RVator's Log

Newsletter of the Twin Cities RV Builder's Group

December 2009

In this issue…

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Upcoming Events

December 12 : Join us for our December get-together. Guest speakers are RV insurance guru Scott Smith and self-proclaimed RV geek Pete Howell.

Coffee and goodies as always. Details on the back. See you then!!

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Minnesota Wing
Van's Air Force

Pres: Doug Weiler, 651-398-1184, dcw@mnwing.org

Sec/Treas: Jim Lenzmeier, 651-633-8488, jlenzmer@msn.com

Shop Notes

-Doug

Way back in my previous life, I flew a desk in the training department at NWA. After spending a couple years working in flight simulator development, I moved to the 757 program with a seemingly lofty title of Flight Training Manager. Essentially I was the #2 guy in the 757 program tasked with all the mundane labors that my boss really didn't want to be bothered with. Mostly I kept track of our students' paperwork as they progressed through the various versions of 757 training. This consisted of monitoring recurrent and initial students as they immersed themselves in the rather intense 5-week checkout on the 757.

The 757 was NWA's first "glass" airplane. Remember this a 1985-era airplane and by today's standards, it was rather rudimentary. Two simple CRT screens had replaced the ADI and HIS but they were still surrounded by familiar "steam" gages. Adding to the higher tech cockpit was a flight management computer or FMS, which was used to enter flight plans and cruise and descent data. Flying the airplane was pretty much like any other airliner. But learning how to program the FMS and manage the "magic" as it was called was a new experience for many of the pilots going through the program.

I remember one day I was sitting in my cube when Captain Henry Buck came around the corner and sat down. Capt. Hank had been having a terrible time going through the initial captain checkout. He had failed his first type ride and was back for remedial training for attempt #2. He was an old school DC-9 captain that started at Southern Airlines and had been driving the old -9 from the day it was new. I think he told me he had 20,000 hours in that airplane which had all the high technology of a steam locomotive. He now had 18 months to go until retirement and dreamed of wrapping up his career as a 757 captain. But the FMS programming had him flummoxed.

"Doug", he said, "You know, I'm just an old Georgia farm boy and I am having a heck of a time with this FMS stuff. My old Navy instructor told me I probably belonged on a tractor instead of flying airplanes but I just gotta learn this 757 before I retire." Capt. Hank was not unusual at that time around the training department. Not only was the 757 on the property but also the new Airbus A320 was on line and pilots were dropping out of that program like flies. The glass cockpit was a daunting change from a ragged-

out -9 with 2 VORs and a crank ADF. I recall lots of strategy meetings on how to best transition our crews from the old jets to the automated cockpit of the new machines.

We rallied behind Capt. Hank and finally got him through the program with some extra training learning how to manage the magic and push the right buttons. He finished his NWA career as a safe and competent 757 captain but his difficulties were not unusual making the leap from airline pilot to "flight computer systems manager "

Flash forward to 2009 and now we find private pilots faced with the same training issues. A few weeks ago, Jean and I borrowed Tom Berge's RV-7A and flew to Vermillion, SD to visit #2 son and his girlfriend. The weather was 2500 overcast at Vermillion with unlimited visibility. We were IMC at 4000 feet and cleared for the GPS 32 approach, which required a procedure turn. Tom's RV is circa 2003 with those funny round dials but a Garmin 530W and a Tru Trak autopilot doing most of the work. My problem is I know just enough about the 530W to be dangerous. No, I really had not sat down and truly learned this box like I should have and as a result every time I fly Tom's airplane, I find myself not 100% confident in managing the "magic".

Without boring you with all the details, my handling of the initial part of the approach was not up to ATP standards (or faithful co-pilot wife's either). After meandering around a sloppy procedure turn I found myself inbound to the initial approach fix but the 530 was still in the holding pattern which serves as the course reversal/procedure turn for this approach. And I couldn't remember how to exit the hold/procedure turn and proceed inbound to the FAF.

Finally I clicked off the "magic" (the autopilot) and hand flew it to the FAF where we broke out into perfectly fine VFR weather. We landed successfully and the mission was accomplished but I'd give myself a C+ on IFR procedures and technique. I really needed to know the workings of the 530 better and practice using it more often (Garmin makes a great trainer that runs on a PC).

My new RV-7 will have dual AFS 3500s, a Garmin 430W, three-axis autopilot with VNAV and probably way too much other magical doodads mostly for the expressed purpose of pancake runs to Eau Claire. I'll have to buckle down and learn the systems and stay current with their function and operation. With all the goodies now available for our RVs, it is not too hard to feel overwhelmed like Capt. Hank did leaving the DC-9 for the 757. Training is the key.

At least Garmin doesn't have a GPS box for my garden tractor… yet!!

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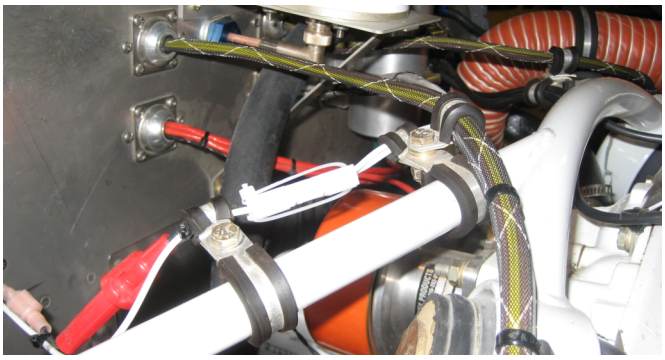
RV Inspection Observations

-Tom Berge

One of the interesting things I find myself involved in is doing inspections of RV projects prior to the DAR arriving on the scene. The thought is to get lots of eyes on a project to find and fix any discrepancies thus making the actual DAR inspection a cleaner process. Through the years I've noticed some recurring problem areas and have decided to shine a light on the more common discrepancies as well as some not so common. Some of these areas are definitely wrong, while others are just my humble opinion. You be the judge.

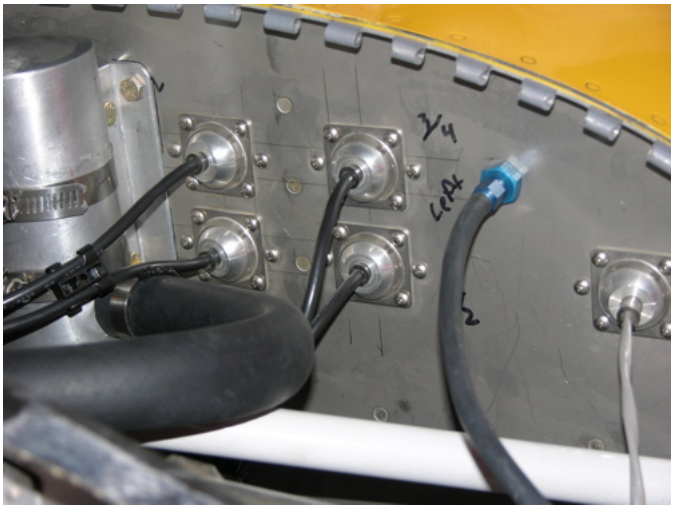
The engine is always fun to inspect. There are lots of ways to do an installation and it's interesting to see how builders have done since we all know that the instructions are somewhat lacking in detail. For the most part, I see the big safety items being done correctly. That being said, I notice a lot of wiring issues. Using tie wraps to attach wires to the engine mount

increases the chances of chaffing. I see a fair amount of wires just being routed every which way with lots of excessive movement. One thing that works really well is to get Adel clamps and put one on the engine mount and another to route the wires.



Adel clamps secure and route wiring in engine compartment

Firewall penetrations are another problem area. Remember that the purpose of the firewall is to keep any potential fire away from the people long enough to get on the ground. I've seen lots of wires and cables being routed through plastic snap bushings. I can see right through these things. And if I can see through them, so can fire. In fact, the fire would melt the bushings and make a bigger hole. The same goes for just using rubber grommets. There are stainless steel shields available to cover the penetrations. Another common problem is mounting pressure transducers on the engine. Don't do it. They will break from the vibration.



Lack of fire sleeves on all of the fuel lines is another common issue. Many times I have seen the fuel lines going to the engine fire sleeved, but the line going to the pressure transducer naked. Fire sleeved oil lines are also good. The biggest issue I find with baffles is how builders connect the portions of the baffles that wrap around the cylinders and heads. There are small tabs bent 90 degrees to accept either a rod with nuts on the end or twisted safety wire. First of all, make sure that the doublers are installed to strengthen the tab for the rod or wire. Next, make certain the rod or wire doesn't hit the cylinder oil return line. A bare rod or wire in contact with the aluminum tube may wear through rather quickly. Bend the rod to clear or put a plastic tube over the twisted wire. Both options work fine although I prefer the twisted wire method. Just make sure the baffles are pulled tight to the cylinder fins.

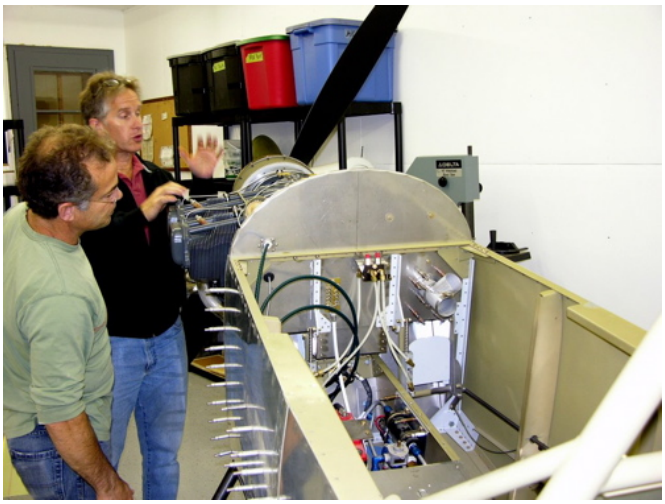
Read the instructions that come with the accessories. I have seen Light Speed ignition control boxes mounted on the hot side of the firewall when the instructions want it on the cold side. For those of you using Light Speed ignition, make sure the plug wires are seated correctly. If they come off during flight it will ruin the ignition coil. Don't use aluminum for primer lines, use copper. The 1/8" aluminum tube is not strong enough and will eventually break. I learned that the hard way. For those of you installing heat muffs on the exhaust pipes, I would suggest adding a clamp on the inside of the end cap flanges to keep the muff from rotating. On occasion I have grabbed a muff and turned it with very little effort and I know eventually it will rotate into something. And speaking of heat muffs, the end caps are eccentrics to allow positioning away from things like the cowl.

The airframes generally seem to be built fine though on most every inspection I do, I will find at least one loose jam nut somewhere. The most common place is on the elevators or rudder. In fact, I'm shocked when I don't find one! Kind of makes me wonder if some of the builders are leaving one loose just for me to find. Take the control stick and while moving it throughout its range, make sure none of the control rods bind up. This is a common issue. All control surfaces should move freely with no binding or stickiness. The elevators, if deflected, should seek a neutral position once you let go. If they do not, be sure that the center bearing bolt is not applying a side load on the elevator horn due to improper spacers between the horn and bearing. Also make sure all controls are hitting the stops. You did install ALL of the stops, right?

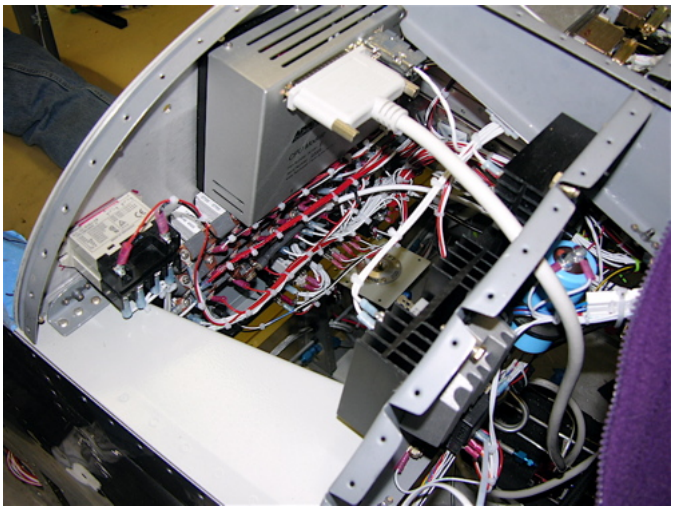
I've found safety wiring done backwards on brake calipers. Make sure the safety wiring can do its job. Recently, while

inspecting a wing root area, I noticed something strange out of the corner of my eye. The fuel tank vent lines seemed kind of strange. They were pointed towards the rear. That was an easy fix. And on the subject of the vent lines, make sure you can blow through them into the tank. Don't use an air compressor to test this, use your lips! Yeah, I know, yuck!

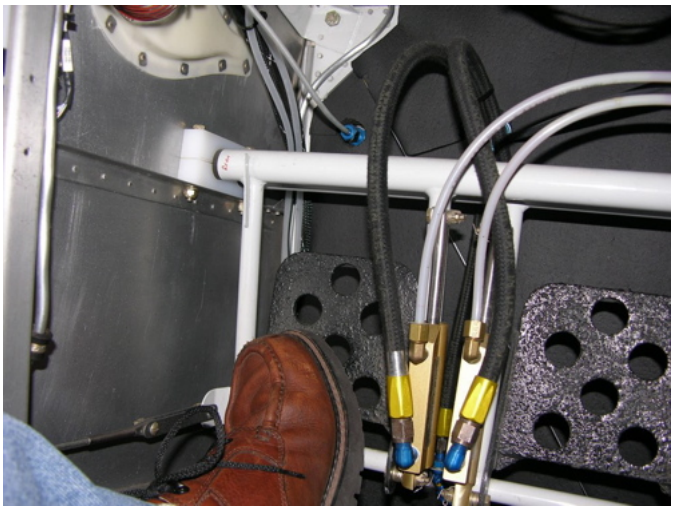
Another common problem is not checking the pitot/static system both prior to flight as well as prior to the avionics shop. The pitot tube can be checked by putting a rubber hose over the end, sealing the drain hole and slowly rolling up the hose to trap the air. Once the airspeed registers 80 knots or so, stop. The speed should remain constant. If not, there's a leak. To check the static side, tape off one port and carefully apply a vacuum with your lips on the other side. Keep going until the altimeter winds up about 2000 feet and pinch off the line. The altitude should hold. If not, there's a leak. Slowly release the vacuum to protect the instruments. One reason to do this check yourself is if there's a leak, your labor rate is cheap. The avionics shop's rate is not. One of the local builders took his plane into an avionics shop and they found a leak in one of the fittings. Their solution was to replace all of the fittings in the system. Ouch!



Inside the cockpit is where things get a bit more interesting. As with the engine installation, there is not as much information provided as one would like. This is also where builders can add their personal little touches. Wiring seems to be a big issue. Regardless of how the systems are designed, the wiring still needs to be routed and supported correctly. It is not uncommon to see long lengths of wire left unsupported. I've seen up to 1-½ feet of unsupported wire running from point A to point B. The wire will eventually break. Use tie wrap blocks. These are the little square standoffs with adhesive on the back that allows tie wraps to securely hold the wires. I find that the adhesive won't hold for long and to solve that issue, I



usually put a pop rivet in the center. Another method would be to apply RTV silicone around the base. Adel clamps also work very well for routing the wires. In between the supports, tie wrap or wax string tie the wires into bundles every few inches, which makes it stronger. When it comes to electrical systems, the hard part is not the circuit. The hard part is figuring out where to route the wires. That takes planning. Alex Peterson once said that the first 90 % of the wiring goes fine and the last 10% turns into a rat's nest. He is right!



The brake pedals / master cylinder assemblies have a common issue with the mounting hardware. The bolts with the castle nuts are not intended to be tightened in this particular application. Their purpose is to act as an axle. Install the nut until the excess play is removed and then install the cotter pin. One thing I always check is if I can rotate these bolts with my fingers. If not, they are too tight. Over tight mounting bolts can cause the brake pedals to hang up slightly, not allowing the cylinder to extend all the way. There is a port in the top of the brake master cylinder that if not uncovered after release of the

brake pedal, can trap some pressure in the brakes lines. As the airplane is taxied about, the master cylinders start to apply more and more pressure. To overcome the drag, the pilot adds more and more power until the brakes overheat potentially starting a fire. I also see missing cotter pins on a regular basis. Just recently, I found the cotters pins missing on the rudder cable links. It's tough landing without the rudder!

I mentioned earlier about moving the control stick to the extremes of travel to check for control rod binding. Another thing that I've seen on occasion is the top of the stick hitting the throttle or some other engine control. No matter how much the builder tries to justify this issue, IT'S NOT RIGHT! Don't care if the stick will never be in a position to hit a control under certain circumstances. IT'S NOT RIGHT! Fix it!

Install a whiskey compass. It's required. Check FAR 91.205 to make sure all the required instruments/equipment are installed for the intended flight conditions. Label everything. Torque bolts as required. (Check out Alex Peterson's article on bolts elsewhere in the newsletter.)

Do the weight & balance in a level attitude. Make sure no wires are able to move on any metal surface. The speed of the chaffing is surprising. These are just some of the things I see on a regular basis. Even with all the inspections I do, I still miss things. That's why it is so important to have many eyes looking. By the way, don't shoot the messenger. The whole purpose is to have a safe experience flying an airplane you built!

Confessions of a Reluctant Test Pilot

-Doug Weiler

Crank up the "Way-Back Machine" for a minute and think back to that first time some wise adult asked you what you do wanted to be when you grew up? Most kids of my generation thought being a fireman would be cool. Or maybe a cowboy/cowgirl or something (today maybe the career of choice might be a Goldman-Sachs bond trader).

I always wanted to a pilot of some sort. First it was an Air Force fighter pilot (shot down when my eyeballs went bad). Then around age 15 or so, I wanted to be an experimental test pilot. Maybe I saw that old movie "Test Pilot" with Clark Gable. Wasn't there a scene in it with Gable plummeting towards the ground trying to rip the wings off some exotic super plane…. you know… he is trying to pull up out of the screaming dive straining with both hands and he just barely makes it with feet to spare. That looked like a lot of fun!

It didn't take too long to discover that you really needed a degree in aeronautical engineering, which apparently required math skills greater than my limited ability to keep track of my paper route customers. Then I thought maybe Piper or Cessna might hire me some day as a production test pilot and I could put all those spanking new Cherokees through their paces before delivery.

The rest of the life story did not exactly follow that path until nearly 50 years later. That early desire to investigate the gray areas of aircraft performancer had long since given way to a career as a flying bus driver. But as the completion of my RV-4 drew near in 2003, I really wanted to make that first flight myself. I figured I was qualified… many thousands of hours.. lots of taildragger time, and I had owned an RV-4 for the past couple years and felt confident in flying an RV.

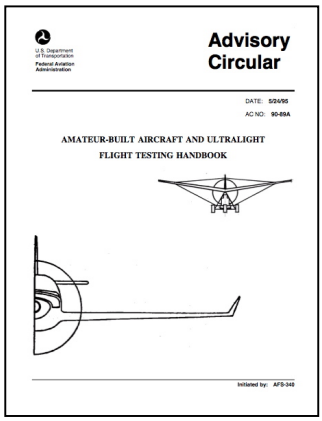
But I distinctly recall the trepidation of that first flight. I had read all these books, drew up a first flight test card, planned for every contingency that I could think of. Alex Peterson stood by to fly chase in his RV-6A. I recall having a little heart-to-heart discussion with the Commander-in-Chief the day before: "Please God, let the engine keep running and don't let me do anything dumb." As it turned out, that first flight was pretty tame which was a good thing!

Since then I have completed seven more first flights of RVs for our local builders. I really haven't gone out of my way to become a RV test pilot for hire. But I will consider it if someone asks. After 46 years of flying I don't want to scratch any aluminum so I have a list of personal criteria:

First is the airport. To make a safe initial test flight doesn't require a 10,000-foot runway, but personally I prefer a field with 2500-3000 feet of hard surface and open fields nearby.

For example, the FAA and MAC prohibit first flights out of Crystal Airport for a reason: there is nowhere to go nearby except someone's back yard. Plan your first flight out of a suitable airport… the bigger the better

Next, I turn loose my "posse" usually composed of Tom Berge, Alex Peterson, and sometimes Pete Howell. This is the BIG inspection(s). These guys I feel are the best RV inspectors on the planet. I tag along of course (since it will be my posterior flying this new airplane) but mostly I stand aside as Tom and Alex dig and dig and dig. It doesn't matter whether this is accomplished before or after the DAR sign-off. After these guys are finished and are happy, I am confident we have flyable airplane.


U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

DATE: 5/24/95
AC NO: 90-89A

AMATEUR-BUILT AIRCRAFT AND ULTRALIGHT FLIGHT TESTING HANDBOOK

Initiated by: AFS-340

Third is paperwork and this is accomplished with the BIG inspection. Here I refer to the FAA's Advisory Circular 90-89A Amateur-Built Aircraft and Ultralight Flight Testing Handbook. As you near the end of your project, this is the Bible!! Start at the beginning and go page by page to be sure you have covered everything. I double-check such things as a pitot/static check, fuel flow check, fuel vent check, etc. In fact, I suggest the builder find a good RV annual inspection form (that you will use later to finish your annual condition inspection) and follow it as an initial airworthiness checklist. Of course, we go over weight and balance plus all the necessary airworthiness and registration. If all is well, next is the first flight.

We need reasonable good weather and light winds. Personally I always have a chase plane helping out (usually Tom or Alex). A chase plane provides confidence in monitoring the safety of the flight and also often a co-pilot flies in the chase plane to record test data.

I follow a basic pre-flight checklist. Most new RVs have new engines so once the engine is started it is going to get hot real fast. Thus the ground taxi and run-up is quick and efficient. Usually I have the chase plane stay on the ground until I get off and begin to circle the airport. If everything looks OK, I'll do a quick full power run up just to see where the RPM stabilizes. A final flight control check, fuel valve and fuel pump and we are ready.

Starting the takeoff run, again a quick glance to confirm full power and then fly the airplane. My thoughts are focused on what to do if the engine quits. At lift off, the first 5 seconds pretty much tells if the airplane flies reasonably straight (I have never had one that is greatly out of trim). Then just a straight climb out looking ahead for a potential landing spot. A turn up over the airport (not touching the throttle) and a climb to about 2500 feet. After about 10 minutes of circling the airport, I radio the chase plane to takeoff and we usually form up around 3000 feet and compare airspeed readings. If everything is still in the green, we separate and I do a power off stall to get an indicated stall speed which then can be translated to a final approach speed for landing. RVs just don't vary in stall speed much (they really shouldn't). Typically it is around 55 knots (clean) or so which then results in an approach speed around 70 knots or 80 mph.

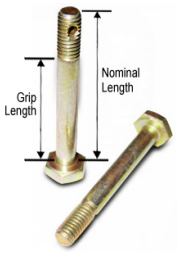
All this time, I am watching oil temps and cylinder head temps. They are often on the high side but as long as they are below the redline, the flight can continue. After about 30 minutes, that is usually enough and I head back to the field with the chase plane in tow. After landing, we check for oil leaks and review the squawk list and determine what (if anything) must be corrected before the next flight. Then its time to celebrate a newly minted RV.

Should you hire a "rent-a-test-pilot"? Totally up to you. If you are current, qualified, and confident, then develop a logical test plan and go for it. If you have doubts, talk to any of the club advisors (me, Tom, Alex,) and we'll be happy to advise you. You'll be savoring those $100 pancakes at Eau Claire in no time!!

The Nuts and Bolts of it All

-Alex Peterson

Bolts. I'm not sure how many of them are in an RV, but there are plenty of them, and each one of them is important. It seems to be a common thing for us to finish an RV, only to find that someone comes along and says something like "This bolt is too long, that bolt is too short." In fact, this is perhaps the most common squawk that I've noted when looking at other builders' almost completed projects. I know I put bolts in a zillion times only to have to immediately take them out again for a longer or shorter bolt or different washer when finishing my RV.



Let's look a little closer at what the function of bolts is. Bolts have two basic functions, often at the same time. First, they act as a clamp to squeeze two or more things together, typically resisting some sort of pulling force. An example of this in our airplanes, are the bolts holding the motor mount to the firewall. The other function is to prevent two or more pieces from sliding relative to one another. This type of bolt loading is called shear. An example of this would be the bolts holding the seat belts into their anchors.

While the study of bolt theory and practical application thereof is a fairly complicated mechanical engineering topic, the basics as they apply to those of us building planes is fairly straightforward. It is my hope that the following will be helpful to any of us building planes in our garages. Be sure also to get a copy (can be downloaded) of AC 43.13-1B, and study Chapter 7, which contains sections discussing proper practices on aircraft fasteners.

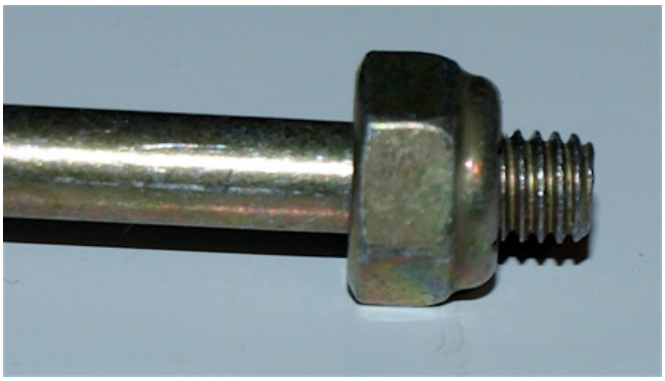
Bolt Strength. It is often eye opening to learn just how strong a bolt it. The steel from which our AN bolts are made has a tensile strength of about 125,000 pounds per square inch. This means a bar of this steel that is 1" x 1" square could support 125,000 pounds before failing! An AN3 bolt, which is nominally 3/16" in diameter, could be loaded to about 3400 pounds before failing. The AN4 size bolt will fail around 6100 pounds! Of course, the designer would typically not select a bolt design that would load them to near this limit.

Clamping Forces. The proper torque for a -3 nylon stop nut, AN365-3, as about 25 in-lbs. About 15 of these are simply to overcome the nylon friction, leaving about 10 in-lbs of torque into the nut. If the bolt threads had no friction, 10 in-lbs of torque would generate about 2000 lbs. of tension in the bolt. Of course, there is thread friction, as well as friction of the nut against the clamped material. The 10 in-lbs generates in reality about 200 to 250 pounds or so of clamping force. In other words, only about 10% or so of the torque goes directly into the clamping force, the other 90% is friction.

Shear Loading. Most of the bolts in our planes are loaded primarily in shear. Consider the main bolts that hold the wing spars in the fuselage. The function of preload in these bolts is to insure that the various parts of the spar and fuselage are in intimate contact, and are not allowed to move relative to one another. The stresses in the bolts will go up if the joints are allowed to separate in a shear-loading situation.

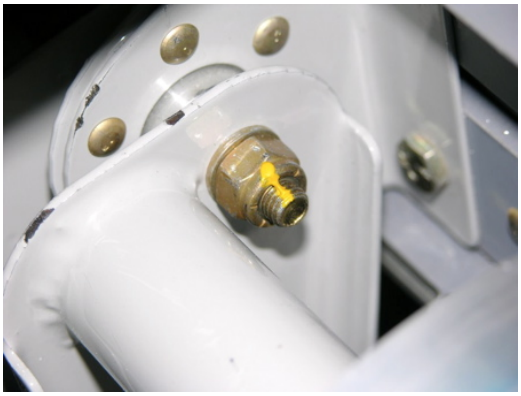
Proper Torque. Almost all of us, if given an AN3 bolt, would tend to way over tighten it without the use of a torque wrench. In fact, I suspect we would apply something like 4 or 5 times as much torque as is proper. In general, this will not cause our airplanes to fall out of the sky, although it could. But, it can have a very dramatic effect on the fatigue life of a bolt. Fatigue life is a description of how many times something can be loaded and unloaded before a crack, and eventual failure, occurs. Paper clips can be bent back and forth about a dozen times before fatigue failure occurs. While you might get by with over tightening a bolt holding some bracket on to the firewall, it is critical to properly torque bolts that are highly cyclically loaded, such as those fastening the connecting rod to the crankshaft. In these cases, the specified torques have, as a main consideration, the fatigue life of the bolt.

One to Three Thread Rule There is a rule for AN bolts that use AN365 stop nuts – once torqued, there should be between one and three threads showing above the nylon in the nut. If there is too little showing, the locking characteristics of the stop nut may be compromised. If more than three threads are showing, it is likely that the nut is not properly clamping the pieces together. This is because the nut has run up against the end of the threads on the bolt. Try it for yourself – take an AN bolt and run the nut all the way until it runs out of thread like this:



Understand also that there is a variation in exact dimensions, so not all will be the same. Many times I have seen bolts in airplanes, purportedly almost ready to fly, that are showing four or more threads. Often these bolts, while having been torqued, can be spun by hand. Make use of the thick and thin washers, AN960-X and –XL (where X is size, like 3), to properly position the nut. This frequently means some trial and error, and the plans are often wrong in the bolt callout. Another rule of thumb is that the bolt is stationary, and does not have a washer under its head, while the nut is rotated, and does contain the washer(s). There are a few exceptions to this rule, so in those cases, put a washer under the head of the bolt.

Inspection Lacquer. One final point with regards to bolts, and a frequent observation in almost ready to fly airplanes (and flying ones for that matter!), is the absence of inspection lacquer, commercially called "Torque Seal". It comes in little tubes, and is available in various bright colors. It is a safety of flight issue in my mind when each and every bolt/nut is not marked with the inspection lacquer. The proper method is to torque one bolt, and then mark that bolt before moving on to torque the next one. While it is tempting to torque up a row of bolts, and then mark that same row, it is a good way to miss torquing one. This is also critically important in tightening the B-nuts on tubing fittings. It is an eye opener to the builder when I spin one loose by hand. Torque one, mark one, which is a good rule to live by.



Minnesota Wing – Van's Air Force
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New Brighton, MN 55112-3454

First Class

Minnesota Wing December Meeting

Saturday, December 12, 2009, 10 am.

Doug and Paul's Hangar at Lake Elmo Airport (21D)
Hangar 41C - Mooney Lane

Our special guest for December will be Scott Smith of Skysmith Insurance. Scott will discuss everything you have ever wanted to know about insuring your RV and the experimental aircraft insurance market in general. Scott is an accomplished author and speaker having given seminars at various air shows, auto shows and boating events. His company insures the majority of local RVs, so his insight will be valuable and informative.

Also on the program is our own Pete Howell who will update us on the latest in LED lighting on his RV-9A and all of the other geeky gadgetry he is working on. Coffee and goodies as usual!!!!!!

Driving directions:

Take I-94 east towards Wisconsin. Go north on Manning Avenue (County road 15). Three miles north to Lake Elmo Airport. Enter at the north entrance (before the RR tracks). Go east past Valter's Aviation to Mooney Lane just past the Civil Air Patrol hangar. Hangar is 41C on the left. (fly-ins are OK as well. Taxi and park of the hangars along taxiway)

Phones: hangar: 651-779-0747, Doug's cell: 651-398-1184