

# AVIATION MAINTENANCE

By Myron Papadakis ©

Aviation Maintenance is unlike automobile maintenance. That is because Aviation is regulated by the F.A.A. and the F.A.R.s pertaining to the maintenance of aircraft. Before becoming specific, it can generally be said that privately owned aircraft with no commercial purpose may be maintained to a lower standard of maintenance, than those aircraft operated for hire such as the Part 121 Airliners.

The standard of maintenance required, the amount of maintenance performed and the periods of time for maintenance are determined by the category of aircraft and the usage it is placed into. Every system and part of an aircraft is built in compliance with the engineering standards of the F.A.A. Thus when an airplane rolls off the assembly line in America it has been designed and built to an in existence set of engineering Rules, These standards have been around a long time.

Here's how it works. I'll say this the engineering standards for the General Aviation Airplane are found in the Federal Air Regulations Part 23 (most recent amendment). For Airliners the Regulation is part 25. These are very large texts of performance, aerodynamic, structural, power plants and all facets of engineering requirements that must be met in order for a new airplane to be certificated. These documents require analysis, testing and demonstrations in order to merit certification.

The numbering system of 23 and 25 are the same so reading one F.A.R. mirrors the other. The engineering standards began before the advent of the F.A.A. under the C.A.A., and they were called C.A.R.s. The engineering standard for general aviation aircraft was C.A.R. 3. It dates back before World War II, and was modified and updated several times to the form it was in 1958.

The F.A.A. was formed in 1958 and for a short while C.A.R.3 was continued so as to have a standard while the new F.A.A. could initiate its own standard. This was issued in print a year or two later as F.A.R. 23. It was virtually identical to C.A.R. 3 last amendment. Since that time F.A.R. 23 has been amended numerous times, a big one being amendment seven. Of course each amendment has a specific date of issuance.

This date of issuance is very important to a general aviation designer. When a manufacturer wants to build a totally new airplane he must apply to the F.A.A. for a Type Certificate. This application includes enough specifications ,plans and drawings that the F.A.A. has good knowledge of what the airplane will be. It is a "Paper Airplane or Conceptual Airplane" at this stage.

When this application is received at the F.A.A. it is stamped with the date. This date determines what specific amendment of the F.A.R. 23 will be adhered to. It is the date of application. This is fair to the builder since there may be a several year lag time between application and new airplane roll out. It would be unfair to make the

manufacturer have to retrofit or redesign to a newer more stringent amendment. These engineering standards do not simply apply to the airframe, all the components within the airplane from rugs to seatbelts to avionics equipments and engines all must meet engineering standards and ultimately have F.A.A. Approval for use.

The prime manufacturer has some latitude in how he will accomplish the task. For instance he may go to an engine manufacturer that has previously had an engine, propeller, and fuel injector approved by the F.A.A. If he does this there is far less engineering for him to accomplish than if they have to design and certify an entirely new system. Regardless of which route is chosen the prime manufacturer. (The one who applied for the type certificate) is the one responsible for demonstrating F.A.R. 23 compliance.

Once this is accomplished, and the components and airframe all are demonstrated in compliance with the appropriate amendment of F.A.R.'s the airplanes design is approved. If it is a new design, a **TYPE CERTIFICATE** is issued and dated and the date of application is still key for that determined which engineering standard was met.

Simultaneously the manufacturer is granted a **PRODUCTION CERTIFICATE** to mass produce airplanes identical to, or very substantially similar to the one that has just been awarded the **TYPE CERTIFICATE**.

When the first production aircraft rolls off the line and passes its acceptance and quality control checks it is issued an **AIRWORTHINESS CERTIFICATE** that will remain with the airplane ,each subsequent airplane will get an identical Airworthiness Certificate.

If that identical airplane is produced for twenty years and in the interim the engineering standards have changed (increased) 3 times the airplane will still be built, demonstrated, and certified to the standards of the day of original application. This is a form of being grandfathered in. In addition, the real operative words from the Type Certificate language are that the follow on airplanes of the Production Certificate will be substantially similar.

The original engineering analysis, prototyping and testing to demonstration was very expensive. Thus, a manufacturer would prefer to modify an airplane under an existing type certificate than apply for a new one. There are two benefits, first if he modifies the old design all he has to demonstrate is the change. He does not have to go through the entire certification process again. Second, if the manufacturer was to apply for a new **TYPE CERTIFICATE** he would have to apply again and he would be required to meet today's tougher engineering standards.

The new standards are tough enough that many of the old type certificates could not be produced today, since they would not meet the new engineering criteria. To some it may seem serious that the F.A.A. grandfathers in old airplane designed to old

engineering and safety standards. It becomes even more of a paradox when one understands that the manufacturers have actively believed having old designs was a proven competitive advantage. These manufacturers would simply add a new version to an old product line and avoid the hassle and cost of recertification.

This isn't shocking in itself, except that a very shockingly high percentage of General Aviation airplanes produced until only recently had their TYPE CERTIFICATE lineage in the late forties and early fifties as **C.A.R.3 airplanes**. In other words some of today's airplanes were still being produced substantially similar to, and certified under engineering standards 40 years and 10 amendments old.

In view of the knowledge that you simply do not pull off on the shoulder when your airplane gets in trouble, it seems a little strange that you can buy an American Airplane built to 1950's engineering, and Detroit can't reproduce and sell its most popular 1957 Chevy convertible, because of having to meet increased highway engineering standards.

There is another strange situation that goes on between the F.A.A. and the manufacturers that is unusual if not suspect. The F.A.A. has a small budget and a big responsibility. That responsibility as delineated in the 1958 ACT made the F.A.A. both the regulatory Agency for Safety and Regulation of aviation industry and it simultaneously gave the F.A.A. the job of promoting American Aviation. This does not put them in conflict with themselves detrimentally near as much as the small budget that they have for regulation and safety. Quite simply they do not have the trained manpower nor the budget to hire more. The simple matter is that there aren't enough inspectors to meet their responsibilities. Thus in order to have any inspection at all they designate civilians to do the job.

The F.A.A. has solved this problem within the bigger reputable aviation manufacturing companies. Like the sheriff of old they have formed a volunteer posse to hunt down the criminals. The manufacturer provides qualified people from their own work force and they become Delegated Engineering Representatives for the F.A.A. These people remain on the Manufacturer's pay roll and they still work for the manufacturer. However in their billfold they carry a F.A.A. license to be an inspector, a test pilot, a flutter specialist and a check airmen. These men build and design the airplane wearing the Manufacturer's logo and at a stage they change hats and become the F.A.A.'s delegated representative and they inspect the work and certify that it satisfied F.A.A. requirements.

The F.A.A. doesn't hand out these DELEGATED OPTION AUTHORITIES easily or lightly. It is the proven and established larger manufacturers that have this deal. It works efficiently. My mother who was a 1923 Wellesley graduate said; "Why Myron , that sounds like letting the fox guard the henhouse " She was from New England . What did she know?

This is not to say that the F.A.A. does nothing, this is to say that they rely heavily on the responsibility and trustworthiness of those representatives. I have personally known a number of these delegated representatives and they run the gamut, just as people do. So we have the F.A.A. relying on the manufacturers delegated representatives for certification inspections, and we have the N.T.S.B. relying on manufacturers representatives for investigations. The Airplane comes equipped in a certain approved fashion, when it leaves the factory with its new airworthiness certificate.

No one is allowed to change the structure or components of the aircraft unless it is changed out with approved identical parts. The airplane may not have any component added or removed without it being approved and shown on the weight and center of gravity for the empty weight aircraft. (This is close to being the same as the military "no change to form fit or function without prior approval")

This is not to say that changes may not be incorporated in civilian airplanes. Of course they can and are. To be legal the change has to be approved if it changes form, fit or function.

The way changes are approved is formalized by the F.A.R.'s and the F.A.A. The inventor of a change will apply to a Regional F.A.A. Office with a **Form 337** for a **SUPPLEMENTAL TYPE CERTIFICATE** for whatever fix or change is being made. One that comes to mind was a door change on an airplane that allowed another window and a special camera mounting for a particular Cessna. This was designed by an aerial photographer for his own airplane ,but it was so successful that it became a standard for others.

The form 337 shows compliance with the original F.A.R.'s and once approved by the F.A.A. it is allowable to install on all airplanes it was intended for. From this S.T.C. modification program, we see old airplanes with different new engines. We see D-18 airplanes with Chromed engines, tricycle gear. We see old Grumman amphibians with turbo prop engines. We see "Speed Conversions" and S.T.O.L. conversions routinely retrofitted. All of these are approved through the S.T.C. program.

In Alaska, where the airplane is the automobile of the outback, and there is the highest usage of airplanes per population, the approval process is stretched a little. Arctic flying for sports purposes is very different than the lower 48 operations. It is not unusual to see make shift coolers replace seats, boats strapped to the side of planes. Spigots drilled into oil cases, gun cases strapped externally, and fish coolers stored in baggage bins. It is not unusual to see a second aircraft battery jury rigged into the system. Sometimes I am sure the weight and balance considerations are beyond that contemplated by the manufacturer. The distances are so great in Alaska the F.A.A. inspectors are a little overwhelmed in trying to enforce compliance in this ruggedly demanding environment.

The maintenance of the airplane is next a subject that is curious in context. A

general Aviation airplane is sold to a consumer with certain expectations and requirements with respect to maintenance. When the airplane came new it had an airworthiness certificate issued by the F.A.A. (the manufacturers delegated option ) . In order for this aircraft to maintain the validity of the airworthiness certificate it is required that the owner maintain it in accordance with approved F.A.A. maintenance requirements.

The F.A.A. licenses A.& P. mechanics and approves maintenance facilities. The manufacturer usually sets up their own dealers maintenance facilities that also are F.A.A. approved. Component part manufacturers have factory repair facilities and there are F.A.A. approved field repair facilities. All repairs that effect the airworthiness of the airplane must be accomplished by an F.A.A. approved and licensed mechanic. (an apprentice may work under the direct supervision of an A & P mechanic but the mechanic must sign off and be responsible for the work.

Any such work must be recorded in either the aircraft logbook or the engine and propeller logbook for the airplane. Any time an AIRWORTHINESS DIRECTIVE is issued against the airplane compliance is required and a recordation of that compliance is to be made in the appropriate logbook.

Certain Components of an airplane have specialized maintenance requirements such as T.B.O. (time between overhaul ) In these cases the components are supposed to be overhauled and repaired based on age in flight hours. An engine may have a 2,000-hour time limit; a fuel injector may have a 1,500-hour overhaul. These independent parts should be completed by an approved facility or mechanic within the time requirement or slightly extended time frame.

Additionally the airplane should receive an Annual Inspection to maintain it's Airworthiness certificate. This inspection must be recorded in the logbooks and completed by a licensed A&P mechanic. There are other requirements relating to the fixing and maintenance of the airplane that must be complied with. Most dealers offer periodic maintenance options to purchasers that keep the airplane in compliance and at standards recommended by the manufacturer.

Investigators know how to research the aircraft logbooks to ascertain both sufficiency of the maintenance and compliance with F.A.R.'s. Aviation is unlike your car, and as a result, many aviation law cases revolve around supervening, intervening negligence revolving around aircraft maintenance.