*Missions for America*
*Semper vigilans!*
*Semper volans!*

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## FEATURE ARTICLE

### *Avgas*

Aviation gasoline (Avgas) is the special fuel used in piston engine aircraft. Pilots use the rule-of-thumb or 6 lb/US gallon to use in the weight and balance determination for a specific aircraft. This article will not consider jet fuel, diesel fuel or motor gasoline.

Avgas is brewed to meet the special requirements demanded by the unique conditions under which aircraft operate such as engine horsepower which changes as oxygen content and temperatures varies as altitude increases. Another issue is that low air pressure can induce vapor lock which will cause failure of a fuel to feed so the volatility of the fuel must meet certain standards.

In addition, as engines were developed to produce higher horsepower, a concomitant necessity was that the engines had higher compression ratios and higher octane fuels. A compression ratio is the relationship between the combustion chamber's total volume when the piston is at its lowest point in the cycle.

The octane rating is what is familiar to most pilots. Octane rating is the standard measure of a fuel's ability to withstand compression in the engine without detonating. During normal operations, fuel combusts. A mixture of avgas and the oxygen content of air delivered during carburation ignites producing thermal energy and by-products, mostly carbon dioxide and water. In an airplane, as altitude changes, the ratio of air to gasoline can be adjusted using the mixture control. In general, increases in altitude demand a leaner mixture, less gasoline to compensate for the reduction in the density of air.

Unless the appropriate octane is used, detonation (knocking) is possible. Detonation is the ignition of fuel before the spark plugs fire. It occurs during the compression cycle due to hot spots in the cylinder. The warning sign is a sound and vibration called knocking or pinging. It can, if ignored, destroy an engine. It is an explosion and the fuel, the complex hydrocarbons which make up gasoline and the oxidizer, have an intramolecular reaction and a supersonic shock wave is formed. The pressure, force/unit area, inside the cylinder increases enormously exceeding the ability of the cylinder system to withstand.

The pistons, rings, valves and spark plugs are subject to unrepairable damage. Holes can be burned into the tops of pistons, the cylinder walls can be scoured, rings will lose their effectiveness and gas will leak into the crankcase. Increased pressure in the crankcase can case it walls to fail and the loss of the oil to the engine will destroy it.

*The top of a piston and a blown jug*

The octane of an aviation fuel is expressed as a number and suffix, either a number or letters. Octane is increased by the addition of tetraethyl lead, the bane of the environmentalist. The pressure to eliminate 100LL has led to attempts to develop lead free avgas but progress is slow. There are benefits to using lead free avgas. The leading of spark plugs is eliminated an the over-all cost of engine maintenance is reduced.

The most common fuel used in light aircraft is 100LL. 100 octane low lead is dyed blue. Before the adoption of 100LL, the fuel used was 80/87 octane and dyed red. The numbers indicated the octane rating for lean and rich mixtures respectively. At one time, the fuel colors were part of the FAA testing. There were five common aviation fuels: Red 80/87, green 91/115, brown 91/96, green 100/130 and purple 115/145. 100/130 was commonly used in commercial and military aircraft and 115/145 was used for high compression military aircraft. Sometimes a lower octane could be substituted but the engine had to be de-rated and operated at lower manifold pressures. 80/87 has been replaced by 100LL which is the only one of the old fuels still available.

In 1935, Jimmy Doolittle, test pilot and holding a Ph.D.in aeronautical engineering from Massachusetts Institute of Technology and the Aviation Manager of Shell Oil Company had the foresight to see that the development of super-charged high compression engines would need higher octane avgas that was currently available. At that time, avgas in use was rated at 80/87. a French émigré,,Eugene Houdry came up with an efficient process to refine 100 octane and Shell adopted it. The U.S, Army Air Force adopted it, added tetraethyl lead and produced 100/130 octane fuel.


*Doolittle and Houdrey*

When German invaded Poland in September of 1939, the Bf-109 was using avgas in the 93 octane range and the British were using 87 octane. This gave the German aircraft a speed advantage. The British, who had stockpiled 100 octane avgas purchased from the United States and acquired from refineries under their control started using it in combat.

There are some complications trying to source what their initial steps were. They involve the Spitfire Mk.I and Mk.II and the Merlin III engine. There seemed to be some retrofitting of the Mk.I but the addition of supercharging and the adoption of the switch from a two bladed wooden propeller to a three bladed two position metal propeller or a three bladed constant speed propeller. Performance was enhanced and a speed increase of 15-35 mph has been cited, depending on which sources your rely on. The Bf 109 lost its speed advantage when the RAF used 100 octane gasoline. A Spitfire could match the By Me 109 and had superior climb performance, a valuable asset for an interceptor.

*Mk.I Spitfire*

*Mk.IIA Spitfire*
*(Credit: IWM)*

*Bf 109E*

For the rest of the war, the Allies used high octane gasoline which the Luftwaffe could not acquire. Jimmy Doolittle's foresight was a major contribution to the air war in Europe and over the Pacific.

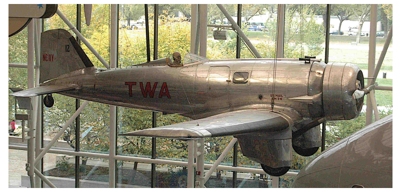
**Mary Feik, CAP Icon**

*(Courtesy of Lt. Col. Art Dammers, CAP Ret'd*

Col Mary Feik, CAP, was one of those extraordinary persona whose life serve as a model of service and achievement. She learned to weld at age eleven and two years later was repairing automobile engines. At 18, Mary moved on to the aviation trades an became and started teaching aviation airframe and power plant technology first at Seymour Johnson Field before moving on to Wright Field in Ohio.

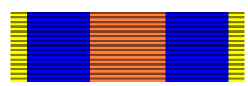
Her career in World War Two saw employment with the U.S.Army Air Corps and its successor, the U. Army Air Force. Mary rose to become the first woman research and development engineer Wright. As a flight engineer, she logged some 6,000 hours in the B-29 and piloted the P-47, P-51 and P-63

After the war, Mary worked as a restoration specialist at the Smithsonian Institutions's Paul E. Garber facility in Silver Hills, Maryland, some of her work is now on display in the National Air and Space Museum. The FAA presented Mary with the Charles Taylor Master Mechanic Award, the minimum requirement is 50 working as an aviation mechanic




*Two of the aircraft Mary restored, the Lockheed Alpha and the Pitts S-1C flown by Betty Skelton*

She spent 34 years in the Civil Air Patrol and the ribbon which is awarded to Cadet Senior Airmen bears her name and she was frequently found at cadet activities from her home squadron, encampments and special activities. Mary has been inducted into the Women in Aviation International Pioneer Hall of Fame.



*Above: Col Feik presents Feik Award to CTWG cadets. Below: Col Feik presents Earhart award to Thames River cadet Brendan Flynn in front of the New England Air Museum's Lockheed Electra, the type which Earhart and Noonan flew on their fatal flight to Howland Island.*