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scenic with fall colours and went very well.

After the deplaning and paperwork, my left shoulder started aching and I started feeling nauseous with flu-like conditions. I decided to go home and lie down. Conditions got worse. It felt as if all my joints had hot, wet sand in them and it hurt to move or to lie still. My chest pains got worse to the point that breathing became difficult. Severe headache and nausea. I phoned my doctor and he was kind enough to see me right away. He sent me to the hospital for chest X-rays, blood work and an electrocardiogram. After more poking and prodding, I was left in an emergency room with my peek-a-boo nightgown and hooked up to a monitor. I lay there in pain for about three or four hours, not knowing what was going on with my body or my career. My doctor came in and informed me that I had pneumonia, brought on by chemical burns to my lungs. They wanted to keep me in the hospital, but, with cuts to our health-care system, no beds were available.

I was discharged at about 7:30 p.m. and told to return in the morning for more tests. The doctor gave me a prescription for an antibiotic and told me to take Tylenol for the pain. Needless to say, I didn't sleep very much and returned at 8:00 a.m. for more tests. I had asked the local refueller for a material safety data sheet (MSDS) after I got home and asked that it be at emergency for me if I needed it during the night. Apparently he didn't have time or something, but, in any case, the information wasn't there. Fortunately, my friend Bruce brought a copy over to me.

In the hospital, the chest X-ray showed slight improvement to my lungs, but, with the MSDS, we discovered that there is also some diethylene glycol monomethyl ether (which is a fancy name for antifreeze) in with the kerosene and naphtha in jet B.

The data sheet says, "Small amounts of jet B drawn into the lungs through swallowing or vomiting may cause **severe** health problems such as bronchopneumonia or pulmonary edema." Bingo!

We had no way of knowing how much fuel I had taken in, and so more tests were performed: a urinalysis, more blood work, a liver-function test and a really neat oxygen test (for this one they poke a needle right into an artery in the wrist). The MSDS stated that the toxicity level for a rat ingesting jet B is 2500 mg/m^3. The relationship of these studies to humans has not been established, but my doctor calculated that less than four spoonfuls in the lungs would be fatal.

With all this wonderful information, I was again discharged and told to wait for test results and not to fly until more was known. All of this started on Thursday, September 25, 1997, and so I spent the weekend at home sick, in pain and grounded. On Monday, September 29, I again went to my doctor and he said that the test results were good, but I still had pneumonia and had to wait another week before having my next X rays and checkup.

I have noticed some vision loss and some memory loss. I don't know what the future will bring and, God willing, I want to keep flying, but, even if I don't, I hope this will help someone else not to do this.

A footnote to the original item stated that the pilot returned to flying status but, tragically, was killed, along with his two passengers, in the crash of a Bell 206 less than a month later. The Transportation Safety Board of Canada was investigating but, at the time of publication, had not determined the cause of the accident. ■

A Primer on Primers

by Patrick Benton

This article was published in the September 1998 issue of ***FAA Aviation News****. The author, an Assistant Professor, School of Aviation Sciences, teaches aircraft systems courses at Western Michigan University. Pilots should check the flight manual of their aircraft type and follow any specific recommended priming techniques.*

Anatomy of a Primer System

The engine priming system seems to be one of the most misunderstood systems on light aircraft. What exactly does the primer do, and how does it do it? Should you use the primer for every start or just when it's cold? Is it okay to prime the engine by pumping the throttle a few times? These are some of the questions frequently asked by new and experienced pilots, including flight instructors.

To develop safe and efficient priming techniques, it is necessary to understand the system and how it works. A primer system is used on aircraft engines to introduce a small amount of atomised fuel into the engine to improve cold starting. The priming system is a stand-alone system and is not part of the carburettor.

"Even if you've had success "priming" with the throttle, it's only a matter of time until an induction system fire occurs..."

The system consists of a fuel pump, discharge nozzles, and interconnecting plumbing. There are two types of systems in use. One type uses a small, manually operated fuel pump located in the cockpit. The other type uses the aircraft electric boost pump to provide fuel pressure to the discharge nozzles. The electric primer system also incorporates an electrically operated valve to control the fuel flow to the nozzles. The discharge nozzles and plumbing (normally one-eighth-inch tubing) are the same for both systems. Most small aircraft use a manual primer system, while large or multi-engine aircraft may have electric primer systems.

The discharge nozzles are very important to the proper operation of the system. They have a small discharge orifice, which causes the fuel to atomise much like the nozzle on a spray bottle of window cleaner. The nozzles are usually located in the cylinder head, in front of the intake valve. Some engines have a nozzle in all the cylinders, while others have nozzles in only some of the cylinders. Sometimes there is only one nozzle for the entire engine. When a single nozzle is used, it is normally located in a central location in the induction manifold, rather than in the cylinder head.

Primer System Operation

The manual primer system uses a single-acting or one-way piston type pump located in the cockpit. When the pump is pulled out, fuel from the main fuel line is drawn into the pump through a check valve. When the pump is pushed in, the fuel exits through a second check valve into the primer lines and out to the discharge nozzles. When operating the manual type of primer, you should wait a few seconds after pulling the pump out before pushing it back in. This allows time for the fuel to fill the pump chamber. If the pump is hard to operate, the seals may be bad or the nozzles could be plugged. Have your mechanic check the system if the pump does not operate easily or if priming does not seem to be effective.

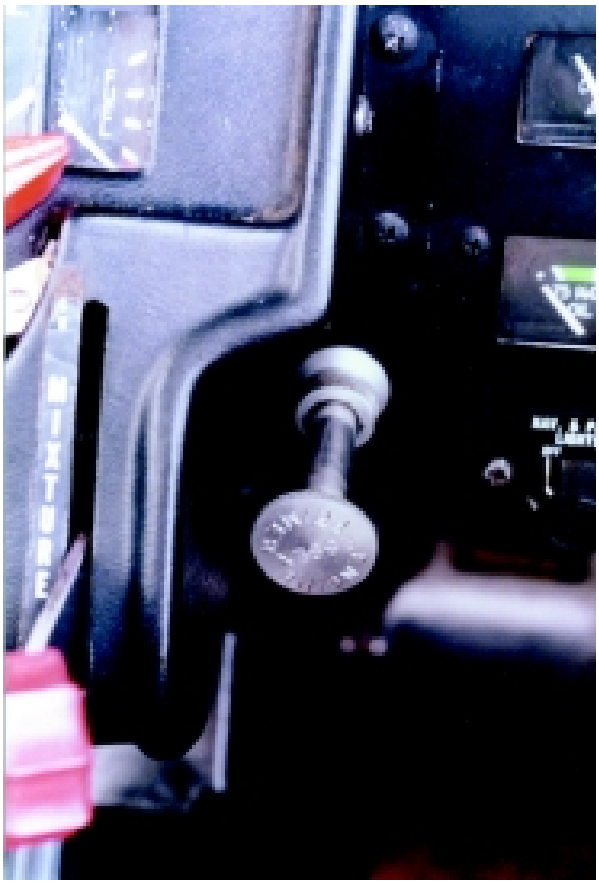
Manual primer pumps are equipped with a locking feature on the pump. This allows the primer pump to be locked in the closed position, which prevents the pump from accidentally opening in flight. If the pump does open with the engine running, fuel will be drawn through the pump and into the engine. This will cause an over rich fuel-air mixture, which will result in power loss or engine stoppage.

An electric primer system uses the boost or auxiliary fuel pump to provide fuel pressure for priming. An electric solenoid valve controls the fuel flow to the nozzles and is operated by a switch in the cockpit labelled PRIME. With the boost pump on, the prime switch can be turned on to send fuel to the cylinders. This is a spring-loaded-off type switch; therefore, you must hold it in the primer position. Keep in mind that when you hold the prime switch in the primer position with the fuel boost pump on, fuel is flowing through the primer system and into the engine. It is very easy to over-prime an engine with an electric primer, so engage the prime switch briefly.

Priming Techniques

Priming techniques vary among aircraft; therefore, it is important to determine the best method for the aircraft that you fly regularly. The engine may not necessarily require priming on every start, depending on the ambient temperature and the engine temperature. Try starting the engine without priming on a warm day or with a warm engine. You may find that the engine starts just fine. There is no set rule, such as "always give it two shots of prime". Experiment with different techniques to see what works best for your aircraft. [Editor's Note: But always check your aircraft's operating handbook or flight manual first.] Remember that the less fuel you have to introduce to get the engine started, the better.

One technique that often works well with both manual and electric systems is to engage the starter and allow the engine to rotate a few times before priming. This allows air to flow into the engine so that, when primer fuel is introduced, it will mix with the incoming air. With a manual primer, pull the primer out, engage the starter, and slowly push the primer in while the engine is cranking. With an electric primer, turn the boost pump on, engage the starter, and then turn on the electric primer for a few seconds. Introducing the fuel into an air stream, rather than into a static engine, greatly improves the effect of priming. It also reduces the possibility of over-priming, which can flood the engine and lead to an induction fire.



Priming with the Throttle

Some pilots – even CFIs – say that they pump the throttle a few times when starting a stubborn, cold engine. This is not a recommended practice, because aircraft engines generally have up-draft or horizontal-draft induction systems. This means that air and fuel must flow upward or horizontally through the carburettor and the induction tubes on their way to the cylinders. If the fuel is not completely picked up by the air and taken into the cylinders, it will drain away from the cylinders and back into the induction system, where the fuel may then form puddles of raw fuel.

The fuel is especially likely to "drop out" or fail to mix with the air stream if the fuel is introduced in a coarse, heavy spray rather than a fine, atomised mist. To illustrate this concept, change the nozzle setting on a spray window cleaner bottle from "spray" to "stream". Squirt some on a window. Notice that when it hits the glass it promptly runs down the window. But with the nozzle set in the "spray" setting, the cleaner is dispersed in a fine mist and does not run off as easily.

The fuel that is discharged from the acceleration system of the carburettor when the throttle is pumped is a coarse, heavy stream – not a fine mist. It is very likely to run down the inside of the induction tubes and form puddles. The primer nozzles are so important because they atomise the fuel. It is possible to form puddles even when using the primer system, so do not over-prime. If you do create puddles of fuel in the induction system and the engine backfires during starting, the fuel can ignite or even explode. This is called an induction system fire and can result in serious injury or damage. Even if you've had success "priming" with the throttle, it's only a matter of time until an induction system fire occurs and spoils your whole day.

Don't be afraid to try different priming techniques to discover what works best for your aircraft. Just remember that there are only two universal rules for priming:

- Less is best, and,
- Do not attempt to prime the engine with the throttle. ■