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RFP-2836/3533/78/3

A GUIDE TO COMMERCIALY AVAILABLE WIND MACHINES

April 3, 1978

MASTER

Work Performed Under Contract No. EY-76-C-04-3533

The Wind Systems Program
Rockwell International
Rocky Flats Plant
Golden, Colorado

U.S. Department of Energy

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Solar Energy

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Prepared with the Assistance of
The American Wind Energy Association
Under Contract #PF71789F

for

The United States Department of Energy
Division of Solar Technology
Federal Wind Energy Program

Contract No. E(29-2)-3533

RFP-2836

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ABSTRACT

This report describes in detail Wind Energy Conversion Systems (WECS) commercially available in the United States. The terms used to describe these wind systems are defined and their significance discussed. Lists of manufacturers and distributors, subsystem components and suppliers, and references are provided.

INTRODUCTION

This report was prepared to provide a description of small wind machines (under 100 kw capacity) commercially available in the United States. The main focus is on machines that might be used to furnish a home, farm, small business, or remote facility with some or all of its electrical power. Other wind machines, designed to produce mechanical power, are also described.

In general, this report answers four primary questions:

- What wind machines are available?
- What are their performance characteristics?
- What are the differences among these wind machines?
- Where can wind machines and associated equipment be purchased?

A total of 66 wind machines from 28 manufacturers are described. The manufacturers provided a data sheet for each machine, describing its physical, performance and operational characteristics. Two summary charts, one for electrical machines and one for mechanical machines, are included to facilitate comparison. All wind systems whose manufacturers provided information by June 31, 1978 are included.

Most of the wind machines described are currently available in the United States. A number of others are now in the prototype or design stage (and noted as such) and will be available shortly.

While this report is primarily concerned with describing the wind machine, additional components required to complete the total wind energy conversion system (towers, storage systems, and inverters), are briefly described.

In addition, a glossary of terms and a discussion of wind technology basics are included to help the reader evaluate the machines. A list of selected references is provided for readers wishing further information on wind energy utilization.

How to Use This Book

The major points of comparison for evaluating the wind machines in this book are rated output and rated wind speed (both of which are selected by the manufacturer as being representative of a machine's optimum performance - i.e., 25 kw @ 20 mph), and cut-in and cut-out wind speed (the points at which the machine begins and stops producing power). In selecting a wind machine, these performance and operational characteristics should be matched with the wind conditions at the site and the energy requirements of a particular application.

Wind conditions are most accurately determined by taking wind speed measurements at the site using an anemometer. A list of companies which

manufacture and/or distribute anemometry equipment is included on page 108. Data from nearby airports or other wind measurement sites may be used to determine typical average wind speeds for a general regional (see references in Appendix C) but this data may not be applicable to a specific site.

A current utility bill, which lists the amount of power (in kilowatt hours) consumed during the billing period, is a readily available source for estimating the output capabilities needed in a machine. The Consumer Service Department of a local utility company can provide any further information needed to assess a particular energy requirement. A method for combining the wind conditions at a particular site with a machine's rated output (which is given in watts or kilowatts) to obtain an estimate of the kilowatt hours to expect from a machine at a particular site is given on pages 8-11. This estimate should aid the reader in selecting machines that would meet his energy requirements.

Once a machine has been selected, the distributor or manufacturer can provide assistance in putting together a total wind system best suited to a particular site, application, and budget. The service provided by local dealers is generally considered beneficial because of their familiarity with local wind conditions and their accessibility for later service. For this reason, most manufacturers do not sell directly to the public when dealerships have been established.

CHAPTER ONE:
WIND POWER AND THE
WIND ENERGY CONVERSION SYSTEM (WECS)

POWER PRODUCTION FROM THE WIND ENERGY CONVERSION SYSTEM (WECS)

This report is primarily concerned with describing the wind machine, which is the equipment at the top of a wind system's tower.

The wind machine, however, is only one component in a WECS. Its performance cannot be defined independent of the system's other elements: The wind, or the WECS "fuel supply"; and the load, or manner in which the energy produced is used. All three elements, taken together, determine how much usable energy a system will produce. Figure 1.1 is schematic representation of a WECS.

The wind, although remarkably constant over long periods of time, is extremely variable in speed and direction. Wind machines are designed to compensate for these complexities in the wind. Yaw, over-speed and voltage control mechanisms (see Chapter Two for definitions of these terms) are examples of machine features that help compensate for the constant variations in operating conditions to ensure reliable system performance.

Because the power in the wind varies with the third power of the wind velocity (doubling the wind speed results in eight times the power), even small fluctuations in the wind speed can result in greatly different power outputs. In addition, constant changes in the wind direction make it difficult to precisely determine the wind speed and, therefore, the power available at any moment. The rate of change in both wind speed and direction varies greatly from site to site. This kind of variability in the wind makes it difficult to predict a standard performance level for a wind machine and the total WECS.

The load on a WECS also affects the amount of energy that a system will yield. A wind system feeding power into a battery bank, for example, will have different performance characteristics than a system feeding a utility line or resistance heater.

Wind machine dealers are knowledgeable in the complexities of the WECS and can help assess the wind conditions at a particular site and the load as parts of the system.

POWER AVAILABLE IN THE WIND

The power available to a wind machine for conversion to useful energy is a function of the area intercepted by the blades, air density and wind speed. $\text{Power Available (Pav)} = \text{Area} \times (\text{Wind Speed})^3 \times k$, where k = a mathematical constant for various units of power, area and velocity, incorporating the value of air density at .00237 slugs/ft³ (the density of air at sea level and 59°F). Different values of k for various units of power, area and velocity are:

Figure 1.1

Figure 1.1: WECS SCHEMATIC

<u>Power</u>	<u>Area</u>	<u>Velocity</u>	<u>Constant (k)</u>
kilowatt	sq. feet	miles per hour	5.1×10^{-6}
kilowatt	sq. feet	knots	7.7×10^{-6}
kilowatt	sq. meters	meters per second	6.1×10^{-4}
horsepower	sq. feet	miles per hour	6.8×10^{-6}
watts	sq. feet	feet per second	1.6×10^{-3}

POWER EXTRACTED

The percentage of available power which a wind machine rotor extracts from the wind is known as the Power Coefficient (C_p). It is simply the ratio between the power extracted and the power available. The theoretical maximum C_p is .593. This value is referred to as the Bétz limit. In practice, power coefficients normally range from .148 for Savonius rotors, to .459 for propeller-type rotors. The power coefficient does not include losses from the drive train, generator, or other subsystems.

DESIGN CHARACTERISTICS OF WIND MACHINES

A particular design can be described in terms of its power coefficient, or efficiency in extracting energy; its tip speed ratio (or speed of rotation relative to the wind); and its solidity, which determines the wind speed operating range.

Tip Speed Ratio

The tip speed ratio is a characteristic of a machine's design which influences its power coefficient. It is the ratio of the velocity at the tip of the blade to the velocity of the wind. High tip speed ratios range between 5 and 10, while low tip speed ratios fall between 1 and 2. Wind machines with low tip speed ratios usually have higher starting torques (start rotating at lower wind speeds), but their blades never reach high speeds. This makes them best suited for mechanical applications such as pumping water. Machines with high tip speed ratios have tip speeds 5 to 10 times faster than the wind, which makes them well suited for electricity production. The following chart illustrates that highest power coefficient values occur at high tip speed ratios.

- A. Savonius rotor
- B. American multi-blade type
- C. Ideal efficiency for propeller type windmills
- D. Dutch four arm type
- E. High speed two blade type
- F. Darrieus rotor

Figure 1.2: POWER COEFFICIENT VS. TIP SPEED RATIO

Solidity Ratio

Solidity Ratio is another characteristic of wind machine design that influences performance efficiency. It is the ratio of blade surface area to the area swept by the blades. Machines that sweep out a larger area in relation to the surface area of their blades have a low solidity ratio and are more efficient. Increased solidity lowers the tip speed ratio and raises starting torque. Relationships between solidity ratio and tip speed ratio are shown in Figure 1.3.

Figure 1.3: SOLIDITY RATIO VS. TIP SPEED RATIO

ESTIMATING POWER PRODUCTION AT A SPECIFIC SITE

There are differences of opinion concerning the most accurate method for predicting how much energy a wind machine will produce at a given site. The intention here is to provide a simplified method for translating the wind machine power data given in the manufacturer's descriptions into more explicit terms: kW hours of production per year or month for a specific site.

This methodology yields only a rough estimate of expected energy production, but it is valuable because it combines a machine's power curve and the wind profile at the site in question to provide a tangible picture of how much electrical or mechanical power a machine will furnish. Accordingly, it shows how the machine could fit into an energy user's total store of fuel.

To use this method, it is necessary to have wind velocity data detailing the percentage of time different wind speeds occur at the site in question. Figure 1.4 is a velocity distribution chart for sites with 8.95 mph (4 m/s), 11.8 mph (5 m/s), and 13.42 mph (6 m/s) annual average wind speeds. This chart includes high, medium, and low distribution patterns for each annual average wind speed, and illustrates the variability in wind profiles among sites with the same average wind speed.

WIND VELOCITY DISTRIBUTIONS FOR THREE DIFFERENT AVERAGE ANNUAL WIND SPEEDS

WIND VELOCITY READING		PERCENTAGE OF HOURLY READINGS (PER YEAR) WHEN EACH WIND VELOCITY OCCURRED								
		8.95 mph (4 m/s) Average Sites			11.18 mph (5 m/s) Average Sites			13.42 mph (6 m/s) Average Sites		
MPH	M/S	HIGH	MED.	LOW	HIGH	MED.	LOW	HIGH	MED.	LOW
2.2	1	14.8%	10.6%	8.5%	9.2%	5.4%	4.1%	5.7%	2.8%	1.9%
4.5	2	16.8%	16.5%	15.9%	12.6%	12.6%	9.5%	9.1%	6.6%	5.5%
6.7	3	15.8%	18.3%	19.4%	13.8%	14.2%	14.2%	11.1%	10.1%	9.5%
9.0	4	13.4%	16.8%	18.7%	13.3%	15.7%	16.7%	11.9%	12.7%	12.9%
11.2	5	10.6%	13.5%	15.1%	11.9%	15.0%	16.5%	11.7%	13.9%	14.9%
13.4	6	8.0%	9.6%	10.3%	10.0%	12.8%	14.1%	10.7%	13.6%	15.0%
15.7	7	5.8%	6.2%	6.1%	8.0%	9.8%	10.5%	9.4%	12.0%	13.3%
17.9	8	4.0%	3.7%	3.1%	6.1%	6.8%	6.9%	7.8%	9.7%	10.5%
20.1	9	2.7%	2.0%	1.4%	4.5%	4.3%	3.9%	6.2%	7.2%	7.4%
22.4	10	1.8%	1.0%	.6%	3.2%	2.5%	2.0%	4.8%	4.8%	4.6%
24.6	11	1.1%	.4%	.2%	2.2%	1.8%	.9%	3.5%	3.0%	3.5%
26.9	12	.7%	.2%	.1%	1.4%	1.3%	.3%	2.5%	1.7%	1.2%
29.1	13	.4%	.1%	0%	.0%	.8%	.1%	1.7%	.9%	.5%
31.3	14	.2%	0%	0%	.6%	.1%	0%	1.2%	.4%	.2%
33.6	15	.1%	0%	0%	.4%	0%	0%	.8%	.2%	.1%
35.8	16	.1%	0%	0%	.2%	0%	0%	.5%	.1%	0%
38.0	17	0%	0%	0%	.1%	0%	0%	.5%	.1%	0%
40.3	18	0%	0%	0%	.1%	0%	0%	.3%	0%	0%
42.5	19	0%	0%	0%	0%	0%	0%	.1%	0%	0%
44.7	20	0%	0%	0%	0%	0%	0%	.1%	0%	0%

NOTE: 100% = 8760 HOURS PER YEAR.

High, Medium, and Low refers to the relative energy content at each site. Since the energy available in the wind increases as the cube of the velocity, a site with a higher percentage of faster winds will provide more available energy even though its average annual wind speed is the same.

Figure 1.4

To develop an estimate of annual output, multiply the system output at each increment of wind speed by the percentage of time that increment occurs each year. Then add all of the resulting products together and multiply by the number of hours in one year (8760). For an example, consider a site at which the annual average wind speed is 11.18 mph (5 m/s). If we use the medium energy velocity distribution as shown in Figure 1.4, along with the power curve from a small wind machine as shown in Figure 1.5, the calculations would be as follows:

Figure 1.5

POWER OUTPUT FROM FIVE METER ROTOR DIAMETER WTG

Figure 1.5

kilowatt hours per year =

.32 kW x 15.7% = .050 @ 4 m/s	3.50 kW x 2.5% = .088 @ 10 m/s
.65 kW x 15% = .098 @ 5 m/s	3.50 kW x 1.8% = .063 @ 11 m/s
1.15 kW x 12.8% = .147 @ 6 m/s	3.50 kW x 1.3% = .046 @ 13 m/s
2.60 kW x 9.8% = .172 @ 7 m/s	3.50 kW x .8% = .028 @ 13 m/s
3.45 kW x 4.3% = .148 @ 9 m/s	3.50 kW x .1% = .004 @ 14 m/s
3.45 kW x 4.3% = .148 @ 9 m/s	

TOTAL = 1.019 x 8760 hours per year =

8,856.360 kilowatt hours per year =

738.30 kilowatt hours per month

It should be noted that winds below the cut-in wind speed are not used, and all winds above the rated wind speed are assumed to produce the rated power output of the generator.

This calculated output shows only power available at the blades. Other factors that must be considered include the inevitable losses which occur in transmission, conversion and storage of energy and rotor power coefficient. (See discussion of power coefficient). In the case of batteries, only about 70% of the energy used in charging can be recovered during discharge.

For sites where only the annual average wind speed is known, the following equation will yield an estimate of power production:

$$P = 2AV^3k$$

where: A = area swept out by blades
V = annual average velocity in mph
k = 5.1×10^{-6}

Again this equation only gives an estimate of the power available at the blades. And the variability in velocity distributions among sites with the same annual average (as illustrated in Figure 1.4) is a further limitation.

The United States Department of Energy's Rocky Flats Plant, managed by Rockwell International, has been designated as the lead agency in the country for the development and testing of small WECS. Data collected by this facility will be included in later editions of this report, thus providing a further reference for assessing wind machine performance.

Wind velocity data can be obtained from sources referenced in Appendix C.

CHAPTER TWO:
DEFINITION OF TERMS

Terms which are used to describe systems that extract energy from the wind can, if not properly defined, adversely influence communications both within the wind energy industry and between the wind energy industry and the public.

Two acronyms are in wide-spread use within the field of wind energy utilization. These are Wind Energy Conversion Systems (WECS) and Wind Turbine Generators (WTGs). There are also a number of symbols and terms which appeared in the Proceedings of The Second Workshop on WECS and in Applied Aerodynamics of Wind Power Machines (see Appendix C).

The terms used in this guide to describe wind systems have been divided into three categories. The Physical Characteristics describe the type of system, rotor size, materials, and weights. The Operational Characteristics describe the WECS' operating range, type of generator or alternator, and control system. The Performance Characteristics describe the maximum and rated power, and power production vs. wind speed.

What follows is a list of the terms that have been used in assessing the wind energy conversion systems, together with their definitions and a brief discussion of their significance.

PHYSICAL CHARACTERISTICS

Generic Description:

Definition

This describes the general type of system including type of extractor, such as propeller, Savonius, Darrieus, multi-rotor, contra-rotating rotor, diffuser augmented, vortex augmented, tip-vane augmented, or concentrator. Axis of rotation (horizontal or vertical) is also given.

Significance

Each type of WECS has individual operating characteristics which are dependent on its design. Each type has limitations on efficiency, speed of rotation, and type of applications to which it is best suited. For a pictorial description of the characteristics of the individual types, see Figures 2.1 and 2.2.

Capture Area:

Definition

The capture area is defined as R^2 , where R is the maximum blade radius for a WECS whose frontal silhouette is a circle. This would be the height times the width for a wind turbine whose frontal silhouette is a rectangle.

TAXONOMY

HORIZONTAL AXIS

Figure 2.1

TAXONOMY

VERTICAL AXIS

PRIMARILY DRAG-TYPE

PRIMARILY LIFT-TYPE

COMBINATIONS

OTHERS

Our thanks to Mr. Frank Eldridge for permission to reprint these pages from his Wind Machines (Reference 4).

Figure 2.2

Significance

The capture area is one of the major limiting factors in determining the amount of power that will be produced by a WECS. Other factors include wind speed, generator capacity, and structural characteristics. A WECS can extract energy only from wind it is exposed to, both in terms of area and speed. It should be noted that various designs augment this effective capture area through the use of concentrators, diffusers, or multiple sets of propellers. This term may have to be further defined as more radical concepts in energy extraction are developed, but capture area will remain one of the major limiting factors to wind energy extraction.

Rotor Diameter:

Definition

The effective rotor diameter of a propeller-type wind turbine is determined by measuring from the center of rotation to the tip of a blade and multiplying by two.

Significance

This is a derivative of capture area, and is a term commonly used in describing a horizontal axis WECS which uses propeller-type blades.

Blade Quantity:

Definition

The total number of rotor blades, of each type, which are used on a wind machine to extract energy from the wind.

Significance

The number of blades relates to the solidity of a given design. (Solidity is defined as the ratio of blade surface area to total swept area.) A WECS with a high solidity ratio, near 100%, generally has a lower rotational speed than a low solidity rotor of the same diameter.

Blade Materials:

Definition

The blade materials include the skin or surface, the core or body of the blade, and the spar or structural element. This will vary with the type of blade construction.

Significance

The importance of blade materials will vary with type of climate and application for which the WECS is intended. Materials descriptions can be used to determine blade life, durability, and maintenance requirements.

System Weight:

Definition

The weight includes all the components of the wind energy conversion system. This includes everything above the top of the tower, and in some cases, components that are part of the tower.

Significance

This weight will have to be raised to the top of the tower and represents a portion of the static load the tower will experience. In addition, the lower limit of the cost of machinery can be estimated on a price per pound of material basis.

Rotor Weight:

Definition:

The rotor is defined as being the blades (or extractor) and the hub to which it is attached.

Significance

The weight of the rotor induces additional structural loads on the tower arising from gyroscopic and centrifugal forces. In many cases, the rotor may be hoisted to the top of the tower separately from the rest of the wind machine.

OPERATIONAL CHARACTERISTICS

Cut-In Wind Speed:

Definition

The cut-in wind speed is that speed at which the wind machine begins to produce useable output. (This is not the start-up wind speed, which is the speed required to begin rotation of the blades.)

Significance

In determining the amount of energy a WECS will produce at a specific site, cut-in speed must be known. All winds below that speed are not used in determining energy production.

Cut-Out Wind Speed:

Definition

This is the wind speed at which the WECS is no longer expected to generate power. It is often referred to as the shut-down wind speed. Method of shut-down is also indicated, i.e. automatic or manual, tail folding, full blade feather, mechanical brake or other.

Significance

The cut-out wind speed is important because it indicates the wind speed above which no power will be produced by the WECS. Winds above that speed would not be used in determining energy production. Some WECS have automatic means to shut themselves off whenever winds exceed a pre-set value. Other designs rely on manual intervention in order to avoid operation in dangerously high winds.

Survival Wind Speed:

Definition

This is the maximum wind speed which the WECS is designed to withstand without sustaining structural failure, not necessarily under load. Appropriate safety factors may be stated.

Significance

The importance of knowing the survival wind speed is apparent. This number should be compared with the maximum winds that are expected at a given site over the anticipated service life of the WECS. It might be noted that in most cases the system is shutdown and not producing power when exposed to the survival wind speed.

RPM @ Rated Output

Definition

The number of complete rotations per minute made by the rotor when the WECS is producing its rated output.

Significance

This operating rpm is significant primarily in component matching, i.e. in selecting the rotor, drive-train, generator, and other components.

Maximum RPM @ Wind Speed

Definition

The maximum rpm expected from the rotor and the wind speed at which it occurs.

Significance

This maximum rpm has a direct effect on system loads. Furthermore, it provides an indication of the operating range of the rotor speed controls.

Overspeed Control:

Definition

Methods used to prevent excessive rotational speeds. Common methods used include: blade feathering, blade stall, mechanical brake, drag brake, lift spoilers, and turning the rotor edgewise to the wind. Operation of overspeed controls may be automatic and/or manual.

Significance

The overspeed control is, in most cases, also the control that is used to protect the WECS from sustaining structural damage which might result from an ungoverned condition.

Yaw Control:

Definition

Yaw control is the means by which the orientation of a horizontal axis WECS is controlled in response to changes in wind direction. A WECS may be free to yaw, damped in yaw, or motor driven in yaw.

Significance

For horizontal axis WECS, the rate of yaw adjustment is important to their performance. The wind is constantly changing in direction even though it may be from a predominant direction. This will affect power production, but more importantly, it will affect the loads experienced by the rotor due to gyroscopic forces. It should be noted that some horizontal axis and vertical axis WTG's do not need yaw control.

Generator/Alternator:

Definition-Description

The description of the generator or alternator includes the type of power generated (AC or DC), continuous rated capacity in volts and amps., and a brief description of the source of the field excitation.

Significance

For a WECS that is used to generate electricity, its generator determines the performance and suitability for a particular application. If the model number is known, performance curves (power vs. rpm, torque vs. rpm, and efficiency vs. rpm) can be obtained from the manufacturer. The nominal and rated voltage and amperage will limit both the power that can be extracted and the types of applications for which a given wind system is suited.

Voltage Regulation:

Definition

Voltage regulation is the method, either by electrical, mechanical, or electronic means, that is used to maintain the system output voltage within desired limits.

Significance

There are a number of applications, battery charging for example, which require voltage control within fairly narrow limits. Other applications, such as line-commutated inverters or resistance heaters do not necessarily require voltage control.

Mechanical Power Transmission:

Definition/Description

With some WECS a speed changer is needed to match rotor rpm with the rpm requirements of the generator or other device. Its speed ratio and type is specified. Common types include gear, belt, and hydraulic. Other methods of mechanical power transmission are indicated where appropriate.

Significance

The power transmission affects system life, overall efficiency, and maintenance. Again, specific types of power transmission offer unique characteristics that may make it best suited for a given application.

PERFORMANCE CHARACTERISTICS

Rated Power @ Wind Speed:

Definition

This term is the rated power which the wind machine produces and the lowest wind speed at which it occurs. Measured at the output terminals of the generator or the slip rings, this excludes internal power requirements, e.g., the field excitation power.

Significance

This term is useful in assessing the energy production of a given WECS at a specific site. In general, the lower the rated wind speed, the larger the energy production for an equal rated power.

Maximum Power @ Wind Speed:

Definition

The maximum power a WECS will produce and the wind speed at which it occurs.

Significance

Some WECS have the capability to produce greater amounts of power than the rated value defined above. In some cases these peaks can be maintained for only short periods of time, but in others they can be maintained indefinitely.

Power Curves:

Definition

These are graphs of WECS performance, with watts or kilowatts (or other system output) plotted against wind speed. An indication is given if they are produced by calculation or by testing. If calculated, the assumed rotor efficiency (C_p) is given.

Significance

These curves are important in that they include all of the subsystem inefficiencies, that is, rotor performance, mechanical power transmission, and generator losses. These curves give a broadly stated indication of how a WECS would perform at a given site. Although the power in the wind increases with the cube of the velocity, generally the actual performance follows a second order curve. The cut-in, rated and shut-down wind speeds are also indicated on these curves.

Altitude:

Definition

The total vertical distance from sea level to the center of the rotor's swept area.

Significance

Power available from the wind is proportional to air density. A WECS whose performance is rated at sea level would provide about 13.8% less output at 5000 feet of altitude in otherwise identical operating conditions.

Testing Procedures:

Definition

If the output data were obtained through actual tests, an indication of how the tests were conducted is given. This includes a description of the type and location of wind measuring devices, methods of data collection, and the method of reducing the raw data. Typically the raw data is spread over a range. At a nominal wind speed, a number of power levels could be recorded depending on the rate of wind speed or direction change. The type of load, i.e., batteries, fixed resistance, or variable resistance, is also specified together with other instrumentation used for the test procedure.

Significance

While power curve for a give WECS may be the most instructive it is, at the same time, the most difficult to obtain. The nature of the wind, the testing methods, and the load all have an impact on wind system performance. In general, a WECS will perform best in a smooth wind flow such as in wind tunnel or "truck" testing (during which the WECS is mounted on a vehicle driven at the desired wind speed). In actual operation, when the wind is constantly changing in direction and speed, performance can be on the order of 25% less than under ideal conditions. The load also plays an important role because at any given level of power production, there will be an optimum load or power requirement that maximizes the efficiency of the generator.

Maximum Axial Thrust

Definition

The sum of the horizontal forces on the blades.

Significance

Axial thrust is a horizontal force the tower must withstand. This figure can be used to assess tower structural requirements when combined with the gravity load and the air drag on the tower and WECS.

Miscellaneous:

Operation Experience

Length of operation of a wind system that is in or being planned for production and is offered for sale.

Manufacturer's Comments

These describe any design features of a wind system which the manufacturer feels are unique or are of special value to the user.

Warranty

The expressed warranties a manufacturer offers with his system, including type of coverage and duration.

Recommended Maintenance

The manufacturer's recommended schedule of maintenance is specified.

Owner's Manual

An indication is given if an owner's manual is available with or without the purchase of a wind system, along with the cost of the manual.

CHAPTER THREE:
WIND MACHINES DATA

NOTE:

The information contained in this chapter has been supplied by the individual manufacturers or derived from fact sheets or specification sheets distributed by the manufacturers. It should be noted that the information contained here is dependent on the manufacturer's ability to correctly test and evaluate performance, evaluate the maximum power coefficient for a given system design and accurately interpret data for a specific system.

In some cases performance data is based on calculations, while in others the data is derived from experimental testing. It is important that the test conditions be clearly understood, and therefore the manufacturers should be contacted if any questions arise. Users of this guide are encouraged to compare performance data for various systems when selecting one for their particular applications. To assist this evaluation process, TABLE 3.1 lists electrical wind machine output in watts for different rotor diameters at various wind speeds. In calculating the power values shown, a power coefficient, C_p , of 0.29 was used. TABLE 3.2 provides a summary of the major characteristics of the mechanical wind machines, arranged according to capacity given a head elevation of approximately 100 feet.

ELECTRICAL WIND MACHINES

TABLE 3.1

SUMMARY - ELECTRICAL WIND MACHINES

The following TABLE is a summary of the major characteristics of each electrical wind machine. The data is arranged according to power output.

<u>NAME AND MODEL NUMBER</u>	<u>SIZE (rated kw)</u>	<u>ROTOR DIAMETER (feet/meters)</u>	<u>NO. BLADES</u>	<u>RATED SPEED MPH/ m/s</u>	<u>CUT-IN SPEED MPH/ m/s</u>
Energy Development Co. (USA) - 445	45.00	40.0/12.2	4	25/11.2	5/2.2
Dominion Aluminum Fabricators (Canada) VAWT 35 X 55*	37.00	36.7/11.2	2 (Darrieus)	33/14.8	13/5.8
Grumman Energy Systems (USA) Windstream 25-B	20.000	25.0/7.62	3	29/12.9	8/3.6
Energy Development Co. (USA) - 440	20.00	38.0/11.6	4	25/11.2	5/2.2
Zephyr Wind Dynamo 15 kVA	15.000	20.0/6.10	3	30/13.4	8/3.6
Dominion Aluminum Fabricators (Canada) VAWT 20 X 30*	14.000	20.0/6.10	2 (Darrieus)	30/13.5	12/5.4
Millville Windmills (USA) 10-3-IND	10.00	25.0/7.60	3	25/11.0	9/4.0
Wind Power Systems, Inc. (USA) Storm Master 10 (Prototype)	6.000	32.8/10.0	3	18/8.0	8/3.6
Aerowatt S.A. (France) 4100FP7G	4.100	32.7/9.30	2	16/7.2	7/3.1
Dakota Wind & Sun, Ltd. 4 kw	4.000	14.0/4.3	3	27/12.0	8/3.6
Dynergy - 5 Meter*	3.300	15.0/4.6	2 (Darrieus)	24/10.7	10/4.4
Product Development Institute (USA) Wind Heat System (Prototype)	3.000	13.6/4.15	3	27/12.0	12/5.4
Product Development Institute (USA) Wind Jennie (Prototype)	3.000	12.5/3.8	3	25/11.1	12/5.4

*Vertical axis

TABLE 3.1 - Summary - Electrical Wind Machines (Continued)

<u>NAME AND MODEL NUMBER</u>	<u>SIZE (rated kw)</u>	<u>ROTOR DIAMETER (feet/meters)</u>	<u>NO. BLADES</u>	<u>RATED SPEED MPH/ m/s</u>	<u>CUT-IN SPEED MPH/ m/s</u>
Kedco, Inc. (USA) 1620	3.000	16.0/4.88	3	25/11.1	11/4.9
North Wind Power Company (USA) Eagle 3kw-32V	3.000	13.6/4.14	3	27/12.2	8/3.6
North Wind Power Company (USA) Eagle 3kw-110V	3.000	13.6/4.14	3	27/12.2	8/3.6
Altos, The Alternate Current (USA) BWP-12A	2.200	8.0/2.4	24	38/17.1	8/3.6
Pinson Energy Corporation (USA) C-2E (Prototype)*	2.000	12.0/3.66	3	24/10.7	7/3.1
Altos, The Alternate Current BWP-12B	2.000	11.5/3.5	N.A.	28/12.5	8/3.6
American Wind Turbine, Inc. (USA) 16 foot	2.000	15.3/4.7	48	20/9.0	10/4.5
Dunlite Electrical Products (Australia) 81/002550 (Standard Model)	2.000	13.5/4.10	3	25/11.0	8/3.6
Kedco, Inc. (USA) 1210	2.000	12.0/3.65	3	26/11.6	11/4.9
Kedco, Inc. (USA) 1610	2.000	16.0/4.88	3	22/10.0	10/4.4
North Wind Power Company (USA) Eagle 2kw-32V	2.000	13.6/4.15	3	22/10.0	8/3.6
North Wind Power Company (USA) Eagle 2kw-110V	2.000	13.6/4.2	3	22/10.0	8/3.6
Whirlwind Power Company (USA) Model A	2.000	10/3.0	2	25/11.2	8/3.6
Kedco, Inc. (USA) 1605	1.900	16.0/4.88	3	20/8.9	7/3.1
Enertech Corp. (USA) 1500	1.500	13.2/4	3	22/9.8	8/3.6

*Vertical axis

TABLE 3.1 - Summary - Electrical Wind Machines (Continued)

NAME AND MODEL NUMBER	SIZE (rated kw)	ROTOR DIAMETER (feet/meters)	NO. BLADES	RATED SPEED MPH/ m/s	CUT-IN SPEED MPH/ m/s
Altos, The Alternate Current (USA) BWP-8A	1.500	8.0/2.4	24	28/12.5	8/3.6
Aero Power Systems, Inc. (USA) SL1500	1.430	10.0/3.05	3	25/11.2	6/2.7
Kedco, Inc. (USA) 1200	1.200	12.0/3.65	3	22/10.0	7/3.1
Kedco, Inc. (USA) 1205	1.200	12.0/3.65	3	22/10.0	8/3.6
Kedco, Inc. (USA) 1600	1.200	16.0/4.88	3	17/7.6	7/3.1
Aerowatt S.A. (France) 1100PF7G	1.125	16.7/5.09	2	16/7.2	7/3.1
American Wind Turbine, Inc. (USA) 12 Foot	1.000	11.5/3.5	36	20/9.0	10/4.5
Dunlite Electrical Products (Australia) 82/002550 (High Wind Speed Model)	1.00	10.0/3.1	3	37/16/5	14/6.3
Sencenbaugh Wind Electric (USA) 1000	1.000	12.0/3.65	3	23/10.3	6/2.7
Aerolectric Company (USA) C-9/C-90 Wind Wizard	0.600	9.0/2.75	3	26/11.6	9/4.0
American Wind Turbine, Inc. (USA) 8 foot	.500	7.6/2.3	24	20/9.0	10/4.5
Sencenbaugh Wind Electric (USA) 500	.500	6.0/1.8	3	24/10.8	10/4.5
Sencenbaugh Wind Electric (USA) 400-14HDS	.400	7.0/2.13	3	20/9.0	9/4.0
Aerowatt S.A. (France) 300FP7G	0.350	10.7/3.26	2	16/7.2	7/3.1
Winco - Division of Dynatechnology (USA) 1222H	0.200	6.0/1.83	2	23/10.3	7/3.1

TABLE 3.1 - Summary - Electrical Wind Machines (Continued)

<u>NAME AND MODEL NUMBER</u>	<u>SIZE (rated kw)</u>	<u>ROTOR DIAMETER (feet/meters)</u>	<u>NO. BLADES</u>	<u>RATED SPEED MPH/ m/s</u>	<u>CUT-IN SPEED MPH/ m/s</u>
Aerowatt S.A. (France) 150FP7G	0.130	6.7/2.04	2	16/7.2	7/3.1
Aerowatt S.A. (France) 247P7G	0.028	3.3/1.00	2	16/7.2	7/3.1
Zephyr Wind Dynamo Tetrahelix S	.007	2.0/.61	2	25/11.2	12/5.4

ELECTRICAL WIND MACHINE DATA SHEETS

(The data sheets are arranged alphabetically by manufacturer.)

MODEL : C9 Wind Wizard, C9D Wind Wizard	TYPE: Electrical
Manufacturer: AeroLectric Company Address: 13517 Winters Avenue Cresaptown, MD 21502 Contact: L. Michael Glick Telephone: (301) 729-2325
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, up-wind. Capture Area: 63.6 ft ² , (5.9 m ²) Rotor Diameter: 9 ft, (2.75 m) System Weight: 50 lbs, (22.6 kGs) Rotor Weight: 22 lbs, (10 kGs) Blade Materials: Wood, urethane finish, or fiberglass and composite material. Number of Blades: Three	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 9 mph, (4 m/s) Shut-Down Wind Speed: 40 mph, (17.6 m/s) (See Note #1) Survival Wind Speed: 90 mph, (40 m/s) RPM at Rated Output: 377 rpm @ 27 mph, (12 m/s) Maximum RPM: 720 rpm @ 40 mph, (18 m/s) Axial Thrust @ Rated Wind Speed: 200 lbs, (890 N) Maximum Axial Thrust: N.A. Overspeed Control: Rotor turns sideways to wind; activated by thrust forces. Yaw Control: Hydraulic dampen down wind tail Generator/Alternator: Electronically controlled alternator with adjustable voltage 12 to 18 volts. Voltage Regulation: 12 to 18 volts. Mechanical Power Transmission: V-belt.	MISCELLANEOUS Length of time machine has been in operation: Three years. Design Features: Portable models C9C with quick mount detachable blade system. Weight 50 lbs. Permanent C9D model available, weight 80 lbs. Same performance characteristics. Warranty: One year, parts and workmanship limited. Owners Manual: Available Maintenance Schedule: Semi-annually inspect system.
PERFORMANCE CHARACTERISTICS Rated Output: 600 watts @ 26 mph, (11.6 m/s) Maximum Output: 770 watts @ 30 mph, (13.4 m/s) Test Procedures: Prony brake.	NOTES: 1. Shut-down wind speed adjustable between 25 and 45 MPH.
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons	<p>SYSTEM OUTPUT in Watts</p> <p>WIND VELOCITY in Miles Per Hour (mph)</p> <p>WIND VELOCITY in Meters Per Second (m/s)</p>

MODEL : SL 1500**TYPE:** Electrical

Manufacturer: Aero Power Systems, Inc.
Address: 2398 Fourth Street
 Berkeley, CA 97410
Contact: Mario V. Agnello
Telephone: (415) 848-2710

PHYSICAL CHARACTERISTICS

Generic Description: Horizontal axis, propeller-type, up-wind.
Capture Area: 78.5 ft², (7.3 m²)
Rotor Diameter: 10 ft, (3.05 m)
System Weight: 160 lbs, (72.6 kGs)
Rotor Weight: 50 lbs, (22.7 kGs)
Blade Materials: Wood, sitka spruce.
 Exterior is painted with acrylic enamel.
 Leading edge covered with stainless steel tape.

OPERATIONAL CHARACTERISTICS

Cut-In Wind Speed: 6 mph, (2.7 m/s)
Shut-Down Wind Speed: 100 mph, (44.7 m/s)
Survival Wind Speed: 100 mph, (44.7 m/s)
RPM at Rated Output: 500 rpm @ 20 mph, (8.9 m/s)
Maximum RPM: 650 rpm @ 25 mph, (11.2 m/s)
Axial Thrust @ Rated Wind Speed: 300 lbs, (1334 N)
Maximum Axial Thrust: N.A. lbs, (N)
Overspeed Control: Mechanical, variable pitch, centrifugally activated.

Yaw Control: None, rotor aligned with wind by tail.
Generator/Alternator: 14 or 28 VAC, 3 phase, rectified for DC output.

Voltage Regulation: Available, (standard)
Mechanical Power Transmission: Gear box, ratio = 3 : 1

MISCELLANEOUS

Length of time machine has been in operation:

Design Features:
 Modified Clark Y airfoil.

Warranty: Defects in workmanship &/or materials are covered for one year from the purchase date. Parts must be returned to an authorized Aero Power repair location for repair or replacement.

Owners Manual: Available, (standard).
 Includes assembly, wiring and maintenance.

Maintenance Schedule: Semi-annually, grease hub. Check blades for nicks and scratches. Inspect entire system. Batteries, if used, should receive an equalizing charge at least every two months.

PERFORMANCE CHARACTERISTICS

Rated Output: 1.43 kW @ 25 mph, (11.2 m/s)
Maximum Output: 1.60 kW @ 30 mph, (13.4 m/s)
Test Procedures: Operation in field.

NOTES:

Initial sales of this system are scheduled for August, 1978

CONVERSION FACTORS

One mph = .44707 m/s
 One gallon = 3.785 liters
 One foot = .3048 meters
 One ft² = .09290 m²
 One kW = 1.341 hp
 One lbm = .4536 kG
 One lbf = 4.448 newtons

**SYSTEM
 OUTPUT
 in
 Kilowatts**

MODEL : 24FP7G (For industrial use only) Manufacturer: Aerowatt S. A. c/o Automatic Power, Inc. Address: P. O. Box 18738 Houston, TX 77023 Contact: Robert Dodge, Engineer (See Notes) Telephone: (713) 228-5208	TYPE: Electrical WINDGENERATOR 24 FP 7G
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, up-wind. Capture Area: 8.55 ft ² , (0.8 m ²) Rotor Diameter: 3.30 ft, (1. m) System Weight: 32 lbs, (14.5 kGs) Rotor Weight: N.A. Blade Materials: Wood Number of Blades: Two	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 7 mph, (3.1 m/s) Shut-Down Wind Speed: None Survival Wind Speed: 133 mph, (60 m/s) RPM at Rated Output: 1120 rpm @ 16 mph, (7.1 m/s) Maximum RPM: 1120 rpm @ 16 mph, (7.1 m/s) Axial Thrust @ Rated Wind Speed: 57 lbs, (254 N) Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; variable pitch, centrifugally activated, blade stalls. Yaw Control: None, rotor aligned with wind by tail. Generator/Alternator: Permanent magnet, brushless. Voltage Regulation: Available Mechanical Power Transmission: Direct drive, ratio = 1:1	MISCELLANEOUS Length of time machine has been in operation: Five years. Design Features: Corrosion resistant metals, simple design. Variable blade pitch angle. Warranty: One year - parts and workmanship. Guaranteed energy output if average wind velocity at site is known. Owners Manual: Available separately. Maintenance Schedule: Semi-annual - inspection.
PERFORMANCE CHARACTERISTICS Rated Output: 0.028 kW @ 16 mph, (7.2 m/s) Maximum Output: 0.028 kW @ 16 mph, (7.2 m/s) Test Procedures: Available upon request. Power curves calculated and tested.	NOTES: "The Aerowatt Wind Generators are designed for industrial use at remote unattended sited where no commercial power is available. They are not suitable for domestic residential applications."

CONVERSION FACTORS

One mph = .44707 m/s
One gallon = 3.785 liters
One foot = .3048 meters
One ft² = .09290 m²
One kW = 1.341 hp
One lbm = .4536 kG
One lbf = 4.448 newtons

SYSTEM
OUTPUT
in
Watts

MODEL : 150 FP7G (For Industrial use only). Manufacturer: Aerowatt S.A. c/o Automatic Power, Inc. Address: P. O. Box 18738 Houston, TX 77023 Contact: Robert Dodge, Engineer (See notes.) Telephone: (713) 228-5208	TYPE: Electrical WINDGENERATOR 150 FP 7 G
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, up-wind. Capture Area: 35.25 ft ² , (3.27 m ²) Rotor Diameter: 6.70 ft, (2.04 m) System Weight: 110 lbs, (49.8 kGs) Rotor Weight: N.A. Blade Materials: Aluminum Number of Blades: Two	MISCELLANEOUS Length of time machine has been in operation: Five years. Design Features: Corrosion resistant metals, simple design. Variable blade pitch angle. Warranty: One year-parts and workmanship. Guaranteed energy output if average wind velocity at site is known. Owners Manual: Available, separately Maintenance Schedule: Semi-annual - inspection.
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 7 mph, (3.1 m/s) Shut-Down Wind Speed: None Survival Wind Speed: 133 mph, (60 m/s) RPM at Rated Output: 540 rpm @ 16 mph, (7.2 m/s) Maximum RPM: 540 rpm @ 16 mph, (7.2 m/s) Axial Thrust @ Rated Wind Speed: 220 lbs, (979 N) Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; variable pitch, centrifugally activated, blades stall. Yaw Control: None, rotor aligned with wind by tail. Generator/Alternator: Permanent magnet, brushless, self-excitation Voltage Regulation: Available Mechanical Power Transmission: Direct drive, ratio=1:1	NOTES: "The Aerowatt Wind Generators are designed for industrial use at remote unattended sites where no commercial power is available. They are not suitable for domestic residential applications."
PERFORMANCE CHARACTERISTICS Rated Output: 0.130 kW @ 16 mph, (7.2 m/s) Maximum Output: 0.130 kW @ 16 mph, (7.2 m/s) Test Procedures: Available upon request. Power curves calculated and tested.	
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kg One lbf = 4.448 newtons	<p>SYSTEM OUTPUT in Watts</p> <p>WIND VELOCITY in Miles Per Hour (mph)</p> <p>WIND VELOCITY in Meters Per Second (m/s)</p>

MODEL : 300FP7G (For industrial use only.)	TYPE: Electrical
Manufacturer: Aerowatt S. A. c/o Automatic Power, Inc. Address: P. O. Box 18738 Houston, TX 77023 Contact: Robert Dodge, Engineer (See Notes.) Telephone: (713) 228-5208	WINDGENERATOR 300 FP 7 G
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, up-wind. Capture Area: 89.9 ft ² , (8.35 m ²) Rotor Diameter: 10.7 ft, (3.26 m) System Weight: 561 lbs, (254.1 kGs) Rotor Weight: N.A. Blade Materials: Aluminum Number of Blades: Two	MISCELLANEOUS Length of time machine has been in operation: Five years. Design Features: Corrosion resistant metals, simple design. Variable blade pitch angle. Warranty: One year - parts and workmanship. Guaranteed energy output if average wind velocity at site is known. Owners Manual: Available seperately. Maintenance Schedule: Semi-annually -inspect.
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 7 mph, (3.1 m/s) Shut-Down Wind Speed: None mph, (None m/s) Survival Wind Speed: 133 mph, (60 m/s) RPM at Rated Output: 320 rpm @ 16 mph, (7.2 m/s) Maximum RPM: 320 rpm @ 16 mph, (7.2 m/s) Axial Thrust @ Rated Wind Speed: 440 lbs, (1958 N) Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; Variable pitch, centrifugally activated, blades stall. Yaw Control: None, rotor aligned with wind by tail. Generator/Alternator: Permanent magnet, brushless, self-excitation. Voltage Regulation: Available Mechanical Power Transmission: Direct drive, ratio = 1:1	PERFORMANCE CHARACTERISTICS Rated Output: 0.350 kW @ 16 mph, (7.2 m/s) Maximum Output: 0.350 kW @ 16 mph, (7.2 m/s) Test Procedures: Available upon request. Power curves calculated and tested.

CONVERSION FACTORS

One mph = .44707 m/s
 One gallon = 3.785 liters
 One foot = .3048 meters
 One ft² = .09290 m²
 One kW = 1.341 hp
 One lbm = .4536 kG
 One lbf = 4.448 newtons

SYSTEM
 OUTPUT
 in
 Watts

MODEL : 1100FP7G (For industrial use only.) Manufacturer: Aerowatt S. A. c/o Automatic Power, Inc. Address: P. O. Box 18738 Houston, TX 77023 Contact: Robert Dodge Engineer (See Notes.) Telephone: (713) 228-5208	TYPE: Electrical WINDGENERATOR 1100 FP 7 G
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, up-wind Capture Area: 219.0 ft ² , (20.3 m ²) Rotor Diameter: 16.7 ft, (5.09 m) System Weight: 1100 lbs, (498.3 kGs) Rotor Weight: N.A. Blade Materials: Aluminum Number of Blades: Two	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 7 mph, (3.1 m/s) Shut-Down Wind Speed: None mph, (None m/s) Survival Wind Speed: 133 mph, (60 m/s) RPM at Rated Output: 230 rpm @ 16 mph, (7.2 m/s) Maximum RPM: 230 rpm @ 16 mph, (7.2 m/s) Axial Thrust @ Rated Wind Speed: 880 lbs, (3914 N) Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; variable pitch, centrifugally activated, blades stall. Yaw Control: None, rotor aligned with wind by tail. Generator/Alternator: Permanent magnet, brushless, self-excitation Voltage Regulation: Available Mechanical Power Transmission: Gear box, ratio=13:1	MISCELLANEOUS Length of time machine has been in operation: Five years Design Features: Corrosion resistant metals, simple design. Variable blade pitch angle. Warranty: One year - parts and workmanship. Guaranteed energy output if average wind velocity at site is known. Owners Manual: Available separately. Maintenance Schedule: Semi-annually - inspect, check oil levels.
PERFORMANCE CHARACTERISTICS Rated Output: 1.125 kW @ 16 mph, (7.2 m/s) Maximum Output: 1.125 kW @ 16 mph, (7.2 m/s) Test Procedures: Available upon request.	NOTES: "The Aerowatt Wind Generators are designed for industrial use at remote unattended sites where no commercial power is available. They are not suitable for domestic residential applications."
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kg One lbf = 4.448 newtons	<p>SYSTEM OUTPUT in Kilowatts</p> <p>WIND VELOCITY in Miles Per Hour (mph)</p> <p>WIND VELOCITY in Meters Per Second (m/s)</p>

MODEL : 4100FP7G (For industrial use only.)		TYPE: Electrical																																				
Manufacturer: Aerowatt S. A. c/o Automatic Power, Inc. Address: P. O. Box 18738 Houston, TX 77023 Contact: Robert Dodge, Engineer (See Notes) Telephone: (713) 228-5208		WINDGENERATOR 4100 FP 7 G
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, up-wind. Capture Area: 740.2 ft ² ,(68.7 m ²) Rotor Diameter: 30.7 ft ,(9.3 m) System Weight: 2000 lbs,(906.0kGs) Rotor Weight: N.A. Blade Materials: Aluminum Number of Blades: Two																																						
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 7 mph,(3.1 m/s) Shut Down Wind Speed: None Survival Wind Speed: 133 mph,(60 m/s) RPM at Rated Output: 150 rpm @ 16 mph,(7.2 m/s) Maximum RPM: 150 rpm @ 16 mph,(7.2 m/s) Axial Thrust @ Rated Wind Speed: 2200 lbs, (9790 N) Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; variable pitch, centrifugally activated, blades stall Yaw Control: None, rotor aligned with wind by tail. Generator/Alternator: Permanent magnet, brushless, self-excitation Voltage Regulation: Available Mechanical Power Transmission: Gear box, ratio=20:1		MISCELLANEOUS Length of time machine has been in operation: Five years Design Features: Corrosion resistant metals, simple design. Variable blade pitch angle. Warranty: One year - parts and workmanship. Guaranteed energy output if average wind velocity at site is known. Owners Manual: Available Maintenance Schedule: Semi-annually - inspect, check oil levels.																																				
PERFORMANCE CHARACTERISTICS Rated Output: 4.100 kW @ 16 mph,(7.2 m/s) Maximum Output: 4.100 kW @ 16 mph,(7.2 m/s) Test Procedures: Available upon request. Power curves calculated and tested.		NOTES: "The Aerowatt Wind Generators are designed for industrial use at remote unattended sites where no commercial power is available. They are not suitable for domestic residential applications."																																				
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons		<div>SYSTEM OUTPUT in Kilowatts</div> <table><caption>Power Curve Data</caption><tr><th>Wind Velocity (mph)</th><th>Wind Velocity (m/s)</th><th>System Output (kW)</th></tr><tr><td>0</td><td>0</td><td>0.0</td></tr><tr><td>5</td><td>2.2</td><td>0.0</td></tr><tr><td>10</td><td>4.4</td><td>0.0</td></tr><tr><td>15</td><td>6.6</td><td>0.5</td></tr><tr><td>16</td><td>7.2</td><td>4.1</td></tr><tr><td>20</td><td>8.9</td><td>4.1</td></tr><tr><td>30</td><td>13.4</td><td>4.1</td></tr><tr><td>40</td><td>17.9</td><td>4.1</td></tr><tr><td>50</td><td>22.3</td><td>4.1</td></tr><tr><td>60</td><td>26.8</td><td>4.1</td></tr><tr><td>70</td><td>31.3</td><td>4.1</td></tr></table>	Wind Velocity (mph)	Wind Velocity (m/s)	System Output (kW)	0	0	0.0	5	2.2	0.0	10	4.4	0.0	15	6.6	0.5	16	7.2	4.1	20	8.9	4.1	30	13.4	4.1	40	17.9	4.1	50	22.3	4.1	60	26.8	4.1	70	31.3	4.1
Wind Velocity (mph)	Wind Velocity (m/s)	System Output (kW)																																				
0	0	0.0																																				
5	2.2	0.0																																				
10	4.4	0.0																																				
15	6.6	0.5																																				
16	7.2	4.1																																				
20	8.9	4.1																																				
30	13.4	4.1																																				
40	17.9	4.1																																				
50	22.3	4.1																																				
60	26.8	4.1																																				
70	31.3	4.1																																				

MODEL : BWP-8B	TYPE: Electrical
Manufacturer: Altos - The Alternate Current Address: P. O. Box 905 Boulder, CO 80302 Contact: Triton Tool & Mfg. Michael Blakley, or Edward Gitlin Telephone: (303) 442-0855
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi-bladed, up-wind Capture Area: 45.7 ft ² , (4.2 m ²) Rotor Diameter: 7.6 ft, (2.32 m) System Weight: 250 lbs, (114 kGs) Rotor Weight: 159 lbs, (26.8 kGs) Blade Materials: Aluminum, 5052 Number of Blades: Twenty-Four	MISCELLANEOUS Length of time machine has been in operation: Three years. Design Features: Light weight. Manual shut-down. Warranty: Major components (except turbine): one year parts and workmanship. Turbine: Manufacturer's warranty--90 days parts and workmanship. Owners Manual: Available for \$20.00. Maintenance Schedule: Semi-annually fluid and system check, annual lubrication.
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 10 mph, (4.5 m/s) Shut-Down Wind Speed: 75 mph, (33.5 m/s) Survival Wind Speed: 100 mph, (44.7 m/s) RPM at Rated Output: 165 rpm @ 28 mph, (12.5 m/s) Maximum RPM: 300 rpm @ 50 mph, (22.4 m/s) Axial Thrust @ Rated Wind Speed: 89 lbs, (396 N) Maximum Axial Thrust: 1400 lbs, (6230 N) Overspeed Control: Aerodynamic drag tends to limit RPM. High thrust turns rotor sideways to wind. Yaw Control: None, rotor aligned with wind by tail. Generator/Alternator: 24VDC, 0-70 amp, trickle draw excitation Voltage Regulation: Solid state controls Mechanical Power Transmission: Gear box, ratio 11:1.	NOTES:
PERFORMANCE CHARACTERISTICS Rated Output: 1.5 kW @ 28 mph, (12.5 m/s) Maximum Output: 2.0 kW @ 40 mph, (17.9 m/s) Test Procedures: On-site installation on tower, electrical output (volt and amp meters), free stream anemometer. Data valid at sea level.	<div> CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft² = .09290 m² One kW = 1.341 hp One lbm = .4536 kg One lbf = 4.448 newtons </div> <div> </div>

MODEL : BW1 - 12 A Manufacturer: Altos - The Alternate Current Address: P. O. Box 905 Boulder, CO 80302 Contact: Triton Tool & Mfg. Co., Michael Blakley or Edward Gitlin Telephone: (303) 442-0885	TYPE: Electrical
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi-bladed, up-wind Capture Area: 100.4 ft ² , (9.3 m ²) Rotor Diameter: 11.5 ft, (3.5 m) System Weight: 300 lbs, (136 kGs) Rotor Weight: 111 lbs, (50.3 kGs) Blade Materials: Aluminum, 6061 Number of Blades: Twenty-Four	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 8 mph, (3.6 m/s) Shut-Down Wind Speed: 60 mph, (26.8 m/s) Survival Wind Speed: 90 mph, (40.2 m/s) RPM at Rated Output: 116 rpm @ 28 mph, (12.5 m/s) Maximum RPM: 200 rpm @ 50 mph, (22.4 m/s) Axial Thrust @ Rated Wind Speed: 194 lbs, (863 N) Maximum Axial Thrust: 3200 lbs, (14240 N) Overspeed Control: Aerodynamic drag tends to limit RPM. High thrust causes rotor to turn sideways to the wind. Yaw Control: None, rotor aligned with wind by tail. Generator/Alternator: 115/200 VAC, 3 phase Voltage Regulation: None Mechanical Power Transmission: Gear box, ratio = 17:1	MISCELLANEOUS Length of time machine has been in operation: One year (Prototype only) Design Features: Light weight. Manual shut-down. High voltage AC system. Warranty: Turbine warranted by original manufacturer for 90 days, parts and workmanship. Other major components are warranted for one year, parts and workmanship. Owners Manual: \$20.00 Maintenance Schedule: Semi-annually inspect entire system and check fluid level. Annually, lubricate system.
PERFORMANCE CHARACTERISTICS Rated Output: 2.2 kW @ 28 mph, (12.5 m/s) Maximum Output: 4.0 kW @ 40 mph, (17.9 m/s) Test Procedures: All data calculated. Tests are in progress. Data from tests will be released after tests are concluded. Data valid at sea level.	NOTES:

CONVERSION FACTORS

One mph = .44707 m/s
One gallon = 3.785 liters
One foot = .3048 meters
One ft² = .09290 m²
One kW = 1.341 hp
One lbm = .4536 kG
One lbf = 4.448 newtons

SYSTEM
OUTPUT
in
Kilowatts

MODEL : BWP - 12 B	TYPE: Electrical
<p>Manufacturer: Altos - The Alternate Current Address: P. O. Box 905 Boulder, CO 80302 Contact: Triton Tool & Jfg. Co., Michael Blakley or Edward Gitlin Telephone: (303) 442-0885</p>	
<p>PHYSICAL CHARACTERISTICS</p> <p>Generic Description: Horizontal axis, multi-bladed, up-wind</p> <p>Capture Area: 100.4 ft², (9.3 m²)</p> <p>Rotor Diameter: 11.5 ft, (3.5 m)</p> <p>System Weight: 300 lbs, (136 kGs)</p> <p>Rotor Weight: 111 lbs, (50.3 kGs)</p> <p>Blade Materials: Aluminum, 6061</p>	
<p>OPERATIONAL CHARACTERISTICS</p> <p>Cut-In Wind Speed: 8 mph, (3.6 m/s)</p> <p>Shut-Down Wind Speed: 60 mph, (26.8 m/s)</p> <p>Survival Wind Speed: 90 mph, (40.2 m/s)</p> <p>RPM at Rated Output: 116 rpm @ 28 mph, (12.5 m/s)</p> <p>Maximum RPM: 200 rpm @ 50 mph, (22.4 m/s)</p> <p>Axial Thrust @ Rated Wind Speed: 194 lbs, (863 N)</p> <p>Maximum Axial Thrust: 3200 lbs, (14240 N)</p> <p>Overspeed Control: Aerodynamic drag tends to limit RPM.</p> <p>High thrust causes rotor to turn sideways to the wind.</p> <p>Yaw Control: None, rotor aligned with wind by tail</p> <p>Generator/Alternator: 24 VDC alternator, trickle draw excitation.</p> <p>Voltage Regulation: Solid state controls.</p> <p>Mechanical Power Transmission: Gear box, ratio= 11:1</p>	<p>MISCELLANEOUS</p> <p>Length of time machine has been in operation: Old prototype, one year.</p> <p>Design Features: Light weight. Manual shut-down.</p> <p>Warranty: Turbine warranted by original manufacturer for 90 days, parts and workmanship. Other major components are warranted for one year, parts and workmanship.</p> <p>Owners Manual: Available for \$20.00.</p> <p>Maintenance Schedule: Semi-annually inspect entire system and check fluid level. Annually lubricate system.</p>
<p>PERFORMANCE CHARACTERISTICS</p> <p>Rated Output: 2.0 kW @ 28 mph, (12.5 m/s)</p> <p>Maximum Output: 2.8 kW @ 40 mph, (17.9 m/s)</p> <p>Test Procedures: Performance data calculated (based on alternator and wind turbine power curves).</p>	<p>NOTES: This model is the same as the BWP - 8B, except where the 12 foot turbine necessitates changes in the speed increasor and 24 V alternator.</p>

CONVERSION FACTORS

One mph = .44707 m/s
One gallon = 3.785 liters
One foot = .3048 meters
One ft² = .09290 m²
One kW = 1.341 hp
One lbm = .4536 kG
One lbf = 4.448 newtons

SYSTEM
OUTPUT
in
Kilowatts

MODEL : 8 Ft.		TYPE: Electrical
Manufacturer: American Wind Turbine Co., Inc. Address: 1016 E. Airport Rd. Stillwater, Ok 74074 Contact: Nancy Thedford Office Manager Telephone: (405) 377-5333		
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi-blade, up-wind. Capture Area: 45.8 ft ² , (4.3 m ²) Rotor Diameter: 7.64 ft, (2.3 m) System Weight: N.A. lbs, (N.A. kGs) Rotor Weight: 50 lbs, (22.6 kGs) Blade Materials: Aluminum Number of Blades: Twenty-Four		
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 10 mph, (4.5 m/s) Shut-Down Wind Speed: 35 mph, (15.7 m/s) (adjustable) Survival Wind Speed: 120 mph, (54 m/s) RPM at Rated Output: 150 rpm @ 20 mph, (9 m/s) Maximum RPM: N.A. Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; tail causes rotor to turn edge-wise to the wind. Yaw Control: None, rotor aligned with wind by tail. Generator/Alternator: Variety available. Pump/Compressor: Variety of electric water pumps Voltage Regulation: Available. Mechanical Power Transmission: Either rim belt drive or direct drive.		MISCELLANEOUS Length of time machine has been in operation: Design Features: High starting torque, and ease of maintenance. Warranty: 90 days, parts & workmanship. Owners Manual: Available only with system purchase Maintenance Schedule: Semi-annually; check belts. Annually; grease, inspect system.
PERFORMANCE CHARACTERISTICS Rated Output: 500 watts @ 20 mph, (9.0 m/s) Maximum Output: N.A. Test Procedures: Moving test bed, prony brake, various instruments, data available on request.		NOTES:
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons	<p>SYSTEM OUTPUT in Watts</p> <p>WIND VELOCITY in Miles Per Hour (mph)</p> <p>WIND VELOCITY in Meters Per Second (m/s)</p>	

MODEL : 12 Ft. Manufacturer: American Wind Turbine Co., Inc. Address: 1016 E. Airport Road Stillwater, OK 74074 Contact: Nancy Thedfor, Office Manager Telephone: (405) 377-5333	TYPE: Electrical
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi-blade, up-wind. Capture Area: 103 ft ² , (9.6 m ²) Rotor Diameter: 11.5 ft, (3.5 m) System Weight: 320 lbs, (144.9 kGs) Rotor Weight: 92 lbs, (41.6 kGs) Blade Materials: Aluminum Number of Blades: Thirty-Six	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 10 mph, (4.5 m/s) Shut-Down Wind Speed: 35 mph, (15.7 m/s) Survival Wind Speed: 100 mph, (45.0 m/s) RPM at Rated Output: 120 rpm @ 20 mph, (9.0 m/s) Maximum RPM: N. A. Axial Thrust @ Rated Wind Speed: N. A. Maximum Axial Thrust: N. A. Overspeed Control: Mechanical; Tail causes rotor to turn edge-wise to the wind. Yaw Control: None, rotor aligned with wind by tail. Generator/Alternator: Permanent magnet, three-phase alternator. Pump/Compressor: Variety of electric water pumps. Voltage Regulation: Available Mechanical Power Transmission: Rim belt drive, ratio - 30:1	MISCELLANEOUS Length of time machine has been in operation: One year. Design Features: High starting torque, ease of maintenance. Warranty: Limited-90 days - parts and workmanship Owners Manual: Available only with system purchase Maintenance Schedule: Semi-annually; check belts, Annually; grease, inspect system.
PERFORMANCE CHARACTERISTICS Rated Output: 1.0 kW @ 20 mph, (9.0 m/s) Maximum Output: N. A . Test Procedures: Moving test bed, prony brake, various instruments. Data available on request.	NOTES: A variety of alternators are available.
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons

MODEL : 16 Ft. Manufacturer: American Wind Turbine Co., Inc. Address: 1016 E. Airport Rd. Stillwater, OK 74074 Contact: Nancy Thedford, Office Manager Telephone: (405) 377-5333	TYPE: Electrical
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi-bladed, up-wind. Capture Area: 183 ft ² , (17.0 m ²) Rotor Diameter: 15.3 ft, (4.7 m) System Weight: 420 lbs, (190.2 kGs) Rotor Weight: 135 lbs, (61.1 kGs) Blade Materials: Aluminum Number of Blades: Forty-Eight	MISCELLANEOUS Length of time machine has been in operation: Three years. Design Features: High starting torque, ease of maintenance. Warranty: 90 days-parts and workmanship. Owners Manual: Available only with system purchase Maintenance Schedule: Semi-annually: check belts, Annually - check, grease, and inspect system.
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 10 mph, (4.5 m/s) Shut-Down Wind Speed: 35 mph, (15.7 m/s) Survival Wind Speed: 100 mph, (45.0 m/s) RPM at Rated Output: 90 rpm @ 20 mph, (9.0 m/s) Maximum RPM: N.A. Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; Tail causes rotor to turn edge-wise to the wind. Yaw Control: None, rotor aligned with wind by tail. Generator/Alternator: Permanent magnet, three-phase. Pump/Compressor: Variety of electric water pumps Voltage Regulation: Available Mechanical Power Transmission: Rim belt drive, ratio-30:1.	NOTES:
PERFORMANCE CHARACTERISTICS Rated Output: 2.0 kW @ 20 mph, (9.0 m/s) Maximum Output: N.A. Test Procedures: Moving test bed, prony brake, various instruments. Data available upon request.	

CONVERSION FACTORS

One mph = .44707 m/s
One gallon = 3.785 liters
One foot = .3048 meters
One ft² = .09290 m²
One kW = 1.341 hp
One lbm = .4536 kG
One lbf = 4.448 newtons

SYSTEM
OUTPUT
in
Kilowatts

MODEL : 4 kW	TYPE: Electrical
<p> Manufacturer: Dakota Wind and Sun, Ltd. Address: P. O. Box 1781 Aberdeen, S. D. 57401 Contact: Orville Lynner or Paul Biorn Telephone: (605) 229-0815 </p>
<p> PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, up-wind Capture Area: 154 ft², (14.3 m²) Rotor Diameter: 14.0 ft, (4.3 m) System Weight: 600 lbs, (275 kGs) Rotor Weight: 75 lbs, (35 kGs) Blade Materials: Wood (Sitka spruce), epoxy paint. Number of Blades: Three </p>	
<p> OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 8 mph, (3.6 m/s) Shut-Down Wind Speed: 40 mph, (17.9 m/s) Survival Wind Speed: 90 mph, (40 m/s) RPM at Rated Output: 300 rpm @ 27 mph, (12 m/s) Maximum RPM: 325 rpm @ 27 mph, (17.9 m/s) Axial Thrust @ Rated Wind Speed: 320 lbs, (1425 N) Maximum Axial Thrust: N.A. Overspeed Control: Blade feathering, activated by centrifugal forces on blades. Yaw Control: None, rotor aligned with wind by tail. Generator/Alternator: 110 VDC, field windings, brushes. Voltage Regulation: Limitation of maximum output voltage Mechanical Power Transmission: None, direct drive. </p>	<p> MISCELLANEOUS Length of time machine has been in operation: Since December 1977 Design Features: Large commutator with four brushes. Basic design is derived from Jacobs Wind Electric plants. Warranty: Limited: Replacement of defective parts during first two years. Owners Manual: Available separately \$10.00 Maintenance Schedule: Semi-annually: Inspect system, and lubricate. </p>
<p> PERFORMANCE CHARACTERISTICS Rated Output: 4 kW @ 27 mph, (12 m/s) Maximum Output: 4 kW @ 27 mph, (12 m/s) Test Procedures: Operated on 50 ft. tower at 1350 ft. MSL at 10°F. Wind speed and output monitored by instruments. </p>	<p>NOTES:</p>
<p> CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft² = .09290 m² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons </p>

MODEL : 20 x 30 VAWT		TYPE: Electrical	
Manufacturer: Dominion Aluminum Fabricators (DAF) Indal Ltd. Address: 3570 Hawkestone Road, Mississauga, Ontario L5C 2V8 Contact: C. F. Wood Telephone: (416) 275-5300 extension #22
PHYSICAL CHARACTERISTICS Generic Description: Vertical Axis, Darrieus Capture Area: 389 ft ² , (36.1 m ²) Rotor Diameter: 20 ft, (6.1 m) System Weight: 1000 lbs, (454 kGs) Rotor Weight: 800 lbs, (363 kGs) Blade Materials: Aluminum alloy Number of blades: Two			
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 10 mph, (4.5 m/s) Shut-Down Wind Speed: 60 mph, (26.8 m/s) Survival Wind Speed: 130 mph, (58.1 m/s) RPM at Rated Output: note #1 Maximum RPM: 200 rpm @ all mph, (all m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Aerodynamic spoilers Generator/Alternator: 8 kW induction generator, 240 VAC, single phase, 60 Hertz Voltage Regulation: line feedback Mechanical Power Transmission: Gearbox		MISCELLANEOUS Length of time machine has been in operation: Three years. Design Features: Warranty: Workmanship and materials Owners Manual: Not available Maintenance Schedule: Semi-annually oil and inspect bearings.	
PERFORMANCE CHARACTERISTICS Rated Output: See note #1 Maximum Output: 14 kW @ 30 mph, (m/s) Test Procedures: Anemometer with wind speed histogram recorder wattmeters, watt-hour meters, voltmeter ammeters. Results to be announced.		NOTES: 1. All machines are experimental and are run at constant speeds selected for the intended application and wind regime. Rated power and wind speed will vary with the selected constant speeds. 2. Cut-in wind speed could vary from 10 mph to 18 mph depending on the installation parameters. 3. Solidity=0.1.	
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons		SYSTEM OUTPUT

MODEL : 82/002550 (High Wind Speed Model)**TYPE:** Electrical

Manufacturer: Dunlite Electrical Products Co., Div. of PYE Ind.
Address: c/o Eneritech Corporation
 P. O. Box 420, Norwich, VT 05055
Contact: Ed Coffin or Robert Sherwin
Telephone: (802) 649-1145

PHYSICAL CHARACTERISTICS

Generic Description: Horizontal axis, propeller-type, up-wind.
Capture Area: 78.5 ft², (7.3 m²)
Rotor Diameter: 10.0 ft, (3.1 m)
System Weight: 500 lbs, (227 kGs)
Rotor Weight: 130 lbs, (59 kGs)
Blade Materials: Galvanized sheet steel. (Stainless steel is optional.)
Number of Blades: Three

OPERATIONAL CHARACTERISTICS

Cut-In Wind Speed: 14 mph, (6.3 m/s)
Shut-Down Wind Speed: None
Survival Wind Speed: 110 mph, (49.5 m/s)
RPM at Rated Output: N.A. rpm @ 37 mph, (16.5 m/s)
Maximum RPM: N.A.
Axial Thrust @ Rated Wind Speed: N.A.
Maximum Axial Thrust: N.A.
Overspeed Control: Mechanical; blade feathering activated by centrifugal forces on fly-ball weights.
Yaw Control: None, rotor aligned with wind by tail.
Generator/Alternator: 12/24/32/48/110 VDC, brushless three-phase alternator with built in rectifiers.
Voltage Regulation: Available (standard)
Mechanical Power Transmission: Gear-box, single-stage, ratio=5:1

MISCELLANEOUS

Length of time machine has been in operation:
 For 41 years, with model changes.
Design Features: Fully enclosed alternator.

Warranty: One year: Parts and Workmanship.

Owners Manual: Available for \$10.00.

Maintenance Schedule: Annual: Inspect system and check oil level. Every five years: Change oil.

PERFORMANCE CHARACTERISTICS

Rated Output: 1.0 kW @ 37 mph, (16.5 m/s)
Maximum Output: 1.2 kW @ 80 mph, (35.8 m/s)
Test Procedures: Wind tunnel, (by Australian Government Agency).
 Performance data taken from Dunlite Dwg. No. 461242.

NOTES: Graph of power output vs. wind speed can only be considered approximate, since blade feathering is not shown.

CONVERSION FACTORS

One mph = .44707 m/s
 One gallon = 3.785 liters
 One foot = .3048 meters
 One ft² = .09290 m²
 One kW = 1.341 hp
 One lbm = .4536 kG
 One lbf = 4.448 newtons

**SYSTEM
 OUTPUT
 in
 Kilowatts**

MODEL : 81/002550 (Standard Model)	TYPE: Electrical
<p> Manufacturer: Dunlite Electrical Products Co., Div. of PYE Ind. Address: c/o Enertech Corporation P. O. Box 420, Norwich, VT 05055 Contact: Ed Coffin or Robert Sherwin Telephone: (802) 649-1145 </p> <p> PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, up-wind. Capture Area: 143.1 ft², (13.3 m²) Rotor Diameter: 13.5 ft, (4.1 m) System Weight: 500 lbs, (227 kGs) Rotor Weight: 130 lbs, (59 kGs) Blade Materials: Galvanized sheet steel. (Stainless steel is optional.) Number of blades: Three </p>
<p> OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 8 mph, (3.6 m/s) Shut-Down Wind Speed: None Survival Wind Speed: 80 mph, (36 m/s) RPM at Rated Output: 185 rpm @ 25 mph, (11 m/s) Maximum RPM: 200 rpm @ 35 mph, (15.6 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; blade feathering activated by centrifugal forces on fly-balls. Yaw Control: None, rotor aligned with wind by tail. Generator/Alternator: 12/24/32/48/110 VDC, brushless three-phase alternator with built-in rectifiers. Voltage Regulation: Standard Mechanical Power Transmission: Gear box, single stage, ratio = 5:1 </p>	<p> MISCELLANEOUS Length of time machine has been in operation: 41 years, (with model changes). Design Features: Fully enclosed alternator. Warranty: One year: Parts and Workmanship. Owners Manual: Available for \$10.00. Maintenance Schedule: Annual: Check oil and inspect system. Every five years: Change oil. </p>
<p> PERFORMANCE CHARACTERISTICS Rated Output: 2.0 kW @ 25 mph, (11 m/s) Maximum Output: 3.0 kW @ 32 mph, (14.3 m/s) Test Procedures: Wind tunnel (by Australian Government agency.) Performance graph taken from Dunlite Manual, Issue #1, Fig 3., issued 1972. </p>	<p> NOTES: In winds above 32 miles per hour, a latch is opened by centrifugal force. This causes the blades to become partially feathered to control RPM in high winds. Latch re-closes when winds diminish to about 20 miles per hour. </p>

CONVERSION FACTORS

One mph = .44707 m/s
One gallon = 3.785 liters
One foot = .3048 meters
One ft² = .09290 m²
One kW = 1.341 hp
One lbm = .4536 kg
One lbf = 4.448 newtons

SYSTEM
OUTPUT
in
Kilowatts

MODEL : 5 Meter VAWT (Prototype)	TYPE: Electrical (Also Mechanical Prime Mover)
<p> Manufacturer: Dynergy Corporation Address: P. O. Box 428, 1269 Union Avenue Laconia, New Hampshire 03246 Contact: Robert B. Allen, Vice President Telephone: (603) 524-8313 </p>
<p> PHYSICAL CHARACTERISTICS Generic Description: Vertical Axis, Darrieus Capture Area: 150 ft², (13.9 m²) Rotor Diameter: 15 ft, (4.6 m) System Weight: 850 lbs, (386 kGs) Rotor Weight: 312 lbs, (244 kGs) Blade Materials: Aluminum, 6061-T6, Extruded Number of Blades: Three (3) </p> <p> OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 10 mph, (4.4 m/s) Shut-Down Wind Speed: N.A. mph, (N. A. m/s) Survival Wind Speed: 100 mph, (44.7 m/s) RPM at Rated Output: 200 rpm @ 24 mph, (10.7 m/s) Maximum RPM: 300 rpm @ any mph, (any m/s) Axial Thrust @ Rated Wind Speed: N. A. Maximum Axial Thrust: 1200 lbs, (5338 N) Overspeed Control: Mechanical caliper on 24" diameter disc brake. Aerodynamic stall tends to prevent excessive RPM. </p> <p> Generator/Alternator: Available Pump/Compressor: Available Voltage Regulation: Available Mechanical Power Transmission: Purchased separately. </p>	<p> MISCELLANEOUS Length of time machine has been in operation: Since December of 1977. Design Features: Adaptable to a wide variety of driven devices. Also in analysis stage of vertical stacking of Dynergy VAWT for increased power output. Warranty: Available. Owners Manual: Available Maintenance Schedule: Semi-annually: inspect system, lubricate. </p>
<p> PERFORMANCE CHARACTERISTICS Rated Output: 3.3 kW @ 24 mph, (10.7 m/s) Maximum Output: N. A. Test Procedures: All output data based on initial test runs. </p>	<p> NOTES: Prototye unit used an alternator manufactured by Zephyr Wind Dynamo Co. Air foil used is NACA 0015, with 6 inch chord. </p>
<p> CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft² = .09290 m² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons </p>	<p> SYSTEM OUTPUT in Kilowatts and Horsepower </p>

MODEL : 440

TYPE: Electrical

Manufacturer: Energy Development Co.
 Address: 179E, R. D. #2
 Hamburg, PA 19526
 Contact: Terrance Mehrkam
 Telephone: (215) 562-8856

PHYSICAL CHARACTERISTICS

Generic Description: Horizontal axis, propeller-type, down-wind
 Capture Area: 1134 ft², (105.4 m²)
 Rotor Diameter: 38 ft, (11.6 m)
 System Weight: 7000 lbs, (3175 kGs)
 Rotor Weight: 925 lbs, (420 kGs)
 Blade Materials: Aluminum, T-6
 Number of Blades: Four

OPERATIONAL CHARACTERISTICS

Cut-In Wind Speed: 5 mph, (2.2 m/s)
 Shut-Down Wind Speed: 40 mph, (18 m/s)
 Survival Wind Speed: 120 mph, (54 m/s)
 RPM at Rated Output: 60 rpm @ 25 mph, (11.2 m/s)
 Maximum RPM: 60 rpm @ any mph, (any m/s)
 Axial Thrust @ Rated Wind Speed: N.A.
 Maximum Axial Thrust: N.A.
 Overspeed Control: Mechanical brake, activated manually or automatically
 Yaw Control: Motor driven, with damping
 Generator/Alternator: Synchronous, 3 Phase, 240 VAC

Voltage Regulation: Available, adjustable from 0 to 250 volts
 Mechanical Power Transmission: Gear box, ratio=20:1

MISCELLANEOUS

Length of time machine has been in operation:
 One year.

Design Features: Manual blade pitch adjustment.
 Automatic shut-down initiated by excessive current, RPM, or vibration.

Warranty: Two years, materials & workmanship.

Owners Manual: Available with machine.

Maintenance Schedule: Lubricate every six months.

PERFORMANCE CHARACTERISTICS

Rated Output: 20 kW @ 25 mph, (11.2 m/s)
 Maximum Output: 20 kW @ any mph, (any m/s)
 Test Procedures: Monitored during normal operation.

NOTES: NACA 4418 airfoil.

CONVERSION FACTORS

One mph = .44707 m/s
 One gallon = 3.785 liters
 One foot = .3048 meters
 One ft² = .09290 m²
 One kW = 1.341 hp
 One lbm = .4536 kG
 One lbf = 4.448 newtons

SYSTEM
 OUTPUT

MODEL : 445		TYPE : Electrical
Manufacturer: Energy Development Co. Address: 179E, R. D. #2 Hamburg, PA 19526 Contact: Terrance Mehrkam Telephone: (215) 562-8856
PHYSICAL CHARACTERISTICS Generic Description: Horizontal, axis, propeller-type, down-wind Capture Area: 1257 ft ² , (116.8 m ²) Rotor Diameter: 40 ft, (12.2 m) System Weight: 9500 lbs, (4309 kGs) Rotor Weight: 1250 lbs, (567 kGs) Blade Materials: Aluminum, T-6 Number of Blades: Four		
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 5 mph, (2.2 m/s) Shut-Down Wind Speed: 40 mph, (17.9 m/s) Survival Wind Speed: 120 mph, (53.7 m/s) RPM at Rated Output: 60 rpm @ 25 mph, (11.2 m/s) Maximum RPM: 60 rpm @ any mph, (any m/s) Axial Thrust @ Rated Wind Speed: 3500 lbs, (15,570 N) Maximum Axial Thrust: N.A. Overspeed Control: Mechanical brake, activated manually or automatically. Yaw Control: Motor driven with damping Generator/Alternator: Synchronous Voltage Regulation: Available, adjustable from 0 to 250 volts Mechanical Power Transmission: Gear box, ratio=20:1		MISCELLANEOUS Length of time machine has been in operation: One year. Design Features: Manual blade pitch adjustment. Automatic shut-down initiated by excessive current, RPM, or vibration. Warranty: Two years, materials & workmanship. Owners Manual: Available with machine. Maintenance Schedule: Lubricate every six months.
PERFORMANCE CHARACTERISTICS Rated Output: 45 kW @ 25 mph, (11.2 m/s) Maximum Output: 45 kW @ any mph, (any m/s) Test Procedures: Monitored during normal operation.		NOTES: NACA 4418 airfoil.
<div style="display: flex; justify-content: space-between;"> <div style="width: 30%;"> CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft² = .09290 m² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons </div> <div style="width: 65%;"> <div style="display: flex;"> <div style="width: 20%; text-align: center;"> SYSTEM OUTPUT </div> <div style="width: 80%;"> </div> </div> </div> </div>		

MODEL : 1500		Enertech TYPE: Electrical																																														
Manufacturer: Enertech Corp. Address: P. O. Box 420 Norwich, Vt. 05055 Contact: Ned Coffin, William Drake Telephone: (802) 649-1145
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, down-wind, propeller type. Capture Area: 143 ft ² , (13.3 m ²) Rotor Diameter: 13.2 ft, (4 m) System Weight: 185 lbs, (84 kGs) Rotor Weight: 48 lbs, (22 kGs) Blade Materials: Wood, neoprene leading edge. Number of Blades: Three																																																
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 8 mph, (3.6 m/s) Shut-Down Wind Speed: 40 mph, (18 m/s) (Avg. for 30 sec.) Survival Wind Speed: 120 mph, (54 m/s) RPM at Rated Output: 170 rpm @ 22 mph, (9.8 m/s) Maximum RPM: 195 rpm @ 60 mph, (27 m/s) Axial Thrust @ Rated Wind Speed: 175 lbs, (778 N) Maximum Axial Thrust: 650 lbs, (295 N) Overspeed Control: Automatic brake. Yaw Control: None Generator/Alternator: Induction generator, 115 VAC, 60 Hz Voltage Regulation: Automatic Mechanical Power Transmission: Gear box, 11.4:1, in oil (synthetic)		MISCELLANEOUS Length of time machine has been in operation: Less than 1 year. Design Features: Solid state control system. Designed for direct utility interface. Warranty: One year, parts and workmanship. Owners Manual: Not available separately. Maintenance Schedule: Annually: Oil change and system inspection.																																														
PERFORMANCE CHARACTERISTICS Rated Output: 1500 watts @ 22 mph, (9.8 m/s) Maximum Output: 1650 watts @ 25 mph, (11.2 m/s) Test Procedures: Performance obtained on truck-mounted test rig.		NOTES:																																														
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons		<div>SYSTEM OUTPUT in Kilowatts</div> <table><caption>Approximate data points from the performance graph</caption><thead><tr><th>Wind Velocity (mph)</th><th>Wind Velocity (m/s)</th><th>System Output (kW)</th></tr></thead><tbody><tr><td>8</td><td>3.6</td><td>0.0</td></tr><tr><td>10</td><td>4.5</td><td>0.4</td></tr><tr><td>15</td><td>6.7</td><td>1.0</td></tr><tr><td>20</td><td>8.9</td><td>1.4</td></tr><tr><td>25</td><td>11.2</td><td>1.7</td></tr><tr><td>30</td><td>13.4</td><td>1.5</td></tr><tr><td>35</td><td>15.7</td><td>1.4</td></tr><tr><td>40</td><td>17.8</td><td>1.4</td></tr><tr><td>45</td><td>20.0</td><td>1.4</td></tr><tr><td>50</td><td>22.3</td><td>1.4</td></tr><tr><td>55</td><td>24.5</td><td>1.4</td></tr><tr><td>60</td><td>26.8</td><td>1.4</td></tr><tr><td>65</td><td>29.0</td><td>1.4</td></tr><tr><td>70</td><td>31.3</td><td>1.4</td></tr></tbody></table>		Wind Velocity (mph)	Wind Velocity (m/s)	System Output (kW)	8	3.6	0.0	10	4.5	0.4	15	6.7	1.0	20	8.9	1.4	25	11.2	1.7	30	13.4	1.5	35	15.7	1.4	40	17.8	1.4	45	20.0	1.4	50	22.3	1.4	55	24.5	1.4	60	26.8	1.4	65	29.0	1.4	70	31.3	1.4
Wind Velocity (mph)	Wind Velocity (m/s)	System Output (kW)																																														
8	3.6	0.0																																														
10	4.5	0.4																																														
15	6.7	1.0																																														
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25	11.2	1.7																																														
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45	20.0	1.4																																														
50	22.3	1.4																																														
55	24.5	1.4																																														
60	26.8	1.4																																														
65	29.0	1.4																																														
70	31.3	1.4																																														

MODEL : Windstream 25-B**TYPE:** Electrical

Manufacturer: Grumman Energy Systems, Inc.
Address: 4175 Veterans Memorial Highway
 Ronkonkoma, New York 11779
Contact: Mr. J.K. Stotz Jr.
Telephone: (516) 575-5584

PHYSICAL CHARACTERISTICS

Generic Description: Horizontal axis, propeller-type, down-wind.
Capture Area: 491 ft², (45.6 m²)
Rotor Diameter: 25 ft, (7.62 m)
System Weight: 2000 lbs, (906 kGs)
Rotor Weight: 750 lbs, (340 kGs)
Blade Materials: Aluminum, extruded, 6063T6

OPERATIONAL CHARACTERISTICS

Cut-In Wind Speed: 8 mph, (3.6 m/s)
Shut-Down Wind Speed: 50 mph, (22.35 m/s)
Survival Wind Speed: 130 mph, (58.1 m/s)
RPM at Rated Output: 137 rpm @ 29 mph, (12.9 m/s)
Maximum RPM: 300 rpm @ any mph, (any m/s)
Axial Thrust @ Rated Wind Speed: 2500 lbs, (11125 N) -note 2
Maximum Axial Thrust: 2850 lbs, (12680 N) -note 2
Overspeed Control: Blade feathering actuated by motor. Centrifugally actuated drag brakes on blade tips.
Yaw Control: None. Rotor aligned down-wind of tower by drag forces.
Generator/Alternator: 220/440 VAC, 60 Hz, 3 phase, brushless.
 AC rectified to DC for direct application to load or input to Gemini Synchronous Inverter for AC applications requiring constant frequency.
Voltage Regulation: Available. (Solid State.)
Mechanical Power Transmission: Gear box, ratio = 14.5 : 1

MISCELLANEOUS

Length of time machine has been in operation:
 More than one year.
Design Features: Three blades. Modified NACA 64₄ airfoil. Electrically controlled variable pitch. Manual override shut down control. Wind pressure switch to detect excessive winds and cause blade feathering.
Warranty: Limited. One year on materials and workmanship.
Owners Manual: To be available at later date.
Maintenance Schedule: Monthly.

PERFORMANCE CHARACTERISTICS

Rated Output: 20 kW @ 29 mph, (12.9 m/s)
Maximum Output: 20 kW @ 29 mph, (12.9 m/s)
Test Procedures: Operation in field. Instantaneous point data collection using anemometers and output sensing devices.

NOTES:

1. Some systems are rated at 15 kW. Rated power is 15 kW at 26 mph (11.6 m/s) for DC operation (direct use or battery charging), or synchronous AC operation using optional 15 kW Gemini Synchronous Inverter).
2. Consult Grumman Energy Systems for tower design information.

CONVERSION FACTORS

One mph = .44707 m/s
 One gallon = 3.785 liters
 One foot = .3048 meters
 One ft² = .09290 m²
 One kW = 1.341 hp
 One lbm = .4536 kG
 One lbf = 4.448 newtons

SYSTEM
 OUTPUT
 in
 Kilowatts

MODEL : 1200	TYPE: Electrical
<p>Manufacturer: Kedco, Inc. Address: 9016 Aviation Blvd. Inglewood, CA 90301 Contact: Terry Rainey, Wind Program Manager Telephone: (213) 776-6636</p>
<p>PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller type, down-wind. Capture Area: 113.0 ft², (10.5 m²) Rotor Diameter: 12 ft, (3.65 m) System Weight: 202 lbs, (92 kGs) Rotor Weight: 71 lbs, (32 kGs) Blade Materials: Aluminum: 2024-T3 Number of Blades: Three</p>	
<p>OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 7 mph, (3.1 m/s) Shut-Down Wind Speed: 70 mph, (31 m/s) Survival Wind Speed: 110 mph, (49 m/s) RPM at Rated Output: 300 rpm @ 22 mph, (10 m/s) Maximum RPM: 300 rpm @ 22 mph, (10 m/s) Axial Thrust @ Rated Wind Speed: 250 lbs, (1112 N) Maximum Axial Thrust: N. A. Overspeed Control: Mechanical; blade feathering activated by centrifugal forces on fly-weights. Yaw Control: None Generator/Alternator: 14.4 VAC, field windings Voltage Regulation: Constant voltage, varying current. Mechanical Power Transmission: Gear box, ratio = 8.76:1</p>	<p>MISCELLANEOUS Length of time machine has been in operation: Three years. Design Features: Automatic vibration-sensing shut-off, manual shut-off and reset. Warranty: One-year parts and labor. Owners Manual: Available for \$7.50 Maintenance Schedule: Annually: inspect system, check fluid levels.</p>
<p>PERFORMANCE CHARACTERISTICS Rated Output: 1.2 kW @ 22 mph, (10 m/s) Maximum Output: 1.2 kW @ 22 mph, (10 m/s) Test Procedures: Moving test bed with voltmeter, ammeter, and anemometer.</p>	<p>NOTES:</p>

CONVERSION FACTORS

One mph = .44707 m/s
One gallon = 3.785 liters
One foot = .3048 meters
One ft² = .09290 m²
One kW = 1.341 hp
One lbm = .4536 kG
One lbf = 4.448 newtons

SYSTEM
OUTPUT
in
Watts

MODEL : 1205**TYPE:** Electrical

Manufacturer: Kedco, Inc.
Address: 9016 Aviation Blvd.,
 Inglewood, CA 90301
Contact: Terry Rainey, Wind Program Manager
Telephone: (213) 776-6636

PHYSICAL CHARACTERISTICS

Generic Description: Horizontal axis, propeller-type, down-wind.
Capture Area: 113.0 ft², (10.5 m²)
Rotor Diameter: 12 ft, (3.65 m)
System Weight: 202 lbs, (92 kGs)
Rotor Weight: 71 lbs, (32 kGs)
Blade Materials: Aluminum; 2024-T3
Number of Blades: Three

OPERATIONAL CHARACTERISTICS

Cut-In Wind Speed: 8 mph, (3.6 m/s)
Shut-Down Wind Speed: 70 mph, (31 m/s)
Survival Wind Speed: 110 mph, (49 m/s)
RPM at Rated Output: 300 rpm @ 22 mph, (10 m/s)
Maximum RPM: 300 rpm @ 22 mph, (10 m/s)
Axial Thrust @ Rated Wind Speed: 250 lbs, (1112 N)
Maximum Axial Thrust: N.A.
Overspeed Control: Mechanical; blade feathering activated by centrifugal forces on fly-weights.
Yaw Control: None
Generator/Alternator: 28.4 VDC, field windings.

Voltage Regulation: Constant voltage, varying current.
Mechanical Power Transmission: Gear box, ratio = 8.76:1

MISCELLANEOUS

Length of time machine has been in operation:
 One and one-half years.
Design Features: Automatic vibration-sensing shut-off. Manual shut-off and reset.

Warranty: One year - parts and labor.

Owners Manual: Available for \$7.50.

Maintenance Schedule: Annually; inspect system, check fluid levels.

PERFORMANCE CHARACTERISTICS

Rated Output: 1.2 kW @ 22 mph, (10 m/s)
Maximum Output: 1.2 kW @ 22 mph, (10 m/s)
Test Procedures: Moving test bed with voltmeter, ammeter, and anemometer

NOTES:**CONVERSION FACTORS**

One mph = .44707 m/s
 One gallon = 3.785 liters
 One foot = .3048 meters
 One ft² = .09290 m²
 One kW = 1.341 hp
 One lbm = .4536 kG
 One lbf = 4.448 newtons

SYSTEM
 OUTPUT
 in
 Watts

MODEL : 1210	TYPE: Electrical
Manufacturer: Kedco, Inc. Address: 9016 Aviation Blvd. Inglewood, CA 90301 Contact: Terry Rainey, Wind Program Manager Telephone: (213) 776-6636
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, down-wind. Capture Area: 113.0 ft ² , (10.5 m ²) Rotor Diameter: 12 ft, (3.65 m) System Weight: 252 lbs, (114 kGs) Rotor Weight: 71 lbs, (32 kGs) Blade Materials: Aluminum; 2024-T3 Number of Blades: Three	MISCELLANEOUS Length of time machine has been in operation: One year. Design Features: Automatic vibration-sensing shut-off manual shut-off and reset. Warranty: One year parts and labor. Owners Manual: Available for \$7.50. Maintenance Schedule: Annually-inspect system, check fluid levels.
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 11 mph, (4.9 m/s) Shut-Down Wind Speed: 70 mph, (31 m/s) Survival Wind Speed: 110 mph, (49 m/s) RPM at Rated Output: 300 rpm @ 26 mph, (11.6 m/s) Maximum RPM: 300 rpm @ 26 mph, (11.6 m/s) Axial Thrust @ Rated Wind Speed: 250 lbs, (1112 N) Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; blade feathering, activated by centrifugal forces on fly-weights. Yaw Control: None Generator/Alternator: 0 to 180 VAC, permanent magnet. Voltage Regulation: None, variable voltage and current Mechanical Power Transmission: Gear box, ratio = 8/67:1	NOTES:
PERFORMANCE CHARACTERISTICS Rated Output: 2.0 kW @ 26 mph, (11.6 m/s) Maximum Output: 2.0 kW @ 26 mph, (11.6 m/s) Test Procedures: Moving test bed with voltmeter, ammeter, and anemometer.	<div> CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft² = .09290 m² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons </div> <div> </div>

MODEL : 1600 Manufacturer: Kedco, Inc. Address: 9016 Aviation Blvd. Inglewood, CA 90301 Contact: Terry Rainey, Wind Program Manager Telephone: (213) 776-6636	TYPE: Electrical
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, down-wind. Capture Area: 201.1 ft ² , (18.7 m ²) Rotor Diameter: 16 ft, (4.88 m) System Weight: 217 lbs, (98.3 kGs) Rotor Weight: 75.5 lbs, (34.2 kGs) Blade Materials: Aluminum, 2024-T3 Number of Blades: Three	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 7 mph, (3.1 m/s) Shut-Down Wind Speed: 60 mph, (27 m/s) Survival Wind Speed: 110 mph, (49.5 m/s) <u>Untested.</u> RPM at Rated Output: 250 rpm @ 17 mph, (7.6 m/s) Maximum RPM: 250 rpm @ 17 mph, (7.6 m/s) Axial Thrust @ Rated Wind Speed: 350 lbs, (155 N) Maximum Axial Thrust: N.A. Overspeed Control: Mechanical. Blade feathering activated by centrifugal forces on fly weights. Yaw Control: None. Generator/Alternator: 14.4 VDC, w/ field windings. Voltage Regulation: Constant voltage, variable amperage. Mechanical Power Transmission: Gear box, ratio = 8.76 : 1	MISCELLANEOUS Length of time machine has been in operation: 2 ½ years . Design Features: Automatic vibration-sensing shut-off, manual shut-off and reset. Warranty: One year - parts and labor. Owners Manual: Available for \$7.50 . Maintenance Schedule: Annually inspect system and check fluid levels.
PERFORMANCE CHARACTERISTICS Rated Output: 1.2 kW @ 17 mph, (7.6 m/s) Maximum Output: 1.2 kW @ 17 mph, (7.6 m/s) Test Procedures: Moving test bed. Instrumentation included: Voltmeter, ammeter, and anemometer.	NOTES:
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons	

MODEL : 1605	TYPE: Electrical
<p>Manufacturer: Kedco, Inc. Address: 9016 Aviation Blvd., Inglewood, CA 90301 Contact: Terry Rainey, Wind Program Manager Telephone: (213) 776-6636</p>	
<p>PHYSICAL CHARACTERISTICS</p> <p>Generic Description: Horizontal axis, propeller-type, down-wind.</p> <p>Capture Area: 201.0 ft², (18.7 m²)</p> <p>Rotor Diameter: 16 ft, (4.88 m)</p> <p>System Weight: 217 lbs, (98 kGs)</p> <p>Rotor Weight: 75.5 lbs, (34.2 kGs)</p> <p>Blade Materials: Aluminum: 2024-T3</p> <p>Number of Blades: Three</p>	
<p>OPERATIONAL CHARACTERISTICS</p> <p>Cut-In Wind Speed: 7 mph, (3.1 m/s)</p> <p>Shut-Down Wind Speed: 60 mph, (27 m/s)</p> <p>Survival Wind Speed: 110 mph, (49.5 m/s) (estimated)</p> <p>RPM at Rated Output: 250 rpm @ 22 mph, (10 m/s)</p> <p>Maximum RPM: 250 rpm @ 22 mph, (10 m/s)</p> <p>Axial Thrust @ Rated Wind Speed: N.A.</p> <p>Maximum Axial Thrust: 350 lbs, (1557 N)</p> <p>Overspeed Control: Mechanical; blade feathering, activated by centrifugal forces on fly weights.</p> <p>Yaw Control: None</p> <p>Generator/Alternator: 0 to 180 VDC, permanent magnet, variable amperage self-excitation.</p> <p>Voltage Regulation: None, variable voltage and amperage.</p> <p>Mechanical Power Transmission: Gear box, ratio = 8.76:1</p>	<p>MISCELLANEOUS</p> <p>Length of time machine has been in operation: Six months.</p> <p>Design Features: Automatic vibration-sensing shut-off, manual shut-off and reset.</p> <p>Warranty: One year - parts and labor.</p> <p>Owners Manual: Available for \$7.50.</p> <p>Maintenance Schedule: Annually: inspect system, check fluid levels.</p>
<p>PERFORMANCE CHARACTERISTICS</p> <p>Rated Output: 1.9 kW @ 20 mph, (8.9 m/s)</p> <p>Maximum Output: 1.9 kW @ 20 mph, (8.9 m/s)</p> <p>Test Procedures: Moving test bed with voltmeter, ammeter, and anemometer.</p>	<p>NOTES:</p>

CONVERSION FACTORS

One mph = .44707 m/s
One gallon = 3.785 liters
One foot = .3048 meters
One ft² = .09290 m²
One kW = 1.341 hp
One lbm = .4536 kG
One lbf = 4.448 newtons

SYSTEM
OUTPUT
in
Watts

MODEL : 1610		TYPE: Electrical
Manufacturer: Kedco, Inc. Address: 9016 Aviation Blvd. Inglewood, CA 90301 Contact: Terry Rainey, Wind Program Manager Telephone: (213) 776-6636		
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, down-wind. Capture Area: 201.0 ft ² , (18.7 m ²) Rotor Diameter: 16 ft, (4.88 m) System Weight: 267 lbs, (120.9 kGs) Rotor Weight: 75.5 lbs, (34.2 kGs) Blade Materials: Aluminum; 2024-T3 Number of Blades: Three		
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 10 mph, (4.4 m/s) Shut-Down Wind Speed: 60 mph, (27 m/s) Survival Wind Speed: 110 mph, (49.2 m/s) (estimated) RPM at Rated Output: 250 rpm @ 22 mph, (10 m/s) Maximum RPM: 250 rpm @ 22 mph, (10 m/s) Axial Thrust @ Rated Wind Speed: 350 lbs, (1557 N) Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; blade feathering, activated by centrifugal forces on fly-weights. Yaw Control: None. Generator/Alternator: 0 to 180 VDC, permanent magnet Voltage Regulation: None, variable voltage and amperage. Mechanical Power Transmission: Gear box, ratio=8.76:1		MISCELLANEOUS Length of time machine has been in operation: Six months Design Features: Automatic vibration-sensing shut-off, manual shut-off and reset. Warranty: One year - parts and labor. Owners Manual: Available for \$7.50. Maintenance Schedule: Annually; inspect system, check fluid levels.
PERFORMANCE CHARACTERISTICS Rated Output: 2.0 kW @ 22 mph, (10 m/s) Maximum Output: 2.0 kW @ 22 mph, (10 m/s) Test Procedures: Moving test bed with voltmeter, ammeter, and anemometer.		NOTES:
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons		

MODEL : 1620 Manufacturer: Kedco, Inc. Address: 9016 Aviation Blvd. Inglewood, CA 90301 Contact: Terry Rainey, Wind Program Manager Telephone: (213) 776-6636	TYPE: Electrical
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, down-wind. Capture Area: 201.0 ft ² , (18.7 m ²) Rotor Diameter: 16 ft, (4.88 m) System Weight: 293 lbs, (133 kGs) Rotor Weight: 75.5 lbs, (34.2 kGs) Blade Materials: Aluminum; 2024-T3 Number of Blades: Three	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 11 mph, (4.9 m/s) Shut-Down Wind Speed: 60 mph, (27 m/s) Survival Wind Speed: 110 mph, (49.5 m/s) (untested) RPM at Rated Output: 250 rpm @ 22 mph, (10 m/s) Maximum RPM: 250 rpm @ 22 mph, (10 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: 350 lbs, (1557 N) Overspeed Control: Mechanical; blade feathering activated by centrifugal forces on fly weights. Yaw Control: None Generator/Alternator: 0 to 180 VDC, Permanent magnet Voltage Regulation: None, variable voltage and amperage Mechanical Power Transmission: Gear box, ratio - 8.76:1.	MISCELLANEOUS Length of time machine has been in operation: One year. Design Features: Automatic vibration sensing shut-off. Manual shut-off and reset. Warranty: One year- parts and labor. Owners Manual; Available for \$7.50. Maintenance Schedule: Annually; inspect system, check fluid levels.
PERFORMANCE CHARACTERISTICS Rated Output: 3.0 kW @ 25 mph, (11.1 m/s) Maximum Output: 3.0 kW @ 25 mph, (11.1 m/s) Test Procedures: Moving test bed with voltmeter, ammeter and anemometer.	NOTES:
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kw = 1.341 hp One lbm = .4536 kg One lbf = 4.448 newtons	<div> SYSTEM OUTPUT in Watts </div>

<p>MODEL : 10 - 3 - Ind</p> <p>Manufacturer: Millville Windmills & Solar Equipment Company Address: P. O. Box 32 (10335 Old Drive) Millville, CA 96062 Contact: Devon Tassen, President Telephone: (916) 547-4302</p>	<p>TYPE: Electrical</p>
<p>PHYSICAL CHARACTERISTICS</p> <p>Generic Description: Horizontal axis, propeller-type, up-wind. Capture Area: 490.8 ft², (45.6 m²) Rotor Diameter: 25 ft, (7.6 m) System Weight: 850 lbs, (386 kGs) Rotor Weight: 230 lbs, (104 kGs) Blade Materials: Aluminum Number of Blades: Three</p>	
<p>OPERATIONAL CHARACTERISTICS</p> <p>Cut-In Wind Speed: 9 mph, (4.0 m/s) Shut-Down Wind Speed: 60 mph, (27 m/s) Survival Wind Speed: 80 mph, (54 m/s) RPM at Rated Output: 80 rpm @ 25 mph, (11 m/s) Maximum RPM: 90 rpm @ any mph, (any m/s) Axial Thrust @ Rated Wind Speed: 112.5 lbs, (500.4 N) Maximum Axial Thrust: 1800 lbs, (8007 N) Overspeed Control: Mechanical; blade feathering, rotor turns edgewise to excessive winds. Yaw Control: None, rotor aligned by tail. Generator/Alternator: 220V, 42 A, AC, 60 Hz, induction.</p> <p>Pump/Compressor: Yes, information on request. Voltage Regulation: Output voltage matched to utility line voltage. Mechanical Power Transmission: Gear box, 3 stage 24:1.</p>	<p>MISCELLANEOUS</p> <p>Length of time machine has been in operation: Nine months</p> <p>Design Features: No inverter required when used to supplement utility supplied power.</p> <p>Warranty: One year</p> <p>Owners Manual: Provided with system.</p> <p>Maintenance Schedule: Semi-annually lubrication, and general inspection.</p>
<p>PERFORMANCE CHARACTERISTICS</p> <p>Rated Output: 10 kW @ 25 mph, (11 m/s) Maximum Output: 10 kW @ 25 mph, (11 m/s) Test Procedures: Operated on tower. Instrumentation included: Amp-meter, volt-meter, and anemometer.</p>	<p>NOTES:</p>

CONVERSION FACTORS

One mph = .44707 m/s
 One gallon = 3.785 liters
 One foot = .3048 meters
 One ft² = .09290 m²
 One kW = 1.341 hp
 One lbm = .4536 kG
 One lbf = 4.448 newtons

SYSTEM
 OUTPUT
 in
 Kilowatts

MODEL : Eagle, 2 kW, 32 V	TYPE: Electrical
Manufacturer: North Wind Power Co., Inc. Address: P. O. Box 315 Warren, VT 05674 Contact: Don Mayer, President Telephone: (802) 496-2995	
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller type, up-wind. Capture Area: 145.3 ft ² , (13.5 m ²) Rotor Diameter: 13.6 ft, (4.15 m) System Weight: 480 lbs, (218 kGs) Rotor Weight: 70 lbs, (31.8 kGs) Blade Materials: Wood (Sitka spruce), fiberglass coated. Number of blades: Three	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 8 mph, (3.6 m/s) Shut-Down Wind Speed: None Survival Wind Speed: 90 mph, (40 m/s) RPM at Rated Output: 265 rpm @ 22 mph, (10 m/s) Maximum RPM: 350 rpm @ 90 mph, (18 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: 300 lbs, (1335 N) Overspeed Control: Mechanical; variable pitch activated by centrifugal forces on blades. Yaw Control: No rate control, rotor aligned by tail. Generator/Alternator: Shunt wound DC 32VDC, self-excitation. Voltage Regulation: Voltage regulation, reverse current protection Mechanical Power Transmission: Direct drive, ratio - 1:1	MISCELLANEOUS Length of time machine has been in operation: Three years. Design Features: Low maintenance, high reliability, direct drive low speed generator. Warranty: One year - unconditional on generator and main components. Owners Manual: Available for \$3.00 Maintenance Schedule: Semi-annually; grease every three to five years - clean or replace brushes. Every five years - refinish blades.
PERFORMANCE CHARACTERISTICS Rated Output: 2 kW @ 22 mph, (10 m/s) Maximum Output: 3 kW @ 90 mph, (40.2 m/s) Test Procedures: Dynamometry, voltmeter and ammeter with tach.. (further information available upon request.) Data valid at sea level.	NOTES: Similar to machines manufactured by Jacobs Wind Electric, which have been in operation over 40 years.
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kg One lbf = 4.448 newtons	

MODEL : Eagle - 2 kW 110 V	TYPE: Electrical
Manufacturer: North Wind Power Co., Inc. Address: P. O. Box 315 Warren, VT 05674 Contact: Don Mayer, President Telephone: (802) 496-2955	
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller type, up-wind. Capture Area: 145 ft ² , (13.5 m ²) Rotor Diameter: 13.6 ft, (4.2 m) System Weight: 480 lbs, (218 kGs) Rotor Weight: 70 lbs, (31.8 kGs) Blade Materials: Wood (Sitka spruce), fiberglass coated. Number of blades: Three	MISCELLANEOUS Length of time machine has been in operation: three years Design Features: Low maintenance, high reliability, direct drive low speed generator. Warranty: One year - unconditional on generator and main components. Owners Manual: Available for \$3.00 Maintenance Schedule: Semi-annually: grease. Every three to five years: clean or replace brushes. Every five years: refinish blades.
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 8 mph, (3.6 m/s) Shut-Down Wind Speed: None Survival Wind Speed: 90 mph, (40 m/s) RPM at Rated Output: 265 rpm @ 22 mph, (10 m/s) Maximum RPM: 350 rpm @ 90 mph, (40 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: 300 lbs, (1335 N) Overspeed Control: Mechanical; variable pitch, centrifugally operated. Yaw Control: No rate control, rotor aligned by tail. Generator/Alternator: Shunt wound, 110 VDC, self-excitation. Voltage Regulation: Available, reverse current protection Mechanical Power Transmission: Direct drive, ratio - 1:1	NOTES: Similar to machines manufactured by Jacobs Wind Electric, which have been in operation over 40 years.
PERFORMANCE CHARACTERISTICS Rated Output: 2 kW @ 22 mph, (10 m/s) Maximum Output: 3 kW @ 90 mph, (40.2 m/s) Test Procedures: Dynamometry, voltmeter and ammeter with tach.. (further information available upon request.)	
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons	<p>SYSTEM OUTPUT in Kilowatts</p> <p>WIND VELOCITY in Miles Per Hour (mph)</p> <p>WIND VELOCITY in Meters Per Second (m/s)</p>

MODEL : Eagle 3 kW 32V	TYPE : Electrical
Manufacturer: North Wind Power Co., Inc. Address: P. O. Box 315 Warren, VT 05674 Contact: Don Mayer, President Telephone: (802) 496-2995
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, up-wind. Capture Area: 145.3 ft ² , (13.5 m ²) Rotor Diameter: 13.6 ft, (4.14 m) System Weight: 480 lbs, (218 kGs) Rotor Weight: 70 lbs, (31.8 kGs) Blade Materials: Wood (Sitka spruce), fiberglass coated Number of Blades: Three	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 8 mph, (3.6 m/s) Shut-Down Wind Speed: None Survival Wind Speed: 90 mph, (40 m/s) RPM at Rated Output: 265 rpm @ 22 mph, (10 m/s) Maximum RPM: 350 rpm @ 90 mph, (40 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: 300 lbs, (1335 N) Overspeed Control: Mechanical; variable pitch, activated by centrifugal forces on blades. Yaw Control: No rate control, rotor aligned by tail. Generator/Alternator: Shunt wound, 32 VDC, self-excitation. Voltage Regulation: Available, reverse current protection. Mechanical Power Transmission: Direct drive, ratio - 1:1	MISCELLANEOUS Length of time machine has been in operation: Three years. Design Features: Low maintenance, high reliability, direct drive low speed generator. Warranty: One year - unconditional on generator and main components. Owners Manual: Available for \$3.00 Maintenance Schedule: Semi-annually grease. Every three to five year: clean or replace brushes. Every five years: refinish blades
PERFORMANCE CHARACTERISTICS Rated Output: 3 kW @ 27 mph, (12.2 m/s) Maximum Output: 4.5 kW @ 90 mph, (40.2 m/s) Test Procedures: Dynamometry, voltmeter and ammeter with tach.. (Further information available upon request). Data valid at Sea Level.	NOTES: Similar to machines manufactured by Jacobs Wind Electric, which have been in operation over 40 years.
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons
SYSTEM OUTPUT in Kilowatts	

MODEL : Eagle 3 kW 110V Manufacturer: North Wind Power Co., Inc. Address: P. O. Box 315 Warren, VT 05674 Contact: Don Mayer, President Telephone: (802) 496-2955	TYPE: Electrical
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, up-wind. Capture Area: 145.3 ft ² , (13.5 m ²) Rotor Diameter: 13.6 ft, (4.14 m) System Weight: 480 lbs, (218 kGs) Rotor Weight: 70 lbs, (23 kGs) Blade Materials: Wood (Sitka spruce), fiberglass coated Number of Blades: Three	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 0 mph, (3.6 m/s) Shut-Down Wind Speed: None Survival Wind Speed: 90 mph, (40 m/s) RPM at Rated Output: 265 rpm @ 27 mph, (10 m/s) Maximum RPM: 350 rpm @ 90 mph, (40 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: 300 lbs, (1335 N) Overspeed Control: Mechanical; variable pitch, activated by centrifugal forces on blades. Yaw Control: No rate control, rotor aligned by tail. Generator/Alternator: Shunt wound, 110 VDC, self-excitation. Voltage Regulation: Available, reverse current protection. Mechanical Power Transmission: Direct drive, ratio - 1:1	MISCELLANEOUS Length of time machine has been in operation. Three years. Design Features: Low maintenance, high reliability, direct drive low speed generator. Warranty: One year - unconditional on generator and main components. Owners Manual: Available for \$3.00 Maintenance Schedule: Semi-annually: grease. Every three to five years: clean or replace brushes. Every five years: refinish blades.
PERFORMANCE CHARACTERISTICS Rated Output: 3 kW @ 27 mph, (12.2 m/s) Maximum Output: 4.5 kW @ 90 mph, (40.2 m/s) Test Procedures: Dynamometry, voltmeter and ammeter with tach.. (further information available upon request.) Data valid at SEA Level.	NOTES: Similar to machines manufactured by Jacobs Wind Electric which have been in operation over 40 years.
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kg One lbf = 4.448 newtons

MODEL : Cycloturbine C2E	TYPE: Electrical
Manufacturer: Pinson Energy Corporation Address: P. O. Box #7 Marstons Mills, Mass. 02648 Contact: Herman M. Drees, President Telephone: (617) 428-8535
PHYSICAL CHARACTERISTICS Generic Description: Vertical axis, cyclically pitched blades Capture Area: 96 ft ² , (8.9 m ²) Rotor Diameter: 12 ft, (3.66 m) System Weight: 439 lbs, (199 kGs) Rotor Weight: 234 lbs, (106 kGs) Blade Materials: Aluminum 6061-T6 Number of Blades: Three	MISCELLANEOUS Length of time machine has been in operation: Prototype 1.5 years. Design Features: High starting torque, simple over-speed control, adaptable to a variety of driven devices. Warranty: One year from installation - all parts and service. Owners Manual: Available. Maintenance Schedule: Annually grease bearings, tighten hardware, replace drive belt.
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 7 mph, (3.1 m/s) Shut-Down Wind Speed: 40 mph, (17.9 m/s) Survival Wind Speed: 110 mph, (49 m/s) RPM at Rated Output: 160 rpm @ 24 mph, (10.7 m/s) Maximum RPM: 200 rpm @ 30 mph, (14 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: 300 lbs, (1334 N) Overspeed Control: Mechanical, centrifugally activated force balance adjusts blade angles. Yaw Control: Not applicable. Generator/Alternator: 120V.- 33A, or 240V -16A, internal excitation. Pump/Compressor: 3 h.p., two stage reciprocating Voltage Regulation: Available Mechanical Power Transmission: Timing belt, two stage, ratio=8.57:1	NOTES:
PERFORMANCE CHARACTERISTICS Rated Output: 2 kW @ 24 mph, (10.7 m/s) Maximum Output: 4 kW @ 30 mph, (14 m/s) Test Procedures: Tachometer and anemometer to dual track strip chart recorder, ammeter and voltmeter, resistive load.
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons	

Product Development Institute	
MODEL : Wind Jennie (prototype)	TYPE: Electrical
Manufacturer: Product Development Institute Address: 4440 Secor Toledo, Ohio 43623 Contact: Tom Nichols Telephone: (419) 473-3266	
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller type, up-wind Capture Area: 113.1 ft ² , (10.5 m ²) Rotor Diameter: 12.5 ft ,(3.8 m) System Weight: 300 lbs,(136 kGs) Rotor Weight: 27 lbs,(12.2 kGs) Blade Materials: Aluminum Number of Blades: Three	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 12 mph,(5.4 m/s) Shut-Down Wind Speed: 25 mph,(11.1 m/s) Survival Wind Speed: 100 mph,(45 m/s) RPM at Rated Output: 300 rpm @ 25 mph,(11.1 m/s) Maximum RPM: 400 rpm @ 26 mph,(11.1 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; variable pitch, centrifugally operated. Yaw Control: None Generator/Alternator: 240 VAC, 3 phase Voltage Regulation: Available Mechanical Power Transmission: Two stage gearing, ratio = 10:1	MISCELLANEOUS Length of time machine has been in operation: Not available. Design Features: Warranty: One year - parts. Owners Manual: Not available. Maintenance Schedule: Annually: inspect system, check belts, lubricate
PERFORMANCE CHARACTERISTICS Rated Output: 3.0 kW @ 25 mph,(11.1 m/s) Maximum Output: 3.0 kW @ 25 mph,(11.1 m/s) Test Procedures: Output data calculated. Prototype testing scheduled to begin in January, 1978.	NOTES:
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons	<div style="text-align: center;"> </div>
SYSTEM OUTPUT	<div style="text-align: center;"> </div>

MODEL : Wind Heat System (prototype)	TYPE: Electrical
Manufacturer: Product Development Institute Address: 4440 Secor Road Toledo, Ohio 43623 Contact: Tom Nichols Telephone: (419) 473-3266	
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, up-wind. Capture Area: 145.3 ft ² , (13.5 m ²) Rotor Diameter: 13.6 ft, (4.15 m) System Weight: 173.5 lbs, (78.7 kGs) Rotor Weight: 27 lbs, (12.3 kGs) Blade Materials: Aluminum, alclad	MISCELLANEOUS Length of time machine has been in operation: Four years. Design Features: Warranty: Alternator warranted by its manufacturer for 90 days. Mechanical parts warranted for 1 year. Owners Manual: Not available. Maintenance Schedule: Annually, inspect entire system and add lubrication.
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 12 mph, (5.4 m/s) Shut-Down Wind Speed: 27 mph, (12.1 m/s) Survival Wind Speed: 75 mph, (33.5 m/s) RPM at Rated Output: 325 rpm @ 21 mph, (9.4 m/s) Maximum RPM: 400 rpm @ 27 mph, (12.1 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Mechanical, variable pitch, centrifugally activated. Yaw Control: None. Rotor aligned with wind by tail. Generator/Alternator: 0 - 240 VAC, self exciting, 15 - 60 Hz, 0 - 12 amperes. Pump/Compressor: Available. Voltage Regulation: Available, (standard) Mechanical Power Transmission: Gear box, ratio = 2:1, right angle drive.	NOTES: Catalogs are available for one dollar.
PERFORMANCE CHARACTERISTICS Rated Output: 1.8 @ 21 mph, (9.4 m/s) Maximum Output: 3.0 @ 27 mph, (12.1 m/s) Test Procedures: Data calculated.	

CONVERSION FACTORS

One mph = .44707 m/s
 One gallon = 3.785 liters
 One foot = .3048 meters
 One ft² = .09290 m²
 One kW = 1.341 hp
 One lbm = .4536 kG
 One lbf = 4.448 newtons

SYSTEM
 OUTPUT
 in
 Kilowatts

<p>MODEL : 400 - 14HDS</p> <p>Manufacturer: Sencenbaugh Wind Electrics Address: P. O. Box 1174, Palo Alto, CA 94306</p> <p>Contact: Jim Sencenbaugh, President Telephone: (415) 964-1593</p> <p>PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller type, up-wind. Capture Area: 38.5 ft², (3.5 m²) Rotor Diameter: 7.0 ft, (2.13 m) System Weight: 65 lbs, (29.48kGs) Rotor Weight: 3 lbs, (1.35 kGs) Blade Materials: Wood (Sitka spruce, Polyurethane finish, Bonded copper leading edge. Number of blades: Three</p> <p>OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 9 mph, (4.0 m/s) Shut Down Wind Speed: 60 mph, (27 m/s) Survival Wind Speed: 80 mph, (36 m/s) RPM at Rated Output: 1000rpm @ 20 mph, (9 m/s) Maximum RPM: 1200rpm @ 25 mph, (11.1 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Rotor tilts upwards in excessive winds. (Activated by rotor thrust). Yaw Control: None, rotor aligned by tail. Generator/Alternator: 14 VDC, self-excitation.</p> <p>Voltage Regulation: Standard Mechanical Power Transmission: Direct drive.</p> <p>PERFORMANCE CHARACTERISTICS Rated Output: 0.40 kW @ 20 mph, (9 m/s) Maximum Output: 0.50 kW @ 26 mph, (11.7 m/s) Test Procedures: Moving flat bed truck, instrumentation. Data averaged. Details available upon request, at cost.</p>	<p>TYPE: Electrical</p> <p>MISCELLANEOUS Length of time machine has been in operation: Six months. Design Features: Direct drive, fixed pitch.</p> <p>Warranty: One year parts and labor.</p> <p>Owners Manual: Available.</p> <p>Maintenance Schedule: Annual inspection: No grease points, bearings lubricated for life.</p> <p>NOTES:</p>
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CONVERSION FACTORS

One mph = .44707 m/s
One gallon = 3.785 liters
One foot = .3048 meters
One ft² = .09290 m²
One kW = 1.341 hp
One lbm = .4536 kg
One lbf = 4.448 newtons

SYSTEM
OUTPUT
in
Watts

MODEL : 500	TYPE: Electrical
Manufacturer: Sencenbaugh Wind Electric Address: P. O. Box 1174 Palo Alto, CA 94306 Contact: Jim Sencenbaugh, President Telephone: (415) 964-1593	
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller type, down-wind Capture Area: 28.3 ft ² , (2.6 m ²) Rotor Diameter: 6 ft, (1.8 m) System Weight: 140 lbs, (63.5 kGs) Rotor Weight: 9 lbs, (4.08 kGs) Blade Materials: Wood (Sitka spruce), bonded copper leading edge, epoxy finish. Number of Blades: Three	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 10 mph, (4.5 m/s) Shut-Down Wind Speed: 60 mph, (27 m/s) Survival Wind Speed: 120 mph, (53.6 m/s) RPM at Rated Output: 1000 rpm @ 24 mph, (10.8 m/s) Maximum RPM: 1200 rpm @ 28 mph, (12.5 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Mechanical: Rotor turns edge-wise to wind, activated by excessive thrust load. Yaw Control: None, rotor aligned by wind. Generator/Alternator: 14 or 28 VDC, self-excitation Voltage Regulation: Standard Mechanical Power Transmission: Direct drive, ratio - 1:1	MISCELLANEOUS Length of time machine has been in operation: One year. Design Features: Simple fixed-pitch design Warranty: One year - parts and workmanship. Owners Manual: Available for \$10.00. Maintenance Schedule: Annually - oil, grease, and inspect system.
PERFORMANCE CHARACTERISTICS Rated Output: 0.50 kW @ 24 mph, (10.8 m/s) Maximum Output: 0.63 kW @ 29 mph, (13.0 m/s) Test Procedures: Moving flat bed truck, instrumentation. Data averaged. Details available on request at cost.	NOTES:

CONVERSION FACTORS

One mph = .44707 m/s
 One gallon = 3.785 liters
 One foot = .3048 meters
 One ft² = .09290 m²
 One kW = 1.341 hp
 One lbm = .4536 kG
 One lbf = 4.448 newtons

SYSTEM
 OUTPUT
 in
 Watts

MODEL : 1000		TYPE: Electrical
Manufacturer: Sencenbaugh Wind Electric Address: P. O. Box 11174 Palo Alto, CA 94306 Contact: Jim Sencenbaugh, President Telephone: (415) 964-1593
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller type, up-wind Capture Area: 113.1 ft ² , (10.5 m ²) Rotor Diameter: 12 ft, (3.65 m) System Weight: 180 lbs, (81.7 kGs) Rotor Weight: 16 lbs, (7.3 kGs) Blade Materials: Wood (Sitka spruce) bonded copper leading edge, epoxy finish. Number of Blades: Three		
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 6 mph, (2.7 m/s) Shut-Down Wind Speed: 60 mph, (27 m/s) Survival Wind Speed: 80 mph, (36 m/s) RPM at Rated Output: 290 rpm @ 23 mph, (10.3 m/s) Maximum RPM: 350 rpm @ 27 mph, (12.1 m/s) Axial Thrust @ Rated Wind Speed: 300 lbs, (1335 N) Maximum Axial Thrust: 900 lbs, (6005 N) Overspeed Control: Mechanical; rotor turns edge-wise to wind, acitvated by excessive thrust load. Yaw Control: None, rotor aligned by tail. Generator/Alternator: 14 or 28 VDC, self-excitation. Voltage Regulation: Standard Mechanical Power Transmission: Helical gear box, ratio 3:1		
PERFORMANCE CHARACTERISTICS Rated Output: 1.0 kW @ 23 mph, (10.3 m/s) Maximum Output: 1.2 kW @ 28 mph, (12.6 m/s) Test Procedures: Moving flat bed truck instrumentation. Data averaged. Details available on request at cost. Data valid at 50 ft. (16m) above sea level.		NOTES:
<div><div><div>CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft² = .09290 m² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons</div><div>SYSTEM OUTPUT in Watts</div></div><div> </div></div>		

MODEL : A		TYPE: Electrical																																		
<p>Manufacturer: WhirlWind Power Company</p> <p>Address: Box 18530</p> <p>Denver, CO 80218</p> <p>Contact: Elliott Bayly</p> <p>Telephone: (303) 534-1567</p>
<p>PHYSICAL CHARACTERISTICS</p> <p>Generic Description: Horizontal Axis, Propeller-type, Down-wind.</p> <p>Capture Area: 78.5 ft²,(7.3 m²)</p> <p>Rotor Diameter: 10 ft ,(3.0 m)</p> <p>System Weight: 71 lbs,(32.2 kGs)</p> <p>Rotor Weight: N.A.</p> <p>Blade Materials: Wood (Sitka Spruce)</p> <p>Number of Blades: Two</p>																																				
<p>OPERATIONAL CHARACTERISTICS</p> <p>Cut-In Wind Speed: 8 mph,(3.6 m/s)</p> <p>Shut-Down Wind Speed: 50 mph,(22.4 m/s)</p> <p>Survival Wind Speed: 80 mph,(35.8 m/s)</p> <p>RPM at Rated Output: 900 rpm @ 25 mph,(11.2 m/s)</p> <p>Maximum RPM: 2000 rpm @ 50 mph,(22.4 m/s)</p> <p>Axial Thrust @ Rated Wind Speed: N.A.</p> <p>Maximum Axial Thrust: N.A.</p> <p>Overspeed Control: Electro-mechanical brake, actuated manually or automatically.</p> <p>Yaw Control: Down-wind optional damping</p> <p>Generator/Alternator: 12/24/32/48/120/240 VAC, 3 phase, permanent-magnet, current-limited.</p> <p>Voltage Regulation: Numerous options.</p> <p>Mechanical Power Transmission: Direct drive.</p>		<p>MISCELLANEOUS</p> <p>Length of time machine has been in operation: Two months</p> <p>Design Features: Automatic shut-down in high winds</p> <p>Warranty: One year parts and labor.</p> <p>Owners Manual: \$10.00 (Refundable with purchase of unit.)</p> <p>Maintenance Schedule: Every five years: lubricate four bearings, refinish and balance blade if necessary.</p>																																		
<p>PERFORMANCE CHARACTERISTICS</p> <p>Rated Output: 2000 watts @ 25 mph,(11.2 m/s)</p> <p>Maximum Output: 2000 watts @ 25 mph,(11.2 m/s)</p> <p>Test Procedures: Operated on moving test bed.</p> <p>Data valid at sea level.</p>		<p>NOTES:</p>																																		
<p>CONVERSION FACTORS</p> <p>One mph = .44707 m/s</p> <p>One gallon = 3.785 liters</p> <p>One foot = .3048 meters</p> <p>One ft² = .09290 m²</p> <p>One kW = 1.341 hp</p> <p>One lbm = .4536 kG</p> <p>One lbf = 4.448 newtons</p>		<table><caption>Performance Data Points (Estimated from Graph)</caption><thead><tr><th>Wind Velocity (mph)</th><th>Wind Velocity (m/s)</th><th>System Output (Watts)</th></tr></thead><tbody><tr><td>8</td><td>3.6</td><td>0</td></tr><tr><td>10</td><td>4.4</td><td>100</td></tr><tr><td>15</td><td>6.7</td><td>400</td></tr><tr><td>20</td><td>8.9</td><td>1000</td></tr><tr><td>25</td><td>11.2</td><td>2000</td></tr><tr><td>30</td><td>13.4</td><td>2000</td></tr><tr><td>40</td><td>17.9</td><td>2000</td></tr><tr><td>50</td><td>22.4</td><td>2000</td></tr><tr><td>60</td><td>26.8</td><td>2000</td></tr><tr><td>70</td><td>31.3</td><td>2000</td></tr></tbody></table>		Wind Velocity (mph)	Wind Velocity (m/s)	System Output (Watts)	8	3.6	0	10	4.4	100	15	6.7	400	20	8.9	1000	25	11.2	2000	30	13.4	2000	40	17.9	2000	50	22.4	2000	60	26.8	2000	70	31.3	2000
Wind Velocity (mph)	Wind Velocity (m/s)	System Output (Watts)																																		
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30	13.4	2000																																		
40	17.9	2000																																		
50	22.4	2000																																		
60	26.8	2000																																		
70	31.3	2000																																		

MODEL : 1222H	TYPE: Electrical
<p> Manufacturer: Winco - Division of Dyna Technology Address: 7850 Metro Parkway Minneapolis, Minnesota 55420 Contact: Sales Department Telephone: (612) 853-8400 </p>
<p> PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, up-wind. Capture Area: 28.3 ft², (2.6 m²) Rotor Diameter: 6.0 ft, (1.83 m) System Weight: 134. lbs, (61. kGs) Rotor Weight: 20. lbs, (9. kGs) Blade Materials: Wood (redwood), varnished. Copper strip leading edge. Number of blades: Two </p>	<p> MISCELLANEOUS Length of time machine has been in operation: Forty years. Design Features: Manually operated brake. Purchase price includes short tower. Warranty: One year - parts and labor. Owners Manual: Available for \$.50. Maintenance Schedule: Annually - oil and inspect. </p>
<p> OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 7 mph, (3.1 m/s) Shut-Down Wind Speed: 70 mph, (31 m/s) Survival Wind Speed: 70 mph, (31 m/s) RPM at Rated Output: 900 rpm @ 23 mph, (10.3 m/s) Maximum RPM: 900 rpm @ 70 mph, (31 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Air brake, activated by centrifugal forces on air brakes. Yaw Control: None, rotor aligned with wind by tail. Generator/Alternator: 12 VDC, wound field with self-excitation. Other voltages available include 24, 28, 32 and 36 VDC. Voltage Regulation: Available. Mechanical Power Transmission: None, direct drive, ratio = 1:1 </p>	<p> NOTES: Maximum amperage is 14. Maximum voltage is 15. </p>
<p> PERFORMANCE CHARACTERISTICS Rated Output: 0.2 kW @ 23 mph, (10.3 m/s) Maximum Output: 0.2 kW @ 23/70 mph, (10/31 m/s) Test Procedures: Tested under various operating conditions during the past 43 years by manufacturer and customers. Data valid at 1000 ft. (305m) above sea level. </p>	
<p> CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft² = .09290 m² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons </p>

MODEL : Storm Master 10 (prototype)	TYPE: Electrical
<p> Manufacturer: Wind Power Systems, Inc. Address: P. O. Box 17323 San Diego, CA 92117 Contact: Ed Salter Telephone: (714) 452-7040 </p>
<p>PHYSICAL CHARACTERISTICS</p> <p> Generic Description: Horizontal axis, propeller-type, down-wind. Capture Area: 845 ft², (78.5 m²) Rotor Diameter: 32.8 ft, (10 m) System Weight: 875 lbs, (398 kGs) Rotor Weight: 285 lbs, (130 kGs) Blade Materials: Fiberglass shell, foam core. Number of Blades: Three </p> <p>OPERATIONAL CHARACTERISTICS</p> <p> Cut-In Wind Speed: 8 mph, (3.6 m/s) Shut-Down Wind Speed: 150 mph, (67 m/s) Survival Wind Speed: 160 mph, (72 m/s) RPM at Rated Output: 130 rpm @ 18 mph, (8.0 m/s) Maximum RPM: 130 rpm @ 18 mph, (8.0 m/s) Axial Thrust @ Rated Wind Speed: 625 lbs, (2780 N) Maximum Axial Thrust: 3250 lbs, (14,460 N) Overspeed Control: Blade stall (windmill brake state). </p> <p> Yaw Control: Geared, driven by steering fan. Generator/Alternator: Variety available including 3 phase, 6-pole, permanent magnet alternator. </p> <p> Voltage Regulation: Available Mechanical Power Transmission: Gear-box, two stage </p>	<p>MISCELLANEOUS</p> <p>Length of time machine has been in operation:</p> <p>Tests scheduled to begin in May, 1978.</p> <p>Design Features: Blade pitch variable to achieve high starting torque and efficient operation. Blades precone 8°. Alternator may be shorted to achieve braking action.</p> <p>Warranty: One year, materials and workmanship.</p> <p>Owners Manual: Available.</p> <p>Maintenance Schedule: Not available.</p>
<p>PERFORMANCE CHARACTERISTICS</p> <p> Rated Output: 6 kW @ 18 mph, (8 m/s) Maximum Output: 6 kW @ any mph, (any m/s) Test Procedures: Data calculated. </p>	<p>NOTES:</p>
<p>CONVERSION FACTORS</p> <p> One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft² = .09290 m² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons </p>

MODEL : 15 kW	TYPE: Electrical
<p> Manufacturer: Zephyr Wind Dynamo Company Address: P. O. Box 241, 21 Stanwood St. Brunswick, Maine 04011 Contact: Willard D. Gillette, President Telephone: (207) 725-6534 </p>
<p> PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, down wind. Capture Area: 314 ft², (29 m²) Rotor Diameter: 20 ft, (6.1 m) System Weight: 675 lbs, (306 kGs) Rotor Weight: 100 lbs, (45 kGs) Blade Materials: Plastic composite. Number of Bladed: Three </p>	<p> MISCELLANEOUS Length of time machine has been in operation: Since December, 1975. Design Features: Light weight, non-metallic blades high ratio of output to weight, low-speed alternator. Warranty: One year: Parts and workmanship. Owners Manual: Available, \$25.00 Maintenance Schedule: </p>
<p> OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 8 mph, (3.6 m/s) Shut-Down Wind Speed: 45 mph, (20 m/s) Survival Wind Speed: 120 mph, (54 m/s) RPM at Rated Output: 300 rpm @ 30 mph, (13.4 m/s) Maximum RPM: 325 rpm @ 45 mph, (20 m/s) Axial Thrust @ Rated Wind Speed: 460 lbs, (2050 N) Maximum Axial Thrust: 1000 lbs, (4450 N) Overspeed Control: Mechanical, aero spoilers up to 45 mph, (20m/s). Automatic yawing out of wind when winds exceed 45 mph, (20 m/s). Yaw Control: Up to 5° of unrestricted yaw. Servo driven in yaw. Generator/Alternator: 15 kW permanent magnet. Voltage Regulation: Available Mechanical Power Transmission: None, direct drive, ratio=1:1 </p>	<p> NOTES: Alternator available separately. </p>
<p> PERFORMANCE CHARACTERISTICS Rated Output: 15 kW @ 30 mph, (13.4 m/s) Maximum Output: 15 kW @ 30 mph, (13.4 m/s) Test Procedures: Operated on tower, with instrumentation to determine wind speed and system output. </p>	
<p> CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft² = .09290 m² One kW = 1.341 hp One lbm = .4536 kg One lbf = 4.448 newtons </p> <p> SYSTEM OUTPUT in Kilowatts </p>

MODEL : Tetrahelix S	TYPE: Electrical
Manufacturer: Zephyr Wind Dynamo Company Address: P. O. Box 241, 21 Stanwood St. Brunswick, Maine 04011 Contact: Willard D. Gillette, President Telephone: (207) 725-6534
PHYSICAL CHARACTERISTICS Generic Description: Vertical axis, gyromill Capture Area: 12. ft ² , (1.1 m ²) Rotor Diameter: 2. ft, (.61 m) System Weight: 5. lbs, (2.3 kGs) Rotor Weight: 3. lbs, (1.4 kGs) Blade Materials: Dacron, Nylon, Aluminum Spars, Kevlar ties. Number of Blades: Two	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 12 mph, (5.4 m/s) Shut-Down Wind Speed: None Survival Wind Speed: 65 mph, (29 m/s) RPM at Rated Output: 430 rpm @ 25 mph, (11.2 m/s) Maximum RPM: 435 rpm @ 25 mph, (11.2 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Halyard may be weighted to allow non-destructive collapse at high windspeeds. Generator/Alternator: 14 VDC, permanent magnet Pump/Compressor: Pump under development Voltage Regulation: Available (standard) Mechanical Power Transmission: None, Direct drive, ratio - 1:1	MISCELLANEOUS Length of time machine has been in operation: One year Design Features: Stowable, quiet, light weight, easily installed, may be operated with axis on a slant Warranty: Thirty days - Materials and workmanship. Owners Manual: Available for \$5.00. Maintenance Schedule: Monthly inspection.
PERFORMANCE CHARACTERISTICS Rated Output: 7 watts @ 25 mph, (11.2 m/s) Maximum Output: 7 watts @ 25 mph, (11.2 m/s) Test Procedures: Moving test bed, mounted 10 feet ahead of land vehicle load was a 12 V battery.	NOTES: Design covered by one or more patents.
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons
SYSTEM OUTPUT in Watts	

TABLE 3.2

SUMMARY-MECHANICAL WIND MACHINES

The following TABLE is a summary of the major characteristics of each mechanical wind machine. The data are arranged according to pumping capacity (gal/hr) with an approximately 100' head elevation.

Name and Model		Capacity (Gal/Hr.)	Elevations (Feet)	Cyl. Dia. (Inches)	Rotor Dia. (Feet)	Rated Wind Speed MPH/(m/s)	Cut-In Wind Speed MPH/(m/s)
Aermotor	702-16	1,700	100	5 3/4	15	20/(9)	9/(4)
Aermotor	702-14	1,050	98	4 1/2	14	20/(9)	9/(4)
Dempster	14 ft.	NO DATA AVAILABLE @ 100' ELEV.			14	15/(6.7)	5/(2.2)
Aermotor	702-12	730	98	3 3/4	12	20/(9)	9/(4)
Dempster	12 ft.	630	108	3 1/2	12	15/(6.7)	5/(2.2)
Heller-Aller	Baker 12	600	100	3	12	15/(6.7)	7/(3.15)
Aermotor	702-10	470	100	3	10	20/(9)	9/(4)
Heller-Aller	Baker 10	460	100	2 1/2	10	15/(6.7)	7/(3.15)
Dempster	10 ft.	357	102	3	10	15/(6.7)	5/(2.2)
Aermotor	702-8	325	94	2 1/2	8	20/(9)	9/(4)
Heller-Aller	Baker-8	250	100	2	8	15/(6.7)	7/(3.5)
Dempster	8 ft.	248	107	2 1/4	8	15/(6.7)	5/(2.2)
Heller-Aller	Baker-6	150	100	2	6	15/(6.7)	7/(3.15)
Dempster	6 ft.	130	95	2	6	15/(6.7)	5/(2.2)
Aermotor	702-6	130	95	2	6	20/(9)	9/(4)
Sparco	D	58	13.1	N.A.	4.17	18/(8)	5/(2.2)
Sparco	P	58	32.8	N.A.	4.17	18/(8)	5/(2.2)
Wadler	271	NOT APPLICABLE			(Savonius)	N.A.	2/(0.9)
Wadler	273	NOT APPLICABLE			(Savonius)	N.A.	2/(0.9)
Wadler	370	NOT APPLICABLE			(Savonius)	N.A.	2/(0.9)
Wadler	672	NOT APPLICABLE			(Savonius)	N.A.	2/(0.9)

MECHANICAL WIND MACHINES

MODEL : 702 - 6 Ft.	TYPE: Mechanical Water Pumper
Manufacturer: Aermotor (Div. Valley Industries, Inc.) Address: Industrial Park P. O. Box 1364 Conway, AR 72032 Contact: Stan Anderson, Coordinator Telephone: (501) 329-9811
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi-bladed, up-wind. Capture Area: 28.3 ft ² , (2.6 m ²) Rotor Diameter: 6 ft, (1.8 m) System Weight: 210 lbs, (95.1 kGs) Rotor Weight: N.A. Blade Materials: Galvanized steel Number of Blades: Eighteen	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 9 mph, (4 m/s) Shut-Down Wind Speed: 28 mph, (12.6 m/s) Survival Wind Speed: 45 mph, (20.3 m/s) RPM at Rated Output: 125 rpm @ 20 mph, (9 m/s) Maximum RPM: 125 rpm @ 20 mph, (9 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: High thrust load causes rotor to turn sideways to wind. Yaw Control: None, rotor aligned with wind by tail. Pump/Compressor: Reciprocating cylinder 2" diameter Mechanical Power Transmission: Single reduction, double gear, ratio= 3.92:1	MISCELLANEOUS Length of time machine has been in operation: 44 years Design Features: Replaceable babbet bearings. Adjustable stroke, manual shut-off. Warranty: One year - materials and workmanship. Owners Manual: Available. Maintenance Schedule: Annually - lubricate with a 10 wt. or lighter non-detergent oil.
PERFORMANCE CHARACTERISTICS Rated Output: See chart @ 15 to 20 mph, (7 to 9 m/s) Maximum Output: See chart @ 15 to 20 mph, (7 to 9 m/s) Test Procedures: 44 years manufacturing experience	NOTES: Water horsepower = (.00000421) x (total head in feet) x (gallons per hour)

CONVERSION FACTORS	PUMPING CAPACITIES								
	Diameter of Cylinder (Inches)	Capacity per Hour (Gallons)		Total Elevation in Feet					
				Size of AERMOTOR					
		6 Ft.	8 - 16 Ft.	6 Ft.	8 Ft.	10 Ft.	12 Ft.	14 Ft.	16 Ft.
One mph = .44707 m/s	1 3/4	105	150	130	185	280	420	600	1,000
One gallon = 3.785 liters	1 7/8	125	180	120	175	260	390	560	920
One foot = .3048 meters	2	130	190	95	140	215	320	460	750
One ft ² = .09290 m ²	2 1/4	180	260	77	112	170	250	360	590
One kW = 1.341 hp	2 1/2	225	325	65	94	140	210	300	490
One lbm = .4536 kG	2 3/4	265	385	56	80	120	180	260	425
One lbf = 4.448 newtons	3	320	470	47	68	100	155	220	360
	3 1/4		550			88	130	185	305
	3 1/2	440	640	35	50	76	115	160	265
	3 3/4		730			65	98	143	230
	4	570	830	27	39	58	86	125	200
	4 1/4		940			51	76	110	180
	4 1/2	725	1,050	21	30	46	68	98	160
	4 3/4		1,170			61	88	125	140
	5	900	1,300	17	25	37	55	80	130
	5 3/4		1,700				40	60	100
	6		1,875		17	25	38	55	85
	7		2,550			19	28	41	65
	8		3,300			14	22	31	50
Capacities shown in the above table are approximate, based on the mill set on the long stroke, operating in a 15 to 20 mile-per-hour wind. The short stroke increases elevation by one-third and reduces pumping capacity one-fourth.									

MODEL : 702 - 8 Ft.	TYPE: Mechanical Water Pumper
Manufacturer: Aermotor (Div. Valley Industries, Inc.) Address: Industrial Park - P. O. Box 1364 Conway, AR 73032 Contact: Stan Anderson, Coordinator Telephone: (501) 329-9811
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi-bladed, up-wind. Capture Area: 50.3 ft ² , (4.67 m ²) Rotor Diameter: 8 ft, (2.4 m) System Weight: 355 lbs, (160.8 kGs) Rotor Weight: N.A. Blade Materials: Galvanized steel Number of blades: Eighteen	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 9 mph, (4 m/s) Shut-Down Wind Speed: 28 mph, (12.6 m/s) Survival Wind Speed: 45 mph, (20.3 m/s) RPM at Rated Output: 105 rpm @ 20 mph, (9 m/s) Maximum RPM: 105 rpm @ 20 mph, (9 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N. A. Overspeed Control: High thrust load causes rotor to turn edgewise to wind. Yaw Control: None, rotor aligned with wind by tail. Pump / Compressor: Reciprocating cylinder Mechanical Power Transmission: Single reduction, ratio = 3.29:1	MISCELLANEOUS Length of time machine has been in operation: 44 years. Design Features: Replaceable babbit bearings, adjustable stroke, manual shut-off. Warranty: One year - materials and workmanship. Owners Manual: Available Maintenance Schedule: Annually - lubricate with 10 wt. or lighter non-detergent oil.
PERFORMANCE CHARACTERISTICS Rated Output: See chart @ 15 to 20 mph, (7 to 9 m/s) Maximum Output: See chart @ 15 to 20 mph, (7 to 9 m/s) Test Procedures: 44 years manufacturing experience.	NOTES: Water horsepower= (.00000421) x (total head in feet) x (gallons per hour).

CONVERSION FACTORS	PUMPING CAPACITIES								
	Diameter of Cylinder (Inches)	Capacity per Hour (Gallons)		Total Elevation in Feet					
				Size of AERMOTOR					
		6 Ft.	8 - 16 Ft.	6 Ft.	8 Ft.	10 Ft.	12 Ft.	14 Ft.	16 Ft.
One mph = .44707 m/s	1 3/4	105	150	130	185	280	420	600	1,000
One gallon = 3.785 liters	1 7/8	125	180	120	175	260	390	560	920
One foot = .3048 meters	2	130	190	95	140	215	320	460	750
One ft ² = .09290 m ²	2 1/4	180	260	77	112	170	250	360	590
One kW = 1.341 hp	2 1/2	225	325	65	94	140	210	300	490
One lbm = .4536 kg	2 3/4	265	385	56	80	120	180	260	425
One lbf = 4.448 newtons	3	320	470	47	68	100	155	220	360
	3 1/4		550			88	130	185	305
	3 1/2	440	640	35	50	76	115	160	265
	3 3/4		730			65	98	143	230
	4	570	830	27	39	58	86	125	200
	4 1/4		940			51	76	110	180
	4 1/2	725	1,050	21	30	46	68	98	160
	4 3/4		1,170			61	88	125	140
	5	900	1,300	17	25	37	55	80	130
	5 3/4		1,700			40	60	85	100
	6		1,875		17	25	38	55	85
	7		2,550			19	28	41	65
	8		3,300			14	22	31	50
Capacities shown in the above table are approximate, based on the mill set on the long stroke, operating in a 15 to 20 mile-per-hour wind. The short stroke increases elevation by one-third and reduces pumping capacity one-fourth.									

MODEL: 702 - 10 Ft.		Aermotor TYPE: Mechanical Water Pumper								
Manufacturer: Aermotor (Div. Valley Industries, Inc.) Address: Industrial Park - P. O. Box 1364 Conway, AK 73032 Contact: Stan Anderson, Coordinator Telephone: (501) 329-9811
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi-bladed, up-wind. Capture Area: 78.5 ft ² , (7.3 m ²) Rotor Diameter: 10 ft, (3.05 m) System Weight: 645 lbs, (292.2 kGs) Rotor Weight: N.A. Blade Materials: Galvanized steel Number of Blades: Eighteen										
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 9 mph, (4.0 m/s) Shut-Down Wind Speed: 28 mph, (12.6 m/s) Survival Wind Speed: 45 mph, (20.3 m/s) RPM at Rated Output: 85 rpm @ 20 mph, (9 m/s) Maximum RPM: 85 rpm @ 20 mph, (9 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Mechanical, high thrust load causes rotor to turn edgewise to the wind. Yaw Control: None, rotor aligned with wind by tail. Generator/Alternator: 12/24/32/48/120/240 VAC, 3 phase, permanent-magnet, current-limited. Pump/Compressor: Reciprocating cylinder Voltage Regulation: Numerous options. Mechanical Power Transmission: Single reduction, ratio = 3.29:1		MISCELLANEOUS Length of time machine has been in operation: 44 years Design Features: Replaceable babbit bearings, adjustable stroke, manual shut-off. Warranty: One year - materials and workmanship. Owners Manual: Available (available with purchase of unit.) Maintenance Schedule: Annually; lubricate with a 10 weight (or lighter) non-detergent oil. (balance blade if necessary)								
PERFORMANCE CHARACTERISTICS Rated Output: See chart @ 15 to 20 mph, (7 to 9 m/s) Maximum Output: See chart @ 15 to 20 mph, (7 to 9 m/s) Test Procedures: 44 years manufacturing experience Data valid at sea level.		NOTES: Water horsepower = (.00000421) x (Total head in feet) x (gallons per hour).								
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kg One lbf = 4.448 newtons		PUMPING CAPACITIES								
SYSTEM OUTPUT in Watts		Diameter of Cylinder (Inches)	Capacity per Hour (Gallons) 6 Ft. 8 - 16 Ft.		Total Elevation in Feet Size of AERMOTOR					
					6 Ft.	8 Ft.	10 Ft.	12 Ft.	14 Ft.	16 Ft.
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100		1 3/4	105	150	130	185	280	420	600	1,000
		1 7/8	125	180	120	175	260	390	560	920
		2	130	190	95	140	215	320	460	750
		2 1/4	180	260	77	112	170	250	360	590
		2 1/2	225	325	65	94	140	210	300	490
		2 3/4	265	385	56	80	120	180	260	425
		3	320	470	47	68	100	155	220	360
		3 1/4		550			88	130	185	305
		3 1/2	440	640	35	50	76	115	160	265
		3 3/4		730			65	98	143	230
		4	570	830	27	39	58	86	125	200
		4 1/4		940			51	76	110	180
		4 1/2	725	1,050	21	30	46	68	98	160
		4 3/4		1,170			61	88	140	140
		5	900	1,300	17	25	37	55	80	130
		5 3/4		1,700			40	60	100	100
6		1,875		17	25	38	55	85		
7		2,550			19	28	41	65		
8		3,300			14	22	31	50		
Capacities shown in the above table are approximate, based on on the mill set on the long stroke, operating in a 15 to 20 mile-per-hour wind. The short stroke increases elevation by one-third and reduces pumping capacity one-fourth.										

MODEL : 702 - 12 Ft.		TYPE: Mechanical Water Pumper																																																																																																																																																																																																													
<p>Manufacturer: Aermotor (Div. Valley Industries, Inc.)</p> <p>Address: Industrial Park P. O. Box 1364 Conway, AR 72032</p> <p>Contact: Stan Anderson, Coordinator</p> <p>Telephone: (510) 329-9811</p>
<p>PHYSICAL CHARACTERISTICS</p> <p>Generic Description: Horizontal axis, multi-bladed, up-wind</p> <p>Capture Area: 113.1 ft²,(10.5 m²)</p> <p>Rotor Diameter: 12 ft ,(3.65 m)</p> <p>System Weight: 1090 lbs,(493.8 kGs)</p> <p>Rotor Weight: N.A.</p> <p>Blade Materials: Galvanized steel.</p> <p>Number of blades: Eighteen</p>																																																																																																																																																																																																															
<p>OPERATIONAL CHARACTERISTICS</p> <p>Cut-In Wind Speed: 9 mph,(4 m/s)</p> <p>Shut-Down Wind Speed: 28 mph,(12.6 m/s) (adjustable)</p> <p>Survival Wind Speed: 45 mph,(20.3 m/s)</p> <p>RPM at Rated Output: 73 rpm @ 20 mph,(9 m/s)</p> <p>Maximum RPM: 73 rpm @ 20 mph,(9 m/s)</p> <p>Axial Thrust @ Rated Wind Speed: N.A.</p> <p>Maximum Axial Thrust: N.A.</p> <p>Overspeed Control: Mechanical, high thrust causes rotor to turn edgewise to wind.</p> <p>Yaw Control: None, rotor aligned with wind by tail</p> <p>Pump/Compressor: Reciprocating cylinder.</p> <p>Mechanical Power Transmission: Single reduction, ratio= 3.50:1</p>		<p>MISCELLANEOUS</p> <p>Length of time machine has been in operation: 44 years</p> <p>Design Features: Not available</p> <p>Warranty: One year - materials and workmanship.</p> <p>Owners Manual: Available.</p> <p>Maintenance Schedule: Annually - lubricate with a 10 wt. or lighter non- detergent oil.</p>																																																																																																																																																																																																													
<p>PERFORMANCE CHARACTERISTICS</p> <p>Rated Output: See chart @ 15 to 20 mph,(7 to 9m/s)</p> <p>Maximum Output: See chart @ 15 to 20 mph,(7 to 9m/s)</p> <p>Test Procedures: 44 years manufacturing experience.</p>		<p>NOTES: Water horsepower - (.00000421) x (total head in feet) x (gallons per hour)</p>																																																																																																																																																																																																													
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MODEL : 702 - 14 Ft.	TYPE: Mechanical Water Pumper
Manufacturer: Aermotor (Div. of Valley Industries, Inc.) Address: Industrial Park, P. O. Box 1364 Conway, AR 72032 Contact: Stan Anderson, Coordinator Telephone: (501) 329-9811
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi-bladed, up-wind. Capture Area: 153.9 ft ² ,(14.3 m ²) Rotor Diameter: 14 ft ,(4.3 m) System Weight: 1695 lbs,(770 kGs) Rotor Weight: N.A. Blade Materials: Galvanized steel. Number of Blades: Eighteen.	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 9 mph,(4 m/s) Shut-Down Wind Speed: 28 mph,(12.6 m/s) Survival Wind Speed: 45 mph,(20 m/s) RPM at Rated Output: 62 rpm @ 20 mph,(9 m/s) Maximum RPM: 62 rpm @ 20 mph,(9 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Mechanical, high thrust causes rotor to turn sideways to wind. Yaw Control: None, rotor aligned with wind by tail. Pump/Compressor: Reciprocating cylinder. Mechanical Power Transmission: Single reduction, ratio=3.43:1.	MISCELLANEOUS Length of time machine has been in operation: 44 years Design Features: Not available. Warranty: One year-materials and workmanship. Owners Manual: Available Maintenance Schedule: Annually - lubricate with a 10 wt. or lighter non-detergent oil.
PERFORMANCE CHARACTERISTICS Rated Output: See chart @ 15 to 20 mph,(7 to 9 m/s) Maximum Output: See chart @ 15 to 20 mph,(7 to 9 m/s) Test Procedures: 44 years manufacturing experience.	NOTES: Water horsepower=(.00000421) x (total head in feet) x (gallons per hour).

CONVERSION FACTORS

One mph = .44707 m/s
 One gallon = 3.785 liters
 One foot = .3048 meters
 One ft² = .09290 m²
 One kW = 1.341 hp
 One lbm = .4536 kG
 One lbf = 4.448 newtons

PUMPING CAPACITIES

Diameter of Cylinder (Inches)	Capacity per Hour (Gallons)		Total Elevation in Feet					
			Size of AERMOTOR					
	6 Ft.	8 - 16 Ft.	6 Ft.	8 Ft.	10 Ft.	12 Ft.	14 Ft.	16 Ft.
1 3/4	105	150	130	185	280	420	600	1,000
1 7/8	125	180	120	175	260	390	560	920
2	130	190	95	140	215	320	460	750
2 1/4	180	260	77	112	170	250	360	590
2 1/2	225	325	65	94	140	210	300	490
2 3/4	265	385	56	80	120	180	260	425
3	320	470	47	68	100	155	220	360
3 1/4		550			88	130	185	305
3 1/2	440	640	35	50	76	115	160	265
3 3/4		730			65	98	143	230
4	570	830	27	39	58	86	125	200
4 1/4		940			51	76	110	180
4 1/2	725	1,050	21	30	46	68	98	160
4 3/4		1,170			61	88	140	230
5	900	1,300	17	25	37	55	80	130
5 3/4		1,700			40	60	100	160
6		1,875		17	25	38	55	85
7		2,550			19	28	41	65
8		3,300			14	22	31	50

Capacities shown in the above table are approximate, based on on the mill set on the long stroke, operating in a 15 to 20 mile-per-hour wind. The short stroke increases elevation by one-third and reduces pumping capacity one-fourth.

MODEL : 702 - 16 Ft.		TYPE: Mechanical Water Pumper																																																																																																																																																																																																															
Manufacturer: Aermotor (Div. of Valley Industries, Inc.) Address: Industrial Park, P. O. Box 1364 Conway, AR 72032 Contact: Stan Anderson, Coordinator Telephone: (501) 329 - 9811
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi-bladed, up-wind. Capture Area: 201.1 ft ² , (18.68 m ²) Rotor Diameter: 16 ft, (4.87 m) System Weight: 2450 lbs, (1190.8 kGs) Rotor Weight: 830 lbs, (376 kGs) Blade Materials: Galvanized steel Number of Blades: Eighteen																																																																																																																																																																																																																	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 9 mph, (4 m/s) Shut-Down Wind Speed: 28 mph, (12.6 m/s) (adjustable) Survival Wind Speed: 45 mph, (20.3 m/s) RPM at Rated Output: 53 rpm @ 20 mph, (9 m/s) Maximum RPM: 53 rpm @ 20 mph, (9 m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Mechanical, high thrust causes rotor to turn sideways to the wind. Yaw Control: None, rotor aligned with wind by tail Generator/Alternator: 15 kW permanent magnet. Pump/Compressor: Reciprocating cylinder. Mechanical Power Transmission: Single reduction ratio=3.29:1		MISCELLANEOUS Length of time machine has been in operation: 44 years. Design Features: Not available. Warranty: One year - materials and workmanship. Owners Manual: Available in the near future. Maintenance Schedule: Annually - lubricate with a 10 wt. or lighter non-detergent oil.																																																																																																																																																																																																															
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8		3,300			14	22	31	50																																																																																																																																																																																																									

MODEL : 6 Ft. helix S	TYPE: Mechanical Water Pumper
<p>Manufacturer: Dempster Industries, Inc. company</p> <p>Address: P.O. Box 848 1, 21 Stanwood St. Beatrice, NB 68310 4011</p> <p>Contact: Inside Sales Department resident</p> <p>Telephone: (402) 7223-4026/4</p>
<p>PHYSICAL CHARACTERISTICS</p> <p>Generic Description: Horizontal axis, multi-bladed, up-wind.</p> <p>Capture Area: 28.3 ft², (2.6 m²)</p> <p>Rotor Diameter: 62 ft, (1.81 m)</p> <p>System Weight: 280 lbs, (126.8 kGs)</p> <p>Rotor Weight: 100 lbs, (45.3 kGs)</p> <p>Blade Materials: Galvanized steel. Aluminum Spars, Kevlar ties.</p> <p>Number of Blades: Eighteen</p>	<p>MISCELLANEOUS</p> <p>Length of time machine has been in operation: Eighty years.</p> <p>Design Features: Fixed pitch blades, light weight, easily installed, may be operated with axis on a slant</p> <p>Warranty: Limited five years-parts and workmanship.</p> <p>Owners Manual: Available for free.</p> <p>Maintenance Schedule: Annually; inspect entire system, change oil.</p>
<p>OPERATIONAL CHARACTERISTICS</p> <p>Cut-In Wind Speed: 5 1/2 mph, (2.24 m/s)</p> <p>Shut-Down Wind Speed: None mph, (-- m/s) See notes</p> <p>Survival Wind Speed: N.A. 5 mph, (2.9 m/s)</p> <p>RPM at Rated Output: N.A. rpm @ 25 mph, (11.2 m/s)</p> <p>Maximum RPM: 160 rpm @ N.A. mph, (N.A. m/s)</p> <p>Axial Thrust @ Rated Wind Speed: N.A.</p> <p>Maximum Axial Thrust: N.A.</p> <p>Overspeed Control: Mechanical: high thrust turns rotor sideways to wind. at high windspeeds.</p> <p>Yaw Control: None, rotor aligned with wind by tail.</p> <p>Generator/Alternator: 12 VDC, permanent magnet</p> <p>Pump/Compressor: Reciprocating cylinder; see chart below.</p> <p>Voltage Regulation: Available (standard)</p> <p>Mechanical Power Transmission: Gear box, single stage ratio=4:1</p>	<p>NOTES: Manual shut-down of system is advisable whenever the pumping rate exceeds 40 strokes per minute.</p>
<p>PERFORMANCE CHARACTERISTICS</p> <p>Rated Output: 0.19 h.p. watts @ 15 mph, (6.7 m/s)</p> <p>Maximum Output: N.A. 7 watts @ 25 mph, (11.2 m/s)</p> <p>Test Procedures: Data calculated and tested. 0 feet ahead of land vehicle load was a 12 V battery.</p>	

CONVERSION FACTORS

One mph = .44707 m/s
 One gallon = 3.785 liters
 One foot = .3048 meters
 One ft² = .09290 m²
 One kW = 1.341 hp
 One lbm = .4536 kg
 One lbf = 4.448 newtons

SYSTEM
OUTPUT
lb
WATTS

PUMPING CAPACITIES (15 Mile-Per-Hour Wind)

Cylinder Size	6 Ft. 5" Stroke Elev. G.P.H.	8 Ft. "A" 7 1/2" Stroke Elev. G.P.H.	10 Ft. 7 1/2" Stroke Elev. G.P.H.	12 Ft. 12" Stroke Elev. G.P.H.	14 Ft. 12" Stroke Elev. G.P.H.
1 7/8"	120 115	172 173	256 140	388 180	580 159
2"	95 130	135 195	210 159	304 206	455 176
2 1/4"	75 165	107 248	165 202	240 260	360 222
2 1/2"	62 206	89 304	137 248	200 322	300 276
2 3/4"	54 248	77 370	119 300	173 390	260 334
3"	45 294	65 440	102 357	147 463	220 396
3 1/4"	39 346	55 565	86 418	125 544	187 465
3 1/2"	34 400	48 600	75 487	108 630	162 520
3 3/4"	29 457	42 688	65 558	94 724	142 620
4"	26 522	37 780	57 635	83 822	124 706

If the wind velocity is increased, or decreased, the pumping capacity of the windmill will also be increased, or decreased. Capacities will be reduced approximately as follows for wind speeds below 15 miles-per-hour:

1. Capacity reduced approximately 20% for 12 mile per hour wind.
2. Capacity reduced approximately 38% for 10 mile-per-hour wind.

MODEL : 8 Ft.		TYPE: Mechanical Water Pumper							
Manufacturer: Dempster Industries, Inc. Address: P. O. Box 848 Beatrice ,NB 68310 Contact: Inside Sales Department Telephone: (402) 223-4026
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi-bladed, up-wind. Capture Area: 50.3 ft ² ,(4.67 m ²) Rotor Diameter: 8 ft ,(2.4 m) System Weight: 388 lbs,(175.5 kGs) Rotor Weight: 120 lbs,(54.3 kGs) Blade Materials: Galvanized steel Number of Blades: Eighteen									
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 5 mph,(2.2 m/s) Shut-Down Wind Speed: — mph,(— m/s) (See notes.) Survival Wind Speed: N.A. RPM at Rated Output: N.A. Maximum RPM: 133 rpm @ N.A.mph,(N.A.m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; high thrust turns rotor sideways to the wind. Yaw Control: None, rotor aligned with wind by tail. Pump/Compressor: Reciprocating cylinder; see chart below. Mechanical Power Transmission: Gear box, single-stage, ratio=3.33:1		MISCELLANEOUS Length of time machine has been in operation: Fifty years. Design Features: Fixed pitch blades. Manual shut-down. Warranty: Limited, five years – parts and workmanship. Owners Manual: Available for free. Maintenance Schedule: Annually; change oil, inspect entire system.							
PERFORMANCE CHARACTERISTICS Rated Output: 0.34 h.p. @ 15 mph,(6.7 m/s) Maximum Output: N.A. Test Procedures: Data calculated and tested.		NOTES: Manual shut-down of system is advised whenever the pumping rate exceeds 40 strokes per minute.							
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons		PUMPING CAPACITIES (15 Mile-Per-Hour Wind)							
		Cylinder Size	6 Ft. 5" Stroke Elev. G.P.H.	8 Ft. "A" 7 1/2" Stroke Elev. G.P.H.	10 Ft. 7 1/2" Stroke Elev. G.P.H.	12 Ft. 12" Stroke Elev. G.P.H.	14 Ft. 12" Stroke Elev. G.P.H.		
		1 7/8"	120 115	172 173	256 140	388 180	580 159		
		2"	95 130	135 195	210 159	304 206	455 176		
		2 1/4"	75 165	107 248	165 202	240 260	360 222		
		2 1/2"	62 206	89 304	137 248	200 322	300 276		
		2 3/4"	54 248	77 370	119 300	173 390	260 334		
		3"	45 294	65 440	102 357	147 463	220 396		
		3 1/4"	39 346	55 565	86 418	125 544	187 465		
		3 1/2"	34 400	48 600	75 487	108 630	162 540		
		3 3/4"	29 457	42 688	65 558	94 724	142 620		
		4"	26 522	37 780	57 635	83 822	124 706		
		If the wind velocity is increased , or decreased, the pumping capacity of the windmill will also be increased, or decreased. Capacities will be reduced approximately as follows for wind speeds below 15 miles-per-hour: 1. Capacity reduced approximately 20% for 12 mile-per-hour wind. 2. Capacity reduced approximately 38% for 10 mile-per-hour wind.							

MODEL : 10 Ft. Manufacturer: Dempster Industries, Inc. Address: P. O. Box 848 Beatrice, NB 68310 Contact: Inside Sales Department Telephone: (402) 223-4026	TYPE: Mechanical; Water Pumper
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi-bladed, up-wind. Capture Area: 78.5 ft ² , (7.3 m ²) Rotor Diameter: 10 ft, (3.05 m) System Weight: 500 lbs, (226.5 kGs) Rotor Weight: 150 lbs, (67.9 kGs) Blade Materials: Galvanized steel. Number of Blades: Eighteen	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 5 mph, (2.2 m/s) Shut-Down Wind Speed: -- mph, (-- m/s) (See notes) Survival Wind Speed: N.A. RPM at Rated Output: N.A. Maximum RPM: 105 rpm @ N. A.mph, (N.A. m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; high thrust turns rotor sideways to the wind. Yaw Control: None, rotor aligned with wind by tail. Pump/Compressor: Reciprocating cylinder; see chart below. Mechanical Power Transmission: Gear box, single stage, ratio=3:1	MISCELLANEOUS Length of time machine has been in operation: Eighty years. Design Features: Fixed pitch blades. Manual shut-down. Warranty: Limited, five years, parts and workmanship. Owners Manual: Available for free. Maintenance Schedule: Annually; change oil, inspect entire system.
PERFORMANCE CHARACTERISTICS Rated Output: 0.53 h. p. @ 15 mph, (6.7 m/s) Maximum Output: N. A. Test Procedures: Data calculated and tested.	NOTES: Manual shut-down of this system is advised whenever pumping rate exceeds 35 strokes per minute.

CONVERSION FACTORS

One mph = .44707 m/s
One gallon = 3.785 liters
One foot = .3048 meters
One ft² = .09290 m²
One kW = 1.341 hp
One lbm = .4536 kG
One lbf = 4.448 newtons

PUMPING CAPACITIES (15 Mile-Per-Hour Wind)

Cylinder Size	6 Ft. 5" Stroke		8 Ft. "A" 7 1/2" Stroke		10 Ft. 7 1/2" Stroke		12 Ft. 12" Stroke		14 Ft. 12" Stroke	
	Elev.	G.P.H.	Elev.	G.P.H.	Elev.	G.P.H.	Elev.	G.P.H.	Elev.	G.P.H.
1 7/8"	120	115	172	173	256	140	388	180	580	159
2"	95	130	135	195	210	159	304	206	455	176
2 1/4"	75	165	107	248	165	202	240	260	360	222
2 1/2"	62	206	89	304	137	248	200	322	300	276
2 3/4"	54	248	77	370	119	300	173	390	260	334
3"	45	294	65	440	102	357	147	463	220	396
3 1/4"	39	346	55	565	86	418	125	544	187	465
3 1/2"	34	400	48	600	75	487	108	630	162	540
3 3/4"	29	457	42	688	65	558	94	724	142	620
4"	26	522	37	780	57	635	83	822	124	706

If the wind velocity is increased, or decreased, the pumping capacity of the windmill will also be increased, or decreased. Capacities will be reduced approximately as follows for wind speeds below 15 miles-per-hour:

1. Capacity reduced approximately 20% for 12 mile per-hour wind.
2. Capacity reduced approximately 38% for 10 mile-per-hour wind.

MODEL : 12 Ft.		TYPE: Mechanical Water Pumper																																																																																																																																				
Manufacturer: Dempster Industries, Inc. Address: 1, O. Box 848 Beatrice, MB 68310 Contact: Inside Sales Department Telephone: (402) 223-4026
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi-bladed, up-wind. Capture Area: 113.1 ft ² , (10.5 m ²) Rotor Diameter: 12 ft, (3.6 m) System Weight: 935 lbs, (423.5 kGs) Rotor Weight: 334 lbs, (151.3 kGs) Blade Materials: Galvanized steel. Number of blades: Eighteen		MISCELLANEOUS Length of time machine has been in operation: Eighty years. Design Features: Fixed pitch blades, manual shutdown. Warranty: Limited, five year - parts and workmanship. Owners Manual: Available. Maintenance Schedule: Annually - change oil, inspect entire system.																																																																																																																																				
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 5 mph, (2.2 m/s) Shut-Down Wind Speed: -- mph, (-- m/s) (See notes) Survival Wind Speed: N.A. RPM at Rated Output: N.A. Maximum RPM: 90 rpm @ N. A. mph, (N.A. m/s) Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; high thrust turns rotor sideways to the wind. Yaw Control: None, rotor aligned with wind by tail. Pump/Compressor: Reciprocating cylinder; see chart below. Mechanical Power Transmission: Gear box, single stage, ratio=3:1		NOTES: Manual shut-down of this system is advised if pumping rate exceeds 30 strokes per minute.																																																																																																																																				
PERFORMANCE CHARACTERISTICS Rated Output: 0.76 hp @ 15 mph, (6.7 m/s) Maximum Output: N.A. Test Procedures: Data calculated and tested.																																																																																																																																						
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kg One lbf = 4.448 newtons		<table border="1"> <caption>PUMPING CAPACITIES (15 Mile-Per-Hour Wind)</caption> <thead> <tr> <th rowspan="2">Cylinder Size</th> <th colspan="2">6 Ft. 5" Stroke</th> <th colspan="2">8 Ft. "A" 7 1/2" Stroke</th> <th colspan="2">10 Ft. 7 1/2" Stroke</th> <th colspan="2">12 Ft. 12" Stroke</th> <th colspan="2">14 Ft. 12" Stroke</th> </tr> <tr> <th>Elev.</th> <th>G.P.H.</th> <th>Elev.</th> <th>G.P.H.</th> <th>Elev.</th> <th>G.P.H.</th> <th>Elev.</th> <th>G.P.H.</th> <th>Elev.</th> <th>G.P.H.</th> </tr> </thead> <tbody> <tr> <td>1 7/8"</td> <td>120</td> <td>115</td> <td>172</td> <td>173</td> <td>256</td> <td>140</td> <td>388</td> <td>180</td> <td>580</td> <td>159</td> </tr> <tr> <td>2"</td> <td>95</td> <td>130</td> <td>135</td> <td>195</td> <td>210</td> <td>159</td> <td>304</td> <td>206</td> <td>455</td> <td>176</td> </tr> <tr> <td>2 1/4"</td> <td>75</td> <td>165</td> <td>107</td> <td>248</td> <td>165</td> <td>202</td> <td>240</td> <td>260</td> <td>360</td> <td>222</td> </tr> <tr> <td>2 1/2"</td> <td>62</td> <td>206</td> <td>89</td> <td>304</td> <td>137</td> <td>248</td> <td>200</td> <td>322</td> <td>300</td> <td>276</td> </tr> <tr> <td>2 3/4"</td> <td>54</td> <td>248</td> <td>77</td> <td>370</td> <td>119</td> <td>300</td> <td>173</td> <td>390</td> <td>260</td> <td>334</td> </tr> <tr> <td>3"</td> <td>45</td> <td>294</td> <td>65</td> <td>440</td> <td>102</td> <td>357</td> <td>147</td> <td>463</td> <td>220</td> <td>396</td> </tr> <tr> <td>3 1/4"</td> <td>39</td> <td>346</td> <td>55</td> <td>565</td> <td>86</td> <td>418</td> <td>125</td> <td>544</td> <td>187</td> <td>465</td> </tr> <tr> <td>3 1/2"</td> <td>34</td> <td>400</td> <td>48</td> <td>600</td> <td>75</td> <td>487</td> <td>108</td> <td>630</td> <td>162</td> <td>540</td> </tr> <tr> <td>3 3/4"</td> <td>29</td> <td>457</td> <td>42</td> <td>688</td> <td>65</td> <td>558</td> <td>94</td> <td>724</td> <td>142</td> <td>620</td> </tr> <tr> <td>4"</td> <td>26</td> <td>522</td> <td>37</td> <td>780</td> <td>57</td> <td>635</td> <td>83</td> <td>822</td> <td>124</td> <td>706</td> </tr> </tbody> </table> <p>If the wind velocity is increased, or decreased, the pumping capacity of the windmill will also be increased, or decreased. Capacities will be reduced approximately as follows for wind speeds below 15 miles-per-hour:</p> <ol style="list-style-type: none"> 1. Capacity reduced approximately 20% for 12 mile-per-hour wind. 2. Capacity reduced approximately 38% for 10 mile-per-hour wind. 		Cylinder Size	6 Ft. 5" Stroke		8 Ft. "A" 7 1/2" Stroke		10 Ft. 7 1/2" Stroke		12 Ft. 12" Stroke		14 Ft. 12" Stroke		Elev.	G.P.H.	Elev.	G.P.H.	Elev.	G.P.H.	Elev.	G.P.H.	Elev.	G.P.H.	1 7/8"	120	115	172	173	256	140	388	180	580	159	2"	95	130	135	195	210	159	304	206	455	176	2 1/4"	75	165	107	248	165	202	240	260	360	222	2 1/2"	62	206	89	304	137	248	200	322	300	276	2 3/4"	54	248	77	370	119	300	173	390	260	334	3"	45	294	65	440	102	357	147	463	220	396	3 1/4"	39	346	55	565	86	418	125	544	187	465	3 1/2"	34	400	48	600	75	487	108	630	162	540	3 3/4"	29	457	42	688	65	558	94	724	142	620	4"	26	522	37	780	57	635	83	822	124	706
Cylinder Size	6 Ft. 5" Stroke		8 Ft. "A" 7 1/2" Stroke		10 Ft. 7 1/2" Stroke		12 Ft. 12" Stroke		14 Ft. 12" Stroke																																																																																																																													
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MODEL : 14 Ft.

TYPE: Mechanical Water Pumper

Manufacturer: Dempster Industries, Inc.
 Address: P. O. Box 848
 Beatrice, NB 68310
 Contact: Inside Sales Department
 Telephone: (402) 223-4026

PHYSICAL CHARACTERISTICS

Generic Description: Horizontal axis, multi-bladed, up-wind.
 Capture Area: 153.9 ft², (14.3 m²)
 Rotor Diameter: 14 ft, (4.3 m)
 System Weight: 1450 lbs, (660 kGs)
 Rotor Weight: 616 lbs, (280 kGs)
 Blade Materials: Galvanized steel.
 Number of Blades: Eighteen

OPERATIONAL CHARACTERISTICS

Cut-In Wind Speed: 5 mph, (2.2 m/s)
 Shut-Down Wind Speed: -- mph, (-- m/s) (see notes)
 Survival Wind Speed: N. A.
 RPM at Rated Output: N.A.
 Maximum RPM: 75 rpm @ N.A. mph, (N.A. m/s)
 Axial Thrust @ Rated Wind Speed: N.A. lbs, (N.A. N)
 Maximum Axial Thrust: N.A. lbs, (N.A. N)
 Overspeed Control: Mechanical; high thrust turns rotor sideways to the wind.
 Yaw Control: None, rotor aligned with wind by tail.
 Pump/Compressor: Reciprocating cylinder, see chart below.
 Mechanical Power Transmission: Gear box, single stage, ratio=3:1.

MISCELLANEOUS

Length of time machine has been in operation:
 Eighty years
 Design Features: Fixed pitch blades,
 manual shut-down.
 Warranty: Limited, five years-parts
 and workmanship.
 Owners Manual: Available for free.
 Maintenance Schedule: Annually; change oil,
 inspect entire system.

PERFORMANCE CHARACTERISTICS

Rated Output: 1.04hp @ 15 mph, (6.7 m/s)
 Maximum Output: N.A.
 Test Procedures: Data calculated and tested.

NOTES: Shut-down of this system is advised if
 pumping rate exceeds 25 strokes per minute.

CONVERSION FACTORS

One mph = .44707 m/s
 One gallon = 3.785 liters
 One foot = .3048 meters
 One ft² = .09290 m²
 One kW = 1.341 hp
 One lbm = .4536 kg
 One lbf = 4.448 newtons

PUMPING CAPACITIES (15 Mile-Per-Hour Wind)

Cylinder Size	6 Ft. 5" Stroke Elev. G.P.H.	8 Ft. "A" 7 1/2" Stroke Elev. G.P.H.	10 Ft. 7 1/2" Stroke Elev. G.P.H.	12 Ft. 12" Stroke Elev. G.P.H.	14 Ft. 12" Stroke Elev. G.P.H.
1 7/8"	120 115	172 173	256 140	388 180	580 159
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4"	26 522	37 780	57 635	83 822	124 706

If the wind velocity is increased, or decreased, the pumping capacity of the windmill will also be increased, or decreased. Capacities will be reduced approximately as follows for wind speeds below 15 miles-per-hour:

1. Capacity reduced approximately 20% for 12 mile-per-hour wind.
2. Capacity reduced approximately 38% for 10 mile-per-hour wind.

MODEL : Baker 6 Ft.		TYPE: Mechanical, water pumper	
<p>Manufacturer: Heller-Aller Company</p> <p>Address: Perry & Oakwood St. Napoleon, OH 43545</p> <p>Contact: James Bradner or Charles Buehrer</p> <p>Telephone: (419) 592-1856</p>
<p>PHYSICAL CHARACTERISTICS</p> <p>Generic Description: Horizontal axis, multi-bladed, up-wind.</p> <p>Capture Area: 28.3 ft²,(2.6 m²)</p> <p>Rotor Diameter: 6 ft ,(1.8 m)</p> <p>System Weight: 220 lbs,(99.6 kGs)</p> <p>Rotor Weight: N.A.</p> <p>Blade Materials: Galvanized steel - 18 gauge</p>			
<p>OPERATIONAL CHARACTERISTICS</p> <p>Cut-In Wind Speed: 7 mph,(3.15 m/s)</p> <p>Shut-Down Wind Speed: 25 mph,(11.2 m/s)</p> <p>Survival Wind Speed: 70 mph,(31.5 m/s)</p> <p>RPM at Rated Output: 150 rpm @ 15 mph,(6.7 m/s)</p> <p>Maximum RPM: N.A.</p> <p>Axial Thrust @ Rated Wind Speed: N.A.</p> <p>Maximum Axial Thrust: N.A.</p> <p>Overspeed Control: Mechanical: high thrust causes rotor to turn sideways to the wind.</p> <p>Yaw Control: None, rotor aligned with wind by tail.</p> <p>Pump/Compressor: Water pump, cylinder type.</p> <p>Mechanical Power Transmission: Gear box, single stage ratio=4:1</p>		<p>MISCELLANEOUS</p> <p>Length of time machine has been in operation: Fifty years.</p> <p>Design Features: Fixed blade pitch, manual shut-down.</p> <p>Warranty: One year - parts and workmanship.</p> <p>Owners Manual: Only descriptive literature available</p> <p>Maintenance Schedule: Annually: inspect entire system, change oil.</p>	
<p>PERFORMANCE CHARACTERISTICS</p> <p>Rated Output: N.A.</p> <p>Maximum Output: N.A.</p> <p>Test Procedures: Not available</p>		<p>NOTES:</p>	

CONVERSION FACTORS	PUMPING CAPACITIES (In a 15-mile-per-hour wind)								
	6 Foot Baker		8 Foot Baker		10 Foot Baker		12 Foot Baker		
	Total Elevation in Feet	Diameter of Cylinder (Inches)	U.S. Gallons Per Hour	Diameter of Cylinder (Inches)	U.S. Gallons Per Hour	Diameter of Cylinder (Inches)	U.S. Gallons Per Hour	Diameter of Cylinder (Inches)	U.S. Gallons Per Hour
One mph = .44707 m/s	25	3	350	3 1/2	900	4	1250	6	2400
One gallon = 3.785 liters	35	2 1/2	240	3	720	3 1/2	925	5	1625
One foot = .3048 meters	50	2 1/4	200	2 1/2	450	3	700	4 1/2	1425
One ft ² = .09290 m ²	75	2	160	2 1/4	350	2 1/2	475	4	1125
One kW = 1.341 hp	100	2	150	2	250	2 1/2	460	3	600
One lbm = .4536 kg	125	1 5/8	120	1 7/8	240	2	280	2 1/2	525
One lbf = 4.448 newtons	150			1 3/4	220	2	280	2 1/2	525
	200					1 7/8	260	2	325
	250					1 3/4	215	2	325
	300							1 3/4	200

The above capacities are approximate. By the total elevation in feet, we do not mean the depth of the well, but the distance to the cylinder. Do not use pipe smaller than that for which cylinders are fitted.

While we recommend the above table, larger cylinders may in many circumstances be used with satisfaction.

<p>MODEL : Baker 8 Ft.</p> <p>Manufacturer: Heller-Aller Company Address: Perry & Oakwood Sts., Napoleon, OH 43545 Contact: James Bradner, V. P., or Charles Buehrer, Pres. Telephone: (419) 592-1856</p> <p>PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi bladed, up-wind Capture Area: 50.3ft², (4.67m²) Rotor Diameter: 8 ft, (2.4 m) System Weight: 360 lbs, (163.08 kGs) Rotor Weight: N.A. Blade Materials: Galvanized steel - 18 gauge.</p> <p>OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 7 mph, (3.15 m/s) Shut-Down Wind Speed: 25 mph, (11.2 m/s) Survival Wind Speed: 70 mph, (31.5 m/s) RPM at Rated Output: 150 rpm @ 15 mph, (6.7 m/s) Maximum RPM: N.A. Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; high thrust load turns rotor sideways to the wind. Yaw Control: None, rotor aligned with wind by tail Generator/Alternator: Not available Pump/Compressor: Water pump, cylinder type. Mechanical Power Transmission: Gear box, single stage ratio=3:1.</p> <p>PERFORMANCE CHARACTERISTICS Rated Output: N.A. Maximum Output: N.A. Test Procedures: Not available</p>	<p>TYPE: Mechanical: water pumper</p> <p>MISCELLANEOUS Length of time machine has been in operation: Fifty years. Design Features: Oil immersed gear box, Fixed pitch blades, manual shut-down. Warranty: One year parts and workmanship. Owners Manual: Only descriptive literature available Maintenance Schedule: Annually - change oil, and inspect entire system.</p> <p>NOTES:</p>
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CONVERSION FACTORS

One mph = .44707 m/s
One gallon = 3.785 liters
One foot = .3048 meters
One ft² = .09290 m²
One kW = 1.341 hp
One lbm = .4536 kg
One lbf = 4.448 newtons

PUMPING CAPACITIES
(In a 15-mile-per-hour wind)

Total Elevation in Feet	6 Foot Daker		8 Foot Daker		10 Foot Daker		12 Foot Daker	
	Diameter of Cylinder (Inches)	U.S. Gallons Per Hour	Diameter of Cylinder (Inches)	U.S. Gallons Per Hour	Diameter of Cylinder (Inches)	U.S. Gallons Per Hour	Diameter of Cylinder (Inches)	U.S. Gallons Per Hour
25	3	350	3 1/2	900	4	1250	6	2400
35	2 1/2	240	3	720	3 1/2	925	5	1625
50	2 1/4	200	2 1/2	450	3	700	4 1/2	1425
75	2	160	2 1/4	350	2 1/2	475	4	1125
100	2	150	2	250	2 1/2	460	3	600
125	1 5/8	120	1 7/8	240	2	280	2 1/2	525
150			1 3/4	220	2	280	2 1/2	525
200					1 7/8	260	2	325
250					1 3/4	215	2	325
300							1 3/4	200

The above capacities are approximate. By the total elevation in feet, we do not mean the depth of the well, but the distance to the cylinder. Do not use pipe smaller than that for which cylinders are fitted.

While we recommend the above table, larger cylinders may in many circumstances, be used with satisfaction.

<p>MODEL : Baker 10 Ft.</p> <p>Manufacturer: Heller-Aller Company Address: Perry & Oakwood St., Napoleon, OH 43545</p> <p>Contact: James Bradner, V. P. or Charles Buehrer Pres. Telephone: (419) 592-1856</p> <p>PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi-bladed, up-wind Capture Area: 78.5 ft², (7.3 m²) Rotor Diameter: 10 ft, (3.05m) System Weight: 475 lbs, (215.2 kGs) Rotor Weight: N.A. Blade Materials: Galvanized steel - 18 gauge</p> <p>OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 7 mph, (3.15m/s) Shut-Down Wind Speed: 25 mph, (11.2m/s) Survival Wind Speed: 70 mph, (31.5m/s) RPM at Rated Output: 150 rpm @ 15 mph, (6.7 m/s) Maximum RPM: N.A. Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: Mechanical, high thrust load turns rotor sideways to the wind. Yaw Control: None, rotor aligned with wind by tail. Generator/Alternator: Available.</p> <p>Pump/Compressor: Water pump, cylinder type</p> <p>Mechanical Power Transmission: Gear box, single ratio- 3:1</p> <p>PERFORMANCE CHARACTERISTICS Rated Output: N.A. @ 15 mph, (6.7 m/s) Maximum Output: N.A. Test Procedures: Not available</p>	<p>TYPE: Mechanical, water pumper</p> <p>MISCELLANEOUS Length of time machine has been in operation: Fifty years Design Features: Oil immersed gear box, Fixed blade pitch, manual shut-down.</p> <p>Warranty: One year - parts and workmanship.</p> <p>Owners Manual: Only descriptive literature available</p> <p>Maintenance Schedule: Annually - change oil, and inspect entire system.</p> <p>NOTES:</p>
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CONVERSION FACTORS

One mph = .44707 m/s
One gallon = 3.785 liters
One foot = .3048 meters
One ft² = .09290 m²
One kW = 1.341 hp
One lbm = .4536 kG
One lbf = 4.448 newtons

PUMPING CAPACITIES
(In a 15-mile-per-hour wind)

Total Elevation in Feet	6 Foot Baker		8 Foot Baker		10 Foot Baker		12 Foot Baker	
	Diameter of Cylinder (Inches)	U.S. Gallons Per Hour	Diameter of Cylinder (Inches)	U.S. Gallons Per Hour	Diameter of Cylinder (Inches)	U.S. Gallons Per Hour	Diameter of Cylinder (Inches)	U.S. Gallons Per Hour
25	3	350	3 1/2	900	4	1250	6	2400
35	2 1/2	240	3	720	3 1/2	925	5	1625
50	2 1/4	200	2 1/2	450	3	700	4 1/2	1425
75	2	160	2 1/4	350	2 1/2	475	4	1125
100	2	150	2	250	2 1/2	460	3	600
125	1 5/8	120	1 7/8	240	2	280	2 1/2	525
150			1 3/4	220	2	280	2 1/2	525
200					1 7/8	260	2	325
250					1 3/4	215	2	325
300							1 3/4	200

The above capacities are approximate. By the total elevation in feet, we do not mean the depth of the well, but the distance to the cylinder. Do not use pipe smaller than that for which cylinders are fitted.

While we recommend the above table, larger cylinders may in many circumstances, be used with satisfaction.

MODEL : Baker 12 Ft.		TYPE: Mechanical, water pumper																																																																																																																						
Manufacturer: Heller-Aller Company Address: Perry & Oakwood St., Mapoleon, OH 43545 Contact: James Bradner, V.P.; Charles Buehrer, President Telephone: (419) 592-1856
PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, multi-bladed, up-wind. Capture Area: 113 ft ² , (10.5 m ²) Rotor Diameter: 12 ft, (3.65 m) System Weight: 800 lbs, (362.4kGs) Rotor Weight: N.A. Blade Materials: Galvanized steel, 18 gauge		MISCELLANEOUS Length of time machine has been in operation: 50 years. Design Features: Oil immersed gear box, fixed pitch blades, manual shut-down. Warranty: One year - parts and workmanship. Owners Manual: Only descriptive literature available Maintenance Schedule: Annually - change oil and inspect entire system.																																																																																																																						
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<p>MODEL : D (w/diaphragm pump & P (w/piston pump)</p> <p>Manufacturer: Sparco (Denmark) Address: c/o Enertech P. O. Box 420, Norwich, VT 05055</p> <p>Contact: Edmund Coffin or Robert Sherwin Telephone: (802) 649-1145</p> <p>PHYSICAL CHARACTERISTICS Generic Description: Horizontal axis, propeller-type, up-wind. Capture Area: 13.6 ft², (1.27 m²) Rotor Diameter: 4.17 ft , (1.27 m) System Weight: 58 lbs, (26.2 kGs) Rotor Weight: 8 lbs, (3.6 kGs) Blade Materials: Cast Aluminum. Number of Blades: Two</p> <p>OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 5 mph, (2.2 m/s) Shut-Down Wind Speed: None Survival Wind Speed: 80 mph, (36. m/s) RPM at Rated Output: N.A. Maximum RPM: 150 rpm @ 18 mph, (8 m/s) Axial Thrust @ Rated Wind Speed. N.A. Maximum Axial Thrust: N.A. Overspeed Control: Mechanical; blade feathering activated by centrifugal forces on blades. Yaw Control: None, rotor aligned with wind by tail.</p> <p>Pump/Compressor: Diaphragm pump (Model D), Piston pump (Model P) Mechanical Power Transmission: Full eccentric drive, ratio - 1:1.</p> <p>PERFORMANCE CHARACTERISTICS Rated Output: Not rated Maximum Output: 58 Gal./hr @ 18 mph, (8 m/s) Test Procedures: Not available.</p>	<p>TYPE: Mechanical Water Pumper</p> <p>MISCELLANEOUS Length of time machine has been in operation: Models D and P over 5 years each. Design Features: Rugged, simple construction.</p> <p>Warranty: One year- parts and workmanship.</p> <p>Owners Manual: Available for \$2.00.</p> <p>Maintenance Schedule: Semi-annually: inspect system, grease.</p> <p>NOTES: Maximum lift; Model D: 13.1 Ft. (4M) Model P: 32.8 Ft. (10M) Water horsepower= .01</p>
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CONVERSION FACTORS

One mph = .44707 m/s
One gallon = 3.785 liters
One foot = .3048 meters
One ft² = .09290 m²
One kW = 1.341 hp
One lbm = .4536 kG
One lbf = 4.448 newtons

**SYSTEM
OUTPUT
in
Liters/Hour
and
Gallons/Hour**

MODEL : 271		TYPE: Mechanical Water Aeration	
Manufacturer: Wadler Manufacturing Co., Inc. Address: Route 2, Box 76 Galena, KS 66739 Contact: Jerry Wade Telephone: (316) 783-1355
PHYSICAL CHARACTERISTICS Generic Description: Vertical axis, Savonius rotor Capture Area: 10.5 ft ² , (0.97 m ²) Rotor Diameter: N. A. System Weight: 16 lbs, (7.2 kGs) Rotor Weight: N.A. Blade Materials: Aluminum Number of Blades: Two			
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 2 mph, (0.9 m/s) Shut-Down Wind Speed: None Survival Wind Speed: 90 mph, (40.5 m/s) RPM at Rated Output: N.A. Maximum RPM: N.A. Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: None Pump/Compressor: Water aeration system . Mechanical Power Transmission: Direct drive, ratio-1:1		MISCELLANEOUS Length of time machine has been in operation: Five years Design Features: Savonius rotor water aeration and lake anti-freezing system. Warranty: Not Available Owners Manual: Available, price unquoted. Maintenance Schedule: Not available	
PERFORMANCE CHARACTERISTICS Rated Output: None Maximum Output: None Test Procedures:		NOTES:	
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons
SYSTEM OUTPUT			

MODEL : 273 Manufacturer: Wadler Manufacturing Co., Inc. Address: Route 2, Box 76 Galena, KS 66739 Contact: Jerry Wade Telephone: (316) 783-1355	TYPE: Mechanical Water Aeration
PHYSICAL CHARACTERISTICS Generic Description: Vertical axis, Savonius rotor Capture Area: 10.5 ft ² , (0.97 m ²) Rotor Diameter: N.A. System Weight: 20 lbs, (9.1 kGs) Rotor Weight: N.A. Blade Materials: Aluminum Number of Blades: Two	
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 2 mph, (0.9 m/s) Shut-Down Wind Speed: None Survival Wind Speed: 90 mph, (40.5 m/s) RPM at Rated Output: N.A. Maximum RPM: N.A. Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: None Pump/Compressor: Water aeration system. Mechanical Power Transmission: Direct drive, ratio - 1:1	MISCELLANEOUS Length of time machine has been in operation: Five years. Design Features: Savonius rotor water aeration and lake anti-freezing system. Warranty: Not available. Owners Manual: Available, price unquoted. Maintenance Schedule: Not available
PERFORMANCE CHARACTERISTICS Rated Output: None Maximum Output: None Test Procedures:	NOTES:
CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft ² = .09290 m ² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons	<div> SYSTEM OUTPUT </div>

MODEL : 370		TYPE: Mechanical Water Aeration
Manufacturer: Wadler Manufacturing Co., Inc. Address: Route 2, Box 76 Galena, KS 66739 Contact: Jerry Wade Telephone: (316) 783-1355
PHYSICAL CHARACTERISTICS Generic Description: Vertical axis, Savonius rotor Capture Area: 15.75 ft ² , (1.46 m ²) Rotor Diameter: N.A. System Weight: 26 lbs, (11.8 kGs) Rotor Weight: N.A. Blade Materials: Aluminum Number of Blades: Three		
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 2 mph, (0.9 m/s) Shut-Down Wind Speed: None Survival Wind Speed: 90 mph, (40.5 m/s) RPM at Rated Output: N.A. Maximum RPM: N.A. Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: None Pump/Compressor: Water aeration system. Mechanical Power Transmission: Direct drive; ratio - 1:1		MISCELLANEOUS Length of time machine has been in operation: Five years. Design Features: Savonius rotor water aeration and lake anti-freezing system Warranty: Not available. Owners Manual: Not available Maintenance Schedule: Not available.
PERFORMANCE CHARACTERISTICS Rated Output: None Maximum Output: None Test Procedures: Not available		NOTES:
<div style="display: flex; justify-content: space-between;"> <div style="width: 30%;"> CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft² = .09290 m² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons </div> <div style="width: 65%;"> <div style="display: flex; align-items: center;"> <div style="width: 20%; text-align: center;"> SYSTEM OUTPUT </div> <div style="flex-grow: 1;"> </div> </div> </div> </div>		

MODEL : 672		TYPE: Mechanical Water Aeration
Manufacturer: Wadler Manufacturing Co., Inc. Address: Route 2, Box 76 Galena, KS 66739 Contact: Jerry Wade Telephone: (316) 783-1355
PHYSICAL CHARACTERISTICS Generic Description: Vertical axis, Savonius rotor. Capture Area: 31 ft ² , (2.9 m ²) Rotor Diameter: N. A. System Weight: 48 lbs, (21.7 kGs) Rotor Weight: N.A. Blade Materials: Aluminum Number of Blades: Three		
OPERATIONAL CHARACTERISTICS Cut-In Wind Speed: 2 mph, (0.9 m/s) Shut-Down Wind Speed: None Survival Wind Speed: 90 mph, (40.5 m/s) RPM at Rated Output: N.A. Maximum RPM: N.A. Axial Thrust @ Rated Wind Speed: N.A. Maximum Axial Thrust: N.A. Overspeed Control: None Yaw Control: None Pump/Compressor: Water aeration system Mechanical Power Transmission: Direct drive, ratio - 1:1		MISCELLANEOUS Length of time machine has been in operation: Five years Design Features: Savonius rotor water aeration and lake anti-freezing system. Warranty: Not available Owners Manual: Available Maintenance Schedule: Not available.
PERFORMANCE CHARACTERISTICS Rated Output: None Maximum Output: None Test Procedures: Not available		NOTES:
<div style="display: flex; justify-content: space-between;"> <div style="width: 30%;"> CONVERSION FACTORS One mph = .44707 m/s One gallon = 3.785 liters One foot = .3048 meters One ft² = .09290 m² One kW = 1.341 hp One lbm = .4536 kG One lbf = 4.448 newtons </div> <div style="width: 65%;"> <div style="display: flex; justify-content: space-between;"> <div style="width: 30%;"> SYSTEM OUTPUT </div> <div style="width: 65%;"> </div> </div> </div> </div>		

APPENDIX A:
WECS MANUFACTURERS AND
DEALERS/DISTRIBUTORS

ELECTRICAL WIND MACHINE MANUFACTURERS

Aerolectric
13517 Winter Lane
Cresaptown, MD 21502

Contact: Kevin Moran
Telephone: 609-547-3488

Aero Power
2398 Fourth Street
Berkeley, CA 94710

Contact: John Harold or
Tom Cummins
Telephone: 415-848-2710

Aerowatt, S.A.
c/o Automatic Power, Inc.
P. O. Box 18738
Houston, TX 77023

Contact: Robert Dodge or
Ernest Tindle
Telephone: 713-228-5208

Altos: The Alternate Current
P. O. Box 905
Boulder, CO 80302

Contact: Edward Gitlin
Telephone: 303-442-0885

American Wind Turbine, Inc.
1016 East Airport Road
Stillwater, OK 74074

Contact: Nancy Thedford,
Office Manager
Telephone: 405-377-5333

Dakota Wind & Sun, Ltd.
P. O. Box 1781
811 First Avenue, NW
Aberdeen, SD 57401

Contact: Paul Biorn or
Orv Lynner
Telephone: 605-229-0815

Dominion Aluminum Fabricators
3570 Hawkestone Road
Mississauga, Ontario
Canada L5C 2V8

Contact: Chuck Wood,
Program Manager
Telephone: 416-270-5300

Dunlite Electrical Products Co.
Enertech Corporation
P. O. Box 420
Norwich, VT 05055

Contact: Ed Coffin or c/o
Robert Sherwin
Telephone: 802-649-1145

Dynergy Corporation
P. O. Box 428
1269 Union Avenue
Laconia, NH 03246

Contact: Robert Allen
Telephone: 603-524-8313

Grumman Energy Systems
4175 Veterans Memorial Highway
Ronkonkoma, NY 11779

Contact: Ed Diamond or
Ken Speiser
Telephone: 516-575-6205

Kedco, Inc.
9016 Aviation Boulevard
Inglewood, CA 90301

Contact: Wind Program Manager
Telephone: 213-776-6636

Electrical Wind Machine Manufacturers (Continued)

Millville Windmills & Solar
Equipment Company
P. O. Box 32
10335 Old Drive
Millville, CA 96062

Contact: Devon Tassen
Telephone: 916-547-4302

North Wind Power Company
P. O. Box 315
Warren, VT 05674

Contact: Don Mayer
Telephone: 802-496-2955

Pinson Energy Corporation
P. O. Box 7
Marstons Mills, MA 02648

Contact: Herman Drees
Telephone: 617-477-2913

Product Development Institute
508 South Byrne Road
Toledo, OH 43609

Contact: Tom Nichols
Telephone: 419-382-0282

Sencenbaugh Wind Electric
P. O. Box 11174
Palo Alto, CA 94306

Contact: Jim Sencenbaugh
Telephone: 415-964-1593

Winco
Div. of Dyna Technology
7850 Metro Parkway
Minneapolis, MN 55420

Contact: Len Attema
Telephone: 612-853-8400

Wind Power Systems, Inc.
P. O. Box 17323
San Diego, CA 92117

Contact: Ed Salter
Telephone: 714-452-7040

W.T.G. Energy Systems, Inc.
P. O. Box 87
1 LaSalle Street
Angola, NY 14006

Contact: Al Wellikoff
Telephone: 716-549-5544

Zephyr Wind Dynamo Company
P. O. Box 241
21 Stamwood Street
Brunswick, ME 04011

Contact: Bill Gillette
Telephone: 207-725-6534

MECHANICAL WIND MACHINE MANUFACTURERS

Aermoter Division
Valley Industries
P. O. Box 1364
Conway, Arkansas 72032

Contact: Stan Anderson
Telephone: 501-329-9811

American Wind Turbine, Inc.
1016 East Airport Road
Stillwater, OK 74074

Contact: Nancy Thedford,
Office Manager
Telephone: 405-223-4026

Dempster Industries, Inc.
P. O. Box 848
Beatrice, NB 68310

Contact: Roy Smith
Telephone: 402-223-4026

Dynergy Corporation
P. O. Box 428
1268 Union Avenue
Laconia, NH 03246

Contact: Bob Allen
Telephone: 603-524-8313

Heller-Aller Company
Perry & Oakwood Street
Napoleon, OH 43545

Contact: James Bradner or
Charles Buehrer
Telephone: 419-592-1856
Mfg. of Baker Windmills

Sparco (Denmark)
c/o Enertech, Inc.
P. O. Box 420
Norwich, VT 05055

Contact: Edmund Coffin at
Enertech
Telephone: 802-649-1145

Wadler Manufacturing Co., Inc.
Route 2, Box 76
Galena, KS 66739

Contact: Jerry Wade
Telephone: 316-783-1355

WIND MACHINE DEALERS/DISTRIBUTORS

COMPANY

PRODUCT NAME

Aermotor
1243 Majesty Drive
Dallas, TX 75247

Aermotor
Contact: Mr. William E. Barney
Telephone: 214-634-1950

Aermotor
2385 South Cherry
Fresno, CA 93706

Aermotor
Contact:
Telephone: 209-486-7200

Aermotor
900 Nabco Avenue
P. O. Box 1321
Conway, Arkansas 72032

Aermotor
Contact: Miles Patten
Telephone: 501-329-2969

Aermotor
6448 Warren Drive
Norcross, GA 30093

Aermotor
Contact:
Telephone: 404-449-1840

Aermotor
518-M North Douglas Avenue
Altamonte Springs, FL 32701

Aermotor
Contact:
Telephone: 305-862-0171

Aermotor
2421 West Main
Ft. Wayne, IN 46808

Aermotor
Contact:
Telephone: 219-432-2595

Aermotor
4655 Colt Road
Rockford, IL 61109

Aermotor
Contact:
Telephone: 815-874-9502

Aermotor
801 Howard Street
Omaha, NB 68102

Aermotor
Contact: Marvin Veselik
Telephone: 402-341-1716

Aermotor
8105 Lewis Road
Minneapolis, MN 55427

Aermotor
Contact:
Telephone: 612-544-4106

Aermotor
2803 South Longview Drive
Middletown, PA 17057

Aermotor
Contact:
Telephone: 717-939-9311

Aermotor
1575 Avon Street Extended
Charlottesville, VA 22901

Aermotor
Contact:
Telephone: 804-977-0445

Alternate Energy Systems
150 Sandwich Street
Plymouth, MA 02360

Elektro, Dunlite, Winco
Contact:
Telephone: 617-747-0771

Wind Machine Dealers/Distributors (Continued)

COMPANY

Automatic Power, Inc.
P. O. Box 18738
Houston, TX 77023

Dean Bennet Supply Company
4725 Lipan Street
Denver, CO 80211

Clean Energy Products
3534 Bagley, N.
Seattle, WA 98103

Coulson Wind Electric
RFD 1, Box 225
Polk City, IA 50226

Crowdis Conservers
RR 3, MacMillan Mt.
Cape Breton, Nova Scotia
Canada BOE 1B0

Edmond Scientific Company
380 EDS Corp. Bldg.
101 East Gloucester Pike
Barrington, NJ 08007

Empire Energy Development Corp.
3371 West Hampden Avenue
Englewood, CA 80110

Environmental Energies, Inc.
P. O. Box 73
Front Street
Copemish, MI 49625

Energy Alternatives
52 French King Highway
Greenfield, MA 01301

PRODUCT NAME

Aerowatt
Contact: Robert Dodge
Telephone: 713-228-5208

Aermotor, Dunlite, Winco
Contact: Deana Bennet
Telephone: 303-433-8291

Jacobs, Kedco, Sencenbaugh,
Wincharger
Contact: Ed Kennell
Telephone: 206-633-5505

Re-conditioned Jacobs, Winco,
Winpower
Contact: R. Coulson
Telephone: 515-547-3488

North Wind
Contact: Daniel Atkins

Aerolectric (Wind Wizard)
Contact: Robert F. McKelvery
Telephone: 609-547-3488

Altos, Winco
Contact: David L. Flook
Telephone: 303-789-1363

Elektro, Dunlite, Re-conditioned
Jacobs
Contact: Timothy J. Horning
Telephone: 616-378-2000

Elektro, Dunlite, Winco,
Sencenbaugh
Contact: Frank Kaminsky or
Klaus Kroner
Telephone: 413-773-5175

Wind Machine Dealers/Distributors (Continued)

COMPANY

PRODUCT NAME

Energy Development Company
179E Road #2
Hamburg, PA 19526

Winco, Homebuilt
Contact: Terrance or Helena
Mehrkam or
Karen Votyas
Telephone: 215-562-8856

Energy - 2000
Route 800, RFD #3
Winstead, CT 06098

Re-conditioned Jacobs (North Wind)
Contact: Robert Hebert
Telephone: 203-379-5185 or
413-528-3440

Enertech Corporation
P. O. Box 420
Norwich, VT 05055

Dunlite, Winco, Sencenbaugh, Sparco
Contact: E. Coffin
Telephone: 802-649-1145

Environmental Resource Group
Box 3A, RD 2
Williston, VT 05495

North Wind, Sparco
Contact: Perry Kleine
Telephone: 802-879-0511 or
802-878-4000

Fenton's Feeders
Route 1, Box 124
Arcadia, FL 33821

Aermotor (Water pumping)
Contact: Catherine Fenton,
Bill Autry, or
Nell Gammage
Telephone: 817-494-2727

Independent Energy Company
314 Howard Avenue
Ewarthmore, PA 19081

Elektro, Dunlite, Winco
Contact: Kendall B. Hampton
Telephone: 617-368-6992

Independent Energy Company
6043 Sterrettania Road
Fairview, PA 16415

Re-conditioned Jacobs, Dakota
Wind Electric
Contact: John D'Angelo
Telephone: 814-833-0829

Kramco
P. O. Box 1536
Allentown, PA 18105

Re-conditioned Jacobs, Winco
Contact:
Telephone: 215-437-6758

Laholms Motor & Bilelektriska A/B
Export Office & Information
Wind Kraft A.E.S.C.
Box #104
S-312 01 Laholm, Sweden

Wind Kraft A.E.S.C.
Contact: Eric Alkstad
Int. Phone: 00946-43020371
Cable: WERKOMP

Makia Ocean Engineering
Box 1194
Kailua, Oahu, Hawaii 96734

Dunlite
Contact: Henry Horn
Telephone: 808-259-5904 or
808-259-5722

Wind Machine Dealers/Distributors (Continued)

COMPANY

PRODUCT NAME

Natural Power Systems, Inc.
3316 Augusta Avenue
Omaha, NB 68144

Dakota Wind Electric, Dunlite,
Sencenbaugh, Sparco
Contact: John Traudt
Telephone: 402-334-5881

O'Brock Windmill Sales
Route 1, 12th Street
North Benton, OH 44449

Baker
Contact: Ken O'Brock
Telephone: 216-584-4681

Pacific Energy Systems
615 Romero Canyon Road
Santa Barbara, CA 93018

North Wind
Contact: Fred Carr
Telephone: 805-969-6603

Prairie Sun & Wind Company
4408 - 62nd Street
Lubbock, TX 79409

Re-conditioned Jacobs, Winco,
Aeropower, Dakota Wind Electric
Aermotor
Contact: Ken Ketner
Telephone: 806-795-1412

Real Gas & Electric
P. O. Box 193
Shingletown, CA 96088

Elektro, Dunlite
Contact: Solomon Kagin
Telephone: 916-474-3852

Rede Corporation
P. O. Box 212
Providence, RI 02901

Dominion Aluminum Fabricating (DAF)
Contact: Ronald Beckman
Telephone: 401-751-7333

Schupbach, Ralph
321 - 13th Street
Alva, OK 73717

Winco
Contact: Ralph Schupbach
Telephone: 405-327-1685

Shingletown Electric
P. O. Box 237
Shingletown, CA 96008

Elektro, Dunlite
Contact: Robert E. Eckert
Telephone: 916-474-3852

Sunflower Power Company
Route 1, Box 93-A
Oskaloosa, KS 66066

Re-conditioned Jacobs, North Wind
Contact: Steve Blake
Telephone: 913-597-5603

Wind Engineering Corporation
Box 5936
Lubbock, TX 79417

Re-conditioned Jacobs, DAF,
Dynergy, Dakota Wind Electric
Contact:
Telephone: 806-763-3182

Windependence Electric
P. O. Box M1188
Ann Arbor, MI 48106

Re-conditioned Jacobs
Contact: Craig Toepfer
Telephone: 313-769-8469

APPENDIX B:
SUBSYSTEM COMPONENTS AND SUPPLIERS

ANEMOMETERS

TOWERS

BATTERIES

INVERTERS

ANEMOMETERS

Anemometers are devices which measure the wind. The manner in which they accomplish this task ranges from an odometer which records the number of miles of wind that pass the recorder, to three-axis anemometers that record wind velocity on three separate planes.

As with all wind system sub-components, anemometers vary widely in terms of accuracy, the type of information obtained, and cost. The value of a certain anemometer or anemometry system will depend largely upon the specific application for which it is used. Again, wind system distributors can help select the proper anemometer or anemometry system.

Dwyer Instruments, Inc.
Box 373
Michigan City, IN 46360

Taylor Instruments
Arden, NC 28704

Bendix Environmental Science Division
1400 Taylor Avenue
Baltimore, MD 21204

Climet Instruments Company
1620 West Colton Avenue
Redlands, CA 92373

Kahl Scientific Instrument Corp.
Box 1166
El Cajon
San Diego, CA 92022

Davis Instrument Mfg. Co., Inc.
513 East 36th Street
Baltimore, MD 21218

Natural Power
New Boston, NH 03070

Aircraft Components
North Shore Drive
Benton Harbor, MI 49022

Danforth
Div. of the Eastern Company
Portland, Maine 04103

Meteorology Research, Inc.
Box 637
Altadena, CA 91001

Robert E. White Instruments, Inc.
33 Commercial Wharf
Boston, MA 02110

Texas Electronics, Inc.
5529 Redfield Street
Box 7151 Inwood Station
Dallas, TX 75209

Maximum, Inc.
8 Sterling Drive
Dover, MA 02030

WTG TOWERS

All wind machines must be placed on a support structure, generally a tower. A variety of factors influence the final choice of a tower for a particular wind machine and application. Two tower types, guyed and free-standing, are applicable for most wind energy installations.

Wind system distributors can help select the best tower for a particular site, but several factors should be considered. Wind machines should be at least 30 feet above the nearest obstruction. The tower must also support the weight of the wind machine and withstand loads imposed by the wind. These loads are a function of both the wind velocity and wind machine rotor diameter. Aesthetics, building codes, and zoning are also considerations in some areas.

There are four American Manufacturers of towers designed specifically for WECS. A number of foreign manufacturers offer their towers through WTG distributors. In addition, there are a number of tower manufacturers who have not been active in the WECS field but may have suitable equipment.

Natural Power Inc.
Francestown Turnpike
New Boston, NH 03070

North Wind Power Company
Box 315
Warren, VT 05674

Unarco-Rohn
6718 West Plank Road
P. O. Box 2000
Peoria, IL 61601

Bayshore Concrete
Bayonne, NJ

BATTERIES

Because the wind is an intermittent energy source, it is often necessary to find a means of storing its energy. Although many energy storage systems such as heat, compressed air and flywheels are now being investigated, the state-of-the-art for electricity storage is the lead acid battery.

There are several types of storage batteries now commercially available. Each type has characteristics that make it best suited for a particular application. The ultimate choice of batteries depends on the total wind system characteristics including wind at the site, the wind turbine generator, and the load.

Batteries Manufacturing Company
14694 Dequindu
Detroit, MI 48212

Bright Star
602 Getty Avenue
Clifton, NJ 07015

Burgess Div. of Clevite Corp.,
Gould
Box 3140
St. Paul, MN 55101

C & D Batteries Eltuce Corp.
Washington & Chewy Street
Conshohocken, PA 19428

Delatron Systems Corporation
553 Lively Boulevard
Elk Grove Village, IL 6007

Delco-Remy Division of GM
Box 2439
Anderson, IN 46011

Eggle-Pichen Industries
Box 47
Joplin, MO 64801

ESB Incorporated - Willard
Box 6949
Cleveland, OH 44101

Exide
5 Pen Center Plaza
Philadelphia, PA 19103

Ever Ready - Union Carbide Corp.
270 Park Avenue
New York, NY 10017

Globe-Union
5757 N. Greenbay Avenue
Milwaukee, WI 53201

Gould Incorporated
485 Calhoun Street
Trenton, NJ 08618

Gulton
212 T Dorham Avenue
Metuchen, NJ 08840

Keystone Battery Company
8301 Imperial Drive
Waco, TX 76710

Mule Battery Company
325-T Valley Street
Providence, RI 02908

RCA
415 South 5th Street
Harrison, NJ 07029

Surrette Storage Battery Co., Inc.
Box 711
Salem, MS 01970

INVERTERS

Inverters are devices that convert direct current power (DC) to the alternative current (AC) more commonly used in this country.

There are a number of considerations in selecting an inverter for a WECS including the amount and quality of the power required, overload capabilities, and cost.

The majority of these systems are designed to operate with a battery bank storage system and are known as "stand alone" inverters. There is also available an inverter known as a synchronous inverter or 'line commutated' inverter. These inverters are designed to feed the power produced to an A.C. line and requires the A.C. line for a voltage signal.

It should be noted that there are quite a few inverter manufacturers and most wind turbine generator distributors also sell inverters.

Allied Electronics 2400 W. Washington Blvd. Chicago, IL 60612 (312) 421-4200	350 to 1000 watt; 12 volt input
Eico Electronic Instrument Co. 283 Malta Street Brooklyn, NY 11207	110 to 220 watt; 12 volt input
Electro Sales Co., Inc. 100 Fellsway West Somerville, MA 02145 (617) 666-0500	20 to 2000 watt; 12 to 200 volt input
Heath Company Benton Harbor, MI 49002 (616) 983-3961	175 watt; 12 volt input
LaMarche Mfg. Company 106 Bradrock Drive Des Plaines, IL 60018 (312) 279-0831	100 to 10000 watt; 24 to 120 volt input
Newark Electronics 500 N. Pulaski Road Chicago, IL (312) 638-4411	100 to 250 watt; 12 volt input
Nova Electric 263 Hillside Avenue Nutley, NJ 07110 (201) 661-3432	30 to 120 watt; 12 to 110 volt input

Ratelco, Inc.
610 Pontius Avenue, N.
Seattle, WA 98109
(206) 624-7770

250 to 2500 watt; 24 to 100 volt
input

Soleq Corporation
5969 Elston Avenue
Chicago, IL 60646
(312) 792-3811

1500 to 6000 watt; 12 to 112 volt
input

Topaz Electronics
3855 Ruffil Road
San Diego, CA 92123
(714) 279-0831

200 to 3000 watts; 12 to 125 volt
input

Willmore Electronics
Box 2973
Durham, NC 27705
(919) 489-3318

45 to 1500 watt; 12 to 120 volt
input

LINE COMMUTATED INVERTERS

Gemini Synchronous Inverters
Windworks
Box 329, Route 3
Mukwonago, WI 53149
(414) 363-4408

4 to 1000 kw; variable voltage input

**APPENDIX C:
SELECTED REFERENCES ON WECS**

SELECTED REFERENCES ON WIND ENERGY CONVERSION SYSTEMS

BIBLIOGRAPHIES

1. Energy from the Wind, 1977
CER-74-75 BLB-RNM-44

Burke, B. L. and Merony, R. N.

Available from:

Engineering Sciences Branch Library
Engineering Research Center
Colorado State University
Foothills Campus
Ft. Collins, CO 80523
(Cost/Copy \$12.95)

A comprehensive, annotated bibliography of general and technical wind energy references, articles, and publications. Best suited for general research work. Updates will be available on a regular basis.

BOOKS

2. Power from the Wind, 1948

Putnam, P.C.

Available from:

Von Nostrand Reinhold Co.
450 West 33rd Street
New York, NY 10001

An excellent historical account of the Smith-Putnam wind turbine project of 1934-1935. This Smith-Putnam turbine was the largest wind generator built to date, (its blades spanned 175 feet) and fed 1200 kw of power into the grid network of Central Vermont utilities whenever the wind exceeded 17 mph.

3. Wind-Catchers, 1976

Torrey, V.

Available from:

Stephen Green Press
Brattleboro, VT 05301
(Cost/Copy \$12.95)

A general historical overview of the use of wind energy systems from the first early water-pumpers (900 AD) through the varied present-day applications. An excellent series of photos accompany the text.

4. Wind Machines, 1975
-Stock # 038-000-00272-4

Eldridge, F.

Available from:

Superintendent of Documents
Government Printing Office
Washington, D.C. 20402

One of the best introductory references on wind energy. A review of the history, viability, taxonomy, and potential of wind machines for energy needs. Includes photos and graphics of various wind energy systems.

5. Simplified Wind Power Systems for Experimenters, 1976

Park, J.

Available from:

Helion
Box 445
Brownsville, CA 95919

As the title implies, this book presents a simplified analysis of wind energy systems. Overall, it provides a review of the aerodynamic, structural, and mechanical design of the wind rotor, power storage, and the entire wind energy conversion system.

6. Applied Aerodynamics of Wind Power Machines, 1974

Wilson, R. E. and Lissaman, P.B.S.

Available from:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
(PB-238-595)
(Cost/Copy \$5.25)

7. Aerodynamic Performance of Wind Turbines, 1976

Wilson, R. E., Lissaman, P.B.S., and Walker, S. N.

Available from:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
(PB-259-089)
(Cost/Copy \$5.25)

Both of these highly technical publications review the aerodynamics of various types of wind power machines and the relative success of various means of extracting power from the wind. The methods reviewed are intended to be of use in the rapid evaluation and comparative analysis of the aerodynamic performance of wind energy systems.

8. The Generation of Electricity by Wind Power, 1955

Golding, E. W.

Available from:

Halsted Press
A Division of John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10016
(Cost/Copy \$19.95)

A classic wind energy publication originally written in 1955 by one of the pioneers in the wind energy field. The book provides a comprehensive review of wind characteristics, the design and operation of wind machines and the economics of wind energy systems in different applications. The revised 1976 edition of the book includes an additional chapter on recent developments in the wind energy field by R. I. Horres, a former colleague of the late Mr. Golding.

9. Wind Power for Farms, Homes and Small Industry
Scheduled for late 1978

Nielsen Engineering and Research, Inc.

Available from:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

The publication is designed to provide information to enable farmers, home-owners, and other prospective small machine buyers to evaluate their energy needs and access the value and utility of wind systems in meeting those needs.

10. Summary Report-Federal Wind Energy Program, January 1, 1977
(ERDA-77-32)

Energy Research and Development Administration
Division of Solar Energy
Wind Systems Branch

Available from:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402
(Stock No. 060-000-00048-4)
(Cost/Copy \$1.15)

A detailed summary of the overall FY 1976 federal projects that are wind-related. Of particular interest is the listing of individual projects that details the principal investigator, the grant amount, background, objectives and approach, and preliminary output.

11. Federal Wind Energy Program, Summary Report, January 1978

U.S. Department of Energy
Division of Solar Technology
Wind Systems Branch

Available from:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402
(Stock No. 061-000-00050-0)

An up-dated summary of the federal program, including all projects funded during FY 1977.

12. Wind Power Climatology of the United States

Sandia Laboratories

Available from:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
(Cost/Copy \$7.60)

13. The Climatic Atlas of the United States

Available from:

Environmental Data Service
National Climatic Center
Federal Building
Asheville, NC 28801
(Cost/Copy \$4.95)

14. United States Wind Speed and Wind Power Duration Tables,
by Months (Cumulative Distributions)
(Scientific Report No. 1)

Coty, U. A.; Court, A; Reed, J. W.

Available from:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

Cumulative distributions of wind speed (meters per second), adjusted to a standard height of 10 meters (33 feet) above ground at 478 places in the United States, for each month and season, and for the year as a whole, are contained in this report. Also gives cumulative distributions of wind power (watts per square meter), by seasons and for the year at heights of 10, 50 and 100 meters above ground.

PROCEEDINGS

15. Proceedings of the Vertical Axis Wind Turbine Technology Workshop, 1976

Available from:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
(Cost/Copy \$13.75)

A compilation of the papers presented at the workshop in the following areas: Wind Energy Programs, DOE's Darrieus Vertical Axis Wind Turbine Program, and other prominent vertical axis wind programs. This is primarily technical information.

16. Proceedings of the Second Workshop on Wind Energy Conversion Systems, Washington, D.C., June 9-11, 1975

Eldridge, F.

Available from:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402
(Stock No. 038-000-00258-9)
(Cost/Copy \$10.00)

These proceedings include papers presented in virtually every area of ERDA's wind energy programs. Large systems (100 kw or larger), mission and regional analysis, international activities, technology development, energy storage, wind characteristics, institutional issues, and working group reports.

17. Proceedings of the American Wind Energy Association Conferences, 1976-1977

Available from:

The American Wind Energy Association
54468 CR 31
Bristol, Indiana 46507
(Available, Fall 1977)

A collection of the proceedings of two major national conferences sponsored by AWEA. The work of the entire wind energy field is represented here including papers from William Heronimus (U. Mass. Wind Energy Project), David Spera (NASA), Terry Healy (Rocky Flats Wind System Test Center), Dr. L. H. Soderholm (Iowa State University), Jack Park (Helion), and William Hughes (American Wind Turbine).

BOOKLETS

18. Planning a Wind-Powered Generating System, 1977

Enertech Corporation
P. O. Box 420
Norwich, VT 05066

A short primer in the basic principles of wind machines, their components, and siting requirements. Includes estimations of power requirements and details of site, tower, and battery storage selections. A "cookbook" for the handyman.

19. Wind Power

Syverson, P. E., Symons, J. G.

Available from:

Wind Power
Box 233
Mankato, MN 56001
(Cost/Copy \$3.50)

A solid introductory work on the components and uses of wind energy systems that is suited for both general and technical readers. This booklet is particularly strong on system planning and engineering.

PERIODICALS

20. Wind Power Digest

Edited by Michael Evans

Available from:

Jester Press
54468 CR 31
Bristol, Indiana 46507
(Cost \$6.00 per year, published quarterly)

An ongoing source for current information on available wind energy hardware, accessories, publications and reports from people working in the field.

21. The Wind Technology Journal

Edited by Carolyn and Herman Drees

Available from:

Wind Technology Journal

P. O. Box 7

Marston Mills, MA

(Cost \$20.00 per year. \$15.00 for members of the American Wind Energy Association. \$40.00 per year for institutions. Published quarterly)

This new publication (published by the American Wind Energy Association) fills the need for up-to-date technical information. The information presented is useful to both general and technical audiences.

22. AWEA Newsletter

Available from:

Wind Technology Journal

P. O. Box 7

Marston Mills, MA

(Cost \$10.00 per year, published quarterly)

The official publication of AWEA dedicated to communication between AWEA Members and interested, non-affiliated individuals as well. Editorially it features news of AWEA organizational activities and industry and product reports.

ENERGY-GENERAL

23. A Time to Choose, 1974

Ford Foundation Energy Policy Project

Available from:

J. B. Lippincott

East Washington Square

Philadelphia, PA 19105

(Cost/Copy \$4.95)

A review of the energy options open to the U.S. through the year 2000. There is a particular emphasis on energy use and its implications.