Timber Tiger Aircraft ST-L

Section 0: Introduction

SAMPLE MANUAL ONLY

All information contained in this sample is to be superseded by content supplied with kits. DO NOT use the information in this sample manual to build your kit.

Flight Report – Glenn Gordon:

Cutting right to the chase, the ST-L is an absolute joy to fly! Its beautiful aesthetic is only surpassed by the wonderful handling and performance of this definitive art deco design. The exquisite styling and flying characteristics combine to make this airplane the dream of the modern grass-roots aviator!

Starting with the walk-around, the first thing one notices is the overall ramp presence of this aircraft. With the top of the cowling towering at 6'-5", the phrases "scaled replica" or "sport pilot" are the last thing that come to mind. Added details such as precisely scaled rivet lines and some beautifully distressed leather adorning the seats and cockpit coamings, leave the admirer forgetting any notion that they're looking at a kit built, scaled-down replica of the legendary Ryan ST aircraft. The aft pilot seating in the tandem cockpits along with the long nose of the airplane create a lot of distance between you and the propeller. The forward view is limited to about the same as the back seat on most biplanes that I've flown. The fact that the cowling is so narrow actually provides some added angle to the forward view.

Step up on the wing and slide yourself down into the cockpit and you'll quickly notice that it's cozy. If you've ever sat in an original Ryan ST then you would find it incredibly spacious thanks to the greatly improved ergonomics of both cockpits on the Timber Tiger design. At just shy of 6 ft, I'm very comfortable in the airplane and have spent several long cross-country days inside of it. Taller pilots will find themselves comfortable as well due to the ability of the builder to mount the rudder pedals anywhere along the lower longerons.

Startup and taxi are uneventful. The steerable tailwheel provides precise control during taxi and snapping the tailwheel out of the detent makes maneuvering in tight spaces a breeze. Forget the heel/cable operated drum brakes of the original Ryan design. The Timber Tiger ST-L features modern Matco disc brakes which provide predictable and controlled brake response.

Lining the airplane up on the runway for takeoff is easy when you let the long nose of this pretty bird guide the way. Ease in the power and you feel that the rudder steering is immediately effective and authoritative, however requires only minimum input to keep the plane pointed straight down the runway. The tail then can be raised almost immediately and you quickly become aware how much this airplane is yearning to climb towards the heavens. I like to gracefully allow the plane to break free from the runway at when it's ready (around 55 KIAS) rather than a distinct takeoff rotation; pilot's prerogative. I'll note here that my initial flights in this plane were at Boulder, Colorado; solo and with full fuel I was still showing 800 fpm climb at 8000' MSL! A little right rudder and a climb-out at 60 knots will quickly show you that the 100 horsepower Rotax up front provides more than enough power for this airframe.

Level the plane off, throttle back to 5200 on the tach, and I was comfortably cruising at 92 KIAS with the engine sipping 5 GPM. Time to feel out the airplane. Some Dutch rolls

quickly gave me a feel for the relationship between the ailerons and the rudder, as well as providing me the opportunity to feel out any adverse yaw tendencies. The ST-L features aileron push-pull tubes rather than the cables found on the original. This serves to ensure that ALL the control forces are light, crisp, and in harmony with each other. Through slow-flight, Dutch rolls, and turns (30°,45°,60° bank angle), I quickly appreciated the thought that went into the (re)design of the ST-L's wing. They responded and felt very similar to a Decathlon (slightly lighter control forces) and didn't require any fancy footwork to keep coordinated. Thanks to the washout added to the ST-L's wing design, the ailerons remain effective right up to the stall break. Stalls were straight-ahead, gentle, and very predictable without any tendency to drop a wing. Holding the stick back and practicing a falling leaf is as easy as on any plane I have flown. A release of back pressure immediately gets the wing flying again.

Coming back into the pattern at 1000'AGL with a power reduction to idle will generally leave you high on final. This airplane has a light wing loading and will glide a long way. Those gear leg fairings however do produce a lot of drag during a side slip, and any excess altitude is easy to shed on final. The aircraft's long nose helps you out with runway alignment during landing. I practiced both three-point and wheel landings on both pavement and sod runways. I finally settled on wheel landings for pavement and high crosswinds, and three-point landings for sod. Flying through Nebraska, I landed the plane in winds gusting to 35 knots with a maximum crosswind component of about 12 knots. The ST-L handles these conditions just fine with good responsiveness and proper crosswind technique. It should be noted that on a wheel landing, the tail takes a long time to come down due to the light wing loading. During this time, the ailerons are still very effective and full aileron deflection for crosswind control will lift a wing back into the air. Supposedly this is just like the original Ryan ST handles. Don't try to rush the tail to the ground or you'll quickly find yourself back in the air with no reserve lift. As fine a reputation as the original Ryan ST has, it still had its quirks caused by the inherently unstable leading-link landing gear. Luckily Timber Tiger did away with this design without compromising the gear's outward appearance. The gear leg fairings now hide a new landing gear design which always tracks straight and true.

Some final items about the Timber Tiger ST-L prototype I flew versus the kits which were based upon it. Several improvements were made to the design based upon learnings from the prototype. These changes have been cut into every ST-L kit produced by Timber Tiger. The major improvements include:

1. Wing fuel tanks in place of the original style nose tank:

    a) Increased fuel capacity

    b) Removes fuel from cockpit

    c) More baggage room

d) More passenger room

e) Easier to fuel

f) Lower CG

g) CG Shifts forward with fuel burn

2. Lowered seats and increased windscreen height for a more scale appearance:

a) Accommodates taller pilots

b) More vertical space for cushions or parachute

c) More scale appearance

d) Ability to sit lower into the airplane if desired

Glenn Gordon with the ST-L. Photo by Leonardo Correa Luna

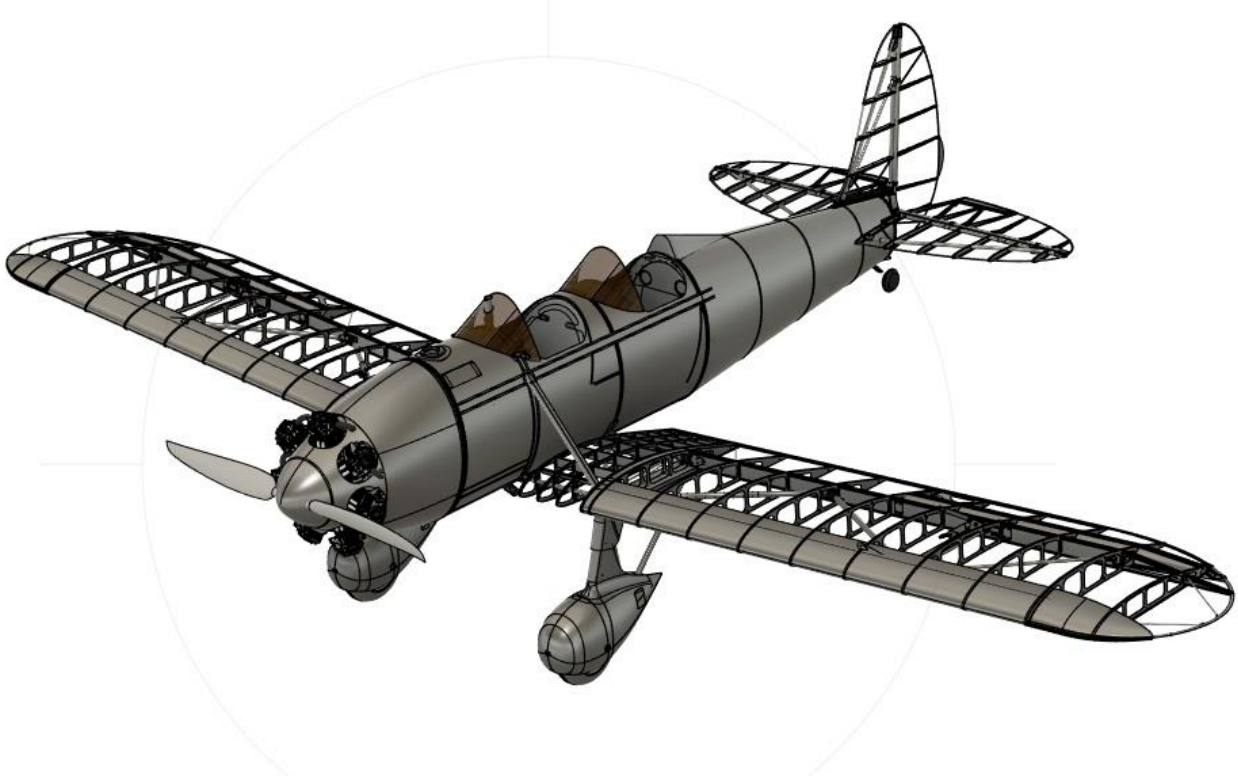
Flight Report – Brooks Mershon:

I had the honor of being trusted to conduct the phase 1 testing from first flight onward in the ST-L. I flew over 65 hours in the aircraft, starting with the first flight at Colorado Air and Space Port, working through its relocation to Boulder with performance evaluation, stall testing, CG envelope verification, and eventually happy pleasure flying with passengers in phase II while the plane lived with me at Shiflet Field in western North Carolina near Asheville. The plane handles like a more agile and higher power to weight ratio Cub in the air and lands like a Cub on stilts. Three point landings on grass are easy as can be and yes, I can see much more out of this plane than my Pitts S-1S! Look cool without sweating the landings! I've never walked away from the plane without looking back at it. You feel like a hero wherever you land. The plane is magic; flying artwork without any nasty characteristics to pay for the beauty. Docile handling with very wide CG range owing to the airfoil chosen for the wing gives you sporty handling without the dark corners that sometimes comes with "fun" airplanes. I look forward to flying clipped wing variants being built. My time in the plane has been a tremendously rewarding chapter of my flying career.

Brooks Mershon over North Carolina

Builder Report – Lee Wolford, Col USAF Ret.:

In March of 2021 I came across an article in an aviation magazine about Timber Tiger Aircraft in Montrose, Colorado building replicas of the Ryan ST-A. Since I had owned a PT-22 and always thought about acquiring another Ryan, this article piqued my interest. Would this company build a PT-22 replica kit for me? In late March of 2021 I contacted Timber Tiger Aircraft to see if they might be interested in my idea. Nick Pfannenstiel, the company owner, answered the phone and was very enthusiastic about the idea. The military PT-22 is a very different airframe from the sportsman's Ryan ST, so we elected to replicate the radial-powered PT-16A. We entered into a contract on April 8, 2021 to build the PT-16A replica using the same airframe as his ST-A. Since then, we have worked together on the changes needed for this specific project. I must say Nick is very knowledgeable and easy to work with. For me it has been a pleasure to work with someone with the enthusiasm and knowledge to make this idea come to fruition. The parts I have received so far are extremely well made and display the best workmanship I have ever seen in a kit airplane. I highly recommend Timber Tiger Aircraft to anyone contemplating building a Kit aircraft.



Lee Wolford's Airplane Layout with a Verner 7u Radial.

Flight Report – J. K. Caldwell:

Who doesn't love the look of the classic Ryan Aircraft? I had the joy of flying the ST-L out of Shiflet Field's grass runway in the beautiful mountains of NC. It was a crisp and cool Fall afternoon and the experience of flying this gorgeous and well-behaved aeroplane was one that I won't forget. I've been able to fly over 125 different aircraft types in my career thus far, including a few hours in rather rare Ryan PT-21 Recruit. While bearing similar classic Ryan lines, the Timber Tiger ST-L is much more well-behaved. There are some planes out there that, while fun to fly, require the pilot to be constantly on their toes and have the footwork of Fred Astaire when landing. Thankfully, the Timber Tiger ST-L is not one of them. The experience of flight and the nostalgia of the "Golden age of Aviation" can be truly enjoyed. My only regret was that the experience was over too soon!

Photo by J. K. Caldwell for "Plane Impressions"

WARNING

In addition to things most veteran builders already know, this Introduction Manual also contains information that is specific to the Timber Tiger Aircraft ST-L. DO NOT skip reading this manual. Skipping this Introduction Manual could cost you money or, worse yet, create a dangerous situation.

WARNING

The parts in this kit were designed to fit together very well. If parts aren't fitting together like you'd expect, that should be a warning that something needs another look. In such a case, do not modify parts without first contacting Timber Tiger Aircraft. A five-minute call to tech support could save you time and money, all while assuring a safe, high-quality level of construction.

WARNING

Before airworthiness inspection, it is the builder's duty to make sure the airplane conforms with all Service Bulletins. Service Bulletins can be found on the Timber Tiger Aircraft website. DO NOT forget to check service bulletins often. The sooner you know about them, the sooner and easier you'll be able to incorporate changes into your airplane.

ST-L Introduction Contents

Air-to-air photos by Distant Thunder Aviation, LLC

0-0: Introduction

So this is it. You've made the jump. You're a little uncertain…but confident it'll pay off. In no time at all, you will be cruising the sky in a replica of what is often considered to be the most beautiful airplane ever conceived. The 1934 Ryan ST. Of course, our Sport Pilot Eligible replica is called the ST-L.

The ST-L is the first of many planned Timber Tiger Aircraft kits designed to bridge the gap between the common WWI and WWII replicas. This era, known as the Golden Age of aviation, has been largely overlooked in recent decades. Timber Tiger Aircraft, Inc. is proud to be the foremost company leading this sector of the kit airplane market. With docile low-speed handling and exciting performance at higher speeds, the ST-L has an undeniable presence at any airport it lands at, making any pilot feel like a hero.

Your kit has been developed in a manner considered to be the best balance of build enjoyment and getting in the air quickly, both of which will place you solidly within our growing community. Each and every part of the ST-L kit was designed with intent and represents a great value to ST-L builders. Throughout the build process, we will guide you, step-by-step, with useful tricks and tips along the way. If you don't have a full technical skillset yet, don't worry. A big part of the project is to learn as you go, and the purpose of this construction manual is to aid you in building those skillsets.

You can do this! If you're a past airplane builder or weekend garage warrior, the task isn't daunting, especially since the plane falls into the "easier than many" category. And newcomers need not worry. If you get a little lost between now and the end of the project, we are here to help. If you're ever unsure about a mistake or the quality of a part, drop us a line and we will do our best to guide you in the right direction.

After you've looked over the plans and construction manual a few times, you can start planning your build (see the next section) and, as soon as you're ready, build an assembly! Typically speaking, the manual and drawings are organized such that you shouldn't need to jump back and forth. Think of it as a linear progression, no different than reading a book.

Remember these instructions are here as a guide. If there is anything in the instructions that seems unclear or incomplete, let us know, enabling us to improve future instructions.

Have fun!

-Nick Pfannenstiel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0-1: Planning Ahead

Airplanes don't get built by winging it. Plan. Dream. Scheme.

First off, why are you building this thing? Besides the obvious point that you're cooler than most people, there are things to consider. The sheer beauty of the plane is apparent. Maybe you've got skill sets you want to hone. Maybe your technical ability is limited and you're on a mission to start on the most rewarding project of your life. Maybe you are social and want to meet other pilots at your typical destinations. The ST-L sure brings people out of the woodwork!

Second, just what is this thing you're building? Well, we know it's a Ryan ST replica, of course, but let's dig deeper. This airplane is built using a traditional semi-monocoque fuselage wrapped around a main steel bulkhead (Bulkhead #2, or BH2). Behind BH2 is BH3, the lower part of which is a heavy-duty wing stub spar of built-up aluminum. BH2, combined with BH3, attach to outer wing panels, creating a very strong bridge-like structure. These outer wing panels are constructed of aluminum I-beam spars, honeycomb aluminum ribs, and a very simple drag truss, which replaces the more traditional drag/anti-drag wires seen in most fabric-covered airplanes. The tail surfaces are nearly identical to the original aluminum tube spar/stamped rib design and are classically rugged in simplicity.

Now that you have an idea of the airplane's structure, envision your airplane as you want to see it built and how you might use it. Do you like to sit high? Consider the taller PT-20 style windscreens. Want the extra sleek look? Consider the standard civilian windscreens. The ST-L isn't just another pretty face. It's a memory-maker. Are you going to give rides to the countless spectators that will come out of the woodwork to see your masterpiece? Are you going to fly off of a vintage grass strip? What color will your airplane be? Don't be afraid of a polished plane. It's not difficult to maintain, despite what many will claim. Spend a weekend giving it an annual polish at the start of every season and go have some (safe!) fun.

As important as it is to dream about those things, it's equally as important to work towards making those dreams a reality. During the build, one of the most important things is planning for the Center of Gravity. Keeping the CG as far forward as possible is important. The exact CG range will be called out later, but keep in mind the ST-L is sensitive to pilot weight. We've been asked several times, "I'm 250 lbs. Will I fit in your plane?" The answer is that the ideal pilot weight for the ST-L is 200 lbs or less and you never know how you might change by the time your plane is done. Yes, you can add more ballast to the nose. If you are installing a Rotax 912 or other lightweight engine, you'll need ballast up front regardless of pilot weight, so there isn't much room for more. It's the price we pay for the ultimate in scale accuracy combined with modern engines (you do want your plane to look like a Ryan ST, correct?). A heavier engine, such as a radial, will allow a heavier pilot, usually without the need for ballast.

As you've noticed, engine choice and CG go hand in hand. What engine are you going to use? Are you going to use the time-proven Rotax 912 ULS? This engine is often considered one of the most reliable engines currently available. In addition, big-bore kits are available and offer more power in a tiny package. What about the newer Rotax 915iS or Jabiru Gen 4 3300 (both will require cowl modifications to work)? Are you going to try a Continental O-200? A Verner radial? Options abound, but keep CG in mind and remember that, as of writing this, the Rotax 912 ULS is the only engine proven on the ST-L airframe, with testing of a Verner 7u scheduled for late 2022.

Plan your paint scheme. Polished planes weigh less. Yellow weighs more than silver, as it is more transparent and requires about twice as many coats for good coverage. Not to mention yellow topcoats sometimes require white undercoats. If we had to guess, yellow probably adds 10 lbs to your plane, nearly all of it aft of the airplane's CG.

Now that you've had a minute to consider those things, circle back to the beginning every now and then to dream a bit as your project comes to life. After all, that *is* the reason you have chosen to build this plane and not something else. It's not the kit airplane everyone else has. It's a dream of a memory-maker, and one dream worth making a reality.

0-2: Saving Time

Let's get this airplane done! Part of the fun is the build, but you're ultimately building an airplane so you can fly it. To aid your progress, Timber Tiger Aircraft kits utilize pre-formed and factory-drilled aluminum parts, pre-welded and primed steel parts, and factory match-drilled holes. You'll have to cut some raw aluminum tubes and angles to length and glue some things together, but you already know how to do that from middle school shop class.

Speeding up your project is all about *workflow*. If you only have an hour of shop time a day, take it. Even just one hour a day can put a big dent in a project over the course of a year. On days that it is too cold or nasty to get to the shop, you can even spend some time looking over the manual and associated drawings.

You can also start an itemized "goal calendar". You won't be able to stick to the calendar perfectly, but it will give you something to shoot for and it will keep you honest. The calendar should be planned to optimize the workflow in a manner that suits your life in the best possible way. Ask friends and family if they might be interested in helping every now and then. After all, building your plane is fun, but the support of family and friends will help a lot.

Family involvement can be a great motivator.

0-3: Working With Materials

While building this plane, you will find it necessary to reference AC 43.13-1B "Acceptable Methods, Techniques, and Practices, Aircraft Inspection and Repair". This FAA document is the standard for acceptable practices. If used often, you will end up with an airplane that is safely constructed and of very high quality. This Advisory Circular goes into far more detail than is possible here and should become a regular part of your library.

Safety:

As always, be sure to wear safety gear whenever you're cutting, grinding, drilling, or otherwise working metals, plastics, woods, composites, or any other construction material. Ear and eye protection are always easy to remember, but get a good respirator to keep aluminum, fiberglass, and other dust out of your lungs. These particulates have been shown to have adverse effects on a person's health, sometimes to a dangerous degree.

Hole-edge-margin:

Let's making something known right away. This information is something that will guide you until your project is complete…and beyond. Unless otherwise specified, every hole in this airplane should be no less than two times the diameter from the center of the hole to the nearest edge of the material the hole is in.

Put another way: distance between the center of the hole and the edge of the material = 2 x hole diameter.

Of course, further away from the edge isn't bad if the part allows, but too close to the edge will result in premature failure of the part.

Metals:

Metal is the most commonly-used construction material in the world, whether it's aluminum, steel, or something else. The ST-L is made of aluminum and steel, with bronze bushings in the control surface hinges. It is critical to understand the differences in working with steel and aluminum, as mishandling of the materials can result in dangerous or even fatal situations.

Cutting:

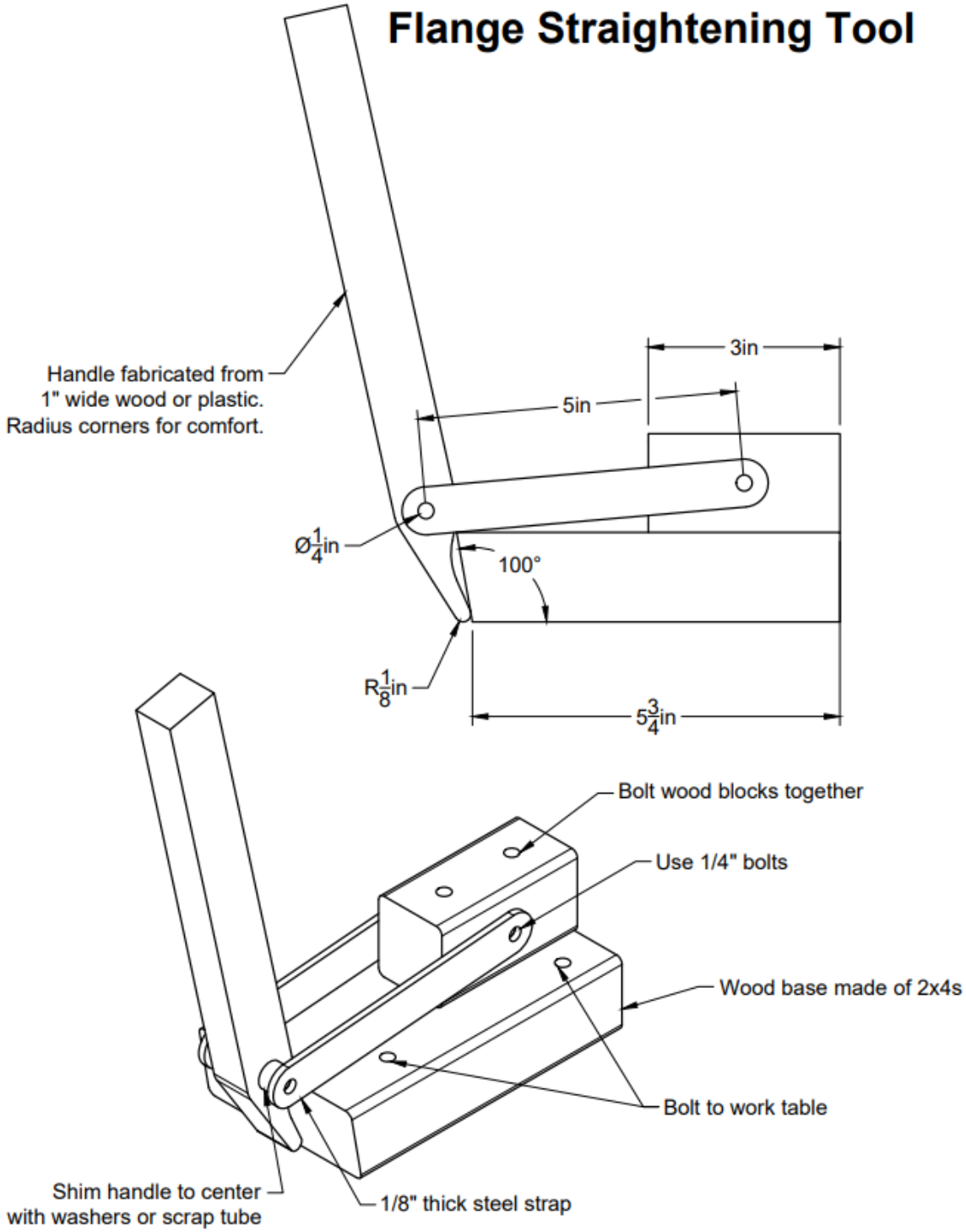
We have all heard the phrase, "measure twice, cut once." That goes without saying in the shop. However, think about how you're actually cutting your parts. You can always cut more material off, but it is usually impossible to add more material back on. So when cutting, creep up on your cut line in increments.

Likewise, when cutting aluminum sheet, use your shears to cut about 1/4" away from the desired cut line. Removing the bulk on the first pass will make a much nicer cut on the second pass, which should be right near the cut line, with only enough material left to allow for sanding and deburring.

While we're talking about shears, never allow the shears to close completely when cutting. Doing so will create a little dimple or even a split in the metal at the tip of the shears. Also pay attention to how the shears are held. Sometimes they cut easier if held a certain way or on a certain side of the part. There are three type of shears, each color-coded for easy identification. Red is right-handed, green is left-handed, and yellow is neutral. Be sure only to use high quality shears. The cheap ones tend to make improper cuts that need a lot of sanding and deburring.

Straightening flanges:

On sheet metal parts, specifically tail surface ribs, it is necessary to bring the under-bent flanges to 90 degrees. To do this, make a flange straightening tool from some scrap wood. Slide the rib along your worktable, using the pointed end of the handle to press the flange into the beveled edge of the block. This tool makes flange straightening fast and easy.



Priming:

You'll be using lots of primer in this airplane. Use a self-etching primer that is safe on aluminum, such as SEM aerosol etch primers or Omni MP220. Before priming, parts should be scuffed with red Scotchbrite or 400 grit sandpaper, then cleaned with an automotive-grade grease and wax remover. These items are all available from your local automotive paint supply store.

As of writing this, the steel parts in this kit are primed with PPG DP-40LF, which is legendary for its rust prevention and durability. This paint should be top-coated with paint anywhere it will see UV rays, such as on the wing stub strut or roll-over post.

Inspect all steel parts for missed areas. Any areas that have no primer should be scuffed with red Sotchbrite to remove rust, then touched up with paint or more DP-40LF. You may be asking yourself why we don't currently use powder coat to get better coverage. With years of experience in the chemical-spraying industry, Timber Tiger Aircraft founder, Nick Pfannenstiel, has seen countless powder coat failures. Most of these failures are due to improperly-used material. Until Timber Tiger Aircraft sees an improvement in powder coating services and technology, time-tested and extremely rugged epoxy primers will be the factory coating of choice.

Marking and labeling parts:

When marking or labeling metal parts, always use ink, never pencil or graphite. The graphite causes corrosion, especially with aluminum. That corrosion can lead to a crack or premature part failure. Before painting parts, be sure to remove any ink with acetone or thinner, otherwise the ink will bleed through the paint. Be thorough removing marker ink before priming a part. It is bound to happen eventually: you will think you removed every bit of a marking from a part, only for the ink to reappear after priming. In some areas you might find it is practical to make your ink-marks on masking tape, then pull the tape when your work is finished.

Lubrication:

When working with metals, it is important to keep things cool and lubed. Any good cutting or drilling oil is recommended for steel. Aluminum prefers plant or animal-based oils, such as coconut oil. Proper lubrication will keep your tools from gumming up, will keep your tools sharp, will reduce the chance of getting broken bits or reamers stuck in assemblies, and accentuates the overall quality of your plane.

Match-drilling:

Many parts of this plane need match-drilling or match-reaming (ream-on-assembly). This includes rivet, bolt, and screw holes alike. Each assembly requires a different process that must be planned ahead of time. These processes are called out in the instruction manual as they occur.

A quick example: to match drill the longeron to the fuselage skin, draw a centerline on the flanges of the longeron. This centerline will be visible through the rivet holes that are pre-drilled in the fuselage skin. With the centerline visible through the skin holes, drill THROUGH the existing hole and into the longeron. Put a Cleco in this hole to hold the parts together and you can now drill the other end of the longeron in exactly the same manner. With a Cleco now on each end of the longerons, match-drilling the rest of the longeron is a piece of cake. Where required, an expandable rivet drilling guide can be used to space rivets equally. These guides are common in the hot rod industry and are often sold by aircraft supply companies.

On parts that require match-reaming, such as the landing gear legs to the wing stub, the idea is much the same. Align the two parts, clamp or secure them so they don't move, and ream them to the appropriate size. If desired, a drill bit can be used to get the hole close in size, but a reamer should be used to finalize the hole, as a reamed hole will be of much higher quality. Reamers of many sizes are available from aircraft supply companies. When the plans or instructions call for reaming, do not drill!! When using drill bits, especially in critical areas, use only the sharpest bits and clean the chips off the tip before moving on to the next hole. Aluminum tends to gum up on the tip of drill bits and can cause the bit to wander, damaging the part you're trying to drill. This is another good place to use lubricant.

One last trick to mention: get a drill stop set. Actually, get two sets. The drill stop is basically a spring that attaches to the drill bit. As the bit breaks through the metal, the spring stops the bit from protruding too much. This is useful for drilling tubes and in other situations where you don't want the tip of the drill bit to damage something nearby after breaking through the material.

Drawing centerlines on tubes:

Drawing centerlines on tubes is much easier than one might think. To aid you, buy a 48" long stick of square aluminum C-channel, available at most home supply stores. Be sure to paint this stick a bright color so it never gets used in a structural application.

Set your tube firmly in the channel, making sure the channel is on a FLAT table. Use your fine-tip marker to trace the tube, along the top edge of the C-channel. It's as simple as that.

Deburring:

To prevent stress risers or cracks in finished parts, all holes and edges must be deburred and all scratches must be polished or burnished. You'll notice most sheet aluminum parts also have edge tabs that need removed and deburred. These tabs held the parts in place during CNC cutting.

There are multiple ways to deburr a hole. You can use 220 grit or finer sandpaper, blue Roloc Scotchbrite discs, a drill bit twisted by hand, a purpose-made deburring attachment for a drill, or (one of my favorites) a Shaviv deburring tool available from any of the airplane supply companies. With a Shaviv deburring tool, you can actually reach the backside of a hole (such as inside a tube) with the hook-shaped bit. Be sure not to over-deburr or you will end up with a countersunk hole! Holes should not be countersunk unless called for! All you're trying to do is break away chips, leaving a nice, squared hole edge. To deburr the *edges* of a part, simply finish with 220 grit or finer sandpaper, making sure to sand WITH the edge of the part. The edges should be very slightly rounded over.

While all metals need proper deburring, aluminum needs careful attention. An improperly-prepared aluminum part is almost guaranteed to fail prematurely. In critical areas such as wing spars or wing drag truss bracketry, failure will almost certainly be catastrophic. For drag tube brackets and other critical aluminum parts, we like to finish in 240 grit or finer, with a blue Roloc Scotchbrite being our ultimate go-to.

Again, take your time with all deburring. Inspect as you go and you will be happier with the end result.

Working with fiberglass:

Working with fiberglass is much the same as working with metal, but more itchy. And you don't need to finish the edges quite as well, but go ahead, just to stay in the groove of things. Fiberglass will also accept soft solid rivets and regular aluminum blind rivets. If there are cracks, bubbles, or seams in your fiberglass part, grind out and smooth the area that requires attention and fill with automotive body filler. Use a good high-quality filler as recommended by your local auto paint supply store. All fiberglass parts should be finished with 220 grit or finer before priming with a good two-part primer. Do NOT use a single part primer or aerosol primer on your parts. You will be disappointed to see it react with any two-part paint that you use over it.

Tip: when riveting fiberglass, use soft solid rivets or standard blind rivets. In some case, it is beneficial to back the rivet with a thin aluminum washer to spread the rivet compression across a greater area of the fiberglass.

Working with acrylic (Windshields):

The biggest thing when working with acrylic is to use a drill bit specifically designed for acrylic. If the appropriate bit is not used, you risk creating damaged or cracked holes. These bits are easy to find online, including from your favorite aircraft supply store.

Construction debris:

You will get construction debris in your plane as you work. Use a vacuum to clear out ALL debris, especially as one last task before your airworthiness inspection. Nothing in this airplane should be loose, causing a potentially dangerous situation. You'll also notice the lower fuselage longerons have vacuum ports, accessible from outside the airplane. These ports are hidden by the wing root fairings. They can be plugged to prevent mice from nesting in the longerons.

Some notes about tube and other raw materials:

When working with steel and aluminum tube, it is critical that no tube is dented. A dented tube will fail prematurely. If a tube is dented, do not use it!

In addition, if you need to purchase a tube to replace a damaged or mis-cut piece, only purchase seamless aircraft tube with the exact material composition noted on the materials list. Do not purchase tube with seams and do not make materials substitutions! Any extruded angle or rectangular tube used in this design MUST have radiused inside corners. If the radius is absent, DO NOT use the material.

To be safe, purchase any raw materials only from aircraft supply stores. If you have a question regarding this matter, contact Timber Tiger Aircraft. Do not make guesses that could get somebody hurt.

0-4: Aircraft Hardware

You might be tempted to save some money. There are great ways to do that, such as flying wire mass purchases through Timber Tiger Aircraft, buying a ***good*** used engine, or scrounging for good used gauges. That's all fine, but for your safety and for the safety of those around you, use ONLY new aircraft hardware. Your kit comes with the required hardware, so use it as the drawings and manual call for. If you lose a bolt, nut, or other hardware item, the replacement you purchase MUST be the same part number as the hardware you lost. These items are readily available from you favorite aircraft supply stores.

Generally speaking, aircraft hardware is simple to use but must be installed following accepted practices. For instance, where possible, use a washer under the head of the bolt and another washer under the nut. A bolt should never have more than four washers on it. Nylon lock nuts (AN365) are standard for non-moving connections. Moving connections need a castellated nut (AN310 or AN320) in combination with a cotter pin. Specific nut/bolt combinations are called for in the ST-L construction manual and drawings. If you notice any discrepancies between the two, please bring them to our attention. Do not make guesses or substitutions or you could cause a dangerous situation.

You will notice that bolts have numbers following a dash (for example AN5-12). This "dash number" indicates the length of the bolt. Grip length is the portion of the bolt that is unthreaded. An appropriate grip length might be the base material thickness plus the thickness of two AN960 washers, which are approximately 1/8" combined.

All nuts, once torqued, should leave one to four bolt threads visible. This is how you know the bolt /nut combination is appropriately installed. Visible thread count can sometimes be adjusted using washers as noted above.

While the ST-L drawings and construction manual guide you with hardware installation, don't forget you can reference the sources in section 0-7 of this manual, specifically AC 43.13-1B "Acceptable Methods, Techniques, and Practices, Aircraft Inspection and Repair" and *Aviation Mechanic Handbook* by Dale Crane, edited by Terry Michmerhuizen. These sources go into far greater depth about hardware than we have room for in this Introduction Manual.

To keep things simple, Timber Tiger Aircraft, Inc. uses only one set of torque values for all AN310, AN315, and AN365 nuts. These values are listed here. Unless specifically called for in the manual, be sure to use this torque chart for every piece of hardware installed. This will help prevent premature wear of parts and keep you confident everything is secure as it should be. Please don't use foot-pounds on bolts smaller than AN7. You risk damaging hardware. In addition, double-check that ALL nuts are properly torqued before moving on to the next step.

Bolt Size	Thread	Torque (inch/lbs)	Torque (ft/lbs)
AN3	10-32	20-25	
AN4	1/4-28	50-70	
AN5	5/16-24	100-140	
AN6	3/8-24	160-190	
AN7	7/16-20	450-500	38 -41
AN8	1/2-20	480-690	40-57
AN9	9/16-18	800-1000	67-83
AN10	5/8-18	1100-1500	92-125

Torque Seal/Torque Indicator:

Loose hardware is a problem. It can cause premature wear to both the parts being fastened and to the hardware itself. Hardware can come loose over time due to vibration and normal flexing of aircraft parts. To tell us if a nut has come loose, or if a bolt is slipping, we use a torque indicator. The torque indicator, applied as shown here, will give a visual "heads-up" that we have a problem. This torque indicator should be applied to every nut as it is torqued to spec.

Safetying of aircraft hardware:

All aircraft hardware needs to be safetied in some manner. See AC 43.13-1B, Section 7 "Acceptable Methods, Techniques, and Practices, Aircraft Inspection and Repair" for lots of good information about safetying.

A note about bolts. Some bolts have drilled shanks, some have drilled heads, and some aren't drilled at all. The part numbers specify the drilled state of the bolt. For instance, AN5-12 has a drilled shank. AN5-12A is undrilled. AN5H-12A has a drilled head. AN5H-12 has a drilled head and a drilled shank.

In places where only the bolt head is accessible, such as on the wing's compression struts, safety wire is used to tie the drilled bolt head to an approved point on the wing structure. In bolt clusters, you might even see the bolts safety wired together such that when one bolt tries to loosen, it is "tightening" the adjacent bolt.

See the diagrams below, pulled from AC 43.13-1B, Section 7.

AC 43.13-1B 9/8/98

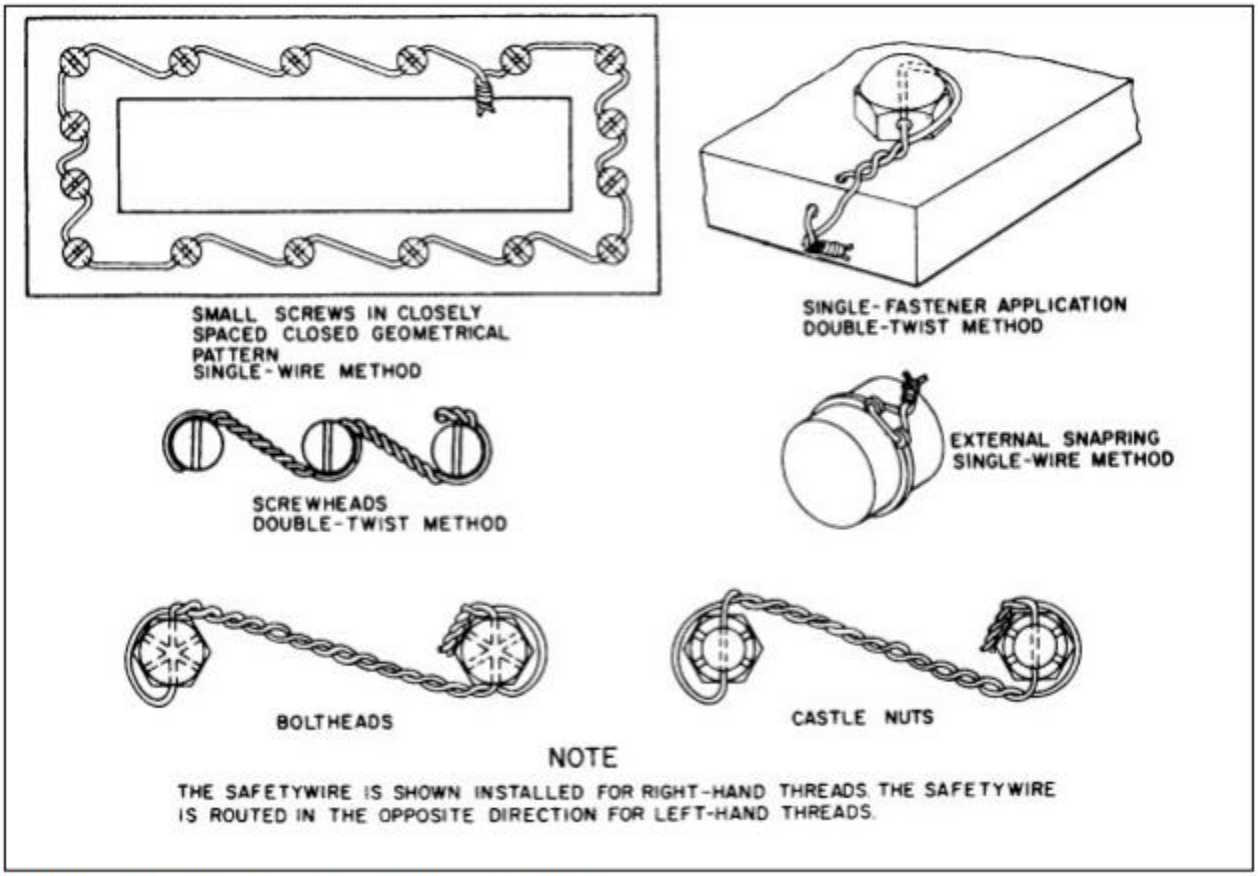


FIGURE 7-3. Securing screws, nuts, bolts, and snaprings.

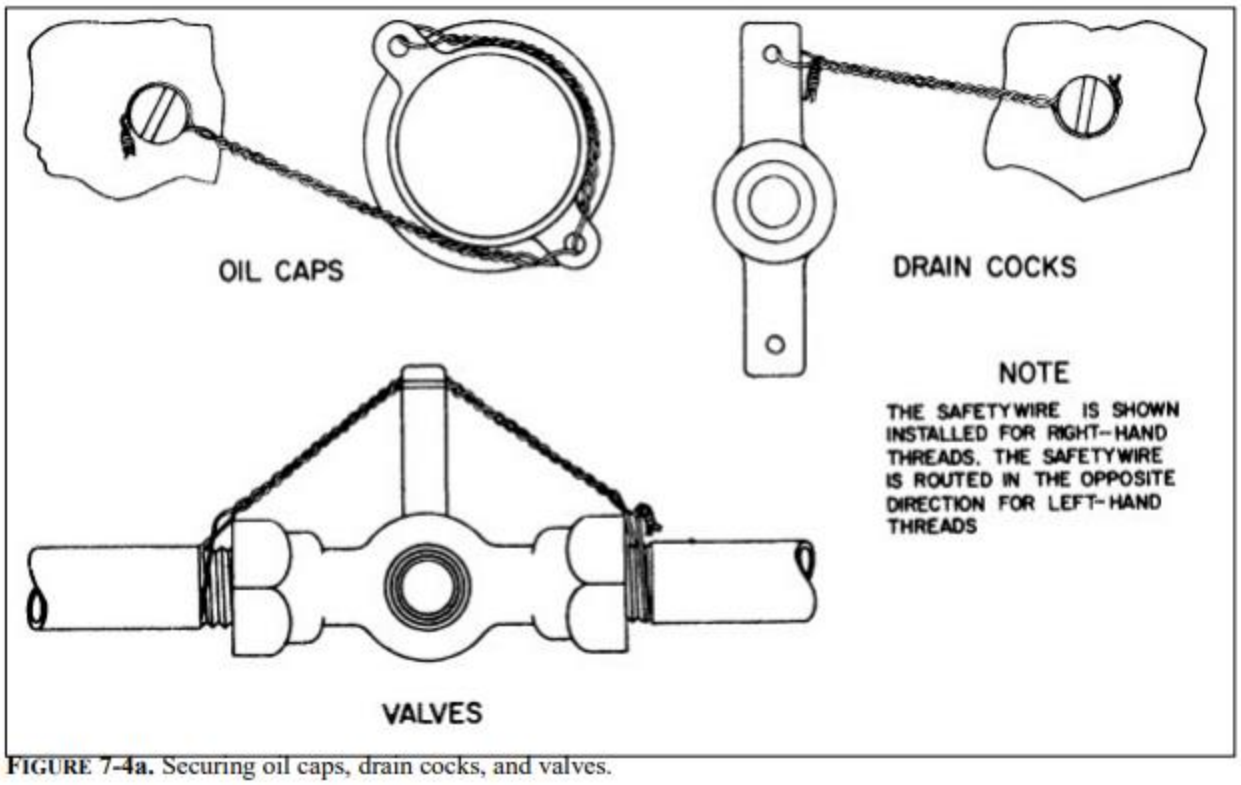
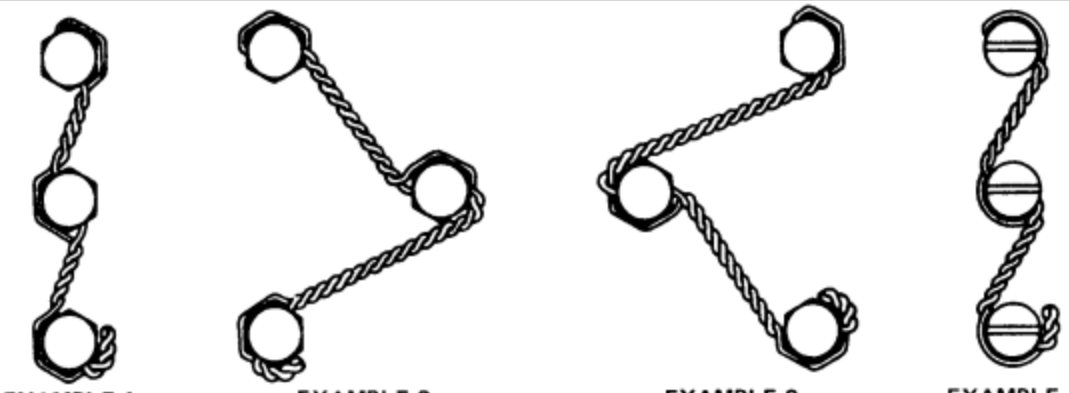


FIGURE 7-4a. Securing oil caps, drain cocks, and valves.



EXAMPLE 1 EXAMPLE 2 EXAMPLE 3 EXAMPLE 4

Examples 1, 2, 3, and 4 apply to all types of bolts, fillister-head screws, square-head plugs, and other similar parts which are wired so that the loosening tendency of either part is counteracted by tightening of the other part. The direction of twist from the second to the third unit is counterclockwise in examples 1, 3, and 4 to keep the loop in position against the head of the bolt. The direction of twist from the second to the third unit in example 2 is clockwise to keep the wire in position around the second unit. The wire entering the hole in the third unit will be the lower wire, except example 2, and by making a counterclockwise twist after it leaves the hole, the loop will be secured in place around the head of that bolt.

EXAMPLE 5 EXAMPLE 6 EXAMPLE 7 EXAMPLE 8

Examples 5, 6, 7, & 8 show methods for wiring various standard items, NOTE: Wire may be wrapped over the unit rather than around it when wiring castellated nuts or on other items when there is a clearance problem.

EXAMPLE 9

Example 9 shows the method for wiring bolts in different planes. Note that wire should always be applied so that tension is in the tightening direction.

EXAMPLE 10

Hollow-head plugs shall be wired as shown with the tab bent inside the hole to avoid snags and possible injury to personnel working on the engine.

EXAMPLE 11

Correct application of single wire to closely spaced multiple group.

FIGURE 7-5. Safety-wiring procedures.

EXAMPLE 12 **EXAMPLE 13**

Examples 12 and 13 show methods for attaching lead seal to protect critical adjustments.

EXAMPLE 14

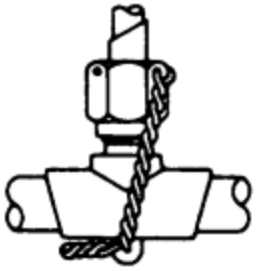
Example 14 shows bolt wired to a right-angle bracket with the wire wrapped around the bracket.

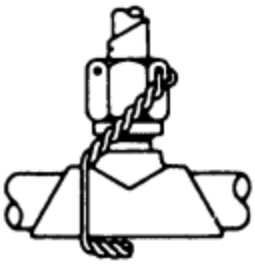
EXAMPLE 15

Example 15 shows correct method for wiring adjustable connecting rod.

EXAMPLE 16

Example 16 shows correct method for wiring the coupling nut on flexible line to the straight connector brazed on rigid tube.





EXAMPLE 17 **EXAMPLE 18** **EXAMPLE 19** **EXAMPLE 20** **EXAMPLE 21**

Fittings incorporating wire lugs shall be wired as shown in Examples 17 and 18. Where no lock-wire lug is provided, wire should be applied as shown in examples 19 and 20 with caution being exerted to ensure that wire is wrapped tightly around the fitting.

Small size coupling nuts shall be wired by wrapping the wire around the nut and inserting it through the holes as shown.

FIGURE 7-5a. Safety-wiring procedures.

Cotter pins are a simple way of safetying a drilled-shank bolt with AN310 or AN320 nut and should always be used in moving or high-vibration connections, such as control stick joints or engine mount bolts. NOTE: NEVER use a cotter pin more than once, regardless of what others might say or do. That cotter pin has been weakened significantly and WILL break prematurely.

There are different ways to properly use a cotter pin. First, the cotter pin needs to be sized appropriately. Diameter is more important than length since cotter pins can be cut shorter.

Bolt Size	Cotter pin part number
AN3	AN380-2-4 / MS24665-136
AN4	AN380-2-4 / MS24665-136
AN5	AN380-2-4 / MS24665-136
AN6	AN380-3-6 / MS24665-289
AN7	AN380-3-6 / MS24665-289
AN8	AN380-4-7 / MS24665-359

See the diagram below, again pulled from AC 43.13-1B, Section 7.

7-127. SECURING WITH COTTER PINS.

a. Cotter pins are used to secure such items as bolts, screws, pins, and shafts. Their use is favored because they can be removed and installed quickly. The diameter of the cotter pins selected for any application should be the largest size that will fit consistent with the diameter of the cotter pin hole and/or the slots in the nut. Cotter pins should not be re-used on aircraft.

b. To prevent injury during and after pin installation, the end of the cotter pin can be rolled and tucked.

NOTE: In using the method of cotter pin safetying, as shown in figures 7-6 and 7-7, ensure the prong, bent over the bolt, is seated firmly against the bolt shank, and does not exceed bolt diameter. Also, when the prong is bent over the nut, ensure the bent prong is down and firmly flat against the nut and does not contact the surface of the washer.

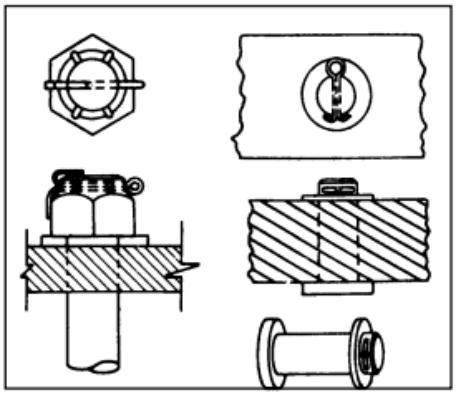


FIGURE 7-6. Securing with cotter pins.

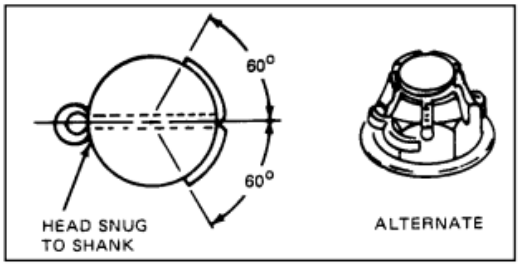


FIGURE 7-7. Alternate method for securing with cotter pins.

7-128.—7-139. [RESERVED.]

Cables:

Cables require special attention. In a nutshell, cables are terminated with two swage ends, a thimble, and often times a shackle. Please note: ONLY USE GALVANIZED CABLE. Stainless cable is tempting, but much more difficult to inspect. Please inspect your cables very often, as a broken cable will almost certainly cause disaster.

For more information on cables, please refer to AC 43.13-1B, Section 7.

AC 43.13-1B

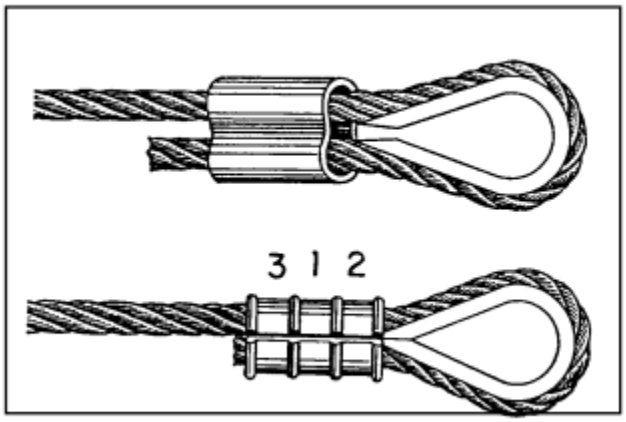


FIGURE 7-14. Typical thimble-eye splice.

Rivets:

There are lots of rivets on this airplane. Don't be afraid of them! Riveting is easier than many think. There are some areas where blind rivets are okay (called out on the drawings), but many areas on this plane MUST use solid rivets. Because you will be using a few solid rivets already, it is recommended that all fuselage skins use solid rivets as well. Sure, you might have to hire a neighbor kid or bribe someone to crawl into the fuselage, but you will be glad you did.

There are two types of solid rivets used on the ST-L. The vast majority are AN470AD (hard). AN470A (soft) rivets are ONLY used on fiberglass fairings. They are NOT to be used on any other part of the airplane. Using a soft rivet where a hard rivet is required will almost certainly result in disaster. DO NOT make substitutions.

Solid rivets are installed with an air-powered rivet gun and a steel bucking bar, which is available in various sizes. Processes vary, but in our shop, the person holding the bucking bar is in control. They call out when they have the bucking bar firmly in position and are ready. Once they give the go-ahead, the person with the rivet gun gives a firm and controlled squeeze of the trigger. Trigger control is important to practice. Don't ever use the tip of your finger to

pull the trigger. You will have far more control if you position the trigger just aft of your first knuckle.

To prevent work hardening and subsequent cracking, a solid rivet should be hit with bursts from the rivet gun as few times as possible. Once you're in the groove, most rivets will need only one or two hits. You'll eventually know when the rivet is appropriately set just by the change in how it sounds. It is up to the person with the bucking bar to check every tenth rivet (or so) with a rivet gauge, available from the aircraft supply stores. The rivet's shop head (see description below) should be of appropriate height and diameter, but don't stress about getting every single rivet exactly perfect. Do the best you can and you'll have rivets that meet or exceed those found on factory planes.

A few notes on solid rivets. A 2x rivet gun is plenty for this plane. The "factory head" is the domed or countersunk head that the rivet has in its unmodified state. In essence, the same as it was when it left the factory. The "shop head" is the end of the rivet that has been crushed and enlarged *in your shop*. While a 1/8" blind rivet will typically fit in a 1/8" hole, a 1/8" solid rivet hole must be drilled with a #30 bit. Likewise, a 3/32" solid rivet requires a #40 hole. This is because solid rivets are slightly oversized. Don't try and ram a solid rivet into an undersized hole. It won't work!

Make sure your panels are perfectly positioned before hitting that trigger or squeezing the rivet. Solid rivets expand in diameter as they are compressed and can actually expand between two sheets of metal that aren't appropriately positioned. A solid rivet will never pull two panels together.

Generally speaking, solid rivets can be sized by using the formula: thickness of material + (rivet diameter x 1.5). So, for two sheets of .032 aluminum being riveted with a 1/8" rivet, we have: (.032 x 2) + (.125 x 1.5) = .064 + .1875 = .2515. Thus, a 1/4" long rivet should be ideal.

Now for the pop-style rivets, which are actually called blind rivets. These are the rivets with the stems (mandrels) that break off as you squeeze the hand riveter gun. You don't need access to the back side of these rivets, hence the term "blind". The ST-L uses Cherry N and Cherry Q rivets. The Q rivet is stronger and retains the mandrel for strength. Therefore, if you see Q in the rivet part number on the drawings, you must verify that you use a Q rivet.

Before installing blind rivets, it is a good idea to dip them in some sort of anti-corrosion paste, such as ECK Corrosion Coating. This will help prevent galvanic corrosion of the mandrel against the aluminum rivet by sacrificing the ECK itself.

The last digit in a Cherry N or Q part number represents sixteenths of an inch of materials to be riveted (maximum grip length). For instance, if you are riveting a .025 thick elevator rib gusset to a .058 wall tube, you must use .025 + .058 = .083" = BSPQ-42 rivet. A BSPQ-41 rivet would only hold up to 1/16" and would, therefore, not work.

If you pull a blind rivet and the mandrel stem is protruding from the rivet, you can use a good set of flush-cut wire cutters to trim the stem back.

As one last reminder, please remember that if a solid rivet is called for on the drawings or manual, you MUST use a solid rivet! If a Q-type blind rivet is called for, you can use a solid rivet in its place, but never a non-Q blind rivet!

0-5: About the Drawings

The ST-L drawings and construction manual are meant to work together. If you have a question about the manual, the answer is likely in the drawings, and vise versa. When something is in question, compare the two prior to calling tech support. It will likely get you back on track a lot faster. Of course, there will be cases where a call to tech support will be required. And that's not a problem! We are here to get you flying ASAP.

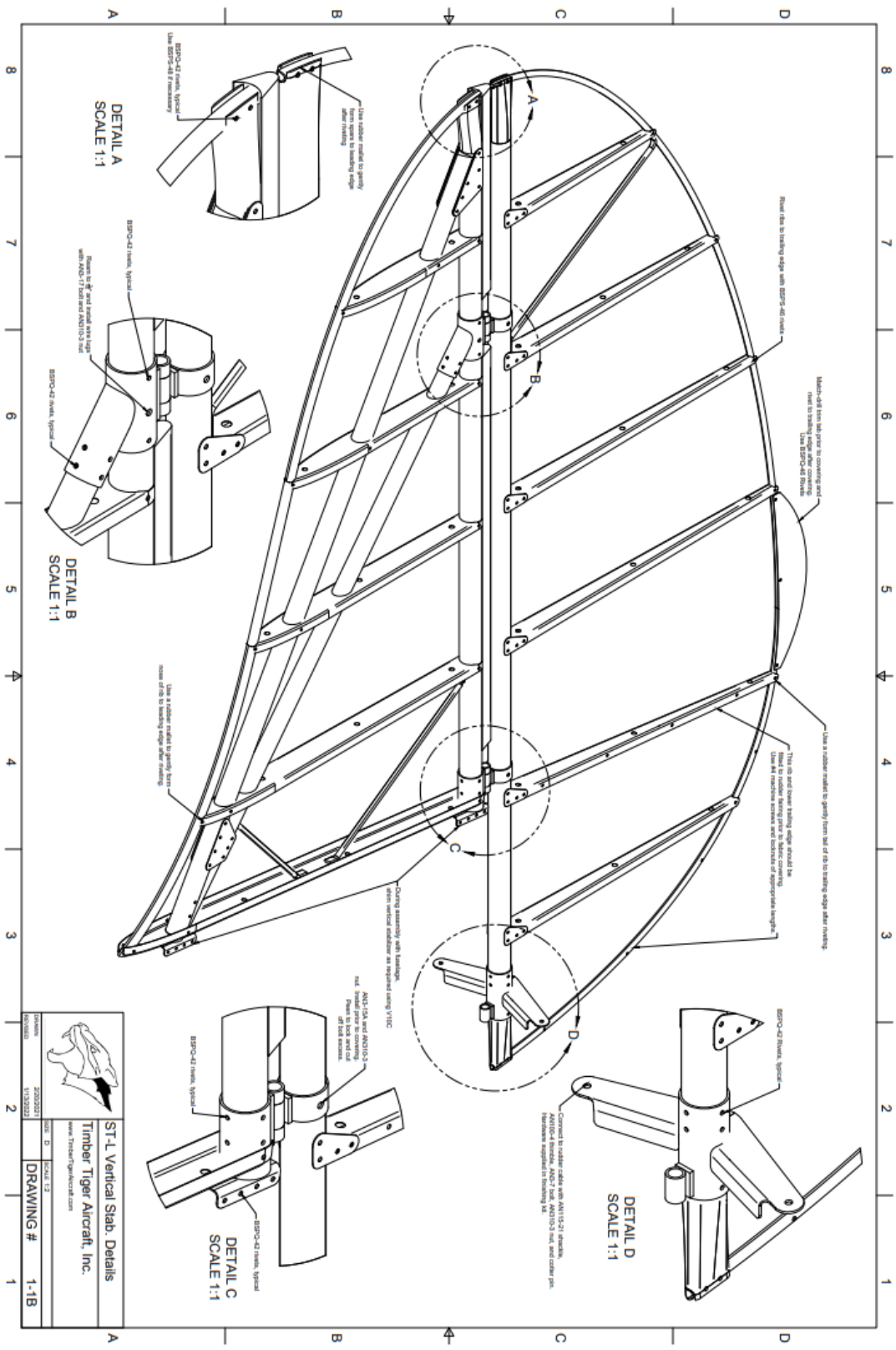
When looking at the drawings initially, things can get overwhelming quickly. However, after you've inspected them a few times, things become clearer. Set aside some time to relax with your favorite beverage and just examine the drawings.

Sometimes you will come across the word "station" or “Sta.” for short. Generally speaking, most points on a set of blueprints are measured from a common point, called the "datum". A "station" is a certain location measured in relation to this datum. By measuring all points from a single datum, tolerance stack-ups (compounded errors in measurements) can be avoided. Always measure from a datum if called for in the blueprints.

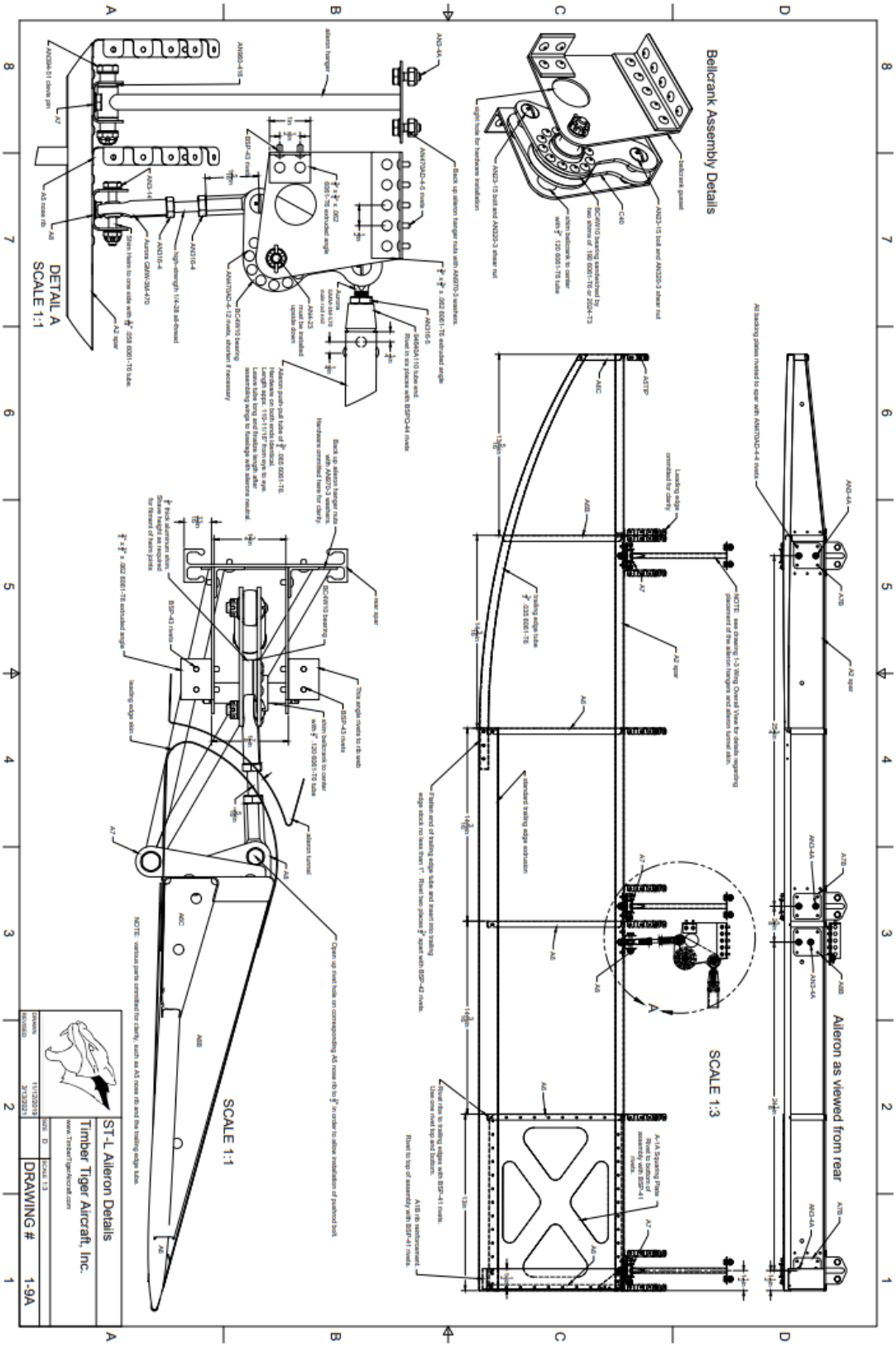
Unless noted otherwise, Timber Tiger Aircraft drawings typically have the front of the assembly shown on the left side of the drawing, rear toward the right side of the drawing. For drawing scale, see the Title Block on the drawing.

One of the best things you can do during construction of your ST-L is to commit to and begin drawing your assemblies full size on the work table, as described later. Drawing the assemblies full-size is a requirement in the construction process, but the practice also allows you to learn about every part of the assembly before you begin cutting anything. Just by doing the drawing, many questions will be answered. This is a good example of “relax and just get it done”.

As one last reminder, we are here to help! Don’t stress over things too much when a call or email can get you back on track.



Sample drawing: Vertical Stabilizer Details



Sample drawing: Aileron Details

0-6: Tooling

Tools are neat in that you might be able to sell them after use or, better yet, hang onto them for your next Timber Tiger Aircraft project. This list is by no means complete, but the following tools will make life easier, safer, and faster.

- 4’ x 14’ work table that you can drill into (37-38” tall or so)
- Measuring devices
- Bench grinder with gray Scotchbrite deburring wheel
- Angle grinder with blue Scotchbrite roloc deburring wheels
- Die grinder with carbide bits (for notching the ends of the stabilizer spar tubes)
- 220 or 240 grit sandpaper
- Red Scotchbrite for prepping aluminum parts for paint/primer
- Your favorite aluminum primer (we like SEM 39683 aerosol etch primer)
- Left and right hand shears
- 90 degree drill or drill snake
- Drill bits of various standard sizes (1/8” through 3/8” and everything between)
- Lots of #30 drill bits
- Drill stops
- Reamers in 3/16”, 1/4”, 5/16”, 3/8”, and 7/16”
- Spring-loaded center punch
- Coping saw or cutoff wheel
- Shaviv deburring tool
- 2x rivet gun
- Rivet cutter (optional)
- Solid rivet squeezer with various dies
- Blind (pop) hand rivet squeezer
- Countersinking tool for a blind rivet squeezer
- Extra fine markers
- Torque wrench that reads in inch-pounds (never foot-pounds!!!)
- Standard sockets and wrenches
- Tape measure
- Screwdrivers
- Regular and needle-nose pliers
- Safety wire pliers
- Electrical wire strippers and crimpers (highest quality only)
- Scissors
- Razor blades
- Small square

- Fine files and a file board for cleaning them
- Nicpress ferrule crimper/swaging tool (aircraft supply stores have really inexpensive ones that work really well)
- Plastic mallet
- Tons of silver and copper Clecos
- Cleco pliers
- Punch for peening AN3 stabilizer bolts
- Eight 1” C-clamps make stabilizer jigging easier

If you don’t have these tools but would find them handy, bribe a buddy with a beverage:

- Band saw
- Bending brake

About your work table:

Your worktable should be large enough for your project. If the table is to be used for your wings, 14’ x 4’ is plenty. A working height of 37” to 38” seems comfortable for most people. The table should be surfaced with something smooth, such as 3/4" MDF. Some people like to surface their tables with melamine. It looks nice, but markings tend to come off, making MDF superior for this particular use. The table will get drilled and cut, so don’t spend big money on your table surface. The table can be shimmed to eliminate twist. A string drawn down the top, about 6” in from the edges will tell you if the table surface is bowed. Try and get any twist and bows to less than 1/16”.

0-7: Sources of Information

There are countless sources of information out there that will aid you in your build. These sources are as follows and are in no particular order. As always, be cautious with any advice taken from a third party, but keep in mind you may find a useful morsel of information in some of the most unlikely places. Of course, Timber Tiger Aircraft, Inc. is in no way responsible for false or misapplied information given by third parties.

1. AC 43.13-1B “Acceptable Methods, Techniques, and Practices, Aircraft Inspection and Repair”. This is a home builder’s must-have.
2. AC 20-27G “Certification and Operation of Amateur-Built Aircraft”
3. Forums. Don't underestimate the power of the online community.
4. EAA chapters. Get to know your fellow builders on a local level.
5. EAA technical counselors/tech advisors. Have them inspect your plane periodically and save the inspection form for your Designated Airworthiness Representative (DAR).
6. Speaking of DARs, find one and get to know them early. Some DARs operate in slightly different ways and have different interpretations of laws. By getting to know your DAR early, you'll be more likely to avoid last-minute problems on final inspection day.
7. Speaking of certification, the EAA sells a certification kit. Purchase it early on so you'll know how to prepare, but check for updates to the information prior to your airworthiness inspection.
8. Videos. The internet is packed with valuable homebuilt airplane tips. As always, pick only reliable sources. Also keep in mind that videos are more difficult to update than written manuals, so written and up-to-date manuals should be the final say in how something is done.
9. There are a lot of books out there. Below are a few good ones, but check your favorite aircraft supply store for many, many more.
    a) The Tony Bingelis series: *The Sport Plane Builder*, *Sport Plane Construction Techniques*, *Firewall Forward*, and *Bingelis on Engines*
    b) *Aircraft Wiring Guide* by Marc Ausman
    c) *Sheet Metal Building Basics* by Jack Dueck
    d) *Aviation Mechanic Handbook* by Dale Crane, edited by Terry Michmerhuizen

0-8: Logging Your Build

The FAA has what is often referred to as the 51% rule. See AC 20-27G for the most complete details. To sum it up, a builder must complete at least 51% of the assembly and fabrication on the airplane. This 51% is based on tasks, not hours. The FAA allows the tasks to be broken up into 10ths of a task, meaning a certain portion can go to the manufacturer or hired builder assist and the remaining portion can go to the builder who will be applying for the Repairman's Certificate.

For guidance, the FAA has come up with the Amateur-Built Fabrication and Assembly Checklist, which is readily available online. Timber Tiger Aircraft has run various scenarios through this checklist and has found the 51% rule is met (with margins) as long as the builder doesn't hire out an excessive amount of work. Use of this checklist isn't required for certification, but it's a VERY good idea to fill it out and have it on hand in case you need further evidence that you completed 51% of the tasks.

Speaking of evidence, take lots and lots of photos with you in them as you complete your tasks. Written logs aren't required but are another great way to prove your 51%. Another tip, and one that you might not suspect: don't go to your final inspection dressed like you're at the country club or coming back from a formal dinner. It has been said time and time again that some Designated Airworthiness Representatives will judge you, and it's true. This exact scenario played out during inspection of the ST-L prototype. We all know you successfully completed 51% of your tasks as the law requires and documented it appropriately, but if you go to your inspection looking like a dime, your DAR may want extra evidence of your work, turning what should have been a rather quick meeting into a painfully long experience.

For additional reassurance, understand and use the FAA's "Amateur-Built Fabrication and Assembly Checklist".

Get those photos!

Of course, it is the builder's responsibility to ensure a successful certification. Timber Tiger Aircraft, Inc. has no say in the matter. Your best plan of action is to:

1. Find a DAR early and learn their expectations.
2. Purchase a certification kit from the EAA. This kit will help you plan ahead and even gives you the current documentation.
3. Get a NEW certification kit just prior to your inspection.
4. Make sure your plane is 100% clean and free of construction debris during inspection.
5. Make sure your airframe, powerplant, and engine logbooks have the correct information before inspection (talk to your DAR).
6. Make sure all engine ADs are complied with and logged in the engine logbook (talk to your DAR).
7. Make sure you have a good Pilot's Operating Handbook written up. Timber Tiger Aircraft, Inc. is working on a POH template you can use.

0-9: Using the Materials List

Your kit includes a full list of all materials. This list not only contains quantities to aid in inventory, but it also tells what bits and pieces are for. If you somehow have an "extra" bolt, find it on the materials list, and it will tell you where that bolt might go. That simple standard applies for all hardware.

Example:

Part Number	Part Name	Qty	Description
AN4-20A	Bolt, undrilled	10	Horizontal stabilizer front spar root Wing drag truss

For raw materials, things are a bit different. For instance, you might see that you have:

Aluminum Tube: 6061-T6			
Part Name	**Tube Length**	**Qty**	**Description**
1-1/8" .058	4' 5'	1 4	Vertical stabilizer main spar Horizontal stabilizer main spar, elevator spar, horizontal stabilizer front spar reinforcing tubes

Based on the above chart, we can see we have five tubes of 1-1/8" .058 6061-T6 aluminum. One is 4' long, four are 5' long. To the right side of the chart, we can see the 4' section is allotted *specifically* for the vertical stabilizer main spar. We can see the other four lengths of 5' are allotted *specifically* for the horizontal stabilizer main spar, elevator spar, and some spar reinforcement tubes. Given that the stabilizer spars are of greater length, it's important to compare the lengths to the drawings to make sure you don't short yourself on spar material by making too many reinforcements from a single tube.

Despite the illusion of added complexity, this materials system is easy to interpret and reduces shipping costs for kits. In addition, if you destroy a tube by accident, it is simple to see exactly what you need to purchase as a replacement (from aircraft materials vendors only!).

In the next section, we begin building the ST-L tail surfaces.

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