

# Batteries and Inverters

Much is being made about inverter/battery power lately so now would be a good time to let you know where Wag'n Tails stands on the topic. Our objective in writing this is to remove the mystery surrounding inverters and correct some of the misconceptions our research has shown to exist out there in the grooming world.

This information is not to establish Wag'n Tails as pro-generator or anti-inverter. Our stance is that we are **PRO-GROOMER**. We continuously strive to provide the very best grooming vehicles on the market. This daily routine requires us to constantly innovate and front the market. An example of this process is our new **5 year/60,000 mile warranty** on our new 2007 models.

## ***About Inverters***

Inverters don't make electricity. Inverters change DC electricity (stored in batteries similar to the one in your car) into AC electricity to run lights, dryers, clippers and other appliances that plug into a socket just like the ones you have in your walls at home.

Inverter/battery systems are not magic, and **they do work**. *Theoretically*, you could power a city using this system if you had enough batteries and that's the key—having enough batteries. All of your electrically powered grooming equipment has to be powered by the batteries you carry with you.

## ***Wag'n Tails and Inverters***

Since we are located in the heart of the RV and specialty vehicle industry, we have privileged access to the best and brightest minds, companies and components on the planet. This fact has allowed us to test the best inverter/battery systems the world has to offer. If it were possible to power recreational vehicles, commercial vehicles, emergency vehicles, boats, etc. economically and realistically with inverter/battery systems alone, the manufacturers of these products would all be doing it and frankly, so would we. *Our position is that the current level of technology required is just not there yet.* In other words, the number of batteries needed is unrealistic in order to groom a minimum of 6 dogs per day in an efficient manner.

So what about using components that use less electricity? Would that make the batteries last longer? The answer is yes. For example, you could use a 9 amp dryer instead of one that uses 17 amps like ours K9 II does. But if you use a dryer that has about half the power, it takes about twice as long to dry the dog so you end up using

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about the same amount of electrical power. ***It's those darn laws of physics that keep getting in the way.***

## ***Want the Technical Stuff?***

If you want all the technical info, we have resource material at the end of this information that can help you out. The internet is a great source so feel free to look it all up there, too. Just know that we used expert sources for the analysis we are about to cover here. Rather than complicating things with amps, volts, watts, amp hours and a bunch of other technical jargon, we will boil it down to a simple, easy to understand analogy of a checking account. Think of the checking account as your battery bank which holds the power stored in all your batteries.

## ***Checking Account Analogy***

Now let's open our checking account. We have to carry a minimum balance in our account that is equal to twice the amount of checks we are going to write because we can only use half of the power in our batteries (DOD). We also have to pay a 10% service fee for each check we write (inverter inefficiency).

Every time you use your dryer, you write a check from your account to cover the power used plus the service fee of 10%. Every time you turn on your lights, you write a check. Every time you use your clippers, you write a check and so on. On some components like clippers and water pumps, we write little checks and on others like dryers and air conditioners, we write big checks.

And by the way, I didn't find one expert that recommended running your air conditioner with an inverter because they use too much power. Since it can be done, we'll include it in our calculations where appropriate. One inverter powered van uses the van air conditioner so you have to run the van engine if you want to be cool. And as you all know, dog hair and groomer sweat are a very bad combination!

So how does the checkbook work on a typical day? Let's groom 6 dogs over our 8 hour day. Figure one hour per dog. On each dog we'll use the dryer for 15 minutes (remember it will take longer if you use a low amp dryer but we'll pretend it doesn't), the clippers and the clipper vacuum system for 15 minutes and the bathing system for 15 minutes per dog. Our lights, monitor panel, power vent, and air conditioner will be on for the entire grooming time of one hour per dog.

Let's look at the Wag'n Tails checking account and a couple of other grooming vans that use inverter/battery systems to see how many checks (and for how much) we

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have to write. This chart shows the van company, each appliance used and the amount of the check written for each appliance to groom 6 dogs as explained above. The amount written for each check varies by the amount of power each appliance uses. For you technologically adept ones, the check amount is equal to amp hours.

**Please Note:** Since we don't produce inverter /battery powered vans, we end the calculation on our van at the amount per dog calculation. Some vans require engine idling to recharge the batteries, heat water and to air condition and heat the van throughout the day. The example below assumes no engine idling. 31 states (and growing) have enacted anti-idling legislation. Violations are punishable by fines and even jail time. Consult your own state laws for regulations in your area. More information on Engine Idling is detailed below.

Also engine idling, in our opinion, defeats the whole purpose of inverter/battery power since a small 2 cylinder generator engine using 0.7 gallons per hour is far more efficient than a 4 to 10 cylinder automotive engine using between 1 to 1.5 gallons per hour.

APPLIANCE	Wag'n Tails	Brand BH	Brand DH
Water Pump(s)*	1	70	88
Power Vents	3	Not Offered	6
Monitor Panel	5	5	5
Water Heater	LP Gas	238	Engine Idle
Clippers	4	4	4
Lights	95	95	25
Dryer	293	150	199
Clipper Vacuum	105	105	151
Air Conditioner	696	450	Engine Idle
<b>Total Checks Written</b>	<b>1202</b>	<b>1117</b>	<b>478</b>
Plus 10% Service Fee	120	112	48
<b>Sub Total</b>	<b>1322</b>	<b>1229</b>	<b>526</b>
Plus Minimum Balance	1322	1229	526
<b>Total Needed In Account</b>	<b>2644</b>	<b>2458</b>	<b>1052</b>
Divided by 6 Dogs per Day	6	6	6
<b>Amount per Dog</b>	<b>441</b>	<b>410</b>	<b>175</b>
<i>Actual Account Amount Supplied with Van</i>		1320	750
Actual Dogs You Can Afford to Groom Based On Power Supplied by the Van Batteries		<b>3.2</b>	<b>4.3</b>
<i>*Wag'n Tails uses DC pumps which use less electricity than the other's AC pumps</i>			

**Simply stated, you need about 50% to 100% more battery power to groom 6 dogs in a day depending on which van you analyze.**

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## ***Number of Batteries***

So how many batteries does it take? If we use the most common 110 amp hour glass mat battery, you need **from 12 up to 24 batteries** to groom 6 dogs and that assumes you are very efficient with your power. What if you want to groom more than 6 dogs? Well, you know what that means--more batteries. At some point, you'll need to consider a trailer to haul them around behind you. When is a half ton of batteries too much? **12 batteries will probably exceed that half ton of weight.**

## ***Time to Make a Deposit***

Now that we've written all of the checks for the day, we need to make a deposit so we can go grooming tomorrow. In the cases shown above, we're actually overdrawn but for demonstration purposes, let's assume we aren't.

To make a deposit, we need to "plug in" our checking account. Batteries have to be recharged which takes time so our deposit takes several hours. How many hours is dependent on several factors like the size of the charger, the number of batteries, how far they are down and even the temperature.

The approximate recharge time for 50% discharged battery bank is 5 hours to 95% capacity based on a battery bank size of (2) 108 amp-hour 12V deep cycle batteries. If double the number of batteries is used, recharge time will double (Source nooutage.com). So if you are using 12 batteries...that's a long time to recharge them all.

## ***Generators***

No need to make a deposit with a generator. It's like having an ATM card with no limit. It just keeps churning out electricity as long as you have gas in the van. Are they free of problems? No, but no piece of machinery is, **including the inverter/battery system.** The key to minimizing problems is regular maintenance. A generator maintained well will last years and we have installed hundreds of them in our vans over the last 10+ years. They are simple systems that are easy to repair and maintain because **we understand that minimizing downtime is crucial** for our groomers. We use Onan generators exclusively because they are the very best commercial generators money can buy and because they have **a network of over 750 service centers nationwide.** Where will you get help with the inverter/battery system when you need it? The Onan warranty is 2 years/2000 hours, they

stand behind them, and we constantly work with Onan to improve them. If there was a better generator available to us, we'd be using it.

## ***Replacing Batteries***

Another factor to consider is replacing the batteries. They do wear out over time and if you consistently use more than 50% of the charge it could be every 2 years or less. Each 100 amp hour battery will cost around \$200. That makes it an expensive proposition to replace a 12 battery (or more) battery bank. And the experts all agree that you can't replace them one at a time. ***You have to replace them all at once.***

## ***Engine Idling***

As we said earlier, some inverter systems require you to run your van engine during the day to recharge your batteries, heat bath water and to heat and cool the grooming area. As of this writing, 31 states have enacted laws prohibiting engine idling. The number of states (and municipalities) enacting this type of legislation continues to grow.

To demonstrate how these laws are being adopted so quickly, we only need to point to the Federal Environmental Protection Agency (EPA). They have developed a "model" law for state and local governments to adopt by simply plugging in the name of the state or locality into the "template" and passing it through the legislative body. To see this EPA designed and promoted "Model Law" go to this link:

[www.epa.gov/smartway/documents/420s06001.pdf](http://www.epa.gov/smartway/documents/420s06001.pdf)

To see what states and municipalities have enacted laws prohibiting or restricting engine idling, follow this link to the American Transportation Research Institute's Compendium of Idling Regulations paper at:

<http://atri-online.org/2005.ATRI.IdlingCompendium.pdf>

**California Law example:** On or after February 1, 2005, the driver of any vehicle subject to this section: (1) shall not idle the vehicle's primary diesel engine for greater than 5.0 minutes at any location. *Source: California Air Resources Board*

### **Truck Engine Idling: EPA New England**

A typical truck burns approximately one gallon of diesel fuel for every hour it idles. If this truck idles for 6 hours a day and operates 300 days per year, it would consume 1800 gallons of fuel per year, simply idling. At the national average (as of

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1/3/07) price of \$2.67 per gallon, it costs \$4,806 per year to idle the engine.

Idling causes twice the wear on internal parts compared to driving at regular speeds. According to the American Trucking Association, such wear can increase maintenance costs by \$2,000 and shorten the life of the engine.

While sitting in an idling vehicle, drivers are exposed to the vehicles pollution more so than when the vehicle is in motion since there is no air flow to vent the emissions.

## **More Info on Engine Idling**

For more information, and I mean **a LOT more information**, type “engine idling law” into your favorite search engine and start reading.

## **Other Considerations**

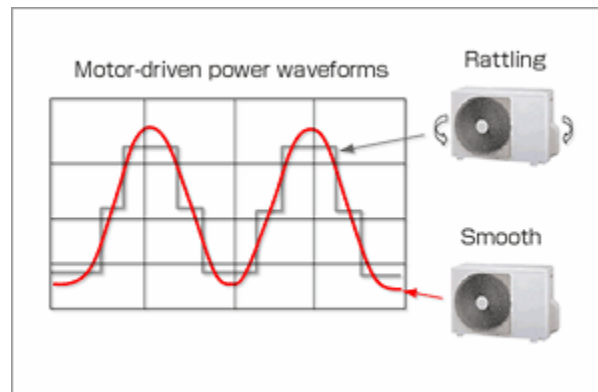
- Flooded lead acid batteries need to be equalized 3 to 6 times a year which involves complicated electronics or a separate battery charger hooked to each battery. If you go with an inverter/battery system, insist on absorbed glass mat (AGM) batteries.
- Fluid levels need to be checked at least monthly.
- Each battery can weigh up to, or even exceeding 100 pounds each which means you have to carry between **one half to three quarters of a ton of extra weight**. That’s right—between 1000 and 1500 pounds of batteries!
- Disposal of worn out batteries in some states can cost as much as \$10 per battery.

## **Technical Information**

**1**--All the experts agree that you shouldn’t consistently use more than half of the power in your batteries. If you do, you drastically reduce their useful life. It’s called 50% maximum depth of discharge or DOD.

**2**—Inverters lose at least 10% of the power from the batteries when they change DC power to AC power. Some lose more but none lose less. That’s known as inverter inefficiency.

**3--** Inverters generate AC power by simulating an alternating waveform (The 60HZ or 60 cycles equipment in the USA and Canada needs to operate), with small steps (see figure 1 below) where as a generator produces a “pure sine wave” due to the rotating mechanism of the generator rotor.



*(Photo NEC Electronics)*

**4--** Inverters best work with non-inductive loads (IE non motor loads). Dryers and AC units are inductive loads that often require 4-6 times the current to start them that it takes to run them. Placing heavy inductive loads on inverters is not recommended for equipment longevity.

**5--** Inverter systems by nature are heavy devices and generate heat, and are not recommended for humid hot environments, this heat generation often requires, integrated cooling fans.

**6--** Inverters do require that the batteries be well charged and maintained and this is a cost that must be considered. If the batteries are low this can have an adverse affect on electronic equipment.

**7--** One must also consider the economics of charging batteries, either you parallel multiple batteries (a large heavy endeavor), or you have one or two that must then be then charged, quite frequently from a vehicles alternator, the vehicle is most often left running, (fuel costs) which can strain the vehicles alternator that was never designed by the vehicles manufacturer to handle the additional charge loads.

**8--**Inverters used in commercial applications will typically have a generator to supplement the battery charging.

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## **Advantages of inverters:**

- Inverters are excellent sources of power that are for the most part silent. They are ideal for electrical devices that are not so voltage sensitive. And must have a good constant source of power for re-charging the batteries.
- They have little maintenance if installed for their specific use, environment and equipment load.
- Depending on the Kilowatt size they are often cheaper than a generator.

## **Disadvantages of inverters:**

- Not ideal for inductive AC and motor loads
- Sensitive electronic equipment can be damaged by poor waveforms generated by low batteries
- Larger KW units are heavy and can only be maintained by specialized factory service centers (Not RV centers) and often require removal with added packaging and shipping costs, (due to their heavy weight), in addition to any repairs.
- Must have a good source of power for re-charging, (costs in fuel and maintenance to run the vehicle)
- Vehicles left idling to charge the battery is generally poor practice and not recommended by the vehicle manufacturer, resulting in more frequent vehicle engine oil changes.
- Batteries will tend to hold less and less charge (much like a car) over time leading to shorter and shorter vehicle run times.
- Due to the amount of integrated circuitry involved internally inverters are not recommended to be installed in dusty, humid environments, due to cooling requirements.

## ***Source Material and Additional Information***

Extremely power hungry appliances such as electric water heaters and electric clothing dryers should either be replaced with gas-powered energy efficient models, or be run on non-inverter supplied power. The storage battery bank must have enough storage capacity to meet your power needs between charging cycles. Making sure the battery storage capacity is about double the power that would be used in a normal use day is a good minimum. *Source: ABS Alaskan Alaska's Natural Power Company, 2007*

Are there any appliances that cannot be run on an inverter?

While the inverter can easily supply a heavy load like an electric heater, the battery capacity is often too low to maintain the supply for any great length of time. The same applies to air conditioning units. *Source: Barden UK Ltd, 2007*

If a battery is discharged to 50% every day, it will last about twice as long as if it is cycled to 80% DOD. The most practical number to use is 50% DOD on a regular basis. Batteries self-discharge faster at higher temperatures. Lifespan can also be seriously reduced at higher temperatures - most manufacturers state this as a 50% loss in life for every 15 degrees F over a 77 degree cell temperature. © 1997-2006 Northern Arizona Wind & Sun, Inc.

New batteries need to be cycled several times before reaching full capacity (50 - 125 cycles, depending on type). Usage should be limited during this period. Deep cycle batteries need to be equalized periodically. Equalizing is an extended, low current charge performed after the normal charge cycle. This extra charge helps keep all cells in balance. Actively used batteries should be equalized once per week. Manually timed charges should have the charge time extended approximately 3 hours. A weak battery will cause premature failure of companion batteries. As batteries age, their maintenance requirements change. This means longer charging time and their capacity decreases. *U.S. Battery Mfg. Co.*

Without this equalization charge, the individual cell voltages will gradually drift apart over time. Capacity decreases more quickly than battery manufacturers claim it should, and eventually one cell will fail short, destroying the battery.

Unfortunately, overcharge equalization is only effective on a small number of series cells, typically a single 12 V battery. High-voltage battery stacks are not adequately equalized and therefore suffer reduced cycle life. The best, but most expensive, method is to provide a completely separate charger for each cell or each 12 V battery.

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Another method is to switch in shunt resistors, which bleed off some of the overcharge and provide a charging path for the weaker cells. This method is better than doing nothing, but not by much. A better method is to simply make sure that each 12 V battery, or preferably each cell, is at the same voltage at the same time. Several methods have been proposed, most of which require precise battery voltage measurement, since battery voltages must be equalized within 1 percent. *Source battery poweronline.com*

**Xantrex Technology** is a great resource to learn more in general about inverter/battery systems in general and specifically this link

<http://www.xantrex.com/web/id/1741/docserve.asp>

*Wag'n Tails would like to thank to Brian Jarvis, President and engineer of Advanced Power Technologies, LLC for his help with this information. Advanced Power Technologies has a wealth of experience in portable power supply systems and backup power systems for a broad range of clientele. Brian assisted with technical points 1 through 8 and reviewed this information in it's entirety for accuracy. Also, we want to note that Brian's wife has owned and operated generator powered grooming vans since 1998.*



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