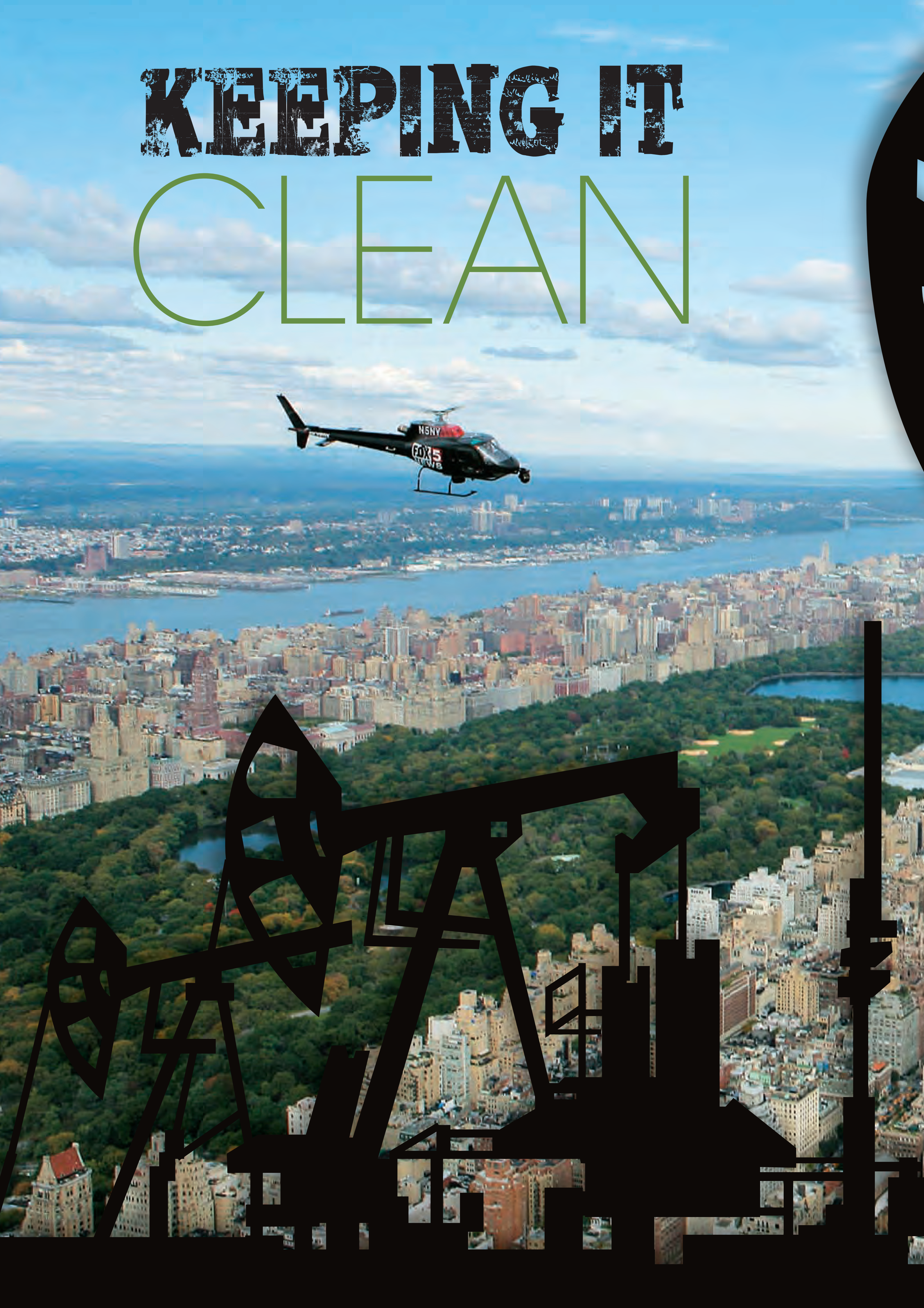
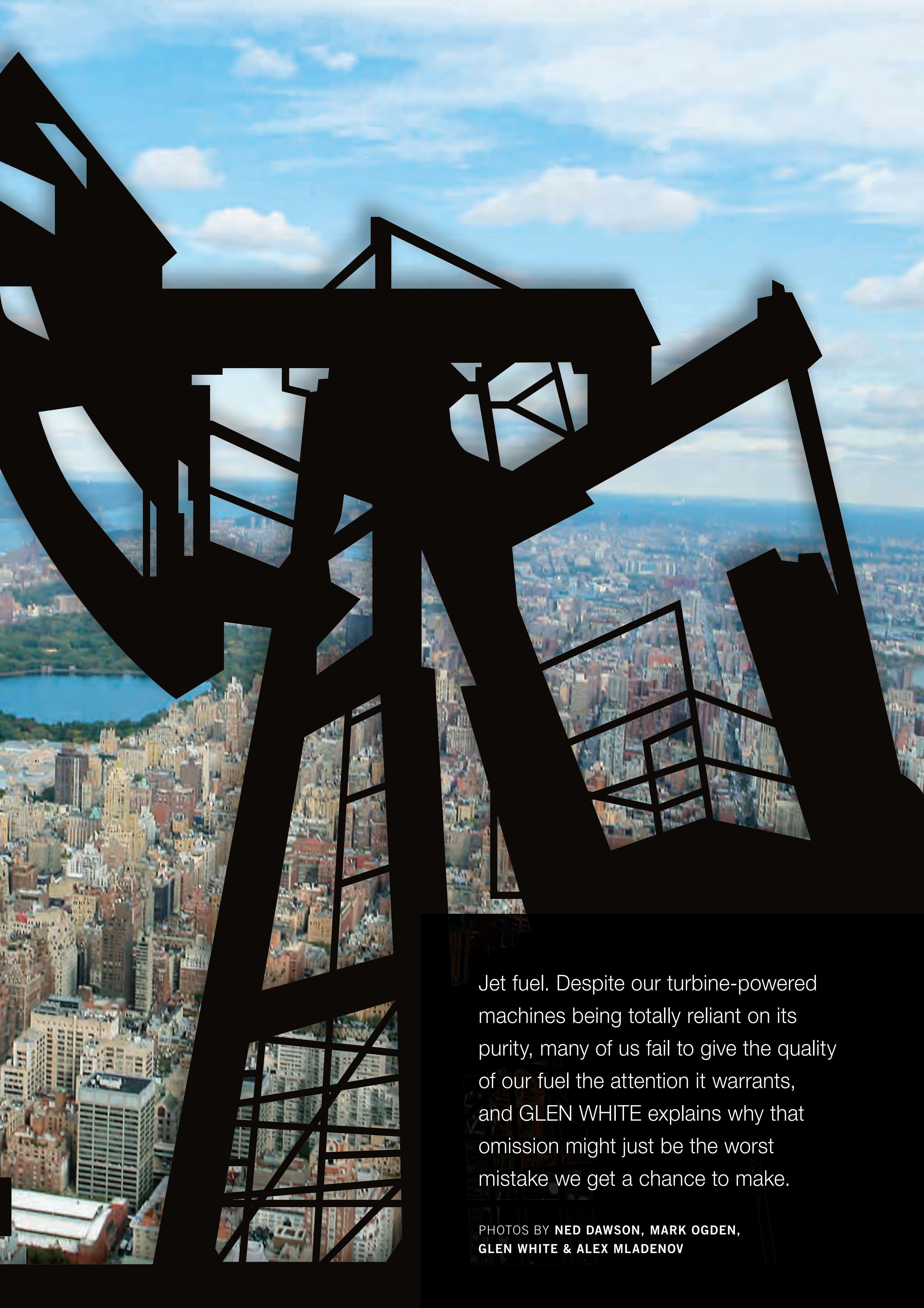
KEEPING IT CLEAN





Jet fuel. Despite our turbine-powered machines being totally reliant on its purity, many of us fail to give the quality of our fuel the attention it warrants, and GLEN WHITE explains why that omission might just be the worst mistake we get a chance to make.

PHOTOS BY **NED DAWSON, MARK OGDEN, GLEN WHITE & ALEX MLADENOV**

Even military workhorses like the AH64D Longbow Apache need fuel. Here a remote refuelling site takes care of two Apaches in South Korea.

On a daily basis we pump hundreds of gallons of an enigmatic malodorous liquid into our helicopters and assume that the aircraft will function in the manner in which they were designed. The components within our airframes store the fuel, pump it through hosing to a fuel control unit, further pressurize it to approximately 600 psi, and meter it into a metal housing in which it is ignited to a temperature of approximately 4500 degrees Fahrenheit. From the moment the jet fuel exits the nozzle into our helicopter's filler port, the toxic smell gives the indication that it would sterilize anything with which it came into contact. This common misconception of presumed purity or sterility has the potential of placing you and your passengers in a precarious situation.

In the 1930s the turbine engine was

first independently developed in both Germany and England in the build-up to World War II. Based on the turbine engine's design, the first turboshaft engine was built in 1948 by Turbomeca as an auxiliary power unit. The unit was later redesigned in 1950 as the Artouste turboshaft engine and initially utilized as an APU and the power-plant for Sud-Ouest's experimental convertiplane. In 1955, after the merger of Sud-Ouest and Sud-Est to create Sud Aviation (later Aerospatiale, then Eurocopter), the Artouste was utilized as the power-plant for the Alouette II.

The propellant used in the early jet engine designs was kerosene because of the low availability and higher flash-point of gasoline. In 1944 the United States published specifications for jet fuel and referred to it as JP-1 (JP = jet propellant). Due to availability, JP-1 was soon replaced with various blends of kerosene and other fuels, JP-2 (1945),

Most helicopters have their fuel testing vents underneath for ease of access.

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JP-3 (1947) and JP-4 (1951). The United States Navy needed a fuel that could be safely stored in large quantities aboard naval vessels and developed JP-5 in 1952 as a high flash-point kerosene for use on aircraft carriers. In 1990 the United States developed JP-8 as a less flammable, less hazardous jet fuel and it was adopted for use by the US Air Force in 1996. Jet-A is only used in the United States and has been the commercial standard for jet fuel since the 1950s. The majority of the remaining world utilizes Jet-A1 in commercial aircraft. The main difference between Jet-A and Jet-A1 is that Jet-A1 has the lower freezing point of -47°C, compared to Jet-A's -40°C. Jet-B is another commercial jet fuel that is available in some areas and consists of a kerosene and naphtha (a highly flammable and volatile fuel) blend. Jet-B has very good cold climate properties with a freezing point of -50°C and burns more efficiently at extremely low temperatures.

From a helicopter pilot's operational viewpoint, jet fuel types are somewhat of a moot point. As long as the limitations section of your flight manual approves the type of jet fuel in the truck that pulls up to your machine, you are going to use it. But whether we have received this fuel from a fixed tank, hydrant system, refueling truck or pumped it from barrels, we need to ensure that the fuel in our aircraft is free of contaminates. When flying in less regulated parts of the world, the requirements for ensuring jet fuel meets the international standard for purity are rarely met. In these less developed areas the individuals dispensing our fuel have little education about the importance of clean, dry fuel in our


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The best defense against fuel system impurities is proper maintenance and the sumping of the system. The sumping of an aircraft fuel system is a simple process that requires very little time or effort.

aircraft. In these areas we need to be vigilant to ensure that we have removed any contaminates that have been placed in our fuel cell during refueling operations. The occurrence of contaminated fuel is not restricted to under-developed regions of the world however, and care needs to be continually observed in monitoring the quality of the fuel in our aircraft. There are four types of contaminates that we need to be aware of when monitoring fuel condition – particulates, water, microbes and icing. These items can dramatically affect the metering or operation of our power-plant, to the point of fatal consequences.

This proved tragically true in an accident on the east coast of the United States in the mid 90s. In February 1995 an AS350B experienced an engine failure at 600 feet over the Charles River in Boston, Massachusetts. The pilot made a right turn to the bank of the river and collided with two metal structures extending from the Harvard Sailing Pavilion, causing fatal injuries to all four occupants. Examination of the aircraft revealed contamination in the after-market Michigan fuel filter, and clogging within the labyrinth ring and slinger wheel of the engine. It was surmised that this clogging caused the engine to flameout. Further examination of the fuel storage tank which was used in fueling the helicopter indicated it was being improperly maintained and that the tank contained substantial amounts of water, as well as a collection of hydrous iron oxide and rust.

Particulates – also known as solids – in fuel can come in various forms including rust, dirt, salts, rubber and scale. These particulates can clog filters and create an unstable flow by impeding the proper operation

In ag ops the fuel is always trucked to the site to enable onsite refuelling, instead of having to always go back to base or a local airfield.

of the fuel control unit or fuel injection system.

Water in our fuel can cause a wide array of problems in the proper operation of our engines. The primary source of water in our fuel cells is from the fuel itself. Jet fuel contains dissolved water within it and the higher the fuel temperature, the more dissolved water it can hold. If the temperature of the fuel decreases, the less dissolved water it can hold and it separates as free water. As fuel temperature varies, therefore, it is constantly either absorbing or expelling water. Since water is denser than jet fuel, free water that forms in the fuel cell will settle to the bottom of the tank. Dissolved water within fuel does not extend any risk to the operation of the fuel system, as long as the temperature of the fuel is above freezing – but large quantities of free water within the fuel system can cause engine power issues and in both large and small quantities it creates an

environment for microorganisms or bacteria to culture.

When jet fuel is first refined the fuel is sterile due to the high temperatures during the refining process. Once the processed fuel has cooled, it is susceptible to bacterial and fungi growth. In order for these microorganisms to cultivate they require a free water environment to grow and multiply as they feed on the hydrocarbons in the fuel. The proliferation of these microbes will be accelerated by a warm and humid climate and a single cell organism weighing one-millionth of a gram can grow into a bio-mass of slimy algae mats weighing 10 kilograms within twenty-four hours. These microorganisms create a multitude of contaminates within the fuel system of an aircraft. The bacteria produce by-products, some of which are acidic, that plug fuel filters, corrode metal, impede the proper operation of the fuel control system and clog the helicopters fuel injection system. If the

microorganism contamination reaches a problem level, a biocide such as Biobar or Kathan may need to be used to purge the fuel of the microbes. These biocides kill the microorganisms in the fuel but do not remove the biomass of the microbes. It may be necessary after biocide use to drain the fuel cells and replace the fuel filter.

The formation of ice crystals from the dissolved water in the fuel can cause some of the same clogging problems that are presented by microbes in the fuel. While the fuel itself will not start to freeze until it gets to -40°C or lower, the water in the fuel will start to freeze once the fuel temperature drops below 0°C. Some aircraft such as the AS350B3 have an oil-to-fuel heat exchanger that warms the fuel prior to it entering the fuel filter and fuel control system. This allows the ice crystals to be melted before they can clog the fuel filter and impede flow through the fuel-metering unit. This allows operations in temperatures down to -20°C without the use of an anti-ice additive. When operating an aircraft without a heat exchanger an anti-ice additive is required below 0°C.

When an anti-ice additive is mixed with jet fuel it inhibits the formation

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of ice crystals by encapsulating water droplets and preventing them from freezing, but it will not remove the water from the fuel. The most common brand of anti-ice found in the United States is PRIST – made of DiEthylene Glycol Monomethyl Ether (DiEGME) – which will lower the freezing point of the water suspended in the fuel down to -46°C. It is widely believed that PRIST has a retarding effect on microbial growth; however, PRIST can no longer officially claim this property for the PRIST Hi-Flash fuel additive due to the cost-prohibitive EPA requirements. When utilizing PRIST it is imperative that it is mixed properly with the fuel and not in a concentration exceeding the airframe manufacturer's recommendations. Eurocopter issued a TELEX in 2006 for the EC120, informing operators of reports of deterioration of the internal skin of the mounting plate sump. Samples were taken from these fuel tanks and tests showed that the deterioration was due to an excessive concentration of anti-icing additive. Eurocopter has also issued an Information Notice (No. 2145-I-28) with recommendations and warnings for fuel quality including the use of anti-ice additives. This notice recommends that unless required by the flight conditions, it is not advisable to add any anti-icing additive. The notice further states that

an excessive concentration of additive can clog the fuel filter, while very high concentrations can cause damage to the internal liner of the tank.

Usually when a fuel system is contaminated there are multiple forms of contamination. On August 24 2001, a Bell 206L-3 was destroyed when it impacted the water during an autorotation after a loss of engine power six miles south of Cameron, Louisiana, in the Gulf of Mexico. Post-accident inspection of the aircraft showed fuel contamination due to the combination of DIEGME, water and bacterial growth, which together resulted in the formation of an apple-jelly type material that blocked the fuel nozzle screen and led to a loss of engine power. Since fuel contamination can have many different sources and even be self-generating, constant monitoring of our fuel quality is necessary. The best defense against fuel system impurities is proper maintenance and the sumping of the system. The sumping of an aircraft fuel system is a simple process that requires very little time or effort. After fueling the aircraft, or after flight, the particulates and/or water may be suspended in the fuel. When sumping a helicopter it is best to wait for a period of time, or perform the check in the morning prior to the first flight of the day. The sump(s)

The start and the finish. Oil comes out of the ground in the GOM and eventually its byproducts end up back in helicopters like the AW139.

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are generally located on the belly of the helicopter under the lowest point of the fuel cells. A clear container is placed under the sump port and the sump mechanism is activated to allow some of the contents in the bottom of the cells to drain out. The container is filled half-way up from each of the cells individually. When examining the sample it is held up to the light then swirled around to view any contaminates in the fuel. Samples should be taken until the fuel is free of any water or particulates.

If an aircraft will sit idle for an extended period of time it is recommended practice to top-off the tanks. This decreases the amount of air in the cell and therefore decreases the amount of moisture available for absorption by the fuel, minimizing the later formation of free water.

Addressing these problems on the ground does require a small amount of effort and time. Addressing them in the air may be less time-consuming but it is undeniably going to be far more dramatic! ■