RACOR

40 YEARS

Of Very Fine Fuel Filtration

Story By Steve D'Antonio

While I've visited many boatbuilders, boatyards, and marine industry manufacturing facilities in my career as a technical journalist, I knew my factory tour of Parker Hannifin's Racor Division would be different. For me, it was pilgrimage of sorts. The name "Racor" is synonymous with fuel filtration, and it is a brand that virtually every cruising boat owner recognizes and identifies with. This was a visit I had planned on making for years—although perhaps under more agreeable weather conditions.

I enjoy northern California's climate and the intoxicating crispness of the clean Pacific air. However, based on the reports I was hearing as I approached my destination of Modesto, it seemed the typical crispness would be punctuated by conditions I hadn't anticipated. Granted, it was December, but this was California, after all. After missing my connection in Salt Lake City because of—you guessed it—a weather delay, I found myself descending through snow just before landing in Oakland. Over the next few days, I would experience hail, lightning, thunder, and more, but it really didn't matter. Short of a wildfire or earthquake, neither of which is ever off the table in California, I was determined to fulfill a desire that had burned within me for many years.

I was on a mission to visit the factory of Racor, whose significance to the marine industry—and other industries, as well—is nearly inestimable. It is from Racor's northern California plant that all Turbine series fuel filters and their matching elements emanate. I had read the Modesto, California, address on countless Racor filter cartridge boxes and had wondered so many times just where that was. I was about to find out.

I met my host and longtime Racor contact, Gary Garcia, manager of Racor's product engineering group, in the facility's lobby. Like numerous other employees I met during my visit, Gary has worked for Racor for many years—he's currently celebrating his 25th anniversary with the company. Employee retention, always a good sign for a business, is a trademark of Racor.

Our initial stop on the tour was the "museum," where product samples of two types are displayed. First, there are the examples of the many filters that put Racor on the map over the last 40 years, including the Filtral, the very first filter marketed by the company, before it was called Racor (more on that later). While Gary and I discussed the collection, I picked up a filter body that looked like a Racor Turbine;

Top left: The Racor "museum" includes a variety of copycat products, some of which are virtually indistinguishable from the real thing. Above left: Two examples of the same filter—the original 1970s design and the current version. Both are still manufactured by Racor. Above right: An example of the Rogers Filtral, the predecessor of today's Racor Turbine series filters.

it had the familiar beige-and-gold housing, but the name on the blue marine label was unfamiliar. It was then that I discovered what makes up the second part of the museum's collection: knockoffs of Racor products. To the untrained eye, many of these products are indistinguishable from the real thing. If imitation is the sincerest form of flattery, Racor is lauded regularly by others.

PRIMARY FUEL FILTRATION

While fuel filtration is discussed on a regular basis in the pages of *PMM*, it's helpful to revisit this vitally important subject in order to fully appreciate Racor's contribution to the field.

Fuel and its filtration are hot topics when talk turns to diesel engine maintenance. And they should be, because they're often the source of engine trouble. In fact, taking into account statistics and anecdotal evidence I've gleaned from years of working as a diesel mechanic, boatyard manager, and systems consultant, I would say that fuel problems—either an inadequate supply of fuel to the engine or contaminated fuel—account for more engine trouble than any other single source.

The average diesel engine's fuel injection system must, by necessity, possess mind-bogglingly minute tolerances that are measured in thousandths or even ten-thousandths of an inch. These exceptionally fine tolerances are necessary in order to achieve the extremely high pressure—sometimes up to 30,000psi, particularly for common-rail engines—that these systems require to function. Even if you own an older engine that has a conventional mechanical design, proper tolerances are still crucial to the health of your engine; it can be

brought to a grinding halt by less than a teaspoon of silica (sand-based dust) or asphaltine, a mineral-based, tar-like substance found in petroleum distillates that essentially amounts to oily dirt. More insidiously, skeletons of bacteria-based life forms living and dying inside a fuel tank and repeatedly entering the fuel injection system will produce a scouring effect that will soon have any high-pressure pump crying "uncle."

KNOW THY DIRT

As if this weren't enough, add water to the mix, and things get really interesting. The high lubricity of diesel fuel is one of the attributes that makes fuel injection systems as we know them possible. Diesel's naturally slippery nature enables it to lubricate fuel injection pumps and injectors under extreme pressure. However, this most assuredly is not the case for water. While water may be slippery enough to make you fall on a wet deck, it's not nearly slick enough to keep an injection pump ticking away. And, as everyone knows, water doesn't burn very well, so it's best to avoid injecting it into the combustion chamber.

Contrary to urban legend, if water makes its way into an injector, it will not flash into steam as it enters the hot nozzle and blow the injector tip off, causing it to rattle around in the combustion chamber like a piece of shrapnel inside a Sherman tank. Water in a diesel fuel system is destructive enough on its own; no embellishment is necessary. Any of the aforementioned contaminants—or worse, a mixture—can offer up a Mickey Finn cocktail that will spell curtains for the fuel system, and possibly the engine itself.

The good news is that nearly all fuel-related problems can be readily understood and diagnosed. As long as you haven't run out of fuel, most of these calamities can be avoided by the judicious use of filtration.

SEQUENTIAL FILTRATION

In any boat with a diesel engine, a relatively inexpensive fuel filter element is all that stands between reliability and potentially serious engine problems. The key to proper fuel filtration is to approach it in a sequential fashion, a process known in the industry as multistep filtration. Industries whose manufacturing processes call for large quantities of ultrapure water (pharmaceutical and semiconductor producers, for example) routinely use such an approach; the fluid moves through progressively finer filters, rather than passing through the finest filter first.

If only it were that simple with fuel. A contentious debate rages on the docks, in engine rooms, and in watering holes onshore: which micron rating is best for the primary filter element? My suggestion is to use two filters of sequentially finer filtration. The first, or primary, filter should have a 10-micron or 30-micron rating. (In Racor's color-coded world, 10-micron elements have blue stripes and lettering, while 30-micron elements have red markings. Two-micron elements are lettered in brown.) The specification of the secondary filter, the one that's on the engine, is determined by the engine manufacturer. This filter typically carries something between a 2- and 7-micron rating. You have no choice here. Simply make sure you use the filter part number specified by the manufacturer.

I know; you've spent your entire cruising life using a 2-micron primary filter. Rest assured, there's a method to my madness, and it's endorsed—in many cases, mandated—by numerous engine and fuel filter manufacturers, including Racor.

There are two reasons for using multistage filtration. First, fine filters (those with a 2-micron rating) are much better at filtering out fine contaminants such as asphaltine if they're called upon to filter only fine contaminants, not larger particles. A micron, by the way, is a millionth of a meter. As a comparison, a grain of salt is 100 microns wide, dust mites are between 100 and 300 microns, the average human hair is 70 microns thick, and bacteria measure about 2 microns in diameter. A white blood cell's diameter is 25 microns.

Here's a useful analogy: If you took a bucket, punched a few small holes in the bottom, filled it with fine sand, and then poured water into it, some sand would leak out of the holes at first. But then the flow of sand would slow, and eventually only water would flow out. If, however, you filled the bucket with a mixture of gravel and sand and poured water into it, chances are the sand would continue to flow out of the holes, because the gravel would keep some paths open. Multistep filtration works in much the same way: contamination is segregated between coarse and fine filters, and both filters work more effectively when they're allowed to be specialists in the work they are called upon to carry out.

The second reason for having a multistage filtration system is that if you capture all the debris, both coarse and fine, in the first filter, the second filter ends up doing very little. As a result, you've effectively halved your filter surface area, and you've limited the ability of your filtration system as a whole to capture and hold contamination while still allowing fuel to flow to the engine.

WATER REMOVAL—THE RACOR WAY

The other half of the filter equation involves water. As previously mentioned, water is a particularly nasty contaminant in that its lubricity is very low. As such,

Photos by Steve D'Antonio

Top: Every tandem and triple Turbine filter is assembled and immersion-tested at this bench at Racor's Modesto, California, plant. Above left: Early on, Racor acquired a plastics molding business, which it incorporated into its production. Here, sight bowls are manufactured for inclusion in Turbine filters. Above right: At this station, Turbine series filter bodies are assembled and tested.

once it gets inside a fuel system, havoc is sure to ensue. Add to that the other obvious side effect—corrosion—and it's clear to see that keeping water out of your fuel system is job number one.

As most cruisers know, water is denser than fuel, so it will sink to the bottom of a fuel tank or any other container. This phenomenon aids in water removal, provided the water is given a chance to settle out of the fuel. If water settles to the bottom of the fuel tank, you might think that's OK; at least the water isn't making it to the engine. The problem with the fuel tank acting as a settling pond is that, once there, not only does the water have no means of escape, it also acts as a nursery for bacteria and corrosion. Given enough time and the toasty environment that exists inside a fuel tank that's installed in an engine room, the birth rate for the tank's micro-residents skyrockets.

The result is a carpet-like biomass across the bottom of the tank that clogs filters and fuel pickup lines, and it gets worse. The by-product of these fuel-munching microbes, which live at the fuel-water interface and eat hydrocarbon components, is hydrogen sulfide, a caustic

chemical that will ultimately corrode metallic fuel tanks and fuel system components. I've excavated bio-carpets and beneath them have found tank bottoms that resembled the cratered, pitted surface of the moon. It's not pretty and often requires tank replacement, a project that can lead to multiple zeros on your boatyard invoice. The final flaw in relying on your fuel tank as a water-containment device is the turbulence that occurs inside a tank when the boat is under way in anything other than the calmest conditions. The washing-machine effect often emulsifies water and fuel, creating a frappe-like mixture that is readily sucked up by the engine.

It's obvious that the best place for water is in the sea, not in your fuel tank or fuel system. The next best place is in a water-separating fuel filter. These filters are not uncommon and are available from Racor and countless other manufacturers. They use the low-tech water-is-heavier-than-fuel approach, allowing gravity to do the work. Once water accumulates in the filter's collection bowl, it can easily be drained. While this method works, it's not completely reliable, because fuel often moves through the filter too quickly to allow the emulsified or entrained water to settle out.

Racor's Turbine series filters work differently, and here's where the company's 40 years of fuel filtration savvy comes into play. As fuel enters the Racor Turbine filter, it moves through a centrifuge that spins off large debris and water droplets. These fall to the bottom of the clear collection bowl, where they can be drained through a heavy-duty, UL-marine- and ABYC-approved valve. Smaller water droplets collect on the filter's integral coalescer cone, roll off, and sink to the bottom of the bowl. The final step in thwarting water from entering your engine involves the use of Racor's proprietary Aquabloc II filter element. The media used in these elements is unique in that it allows fuel to pass, but not water. I've seen Racor Turbine series filters that were filled to the brim with water, yet the engine's secondary filter stayed "dry" (it was filled with fuel, but free of water). When this happens, the engine stops running, but no water reaches the fuel injection system. Mission accomplished, right? Not always. Ironically, I've heard skippers complain that the filter stopped the engine because it was clogged with water. That's ludicrous, of course; the filter did its job. However, there is a solution to this "problem," as well: installing a water-sensor probe in the filter bowl. (Opt for a combination audible and visual alarm, rather than a simple light, which you might not notice.) The probe and alarm will alert you long before the filter's water table rises to supercritical levels.

Photos by Steve D'Antonio

Left: The Modesto facility is capable of making tens of thousands of fuel filter elements each year. Right: Completed marine-series Turbine filters await packaging and shipment.

The beauty of the multifront filtration and water-removal battle plan that's used by Racor lies in its simplicity. Careful inspection of the earliest Racor Turbine filter (back then, it was called the Rogers Filtral) reveals a number of similarities with the current model: the clear bowl, the T-handle lid for easy removal, an early version of the centrifuge, and a metallic drain. The roots are deep ones, indeed, stretching back 40 years. With the exception of a hollow, floating aluminum ball that acts as a check valve, the Turbine filter has no moving parts. Today's Racor Turbine was built on a sound foundation and

has benefited from four decades of innovation and manufacturing acumen.

You've probably noticed that I've mentioned Racor's Turbine series filters multiple times in this article. Racor makes scores of marine filters other than the Turbine; however, in my opinion, few offer so much in such a well-refined, efficient, easily serviced, and reliable package. Anyone who has ever used one knows what I mean.

THE REST OF THE STORY

After leaving Racor's "museum," Gary Garcia and I moved on to the meat of the visit: the shop floor. I was escorted through the entire manufacturing plant, all 233,000 square feet of it, where I was able to watch filter bodies and elements spring to life, from raw material to finished and tested product.

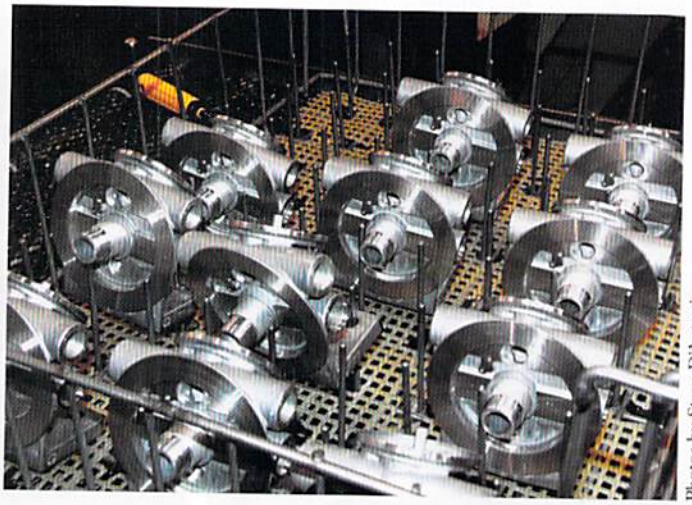
Racor manufactures a large assortment of filter housings and elements for its familiar products, but it also makes hundreds of proprietary filtration products for dozens of other well-known manufacturers such as Volvo, Navistar, AC Delco, Kenworth, Peterbilt, Mack, Cummins, John Deere, and more. (During my tour, I even glimpsed the casting for the fuel filter on my Ford diesel pickup truck.) It's no accident that the world's best-known manufacturers of automotive and marine engines choose Racor for their filtration needs. And, when I say that Racor makes components for these folks, I'm not talking only about pleated paper elements; Racor casts intricate aluminum and plastic housings for specialized applications.

It's interesting how little some filter designs have changed over the decades. If the design works well, why muck with it, right? In some cases, on the assembly line I could see examples of the same filter in both its 1970 and present-day skins, interchangeable in every way. The latter are easier and less expensive to manufacture, and they probably last longer and work a little better. However, some manufacturers choose to stick with tried-and-true elements, staying with original, familiar designs. Racor is happy to oblige, supplying whatever works best for the customer.

While much of Racor's manufacturing process is automated and computer controlled, many parts are still assembled by hand. For example, of all the Racor tandem 500, 900, and 1000 MAX series fuel filter assemblies I've installed, worked on, and inspected, I've never encountered one whose complex plumbing-selector valve or fittings leaked, and now I know why. As Gary and I walked through the plant, we encountered an assembly and testing station dedicated to tandem MAX series filters (these are dual filters) where each one is hand assembled, then pressurized and submerged in water to identify leaks. If you own one of these filters, it was born and tested here.

If you think Racor only makes fuel filters, you're mistaken. The company manufactures filtration products for just about anything on an engine that needs to be filtered: air, coolant, transmission and hydraulic fluid, crankcase oil, and crankcase ventilators. Racor also produces a full line of fuel, oil, and coolant additives. The Modesto plant concentrates on fuel filtration products, including fuel filter bodies and elements, and all their various parts and pieces. Another Racor facility, located in Holly Springs, Mississippi, manufactures air filters, oil filters, and other hydrocarbon filtration products.

As an incurable history enthusiast, whenever I write



Photos by Steve D'Antonio

Left: Racor makes filters for a number of manufacturers; these products are branded specifically for each company. Right: The plant's aluminum casting capabilities are impressive. Here, proprietary filter housings emerge from an etching bath.

about a marine manufacturer, I want to know how the company got started. Racor's story began in 1968, when Modesto inventors Wendel Rogers and Shannon Copeland developed a filter that utilized a combination of gravity and centrifugal force to separate water from diesel fuel. The filter included a replaceable, pleated paper element for capturing debris. This humble assembly was the predecessor to the now-ubiquitous 1000FH and other Turbine series designs. They called it the Rogers Filtral, the name stemming from the surname of one inventor and the fact that the filter "did it all." The filter was a success, albeit a limited one. While Rogers and Copeland had good ideas and creative talent, like so many other start-up businesses, they lacked capital.

That's where Mark Richards entered the picture. Into the creative mix he injected cash, and with it, the three entered into a partnership and opened for business. They were off to a good start—they had a well-engineered product and an investor; now all they needed was a name for the company. As the story goes, the three sat on a porch sharing a bottle one balmy California evening in December 1969. One proposed that they combine letters from each of their last names. "How about Richards And Copeland Or Rogers?" Richards suggested. The three laughed, but then realized it sounded right. They talked it over, came up with the acronym "Racor," and toasted their success—and Racor Industries Inc. was born. The original plant, not much more than a commercial garage located on Eighth Street between K and L Streets in downtown Modesto, initially employed between 18 and 25 people, depending on demand.

At this point, "Rogers" was dropped from "Rogers Filtral," and the filter became known as the Racor Filtral, and eventually the Racor 1000FA. I've often wondered about the origins of Racor part numbers—do they have something to do with cubic millimeters, flow rate multipliers, or service intervals? Nope, it's nothing that technical. "1000" was simply a big, easy-to-remember number (the marketing guys had input here, no doubt); "F" stood for—what else?—"filter"; and "A" indicated that it was the first model. They're currently in the FH series, although there were no B, C, or D models. The marine ("MA") version of the filter wouldn't be introduced for another decade. In 1972, the equally familiar 500 series Turbine was introduced, the 500FA, so named because it is about half the size of the 1000.

With its expanded product line, Racor received a $50,000 order from International Harvester. That was a

large chunk of change in 1972, when a stamp cost 8 cents and the average household income was under $10,000. In 1974 the company moved out of the garage into a large facility, and employment grew to 100. Around this time, Rogers and Copeland left Racor, the latter starting a competing filtration company with some family members. That firm, called Dahl Manufacturing, is still in business and offers a marine product line, too.

The Racor 200FG, since superseded, was introduced in the early '70s and helped put Racor on the map. At times, the company was producing 15,000 of these filters a month: a significant volume for a relatively small operation. Still growing, in 1980 the company moved to the 15-acre, 200,000-plus-square-foot facility that I toured, which today employs more than 600 people. Along the way Racor acquired a few other smaller companies that supplied specialized metal and plastic components, ensuring a reliable, cost-controlled parts stream. As mentioned earlier, Racor also actively and successfully pursued OEM agreements with such companies as Ford, GM, and Chrysler, providing designs that suited those companies' needs and budgets. It's clear to see that Racor is much more than a manufacturer of marine primary fuel filters. In 1985, cofounder and current CEO Mark Richards sold Racor to Parker Hannifin, making the company the Racor Division of the Parker Fluid Power Group.

Today, the Modesto plant is capable of turning out hundreds of thousands of filters every month. Not content to rest on its substantial laurels, Racor continues to offer the tried-and-true filtration products so many boat owners have come to know and respect, along with innovative, groundbreaking filter system and filtration designs.

In spite of the weather and travel challenges I faced during my trip to Racor's California factory, it was well worth the effort. As I said my goodbyes to Gary and took one last look around the plant's lobby, I couldn't help but think that here was the essence of an American entrepreneurial story: from a couple of creative minds and an evening toast to a fledgling company to a leader in the filtration industry. It doesn't get much better than that.

Steve owns and operates Steve D'Antonio Marine Consulting (www.stevedmarine.com), providing consulting services to boat buyers, owners, and the marine industry.