XL-FG

1 — Last update: Dec 10, 2020

Velocity Aircraft

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(Shared with SE-FG, SE-RG, XL-FG, XL-RG)

1.1. 1.1 – Overview

1.1 – Overview

1.1.1 – Description

The Velocity Aircraft is a four place family style homebuilt that has high performance yet remains a safe, practical, and stable aircraft. It is uncomplicated to build, comfortable to fly, easy to maintain, and beautiful to see.

- The RG option was the first major modification to be offered and incorporates retractable landing gear into any Velocity kit. This offers increased cruise speed and enhanced aesthetics.

- The yoke option was the last major modification. This option was designed with the newer pilot in mind. The yoke is a more conventional setup that is actuated just like the control system found in many trainers.

1.1.2 – Getting Started

Do your homework. The Velocity kit has been designed to be buildable by builders with limited experience. Still, the better you do your homework, the easier the job will be and the better the finished product.

- Join VOBA – Velocity Owners and Builders Association. www.VelocityOwners.com

- Get back issues of the Velocity Views.

- Join the Experimental Aircraft Association and a local chapter. The E.A.A. can be contacted at 1-800-843-3612.

- Join the Central States Association, an association for fans of Rutan type aircraft. You may contact them at:
  Terry Schubert
  Central States Association 9283 Lindberg Boulevard
  Olmsted Falls, Ohio 44138-2407

- Build your reference library – and read it. There are many excellent books avail- able to the homebuilder. There are any number of excellent books to help you with for starters, we would recommend:

- AC 43.13- 1B, 2B Acceptable Methods Techniques and Practices. This is the Aircraft Mechanics Bible. This is definitely a must have book.

- Amateur Built Aircraft Reference Material. This is most of the FAAadvisories and forms needed for the Experimental aircraft builder.

- The Sportplane Builder, Firewall Forward,

- Sportplane Construction Techniques, and On Engines, by Tony Bingelis.

- Custom Built Sport Aircraft Handbook, an E.A.A. publication.

- The Aircraft Spruce and Specialty Company catalog. Composite Construction for Homebuilt Aircraft, Jack Lambie. Light Plane Maintenance, Subscribe at:
  P.O. Box 420234
  Palm Coast, Florida 32142 (800) 829-9085

- Start a construction log. When it comes time to fly your airplane, the better you have documented the construction process, the easier it will be to please the F.A.A.. Be sure to include entries for:
  - Task (what you were doing)
  - Date
  - Start and stop times
  - Elapsed time

- Take photographs and / or video of your progress to further document. They will ease the review with the FAA and provide a personal record of your efforts. Make sure your in a few of the photos working to show you actually worked on the plane.

1.1.3 – Video Tapes

A series of video tapes are provided with each kit. They were made while building the Velocity from a kit like yours. The sketches and narratives were made at the same time so that you can view the tapes a step at a time before going into your shop and then use your manual with familiarity. Since there are changes made to the aircraft that do not get incor- porated into the video, use the tapes for building technique only and refer to your manual and newsletters for dimensions.

1.1.4 – Contents of Manual

The Velocity Homebuilding Construction Manual includes sketches, and detailed narra- tives of how to build a complete Velocity aircraft. The manual attempts to describe the construction steps in the optimal sequence to follow for each assembly. Cure times, space requirements, and personal preferences may change this sequence. There are times when portions of one chapter cannot be completed until sections from another chapter have been completed. We have attempted to indicate these areas in the manual, but you should read ahead and be familiar with the area in which you are working. We have provided a Flow Chart which shows the order in which way we at the factory prefer to build the airplane. Use this as a reference.

___ Each construction step has a line to the left (like this paragraph) to check when that step has been completed.

|___| Paragraphs with the check-box to the left ask the builder to verify a measurement, alignment, or structure. Follow the old carpenters' advice to "Measure twice, cut once."

Though the Velocity is designed to be buildable by a first-time aircraft builder, this manual does not attempt to teach basic building terms and techniques. There are also some skills, such as constructing the radio wiring harness, painting and flight testing, that a builder might best seek help to complete.

Drawings in the manual are to illustrate general shape, fit and construction of the airplane. **Unless otherwise specified, drawings are not to scale.**

Templates in the manual should be photocopied to use. Check the copies against the originals to make sure they do not p. change size during the copying. There are also a number of full size templates included with your kit.

1.1.5 – Getting Help While Building

- Review the video tapes.
- Review the entire Velocity Construction Manual and the appendix, as it is packed with helpful information not found in the rest of the manual.
- Repeat 1 and 2 above.
- Talk to fellow members of the E.A.A., particularly those with composite building experience.
- Get started with the project. Answers to questions become obvious common sense with hands on experience.
- Ask another person for their understanding of what is written or drawn.
- Replay your video for the part in question.
- Review the newsletters for clarifications.
- Contact us: Velocity, Inc.
  200 West Airport Drive Sebastian, FL 32958
  Builders line: (772) 589-0309
  Phone: (772) 589-0309
  Fax: (772) 589-1893
  E-Mail: Support@VelocityAircraft.com

1.1.6 – Modifications

Any changes made by the builder in the construction of the Velocity may alter the integrity of the aircraft structurally, aerodynamically, or both. Such changes could result in an aircraft that is extremely dangerous to operate.

1.2. 1.2 – Materials

1.2 – Materials

1.2.1 – Epoxies

Aero-Poxy – This is a one – one mix Structural Adhesive. Used in the kit for bonding premade parts together and bonding in Metal parts. Structural Adhesive usually needs to be thickened with a filler like Cabosil.

EZ-Poxy – is used in all major lay-ups on foam and all lay-ups of glass to glass. EZ-Poxy hardener is mixed with DER 324 resin at a 44:100 ratio. For lay-ups on foam, a slurry of EZ-Poxy and micro balloons is used. Throughout the construction manual this mixture is referred to as Micro-Slurry. It is also used with milled fiber for structural fillets and structural bonding such as hinge pockets for the speed brake, doors, etc. This epoxy was known as Epolite (2180/2183/2184) and SafetyPoxy in past manuals.

VelociPoxy – these systems are used primarily in the finishing and filling , never for glass lay-ups. VelociPoxy hardener is mixed with DER 324 resin at a 1:2 ratio. For finish work, VelociPoxy is mixed with micro-balloon to create a smooth easy to sand filler that is flexible. This epoxy was known as AlphaPoxy in the past manuals.

The resin for both EZ-Poxy and VelociPoxy are the same, only the hardener is different. The Resin is clear in color and is known as DER 324.

You may see references in books and catalogs and videos to Safe-T-Poxy, or Hexcel Epolite they have been replaced by EZ-Poxy, and Genimid or AlphaPoxy has been re- placed by VelociPoxy. You may substitute the West System or Resin Research epoxy for VelociPoxy if desired.

1.2.2 – Glass Cloth

E-glass – (Electrical) the standard of the industry, both for marine and general aviation use. It is used throughout the construction.

Fiberglass is usually named for the orientation of the strength fibers in it and the weight of the cloth.

Knytex 20 Ounce Triaxial – called TRIAX in the construction manual, is used through- out. TRIAX has strength fibers running in three directions with one of them being the MajorAxis. The MajorAxis is shown by a line on the cloth. The builder will use it for bulkhead reinforcement, the skin of the wings and canard, and fabrication of various hard points and energy absorbing pads.

Hexcel 7.2 Ounce Unidirectional – called UNI in the manual. UNI has strength fibers running in one direction. UNI is used at the factory in the molding of the outer fuselage skin. It is used by the builder in the winglets, winglet attachment, eleva- tors and canard skin.

8.9 Ounce Bi-Directional – referred to as BID in the manual. BID has strength fibers that run in two directions. BID is a coarse woven cloth used by the builder through- out to attach mating parts as well as constructing wing, rudder, and aileron end ribs.

S-Glass – a structural fiber, strong in tension, used in the spar caps and gear legs at the factory.

Hexcel 17 Ounce Biaxial Cloth – used by Velocity in premolded parts only such as the fuselage outer skin and landing gear reinforcement for torsional loading.

Hexcel 12 Ounce Biaxial Cloth – used by Velocity in premolded parts only such as the inner fuselage and strake skins and other small parts like the spinner, wheel pants, sump tank, etc.

Knytex 17 Ounce Biaxial Cloth – used by Velocity for primary shear web construction in all spars to handle compression loading.

Knytex 12 Ounce Biaxial Cloth – used by Velocity in secondary shear web construction.

Certanteed 22 Ounce Woven Roving – used only by Velocity in the cowling reinforcement.

Carbon – used in the Elite models for fuselage stiffening and in the RG for main gear reinforcement. There are no Kevlar or hybrid fabrics used in the Velocity aircraft.

1.2.3 – Fillers

Glass Bubbles – These are microscopic glass bubbles that the builder adds to resin to form a slurry for filling voids, forming fillets under glass lay-ups, and joining foam to foam and glass to foam. Mixed with **EZ-Poxy**, the bubbles lighten the lay-up and provide resistance to delamination. It is used with all foam lay-ups. The **EZ-Poxy** slurry is called **Micro-Slurry** in the manual. A dryer and thicker form of **Micro-Slurry** is called **Micro-Balloon**.

Many people have been confused by statements to use **EZ-Poxy Micro-Slurry** to cover the blue polystyrene foam surfaces just prior to glassing, since we also state in the plans that **EZ-Poxy** will dissolve the blue foam, but the slurry mix will not harm the blue foam. The epoxy has been sufficiently diluted by the filler material so do not be apprehensive about using the **EZ-Poxy** slurry on the core surfaces.

Milled Fiber – finely chopped glass fiber that the builder adds to resin to form a slurry to fill voids at hard points, attach glass to metal, and other structural glass to glass construction. It is light green in color, and much denser than the glass bubbles.

Milled fiber is used for installing hard points, structural fillets and fairings, etc. It has superior secondary adhesive qualities. Mix with **EZ-Poxy** for filling voids around structural glass to glass layups for compatibility with the **EZ-Poxy** layups. Use with **Structural Adhesive** to attach metal pieces. Resin and **Milled Fiber** slurry is called **Micro-Glass** in the manual.

Flox – Flocked cotton fiber which may be used as a structural filler interchangeably with the milled fiber described above. Flox is not as dense or heavy as milled fiber.

Cab-O-Sil – this is a thickening agent for resin or structural adhesive . We found that by adding **Cab-O-Sil** to **VelociPoxy** or **EZ-Poxy**, we formed a strong, solid, heavy, but nonporous filler. When mixed with **VelociPoxy** to a paste consistency, it is good for fixing chipped or damaged edges of cowlings, doors, etc.

We also found it to be very helpful in filling the porous surfaces left after the **Micro-Balloon** process has been sanded. Apply with a putty knife or squeegee to porous surfaces. A small amount of **Cab-O-Sil** may be added to **Micro-Balloon** to make the mixture stickier, so that it stays where up put it. This is especially helpful on vertical or upside down lay-ups.

Be careful to remove all excess **Cab-O-Sil**, because once it has cured, it is very difficult to sand. Following cure, sand with 120-180 grit paper, then prime with epoxy primer. You will find that all those annoying pin holes have disappeared.

1.2.4 – Glues

Hot Glue – useful for holding parts in place, faster and cleaner than **Bondo**. It holds foam very well.

Bondo – a fast hardening putty that can be bought at any auto supply or hardware store. It is used to hold parts in place while applying permanent glass lay-ups. Do not use on blue foam because it will dissolve the foam.

5 Minute Epoxy – this is supplied in the kit and is used for quick bonding to hold parts in position for permanent lay-ups. It will not dissolve the blue foam.

CA or Super Glue – the thick type, works well for holding parts in place.

1.2.5 – Foam

Blue Polystyrene – this blue foam is a premium grade of extruded, not expanded, foam. All the foam parts have been pre-cut by Velocity with a hot wire to form the airfoils in the wings, winglets, and elevators.

Blue P.V.C. know as Dyvinicel – used extensively in the factory in the molding process of the Velocity aircraft. The builder uses it in the fabrication of the rear bulkhead and strake baffles and bulkheads.

1.2.6 – Plywood

Marine Grade Plywood – The wood supplied with the Velocity kit is a superior grade 6 mil, 5 ply plywood . It is specially p. designed and manufactured for epoxy lamination in the marine industry. It is superior to aircraft birch when used with epoxy for lamination of wood to glass as used in the Velocity construction process.

1.2.7 – Hardware

Wherever possible, aircraft grade hardware is supplied with the Velocity kit. A few special purpose fasteners are provided.

1.2.8 – O.E.M. Equipment

Many components are obtained by Velocity from the Original Equipment Manufacturer to keep the overall kit price to a minimum. These include wheels, brakes, tires, tubes, actuators, cables, etc. and materials.

1.2.9 – Machined Parts

Velocity has a complete machine shop including welding facilities that provide specialty items such as machined gear castings, control systems parts and assemblies as well as weldments for engine mounting and exhaust.

1.3. 1.3 – Construction Techniques

1.3 – Construction Techniques

1.3.1 – Mixing Epoxy

Epoxy resin is mixed in a ratio that allows it to combine at a controlled rate to form strong solid substance we call “glass”.

It is very important that the correct proportions of resin and hardener are used, otherwise, the results will be a substance that never hardens or one that hardens too quickly. Either condition produces a bad product.

We recommend the purchase of an epoxy ratio pump. It will save time, money, and inadvertent error. A proper ratio pump is manufactured by Michael Engineering and can be purchased directly from Velocity or an aircraft supply house such as Aircraft Spruce or Wicks. The time savings alone over using a scale is worth the price of the pump.

If preferred, a balance beam scale may be constructed per Figure 1-1. This scale is designed to mix the **EZ-Poxy** resin and hardener in one container as opposed to the “wet cup” balance beams in use with other kits. The “wet cup” method works but is a nuisance to most builders.

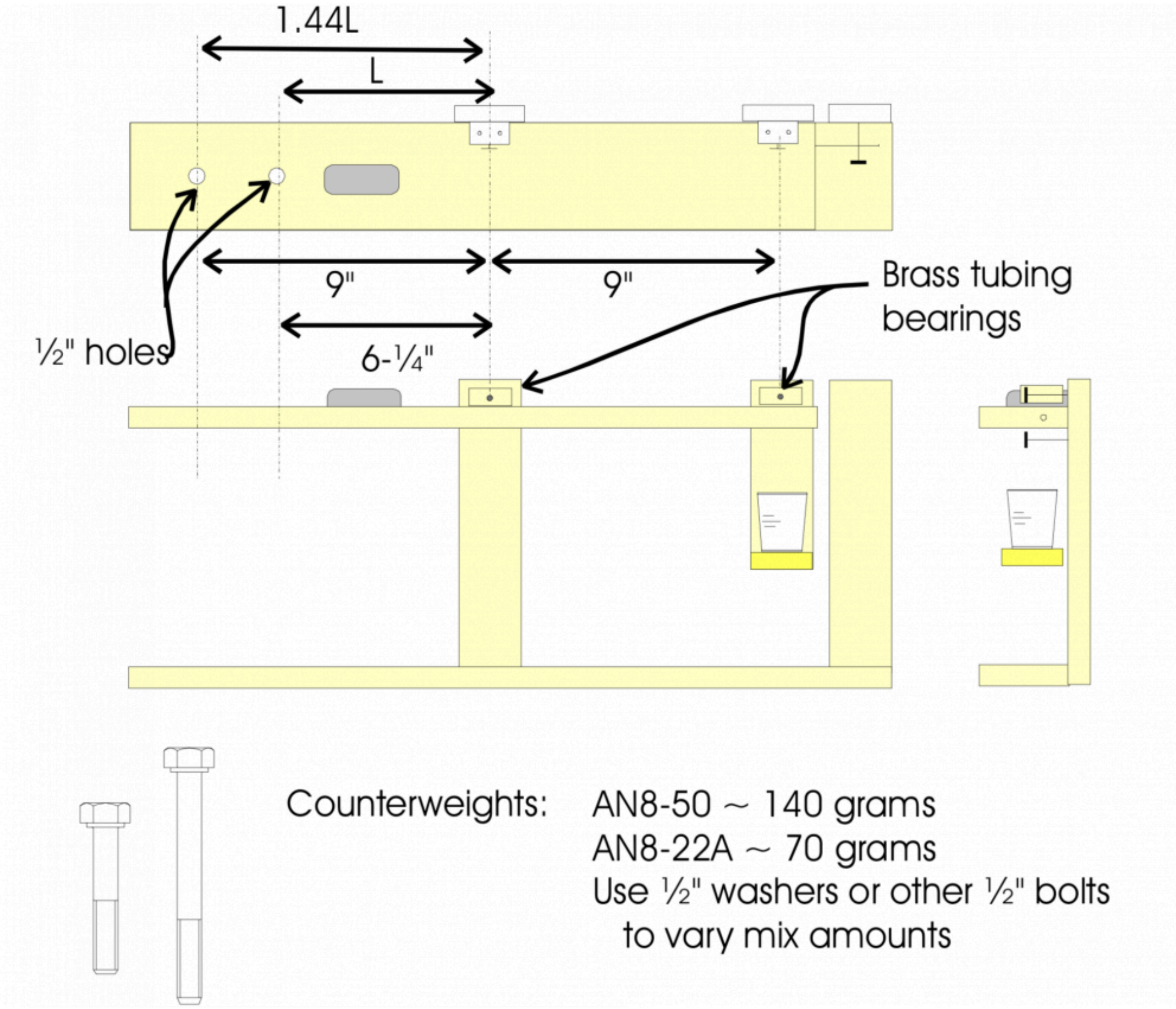


Figure 1-1. One Container Epoxy Balance

The **VelociPoxy** or **West System** epoxies are mixed according to the directions on their containers, ***not with the balance***. You may purchase dispensing pumps for each different type of epoxy for ease of use.

Make a varied selection of counterweights to facilitate convenient quantities of mix.

It is important to mix the epoxy using the following steps. Post them on the wall behind the balance beam. For calibrating it has been suggested to use pennies in the desired Ratio Example 43-100 to check the accuracy of your scale.

- Place the empty mixing cup on the balance beam
- Balance the scale with the frameweight. (Be sure the counterweight is removed)
- Put the appropriate counterweight on holder “L”.
- Pour epoxy into the mixing cup to balance the scale.
- Move the counterweight to holder “1.44L”
- Add hardener to mixing cup to balance the scale.

A couple of cautions: Putting too little hardener in the mix will prevent a complete cure, the lay-up will stay soft or sticky. Putting too much will make the mix cure prematurely, maybe right in the middle of your lay-up!

Take care when adding the hardener. Be sure to stir the mixture well, and do not add fresh epoxy to an old batch of mixed epoxy.

At times when the ambient air temperature is around freezing, the cure time for the epoxies will increase from hours to into days. A small heat source applied to the area for a few hours will bring your cure times back to normal. You should not do any body contouring while the temperatures is low either, as a spreadable mixture will be far too heavy.

1.3.2 – Cutting Cloth

Keep a neat clean flat area for cutting your cloth. Scissor cut large and irregular shaped pieces. Cut narrow tapes with a razor.

All BID tapes are cut on a 45 degree bias, i.e.: 45 degrees with the edge of the cloth. It is a good idea to cut about twenty 2” and 3” tapes and keep them handy in a box.

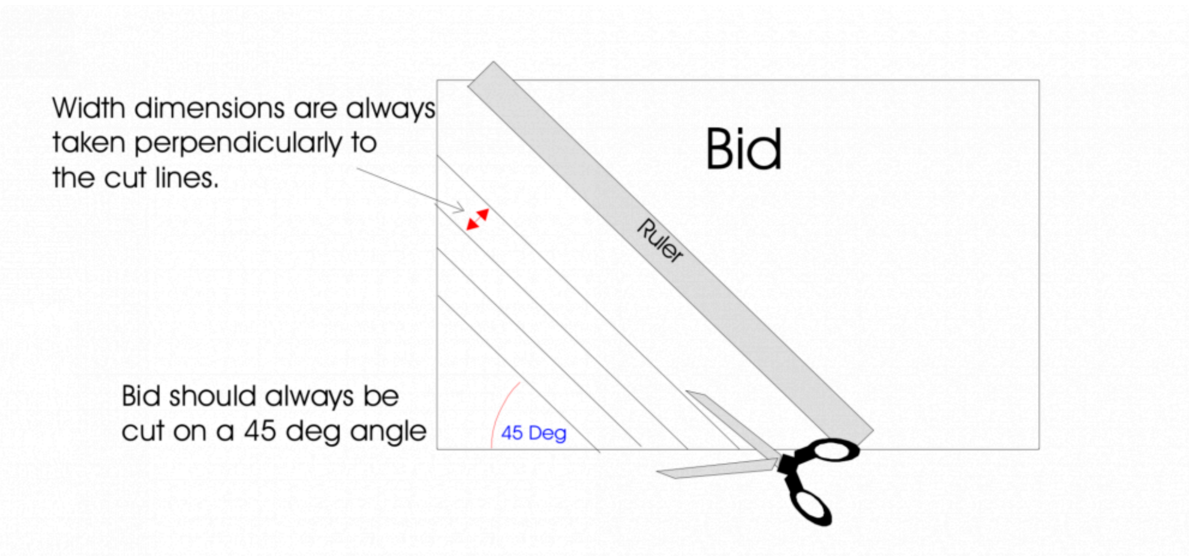


Figure 1-2. Cutting Bid

When marking to cut on the 45 degree bias the widths specified in the manual are perpen- dicular to the cut lines, and are not measured along the edges of the cloth roll, i.e.: a 2” wide tape is almost a 2-7/8” distance along the cloth roll edge.

Stagger the overlaps on multiple lay-ups to avoid big bumps in one spot. If more than one piece has to be used for one layer of **UNI**, e.g. on the elevators, butt the ends, do not overlap. Stagger the butting positions on subsequent layers.

1.3.3 – Sanding

Always sand existing cured glass before another lay-up. If there are oils or other substances on the surface, wipe the surface down with acetone before sanding. Use coarse (36 / 40 grit) paper for your sanding, and power sanders are OK provided you only lightly sand with them. This provides a grip for the new glass and removes the shiny top layer of cured epoxy. **There is no need to sand aggressively and cut into the fibers of the previous lay-up.**

1.3.4 – Glassing Foam

Mix glass bubbles with **EZ-Poxy**, making **Micro-Slurry**, for glass cloth lay-ups on foam. Mix to a mayonnaise texture. Always spread a coating of **Micro-Slurry** onto the foam before gluing or glassing. A lighter lay-up and a more complete bond will result.

Mix **Micro-Balloons** with **VelociPoxy** for foam to foam gluing. Mix to a paste or whipped cream consistency for foam to existing glass. **Do not put Micro-Slurry or Micro-Balloon between multiple cloth lay-ups and existing glass.** The bond in this case would not be as strong.

1.3.5 – Using Hot Glue, Bondo or 5-Minute Epoxy

Bondo is handy for holding parts in place while applying glass lay-ups. Hot glue is a better choice for most jobs because you can glass right over it. Use in small “dobs”. Be aware that Bondo dissolves blue foam! Use small dobs of **5-Minute Epoxy** to hold blue foam in place.

1.3.6 – Glassing Cloth

Wet out cloth with a brush and a squeegee. The brush works better if about half the bristles are cut off. Dab or “stipple” the epoxy into the cloth where it appears dry or has air underneath.

A shallow angle between the surface and the squeegee will force the epoxy into the fabric. A straight or more vertical angle will remove epoxy. You want just enough to wet the fabric completely, no dry spots, but no more because it adds weight.

On a flat surface a large flat trowel or flexible putty knife works well. On confined or curved areas, use a flexible plastic squeegee.

Small, multiple layers of glass cloth are pre-wet, one on top of another, on a flat, plastic covered, or glass surface for a more thorough but not too wet lay-up and ease of application. Scissor trim cloth within 1/4” of edges to prevent lifting due to the weight of the wetted cloth drooping over the edge. Knife trimming an edge in four to six hours (when the lay-up is rubber and does not want to pull off the bonding surface) is much easier than sawing, grinding, or sanding once cured.

1.3.7 – Filling

Filling is done with **Micro-Balloon**. Small dings and voids are filled with a dry (thick) mix.

Micro-Balloon slurry fills voids, pores, and roughness between a cloth lay-up and foam and provides for better adhesion to the foam.

Do not apply slurry between a cloth lay-up and smooth bare glass , the resulting bond between glass to glass is not as strong. **Micro-Balloon** is used to fill in (sanded) glass areas. **Micro-balloons** are mixed with **VelociPoxy** resin to a thick paste (like peanut butter). This is then spread and smoothed with a trowel, you will be amazed at how dry (i.e.: light) your micro can be and still be spread out.

As with squeegeeing epoxy, the trowel angle determines the thickness or quantity of filler. **VelociPoxy** filler is easily sanded, shaped, and will finish smooth enough for paint priming. This can be used to repair dings or irregularities in the foam before glassing. Let cure and sand prior to glass lay-up.

Micro-Glass or **Flox/EZ-Poxy** fill is used in structural areas. Mix **Milled Fiber** or **Flox** with **EZ-Poxy** for structural lay-ups and with **Structural Adhesive** for hard points.

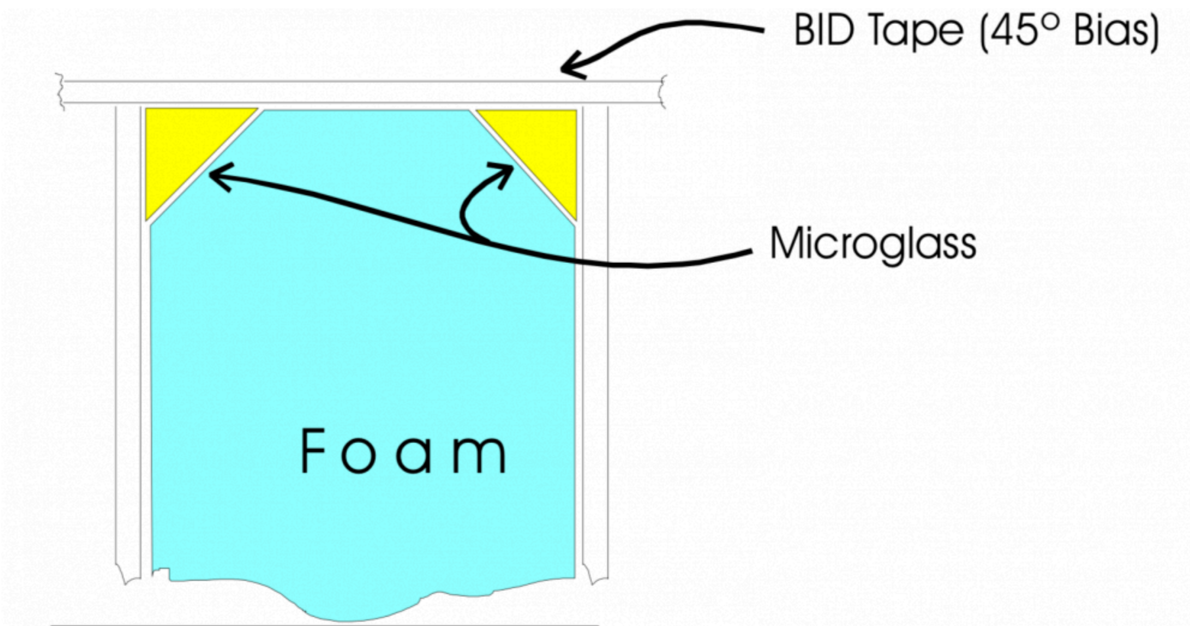


Figure 1-3. Micro-Glass Filet

All composite edges are relieved by sanding away about an 1/8” wedge of foam from the internal skin surfaces and filled with **Micro-Balloon** just before applying **BID** tapes to cover these edges. See Figure 1-3. Be sure to remove foam cleanly to the inside of the glass skins.

1.3.8 – Attaching / Joining

ALWAYS . . .

- Cut cloth to size in advance.
- SAND glass join lines to a sufficient margin for lapping glass lay-ups, delamination WILL occur if you do not.
- SAND metal parts prior to glassing, delamination WILL occur if you do not.
- Lightly pre-wet glass areas to be glassed over.

- Use **BID** cut on a 45° bias only.

- All glass should be handled carefully to avoid kinking the fibers. Kinks destroy the strength of that portion of glass. **TRIAX** is particularly vulnerable to handling damage. Kinks can and must be pulled out as shown in the video but it is best to avoid them.

- Pre-coat foam with **EZ-Poxy Micro-Slurry** for glass to foam.

- Pre-wet multiple glass cloth pieces for small lay-ups or hard points on a flat surface covered with visqueen. Allow the lay-up to set slightly so that the epoxy is not runny. Brush a fresh coat of epoxy on the area slated for applica- tion, and transfer glass to lay-up point.

- Follow the lay-up schedule in the construction manual.

1.3.9 – Hardware

Hardware is packaged and labeled with standard identification numbers and all hard- ware parts are referred to by these numbers throughout the construction manual.

Use the hardware called out in the plans. Structural hardware in the Velocity is aircraft grade, Air Force – Navy (AN) or Military Standard (MS) specification type. **Do not** substitute standard hardware store fasteners for these. The strength and toler- ances are not intended to be the same as AN hardware.

If the specified bolt is installed and appears to be too long or too short, double check the structures being fastened to confirm they are correct. Better yet, have someone else check. Bolts that are too long can interfere with other systems such as landing gear or control systems. Bolts that are too short may fail to provide sufficient grip.

Correct length, properly installed bolts should have none of the threaded portion in the fastened structure. Generally three threads should show past the nut after it has been tightened, up to three washers may be used to achieve this.

Whenever possible, bolts should be installed with the head up or forward. This positioning tends to prevent the bolt from slipping out if the nut is accidentally lost.

1.3.10 – Work Habits

To avoid building an allergic reaction to working with the chemicals involved with building a composite airplane, wear plastic gloves while working with the resin and a face mask while sanding, grinding, or cutting with a power tool.

Never wash epoxy off with acetone! It removes the protective oils from your skin and washes the poison right through your pores into your system. Fast Orange hand cleaner (available at most hardware stores) works great at removing curing resin from your hands and skin.

Allergic reactions may not occur immediately. There is a cumulative buildup that appears after varying exposure to the resins and inhalation of dust. Do not wait for it to happen. Once it does, it is usually a permanent allergy and you will not be able to finish your airplane. While it goes away with abstinence, it comes back almost immediately with exposure to the resin or dust.

The **EZ-Poxy** is supposed to be nontoxic. Some people are not affected by any of the resins. Almost no one has a problem with these composite materials if reasonable precau- tions are taken. There are people who have worked full time for years that have no problems because they have good self protective work habits.

- Work at learning to mix, apply, cut sand, and apply, keeping the materials on the tools and the airplane and away from your body, inside and out.

- Keep lay-up and wetting areas clean as you work, no drips, no runs, no errors. It also saves a lot of work later.

We want you to have an enjoyable experience. We want you to finish your airplane. We want you to spread the good word and get others to enjoy it as well. **Take proper precautions!**

1.3.11 – Patching Foam

To patch a void, break, or ding that is too large to fill with dry microspheres, cut out a cavity in the foam with straight and smooth sides. Then cut a block to fit snugly leaving it large enough to protrude from the cavity for trimming and contouring to the original surface.

1.3.12 – Use of a Level

Level with a carpenter’s level on top of a straight edge. Do all leveling with a level that has been marked “top” and “right” so that, in use, you always orient the level the same way. This avoids errors due to slight differences when the level is turned over or around.

Proper flight and performance require the fuselage to be carefully leveled for-and-aft and side-to-side, several times during construction. Directions for doing this are shown in the video.

We use simple bubble levels to build our airplanes at Velocity. If you decide to use super accurate digital or laser levels realize that you will not be able to get things to within 1/1000 of a degree. The molds for the Velocity were all hand built and are not done to this level of accuracy. Don’t worry, your airplane will still fly straight.

1.3.13 – Micro-Glass / Micro-Slurry

Clean off any excess Micro-Balloon from joints or surfaces while it is still wet. It is hard to do later and you may sand, grind, or chip away more than you want to.

1.3.14 – Peel Ply

Peel ply is a light weight, Dacron or polyester material (normally 2.7 oz. Dacron) which does not bond with epoxy. It is applied over the top layer of a lay-up **and then removed after the epoxy has cured.**

It can be used in lay-ups to texture a glass layer for bonding with a subsequent lamination. Using peel ply between laminations eliminates the need for as much sanding for glass-to- glass bonding. It also leaves smoother edges on your lay-ups. Peelply traps excess resin in a lay-up that is removed when the peel ply is removed. Remember, it does not remain in the structure. Peel Ply can be purchased from Aircraft Spruce or other Fiberglass Distributors.

1.3.15 – Tapping

Tapping is the process of creating a female (internal) thread in a (usually metal) structure. Tapping is used in the construction of the Velocity to create attachments to various hard- points such as for seatbelts and to install fuel fittings.

- Drill specified size hole in piece to be tapped. Make sure to use a sharp, properly sized tap. Remember, taps, like bolts, are sized by diameter and thread pitch. For blind hole tapping, a bottoming tap is recommended. It will produce the greatest thread depth. You would need a same size plug or taper tap to start the thread.

- Lubricate tap and material with a tapping fluid such as LPS Tap-All. Use lubricat- ing fluid freely.

- Turn tap into hole making sure that it is square to the metal surface being tapped. You will not be able to true up the tap after it has started to cut.

- Back tap out and clear chips frequently.
- **Do not** continue to apply pressure to the tap after it has bottomed out.

- Remove burrs on the tapped hole with a smooth file. Use a rag, not your fingers, to wipe away excess cutting oil and chips.

1.3.16 – Fluid Lines and Fittings

Brake, fuel, pitot / static, and RG hydraulic systems require the installation of fittings and, in some instances, bending metal tubing. Follow instructions that come with tools and practices described in publications. You might want to practice on a few pieces of scrap material before trying the real parts.

When cutting tubing, it is important to produce a square end, free of burrs. Tubing may be cut with a tube cutter . A tube cutter can be used with any soft metal tubing such as copper, aluminum, or aluminum alloy. A tubing cutter can be bought at any hardware store for a few dollars.

Remove any burrs from the cut using a file, knife or deburring tool. Use care to avoid reducing the wall thickness or fracturing the end of the tube, this can lead to fractured flares or defective flares which will not seal properly.

Some sort of tubing bender will be needed to avoid kinking tubing as it is being bent. There are several varieties ranging in price from a few dollars to a few hundred. For the amount of work and size of tubing involved in the Velocity, low cost spring tube benders are a good choice.

Some of the fittings that will go on the tubing will require the end of the tube to be flanged. Aviation standard flanges are **37 degrees**. Do not use automotive flaring tools as they produce a **45 degree flare** which is unacceptable and will fail during service.

1.3.17 – Countersinking

There are several places where screws or rivets require a countersunk hole in the structure that they are fastening. Countersinking in an aircraft differs from street variety in two ways.

First, the angle of the cut required for aviation fasteners is normally 100 degrees. Non- aviation countersinks can range from 60 to 120 degrees.

Second, it is far more important to control the depth of countersink cut. Carpentry coun- tersinks are just a shaped drill bit. Aviation countersinks are an adjustable depth tool which holds the cutter and controls depth of cut.

The design of the tool assures consistent depth of cut and to limit the depth so that the attachment is not weakened by removal of too much material.

These Countersinks and Countersink cages can be bought through aircraft supply store like Wicks or Aircraft Spruce.

1.4. 1.4 – Quality Assurance

1.4 – Quality Assurance

1.4.1 – Quality Control

An advantage of composite construction is the ease of quality assurance. Since the struc- ture is all external, problems are often visible. Any wrinkles or cracks or distortions at any time should be inspected to assure that they do not represent a structural problem which would compromise safety.

|___| Check for resin lean areas. Resin lean areas will appear white and are fixed with additional epoxy applied to or injected into the area.

|___| Check for wrinkles in the fibers. Kinking in the fibers significantly compromises the strength of the structure. Kinks or bumps in a structural piece greater than 2” of chord are likely cause for rejecting the part. Span wise measurement of kinking is unnecessary because the first kink is the one that compromises the structure.

|___| Check for delaminations or bubbles. If caught before cure, stipple epoxy into the area with a brush (poke at the area), then cover the area with plastic wrap to prevent air from reentering the trouble spot. Weigh down the plastic wrap until the laminate is cured.

The best time to fix any problem in the laminate is before it cures. After cure, delamina- tions and bubbles can be detected by tapping the wing with a coin. Any flaws can be fixed by drilling a small hole and injecting epoxy to fill the void.

1.4.2 – Mindset of a Builder

There are a few practices that a builder can adopt in order to assure that they will complete the Velocity kit they start.

When you start your construction, do not think of building the whole airplane at once. Instead break it down into more manageable pieces. For instance complete building the wings first. Than the canard. Then do the control surfaces on the wings and canard. If you break down the airplane into smaller more manageable tasks rather than looking at it as one large task you will have a better chance of sticking with it through completion.

As you build read through a complete chapter before starting a task. Try to understand the “ Complete Picture” before you start. For instance when you install the counterweight onto your canard. If you do not read the complete section you might not know that the counterweights could limit our elevator travel if not put in correctly. Try as best as you can to visualize why you are constructing a part a certain way. If you spend a little time to understand what the final outcome of a certain task should be it should keep you from making errors.

1.5. 1.5 – Tools

1.5 – Tools

There are a few special tools required to build a Velocity. There are a number of tools that can make the job a lot easier and save time.

1.5.1 – Water Level

A water level is assembled by attaching an 8' tape measure to any vertical surface with 0" being on the floor. Take approximately 30' of 1/2" clear plastic tubing, attach one end permanently at the 8' mark. Partially fill water colored with antifreeze or dye and use a spring clamp on the free end so water does not run out while moving about.

1.5.2 – Benches

Build a sturdy fuselage support bench approximately 7' x 3' x 18" high. This establishes a convenient working height. Construct four sawhorses that stand at a comfortable working height. Purchase a pair of 3' wide interior doors and check them for flatness. These are used for tabletops on the sawhorses.

1.5.3 – Necessary Tools

It is assumed that the builder will already have a standard set of tools. This includes hammers, screw drivers (slotted and phillips), pliers, wrenches, sockets, knives, levels, hex wrenches, tape measures, carpenter squares, clamps, files, scissors, sanding blocks, etc…

- Drill bits: 12" long by 1/4", #19 (#8 clearance), #21 (#10 tap), #30 (1/8" rivet),
- #40 (3/32" rivet), #11 (3/16"/#10 clearance), 1/4", 3/8"
- Taps: 10-32, 1/4"-28. 1/4" and 3/8" N.P.T.
- Hole saws: 1", 1-1/8", 1-1/2", 2-1/4", 2-1/2", 3-1/8", 3-3/4"
- Pop rivet tool
- Hand tools: Including drill and saber saw. (Hacksaw blades will work).
- Cleco pliers and clecos.

1.5.4 – Nice To Have Tools

- Micheals Engineering Epoxy Ratio Pump – 100:44 ratio. This is borderline neces- sary. It will save somewhat on the amount of epoxy you use and considerably in time and tedium of using a balance to measure epoxy and hardener.
- Bench Grinder / Buffer
- Drill Press
- Band saw
- Cordless Drill
- Air Compressor (minimum 5 horsepower if used with pneumatic sanding tools)
- Spray Gun
- Air Driven Die Grinder and a Small Right Angle Grinder with Accessories
- Air Saw
- Dremel Tool with Fiberglass Cutting Discs
- Small Electric Vibrating Sanders (for Light Lay-Up Preparation Sanding Only).
- Reamers: 3/16” and 1/4”

2. 2 – Wings/Winglets

Contents

(Shared with XF, XR)

2.1. 2.0 – Chapter Preface

2.0 Chapter Preface

2.0.1 – Parts

Part Number	Description	Qty
MP0201	Spar, Wing, Center	1
MP0202	Spar, Wing, Pilot	1
MP0203	Spar, Wing, Co-Pilot	1
AN8-30A	Bolt, 1/2” Wing Attach	6
AN363-820	Nut, 1/2”	6
USSGR8-1/2	Washer, 1/2”	12
FC0201	FoamCore, Wing, Pilot, LE, IB	1
FC0202	Foam Core, Wing, Pilot, LE, Center	1
FC0203	FoamCore, Wing, Pilot, LE, OB	1
FC0204	FoamCore, Wing, Pilot, TE, IB	1
FC0205	FoamCore, Wing, Pilot, TE, IB Center	1
FC0206	FoamCore, Wing, Pilot, TE, OB Center	1
FC0207	FoamCore, Wing, Pilot, TE, OB	1
FC0211	FoamCore, Wing, Co-Pilot, LE, IB	1
FC0212	FoamCore, Wing, Co-Pilot, LE, Center	1
FC0213	FoamCore, Wing, Co-Pilot, LE, OB	1
FC0214	FoamCore, Wing, Co-Pilot, TE, IB	1
FC0215	FoamCore, Wing, Co-Pilot, TE, IB Center	1
FC0216	FoamCore, Wing, Co-Pilot, TE, OB Center	1
FC0217	FoamCore, Wing, Co-Pilot, TE, OB	1
MI0201	IBeam, Aluminum15’	2
MI0202	Nylaflow3/16” Rudder Conduit/Brk Line	34’
MP0204	Vortilon Material	1
TE0201	Template, Wing & Winglet Attachment	1
MA0201	Counterweight, 1/2” Steel	144”
MA0202	Torque Tube, Aileron	21”
MA0203	Backing Plate, Aileron Hinge	40”

MS200001-P6	Hinge, Aileron/Rudder	40”
AN526-1032R8	Screw, AN526C-1032R8	14
AN960-10L	Washer, AN960-10L	14
MS21042-3	Nut, MS21042-3	14
BSP-4-4	Pop Rivet, Small	30
LER-01	Inboard leading edge root	2
TER-01	Inboard trailing edge root	2
	Copper foil tape	90”
	Torroids	6

Part Number	Description	Qty
FC0301	Foam Core, Winglet , Pilot , Upper	1
FC0302	Foam Core, Winglet , Pilot , Lower	1
FC0303	Foam Core, Winglet , Co-Pilot , Upper	1
FC0304	Foam Core, Winglet , Co-Pilot , Lower	1
–		
MS200001-P6	Hinge, Aileron/Rudder	24”
AN526C-1032R8	Screw, AN526C-1032R8	18
AN960-10L	Washer, AN960-10L	18
MS21042-3	Nut , MS21042-3	18
BSC-4-4	Rivet , Small, Countersunk	30
MA0301	Bellcrank, Rudder	2
MA0302	Spring, Rudder Return	2
MA0303	Anchor, Rudder Spring	2
MI0302	Cable, Rudder	30’
HW0301	Sleeve, Niccopress 1/16”	2
HW0302	Thimble 1/16”	2

2.0.2 – Tools List

Description
Plumb Bob
2 Saw Horses
2” Hole Saw
Soldering Iron

Inclinometer
Level
3/16”, 1/8” drill
1/8” clecos
Square
I-beams
Wing Incidence Jig
1/2 plywood 2”×5”

2.0.3 – Supplies List

Description
VelociPoxy
EZ-Poxy
Glass Bubbles
Milled Fiber
Bondo
5 Minute Epoxy
Duct Tape (at least one roll)
Fiberglass Strapping Tape
Sand Paper 36 -80 grit
Bondo / Hot Glue
2 × 4’s 8 ft long
luwan hollow core doors
5 min epoxy

2.0.4 – Glass List

Type	Size	Qty
TRIAX	50” × 14’+ (cut to size of wing)	4
BID	15” × 33”	6
BID	12” × 23”	6
UNI	3” × 30” (bolt access reinforcement)	8
BID	6” × 72” (aileron well)	6
BID	6” × 6” (OB aileron well)	6

BID	10” × 6” (IB aileron well)	6
BID	4” × 10” (hinge hardpoint)	6
BID	4” × 8” (hinge hardpoint)	12
FINE BID	6” × 72” (aileron)	2
FINE BID	6” × 4” (aileron OB)	2
FINE BID	10” × 4” (aileron IB)	2
UNI	30” × 62”	8
–		
BID	4” × 12”	16
BID	7” × 16”	12
BID	7” × 20”	4
BID	34” × 20”	2
BID	32” × 18”	2
UNI	28” × 15”	4
UNI	26” × 14”	4
UNI	24” × 13”	4
UNI	20” × 11”	4
UNI	18” × 10”	4
UNI	16” × 8”	4
UNI	14” × 7”	4
–		
BID	4” × 50”	12
BID	4” × 4”	12
BID	2-1/2” × 5”	36

2.0.5 – Process Overview

Construction Process	Pilot Side Completion Date	Co-Pilot Side Completion Date
Wings		
Prepare and Jig Spar		
Fit LE Foam Cores		
Attach LE Foam Cores		
Fit TE Foam Cores		
Attach TE Foam Cores		

Prepare and Jig Top Wing for Skin		
Install Rudder Conduit		
Skin Top of Wing		
Prepare and Jig Bottom Wing for Skin		
Skin Bottom of Wing		
Create TE Rib		
Create LE Rib		
Create Wing Bolt Access Holes		
Cover Wing Bolt Access Holes		
–		
Winglet		
Assemble Foam Cores		
Glass Inboard Surface		
Install Comm Cable		
Glass Outboard Surface		
Prepare Winglet for Attachment		
–		
Attachment		
Jig Winglet in Position		
Winglet Lay-up “A”		
Winglet Lay-up “B”		
Winglet Lay-up “C”		
Winglet Lay-up “D”		
–		
Ailerons		
Prepare Wing for Winglet		
Cut Out Aileron		
Create Aileron Well		
Glass Aileron Well & Ribs		
Attach Counterweight		
Attach Torque Tube and Backing Plates		
Attach Hinges		
Fit Aileron Onto Wing		

Balance Aileron		
–		
Rudders		
Cut Out Rudders		
Create Rudder Wells		
Lay-up Rudder Hinge Pads		
Install Hinges		
Attach to Winglet		
Install Bellcrank		
Install Return Spring		
–		
Winglet Bottoms		
Installation		

2.0.6 – Documentation Changes

Oct 01, 2018 – Original Web Release

2.2. 2.1 – Wing Core

2.1 – Wing Core

2.1.1 – Joining Leading Edge Wing Cores to Spar

___ Sand all four surfaces of the wing spars using 36/40 grit sandpaper. Light, but thorough, sanding is needed on the spar leading and **trailing edge** where the foam cores attach. More thorough sanding is needed on the spar cap surfaces where the wing skins will go.

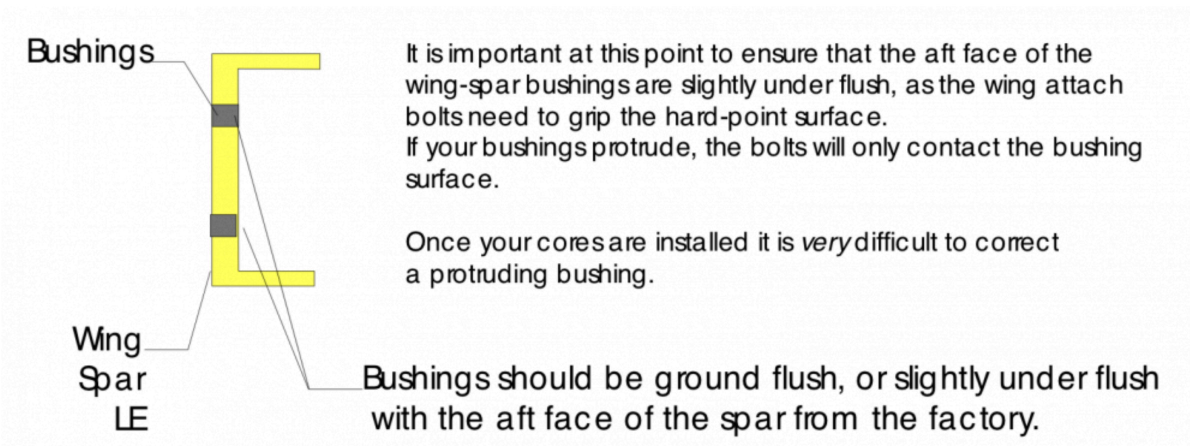


Figure 2-1. Spar Bushings

___ Suspend the spars on two sawhorses with the **leading edge** up. Level the spar crosswise by leveling across the two **outboard** wing attach bushings. Lengthwise leveling is not necessary.

___ Fit the **leading edge** foam blocks into position on the spar. The root (**inboard**) edge of the foam aligns with the spar “knee”. The knee is located 2” **outboard** of the centerline of the wing attach outer holes.

___ **Bondo** small blocks of wood onto the spar where the cores tend to hang over the edge. Space as many blocks as necessary to hold the foam cores properly in line with the spar surface.

Use a strip of duct tape on these blocks to prevent epoxy from adhering to them when the foam cores are Micro-Ballooned to the spar.

The foam cores may have a curve or twist in them because of internal stresses, so, make sure the foam edges align properly with the spar cap edges, i.e. centered. Shim if necessary.

- Check again that the spar surface is level. If the bushings are not square to the end of the spar, use the hardpoint under the bushing to level.

- Check that the water lines drawn on each end of the foam cores are plumb and straight. Use a level or preferable a plumb bob to assure a near plumb alignment.

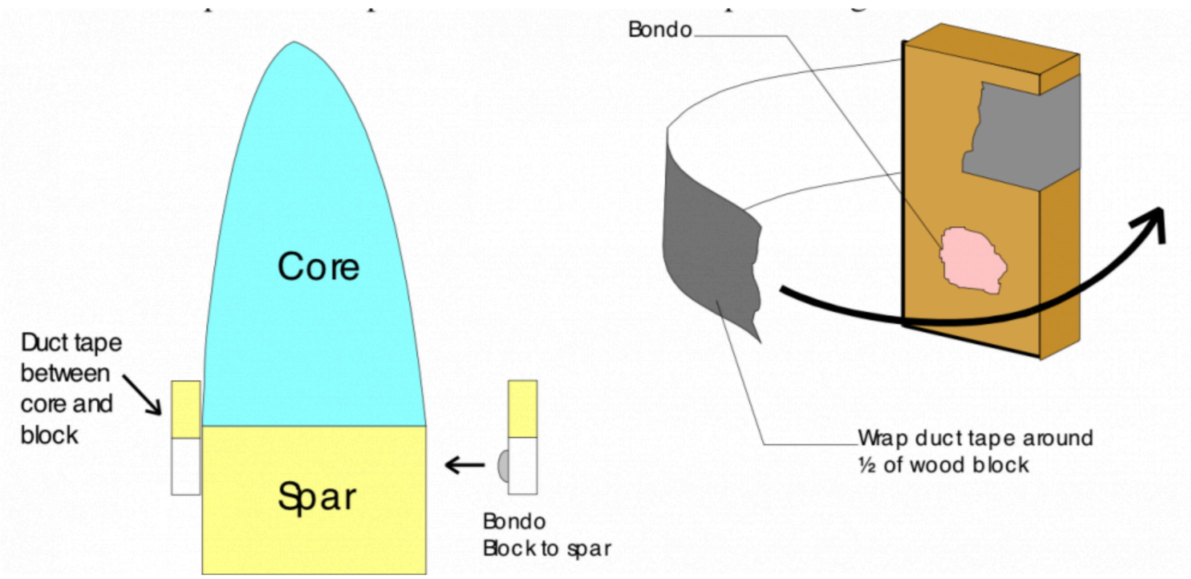


Figure 2-2. Core to Spar

___ Sand the block ends to fit well together, if necessary, by placing a piece of sandpaper between them. Hold the blocks together with gentle pressure and work the sandpaper until the blocks fit flush.

___ Remove the foam blocks from this jig and smear a slurry (mayonnaise-like consistency) of **VelociPoxy Micro-Balloon** along the flat surfaces that join to the spar and on the surface where the foam cores butt together. Now replace the cores onto the spar, sliding them back and forth to spread the **Micro-Balloon**, until the cores make firm contact with the spar surface.

- Check alignment with the “knee” and both edges of the spar along the full length.

Note: Remove any Micro-Balloon that oozes out with a putty knife. Fill any voids with a dry Micro-balloon mixture and remove all excess slurry prior to cure.

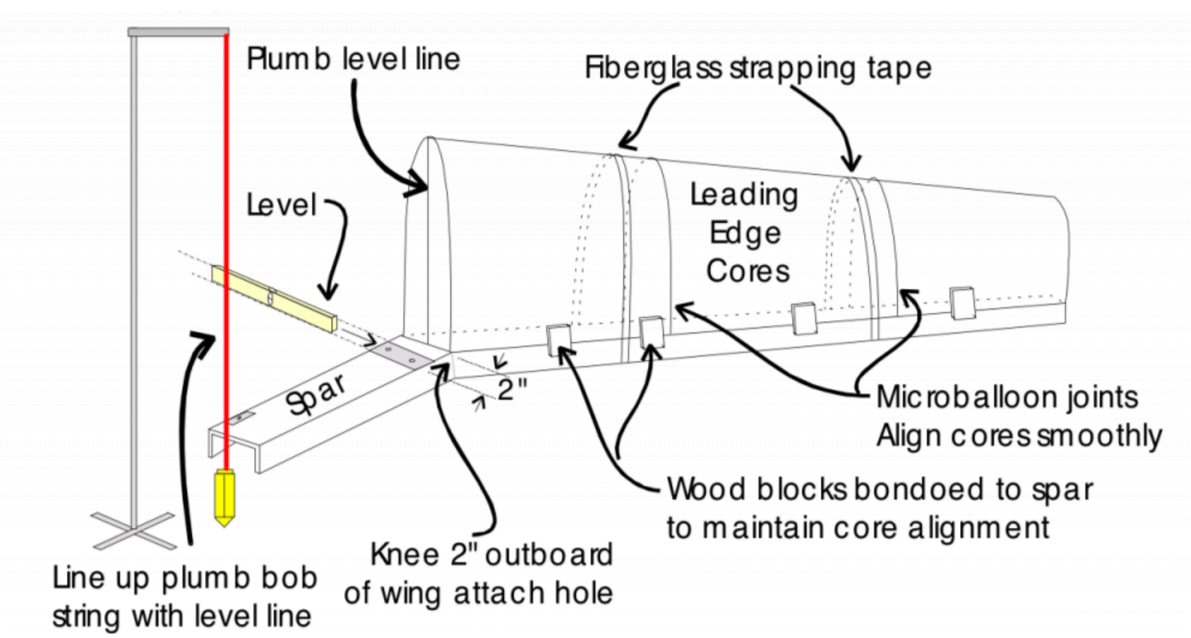


Figure 2-3. Jigging Wing Leading Edge Cores for Attaching Spar

The alignment of the foam core blocks at their joint can be held securely in line using nails pushed into the foam through the adjoining block. Several layers of masking tape (strapping tape is stronger) wrapped around the blocks and the spar at many convenient locations will hold the cores securely in their proper place.

- Check that the alignment blocks are secure.
- Check that the spar **leading edge** face is level.
- Check that the foam blocks are plumb at the root and tip.

___ When everything is aligned, plumb, and correct, let it cure.

2.1.2 – Joining Trailing Edge Wing cores to Spar

Turn the **leading edge** down resting the flat surface of the spar on one saw horse. Place a scrap piece of foam that came from the block that the **leading edge** was cut from under the tip of the wing to protect it, and rest the wing tip on another saw horse.

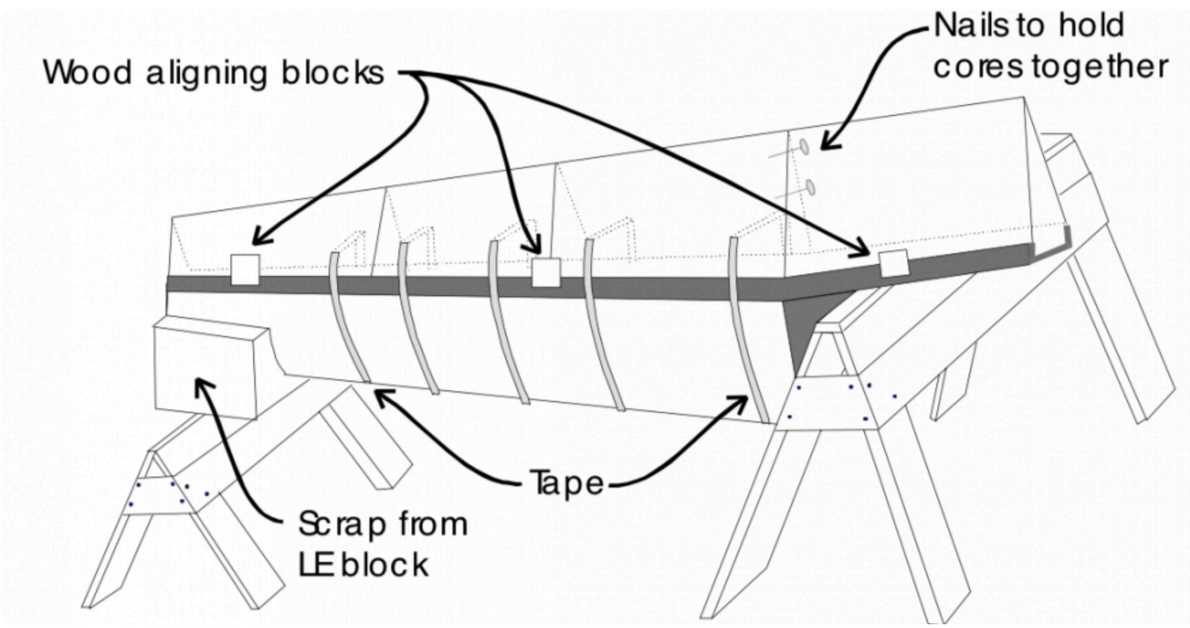


Figure 2-4. Trailing Edge Cores

Run a short length of RG-58 down the channel you burned in the foam to the base of the strips. You want to leave about 18” sticking out the inboard edge of the wing. One strip is soldered to the core of the RG-58 cable, while the other half is soldered to the sheath. Do not forget the torrid and head shrink as shown in Figure 2-6.

- Place the **trailing edge** foam cores in position on the back of the spare and check their fit and alignment. The **inboard edge** of the **inboard trailing edge** core should be flush with the **inboard** end of the wing spar when in the correct position. Butt the rest of the cores to fit.

- Make sure the trailing edge cores are installed right side up. The aileron torque tube hole on the inboard core should be toward the **top** surface of the wing.

___ Sand butt lines if necessary for good fit.

___ Holding a level under the spar against the flat surface of the two **outboard** hard points, level the spar. Use the wood blocks Bondoed to the spar just as you did for the **leading edge** of the wing. Join all three **trailing edge** foam cores to the spar using **Micro-Slurry** and join the **inboard** core to the two **outboard** cores.

___ Pull the foam securely to the spar using 3/4” fiberglass strapping tape. Thread the tape through a slot cut in the **trailing edge** blocks about 3” above the spar using a hack saw blade to first cut the slot then to push the tape through the slot. Wrap the tape around the **leading edge** cores to hold them firmly in place. Using shims between the tape and the spar cap, the foam can be guided into proper alignment. Nails can be driven through the foam into the shear web (not the spar cap) to hold the cores in their proper place.

- Check all level lines to be plumb. Shim as necessary.

Note: Do not worry if the trailing edge is not straight at this point. You will make it so in the next step.

Hint: When gluing the trailing edge cores onto the spar, use packaging tape to attach the two I-beams into a pinching device. After you get the cores microed in place and nailed together, slide this I beam pincher over the trailing edge and recheck. Placing weights along the beams will reduce the amount of strapping tape required.

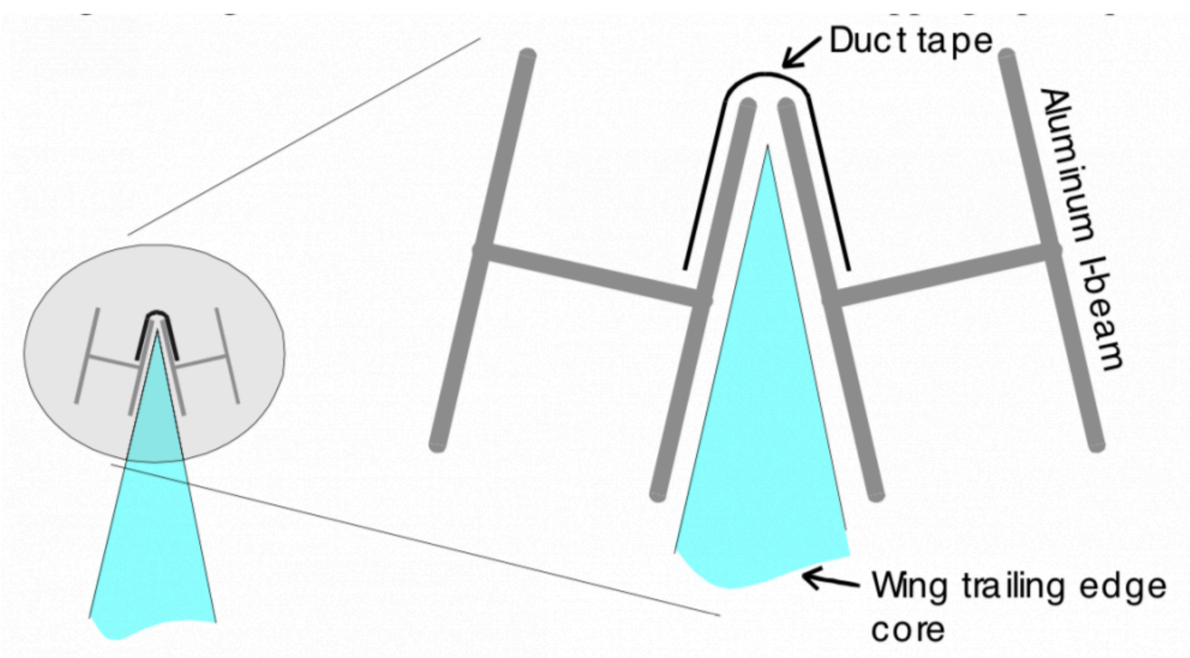


Figure 2-5. Maintaining Foam Core Trailing Edge Alignment

2.1.3 – Navigation (VHF) Antenna

Your NAV antenna needs to be installed on the lower inboard surface of the wing before the lower wing is glassed. Measure 23” outboard from the outboard wing attach hardpoint and 4-1/2” forward of the wing spar. From this point draw a line parallel to the spar inboard. Along this line there is a cylindrical channel about 1/2” beneath the foam for routing a line of RG-58. Look at the inboard opening forward of the wing spar to verify the position of the channel.

Lay your tape out onto the wing as shown in Figure 2-5. It is in the shape of a “V”, with the angle of intersection being 125 degrees and the ends no more than 1/2” apart. When satisfied with placement remove backing on tape and stick to foam. The ends of the copper tapes will be approximately 2” from the leading edge when in the correct position.
You will need to dig out a little foam at the base of the copper strip for the antenna connection.

NAV Antenna Installation

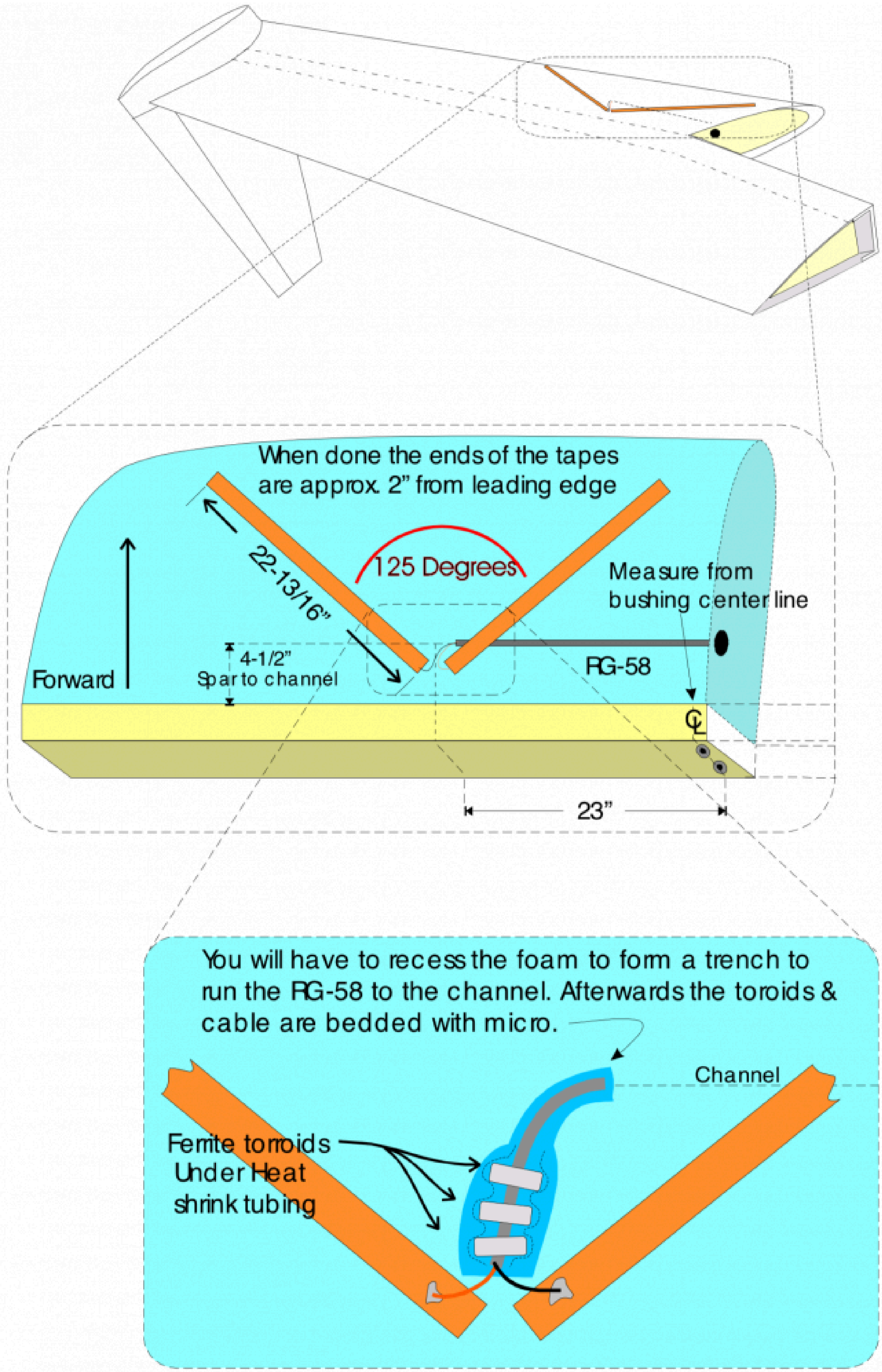

When done the ends of the tapes are approx. 2" from leading edge
125 Degrees
22-13/16"
Measure from bushing center line
4-1/2" Spar to channel
Forward
RG-58
23"
You will have to recess the foam to form a trench to run the RG-58 to the channel. Afterwards the toroids & cable are bedded with micro.
Channel
Ferrite toroids Under Heat shrink tubing

Figure 2-6. VHF Navigation Antenna

Run a short length of RG-58 down the channel you burned in the foam to the base of the strips. You want to leave about 18” sticking out the inboard edge of the wing . One strip is soldered to the core of the RG-58 cable, while the other half is soldered to the sheath .Do not forget the Torroids and heat shrink as shown in Figure 2-6.

2.3. 2.2 – Wing Skins

2.2 – Wing Skins

2.2.1 – Lower Skin

___ Make a table with two straight 2×4's and a luwan hollow core door. The objective is to make a table that is flat and twist free.

Set one of your I-beams on the trailing edge of the table. Rest your wing on the table, top side down.
Prop the front side of the wing up until the trailing edge rests on top of the I-beam. You will need to shim the outboard wing tip under the spar.

Twist the I-beam to match the curve in the trailing edge. Glue and shim the I-beam to the table so it will maintain this shape. Run a piece of duct tape down the top of the I-beam.

Rest the wing trailing edge on the I-beam.

You may have a spot on the wing that will need a little weight to have the wing trailing edge sit on the I-beam. Remember the amount of weight and location to use when glassing wing.

The straight edge gets bonded in a few spots to the trailing edge with about 1/4" of the straight edge protruding out past the foam (see Figure 2-8a).

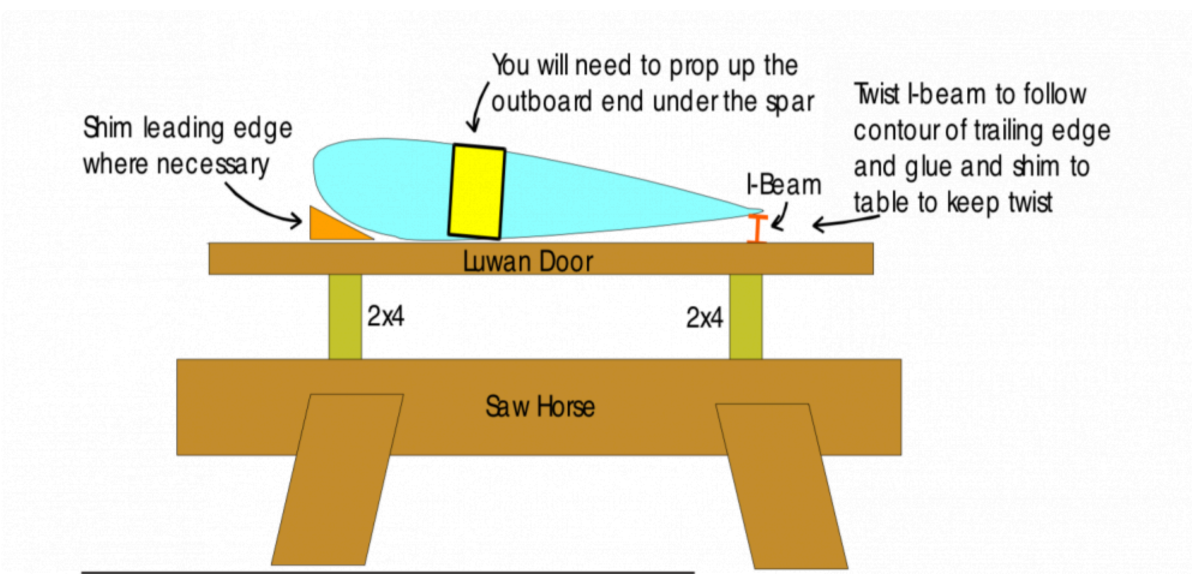


Figure 2-7. Supporting the Wing for Lower Skin Lay-Up

- Check the level lines on the cores to see that the tip and root lines match up.
- Sight down the **trailing edge** to be sure that it is straight.

___ Use a small straight edge like a tongue depressor to show where the bottom skin will meet the I-beam. Refer to figure 2-8b. Using a marker draw a line along the I-beam where the tongue depressor runs into it. This will show where you need to have glass to glass contact.

To prepare the cores for glassing, you must first remove some of the foam from the trailing edge in order to provide an area for a glass to glass contact when the upper skin is applied.

___ Measure 5/8” forward from the line you just drew on the I-beam. Remove the foam on the trailing edge to this point. (see Figure 2-8b). This should leave a trailing edge thickness from 3/16” at the tip to 3/8” at the root.

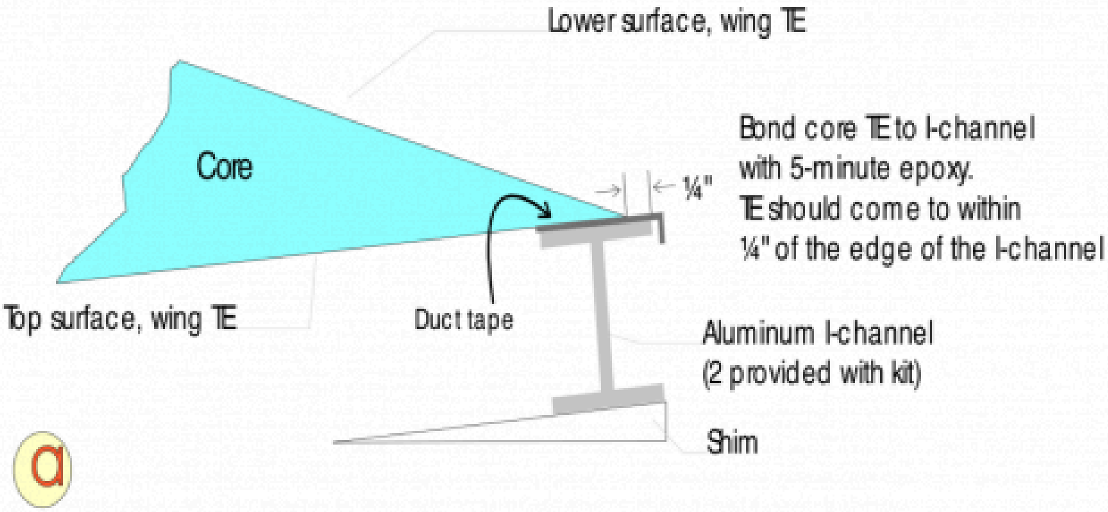
___ Taper this foam edge slightly (see Figure 2-8c). This will form your trailing edge and assure that it is straight.

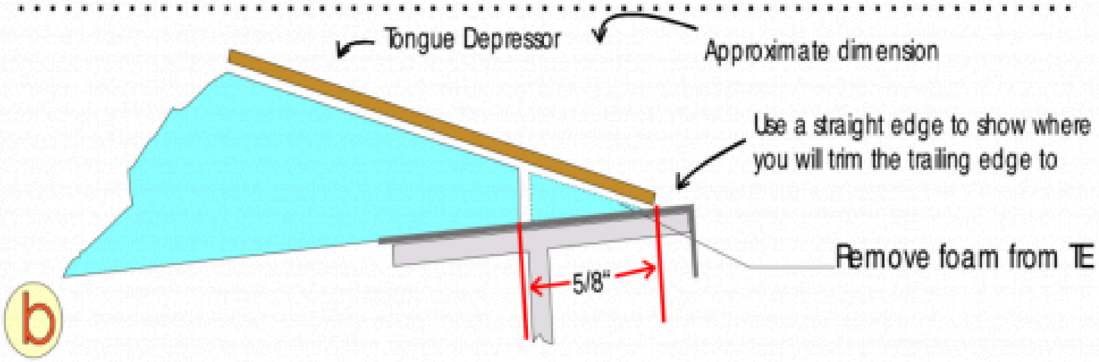
- Check the foam cores with a straight edge to find any high points.

If any are found, remove them with a sanding block. Use dry **VelociPoxy Micro-Balloons** to fill any low places, cracks, or dings. Let cure, then sand smooth before glassing. It is a lot easier to do repairs on the foam now than it is once the outer skin is applied! Measure the chord both **inboard** and **outboard** and try to make both wings the same. Record these measurements below.

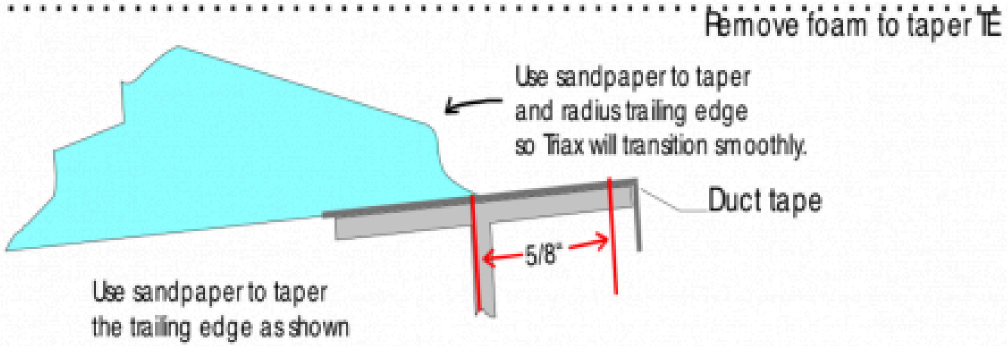
Left wing **inboard** chord ____ Left wing **outboard** chord ____

Right wing **inboard** chord ____ Right wing **outboard** chord ____

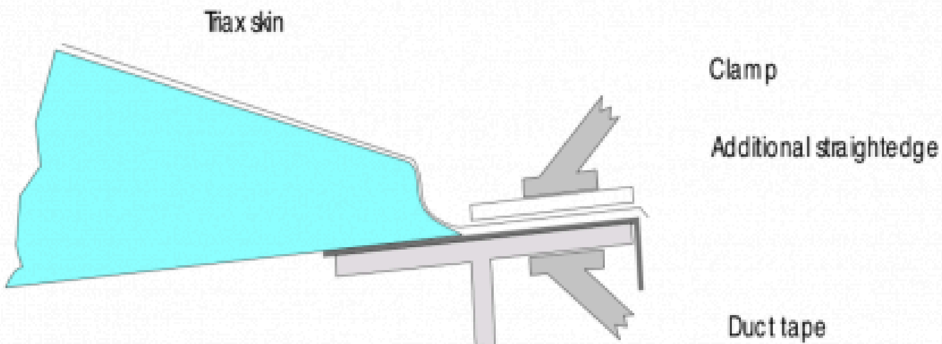




Once the core is bonded in place to the I-beam, Using a small straight edge like a tongue depressor mark where the wing bottom skin will intersect the I-beam. From this point remove enough foam along the TE to expose approximately 5/8" of the aluminum I-beam in front of this line.. This should leave a core TE approximately 3/16" at the tip to 3/8" at the root.



Cover the exposed aluminum with a length of duct tape. This will prevent the Triax skin from adhering to the aluminum



When you apply the triax skin, allow it to extend past the edge of the aluminum

Figure 2-8. Wing Trailing Edge Treatment

2.2.2 – Wing Leading Edge Rib

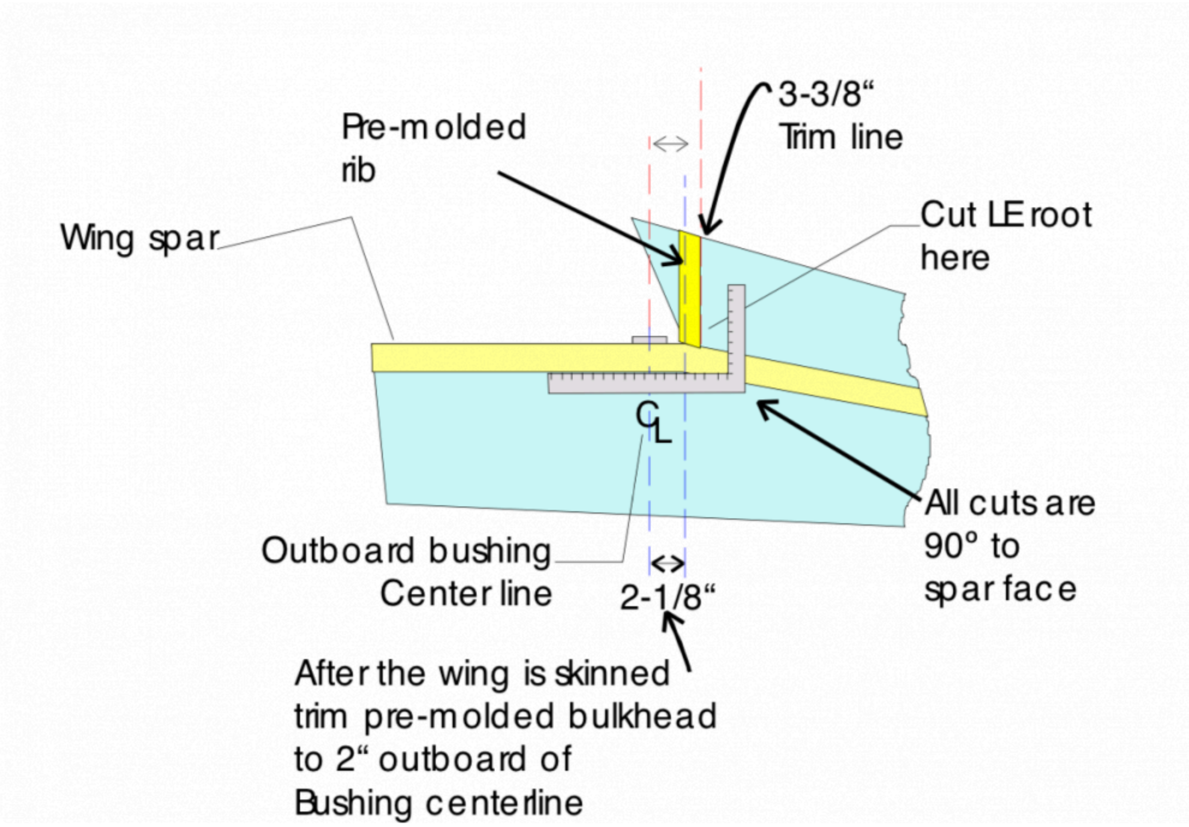


Figure 2-9. Wing Leading Edge Trimming

Make sure your wing is properly supported and check your level lines before cutting off inboard cores.

___ Measure 3-3/8" outboard from the outboard bushings centerline. Draw a line that is perpendicular to the spar face over the leading inboard wing core. Cut the foam core on this line back to the spar. (see Figure 2-9).

___ Sand the top, bottom and inboard side of the rib. Micro-Slurry the outboard side of the premolded rib and use structural adhesive and Flox between the premolded rib and spar. Hold in place with 2 wood screws through the bulkhead into the foam until cured.

___ After the top and bottom wing surfaces are glassed we will come back and trim the inboard edge of this rib to 2-1/8" outboard of the bushing centerline.

2.2.3 – Wing Root Ribs

___ Using a square mark a line 6" from the inboard edge of the spar. Using a square place a mark at the trailing edge straight back from this mark.

___ Place a mark 2” from the inboard edge of the spar.

___ Draw a line from your 2” mark back to your 4” trailing edge mark. Refer to Figure 2-10.

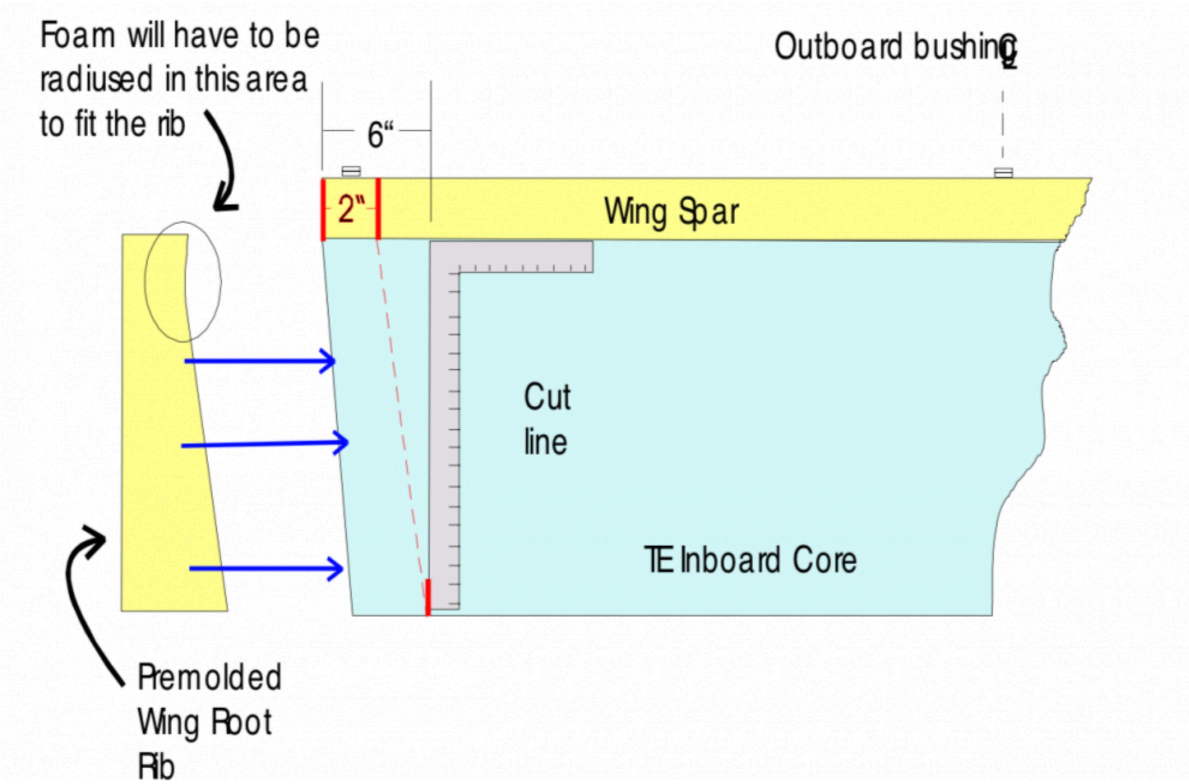


Figure 2-10. Wing Root Trim

___ Trim off the inboard edge of the wing to this line. Keep the cut as straight ,up and down from the top to bottom skin, as you can. The top and bottom skins should be trimmed in a vertical plane.

___ Insert your premolded rib at the end of the trailing edge inboard core. You will need to radius the foam by the front of the premolded rib in order to get it to fit properly. You want to make sure that the inboard edge of the rib is perpendicular to the spar when done.

___ Sand the exterior of the rib. Use micro-slurry to bond the rib to the foam. Hold in place with a few wood screws. Make sure that the edges of the rib line up with the edges of the foam.

___ Where the rib meets the spar glass all the joints with 2 plies of BID 2” wide.

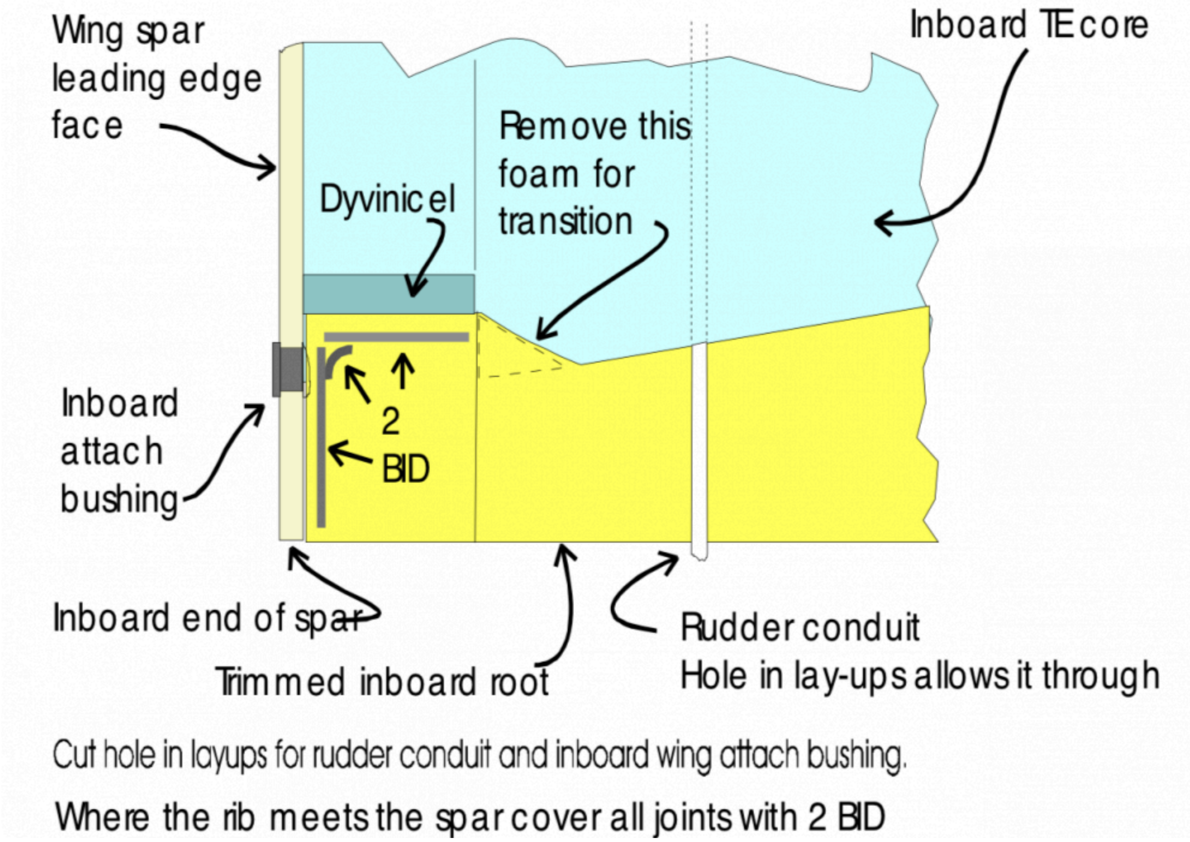


Figure 2-11. Wing Trailing Edge Rib Detail - Viewing from Top Wing

2.2.4 – Glassing

___ Sand spar cap thoroughly and sand the shear web area between the inner and outer hard points (as the skin laps over onto this area). Radius the leading edge of the spar cap from the outboard bushing in so that the glass will lay over it easier.

___ Pre-cut a piece of **TRIAX** cloth approximately 4” longer than the overall wing. Lay it on a flat, clean surface and try to work out as many of the squiggles as you can before doing the actual lay-up. Do not pull so much as to distort the other fibers. Some builders have had luck rolling the glass off the roll directly on to the wing.

___ When you are satisfied with the condition of the cores, apply **EZ-Poxy Micro-Balloon** slurry to the foam. Wet out the spar cap and the tape on the **trailing edge** straight edge with epoxy. Let this get tacky before continuing.

___ With the UNI-directional fibers (smooth side) facing up, drape the **TRIAX** skin onto the wing with the fabric edge parallel to the trailing edge and approximately 1/4” out past the aluminum. This will be trimmed off later with a saw or a razor knife.

___ Trim the cloth even with the **leading edge** and approximately 1” past the tip and root of the wing. In the spar area, allow it to cover a little more than 1/2 of the vertical height of the shear web.

___ Cut out in the area of the wing attach fittings. Using **EZ-Poxy**, wet out the entire wing skin using a paint brush, squeegee, or putty knife. Remove any excess resin.

- After total wet-out, check the surface for bubbles or areas that do not conform. In particular, at the corner of the inside spar, use a piece of saran wrap to hold the glass in place during cure. The plastic keeps air from getting in behind the wet glass, therefore holding it to the surface.

Several of our builders have clamped a second straight edge along the trailing edge above the first straight edge to be sure that the rear of the cores have good contact with the lower straight edge. The second straight edge also serves to pinch the glass down tight against the foam (see Figure 2-8d).

- Check all level lines and make sure everything is level and straight.

___ Trim all excess cloth hanging off the edges and let lay-up cure thoroughly before handling.

Note: IMPORTANT: During the initial cure, keep checking the skin. The glass tends to bubble or wrinkle sometimes, the area of the core- to- spar intersection usually being the most affected. If bubbling or wrinkling does occur, weigh down that particular area with a flat piece of wood wrapped in visqueen or saran wrap. Be careful not to apply too much weight.

___ Prior to installing the top skin, it will be necessary to mark trim lines. Use a straight edge to make these lines. (Using a chalk line as a reference to start with is a good idea.) Mark the **leading edge** trim line for the bottom skin.

You want the top skin (not yet applied) to overlap the bottom skin 2”, so make a line 2” aft of the leading edge trim line. Knife trim or sand the trailing edge to the outer edge of the I-beam at the **trailing edge** of the wing. (see Figure 2-12).

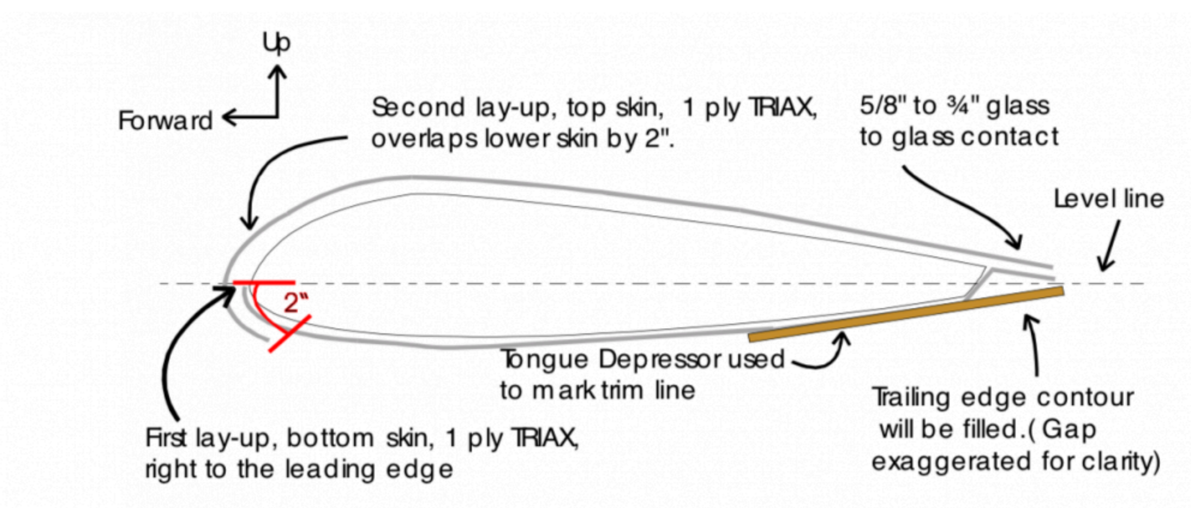


Figure 2-12. Wing Lay-Ups

___ Cut away the excess wing skin from the **leading edge**, **trailing edge**, root, and tip. Use a file or sanding block to taper the **leading edge** skin and 40 grit sandpaper to smooth and prepare for the top skin overlap.

___ Remove the straightedges, turn wing right side up and reinstall the **trailing edge** straightedge with **Bondo** (or **Hot Glue**) on the bottom side of the glass skin below the **trailing edge** for support. (Do not forget to do a little sanding so the **Bondo** will stick).

___ Prepare the top surface with careful sanding using the long sanding board to remove minor high areas.

___ Fill any low areas or holes with dry **VelociPoxy Micro-Balloon**, and be careful not to get any on the spar cap.

2.2.5 – Rudder Conduit Installation

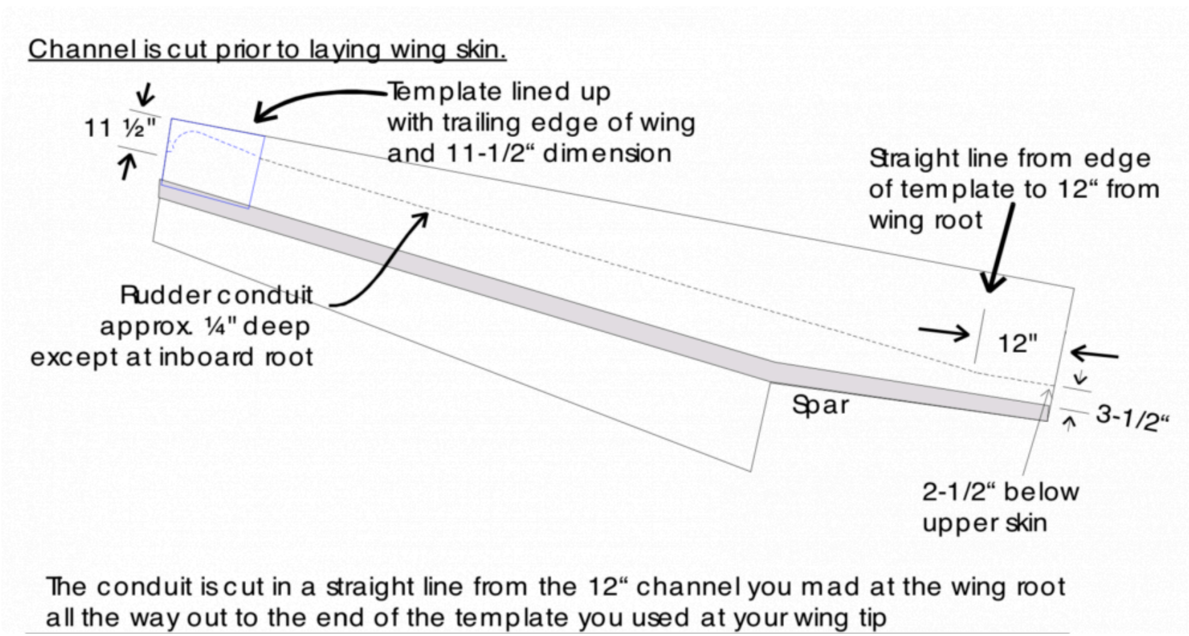


Figure 2-13x. Rudder Conduit Layout

looking down on the top surface of right wing.

___ Measure and mark a point 11-1/2" forward of the outer end **trailing edge**.

___ Refer to section 2.7.1 for aileron cut out to insure there is no interference between aileron well and rudder cable.

___ Run a small soldering iron along a straight edge to melt a shallow channel (about 3/16" wide, 1/4" deep) in the foam core the length of the wing following the lines you have drawn. At the **inboard** end of the wing deepen the channel for the conduit by cutting down about 2-1/4" more over the 12" straight line you just drew. The conduit should extend from the root of the wing approximately 2-1/2" below the upper skin.

___ Install the 3/16" O.D. nylon tubing. Let the tubing extend past the ends of the wing 4" **inboard** and **outboard**.

___ Install the rudder cable conduit with dry **VelociPoxy Micro-Balloon**. Scrape off any excess micro and allow to cure.

___ Sand smooth before applying glass skin.

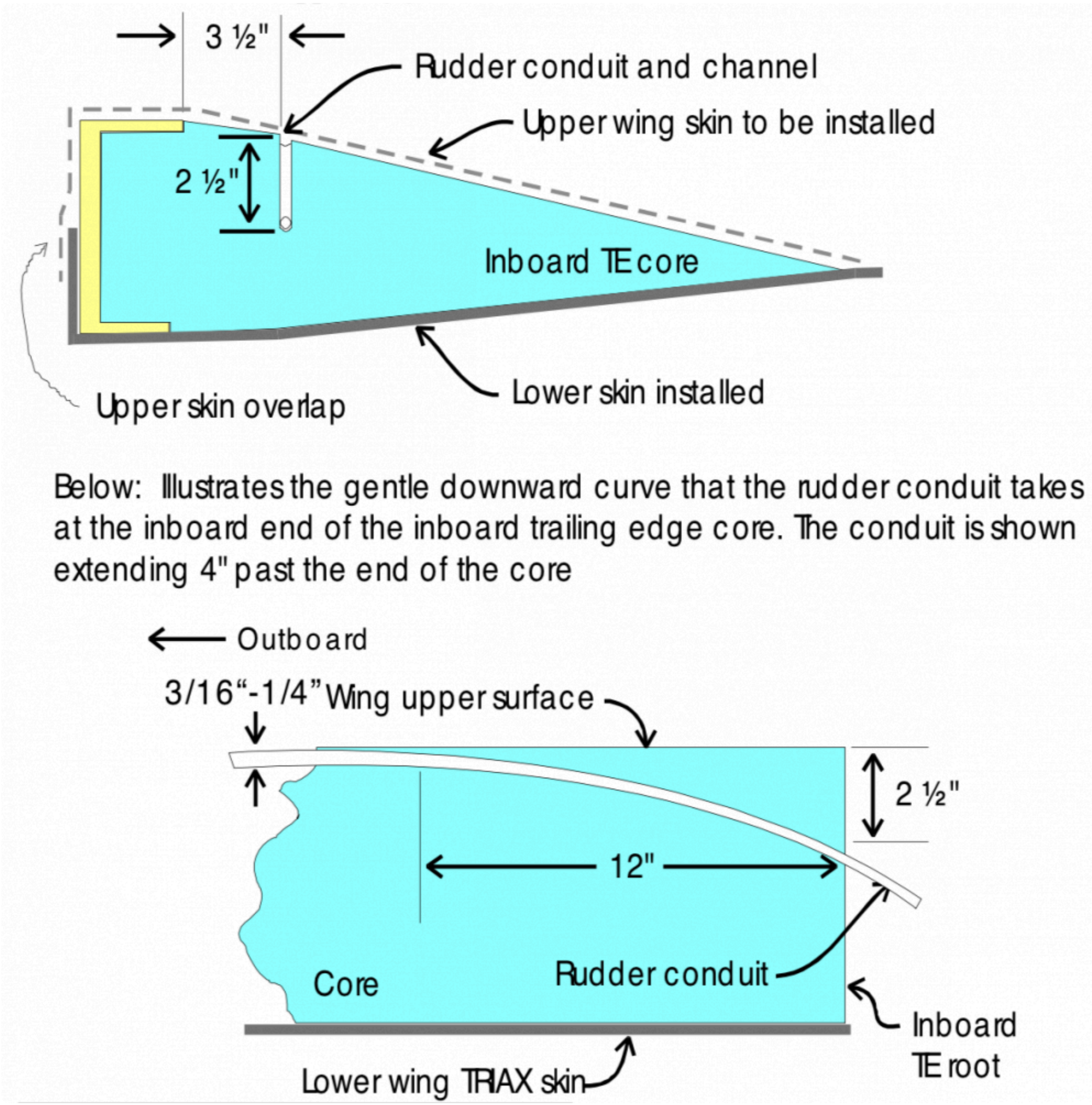


Figure 2-14. Rudder Conduit Installation

2.2.6 – Top Wing Skin

___ Prepare the top surface for glassing as you did on the bottom of the wing. Carefully sand the **trailing edge** of the lower skin for a good glass- to- glass bond. Mix **EZ-Poxy** and glass bubbles (to make **Micro-Slurry**) to the consistency of mayonnaise. Trowel the wet **Micro-Slurry** on the exposed foam, filling the pores, to provide a voidless bond between the cores and skin. Again, do not let any **Micro-Slurry** onto the spar caps or exposed glass at the **trailing edge**. Remove all excess **Micro-Slurry**.

___ Lay on **TRIAX** fiberglass cloth with the selvage edge parallel to and overlapping the **trailing edge** slightly. Cut the cloth leaving a 1” overlap at the root and tip ends. Mark the cloth with a straight edge allowing enough overlap onto the previously prepared **leading edge** on the bottom skin.

- In the spar area, the upper skin should overlap the lower as shown in Figure 2-12.

___ The **TRIAX** cloth will not be wide enough to span the entire width of the wing. You will need to add a small triangular piece of cloth at the inboard leading edge core to finish the lay-up. Overlap the other cloth by about 1”.

___ **Again**: Remove the trimmed cloth and pull out the “loops.”

___ Pre-wet approximately 2” of the lower skin in the overlap area (**leading edge**). Pre-wet the exposed fiberglass at the **trailing edge** and spar cap.

___ Level the wing using the level lines at the root and tip. This is very important to make sure you do not introduce a twist to the wing.

___ Apply the **EZ-Poxy** resin as you did on the bottom skin. Prop up or weigh down the leading and/or **trailing edge(s)** to secure these level until cured.

- Check once more for any twist in the wing. This is your last chance to correct any twist, as the wing becomes very rigid once the upper skin has cured.

Keep checking during the cure for any bubbles or ripples. Knife trimming is possible in four to six hours. Trim all edges and let thoroughly cure two to three days.

2.2.7 – Wing Attach Bolt Access Holes

___ On both the top and bottom skins, measure and mark a point 2” aft of the spar (about 5” aft of the hardpoint face) on a perpendicular line aligned with the double hard point centerline.

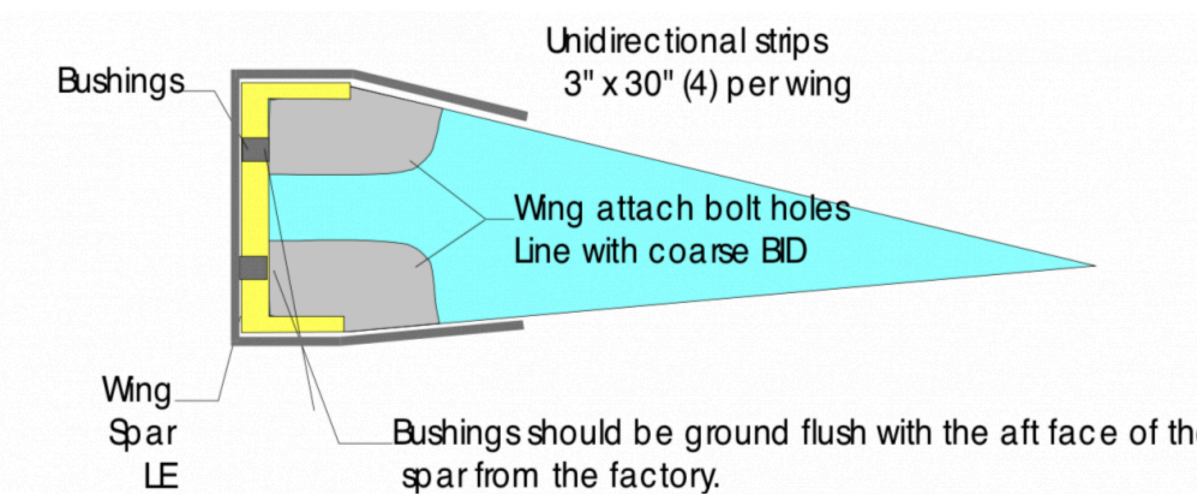


Figure 2-16. Wing Attach Bolt Hole Detail - Side View

___ Use a hole saw to drill a 2” hole through the skin. Angle the hole in the foam toward the spar where there is already a built in cavity behind the hardpoint. Enlarge the hole in the skin in a tear drop shape pointed toward the spar. Sand the hole smooth and line the hole with a layer of **BID**.

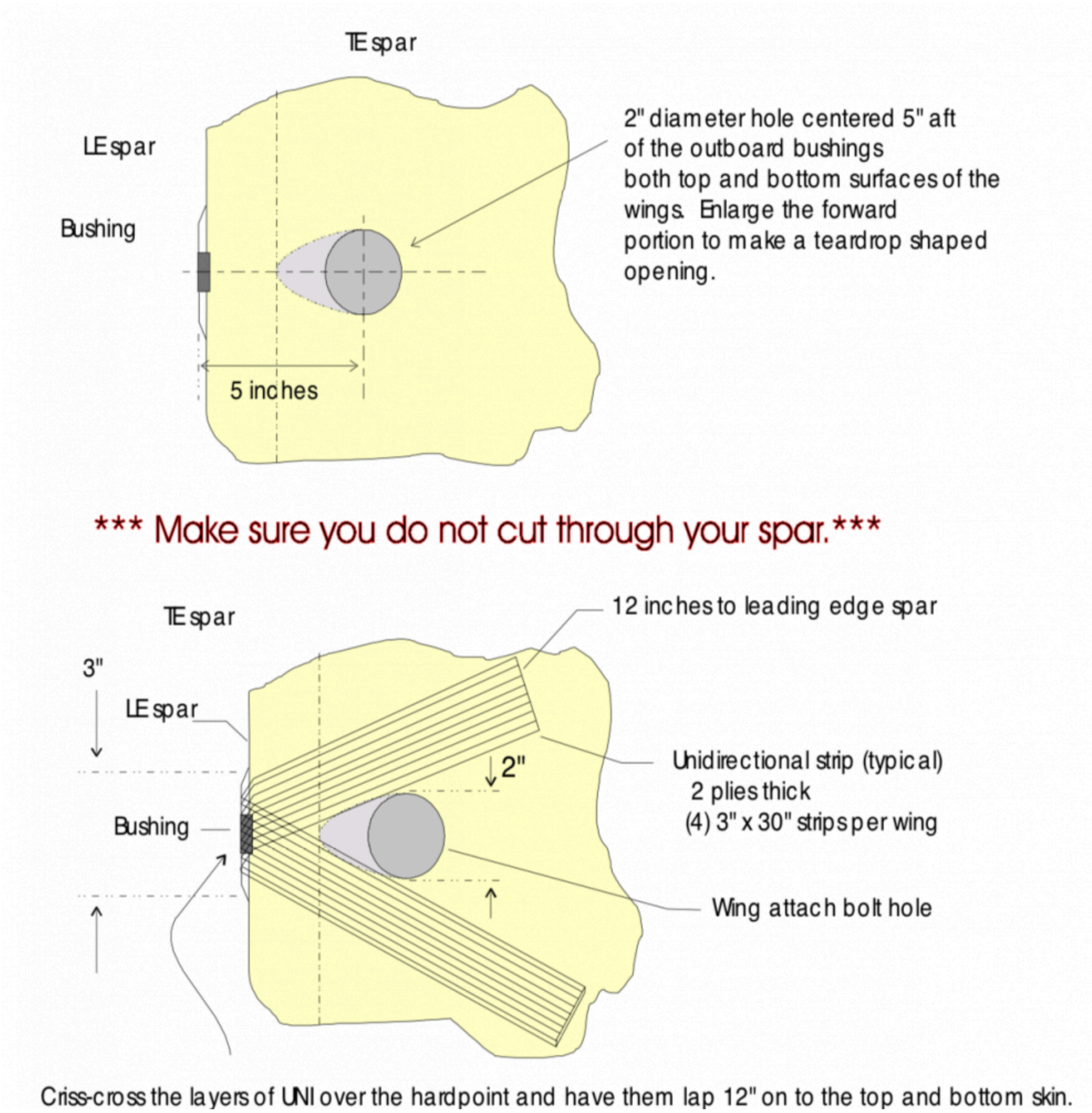


Figure 2-17. Wing Attach Bolt Hole Reinforcement

___ Cut eight (four per wing) 3” × 30” strips of *UNI*-directional cloth, axis lengthwise.

___ Lay-up over double **outboard** hardpoints lapping 12” onto top and bottom wing skins. Cut holes allowing the bushings to protrude through the lay-ups. Angle the strips to just “straddle” the wing attach holes.

After finishing, you will cut hole covers to match the tear drop shape from thin aluminum stock approximately .016. Paint the covers and install with silicone sealer after airplane has been painted.

2.4. 2.3 – Winglets

2.3 – Winglets

2.3.1 – Preparing Winglets for Glassing

- When removing the winglets from the billets they were cut from, be careful to not destroy the billets. We will use the billets to keep the contour of the winglet correct when glassing. After removing the winglets from the billet cut the ends off the billets down the leading edge of the winglet cutouts as shown in Figure 2-18.*

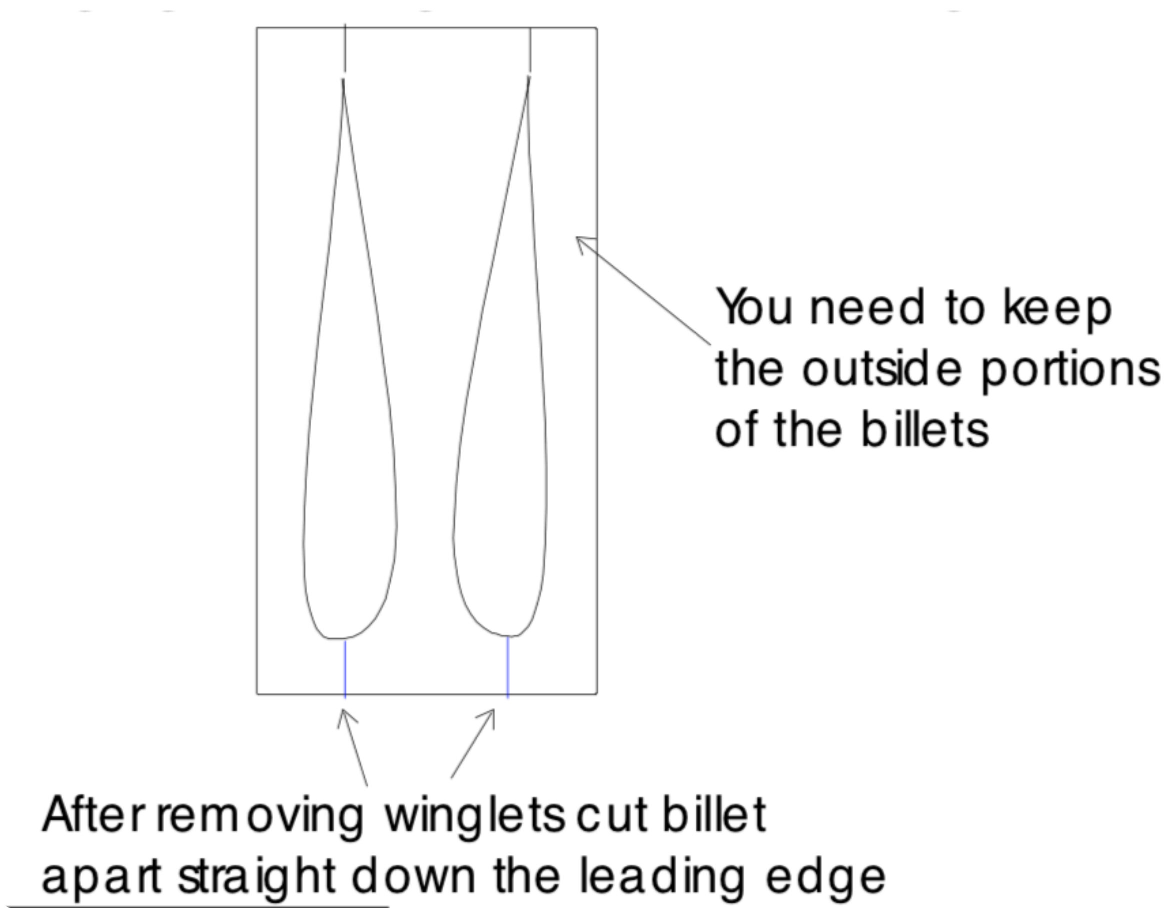


Figure 2-18. Winglet Billet Cutout

___ Next you will have to trim your winglet cores. Measure the top of your winglet and place a mark 12” aft of the leading edge. Do the same at the bottom and make a mark 28” aft of the leading edge. Draw a line between these two marks and trim your winglet to this mark. Draw a line 1” forward of this line parallel with the trailing edge.

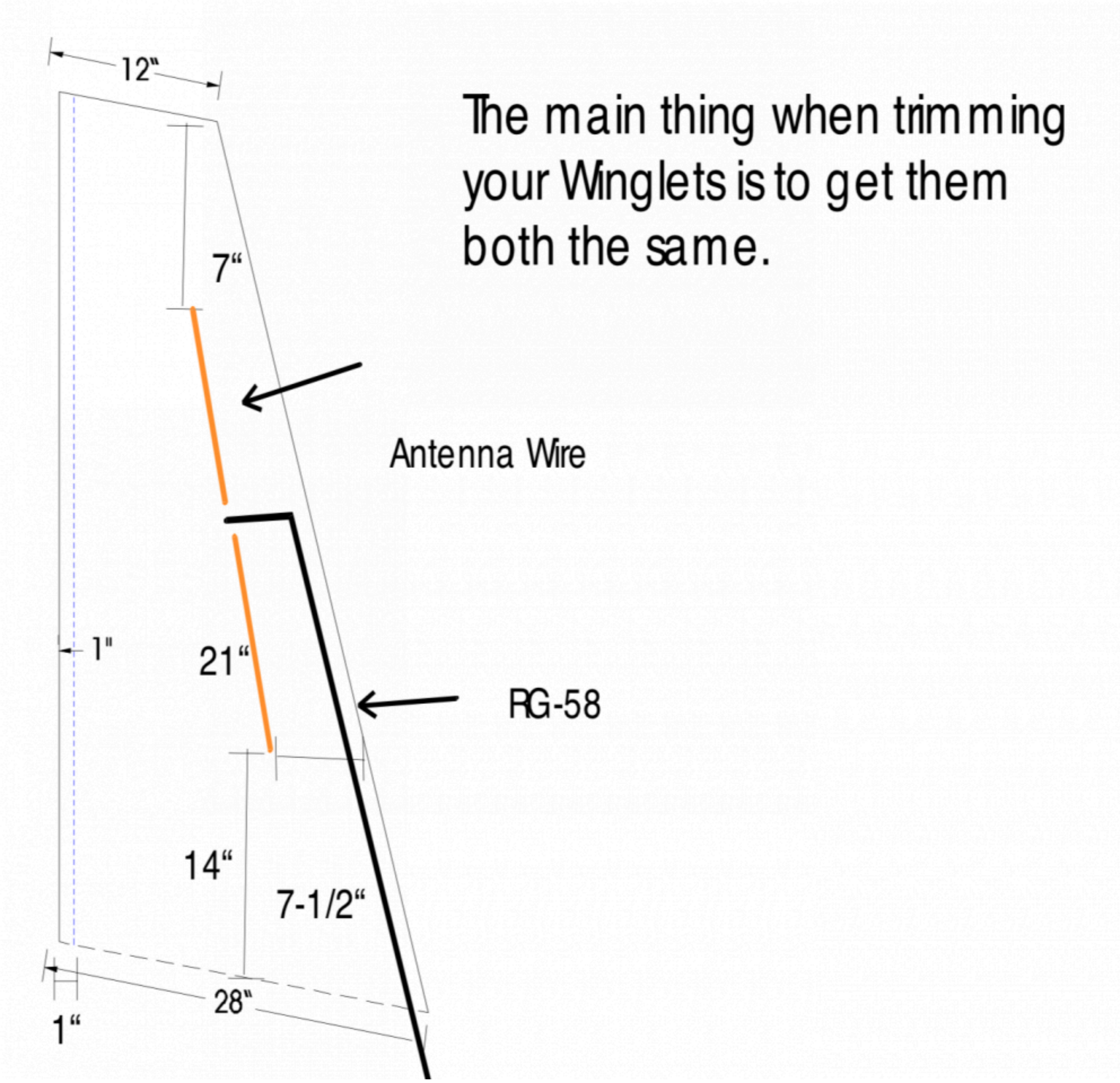


Figure 2-19x. Winglet Dimensions

___ You can now install the Comm antenna on the inboard side. The copper foil tape runs parallel to the leading edge. Lay the 21” long pieces of foil tape down so they are 7-1/2” aft of the leading edge and 7” down from the top of the winglet and 6” from the bottom with a 1/2” gap between them. Use masking tape to temporarily hold the foil down onto the foam Do not peel off the backing yet.

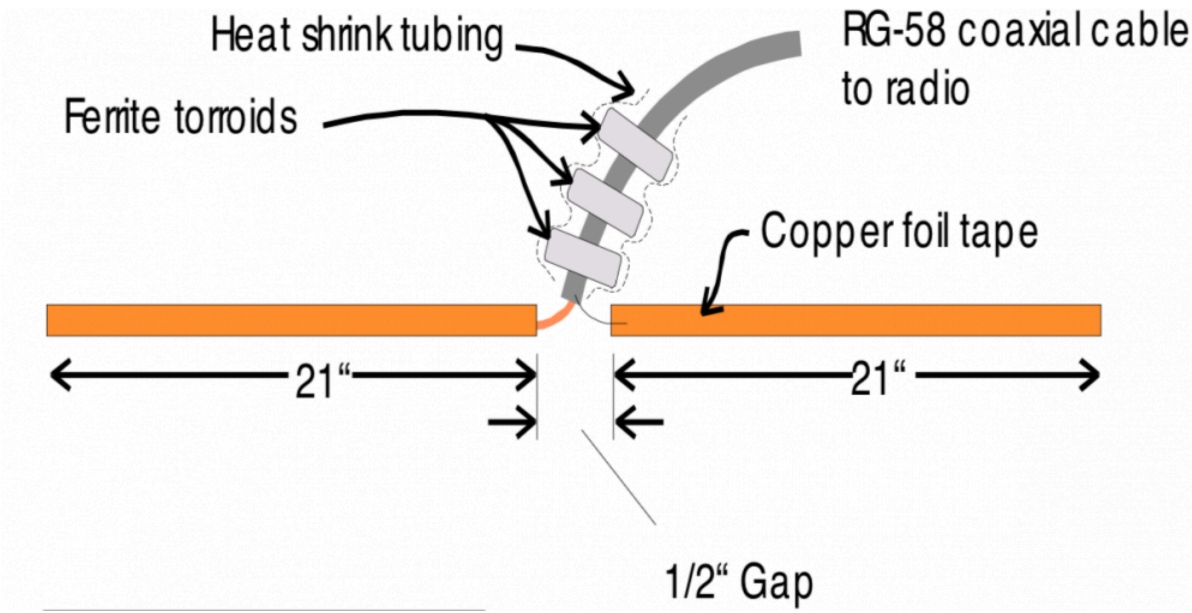


Figure 2-20. Terroid Installation

___ Pre-solder the ends of the tapes where the coax will be connected. Strip back approximately 1/2" to 3/4" of the outer insulation on the RG58 coax. Comb the shielding to one side, then remove 1/2" of the inner insulation surrounding the center conductor. Pre-solder both the center conductor and the tip or the shielding.

___ Mark a line on the foam for the coax as shown in Figure 2-19. It must be perpendicular to the copper tapes until it reaches a point approximately 1" behind the leading edge of the winglet. It then parallels the leading edge down to the bottom . Burn a channel with a soldering iron on the marked line to accommodate the coax.

___ Next, peel the backing off the foil tapes and press them in place. Feed the coax along the channel , install toroids and solder the ends onto the tapes. Now press the coax and toroids down into the foam until flush.

The other end of the coax will be routed down the conduit hole in the wing to a quick disconnect at the wing root.

2.3.2 – Glassing Inboard surface

Before glassing the winglet take a good look at its profile and notice the curve at the trailing edge of the winglet. You need to retain this curve when we glass the winglets. To do this you need to install the winglets back into the billet sections you saved. This will retain the contour of the winglet even with the weight of the glass on it. Lay the billet halves on a flat table.

Cut two layers of **UNI*-directional cloth. The first layer will be laid up with the major axis parallel to the *trailing edge**, and the second with the major axis parallel to the **leading edge**.

___ Fit the cloth to overlap the **trailing edge** by at least 1-1/2" and trim to within 1" of the center of the other winglet edges. **Be sure that there is enough UNI-directional fiber to form the trailing edge at the bottom tip.**

___ Using dry **VelociPoxy Micro-Balloon**, fill any voids or depressions in the foam including covering the antenna coax , and sand down the high areas.

___ **Micro-Slurry** the inboard (curved) side of the cores, and apply the UNI skin with EZ-Poxy. Let cure.

___ Remove 1” of the trailing edge foam up to the line you previously drew on the winglet.

___ Trim, file, and sand the **leading edge, trailing edge, top, and bottom**. Be sure to sand back from the edges where the opposite skin will overlap.

___ Sand the exposed area along the **trailing edge**.

2.3.3 – Glassing Outboard Surface

The outboard side should retain its shape for glassing after the inside has been glassed. You can lay the outboard side on a flat table for glassing.

Trim the trailing edge of foam to the 1” dimension you marked on the winglet. Refer to figure 2-19. Radius the edge of the foam to allow glass to transition smoothly. Sand and prep the exposed glass.

The outboard surface of the winglet receives the same lay-up schedule as the cambered inboard surface. The only difference is that the glass wraps around the top, bottom, and **leading edge**, overlapping the opposite skin by approximately 1”.

___ Pre-wet all the areas where the skins will overlap. **Micro-Slurry** the foam, then apply one layer of **UNI** with the major axis parallel to the leading edge, and another layer running parallel to the **trailing edge**. Use the plastic wrap technique to hold the glassed cloth around the edges, wherever necessary. Cutting slits in the cloth at the tips will help. Let cure.

___ Measure the top of the winglet and place a mark at 12” on the trailing edge and measure the bottom and place a mark at 28”. Draw a line between the two mark and cut or sand the trailing edge to this line.

2.3.4 – Winglet Marking

___ On the top of the winglet mark a point 4-1/8” in from the trailing edge. Measure down the trailing edge and place a mark at 56”. With a square place a mark 7-1/2” forward of the 56” mark. Connect this mark with the 4-1/8” mark you drew on the winglet top. This is you rudder line. Refer to figure 2-21.

___ Mark a point on the trailing edge of your winglet 52-1/2” down from the top. Place the winglet template on the cambered side of your winglet, with the **trailing edges aligned**, and the bottom aft template edge at your 52-1/2” mark.

___ Trace a line following the lower edge of the template onto the winglet back to the rudder line. This will serve as your cut line.

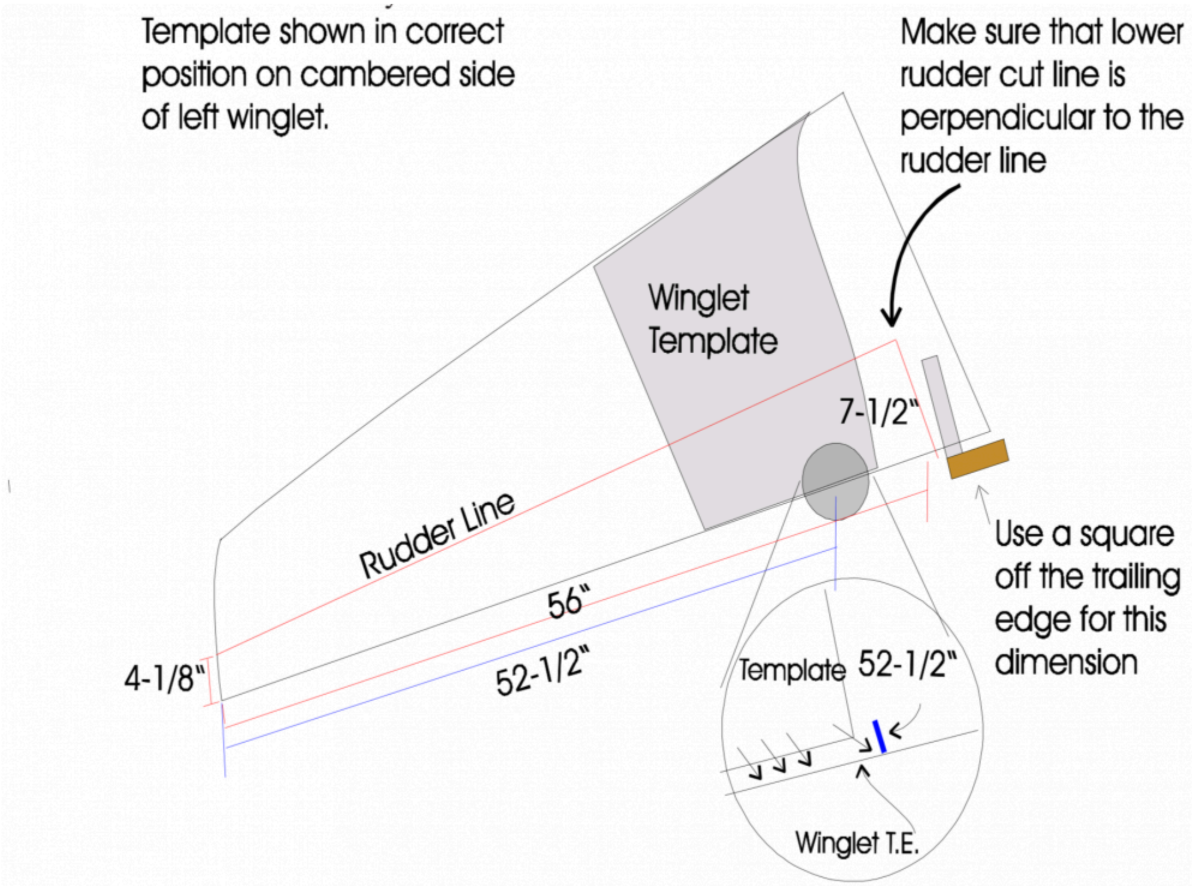


Figure 2-21x. Winglet Trim Template

___ Mark both sides and cut from the leading edge back to the rudder line, then down the rudder line through the bottom of the winglet.

- *** Do not cut aft of the rudder line and do not cut through the coaxial cable from your comm antenna. If you do damage the coaxial cable, connectors are available at Radio Shack for a couple of bucks.*

___ Mark a line about 3/8” aft of the foam **trailing edge**, running parallel to the aft edge of the foam. This line will serve as your final **trailing edge** on the rudder. Do not cut down to it now, just mark it.

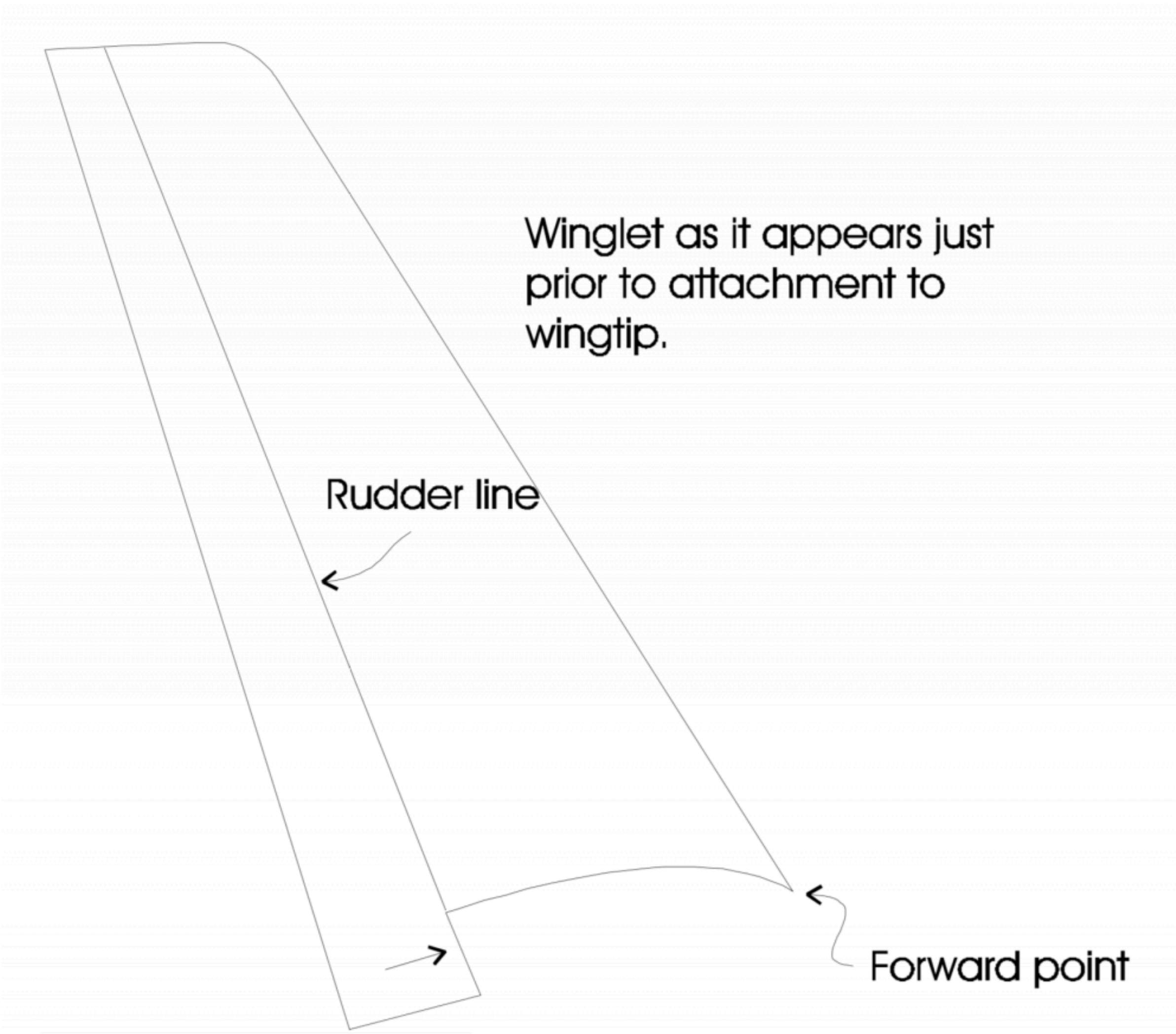


Figure 2-21xb. Rudder After Trimming

Figure 2-20 shows how the winglet will look after you have made your cut with the template.

2.5. 2.4 – Wingtip Trimming

2.4 – Wingtip Trimming

2.4.1 – Wingtip Trimming

___ Using the prerecorded measurements you made of the root and tip chords (section 2.2.1), mark the trailing edge with a chalk line or straight edge. Trim and smooth the wing trailing edge. Use a long sanding block. Wear a pair of work gloves while sanding the trailing edge. It is very sharp at this point and if you slip you can cut yourself.

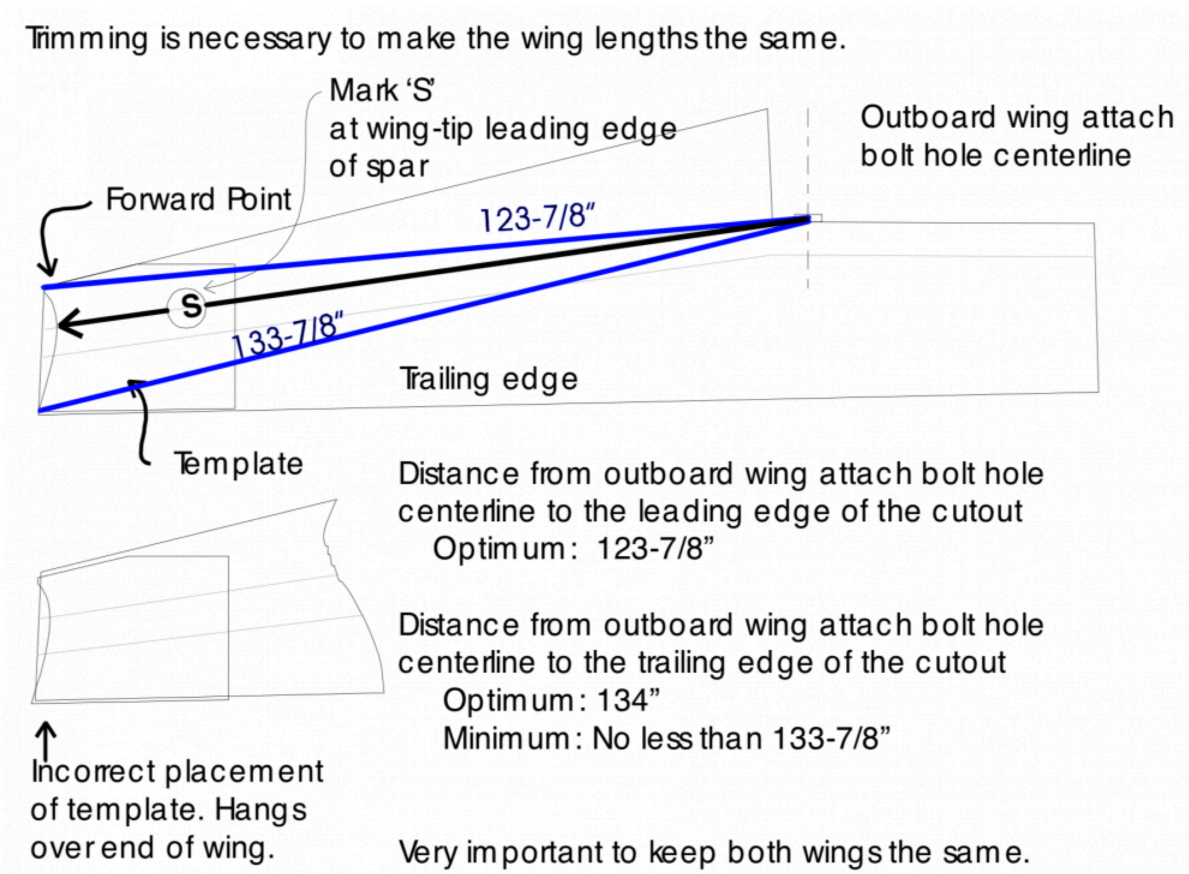


Figure 2-22x. Winglet to Wing Trimming

*Positioning the Template

Note: The inboard rudder cutline coincides with the trailing edge of the wing.

___ Measure and mark the winglet leading edge reference point on the top surface of the wing 123-7/8" from the centerline of the outboard hardpoints. (Fig. 2-22) Be consistent in your method with both wings.

___ Place the winglet- to- wing template on the wing top surface with the **trailing edges** aligned. Position the template cambered cut line to coincide with the 123-7/8" and the trailing edge 134" reference mark. (See notes in section 2.5.3)

If any portion of the template curve hangs off the end of the wing, move the template in until you can draw an unbroken line on the wing tip along the curve of the template.

___ As an additional reference, mark the new intersection point of the template curve and the wing spar* leading edge*, then take a measurement from that intersection point to the center line of the **outboard** bolt hole. Record those measurements here:

Left Wing: _____ Right Wing: _____ Distance ‘S’: _____

___ Make a mark on the other wing’s spar **leading edge** at the same point, and place the template there to ensure that it will not hang over the end. If all looks good, double check your measurements to be sure that the winglet cutouts will be the same distance from the **outboard** mounting hole center line on each spar.

Note: It is very important to maintain symmetry in the construction of the wings, so we want the measurement above to be the same for both wings.

___ Mark the wing tip per the template. Cut off the wing tip as marked (a portion of the spar end is cut off in the process), trimming the forward tip parallel to the existing pre-cut core.

Record another comparative reference distance (any distance will suffice – this is just an accuracy check) to transfer to the second wing, especially if you are building one at a time. Place one side of a large carpenter square on the* trailing edge*. Align the other side of the square with the wing tip cutout. The measurement between the wing **leading edge** and **trailing edge** at this point should be the same for both wings.

Sand trimming to match is much easier prior to installing the winglet.

After cut: Left Wing: _____ Right Wing: _____ Distance: _____

2.6. 2.5 – Winglet to Wing Attachment

2.5 – Winglet to Wing Attachment

2.5.1 – Overview of Winglet to Wing Attachment

- Wingtip has been trimmed using appropriate template.
- Recess foam wedges in both wingtip and winglet. Allows for glass lay-up running between the two assemblies. (Figure 2-23)
- Initial fit of winglet to wingtip, followed by temporary attachment (using **Bondo**, clecos, clamps, etc.) once in position
- Lay-up A and B (Figure 2-28). “A” ties **inboard** winglet to top wing skin, from inner skin surfaces. “B” which must make glass- to- glass contact with “A” for entire length, serves as a shear web, and covers the exposed foam of the wingtip and the winglet.
- Installation of foam core, then application of lay-up “C” and “D”. Layup “C” ties the **outboard** winglet skin to the lower wing skin. “D” ties the outer IB winglet skin to the outer top wing skin.
- Reinstallation of forward lower portion of winglet, which was removed at the initial cutout.

2.5.2 – Winglet and Wing Preparation

Cut out foam wedges 1/2” x 1/4” into the winglet against the outer side skin, and 2” × 1” wedges against the inner side skin along the winglet to wing attach intersections. It is advisable to save the foam from the deeper cut, as you will need to fill in the space after Layup A (Figure 2-28) has been completed.

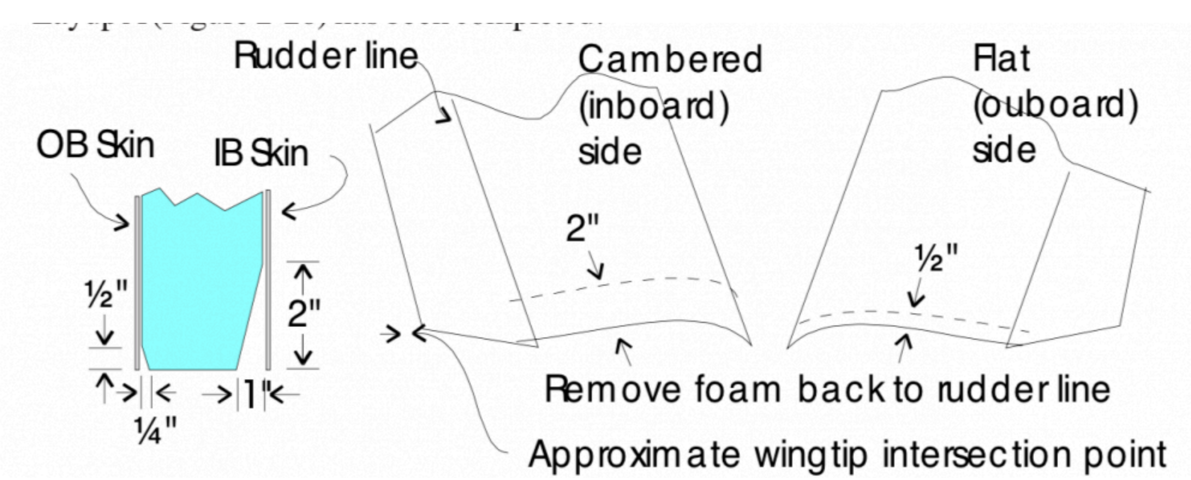


Figure 2-23. Winglet Foam Reliefs For Winglet Attachment Lay-Up

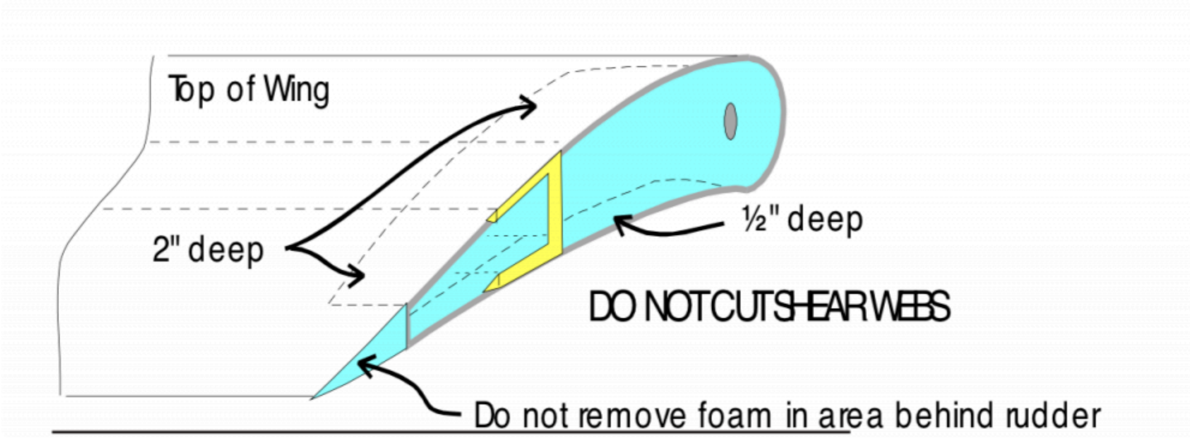


Figure 2-24. Foam Trimming for Winglet Attachment Lay-Ups

___ Level the wing, upright, with a level on the spar cap section inboard of the “knee”. Level with the incidence gauge at the **leading edge** root. Along the winglet- to- wing attach intersections, cut out wedges of foam 2” into the wing tip under the top skin. Do the same 1/2” deep above the bottom skin. Do not cut through the spar shear webs.

___ Cut out the foam in the area where the rudder internal bellcrank will go. The template that you used to cut the rudder conduit groove in the wing foam also marked out the general location at the end of the wing where the bellcrank will travel. Remove this foam from around the rudder Nylaflow from the top to bottom wing skins.
image

2.5.3 – Set-Up and Alignment

___ Place a level along the top spar cap of the wing, and place the wing incidence jig provided with the kit in position (about 1” outboard of the leading edge root, and approximately 125” inboard of the trailing edge wingtip). Use both devices to get the wing level.

|___| A good double check is to make sure that the outboard attach bushings are plumb when the jig and the level are telling you that the wing is in position. Secure the wing once you are satisfied, and it will not hurt you to check it periodically during the winglet attachment process to be sure that you haven’t accidentally moved it.

Note: Important: Make frequent checks to be sure that the wing remains level throughout the following procedure.

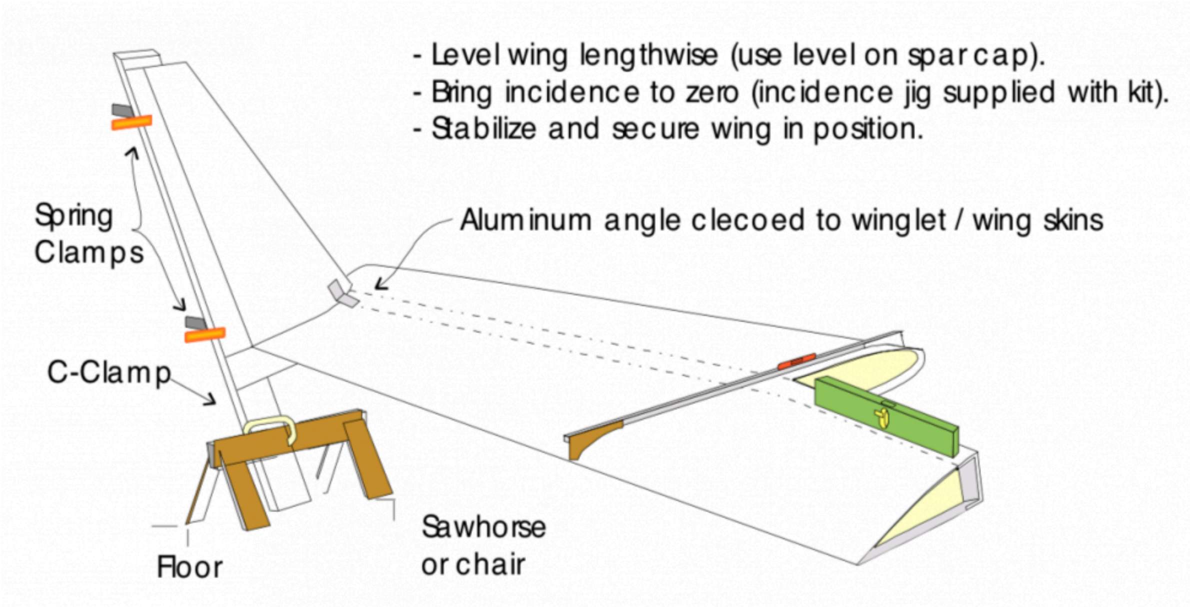


Figure 2-25. Jigging Wing and Winglet for Attachment to Each Other

___ Clamp a vertical prop to the **trailing edge** of the winglet and to something movable on the floor, like a chair or a sawhorse.

___ Record the measurement from the ‘**forward point**’ of the wing tip cutout to the **outboard** attach bolt center line. This measurement is “X”. It should be 123-7/8”.

Bend a couple of thin metal angles to cleco the winglet to the wing temporarily. (The winglet goes on the wing with the cambered side in, flat side out). Place the winglet ‘forward point’ at the wing tip ‘forward point’. One of the metal angles clecoed near the winglet **leading edge** and clamped to the top wing skin works well while adjusting the winglet’s position.

___ **The trailing edge measurement should be at least 10” greater than the leading edge measurement to achieve proper angle of attack.** This measurement is shown as “Z” in Figure 2-25. If “X” = 123-7/8” then “Z” should at least be 133-7/8” . If “X” = 124” then “Z” should be at least 134”.

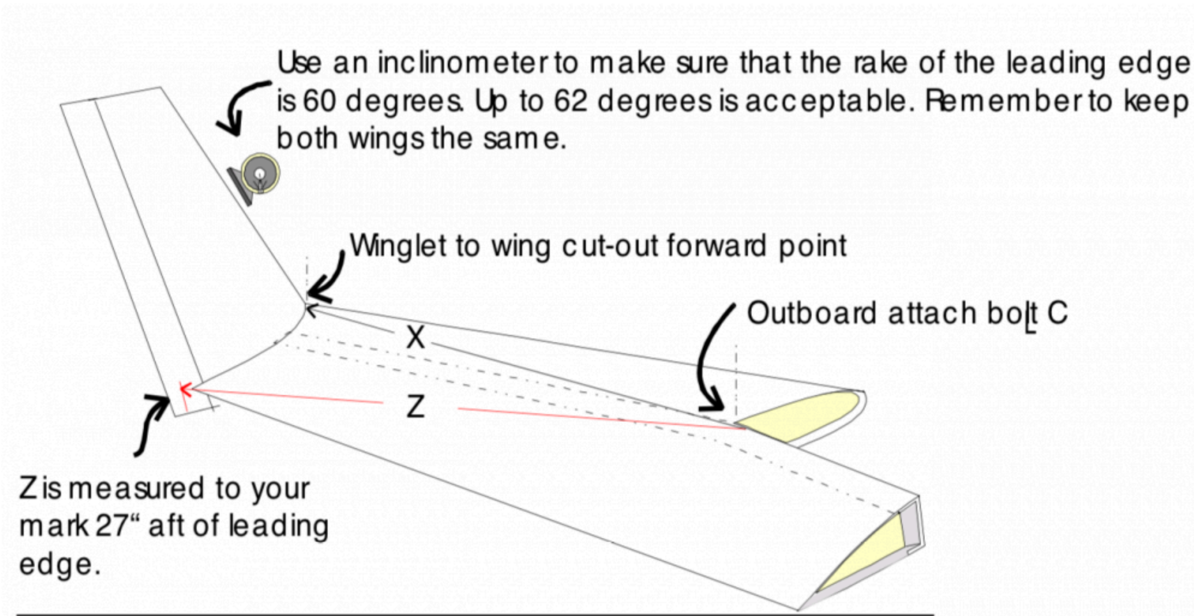


Figure 2-26. Winglet Alignment. "Z" Should be 10" Greater than "X"

- As a cross check you can bolt the wings to the center section spar. Measure and record the distance between the forward most points of the winglets. Measure and record the distance between the trailing edges of the rudders. The difference between these two measurements should be 1/2" to 1". If measurement X is the same for both wings, the winglets will now be symmetrical with the optimal trailing edge "kick out."

___ Use an inclinometer on the winglet leading edge and adjust the rake to 60 degrees (up to 62 degrees is acceptable).

- Remember it is very important to keep the measurements and the rake of the two wings the same.*

___ Measure back and up from the winglet **leading edge** onto the outboard side where it is nice and straight and mark a common point on both winglets to compare vertical alignments.

___ Adjust the winglet vertically to 0 degrees. Use an inclinometer on the flat outside of the winglet. **Bondo** two or three supports, from high up on the winglet, to the wing. Put dabs of **Bondo** along the winglet- to-wing junction as well. The rudder cable tubing is to exit the outer side of the winglet 5" forward of the 'rudder line'.

___ Route any antenna cable from the winglet through the access hole provided in the wing **leading edge** foam core.

2.5.4 – Winglet Attachment Lay-Ups

All BID is cut on a 45 degree bias. Cut all **UNI** with the major axis along the long dimensions.

- Make sure all lay-ups stay forward of the rudder line drawn earlier.

You will do four lay-ups on each winglet to complete the main attachment process. Refer to the Figure 2-28 for a cross sectional view of the lay-up. Sand areas to be glassed and cut plies of **BID** and **UNI** for each winglet- to- wing layup per the glass layup schedule below.

	Dimensions	Fabric	Plies Per Lay-Up	Total Plies Required	
Lay-up "A"					
	4” ×12”	BID	8	16	
Lay-up "B"					
	7” ×16”	BID	8	16	
Lay-up "C"					
	34” ×20”	BID	1	2	
	32” ×18”	BID	1	2	Trim the above plies to taper down to 3” at the ends.
	28” ×15”	UNI	1	2	
	26” ×14”	UNI	1	2	
	24” ×13”	UNI	1	2	
	20” ×11”	UNI	1	2	
	18” ×10”	UNI	1	2	
	16” ×8”	UNI	1	2	
	14” ×7”	UNI	1	2	
Lay-up "D"					
	34” ×20”	BID	1	2	
	32” ×18”	BID	1	2	Trim the above plies to taper down to 3” at the ends.
	28” ×15”	UNI	1	2	
	26” ×14”	UNI	1	2	
	24” ×13”	UNI	1	2	
	20” ×11”	UNI	1	2	
	18” ×10”	UNI	1	2	
	16” ×8”	UNI	1	2	
	14” ×7”	UNI	1	2	

Note: Lay-up “D” is same as Lay-up “C”

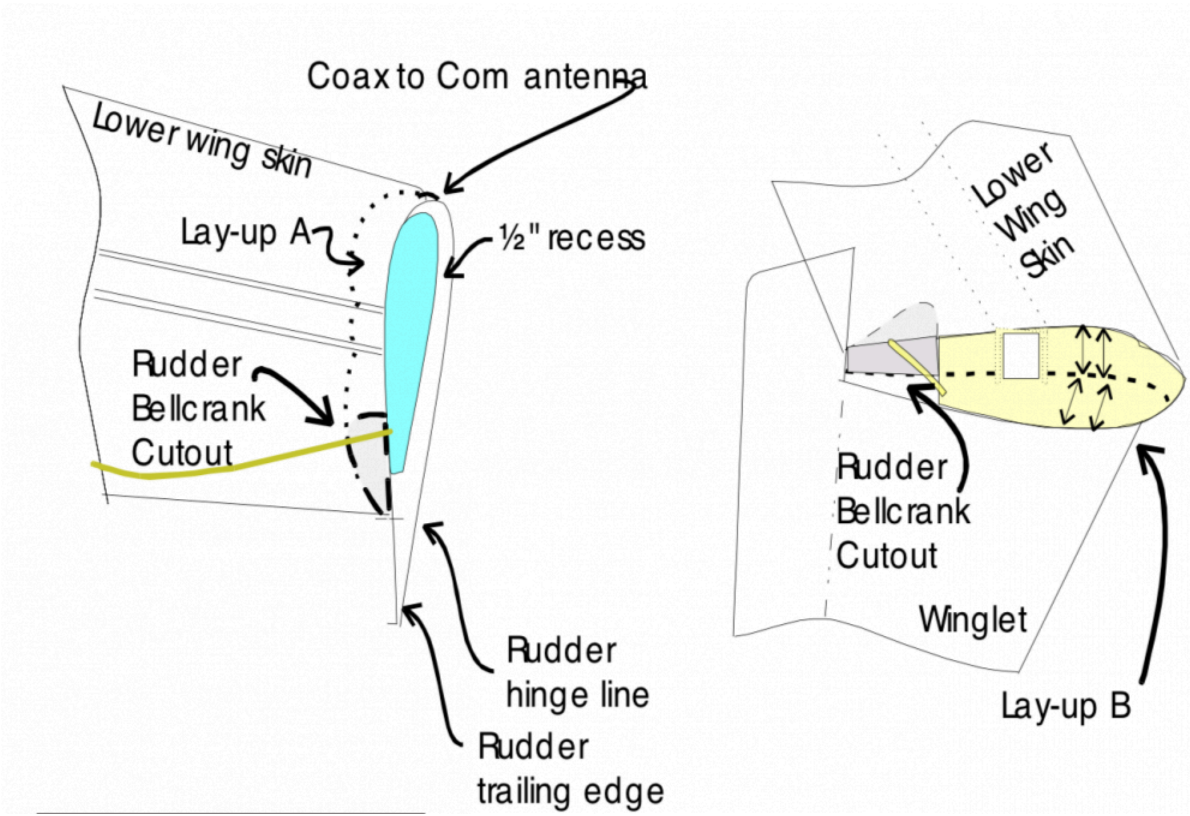


Figure 2-27. Lay-up A and B

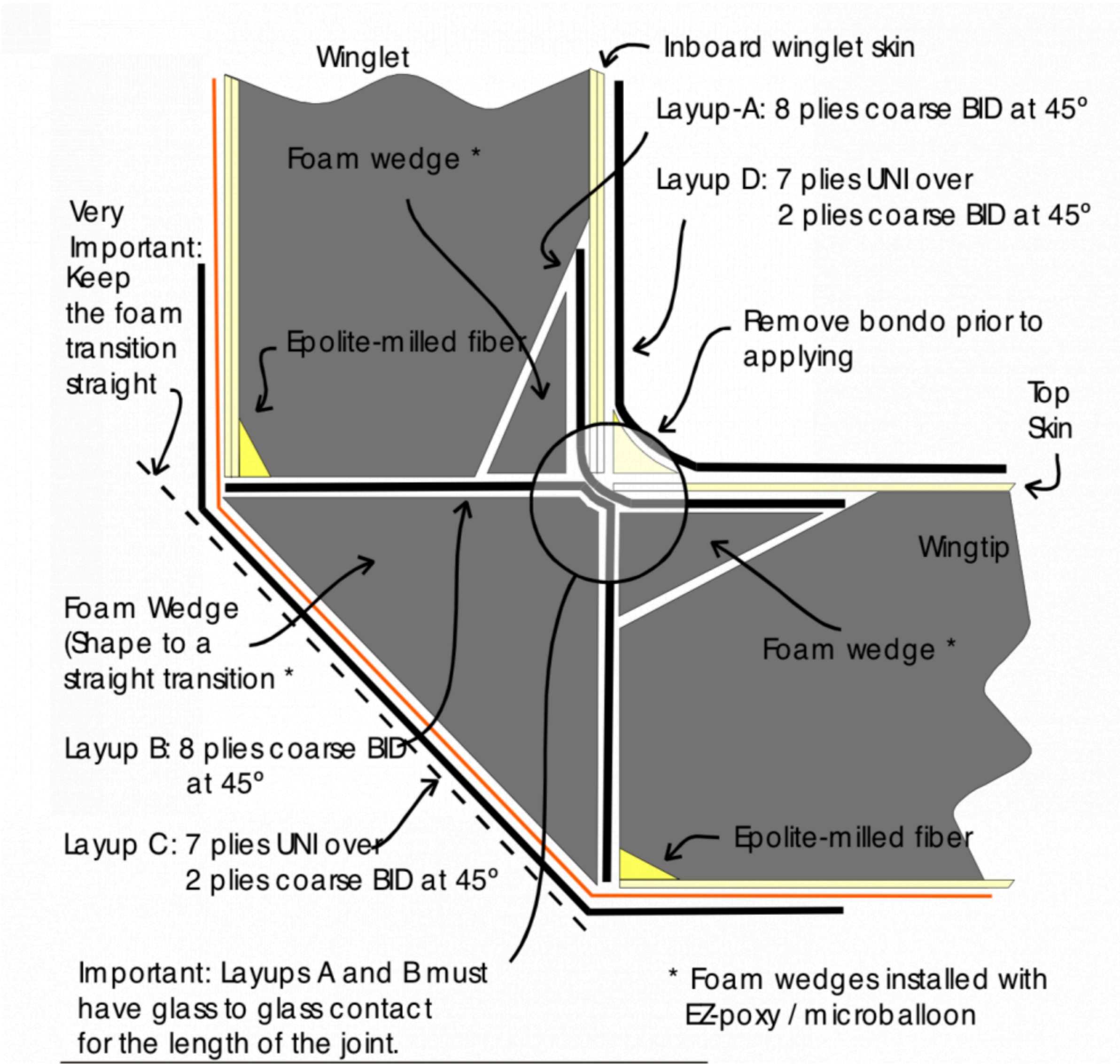


Figure 2-28. Winglet Attachment Layup Cross Section Detail

Layup A

___ Cut 8 plies of 4” × 12” coarse **BID** (cut on a 45 degree bias).

___ Start by inserting each ply into the 2” winglet recess (inboard side), wetting and stippling with a brush. Snip slots with scissors to straddle the wing spar shear webs and install the cloth into the 2” wing recesses (against inner top skin).

___ After the final ply, fill the remaining voids with the blue foam wedges that you cut out earlier, bonding them into place with **EZ-Poxy Micro-Balloon**, using the excess to fill in the smaller voids not filled by the foam wedges. Be careful not to go too fast and generate an exothermic condition that will damage the foam core.

Layup B

___ Following cure of layup “A”, sand the exposed blue foam of the winglet and the wingtip to make a smooth surface for layup “B”.

___ Cover the exposed foam with a **EZ-Poxy Micro-Slurry**, and fill the small 1/2” recesses in the winglet and the wingtip with **EZ-Poxy** and **Milled Fiber**.

___ Cut 8 plies of 7” × 16” coarse **BID**, all on a 45 degree bias.

___ Apply the 7 × 16 layers extending from the rudder conduit (front of the rudder bellcrank cutout) forward to the winglet **leading edge**. Refer to Figure 2-26.

Note: These lay-ups should make an excellent glass- to- glass contact with the corner of layup “A”, for the length of the winglet- to-wingtip junction.

|___| Be sure the rudder cable tubing exits the winglet 11-1/2” forward of the trailing edge.

___ Let cure, then trim off excess glass.

___ Cut and fit a block of foam in the corner recess formed by layup “B”. Bond in place with **EZ-Poxy Micro-Balloon**. Line up the trailing edge of the foam with the rudder bellcrank cutout.

___ Shape the outer surface to form a straight, not rounded, transition from the wing bottom to winglet outer surface. The contoured surface twists fore to aft but, must be a series of straight lines from the bottom wing skin to the outer winglet skin in order to get a wrinkle free layup. (referring to layup “C”).

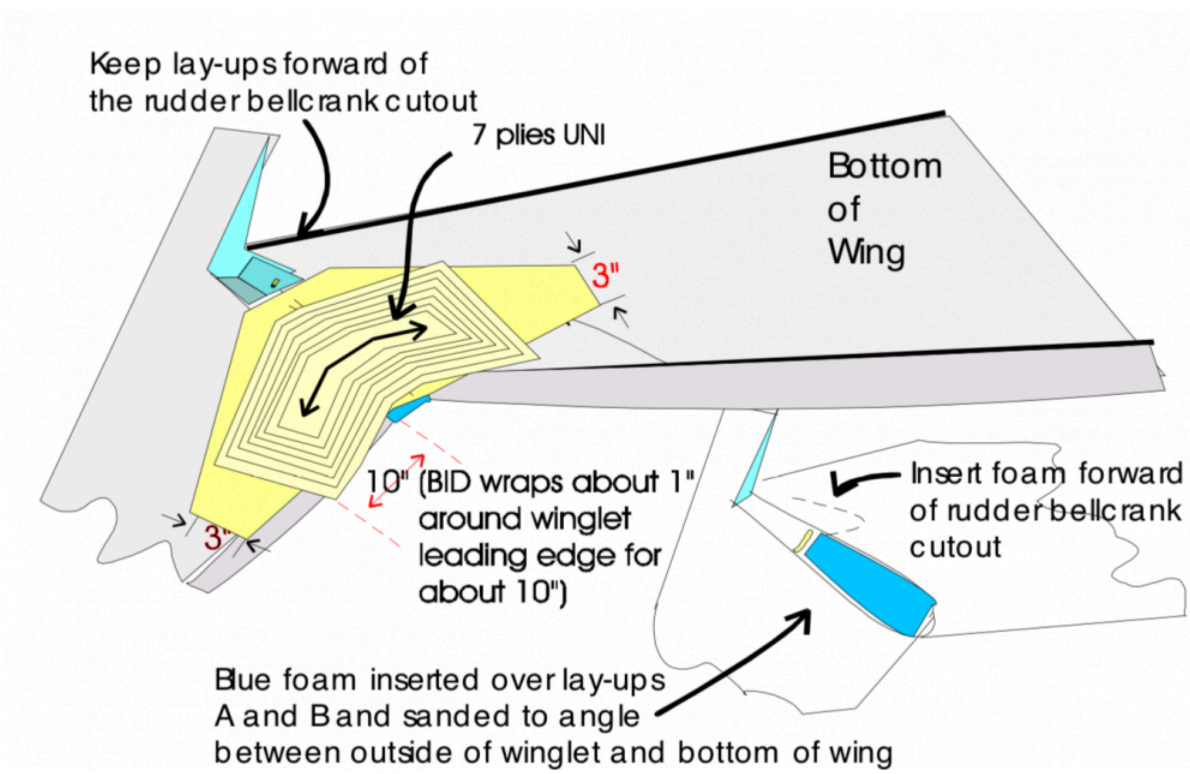


Figure 2-29. Layup C Detail

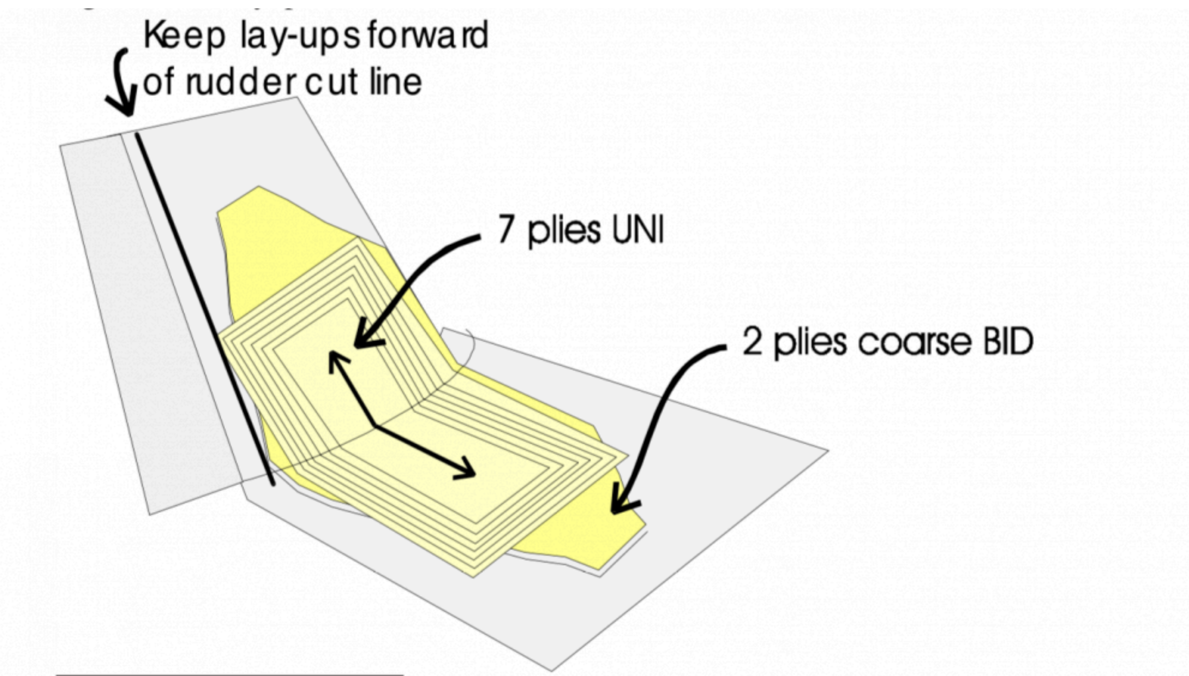


Figure 2-30. Layup D Detail

Lay-up C and D

___ Do lay-up C and D according to the schedule at the beginning of 2.5.4 cutting the **BID** on a 45 degree bias. The plies of **BID** wrap around the winglet **leading edge** about 1”, up to about 10” above where it joins the wing. See Figure 2-29.

2.7. 2.6 – Filling and Sanding Wings and Winglets

2.6 – Filling and Sanding Wings and Winglets

2.6.1 – Filling and Sanding Wings and Winglets

Note: Before cutting out ailerons or rudders you should have already filled and sanded your wing surface and prepped it through primer. This is very hard to do after you have cut your control surfaces out.

Wear a mask to prevent inhaling glass bubbles. Mix **VelociPoxy Micro-Balloon** to a consistency that barely runs out of the bucket.

___ Heap on material and trowel with a large blade. Control thickness with the blade- to- surface angle. A steep angle thins the coating and a shallow angle leaves more material. The builder will find it advantageous to fill in the depression left by the spar (both upper and lower surfaces) first, and let it cure .

___ Once cured, sand it down to more closely coincide with the wing curvature, then apply **VelociPoxy Micro-Balloon** over the entire surface of the canard.

Be aware that different mixes of slurry will sand differently, so try to minimize the number of filler applications that you make to any surface.

___ Following cure, you can start to obtain the contour with a small 17” long sander with 36 grit sandpaper. Make sure you always work your sandpaper at 45 degree overlapping passes. You can then move to a long sanding block (3’ or more) to smooth your contours. We generally start with 36 grit file sand paper and end the initial sanding process with 80 grit file sandpaper. Patience is a real virtue when it comes to the sanding process.

___ It is a good idea to seal the surface with primer once you have obtained the proper contour. We use a US Paints 545 primer here at Velocity. Epoxy compatible primers or urethane primers work well.

2.8. 2.7 – Ailerons

2.7 – Ailerons

2.7.1 – Aileron Cutouts

___ Starting at the wing tip **trailing edge** (where it meets the winglet), measure 30” **inboard** along the wing **trailing edge** and make a mark.

___ Make another mark on the **trailing edge** 72” **inboard** of the first mark (102” from your starting point).

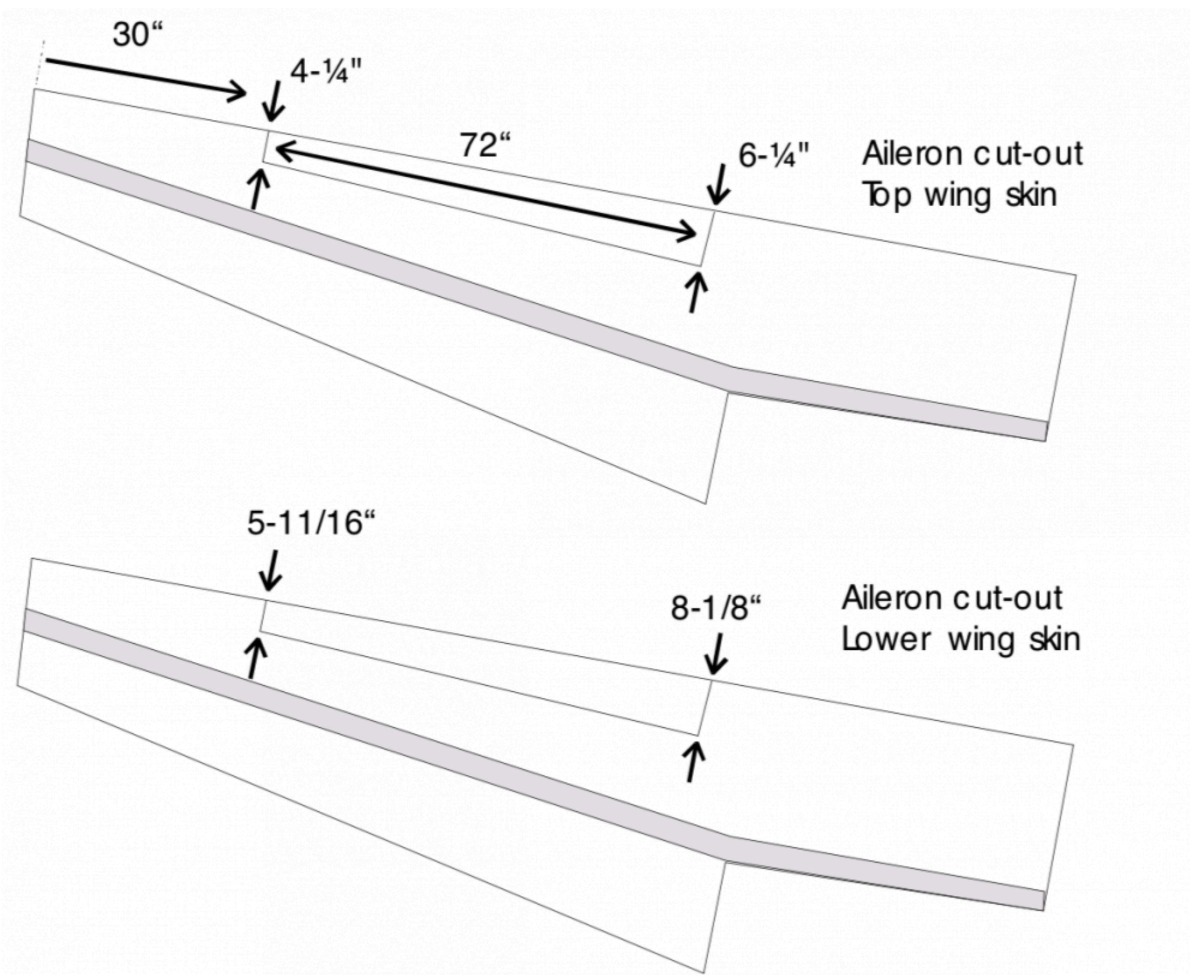


Figure 2-31. Aileron Cutouts

___ From the 30” mark, draw a line 4-1/4” long on the top surface of the wing, running perpendicular to the wing **trailing edge**.

___ From the same 30” mark, draw a line 5-11/16” long on the bottom surface of the wing, again perpendicular to the wing **trailing edge**.

___ At the **inboard** mark on the **trailing edge**, draw a line 6-1/4” long on the top surface of the wing, and one 8-1/8” long on the bottom. Both should run perpendicular to the wing **trailing edge**.

___ Connect the endpoints of the two lines on the top surface, and then connect the endpoints of the lines you drew on the bottom surface. These form the aileron cutout lines.

___ With a Dremel cutting wheel, cut through the skins along the aileron cutout lines. Use a knife or hacksaw blade to cut the foam at each aileron end. From the top side, cut the foam down to the bottom skin (not through it), angled slightly forward to leave more foam in the aileron. From the bottom, cut the foam back toward the **trailing edge** until the aileron is free (see Figure 2-32).

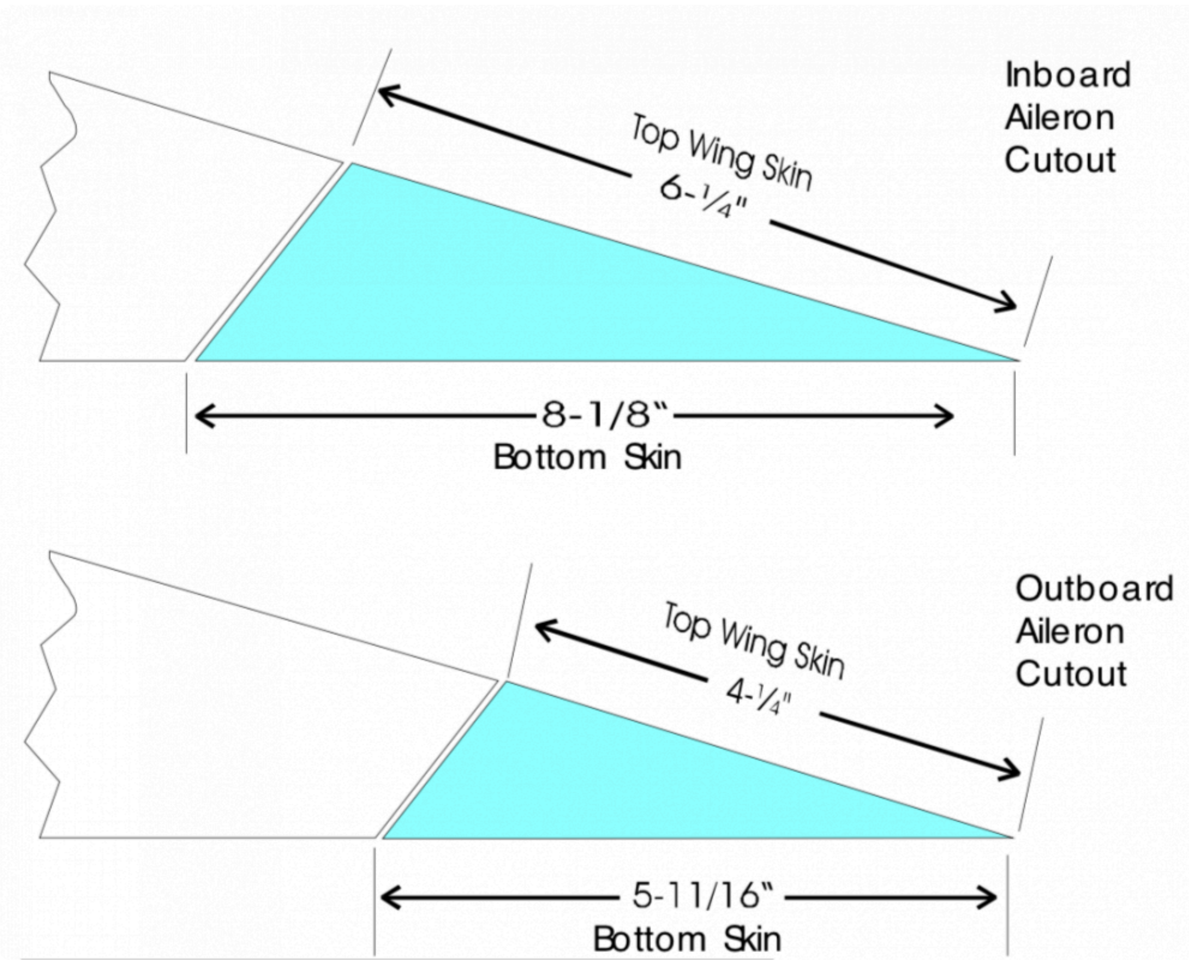


Figure 2-32. Aileron Cutout Detail - Cross Section

2.7.2 – Aileron Wells

Beginning 5” from the **inboard** end of the ailerons and aileron well, measure and mark the hinge center positions 31” apart (top of wing). There is one 8” hinge **inboard** and two 6” hinges **outboard**.

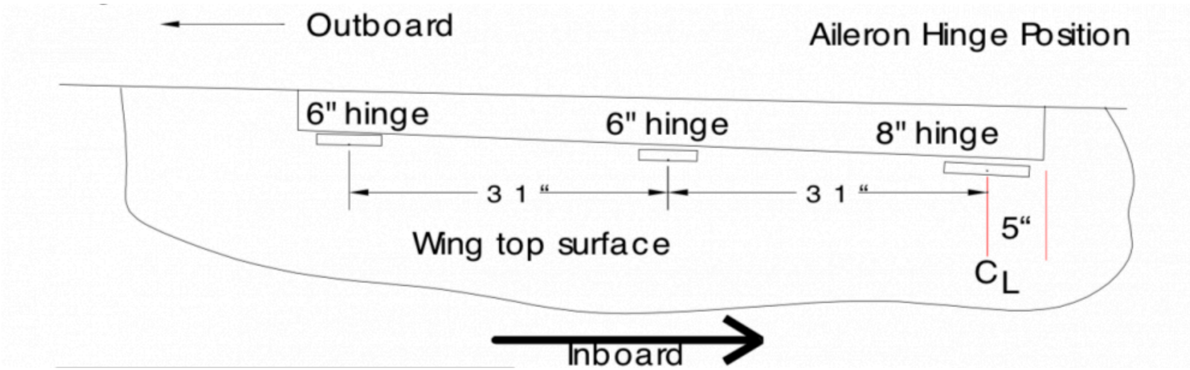


Figure 2-33. Aileron Hinge Location

___ Remove foam from the aileron cutout (see Figure 2-34). Recess the cutout ends 3/4” to form small ribs. You may use tubing with coarse sandpaper to achieve the final configuration of the well which is to be a concave cavity. Expose 1-1/2” of upper inner skin, and 3/ 4” of lower inner skin for the length of the aileron cutout.

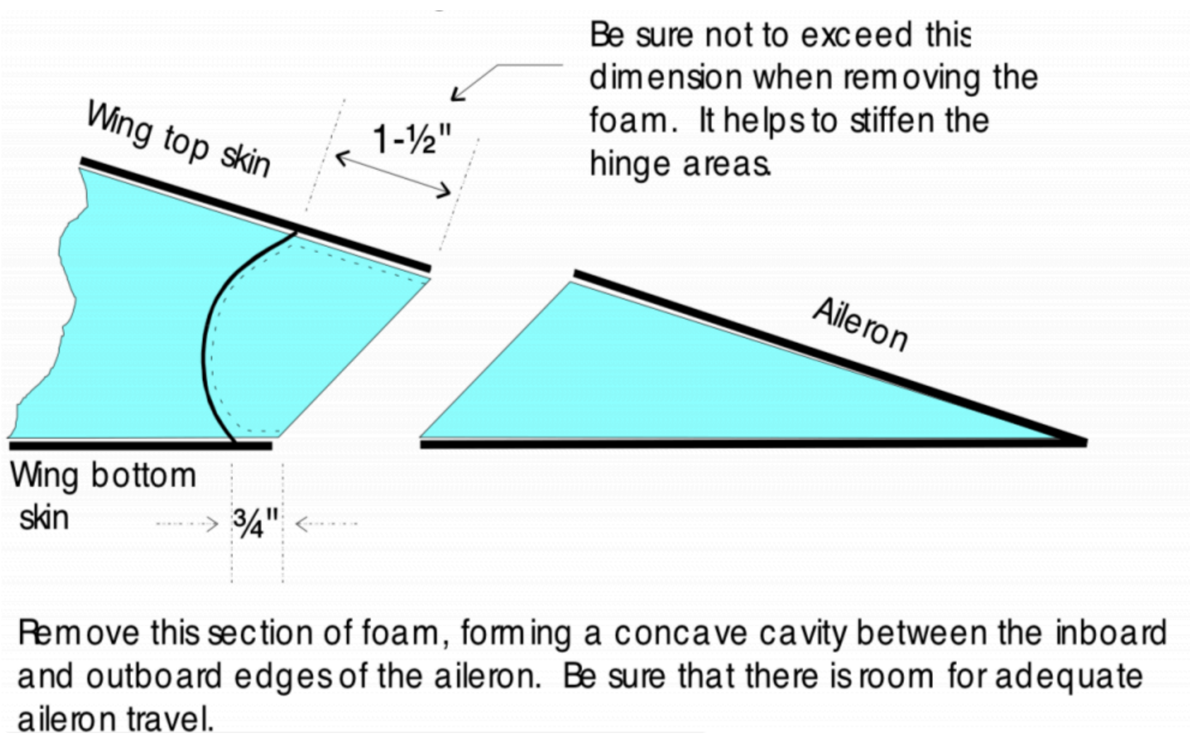


Figure 2-34. Aileron Well Contouring - Cross Section

___ Make a template of the ends of the ailerons so you can make sure you remove enough foam. Refer to section 2.7.4 to allow for the counterweight on the front of the aileron. This is usually where contact with the cutout is most noticed.

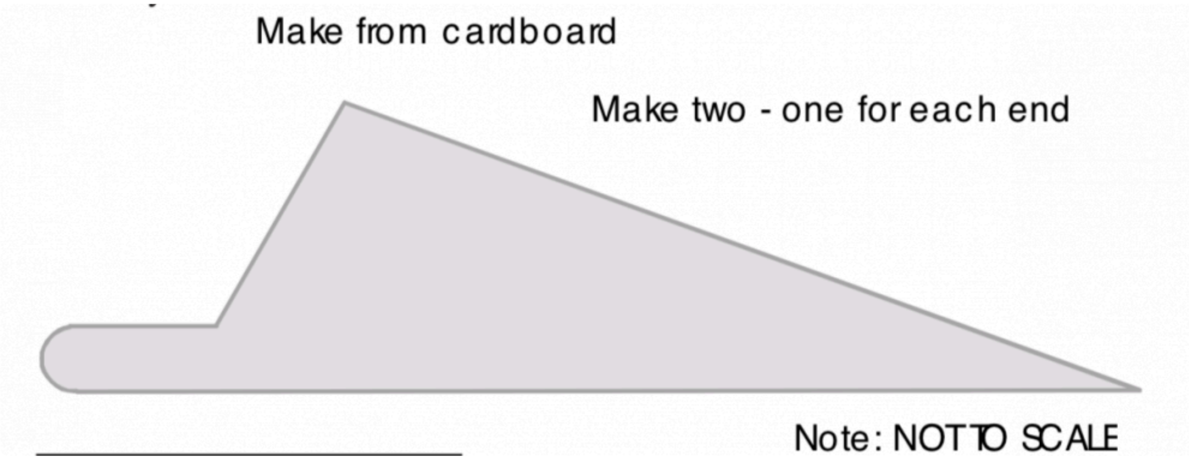


Figure 2-35. Aileron Template

2.7.3 – Glassing Aileron Well and Ribs

___ Sand the exposed inner skins, Micro-Slurry the exposed foam, wet the glass areas, and lay-up 3 plies of 6” × 72” BID, and small pieces for the aileron well end ribs.

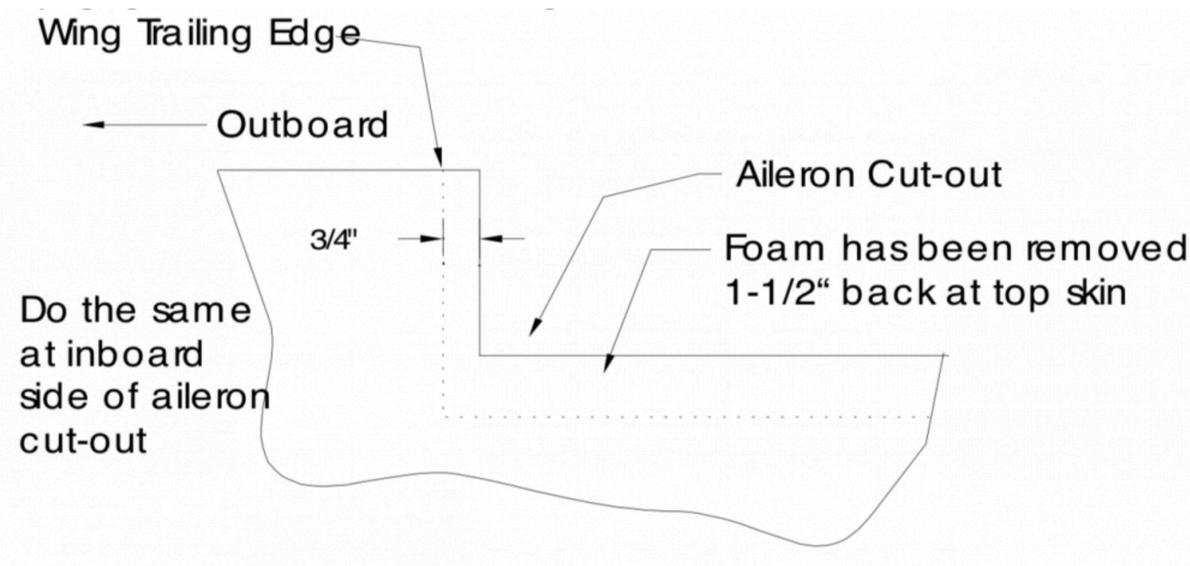


Figure 2-36. Foam Removal for Aileron Wells and Ribs

___ In addition to removing the foam section just forward of the aileron, also remove foam at the sides of the aileron cutouts (see Figure 2-36). Remove about 3/4” of foam, exposing the inner surfaces of the wing skins. You are constructing a rib, just like the ones at the wing root.

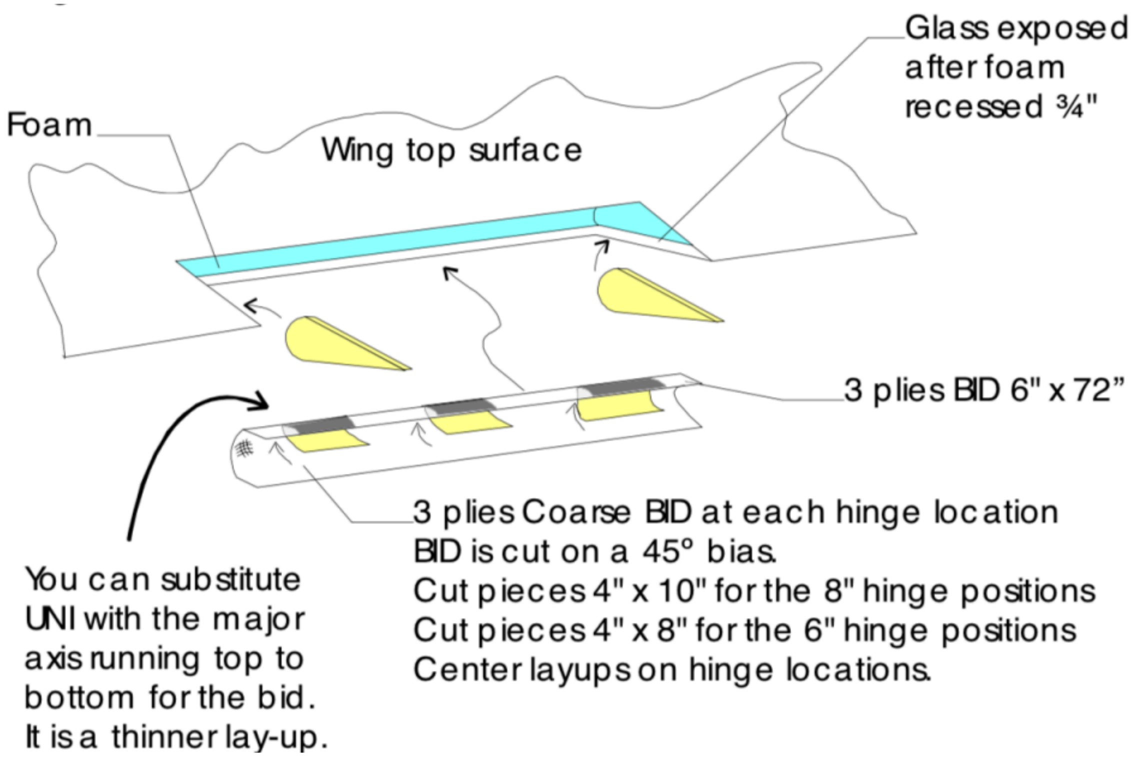


Figure 2-37. Aileron Well Reinforcement

___ Cut (6) pieces of 4” × 10” coarse **BID**, and 12 pieces of 4” × 8” coarse **BID**, all on a 45 degree bias. Apply three plies of the 4” × 10” **BID** at each of the 8” hinge locations, and three plies of the 4” × 8” **BID** at the 6” hinge locations. These lay-ups will serve as reinforcements, and are shown in Figures 2-37 and 2-38.

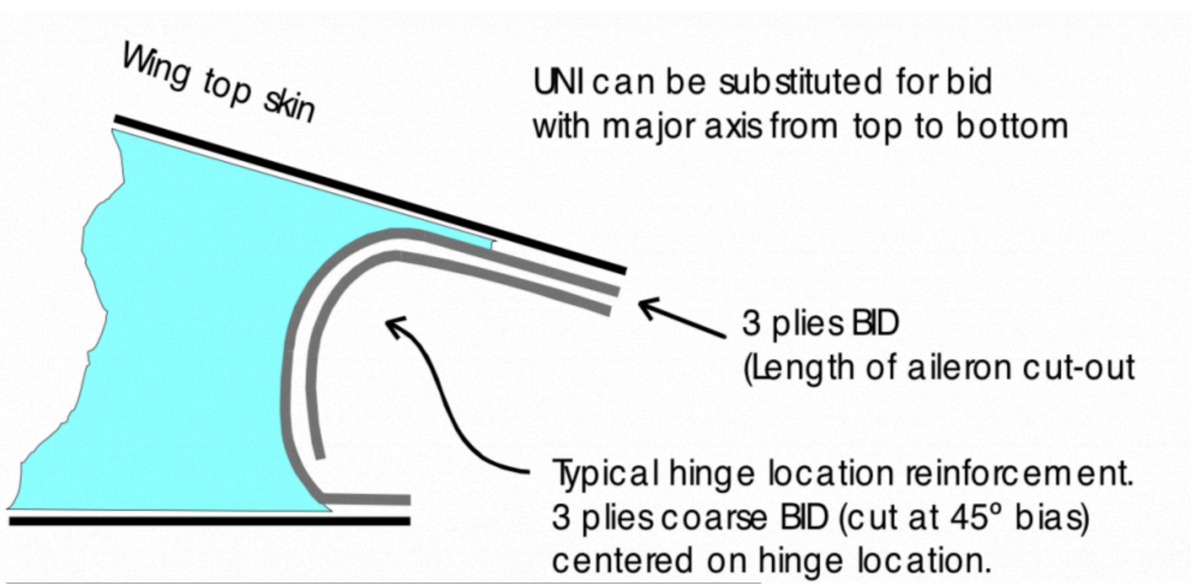


Figure 2-38. Aileron Well Reinforcement - Cross Section

2.7.4 – Aileron Construction

Light weight, **balanced** ailerons are critical to the performance and safety of your aircraft. The reasons for our concern in the area of aileron weight and balance are:

1. The Center of Gravity of the ailerons is at station 180, which is approximately. 60" aft of the aircraft's in-flight Center of Gravity. Overweight ailerons are detrimental to the overall Center of Gravity of the aircraft.
2. Overweight ailerons lower the aircraft's aerodynamic resistance to flutter, even though the ailerons are in balance. The excessive weight of the ailerons could induce twisting in the wings under certain gust loading conditions, due to the mass concentrated at the trailing edge wing panel.
3. Out of balance ailerons can flutter, and can cause flutter in the airframe, which is usually catastrophic. The ailerons must be balanced!

This section describes the preferred method of building the ailerons. They should weigh around 9 pounds when finished.

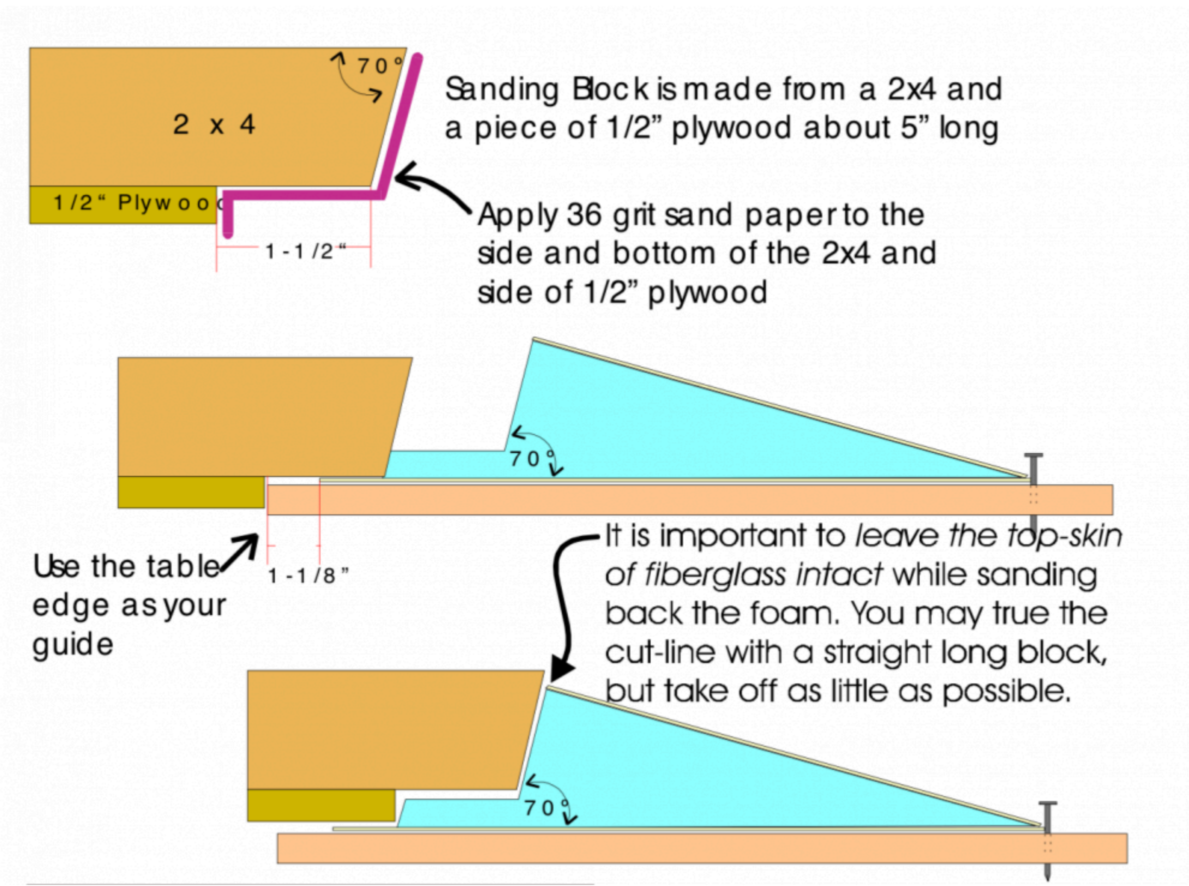


Figure 2-39. Sanding Leading Edge of Aileron

Warning: Excessive removal of top skin during foam-core sanding (fig. 2-38) increases the gap between the trailing edge of the wing, and the aileron.

___ Make a sanding block using a 2 × 4 and piece of 1/2" plywood. Refer to figure 2-39.

___ Install your ailerons so the bottom skin leading edge is 1-1/8" away from the edge of the table. We use hollow core Luwan doors. Insert a few nails along the trailing edge of the aileron to keep it from moving when you start sanding.

___ Using your sanding block and the table edge as a guide sand the front of the aileron foam off down to the outer skin.

___ Next rest the bottom of the 1/2” plywood part of the sanding block flat against the bottom skin of the aileron that you just sanded. Sand the exposed foam until your reach the top skin fiberglass.

___ Make sure you keep the block as square to the table as you can and try not to take away any of the top skin glass. If you do you will change the hinge mounting locations.

___ Now you can install the counterweight. Remove the nail and push the aileron back from the edge of the table. Draw the outline of the aileron as it lies flat. At the inboard end of the aileron drawing, project the 8-1/8” line forward 1/8”, and make a mark 8-1/4” forward of the trailing edge.

___ At the outboard end, project the 5-11/16” line forward 1/8”, making a mark 5-13/16” forward of the trailing edge.

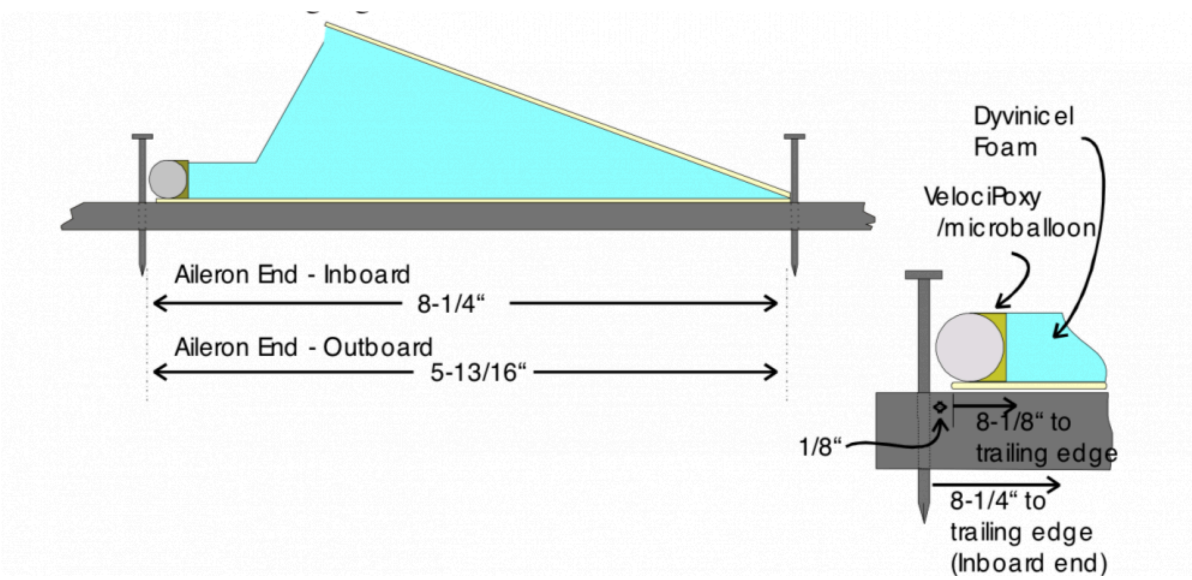


Figure 2-40. Foam Inserts for Ailerons

___ Draw a line between the two marks that you just made. If you place the aileron in position in the outline, there should be a 1/8” space between the lower skin leading edge and the line you just drew. The line represents the leading edge of the lower aileron once the counterweight and **BID** layer are installed. The aileron leading edge cannot extend beyond this line.

___ Drive several nails into the wood, just touching the boundary lines so that you can lay the aileron back into the outline. Cut (2) 72” sections of aileron counterweight rod. Install each section on the bottom **leading edge** of the aileron with 5 minute epoxy, without having any part of the aileron fall outside these boundaries. The nails will serve as a stable support for the counterweight while the **5 Minute Epoxy** and **VelociPoxy Micro-Balloon** is curing.

Note: IMPORTANT: The finished length between the counterweight leading edge (with one ply of BID applied) and the aileron trailing edge must not exceed 5-13/16” at the outboard end nor 8-1/4” at the

inboard end. The maximum counterweight protrusion into the airstream after installation must not exceed 1/2” at the outboard end nor 3/4” at the inboard end.

2.7.5 – Torque Tube and Hinge Backing Plates

___ Carve a 3/4” channel 5/8” down, 9” long, parallel to the top skin at the inboard end of the aileron. The torque tube is 3/4” x 10-1/2” so that 1-1/2” extends beyond the aileron.

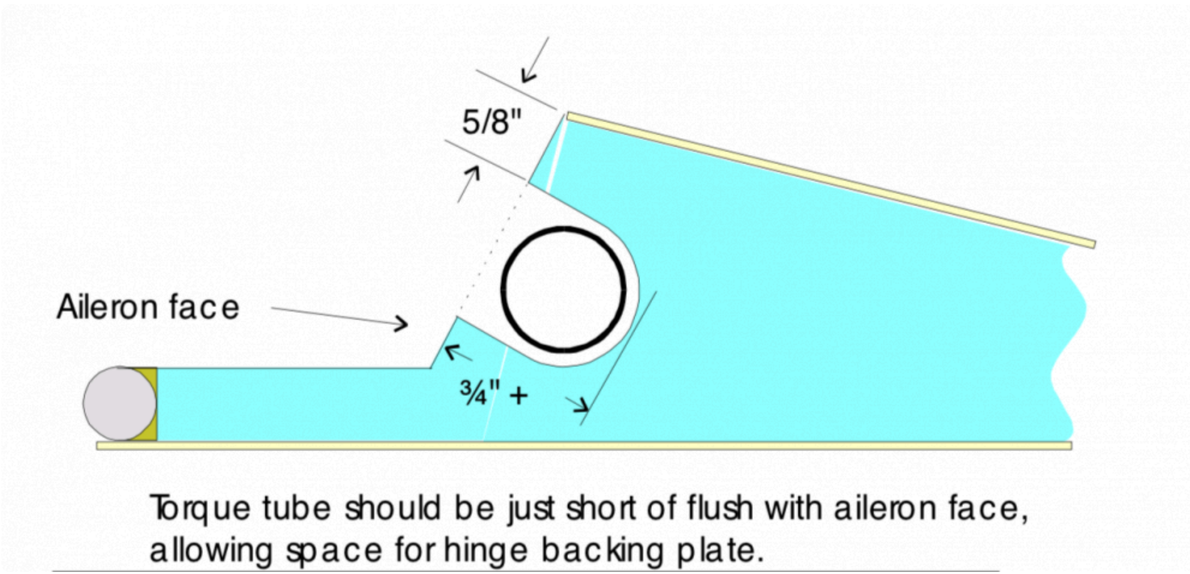


Figure 2-41. Torque Tube and Hinge Backing Plate Channel Cross Section

The torque tube should fit about 1/16” short of flush with the forward face of the aileron, allowing for the thickness of the **inboard** position hinge backing plate (see Figure 2-41).

The torque tube channel extends 9” into the aileron from the **inboard** end. 1-1/2” of the tube should extend from the end of the aileron when correctly installed.

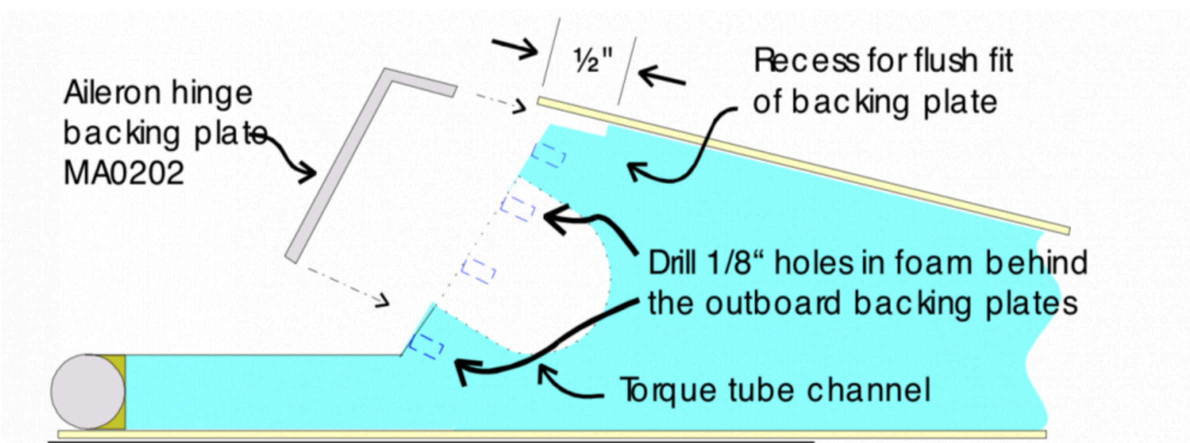


Figure 2-42. Hinge Backing Plate Installation - Cross Section

___ Cut a 1/2” deep slot under the top skin at each hinge location to accommodate the short bent portion of the hinge backing plate. Drill about twelve 1/8” equally spaced holes behind the two outboard backing plates.

- Check the fit of the backing plate in the slot, then recess the foam just a bit so that the plate fits flush with the forward face of the aileron (see Figure 2-42). Aslight modification to the bend in the backing plate may be necessary to get it to conform to the rest of the aileron face. You want the bend in the plate as close to the upper **leading edge** as possible, but still want the plate to be flush with the forward face of the aileron.

___ Drill holes in the short flange of the backing plate to allow penetration of the **VelociPoxy Micro-Glass** for better bonding. Sand the torque tube and angular backing plates.

___ If you have already Micro-Ballooned your wings, sand micro down to the glass about 1/2” back from the top and bottom **leading edge**’s for bonding. Also sand the torque tube and angular backing plates.

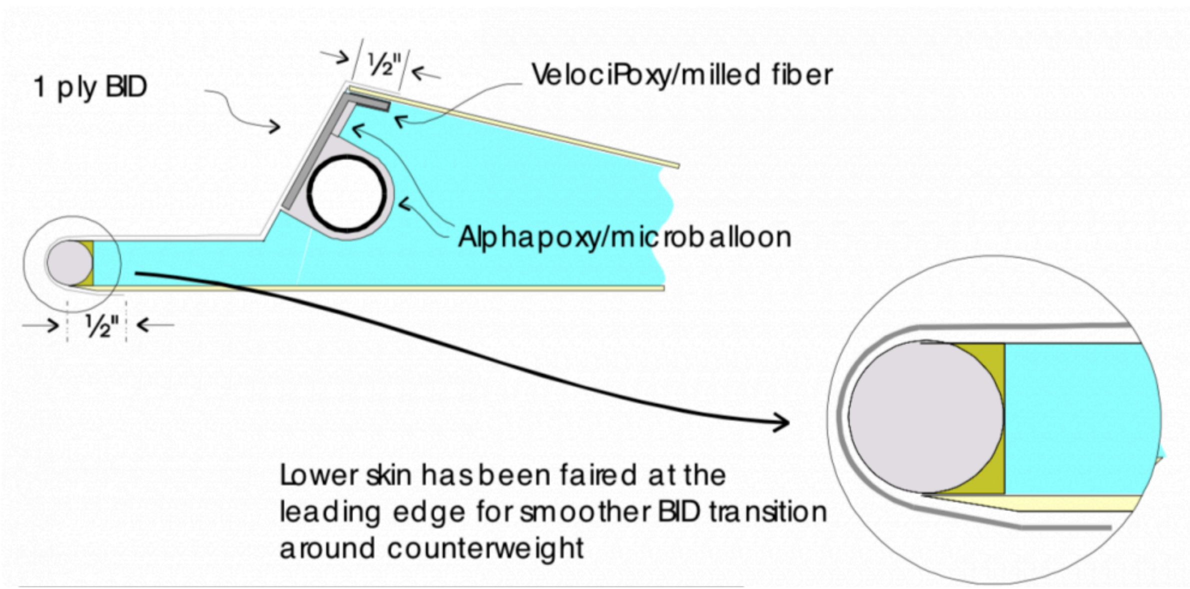


Figure 2-43. Aileron Counterweight Detail Cross Section

___ Taper the lower skin **leading edge** into the counterweight, as shown in the inset in Figure 2-43. This will make for a smoother transition when you apply the lay-up to the forward face of the aileron.

___ Install the torque tube with **VelociPoxy Micro-Glass**, keeping it parallel to the top and **almost** flush with the forward face of the aileron (to clear hinge backing plate.

___ The backing plates for the hinges are installed with two different fillers. The short flange, which fits on the top face of the core, is installed with **VelociPoxy Micro-Glass (Milled Fiber)**, whereas the bond between the long flange and the foam is made with **VelociPoxy Micro-Balloon**.

___ Slurry the exposed foam with **EZ-Poxy Micro-Balloon**, then apply 1 ply of **BID** extending the length of the aileron. It should be cut at the usual 45 degree bias. Apply the cloth as shown in Figure 2-43, overlapping the top skin **leading edge** by 1/2”, forward around the counterweight, and on to the bottom skin by 1/2”.

___ Cover the **inboard** and **outboard** ends of the ailerons with one ply **BID**.

2.7.6 – Hinge Installation

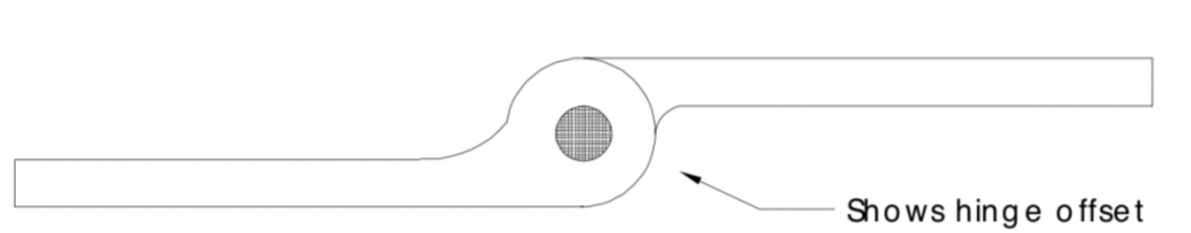


Figure 2-44. Aileron Hinge Offset

___ Find the 6’ section of aileron hinge provided with the kit. Remove the hinge pin, reverse the halves to offset the hinge as shown in Figure 2-44 and replace the pin.

___ Cut four hinges 6” long and two hinges 8” long. The remainder will be used for the rudder hinges, which are not offset.

- After the hinges are cut it is a good idea to cut each hinge pin about 1/8” shorter or grind to a point and peen the end of each hinge closed to trap the hinge pin in. This will make sure that you do not loose your hinge pins.

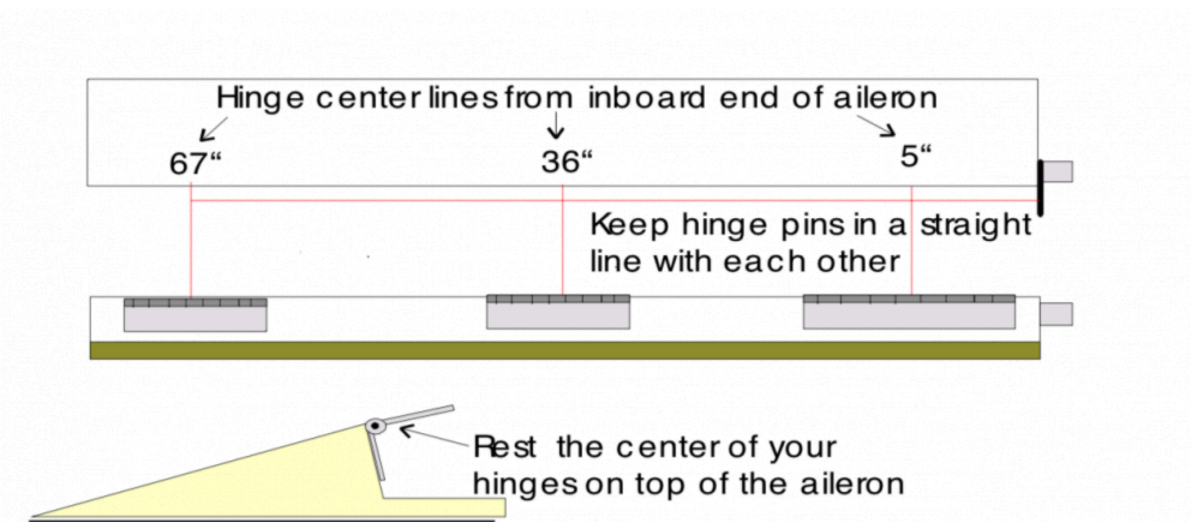


Figure 2-45. Aileron Hinge Notches

___ From the inboard end of the aileron measure and mark the centerline positions as shown in Figure 2-45.

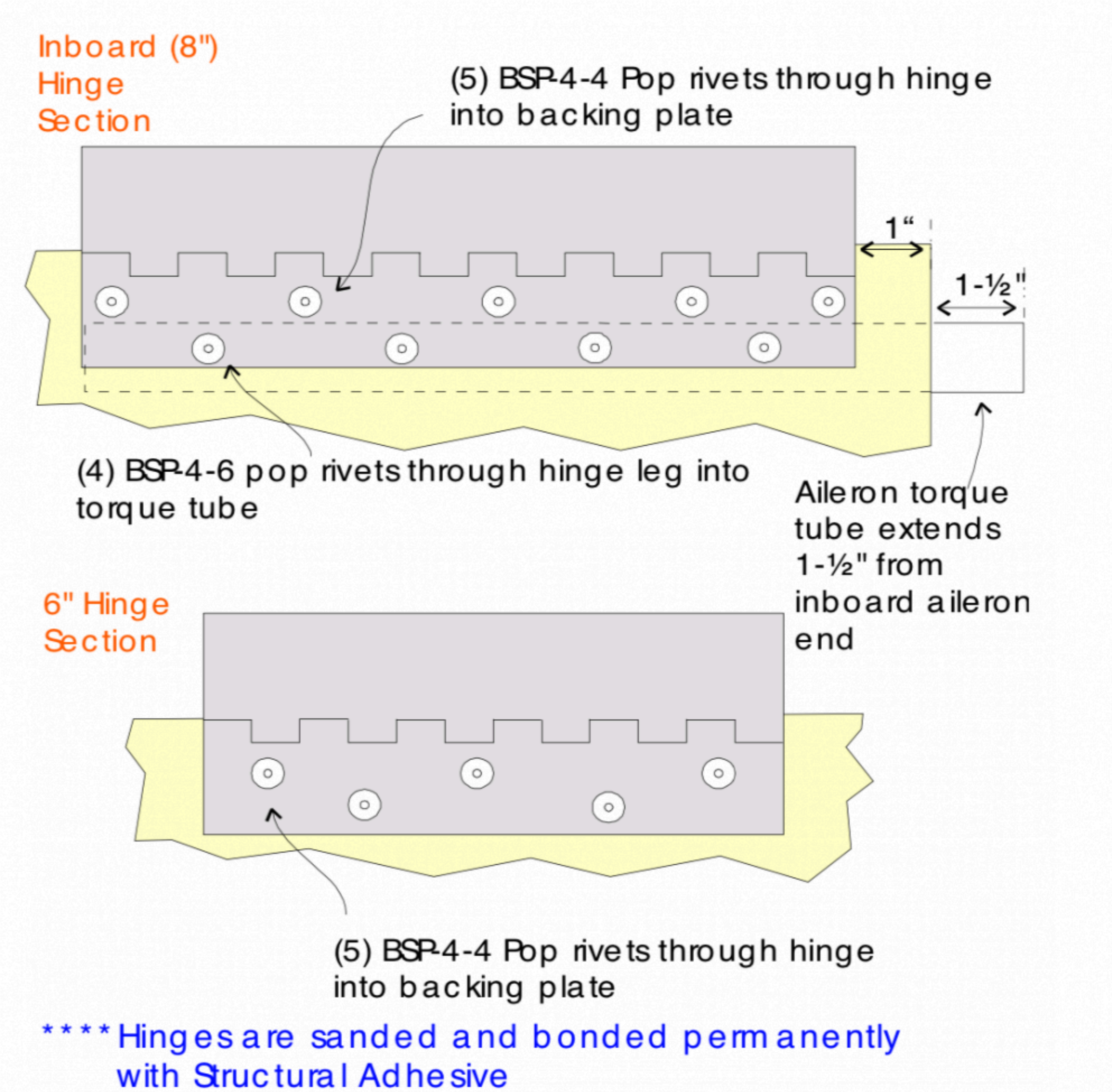


Figure 2-46. Aileron Hinge Attachment

Install the two 6” outboard hinges as shown in figure 2-46. Make sure you sand both the hinge and aileron before you use structural adhesive and rivets to mount the hinge on.

Install the 8” inboard hinge as shown in figure 2-46. Pay close attention to make sure that your lower rivet holes are into the center of the aileron torque tube that is under the surface.

___ Cut or sand at least an 1/8” from the **lower** wing cutout **trailing edge** for future clearances of the counterweight. Sand all edges straight.

___ Now you are ready to install the aileron to the trailing edge of the wing.

___ Place your aileron back up in the aileron well and mark your aileron hinge locations on the wing. Cut an 1/8” notch out of the wing forward of the hinge locations. After you have done this you can use a file or a sanding block to radius the trailing edge of the slots to allow the hinge to rest squarely against the inside of the aileron well.

___ Make trial fits and sand or file away interferences so that the aileron installs back into the cutout properly. Slight misfits may be corrected with micro-spheres filling and sanding later. You want the trailing edge of the aileron to be equal with the trailing edge of the wing.

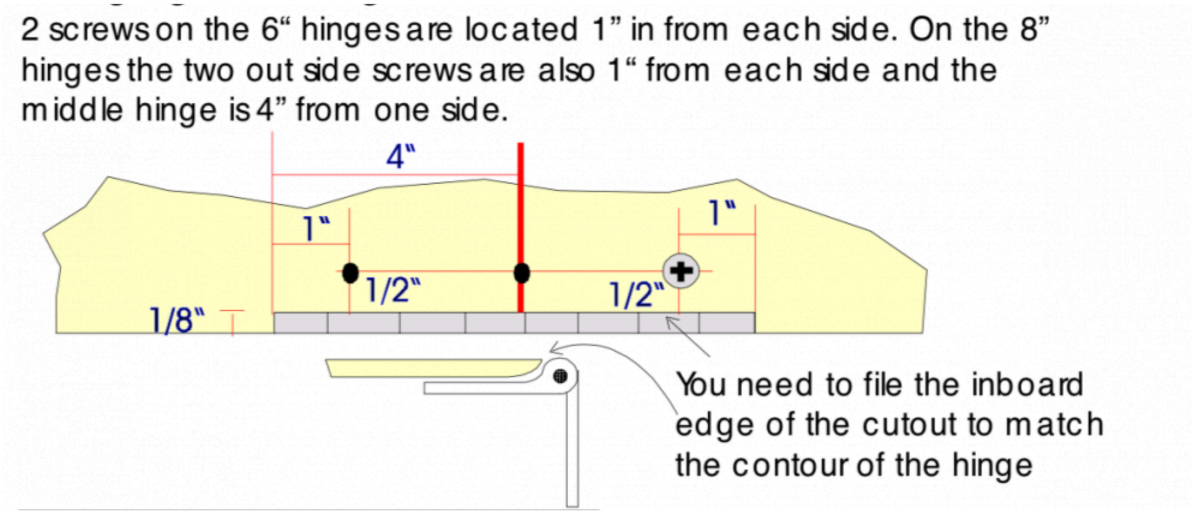


Figure 2-47. Trailing Edge of Aileron Well

___ Predrill (2) 1/8" mounting holes in the wing at each 6" hinge location , and (3) 1/8" holes in the wing at each 8" hinge location. Refer to Figure 2-47 for spacing.

___ Hold the aileron up in place in the aileron well. This is easier to do with a partner. While holding the aileron in place rotate the trailing edge up slightly. Slide a Rigid straight edge up in the slot to put pressure on the hinge from the back side. When you are satisfied that the hinge is in its proper location mark one of the screw locations on each hinge. Remove aileron from wing and drill out the one screw location on each hinge to 1/8".

___ Reinstall hinge to aileron well using cleco's. After the aileron is back in its location and you are satisfied with the fit of the hinges use the predrilled holes in the wing to drill the remaining holes in the ailerons. After each hole you drill install a cleco in the hole.

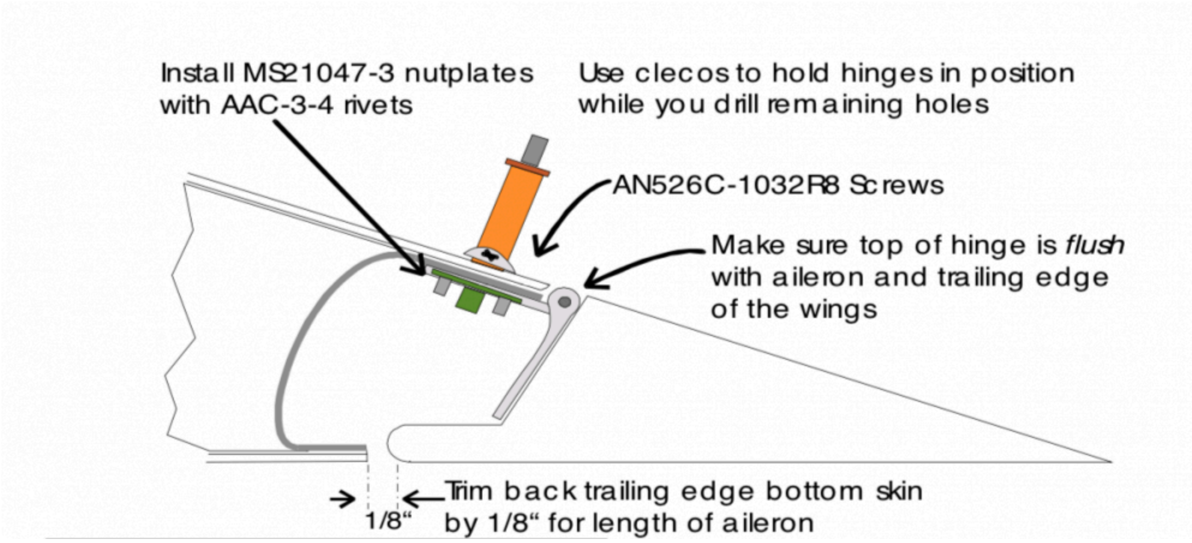


Figure 2-48. Locating Aileron Hinge

___ After all the holes are drilled and the hinges are held in place with clecos check operation of aileron. When satisfied with aileron hinge placement remove one cleco at a time and drill through both the wing and hinge with a 3/16" drill. You may want to do this to one hole on each hinge and then remove the aileron and install MS21047-3 nutplates. Reinstall hinge with AN526C-1032R8 screws, and open up remaining holes to 3/16". Install remaining nutplates. Refer to Figure 2-48.

2.7.7 – Balancing the Ailerons

Note: This is critical to the safe operation of your aircraft. Proper balancing of the ailerons is directly related to your aircraft's Vne (Never exceed speed.) If the ailerons are not properly balanced, flutter can occur at any airspeed with catastrophic results.

___ Hold After hanging your ailerons (see Figure 2-49) – they should balance such that a chord line (from the trailing edge, projecting through the center of the front of the aileron) will be slightly nose-down. It is better to reach this balance point by removing material from the aileron surface aft of the pivot point, than to add weight in the counterweight area. If weight must be added, add with patches of glass or rivets.

Note: The finish coat will add some weight to the aft portion of the aileron and the assembly will need to be re-balanced following application of finish coat.

___ Once you have shot your finish coat, you will need to re-balance your ailerons. Use the same method described above. Two things must hold true for you to use these ailerons:

1. The total weight of each aileron must not exceed 9.5 lbs. In the case that you are too heavy, and you have removed all the material that you feel you can – notify us. We will supply you with new aileron cores, as well as directions for a new procedure that we have used here at the factory to construct lighter units. As the ailerons sit at about station 180, there is an advantage CG-wise in decreasing the total weight of the assembly.
2. The aileron must still balance with the chord line still slightly nose down.

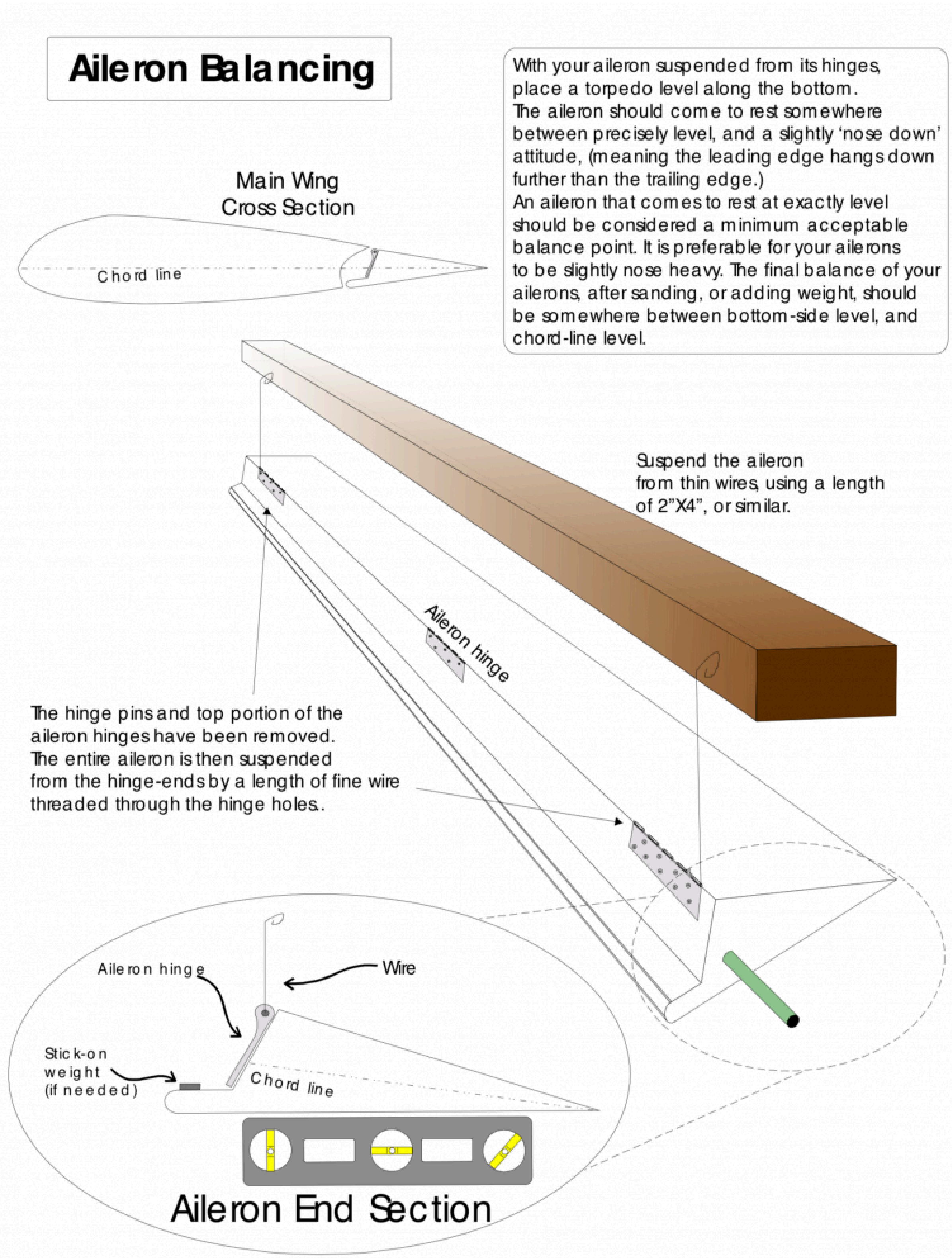


Figure 2-49. Aileron Balancing

2.9. 2.8 – Rudders

2.8 – Rudders

2.8.1 – Rudder Cut-Outs

Note: Before cutting out rudders you should have already filled and sanded your winglet surface and prepped it through primer. This is very hard to do after you have cut your control surfaces out.

___ Cut out the rudders along the previous markings that were made earlier in this section during the winglet construction.
image

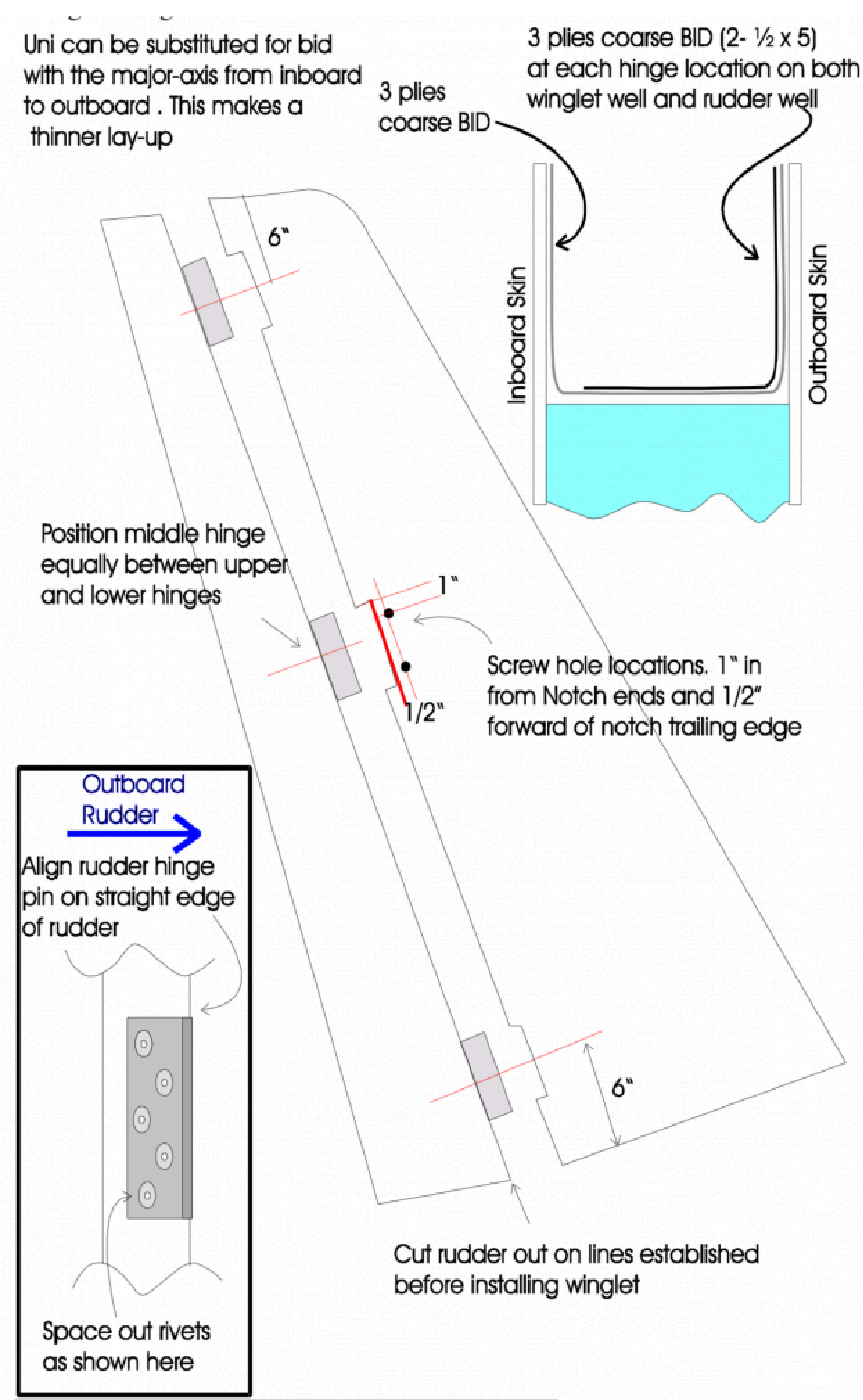

Uni can be substituted for bid with the major-axis from inboard to outboard . This makes a thinner lay-up
3 plies coarse BID
3 plies coarse BID (2- ½ x 5) at each hinge location on both winglet well and rudder well
Inboard Skin
Outboard Skin
6"
Position middle hinge equally between upper and lower hinges
1"
1/2"
Screw hole locations. 1" in from Notch ends and 1/2" forward of notch trailing edge
Outboard
Rudder
Align rudder hinge pin on straight edge of rudder
Space out rivets as shown here
6"
Cut rudder out on lines established before installing winglet

Figure 2-50. Rudder Cut Out and Well Reinforcement

2.8.2 – Rudder and Rudder Wells

___ Beginning 6” from the top and bottom of the rudder and rudder well, measure and mark two hinge center positions on the outboard side. They are all 4” hinges. Figure 2-50 shows the hinge locations. The rudders will hinge at the outboard surface of the winglet (the flat side). Remove 1-1/4” foam from the winglet rudder wells and rudders.

___ Sand the exposed inner skins, **Micro-Slurry** the exposed foam, wet the glass areas, and layup 3 plies of 4” × 60” **BID**, and small pieces for the rudder well end rib.

___ At each hinge location (both in the winglet well and the rudder well), apply three plies of 2-1/2” x 6” **BID** cut at a 45 degree bias. The pieces should fit as shown at the top of Figure 2-50 , extending across the bottom of the well and up the inner surface of the outboard skin to the rudder cut line. Let cure, then trim and sand flush with the cut line.

2.8.3 – Rudder Hinge Installation

___ Sand all edges straight.

Figure 2-51. Rudder Hinge Profile

___ The rudder hinges are different than the aileron hinges. You are still using the same MS200001-P6 piano hinge but the two hinge halves have to be assembled as shown in Figure 2-51.

___ Cut six 4” long pieces of hinge for your rudder hinges.

- After the hinges are cut it is a good idea to cut each hinge pin about 1/8” shorter or grind to a point and peen the end of each hinge closed to trap the hinge pin in. This will make sure that you do not loose your hinge pins.

___ Install the hinges on the rudder along the marks that you placed. Refer to Figure 2-50. Drill through the hinges and skin and countersink the outer skin for 1/8” flush head pop rivets. Make sure to keep the hinge pins in line so you do not have any binding. Use the straight edge of the rudder to do this. Detach hinges, clean off the epoxy and sand the hinges and mounting areas for bonding. Apply **Structural Adhesive** to the hinges and mounting areas on the rudder and pop rivet the hinges to the rudder. Use 5 rivets (BSC-4-4), staggered on each hinge. Let cure.

___ Cut 1/8” notches in the rudder well to accept the hinges as you did for the ailerons. You will have to file the trailing edges of this notches in order to allow the hinge to sit flush with the outside skin.

Remove the rudders and drill two 1/8” holes per hinge notch. The holes should be 1 inch from the ends and 1/2” forward of the trailing edge of the notch.

This next step is easier with a partner. Reinstall the rudders and use a straight edge to put pressure on the hinge from the back. Mark the hinges through the holes in the rudder well. Remove the rudder and drill one hole out on each hinge to 1/8”. Reinstall the rudders with 1/8”clecos in the holes you drilled. Check the rudders for proper operation. When satisfied with you rudder installation drill the remaining holes in the rudder out to 3/16”.

___ Remove the rudder and install MS21047-3 nutplates with AAC-3-4 rivet on the holes you just drilled as you did with the aileron hinges.

___ Reinstall the rudder with AN526-1032R8 screws and drill the remaining holes.

___ Remove rudder and install nutplates on the remaining screw holes.

2.8.4 – Rudder Horn Installation

___ Remove 3/4” of foam from the bottom of the rudder.

___ Place your rudder horn on the bottom of your rudder. Line up the flat side of the rudder horn with the outside skin of the rudder. Make sure that the rudder cable attach hole is 5” forward of the hinge point. Refer to Figure 2-52.

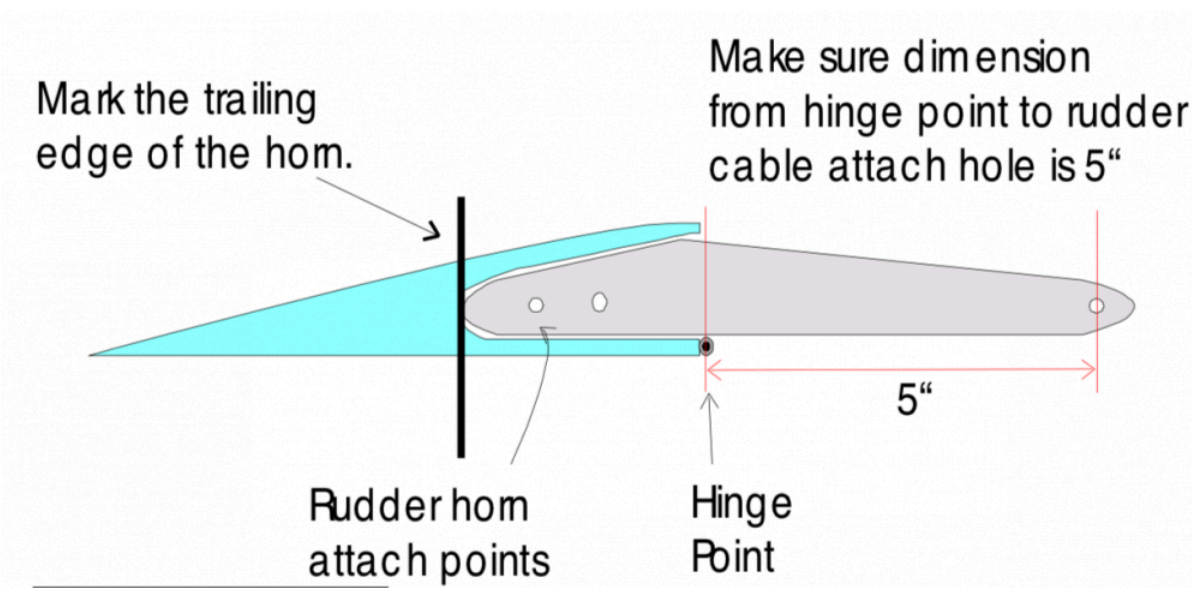


Figure 2-52. Rudder Horn

___ Mark the trailing edge of the horn on the rudder.

___ Slurry the foam and install the hardpoint making sure that it is flush with the rear line you drew for the horn. You also want to make sure that the marks you drew for the screw locations are somewhat centered on the hardpoint. Cover with 3 bid. Let cure.

___ Once you have fit your rudder horn to your rudder you will need to drill it for the attachment holes. Drill two #21 hole through the rudder horn.. Make sure that the holes are aft of the rudder hinge point. To install rudder horn test fit the horn so that the straight edge of the horn is parallel to the hinge side of the rudder and that the 5 ” dimension is correct. When satisfied with location drill into hard point with #21 drillthrough the holes you previously drilled in the horn. Tap the hardpoint with a 10- 32 tap. Drill the holes in the rudder horn out to 3/16”. Install horn to hardpoint using two 10-32 screws.

___ Install rudder to winglet. Check to make sure the end of the horn where the rudder cable attach hole is in the same “plane” as the Nylaflow coming out of the end of the wing for the rudder cable. If it is not you can bend the rudder horn slightly just forward of the hardpoint attach screws.

2.8.5 – Rudder Return Spring

___ Drill a 1” hole approximately 18” up from the bottom of the winglet inside the winglet rudder well. The hole should almost be touching the inboard side skin of the winglet (opposite the hinge side). This is very important to get the most leverage. Put your hole saw on a 1/4” rod and drill out foam to 5” deep.

___ Install the spring tube assembly with **VelociPoxy Micro-Balloon**.

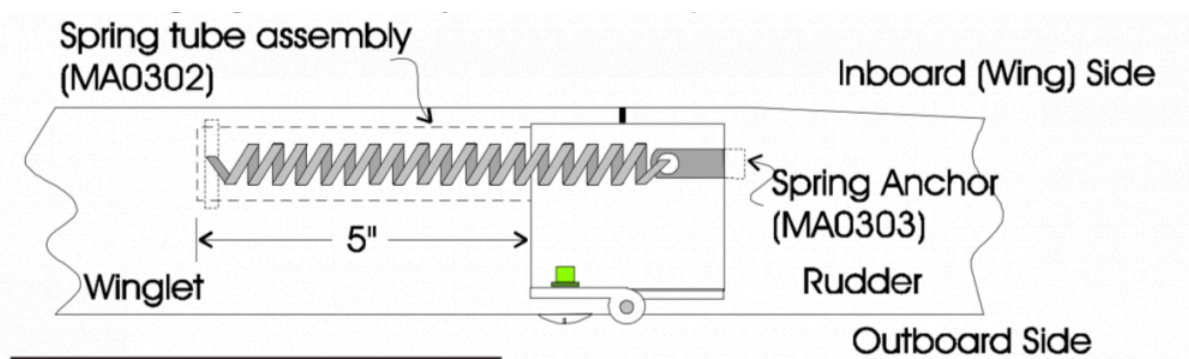


Figure 2-53. Rudder Return Spring

___ In the rudder itself, directly opposite the hole you just bored, cut out a small slit in the web to accept the spring anchor. This also favors the wing-side skin of the rudder.

___ Clear out a bit of foam and install the anchor with VelociPoxy Micro-Glass. The exposed end of the spring must be cut to form a hook to loop over the anchor.

2.10. 2.9 – Winglet Bottom

2.9 – Winglet Bottom

2.9.1 – Prepare Winglet Bottom

The premolded winglet bottoms are oversized when you get them so that they may act as a fairing for the end of your wing as well as the bottom extensions of the winglet. If you have fast-build wings, you will need to trim the excess portion of the part so that it just reaches the indentation for the position lights but leaves at least a 1/2” flange all the way around the part for attachment to the wing.

There are a few ways of attaching these parts to the bottom of your wing and you should decide which one to use based on your own situation or preference.

2.9.2 – Attaching Winglet Bottom to Wing

In this case you can use two methods. One is to sand the primer off where the attachment will take place, sand the inside surface of the flange, and glue them in place with structural adhesive. Once set, fair the edges to make a flush fit. There is no need to glass over the joint.

The second method could be used if the fit does not look good enough or you think the flange would be too hard to fair into the surface. Cut the flange off, sand the primed surface of the part down to the glass and install with two plies of **BID**. Be careful to get the parts lined up since you have removed the part that originally lined everything up. The first tape would be about 1 1/2” wide and the second 1” wide, both centered over the joint. Then you would finish this off just as you did the other tape glass joints. In either case, do not forget to drill a hole in the bottom for water drainage.

After installing the winglet bottom you will need to fit a Dyvinicel rib to the trailing edge as shown in Figure 2-54. Hotglue the rib in place 1/4” below the rudder line. Put micro over the rib and glass with 2 BID onto the 1/4” sides of the winglet. Knife trim after it has cured.

The winglet itself is thick enough to be installed without any ribs in it but you could hotglue in a rib or two as shown in Figure 2-54 if you want to. If you do put in ribs do not put them in all the way to the bottom of the winglet. You need a space so water can drain to the hole you drilled at the lowest point in the winglet.

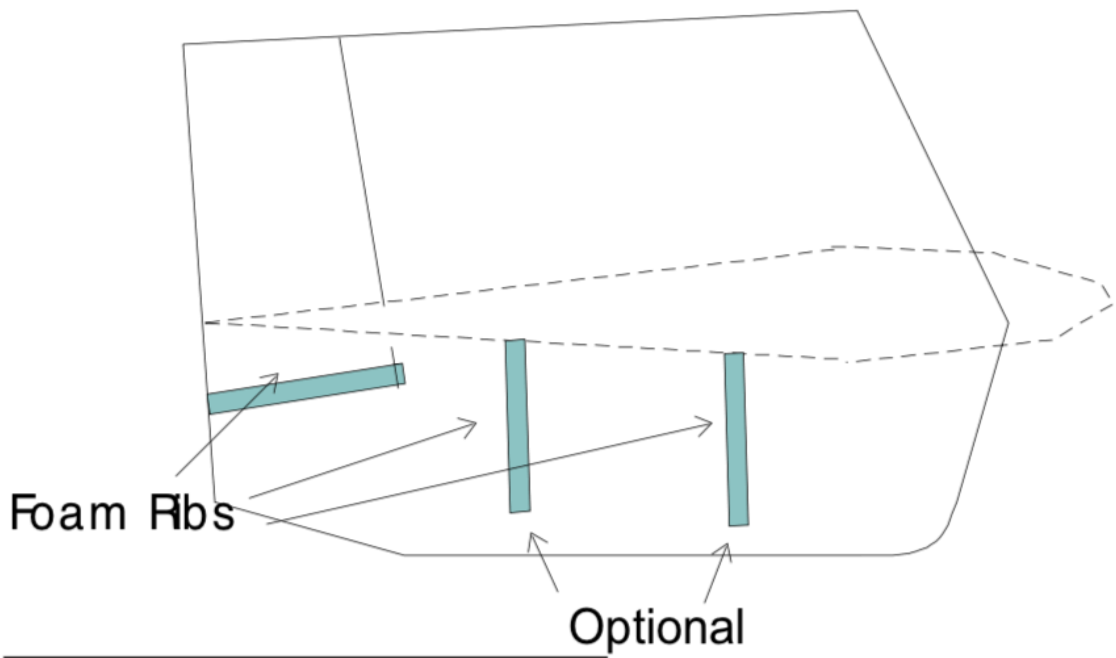


Figure 2-54. Winglet Bottom Ribs

3. 3 – Canard/Elevators

Contents

(Shared with XF, XR)

3.1. 3.0 – Chapter Preface

3.0 – Chapter Preface

3.0.1 – Parts List

Part Number	Description	Qty
MA0401	Lift Tab, Canard	2
MP0401	Spar, Canard	1
AN4-6A	Bolt, AN4-6A	6
AN960-416	Washer, AN960-416	6
MI0401	Incidence Jig, Canard	1
FC0401	Foam Core, Canard, LE IB	2
FC0402	Foam Core, Canard, TE IB	2
–		
MA0407	Torque Tube, Elevator	1
FC0411	Foam Core, Elevator	3
VEHA-01	Hinge Arm, Elevator	8
VELH-02 RIGHT	Pre-formed Hinge, Elevator (Right)	4
VELH-02 LEFT	Pre-formed Hinge, Elevator (Left)	4
MS24693S-272	Screw, MS24693S-272	8
MS21042-3	Locknut, MS21042-3	16
BSP-4-4	Pop Rivet, Medium	16
MS27039-1-09	Screw, MS27039-1-09	8
AN960-10L	Washer, AN960-10L	16
–		
MA0404	Concentric Torque Tube, Elevator, Pilot	1
MA0405	Concentric Torque Tube, Elevator, Co-Pilot	1
MA0412	Counterweight Arm, Elevator, Pilot	1
MA0413	Counterweight Arm, Elevator, Co-Pilot	1
MA0406	Hinge Assembly, Elevator, Center	1
MA0408	Counterweight, Elevator, IB, Pilot	1
MA0409	Counterweight, Elevator, IB, Co-Pilot	1
MA0410	Counterweight, Elevator, OB, Pilot	1

MA0411	Counterweight, Elevator, OB, Co-Pilot	1
AN4-12A	Bolt, AN4-12A	1
MS24694S-59	Screw, MS24694S-59	8
MS24694S-70	Screw, MS24694S-70	2
MS24693S-272	Screw, MS24693S-272	4
MS21042-4	Locknut, MS21042-4	1
MS21042-3	Locknut, MS21042-3	10
AN960-416L	Washer, AN960-416L	4
AN960-10	Washer, AN960-10	6

3.0.2 – Tools List

Description
Drill & Tap for 1/4” × 28 Bolt
1/4” Ignition Wrench
.#30 Drill Bit
.#21 Drill Bit
100º Countersink
Inclinometer

3.0.3 – Supplies List

Description
VelociPoxy
EZ-Poxy
Glass Bubbles
Milled Fiber
Bondo
5 Minute Epoxy
Loctite
1/2” Electrical Conduit
4’ Dowel
1-1/2” ID P.V.C. Pipe
Aluminum I-Beams (from Chapter 2)

3.0.4 – Glass List

Type	Size	Qty
TRIAX	13” × 184”	1
TRIAX	14-1/2” × 184”	1
TRIAX	23.5” × 184”	1
UNI	8” × 138”	2
UNI	6” × 96”	2
UNI	8-1/2” x Roll @ 45º Bias (see manual)	12

3.0.5 – Process Overview

Construction Process	Completion Date
Canard	
Attach Lift Tabs	
Attach FoamCores to Spar	
Prepare for Skinning	
Lay-up ‘A’	
Lay-up ‘B’	
Lay-up ‘C’	
–	
Elevators	
Assemble Cores	
Attach FoamCores to Torque Tubes	
Lay-up Top Elevator Skins	
Lay-up Underside Elevator Skins	
Micro-Balloon Canard	
Micro-Balloon Elevators	
Attach Elevator Hinges	
Attach Elevator Hinge Arms	
Attach Elevator Counterweights	
Attach Elevator Torque Arms	
Check for Proper Motion	
Balance Elevator	

3.0.6 – Documentation Changes

Oct 01, 2018 – Original Web Release

3.2. 3.1 – Critical Dimensions

3.1 – Critical Dimensions

3.1.1 – Reference list

Canard Length (prior to installation of canard tips)	180.0”
Canard Cord	11-7/8”
Elevator hinge positions (from canard Center Line)	
1	23”
2	43-1/4”
3	64-1/2”
4	85”
Elevator Chord	7.0”

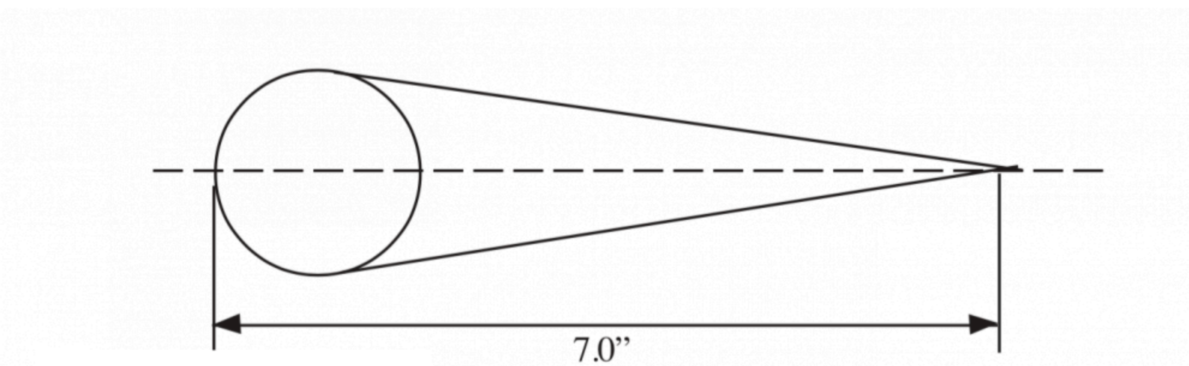


Figure 3-1. Elevator Chord Glass to Glass Contacts

Canard trailing edge	7/8”
Elevator trailing edge	1/4”-3/8”
Elevator Deflection	
Full Up	24 – 26o
Full Down	28o min.
Gap between Canard trailing edge and Elevator	
Elevator Neutral Position	0.050”
Elevator Full Down	0.200”
Elevator Full Up:	Not critical as long as full deflection is achieved.

3.3. 3.2 – Canard Core Preparation

3.2 – Canard Core Preparation

3.2.1 – Installation of Lift Tabs

___ The top cap of the canard spar has a slight curve while the bottom cap is flat. The **leading edge** is thick and the **trailing edge** is lighter. On the **leading edge** spar face, draw both a vertical and a horizontal centerline.

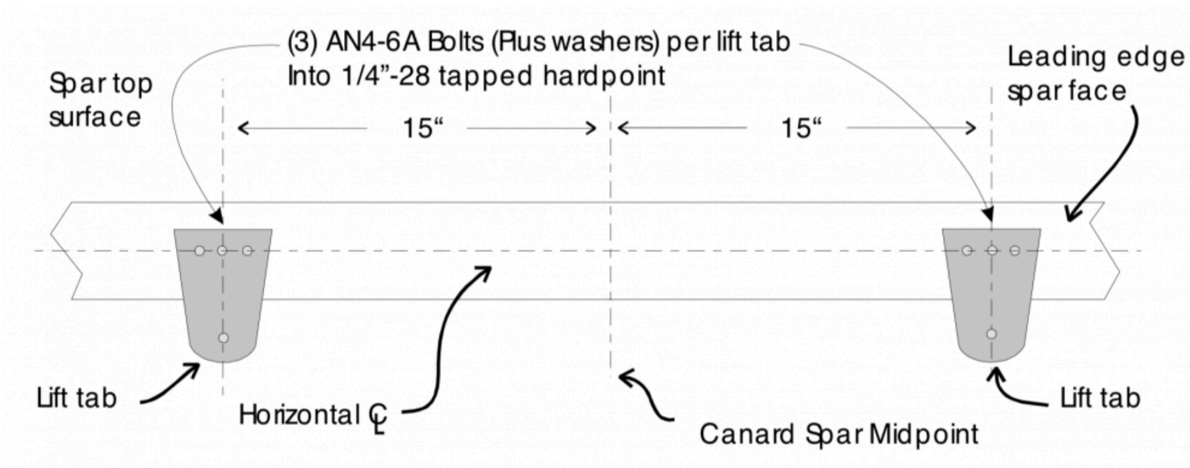


Figure 3-2x. Lift Tab Canard Attachment

___ Measure 15" **outboard** to each side of the vertical centerline, and mark these points on the horizontal centerline. At these points, drill and tap into the **leading edge spar** face for a 1/4"-28 bolt (there are aluminum hardpoints built into the spar). Attach each aluminum tab supplied through the center hole with a 1/4"-28 × 3/4" bolt (AN4-6A) and 1/4" washer (AN960-416).

___ Align the aluminum attachment tabs vertically. Drill and tap the other two holes through each tab.

___ Sand the spar and the spar side of each tab. Apply a mix of **VelociPoxy** and **Milled Fiber** between the spar and the tab, as well as in each bolt hole. Firmly bolt the tabs into place.

3.2.2 – Foam Cores

___ Sand spar surfaces. Set spar and cores on a long flat surface or clamp the lift tabs to a sawhorse.

___ Fit **leading edge** foam cores onto the spar, cutting off pointed tips and trimming out clearance for the tabs. Attach the cores with **Micro-Balloons** using masking tape to hold in place.

___ Fit and bond the **outboard full size cores** onto the tips of the canard. Pin and tape them in place.

___ Bond the **trailing edge** cores in the same way using scrap pieces from the billet they came in to protect the **trailing edge** while taping into place. Line the **trailing edges** up with the **full size cores** that are already installed.

- Check the chord and compare the dimension to that of the outboard cores before microing into place. Make sure cores fit evenly on the spar.

- Check for alignment and conformity . Use shims between the spar and cores if necessary and pull the tape tighter on the side that leans away from its proper alignment. It is O.K. for the cores to overlap the spar a little.

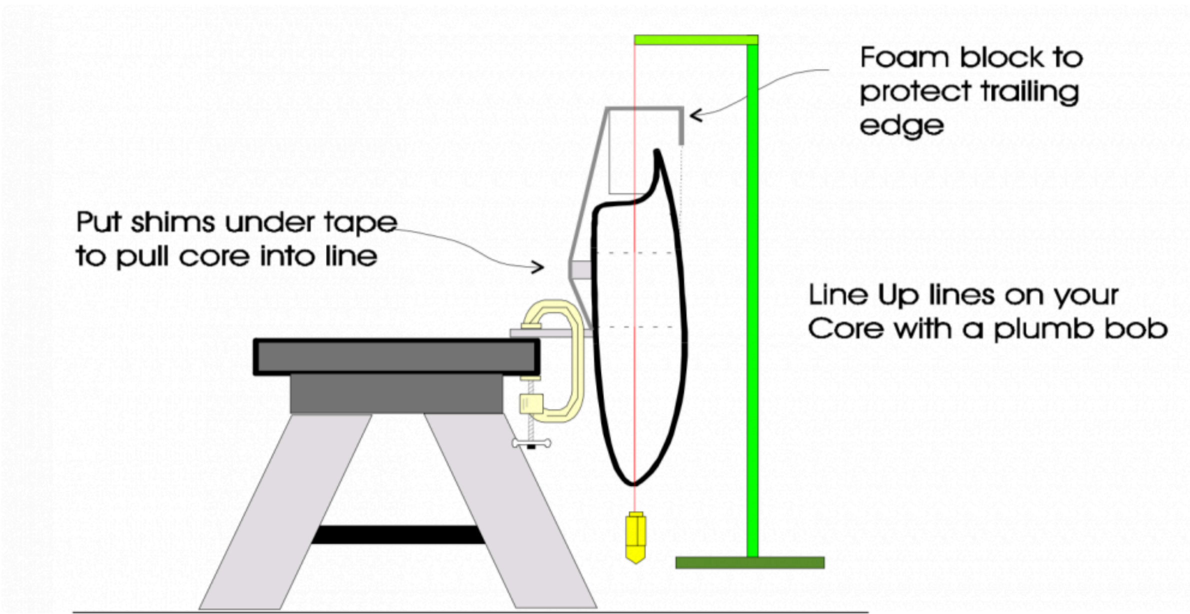


Figure 3-3. Alternate Canard Core / Spar Alignment Technique

A little fill on the spar cap area after the glass lay-ups is better than filling all the core areas to match the spar. The latter runs the risk of changing the basic airfoil. Allow to cure.

- **Check repeatedly** to be sure there is no twist to the canard. It is relatively easy to fix prior to skinning the surface, and practically impossible afterwards. Allow to cure.

3.2.3 – Preparation for Skinning

___ Dress down irregularities with 100 grit (light sanding). Use a long sanding block to contour the **leading edges**. A 3 foot block would be very advantageous later in the construction. At Velocity, we use up to 5-foot aluminum blocks.

___ Use **5 Minute Epoxy** to bond one long straightedge to the top surface of the canard, 2” back from the **leading edge**. **Invert the canard and carefully sand and fair the canard bottom**.

Note: Important: It is extremely important to remove any twist from the canard prior to applying either skin. Follow these steps to minimize the chances of getting any twist in your canard.

1. Straightedges must be parallel to each other and uniform along the length of the canard. By that we mean that if the I-channel is 2” from the **leading edge** at one point, it should be 2” from the **leading edge** at all points. The same applies to the **trailing edge**.
2. I-channels should be level lengthwise with no sag in the middle or at the ends. A good support point for the straightedges is 3 to 3-1/2 feet in from the ends. Be sure that the gap between the straightedges and the canard surface is uniform for the length of the canard.
3. Sight down the **leading edge** and **trailing edge** of the canard to detect any misalignment of the cores. Your vision is surprisingly sensitive with regard to a straight line.

___ Put duct tape on the other long straightedge. Place it under, and parallel to, the canard **trailing edge** so that the straightedge aft edge is 12” from the canard **leading edge**. (See Figure 3-5).

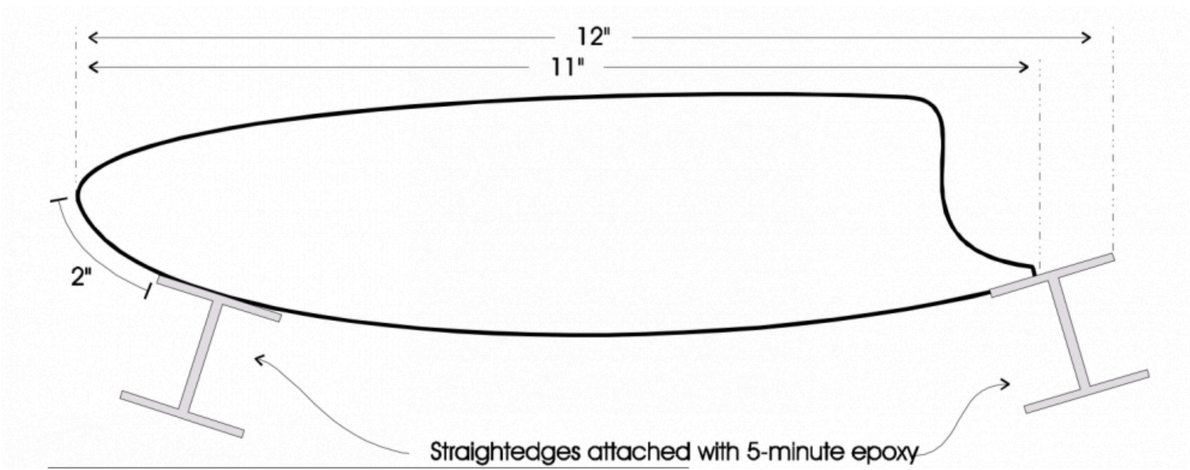


Figure 3-4. Jigging Canard for First (Bottom) Lay-Up

___ Shim the straightedges against the cores so that their surfaces are parallel to the core surfaces. Bond with the 5 Minute Epoxy mix in this position clamping and weighting as required.

___ Trim the **trailing edge** to 11” from the **leading edge** leaving 1” of the straightedge exposed. Use a 1-1/2” OD tube to sand the concave **trailing edge** core area. Sand the **trailing edge** to a taper.

3.4. 3.3 – Glassing the Canard

3.3 – Glassing the Canard

3.3.1 – Canard Lay-up Schedule

The canard receives four layers of glass as shown in the following table and in Figure 3-5.

Dimensions	Fabric	Plies Per Lay-Up	Total Plies Required
Lay-up ‘A’			
12.5” × 184”	TRIAX	1	1
Lay-up ‘B’			
14.5” × 184”	TRIAX	1	1
Lay-up ‘C’			
23.5” × 184”	TRIAX	1	1

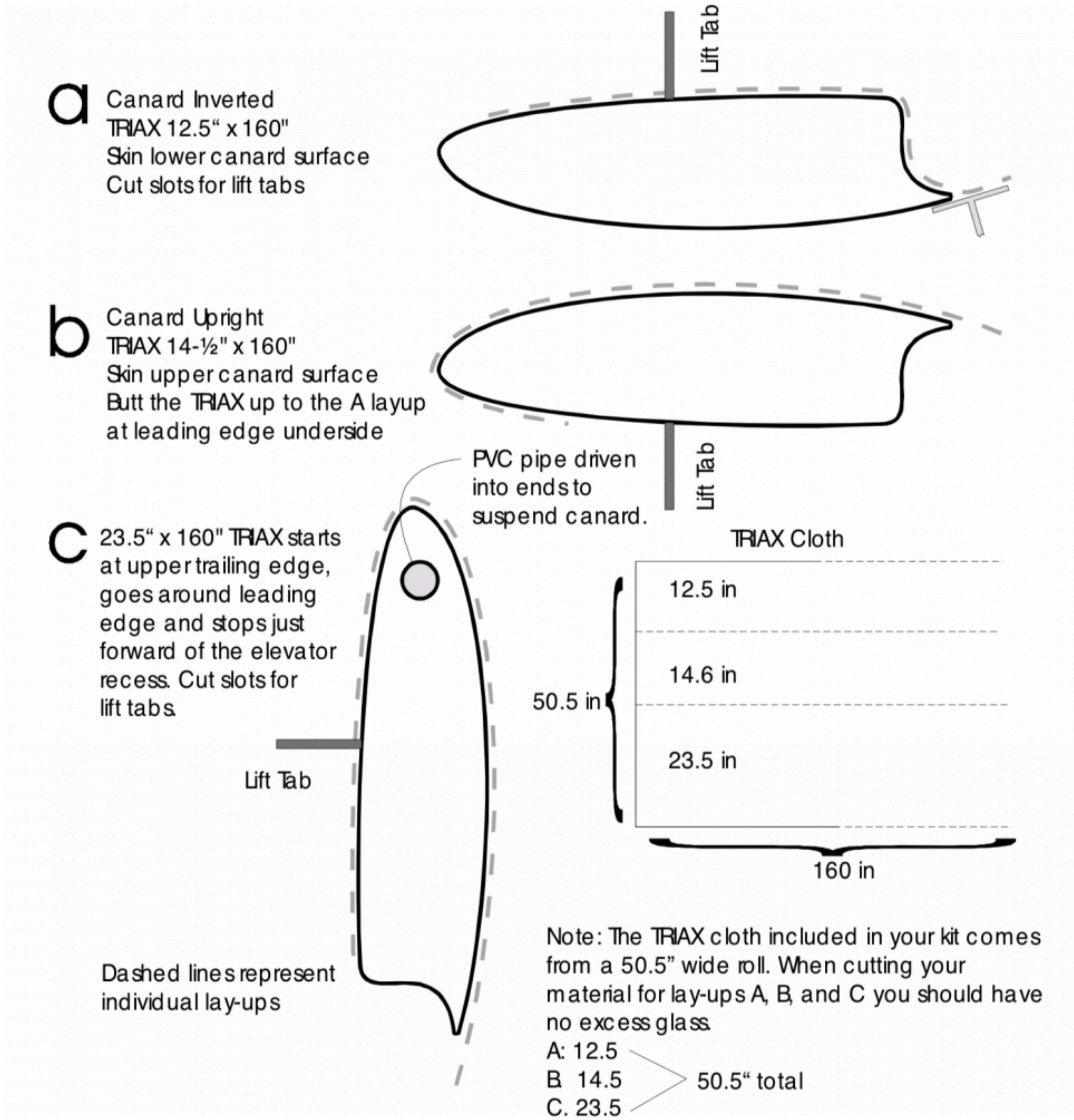


Figure 3-5. Canard Lay-Up Detail

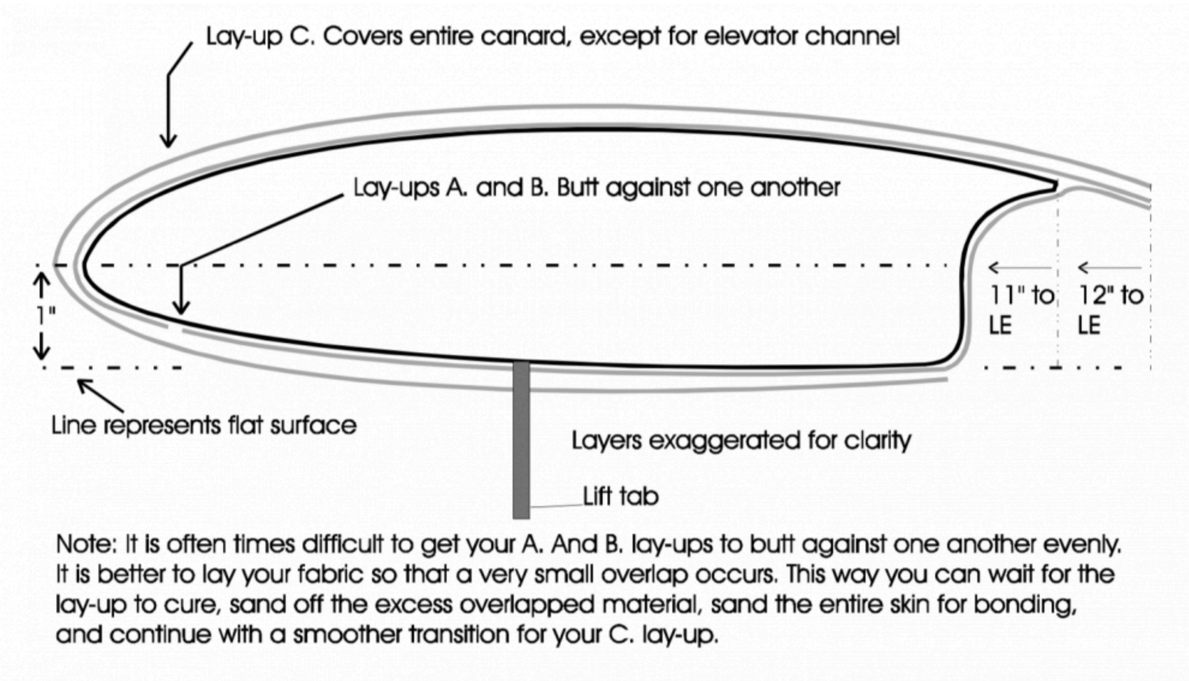


Figure 3-6. Canard Lay-Up Summary

3.3.2 – Canard Lay-up A

- Canard is upside down, and supported as shown in diagram. Cut a 12.5” × 184” piece of **TRIAX** cloth.
- Sand the spar cap surface. **EZ-Poxy Micro-Slurry** the canard bottom cores from a line about 1/4” aft of the **leading edge**, filling core pores and voids, avoiding the spar cap. Large voids should be filled with dry **Micro-Balloon** (just add some **Glass Bubbles** to any leftover **Micro-Slurry**).
- Recheck for twist with a level across the straightedges at both ends. Using **EZ-Poxy**, wet the spar cap and lay-up the **TRIAX**, selvage edge forward, overlapping the **trailing edge** aluminum slightly. Pull out the longitudinal loops in the cloth. Keep checking for lumps or bubbles that might occur while the lay-up is curing.
- It is important to let each of these lay-ups cure properly before moving on to the next.

3.3.3 – Canard Lay-up B

- File the rough **leading edge** and sand about 1” aft for the possibility of overlapping skins during wet lay-up.
- Sand the spar cap.
- Trim the **trailing edge** back 1/4”. Remove the straight edges.
- Sand the **trailing edge** skin for bonding.
- With canard right side up, **Bondo** a straightedge to the glassed **trailing edge**. **Bondo** or clamp

straightedge to table as well. Use the second straightedge to support the **leading edge** of the canard. Place it back by the lift tabs so that the overlap of the skin is accessible.

- Check top surface with template for a smooth conformance. Lightly sand as required. Recheck for twist. Shim as required.

- Cut a section of **TRIAX** 14-1/2” x 184” long. Trial fit the cloth. In proper position, the cloth should butt-up to lay-up A, and should hang slightly off the canard **trailing edge**.

- Remove the cloth from the canard, and wet out the following:

___ Top spar cap

___ Overlap area on bottom skin

___ Exposed bottom **trailing edge** skin

Put the cloth back on the canard, and finish the lay-up. Recheck your alignment, and let cure.

3.3.4 – Canard Lay-up C

___ Force pieces of 1/2” electrical conduit into both ends of the canard about 6” and suspend the canard on two saw horses.

___ Cut 1 layer of **TRIAX** 23.5” × 184”. This layer goes from the top **trailing edge**, all the way to the elevator recess on the bottom side. You will have to cut slots in the glass in order to lay the cloth over your canard tabs.

___ Sand the glass to ensure proper adhesion of glass/resin matrix. Wet with **EZ-Poxy** and apply lay-ups. Let cure.

3.5. 3.4 – Elevator Construction

3.4 – Elevator Construction

3.4.1 – Assemble Cores

___ Cut the elevator torque tube material in half, this will give you two 72” pieces.

___ Cut and mate the core pieces to make two 72” elevators. Trim off any interfering foam to fit to the torque tubes.

___ Sand the tubes and bond the foam cores to the tubes, flush at one end, with **VelociPoxy Micro-Slurry**. Use masking tape to hold the cores to the torque tubes and place the entire assembly on a flat surface and weight down, allow to cure.

___ Remove the holding tape, attach the cores to a flat surface, laying **trailing edge** on a 2” wide strip of duct tape, with dobs of 5 Minute Epoxy.

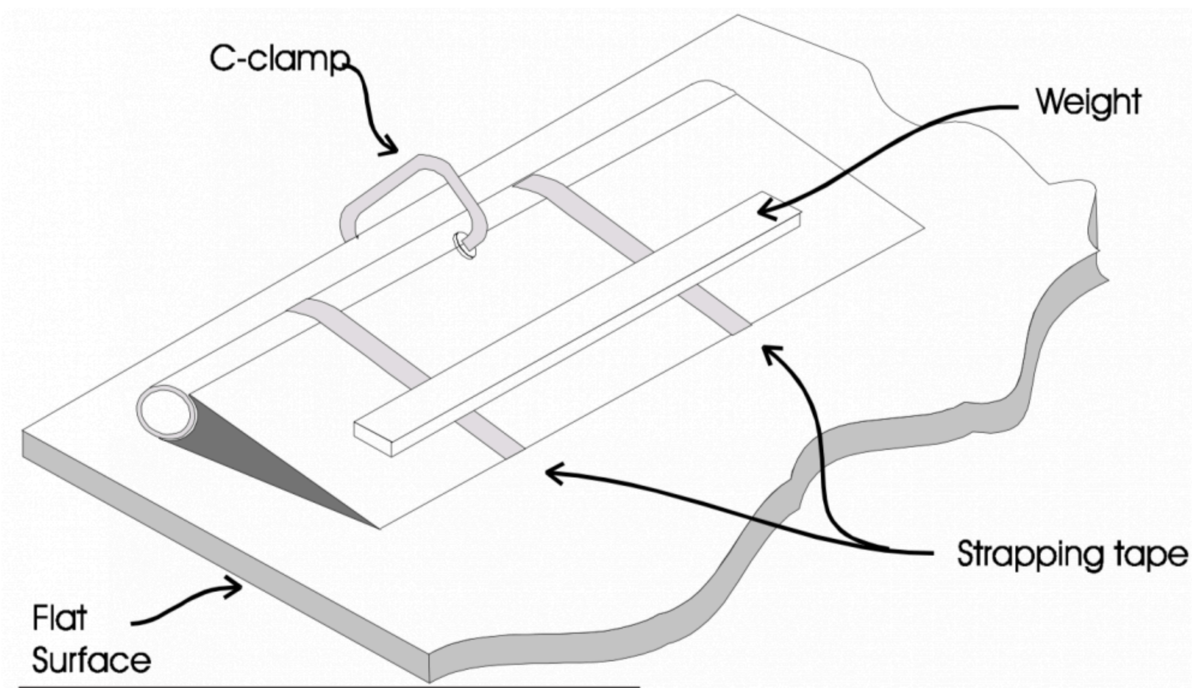


Figure 3-7. Jigging Elevator Cores, Torque Tube

___ Trim **trailing edge** straight, 6-5/8” from **leading edge** leaving 1/16” to 1/8” **trailing edge** foam thickness. See Figure 3-8. Sand any irregularities, and fill any voids with dry **VelociPoxy Micro-Balloon**. Weight control is very important in the elevators.

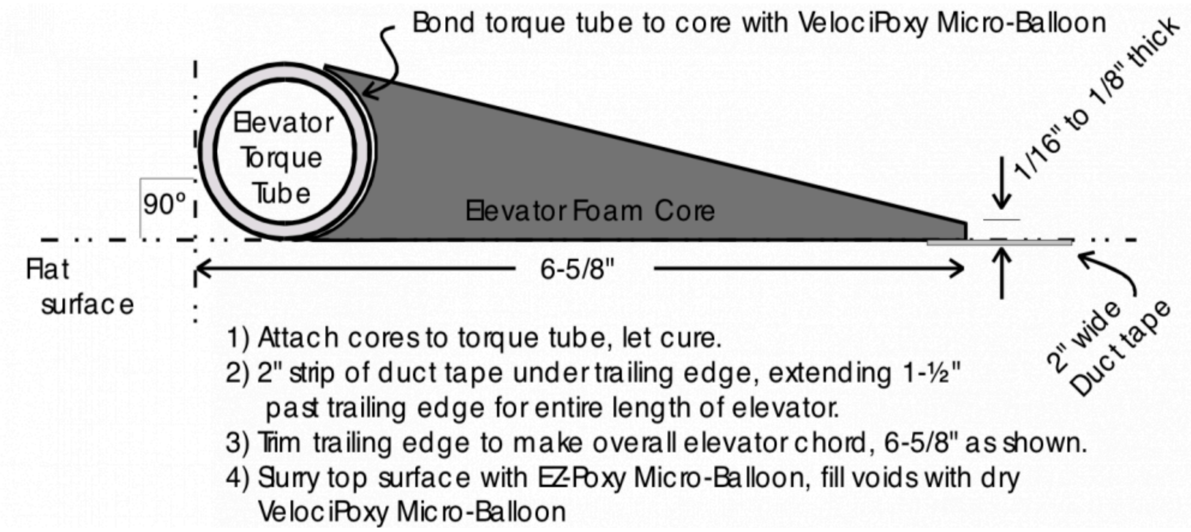


Figure 3-8. Fitting Torque Tube to Aileron Core

3.4.2 – Lay-up Procedure – Side One

___ Cut 12 pieces of **UNI** 8-1/2” wide, on a 45 degree bias. Don’t forget the 8-1/2” width is perpendicular to the cut lines, not along the edge of the cloth roll. Butt, do not overlap, pieces in the same layer. Stagger the butt positions on the second layer. See Figure 3-9.

___ Apply **EZ-Poxy Micro-Slurry** to the core surfaces, avoiding tubes, and wet out two plies of **UNI**, laying up the bias in opposing directions (fibers at 90 degrees). Keep **leading edge** straight, wrapping around 3/4ths of the tube, as the opposite side lay-up will neatly overlap this lay-up. Overlap the **trailing edge** onto the duct tape 1”. Let cure.

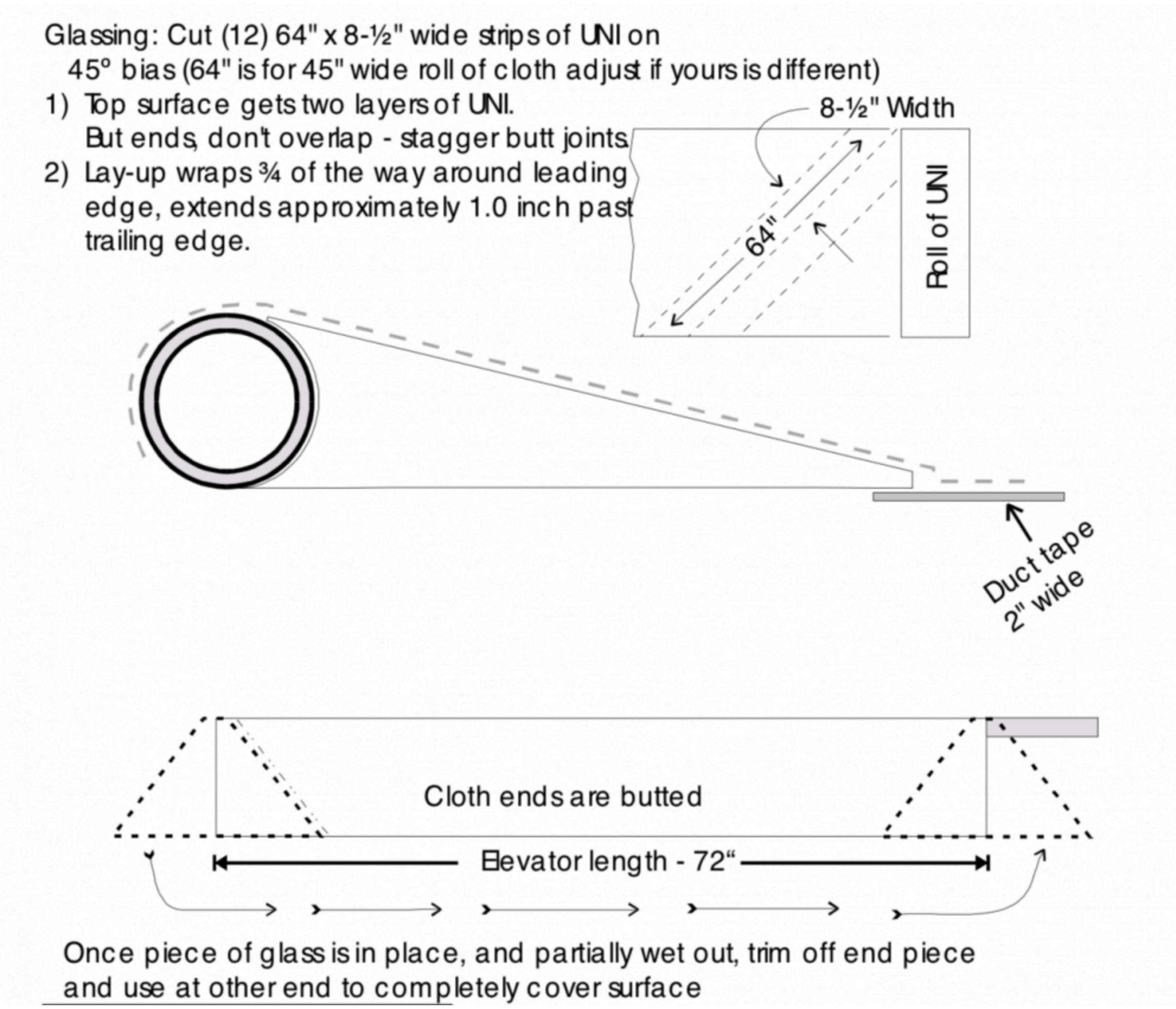


Figure 3-9x. First Elevator Lay Up

3.4.3 – Lay-up Side Two

___ Clean up work, sanding the tube and **trailing edge** glass for bonding to next lay-up. Trim **trailing edge** 7-1/4" from **leading edge**.

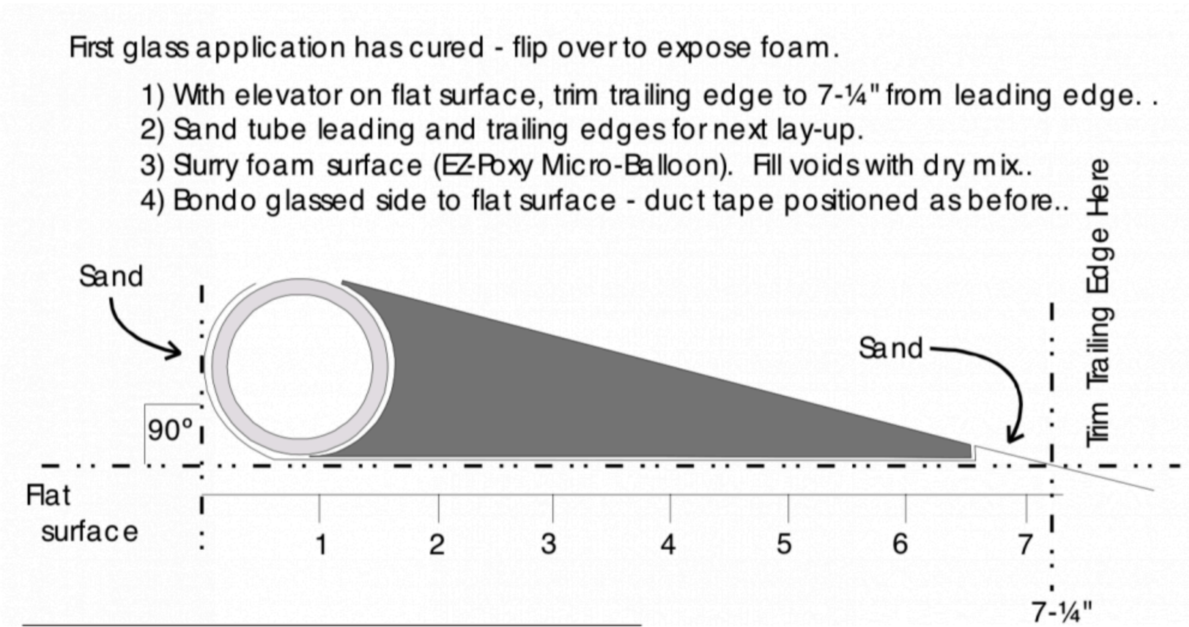


Figure 3-10. Preparing to Glass Top of Elevator

___ **Bondo** the elevators, glass side down, on a flat surface. Duct tape should be in the same position as for the first lay-up you did.

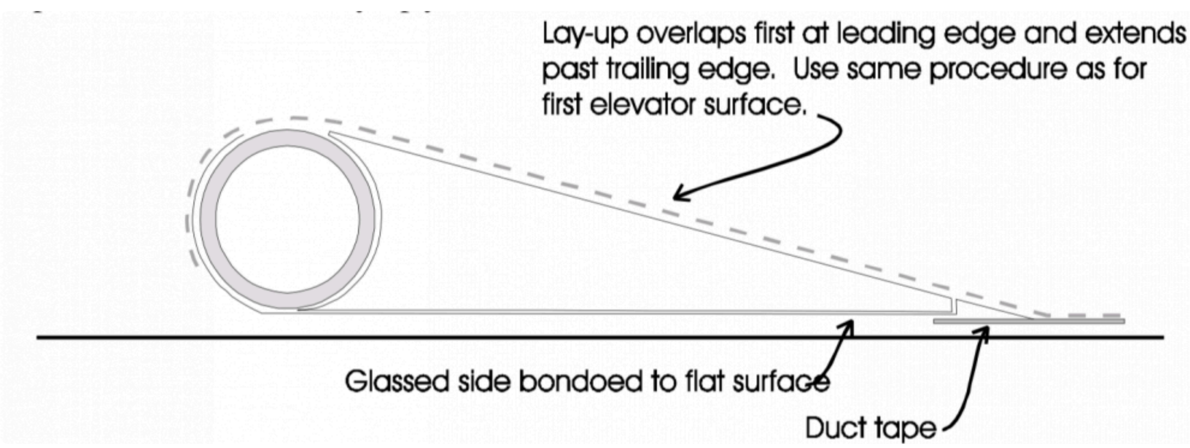


Figure 3-11. Second Elevator Lay-Up

___ Prepare surfaces with **EZ-Poxy Micro-Balloon**, and fill voids with dry mix. Pre-wet the non-foam contact areas (glass **trailing edge**, and tube **leading edge**). Apply lay-ups as before, overlapping at the **leading edge** of the previous lay-up.

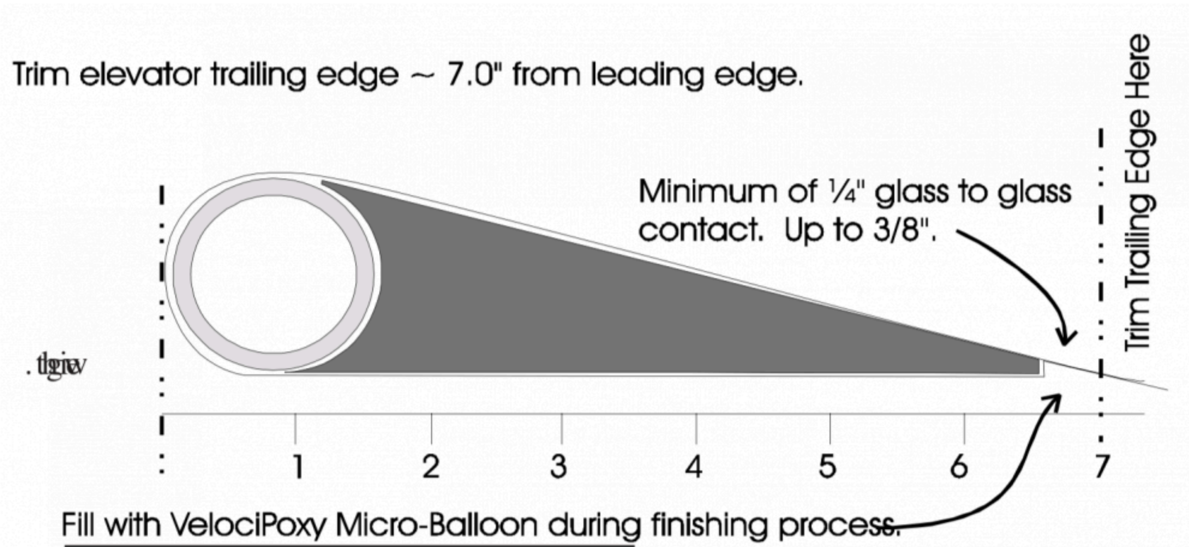


Figure 3-12. Trimming Elevator After Glassing

___ Let cure and trim the **trailing edge** 7" from the **leading edge**. You want a minimum of 1/4" of glass-to-glass bond in the **trailing edge**, but not more than about 3/8". Too wide a **trailing edge** requires heavy contour filling and additional counter balance.

___ Fill and contour elevator and canard surfaces. Sand canard and elevators to receive a filler mix of **VelociPoxy Micro-Balloon**.

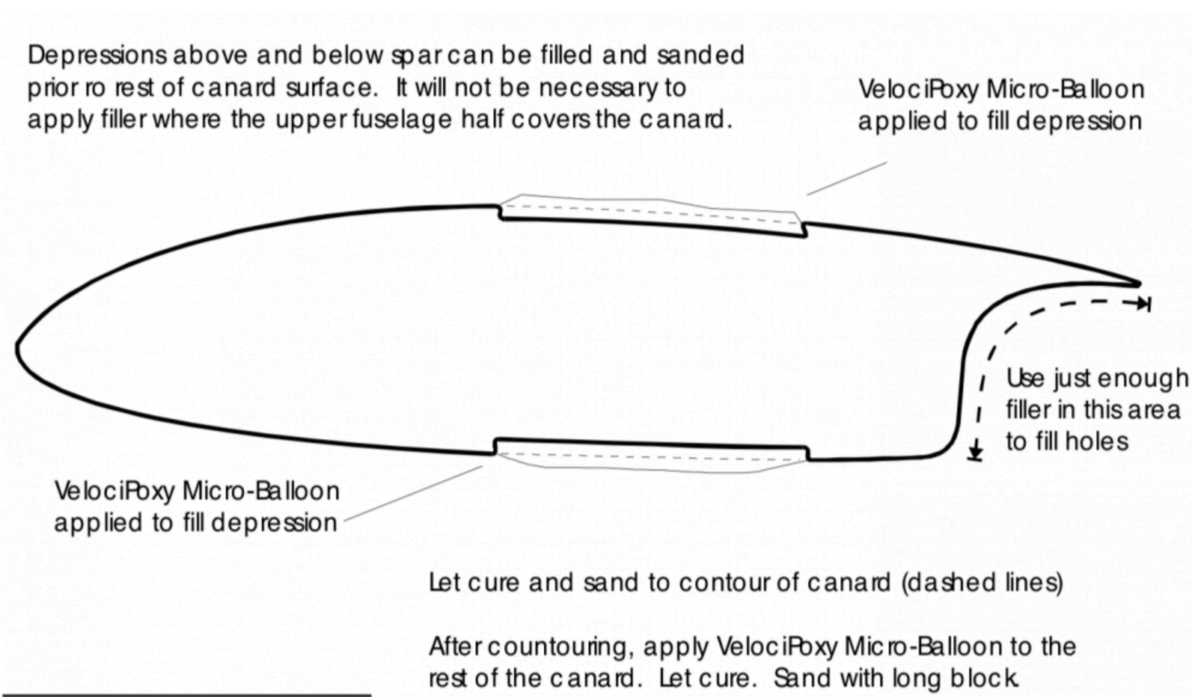


Figure 3-13. Filling Canard

Wear a mask to prevent inhaling glass bubbles. Mix **VelociPoxy Micro-Balloon** to a consistency that barely runs out of the bucket.

___ Heap on material and trowel with a large blade. Control thickness with the blade-to-surface angle. A steep angle thins the coating and a shallow angle leaves more material. The builder will find it advantageous to fill in the depression left by the spar (both upper and lower surfaces) first, and let it cure (See Figure 3-13).

___ Once cured, sand it down to more closely coincide with the canard curvature, then apply **VelociPoxy Micro-Balloon** over the entire surface of the canard.

Be aware that different mixes of slurry will sand differently, so try to minimize the number of filler applications that you make to any surface.

___ Following cure, use a long sanding block (3’ or more) to smooth your contours. We generally start with 36 grit File board paper and end the initial sanding process with 80 grit File board paper Patience is a real virtue when it comes to the sanding process.

3.4.4 – Elevator to Canard Fit

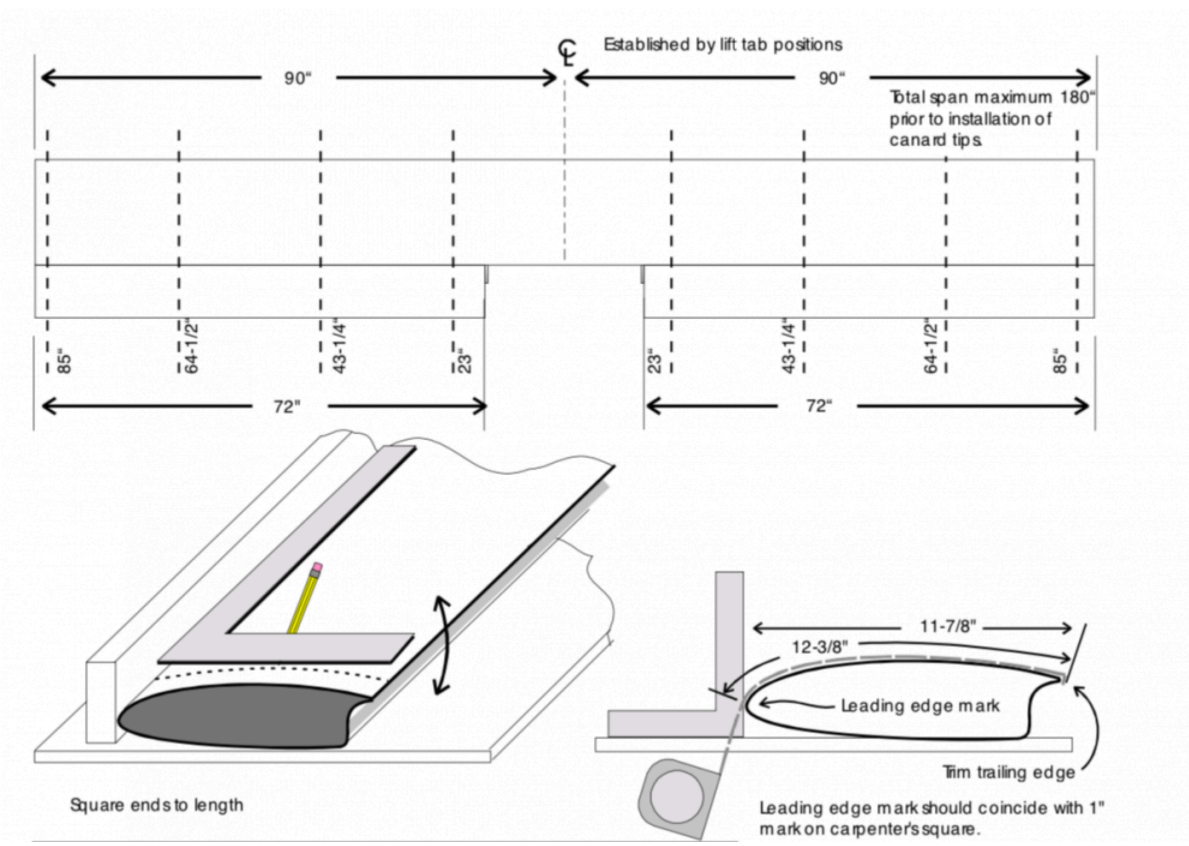


Figure 3-14x. Trimming Canard for Elevator Installation

___ See Figure 3-14. Find and mark the center of the canard halfway between the installed lift tab centerlines. Measure and mark 90” outboard of this center point and square off the canard ends.

TIP: Lay a 2” × 4” against the **leading edge** and rock a carpenter’s square over the surface while marking.

___ Square off the elevator outboard ends. Trim the **trailing edge** of the canard 12-3/8” from the **leading edge**.

___ Mark a **leading edge** reference mark with the canard bottom on a flat surface and a square. Hook the tape measure on the **trailing edge** and wrap over the canard top to the **leading edge** for this measurement.

___ Measure and mark points from the centerline, along the bottom surfaces, on canard and elevators as follows: 23”, 43-1/4”, 64-1/2”, 85”. These marks will serve to position your elevator hinge arms and hinges.

___ Square off the outboard end of the elevator with the torque tube. The elevator inboard end will be trimmed when the canard is mated to the fuselage. Place the elevators in place behind the canard and line up the outside edges of the Canard and Elevator. Transfer the marks you made on your canard to your elevators.

Now that you have made your positioning marks for the elevator hinges and hinge arms, it is time to begin the installation. Pull out your (8) elevator hinges (MA0403) and your (8) hinge arms (MA0402).

3.4.5 – Elevator Hinge Installation

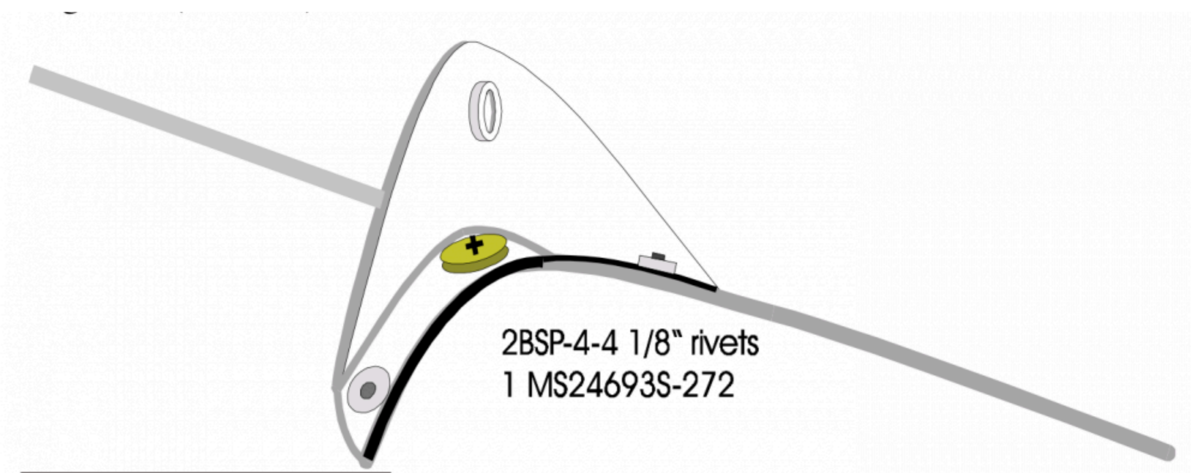


Figure 3-15. Elevator Hinge

Note: You are supplied with both right and left elevator hinges. When installing the hinge the Vertical tab portion of the hinge always is on the inboard side. Refer to Figure 3.16.

___ On the bottom surface of your elevators, place your hinges such that the vertical tabs (holding the bushings) are aligned with the positioning marks.

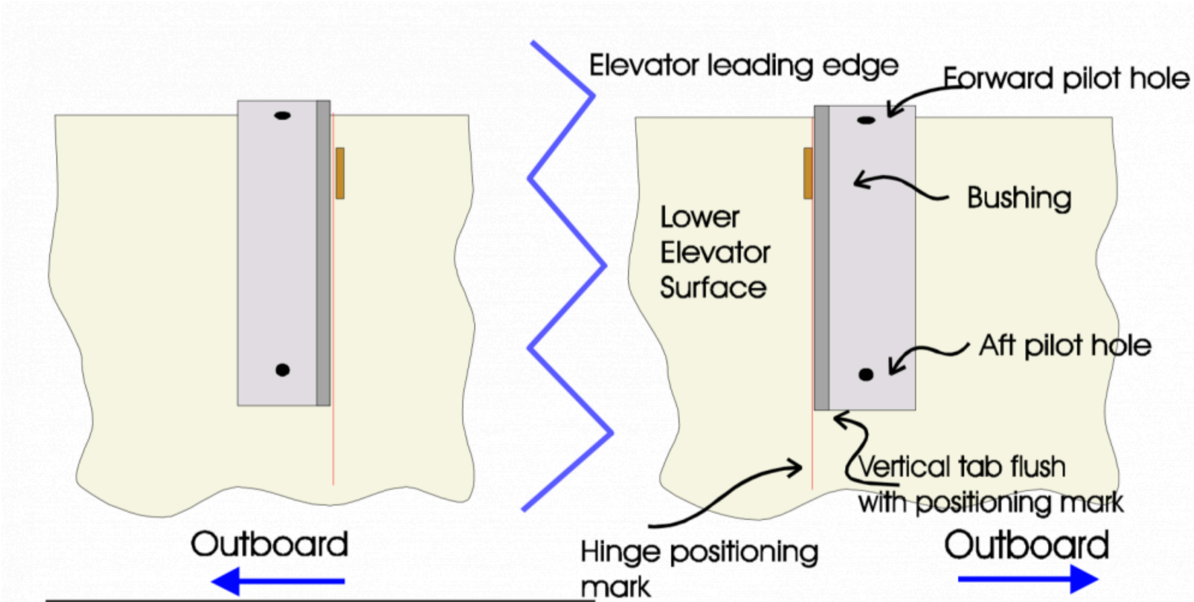


Figure 3-16. Fitting Elevator Hinge to Elevator

- The outside surface of the vertical tab should be flush with the marks. The hinges should be self-aligning with respect to each other, but sight down through the bushings to be sure.

If a hinge is out of alignment by more than 1/16”, shift it to be in line. Though a bit time consuming, you can clamp a strand of fishing line at one end, and run the other through the bushings to really center things up.

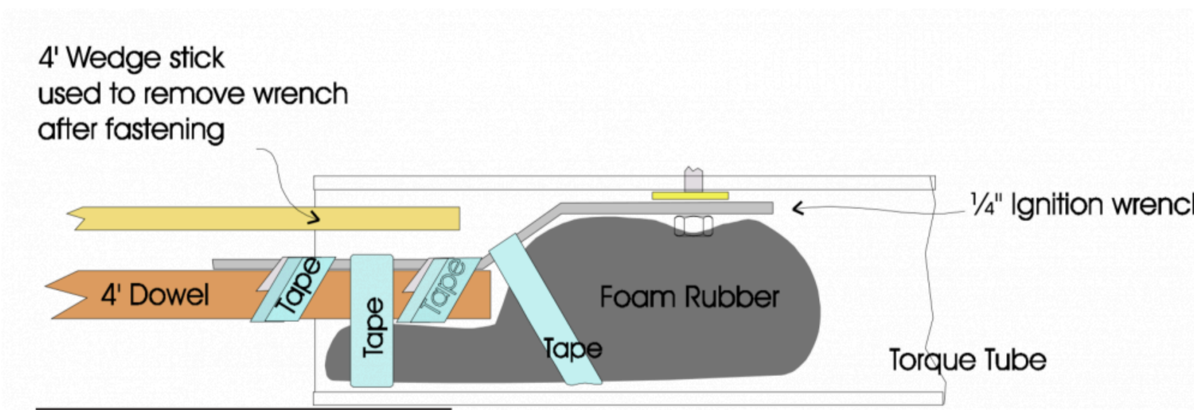


Figure 3-17. Installing Elevator Hinge

___When you are pleased with the hinge positions, use a #30 bit to open a hole in the torque tube, using the forward pilot hole in each hinge as a guide. See Figure 3-16.

___ Sand the mating surfaces, both hinge and elevator, bed the hinge in **VelociPoxy Micro-Glass (Milled Fiber) or Structural Adhesive**, and pop rivet into place using BSP-4-4 Pop Rivets (1/8”).

___ Align the hinges fore and aft square with the elevator **trailing edge**, then drill and pop rivet the aft hole. Carefully clean off the excess **Structural Adhesive**, and let cure.

For the next step, construct a 4’ wrench, by attaching a 1/4” ignition wrench to a dowel rod or stick. See Figure 3-17.

The extended wrench needs to fit inside the elevator torque tube. You will be securing the hinges to the torque tube with MS24693S-272 screws and MS21042-3 locknuts, and this wrench is used to tighten them down.

A bit of foam rubber taped under the wrench will ‘squeeze’ it up against the tubing. To remove the wrench after fastening the screws, slide another long stick above the wrench handle to pry it away from the nut.

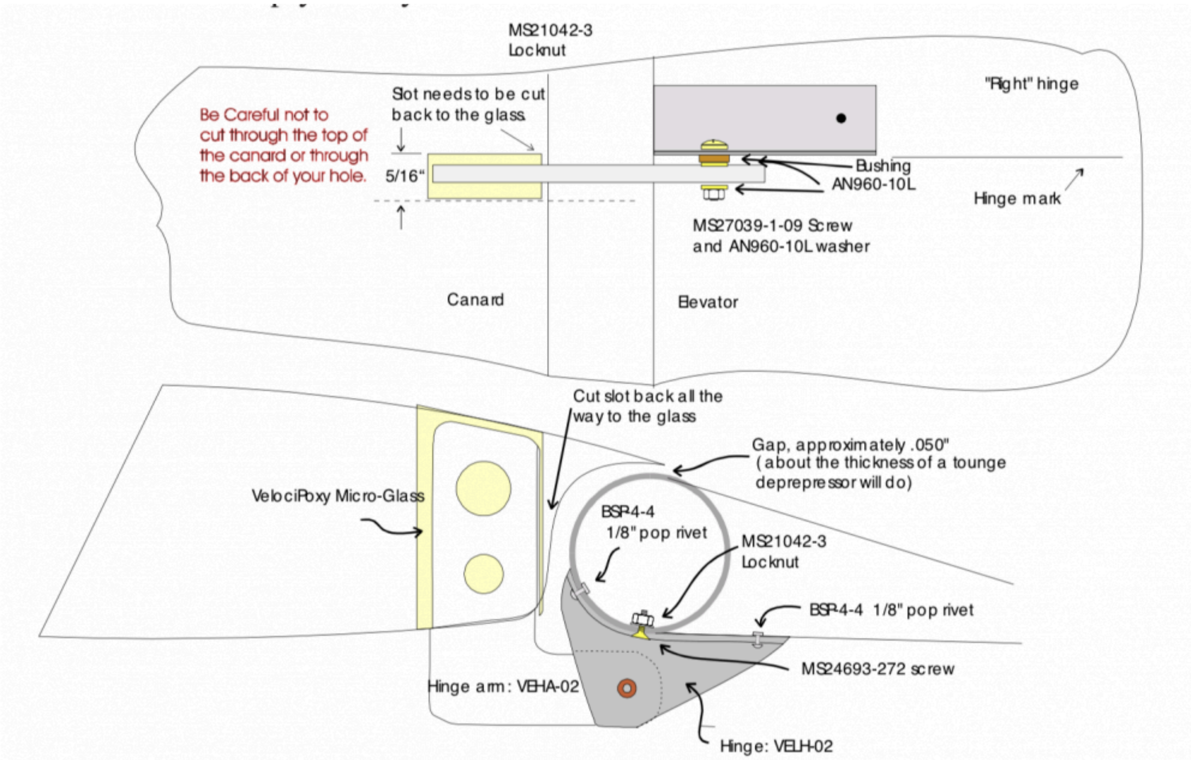


Figure 3-18. Elevator Hinge Installation

___ See Figure 3-18. Drill a 3/16” hole in each hinge (countersink 100 degrees) as far aft of the forward pop rivet as possible without going into the elevator foam. Use hardware listed in previous paragraph for installation.

3.4.6 – Hinge Arm Installation

___ Once the **Structural Adhesive** has cured, install the arms to the elevator-mounted hinges. Attach to the side of the hinge where the bushing protrudes. Use a MS27039-1-09 screw, (2) AN960-10L washers, and a MS21042-3 nut for this attachment.

Do not over tighten as to interfere with free movement. If a misalignment occurs, you can bend the hinge slightly to make it perpendicular to the elevator.

___ Turn the canard upside down and locate the elevators in the **trailing edge** slot. You may want to tape tongue depressors as shims along the **trailing edge** of the canard. This will keep a gap of about .050” from the top of the elevator to the canard. You want to make sure that both elevators are in the same position. You can clamp a straight edge across the top of the elevators to hold them. Make sure the canard is well supported as you cut the slots and bond the hinges in. If the canard is bowed when hinges are installed in may cause some binding. A table might work better for support at this stage than saw horses.

___ Rotate the hinge arms to locate the slots to be cut on the canard bottom to accept the hinge arms. Mark these points and remove approximately 5/16” × 1-1/4” of lower skin (See Figure 3-21). Make a slot in the canard that goes all the way to the top skin and all the way to the back skin. Refer to 3-19. A 5/16” drill bit works nicely to drill out the slot, but be careful not to drill through the top skin As a precaution, grind the tip off your drill bit so that it won’t drill through the top skin. **Be careful not to cut through the glass.**

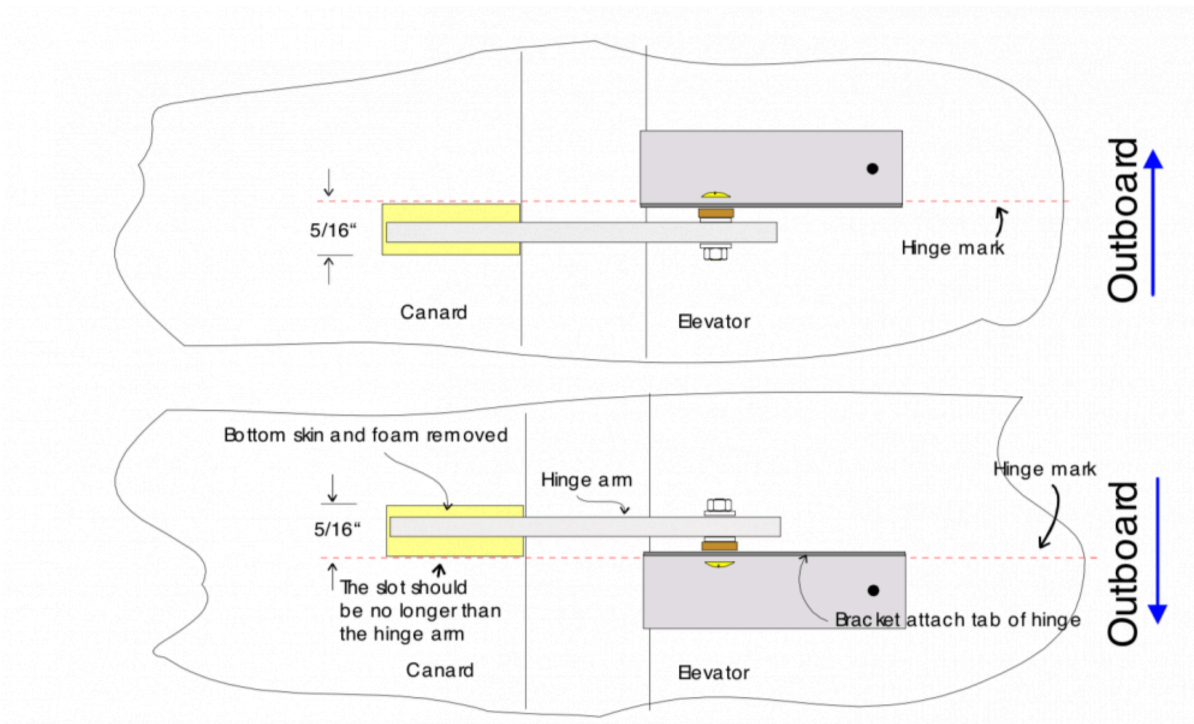


Figure 3-19. Hinge Arm Installation

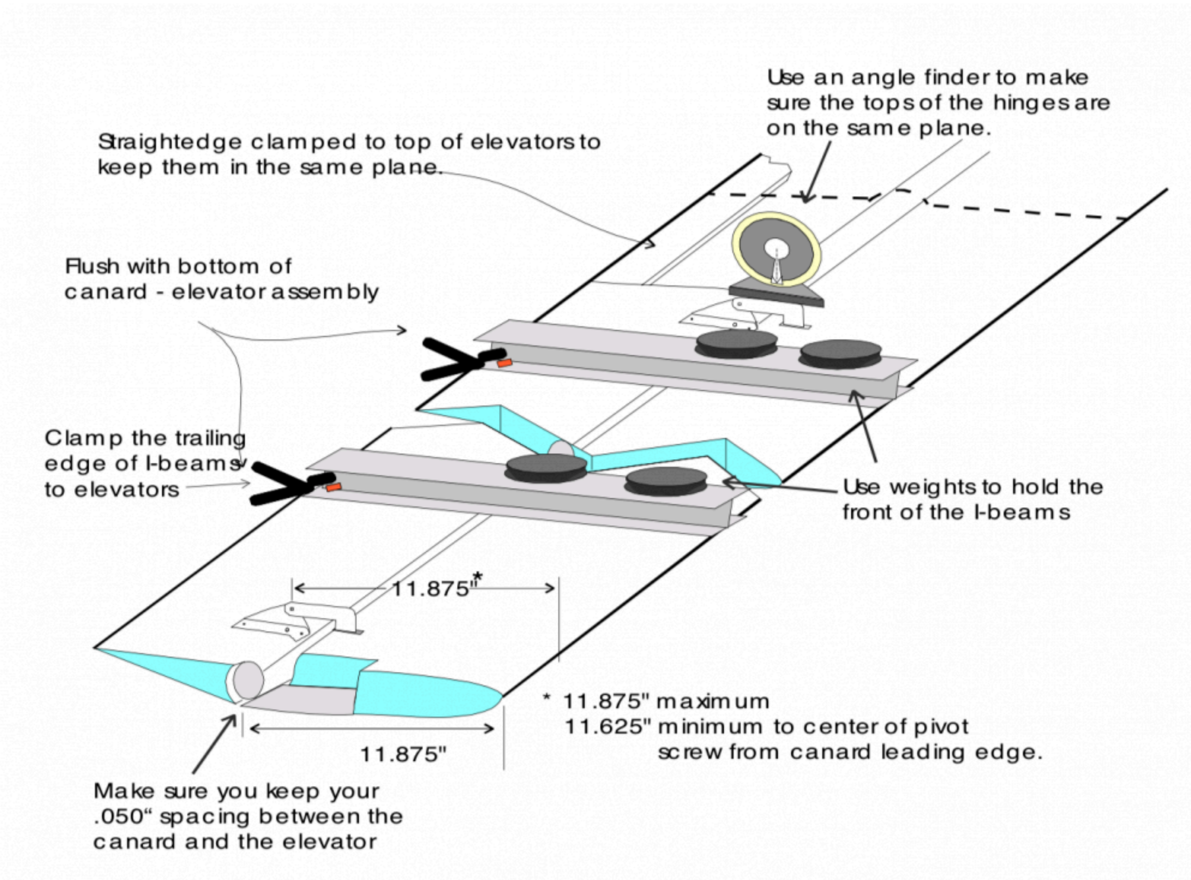


Figure 3-20. Elevator Hinge Arm Installation

3.6. 3.5 – Canard Final Preparation for Elevators

3.5 – Canard Final Preparation for Elevators

3.5.1 – Positioning the Elevator

___ Place the canard upside down, and using a 3’ straightedge with 100 grit paper glued to it, straighten the **trailing edge** of the canard from one end to the other. Try to maintain the 11.875” dimension for the chord.

___ Once you have straightened the **trailing edge**, taper the bottom of the **trailing edge** up to the top skin, leaving approximately 1/16” to 1/32” **trailing edge** thickness at the tip. The next step is to install the elevators.

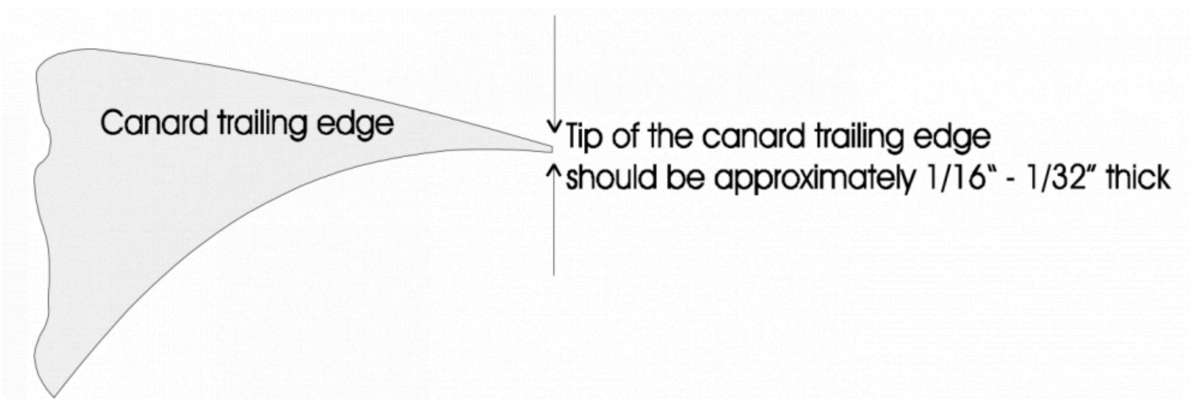


Figure 3-21. Canard Trailing Edge

___ Reinstall the elevators at the **trailing edge** of the canard once the hinge slots are cut. Use a straight edge clamped to the back of the elevators to hold them together. Cut four 2 foot sections off your aluminum I-beams. Clamp these to the elevator so that the I-beam is flush with the bottom of the elevator. Use lead weights to hold the front side of the I-beam flat on the canard. Refer to Figure 3-20.

___ Align the *trailing edge*s of the elevators so that they are in the same plane.

The critical things to watch for during this procedure are as follows:

- Make sure that both of the elevators are in the same plane. Clamp a straightedge to the top of both elevators to hold them in the same plane.
- The gap between the elevators and the canard **trailing edge** is consistent, and approximately 0.050”. Tape a few tongue depressors down the **trailing edge** to maintain this gap. If you have trouble maintaining this gap, check where your I-beams where they meet the canard. You might also try some shimming between the Canard and I-beams if necessary. Double check to make sure the canard is flat and well supported.

The proper gap is not only critical for operation but it presents the best appearance.

- The dimension from the **hinge pivot screw** to the **leading edge** of the canard should be the same as the dimension from the **leading edge** to the **trailing edge** of the canard.

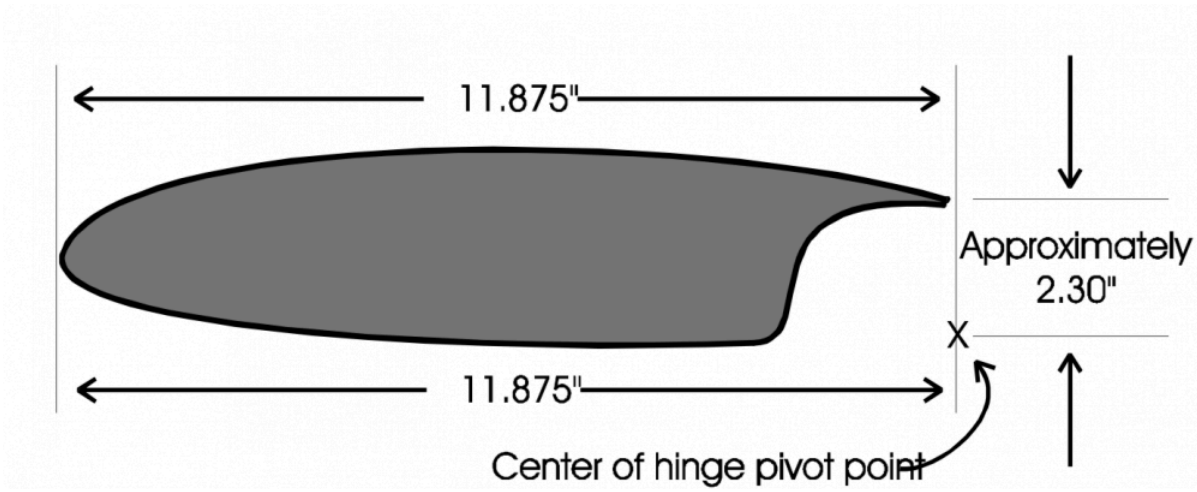


Figure 3-22. Hinge Pivot Point Dimensions

___ With all this jigged into place, check to make sure that your hinge pivot points are exactly above the **trailing edge** of the canard (the same distance back as the **trailing edge** of the canard). Make sure that your hinges are flat against the back of the cutout in the canard. Use an anglefinder to make sure the tops of the hinges are all at the same angle. Refer to picture 3-20. Shim and adjust accordingly if necessary.

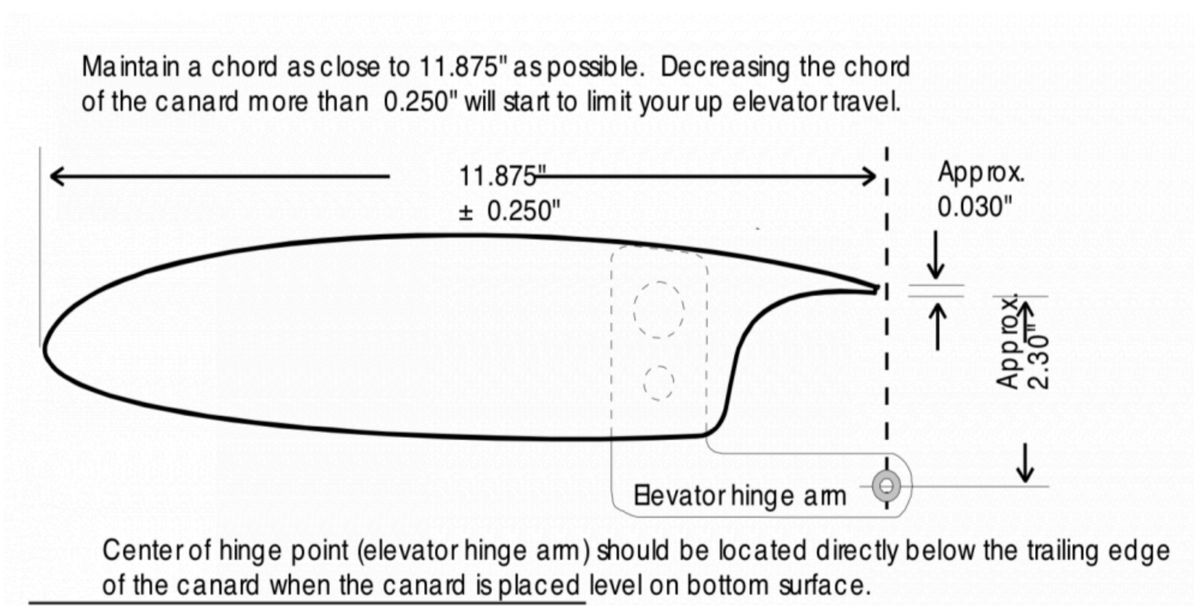


Figure 3-23. Elevator Hinge Arm Alignment

___ Once you are satisfied with the fit, fill the cavity with a thin slurry of **VelociPoxy Micro-Glass or Flox** and epoxy. Let cure. Remove the screws from the hinges and take off the elevators.

3.5.2 – Positioning torque / counterweight arms

Locate the following items:

Part Number	Description	Qty
	Concentric Torque Assembly	2
MA0412	Counterweight Arm, Elevator, Pilot	1
MA0413	Counterweight Arm, Elevator, Co-Pilot	1
MA0406	Hinge Assembly, Elevator Center	1
MA0408	Counterweight, Elevator IB, Pilot	1
MA0409	Counterweight, Elevator IB, Co-Pilot	1
MA0410	Counterweight, Elevator OB, Pilot	1
MA0411	Counterweight, Elevator OB, Co-Pilot	1
AN4-12A	Bolt, AN4-12A	1
MS24694S-59	Screw, MS24694S-59	8
MS24694S-70	Screw, MS24694S-70	2
MS24693S-272	Screw, MS24693S-272	4
MS21042-4	Locknut, MS21042-4	1
MS21042-3	Locknut, MS21042-3	10
AN960-416L	Washer, AN960-416L	4
AN960-10	Washer, AN960-10	6

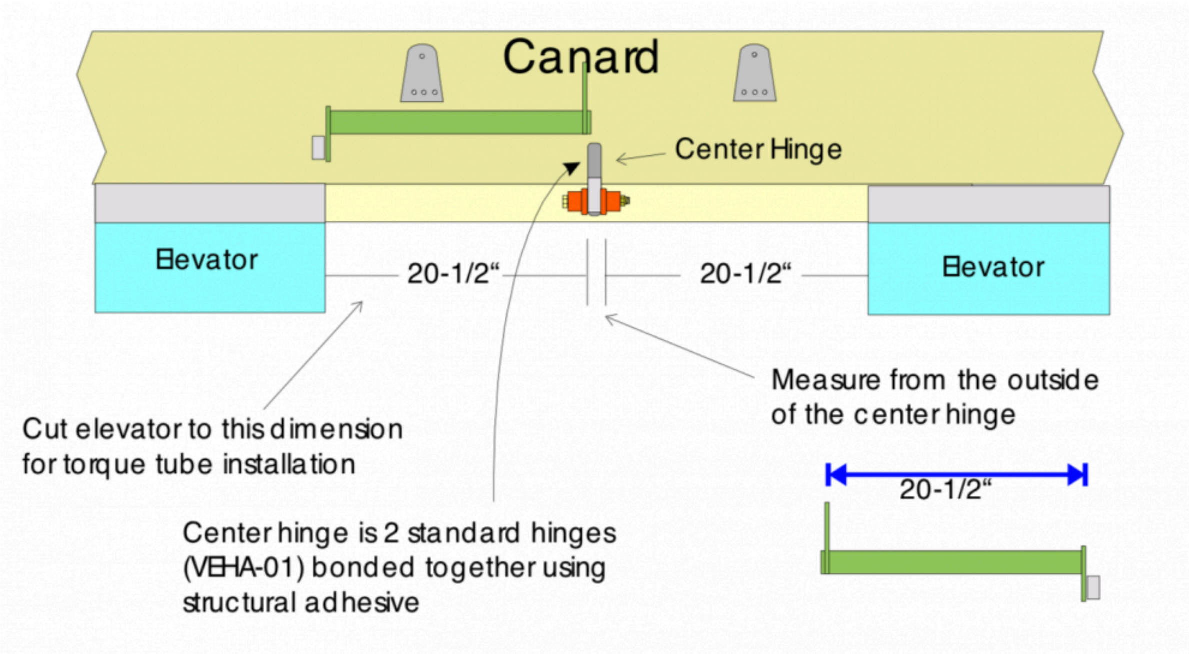
We will install the center hinge arm on the center line we came up with earlier. Locate the hinge arm along the back of the of the canard in the same location as you did the other hinge arms. Cut out the slot for the center hinge arm in the same manner. Sand the hinge arm where it will bond into the canard. Insert the hinge arm in the slot.

Now you can use a piece of string that you will pass through the two inner most hinges through the hole in the in the center hinge. This will keep the assembly lined up. Make sure that your center hinge is also perpendicular to the string so you will not have any binding when the concentric torque tube is installed. When satisfied with your alignment bond the hinge in as you did the others. Use the angle finder on this hinge arm as well.

Once the center hinge is cured drill the hole out to 1/4” and bolt on the canard center hinge oilite bushings as seen in Figure 3-24.

With the elevators in place measure from the center hinge out to the elevator torque tubes 20-1/2” each side. Mark the tubes this is where the elevator tubes will need to be cut to install the torque tube. Refer to

Figure 3-24.



After you have marked the elevators remove them from the canard and cut them to your line. Try and keep your cuts as perpendicular to the elevator as you can. Slide the aluminum bushing on the end of your torque tube into the elevator and reinstall it. Install the other end of the torque tube into your center hinge arm. Reinstall the screws in your other hinge arms and check for binding when moving the elevator. If there is binding you may have to trim the elevator torque tube more.

Now you can install the concentric torque tube permanently. Support the elevator s with the aluminum I-beams as you did to install the hinges. Double check that your elevators are in line with each other. Mark a center line down the outside tab of your concentric torque tube. Refer to Figure 3-25. With the Concentric torque tubes installed in the elevator align the center line that you drew with the bushing on your inner most hinge arm. When satisfied with alignment you can drill a small 3/32 hole through the elevator torque tube into the aluminum bushing about 1/2". Install a 3/32" rivet. This will temporarily hold your arrangement togather so you can check to make sure everything is in the right place before you drill your 3/16" hole.

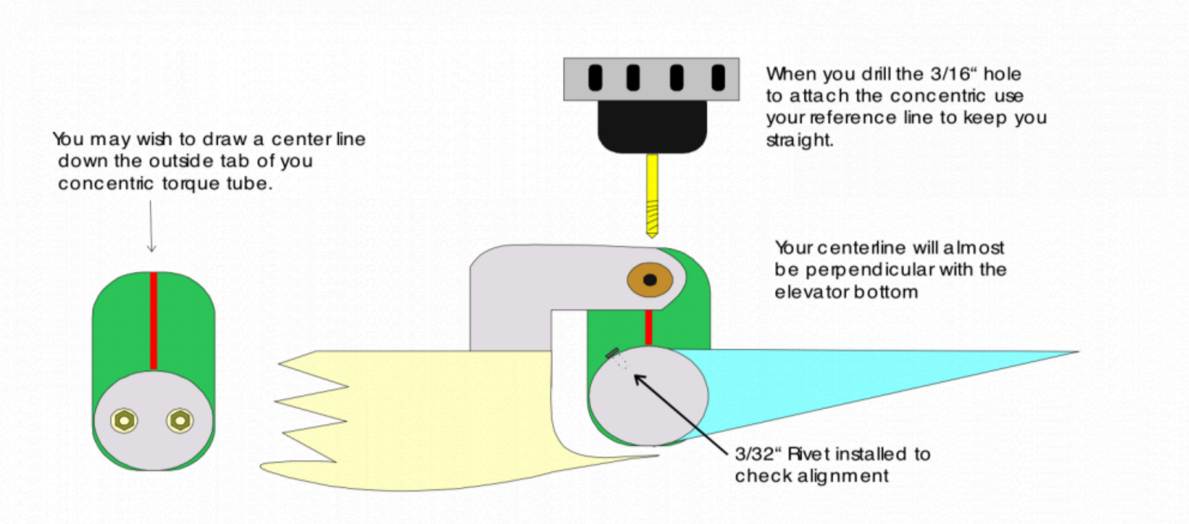


Figure 3-25. Concentric to Elevator Alignment

When you are satisfied with your alignment you can drill a hole for the MS24694S-59 screw that will hold the concentric torque tube to the elevator. The bushing on the elevator torque tube is 3/4" thick so space your hole 3/8" from the end to remain centered in the bushing. Slide a piece of aluminum or a putty knife between the elevator and the canard to protect it from your drill. It is very important that you keep the drill straight up and down as you drill this. I prefer to do this with an assistant so they can watch my drill. In stead of drilling with a 3/16" drill it is best to drill an 11/ 64" hole and then go back with a 3/16" reamer. This leaves a very tight hole with no slop. You will need to rotate the elevator and torque tube assembly so you can countersink the elevator torque tube for the MS24694S-59. The counter sunk side faces the bottom of the canard. Now you can install the MS23694S-59 and the MS21042-3 locknut to hold it in place. Reinstall the elevators so you can install the counterweight arms.

Attach the **left outboard counterweight** to the **left counterweight arm**, and the **right outboard counterweight** to the **right counterweight arm**. Each counterweight is attached using (2) MS24694S-59 screws and (2) MS21042-3 locknuts. The counterweights will be attached to the **inboard** side of the arms.

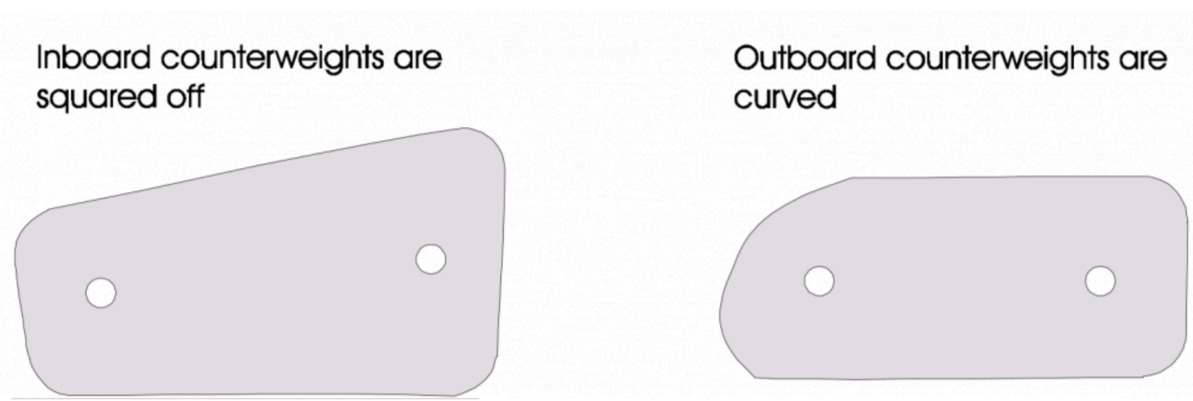


Figure 3-26. Elevator Counterweights

___ Slide the counterweight arms into the ends of the elevator torque tubes. When you install the canard tips in the Fairing section Chapter 11 you can make a small notch in them to accept the counterweight arm.

___ Cut out a notch 1-1/4" in from the canard ends, extending 5-1/4" forward of the **trailing edge** of the canard.

___ Remove the lower skin and foam, leaving the inner top skin intact. See Figure 3-27.

___ Rotate the counterweight arms in the elevator and check to make sure the cutout is large enough for the counterweight and the one ply of **BID** you use to cover the hole.

___ When satisfied, remove the elevators, and glass over the exposed foam sides with one layer of **BID**. Let cure.

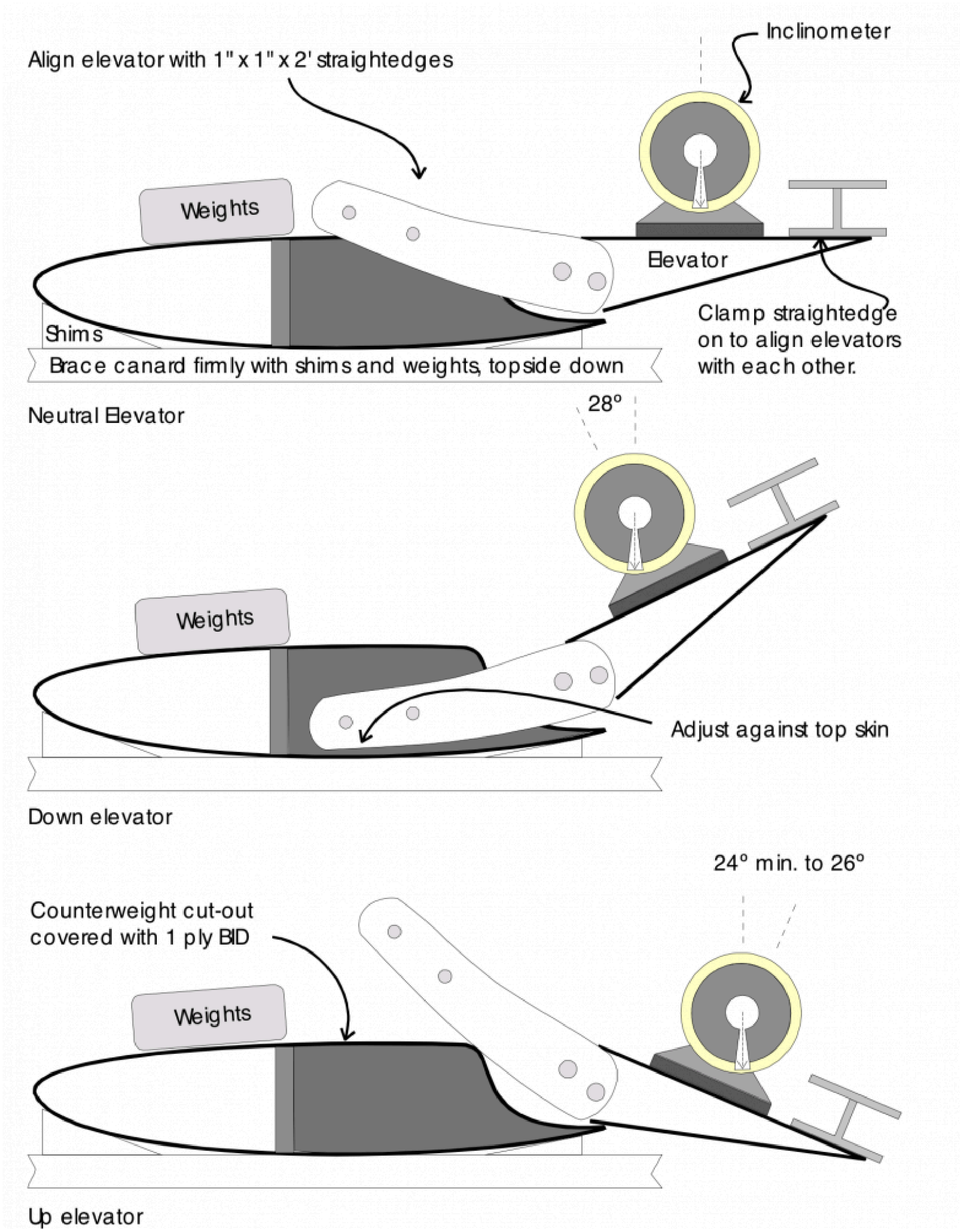


Figure 3-27. Elevator Travel Measurement

___ Using weights, secure the canard in position, upside down, so that it will not move. With the torque arms and counterweight arms in place, install the elevators to the canard. Using the straightedges that you employed while making your positioning marks, establish neutral position for the canard/elevator assembly. Bolt the two halves of you concentric together to ensure that both counterweights will be installed in the right place. With an inclinometer (available at Sears), measure your free **trailing edge** movement. If you don't have an inclinometer, you can equate 1" of **trailing edge** movement to approximately 10 degrees deflection.

See Figure 3-27.

The minimum acceptable deflection is as follows:

Up Elevator	24 degrees min (preferably up to 26 degrees)
Down Elevator	28 degrees (approximately 2-3/4” deflection from neutral)

(Remember the assembly is upside down right now, so don’t get the two measurements switched around)!

The counterweight arms (outboard) can limit the down elevator travel so it is very important to make sure you get a minimum of 28 degrees of down travel.

In this position, the counterweight arms should be pressing against the upper skin of the cutout you made earlier.

If you are pleased with how everything looks, secure it all carefully in place. It would be a good idea at this point to use hot glue to bond the counterweight arms and torque arms in place on the torque tube. (Another technique to hold things in their proper position before you drill is to drill a 3/32” hole through the torque tube and the bushing and use a flush head 3/32” rivet to hold things in place to check proper placement.

___ Set the elevators to neutral position. Use the same technique we used to drill the 3/16” holes to install the concentric torque tube. See Figure 3-28 and Figure 3-29.

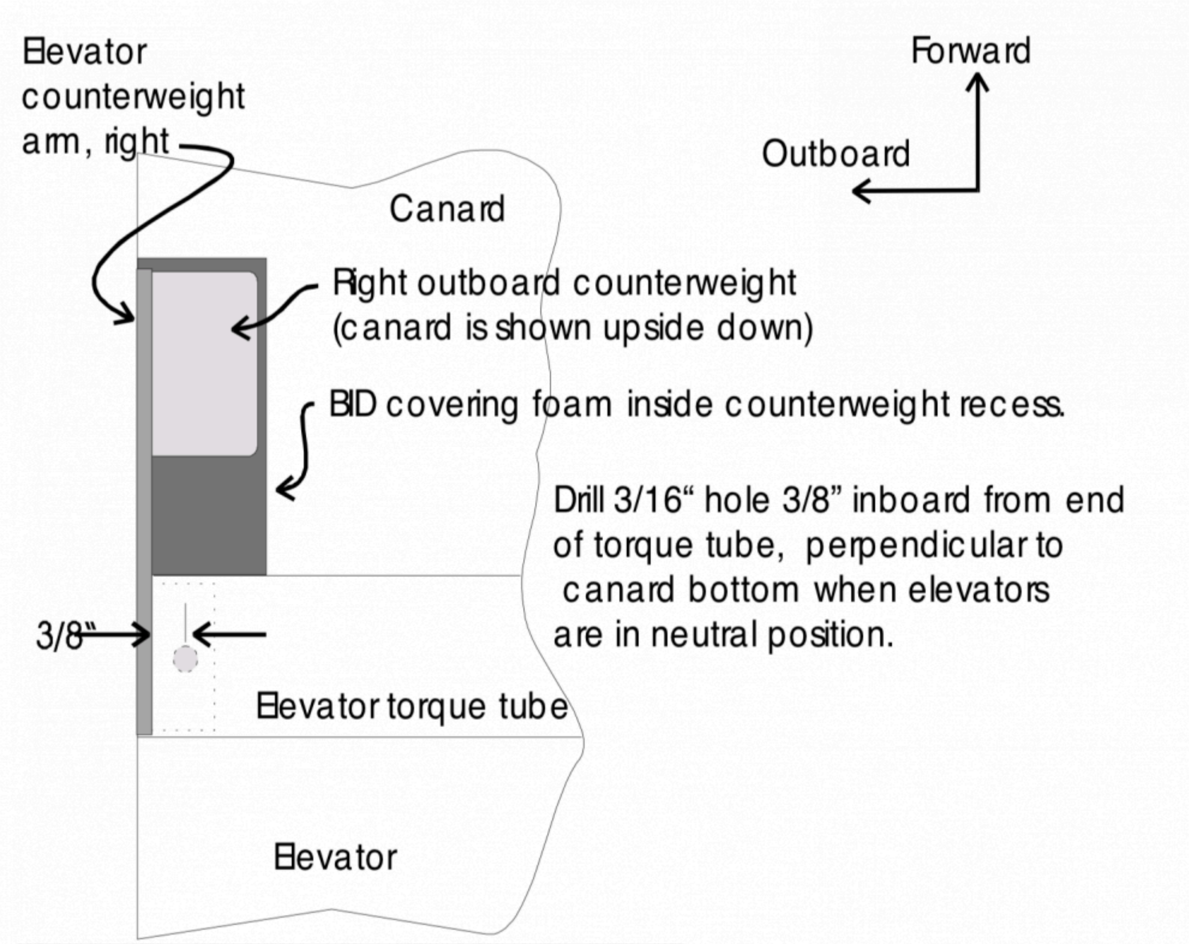


Figure 3-28. Outboard Elevator Counterweight Wells

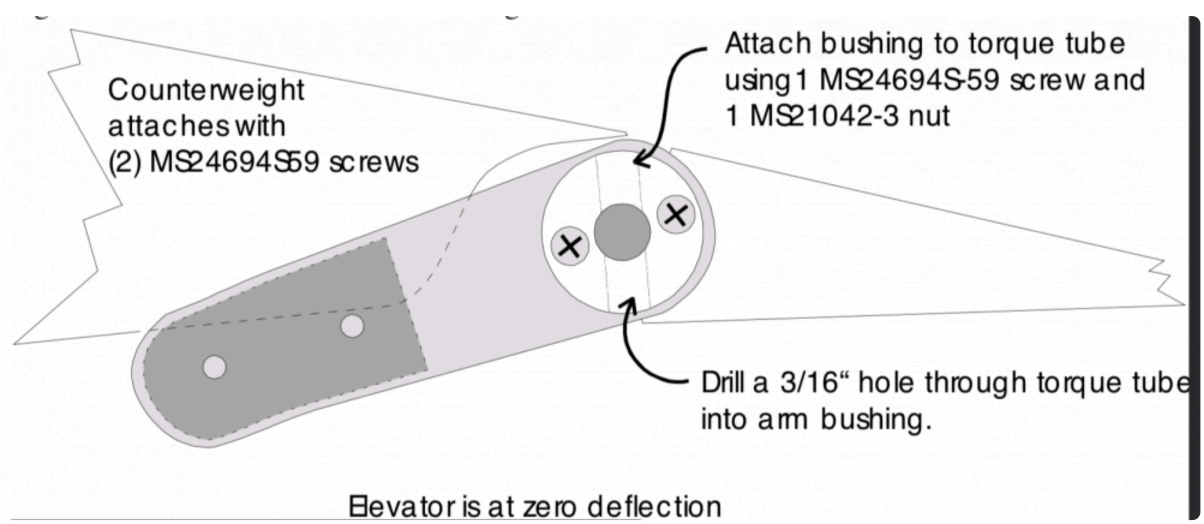


Figure 3-29. Outboard Elevator Torque Arm Attachment

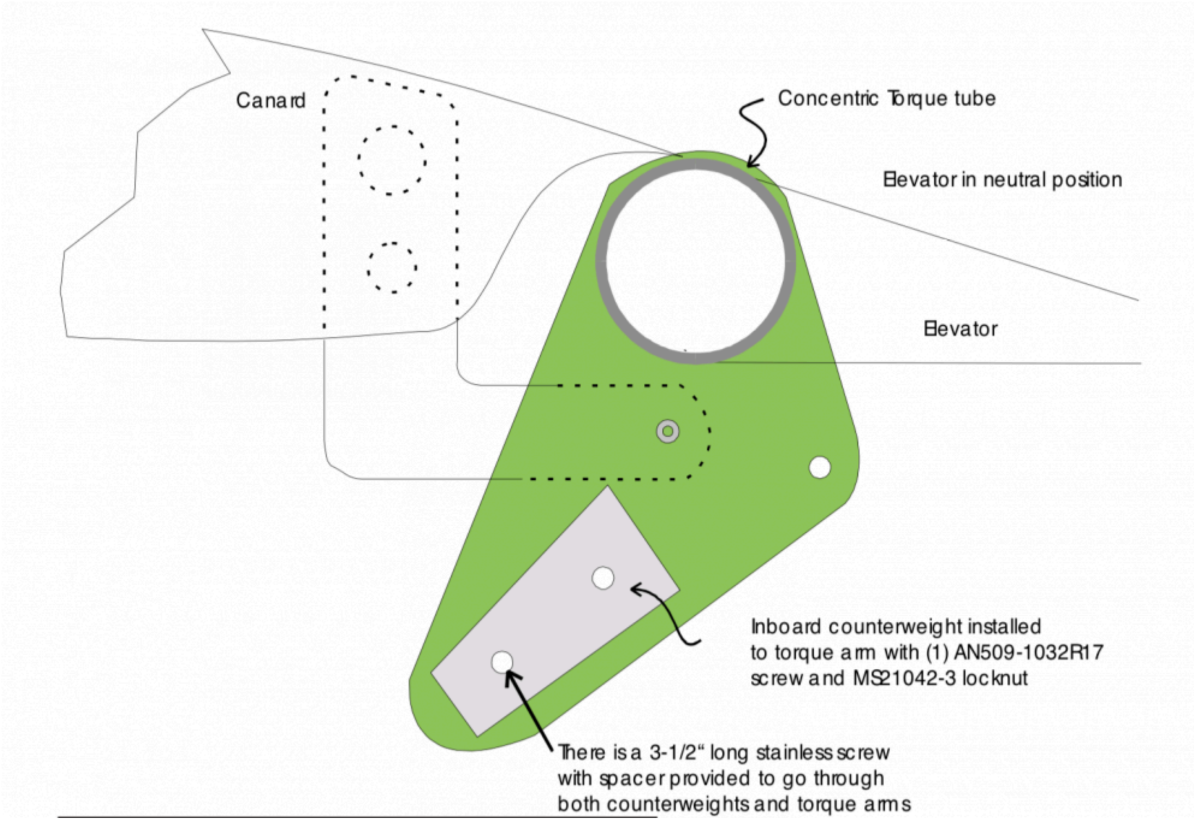


Figure 3-30. Inboard Counterweight Installation

Install the **inboard** counterweights to the concentric torque tube assembly using (1) MS24694S-59 screw and (1) MS21042-3 locknut on the top counterweight hole. The lower hole get a 3-1/2” long screw that goes through both counterweights and torque arms. Use the spacer in between the torque arms. The counterweights will attach to the outboard sides of the torque arms.

3.5.3 – Elevator Balancing

___ Have the elevators installed loosely on the canard for balancing. Block the canard up on a flat table as you did to check you elevator travel.

Without paint, the elevators should hang slightly nose down. Ideally, with the final finish applied, the elevators should balance bottom side level. A bit nose down is acceptable.

The reason for proper balancing is to prevent flutter. Flutter can occur at high speeds and is aggravated by turbulence. Thus, to achieve the highest safe Vne (Never exceed speed), all control surfaces must conform to the above balancing criteria.

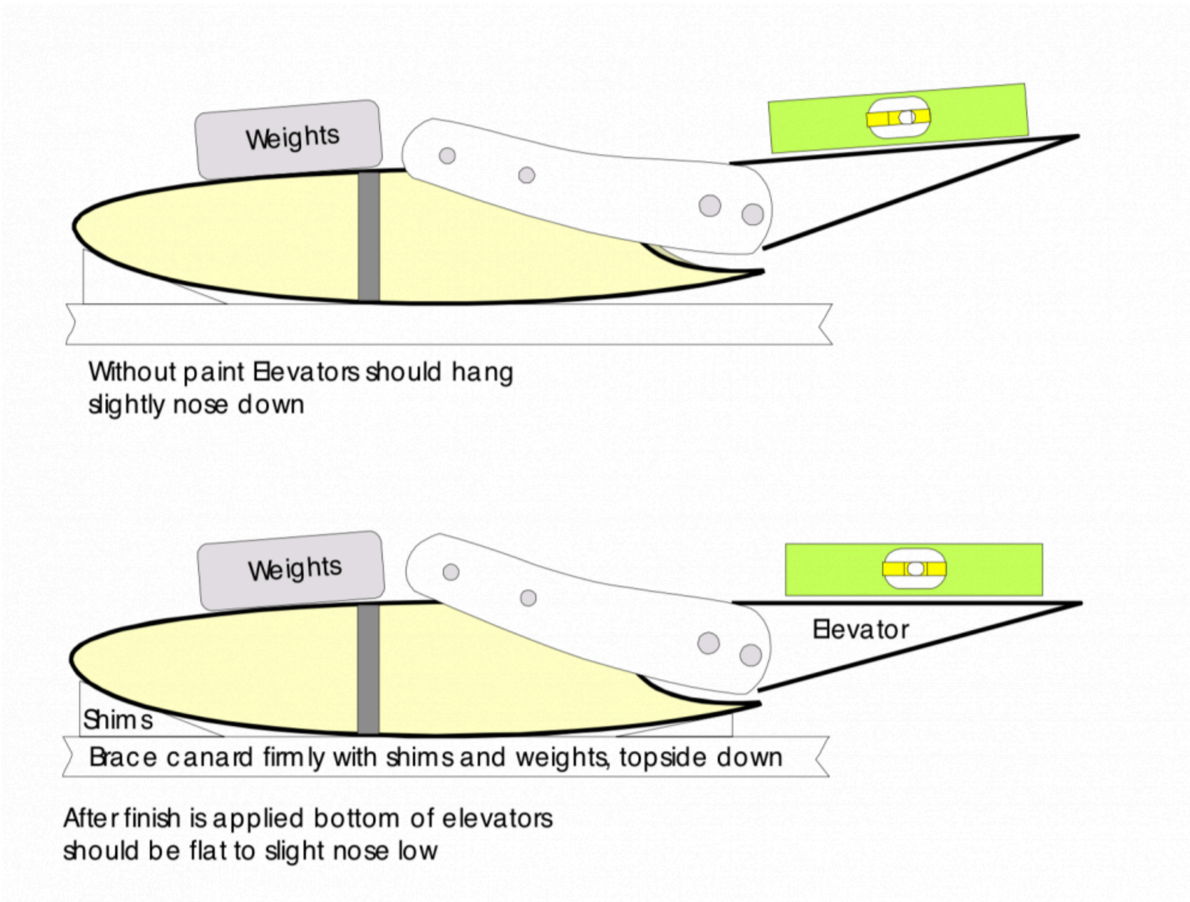


Figure 3-31. Elevator Balancing

4. 4 – Bulkheads

Contents

(Shared with XF, XR)

4.1. 4.0 – Chapter Preface

4.0 – Chapter Preface

4.0.1 – Parts List

Part Number	Description	Qty
MP0501	Bulkhead, Canard	1
MP0502	Instrument Panel ***or***	1
MP0503	Canted Instrument Panel	1
MP0504	Wiring Ducts	2
MP0505	Tray, Battery	1
AAC-3-4	Pop Rivet, Small	20
–		
	Bulkhead, Firewall	1
	Bulkhead, Gear	1
	Gear Saddles, Left and Right	1
LLMP	Landing Light Holder	1
LLL	Landing Light Lens	1
LLAS	Landing Light Assembly Hardware	

4.0.2 – Tools List

Description
Water Level
Roll Tape Measure
Plumb Bob
Clecos

4.0.3 – Supplies List

Description
48” Level
Small Level Tubes
Masking Tape
Structural Adhesive

Glass Bubbles
EZ-Poxy
Cabosil
Flox

4.0.4 – Glass List

Type	Size	Qty
BID	3’ × 3” Around Fuselage	6
BID	3 1/2” × 1/2 Around Fuselage	1
TRIAX	Floor Reinforcement	2
BID	3” x Battery Tray	2

4.0.5 – Process Overview

Construction Process	Completion Date
Prepare Bulkheads	
Level & Jig Fuselage	
Mark Bulkhead Locations	
Trim Ducts	
–	
Dry Fit Bulkheads and Ducts	
Locate and Fasten Bulkheads	
Bond In Firewall	
Reinforce Floor	
Bond In Main Gear Bulkhead	
Install Other Bulkheads & Fixtures	
Prepare Keel for Installation	
Bond In Canard Bulkhead	
Bond In Battery Bulkhead	
Bond in Landing Light holder	

4.0.6 – Documentation Changes

Oct 01, 2018 – Original Web Release

4.2. 4.1 – Bulkhead Preparation

4.1 – Bulkhead Preparation

4.1.1 – Locate Bulkhead Placement

Note: There is an index hole in the fuselage flange 1” forward of the airplane. All measurements on the plane include this 1”.

To locate bulkhead placement inside the fuselage you must level the fuselage upright. (See Figure 4-1 and Figure 4-2). Use a water level as described in chapter 1 to place the nose of the aircraft at the same level as the back lowest section at the center of the rear of the cowling.

___ Measure bulkhead locations **along fuselage centerline** (Figure 4-2). Mark the bulkhead positions on the flange **perpendicular to the centerline**.

The measurements along the flange are approximate and can be used to verify bulkhead location. However, since the fuselage is not perfectly symmetrical, there may be minor differences from one side to the other when the bulkheads are perfectly square.

- The canard bulkhead measurement is for the **forward** side position.
- The instrument panel and firewall measurements are to the **aft** side positions.

___ Centrally, on the side of the fuselage, about 6” down from the flange, place masking tape and mark a level line on it. Use this line for all future longitudinal leveling.

It is a good idea to **Bondo** a couple of bubble levels on the fuselage floor, one on the longitudinal axis and one on the transverse axis. Make sure they are level, of course. A good place is just behind the instrument panel, ahead of the front seat, to the left of the console. These can also be referred to for future leveling.

___ Place a straightedge across fuselage at the marked locations for bulkheads and, using a plumb bob every few inches across fuselage, mark points to locate bulkheads transversely.

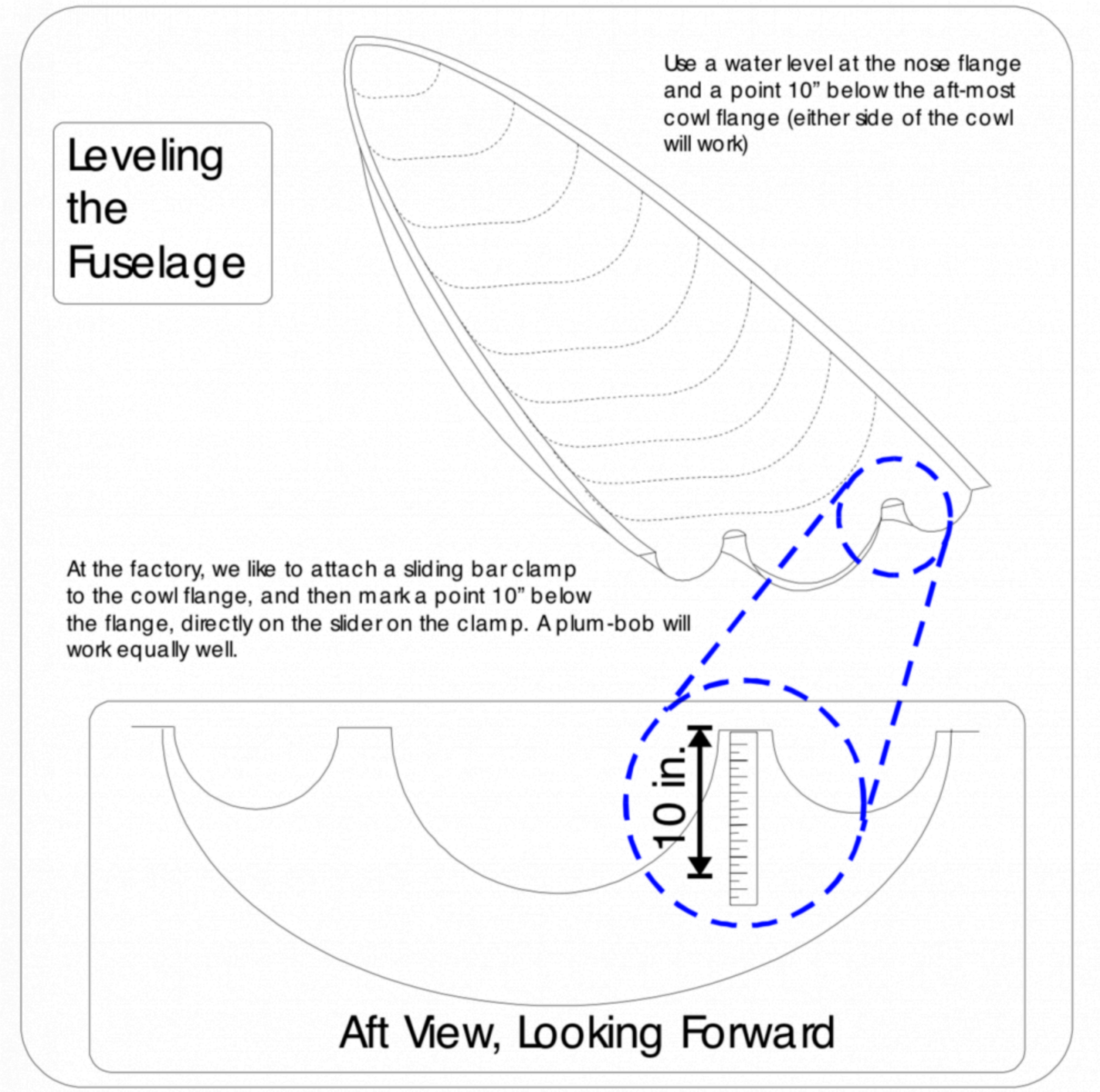


Figure 4-1xa. Leveling the Fuselage

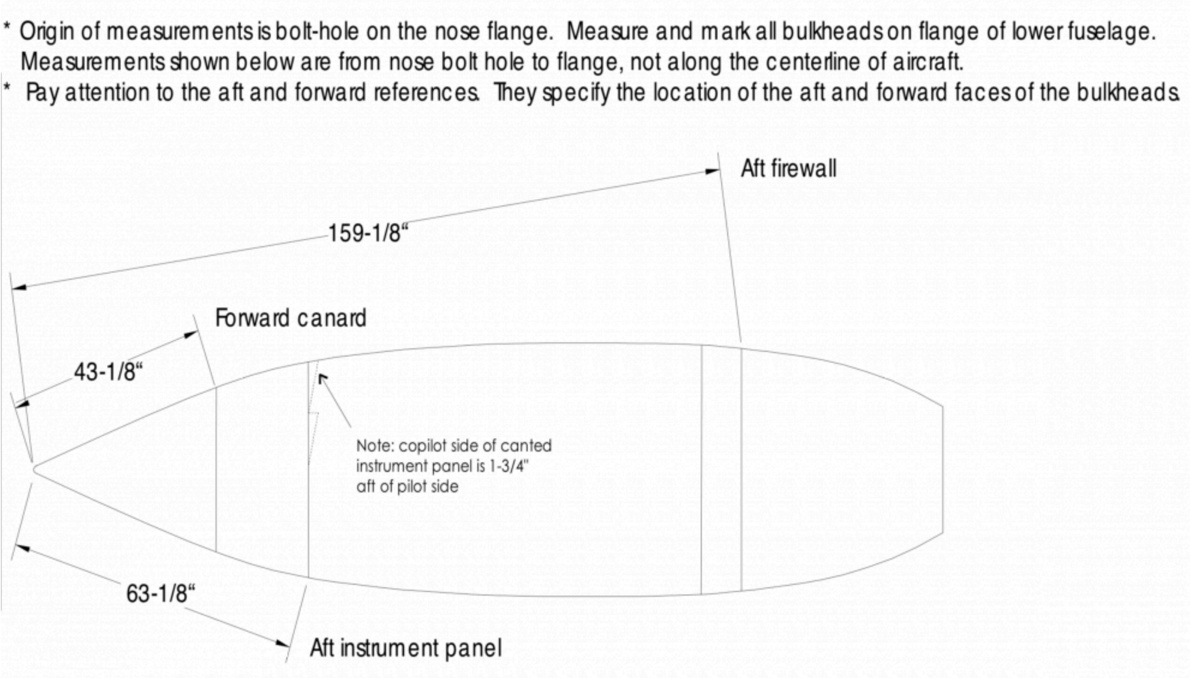


Figure 4-1x. Bulkhead Locations on a Diagonal Referenced to Nose Bolt Hole

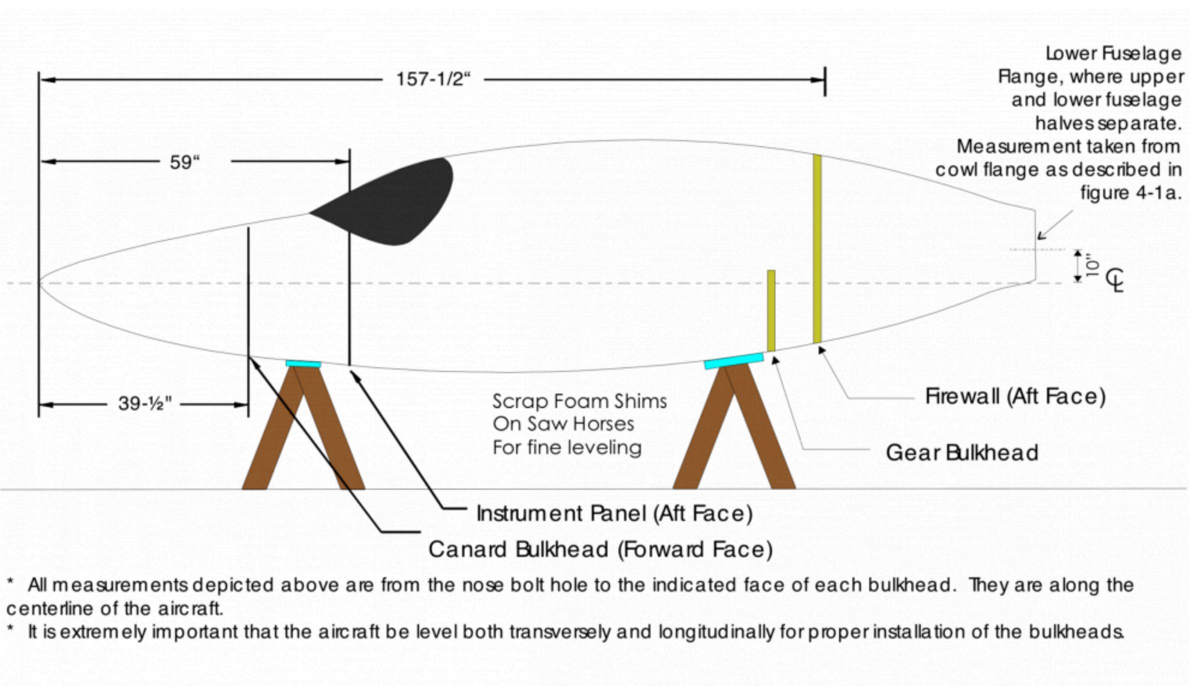


Figure 4-2x. Bulkhead Locations Referenced to Aircraft Centerline

4.3. 4.2 – Install Bulkheads

4.2 – Install Bulkheads

4.2.1 – Preliminary Fitting of Parts

Wiring Ducts

The wiring ducts have a joggle in one end that corresponds to the end of the foam in the rear of the fuselage. If the duct will not reach the canard bulkhead, the foam will need to be beveled to allow the duct to move forward.

___ Trim the flange on the ducts down to 1/2”.

___ Lay the ducts in the fuselage temporarily.

As you are fitting the firewall, gear bulkheads, and canard bulkhead, cut the flanges of the ducts off under the flanges of these bulkheads to all them to go down as far as possible.

Firewall

___ There are 3 locating dimples on the fuselage outer skin. One in the center of the pane the other two are on the sides about 2 inches down from the flange. The firewall flange has three (3) 1/8” hole locating marks on it. Drill these out to 1/8”.

___ Install the firewall (flange forward) over the ducts and cleco in place.

Gear Bulkhead

___ Set the molded gear pockets in place in front of the firewall. This will give the proper spacing for the gear bulkhead.

___ Temporarily set gear bulkhead in place (flange aft).

Canard Bulkhead

The canard bulkhead and the keel must be fit at the same time. Refer to chapter 6 for keel install.

The premarked holes in the Canard bulkhead are **not** used to index the canard bulkhead.

___ Measure 43-1/8” back from the nose bolt hole on each side of the fuselage and place a mark.

___ Install the canard bulkhead (flange aft) at your 43-1/8” marks making sure it is plumb with the firewall and that it is **level laterally with the gear pockets. (Very important)**

Note: It is very important to get the canard top and gear pocket top to match up laterally. Your center spar and your canard rest on these and this will make sure that they line up laterally. Also measure from the canard bulkhead to the firewall along the flange on each side of the airplane. If the bulkheads are square to each other this measurment will be the same on each side.

Preparations for Bonding

___ Draw around the perimeters of all of the bulkheads and the ducts with a marker to mark their locations.

___ Sand all contact areas on the bulkheads and fuselage. Clean thoroughly with denatured alcohol.

___ Bevel the inboard vertical edges of the gear pockets to allow later layups to transition smoothly from the gear pockets onto the firewall.

Retractable Gear – You will want to cut the nose gear door hole out before bonding the canard bulkhead. Refer to Section 7.1.1.

4.2.2 – Bonding Procedures

Before bulkheads are bonded in, sand each bulkhead around the perimeter and 2” on the fuselage side without the flange. The flanged side of the bulkhead does not need any glassing.

The structural adhesive is a 1 to 1 mix, and you will need to add enough Cab-O-Sil and Flox to make a pasty mixture like mayonnaise.

Canard Bulkhead and Wiring Ducts

___ Bond the ducts and canard bulkhead in place with the keel temporarily in place to line things up. **Do not bond the keel down.** Do the next step before things cure.

___ Using BSP-4-4 rivets, rivet the canard bulkhead to the fuselage with 8 rivets. Use 18-20 rivets on each duct. Cleco (do not rivet) the portion of each duct that is between the firewall and gear bulkhead.

Gear Box Area

We will now bond the firewall, gear pockets, and gear bulkhead to each other then bond this whole assembly into the fuselage.

___ Spread adhesive on the contact surfaces of each part and hold them together loosely with a length of 1/4” threaded rod and nuts. Do the next steps before this cures.

___ Spread adhesive on the flanges of the bulkheads and on the contact surfaces of the pockets and install them in place. Note that for the pockets you must spread adhesive on any surface that contacts the fuselage, wiring duct, or bulkhead.

Retractable Gear: Lay a long level across the gear pockets and make sure they are level. The hole through them was drilled to 3/8” to allow some movement to position them properly.

Install the center cleco and then the side cleco’s in the centering holes in the fuselage and firewall. Coat the cleco’s with Vaseline so you can get them back out after cure.

IMPORTANT: Make sure the gear pockets are level with the canard bulkhead and make sure that the gear bulkhead and the firewall are level vertically.

___ To hold the firewall and gear bulkhead tightly against the gear pockets, install 3 large rivets (612 AA) on the front and back sides of the pockets. Install them spaced 2” apart horizontally. They should be centered approximately 11-1/2” below the fuselage flange.

4.2.3 – Glassing Bulkheads

All bulkheads are glassed with 2 plies of **BID** approximately 3” wide with the axis at 45 degrees overlapping equally on the bulkheads and fuselage (see Engine Bulkhead below for additional layups). The flanged side of the bulkheads do not need to be glassed.

4.2.4 – Engine Bulkhead

The engine bulkhead (ie. firewall) receives a third layer of **BID** that joins the engine side of the firewall to what will become the cowling flange. Cut a **BID** strip approximately 3.5” wide. Apply the **BID** so that it laps 2” onto what will become the inside of the cowling. Lap the remaining portion of the strip onto the rear face of the firewall.

4.2.5 – Engine and Gear Bulkheads

___ Apply one layer of **TRIAX**, 7” × 39”, major axis fore and aft (the 7” dimension), between the engine and gear bulkheads, centered transversely, running from one duct to the other. This reinforces the floor at this point.

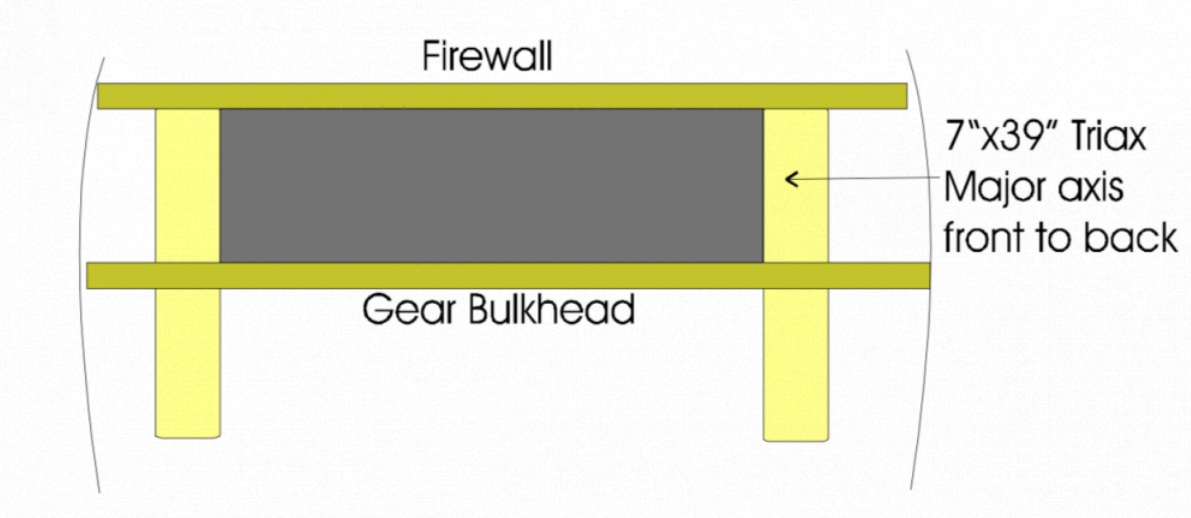


Figure 4-3x. Triax Reinforcement

___ Drill a 1” hole in both ducts just forward of the engine bulkhead toward the bottom of the fuselage for later routing of wires and brake lines.

4.2.6 – Cowl

___ After the firewall is installed you can remove the lower cowling. The upper cowling is removed and flanged in the same way as the lower cowling but you must first install the top fuselage half which is located in the “Doors / Windows” section.

___ Draw a line parallel to the firewall on the lower fuselage half 1-3/4” away from the firewall. This will be the line that you will your cowling cut line. There already is a cowling cut line that you can use as a reference. Place a piece of masking tape along this spot line to form a smooth, fair line for cutting off the cowl. Start cutting the cowling free about 6” at a time. After you have made the cut attach tongue depressor pieces across the cut with hot glue. Wait until the glue cools on the piece you just cut before you make the next cut. This will keep the cowling lined up properly. Cut the cowling free all the way down to the flanges. Don’t cut through the flanges at this time.

___ Place 2” wide duct tape across the fuselage where it meets the aft firewall face, from side to side. Line up the aft side with your cut line.

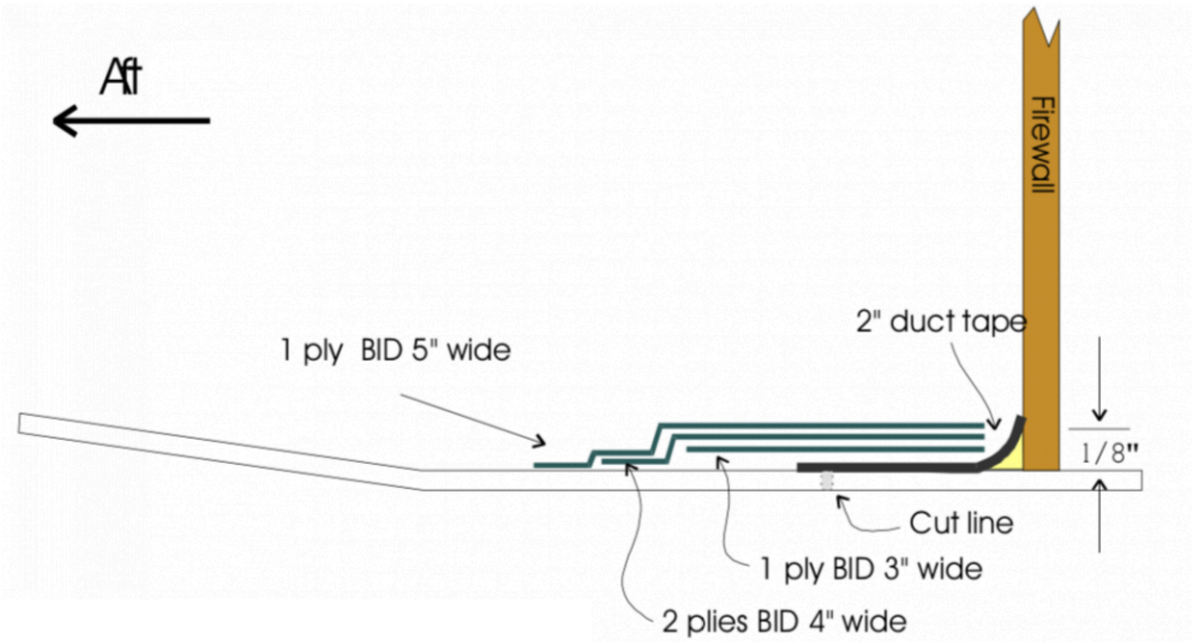


Figure 4-4. Cowling Flange Lay-Up

___ Apply one layer of 3" and two layers of 4" **BID** tape across the fuselage over the duct tape but just butting into the duct tape radius at the firewall.

___ Put 1 layer of 5" wide **BID** . This creates the cowl flange.

___ After cure you will need to drill the attach holes before removing cowl.

___ Drill 1/8" holes through the lip and fuselage 1-1/8" aft of the firewall (or 5/8" forward of the cut line), spaced 6" apart, from the centerline to each side of the fuselage. These holes will become future nut plate locations and are used for clecos while doing various fitting operations.

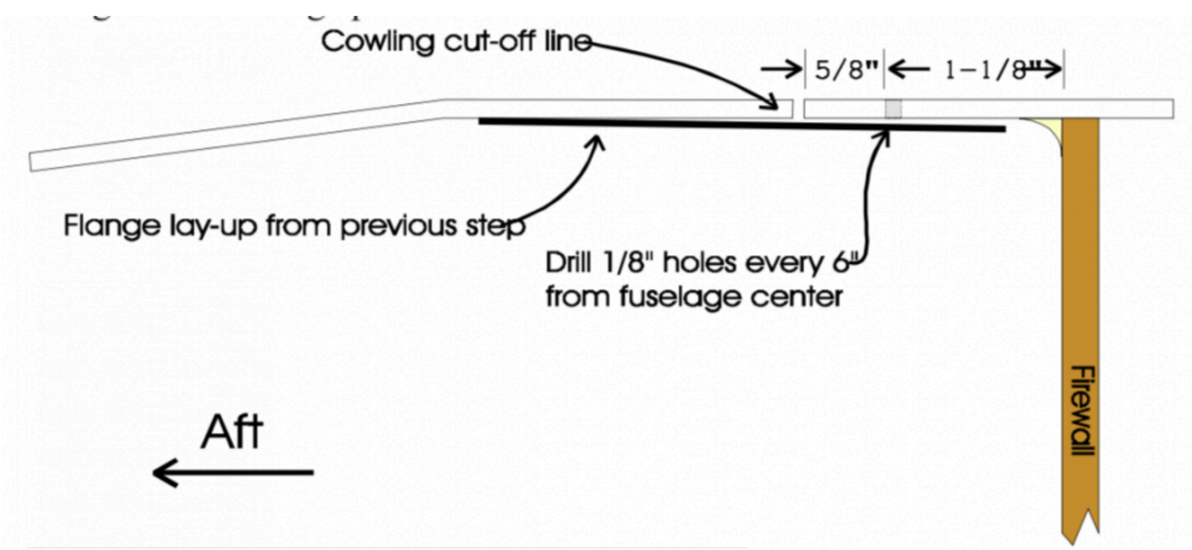


Figure 4-5. Cowling Cut Line and Nut Plate Holes

___ Now you can cut through the flanges between the fuselage and cowling.

___ Break the cowl away from the fuselage, sand the edges, remove the tape, and clean up.

4.2.7 – Canard Bulkhead Notes

You will use the keel to install the canard bulkhead since the flange on the keel indexes to the canard bulkhead. Use clecos or self-tapping screws to install temporarily for fitting.

The canard bulkhead comes as a flanged, premolded part. This makes it easier to fit into it position. Trim the flange to 3/4" wide. The flange will need to be removed in the area of the keel. The keel will be installed in Chapter 6.

4.2.8 – Battery Shelf

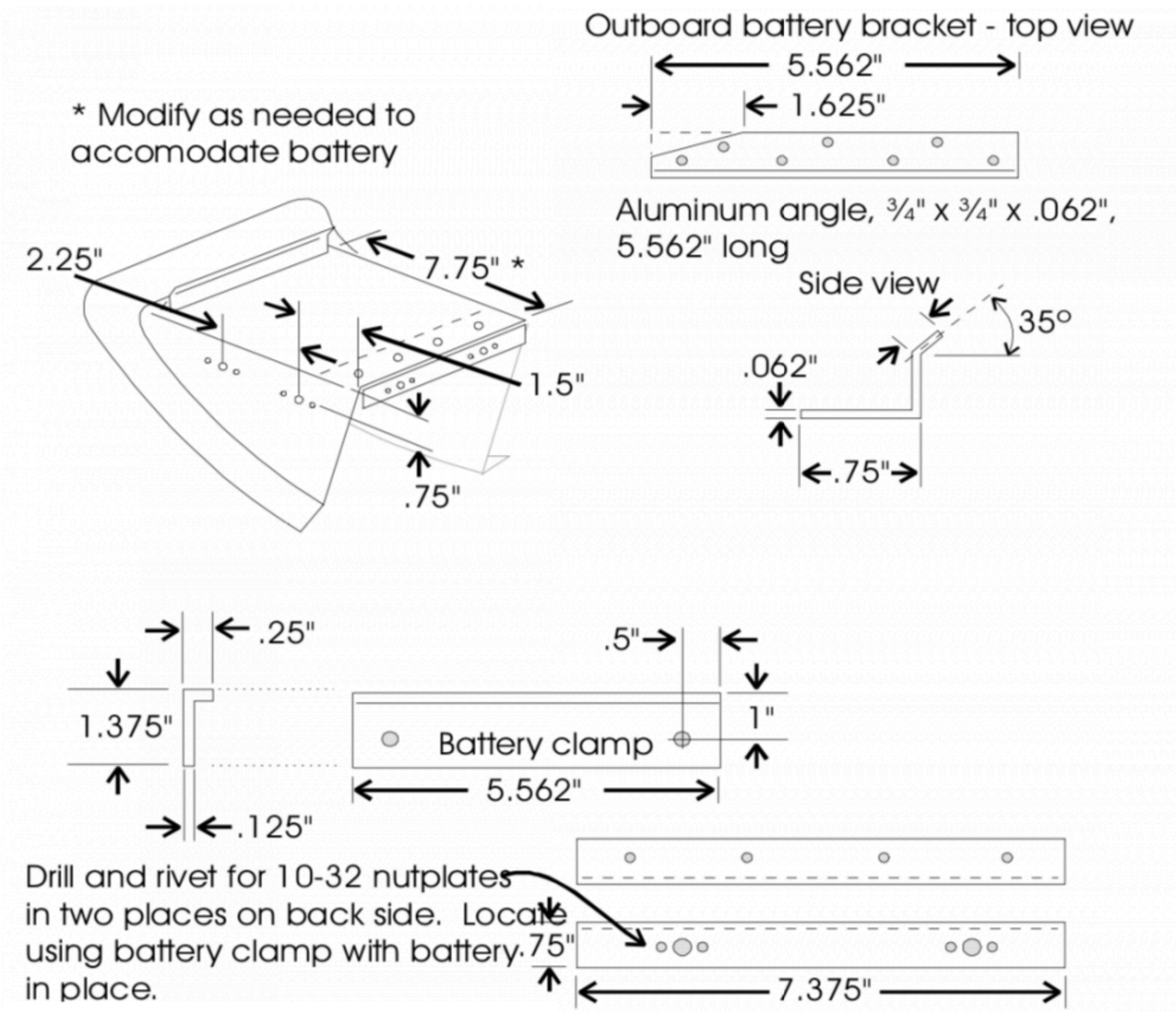


Figure 4-6. Battery Tray Assembly

___ Assemble the battery shelf and brackets as shown in Figure 4-6.

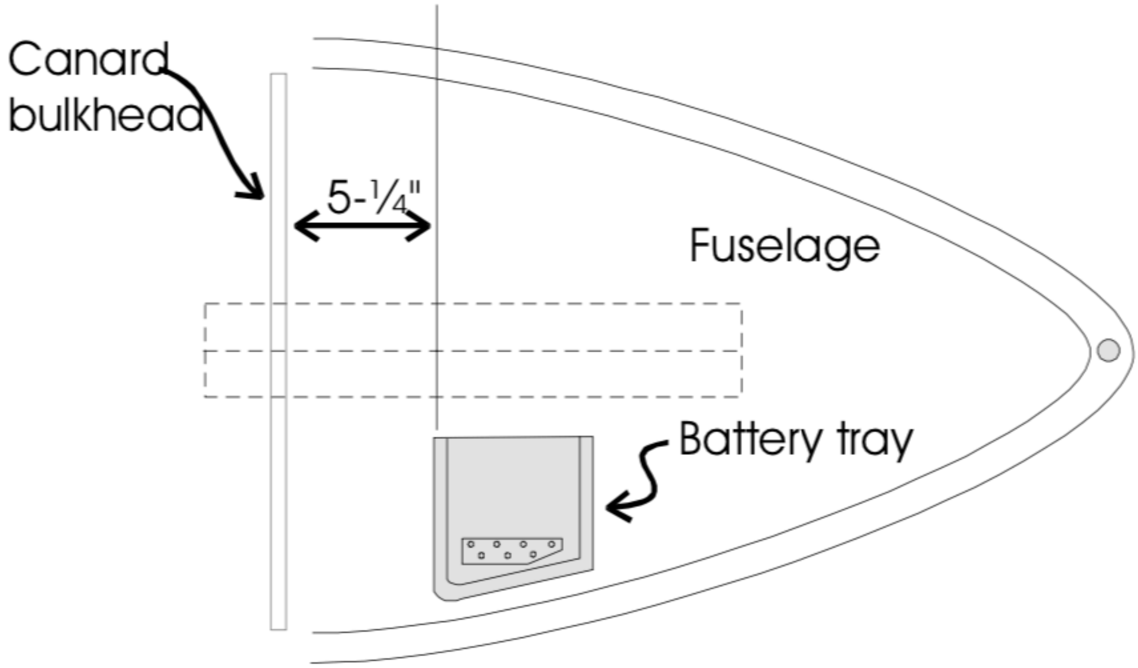


Figure 4-7. Battery Holder Assembly

___ Sand the bottom of the flanges and the fuselage. Spread structural adhesive on the bottom of the flanges and position the shelf in the position shown above.

4.2.9 – Landing Light

___ Cut out the inside of the premoded flange for the landing light on the nose of the airplane. Leave a 1/4" lip all the way around the exterior to mount the lens to.

___ Place the landing light holder in the nose of the airplane. Center it from left to right in the hole you just cut and push it as far forward as it will go. You may need to trim the flange off the front of the holder to allow it to slide further forward.

___ When satisfied with fit mark the location for the holder. Remove the holder and sand both the holders flange and the fuselage where it will go. Install holder using **Structural Adhesive**. You may want to place a weight on top of the holder as the adhesive cures.

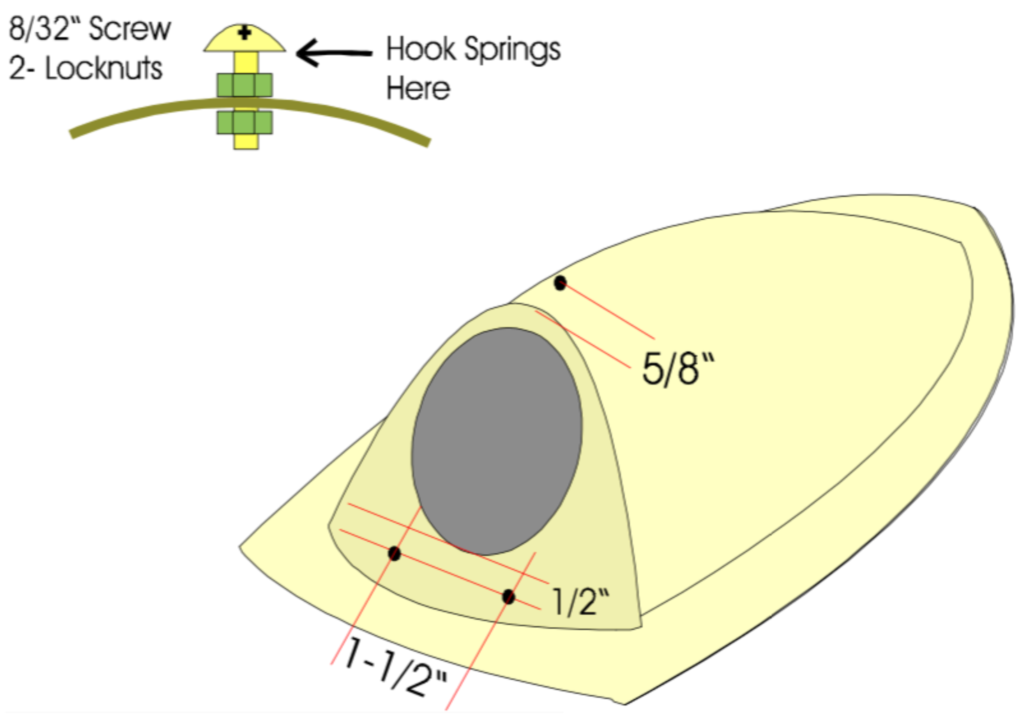


Figure 4-8. Landing Light Holder

Install three 8-32 screws with nuts as shown in figure 4-9. The springs that hold in the landing light hook around these screws. It is not a bad idea to cover the springs with rubber or tygon tubing to act as an insulator so you do not accidentally short out the battery.

The lens for the light can be installed with silicone after the aircraft is painted.

5. 5 – Doors and Windows

Contents

(Shared with SF, SR, XF, XR)

5.1. 5.0 – Chapter Preface

5.0 – Chapter Preface

5.0.1 – Parts List

Part Number	Description	Qty
VLHALR	Lock Housing-Right Assembly	1
VLPRLR-01	Latch left right push rods	6
VLBSPA-01	Latch Base and Spring Pivot	2
VLCKP-1	Pilot side security Lock	1
VPDDB-02	Pressure door dampner ball	4
V-DMS-01	Door Micro Switch	2
VMDH-02	Door Hinge	4
VGSNC-02	Cover	2
VDDD-02	Bracket	2
VDLC-02	Cover	2
VTDS-022	Door seal	24 ft
VLBALR-01	Latch assembly	2
VPDD-02	Gas springs	2
MS24693C-273	10. Screws	32
V8052CL-01	CamLock	1
VCBLR-01	Carbon Beams	2
	Door Gas Spring Assembly	2

5.0.2 – Tools List

Description
.#21, 1/8”, 3/32”, 5/16” 1/4” 3/16” 17/32” drills
10-32, 5/16-18 taps
5/8”, 3/4” hole saws
Razor Knife
1/8” clecos

5.0.3 – Supplies List

Description
36-80 grit sandpaper
tounge depressors
Structural Adhesive
Flox
Cardboard For door template

5.0.4 – Glass List

Type	Size	Qty
Triax	5” × 48”	2
Triax	4”× 48”	4
Triax	3” × 48”	2
Bid	2” × 65”	6
Bid	2” × 48”	8
Bid	2” × 3”	24
Bid	3” Long enough to make it around fuselage 4x’s	

5.0.5 – Process Overview

Construction Process	Completion Date
Window Cutouts	
Install Windows	
Cutout doors	
Install Top fuselage	
Install door flanges	
Install door latch and locks	
Install latch pin tubes	
Install Carbon Beams	
Install Gas springs	

5.0.6 – Documentation Changes

Oct 01, 2018 – Original Web Release

5.2. 5.1 – Windows

5.1 – Windows

5.1.1 – Window Cutouts

NOTE: The following instructions apply to the windshield and aft windows, not the door windows.

___ Cut out the window holes as marked on the top fuselage half using a saber saw. Start the cut to the inside of the marked lines.

___ Smooth out the nicks with a sanding block on the straights and a pipe wrapped with sandpaper in the corners.

___ Mark a 3/4” border on the inside of all window holes. Cut through the inner skin with a Dremel tool along these lines.

___ Cut out the foam with a razor knife taking care not to press the outer skin too hard causing delamination. Clean and sand the foam away from the outer skin for future bonding.

5.1.2 – Fit Windows

___ Place windows in a position of best conformance on the outside of the fuselage. Mark the windows with a water soluble pen from the inside. Remove and cut the windows 3/8” to 1/2” outside the markings. Fit the windows from the inside without cutting away too much glass. See Figure 5-1.

NOTE: The videos show to use clecos to install the windows. We have come up with an easier and more effective method, eliminating the need to drill holes and then fill them later.

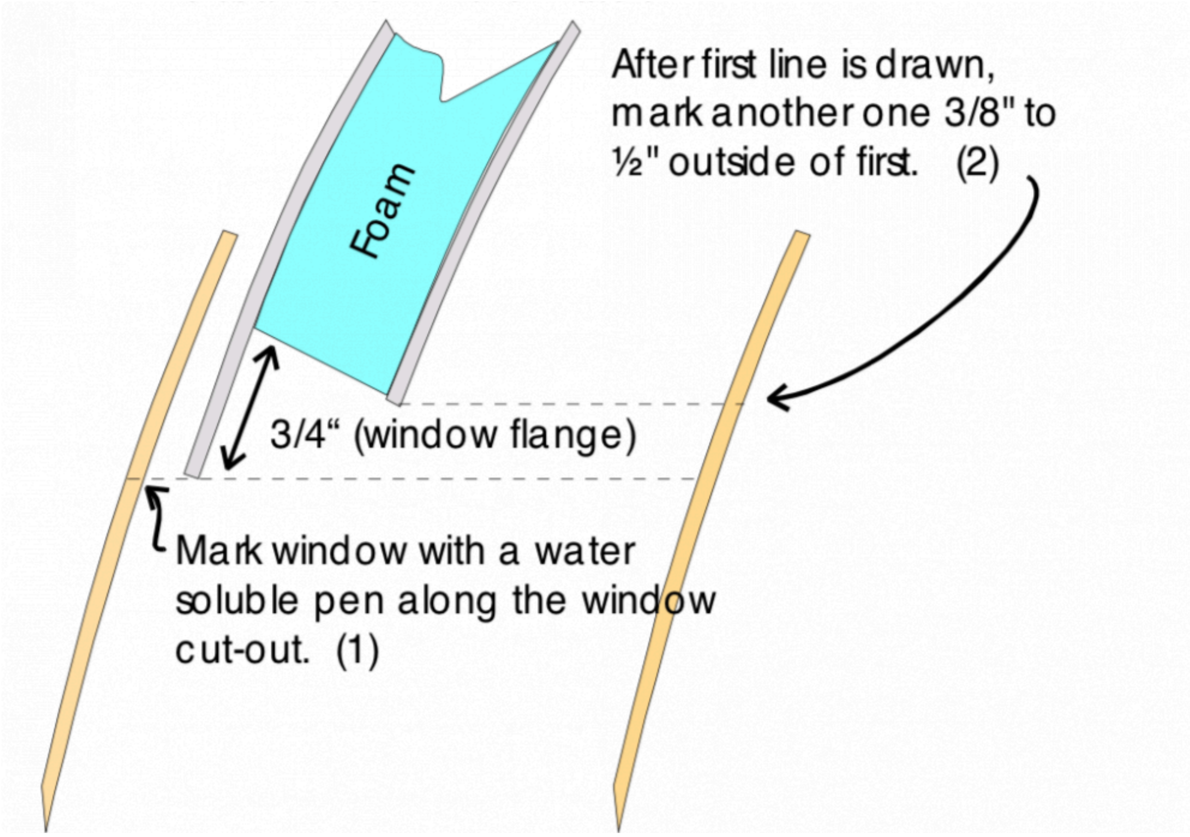


Figure 5-1. Fitting Windows and Creating Fuselage Flange

___ Cut approximately 25-35 wood wedges from your mixing sticks, as shown in Figure 5-3. These will be used to hold the window in place for fitting and cure. As the wedge is pushed into the foam it will push against the inner skin, and subsequently against the window, forcing the window outward, against the outer fuselage skin. Be careful not to jam the wedge in too hard, as it can cause delamination of the inner and outer skins from the foam.

___ Once the window will fit into the recess with no interference, cover both sides with duct tape. The window hole should already be smoothed up, and have nice straight lines and clean curves.

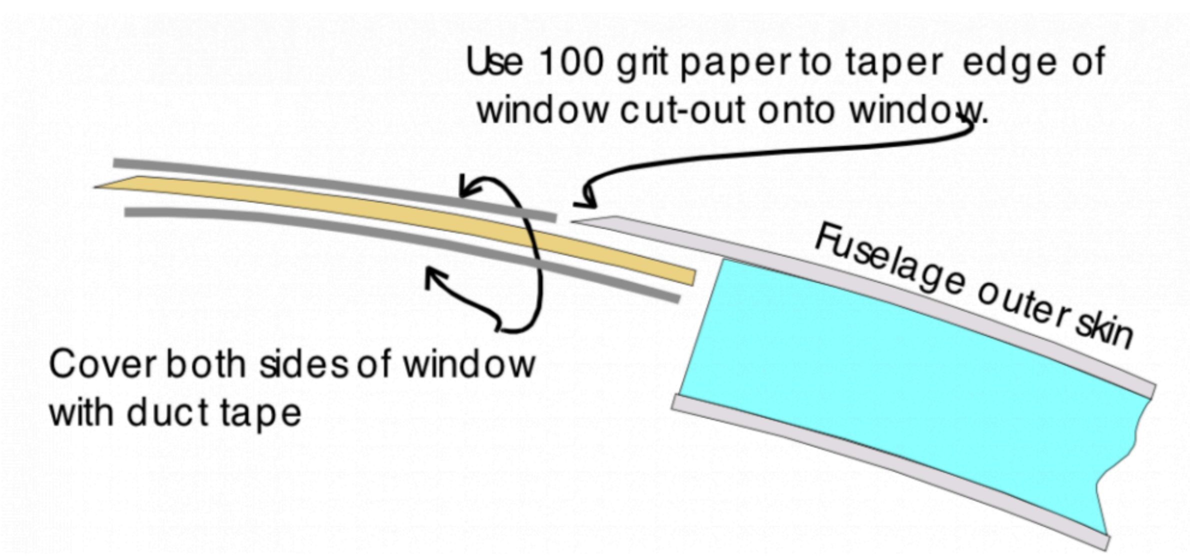


Figure 5-2. Preparing Fuselage Window Frame Edge

___ Using 100 grit paper, taper the edges of the window cutouts from the outside so that they transition smoothly into the window (Figure 5-2). Replace the taped window into the hole, and work it until you can get a near-perfect fit.

___ At worst, there should be only a few small gaps between the window and the outer fuselage skin visible from outside the aircraft.

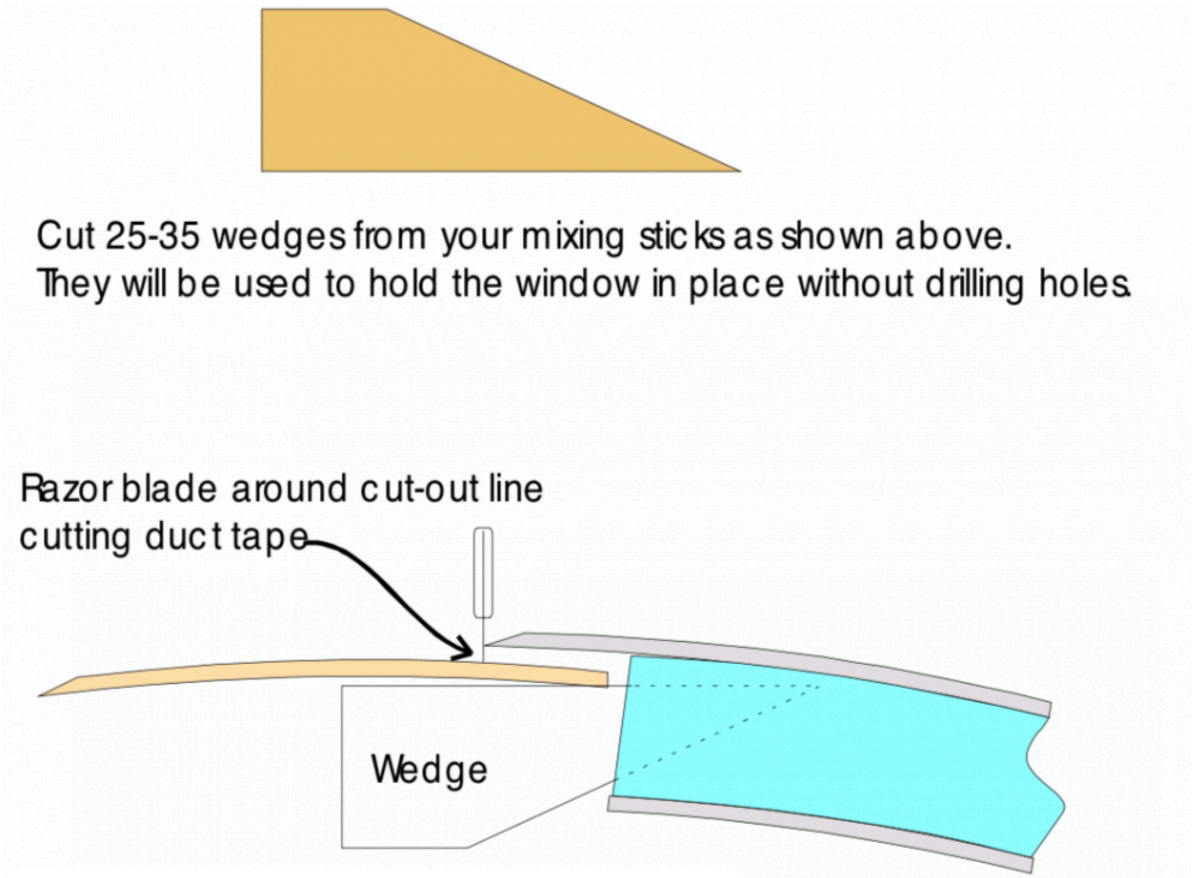


Figure 5-3. Temporary Installation of Windows

___ When you are satisfied with the fit, insert some of the wedges to hold the window in place. Trace around the window cutout carefully with a razor blade, cutting the duct tape as close to the edge of the fuselage skin as possible (Figure 5-3).

___ Remove the wedges, and the window, and peel away the duct tape skin around the outside edge of the window. Rough up the exposed Plexiglass with some 100 grit paper, for superior bonding to the fuselage skin (Figure 5-4). Be sure that all viewing surfaces of the window are still covered with duct tape.

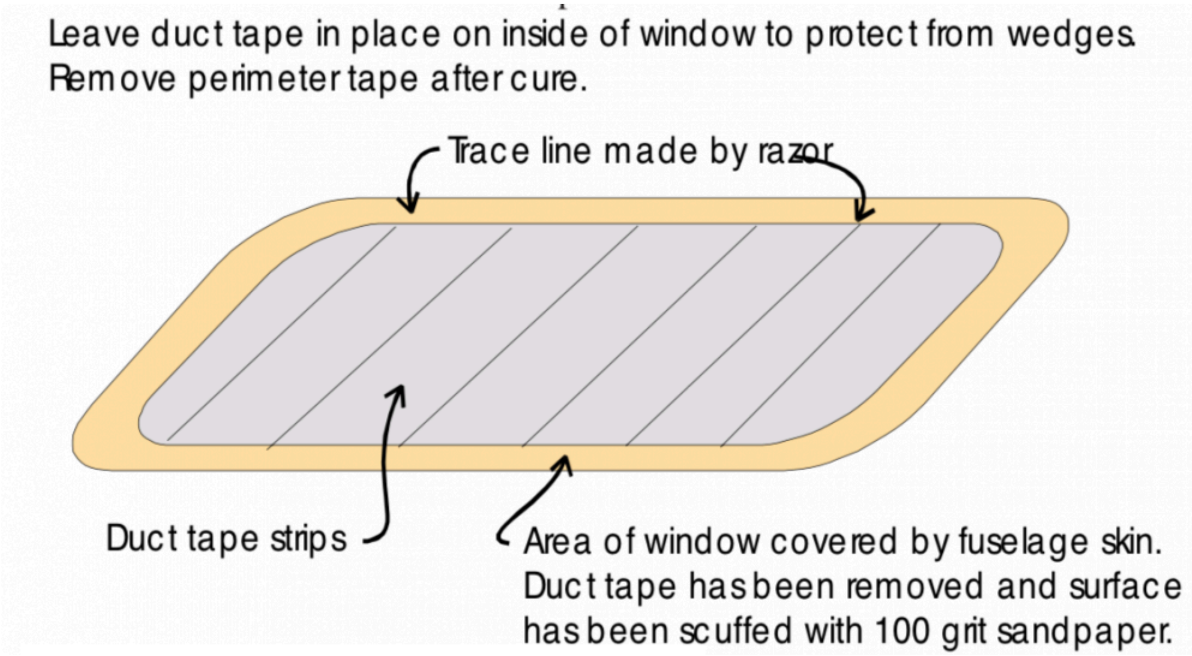


Figure 5-4. Trimmed Window Ready to Install

5.1.3 – Install Windows

___ Sand the inner surface of the window flange and clean it off with alcohol. Mix a slurry of **VelociPoxy and Milled Fiber** (West system will also work well here). Apply the slurry to the inner surface of the window flange on the fuselage, then carefully press the window into place.

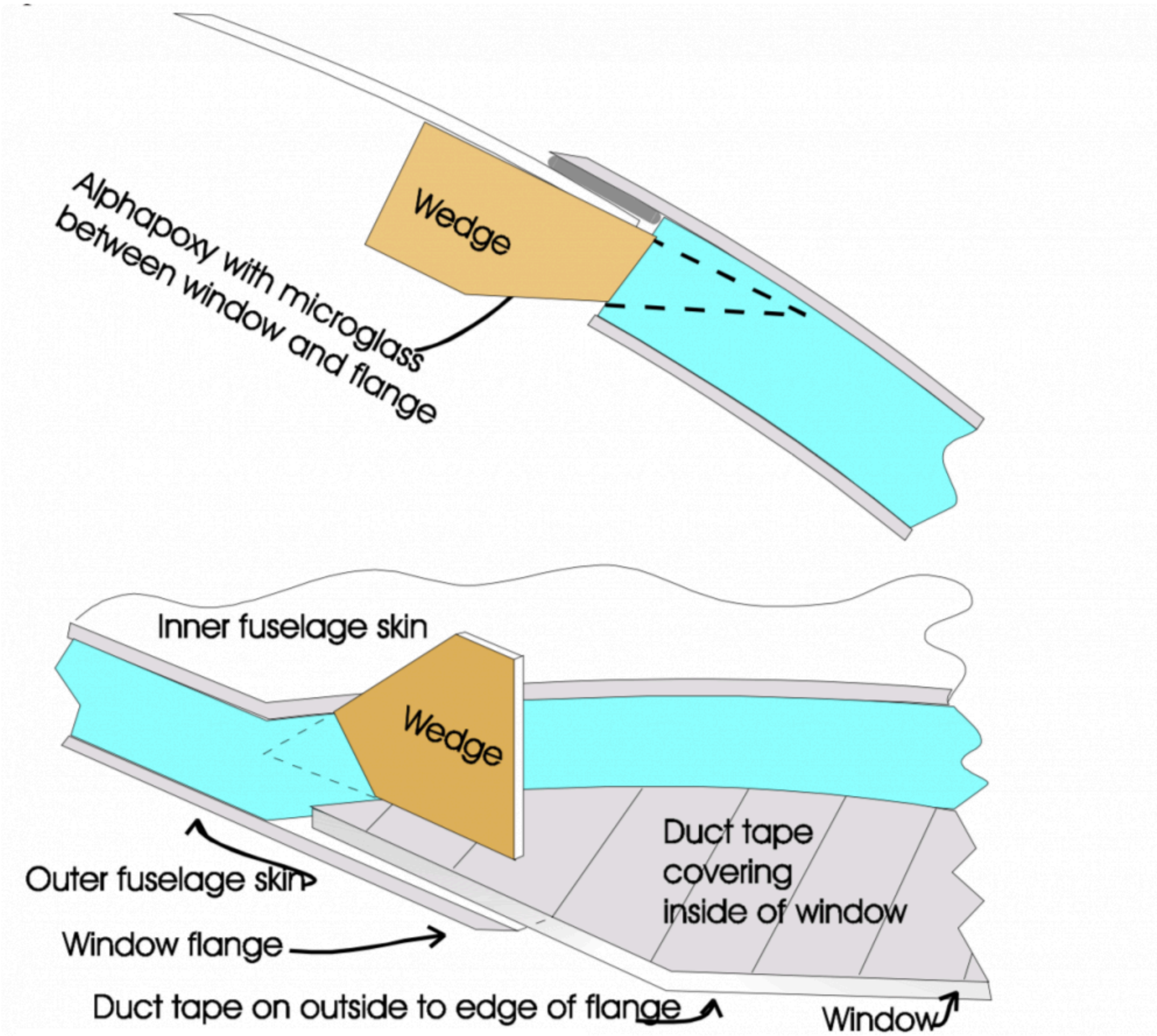


Figure 5-5. Final Installation of Windows

___ Get it aligned as you did earlier, then use the wedges to hold it in place. Try and space the wedges evenly around the window (approximately every 3”). If gaps are still visible from the outside, use extra wedges at those locations to seal the spaces. Remember, do not press the wedges in hard enough to delaminate any of the fiberglass from the foam. Let cure, and remove the wedges.

___ On the inner surface of the window, trim the duct tape back approximately 1/2” from the edge, all the way around the window. If possible, trim the tape all the way back to the edge of the window flange. If you go past the flange edge, cover back up with tape.

___ Score the exposed Plexiglass with 100 grit paper, then trowel a thick slurry of VelociPoxy and Micro Balloons up to the new edge of the tape. Smooth and trim with trowel. Take the time now, it is a mess later. Let cure.

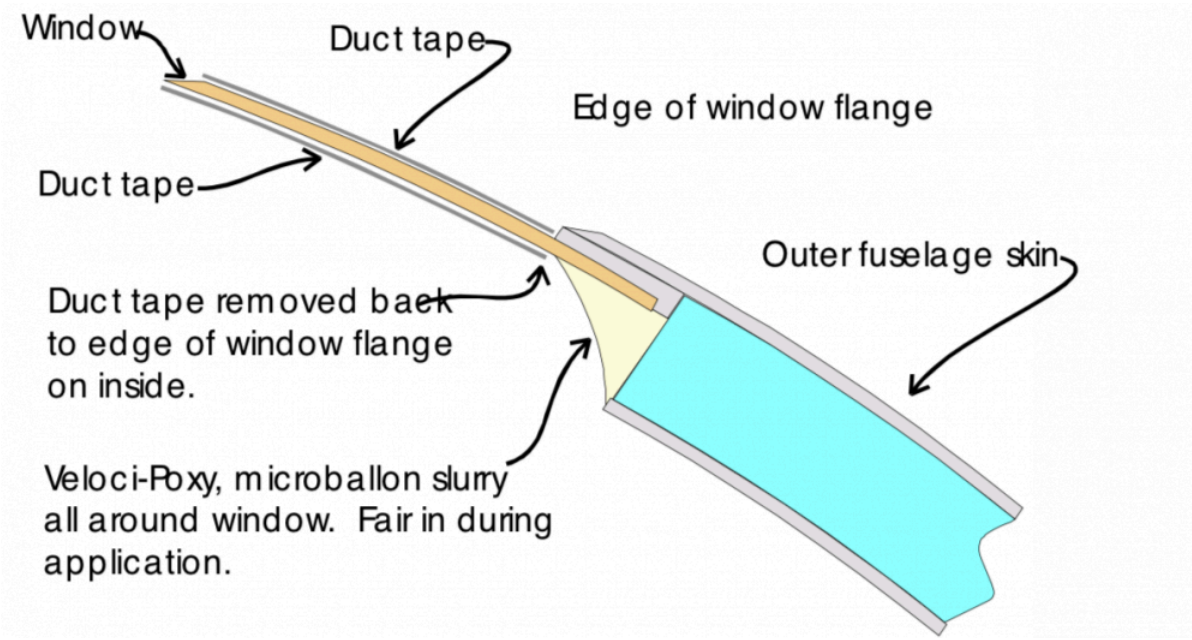


Figure 5-6. Cross Section Detail of Installed Windows

At this time, it is advisable to finish out the areas around the windows for painting. It is quite easy to fill and sand these areas while the top is off.

HINT: It is not mandatory, but you can also back up this *Micro-Balloon with a ply of **BID** around the windows.*

TIP: Cut a corner off a baggy, and use it like a cake decorator to apply Micro-Slurry.

HINT: After your Micro has cured remove the duct tape and cover the window inside and out with butcher paper. Duct tape will be hard to get off it is allowed to sit on your windows for a long time. Use good quality masking tape to install the butcher paper.

TIP: To remove stubborn masking tape we use “OOPS.” It is a solvent for removing adhesives. You can get it at most local hardware stores.

5.3. 5.2 – Fuselage Top Installation

5.2 – Fuselage Top Installation

5.2.1 – Install Top Half

After you have installed the front windshield and the rear windows your top fuselage is ready for installation.

We are also assuming that your bottom fuselage is ready for the top. Everything should be done in the bottom including the sanding in the appropriate areas.

___ Place your bottom fuselage half on your jig so that it is level front to back and side to side.

___ On both the top and bottom fuselage halves cut out a section 3” inside the door trim lines. This will allow access to the inside of the fuselage to glass.

Be very careful with the fuselage halves after you cut the door sections out. There is not much strength at this point of the fuselage once you cut these sections out so have help to move the fuselage halves around so you do not damage them.

___ Remove all flanges from the fuselage halves and sand back about 2” on the inner and outer skins on both the upper and lower halves of the fuselage. We are now ready to install the fuselage top.

___ Make sure the top flange of the firewall has been sanded and sand the inside of the upper fuselage where the fuselage top will touch it. You will also be glassing the side of the firewall without the flange so sand 3” in around the perimeter of the back of the firewall as well.

___ Mix up a thick mixture of **Structural Adhesive** and **Flox** and spread it out evenly on top of the firewall flange.

___ With a partner to help you place the fuselage top onto the bottom. Have your partner line up the halves at the nose first. As you lower the back half of the fuselage top spread the sides slightly to help get the top over the firewall without scraping off all the **Structural Adhesive**.

___ To align the top with the bottom we use aluminum tabs every 6” around the perimeter of the fuselage. Before we start we drill two 1/8” holes in the tabs as shown in figure 5-7.

___ When you go to install them to the airplane we drill 1/8” holes through the outer skin of the fuselage using the holes in the tabs as a guide. Install 1/8” clecos through the tabs into the outer skin.

___ You could use tongue depressors and hot glue to align the bottom with the top.

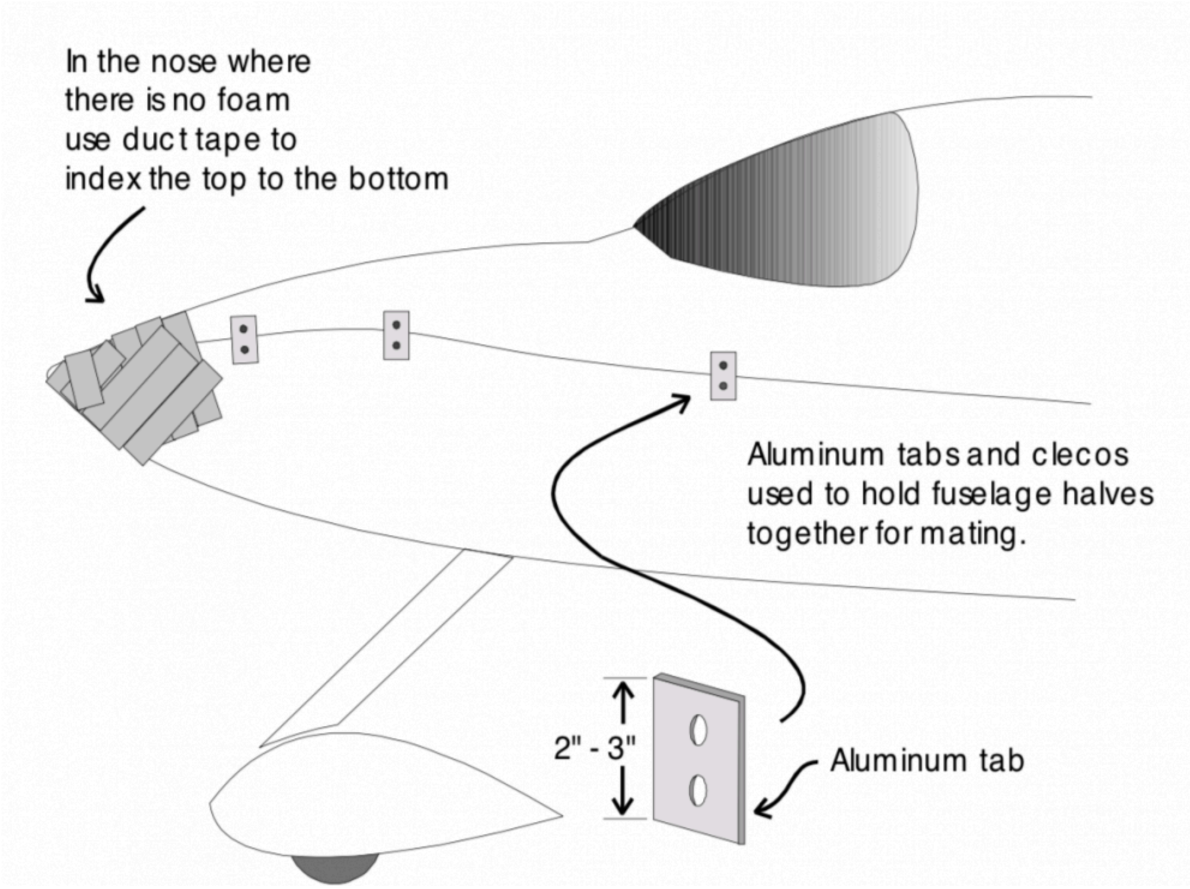


Figure 5-7. Upper Fuselage Half Installation

___ In the nose of the airplane where there is no foam in the fuselage halves use duct tape to align the halves.

___ In between the tabs on the outside of the fuselage put duct tape across the gap. This will keep the **Micro** from seeping out when glassing the inside.

___ When you get into the airplane be careful to not to upset the airplane.

___ Using an angle finder and a level make sure the top of the firewall is parallel to both the bottom of the firewall and the canard bulkhead. If you need to move the top of the firewall forward or aft do so and drill two or three 1/8” holes through the firewall flange and through the inside skin. Install 1/8” clecos to hold firewall while it cures. Put some vaseline or DC-4 on the ends of the clecos to keep them from sticking to the **Structural Adhesive**.

___ When satisfied with fit of top and bottom half, fill all inside gaps with **EZ-Poxy Micro-Balloon** and cover inside skin with two plies of **BID**.

___ In the nose where there is no core and the gap is wide, cover the **outside** with duct tape and glass across the tape from the **inside** onto the upper and lower fuselage with 3 layers of **BID** (Figure 5-7).

___ Let the inner lay-ups cure, then remove the tabs on the outside skin. Sand thoroughly and apply two plies of **BID** to all outside seams. Pay particular attention to the area which becomes part of the fuel tank

5.2.2 – Door Cutout

The premolded doors come to you with the inner stiffener installed and a reference mark all around its outside. Cut to within a 1/16" of the reference line then sand the edge of the door all the way around until you are to the reference mark. Make the edges of the doors as straight as you can when sanding.

___ Using a straight edge make sure that the top of the door where the hinges will be attached are straight and square with each other.

___ Lay your door down on a piece of paper with the outside facing down. A large piece of Butcher paper will work or tape a few smaller pieces of paper together. Trace a template of the outside of the door. Be as precise as you can. Do this for both doors.

___ The templates drawn on the fuselage are for reference. Each fuselage changes slightly after the two fuselage halves are joined and that effects the door installation. Line up the top hinge locations of your template with those on the fuselage. Line up the template with the aft door line on the fuselage top. The lines may be slightly off on the bottom fuselage half. When you are satisfied with the placement of the template trace the perimeter of it onto the fuselage. Use this as your cut line for the door.

___ Cut the door openings to the lines you just drew on the fuselage. Be careful not to destroy the pieces you are cutting out. You will use them to make your door flanges.

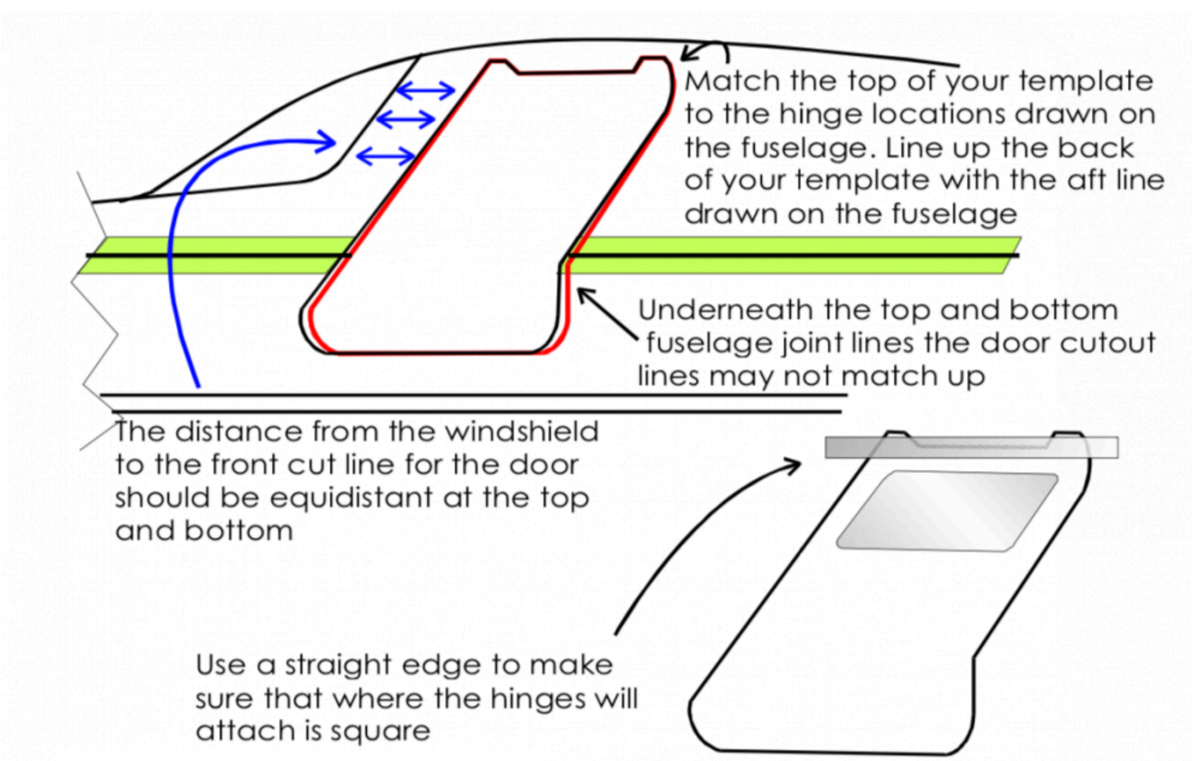


Figure 5-8. Cutting Door Opening

___ Fit and sand the Fuselage opening in order to get the door to fit flush in the hole. Try and make a uniform 1/8” gap all the way around the door. Do not worry to much if your gap is a little larger in some spots you will be adding some glass back in on the door frame.

___ You will notice that just inboard of the top of your cutout there are recesses and pads already made. This is where your hinge will attach after the door is installed.

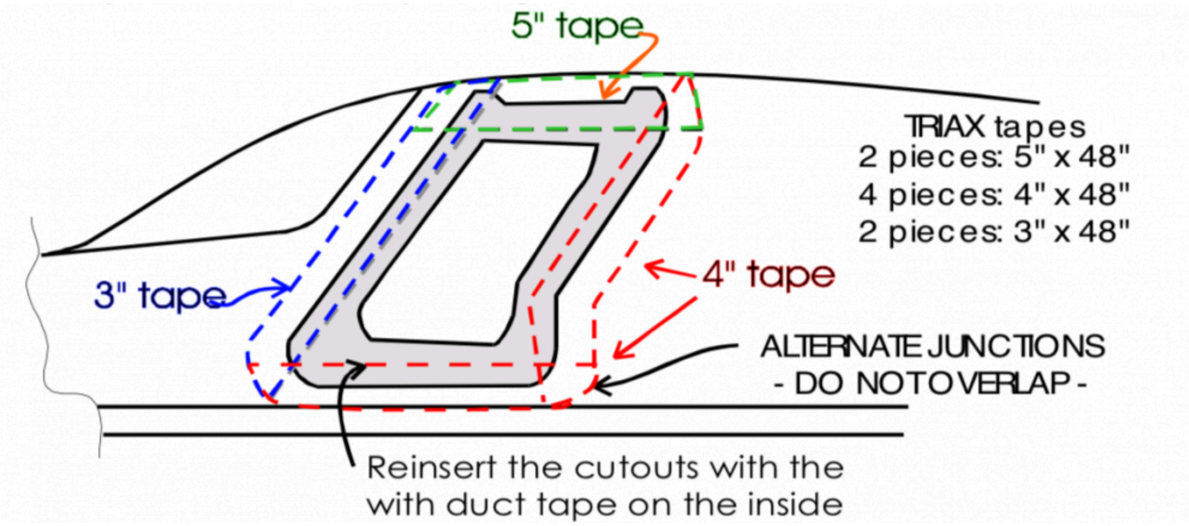


Figure 5-9. Door Lip Construction

___ Sand a 3” to 4” margin around the door hole, inside (sand about a 5” margin along the hinge side).

___ Duct tape the inside of the pieces you cut out of the door opening. Using hotglue and tongue depressors reattach these pieces back in place. Line up the inside surface with the inside fuselage skin.

___ Cut about 32’ of 4”, 16’ of 3”, and 16’ of 5” TRIAX cloth strips, axis long.

___ Trim the lengths to fit around the door opening. Cut the strips on the first layer so they butt into each other at the upper corners. Cut the strips on the second layer so that they butt into each other at the lower corners overlapping the joints on the first layer. Do not overlap the joints and do not butt the second layer pieces in the same place as you did the first layer.

___ You want to overlap at least 5/8” onto the door cutout you reinstalled.

5.2.3 – Fuselage Door Hole Treatment

___ Once this lay-up has cured, pop the cutout pieces from the opening and trim the lip to 5/8”. Sand the outside exposed surface of the flange that was touching the duct tape on the cutouts.

___ Cut **six** pieces, 2” × 65”, **BID**. Remove a small wedge of foam next to the outer skin with a wedge of sand paper. Fill that void with **Flox** or **EZ-Poxy Micro-Glass** and apply three plies of **BID** around the door hole from the edge of the lip to the edge of the outer skin. Do not bother to glass at the four (two per side) 2” hinge lines, as these will be reinforced later. Let cure.

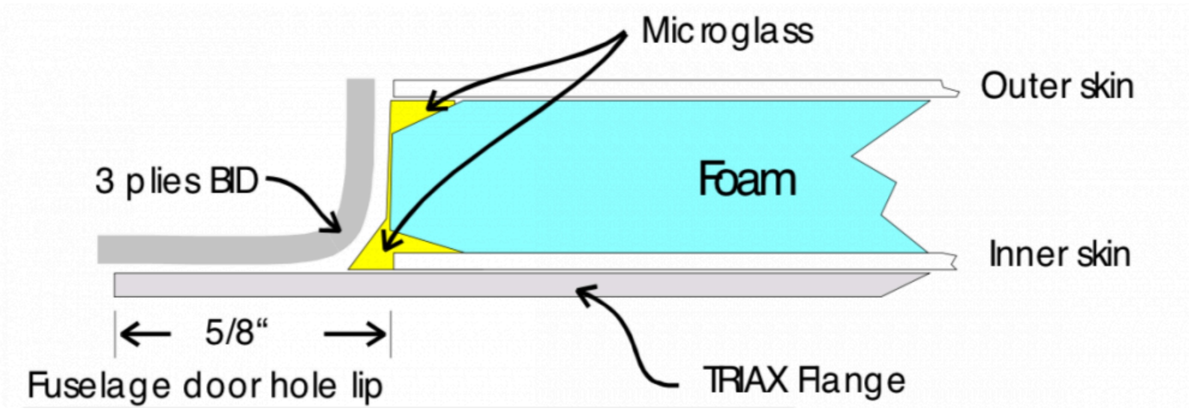


Figure 5-10. Fuselage Door Hole Detail Cross-Section

5.2.4 – Door Hinge Installation

___ Straighten up the edges of your door where the hinges will be installed. Round the underside surface to match the radius found on the hinge. On the door, mark the centerline of the hinge pads, they should be approximately 18-7/8" apart.

___ Clamp the bottom (flat side) of the hinges about 18-7/8" apart, center to center, on a straightedge to keep the hinge pins in line. Sand the side of the free hinge that will be facing the door.

___ Mix a thick mixture of Structural Adhesive and Flox and butter it onto the back of the free hinge side. Position the free halves of the hinges onto the door, centered on the hinge areas with the hinge pin centerlines outboard of the lip. Clamp in place, squeezing the Structural adhesive, keeping the hinge pins in line with the straightedge.

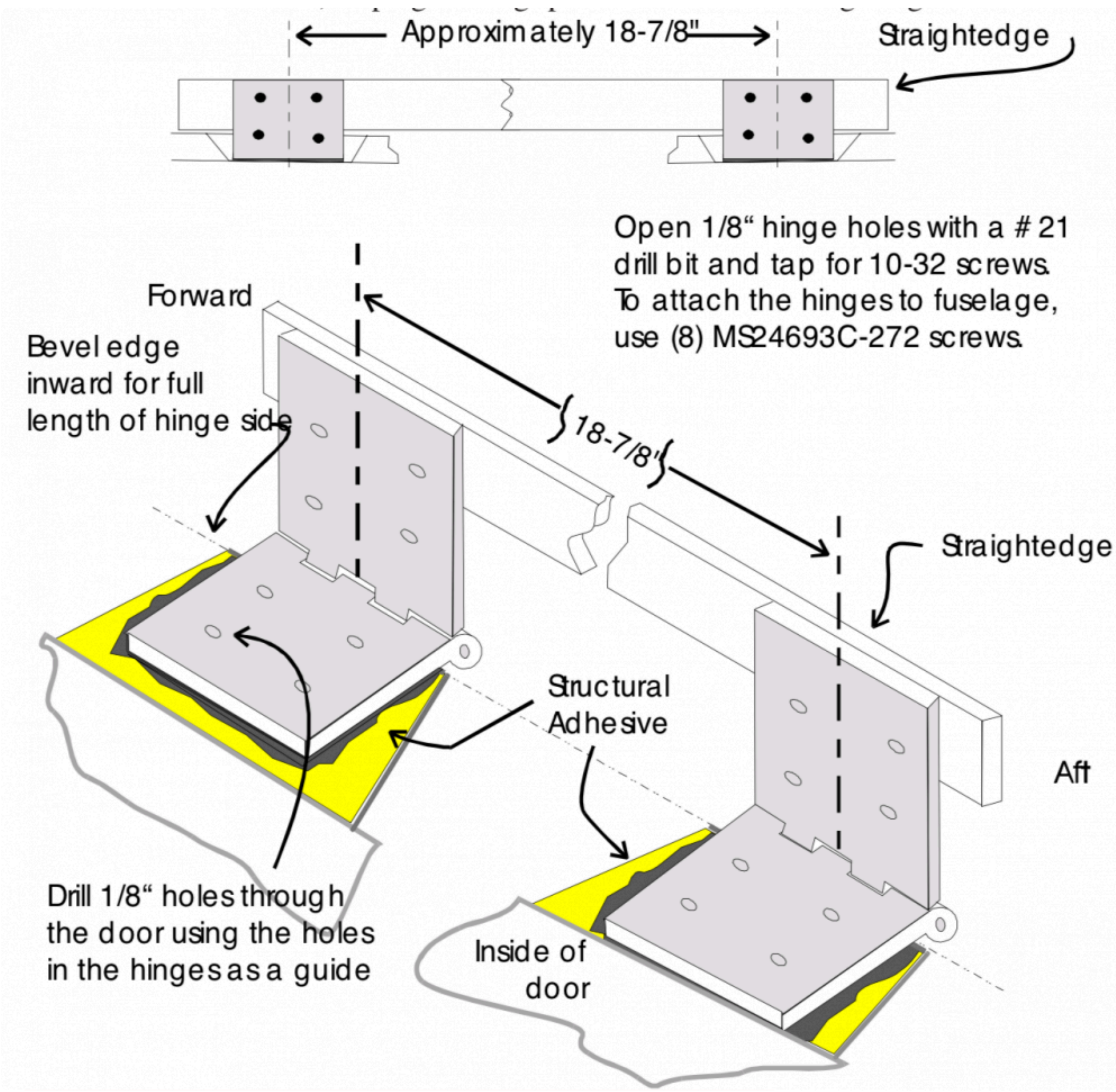


Figure 5-11. Aligning and Installing Door Hinges (VMDH-02)

___ Be sure the hinges operate attached to the straightedge.

___ Drill four 1/8" holes in the door at each hinge using the holes in the hinge as a guide. Install 4 1/8"clecos in each hinge. Clean off excess Structural Adhesive that squeezes out. Make sure that the hinges still operate smoothly without binding. This is the last chance to do something about it.

Once the structural has cured drill the holes out with a #21 drill bit. Countersink the fiberglass on the door so that when a 10-32 screw is installed it will be in a little deeper than flush. Tap the holes with a 10-32 tap. Install 4 MS24693C-273 stainless steel screws in each hinge.

These hinges are attached permanently to the door. You can fill in the Heads of the screws with **Veloci-poxy and Micro-Balloon**. You can use the same mixture to fair in the hinge on the inside.

5.2.5 – Install Door with Hinges to Fuselage

___ Remove the clamped straightedge from the hinges and wrap the free hinge halves with duct tape to prevent adhesion.

___ Trim about 3/16” inboard, 2” wide, from the fuselage hinge areas for clearance of the hinge pivoting portion. This notch is shown in Figure 5-12. Using hot glue and tongue depressors glue your door back into the door openings as you did with the cutout earlier.

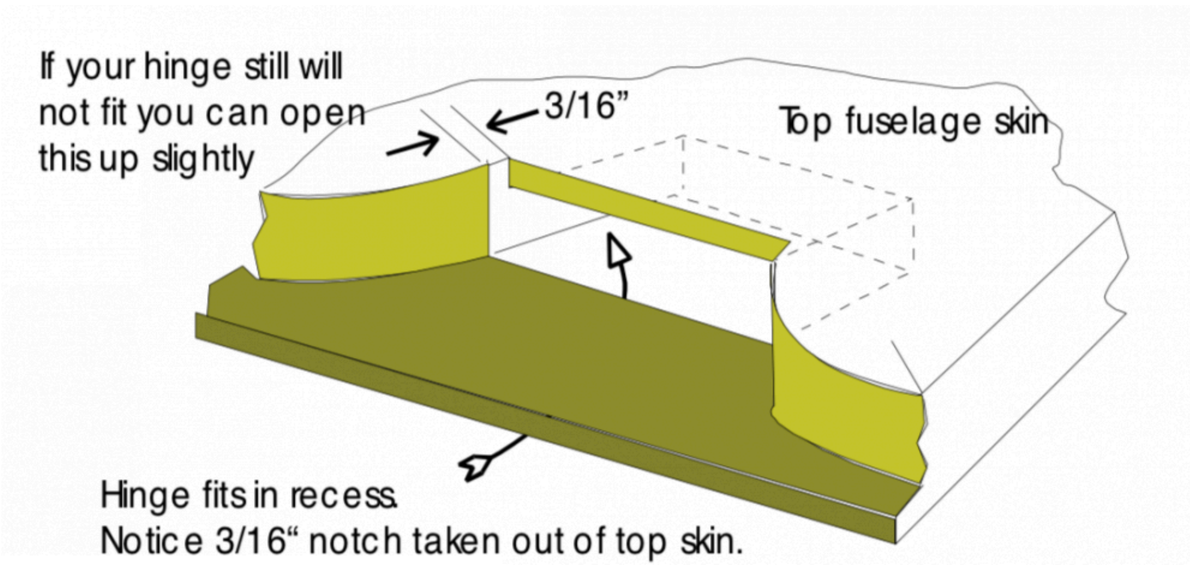


Figure 5-12. Hinge Pocket

___ It is best to do this next step with a partner. Push the hinge up tight against the inside skin of the fuselage. Using an 1/8” drill, drill a hole in the hinge pad using the hole in the hinge as a guide. Have a partner insert a cleco from the outside . Drill the other holes having your partner insert a cleco after each hole is drilled.

___ After the holes are drilled remove the clecos. Drill out the holes in the hinges to #21. Tap the holes with a 10-32 tap.

___ Drill the holes in the fuselage out to 3/16”.

Countersink the holes from the outside, and fasten each hinge with four MS24693C-272 screws (eight for each door, sixteen total). Do not overtighten, you could distort the hinge positions.

___ Break the tongue depressors loose and check the operation of the door. Any binding is easier to correct at this point.

___ **Bondo** the doors back in place. Remove the hinge screws. Put Micro-Glass in the fuselage recesses to bed the hinges (make sure you have covered them with duct tape. Press the fuselage hinge halves into the Micro-Glass flush with the inner skin.

___ Coat the screws with candle wax or vaseline and refasten the hinges, again, without overtightening.

If you carefully avoided getting epoxy on the hinges and from between the door and fuselage and you waxed the screws, you should be able to remove the door. The duct tape can then be removed from the hinges.

5.4. 5.3 – Latches

5.3 – Latches

Part Number	Description	Qty
VLPRLR-01	Latch-LT&RT Push Rods	6
VLBSPA-01	Latch Base and Spring Pivot	2
VLHALR-01	Lock Housing Right Assembly	1
VLCKP-1	Pilot Side Security Lock Assembly	1
VPDDB-02	Pressure Door Dampner Ball and Clip	4
V-DMS-01	Door Micro Switch Warning	2
VMDH-02	Door Hinge	4
VGSNC-02	For Door Gas Spring Nut Cover	2
VDDD-02	Door Dampner Bracket	2
MS24693C-273	10. Countersink Phillip Screw	32
V8052CL-01	Cam Lock-Left Door Assembly	1
VDLC-02	Door-Elite Latch Cover	2
VPMDL-01	Door Left Molded Part	1
VPMDR-01	Door Right Molded Part	1
VTDS-022	Trim-Lock Door Seal	24ft
VLBALR-01	Latch Assembly Lt and Rt	2

5.3.1 – Install Door Latch Mechanism

After your doors are moving up and down nicely, you can install the latch assemblies.

___ Remove your doors.

___ At the mark on your door (upper forward corner of the foam) cut through the **inner skin only** with a 3/4” hole saw.

___ Open up the 1/4” pilot hole with a 1/2” drill bit all the way through the door. Peel the inner skin of the door away (3/4” diameter circle) and remove the foam to the outer skin.

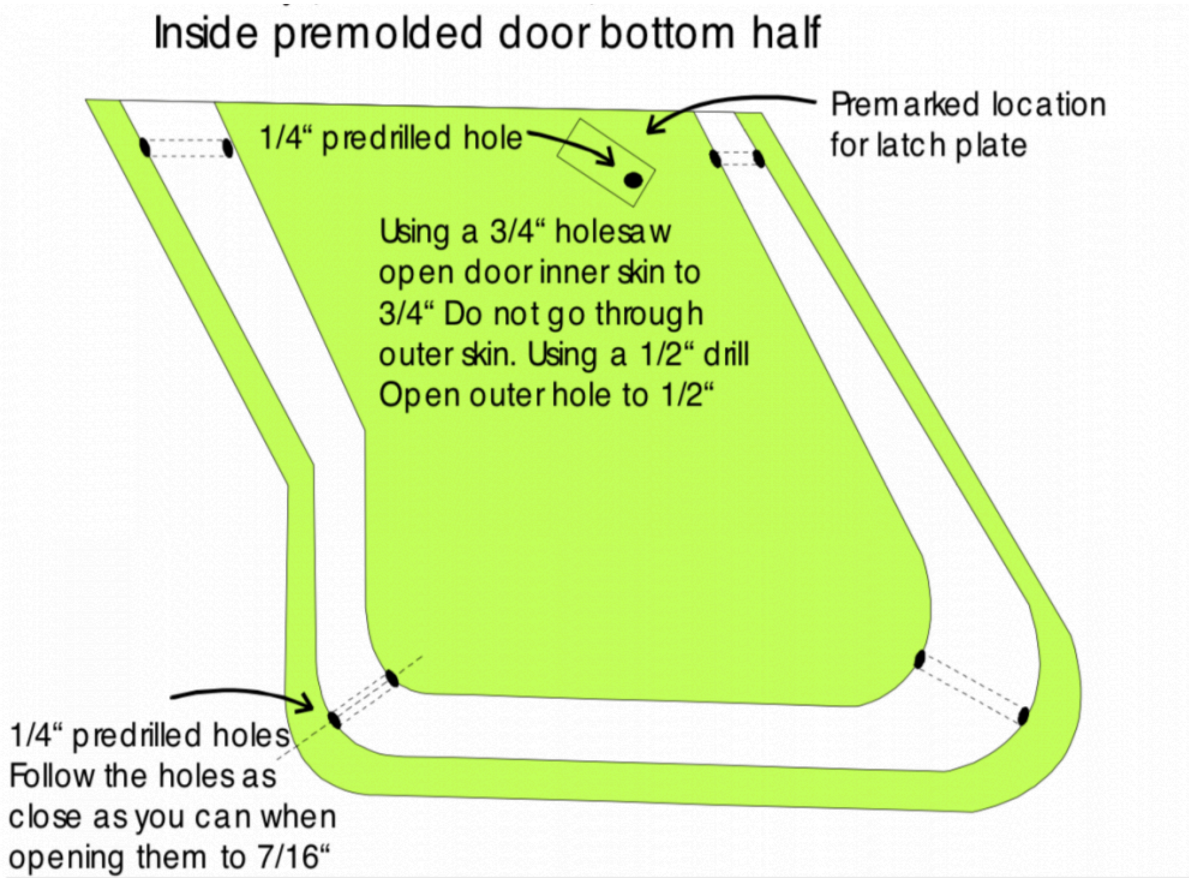


Figure 5-13. Latch and Latch Pin Locations

Marked on door drawing for reference only.

5.3.2 – Latch Base Assemblies

___ Sand one surface of the plate. Using the parts listed in the list above and in Figure 5-14, put these parts together, sanded surface away from the parts. Countersink for the rivets AWAY FROM the side that will be against the doors (sanded surface). Also, note the orientation of the latch bearing carrier.

___ Slide the spring pivot through the AN 970-4 washer in the plate and secure with the 1/4" E-Clip.

Make sure the spring pivot rotates easily and the overcenter spring rod slides into the hole properly.

___ Directly under the position of the spring pivot, you will need to drill a 17/32" hole through the **inner** skin only. Orientation of this plate can be seen on the door. This will leave room for the rotation of the spring pivot.

___ Put the Latch Base Assembly in place to make sure it sits flat on the surface. Recess the inner skin as necessary to clear the rivets. When satisfied, use **Structural Adhesive** to bond in place. **Keep the Adhesive away from the E-clip.** After cure, drill 1/ 8" holes, four places, and rivet.

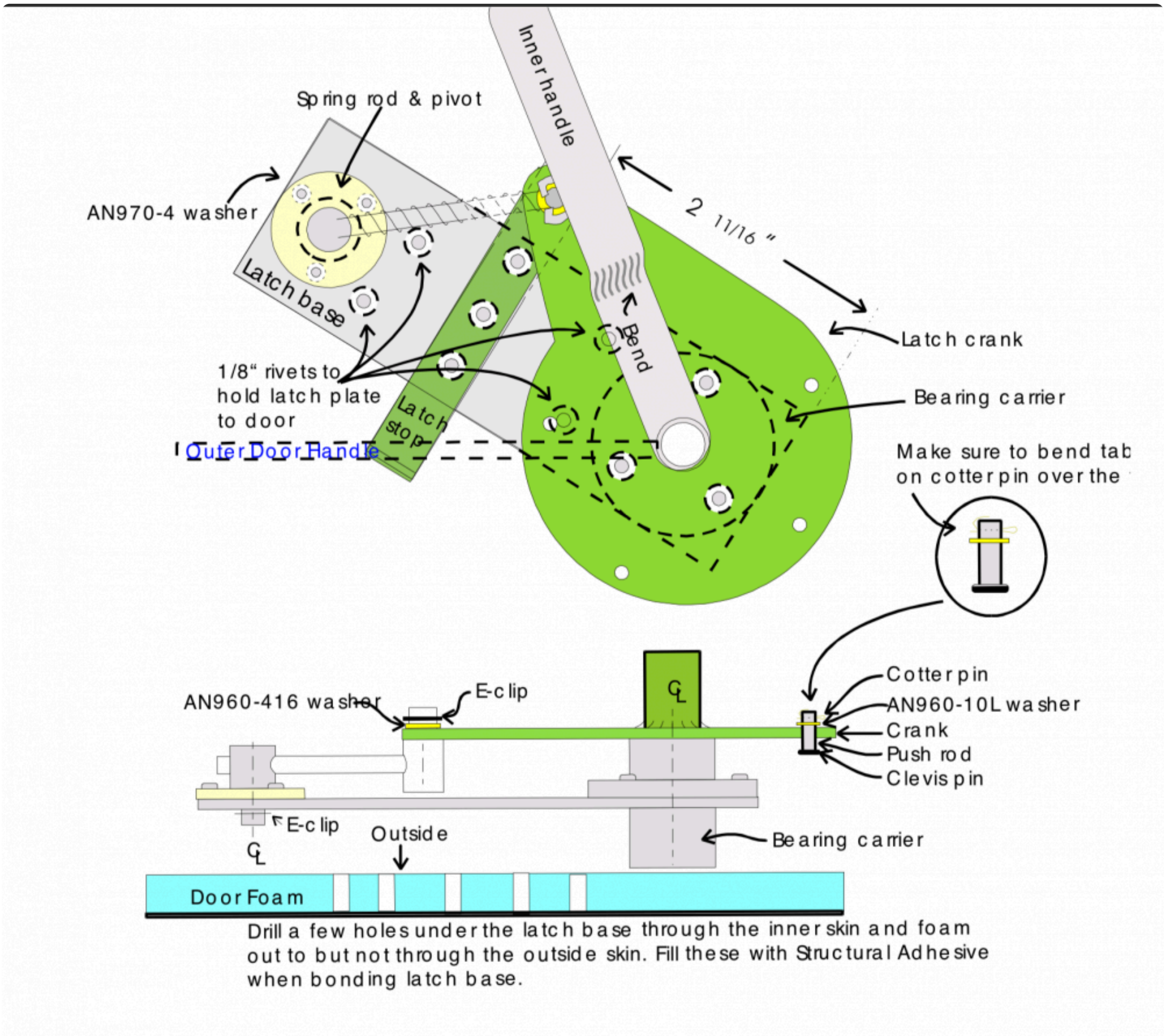


Figure 5-14. Latch Base and Spring Pivot Assembly - Left Side, Unlatched

___ Assemble the outer handle, inner handle, and latch crank to the door. In the latched position, the outer handle will be roughly parallel to the window line and aft, the inner handle will be at approximately the 11 o'clock position.

___ Rotate the handle to the mid point of its travel. Put the latch pins on the end of the 3 long push rods using the 1" set screws.

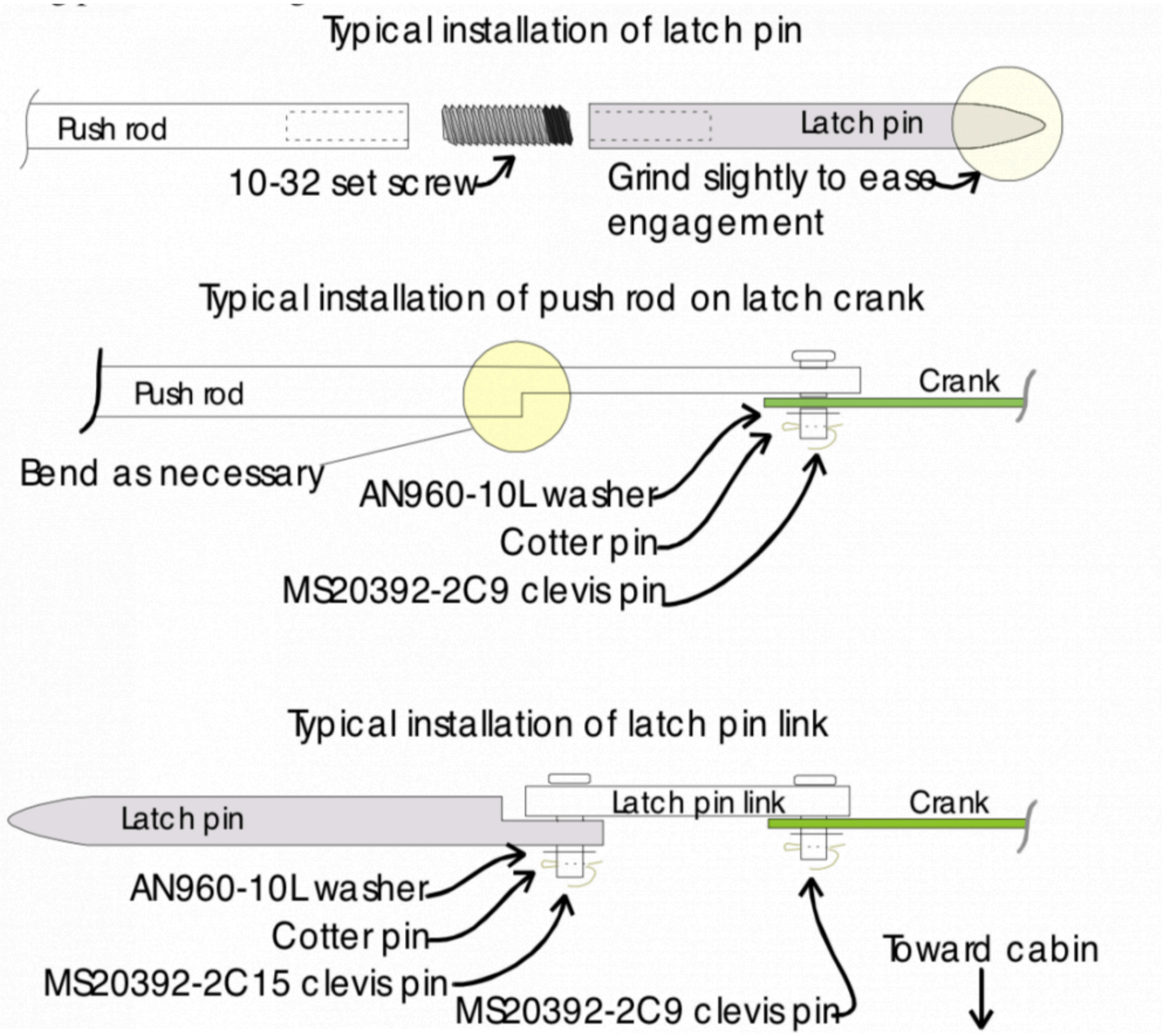


Figure 5-15. Typical Latch Pin Assembly

The two longest rods, the ones that go down, need to have a slight bend in them at the junction of the round and the flat. This lets the milled section ride fairly parallel with the latch crank.

___ The pin tube locations on the door stiffeners have been predrilled to 1/4”. You will need to open up these holes to 7/16”. Be very careful to line the drill up with the orientation of the holes. There are wood inserts in the stiffener that you will be drilling through.

___ Slide the push rods through the holes and attach to the latch crank. You can also attach the latch pin link and pin to the crank.

___ With the latch crank in the middle of its travel , center the pins at the outer end of the hole and notice the angle or room around the pin. You may need to ream the hole to accept the 7/16” latch pin tubes without binding the rod.

___ Slide the tubes over the latch pins and into the holes. Note if there is any binding and clearance that area. Grind ends of tubes to match contour of door frame.

When satisfied with the operation of the pins in the tubes, use **Structural Adhesive** to bond the tubes in place with the latch crank in the middle of its travel, and the pins in the tubes with the tube ends flush with the door frame. Keep the adhesive off the pins and any voids should be filled with this mixture.

After these tubes are installed you are almost done with the door. Go ahead and install the rest of the assembly as shown in the diagram. Also, you can locate and install the lock housing and stop collar.

Note: Use Lock-Tite on the 10-32 stud between the pushrod and the latch pin. If the latch pin unscrews when the door is locked you will not be able to open it.

5.3.3 – Pilot Door Security Lock

The primary difference between the pilot and copilot door lock is an extra 3/16” rod which extends outside the door to provide emergency entrance in the event of pilot incapacitation. This extra 3/16” rod will require a 3/16” wide slot to allow the rod to be lifted up in order to move the closed door handle to the open position.

___ Slide the aluminum block over the upper door locking rod so it is position approximately 7” aft of the door handle. This aluminum block may have to be reamed to fit over the rod. Position this block so that the offset in the block is on the lower side (the thickest portion of the block is toward the top of the door). If your kit has a round block orientation is not a factor.

___ Remove the pin from the security lock and position the aluminum “U” channel against the inside of the door.

___ With the door handle in the latched position, place the “U” channel so that the lock pin hole is 7” aft of the center of the door handle and the “U” channel is 1/32” above the lock stop collar. You may need to reassemble the pin into the “U” channel and check your fit and action before continuing.

___ Once you are sure where the 3/16” pin will exit through the door, drill a 3/16” hole through both the inner and outer skins.

___ Drill a second 3/16” hole from the outside skin approximately 1/4” higher than the first hole and connect the two holes with a small file. This will create a slot on the outside and inside skin for the 3/16” security rod to move.

___ Drill four 1/8” holes in the “U” channel positioned far enough from the edge to allow a pop rivet tool to work.

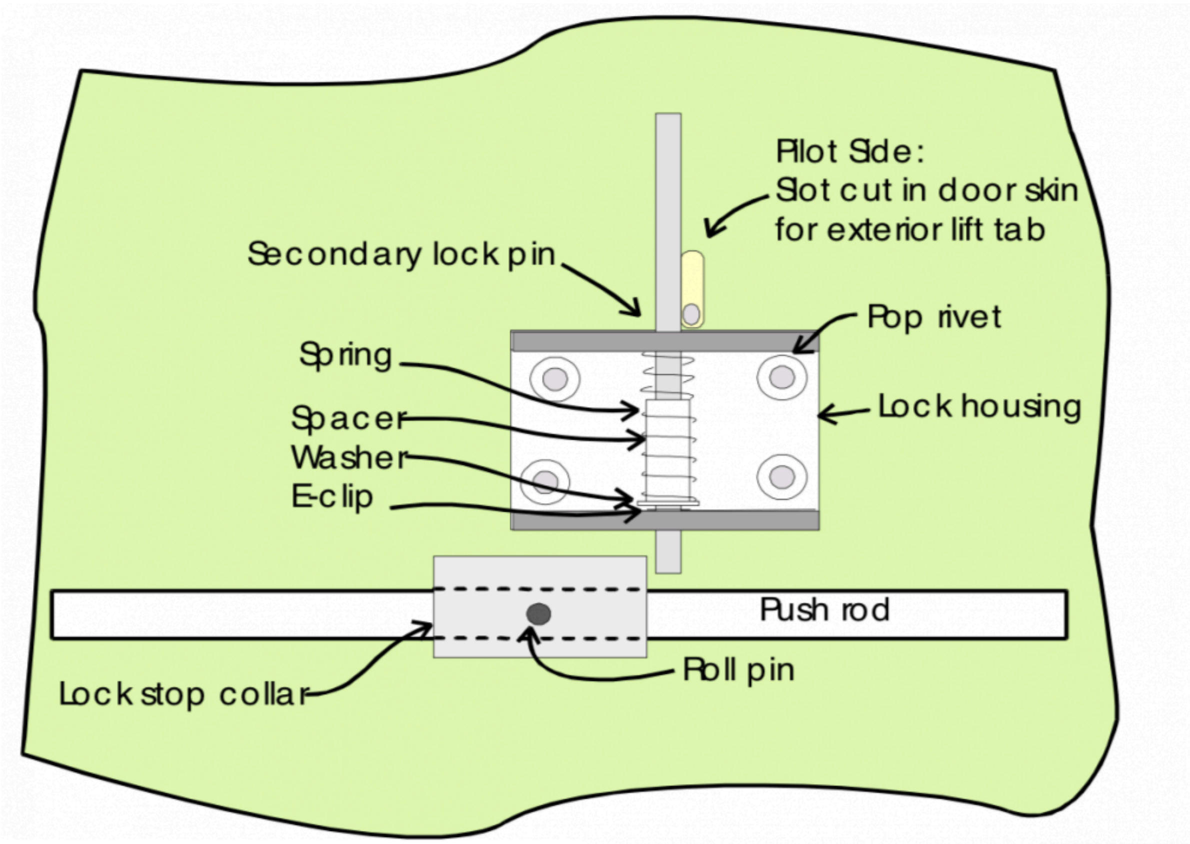


Figure 5-16. Lock Housing Assembly

___ Reposition the “U” channel with the locking pin properly installed and positioned on the inside skin. Check the operation of the pin to make sure everything works properly.

___ With the “U” channel held in place, drill the four 1/8” holes through the inner skin.

___ Sand the aluminum face of the “U” channel and the fiberglass inner skin, clean with alcohol, and apply **VelociPoxy Micro-Glass or Flox** (or **Structural Adhesive/Flox**) and pop rivet into place.

___ Move the aluminum block until a good snap fit with the locking pin is assured. Drill a 3/32” hole through the collar and aluminum rod. Insert the roll pin. Removal of the rod will probably be necessary to tap the roll pin into place.

___ Reinstall the inner door cover and mark the exact location where the threaded pin will exit the top of the cover panel. Drill a hole in the inner door cover for installation of the aluminum “pull” knob.

5.3.4 – Installing Door lock

___ The instructions below are for the lock cylinder that can be purchased through Velocity. This installation installs the lock housing from inside the door. You can purchase a lock kit locally at a hardware store that has a longer body. This can be installed from the outside which is an easier installation. The reason velocity does not do this is because the method below provides a flush appearance where the other style has more of the lock exposed on the outside.

___ There are two locations you can install the lock cylinder. The easiest would be just below the secondary lock location so you can use the same lock stop collar. Any other location and you will need to install another lock stop collar.

___ The locking tab must be removed by removing the screw at the back so the bezel can be ground down. This will allow the lock to be installed inside out (Figure 5-17) and also to be flush with the outside skin. This lock will be installed on the ***pilot side door only***.

___ When satisfied with the position, mark the center position for the lock and pilot drill. Using a 1” hole saw, cut only through the inner skin and foam. Using a 5/8” hole saw, drill the outer hole out to about fit the cylinder – measure your lock cylinder to confirm.

The lock will rotate clockwise to lock.

___ Lock is only used on pilot side door.

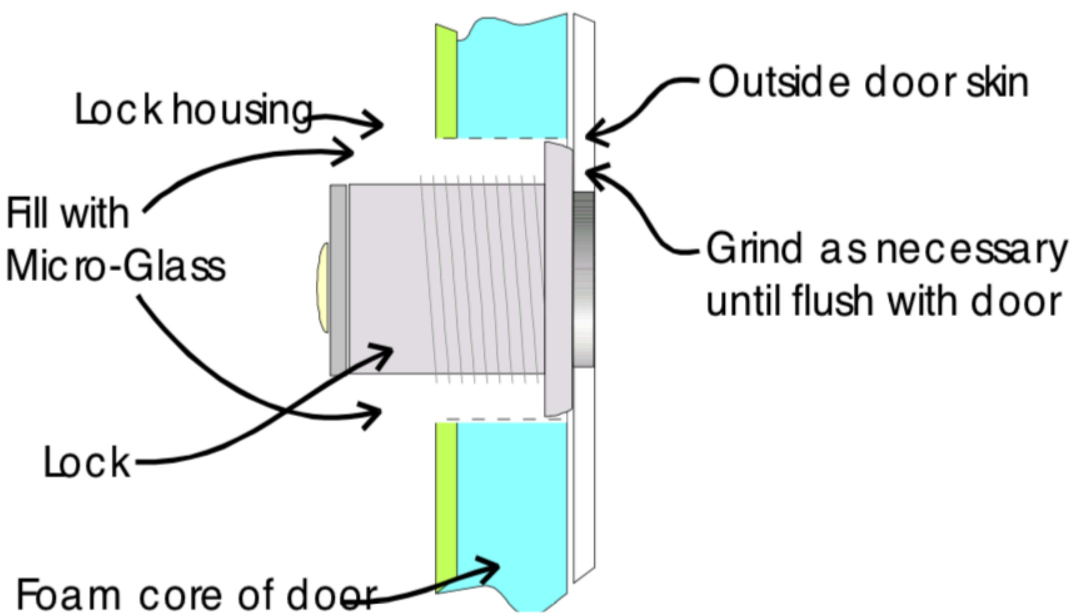


Figure 5-17. Detail of Lock Installed in Door

5.3.5 – Install Windows in Doors

___ You need to install your doors to line up the bottom cut line for your window. Use a straight edge held on the bottom of the rear window and the windshield. Mark where this line crosses the door. This is now your bottom cut line.

___ Next you will radius the bottom corners of the window cutout. We use the top off of an ordinary spray can to give us the radius we need in the corners. An ordinary spray can has a diameter of 2-1/4”.

___ When satisfied, cut the hole out of the door for the window. Clean the hole up.

___ Grind the inside of the door around the stiffener to thin it out toward the edge. An angle die grinder with the a small sanding pad works the best for this. **Be careful to not grind all the way through.**

___ Cover your window with duct tape as you did for your other window installations. Set your window on the outside and mark the window through the hole. Remove the window and follow this line with a razor blade. Remove the tape outside the line.

___ With a die grinder sand the window outside the line. You can put a slight bevel on the window to get it more flush with the outside of the door.

___ Round the outer edge of the door around the window to transition it before you bond the window in since it is tough to do afterwards.

___ Install the window as you did the others, except there is no room for wedges. You can use a few small weights to hold the window in place while the VelociPoxy cures. You can also use a little duct tape on the outside of the window to keep it from sliding around.

5.3.6 – Install the Latch Pin Tubes in Fuselage

This should be done before the Carbon beams are installed around the door cutout.

Close the door, engage the latches, and see how much if any of the fuselage you will have to remove to enable these pin tubes to install. Only the bottom pin tubes should be affected since the fuselage is starting to curve around at that point.

With the latch pins retracted, the tips should not protrude out past the edge of the stiffener. A small amount would be acceptable as long as it would clear the door seal after it is installed.

You may find that the door does not match the contour of your fuselage all the way around it’s perimeter. This is due to the fact that each airplane comes out just a little differently when the two fuselage halves are joined. You may have to push your door out in places to get it to conform. If your keel is installed you can cut a small piece of wood or tubing to brace the door from the keel.

___ Close the door and use hot glue and tongue depressors to hold it as close to flush as you can. Use sticks to span the crack. Set your latch pin tubes in position across from the door latch pin tube and even with the edge of the lip and engage the pin. Do this one latch pin at a time until the receiving latch pin tube hangs free then move on to the next.

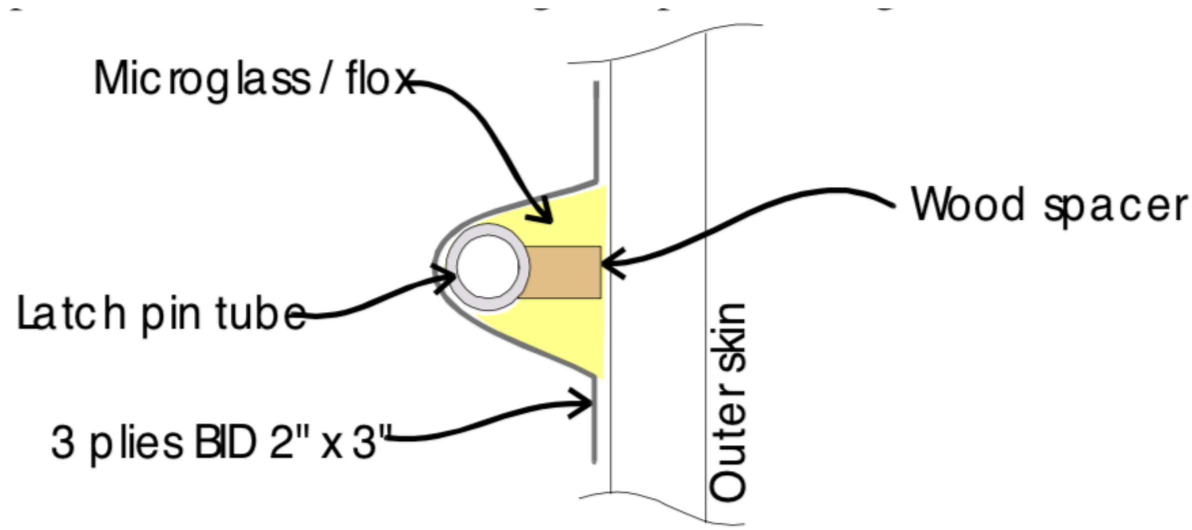


Figure 5-18. Fuselage Latch Pin Tube

___ After all pin tubes have been fit, install the tubes. Refer to Figure 5-18. It is easiest to tack them in place with a wood block and 5-Minute epoxy. Then, pack around it with Flox and lay 3 plies of **BID** overlapping onto the fuselage by at least an inch.

___ After your pin tubes have been installed you may find that your door latch pins do not exactly line up with them. With the door closed the application of some heat can let the door “relax” and conform better to the fuselage. Make sure you do not apply too much heat to one area. You don’t want to start to melt and burn the door. We have found that once the airplane is built and left outside in the sun with the doors closed the doors will work much better.

5.5. 5.4 – Carbon Beams

5.4 – Carbon Beams

5.4.1 – Install Carbon Beams

___ Fit each of your beams in place about 3/4" aft of the door opening (edge of lip), or about even with the outside edge of the door opening. Some sanding may have to be done to make them fit well. They rest on the duct. You will have to notch the beam to clear the latch pin tubes.

___ After the beams are fit you will have to make two wood inserts for the seat belt shoulder harness and install it in the rear beams. Use a piece of 2 × 4, 2-3/4" long by the width of the beam. They need to fit into the beam, centered 26" from the bottom. This is also the dimension above the duct.

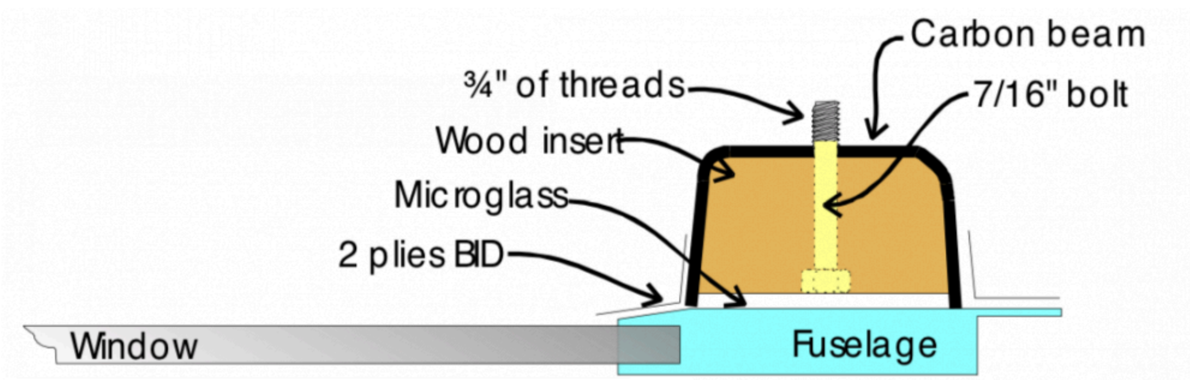


Figure 5-19. Wood Insert in Carbon Beam

___ With a straight edge across the back side of the beam, you need to see approximately 1/ 16" clearance to the wood block. When satisfied, bond the block into the beam with **EZ-Poxy Micro-Glass**.

___ After cure, drill a 7/16" hole through the block and beam at the 26" dimension for the seat belt bolt. Dig some of the wood away around the edge of the hole for the head of the bolt. Slide the 2" long bolt into the hole until you have 3/4" of threads sticking out of the carbon side of the beam. You may have to dig a bit more wood out to get this to occur.

___ Bond your bolts into their holes with **Structural Adhesive and Flox**. Make sure you have sanded the fuselage around your beams as well as the sides of your beams.

___ Sand the front and back side of the beam. Sand the fuselage in front of and behind the beams. Pack the back side of those wood blocks (remember you left about 1/16" clearance) with **VelociPoxy Micro-Glass** and put your beams in place. We used a clamps to hold the beams in place while they are curing. Run a fillet of **VelociPoxy Micro-Glass** and 2 plys of **BID** down the front and back of each beam and Keep the beam lined up with door opening with the proper clearance.

5.4.2 – Install Door Seal

Before installing the seal you must cut groves between the door lip and the latch pin tubes for clearance of the seal. A die grinder with a 3” to 4” cut wheel works very well for this. Cut just deep enough for the seal to slide on.

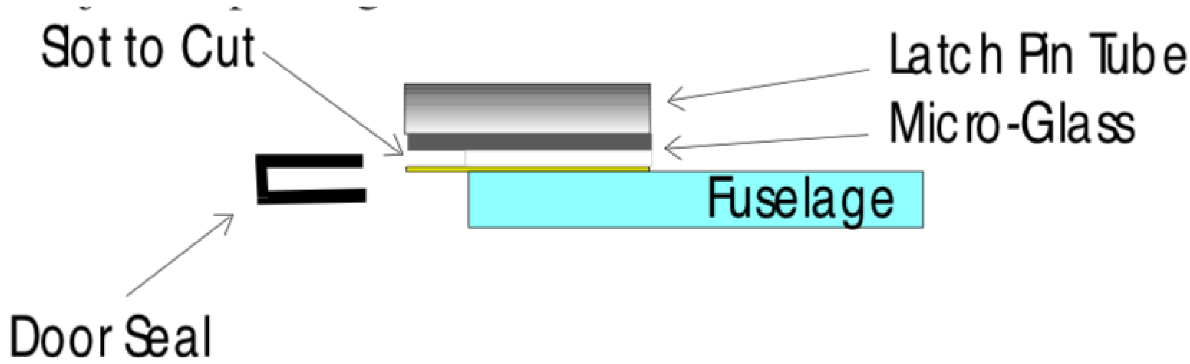


Figure 5-20. Cutting Grooves for the Door Seal

5.6. 5.5 – Finishing the Doors

5.5 – Finishing the Doors

5.5.1 – Install Door Gas Springs

___ Attach the doors if they are not already attached, and close the doors. We will install the springs on one door first then match the second door to it.

___ Locate your 3/4” x 1/2” hardpoints. They are made out of 1/4” aluminum. Mark the center of the hardpoint and drill a 1/4” hole through it.

___ On the carbon beam measure 14” up from the top pin tube and place a mark across the whole beam.

___ Place your hardpoint so that the hole you drilled is on your 14” mark right at the front corner of the beam. Using a little hot glue, glue the hardpoint to the corner. By corner I mean you want the hardpoint teetering on the corner. If the hardpoint was put on either flat side of the carbon beam the gas spring would not be able to actuate. When satisfied with location pack EZ-poxy and Flox around the hardpoint and glass over the hardpoint with one **BID**. After this has cured drill through the **BID** and carbon beam with a 1/4” drill bit where you had already drilled through the hardpoint. Tap the hardpoint with a 5/16-18 tap.

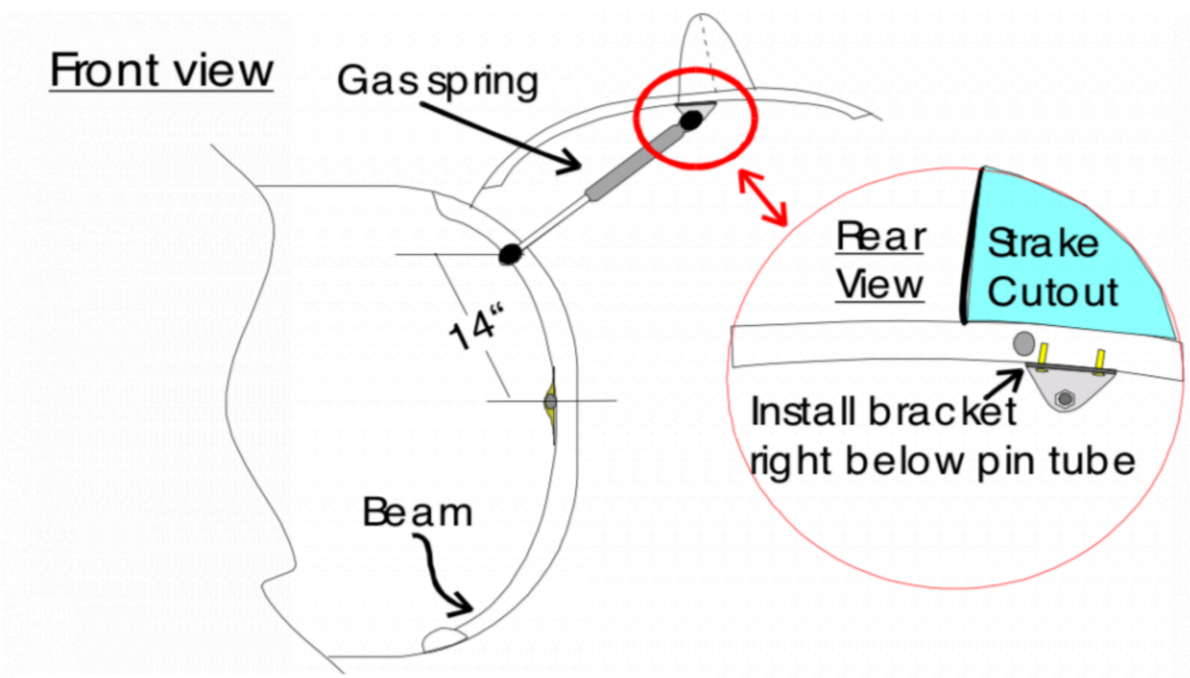


Figure 5-21. Door Gas Spring Installation

___ You will locate the aluminum angle for the other end of the gas spring just under the pin tube in the door. The angle is held in with PK screws and uses the same wood hardpoint that the pin tube uses. Line up the top edge of the bracket with the bottom of the tube. Drill a pilot hole for the screws with a 3/32” drill bit. Attach the angle.

___ Screw the ball ends into your hardpoint and the aluminum angle.

___ Pop off the black plastic caps off the ends of the gas springs. Snap the spring over the ball ends in the orientation shown in figure 5-21. Replace the black caps.

___ Install your hard point on the second doors carbon beam and tap it as you did the first. Install the ball end in the hardpoint and the aluminum angle. Install the gas spring. Do not install the aluminum angle on the door yet.

___ Have a partner hold the door open with the spring held up to the door. Walk in front of the plane and sight the tops of the two doors. When they are equal place a mark where the second aluminum angle hits the door. Refer to Figure 5-22. It should be right under the pin tube like the first. Drill pilot holes and install the screws.

6. 6 – Fuselage

Contents

6.1. 6.0 – Chapter Preface

6.0 – Chapter Preface

6.0.1 – Parts List

Part Number	Description	Qty
	KeelHard Points	4
	Aluminum Seathard points	16
	Nose access cover	1
MS21047	Nutplates	4
MS224693S-272	10-32 Countersunk screw	4
AAC-3-4	1/8” rivet	8
	Instrument Panel	1
AN6-16A	Bolt	2
AN960-616	Washers	2
AN970-6	Washers	2
AN363-624	Nuts	2
AN4-7A	Bolt	4
AN970-4	Washers	8
BSPS-4-6	1/8” rivets	8
MS21047-4	Nutplates	4
VATTS-01	Aileron Torque Tube Support	1
AN526C-1032-R8	Screw	2
Speed brake actuator	1	

6.0.2 – Tools List

Description
Level
File
1-1/2 hole saw
10-32 tap, 1/4-20 tap
Drill

6.0.3 – Supplies List

Description
Duct Tape
Hot Glue
4-3/4” Long 1/2” PVC Pipe
1/2” all thread 6”
1/4-20 nuts (2)
1 × 4 Scrap Wood
(2) 3” × 8” pieces scrap wood
(2) 3” × 6” pieces scrap wood
Structural Adhesive
Masking Tape

6.0.4 – Glass List

Type	Size	Qty
BID		
Triax	3”× 11”	6
Triax	9”× 13”	2
Triax	8”× 18”	8
Triax	3”× 20”	8
Triax	3”× 12”	10
Triax	6”× 12”	6
Triax	6”× 8”	2
Triax	3”× 8”	2
Triax	22”× 30”	1
Triax	18”× 26”	1

6.0.5 – Process Overview

Construction Process	Completion Date
Speed Brake Instalation	
Keel Access Holes	
Keel Hardpoints	
Seat Hardpoints	

Aileron Control System	
Control Stick Assembly	
Keel Instalation	
Keel Stifeneing Lay-ups	
Speed Brake Actuator Instalation	
Nose Access Cover	
Mount Master Cylinders	
Rudder Pedal Install	
Rudder Nylaflow Install	
Instrument Panel	
Spar Leveling	
Spar Instalation	
Doghouse Cutout	
Canard Tab Reinforcements	

6.0.6 – Documentation Changes

Oct 01, 2018 – Original Web Release

6.2. 6.1 – Speed Brake

6.1 – Speed Brake

6.1.1 – Speed Brake Cutout

The speed brake is pre-marked on the bottom fuselage. **Be careful, you do not want too large a cut line.**

___ Cut with a hacksaw blade making sure to keep your blade perpendicular to the bottom of the fuselage. **Cut out brake hole very carefully as the cut out portion will be used as your speed brake.** Support the brake while making the last part of the cut so as not to let it break out. Sand the edge of the hole with a block on the straight and a pipe in the corners.

___ Use folded sandpaper to sand a relief about 1/8” × 1/8” deep around the upper and lower edges of the brake hole on the **fuselage only** we will do the speed brake later. See Figure 10-1. Fill relief flush with **Flox/EZ-Poxy**. Glass over edge with **BID** cut overlap- ping edge about 1/4”. Let cure and trim carefully with razor knife. Lightly sand rough edges.

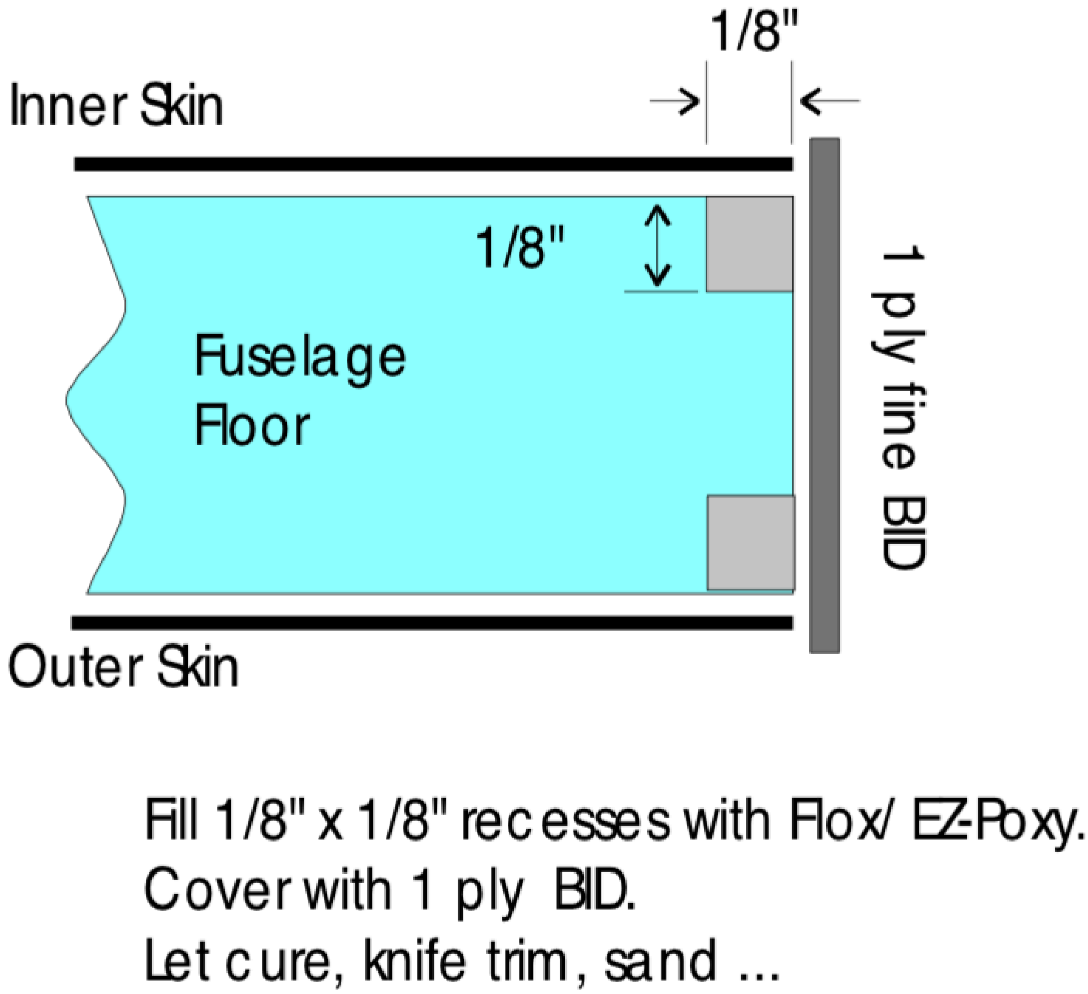


Figure 6-1. Reinforcing Speed Brake Hole

6.1.2 – Reinforcements

On the speed brake **leading edge**, measure and mark points 7” to the right and left of the centerline. Measure and mark 1-1/2” to each side of these points and 3” aft forming 3” × 3” squares.

___ Inside fuselage, reinstall speed brake and duplicate 3” × 3” squares directly in front of the squares in the speed brake as in Figure 6-2. This square will accept the other half of the hinge. Cut out the inner skin and foam in these squares down to the outer skin and sand the exposed glass as well as a 1” margin on the inner skin around the recesses.

___ Measure and mark a 3” × 5” rectangle on the speed brake inner skin, centering the 5” dimension 8” forward of the trailing edge. The 3” dimension is offset to the right of the centerline . Refer to Figure 6-2 above.

___ Cut out the marked rectangle down to the outer skin and sand the exposed glass area as well as a 1” margin around the inner skin hole. This recess is for the actuator hard point.

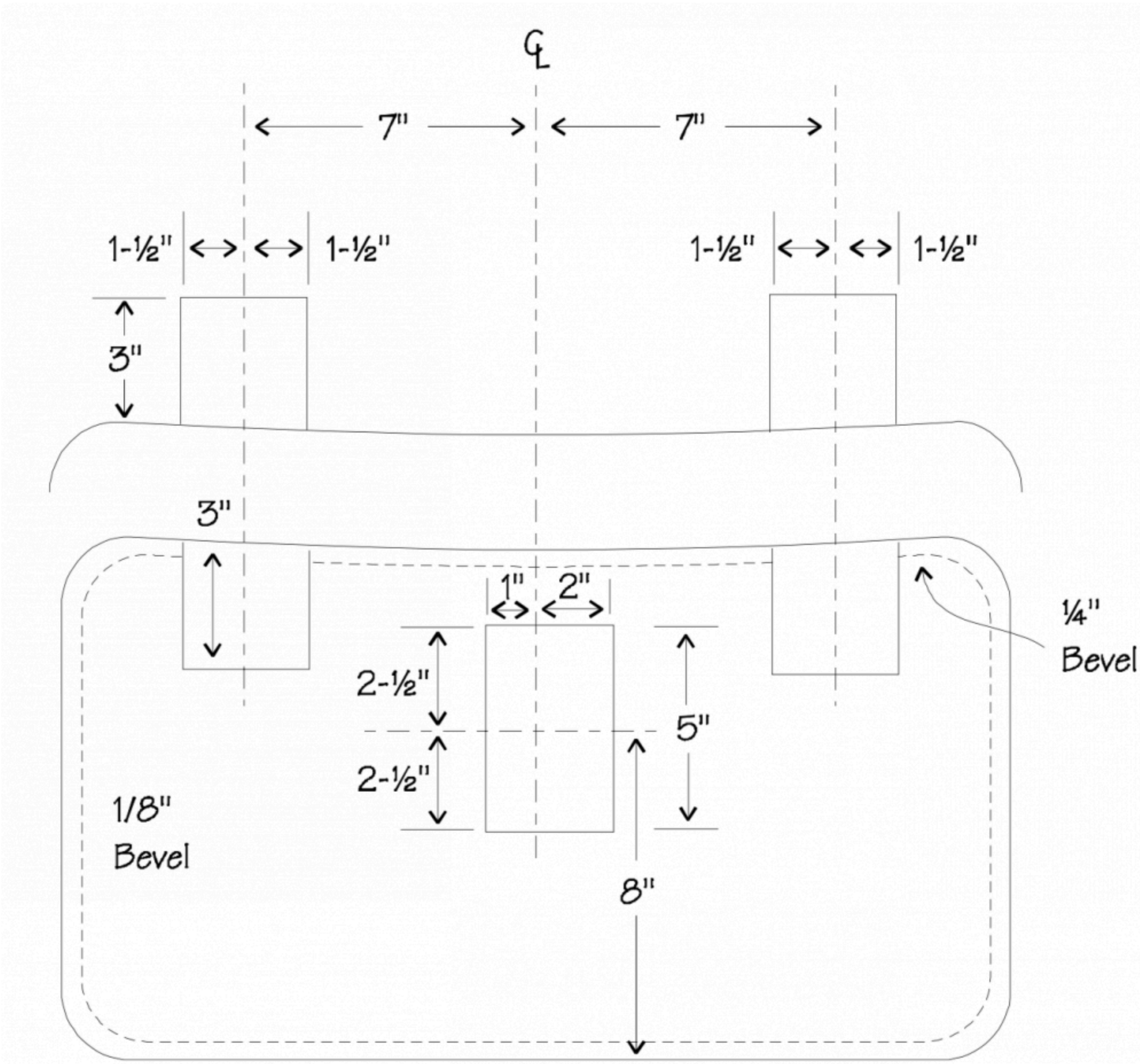


Figure 6-2. Speed Brake Cutout and Hard Point Locations

6.1.3 – Hard Points

Hardware required:

Part Number	Description	Qty
MS24693C-272	Screws	16
VMBA-01	Hinge, Speed Brake Machined	2
	21. Drill Bit	
	#10-32 Tap	

___ Sand the skin in and around the cutout areas. Fill any voids in the foam around all the hinge recesses (door and fuselage) with **Micro-Glass**.

___ Apply 5 plies of 3” × 3” **TRIAX** in the hinge area. Put a finger radius of **Micro-Glass** in the corners and cover the recesses with a layer of **BID** lapping onto the inner skin about an inch.

___ For the actuator hardpoint, sand the skin in and around the cut out area. As above, fill any voids in the foam around the recess with **Micro-Glass**. Apply 5 layers of 3” × 5” **TRIAX** in the actuator hardpoint area. Put a finger radius of **Micro-Glass** in the corners and cover the recess with a layer of **BID** lapping onto the inner skin approximately one inch.

6.1.4 – Install Speed Brake

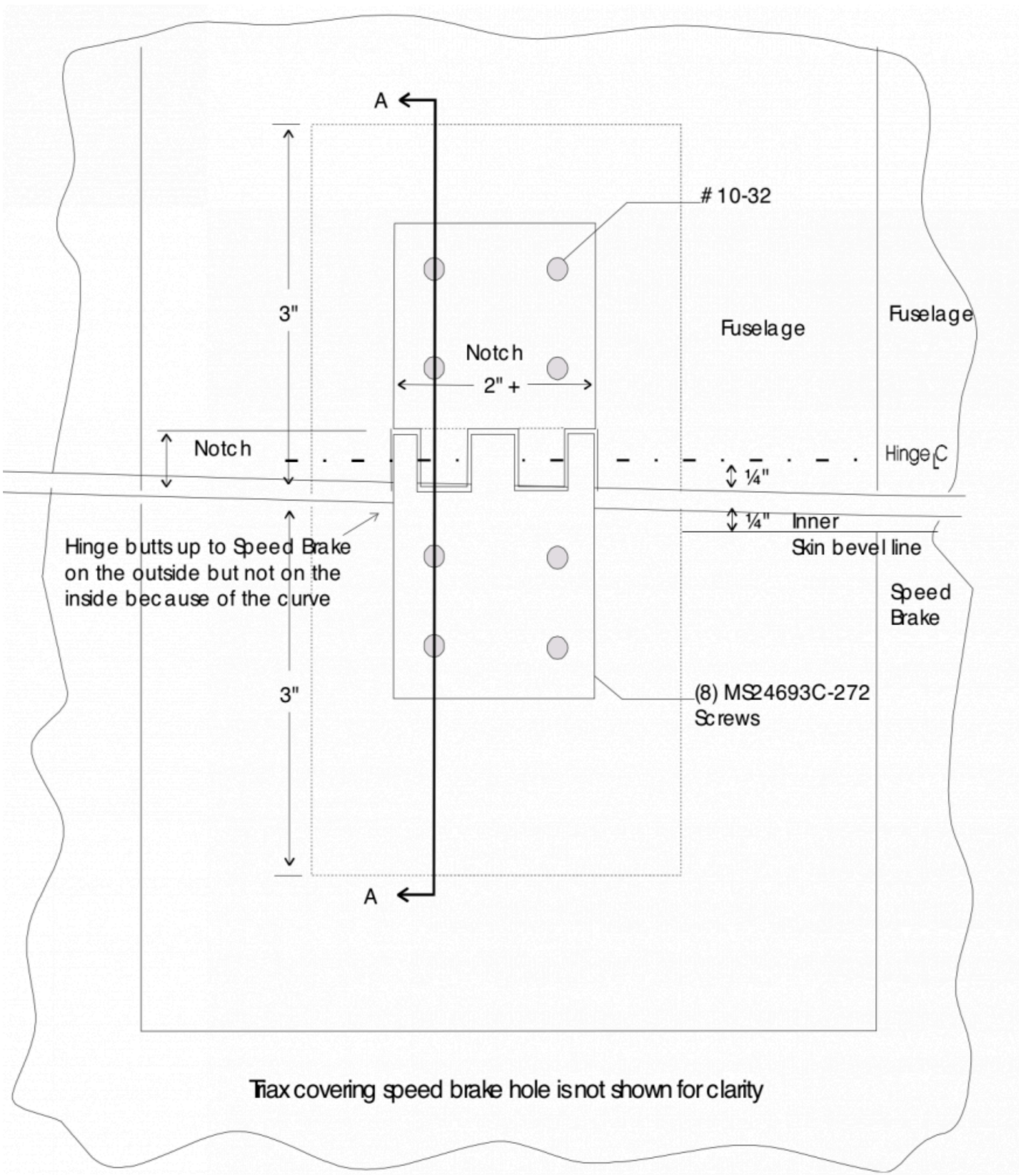


Figure 6-3. Speed Brake Hinge Installation

___ Cut 3/8” notches 2” wide in the lower fuselage skin centered on the aft edge of the hinge pockets.

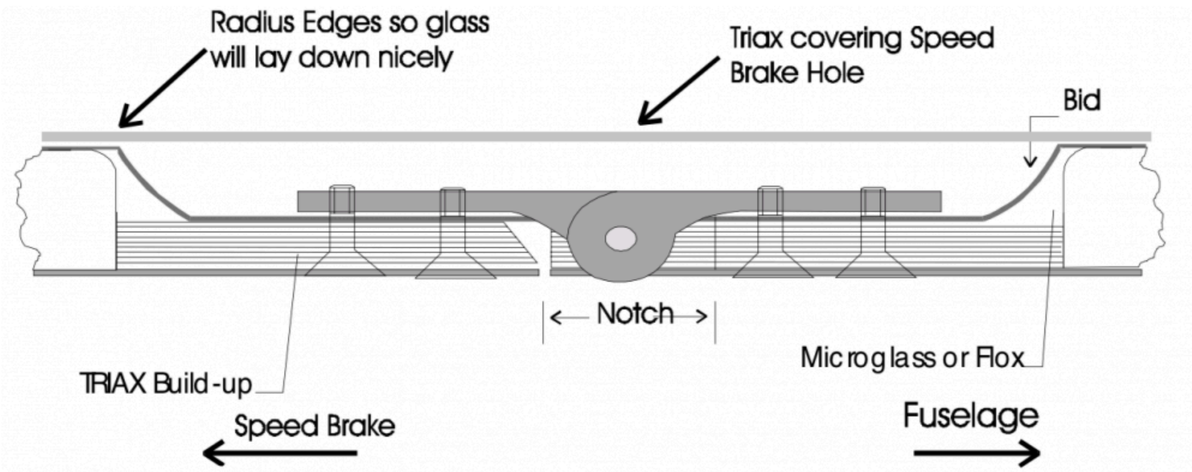


Figure 6-4. Speed Brake Installation Cross-Section (section A-A)

___ Place your hinges on your speed brake centered on the **TRIAX** pads. Line the hinges up so that the hinge is tight against the speed brake. Make sure that the hinge is parallel to the center line. The inside of the hinge will not be against the speed brake because of the curve on the front of the door. Refer to figure 6-3. Using the hole drilled in the hinges as a guide drill out one 1/8” hole in each. Remove the hinge and drill this hole out with a #21 drill bit and tap with a 10-32 tap. Drill the hole out in the speed brake to 3/16”. Attach the speed brake to the hinges using 3/16 screws. We are just using one screw so we can make sure our alignment is working before drilling the others.

___ Place speed brake in fuselage. You will need to cut out a notch in the fuselage to allow the hinge to fit. Refer to 6-3. Install speed brake so that you have equal clearance all around the speed brake. Using hotglue and tongue depressors glue speed brake in this position. Drill one 1/8” hole through each hinge into the fuselage. Remove speed brake drill and tap hole in hinge as you did previously and open hole in fuselage to 3/16.

___ Reinstall speed brake with 3/16” screws.

|___| Check alignment and operation of speed brake. We will need to open up the gap between the speed brake and the fuselage. You need it to be 1/16” on the sides and the back and 1/ 8” in the front side. If the speed brake swings through its travel smoothly drill for the other screw holes as you did the first ones. You will have to countersink the holes to allow you to use MS24693C-272 countersunk screws.

___ On the inside of Speed Brake cutout draw a line 1/8” from the edge all the way around the two sides and back of the cutout. Draw a line 1/4” from the edge on the front. Cut through the inside glass along this line. **DO NOT** cut through the outside glass or foam. Using sandpaper bevel the edges between the inside and outside skins of the speed brake.

___ With a folded piece of sandpaper, remove the foam at the inside and outside skins as you did on the speed brake hole. Fill the reliefs with **Micro-Baloon** and cover brake edges with one ply of **BID** cloth cut on a 45 degree bias. Let cure.

Reinstall the speed brake.

6.1.5 – Cover Speed Brake Hole and Edges

___ **Bondo** stirring sticks on the outside skin around the speed brake hole so you may set the brake back in the hole from the inside. After turning fuselage upright, add pieces of stick to shim the speed brake up in the hole to produce an operating clearance of about 1/16” (1 stir stick). Cover the inside of your speed brake with duct tape or Saran Wrap . Install the hinges to the speed brake. Install the speed brake to the fuselage. Install the hinges to the fuselage using one AN960-10 washer between the top of the **TRIAX** pad and the hinge. This washers and the tongue depressors both have approximately 1/16” thickness.

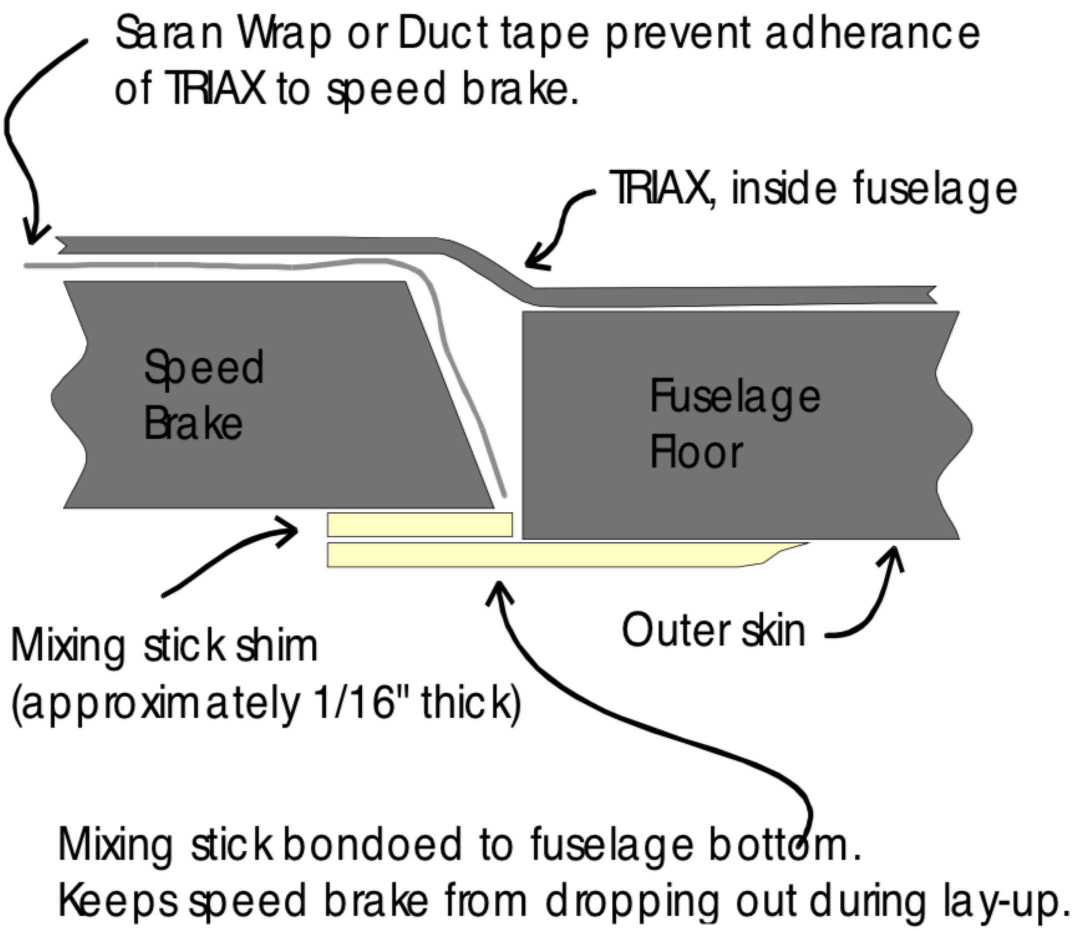


Figure 6-5. TRIAX Over Speed Brake Cutout

___ In this step you should pre-wet **TRIAX** on a sheet of plastic and let partially cure to prevent epoxy running into gap between brake and fuselage. Prime area around hole and in front of hinges with epoxy and lay in one layer of 22” × 30” **TRIAX** with major axis perpendicular to the centerline, centered over the hole. Make sure this first lay-up lays onto the fuselage at least 1” in front of the hinges. Next lay-up a 18” × 26” **TRIAX**, major axis parallel to the centerline, centered over hole. Let cure. After cure disassemble remove the AN960-10 washers and reinstall the speed brake.

___ After the keel is installed you will install the speed brake actuator.

6.3. 6.2 – Keel

6.2 – Keel

The keel comes to you as a one piece structural member that does several things:

- It indexes and supports the nose gear system.
- It houses the control system.
- It carries the actuator for the speed brake .

The keel has a substantial flange built all around it so as to hold shape while fitting it into position.

Note: The keel has a number of markings on it. Some show the size and shape of cutouts and others show drilling positions only. Do not cut the keel without knowing exactly what should be done.

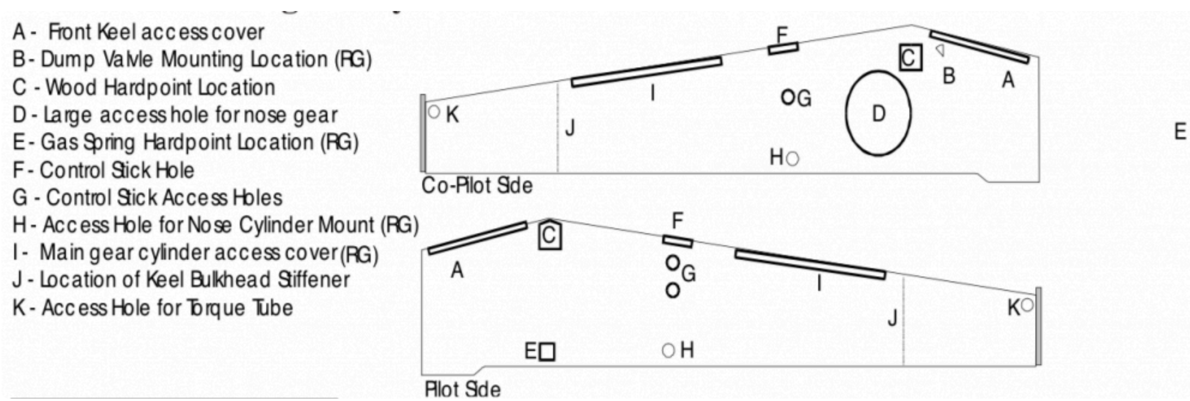


Figure 6-6. Keel Marking Key

6.2.1 – Forward Keel Access Hole

There are two rectangular access holes to cut in the top of the keel. They are premarked on your keel at the factory.

___ Cut the access covers on the marked lines and sand the outside faces.

___ Duct tape around the outside of the hole on the keel itself, hot glue the cover back on lightly, and glass a flange around the hole with four **BID** tapes 1” onto the cover and 1” onto the tape.

___ Add one more layer of **BID** covering the whole plate and the other **BID** tapes.

___ Cut out the oval hole in the middle of the cover plate. This is used for the elevator torque tube. Figure 6-7 shows the cutout and placement of screws and nutplates for the forward holes.

___ Attach the rear cover plate with eight evenly spaced nutplates around the perimeter and one in the top of the keel bulkhead stiffener that will be installed later.

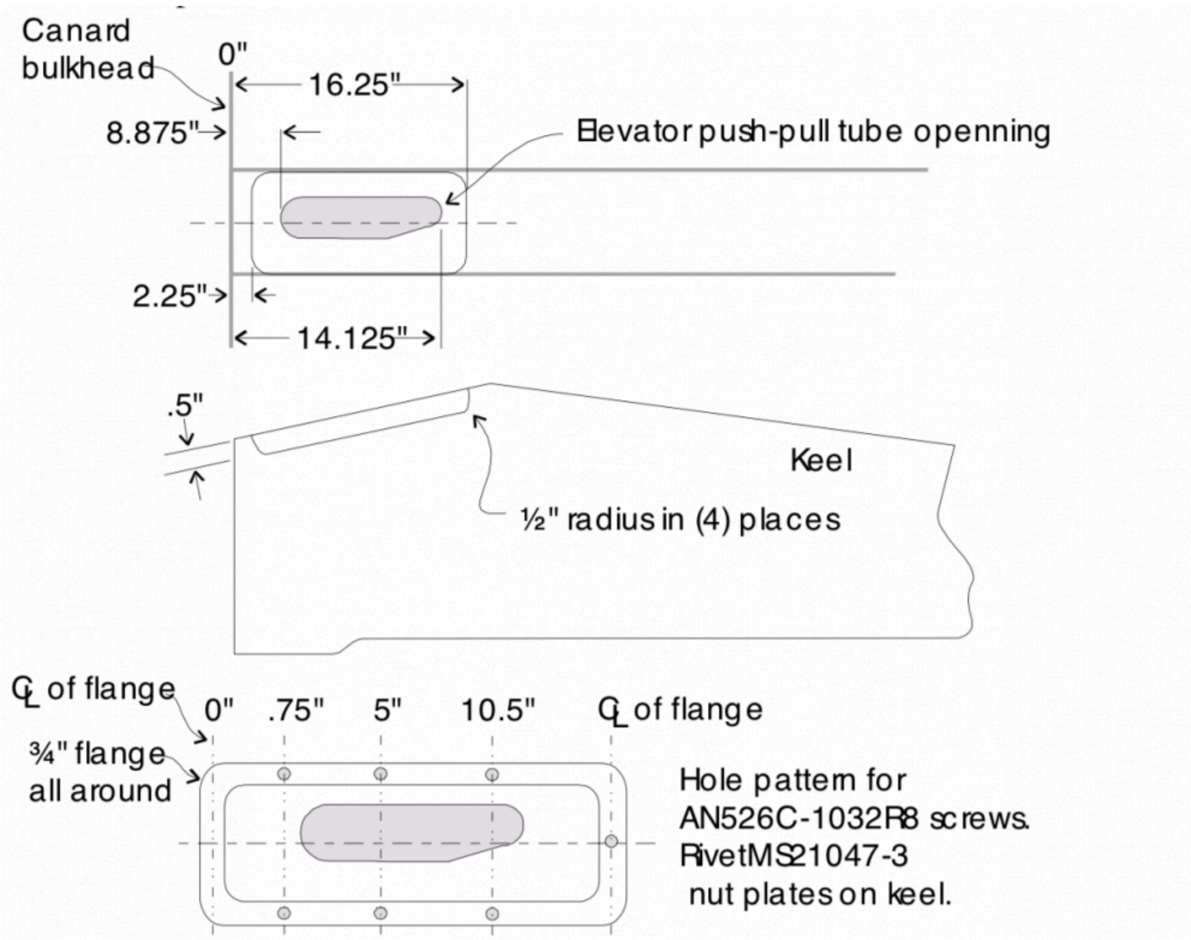


Figure 6-7. Forward Keel Access Hole

6.2.2 – Aft Keel Access Holes

You may cut a 6” access hole to help you access the speed brake actuator. Locate the hole where it gives you good access to both the top and bottom of the actuator.

___ After cutting out the hole, cut the outer skin and foam back 3/4”.

___ Bevel the foam, **Micro-Balloon** the foam, and glass in place with two **BID** layers over the foam, overlapping onto the keel 1/2” and covering the exposed inner skin of the keel.

___ The cover plate, p/n VKAC-01, is supplied in the kit. Cut it out and attach with six evenly spaced #10 nutplates.

6.2.3 – Fitting the Keel

Note: The keel must be in the center of the aircraft.

___ At the same time you fit the keel you must fit the canard bulkhead. (Refer to Chapter 4) Make sure you check the distance from the side of the fuselage to the top of the keel in several locations to make sure it is in the center. The keel should fit against the canard bulkhead.

___ When satisfied with the fit, drill and cleco the bulkhead and keel in position. Remove the keel and canard bulkhead for further work inside.

Note: You will need to trim the keel in the area of the speed brake and at the front of the keel to allow the keel to lay flat on the fuselage floor.

6.2.4 – Keel Hardpoints

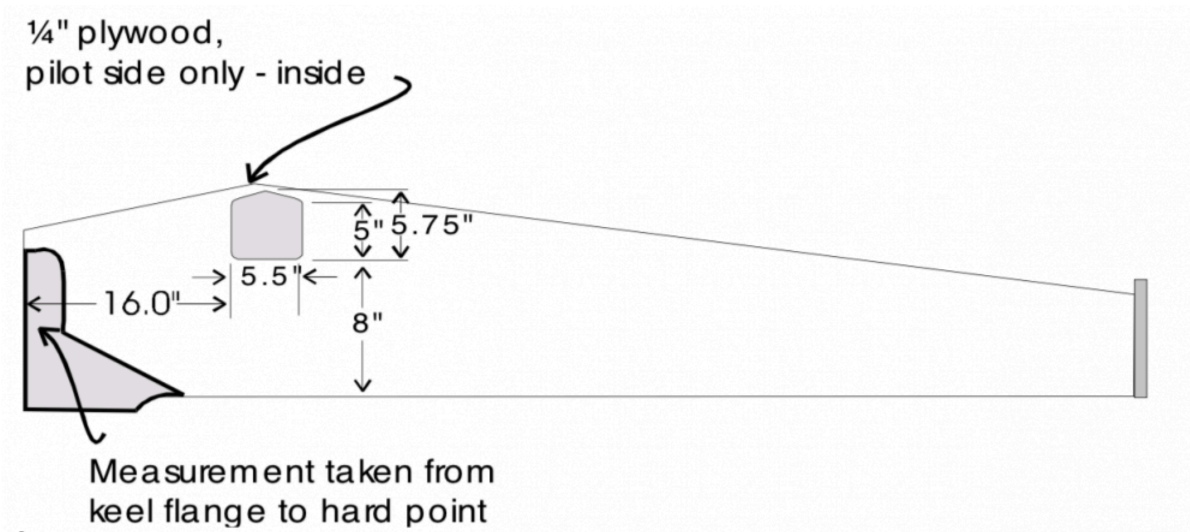


Figure 6-8. Keel Hardpoints

There is one piece of 1/4” plywood that gets installed into the keel. The keel is factory marked and Figure 6-8 shows the locations. This piece is installed to the inside of the keel with **EZ-Poxy** mixed with **Cabosil** to make it sticky. Cover the plywood with four piles of **BID**, lapping 1” to 2” onto the keel. They should either have a small taper or filet to provide a smooth transition for the glass. To hold the hardpoints in place while curing you can brace them to the other side of the keel with a small piece of dowel rod.

6.4. 6.3 – Seats and Hardpoints

6.3 – Seats and Hardpoints

6.3.1 – Fuselage Hardpoints

___ Install front seat hardpoints in the floor. All eight are measured from the fuselage centerline and from the aft face of the canard bulkhead. The inboard hardpoints can be installed on the surface and covered with two plies of **BID**. The outboard hardpoints are embed in the floor with **Micro-Glass** or **Flox** and cover with two plies **BID**. This keeps the seat level.

The rear seat hardpoints are provided in the kit. We do not show a location for them because this depends on how a builder decides to do their back panel in the airplane. Your rear seat rail are predrilled in the mounting locations. Use the rear seat rails to position your hardpoints and install them as you did the front seat hardpoints.

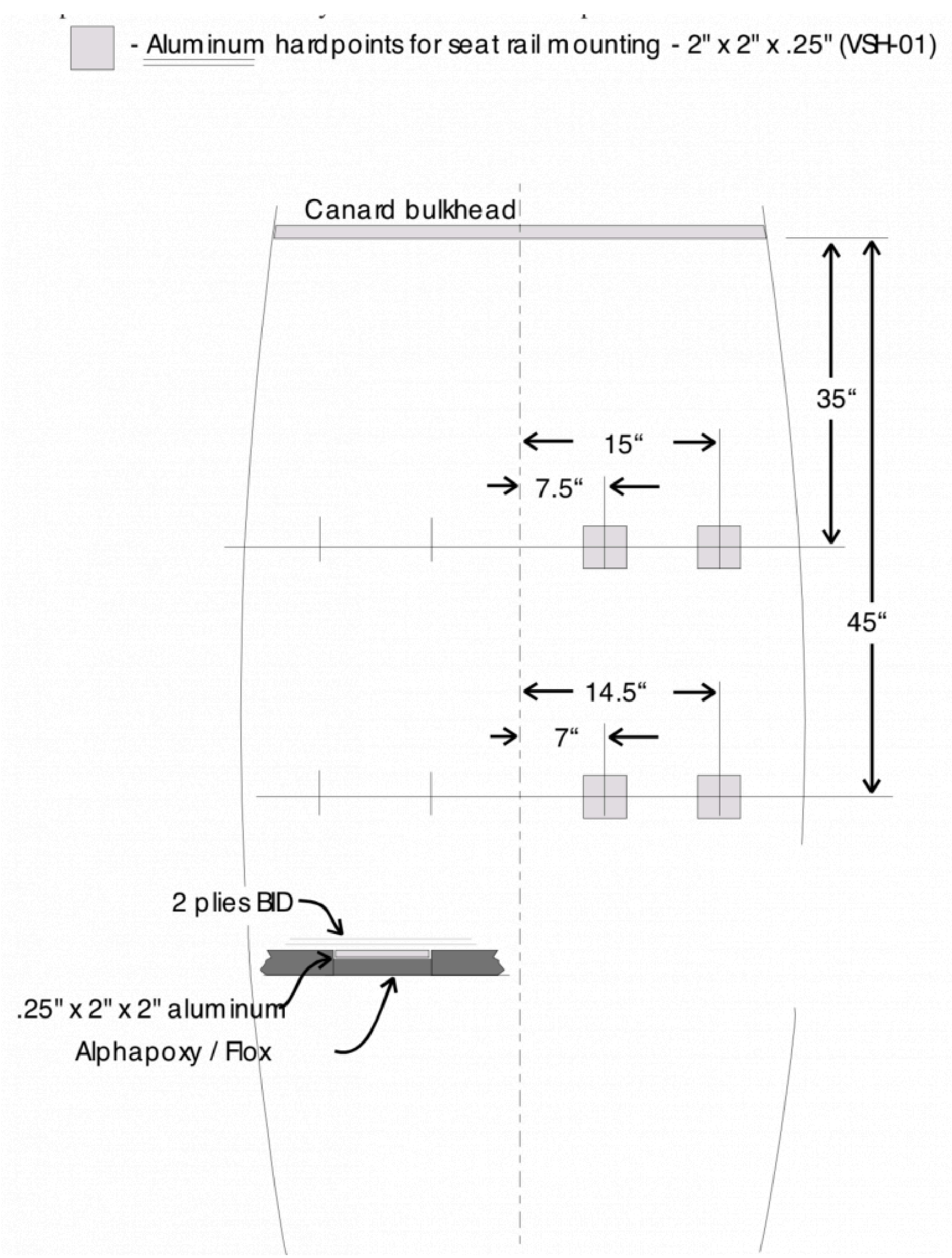


Figure 6-9x. Fuselage Hardpoints

6.3.2 – Seat Belt Hardpoints

Locations of the hardpoints are shown in Figures 6-10,11, and 12. You can tap the hardpoints prior to installation, but you will still have to drill and re-tap the holes.

___ **Structural Adhesive / Flox** or **Veloci-Poxy Micro-Glass** the hardpoints into position, transition the edge with the same goo, and glass over with three layers of **BID** and **EZ-Poxy**. It is permissible to lay-up the **EZ-Poxy** before the **Veloci-Poxy** is cured.

___ After cure, drill and tap the hardpoints as required. **When drilling and tapping, be careful not to go through the outer skin.** When you feel the drill going through, ease up on the drill and you will finish in the foam. Be careful with your tap as well or you will put a bump in your outer skin.

___ The shoulder harness for the rear seats can be bolted to the angled bulkhead with a wide area washer on the bottom side.

6.3.3 – Front Seats

Position and install all eight seat hard points (2” × 2” × 1/4” aluminum) according to plans.

___ Position the seat rail appropriately over the hard points and 2” from the rail to the center console. It is important that the seat rail is parallel to the sides of the keel to eliminate pinching when the seat is moved fore and aft.

___ You have already installed your inboard seat hardpoints on top of the inside glass to help give you a level seating position. If needed you can also use 1/4” washers to shim up seat rail to give you a level position. Measure washer thickness and make a permanent spacer out of aluminum.

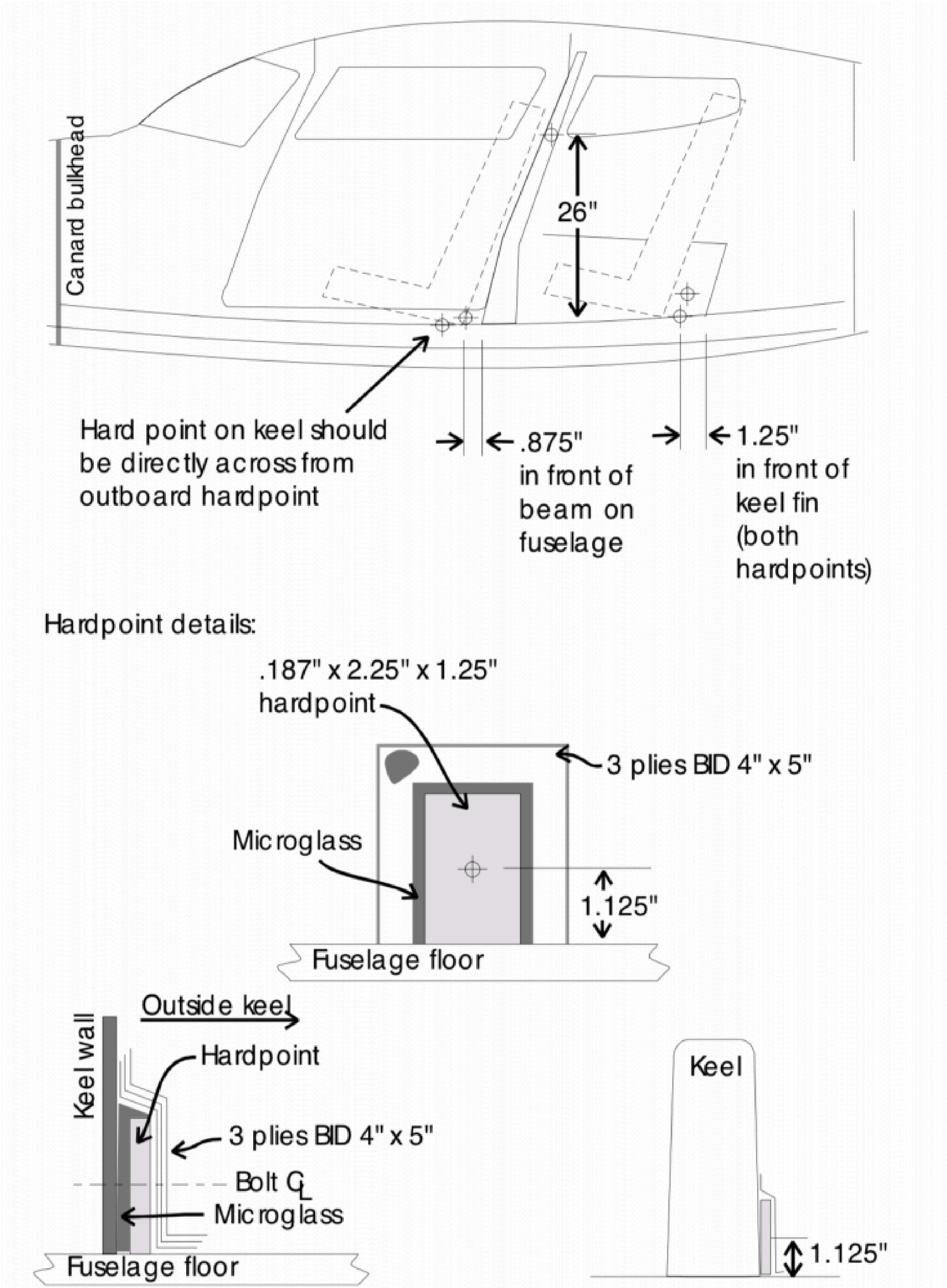


Figure 6-10. Seat Belt Hardpoint Installation

___ Drill and tap hard points for 1/4”-20 rod. The 1/4”-20 rod with nuts can be purchased at any hardware store. **Be very careful when drilling and tapping these holes as you can go right through the fuselage.**

___ Screw the rods into the tapped holes, measure and cut off for proper height (remember to add a little for carpet). Install the rails and check for proper fore/aft movement.

To complete the seat-to-rail installation, it is best to have the seat-tilt side supports attached and the seats upholstered. If you prefer to install prior to upholstery, it will be necessary to have the bottom back tilt plates installed and to do this, you will need to simulate the thickness of the upholstery.

___ The side plates can be installed by first installing the bottom plate. This is done by placing the seat bottom on a flat surface and setting the side plate so that the angled portion of the plate matches the angled portion of the seat. This angle on the seat is the area that would normally rest on the fuselage side ducts. Once set, drill and tap for 10/32 screws (two per side).

___ When both seat bottom side plates are attached, set the seat backs in place and install with two 10/32 machine screws. The seat back plates will need to be cut off just where the taper begins.

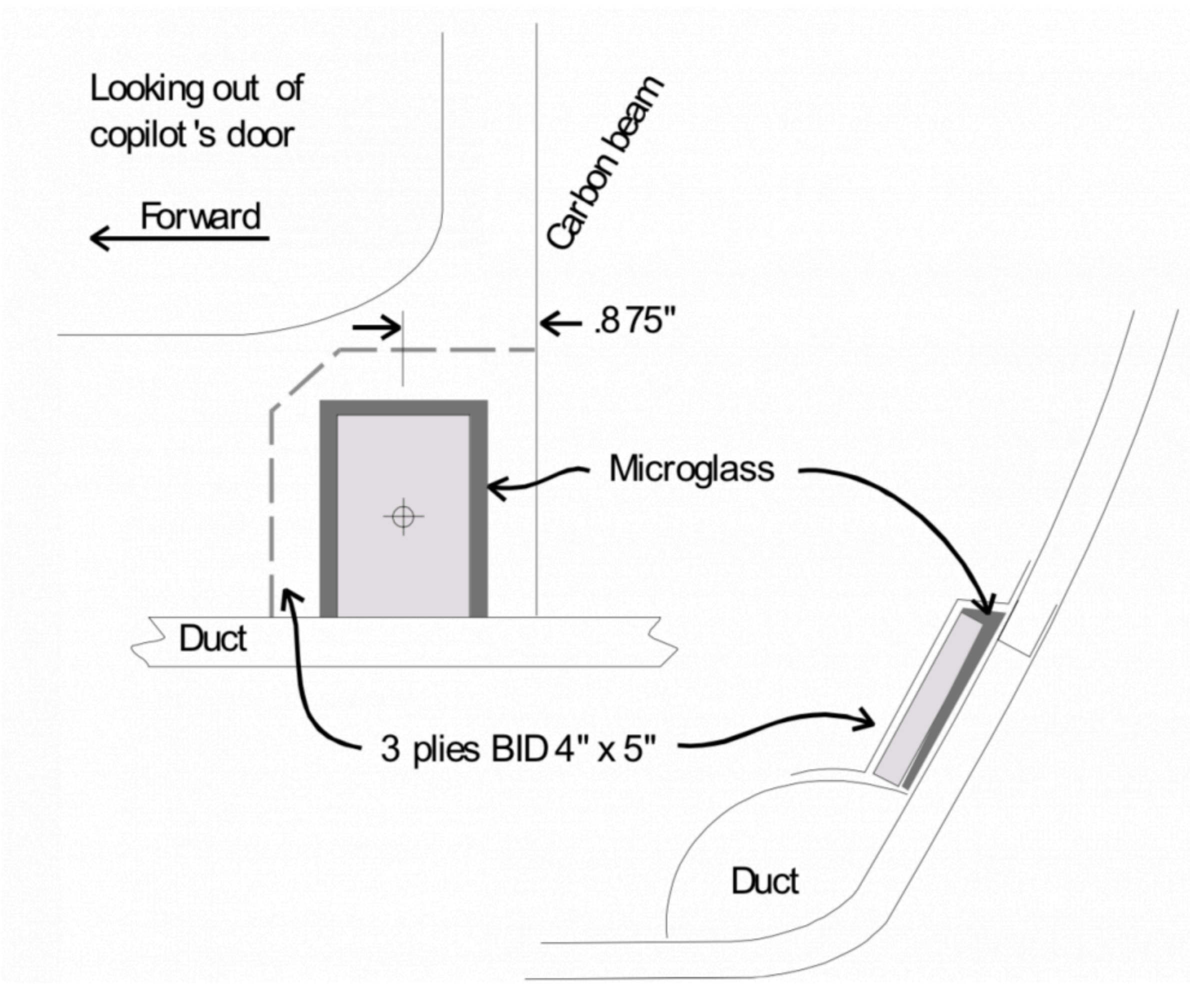


Figure 6-11. Seat Belt Hardpoint Detail

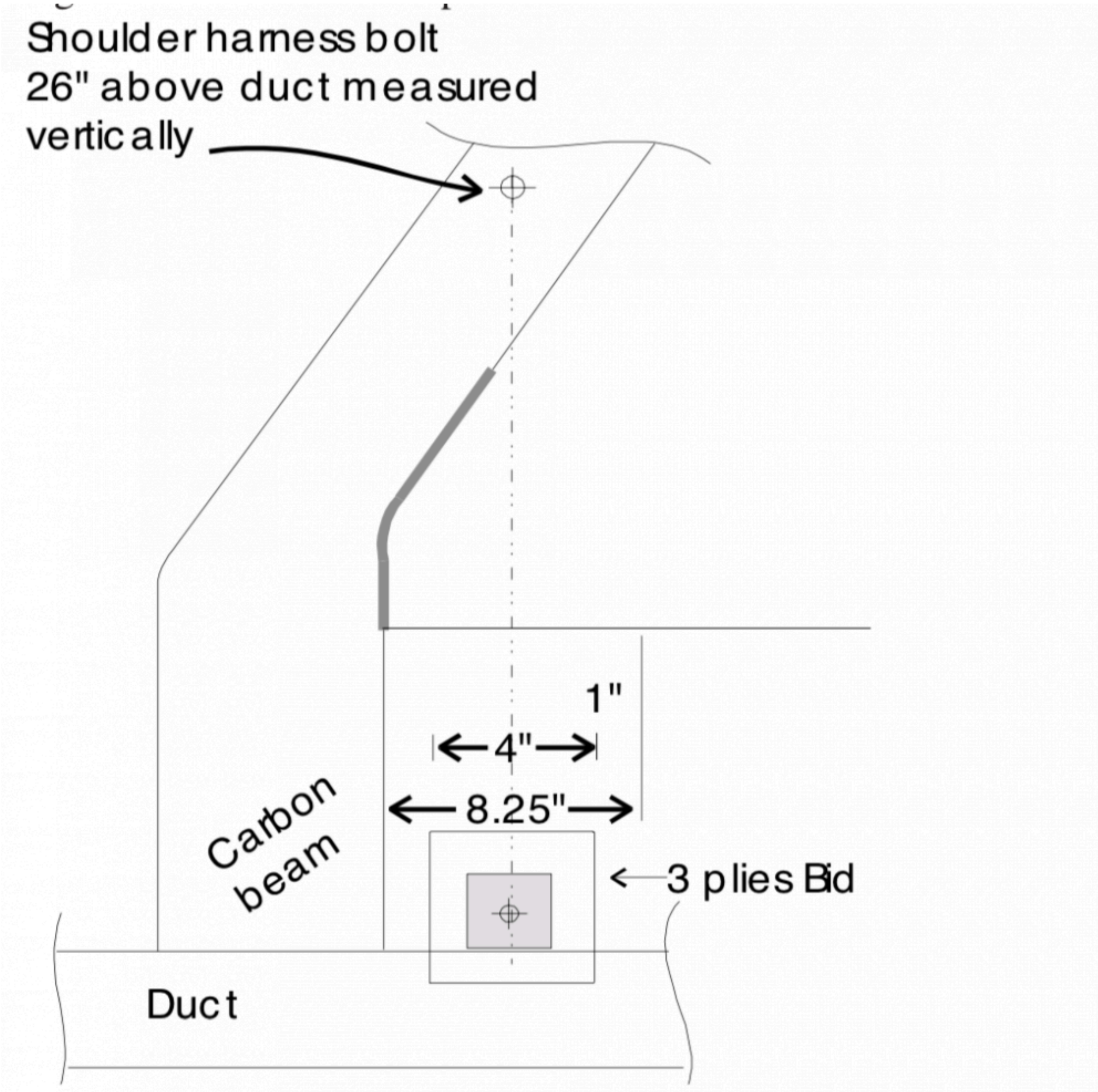


Figure 6-12. Seat Belt Inertial Reel Hardpoint

We have previously installed aluminum hard points in the seats to accept the 10/32 tapped holes. Remember to allow for the upholstery when installing these plates.

If you have purchased our interior kit upholstered seats, the process is the same.

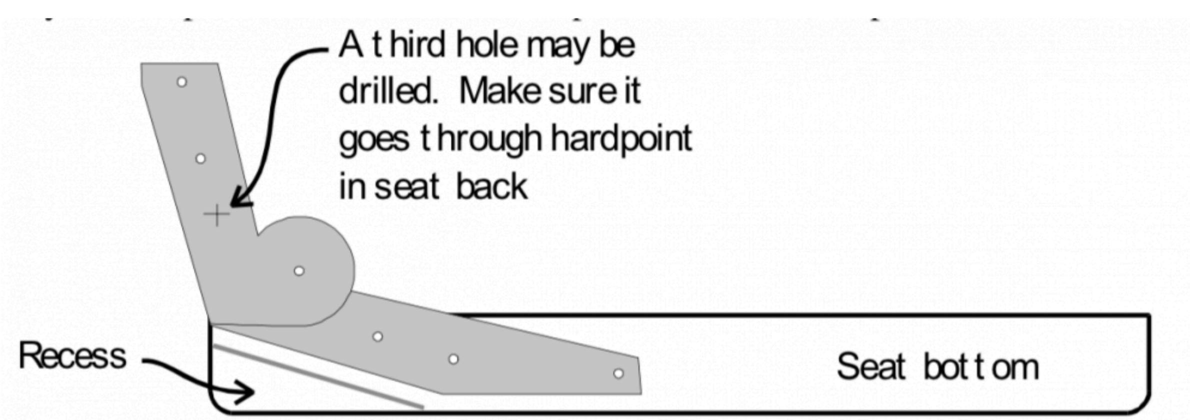


Figure 6-13. Seat Side Plates

___ To install the seats to the rails, first move the seat position to full aft. It will also be necessary to install spacers along the front and rear portions of the seat bottoms where they attach to the rails. The spacers are made of strips of 1/4" plywood. These spacers are used to bring the seat to proper height. Shorter pilots/co-pilots, will need about a 1-1/2" spacer front and rear, tall pilots/co-pilots may need only 1/2" inch spacer. These may later be adjusted (fine tuned) to your exact needs.

___ Place the spacers over the seat rails and set the seat over the spacers. Move the seat to the full aft position (front of seat approximately 2" in front of attach bracket). This should place the seat back just in front of the carbon door stiffeners. Once satisfied with the fit, reach under the seat and mark the position using a felt pen.

___ Remove the seat and seat rails. Drill through the seat and rail in four places. An inch or so in from each end will work. Attach the seat to the rail with (4) AN3 bolts and nuts. Use AN970-3 washers on the seat (cushion) side. Attach the spacers to the seat with 1 layer of **BID**.

Final seat back position (lean) can be changed by adding to or sanding away the aluminum stop blocks.

___ If you have purchased our interior kit, the row of staples attaching the center section of the upholstery to the leading edge of the seat will need to be removed and the center section lifted up to gain access to the bolts used in attaching the bottom seat to the seat rails.

6.3.4 – Rear Seats

Attach the rear seat backs to the seat pans using the side hinge pivots in the same way that you assembled the front seats in the previous section.

Install the seat to the seat rail as you did with the front seats. Push the seat rail to its full aft position. Check to make sure you have the release handle so it will face toward the keel. Center the rail on the bottom seat pan 2-1/4" from the rear of the pan. This gives room for the upholstery.

___ Place your seat rails in the airplane so that with the rails in the full aft position just forward of the rear seat bulkhead. This is up to you. Some builders create a back panel that will allow a bag or two behind the seats when they are all the way back. Once you are satisfied with you position mark the hardpoint locations for the back seat using the predrilled holes in the seat rail as your guide.

___ Install the seat hardpoints as you did the front seat hardpoints. All the hardpoints can be recessed in the foam or installed on the surface this is your choice. After the hardpoints are installed mark your location for drilling and tapping as you did with the front seat.

6.5. 6.4 – Keel Controls

6.4 – Keel Controls

6.4.1 – Keel Control Assembly Locations

___ There is a location marked on the top centerline of the keel, approximately 11” aft of the instrument panel. Drill a 3-1/8” hole. This is where the control stick exits. Dimensions on Figure 6-16 are approximate and are for reference only.

___ Also marked on the sides of the keel at this same 11” distance aft of the panel are holes to be cut for access for assembling the stick mechanism.

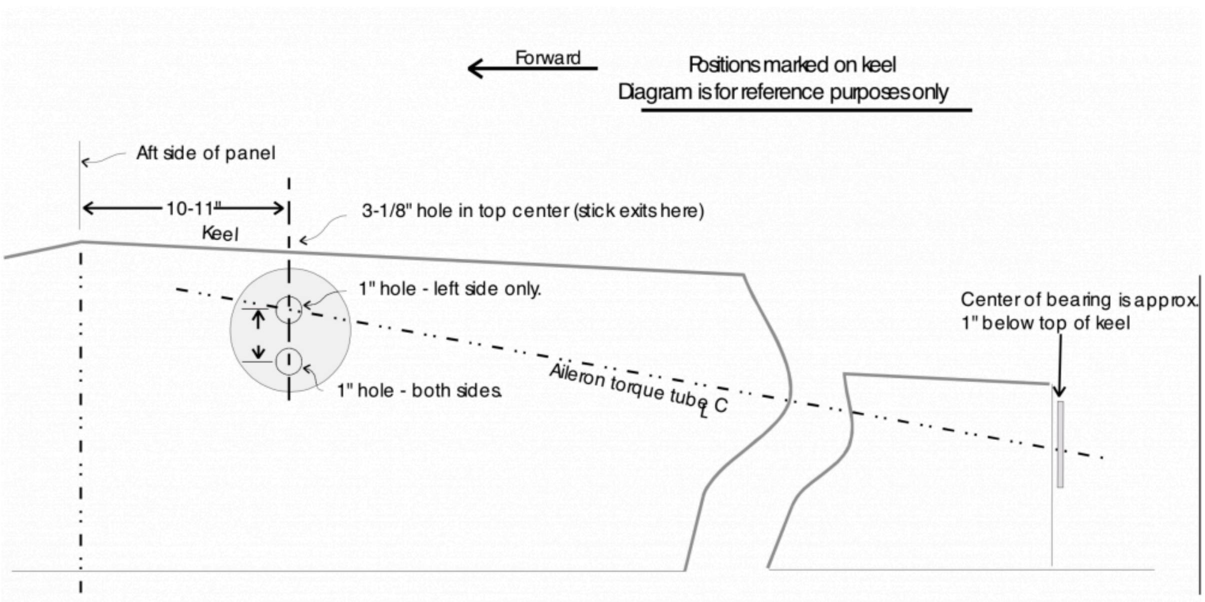


Figure 6-15. Keel and Control Stick Layout

6.4.2 – Forward Aileron Torque Tube Bearing

You will need to install the front torque tube bearing to the aileron torque tube. Clamp the aileron torque tube in a bench vise . There is an aileron torque tube retainer that comes to you inserted in the front of the aileron torque tube taped in place. Remove the retainer and install it through the aileron torque tube bearing. Refer to 6-16 to make sure the bearing is facing the right direction. With the retainer installed tight up to the aileron bearing you will need to drill a 3/16” hole for the bolt to hold the retainer. This hole is located 3/4” behind the bearing. Make sure the bushings for the control stick are perpendicular to the hole you are drilling.

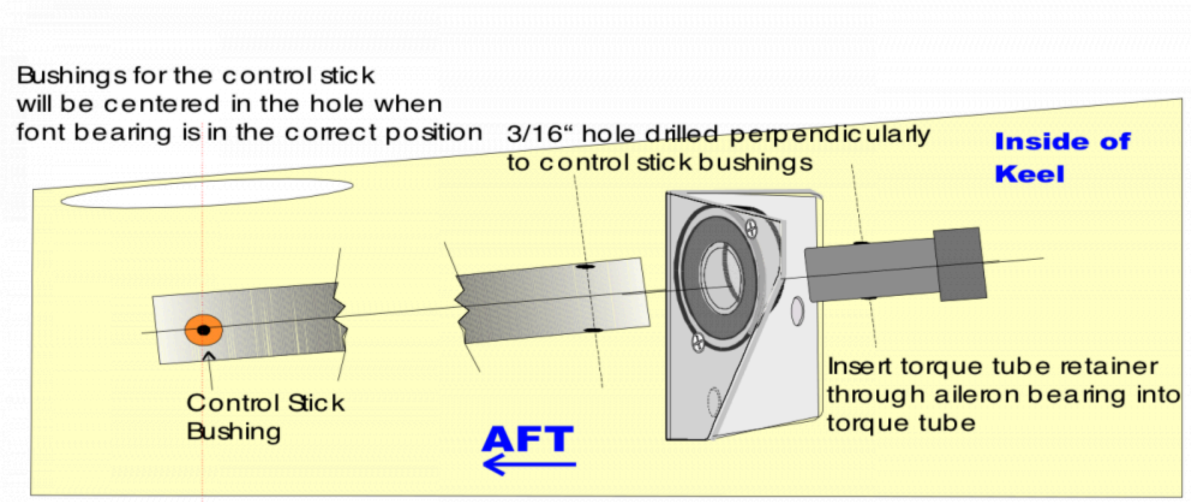


Figure 6-16 Torque Tube Retainer Installation

	Forward Aileron Control Bracket	
Qty	**Description**	**Part Number**
1	Bracket, Front Aileron Torque Bearing	VFAB-01
1	Control Torque Tube, Aileron (End with retaining sleeve to front of aircraft)	VATT-XL
3	Bolt	AN3-7A
6	Washers (use as shims if necessary)	AN960-10
3	Locknuts	MS21042-3

___ The front aileron torque bearing bracket is mounted flange forward on the pilot side of the keel. The extreme front end of the bearing itself is 18-1/4" aft of the front flange of the keel. The center of the bearing is 12-1/2" above the bottom keel flange. The control stick bushings will be in the center of the hole you cut for the control stick when the front bearing is in the correct position. See Figure 6-16. Use (3) AN3-7A bolts, AN960-10 washers, and MS21083N3 nuts. For now, install it with just one bolt so that you can adjust the angle as you install the rear aileron control bracket. Counter bore the foam in the keel to allow the head of the bolt to be flush with the keel inner skin.

6.4.3 – Rear Aileron Control Bracket

	Rear Aileron Control Bracket, Hardware List	
Qty	**Description**	**Part Number**
1	Bracket, aileron control system	VBAC-01
1	Aileron bellcrank	VABC-01
2	Cable, push-pull, 7-1/2 ft. (8 ft on 173)	VPPC-01
2	Rod end, 1/4-28 female	MW4
2	Clamp and shim, control cable, aileron	VCCC-01
1	Spacer, aileron cable standoff	VACS-01

1	Pulley, roll trim	MS24566-1B
1	Line & spring, roll trim	VRTLS-01
1	Motor, roll trim	VRTM-01
1	Control torque tube, aileron	VCTT-01
4	Bolts	AN 3-5A
3	Bolts	AN 3-11A
3	Bolts	AN 3-5A
1	Bolt	AN 4-12A
2	Washers	AN 960-416
4	Washers	AN 970-3
1	Washer	AN 960-10L
9	Locknuts	MS21042-3
1	Locknut	MS21042-4
2	Pop rivets, 1/8” protruding	BSP-44

___ Mount this assembly against the aft side of the keel fin with the center of the bearing 1” below the top of the inside of the keel. See Figure 6-17 for bearing orientation. Use (4) AN3-5A bolts, AN970-3 washers, and MS21042-3 locknuts. Using the holes in the bracket as a guide drill through the fiberglass holes to attach the roll trim motor and shaft. Install the roll trim motor and pulley to the rear control bracket by inserting the studs on the motor through the plate and securing with two 3/16” locknuts. You will have to open up holes in the fiberglass to allow all the bolts except the four mounting bolts to tighten up against the aluminum control bracket.

Install the rear of the keel onto the front keel section. Install the aileron torque tube and insert it into the aileron torque tube bellcrank. It will be a little long and need to be trimmed. Measure the gap between the rear aileron section and the front section. Trim this amount off of the aileron torque tube. This will assure the aileron torque tube is tight up against the rear aileron torque tube bearing.

Locate the aileron torque tube bellcrank. Drill two 1/8” holes 2” up from the bottom tip of the bellcrank, 3/16” in from each side, for the trim spring attachments. These holes can be moved up or down to achieve the desired trim action.

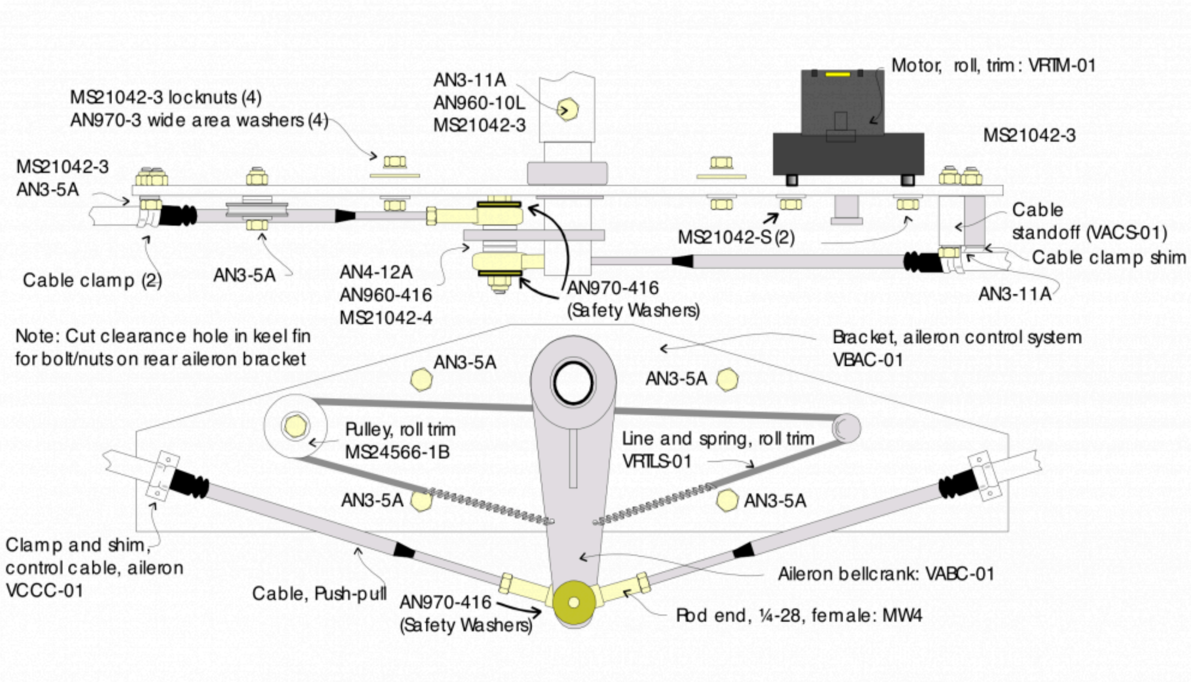


Figure 6-17. Aft Aileron Control Assembly

6.4.4 – Mid-bearing Support

With the aileron tube temporarily installed and aligned with the bearing in the rear bracket, measure the distance from the side and top of the keel to the center of the tube at the factory-marked position of the keel bulkhead stiffener rib (VKBS-01). Now drill a 1" hole in the rib at that location.

___ Remove the torque tube and sand the area of contact for the rib to keel.

___ Install the rib with the flange forward of the locator line on the keel with **Structural Adhesive**.

___ Reinstall the torque tube and verify that the tube passes through the center of the hole. If not, file the hole to get enough clearance for the intermediate bearing (VIB-01). When satisfied, install the bearing, flange forward, with **Structural Adhesive**.

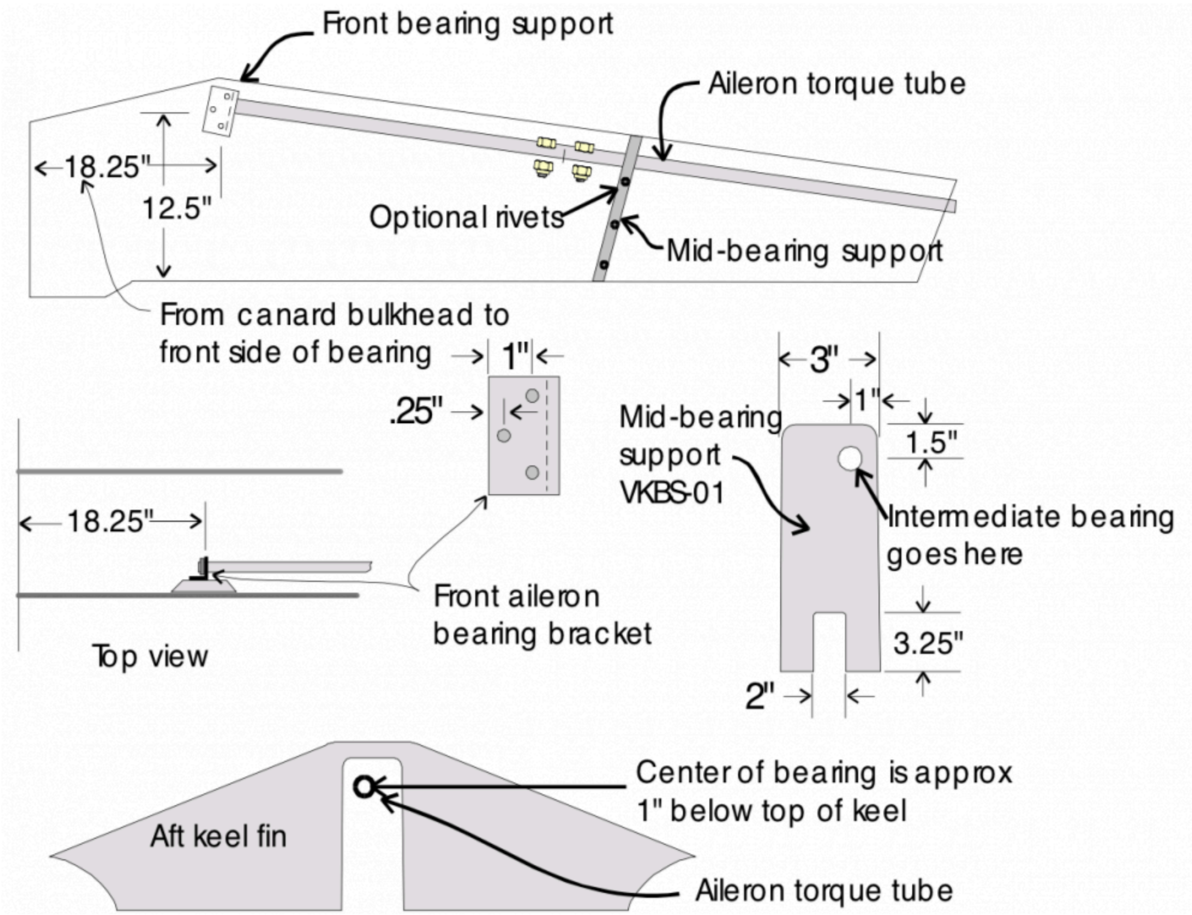


Figure 6-18. Aileron Torque Tube Installation in Keel

___ Now install the other two bolts into the front aileron bracket.

___ Reinstall the torque tube to the front bracket.

6.4.5 – Control Stick Assembly

___ Assemble the control stick to the torque tube. The hole in one side of the stick is tapped for the threaded portion of the stick pivot bolt. The nut locks it in place. **Do not drill this hole out by mistake.**

	Keel Control Assemblies, Hardware List	
Qty	**Description**	**Part Number**
1	Control Stick Assembly	VCSA-01
1	Control Torque Tube, Aileron	VCTT-01
1	Elevator Push Rod Assembly	VEPR-01
2	Rod End, 1/4”-28 Male	MM4
2	1/4”-28 Nut	BI1428
1	Bolt	AN4-15A
1	Bolt	AN4-17A

4	Bolt	AN3-10A
4	Washer, Thin	AN960-416L
2	Locknut	MS21042-4
4	Locknut	MS21042-3

Note: Some bolts may come assembled to the stick and tube assemblies.

___ Insert the bellcrank into the torque tube. With the control stick up and the bellcrank down, i.e. each pointing in opposite directions and their centerlines parallel to each other, drill a 3/16” hole horizontally for an attaching bolt about 3/4” from the end of the torque tube through both pieces holding both in the above alignment. There are two circles premarked at the rear of the keel to cut holes for access to your torque tube.

___ Remove the bellcrank and control stick from the torque tube. Reinsert the torque tube into the keel and permanently install the front torque tube retainer.

___ Install the two roll trim springs into the attachment holes of the bellcrank. Tie the line to the left spring, route the line clockwise around the pulley, wrap around the trim motor shaft (two complete wraps) and tie to the right spring. Be sure there is sufficient tension on the springs with no slack. If the motor shaft slips during operation more tension is required.

___ Locate the two aileron control cables and thread on the (2) 1/4” rod ends. Screw them on about halfway to ensure adequate threads for adjustment. Be careful during future adjustment that you have at least 3/8” of the cable threads in the rod end and use the locknuts provided on the cables.

___ Install the cables as shown in Figure 6-17 using the proper bolts, nuts, washers, shims, and spacers. This step can be done later, but make a note as to where to locate this information.

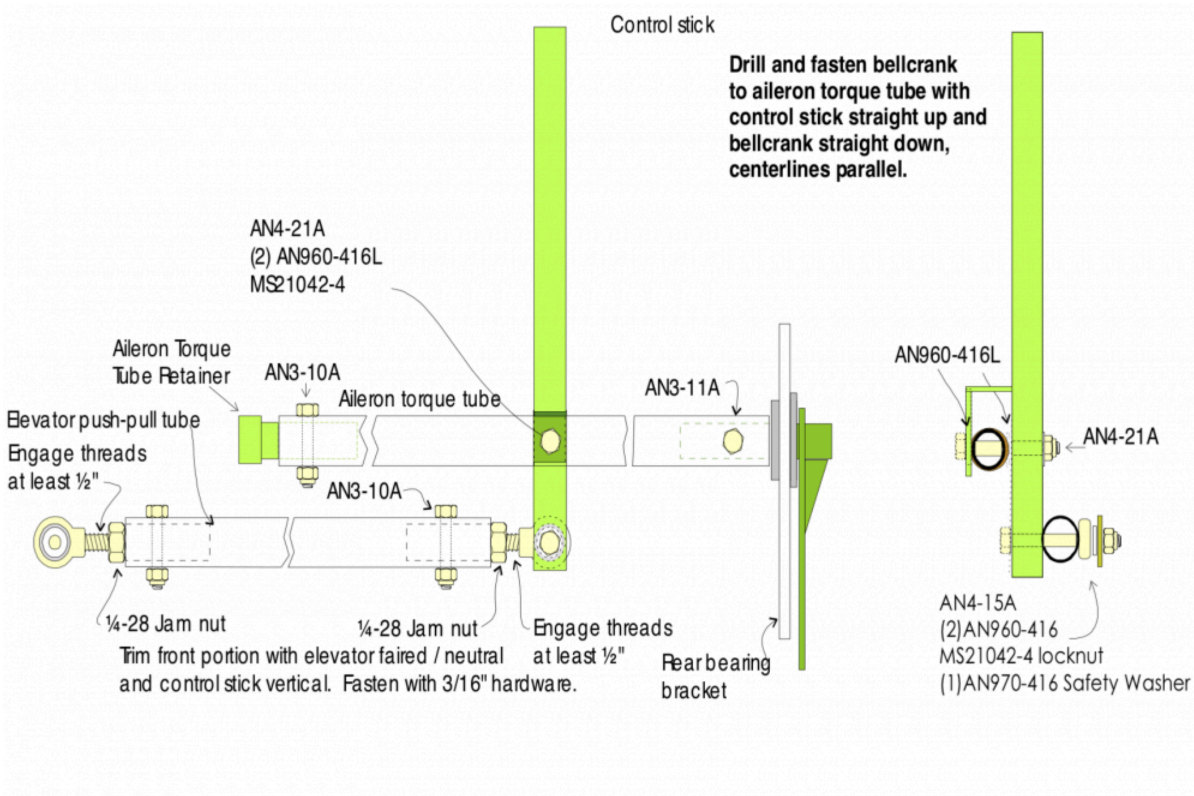


Figure 6-19. Control Stick Assembly

6.4.6 – Aileron Torque Tube Support

The aileron torque tube support, VATTS-01, gives support to the torque tube between the control stick and the mid-bearing support.

Slide the support under the torque tube approximately 2-1/2" behind the control stick and toward the pilot side of the keel. Insure that it will not interfere with the stick in any of its motions.

You should be able to see the outline of the bracket on the side of the keel. Shine a light from behind if needed. Drill two holes through the keel bracket with a #21 drill. Remove the bracket and tap the holes with a 10-32 tap. Reinstall the bracket and secure with (2) AN526C-1032R8 screws.

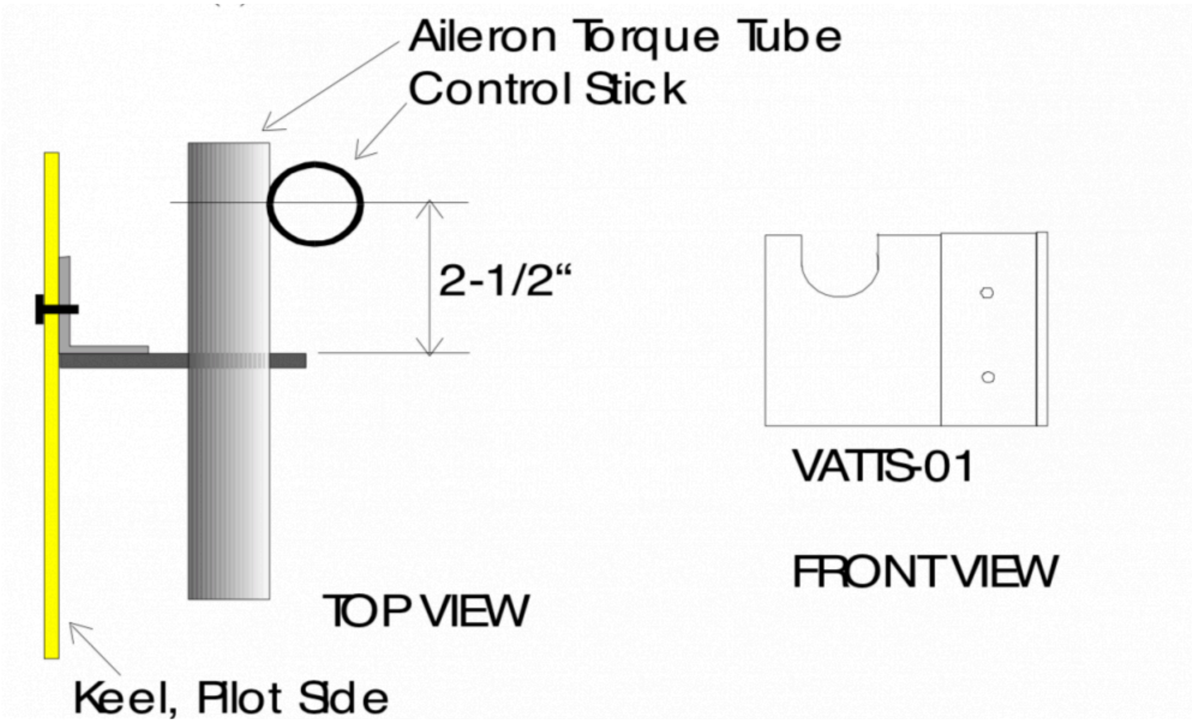


Figure 6-19xb. Aileron Torque Tube Support

6.4.7 – Keel Installation

Before permanently installing the keel make sure you have done the following:

- Make sure the nose gear has been prepared as described in chapter 7.
- Control system components have been installed in the keel.
- Canard bulkhead and keel have been checked for fit.

It has come to our attention from one of our builders that the hydraulic fluid from the gear system can seep into the foam through the skin if allowed to sit for a period of time. Before the keel is installed, the floor inside the keel area should be coated and sealed with epoxy to prevent this from happening. You can also coat the inside surface of the bottom cowling, floor of the nose section around the brake system, battery, hydraulic pump and plumbing, and any area that could be exposed to oil or hydraulic fluid.

Bond the keel in place using **Structural Adhesive** as shown in Chapter 4.

6.4.8 – Keel Stiffening Lay-ups

After the keel and canard bulkhead are installed, you need to do all of the reinforcing lay-ups.

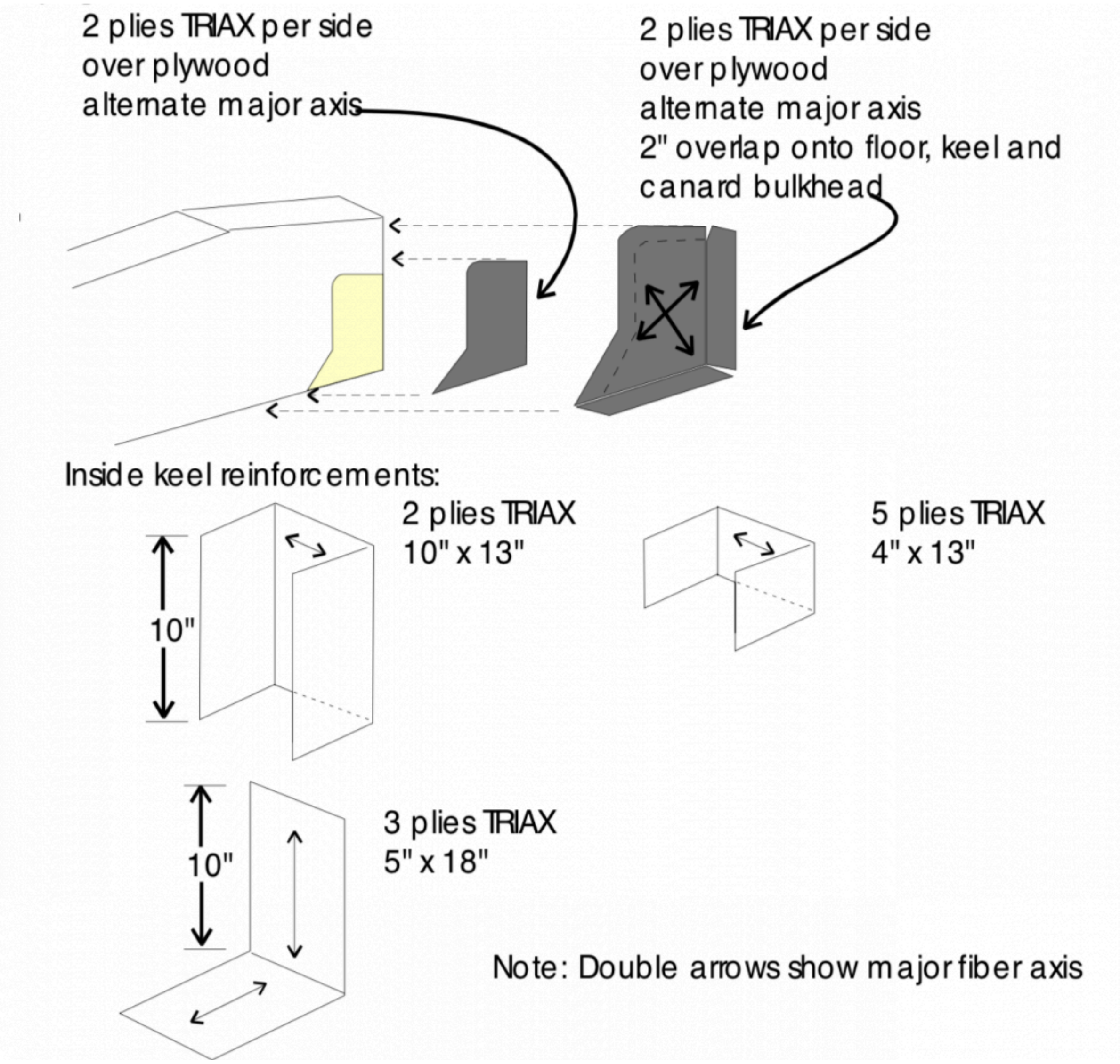


Figure 6-21. Keel Stiffening Lay-Ups

___ Install the **TRIAX** stiffeners as shown in the Figure 6-21.

___ Each side of the keel gets two small and two larger **TRIAX** layers. The last two plies lap onto the floor and canard bulkhead as well as lapping the wood stiffener.

___ The inside gets:

- Three 5” × 18” **TRIAX** from the floor up onto the canard bulkhead.
- Two 10” × 13” layers of **TRIAX** from one side of the keel onto the canard bulkhead, and onto the other side of the keel.
- Five layers of **TRIAX**, 4” × 13” centered 5” below the top bolt hole position.

Observe the major fiber orientation as shown in the diagram.

6.6. 6.5 – Speed Brake Actuator

6.5 – Speed Brake Actuator

6.5.1 – Installation

The positioning of the actuator and keel controls are interrelated. Now that you have installed your aileron torque tube you can install your speed brake actuator.

___ Center the actuator bracket (VAB-01 2” length) on the speed brake hardpoint.

___ Drill holes in the locations shown in Figure 6-22.

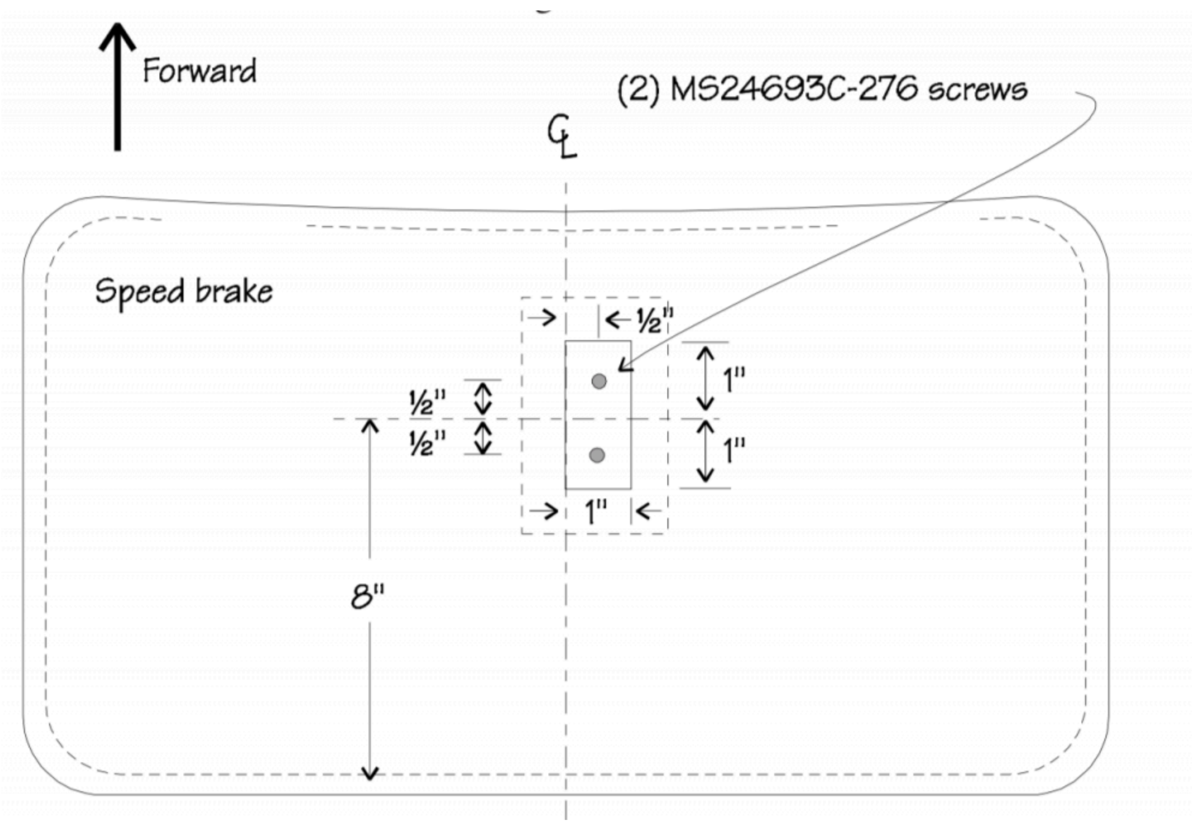


Figure 6-22. Speed Brake Actuator Hardpoint

___ Install the bracket with #10 × 1” flat head screws (MS24693C-276) and MS21047-3 nutplates. The nutplates should be attached to the bracket with 3/32 rivets (AAC-3-4).

___ Cut out a hole in the fuselage floor to clear the bracket with the speed brake closed.

___ Attach the actuator arm to the aluminum channel bracket with an AN4-14A bolt and MS 21042-4 nut. Put the top actuator bracket on the top of the actuator using the same hardware.

You will need to trim the bottom of the bracket as shown in Figure 6-23 to allow the actuator to move without binding. The sketch is merely approximate, so you may have to experiment just a bit for proper fit.

Quantitiy	Description	Part Number
1	Actuator, 6” speed brake	VSBA-01
1	Bottom actuator bracketat speed brake	VAB-01
1	Top Actuator bracket at keel	VAB-03
2	Screws	MS24693C-276
2	Screws	MS27039-1-07
2	Bolts	AN4-14A
2	Locknuts	MS21042-4
4	3/32 pop rivets	AAC-3-4
4	Nutplates	MS21047-3
?	Washers	AN960-416 Used as shims for the pivot bolts

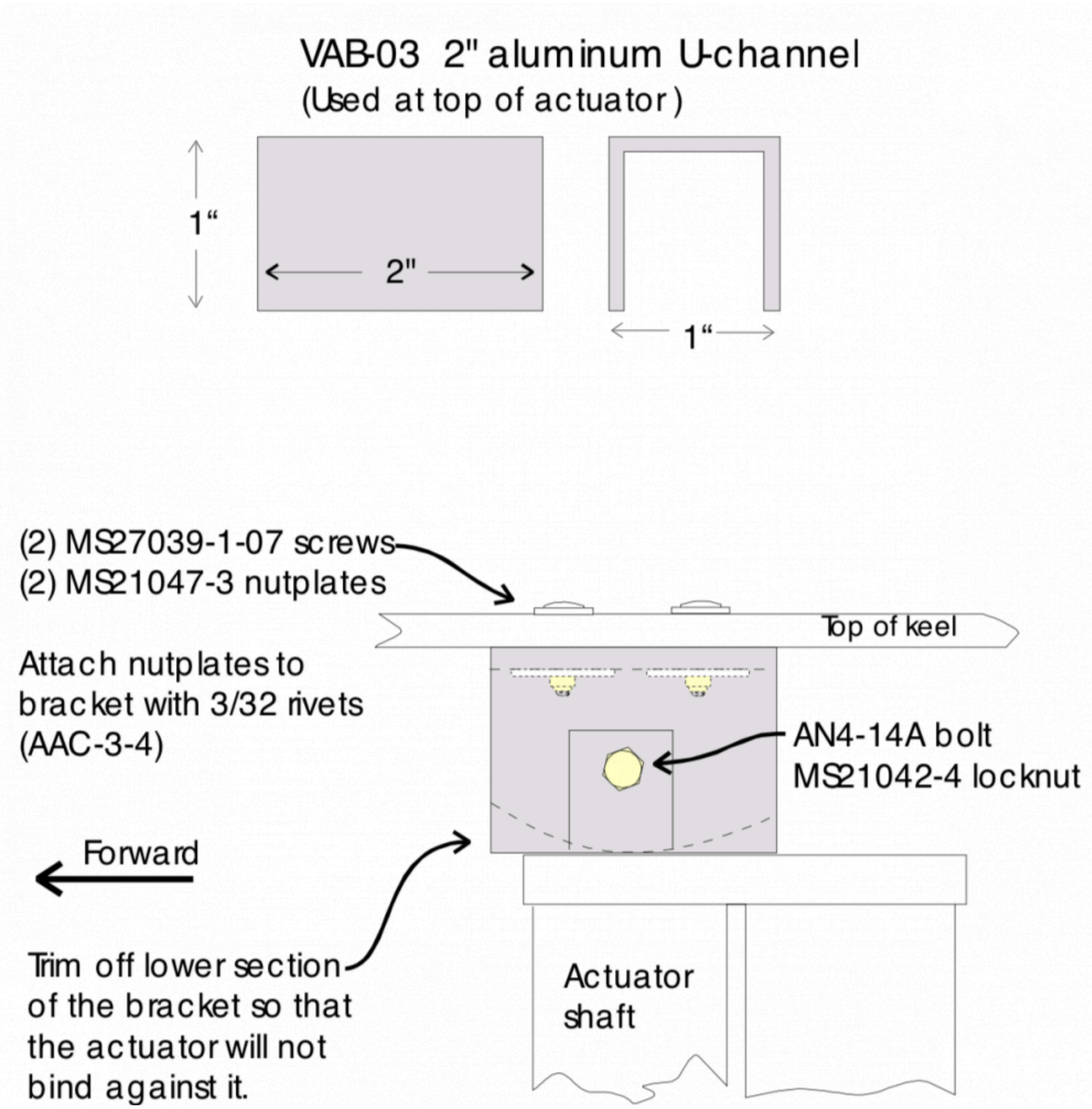


Figure 6-23. Upper Speed Brake Actuator Detail

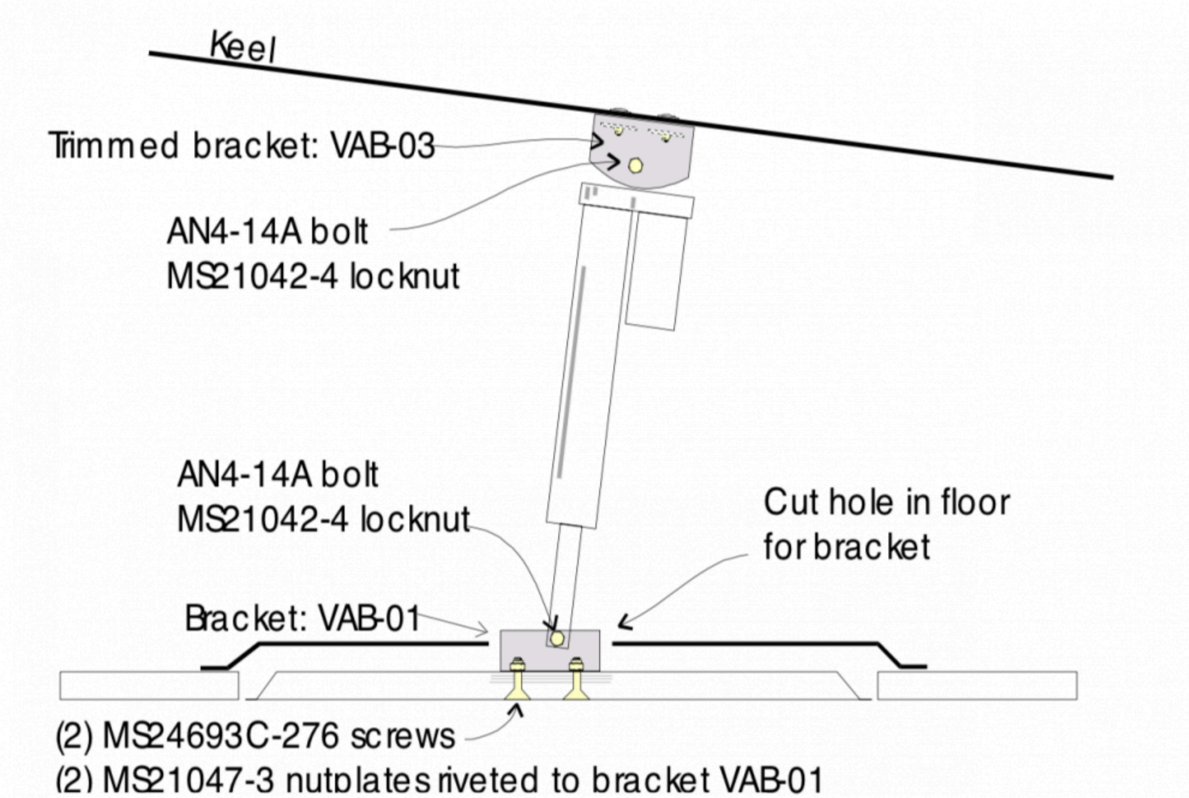


Figure 6-24. Speed Brake Actuator Installation

___ Fit the actuator inside the rear of the keel and hold the upper bracket up against the inside upper skin of keel. Drill down through the keel top and bracket.

___ Bolt the bracket into place with (2) MS27039-1-07 screws and (2) MS21047-3 nutplates. The nutplates are installed with 3/32 rivets.

___ Check the speed brake for operation by connecting the actuator leads to a battery. Reverse leads to reverse action. Make sure that the brake closes completely.

6.7. 6.6 – Forward Fuselage Treatments

6.6 – Forward Fuselage Treatments

6.6.1 – Nose Access Cover

This cover is a molded part, p/n VMAP-01.

The flange recess is molded into the fuselage top.

___ On the fuselage top, mark a line around the perimeter of the hole, 5/8” inside the edge of the molded recessand cut to this line. This will become the flange for the cover.

___ Drill countersunk holes for #10 screws at the four corners of the cover, through the lip, and install 10-32 nutplates with 3/32” pop rivets.

___ Install the cover with (4) MS24693C-272 screws.

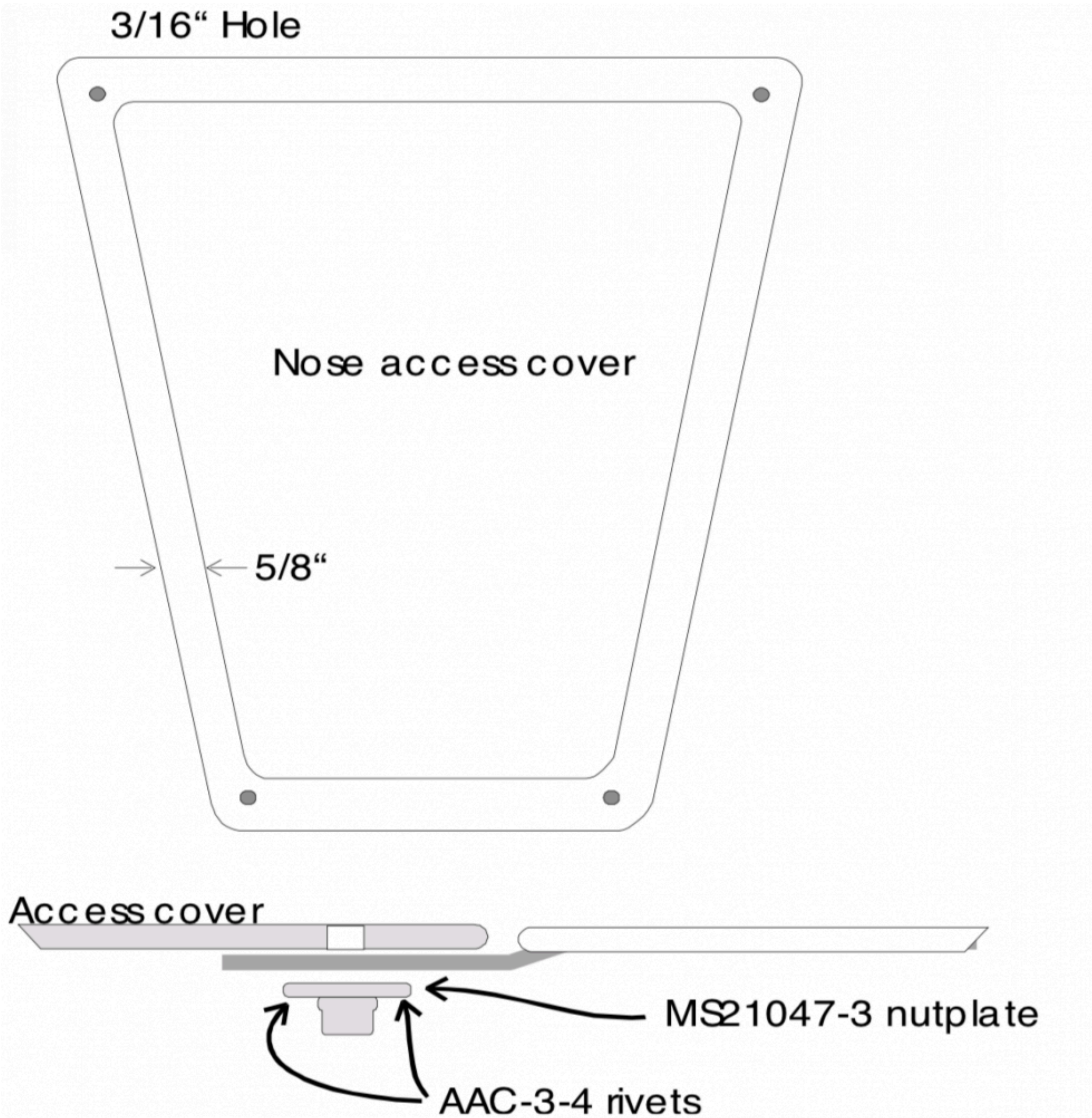


Figure 6-25. Upper Fuselage Reinforcement for Canard Installation

6.8. 6.7 – Pedal System / Brake Cylinders

6.7 – Pedal System / Brake Cylinders

	Rubber Pedal / Brake Cylinder Inst allat ion Hardware List	
Qty	**Description**	**Part Number**
2	Master Brake Cylinder	VMBC-01
1	Brake and Rudder Pedal Assembly	VBRPA-02
4	Brake and Rudder Pedal	VBRP-01
1	Brake Pedal Mount, Left	VBML-01
1	Brake Pedal Mount, Right	VBMR-01
2	Brake Push Tube	VBPT-01
2	Brake Pedal Push Block	VBPB-01
2	Roll Pin, 1/8” × 1”, Brake Push Tube	VPTRP-01
2	Fitting, 1/8”, brake line	VFBL-01
4	Bolt	AN3-7A
5	Bolt	AN3-10A
1	Bolt	AN3-11A
4	Bolt	AN5-10A
4	Washers-Thin	AN960-516L
4	Locknuts	MS21083N5
14	Washers-Thin	AN960-10L
14	Locknuts	MS21042-3
	1/4” Drill Bit	
	1/8” Drill Bit	
	3/16” Drill Bit	
	1-1/2” Hole Saw	

6.7.1 – Mount Master Cylinders

___ Measure and mark horizontal and vertical centerlines on the molded brake box on the front face of the canard bulkhead (when finding the vertical centerline, do not include the portion that is angled in your measurements – just use the portion that is parallel to the bulkhead face).

___ Drill two 1-1/2” holes, centered 1/2” above the horizontal centerline and 2-1/4” out from the vertical centerline. Using the master cylinder as a guide, drill four 5/16” holes for mounting. See Figure 6-26.

___ Mount the master cylinders with (4) AN4-10A bolts, (4) AN960-516L washers, and (4) MS21083N5 nuts.

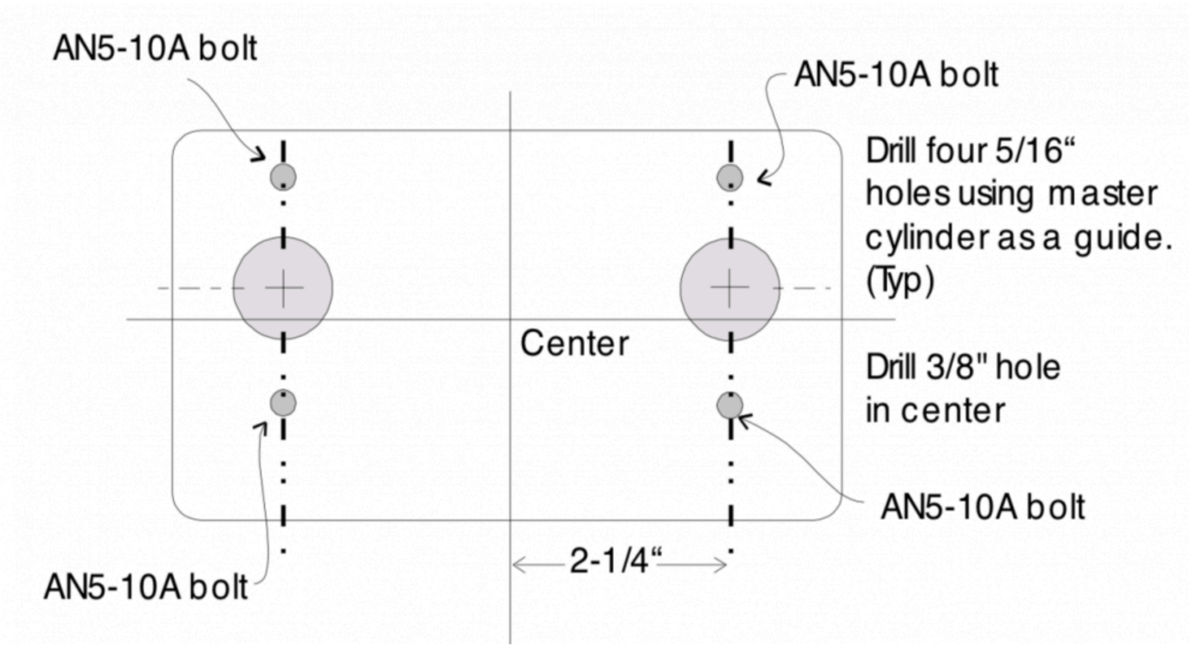


Figure 6-26. Master Cylinder Mounting Locations on Brake Box

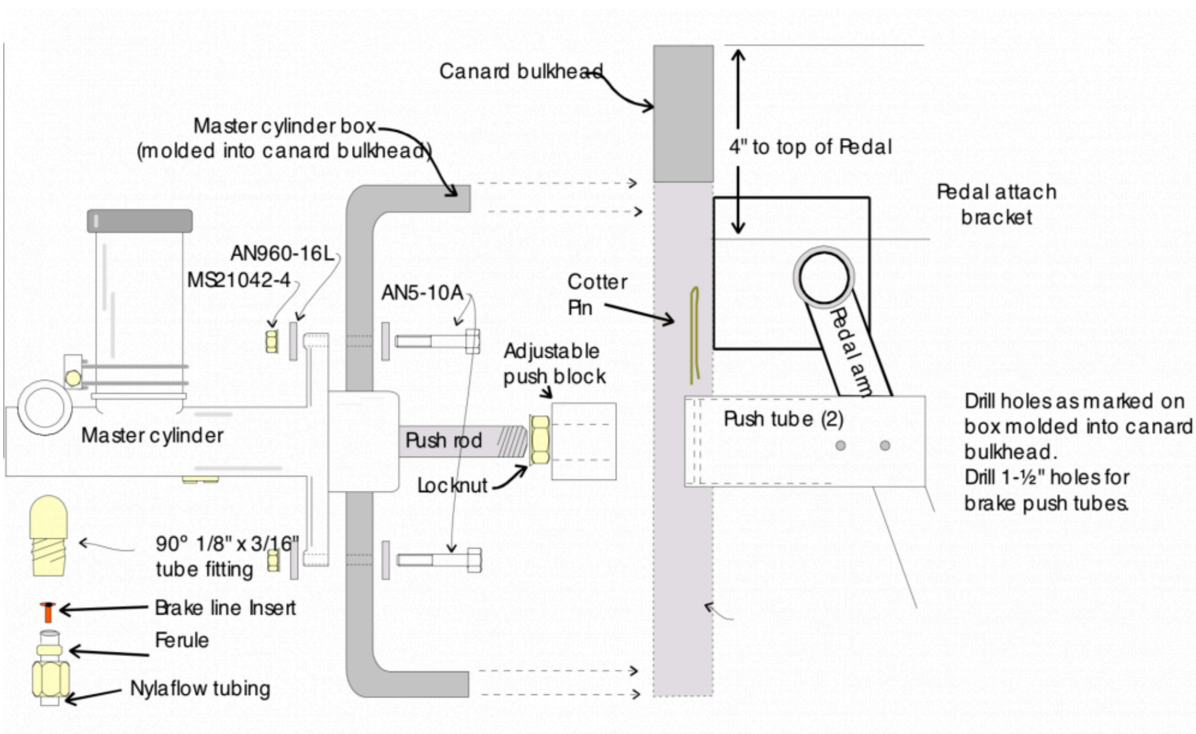


Figure 6-27. Brake Master Cylinder Assembly

6.7.2 – Assemble Rudder Pedals

___ Install the pedals into pedal arms with (4) AN3-7A bolts, (4) AN960-10L washers, and (4) MS21042-3 nuts. Multiple holes can be drilled in pedals for adjustment.

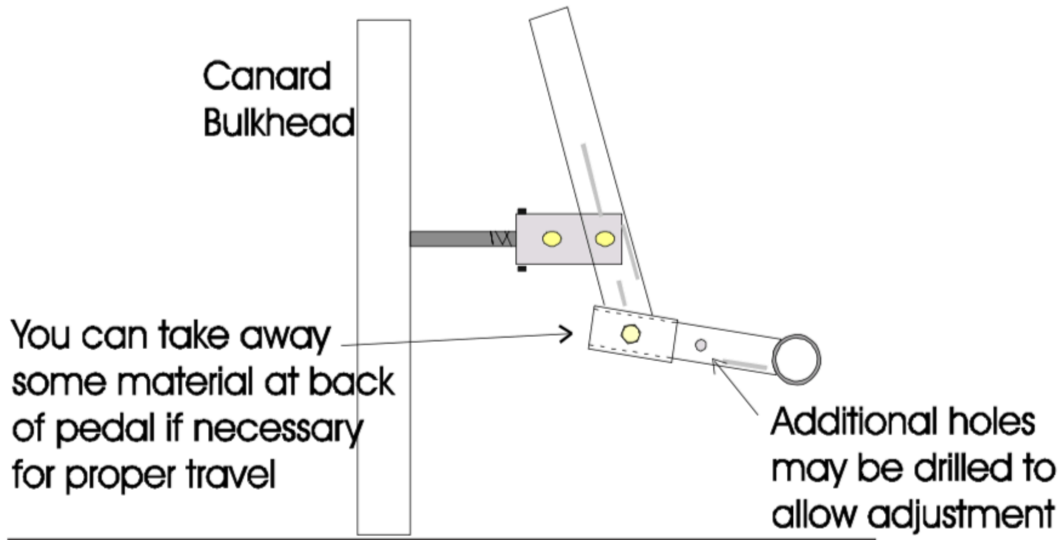


Figure 6-28. Rudder Pedal to Pedal Arm Assembly

___ Install push tube and push tube stop bolts to the pilot's pedal arms with (4) AN3-10A bolts, (4) AN960-10L washers, and (4) MS21042-3 nuts.

___ Install rudder actuator arms to assembly using (1) AN3-11A bolt on pilot's side, (1) AN3-10A bolt on the co-pilot's side, (2) AN960-10L washers, and (2) MS20142-3 nuts. Make sure to put the mounting blocks on each side first.

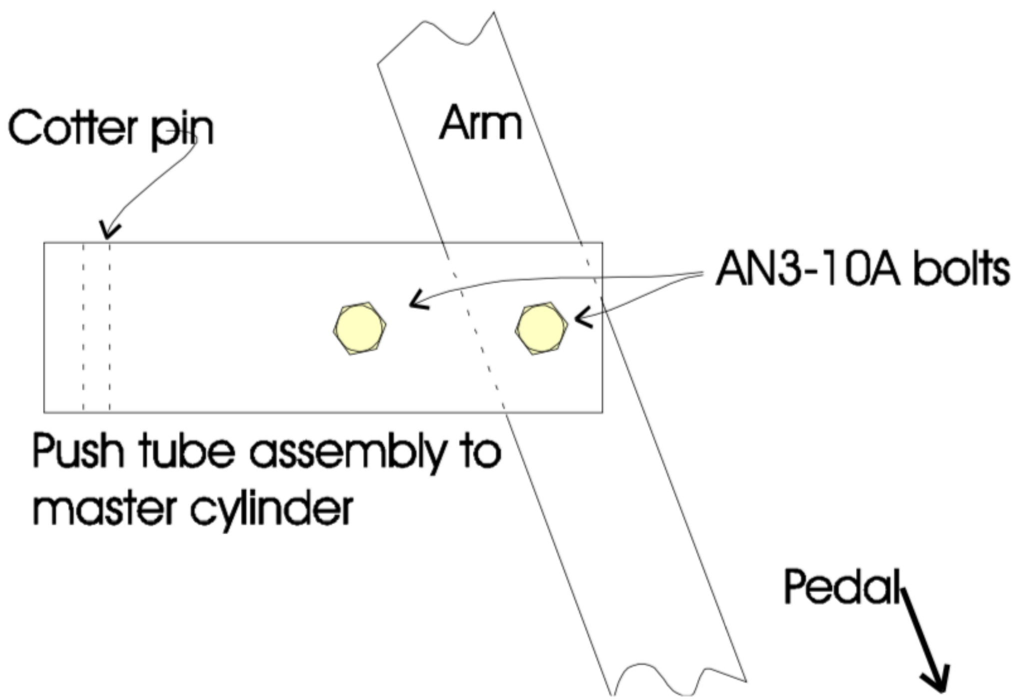


Figure 6-29. Brake Push Tube to Pedal Arm Attachment

6.7.3 – Mount Pedals

___ Position the rudder and brake pedal assembly centered against the bulkhead approximately 4" below the top of the canard bulkhead, or spaced just above the keel.

___ Drill #21 pilot holes through the bulkhead using the attach brackets as a guide. Remove these brackets and tap them with a 10-32 tap. You don't have to tap the whole block, but you need enough threads to fully engage your bolts. Enlarge the holes in the bulkhead to 3/16". Install the assembly with (4) AN3-11A bolts.

___ Install two 1/8", 90 degree fittings (use Permatex #2), and brake lines as shown if figure 6-27. Run the brake lines down the pilot's side duct, exiting the duct under the gear in front of the firewall, and leading down the appropriate gear leg.

Do not make these lines too short! Length should be approximately 15' right and 12' left. This will allow you to remove the gear leg. The adjustments of the push block and the installation of the lock nut will be done when the brakes are installed and the fluid is added.

Do not use anything but Dot 5 brake fluid. Aircraft brake fluid will ruin the Toyota master cylinders and automotive brake fluid will mess up the aircraft brakes. DOT 5 brake fluid is the only type you can use.

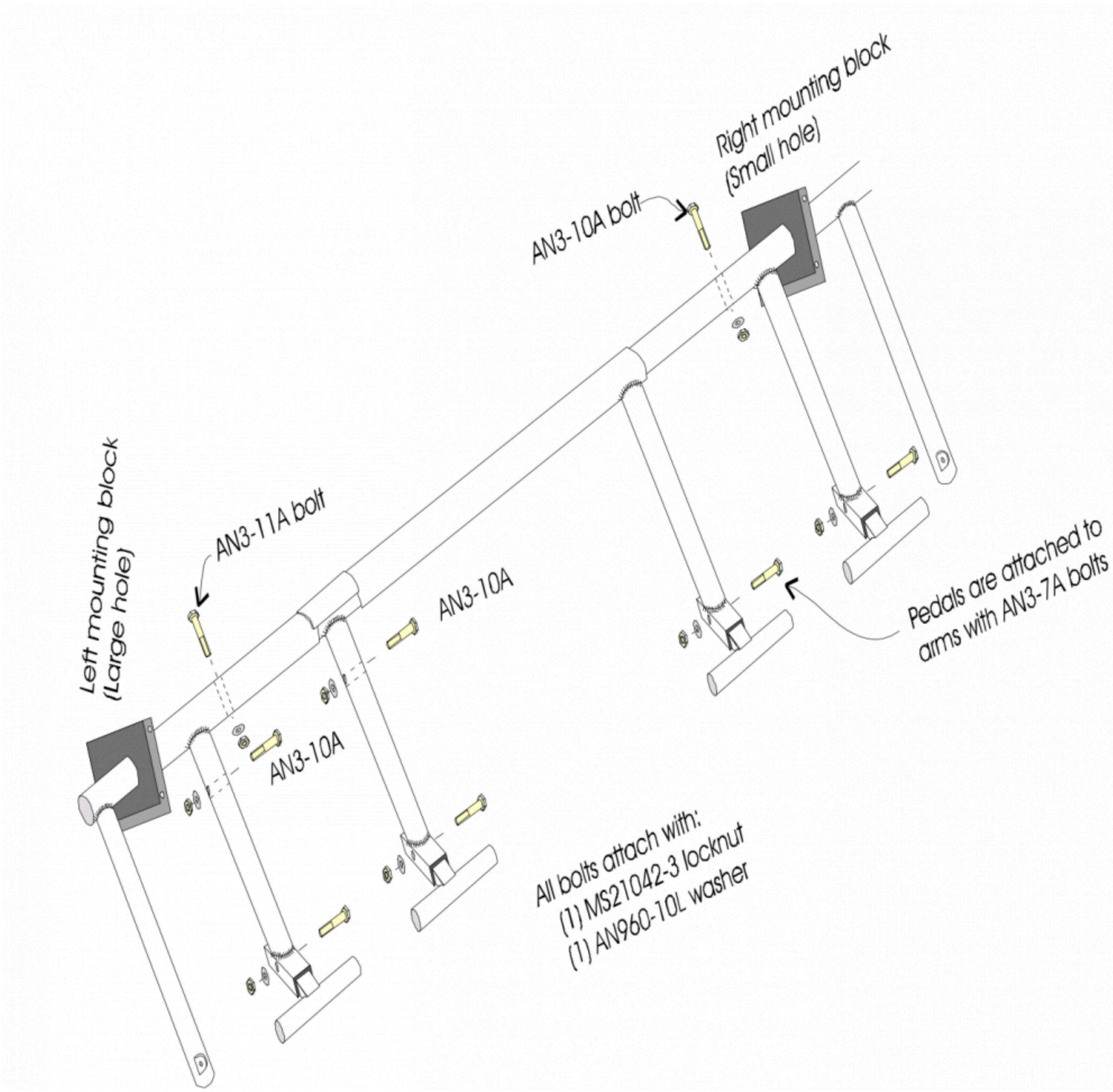


Figure 6-30. Rudder / Brake Pedal Assembly

6.7.4 – Install Nylaflow Tubing for Rudder Cables

___ Drill a 3/16” hole through the firewall 5” from each side, just below the center section spar. Also drill a 3/16” hole through the gear bulkhead just inboard of the transverse bulkhead, 8” above the duct.

___ Cut two lengths of the 3/16” Nylaflow tubing provided, to run from the back of the firewall (protruding slightly) to within 6” of the canard bulkhead. Route the tubing with a smooth curve, with the forward end at the same height as the cable attach point on the rudder pedal arm. The tubing will have to pass through the bottoms of both carbon beams at the door.

Hot Glue the tubing to the fuselage sides. Using one layer of **BID** glass the tubing in place the entire length except for the last 6 inches on each end.

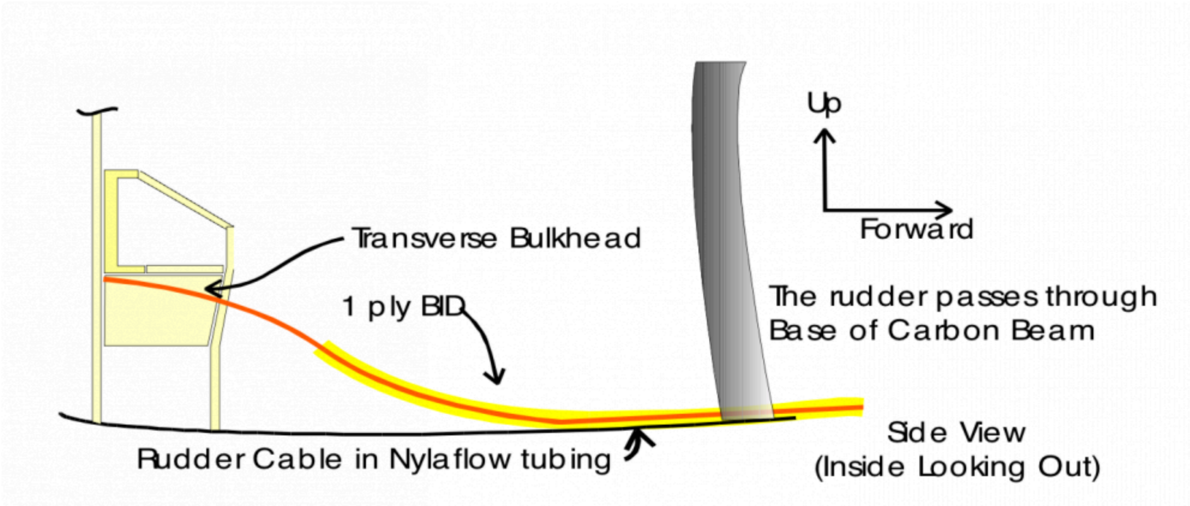


Figure 6-31. Rudder Cable Fuselage Conduit

6.9. 6.8 – Instrument Panel

6.8 – Instrument Panel

6.8.1 – Locate Panel

The instrument panel aft face (in front of the pilot) is located 21” aft of the canard bulkhead face. (Aircraft with a Yoke installation have a different dimension for the panel. Refer to you Control System Chapter.) The bottom flat horizontal part of the panel should be 17” off the floor on each side and level. You will need to trim the center of the panel to obtain this.

6.8.2 – Install Panel

The instrument panel is installed so that you may remove it in the future for maintenance if needed. After the panel has been trimmed to fit duct tape the outside back edges where the panel meets the fuselage and the bottom where the panel meets the keel. Install the panel using hot glue or Bondo in the position you want it. Lay-up 5 layers of **BID** 4 inches wide down each side of the panel so that 2 inches are on both the fuselage and the panel. Lay up 5 **BID** 4”x4” patch between the top of the keel and the panel. After this glass has cured and before removing the panel mark and drill the panel for screws to hold it in. Lay out your pattern so the screws are equally space and you are far enough in from the fuselage to use a screwdriver to remove them. Also make sure that you are on the flange that you just made and that you leave enough room for nutplates. After you have drilled you holes you can remove the panel. Trim the flanges to give them a smooth edge.

- Many builders make a small removable insert in there panel for there throttle mixture and prop controls. This allows these controls to stay in the airplane if the panel is removed. After you have trimmed and fit your panel layout where you will want your throttle mixture and prop to go . Draw two cut lines around your control locations. Keep in mind that there are large nuts to hold these cables in and leave enough room for them. Cut out the bottom pilots side of the panel along your lines. Duct tape the back of the instrument panel along your cut out. Lay your instrument panel flat on a table and hot glue back in the piece you just removed. Make sure that the front of the panel and the cutout are flat against the table. Now you can lay up a 5 **BID** flange from the back of the panel onto the duct tape. Mark out your screw locations and drill before separating the pieces.

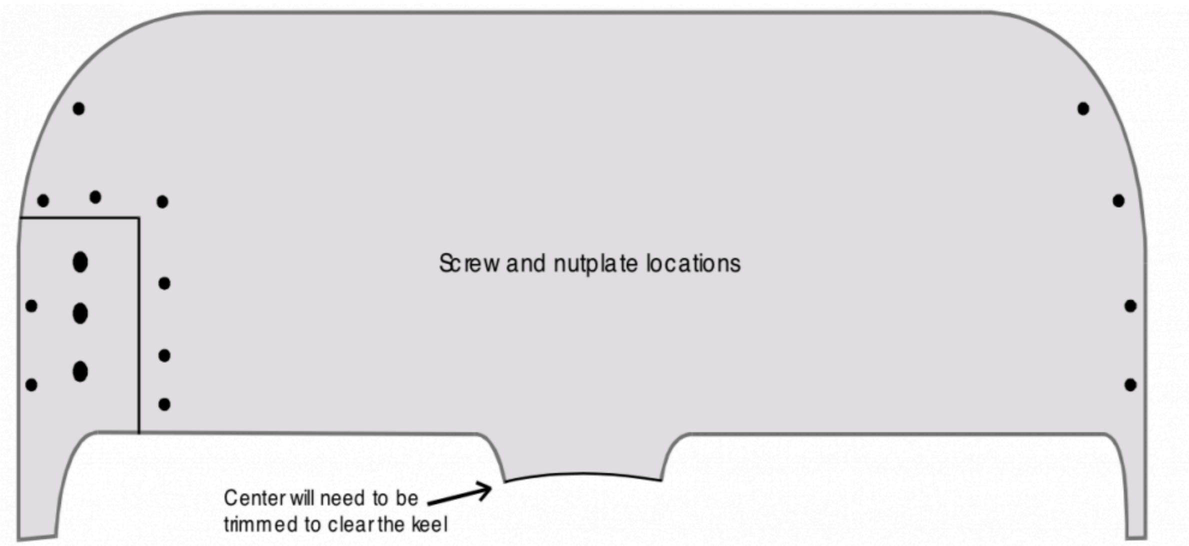


Figure 6-32. Instrument Panel / Keel Joint

6.10. 6.9 – Installing Main Spar

6.9 – Installing Main Spar

6.9.1 – Spar Positioning

___ Level the fuselage fore and aft and side to side along the premolded gear pockets. Cut out a 3” wide hole 10-1/2” high from the top of the premolded gear pockets up right against the firewall.

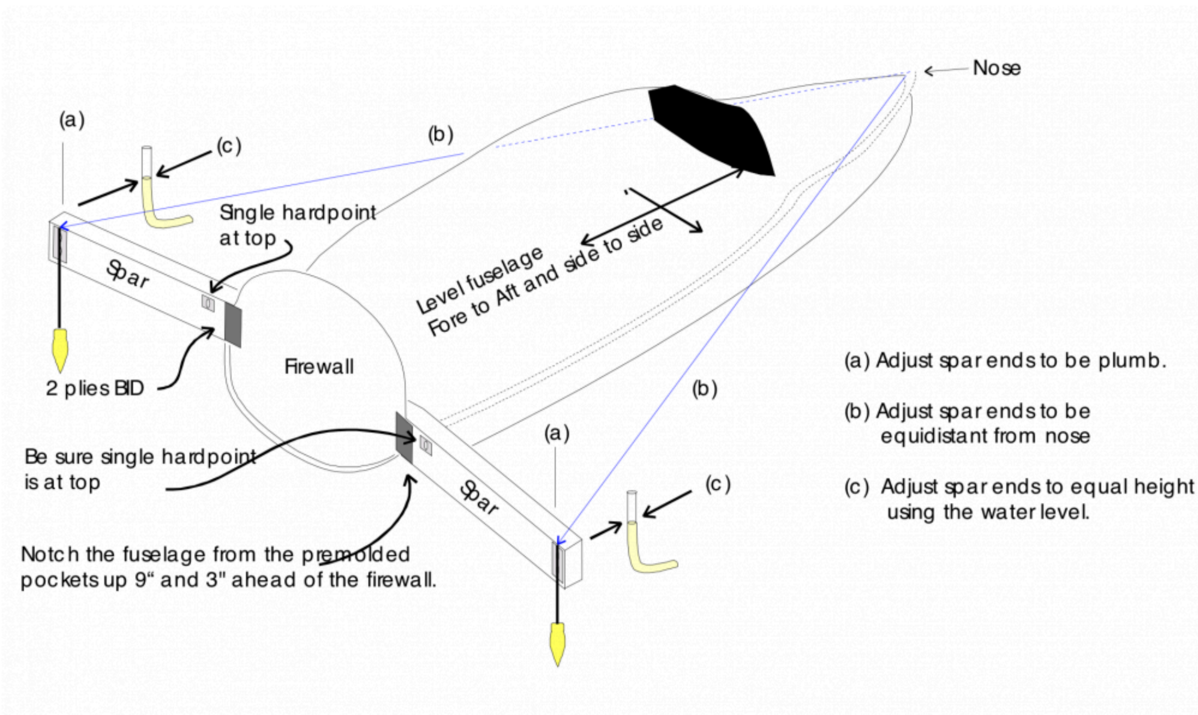


Figure 6-33. Aligning Spar for Installation

___ Center the spar in place with the inboard single hardpoint **up top**.

___ Using a marker draw a line where the spar meets the firewall top and bottom. Also mark where the back of the spar meets the firewall.

___ Sand 2” above the top line and 2” below the bottom line. Sand the top of the premolded gear pockets. Sand the bottom of the spar where it will sit on the gear pockets. Sand the top and bottom spar cap where it will meet the firewall. Sand the back of the spar about 4” inside the lines you drew on it earlier.

6.9.2 – Spar Installation

___ Before installing the spar you must notch out the firewall. Cut a 2” x 10-1/2” notch, making it even with the bottom of the spar cutout in the fuselage.

___ On the front side of the firewall mark a line 1” inboard of the notch. Chamfer the wood from this line to the edge of the notch as needed to allow the spar to set against the firewall. You may need to chamfer more than 1” of material to allow the spar to lay flat against the firewall. Sand 2” in from your cutout of the firewall side.

Make sure your fuselage is level fore and aft and left to right before installing. Put the spar in place with the center of spar aligned with the fuselage centerline.

___ **Spar plumb:** With a level on the outboard hard points, shim the spar to be plumb. If they differ, split the difference. See Figure 6-33 (a).

___ **Spar sweep:** Adjust the spar ends to have the same distance from the nose bolt hole to the plumbed level on the outboard hard points. Be consistent with your measuring reference points at each end. Slip bolts into the outboard hardpoints to use as a guide. See Figure 6-33 (b).

___ **Spar level:** Use the water level to set the spar ends at the same height. Do a dry run first with your spar to see how it will fit. Find out where you may need shims so when you go to bond in the spar it will go smoothly.

___ You will need to mix up about 1 cup on **Structural Adhesive** with **Flox** in order to bond in the spar.

Spread a bed of **Structural Adhesive** on top of the gear pockets where the spar will go. On the back side of the spar spread **Structural Adhesive** 3” in from the lines you drew earlier. Now, with some help reinstall the spar. Re-level the spar as you did above. When satisfied with the level of the spar leave it alone until it cures.

6.9.3 – Lay-ups

Note: Don’t forget to sand before applying your lay-ups. BID is always cut on a 45 degree bias. Unless noted, TRIAX major axis is on the long dimension. Pre-wet multiple layers of TRIAX on plastic. Precutting the plies called for in this chapter will make your work go much easier.

___ **Micro Glass** a radius along the firewall to spar line. Apply two plies of 3” × 47” piece of **BID** along the engine bulkhead to spar line, top and bottom Figure 6-34.

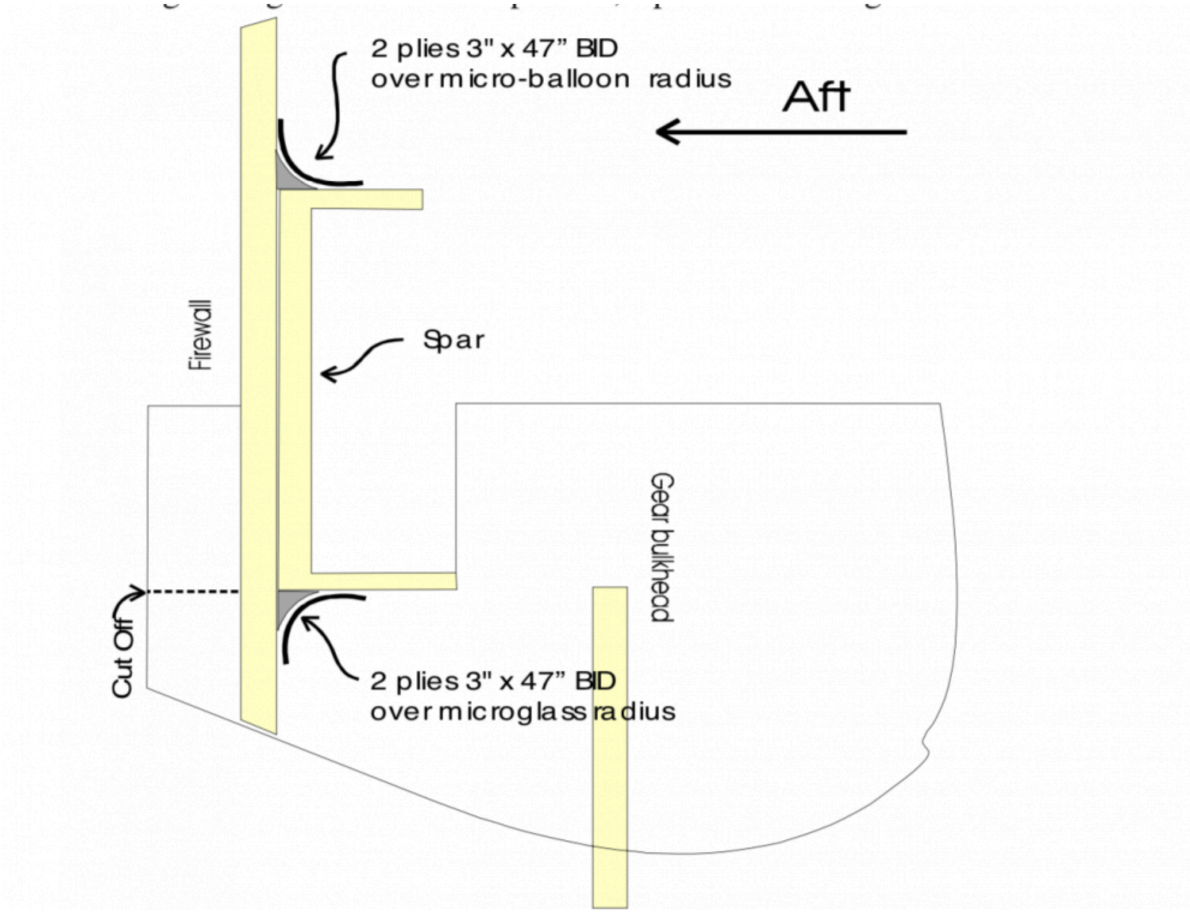


Figure 6-34x. Spar to Firewall Joint

___ Apply two plies of 3” × 10-1/2” **BID**, lapping the aft sides of the firewall and spar. Figure 6-35. Cut off fuselage behind firewall even with bottom of spar.

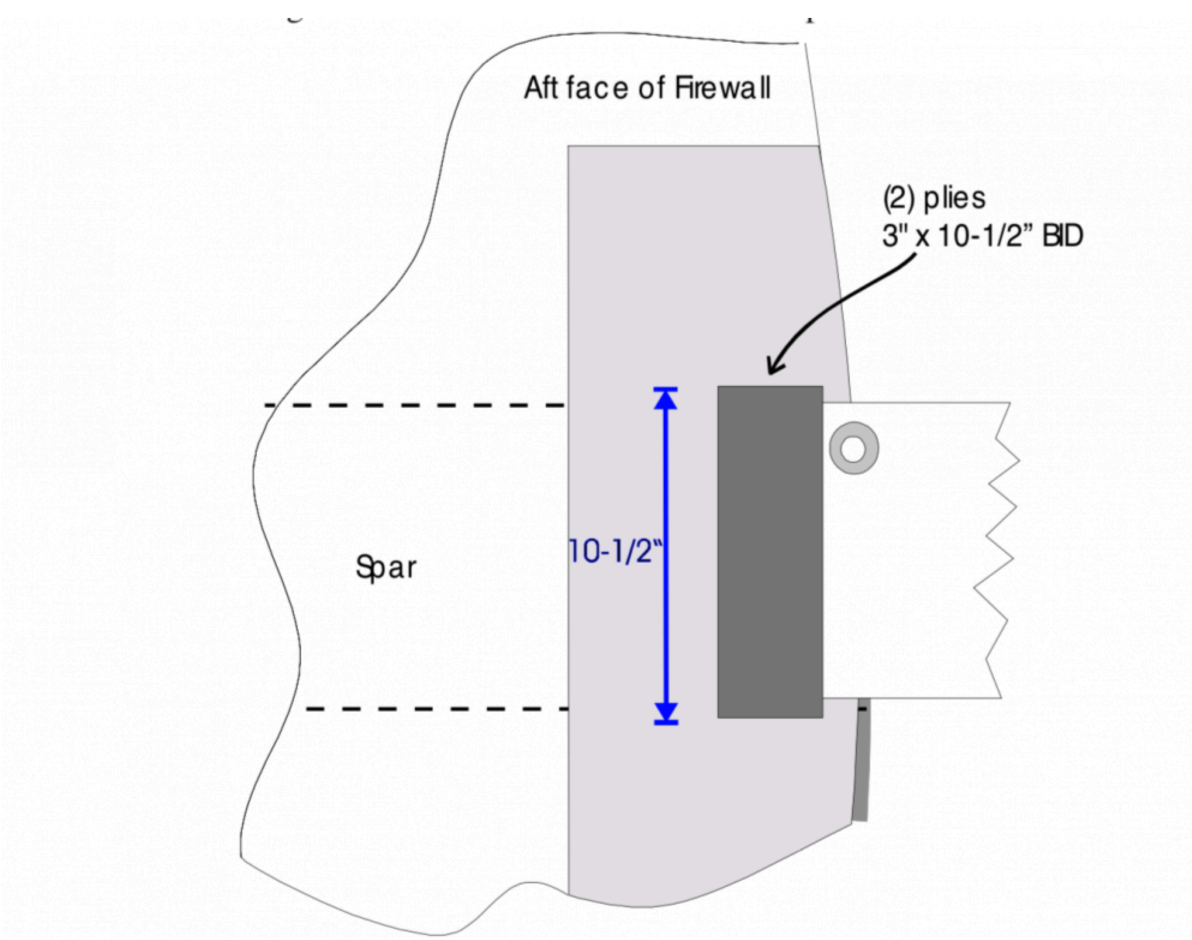


Figure 6-35x. Aft Spar to Firewall Reinforcement

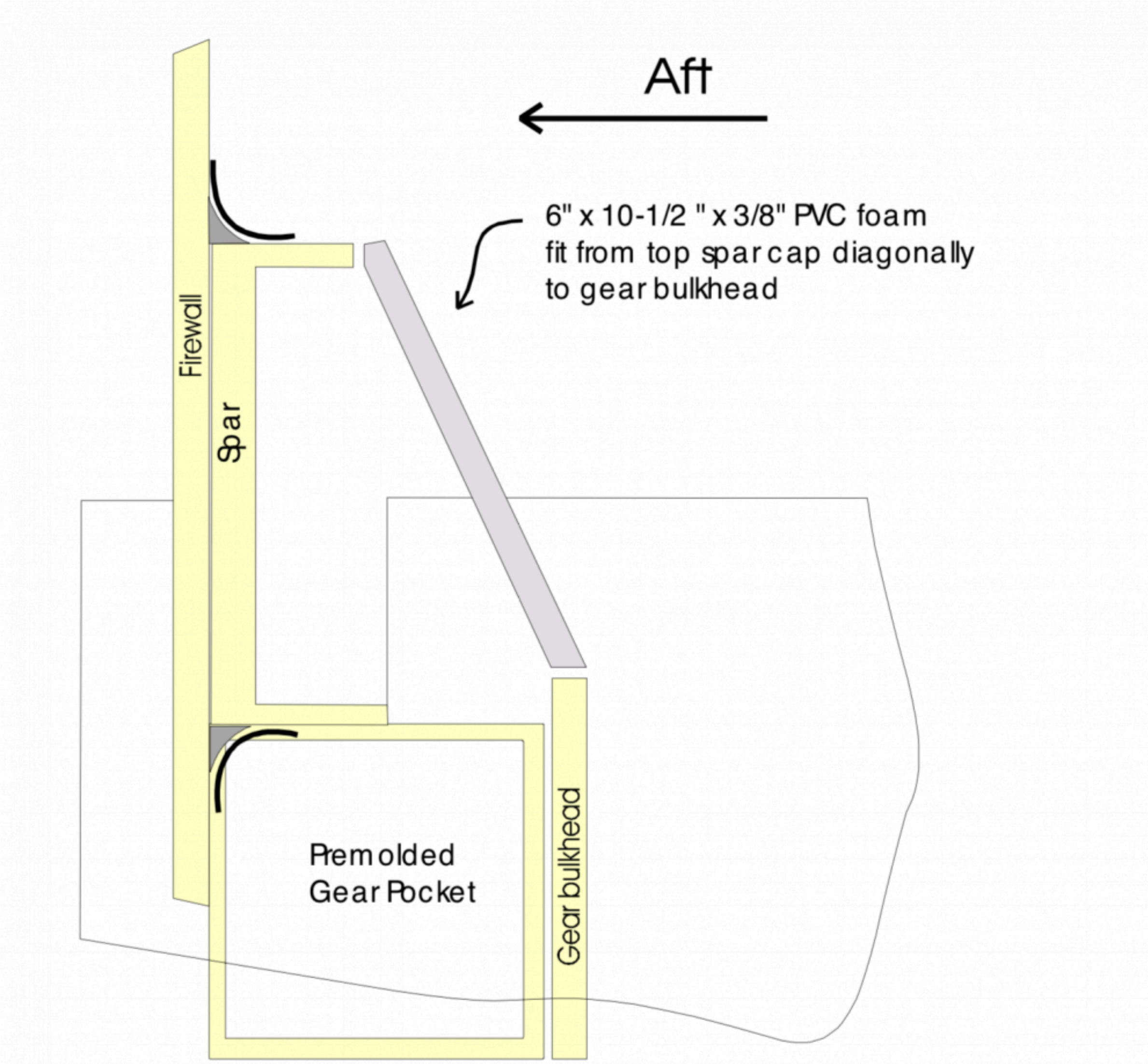


Figure 6-36xf. Foam Inserts for Main Gearbox Firewall Reinforcements

___ Cut two pieces, one for each side, of 3/8" dyvinicel foam, 6-1/4" wide by about 9" to fit between the top forward edge of the spar cap angling down onto the gear bulkhead. Taper these pieces to fit. See Figure 6-36.

6.9.4 – TRIAX Reinforcements

The section of the airplane that takes the most regular abuse is the section from the gear bulkhead back to and including the firewall. These sections need to be reinforced to be very durable. This is done with **TRIAX**. The cutting schedule below is enough **TRIAX** to do all of these lay-ups. They all can be wet out on visqueen and allowed to get tacky (about 1-2 hours depending on temperature and humidity) Beforehand. Peel ply will help to keep the **TRIAX** from draining once installed.

Quantity	Size	Location
4	7" × 8"	Spar/Slant Bulkhead
4	7" × 25"	Spar/Slant Bulkhead/Gear Bulkhead

4	7” × 35”	Spar/Slant Bulkhead/Gear Bulkhead
8	6” × 18”	Side Reinforcements Top of Spar
8	9” × 22”	Firewall/Fuselage/Gear Bulkhead
4	4” × 12”	Gear Bolt Hole
4	6” × 8”	Top Center
6	5” × 5”	Continental Engine Side at Lower Engine Mount
12	5” × 12”	Continental Fuselage Side Lower Mount Reinforcement to Fuselage

___ Cut 4 plies, 2 for each side, of 7” × 8” **TRIAX** and apply to the top of the spar and up the firewall. See Figure 6-37.

___ Cut 4 plies, 2 for each side, of 7” × 25” **TRIAX** and apply to the firewall about 7-1/2” above the spar, across the top of the spar, down the angled foam and onto the gear bulkhead about 2”. See Figure 6-37.

___ Cut 4 plies, 2 for each side, of 7” × 35” **TRIAX** and apply over the previous lay-up and on down to the fuselage floor. See Figure 6-37.

___ Cut 4 plies, 2 for each side, of 4” × 12” **TRIAX** and apply, crossed, over the gear bolt hole area on the gear bulkhead, one lapping onto the fuselage side and one lapping onto the conduit and floor. See Figure 6-39.

___ Cut 4 plies, 2 for each side, of 4” wide **BID**. Install from top of slant bulkhead down to the gear bulkhead. This attaches the slant bulkhead to the fuselage. It can be installed before or after the **TRIAX**.

___ Cut 8 plies, 4 for each side, of 9” × 22” **TRIAX** and apply over the gear bolt hole locations in the firewall and gear bulkheads just above the ducts, lapping onto the side of the fuselage above the ducts. See Figure 6-37.

The last lay-up is **four** plies of **BID** that extends from the underside of the top spar ledge, down across the inside surface of the angled piece, onto the gear bulkhead, and across the top of the horizontal bulkhead onto the lower spar ledge. It also laps around about 1” onto the transverse bulkhead. See Figure 6-37.

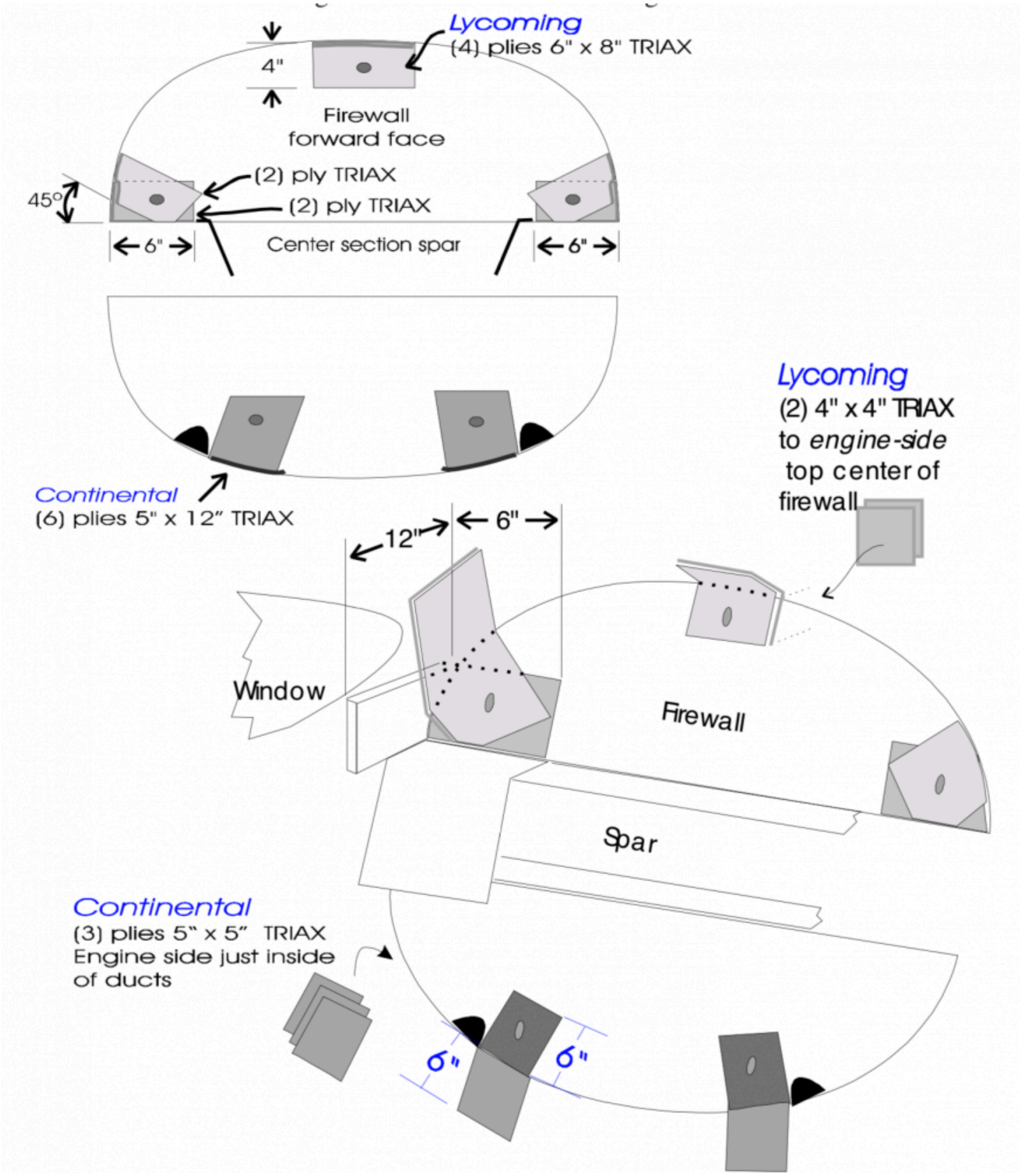


Figure 6-37xf. Upper Spar to Bulkhead Ties

___ Cut eight 6” × 18” . Pre-wet these out on plastic in sets of two. Starting above the spar lay 6” onto the firewall and 12” onto the fuselage. One set of the two will pass below the window while the other will go above the window. Refer to figure 6-38.

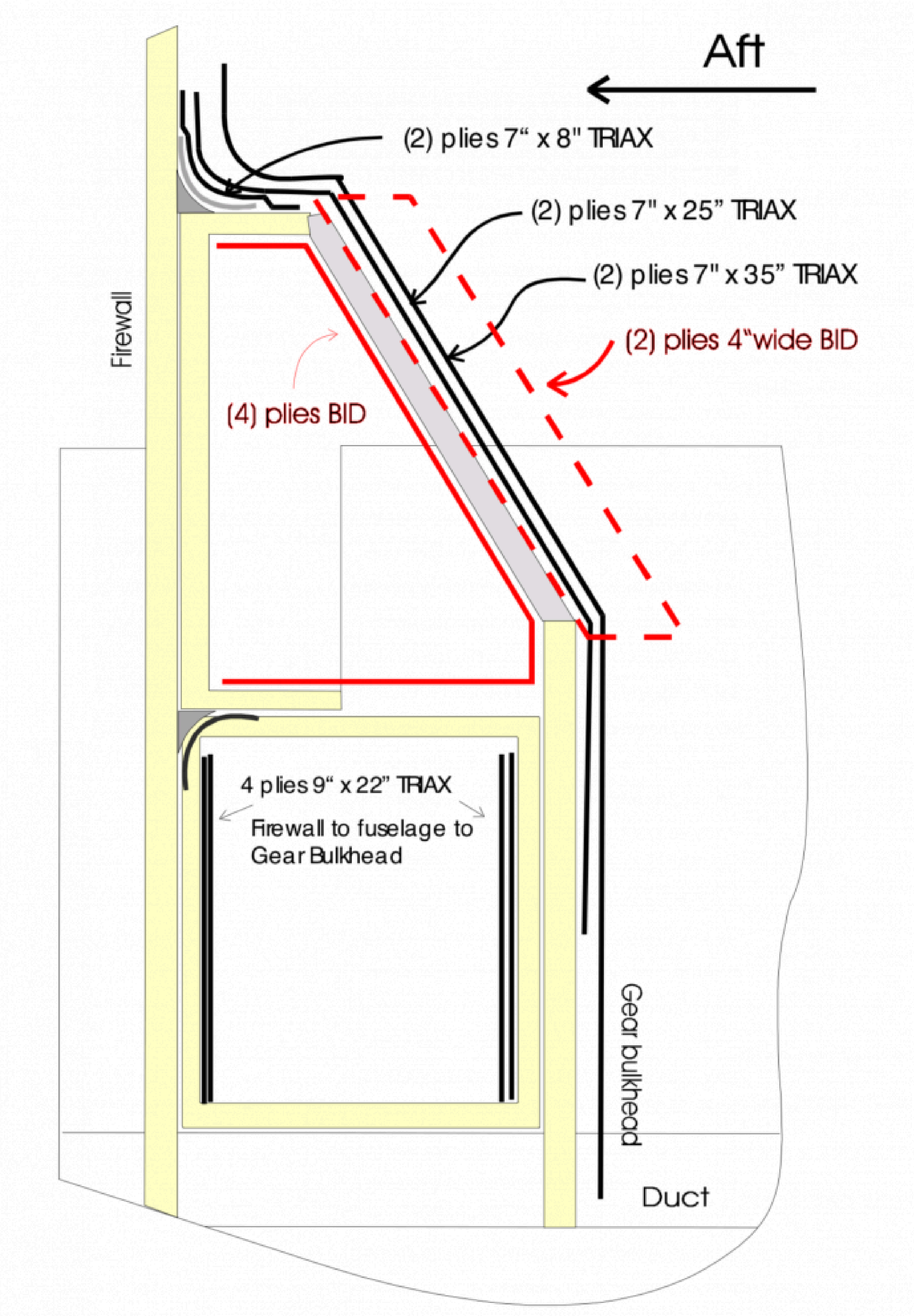


Figure 6-38x. Firewall Reinforcements

___ For a **Lycoming IO-540** installation cut four 6" × 8" pieces of **TRIAX**, axis lengthwise install them on the top of the firewall as shown in figure 10-38. Also apply two 4" × 4" plies of **TRIAX** on the aft side top center of the firewall (opposite the lay-up on the front).

___ For a **Continental IO-550** installation cut 12 pieces of 5” x 12” **TRIAX**. 6 plies each side is installed just inboard of the wiring ducts so that 6” is on the firewall and 6” is on the fuselage floor. Also apply three 5” x 5” plies of **TRIAX** on the engine side just inboard of the wiring duct.

All these pieces serve to tie the firewall and upper fuselage together and reinforce the upper engine mounting points.

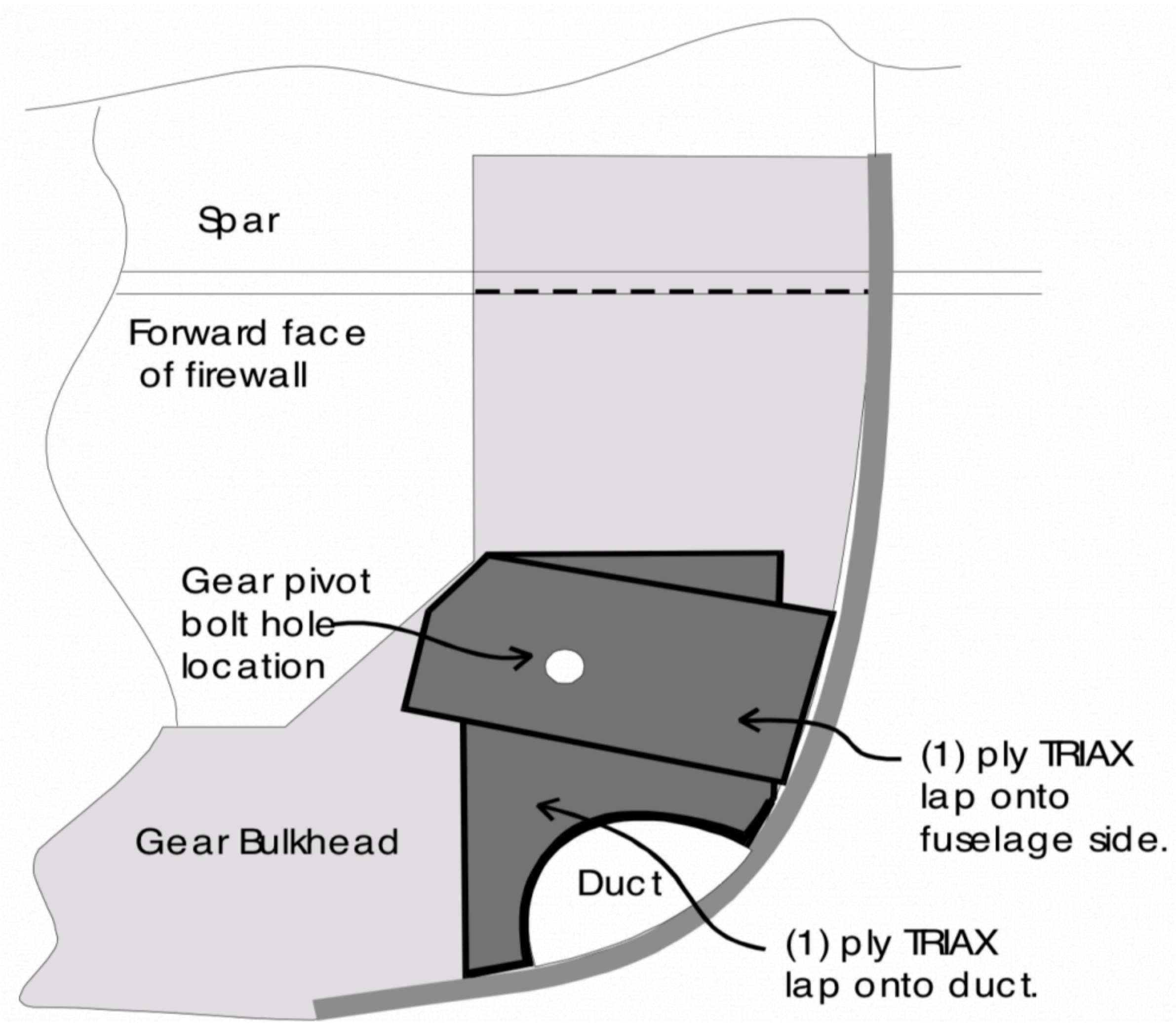


Figure 6-39. Main Gear Bolt Hole Pad

|___| Make sure you have not forgotten the 7” x 39” one ply **TRIAX** reinforcement on the fuselage floor between the firewall and gear bulkhead. See Chapter 4.

|___| Check all the lay-ups to be sure they are not pulling away from the corners. Let cure.

6.11. 6.10 – Canard Reinforcements

6.10 – Canard Reinforcements

___ Level and plumb the fuselage.

Using the template found at the end of this chapter follow the instructions to cutout the doghouse. Open up the front and aft cutout before you precede by using 80 grit sand paper. Make sure you keep the gap no greater than 1/8”. After you cut the cover out groove a little bit of the foam around the edge of both the fuselage and the cover. Fill with **Micro Baloon** and cover the exposed foam with 1 layer of **BID**.

___ Using a level and your incidence block, get the canard level right, left, fore, and aft. Also make sure that it is perpendicular to the fuselage by measuring back to the outboard hardpoints in the main spar from the **trailing edge** of the canard. If your canard is not level left to right shim the canard so that one side is touching the canard bulkhead. The gap between the canard and the bulkhead will be filled when you install your canard bushings. You will need to get the canard lift tabs as close to the canard as you can. You may have one lift tab that is not perfectly flat against the canard. When the bushings are installed we will be able to take care of this also.

6.10.1 – Canard Attachment Reinforcement

___ Pre-cut eight pieces of 8” × 18” **TRIAX**, axis lengthwise. Trim to fit as shown in the sketch lapping 4” below the canard cutout, 4” above and below the fore and aft sides of the opening, and 5” onto the canard bulkhead.

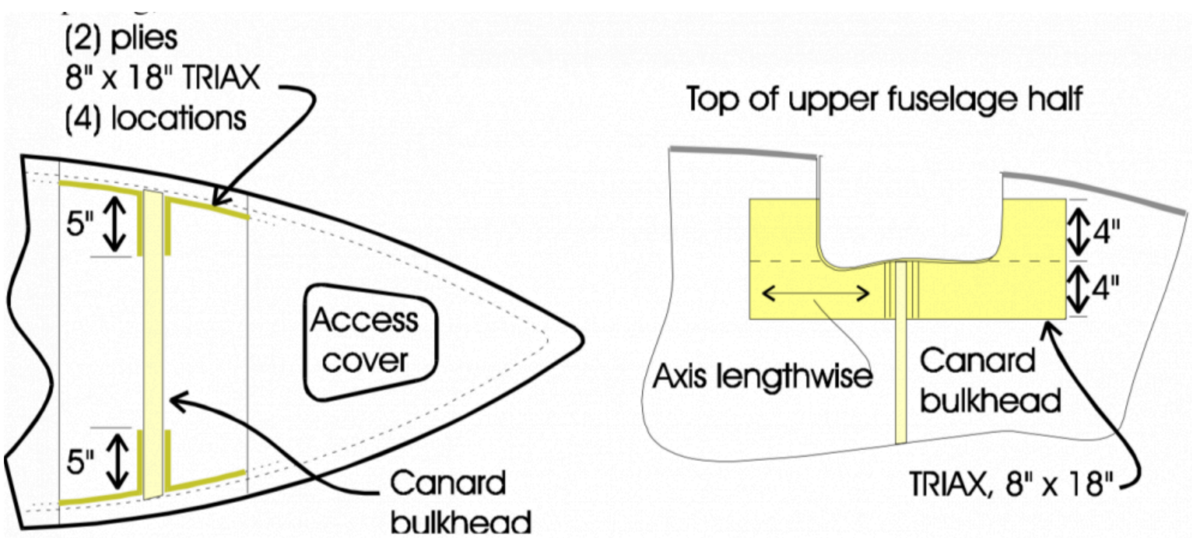


Figure 6-40. Forward Fuselage Treatments

___ After cure of the reinforcements, trim them back to the edges of the canard cutout. Square up and straighten any cut lines with a sanding block, remove 1/8” foam behind the inner and outer skins. Fill the recesses with **EZ-Poxy Micro-Glass**, and apply 1 ply of **BID** on a 45 degree bias. Let cure.

___ Reinstall the canard and check to make sure that it is set in position:

Level – Left to right using a level. After that stand at least 10 feet in front of the airplane and sight the top of the canard and the spar and make sure they are level with each other. Refer to Figure 6-41.

Centered – Left to right lining the center line of the airplane with the center line of the fuselage

Proper Incidence – using you canard incidence gauge

Straight – Making sure that the distance from the canard tips to the center spar tips are equal.

Using the predrilled holes in the lift tabs as guides, drill 1/4” pilot holes in the canard bulkhead. Remove the canard and open these holes up to 1” to accept bushings using a hole saw.

___ Enlarge the holes in the lift tabs to 3/8” so they will accept the attach bolts. As a dry run, put the bushings in, put the canard back in place, and fit the bolts.

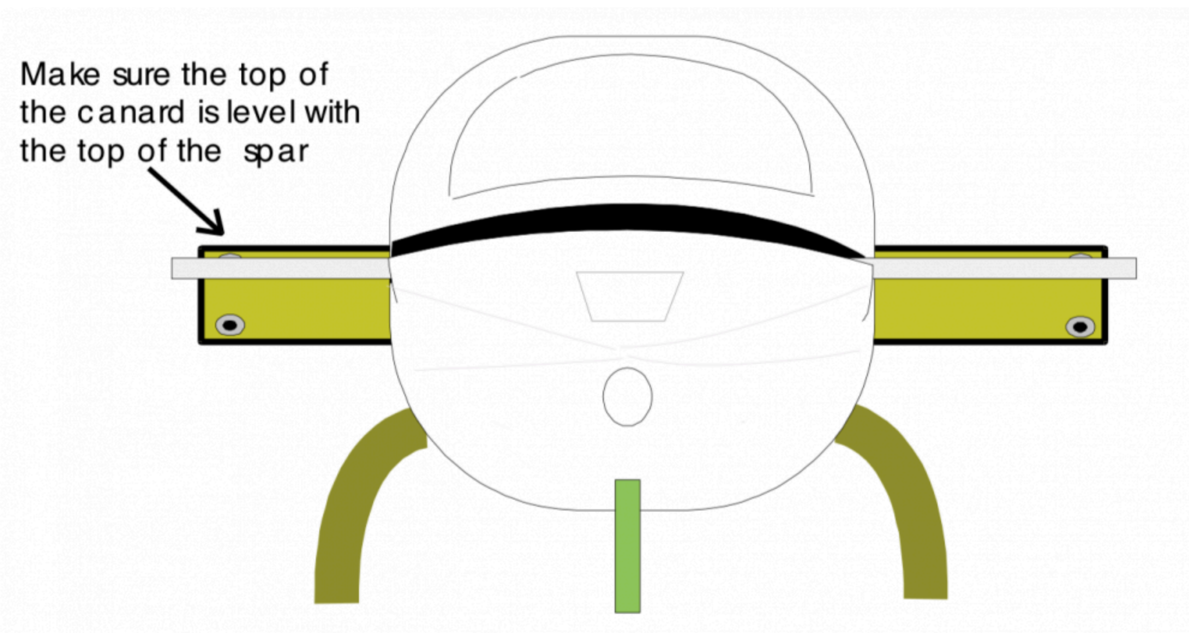


Figure 6-41. Leveling Canard with Center Spar

If your canard has a small gap on one side between the bottom of it and the bulkhead when level we will fill that when we install the bushings. Run one layer of duct tape on the bottom side of the canard from left to right where it meets the bulkhead. Make a bed of **EZ-Poxy** and **Micro-Balloon** along the top of the bulkhead. Install the bushing using **Structural Adhesive** mixed with **Flox** . Put your canard in place. Install the nuts and bolts tight as shown in figure 6-42. Put a little vaseline on the washers so they will not stick. Relevel and center you canard and check your incidence. Check it twice. Shim as needed to keep it in place. You may have one bushing that sticks out in front of the canard slightly farther than the other because the canard bulkhead was installed slightly crooked. This should not affect anything. Now go back and clean off any extra **Micro-Glass** that has squeezed out between the bulkhead and the canard.

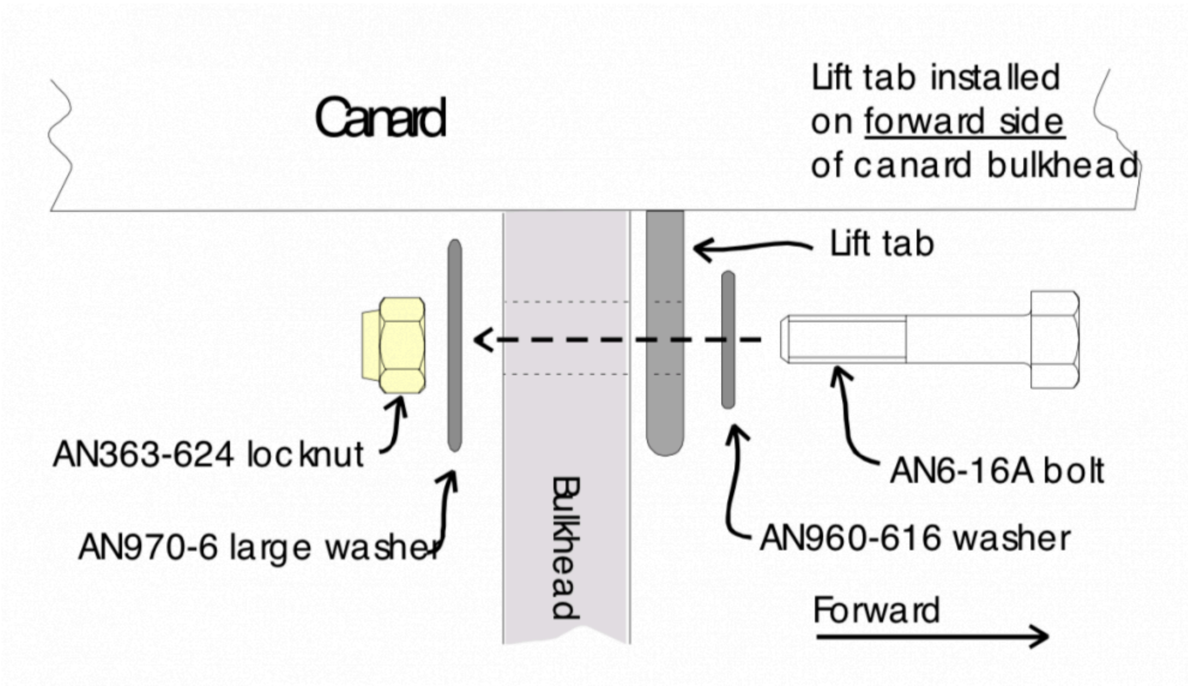


Figure 6-42. Canard Mounting Tabs

6.10.2 – Canard Top Attachment Points

___ Install your canard in position in your airplane. Duct tape the bottom inside of your doghouse cover on each side 3”. Install your doghouse cover. Trace a line on your canard where the doghouse sits. Your doghouse will need to be trimmed to fit the canard before you do the next step. When you are satisfied with how your doghouse sits on the canard hot glue or Bondo it to the canard on the outside of the cover. Remove you canard from the airplane carefully. Use scrap wood or Dyvinicel to make backer boards to layup 3” × 3” **TRIAX** pads on the aft and front sides of the canard just above the **trailing and leading edges**. Put duct tape on the backer boards where the pads will be laid up. Hot glue the boards onto the **trailing edge** of the canard cover just above the trailing edge of the canard. Hot glue the front boards on so they but up to the top of the leading edge. Make sure the backer boards are large enough to lay a 3”x3” pad onto.

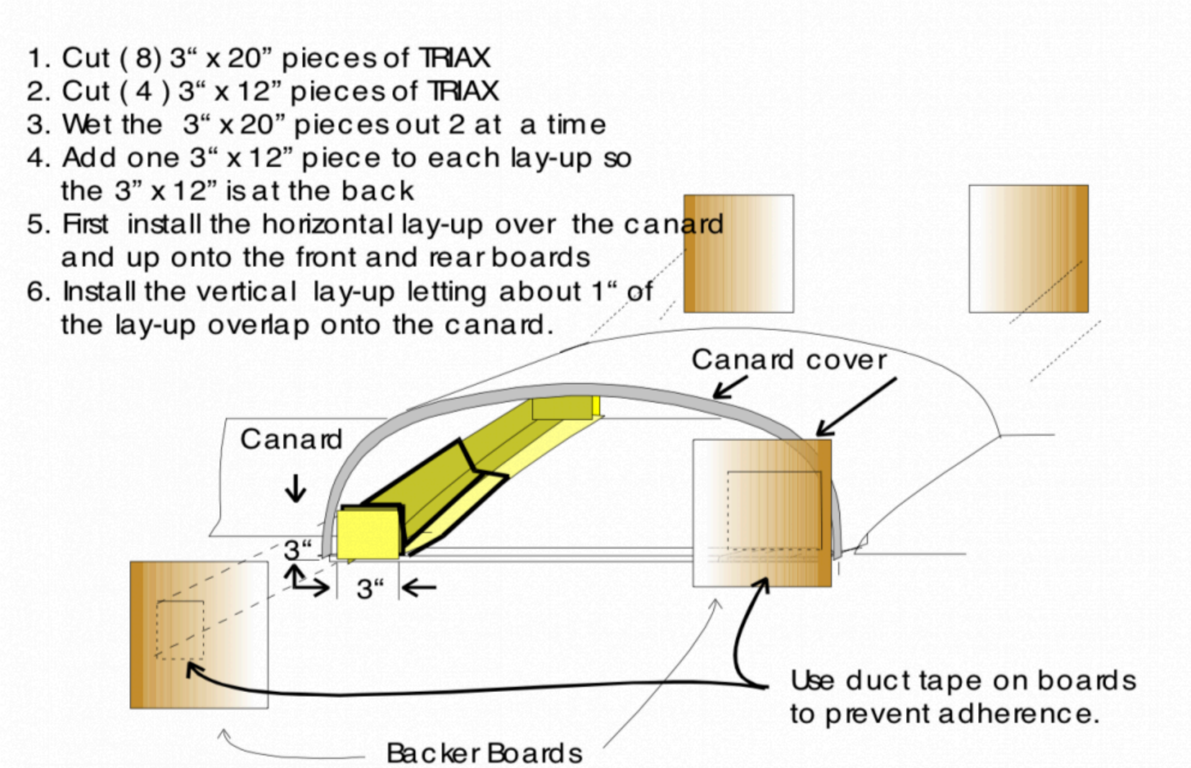


Figure 6-43. Canard Torsion Tabs

A small piece of wood with duct tape on it will have to be placed between the backer boards and the **trailing edge** of the canard to span the gap and support the **TRIAX** until it cures. Make sure it does not sag. If the **TRIAX** is too low, it will interfere with the operation of the elevators.

___ Sand all areas on top of the canard.

___ Cut eight 3” x 20” pieces of **TRIAX** (major axis lengthwise) and wet out two at a time on some visqueen. Cut four 3” x 12” pieces of **TRIAX** and lay one on top of each lay-up of 3” x 20” . The aft pad is thicker than the front pad so have the 3” x 12” lined up with the trailing edge of the lay-up. On each side place one of these layups so it starts on your front backer board and finishes on your rear backer board creating the 3” x 3” pads. The first layup has 2” of its width on the canard and 1” overlapping onto the doghouse. The second layup has 2 “ on the doghouse and 1” overlaping onto the canard. Work the coners ot make the glass conform to them as best you can. This forms a six-ply 3” × 3” pad at the aft side and a four-ply 3” x 3” pad at the front side. Put aside and let cure. Refer to figure 6-43 and 6-44.

Once cured mark three equally spaced holes 1” off the canard along the doghouse. Drill three 3/16” holes through the doghouse and the **TRIAX**. Refer to figure 6-45.You can now remove the doghouse. You can now install MS21047-3 nutplates on the **TRIAX** flange where you drilled your three holes on each side. Now the doghouse can be held in place with three 10-32 screws on each side. Pop the doghouse back off and run one layer of duct tape along the outside of the lift tab so it will be under the edges of the doghouse. Reinstall the doghouse and secure it on the inside with a little hot glue. Now you can fill the radius between the doghouse and the canard with Epoxy and **Flox** and cover with one layer of **BID**. Make this a smooth transition. The bottom edge that you just filled and glassed will need to be trimmed.

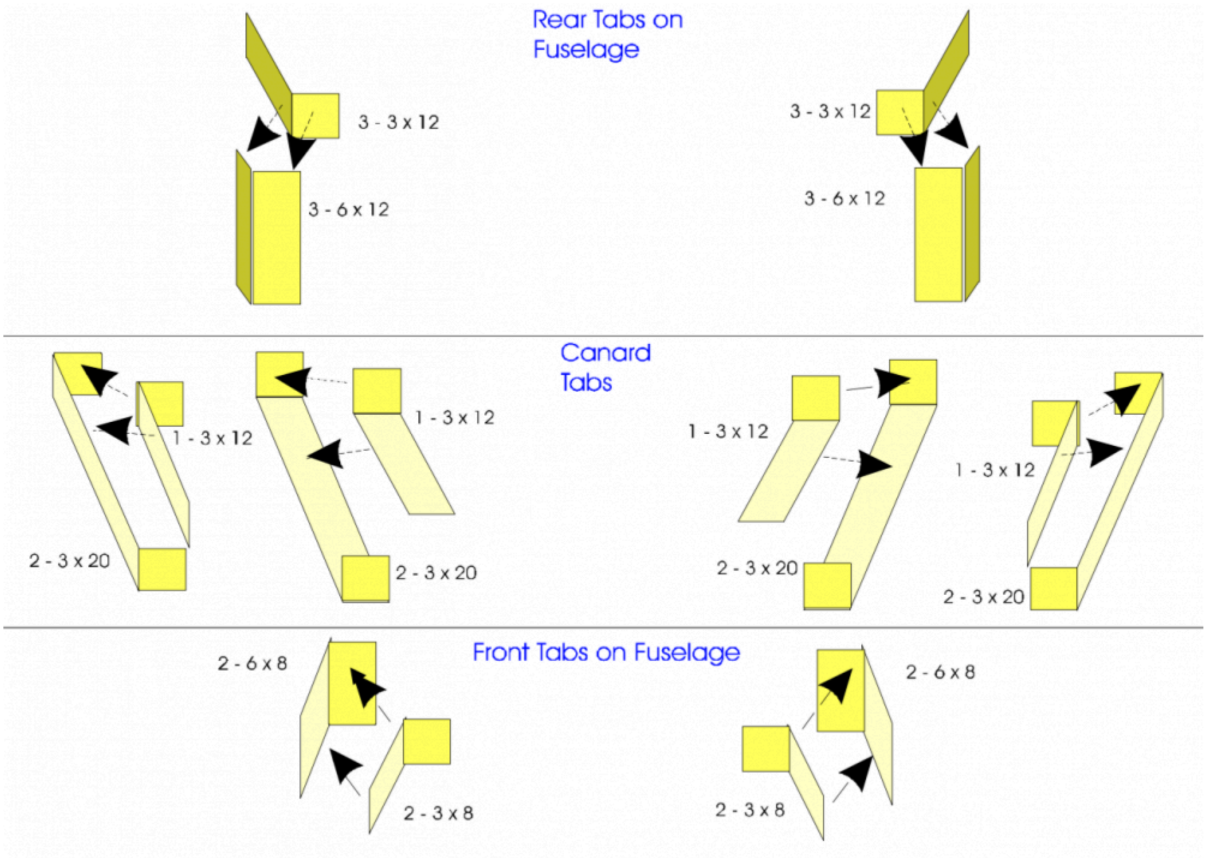


Figure 6-44. Canard Tab Lay-up Schedule

On the fuselage, prepare an area for mating the 3” × 3” pads you just made on the canard. Sand the inner skin for about 12” aft and 12” below the pad area at the rear of the canard cutout. Forward of the canard cutout sand a 12” x 12” area. Duct tape the outside of the tabs that you just made on the canard. Instead of using scrap wood we will lay-up our tabs for the fuselage right onto these tabs. Reinstall the canard without the doghouse. Install the bolts through the tabs and the canard bushings.

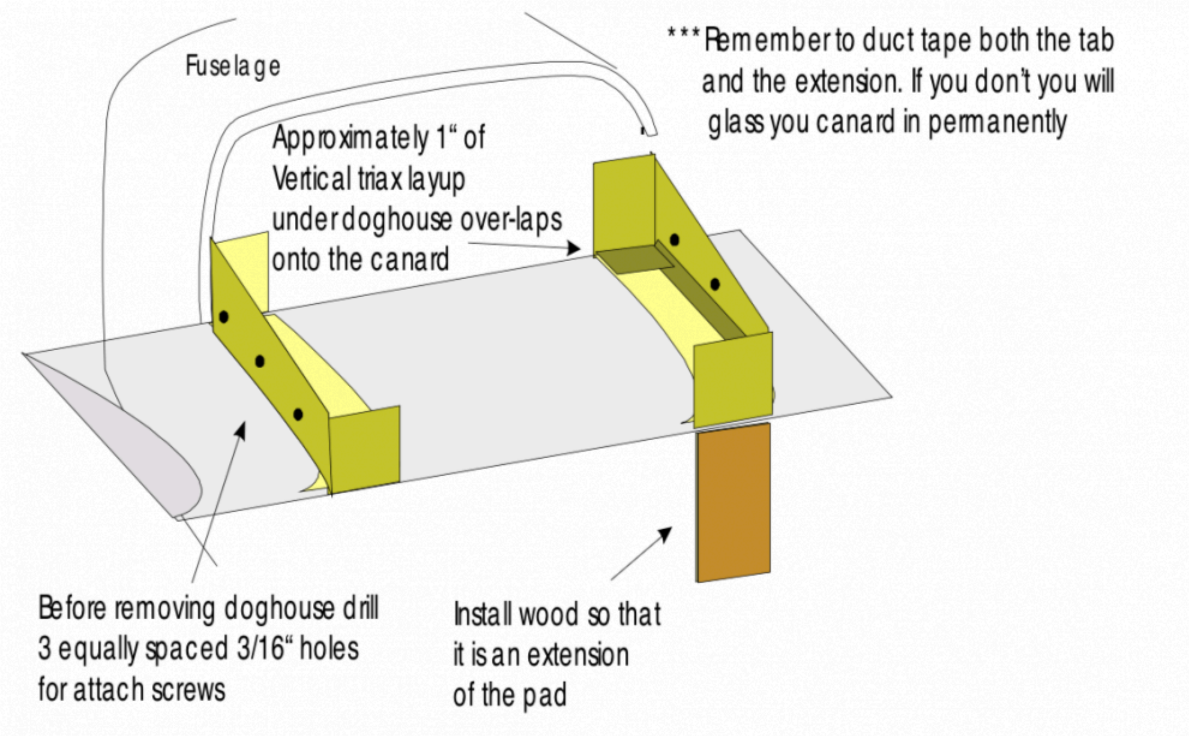


Figure 6-45. Fuselage Mate for Canard Torsion Tab

___ With the canard in place we will need two 3" x 8" pieces of scrap wood (for the aft side) and two 3" x 6" scraps of wood (for the front side) all with one side covered with duct tape. These need to be installed under the canard so they are an extension of the pad we just laid up. Refer to figure 6-45.

___ For the rear tabs cut six pieces of 6" × 12", and six pieces of 3" × 12" **TRIAX**. Pre-wet three plies at a time on some visqueen. The 6" × 12" are installed vertically with 3" on the tab and scrap wood and 3" on the fuselage. Install the 3" × 12" horizontally onto the side of the fuselage, with 3" overlapping your canard tab. This forms a six-ply pad that mates with the one on your canard .

___ For the front tabs.Cutfour pieces of 6" × 8", and six pieces of 3" × 8" **TRIAX**. Pre-wet two plies at a time on some visqueen. The 6" × 8" are installed vertically with 3" on the tab and scrap wood and 3" on the fuselage. Install the 3" × 8" horizontally onto the side of the fuselage, with 3" overlapping your canard tab. This forms a six-ply pad that mates with the one on your canard .

Reinstall the canard, file away any interference, and bolt in place. Drill a 1/4" hole through both pads. Using 1/8" pop rivets, attach a 1/4" nutplate to the front side of the front tab and back side of the back tab through a 1/4" wide area washer. Lightly sand the back of the washer and the back of the pad. Spread **Structural Adhesive** between the pad and the washer.

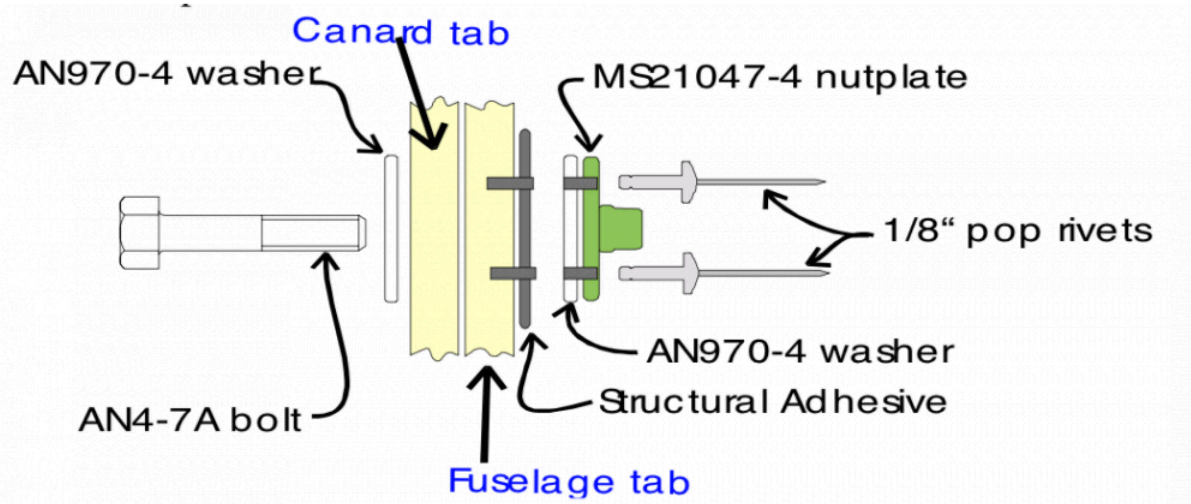


Figure 6-46. Aft Canard Attachment Cross-Section Detail

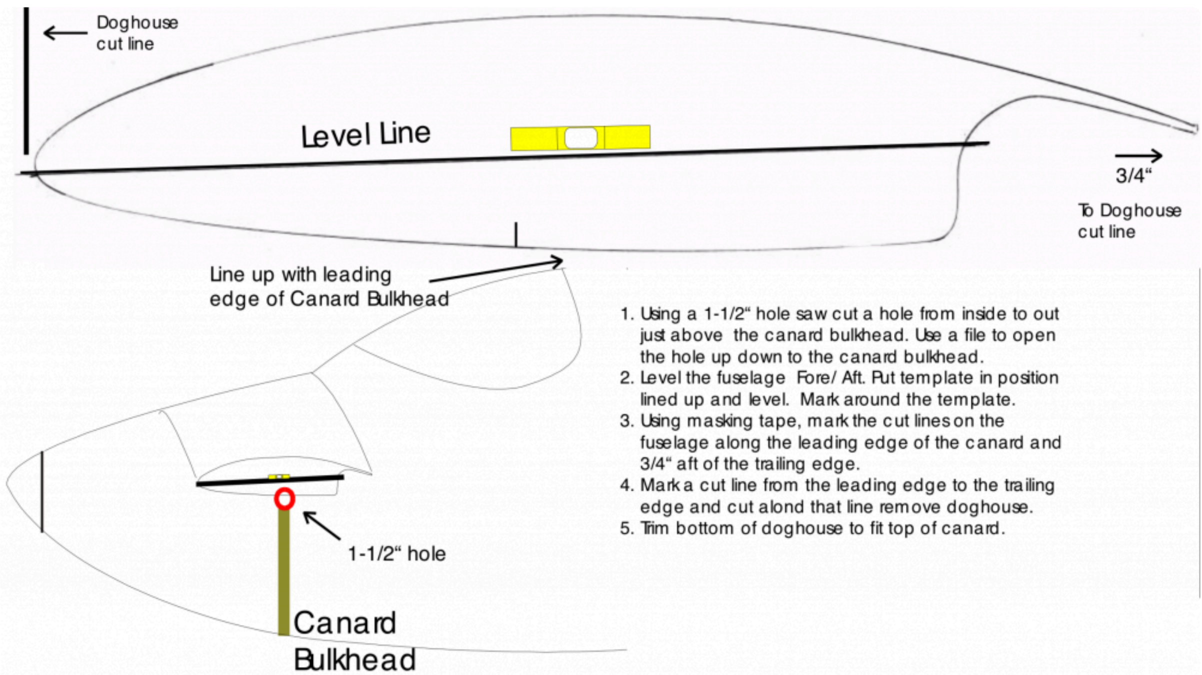


Figure 6-47. Dog House Cut Line

NOT TO SCALE

[Template 6-47. Dog House Cut Line]

TO SCALE WHEN PRINTED ON LEGAL SIZED PAPER

6.12. 6.11 – Overhead Fresh air Duct

6.11 – Overhead Fresh air Duct

6.11.1 – Overhead Fresh air Duct

This installation may be easier with the airplane upside down. You will be flipping your airplane over when you get to the end of the fuel strake installation so you may want to do this installation then.

You will first need to install the small NACA scoop in the top of the fuselage. Draw a center line down the top of the airplane. Using the NACA scoop as a guide mark, cut the hole for the scoop about 11” from the cowling cut line centered on your line. The NACA scoop is installed with the pointed end facing forward. Slide the scoop down into position and file the hole until it fits nicely. Remember to have the bottom of the front of the NACA scoop flush with the outside surface of the fuselage. The back of the NACA scoop should be about 1” deep. You will have to trim off some of the scoop since it will extend above the surface of the fuselage once fit.

At the rear of the scoop cut the inside skin of the fuselage 3/4” back from the rear of the scoop. Bevel the foam back to this cut line. The will open the scoop up more and improve airflow. Remove a little foam around the edges, and glass over with one layer of **BID**. Do not try to wrap the **BID** around the corners. Wait until after it has cured then cut the **BID** flush to the fuselage skin with a razor blade.

Sand the exterior of the NACA scoop where it touches the fuselage. Install the NACA with **Flox** and **EZ-Poxy**. Glass the inside of the scoop to the fuselage with a 1” wide layer of **BID**. There is no need to glass the NACA scoop on the exterior.

Now the fresh air duct can be installed. Position the duct on the roof of the fuselage. The are around the carbon beams will need to be trimmed in order to allow the duct to rest in place. The notch at the trailing edge of the duct is to allow you to access your top engine mount bolt. Using a marker draw a line around the duct on your fuselage roof. Using an 1/8” drill, drill a hole through the flange on the duct into the inside skin of the fuselage every 18” around the duct. Do not drill through the outer skin.

Remove the duct and sand 1” inside the line you drew as well as sanding the flange. Using **Structural Adhesive and Cabosil** bond the duct in place. Instal IBSP-4-4 rivets in the 1/8” holes you drilled to hold the duct in place while your adhesive cures.

Holes can now be drilled for vent installation. Our typical installation places the front two vents about 10” aft of the windshield. The rear vents are located about 40” aft. Many people install lights in their ovehead vent. If lighting is mounted in the overhead vent the wiring runs out the back of the duct. Keep the exit hole high at the rear of the duct.

The last thing that you will have to do is to drill a 3/8” hole in the rear lowest corner. Insert a 3/8” aluminum tube flush with the inside surface, **Flox** around the tube and glass with one **BID**. This tube should be long enough to extend down through the floor flush with the outer skin. Route the tube so it doesn't interfere with the landing gear. Your duct is typically upholstered before the headliner as a separate piece

7. 7 – Landing Gear

Contents

7.1. 7.0 – Chapter Preface

7.0 – Chapter Preface

7.0.1 – Parts List

Part Number	Description	Qty
MP0901	Main Gear Leg	1
MP0902	Gear Saddle	2
BUSH5/8	O.D. Bushing 5/8” O.D.	2
KBUSH1	Knurrled Bushing 1-1/4” O.D.	4
BOLT1/2-13×10	Main Gear Bolt, 1/2”-13 × 10” L #8	2
WASH7/16	Main Gear Washer, 7/16” #8	4
NUT1/2-13	Main Gear Locknut, 1/2”-13	2
–		
MA0901	Nose Gear Fork	1
KBUSH1	Knurrled Bushing 1” O.D.	2
BOLT3/8-16×7	Nose Gear Bolt, 3/8”-16 × 7” #8	1
AN960-616	Nose Gear Washer, AN960-616	2
NUT3/8-16	Nose Gear Locknut, 3/8”-16	1
MA0902	Nose Gear Shock Mount	1
MA0903	Nose Gear Alum Angle, Gear Stop, Righ	1
MA0904	Nose Gear Alum Angle, Gear Stop, Left	1
MA0905	Nose Gear Alum Bar, Gear Stop	1
NUT1/2-13	Nut, 1/2”-13	1
MS21083N6	Nut, MS21083N6	2
AN4-13A	Bolt, AN4-13A	4
AN970-4	Washer, AN970-4	4
AN960-416	Washer, AN960-416	8
MS21083N4	Nut, MS21083N4	4
CAPSCR1/4-20×1	Cap Screw, 1/4”-20 × 1”	4
TE0901	Cut Out Template	1

7.0.2 – Tools List

Description
Plumb Bob
Jig Saw
1/4” Drill Bit 12” Long
1” Hole Saw
5/8” Hole Saw
1-1/4” Hole Saw
2” Hole Saw
1/4 × 20 Tap

7.0.3 – Supplies List

Description
EZ-Poxy
VelociPoxy
Milled Fiber
Micro Balloon
Structural Adhesive
Bondo

7.0.4 – Glass List

Type	Size	Qty
Triax	4” × 11”	20
Triax	4” × 20”	16
BID	8” × 7”	12
Triax	4” × 4”	8

7.0.5 – Process Overview

Construction Process	Completion Date
Main Gear	
Cut Out Gear Openings	
Fit In Gear	
Attach Gear Saddles	

Reinforce Gear Saddles	
Install Bushings Into Saddles	
Reinforce Bushings	
Install Main Gear Bushings	
Triax Over Bushings	
–	
Nose Gear	
Cut Nose Gear Hole	
Locate Nose Gear Bushings	
Install Nose Gear Bushings	
Position Shock Mount	
Install Shock Mount	
Install Captivator Plates	

7.0.6 – Documentation Changes

Oct 01, 2018 – Original Web Release

7.2. 7.1 – Main Gear

7.1 – Main Gear

7.1.1 – Gear Cutouts

___ Draw a dark line on the fuselage 3/8” above the edge of the wiring duct flanges, running from the aft face of the gear bulkhead to the front face of the firewall. Using a bright flashlight placed inside the fuselage at the line trace this line onto the outside of the fuselage.

Using Figure7-11 as a template line the template up to the fuselage as shown in figure 7-1. Have the bottom of the teardrop gear leg shape on your line 3/8” above the conduit.

Cut the tear drop out. This teardrop shape is a starting point and may need to be opened up slightly to allow the gear leg to slide in.

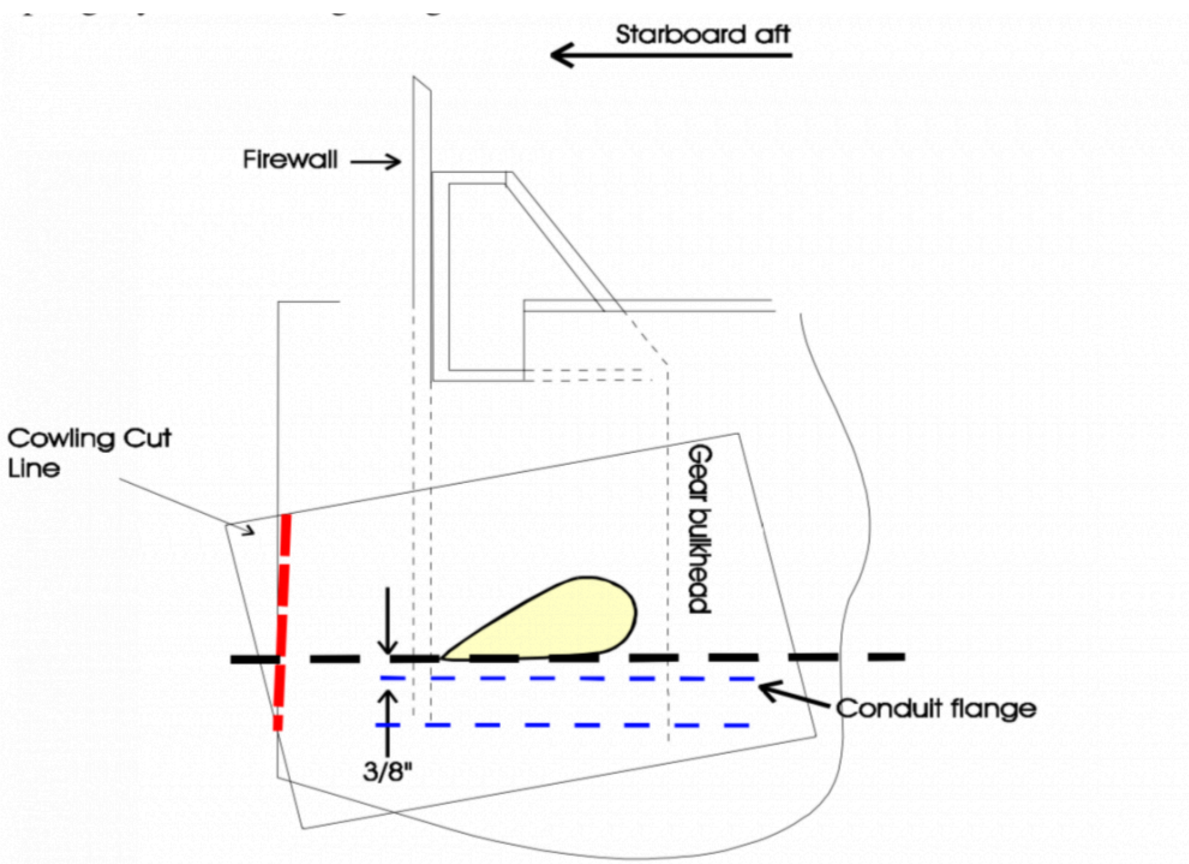


Figure 7-1. Main Gear Fuselage Cutouts

7.1.2 – Locate Gear Positions

Level the fuselage for-to-aft and side-to-side.

You will need to find the center point on the firewall as well as the gear leg. Measure left to right along your firewall and using a level draw a line straight up and down on the center of your firewall.

To find the center of your gear leg you will need to hold your gear leg upside down and place a level across both gear legs. Whole you hold the bow level have a partner measure the distance between the gear leg and find the center line. Drop a plumb bob down from the center line and place a mark on the top of the bow. This is now your center line for your Main gear bow.

___ Before the gear is installed sand the entire gear leg.

___ Insert the gear into position. The fuselage will have to be rolled on its side for this.

___ Line up the center of the gear with the centerline on the firewall .

___ Use a tongue depressor between the bottom of the gear leg and the fuselage to hold the gear up far enough.

___ Align the front tip of each gear at 144-7/8" as shown in Figure7-2. Equalize the distances to each tip diagonally if possible. If the gear bulkhead or firewall limits your movement, average the difference to get as close to equal as you can. You should have 1/4" of space between the gear and the firewall when in the correct position.

7.1.3 – Fit Gear Saddles

___ Sand the inner and outer surfaces of the saddles. You may choose to round the tops of the saddles at this time.

___ Cut sixteen (16) pieces of **TRIAX**, orientation on the long dimension, the same size as the outer surface of the saddles.

___ Layup eight (8) pieces on a piece of plastic, let cure until tacky, and apply them to the outer edge of each saddle. Pre-wet the saddle with fresh epoxy before applying the layers. After cure, trim the **TRIAX** to the edge of the saddle.

___ Mark a vertical centerline on the forward side of both the rear tab and the forward tab on each saddle. Reference figure 7-3.

___ Slide the saddles into position.

The saddle needs to have the center line on the front tab line up with the predrilled hole in the gear bulkhead. You will need to grind the outboard rear side of each saddle in order to to get them in the right place. Stick a 1/4" drill bit through the premarked hole to scratch a reference mark on the saddles before you take them out to grind on them. This will give you an indication on how much more grinding will be needed.

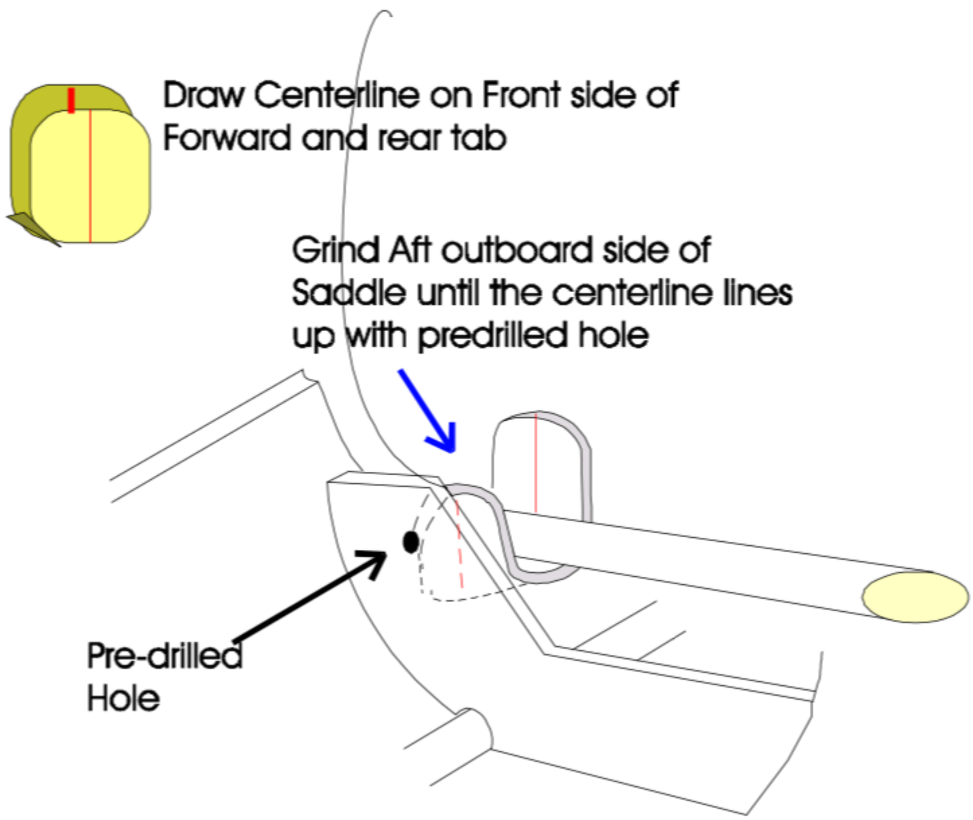


Figure 7-3. Gear Saddle Fitting

Remove the saddles and coat the inside surfaces with **EZ-Poxy Micro-Glass (Structural Adhesive)**. Clamp them in position on the gear leg and allow them to cure. Make sure the gear legs will not move.

7.1.4 – Upper Gear Saddle Construction

___ Layup 10 layers of 4” x 11” **TRIAX** inside each saddle as shown in Figure 7-4. Sand and pre-wet the areas to be glassed. Wet out 2 layers at a time on plastic (longitudinal fibers down). This will prevent kinking in the corners.

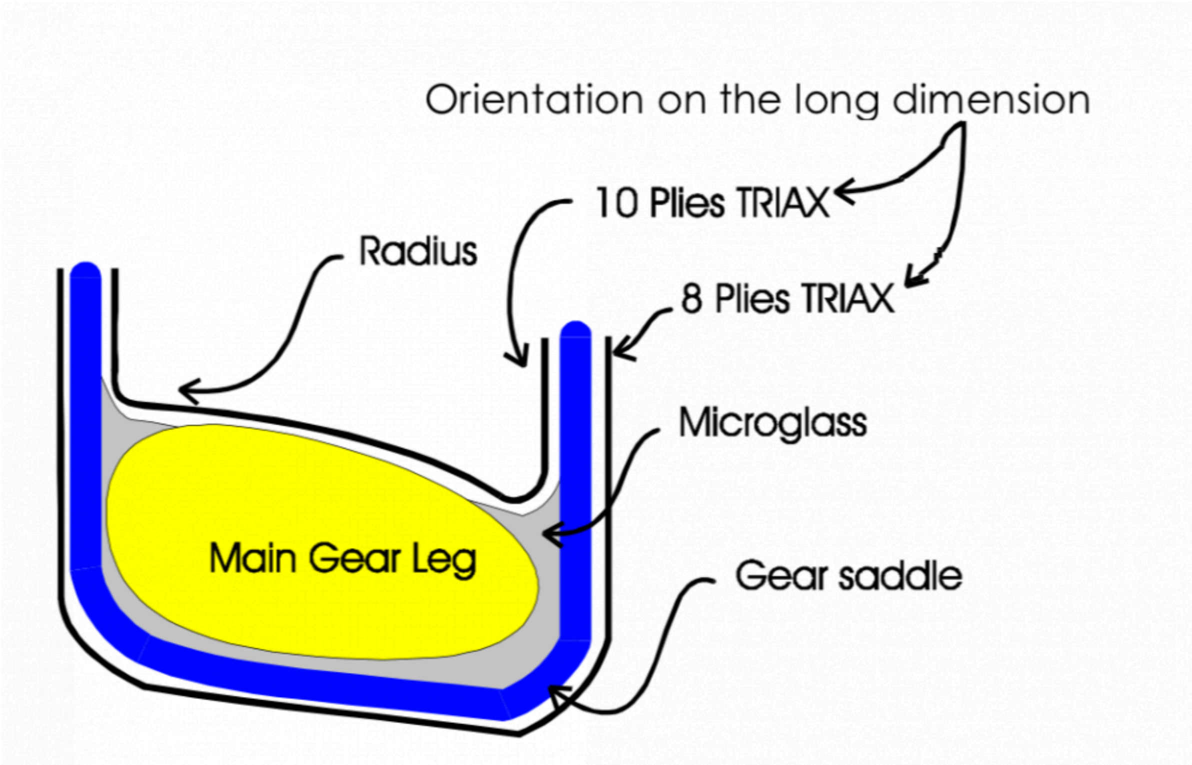


Figure 7-4. Main Gear Saddle Lay-Up

You will need a 12” long 1/4” drill bit for this next step. With the gear legs still blocked in place and the fuselage level we will drill the hole in the saddle and firewall. Insert the drill into the predrilled hole in the gear bulkhead and drill through the forward tab of the saddle. Try to stay parallel to the top of the gear leg. Keep in mind that you will be installing a 5/8” outside diameter bushing in between the saddle tabs. We want this to sit on top of the **TRIAX** layup. If you keep about 3/16” of space between the top of the gear leg and the bottom of the drill this will be perfect.

7.1.5 – Cut Holes for Bushings

You will need a 1-1/4” and a 5/8” hole saw, and your 12” 1/4” drill bit. You will install the hole saws high up on your drill bit so your drill bit will keep your hole saw lined up with the rest of your holes.

___ Cut a 1-1/4” hole 3/4 of the way through the gear bulkhead only.

___ Cut a 1-1/4” hole all the way through the firewall from the rear.

___ Finish off the 1-1/4” hole through the gear bulkhead..

___ Cut a 3/4” hole 3/4 of the way through the front tab.

___ Cut a 3/4” hole the rest of the way through the rear tab.

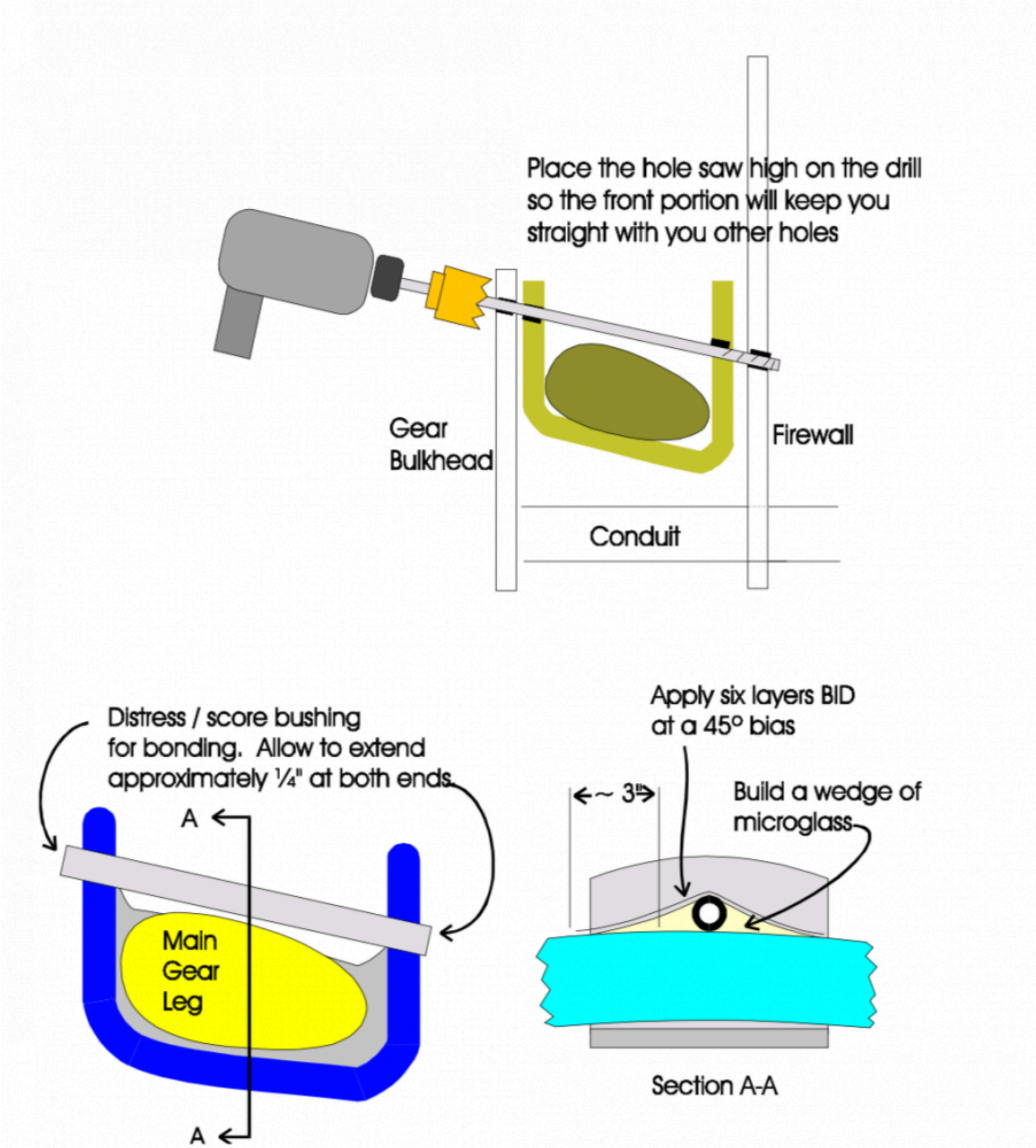


Figure 7-5. Main Gear Bushing

7.1.6 – Steel Gear Bushings

___ Distress (score) the exterior of the 3/4” O.D. bushing (found in the Main Gear Bolt and Bushing Assembly) for better bonding. Press in the bushing without undo force. You may grind into the 10 **TRIAX** slightly if necessary. Do not be concerned about the bushing not being square with the saddle tabs. The knurled bushing will compensate for this later. Make it extend out equally from both tabs. Sand bonding areas. Fill voids with **EZ-Poxy Micro-Glass**.

___ Lay in a thick paste of **EZ-Poxy Micro-Glass**, forming a wedge below the bushing.

___ Apply six layers of **BID** over the bushing, lapping onto the gear about 3” each way. See Figure 7-5.

7.1.7 – Knurled Bushing Installation

___ Clean the knurled bushings (found in the Main Gear Bolt and Bushing Assembly) with a solvent such as acetone to remove the machining oils.

___ Spread **Veloci-Poxy Micro-Glass (Structural Adhesive/ Flox)** on the outside surfaces of the bushings and on the insides of the holes in the bulkheads. Slip the bushings into the holes.

___ Coat the gear bolts (found in the Main Gear Bolt and Bushing Assembly) with vaseline to prevent bonding and slide them into place. Tighten a nut snugly to hold the knurled bushings against the gear bushings, let cure, and then remove the bolts.

___ Apply a transition area of **EZ-Poxy Micro-Glass** around the bushings on the front of the gear bulkhead and rear of the firewall to allow a smooth transition for the **TRIAX** to follow.

___ Apply 2 layers of 4” x 4” **TRIAX** (alternating the orientation) over each bushing on the front of the gear bulkhead and on the rear of the firewall. After cure, open the holes back up and reinstall the bolts with the one wide-area washer on each end and a nylock nut. These can be found in the Main Gear Bolt and Bushing Assembly. See Figure 7-6.

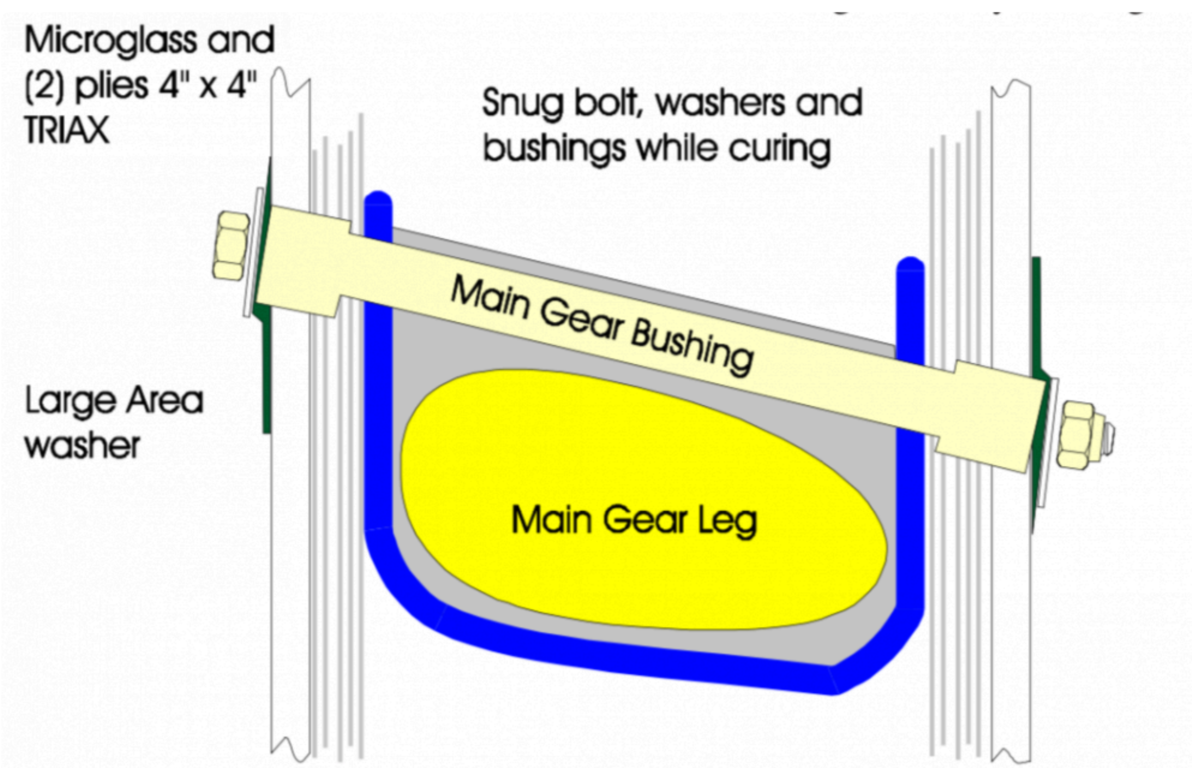


Figure 7-6. Main Gear Installation

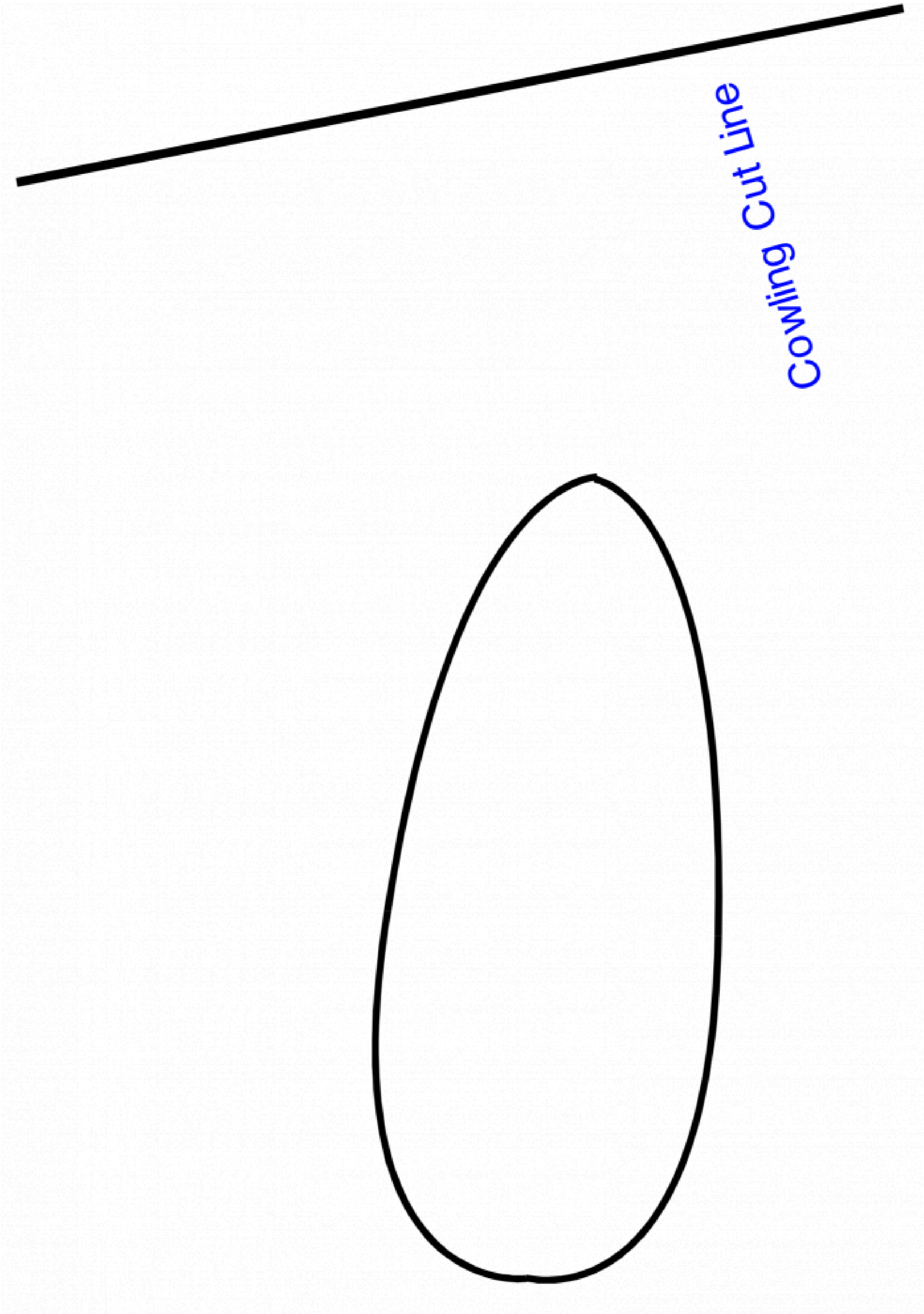


Figure 7-11. Main Gear Cutout Template
NOT TO SCALE

[Template 7-11. Main Gear Cut-Out Template]

TO SCALE WHEN PRINTED ON LEGAL SIZED PAPER

7.3. 7.2 – Nose Gear

7.2 – Nose Gear

7.2.1 – Level Fuselage and Mark References

___ Level the fuselage fore to aft, side to side with the main gear tips touching the floor. If your gear legs are not even you should trim the longer one to match the shorter one. Use the same method used in Chapter 8 to make sure the axles are installed at the same height.The floor should be reasonably level.

___ Measure and mark a vertical centerline on the forward and aft side of the canard bulkhead. Use a plumb bob. Tape a plumb bob centered on the fuselage nose. Mark a fore to aft centerline on the floor from the nose back to about the canard bulkhead.

7.2.2 – Install Nose Gear Strut

At this point you must complete Chapter 6 before moving on. All of the lay-ups in the keel must be done before you can install the nose gear properly.

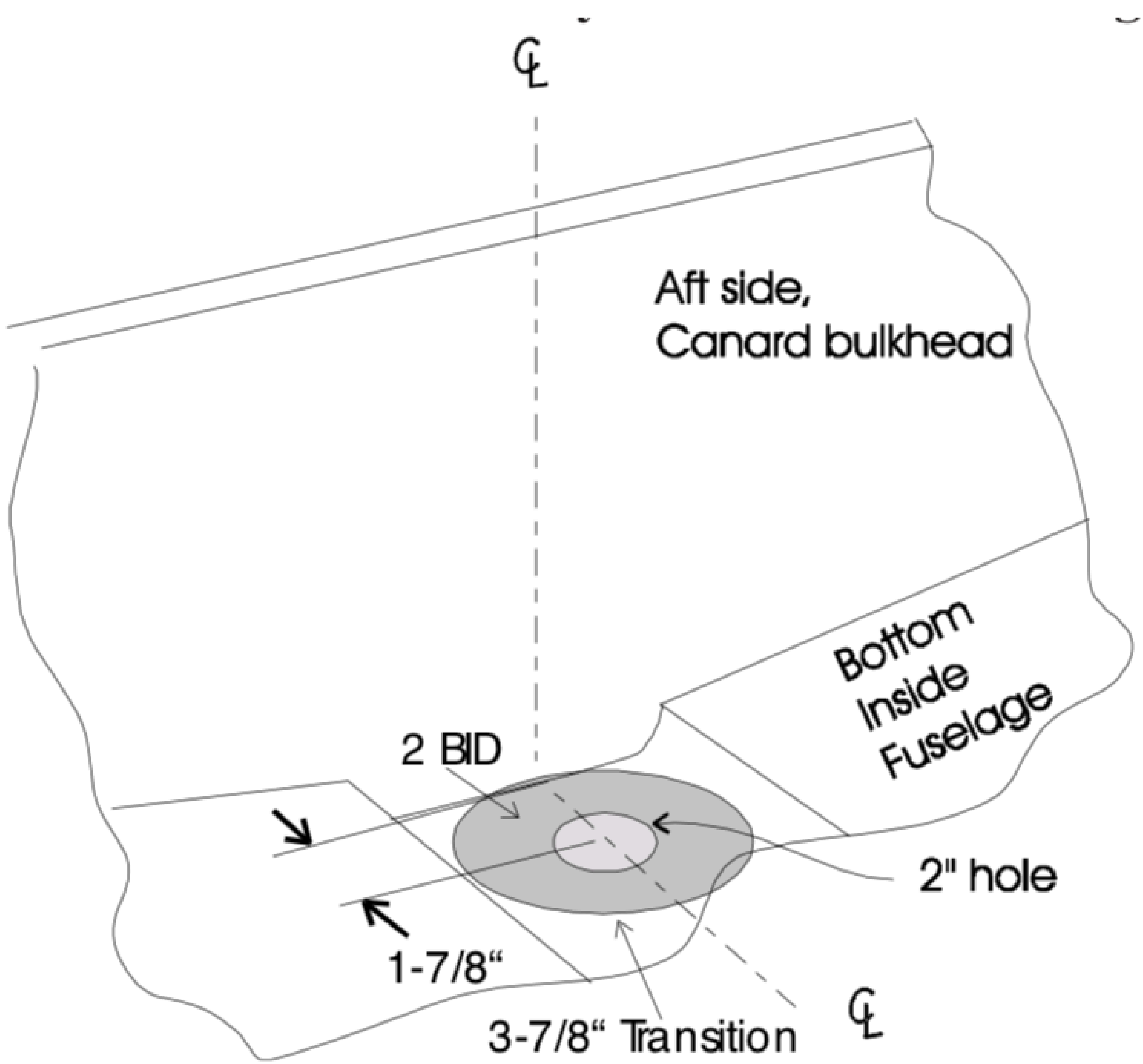


Figure 7-7. Nose Gear Cutout

The critical things to remember are:

1. The nose gear should be the proper height in the fuselage. See Figure 7-8.
2. The gear should be plumb side to side.
3. The kingping should be 2-4 degrees bottom forward from vertical.

___ Measure 1-7/8” along the centerline of the fuselage floor back from the aft face of the canard bulkhead. At this point, cut a 3-7/8”” hole in the inner skin. Cut the foam to the outer skin leaving a 1/4” wide ring of foam. Bevel this down to the outer skin. Cut a 2” hole with a hole saw and cover with 2 plies of 6” diameter **BID**. See Figure 7-7. File as necessary to enable you to slip the nose gear through the floor. Most filing will be done side to side.

Measure across the canard bulkhead and draw a centerline down it. Measure 4” up from the fuselage floor and put a mark. Measure a 1/4” off the centerline towards the pilot side and place a mark. At this point drill a 1/2” hole. This is for the shock mount. The stud off the back side of it is offset. You can install the shock as shown in figure 7-8.

___ On the inside of the keel, at the front flange, measure 8-11/16” up from the inside skin of the fuselage. From this point, measure 2-1/8” back from the front keel flange and mark the keel. This is the approximate location of the aluminum knurled bushing.

___ At this point you can install the mount and strap and insert the gear strut (without the fork) so it rests 9/16” above the floor of your workshop. Remember the fuselage is level with the main gear tips on the ground. Position it parallel to the canard bulkhead, plumb side-to-side, Measure the angle of the threaded portion of the bottom of the strut (the kingpin). It should be 2 degrees (minimum) to 4 degrees (maximum) bottom forward. Adjust its position as necessary. See Figure 7-10.

___ Compare the location of the upper gear bushing with you premarked location and remark as necessary. Remove the gear and drill a level and square 1/4” hole through the keel at the marked location.

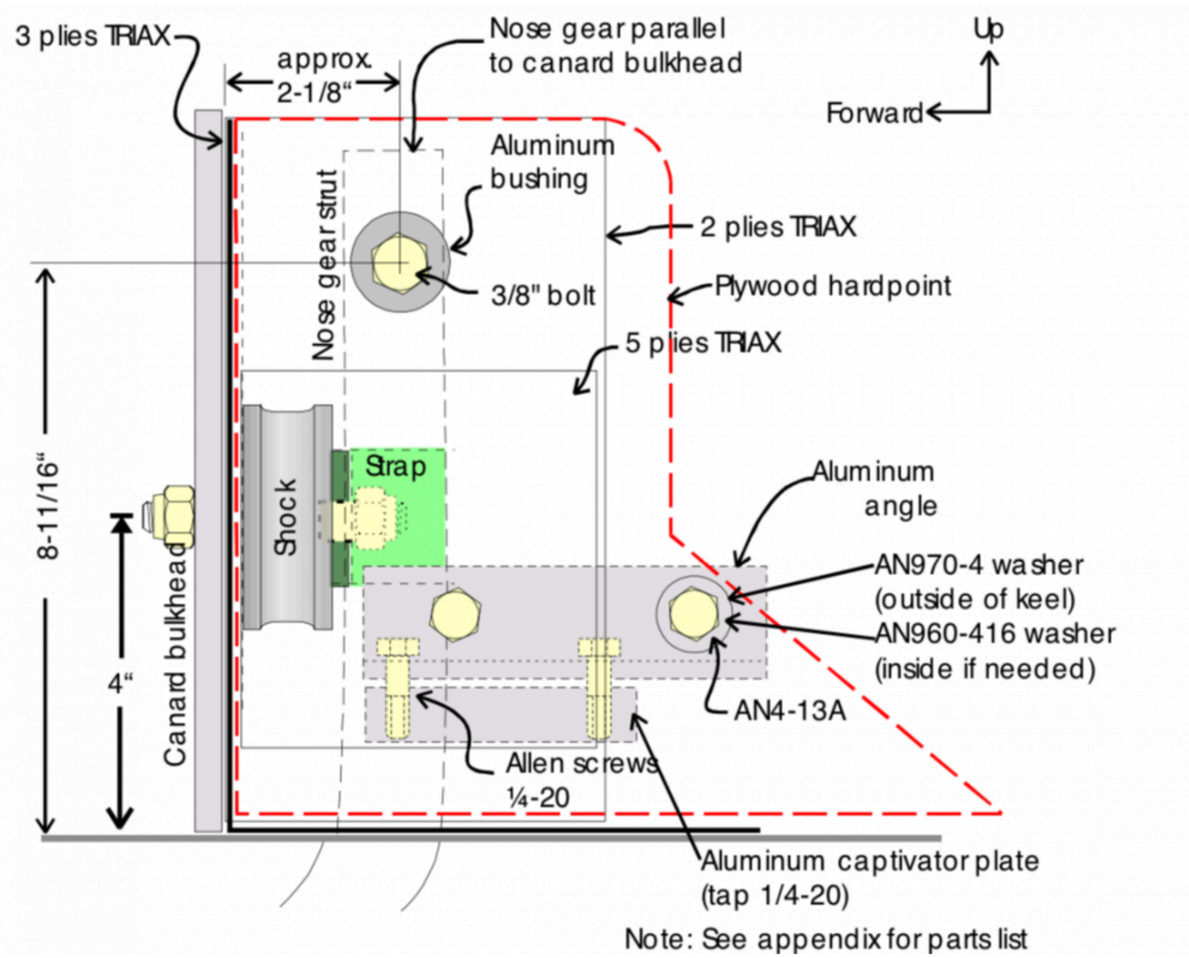


Figure 7-8x. Nose Gear Installation Side View

TRIAX reinforcements added when keel is installed.

___ Open those holes up to 1” with a hole saw. Insert the knurled bushings and the gear to check alignment. You can file the hole slightly to get things to line up if you have to.

___ When satisfied with the fit, lubricate your bolt, **Veloci-Poxy Micro-Glass (Structural Adhesive / Flox)** the bushings in place against the gear leg bushing, slide the bolt through the assembly and lock into position with a non-locking nut. After cure, remove the gear.

___ Install the gear back into position against the shock. Take the airplane off the jack stand and allow it to rest on the nose gear before installing the rear captivator. Put the rear captivator into position with one of the angles clamped to it. Adjust the angle and the captivator so they are lined up correctly and clamp tightly.

___ Remove these parts and drill and tap the captivator for 1/4-20 allen screws. Loosely bolt these pieces together and put it back into position behind the gear leg. Fit the other angle over the captivator and clamp into position. The angle you already drilled and tapped may need to be removed in order to remove this assembly.

___ Drill and tap the holes in the captivator as you did on the other side. Put this captivator together in position up against the gear leg. It would help to jam it up against the gear with some pressure. ou can use a flashlight inside the keel to show the position of the angles on the outside of the keel. Drill 2 holes through the keel into each angle as shown in Figure 7-8.

- There is an alternative method to install this rear captivator that is more precise but it requires a right angle drill. Basically pre-drill the aluminum angles where you want the bolts to go through with a 3/16" bit. Put the assembly into position and drill one hole from the inside out with the right angle drill. Install a 3/16" bolt through the hole. Drill the next hole and so on. You may have to remove the assembly after to drill all the way through the keel because right angle bits are usually short.*

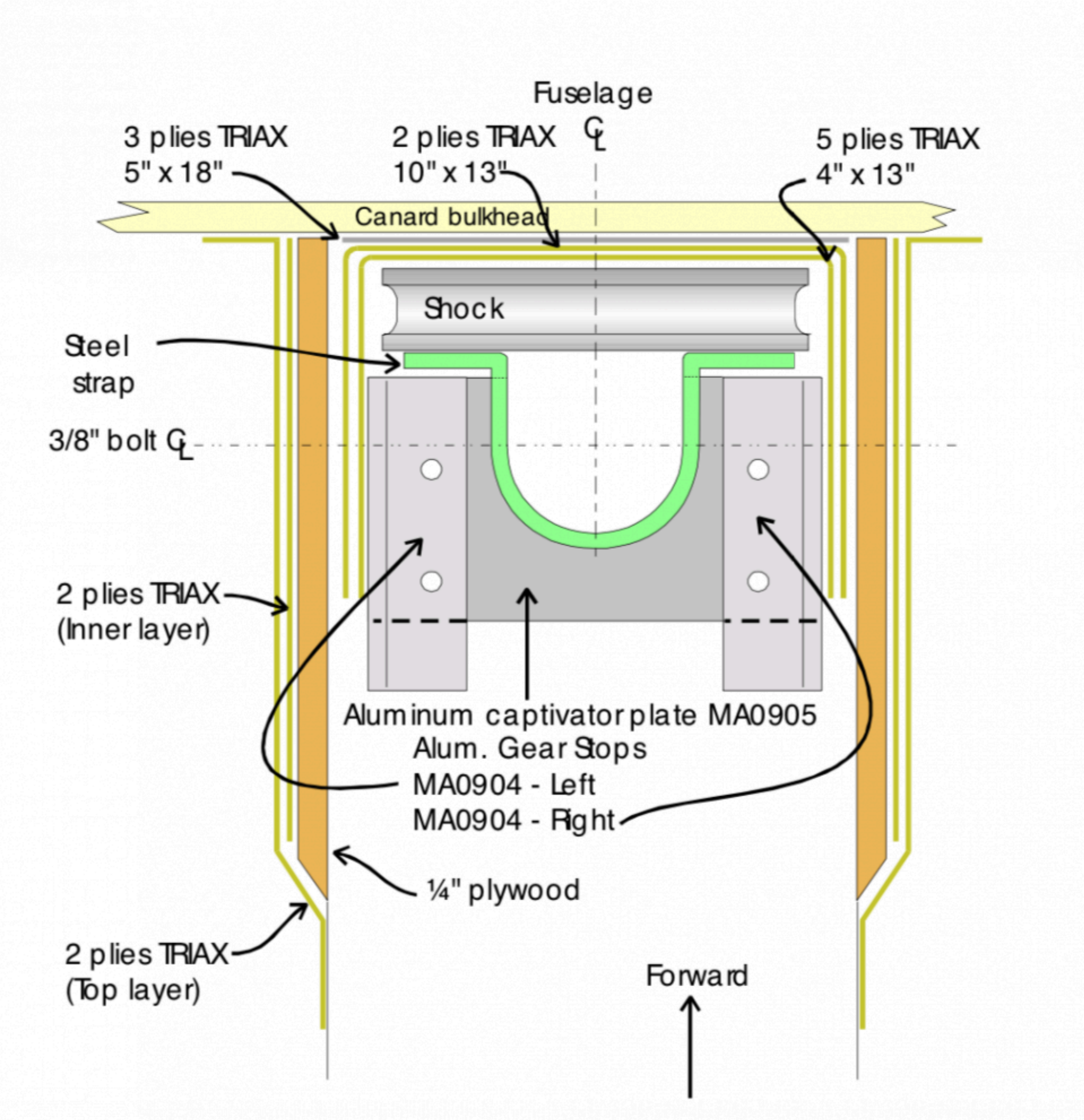


Figure 7-9. Nose Gear Installation - Top View

TRIAX reinforcements added at keel installation.

___ Drill through the keel from the outside on through the angles on the other side. You should shoot for the center of the upward leg of the angle when you are drilling through. Figure 7-8 and Figure 7-9 show this best. Bolt the system together as shown.

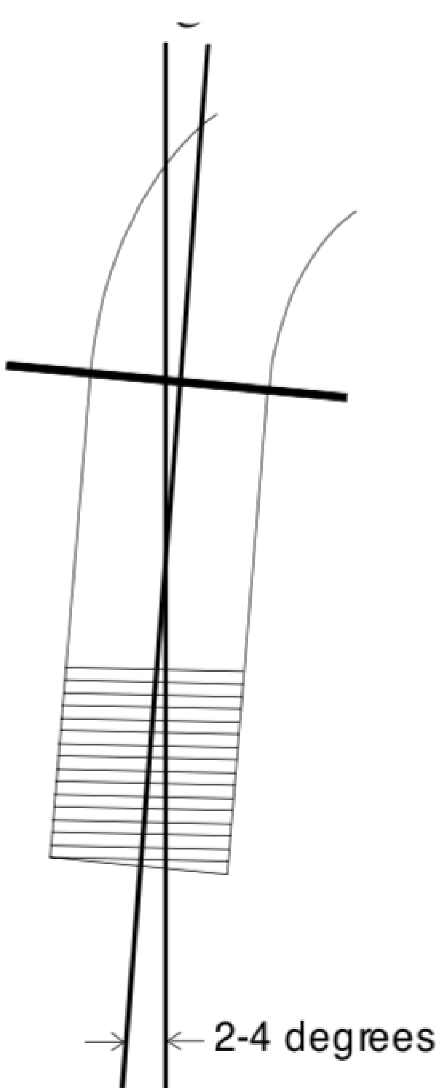


Figure 7-10. Angle of Nose Gear Strut Kingpin

(Exaggerated for Clarity)

8. 8 – Wheels / Axles

Contents

(Shared with SF, XF)

8.1. 8.0 – Chapter Preface

8.0 – Chapter Preface

8.0.1 – Parts List

Part Number	Description	Qty
	Nylaflow Brake Lines	10’
	Gear Cuff, Pilot	1
	Gear Cuff, Co-Pilot	1
	Aluminum backing plate	2
	Main Gear Axles	2
AN5-34A	Bolt	4
AN6-34A	Bolt	4
AN960-516	Washer	4
AN960-616	Washer	4
MS21045-5	Locknut	4
AN363-624	Locknut	4
	Wheel Assembly	2
	Rim	2
	Tube	2
	Tire	2
	Wheel Assembly	1
	Fork	1
	Rim	1
	Tire	1
	Tube	1
	Set Screw	1
	Axle	1
	Screw	1
	Phenolic Washer	1
	Large Washer	2
	Belleville Washer	4
	Nylock Nut	1

8.0.2 – Tools List

Description
Long Level
Roll Tape Measure
Plumb Bob
Aluminum Ibeams

8.0.3 – Supplies List

Description
Bondo
EZ-Poxy
DOT 5 Brake fluid

8.0.4 – Glass List

Type	Size	Qty
BID	2” × 36”	2
BID	4” × 18”	4
Triax	4” × 3’-6”	18

8.0.5 – Process Overview

Construction Process	Completion Date
Main Gear	
Jig Fuselage	
Route Brake Lines	
Attach Gear Cuffs	
Build Triax Axle Pads	
Fabricate Aluminum Baking Plates	
Mount Axles	
–	
Nose Gear	
Assemble Nose Wheel	
Adjust Nose Wheel	

8.2. 8.1 – Wheels and Axles

8.1 – Wheels and Axles

8.1.1 – Brake Lines and Cuffs

___ Suspend the fuselage by blocking it up under the outboard ends of the center section spar and also under the belly just aft of the nose gear. Get it level forward-aft, right-left with the main gear tips about 7” off the ground. If the gear is uneven, trim the longest one down. You can check the gear leg length by using a line level suspended from a piece of string. Attach the string to the bottom of one of the gear legs and stretch it to the bottom of the other. Do not reference gear leg length by the floor. You may have a slanting floor.

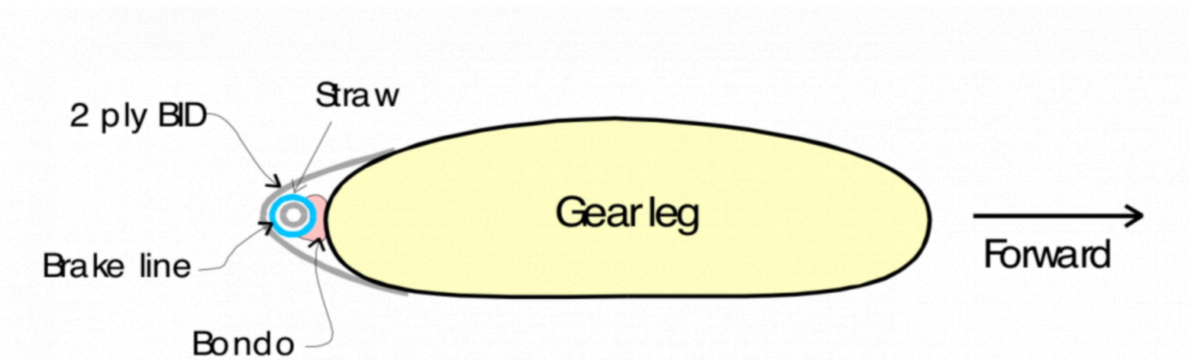


Figure 8-1. Brake Line Attachment to Main Gear Leg

___ The brake lines must be installed before the axles and gear leg cuffs.

___ Route the appropriate brake lines down the rear of each gear leg. Slide drinking straws down over the brake line. Sand the back edge of the gear leg and Bondo the straws into place using the brake lines to hold the routing. . Sand smooth once the Bondo has cured, but take care not to abrade the straws too much. The straws will allow you to replace the brake line in the future if needed.

___ Apply a 2” wide strip of **BID** tape, glassing the line to the gear down to within 8” of the gear end. Allow about 15” of free tubing to extend past the point where the tape glass ends.

|___| Be sure that there is at least 1/2” – 5/8” clearance between line and where the tubing comes through the fuselage side. Radical movement of the gear during extremely hard landings could sever the brake line if adequate clearance is not provided.

___ Slide the gear cuffs up the legs to mate with the fuselage sides. Sand the edges of the cuffs smooth so that they conform to the fuselage sides. When you are happy with the fit, Bondo or hot glue them into place.

___ With the gear unloaded, the cuffs should be approximately 1/16” away from the fuselage sides at the bottom and 3/16” away at the top.

___ Permanently bond them to the gear leg with 2 plies of **BID** around the bottom of the cuff extending onto the gear leg. Any interference between the cuff and fuselage when gear is loaded can be sanded away later.

8.1.2 – Install Main Gear Axles

___ Sand the lower 6” on both gear legs thoroughly. Measure 2” up from the bottom of **shorter** landing gear and place a mark. Now go to the outside of the gear leg and find the center line of the gear leg. Draw a line down the center. Draw another line parallel to this first line but 1/4” aft of the first. Where the aft vertical line meets your 2” from the bottom mark is your axle center position. Center your axle over this location and clamp it in place. **The smaller holes go on top.** When satisfied with your position drill the 4 axle holes using your axle as a template. Temporarily install your axle using (2)AN5-32A bolts and

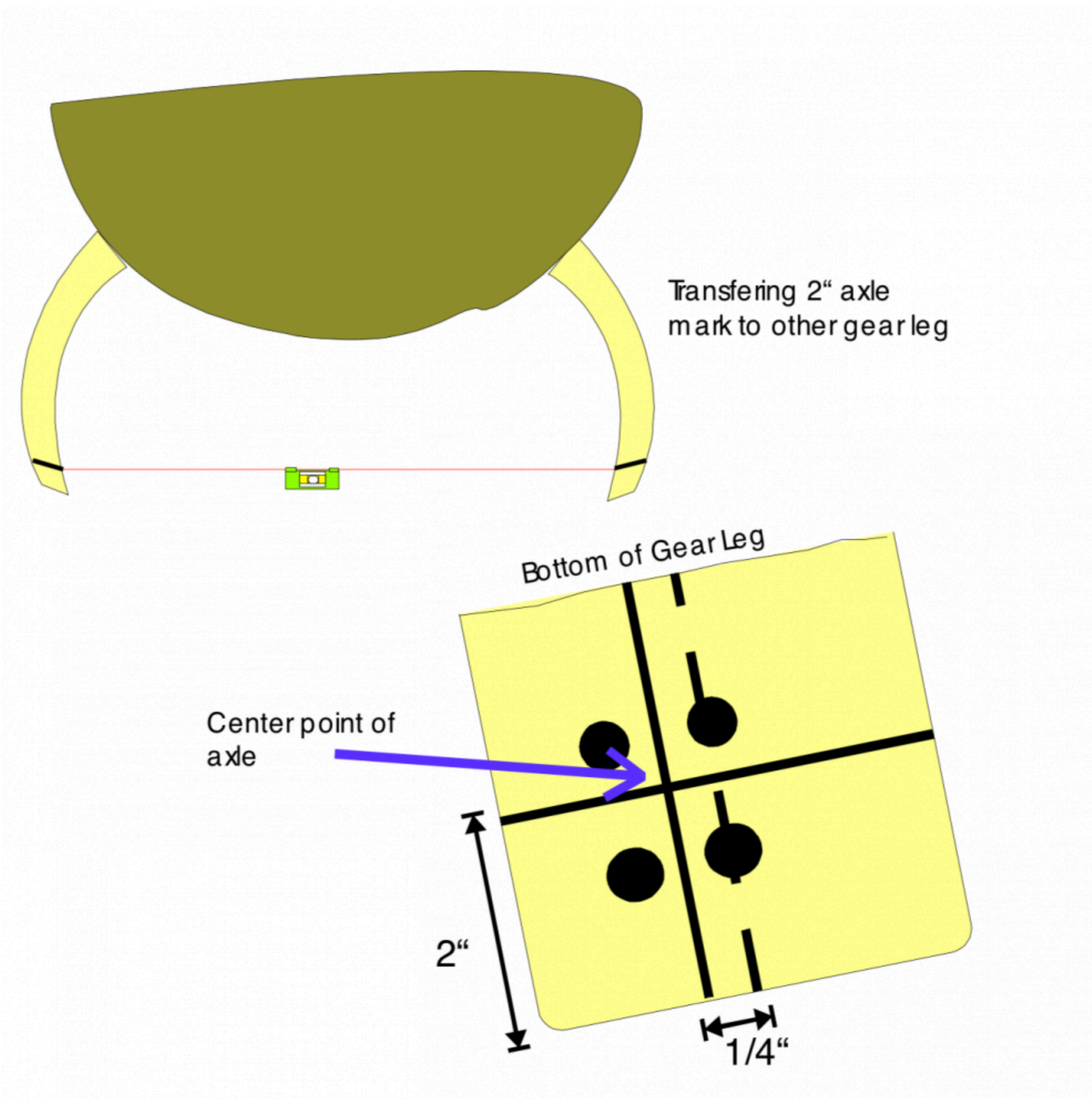


Figure 8-2. Axle Location

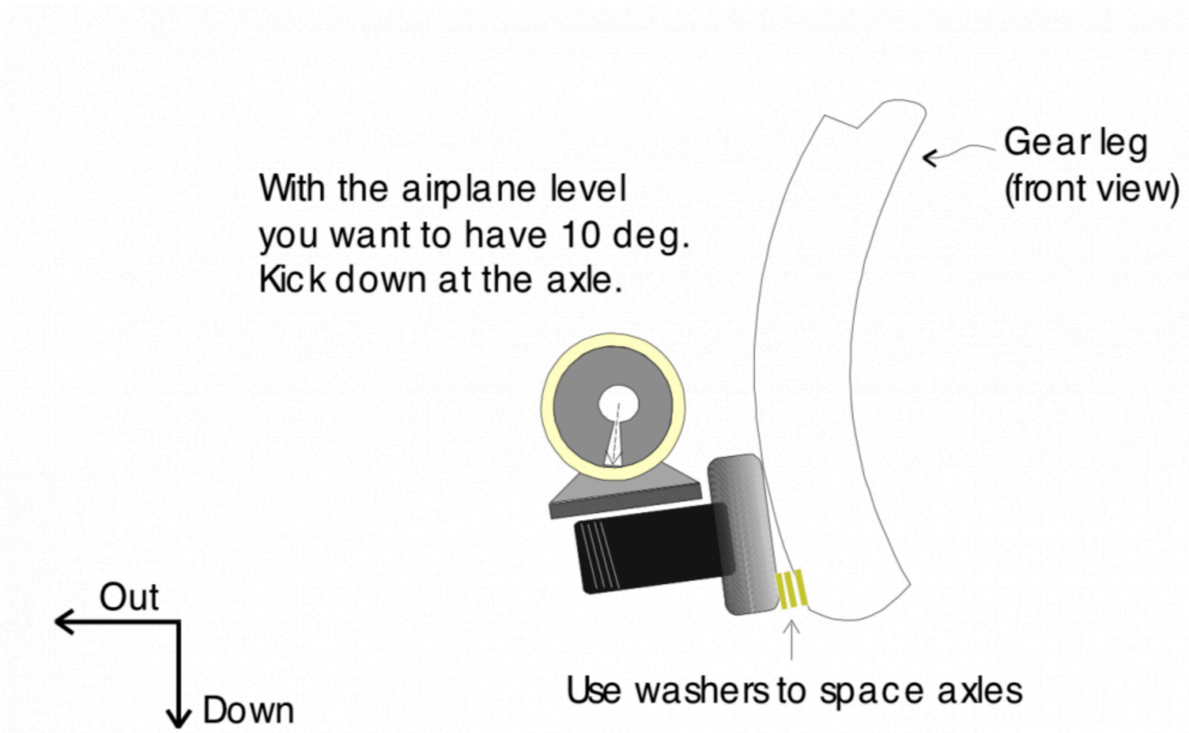


Figure 8-3. Main Gear Axle Pad

___ I prefer to wait until the airplane has the engine and wings on it before I do the next steps. If it is done before however, it may just require some shims to get the proper axle position. Jack the airplane off the ground and level it from left to right. Using 3/8” washers on the bottom bolts shim the back of the axle until you have 10 degrees down at the ends of the axle. This will get the camber needed for a fixed gear. Refer to Figure 8-3.

Now you can put the airplane back on the ground. Before we make a permanent pad we will check the toe-in. Roll the airplane back and forth 5-6 feet a few times. Drop a plumb bob off the nose of the airplane and make a mark on the floor. Stretch a string between your two axles and measure it. Find your center point and draw a mark on the floor. Connect your marks on the floor. This is your center line. Take the two long I-beams and line then up on the sides of your tires . Measure the distance from the center line to the I-beam right behind one of your tires. Measure the distance from your nose mark straight out to the I-beam. The proper toe-in will have a 1” less measurement at the nose. If your airplane is different you will need to shim the axles. Expect to get approximately 1” change per .010” shim. A standard washer is about

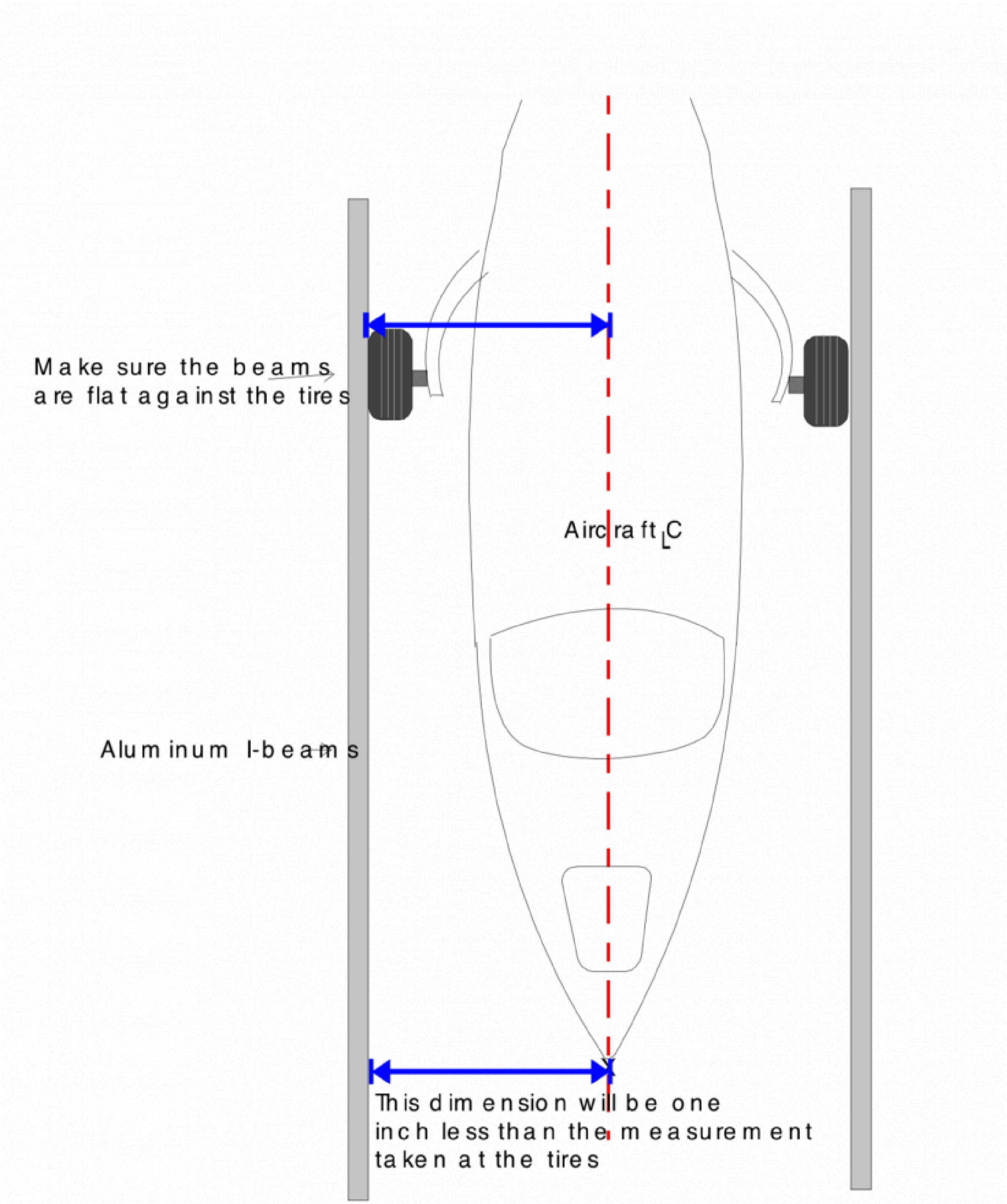


Figure 8-4. Checking Toe-In

Once the axle position is established you can make a permanent pad that will hold the proper axle location. Remove the axle and cover the base with one layer of duct tape. Cover your AN5 and AN6 bolts with DC-4 or Vaseline. Reinstall the axle to the gear leg being careful not to get the washers covered with the vaseline. If they get some on them after assembly wipe them off with a little alcohol on a rag. Mix up a batch of **Flox** and **EZ-Poxy**. Put a little **Cabosil** in it to make it a little sticky. Pack this mixture between the axle and the gear leg. Be sure it gets in all around the washers. Conform it so that it follows the curve of the axle base. Let this cure.

After the mixture is cured come back and remove the axle and bolts. The washer will be captured in the mix and will not come out. Remove the duct tape from the axles.

Before you reinstall the axles a backing plate will need to be made to fit between the back of the gear leg and the nuts. You will also attach your wheel pant bracket to this plate. Install the plate as shown in Figure 8.5.

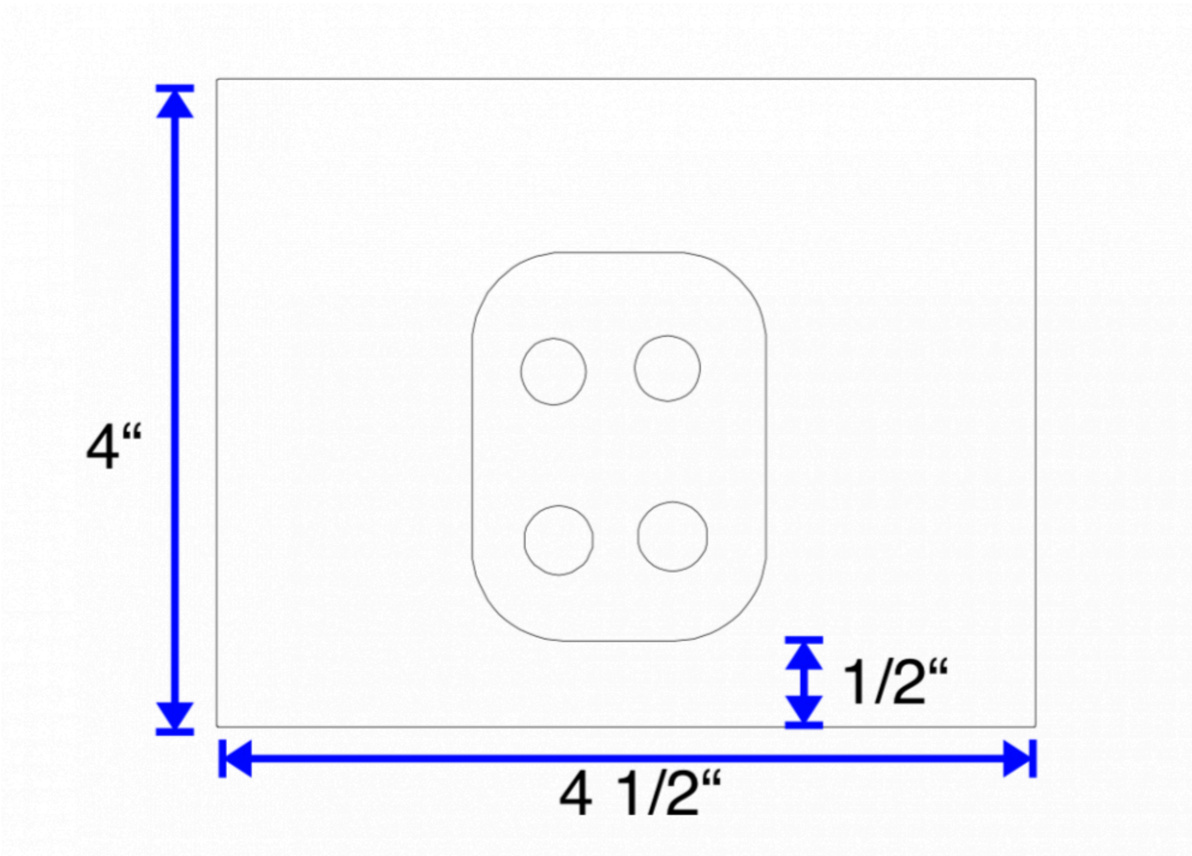


Figure 8-5. Backing Plate Spacing

The last step is to relieve the bottom of the gear leg for the brakes.

___ You may have to grind a little on the gear leg to get clearance for the caliper to move freely. Allow at least 1/8” clearance. **Make sure you do not grind too much material around the lower rear bolt hole.** Move the caliper through its travel in and out and make sure you have clearance.

___ Now install the brake lines to the assembly. Use 1/8” pipe, 3/16” tubing, a 90 degree fitting, and liquid Teflon seal.

___ Once the system is all hooked up, add **DOT5** brake fluid and bleed the system from the bleeder on top of the brake assembly. The top of your brake master cylinders reads dot3. Dot3 is not compatible with the Matco brakes so it is a good idea at this time to mark the tops of your master cylinder **DOT5** to avoid confusion in the future.

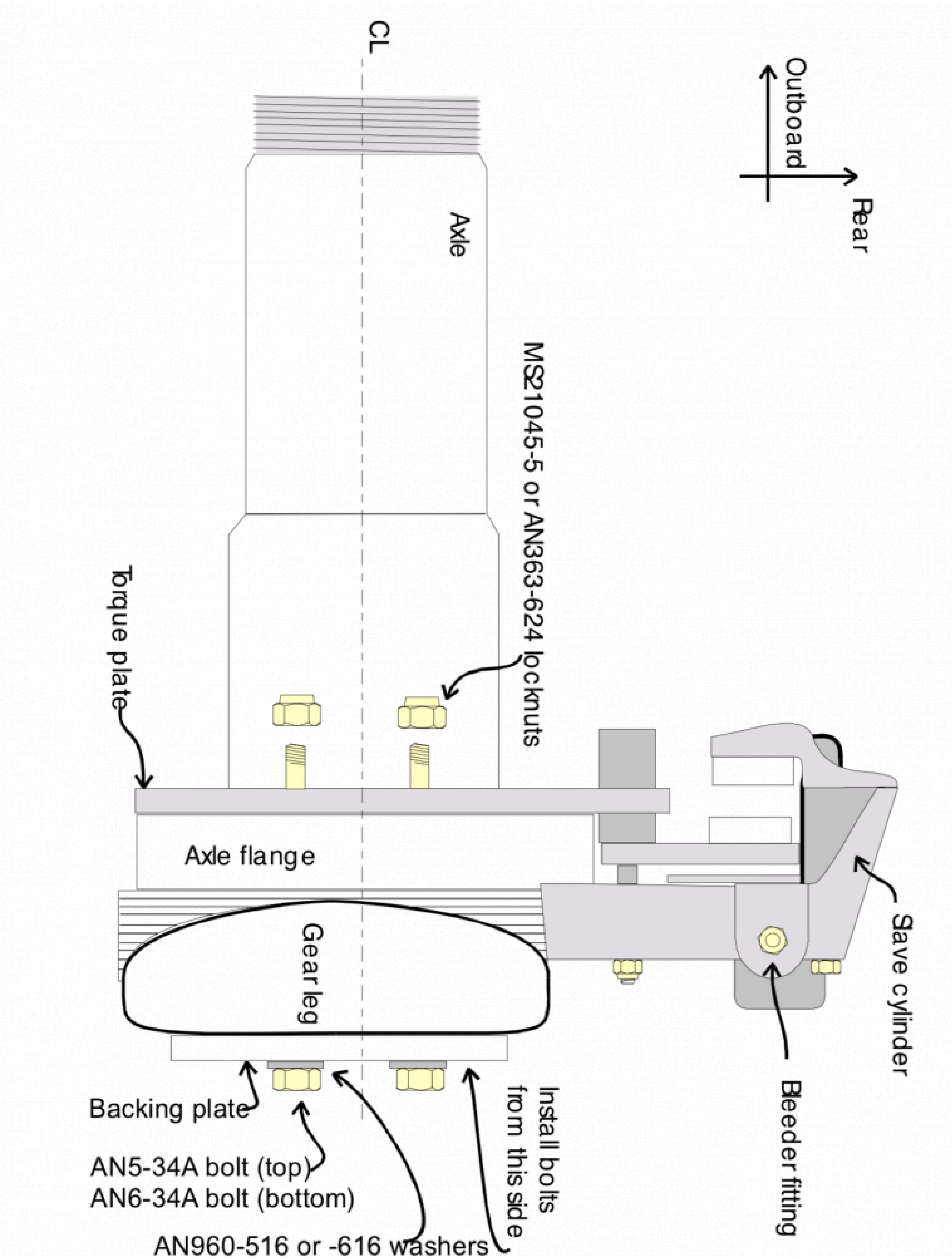


Figure 8-6. Main Gear Axle Assembly Detail

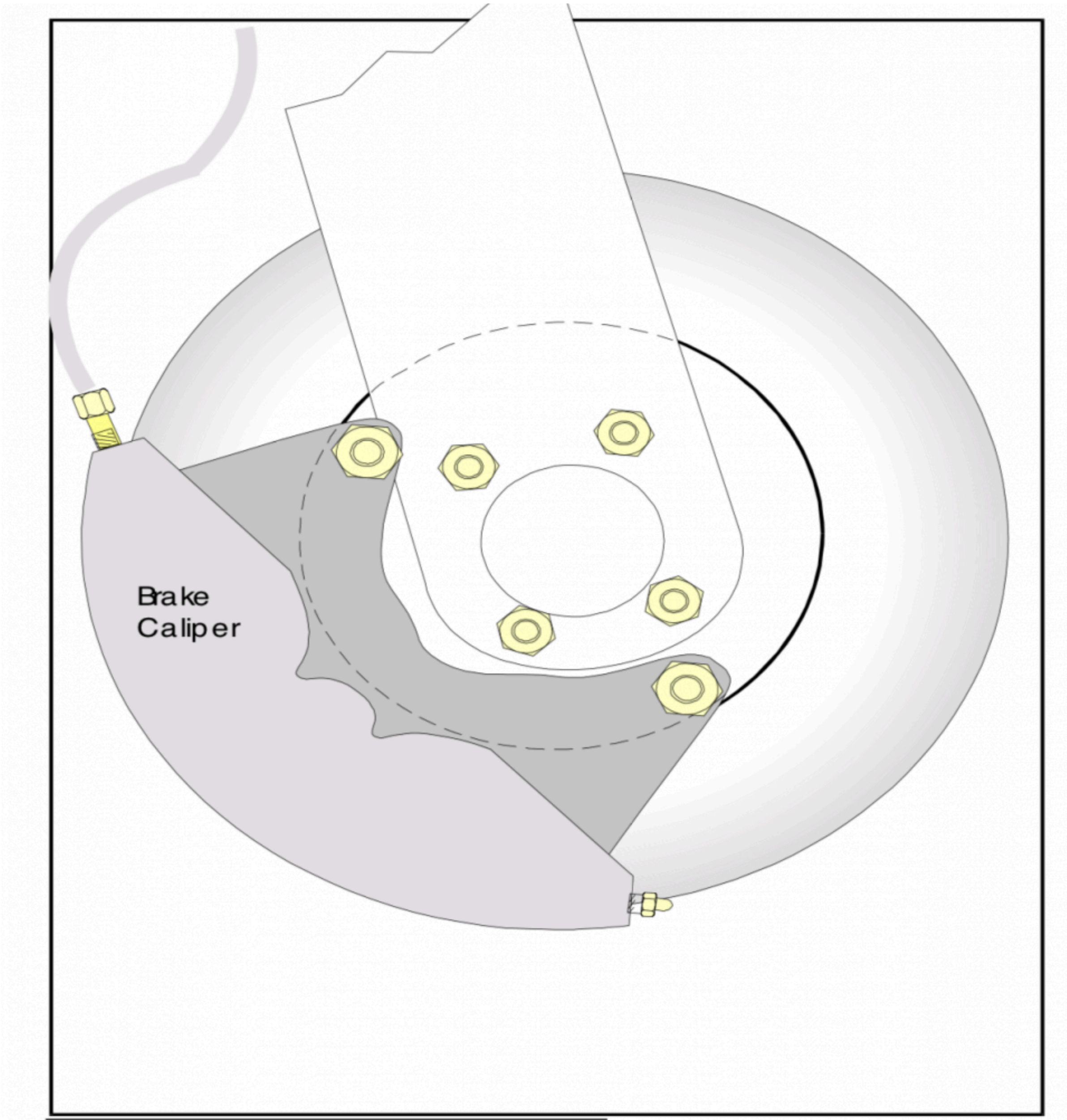


Figure 8-7. Brake Assembly Side Detail

8.3. 8.2 – Nose Wheel Installation

8.2 – Nose Wheel Installation

8.2.1 – Nose Wheel Installation

The fork assembly comes with the axle, shims, and set screw in place.

___ Assemble the nose wheel, tire, and tube with the three 5/16” × 3” bolts and locknuts provided. Inflate tire to 45 psi, and maintain it at that pressure.

___ Grease the axle and spacers. with a little wheel bearing grease. Lock axle into place using the set screws provided. Install the fork and wheel onto the nose gear using the diagram below.

___ Tighten the nylock nut until it takes about 15-20 pounds to rotate the tire when pushing on the rear of the tire. This is a good starting point. Experiment until you have it loose enough for easy taxiing while being tight enough to prevent shimmy. It is better to be tighter.

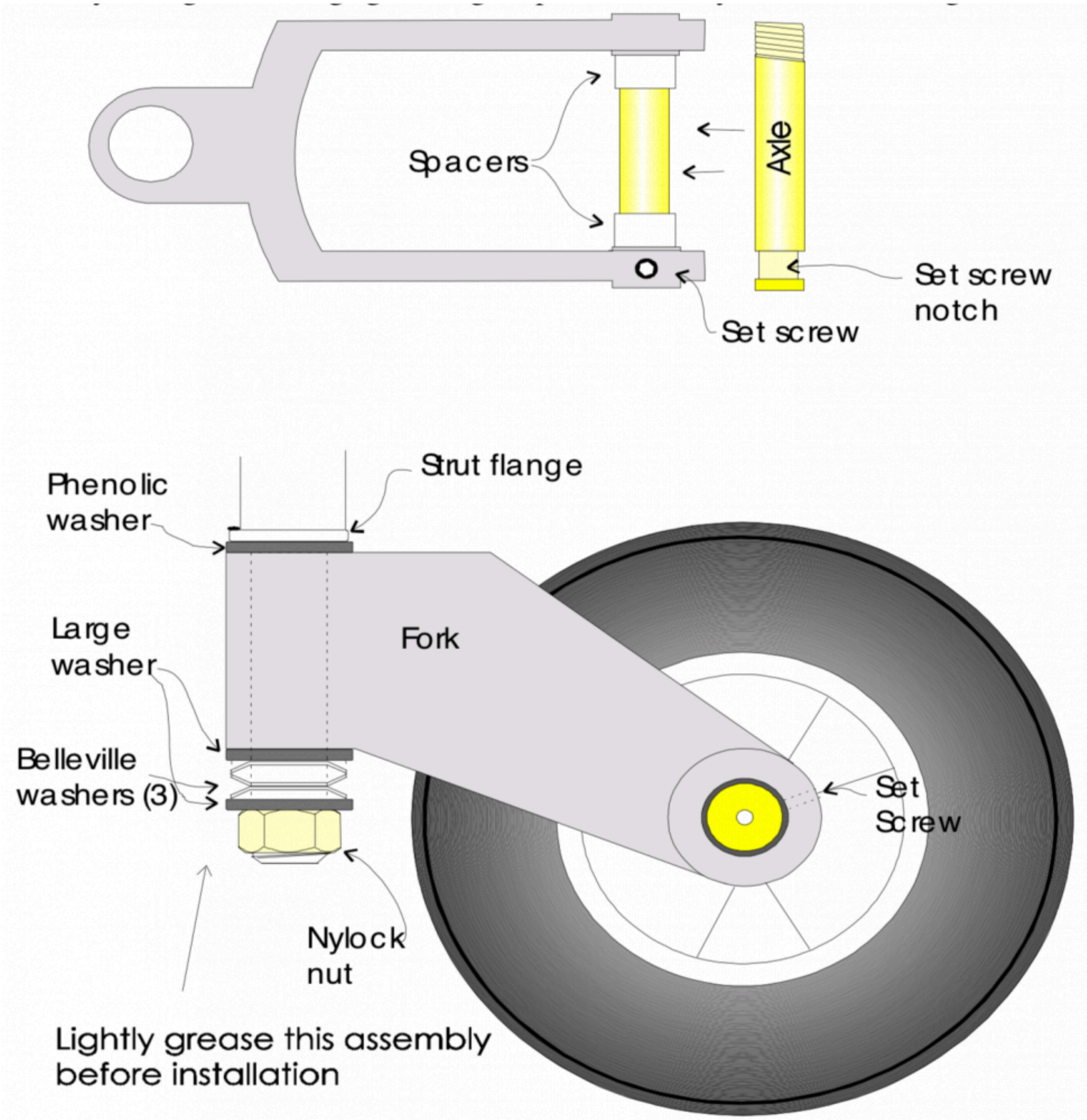


Figure 8-8. Nose Wheel Assembly

Note: It is extremely important throughout the operation of the Velocity to maintain proper inflation in the nose wheel tire and adequate pressure on the Belleville washers.

The Belleville washers prevent shimmying, which can be disastrous in a tricycle-gear aircraft such as the Velocity.

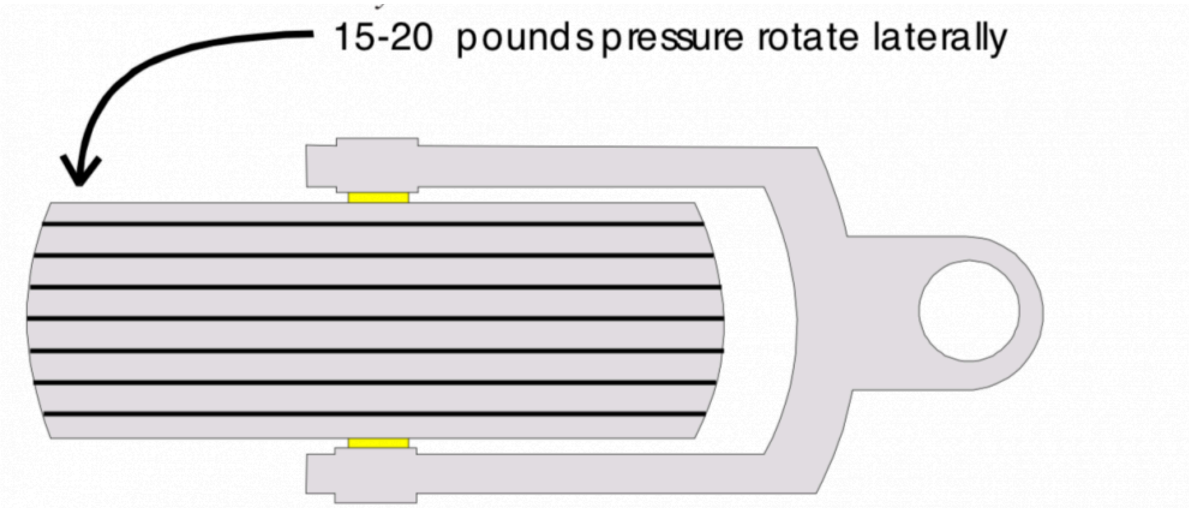


Figure 8-9. Nose Wheel

9. 9 – Fuel System

Contents

9.6.2 – Wing Strake to Beam Support

9.6.3 – Installing Leading Edge of Strake onto Door

9.7 – Fuel System Plumbing

9.7.1 – Solid Fuel Line Installation

9.1. 9.0 – Chapter Preface

9.0 – Chapter Preface

9.0.1 – Parts List

Part Number	Description	Qty
	Wing Incidence Jig	1
	Wing Bolts	6
	Wing Attach Washers	12
	Sight Gauge Elbow	4
	3/8” Aluminum Tubing	
	Fuel Cap	2
	Pilot Lower Strake	1
	Pilot Upper Strake	1
	Co-Pilot Lower Strake	1
	Co-Pilot Upper Strake	1
	Sump Tank	1
	Sump Tank Lid	1
	Aluminum Hardpoints, Sump Tank	3
	4×8 Dyvinicel sheet	1
AN816-6D		3
AN818-6D		13
AN819-6D		13
AN822-6D		4
AN827-6D		1
AN832-6D		1
AN924-6D		1
CAV-110		1
MS21042-3		4
AN3-10A		4
AN970-3		4

9.0.2 – Tools List

Description
Jig Saw
Kitchen Strainers
Fly Cutter (or hole saws)
1/8” Pipe Thread Drill & Tap
1/4” Pipe Thread Drill & Tap
5/16” Drill & Tap
Jacks for Wings
I-Beams
Carpenters Square

9.0.3 – Supplies List

Description
EZ-Poxy
Milled Fiber
Micro Balloons
Cab-o-Sil
Bondo
1/2” – 20 Nuts (6)
Structural Adhesive
Flox

9.0.4 – Glass List

Type	Size	Qty
BID	9” × 55” (Strake Skin to Skin)	8
BID	2-1/2” × 55” (Strake to Spar)	8
BID	2-1/2” x Length of Strake	16
BID	2’ × 8’	2
BID	3” x Attach Bulkheads & Baffles	
BID	Cover Fuel Fittings	
BID	Cover Foam At Naca Vent	
BID	Cover Around Fuel Cap	

BID	4” x Length of Fuselage	8
BID	Bulkheads to Upper Strake	4
Triax	4” × 24”	4
Triax	4” × 28”	4
BID	Cover Sump Hardpoints	
Triax	3” × 6” Sump Mounting Pads	12
FINE	Perimeter of Sump Tank	2
FINE	4” x Forward Strake to Door	16

9.0.5 – Process Overview

Construction Process	Pilot Completion Date	Co-Pilot Completion Date
Attach Lower Strake		
Create Transfer Template		
Level Fuselage		
Position Lower Strake		
Trim Lower Strake		
Bevel Lower Strake		
Attach Lower Strake		
Glass Strake to Spar		
Attach Strake to Wing		
Cut Out Baggage Access Holes		
–		
Attach Bulkheads & Baffles		
Trim & Fit Upper Strake		
Create Baffles & Bulkheads		
Trim Baffles & Bulkheads		
Mount Baffles & Bulkheads		
Seal fuel tank		
Install Bulkhead Sight Gauges		
Install Fuel Line		
Install Fuel Strainer		
Install Vent Line		
Install Vent Manifold		

–		
Install Upper Strake		
Install Fuel Cap		
Final Fit Upper Strake		
Clean Tank Thoroughly		
Seal Tank		
Attach Upper Strake		
Cut Wing From Strakes		
Complete Upper Strake Installation		
Install Remaining Bulkheads		
Outboard Strake Re-Inforcements		
–		
Sump Tank		
Install Hardpoints in Sump Tank		
Drill & Tap Hardpoints		
Install Sump Mounting Pads		
Install Sump Tank Vent		
Install Low Fuel Warning System		
Clean Tank		
Seal Tank		
Attach Tank Cover		
Attach Tank to Fuselage		

9.0.6 – Documentation Changes

Oct 01, 2018 – Original Web Release

9.2. 9.1 – Transfer Template

9.1 – Transfer Template

9.1.1 – Transfer Template

Note: At this time it is advisable to build your wings and canard if you have not already done so. You will need the wings and the canard mounted to the fuselage for proper mating of the fuel strakes.

If you have room to attach the wing then do so and skip this section of making a transfer template. The wing itself, rigged in its proper position, will then be the template to which you fit the strakes. It will also align/twist the ends of the carry through spar to minimize the shimming necessary for rigged flight.

Note: Avoid the transfer template if at all possible.

The purpose of this template is to transfer the shape of the leading edge wing root to the outboard end of the wing strake without having to install the wing. In order to install the strake halves to match the leading edge wing roots build a transfer template. Use 1/2” plywood for the templates.

It is essential that the factory cut edges be used for the ends of the patterns that join to each other to achieve squareness. Accuracy here saves a lot of filling and sanding later and provides a good finished appearance. See Figure 9-1.

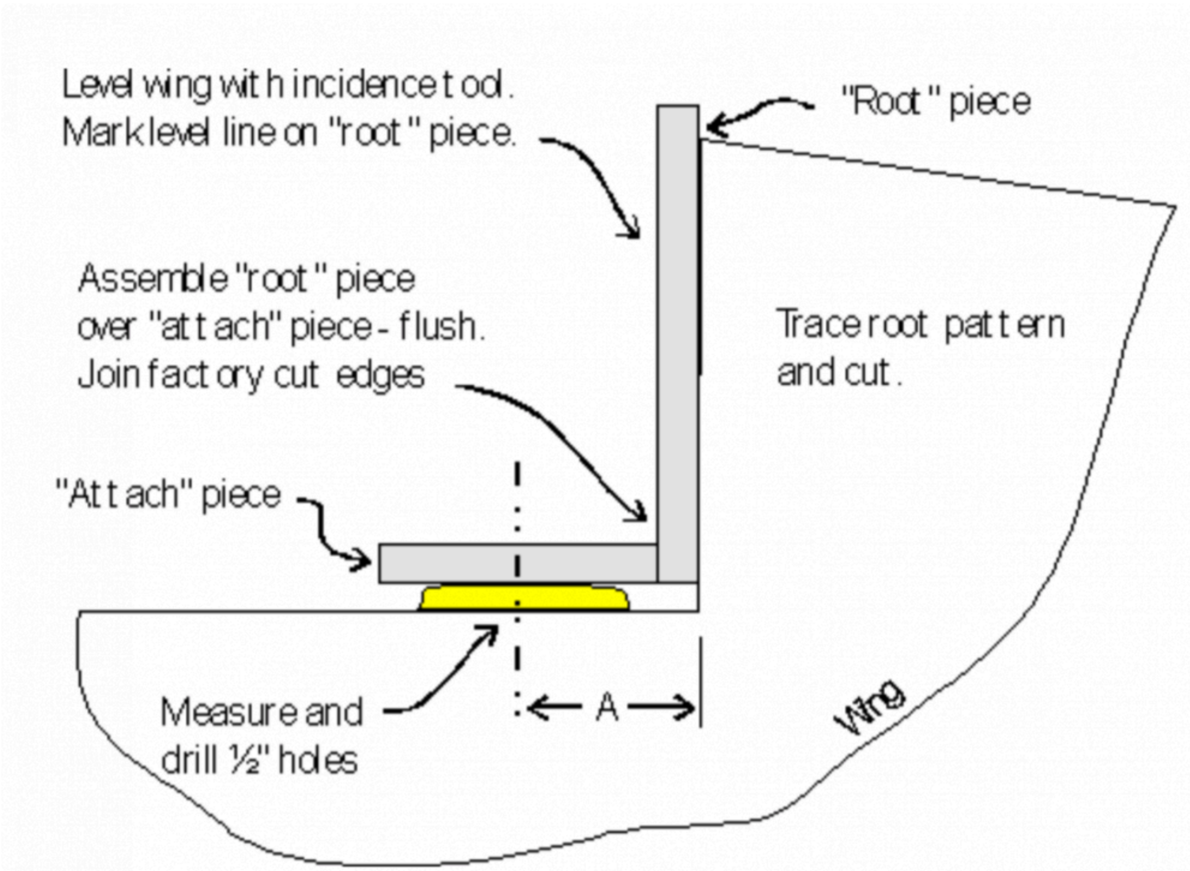


Figure 9-1. Transfer Template Construction - Tracing Wing Root

When the wing was built, you cut the leading edge root square with the front inboard spar face. Recheck and carefully sand for squareness.

The first step is to construct a pattern of the leading edge wing root.

___ Cut a root piece slightly larger than the leading edge wing root with a factory edge on one end.

___ Cut an attach piece about 6” × 6” with one good factory edge (mark that edge for identity).

___ Join the two pieces at their factory cut edges, lapping the root piece over the attach piece, keeping the joining edges absolutely flush. Measure from the leading edge wing root to the attach bolt hole centerlines.

___ Transfer these measurements to the outside of the attach piece and drill the two 1/2” holes.

___ Install joined pieces to the wing and trace the leading edge root shape onto the root piece.

___ Level the wing using the incidence tool provided. Mark a level line on the root piece. Remove the pattern assembly and carefully transfer the level line to the opposite side.

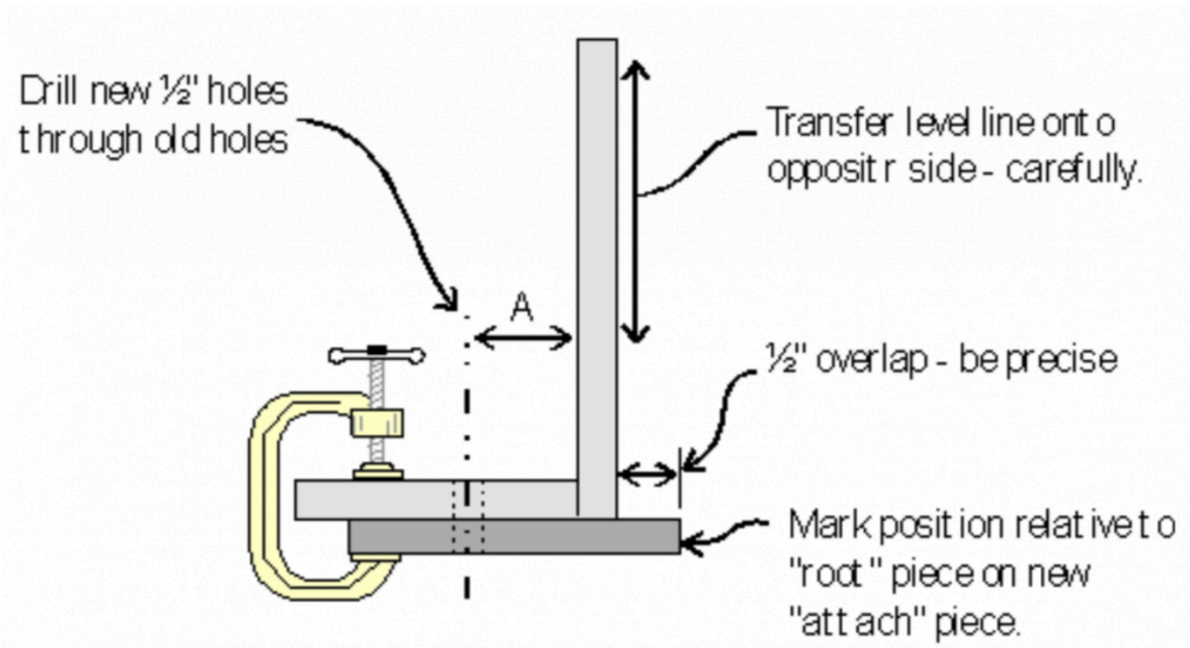


Figure 9-2. Transfer Template Replicate Attach Process

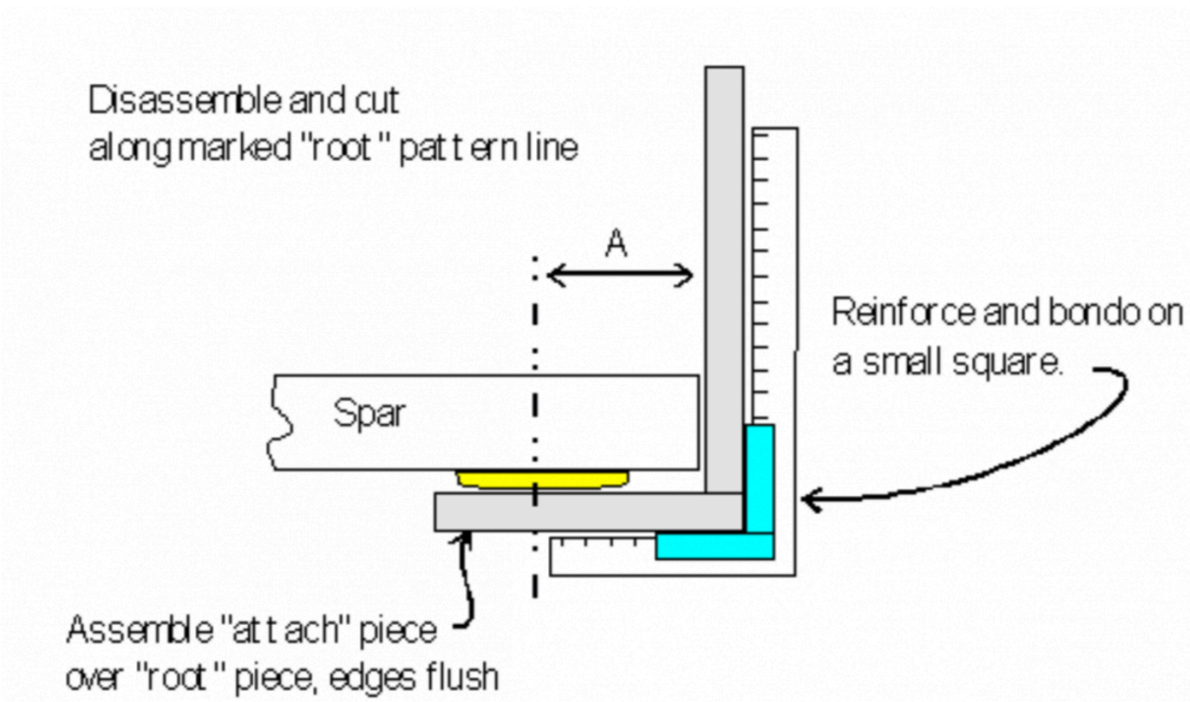


Figure 9-3. Transfer Template - Final Assembly

___ Cut another attach piece as before. Align and clamp this piece so that the factory edge extends 1/2" beyond the outside corner of the pattern assembly. Be precise and check the 1/2" extension along its full length.

___ Drill holes in the new attach piece using the old holes as a guide. Carefully mark the relative position of the new attach piece to the root piece. The transferred level line is a good point of reference.

9.3. 9.2 – Lower Fuel Strake

9.2 – Lower Fuel Strake

9.2.1 – Preparation

___ Level your fuselage fore and aft, and install one wing at a time, both wings if you have room. If you do not have room, build the transfer template described in Section 9.1.1.

___ Using your wing attach bolts for fit, go to the hardware store and get some 1/2”-20 nuts and save your locknuts for final assembly.

___ Once the wing(s) is bolted to the center section spar, check the level of the wing using your incidence block.

___ To adjust to level, support the wing outboard, and twist the spar with the wing by shimming the outboard support until zero incidence is achieved. Be sure that nothing moves during the strake installation process.

The strakes take all the torsional loading back into the fuselage and they are not rigid until the upper halves of both the strake and the fuselage are complete.

If you are using transfer templates, twisting of the spar becomes difficult, so shim washers must be used if any variations occur. (Keep track of how many washers are used and their positions).

9.2.2 – Lower Strake Alignment

Note: The next paragraph is of critical importance!

The elevation of the leading edge of the strake at the fuselage side (Point A) with respect to the elevation of the bottom of the lower spar cap (Point B) is of great importance. **The strake leading edge must be 2-7/8” +- 1/8” higher than the lower spar cap at the side of the fuselage.**

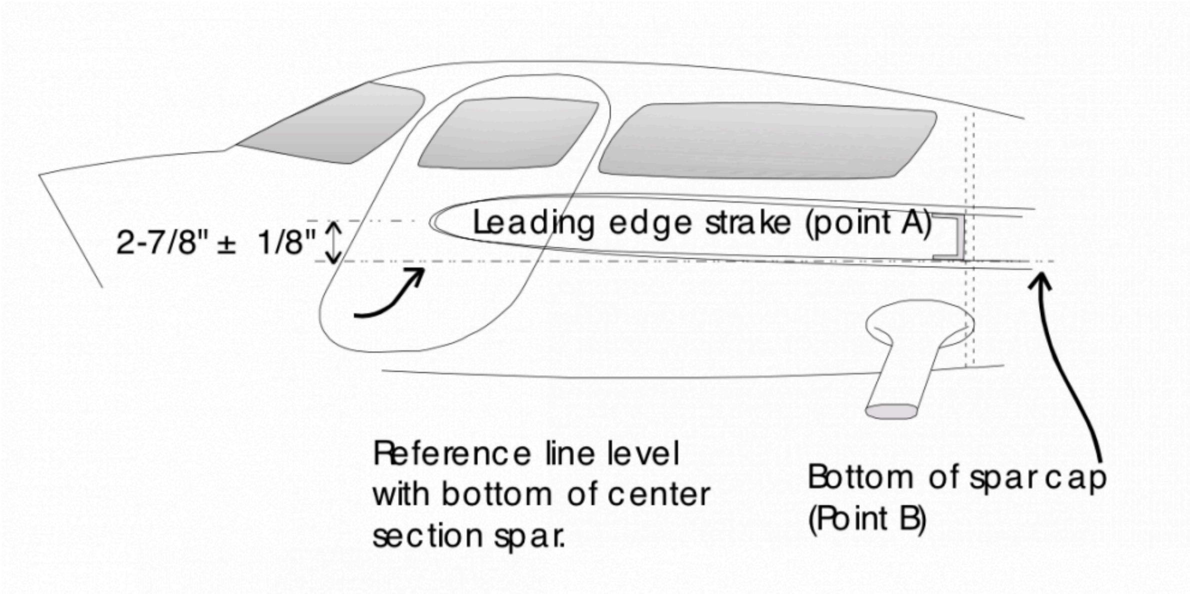


Figure 9-4x. Strake Location References

___ Prior to cutting the sides of the fuselage and installing the strakes, check the above dimensions carefully. Proper installation will result in a -0.5 degree angle of attack on the inboard fuel strake area. This angle of attack is critical in maintaining the proper center of lift. See Figure 9-4.

___ With the fuselage level for-to aft, and side-to side, draw a reference line level with the bottom of the center section spar where it meets the fuselage side. It should go about 78" forward from the aft side of the spar.

___ Draw a parallel line 2-7/8" +- 1/8" above the line drawn in the last step running about 76" – 78" from the aft spar face. This is the centerline of the strake leading edge at its inboard end. **Get both sides the same.** Check measurement using a water level.

Note: Due to a change at the factory, there is a discrepancy between the video and the plans during the following steps. In the past, the strake had the foam recessed, leaving a lip 4-5" wide running the length of the trailing edge. This is no longer the case. It was difficult to make the recessed edge fit parallel to the c-section spar. Now, we do not remove the foam at the factory. The builder does it, allowing him to custom fit the strake trailing edge to his aircraft. This change applies to both upper and lower strakes.

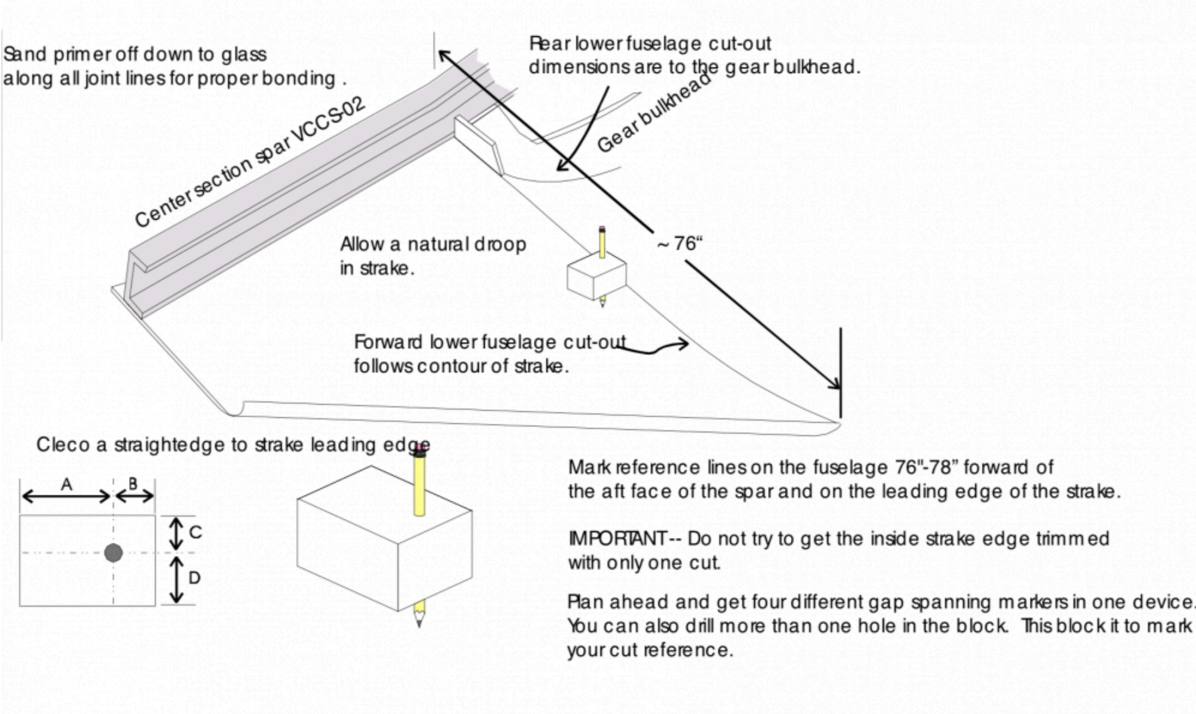


Figure 9-5x. Fitting Strake to Fuselage

___ Using a sawhorse, some shims, and a 2 × 4 piece of wood, support the lower strake up under the spar and support the **leading edge inboard** centerline mark even with the line on the fuselage side approximately 76” forward of the aft spar face.

___ You want to have approximately 1” of the strake trailing edge, lapping over onto the wing. This will serve as a fairing, bridging the spar gap. Fashion a pen/pencil to a small block of wood to bridge the gap between fuselage and strake and guide the marker along the fuselage side marking a cutoff line on the strake. Take small bites as you cut and try the fitting. Pay careful attention to the **outboard** edge match with the wings. See Figure 9-5. Trimming is required here.

It is a good idea to place the leading edge of the strake 1/4” aft of the leading edge of the wing. The top strake and glass work on the leading edge will make up the differance when they are installed.

Before you cut, think of what will be affected; cutting in one place will affect another place! You want to square up the outboard end of the strake with the inboard end of the leading edge wing root, and get a smooth transition of the strake curve to the wing curve. Keep in mind that the transition match up might change a small bit once the foam is removed from the trailing edge of the strake.

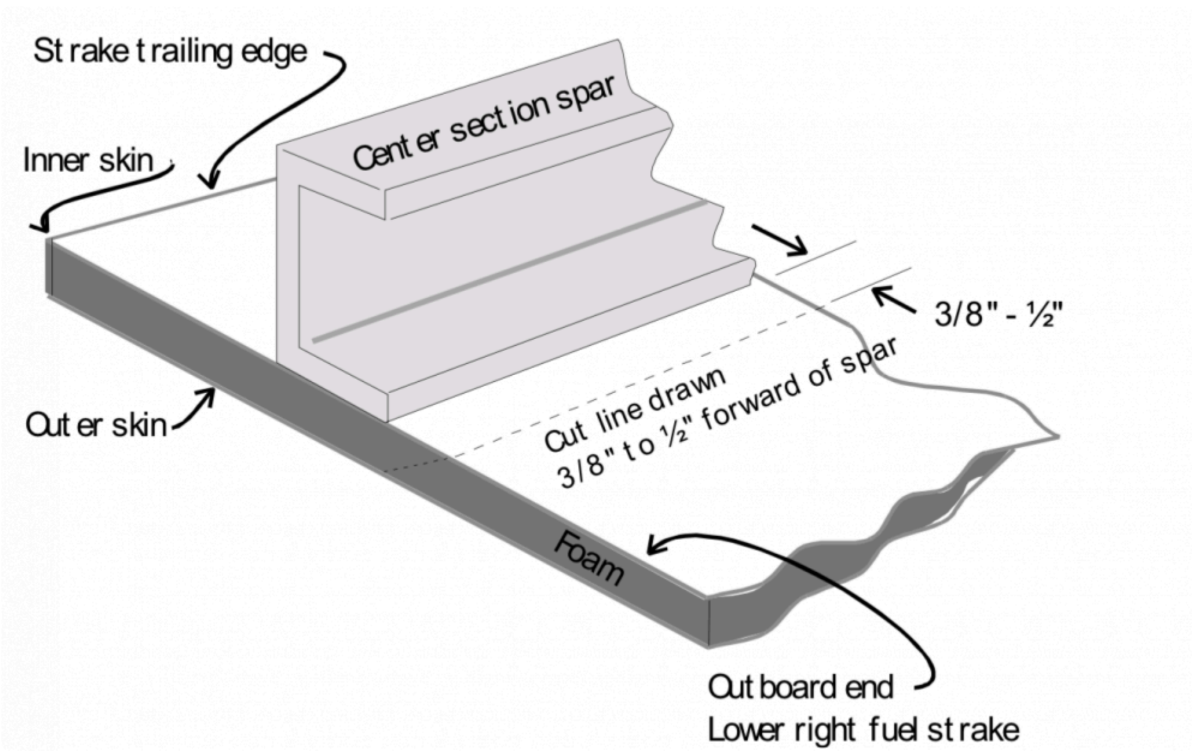


Figure 9-6. Cut Line for Inner Strake Skin and Foam Removal

View is of the right end of the center section spar and lower right fuel strake prior to removal of inner skin and foam from the trailing edge.

___ Once you are pleased with the fit of the strake, mark a line where the strake meets the leading edge of the center section spar. Pull the strake half, and mark another line, parallel to the first, approximately 3/8” to 1/2” forward of the first.

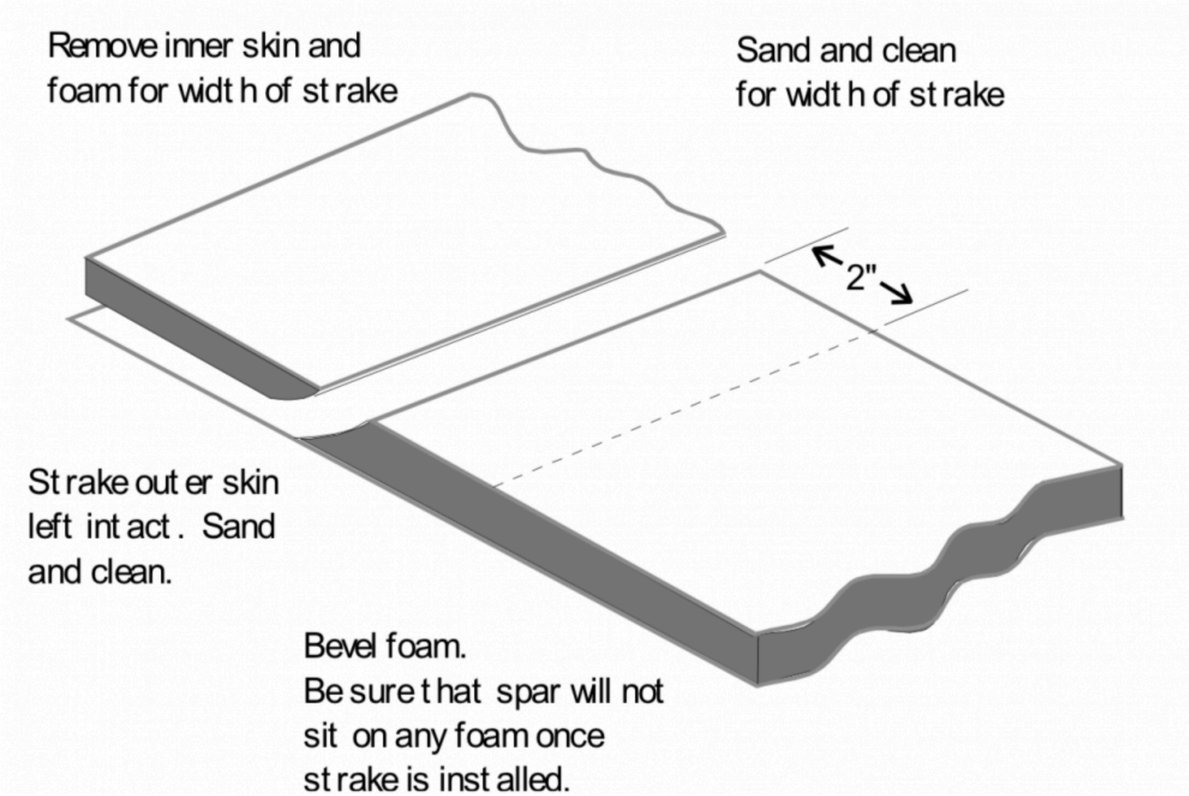


Figure 9-7. Removal of Strake Inner Skin and Foam

___ Remove the inner skin and foam aft of the second line that you drew, leaving the outer strake skin intact. See Figure 9-7.

___ Clean up the inner surface of the outer skin with some 80/100 grit paper and some acetone. At the same time, clean and sand the inner surface of the inner skin, up to 2” forward from the edge of the recessed foam.

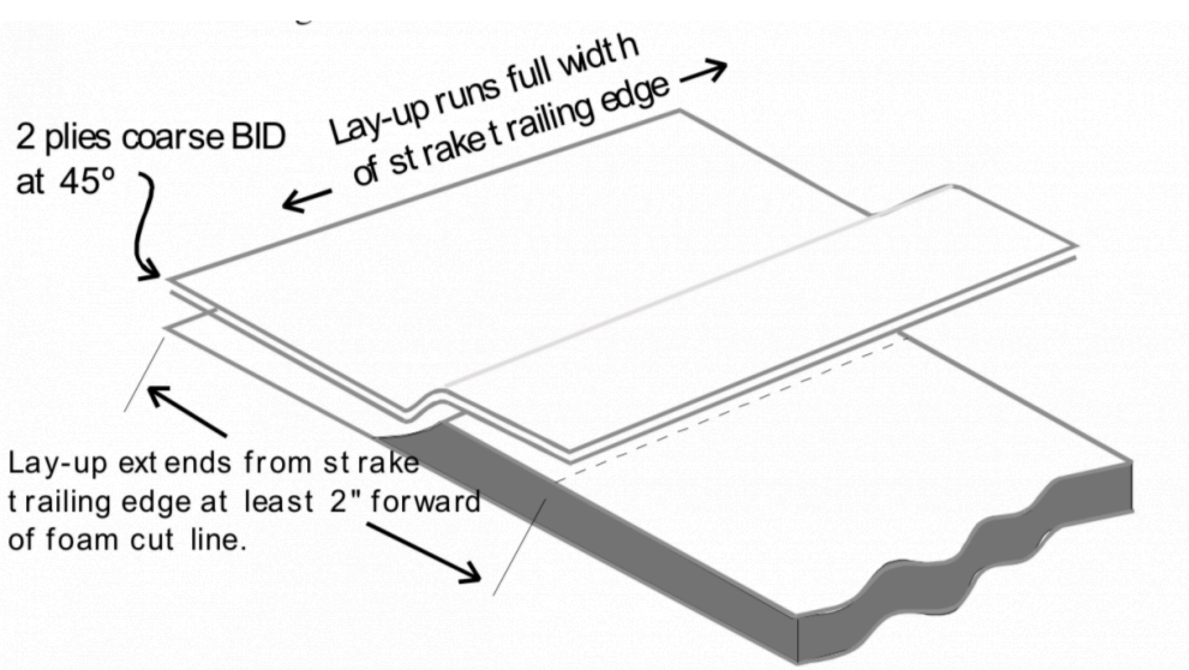


Figure 9-8. Lay-Up Over Inside of Lower Strake

___ Bevel the foam transition so that you do not have a 90 degree bend for the following glass lay-ups to contend with.

___ Place the strake back into position, and check the fit once more. The new edge of the foam should run parallel to the forward face of the center section spar, about 3/8” to 1/2” forward of it.

___ If everything lines up, pull the strake, and prepare to lay up 2 plies of **BID** (cut on a 45 degree bias) along the length of the trailing edge. Be sure that (1) the foam is beveled, (2) exposed foam is covered with slurry, (3) the strake surface is pre-wet with epoxy.

___ The cloth should be cut wide enough to extend from 2” forward of the edge of the foam back to the trailing edge of the strake (approximately 9” by 48”). Apply the glass, and let cure.

After the proper fit is achieved and all the seams and edges line up, it is time to cut out the side of the fuselage for baggage access.

___ Reinstall the lower strake half, supporting it firmly under the spar with a straightedge. At the point where the fuselage and leading edge intersect, support with a sheet metal screw or cleco. Asheet metal screw run from the inside of the fuselage into the foam of the strake (near the leading edge) steadies the strake up nicely.

___ With the strake hanging, sight down the line of intersection between the fuselage and strake to make sure that it is a nice, constant curve. You do not want any binding against the side of the fuselage. Mark the fuselage side where it intersects the inner skin of the strake. Also, support the strake at the wing root or transfer template with blocks Bondoed to the roots or the template.

It is to your advantage to get the outboard end of the strake to match the curve of the wing root as closely as possible. Use clamps, weights, etc. to achieve this. It will save you a lot of work later. Be sure that the two sides are the same.

9.2.3 – Cut out Lower Baggage Access Openings

The forward access openings simply follow the upper skins of the lower strakes. Cut away the fuselage sides from these areas.

Measure and mark the vertical edges of the rear access openings about 18” forward of the gear bulkhead and continue to approximately 8” behind the rear door cutout. Later you will trim the front of the opening to follow the contour of the carbon beams. Temporarily install the top strake to get an idea where to cut the top of the cutout. It is best to cut inside your lines, then file down later.

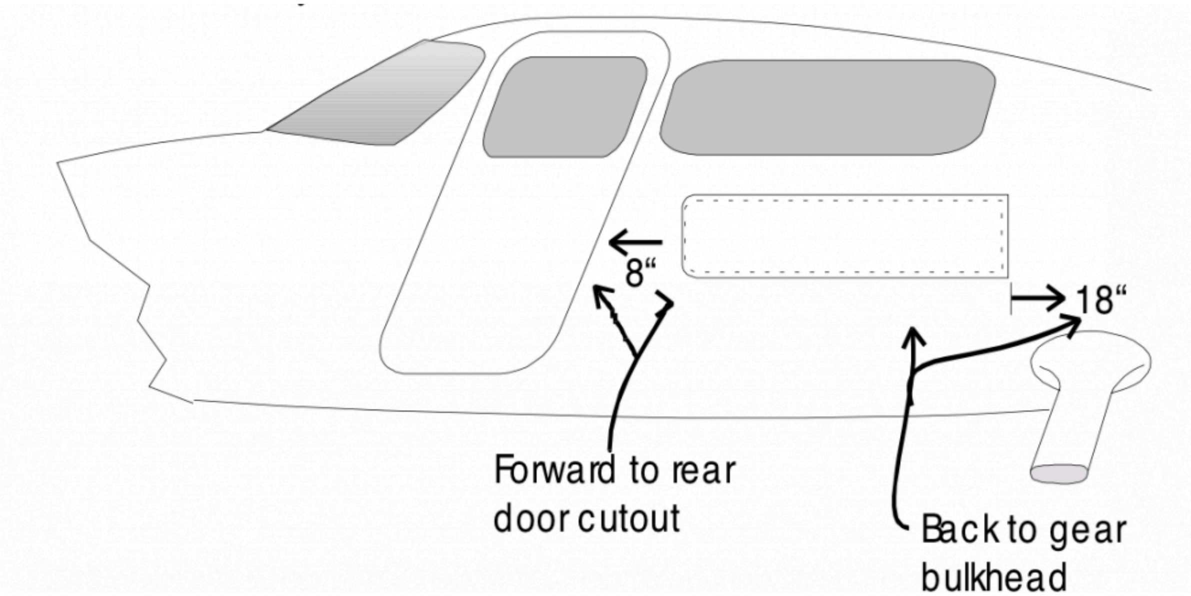


Figure 9-9x. Openings for Access to Strakes

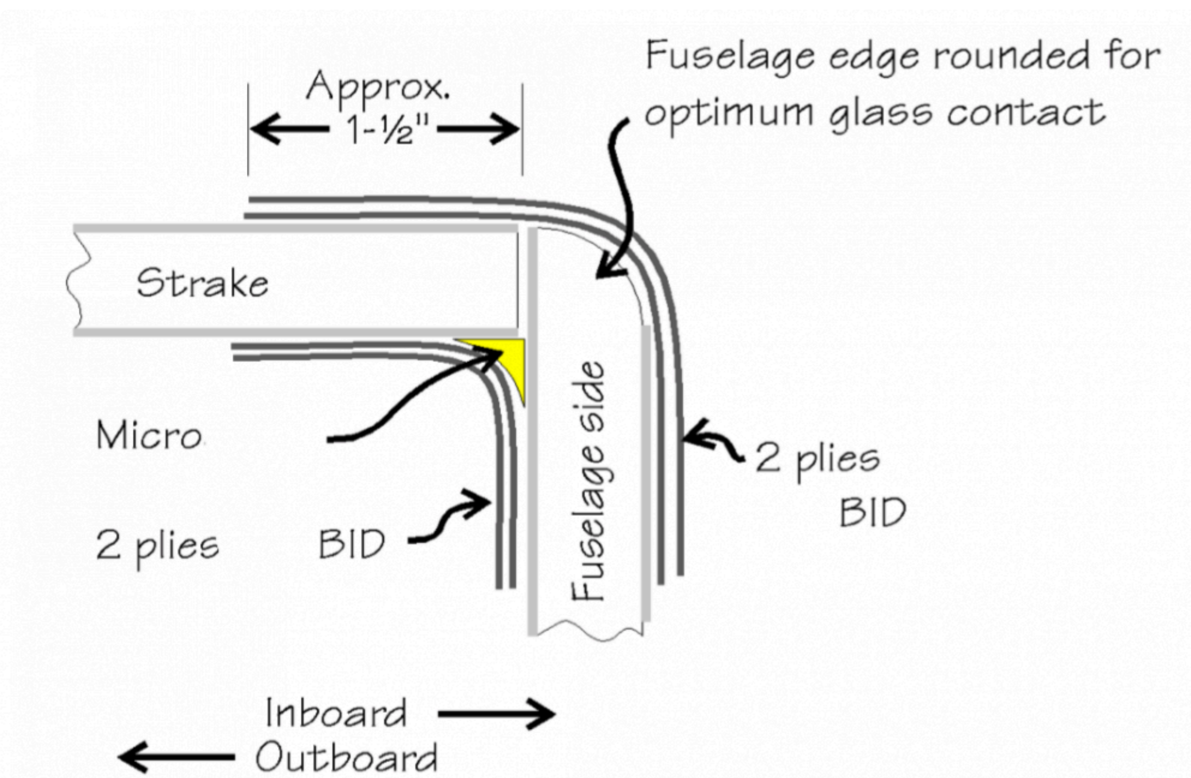


Figure 9-10. Treatment of Access Cutout Junctions

___ At this time it is very important to thoroughly sand all the areas where the strake and fuselage intersect as well as where the strake and spars intersect. Proper mating of these components is very critical. The strakes not only carry fuel and baggage, but they transfer torsional loading into the fuselage (so break out the sandpaper)!

___ In the areas where the outer skins meet strake/fuselage it is necessary to remove primer back approximately 2” to accept the tape glass. On the inner skins of the fuselage, it is necessary to round the corners slightly so tape glass will conform around the corners. See Figure 9-10.

9.2.4 – Lower Strake Half Glassing

___ Make a trial run and get your skins and supports ready for the installation. Make sure that everything fits well and both sides are the same. Notice that the lower strake trailing edge extends aft of the center section spar and overlaps the lower surface of the wing by about an inch with the solid foam core wings. This trailing edge is going to be bonded to both the spar and the wing, and therefore necessitates a cut line to allow wing removal.

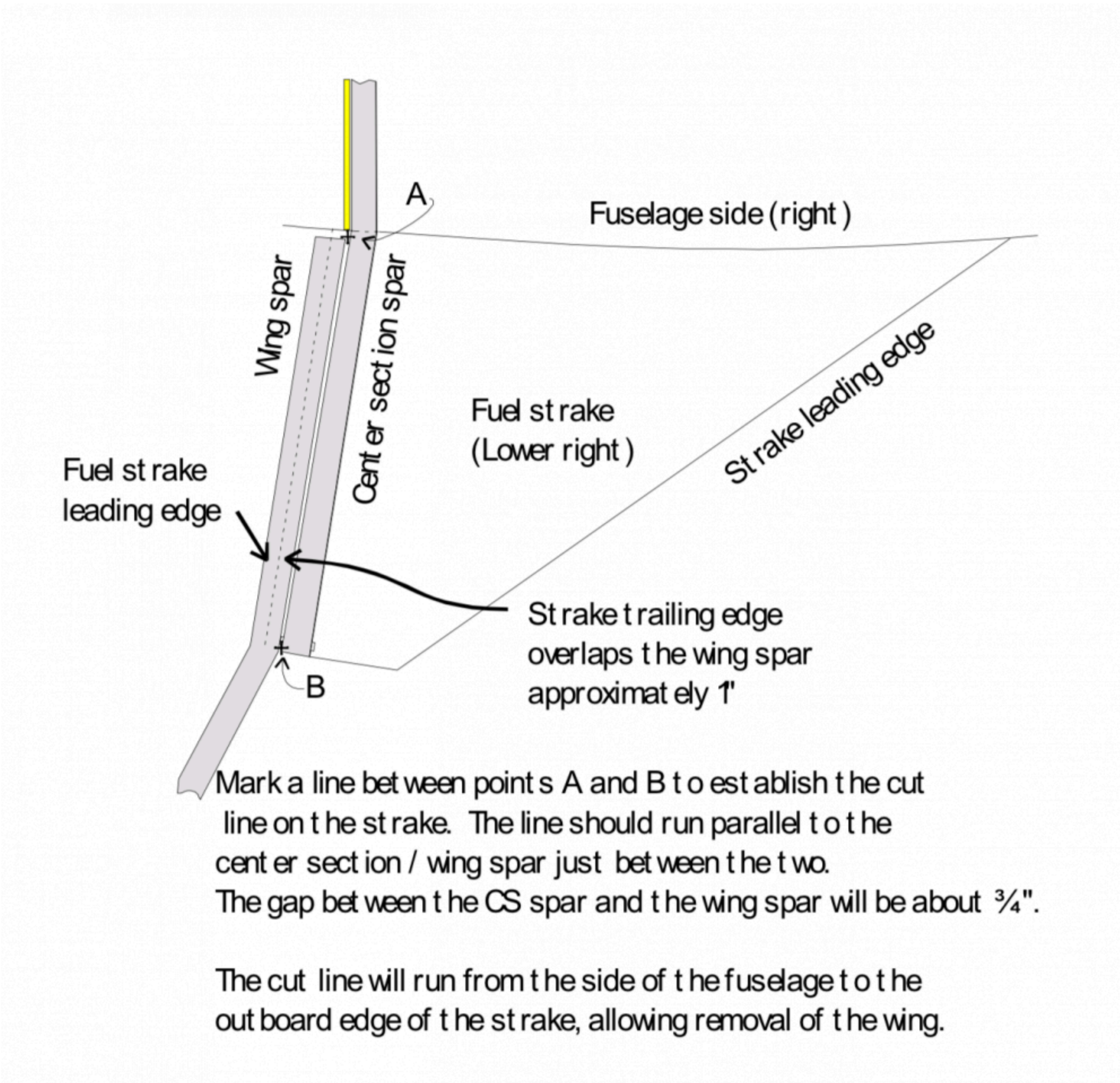


Figure 9-11. Establishing Strake Trailing Edge Trim Line

The cut will be made following complete installation of the fuel strake system, but now is a good time to mark where the cut line will go. The cut line will run parallel to the center section spar and the wing spar, midway between the two, extending from the fuselage side to the outboard edge of the strake. See Figure 14-12. **Be careful not to cut the spar cap when the cut is made!**

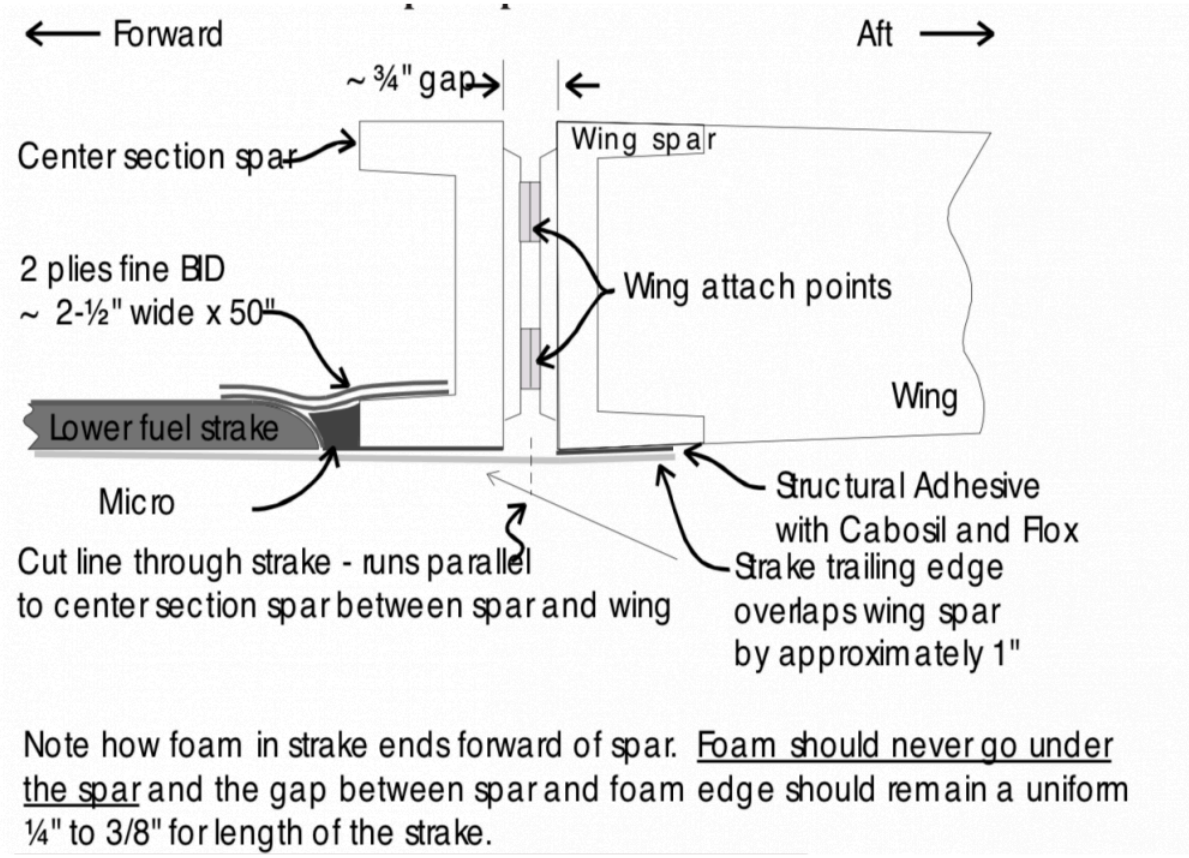


Figure 9-12. Wing / Spar / Strake Junction - Cross Section

___ You will need a healthy amount of **Structural Adhesive and Cabosil** to mate the strake skin to the center section spar cap and the wing spar cap. **EZ-Poxy** and **Flox** may also be used. Apply the **Structural Adhesive** to the strake in area below the spars and jig into place. Mound the **Structural Adhesive** to the center and the front of the Spar. If there are gaps at the back they can be filled in when the wing is removed. To hold the strake in position use a section of the aluminum I-beam supplied in your kit. Cover the top of the beam with duct tape. Screw a wood screw into the side of the fuselage just forward of the firewall and under the center spar. You want it high enough so that it will take a little force to push the I-beam in between the strake bottom and the screw. On the opposite end of the I-beam drill a hole large enough for another wood screw so you can screw the I-beam up to the wing. At the inside portion of the wind you have a flange that is about 2 inches deep. Drive the wood screw into this flange. This will hold the aft end of the strake up tight to the spar.

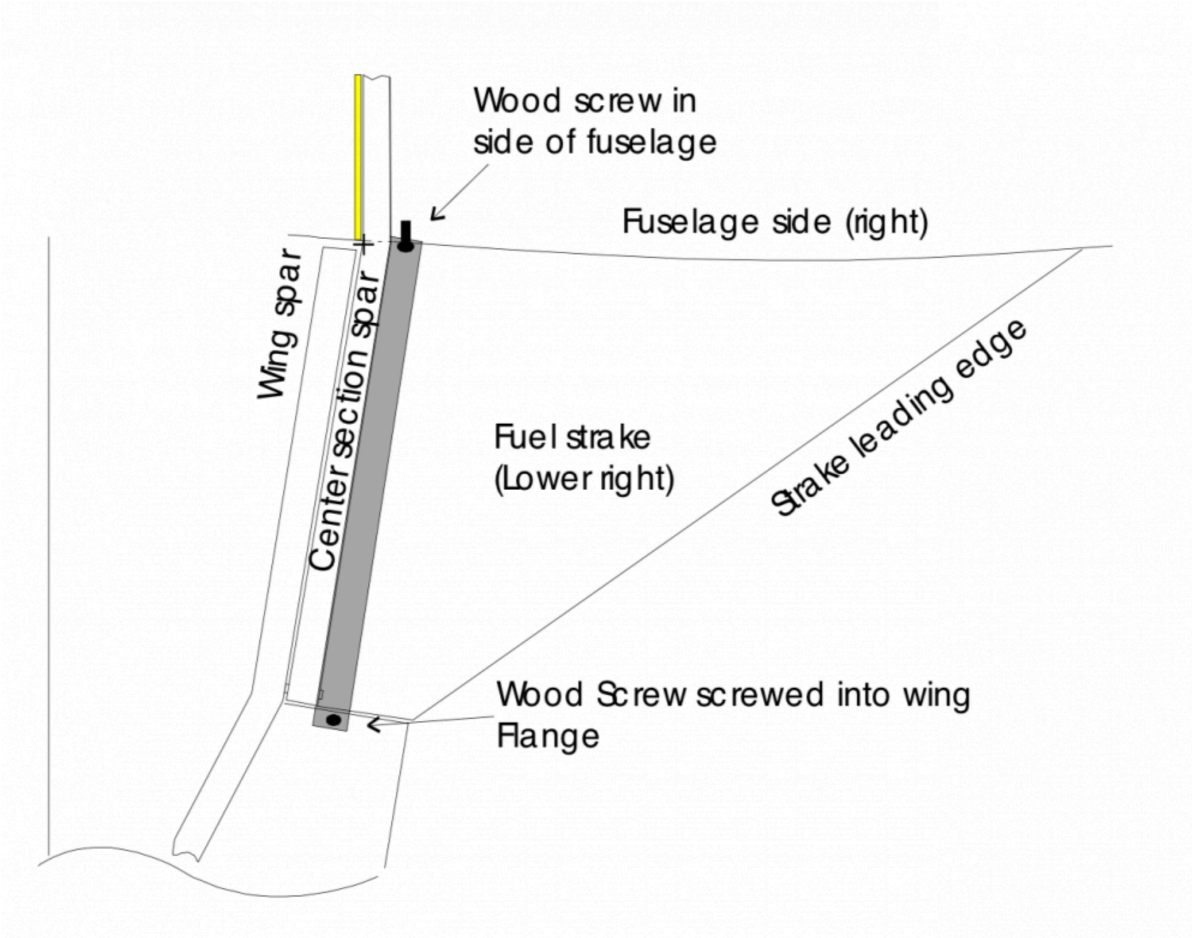


Figure 9-13. Holding Lower Strake in Place with I-Beam

___ Lay-up two plies of **BID** to tie the strake inner skin to the forward face of the center section spar. The lay-up should run the length of the spar-to-strake contact area. See Figure 9-12.

It will be necessary to remove primer in the areas where the outside surface of the strake intersects the outside surface of the fuselage. Take the primer back about 2" on both the strake and the fuselage side, then apply a finger radius of **Micro-Glass** along the length of the intersection, Figure 9-12. As shown in Figure 9-10, you should round the inside corners of the fuselage where it meets the strake to facilitate better surface contact by the fiberglass that you will be applying in the next step.

All areas of intersection of strake to fuselage (inside and out) get 2 plies of **BID** tape glass approximately 2-1/2" wide cut at a 45 degree bias. Check everything and let cure.

It might be advantageous for the builder to be able to differentiate between the upper and lower strakes without having to rely upon the labels alone. Looking at the strake from the outboard end, you will notice that the upper strake has a more pronounced curvature than does the lower strake. Just in case your labels fell off, this might be nice to know.

To fit the upper strake, use exactly the same procedure that you used to fit the lower strake skin. Do not force anything and think first before cutting. It will be necessary at this time to fit the upper half of the fuselage.

___ First remove the flange in areas where affected and remove the area forward of the firewall to accept the main spar. It might be helpful to remove small sections of the flange in the nose area to insure proper alignment of outer skins so there will not be any surprises when it comes time to finish the mating line between the upper and lower fuselage halves.

The baggage cutout in the rear is an extension of the lower cutout right up to the inner skin of the upper strake.

___ The sanding and preparation of the upper strake and fuselage is the same as that of the bottom strake.

After fitting the upper strake, overlap the leading edges and cleco together inboard and outboard of the fuel tank. In the center of the leading edge where the fuel tank is, use duct tape every inch or two to hold in place while fitting the bulkheads and baffles.

9.4. 9.3 – Internal Strake Structures

9.3 – Internal Strake Structures

9.3.1 – Baffles and Bulkheads

You will need to glass the 4’x8’ piece of Dyvinicel foam to cut your baffles and bulkheads from. Lay the dyvinicel down on a flat surface. Your glass is only 36” wide so slurry the foam up to this point. Keep the slurry wet so it will spread easier. Lay one layer of **BID** over the top of the slurry and wet out. Make sure you get all the bubbles out under the glass. If you have it is not a bad idea to peel ply this also. Repeat this on the other side after this side has cured. You have a roll of baffle and bulkhead templates. Cut them out and arrange them on your 3’x8’ glassed dyvinicel. You will not have much extra. Trace around the templates and cut them out.

Note: To ease in sealing the interior baffles you can add a second layer of *BID to the inside of the perimeter bulkheads.*

___ Fit all baffles and bulkheads to the lower strake first. Mark the exact location of each piece on the lower skin before removal.

___ Carefully set the upper skin on and sight through the baggage area or wing root to locate any gaps or interference. Sand or cut to fit. Baffles and bulkheads can be temporarily held in place with Bondo or hot glue. I prefer to cut small triangles that are 1” on all sides. Hot glue them to the bottom of you baffles and they act as feet keeping your baffles upright.

___ Here are some hints when fitting the baffles, and bulkheads:

- With bulkheads temporarily in place, mark them and the strake bottom every 6” or so. Remove the bulkheads and place the strake top onto the bottom. Using a tape measure, measure the height at each point and transfer this measurement to the bulkheads. Connect the dots and sand. You want to have about 3/16” gap between the bulkhead and top strake to allow for **Micro-Glass**.
- After you get them close, fit and Bondo one piece at a time in place and keep trimming it until you get just a little clearance. Agood coarse file works well for this.
- As you fit each baffle or bulkhead, groove the top of the foam to give the **Micro-Glass** that will be used to bond the top strake (Section 9.3.4) a better grip.

See Figure 9-14 for bulkhead/baffle layout. The **baffles** are located within the fuel cell. They are installed with one ply of **BID** tape on each side of the baffle. The function of the baffles is to prevent the fuel from sloshing and to add rigidity to the structure of the craft.

The **bulkheads** serve as the boundaries of the fuel cell. These are installed with two plies of **BID** tape on each side of the bulkhead and require extra coats of epoxy on the fuel side to seal in the fuel. The bulkheads are installed first and properly sealed before the baffles are installed.

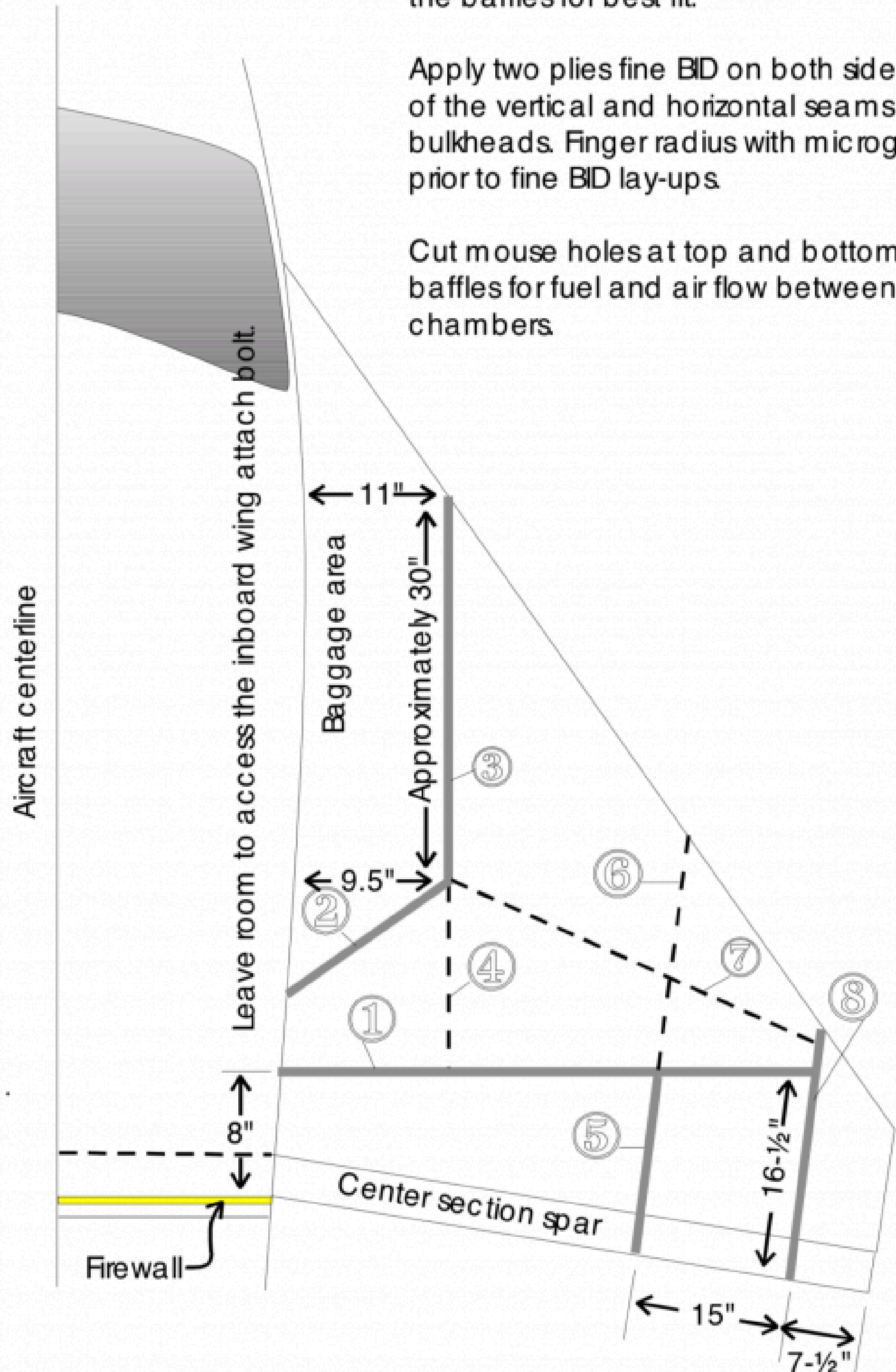
Note: Do not install the two bulkheads that go back to the spar from the long rear bulkhead (5 and 8) until after the top strakes are installed and the rear bulkhead to strake top joint is glassed.

Note: Any modifications to the tank or baggage areas to accept more or less fuel may affect the C.G. When fuel is added. We do not recommend any change to the established placement of bulkheads / baffles in the fuel strakes. Careful attention must be paid when calculating the C.G. Shift when fuel is added and the aircraft is at attitudes other than that of level flight. The specifications called for in these plans account for such conditions quite satisfactorily. If you disregard our warning, please be careful.

Dimensions are approximate, install the baffles for best fit.

Apply two plies fine BID on both sides of the vertical and horizontal seams of bulkheads. Finger radius with microglass prior to fine BID lay-ups.

Cut mouse holes at top and bottom of baffles for fuel and air flow between chambers.



1 . . . Rear fuel bulkhead
2 . . . Inboard forward fuel bulkhead
3 . . . Inboard fuel strake bulkhead
4 . . . Aft interior baffle
5 . . . Center strake rib
6 . . . Center baffle
7 . . . Forward baffle
8 . . . Outboard fuel bulkhead

Figure 9-14. Fuel Baffle and Bulkhead Location

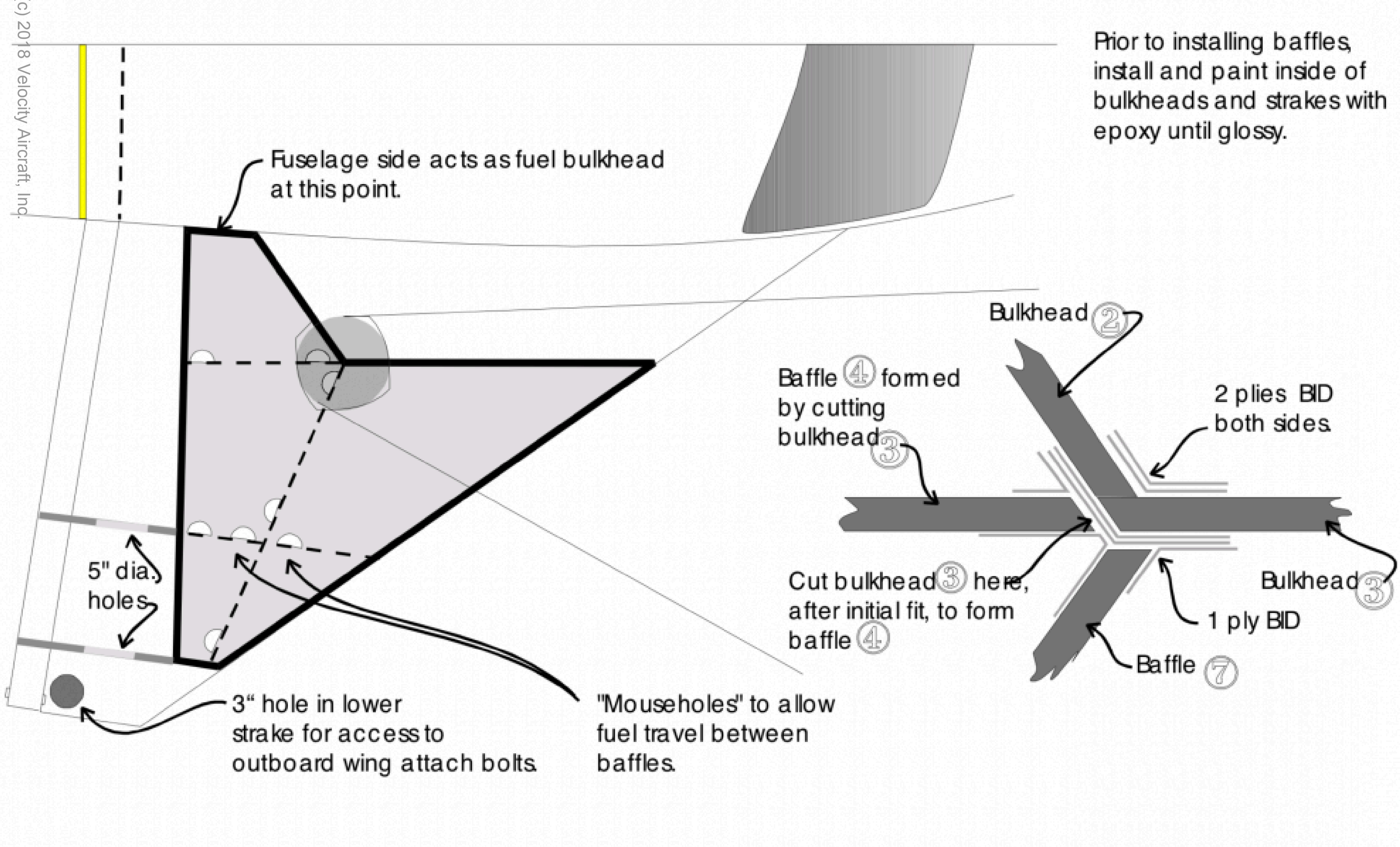

Prior to installing baffles, install and paint inside of bulkheads and strakes with epoxy until glossy.
Fuselage side acts as fuel bulkhead at this point.
5" dia. holes
3" hole in lower strake for access to outboard wing attach bolts.
"Mouseholes" to allow fuel travel between baffles.
Bulkhead 2
Baffle 4 formed by cutting bulkhead 3
2 plies BID both sides.
Cut bulkhead 3 here, after initial fit, to form baffle 4
Bulkhead 3
1 ply BID
Baffle 7

Figure 9-15. Fuel Baffle and Bulkhead Detail

9.3.2 – Install Strake Baffles

___ Install all bulkheads before you install any baffles, see Figure 9-15.

In general, the following applies throughout the installation. All patterns are oversize and will require trial trim fits. While fitting, check the strake to be sure you are not distorting its shape. Follow the Figures 9-14 and 9-15 for locations in the strake, placement of mouse holes for fuel flow and venting, and lay-ups for glassing in place.

Use **two** plies of **BID** at all joints, inside and out, that are part of the periphery. Always apply a good finger radius of **Micro-Glass** at these joints first. One ply of **BID** is sufficient to hold the inner baffles .

Note: When you build your fuel tank you will be sealing it either with EZ-Poxy or Jeffco. Jeffco is more resistant to odd fuel additives that may be found in diesel fuels. If you decide to use Jeffco you will need two 1 gallon kits to seal your tanks. Also Jeffco cures faster than EZ-Poxy so when using Jeffco have everything ready before you mix your Jeffco.

When sealing bottom strake and baffles apply liberally to all surfaces that are between the fuel and the outside, i.e. the inner strake skin and all surfaces that form the tank or fuel containment. Sand these skins and paint them until they are shiny and nonporous. When using **Jeffco** we apply two coats and we thicken the **Jeffco** with a small amount of **Cabosil**. When applying more than one coat apply second coat before the first one completely dries. You want the first coat just slightly tacky to the touch when applying the second coat.

9.3.3 – Bulkhead Fuel Fittings

Install the fuel gauge fittings (Fitting, 3/8 Elbow, Sight Gauge – Part# VFSG-01) through the inboard forward fuel bulkhead, about 4” inside both baggage compartments at the top and bottom. We also carry a clear plastic fuel gauge that is lighted that can be installed instead.

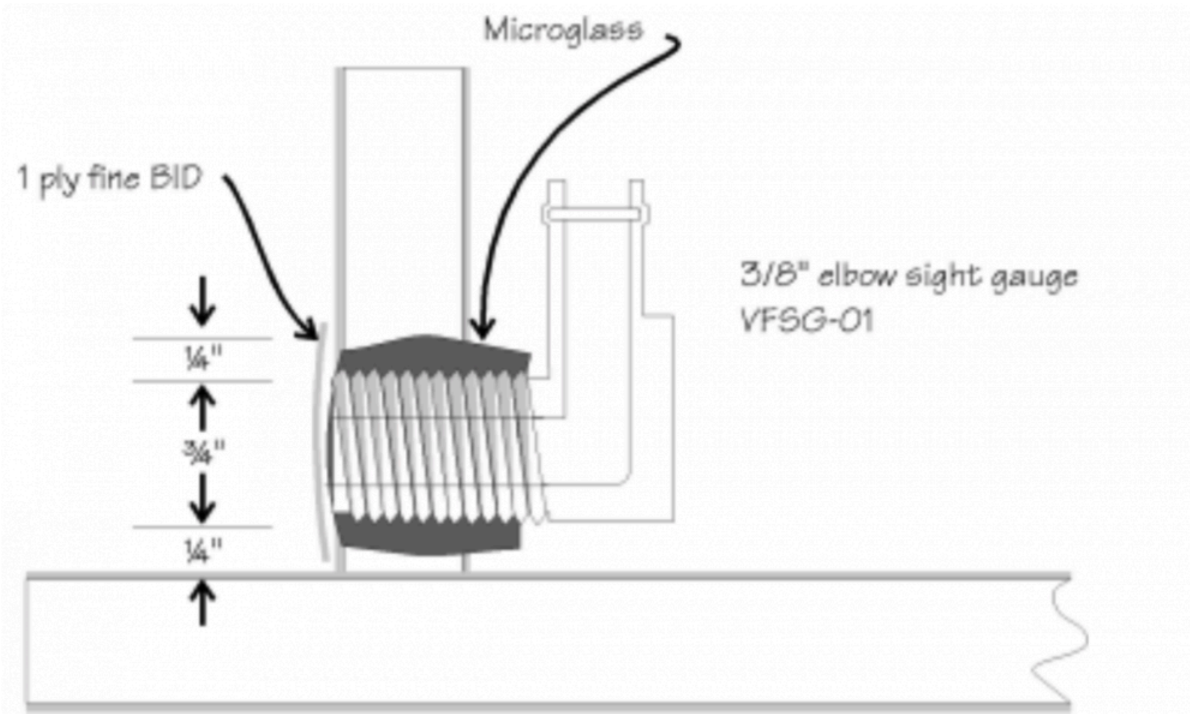


Figure 9-16. Bulkhead Fuel Sight Gauge Fitting Cross-Section

___ Drill a 3/4” hole in these locations. Gouge out about 1/4” of foam from between the bulkhead skins. **Micro-Glass** in the fittings provided with the bottom fittings pointing up at the top fittings and vice versa (depending on whether you are standing on your head or not). Put **BID** over the **Micro-Glass** on all fuel lines and fittings on the inside of the tank.

___ Drill a 3/8” hole through the fuselage (both sides) near the rear lower corner of the fuel tank for the fuel feed line(s). Gouge out about 1/8” of foam exposing both fuselage skins. **EZ-Poxy Micro-Glass** a 20” piece of 3/8” aluminum fuel tubing in this hole with smooth bends along the forward edge of the bottom spar cap.

___ **Micro-Glass** a small piece of stainless steel or brass screen over the hole, inside the tank, cut from a kitchen strainer, or window screen.

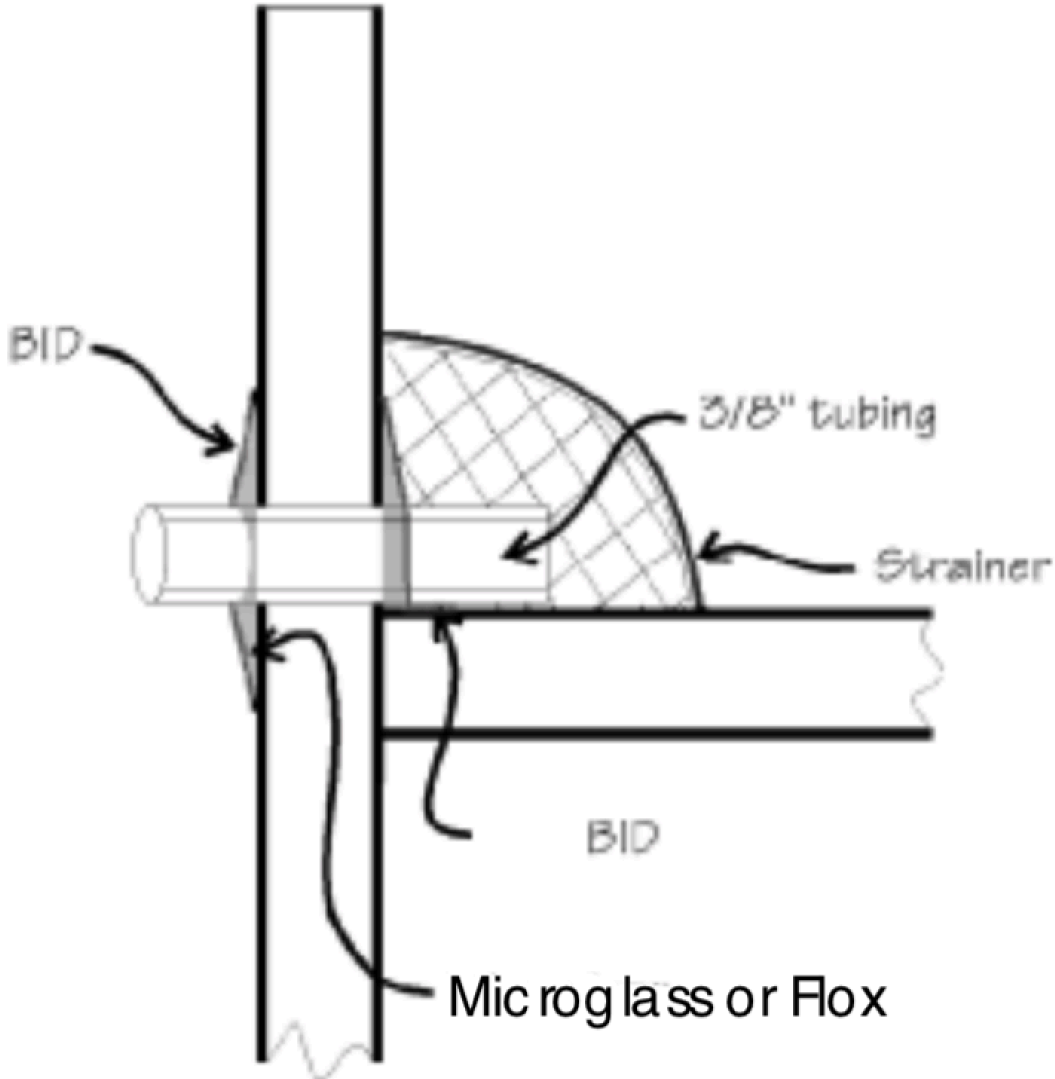


Figure 9-17. Fuel Line Detail

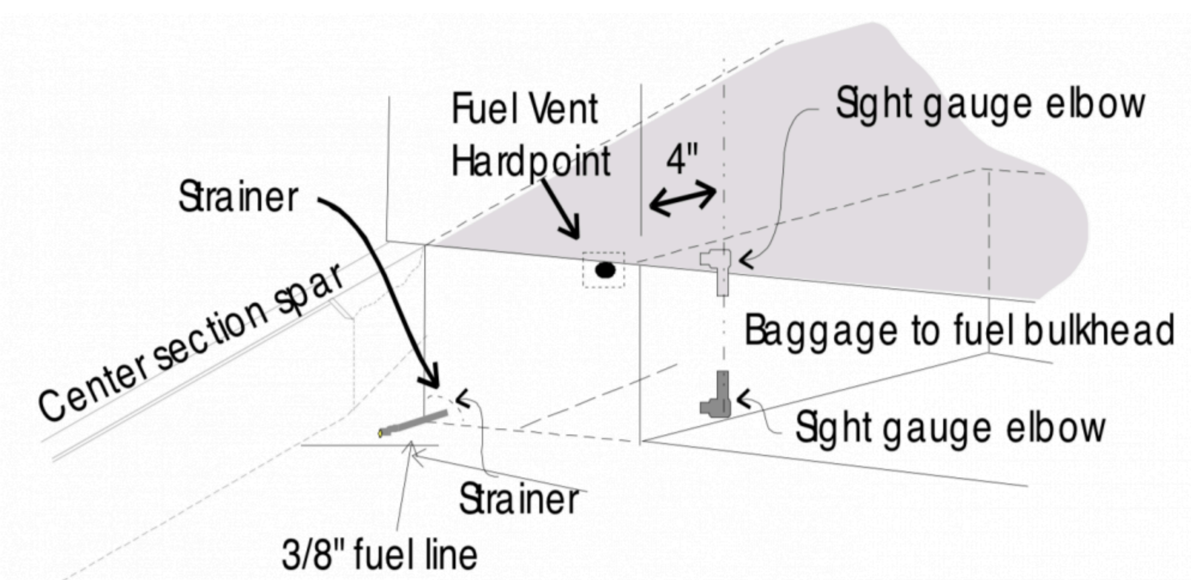


Figure 9-18. Fuel and Vent Lines

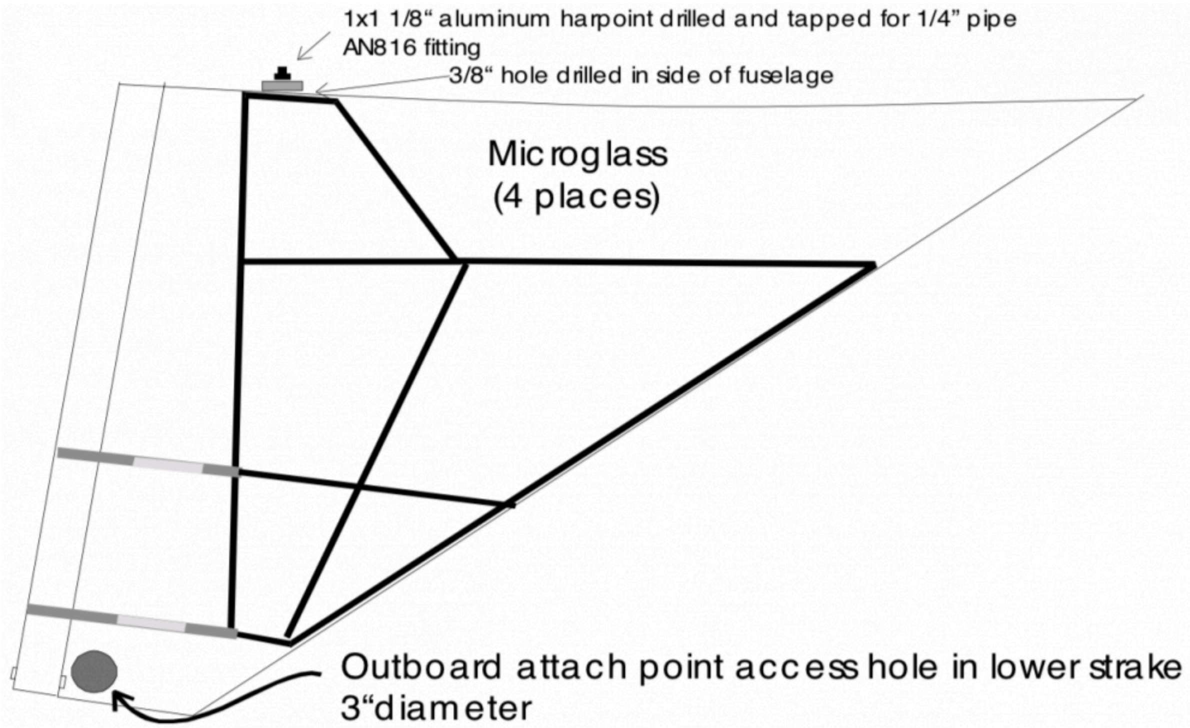


Figure 9-19. Strake Vent Lines

9.3.4 – Fuel system venting

The Velocity uses 3/8" vent lines from each of the three fuel tanks to a common manifold at the top of the firewall.

___ Fit your top strake in place and draw a line on the fuselage where it is. Drill a 3/8" hole in the side of the fuselage 8 1/2" forward of the **Aft** side of the center spar 5/8" down from your top strake reference line. This will put the very edge of your hole just under the top of the strake. Next drill a 7/16" hole in a 1×1 inch piece of 1/8" aluminum. Tap this hole for 1/4 pipe. Using **Structural Adhesive** bond your hardpoint on to the side of the fuselage making sure the hole in the fuselage and the hole in the hardpoint are lined up. After the **Structural Adhesive** has cured glass over the hardpoint with two **BID**. When the **BID** has cured clear the hole in the hardpoint using an Exacto knife. Using liquid Teflon or Permatex #2 insert an AN816 -6D fitting. Repeat for other side.

Aluminum vent lines will have to be made to connect your tank vent to the manifold (AN827-6). Using AN818-6d nuts and AN819-6d sleeves connect your 3003 3/8" aluminum vent lines to your hardpoints and your manifold. Refer to Figure 14-20.

The manifold vents to the outside using a 3/8" aluminum tubing, again joined by AN818 nuts and 819 sleeves. Use Adel clamps to hold Your manifold(AN827-6) and your aluminum lines coming from the fuel tank and also exiting out the bottom.

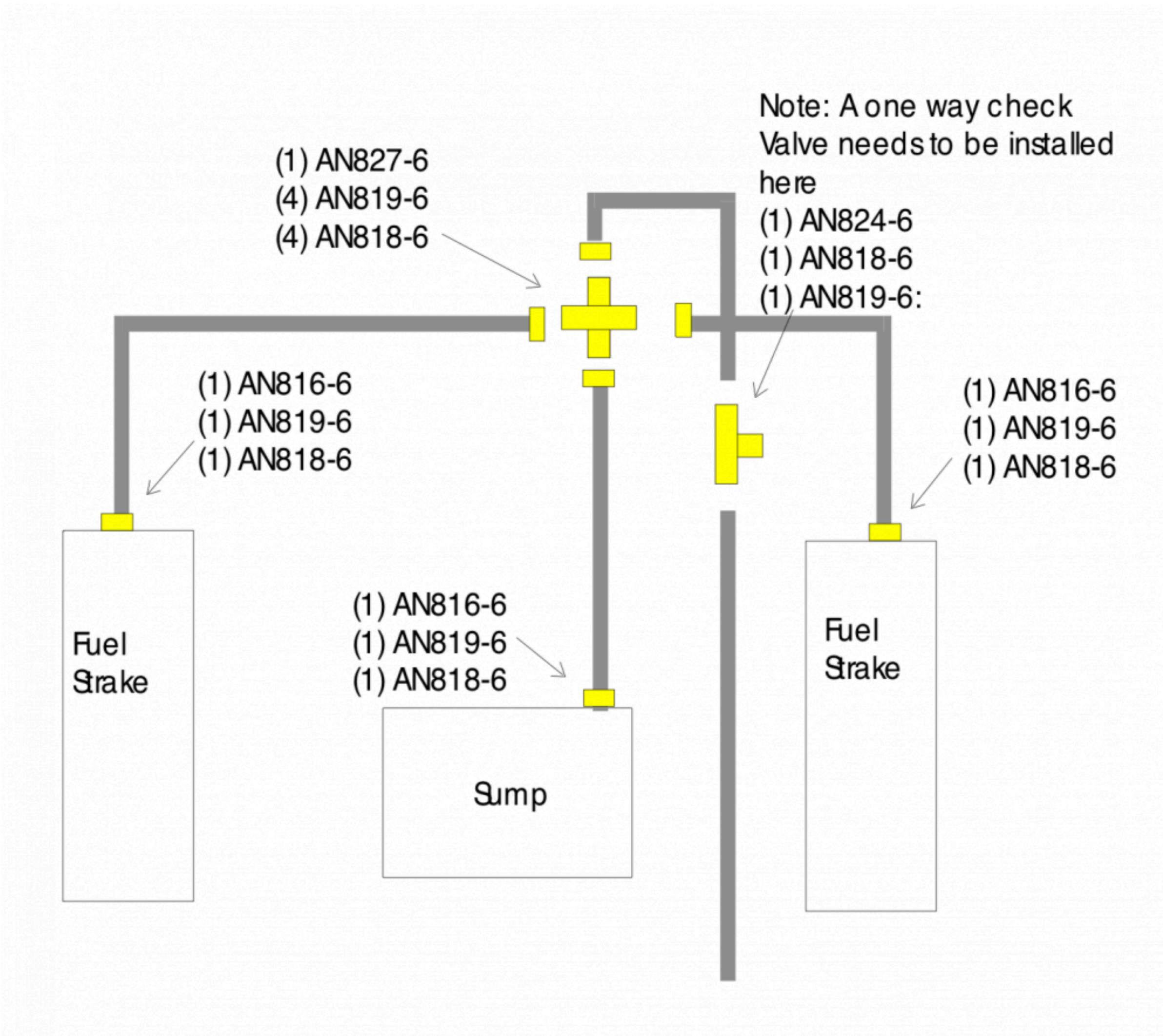


Figure 9-20. Fuel System Vents

Route lines to avoid low points until reaching the manifold (AN827-6). Avoid any control or landing gear structures to keep from interfering with their operation.

___ From the manifold (AN827-6). the vent lines run down and out the bottom of the airplane just forward of the firewall. A one way check valve is installed in this line as shown in Figure 9-20. This will allow your tanks to vent if your main line ever gets clogged. Let the line protrude 3/8” to 1/2” out of the fuselage bottom. Cut off the end at an angle as shown in Figure 9-21. For extra insurance against blockage, drill a 1/8” hole in the aft side of the vent tube.

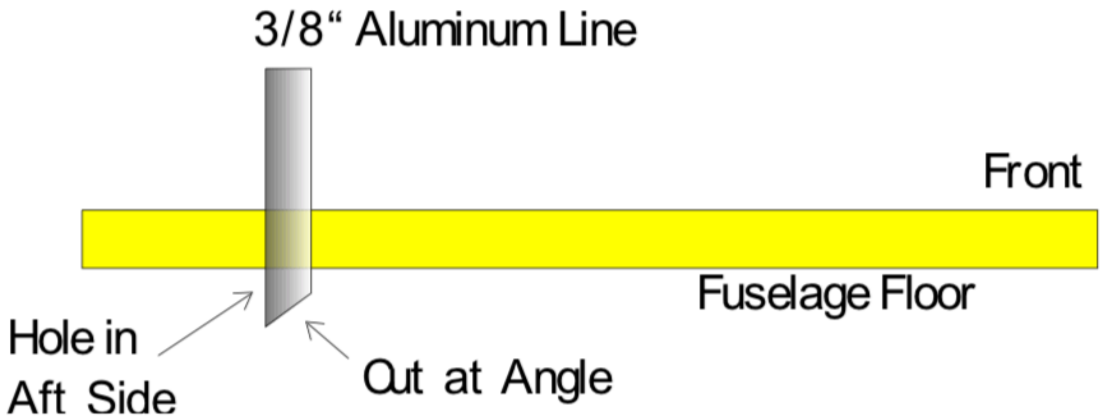


Figure 9-21. Fuel Tank Vent

9.5. 9.4 – Upper Strake Half

9.4 – Upper Strake Half

9.4.1 – Fuel Cap Installation

___ Install the fuel cap before installing the upper strake. The fuel cap should be installed outside the prop arc just in case a fuel cap ever came off in flight. Use Figure 9-14 as a guideline to position it centered in the area off of the rear fuel bulkhead, at a high point on the strake.

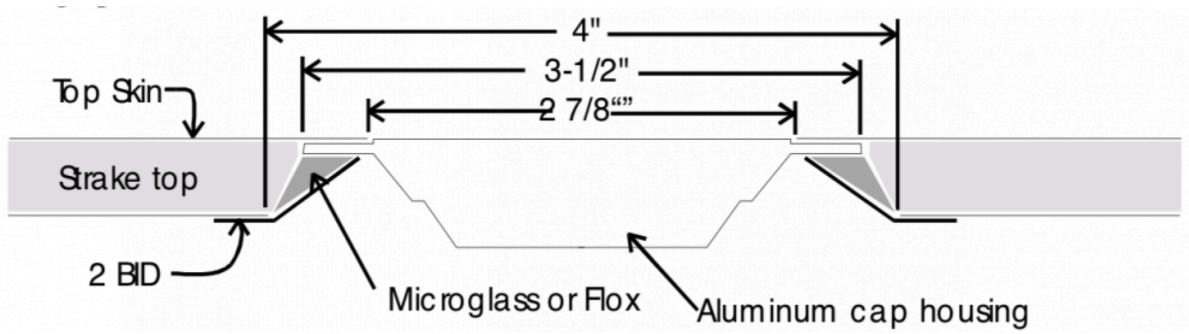


Figure 9-22. Fuel Cap Installation

___ Before you start cutting holes measure the dimensions of the caps you have to be sure you do not cut the wrong size holes.

Using a 4” hole saw, cut through the **bottom skin only**. Peel off the bottom skin. With a 3-1/2” hole saw, drill through the **foam only**, up to the top skin but not through it. Finally, using a 2-7/8” diameter hole saw, cut through the top skin. Sand the opening until the cap fits in the hole from the bottom side and it is flush with the top skin. Bevel away the foam around the hole to make a nice transition. Sand the skins and aluminum cap housing for good adherence.

___ Pre-wet the housing and bed into the hole. It is important to be sure there is a complete seal of **EZ-Poxy Micro-Glass** over the foam to prevent gasoline from seeping into the foam of the strakes. While it will not hurt the foam, it could eventually find its way somewhere to give the impression of a leak. Apply two layers of **BID** lapping from the bottom strake skin onto the **Micro-Glass** and cap housing. Let cure. If you use a weight to hold the housing in place, be careful as to not deform the shape of the strake around the cap.

Note: A composite airplane cannot be bonded through its skin like a metal airplane can. We have come up with a method to bond the filler caps to the engine. This is an optional step.

Before bonding you aluminum cap ring housing in , drill a 5/32” hole in the flange and countersink it. You will need about 5 feet on #16 wire for each strake. Crimp a #14-16 #8 wire terminal on the end of the #16 wire. Install an 8-32 countersunk screw in the hole you drilled and on the back side install your wire terminal and a lock nut. Now you will have to make a hole large enough for the wire that runs straight back from the hole for your fuel cap to the center spar. A long coat hanger that has been straightened out works well for this. You may also use a long drill but be careful. Now you can bond in your cap. When you do make sure you pack some Micro down the hole with the wire to seal it. Route the wires to your engine and attach them. Now a fueler can ground to your engine when fueling your airplane.

9.4.2 – Fitting the Upper Strake Half

___ After complete cure of the bulkheads and baffles, reinstall the upper strakes. Use a light to shine through the tank area and check the fit between the baffles and bulkheads and upper skin.

___ Sand or file any high points down to ensure uniform fit (especially at the bulkheads). When you are satisfied, sand all the mating surfaces. Also sand outside the leading edge of the lower strake and inside the leading edge of the upper strake where the two overlap. Sand the upper spar cap and all areas where the bulkheads touch the inner skin.

9.4.3 – Upper Strake Half Installation

___ Mark reference lines on the fuselage and wing between the two spars. This will establish the cut line for the strake (See Figure 9-11). Also mark a line on the fuselage where the strake rests. Fit the top strake and drill and install about ten cleco's both inboard and outboard of the tank on the leading edge.

___ After the top fuselage is on and before the top strakes are installed, make sure you seal all areas around the gear well, fuselage line, and bulkhead, with a wet **two** ply **BID** lay-up.

Note: Clean and vacuum the tank area very thoroughly. Any debris left in the tank will be hard to remove once the top is on. Any remaining foreign material will end up in your fuel system.

___ When using **Jeffco** you have a limited time to get your top on before the **Jeffco** starts to cure. We like to take no more than one hour to seal a tank. You need to paint two coats of **Jeffco** on the top strakes just as you did the bottom strake. The top strake will need to be installed before the second coat cures. After you have applied the first coat of **Jeffco** to the top strake start to mix your **Jeffco** to seal your tanks.

While you are mixing the **Jeffco** to seal the tanks have a partner mix enough structural adhesive and **Cabosil** to bond the spar to the upper strake. Spread this mixture out along the spar cap making sure you get good coverage on the front and middle which will not be accessible once the strake is on.

The top is sealed with a **Jeffco Flox** mix that is put on top of the baffles before the tank top goes on. You cannot mix up one large batch of **Jeffco** to do the entire tank because it would start to exotherm before you were finished. It is better to mix two smaller batches. Mix one cup of the hardener to two cups of the resin in a large container. Mix in **Flox** until you get a thick cake icing like consistency. Spoon this mixture into a 1 gallon heavy duty freezer bag. Cut the corner off the bag. Using the freezer bag like a cake icing bag , lay a bead of **Jeffco** and **Flox** on top of all of your baffles and bulkheads. Your bead should be about 1/2 thick. Also fill the leading edge of the top strake with the **Jeffco** /*Flox* mixture to a 1/2” thickness.

___ After the second coat of **Jeffco** has tacked up get some help and install the upper strake, gently setting it straight down. Avoid sliding the strake so as not to knock any of the **Jeffco*/*Flox** out of place. Clip the clecos into the leading edge, and check for any voids in the overlap outboard and inboard of the fuel tank. In between where the clecos are you may want to wrap the leading edge with long strips of duct tape to hold the top strake half tight to the bottom.

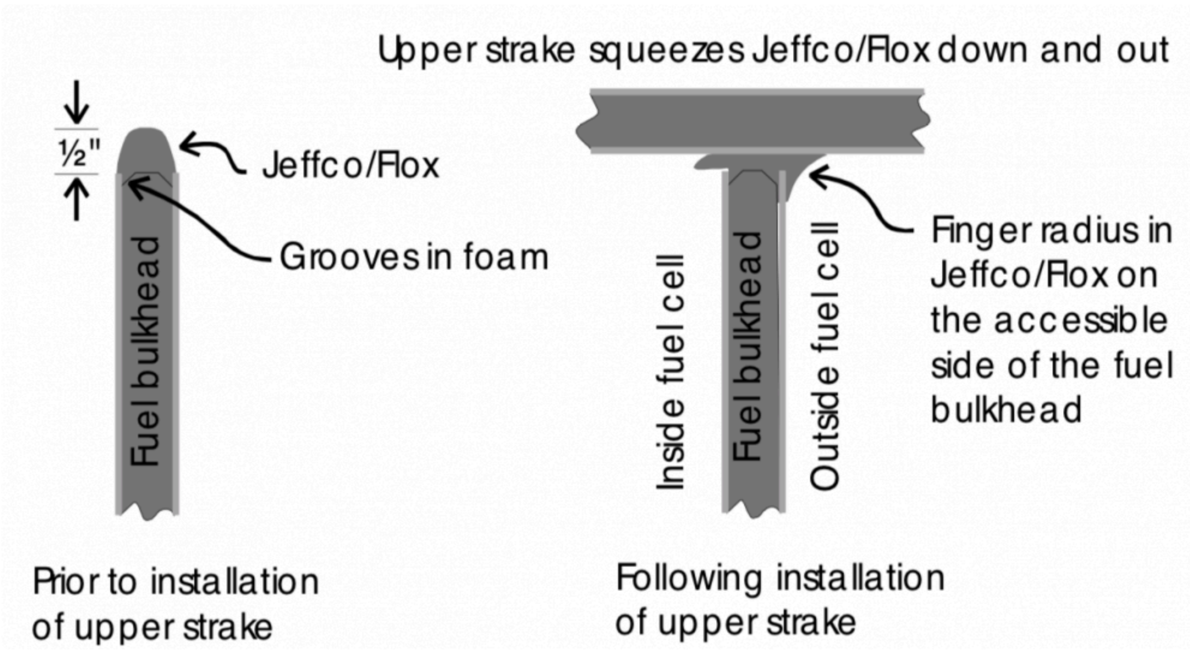


Figure 9-23. Joining Upper Strake to Fuel Bulkhead and Baffle

___ Use the same aluminum I-beam you used on the bottom strake along the center spar on the top. Add some weight to the top of the beam to hold it down. Check the line you initially put along the fuselage and see where your strake is sitting. If it is higher than the line you may put a small weight on it right next to the fuselage in order for it to sit correctly. Do not put too much weight on the unsupported part of the strake because this could permanently deform the upper strake.

___ At this time only areas inside the fuel strake and the aft bulkheads inboard in front of the spar are accessible. Use your finger (or a mixing stick) to form a radius with the excess **Jeffco*/*Flox**. You may also want to duct tape a bent over spoon to a stick to reach into the rear of the strake and smooth over the top joint on the rear bulkhead. Do this from inside the airplane. Let the top strake cure before proceeding.

___ Before attaching the strake to the side of the fuselage, force some **Micro-Glass** down between the strake edge and the fuselage side. Pay particular attention to the area just to the rear of the baggage strake where the fuel comes into contact with the side of the fuselage.

___Tape glass the strake to the side of the fuselage with two plies **BID**. Tape glass the inside of the baggage compartment with two **BID** also. When you are satisfied that everything that you can get to is sealed and glassed, let cure completely.

Some visual inspection of the outboard seams can be made through the bolt access cover in the lower strake skin.

___ After cure, remove the clecos in the leading edge. Sand the overlap smooth. Fill the cleco holes with **Micro-Glass** and cover the seam with two plies of **BID**.

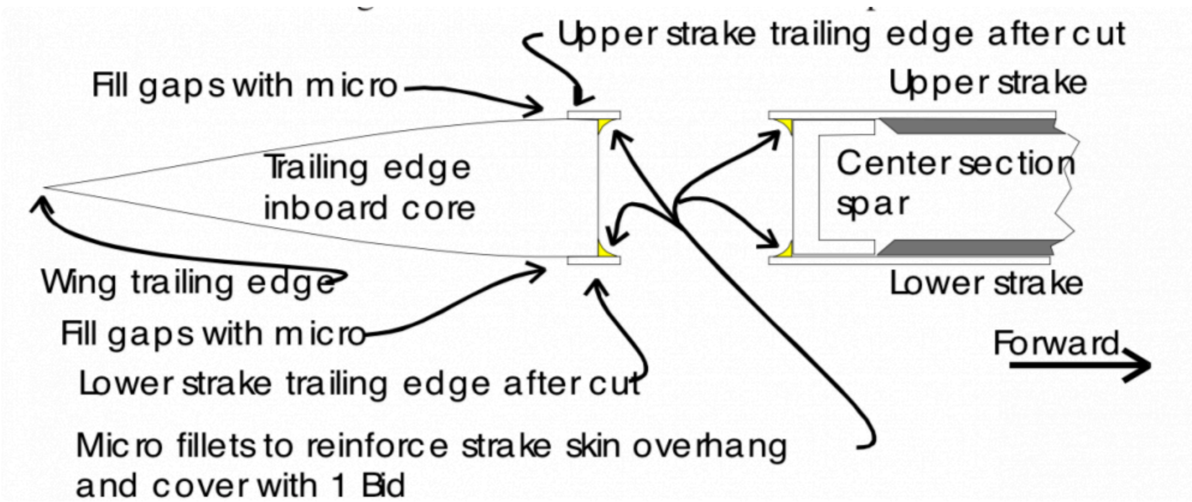


Figure 9-24. Separating Wing from Spar After Fuel Strake Installation

___ Using a straight edge, connect the marks on the fuselage with the marks on the wings and carefully cut the wing off. After both upper and lower seams are cut, take the bolts out and remove the wing.

___ The intersection of strake to fuselage can now be sanded and filled with **Micro-Balloon**. A radius of **Micro-Balloon** can be put in here to achieve a more pleasing cosmetic intersection (See Figure 9-24).

___ After the top strakes are on, you will turn the plane over to glass the spar to strake junction and the strake to long rear bulkhead junction. Assuming you sanded these areas earlier, the easiest way to do these lay-ups is to wet out the **two BID** tapes, full length, on a piece of plastic.

___ Using a wood dowel with a nail sticking out the end, hold onto one end of the plastic while you reach in and lay it in place. Pull the plastic off and use a yard stick to press the lay-up down.

___ Refit and install bulkheads 5 and 8, each side, with two plies if **BID** all around them inside and out if you can reach it.

___ After removal of the wing, the areas in the outboard bulkhead, aft outboard bulkhead, and upper strake are accessible. At this time, check for any voids or gaps in this area, as it is very rough and rugged. You will have to sand the skins a bit, fill with **Micro-Glass**, and cover with two plies of **BID**.

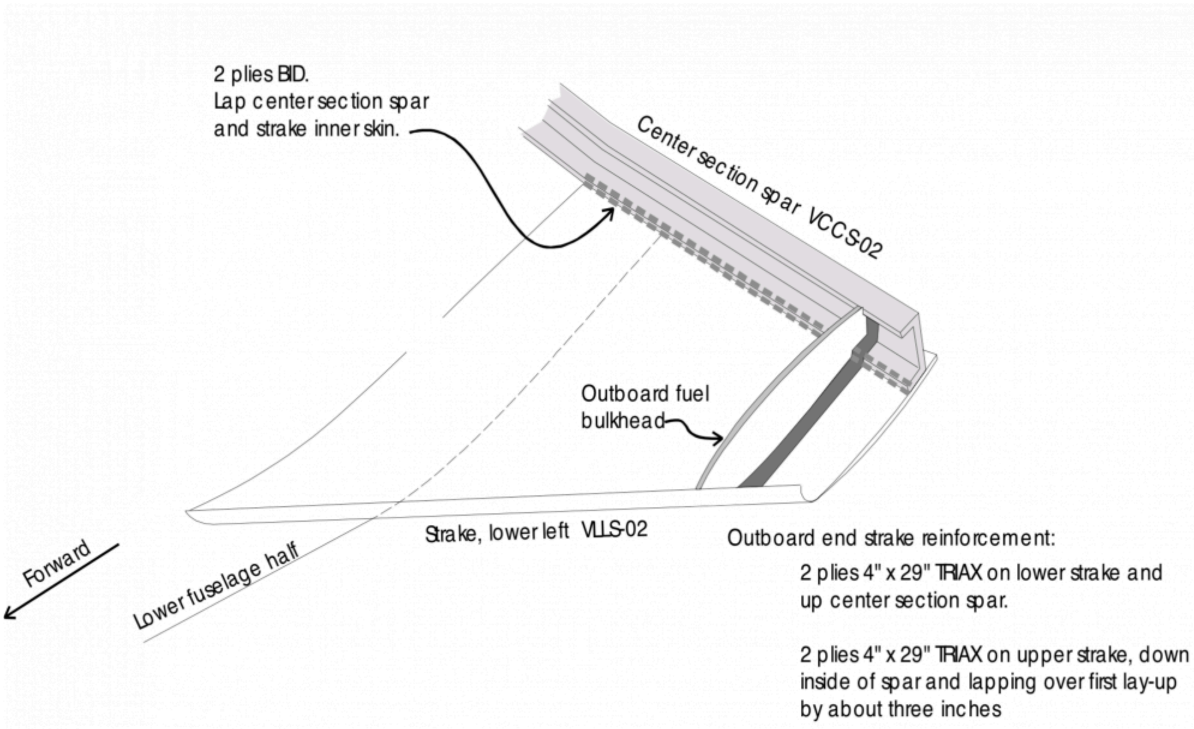


Figure 9-25. Outboard and Strake Reinforcement

9.4.4 – Outboard End Strake Reinforcement

___ Cut 8 strips of **TRIAX** 4” wide by 29” long. The major axis should run lengthwise.

___ On the outboard side of the outboard fuel bulkhead, sand a 4” wide strip, roughing up the surfaces on the upper and lower strakes, as well as on the inside of the spar. Level any voids between the spar caps and the strake inner skins with **Micro-Balloon**.

___ Apply two of the strips along the bottom strake in the sanded area, starting at the strake **leading edge**, and extending up the spar shear web.

___ Apply the other two strips to the upper strake, lapping down the spar shear web a few inches. For increased reinforcement, overlap the lower lay-up with the upper layer by an inch or so at the strake leading edge.

9.6. 9.5 – Sump Tank and Fuel Lines

9.5 – Sump Tank and Fuel Lines

9.5.1 – Fuel Lines

The XLFG comes to you with a premolded sump tank. The tank has hardpoints installed for the main tank inlets. You must install the hardpoint for the drain, outlet to engine and the vent.

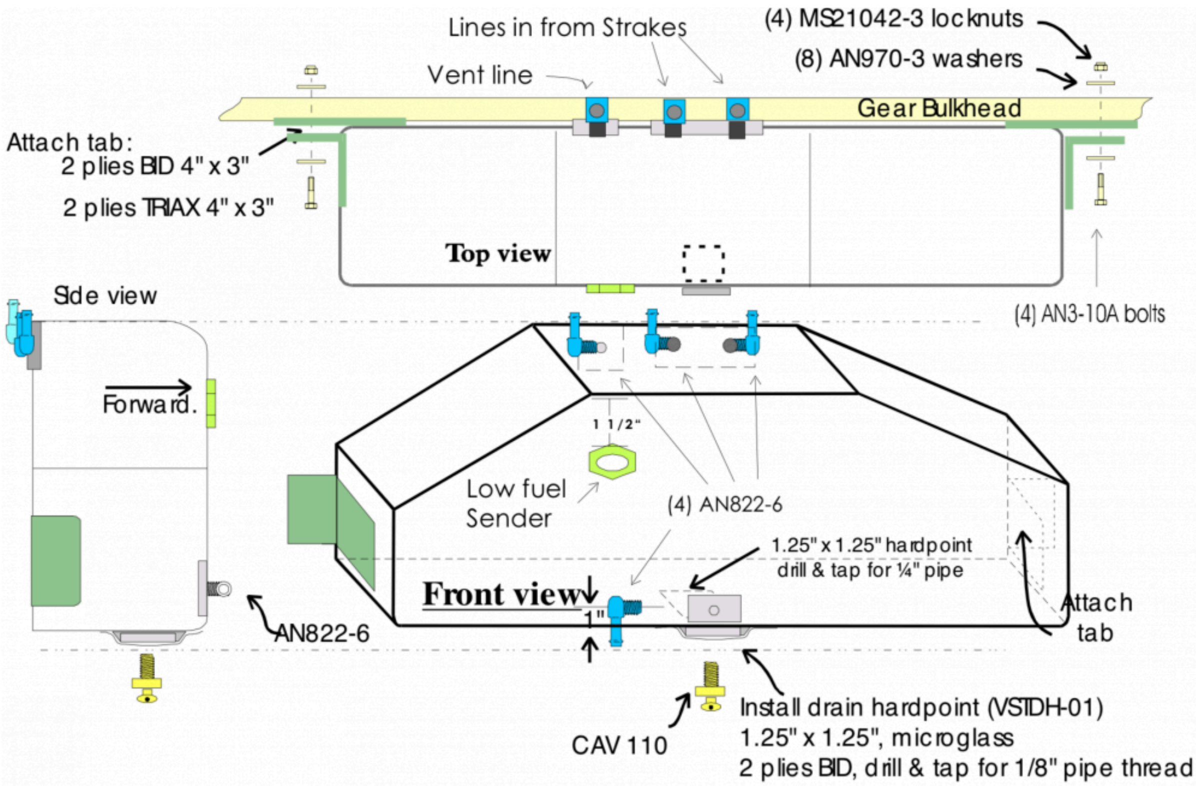


Figure 9-26. Sump Tank Installation

___ Drill the pre-installed hardpoints to 7/16 and tap for 1/4 pipe. Remember, pipe thread or NPT are entirely different from standard threads.

___ Install 1-1/4” x 1-1/4” x 1/4” aluminum hardpoints for the tank drain , vent and the outlet to engine. The tank drain hardpoint should be on the bottom of the tank centered 1/4” back from the forward edge of the tank. The vent hardpoint should be as high as you can install it in the tank. The outlet to the engine should be centered in the tank 1” above the bottom. The outlet will be installed on the tank cover. Micro-Glass the hardpoints in place, create radius / taper around aluminum to keep glass from bubbling up. Cover with **two** plies **BID**.

___ Drill an 11/32” hole in the drain hardpoint and tap it for 1/8 pipe. Drill a 7/16” hole in the vent hardpoint and engine outlet and tap them for 1/4 pipe.

___ Optional: You can install a low fuel sender in your sump. This will turn on a light on your panel when the fuel level in the sump starts to drop. The hardpoint for the sender is drilled and tapped and comes with the sender. Drill a 3/4 inch hole in the front of your sump 1-1/2" below the top. Using Micro-Glass and 2 BID attach the hardpoint like the others in the sump.

9.5.2 – Install the Sump Tank Cover

___ Cut out the cover to fit the front of the tank. Clean the inside of the tank and cover, MEK works well, and sand again to eliminate hand prints, etc. Paint the inside of the sump tank and cover liberally with as many coats as it takes to make the surface shiny with no fabric weave showing. Let cure and inspect it again. Repeat if necessary.

___ Sand a full 1" margin around the outside front edges of the tank and cover. Apply small bead of Micro-Glass to the edge of the tank. Put the cover in place and apply 2 plies of **BID** with a liberal amount of epoxy. Let cure.

___ Clean and sand the outside completely as you did the inside. Paint the outside repeatedly for a shiny, weave free, finish.

9.5.3 – Install Mounting Tabs

___ Cut **four** 3" × 4" pieces of **TRIAX**, axis long, and **four** 3" × 4" pieces of **BID**.

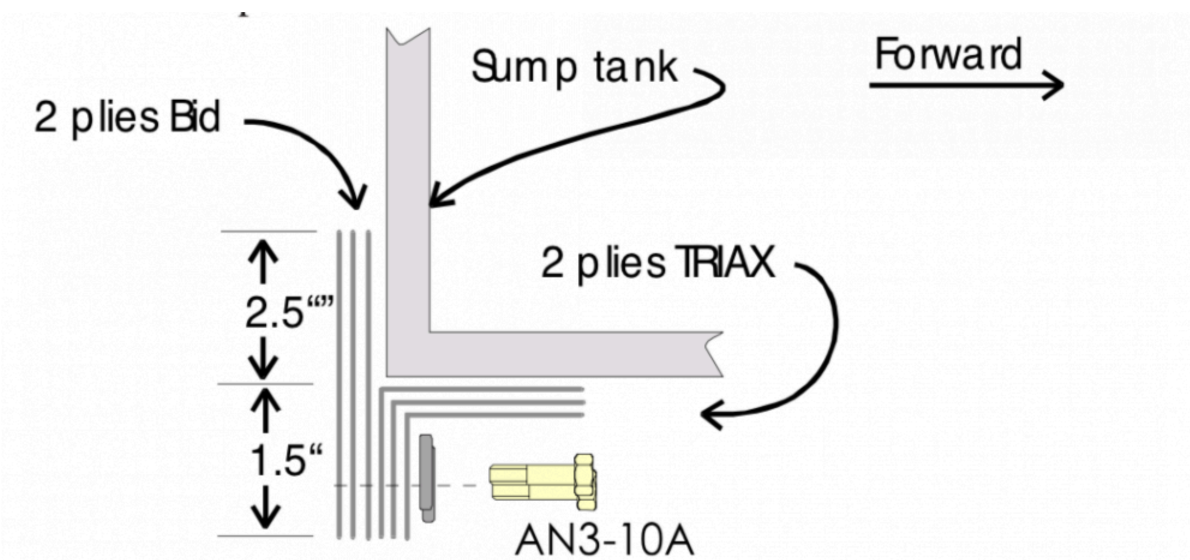


Figure 9-27. Sump Tank Mounting Tabs

___ Sand rectangles in the vertical center of the tank on the sides and back.

___ Apply **two** of the 2 ply **BID** pads on the back of the sump tank, horizontally, lapping 2.5" onto the back of the tank and letting 1.5" extend out as a tab. Lay the tank down on the plastic covered surface, back side down, and smooth the tabs straight against the plastic.

___ Apply the other two 2 ply **TRIAX** pads onto the sides of the tank, aligned with the above pads, lapping 2.5 " onto the tank sides and 1.5" onto the above pads, forming a 4 ply 1.5" × 3" mounting tab.

9.5.4 – Sump Tank Installation

The sump tank is positioned centered in front of the gear bulkhead.

___ In this position, drill (4) 3/16" holes (2 per side) and bolt to the gear bulkead with AN3-10A bolts and large area washers.

___ Once the sump is fitted into place, a hole must be drilled through the bottom of the fuselage to facilitate access to the sump drain.

9.7. 9.6 – Wing Strake Cutout

9.6 – Wing Strake Cutout

9.6.1 – Wing Strake Cutout

The strakes of an XL are 76” from the trailing edge of the main spar at the side of the fuselage. The leading edge is 2-7/8” +- 1/8” above the bottom of the main spar.

The cut you made earlier in the strake area of the fuselage went from the rear fuel bulkhead forward to within 8” of the door line.

___ After the top strake is installed, make a mark on the leading edge of the strake outboard of the fuselage, using a square held along the fuselage at the strake door intersection point. Another reference point for this is 30” from the intersection of the fuselage join line and the door line mark on the fuselage. If the forward position of your strake is more than 76” from the rear side of the main spar, that 30” measurement will not be enough. This will be your reference point for your cut template.

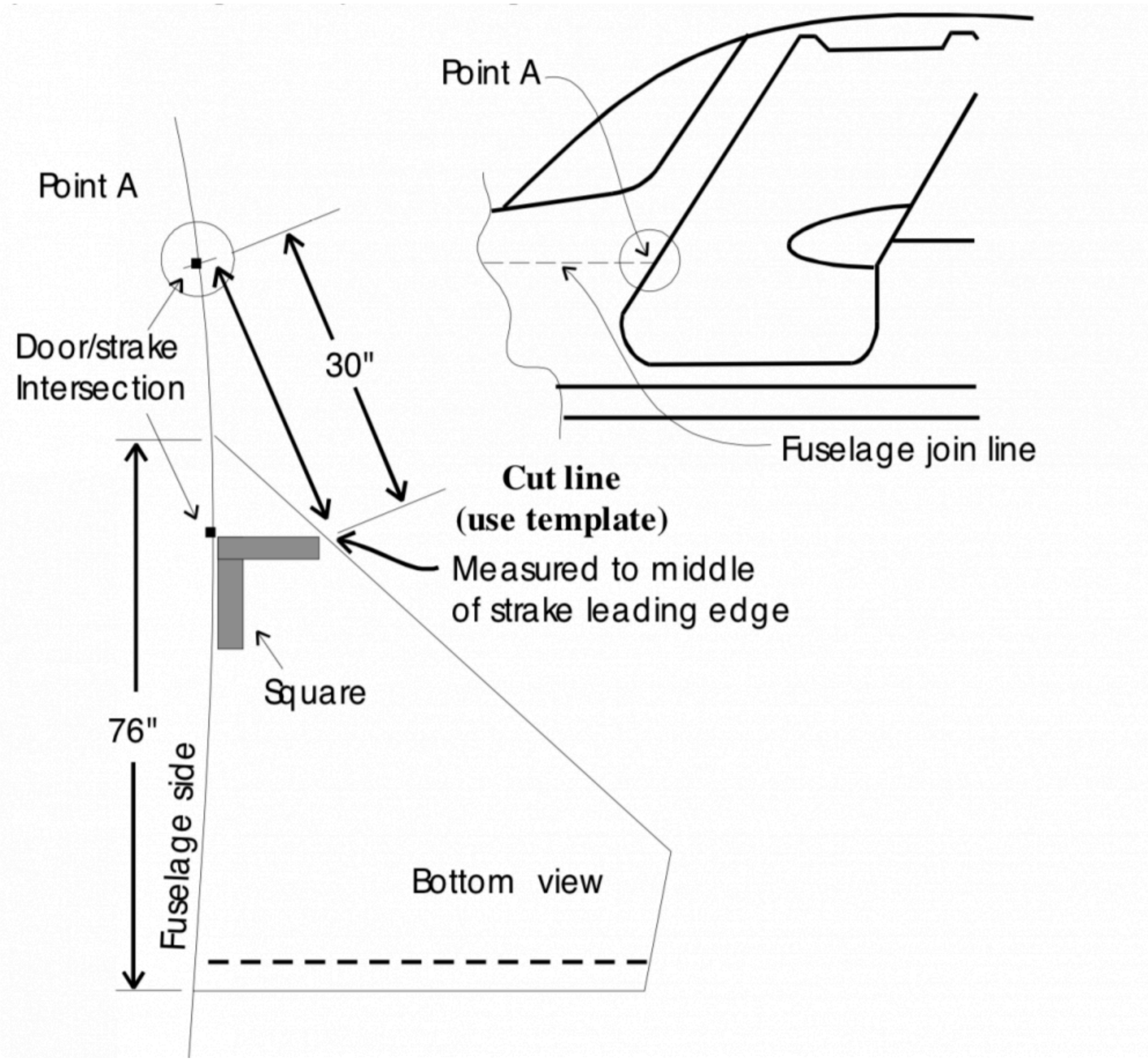


Figure 9-28x. Strake Cutout for Door

___ Copy the paper template labeled “Strake Slice Template” you received with your kit to a thin piece of plywood veneer or stiff cardboard. Place the L.E. Point of the template at the 30” mark, aligning the back edges of the template with the door cut line above and below the strake. Some trimming of the template may be required for your particular installation to get a good fit. Use a marker to mark this cut line. This gives you a straight cut through the strake.

Note: Before you make your cut double check the position of your front fuel bulkhead. If you installed your bulkhead too far forward you can move your cut line further forward to insure you do not cut into your fuel tank.

___ Cut the front section of the strake off now and try and cut as if you were slicing it off at a continuous angle. Now you have access to the whole door line.

9.6.2 – Wing Strake to Beam Support

___ With your beams installed, you can now cut the rest of the fuselage away in the wing strake area right up to the beams. Be very careful not to cut into the beams.

Its a good idea to cut within 1/8” then file or sand to the beams.

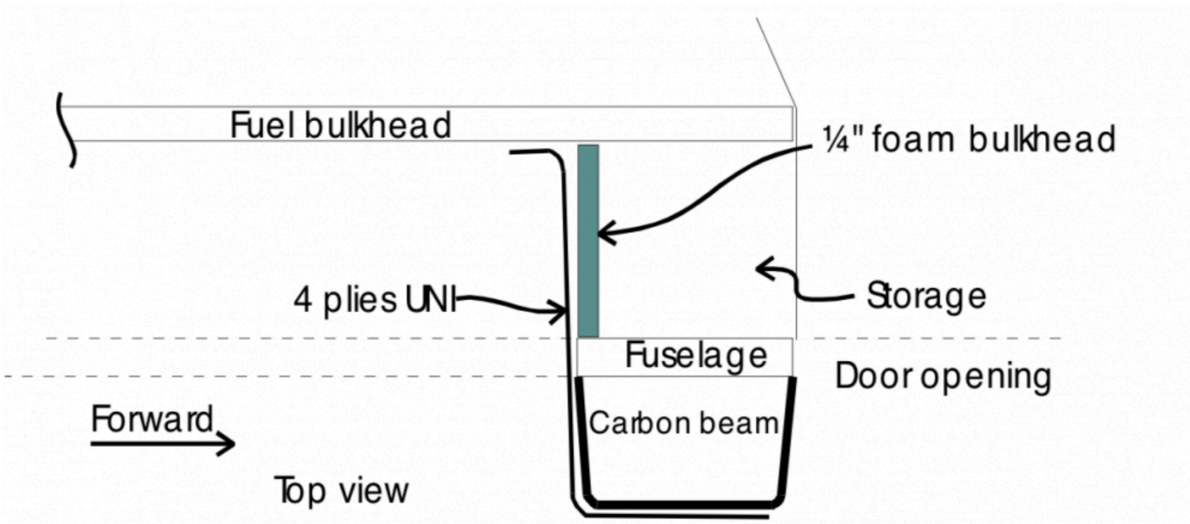


Figure 9-29. Strake to Beam Support

___ Using the template provided, make two **1/4”** (or 3/8”) foam bulkheads. These bulkheads will mount flush with the rear side of the beam and extend perpendicular from the side of the fuselage, out to the inside bulkhead of the fuel tank.

___ In order to keep this bulkhead following flush with the beam, you will need to heat the foam up with a blow dryer and do some shaping. Sand the area around the bulkhead, fore and aft, wing strake and fuselage.

___ Sand the rear side and inside surfaces of the beams. Install this foam bulkhead with hot glue or Bondo, (small dabs). **EZ-Poxy Micro-Slurry** the foam as normal procedure, and apply thicker **Micro-Balloon** to form a radius in all the corners of the bulkhead.

___ Pre-wet the beams beside the bulkhead. Apply 4 layers of **UNI**, orientation horizontal, from the forward bend in the beam, across the inside surface, around to the rear surface, and across the rear side of the bulkhead, onto the inside fuel bulkhead about 1-1/2”. You may also be lapping onto the wing strake surfaces an inch or so.

___ **EZ-Poxy Micro-Slurry** the forward side of the foam bulkhead, radius the corners, and glass the bulkhead with two plies **BID**. Make the pieces big enough to lap onto the fuselage and strake surfaces. If it is not big enough just use glass tapes to attach it to the strake surfaces.

9.6.3 – Installing Leading Edge of Strake onto Door

___ Clean up the cut off section of the strake so that it is straight and smooth.

___ Close and latch the door. Hot glue some pieces of a mixing stick around the front of the cut off section of the strake. These are just used for spacing.

___ Clean up the mating edge of the front section of the strake. Put it in place and check the fit. You can space it out from the fuselage if you need to, or take some away, in order to get it to fair in properly.

___ When properly fit, mark the outline of the piece onto the door. Remove the leading edge and remark the line about 1/2” inside the other line. Also, mark the approximate position of the door stiffener onto the outside surface. Cut this section out of the door, making sure you **do not cut into the stiffener**. You should be flush with the inside surface of the stiffener.

___ Sand all around the strake leading edge and door where it will bond in place. Reposition the leading edge and tack in place with 5 minute epoxy. **Micro-Balloon** radius around to match the rest of the strake, and glass with two plies **BID**. **Micro-Balloon** a radius around the inside of the strake leading edge and glass with one ply **BID**.

___ Open the door and remove the first 3/8” or so of inside glass and foam around the opening of the strake that is attached to the door. This is the area that faces the other part of the strake.

___ Cut a piece of 1/4” dyvinicel foam, that will fit into this area that you just relieved. Make sure that it is flush with the surface so it does not hinder closing and glue in place with 5 minute epoxy. Relieve some foam from the outside edge around next to the outside skin with some 36 grit sand paper. **Flox** or Micro-Glass the edge, Micro-Slurry the foam, and glass with one layer of **BID** on each side.

___ After cure, remove the door. On the fuselage (strake), you have exposed foam all around the opening.

There are two ways of dealing with this area. First, you can just remove some foam as you have done many times before, all around the foam to outside skin junction and inside skin to foam junction. Fill this void with **Flox** or Micro-Glass and glass over with one layer of **BID**.

We prefer to make a pocket using some cured glass sheet (**4 BID**) about 3” high that fit flush with the edge. Hold the piece of glass up to the strake and trace around the edges. Cut the sheet so your part will fit just inside the strake. Hot glue the piece in place and cover the edges of the strake and your part with one layer of **BID**.

9.8. 9.7 – Fuel System Plumbing

9.7 – Fuel System Plumbing

9.7.1 – Solid Fuel Line Installation

In your kit you received 18 feet of 3/8” 3003 aluminum tubing. This will be used to plumb your fuel system. In the engine install section we go in depth on how to flare tubing. You will need to get a flaring tool that will do 37 degree flares. There are automotive flaring tools that do not have the correct degree of flare, so make sure it is an aircraft flaring tool. You will also need a tubing bender that will accommodate 3/8” tubing.

Thread on AN fittings does not always stop at the same place. You may screw in one fitting and it points directly up when tight but the next fitting may be pointing directly down. If you can’t get a fitting tight and pointed in the right direction try another one.

Be careful when bending your tubing. You do not want to kink or put a flat spot in your tubing. If you do this will affect the flow of the fuel. If you are not sure about a bend start with a smaller bend. You can always bend a little more but if you try to straighten bends this is when you kink tubing.

Figure 9-31 gives you the routing of the fuel lines as well as the fittings used.

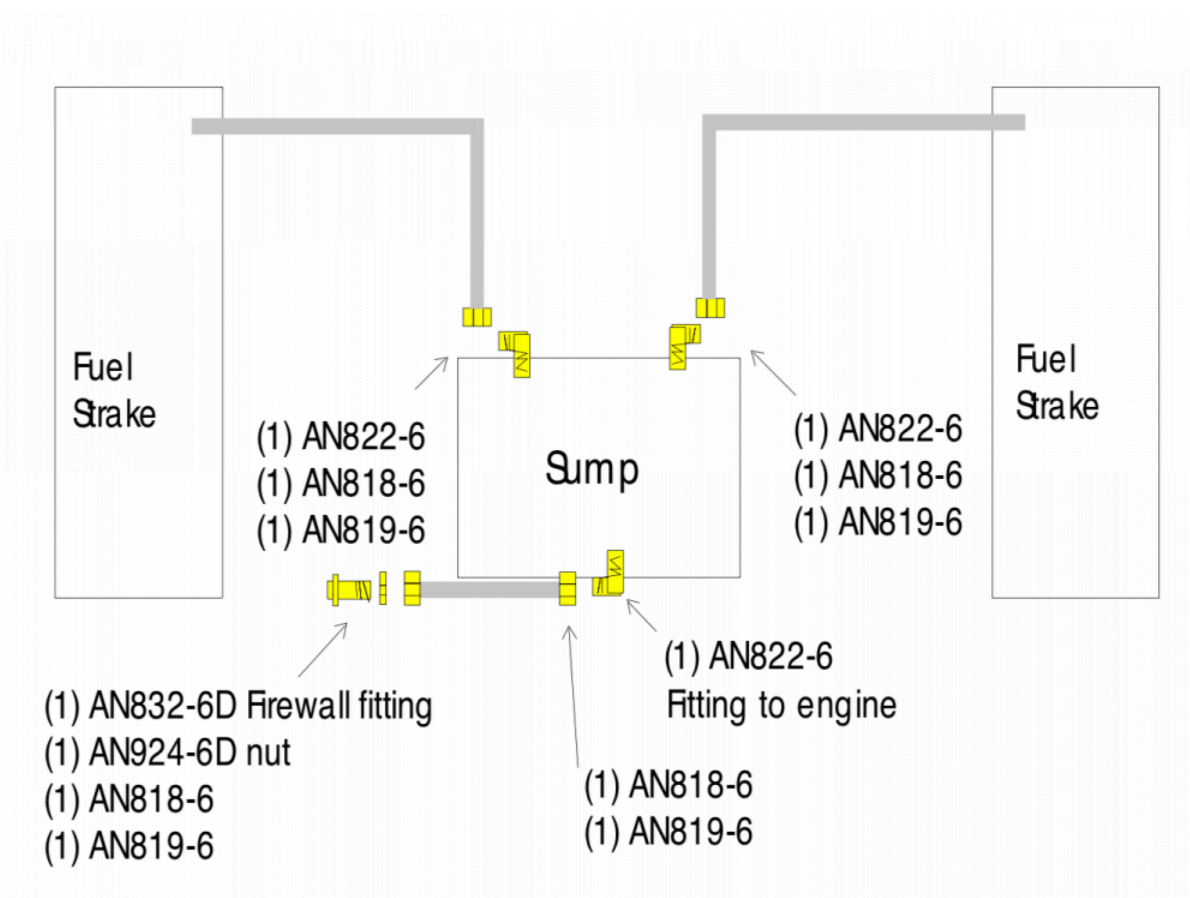


Figure 9-30. Fuel Line Routing

10. 10 – Control Systems

Contents

(Shared with SF, SR, XF, XR)

10.1. 10.0 – Chapter Preface

10.0 – Chapter Preface

10.0.1 – Parts List

Part Number	Description	Qty
AN4-15A	Bolt	1
AN4-10A	Bolt	3
AN960-416	Washer	11
MS21042-4	Nut	4
MM-4	Rod Ends	2
S24-17A8-04	Elevator Trim Actuator	1
VAB-02	Long Actuator Bracket	1
VPTB-01	Short Actuator Bracket	1
AN4-14A	Bolt	2
AN526C-1032R8	Screw	2
VPTS-01	Trim Spring	1
	Trim Spring Bracket	1
MS27039-1-07	Screws	9
AN960-10L	Washer	20
MS21042-3	Nut	36
AN970-3	Washer	2
AN3-13A	Bolt	1
VSS-01	Sparrow Strainer	1
AN111	Cable Bushings	4
AN3-5A	Bolt	8
VRSC-01	1/16 Stainless Steel Cable	
	1/16 Nycopress	4
	Pulleys	2
VPBR-BLTR-01	Pulley Brackets	4
VCP-01	Cotter Pins	2
VCAS	Springs	2
	Spring Tabs	2

VRCA-01	Rudder Cable Adjuster	2
AN3-7A	Bolt	4
VAUJ-01	5/8 .058 Steel Tube	2
AN3-10A	Bolt	2
MS24693S-272	Screws	3
VPPC-02	Push/Pull Cables	2
AN970-4	Washer	2
MW-4	Rod Ends	4
VEPR-01	Elevator Push Tube	1
VBBA-L-01	Aileron Wing Brackets	2

10.0.2 – Tools List

Description
Drill Motor
3/16” Drill
11/64” Drill
3/16” Reamer
Nycopress Tool
1/2” Drill

10.0.3 – Supplies List

Description
Structural Adhesive

10.0.4 – Glass List

Type	Size	Qty
BID	3” × 6”	2
BID	1-1/2” × 4”	4

10.0.5 – Process Overview

Construction Process	Completion Date
Install Control Stick Push Tube	
Elevator Trim	

Sparrow Strainer Installation	
Rudder Cable Installation	
Rigging of the Ailerons	

10.0.6 – Documentation Changes

Oct 01, 2018 – Original Web Release

10.2. 10.1 – Elevators

10.1 – Elevators

10.1.1 – Introduction

To install and rig the rest of the control systems in the Velocity, your aircraft must be assembled to the point that the wings, winglets, etc. are attached. First we will rig the canard.

In the previous chapters you installed the elevators to the canard, installed the torque arms to the elevators, and installed the canard to the airframe. All that remains to be done now is to link the torque arms to the stick, and install the pitch trim system.

10.1.2 – Installing Control Stick Push-Tube Assembly

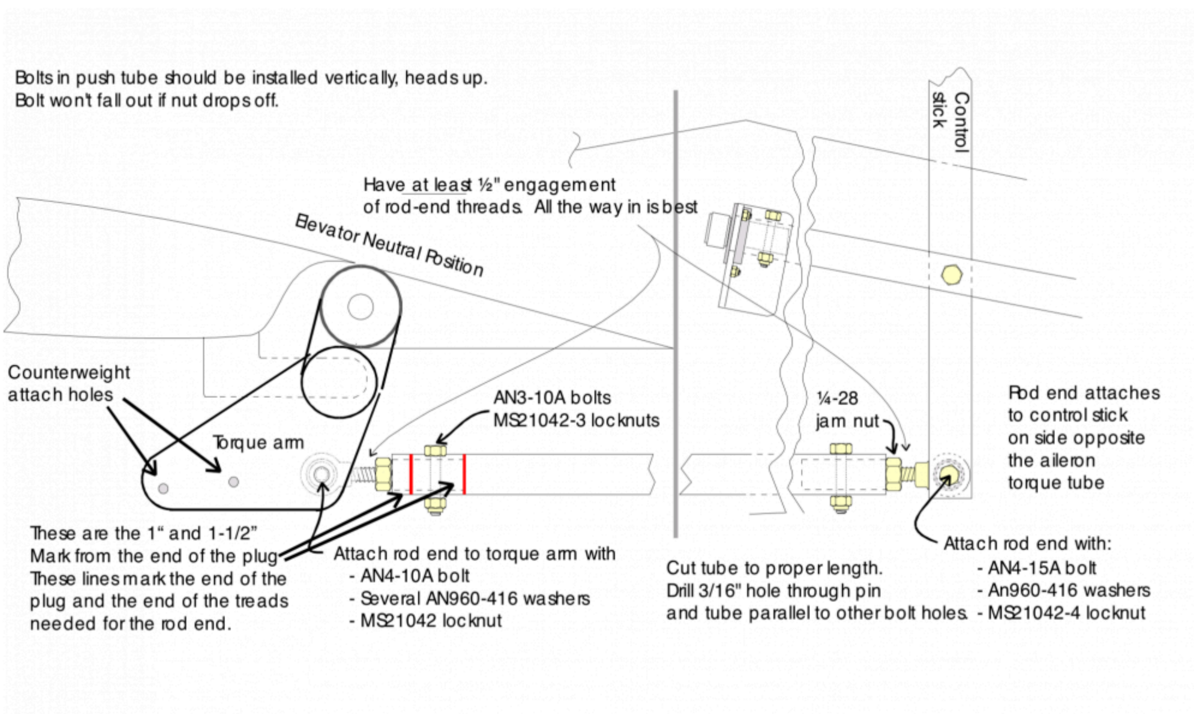


Figure 10-1. Control Stick, Push Tube Assembly

___ Locate the push tube assembly, VET-02, and install an MM-4 rod end in the end that has the bolted on plug. This will attach to the control stick.

___ The rod ends should be engaged as far as possible into the torque tube. **The jam nut should not be tightened so much that it stretches the rod end.**

___ Bolt the rod end to the bottom hole in the control stick (p/n VCSA-01). It goes on the side opposite the aileron torque tube. Use an AN4-15A bolt, (2) AN960-416L washers, and a MS21042-4 locknut.

___ Install the stick assembly into the console and jig the stick straight up and down. It will be slightly forward of perpendicular to the top of the keel. This is the stick neutral position. Bring the push tube through the hole previously cut in the top of the keel

___ Put the canard in place with the elevators neutral. Making sure to keep the control stick in its neutral position rotate the push tube up to the torque arms of the concentric torque tube. Refer to Figure 10-1. Mark the push tube where it meets the end of the torque arm.

___ Remove the canard. Measure 1/8" in (shorter) from your mark on the push tube and place another mark. Cut the push tube at this second mark.

Install another MM-4 rod end to the second plug. Screw the rod end in half way on its threads. Install the rod end/plug on the torque arms using an AN4 bolt. There is no need to put a nut on this bolt now because you are just using it to hold the rod end.

Reinstall the canard and check the fit. To slide the plug in the tube rotate the elevators full down and move the stick full forward. If you cannot get it in, you may have to trim the tube a little shorter. Do not cut too much because we want plenty of material in front of the bolt we will install next.

___ With both the stick and the elevator at their neutral positions mark the plug around the end of the tube. Remove the canard and elevator tube. Remove the rod end and plug off the torque tube and insert it in the push tube up to the previous line you drew. With the plug inserted in the push tube measure from the top of the plug down 1-1/2" on the push tube and place a mark. Now measure from the top of the plug down 1" to the push tube and place a mark. Drill a vertical 3/16" hole through the tube and plug centered in between these two marks. Make sure you are parallel with the bolt already installed at the rear of the push tube. This will give you plenty of material on both the aft end of the plug and the front end of the tube. See figure 10-1. It looks best if the plug end flush with the tube.

___ Reinstall to canard and stick assembly. Check for clearance, and for full elevator deflection with stick both to left and right. Before you finish with the push tube make sure the lock nuts are tight on the rod ends.

Full elevator deflection results in at least 26 degree trailing edge down elevator travel and 23 degree trailing edge up elevator travel. Verify that the keel cutout does not limit travel. We use the cutout in the keel as a control stop so you want to make sure that when you reach your control travel limits your stick hits the edge of the cutout. This will keep a pilot from putting stress on the control system

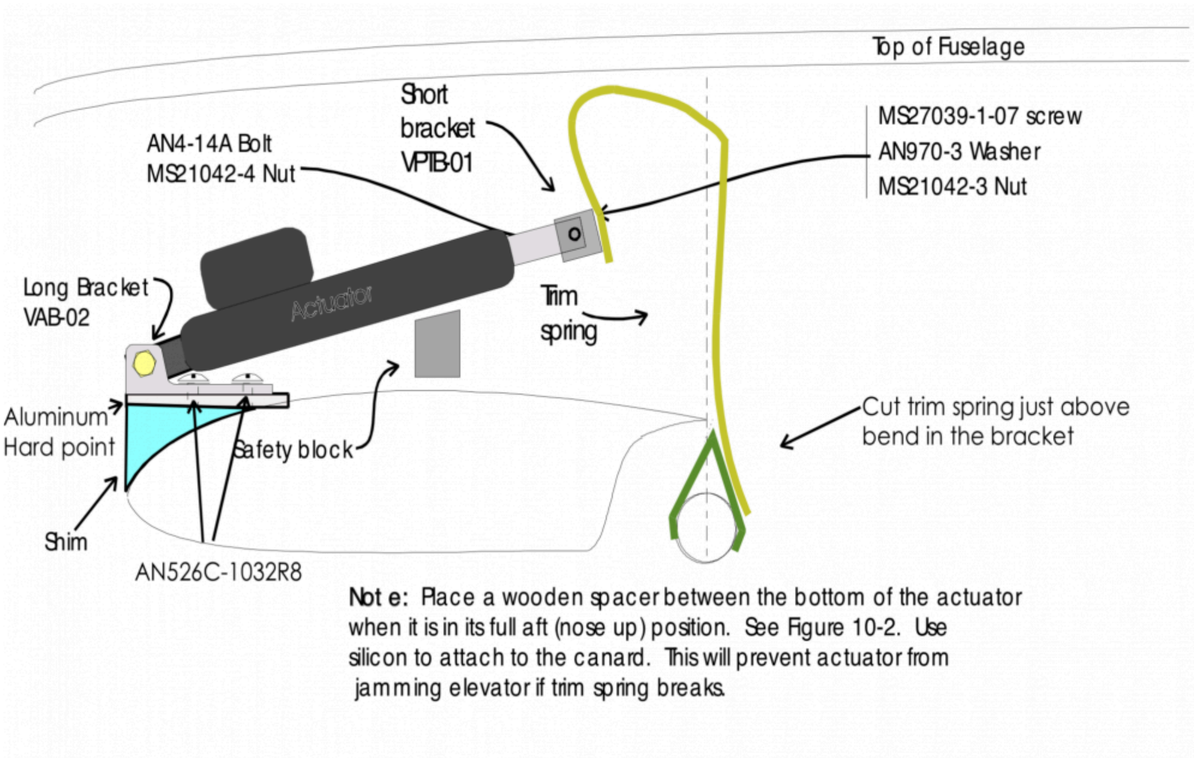


Figure 10-2. Elevator Electromechanical Trim

10.1.3 – Elevator Trim

___ **Locate a position for the trim spring that will not interfere with the radios.** Slightly left of center will be the best spot. Using a piece of scrap blue foam (or wood) contour a shim that will go at the leading edge of the canard. Refer to figure 10-2. Make sure that the shim is long enough and wide enough to accommodate bracket VAB-02. You want the shim to be located right at the leading edge of the canard. Cut a piece of 1/8” aluminum that is 4”x1” and sand both sides of it. Sand the area on the canard where you want your trim spring to be installed. Using micro and EZ-poxy attach the foam to the top of the canard and the piece of aluminum to the top of the foam. Cover the whole assembly with 2 bid that is about 3” x 6” . To get the glass to lay down properly you may have to make a few cuts at the corners.

___ Modify the long bracket (VAB-01) as shown in Figure 10-2 to allow the actuator to move up and down. Drill two evenly #21 spaced holes centered on the long bracket as shown in figure 10-2. Place the bracket on top of the shim and aluminum hardpoint you just installed and line it up centered and even with the leading edge. Drill two #21 holes through the aluminum hardpoint using the two holes already drilled in the bracket as your guide. **Be careful to not drill into the canard.**

Remove the bracket and enlarge these holes to 3/16”. Tap the holes in the aluminum hardpoint with a 10-32 tap. Install the bracket on the hardpoint using two AN526C-1032R8 screws.

Snap the spring bracket onto the torque tube. Position the trim spring about 1/4” below the top of the canard cover and cut off the trim spring just above the little bend in the bracket. Remove this assembly and bolt the spring to the bracket using (2) MS27039-1-07 screws, AN970-3 washers on the spring side, and MS21042-3 locknuts. See Figure 10-3.

Drill one 3/16” hole in the base of the short bracket (VPTB-01) and two 1/4” holes in the legs, allowing clearance for the end of the actuator. Attach the bracket approximately 3” down from the top of the spring as shown in Figure 10-2.

Attach the short bracket to the actuator and the trim spring using the hardware shown if figure 10-2.

Using a battery attached to the actuator leads run the actuator out and in. Make sure it is fully retracted for the next step.

Rotate the elevator trailing edge up so it is 1-1/2” above the neutral position. You will have to cut a slot in the trailing edge of the canard to allow full travel of the trim spring. With the elevator held in this position clamp the spring bracket to the offset concentric torque tube. Now drill a hole through the spring bracket in order to attach it. It would be best to do this with a partner that can make sure you are drilling straight. Center punch for a hole centered in the bracket. Refer to figure 10-3. It would be best to drill a 11/64” hole and ream it to 3/16” but if you do not have that drill a 3/16” hole. Have your partner make sure you stay perpendicular to the top of the tube. Drill all the way through. In stall an AN3-13A bolt and AN960-10L washer and MS21042-3 lock nut to hold the bracket in place.

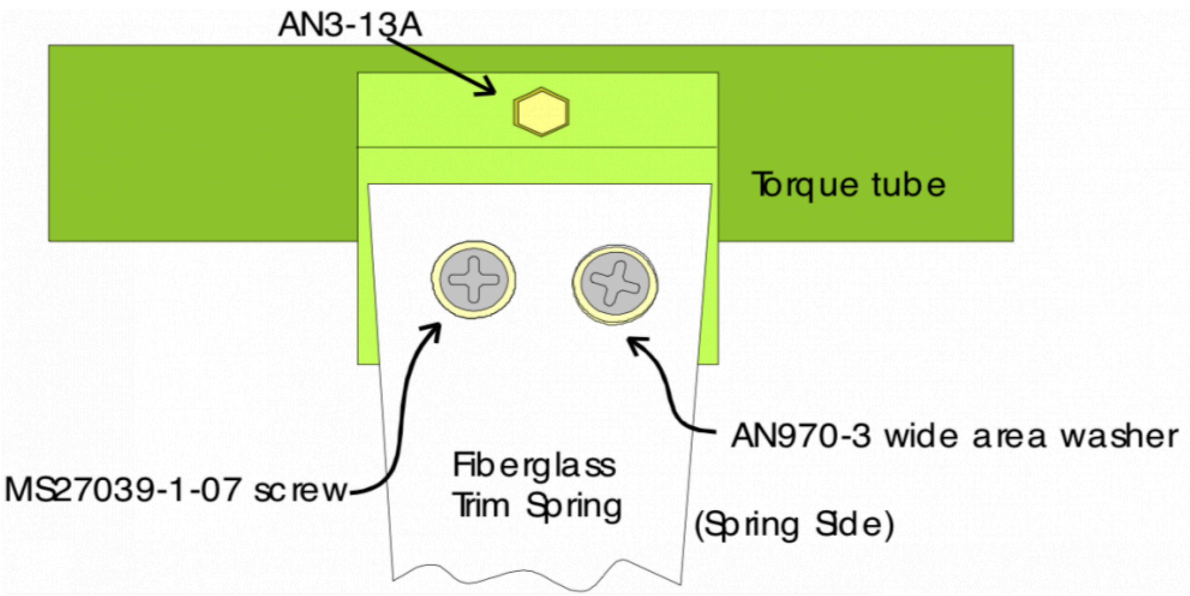


Figure 10-3. Elevator Trim Spring to Torque Tube Attachment

After you have installed the trim spring make sure that you can achieve 23 degrees of elevator travel trailing edge up. You may have to trim the trailing edge of the canard in front of the trim spring. Make sure that the trim spring will not limit your elevator travel.

10.1.4 – Aerodynamic Trim (Sparrow Strainer)

The aerodynamic trim is simply a small inverted airfoil, that helps trim the aircraft, especially around cruise speed. It seems to minimize the number of electric trim inputs made by the pilot, and really helps us take advantage of the inherent stability of the Velocity.

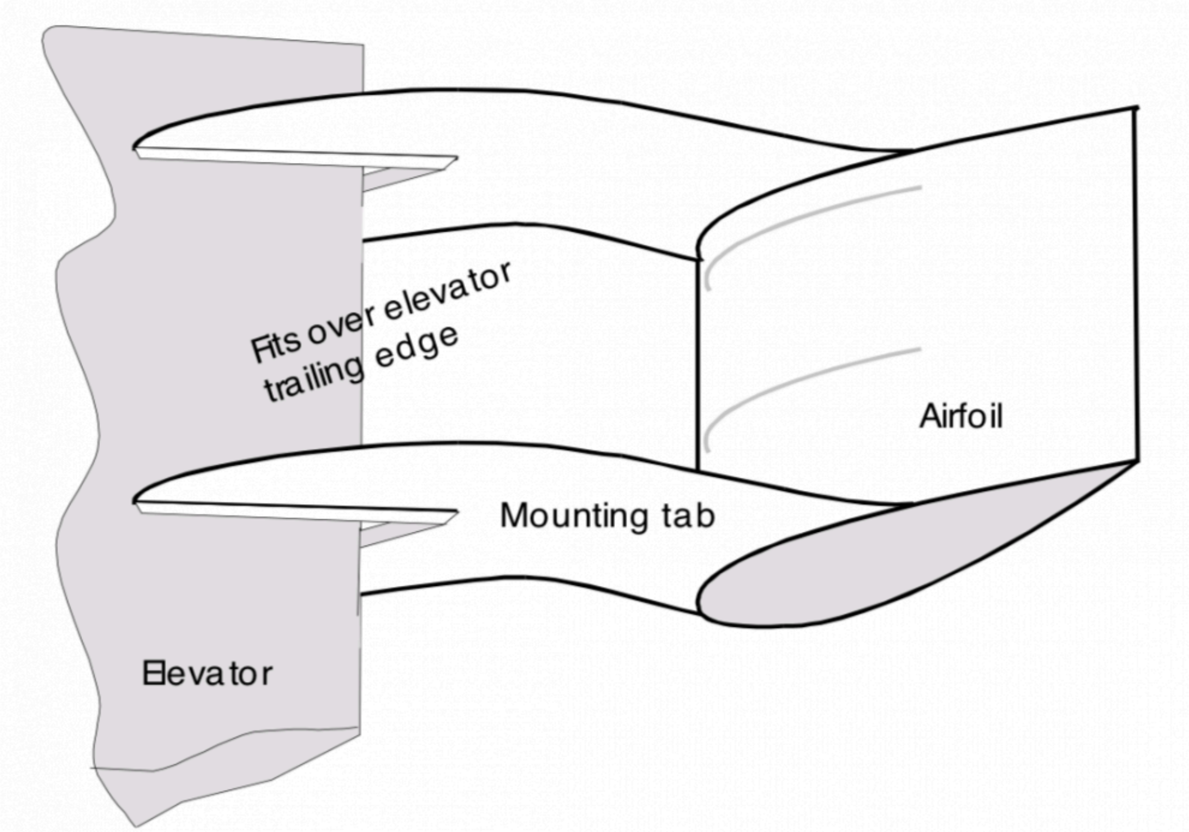


Figure 10-4. Aerodynamic Trim (Sparrow Strainer)

___ The airfoil is supplied with the kit. The mounting tabs are cut out of supplied glass laminate. Stack the pieces on top of each other so that you cut both tabs at once and their shapes will be identical.

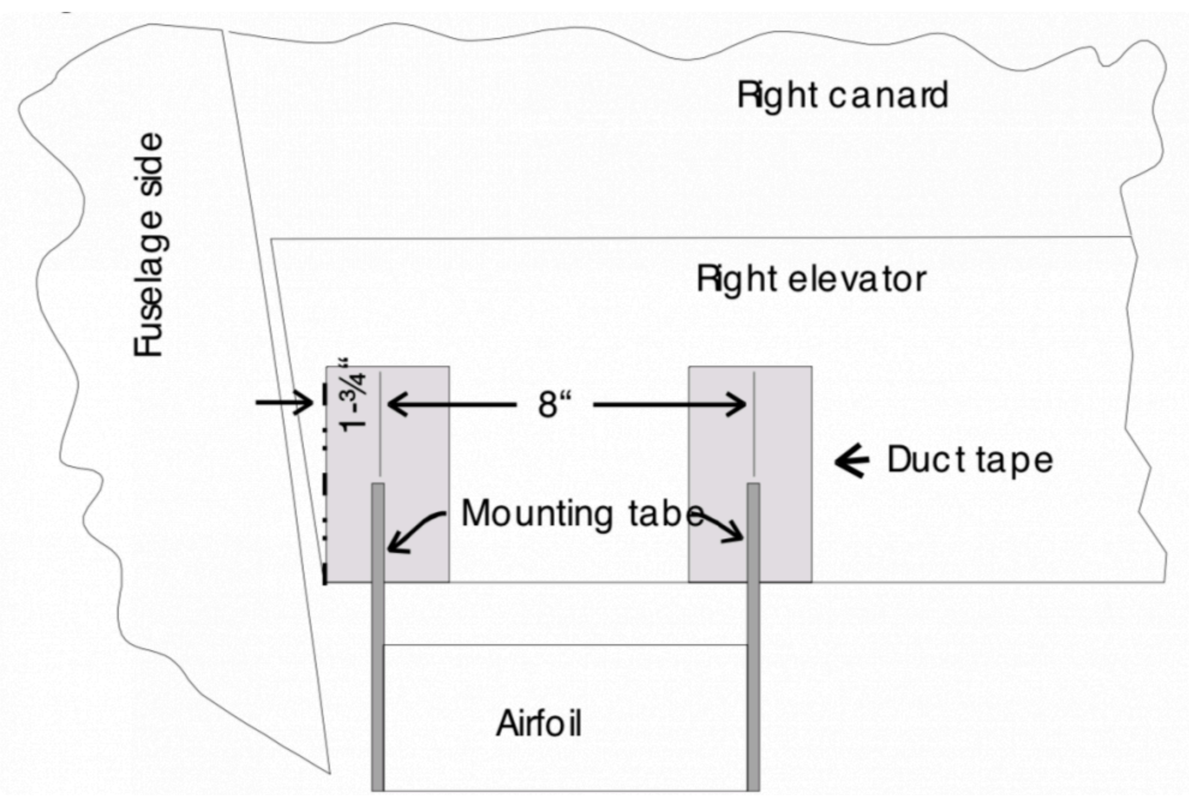


Figure 10-5. Aerodynamic trim location - top view.

___ Remove wedges of foam at each end of the airfoil – clean to the glass. Sand the mating surfaces of the mounting tabs and assemble with **Micro-Glass**. Jig to maintain alignment during cure.

The unit will be mounted on the right elevator in the position shown in Figure 10-5. The **inboard trailing edge** mounting tab is located 1-3/4” outboard from the **inboard trailing edge corner** of the right elevator. The **outboard** mounting tab will be 8” **outboard** of the first tab.

___ Lay strips of duct tape at the locations shown in Figure 10-5. Mask around them to avoid getting epoxy on the elevator’s trailing edge.

___ Lay up a 1/2” wide flange in the trim location using **three** plies of BID. After cured, but before removing to trim, attach mounting arms to these flanges using a radius of **Micro-Glass**.

___ After the whole assembly has cured, remove from the elevator and trim the flange area.

___ Attach to the designated location on the elevator using silicone adhesive after the canard and elevators have been painted.

10.3. 10.2 – Rudders

10.2 – Rudders

10.2.1 – Rudder Cable Installation

In the fuselage section, you installed the rudder cable conduits down each side of the fuselage, and in the wing section, you installed the conduits in the wings. Now it is time to install the actual cable in the conduit.

___ Cut off the conduit so that it extends only about 1/4” aft of the firewall.

Install an AN-111 cable bushing on one end of a length of 1/16” stainless steel cable. Refer to Figure 10-6. Run the cable through the nicopress sleeve around the cable bushing and back through the sleeve. You can use a small pair of vice grips to help hold the assembly taught as you use the nicopress tool on the sleeve. Do not clamp so tight with the vice grips to dent or cause any marking on the cable.

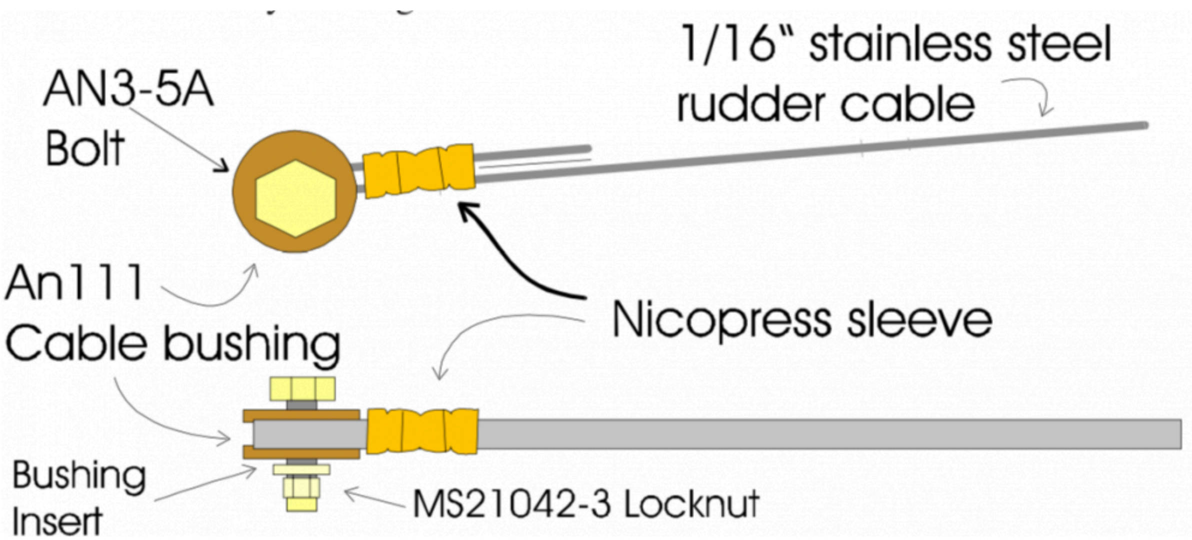


Figure 10-6. AN-111 Cable Bushing Installation

___ Run a length of stainless steel cable down each side of the fuselage. Keep the end with the cable bushing up at the rudder pedals. Leave yourself approximately 12” of cable extending through the firewall. Install the cable bushing at the rudder pedals as shown in Figure 10-7.

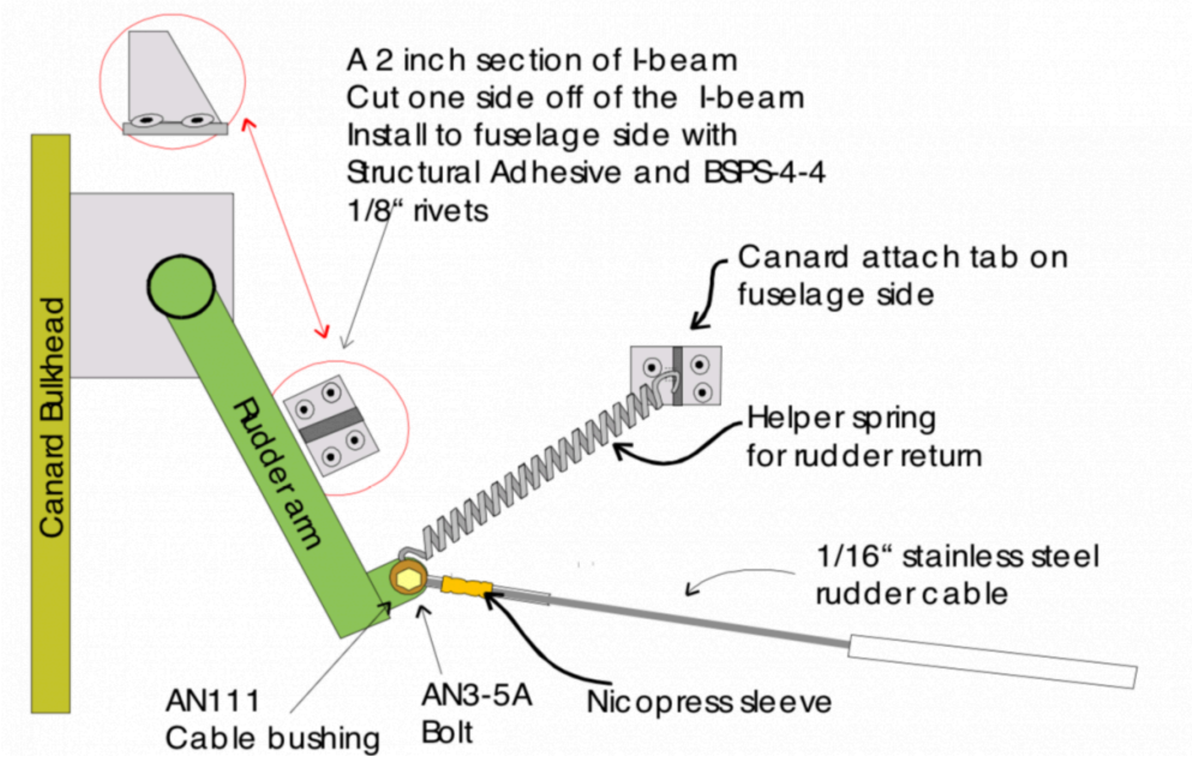


Figure 10-7. Rudder Cable to Rudder Pedal Attachment

___ Install another cable bushing on a length of cable and run it down the conduit in the wings leaving the cable bushing out at the winglet. It may be easier to insert the cable from the wing root end and then install the cable bushing on them. Do this for both sides. Install the cable to the rudder bellcrank as you did at the rudder pedals. With the rudder in the neutral position leave yourself about 8” sticking out the wing root.

Take the two ends of your cable and pull them so they are slightly taught and clamp them together using a small vise grip. Make sure that you do not clamp so tight that it dents or marks the cable.

___ Assemble the pulleys and the two angle brackets with AN3-6A bolts and MS21042-3 nuts.

Position your pulley so that the cable comes through the firewall, around the pulley, and straight towards the wing conduit. Move the pulley around to achieve best alignment. When you are satisfied with the pulley position, attach the fixture to the firewall with (4) 3/4 x #8 sheet metal screws. Install the small cotter pin as shown in figure 10-8 to keep the cable from jumping track.

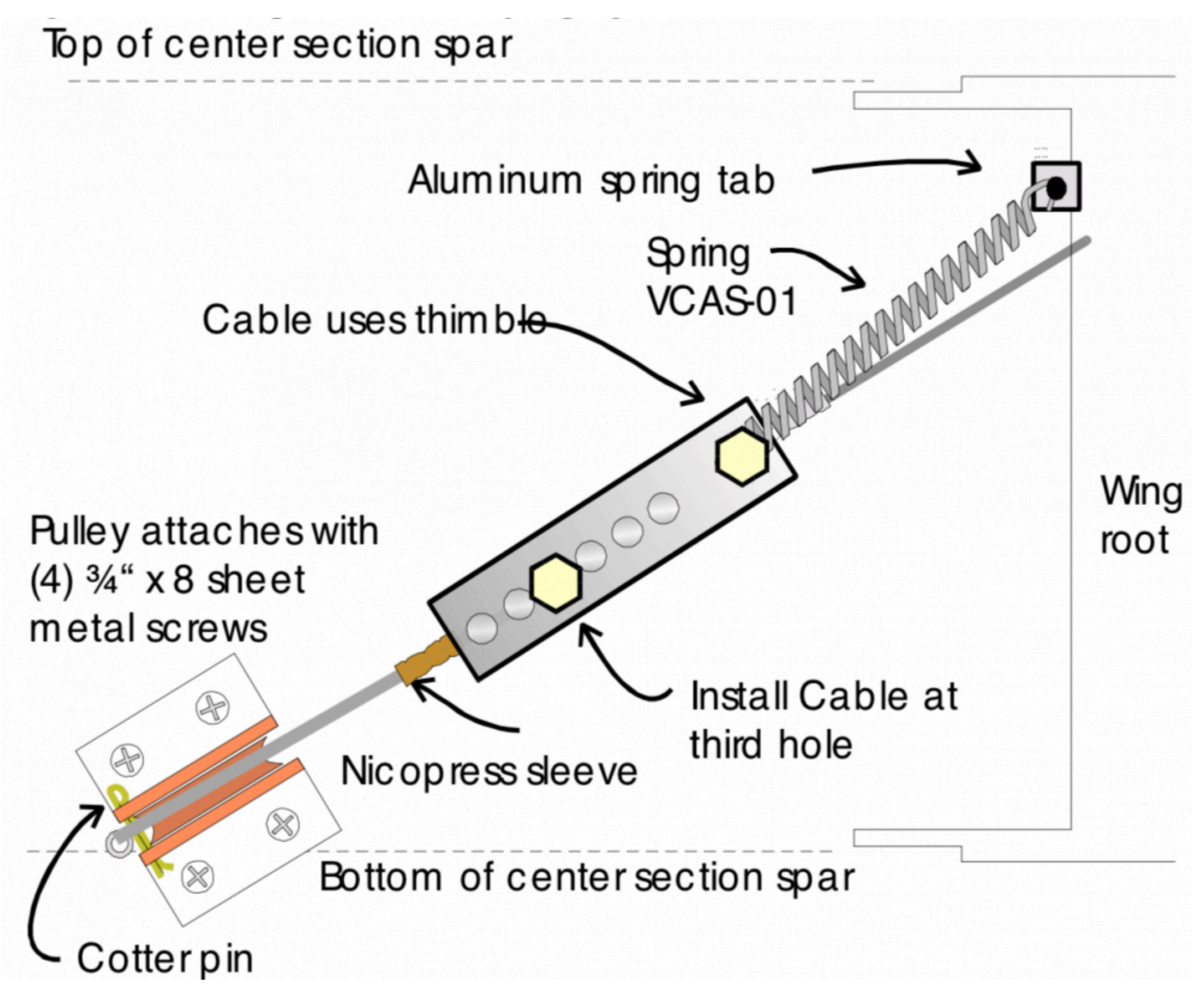


Figure 10-8. Wing Root Rudder Cable Assembly

Measuring from the trailing edge of the rudder where it meets the wing pull on the cable until you get 3-1/2 “ of travel. Next push your rudder pedals until they are 1/4”from the canard bulkhead. You may want to make a 1/4” spacer that you can use for both pedal installations to make sure they are even. With the rudder and pedals in this position again clamp the two cables together in the engine compartment close to your pulley.

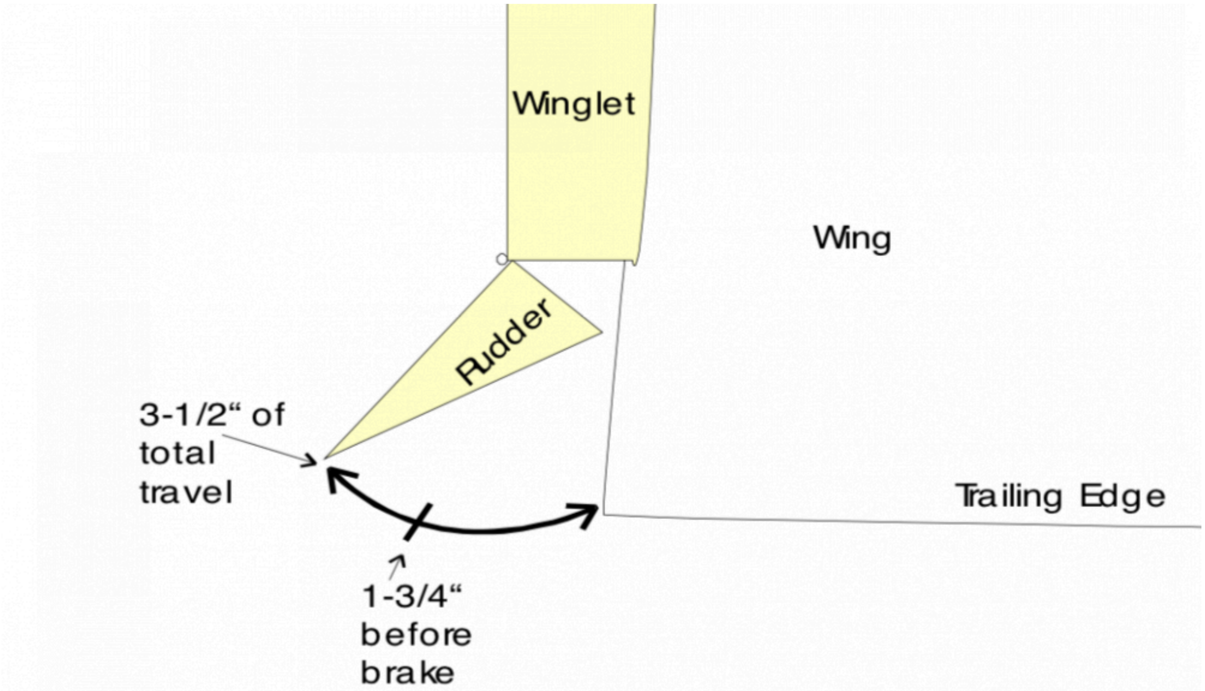


Figure 10-9. Rudder Travel

Allow the rudder to go back to it’s neutral position and the rudder pedal to come back from the bulkhead. With the rudder pedals in this position put your rudder pedal stop here as shown in Figure 10-7. From this position now you are allowed to get 3-1/2” of rudder travel before contacting the canard bulkhead.

Have a partner hold the rudder in its neutral position. Pull the cable in the wing taught and mark it where it exits the wing root. Now pull the cable and allow the rudder to operate so your mark is away from the wing root. Install a Nicopress sleeve and thimble so that it is inside the mark by at least a 1/4” . Cut off the excess cable and push the rudder back to its neutral position and tape the rudder here so it wont move. Install the rudder adjuster on the Nicopress thimble coming out of the wing as shown in figure 10-8.

On the other end of the rudder adjuster push a thimble around the AN3 bolt. Route the cable coming from the fuselage through a Nicopress sleeve around the thimble and back through the sleeve. With the rudder taped to the neutral position and the rudder pedal back fully against its stop pull the cable around the thimble taught and use a small vise grip to hold tension on the cable. Do not clamp the vise grip so tight that it dents or marks the cables. Set the nicopress using a nicopress tool. Cut off the excess cable.

Now your rudder cables should be done and they should allow you to get at least 3-1/2” of rudder travel before hitting the canard bulkhead.

You are shown how to adjust the block on your brake master cylinder in the chapter 6 where the rudder pedals are installed. This will need to be adjusted to allow at least 1-3/ 4” of rudder travel before hitting the brake and 3-1/2” total travel of the rudder with full brake engagement.

___ Another rudder return spring is installed in the wing root to add in returning the rudder to neutral. Just aft of where the cable enters the wing root cut a small slit to except the spring tab. Refer to Figure 10-9. The installation is the same as the spring tab you installed in the rudder. Fill the slit with Flox and epoxy and insert the spring tab. Place one end of the spring through the tab and the other end around the top AN3-7A bolt on the adjuster. You want to keep the spring as close to in line with the travel of the rudder cable as you can.

After some use, the system may need readjustment to achieve full rudder deployment. Rudders on the Velocity are not critical, and the aircraft can be operated without them, but they sure come in handy during taxi and final approach.

10.4. 10.3 – Ailerons

10.3 – Ailerons

10.3.1 – Rigging of the Roll System (Ailerons)

___ To complete this portion of the project, the wings must be on the airframe.

___ The first step is to install the aileron torque tubes to the ailerons. Remove the aileron from the wing and install the 3” long piece of 5/8” × .058 wall steel tube (VAUJ-01) as shown in Figure 10-10. Install the 6 ‘ 3/4” aluminum tubing (VATT-01) to the other end of the steel tube as shown. Use an 11/64th drill and a 3/16” reamer to drill the hole. Attach with (2) AN3-10A bolts, (2) AN960-10L washers, and (2) MS21042-3 nuts.

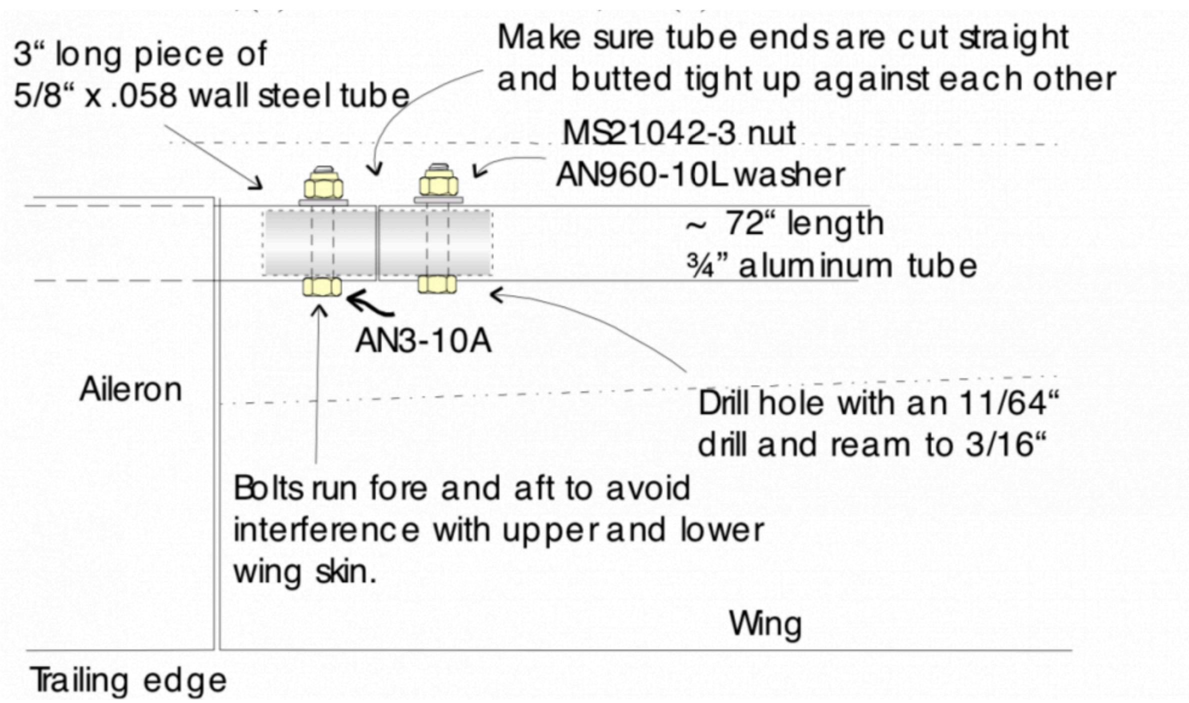


Figure 10-10. Aileron Torque Tube Assembly

Make sure that the bolts are oriented fore and aft with respect to the airframe. If they are not, they will interfere with the upper and lower skins of the wings.

___ Reinstall the aileron to the wing and check for any interference between the tube, and wing foam. You will have to wrap a piece of sand paper around a piece of tubing or a broom handle and elongate the hole until their is no interference. Using a long piece of tubing with one person at each end works well.

___ Once the ailerons are in place, locate the aileron bellcranks, aileron bearing brackets, and aileron cable bracket.

The inside of the aileron bearing is located 2” in from the cowling flange. Refer to figure 10-12. You will need to trim the aileron torque tube to allow it to butt up tight to the bearing.

The bearing brackets are two piece to allow you to fit them to your wing root. Slide the top bearing bracket onto the bellcrank and insert the bellcrank into the torque tube. You will probably have to sand off the primer on the bellcrank to allow it to fit in the tube. Fit the bearing brackets to the wing root. Mark and drill the upper and lower bearing brackets and install hardware as per Figure 10-12.

___ Fasten the bearing bracket to the wing flanges. Slide the bracket into position, centering the torque tube in the hole in the wing root.

___ Drill (4) 3/16” holes (two at the top and two at the bottom) through both the wing root flange and the bracket. Countersink the flange side, and install the bracket to the wing root with (4) MS24693S-272 flathead screws, (4) washers, and (4) MS21042-3 nuts.

Now you can install the aileron push pull cables.

___ Using a 1/2” drill you will need to drill holes through both the gear bulkhead and the firewall. Refer to Figure 10-11 for Fixed Gear or Retract Gear as appropriate. **The fixed gear through gear bulkhead hole is slightly lower than for an retractable gear**

Try to drill the holes in the direction the cable will run to allow the straightest routing. The cable routing needs to be as smooth and as straight as possible. The straighter the push-pull cables the less slop in the system and the lighter the ailerons will feel.

Make sure that where the cables pass through the gear bulkhead and the firewall they do not get kinked.

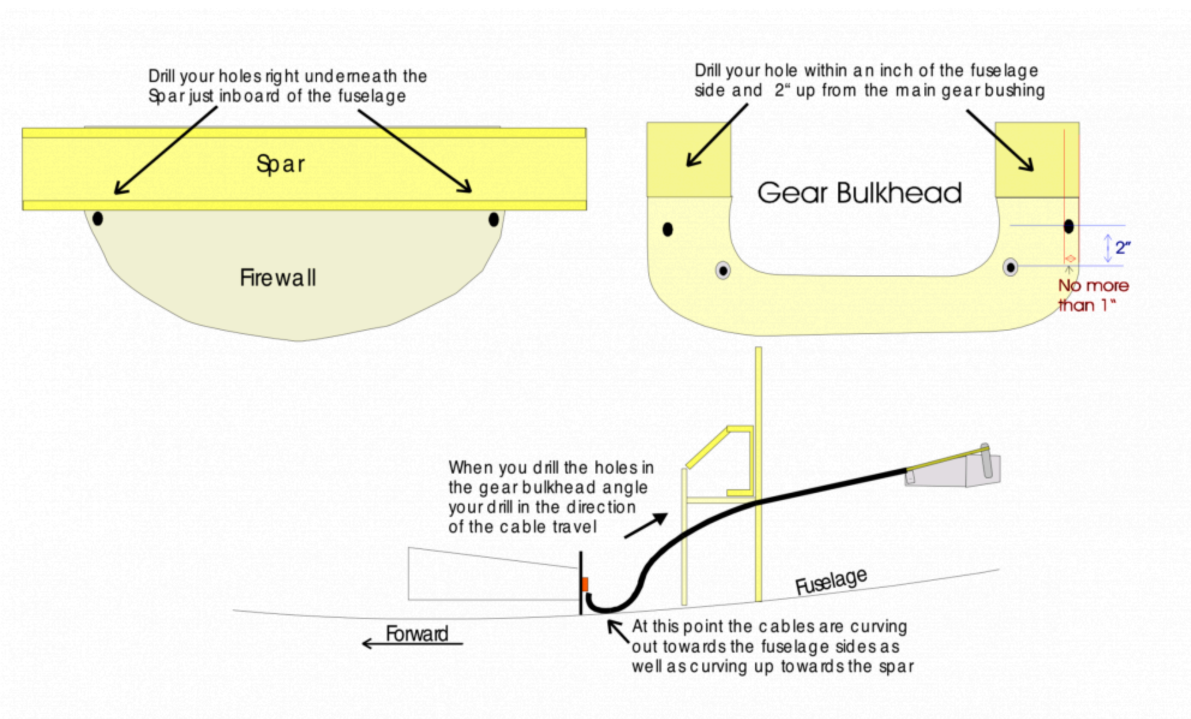


Figure 10-11. Aileron Cable Routing (Fixed Gear)

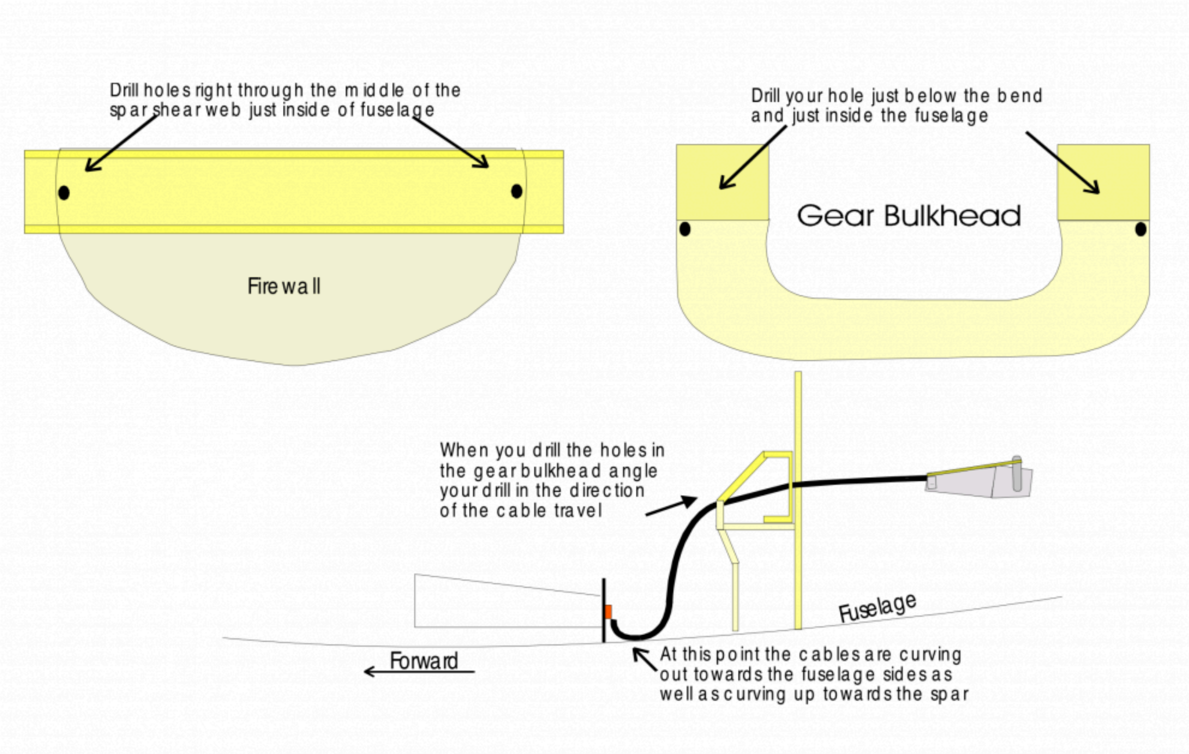


Figure 10-11. Aileron Cable Routing (Retractable Gear)

VERY IMPORTANT: Upon installing the push-pull cables, you must keep the cables as straight as possible at both ends where the clamps are attached. The point where the sheath starts is easily bent and causes considerable binding and premature wear if it is not kept straight.

Once the cables routed properly you can rig our aileron system. First you will need to find the middle of our cable travel. Push the cable in as far as it will go on one end and mark the cable.

Pull the cable out and measure the distance between the mark and the end of the outer sheath. Using a tape measurer place a mark at the midpoint. Do this to both cables at both ends.

Clamp the control stick so both the stick and the aileron bellcrank at the back of the keel are vertically centered and can not move. At the rear of the keel install the rod ends with the bellcrank perfectly vertical and the midpoint marks right at the outer sheaths of the cable. Clamp the cables to the aileron keel bracket. These holes are predrilled and should not be changed. Refer to the fuselage section figure 6-12.

The idea is to get the cable centered, the rod ends screwed on to the middle of their travel while the control stick and ailerons are neutral and the approach angles are 90 degrees. This will give you equal travel up and down. This also gives the most travel up and down.

Clamp the ailerons so they cannot move from their neutral position.

At the wing root install the rod-ends on the end of the push/pull cables. Screw the rod ends in all the way and back them out 4 complete turns. Attach the rod ends to the aileron bellcranks using an AN4-10A bolt, (2) AN960-416 washers,(1)AN970-4 large area washer and an MS21042-4 locknut as shown in Figure

10-12. Keeping the midpoint mark at the end of the outer sheath of both cables you want to position the cable clamps on the cable bracket so it allows a smooth cable transition from the firewall and the approach angle to the bellcrank is 90 degrees.

Lightly clamp the aileron torque tube just outboard of the aileron bellcrank to keep the aileron bellcrank from turning. We will locate the cable clamp before we permanently install the aileron bellcrank. You will need two Cable Clamp angles and the cable Clamp strap. Position the Cable clamp angles on the wing flanges as shown in figure 10-7. Install the cable clamp strap to the angles leaving .

Hold the cable clamp up against the cable clamp strap and position it so that the cables are as straight as possible and the approach angle to the aileron bellcrank is 90 degrees. Using small vise grip hold the cable clamps in position.

___ Drill two 3/16” holes and clamp the cable to the strap with (2) AN3-5A bolts, (2) AN960-10L washers, and (2) MS21042-3 nuts. Install the cable clamps and shims as shown in figure 10-7.

After the clamps are secured you can proceed to the aileron bellcranks.

___ To allow better access to the aileron torque tube bolts drill a 3/4” hole with a hole saw through both the flange and the aluminum bracket. Refer to Figure 10-12. Center the hole up with the aileron torque tube and make sure you do not cut through the edge of the aileron bracket.

___ Double check that the approach angle is 90 degrees and the cables have their middle marks right at the end of the outer sheath.

Using a small vise grip clamp the aileron bellcrank so it will not rotate when you start drilling. With the vise grip holding the tubes you can carefully rotate the assembly and make sure you are getting the proper aileron travels.

___ With a partner helping to keep you straight and perpendicular to the torque tube , use a 11/ 64” drill to drill a hole from top to bottom through the aileron torque tube.

___ Follow up with a 3/16” reamer.

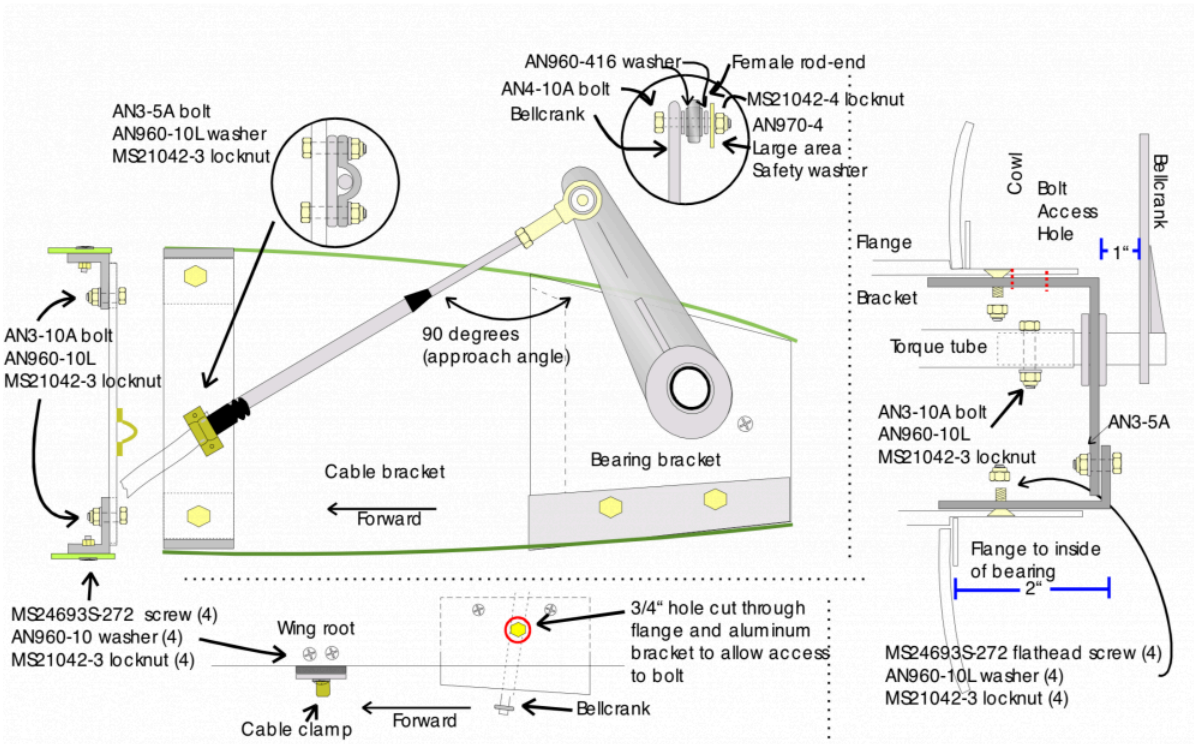


Figure 10-12. Wing Root Aileron Cable Bracket Assembly

___ Install the AN3-10A bolt, AN960-10L Washer and MS21042-3 locknut onto the assembly as shown in Figure 10-12.

Your control system is now centered with an approach angle of 90 degrees. Done properly you will get 2-1/2" travel up and down minimum.

If any binding occurs, check for misalignment of the cables, overtightened bolts, lack of lubrication, or misalignment of the bearing to the torque tube. When the stick is fully deflected, you should get at least 2-3/8" of deflection at the inboard trailing edge of the ailerons, both up and down. A properly rigged system will get approximately 2-1/2" of both up and down travel.

Any adjustments should be made with the threaded rod ends. Be careful to always use locknuts and that there is at least 1/4" of thread in the rod end following any adjustments. The system will become smoother with use.

If excess slop occurs, it is usually the result of sloppily drilled holes in mated components in the linkage between the ailerons and stick. Always drill the control system bolt holes undersized and use a reamer to open up the holes to the final dimension. If you find a poor joint, you can re-drill and ream the hole for the next larger bolt size. A sloppy connection will only get worse with time.

Note: Be aware that sloppy controls directly affect an aircraft's VNE. Flutter usually starts at a control surface. Keep a close eye on the system. If something shows up that should not be there, investigate and repair prior to your next flight.

11. 11 – Fairings

Contents

11.1. 11.0 – Chapter Preface

11.0 – Chapter Preface

11.0.1 – Parts List

Part Number	Description	Qty
MP1805	NACA Duct, Pilot	1
MP1806	NACA Duct, Co-Pilot	1
MP1808	Wheel Pant, Nose, Right	1
MP1809	Wheel Pant, Nose, Left	1
MP1810	Wheel Pant, Main, Pilot, OB	1
MP1811	Wheel Pant, Main, Pilot, IB	1
MP1812	Wheel Pant, Main, Co-Pilot, OB	1
MP1813	Wheel Pant, Main, Co-Pilot, IB	1
MP1814	Struct Cover, Nose	1
MP1815	Canard Tip	2
MP1816	Counterweight Fairings, Elevator	2
AN526C-1032R8	Screw, AN526C-1032R8	22
MS21047-3	Nutplate, MS21047-3	22
	Pop Rivet, AAC-3-4-3/32”	36
MA1801	Nose Gear Tab	1
	Screw, 10-32	5
MS27039-1-07	Screw, MS27039-1-07	4

11.0.2 – Tools List

Description
Razor Knife
Hacksaw Blades
Jig Saw / Air Saw
Clecos

11.0.3 – Supplies List

Description

EZ-Poxy
Veloci-Poxy
Duct Tape
Micro-Balloon
Milled-Fiber
Bondo
Pour Foam
5-Minute Epoxy
Piano Hinge
1/8” × 1” Aluminum Bar

11.0.4 – Glass List

Type	Size	Qty
BID	5” × 18”	10
BID	3” × 24”	4
BID	3” × 24”	8
BID	8” × 24”	8
BID	3-1/2” × 22”	20
BID	4” × 18”	8
BID	4” × 18”	8
BID	1” × 18”	8
BID	1” × 20”	5
BID	3” × 24”	15
BID	4” × 18”	4
BID	6” × 6”	2

11.0.5 – Process Overview

Construction Process	Completion Date
Relocate Cowling Seam	
Install premolded NACA scoops	
Install Oil Access Door	
Install Main Wheel Pants	
Install Nose Wheel Pant	

Install Canard Tips	
Install Counterweight Fairings	

11.0.6 – Documentation Changes

Oct 01, 2018 – Original Web Release

11.2. 11.1 – Cowl Treatments

11.1 – Cowl Treatments

11.1.1 – Cowling Relief Hole for Wing

Since the wings extend into the engine compartment, the cowling must be cut to allow the wing to slide through. Locate the “Cowling Cut Template” on the roll of XL Elite templates.

___ Level the aircraft fore and aft.

___ Cut the factory flanges off the cowling and cleco the upper and lower halves to the fuselage.

___ On your wing, measure the distance from the forward side of the inboard hardpoint busing back to the trailing edge of the wing. See Figure 11-1. Transfer this measurement to the cowling, using the inboard hardpoint bushing on the center section spar.

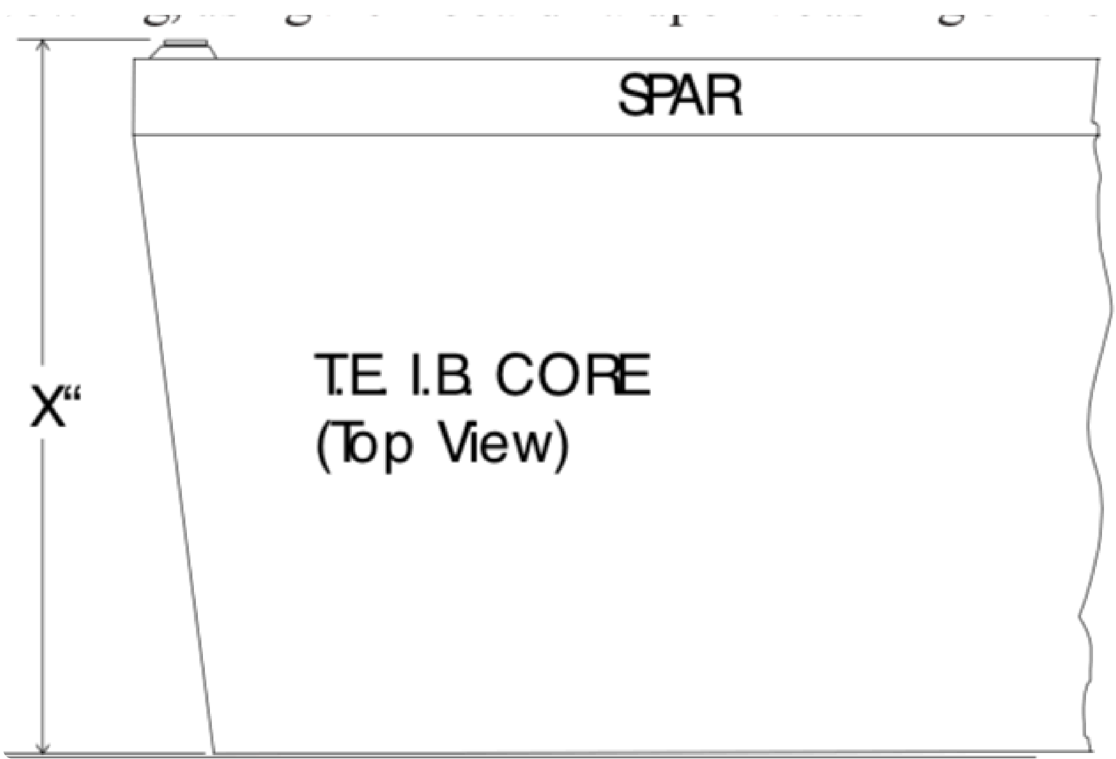


Figure 11-1x. Measuring for Template Placement

___ Place the template on the cowling with the trailing edge aligned with the mark on the cowling. The top and bottom of the template should be aligned with the top and bottom spar caps. Level it using the level line on the template. (See Figure 11-2)

___ Cut the hole out for the wing, staying inside the line so you can trim it to fit later.

___ Remove the cowlings.

___ Install the wings and confirm that they are at the proper incidence.

___ Trim the top cowling to fit the wings and then the bottom. Make sure you have a little clearance between the wing and the cowlings so that they are not binding.

___ Using mixing sticks and **Bondo**, attach the top and bottom cowlings together on the inside.

___ Duct tape the gaps between the sticks.

___ Sand the outside surfaces of the cowling at least 1" each side of the joint down to the glass.

___ Glass the joint with 2 **BID**, thus connecting the cowlings.

___ After it has cured, remove the sticks and sand the **Bondo** off.

___ Sand and glass the inside joint line with 2 **BID**.

___ Mark a new split line from the trailing edge point of the wing off the end of the cowling. (See Figure 11-2). This line will end up about 2" lower than the center of the outlet hole.

___ Cut the cowling apart along this line.

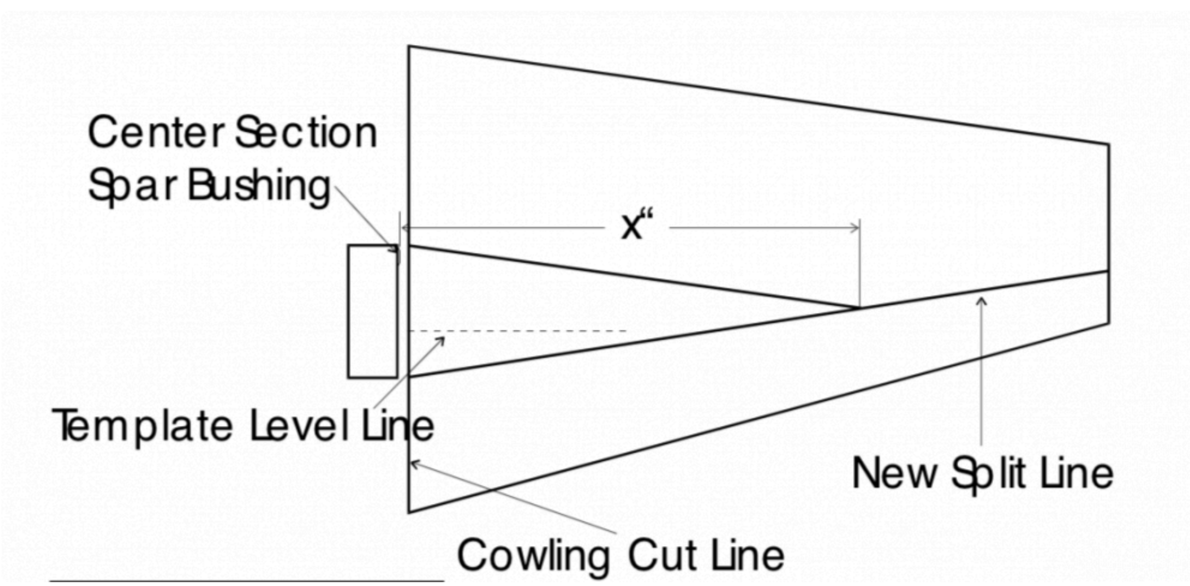


Figure 11-2x. Placing Template

11.1.2 – Cowling Joint Flanges

___ Sand the inner surface of the upper cowling at the cut line in preparation for the flange.

___ Duct tape the lower cowling inner surface just around the edge of the new cut line and reconnect the two cowlings on the outside with sticks and **Bondo**.

___ Create a flange with 5 **BID** that extends down onto the duct tape about 1-1/2” and about 2” onto the other surface.

___ Drill three (3) 1/8” holes in the flange 1/2” below the cut line starting 1/2” behind the wing trailing edge and spaced 6” apart.

___ Separate the cowlings and trim the flange back to about 1”.

11.1.3 – Upper Cowl-to-Wing Flanges

Before creating the upper flange you must have fit the cowling to the wing. Do this installation with the lower cowling off. Sand the upper surface of the portion of the wing that is inboard of the cowling and the inner (underside) surface of the upper flange on the wing that is flush with the cowling.

___ Duct tape the cowling’s inside surface all along the contact point of the wing.

___ On the front portion of the cowling along the wing, lay-up a five (5) **BID** flange on the inside of the cowling, covering the upper surface of the wing and extending 1-1/2” onto the duct tape. See Figure 11-3a.

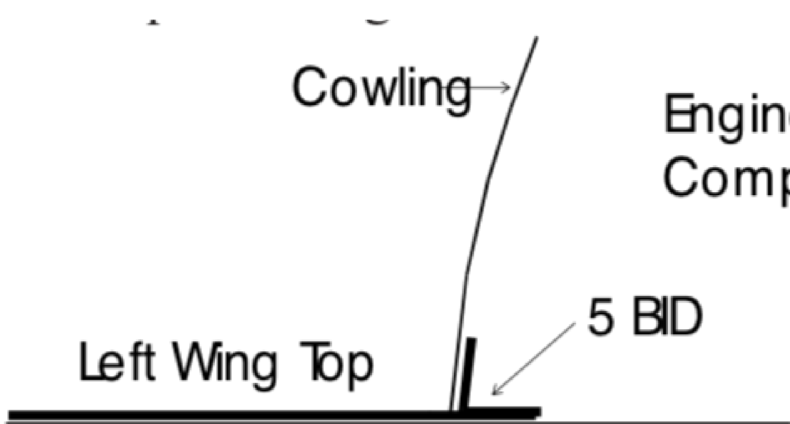


Figure 11-3ax. Upper Cowl Flange-Front

___ After cure, drill four (4) 1/8” holes 11/16” above the surface of the wing, starting 5-1/2” from the trailing edge of the wing and spaced 6-1/4” apart. Remove the cowling and trim the flange back to approximately 1-1/8”.

___ Note: Do not drill the aft holes too close to the wings in the cowling. This will make it hard to get a screwdriver in later to take off and put on the cowling.

11.1.4 – Lower Cowling Flanges

___ With the top cowling in place install the bottom cowling. Cleco the bottom cowling to the firewall flange and put 2-3 dabs of hot glue or Bondo down each side of the bottom cowling where it meets the wing. Carefully remove the top cowling. You may need to prop up the trailing edge of the cowling to keep it in place. Duct tape the lower cowling inside surface where it meets the wing. Sand the top-inside surface of the wings .

___ Once this is done, lay-up a 3-1/2” wide five (5) **BID** flange from the wing onto the inside of the lower cowling about 1-1/2” onto the duct tape. See Figure 11-3b.

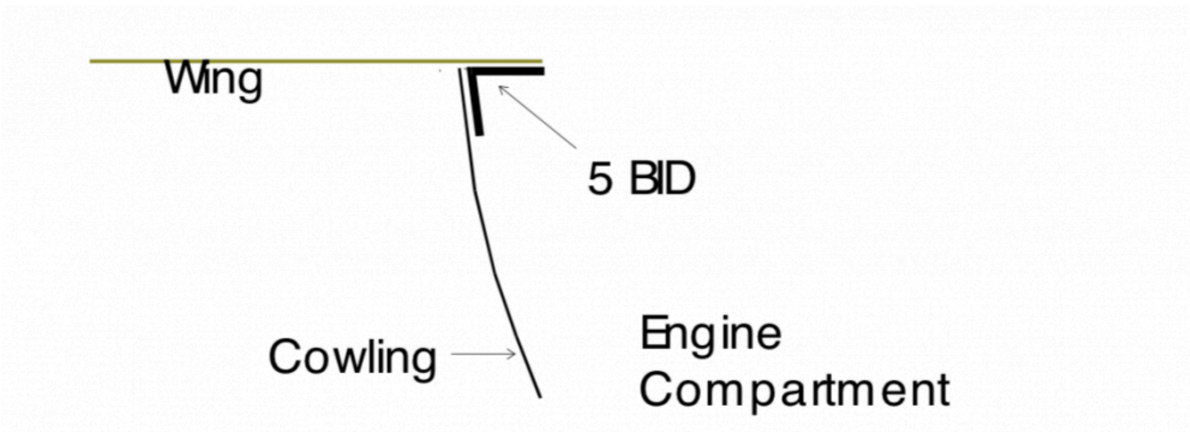


Figure 11-3bx. Bottom Cowling Flange

___ After cure, drill three (3) 1/8” holes 11/16” from the cut line with the first hole starting 1” from the front cowling cut line and space the other two 6-1/4” apart.

___ Drill two (2) more 1/8” holes 11/16” from the wing’s lower surface with the first hole about 5-1/8” from the trailing edge of the wing and the last one 6” from the first.

___ Remove the cowling and trim the flange down to about 1-1/8”.

___ See Figure 11-3c for all the hole locations.

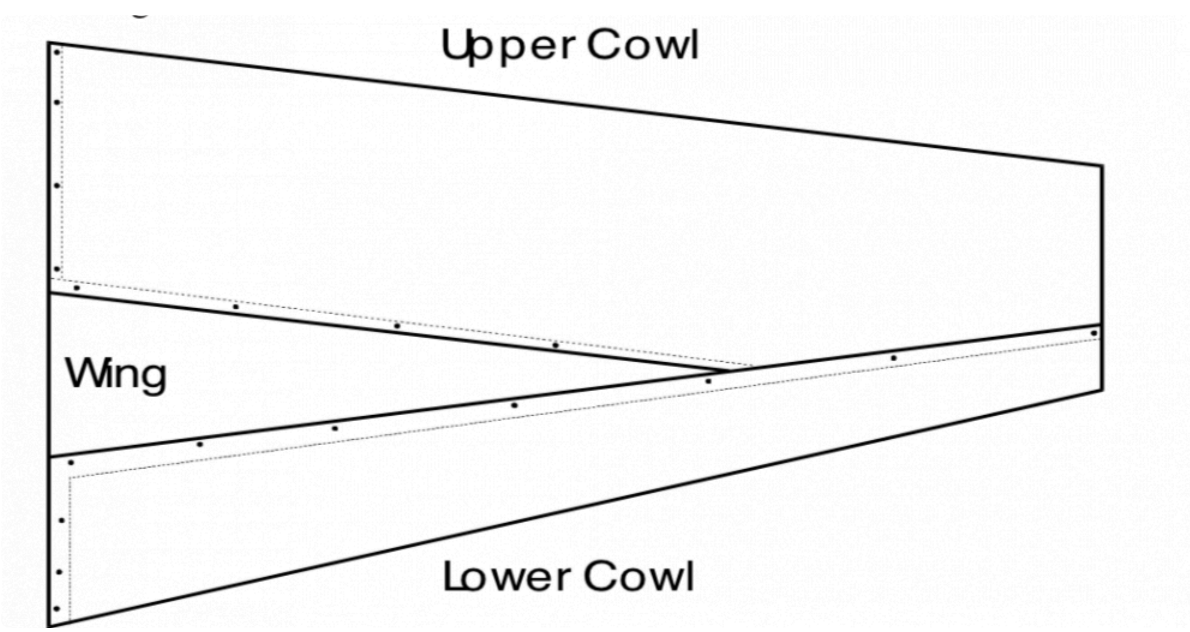


Figure 11-3cx. Hole Placement

The last flanges to create are the two on either side of the spinner.

___ Duct tape the inside of the bottom cowl at these two points.

___ Sand the upper cowling in preparation for the glass flange.

___ Install the cowlings and lay-up a 3” wide five (5) **BID** flange that extends 1-1/2” down onto the duct tape.

___ After cure, drill one 1/8” hole on each side in the center approximately 5/8” down from the cut line.

11.1.5 – Premolded NACA Scoop Installation

p. You are provided with a left and right scoop. If you lay the scoops over the recessed area in the top of the fuselage you will be able to tell left from right. Using your scoops as a guide cut out the recess in the fuselage approximately 5/8” from the sides of the indention creating a flange for the scoop to lie into. Make your forward cut line 5 inches aft of the recess line. At the back of the recess cut all the way to the back line since the scoop you will be placing in the cutout will be sliding back through a hole you will cut in the firewall.

Figure 11.6x – Cutout for Premolded NACA Scoops

You are provided with a left and right scoop. If you lay the scoops over the recessed area in the top of the fuselage you will be able to tell left from right. Using your scoops as a guide cut out the recess in the fuselage approximately 5/8” from the sides of the indention creating a flange for the scoop to lie into. Make your forward cut line 5 inches aft of the recess line. At the back of the recess cut all the way to the back line since the scoop you will be placing in the cutout will be sliding back through a hole you will cut in the firewall.

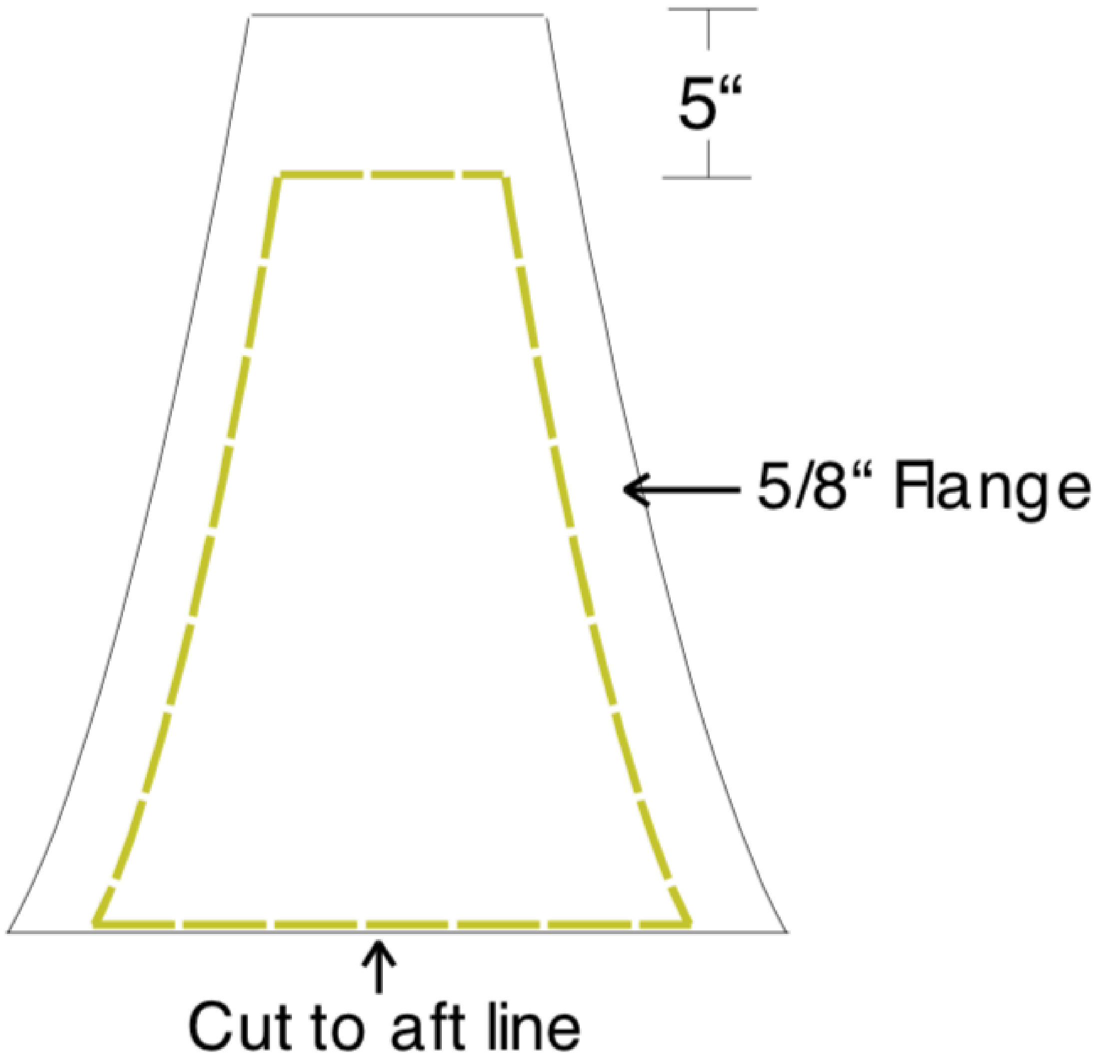


Figure 11-4. Cutout for Premolded NACA Scoops

After you have cut your hole in the fuselage, you now will cut your holes through the firewall.Again using your scoop as a guide cut a hole through the firewall that will allow the scoop to protrude through the firewall so it is flush with the aft face. This will require notching the rear section of the firewall. Leave 1/8” to 3/16” of firewall material at the top of your cutout so the cowling flange will remain strong. As you fit the scoop down into position you will have to bevel the 5 inches of material you left at the front of the scoop to allow it to go down. You may also have to trim the flange on the scoop to allow it to fit in the recess. When satisfied with the fit drill 1/8” hole every 4 to 5 inches around the perimeter for clecos.

Remove the scoop and sand the underside of the flange where it will mate to the fuselage as well as the sides where it will be glassed inside the fuselage. Sand the mating surfaces on the fuselage. Using structural adhesive mixed with a little cabosil bond the scoop in place. Install cleco’s to hold position.

After cure remove the cleco’s and sand the area around the flange. At the firewall, radius the three sides of the flange. You will be laying glass over this radius so make sure it is smooth. Sand off about 1” of primer at the aft end of the scoop. Using one layer of **BID** glass the scoop to the back side of the firewall. Make sure you do not have any air bubbles at the radius.

Using a 2 **BID** lay-up that is 3 inches wide glass the scoop to the fuselage inside the airplane around the perimeter of the scoop. Make sure you use Micro on the corners first to allow the glass to lay down smoothly.

11.1.6 – Oil Access Door

You may wish to wait until your engine is installed to verify these dimensions but this is what we used with our Lycoming IO-540. The oil door is basically a 6” diameter hole with a 4” flat on the left side for the attachment of the hinge. The center of the door is located 18” aft of the cowling cut line and approximately 25-1/4” from the right edge of the cowling at the wing. When you come up from the wing, make sure you start 18” aft of the cowling cut line. If you have a 6” sanding disc, it is easy to measure and cut the edge of the disc to give that 4” flat, and use that as a template to mark your hole.

___ Cut out the door and duct tape the inside in preparation for constructing a flange.

___ Sand the inside of the cowling around the hole.

___ Hot glue the door into position and apply five (5) **BID**, lapping 1/2” onto the door and the cowling.

___ Install the hinge to the door with five (5) BSC-44 rivets.

___ Notch out the cowling for the hinge.

___ Rivet the hinge to the cowling with five (5) BSC-44 rivets.

The preferred method of holding the door closed is to use a hartwell type spring latch that can be bought through an aircraft supply store. If this is not available the door can be held closed with one 10-32 screw and a nutplate through the flange.

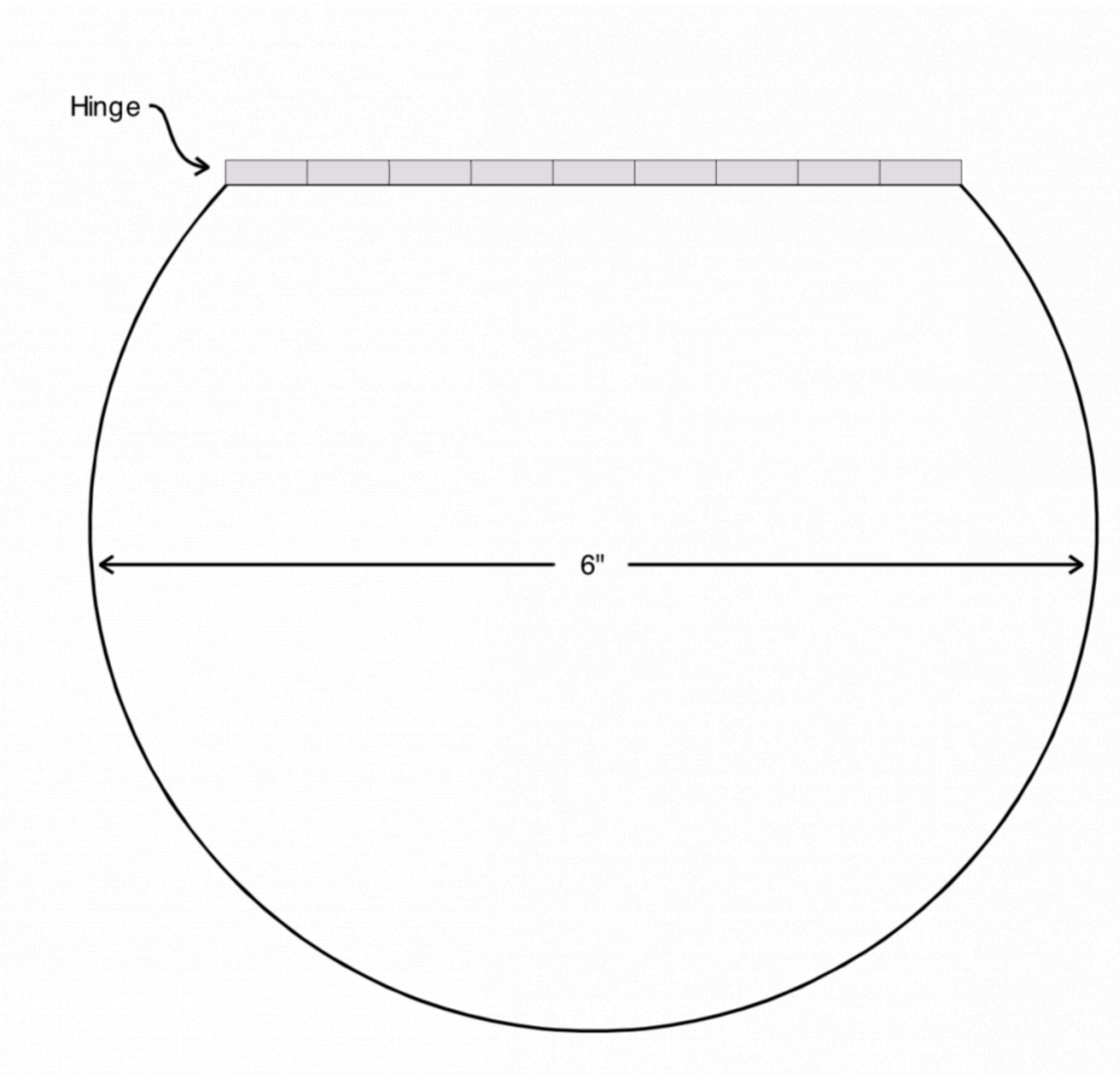


Figure 11-5. Circular Oil Access Door

11.1.7 – Cowl Attachment

The upper and lower cowl screws are installed in the same way using the locations located below.

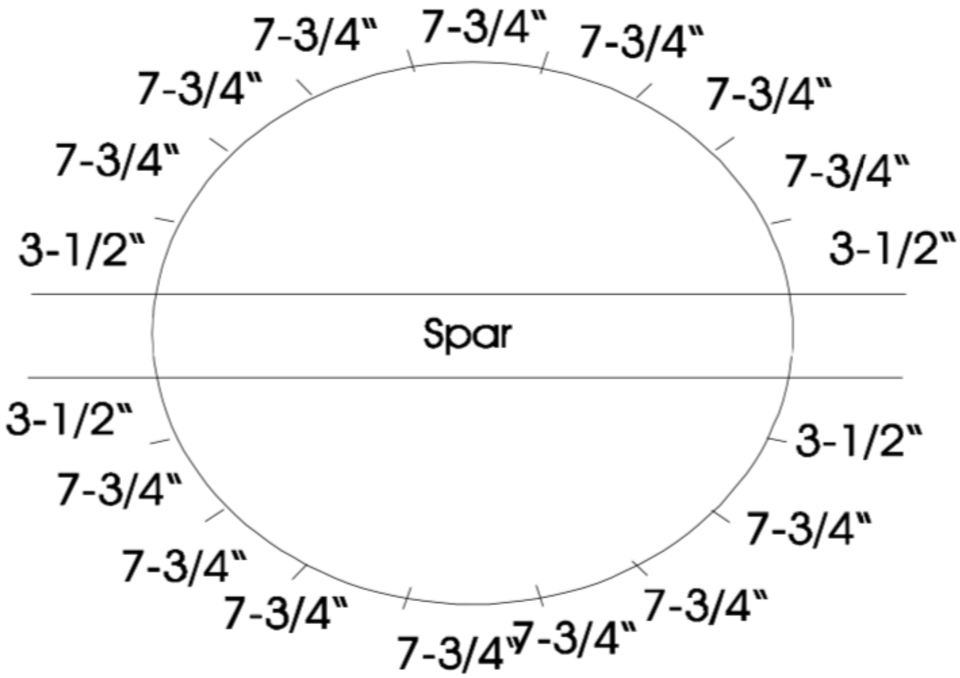


Figure 11-6x. Nutplate Locations

11.3. 11.2 – Wheel Pants

11.2 – Wheel Pants

11.2.1 – Main Wheel Pants

The wheel pants come to you in front and back halves. Both main pants are the same, there is no difference by between left and right. You will also need your nose gear fairing and your left and right wheel pant to gear fairing.

Before you install your axles you will want to slide your wheel pant to gear fairings onto the gear leg. Install your axles with the aluminum backing plates that go on the inboard side of the gear leg. Use your axle as a template to drill the holes in your backing plates. You have two 2”x12”x1/8” strips of aluminum. These strips are used to attach the inside portion of the wheel pant to the aluminum plate. Attach these strips to you aluminum backing plate as shown in Figure 11-12. Make sure that these strips are kept level with the ground.

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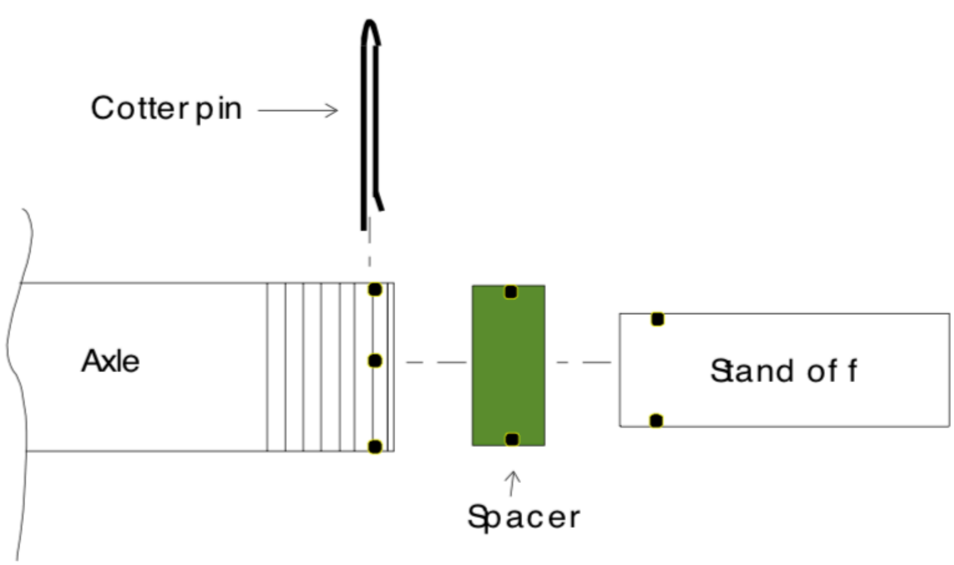


Figure 11-13. Outside Wheel Pant Standoff

Trim the wheel pants to the trim lines located on them. Trial fit the gear sections to the wheel starting with the aft pant section. You will have to trim the wheel opening at the bottom of the wheel pant as well as the cut out for the gear leg at the top. You will need to have at least 1/2” clearance around the main tires. This will keep the tire from ripping up your wheel pant when it loses some air. With the aircraft sitting level fit the pant so that it is parallel to the ground. The wheel pant should also sit parallel with the longitudinal axis of the airplane. Do not use the mold seam as the centerline of the wheel pant. This is not the center of the pant. You will need to bend the strap that you have fastened to the back of the gear leg so that it touches the wheel pant. The front of the strap goes to the front wheel pant half the back of the strap goes to the back. After the strap is flat against the back of the pant and the wheel pants are level you can drill the holes for the nutplates. Use an 1/8” drill bit and cleco’s first and after all the holes are drilled go back and open the holes up to 3/16”. Refer to figure 11-12.

With the rear pant section on and the front off install the wheel pant standoff into the end of the axle. The standoff has a collar that goes around it so that if fits snugly in the axle. Refer to figure 11-13. The cotter pin that is used to safety the axle nut also holds on the standoff. Adjust the standoff so that it buts up to the inside of the rear wheel pant section. Mark the standoff where it enters into the axle. Remove the aft wheel pant half so you can drill an 1/8” hole through the standoff using the holes at the end of the axle as your guide. Install the cotter pin through the end of the axle and standoff. Now you will need to find the location for the bolt hole location on your wheel pants. I like to use a 10-32 screw or bolt. Cut the head off of the bolt and thread it into the hole. Install the rear wheel pant and level the pant up as you did for installing the inside attach points. Now using a hammer tap the wheelpant in the location where the axle touches it. The bolt you screwed in will leave a mark on the wheel pant exactly where you will need to drill a 3/16” hole. Reinforce the area around where this screw hole is with a 3 bid layup that is 1” x 1”. Drill out the hole and install the back half of pant onto the gear.

!(zoom caption)https://manula.r.sizr.io/large/user/13908/img/figure-11-14x-wheel-pant-screw-hole-location.png

Once the wheel pants are fit to the gear remove them and reassemble the two halves. You may want to draw a few lines from the front half to the rear half to help keep your alignment. Mark the pant every 3 inches around the split line. The back wheel pant half has a premade flange on it so 1/2” forward of the split line on your 3 inch marks drill 1/8” holes using cleco’s to hold the pant together. I prefer to drill my hole alternating from one side to the other following up with cleco’s so I keep my alignment. Pay close attention to the aft wheel pant section when drilling that it stays close to the back of the front pant and stays lined up. To accomplish this you may want to use a short drill bit and a block of wood that is thicker than the length of the drill. Back the holes up with the wood before you drill to keep a tight fit. Watch out for your hands. You can reassemble the pants on the airplane using the clecos to double check alignment. When satisfied with fit drill the holes out to 3/16”.

Locate your AN526C-1032R8 stainless steel pan head screws, MS21047-3 nutplates, and AAC-3-4 3/32” pop rivets. Install the nutplates to the inside of all the holes drilled in the flanges. Trial fit the halves together and see how they fit.

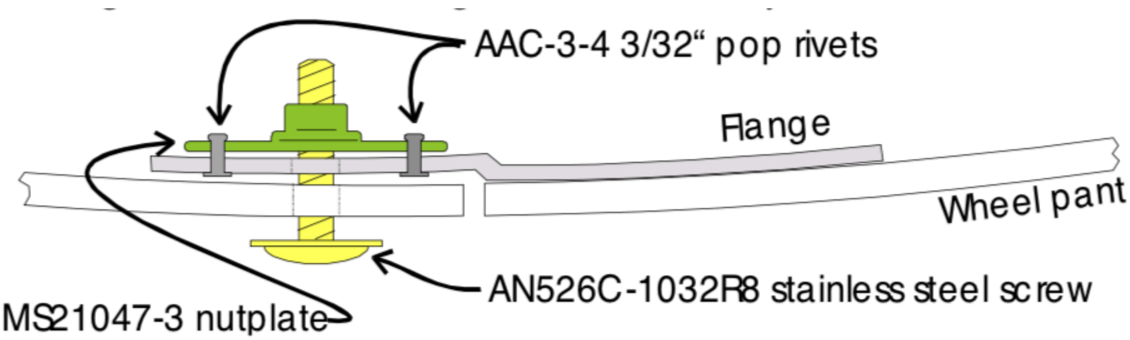


Figure 11-9. Wheel Pant Fastener Detail

Since the wheel pants enclose the tire and brake assembly the inside of the wheel pant can become very hot. Creating a scoop on the inside of the wheel pant that is in line with the brakes helps get airflow to the brakes. Use the template below for the scoop. Line up the scoop so that it is in line with the brakes and parallel to the pant.

11.2.2 – Nose Strut Cover – Installation

___ The nose gear wheel pant is installed by attaching (2) 10-32 screws to the axle and one 10-32 screw through a tab attached to the front of the gear fork.

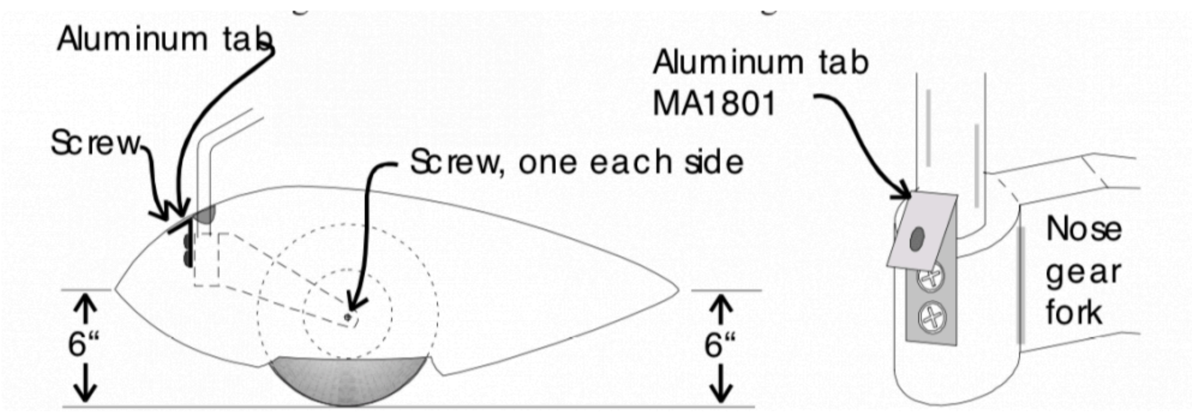


Figure 11-15. Nose Wheel Pant Installation

___ Slip the fairing over the strut leg and establish approximately 1/4” – 3/8” clearance at the top and bottom. Get the nose wheel straight, and tape the fairing into place, making sure that it points straight aft. If it does not, the plane will yaw.

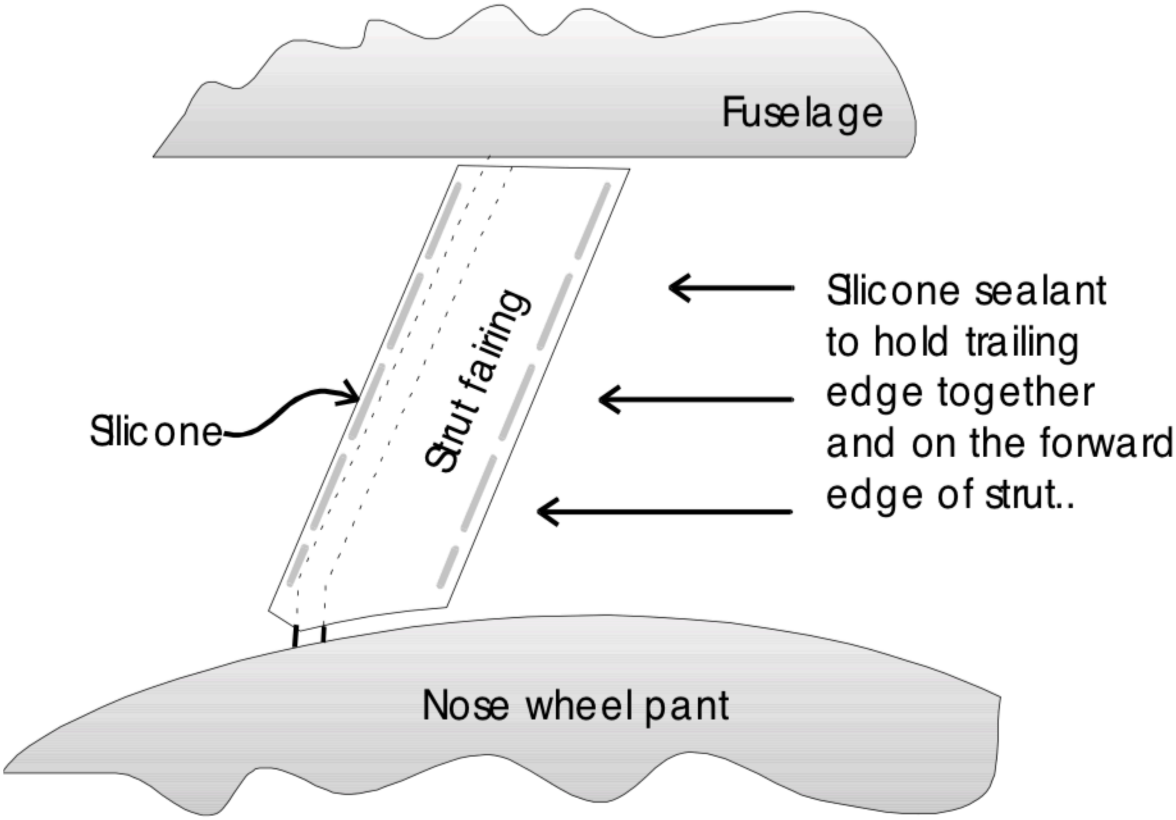


Figure 11-16. Nose Gear Strut Cover Installation

___ Rotate the nose wheel 180 degrees. Remove material on the lower front corner of the fairing so that it will clear the pant by 1/4” when the wheel assembly is turned around backwards. When the final assembly is complete, run silicone sealant between the front of the gear leg and the fairing and between the rear halves of the fairing. Tape in place until cure. In the event that you need to remove the fairing, cut the silicone with a razor knife .

___ Rotate the nose wheel 180 degrees. Remove material on the lower front corner of the fairing so that it will clear the pant by 1/4” when the wheel assembly is turned around backwards. When the final assembly is complete, bed the screws in silicone sealant between the rear halves of the fairing, and tape in place until cure. In the event that you need to remove the fairing, cut the silicone with a razor knife and remove screws.

11.4. 11.3 – Canard Tips

11.3 – Canard Tips

11.3.1 – Installation

___ You have received a premolded set of canard tips. The tips have a flange on them that fits inside the skin of the canard. Using a hacksaw blade cut a groove around the edge of the canard. The groove should not be much wider than the hacksaw blade and no deeper than 3/4”. Refer to figure 11-17. Test fit the canard tip onto the canard. You may have to remove a little more foam along the leading edge of the canard to allow the tip to move aft so the trailing edge lines up with the elevator. Refer to figure 11-18. With both tips in place stand back and make sure both tips are at the same level. Run a string from the top of one tip to the other. If the string is parrallel to the canard top then the tips are at the same level.

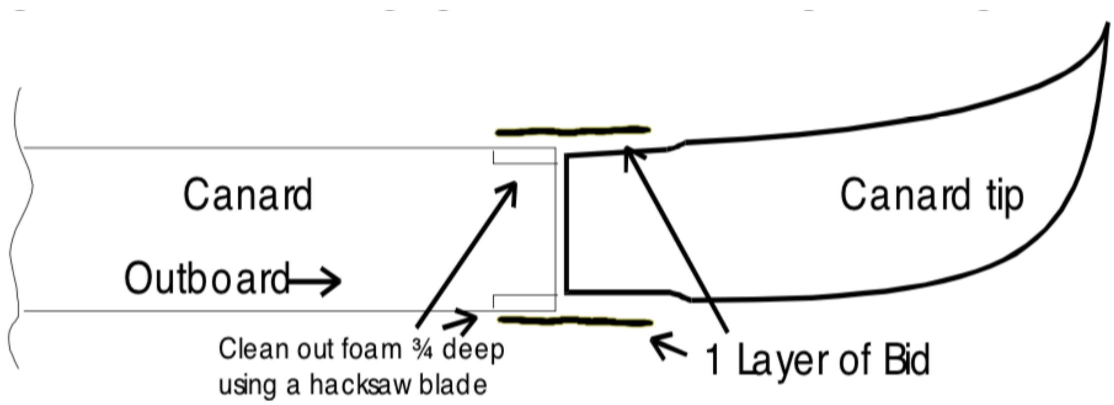


Figure 11-17. Canard Tip Installation

___ When satisfied with fit sand the flange of the canard tip. You will also need to sand 1 inch onto the canard and 1 inch onto the tip where you will glass them togather. Install the canard tip using structural adhesive. Lay one layer of **BID** over the joint. If your canard tip is pushed back from the leading edge this can be filled with Micro-ballon and contoured with light sanding after it cures.

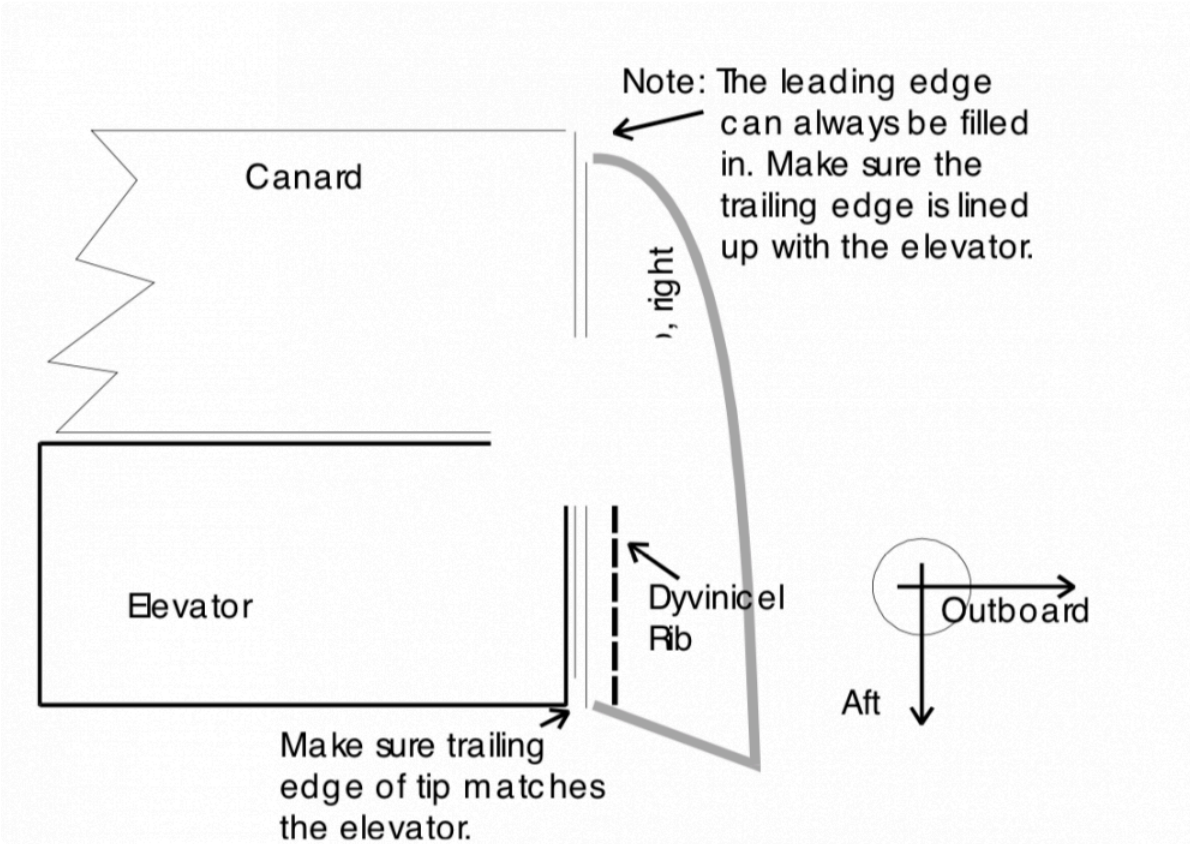


Figure 11-18. Canard Tip Installation - Top View

You will need to make a small rib to enclose the back inboard side of the canard tip. This can be made from a small piece of Dyvinicel foam. Fit in place and hot glue the rib 1/4 back from the edge. Cover the rib with one layer of **BID**.

11.3.2 – Counterweight Fairings

The purpose of these fairings is to prevent ice buildup on the counterweights.

The fairings do not cover the counterweights, they are placed just in front of them. Position them back just far enough to clear the counterweight as it swings through its motion. Attach them to the bottom of the canard with silicone after painting the airplane. See Figure 11-19.

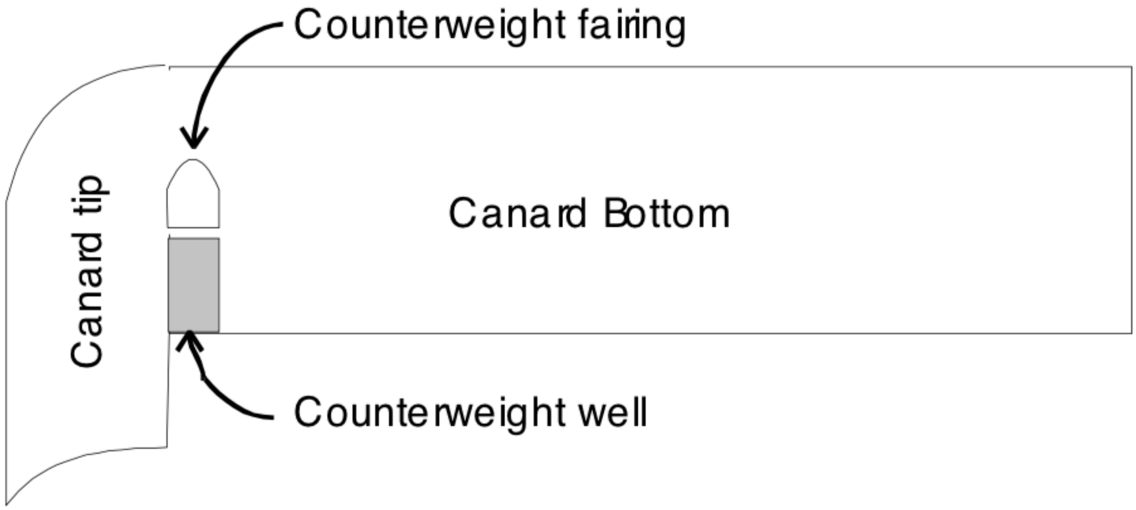


Figure 11-19. Counterweight Fairing Installation

12. 12 – Lycoming Engine / Propeller

Contents

(Shared with XF, XR)

12.1. 12.0 – Chapter Preface

12.0 – Chapter Preface

12.0.1 – Parts List

Part Number	Description	Qty
AN7-36A	AN7-36A Bolt	4
AN960-716 Washer	4	
AN363-720	AN363-720 Locknut	4
	1 1/2’ Clear Fuel Line	1
BSP-44	1/8” Pop Rivets	8
MP1701	Oil Cooler Inlet Scoop	1
MP1702	Oil Cooler Outlet Scoop	1
MP1703	Oil Cooler Housing	1
AN7-34A	AN7-34A Bolt	4
MS9276-13	MS9276-13 Locking Tab	4

12.0.2 – Tools List

Description
Basic Hand Tool Kit Needed to Work on Engine
1/8” or 1/4” Drill & Tap
7/16” Drill
Pop Rivet Gun
2. Phillips Screwdriver

12.0.3 – Supplies List

Description
Refer to Engine Install Packing List
Silicon Sealant
Permatex #2
5 Minute Epoxy
EZ-Poxy or Jeffco

Micro-Balloons
Threadloc
3/8” I.D. 3003 aluminum tubing
1/4” 5052 aluminum tubing
Hose Clamps
Adel Clamps
Oil Cooler
Oil Cooler Lines (1/2” Aluminum)

12.0.4 – Glass List

Type	Size	Qty
BID	3” Wide as Required	

12.0.5 – Process Overview

Construction Process	Completion Date
Engine Installation	
Mount your engine to your engine mount	
Locate Center of Aft Opening	
Locate Engine Mount	
Drill Firewall & Attach Mount	
–	
Fluid Lines and Controls	
Install aluminum oil lines	
Install fuel system lines	
Install intake drain lines	
Install pressure and temperature lines	
Install throttle, mixture and prop cables	
Pressure check fuel system	
Fuel sight guages	
–	
Front Oil Cooler	
Mount Oil Cooler Inlet	
Mount Oil Cooler Outlet	

Mount Oil Cooler	
Install oil cooler lines	
Route Heater Tubes	
Route Fresh Air Tubes	

12.0.6 – Documentation Changes

Oct 01, 2018 – Original Web Release

12.2. 12.1 – Engine Installation

12.1 – Engine Installation

12.1.1 – Introduction

The engine install package comes to you with most of the parts you will need to install the 260HP IO540 Lycoming and plumb it. If you have not purchased the engine install package, use these instructions as a reference.

12.1.2 – Engine Mounts

The first thing you need to do is bolt the engine to the mount. Using the set of Barry Engine mounts (part #94110-02) with AN7-27A bolts, AN970-716 washers, and AN363-720 nuts, mount the engine to the mount. It is easiest to loosely fit all 4 before tightening them up. This step may take a little prying to spread the mount to fit right. A common call we receive from builders is that the mount will not fit the engine. The mount is welded on a jig and can only be welded one way. Make sure the Barry mounts are firmly in place before tightening.

Some countries require a 0.016” stainless firewall to be installed. This is the time to do that. Make sure you cut holes for the gear bolts before you secure the stainless to the firewall with silicon and rivets around the perimeter. The silicon is used to seal the edges so you will not cut yourself on the sharp stainless steel. You do not need too many rivets as everything that goes against the firewall, including the engine mount, will hold it in position. Under the firewall, a thin 1/16” sheet of fiberfrax is good as an insulator since backside high temps are what we are trying to avoid. Other materials, such as nomex, can be used as well.

Before we install the engine we need to prepare the fuselage for it. Level your airplane and support it so it will not move. I prefer to use jacks to hold the center spar solid. Next put your top and bottom cowling on. Cleco or screw it to the flange around the firewall. Clamp the flanges or use screws to hold the cowling together at the prop end. Next take a measurement from the cowling to the floor at the center of the rear cutout. I like to use a plumb bob for this and measure the length of the string. Next measure the diameter from top to bottom of the your propeller hole. You can now remove the cowlings.

___ Position the engine against the firewall with an engine hoist. Install the lower cowling so you can center the engine right to left as well as up and down. Reposition the cowling so that you get the same dimensions to the ground as you previously measured from the rear hole in the cowling. The bottom cowling without the top one attached will lag slightly and may need to be propped up . With the engine mount against the firewall you want the engine to be approximately 1/4” to 3/8” **above center** in The propeller hole and level and centered from right to left. The engine is high because it will sag when unhooked from the hoist.

___ When satisfied, drill through one of the tubes in the mount on through the firewall with a 7/16” drill bit. Slide a bolt (AN7-33A) through to confirm the position of the mount against the firewall. Continue to drill holes and slide bolts in until all 5 are drilled. You can now mount the engine with AN970-7 washers and AN363-720 locknuts. You may want to wait for final installation until after the oil line work (below) is done.

12.3. 12.2 – Fluid Lines

12.2 – Fluid Lines

12.2.1 – Aluminum Oil Lines

Before the engine is in place on the firewall, it is a good idea to install the oil lines from the oil cooler to the firewall. You will need a tube cutter, heat gun, and a 37 degree flaring tool to do this job.

___ Install the AN822-8D fittings into the oil cooler with Permatex #2. Make sure the fittings are angling back at the right angle to line up with the duct that the lines will be going into.

___ From your roll of 1/2” 3003 aluminum tubing, cut 2 lengths that will span from each of the fittings to 4” or so out the back of the firewall. The final length will be determined when we mount the bracket on the firewall.

___ Cut 2 lengths of 3/4” shrink tubing that will span from just aft of the firewall to just forward of the canard bulkhead. Slide these pieces over the oil lines and shrink them down onto the lines with a propane torch or a good heat gun.The shrink tubing will slide onto the line easier if air pressure is applied to the open end of the heat shirnk tubing as it is slid on. Be careful not to heat things up too much.

___ Slide these two tubes through the duct on the pilot side.

___ Slide the AN818-8D nuts and AN 819-8D sleeves onto the oil lines and flare the tubing. Make sure you have the nuts and sleeves facing the right direction. If you have never flared tubing before, you may want to practice on some scrap pieces before doing the real thing. Refer to *A.C. 43.13-1B ,2B Acceptable Methods, Techniques and Practices* for flaring technique.Once you have flared the tubing, finger tighten the tubing with its fittings onto the oil cooler fittings.

At the other end of the tubing, you will need to mount the aluminum oil line bracket. You will end up with this bracket grabbing onto the lines at the AN818-8D nut or whatever area of the coupling that will slide up into the bracket.

___ Once you have determined exactly how long the lines need to be, cut them off and install the ends are you did before. Remember to slide the nuts and sleeves on the tubing before you flare it.

___ Finger tighten the line fittings onto the AN 815-5D unions.

___ Position the bracket down over the nuts on the lines. Make sure the lines are not touching the edge of the hole.

___ Drill the pilot holes through the existing holes in the bracket into the firewall and secure the bracket with

#10 sheet metal screws.

___ When you are ready, tighten all the fittings and secure the nuts to the bracket with safety wire.

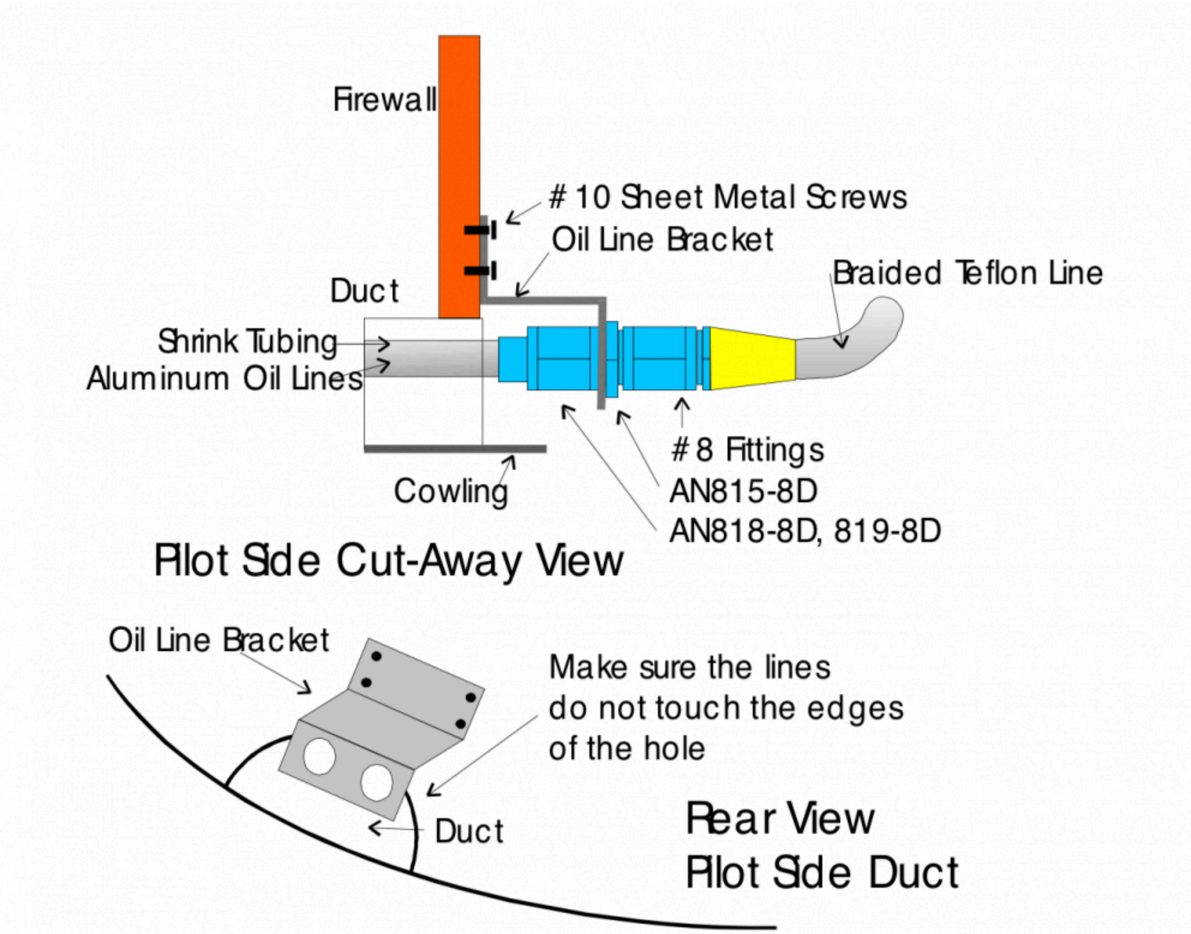


Figure 12-1. Oil Line Bracket and Fitting Detail

All fittings that are attached to an engine need to be steel fittings. Aluminum fittings are not acceptable.

If you are going to use the standard size oil coolers Bought from Velocity you will need to install a second one mounted in the engine compartment.

There are 3 aluminum pieces that make up the bracket that holds the oil cooler to the firewall. At this time, take the 3” aluminum flange and fit it into the preconstructed aluminum part with the 3” hole. Rivet it permanently in place with (4) 1/8” pop rivets. You can also fit this new combination piece to the two side brackets (check- ing the fit to the oil cooler) and attach to the side brackets with 2 or 3 rivets each.

The location that you put your oil cooler at depends on where you have mounted your other accessories on the firewall. We locate ours just left (pilots side) of the center about 8 inches and about an inch off the bottom of the firewall. We are running fresh air to our cooler from our plenum runner so keep that in mind as well.

Temporarily mount your brackets to the cooler and put the assembly in place on the firewall centered about 8” to the left of center (or where it fits good). You should have it as low as you can get it while still allowing the flange of the cowling to slide into position. It needs to be perpendicular to the cowling flange. Mark the holes for attachment of the bracket to the firewall. Using four (4) 10-32 screws with washers and lock nuts mount the assembly to the firewall.

You will need to install the other 3” aluminum flange on the bottom of the pilots side runner. First mark your location on the bottom of the runner and cut a 3” hole using a hole saw. Next sand the flange using a little sand paper and bond it in place using some structural adhesive and 4 1/8” rivets.

We can now make the oil line hook ups to your cooler. The return line from your front cooler (the one going back into the engine), will connect to this rear mounted cooler. You do not want the oil to flow through the rear cooler first since you would loose valuable cabin heat. You can go to either port of the cooler, but we usually go to the bottom port. You will need to secure the right angle fitting coming out of the cooler at the appropriate angle to line it up to the incoming line. Off the top of the cooler, you will go to the inlet port on the engine.

Get your braided stainless Teflon #8 line out of the box. It is the largest diameter of the three lines that came with the package.

___ Clean up the end of the hose with a razor blade and scissors.

___ Slide the nut over the hose. Carefully pry the braid away from the hose.

___ Slide the ferrule onto the Teflon hose until the hose bottoms out inside the ferrule. Lubricate the inside of the hose with Engine Oil and slide the fitting into the hose until it bottoms out on the ferrule. It may be easier to bevel the teflon edge of the hose with a rat tail file to allow the insert to slide in easier.

___ Slide the nut down onto the fitting and turn clockwise. Lock the nut into the vise with light pressure and tighten the assembly until it stops. It usually bottoms out.

Finger tighten the assembly to one of the engine fittings, extend the line down to the union at the firewall, give it some room for flexing, take into account how the fitting effects the line length, and mark the line for cutting.

___ Wrap the line at the mark (centered) with several layers of masking tape. As you cut, the tape will help hold the braid together. Put the line into a vise with the cut position right next to the jaws of the vise. Cut the line off with a hacksaw. (A cutoff wheel on a die grinder works best.)

___ Remove the masking tape, clean up the end of the line, and put the fitting on this end just like you did the other.

___ When finished with the line blow it out real good in both directions to clean out the junk. You should also stretch it out and look through it at a light to confirm that it is clean Do the other oil lines in the same manner as you did the first one.

At this point, check your engine to see if the in and out ports for the oil cooler have the proper fittings in place or not. The elbow (AN823-8) goes on the top and the nipple (AN816-8) goes in the middle.

Remember only steel fittings can be used in the engine.

If your engine is different, just make sure that your routing is comfortable. Install these fittings with **Permatex #2** sealant. This is available at your local auto parts store. In order to make sure the front oil cooler sees the hot oil first, you would want to go from the middle fitting (nipple) to the front cooler, back to the rear cooler, then to the top fitting (elbow). You will need to make the two lines running to the engine with the #8 stainless hose.

12.2.2 – Fuel Plumbing

In Chapter 9 you installed your sump tank. Most of our customers are mounting the drain valve (CAV-110) right to the bottom of the sump tank which requires a 3/4” hole to be drilled into the bottom of the plane directly under it. In the fixed gear aircraft, there is foam to think about which means you will need to glass the edge of the foam to close it out. Do not bother trying to wrap it around the edge of the hole, just glass it like a tube and trim off the inside and outside edges flush with the surfaces. The CAV-110 valve should be recessed inside this hole so in the event of an accident there isn’t any exposed steel part to spark on concrete and cause a fire hazard.

All of our fuel and vent lines used in the Velocity are made from 3003 3/8” aluminum tubing. Make sure that the flare tool used on all of these lines is a 37 degree flare tool.

Coming out of the sump we go to the fuel shut off valve (which is provided in the install kit) then on to the AN833-6D firewall fitting. On the engine side of the firewall we start with the fuel filter than to the boost pump (Weldon #B-810J) . Again all the lines are 3003 3/8” aluminum with AN818-6 nuts and AN819-6 sleeves at the flares.

Note: All lines aft of the firewall that have flammable fluid in them (oil or gas) need to have a Fire sleeve to protect them , both solid and flexible lines. We supply Aeroquip fire sleeve in our engine install package.

The electric boost pump is part of the engine install package. The pump has 4 drain ports around it. The position of the pump will determine which port will have a fitting and line coming out of it for a drain. After the pump has been positioned, you will use the port facing down as your drain. Use a compression fitting and Nylaflow tubing like in the brake system to route the fuel out. This only acts as a drain if the pump diaphram fails.

The inlet and outlet ports are marked on the pump. Remove the plugs, if there are any, from the main ports of the pump. Install the AN815-6D fittings with AN6227B-10 O-rings into the pump. Use a little lubricant (DC-4) on the O-rings as you do not want to damage it as you tighten up the fittings.

On the inlet side, flare the piece of 3/8” aluminum tubing (can be shorter and bent) and install it with an AN818-6D nut and AN819-6D sleeve. Typically, the fuel comes out of your sump tank, through a filter, and into this aluminum line on the pump. The outlet side of the pump will accept the #6 fuel line that goes to the mechanical pump on the engine. We usually make a mount for the fuel pump out of **TRIAX**. Cover the pump with duct tape and place it on plastic on a flat surface. Lay 3 layers of **TRIAX** or 6 layers of **BID** over it tucking it in around the pump and making sure it lays flat on your table for 2 inches each side. After this has cured, trim the mount and cut two small holes at the bottom of the ring to accept a hose clamp. Clamp the pump to the mount and position on firewall. Drill through the mount and firewall and hold in place with two 1/4” bolts through the base.

From here on you will be making three fuel lines – one from the boost pump to the inboard (pilot) side of the mechanical fuel pump on the engine (#6 hose), one from the outboard side of the mechanical fuel pump to the fuel servo (#6 hose), and one from the fuel servo to the spider valve (#4 hose). This hose material is the same type as used in the oil line hoses that you made earlier and are assembled the same way. The #4 line is especially difficult to make so take your time.

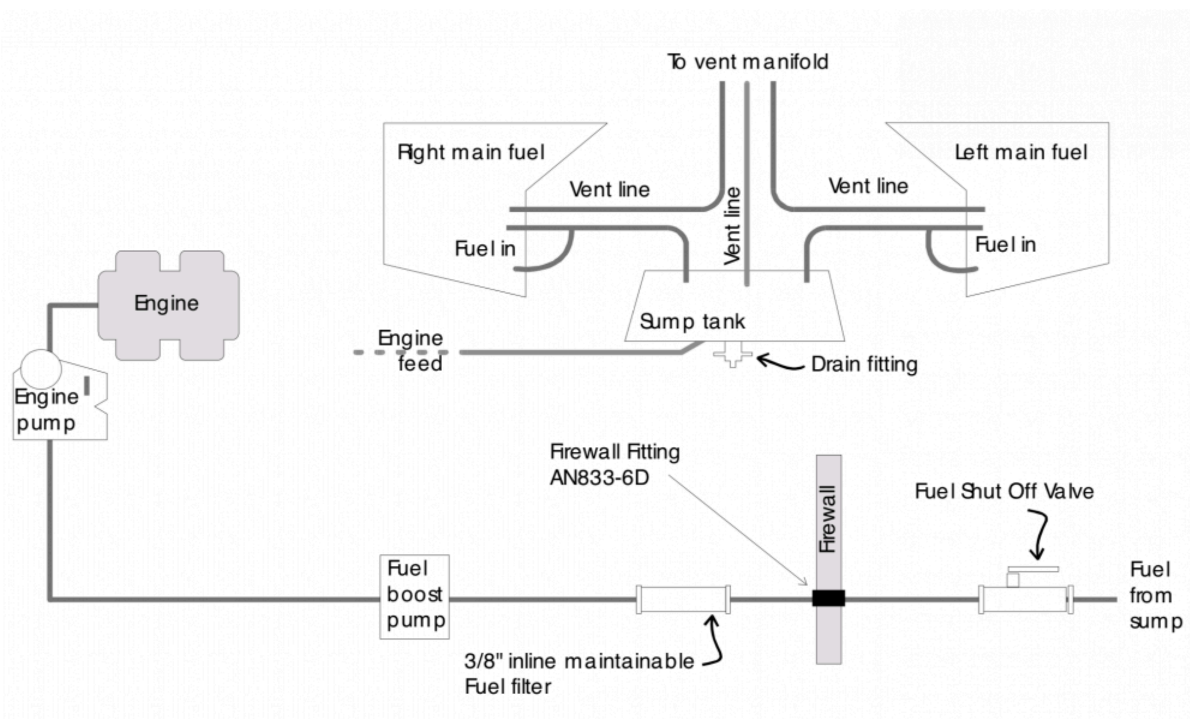


Figure 12-3. Fuel System Schematic

12.4. 12.3 – Controls, Cooling and Prop

12.3 – Controls, Cooling and Prop

12.3.1 – Throttle, Mixture, and Prop Controls

The right angle fuel servo adapter will mount so that it faces the firewall. In order to get the fuel outlet to the spider to fit in under the sump (it is facing up), you will most likely need to shim the servo where it attaches to the adapter. The servo will end up tightly positioned between the engine and the cowling.

The throttle arm is on the pilot side of the fuel servo pointed up. The mixture arm is on the passenger side and is also pointed up. Both of the aluminum brackets that hold these cables are bolted to the sides of the right angle adapter were it attaches to the engine. (See sketches on next page) The last bracket is for the governor cable, it mounts to the starter attach bolts and extends toward the passenger side with the flange at the outside facing downward. The brace for the governor bracket goes from the bottom aft governor attach stud to the bracket. At the bracket drill a 1/4” hole and attach with an AN 4 bolt locknut and washer.

The three controls are mounted on the left side of the instrument panel vertically starting with the throttle – prop – mixture. This requires holes in the panel to accept the controls and the cables are routed in a nice arc, down to the duct, and back to the engine. Remember that the fuselage curves inward in front of the instrument panel and the cables have a 12” long section for the vernier control so you can’t put the controls too close to the side of-the fuselage. The mixture and throttle cables extend past the fuel servo, loop around, and head back to it and the arms. The connections are made with MW-3 rod ends on the cable and AN-3 bolts into the control arm of the servo or governor. Check the throw of the cables to make sure the clamps (similar to the aileron cable clamps) will be in the correct position. You may have to drill new holes if the others don’t allow the correct movement. You may also have to move the control arms on the servo a little to get the proper movement. When in the proper position, clamp the cables to the brackets with the clamp sets. The clamps are installed with #10 screws or bolts and nuts.

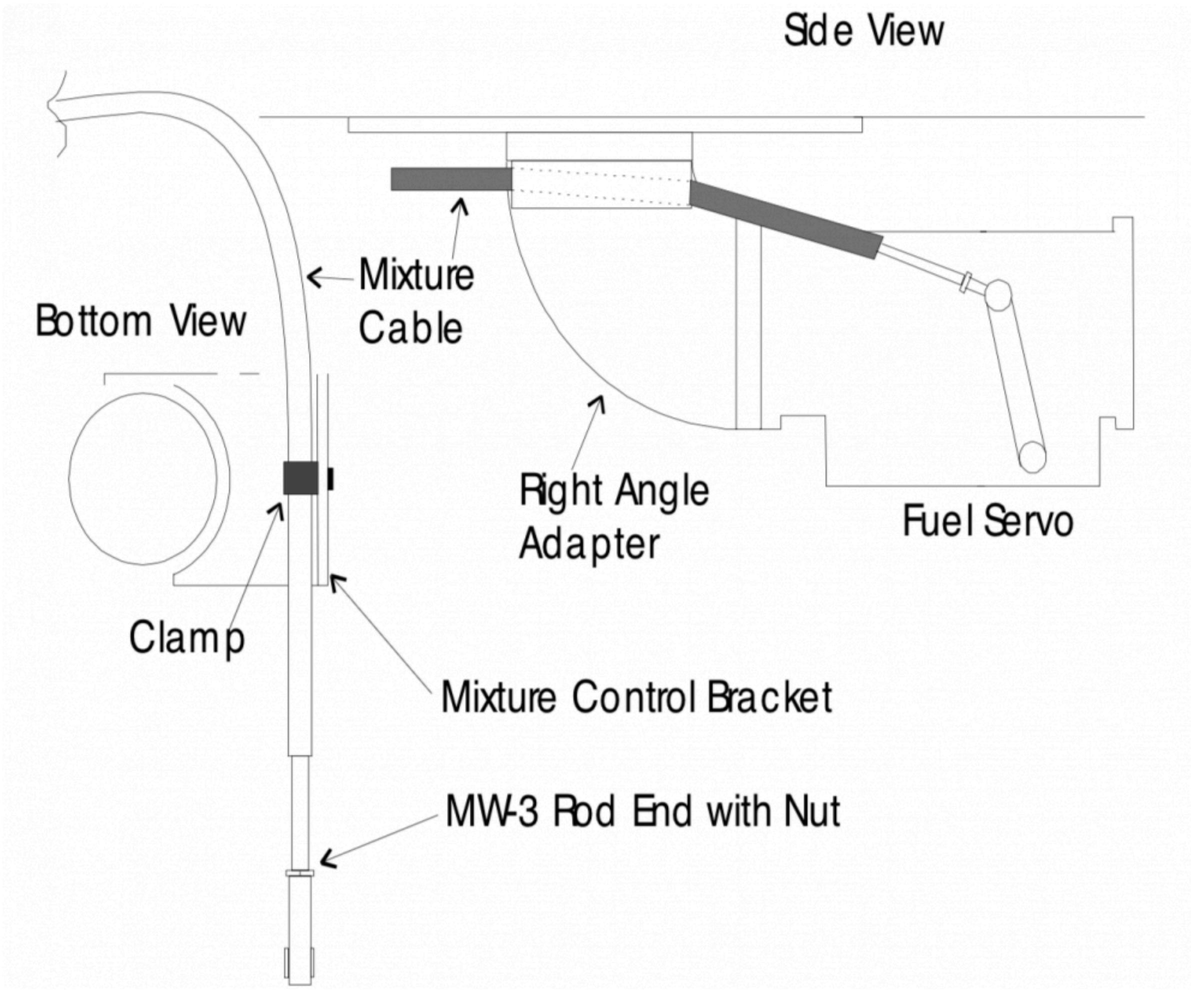


Figure 12-4x. Mixture Cable Installation

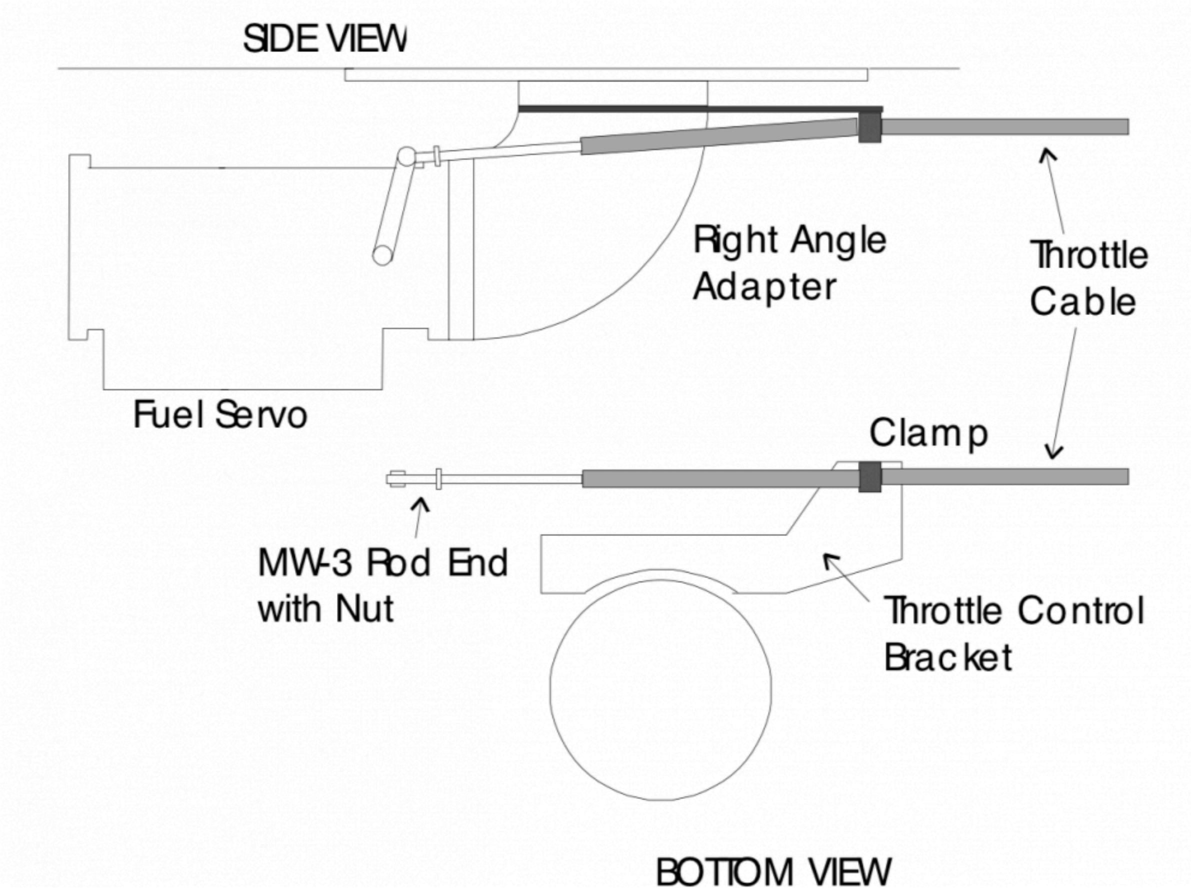


Figure 12-5x. Throttle Cable Installation
**

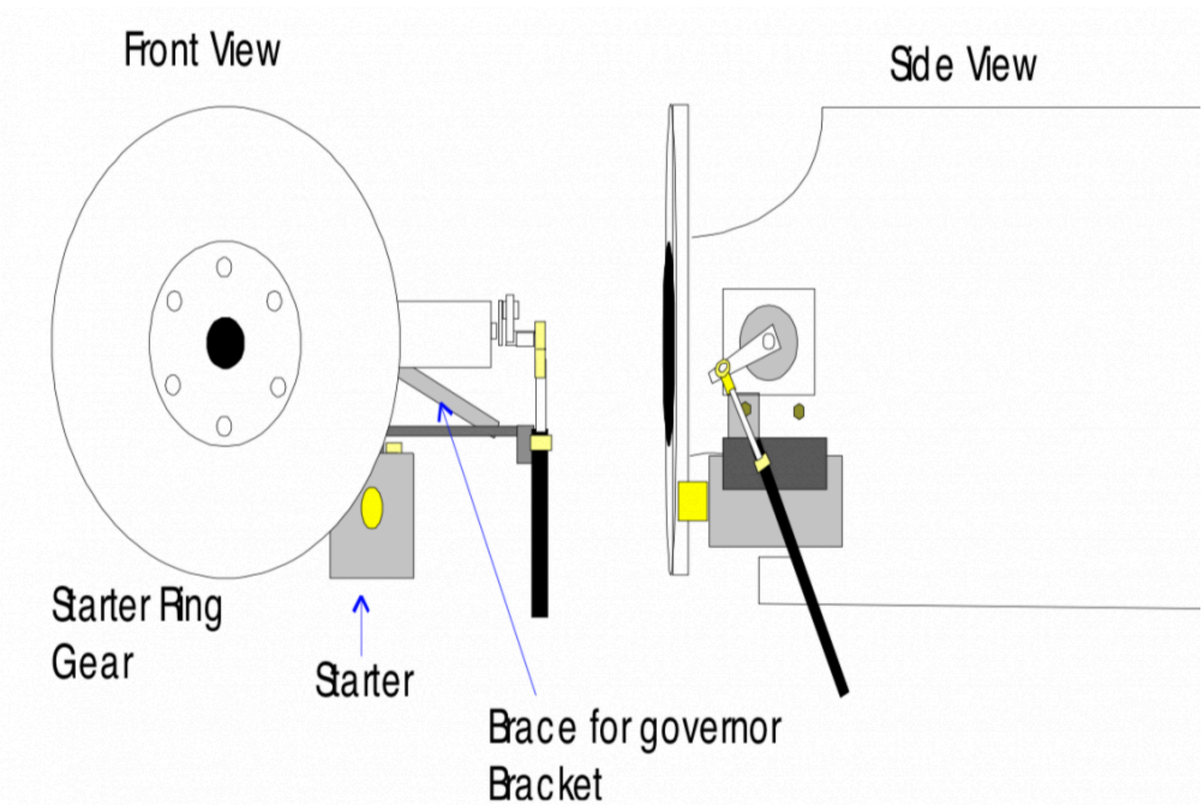


Figure 12-6. Propeller Cable Installation

12.3.2 – Pressure Checking Fuel System

Caution must be taken while pressure checking your fuel system. Use an altimeter as a pressure gauge and pressurize your system no more than it takes to make a 1500’ change in the altimeter or an airspeed indicator to 180 knots.

___ Check that all fittings are tight and block off the fitting that lead to the engine.

The best place to install the altimeter is at one of the fuel tank vents. The ideal way to close off a vent line is to make up some caps out of flared 3/8 tubing with an AN818-6 and an AN819-6 on one end and bend over the other end and hit it with a hammer to seal it. If you don’t have any AN 818 or AN819 left you can use a small piece of hose over your aluminum tube and clamp shut the other end.

___ When all the lines are sealed and the altimeter is installed, carefully inflate the fuel system to 1500’ on the altimeter. This can be done by blowing into the feed lline with your mouth. **Do not overinflate!**

Close off the feed line and watch for an altitude change. If a rapid change occurs, listen for a leak, and verify with soapy water. Check fittings and fuel caps first, then try to isolate the leak to either the sump tank or one of the mains. Continue to paint all areas with soapy water until all the leaks are found. Clean off the soapy water with clean water and alcohol, then let the area dry completely.

If a leak is detected , use a vacuum cleaner to apply negative pressure to your tank. Hold the hose over the filler opening with a small gap being careful not to vacuum so much so as to harm the structure. Brush **Jeffco** or **EZ-Poxy** over the leak for a couple of minutes, remove the vacuum, and continue to brush on the epoxy for a minute or so.

Recheck the system following cure, and keep in mind that a good leak free system should hold an altitude indefinitely, although small changes due to temperature variations should be expected.

12.3.3 – Fuel Sight Gauges

When you built your tanks, you installed two brass elbows in the rear baggage bulkhead. These are to be connected with a piece of clear fuel line (polyurethane tubing) utilizing either small hose clamps or good heavy duty nylon cable ties. Do not use tygon tubing as it will become brittle. We do stock a premade sight gauge that is lighted for night operation, looks good and is more durable than plain tubing.

Cable ties are not as good, but they look better and we have not experienced any problems with them on our aircraft. When calibrating your gauges, get the aircraft level on the ramp, and then fuel up with 5 gallons at a time on each side. Mark the consecutive levels with tape or a permanent marker. Make sure that you close off the line to the sump tank while doing this (to prevent cross-feeding), and reopen the lines when completed.

12.3.4 – Cooling Plenum Chamber

Your engine should have the bottom inter cylinder baffles installed, which usually come with the engine.

The NACA scoop/ Plenum installation is what Velocity is currently using for engine cooling in our airplanes. The NACA scoops were installed in your fuselage in the Fairing section. Below is a description of how to install the plenum and runners.

The fuel injection spider valve should be in its normal position, which is in the top center of the engine. The lines should be insulated with some type of heat resistant wrap or fire sleeve to lessen the effects of heating of the fuel while you are taxiing or on approach, which can cause engine roughness. We are not using any on our system right now and it seems to work just fine, but that may not always be the case.

___ Fit the two plenum pieces on top of the engine, one at a time, and trim them until they fit down into the proper position. Sand along the edges of the aft plenum half where it butts together with the front one . We now want to create a flange so we can attach the two halves to each other. Duct tape along the edge of the front plenum half. Lay up three layers of **BID** 3 inches wide along this seam so that it is touching the aft plenum half and goes over the duct tape on the front side and 11/2 inches. I prefer to do this all on the engine so every thing lines up just right. So make sure you protect the engine from the epoxy. After the **BID** has cured before separating the two halves drill 1/8” holes through your flange and your forward half every 4 inches and leaving 1/2 inch from the joint making sure you have at least one on each side of the plenum. Now you can separate the two halves.

The next thing is to install the two runners Shift the runners as necessary to make sure they align up and transition as smoothly from the inlet holes in the firewall to the plenum. Mark around the runner where it meets the plenum. Sand at least two inches around the bottom of the runner and sand around the top two inches of plenum where it meets the firewall. Duct tape 2 inches on the plenum all around where the runner meets it except for on the bottom side. Create a 3 **BID** flange as you did above around the runner except for the bottom. After the **BID** has cured drill 1/8” holes at least every 3 inches. Next sand the plenum where it meets the bottom side of the runner. Duct tape the runner and create a flange and drill two equally space 1/8” hole here as well. This flange is made part of the plenum to allow easier removal. After the flanges are made you can go ahead and cut the plenum out where the runner meets it.

Access holes to allow you to do routine maintenance on your airplane like spark plug changes need to be made. These holes need to be positioned over your spark plugs and run from front to back on the plenum. After you cut these access holes out tack them in place with some hot glue duct tape around the hole on the plenum and create a flange like above. After the flange is cured drill 1/8” holes every 4 inches around the access hole flange. Some of our builders have been joining the runner to the access hole cover and making it all one piece this is also an option.

After all of your plenum flanges are done you can enlarge all of the 1/8” holes to 3/16 and install 10/32 nutplates into the plenum so you can attach them. **Make sure you do not install nutplates where they can rub into your engine or injector lines.**

At the firewall you will need to make a flange from your runner to the firewall to help seal it. Duct tape the firewall where the runner meets it. Lay up a 3 **BID** flange from the runner onto the firewall. After cure pop off the runner from the firewall and lightly sand the flange. Leaving the duct tape in place put in a thin layer of silicone on the duct tape and reinstall the runner. Let the silicone cure then slowly remove the runners.

The runners are held in place at the firewall by the screws that hold the engine cowling on. Your flange for your engine cowling should already be drilled for the cowling if not refer to chapter 11. Install the runners and using the holes in the Fuselage cowling flange drill two 1/8” holes in each runner. Remove the runners. These holes will have to be reinforced before installing the nutplates. Structural adhesive one 1 1/2” x 1 1/2” piece of 0.030-0.040 aluminum centered on the inside of the holes that you have just drilled in the runners. After your adhesive has cured drill out the hole to 3/16” and install 10-32 nut-plates.

The servo gets its fresh air from a flange mounted on the bottom copilots runner. First off find a suitable location to install the flange on the runner. You want to make as direct a route with as little bends as possible with your Scat. After you have chosen your location using a hole saw drill a 2 1/2” hole. Sand one inch all around the hole and sand the base of your flange. Attach your flange to your runner using structural adhesive and four 1/8” rivets. Some builders have also opted to install a stainless steel mesh screen at the runner to prevent any large object from blocking the air to the engine.

At the servo a flange needs to me made to allow the Scat to be attached to the servo. For this we need a scrap piece of aluminum (or any smooth flat plat) that is at least 5” x 5”. You will also need something that is cylindrical with a diameter of 2 1/2”. I prefer to use a cap off a spray can. Attach the cap to your plat with a small bit of hot glue. We will need to remove this cap later so do not use too much glue. Next you will need to put four to five coats of car wax on your part to act as a mold release. Mix some **EZ-Poxy** with **Cabosil** until you have a cake icing consistency. You can use Micro if you do not have **Cabosil**. Cut several strips of **BID** 6” wide by about 24” long. Using EZ-poxy wrap the strips around your part. The strips need to go on the plate and on the cap at the same time. Continue to put strips around the part until you have 5 layers of **BID** around it. After your part has cured pop the cap and fiberglass piece off the aluminum plate. Then using pliers twist the cap out of the inside of the part. Trim the part to fit centered on your servo and drill the four 1/4” mounting holes. Make sure you leave enough of a flange to attach the Scat to with a hose clamp. Attach the fiberglass flange to the servo with four 1/4 – 20 bolts that are drill for safety wire and large area washers.

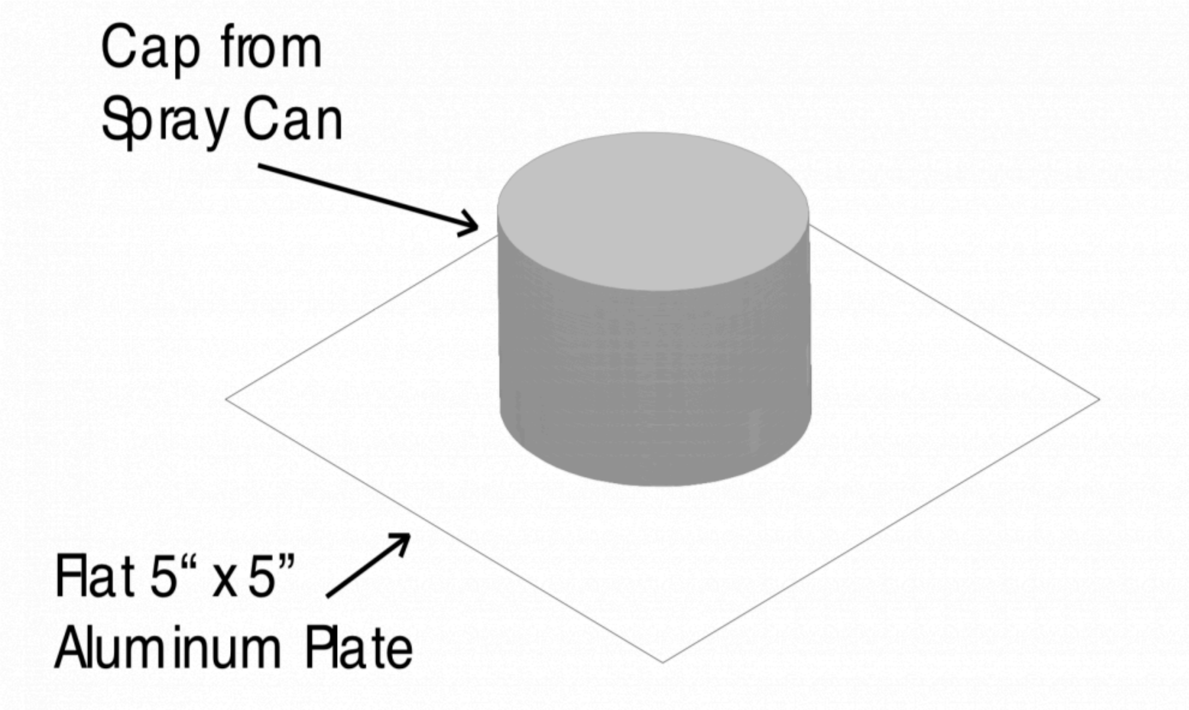


Figure 12-7. Mold Used to Make Fuel Servo Fiberglass Flange

The front copilots side of the plenum has a gap between the engine and the plenum. We fill this gap with a small piece of .030-.040 aluminum. This is siliconed in place directly onto the #4 cylinder barrel fins.

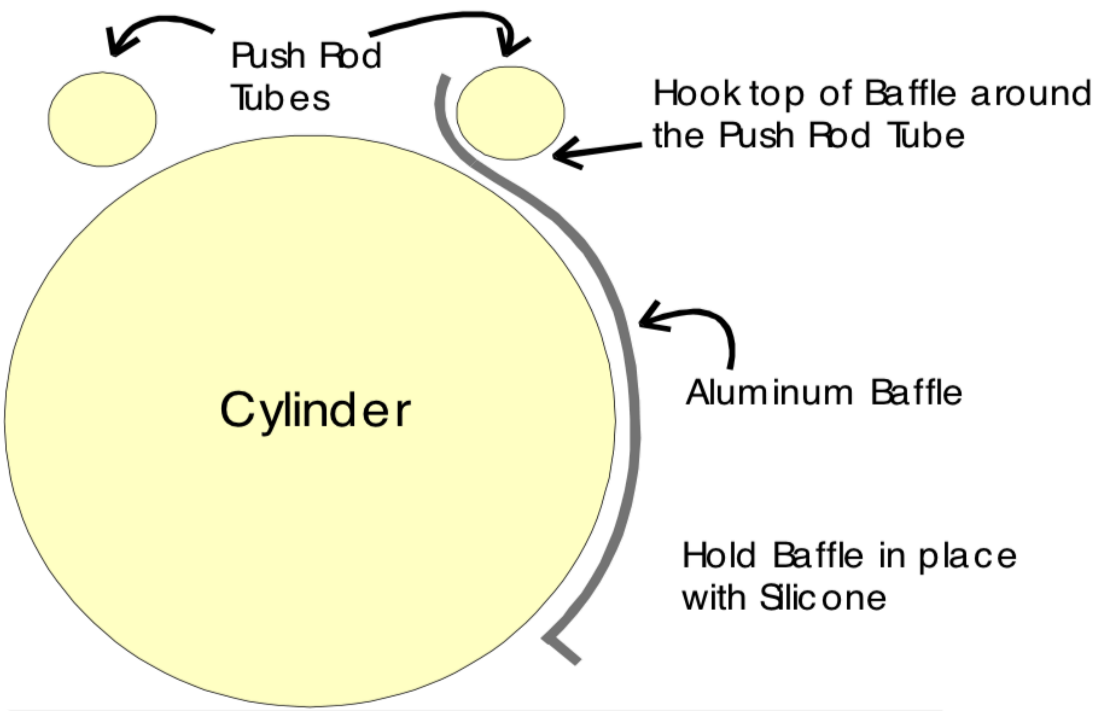


Figure 12-8. Aluminum Cylinder Baffles

After all the parts have been fitted, you will need to install the plenum. Beside the valve covers there are 1/4”-20 holes for attaching baffling. You need to use at least 2 of these per side to attach your plenum. You will also need to silicon the perimeter of the plenum to the engine to keep it from deforming under pressure and heat. If you do not want to do that, you can safety wire the cylinder and head areas front to back in order to hold it together. This would require 2 small holes drilled in the lower portion of the plenum in front of each cylinder and head (4 places). The wire would then route under the engine cylinders and heads from front to back. Make sure the wire doesn't rub on aluminum, which could rub through.

After you fly the plane, you may need to fashion diverters to get the temps even. We spent a lot of time to eliminate the need for these but it still could happen.

12.3.5 – Propeller

The propeller used for the XL is a constant-speed MT. This is a lightweight, high- quality propeller that is manufactured in Germany. You could use a fixed-pitch pro- peller but you will lose utility. We are distributors for this prop and can get you a good discount on it. It usually takes about 90 days from time of the order to receive it.

12.3.6 – Nose Mounted Cooler

The fuselage comes to you with premarked positioning for the inlet and outlet of the cooler. It is important to remember that the lines on the fuselage for the outlet depict only the approximate size of the hole in the outer skin.

The inside skin is only cut to the canard bulkhead. To be safe, add another rear cut line on the fuselage about 3" in front of the other one. This will ensure that you will cut in front of the canard bulkhead.

The first thing you will be installing is the NACA scoop. Three sides of the flange for the oil cooler are already molded into the scoop.

___ Cut the hole and insert the scoop into position. Before you start trimming the scoop, put the cooler into position on the scoop's flange. It would help at this time to remove some inside skin and foam beside the cooler to allow it to move closer to the side thus reducing the ramp angle and giving theretracted nose gear more room in a RG.

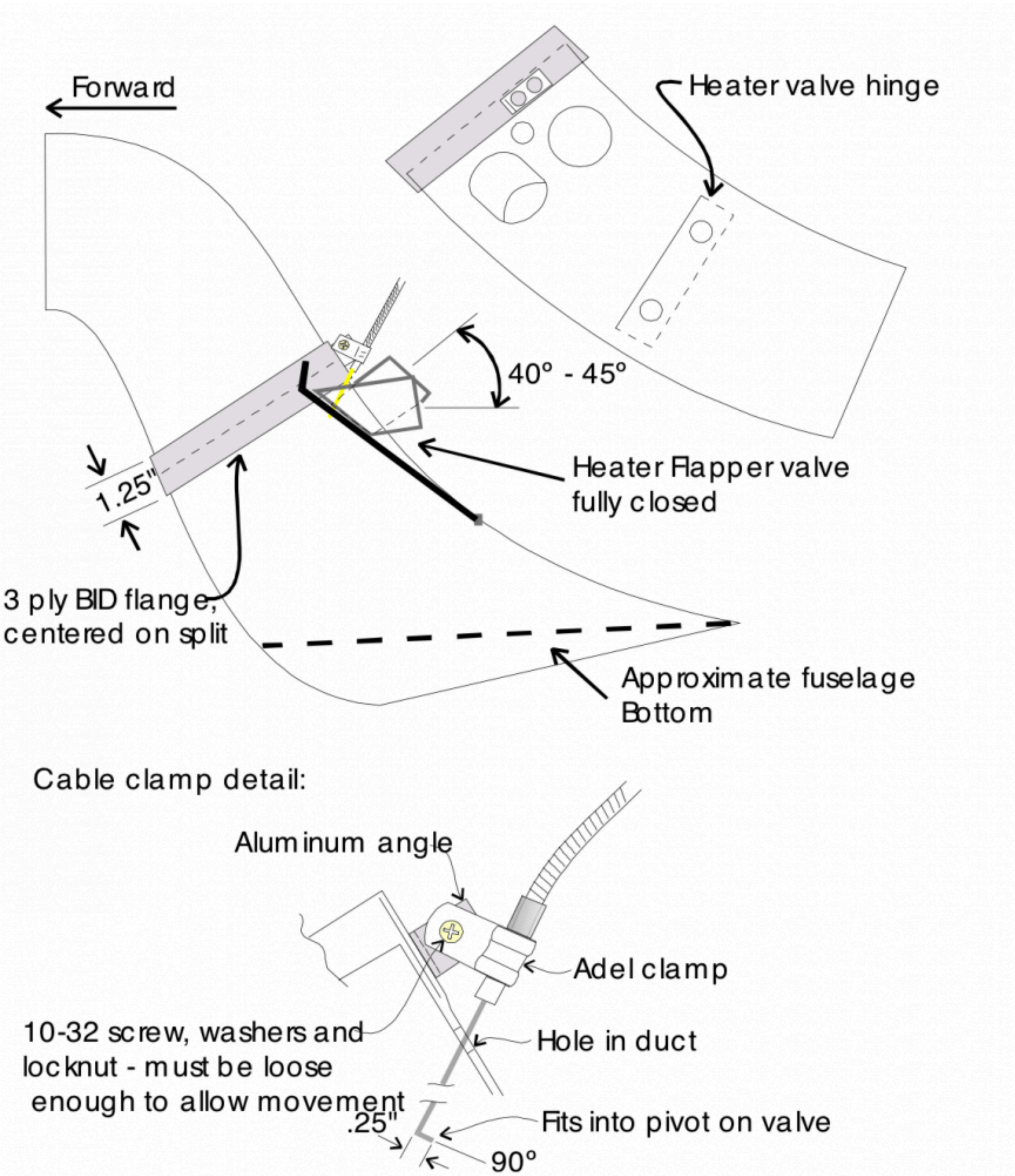


Figure 12-9. Oil Cooler Duct

See appendix for parts list.

___ After you have removed the skin and foam, glass with 2 **BID** overlapping the inside skin by 1" or so. Make sure you round the edges to allow the glass to stay on the surface.

___ Put the scoop back in position and make sure you have the leading edge of the scoop transitioning nicely into the fuselage. You also want the scoop flush with the outside at the upper and lower surfaces. Keep the edges sharp but the very nose of the scoop should be a nice smooth transition onto fuselage. Tack in place with Bondo or hot glue.

___ Cut the duct into two pieces using the pre-drawn line as your guide. Duct tape the upper section, tack back together with hot glue (inside if you can reach), and lay-up a 3 **BID** flange as shown in the drawing. After cure, pull apart and remove the duct tape. Put it back together for fitting into the fuselage.

___ Fit the duct in place by filing the hole until the duct slides into position. The rear-most cut will get rounded toward the rear in order to get the duct to fit into its proper position. It may not reach the mark on the fuselage but it should be within 1/2” or so.

___ Think about where the oil cooler will fit so your spacing is correct. After you have the duct positioned correctly, tack the oil cooler into position with the duct fitting up against it to check the fit of all three components. At this time you may want to fit the other components into the bottom section of the duct before it is permanently attached to the fuselage. The drawing shows how the pieces fit together.

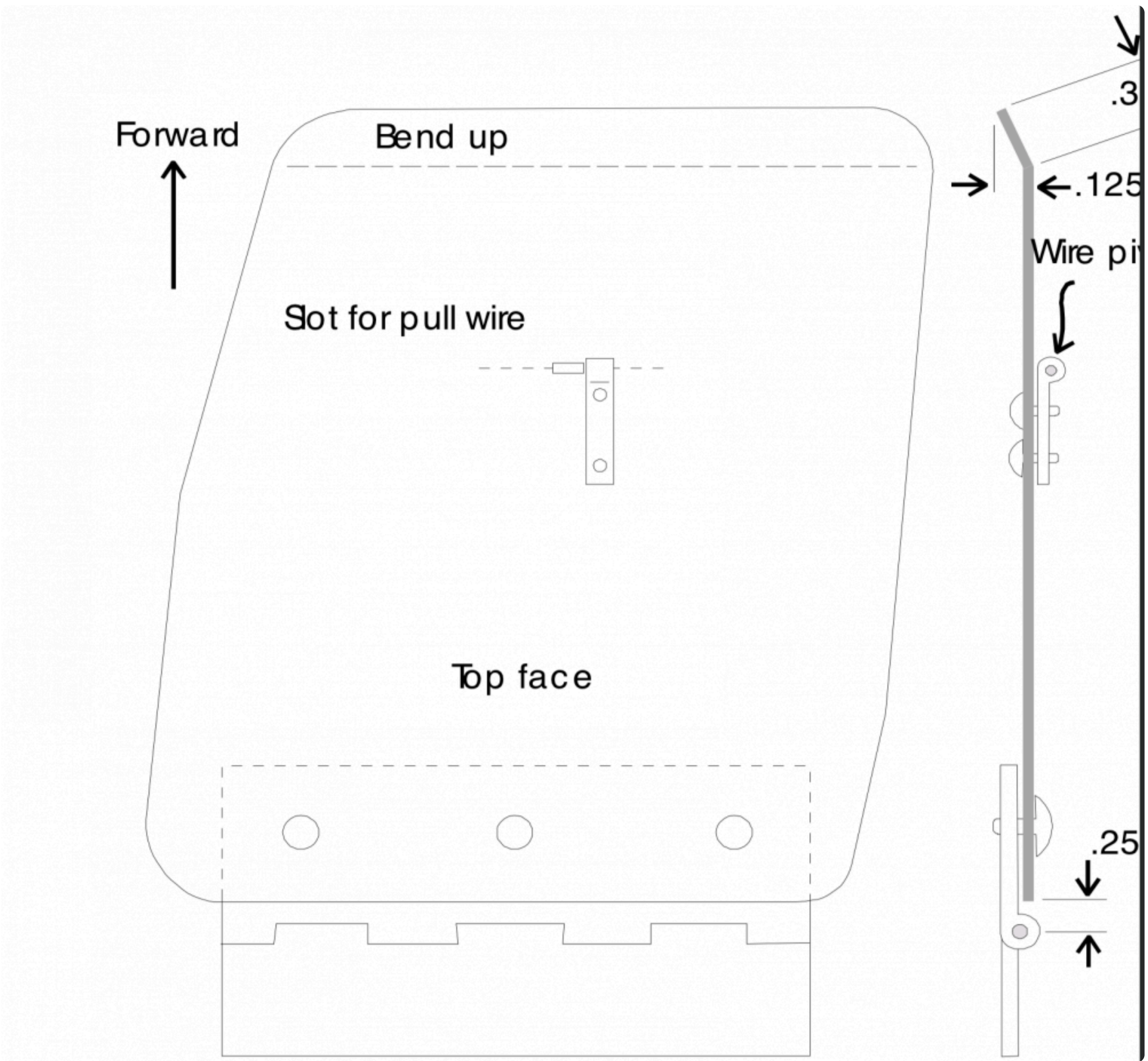


Figure 12-10. Heater Valve (Full Size Template)

NOT TO SCALE

[Template 12-10. Heater Valve Full Size Template]

TO SCALE WHEN PRINTED ON LEGAL SIZED PAPER

___ With the assembly in place, **5-Minute Epoxy** the bottom of the duct to the floor in a few places. Remove the upper section of the duct and the cooler if it is there. **Micro-Balloon** and tape glass (two plies **BID**) the duct to the fuselage and canard bulkhead on the inside of fuselage. Glass the outside of the duct to the fuselage with 1 **BID** after sanding around it for adhesion. You can also micro and tape glass the NACA scoop in with two plies **BID** on the inside only.

___ Duct tape around the oil cooler where it meets the duct. Attach the oil cooler to the flange with four #10 sheet metal screws. Put the upper section of the duct into position and make a two plies **BID** flange that goes from the duct just onto the cooler where you have duct taped it. This will make a good seal on the back side. You don't have to screw this one on, we usually just silicone it in place during final assembly.

You will install the NACA scoop for fresh air on the other side of the fuselage. This is a smaller scoop than the one for the oil cooler. It gets mounted just like the other scoop except it is closed off on the back end.

The flat section of the scoop, (top side), is where you will cut a 1-3/4" hole to attach the aluminum tube for the outlet. You will then route your tubing over or through the canard bulkhead to your eye ball vents on your panel.

13. 12 – Continental Engine / Propeller

Contents

(Shared with XF, XR)

13.1. 12.0 – Chapter Preface

12.0 – Chapter Preface

12.0.1 – Parts List

Part Number	Description	Qty
AN7-36A	AN7-36A Bolt	4
AN960-716 Washer	4	
AN363-720	AN363-720 Locknut	4
	1 1/2’ Clear Fuel Line	1
BSP-44	1/8” Pop Rivets	8
MP1701	Oil Cooler Inlet Scoop	1
MP1702	Oil Cooler Outlet Scoop	1
MP1703	Oil Cooler Housing	1
AN7-34A	AN7-34A Bolt	4
MS9276-13	MS9276-13 Locking Tab	4

12.0.2 – Tools List

Description
Basic Hand Tool Kit Needed to Work on Engine
1/8” or 1/4” Drill & Tap
7/16” Drill
Pop Rivet Gun
2. Phillips Screwdriver

12.0.3 – Supplies List

Description
Refer to Engine Install Packing List
Silicon Sealant
Permatex #2
5 Minute Epoxy
EZ-Poxy or Jeffco

Micro-Balloons
Threadloc
3/8” I.D. 3003 aluminum tubing
1/4” 5052 aluminum tubing
Hose Clamps
Adel Clamps
Oil Cooler
Oil Cooler Lines (1/2” Aluminum)

12.0.4 – Glass List

Type	Size	Qty
BID	3” Wide as Required	

12.0.5 – Process Overview

Construction Process	Completion Date
Engine Installation	
Mount your engine to your engine mount	
Locate Center of Aft Opening	
Locate Engine Mount	
Drill Firewall & Attach Mount	
–	
Fluid Lines and Controls	
Install aluminum oil lines	
Install fuel system lines	
Install intake drain lines	
Install pressure and temperature lines	
Install throttle, mixture and prop cables	
Pressure check fuel system	
Fuel sight guages	
–	
Front Oil Cooler (optional)	
Install Sandwich Adapter Plate	
Mount Oil Cooler Inlet	

Mount Oil Cooler Outlet	
Mount Oil Cooler	
Install oil cooler lines	
Route Heater Tubes	
Route Fresh Air Tubes	

12.0.6 – Documentation Changes

Oct 01, 2018 – Original Web Release

13.2. 12.1 – Engine Installation

12.1 – Engine Installation

12.1.1 – Introduction

The engine install package comes to you with most of the parts you will need to install the 310HP IO550 Continental and plumb it. If you have not purchased the engine install package, use these instructions as a reference.

There are certain things that you will have to do repeatedly as you install your engine. I will give you a list of these things once here so I don’t have to bore you with the same stuff over and over.

1. All fittings that you put in to the engine need to be steel fittings without exception.
2. All pipe thread fittings need to be installed with Permatex #2 except for the vacuum pump fittings.
3. All rod ends installed on your aircraft need to have safety washers installed on them. A safety washer is a large area washer that will keep the rod end attached to your control arm even if the rod end fails.
4. Every line that you install on your engine should be tightened as it is installed. Do not leave a line to be tightened later. After you are through with you engine installa- tion start at one end of each system (the front oil cooler for example) and go through and tighten each nut.

12.1.2 – Engine Mounts

The first thing you need to do is bolt the engine to the mount. Using the set of Lord mounts part # J-9613-54 with AN7-34A bolts, and MS9276-13 locking plates mount the engine to the mount. (Refer to 12-1.) It is easiest to loosely fit all 4 before tightening them up. This may take a little prying to get everything to line up. Make sure that the dynafocals sit square against the engine mount and are not crooked. Remember the spacer that goes in between the dynafocals .The 1/8” roll pin goes through the 1/8” hole in the engine mount. This keeps the dynafocals from turning. There is a small hole drilled next to the 7/16” hole for the engine mount bolt. This is where the tab of the MS9276-13 goes. After the engine bolts have been tightened bend the tabs around the head of the bolt to safety it.

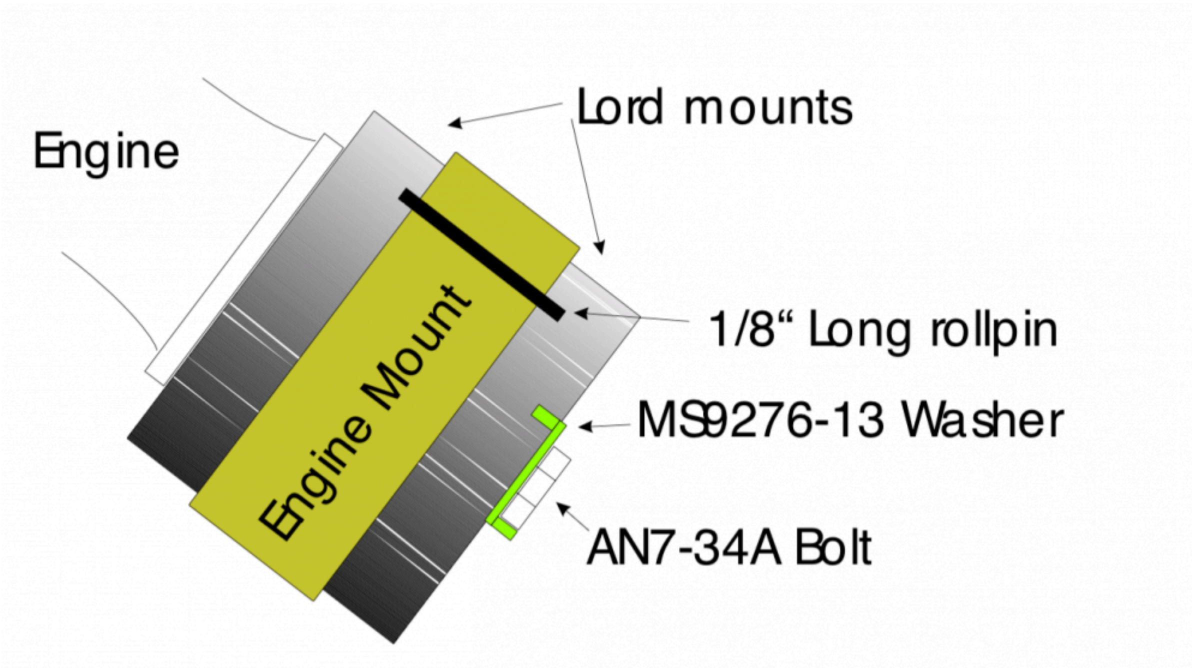


Figure 12-1xc. Engine to Engine Mount Install

Some countries require a 0.016" stainless firewall to be installed. This is the time to do that. Make sure you cut holes for the gear bolts before you secure the stainless to the firewall with silicon and rivets around the perimeter. The silicon is used to seal the edges so you will not cut yourself on the sharp stainless steel. You do not need too many rivets as everything that goes against the firewall, including the engine mount, will hold it in position. Under the firewall, a thin 1/16" sheet of fiberfrax is good as an insulator since backside high temps are what we are trying to avoid. Other materials, such as nomex, can be used as well.

Before we install the engine we need to prepare the fuselage for it. Level your airplane and support it so it will not move. I prefer to use jacks to hold the center spar solid. Next put your top and bottom cowling on. Cleco or screw it to the flange around the firewall. Clamp the flanges or use screws to hold the cowling together at the prop end. Next take a measurement from the cowling to the floor at the center of the rear cutout. I like to use a plumb bob for this and measure the length of the string. Next measure the diameter from top to bottom of the your propeller hole. You can now remove the cowlings.

___ Position the engine against the firewall with an engine hoist. Install the lower cowling so you can center the engine right to left as well as up and down. Reposition the cowling so that you get the same dimensions to the ground as you previously measured from the rear hole in the cowling. The bottom cowling without the top one attached will lag slightly and may need to be propped up . With the engine mount against the firewall you want the engine to be approximately 1/4" to 3/8" **above center** in the propeller hole and level and centered from right to left. The engine is high because it will sag when unhooked from the hoist.

___ When satisfied, drill through one of the tubes in the mount on through the firewall with a 7/16" drill bit. Slide a bolt (AN7-33A) through to confirm the position of the mount against the firewall. Continue to drill holes and slide bolts in until all 4 are drilled. You can now mount the engine with AN970-7 washers and AN363-720 locknuts. You may want to wait for final installation until after the oil line work (below) is done.

13.3. 12.2 – Fluid Lines

12.2 – Fluid Lines

12.2.1 – Aluminum Oil Lines

The Continental IO550 N2B comes with an oil cooler attached to the engine. We do have an airplane that is flying using just this cooler but we have elected to run a second cooler in the nose for cabin heat and help in oil cooling. If you decide to run a second oil cooler you will need to use an Oil Sandwich Adapter Plate at the oil filter location. The oil filter sandwich plate that we have used is 1 5/16” thick and comes with a thermostat that is set for 180 deg. This will allow our engine to heat up before it will send the oil to the front cooler. You will have to run a shorter oil filter than the 48-109 that the engine came with. The 48-108 filter will fit well after the Adapter plate is installed. Position the outlet on the adapter plate so they are facing towards the firewall just slight facing the copilots side. You may have an oil adapter that is set up for larger lines than we use for our oil system. You will need an AN912-4D bushing to reduce the outlet size down to 1/2”. You can then install two AN823-8 fittings into the bushings.

Before the engine is in place on the firewall, it is a good idea to install the oil lines from the oil cooler to the firewall. You will need a tube cutter, heat gun, and a 37 degree flaring tool to do this job.

___ Install the AN822-8D fittings into the oil cooler with Permatex #2. Make sure the fittings are angling back at the right angle to line up with the duct that the lines will be going into.

___ From your roll of 1/2” 3003 aluminum tubing, cut 2 lengths that will span from each of the fittings to 4” or so out the back of the firewall. The final length will be determined when we mount the bracket on the firewall.

___ Cut 2 lengths of 3/4” shrink tubing that will span from just aft of the firewall to just forward of the canard bulkhead. Slide these pieces over the oil lines and shrink them down onto the lines with a propane torch or a good heat gun.The shrink tubing will slide onto the line easier if air pressure is applied to the open end of the heat shirnk tubing as it is slid on. Be careful not to heat things up too much.

___ Slide these two tubes through the duct on the pilot side.

___ Slide the AN818-8D nuts and AN 819-8D sleeves onto the oil lines and flare the tubing. Make sure you have the nuts and sleeves facing the right direction. If you have never flared tubing before, you may want to practice on some scrap pieces before doing the real thing. Refer to *A.C. 43.13-1B ,2B Acceptable Methods, Techniques and Practices* for flaring technique.Once you have flared the tubing, finger tighten the tubing with its fittings onto the oil cooler fittings.

At the other end of the tubing, you will need to mount the aluminum oil line bracket. You will end up with this bracket grabbing onto the lines at the AN818-8D nut or whatever area of the coupling that will slide up into the bracket.

___ Once you have determined exactly how long the lines need to be, cut them off and install the ends are you did before. Remember to slide the nuts and sleeves on the tubing before you flare it.

___ Finger tighten the line fittings onto the AN 815-5D unions.

___ Position the bracket down over the nuts on the lines. Make sure the lines are not touching the edge of the hole.

___ Drill the pilot holes through the existing holes in the bracket into the firewall and secure the bracket with #10 sheet metal screws.

___ When you are ready, tighten all the fittings and secure the nuts to the bracket with safety wire.

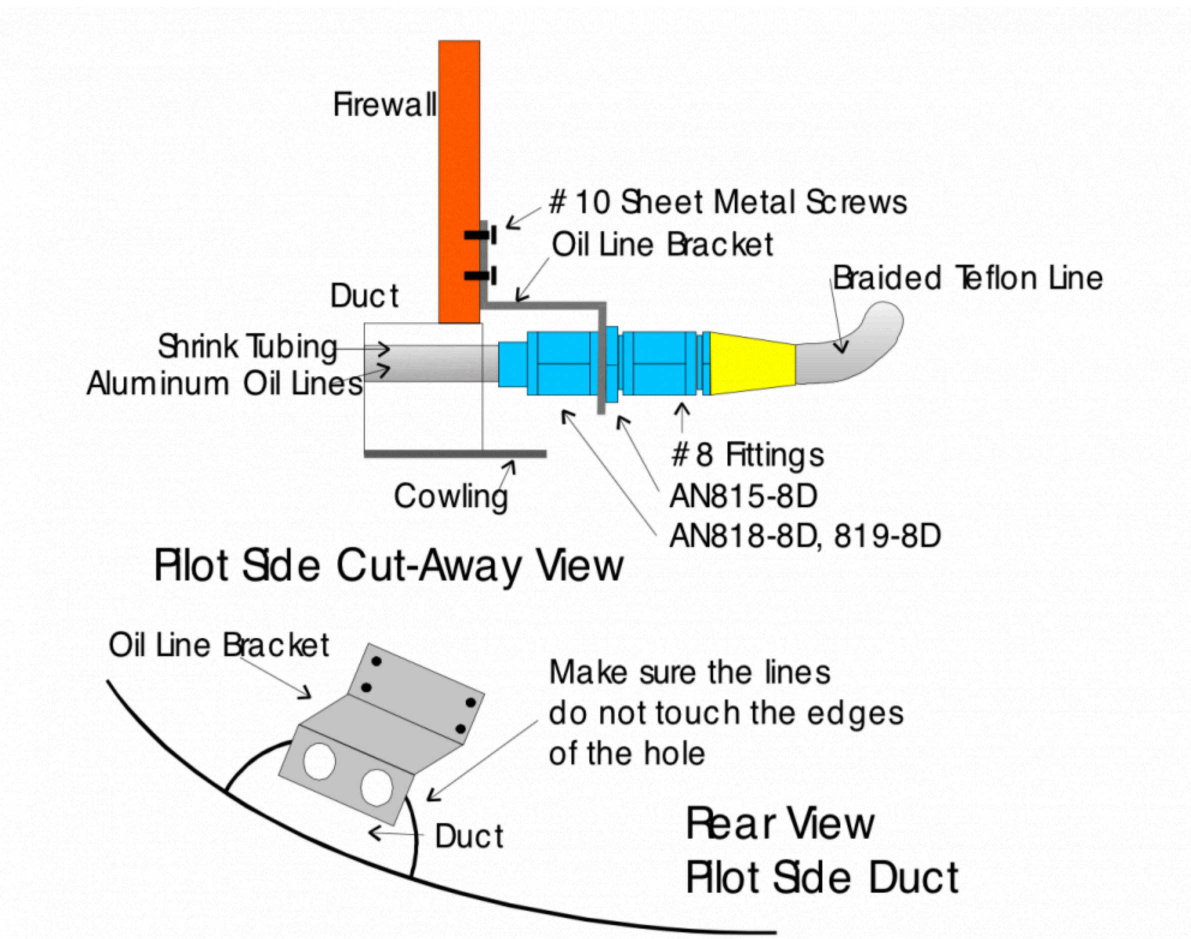


Figure 12-1. Oil Line Bracket and Fitting Detail

All fittings that are attached to an engine need to be steel fittings. Aluminum fittings are not acceptable.

Get your braided stainless Teflon #8 line out of the box. It is the largest diameter of the three lines that came with the package.

___ Clean up the end of the hose with a razor blade and scissors.

___ Slide the nut over the hose. Carefully pry the braid away from the hose.

___ Slide the ferrule onto the Teflon hose until the hose bottoms out inside the ferrule. Lubricate the inside of the hose with WD40 and slide the fitting into the hose until it bottoms out on the ferrule.

___ Slide the nut down onto the fitting and turn clockwise. Lock the nut into the vise with light pressure and tighten the assembly until it stops. It usually bottoms out.

Finger tighten the line with fittings to one of the engine fittings, extend the line down to the union at the firewall, give it some room for flexing, take into account how the fitting effects the line length, and mark the line for cutting.

___ Wrap the line at the mark (centered) with several layers of masking tape. As you cut, the tape will help hold the braid together. Put the line into a vise with the cut position right next to the jaws of the vise. Cut the line off with a hacksaw. (A cutoff wheel on a die grinder works best.)

12.2.2 – Fuel Plumbing

In Chapter 9 you installed your sump tank. Most of our customers are mounting the drain valve (CAV-110) right to the bottom of the sump tank which requires a 3/4” hole to be drilled into the bottom of the plane directly under it. In the fixed gear aircraft, there is foam to think about which means you will need to glass the edge of the foam to close it out. Do not bother trying to wrap it around the edge of the hole, just glass it like a tube and trim off the inside and outside edges flush with the surfaces. The CAV-110 valve should be recessed inside this hole so in the event of an accident there isn’t any exposed steel part to spark on concrete and cause a fire hazard.

All of our fuel and vent lines used in the Velocity are made from 3003 3/8” aluminum tubing. Make sure that the flare tool used on all of these lines is a 37 degree flare tool.

Coming out of the sump we go to the fuel shut off valve (which is provided in the install kit) then on to the AN833-6D firewall fitting. On the engine side of the firewall we start with the fuel filter than to the boost pump (Weldon #B-810J) . Again all the lines are 3003 3/8” aluminum with AN818-6 nuts and AN819-6 sleeves at the flares.

Note: All lines aft of the firewall that have flammable fluid in them (oil or gas) need to have a Fire sleeve to protect them , both solid and flexible lines. We supply Aeroquip fire sleeve in our engine install package.

The electric boost pump is part of the engine install package. The inlet and outlet ports are marked on the pump. Remove the plugs, if there are any, from the main ports of the pump. Install two AN919-12D modified fittings with AN6227B-10 O-rings into the pump. Use a little lubricant (DC-4) on the O-rings as you do not want to damage it as you tighten up the fittings.

The fuel comes from your firewall fitting, through a short aluminum line to a filter (Airflow performance maintainable fuel filter supplied in engine install.) After the filter you go through another short line to the electric fuel pump. We usually make a mount for the fuel pump out of triax. Cover the pump with duct tape and place it on plastic on a flat surface. Lay 3 layers of triax or 6 layers of bid over it tucking it in around the pump and making sure it lays flat on your table for 2 inches each side. After this has cured, trim the mount and cut two small holes at the bottom of the ring to accept a hose clamp. Clamp the pump to the mount and position on firewall. The pump has 2 drain ports around it. After the pump is positioned make sure that the drain port on the bottom of the pump is not covered by the fuel pump clamp. Drill through the mount and firewall and hold in place with two 1/4” bolts through the base. This method can also be used to make a mount for you fuel filter.

On the inlet side of the mechanical pump you will have to remove the 1/2” 90 degree fitting and install an AN822-6 fitting. Now you will need to make 2 fuel lines – one from the boost pump to the inboard (copilot) side of the mechanical fuel pump on the engine (#6 hose), and one from the outlet side of the mechanical fuel pump to your fuel flow sender. The IO550 N2B comes from Continental with a #6 line from the fuel pump to the fuel servo. Disconnect this line from the fuel pump and still use it between your fuel flow sender and the servo. If you do not have a fuel flow sender you do not have to make this extra line.

The Continental engine also requires a Fuel Vapor return line. The fitting located on the pilots side of the mechanical fuel pump is for the vapor return line. You need to install a one way check valve in the vapor return line (Aircraft Spruce carries one that works well P/N 10630). Run a flexible line from the vapor return fitting on the fuel pump to your check valve. Make sure your valve is positioned so it will allow the vapor to return from the engine. You can then run a small hard line from the check valve to the AN833-6D firewall fitting. Then run a small line from the firewall fitting to the sump. I like to run both the line going to the engine from the sump and the vapor return line on the lower copilots side of the firewall. Just make sure you have proper clearance for you Retractable Gear throughout its travel. The return line for the Continental will go next to the in line from the Copilots main tank. You will need to have this drilled and tapped for 1/4 pipe and insert fitting AN822-6 as you did for the main tank line.

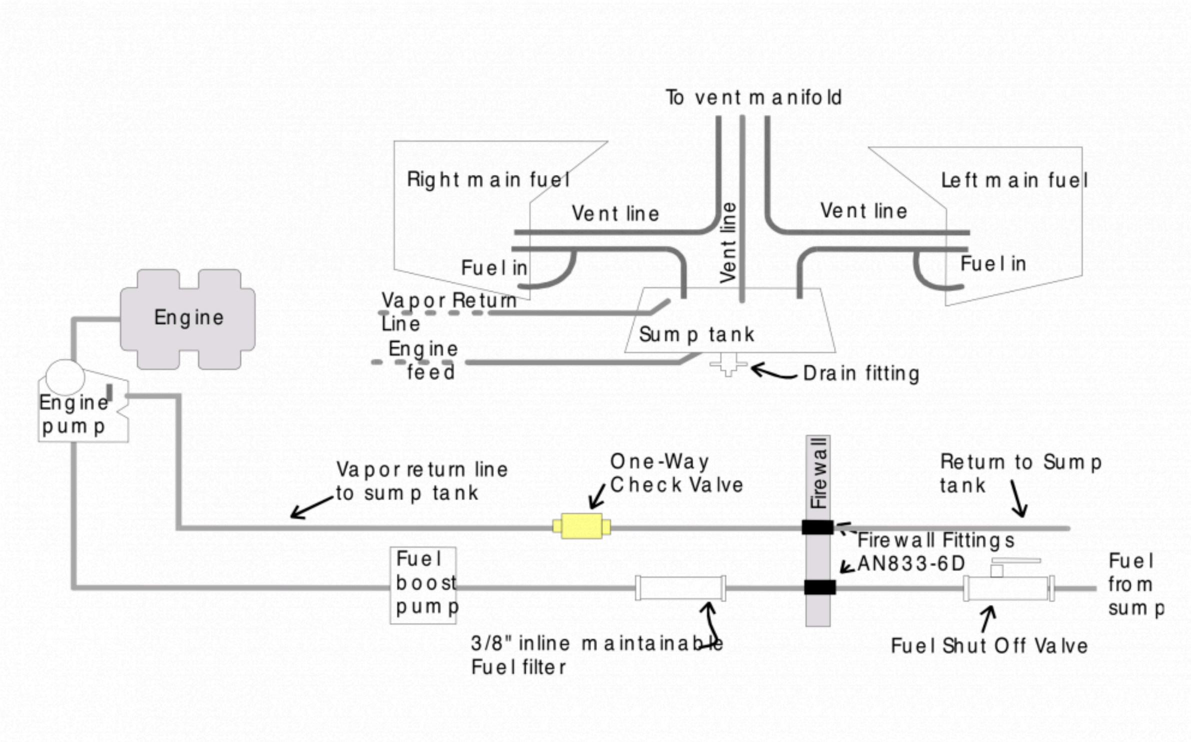


Figure 12-3xca. Fuel System Schematic

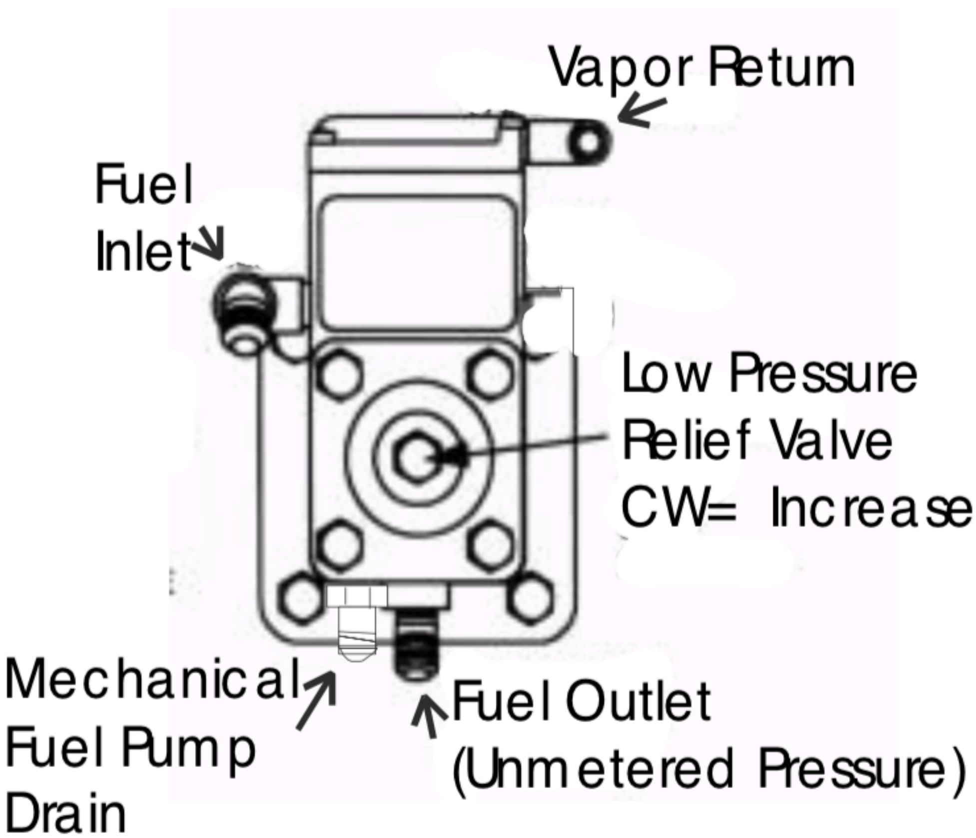


Figure 12-3xcb. Fittings on Continental Fuel Pump

12.2.3 – Intake Drain Lines

On the continental engine there are three separate components that we have to create drain lines for, the mechanical fuel pump, the intake manifold and the fuel divider manifold (spider.) The drain on the mechanical fuel pump is located on the bottom of the fuel pump behind the fuel outlet fitting (refer to figure 12-4.) This drains function is to route gas out of the airplane in case the diaphragm in the fuel pump breaks. Make up a short (3 inches) 1/4” aluminum line with one AN818-4D and one AN819-4D. Attach this to the drain. Attach a length of Mil-H-6000 fuel line to the open end of your drain line and secure with a hose clamp. Run the other end of the fuel line to exit at the bottom of the firewall. Attach it to a 2 inch piece of 1/4” aluminum with a hose clamp and extend this through a 1/4” hole you drill in the cowling flange.

The intake manifold on the Continental has 3 separate 1/4” lines on each side of the engine comingfromeachcylinderheadstoamanifold.Fromhereweneedtomake two hard lines that join together at the back of the engine at an AN824-4D Tee fitting. After a short run from the AN824 you will switch to Mil-H-6000 line. Before the drain exits the cowling you have to connect to a short run of 1/4” aluminum line that is flared at one end with an AN818-6D and an AN819-6D. Screw in an AN815-4-4D fitting into your 1H19-6 Cylinder drain valve. This is provided by Continental. Attach you line to this and route the drain valve out the bottom of the airplane.

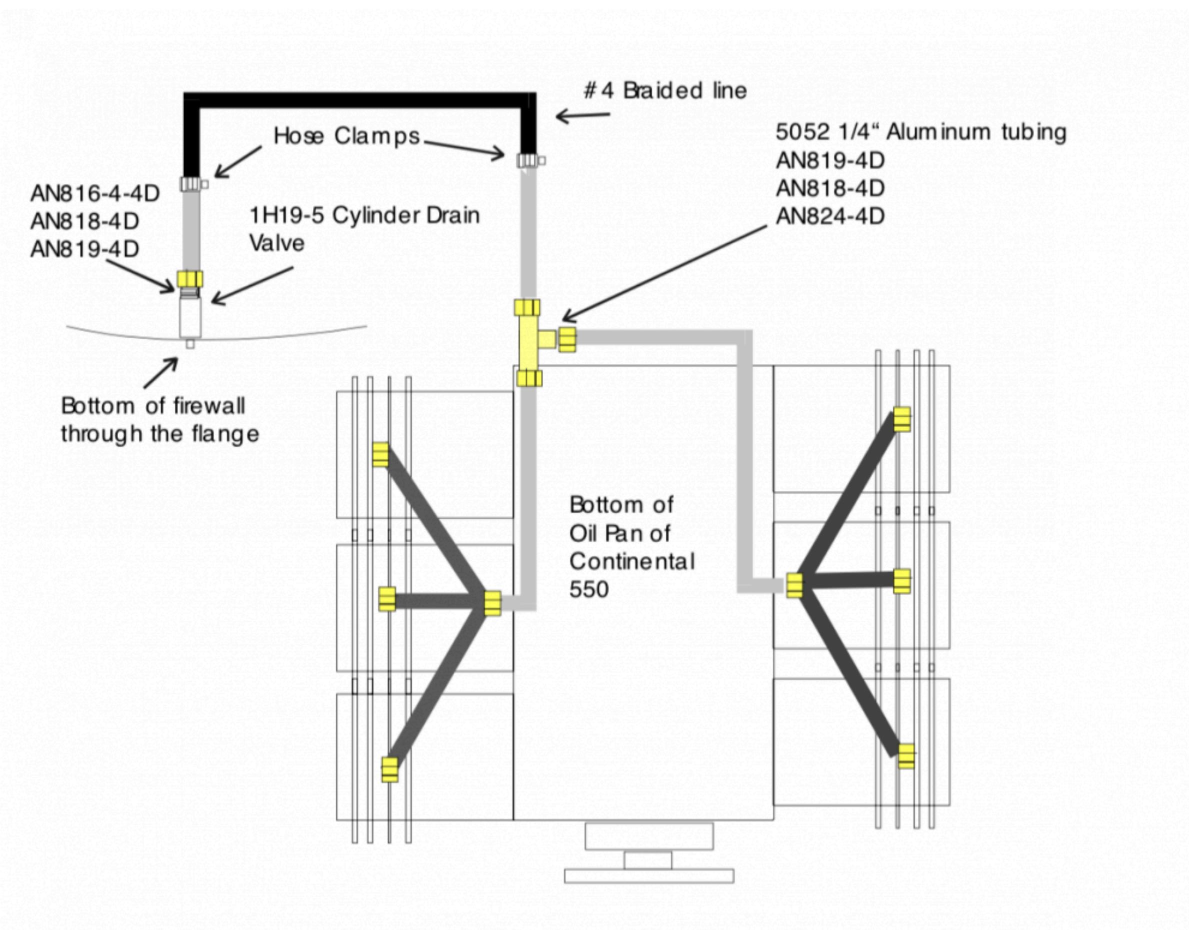


Figure 12-3xcc. Cylinder Drain Plumbing

The last drain you will have to make is from the fuel flow divider (spider valve). On the copilots side of the divider there is a 45 degree fitting that has a nipple on it. Remove this fitting and replace it with an AN822-4D. From this fitting make a solid 1/4” aluminum line flared at one end with an AN818-4D and an AN819-4D, run the other end straight back towards the rear of the engine. Cut this line so that it extends 2 inches past the rear of the engine. Attach Mil-H-6000 flexible line here and run it down the firewall. Use a short piece of solid line before exiting the cowling as you did on your other drain lines.

12.2.4 – Pressure and Temperature Lines

On any engine installation there will be several pressure and temperature senders that will have to be plumbed to the engine. **Never screw a pressure sending unit directly into the engine.** Most senders are designed to be mounted on the firewall and have lines running to specific ports on the engine.

The manifold pressure port is located on the copilots side of the fuel servo. (Refer to picture 12-6) At this location you will find two openings. The top opening will have a plug in it and the bottom opening will have a 45 degree brass fitting in it. Remove the 45 degree fitting and move the top plug down to this location. Install an AN823-4 in the top port facing down and slightly aft. You will need to make a #4 line from this fitting to back on the firewall.

The oil pressure port is located on the back of the oil cooler base. (Refer to Figure 12-3c) Install an AN823-4 fitting that has had one end welded shut and redrilled with a #60 drill into the port (supplied in engine install.) Make a #4 line that runs from this fitting to your sender on the firewall.

The oil temperature port is located on the copilot side of the oil cooler base. (Refer to Figure 12-3d) The thread for this port is a 5/8-18 . Some engine monitoring systems have there temperature probes made with this thread. Others are set for 1/8 pipe thread. If this is the case you need to install a bushing into this port first. Make sure that when you buy your engine gauges you make sure the person you are buying them from know that you have a Continental IO-550. These straight threaded fittings use a copper crush washer to seal them.

On the back of your Fuel flow Divider there is a 45 degree #3 fitting. This fitting needs to be removed and you need to install an AN823-4 with the end welded and drilled with a #60 drill. You then can make a #4 flex line from the flow divider to your sender on the firewall. (Refer to Figure 12-3a)

Keep your wiring in mind when you locate your senders on the firewall. I try to keep all my sending unit close together so I can keep my wiring close together and tidy.

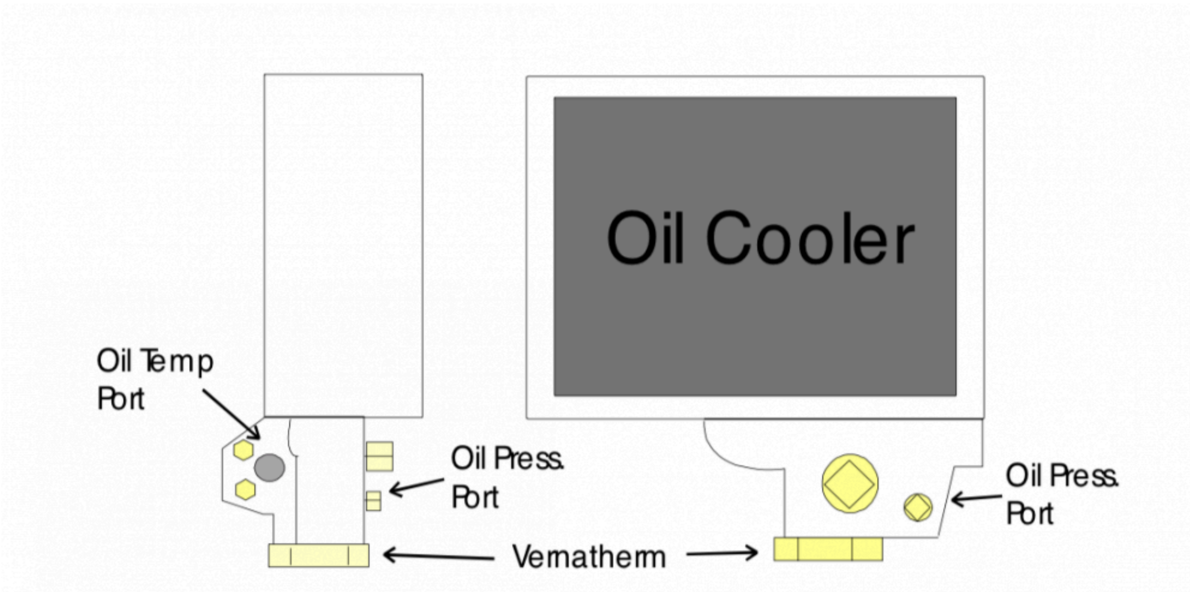


Figure-12-3xcd. Oil Temperature and Pressure Ports

13.4. 12.3 – Controls, Cooling and Prop

12.3 – Controls, Cooling and Prop

12.3.1 – Throttle, Mixture, and Prop Controls

The throttle on the continental is located on top of the engine on the copilots side. The mixture control is located on the bottom of the mechanical fuel pump. With your engine you got a small white cloth bag that has both the throttle arm and the mixture arm. The arm on the throttle is mounted so that the bend in the arm is away from the engine. With the butterfly valve closed on the throttle you want to mount the arm at the 4 o'clock position, 12 o'clock being straight up. Turn the shaft for the mixture control as far clockwise as it will allow you to. This will put your mixture at idle cutoff. Go ahead and install the mixture arm at the 4 o'clock position as well. The arm for the mixture has a raised boss at the center of it this needs to face away from the engine.

The three controls are mounted on the left side of the instrument panel vertically starting with the throttle – prop – mixture. This requires holes in the panel to accept the controls and the cables are routed in a nice arc, down to the duct, and back to the engine. Remember that the fuselage curves inward in front of the instrument panel and the cables have a 12" long section for the vernier control so you can't put the controls too close to the side of-the fuselage. The mixture cable is routed to the back of the engine pointing up towards the mechanical fuel pump. The throttle is routed around the back side of the engine and up and over the oil cooler on the copilots side. The prop governor cable is routed around the back of the engine following the engine mount and down the copilot side toward the prop. The connections to the control arms are made with MW-3 rod ends on the cable and AN-3 bolts into the control arm of the servo, mixture control, or governor. On the governor check the throw of the cable to make sure the clamp (similar to the aileron cable clamps) will be in the correct position. When you are sure you have the correct position drill two 3/16" hole using the clamps as your template. The holes for the throttle bracket are already drilled for you. Clamp the cables to the brackets with the clamp sets. The clamps are installed with #10 screws or bolts and nuts. The throttle cable will need to be bolted to its bracket before the bracket is installed.

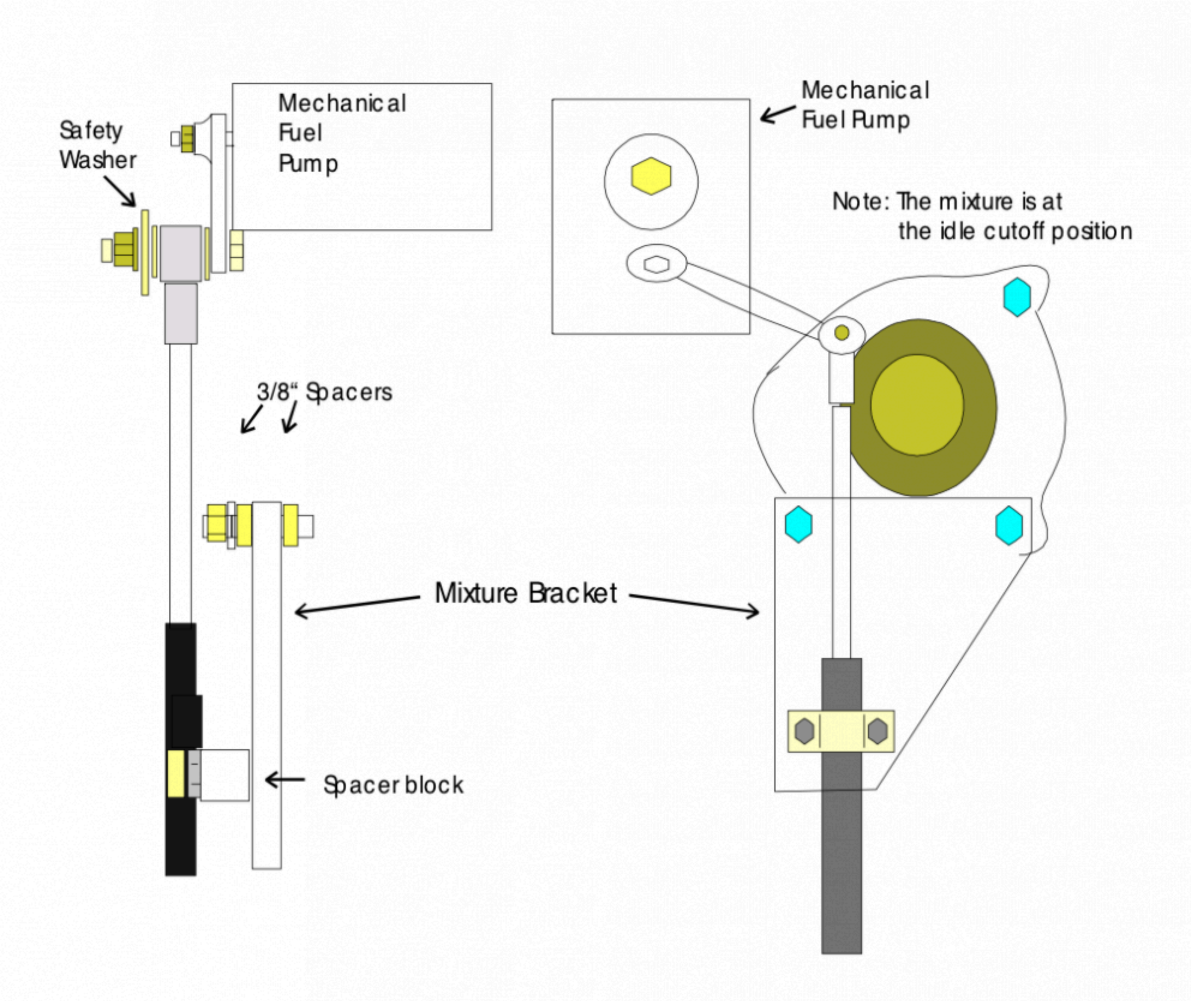


Figure 12-4xc. Mixture Cable Installation

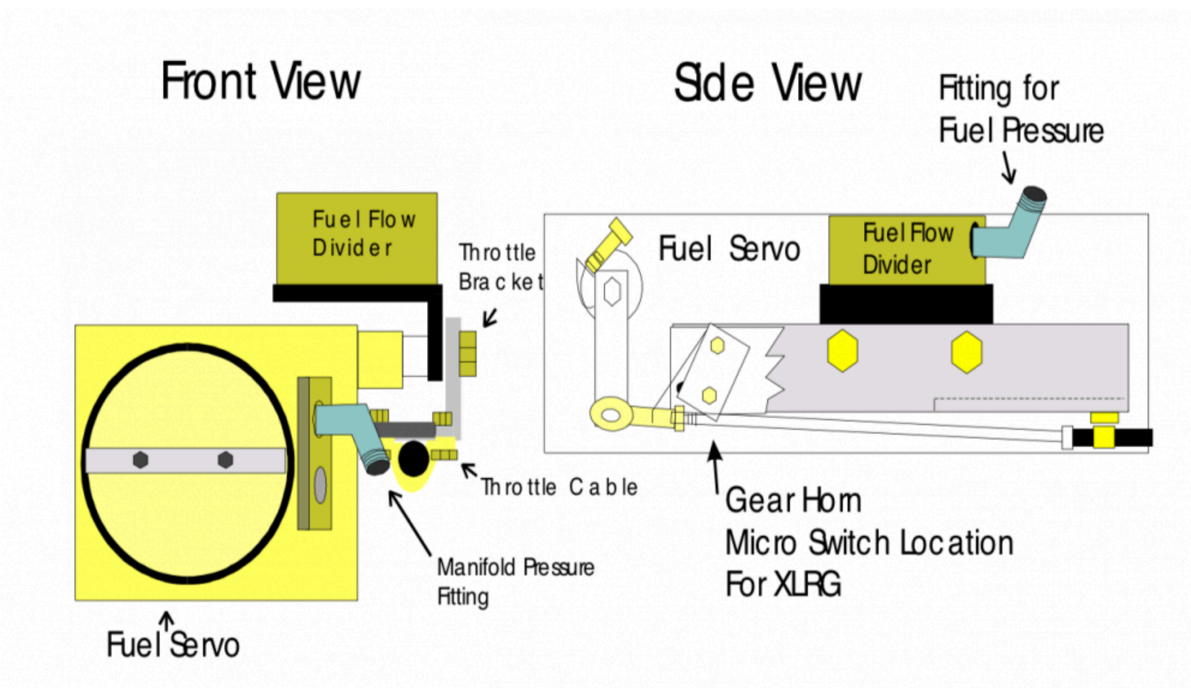


Figure 12-5xc. Throttle Cable Installation

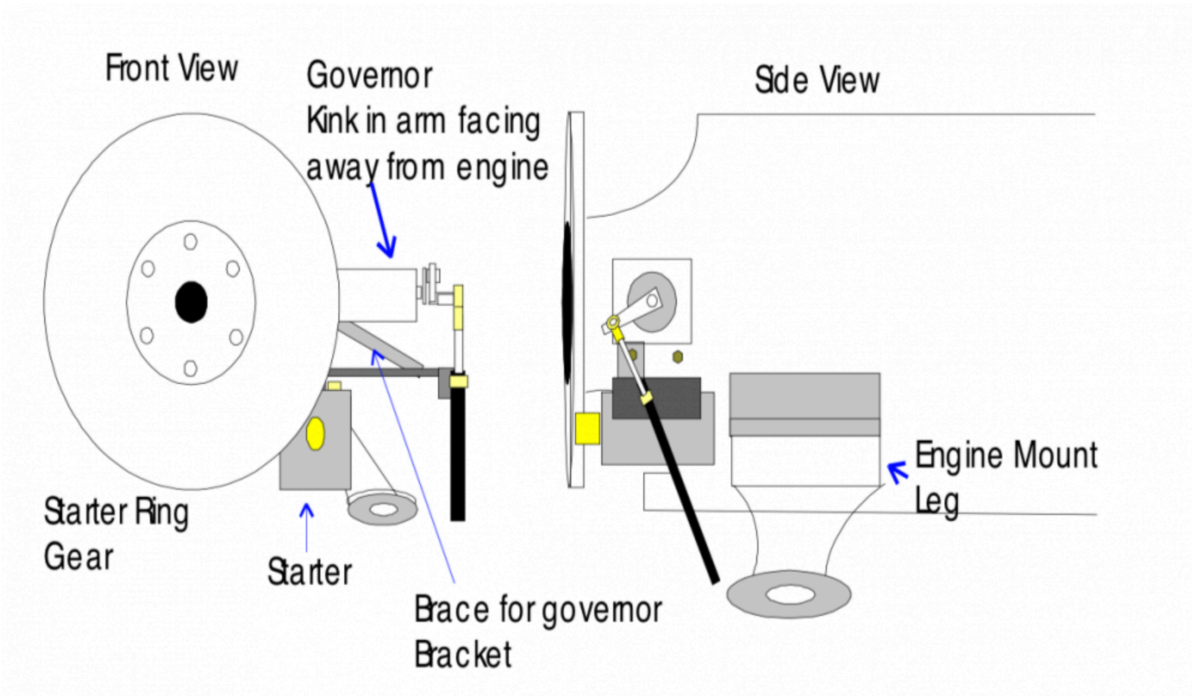


Figure 12-6xc. Propeller Cable Installation

12.3.2 – Pressure Checking Fuel System

Caution must be taken while pressure checking your fuel system. Use an altimeter as a pressure gauge and pressurize your system no more than it takes to make a 1500’ change in the altimeter or an airspeed indicator to 180 knots.

___ Check that all fittings are tight and block off the fitting that lead to the engine.

The best place to install the altimeter is at one of the fuel tank vents. The ideal way to close off a vent line is to make up some caps out of flared 3/8 tubing with an AN818-6 and an AN819-6 on one end and bend over the other end and hit it with a hammer to seal it. If you don’t have any AN 818 or AN819 left you can use a small piece of hose over your aluminum tube and clamp shut the other end.

___ When all the lines are sealed and the altimeter is installed, carefully inflate the fuel system to 1500’ on the altimeter. This can be done by blowing into the feed lline with your mouth. **Do not overinflate!**

Close off the feed line and watch for an altitude change. If a rapid change occurs, listen for a leak, and verify with soapy water. Check fittings and fuel caps first, then try to isolate the leak to either the sump tank or one of the mains. Continue to paint all areas with soapy water until all the leaks are found. Clean off the soapy water with clean water and alcohol, then let the area dry completely.

If a leak is detected , use a vacuum cleaner to apply negative pressure to your tank. Hold the hose over the filler opening with a small gap being careful not to vacuum so much so as to harm the structure. Brush **Jeffco** or **EZ-Poxy** over the leak for a couple of minutes, remove the vacuum, and continue to brush on the epoxy for a minute or so.

Recheck the system following cure, and keep in mind that a good leak free system should hold an altitude indefinitely, although small changes due to temperature variations should be expected.

12.3.3 – Fuel Sight Gauges

When you built your tanks, you installed two brass elbows in the rear baggage bulkhead. These are to be connected with a piece of clear fuel line (polyurethane tubing) utilizing either small hose clamps or good heavy duty nylon cable ties. Do not use tygon tubing as it will become brittle. We do stock a premade sight gauge that is lighted for night operation, looks good and is more durable than plain tubing.

Cable ties are not as good, but they look better and we have not experienced any problems with them on our aircraft. When calibrating your gauges, get the aircraft level on the ramp, and then fuel up with 5 gallons at a time on each side. Mark the consecutive levels with tape or a permanent marker. Make sure that you close off the line to the sump tank while doing this (to prevent cross-feeding), and reopen the lines when completed.

12.3.4 – Cooling Plenum Chamber

The NACA scoop/ Plenum installation is what Velocity is currently using for engine cooling in our airplanes. The NACA scoops were installed in your fuselage in the Fairing section. Below is a description of how to install the plenum and runners.

___ Fit the center section of the plenum to the top of the engine. You may want to duct tape your engine in parts and extend the sides of the plenum down to the engine and on the duct tape.

The next thing is to install the two runners. There is a left and a right runner. The shorter runner goes of the copilots side. Shift the runners as necessary to make sure they align up and transition as smoothly from the inlet holes in the firewall to the plenum. Mark around the runner where it meets the plenum. Sand at least two inches around the bottom of the runner and sand around the top two inches of plenum where it meets the firewall. Duct tape 2 inches on the plenum all around where the runner meets it except for on the bottom side. Create a 3 bid flange all around the top and sides of the runner. After the bid has cured drill 1/8" holes at least every 3 inches. Next sand the plenum where it meets the bottom side of the runner. Duct tape the runner and create a flange and drill two equally spaced 1/8" hole here as well. This flange is made part of the plenum to allow easier removal. After the flanges are made you can go ahead and cut the plenum out where the runner meets it.

After the runner are fit you can now fit the side covers. The side covers will allow you to gain access to the top of the engine for routine maintenance. You may have to trim the side cover where it meets the top of the cylinders. Once the covers are fitting well, while they are in place on the plenum drill 1/8" hole around the perimeter every 3 inches.

After all of your plenum flanges are done you can enlarge all of the 1/8" holes to 3/16 and install 10/32 nutplates into the plenum so you can attach them. Make sure you do not install nutplates where they can rub into your engine or injector lines.

At the firewall you will need to make a flange from your runner to the firewall to help seal it. Duct tape the firewall where the runner meets it. Lay up a 3 bid flange from the runner onto the firewall. After cure pop off the runner from the firewall and lightly sand the flange. Leaving the duct tape in place put in a thin layer of silicone on the duct tape and reinstall the runner. Let the silicone cure then slowly remove the runners.

The runners are held in place at the firewall by the screws that hold the engine cowling on. Your flange for your engine cowling should already be drilled if not refer to chapter 11. Install the runners using the holes in the Fuselage cowling flange drill two 1/8” holes in each runner. Remove the runners. These holes will have to be reinforced before installing the nutplates. Structural adhesive one 1 1/2” x 1 1/2” piece of 0.030-0.040 aluminum centered on the inside of the holes that you have just drilled in the runners. After your adhesive has cured drill out the hole to 3/16” and install 10-32 nutplates.

You will need to allow access to your oil filler and dipstick. This will be located under the runner on the copilots side. After your runner has been fit locate the oil filler on the copilots runner. Using a 3” hole saw drill a hole. Take the runner off the airplane when you drill this. Reinstall the runner and remove the dipstick. Cut the bottom off of a plastic drinking cup. Now you can take the cup and fit it in the hole you have cut. Push it down in the hole until the cup is 1/8” past the top of the filler. Make sure you have enough room to get you fingers in the hole to take the dip stick out. Hot glue the cup in place and carefully remove the runner. Glass a 3 BID layup around the cup and onto the plenum. After it has cured remove the cup and trim.

Make sure you attach your plenum to the cylinder at the front and the back of the engine.This will keep it from moving away from the cylinders under pressure. You can use a small bit of silicone or safety wire to do this.

12.3.5 -Propeller

The propeller used for the XL is a constant-speed MT. This is a lightweight, high- quality propeller that is manufactured in Germany. You could use a fixed-pitch propeller but you will lose utility. We are distributors for this prop and can get you a good discount on it. It usually takes about 90 days from time of the order to receive it.

12.3.6 – Nose Mounted Cooler

The fuselage comes to you with premarked positioning for the inlet and outlet of the cooler. It is important to remember that the lines on the fuselage for the outlet depict only the approximate size of the hole in the outer skin.

The inside skin is only cut to the canard bulkhead. To be safe, add another rear cut line on the fuselage about 3” in front of the other one. This will ensure that you will cut in front of the canard bulkhead.

The first thing you will be installing is the NACA scoop. Three sides of the flange for the oil cooler are already molded into the scoop.

___ Cut the hole and insert the scoop into position. Before you start trimming the scoop, put the cooler into position on the scoop’s flange. It would help at this time to remove some inside skin and foam beside the cooler to allow it to move closer to the side thus reducing the ramp angle and giving the gear more room.

13.5. 12.4 – Exhaust Installation

12.4 – Exhaust Installation

12.4.1 – Overview

The continental exhaust comes to you in pieces that you will need to assemble and clamp together to make your final installation. This allows you to mark and cut your exhaust to length without having to disassemble the exhaust.

12.4.2 – Cowling Cutout

First you need to install your exhaust to the engine. Both the pilot and copilot side will use one center stack, one side exhaust A and one side exhaust B. If you pick up all for side exhaust pieces you will notice that the flanges where the pipes bolt up to the engine are different for A and B. Assemble the pipes to the engine so that the three pipes come together. Make sure you install the gasket on top of the exhaust and tighten at least on of the four mounting nuts on each stack.

We need to make a template of where the exhaust sits that we can transfer to the cowling for cutting. You will need a piece of cardboard that is long enough to extend from behind your exhaust to about 1 foot in front of the cowling flange. Cutout a hole in the cardboard that is just large enough to fit all three exhaust through. Make sure to have the cardboard orientated so that you have at least 1 foot of it forward of the cowling cut line. With the cardboard pushed up over the exhaust in the approximate place where the cowling would be make a reference mark on each side of the card- board where it runs over the cowling cut line. You also want to mark on the cardboard where it meets the gear leg. You may have to cut the cardboard so that the gear leg doesn't interfere with it. You can also put a few reference marks on the fuselage and cardboard to mark it's location.

Remove the exhaust pipes and install the cowling. Reinstall the cardboard template and line it up with the reference marks you made on it and the fuselage. Tape it to the bottom of the cowling. Using a marker transfer the position of the hole in the template to the bottom cowling. Remove the cowling and cut out the exhaust exit. At this time you want to make the hole just large enough to fit the exhaust.

Reinstall the bottom cowling. Reinstall the exhaust with the bottom cowling in place. Without the top cowling on you can get the exhaust pipes down between the engine and bottom cowling and down through the hole you cut in the bottom cowling. Remember to install the gaskets . You will only need one nut tightened up on each flange because you will remove the exhaust again. Mark a line all the way around the three exhaust pipes where they meet the cowling. Also mark the cowling 1/4 around the exhaust. This will be the cut line for the exhaust exit so take your time and make it pretty. You want to create an oval hole around all three exhaust.

Remove the exhaust. Now remove the bottom cowling. Cut the bottom cowling out to your cut line. Use a little sand paper to smooth out your cut after you are done.

12.4.3 – Exhaust Stack Trimming

You will now want to draw a line on each exhaust pipe that is 1-1/2” further down than the mark you made earlier. This will be you cut line for the exhaust. These lines will not be straight across since they follow the cowling. Lightly clamp a stack in a vise using a rag wrapped around the stack so as not to mar it. Cut the stack on your cut line using a hack saw. Do this for each of your stacks. Dress the ends of the cut with a file or sandpaper to remove the burrs.

Reinstall the exhaust stacks to the engine. Make sure you install the gaskets again and do not tighten the stacks up all the way. Assemble the clamps to the exhaust to hold them together. Use one outside clamp around each side exhaust and put one center half clamp around the outside and inside of the center stack. Hold them together with the stainless bolts and nuts do not tighten them up all the way yet. Position them so that they will be just inside the cowling when installed. Tighten the stacks to the engine and install the rest of the lock washers and nuts. Now tighten the stainless nuts and bolts for the clamps.

14. 13 – Electrical / Instrumentation

Contents

(Shared with SF, SR, XF, XR)

14.1. 13.0 – Chapter Preface

13.0 – Chapter Preface

13.0.1 – Parts List

Part Number	Description	Qty
	Trim Switch	2
	Speed Brake Switch (opt)	1
	Speed Brake Light (opt)	1

13.0.2 – Tools List

This chapter may require special tools which will vary depending on your choice of instrumentation and navigation equipment. Please consult the installation manuals which came with these units.

13.0.3 – Supplies List

Description
Copper Foil
Ferrite Torroids
RG-58 Cable
Heat Shrink Tubing
Veloci-Poxy
Micro-Balls
Battery(s)
Wire
Switches
Circuit Breakers
Connectors
Instruments
Avionics
Strobe/Nav Lights and Equipment
Vacuum/Static/Pitot Lines and Equipment

13.0.4 – Glass List

Type	Size	Qty
FINE BID	Cover Various Antennas	

13.0.5 – Process Overview

Construction Process	Completion Date
Install Antennas	
Glide Slope	
Marker Beacon	
Transponder	
GPS	
ELT	
–	
Panel	
Design	
Construct	
Wire	
–	
Electrical	
Plan	
Install	
Trim & Speed Brake Systems	
P-Leads	
Lighting	
–	
Vacuum	
Vacuum Lines	
Static Lines	
Pitot Lines	

13.0.6 – Documentation Changes

Oct 01, 2018 – Original Web Release

14.2. 13.1 – Antennas

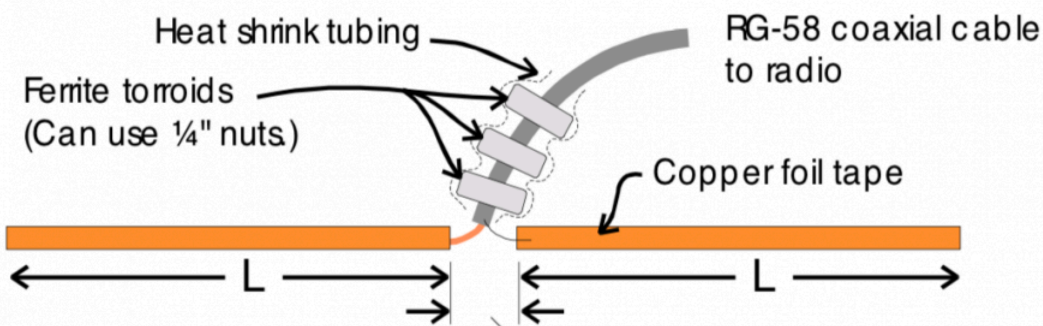
13.1 – Antennas

13.1.1 – Introduction

There have been many theories concerning optimum antenna installation in composite aircraft, and many articles and books published about these theories. We will tell you how we install our antennas, with which we have had great success. It is up to you whether you wish to follow our recommendations.

We use simple dipole antennas that consist of two copper strips (or wire) of equal length. One strip is attached to the core of an RG-58 cable, while the other half is connected to the sheath and runs in the opposite direction.

All of our antennas are in the fuselage with the exception of the COM and NAV antennas, which you installed in the Wing/Winglet section.



Function	L (inches)
Com	20.3
Nav	22.8
Marker	34.3
Glideslope	7.5

Figure 13-1. Dipole Antenna Installation

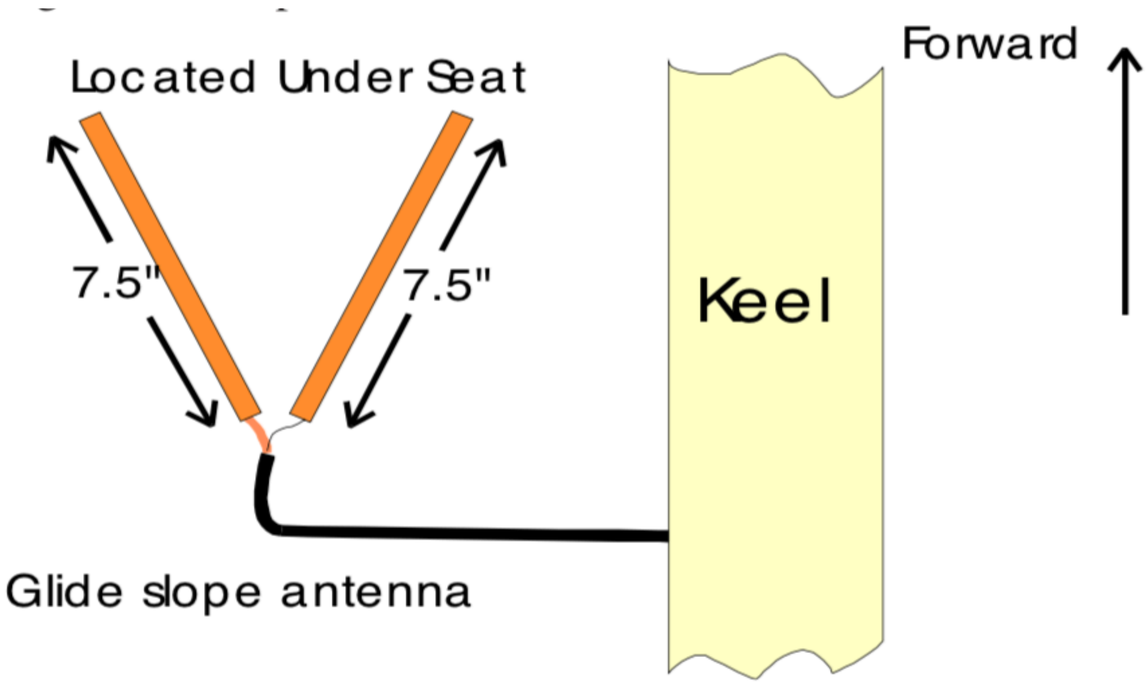


Figure 13-3. Glide Slope Receiver Antenna

13.1.2 – Glideslope Antenna

The Glide Slope antenna strips are 7.5” long, and located on the floor to the left or the right of the keel underneath one of the front seat locations. Cover the antenna tape with one BID after installation.

13.1.3 – Transponder

We use the antenna supplied with the transponder, but we must use a thin sheet of aluminum (approximately 7” × 7”) bolted to the back as a ground plane. We prefer to install this antenna at just in front of the firewall. Mount the antenna so that the end of it portrudes from the bottom of the airplane. We want to make sure that the stainless steel used on the firewall does not block out the antenna.

13.1.4 – GPS

Most GPS antennas are compact. Since fiberglass does not block the signal from the satellites used for GPS, these antennas may be mounted inside the aircraft.

For ease of installation, accessibility, and keeping the coax cable run from antenna to receiver as short as possible, build a small shelf to install on top of the landing light. No ground plane is needed for these antennas to work properly, so the shelf may be built out of fiberglass. This location ensures good reception and does not “dirty up” the exterior of your airplane.

13.1.5 – ELT

Emergency locator transmitters (ELTs) are generally compact and completely self contained including the antenna. External antennas should be mounted on the cabin side of the firewall in a vertical orientation.

You want to mount the ELT antenna at the rear of the airplane so if you do have an accident the unit has the best chance of remaining intact.

14.3. 13.2 – Instrument Panel

13.2 – Instrument Panel

13.2.1 – Instrument Panel

There are a couple of factors that a builder should keep in mind while laying out there panel.

___ Remember all of your instruments have depth as well as the space they will take up on the panel. Think three-dimensionally when laying out your panel. Both the top and sides of the airplane slope inward as you move forward of the panel. The elevator push tube is on top of the keel just forward of the instrument panel.You also have an elevator pitch trim mechanism to think about. If you have yokes in your airplane there is a whole control system that you have to work around.

___ Keep a standardized panel lay-out. By this I mean keep your instruments and controls layed out in a similar fashion as you would find them in a Certified airplane. For instance if you are using the standard six flight instruments mount them in the same order that every other aircraft manufacturer does.(Shown in Figure 13-4)

___ We all have seen instrument panels that are so jammed packed with instrumentation you think they would feel right at home in the space shuttle. You may need the space shuttle to get these panels off the ground because all that extra junk adds weight. Honestly sit down and evaluate the type of flying you will be doing , then base your panel around that. All the extra bells and whistles are not needed. Remember that your instrument panel is is at a far forward CG and a heavy panel will adversly affect the rotation and landing characteristics.

We suggest that you finish your panel face out with a flat paint. Prior to doing any work on the panel, construct a cardboard mock-up of your panel, then transfer locations and dimensions to the actual panel once you are satisfied with your layout.

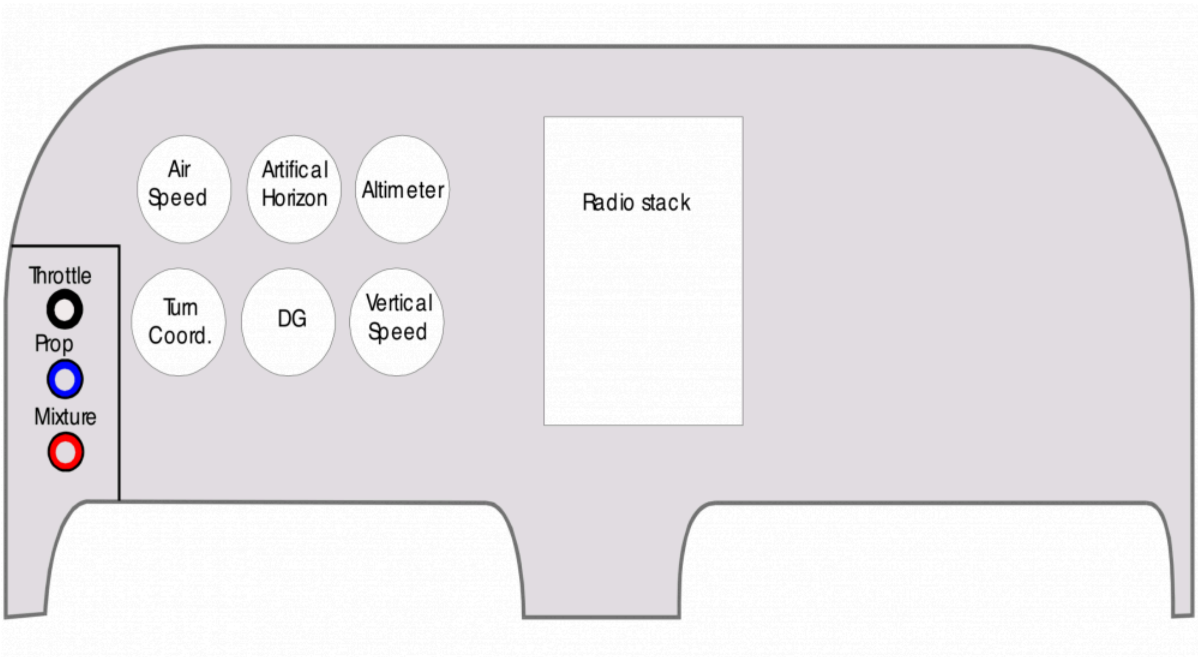


Figure 13-4. Instrument Panel Layout

You will find that working with a fiberglass instrument panel is a lot easier than working with a metal one. Mistakes can be repaired easily with fiberglass and filler.

When mounting your flight instruments, you will need a 3-1/8” hole saw, and you will need either a 2” or 2-1/4” hole saw for your engine instruments. Cutting for the radio stack can be done with a saber saw and a flat file. Smaller holes can be drilled and then altered with a rattail file to fit switches, breakers, etc…

Flight instruments are to be mounted with 6-32 instrument screws. **Be careful: too long a screw can damage instruments!** Breakers, switches, and ignition switch are installed with lock nuts that are provided with the switches.

We suggest two techniques for installing your avionics. First, bond a 1” × 1” × 1/16” aluminum angles to the back of the panel with **Structural Adhesive/Flox** on both sides of the radio stack on the flat panel or the left (pilot’s) side of the canted panel . We also drill and coutersink the panel for four 10-32 countersunk screws per side. We counter sink so the heads of the screws will sit just below the suface so we can fill over the heads.

Sand aluminum and panel back first, and then install to back of panel. Space between avionics cutout so the trays will fit between the legs of the angles. On the canted panel, the right side angle can be mounted behind the canted portion of the panel. The avionics trays will have to be drilled to allow attachment to the angle.

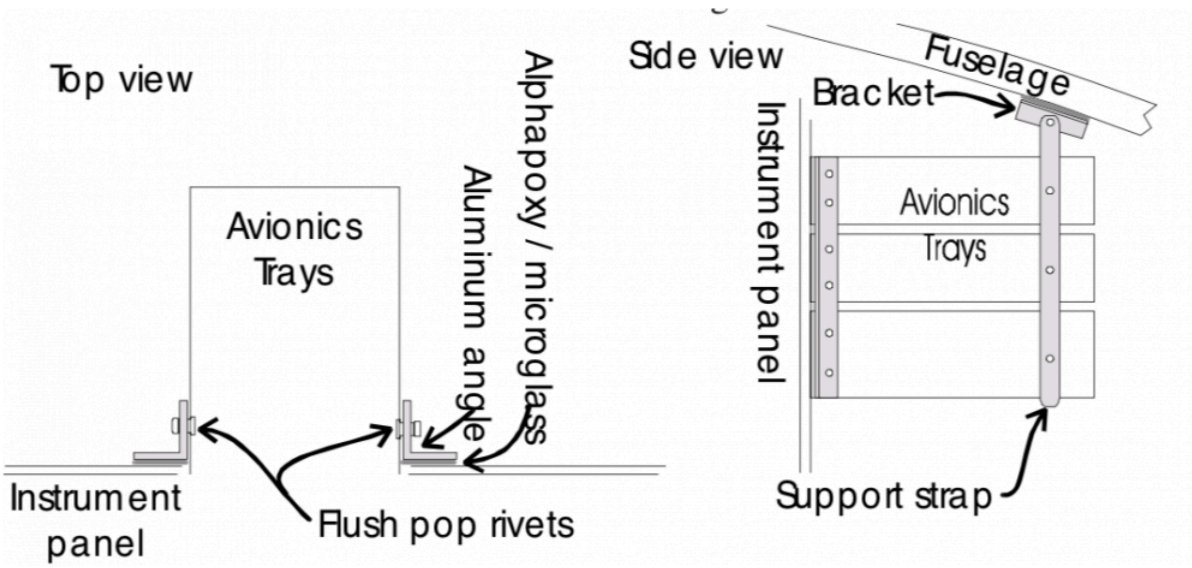


Figure 13-5. Brackets for Mounting and Supporting Radios

The second method of mounting the trays is to use 1” × 1/4” aluminum bar stock cut to length. On the canted panel, the right hand side piece must be contoured to the panel so that the 1/4” edge is flush to the back side of the panel where the trays will fit. Drill and tap #6-32 holes in the proper place on the 1” side for attaching the radio trays. Drill and tap #6-32 holes for screwing the aluminum strips to the panel. Again, space the strips to fit the radios to the avionics cutout.

Once the **Structural Adhesive** has cured, install your trays with flush head pop rivets or #6-32 screws as necessary, to the legs of the angles. Support the back of your avionics by attaching to a small bracket bonded with **Structural Adhesive** to the inner skin of the fuselage above the rear of your avionics package. See Figure 13-5.

We suggest that you cut all the holes, trial fit your flight instruments, and then remove them while wiring your switches and breakers. This allows more access when you have to solder leads.

13.2.2 – Engine Instruments

For a Velocity with a fixed pitch prop, you will need an RPM (Tach), Oil Temperature, Oil Pressure, and a Volt and/or Amp gauge. At minimum, a single CHT is needed. A single EGT/CHT is nice, and an EGT/CHT scanner is the ideal way to go. If you have a constant speed prop, you would need a manifold pressure gauge. Optionally, a Hobbs meter, clock, OAT (Outside Air Temp) and a fuel flow gauge are nice to have.

We suggest that you wire your engine instruments after installing and wiring your basic aircraft electrical power system components (i.e. battery, alternator, circuit breakers, switches, relays, etc.).

14.4. 13.3 – Electrical System Completion

13.3 – Electrical System Completion

13.3.1 – Introduction

This is an area in which some builders will have trouble. Because of the mystique surrounding much of what is electrical, especially the avionics stack. Others, because of a complete lack of understanding of electrical systems and electronics. “I know that if it does not come on when I flip the switch, it is not working right! That is what I know about electricity!” If you have any doubts about your abilities in this area please **get assistance**.

The order in which items are installed, and their location, is only suggestive. The description in the text is how Velocity has done it in the past. Everybody has their own techniques of installing components and there are so many different engines and optional equipment available that it is virtually impossible to cover everything. Use this text as a guideline. If the installation manual accompanying your particular system(s) does not indicate the same methods or materials, follow the manufacturers recommended procedures and materials if they apply to composite construction.

Velocity, Inc. has several suggestions to make concerning your electrical system. First, get a good book on basic aircraft electrical systems. Several are available through any good aviation book store. One book that is a must is AC43.13-2A-2B Acceptable Methods Techniques and Practices. This is the A&P’s bible. It has many sections on basic aircraft wiring and is an excellent refrence.

Do your homework and plan, plan, plan! With proper planning and the right tools, the electrical system can be a straight forward installation. Even the best electrical system can be difficult to redo.

We generally run the majority of our wiring down the co-pilots side duct. The pilot side duct is where we run our oil lines and we want to keep the electrical away from this heat.

It is recommended that electrical wire and terminals approved for general aviation use be used. The initial cost is not that much more, and the safety factor gained is well worth the investment. Circuit breakers (resetable) are preferred to fuses if for no other reason you do not have to fumble around for a good fuse if one blows out at a bad time (on final in actual IFR or at night)!

All wire sizes detailed in these instructions are good for the average Velocity. If you have a bigger starter, alternator, or considerably more electrical systems and/or avionics than the average Velocity, your wire sizes will need to be adjusted accordingly. If you are not sure what size wire you need, refer to the AC43.13-2A & 2B. There are two charts in the electrical section just for that purpose.

13.3.2 – Basic Electrical System

The battery installation comes first. We use a small (7” high, 8” wide, and 6-1/2” deep) battery with side terminals. We install the battery on the right hand side of the nose compartment,(just forward of the hydraulic pumpon RG’s), with the battery support bracket supplied in the kit.

Now, mount all electrical hardware (i.e. switches, solenoids, circuit breakers, terminals, etc.) where you want to put them. The shortest, most direct cable runs of wire, without interfering other aircraft systems, should be the prime consideration for you battery, starter, and gear pump solenoids. These are usually mounted on the forward side of the canard bulkhead.

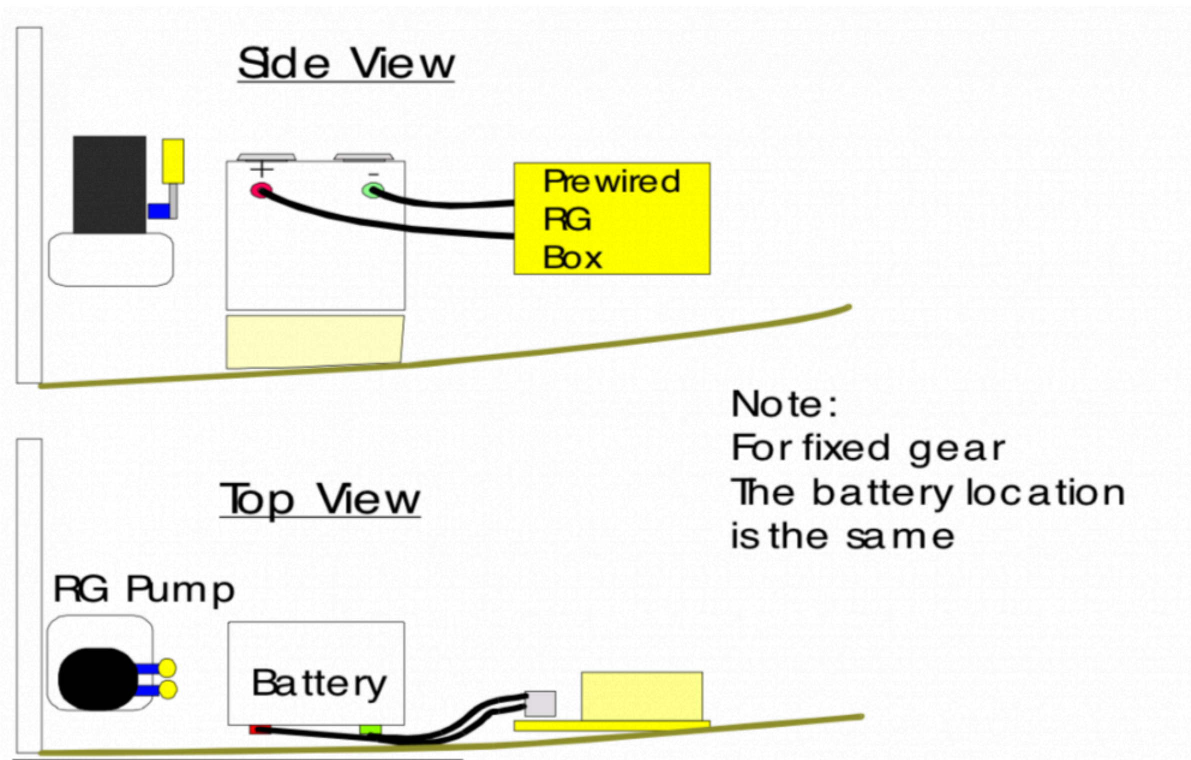


Figure 13-6. Battery Placement

Referring to Figure 13-6, let’s start with the battery cables, or wires. #4 wire can be used with the lightweight SKYTEC starter, use #2 if the old style starter is used. A #4 wire should run between the battery ground (-) and the engine case. This needs to be grounded directly to the case, not an accessory, and remove any dirt, grease, or paint, where the terminal attaches to the case. A#4 wire should go from the battery positive (+) to the **Batt** side of the master solenoid. From the opposite side of the master solenoid, a #4 wire should go to the **Batt** side of the starter solenoid. Also from the **opposite side** of the master solenoid, a #10 wire should run to the circuit breakers located on the instrument panel. The last #4 wire to be run is between the opposite side of the starter solenoid and the starter.

If you want a single switch to control your avionics power, a circuit breaker switch or a power relay controlled by a small, panel mounted switch should be wired between the main circuit breaker bus and the radio bus. A #10 or #12 wire should be used between these two buses, depending on the amount of radios you are installing. If you have a lot of radios, use the #10 wire. If you use a circuit breaker type switch, consider installing two (2) switches just in case one should fail. If you are using a relay, consider wiring it so that when the "Battery Master" switch is **ON** and the "Radio Master" switch is in the **OFF** position, the relay is energized and interrupting the power to your radio bus. When you flip the Radio Master switch **ON**, you de-energize the relay allowing power to the radio bus. This gives you a built in fail safe should your switch or relay fail to operate normally. See Figure 13-8.

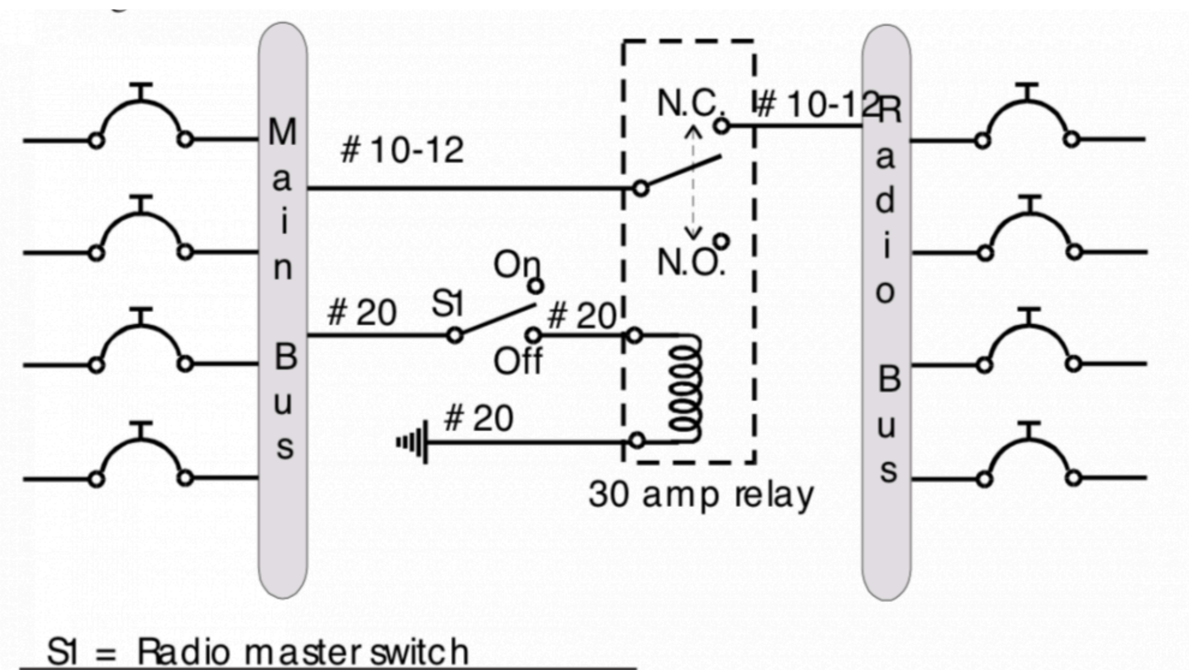


Figure 13-7. Avionics Master Switch Circuit

A #10 wire should be run from the battery ground (-) to a grounding strip behind the instrument panel. This strip should be large enough to facilitate all grounds needed in the forward half of the airplane. For all electrical grounds in the rear half of the airplane, run a #10 wire from the engine case to a grounding strip on the cabin side of the firewall. Remember, in a composite aircraft, every system that requires a power wire will also require a ground wire.

Most of the aircraft electrical systems, **excluding** the strobe light, electronic ignition(s), and the P-leads for the magneto system(s) will require #18 wire. The strobe lights and the electronic ignition system should use #18 shielded wire for primary power. A#18 shielded wire should also be used for the P-leads as well. The P-lead shield should be grounded on the body of the magneto only. For the strobe and electronic ignition wire, the shield should be grounded on one end only, the end closest to the device…not the switch.

The statements above are general rules of thumb. Follow the instructions of your specific equipment if they are different from these instructions.

Your avionics should be wired according to the manufactures installation manual(s).

13.3.3 – Trim, Speed Brake, & Speed Brake Warning

Power for the Trim and Speed Brake (if applicable) is from a single 10 amp circuit breaker. If you are installing just the trim motors, you will need a 5 amp circuit breaker. The power and ground wire for these systems are first routed to the appropriate switches, whether in the control grip or in the throttle quadrant. These wires are then run to the appropriate motor. Figure 13-8 shows the wiring for these two systems. The power and ground wire is effectively crossed on the four outside terminals of each switch and the two center terminal then go to the motor. The speed brake switch is a double pole, double throw (DPDT)(on-on) switch while the pitch and roll trim switches are DPDT (mom)-off- (mom). (mom) = momentary on

The speed brake is wired so that it is either fully extended or fully retracted. There is no need to stop it in mid travel.

The pitch trim system uses a 24 volt motor in a 12 volt circuit so that a slower trim speed can be obtained. Since this is a screw type motor, there is a small lead-lag time difference between releasing the switch and the actual stopping of the motor. The voltage difference and some experience will achieve excellent trimming capabilities from any pilot.

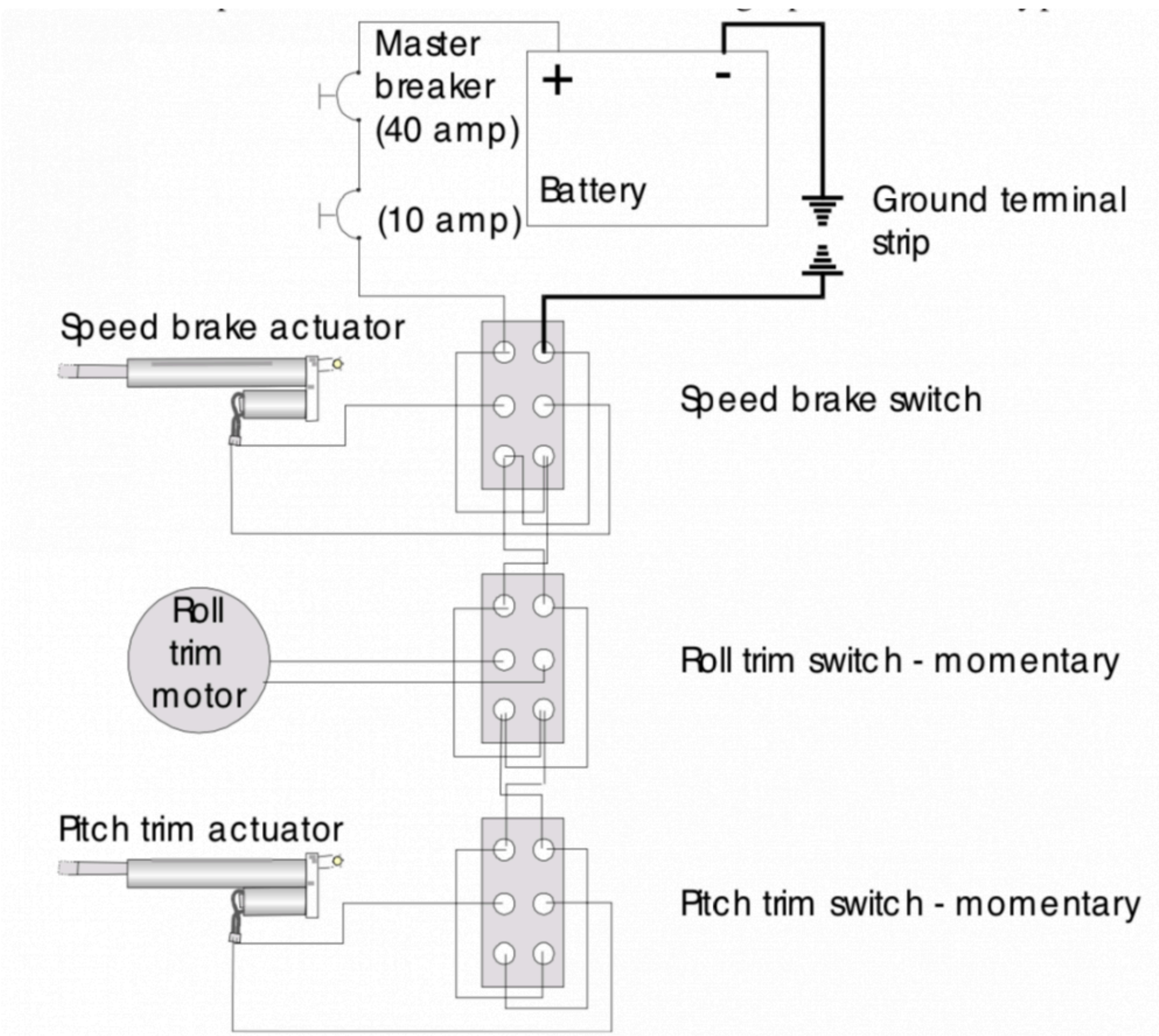


Figure 13-8. Speed Brake and Trim Switch Wiring Diagram

Parts for the speed brake warning system can be purchased at Radio Shack. All that you need is a normally closed micro switch and a small red 12 volt indicator light. This circuit consists of a piece of #22 gauge wire starting at your speed brake circuit breaker and leading to the indicator light located conspicuously on your instrument panel. The wire then runs from the other lead on the light to the micro switch. The other terminal on the micro switch is connected to a ground buss. Install the micro switch through the floor of your fuselage at the aft side of the speed brake so that the speed brake will turn the warning light “off” when the speed brake is fully retracted. When the door begins to extend, the light should illuminate giving the pilot warning that the speed brake is not fully retracted.

13.3.4 – Switches and Circuit Protection

Again, electrical parts and supplies should be **approved for general aviation use**.

At the very least, you will need the following circuit breakers and switches:

- 1 ea. Alternator Circuit Breaker – rated at just above the alternator maximum output amperage.
- 1 ea. Alternator Regulator (field) Circuit Breaker – usually 5 amps.
- 1 ea. Fuel Pump Circuit Breaker and Switch – usually 10 amps.
- 1 ea. Speed Brake and/or Trim Circuit Breaker and Switches – 10 amps.

Next, the average Velocity will have:

- 1 ea. Nav Light Circuit Breaker and Switch – 10 amp.
- 1 ea. Strobe Light Circuit Breaker and Switch – 10 amp.
- 1 ea. Instrument (Gyros) Circuit Breaker – 5 amp.
- 1 ea. Landing Light Circuit Breaker and Switch – 10 amp.
- 1 ea. Panel/ Cabin Light(s) Circuit Breaker – 5 amp.
- ? ea. Avionics Circuit Breakers – as required by the manufacturer.
- 1 ea. Normally open switch for Push to Talk – usually mounted on the top of the control grip.

Optionally, you may want or need:

- 1 ea. Avionics Master Switch (Circuit Breaker or Relay system)
- 1 ea. Auxiliary Power Receptacle Circuit Breaker (for laptop equipment) – not to exceed 5 amps.
- 1 ea. Pitot Heat Circuit Breaker and Switch – 10 amps.(There are large pitot tubes that require 20 AMP breakers that we prefer to not use)
- 1 ea. Clock and/or Hobbs Fuse or Circuit Breaker – 1 amp.
- 1 ea. Stereo Circuit Breaker – usually 5 – 10 amps.

A rule of thumb for circuit breakers is: protect the wire…not the device. Do not put a 15 amp circuit breaker with 22 ga. wire! The wire will get too hot before the circuit breaker does its job! AC 43.13 1B-2B has tables that let you know what is an acceptable breaker for a certain wire size.Always follow the manufacturers written installation instructions.

Another point to remember is that an electrical circuit is not complete without a sufficient ground. If a circuit requires a #10 wire for power it will require a #10 wire for ground. Do not use a ground wire that is smaller than the power wire.

13.3.5 – Avionics

We **strongly recommend** that you get a professional or someone with experience to wire your avionics. If you feel confident enough to wire your own radios, keep in mind most manufacturers will not warranty their radios unless it has been pre-wired by an approved agency or source. Check with the manufacturer first!

One or two radios may not be too difficult to work with. However, when you have a full panel full of radios, there is a gambit of things to take into consideration prior to wiring the ‘package’. Radio interfacing, or interconnecting, is something that is constantly evolving and may be difficult to fully understand.

Your mike and phone jacks for the pilot, copilot, and passengers may be located anywhere that is convenient for you. Generally, the pilot and copilot jacks are mounted either in the lower center, or on the far left and right side of the instrument panel. Placement of the jacks should provide for easy access and noninterference from headset cables to other aircraft systems. The passenger jacks are mounted on the keel (one set on each side), just above the floor level, just in front of the back seat brackets. Relative ease of access should be the consideration without potential damage to the plugs from your passengers feet!

A Push-To-Talk, or PTT, should be mounted in the control grip. Some avionics offer options such as remote frequency transfer (Comms and Navs typically), and remote Transponder ident. If these options are available…and desired…these switches would best be suited in the control grip also.

It is important to use the right size (amperage) circuit breaker for your radios. For you IFR flyers, try not to gang too many radios to one circuit breaker (i.e. one comm, one nav, and the marker beacon to one circuit breaker). Ideally, one radio, one circuit breaker. It is most frustrating to lose a nav (and/or a comm) radio just because the marker beacon shorted out for some reason! Just something to think about!

Most important of all, though, is use the right size circuit breaker as recommended by the manufacturer. Too small a breaker (i.e. using a 2 amp breaker instead of a 3 amp) or too large a breaker (i.e. using a 3 amp instead of a 2 amp) may result in costly misfortune.

13.3.6 – P-Leads

These leads must be shielded (usually #18 ga. shielded wiring). The shield at the mag end should be grounded directly to the mag case at the mag case ground screw. The center conductor should go to the mag **P-lead** terminal. The shield(s) at the switch end should be connected to the switch(es) so that when the mag switch is **OFF**, the center conductor and the shield are “shorted”, or connected together. If you wish to run a grounding wire from the shields to an ‘airframe ground’, as a safety feature, use an un-shielded #18 ga. wire for that purpose.

If you are using an electronic ignition in place of one (or both) mag(s), your ignition switch will be switching battery positive (+) to the ignition system. If you want to use a emergency backup battery on your electronic ignition, consider using a Single Pole, Double Throw (SPDT) (on – off – on) switch. One **ON** position (terminal) goes to the aircraft electrical system, the other **ON** position (terminal) goes to the emergency backup battery. The center position (terminal) goes to the electronic ignition system. Be sure to label the switch accordingly so that you don't accidentally run your emergency battery down during normal flight!

This should complete all the electrical wiring that is to be done in the nose of the aircraft.

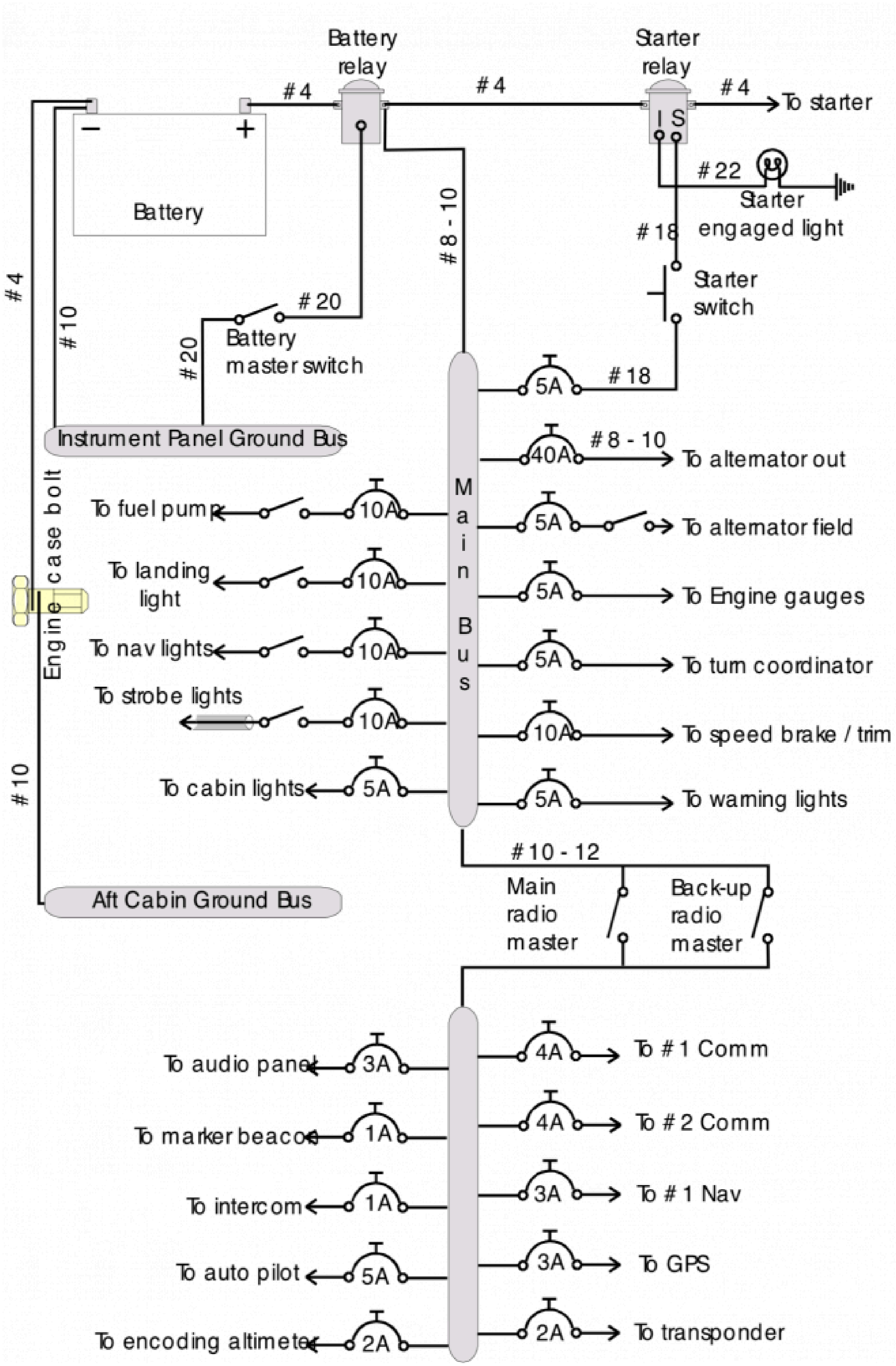


Figure 13-9. Basic Wiring Diagram

14.5. 13.4 – Pitot – Static and Vacuum Instruments

13.4 – Pitot – Static and Vacuum Instruments

13.4.1 – Vacuum System

Most Lycomings come with vacuum pumps. In the Velocity, you will probably have only two vacuum-operated instruments, directional gyro and artificial horizon. We use the same 3003 aluminum tubing run down the pilot duct as you did for the oil cooler. At the back end we use a length of automotive 1/2" rubber line to connect the tubing to the vacuum pump. In front of the canard bulkhead we use reinforced clear PVC tubing to connect the aluminum tubing to the vacuum regulator..

This P.V.C. tubing can be purchased at Ace Hardware stores along with all the other supplies for your Pitot Static plumbing.

The regulator can be mounted through the canard bulkhead. Make sure you pick a spot that does not interfere with brake or gear operations.

From the regulator to the instruments, we run a 3/8" ID polyethylene tube utilizing 1/4 or 1/ 8 male thread by 3/8 hose fittings, straight, "L's", or "T's", as needed.

After the instruments a fiter is needed. Use a proper aircraft vacuum filter. Homemade filter will deterierate over time and can flake pieces of garbage into your instruments.

13.4.2 – Static Port

The static port (see Figure 13-10) is made with a piece of 3/8" soft aluminum tubing about 5" long embedded vertically in the pilot side of the fuselage.

___ Bend a 3/4" offset in the center of the tube described below. Bend over the base of the tubing and pinch it shut.

___ Remove the inner skin and foam in a section approximately 1/2" wide by 4" high, centered 9" aft of the canard bulkhead and 9" below the elevator. Install the tube vertically, and flush with the outer skin.

___ Following cure, drill (3) 1/16" holes from the inside out through the tube and outer skin. The holes should be about 1/2" apart vertically. Fill the holes on the inside with micro and cover with one ply of **BID**.

___ Connect the tube to your rate of climb, altimeter, and airspeed with poly tubing and P.V.C. fittings.

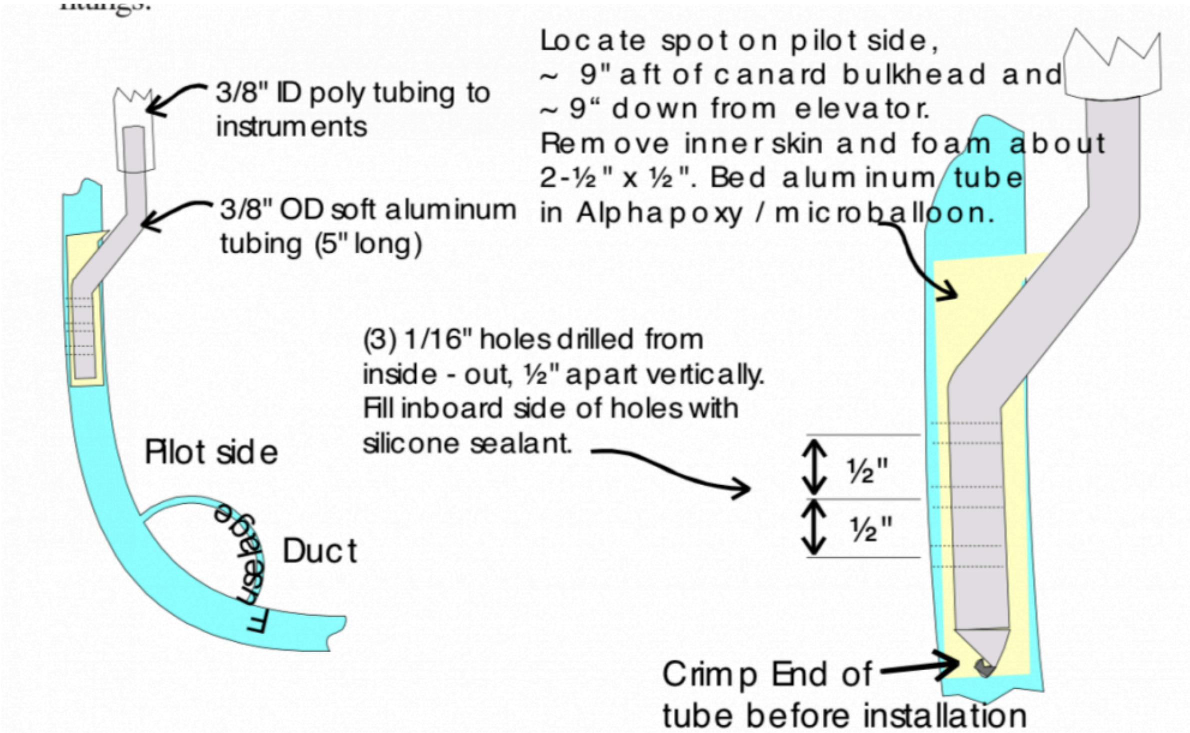


Figure 13-10. Static Port Detail

13.4.3 – Pitot Tube

There are many variations of pitot tubes and systems. If you are considering serious IFR work, you might want a heated pitot tube. Whatever you install, and however you install it, remember that it requires undisturbed air and that it will not be affected by angle of attack. So, if you are going to make any special installations, plan ahead.

Since most of our builders prefer to install a heated pitot tube Velocity has come up with a heated pitot installation kit. We mount the pitot tube under the canard on the pilot side. This keeps it out of the way of people walking around the airplane. Refer ti Figure 13-13. Make sure the pitot tube is located far enough aft of the rudder pedals to not interfere with them.

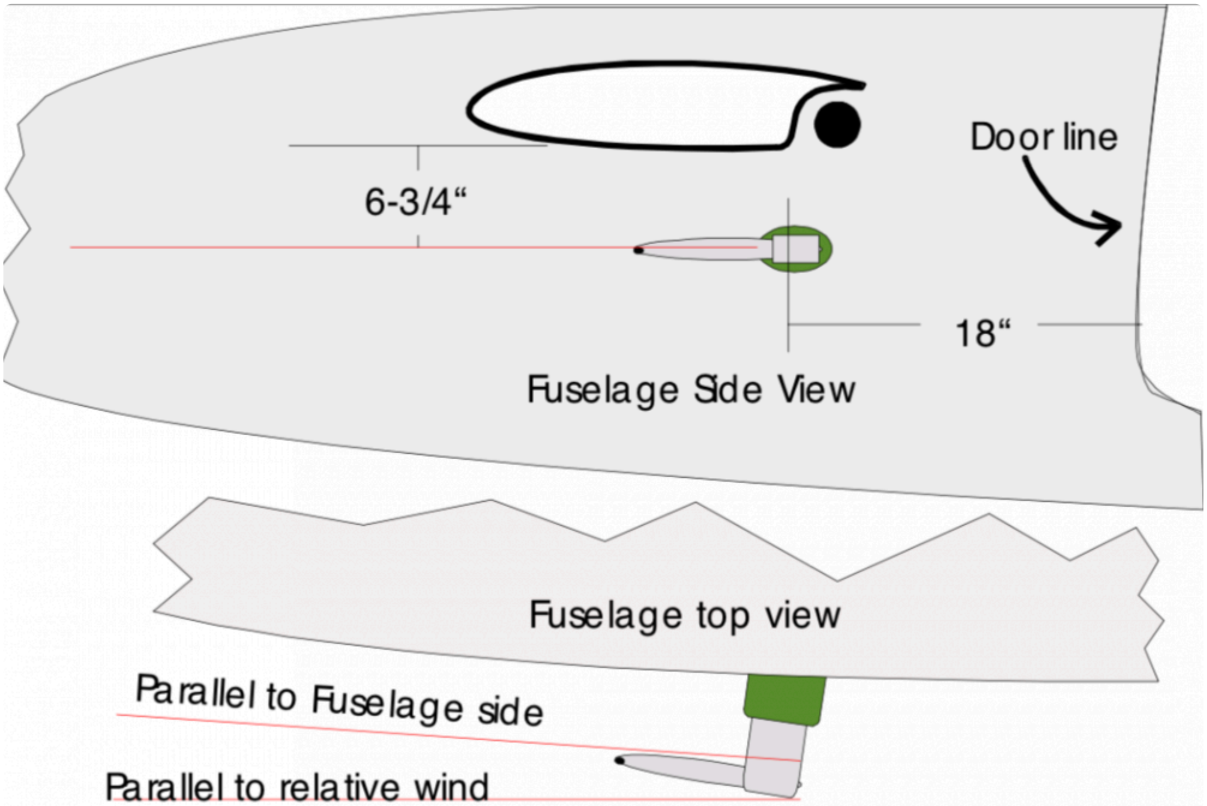


Figure 13-11. Pitot Tube Installation

Install the pitot tube into the stremline tubing. Transfer the centerlines of the screw holes to attach the pitot to the streamline tubing. Drill the mounting holes at least 1/8” from the edge of the tubing. Cut out a hole large enough to insert the stremlined tubing intothe fuselage snuggly. You want this tubing in line with the airflow. Insert the tubing into the hole you cut and place the pitot tube inside it. You will want to position the pitot tube so that it is in between being parallel to the fuselage side and in line with the airflow. The streamline tubing will also need to extend at least 1/4” inside the fuselage.Draw a line around the streamlined tubing where it meets the fuselage. Sand the exterior of the streamlined tubing where it will be bonded to the fuselage.Remove the pitot tube and bond the stremlined tubing to the fuselage using **EZ-Poxy and Flox**. Make a fillet between the streamlined tubing and the inside skin and cove with one ply **BID**.

15. 14 – Final Assembly and Finishing

Contents

(Shared with SF, SR, XF, XR)

15.1. 14.0 – Chapter Preface

14.0 – Chapter Preface

14.0.1 – Parts List

Part Number	Description	Qty
MA2001	Tie Down Alum Bracket	2
AN3-5A	Bolt, AN3-5A	4
AN960-10	Washer, AN960-10	4
MS21042-3	Locknut, MS21042-3	4

14.0.2 – Tools List

This chapter requires no tools.

14.0.3 – Supplies List

This chapter requires no supplies.

14.0.4 – Glass List

This chapter requires no glass.

14.0.5 – Process Overview

Construction Process	Completion Date
Install Components	
Install Canard	
Install Elevators	
Install Aircraft Tie Downs	
Install Wings to Aircraft	
Make Bolt Hole Covers	
Attach Wing Bolt Hole Covers	
Attach Rudders	
Attach Ailerons	
Control Systems	
Rig Rudders	

Rig Brakes	
Check Main Gear	
Check Nose Gear	
–	
Check Systems	
Check Fuel System	
Check Engine / Prop Attachments	
Install Enginge Plenum	
Check Oil Cooling System	
Check Pitot / Static System	
Check Electrical System	
Check Engine Gagues	
Check P-leads	
Install Crankcase Breather	
Check Alternator	
Check Vaccum Pump	
Perform Weight & Balance	

14.0.6 – Documentation Changes

Oct 01, 2018 – Original Web Release

15.2. 14.1- Final Assembly Procedures

14.1- Final Assembly Procedures

Note: It is advisable to perform the work in this section prior to application of final paint coat. We recommend that you flight test the aircraft in primer coat.

Many items in this chapter are covered in the construction manual. They are repeated here to serve as a reminder.

14.1.1 – Canard / Elevators

There are six bolts used to attach the canard to the fuselage of the ***Velocity***, (4) AN4-7A and (2) AN6-16A. The AN6-16A bolts take the majority of the load back into the canard bulkhead while the AN4-7A bolts take on the torsional loading. See Figure 20-1. In all instances, there must be proper bolt installation.

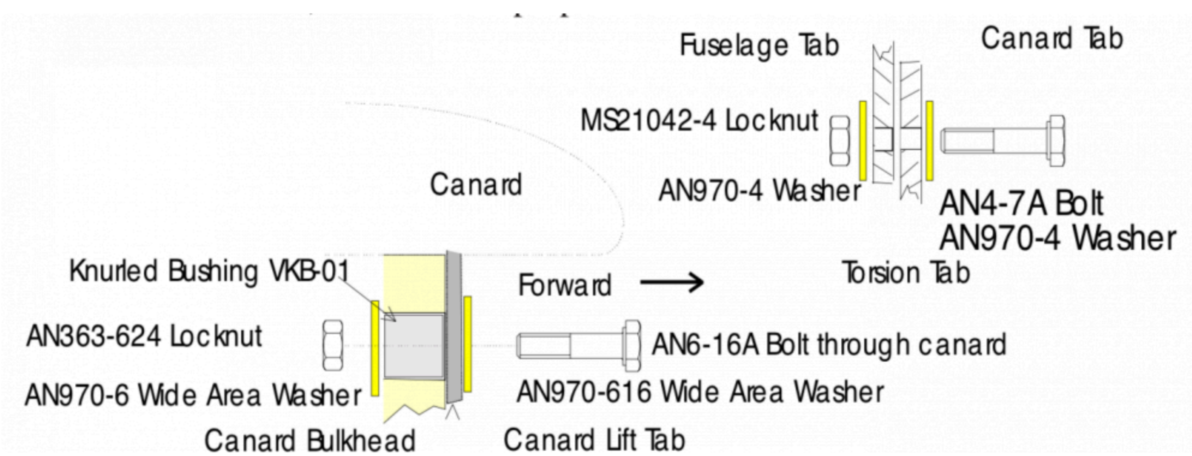


Figure 14-1. Canard Attachment

You will note that in the assembly of the elevator – canard hinges, (Figure 14-2) there are 2 washers, one on each side of the elevator mounted hinge. The hinge arm, mounted to the canard, connects to the hinge on the side where the bushing protrudes from the hinge. When installing the assembly, tighten the hinge screw until it is snug, then back it off one-half turn. Lock it in place with the appropriate locknut. It helps to lubricate the screw with some white grease. Once assembled, check the system for binding and full travel.

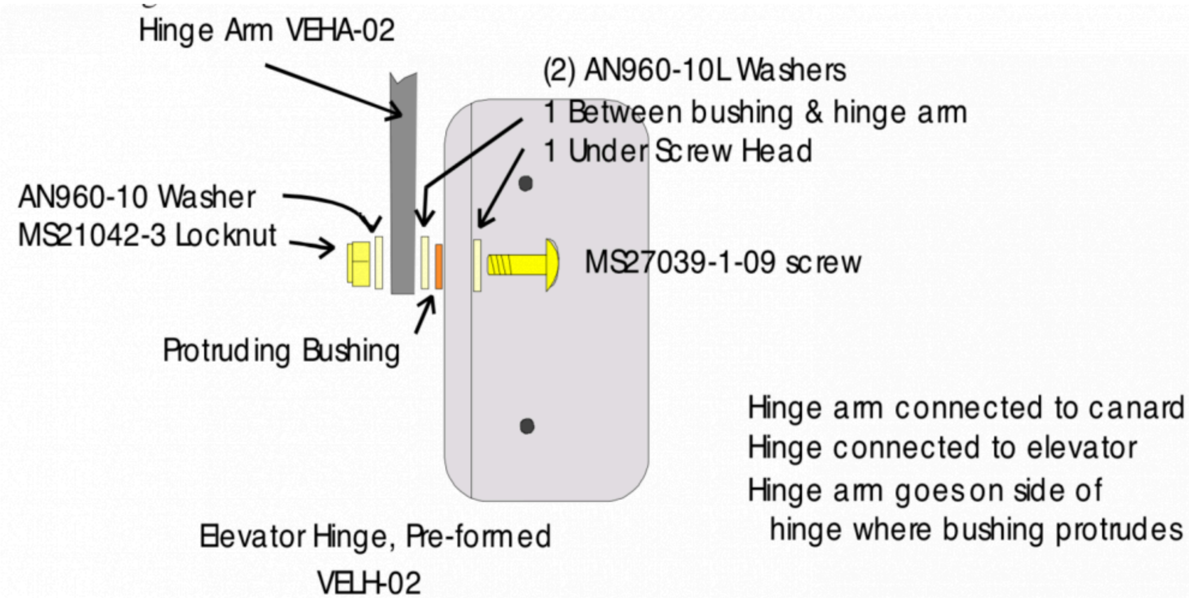


Figure 14-2. Elevator / Canard Hinge Assembly

Moving on to the elevator linkage, it is a good plan to install all bolts in vertical position with the head up and two threads showing once the lock nuts are installed. The linkage should be installed such that the stick is slightly forward of vertical when the elevators are in the neutral position. Be sure that when the stick is pulled to full aft, the holes in the top and the front of the console are large enough to allow full aileron deflection. Once full deflection is reached your stick should bottom out on the side of the cutout. If it does not then you can put stress on the system that it wasn't designed for. If your control stick cutout is too large you can glass the cutout back in or use thin aluminum to attach to the keel with screws to close up the hole.

Once the assembly is complete, operate the stick to the maximum in all directions. While doing this, check for binding or interference of the torque tube, stick, and counterweights with the rudder bar.

|___| Maintain at least 1/8" clearance everywhere.

|___| Be sure that you are getting full 26 degree down elevator and, at least, 21 degrees up elevator.

|___| Keep in mind when you are installing the pitch trim system that you are going to need more down elevator than up elevator. Adjust accordingly.

|___| Check your canard incidence.

|___| Now, it is a good idea to have a friend read this section and recheck everything once more

14.1.2 – Aircraft Tie Downs

A small aluminum tab is installed at each end of the center section spar as shown in Figure 14-3. Each tab is installed with two each AN3-5A bolts, AN960-10 washers and MS21042-3 locknuts.

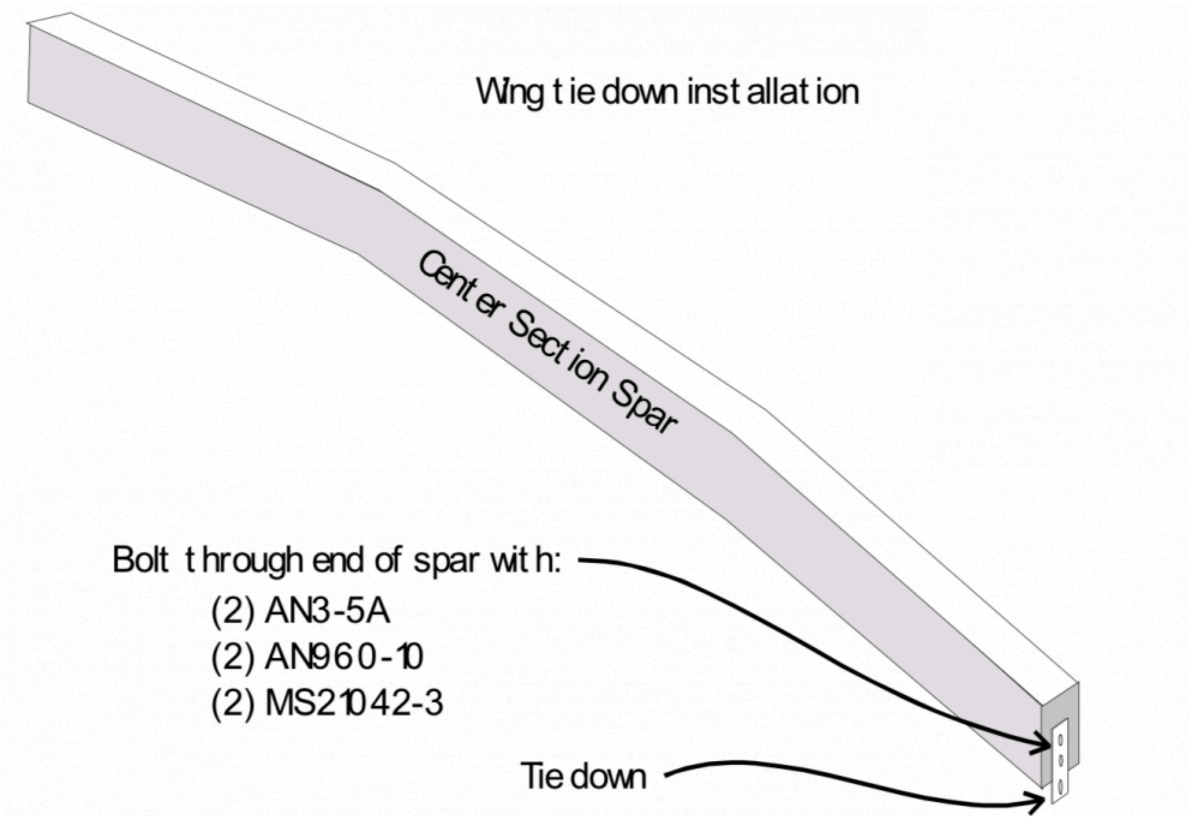


Figure 14-3. Tie Down Installation

14.1.3 – Wings to Aircraft

When installing the wings to the airframe, the first thing to do is to make sure that you have the proper hardware on hand. You will need (6) AN8-30A bolts, (12) 1/2” Grade 8 Wing Washers and (6) AN363-820 locknuts. It may be necessary to utilize extra washers as well, depending on the bolts that you are using. Utilize AN960-816L washers as shims to achieve proper wing incidence.

|___| Check the mating bushings for flatness and conformity.

|___| Check the other end of the bolt holes for flatness, glass buildup, excess epoxy, etc.

Once you are sure that everything is clean, flat, and parallel, install the wings with the appropriate hardware, adding shims if necessary to achieve proper incidence. With the fuselage level use your wing incidence jig to check it. Torque the wing attach bolts to 35-40 foot-pounds. You will need (2) 3/8” drive ratchets, a 3/4” deep socket, 3/4” standard socket, and a 3/8” universal joint with a 3/8” extension.

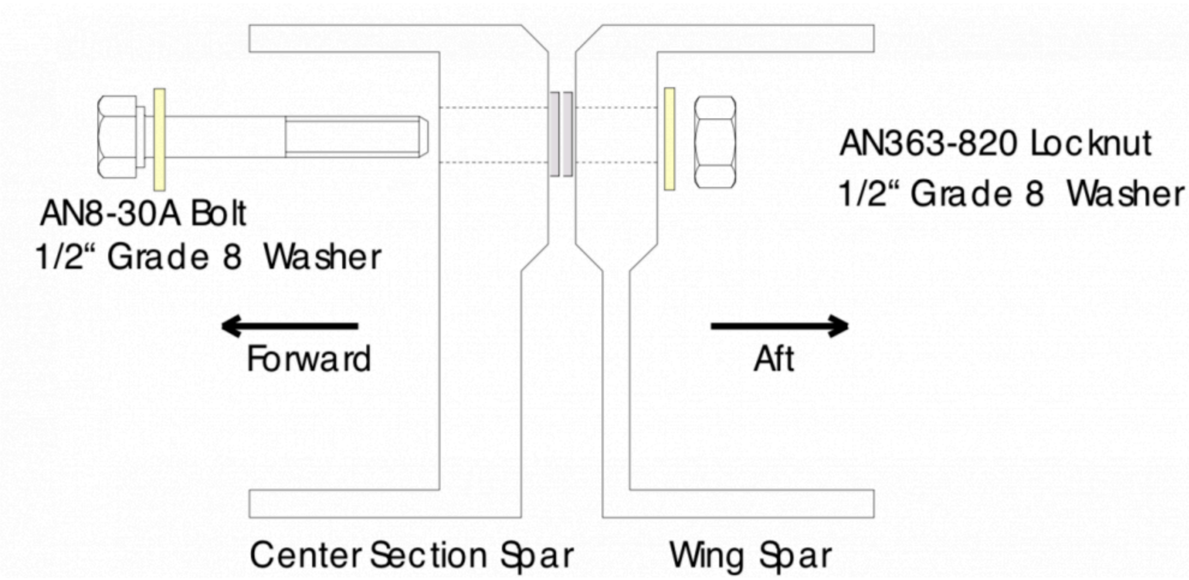


Figure 14-4. Wing Attachment

The mating bushings must fit together evenly, and the surface under the bolt head and nut must be clean and flat. Otherwise, you will get a false torque rating on the bolts. Once the bolts are torqued, lift the aircraft by the winglets and shake the aircraft to ensure that there is no play in the wing-to-spar attachment points. When the aircraft is painted, the gap between the wing and the fuselage can be filled with silicone sealant. A small bead of silicone along the top joint lines will keep water from leaking in between the two spars. The bolt holes can be covered with 0.016 aluminum cover plates secured with silicone sealant.

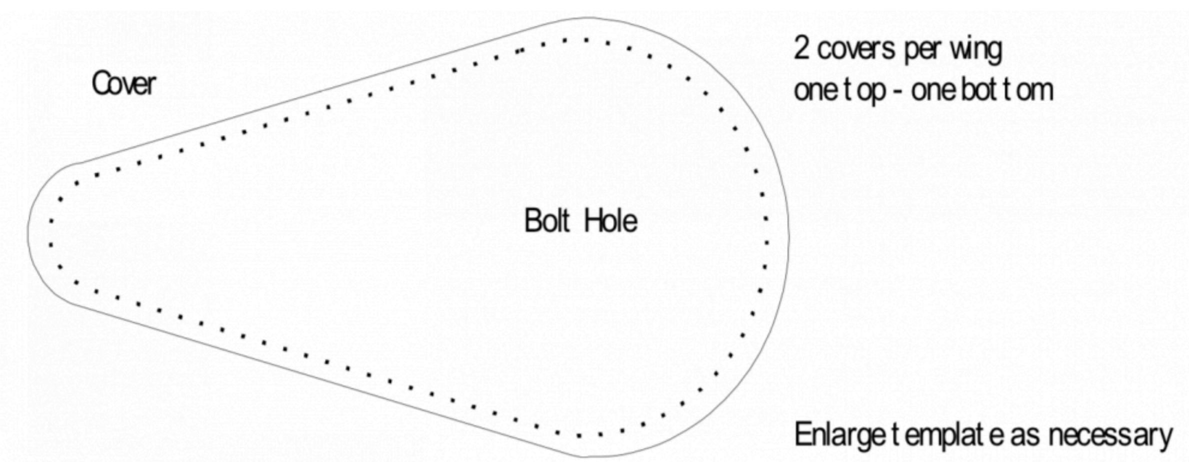


Figure 14-5. Wing Attach Bolt Hole Covers

NOT TO SCALE

Template 14-5. Ring Attach Bolt Hole Cover Template
TO SCALE WHEN PRINTED ON LEGAL SIZED PAPER

|___| With the fuselage level, check the wing incidence with you wing incidence jig.

|___| Check the incidence of one wing against the other. You want both wings to be at the same angle of incidence. Adjust with shims.

|___| Check the incidence with the fixture leading edge just outboard of the strake, and trailing edge just inboard of the aileron.

|___| Torque on bolts should be 35-40 foot pounds.

|___| Go back and check the canard incidence and make sure both wings have there incidence jigs centered with the fuselage level.

Once the wings are installed properly, it is time to install the ailerons and rudders. Each rudder is installed with:

- (6) AN526C-1032R8 screws
- (6) MS21047-3 nutplates

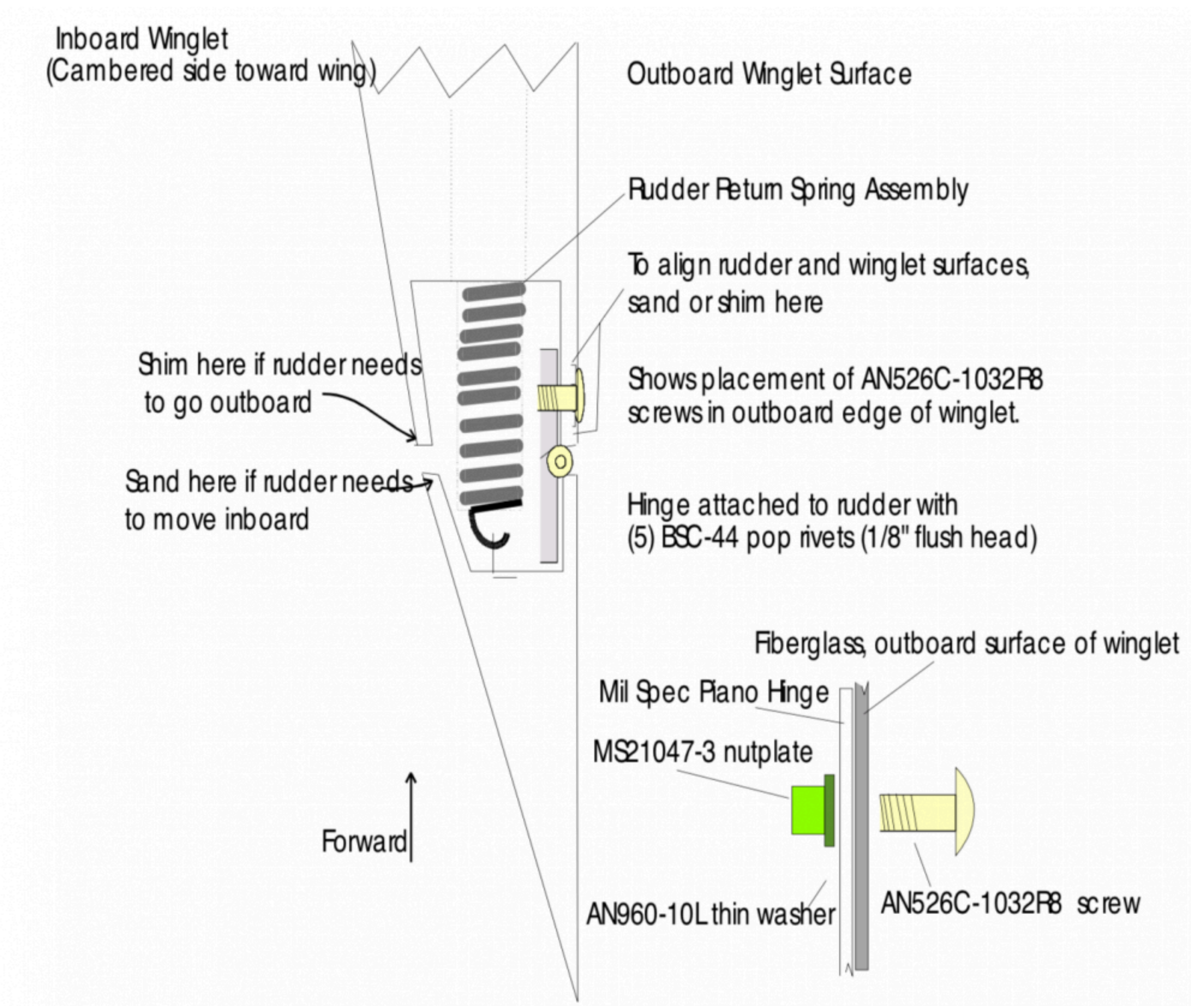


Figure 14-6. Rudder Attachment

|___| Check the rudder for clearance and binding when rudder is deflected to the point that the bellcrank touches the winglet.

|___| With the rudder fully deflected, check the tension on the return spring. The spring should have enough

tension to return the rudder firmly to the trailing position.

If the spring fails to return the rudder to its original position, find the cause of the interference, and remove material as necessary. If the rudder goes too far, construct a small rubber or wood shim to hold the rudder in perfect trail. Install the shim with 5 minute epoxy. In the case that the rudder surfaces don't align with the winglet surface, a little shimming or sanding can be done behind the hinge. Take due care not to add or sand too much.

14.1.4 – Ailerons

The first thing to check for when installing the ailerons is adequate clearance. There should be at least 1/16" space everywhere, especially in front of the counterweights. The aileron hinges are bolted to the wings in the same manner as the rudders are attached to the winglets.

When the ailerons are in place, check for adequate deflection, which is approximately 2-1/2" both up and down at the inboard trailing edge.

|___| In order to ensure that no binding occurs during flight, lift wing by the lower winglet until the main tire is off the ground. Check the aileron operation. This simulates approximately 2-1/2 Gs of loading. Make sure you do this one wing at a time. In the case that full down deflection is not achieved, check the clearance between the bolts that hold the outboard hinge to see if they are interfering with the hinge or the counter-weight. See diagram for advice on dealing with this situation.

Note: If you find that screw and nut are interfering with the aileron travel, do not attempt to remedy the situation by shortening the screw. Always leave two threads showing past the nut. Cut a pocket in the hinge and aileron for the screw and nut to fit down into instead.

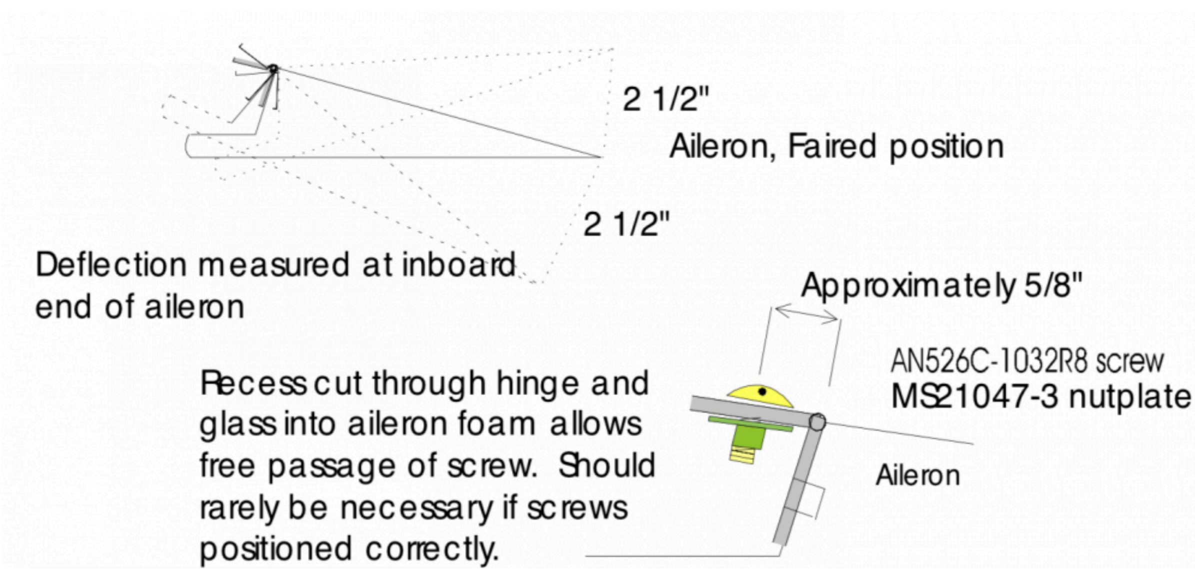


Figure 14-7. Aileron Attachment

Sometimes binding will occur between the torque tube and the wing foam. Remedy this by removing excess foam with sandpaper attached to a broomstick.

|___| Check your ailerons for proper balance, especially after you have painted them. If more weight is needed, add some stick-on weights just above the inboard end section of the counterweight. Cover the new weights with 1 ply of BID.

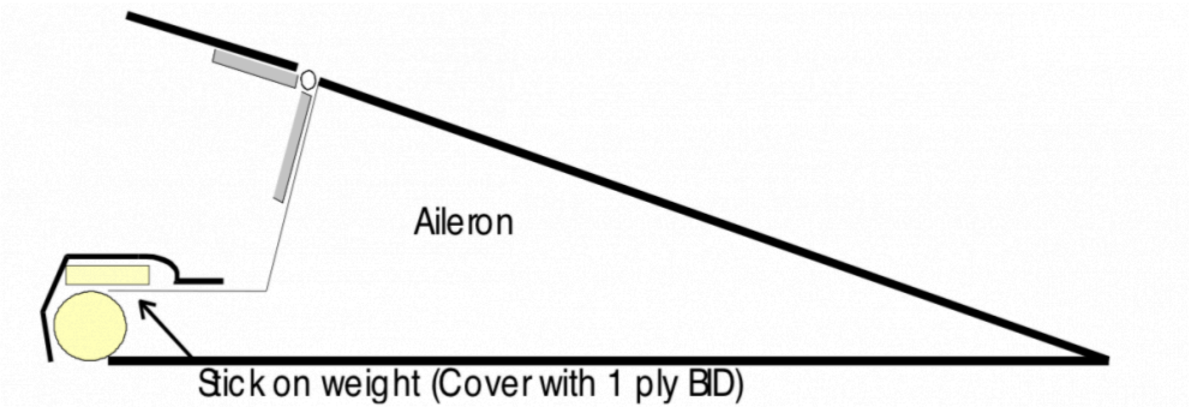


Figure 14-8. Aileron Balance Adjustment

|___| Check all your aileron torque tube hardware. Make sure that all of the bolt holes that were drilled were tight and there is very little slop in the aileron system.

Note: Do not over tighten the bolts as to cause distortion in the torque tube (cause it to become egg shaped).

14.1.5 – Control System

We covered some of the control system components earlier in this chapter, but we feel that it is important not to overlook anything in this area.

Elevator Push Tube Checklist

|___| All attachment bolts must be installed vertically and tightened securely with at least two threads showing past the nut.

|___| The rod ends on each end of the tube must have at least 1/2” threaded into the bushing, and the jam nut must be installed and locked.

|___| Make sure that you stick cutout is large enough to allow full travel of the control surfaces without bottoming out.

|___| Your control stick cutout should also be small enough to act as a stop for your control stick so you do not put excessive pressure on the control system.

|___| Elevator counterweight clears the rudder bar, and the control components clear all wiring and plumbing.

|___| Stick stands approximately 5 – 10 degrees forward of vertical when the elevators are in the neutral

position.

|___| The pitch trim is set up so that most of the spring tension is for the down elevator (clear of all wires and plumbing). We install the operation switches to work in the same direction as the elevator; switch up, elevator up (nose down) – switch down, elevator down (nose up).?

Roll System Checklist

|___| Stick is in vertical position when the ailerons are fared in. Roll trim chord in center of travel springs is equal.

|___| Make sure you can achieve full aileron deflection at both full forward and full aft stick.

|___| The rod ends on the push-pull cables have at least .375" threaded into the bushing, and the jam nut must be installed and locked.

|___| Aileron bellcranks do not interfere with the engine, baffling, wiring, or engine cowl.

|___| Bellcranks have a 90 degree approach angle to push-pull cables when ailerons are neutral.

|___| All AN bolts are installed vertically with proper locknuts and at least 2 threads showing unless instructed otherwise.

|___| No sharp bends in the push-pull cable, especially at the ends where the plastic sheath terminates. Slide back the rubber cups and lubricate the ends of the cables with white grease.

|___| No binding or stiffness in the system. Cables are away from the exhaust pipes and have proper heat shield installed on them.

|___| Check roll trim for proper operation.

|___| Switch should be installed so that the aircraft rolls in the direction of the deflection of the switch. (Switch left, stick left, left aileron up).

Speed Brake

|___| Check operation for sticking or binding. The maximum extension angle should be 60 degrees. Wire the system so that when the switch is up, the brake is up. When the switch is down, the brake is down (deployed). Make sure that the speed brake closes completely.

Note: Never deploy the speed brake when air speed is greater than 110 knots.

14.1.6 – Rudder Pedals, Cables,

Before any adjustments can be made to the system, all slack in the rudder cables must be eliminated. When rigging the rudders, you will find it necessary to balance the brakes and rudders by adjusting the aluminum block on the master cylinder push rod. Any adjustment to the rudder cables is done in the engine compartment with the shroud adjusters.

Rudder adjustment references are taken from where the rudder meets the wing trailing edge. You are looking to achieve 2-1/2” of rudder travel before brakes are engaged and 3-1/2” to 4” full deflection. You want to make sure that the rudder moves as soon as the pedal is depressed.

The brake master cylinder should stop the pedal before it reaches the canard bulkhead. If you breaks do not feel solid you may have air in the brake lines.

14.1.7 – Vortilon Installation

Vortilons are added to the leading edge of each wing to help maintain laminar flow at low speeds. They should be installed prior to flight. They will noticeably improve low-speed handling of the aircraft.

___ There are two triangular shaped premoded vortilon pieces in your kit. They are marked “L” and “R”. The “L” is the pilots side and the “R” is the copilots. Cut out the vortilons along the lines on the premolded parts. You will notice that the three vortilons you cut out of each piece are not the same size. The inboard vortilon is the larger of the three and the outboard the smallest. Placement for the vortilons is shown in Figure14-9 and 14-10.

___ Vortilons are attached to the wing leading edge using silicone adhesive.

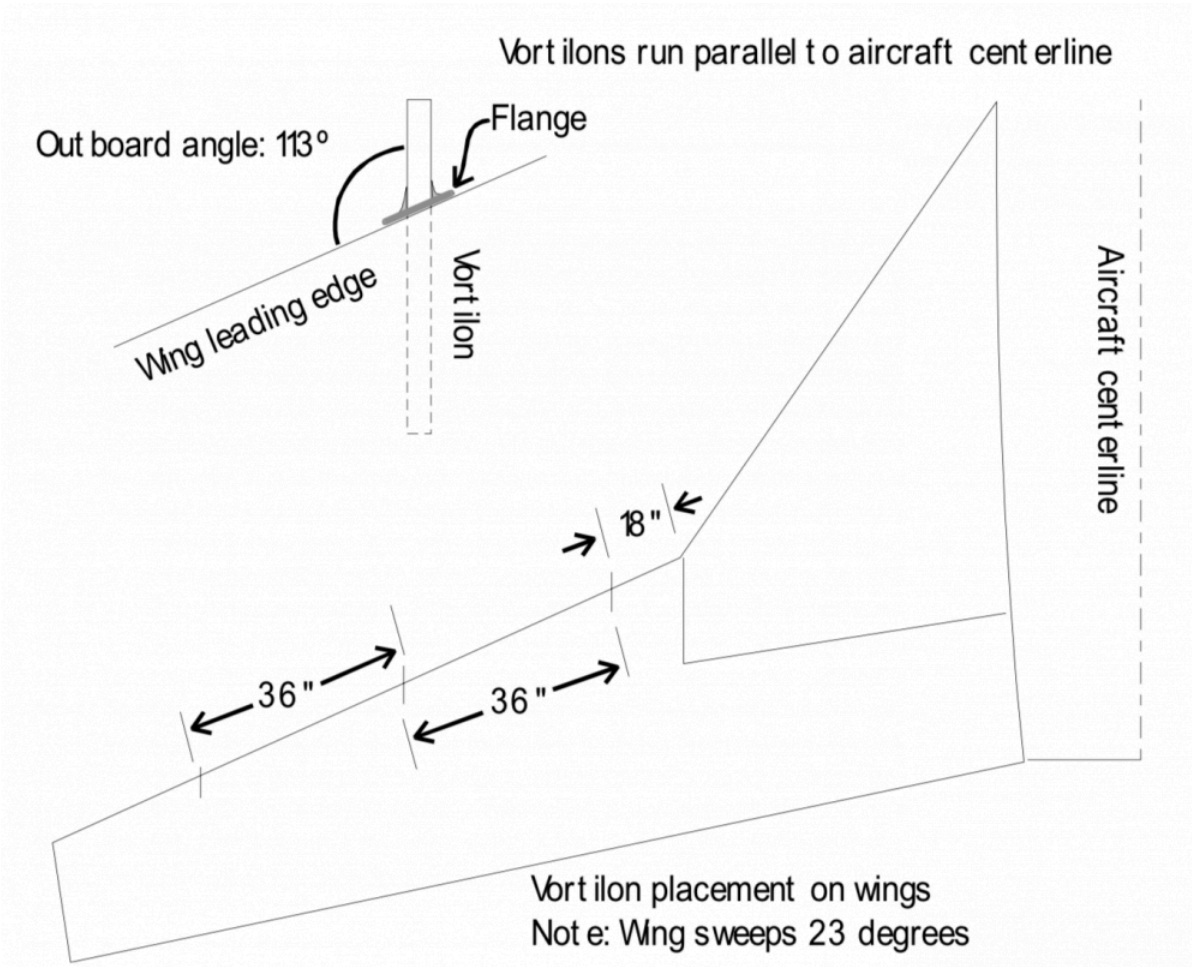


Figure 14-9. Vortilon Locations

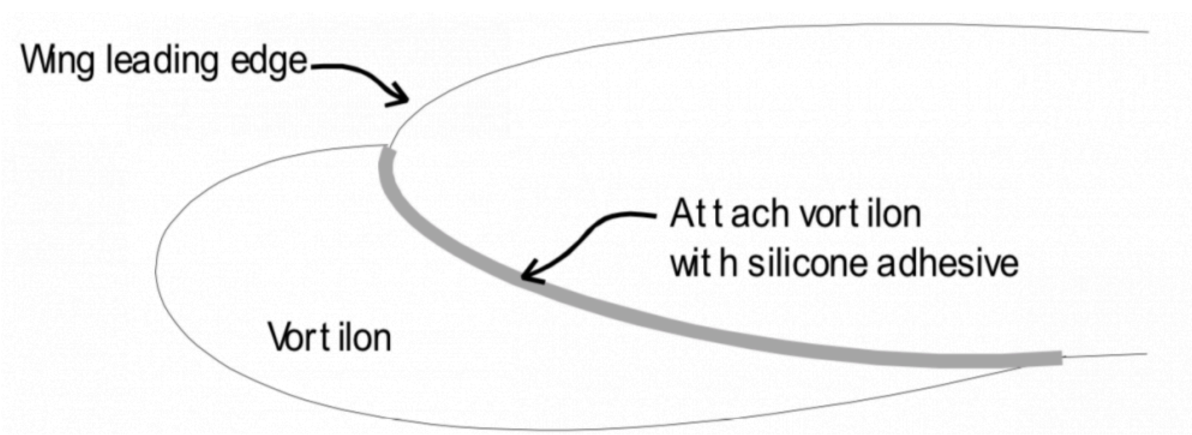


Figure 14-10. Vortilon Attachment

14.1.8 – Brake Bleeding

You need to fill the brake system a certain way with **DOT 5** brake fluid in order to make sure you do not get any air trapped in the brake lines. Air in the brake lines will cause inadequate braking and a brake pedal that feels “Mushy.”

Our preferred method of bleeding the brakes at Velocity is to back bleed the brakes. To do this you need oil squirt can, and a small piece of flexible tubing tight enough to just fit over the bleeder valve on the brakes.

___ Attach the flexible tubing to the oil squirt can and use a hose clamp to hold it on. Fill the can full of DOT 5 and pump the handle on the squirt can until the flexible tubing is full of fluid.?

___ Crack open the bleeder valve on the brake using a 1/4” wrench.

___ Attach the flexible line to the bleeder valve and start pumping.

___ Have a partner watch the brake master cylinder up in the nose and to tell you when you have filled it up.

___ If you are still getting bubbles at the master cylinder when the cup is filled remove some of the fluid from the cup and keep pumping.

___ Keep an eye on the fluid in you squirter can. You do not want to pump air into the system.

___ Once the cup is filled use the 1/4” wrench to shut off the bleeder valve before removing the flexible tube.

Even after doing this your brakes may still have some air trapped in them. After you do your initial taxi tests and flights you may want to repeat these steps.

|___| There is another method that is not as effective. One person sitting in the pilots seat pumps the master cylinder, while the other opens and closes the bleeder fitting on the wheel cylinder. Maintain a reasonable fluid level in the master cylinder during the bleeding process.

14.1.9 – Landing Gear, Wheels, Brakes, Fairings

The hole in the floor that allows passage through for the strut should have a 3/16” – 1/ 4” clearance for movement. This gap can be filled with silicon sealant after final paint coat. The nose gear strut should be vertical from side to side, and swept approximately 45 degrees forward. The king pin should be vertical from right to left and about 2 degrees bottom forward. The design change is a further preventative measure against shimmy.

Nose Wheel

|___| Check for side play. Tighten axis and secure with set screw.

|___| Adjust 1” nut on king pin to provide adequate tension on the shimmy dampener. It should take 10 – 12 pounds of pressure on the trailing side of the tire to move it laterally.

|___| Balance the nose wheel by turning it at high speed with a grinder or sander. Locate the heavy side by allowing the wheel to settle, then add the appropriate stick on weight to the inside of the rim. Caution: An out of balance nose wheel can induce shimmy.

|___| Maintain 45 psi tire pressure.

|___| Clearance between wheel pant and tire, 1” front and rear, 1/2” on both sides.

|___| Perform all initial taxi and flight testing without wheel pants installed.

|___| Maintain at least 1/4” clearance between the strut cover and the fuselage bottom, and 1/2” clearance between the strut cover and wheel pant.

Main Wheels, Tires, Brakes, and Fairings

|___| Check installation and securing of gear attach bolts to fuselage, and axle attach bolts to main gear.

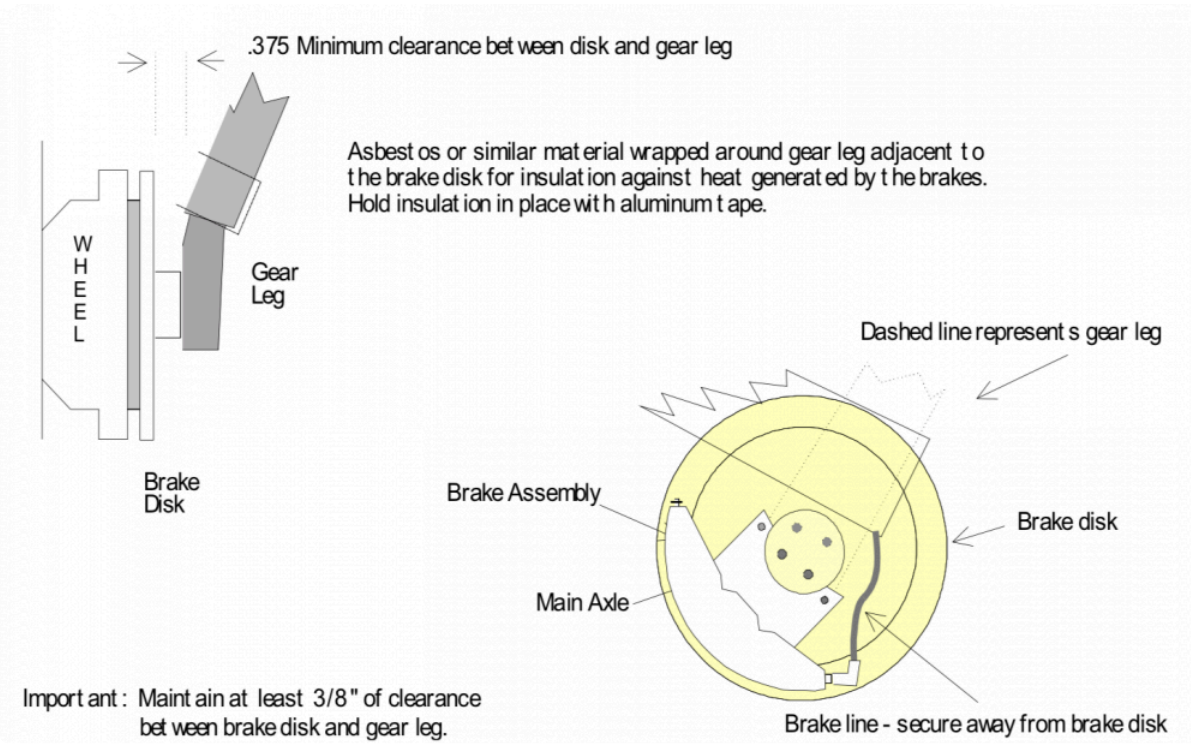


Figure 14-11. Wheel / Brake Installation

|___| Check brake operation, look for fluid leaks, check fluid level – use DOT 5 brake fluid .

|___| Inflate main tires to 55 psi. Under inflated tires are detrimental to ground handling and takeoff roll.

|___| Toe-in should 1” per side. Refer to Wheels and Axle section for diagram.

|___| Check the axle bearings, and pack with appropriate grease. Snug up the axle nuts, and secure them with cotter pins. Don’t forget the wheel pant stand off.

|___| Check the wheel pant clearance. It should be at least 1” between the tire and pant, fore and aft, and 1/2” on the sides. Be sure that the wheel pants are secured properly. A loose wheel pant is capable of causing an accident.

14.1.10 – Fuel System

Fuel Tanks

|___| Purchase approximately 10 gallons of gas, open the sump drain, and add the fuel to one of the main tanks. Slosh the fuel by rocking the aircraft. Strain the fuel as it drains out of the sump, and add the gas to the other main tank.

|___| Check the flow from the main tanks to the sump. Collect the fuel once more, strain it, and use it in your lawn mower.

|___| Check the operation of your fuel caps. They should operate freely, and a little DC 4 or vaseline applied to the O-ring will help them do so.

|___| Be sure that the vent system is clear.

|___| Calibrate your fuel sights by adding fuel in 5 gallon increments, and appropriately marking the sight gauge tubing with paint or bands of tape. Be sure that the line from the main tank to the sump tank is closed off before you calibrate the system, or you'll be going nowhere fast. When you finish, don't forget to remove the restricting device.

|___| Check all clamps, fittings, and hoses in the fuel system.

|___| Route all fuel and control lines away from heat sources such as exhaust manifolds. Make sure that all flammable fluid lines that are on the engine side of the firewall are protected with firesleeve.

|___| Fuel flow. Disconnect your fuel line from the mechanical fuel pump, then switch on the boost pump. You are supposed to get at least 150% flow of what the engine requires. So if your engine burns 20 GPH you should get at least 30 GPH. Another check to make is as follows: Switch off the boost pump and hold the fuel line below the aircraft. If the system is plumbed correctly, you will still have flow. If you don't have flow, check your fuel filter and the fuel pump bypass valve.?

|___| The Bendix injection units have a final filter in them. Check the engine manual for proper service procedure and cleaning, then check after approximately 2 hours of engine operation.

|___| An aviation fuel leak will create a blue stain. Use only aviation fuel 100LL. Using fuels other than that specified may be harmful to your fuel systems or engine. It is not worth risking your life and property just to save a few cents per gallon.

14.1.11 – Powerplant / Propeller

For information regarding the powerplant that you have installed in your Velocity, refer to the engine manufacturer's manual.

It is now time to check the positioning of your engine and propeller. Level the aircraft fore and aft, and check the incidence of both wings and the canard with the leveling jigs provided. Now, check the engine mount bolts, both at the firewall and at the Dynafocal end of the engine mount.

|___| Check torque on your prop bolts according to the prop manufacturer's installation instructions.

|___| To check prop runout, rest a straight edge on the top edge of your wing and rotate the prop so that the prop tip is next to the end of your straight edge. Rotate the prop 180 degrees and measure the distance from that prop tip to the end of the straight edge. The difference of the two measurements must be less than 1/8". If the difference is greater than 1/8", check the bolt torque, propeller uniformity, or the flange on the engine

Note: It is extremely important to keep a constant eye on the prop bolt torque for the first 50 hours of operation on a wooden prop. In the case that the aircraft is flown with improperly torqued bolts, you will lose your propeller. Watch that torque.

|___| If applicable check the torque on the bolts connecting the prop extension to the engine flange. Safety wire these bolts prior to operation

|___| Check the spinner for smooth operation. Be sure it is secure, and that there are no existing cracks.

|___| Check the bolts on the exhaust system, and check all engine bolts for proper torque. Check to make sure you have your safety cables on your exhaust system.

|___| Be sure that there is no binding when the throttle and mixture controls are operated. Lubricate the assembly as necessary.

|___| Check for adequate throttle and mixture travel to ensure full throttle, rich mixture, fuel shutoff, and proper idle. Make sure that the operation is in the direction you expect, you don't want any surprises.

|___| Make sure that your throttle mixture and prop controls have an 1/8" "cushion" at the panel.

|___| Check the P-leads (cold mags when the ignition switch is in the off position). Ignition wires should be properly secured, up and away from the exhaust pipes, aileron controls, and rudder cables. Check for proper shielding and grounding. Check the ignition switch to ensure that it is compatible and wired correctly for your engine magneto installation. An improperly wired ignition switch can make a Lycoming even harder to start. Improper wiring can also lead to destruction of your starter and flywheel.

|___| Timing on the engine should match manufacturer's specifications. Check engine oil level.

|___| Examine your plenum installation carefully. Make sure that you do not have any gaps where air can leak out the side of the plenum instead of cooling the engine. You can use silicon to seal around the plenum so there is no leaks on the sides of the plenum.

|___| Let the engine run for approximately 190 degrees or until the front oil coolers feels warm. Remove the cowl and check for leaks. Check the connections on the front oil cooler for leaks.

|___| Remove the nose access cover and check for oil leaks around the oil cooler.

|___| Place your hand on the oil cooler to see if the oil is heating up. If not, check the engine oil thermostat (vernathurm).

Replace the cowl and run the engine up to full power. You should get at least 2400 RPM static with a fixed pitch prop or 2650RPM with a constant speed prop. If you do not, check the engine performance with the engine manual, and also consult with the prop manufacturer.

14.1.12 – Pitot / Static System

Check the pitot and static system for proper plumbing. Be sure that there are no line obstructions or kinks in the vacuum tubing. Isolate any tubing from control system components or other moving parts. We recommend that you have your pitot system checked at your local FBO if possible. First flight without an airspeed indicator can be quite interesting, so take proper precautions and get these systems checked out before you leave the ground.

If you have a transponder on board you will need a pitot static check done by a radio shop. This is a biannual check.

14.1.13 – Electrical System

This area of final assembly can be as complicated as you wish. We feel that the more gadgets you have, the more problems, so keep it simple. We will only cover areas critical to the safe operation of the aircraft.

|___| Proper battery weight is between 30 – 33 pounds. The battery should be mounted securely.

|___| Battery leads are properly secured, away from external heat and any moving parts.

|___| Solenoid located in the forward compartment, protected from loose objects that might cause a short.

|___| Solenoids mounted straight up and down and not side to side to help prevent them from sticking open or shut.

|___| Electrical wires are bundled and secured away from any moving parts such as control system components. The wires should also be isolated from heat such as exhaust manifolds. Do not leave wires dangling where they can get caught on someone's feet or clothing – chances are they will.

|___| Use lock washers on all electrical connections. Soldering leads is best, and if you use crimp on connectors, make sure that you are using the proper tool and that you are using it correctly.

|___| Check tachometer for accuracy. Most aircraft tach installations are a nightmare.

|___| Oil pressure / oil temperature. This is a very important installation. Follow the manufacturer's recommendations to the letter. Check the pressure sender for leaks and proper grounding.

|___| Check the oil temperature accuracy with a candy thermometer lowered into a container of heated oil. Maximum oil temperature sustained should be 210 degrees Fahrenheit. EGT / CHT – This is also a critical installation. Install exactly per manufacturer's recommendations. Calibrate the CHT with hot oil, propane torch, and a candy thermometer. If you have only one or two probes, alternate them on different cylinders. The CHT on the right front (passenger firewall, cylinder #4) side – seems to run the hottest, so start with your CHT probe under the top spark plug of the number 4 cylinder. Do not operate the engine above the manufacturer's specified redline. Maximum CHT for the Lycoming is approximately 500 degrees Fahrenheit and 430 max continuous.

14.1.14 – Alternator

Secure the alternator properly. Check the clearance between the alternator and the cowl, engine baffling, and the flywheel. Be sure that the alternator is the proper size and is tensioned correctly. As the alternator is subjected to extreme vibration, it is necessary to keep a close watch on it and its mounting hardware. The brackets have a tendency to break and the bolts to loosen. We guard against those situations with safety-wire and lock washers. Protect your positive lead wire (+) from shorting . A further safeguard is to keep the + lead away from heat and moving parts. This wire runs to your battery, and could start a fire if shorted

14.1.15 – Vacuum Pump System

Be sure that the vacuum pump is plumbed properly. Incorrect setup could result in damage to your flight instruments. Make sure that the fitting that is screwed into the exhaust fitting point downward to keep water and other foreign objects from dropping into it.

It is important to install a vacuum regulator between your vacuum pump and the instruments to ensure that your instruments are operating at the proper speed.

Note: Before moving to the next section, have a friend read through the previous material and double check everything that we've covered so far.

16. 15 – Interior

Contents

(Shared with SF, SR, XF, XR)

16.1. 15.0 – Chapter Preface

15.0 – Chapter Preface

15.0.1 – Parts List

Part Number	Description	Qty
VTDS-022	2 part TrimLock Door trim	24 ft
	Foam, 1/2”	
	Foam, 3/8”	

15.0.2 – Tools List

Description
Razor Knife
Hacksaw Blades
Jig Saw

15.0.3 – Supplies List

Description
EZ-Poxy
Duct Tape
3/4” Plywood
Headliner Material
Carpeting
Upholstery
Seat Foam
3M Super Trim Adhesive

15.0.4 – Glass List

No glass work in this section.

15.0.5 – Process Overview

Construction Process	Completion Date
Install Window Frames	

Install Fuselage Headliner	
Install Carpeting	
Create & Install Side Panels	
Create & Install Door Panels	
Upholster Glare Shield	

15.0.6 – Documentation Changes

Oct 01, 2018 – Original Web Release

16.2. 15.1 – Materials

15.1 – Materials

A nice interior should run you around $1500-$2000 if you have the seats upholstered by a professional, and do the carpet, headliner, and side panels yourself.

15.1.1 – Headliner

This is late model headliner material, which is a velour cloth fabric with a piece of 1/4” foam bonded to the back. It comes in many colors and is glued to the interior of the fuselage and door from the windows up with contact cement. You will need approximately 4 yards at a cost of around $15 to $20 per yard.

15.1.2 – Carpet

We use automotive type with the black rubberized backing. It comes in a lot of colors, and you will need approximately 12 linear yards at a cost of around $25 to $30 per yard.

15.1.3 – Upholstery

This is up to you. Cost may vary as much as $15 to $20 per yard. You will need approximately 3 yards for side panels, and it is up to your seat cover man as to how much you will need for the seats themselves.

15.1.4 – Seat Foam

Usually costs $50 to $100. Like other items, what you use is a matter of personal preference however probably no other item will affect your comfort as much.

15.1.5 – Glue for Installation

We use 3M Super Trim Adhesive (part #08090). You will need 4 or 5 of these spray cans. The stuff works great, and will get you higher than a kite if you do not have adequate ventilation. Super Trim Adhesive is available at most auto body supply stores.

15.1.6 – Trim and Weather-Stripping

Velocity now supplies a trim and weather stripping system made by Trimlock. It is a two part system. The trim that clips on the door flange is Trimlock part number 100B7×3/16B. The seal that sticks to the door is X109HT. If you need to get different sizes it is available through many hardware or auto parts stores.

16.3. 15.2 – Installation

15.2 – Installation

15.2.1 – Fuselage Headliner

Installing the headliner can be complicated if you do not go about it correctly The trick is to first establish a centerline on both the fuselage and the foam side of the headliner, and then work from the center out.

It works well if you stop the foam an inch or so from the window. This will allow your window trim rings to sit flush with the upholstry when they are installed.

Note: If you are going to install a GPS Antenna on the roof, make sure that it is in place prior to installing the headliner.

Make sure that the area around your door hinges has been glassed in before the headliner is installed.

___ Once the headliner is in place, trim flush around the door cutout lip and glue the liner securely in place with some extra contact cement.

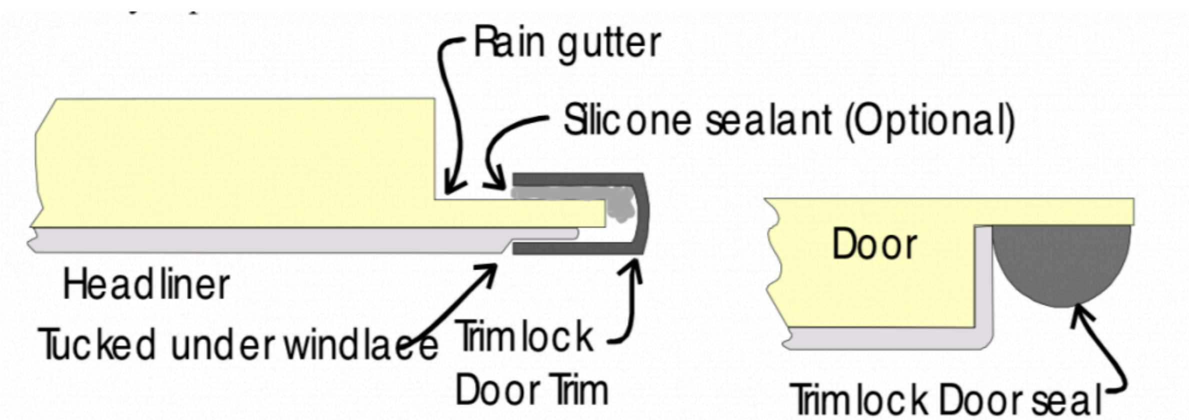


Figure 15-1. Fuselage Headliner Installation

We will use our headliner material to upholster down about 2/3rd's of the way down the fuselage side. We also upholster the tops of the baggage strakes.

15.2.2 – Window Frames

These are included in the kit. They can be covered with upholstery and screwed in place.

15.2.3 – Carpeting

Installing the carpets is done with contact cement or 3M spray adhesive applied directly to the inner skin of the lower half of the fuselage. You will be carpeting the following:

- Bottom and sides of the baggage strakes.
- Floor.
- Lower half of the cabin side of the canard bulkhead.
- Lower sides of the cabin up to the side panels.
- Center console.

The side panels in the rear come to the bottom of the baggage cutouts, and the side panels in front come down to the center of the leading edge of the strakes. Therefore, the carpet must come approximately 1” higher than the side panels, so that the panels will hide the edge of the carpet.

You will need plenty of sharp razor blades, but be careful not to damage the glass behind the carpet.

Note: Do not cover your access panels that you made to get at the gear and the control system. You can remove these covers and cover them with carpet separately.

15.2.4 – Side Panels

The side panels are constructed out of door skins or stiff poster board, and serve to cover the area between the windows and the carpet. The best way to build your side panels is to make paper templates and then transfer the pattern to the panel material.

Once you have constructed and fitted the panels, cover one side with 3/8” foam, and then cover that with your upholstery material. Put them together with the spray adhesive, first gluing the foam to the panel, then the fabric to the foam. Wrap the fabric around the edges of the panel so that about 1” of fabric extends onto the back of the panel.

Install the panels to the aircraft with either silicone sealant or contact cement. Prop the panels into place while the contact agent cures. We prefer to use the silicone, as it is easier to remove if necessary.

15.2.5 – Interior Door Cover

___ The molded cover over the door mechanism is installed by first cutting the slot for the handle.

___ Cut fit and install several wood or hard foam blocks with 5-Minute Epoxy. Space them evenly around the door. These are used to support the cover off of the linkage. We prefer to use PK screws(or wood screws) to hold the panels into these wood spacers. You can also use automotive trim screws that you can cover with a cap that matches your interior.

15.2.6 – Glare shield

After your glare shield has been fitted it can be upholstered. Some builders have just filled and painted there glare shields with flat black paint. We prefer to have it upholstered in a flat black vinyl when we have are seats upholstered.

15.2.7 – Rear Cover Panel

From the top of the Gear bulkhead up you will need to creat a panel to cover your sump tank and gear mechanism. We prefer to use Dyvinicel foam that has been glassed with one ply of bid on each side. You can use plywood but this is a heavier installation. The panel needs to clear the over center mechanism for the main gear on an RG. This is very important. You do not want to have anything can can foul the operation of the gear.

17. 16 – Flight Testing

Contents

(Shared with SF, SR, XF, XR)

17.1. 16.0 – Chapter Preface

16.0 – Chapter Preface

16.0.1 – Parts List

This chapter requires no parts.

16.0.2 – Tools List

This chapter requires no tools.

16.0.3 – Supplies List

This chapter requires no supplies.

16.0.4 – Glass List

This chapter requires no glass.

16.0.5 – Process Overview

This chapter has no processes.

16.0.6 – Documentation Changes

Oct 01, 2018 – Original Web Release

17.2. 16.1 – Final Preparation

16.1 – Final Preparation

16.1.1 – Placarding and Markings

Now that you have done everything in the preceding sections and chapters, sometimes at least twice, it is time to get into the fun part, taxi and flight testing your aircraft! It is very important that everything in Chapter 14 has been done, and has been rechecked by another person.

A recommended reference for this phase in your project is the ***Custom Built Sport Aircraft Handbook***. This is an E.A.A. publication dealing with safety and design and the licensing process. There is a nice safety checklist to guide the builder through the pre-first flight inspections. The FAA has a book called *Amateur Built Aircraft Reference Material* that is most of the FAA publications that would be useful to a builder. Also check out AC90-89A *Amateur-Built Aircraft & Ultralight Flight Testing Handbook*.

The necessary inspections by the F.A.A. must be done before going into flight testing, and the federal regulations pertaining to the aircraft must have been complied with.

- Final inspection air worthiness certificate issued and displayed.
- Operating Limitations (Issued by FAA Inspector.)
- N numbers properly displayed.
- All warning and identification plates must be properly displayed.
- Accurate weight and balance completed and analyzed.

The following are a few hints concerning the inspection of the aircraft and how to deal with

F.A.A. inspectors:

1. N numbers must have characters at least 3” tall and a color contrasting with that of the fuselage. On our factory aircraft they are displayed horizontally on the lower winglets. (Don’t use Duct Tape.)
2. Experimental passenger warning and ID plate displayed on the inside of the door just above the hinged side. These are 4” × 24”, and should be clearly visible when the door is open. The plates and placards are available at aircraft supply houses such as Wicks and Aircraft Spruce.
3. External ID plate is a small aluminum tab approximately .060” thick, 3/4” high, and 6” long. It contains the following information:
   Aircraft Type – Velocity XLRG
   N-number

Serial Number.
We rivet ours to the pilot side Just forward of the cowling cut line.

4. An accurate weight and balance in the aircraft to show to the inspector. This is necessary to obtain a certificate of airworthiness.

16.1.2 – Inspections

It has been our experience that many federal inspectors lack in-depth knowledge of this type of aircraft construction and configuration. Therefore, they tend to overlook many things that are of critical importance to the airframe, and concentrate instead on areas where they are knowledgeable and experienced such as powerplant, hardware, and *paperwork*.

The inspector can be extremely helpful with fuel systems, wiring, and other systems common to production aircraft. They are also bound by their authorities to have the proper paperwork. When you call for your inspection, make sure that you have all the necessary paperwork completed and complied with. These guys are really good fellows, and can be very helpful but, help them by having everything ready when they get there.

Though not mandatory, it is advisable that you enlist the aid of a representative of your local E.A.A. chapter who is familiar with composite construction. Get him to come and inspect your aircraft during the various stages of construction, as well as just prior to first flight. This will give you some peace of mind, and you'll probably make a new friend.

Check with him to see if he knows of anyone locally operating a Rutan-type canard aircraft or Velocity that would be interested in giving you some pointers, or might be willing to assist you in your first flights. This might be accomplished by a couple of flights in his E-Z or Velocity.

Depending on if you are planning on getting insurance or not you may require an Insurance Inspection. Velocity has several inspectors around the country that are knowledgable individuals who have built Velocities themselves. This inspection is a good idea even if you do not require it for your insurance company. It is a good idea to have a person experienced with Velocities to double check your work.

16.1.3 – Pilot Qualifications

We find that the total hours logged is not as important as the number of different aircraft flown when transitioning to the Velocity. Aperson who has been flying a Cessna 172 all his life, say with 10,000 hours, will have a harder time than a reasonably low time pilot who has experience in many different aircraft.

It is very important to be current and fly frequently in the few months prior to your first flight in your Velocity. Many builders concentrate on the construction of their aircraft and let their piloting skills deteriorate. Keep flying, even if it means putting down the sandpaper for a few hours a week.

Velocity offers a flight training program at the Factory for its builders. We will take you through two to three hours of ground school. After familiarizing the builder with the flying characteristics of the Velocity on the ground it is time to do some flying. We start off with basic air work then transition to takeoffs and landings. After a pilot has mastered landing the Velocity we will go through emergency procedures and first flight procedures.

We at Velocity want every builder who is finishing up their Velocity to get a factory checkout. A month or less before you are ready to fly your Velocity is when you should get a check out. This will keep the training fresh in your mind while you are making your first flights. Most insurance companies have now also made factory checkouts part of their requirements as well. We require a few things for a pilot to come to Velocity for training.

- Own a Velocity (We get many requests for training from pilots without airplanes.)
- Have a current biannual flight review.
- Flown 10 hours in the last 3 months (preferably in a high performance airplane.)
- High performance checkout (This is not required if you own a Standard body fixed gear with a fixed pitch propeller.)

It is unfortunate, but the first flight record for experimental aircraft is not that great. It usually is not the fault of the aircraft involved, but rather points to the fact that many of the pilots involved in these incidents let their flying skills deteriorate while constructing the aircraft. In many cases, the pilot was unaware of what to expect when the airplane took to the air. So practice and don’t feel compelled to fly the aircraft until you and it are completely ready. The next section is a true account of what happened when taxi testing the first Velocity.

16.1.4 – True Story

Written by Dan Maher

After spending seven months building the prototype Velocity, I was a very low time pilot with perhaps 120 hours, and had been doing very little flying while working on the prototype. I had the cards stacked against me in the piloting department, not to mention that many of the self-proclaimed authorities on canard aircraft warned me that the Velocity would not fly, and if it did, it would certainly crash.

Being a level headed fellow, I purchased a parachute and hired a professional test pilot to perform the initial flight testing in the aircraft. One day, when the weather was good, I decided to taxi test the plane to check the brakes, elevators, rudders, etc. for the test pilot. The test went something like this … first run down the strip, 45 knots, everything OK.

Second run down the strip, 55 knots, oops, flying. Gotta get down, pull the throttle back, engine idling too fast, speed building, runway ending, throttle forward, go around! First pass on final, airspeed is 90 knots and accelerating, engine idling, go around again.

Finally, third pass, mile final, mags off, beautiful landing. “Where’s the bathroom?” First flight. Parachute is safe and sound at home in the closet. Test pilot is 200 miles away. What am I doing here? Boy, am I lucky. Since that first flight, the aircraft has flown beautifully, and I have enjoyed over 300 hours in it since without experiencing a problem. Talk about a lucky fool.

This stuff does happen, but don’t let it happen to you. You might not be as lucky as I was. Be prepared, and if there is any doubt, swallow the big ego and let a competent professional perform the initial flight testing. I find that these guys enjoy this work, and excel at it.

17.3. 16.2 – Testing

16.2 – Testing

16.2.1 – Taxi Testing

Make sure that all your inspections have been done and the airplane is ready for flight. Make sure you have adequate braking before you get too fast with the airplane. Watch your engine temperatures and pressures. It is not a good idea to do prolonged ground running on a new or rebuilt engine that hasn't been broke in yet. If an engine is run for too long a period of time on the ground before it is broke in you can glaze the cylinders which will lead to high oil consumption. Keep this in mind and keep your ground run short.

All taxi testing and early test flights are done with wheel pants removed. This helps prevent overheating of the brakes and therefore the main gear adjacent to the brake disk. This testing should be done at speeds of less than 40 knots on a good, hard, smooth surface, free of loose gravel, etc.

Select a day with minimal wind and light traffic, if possible. Make sure that brakes and rudders are working correctly, and that your seat is in such a position that you have optimum visibility yet can work the brakes without any problem.

All taxi testing must be done within the first flight CG box. Put approximately 10 gallons of fuel in each main tank, and allow the fuel to settle into the sump. Park the aircraft on a level surface so that the fuel will distribute itself evenly.

During low speed taxi maneuvers, you should get used to the feel of your aircraft on the ground. Pay attention to how the brakes work, how the nose wheel responds, when the rudders take effect, etc. We have found that during low speed taxiing, it is better to jab the brake to turn the nose wheel, rather than riding the brake and inducing break wear and heat buildup. Spend a couple of hours, and get familiar with the effects that crosswinds or variations in runway / taxiway surfaces will have on your Velocity. Once you are satisfied:

|___| Remove your cowl and check for leaks or other problems.

|___| Check your brakes again. Bleed again if necessary.

16.2.2 – High Speed Taxiing

When you begin high speed taxi testing, you should have at least 4000' of good, smooth, clear runway to work with. Weather conditions should be calm, no crosswind, and there should be little or no traffic. Early morning is a preferable time for these operations.

|___| Remember, no wheel pants during taxi testing.

Other canard aircraft designers suggest that you do the tests we recommend in two other aircraft first. We think this is an excellent idea. You are provided with the opportunity to experience a few strange, new maneuvers in an aircraft that you are familiar with and feel comfortable in.

You will need a lot of runway to accelerate to speed, maintain that speed, then decelerate. Set your pitch trim to neutral and the roll trim to neutral.

Run your taxi tests in increments of 5 knots, beginning with 30 knots and ending at 50 knots. At 50 knots, the Velocity might rotate if full aft stick is applied, but the aircraft will not lift off. Do not rotate at this time, just make numerous runs by accelerating to desired speed, then reducing power to idle, and then feel the aircraft out.

Allow sufficient time between runs to cool brakes and landing gear. It is a good idea to get under one of the wings and lift the airplane until the wheel is off the ground. This will help remedy the tendency of the gear to creep. You also want to keep an eye on your engine temperatures. You do not want to do prolonged ground running because the engine does not get the cooling air it needs at these low speeds.

Operate the ailerons, rudders, elevator (slightly), and the brakes. Practice reaching the desired speed and maintaining it with small throttle adjustments. You will be surprised at how little power is necessary to maintain speed in a Velocity.

Caution: Be sure that the engine is idling below 900 RPM.

This is a good time for you to establish a visual reference of where 0 degree attitude is in relationship to the horizon, as well as the elevation of the pilot and the aircraft from the runway surface. This will be very useful in determining flare height when doing landings. Don’t short change yourself, spend a day performing these exercises. It will be time well spent.

16.2.3 – High Speed Taxi Nose Wheel Liftoffs

To proceed into this phase, you must master the technique of reaching a speed and maintaining it until braking. Nose wheel liftoff speeds will vary from one aircraft to another, depending on gross weight and CG placement. Make sure that your CG is in proper position at this point.

To find your rotation speed, accelerate to approximately 45 knots, **pull the power back** to maintain speed and slowly pull the stick back. If rotation is achieved, slowly relax the stick and let the nose wheel settle. Do not force the stick forward quickly. If rotation is not achieved, go back around and repeat this procedure approximately 3 knots faster. Repeat the procedure until rotation is achieved.

The Velocity will fly shortly after rotation. Some canard aircraft will rotate 10-15 knots before flight. The Velocity, however, flies a lot sooner. The placement of the main gear makes it possible for the Velocity to fly approximately 5 knots past rotation speed, unless the aircraft is very heavily loaded.

Be sure the power is back when you try to rotate. Once rotation speed is determined, practice holding the nose gear just a couple of inches off the ground, maintaining power, then letting the nose wheel settle gently to the ground while relaxing back pressure and reducing power.

Do not over rotate. If you do, reduce power and let the nose down gently. Practicing the art of holding the nosewheel slightly off the ground will give you a good hand on controlling the pitch of the aircraft.

Note: Do not allow the aircraft to exceed 60 knots during the preceding exercise. Be sure that you do not rotate the nose too high or you will be flying.

When you feel that you have things under control, set your elevator trim to the position where it will assist you in holding the nose slightly off the ground, but will not add enough correction to cause the aircraft to over rotate. It will be necessary for you to assist the trim to induce rotation, but once rotation is achieved, the trim should hold its own. At this point, stop the aircraft and note the position of the elevators and the stick. Set the trim at this position for the first flight.

16.2.4 – Runway Hops

If you have sufficient runway you can do a runway hop after you have mastered the high speed taxi skills. AVelocity can rotate as slow as 50 knots if the power is pulled back so we have to be ready to fly at any speed over this. You have to understand as the pilot in command that if you get into a situation where you are airborne and running out of room you may have to add power and fly the airplane.

As you are doing your high speed taxi tests you will reach a speed where the airplane will start to feel light and want to try to lift off the ground. The Velocity will rotate at a slower speed with the power pulled off than with the power on. This is because the thrust line of the aircraft is slightly higher that the centerline of the airplane.

As you did with your high speed taxi tests accelerate down the runway until you reach between 55-60 knots reduce the power to idle and increase back pressure. After the nose has lifted off the ground it does not take much more angle of attack to get the mains off the ground. Be careful not to over rotate. With the power at idle you should have enough momentum to hop into the air for no more than 5 feet. When you are in the air pay attention to the roll and yaw characteristics of the airplane with the stick centered and no rudder input. If you notice the airplane roll or yaws you can shim a rudder or a wing to correct this now. I find it better to experience a problem at 5 feet off the ground and correct it rather than on my first flight when I am hundreds of feet in the air.

16.2.5 – First Flight

The wheel pants should be off for your first flight in the Velocity. Check your tires, brakes and shimmy damper. Are you ready? If not, get some rest, wait for good weather, and keep reminding yourself that you spent a lot of time and effort getting to this point – don’t rush into it! If there are any squawks or nagging problems in the aircraft, fix them now.

There are many things that a pilot should think about before flying an airplane for the first time.

___ Evaluate your airport. Make sure you use the longest largest airport that is available to you. If you have to take the wings off the airplane and trailer it to a better airport than do it. An once of prevention may keep you from pulling your airplane out of the weeds.

___ Know the surrounding area. If you have a runway that on one side faces a town and the other end faces a field take off towards the field. I make sure I know the area around the airport and before I fly I have figured out what I will do if I run into a problem at any altitude and any point around the airport.

___ You want to make sure you have the right weather for the first flight. You want a no wind condition. If you have a lot of wind it is hard to evaluate if an airplane is rolling or yawing because the airframe isn't straight or because the wind or turbulence is moving you.

___ I find it best to just have a small support crew with me as I perform a first flight. If you have alot of people watching a first flight it puts more pressure on the pilot. You will have enough pressure and things to worry about already.

The following will brief you on what to expect in the way of differences between the Velocity and conventional aircraft.

- Rudder / Brake – both rudders can be deployed at the same time in the Velocity, so take care not to do so in flight. It is advisable to remove your feet from the pedals during flight in order to resist unintentional yawing of the aircraft. Remember to relieve the pressure on the rudder pedals at point of touchdown so that you don't inadvertently land with the brakes on.

- All aircraft fly differently. Some are loose and sloppy while others are tight and precise. The Velocity responds to pitch and roll inputs immediately and the smallest increment of input will be felt. Be sure to avoid overcontrol of the aircraft, especially when dealing with pitch. Use your trim to stabilize the aircraft. We have found that over rotation is a mistake that beginning pilots tend to make. Once the aircraft rotates, relax slightly on the stick pressure and let the aircraft fly itself off. Keep the canard well below the horizon.

Your first liftoff should be very conservative. Climb out at 100-110 knots, stay very close to the airport and do not do anything foolish.

Limit your airspeeds to 140-150 knots. Trim your aircraft for hands off flight. There is very little trim change when power is applied or reduced.

On a retractable gear airplane I prefer to retract the gear on the first flight. This allows me to fly fast enough to keep the engine cool. In order to have enough confidence in the RG system I will have done over 50 retracts with the airplane on jacks to make sure it works properly.

Spend your first flight feeling out your pitch, roll and yaw responses. Pay especially close attention to your engine RPM, temperatures, and pressures. If it looks like a potential problem is developing, land and check it out immediately.

A good approach speed is approximately 85-90 knots, and touchdown with a slight flare at 70-75 knots. We suggest that you fly the aircraft on to the runway on your first few landings, but take care not to put the nose wheel down first.

|___| After your first flight, take a couple of hours to go over your aircraft thoroughly.

|___| It is advisable to flush your fuel system and clean all the fuel filters.

|___| Check for signs of leaking oil, chafing of wires or hoses, and any evidence of any type of overheating .

|___| If there is a problem with the aircraft trim, such as a tendency to roll or yaw, investigate and make the necessary adjustments before your second flight.

Aircraft are not like us, they do not heal themselves. Small problems seem to get worse with the passage of time, and sometimes lead to other problems.

Once all the bugs have been dealt with, it is time to do some more flying. Get used to the aircraft. Keep it within the CG box prescribed for the first flight for at least the first ten hours of flight. Do not exceed 150 knots indicated. Practice your approaches, departures, and pattern work. Get familiar with the effect that your speed brake has on your glide path.

Remember that you have 25-40 hours of restriction to fly off, so make good use of the time. Get familiar with all aspects of your Velocity. As you expand the flight envelope, document the performance limitations and restrictions that you personally place on your aircraft. Spaces are provided in the Owner's Manual for such documentation. ***Remember – no operations outside the envelope established by Velocity Aircraft. Feel free to limit your aircraft within the box.***

16.2.6 – Envelope Expansion

We suggest that you wear a parachute during all flight testing. Remember that you have approximately 40 hours of restricted flight time, so use it wisely.

40 hours is enough time in which to complete a very professional test flight program and acquaint yourself thoroughly with your aircraft without leaving the area of your home field. When you start adding or removing weight to the aircraft do so in small increments, and calculate your CG as you do so in order to avoid going outside of the flight envelope. If at any time you feel uncomfortable about the weight or CG be sure to limit your aircraft accordingly.

When attempting pitch bucks (canard stalls), maintain at least 6000 feet AGL. Approach the pitch buck while maintaining altitude. Slowly bring the stick back until minimum speed is achieved. Pitch buck speed will vary from approximately 55 – 63 knots (light load) to 65-70 knots at heavy load with a forward CG.

Your aircraft will exhibit different stall characteristics under different CG and weight combinations. Usually, when the load is light and the aircraft is in the middle CG range, it will just mush. As the weight increases and the CG moves forward, the stall should become a slight bucking action. This is a good thing to take note of as you do not want the aircraft to do this while landing.

Record the type of stall you encounter at a particular speed as well as the weight and CG position at which you were flying. Familiarize yourself with the various stall characteristics, it can be valuable in setting up your landing speeds.

As a rule, I use approximately 10 knots above liftoff speed for a touch down speed. We generally use 100 knots in the pattern and 90 knots on approach.

When you are flying with new weights and CG conditions, make a mental note of the liftoff speed and take it into consideration during approaches and landings. If you are operating in crosswinds or gusty conditions, carry approximately 10 knots extra speed.

Once you become more familiar with your aircraft, you can adjust your approach and landing speeds to whatever you feel comfortable with.

Check the CG location of the aircraft, and placard your aircraft to limit your CG box forward of this point. During our flight testing, we use 100 pound bags of sand wrapped in plastic and duct tape. They are held in place in the seats with the seat belts and some rope. The only problem is that sand does not sit in a seat, and its CG will be several inches forward than that of a human body.

The best way to correct for this is to mark the center of the bag, weigh the bag, and measure its distance from a bulkhead, such as the instrument panel or the firewall. Add or subtract this dimension to find the arm of the sandbag. Multiply the arm by the weight to find the moment, then plug the moment into the formula to find the resultant CG of the aircraft. I find personally that the bags of sand don’t complain much.

During this phase of envelope expansion, it is very helpful to record things like rotation and liftoff speeds and distances, best rate of climb, best angle of climb, landing roll, distance over obstacles, etc. Because of differences in finish, construction, and engine and propeller combinations, each aircraft will perform differently. It is therefore very important to know and document your particular aircraft.

Specifications from our factory aircraft are listed to give you an idea as to what to expect. You will find that the propeller is usually the culprit when large changes become apparent in some performance areas. When choosing a propeller, decide what kind of conditions, weights, and distances the aircraft will experience most of the time.

16.2.7 – High Speed Flight Envelope Expansion

Flutter

Prior to this procedure ask yourself, “Did I balance those elevators and ailerons properly?” When flutter occurs, it usually begins in a control surface. We have never experienced any problems with our aircraft in this regard, but we do take great care when balancing our control surfaces. For this particular test, maintain at least 7500 feet AGL and wear a parachute.

There has never been a Vne established for the Velocity, since each aircraft will be built differently and will have its own Vne. We placard our aircraft at 200 knot redline. This will keep you within the design limitations of the aircraft.

When expanding your envelope, begin at 150 knots and kick the rudder, jab the stick left, right, forward, and aft. The controls and the aircraft should return immediately following each input. Any movement other than straight and level in the airframe should cease. Add 5 knots and repeat the procedure.

When entering speeds that your aircraft will not maintain on straight and level course, dive the Velocity, level her off, and repeat the control inputs. Keep a close watch on your engine’s RPM. When you reach a point that your controls begin to act differently, or do not damp out like the time before, STOP!

Don’t go any faster. Land the aircraft and check the suspicious control. Check the balance and solve the problem prior to progressing on to a test conducted at a higher speed. If you are satisfied with this speed, placard your aircraft for 5 knots below it. Do not expand the envelope beyond 200 knots indicated.

16.2.8 – Flying the Velocity

Once in the air, you will find that your Velocity will fly much like any conventional aircraft. One thing that you will notice is the absence of any adverse yaw. This allows you to operate your aircraft without the use of rudders. Approximately 95% of your flying will be without the use of rudders, which are mostly used for taxiing and for control of the yaw of the aircraft just prior to touchdown. The XL’s will use more rudder than a standard wing Velocity at pattern speeds to keep turns crisp.

16.2.9 – Crosswind Landings

In a crosswind landing, it is best to crab the aircraft down on final, and just before touchdown, use a little rudder input while in ground effect to straighten things out. It is all right to land the Velocity in a slight crab, as the aircraft will immediately straighten out once contact is made with the ground.

I feel quite comfortable in crosswinds in the 15-25 knot range, and have landed in crosswinds exceeding 30 knots. I do not slip or cross-control the aircraft. Velocities do not have as much side area as most conventional airplanes. You will pick up as much speed in a slip in a Velocity as you will pushing the airplane over in a dive that is of the same pitch attitude. We do not recommend slipping as a crosswind or descent procedure in the Velocity, it could turn into a potentially dangerous situation.

First, there is the possibility of stalling a winglet which could result in a departure. Secondly, when slipping an aircraft with swept wings, the wing opposite the direction that the aircraft is being slipped, or the forward rear wing, is more perpendicular to the relative wind. This gives the leading wing more leverage and lift than the trailing wing, thus allowing the possibility that the aircraft could be forced into a stall during exaggerated cross-control and slow flight. Thirdly, with the majority of the fuselage being forward of the wings, there is a chance that the fuselage could blank out the wind to the trailing wing.

If you insist on slipping or cross-controlling your Velocity, do it at a safe altitude. The best advice is do not do cross-controls or slips in a Velocity. Other than this, flying the Velocity is very conventional.

18. Options

18.1. Dash 5 – Cut Down Keel & Rear Bench Seat

Keel Cut Out

It is easiest to install all of the aileron controls in the keel before the keel is installed in the airplane. Do the following steps with your keel on a work table.

Using the cover provided for the aft keel cutout place the cover on the side of the keel with the rear of the cover five inches forward of the tail of the keel and use it as a template to draw a line on the side of the keel for your cutout. Draw a second line about 1/4” inside your first line and cut the keel out to this line. Now you should be able to place the cover inside the cutout and trim out the opening to allow the cover to fit into place. The flange of the cover goes on the outside of the keel. Make sure you leave yourself enough flange to attach nutplates to secure the cover. Mark mounting holes 1” from the top of the cover and drill 1/8” holes every 8” around the perimeter of the cover to attach it with clecos. Later these holes can be drilled to 3/16” for screws and nutplates can be installed in the keel. Start with one mounting screw hole centered on both the top front and top back of the cover. The placement isn’t that critical so if you have to move one of the mounting holes to clear the Main Gear cylinder that is OK.

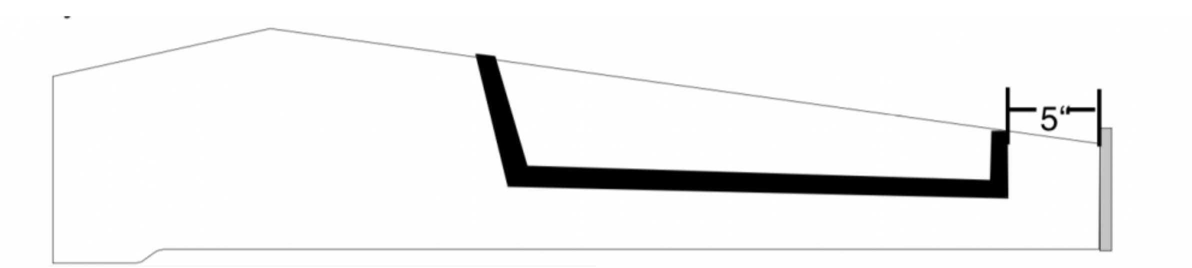


Figure D5-1. Cut-Down Keel Cover Install

___ There is a location marked on the top centerline of the keel, approximately 9.5” aft of the instrument panel. Drill a 3-1/8” hole. This is where the control stick exits. Dimensions on Figure 6A-1 are approximate and are for reference only.

___ Also marked on the sides of the keel are holes to be cut for access for assembling the stick mechanism.

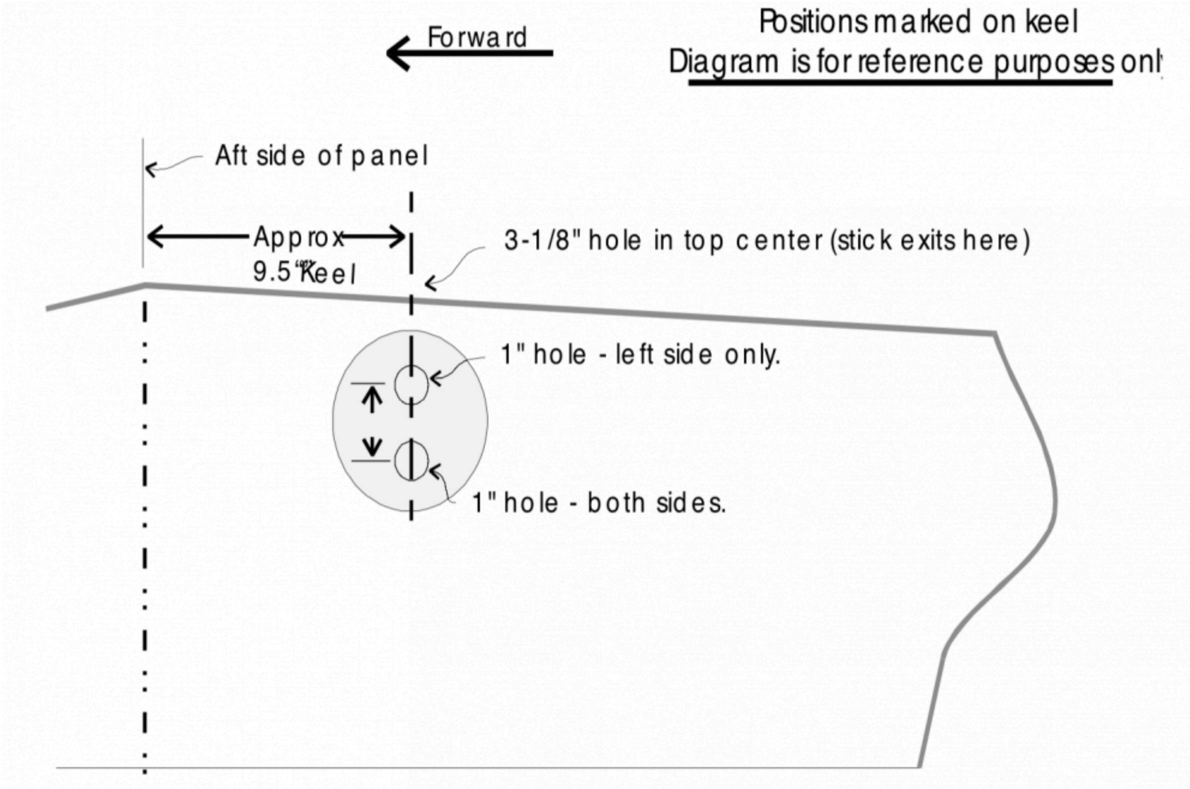


Figure D5-2. Keel and Control Stick Layout

Upper Aileron Torque Tube Bearings

	Upper Aileron Control Bracket	
Part Number	**Description**	**Qty**
VFAB-01	Bracket, Front Aileron Torque Bearing	2
VATT-XL	Upper Aileron Torque Tube, Aileron (End with retaining sleeve to front of aircraft)	1
AN3-7A	Bolt	3
AN3-5A	Bolt	2
AN960-10	Washers (use as shims if necessary)	10
MS21042-3	Locknuts	5

Clamp the upper aileron torque tube in a bench vise . There is an aileron torque tube retainer that comes to you inserted in the front of the aileron torque tube taped in place. Remove the retainer and install it through the aileron torque tube bearing. Refer to 6A-3 to make sure the bearing is facing the right direction. With the retainer installed tight up to the aileron bearing you will need to drill a 3/16” hole for the bolt to hold the retainer. This hole is located 3/4” behind the bearing. Make sure the bushings for the control stick are perpendicular to the hole you are drilling.

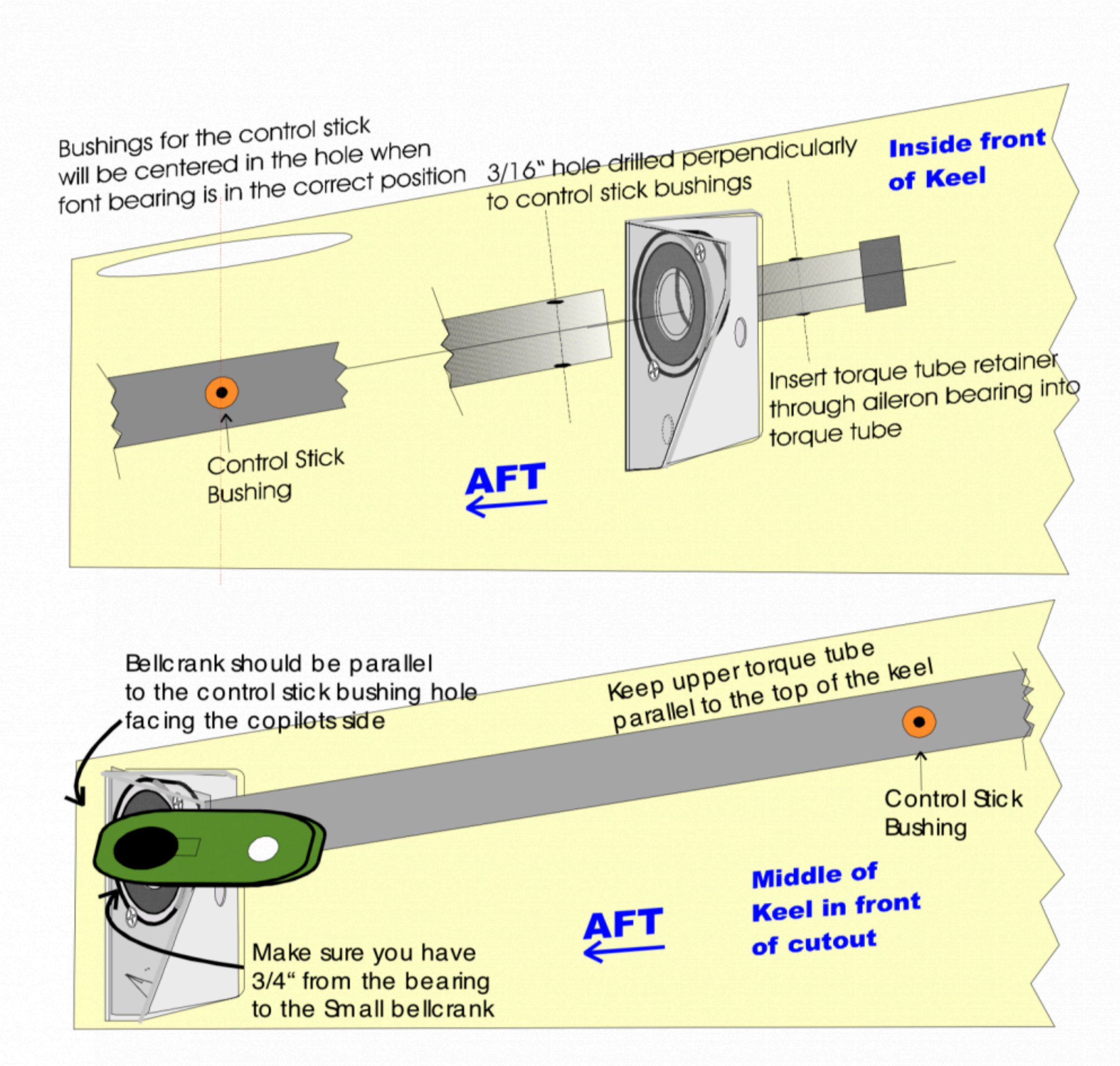


Figure D5-3. Torque Tube Retainer Installation

___ At the rear of the upper aileron torque tube slide one of the short bellcranks through the aileron torque bearing and into the rear of the torque tube. The rear aileron torque tube bearing bracket has the flange mounted forward just like the front bracket. Ori- entate the small bellcrank so that it is parallel to the control bushing hole and that it has the bellcrank facing the copilots side. With the bearing tight up against the torque tube allow the bellcrank to protrude 3/4" out from the bearing. Using a small vise grip put slight clamping pressure on the sides of the aileron torque tube so it will keep the bellcrank from moving when drilled. Drill a 3/16" hole parallel to the hole you drill in the front retainer and install

The front aileron torque bearing bracket is mounted flange forward on the pilot side of the keel. The extreme front end of the bearing itself is 18-1/4" aft of the front flange of the keel. The center of the bearing is 12-1/2" above the bottom keel flange. The control stick bushings will be in the center of the hole you cut for the control stick when the front bearing is in the correct position. See Figure 6-11. Use (3) AN3-7A bolts, AN960-10 washers, and MS21042-3 nuts. For now, install it with just one bolt so that you can adjust the angle as you install the rear aileron control bracket. Counter bore the foam in the keel to allow the head of the bolt to be flush with the keel inner skin.

Raise the rear upper aileron torque tube bearing until the torque tube is parallel with the upper surface of the keel. Using (3) AN3-5A bolts, AN960-10 washers and MS21042-3 nuts install the rear upper bearing bracket.

Control Stick Assembly

___ Assemble the control stick to the torque tube. The hole in one side of the stick is tapped for the threaded portion of the stick pivot bolt. The nut locks it in place. **Do not drill this hole out by mistake.**

	Keel Control Assemblies, Hardware List	
Description	**Part Number**	**Qty**
VCSA-01	Control Stick Assembly	1
VCTT-01	Control Torque Tube, Aileron	1
VEPR-01	Elevator Push Rod Assembly	1
MM4	Rod End, 1/4-28 Male	2
BI1428	1/4” – 28 Nut	2
AN4-15A	Bolt	1
AN4-17A	Bolt	1
AN3-10A	Bolt	4
AN960-416L	Washer, Thin	4
MS21042-4	Locknut	2
MS21042-3	Locknut	4

Note: Some bolts may come assembled to the stick and tube assemblies.

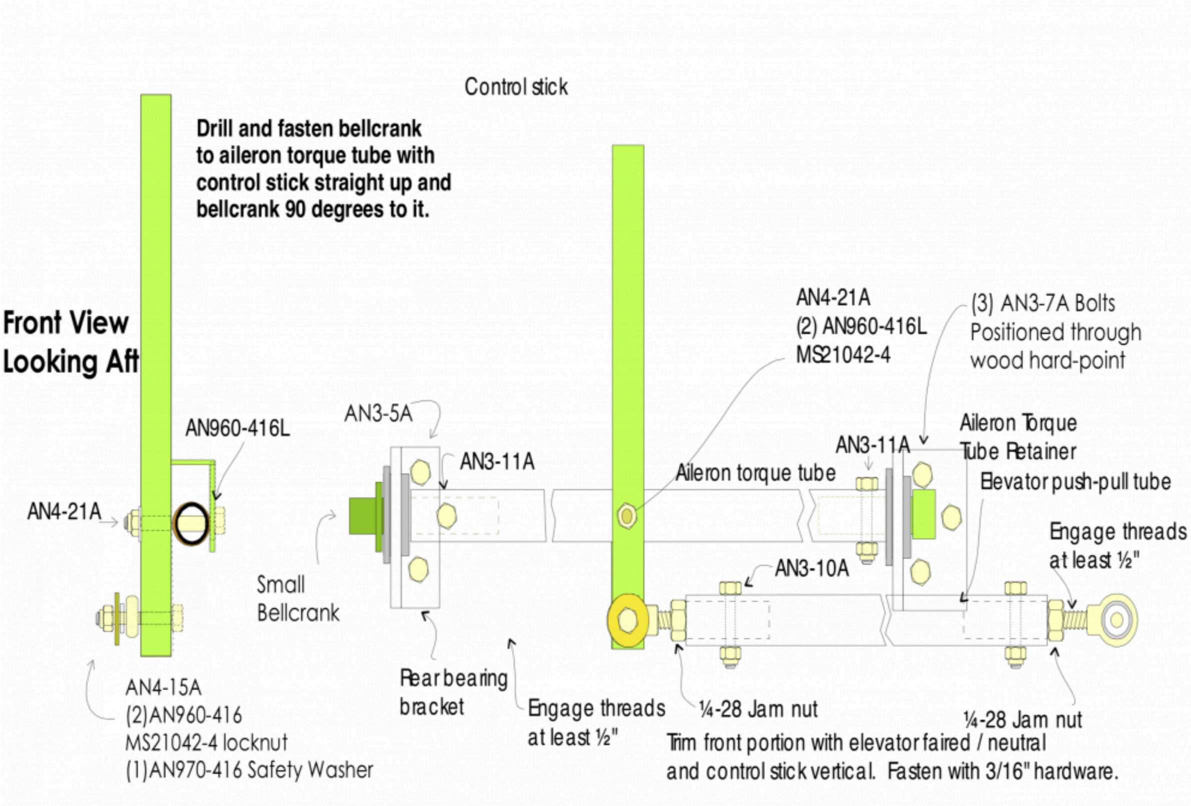


Figure D5-4. Control Stick Assembly

Lower Aileron Torque Tube

	Rear Aileron Control Bracket, Hardware List	
Part Number	**Description**	**Qty**
VBAC-01	Bracket, Aileron Control System	1
VABC-01	Large Aileron Bell Crank	1
	Small Aileron Bellcrank	1
VPPC-01	Cable, Push-Pull	2
MW4	Rod End, 1/4-28 Female	2
VCCC-01	Clamp and Shim, Control Cable, Aileron	2
VACS-01	Spacer, Aileron Cable Standoff	1
MS24566-1B	Pulley, Roll Trim	1
VRTLS-01	Line & srping, Roll Trim	1
VRTM-01	Motor, 12 RPM, Roll Trim	1
VCTT-01	Lower Aileron Torque Tube	1
AN3-5A	Bolts	4
AN3-11A	Bolts	4
AN3-5A	Bolts	3

AN4-12A	Bolt	1
AN960-416	Washers	2
AN970-3	Washers	4
AN960-10L	Washer	2
MS21042-3	Locknuts	10
MS21042-4	Locknut	1

___ Now you are ready to install the lower aileron torque tube. Install the aileron torque tube bearing bracket as you did with the upper torque tube. The flange of the bearing bracket on the lower tube faces aft. Insert the small bellcrank through the bearing bracket. Assemble the Push rod with MM-4 rod ends as shown in figure 6A-5. Attach the rod ends to both small bellcranks using AN4-10A bolts, AN970-4 washers, AN960- 4 washers and MS21042-4 locknuts. With both small bellcranks perpendicular to the control stick and facing the copilots side adjust the position of the lower bracket so that the push rod is perpendicular to the top aileron torque tube. You want to mount the lower bracket so that the bracket is installed just aft of the foam in the keel. This will have the bracket protruding about 3/4" in front of the bearing. Drill (1) 3/16" hole through the lower bearing bracket and loosely install (1) AN3-7A bolt, (1)AN960- 10 washer, and (1) MS21083N3 nut.

You need to orientate the front lower aileron bracket so that your lower aileron torque tube can run straight back to the rear aileron control system bracket. You will need to cut your lower aileron torque tube to length. Have a partner hold the rear aileron control system bracket up to the rear of the keel offset towards the pilot side as shown in figure 6A-6. Take a measurement from the rear of the forward bearing to the front of the aft bearing. This is the distance you can cut your torque tube to.

Install the lower torque tube onto the small bellcrank. The torque tube should be tight up against the bearing. With both small bellcranks perpendicular to the control stick and the push rod clamp a small vise grip to the lower aileron torque tube so that it will hold the small bellcrank in position. Drill a 3/16" hole through the torque tube perpendicular to the small bellcrank. You may need to disassemble the push rod and remove the torque tube and bearing bracket. Install an AN3-11A bolt AN960-10L washer and MS21042-3 nut to hold the small bellcrank in place. Reinstall the bear- ing bracket and torque tube.

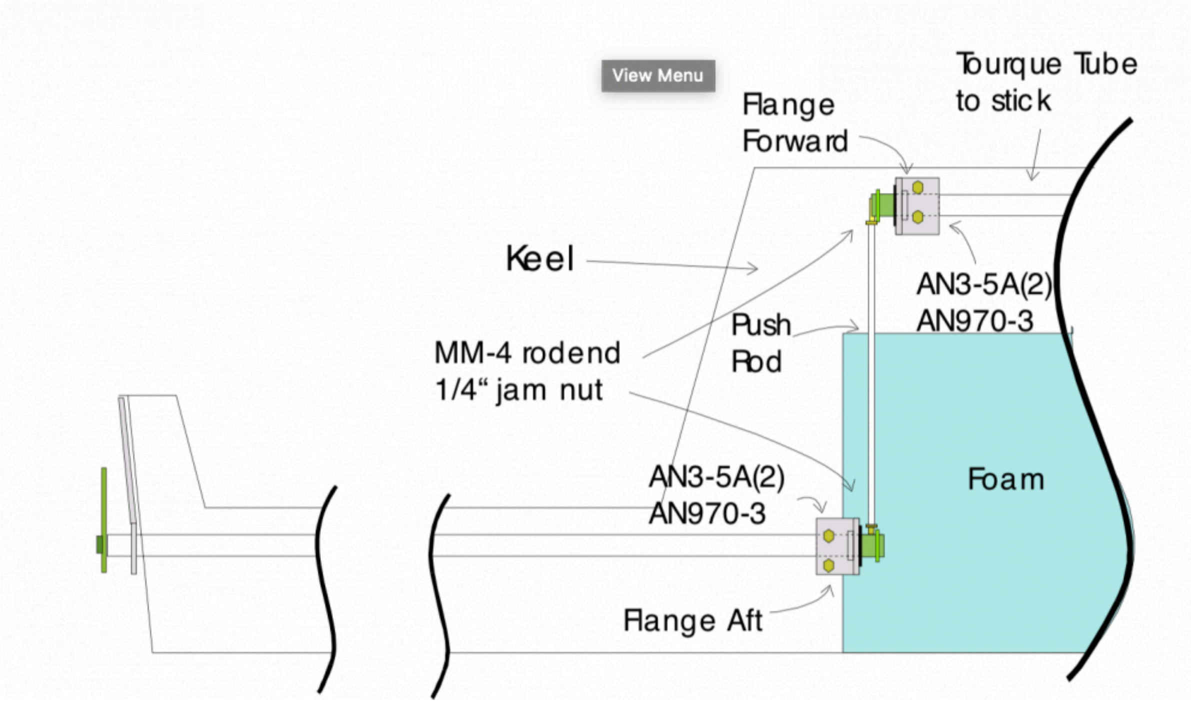


Figure D5-5. Aileron Torque Tube Installation

Insert the large bellcrank through the aileron control system bracket and install onto the lower torque tube. Position the control system bracket so that you have the straightest path from the lower aileron bearing bracket. RG aircraft have a main gear cylinder that also fits into this section of the keel. Mount the aileron control system bracket with the (4) AN3-5A bolts as shown in figure 6A-6. With the large bellcrank facing up and perpendicular to the small bellcrank clamp a small vise grip around the lower torque tube. You will now need to drill a 3/16" hole parallel to the large bellcrank through the aileron torque tube. Install an AN3-11A bolt, AN960-10L washer, and a MS21042-3 nut. It may be easier to drill this hole if the assembly is removed from the keel. Make sure that the aileron torque tube is tight between the two bearings. If there is some play you can cut a spacer from a scrap piece of 3/4" x .058 aluminum.

Locate the aileron torque tube bellcrank . Drill two 1/8" holes 2" down from the top tip of the bellcrank, 3/16" in from each side, for the trim spring attachments. These holes can be moved up or down to achieve the desired trim action.

___ Install the two roll trim springs into the attachment holes of the bellcrank. Tie the line to the left spring, route the line clockwise around the pulley, wrap around the trim motor shaft (two complete wraps) and tie to the right spring. Be sure there is sufficient tension on the springs with no slack. If the motor shaft slips during opera- tion more tension is required. Coating the line with belt dressing reduces slipping as well.

___ Locate the two aileron control cables and thread on the (2) 1/4" rod ends. Screw them on about halfway to ensure adequate threads for adjustment. Be careful during future adjustment that you have at least 3/8" of the cable threads in the rod end and use the locknuts provided on the cables.

___ Install the cables as shown in Figure 6-12 using the proper bolts, nuts, washers, shims, and spacers. This step can be done later, but make a note as to where to locate this information.

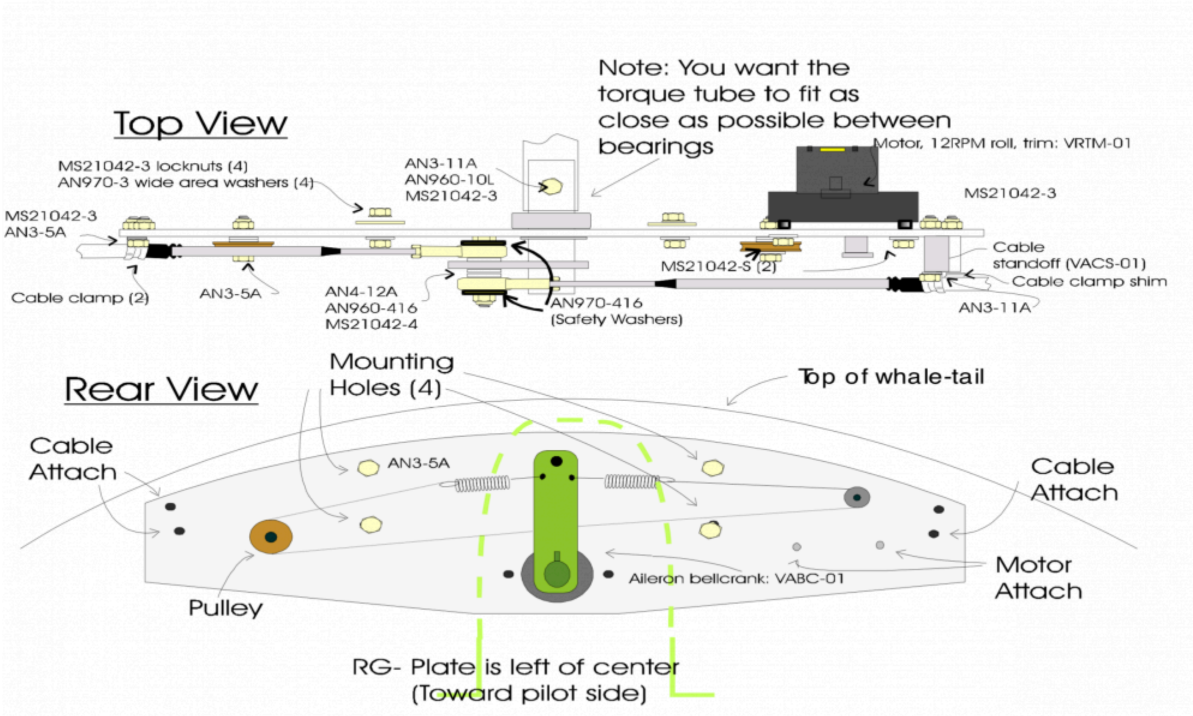


Figure D5-6. Aft Aileron Control Assembly

18.2. Dash 5 – Rear Seat Installation

Bottom Seat Pan Installation

	Dash Five Rear Bench Seat Hardware List	
Description	**Part Number**	**Qty**
VSRB-02	Rear Seat Bottom	1
VRSBR-03	40/60 Rer Seat Backrest	1 Set
SSBLK-01	Rear Seat Support Bulkhead	1
	Pivot Tube 3/4”×.058 49” Long	1
CSSB-01	Pivot Tube Center Support	1
BRSB-01	Backrest Support Bracket	2
CSAB-01	Center Support Angle Bracket	1
CSHP-01	Center Support Hardpoint	1
SBRB-01	Seat Bottom Retaining Bracket	2
SBS-02	Spacer Bushing 1”	2
SBS-01	Spacer Bushing .075”	4
BSP-44	1/8” Protruding Pop Rivets	12
	10. x 3/4” Sheet Metal Screw	4
AN526C-1032R8	10-32 Screws	4
TMFGB-01	Tube Mounts : Fiberglass Blocks	2

Your seat consists of the molded lower seat shell. Two molded seat backs and a molded lower seat support. In addition, there are other components that make up the bench seat hardware.

Starting at the **forward edge** of the rear carbon beam just where the beam contacts the lower duct, measure 14.5” aft and place a mark on the duct. Do this on both ducts as this will establish the placement of the lower seat support. Refer to figure 6A-7.

Next, trim the lower seat support as necessary to fit the bottom fuselage and place vertically on the previously marked location. Hot glue in position.

Note: The support will eventually be attached permanently to the bottom seat shell and not the airframe.

Now position the bottom seat shell on top of the support with the forward edge of the seat extending 1” forward of the support. Check for alignment and make adjustments as necessary. The seat should rest on the carbon keel cover and just touch the right and left duct. Add spacers where necessary to make this happen.

Sand the forward lower portion of the seat bottom in preparation for attaching to the lower seat support. Mix **Micro** and **EZ-Poxy** into a cake icing consistency and apply to the top of the lower seat support. Form an inverted "V" with the micro right on top of the exposed foam of the support.

Carefully position the bottom seat shell back onto the seat support maintaining 1" space between the front of the seat and the support. Press down on the seat bottom to squeeze the micro flat. Double check the 1" space and leave for cure.

After curing, pop the assembly off the airframe where it was held in place by the hot glue. Now sand the seat area to remove any surplus micro. It should not be necessary to micro radius as their should be enough cured micro to establish this radius. Now apply one 2" wide strip of **BID** to the front and one to the back side of the assembly. Let cure.

The two small aluminum u-channels will be used to keep the bottom seat from moving fore and aft. Place the aluminum channels under the seat bottom support so they "cup" the support right where the duct meet the fuselage side. Don't attach to the duct itself but instead to the flange area where the duct is attached to the fuselage side. Refer to figure 6A-7. Drill two 1/8" holes in the channels and attach to the duct flange with **Structural Adhesive** and two 1/8" pop rivets. Remember to sand both the channels and the area on the flange where they attach.

Seat Back Installation

Measure back from the forward edge of the carbon beam 33" and mark the inside of the fuselage. Measure up 6 1/2" from the duct and make another mark. Where the two marks meet will be the placement of the 3/4" aluminum tube that allows the rear seat back to rotate. Trim the aluminum tube so that it just touches the center of the marks on either side of the fuselage.

Locate the 3/8" thick fiberglass brackets with the 3/4" groove centered on the marks and drill a small pilot hole through the fuselage inner skin for two small screws that will be used to hold the brackets in place. Use the 3/16" holes in the bracket as locators for the pilot holes. Place the 3/4" aluminum tube in the grooves and check for level. (* The fuselage needs to be level first.*) Make any minor adjustments to the brackets to make the tube level.

Remove the tube and brackets, Sand the bracket mating surfaces with 36 grit sandpaper and coat the mating surface with **Structural Adhesive** thickened with a little Flox. Place the brackets back into the fuselage and lightly tighten the screws to properly position the brackets and squeeze out excessive adhesive. Let cure.

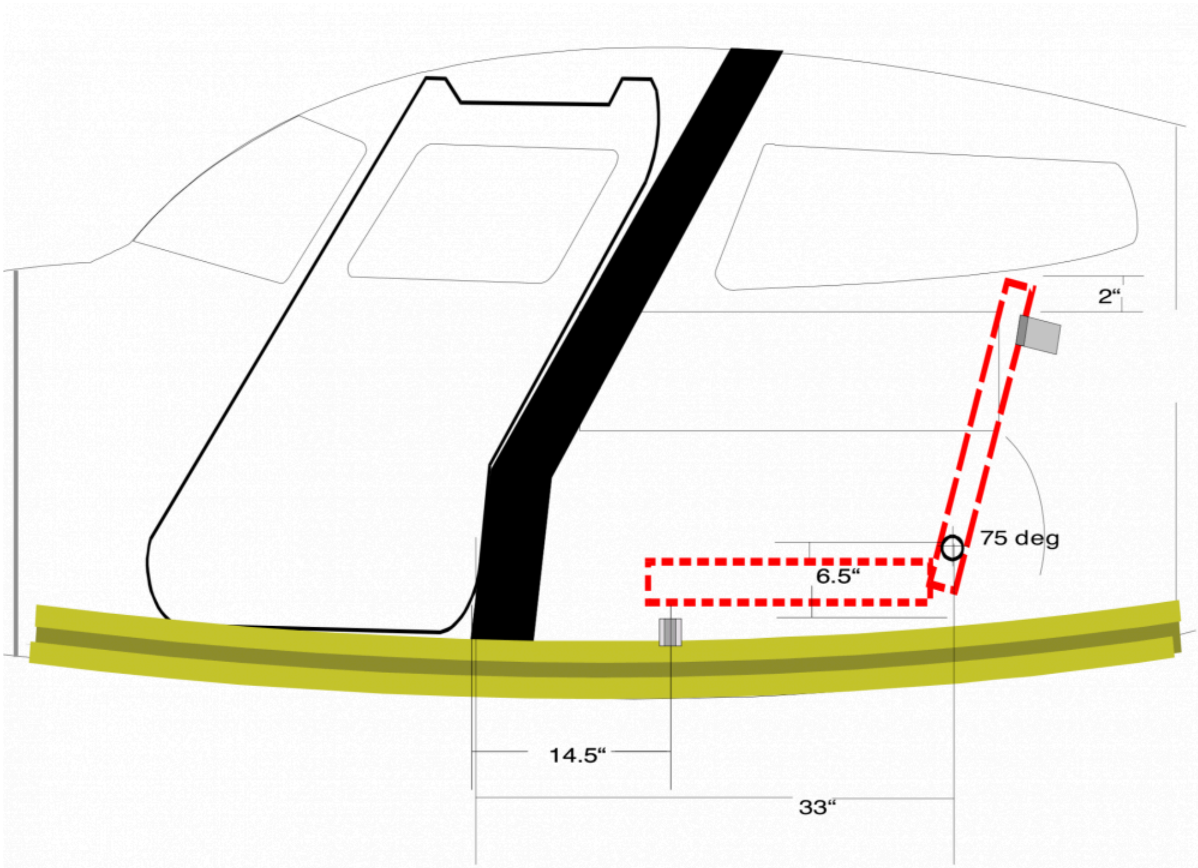


Figure D5-7. Rear Seat Installation

Measure up 3-1/2" from the bottom of each of the seat back shells and mark for drilling the 3/4" holes as close to the foam core as possible to give maximum strength. It may be easier to start this hole from the inside where you can see the foam. After the holes are drilled, insert the 3/4" aluminum tube and check to make sure the seats align properly. Make any minor adjustments as necessary. The seats are designed to allow normal padding and upholstery for side-to-side clearance.

The 3/4" tube is supported in the middle by the supplied 1-1/4" x 3/16" aluminum stock. A 3/4" slot is machined in one end and is positioned on the floor of the aircraft directly under the 3/4" tube and attached to the floor with an aluminum hard point and an aluminum angle. Measure and mark the 3/4" aluminum tube 19-1/2" from one end and position the tube back into the side slots with the mark on the pilots side. (This mark represents the 60/40 split in the rear seat backs.) Position the slotted machined strap on the mark and allow it to extend down to the bottom of the fuselage and mark the spot for placement of the aluminum hardpoint.

Sand the hardpoint on both sides and also sand the fuselage in a 8" square patch where the hardpoint will be installed. Proceed to attach the hard point to the surface of the fuselage with **Structural Adhesive** thickened with Flox. Complete the attachment by Micro ballooning the edges of the hard point and applying two **BID** over the hardpoint extending 2" beyond the hardpoint onto the fuselage. Let Cure.

Attach the aluminum angle bracket to the hard point by drilling and tapping the hardpoint for two 10/32 machine screws. Reposition the aluminum slotted strap under the 3/4" tube and against the side of the aluminum bracket and lock in place with a vice grip or clamp. Drill and tap for two 10/32 screws to complete the center support. The aluminum strap may need to be bent to position under the mark on the 3/4” tube.

The seat back angle is established using a level finder positioned on a flat part of the seat back. The angle we use is 75 degrees from horizontal. Refer to Figure 6A-7.

Position the copilot seat back angle support brackets on the side of the fuselage so that the top of the bracket is 2” down from the top of the seat back. This bracket will have the same angle as the seat back. Mark the position on the fuselage side and sand both the fuselage side and the attach face of the aluminum bracket.

Drill four 1/8” holes in the bracket position it on the fuselage sides using the seat back as your angle guide. Drill mating holes in the fuselage inner skin.

Using **Structural Adhesive** that has been thickened with Flox attach the bracket to the side of the fuselage using four 1/8” pop rivets. Repeat for the pilot side lining up the split line on the 40/60 seat back to achieve the same angle for the pilot side.

After upholstery, use Velcro to hold the seat backs to the angle brackets. Insert one 3/ 4” thin aluminum washer on either side of the center support bracket and one 3/4” thick aluminum washer on the outboard ends of the 3/4” pivot rod.

18.3. Rudder Pedal / Toe-Brake

Installing Toe-Brake Assembly

Prepare mounting blocks by enlarging the four small holes in the blocks using a 3/16” drill. Slide the mounting blocks onto the assembly end tubes (Figure D5-9) then insert tubes into the main assembly. Bolt in place using AN3-11A bolts and AN960-10 Washers under MS21042-3 nuts.

Install pedals (Figure D5-8) using one AN3-12 bolt, one AN960-10 washer, one AN310-3 castle nut, and one MS24665-132 cotter pin.

Install the 8 brass elbows into the cylinders with the ends pointing up towards the threaded shaft. Also install the T-fitting into the resevoir. Use Permatex #2 on the pipe threads. **Do not use Teflon tape.**

Prepare the brake cylinders by first removing the mounting fork and jam nut. Install one NAS1149F0663P washer then one #14 spring on each shaft. Screw the Jam nut and mounting fork back onto the shaft leaving a gap of about 1/8” between the attachment bolt and the end of the threaded shaft. Mount each cylinder using one AN3-15 bolt, four AN960-10 washers and one AN310-3 castle nut. Use three of the AN960-10 washers as spacers as shown in Figure D5-8.

Attach MW5 rod ends to the pedals using one AN5-11a bolt, four NAS1149F0563P washers, and one MS21083N05 nut per rod end. Use 2 spacer washers on one side of the rod end and one on the other side to aid in alignment. Refer to Figure D5-8 for orientation.

Install each rudder cable pull arm (Figure D5-9) with the cable tab facing aft using an AN3-11A bolt, AN960-10 washer and an MS21042-3 nut. Install the 10/32×1” adjustment set screw and 10/32 jam nut.

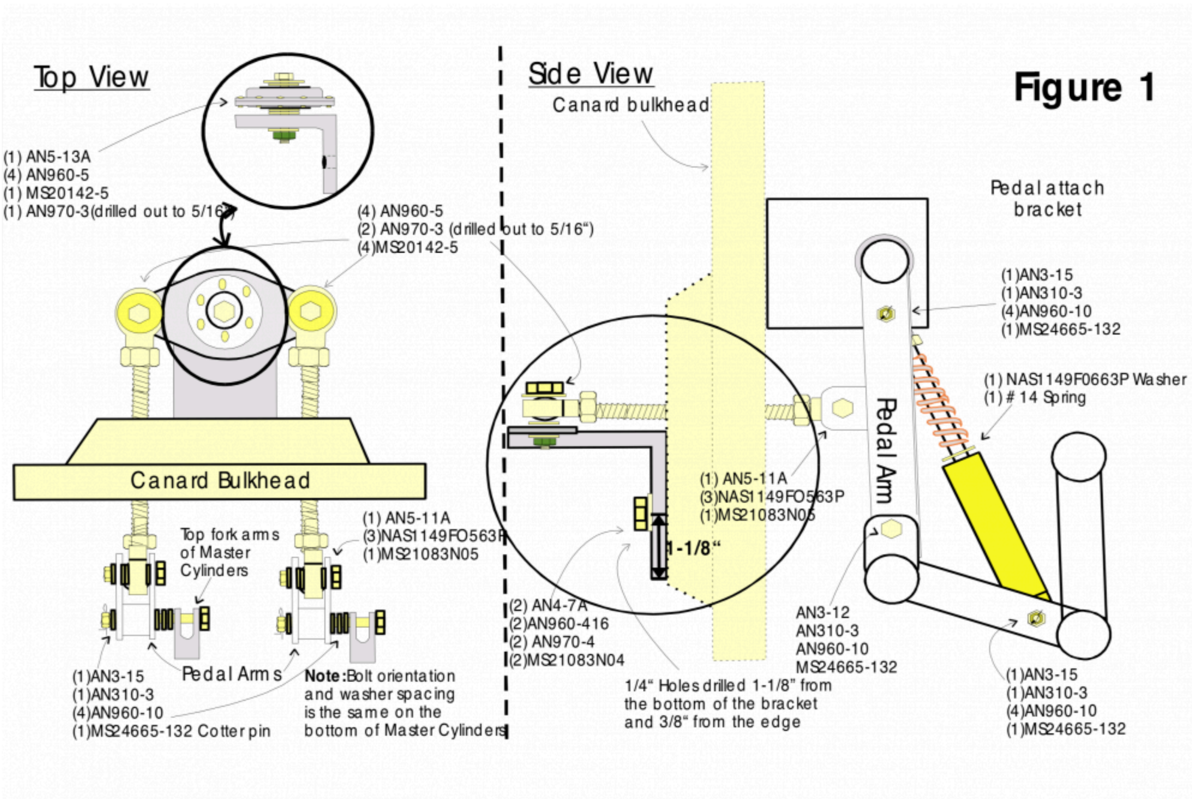


Figure D5-8. Toe Brake / Rudder Pedal Assembly

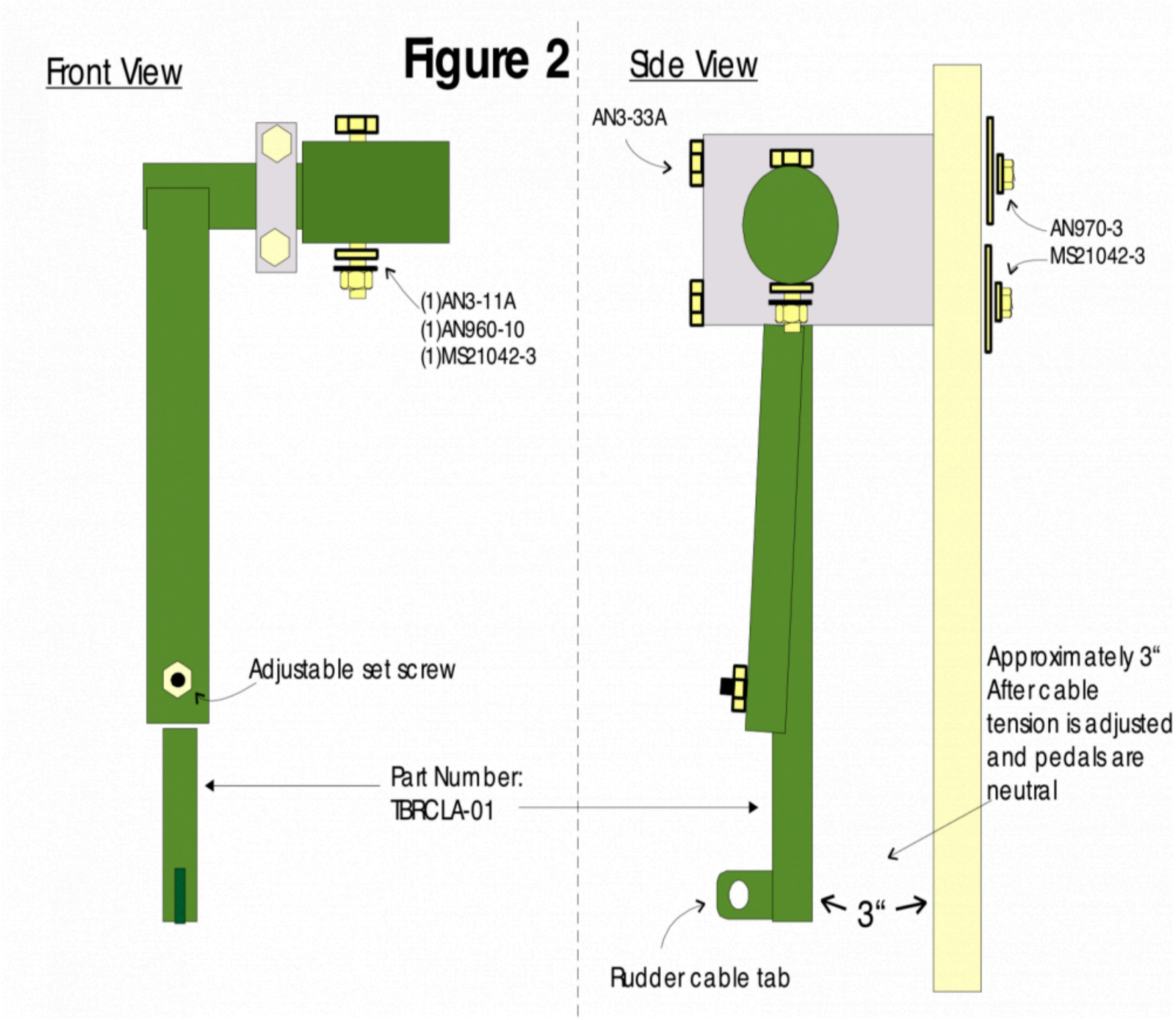


Figure D5-9. Rudder Cable Pull Arms

Prepare the canard bulkhead for attaching the bellcrank bearing bracket (Figure D5-8) The bellcrank bearing gets mounted to the box on the canard bulkhead. You will need to drill two 1/4” holes in the bellcrank bracket to mount it 1-1/8” up from the bottom of the bracket and 3/8” in from each side. This bracket should be level and flush with the bottom of the box and centered on the flat area of the box. Mark the two 1/4” mounting holes and draw a line across the top of the bracket where it meets the bulkhead. Now draw another line 5/8” above the top of the bracket and parallel with it. This line will be used to locate the two holes for the connecting rods that attach the pedal assembly to the bellcrank. Using the 2 outer holes on the Bellcrank as a guide, drill two 1” holes through this top line centered over the bracket. If you are retrofitting the system, your holes are larger but that is o.k.

Assemble the Bellcrank to the bellcrank bearing bracket and mount to the bulkhead as follows. Drill out three AN970-3 wide area washers to 5/16”. Place one wide area washer on an AN5-13A bolt and one NAS1149F563P. Insert the bolt through the top of the bellcrank then place two NAS1149F0563P washers used as spacers then through the bellcrank bearing bracket. Use one more 5/16” washer and one MS21083N05 nut to secure bolt. Mount the assembly to the bulkhead using two AN4-7A bolts, two AN970-4 washers , two AN960-416 washers , and two MS21083-N04

Set the rudder pedal assembly in place over the top of the keel. Place a 1/2” spacer between the keel and the rudder pedal assembly to get it at the right height on the canard bulkhead. Level the assembly with the top of the canard bulkhead. Insure there is sufficient clearance for the rudder cable pull arms at the floor on each side of the rudder pedal assembly. Slide the aluminum mounting blocks inboard up against the other tubing so the assembly cannot move side to side. Using the mounting blocks as a drill guide, drill through the block into the canard bulkhead. After drilling the first hole install an AN3-33A bolt through the hole and continue to do the same for the following three holes. Secure the bolts using an AN970-3 wide area washer and MS 21042-3 locknut on the front side of the canard bulkhead.Do not overtighten these bolts as it could cause binding.

Install the 5/16-24 threaded rod with the 5/16-24 jam nuts to the MW5 rod ends mounted on the pilot side rudder pedals and have them pass through the holes in the canard bulkhead. Add one 5/16-24 jam nut and one MW5 rod end to each end of the two threaded rods. Adjust the MW5 on the threaded rods so that with the rudder pedals in the neutral position (left and right in line with each other) the rudder bellcrank is parallel to the canard bulkhead. Center the threaded rod so you have equal amounts of the rod in each rod end. Lock the rod ends in place using the 5/16-24 jam nuts. When satisfied with your alignment install the rod ends to the bellcrank. Use one AN5-11A, one AN970-3 drilled out to 5/16” , two NAS1149F0563P washers and one MS21042-5 nut. Refer to Figure D5-8 for orientation of the washers.

Rudder cable installation is done in Chapter 10. The Adjustable cable set screw allows you to adjust your cable tension. You may want to readjust your MW5 rod ends to allow for full rudder travel. With the tension on the rudder cables adjusted and the rudder pedal neutral you want to have approximately 3” from the rudder cable pull arms to the canard bulkhead. Refer to Figure D5-9.

At this point you can do a dry run with the plumbing. Mount the resevoir somewhere that is easily accessible through the access panel in front of the plane. The resevoir needs to be higher than the top fittings of the brake cylinders.Remember you want to be able to service this easily so mount it in the nose compartment where it is easy to access it through the nose hatch. We prefer the Copilots side to keep the brake lines away from the oil cooler.

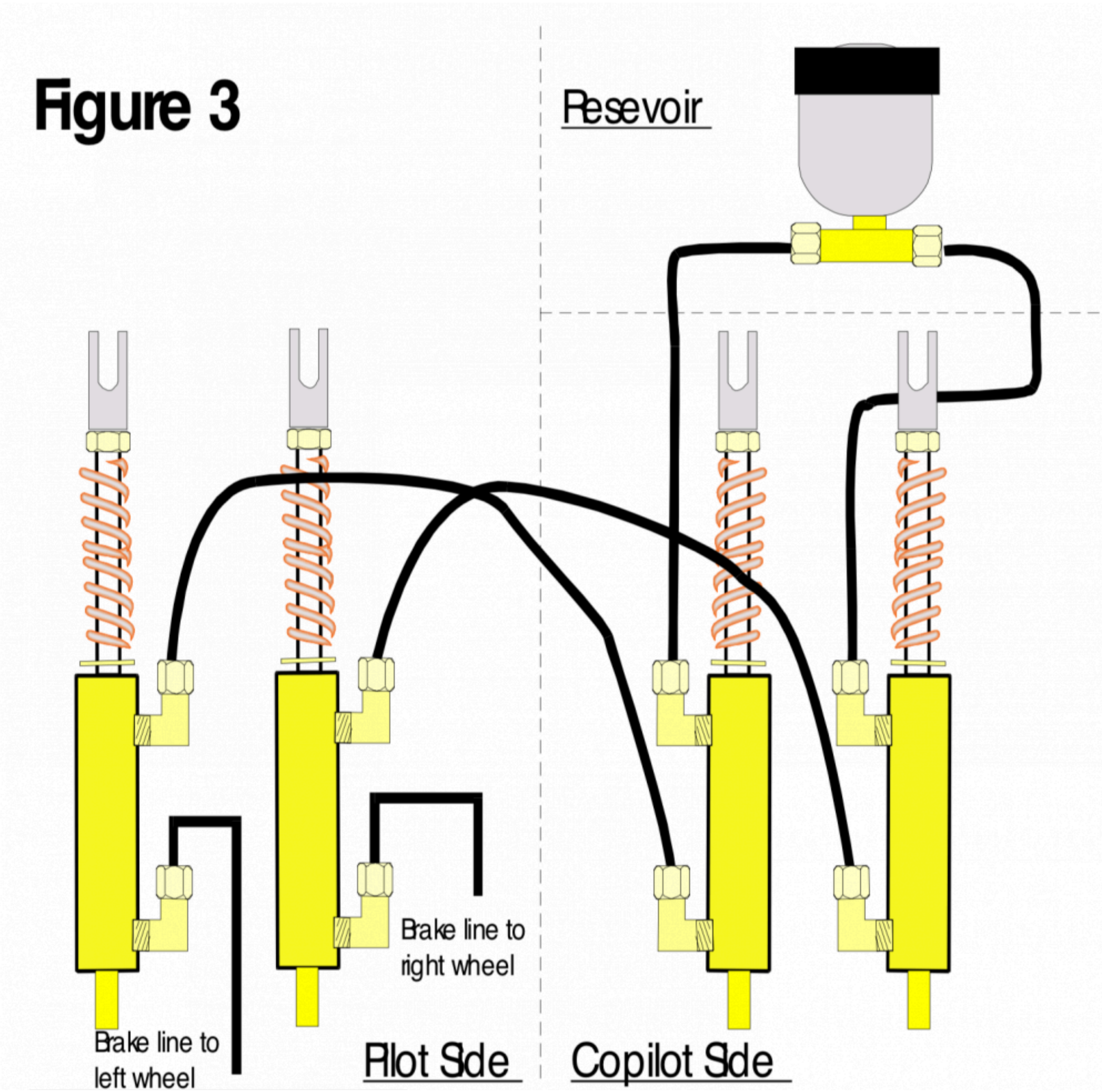
After mounting the resevoir you can plumb the system referring to Figure D5-10. You basically go from the top left pilot side cylinder to the bottom left passenger side cylinder. Then from the top right pilot side cylinder to the bottom right passenger side cylinder. From the bottoms of the pilot side cylinders you go to the wheel calipers. From the top of the passenger side cylinders you go to the reservoir. When you get all the lengths correct and can see how to secure them into place, you can tighten all the fittings.

The brake line installation is completed in chapter 8. Once the brake line installation is completed and you do not have to turn the airplane over anymore for finish work you can fill the system with 5606A red hydraulic fluid (Aeroshell Fluid-4).

Note: Non-toe brake systems use DOT-5 Silicon brake fluid only.

Use Mil Spec 5606 Aviation ‘Red” Hydraulic fluid as brake fluid for all Toe Brake Systems.

Figure 3


Resevoir
Brake line to
right wheel
Brake line to
left wheel
Pilot Side
Copilot Side

18.4. Cleveland Brake Install

	Cleveland Brake Hardware List	
Part Number	**Description**	**Qty**
MS21045-6	3/8” Nut	4
MS21045-5	5/16” Nut	4
CAS-01	1/4” Aluminum Spacer	2
PHS-01	1/8” Phenolic Spacer	2
XT-600	Axles W/Cut Down Washer	2
199-60	Cleveland Wheels and Brakes	1 Set
6808	Hub Caps	1 Set
AN5-32A	RG Only 5/16” Bolt	4
AN6-32A	RG Only 3/8” Bolt	4
AN5-34A	FG Only 5/16” Bolt	4
AN6-34A	FG Only 3/8” Bolt	4

We are using a Matco axle with the Cleveland brake installation witch requires us to use a few extra parts to assure proper spacing.

First we will need to modify the caliper attach plate to allow it to sit properly on our gear leg. You will drill two additional holes as described in Figure D5-11 to allow the caliper to be installed on the back corner of the gear leg. This will allow the brake to be installed without having to cut a lot of gear leg material off for clearance.

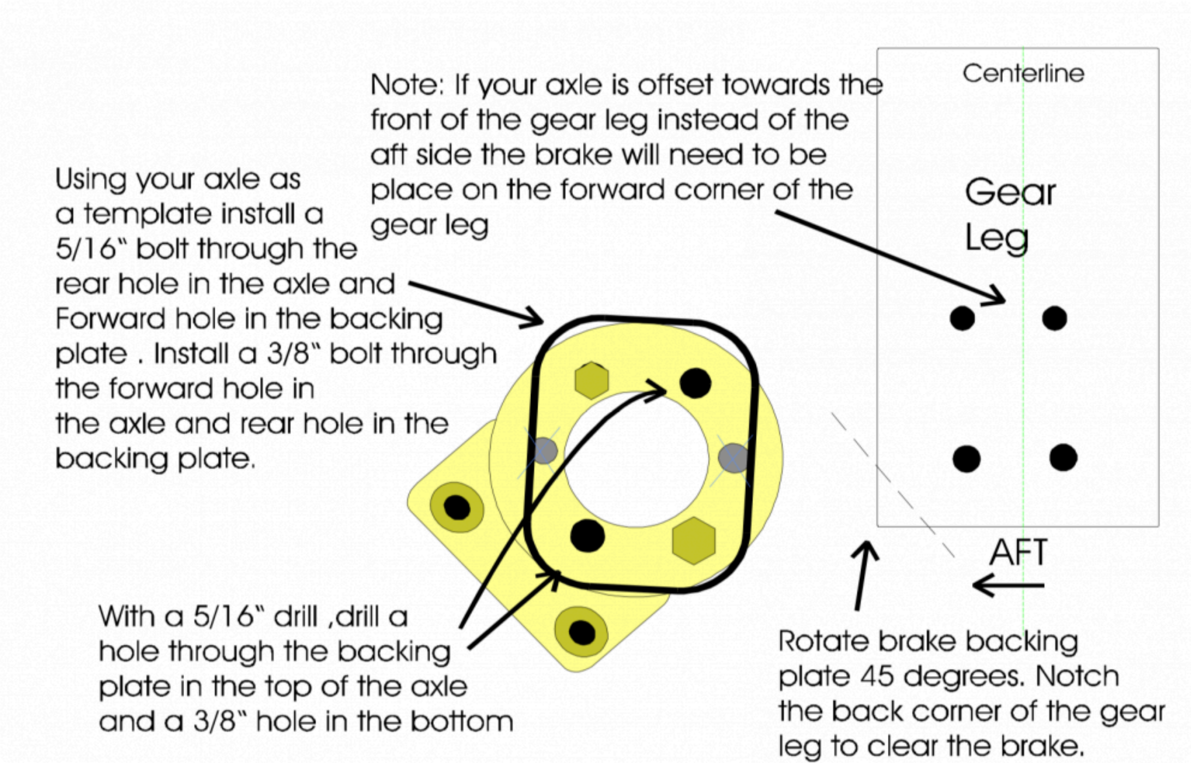


Figure D5-11. Cleveland Caliper Attach Plate

In order to get the Cleveland caliper to line up properly with the brake disk, you will need to slide the supplied 1/4" thick aluminum spacer over the axle up against the outer face of the flange.

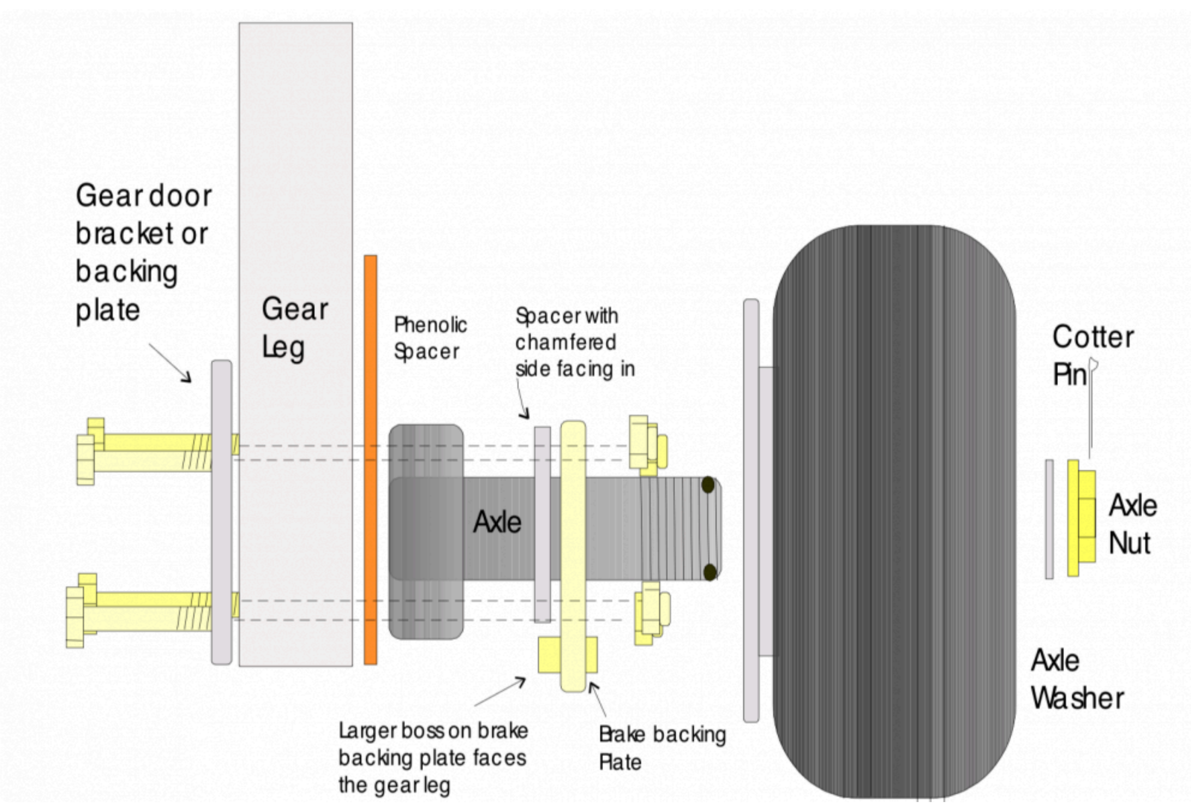


Figure D5-12. Cleveland Brake Axle Spacer and Backing Plate

Slide the caliper brake backing plate onto the axle up against the spacer. Between the gear leg and the axle you can install the 1/8” thick phenolic spacer/insulator.

Note: If this is a retrofit on an RG make sure the tire fits into the wheel well as it did before. If you find the spacer is too thick it would be better to remove some of the flange of the axle instead of the spacer/insulator.

The axle holes need to be at the bottom of the plate allowing the plate to extend up the gear leg protecting it from the heat of the disc. The caliper can then slide onto the caliper holder. The wheel then goes onto the axle followed by the spacer washer and the nut. The plate with the other side of the brake pads then gets bolted to the caliper to finish the brakes. For clearance purposes, we like to bolt this together from the inside out. This leaves the least amount of protrusion for the gear doors or wheel pants.

Dash 5 – Main Gear Leg Torsional Reinforcement

Gear Leg Preparation

The main gear comes to you with a 3/4” hole where the bushing will go. This hole should have been reamed for a good fit here at the factory so you should not have to do any fitting.

Carbon BID Gear Leg Torsional Reinforcement

___ Completely sand the legs with 36 – 40 grit sandpaper in preparation for the torsional layups.

___ Jig the gear legs, leading edge down with the tips on the table, and lightly Bondo them so they can not move around. Try to avoid getting any Bondo on the other surfaces of the gear leg.

___ For retractable gear models: Cut ten 10” wide strips of **Carbon BID** per gear leg.

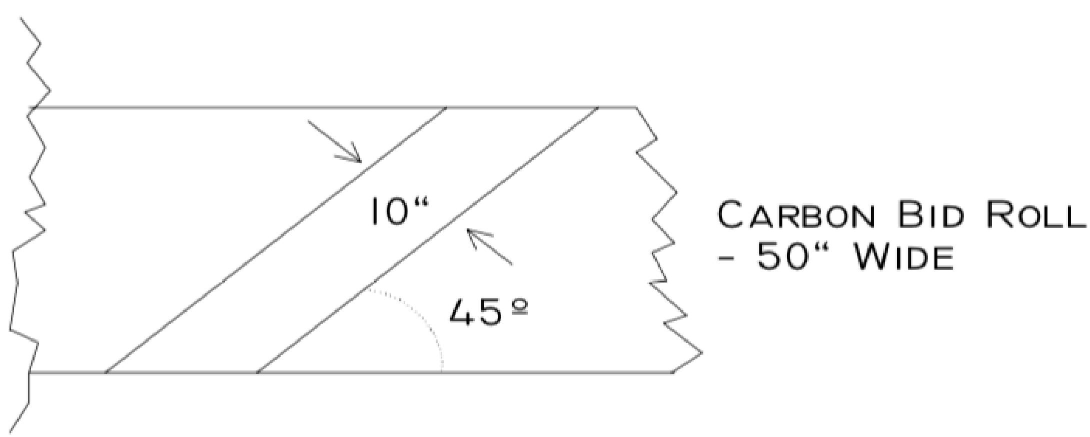


Figure D5-23. Cutting Carbon Torsional Lay-Up Strips

___ You will be installing an 1-1/4” tall steel collar on top of the gear leg so lay your torsional wraps up to this point. If you lay them further you may have to grind them back off to allow the collar to fit. You will Lay-up six 10” wide strips of **Carbon BID** at a 45 degree bias over the gear’s trailing edge, down both sides of the gear.

- The first two layers go the full length of the gear.
- For the next two layers cut one of your 10” strip in half lengthwise. Start the layup 3” above the pivot and lay it toward the bottom of the gear leg.
- The last two layer go the full length of the gear.

___ After this six-ply **Carbon BID** lay-up has cured, break the gear legs loose from the table, turn them over, and trim the rough edge. Taper it so there will be a fairly smooth transition for the last set of six plies of **Carbon BID**. Completely sand the gear legs and bond them to the table again, this time trailing edge down.

___ Lay-up the last six **Carbon BID** plies exactly like the first six. When cured, trim and sand smooth without damaging the lay-up. Reopen the bushing holes using a drill and a round file.

___ If you already have the standard **UNI** torsional wraps installed on your gear leg and you are just upgrading to the tougher **Carbon BID** wrap the layup schedule is different. Prep the gear leg as shown above and bondo it to your table using Bondo.

___ Cut four 10” wide strips of **Carbon BID** per gear leg.

The first two layers go the full length of the gear.

___ After the two-ply **Carbon BID** lay-up has cured, break the gear legs loose from the table, turn them over, and trim the rough edge. Taper it so there will be a fairly smooth transition for the last set of six plies of **Carbon BID**. Completely sand the gear legs and bond them to the table again, this time trailing edge down.

___ Lay-up the last two **Carbon BID** plies exactly like the first two. When cured, trim and sand smooth without damaging the lay-up. Reopen the bushing holes using a drill and a round file.

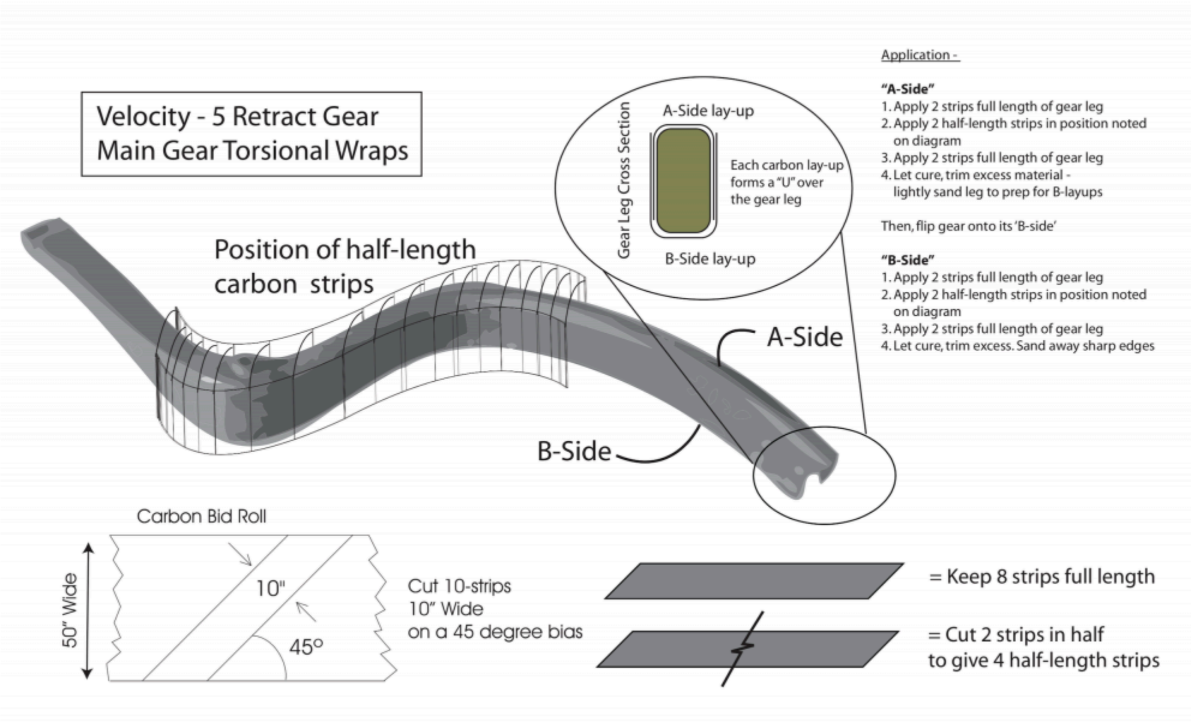


Figure D5-24. Retractable Gear Torsional Wraps

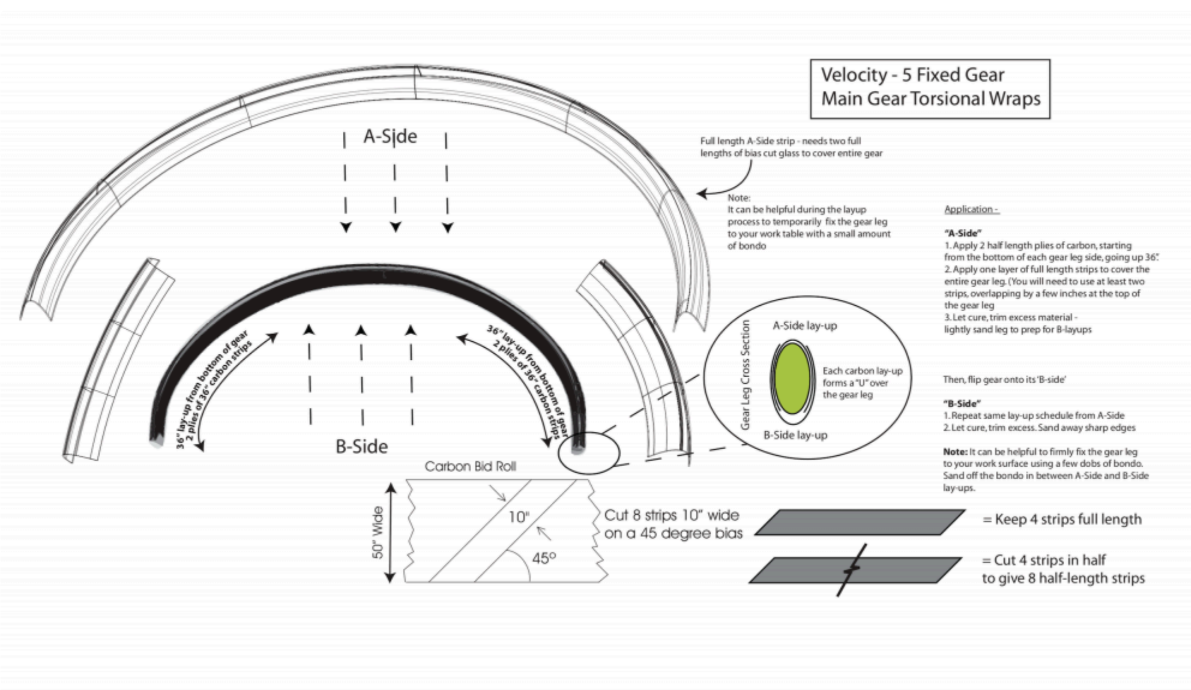


Figure D5-25. Fixed Gear Torsional Wraps

18.5. Installation of the FG Shimmy Dampener

Since the installation of the system onto the fork assembly has already been done, these instructions will be for the installation of the nose gear bushing bracket and the stop bracket.

The stop bracket is installed on the aft side of the welded on washer at the bottom of the gear leg. You can see from the picture how it is mounted on top of the washer right up against it and centered as best you can directly aft. It is easiest to drill from the bottom up since the gear is in the way drilling on the top side. In order to do this, you will use your bracket as a drill guide and clamp it to the underside of the washer (centered aft right up against the washer) then drill with a #21 drill bit (5/32" will work as well) through the bracket up through the washer. If you have to, slide another drill bit into the drilled hole then move the clamp so you can drill the other hole. Once drilled, remove the bracket and drill the holes out to 3/16" or if you have numbered bits, you can drill slightly oversized. Countersink those holes on the underside of that washer, with a 100 degree countersink. Some larger drill bits are close to 100 degrees so you can compare the screws to the bit and use that if you don't have the countersink. You just need to make sure the head doesn't interfere with the fork. Go ahead and attach the bracket on the top side with the screws coming up from the bottom. Later, you will locktite those screws in place. Slide your fork up in place and check your stops to make sure you are not rubbing on anything through the motion and that the pins in the fork match up with the stop.

The nose gear bushing bracket is installed in the bottom of the gear leg and meshes with the dampener. Make sure the dampener pin is in the middle of it's movement (should be centered front to back). Basically you want the bushing bracket to almost touch the dampener to get full engagement of the shear pin. You can always grind the bottom of the bushing bracket later if you get it too close to the dampener. Once you establish how much the bushing bracket sticks out of the gear, remove the dampener and the bushing bracket. Using a 1/8" drill bit, drill a hole in the side of the gear leg near the bottom of the threaded area of the gear. Only go through one side at this time. Depending on how close to the bottom of the gear you are, you may be below the nut once installed so you the dowel pin that holds this bracket in can be full length instead of cut down to fit inside the confines of the threads (about 1 1/8"). In any case, slide your bracket back in place with the correct orientation (front to back on the slot) and protruding the correct amount out of the gear, then drill through hole you already have on through the bracket and out the other side of the gear. You can then open that hole up to 3/16" to match the dowel pin that you will be installing. If you open up the holes in the bracket and the gear separately, if will make the fit of the dowel tighter than if you just drill through.

them all at once. You want a tight fit on the pin since that makes the bracket nice and tight so you don't have slop right to left with the dampener. If you make this pin just wide enough to not interfere with the threads, you can locktite the assembly in place since the nut will just thread right over the pin installation. If you leave it full length, you will have to wait to install it until you have the fork, washers, nut, etc. installed on the gear. I give you a choice here since either way will work equally as well.

Adjustment

The first thing to do after assembly is to tighten the large nut (the one that holds the fork on) so that its only function is to give some friction while taxiing on sloped taxi ways. If you set it real loose, it will have more tendency to follow the crown than if you add some tension. Since this is no longer your shimmy dampener, you can set it for best steering. This dampener comes to you with full span dampening. There are adjustments to limit this dampening to a narrower range but we don’t need that so leave that alone. The only adjustment you really need is with the large dial. We have tried different settings up to full dampening and I would set in on full dampening (clockwise with the big knob to the stop) first then back it off as much as 180 degrees (half turn back) as a min. The tighter you make it you can tell that it limits the speed of the turn of the fork. That is all good since you don’t need to be jamming one brake fast and hard. We have locked one brake up to turn the aircraft and we just have enough motion to do that as long as you were good with your stop and bushing brackets.

Wheel pants

On the XL, the wheel pant is large enough to cover the mechanism but on the small one you will have to relieve some wheel pant to clear the dampener. I recommend you set the dampener before you install the wheel pant but you can cut a hole in the bottom of the pant so you can access the dampener. On the std FG you will be able to access the dampener unless you modify the pant to cover it.

19. Velocity Flow Chart

This flow chart is provided to help you , the builder , navigate through the construction manual. This is the same basic order we use to build airplanes at the Velocity Service Center. Pay attention to the column that tells you which style Velocity (FG / RG / ALL) the task is meant for. Make sure you first read and understand chapter one of the manual. This will introduce you to the materials used during construction and the tips to using the manual.

Make sure you clip the corners of your manuals pages off after you have completed all tasks on that page as well as check the topic off of the flow chart sheet. When your airplane is completed every single page should have its corner clipped and all tasks on the chart should also be checked. This chart is for reference only and will be modified as we get feedback from you.

	RG/ FG/ ALL	Action	Chapter	Check Off
1	All	Read chapter one of your manual and review the construction	DVD’s	
2	All	Cut out Doghouse	6	
3	All	Cut out and install premolded NACA scoops	11	
4	All	Install Overhead plenum NACA (do not install plenum until flipping airplane)		
5	All	Fit keel in airplane and then remove to install control system	6	
6	All	Install wood hardpoints for control system in keel	6	
7	All	Cut out and layup inspection covers in keel	6	
8	All	Install nut plates to hold inspection covers	6	
9	FG	Cutout Speed brake on bottom of airplane	6	
10	FG	Install hard points on speed brake and finish edges of brake	6	
11	FG	Cover Speed brake hole and hinges	6	
12	RG	Cut out nose gear door hinges	7	
13	All	Install top Triax pad on firewall for Lycoming engine mount or the lower pads for a continental engine	6	
14	RG	Complete fiberglass portion of nose gear door installation	7	
15	All	Install Heater flapper valve and aluminum outlet tubes in oil cooler exit	12	
16	All	Cut out oil cooer inlet and outlet ducts	12	
17	All	Install front oil cooler ducts	12	
18	All	Install rear aileron control bracket to keel rear section	6	
19	All	Install aileron torque tube and control stick in keel	6	
20	All	Mid bearing support installed in keel (XL)	6	

21	RG	Install main gear and nose gear cylinder	7	
22	RG	Install AN fittings into main and nose gear cylinders (tape over the ends)	7	
23	RG	Install flexible hydraulic lines between nose and main gear cylinders	7	
24	All	Fit and install battery tray	4	
25	All	Fit and install Landing Light Assembly	4	
26	All	Structural Adhesive front of keel in place	6	
27	All	Install front keel stiffening layups	6	
28	FG	Install speed brake actuator	6	
29	RG	Install nose gear bushing plates	7	
30	All	Glass edges of canard cutout to seal it		
31	All	Fit and fair in nose access cover	6	
32	RG	Install nose gear gas spring and shock assembly	7	
33	RG	Install nose gear door cylinder and assembly	7	
34	RG	Install RG hydraulic power pack	7	
35	RG	Install MG pulley and cable assembly	7	
36	All	Install rudder pedals	6	
37	All	Fit instrument panel into airplane (Once the panel has been fitted it can have the instrument holes cut out be finished and sent out to be wired).	6	
38	All	Install seat hardpoints	6	
39	All	Use Velocipoxy and micro to fair in back of windows	5	
40	All	Construct sump tank	9	
41	All	Glass side of canard bulkhead opposite the flange	4	
42	RG	Install sequence valve assembly	7	
43	RG	Install Dump Valve	7	
44	RG	Install nose gear guides	7	
45	RG	Install hydraulic power pack	7	
46	RG	Install hard lines for RG system	7	
47	All	Install Center Spar	6	
48	All	Install all Triax reinforcements on the forward side of the firewall between the center spar and the gear bulkhead.	6	
49	FG	Install main gear bushings (bushing in firewall and gear bulkhead are just temporarily installed for transport in the Fastbuild kit)	7	
50	FG	Triax over main gear bushings	7	
51	RG	Place airplane on jacks and remove main gear		
52	RG	Cut out fuselage to allow main gear retract and complete transverse bulkhead	7	

		installation		
53	RG	Install main gear bushings	7	
54	RG	Triax over main gear bushings	7	
55		Permanently install steel bushings in gear legs and make aluminum spacers	7	
56	All	Install straws on MG for brake lines	8	
57		Install canard attachment reinforcements (triax)	6	
58	All	Install Canard bushings	6	
59	All	Complete all canard Triax reinforcements	6	
60	All	Install hinges on elevators	3	
61	All	Install hinge arms in canard	3	
62	All	Attach canard tips	11	
63	All	Install concentric torque tube	3	
64	All	Install counterweights	3	
65	All	Check balance of elevators	3	
66	All	Install elevator pitch trim actuator	10	
67	RG	Install main gear	7	
68	All	Install main wings prep for strake install (you can use plain nuts to install the main wings and save your locknuts)	9	
69	All	Temporarily install doors (hinges do not have to be completed yet)	9	
70	All	Fit lower strake	9	
71	All	Cut out baggage access opening	9	
72	All	Install lower strake bottom (If you are doing one strake at a time you may glass the bottom to the door as well. If you are doing both at the same time do not glass to door so you can remove the doors)	9	
73	All	Fit top strake	9	
74	All	After bottom strake is attached permanently you can remove wings to provide more space	9	
75	All	Glass dyvinicel sheet to make fuel tank baffles	9	
76	RG	Cut out opening for gear and wheel well	9	
77	RG	Fit gear and wheel well	9	
78	All	Cut out baffles a little larger than templates	9	
79	RG	Glass top flange on wheel well	9	
80	All	Fit baffle bottoms to bottom strake	9	
81	RG	Fit baffle tops to top strake	9	
82	All	Reposition all baffles in bottom strake and tack in place	9	

83	All	Glass bulkheads and baffles to lower strake	9	
84	All	Install hardpoint for fuel vent and main fuel line	9	
85	All	Install sight tubes	12	
86	All	Install fuel caps in strake top	9	
87	All	Plug fuel lines and remove senders and coat tank to seal with 2 coats of Jeffco or EZ-poxy	9	
88	All	Coat strake top with Jeffco or EZ-poxy in fuel tank area	9	
89	All	Cut wing access bolt hole	9	
90	All	Practice fuel strake top installation with partner	9	
91	All	Install strake top	9	
92	All	Cut wing from strake	9	
93	All	Remove wings	9	
94	All	Cut leading edge from strake that will go on the door (or is already attached to the door)	9	
95	All	Install door and glass leading edge of strake to it	9	
96	All	Install outboard end stake reinforcement	9	
97	All	Finish glassing on exterior of fuel tank bottom seams and back of spar to strake top and bottom	9	
98	All	Pressure check each main fuel tank	12	
99	All	Complete finish work between strake top and fuselage and leading edge of strake	9	
100	All	Reinstall wings		
101	All	Complete finish work between strake top and wing (recut line between wing and strake)	9	
102	All	Remove wings		
103	All	Flip airplane		
104	All	Finish glassing on exterior of fuel tank top seams	9	
105	All	Complete finish work between strake bottom and wing (recut line between wing and strake)	9	
106	All	Complete glass work between strake top and inside of baggage well	9	
107	All	Install overhead fresh air plenum	9	
108	RG	Fit main gear doors and install attach brackets onto gear legs	7	
109	All	Fill sand and prep gear legs for primer (RG's may be easier to remove legs from plane for this)	8	
110	All	Complete all finish work on bottom of airplane including all bolts that protrude through the floor and around the oil cooler exit		
111	All	When completed with all bottom finish work the bottom of the airplane can be		

		primed to prep it for paint		
112	All	Remove wings		
113	All	Flip airplane back onto it’s gear		
114	All	Install sump tank	9	
115	All	Install fuel plumbing between main tanks and sump tank and sump tank and firewall fitting (RG’s make sure you cycle your gear to make sure your gear clears your fuel lines)	9	
116	All	Install Fiberfrax and stainless steel on firewall	12	
117	All	Install oil lines to forward oil cooler (make sure to cover them at the firewall until the flexible oil lines are installed)	12	
118	All	Install rudder cable nylaflow in airplane from pedals to the firewall	6	
119	All	Bond in rear keel (whale tail) section and install rear aileron bellcrank in keel	6	
120	All	Install Aileron push/pull cables through firewall	10	
121	All	Install Aileron torque tube	10	
122	All	Install Aileron bellcrank and bearing brackets in wing root	10	
123	All	Install Rudder hinges	2	
124	All	Install rudder horn	2	
125	All	Install rudder return spring	2	
126	All	Install Aileron hinges	2	
127	All	Install rudder cable in airplane and wing nylaflow	10	
128	All	Install rudder pulley and cable adjuster between firewall and wing root	10	
129	All	Install winglet bottom	2	
130	All	Fit top and bottom cowling and flange	11	
131	All	Install Door hinges	5	
132	All	Install secondary lock in door	5	
133	All	Install key lock	5	
134	All	Fit door trim panels	15	
135	All	Install door gas springs	5	
136	All	Assemble seat backs to bases with seat hinges	6	
137	All	Install seat belt hardpoints	6	
138	All	Remove wings		
139	All	You will now progress into engine installation. Before installing the engine it is easier to finish as much component installation onto the firewall as you can.		
140	All	Fit fiberfrax and stainless to firewall and install	12	
141	All	Install front oil cooler lines and bracket on firewall	12	

142	All	Install secondary oil cooer	12	
143	All	Install electric fuel pump	12	
144	All	Plumb aluminum lines between firewall bulkhead fitting and fuel pump	12	
145	All	If using a prewired harness you can begin routing the main harness and installing the terminal blocks on the firewall and in the rear of the airplane	Harness instruction	
146	All	Mount the engine mount on the engine	12	
147	All	Mount the engine on the firewall	12	
148	All	Fabricate oil access door	11	
149	All	Install oil and fuel line plumbing from the airframe to the engine	12	
150	All	Install engine senders on firewall and wire	12	
151	All	Plumb flexible lines between engine and senders	12	
152	All	Jack airplane up and fit brakes to gear legs	8	
153	FG	Create axle pad on gear leg	8	
154	All	Check for toe in and camber. Shim axle to correct	8	
155	FG	Fit and install gear fairing cuffs at fuselage	11	
156	FG	Fit and install main and nose wheel pant	11	
157	FG	Fit nose strut fairing	11	
158	All	Installed prewired panel		
159	All	Connect panel wiring to premade harness	Harness instruction	
160	All	Install Throttle , Mixture and Prop control cables	12	
161	All	Install pitot tube	13	
162	All	Install Static port	13	
163	All	Install vacuum system and static system	13	
164	All	Install engine cooling plenum and runners to NACA scoops	12	
165	All	Cut exhaust exit in cowling	12	
166	All	Trim exhaust tubes and permanently install on engine	12	
167	All	Install prop as per manufacturers recommendations and trim or modify rear cowling as necessary to fair in	12	
168	All	Install canard	14	
169	All	Complete control stick to concentric torque tube installation	10	