

lems. Therefore heating, ventilation and air conditioning (HVAC) equipment is kept to a minimum. Make-up air or fresh outside air is limited or non-existent.

Make-up air should represent 25% of a yacht's airflow. Designers prefer to recycle air as it is usually warmer or cooler than outside air, so less energy is required to heat or cool the air. The problem is the same air is constantly being turned over. This is especially true in the lower staterooms. Assuming no one opens a port hole and each stateroom has its own air handler (heating/cooling unit) and two people are in a stateroom with the door closed, there is no fresh air circulating, just recycled air. This is true for the entire lower stateroom area. The only way to get fresh air down the stairway via Brownian motion or a very slow molecular air transfer. Trying to get fresh air down a stairway into closed staterooms is like trying to blow air into a bottle. The old air has no place to go so the area ends up with a static air situation. With all the airborne bacteria, molds, yeasts and VOC's, this build up can cause very serious problems. Most bacteria are harmless, but when there is a build up of billions, it drastically increase your chances of exposure to a bad one.

Diesel Fuel. A yacht can carry anywhere from a few hundred to tens of thousands of gallons of diesel fuel. The fuel, of course, is confined to the fuel tank. Most yachts have a diesel fuel odor. Some are subtle, some are stronger. Assuming there are no leaks or spills, you will still get diesel odors from the fuel tank vents that relieve air pressure caused by fuel displacement of air and temperature variations. Fuel vents vent outside the boat. However, some diesel odors always seem to find their way inside the yacht, plus the engine room usually has many small leaks and venting. Why is this important to the yacht owner's indoor air problems? Aside from diesel fuel odor being unpleasant, diesel fuel is a microbial breeding ground and food source. Diesel fuel has the ability to harbor and grow 30 types of bacteria, 12 yeasts and over 80 fungi species. When fuel odors are present, these odors actually represent minute aspirated fuel particles that can easily be carrying some of the bacteria, yeast or fungi known to grow in diesel fuel.

Bilge odors. All yachts have bilges, and with them come odors, oil, fresh water from air conditioner condensers, and soapy wash water. All are excellent breeding grounds for bacteria. Oil, like diesel fuel, contains bacteria, yeast and fungi. Soap and detergents contain phosphates, which can fertilize our lawns and gardens but can also fertilize microbial growth. As with diesel odors, bilge odors aspirate minute particles of bilge water loaded with microbial and food sources for the microbials.

Holding tank odors. Yes, sewage stored in a yacht holding tank can run from 50 gallons to over 5,000 gallons. Again, these tanks are vented outside of the hull, and are a huge source of bacteria, viruses, methane, and hydrogen sulfide gases, and of course, odors. These sewage gases, bacteria and odors always seem to find their way into the yacht, again providing microbials as well as food sources for the microbials themselves.

Wastewater Related Diseases and Viruses from Inhalation*

- Tuberculosis
- Histoplasmosis
- Coxsackie A&B
- Adenovirus
- Bacteria Dysentery
- Common Cold
- Echovirus
- Rotavirus

*Water Pollution Control Federation

Molds are gaining worldwide attention. Multimillion dollar homes are being razed due to mold contamination. Insurance companies are excluding mold damage from their coverage. Mold spores are everywhere. They simply need still air, moisture and a food source. Yachts provide a perfect atmosphere for growing mold. Ideal food sources are leather, paper, fabric and wood. This combined with stagnant air and dampness produces a perfect mold farm.



Healthy Yacht Air Sample



Sick Yacht Air Sample

VOC's or volatile organic compounds are a common indoor air problem as they are everywhere: cleaning compounds, plastics, furniture, etc. All are found on a yacht. However, a yacht will have much higher levels of VOC's than a home due to all the glues, sealants, oils and fuel. A fiberglass vessel will be continuously off gas VOC's.

Lysteria Monocytogenes is a unique strain of bacteria that can live in a very cold atmosphere and is often found in sink and shower drains and ice makers. When food poisoning breaks out in a restaurant and nearly everyone gets sick, it is usually from the ice machines lysteria bacteria. Most patrons are served ice and water or ice in a drink. Lysteria loves yachts - lots of ice machines, lots of drains and shower sumps to grow in. Drains, shower sumps and heads also add to the yacht odor and overall bacteria problems.

Norwalk Virus represents a very serious problem to the cruise and yacht industry. Thousands have been infected and many cruises cut short. Why is Norwalk so prevalent on a ship? Norwalk is most likely transferred by surface to hand contact in a confined environment. It is very difficult to contain. Disinfect surfaces or wash your hands frequently.

Staph Bacteria. There is a strain of staph that is frequently and accurately reported by the media as flesh-eating bacteria. The wounds are black, and it literally digs a hole into the flesh. The full name is streptococcal bacteria and it does eat flesh. There have been an unusual number of cases on yachts. Why yachts again? They are ideal breeding grounds for microbials and the higher number that you are exposed to means the harder time your immune system has to fight them off and the higher the odds are that you will be exposed to a dangerous microbial.



Staph infected leg also known as Flesh Eating Bacteria



A finger infected with Flesh Eating Bacteria

All of the above lead to Sick Yacht Syndrome. All can be controlled with the right program. Your yacht can be as fresh as the air at sea.

Healthy Yacht Hints

- Good housekeeping. Keep it clean and clutter-free to promote air circulation.
- A filtered advanced oxidation fresh air makeup system. This will help prevent stale air and provide a positive pressure atmosphere in the yacht.
- A continuous duty advanced oxidation HVAC air purification system. This will kill airborne and surface bacteria, viruses, mold, yeast and odors.



HVAC Air Purification Unit

- A positive ventilation, oxidation and circulation system. This will kill microbials as above, plus provide full vessel air circulation to prevent stale air pockets.

- An advanced oxidation holding tank ventilation system. Advanced oxidation gases are circulated through the holding tank to oxidize sewer gases, viruses, bacteria and odors.



Holding Tank Ventilation System

- An advanced oxidation fuel filtration system. This will kill microbials in diesel fuel without the use of chemicals. Engines will run cleaner and fuel microbials will be limited.



Advanced Oxidation Fuel Filtration System

- A continuous duty advanced oxidation ice machine and drain and head system. This kills lysteria bacteria.

Advanced oxidation is a new technology that uses friendly oxidizers to oxidize (kill) mold, viruses, bacteria, yeast, VOC's and smoke into harmless CO2 and water. By friendly oxidizers, we mean oxidizers that turn into safe oxygen and hydrogen when the oxidation or kill occurs. Advanced oxidation or PHI cells create gases and ions such as hydro-peroxides, superoxide ions and ozonide ions. These aggressive gases are developed by targeting a high intensity UV light on a precious metal target. Unlike ozone generators, advanced oxidation systems use redundant safe oxidizers and are widely used by all major food processors, the military, major cruise ships, homeland security, hospitals,

assisted living facilities, hotel chains, etc.

Envision is owned by RGF and is the world's first environmentally friendly mega yacht. **Envision** is equipped with over 50 advanced oxidation PHI technologies and provides its guests with a safe chemical and microbial-free atmosphere.

Ronald G. Fink is President/CEO of the RGF Environmental Group, West Palm Beach, FL. He is a Mechanical Engineer and also has a U.S. Coast Guard captain's license. He has published over 50 technical papers and holds numerous patents. Mr. Fink has a 40-year background in nuclear testing, nuclear power and advanced oxidation technology. RGF Environmental Group is a technology company with over 500 environmental products. Visit www.rgf.com for more information.



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the USDA / FDA / FSIS for food processing.



RGF[®]
ENVIRONMENTAL GROUP, INC.

3875 Fiscal Court, West Palm Beach, FL 33404 U.S.A.

(800) 842-7771 (561) 848-1826 fax: (888) 848-0047

www.rgf.com e-mail: rgf@rgf.com

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