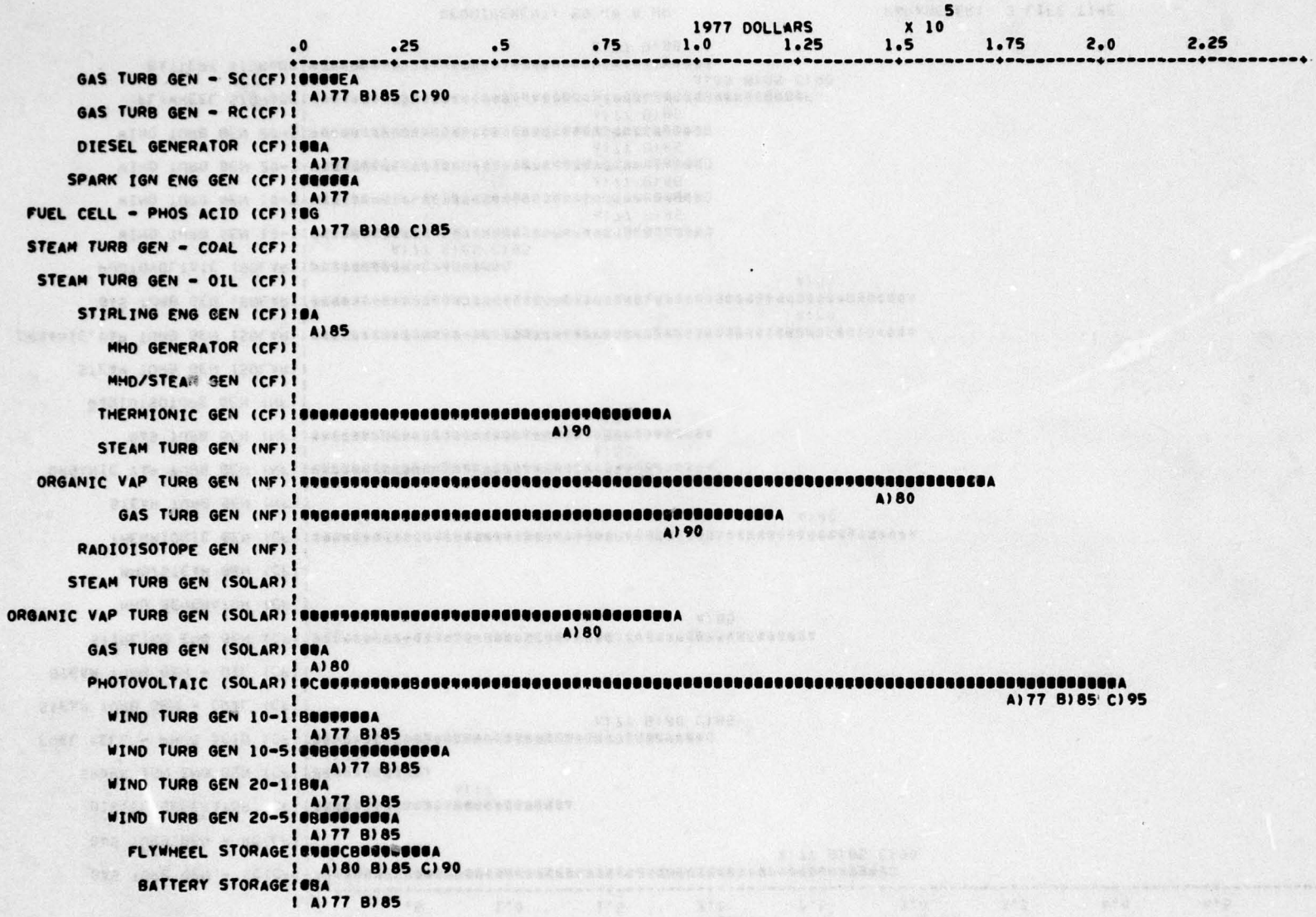
REQUIREMENT

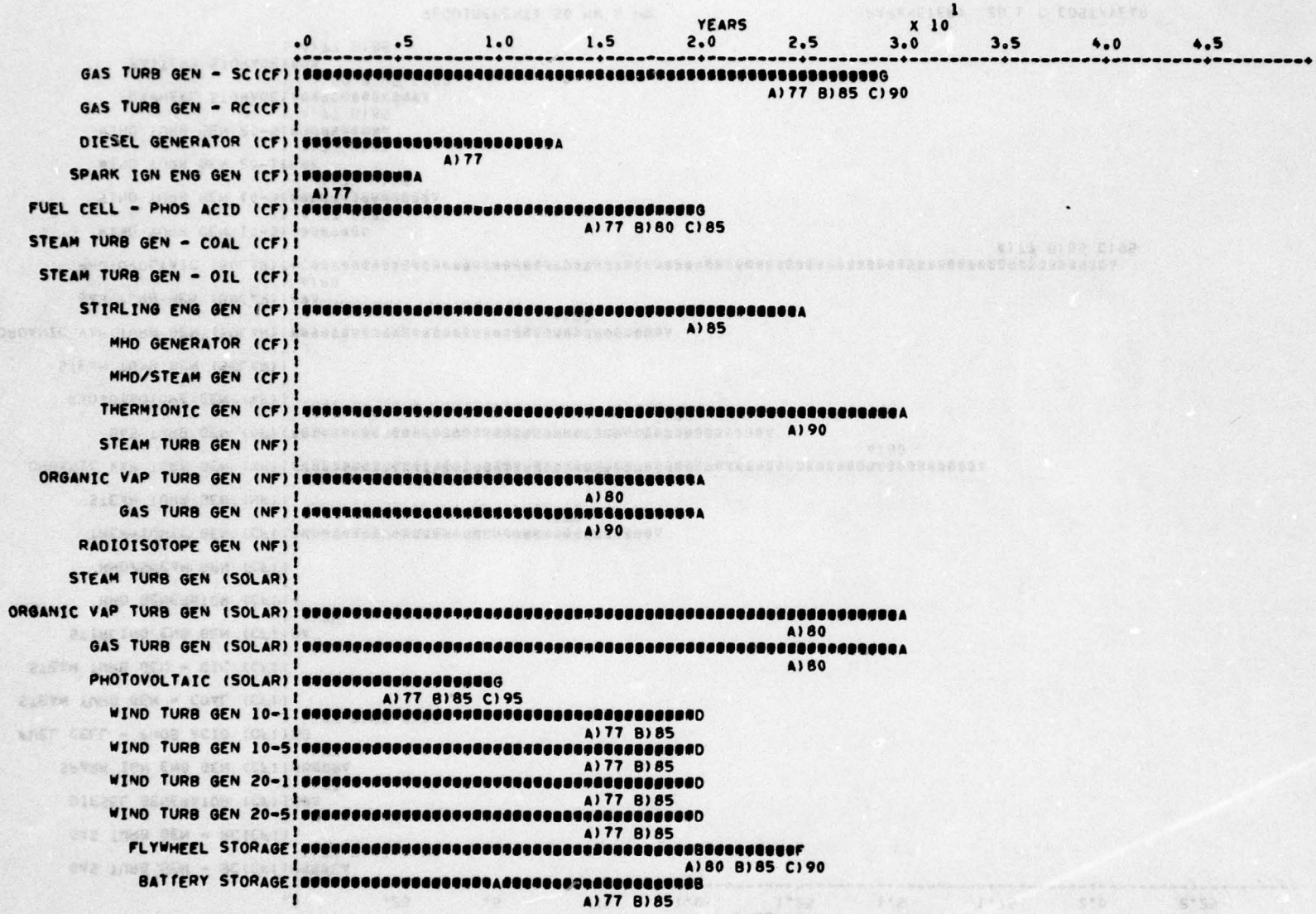
Power Level:	50 Kw
Operating Mode:	8 hours per day
Frequency/Phase:	60 Hz/3Ø
Voltage Level:	480 V

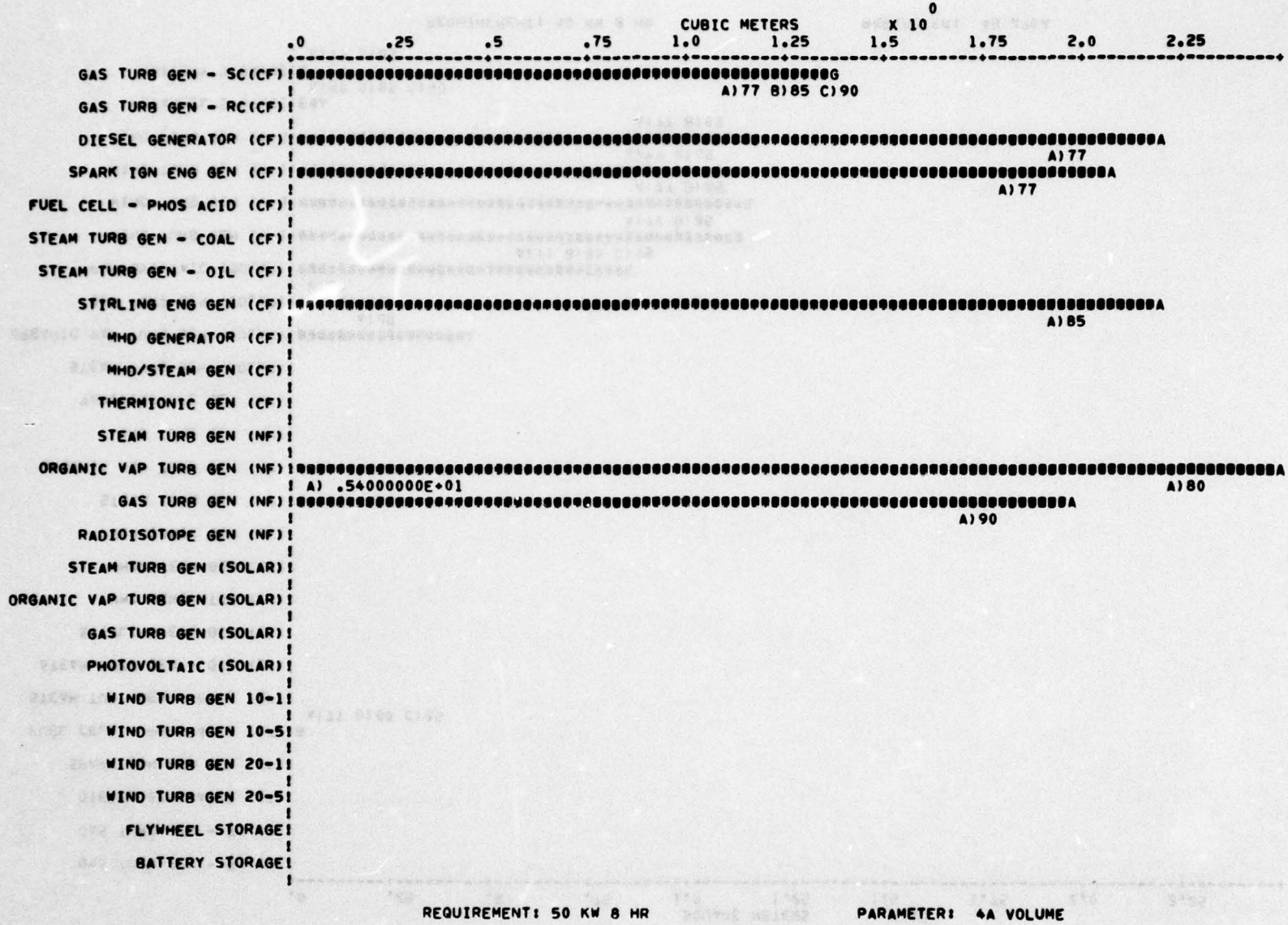


REQUIREMENT: 50 KW 8 HR PARAMETER: 1 ACQUISITION COST

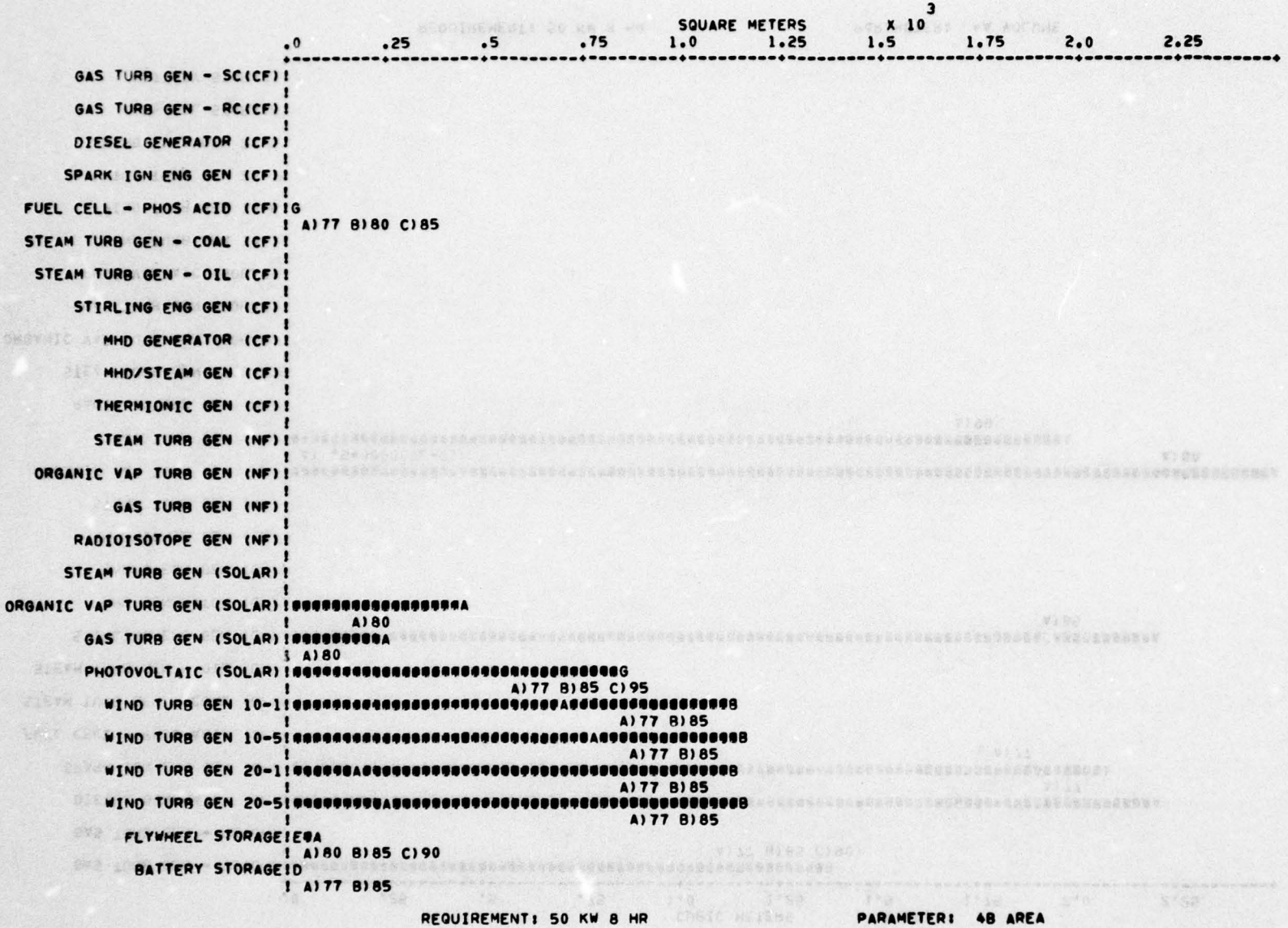

1977 DOLLARS x 10^6
.0 .25 .5 .75 1.0 1.25 1.5 1.75 2.0 2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A) .28300000E+07
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A) .34900000E+07
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A) .28650000E+07
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 50 KW 8 HR
PARAMETER: 2A LIFE CYCLE COST

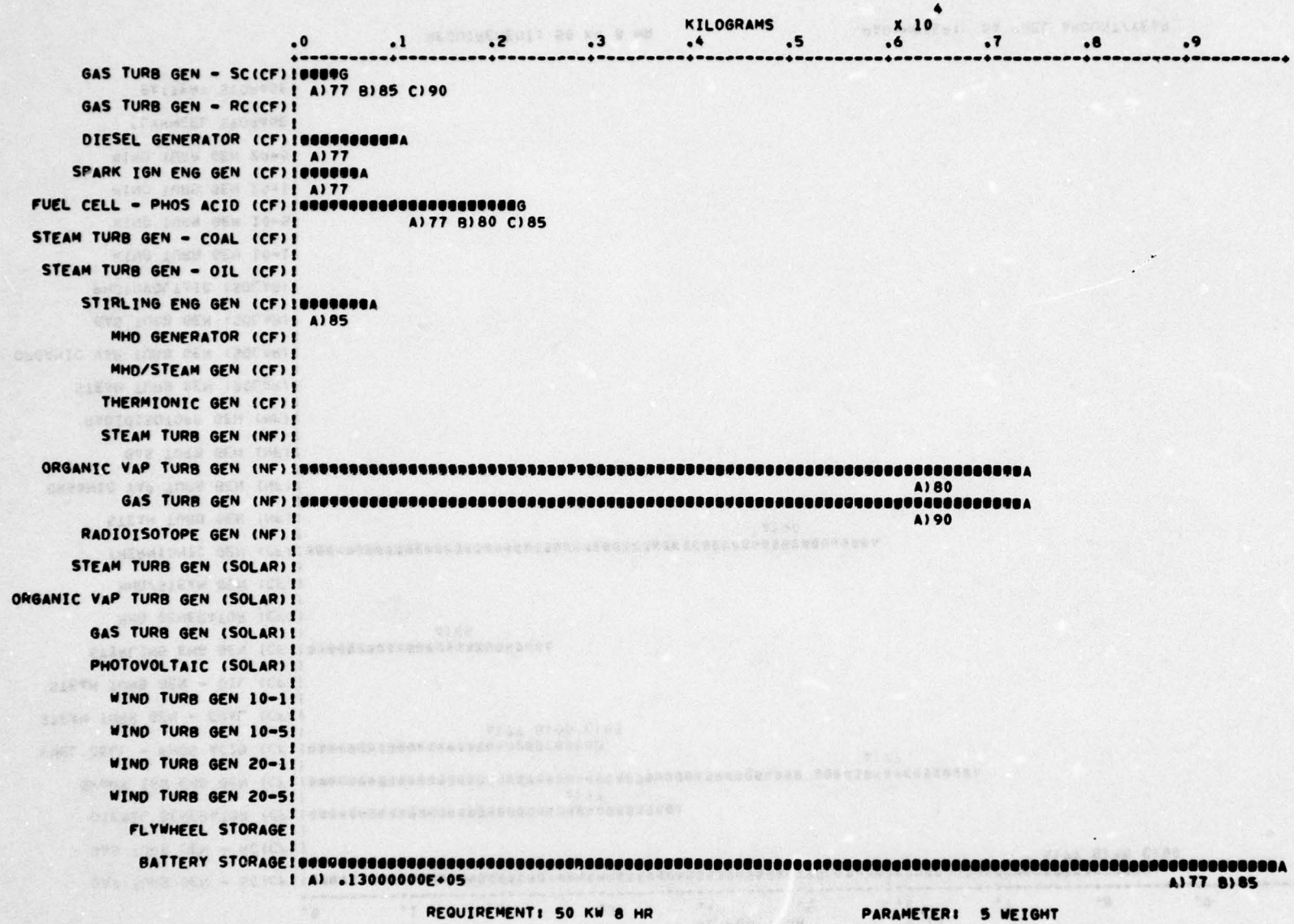

1977 DOLLARS
X 10^5
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 50 KW 8 HR
PARAMETER: 28 L C COST/YEAR

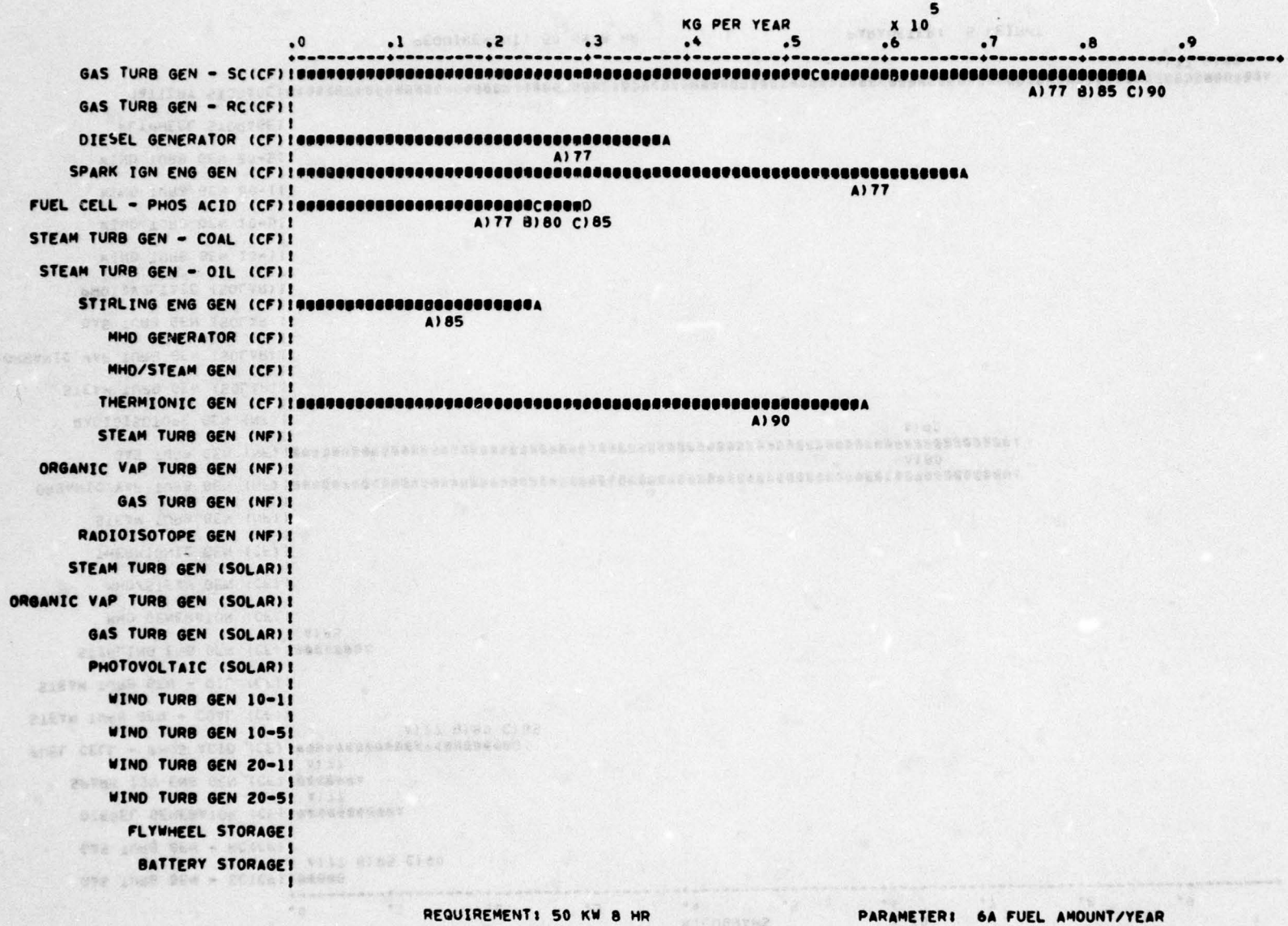

YEARS
X 10^1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 50 KW 8 HR
PARAMETER: 3 LIFE TIME



REQUIREMENT: 50 KW 8 HR PARAMETER: 4A VOLUME

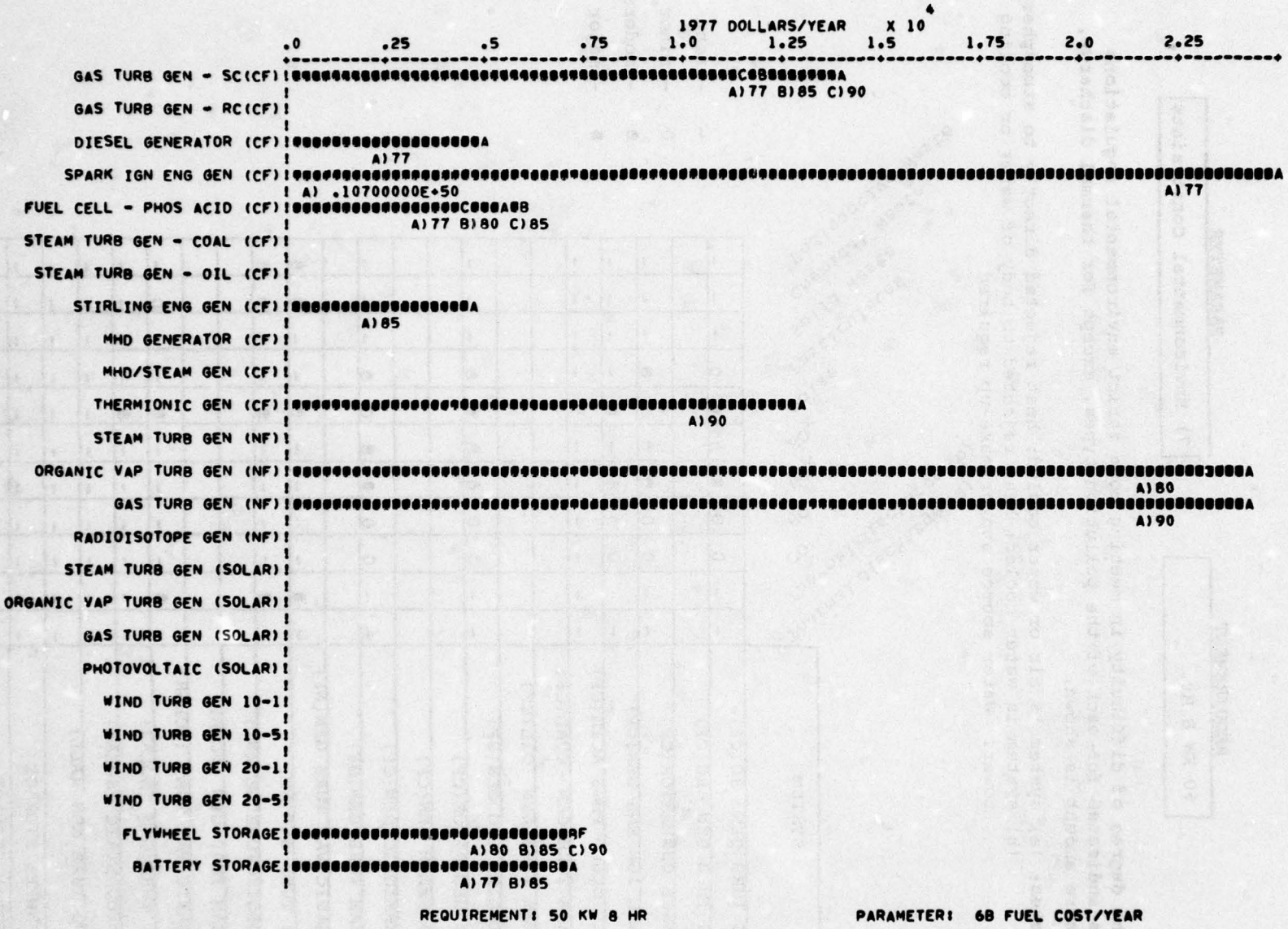

SQUARE METERS X 10^3
.0 .25 .5 .75 1.0 1.25 1.5 1.75 2.0 2.25
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 50 KW 8 HR
PARAMETER: 48 AREA


KILOGRAMS
X 10^4
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
A) .13000000E+05
A)77 B)85
REQUIREMENT: 50 KW 8 HR
PARAMETER: 5 WEIGHT



REQUIREMENT: 50 KW 8 HR

PARAMETER: 6A FUEL AMOUNT/YEAR


1977 DOLLARS/YEAR X 10^4
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A) .10700000E+50
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 50 KW 8 HR
PARAMETER: 68 FUEL COST/YEAR

REQUIREMENT	PARAMETER
50 KW 8 Hr.	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
GAS TURB GEN - RC(CF)											
DIESEL GENERATOR(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
SPARK IGN ENG GEN(CF)	-	-	0	0	◐	-	◐	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	◐	-	-	-	-
STEAM TURB GEN - COAL(CF)											
STEAM TURB GEN - OIL(CF)											
STIRLING ENG GEN(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
MHD GENERATOR(CF)											
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)	-	-	0	0	●	◐	0	◐	-	-	-
STEAM TURB GEN(NF)											
ORGANIC VAP TURB GEN(NF)	-	●	-	-	-	-	◐	-	-	0	◐
GAS TURB GEN(NF)	-	●	-	-	-	-	◐	-	-	0	◐
RADIOISOTOPE GEN(NF)											
STEAM TURB GEN (SOLAR)											
ORGANIC VAP TURB (SOLAR)	-	●	-	-	-	-	◐	-	-	0	-
GAS TURB GEN (SOLAR)	-	-	-	-	-	-	◐	-	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
WIND TURB GEN (ALL)	-	-	-	-	-	-	-	-	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	-	-	-	-
BATTERY STORAGE	-	-	-	-	-	-	-	-	-	-	-

- - none
0 - minor
◐ - moderate
● - major

REQUIREMENT

50 KW 8 Hr.

PARAMETER

8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- - - no limitation
- O - minor limitation
- ⊖ - major limitation
- ● - overriding limitation

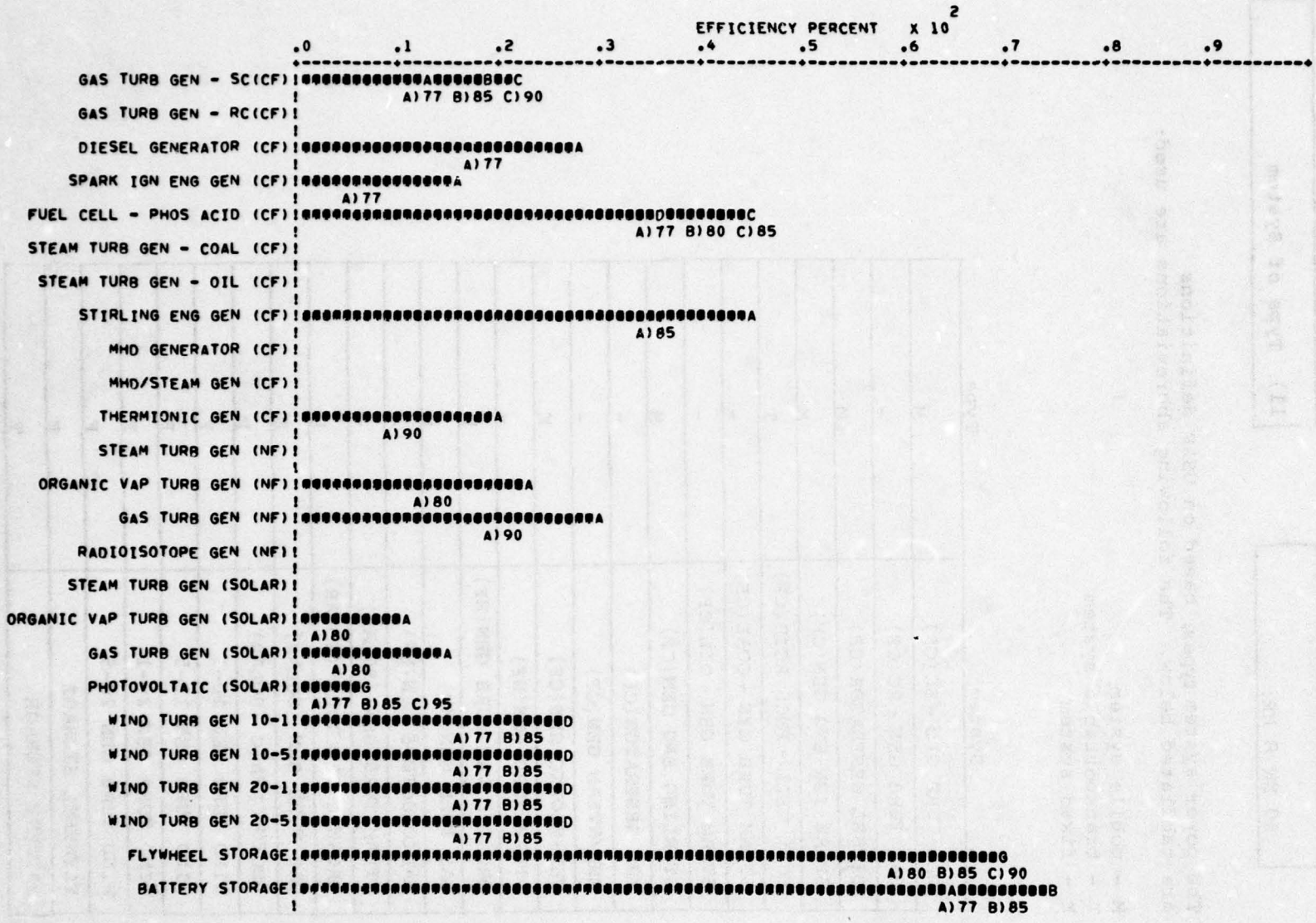
SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	O	●	-	-	-	-
GAS TURB GEN - RC(CF)								
DIESEL GENERATOR(CF)	-	-	-	●	-	-	-	-
SPARK IGN ENG GEN(CF)	-	-	-	●	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)								
STEAM TURB GEN - OIL(CF)								
STIRLING ENG GEN(CF)	-	-	O	●	-	-	-	-
MHD GENERATOR(CF)								
MHD/STEAM GEN(CF)	⊖	⊖	●	●	-	-	-	-
THERMIONIC GEN(CF)	O	O	O	●	-	-	-	-
STEAM TURB GEN(NF)								
ORGANIC VAP TURB GEN(NF)	⊖	-	O	O	-	-	●	-
GAS TURB GEN(NF)	⊖	-	●	O	-	-	●	-
RADIOISOTOPE GEN(NF)								
STEAM TURB GEN (SOLAR)								
ORGANIC VAP TURB (SOLAR)	⊖	-	O	-	●	-	-	-
GAS TURB GEN (SOLAR)	-	-	O	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1	-	-	-	-	-	●	-	-
WIND TURB GEN 10-5	-	-	-	-	-	●	-	-
WIND TURB GEN 20-1	-	-	-	-	-	●	-	-
WIND TURB GEN 20-5	-	-	-	-	-	●	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	●
BATTERY STORAGE	-	O	-	-	-	-	-	●

REQUIREMENT	PARAMETER
50 KW 8 Hr.	9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
0 - Characteristic has minor effect on system performance
◐ - Characteristic has moderate effect on system performance
● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	◐	0	-	-	0	0	0
GAS TURB GEN - RC(CF)							
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)	◐	0	-	-	0	0	0
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)							
STEAM TURB GEN - OIL(CF)							
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)							
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	◐	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)	0	0	-	-	◐	◐	◐
GAS TURB GEN(NF)	0	◐	-	-	◐	0	◐
RADIOISOTOPE GEN(NF)					-	-	-
STEAM TURB GEN (SOLAR)							
ORGANIC VAP TURB (SOLAR)	-	0	●	-	◐	◐	-
GAS TURB GEN (SOLAR)	-	-	●	-	◐	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-
BATTERY STORAGE	-	-	-	-	-	-	-



REQUIREMENT: 50 KW 8 HR

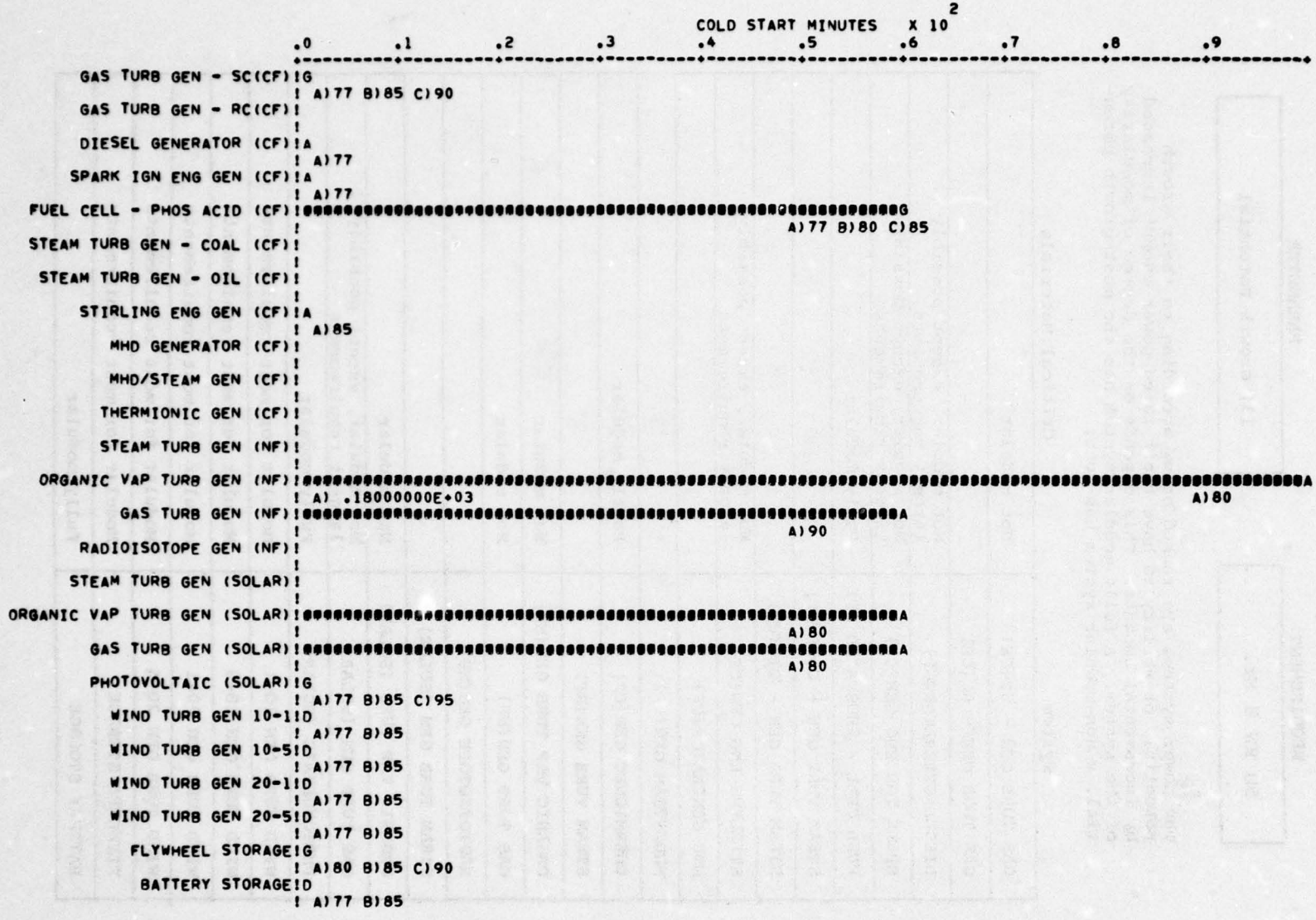
PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
50 KW 8 HR.	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	M
GAS TURB GEN - RC(CF)	-
DIESEL GENERATOR(CF)	M
SPARK IGN ENG GEN(CF)	M
FUEL CELL - PHOS ACID(CF)	T
STEAM TURB GEN - COAL(CF)	-
STEAM TURB GEN - OIL(CF)	-
STIRLING ENG GEN(CF)	M
MHD GENERATOR(CF)	-
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	M
STEAM TURB GEN(NF)	-
ORGANIC VAP TURB GEN(NF)	F
GAS TURB GEN(NF)	F
RADIOISOTOPE GEN(NF)	-
STEAM TURB GEN (SOLAR)	-
ORGANIC VAP TURB (SOLAR)	F
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	F
WIND TURB GEN 10-5	F
WIND TURB GEN 20-1	F
WIND TURB GEN 20-5	F
FLYWHEEL STORAGE	F
BATTERY STORAGE	T



REQUIREMENT: 50 KW 8 HR PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
50 KW 8 Hr.	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

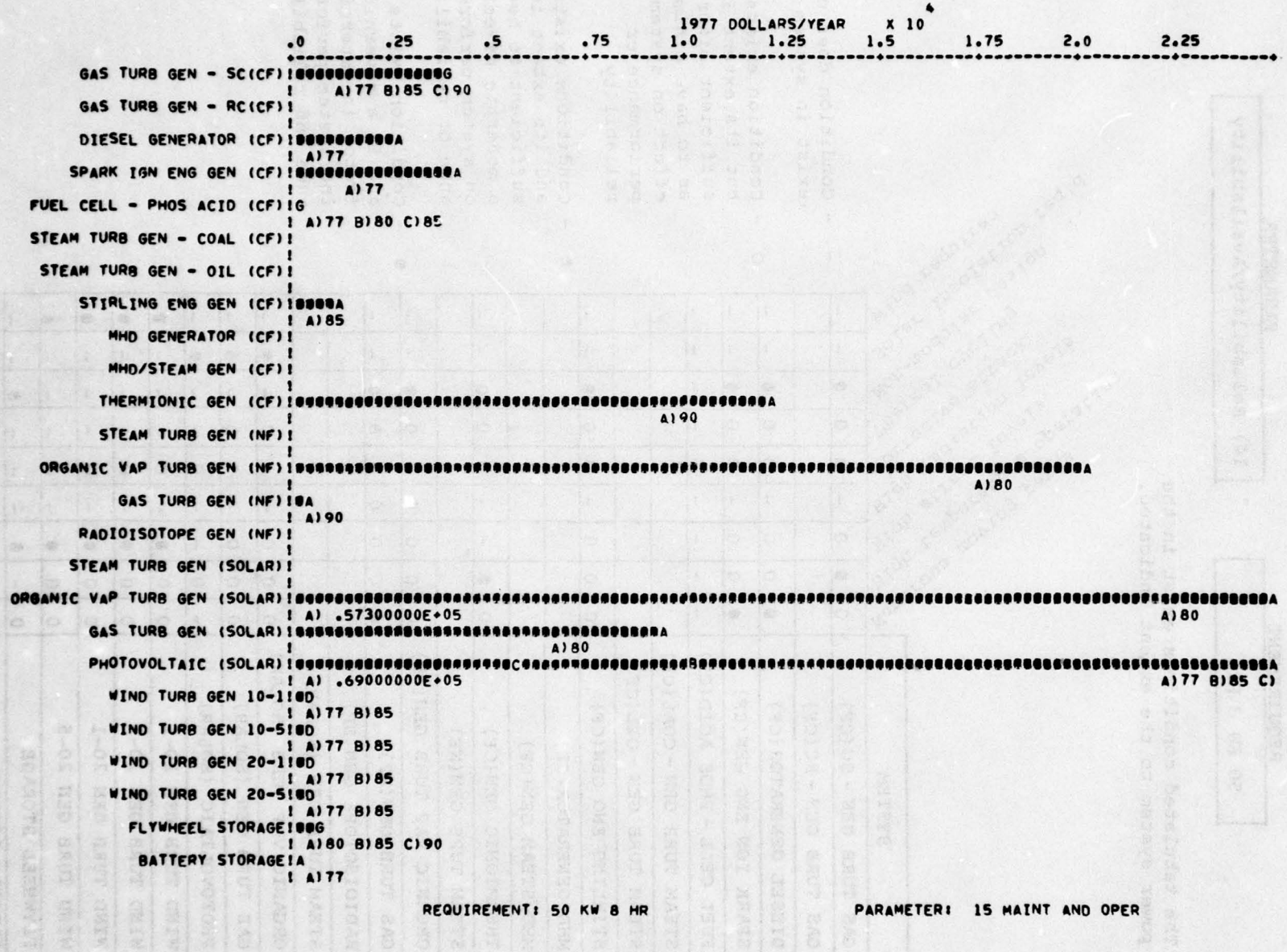
System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	Not modular, except possibly largest requirements
SPARK IGN ENG GEN(CF)	Not modular, except possibly largest requirements
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	Not modular, except possibly largest requirements
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	Not modular
GAS TURB GEN(NF)	Not modular
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	Not modular
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	Modular for most requirements
WIND TURB GEN 10-5	Modular for most requirements
WIND TURB GEN 20-1	Modular for most requirements
WIND TURB GEN 20-5	Modular for most requirements
FLYWHEEL STORAGE	Modular for most requirements
BATTERY STORAGE	Fully modular

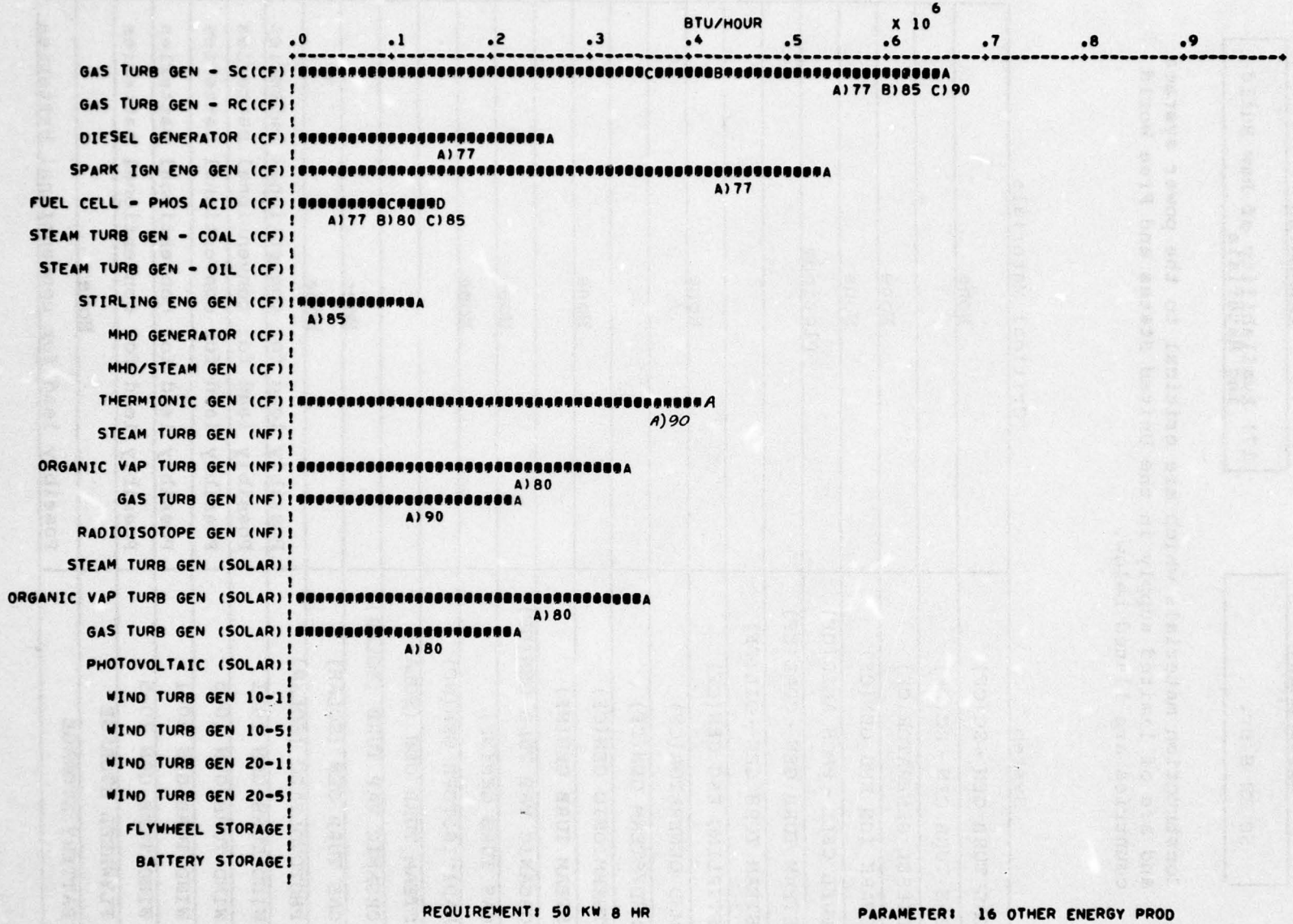
REQUIREMENT	PARAMETER
50 KW ∂ Hr.	14) Reliability/Availability

The tabulated conditions exist in the power system to the extent indicated.

SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	0	●	0	-	●	0	●	-	-
GAS TURB GEN - RC(CF)									
DIESEL GENERATOR(CF)	●	0	0	-	0	0	●	-	-
SPARK IGN ENG GEN(CF)	●	0	0	-	0	0	●	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	0	-	-	-	-
STEAM TURB GEN - COAL(CF)									
STEAM TURB GEN - OIL(CF)									
STIRLING ENG GEN(CF)	0	0	0	-	0	0	●	-	-
MHD GENERATOR(CF)									
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	0	●	-	-	⊖	0	0	-	-
STEAM TURB GEN(NF)									
ORGANIC VAP TURB GEN(NF)	0	0	0	0	-	0	●	-	-
GAS TURB GEN(NF)	●	0	0	0	-	⊖	●	-	-
RADIOISOTOPE GEN(NF)									
STEAM TURB GEN (SOLAR)									
ORGANIC VAP TURB (SOLAR)	0	0	0	-	-	0	-	●	-
GAS TURB GEN (SOLAR)	0	0	0	-	0	0	-	●	-
PHOTOVOLTAIC (SOLAR)	-	0	-	-	0	-	-	●	-
WIND TURB GEN 10-1	0	0	●	-	0	-	-	-	●
WIND TURB GEN 10-5	0	0	●	-	0	-	-	-	●
WIND TURB GEN 20-1	0	0	●	-	0	-	-	-	●
WIND TURB GEN 20-5	0	0	●	-	0	-	-	-	●
FLYWHEEL STORAGE	0	-	●	-	-	-	⊖	-	-
BATTERY STORAGE	-	0	-	-	0	-	-	-	-

- \- - Condition does not exist in system
- 0 - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability
- ⊖ - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability
- ● - Condition exists and is a governing factor in determining system performance and reliability


1977 DOLLARS/YEAR X 10^4
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A) .57300000E+05
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A) .69000000E+05
A)77 B)85 C)
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77
REQUIREMENT: 50 KW 8 HR
PARAMETER: 15 MAINT AND OPER


BTU/HOUR
X 10^6
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 KW 8 HR
PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
50 KW 8 Hr.	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

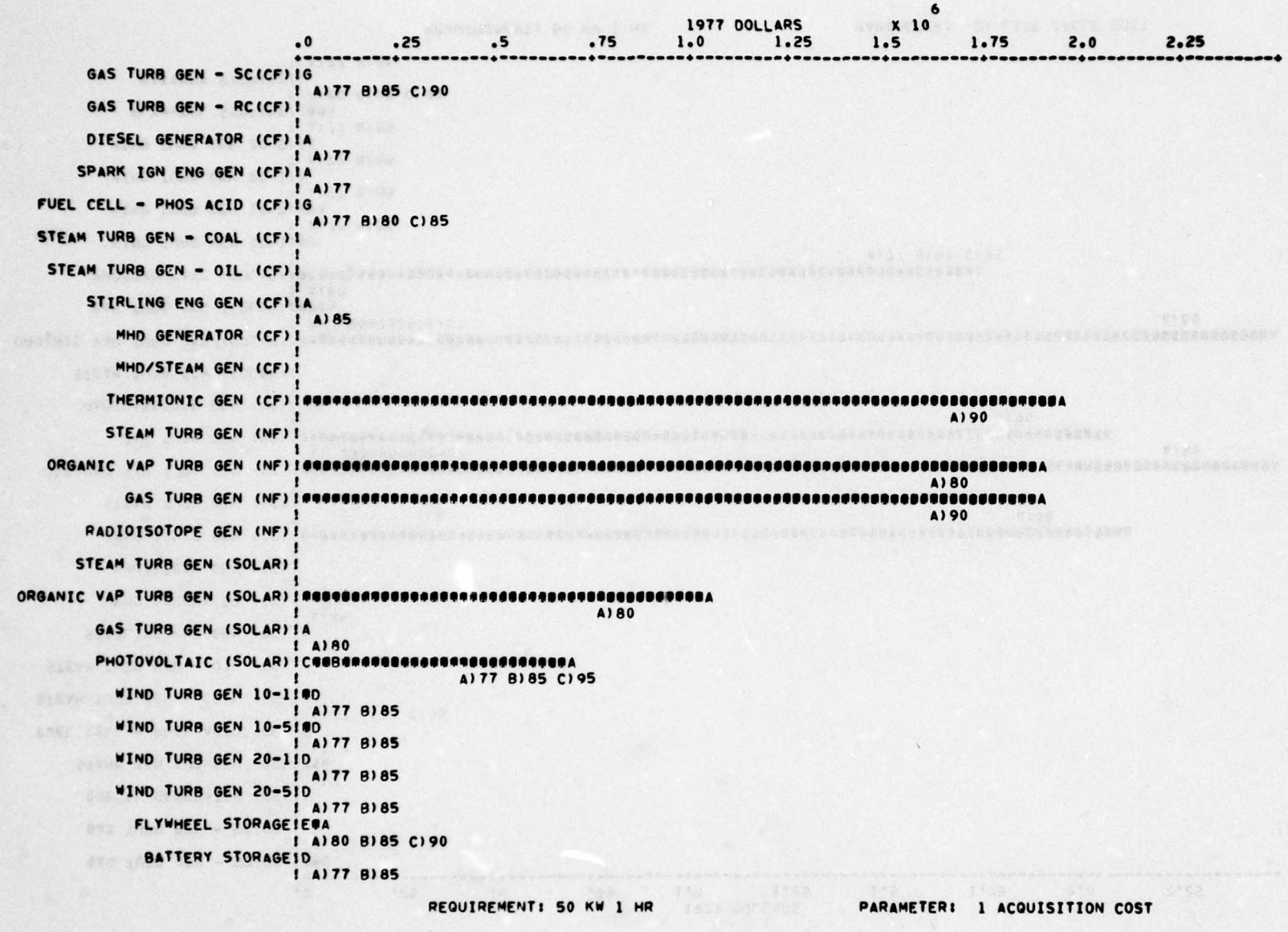
System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	None
SPARK IGN ENG GEN(CF)	None
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	None
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	None
GAS TURB GEN(NF)	None
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	None
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	Possibly lead for conventional batteries
WIND TURB GEN 10-5	Possibly lead for conventional batteries
WIND TURB GEN 20-1	Possibly lead for conventional batteries
WIND TURB GEN 20-5	Possibly lead for conventional batteries
FLYWHEEL STORAGE	None
BATTERY STORAGE	Possibly lead for conventional batteries

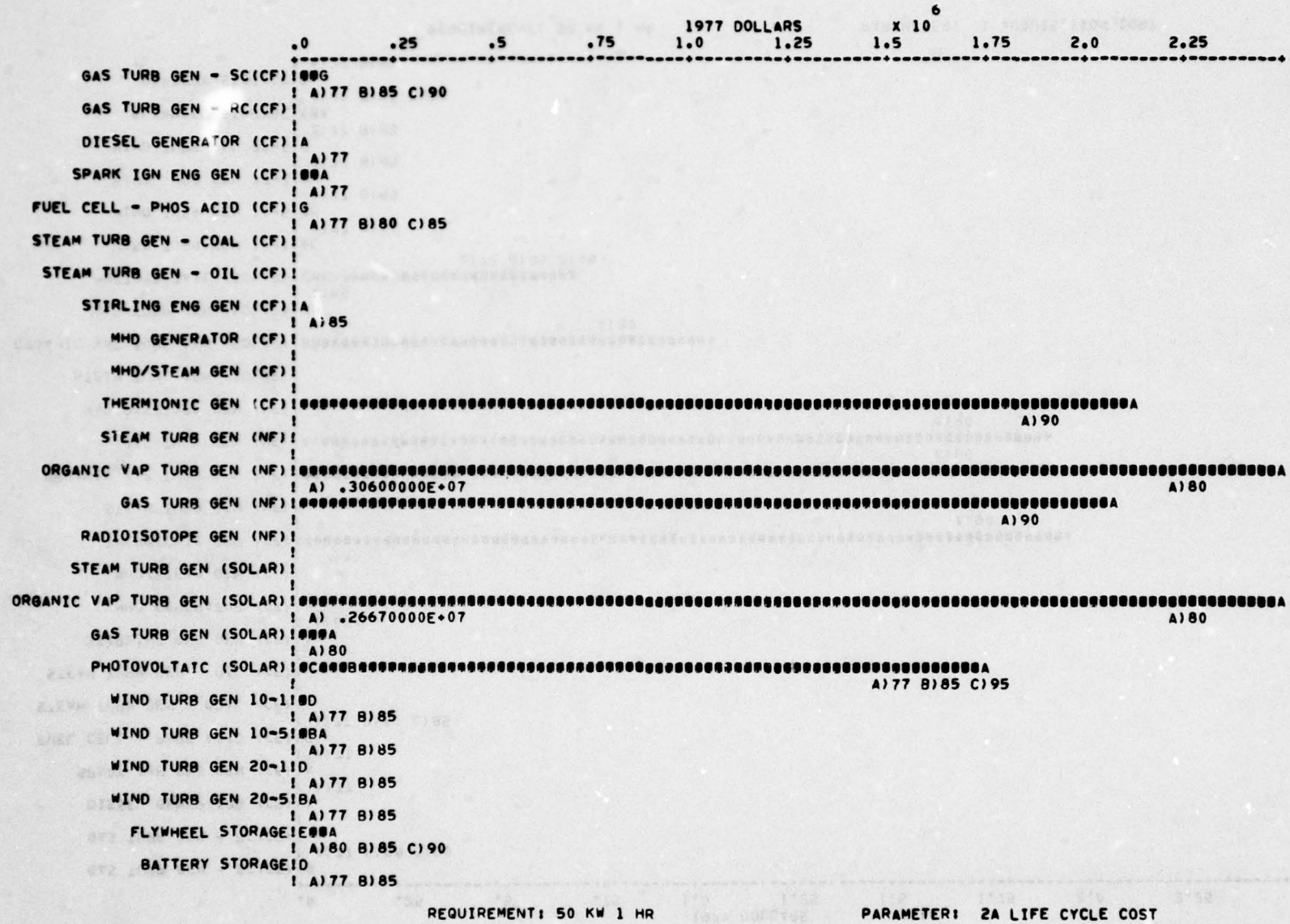
SECTION XII

FIFTY KILOWATT, 1 HOUR

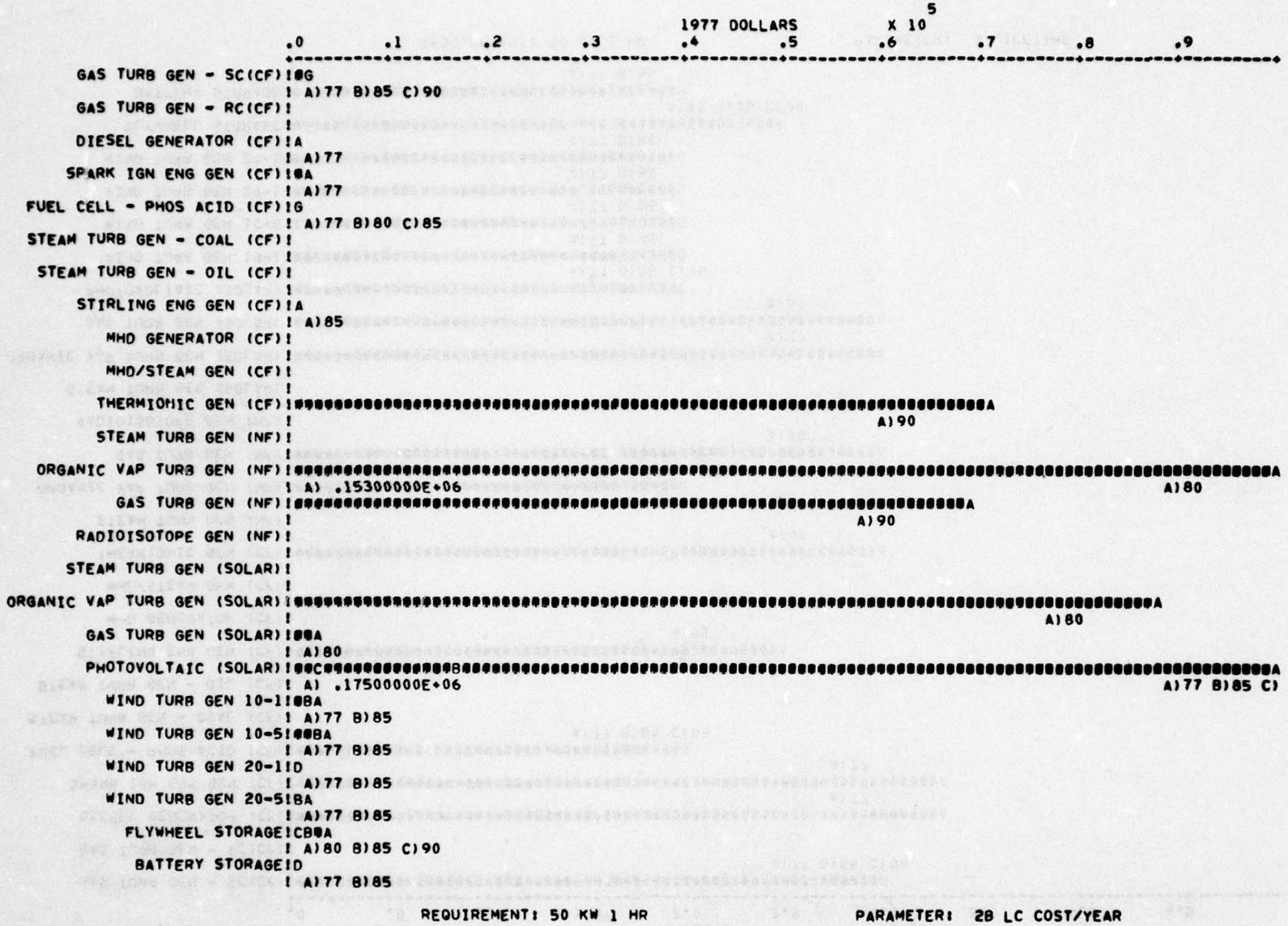
REQUIREMENT

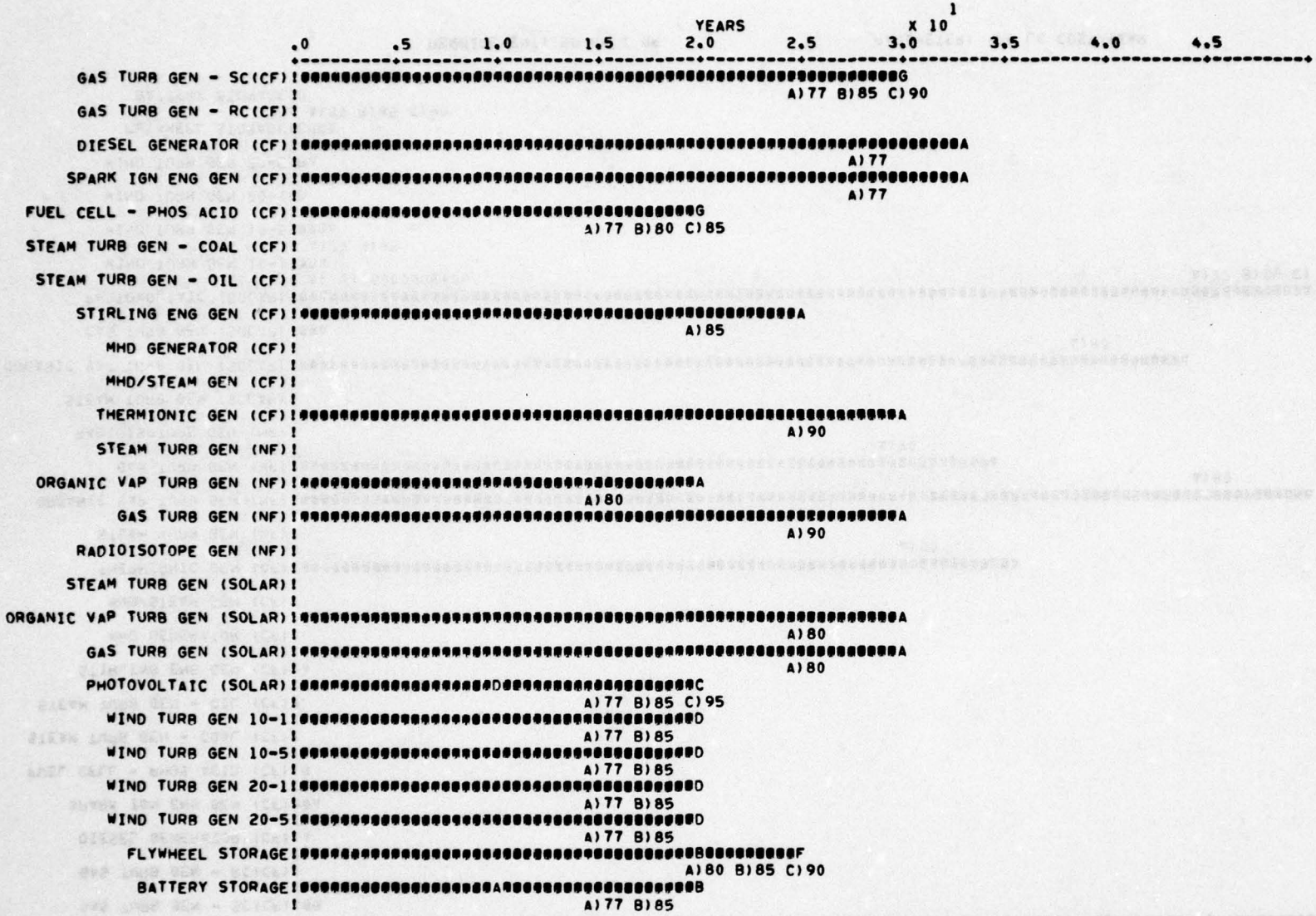
Power Level:	50 Kw
Operating Mode:	1 hour per day
Frequency/Phase:	60 Hz/3Ø
Voltage Level:	480 V


1977 DOLLARS
X 10^6
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 50 KW 1 HR
PARAMETER: 1 ACQUISITION COST

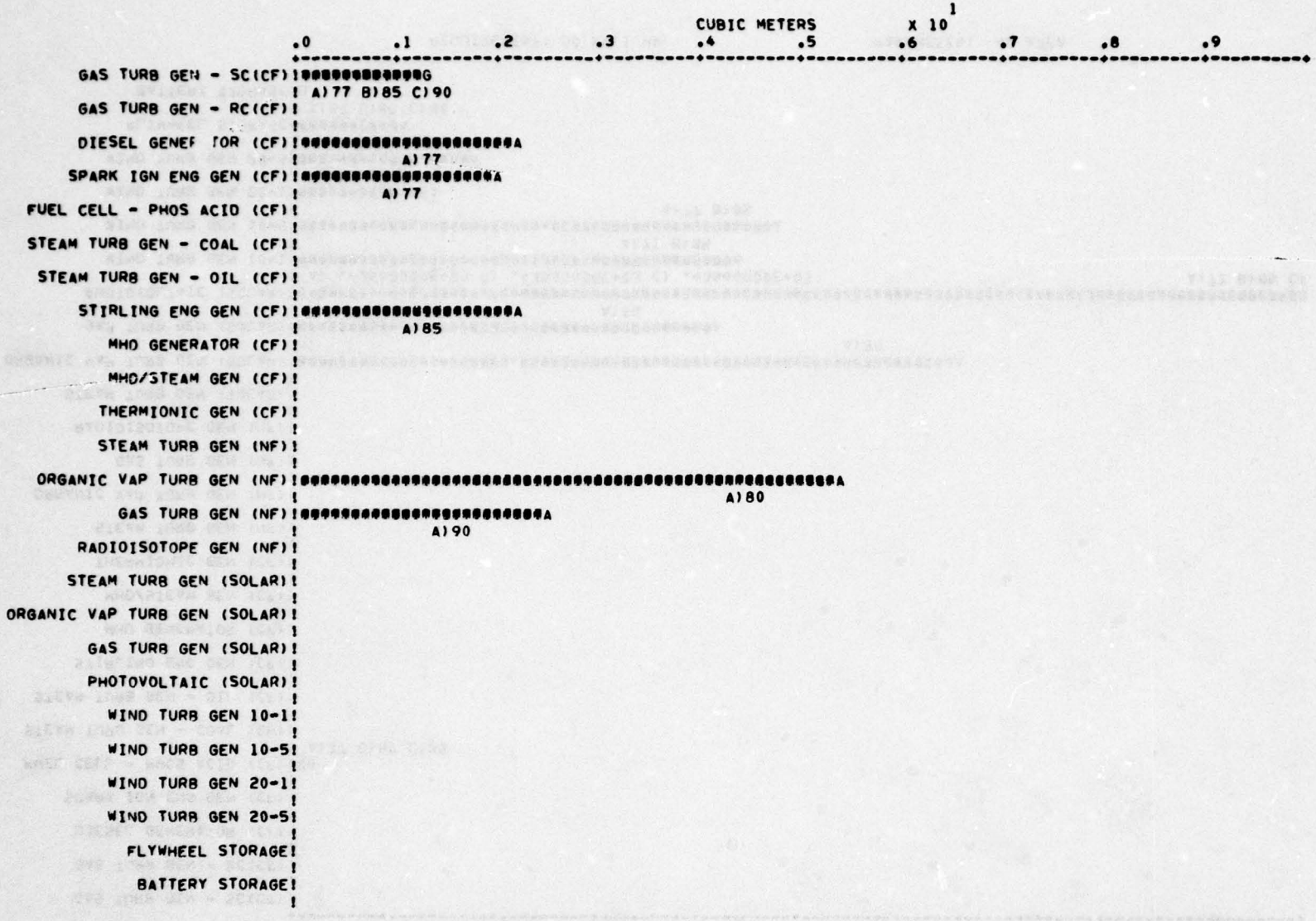


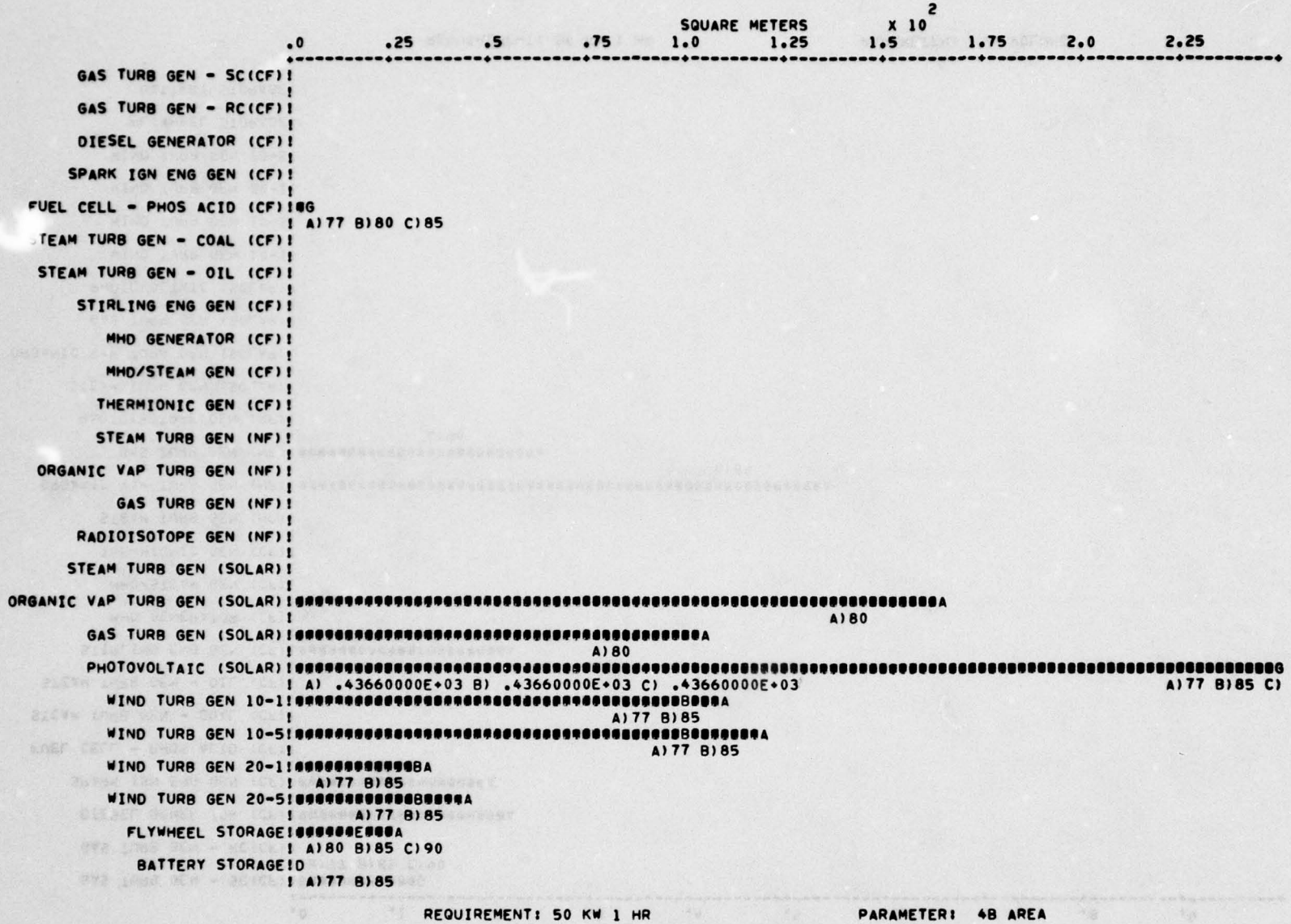
REQUIREMENT: 50 KW 1 HR PARAMETER: 2A LIFE CYCLE COST

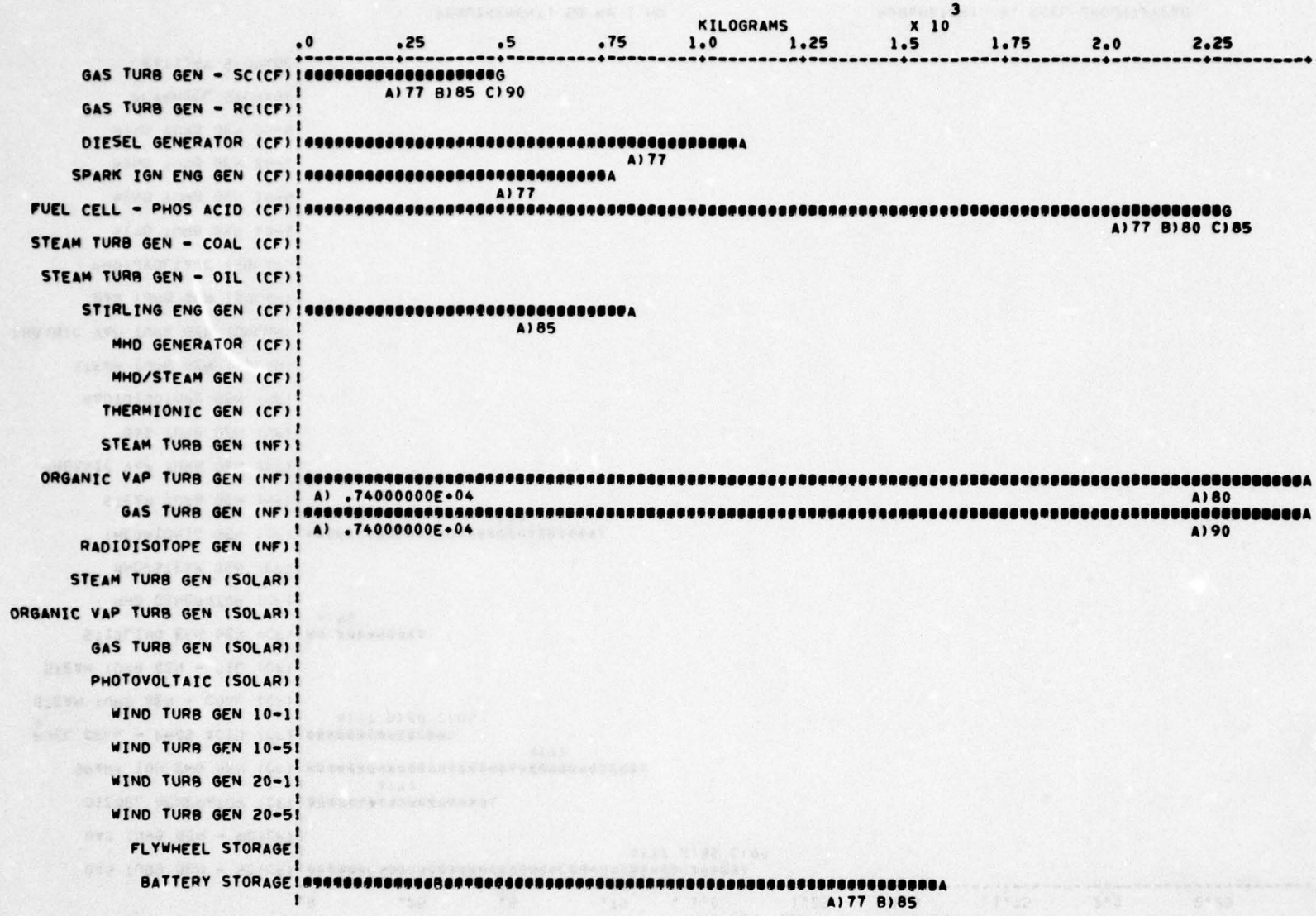

1977 DOLLARS
X 10^5
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A) .15300000E+06
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A) .17500000E+06
A)77 B)85 C)
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 50 KW 1 HR
PARAMETER: 28 LC COST/YEAR

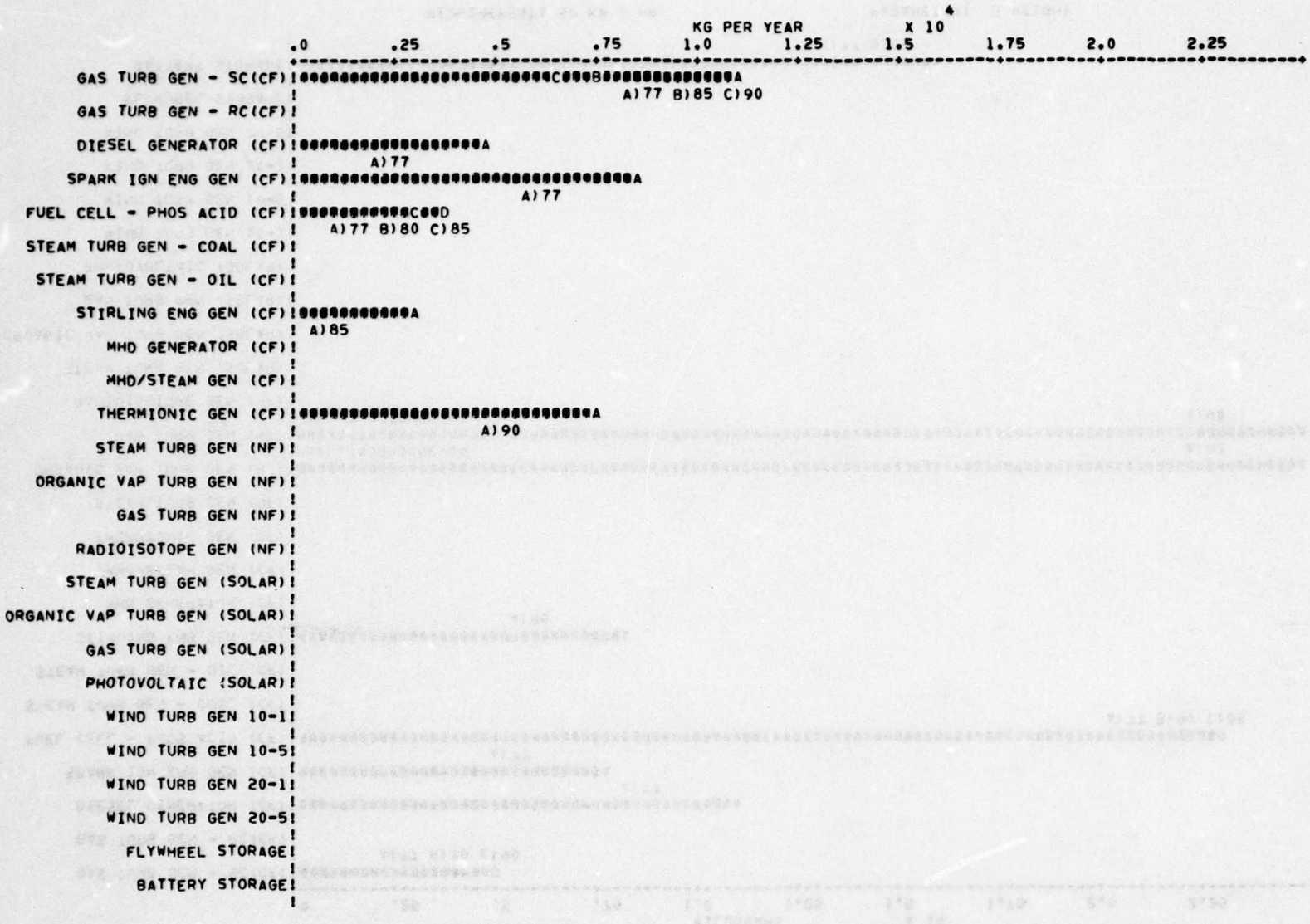


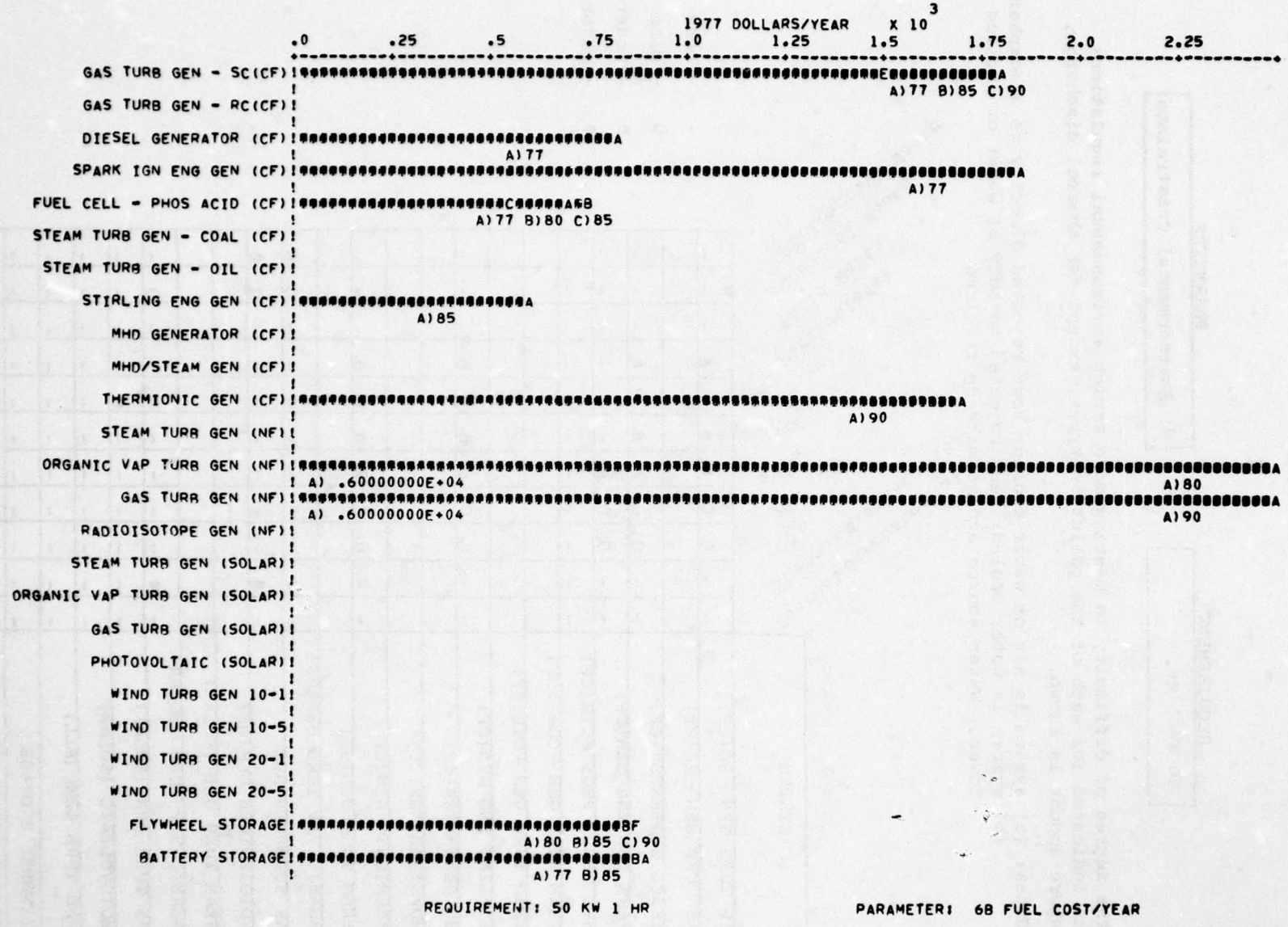
REQUIREMENT: 50 KW 1 HR PARAMETER: 3 LIFETIME


CUBIC METERS
X 10^1
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENER TOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 KW 1 HR
PARAMETER: 4A VOLUME


SQUARE METERS X 10^2
.0 .25 .5 .75 1.0 1.25 1.5 1.75 2.0 2.25
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A) .43660000E+03 B) .43660000E+03 C) .43660000E+03
A)77 B)85 C)
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 50 KW 1 HR
PARAMETER: 48 AREA


KILOGRAMS
X 10^3
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A) .74000000E+04
A)80
GAS TURB GEN (NF)
A) .74000000E+04
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 50 KW 1 HR
PARAMETER: 5 WEIGHT


KG PER YEAR
X 10^4
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 KW 1 HR
PARAMETER: 6A FUEL AMOUNT/YEAR


1977 DOLLARS/YEAR X 10^3
.0 .25 .5 .75 1.0 1.25 1.5 1.75 2.0 2.25
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
A) 77 B) 85 C) 90
A) 77
A) 77
A) 77 B) 80 C) 85
A) 85
A) 90
A) .60000000E+04
A) 80
A) .60000000E+04
A) 90
A) 80 B) 85 C) 90
A) 77 B) 85
REQUIREMENT: 50 KW 1 HR
PARAMETER: 68 FUEL COST/YEAR

REQUIREMENT	PARAMETER
50 KW 1 Hr.	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
GAS TURB GEN - RC(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
DIESEL GENERATOR(CF)	-	-	0	0	◐	-	◐	-	-	-	-
SPARK IGN ENG GEN(CF)	-	-	-	-	-	-	◐	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	◐	-	-	-	-
STEAM TURB GEN - COAL(CF)											
STEAM TURB GEN - OIL(CF)											
STIRLING ENG GEN(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
MHD GENERATOR(CF)											
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)											
STEAM TURB GEN(NF)	-	-	0	0	●	◐	0	◐	-	-	-
ORGANIC VAP TURB GEN(NF)											
GAS TURB GEN(NF)	-	●	-	-	-	-	◐	-	-	0	◐
RADIOISOTOPE GEN(NF)	-	●	-	-	-	-	◐	-	-	0	◐
STEAM TURB GEN (SOLAR)											
ORGANIC VAP TURB (SOLAR)											
GAS TURB GEN (SOLAR)	-	●	-	-	-	-	◐	-	-	0	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	◐	-	-	-	-
WIND TURB GEN (ALL)	-	-	-	-	-	-	-	-	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	-	-	-	-
BATTERY STORAGE	-	-	-	-	-	-	-	-	-	-	-

- - none
0 - minor
◐ - moderate
● - major

REQUIREMENT	PARAMETER
50 KW 1 Hr.	8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- \- - no limitation
- O - minor limitation
- ⊖ - major limitation
- ● - overriding limitation

SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	O	●	-	-	-	-
GAS TURB GEN - RC(CF)								
DIESEL GENERATOR(CF)	-	-	-	●	-	-	-	-
SPARK IGN ENG GEN(CF)	-	-	-	●	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)								
STEAM TURB GEN - OIL(CF)								
STIRLING ENG GEN(CF)	-	-	O	●	-	-	-	-
MHD GENERATOR(CF)								
MHD/STEAM GEN(CF)								
THERMIONIC GEN(CF)	O	O	O	●	-	-	-	-
STEAM TURB GEN(NF)								
ORGANIC VAP TURB GEN(NF)	⊖	-	O	O	-	-	●	-
GAS TURB GEN(NF)	⊖	-	●	O	-	-	●	-
RADIOISOTOPE GEN(NF)								
STEAM TURB GEN (SOLAR)								
ORGANIC VAP TURB (SOLAR)	⊖	-	O	-	●	-	-	-
GAS TURB GEN (SOLAR)	-	-	O	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1	-	-	-	-	-	●	-	-
WIND TURB GEN 10-5	-	-	-	-	-	●	-	-
WIND TURB GEN 20-1	-	-	-	-	-	●	-	-
WIND TURB GEN 20-5	-	-	-	-	-	●	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	●
BATTERY STORAGE	-	O	-	-	-	-	-	●

REQUIREMENT

50 KW 1 Hr.

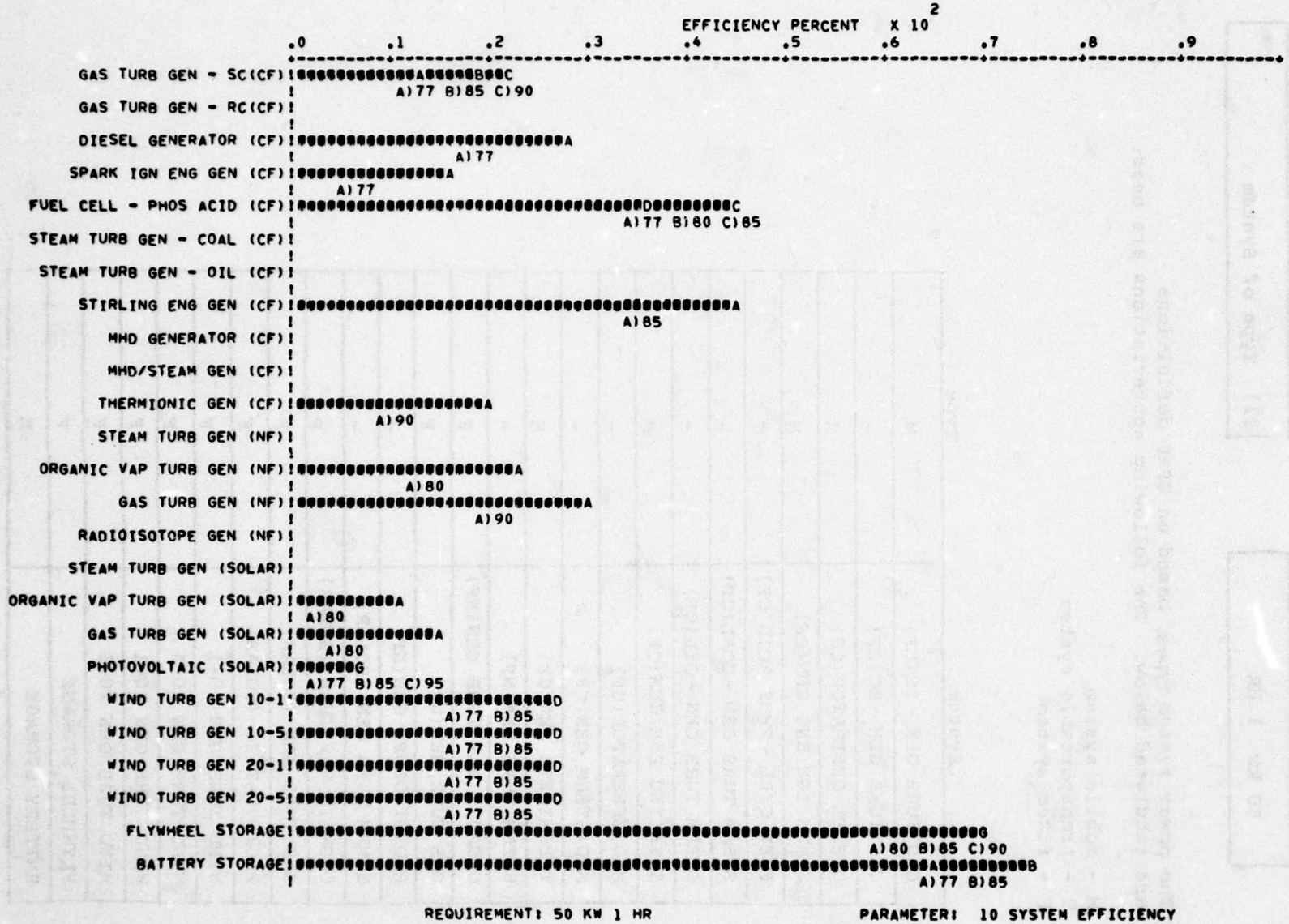
PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
0 - Characteristic has minor effect on system performance
◐ - Characteristic has moderate effect on system performance
● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	◐	0	-	-	0	0	0
GAS TURB GEN - RC(CF)							
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)	◐	0	-	-	0	0	0
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)							
STEAM TURB GEN - OIL(CF)							
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)							
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	◐	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)	0	0	-	-	◐	◐	◐
GAS TURB GEN(NF)	0	◐	-	-	◐	◐	◐
RADIOISOTOPE GEN(NF)							
STEAM TURB GEN (SOLAR)							
ORGANIC VAP TURB (SOLAR)	-	0	●	-	◐	◐	-
GAS TURB GEN (SOLAR)	-	-	●	-	◐	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-
BATTERY STORAGE	-	-	-	-	-	-	-



REQUIREMENT: 50 KW 1 HR

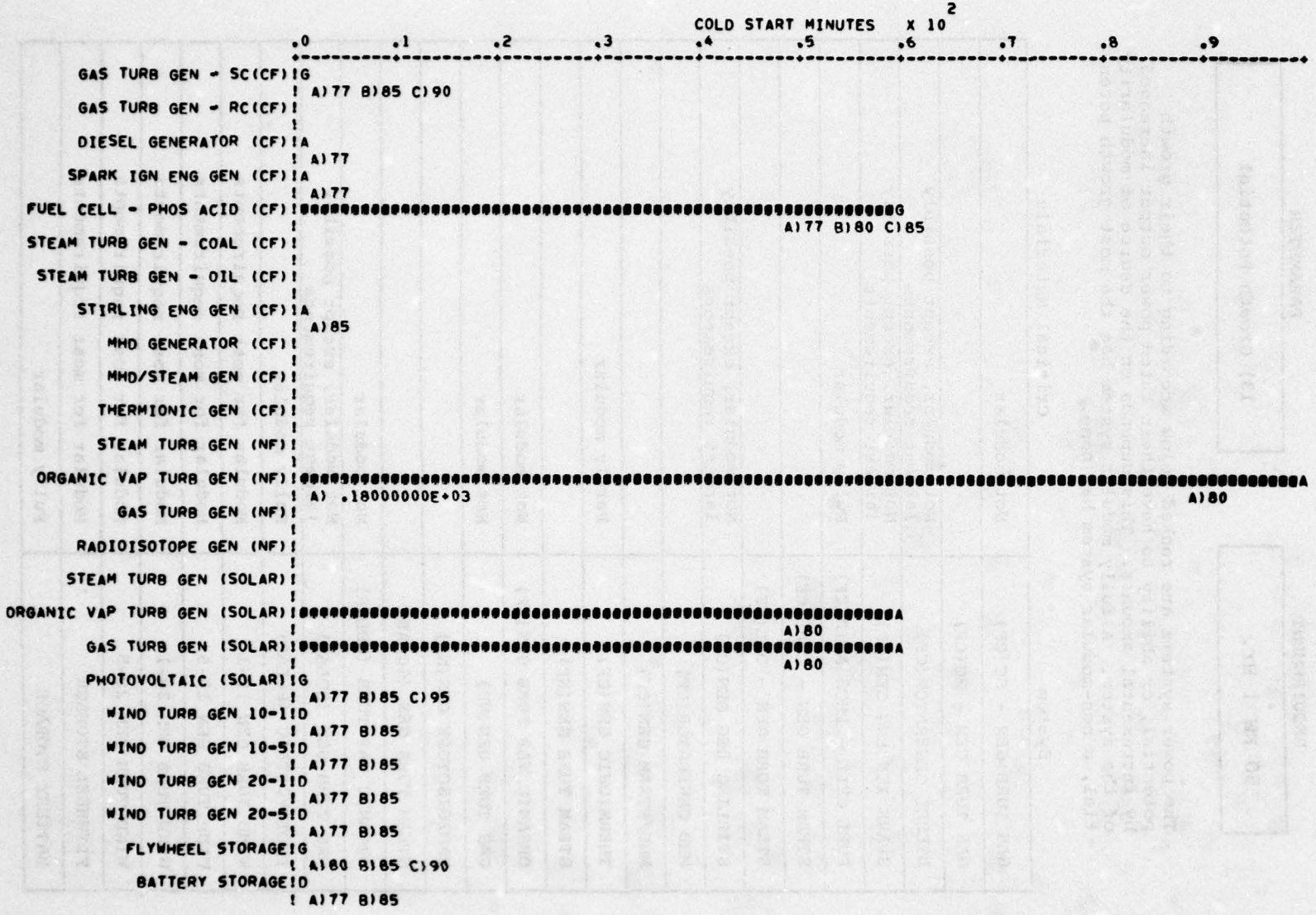
PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
50 kw 1 HR	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	M
GAS TURB GEN - RC(CF)	-
DIESEL GENERATOR(CF)	M
SPARK IGN ENG GEN(CF)	M
FUEL CELL - PHOS ACID(CF)	T
STEAM TURB GEN - COAL(CF)	-
STEAM TURB GEN - OIL(CF)	-
STIRLING ENG GEN(CF)	M
MHD GENERATOR(CF)	-
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	M
STEAM TURB GEN(NF)	-
ORGANIC VAP TURB GEN(NF)	F
GAS TUPB GEN(NF)	F
RADIOISOTOPE GEN(NF)	-
STEAM TURB GEN (SOLAR)	-
ORGANIC VAP TURB (SOLAR)	F
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	F
WIND TURB GEN 10-5	F
WIND TURB GEN 20-1	F
WIND TURB GEN 20-5	F
FLYWHEEL STORAGE	F
BATTERY STORAGE	M



REQUIREMENT: 50 KW 1 HR

PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
50 KW 1 Hr.	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	Not modular, except possibly largest requirements
SPARK IGN ENG GEN(CF)	Not modular, except possibly largest requirements
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	Not modular, except possibly largest requirements
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	Not modular
GAS TURB GEN(NF)	Not modular
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	Not modular
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	Modular for most requirements
WIND TURB GEN 10-5	Modular for most requirements
WIND TURB GEN 20-1	Modular for most requirements
WIND TURB GEN 20-5	Modular for most requirements
FLYWHEEL STORAGE	Modular for most requirements
BATTERY STORAGE	Fully modular

REQUIREMENT	PARAMETER
50 KW 1 Hr.	14) Reliability/Availability

The tabulated conditions exist in the power system to the extent indicated.

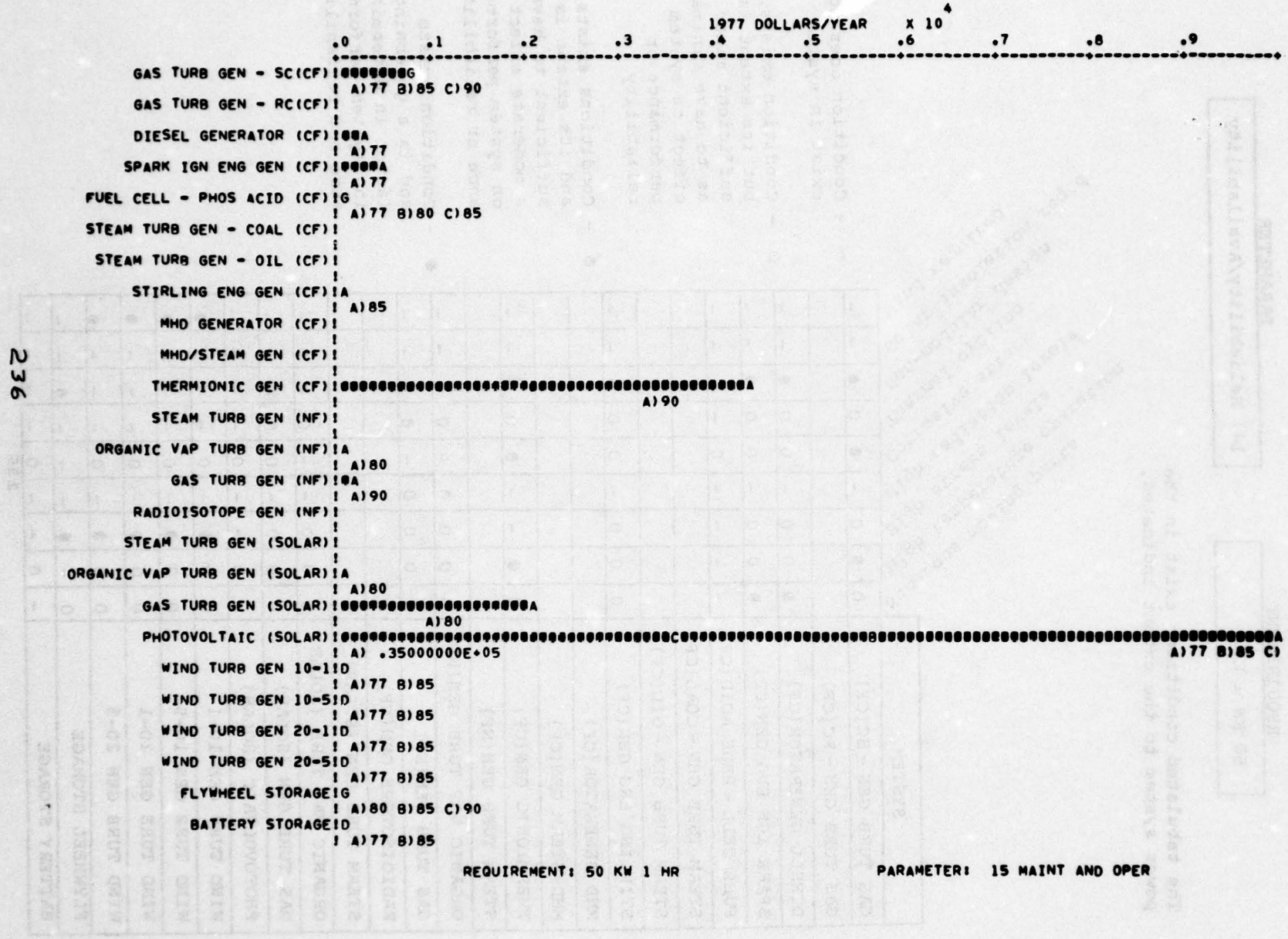
SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	O	●	O	-	●	O	●	-	-
GAS TURB GEN - RC(CF)									
DIESEL GENERATOR(CF)	●	O	O	-	O	O	●	-	-
SPARK IGN ENG GEN(CF)	●	O	O	-	O	O	●	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	O	-	-	-	-
STEAM TURB GEN - COAL(CF)									
STEAM TURB GEN - OIL(CF)									
STIRLING ENG GEN(CF)	O	O	O	-	O	O	●	-	-
MHD GENERATOR(CF)									
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	O	●	-	-	●	O	O	-	-
STEAM TURB GEN(NF)									
ORGANIC VAP TURB GEN(NF)	O	O	O	O	-	O	●	-	-
GAS TURB GEN(NF)	●	O	O	O	-	●	●	-	-
RADIOISOTOPE GEN(NF)									
STEAM TURB GEN (SOLAR)									
ORGANIC VAP TURB (SOLAR)	O	O	O	-	-	O	-	●	-
GAS TURB GEN (SOLAR)	O	O	O	-	O	O	-	●	-
PHOTOVOLTAIC (SOLAR)	-	O	-	-	O	-	-	●	-
WIND TURB GEN 10-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 10-5	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-5	O	O	●	-	O	-	-	-	●
FLYWHEEL STORAGE	O	-	●	-	-	-	●	-	-
BATTERY STORAGE	-	O	-	-	O	-	-	-	-

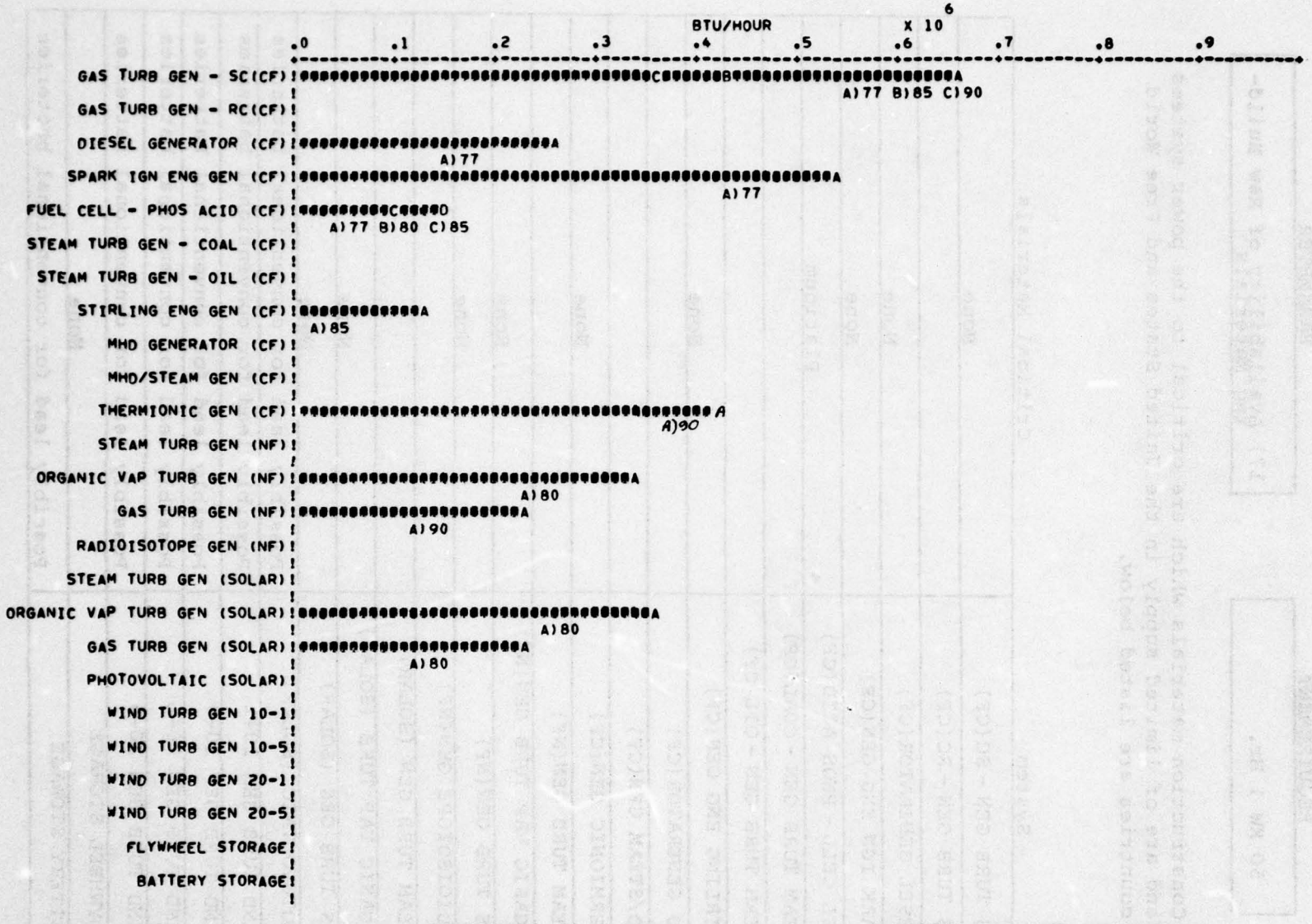
- - Condition does not exist in system

O - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability

● - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability

● - Condition exists and is a governing factor in determining system performance and reliability


1977 DOLLARS/YEAR X 10^4
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A) .35000000E+05
A)77 B)85 C)
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 50 KW 1 HR
PARAMETER: 15 MAINT AND OPER


BTU/HOUR
X 10 6
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
A)80
GAS TURB GEN (NF)
A)90
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 50 KW 1 HR
PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
50 KW 1 Hr.	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

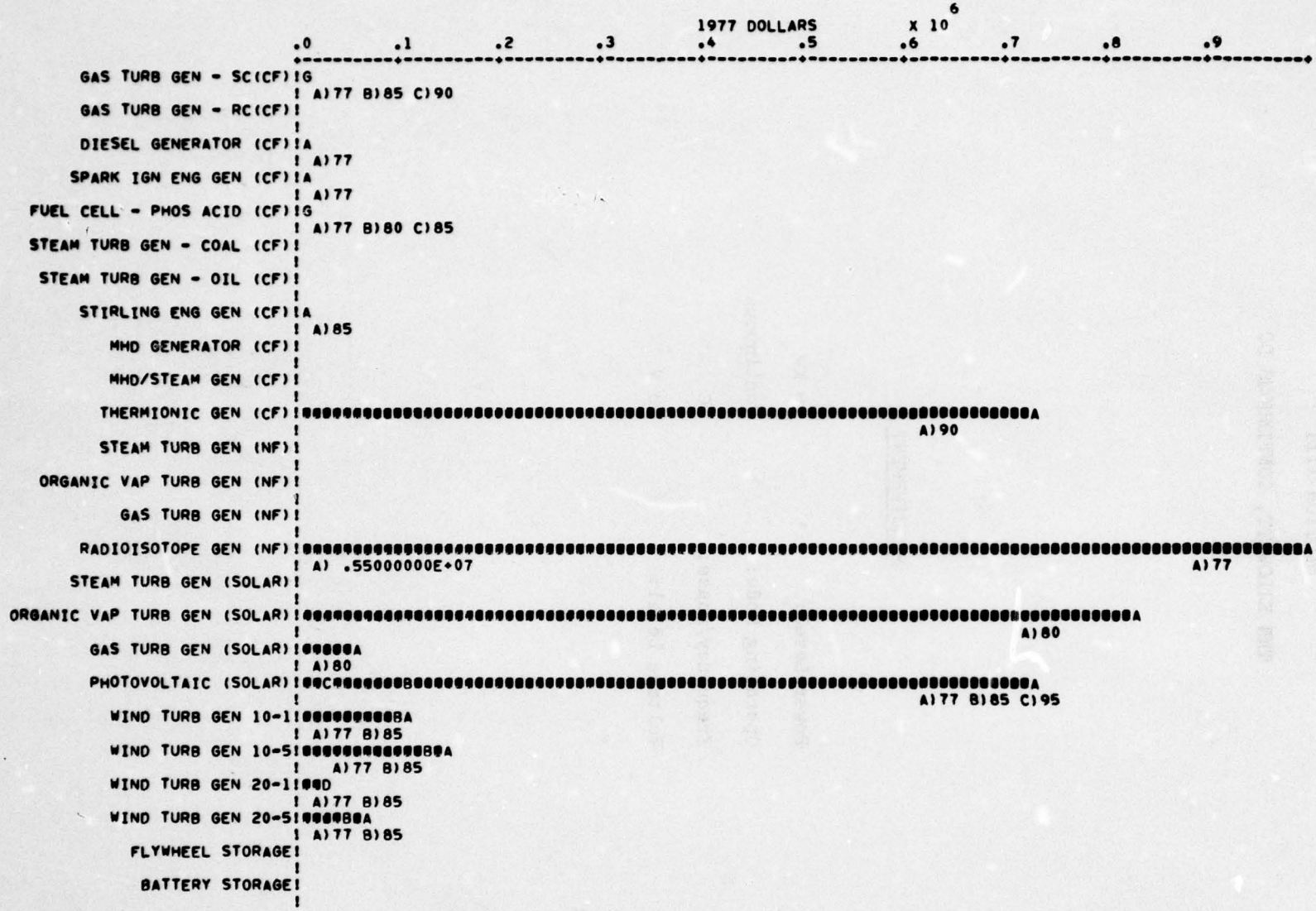
System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	None
SPARK IGN ENG GEN(CF)	None
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	None
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	None
GAS TURB GEN(NF)	None
RADIOISOTOPE GEN(NF)	
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	None
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	Possibly lead for conventional batteries
WIND TURB GEN 10-5	Possibly lead for conventional batteries
WIND TURB GEN 20-1	Possibly lead for conventional batteries
WIND TURB GEN 20-5	Possibly lead for conventional batteries
FLYWHEEL STORAGE	None
BATTERY STORAGE	Possibly lead for conventional batteries

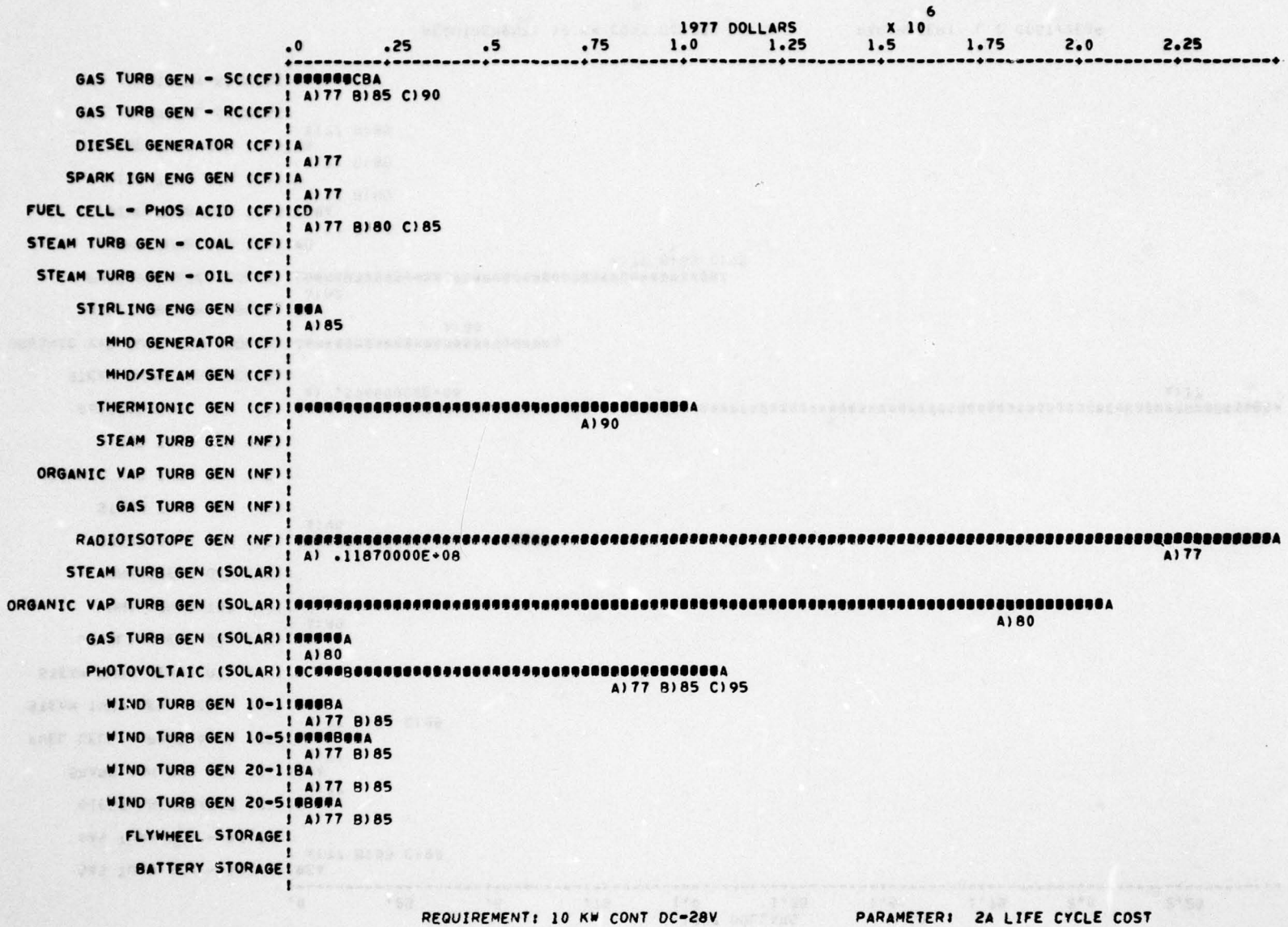
SECTION XIII

TEN KILOWATT, CONTINUOUS DC

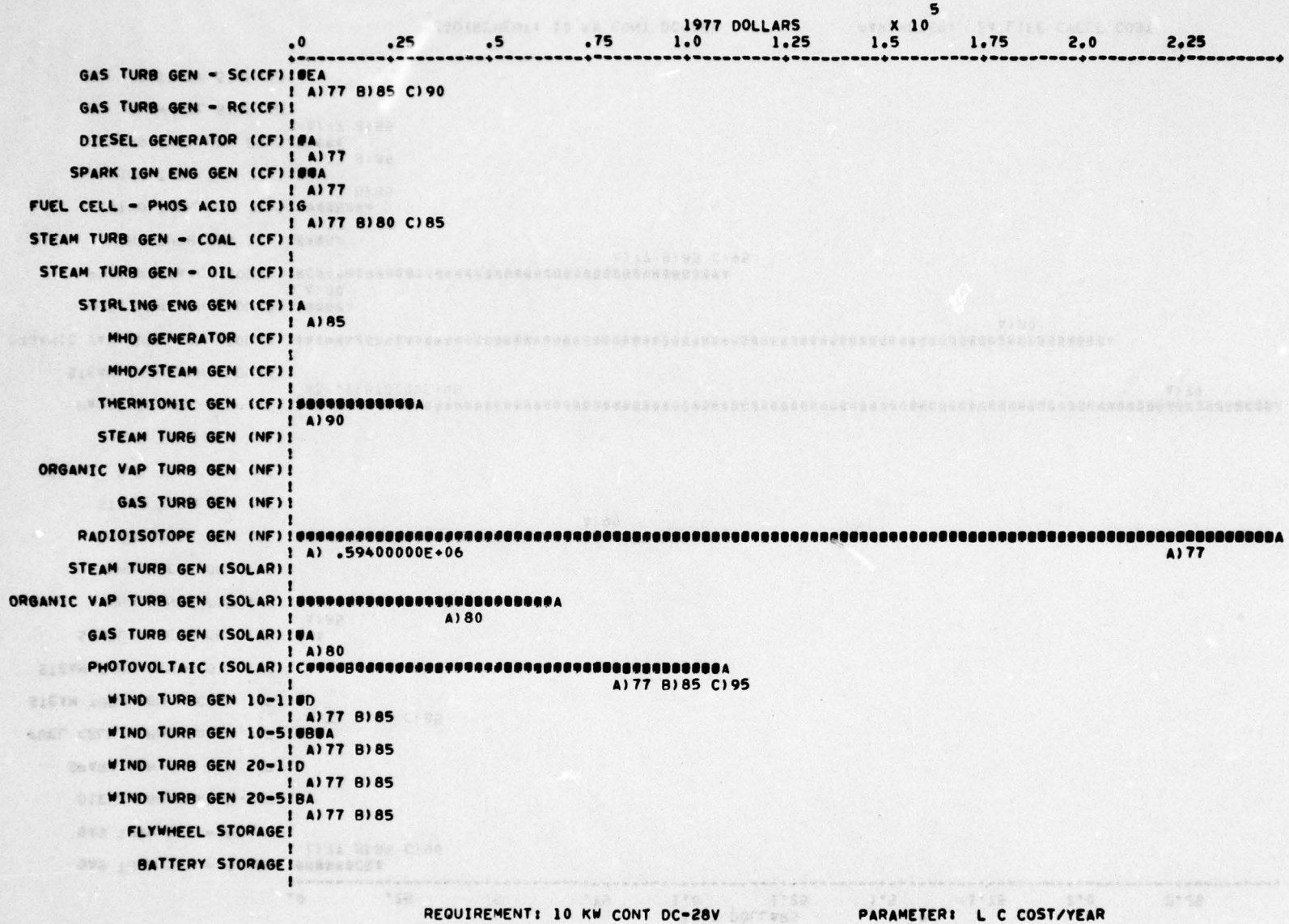
REQUIREMENT

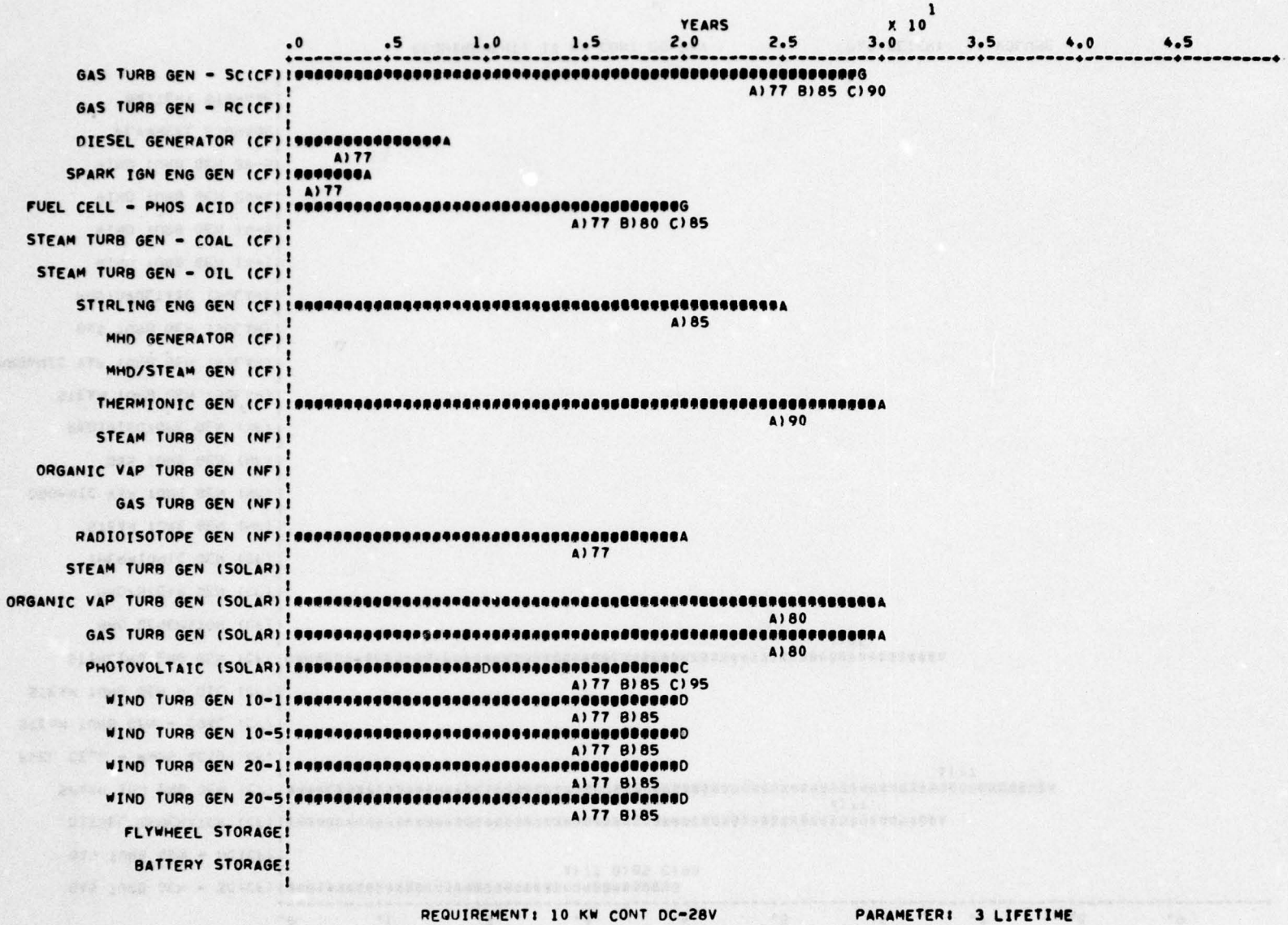
Power Level:	10 Kw
Operating Mode:	Continuous
Frequency/Phase:	DC
Voltage Level:	28 V

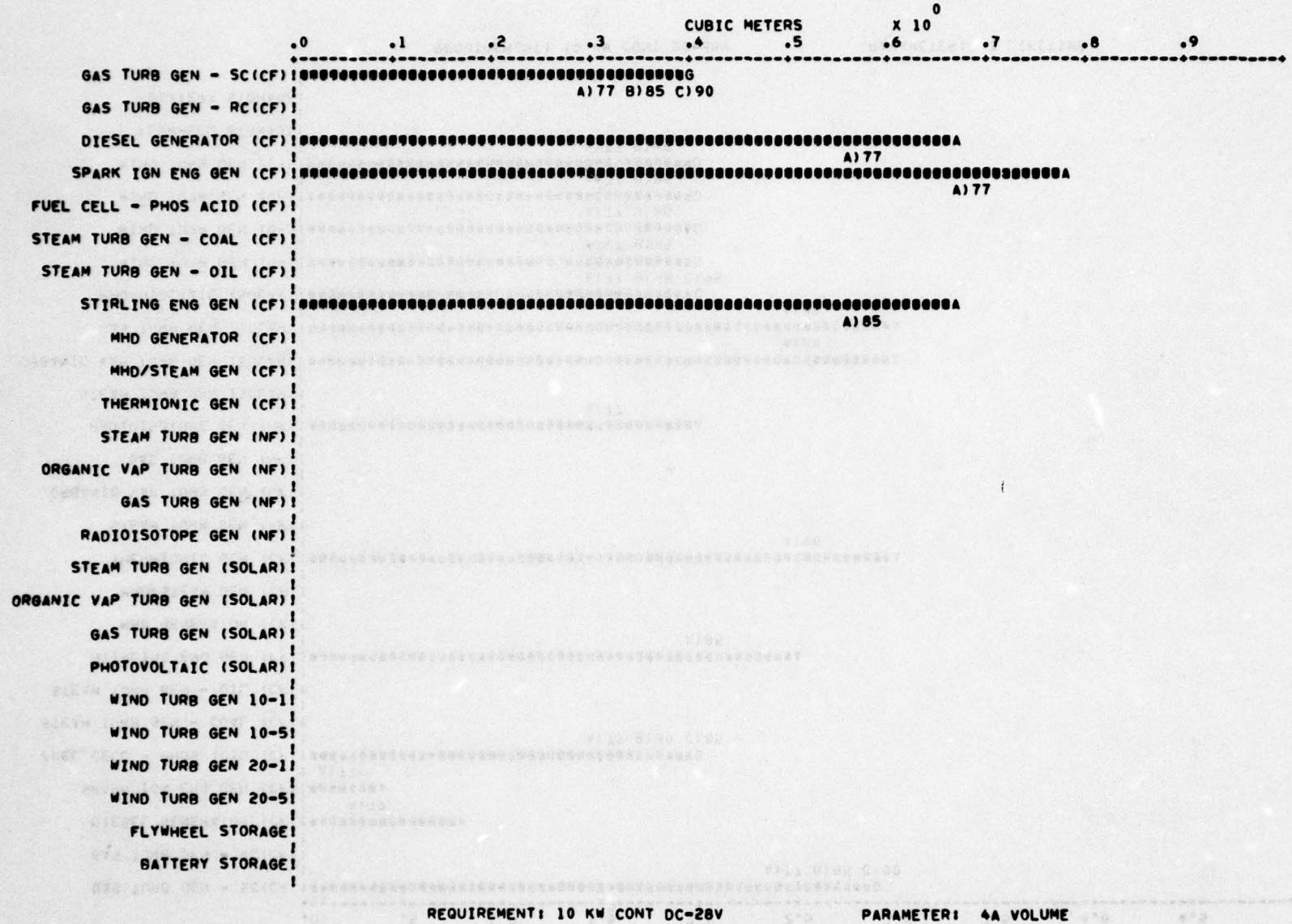

1977 DOLLARS
X 10^6
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A) .55000000E+07
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT DC-28V
PARAMETER: 1 ACQUISITION COST



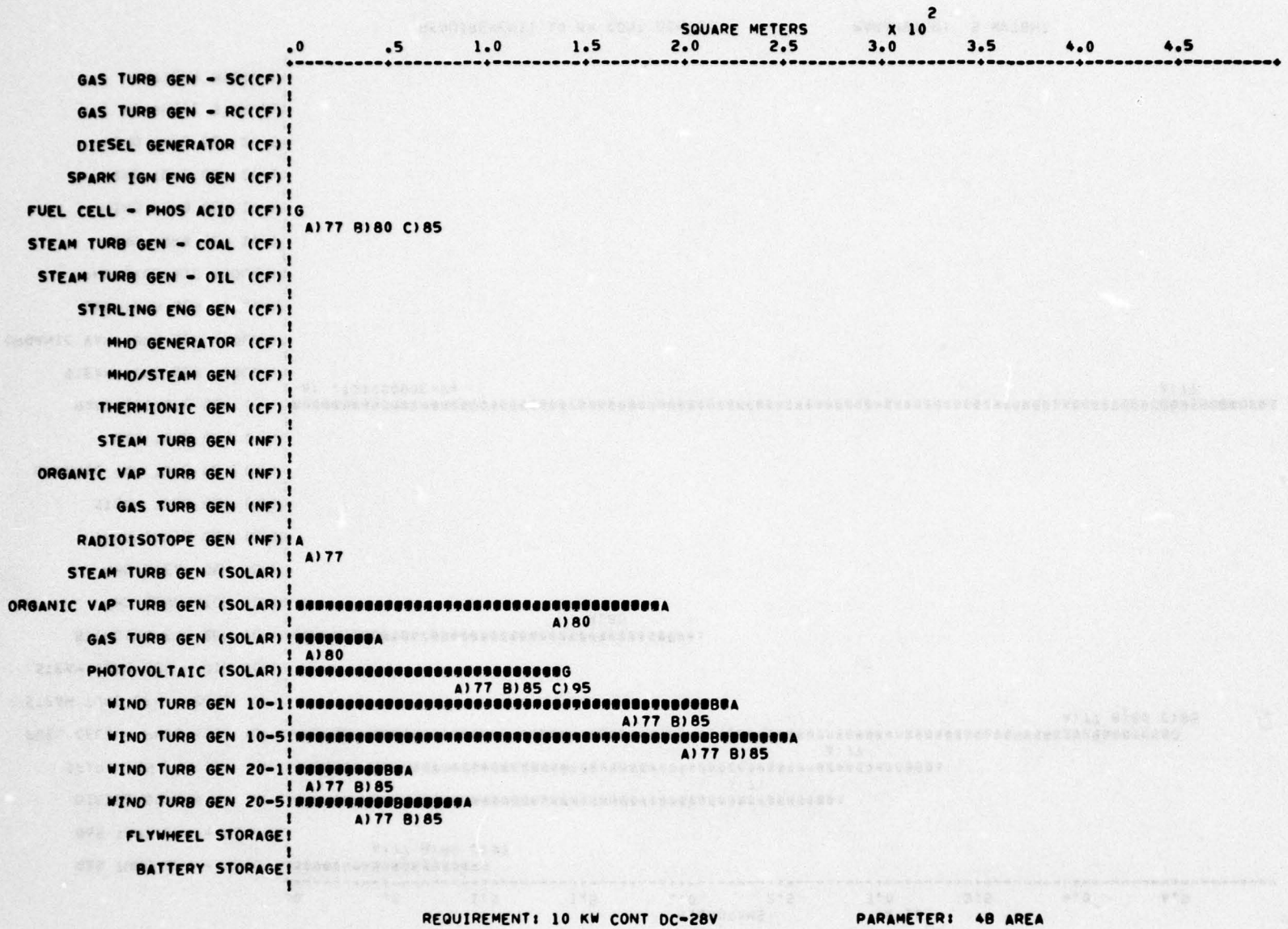
REQUIREMENT: 10 KW CONT DC-28V PARAMETER: 2A LIFE CYCLE COST


1977 DOLLARS
X 10^5
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A) .59400000E+06
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT DC-28V
PARAMETER: L C COST/YEAR

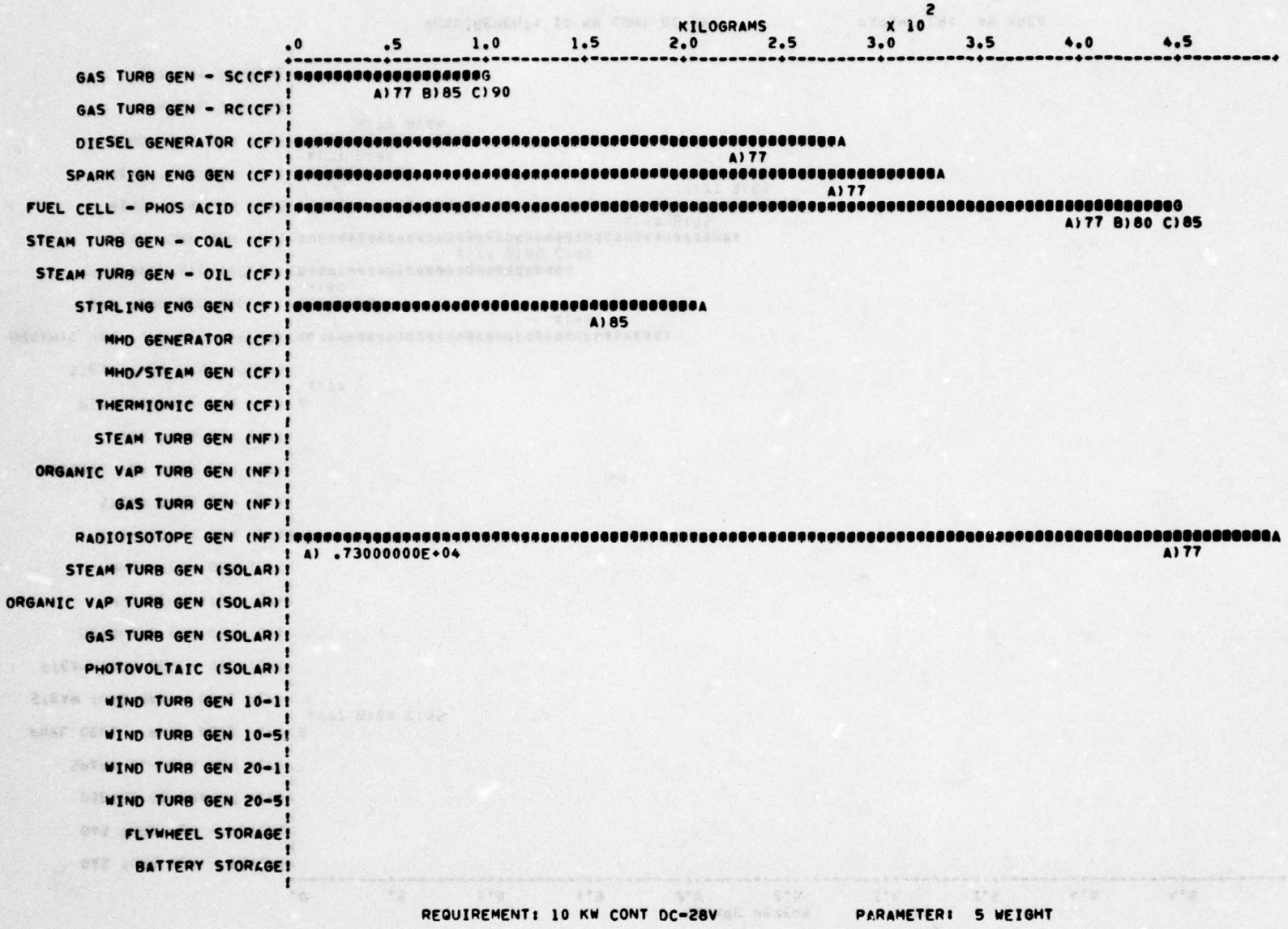

YEARS
X 10 1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT DC-28V
PARAMETER: 3 LIFETIME



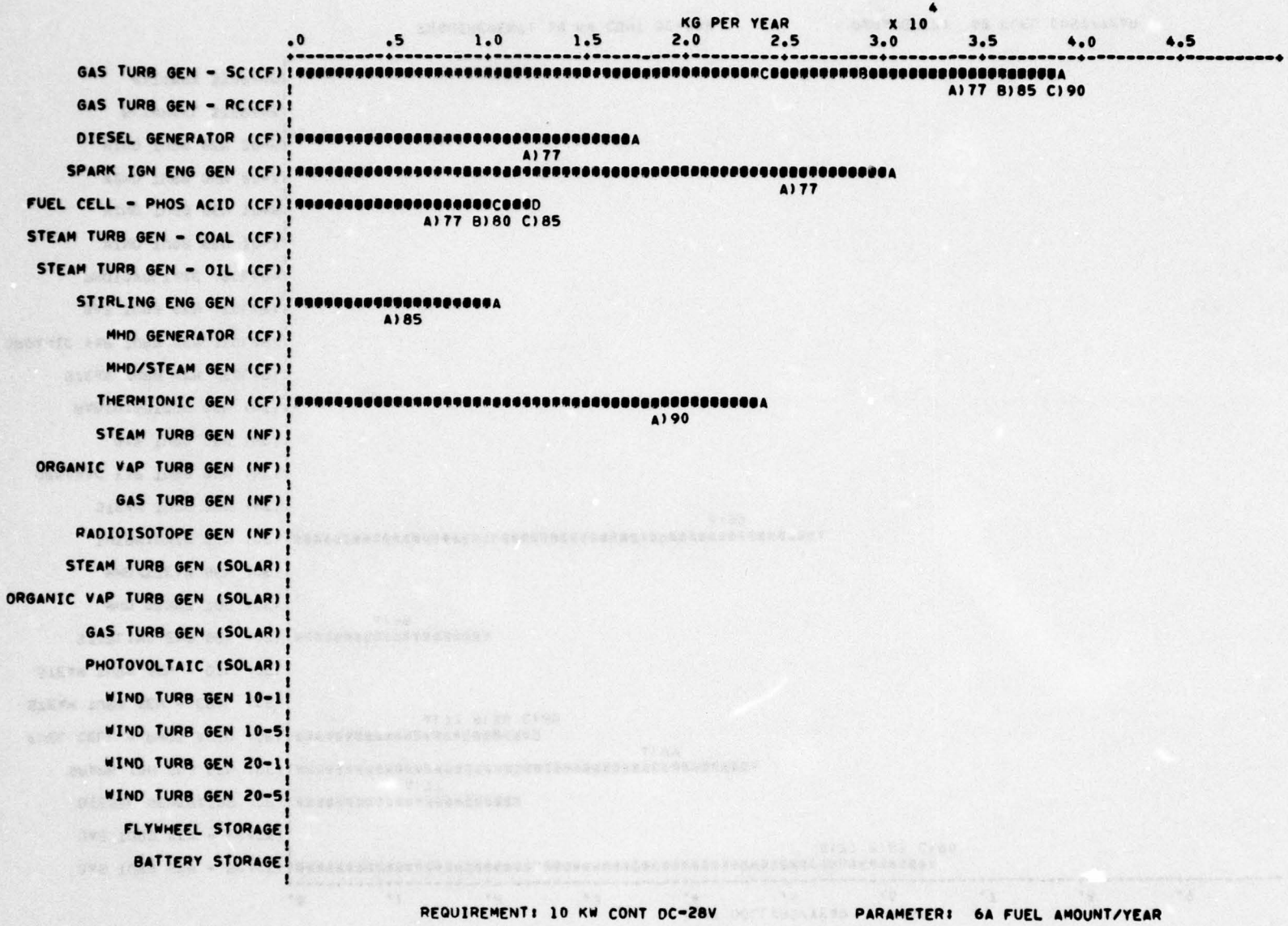
REQUIREMENT: 10 KW CONT DC-28V PARAMETER: 4A VOLUME



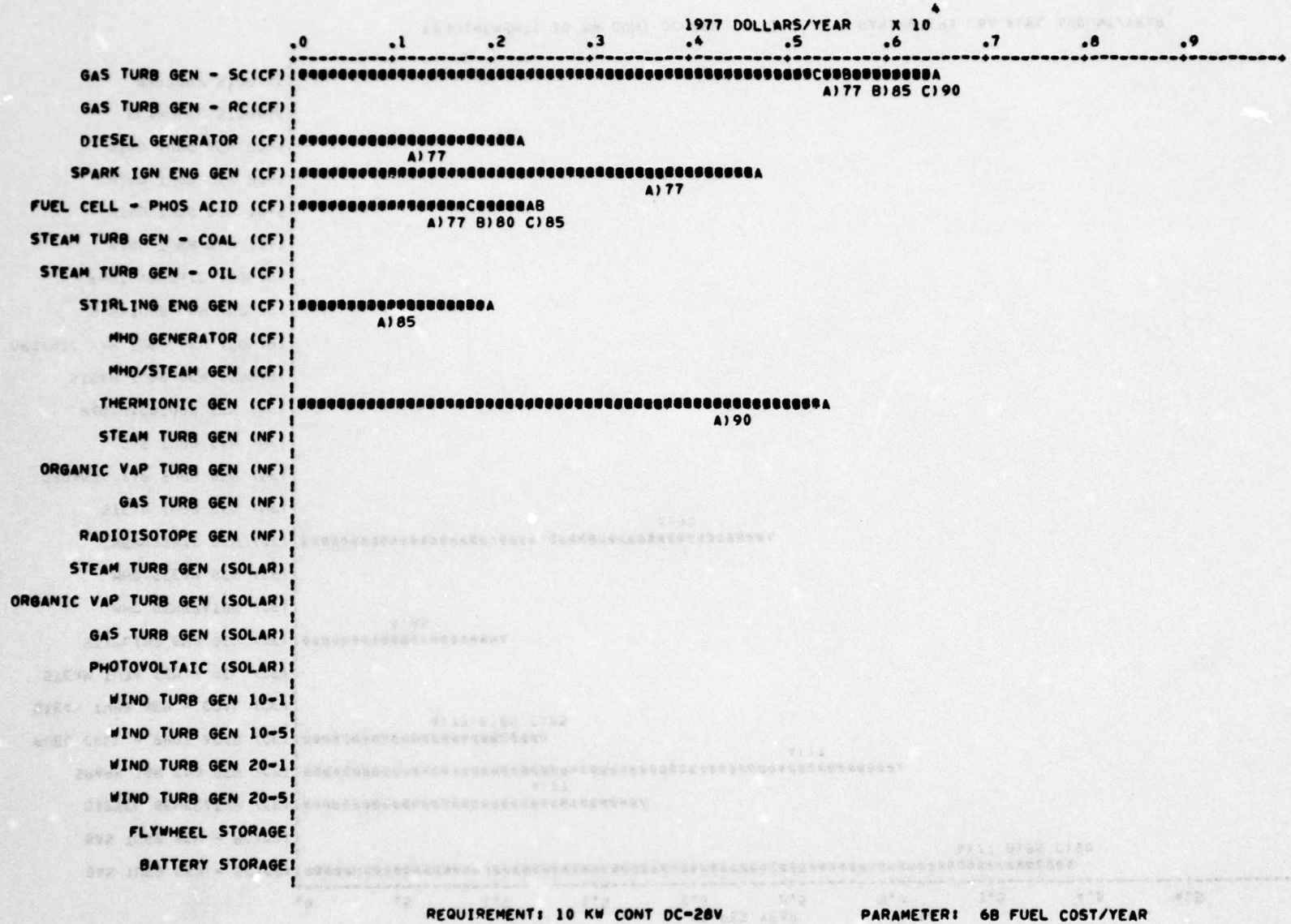
REQUIREMENT: 10 KW CONT DC-28V PARAMETER: 48 AREA



REQUIREMENT: 10 KW CONT DC-28V PARAMETER: 5 WEIGHT



REQUIREMENT: 10 KW CONT DC-28V PARAMETER: 6A FUEL AMOUNT/YEAR


1977 DOLLARS/YEAR X 10^4
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT DC-28V
PARAMETER: 6B FUEL COST/YEAR

REQUIREMENT	PARAMETER
10 KW Cont. DC-28V	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
GAS TURB GEN - RC(CF)											
DIESEL GENERATOR(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
SPARK IGN ENG GEN(CF)	-	-	0	0	◐	-	◐	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	◐	-	-	-	-
STEAM TURB GEN - COAL(CF)											
STEAM TURB GEN - OIL(CF)											
STIRLING ENG GEN(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
MHD GENERATOR(CF)											
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)	-	-	0	0	●	◐	0	◐	-	-	-
STEAM TURB GEN(NF)											
ORGANIC VAP TURB GEN(NF)											
GAS TURB GEN(NF)											
RADIOISOTOPE GEN(NF)	-	-	-	-	-	-	-	-	-	-	-
STEAM TURB GEN (SOLAR)											
ORGANIC VAP TURB (SOLAR)	-	●	-	-	-	-	◐	-	-	0	-
GAS TURB GEN (SOLAR)	-	-	-	-	-	-	◐	-	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
WIND TURB GEN (ALL)	-	-	-	-	-	-	-	-	-	-	-
FLYWHEEL STORAGE											
BATTERY STORAGE											

- - none
0 - minor
◐ - moderate
● - major

REQUIREMENT

10 KW Cont. DC-28V

PARAMETER

8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- - - no limitation
- O - minor limitation
- ⊖ - major limitation
- ● - overriding limitation

SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	O	●	-	-	-	-
GAS TURB GEN - RC(CF)								
DIESEL GENERATOR(CF)	-	-	-	●	-	-	-	-
SPARK IGN ENG GEN(CF)	-	-	-	●	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)								
STEAM TURB GEN - OIL(CF)								
STIRLING ENG GEN(CF)	-	-	O	●	-	-	-	-
MHD GENERATOR(CF)								
MHD/STEAM GEN(CF)								
THERMIONIC GEN(CF)	O	O	O	●	-	-	-	-
STEAM TURB GEN(NF)								
ORGANIC VAP TURB GEN(NF)								
GAS TURB GEN(NF)								
RADIOISOTOPE GEN(NF)	-	-	-	-	-	-	●	-
STEAM TURB GEN (SOLAR)								
ORGANIC VAP TURB (SOLAR)	⊖	-	O	-	●	-	-	-
GAS TURB GEN (SOLAR)	-	-	O	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1	-	-	-	-	-	●	-	-
WIND TURB GEN 10-5	-	-	-	-	-	●	-	-
WIND TURB GEN 20-1	-	-	-	-	-	●	-	-
WIND TURB GEN 20-5	-	-	-	-	-	●	-	-
FLYWHEEL STORAGE								
BATTERY STORAGE								

REQUIREMENT

10 KW Cont. DC-28V

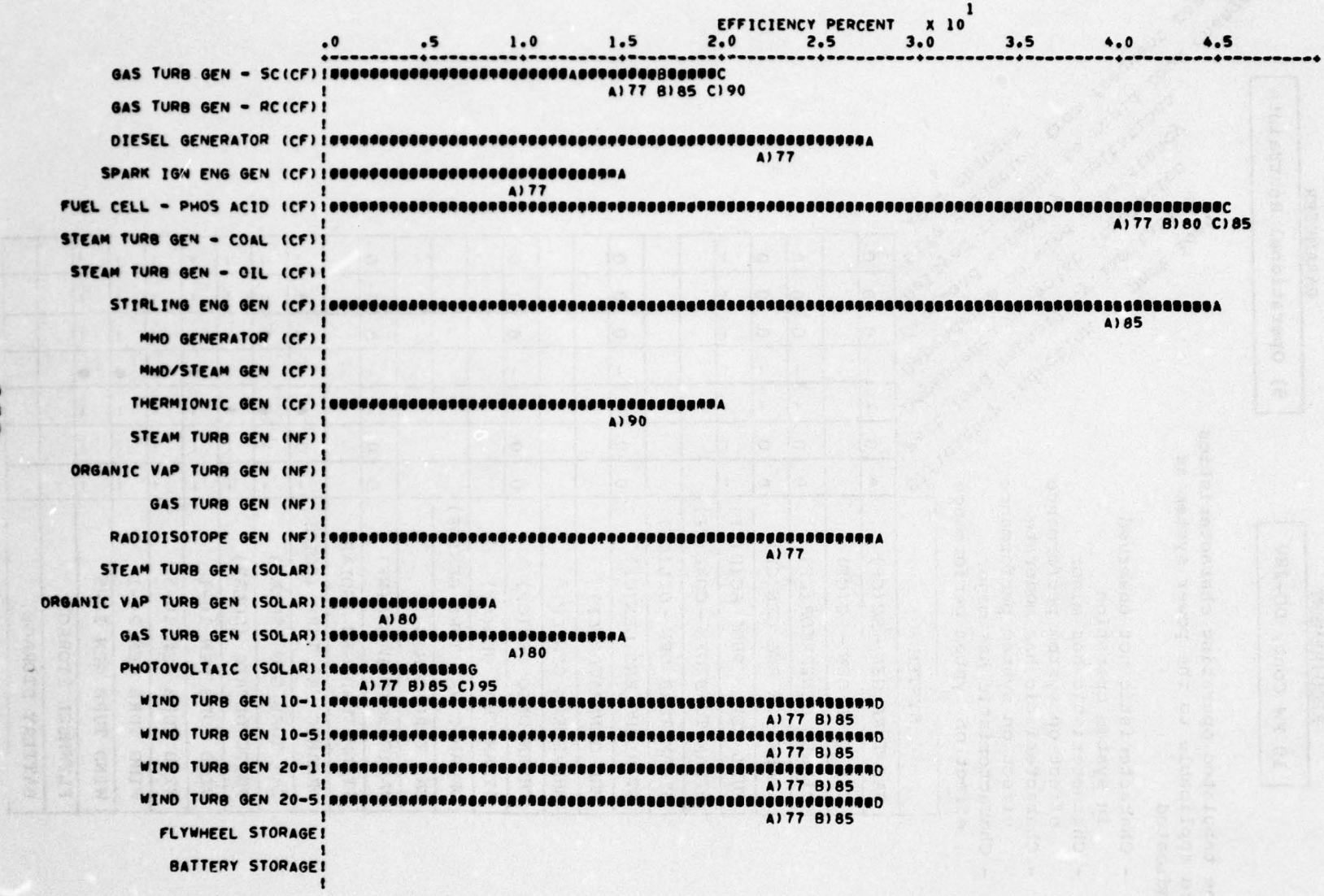
PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- \- - Characteristic not observed in system operation
- 0 - Characteristic has minor effect on system performance
- ⊖ - Characteristic has moderate effect on system performance
- ● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	⊖	0	-	-	0	0	0
GAS TURB GEN - RC(CF)							
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)	⊖	0	-	-	0	0	0
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)							
STEAM TURB GEN - OIL(CF)							
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)							
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	⊖	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)							
GAS TURB GEN(NF)							
RADIOISOTOPE GEN(NF)	0	0	-	-	⊖	0	0
STEAM TURB GEN (SOLAR)							
ORGANIC VAP TURB (SOLAR)	-	0	●	-	⊖	⊖	-
GAS TURB GEN (SOLAR)	-	-	●	-	⊖	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE							
BATTERY STORAGE							



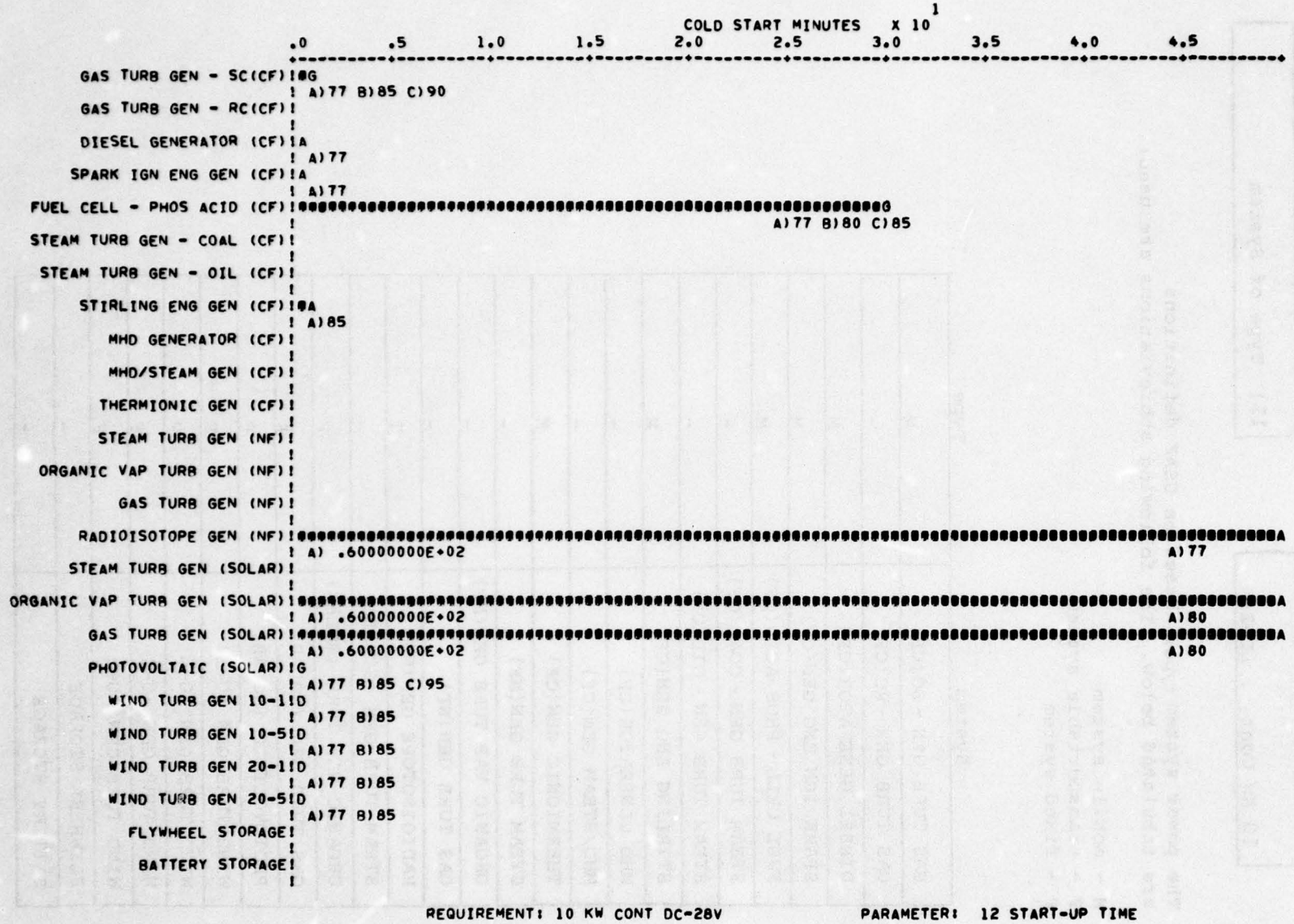
REQUIREMENT: 10 KW CONT DC-28V PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
10 KW Cont . DC-28V	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	M
GAS TURB GEN - RC(CF)	-
DIESEL GENERATOR(CF)	M
SPARK IGN ENG GEN(CF)	M
FUEL CELL - PHOS ACID(CF)	M
STEAM TURB GEN - COAL(CF)	-
STEAM TURB GEN - OIL(CF)	-
STIRLING ENG GEN(CF)	M
MHD GENERATOR(CF)	-
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	M
STEAM TURB GEN(NF)	-
ORGANIC VAP TURB GEN(NF)	-
GAS TURB GEN(NF)	-
RADIOISOTOPE GEN(NF)	T
STEAM TURB GEN (SOLAR)	-
ORGANIC VAP TURB (SOLAR)	F
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	F
WIND TURB GEN 10-5	F
WIND TURB GEN 20-1	F
WIND TURB GEN 20-5	F
FLYWHEEL STORAGE	-
BATTERY STORAGE	-



REQUIREMENT: 10 KW CONT DC-28V PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
10 KW Cont. DC-28V	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	Not modular, except possibly largest requirements
SPARK IGN ENG GEN(CF)	Not modular, except possibly largest requirements
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	Not modular, except possibly largest requirements
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	
RADIOISOTOPE GEN(NF)	Not modular
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	Not modular
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	Modular for most requirements
WIND TURB GEN 10-5	Modular for most requirements
WIND TURB GEN 20-1	Modular for most requirements
WIND TURB GEN 20-5	Modular for most requirements
FLYWHEEL STORAGE	
BATTERY STORAGE	

REQUIREMENT	PARAMETER
10 KW Cont. DC-28V	14) Reliability/Availability

The tabulated conditions exist in the power system to the extent indicated.

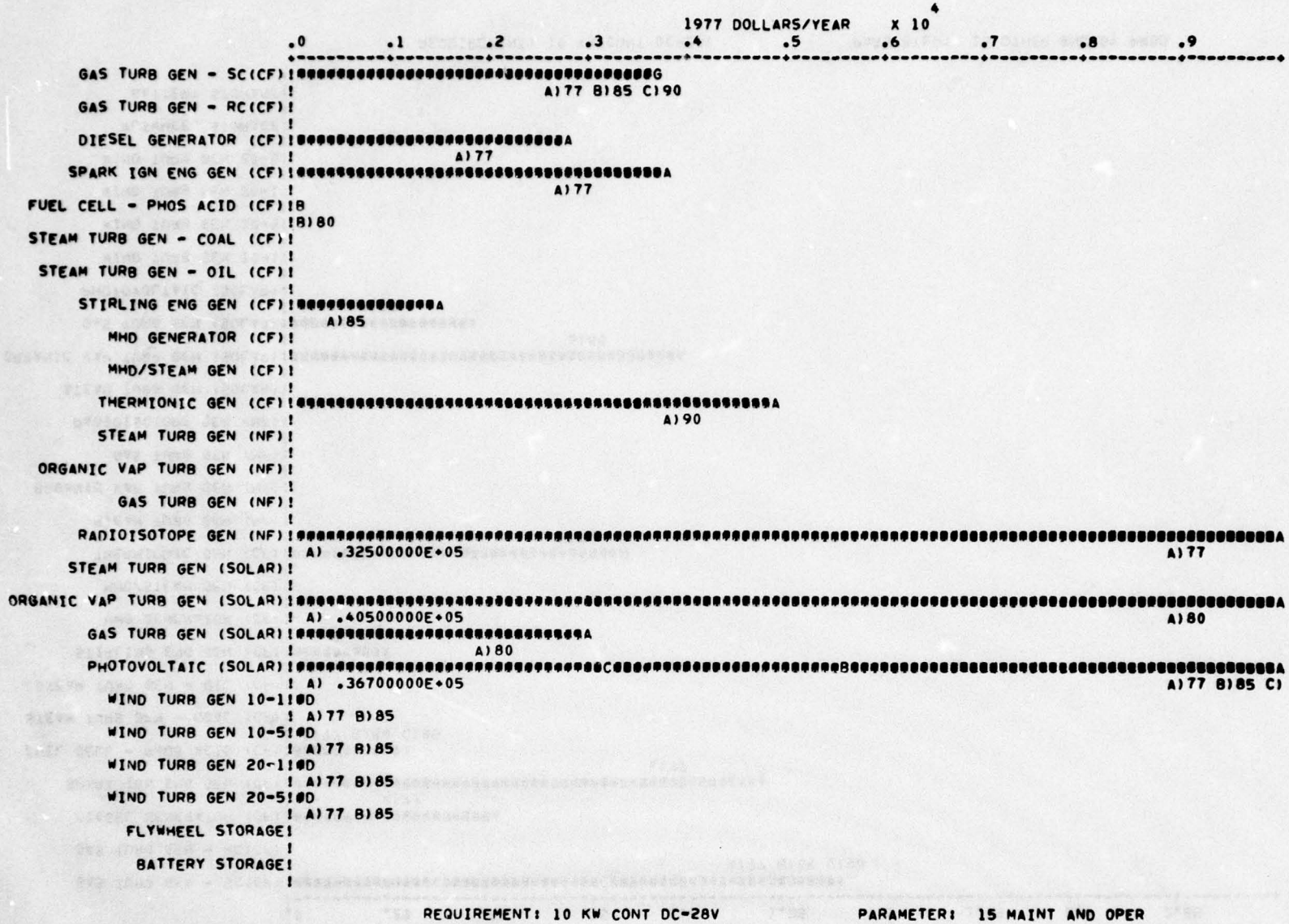
SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	o	●	o	-	●	o	●	-	-
GAS TURB GEN - RC(CF)									
DIESEL GENERATOR(CF)	●	o	o	-	o	o	●	-	-
SPARK IGN ENG GEN(CF)	●	o	o	-	o	o	●	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	o	-	-	-	-
STEAM TURB GEN - COAL(CF)									
STEAM TURB GEN - OIL(CF)									
STIRLING ENG GEN(CF)	o	o	o	-	o	o	●	-	-
MHD GENERATOR(CF)									
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	o	●	-	-	●	o	o	-	-
STEAM TURB GEN(NF)									
ORGANIC VAP TURB GEN(NF)									
GAS TURB GEN(NF)									
RADIOISOTOPE GEN(NF)	o	o	o	o	-	o	●	-	-
STEAM TURB GEN (SOLAR)									
ORGANIC VAP TURB (SOLAR)	o	o	o	-	-	o	-	●	-
GAS TURB GEN (SOLAR)	o	o	o	-	o	o	-	●	-
PHOTOVOLTAIC (SOLAR)	-	o	-	-	o	-	-	●	-
WIND TURB GEN 10-1	o	o	●	-	o	-	-	-	●
WIND TURB GEN 10-5	o	o	●	-	o	-	-	-	●
WIND TURB GEN 20-1	o	o	●	-	o	-	-	-	●
WIND TURB GEN 20-5	o	o	●	-	o	-	-	-	●
FLYWHEEL STORAGE									
BATTERY STORAGE									

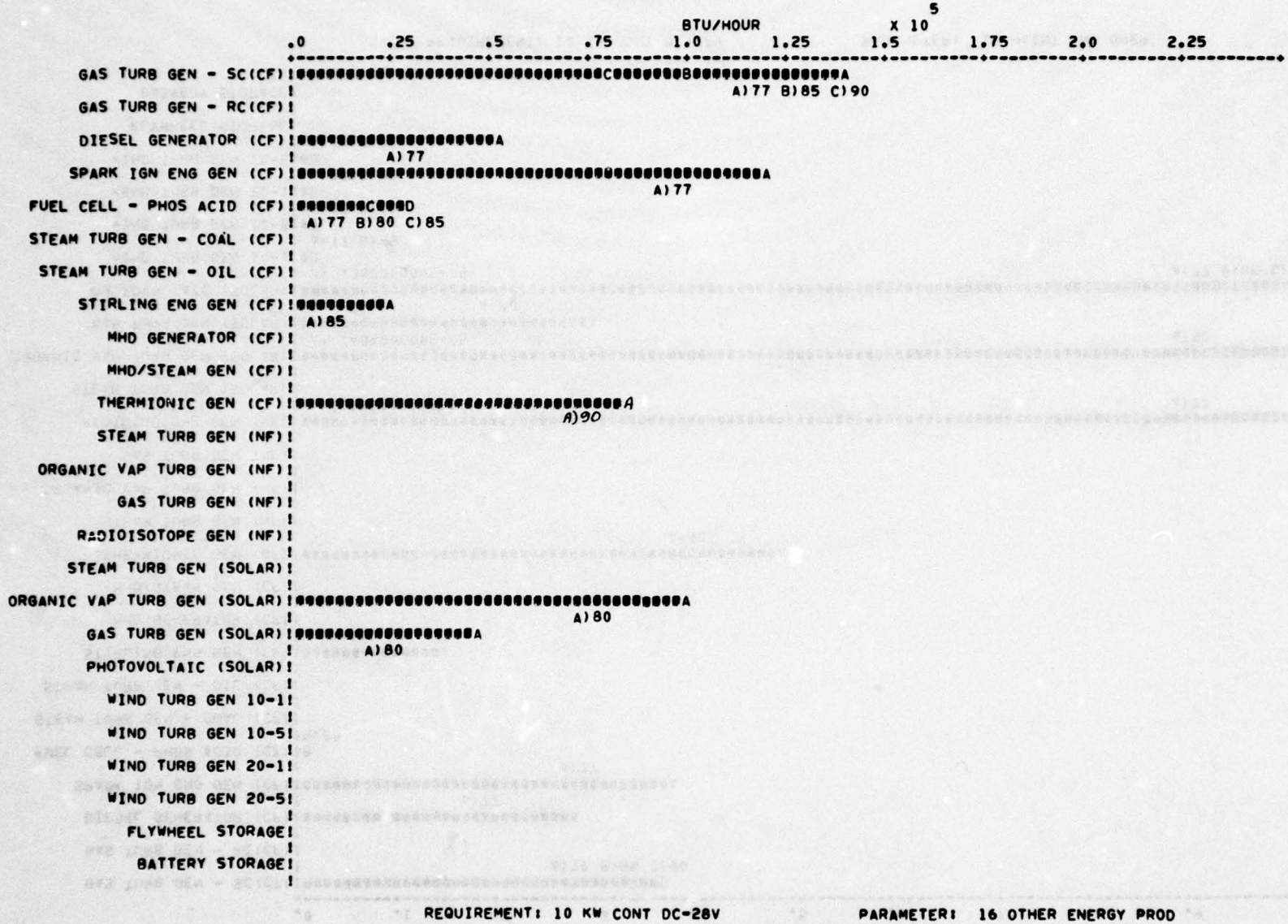
- \- - Condition does not exist in system

o - Condition exists, but its extent is sufficiently minor as to have minimal effect on system performance or reliability

● - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability

● - Condition exists and is a governing factor in determining system performance and reliability


1977 DOLLARS/YEAR x 10^4
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
B)80
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A) .32500000E+05
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A) .40500000E+05
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A) .36700000E+05
A)77 B)85 C)
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT DC-28V
PARAMETER: 15 MAINT AND OPER


BTU/HOUR
X 10^5
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT DC-28V
PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
10 KW Cont. DC-28V	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

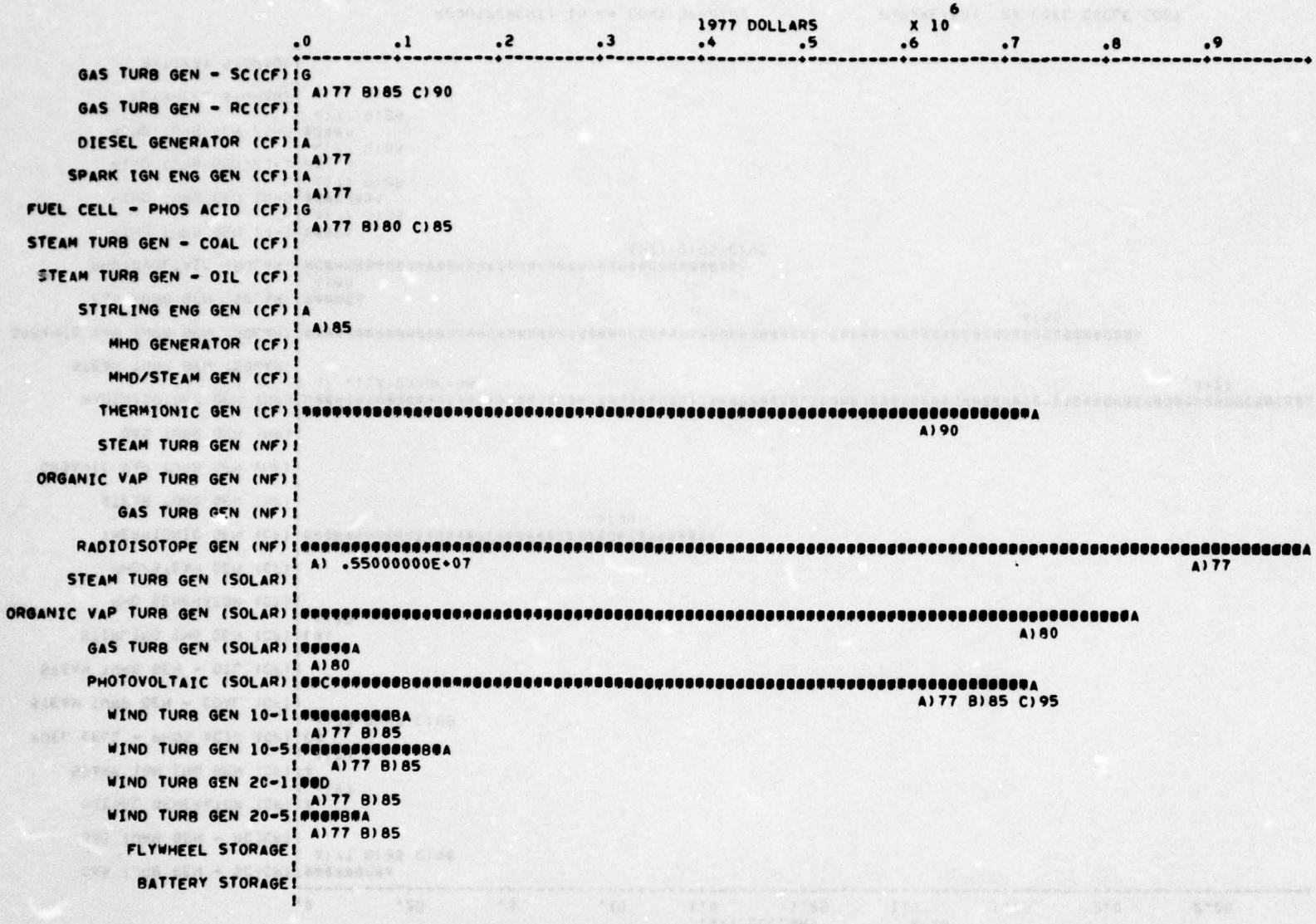
System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	None
SPARK IGN ENG GEN(CF)	None
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	None
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	
RADIOISOTOPE GEN(NF)	None
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	None
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	Possibly lead for conventional batteries
WIND TURB GEN 10-5	Possibly lead for conventional batteries
WIND TURB GEN 20-1	Possibly lead for conventional batteries
WIND TURB GEN 20-5	Possibly lead for conventional batteries
FLYWHEEL STORAGE	
BATTERY STORAGE	

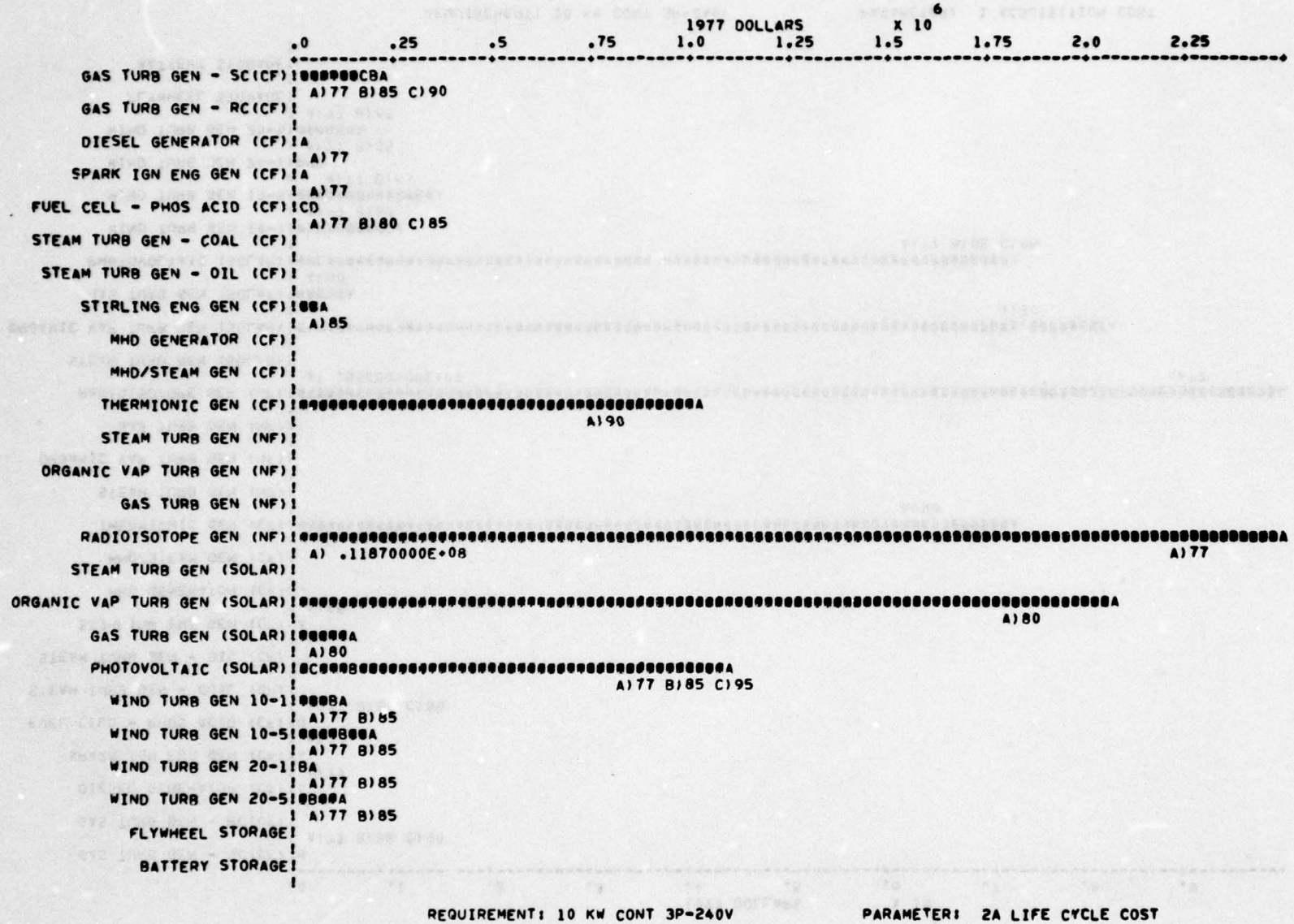
SECTION XIV

TEN KILOWATT, CONTINUOUS 3Ø

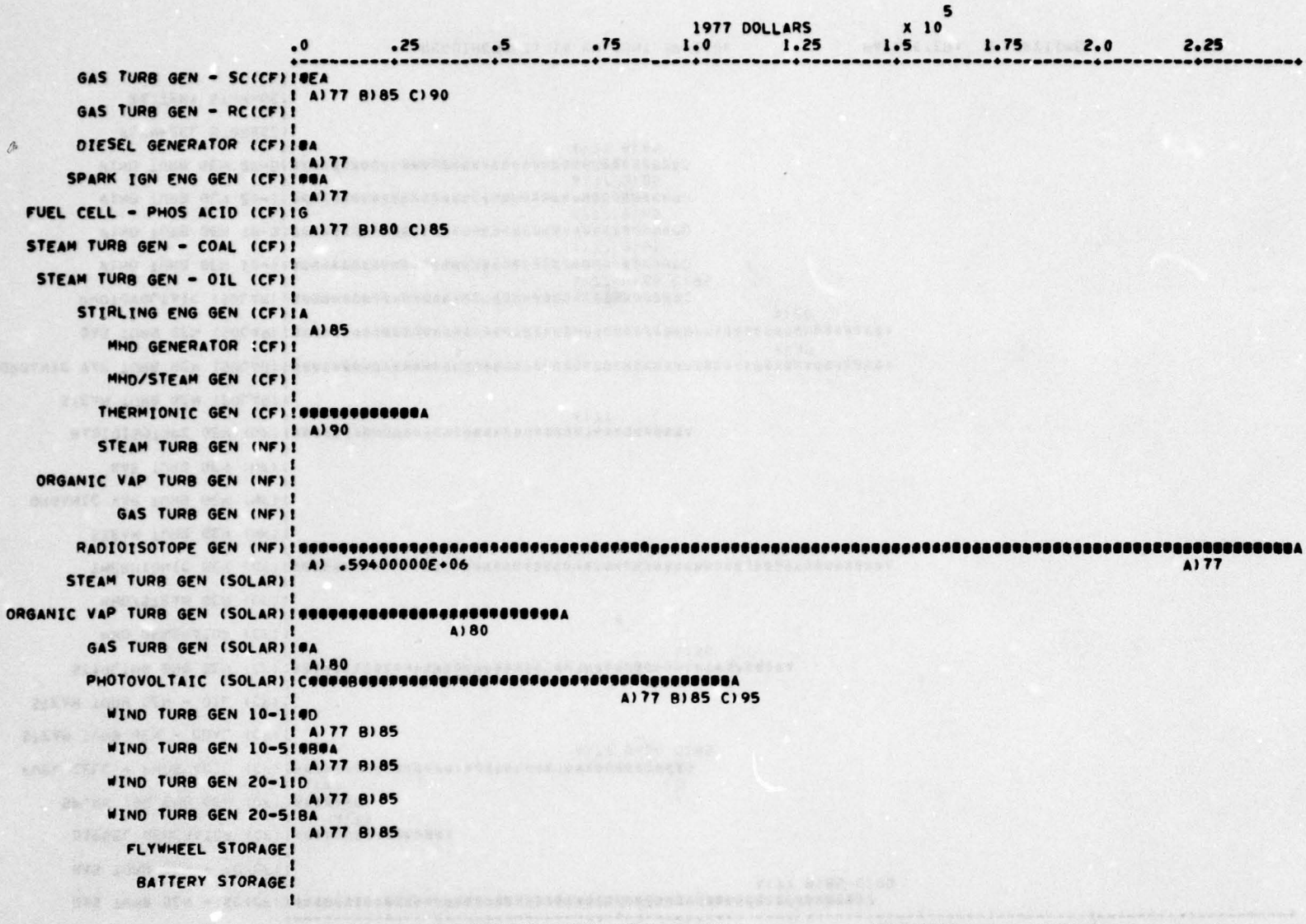
REQUIREMENT

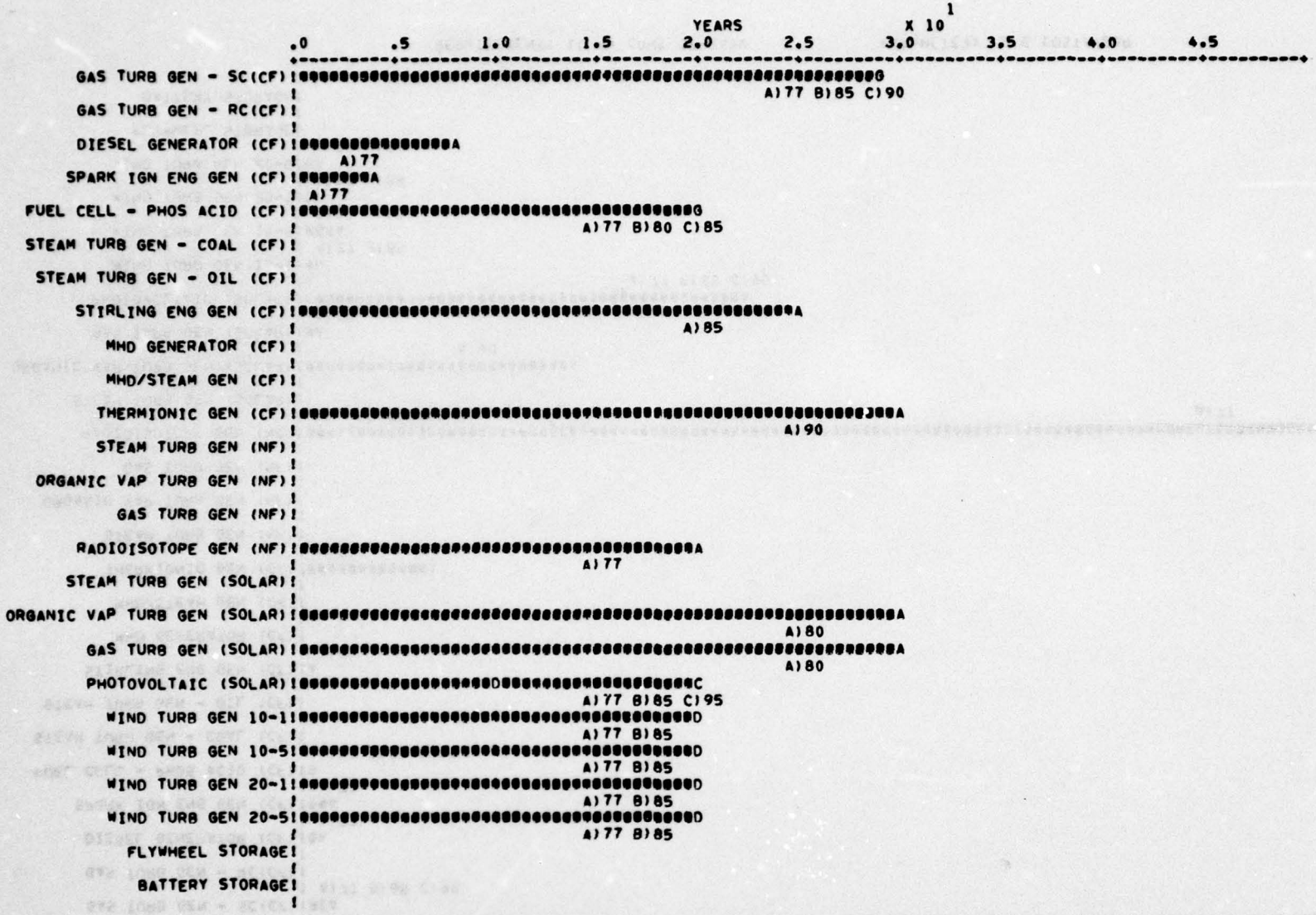
Power Level:	10 Kw
Operating Mode:	Continuous
Frequency/Phase:	60 Hz/3Ø
Voltage Level:	240 V


1977 DOLLARS
X 10^6
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A) .55000000E+07
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 3P-240V
PARAMETER: 1 ACQUISITION COST



REQUIREMENT: 10 KW CONT 3P-240V PARAMETER: 2A LIFE CYCLE COST


1977 DOLLARS
X 10^5
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A) 77 B) 85 C) 90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A) 77
SPARK IGN ENG GEN (CF)
A) 77
FUEL CELL - PHOS ACID (CF)
A) 77 B) 80 C) 85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A) 85
MHD GENERATOR :CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A) 90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A) .59400000E+06
A) 77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A) 80
GAS TURB GEN (SOLAR)
A) 80
PHOTOVOLTAIC (SOLAR)
A) 77 B) 85 C) 95
WIND TURB GEN 10-1
A) 77 B) 85
WIND TURB GEN 10-5
A) 77 B) 85
WIND TURB GEN 20-1
A) 77 B) 85
WIND TURB GEN 20-5
A) 77 B) 85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 3P-240V
PARAMETER: L C COST/YEAR


YEARS
X 10^1
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.5
1.0
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2.0
2.5
3.0
3.5
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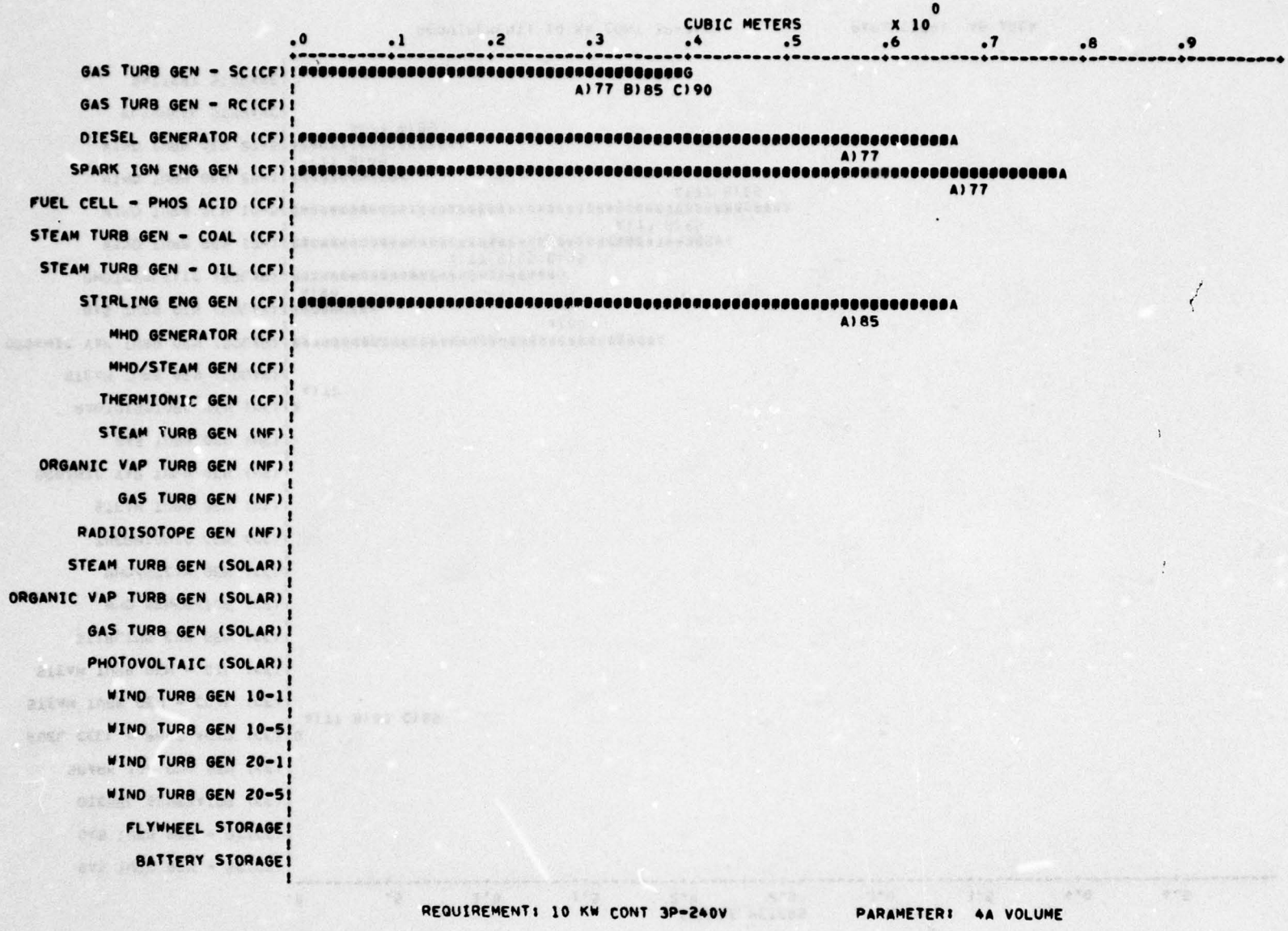
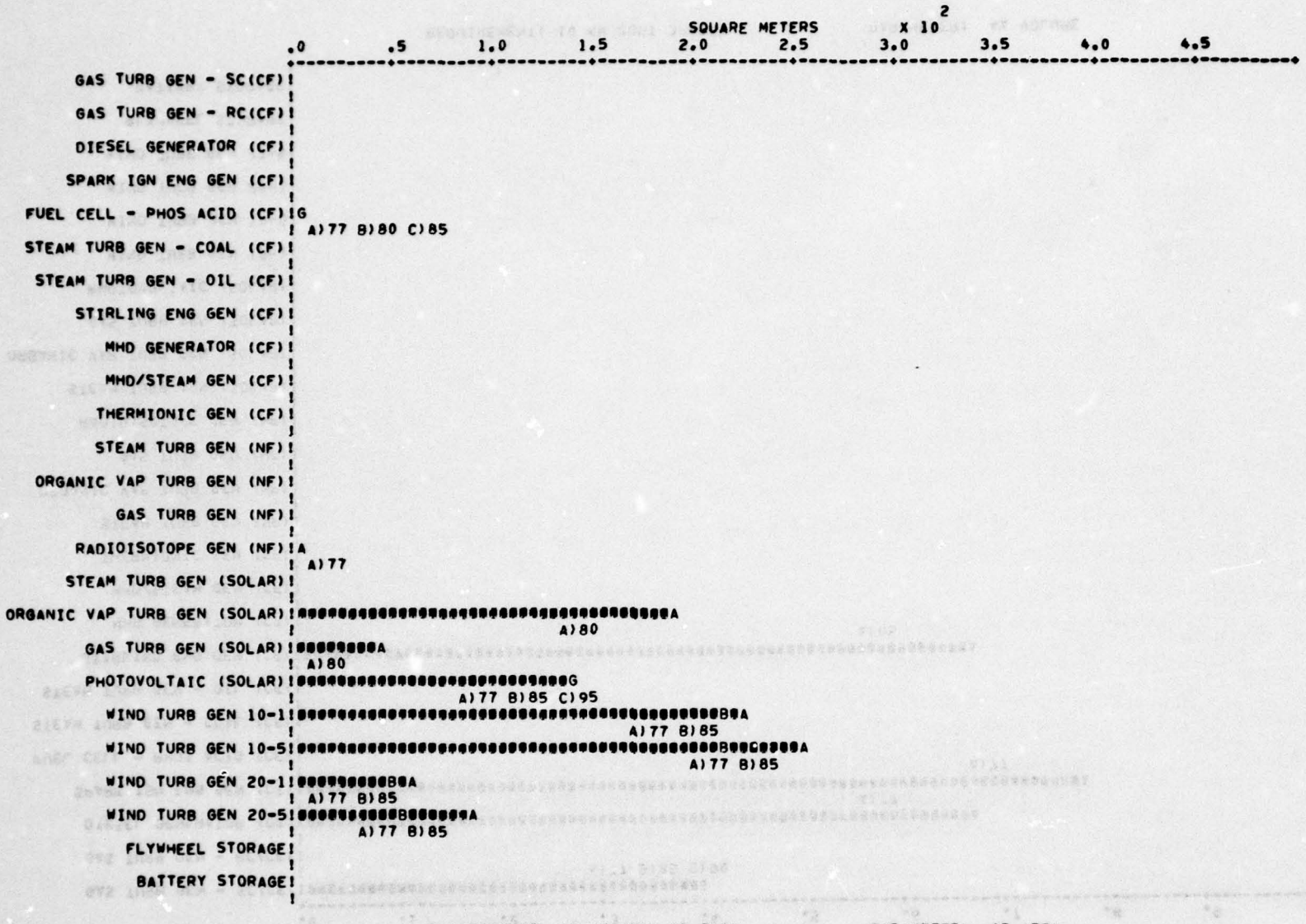
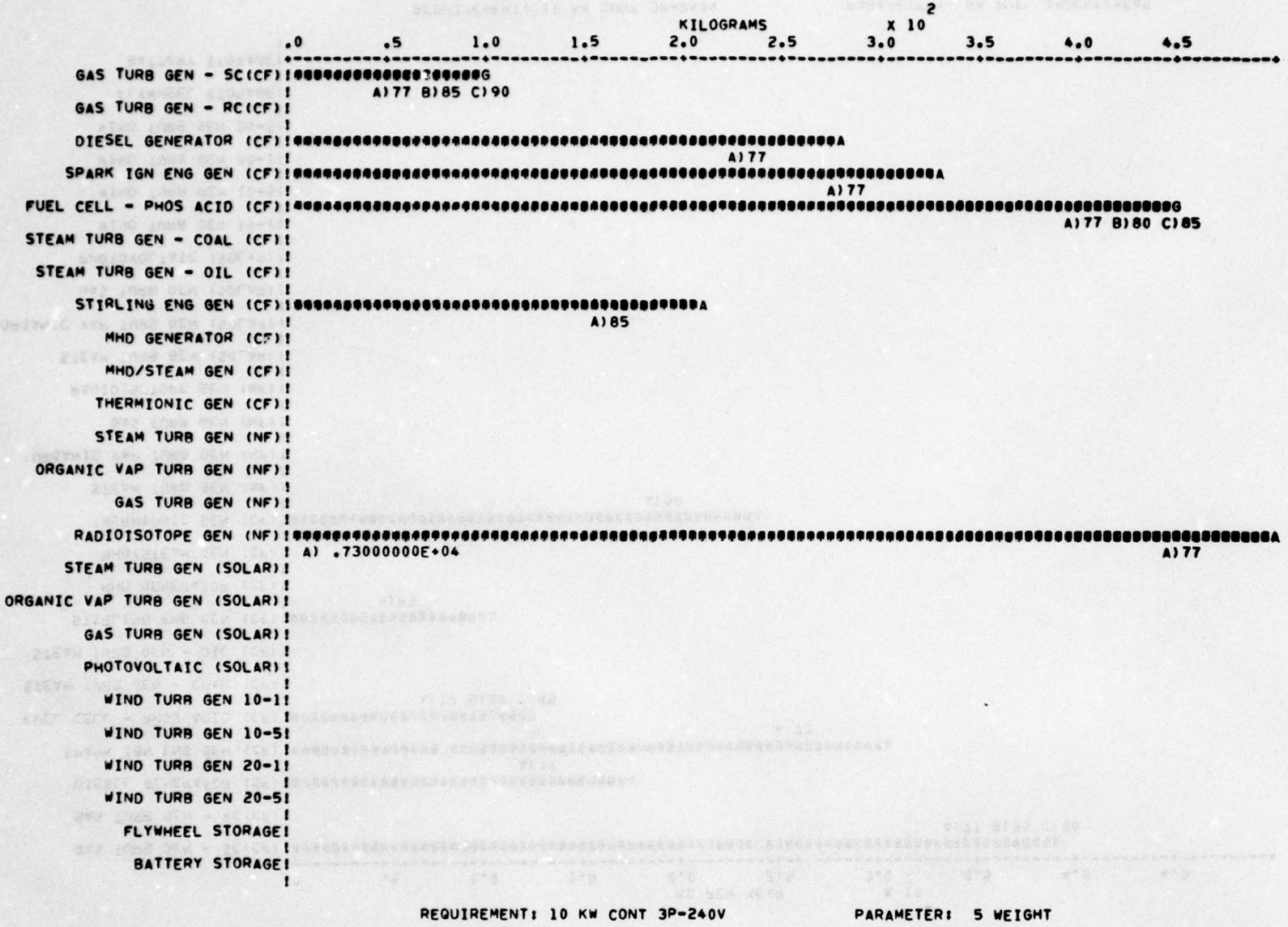
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 3P-240V
PARAMETER: 3 LIFETIME



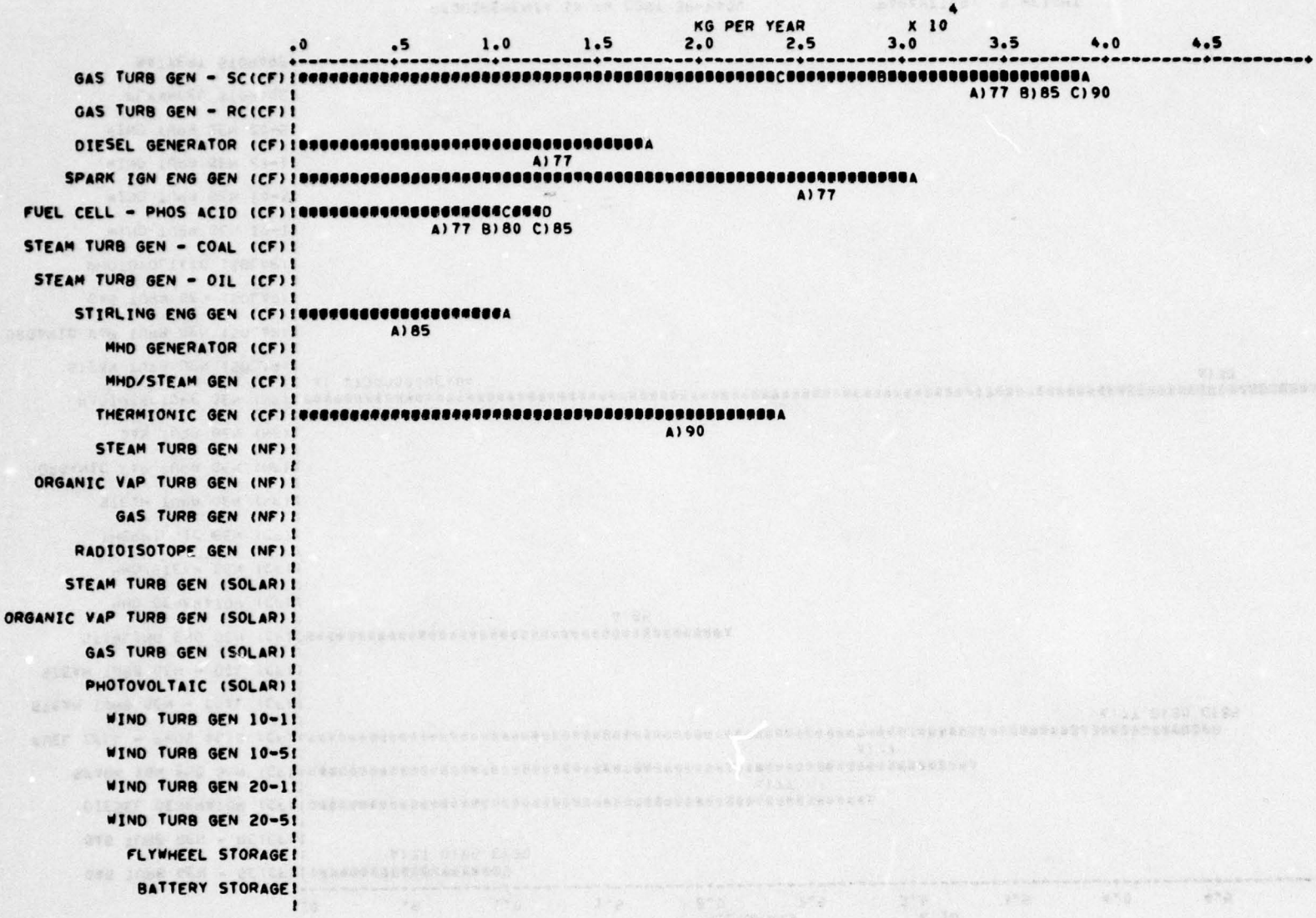
REQUIREMENT: 10 KW CONT 3P-240V PARAMETER: 4A VOLUME



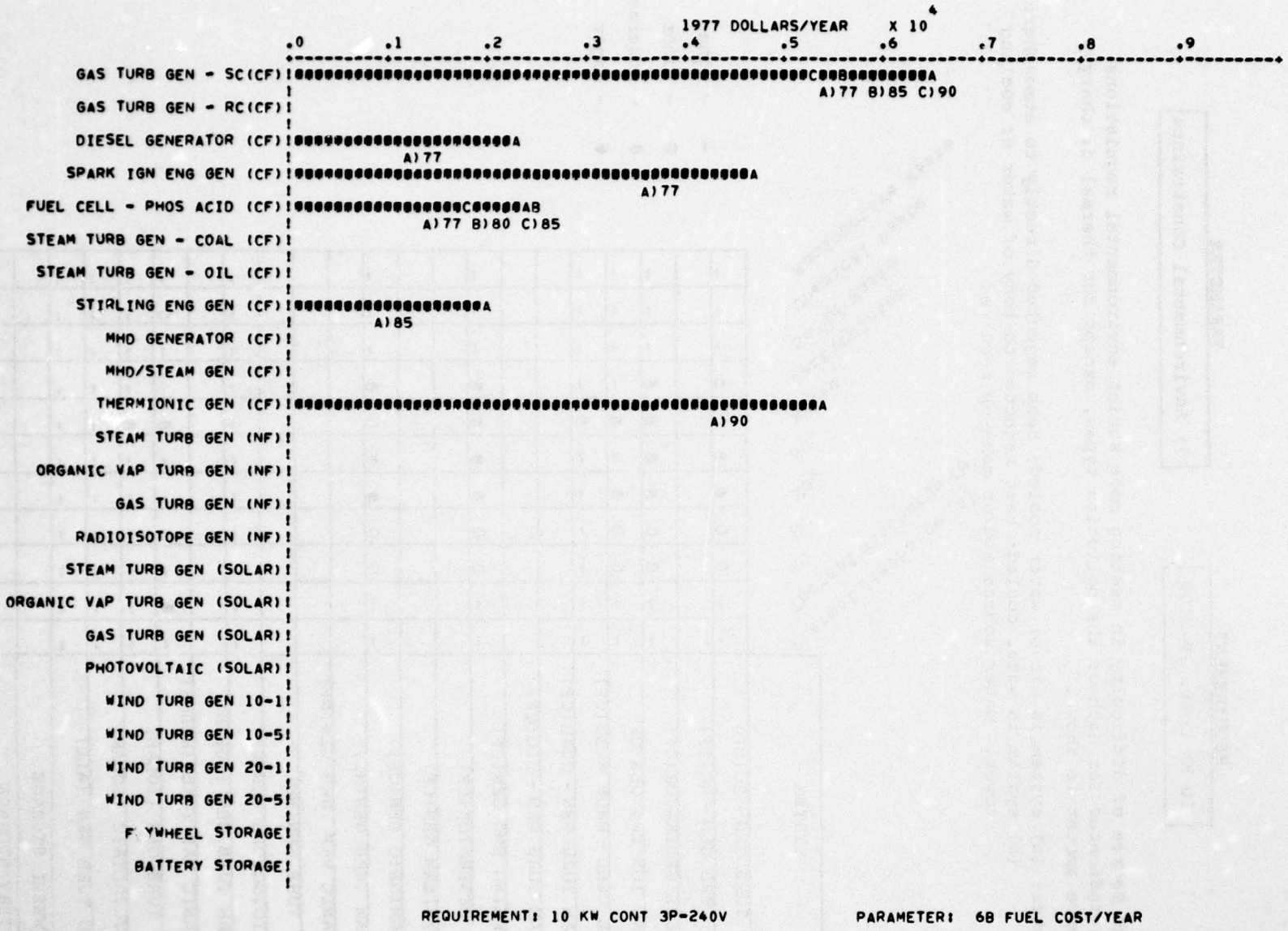
REQUIREMENT: 10 KW CONT 3P-240V PARAMETER: 48 AREA



REQUIREMENT: 10 KW CONT 3P-240V PARAMETER: 5 WEIGHT



REQUIREMENT: 10 KW CONT 3P-240V PARAMETER: 6A FUEL AMOUNT/YEAR



REQUIREMENT: 10 KW CONT 3P-240V

PARAMETER: 68 FUEL COST/YEAR

REQUIREMENT	PARAMETER
10 KW Cont. 3P-240V	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
GAS TURB GEN - RC(CF)											
DIESEL GENERATOR(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
SPARK IGN ENG GEN(CF)	-	-	0	0	◐	-	◐	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	0	-	-	-	-
STEAM TURB GEN - COAL(CF)											
STEAM TURB GEN - OIL(CF)											
STIRLING ENG GEN(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
MHD GENERATOR(CF)											
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)	-	-	0	0	●	◐	0	◐	-	-	-
STEAM TURB GEN(NF)											
ORGANIC VAP TURB GEN(NF)											
GAS TURB GEN(NF)											
RADIOISOTOPE GEN(NF)											
STEAM TURB GEN (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
ORGANIC VAP TURB (SOLAR)											
GAS TURB GEN (SOLAR)	-	●	-	-	-	-	0	-	-	0	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	◐	-	-	-	-
WIND TURB GEN (ALL)	-	-	-	-	-	-	-	-	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	-	-	-	-
BATTERY STORAGE											

- - none
0 - minor
◐ - moderate
● - major

REQUIREMENT

10 KW Cont. 3P-240V

PARAMETER

8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- \- - no limitation
- O - minor limitation
- ⊖ - major limitation
- ● - overriding limitation

SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	O	●	-	-	-	-
GAS TURB GEN - RC(CF)								
DIESEL GENERATOR(CF)	-	-	-	●	-	-	-	-
SPARK IGN ENG GEN(CF)	-	-	-	●	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)								
STEAM TURB GEN - OIL(CF)								
STIRLING ENG GEN(CF)	-	-	O	●	-	-	-	-
MHD GENERATOR(CF)								
MHD/STEAM GEN(CF)								
THERMIONIC GEN(CF)	O	O	O	●	-	-	-	-
STEAM TURB GEN(NF)								
ORGANIC VAP TURB GEN(NF)								
GAS TURB GEN(NF)								
RADIOISOTOPE GEN(NF)	-	-	-	-	-	-	●	-
STEAM TURB GEN (SOLAR)								
ORGANIC VAP TURB (SOLAR)	⊖	-	O	-	●	-	-	-
GAS TURB GEN (SOLAR)	-	-	O	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1	-	-	-	-	-	●	-	-
WIND TURB GEN 10-5	-	-	-	-	-	●	-	-
WIND TURB GEN 20-1	-	-	-	-	-	●	-	-
WIND TURB GEN 20-5	-	-	-	-	-	●	-	-
FLYWHEEL STORAGE								-
BATTERY STORAGE								

REQUIREMENT

10 KW Cont. 3P-240V

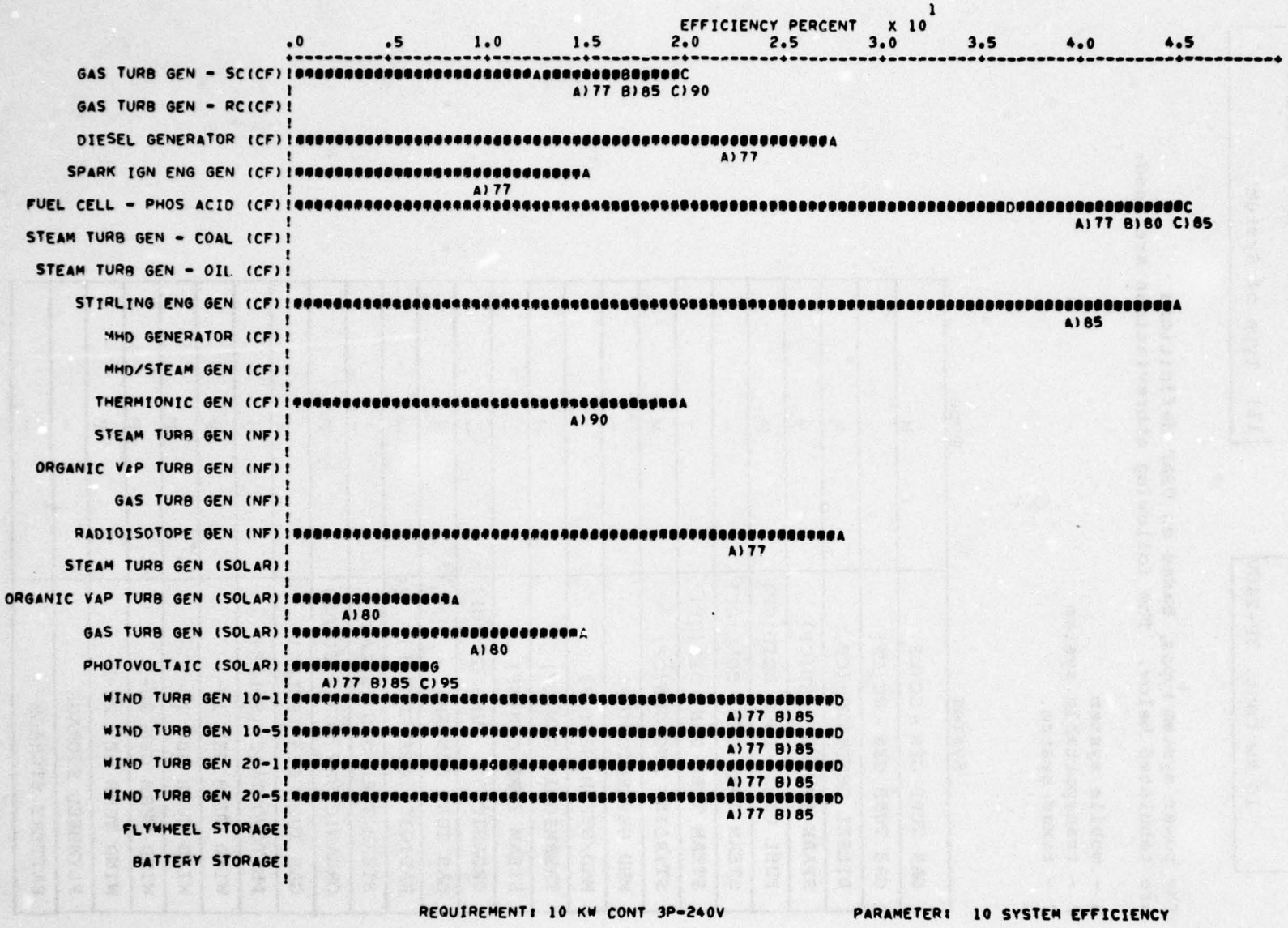
PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
0 - Characteristic has minor effect on system performance
◐ - Characteristic has moderate effect on system performance
● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	◐	0	-	-	0	0	0
GAS TURB GEN - RC(CF)							
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)	◐	0	-	-	0	0	0
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)							
STEAM TURB GEN - OIL(CF)							-
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)							
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	◐	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)							
GAS TURB GEN(NF)							
RADIOISOTOPE GEN(NF)	0	0	-	-	◐	0	0
STEAM TURB GEN (SOLAR)							
ORGANIC VAP TURB (SOLAR)	-	0	●	-	◐	◐	-
GAS TURB GEN (SOLAR)	-	-	●	-	◐	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE							
BATTERY STORAGE							

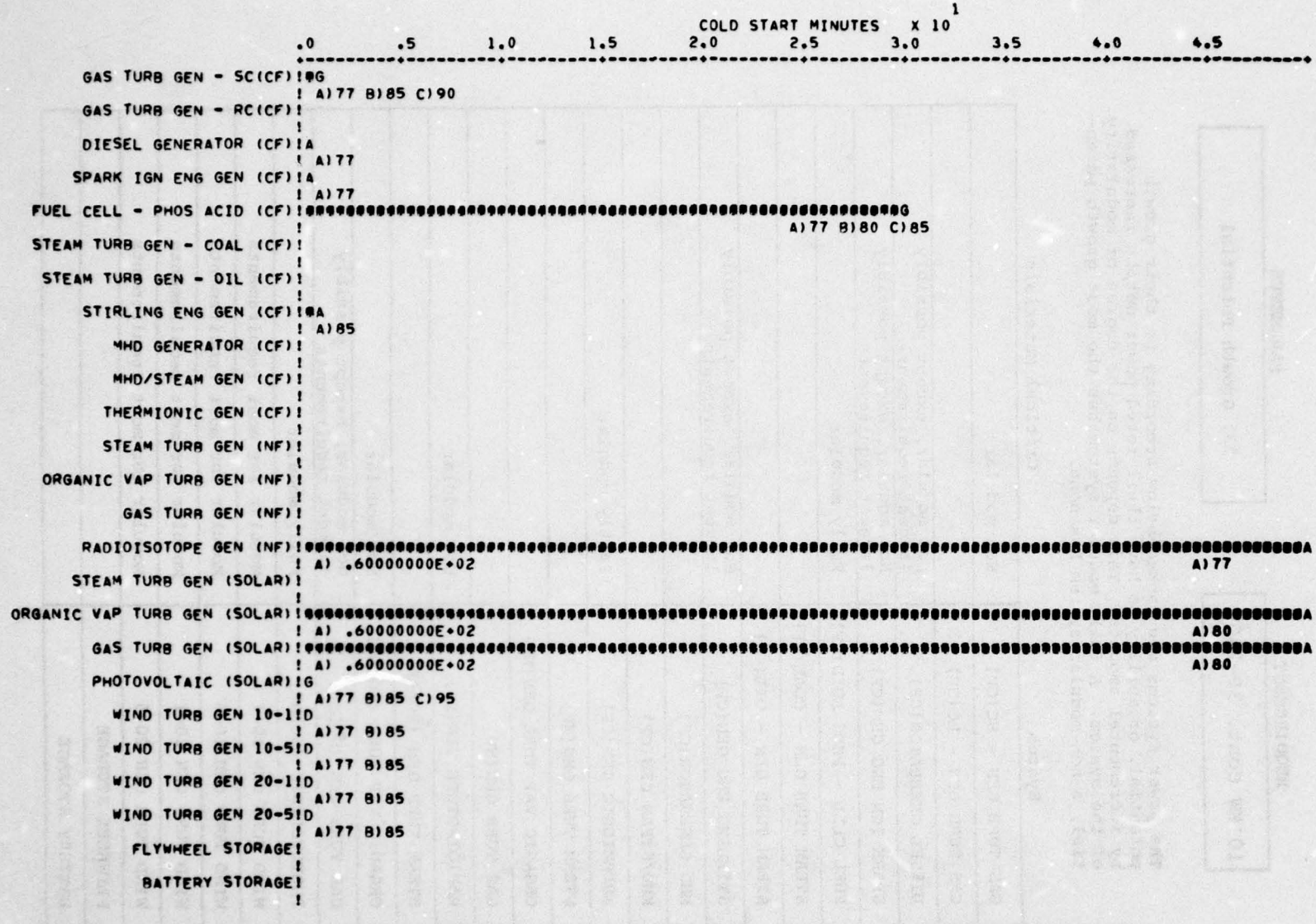

EFFICIENCY PERCENT X 10^1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC V&P TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 3P-240V
PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
10 kw Cont. 3P-240V	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	M
GAS TURB GEN - RC(CF)	-
DIESEL GENERATOR(CF)	M
SPARK IGN ENG GEN(CF)	M
FUEL CELL - PHOS ACID(CF)	M
STEAM TURB GEN - COAL(CF)	-
STEAM TURB GEN - OIL(CF)	-
STIRLING ENG GEN(CF)	M
MHD GENERATOR(CF)	-
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	M
STEAM TURB GEN(NF)	-
ORGANIC VAP TURB GEN(NF)	-
GAS TURB GEN(NF)	-
RADIOISOTOPE GEN(NF)	T
STEAM TURB GEN (SOLAR)	-
ORGANIC VAP TURB (SOLAR)	F
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	F
WIND TURB GEN 10-5	F
WIND TURB GEN 20-1	F
WIND TURB GEN 20-5	F
FLYWHEEL STORAGE	-
BATTERY STORAGE	-



REQUIREMENT: 10 KW CONT 3P-240V PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
10 KW Cont. 3P-240V	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

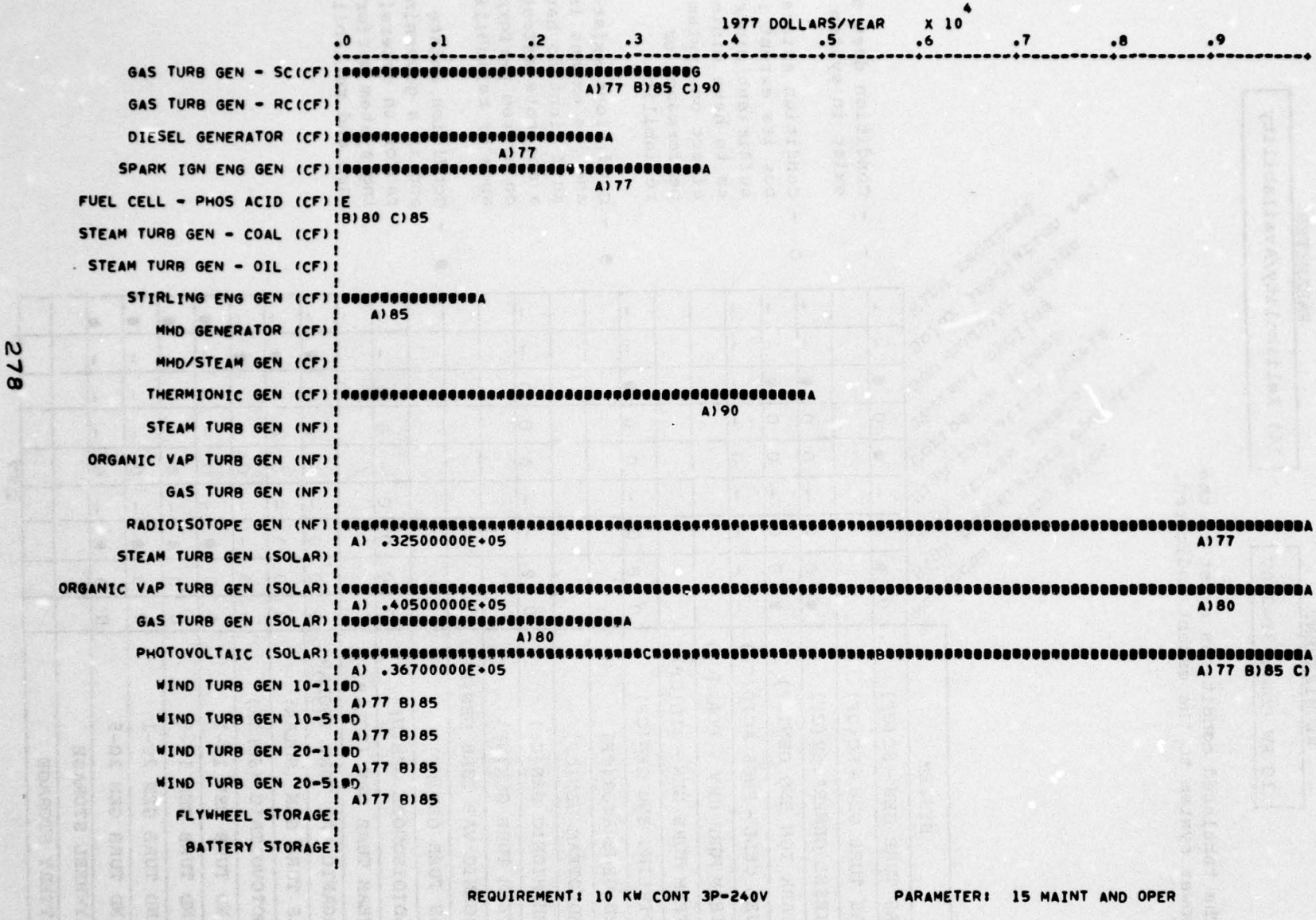
System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	Not modular, except possibly largest requirements
SPARK IGN ENG GEN(CF)	Not modular, except possibly largest requirements
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	Not modular, except possibly largest requirements
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	
RADIOISOTOPE GEN(NF)	Not modular
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	Not modular
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	Modular for most requirements
WIND TURB GEN 10-5	Modular for most requirements
WIND TURB GEN 20-1	Modular for most requirements
WIND TURB GEN 20-5	Modular for most requirements
FLYWHEEL STORAGE	
BATTERY STORAGE	

REQUIREMENT	PARAMETER
10 KW Cont. 3P-240V	14) Reliability/Availability

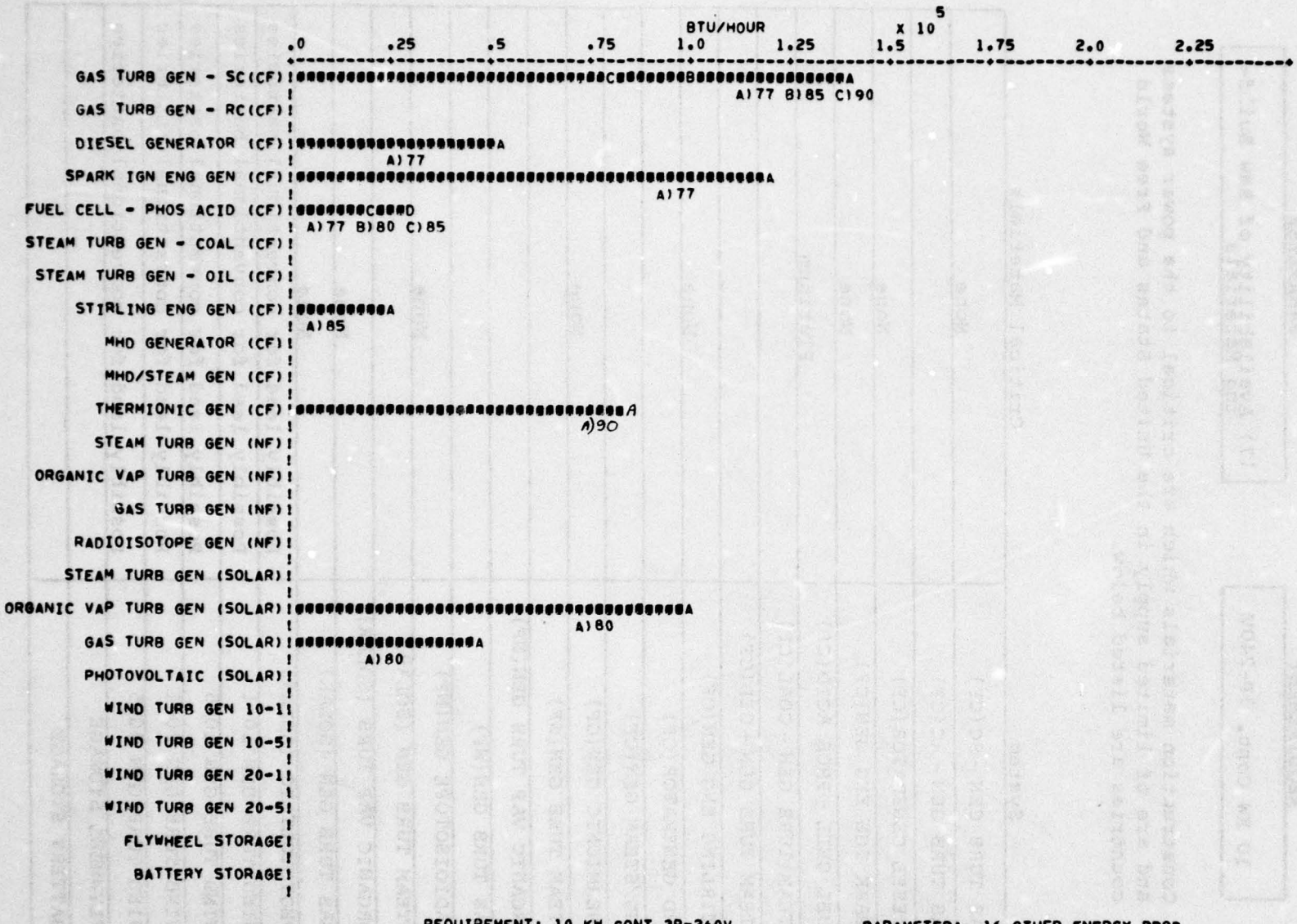
The tabulated conditions exist in the power system to the extent indicated.

SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	O	●	O	-	●	O	●	-	-
GAS TURB GEN - RC(CF)									
DIESEL GENERATOR(CF)	●	O	O	-	O	O	●	-	-
SPARK IGN ENG GEN(CF)	●	O	O	-	O	O	●	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	O	-	-	-	-
STEAM TURB GEN - COAL(CF)									
STEAM TURB GEN - OIL(CF)									
STIRLING ENG GEN(CF)	O	O	O	-	O	O	●	-	-
MHD GENERATOR(CF)									
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	O	●	-	-	O	O	O	-	-
STEAM TURB GEN(NF)									
ORGANIC VAP TURB GEN(NF)									
GAS TURB GEN(NF)									
RADIOISOTOPE GEN(NF)	O	O	O	O	-	O	●	-	-
STEAM TURB GEN (SOLAR)									
ORGANIC VAP TURB (SOLAR)	O	O	O	-	-	O	-	●	-
GAS TURB GEN (SOLAR)	O	O	O	-	O	O	-	●	-
PHOTOVOLTAIC (SOLAR)	-	O	-	-	O	-	-	●	-
WIND TURB GEN 10-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 10-5	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-5	O	O	●	-	O	-	-	-	●
FLYWHEEL STORAGE									
BATTERY STORAGE									

- \- - Condition does not exist in system
- O - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability
- ⊖ - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability
- ● - Condition exists and is a governing factor in determining system performance and reliability



REQUIREMENT: 10 KW CONT 3P-240V PARAMETER: 15 MAINT AND OPER


BTU/HOUR
X 10^5
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.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 3P-240V
PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
10 KW Cont. 3P-240V	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

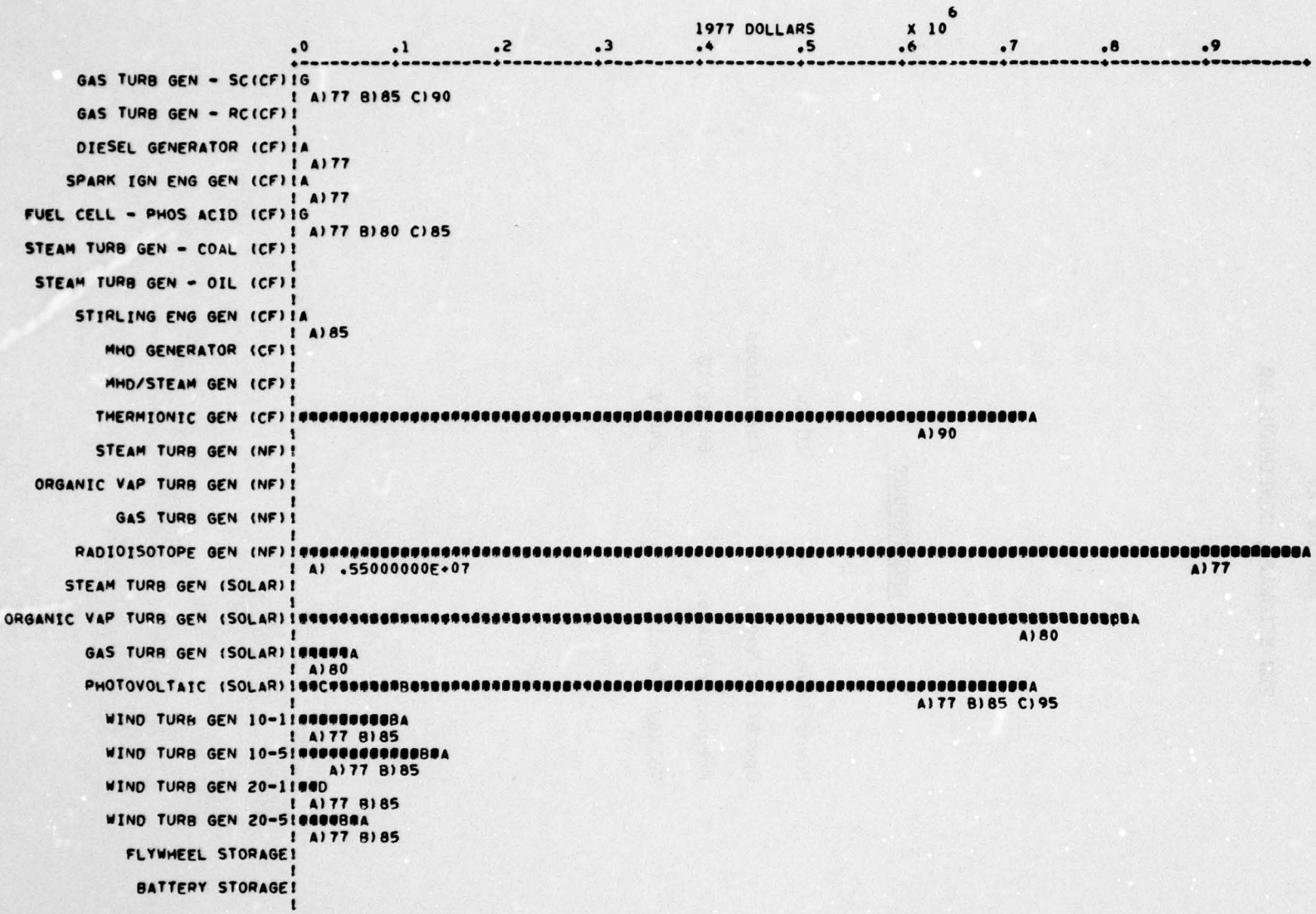
System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	None
SPARK IGN ENG GEN(CF)	None
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	None
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	
RADIOISOTOPE GEN(NF)	None
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	None
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	Possibly lead for conventional batteries
WIND TURB GEN 10-5	Possibly lead for conventional batteries
WIND TURB GEN 20-1	Possibly lead for conventional batteries
WIND TURB GEN 20-5	Possibly lead for conventional batteries
FLYWHEEL STORAGE	
BATTERY STORAGE	

SECTION XV

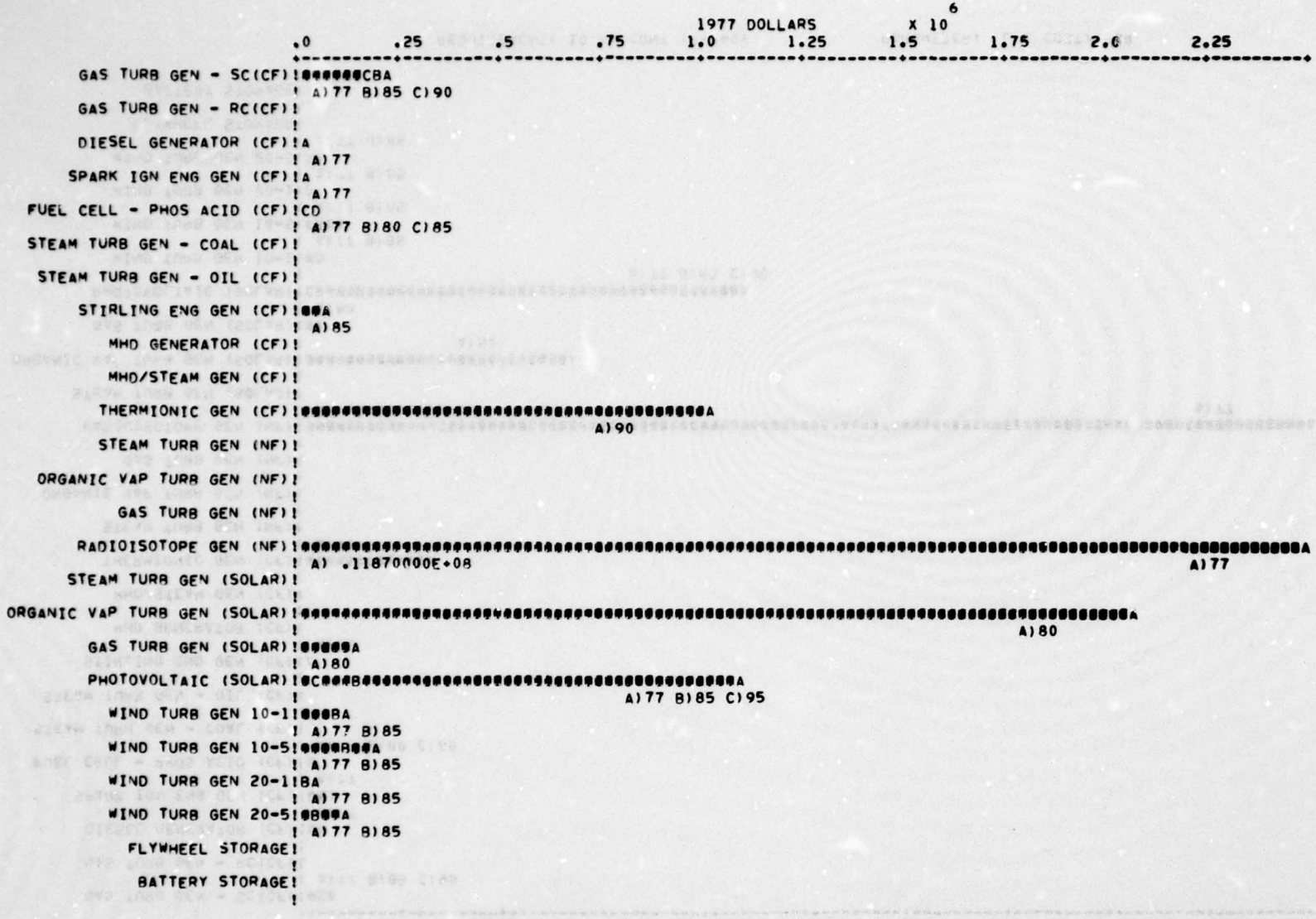
TEN KILOWATT, CONTINUOUS 1Ø

REQUIREMENT

Power Level:	10 Kw
Operating Mode:	Continuous
Frequency/Phase:	60 Hz/1Ø
Voltage Level:	240 V



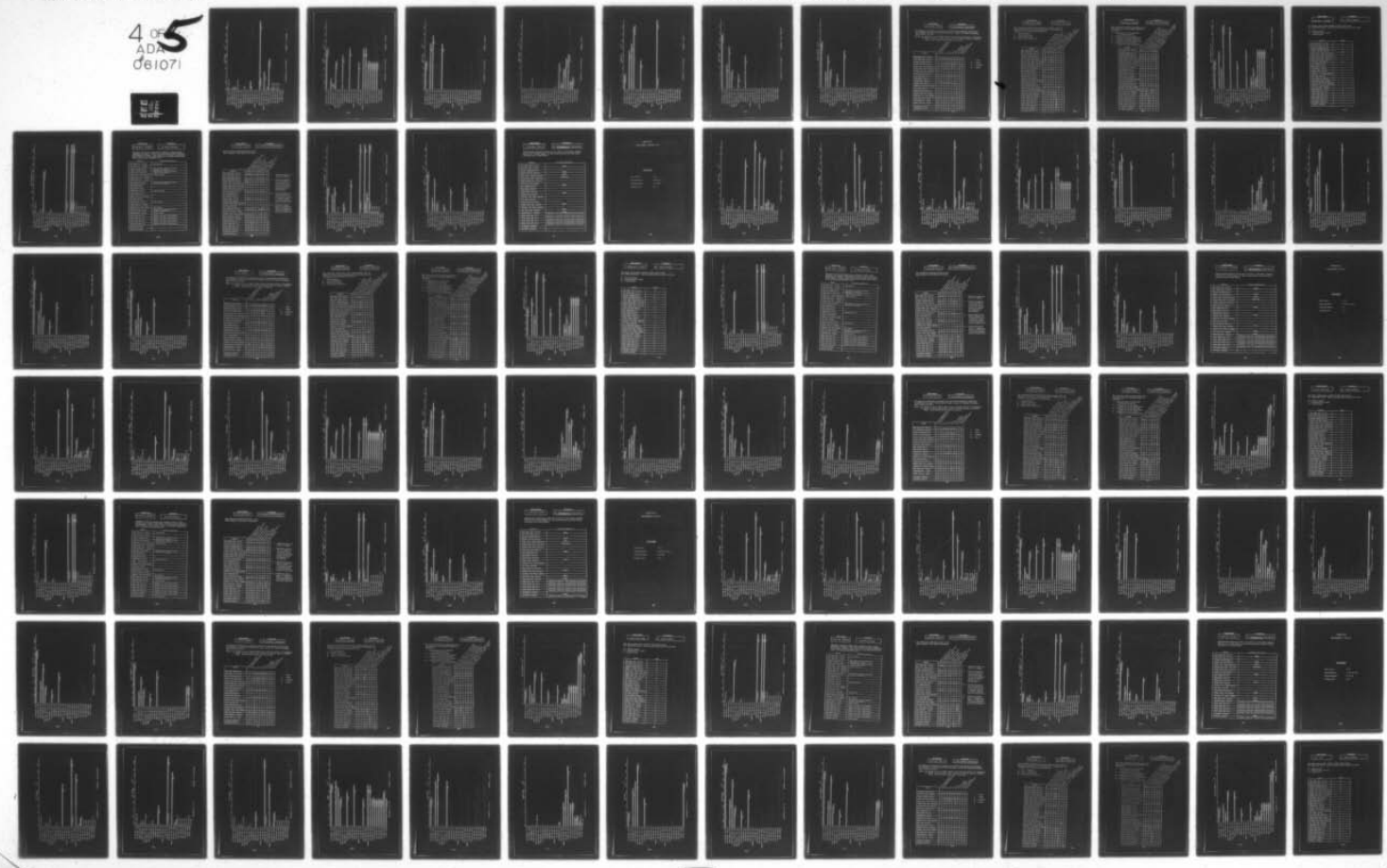
REQUIREMENT: 10 KW CONT 1P-240V PARAMETER: 1 ACQUISITION COST

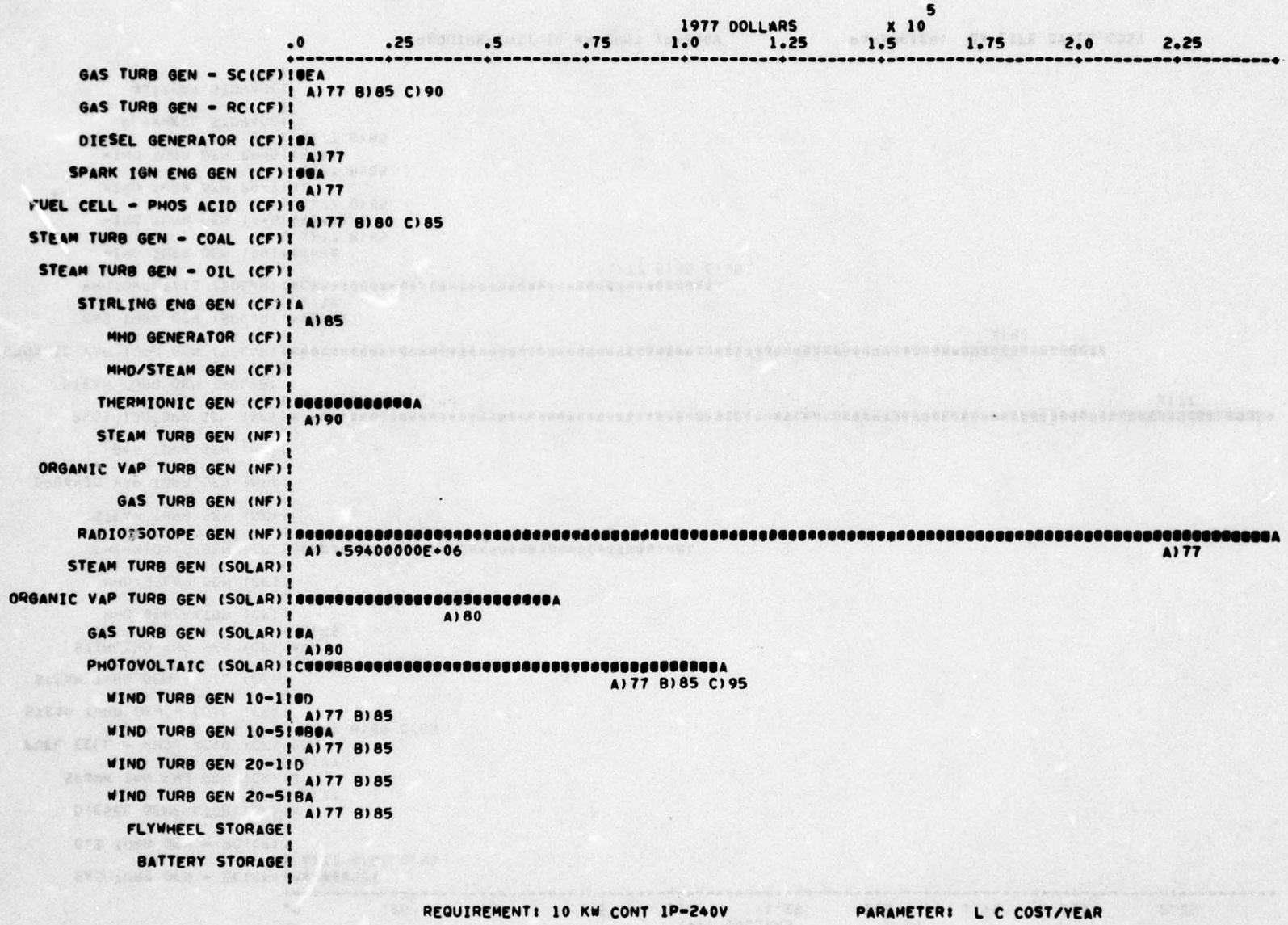


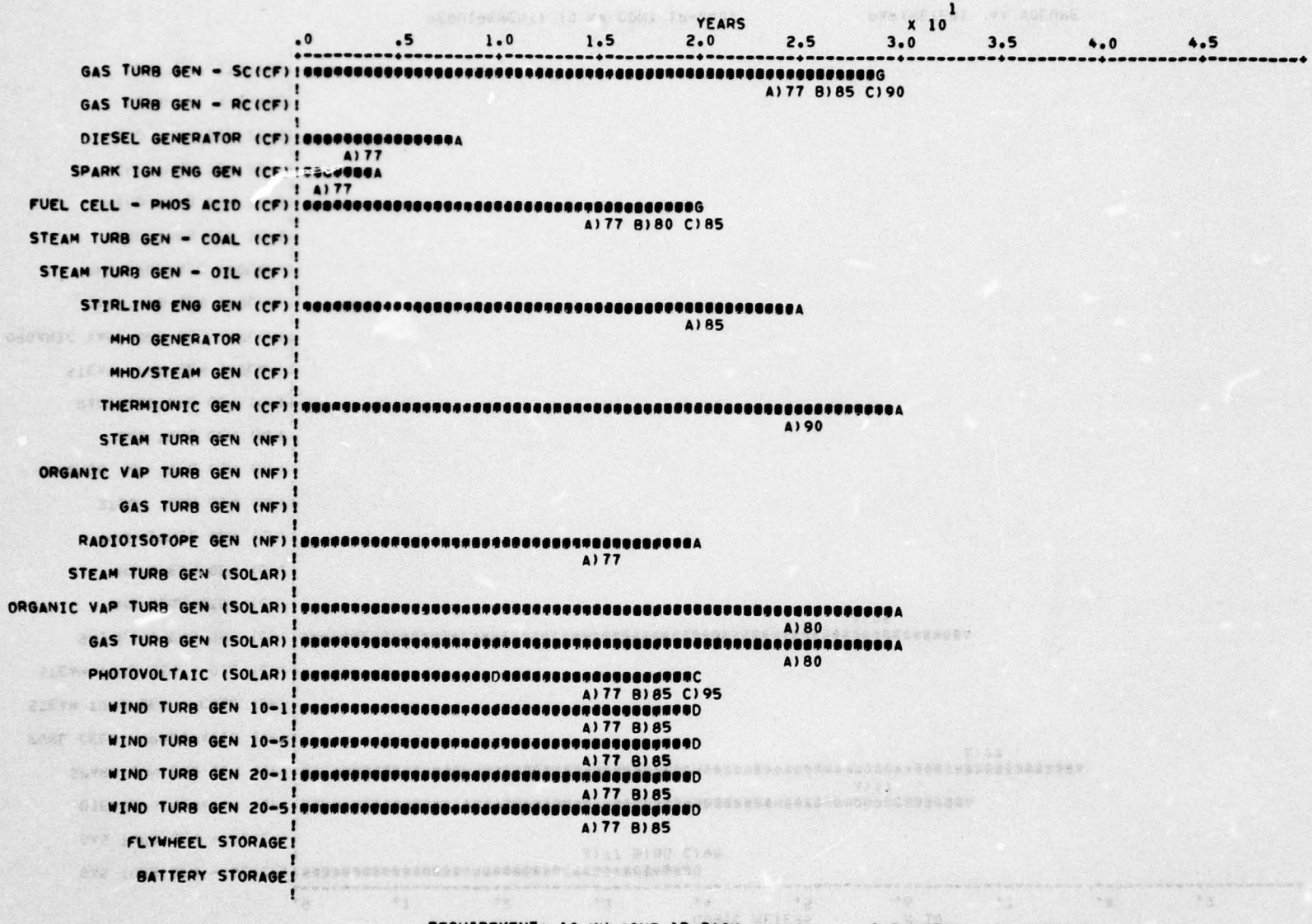
REQUIREMENT: 10 KW CONT 1P-240V PARAMETER: 2A LIFE CYCLE COST

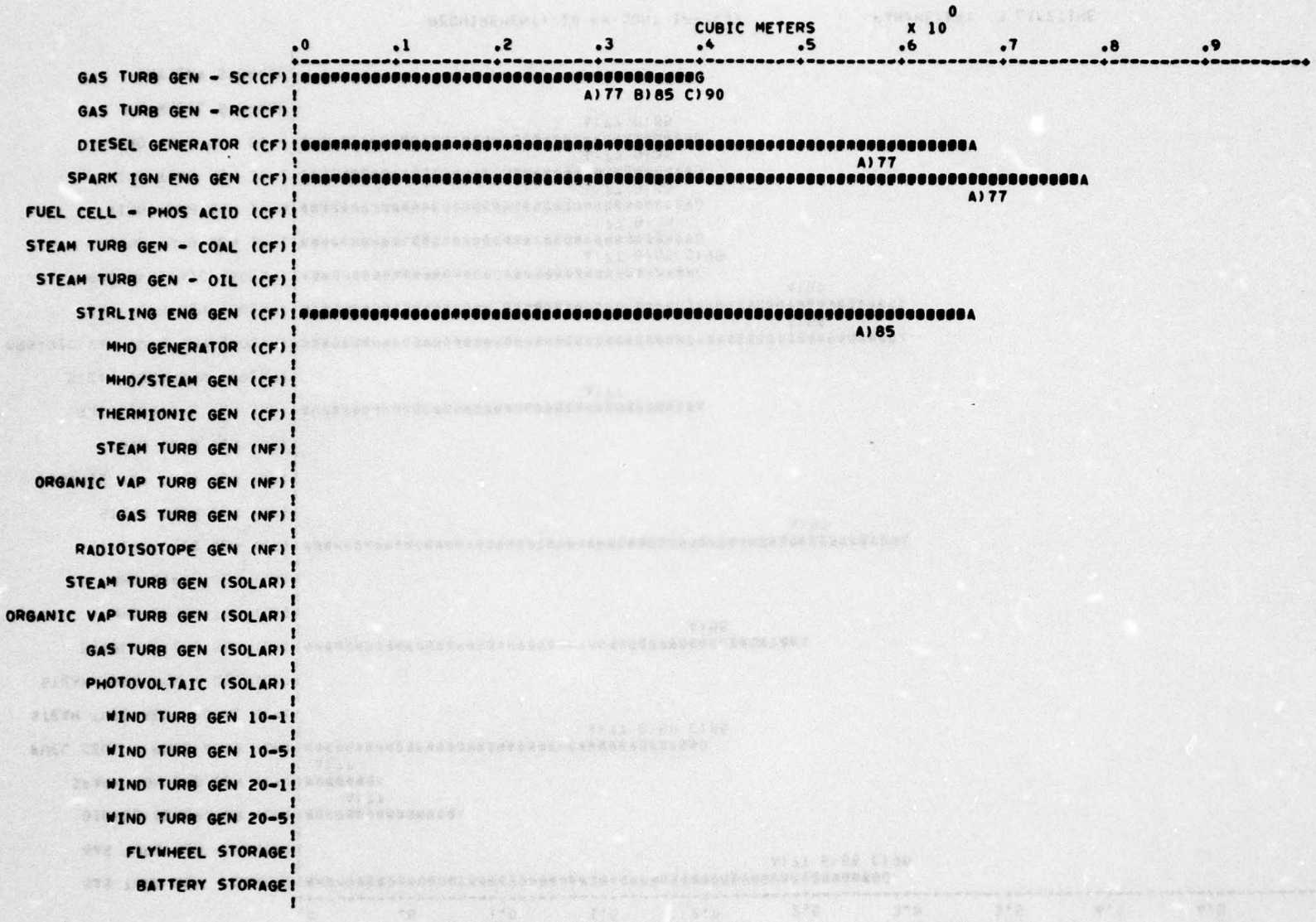
AD-A061 071 BURNS AND ROE INC WOODBURY NY F/G 10/2
USAF TERRESTRIAL ENERGY STUDY. VOLUME III. PART I. SUMMARY DATA--ETC(U)
MAY 78 D C HALL, A CARLSON, D FULLER, R REYER F33615-76-C-2171
UNCLASSIFIED AFAPL-TR-78-19-VOL-3-PT-1 NL

4 OF 5
AD A061071

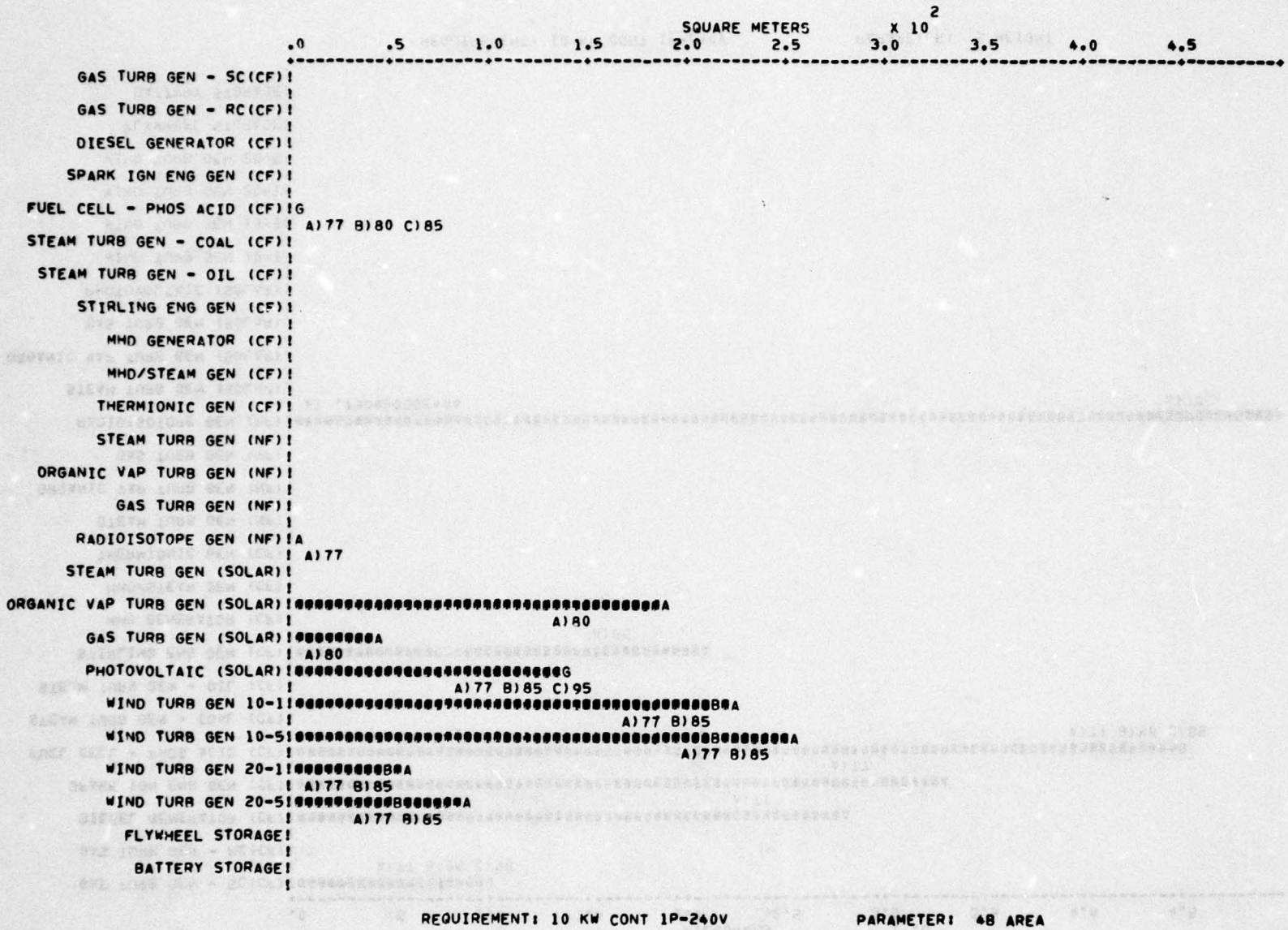



1977 DOLLARS
X 10^5
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A) .59400000E+06
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 1P-240V
PARAMETER: L C COST/YEAR


YEARS
X 10^1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 1P-240V
PARAMETER: 3 LIFETIME



REQUIREMENT: 10 KW CONT 1P-240V PARAMETER: 4A VOLUME


SQUARE METERS X 10^2
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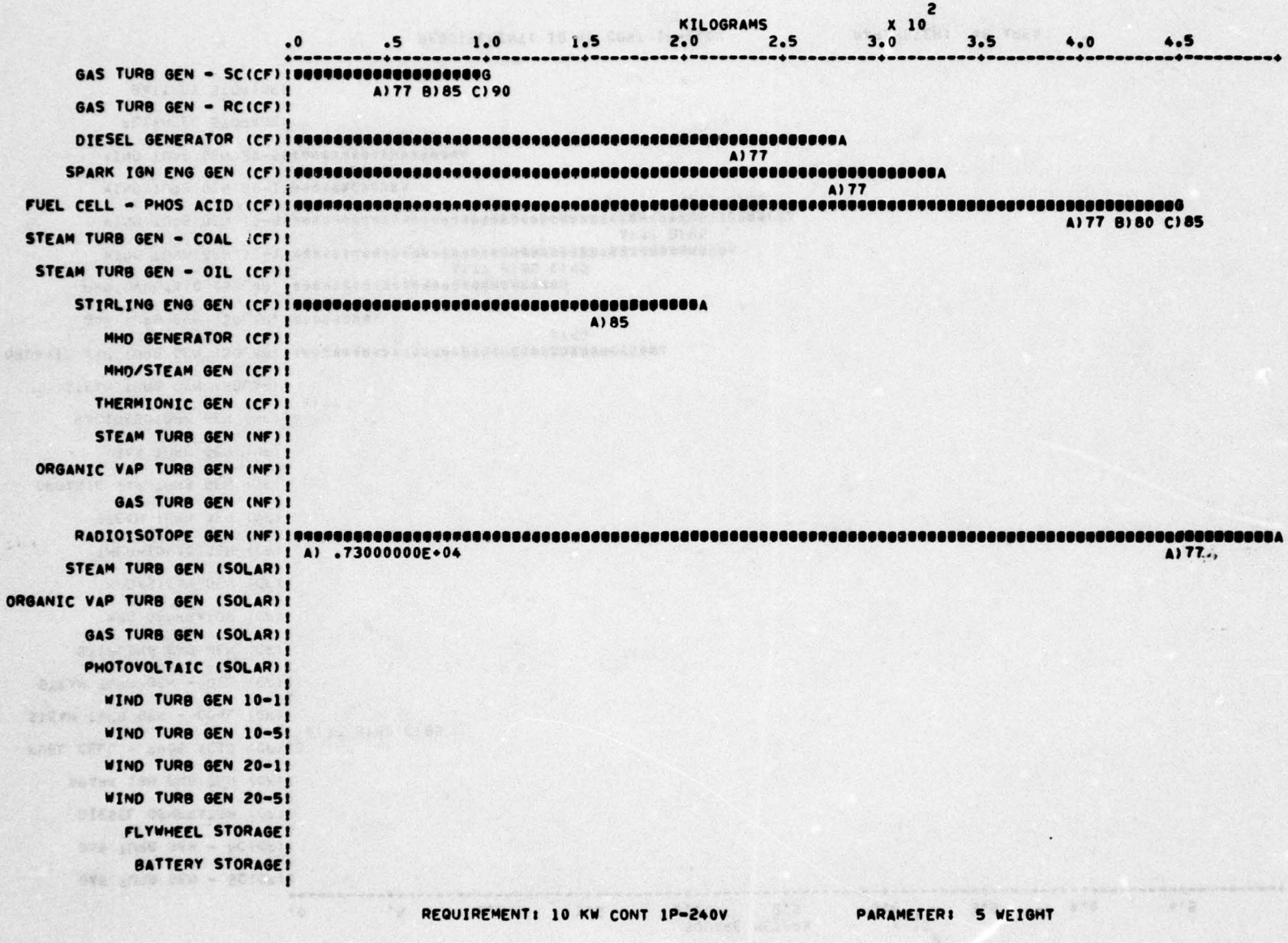
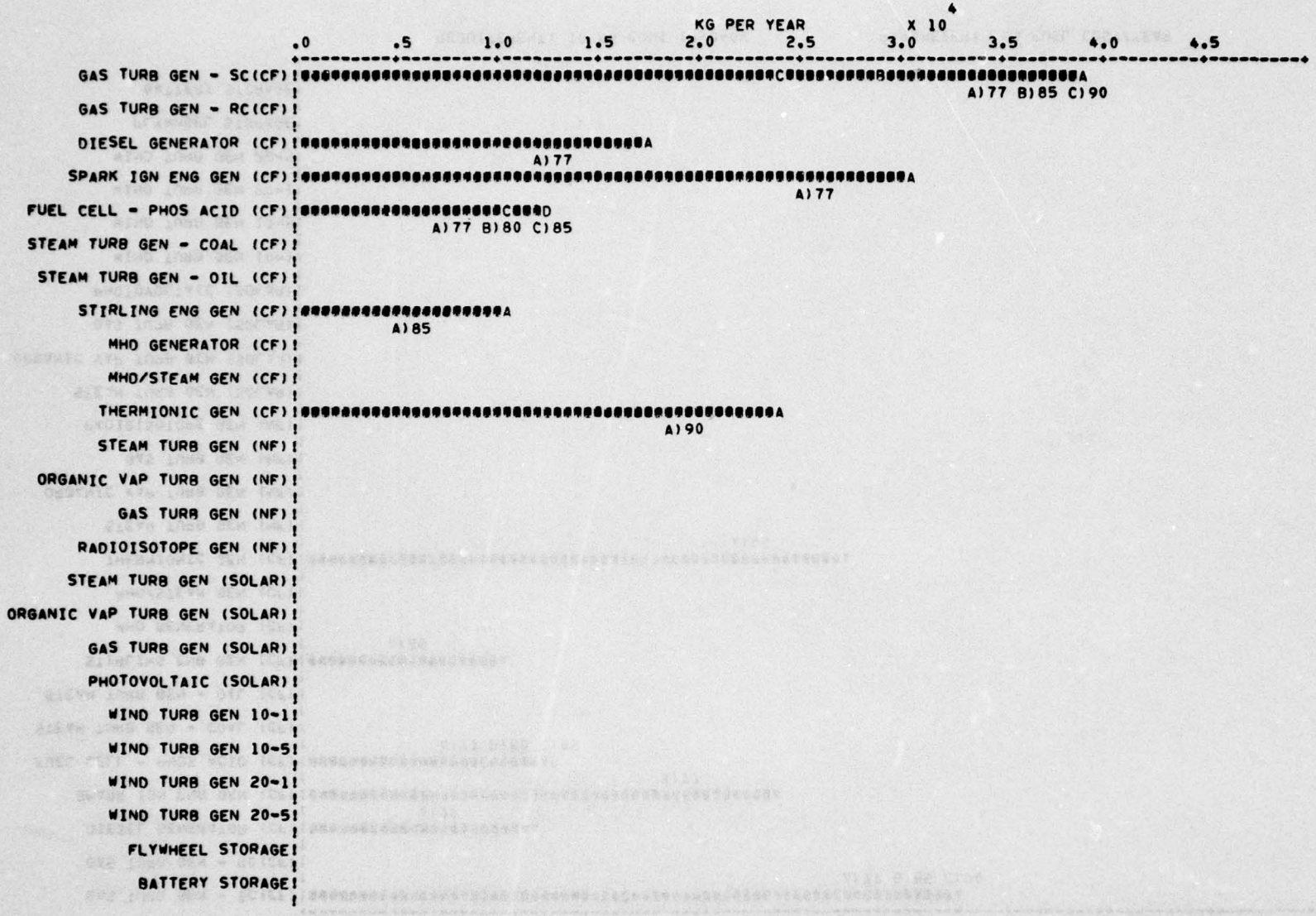
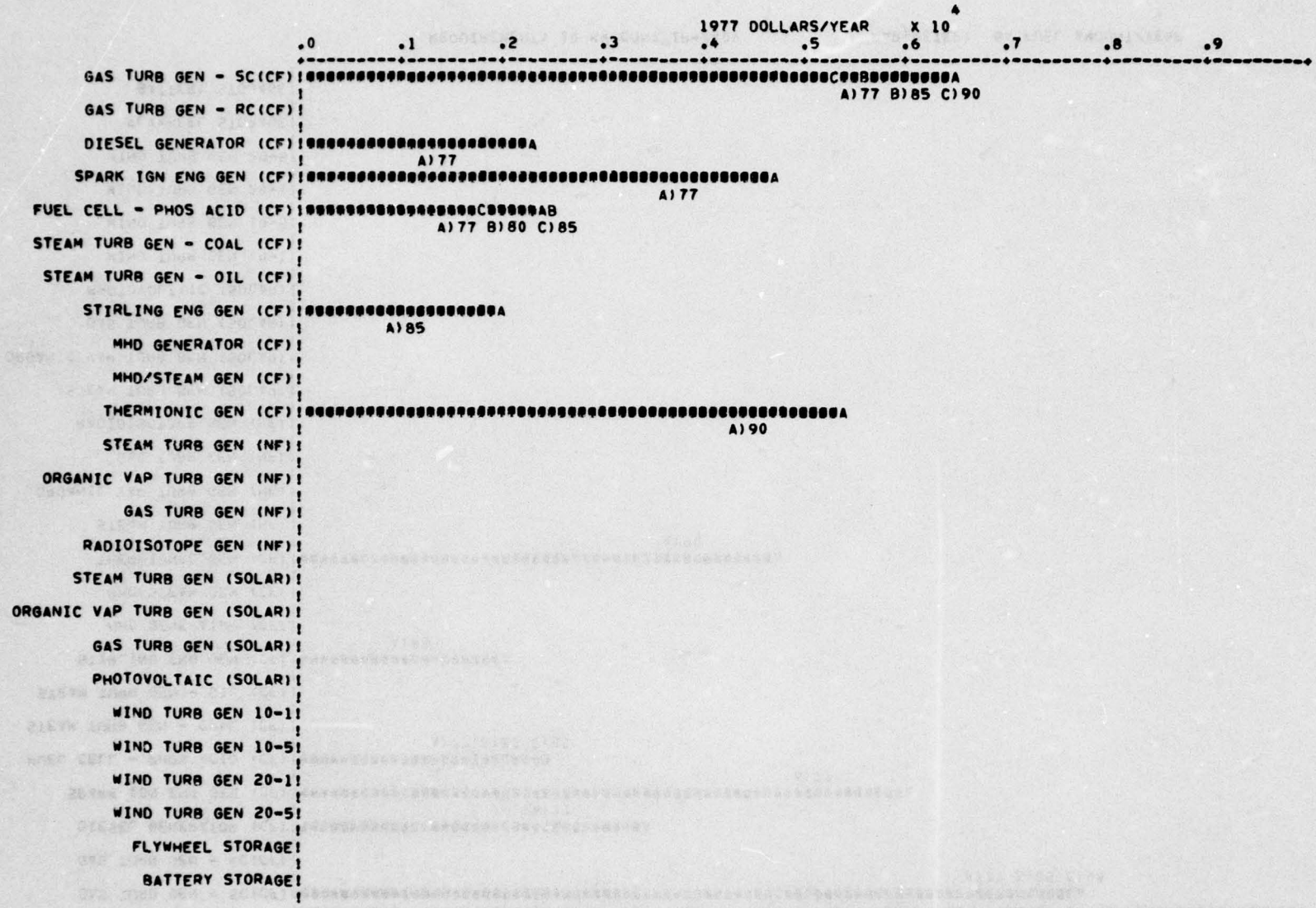
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
A)77 B)80 C)85
A)77
A)80
A)80
A)77 B)85 C)95
A)77 B)85
A)77 B)85
A)77 B)85
A)77 B)85
A)77 B)65
REQUIREMENT: 10 KW CONT 1P-240V
PARAMETER: 48 AREA


KILOGRAMS
X 10 2
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A) .73000000E+04
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 1P-240V
PARAMETER: 5 WEIGHT


KG PER YEAR
X 10^4
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 1P-240V
PARAMETER: 6A FUEL AMOUNT/YEAR


1977 DOLLARS/YEAR X 10^4
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
A)77 B)85 C)90
A)77
A)77
A)77 B)80 C)85
A)85
A)90
REQUIREMENT: 10 KW CONT 1P-240V
PARAMETER: 68 FUEL COST/YEAR

REQUIREMENT	PARAMETER
10 KW Cont. 1P-240V	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
GAS TURB GEN - RC(CF)											
DIESEL GENERATOR(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
SPARK IGN ENG GEN(CF)	-	-	0	0	◐	-	◐	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	◐	-	-	-	-
STEAM TURB GEN - COAL(CF)											
STEAM TURB GEN - OIL(CF)											
STIRLING ENG GEN(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
MHD GENERATOR(CF)											
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)	-	-	0	0	●	◐	0	◐	-	-	-
STEAM TURB GEN(NF)											
ORGANIC VAP TURB GEN(NF)											
GAS TURB GEN(NF)											
RADIOISOTOPE GEN(NF)											
STEAM TURB GEN (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
ORGANIC VAP TURB (SOLAR)											
GAS TURB GEN (SOLAR)	-	●	-	-	-	-	◐	-	-	0	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	◐	-	-	-	-
WIND TURB GEN (ALL)	-	-	-	-	-	-	-	-	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	-	-	-	-
BATTERY STORAGE											

- - none
0 - minor
◐ - moderate
● - major

REQUIREMENT	PARAMETER
10 KW Cont. 1P-240V	8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- - - no limitation
- O - minor limitation
- ⊖ - major limitation
- ● - overriding limitation

SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	O	●	-	-	-	-
GAS TURB GEN - RC(CF)								
DIESEL GENERATOR(CF)	-	-	-	●	-	-	-	-
SPARK IGN ENG GEN(CF)	-	-	-	●	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)								
STEAM TURB GEN - OIL(CF)								
STIRLING ENG GEN(CF)	-	-	O	●	-	-	-	-
MHD GENERATOR(CF)								
MHD/STEAM GEN(CF)								
THERMIONIC GEN(CF)	O	O	O	●	-	-	-	-
STEAM TURB GEN(NF)								
ORGANIC VAP TURB GEN(NF)								
GAS TURB GEN(NF)								
RADIOISOTOPE GEN(NF)	-	-	-	-	-	-	●	-
STEAM TURB GEN (SOLAR)								
ORGANIC VAP TURB (SOLAR)	⊖	-	O	-	●	-	-	-
GAS TURB GEN (SOLAR)	-	-	O	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1	-	-	-	-	-	●	-	-
WIND TURB GEN 10-5	-	-	-	-	-	●	-	-
WIND TURB GEN 20-1	-	-	-	-	-	●	-	-
WIND TURB GEN 20-5	-	-	-	-	-	●	-	-
FLYWHEEL STORAGE								
BATTERY STORAGE								

REQUIREMENT

10 KW Cont. 1P-240V

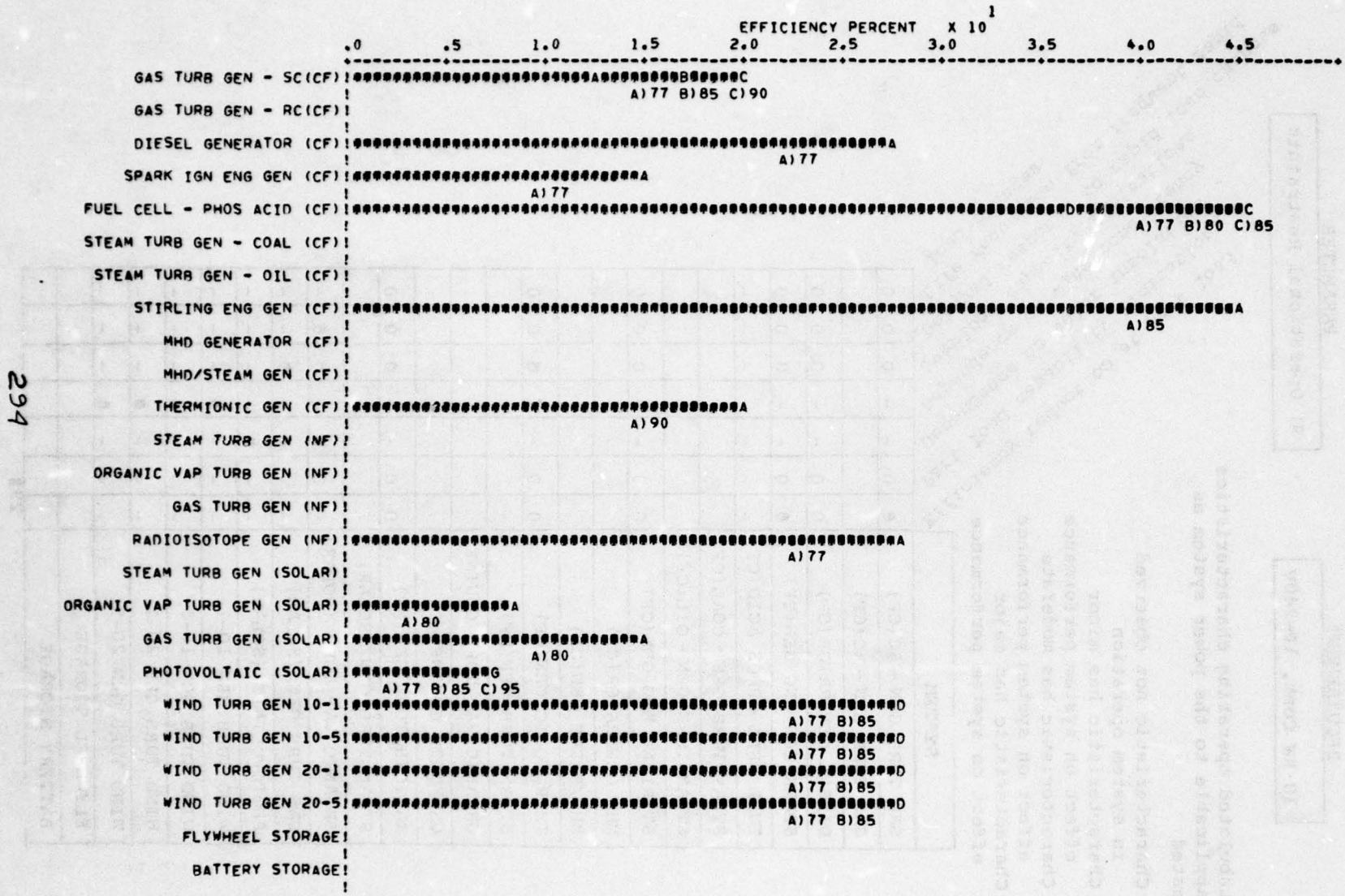
PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
0 - Characteristic has minor effect on system performance
◐ - Characteristic has moderate effect on system performance
● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	◐	0	-	-	0	0	0
GAS TURB GEN - RC(CF)							
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)	◐	0	-	-	0	0	0
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)							
STEAM TURB GEN - OIL(CF)							
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)							
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	◐	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)							
GAS TURB GEN(NF)							
RADIOISOTOPE GEN(NF)	0	0	-	-	◐	0	0
STEAM TURB GEN (SOLAR)							
ORGANIC VAP TURB (SOLAR)	-	0	●	-	◐	◐	-
GAS TURB GEN (SOLAR)	-	-	●	-	◐	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE							
BATTERY STORAGE							



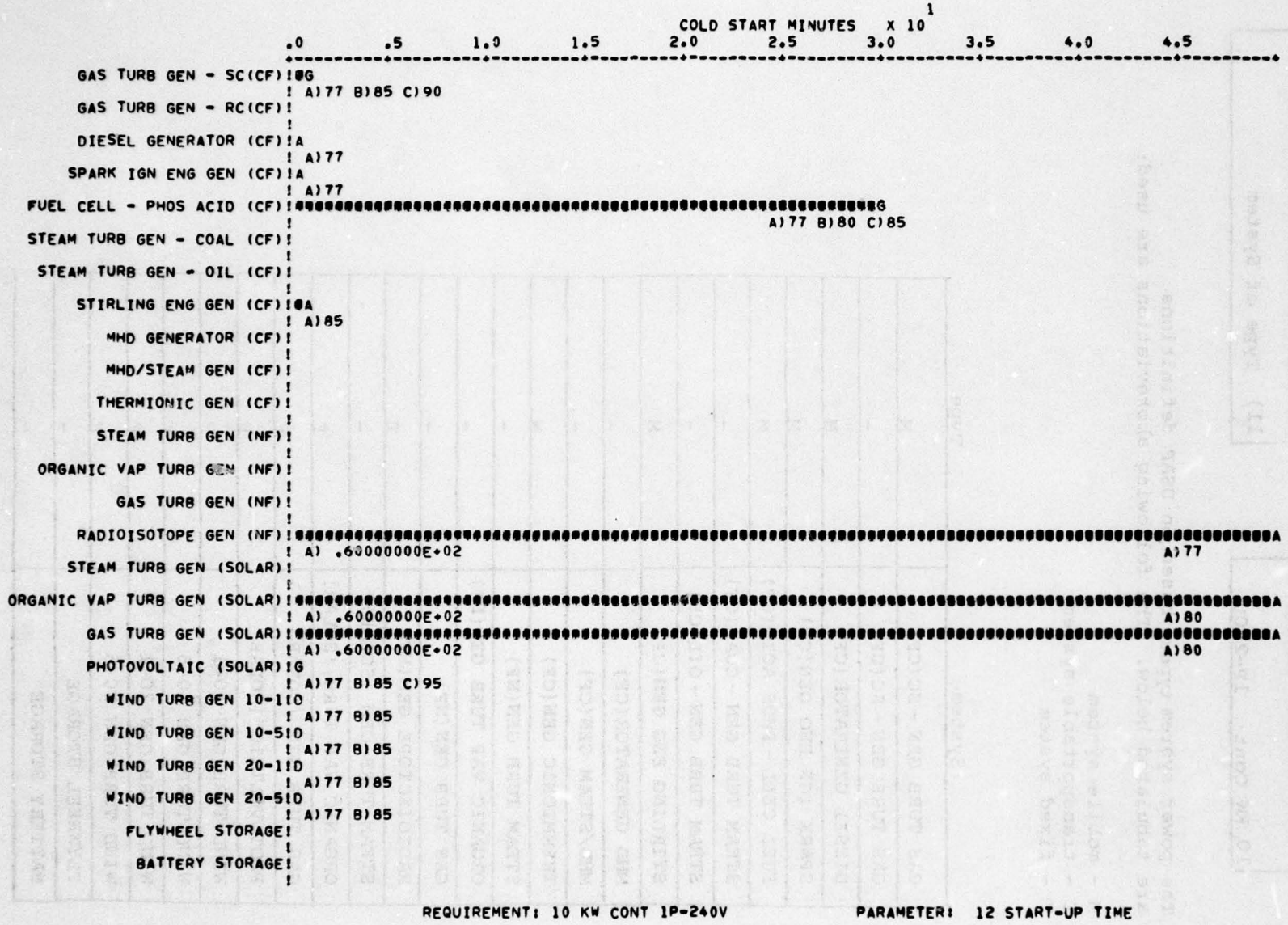
REQUIREMENT: 10 KW CONT IP-240V PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
10 KW Cont 1P-240V	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	M
GAS TURB GEN - RC(CF)	-
DIESEL GENERATOR(CF)	M
SPARK IGN ENG GEN(CF)	M
FUEL CELL - PHOS ACID(CF)	M
STEAM TURB GEN - COAL(CF)	-
STEAM TURB GEN - OIL(CF)	-
STIRLING ENG GEN(CF)	M
MHD GENERATOR(CF)	-
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	M
STEAM TURB GEN(NF)	-
ORGANIC VAP TURB GEN(NF)	-
GAS TURB GEN(NF)	-
RADIOISOTOPE GEN(NF)	T
STEAM TURB GEN (SOLAR)	-
ORGANIC VAP TURB (SOLAR)	F
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	F
WIND TURB GEN 10-5	F
WIND TURB GEN 20-1	F
WIND TURB GEN 20-5	F
FLYWHEEL STORAGE	-
BATTERY STORAGE	-



REQUIREMENT: 10 KW CONT 1P-240V PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
10 KW Cont. 1P-240V	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	Not modular, except possibly largest requirements
SPARK IGN.ENG GEN(CF)	Not modular, except possibly largest requirements
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	Not modular, except possibly largest requirements
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	
RADIOISOTOPE GEN(NF)	Not modular
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	Not modular
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	Modular for most requirements
WIND TURB GEN 10-5	Modular for most requirements
WIND TURB GEN 20-1	Modular for most requirements
WIND TURB GEN 20-5	Modular for most requirements
FLYWHEEL STORAGE	
BATTERY STORAGE	

REQUIREMENT	PARAMETER
10 KW Cont. 1P-240V	14) Reliability/Availability

The tabulated conditions exist in the power system to the extent indicated.

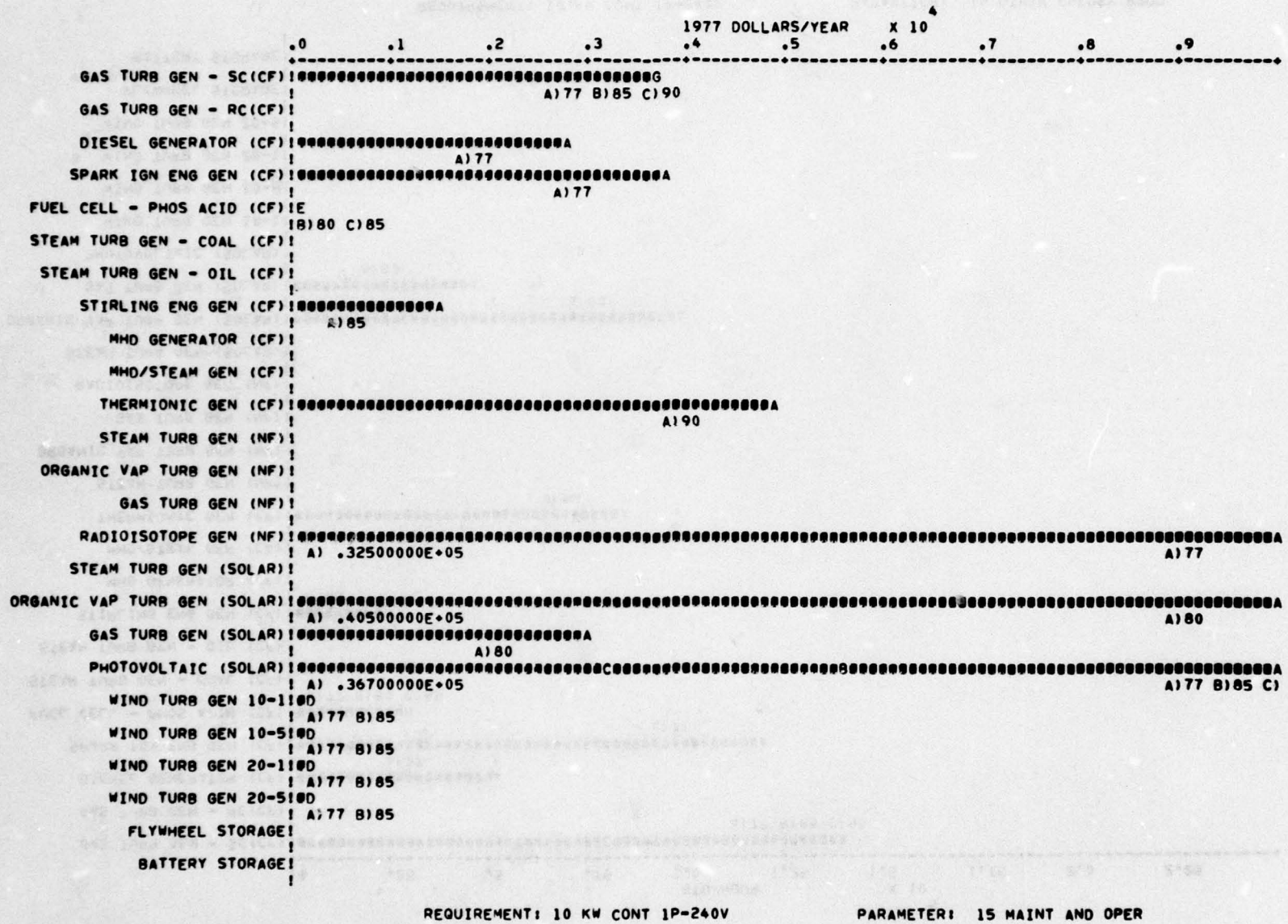
SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	0	●	0	-	●	0	●	-	-
GAS TURB GEN - RC(CF)									.
DIESEL GENERATOR(CF)	●	0	0	-	0	0	●	-	-
SPARK IGN ENG GEN(CF)	●	0	0	-	0	0	●	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	0	-	-	-	-
STEAM TURB GEN - COAL(CF)									
STEAM TURB GEN - OIL(CF)									
STIRLING ENG GEN(CF)	0	0	0	-	0	0	●	-	-
MHD GENERATOR(CF)									
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	0	●	-	-	●	0	0	-	-
STEAM TURB GEN(NF)									
ORGANIC VAP TURB GEN(NF)									
GAS TURB GEN(NF)									
RADIOISOTOPE GEN(NF)	0	0	0	0	-	0	●	-	-
STEAM TURB GEN (SOLAR)									
ORGANIC VAP TURB (SOLAR)	0	0	0	-	-	0	-	●	-
GAS TURB GEN (SOLAR)	0	0	0	-	0	0	-	●	-
PHOTOVOLTAIC (SOLAR)	-	0	-	-	0	-	-	●	-
WIND TURB GEN 10-1	0	0	●	-	0	-	-	-	●
WIND TURB GEN 10-5	0	0	●	-	0	-	-	-	●
WIND TURB GEN 20-1	0	0	●	-	0	-	-	-	●
WIND TURB GEN 20-5	0	0	●	-	0	-	-	-	●
FLYWHEEL STORAGE									
BATTERY STORAGE									

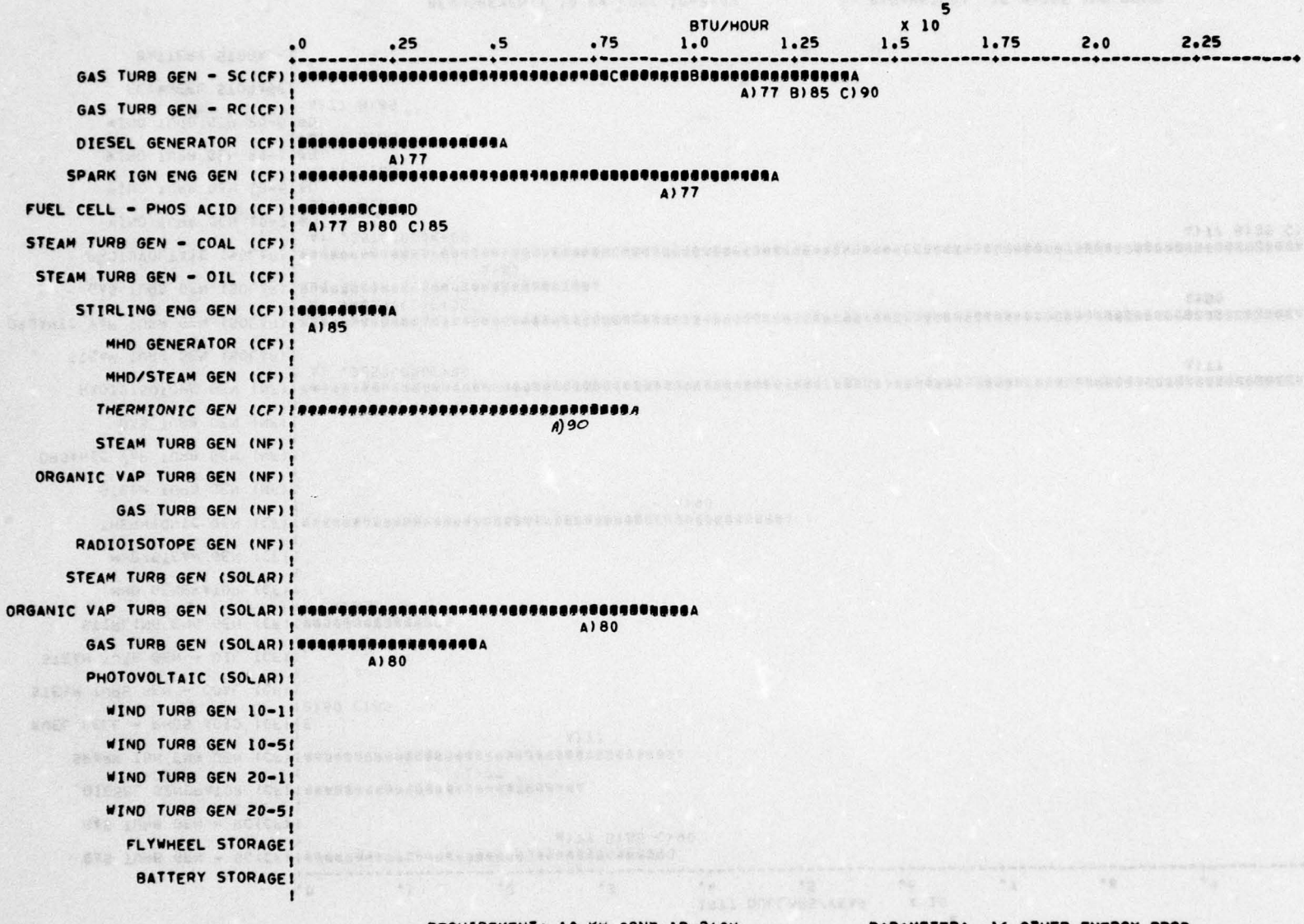
- - Condition does not exist in system

0 - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability

⊖ - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability

● - Condition exists and is a governing factor in determining system performance and reliability


1977 DOLLARS/YEAR X 10^4
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A) .32500000E+05
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A) .40500000E+05
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A) .36700000E+05
A)77 B)85 C)
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 1P-240V
PARAMETER: 15 MAINT AND OPER



REQUIREMENT: 10 KW CONT 1P-240V PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
10 KW Cont. 1P-240 V	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

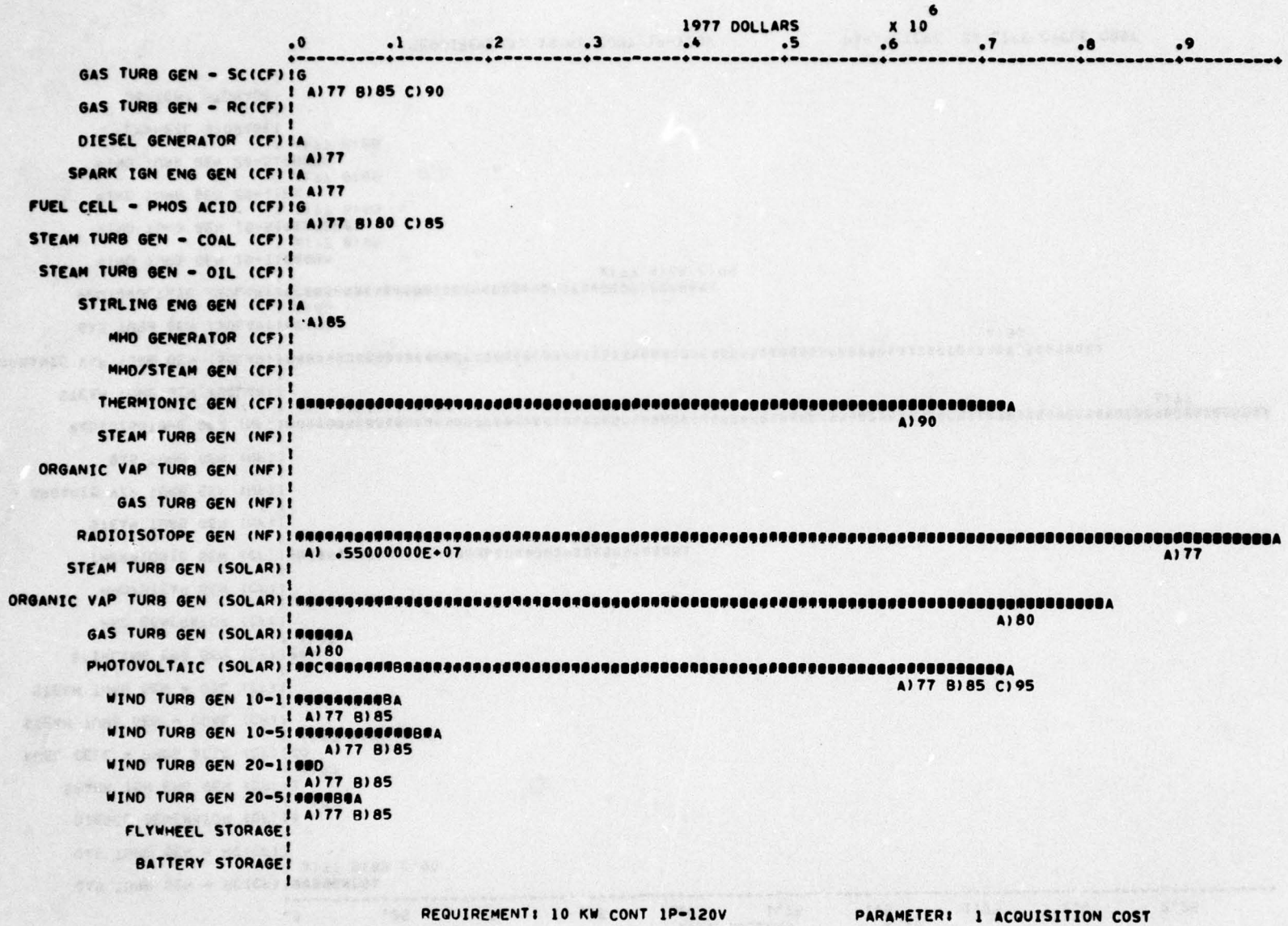
System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	None
SPARK IGN ENG GEN(CF)	None
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	None
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	
RADIOISOTOPE GEN(NF)	None
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	None
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	Possibly lead for conventional batteries
WIND TURB GEN 10-5	Possibly lead for conventional batteries
WIND TURB GEN 20-1	Possibly lead for conventional batteries
WIND TURB GEN 20-5	Possibly lead for conventional batteries
FLYWHEEL STORAGE	
BATTERY STORAGE	

SECTION XVI

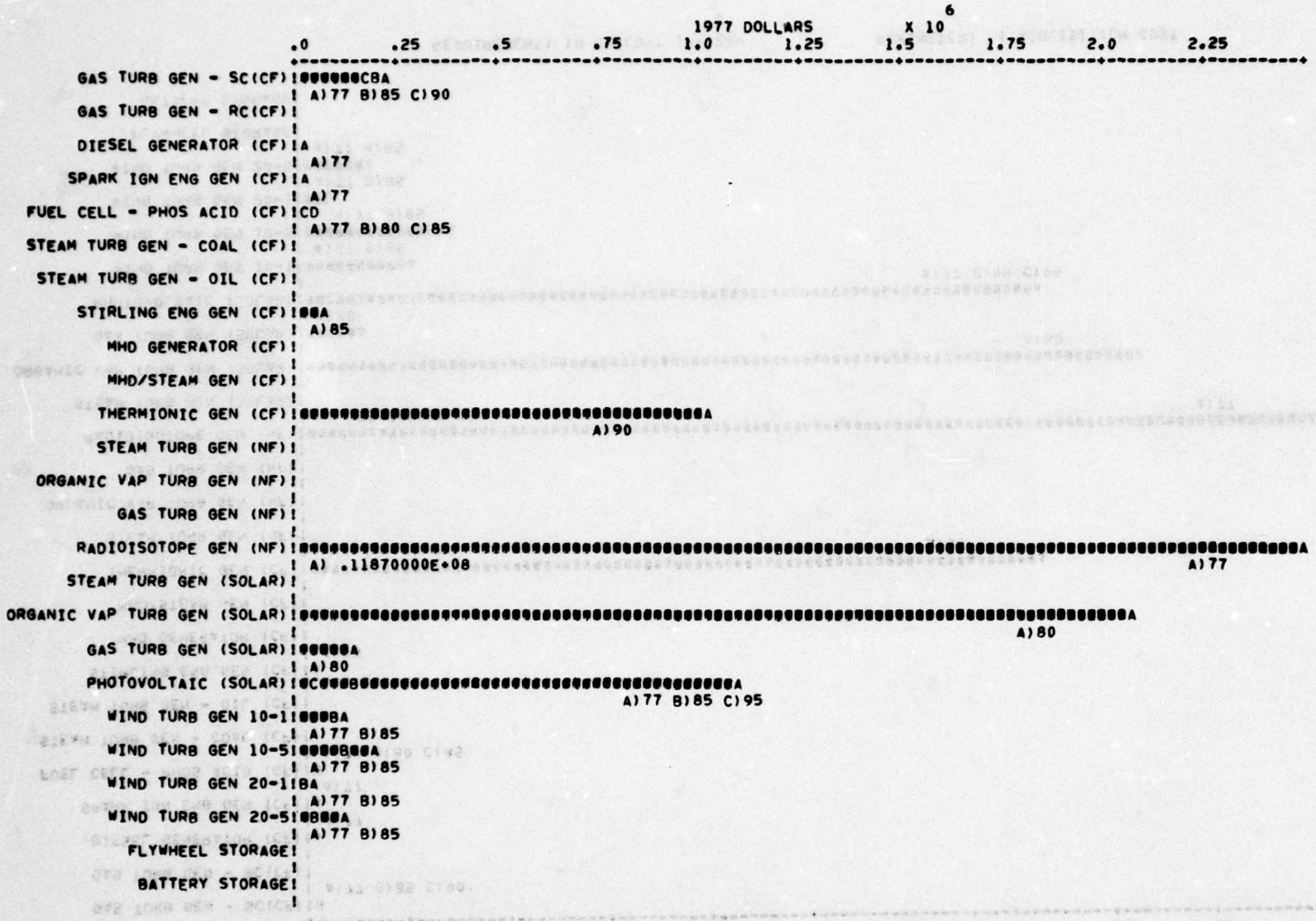
TEN KILOWATT, CONTINUOUS 1Ø

REQUIREMENT

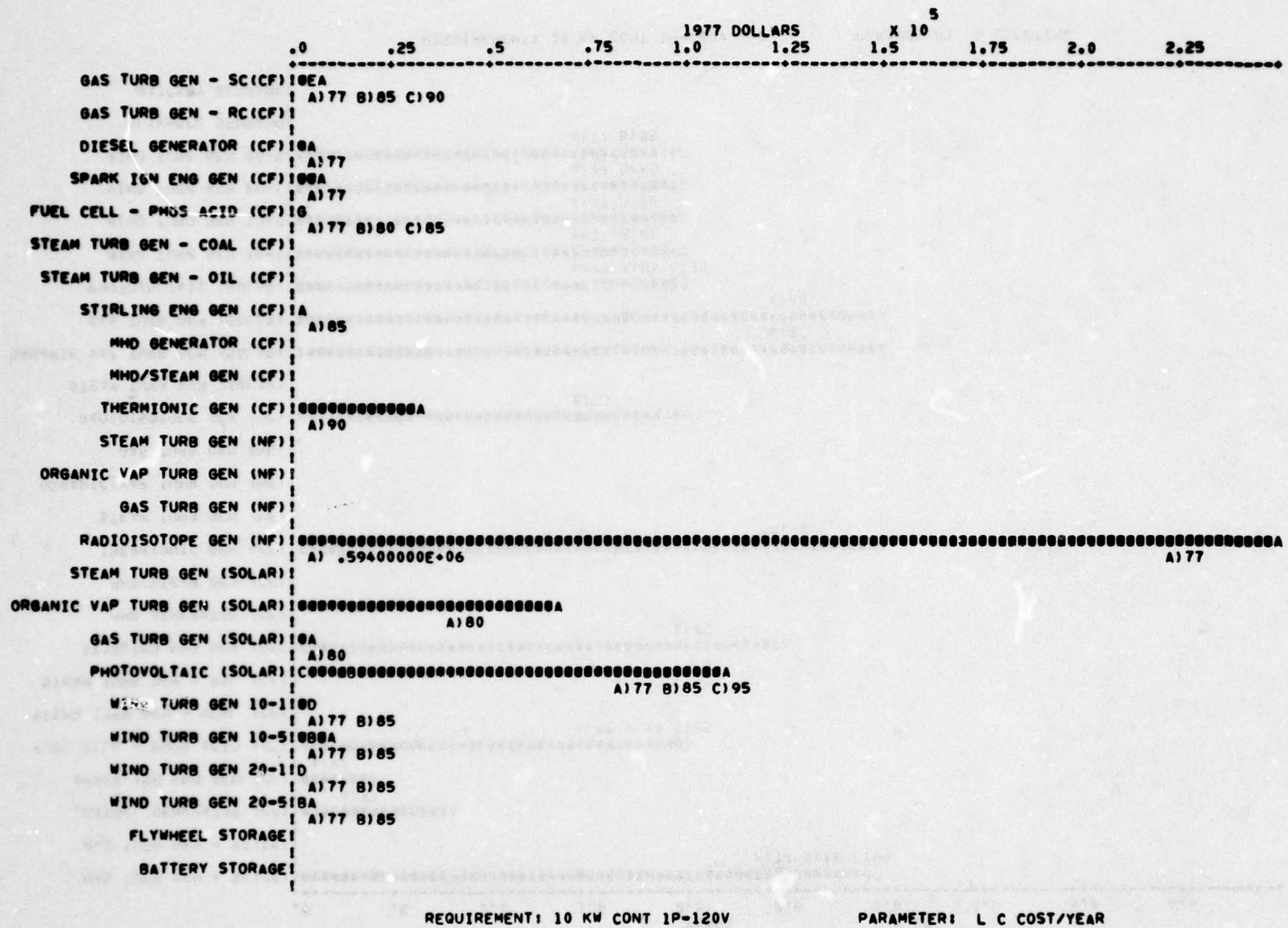
Power Level:	10 Kw
Operating Mode:	Continuous
Frequency/Phase:	60 Hz/1Ø
Voltage Level:	120 V

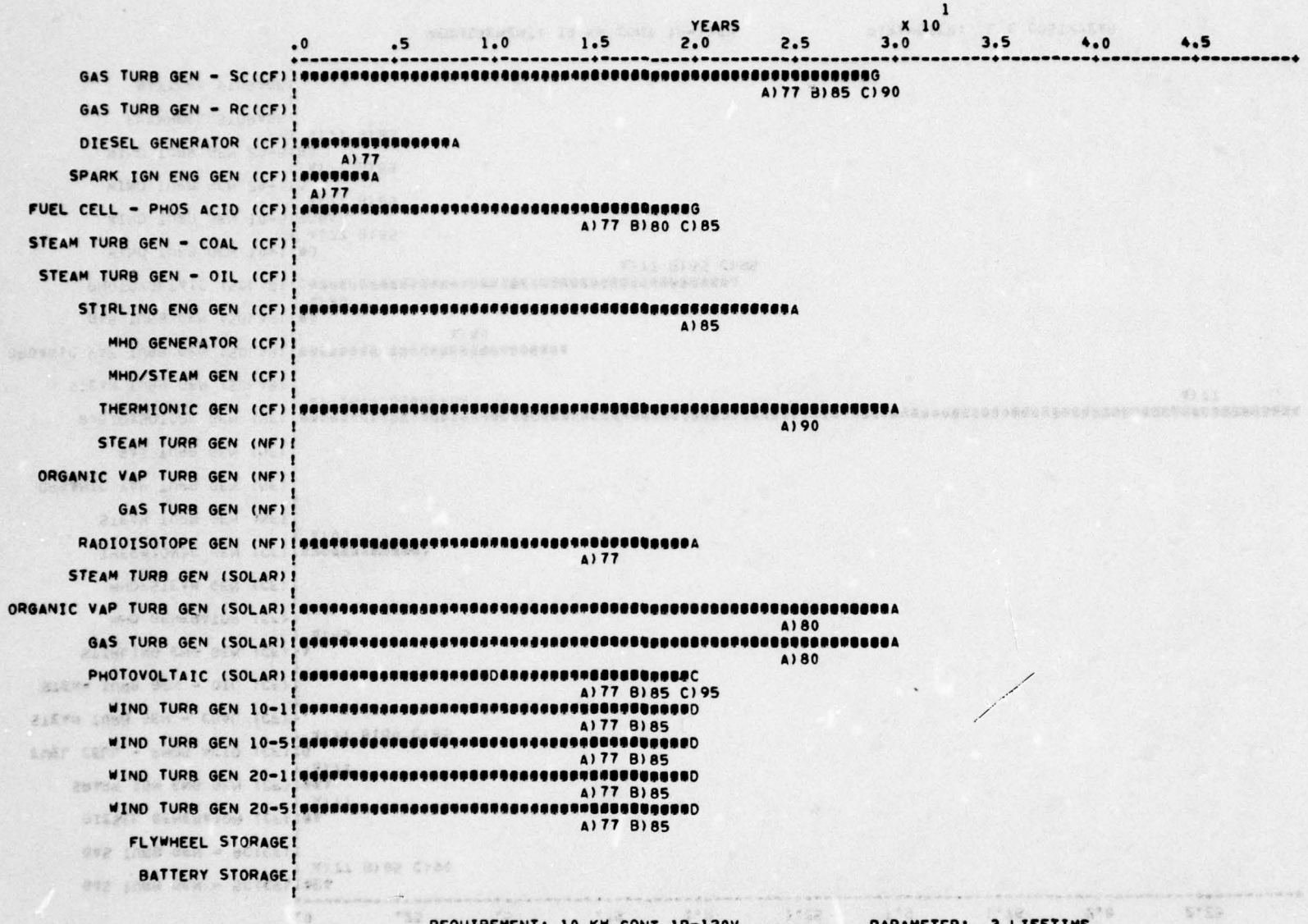


REQUIREMENT: 10 KW CONT 1P-120V PARAMETER: 1 ACQUISITION COST

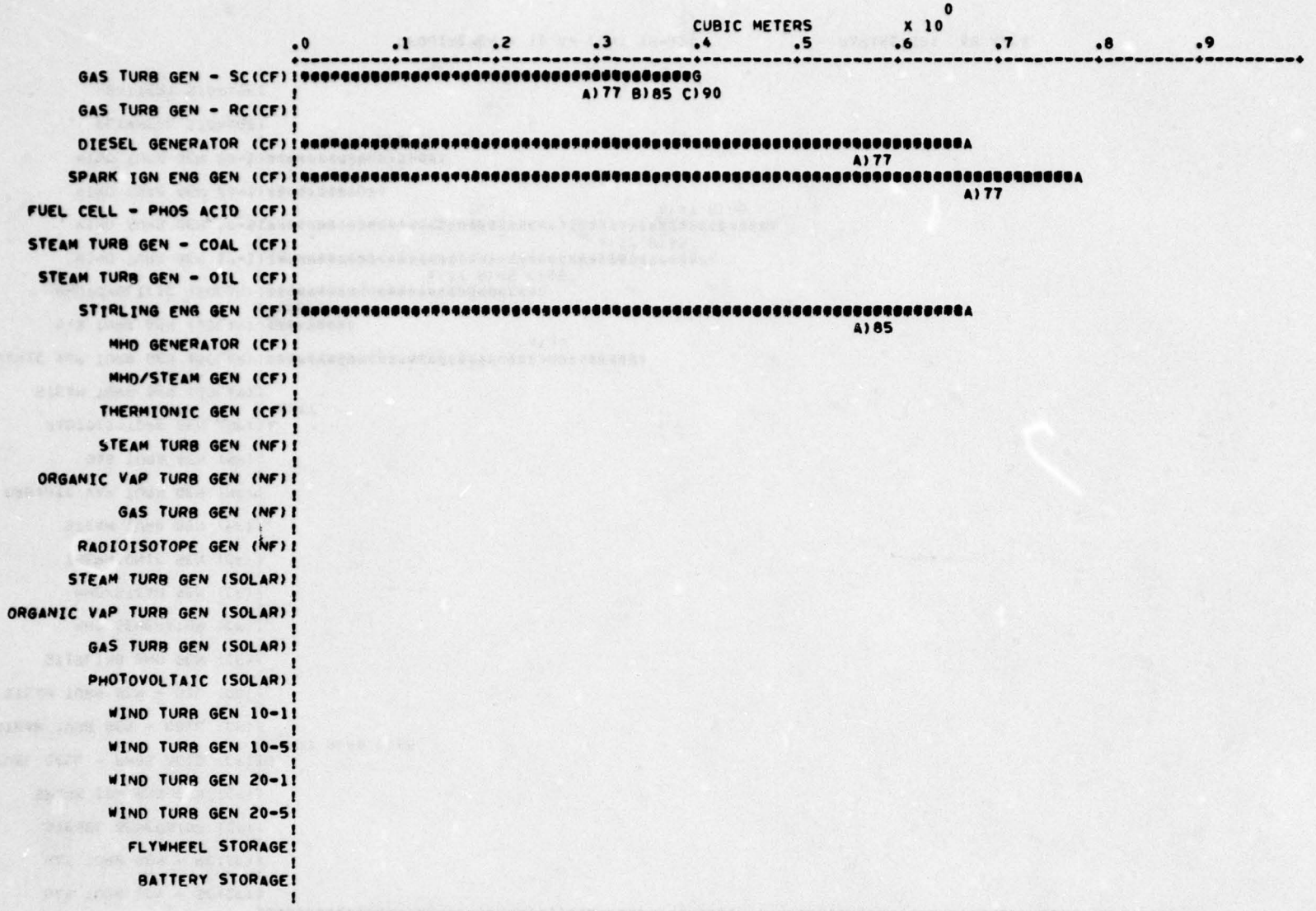


REQUIREMENT: 10 KW CONT 1P-120V PARAMETER: 2A LIFE CYCLE COST

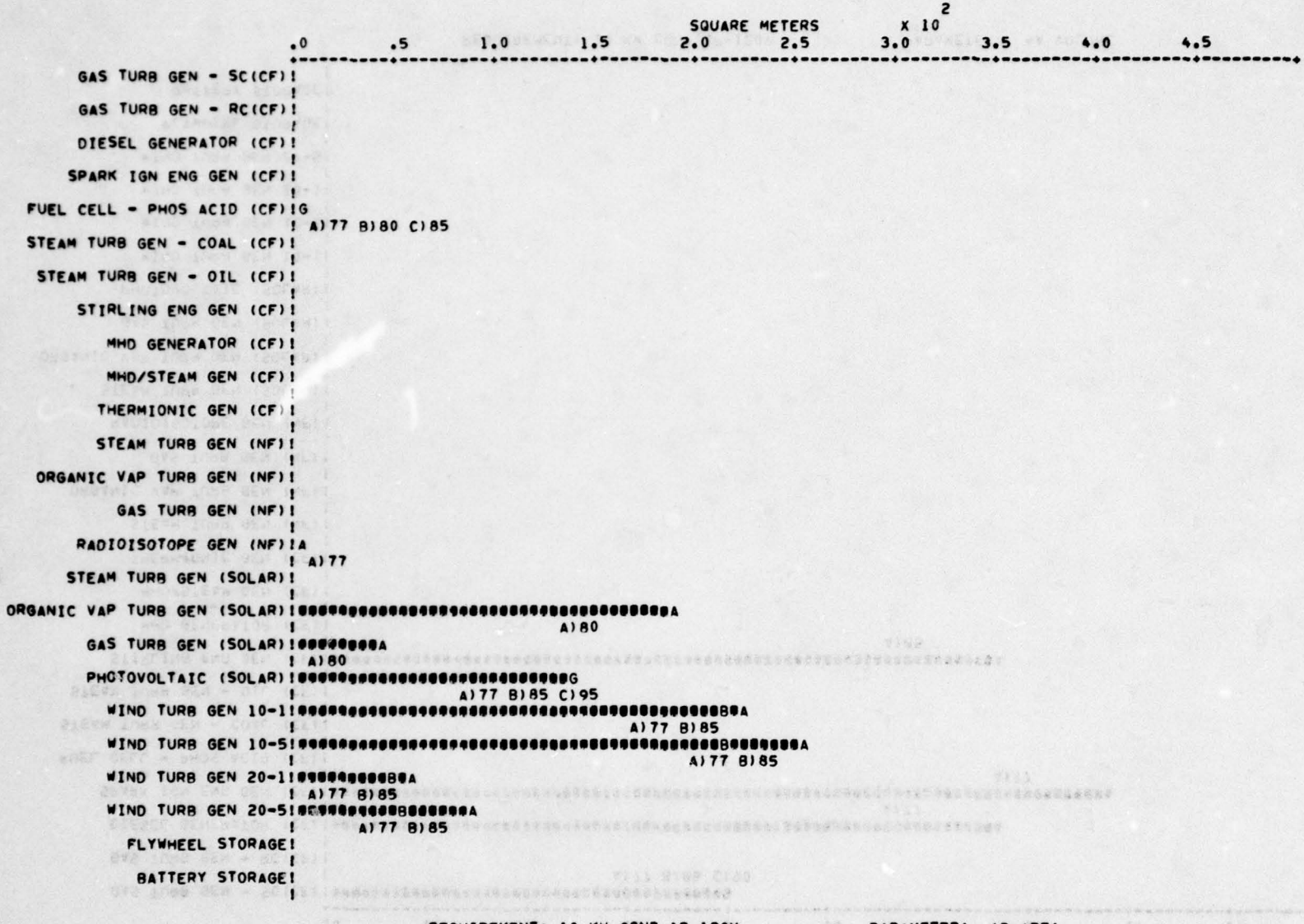

1977 DOLLARS
X 10^5
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A) .59400000E+06
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 1P-120V
PARAMETER: L C COST/YEAR

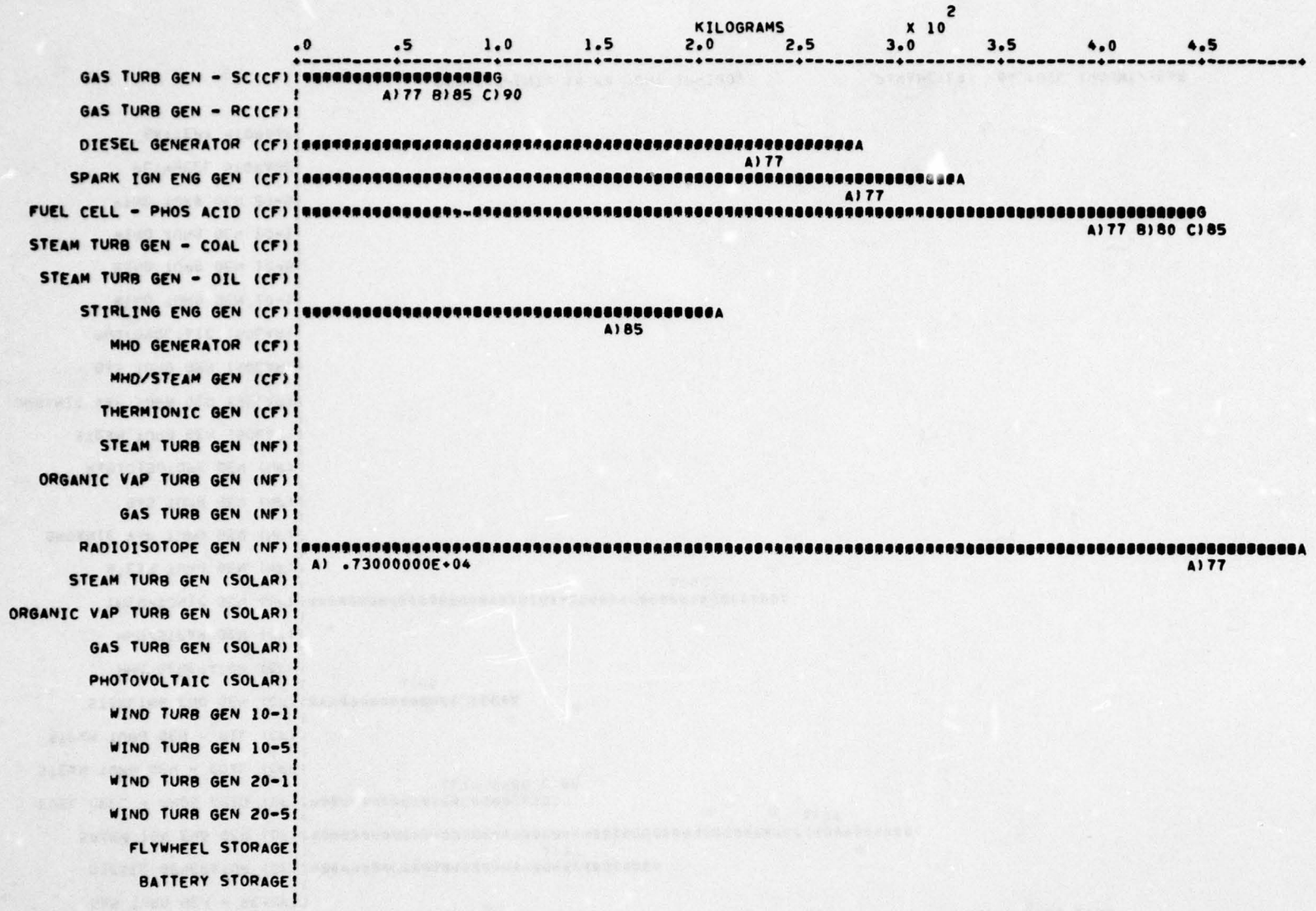


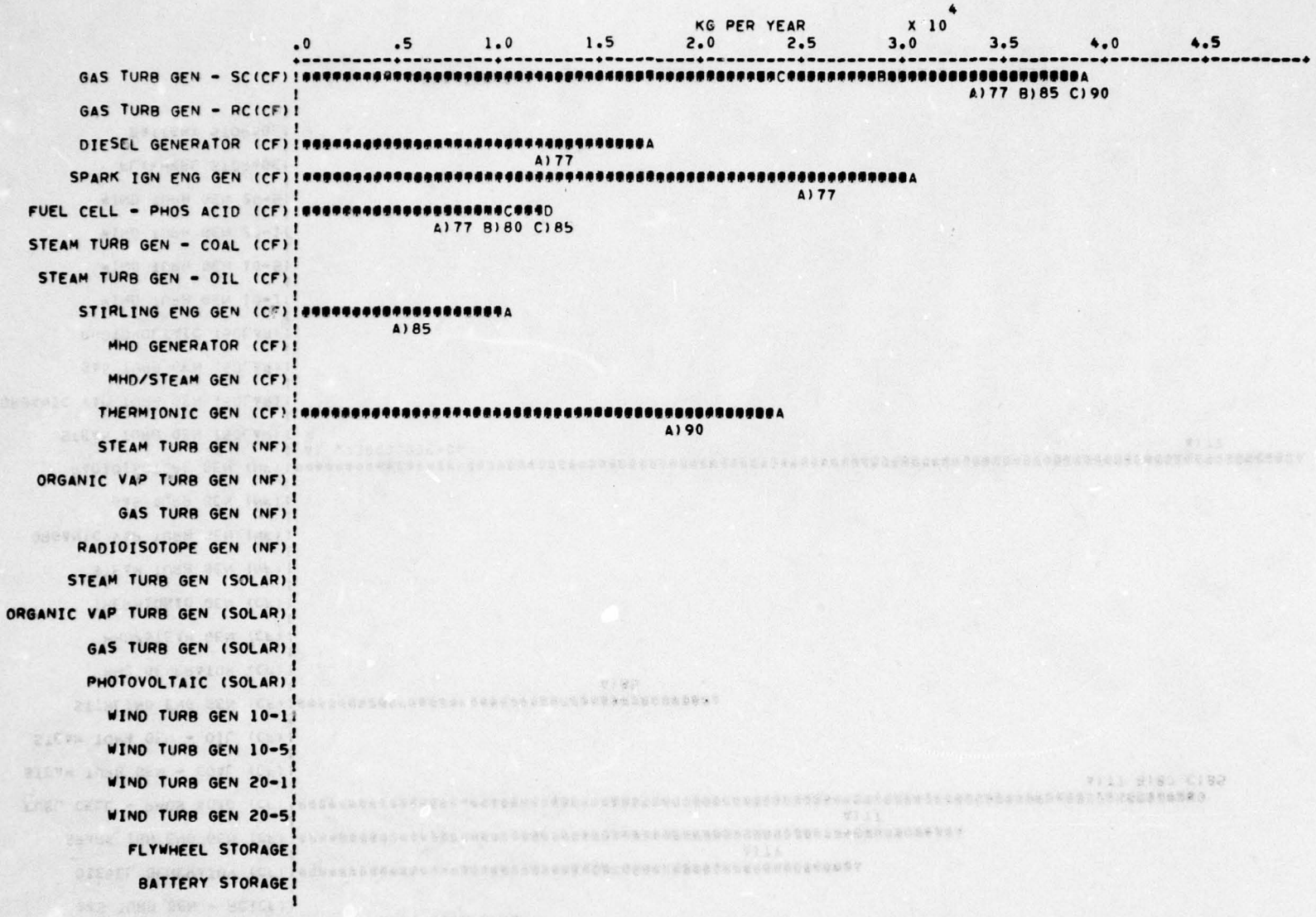
REQUIREMENT: 10 KW CONT 1P-120V PARAMETER: 3 LIFETIME

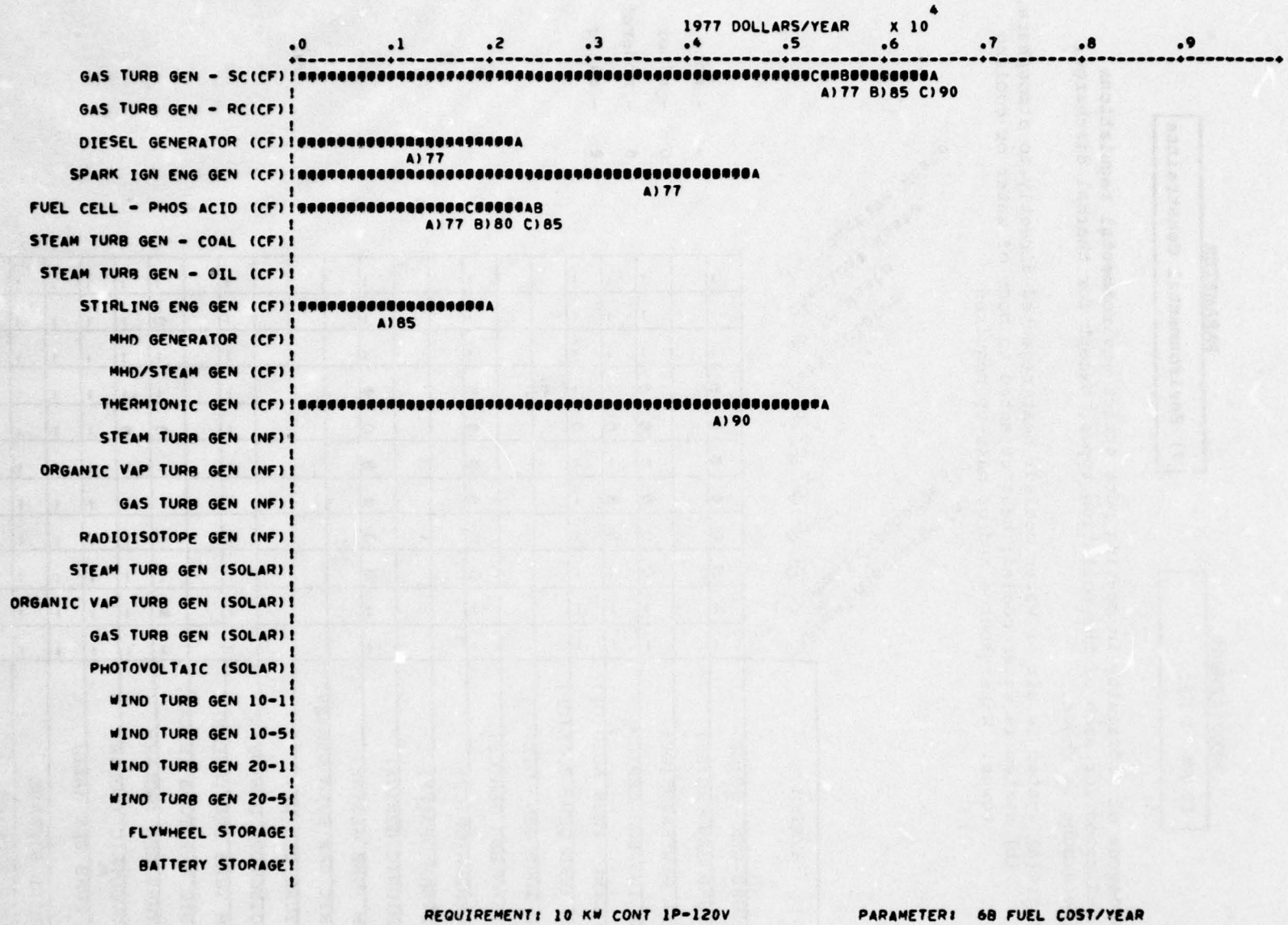


REQUIREMENT: 10 KW CONT 1P-120V PARAMETER: 4A VOLUME


SQUARE METERS X 10^2
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 1P-120V
PARAMETER: 48 AREA


KILOGRAMS
X 10 2
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A) .73000000E+04
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 1P-120V
PARAMETER: 5 WEIGHT


KG PER YEAR
X 10^4
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 1P-120V
PARAMETER: 6A FUEL AMOUNT/YEAR


1977 DOLLARS/YEAR X 10^4
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 1P-120V
PARAMETER: 68 FUEL COST/YEAR

REQUIREMENT	PARAMETER
10 KW 1 HR.	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
GAS TURB GEN - RC(CF)											
DIESEL GENERATOR(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
SPARK IGN ENG GEN(CF)	-	-	0	0	◐	-	◐	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	◐	-	-	-	-
STEAM TURB GEN - COAL(CF)											
STEAM TURB GEN - OIL(CF)											
STIRLING ENG GEN(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
MHD GENERATOR(CF)											
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)	-	-	0	0	●	◐	0	◐	-	-	-
STEAM TURB GEN(NF)											
ORGANIC VAP TURB GEN(NF)											
GAS TURB GEN(NF)											
RADIOISOTOPE GEN(NF)	-	-	-	-	-	-	-	-	-	-	-
STEAM TURB GEN (SOLAR)											
ORGANIC VAP TURB (SOLAR)	-	●	-	-	-	-	◐	-	-	0	-
GAS TURB GEN (SOLAR)	-	-	-	-	-	-	◐	-	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
WIND TURB GEN (ALL)	-	-	-	-	-	-	-	-	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	-	-	-	-
BATTERY STORAGE	-	-	-	-	-	-	-	-	-	-	-

- - none
0 - minor
◐ - moderate
● - major

REQUIREMENT

10 KW Cont. 1P-120V

PARAMETER

8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- - - no limitation
- o - minor limitation
- ⊖ - major limitation
- ● - overriding limitation

SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	o	●	-	-	-	-
GAS TURB GEN - RC(CF)								
DIESEL GENERATOR(CF)	-	-	-	●	-	-	-	-
SPARK IGN ENG GEN(CF)	-	-	-	●	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)								
STEAM TURB GEN - OIL(CF)								
STIRLING ENG GEN(CF)	-	-	o	●	-	-	-	-
MHD GENERATOR(CF)								
MHD/STEAM GEN(CF)								
THERMIONIC GEN(CF)	o	o	o	●	-	-	-	-
STEAM TURB GEN(NF)								
ORGANIC VAP TURB GEN(NF)								
GAS TURB GEN(NF)								
RADIOISOTOPE GEN(NF)	-	-	-	-	-	-	●	-
STEAM TURB GEN (SOLAR)								
ORGANIC VAP TURB (SOLAR)	⊖	-	o	-	●	-	-	-
GAS TURB GEN (SOLAR)	-	-	o	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1	-	-	-	-	-	●	-	-
WIND TURB GEN 10-5	-	-	-	-	-	●	-	-
WIND TURB GEN 20-1	-	-	-	-	-	●	-	-
WIND TURB GEN 20-5	-	-	-	-	-	●	-	-
FLYWHEEL STORAGE								
BATTERY STORAGE								

REQUIREMENT

10 KW Cont. 1P-120V

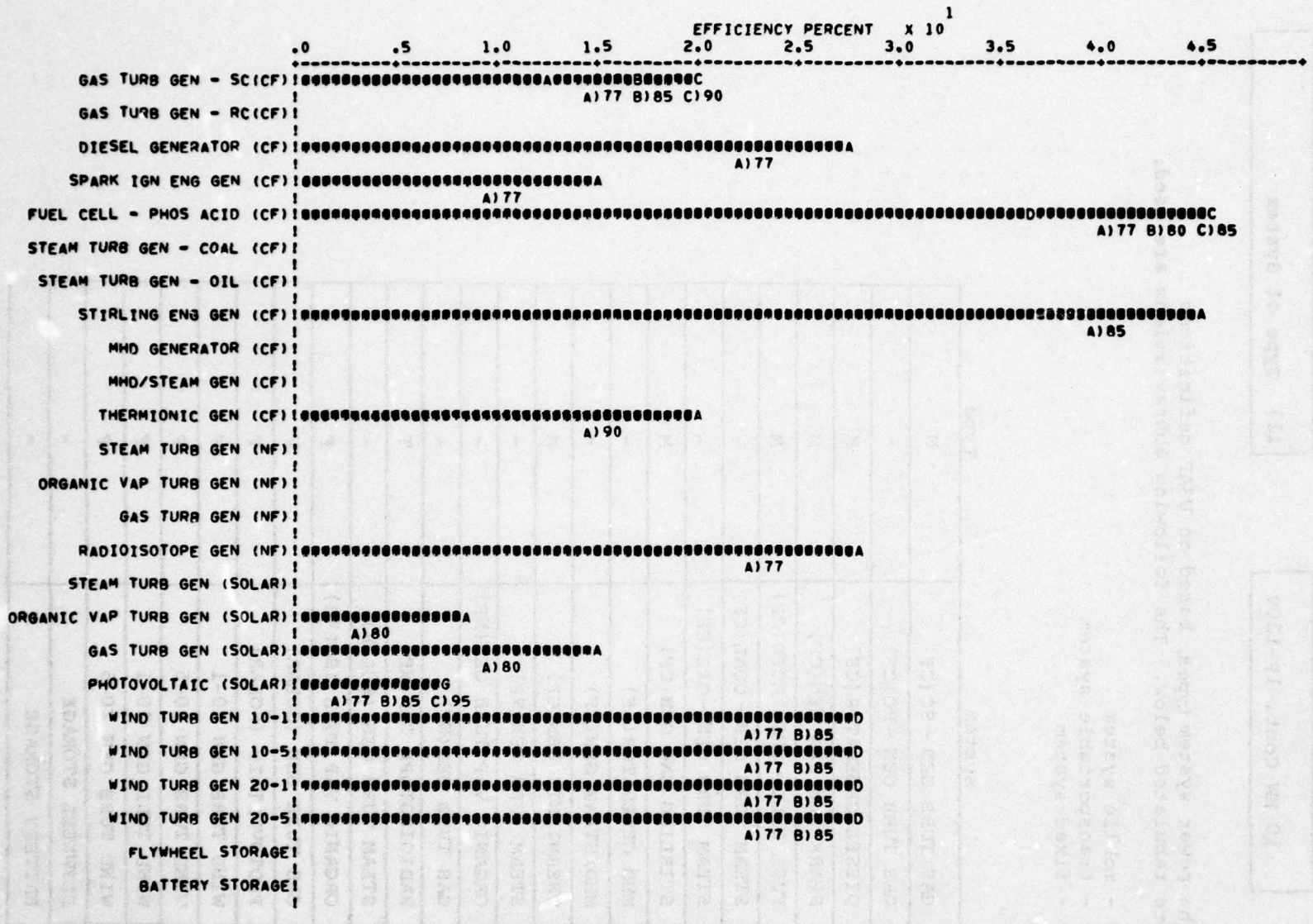
PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
0 - Characteristic has minor effect on system performance
◐ - Characteristic has moderate effect on system performance
● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	◐	0	-	-	0	0	0
GAS TURB GEN - RC(CF)							
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)	◐	0	-	-	0	0	0
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)							
STEAM TURB GEN - OIL(CF)							
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)							
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	◐	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)							
GAS TURB GEN(NF)							
RADIOISOTOPE GEN(NF)	0	0	-	-	◐	0	0
STEAM TURB GEN (SOLAR)							
ORGANIC VAP TURB (SOLAR)	-	0	●	-	◐	◐	-
GAS TURB GEN (SOLAR)	-	-	●	-	◐	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE							
BATTERY STORAGE							



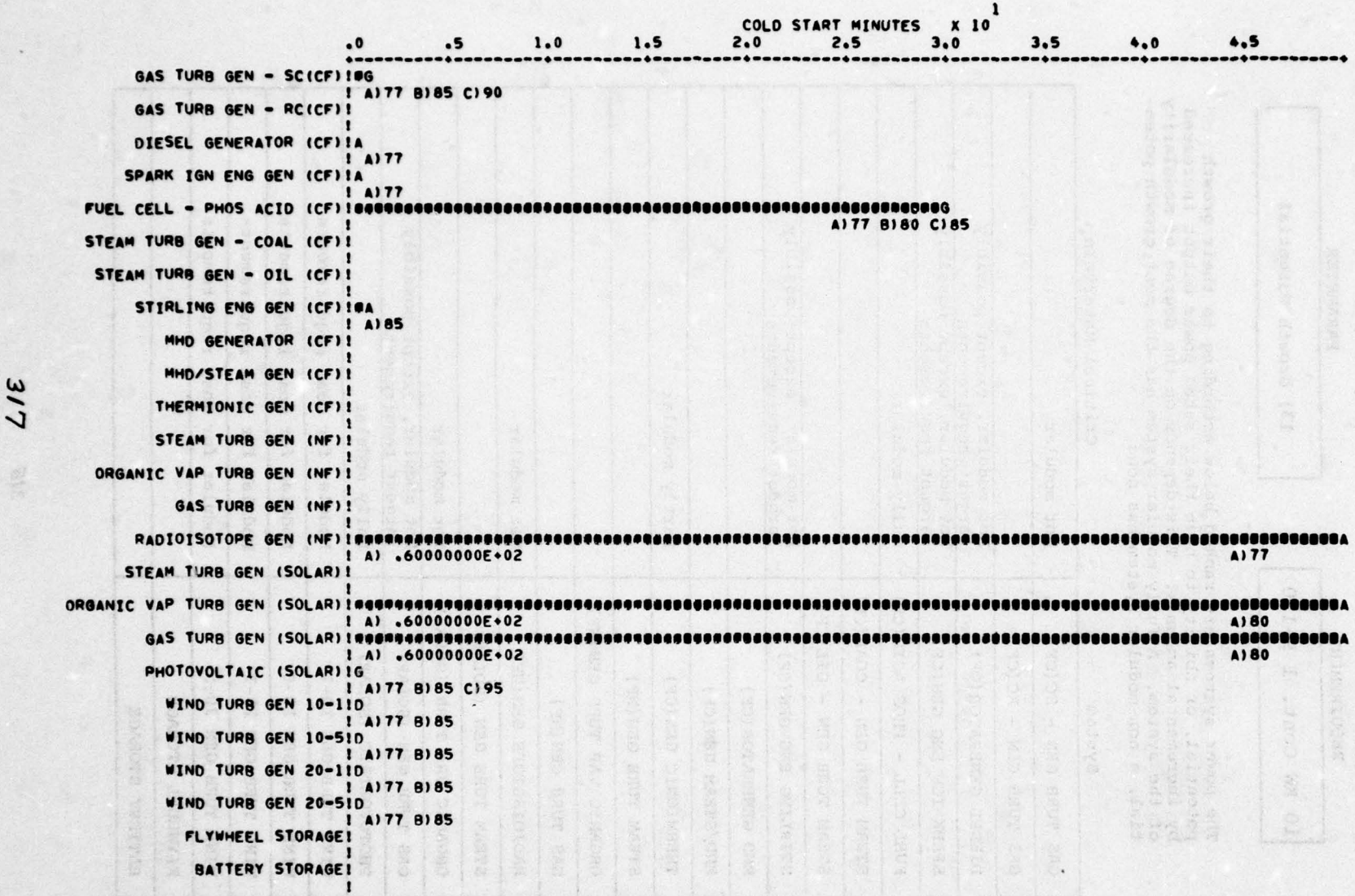
REQUIREMENT: 10 KW CONT 1P-120V PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
10 KW Cont. 1P-120V	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	M
GAS TURB GEN - RC(CF)	-
DIESEL GENERATOR(CF)	M
SPARK IGN ENG GEN(CF)	M
FUEL CELL - PHOS ACID(CF)	M
STEAM TURB GEN - COAL(CF)	-
STEAM TURB GEN - OIL(CF)	-
STIRLING ENG GEN(CF)	M
MHD GENERATOR(CF)	-
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	M
STEAM TURB GEN(NF)	-
ORGANIC VAP TURB GEN(NF)	-
GAS TURB GEN(NF)	-
RADIOISOTOPE GEN(NF)	T
STEAM TURB GEN (SOLAR)	-
ORGANIC VAP TURB (SOLAR)	F
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	F
WIND TURB GEN 10-5	F
WIND TURB GEN 20-1	F
WIND TURB GEN 20-5	F
FLYWHEEL STORAGE	-
BATTERY STORAGE	-



REQUIREMENT: 10 KW CONT 1P-120V PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
10 KW Cont. 1 P-120	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

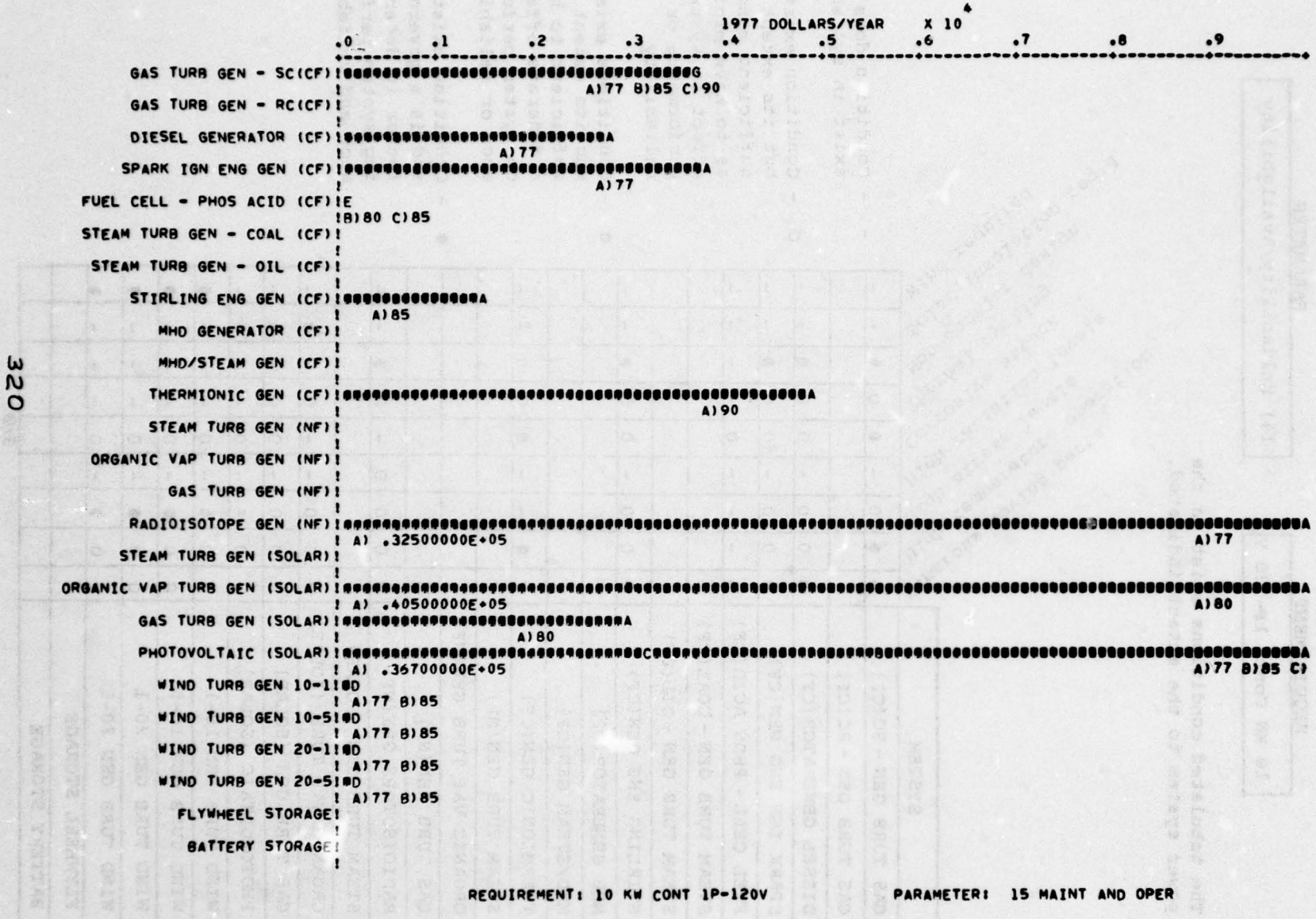
System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	Not modular, except possibly largest requirements
SPARK IGN.ENG GEN(CF)	Not modular, except possibly largest requirements
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	Not modular, except possibly largest requirements
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	
RADIOISOTOPE GEN(NF)	Not modular
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	Not modular
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	Modular for most requirements
WIND TURB GEN 10-5	Modular for most requirements
WIND TURB GEN 20-1	Modular for most requirements
WIND TURB GEN 20-5	Modular for most requirements
FLYWHEEL STORAGE	
BATTERY STORAGE	

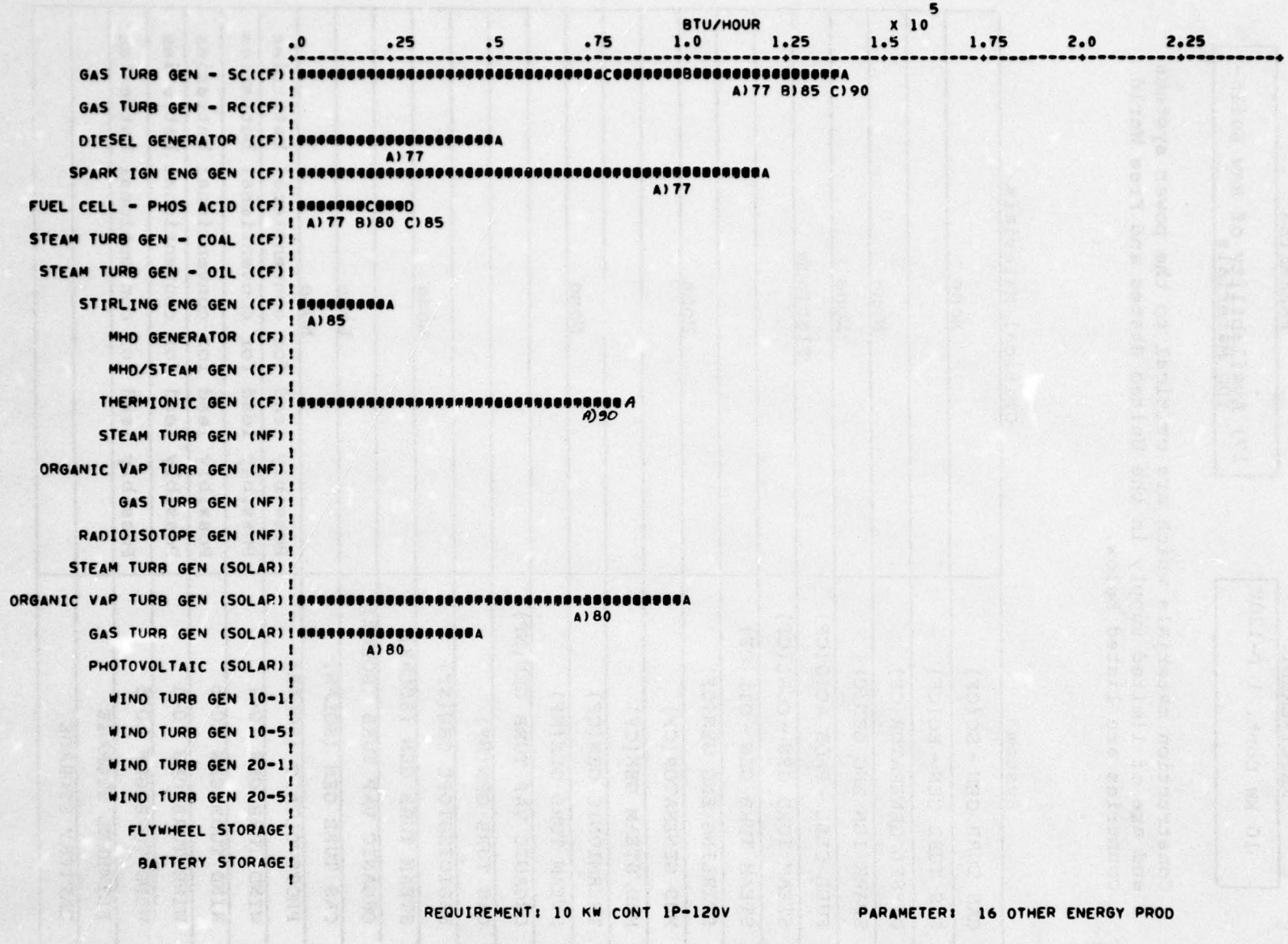
REQUIREMENT	PARAMETER
10 KW Cont. 1P-120 V	14) Reliability/Availability

The tabulated conditions exist in the power system to the extent indicated.

SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	O	●	O	-	●	O	●	-	-
GAS TURB GEN - RC(CF)									
DIESEL GENERATOR(CF)	●	O	O	-	O	O	●	-	-
SPARK IGN ENG GEN(CF)	●	O	O	-	O	O	●	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	O	-	-	-	-
STEAM TURB GEN - COAL(CF)									
STEAM TURB GEN - OIL(CF)									
STIRLING ENG GEN(CF)	O	O	O	-	O	O	●	-	-
MHD GENERATOR(CF)									
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	O	●	-	-	●	O	O	-	-
STEAM TURB GEN(NF)									
ORGANIC VAP TURB GEN(NF)									
GAS TURB GEN(NF)									
RADIOISOTOPE GEN(NF)	O	O	O	O	-	O	●	-	-
STEAM TURB GEN (SOLAR)									
ORGANIC VAP TURB (SOLAR)	O	O	O	-	-	O	-	●	-
GAS TURB GEN (SOLAR)	O	O	O	-	O	O	-	●	-
PHOTOVOLTAIC (SOLAR)	-	O	-	-	O	-	-	●	-
WIND TURB GEN 10-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 10-5	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-5	O	O	●	-	O	-	-	-	●
FLYWHEEL STORAGE									
BATTERY STORAGE									

- \- - Condition does not exist in system
- O - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability
- ⊖ - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability
- ● - Condition exists and is a governing factor in determining system performance and reliability


1977 DOLLARS/YEAR X 10^4
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A) .32500000E+05
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A) .40500000E+05
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A) .36700000E+05
A)77 B)85 C)
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 1P-120V
PARAMETER: 15 MAINT AND OPER


BTU/HOUR
X 10^5
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
REQUIREMENT: 10 KW CONT 1P-120V
PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
10 KW Cont. 1 P-120V	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

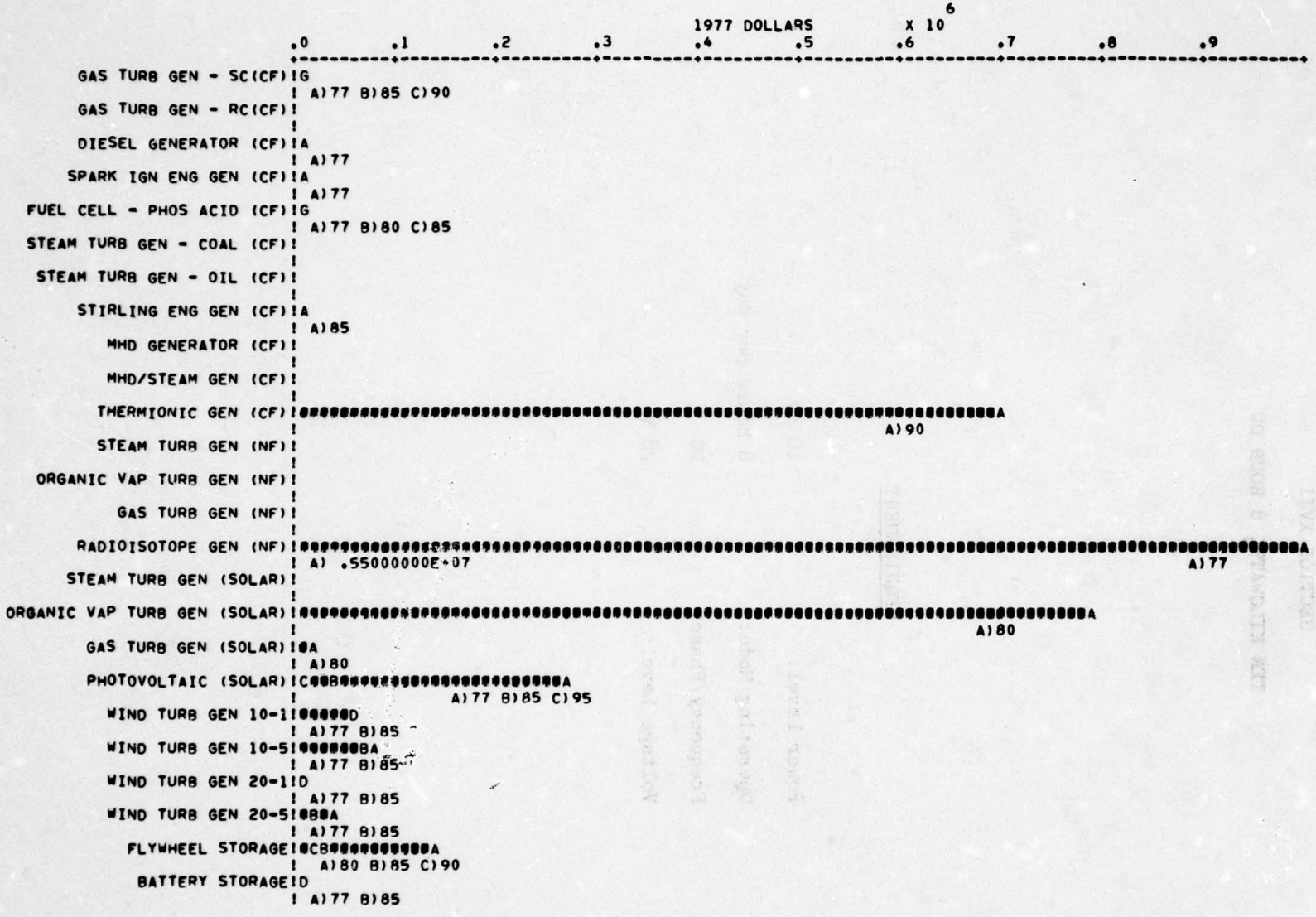
System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	None
SPARK IGN ENG GEN(CF)	None
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	None
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	
RADIOISOTOPE GEN(NF)	None
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	None
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	Possibly lead for conventional batteries
WIND TURB GEN 10-5	Possibly lead for conventional batteries
WIND TURB GEN 20-1	Possibly lead for conventional batteries
WIND TURB GEN 20-5	Possibly lead for conventional batteries
FLYWHEEL STORAGE	
BATTERY STORAGE	

SECTION XVII

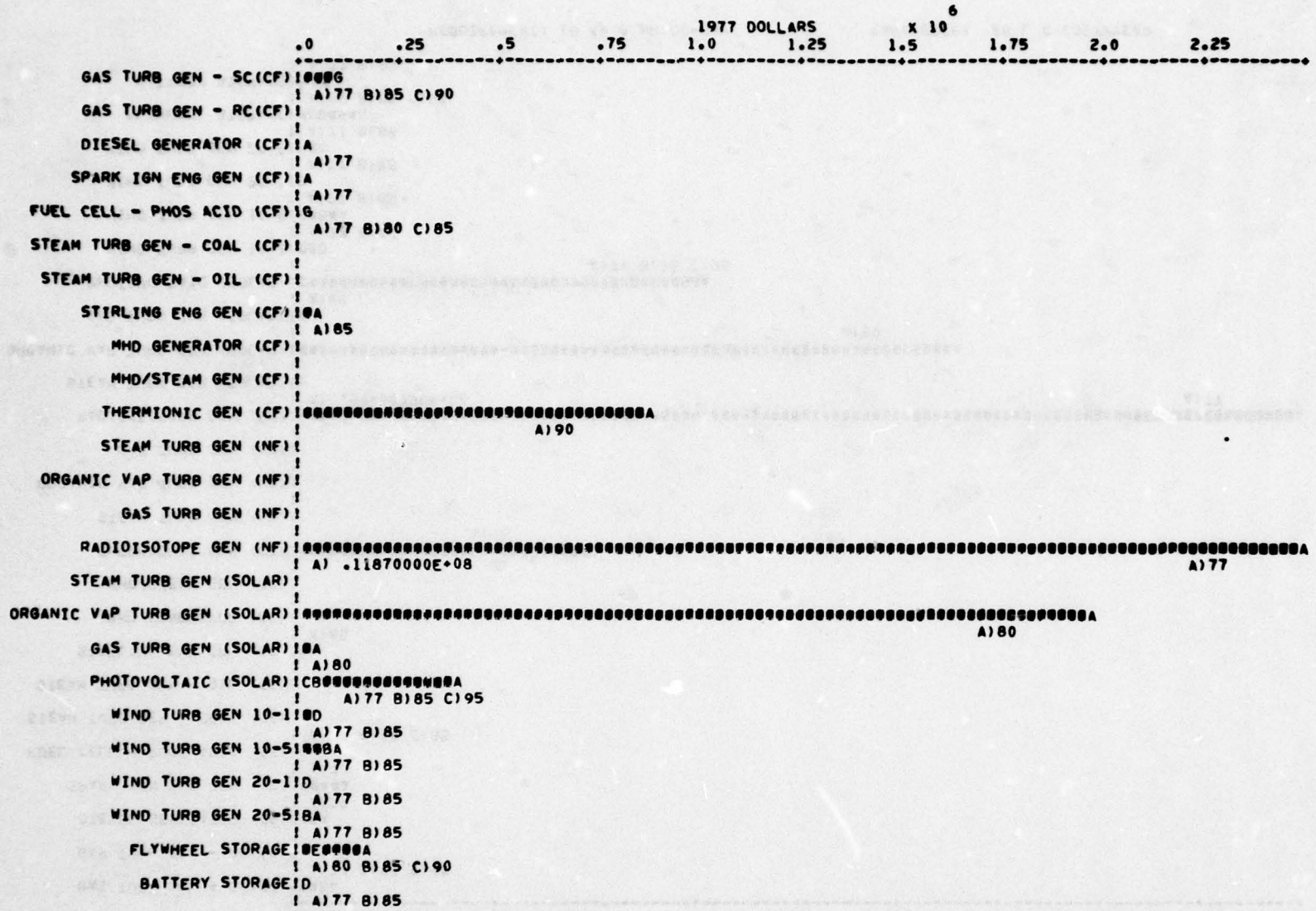
TEN KILOWATT, 8 HOUR DC

REQUIREMENT

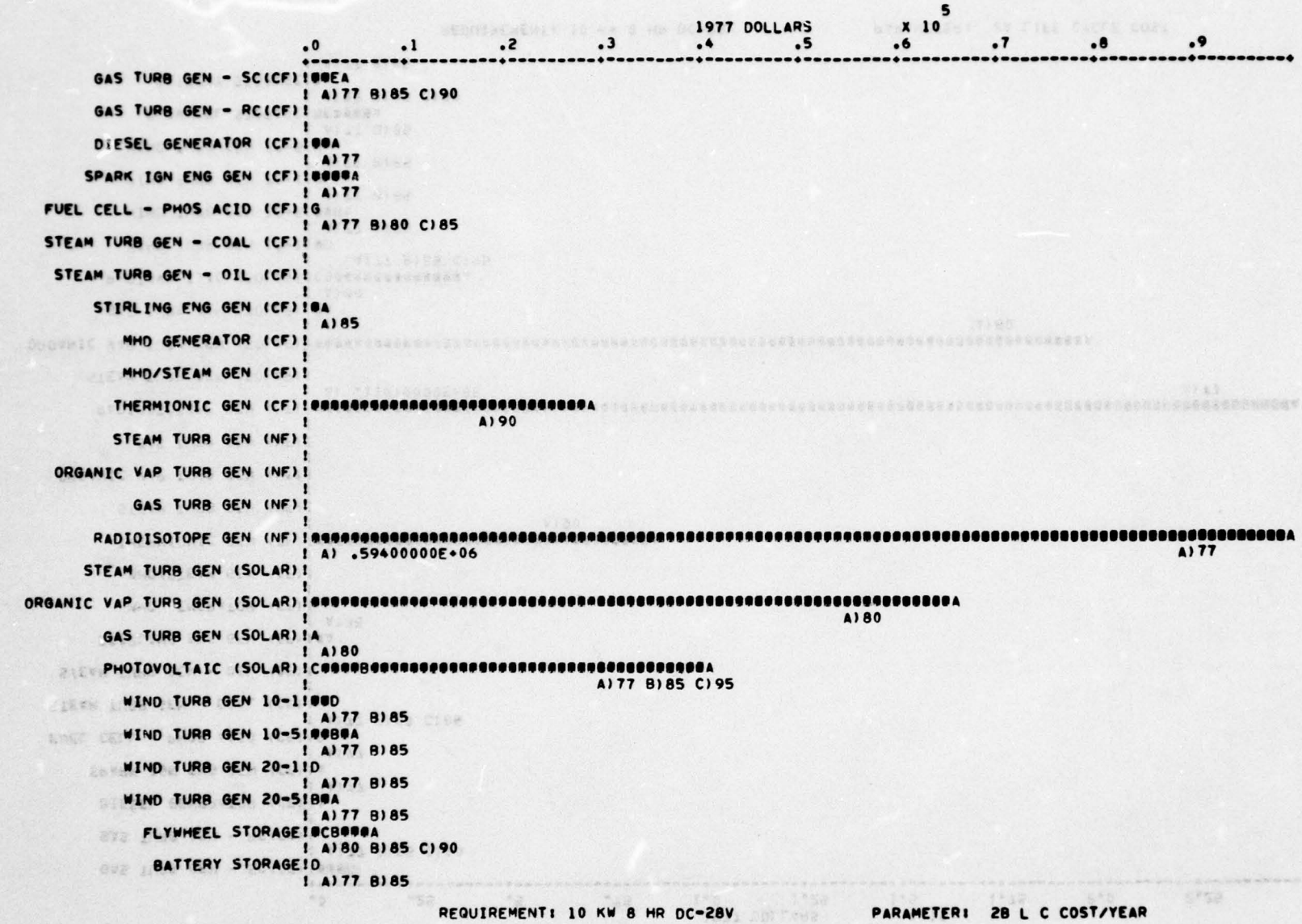
Power Level:	10 Kw
Operating Mode:	8 hours per day
Frequency/Phase:	DC
Voltage Level:	28 V

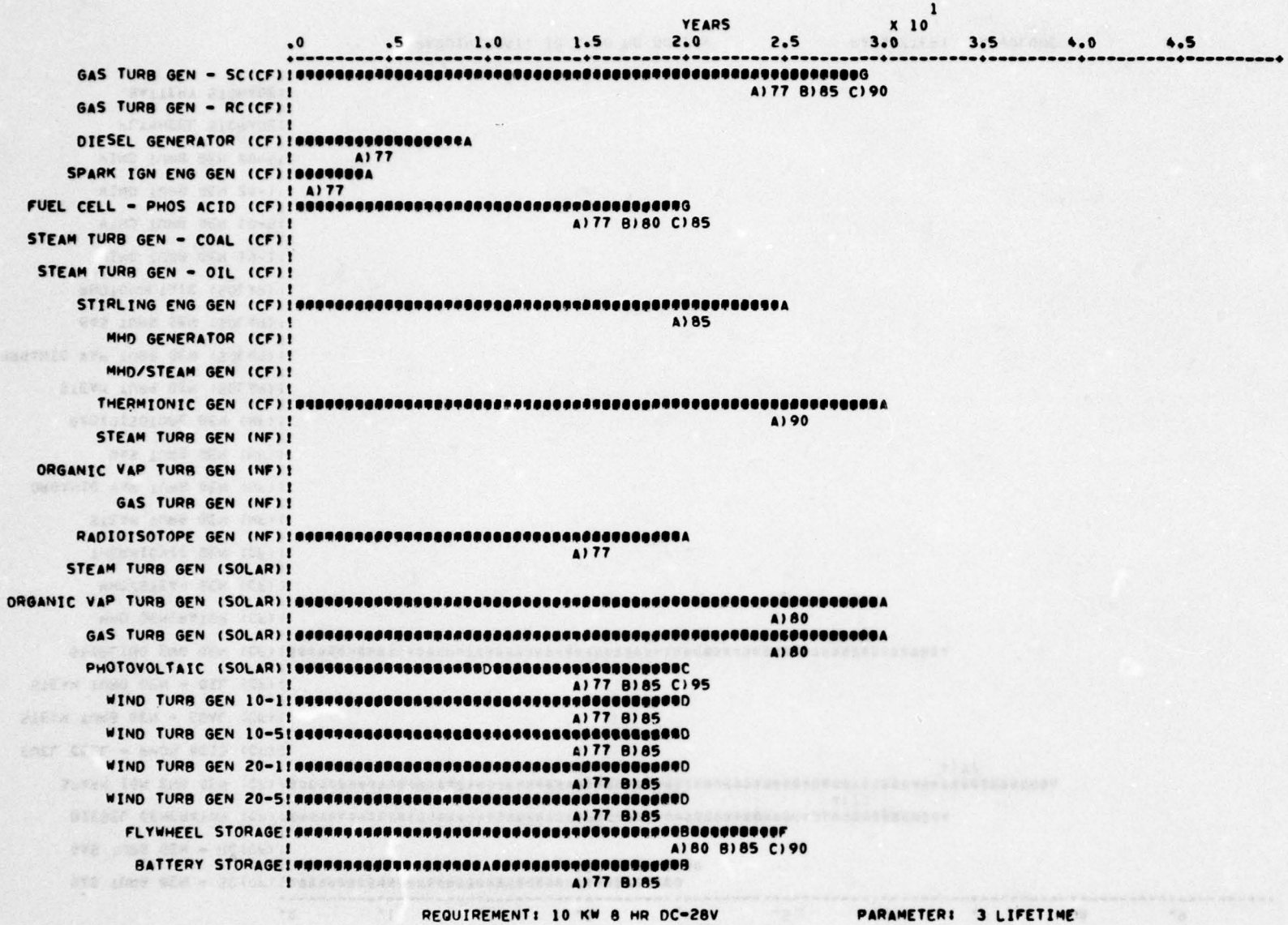


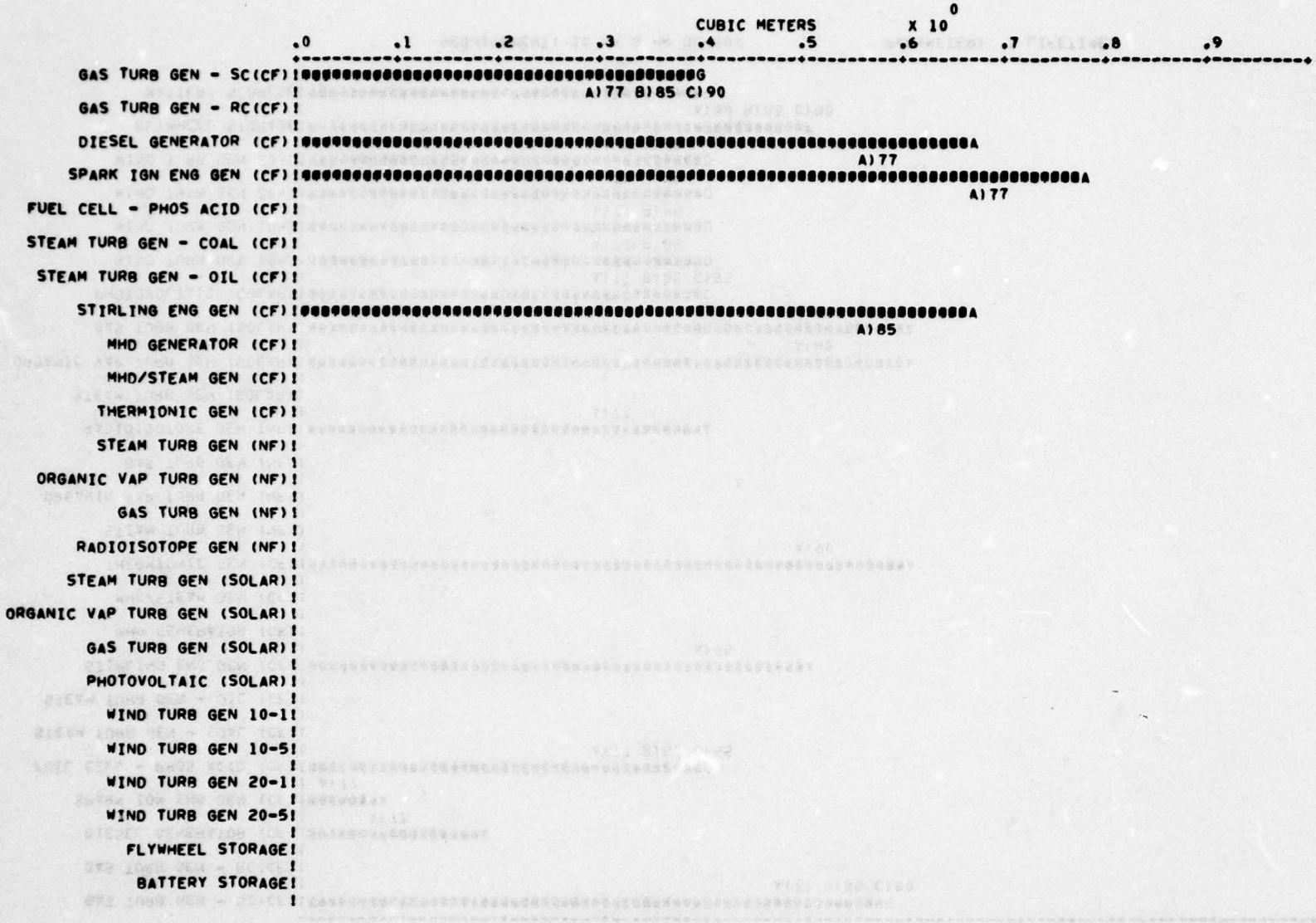
REQUIREMENT: 10 KW 8 HR DC-28V PARAMETER: 1 ACQUISITION COST



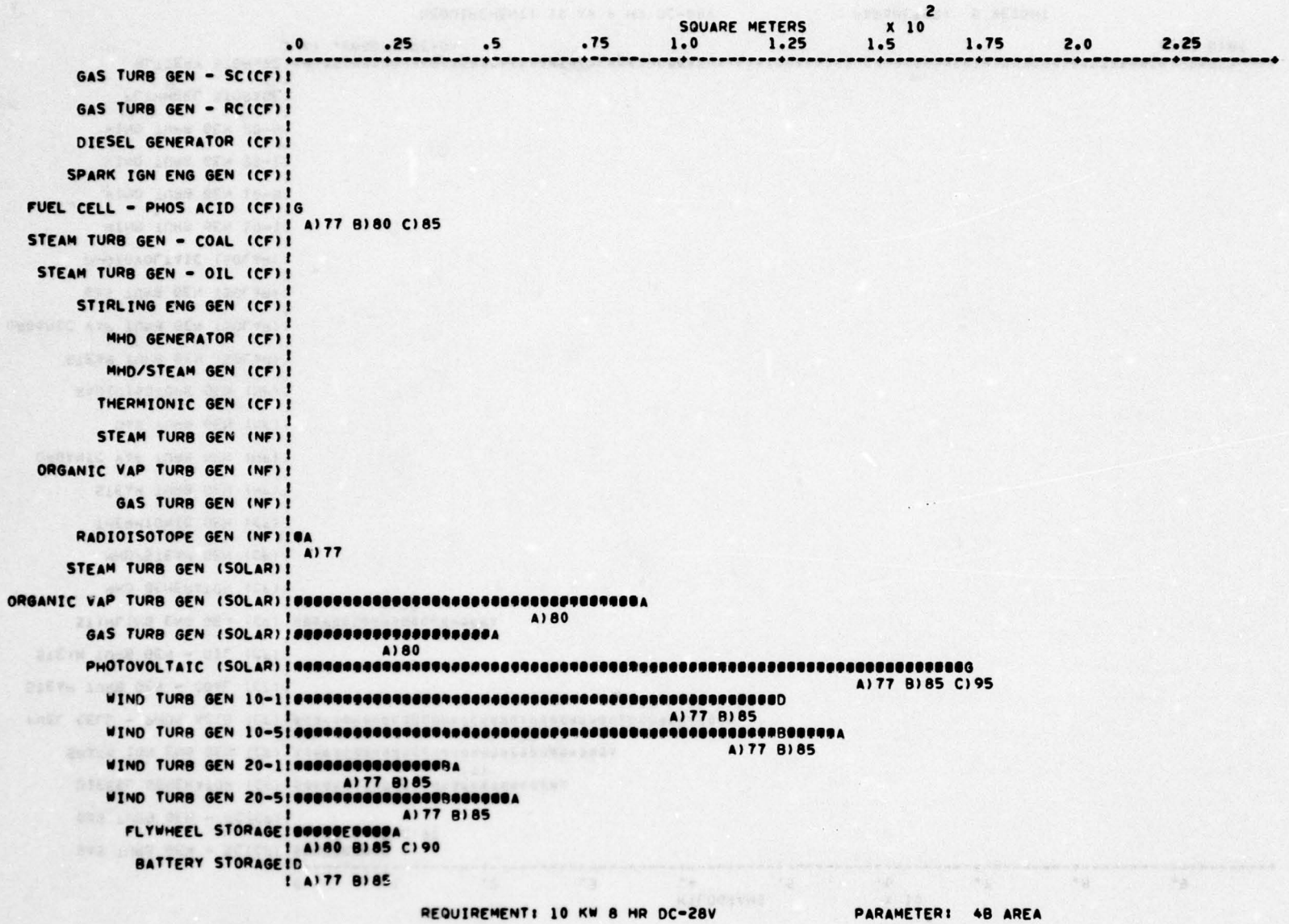
REQUIREMENT: 10 KW 8 HR DC-28V PARAMETER: 2A LIFE CYCLE COST

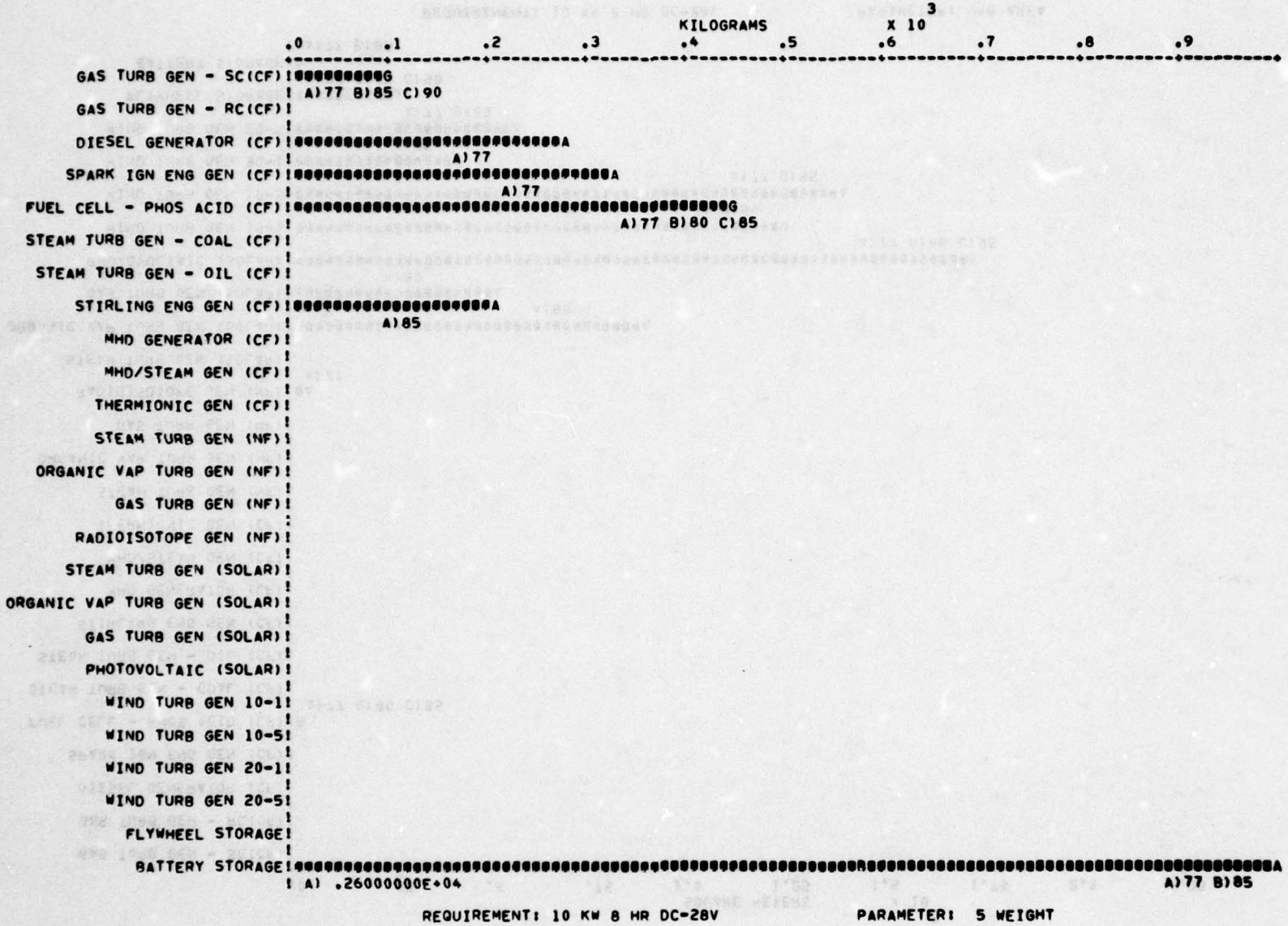

1977 DOLLARS
X 10^5
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A) .59400000E+06
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 KW 8 HR DC-28V
PARAMETER: 28 L C COST/YEAR


YEARS
x 10^1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 KW 8 HR DC-28V
PARAMETER: 3 LIFETIME

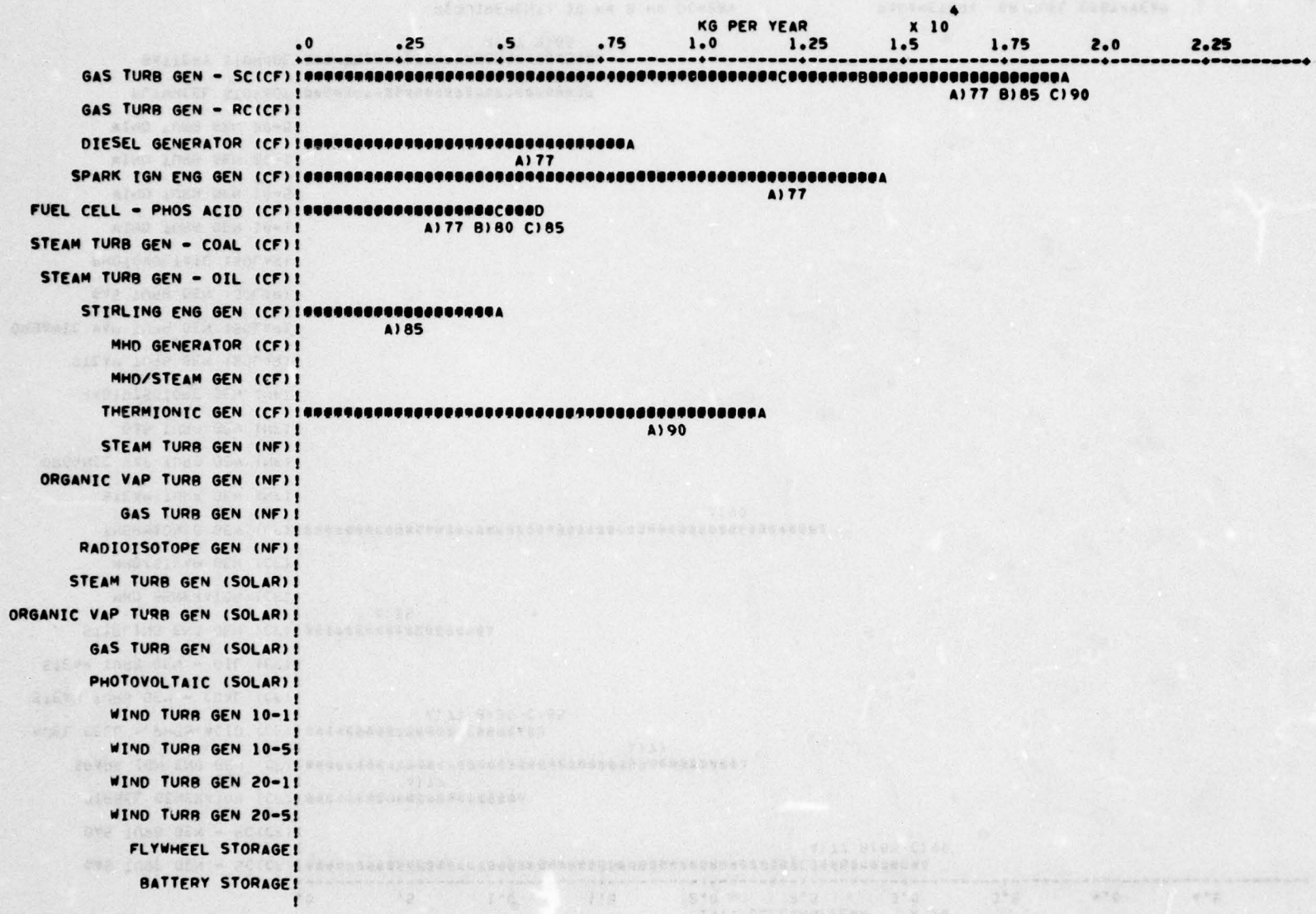


REQUIREMENT: 10 KW 8 HR DC-28V PARAMETER: 4A VOLUME


SQUARE METERS x 10^2
.0 .25 .5 .75 1.0 1.25 1.5 1.75 2.0 2.25
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
G
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
D
A)77 B)85
REQUIREMENT: 10 KW 8 HR DC-28V
PARAMETER: 4B AREA

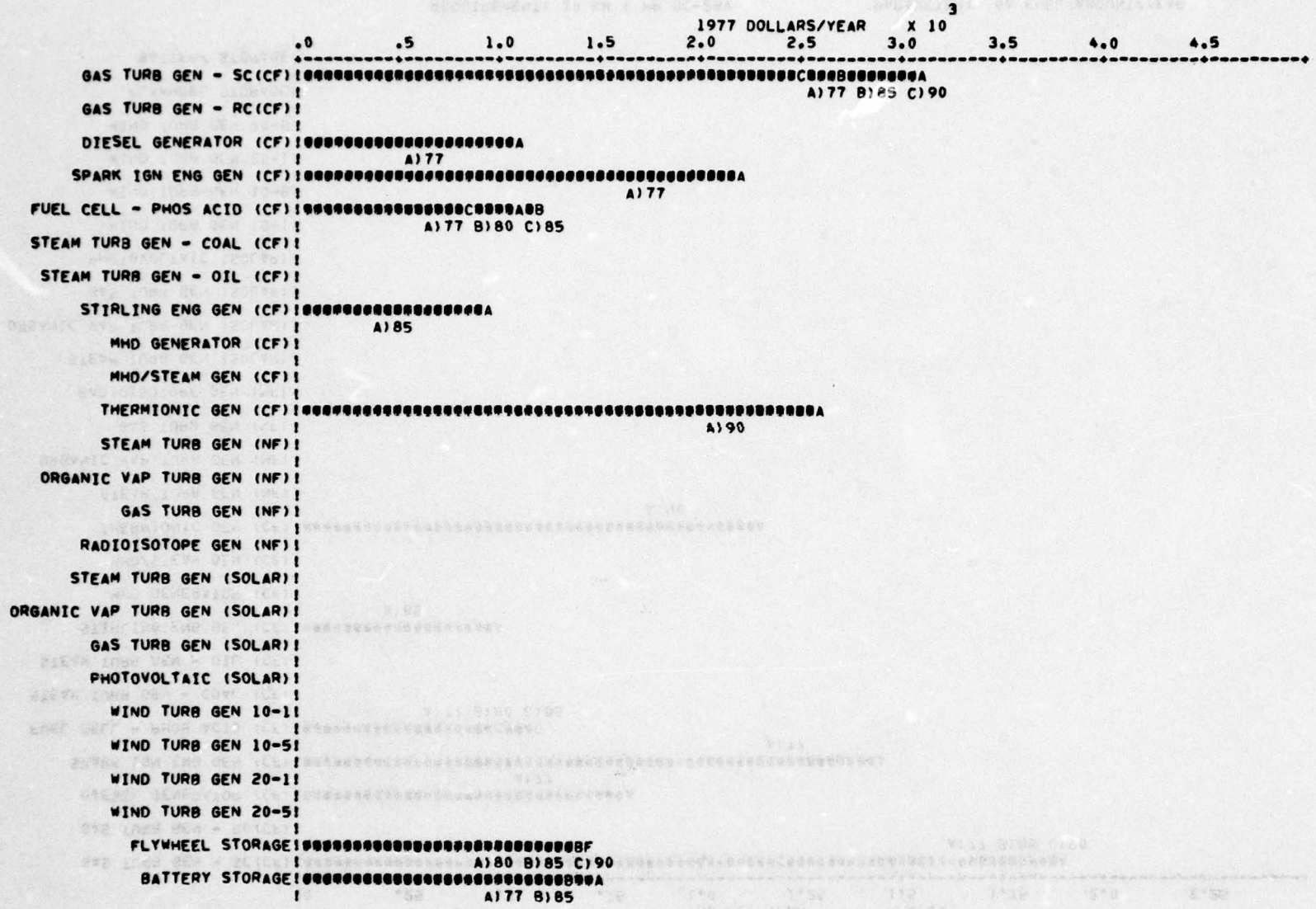


REQUIREMENT: 10 KW 8 HR DC-28V PARAMETER: 5 WEIGHT



REQUIREMENT: 10 KW 8 HR DC-28V

PARAMETER: 6A FUEL AMOUNT/YEAR



REQUIREMENT: 10 KW 8 HR DC-28V PARAMETER: 6B FUEL COST/YEAR

REQUIREMENT	PARAMETER
10 KW 8 Hr. 3P-240V	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	●	●	●	-	-	-
GAS TURB GEN - RC(CF)											
DIESEL GENERATOR(CF)	-	-	0	0	●	●	●	●	-	-	-
SPARK IGN ENG GEN(CF)	-	-	0	0	●	-	●	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)											
STEAM TURB GEN - OIL(CF)											
STIRLING ENG GEN(CF)	-	-	0	0	●	●	●	●	-	-	-
MHD GENERATOR(CF)											
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)	-	-	0	0	●	●	0	●	-	-	-
STEAM TURB GEN(NF)											
ORGANIC VAP TURB GEN(NF)											
GAS TURB GEN(NF)											
RADIOISOTOPE GEN(NF)	-	-	-	-	-	-	-	-	-	-	-
STEAM TURB GEN (SOLAR)											
ORGANIC VAP TURB (SOLAR)	-	●	-	-	-	-	●	-	-	0	-
GAS TURB GEN (SOLAR)	-	-	-	-	-	-	●	-	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
WIND TURB GEN (ALL)	-	-	-	-	-	-	-	-	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	-	-	-	-
BATTERY STORAGE	-	-	-	-	-	-	-	-	-	-	-

- - none
0 - minor
● - moderate
● - major

REQUIREMENT	PARAMETER
10 KW 8 Hr. DC-28V	8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- - - no limitation
- O - minor limitation
- ⊖ - major limitation
- ● - overriding limitation

SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	O	●	-	-	-	-
GAS TURB GEN - RC(CF)								
DIESEL GENERATOR(CF)	-	-	-	●	-	-	-	-
SPARK IGN ENG GEN(CF)	-	-	-	●	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)								
STEAM TURB GEN - OIL(CF)								
STIRLING ENG GEN(CF)	-	-	O	●	-	-	-	-
MHD GENERATOR(CF)								
MHD/STEAM GEN(CF)								
THERMIONIC GEN(CF)	O	O	O	●	-	-	-	-
STEAM TURB GEN(NF)								
ORGANIC VAP TURB GEN(NF)								
GAS TURB GEN(NF)								
RADIOISOTOPE GEN(NF)	-	-	-	-	-	-	●	-
STEAM TURB GEN (SOLAR)								
ORGANIC VAP TURB (SOLAR)	⊖	-	O	-	●	-	-	-
GAS TURB GEN (SOLAR)	-	-	O	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1	-	-	-	-	-	●	-	-
WIND TURB GEN 10-5	-	-	-	-	-	●	-	-
WIND TURB GEN 20-1	-	-	-	-	-	●	-	-
WIND TURB GEN 20-5	-	-	-	-	-	●	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	●
BATTERY STORAGE	-	O	-	-	-	-	-	●

REQUIREMENT

10 KW 8Hr. DC-28V

PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
0 - Characteristic has minor effect on system performance
◐ - Characteristic has moderate effect on system performance
● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	◐	0	-	-	0	0	0
GAS TURB GEN - RC(CF)							
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)	◐	0	-	-	0	0	0
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)							
STEAM TURB GEN - OIL(CF)							
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)							
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	◐	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)							
GAS TURB GEN(NF)							
RADIOISOTOPE GEN(NF)	0	0	-	-	◐	0	0
STEAM TURB GEN (SOLAR)							
ORGANIC VAP TURB (SOLAR)	-	0	●	-	◐	◐	-
GAS TURB GEN (SOLAR)	-	-	●	-	◐	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-
BATTERY STORAGE	-	-	-	-	-	-	-

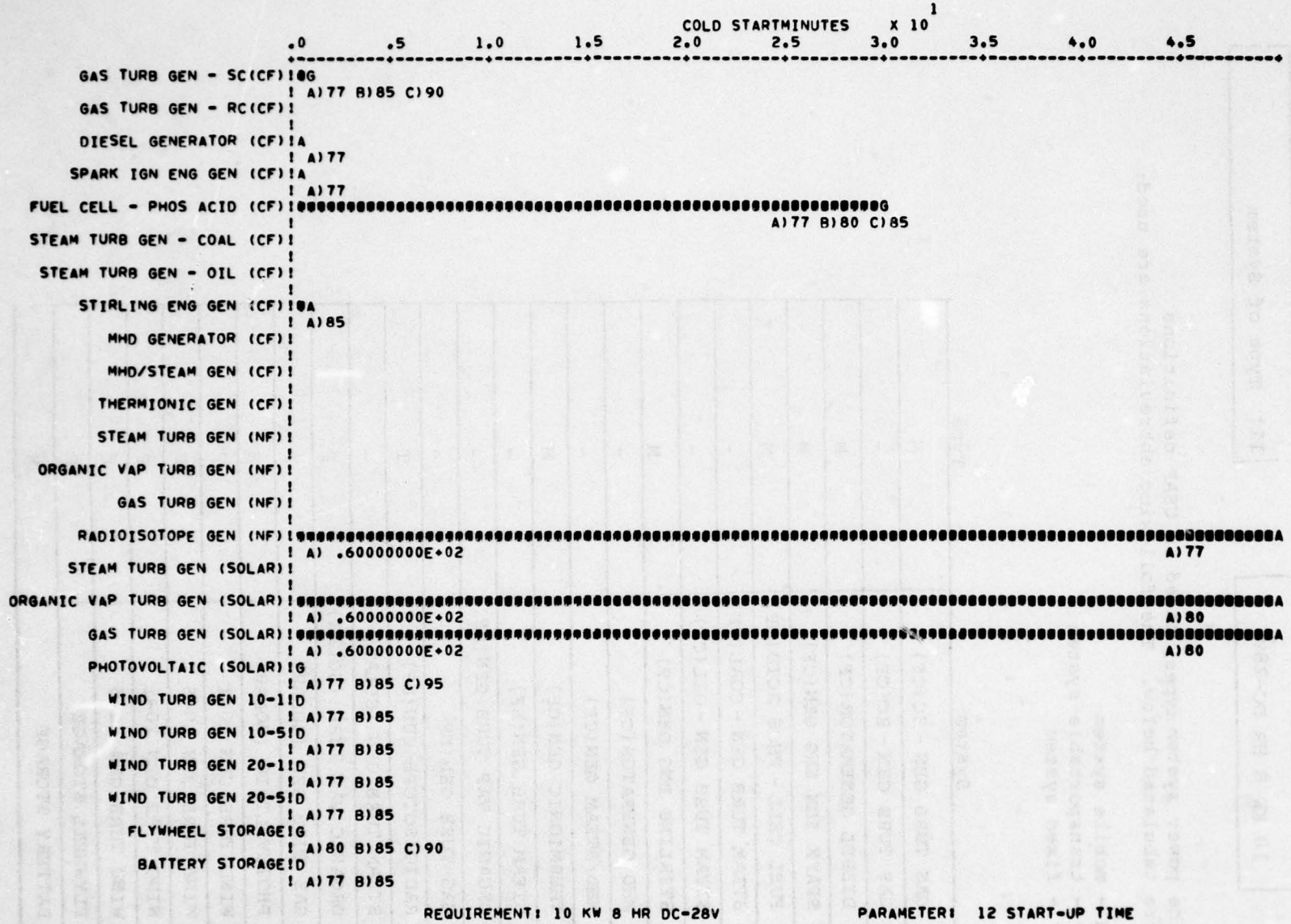
REQUIREMENT: 10 KW 8 HR DC-28V PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
10 KW 8 HR DC-28V	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	M
GAS TURB GEN - RC(CF)	-
DIESEL GENERATOR(CF)	M
SPARK IGN ENG GEN(CF)	M
FUEL CELL - PHOS ACID(CF)	M
STEAM TURB GEN - COAL(CF)	-
STEAM TURB GEN - OIL(CF)	-
STIRLING ENG GEN(CF)	M
MHD GENERATOR(CF)	-
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	M
STEAM TURB GEN(NF)	-
ORGANIC VAP TURB GEN(NF)	-
GAS TURB GEN(NF)	-
RADIOISOTOPE GEN(NF)	T
STEAM TURB GEN (SOLAR)	-
ORGANIC VAP TURB (SOLAR)	F
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	F
WIND TURB GEN 10-5	F
WIND TURB GEN 20-1	F
WIND TURB GEN 20-5	F
FLYWHEEL STORAGE	F
BATTERY STORAGE	M



REQUIREMENT: 10 KW 8 HR DC-28V PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
10 KW 8 Hr. DC-28V	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	Not modular, except possibly largest requirements
SPARK IGN ENG GEN(CF)	Not modular, except possibly largest requirements
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	Not modular, except possibly largest requirements
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	
RADIOISOTOPE GEN(NF)	Not modular
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	Not modular
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	Modular for most requirements
WIND TURB GEN 10-5	Modular for most requirements
WIND TURB GEN 20-1	Modular for most requirements
WIND TURB GEN 20-5	Modular for most requirements
FLYWHEEL STORAGE	Modular for most requirements
BATTERY STORAGE	Fully modular

REQUIREMENT	PARAMETER
10 KW 8 HR. DC-28V	14) Reliability/Availability

The tabulated conditions exist in the power system to the extent indicated.

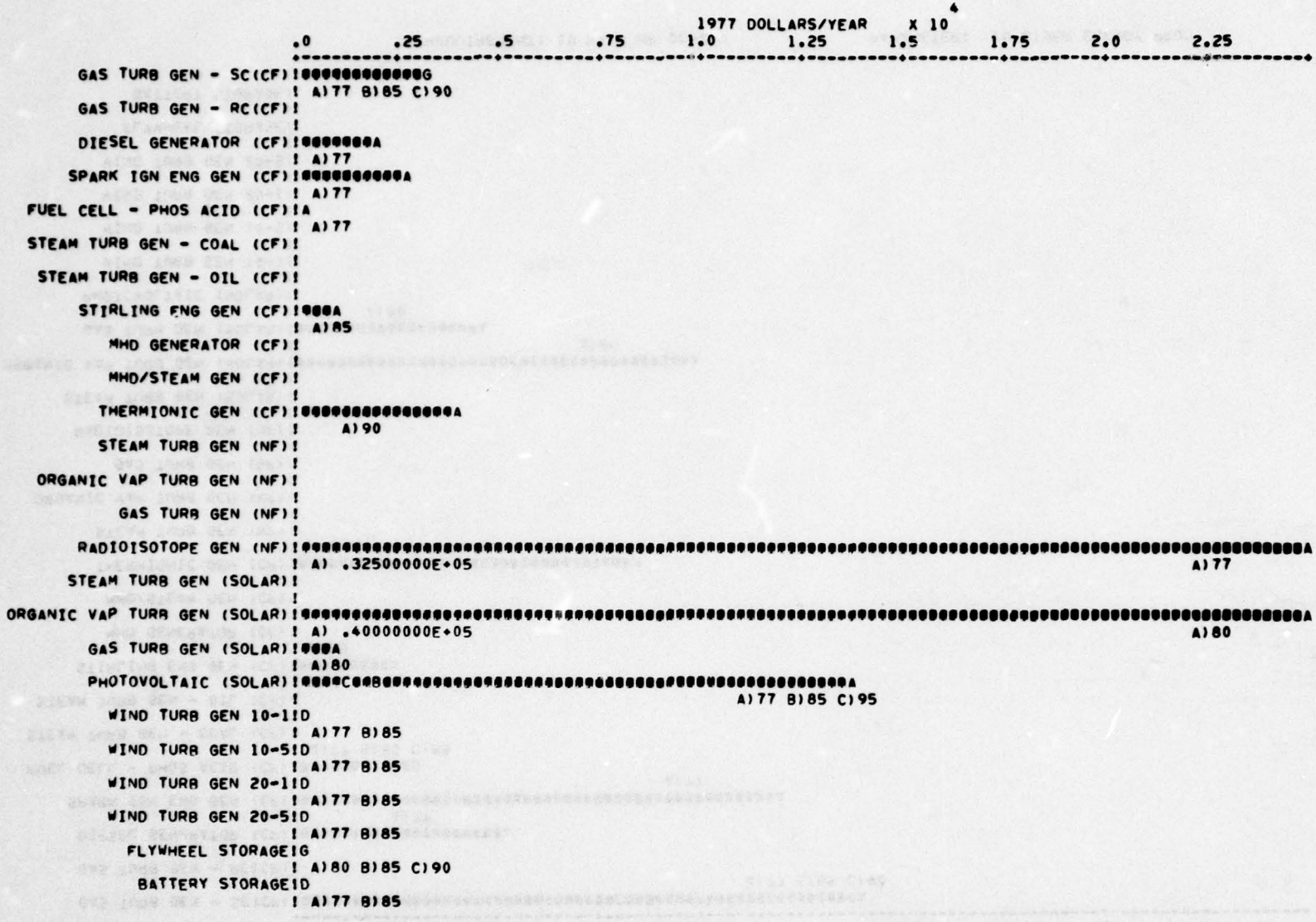
SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	o	●	o	-	●	o	●	-	-
GAS TURB GEN - RC(CF)									
DIESEL GENERATOR(CF)	●	o	o	-	o	o	●	-	-
SPARK IGN ENG GEN(CF)	●	o	o	-	o	o	●	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	o	-	-	-	-
STEAM TURB GEN - COAL(CF)									
STEAM TURB GEN - OIL(CF)									
STIRLING ENG GEN(CF)	o	o	o	-	o	o	●	-	-
MHD GENERATOR(CF)									
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	o	●	-	-	◐	o	o	-	-
STEAM TURB GEN(NF)									
ORGANIC VAP TURB GEN(NF)									
GAS TURB GEN(NF)									
RADIOISOTOPE GEN(NF)	o	o	o	o	-	o	●	-	-
STEAM TURB GEN (SOLAR)									
ORGANIC VAP TURB (SOLAR)	o	o	o	-	-	o	-	●	-
GAS TURB GEN (SOLAR)	o	o	o	-	o	o	-	●	-
PHOTOVOLTAIC (SOLAR)	-	o	-	-	o	-	-	●	-
WIND TURB GEN 10-1	o	o	●	-	o	-	-	-	●
WIND TURB GEN 10-5	o	o	●	-	o	-	-	-	●
WIND TURB GEN 20-1	o	o	●	-	o	-	-	-	●
WIND TURB GEN 20-5	o	o	●	-	o	-	-	-	●
FLYWHEEL STORAGE	o	-	●	-	-	-	◐	-	-
BATTERY STORAGE	-	o	-	-	o	-	-	-	-

- \- Condition does not exist in system

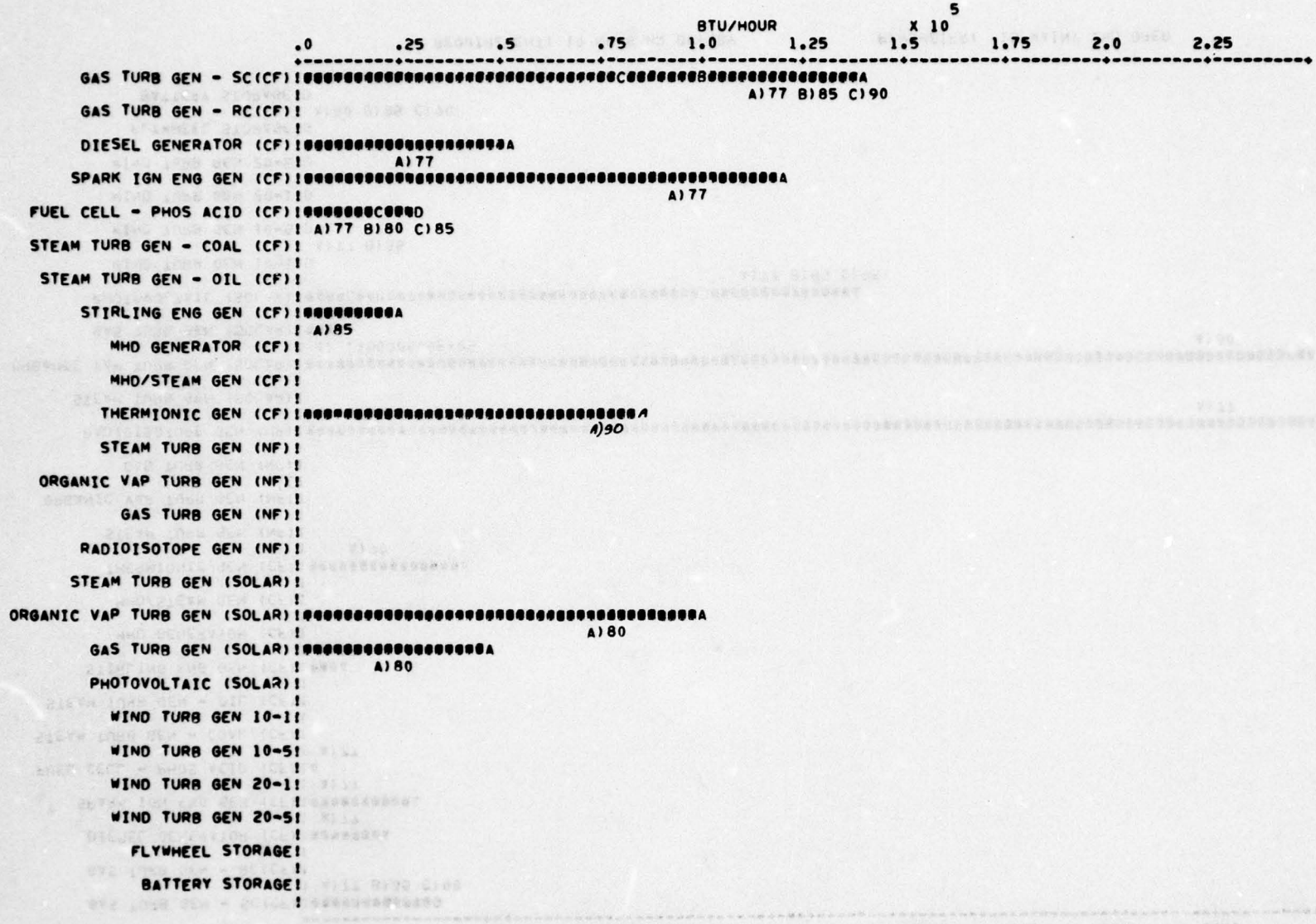
o - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability

◐ - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability

● - Condition exists and is a governing factor in determining system performance and reliability



REQUIREMENT: 10 KW 8 HR DC-28V PARAMETER: 15 MAINT AND OPER



REQUIREMENT: 10 KW 8 HR DC-28V PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
10 KW 8 Hr. DC-28V	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

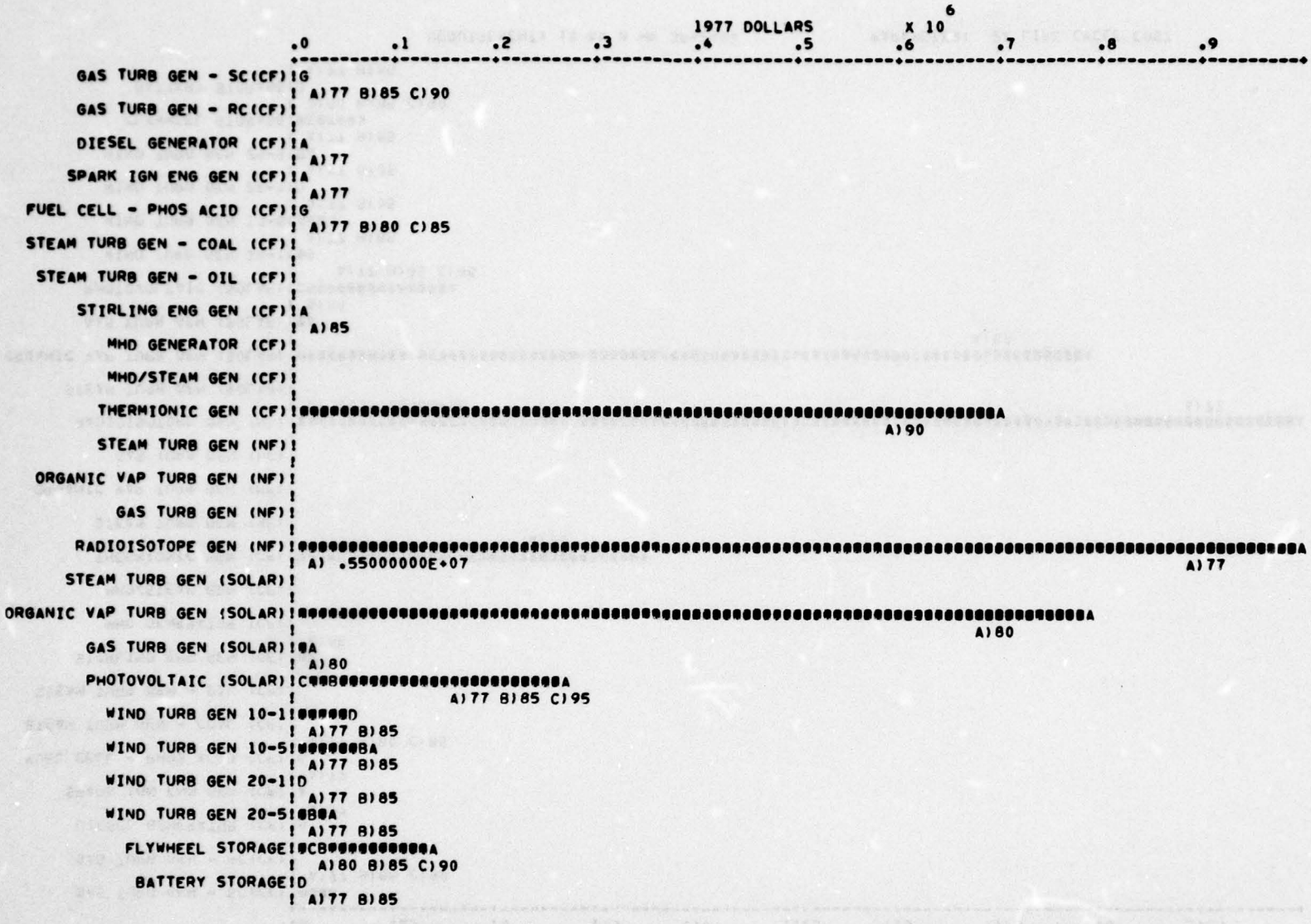
System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	None
SPARK IGN ENG GEN(CF)	None
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	None
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	
RADIOISOTOPE GEN(NF)	None
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	None
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	Possibly lead for conventional batteries
WIND TURB GEN 10-5	Possibly lead for conventional batteries
WIND TURB GEN 20-1	Possibly lead for conventional batteries
WIND TURB GEN 20-5	Possibly lead for conventional batteries
FLYWHEEL STORAGE	None
BATTERY STORAGE	Possibly lead for conventional batteries

SECTION XVIII

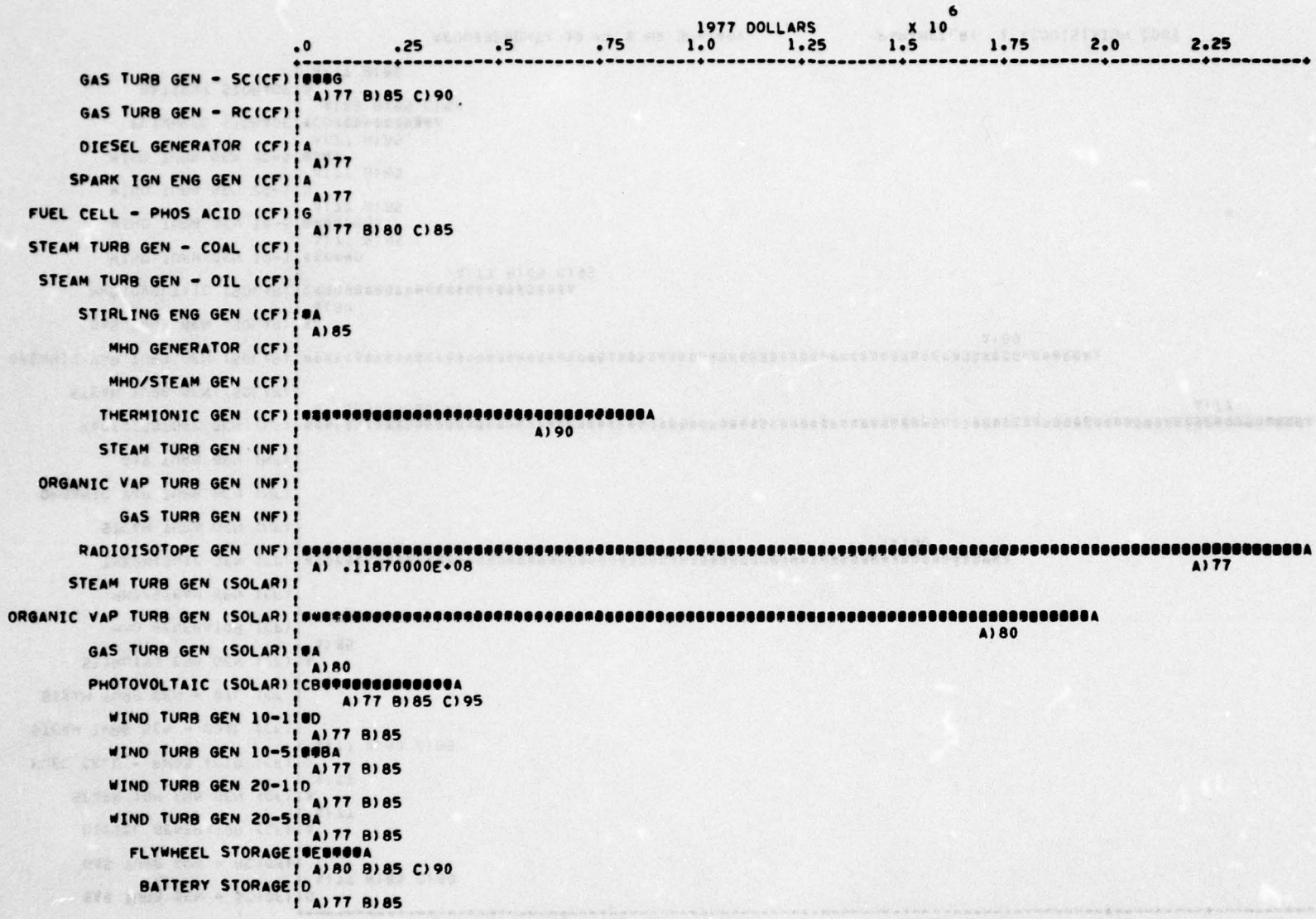
TEN KILOWATT, 8 HOUR 3Ø

REQUIREMENT

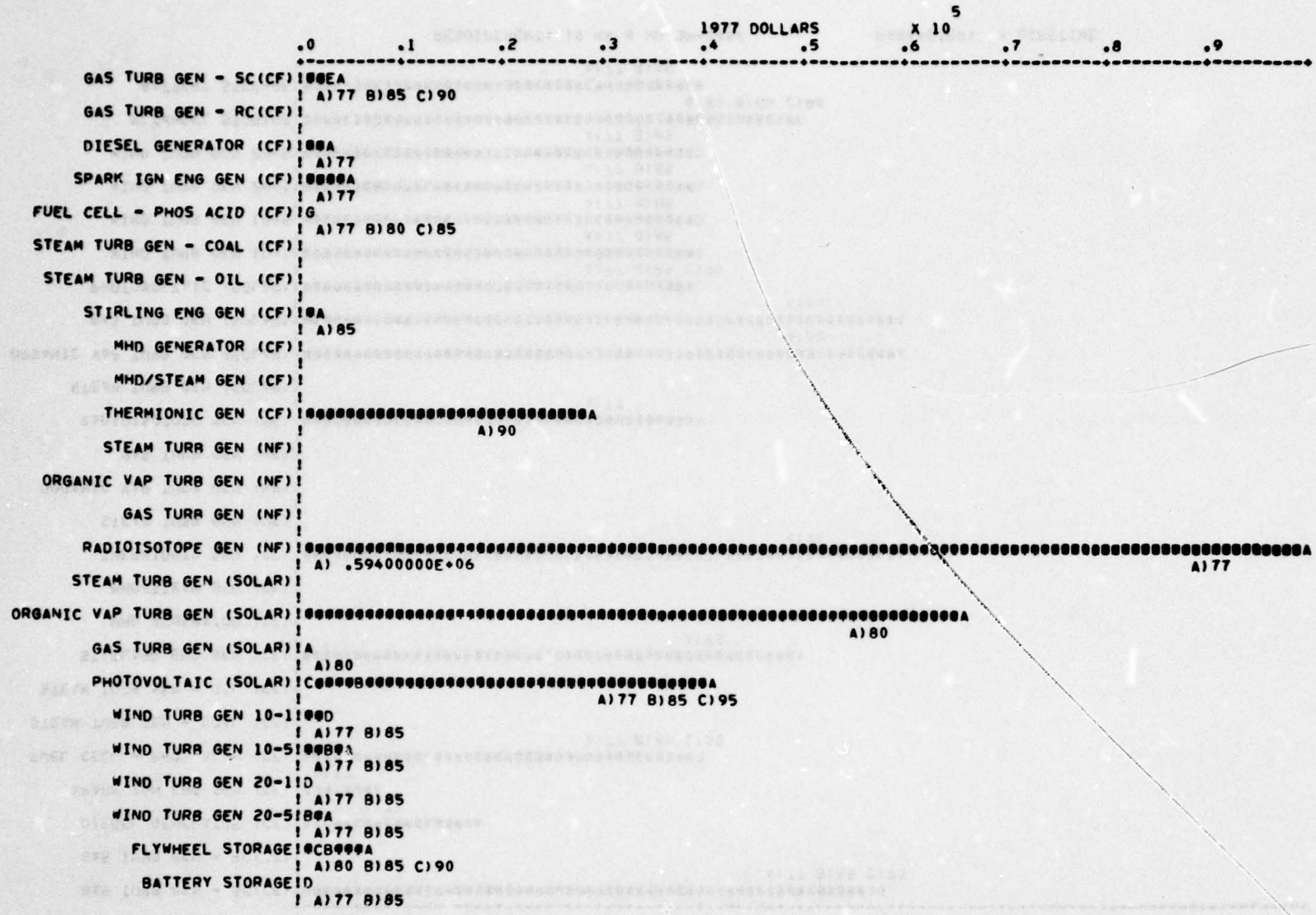
Power Level:	10 Kw
Operating Mode:	8 hours per day
Frequency/Phase:	60 Hz/3Ø
Voltage Level:	240 V



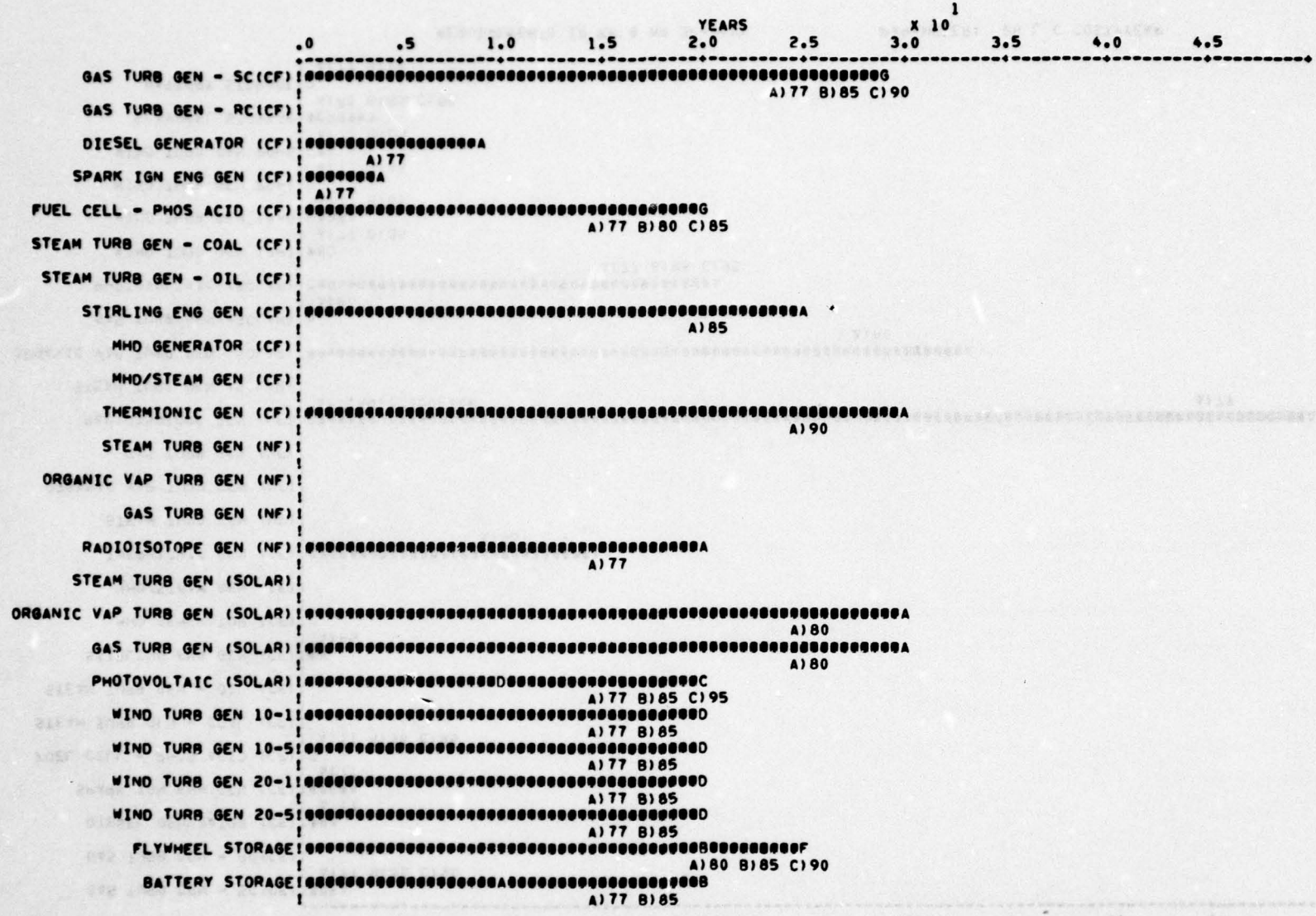
REQUIREMENT: 10 KW 8 HR 3P-240V PARAMETER: 1 ACQUISITION COST

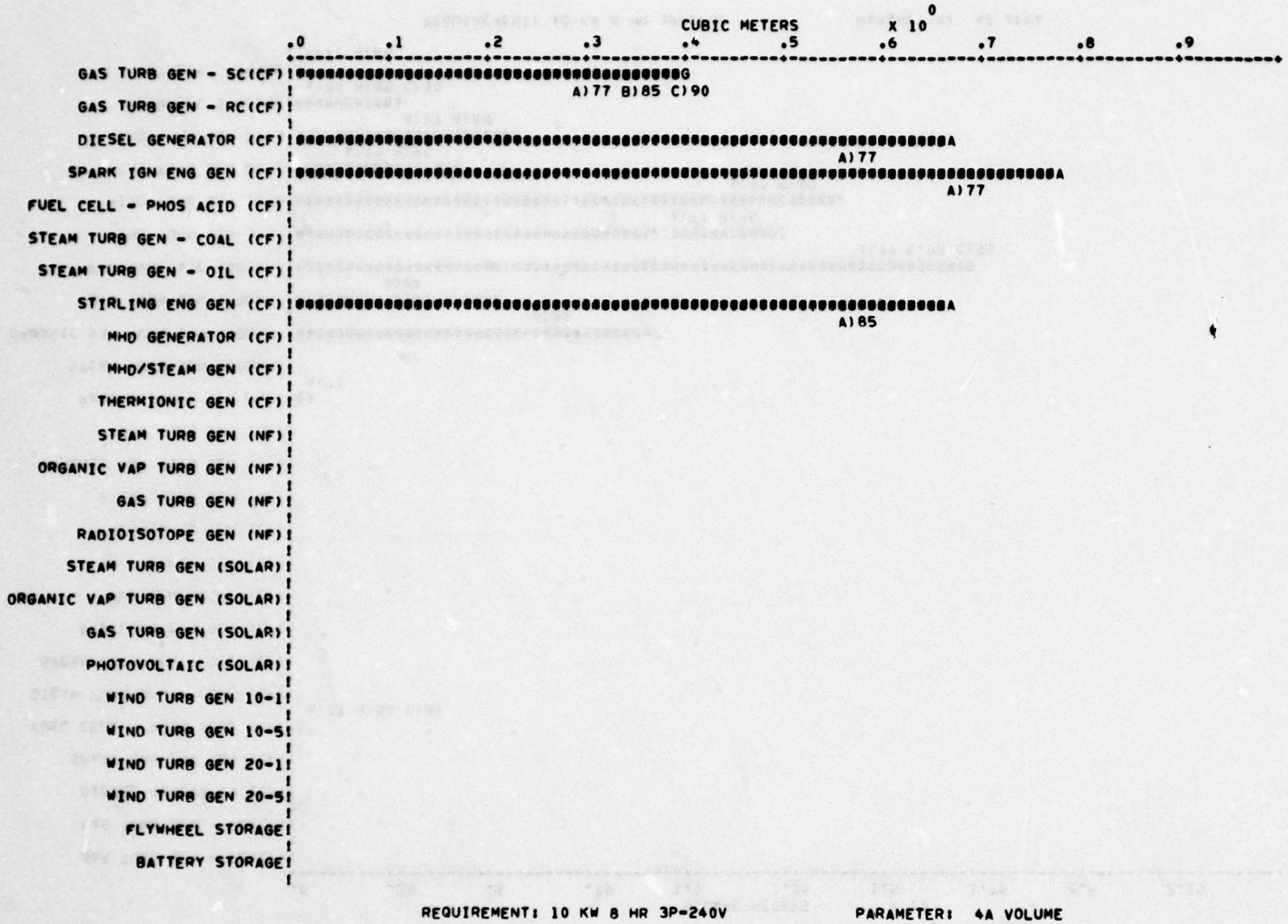


REQUIREMENT: 10 KW 8 HR 3P-240V PARAMETER: 2A LIFE CYCLE COST

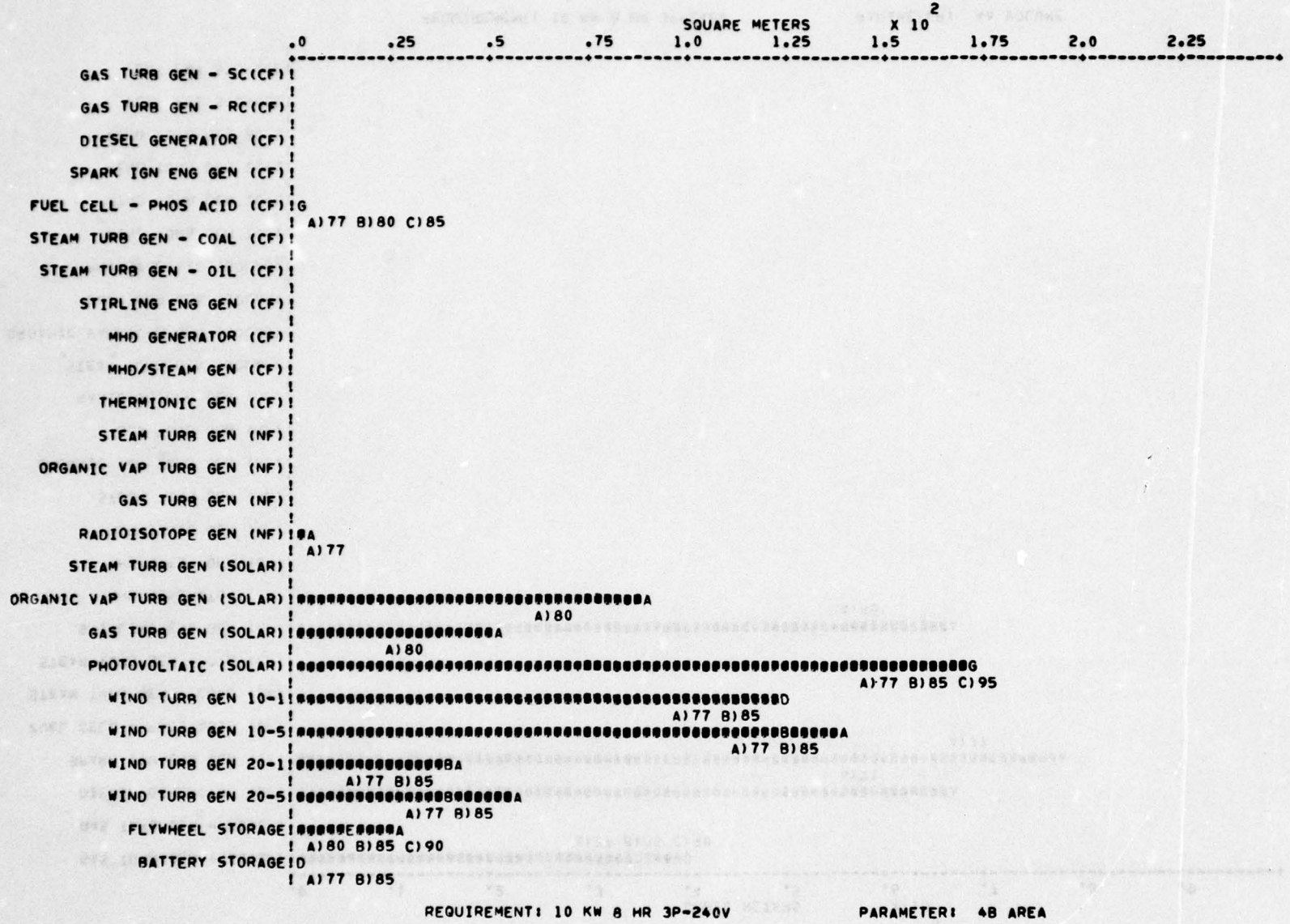


REQUIREMENT: 10 KW 8 HR 3P-240V PARAMETER: 28 L C COST/YEAR

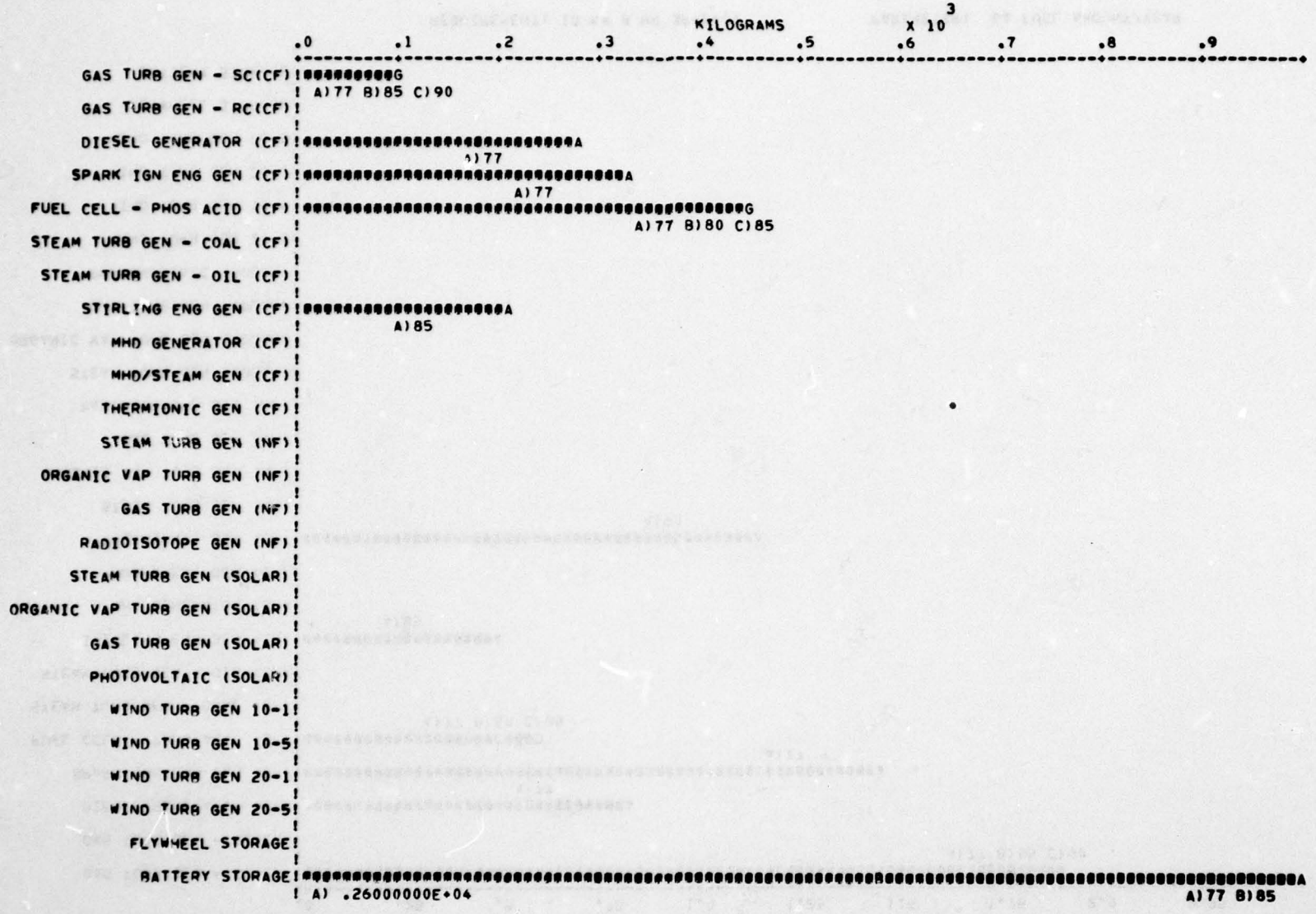

YEARS
X 10^1
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 KW 8 HR 3P-240V
PARAMETER: 3 LIFETIME



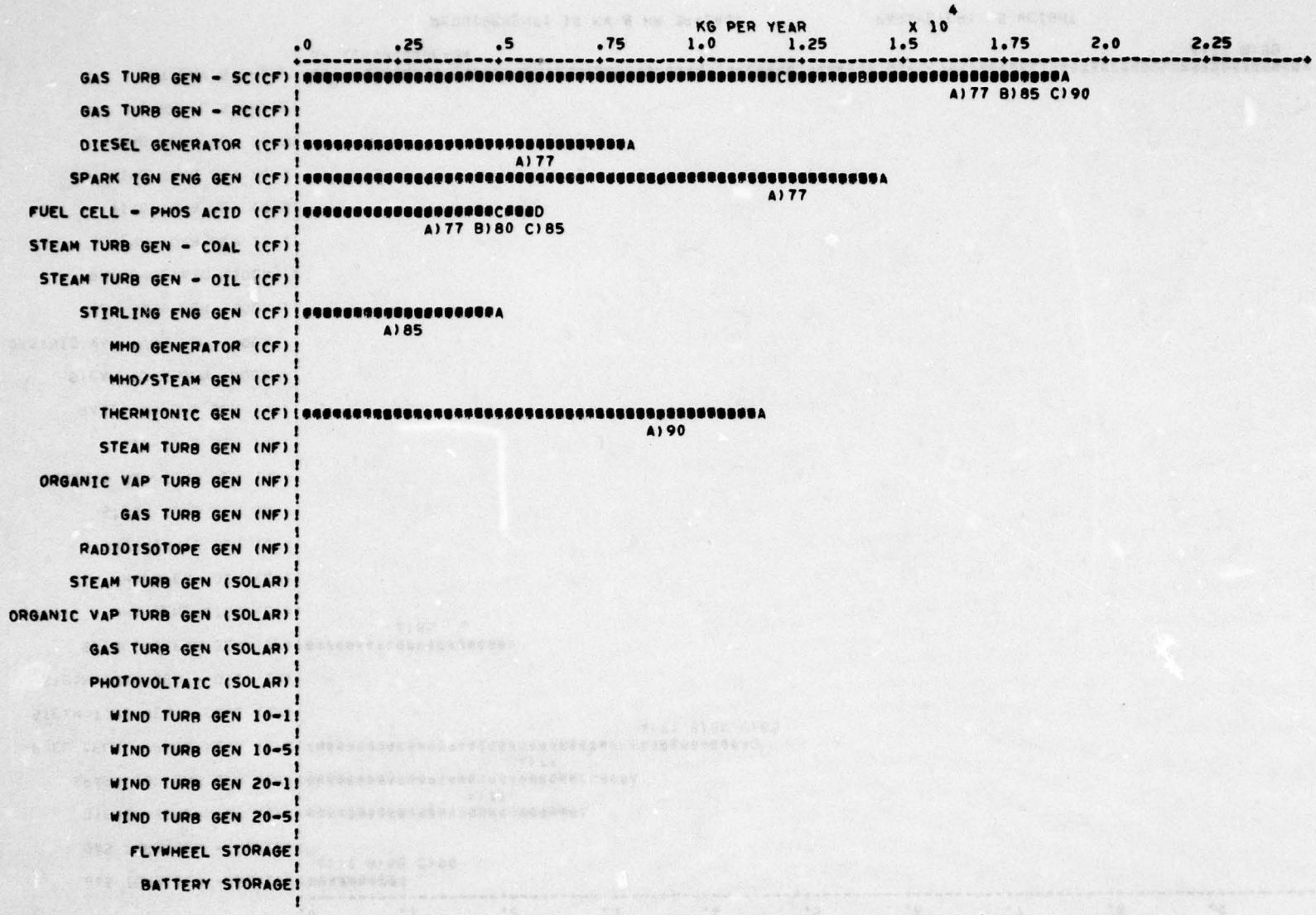
REQUIREMENT: 10 KW 8 HR 3P-240V PARAMETER: 4A VOLUME



REQUIREMENT: 10 KW 8 HR 3P-240V PARAMETER: 48 AREA

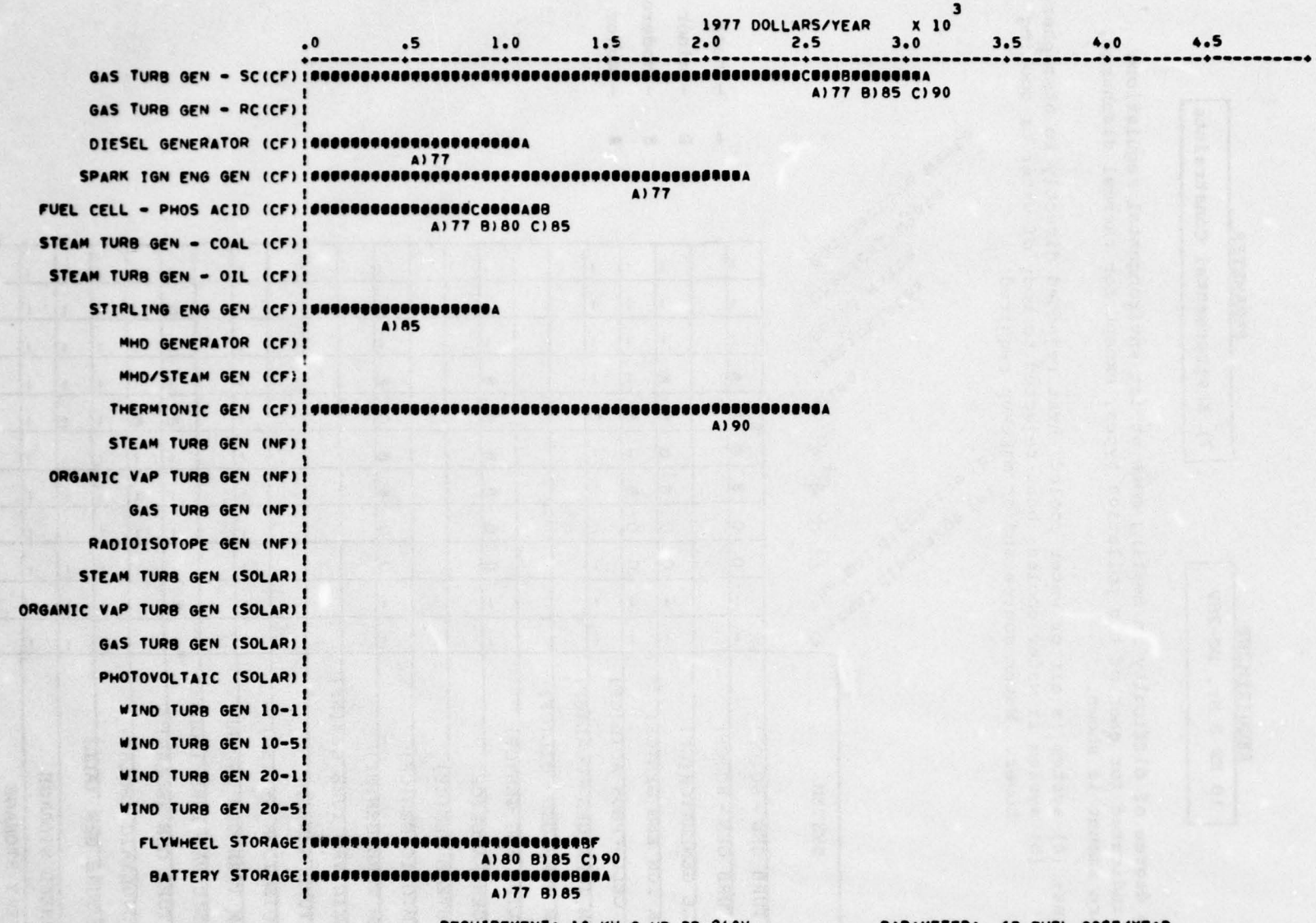


REQUIREMENT: 10 KW 8 HR 3P-240V PARAMETER: 5 WEIGHT



REQUIREMENT: 10 KW 8 HR 3P-240V

PARAMETER: 6A FUEL AMOUNT/YEAR



REQUIREMENT: 10 KW 8 HR 3P-240V PARAMETER: 68 FUEL COST/YEAR

REQUIREMENT	PARAMETER
10 KW 8 Hr. DC-28V	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
GAS TURB GEN - RC(CF)											
DIESEL GENERATOR(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
SPARK IGN ENG GEN(CF)	-	-	0	0	◐	-	◐	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	0	-	-	-	-
STEAM TURB GEN - COAL(CF)											
STEAM TURB GEN - OIL(CF)											
STIRLING ENG GEN(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
MHD GENERATOR(CF)											
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)	-	-	0	0	●	◐	0	◐	-	-	-
STEAM TURB GEN(NF)											
ORGANIC VAP TURB GEN(NF)											
GAS TURB GEN(NF)											
RADIOISOTOPE GEN(NF)	-	-	-	-	-	-	-	-	-	-	-
STEAM TURB GEN (SOLAR)											
ORGANIC VAP TURB (SOLAR)	-	●	-	-	-	-	◐	-	-	0	-
GAS TURB GEN (SOLAR)	-	-	-	-	-	-	◐	-	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
WIND TURB GEN (ALL)	-	-	-	-	-	-	-	-	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	-	-	-	-
BATTERY STORAGE	-	-	-	-	-	-	-	-	-	-	-

- - none
0 - minor
◐ - moderate
● - major

REQUIREMENT

10 KW 8 Hr. 3P-240V

PARAMETER

8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- - - no limitation
0 - minor limitation
⊖ - major limitation
● - overriding limitation

SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	0	●	-	-	-	-
GAS TURB GEN - RC(CF)								
DIESEL GENERATOR(CF)	-	-	-	●	-	-	-	-
SPARK IGN ENG GEN(CF)	-	-	-	●	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)								
STEAM TURB GEN - OIL(CF)								
STIRLING ENG GEN(CF)	-	-	0	●	-	-	-	-
MHD GENERATOR(CF)								
MHD/STEAM GEN(CF)								
THERMIONIC GEN(CF)	0	0	0	●	-	-	-	-
STEAM TURB GEN(NF)								
ORGANIC VAP TURB GEN(NF)								
GAS TURB GEN(NF)								
RADIOISOTOPE GEN(NF)	-	-	-	-	-	-	●	-
STEAM TURB GEN (SOLAR)								
ORGANIC VAP TURB (SOLAR)	⊖	-	0	-	●	-	-	-
GAS TURB GEN (SOLAR)	-	-	0	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1	-	-	-	-	-	●	-	-
WIND TURB GEN 10-5	-	-	-	-	-	●	-	-
WIND TURB GEN 20-1	-	-	-	-	-	●	-	-
WIND TURB GEN 20-5	-	-	-	-	-	●	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	●
BATTERY STORAGE	-	0	-	-	-	-	-	●

REQUIREMENT

10 KW 8 Hr. 3P-240V

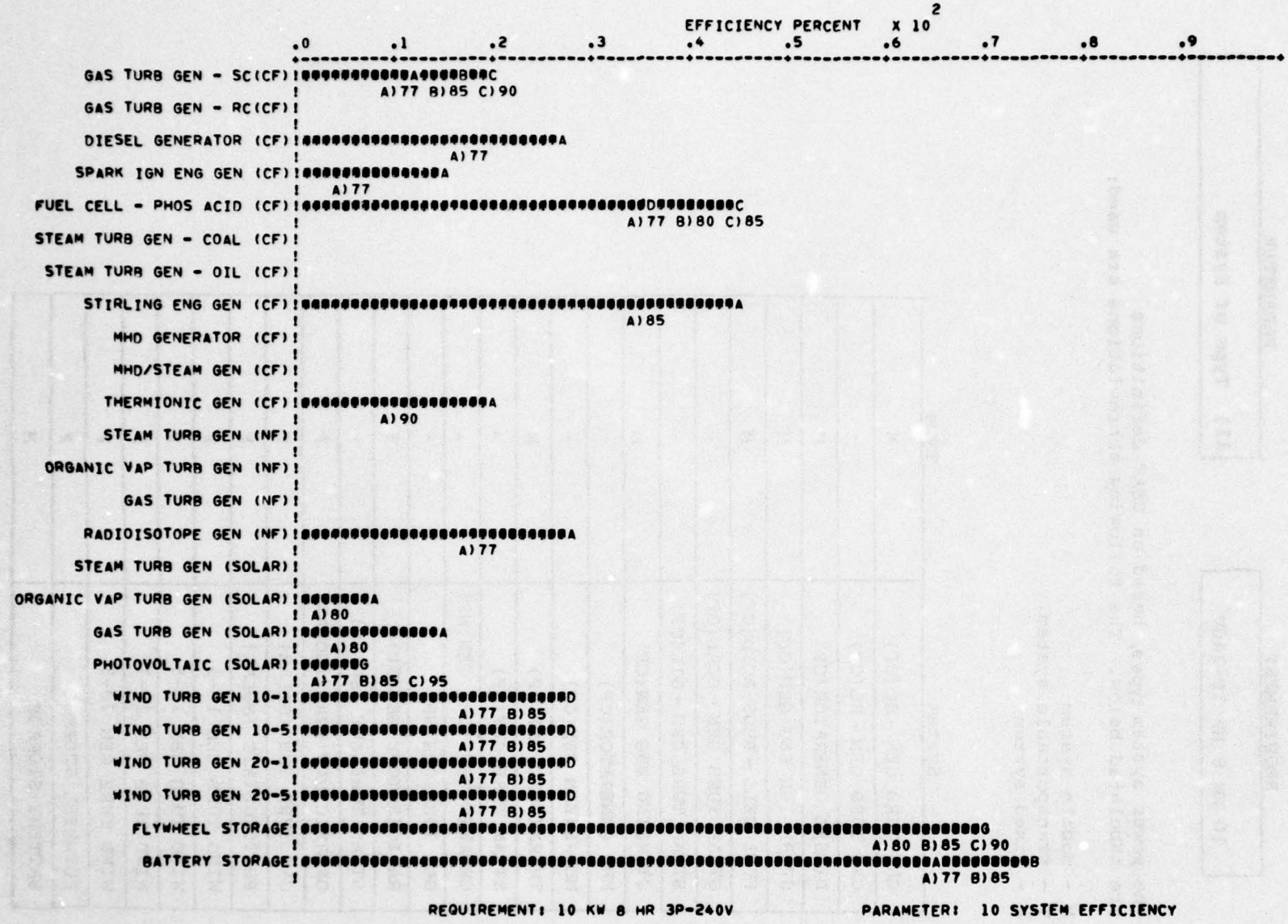
PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
0 - Characteristic has minor effect on system performance
◐ - Characteristic has moderate effect on system performance
● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	◐	0	-	-	0	0	0
GAS TURB GEN - RC(CF)							
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)	◐	0	-	-	0	0	0
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)							
STEAM TURB GEN - OIL(CF)							
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)							
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	◐	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)							
GAS TURB GEN(NF)							
RADIOISOTOPE GEN(NF)	0	0	-	-	◐	0	0
STEAM TURB GEN (SOLAR)							
ORGANIC VAP TURB (SOLAR)	-	0	●	-	◐	◐	-
GAS TURB GEN (SOLAR)	-	-	●	-	◐	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-
BATTERY STORAGE	-	-	-	-	-	-	-

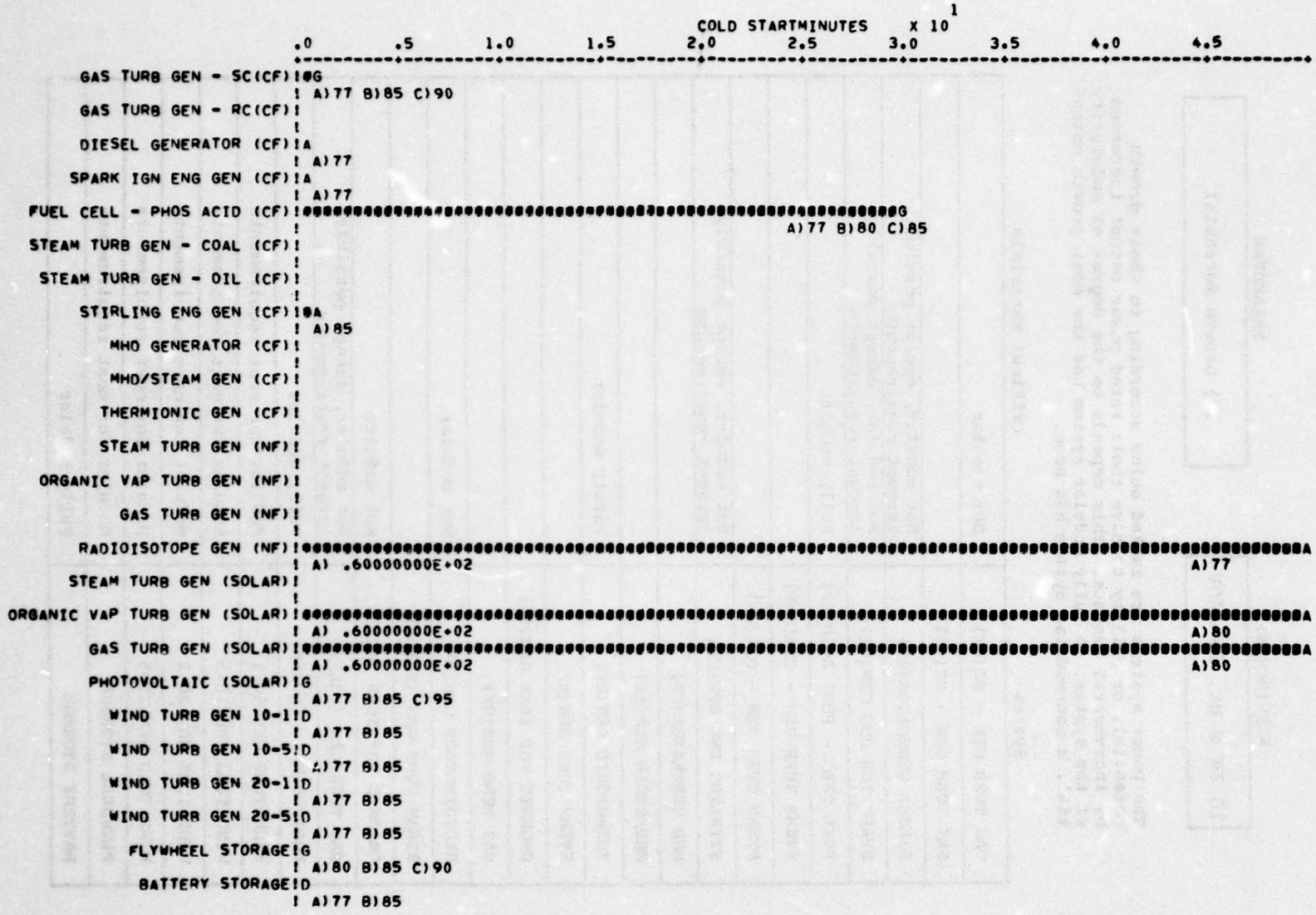

EFFICIENCY PERCENT X 10^2
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 KW 8 HR 3P-240V
PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
10 KW 8 HR 3P-240V	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	M
GAS TURB GEN - RC(CF)	-
DIESEL GENERATOR(CF)	M
SPARK IGN ENG GEN(CF)	M
FUEL CELL - PHOS ACID(CF)	M
STEAM TURB GEN - COAL(CF)	-
STEAM TURB GEN - OIL(CF)	-
STIRLING ENG GEN(CF)	M
MHD GENERATOR(CF)	-
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	M
STEAM TURB GEN(NF)	-
ORGANIC VAP TURB GEN(NF)	-
GAS TURB GEN(NF)	-
RADIOISOTOPE GEN(NF)	T
STEAM TURB GEN (SOLAR)	-
ORGANIC VAP TURB (SOLAR)	F
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	F
WIND TURB GEN 10-5	F
WIND TURB GEN 20-1	F
WIND TURB GEN 20-5	F
FLYWHEEL STORAGE	F
BATTERY STORAGE	M



REQUIREMENT: 10 KW 8 HR 3P-240V PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
10 KW 8 Hr. 3P-240V	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

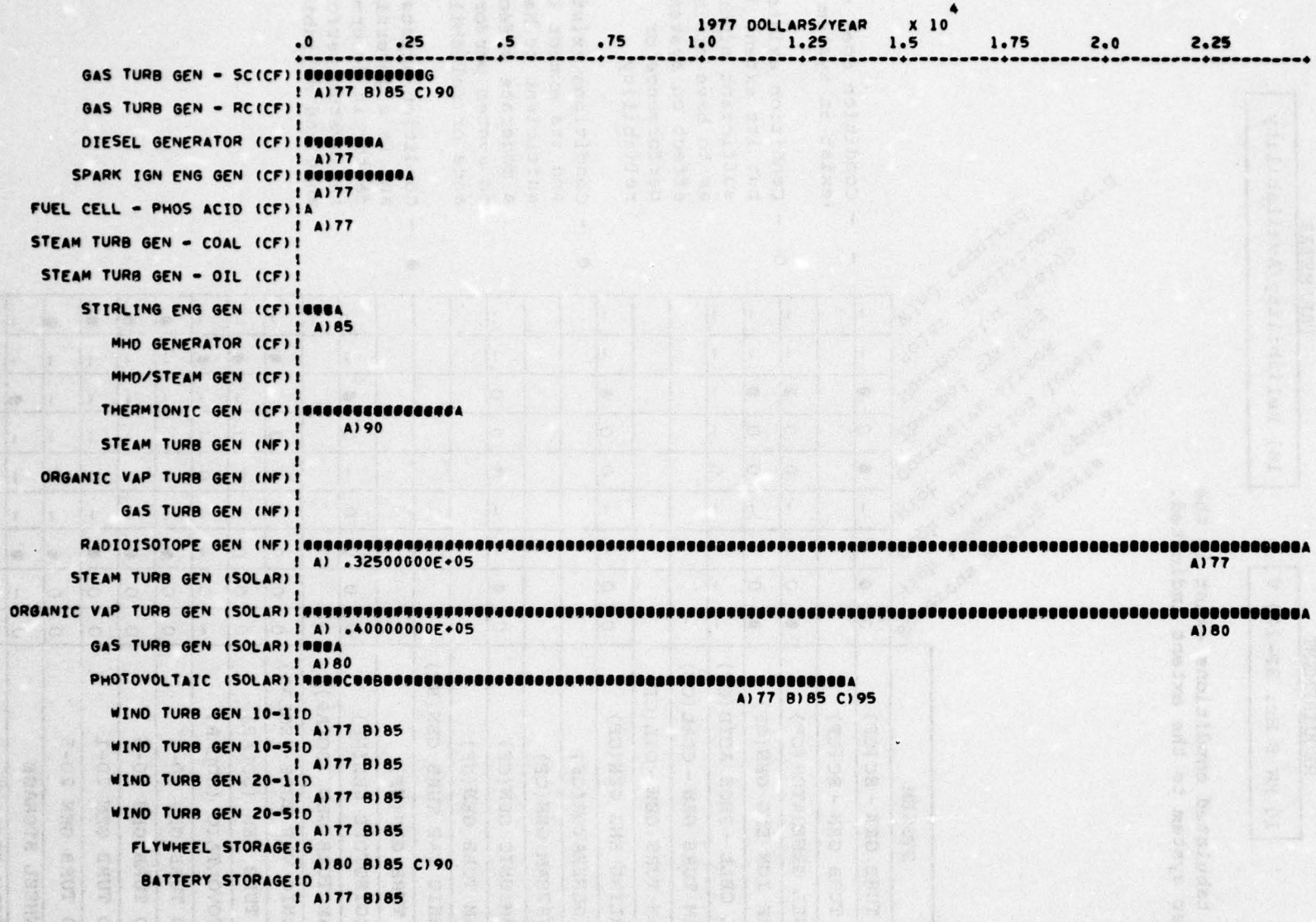
System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	Not modular, except possibly largest requirements
SPARK IGN ENG GEN(CF)	Not modular, except possibly largest requirements
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	Not modular, except possibly largest requirements
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	
RADIOISOTOPE GEN(NF)	Not modular
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	Not modular
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	Modular for most requirements
WIND TURB GEN 10-5	Modular for most requirements
WIND TURB GEN 20-1	Modular for most requirements
WIND TURB GEN 20-5	Modular for most requirements
FLYWHEEL STORAGE	Modular for most requirements
BATTERY STORAGE	Fully modular

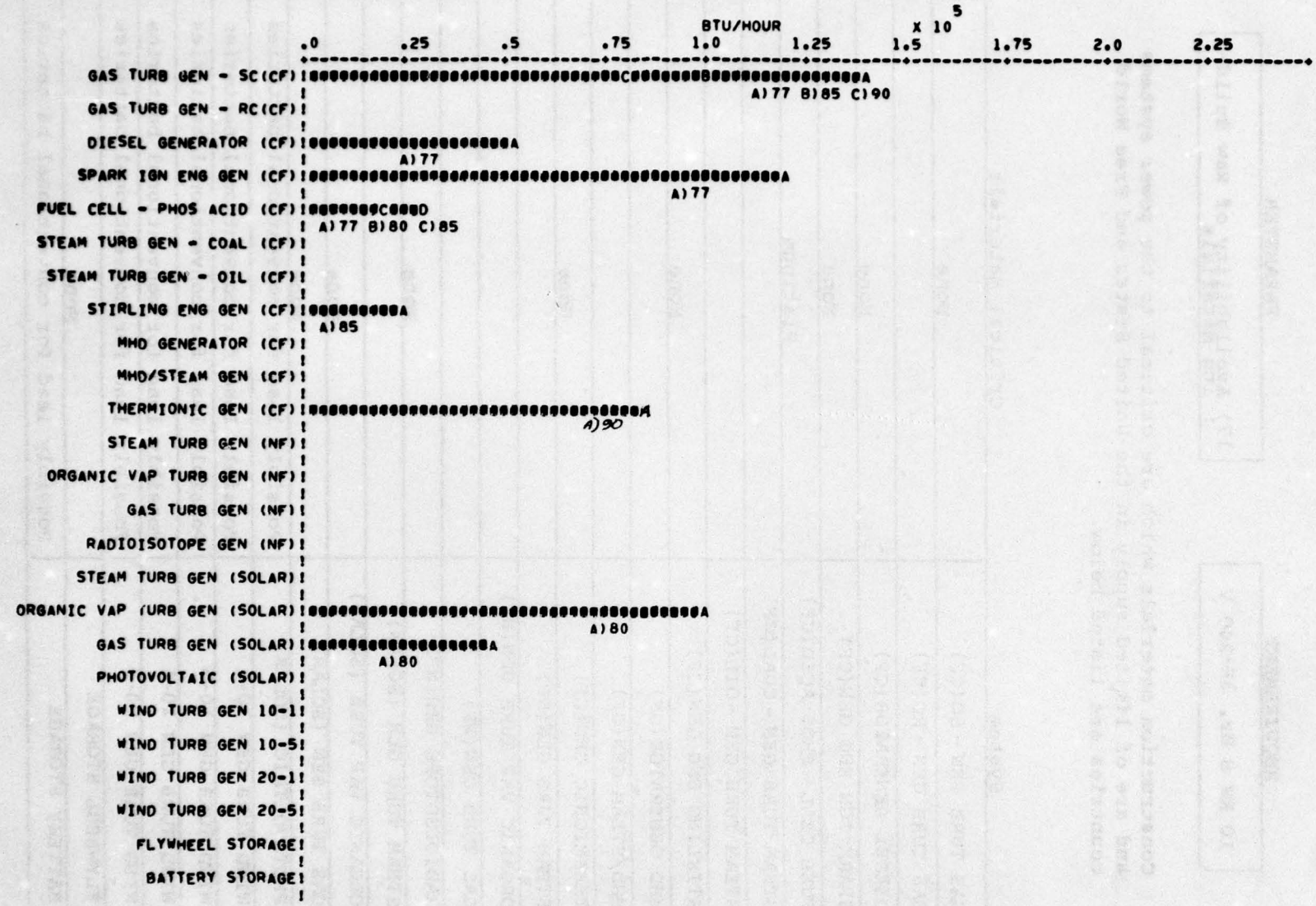
REQUIREMENT	PARAMETER
10 KW 8 Hr. 3P-240 V	14) Reliability/Availability

The tabulated conditions exist in the power system to the extent indicated.

SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	O	●	O	-	●	O	●	-	-
GAS TURB GEN - RC(CF)									
DIESEL GENERATOR(CF)	●	O	O	-	O	O	●	-	-
SPARK IGN ENG GEN(CF)	●	O	O	-	O	O	●	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	O	-	-	-	-
STEAM TURB GEN - COAL(CF)									
STEAM TURB GEN - OIL(CF)									
STIRLING ENG GEN(CF)	O	O	O	-	O	O	●	-	-
MHD GENERATOR(CF)									
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	O	●	-	-	⊖	O	O	-	-
STEAM TURB GEN(NF)									
ORGANIC VAP TURB GEN(NF)									
GAS TURB GEN(NF)									
RADIOISOTOPE GEN(NF)	O	O	O	O	-	O	●	-	-
STEAM TURB GEN (SOLAR)									
ORGANIC VAP TURB (SOLAR)	O	O	O	-	-	O	-	●	-
GAS TURB GEN (SOLAR)	O	O	O	-	O	O	-	●	-
PHOTOVOLTAIC (SOLAR)	-	O	-	-	O	-	-	●	-
WIND TURB GEN 10-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 10-5	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-5	O	O	●	-	O	-	-	-	●
FLYWHEEL STORAGE	O	-	●	-	-	-	⊖	-	-
BATTERY STORAGE	-	O	-	-	O	-	-	-	-

- \- Condition does not exist in system
- O - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability
- ⊖ - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability
- ● - Condition exists and is a governing factor in determining system performance and reliability


1977 DOLLARS/YEAR X 10^4
.0
.25
.5
.75
1.0
1.25
1.5
1.75
2.0
2.25
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A) .32500000E+05
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A) .40000000E+05
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 KW 8 HR 3P-240V
PARAMETER: 15 MAINT AND OPER



REQUIREMENT: 10 KW 8 HR 3P-240V PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
10 KW 8 Hr. 3P-240 V	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

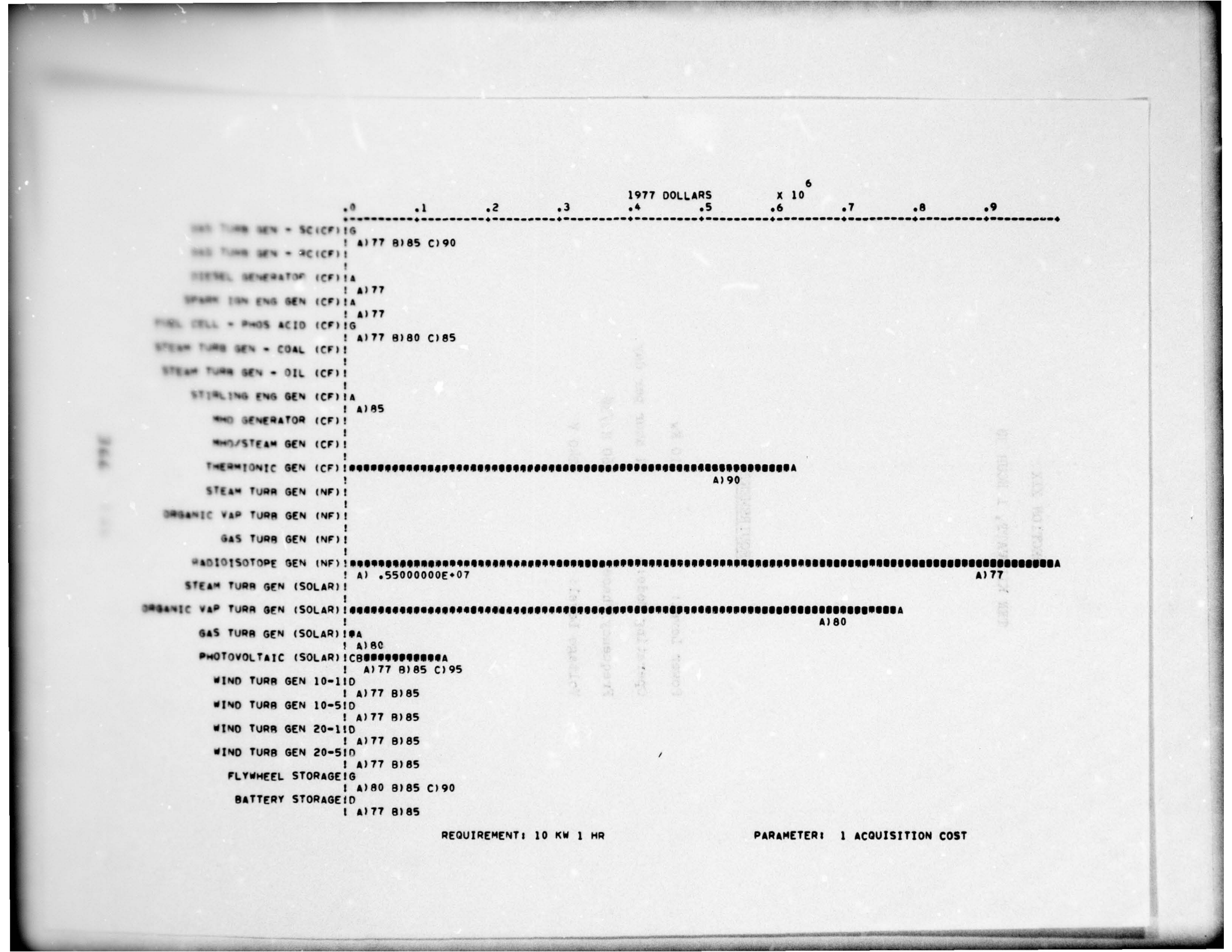
System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	None
SPARK IGN ENG GEN(CF)	None
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	None
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	
RADIOISOTOPE GEN(NF)	None
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	None
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	Possibly lead for conventional batteries
WIND TURB GEN 10-5	Possibly lead for conventional batteries
WIND TURB GEN 20-1	Possibly lead for conventional batteries
WIND TURB GEN 20-5	Possibly lead for conventional batteries
FLYWHEEL STORAGE	None
BATTERY STORAGE	Possibly lead for conventional batteries

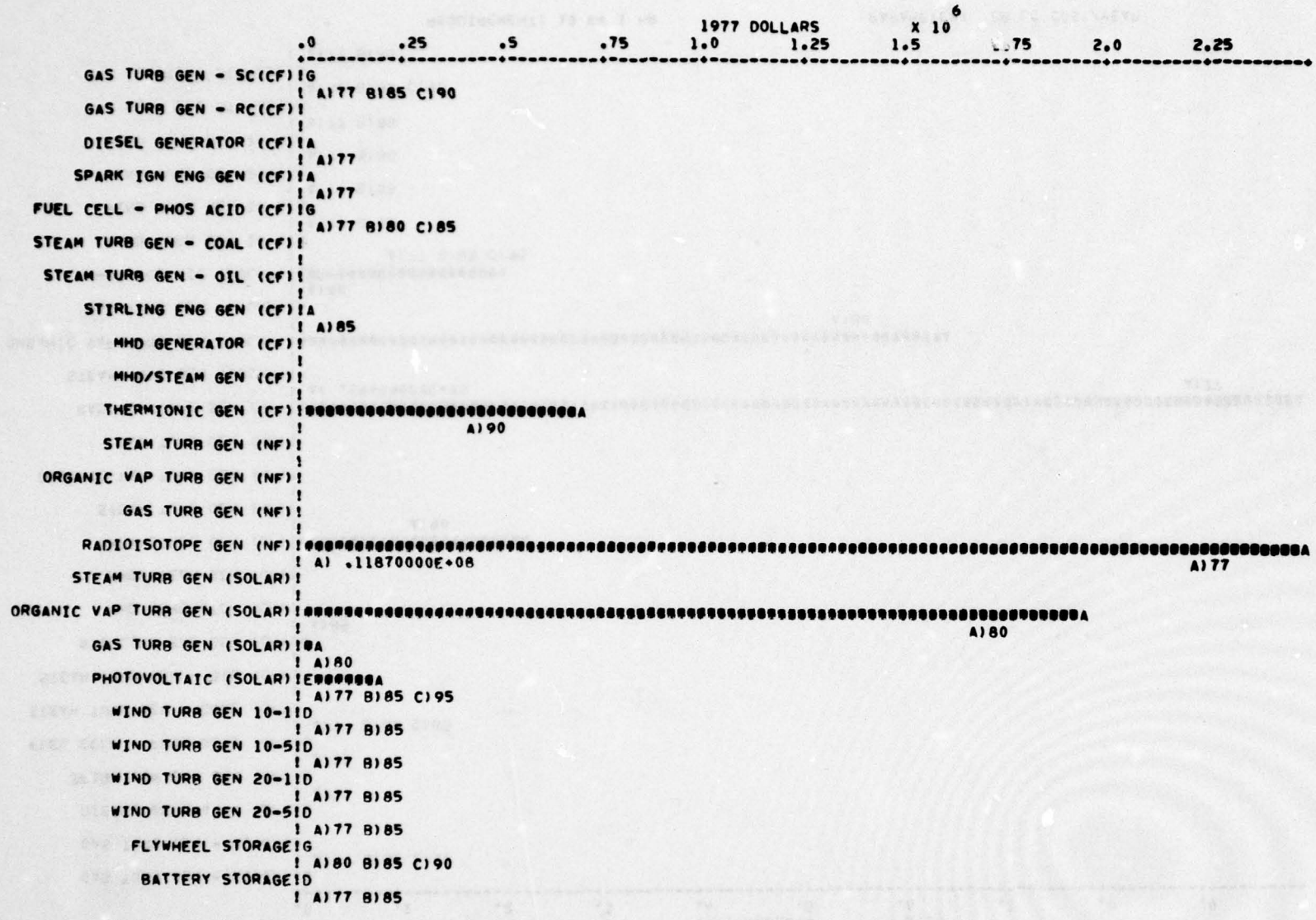
SECTION XIX

TEN KILOWATT, 1 HOUR 3Ø

REQUIREMENT

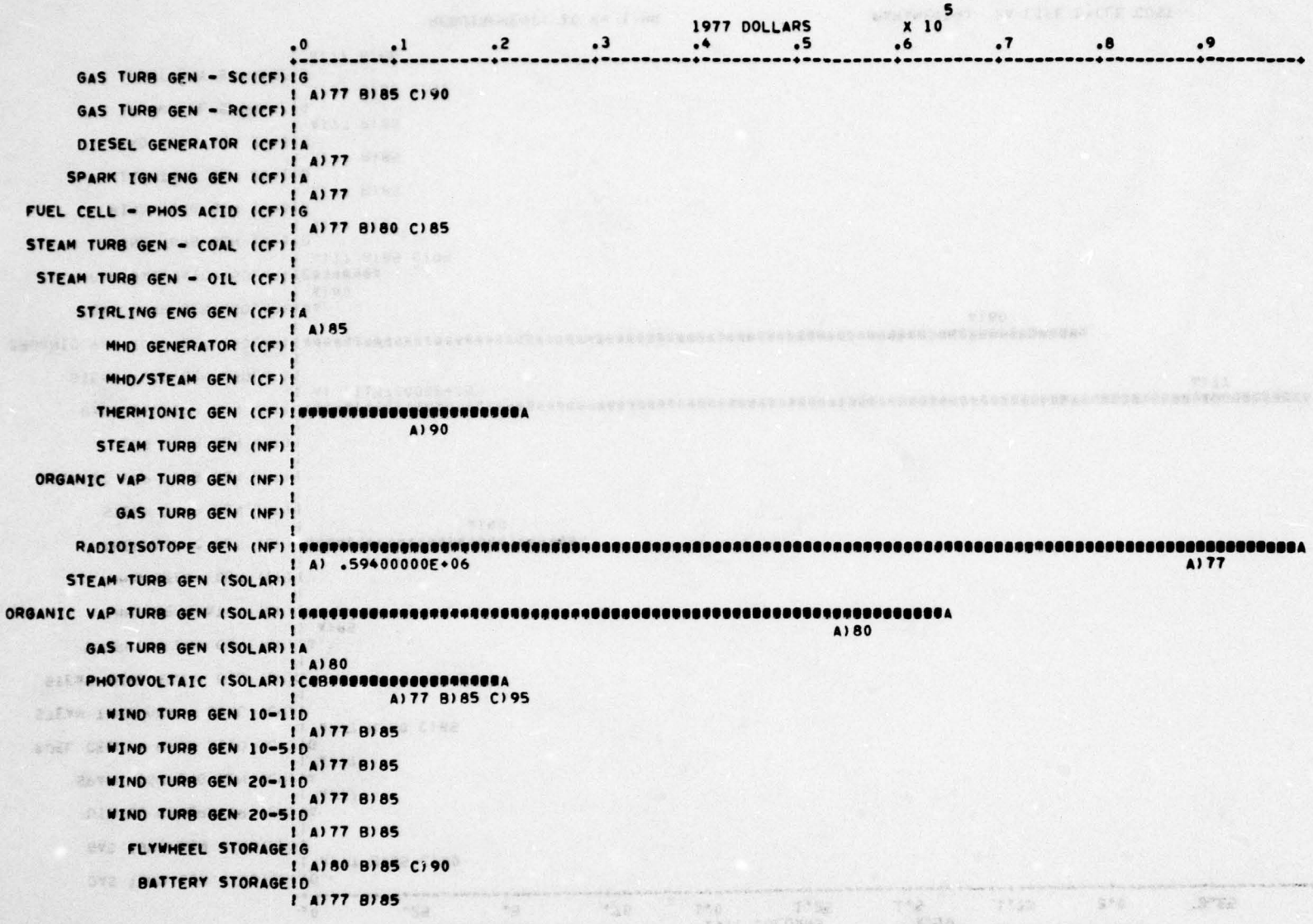
Power Level:	10 Kw
Operating Mode:	1 hour per day
Frequency/Phase:	60 Hz/3Ø
Voltage Level:	240 V


1977 DOLLARS
X 10^6
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK ION ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
A) 77 B) 85 C) 90
A) 77
A) 77
A) 77 B) 80 C) 85
A) 85
A) 90
A) .55000000E+07
A) 77
A) 80
A) 80
A) 77 B) 85 C) 95
A) 77 B) 85
A) 77 B) 85
A) 77 B) 85
A) 77 B) 85
A) 80 B) 85 C) 90
A) 77 B) 85
REQUIREMENT: 10 KW 1 HR
PARAMETER: 1 ACQUISITION COST

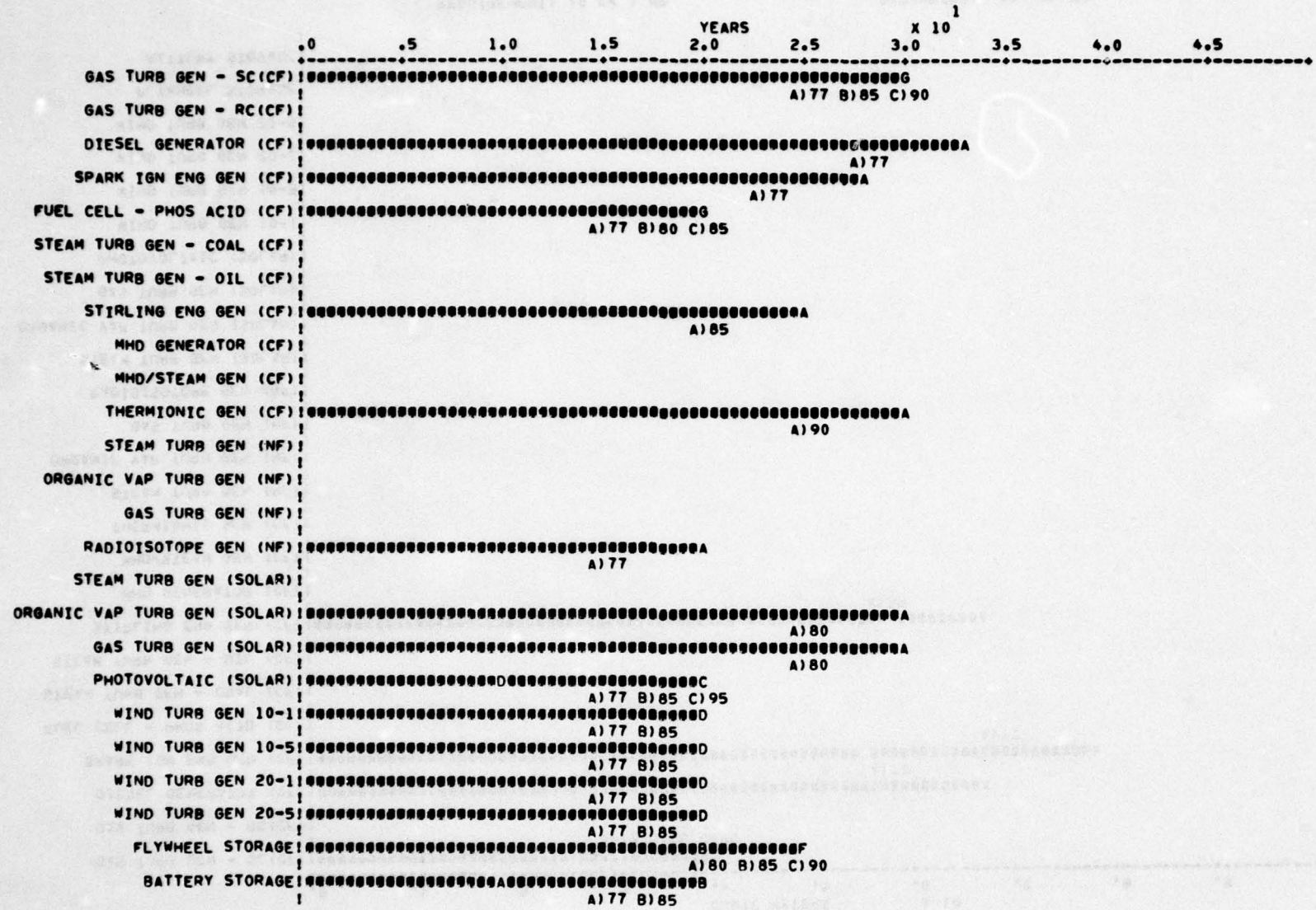


REQUIREMENT: 10 KW 1 HR

PARAMETER: 2A LIFE CYCLE COST

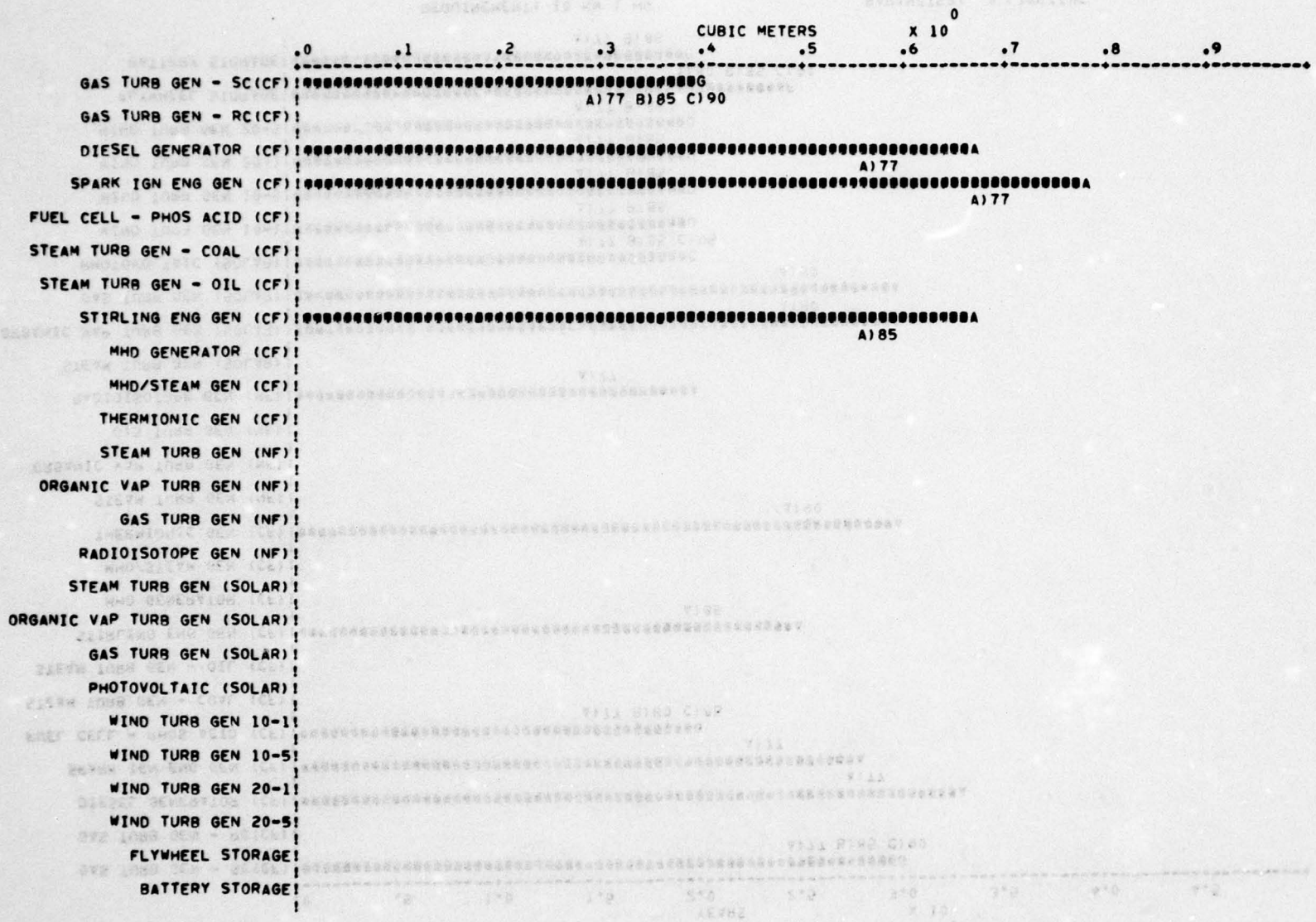


REQUIREMENT: 10 KW 1 HR PARAMETER: 28 LC COST/YEAR



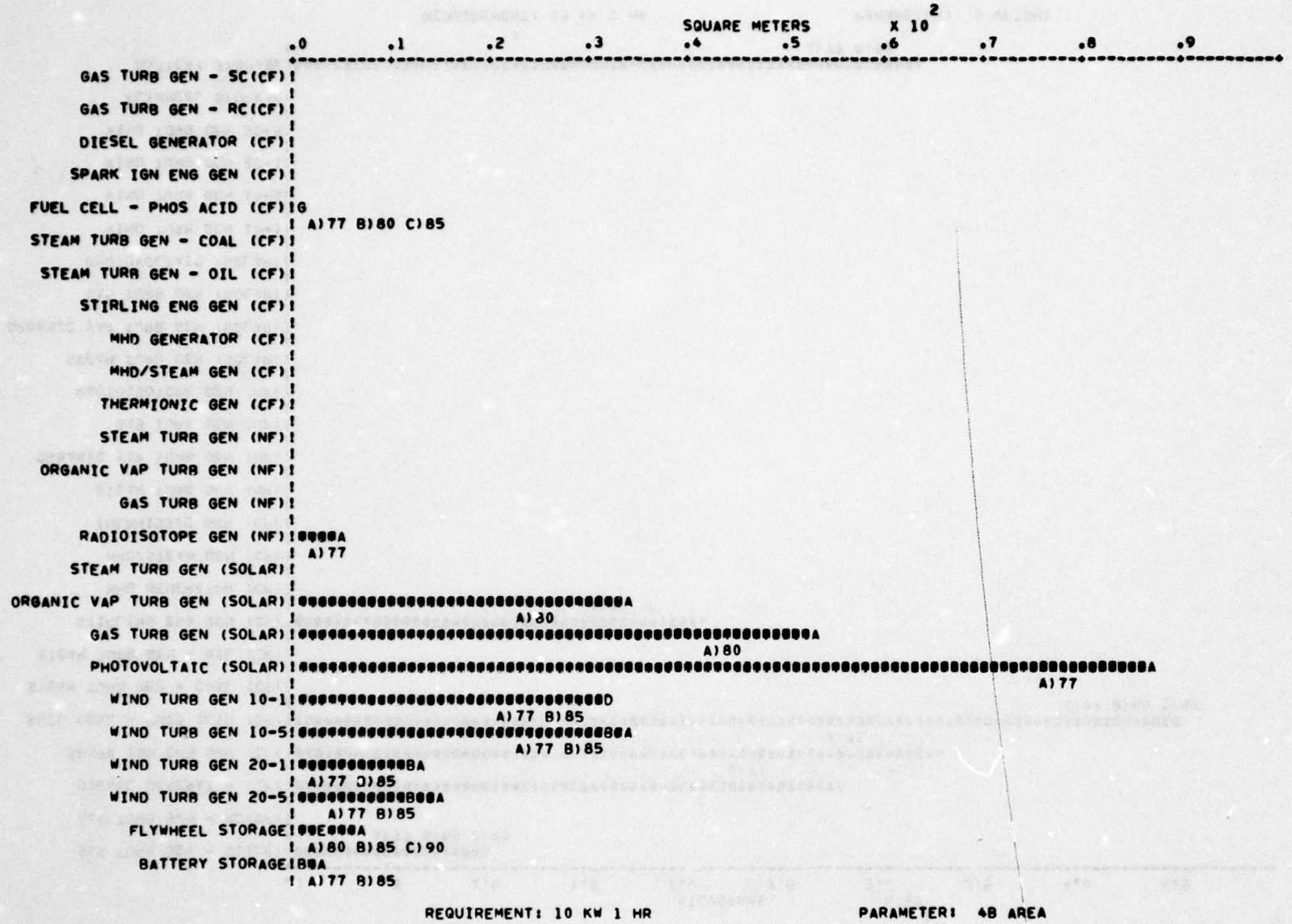
REQUIREMENT: 10 KW 1 HR

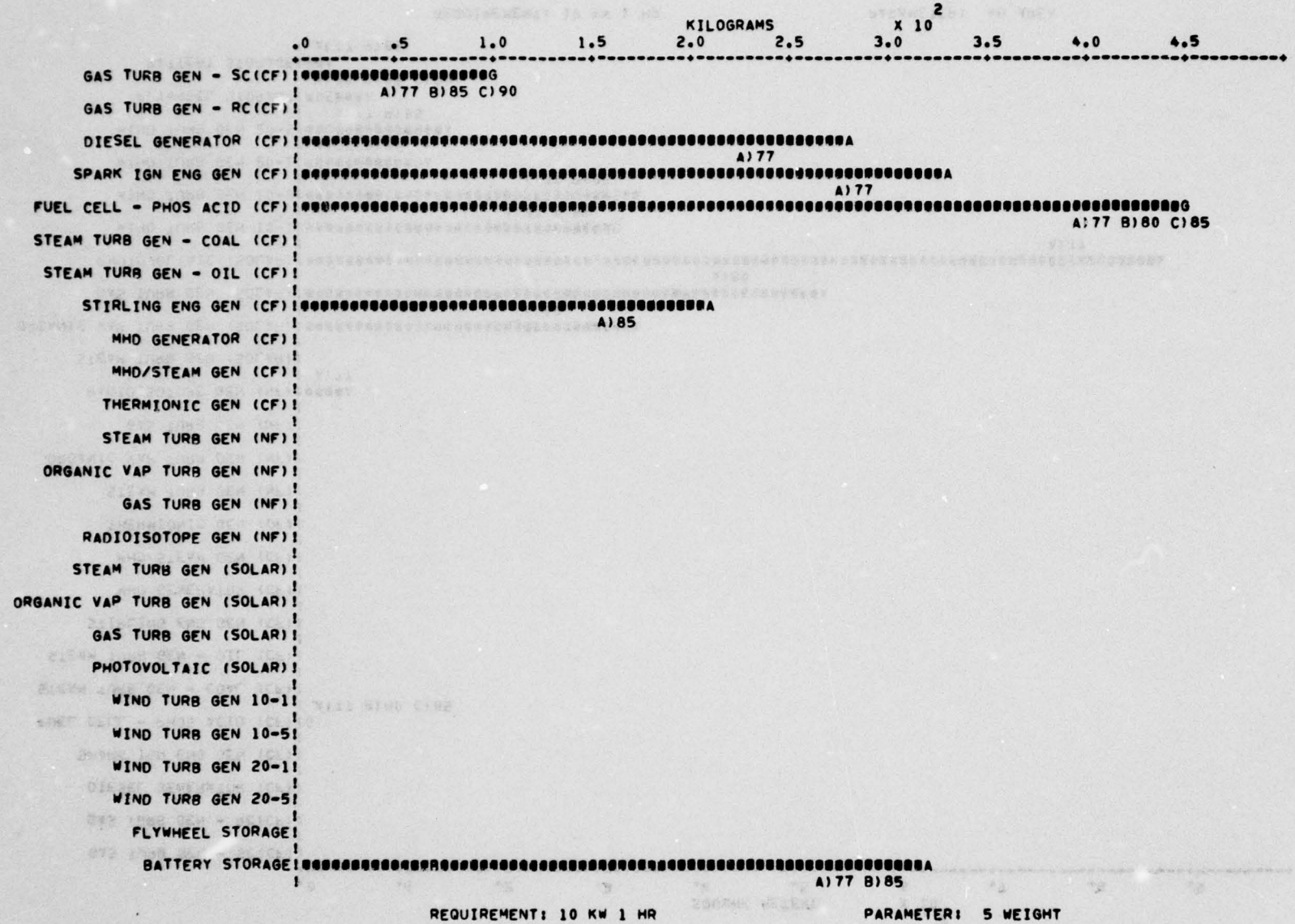
PARAMETER: 3 LIFETIME

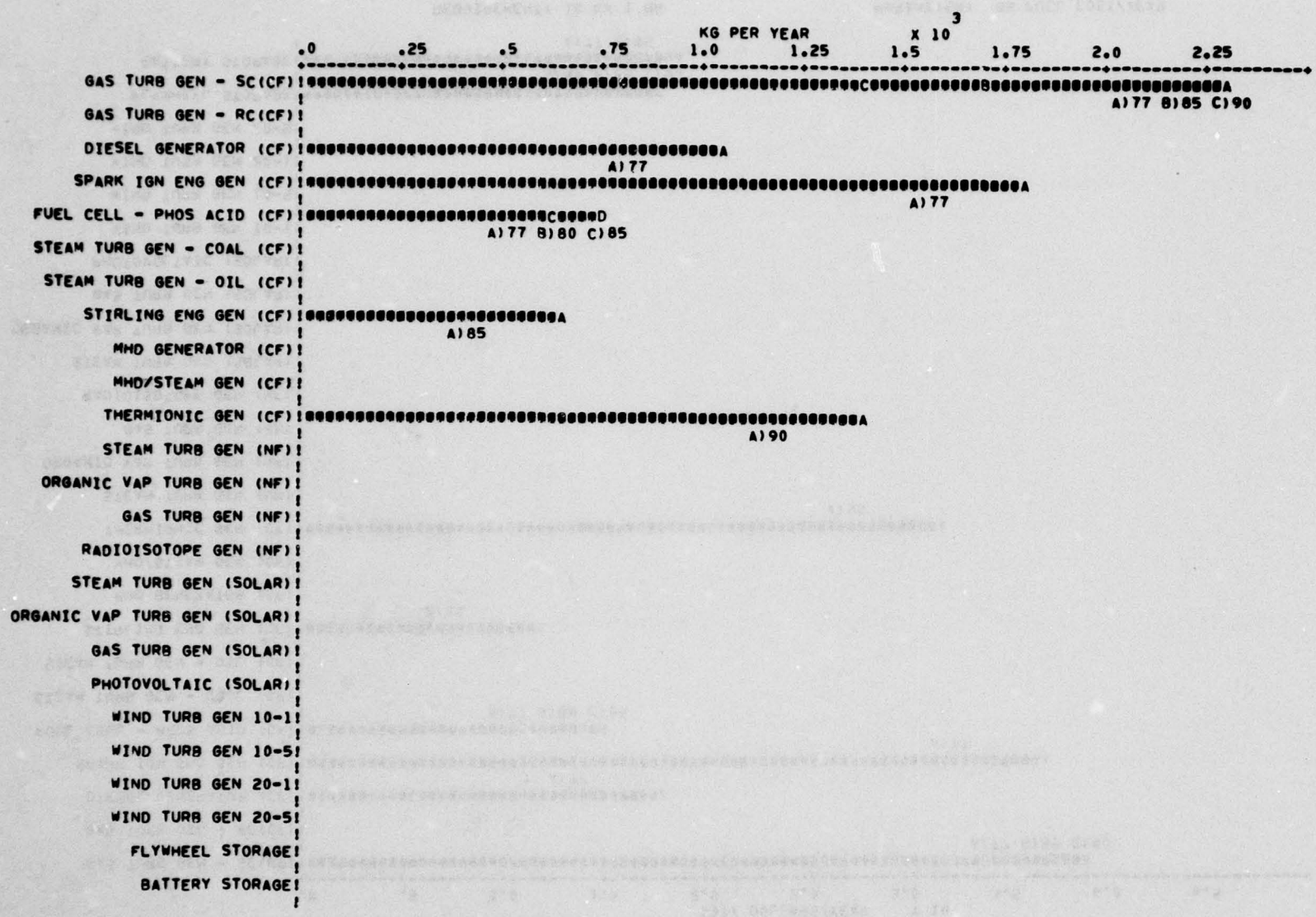


REQUIREMENT: 10 KW 1 HR

PARAMETER: 4A VOLUME

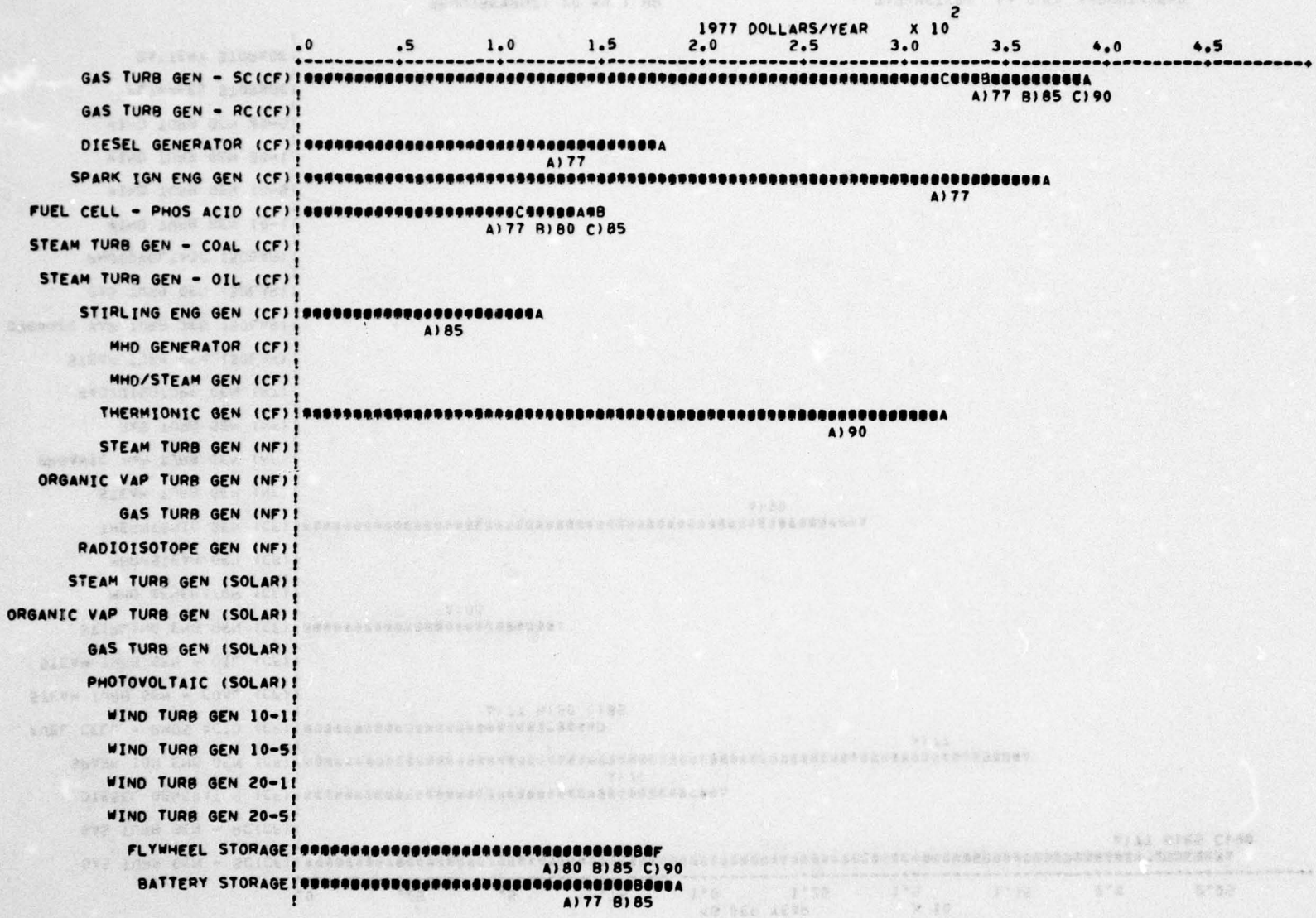

SQUARE METERS X 10 2
.0 .1 .2 .3 .4 .5 .6 .7 .8 .9
GAS TURB GEN - SC(CF)
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
SPARK IGN ENG GEN (CF)
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 C)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 KW 1 HR
PARAMETER: 4B AREA


KILOGRAMS
X 10 2
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 KW 1 HR
PARAMETER: 5 WEIGHT



REQUIREMENT: 10 KW 1 HR

PARAMETER: 6A FUEL AMOUNT/YEAR


1977 DOLLARS/YEAR X 10^2
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
GAS TURB GEN (SOLAR)
PHOTOVOLTAIC (SOLAR)
WIND TURB GEN 10-1
WIND TURB GEN 10-5
WIND TURB GEN 20-1
WIND TURB GEN 20-5
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 KW 1 HR
PARAMETER: 68 FUEL COST/YEAR

REQUIREMENT	PARAMETER
10 KW Cont. 1P-120 V	7) Environmental Constraints

The degree of difficulty in meeting more strict environmental regulations is indicated for each of the pollution types, except for thermal discharge, where amount is shown.

Notes: (a) system is air or water cooled; heat rejected directly to atmosphere.
(b) system is water cooled; heat rejected to body of water or cooling tower. Water source and/or make-up required

SYSTEM	Thermal discharge (a)	Thermal discharge (b)	CO	HC	NOx	SOx	Noise	Particulates	Solid Waste	Chemical Waste	Radioactive Waste
GAS TURB GEN - SC(CF)	-	-	0	0	●	◐	◐	◐	-	-	-
GAS TURB GEN - RC(CF)											
DIESEL GENERATOR(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
SPARK IGN ENG GEN(CF)	-	-	0	0	◐	-	◐	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	0	-	-	-	-
STEAM TURB GEN - COAL(CF)											
STEAM TURB GEN - OIL(CF)											
STIRLING ENG GEN(CF)	-	-	0	0	◐	◐	◐	◐	-	-	-
MHD GENERATOR(CF)											
MHD/STEAM GEN(CF)											
THERMIONIC GEN(CF)											
STEAM TURB GEN(NF)	-	-	0	0	●	◐	0	◐	-	-	-
ORGANIC VAP TURB GEN(NF)											
GAS TURB GEN(NF)											
RADIOISOTOPE GEN(NF)											
STEAM TURB GEN (SOLAR)	-	-	-	-	-	-	-	-	-	-	-
ORGANIC VAP TURB (SOLAR)											
GAS TURB GEN (SOLAR)	-	●	-	-	-	-	◐	-	-	0	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	-	-	◐	-	-	-	-
WIND TURB GEN (ALL)	-	-	-	-	-	-	-	-	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	-	-	-	-
BATTERY STORAGE											

- - none
0 - minor
◐ - moderate
● - major

REQUIREMENT	PARAMETER
10 KW 1 Hr.	8) Location Restraint

The locational limitations of the power system, and the degree of difficulty in overcoming these limitations are indicated in the following tabulation.

- - - no limitation
- O - minor limitation
- ⊖ - major limitation
- ● - overriding limitation

SYSTEM	Water req'd for cooling	Water req'd for process	Manning req'd during oper.	Fuel deliveries req'd	Solar insolation req'd	Adequate wind speed req'd	Isolation from population req'd	Electricity req'd for charging
GAS TURB GEN - SC(CF)	-	-	O	●	-	-	-	-
GAS TURB GEN - RC(CF)								
DIESEL GENERATOR(CF)	-	-	-	●	-	-	-	-
SPARK IGN ENG GEN(CF)	-	-	-	●	-	-	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	●	-	-	-	-
STEAM TURB GEN - COAL(CF)								
STEAM TURB GEN - OIL(CF)								
STIRLING ENG GEN(CF)	-	-	O	●	-	-	-	-
MHD GENERATOR(CF)								
MHD/STEAM GEN(CF)								
THERMIONIC GEN(CF)	O	O	O	●	-	-	-	-
STEAM TURB GEN(NF)								
ORGANIC VAP TURB GEN(NF)								
GAS TURB GEN(NF)								
RADIOISOTOPE GEN(NF)	-	-	-	-	-	-	●	-
STEAM TURB GEN (SOLAR)								
ORGANIC VAP TURB (SOLAR)	⊖	-	O	-	●	-	-	-
GAS TURB GEN (SOLAR)	-	-	O	-	●	-	-	-
PHOTOVOLTAIC (SOLAR)	-	-	-	-	●	-	-	-
WIND TURB GEN 10-1	-	-	-	-	-	●	-	-
WIND TURB GEN 10-5	-	-	-	-	-	●	-	-
WIND TURB GEN 20-1	-	-	-	-	-	●	-	-
WIND TURB GEN 20-5	-	-	-	-	-	●	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-	●
BATTERY STORAGE	-	O	-	-	-	-	-	⊖

REQUIREMENT

10 KW 1 Hr.

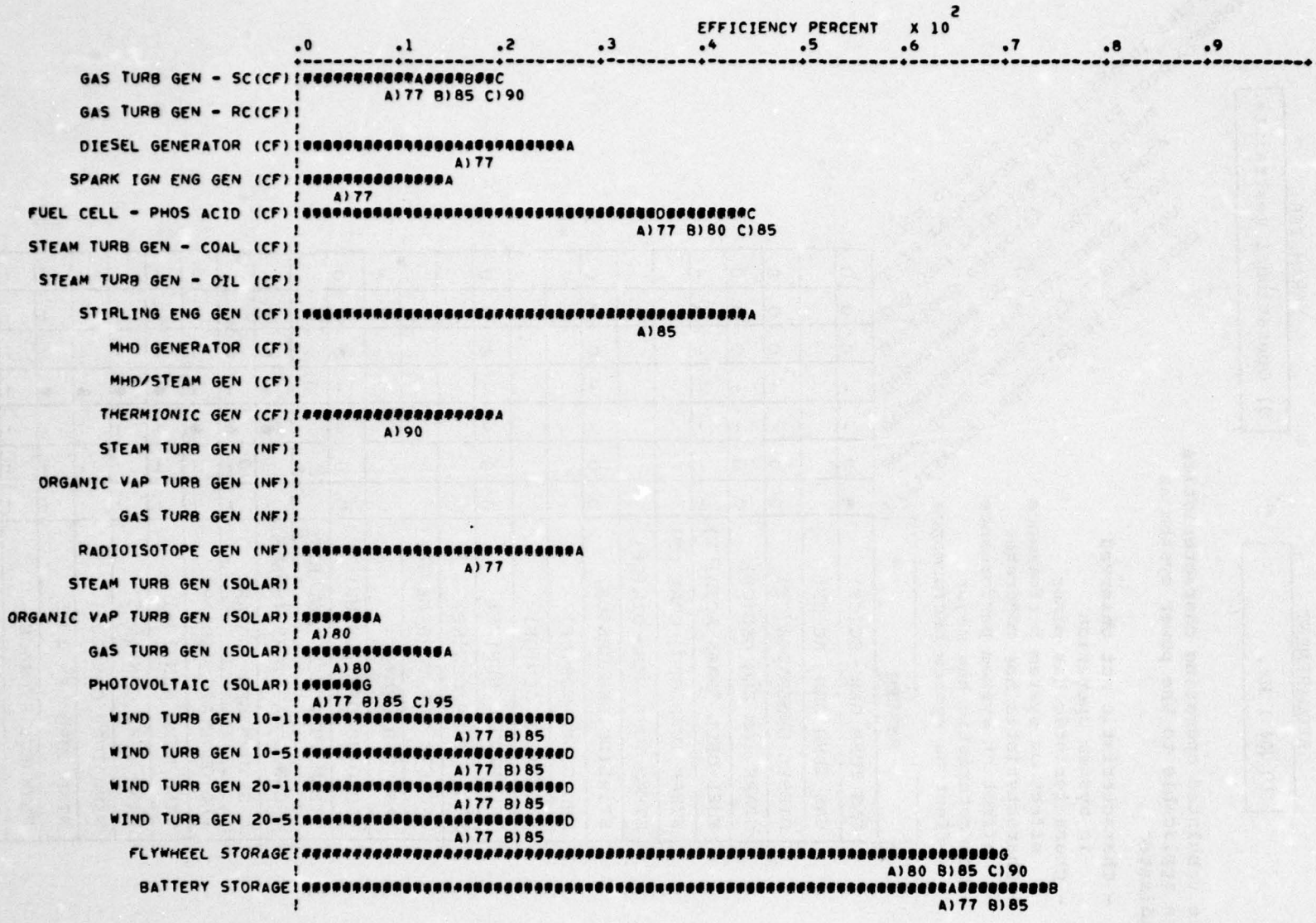
PARAMETER

9) Operational Restraints

The tabulated operating characteristics are applicable to the power system as indicated

- - - Characteristic not observed in system operation
- 0 - Characteristic has minor effect on system performance
- ⊖ - Characteristic has moderate effect on system performance
- ● - Characteristic has major effect on system performance

SYSTEM	Efficiency reduction at part load	Part load capability limitation	Dependence on solar insolation	Dependence on wind consistency	Overload capacity limitations	Delayed response to rapid load changes	Life reduction from frequent rapid load changes
GAS TURB GEN - SC(CF)	⊖	0	-	-	0	0	0
GAS TURB GEN - RC(CF)							
DIESEL GENERATOR(CF)	0	0	-	-	0	0	0
SPARK IGN ENG GEN(CF)	⊖	0	-	-	0	0	0
FUEL CELL - PHOS ACID(CF)	-	-	-	-	-	-	-
STEAM TURB GEN - COAL(CF)							
STEAM TURB GEN - OIL(CF)							
STIRLING ENG GEN(CF)	0	0	-	-	0	0	0
MHD GENERATOR(CF)							
MHD/STEAM GEN(CF)							
THERMIONIC GEN(CF)	0	0	-	-	⊖	0	0
STEAM TURB GEN(NF)							
ORGANIC VAP TURB GEN(NF)							
GAS TURB GEN(NF)							
RADIOISOTOPE GEN(NF)	0	0	-	-	⊖	0	0
STEAM TURB GEN (SOLAR)							
ORGANIC VAP TURB (SOLAR)	-	0	●	-	⊖	⊖	-
GAS TURB GEN (SOLAR)	-	-	●	-	⊖	-	-
PHOTOVOLTAIC (SOLAR)	-	-	●	-	-	-	-
WIND TURB GEN 10-1	-	-	-	●	-	-	-
WIND TURB GEN 10-5	-	-	-	●	-	-	-
WIND TURB GEN 20-1	-	-	-	●	-	-	-
WIND TURB GEN 20-5	-	-	-	●	-	-	-
FLYWHEEL STORAGE	-	-	-	-	-	-	-
BATTERY STORAGE	-	-	-	-	-	-	-


EFFICIENCY PERCENT X 10^2
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
GAS TURB GEN - SC(CF)
A)77 B)85 C)90
GAS TURB GEN - RC(CF)
DIESEL GENERATOR (CF)
A)77
SPARK IGN ENG GEN (CF)
A)77
FUEL CELL - PHOS ACID (CF)
A)77 B)80 C)85
STEAM TURB GEN - COAL (CF)
STEAM TURB GEN - OIL (CF)
STIRLING ENG GEN (CF)
A)85
MHD GENERATOR (CF)
MHD/STEAM GEN (CF)
THERMIONIC GEN (CF)
A)90
STEAM TURB GEN (NF)
ORGANIC VAP TURB GEN (NF)
GAS TURB GEN (NF)
RADIOISOTOPE GEN (NF)
A)77
STEAM TURB GEN (SOLAR)
ORGANIC VAP TURB GEN (SOLAR)
A)80
GAS TURB GEN (SOLAR)
A)80
PHOTOVOLTAIC (SOLAR)
A)77 B)85 C)95
WIND TURB GEN 10-1
A)77 B)85
WIND TURB GEN 10-5
A)77 B)85
WIND TURB GEN 20-1
A)77 B)85
WIND TURB GEN 20-5
A)77 B)85
FLYWHEEL STORAGE
A)80 B)85 C)90
BATTERY STORAGE
A)77 B)85
REQUIREMENT: 10 KW 1 HR
PARAMETER: 10 SYSTEM EFFICIENCY

REQUIREMENT	PARAMETER
10 KW 1 HR	11) Type of System

The power system types, based on USAF definitions are tabulated below. The following abbreviations are used:

M - mobile system
T - transportable system
F - fixed system

System	Type
GAS TURB GEN - SC(CF)	M
GAS TURB GEN - RC(CF)	-
DIESEL GENERATOR(CF)	M
SPARK IGN ENG GEN(CF)	M
FUEL CELL - PHOS ACID(CF)	M
STEAM TURB GEN - COAL(CF)	-
STEAM TURB GEN - OIL(CF)	-
STIRLING ENG GEN(CF)	M
MHD GENERATOR(CF)	-
MHD/STEAM GEN(CF)	-
THERMIONIC GEN(CF)	M
STEAM TURB GEN(NF)	-
ORGANIC VAP TURB GEN(NF)	-
GAS TURB GEN(NF)	-
RADIOISOTOPE GEN(NF)	T
STEAM TURB GEN (SOLAR)	-
ORGANIC VAP TURB (SOLAR)	F
GAS TURB GEN (SOLAR)	F
PHOTOVOLTAIC (SOLAR)	F
WIND TURB GEN 10-1	F
WIND TURB GEN 10-5	F
WIND TURB GEN 20-1	F
WIND TURB GEN 20-5	F
FLYWHEEL STORAGE	F
BATTERY STORAGE	M

AD-A061 071 BURNS AND ROE INC WOODBURY NY F/G 10/2
USAF TERRESTRIAL ENERGY STUDY, VOLUME III, PART I, SUMMARY DATA--ETC(U)
MAY 78 D C HALL, A CARLSON, D FULLER, R REYER F33615-76-C-2171
UNCLASSIFIED AFAPL-TR-78-19-VOL-3-PT-1 NL

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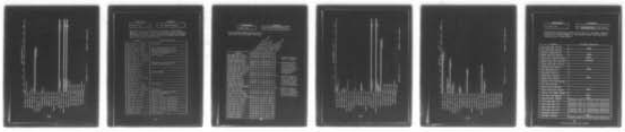

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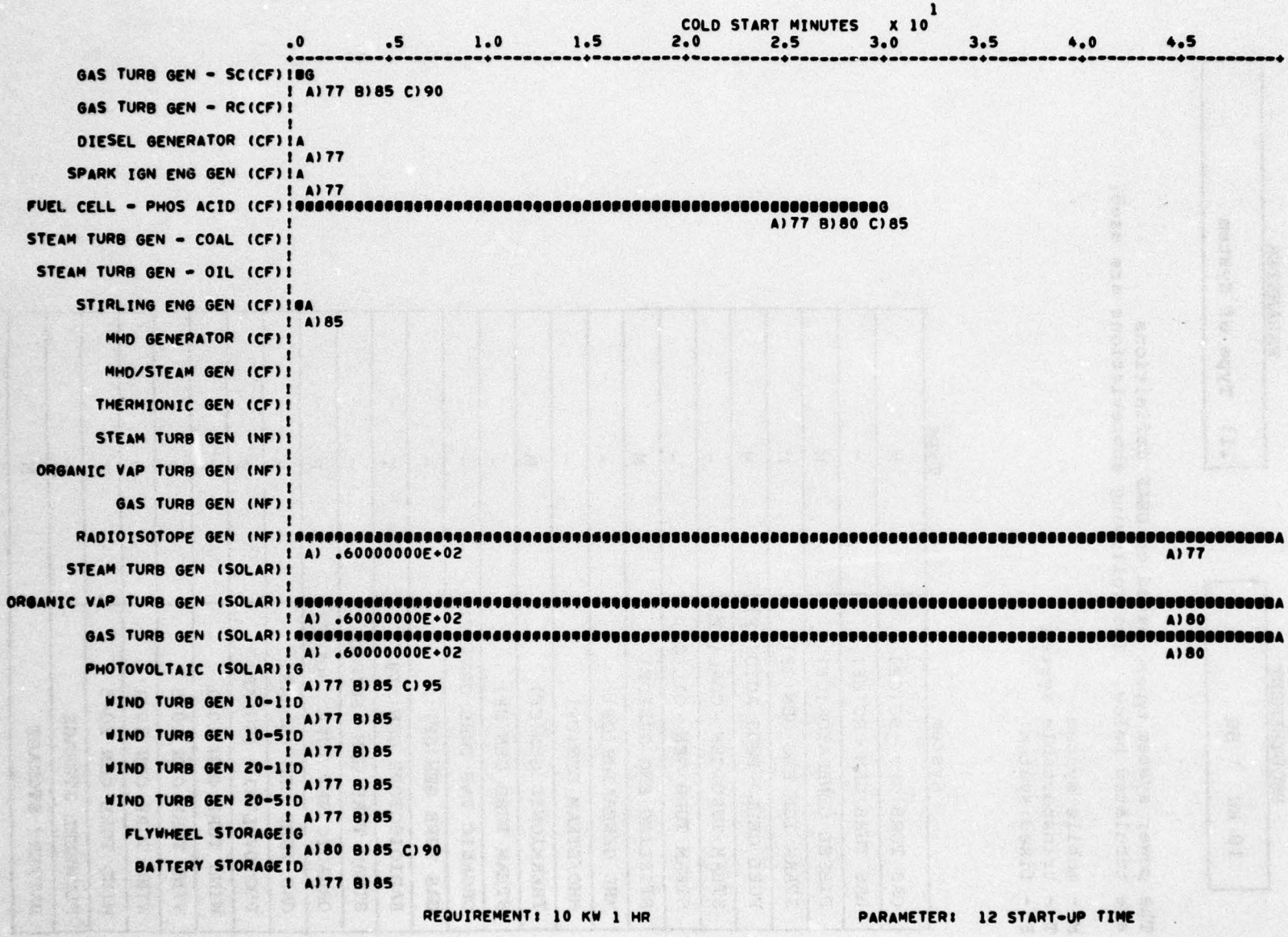


REQUIREMENT: 10 KW 1 HR PARAMETER: 12 START-UP TIME

REQUIREMENT	PARAMETER
10 KW 1 Hr.	13) Growth Potential

The power systems are ranked below according to their growth potential, or ability to have their rated power output increased by incremental amounts. This depends on the degree of modularity of the system. A fully modular system has the most growth potential, a non-modular system has none.

System	Critical Materials
GAS TURB GEN - SC(CF)	Not modular
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	Not modular, except possibly largest requirements
SPARK IGN ENG GEN(CF)	Not modular, except possibly largest requirements
FUEL CELL - PHOS ACID(CF)	Fully modular
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	Not modular, except possibly largest requirements
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	Partly modular
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	
RADIOISOTOPE GEN(NF)	Not modular
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	Not modular
GAS TURB GEN (SOLAR)	Not modular, except possibly largest requirements
PHOTOVOLTAIC (SOLAR)	Fully modular
WIND TURB GEN 10-1	Modular for most requirements
WIND TURB GEN 10-5	Modular for most requirements
WIND TURB GEN 20-1	Modular for most requirements
WIND TURB GEN 20-5	Modular for most requirements
FLYWHEEL STORAGE	Modular for most requirements
BATTERY STORAGE	Fully modular

REQUIREMENT	PARAMETER
10 KW 1 Hr.	14) Reliability/Availability

The tabulated conditions exist in the power system to the extent indicated.

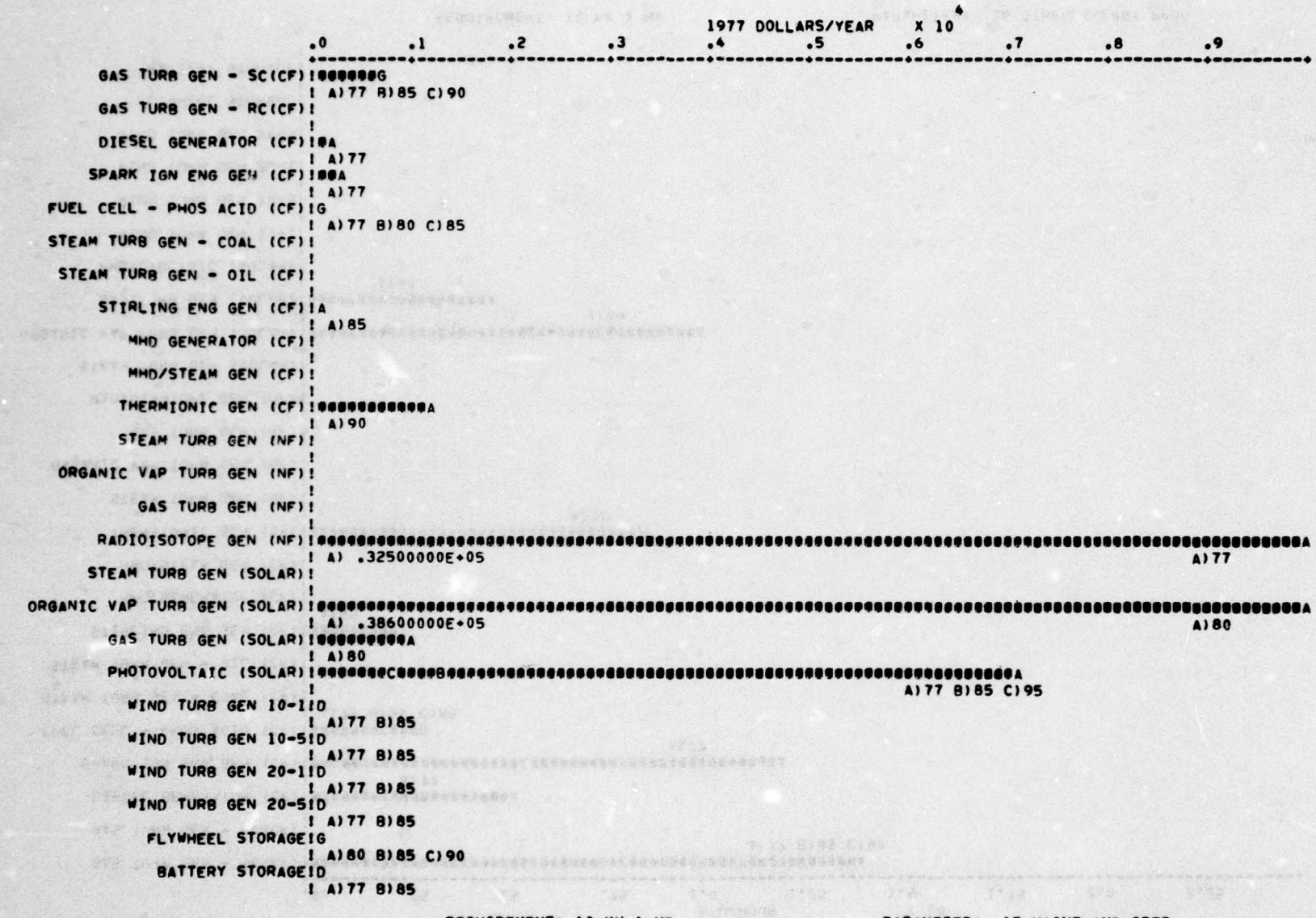
SYSTEM	Numerous moving parts	High temperature operation	High stress levels	High radiation levels	Corrosive attack	Thermal cycling	Non-modular design	Solar insolation req'd	Wind required
GAS TURB GEN - SC(CF)	O	●	O	-	●	O	●	-	-
GAS TURB GEN - RC(CF)									
DIESEL GENERATOR(CF)	●	O	O	-	O	O	●	-	-
SPARK IGN ENG GEN(CF)	●	O	O	-	O	O	●	-	-
FUEL CELL - PHOS ACID(CF)	-	-	-	-	O	-	-	-	-
STEAM TURB GEN - COAL(CF)									
STEAM TURB GEN - OIL(CF)									
STIRLING ENG GEN(CF)	O	O	O	-	O	O	●	-	-
MHD GENERATOR(CF)									
MHD/STEAM GEN(CF)									
THERMIONIC GEN(CF)	O	●	-	-	⊖	O	O	-	-
STEAM TURB GEN(NF)									
ORGANIC VAP TURB GEN(NF)									
GAS TURB GEN(NF)									
RADIOISOTOPE GEN(NF)	O	O	O	O	-	O	●	-	-
STEAM TURB GEN (SOLAR)									
ORGANIC VAP TURB (SOLAR)	O	O	O	-	-	O	-	●	-
GAS TURB GEN (SOLAR)	O	O	O	-	O	O	-	●	-
PHOTOVOLTAIC (SOLAR)	-	O	-	-	O	-	-	●	-
WIND TURB GEN 10-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 10-5	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-1	O	O	●	-	O	-	-	-	●
WIND TURB GEN 20-5	O	O	●	-	O	-	-	-	●
FLYWHEEL STORAGE	O	-	●	-	-	-	⊖	-	-
BATTERY STORAGE	-	O	-	-	O	-	-	-	-

- \- Condition does not exist in system

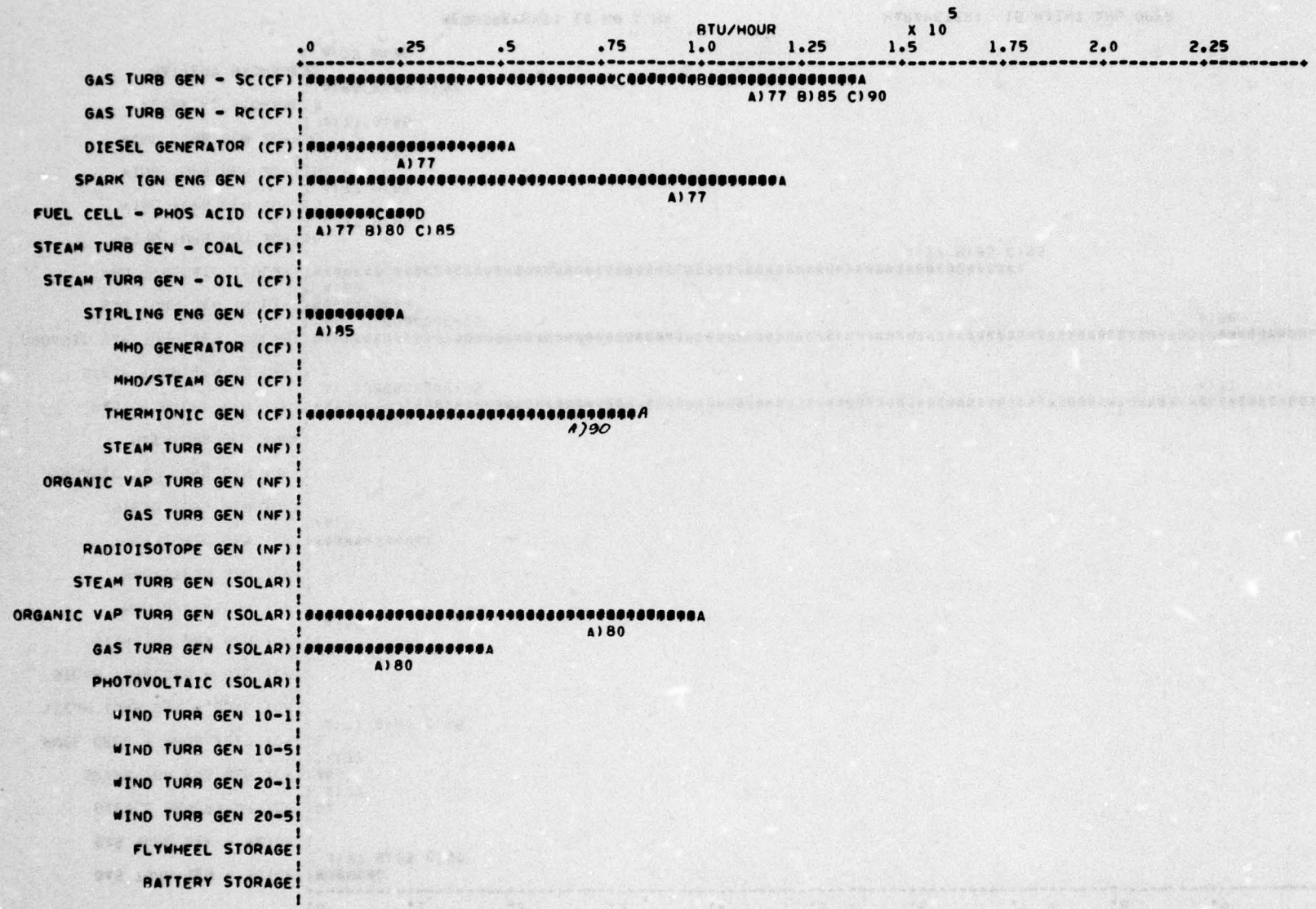
O - Condition exists, but its extent is sufficient minor as to have minimal effect on system performance or reliability

⊖ - Conditions exists, and its extent is sufficient to have a moderate effect on system performance or reliability

● - Condition exists and is a governing factor in determining system performance and reliability



REQUIREMENT: 10 KW 1 HR PARAMETER: 15 MAINT AND OPER



REQUIREMENT: 10 KW 1 HR

PARAMETER: 16 OTHER ENERGY PROD

REQUIREMENT	PARAMETER
10 KW 1 Hr.	17) Availability of Raw Building Materials

Construction materials which are critical to the power systems and are of limited supply in the United States and Free World countries are listed below.

System	Critical Materials
GAS TURB GEN - SC(CF)	None
GAS TURB GEN - RC(CF)	
DIESEL GENERATOR(CF)	None
SPARK IGN ENG GEN(CF)	None
FUEL CELL - PHOS ACID(CF)	Platinum
STEAM TURB GEN - COAL(CF)	
STEAM TURB GEN - OIL(CF)	
STIRLING ENG GEN(CF)	None
MHD GENERATOR(CF)	
MHD/STEAM GEN(CF)	
THERMIONIC GEN(CF)	None
STEAM TURB GEN(NF)	
ORGANIC VAP TURB GEN(NF)	
GAS TURB GEN(NF)	
RADIOISOTOPE GEN(NF)	None
STEAM TURB GEN (SOLAR)	
ORGANIC VAP TURB (SOLAR)	None
GAS TURB GEN (SOLAR)	None
PHOTOVOLTAIC (SOLAR)	Possibly lead for conventional batteries
WIND TURB GEN 10-1	Possibly lead for conventional batteries
WIND TURB GEN 10-5	Possibly lead for conventional batteries
WIND TURB GEN 20-1	Possibly lead for conventional batteries
WIND TURB GEN 20-5	Possibly lead for conventional batteries
FLYWHEEL STORAGE	None
BATTERY STORAGE	Possibly lead for conventional batteries

*U.S.Government Printing Office: 1978 — 757-080/730