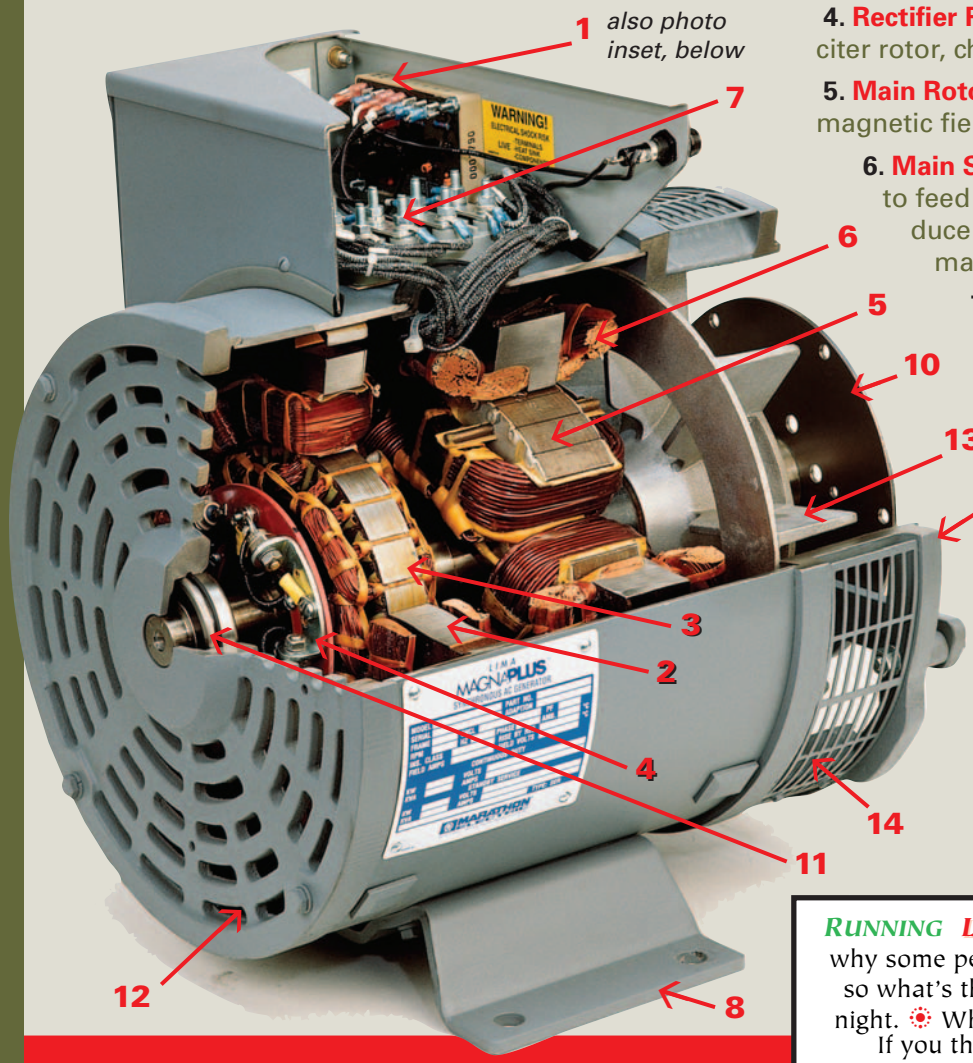
Smooth Operator

BRUSHLESS GENERATORS—Anatomy

Generator performance, efficiency, and troubleshooting is dependent on the "type" of generator we're talking about–how it's regulated, how it's excited. We explore the 4 different types in ***Power is Knowledge*** *(pg. 2)*. What type of excitation determines the style of generator, and when buying a genset it tells you what your options are–for price and performance. If choosing the wrong type on price alone you'll be disappointed in the generator's performance.

Generator styles also vary greatly in terms of how much fuel's required to generate electrical output–the fuel efficiency and cost of operation. If choosing your system on sticker price alone you may well pay dearly, later on, each and every time you visit the fuel dock *(pg. 3)*.

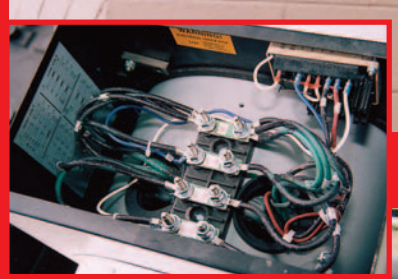


Knowing styles of excitation is essential for troubleshooting–if a generator doesn't work it may not work in several different ways. We'll shoot some generator trouble in coming issues but need to know what components we're dealing with first, starting here with the pieces & parts of ***Brushless Generator Anatomy***.

1. **Voltage Regulator:** Takes the residual voltage from main stator, builds voltage & maintains system voltage.
2. **Exciter Stator:** Receives output voltage from voltage regulator to build magnetic field, creating voltage in exciter rotor (producing electricity).
3. **Exciter Rotor:** Builds excitation voltage & sends to rectifier ring.
4. **Rectifier Ring *(Diodes):*** Receives output voltage from exciter rotor, changes it to DC voltage & feeds to main rotor.
5. **Main Rotor:** Takes voltage from rectifier ring & builds magnetic field that produces electricity in main stator.
6. **Main Stator:** Output voltage leaves from main stator to feed bus bars—output can be reconfigured to produce different voltages and phases from the same machine.
7. **Bus Bar *(Link Bar):*** The point where the power leads connect to the generator.
8. **Mounting Foot:** Supports rear of genset.
9. **Engine Adaptor:** Allows a mechanical connection to the engine.
10. **Drive Plate:** Connects generator to engine flywheel & supports front end of the generator rotor assembly.
11. **Bearing:** Supports the rear of the rotor assembly (i.e., single bearing generator).
12. **Cooling Air Inlet:** Air enters through back.
13. **Cooling Fan:** Pulls air through generator to cool the windings.
14. **Grill–Cooling Air Outlet:** Air discharges.

MAGNAPLUS® *cutaway diagram courtesy of Marathon Electric, Wausau, Wis.*

RUNNING LIGHT : Light travels faster than sound, which is why some people appear bright til you hear them speak. O.K., so what's the speed of dark? A day without sunshine is like, night. What happens if you get scared half to death twice? If you think nobody cares, try missing a couple of payments. Everyone has a photographic memory. Some just do not have film. Eagles may soar, but weasels do not get sucked into jet engines. Just remember–if the world did not suck, we would all fall off.



voltage regulator

ISUZU DIESEL

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Generator problems?
Low voltage,
NO voltage?
Low frequency?
No current?

The solution depends on what type of generator you're talking about.

Our shop crew tests every **MER***made* genset before it leaves the Seattle shop–guaranteed.

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ENGINES—DEERE REPOWERS

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FUEL-EFFICIENT JOHN DEE in both pleasure & commerci

JOHN DEERE

Built at Westport Shipyard originally as a tuna/salmon troller, *Miss American Pie* had 25 years of service from its Detroit Diesel 8V92.

"Fuel efficiency wasn't a huge thing when we decided to repower. The economy really wasn't an issue last October, November. Now it became a bigger issue." **Karl Kollen**

"Vern said it had another year or two left in it," says skipper Karl Kollen recalling mechanic Vern Suggett's advice. "Thought to rebuild but it had some problems, with parts hard to get.

"Decided to go with a new engine," he says. "I wanted a little more power." So Karl went with a DEERE–the 6125AFM–and a Tier 2 EPA emissions rating before mandatory compliance for pleasure craft *(on 1.1.06)*.

"He thought it was a good idea to catch up to the 21st century–he was losing hp, wanted more speed. It's all about cleaner air." **Vern Suggett**

Karl says he could've had less power for less money with a smaller JD, as did the boat's sister ship, *High Hope*: "I asked him about it. He actually went down in hp, wanted more economy."

As it is, the repowered *Miss American Pie's* performance posts some impressive numbers, as does the JD's fit: "More room in the engine room with the JOHN DEERE," says Karl. "This one's in-line 6, other one's V-8. Definitely more room on the sides, and just a few inches longer."

He also says fueling up in Canadian waters cost about 60¢/liter in 2004 but this past season he paid almost $1/liter–upwards of $3/gal.

Compared to the 8V92 Detroit Diesel's cruise speed of 9-10 kts @ 1750 rpm burning 13.6 gal/hr *(top speed 12 kts @ 2250), the JD 6125AFM cuts fuel & goes faster–* cruising 10 kts @ 1400 on 7.5 gal/hr *(top speed 15-16 kts @ 2000 rpm).*

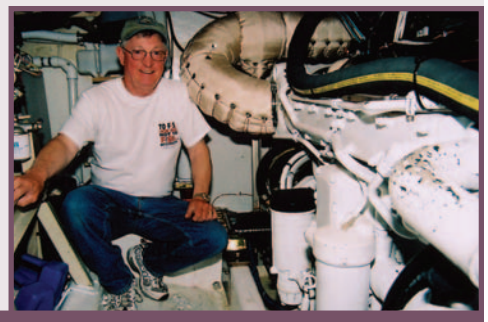
"Two-cycle Detroit Diesels," says installer Vern, "are a very loud & inefficient engine. We're now getting into an engine that's much more sophisticated. Since electronic injection you have a much quieter engine because fuel's metered more closely–& no smoke."

"The noise level went down probably 50%. I think it's a factor, if you've been around the screaming jimmies." **Karl**

"At cruise speed it felt like we were idling along," he says. "At 1800 doing close to 12 knots it felt like we're doing about 8. Before, speed was associated with loudness of engines. This engine's so much quieter the two don't come together."

Karl says he went with a MERmade engine because of recommendations & the **MER*made* Isuzu 12.5-kW hotel set** he bought in '95: "It's been very reliable," he says. "Haven't had any trouble with it in 10 years."

"It all turned out fine. Bob's done a great job, coordinating it, getting the sea trials underway. Everything's working the way it should be, right within specs." **Karl**



Karl Kollen and his *Miss American Pie* MER-made signature-white JD 6125AFM rated for pleasure: 455 hp @ 2000 rpm.

Shooting Trouble

GENSET EXCITATION SYSTEMS—PROS, CONS

POWER IS KNOWLEDGE ... *the knowledge of power*

Since horsepower & kilowatts are both a measure of power they say the same thing. This is Power Math–the math behind power: **1 hp = .745 kW** **1 kW = 1.34 hp** *(1 ÷ .745 = 1.34)*

That relationship is a constant, and has nothing to do with fuel consumption.

If we had a generator that was 100% efficient in transforming horsepower output of an engine into electricity, then we'd be able to use the formula **1 hp = .745 kWe** (kilowatts electric).

Put in 26.8 hp and you get out 20 kW-electric

26.8 hp x .745 = 20 kW

But generators are not equal in their ability to transform horsepower to usable electricity. With basically 4 different styles, let's compare how efficiently they'll produce 20 kW.

1. SER or EXTERNALLY REGULATED GENERATORS

(a.k.a. Standard Voltage Regulator) Most common & relatively efficient at ***85-92%*** depending on their ratings and conductor content. They ***hold their nameplate voltage within 1%*** from no load to full load even if the frequency varies by 4-5%, accomplishing this by means of a solid-state external voltage regulator that varies the field current to the excitation windings depending on the load. They ***can also start motors well if oversized*** but modern versions using high-temperature-rise insulations & less copper cause motor-starting capacity to suffer.

Very good voltage control over full kW range of generator makes a good general-purpose generator system for majority of marine applications, such as small (hotel) loads. Examples calling for critical voltage regulation include microwaves, computers, electronic communications—it's not uncommon for gensets to burn this stuff up.

PMG-EXCITED GENERATORS–A subcategory of SERs, with the ***same good voltage control & 85-92% efficiency***. Added to any SER generator for a dedicated, more robust excitation system, a small PMG generator supplies current to the voltage regulator which controls generator voltage for ***better motor starting & improved fault current characteristics.***

Excitation current is independent of the generator load–it doesn't see the applied load come in–so excitation voltage is constant & doesn't deteriorate. PMGs increase motor starting capability an average of 15%. They are sometimes more economical than if self-excited. *26.8 hp ÷ .90 = 29.78 hp* **A 90% efficiency rating will require 29.78 hp input.**

2. MAC GENERATORS

Self-excited or transformer-controlled, they can be very efficient if sized properly. ***85-92% efficiency*** in converting hp to kWe. ***Start motors beautifully*** but voltage is sensitive to engine rpm and ***don't control voltage output as well*** as an externally regulated generator.

Currently most expensive—but less expensive than oversizing the genset to start a large electric motor. Often used to run refrigeration systems together with a smaller hotel set that saves fuel plus wear & tear on the expensive unit.

3. CAPACITOR-START GENERATORS

Use a current storage device known as a capacitor to supply the excitation current. Generally of ***lower quality & copper content***–typically a ***67-75% efficiency*** rating in converting hp to kWe–they're commonly used behind high-speed gasoline engines or ***low-cost*** diesel counterparts.

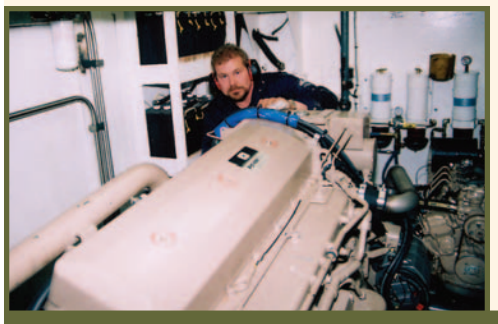
NT JOHN DEERE *6125AFM*
re & commercial applications

In the proud but dwindling ranks of the grand old halibut schooners from back in the day, the 1928 *Aleutian* took years off her age last winter with a major overhaul of most all her systems–centerpieced by a JOHN DEERE 6125AFM repower.

Only the 4th owner in the boat's 8 decades, David Glem ran it with an 8V71 Detroit Diesel for most the past 20 years on his watch, which had replaced a Detroit Diesel 610 for 37 years before that.

"It was never big enough," David says of the Detroit 8V71. "Should've been a bigger engine. Everything wasn't big enough–reduction gear too small, the engine–kept blowin' it up. Only got 8,000 hours and had to overhaul it. This would've been my 5th overhaul.

"We could do about 8 knots on a good day," he says, "going downhill with the wind. Could never run too fast, 1400 at the most. Stack temperatures go way up."

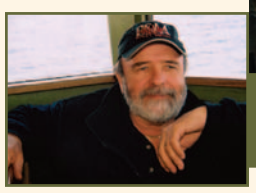


Engineer Todd Hoppe & *Aleutian's* MER-made factory-issue brown DEERE 6125AFM rated for commercial use: 341 hp @ 1800 rpm.

David says mechanic Vern Suggett kept saying, "Put a Deere in."

"Started doing my homework," says David, "talked to everyone."

"If I repowered it'd be a John Deere. Everyone I talked to who has 'em likes 'em." **owner David Glem** *(right)*



"We changed everything," he says. "New engine, new reduction gear, exhaust, keel cooler, shaft, rewired the boat, went from 32 V to 24."

F/V Aleutian

***Aleutian*–a 1928 wood displacement hull with 68'9" keel, 19'6" beam, 9' draft–enjoys greater fuel efficiency at faster speeds with a DEERE.**

Electronic fuel injection transforms engine fuel efficiency, and sea trials of the *Aleutian's* Deere bore this out.

Compared to the 8V71 Detroit cruising 7.8 kts @ 1450 rpm burning 7.8 gal/hr, *the JD 6125AFM bested the Detroit in both fuel consumption & speed*–comparably the 7.8 kts @ 1150 rpm & 6.25 gal/hr, or hull speed at 9 kts & 9 gal/hr @ 1400 rpm.*

"The new engine's fantastic. If I want to stay at 8 knots I'll bet we'll save 40% in fuel." **operator Pat Hunter** *(below)*

The JD also got high marks from captain & crew for the quiet ride. With the new engine in, "Started it up," David says, "and Pat was on the dock. We realized we couldn't hear the auxiliary, thought something was wrong."

"Standing right next to the boat I panicked," says Pat, "because I knew it wasn't running. Ran down to the engine room–and it was. The old engine was so noisy that I was embarrassed running it in town. Sounded like a string of firecrackers–a gangster's Thompson machine gun."

"You know what's nice about it–sittin' in the wheelhouse, listening to music. Before, we had to turn it up **above** the engine, & I slept next to it. You want them to listen to music, it keeps 'em awake. But now I can sleep." **Pat**

Keeping her appointment with halibut season this spring, the *Aleutian* left for Alaska shortly after sea trials on a shakedown cruise of all new systems en route.

"Thank god there was MER there on the other side of the phone when we called. I very much respect the guys at MER–very much." **Pat Hunter**

SHOCK AT THE DOCK: *fuel savings at a glance*

What began with a maritime industry feeling the fuel pinch heading into the 2005 season ended with a double disaster to send it reeling. Hammered by hurricanes, the sky's the limit on fuel costs. Yep, we're all waking up & smelling the coffee now.

Investing in fuel-efficient equipment will pay for itself many times over in fuel savings.

So when shopping for a genset, what difference does the generator type make? The 4 types of excitation *(pg. 2)* convert horsepower to electrical energy at different levels of efficiency. If you need 20 kWe to run your equipment then you will need somewhere between a 27- and 40-hp engine to drive it, depending on how efficient the generator windings are.

(Capacitor-Start *continued*)

Voltage dependent on rpms—poor voltage regulation, very poor motor starting. Most commonly used in applications when generator not frequently used & good voltage control not critical.
26.8 hp ÷ .67 = 40 hp **A low-efficiency generator could require as much as 40 hp input to generate that 20 kWe.**

4. PERMANENT MAGNET GENERATORS

Most efficient of all–up to ***98%***–they don't need excitation windings. Coupled with variable-speed technology, use rare-earth permanent magnets to create magnetic field. Common in smaller sizes under 6 kW, ***costly to build*** & therefore rare in larger sizes. Under development & newly introduced to marketplace. *26.8 ÷ .98 = 27.35 hp* **20 kWe requires only 27.35 hp.**

Within those 4 categories ranging from 98% to 67% efficiency–it's important to know what you're buying.

Assuming for just a minute that all engines produce the same amount of hp with each gallon of fuel *(a fallacy we'll address next issue)* with approximately 20 hp in each gallon of diesel, then the difference in fuel burned to produce 20 kWe for each hour of operation will vary between 1.35 & 2 gal/hr.

If you use your generator 2500 hrs per year that's the difference between 3,375 gallons (2500 x 1.35) vs. 5,000 gallons (2500 x 2). ***That's a savings of 1,625 gallons per season.***

At today's fuel costs of $2.40/gal, that's a difference of $3,900 in the first year and in excess of $30,000 over the useful life of a good generator *(about 20,000 hrs).*

Because how much fuel's required to generate 1 kW of electricity varies, do the math and it's clear how your fuel savings in one season alone more than pays the difference in upfront cost for a fuel-efficient generator. ***So the next time you're tempted to save $500 bucks on Brand X, you might want to ask yourself if you can really afford to.***

If bad goes to worse and we recalculate at $5/gal, then first-year savings climb to $8,125 and life-span savings more than double—to $65,000. But, $5/gal? ... let's not go there.

But do call us, stop in the shop, or drop by **Pacific Marine Expo booth #1119** and we'll crunch your numbers for you. MER can help you think smart, using the Power of Math.

* *(from top story):* **The *Aleutian's* old prop is seriously undersized & performance should improve dramatically with the new propeller.**

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Vol. 6 Fall 2005

FUEL-EFFICIENCY ISSUE

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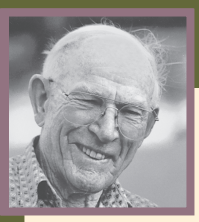
MARINE ENGINE & REPAIR quarterly

news you can use:

Generators—Excitation—Fuel Efficiency
—DEERE Repowers ... & Ivan Fox



From the Founder—
Ivan Fox Remembers ... END OF AN ERA

Quite some time ago fish traps were king in catching salmon for Alaska processing. Many say the era of salmon traps ended in 1958–the last year Alaska was a territory–when statehood outlawed the use of traps in '59. From his vantage with San Juan Fishing & Packing Co. on Kodiak Island, Ivan recalls how traps became economically unfeasible–even before outlawed.

Traps by law were always located at the same location every year. We had about a dozen company boats–small boats, generally about 28 to 30 ft. in length, with open holds like large skiffs. We also had about a dozen independently owned boats. This gave us a good balance, as the boats could travel to where the runs were if we didn't have a trap in that particular area.

The economics of the traps declined as the seine boats became larger and were using larger & deeper seines. They found out that they could cork traps. The boats were holding hooks off the leads–unlawful, however, quite productive for them. To give you an idea what was produced by our No. 7 trap on Raspberry Cape, in 1937 the trap catch was 480,000 salmon. This trap slowly declined. In 1956 the catch was 68,000 fish and 1957, 51,000. So the fact that the larger boats 40 to 50 ft. were able to use deeper and longer seines contributed to the decline in the traps' productivity. The decline in productivity continued as well as the decline in the economics.

Toward the end of the era of traps, there were some that were not profitable and they would not have been constructed, except the law read that if you didn't have a fishable trap on a licensed location, you lost your license. The company continued constructing these non-profitable traps as they had hopes the lobbying going on in Juneau would rule in their favor. The last year of the traps was '58.

After the demise of the traps we started to build a fleet of seiners. Some were company-owned boats, and some we financed for individuals. We also built up a group of setnetters, generally in the area of the old trap sites.

I think the loss of the salmon traps was good for the industry. It encouraged the building of larger vessels, locally owned, that eventually entered the crab and shrimp fishery which made a large contribution to the local economy.

Writer/Editor/Photographer: JANA M. SUCHY