# When Size Does Matter

## Sizing Refrigeration

Whether looking at refrigeration for the first time or as an upgrade to your existing operation, an engineered system will keep you fishing—not working on equipment—and save you money. **When refrigeration is in your future, always plan your system before buying the genset, or chances are you'll end up underpowered, underproducing, or buying another one**.

Large electric motors need a huge amount of amperage momentarily when starting—an **inrush current** 5–8 times greater than running current. You'll have problems if a generator's not designed to accommodate inrush, and remedies to undersized gensets can be expensive: Adding a soft-starter to reduce inrush could cost thousands, or a new generator means replacing wiring and panels all up the line too.

### The Vision Thing

Refrigeration folks ask questions to find out just what your vision is, in order to calculate required refrigeration tonnage and the power needed to run it.

- *What does your market require?*
- *What do you want to do—freeze? chill?*
- *What's the product you want to end up with?*
- *How much product—pounds per day, pounds per hour? How cold, how fast?*
- *Where do you want to do it? Where does it fit on the boat? What's your hold like—configuration, insulation quality? Where's your processing area?*

AND THEN,

- *How much refrigeration would you need to do that? How much power would you need to run it?*

Either chilling a water volume and product weight, or freezing a specific number of pounds, down to a desired temperature in a specified amount of time will determine required refrigeration tonnage. Here's where Reality comes in to challenge—and perhaps revise—the Vision, to find a solution both practical and affordable to your operation.

## Sizing the GenSet

Buying a genset before knowing your refrigeration needs is like buying a fishing permit without knowing the area, the gear, or the type of fish it's good for. But, hey, you have a permit.

Getting the generator first will dictate what you can—or can't—do. Maybe you can't refrigerate at all, or maybe you'll have to turn other things off when refrigerating just to manage the load and prevent brownouts. But, hey, you got a generator.

### All kW Are Not Created Equal

Buying a genset based solely on the nameplate kW rating overlooks crucial factors—the boat's total load, and the heavy load demanded on starting the refrigeration motor.

"You can't change physics," MER Equipment General Manager Mike Hoyt likes to say. "Too often fishermen call and say they need 20 kW. Don't trust the nameplate. Just because it says 20 kW doesn't mean it does what you want it to do—not all 20 kW act the same."

MER shoots down old Rules of Thumb that might say a 15 HP refrigeration system needs a 30 kW generator to run it.

"Because of technology changes those rules don't really apply," says owner Bob Allen, suggesting fishermen do their homework or ask the experts "so they don't buy one too big or too small."

Most problems occur either in choosing undersized or single-phase generators when not appropriate for refrigeration. Check how your boat's wired. It's more efficient to run 3-phase on motors larger than 5 HP—winches, anchor windlass, big bilge pumps, refrigeration compressors—and most refrigeration systems are 3-phase.

Hoyt says you can always buy a cheaper generator. The more expensive gensets—more copper, more efficient, more fuel economy—are not requiring the same amount of horsepower to produce the same amount of kilowatts.

"If a fisherman doesn't ask the right questions they'll find a less expensive one that won't do the job."

In assessing total load consider both the hotel load—power for galley, deck lights, water heater, TV—and the refrigeration. First question the power folks ask is about your refrigeration, so if you haven't gone there yet they'll have to send you back. Need to know what you're powering.

**Simple Load Analysis:**

- *What are you doing for refrigeration?*
- *How big's the motor?*
- *What's the motor code?*
- *What's your hotel load going to be?*
- *Do you have running lights—what kind, how many, how big?*

The trick is sizing a generator big enough to run the refrigeration but small enough to run the house load when not running the system. MER recommends a generator one or two sizes bigger to get motor-starting ability. If figuring you need 20 kW, Hoyt suggests a 25 kW so you have room for growth and don't run it to the limit. "Invariably they'll want to add something else." AC power's tempting on a boat. The bigger generator also has a better efficiency rating—saving fuel, running cool—and a longer life, but you want to size appropriately to keep a load on it.

How much power and what size genset you need invariably comes back to how much product you want to produce—the vision thing—and that determines refrigeration size first. Work from that premise: *First check your markets. What do you want to accomplish? What equipment do you need to do it? What and how much power do you need to run it?*

***INTEGRATED MARINE SYSTEMS recommends following these guidelines along a sequential path to get the right genset for the right refrigeration system—both must work together for your operation to succeed.***

# Tech Tips—Voltage Dip & Other Variables

Jim Wright of Marathon Electric—manufacturer of LIMA-brand generators—says that when limited-capacity generators are hit with very large inrush current the voltage decays very rapidly until the motor reaches running RPM, then goes back up, akin to cruise control.

"The real trick in motor starting is to get the motor to accelerate in speed up to this point," says Senior Product Engineer Wright, explaining that the genset should be sized for this full peak current-inrush capability.

With the motor's rotor initially at a standstill, momentarily the motor requires additional power to start—typically drawing 5–8 times its rated full-load current. Wright says the motor's power demand will decrease—but not much—until reaching 80% rated RPM, when it goes down radically.

Precisely evaluating motor-starting capability depends on the motor characteristics. To calculate power requirements MER owner Bob Allen looks to the nameplate data off the refrigeration motor tag: **HP and NEMA starting code letter, or locked-rotor amps**. These National Electrical Manufacturers Association NEMA codes classify motors by the ratio of locked-rotor kVA (kilovolt amperage) per HP. Different motors of equal horsepower may well have different starting codes, depending on the purpose of the motor.

MER General Manager Mike Hoyt also says that generator manufacturer ratings are not consistent, so "you kind of have to rely on the genset guys" to figure out the equivalent starting kVA of a motor from its NEMA code or lock-rotor amps.

"Voltage change is one of the functions of the size of the unit," says Wright, and economically sizing a generator to the load is to "decide how much transient voltage dip you can tolerate." Simply put: The generator has to produce X amount of kVA to get the motor started. If you want to limit depth of the dip, have to use a bigger generator. If it can go deep, use a smaller one.

Hoyt sizes most generators so when the largest motor goes on-line voltage droop does not exceed 30%: "If greater than 30% the generator's too small." He says a large voltage dip that separates magnetically-held motor contactors can make them chatter or the lights go dim.

Today's newer, better insulation on the windings allows generators to run at higher temperatures by using less copper and steel to get the same nameplate kilowatt rating. Less active material may result in a greater voltage dip for a given starting load.

Wright explains that insulation systems allow the windings to carry more current—so there's more heat but not more guts to the generator. It's just running harder.

As load increases the hotter it gets. Nameplate temperature rise at a given load is the running temperature above ambient. A generator exceeding the permitted load will waste fuel, wear rapidly, fail prematurely. For every 10°C above rated operating temperature the insulation's life expectancy cuts in half; running 20°C hotter cuts it to 25%. Nameplates sometimes ignore temperature rise, but running at high temperatures or right to the limit can reduce generator life.

Where the total load dictates generator size, the largest motor that it starts (and when) will determine generator type—whether chiller or freezer, what the motor's turning doesn't matter. Newage AVK SEG suggests the electronically regulated precision voltage control **(standard voltage-regulated)** together with the PMG (permanent magnet generator) for better motor-starting ability, the best of both worlds. Newage AVK SEG, a.k.a. Stamford, offers a number of options as well as version-specific designs for marine applications.

Most often Seattle's MER sells the **self-regulated (motor-starting)**, or LIMA MAC-style (Motor Application Characteristics), for its higher copper/steel content and better starter ability. Designed 1:1—1 kW starts 1 HP—motor starters generate extra amperage with higher ability to take the load. Standard voltage-regulated generators are limited to 2–3 kW per HP starting capacity.

Think about your refrigeration needs and options first. At IMS, we work together with generator companies to build a system adequate to the task and sufficiently powered to run the show—refrigerating the catch while keeping the lights on too.


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