Parmatic goes to sea with FFG

The following article which was reprinted from Marine Engineering/Log, clearly shows the unique and wide range of filtration and separation equipment which only **PARMATIC** can offer.

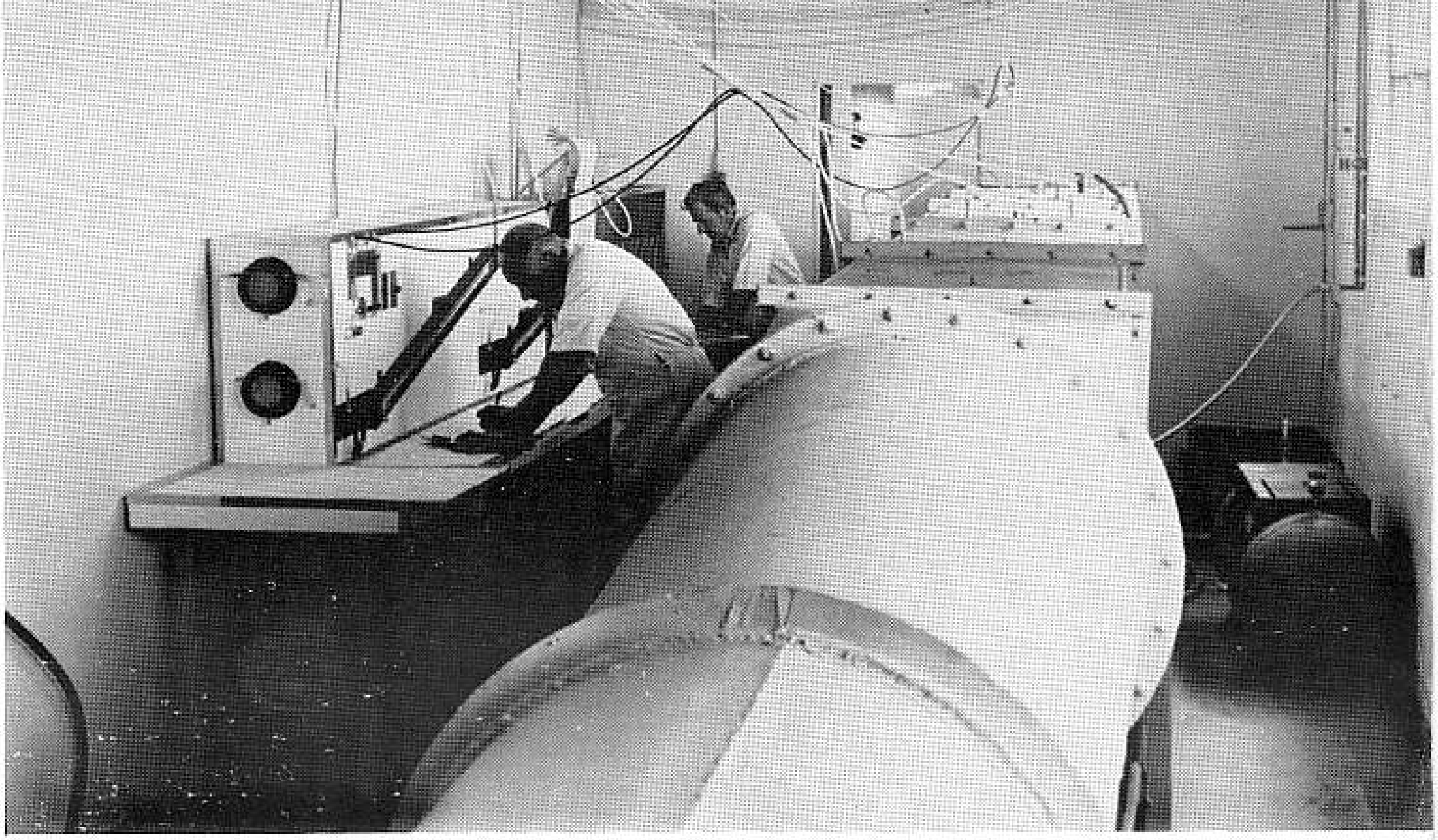

FIGURE 1—Parmatic's wind tunnel was designed to evaluate air intake moisture separators for marine gas turbine engines

All major systems in FFG-7* boast new refinements in filter technology

To effectively meet the challenges of the future, the U.S. Navy is making significant changes in several areas, one of which is the introduction of the aircraft derivative gas turbine as a major prime mover in the fleet. Not only do these engines offer a much greater power output for the same weight and size as is available from other power sources, but they also provide instant peak power.

Inevitably with the introduction of gas turbines, coupled with a need for improved reliability in other areas, new requirements in filtration technology have developed. The new gas turbine frigate *Oliver Hazard Perry* (FFG-7) represents an excellent example of how this technology has been put to work by Parmatic Filter Corporation, the company that has played a significant role in making available advanced designs of filtration and separation equipment for virtually every key system on this ship. This contribution resulted from Parmatic working closely with such agencies as the Naval Ship Engineering Command (NAVSEC); the naval architects, Gibbs & Cox; and the builder of the lead ship, Bath Iron Works.

Supporting the massive design effort, Parmatic is equipped with an exceptional range of test facilities that allow testing of virtually any type of filtration equipment likely to be required by a modern vessel—all very necessary to ensure that the demanding Navy specifications are effectively met, as well as maintaining consistent high quality of follow-on production units.

Key areas of major system. One of the most critical areas of filtration for a gas turbine powered warship is with respect to the efficient removal of salt from the air intake. This is a complex problem in view of the many inherent variables, coupled with the very large volume of air that a typical engine consumes, and the relatively small amount of salt that can cause corrosion in the engine.

As an example of the variables, to mention a few, there are ship aerodynamics, speed and heading of the ship, speed and direction of the wind relative to the ship, location and height of the air intake, etc. Another important factor is the humidity, which determines whether the salt will be liquid or solid, or some form in between. These factors and others determine the nature and concentration of the moisture at the separator intake.

At present there is no unanimity with respect to the degree of salt concentration that is tolerable at the intake to the engine. However, one figure frequently quoted is a maximum of 0.010 ppm salt to air ratio by weight. The difficulty in achieving this under all conditions can better be appreciated by stating that it is equivalent to one small salt water droplet of only 2 millimeters diameter in 16,700 cubic feet of air.

On the FFG-7 there is a separate air intake system for each of the two General Electric LM2500 engines, the intake to each system being located amidships, port and starboard. Each separator handles up to 123 pounds per second mass flow of air, with an extremely low overall pressure drop.

The air, after passing through a bank of louvres, enters a settling chamber designed to separate out some of the moisture by gravity, following which the air passes through

*FFG—the largest warship program since World War II covering 71 ships, 6 shipyards, and 4 navies.

FIGURE 2—Typical duplex fuel oil prefilter aboard "Oliver Hazard Perry"

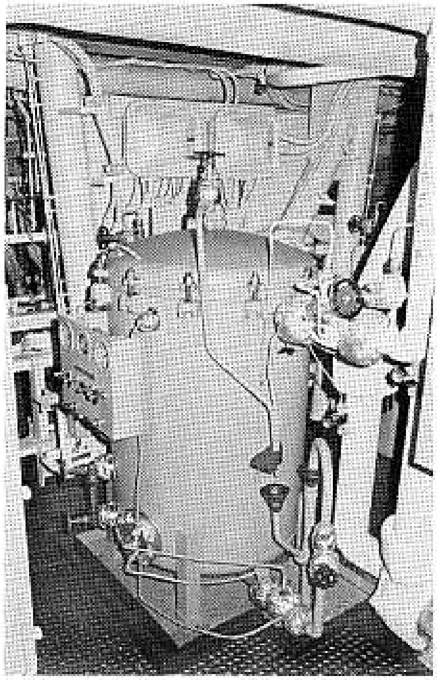

FIGURE 3—Fuel filter coalescer is an important part of fuel system in FFG-7

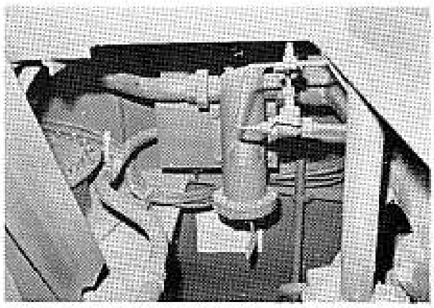

FIGURE 4—Typical Parmatic sea water filter for FFG-7's cooling systems

the Parmatic moisture separator designed to coalesce small droplets into larger droplets that, as a result of gravity, drain downwards into suitable collectors. After leaving the separator, the air turns through a 90-degree bend into the main engine intake duct.

To prevent icing of the moisture separator, Parmatic has designed and supplied an anti-icing system that utilizes compressor bleed air from the engine, air that is effectively mixed with the incoming engine intake air, thereby raising the temperature to prevent freezing of the moisture separator.

Figure 1 shows one item of specialized test equipment that Parmatic has for evaluating marine type moisture separators, in this case an 85-ft-long wind tunnel that, under controlled temperature and humidity conditions, can generate salt water sprays all the way from solid water to aerosols of 0.4 microns. The entire duct area of the tunnel is monitored to record pressure drop and velocity, while sophisticated equipment monitors particle size distribution together with the particulates on the downstream side of the separator. This tunnel is comparable to and has many of the features utilized at the National Gas Turbine Establishment in their tunnel, which organization is the testing source for the Royal Navy.

Lube oil filtration. Another major change in filtration requirements, not limited to gas turbine powered ships, but applicable to all ships, has been the decision by the Navy to improve lubricating oil filtration, particularly as applied to main reduction gears and auxiliary equipment.

The Parmatic duplex lubricating oil filter supplied for the main lubricating oil reduction gear requirements on the FFG-7 meets the latest specifications of NAVSEC, which are primarily directed to improving filtration efficiency, contaminant retention capability, as well as improving the overall safety of the equipment, both in operation and during maintenance.

The FFG-7 duplex filter handles 500 gpm of lubricating oil, and provides a filtration efficiency of 25 microns absolute when tested with AC fine dust. This contrasts with earlier lubricating oil strainers that were generally rated at 80 mesh, offering as a result coarse straining of 70-80 microns. In addition, the Parmatic unit offers a dirt-holding capacity of 1-1/2 grams per gpm of flow, for a total of 750 grams, achieved at a very small increase in overall pressure differential across the filter.

When the operating housing, due to collected contaminant, reaches the pre-determined differential pressure, rapid changeover of operation to the second housing, which contains clean filter elements, is possible. These filters can be supplied with either manual or automatic changeover features.

As the direction of fluid flow is from inside the filter elements to the outside, all collected contaminant is removed with the filter elements. The elements are cleanable and utilize simple cleaning techniques, a desirable factor when the availability of exotic cleaning equipment is restricted.

With respect to safety, the filter incorporates the very latest features to protect both personnel and the ship against either operational failure or fire. Parmatic, in conjunction with Litton and NAVSEC, pioneered these safety features, commencing with the LHA program. The safety features vary, depending on the particular application. However, as an example, it is impossible for maintenance personnel to open a housing which is on-service and under pressure, as was the case with earlier designs.

These innovations insure improved efficiency, safer operation and extended element cleaning life.

Fuel filters & coalescers. The fuel system represents another area where effective filtration, coupled with the added requirement to remove water from the fuel, is critical.

Like other prime movers, the aircraft derivative gas turbine prefers clean fuel; it is, however, versatile in that it can operate on a wide variety of fuels. For the gas turbine's full potential to be realized in the marine field, the trend must be to lower cost fuels in the higher viscosity ranges, particularly as these fuels have low metal and ash characteristics, which make them desirable for high-temperature and high-performance engines.

Effective filtration is necessary because, at these higher temperatures, metallic corrosion of the turbine blades is promoted. In particular, metals such as copper, lead, sodium, and vanadium combine with oxygen and sulphur to form corrosive materials. These materials can also cause the fuel nozzles to block and, if one or more nozzles become blocked, then a greater volume of fuel will pass through the remaining open nozzles causing overheating of the turbine blades and combustion chambers.

Although the filtration problems are less with a fuel such as JP-5, the Navy has to be in a position to utilize such fuels as Navy diesel and heavy distillate fuels. Although the heavy distillates have similar filtration problems to the lighter distillates, they must be heated in order to avoid wax formation. With these heavy distillates it is imperative to have efficient filtration in order to maintain high combustion efficiency and to minimize the formation of carbon and char in the hot section, because both carry vanadium compounds that chemically attack the engine components.

With the foregoing in mind, the main propulsion system of the FFG-7 is provided with filtration equipment which will allow for the use of more than one type of fuel.

Pre-filters, each rated at 100 gpm, are placed in advance of the main fuel filter coalescers of equal capacity. The primary object of the pre-filters is to reduce the amount of contaminant reaching the main fuel filter coalescers, thereby extending the useful life of these units before maintenance becomes necessary.

In addition to coalescing the small water droplets into larger droplets for subsequent removal from the system, the fuel filter coalescers are also required to be extremely fine filters. However, as the coalescer cartridges accumulate contaminants, the pressure drop through them increases and at a pre-determined pointed the cartridges must be replaced, otherwise the coalescing becomes impaired.

To ensure that all the free water is removed after passing through the coalescer cartridges, the fuel is then directed through additional separator cartridges located downstream.

At appropriate points the system is fitted with automatic drain valves, which automatically dump collected water and, in addition, automatic shutoff valves are available to shut off the fuel flow in the event of excessive water in the supply.

There is a second fuel system designed to operate primarily with JP-5 fuel; this has filter coalescers rated up to 75 gpm. One of the services provided by this particular system is to make clean fuel available for helicopter use.

In addition to the main system filters and separators already discussed, other Parmatic filters are to be found in a variety of applications ranging from the filtration of demineralized water utilized in radar system electronics, to sea water cooling filters, and high pressure air filters in the torpedo charging system. **ME/L**

EDITOR'S NOTE: This article and the accompanying illustrations appear through the courtesy of Parmatic Filter Corporation.